Augmentation of the BMP Pathway in the Osteoblast Lineage and in a Critical Defect Osteosynthesis Model

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INTRODUCTION: BMP-2 and BMP-7 have been in clinical use for nearly a decade with expanding indications. However, they carry significant comorbidity and require supraphysiologic doses. The next generation of biologics will have better efficacy with less comorbidity at lower doses. Smad6 is an intracellular regulatory protein that preferentially inhibits the BMP pathway that commits mesenchymal stem cells to an osteoblast lineage. We hypothesized that a transgenic Smad6 knock-out (KO) mouse would exhibit increased osteoblastic gene transcription in neonate calvarial osteoblasts over the wild type (WT), and demonstrate an augmented response to a recently described critical defect fracture model to establish Smad6 as a therapeutic target.

METHODS: C57/Bl6 Smad6 KO and WT mouse calvaria were harvested at five days old and homogenates cultured in osteoblast-specific media. RNA was extracted, converted and osteogenic markers underwent quantitative PCR. Runx2 cDNA was downregulated and osteocalcin cDNA was upregulated on Day 8 in cultured Smad6 KO versus WT calvarial osteoblasts, consistent with increased BMP signalling and osteogenic differentiation. Day 5 RNA chip microarray data were analyzed. Example genes include Runx2, expressed in the KO, absent in the WT; serotonin was absent in the KO, expressed in the WT. C57/Bl6 Smad6 KO mice were outbred with CD1 mice to generate animals with a stable life cycle. Three age-matched littermate KO and WT pairs received left open femur diaphyseal plating of a 1.75mm critical defect. All KO animals and two WT animals bridged the osteotomy site. Volumetric analysis showed no statistically significant critical defect by four weeks and showed bridging osteoid at six weeks. Histologic criteria for union were the presence of bridging cortical bone, osteoid or cartilage nests at the femoral osteotomy site. All KO animals and two WT animals bridged the critical defect by four weeks and showed bridging osteoid at six weeks. Volumetric analysis showed no statistically significant difference in the calcified fracture callus between the KO and WT.

DISCUSSION AND CONCLUSION: The absence of Smad6 upregulates osteogenic gene expression. The absence of serotonin in Smad6 KO calvarial osteoblasts suggests Smad6 may modulate serotonin-mediated regulation of bone formation. No difference in the development or character of the controlled fracture site was found in vivo. This discrepancy may be explained by the changes in genetic background after outbreeding with CD1 mice to stabilize the multi-system phenotype of the global Smad6 KO. It may also be related to the specific molecular mechanisms of intramembranous or primary bone healing present in our fracture model. Further studies are underway to more closely approximate endochondral healing, to seek qualitative and quantitative differences in a more BMP-controlled healing mode.

Donor Site Morbidity with Reamer-Irrigator-Aspirator (RIA) Use for Autogenous Bone Graft Harvesting

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INTRODUCTION: Donor site morbidity, complication rate and possible risk factors using the reamer-irrigator-aspirator (RIA) system for intramedullary autogenous bone graft harvesting were investigated. Laboratory studies have shown no significant impairment in biomechanical properties after RIA use. Quantitative biochemical analyses of the harvested graft revealed higher growth factor concentrations and osteogenic cell differentiation compared to standard donor sites. Low complication rates and risk factor guidelines for patient selection could make this a preferred technique in nonunion, fusion and evolving complex reconstructive surgery requiring nonstructural bone grafting.

METHODS: All consecutive RIA patients of a single university affiliated level-1 trauma center between 1/2005 and 12/2010 were assessed regarding the intra- and postoperative complication rate in a retrospective chart and radiographic review study. Variables of interest were date and type of operative revision, weight bearing restrictions, radiographic donor site inner/outter core diameter in correlation with the amount of harvested bone graft and reamer head size, significant co-morbidities and patient demographic data. The number, time intervals for repeat RIA, indication, site/approach and technique were analyzed.

RESULTS: During a 72-month review period, 204 RIA procedures in 184 patients were performed in the most recent 48 months. Mean age at surgery was 50±14 years (16-86) including 77 females (42%) and 107 males (58%) with a mean body mass index (BMI) of 30.1±8.3 kg/m² (17.5-51.6) and 30.7±6.2 kg/m² (20.4-50.6). RIA-indication was bone graft harvesting in 98.6% and intramedullary irrigation and debridement in 1.4%. Donor sites were antegrade femur (trochanteric entry) 175 (85.8%), retrograde four (1.9%), antegrade tibia in seven (3.4%) and retrograde 18 (9.3%). Sixteen
patients had a RIA procedure twice, two patients three times, using different donor bones each time. Same bone harvesting was done in four cases. Mean amount of bone harvested was 47±22ml (20-85ml). The complication rate was 1.9% (n=4) including two cases with trauma associated fracture at the donor site 17 and 41 days postoperatively. Revision included retrograde femoral nailing in two cases (supracondylar femur fractures) six and 41 days postoperatively after antegrade femoral RIA, one trochanteric entry femoral nail 17 days postoperatively (subtrochanteric fracture) after retrograde femoral harvesting and one prophylactic stabilization with trochanteric entry femoral nail for intraoperative posterior femoral cortex penetration without fracture. No tibia fractures, revisions for infection, bleeding/hematoma or device failure were noted. Weight bearing restrictions were limited to the revised cases only.

DISCUSSION AND CONCLUSION: Preoperative patient counseling and risk assessment as well as intraoperative diligence and fluoroscopic monitoring are paramount to decrease the risk of technical errors and associated complications. The RIA system is a reliable, safe and efficient technique with low donor site morbidity, which is successfully implemented for harvesting large volumes of nonstructural autogenous bone graft. The clinical relevance of potentially superior osteogenic properties is subject for further investigation.

PAPER NO. 18

Cell Viability and Osteogenic Potential of Bone Graft Obtained Via Iliac Crest Versus Reamer Irrigator Aspirator

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INTRODUCTION: The iliac crest has long been the gold standard for autogenous bone graft, but issues related to patient morbidity have led surgeons to seek alternatives. Reaming debris obtained with standard intramedullary reamers has been shown to contain viable bone cells and has recently been identified as a source of multipotent stem cells with osteogenic capability. With the advent of the reamer-irrigator-aspirator (RIA) system, a more efficient method of obtaining intramedullary bone graft has become possible. Several growth factors and mesenchymal stem cells have been identified in the aspirate. Until now there has been no definitive evidence that bone graft obtained using RIA, on a cellular level, is viable or capable of differentiating into osteogenic tissue and it has not been compared it to the iliac crest. The purpose of this study was to compare cell viability and osteogenic potential between bone graft obtained from the iliac crest and using RIA.

METHODS: Osseous samples were obtained from patients undergoing autogenous bone graft harvesting using either RIA (n=26) (all femurs) or ICBG (n=10). Cell viability was assessed using trypan blue. Flow cytometry using cell surface markers CD 45, 34, 90 and 105 were used to identify the degree of differentiation of the cellular aspirate before and after culture. The tissue was cultured in basic growth media for 14 days and then introduced to inductive media for 14 days. Supernatant was taken at three-day intervals starting at day four until day 28 when the cultured cells reached confluency. Osteocalcin production was measured in the supernatant using enzyme linked immunoassay (ELISA). Alizarin red staining for calcium deposition and alkaline phosphatase was also done after culture to further evaluate for osteogenesis.

RESULTS: Both RIA and iliac crest tissue yielded cellular viabilities of at least 95%. Cell surface markers demonstrated growth of bone marrow derived mesenchymal stem cells (MSCs) during tissue culture by staining positive to CD 45 and CD 105 and negative for CD 45 and CD 34. Differentiation towards osteogenic lineage was shown by production of osteocalcin, which significantly increased after induction in ICBG group by 525.9% and in the RIA group by 458.6%. Student t-test demonstrated a significant increase in osteocalcin concentration between pre and post culture within the IC and RIA groups (p<0.001 for both). However, there was no statistical difference between IC and RIA groups (p=0.55). All samples stained positive for alizarin red to signify calcium and alkaline phosphatase deposition within the matrix, which further shows differentiation towards osteogenic lineage.

DISCUSSION AND CONCLUSION: Both RIA and iliac crest bone graft harvesting yielded a high concentration of viable cells that differentiated into the osteogenic lineage indicating that both methods are valid. Clinical studies are needed to further compare the clinical validity of the RIA method to iliac crest harvesting.

PAPER NO. 19

BMP-2 mRNA Expression after Endothelial Progenitor Cell Therapy for Fracture Healing

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INTRODUCTION: Endothelial progenitor cells (EPCs) represent a population of novel precursor cells with known ability to participate in angiogenesis. Our previous studies have shown that local EPC therapy significantly increased angiogenesis and osteogenesis to promote fracture healing, and restored the biomechanical properties of the fractured bone. However, the cellular and molecular mechanisms that govern angiogenesis and osteogenesis, and role that the EPC plays during fracture healing, remain largely unknown. The purpose of this study was to better understand how EPCs enhance osteogenesis and angiogenesis by determining if there is an increased expression of BMP-2 after EPC local therapy for a rat segmental bone defect.

METHODS: The EPCs were isolated from bone marrow and cultured for seven to 10 days for treatment in the rat segmental bone defect. A total of 56 rats were studied. The treatment group received 1x10^7 EPC locally at the bone defect and control animals received saline only for one, two, three and 10 weeks. Animals were sacrificed at the end of the treatment period, and specimens from the fracture gap area were collected and pulverized and total mRNA was extracted. BMP-2 mRNA was measured by reverse-transcriptase polymerase chain reaction (RT-PCR) and quantified by VisionWorksLS. All measurements were performed in triplicate.

RESULTS: The expression of BMP-2 mRNA was different in rats of the treatment group compared to the expression in rats of the control group at week one (EPC: 0.59 ± 0.10, Control: 0.31 ± 0.08, p=0.05), week two (EPC: 0.40 ± 0.06, Control: 0.23 ± 0.04, p=0.04), week three (EPC: 0.33 ± 0.06, Control: 0.18 ± 0.03, p=0.04), week 10 (EPC: 0.31 ± 0.06, Control: 0.21 ± 0.04, p=0.15). The highest mean expression of BMP-2 in the treatment rats was observed at one week, and the loWVlue at three weeks in the control group.

DISCUSSION AND CONCLUSION: These findings demonstrate that EPCs promote fracture healing by increasing BMP levels and...
thus stimulating angiogenesis and osteogenesis, a process that is essential for early callus formation and bone regeneration.

PAPER NO. 20
◆ Risk of Nonunion Repair Failure in the Elderly
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INTRODUCTION: Fracture care in the elderly presents challenges related to poor bone quality and healing potential. When treating nonunions in the elderly, it would follow that iliac crest bone graft is of less quality and results in more nonunion repair failures than the same in the young. Our study analyzes the predictors of nonunion repair failure in the elderly, and compares them to younger “controls” who also were treated for nonunion.

METHODS: Retrospective review of a single institution database produced 51 patients older than 60 years at the time of initial nonunion treatment with follow up to radiographic and clinical healing. A matched cohort of patients less than 60 years old with nonunions was obtained from the same database. Demographic, injury, treatment and follow-up information were collected from the medical record. Failure was defined as the need for more than one nonunion repair operation to achieve union.

RESULTS: Forty-three (84%) of 51 elderly patients had successful nonunion treatment with one surgical repair. All patients went on to radiographic and clinical union. Forty-four (75%) of 59 younger patients had a successful, single surgery. Patient demographics and comorbidities were not associated with risk of failure. Multiple biologic and mechanical treatments were employed, none of which could be associated with higher failure rates. The rate of failure associated with use of iliac crest bone graft without other biologic supplementation was the same in both groups (20%). The relative risks of failure of initial nonunion repair in the elderly for open fractures (three of eight), atrophic nonunions (five of 21) and operatively treated fractures (seven of 36) were 3.23, 2.38 and 2.92, respectively.

DISCUSSION AND CONCLUSION: Fracture nonunion can be successfully treated in the elderly patient. Despite concerns about healing potential and biologic activity of autograft in the elderly, failure rate of nonunion repair with iliac crest bone graft was the same in the elderly and non-elderly cohorts. Predictors of first time failure of nonunion repair in the elderly are open fracture, atrophy of nonunion and operatively treated fracture. Multiple biologic and mechanical treatments can be employed, but no differences in their success were demonstrated in our heterogeneous population.

PAPER NO. 21
◆ “Same Day” Ex-Vivo Regional Gene Therapy: A Novel Strategy to Enhance Bone Repair
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INTRODUCTION: We have previously demonstrated that the ex vivo regional gene therapy using BMP-2 producing bone marrow cells can heal a critical sized femoral defect in animals. However, the conventional ex vivo gene therapy involves culture expansion of the bone marrow cells, which is expensive, time-consuming, carries a risk of infection and can alter the biological characteristics of stem cells. The purpose of this study was to develop a novel “same day” gene therapy strategy in which the cell harvest, viral transduction and implantation will be performed on the same day without culture expansion of the bone marrow cells.

METHODS: A rat segmental femoral defect (8mm) model was used in this study. In the “same day” strategy the buffy coat cells were harvested from the rat bone marrow and transduced with a lentiviral vector expressing BMP-2 for one hour. In order to ensure robust BMP-2 production following short duration viral transduction (one hour), we modified the standard lentiviral vector to a two step transcriptional amplification vector system (TSTA). The process of cell harvest and viral transduction was easily completed in less than three hours. The quality of bone formed in the rat femoral defect was assessed using plain radiographs, microCT, biomechanical testing, histology and histomorphometric analysis.

RESULTS: The transduced “same day” cells produced similar amount of BMP-2 as the cultured bone marrow cells in vitro. All the femoral defects treated with “same day” gene therapy demonstrated complete healing (radiographic and histologic) at eight weeks. In contrast to the femoral defects treated with conventional ex vivo gene therapy, the “same day” strategy induced earlier radiographic bone healing and a significantly higher bone volume (plain radiograph, microCT) in the defects.

DISCUSSION AND CONCLUSION: The “same day” strategy represents a significant advance in the field of ex vivo regional gene therapy because it offers a solution to the limitations associated with the culture expansion process required in the traditional ex vivo approach. The “same day” strategy should be cost-effective when adapted for human use.
the placebo. Compliance was moderate with 6.2 hours average daily use. Overall, 16 in the active and 15 in the inactive group experienced a primary event (risk ratio, 1.02; 95% confidence interval, 0.95 to 1.10; p=0.72). By per protocol analysis, there were six (12.2%) primary events in the active, compliant group and 26 (15.1%) in the combined placebo and active, non-compliant group (risk ratio, 0.97; 95% CI, 0.86-1.10; p=0.60). No between group differences were found for surgical intervention for any reason, radiologic union or functional measures. DISCUSSION AND CONCLUSION: Adjuvant PEMF stimulation does not prevent secondary surgical interventions for delayed/non-union, nor improve radiologic union or patient-reported functional outcomes in acute tibia shaft fractures.

PAPER NO. 23

**Can We Trust Intraoperative Culture Results in Nonunions?**

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INTRODUCTION: Orthopaedic infections can become chronic when bacteria adopt a biofilm mode-of-growth, which is resistant to both host defense mechanisms and antibiotics. Direct microscopy has shown that biofilms can inhabit the surface of internal fixation devices. As they grow poorly on agar media, the bacteria in biofilms are difficult to identify using standard culture techniques. The purpose of this study was to determine the validity of routine intraoperative cultures in detecting the true presence of biofilm bacteria in delayed osseous healing.

METHODS: Thirty-four patients with nonunions were scheduled for surgery and enrolled in this ongoing, double-blinded, prospective study funded by the Orthopaedic Trauma Association (OTA). Intraoperative samples of tissue and membrane were collected from removed biomaterials. The nonunion sites and hardware were tested for bacterial contamination and biofilms utilizing standard cultures, DNA-based technology (Ibis), and RNA-based fluorescent in situ hybridization (FISH). Samples were visualized using confocal microscopy to visualize FISH probes specific to bacteria found during culture and Ibis analysis.

RESULTS: The mean age of the patients was 48.41 years (range 17-71). The anatomical sites of nonunions were: seven femoral shaft, two distal femur, two proximal femur, one femoral neck, one femoral neck and shaft, two supracondylar humerus, one humeral shaft, 14 tibial shaft, three tibial pilon and one tibial plateau. Thirteen patients had open fractures. Of the 34 patients with nonunions, 23 (67%) had negative cultures and Ibis tests were utilized to make pairwise comparisons between groups.

DISCUSSION AND CONCLUSION: Our preliminary data indicate that culture results taken at the site of nonunion should be read with a degree of skepticism since negative cultures often do not detect bacteria in biofilms. The failure to identify the bacterial presence may result in continued nonunion and additional surgery.

PAPER NO. 24

**Does Removing Local Soft Callus Influence Early Fracture Healing?**

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INTRODUCTION: Removing soft callus at the time when osteosynthesis is performed in the first one to two weeks after injury in humans may interfere with early fracture healing. While it is necessary to remove the biological material from bone ends to adequately reduce the fracture, it is unclear what effect this procedure has on fracture repair. We hypothesized that the removal of initial local fibrocartilage callus from a transverse femur fracture in a rat will be detrimental to early fracture healing.

METHODS: An open, transverse femur fracture was created in 30 male Sprague-Dawley rats (320-360g) and stabilized with a 1.1 mm intramedullary Kirschner wire (K-wire). Twenty-one days later, the fracture site was surgically exposed, K-wire retracted, and a scalpel was passed through the fracture site. Group A (n=10) served as the control and the callus was not removed. In Group B (n=10), the callus was removed and discarded, and in group C (n=10), the callus was removed and within five minutes replaced at the fracture site. The wires were re-inserted and after an additional 21 days of healing, the rats were sacrificed and femurs harvested. Three-point bending was performed on the ex vivo femurs to determine failure force and energy to failure. Callus and bone volume were calculated using high resolution animal fluoroscopy and normalized to the contralateral uninjured femur. Mann-Whitney U tests were utilized to make pairwise comparisons between groups.

RESULTS: Twenty-nine of 30 rats survived the duration of the study. Formation of bridging callus was confirmed radiographically in all fractures at the 42-day time point. Structural properties declined in femurs with callus removed as there was a statistically significant decrease of 74% in energy to failure versus control (p<0.05), and a non-significant 51% decrease in failure load versus control (p=0.08) (Figure 1-2). There was some recovery of failure force and energy to failure when the callus was replaced in comparison to callus removed by 39% and 59% respectively, but both values were still lower than control. These differences were not statistically significant. The normalized callus volume in the callus replaced group increased by 30% over control (p<0.05). Removal of callus without replacement did not result in a significant change in normalized callus volume versus control.

DISCUSSION AND CONCLUSION: We utilized a rat femur fracture model to recreate the typical fracture site preparation with callus removal. Our data suggest that removal of local soft callus compromises early fracture healing. It is possible, although not proven by this study, that replacing the adjunct may mitigate these negative consequences. Total removal of early fibrocartilage caluus may unnecessarily impair biological healing.
The Role of G-Protein Coupled Estrogen Receptor 1 in Fracture Healing
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INTRODUCTION: G protein-coupled estrogen receptor 1 (GPER1) is a novel receptor that binds to estrogen with high affinity. The receptor is present on growth plate chondrocytes, osteocytes, osteoblasts and osteoclasts and has been shown to play a role in estrogen-promoted growth plate closure and bone remodeling. The purpose of this study was to determine the role of GPER1 in fracture healing utilizing a mouse femur fracture model.

METHODS: Wild-type (GPER1+/+) mice and GPER1-deficient (GPER1−/−) mice underwent retrograde intramedullary nailing of the right femur followed by creation of a closed femur fracture utilizing a previously established model. Animals were sacrificed at one week and six weeks and the injured femur was analyzed using histology, microCT and biomechanical testing (three-point bending stiffness).

RESULTS: Fifteen wild-type and 19 GPER1-deficient mice were utilized. At one week after fracture, there was no difference in the histologic appearance (Figure 1) or three-point bending stiffness (Figure 2) of the fracture between the wild-type and GPER1-deficient groups. At six weeks after fracture, increased formation of hard tissue callus with mineralized tissue was found in both groups (Figure 1). In further analysis using microCT (Figure 3), increases of bone mineral density (BMD) and bone volume (BV) were found in the GPER-1 deficient mice suggesting an accelerated healing process when compared to the wild-type mice. At six weeks, the three-point bending stiffness of the GPER-deficient fractured femurs was also greater than those of the wild-type femurs (p=0.02) and approached 74% of the control (unfractured) femur (Figure 2).

DISCUSSION AND CONCLUSION: GPER-1 deficient mice demonstrated accelerated healing of a closed femur fracture at six weeks as demonstrated by microCT and biomechanical testing. This study demonstrates that GPER-1 plays a significant role in the regulation of fracture healing and the receptor may serve as a useful target for potential therapeutic modalities to enhance fracture healing.

Frzb is a Dominant Regulator of Wnt Signaling During Early Fracture Healing in Mice
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INTRODUCTION: Wnt signaling plays a role in normal and pathological bone healing and bone mass regulation through control of cell differentiation along the osteoblast or chondrocyte lineages. Here we hypothesize that Wnt signaling regulates bone healing in a stage-dependent manner through differential utilization of beta-catenin signal transduction.

METHODS: Twelve-week-old male C57/BL6 mice were used in this study. A closed mid-diaphyseal femoral fracture was induced after retrograde insertion of a 23G intramedullary needle under sterile conditions (Figure 1). Two mice were sacrificed at five, 14 and 21 days post-fracture (PF). The fracture callus and corresponding segment of the contralateral femur were harvested and the bone marrow removed under RNase-free conditions. RNA was extracted. Reverse transcriptase and real time polymerase chain reaction were performed. The increase in gene expression of the fracture callus with respect to a contralateral limb was calculated.

RESULTS: At a minimum of one of the three time points, 19 different genes were up-regulated more than 10-fold in the fracture callus and nine genes more than 20-fold (Figure 2). Frzb (aka Sfrp3) was the most highly up-regulated gene. Many Wnts (1, 2b, 4, 5a, 5b, 7b, 8b, 11 and 16) were up-regulated at all three time points during healing. Wnt3a, 6 and 8a were all down-regulated on Day 5 PF and up-regulated on Day 21 PF. Wnt9a and 16 are up-regulated on Days 5 and 14 PF but down-regulated on Day 21 PF.

DISCUSSION AND CONCLUSION: Frzb-deficient mice demonstrated accelerated healing of a closed femur fracture at six weeks as demonstrated by microCT and biomechanical testing. This study demonstrates that GPER-1 plays a significant role in the regulation of fracture healing and the receptor may serve as a useful target for potential therapeutic modalities to enhance fracture healing.
results of this study demonstrate that knockout of Frzb (Sfrp3) may have an even more dramatic effect.

PAPER NO. 27

Platelet Concentrate in Treatment of Non Union of Long Bones
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INTRODUCTION: The process of fractures union is characterized by the recruitment and differentiation of osteoblastic and osteoclastic cell populations, whose cellular activities are coordinated and regulated by an elaborate system of growth factors and cytokines. The most important growth factors required in the process are platelet-derived growth factor (PDGF), vascular endothelial growth factor (VEGF) and transforming growth factor-beta (TGF-β). PDGF released from the alpha granules are platelets for the purpose of angiogenesis, chemotaxis and mitogenesis. In addition, PDGF upregulates vascular endothelial growth factor (VEGF), further enhancing angiogenesis. Transforming growth factor-beta (TGF-β) released by platelets also appears to play a role in chemotaxis and cell proliferation during wound-healing.

METHODS: We injected 20-30 ml (depending upon site) of autologous platelet concentrate (1,000,000 platelets/µl) under image intensifier in non-united fractures of long bones (35 tibia, 15 femur, five humerus, five radius) of 60 patients. The efficacy of platelet concentrate in fracture healing was evaluated clinically and radiologically at serial follow-ups at two months after injection of platelet concentrate and thereafter every four weeks to assess bone union.

RESULTS: There was evidence of callus formation in 55 patients by the end of eight weeks. Forty of these 55 patients had bridging trabeculae by 12 weeks and the remaining 15 patients had fracture union by 24 weeks. The fracture did not unite in five patients (two tibia, two femur, one radius) at 24 weeks follow up.

DISCUSSION AND CONCLUSION: The administration of platelet rich plasma into the non-union site of long bones enhanced union rate, with a definitive radiological evidence of fracture healing.

Clinical relevance: platelet injection in non-united fractures can save an extra surgery and shorten the union time.

PAPER NO. 28

Prevalence of Vitamin D Deficiency in Orthopaedic Trauma Patients
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INTRODUCTION: The role of vitamin D in general health maintenance is a topic of increasing interest and importance in the medical community. Various authors have demonstrated a correlation between vitamin D deficiency and muscle weakness, fragility fractures and fracture nonunion. Documenting the prevalence of vitamin D deficiency in orthopaedic trauma patients is of vital importance as a first step in raising awareness among orthopaedic traumatologists and further determining a screening and treatment strategy for vitamin D deficiency in the trauma patient population. The purpose of this study was to determine the prevalence of vitamin D deficiency or insufficiency in orthopaedic trauma patients at a level 1 trauma center.

METHODS: A retrospective medical record review was done of all orthopaedic trauma patients above the age of 18 managed at a university level 1 trauma center from January 1, 2009 to September 30, 2010 to identify patients that had a documented 25-hydroxyvitamin D level. Vitamin D deficiency was defined as a 25-hydroxyvitamin D level of less than 20 ng/ml and insufficiency was defined as a level between 20 and 32 ng/ml.

RESULTS: A total of 889 of 1,830 patients were identified that had a 25-hydroxyvitamin D level. Vitamin D deficiency was defined as a 25-hydroxyvitamin D level of less than 20 ng/ml and insufficiency was defined as a level between 20 and 32 ng/ml.

DISCUSSION AND CONCLUSION: Both vitamin D deficiency and insufficiency had an overall prevalence of 77.4%. However, combined deficiency and insufficiency had a 26.6% prevalence at 77.4% (p=0.08). The 35-55 year olds had a lower prevalence of deficiency (25%, p=0.16) and insufficiency (41.7%, p=0.16) than other females. Males age 18-25 had a lower prevalence of deficiency (25%, p=0.41) and insufficiency (36.7%, p=0.16) than other males. Otherwise, no remarkable differences were detected in prevalence of deficiency or insufficiency based on age or sex.

The FDA has not cleared the drug and/or medical device for the use described in this presentation (i.e. the drug or medical device is being discussed for an off label use). For full information refer to page 14. An alphabetical faculty financial disclosure list can be found starting on page 19.
INTRODUCTION: Fracture healing follows a cascade of cellular events that when impaired, results in significantly weaker bone or delayed union. We have previously shown that the progressive ankylosis protein (ANK), which transports intracellular pyrophosphate (iPPi) to the extracellular milieu, together with alkaline phosphatase (APase), an enzyme that hydrolyzes extracellular PPI (ePPI) to inorganic phosphate (ePi), stimulates osteogenic differentiation of precursor cells via the regulation of ePPI/ePi homeostasis. Consequently, lack of ANK function in ank/ank mice results in delayed bone formation and ultimately osteoporosis. Since a key event in bone fracture healing is the differentiation of precursor cells along the chondro/osseous lineages, the goal of this study was to determine whether ANK plays a role in bone fracture healing with the ultimate goal to define novel therapeutic targets for the improvement of bone fracture healing.

METHODS: We utilized a well-established femur fracture model in six-week-old ANK-deficient (ank/ank) mice and wild type (WT) littersmates. Mice were followed with weekly x-rays and groups were euthanized at two and five weeks (n = 5 in each group). Bone fracture healing, including the size and nature of the fracture callus, was analyzed by histology, microCT and biomechanical testing.

RESULTS: ank/ank mice showed a marked delay in callus formation compared to WT littersmates. At two weeks the callus of ank/ank mice contained markedly reduced amounts of cartilage compared to the amount of cartilage in WT callus. The ank/ank callus and the WT callus contained mostly hypertrophic chondrocytes at two weeks. MicroCT analysis at two weeks revealed a markedly reduced size of callus, and reduced mineralized areas in the callus compared with these characteristics of WT callus. MicroCT and histological analyses at five weeks revealed a markedly reduced bone density, decreased trabecular number and thickness, increased trabecular separation and a reduced cortical thickness of the ank/ank fractured bone compared with the wild type fractured bone.

Bone biomechanical testing revealed that the ank/ank fractured bone required significantly less load to induce failure after five weeks than the fractured wild type bone. Fractured ank/ank bone or fractured wild type bone showed similar loads to failure as unfractured ank/ank bone or wild type bone, respectively.

DISCUSSION AND CONCLUSION: In this study we show for the first time that ANK plays a crucial role in bone fracture healing. Lack of ANK resulted in delayed callus formation, a smaller size callus, reduced areas of cartilage in the callus, reduced mineralized cartilage area after two weeks and reduced new-formed bone after five weeks. Consequently, bone strength was markedly reduced after five weeks in ank/ank mice compared to WT littersmates. These findings reveal that ANK affects early stages of fracture healing, namely the differentiation of precursor cells along the chondro/osseous lineages. More importantly, the ank/ank fracture model mimics fracture healing of osteoporotic bone. In conclusion, we discovered a novel protein, ANK that plays a crucial role in bone fracture healing. Current work is ongoing to understand the mechanisms of how ANK regulates precursor cell commitment and differentiation along the chondro/osseous lineages with the ultimate goal to develop novel treatment strategies for bone fracture healing.

PIER NO. 30

Effect of Tibial Nonunion on Health-Related Quality of Life

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INTRODUCTION: Tibial nonunion is disabling, but to our knowledge no quantitative evaluation of the effect on health-related quality of life (HRQOL) has been reported. METHODS: There were 260 consecutive patients with tibial nonunion (88 women, age 46.3±15.6 years; 172 men, age 48.7±15.2 years) who were referred to the senior author (MRB) at our tertiary care center between 1990 and 2010.RESULTS: The 12-Item Short Form Health Survey (SF-12) Physical Component Scale scores averaged 27.4±6.7 and showed an extremely large and disabling effect on physical health. The Mental Component Scale averaged 42.4±7.0 and indicated a substantial detrimental effect on mental health. The impact on physical health was comparable to reported effects of end-stage hip arthroplasty and was significantly worse (p<0.005) than congestive heart failure. AAOS Lower Limb Core Scale scores averaged 51.9±19.3 and were also consistent with high levels of physical disability attributable to the lower limb. Brief Pain Inventory Intensity averaged 4.8±2.5 and Interference averaged 6.9±2.2 suggesting that pain was a substantial contributor to disability. Responses to the Time Trade-Off questionnaire indicated that patients were willing to trade an average of 36% of their remaining lives to regain their health which was equivalent to 12 years of life in these patients. The presence of infection did not significantly affect any of the HRQOL measures (p=0.05).

DISCUSSION AND CONCLUSION: Tibial nonunion is an extremely disabling chronic medical condition that negatively affects both physical and mental health and quality of life. To the best of our knowledge, this is the first study of its kind reporting on a large consecutive series.
IV. Conservative treatment with skeletal traction was performed in cases of type I, 28 of type II, nine of type III and seven of type IV, comminuted fracture. We treated 59 femoral head fractures according to this classification and retrospectively reviewed them.

INTRODUCTION: The purpose of this study is to present the mid-term results of 59 cases of femoral head fracture which were treated according to a modified Pipkin’s classification. METHODS: We modified Pipkin’s classification as follows: type I, small fragment distal to the fovea centralis (FC); type II, large fragment distal to the FC; type III, large fragment proximal to the FC; type IV, comminuted fracture. We treated 59 femoral head fractures according to this classification and retrospectively reviewed them at an average follow up of 8.4 years (3-21 years). There were 15 cases of type I, 28 of type II, nine of type III and seven of type IV. Conservative treatment with skeletal traction was performed in four type II cases, excision of the fragment in 15 type I and 10 type II cases, fixation of the fragment in 14 type II and all nine type III cases, and total hip replacement (THR) in all seven type IV cases.

RESULTS: According to Epstein’s criteria, the overall clinical results of the 52 cases excluding type IV cases were excellent in 16 (31%), good in 28 (54%), and fair in eight (15%). Two patients treated with conservative treatment revealed malunion of the head fracture, and required osteotomy. Three patients treated with fixation revealed osteonecrosis of the femoral head, and two of these three patients underwent Sugioka’s operation.

DISCUSSION AND CONCLUSION: For the first time, we could show that a high correlation exists between disabilities, quality of life and psychological consequences after pelvic fractures.

Psychological Consequences After Pelvic Ring Fractures
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INTRODUCTION: Pelvic ring fractures caused by trauma are severe injuries with well described radiological and clinical outcomes, whereas psychological consequences are less well documented. The purpose of this study was to investigate patient-reported outcome following treatment of pelvic fractures regarding functional outcome, quality of life, depression and anxiety.

METHODS: In a retrospective analysis, 92 patients with type B and C fractures of the pelvic ring were treated between 2003 and 2009 at our level I trauma center. For this purpose, patient charts, surgery reports and x-ray images were analyzed consecutively. The outcome of 62 patients could be evaluated regarding the mobility and function according to Extra Short Musculoskeletal Function Assessment questionnaire (XSMFA), quality of life according to short-form 12 (SF12) and depression according to Beck Depression Inventory (BDI) and Hospital Anxiety and Depression Scale (HADS).

Statistical analysis was performed with the computer software SPSS.

RESULTS: Mean age of patients at time of accident was 48±17 years. A total of 16% of patients were female. Mean follow up was 57±21 months. Mean functional index of XSMFA was 23±19. Patients with AO C-type fracture (MCS: 44±13, BDI: 12±12) had statistically lower results in summary score of the SF36 (MCS) and BDI compared to patients with AO B-type fracture (MCS: 52±7, BDI: 6±8) (p<0.05). XSMFA and physical summary score of the SF36 (PCS) correlated highly with BDI and HADS (p<0.01). Patients who were depressed showed significantly worse results in relation to the XSMFA and the SF12 score (p<0.01).

DISCUSSION AND CONCLUSION: For the first time, we could show that a high correlation exists between disabilities, quality of life and psychological consequences after pelvic fractures. Therefore, we recommend inclusion of psychological components in the treatment and outcome-evaluation of the pelvic ring fracture in future.

The Clinical and Radiographic Outcomes of 59 Femoral Head Fractures
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INTRODUCTION: The purpose of this study is to present the mid-term results of 59 cases of femoral head fracture which were treated according to a modified Pipkin’s classification.

METHODS: We modified Pipkin’s classification as follows: type I, small fragment distal to the fovea centralis (FC); type II, large fragment distal to the FC; type III, large fragment proximal to the FC; type IV, comminuted fracture. We treated 59 femoral head fractures according to this classification and retrospectively reviewed them at an average follow up of 8.4 years (3-21 years). There were 15 cases of type I, 28 of type II, nine of type III and seven of type IV. Conservative treatment with skeletal traction was performed in four type II cases, excision of the fragment in 15 type I and 10 type II cases, fixation of the fragment in 14 type II and all nine type III cases, and total hip replacement (THR) in all seven type IV cases.

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DISCUSSION AND CONCLUSION: According to Epstein’s criteria, the overall clinical results of the 52 cases excluding type IV cases were excellent in 16 (31%), good in 28 (54%), and fair in eight (15%). Two patients treated with conservative treatment revealed malunion of the head fracture, and required osteotomy. Three patients treated with fixation revealed osteonecrosis of the femoral head, and two of these three patients underwent Sugioka’s operation.

Indications and Outcomes of Anterior Subcutaneous Fixator (InFix) in Pelvis Fractures: A Multicenter Study
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INTRODUCTION: Anterior pelvic fixation after a pelvic fracture can be accomplished with external fixation, plating or percutaneous screws. External fixation is convenient for the surgeon but uncomfortable for the patient and is difficult in obese patients. We have developed an anterior internal fixator which is biomechanically sound, is based on external fixation technology but sits under the skin (InFix) METHOD: A retrospective review was performed on 96 patients from four Level 1 trauma centers who had suffered unstable pelvic fractures and had been treated with an InFix and the appropriate posterior fixation.

RESULTS: The indications for fixation were: LC1 5, LC2 14, LC3 17, APC 2 18, APC3 14, VS 21, CM 7. Follow up averaged 15 months (range six to 40). Patients had good mobility and all the fractures healed. Complications included four early revisions which were due to technical error, and three infections. Twenty-eight patients (29%) reported some irritation of lateral femoral cutaneous nerve due to technical error, and three infections. Twenty-eight patients (29%) reported some irritation of lateral femoral cutaneous nerve due to technical error, and three infections. Twenty-eight patients (29%) reported some irritation of lateral femoral cutaneous nerve due to technical error, and three infections. Twenty-eight patients (29%) reported some irritation of lateral femoral cutaneous nerve due to technical error, and three infections. Twenty-eight patients (29%) reported some irritation of lateral femoral cutaneous nerve due to technical error, and three infections. Twenty-eight patients (29%) reported some irritation of lateral femoral cutaneous nerve due to technical error, and three infections. Twenty-eight patients (29%) reported some irritation of lateral femoral cutaneous nerve due to technical error, and three infections.
Accurate Radiographic Assessment of Pelvic Ring Fracture Deformity

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INTRODUCTION: Traumatic pelvic deformity has typically been assessed using plain radiographs in addition to computed tomography (CT) scan. Plain radiograph deformity measurements, typically used to assess post-treatment reduction and reporting results in literature, have not been validated and do not fully describe the deformity in three dimensions. This study will assess the validity and reliability of existing measurement systems and propose a new system to fully characterize pelvic fracture deformity on plain radiographs.

METHODS: Pelvis radiographs of 20 patients with no known pelvic injury were reviewed. A coordinate system was developed by defining the superior margin of the sacrum as the x-axis; and a perpendicular line down the midline of the sacrum as the y-axis. The point of origin was defined as the intersection of the axes. Averages of all measurements were compared with those obtained from a radiopaque sawbones model to assess its representation of normal radiographic anatomy. The models were used to simulate recognized pelvic ring fracture patterns including anteroposterior compression (APC), lateral compression (LC) and vertical shear (VS). Direct physical measurements using calipers were made to serve as a gold standard of displacement. CT scans with axial, coronal, sagittal and three-dimensional reconstructions of intact and injury models will be obtained and used to create computer reconstructed radiographs (CRR) simulating standard AP, inlet and outlet views. Currently described measurement techniques will then be applied to the CRR of each model. The validity of these measurement systems was then assessed by comparing the values obtained to the actual displacement in each plane as measured by CT scans and direct measurements on the model.

RESULTS: We found the sawbones model correlated well with normal patient radiographic anatomy with all radiographic landmarks used within one standard deviation of our average. Two-dimensional CT scan reconstruction displacement correlated well with direct caliper measurement displacement as was used as gold standard for comparison. Utilizing current techniques it was found that measures of anterior symphysis diastasis correlated reasonably well between CT and radiographs: 0.7mm for APC, 0.4mm for LC and 1.5mm for VS. The correlation of sacroiliac (SI) joint injury were less accurate with 2.9mm, 3.6mm and 5.3mm, respectively. We found no radiographic correlation between AP CRR and axial rotation. There are no current methods of radiographically assess axial or sagittal rotation as a result of these fractures.

DISCUSSION AND CONCLUSION: Current techniques to measure pelvis fracture deformity are incomplete and have suboptimal accuracy. We recommend cautious interpretation of plain radiographs using current measurement techniques. A new system should be developed to accurately assess the known deformities on plain radiographs. AIDED BY A GRANT FROM THE ORTHOPAEDIC TRAUMA ASSOCIATION

Percutaneous Retrograde Posterior Column Acetabular Fixation: Is the Sciatic Nerve Safe? A Cadaveric Study

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INTRODUCTION: Percutaneous screw fixation has been advocated for minimally displaced posterior column acetabular fractures with the potential benefit of allowing early mobilization and preventing further displacement. This is particularly useful when there is an associated anterior column fracture to avoid more extensive exposure and in polytrauma cases where multiple associated extremity fractures warrant early mobilization and possibly fixation. Little has been published on the safety of the retrograde technique, especially with regards to neurological structures. The purpose of this cadaveric study was to determine the proximity of the neurologic structures to the path of the screw inserted percutaneously utilizing a guide wire into the ischial tuberosity. Our hypothesis was that the sciatic nerve is at a safe distance from the trajectory of the screw.

METHODS: Ten screws were inserted percutaneously in 10 limbs (five cadavers) under fluoroscopic guidance. Dissection was then performed to expose the head of the screw as it entered through the ischial tuberosity and was then extended laterally to expose the sciatic nerve, the inferior cluneal and the posterior cutaneous nerve of the thigh. The distances from the head of the screw to these neurosurgical structures were measured. The axis of inclination of the guide wire was also noted to determine the ideal pathway.

RESULTS: The distance from the center of the screw head to the sciatic nerve averaged 5.2 cm (range, 4 to 6 cm). The average distance between the center of the screw head and the posterior cutaneous nerve of the thigh was 3.5 cm (range, 3 to 4 cm). The inferior cluneal branches were the closest to the path of the screw with an average distance of 0.4 cm in seven specimens (range, 0.1 to 0.5 cm) and were injured by the screw in two and could not be located in another specimen. The inclination of the guide wire was approximately 15 degrees from the midline in both the sagittal and the coronal planes.

DISCUSSION AND CONCLUSION: The sciatic nerve and the posterior cutaneous nerve of the thigh appear to be safe during retrograde percutaneous screw fixation of a posterior column acetabular fracture through a central entry point in the ischial tuberosity and following the inclination shown in this study. However, care must be taken to avoid injury to the inferior cluneal nerves.
Quality of Life and Sexual Function Following Traumatic Pelvic Fracture
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INTRODUCTION: Pelvic fractures are indicators of severe trauma and high energy absorption. They are associated with multiple local or distant concomitant injuries, which explain their high mortality and morbidity. The aim of this study is to investigate the late sequel of traumatic pelvic fractures (PFX) focusing on quality-of-life and sexual-function.

METHODS: From a database of prospectively documented data, patients who had suffered a PFX and had been treated operatively in our institution from January 2008 to January 2009 were eligible to participate in this study. Ethics committee approval was obtained. Exclusion criteria were patients less than a year post-injury, pathological fractures, patients <18 or >65, and patients with comorbidities linked to sexual dysfunction. Demographics, injury mechanisms, fracture patterns (Young-Burgess classification), injury-severity-score (AIS/05-ISS), urogenital injuries and clinical outcome were recorded and analyzed. Health-related-quality-of-life was assessed using the (EuroQol-5D) and sexual-function using the international index of erectile function and the female sexual function index. Patients were asked to fill the questionnaires twice (once documenting their state prior to their injury and the second time recording their state after the injury). The minimum follow up was 12 months (range 12-30).

RESULTS: Out of 85 patients that met the inclusion criteria, 67 patients (24 females) with a mean age of 44 years (19-65) consented to participate in this study. Their mean ISS was 25 (9-58), while five (7.4%) had isolated PFX. There was shown to be a significant decrease in quality-of-life (p<0.0001) and sexual function (p<0.0001). The decrease was significant in all five EQ5D domains with mobility, usual activities and pain as the most significantly affected (p<0.0001). A total of 50.7% (34) patients reported a significant (p<0.0001) decrease in their post-injury sexual function score (55.5% males, 47.8% females). Linear regression showed urinary tract injury to be an independent risk factor for sexual dysfunction (p<0.0001), while a Mann-Whitney-U-test identified that the PFX severity (VS-AP3-LC3-CMI vs. LC1-LC2-AP1-AP2-ILBL) correlated to sexual dysfunction (p=0.0463).

DISCUSSION AND CONCLUSION: Both genders, irrespective of age subgroups, suffering a PFX severe enough to undergo surgery, are at risk of a significant decrease of their quality-of-life and sexual-function. The presence of certain fracture types and urinary tract injuries can be used as predictors of late morbidity and early multidisciplinary management.

Management of Combined Injuries of the Acetabulum and Pelvis
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INTRODUCTION: Combined injuries of the acetabulum and pelvis constitute one of the most challenging injuries to manage. These injuries entail unique management and reconstructive procedures. Patients with such combined injury usually have high injury severity, require lengthy hospital stays and frequent ICU admission. There have been very limited reports describing this injury combination. The objective of the study was to present our experience with this injury combination, along with describing a treatment algorithm, fixation methods and order. We discussed our results of management of such a challenging injury. It is one of the very first few studies discussing this injury combination in detail.

METHODS: Forty-two cases of combined acetabular and pelvic ring injuries were managed in this prospective case series. There were 26 males (62%) and 16 females (38%). All injuries were high energy injuries. The mean age was 37 years, range (17 - 65 years). The Letournel and Young&Burgess classifications were used to classify acetabular and pelvic injuries respectively. The most common acetabular fracture was transverse fracture pattern (33%) and the most common pelvic fracture was AnteroPosterior Compression (APC II&III) type in 48% of cases. The most frequent injury combination was transverse treatment at level 1 trauma center compared with that at non-trauma centers. The purpose of this study was to investigate the impact of trauma center care on outcomes after pelvic injuries, recognizing that these results could have important implications for appropriate triage of these severely injured patients.

METHODS: Mortality and quality of life related measures were compared among patients treated in 18 hospitals with a level 1 trauma centers and 51 hospitals without trauma centers in 14 states. Complete data were obtained on 829 adult trauma patients (18-84 years old) with at least one pelvic ring or acetabular injury (OTA 61 or 62). We used inverse probability of treatment weighting to adjust for observable confounding between patients treated at trauma centers versus those treated at non-trauma centers.

RESULTS: After adjustment for case mix, in-hospital mortality was significantly lower at trauma centers versus non-trauma centers (RR 0.10, 95% CI 0.02-0.47), as was death by 90 days (RR 0.10, 95% CI 0.02-0.47), and one year (RR 0.21, 95% CI 0.06-0.76) for patients with more severe acetabular injuries (OTA 62-B and 62-C). Patients with combined pelvic ring and acetabular injuries treated at trauma centers had lower mortality by 90 days (RR 0.34, 95% CI 0.14-0.82) and one year (RR 0.30 95% CI 0.14-0.68). Average differences in SF-36 physical functioning and musculoskeletal functional assessment at one year were 11.4 (95%CI 5.3 - 17.4) and 13.2 (1.7 - 24.7) respectively, indicating statistically and clinically significant improved outcomes with treatment at trauma centers for more severe acetabular injuries.

DISCUSSION AND CONCLUSION: Our findings show that risk of mortality is significantly lower for patients with severe acetabular injuries and that these patients also enjoy improved physical functioning at one year when care is provided in a trauma center than in a non-trauma center. Patients with severe acetabular injuries and any combined acetabular and other pelvic ring injury should be triaged to trauma centers.
STABILITY OF PUBIC SYMPHYSIS DISRUPTION: LOCKED VERSUS UNLOCKED VERSUS HYBRID 4-HOLE PUBIC SYMPHYSIS PLATING

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INTRODUCTION: Fixation of symphysis pubis (SP) is critical for stabilization of many types of unstable pelvic ring fractures. The forces of activities of daily living on the SP often cause loosening of plate and screw constructs. It is hypothesized that for an unstable pelvic ring fracture of the SP and sacroiliac joint (SI), a pre-contoured SP plate with hybrid fixation, emphasizing screw purchase into the most inferior aspect of the body of the pubis will provide a more rigid construct of both the SP and the SI. SI motion will also decrease with SP stability.

METHODS: Tile type C pelvic injuries were simulated in pelvic model. The SPs were fixed using plates with either four locked screws, four non-locked screws, or hybrid technique with two locked screws applied in the end holes and two long, non-locked screws in the central holes (see figure). The SI joint on the "non-injured" side was fixed with a 7.3 mm cannulated screw into the S1 body and the "injured" side had the SI joint separated. Five constructs were prepared for each plating technique. Model femurs were cut in the distal diaphysis and placed in an adjustable angle vise at 8° of varus with the hip joint is in full extension. A tension band to simulate the pull of the abductors was applied from the greater trochanter to the iliac wing with a turnbuckle for length adjustment. A cyclic compression load of 15 N to 150 N was applied through the spine with the femur held fixed. After loading, the femur was held at the greater trochanter and the pelvis subjected to a side load of 100 N measured by a dynamometer to simulate forces that may occur from a fall. Movements of the SP joint and angular changes of the screws were measured by the fluoroscope and analyzed with imaging software. From the load-displacement curves, a slope was identified in the linear range and defined as the stiffness of the construct. The movements measured by the camera were translated into a custom software program which calculated the 6 degrees of freedom of motion across each joint during loading. Statistical comparisons were made by Student’s t-test.

RESULTS: There was no significant difference in overall construct stiffness between the two methods of SP fixation in this model, although the hybrid average stiffness was slightly better than all locked or unlocked screws. The motions at the SP joint were only slightly different between groups and none were statistically significant, though the vertical translations and the ML plane rotations, with the hybrid fixation were slightly reduced. The same was true for the SI joint vertical translations, but there was a significant improvement with the hybrid fixation in ML plane rotations, P < 0.02. The closing of the SP joint with lateral load was significantly improved with the hybrid fixation, (P<0.05).

DISCUSSION AND CONCLUSION: Unlike many other applications comparing locked vs. unlocked plating, this study showed no advantage for locked plating. The major loading path from the lumbar spine to the hip joints is through the SI joints, not through the SP joint. However, with side loading the SP joint bears a similar amount of load to the SI joint. Thus the side load provides a more sensitive test of the fixation achieved at the SP joint. Because the SP joint has a long lever arm to the SI joint, its stability can have a major effect on the SI joint.

PAPER NO. 145

WILL SACRAL GEOMETRY ACCOMMODATE A SCREW ACROSS BOTH SACROILIAC JOINTS?

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INTRODUCTION: Unstable sacroiliac (SI) joint injuries typically require posterior fixation. Percutaneous screw fixation of the SI joint is a well-established technique. When the injury involves both SI joints, a bilateral screw across both SI joints is being performed in selected cases. However the optimal path for unilateral SI screws is not coincident with the contralateral side (transverse). The risk of violating cortex, exposing vital structures to possible injury while placing a bilateral screw across both SI joints, has not been established. The purpose of this study is to determine if the bony geometry of the S-1 and S-2 segments can accommodate a straight screw path across both SI joints. It is hypothesized that there is sufficient space for a transverse straight line path across both SI joints.
joints to place a bilateral screw in both the S-1 and S-2 segments. METHODS: 3D analysis of 432 pelvic CTs was performed to determine the proportion of pelves that could accommodate bilateral SI screws. Bone cortex was identified by voxel density producing a mesh of the cortical contours. A straight line path was digitally placed within the S-1 or S-2 segment extending across both SI joints and both posterior ilia (Figure 1). The diameter of the path was increased until it contacted cortex geometrically defining the maximum diameter (Dmax). 10 mm was defined as the smallest diameter in which a skilled surgeon could consistently and safely place a 7.3 mm screw allowing a 2.7 mm margin for error. The relationship between Dmax of 10 mm to gender, age and BMI was analyzed using binomial logistic regression with α < 0.05.

RESULTS: A total of 74% of pelves had 10 mm or more in S1, 76% in S2, and 44% in both the S1 and S2 segments (Figure 2, grey line represents S-1 and black is S-2). In 6% of pelves neither S-1 nor S-2 had a 10 mm path for the bilateral screw. Some 15% of S-1 had <7mm. Fewer females than males had Dmax of 10 mm or greater at S-1 (p = 0.049) and S-2 (p<0.001). No association was found with age or BMI.

DISCUSSION AND CONCLUSION: A total of 26% of pelves lacked sufficient bone to pass a trans-sacral screw across both SI joints in the S1 segment and 24% lacked sufficient bone to pass a trans-sacral screw across the S-2 segment and 6% lacked sufficient bone in both the S-1 and S-2 segments. The complexity of the geometry and the uncertainty from overlying shadows can make it difficult to determine when adequate space is present by fluoroscopy. Separate unilateral SI screws on each side may be safer than a bilateral screw traversing both SI joints when experience with this procedure is limited.

PAPER NO. 146

The Orthopaedic Traumatologist and the Peritrochanteric Hip Fracture—Does Experience Matter?
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INTRODUCTION: The purpose of this study was to review our protocol of sliding hip screws for stable and intramedullary (IM) devices for unstable peritrochanteric fractures to evaluate the correctness of the decisions made based on complication rates and on shortening of the fractures. METHODS: Over a five-year period, two orthopaedic traumatologists followed a protocol utilizing a standard sliding hip screw (DHS) for all fractures that were felt to be stable and a cephalomedullary nail for unstable fractures. This was based on medial or subtrochanteric extension and the status of the lateral wall. Injury radiographs were then re-reviewed independently by a blinded observer to classify each fracture pattern as stable or unstable based on the Evans classification.

RESULTS: Of 121 patients, 62 were classified as stable and 59 unstable. Based on the reclassification, stable fractures were treated with a DHS in 59 and an IM nail in three cases, and unstable fractures with an IM nail in 55 and a plate in four cases. The average operating time and transfusion need was 86 ±42 mins and 24% for the DHS and 115 ± 30 mins and 39% for nails. The tip apex distance averaged 16mm with 2/61 (3.3%) > 25mm for plates and 22mm with 6/60 (10%) > 25mm for IM nails. Two partial cutouts occurred, both in the DHS group (15mm, 19mm TAD).

Final shortening was 5.9 ± 5 mm and 5.3 ± 5mm and the neck shaft angle averaged 135° and 126° respectively for the plate and nail groups. DISCUSSION AND CONCLUSION: This study validates a protocol utilizing sliding hip screws for stable and IM nails for unstable peritrochanteric fractures. We found that sliding hip screws resulted in less operative time and lower tip apex distances. Despite 10% of the IM nails having a tip apex angle of > 25mm, there were no cases of cutout, indicating that this measure may not be as important for IM nails. A protocol utilizing sliding hip screws for stable and IM nails for unstable peritrochanteric hip fractures based on the judgment of experienced surgeons is reasonable and can save costs compared to using IM nails for all cases ($104,898 in this series).
across either the S1 body (TS1) (three specimens), or one across the S1 body and one across the S2 body (TS12) (three specimens) (6.5 mm diameter, 140-170 mm length, partially threaded). All groups received plate osteosynthesis of the superior pubic rami osteotomy. To measure fracture gapping, seven pairs of reference points about the fracture were created in the sacral cortex. These points served as markers for the MicroScribe 3DLX digitizing system. After loading from 5-25N for five preconditioning cycles, all pelvis were loaded for three cycles from 25-400N in 25N increments using an inverted pelvic osteotomy. Single limb-stance model with contralateral limb stabilization on an Instron materials testing apparatus. Following cyclical testing, specimens were loaded to ultimate failure at 25N increments. Marker digitization was performed at each loading increment. Data was used to calculate construct stiffness and fracture gapping with clinical failure defined as 5 mm of gapping between the fracture at the adjacent paired markers in the neural foramina. Stiffness among the groups was defined by the linear region of the load-displacement curve. Non-paired T-tests with significance set at p≤0.05 were used for statistical analysis.

**RESULTS:** TS1 demonstrated statistically higher stiffness about the S1 neural foramina in comparison to IS1 (TS1: 271.7 ± 77 N/mm, IS1: 164.0 ± 30 N/mm, p < 0.05) as well as higher load to clinical failure at the S1 neural foramina (TS1: 1067 ± 88 N, IS1: 675 ± 139 N, p = 0.01). The load to clinical failure about the S2 neural foramina was statistically different between the TS1 and IS1 (TS1: 1050 ± 90 N, IS1: 637 ± 138 N, p = 0.01) but the stiffness was not (TS1: 192.9 ± 46 N/mm, IS1: 149.2 ± 42 N/mm, p = 0.25). TS12 demonstrated statistically higher load to clinical failure at the S2 neural foramen in comparison to IS1 (TS2: 1075 ± 300 N, p < 0.05) yet did not illustrate significantly higher stiffness at that site (TS2: 337.6 ± 172 N/mm, p = 0.08). The stiffness and load to clinical failure between TS12 and IS1 about the S1 neural foramen were not statistically significant (TS2: 224.1 ± 110 N/mm, p = 0.33; TS2: 950 ± 295 N, p = 0.22). There were no statistical differences between TS1 and TS12 for all measures or among any of the groups concerning load to ultimate failure.

**DISCUSSION AND CONCLUSION:** The placement of trans-sacral screws provides increased stiffness at corresponding sacral levels while providing greater resistance to clinical failure.

**PAPER NO. 148**

**Pelvic Fracture Classification as a Key to Transfusion Requirements**

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**INTRODUCTION:** The Young-Burgess classification of pelvic fractures (PFx), dated since the ‘90s, has been shown to correlate with blood transfusion, overall resuscitation requirements and outcomes. Our purpose was to investigate whether this is still valid following the ongoing advances in trauma care (reduced rescue times, transfusion guidelines, interventional radiology and advances in our understanding of the physiological response to injury, general trauma management).

**METHODS:** Prospective comparative analysis of blunt-PFx with complete hospitalization documentation of their first 48 hours. Children, pathological fractures and dead-on-arrival cases were excluded. Demographics, ISS, hospital/ITU stay, transfused blood products and mortality were documented. Descriptive statistics were utilized as appropriate.

**RESULTS:** A total of 110 patients met the inclusion criteria (males 63.6%, average age 38.5 years(15-90)). The average overall ISS was 21(5-45), and the average length-of-hospital-stay 23.7days(4-67). Some 41.8% required ITU-treatment for average 6.3 days(2-29). The overall mortality was 6.5%, referring to a subgroup of significantly higher ISS (average 41.6(17-66)). The average overall transfusion requirements for RBC/FFP/PLT were 4.5(1-23) / 1.5(1-12) / 1.1(1-12) units respectively. The subgroups (Young-Burgess classification) were LC1= 38 cases-34.2%, LC2= six cases-5.4%, LC3= two cases-1.8%, AP1= two cases-1.8%, AP2= 29 cases-26.1%, AP3= 10 cases-9%, VS= eight cases-7.2%, CMI= four cases-3.2%, Iliac-Blade= 11 cases-9.5%. The mean ISS was higher in the CMI, VS, AP2 and AP3 groups (30.3, 20.4, 21.8 and 26.7 respectively) when compared with the rest. All these characteristics were comparable to those of the original publication of Burgess in 1990. AP3-group had the highest average red cell transfusion rates, seven units(4-12), followed by VS-injuries 4.5 units(2-8). The relative numbers of the Burgess were significantly higher (AP3=3.4 units, VS=9.4 units). The mortality was highest between the LC3-group(33.3%) differing from the study of Burgess (AP3-group(42.8%)).

**DISCUSSION AND CONCLUSION:** The classification of Young and Burgess appears to withstand the test of time as to its correlation to the resuscitation requirements and the clinical outcome; however substantial differences to the reported quantitative parameters were noticed.

**PAPER NO. 149**

**Pararectal Approach for Anterior Intrapelvic Management of Acetabular Fractures**

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**INTRODUCTION:** A new anterior, intrapelvic, extraperitoneal approach for treatment of displaced acetabular fractures involving predominantly the anterior column and the quadrilateral surface is introduced for anatomic restoration with minimal access morbidity. The extraperitoneal space is entered along the lateral border of the rectus abdominis muscle, the so-called “pararectal” approach, to establish five “windows” for instrumentation.

**METHODS:** The feasibility of secure dissection and optimal instrumentation of the pelvis has been assessed in five human cadavers before its clinical implementation in a consecutive series in 20 patients (mean age 59 years, range: 17-90 years; 17 male) since 12/2009. Patients are assessed for occurrence of intraoperative complications, quality of reduction on CT scans and the clinical outcome at a minimum follow up of one year.

**RESULTS:** In cadavers, the pararectal approach facilitated sufficient extraperitoneal access to visualize the inner surfaces of the hemipelvis. Secure instrumentation of the pelvis with respect to neurovascular structures at risk during dissection was facilitated. In patients, radiographic analysis confirmed statistically significant reduction of fracture displacement [pre- vs. postoperative (mean±SD): gap 11.5±6.5mm vs. 0.8±1.3mm, p<0.001; step-off 3.3±2.6mm vs. 0.1±0.3mm, p<0.001]. Noted intraoperative complications have been lesions to the peritoneal sac in two patients and minor vascular damage in two other patients.

**DISCUSSION AND CONCLUSION:** The pararectal approach has the potential to facilitate proper reduction of complex acetabular fractures since multi-directional placement of screws and various

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plate configurations are feasible without vast retraction of the soft tissues. The visualization of the fracture pattern, more efficient placement of reduction tools and easier screw placement might be further advantageous in treatment of acetabular fractures.

PAPER NO. 150
Can MRI Detect Ligamentous Injury in Pelvic Ring Disruptions?
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INTRODUCTION: Despite its theorized importance in determining pelvic stability after injury, little is known regarding the integrity of the ligamentous pelvic constraints in patients with pelvic fracture. Our hypothesis was that magnetic resonance imaging (MRI) could be used to visualize these ligamentous structures.

METHODS: Our study group was composed of nine patients with an acute anteroposterior compression pelvic ring injury and 26 controls without pelvic ring injury. The patients with pelvic ring injury were prospectively enrolled and MRIs were obtained within 14 days of injury for purposes of this Institutional Review Board-approved study. Injuries were classified by Young-Burgess. The control group was created from already obtained MRIs of the pelvis for other reasons in non-trauma patients. In both groups, two MRI sequences (axial T1 and 3D volume with T2 weighting) were reviewed by the same attending musculoskeletal radiologist to determine if the integrity of the sacrotuberosus (ST), sacrospinous (SS), anterior sacroiliac (ASI), posterior sacroiliac (PSI) ligaments and pelvic floor musculature was possible in 96%, 100%, 89%, and 87% of the control patients, respectively. All seven patients with anteroposterior compression type II injuries had rupture of the ASI (0% intact, p<0.001 Fisher exact compared with controls) and none had rupture of PSI. Four of seven (43% intact, p<0.001) had injury to the SS ligament (three partial tears, one complete) and four of seven had partial tearing of the pelvic floor musculature. Only one patient had a partial tear of the ST ligament (NS). Two patients had an anteroposterior compression type I injury and showed injury to multiple ligaments consistent with these injuries.

DISCUSSION AND CONCLUSION: The ligaments that are thought to be significant in pelvic stability appear to be easily visualized using MRI of injured and non-injured pelvises. This non-invasive imaging modality may hold great promise in helping to differentiate stable from unstable mechanical patterns and helping to determine who would benefit from operative treatment as it has in other areas of orthopaedic surgery.

PAPER NO. 182
Proximal Femoral Replacement in the Management of Acute Periprosthetic Fractures of the Hip
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INTRODUCTION: The population of patients with indwelling hip arthroplasty is growing rapidly. In the presence of advancing osteopenia, lytic defects and a history of revision arthroplasty, these patients are exposed to massive failure of implants at the time of periprosthetic fracture and may have few reconstructive options. This study sought to examine the outcomes of performing proximal femoral replacement (PFR) as compared to revision total hip arthroplasty (REVF) or open reduction internal fixation (ORIF) in these non-oncologic hosts.
METHODS: We retrospectively identified 101 consecutive periprosthetic hip fractures treated at our tertiary trauma and arthroplasty center over a recent 10-year period with minimum one year and average 35 month follow-up. Three treatment groups were identified: proximal femoral replacement (n=23), revision total hip arthroplasty (n=20), and open reduction internal fixation with arthroplasty implant retention (n=58). We recorded patient demographics, comorbidities, fracture type, treatment profiles, functional status, complications and mortality. The three groups were compared using analysis of variance and chi-squared analysis.

RESULTS: The PFR group was similar to the REV and ORIF groups in all regards except incidence of pre-existing pulmonary disease (39% vs. 15% vs. 16%, p=0.048) and distribution of Vancouver grade (PFR: 62% b2, 22% b3, REV: 100% b2, ORIF: 81% b1, 19% a, p<.001), but showed a trend toward higher overall mortality during the mean 35-month follow up (52% vs. 20% vs. 34%, p=0.086). One-year mortality (26% vs. 10% vs. 10%, p=0.15) and summary non-death complications including deep vein thrombosis (DVT), infection, dislocation and other measures (30% vs. 40% vs. 34%, p=0.80) were not different between groups. Comparing only the PFR group to the REV group, PFR had a trend towards higher dislocation (26% vs. 5%, p=0.062) and need for revision arthroplasty (22% vs. 3%, p=0.10). Infection rates (17% vs. 15%, p=0.83) were not different, but were comparatively lower in the ORIF group (3%, p=0.079). The ORIF group had a 12% incidence of nonunion requiring revision. Operative times were not different between groups (172 min. vs. 162 min. vs. 168 min, p=0.92). PFR implant survival for revision was 94.1% at one year and 69% at five years.

DISCUSSION AND CONCLUSION: PFR is an expeditious reconstruction option for periprosthetic fractures with bone loss about the hip and allows for early mobilization and ambulation. Although complication profiles and short-term mortality are high, they are nevertheless similar to revision arthroplasty or ORIF when treating this difficult clinical problem. We attribute the high dislocation rate to the absence of constrained design use in a portion of our series.

PAPER NO. 183
Periprosthetic Supracondylar Femur Fractures: Mechanical Relevance of Anterior Cortex Notching
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INTRODUCTION: Mechanical factors may influence survival of total knee arthroplasty. Our findings strongly suggest notching of the anterior femoral cortex during total knee arthroplasty influences fracture pattern and risk of early fracture. More than 400,000 (2003) total knee arthroplasty (TKA) procedures are performed annually in the United States. The prevalence of supracondylar fractures after total knee arthroplasty is approximately 1% (range 0.5 to 2%). Different general risk factors for femoral fractures proximal to a total knee replacement have been documented. Procedure related factors including notching of the anterior cortex of the distal femur have been discussed controversially. The purpose of this study was to define risk factors for periprosthetic supracondylar femur fractures after total knee arthroplasty.

METHODS: We identified 35 patients who underwent operative treatment of 36 supracondylar femur fractures after total knee replacement between 2002 and 2009 in two level I trauma center. The injuries were classified according to the OTA/AO and Lewis/Rorabeck classification. Mechanism of injury and time from arthroplasty to fracture were recorded. Plain radiographs were examined using adjusted rulers and the picture archiving and communication system (PACS).

RESULTS: Mean age was 73.2 years (range 54 to 95 years). Gender was four male and 31 female patients. The average BMI was 32.4 kg/m² (18-54 kg/m²). Mean follow up was 22 months (6-89). A total of 31 patients (88.6%) suffered from a low energy injury mechanism and four patients had a high energy injury mechanism. Open fractures occurred in two patients. All patients were classified as 3A fractures. Nine patients (25%) were diagnosed with notching of the anterior femoral cortex. The mean time from TKA implant to fracture was 70 months (1-180). The mean distance to prosthesis fracture measured on plain radiographs was 26 mm (0-109 mm). Distance from prosthesis to fracture was significantly shorter with notching (3.2 mm, 0-32 mm) than without notching (39 mm, 0-109 mm) (p=0.02). In addition, with notching 77.8% (7/9) had a fracture ≤ 5 mm from the prosthesis compared to 25.9% (7/27) without notching.

DISCUSSION AND CONCLUSION: Different general risk factors for femoral fractures proximal to a total knee replacement have been documented. These fractures have been associated with rheumatoid arthritis, chronic steroid therapy and other conditions that result in osteopenia of the distal part of the femur. Procedure related factors including notching of the anterior cortex of the distal femur have been discussed controversially but may influence survival of total knee arthroplasty. Our findings strongly suggest notching of the anterior femoral cortex during total knee arthroplasty influences fracture pattern and risk of early fracture, decreases surgical treatment options and increases morbidity. Further studies are warranted.

PAPER NO. 184
A Population-based Matched Cohort Study of Total Knee Replacement after Operatively Fixed Tibial Plateau Fractures
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INTRODUCTION: Intra-articular fractures of the proximal tibia are commonly treated with open reduction and internal fixation (ORIF) to restore alignment and stability and achieve an anatomic joint reduction. If achieved, these goals should minimize post-traumatic arthritis (PTA) and subsequent salvage operations. Anecdotal experience and few published long-term follow up of tibial plateau surgery patients suggests that PTA necessitating total knee arthroplasty (TKA) is relatively uncommon. However, the rate of TKA after ORIF tibial plateau has never been compared to the rate of TKA in the general population. The goals: (1) Define the temporal relationship between ORIF tibial plateau and eventual TKA, compared to a matched sample from the general population; (2) Identify the patient, provider and surgical factors associated with a greater risk of eventual TKA after ORIF tibial plateau.

METHODS: Administrative datasets from the province of ON were used to identify all patients who underwent ORIF tibial plateau from 1996-2009. Patients younger than 16 years, non-ON residents, bilateral injuries and those who underwent TKA or ORIF tibial plateau in the previous five years were excluded. The main outcome was TKA determined by physician fee code in the follow-up period. Patients were censored if they died, moved from the community or left Canada.
Average follow-up Harris Hip Score was 67.9, which was significantly worse compared to our historic controls (avg 84.7). The remaining seven patients (36.8%) experienced catastrophic failure. Modes of failure consisted of broken screws with varus displacement, intra-articular penetration of the fixed angle screws after collapse of the head fragment or dissociation of the distal screw from the shaft. Five of these patients required THR while the remaining two died.

**DISCUSSION AND CONCLUSION:** ORIF of femoral neck fractures using a locking plate construct was associated with unacceptably poor outcomes. Femoral neck union seems to require some amount of micromotion along the axis of the neck to counteract the presence of any fracture site resorption or distraction. The stiffness of this construct prevented any such autodynamization, leading to failure.

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**PAPER NO. 186**

**Early Detection of Lateral Cortical Lesions in Atypical Subtrochanteric Fracture Using DXA Hip Images**

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**INTRODUCTION:** To assess the use of DXA hip imaging in its ability to accurately depict changes in the lateral cortex of the proximal femur prior to the occurrence of atypical subtrochanteric fractures in patients on bisphosphonate therapy. METHODS: The medical records and the most recent DXA hip images of 47 women who sustained atypical subtrochanteric fractures were retrospectively reviewed. Of these, 28 had images before the index date were compared. Among the ORIF plateau cohort, a survivorship analysis using a cox proportional hazards model was fit to the data and included patient factors, surgical factors and surgeon volume of procedure. A cox model was also applied to the mixed cohort including controls and operatively treated patients. Hazard ratios with 95% confidence intervals were calculated. RESULTS: We identified 8426 patients with a median age of 48 years (IQR 37-61) and 48.5% female who underwent ORIF tibial plateau. These were matched to 33698 controls. The prevalence of TKA after two years was 0.32% post-ORIF vs. 0.29% in controls; after five years 5.3% vs 0.82%; and after 10 years 7.3% vs 1.8%. The Kaplan-Meier survival was 98.2% (controls) and 92.7% (ORIF) at 10 years. Co-morbidity was found to be a risk for TKA. After adjusting for co-morbidity, tibial plateau ORIF increased the likelihood of TKA (HR 5.29 (4.58-6.11) p<0.0001. In the surgical cohort alone, higher rates of TKA were associated with age (HR 1.03 per year (1.03-1.04); p<0.0001), bicondylar fracture types (HR 1.53 (1.26-1.84); p<0.0001), and greater co-morbidity (HR 2.17 (1.70-2.77); p<0.001). Factors such as after-hours surgery, surgeon volume and academic hospital status were not risk factors for subsequent TKA.

**DISCUSSION AND CONCLUSION:** Patients who undergo operative repair of a tibial plateau fracture have a four-fold higher prevalence of TKA after 10 years compared to age and gender matched controls.

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**PAPER NO. 185**

**Outcomes Following Internal Fixation of Femoral Neck Fractures with a Novel Locking Plate Implant**

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**INTRODUCTION:** Femoral neck shortening after open reduction internal fixation of femoral neck fractures is a common problem. We utilized a fixed angle implant designed specifically for femoral neck fractures in order to provide a more rigid construct to prevent loss of reduction and shortening. It was our hypothesis that this device would result in better preservation of intraoperative reduction and improved clinical outcomes compared to historical controls. METHODS: A total of 21 consecutive patients were treated with a posterolateral femoral locking plate. This consisted of a side plate accommodating multiple 7.3 and 5.0 locking screws directed into the femoral head at converging/diverging angles and a single shaft screw. One-year follow up was required. Maintenance of reduction was assessed by comparing immediate postoperative and final follow-up x-rays. Harris Hip Scores, complications and secondary operations were noted. RESULTS: Eighteen of 21 femoral neck fractures with mean follow up of 16 months were analyzed. Seventeen of 18 had anatomic reductions. Eleven of 18 (61.1%) achieved bony union; in these patients, the average displacement of the center of the head was 0.78mm inferiorly and 1.62mm medially with an average increase of 2.41 degrees of varus. These results do not differ from historical controls. In these patients, complications include one instance of hardware fracture, two total hip replacements and one ORIF for a subtrochanteric femur fracture at the level of the distal screw. The

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**PAPERS, POSTERS & SCIENTIFIC EXHIBITS TRAUMA**
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Outcomes of Cephalomedullary Fixation for Low-Energy Intertrochanteric Hip Fractures

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INTRODUCTION: Tip apex distance (TAD) has been shown to be the best indicator for screw "cut out" with compression hip screws. Some studies have shown similar trends with cephalomedullary (CM) fixation as well. The primary aim of the study is to determine if a TAD greater than 25 mm increases risk of "cut out" following modern design CM fixation of low-energy, geriatric, intertrochanteric fractures of the proximal femur. Secondary aims include reoperation for all causes and mortality within one year. METHODS: We conducted a multi-center, retrospective study reviewing perioperative variables and reporting on the outcomes of reoperation and mortality within one year of surgery. All low energy intertrochanteric hip fractures in patients over 55 treated with cephalomedullary fixation between January 2006 and December 2009 were reviewed. Exclusion criteria included age <55; high energy, open, pathologic or subtrochanteric/reverse oblique fractures; neurovascular compromise or spasticity; inadequate perioperative data; or greater than seven-day delay to surgery. RESULTS: The current data include 386 patients from six centers with an average age of 80.0 (range 55-99), and 70.0% were female. ASA scores ranged from 2 - 5 with 69.9% being ASA 3. Four patients at one center were designated ASA 5. Time from presentation to surgery was <48 hours for 77.5% of patients. 37.6% of fractures were simple (OTA A1) and 62.4% were multifragmentary (OTA A2). A distal locking screw was utilized in 75.1% of cases. Tip-apex distance averaged 20.0 mm (range 7.3 - 54 mm) and 78 implants (20.3%) were placed at a TAD > 25mm. The all cause reoperation rate was 4.7% (18 patients). "Cut out" of the lag screw in the femoral head was seen in six patients. TAD of the failed implants averaged 25.0 (range 18.5-29). Three patients returned to the operating room for deep infection. Six patients had another fall resulting in a periprosthetic fracture requiring reoperation. Four patients had the lag screw/helical blade removed or exchanged secondary to pain at the lateral prominence. A total of 56.3% of patients were discharged to a skilled nursing facility while only 17.8% were discharged home. The all-cause mortality within one year was 21.8% for this patient population. DISCUSSION AND CONCLUSION: Geriatric intertrochanteric hip fractures can be successfully treated with cephalomedullary fixation, with an all-cause low reoperation rate of 4.7%. Failure of fixation due to "cut out" of the femoral head was seen in only six cases despite 78/386 implants (20.3%) being placed at TAD > 25 mm. This data is in contrast to a recent meta-analysis that indicates a higher reoperation rate with cephalomedullary implant use compared to the compression hip screw. These data suggest that the cephalomedullary implant may be more forgiving to the surgeon than the compression hip screw with respect to tip-apex distance.

Stopping Bisphosphonate Treatment Decreases the Risk of Having a Second Atypical Femur Fracture

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Denise Greene, RNP, Cypress, CA
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INTRODUCTION: There is growing evidence of an associate of atypical femur fracture and use of bisphosphonates. In patients with an index atypical femur fracture, over 20% will develop an atypical femur fracture on the contralateral femur. There is no published work showing if stopping the bisphosphonate treatment reducing the risk of developing an atypical femur fracture on the contralateral femur. The objective of this study is to evaluate the occurrence of bilateral atypical femur fracture in patients who either continued or discontinued bisphosphonate treatment after their index atypical femur fracture. METHODS: This was an observational study. Data were collected on all femur fractures from 1/1/2007 until 12/31/2009 in patients older than 45 years enrolled in a large HMO in CA. Potential atypical fractures were identified by femur fracture ICD9 codes and adjudicated by examination of the radiographs. Bisphosphonate exposure was obtained the health plans pharmacy database. The primary analysis examined the occurrence of a contralateral atypical femur fracture after the index atypical femur fracture had occurred in patients who either continued or discontinued use of bisphosphonates. RESULTS: There were 126 patients with an atypical femur fracture identified during the study period who were on a bisphosphonates prior to their atypical femur fracture. The incidence of bilateral atypical femur fractures is 41.2% in patients who continue bisphosphonates for three or more years after the index atypical femur fracture versus 19.3% in patients who discontinue bisphosphonates for less than three years after their index atypical femur fracture. The risk of a contralateral atypical femur fracture is decreased by 53% (p = .042) if bisphosphonates were stopped after the index atypical femur fracture.
(segmental), and 12 32-C.3 (multifragmented) fractures (four open grades 3A/B). The median length of the segment or, of the comminution was 13.1cm (3.9-26.6). There was bone loss in five cases (ranging 7.8 to 13.6cm). Median ISS was 22 (9-41), median NISS was 27 (13-43). Half were managed according to ETC and half in stages (DCO). Deep local sepsis complicated six cases, one thromboembolism, one femoral head AVN and two systemic complications. Three months post-injury mortality was 18%. The rest, nine of 19 fractures, united after median period of eight months (six to nine). There were two delayed-unions (healed at 11 and 12 months) and eight nonunions. Secondary interventions were necessary for nine cases (six healed, three still under treatment). DCO was associated with higher ISS/NISS, mortality, while the clinical outcome of either treatment protocol was comparable.

**Discussion and Conclusion:** Severe femoral fractures represent an index injury of severe trauma and are associated with multiple other injuries. Their mortality, complication rate and final clinical outcome remain suboptimal irrespective of different management strategies.

**Paper No. 192**

**Discontinuation of Clopidogrel is Not Necessary in Hip Fracture Surgery**

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**Introduction:** An increasing number of elderly patients are managed with long-term antithrombotherapy. Such patients often present with hip fractures requiring surgical intervention and may be at an increased risk of perioperative bleeding and complications. Our aim was to ascertain whether it is necessary to stop clopidogrel preoperatively to avoid postoperative complications following hip haemiarthroplasty surgery.

**Methods:** A retrospective review of 102 patients with ongoing clopidogrel therapy and patients not on clopidogrel who underwent hip haemiarthroplasty for an intracapsular proximal femoral fracture was undertaken. Statistical comparison on pre- and postoperative haemoglobin (Hb), ASA grades, comorbidities, operative times, transfusion requirements, hospital length of stay (LOS), wound infection, haematoma and reoperation rates between the two groups was undertaken. Regression analysis was undertaken to ascertain the risk ratios (RR) of complication and transfusion associated with clopidogrel.

**Results:** There were 50 patients in the clopidogrel group (CG) and 52 in the non-clopidogrel group (NCG). The mean age was 83 years. There was no difference with respect to ASA grade, comorbidities (except cardiac comorbidities), age, gender and operation times between the two groups. The mean preoperative Hb was 12.5 g/dl and 12.6 g/dl respectively in the CG and NCG (p=0.72). The mean postoperative Hb was 10.8 g/dl and 11.1 g/dl respectively in the CG and NCG (p=0.37). Four and two patients respectively required transfusions postoperatively in the CG and NCG (p=0.37). There was no difference with respect to LOS, wound infection, haematoma and reoperation rates between the two groups postoperatively. The covariate adjusted RR for complications and transfusion while being on clopidogrel were 0.92 (95% CI: 0.23 - 3.61) and 1.2 (95% CI: 0.20 - 7.69) respectively.

**Discussion and Conclusion:** Maintaining clopidogrel therapy throughout the perioperative period in high risk patients with intracapsular proximal femoral fractures is not associated with an increased need for transfusion or complications following hip hemiarthroplasty surgery.

**Paper No. 193**

**Transosseous Suturing of Patellar Fractures - A Prospective Cohort with a Historical Control Study**

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**Introduction:** Although tension band wiring fixation of patellar fracture is the most widely used technique, the metal implants related complications including implant failure and postoperative pain are very common and additional procedures are often necessary to treat the complications. The purpose of this study is to evaluate a totally metal free technique using transosseous suturing method and compare with the traditional fixation technique.

**Methods:** A total of 25 patients (mean age of 59.60 years) with displaced patellar fracture treated by transosseous suturing technique were compared with a historical control group of 25 patients who underwent modified tension band wiring fixation of patellar fracture. Lysholm knee scoring scale, union time, union rate, operation time, number of procedures, mean hospitalization days and the complications were compared between cases and controls.

**Results:** Lysholm knee scoring scale (94.3±5.1 versus 93.0±4.4), union time (8.43±2.92 weeks versus 8.64±2.82 weeks) and operation time (69.00±19.31 versus 64.89±14.27 minutes) were not different between two groups. Mean hospitalization days (4.04±1.40 versus 5.76±1.50 days; P < 0.001), number of procedures and the complication rates were significantly lower among transosseous suturing group (P < 0.001).

**Discussion and Conclusion:** Transosseous suturing technique is safe and effective in the transverse or comminuted fracture of patella. Obviously, our method didn’t require removal of the painful implants and can be applicable not only in the transverse patellar fracture but also in the comminuted fractures. The complication rate is significantly lower than conventional tension band wiring technique. Now we prefer to use transosseous suturing technique for patellar fractures.

**Comparison of two groups**

<table>
<thead>
<tr>
<th></th>
<th>Transosseous suturing (n=25)</th>
<th>Tension band wiring (n=25)</th>
<th>P values</th>
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</thead>
<tbody>
<tr>
<td>Age</td>
<td>59.60±14.26</td>
<td>60.70±12.71</td>
<td>0.885</td>
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<td>Sex (M/F)</td>
<td>15/10</td>
<td>13/12</td>
<td>0.569</td>
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<tr>
<td>Time to union (week)</td>
<td>8.43±2.92</td>
<td>8.64±2.82</td>
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<td>Operation time</td>
<td>69.00±19.31</td>
<td>64.89±14.27</td>
<td>0.395</td>
</tr>
<tr>
<td>Hospitalization days</td>
<td>4.04±1.40</td>
<td>5.76±1.50</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Number of procedures</td>
<td>25/0</td>
<td>12/11/2</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Complications: Skin irritation</td>
<td>2</td>
<td>12</td>
<td>0.001</td>
</tr>
<tr>
<td>Complications: Loss of reduction</td>
<td>0</td>
<td>2</td>
<td>0.490</td>
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<tr>
<td>Lysholm knee scoring scale</td>
<td>94.3±5.1</td>
<td>93.0±4.4</td>
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</tr>
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PAPER NO. 194

Gait Analysis after Retrograde and Trochanteric Intramedullary Nailing of Femoral Shaft Fractures

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J. T. Watson, MD, Saint Louis, MO
Lisa K. Cannada, MD, Clayton, MO

INTRODUCTION: The entry starting point for femoral nailing continues to be the focus of debate. Current dogma suggests that retrograde nailing leads to knee pain. Yet the effects of retrograde nailing on gait have not been thoroughly determined. The purpose of this study was to evaluate entry portal influence on gait and stair climbing status following retrograde and trochanteric entry nailing.

METHODS: Institutional Review Board (IRB) approved inclusion criteria included adult patients with isolated femur fractures treated with intramedullary nailing that were clinically and radiographically healed and demonstrated at least six months of device-free ambulation. Demographic and fracture data were collected on the participating subjects. Subjects then completed a musculoskeletal function assessment (MFA) questionnaire, ambulated on a treadmill and demonstrated up and down stair climbing ability. Videotape analysis of all subjects was done by one physician using model software. Data collected included observations of antalgic gait and gait asymmetry on both the treadmill and stair ascent/descent. Additional data points included velocity of gait, hip and knee angles at toe-off and heel-strike. Statistical analysis was completed using descriptive methods to calculate mean and standard deviation. Frequency tables were used for calculation of categorical data significance and Mann Whitney U tests for nominal data sets.

RESULTS: Sixteen patients underwent gait analysis. Subjects were separated into groups based on entry portal location: eight trochanteric entry and eight retrograde intramedullary nails. The average age of the patients was 29 (range: 22-44) in the trochanteric entry group and 32 in the retrograde group (range: 22-45). The average length of time from injury to participation in the study was 24 months (range: 10-41). There was no significant difference between the groups on the MFA questionnaire (p=.127). No differences were noted in subjective measures of gait or stair climbing. When evaluating the kinematics of the knee, no significant difference was measured of the normal or affected knee at heel-strike (p=.550 and .154) or at toe-off (p=.527 and .669). When comparing the hip kinematics between entry portal groups, trochanteric entry patients demonstrated significant differences on the normal limb at toe-off (p<.05) and on the affected limb at heel strike (p<.05) but no significant difference was seen in the normal hip at heel-strike (p=.057) or the affected extremity at toe-off (p=.288).

DISCUSSION AND CONCLUSION: Previous studies have shown significant effects from antegrade femoral nailing in terms of hip abductor function and lower extremity biomechanics. No such studies exist looking at retrograde femoral nailing or comparing the two methods. Although we found no subjective difference in how a patient perceives their lower extremity function, there is an effect on hip function at toe-off of the normal and heel-strike of the affected leg in the trochanteric entry nailing group that is not seen in the retrograde group. Although retrograde nailing does involve the knee joint for proper entry portal placement, it does not have any significant effect on gait function. In conclusion, trochanteric or retrograde nailing may lead to some residual discomfort to the patient but trochanteric entry nailing has the potential to cause a mechanical disturbance in gait. Patients treated with retrograde nails did not demonstrate gait disturbances.

PAPER NO. 195

Optimal Timing for Intramedullary Nailing of Femoral Shaft Fractures Depends on Injury Severity

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Robert V. Cantu, MD, Lebanon, NH
Kevin F. Spratt, PhD, Lebanon, NH

INTRODUCTION: Optimal surgical timing (ST) for treatment of femur fractures in severely injured patients remains controversial. This study was performed to examine in-hospital mortality for patients with femur fractures with surgical timing (ST) and injury severity score (ISS).

METHODS: The National Trauma Databank-version 7.0 was used to evaluate in-hospital mortality for patients presenting with unilateral femur fractures relative to timing and ISS. Chi-square tests evaluated baseline interrelationships of...
PAPERS, POSTERS & SCIENTIFIC EXHIBITS  TRAUMA

**Forceps Reduction of the Ankle Syndesmosis: A Cadaveric Investigation of a Common Technique**

**Thomas Ebinger, MD, Iowa City, IA**

**Phinit Phisitkul, MD, Iowa City, IA**

**JL L. Marsh, MD, Iowa City, IA**

INTRODUCTION: This study investigated the effectiveness of forceps reduction of syndesmosis injuries in a cadaveric model with computed tomography (CT). We hypothesized that there is a location and vector to apply forceps that most accurately reduces the syndesmosis across a range of degrees of induced instability.

METHODS: The study was performed on 10 through the knee lower extremity cadaver specimens. The ankles were dissected to expose all ankle stabilizing structures including the AITFL, syndesmosis, interosseous membrane, deltoid ligament, and the posterior malleolus. Specimens were then sequentially destabilized by releasing or fracturing the structures listed above in a stepwise fashion. Following each step of destabilization we applied clamps to the specimen in three different configurations with respect to the fibula and tibia (Figure 1): posterior tibia-anterior fibula (A3), mid fibula-mid fibula (B2), and anterior tibia-posterior fibula (C1). Clamps were applied with a measurable compressive force for reduction. Following each reduction a CT scan was performed. Syndesmotic reduction was then evaluated on axial cut CT images using the technique described by Elgafy (a direct measurement of anterior and posterior syndesmotic width). Differences between the reductions for different forceps positions and degrees of induced instability were evaluated using ANOVA and paired T test.

RESULTS: At high levels of instability (following release of deltoid ligament, small and large posterior malleolar fractures) there was consistent malreduction of the syndesmosis (P<0.05) with anterior tibia-posterior fibula and posterior tibia-anterior fibula forceps configurations whereas the mid fibula-mid fibula forceps configuration showed no statistical difference in syndesmotic measurements from control ankles.

DISCUSSION AND CONCLUSION: Compression of the syndesmosis with forceps tips applied to the mid tibia-mid fibula position most reliably reduced the syndesmosis to its anatomic position. Application of forceps resulting in a diagonally directed reduction vector caused reproducible malreduction of the syndesmosis. Anatomic and fluoroscopic landmarks can be used to consistently identify the optimal forceps positions.

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**Table 1. Unadjusted and Adjusted Mortality Rates by ISS and Surgical Timing**

<table>
<thead>
<tr>
<th>Surgical Timing (ST)</th>
<th>ISS</th>
<th>ST1:(0-12hr) N=4003</th>
<th>ST2:(13-24hr) N=1751</th>
<th>ST3:(25-48hr) N=1027</th>
<th>ST4:3-30days N=759</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mild-ISS=9 N=2796</td>
<td>0.12-(unadj) 0.30-(adj)</td>
<td>0.17-(unadj) 0.25-(adj)</td>
<td>0.58-(unadj) 0.66-(adj)</td>
<td>1.19-(unadj) 1.43-(adj)</td>
<td></td>
</tr>
<tr>
<td>Moderate-ISS=(10-19) N=3155</td>
<td>0.30-(unadj) 0.71-(adj)</td>
<td>0.29-(unadj) 0.67-(adj)</td>
<td>0.29-(unadj) 0.66-(adj)</td>
<td>0.66-(unadj) 1.93-(adj)</td>
<td></td>
</tr>
<tr>
<td>Severe-ISS=(21-75) N=1589</td>
<td>0.72-(unadj) 4.01-(adj)</td>
<td>0.34-(unadj) 2.28-(adj)</td>
<td>0.49-(unadj) 2.36-(adj)</td>
<td>2.24-(unadj) 5.49-(adj)</td>
<td></td>
</tr>
</tbody>
</table>

**Table 2. Selected In-hospital Relative Risks by Surgical Timing within Specific ISS Levels.**

<table>
<thead>
<tr>
<th>Comparison</th>
<th>ISS-level</th>
<th>RR</th>
<th>95%CI</th>
<th>Interpretation: In-hospital mortality was:</th>
</tr>
</thead>
<tbody>
<tr>
<td>ST4 vs. 1</td>
<td>Mild</td>
<td>4.93</td>
<td>1.60-15.22</td>
<td>4.78 times more likely if surgery in 3-30 days vs. &lt;12hr with ISS of 9</td>
</tr>
<tr>
<td>ST4 vs. 2</td>
<td>Mild</td>
<td>5.75</td>
<td>1.54-21.41</td>
<td>5.66 times more likely if surgery in 3-30 days vs. 13-24hr with ISS of 9</td>
</tr>
<tr>
<td>ST4 vs. 1</td>
<td>Moderate</td>
<td>3.01</td>
<td>1.04-8.70</td>
<td>3.01 times more likely if surgery in 3-30 days vs. &lt;12hr when ISS was 10-19</td>
</tr>
<tr>
<td>ST4 vs. 1</td>
<td>Severe</td>
<td>1.40</td>
<td>0.76-2.56</td>
<td>1.40 times more likely if surgery in 3-30 days vs. &lt;12hr when ISS was 20-75</td>
</tr>
</tbody>
</table>

DISCUSSION AND CONCLUSION: This study supports the work of prior authors who reported that early nailing of femur fractures was beneficial, but also is consistent with more recent studies recommending at least 12 hours delay in fixation in severely injured patients to promote better resuscitation. However, contrary to other recently reported results, delaying definitive care beyond 12% were 65+ years-old, 69% were female, 64% were white, 16% had an open fracture, 9.6% had comorbidities, and there was a 1.4% overall in-hospital mortality rate. Unadjusted and adjusted mortality rates per hundred by timing and ISS groups (Table 1) are summarized below along with selected relative risks (Table 2).
intravenous sedation and a popliteal block. Post-operative, all patients were monitored for their post-operative pain at two, four, eight, 12, 24, and 48 hours after surgery using visual analog scale (VAS). Patients were also monitored for signs of allergic or toxic reactions and post-operative nausea and vomiting. All patients were followed for at least three months to confirm fracture healing.

RESULTS: Fifty-one patients agreed to participate in the study. Twenty-five patients received popliteal block while 26 patients received GETA. There were no anesthesia related complications. At two, four, and eight hours post-operatively, patients who underwent GETA demonstrated significantly higher pain. At 12 hours there was no significant difference between the two groups with regard to pain control. However, by 24 hours, those who had received popliteal blocks had significantly higher pain with no difference by 48 hours.

DISCUSSION AND CONCLUSION: Popliteal block provides equivalent post-operative pain control to general anesthesia alone in patients undergoing operative fixation of ankle fractures. However patients who receive popliteal blocks do experience a significant increase in pain between 12 and 24 hours. Recognition of this “rebound pain” with early narcotic administration may allow patients to have more effective post-operative pain control.

PAPER NO. 528

Psychometric Analysis of Three Functional Outcome Scores in Tibial Plateau Fractures

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Henry M. Broekhuyse, MD, Vancouver, BC, Canada
Pierre Guy, MD, Vancouver, BC, Canada
Piotr A. Blachut, MD, Vancouver, BC, Canada
Gerard Slobogean, MD, MPH, Vancouver, BC, Canada
Kelly A. Lefaivre, MD, Vancouver, BC, Canada

INTRODUCTION: There are many general, orthopaedic, and injury specific functional outcome measures available to the orthopaedic researcher. There is little guidance to which measure in patients undergoing operative fixation of ankle fractures. However patients who receive popliteal blocks do experience a significant increase in pain between 12 and 24 hours. Recognition of this “rebound pain” with early narcotic administration may allow patients to have more effective post-operative pain control.

Do Antibiotic Nails Work for Treating Infected Tibia Fractures?

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Robert V. O’Toole, MD, Baltimore, MD
Theodore T. Manson, MD, Bel Air, MD

INTRODUCTION: Despite the widespread use of custom-made antibiotic impregnated cement nails to treat postoperative deep infection after tibial nailing, almost no data exists regarding the efficacy of this treatment strategy. Our hypothesis was that treating tibia infections with antibiotic impregnated cement nails results in a low rate of infection recurrence at intermediate follow up.

METHODS: We reviewed all patients who underwent intramedullary nailing of a tibia fracture at a single Level I trauma center between 2000-2010 (n=1205) to identify our study group of patients who went on to have an antibiotic nail placed for deep postoperative infection (n=41). We excluded patients who did not have at least six months of follow up leaving 32 patients in the study group (average follow up = 17.6 months). No patient was excluded who demonstrated evidence of infection, regardless of follow up. Average age was 37.8 years, and 93.8% of the patients initially had open fractures. Thirty-four percent had MRSA as at least one of the infecting organisms. Clearance of infection was defined as no further infection or recurrent infections and 24 (75%) who demonstrated no evidence of infection, regardless of follow up. After antibiotic nail removal and underwent massive debridement and ring fixator placement, both with subsequent clearance of infection. The remaining six infections resulted in one below knee amputation, one chronic antibiotic suppression, two patients healed with the antibiotic nail in, underwent removal and debridement with no further infection, and two patients with draining wounds that are still undergoing attempts at infection clearance. No complications of the use of the antibiotic nail were observed.

DISCUSSION AND CONCLUSION: Osteomyelitis after tibial nailing, almost no data exists regarding the efficacy of this treatment strategy. Our hypothesis was that treating tibia infections with antibiotic impregnated cement nails results in a low rate of infection recurrence at intermediate follow up.

RESULTS: There were eight (25%) patients who had persistent or recurrent infections and 24 (75%) who demonstrated no evidence of infection after the initial antibiotic course was stopped.

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treatment tool clearing 75% of infections at the six-month mark. Further work is needed to compare this treatment algorithm to other strategies such as antibiotic treatment without nail removal and massive debridement with ring fixator placement.

PAPER NO. 530
Delayed Flap Reconstruction with Vacuum Assisted Closure Management of the Open IIIB Tibial Fracture
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Kaan Irgit, MD, Danville, PA
Kent Strohecker, MS, Danville, PA
Michelle Matzko, PhD, Danville, PA
Nathaniel C.H. Wingert, MD, Danville, PA
Joseph G. DeSantis, MD, Danville, PA
Wade R. Smith, MD, Englewood, CO

INTRODUCTION: Vacuum Assisted Closure (VAC) therapy has been shown to be effective at reducing bacterial counts in wounds until definitive bony coverage. However, there is continued debate over timing and type of definitive wound coverage even with VAC therapy application. METHODS: From 2004 to 2009, 32 patients with Gustilo Type IIIB open tibia fractures initially treated with VAC therapy were included. The number of debridements, length of treatment with VAC dressing, definitive wound coverage management, and length of hospital stay, flap-related complications, and time to radiographic fracture healing were recorded. RESULTS: The mean Injury Severity Score (ISS) was 17.3 ± 2.0. All wounds closed after being treated with the primary VAC closure. The mean interval between the initial injury and definitive intervention was 10.9 ± 0.3 days. Twenty of 27 patients (74%) underwent rotational muscle flaps; four received free muscle flaps and three only with split-thickness skin grafts for definitive wound coverage. Nine of 32 (28%) patients underwent below the knee amputation (BKA), five without flap coverage after several VAC sessions and four after definitive flap coverage. The average time to union was 10.0 ± 2.0 months. Eight patients developed nonunion and 11 patients developed infections. The average follow-up time is 2.4 ± 0.2 years. Patients were divided into two groups for analysis according to the interval time. The rate of infection was significantly increased in patients who had an interval of more than seven days from the time of injury to flap coverage. DISCUSSION AND CONCLUSION. The VAC therapy may help to reduce the flap size and need for a flap transfer for type IIIB open tibial fractures. However, prolonged periods of VAC usage, greater than seven days, should be avoided to reduce higher infection and amputation risks.

PAPER NO. 531
Plain Radiographs versus CT after Open Reduction Internal Fixation of Tibial Pilon Fractures: What Are We Missing?
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Lauren N. Hinojosa, MD, Dallas, TX
Florian Nickisch, MD, Salt Lake Cty, UT
Rahul Banerjee, MD, FACS, Dallas, TX

INTRODUCTION: Past studies have suggested that anatomic reduction of the articular surface does not correlate with patient outcomes after open reduction internal fixation (ORIF) of tibial pilon fractures. However, these studies are based on post-operative plain radiographs. Our hypothesis was that plain radiographs and fluoroscopy underestimate the severity of articular incongruency after ORIF when compared to post-operative CT scan. METHODS: Intraoperative fluoroscopy, post-operative plain radiographs, and post-operative CT scans were reviewed by a blinded reviewer in 34 patients that underwent ORIF of a tibial pilon fracture. The articular reduction was judged based on articular step-off and articular gap, each of which was measured using a digital imaging software package. For each imaging modality, the reviewer determined whether the articular reduction was anatomic (< 2 mm displacement), fair (2-4 mm displacement) or poor (> 4 mm displacement). The worst (highest) measurement of either the step-off or gap was used to categorize each patient’s images. RESULTS: Of the 34 patients, there were two AO/OTA 43B1 fracture, two 43B3 fractures, eight 43C1 fractures, seven 43C2 fractures, and 15 43C3 fractures. Fluoroscopic images demonstrated anatomic reduction in 19 patients, fair reduction in nine patients, and poor reduction in five patients. Plain radiographs showed 15 anatomic, eight fair, and four poor articular reductions. Articular reduction could not be judged in seven of the sets of plain x-rays and one set of fluoroscopic images due to surgical implants that obscured the articular surface. CT scan demonstrated 10 anatomic, 10 fair, and 14 poor reductions. The assessment of articular reduction correlated between all three imaging modalities in only 15 of 34 cases (44%). In 13 cases (38%), the CT assessment suggested a worse articular reduction than the assessment on fluoroscopy or plain x-ray. In one case, the CT assessment demonstrated a better reduction than the assessment on fluoroscopy or plain x-ray. In three cases, the CT scan demonstrated an inaccurate reduction of the syndesmosis which was not seen on either the fluoroscopy or the plain x-ray. DISCUSSION AND CONCLUSION: Fluoroscopic and plain radiographic assessment of articular reduction after ORIF of pilon fractures is inaccurate when compared to post-operative CT scan. Past studies, which have failed to show a correlation between anatomic articular reduction and clinical outcome, have utilized plain x-rays. Our study suggests that this method of assessment is limited and therefore, the importance of anatomic reduction in the clinical outcome of operative treatment of pilon fractures may not be accurately described in the literature.

PAPER NO. 532
Semi-Extended Tibial Nailing: Knee Pain No Different than that of an Uninjured Background Population
David Rothberg, MD, Salt Lake City, UT
Erik Kubiak, MD, Salt Lake City, UT

INTRODUCTION: There has been growing concern that the current renewed interest in semi-extended tibial nailing will be accompanied by an increase in iatrogenic knee injury. The purpose of this study is to describe injury characteristics and quantify knee pain six to 12 months post extended tibial nailing for Orthopaedic Trauma Association (OTA) classified 42 A-C tibia fractures and compare it to the background prevalence of knee pain in our patient population. METHODS: Eighteen consecutive patients, collected from 8/08 to 1/10, presenting to our university emergency room with 18 OTA classified 42 A-C tibia fractures who underwent tibial nailing through a semi-extended, parapatellar approach. They were given Lysholm Knee Score (LKS) questionnaires at six and 12 months post-operation. Age, mechanism, OTA classification, Gustilo/Anderson and Tscherne classification, Nail-Apex distance (NAD), nail make and diameter, additional fixation, inter-operative complication, post-operative complication, weight-bearing status, additional post-operative procedures, and approach data was collected on all fracture patients. This data was compared to LKS questionnaires of patients presenting to our university trauma clinic with isolated upper
Can Tibial Fracture Gap Volume Be Measured from Plain Radiographs?

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Theodore T. Manson, MD, Bel Air, MD
Robert V. O'Toole, MD, Baltimore, MD

INTRODUCTION: The volume of bone defects is an important parameter in the treatment of open tibial shaft fractures. Currently there are no validated techniques to determine the volume of bone defects based on radiographs alone. Our goal was to create and validate such a technique. METHODS: Fifteen standardized synthetic models of the tibia were divided into three different types of bone defects. Each model was tested with a protocol of three increasing standardized bone defects to create our sample group of 45 bone defects with nine different types of defects. The defect size ranged from 4to 27mL. The actual volume of each defect was determined using a customized and validated "Eureka can." Orthogonal radiographs were obtained for each specimen. Several candidate equations were compared for their ability to predict the actual volume based on radiographic measurements. RESULTS: A simple equation modeled after the volume of a triangular prism performed best: \( V = \left| \frac{1}{2} (\text{Long Gap} + \text{Short Gap}) \right| W_L \), where \( V \) = Volume of defect, Long Gap = longest bone gap on any view, Short Gap = shortest gap on any view, \( W_L \) = width of bone on AP radiograph, and \( W_L \) = width on lateral radiograph). This relatively simple linear equation predicted the actual volume well with a mean error of only 12.8% (95% CI: 10.0% to 15.6%). DISCUSSION AND CONCLUSION: To our knowledge this is the first validated technique for measuring tibial fracture gap volume based only on two dimensional radiographic measurements. This technique may prove useful as a research tool as it could provide an accurate determination of the size of tibial fracture gaps for clinical trials. Further, it may have use as a clinical tool to guide treatment by more accurately determining bone gap volumes from radiographs alone.

PAPER NO. 534

Saline Load Test for Traumatic Arthrotomies of the Ankle

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Brad D. Blankenhorn, MD, Salt Lake City, UT
Christopher W. DiGiovanni, MD, Providence, RI

INTRODUCTION: An important component of evaluating complex peri-articular wounds is evaluation of communication with the underlying joint space. A traumatic arthrotomy or "open joint" requires prompt operative intervention. A frequently used tool for evaluation of traumatic arthrotomies is the saline load test. There exists no information in the current literature regarding the minimal amount of fluid that is required to reliably detect or diagnose traumatic arthrotomies of the ankle. The purpose of this study was to provide a point of reference for physicians employing the saline load test for complex wounds about the ankle. METHODS: Patients presenting for elective ankle arthroscopy were enrolled in the study after obtaining consent. Preoperative bilateral range of motion along with age and indication for arthroscopy was collected. A standard lateral portal, approximately 4mm in size, was made using a 15 blade. The arthrotomy was confirmed by direct arthroscopic visualization. An 18 gauge needle was then placed into the ankle joint medial to tibialis anterior. Normal saline was injected in 5cc increments until frank extravasation from the arthrotomy was observed. The minimal amount of normal saline required was recorded and statistically analyzed. RESULTS: Twenty-one patients with a mean age was 48 were enrolled in the study. The average amount of normal saline injected into the ankle that resulted in extravasation was 10.3cc. In order to determine 90% of simulated ankle arthrotomies 23cc of saline was required, while 95% of arthrotomies were detected with 30cc of saline. (Chart #1). Total operative side range of motion averaged 52 degrees and non-operative side total range of motion was 64 degrees (p=0.0312). However, range of motion did not correlate with saline amount (r²=0.013368) (Chart 2). DISCUSSION AND CONCLUSION: It is critically important to determine if traumatic wounds about the ankle violate the underlying joint space. Our study was intended to guide the implementation of the commonly employed saline load test for diagnosis of tibiotalar traumatic arthrotomies. Based on our results a minimum infusion of 30cc is recommended to identify 95% of 4mm traumatic arthrotomies. This value needs to be interpreted with the understanding that our study is limited by its inherently simulated nature. The fact that our patients presented with preexisting tibial pathology is evidenced by a statistically significant reduction in ankle range of motion compared to the "normal" contralateral side. Capsular scarring and decreased joint volume could have also contributed to this loss of motion and may have led to lower volumes required for extravasation. In conclusion, this work provides a point of reference for performing the saline load test. Based on these results we recommend 30cc to be infused when attempting to identify open ankle joints.
INTRODUCTION: The difficulty of reducing tibial plateau fractures (TPF) located in the posterolateral part of the tibial plateau through anterolateral (AL) approaches is well recognized. Although alternative direct posterolateral (PL) approaches have been recently proposed their potential benefits relative to traditional AL approaches are yet to be demonstrated. The aim of this study was to compare the two-year results of TPF in which the lateral tibial condyle fracture was solely or predominantly located posteriorly in two patient cohorts: one in which the lateral condyle fracture was treated through a direct PL transfibular approach and a second one in which the lateral condyle fracture was treated through an indirect AL approach.

METHODS: Between 2004 and 2009, 18 41B3 lateral TPF isolated to the posterior part of the condyle, as well as 13 41C3 TPF whose lateral condyle fracture component was predominately posterior, were treated in our institution. Between 2007 and 2009, nine of the 18 41B3 and five of the 13 41C3 fractures had their lateral condyle fracture treated through a direct PL transfibular approach, with the 41C3 fractures having associated anteromedial (AM) and posteromedial (PM) approaches as required, and were followed up prospectively. The remaining nine 41B3 and eight 41C3 fractures had their lateral condyle fracture treated through an AL approach or a combined AL AM or PM approach respectively, between 2004 and 2006 and served as a control. The fracture reduction achieved and the maintenance of fracture reduction were assessed by measuring articular steps using manual methods on immediate postoperative radiographs and two-year follow-up radiographs respectively. Overall knee function at two years was assessed using the Lysholm score.

RESULTS: All fractures treated through a direct posterolateral approach were reduced with no measurable articular step on standard radiographs and had no overtime loss of reduction. The median postoperative articular step for the 41B3 fractures treated through an anterolateral approach was 4.25mm (range 0 to 10.7) which over time deteriorated to 7.4mm (range 7 to 11.9). For the 41C3 fractures, the median postoperative articular step was 4.6mm (range 3 to 9.7) which over time deteriorated to 5.3mm (range 4 to 8.1). At two years, the patients with a 41B3 fracture in the posterolateral approach cohort had much improved Lysholm scores, medians 91 (range 53 to 100) versus 79 (range 16 to 95). For the 41C3 fractures the median Lysholm scores in the posterolateral approach cohort were improved but to a lesser degree, medians 63 (range 57 to 76) versus 53 (range 6 to 90).

DISCUSSION AND CONCLUSION: This study suggests that a direct approach ensures better fracture reduction, fixation and functional outcomes at early follow up for these fractures. Adequate maintenance of fracture reduction during healing is likely to suggest continuance of such differences at long term follow up.
Efficacy of Popliteal Fossa Nerve Blockade as an Adjuvant to General Anesthesia in Ankle Fracture Patients

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Thuan V. Ly, MD, Saint Paul, MN
Andrew C. Peters, BA, Hershey, PA
Thuan V. Ly, MD, Saint Paul, MN

INTRODUCTION: Regional anesthesia is commonly used in place of, or in conjunction with, general anesthesia in elective, outpatient foot and ankle surgery. However, there is minimal data about its use in fracture care. This retrospective chart review evaluated the efficacy of popliteal fossa nerve blockade (PFNB) as an adjuvant to general anesthesia in ankle fracture surgery.

METHODS: We reviewed the charts of patients who underwent open reduction and internal fixation for either bimalleolar or bimalleolar equivalent ankle fractures. Group I (24 patients) received general anesthesia alone and Group II (13 patients) received general anesthesia with PFNB. Variables included in analysis were patient's age, sex, injury pattern, ASA score, operative tourniquet time, block usage, daily pain scores, and post-operative narcotic usage.

RESULTS: Patients who had general anesthesia plus PFNB had lower pain scores (mean of 5.6 vs. 7.3) and lower narcotic usage (mean of 41 mg morphine vs. 98mg) during the first hospital day. These differences were significant (p<0.005) and normalized by the second hospital day.

DISCUSSION AND CONCLUSION: Popliteal fossa nerve blockade was effective in decreasing immediate post-operative pain and narcotic usage in this retrospective chart review of ankle fracture patients.

Reamed versus Unreamed Nailing of Tibial Shaft Fractures in Patients Requiring Two or More Re-operations

Mohit Bhandari, MD, Hamilton, ON, Canada

INTRODUCTION: The Study to Prospectively Evaluate Reamed Intramedullary Nails in Tibial Shaft Fractures (SPRINT) trial randomized 1,226 patients with tibial shaft fractures treated by intramedullary (IM) nailing to reamed versus unreamed groups. Using data from this trial, we aimed to determine if there was a difference in the number of patients who required two or more re-operations between the reamed and unreamed groups. We also describe this subgroup of patients.

METHODS: Using the SPRINT data, we identified patients who required two or more re-operations during the 12 month follow-up period. We determined if there were differences in the number of patients with two or more re-operations in the reamed compared to the unreamed treatment group and in patients with open fractures compared to patients with closed fractures. We also documented whether these patients had additional re-operations planned after their 12 month follow up. We compared patient and fracture characteristics in those patients who had two or more re-operations with those who did not have two or more re-operations.

RESULTS: We identified 44 patients who required two or more re-operations. No difference between the reamed and unreamed treatment groups was found in the risk of having two or more re-operations. Patients with two or more re-operations were older (p=0.03), had a higher frequency of open fractures (p<0.001) and had a higher energy mechanisms of injury (p<0.001). Twelve of the 44 patients had additional re-operations planned for after the 12 month follow-up period. The first re-operation was in response to infection for 25 of the 44 patients who required two or more re-operations. Of these 25 patients who had a re-operation to treat infection as their first re-operation, 15 were treated with a reamed nail and 10 were treated with an unreamed nail (p=0.076).

DISCUSSION AND CONCLUSION: A relatively small subgroup of tibial shaft fracture patients required two or more re-operations. Of the patients who had two or more re-operations, over a quarter of them had another re-operation planned after one year from their injury. Patients who had multiple re-operations were typically older, had a higher frequency of open fractures and a higher frequency of high energy fractures than patients who did not have any or only one re-operation. In addition, the first re-operation was often required to treat infection. In the 44 patients who had two or more re-operations, we found a trend towards a higher incidence of the first re-operation being in response to infection in the reamed group than in the nonreamed group. Further study is required to assess the corroborating consequences of needing multiple re-operations including economic impact, pain and function, as well as strategies to prevent further morbidity in this high risk group of patients.

Radiographic Predictors of Compartment Syndrome in Tibial Plateau Fractures

Bruce Ziran, MD, Atlanta, GA
Stephen J. Becher, MD, Atlanta, GA

INTRODUCTION: The purpose of this paper was to evaluate the relationship of specific radiographic characteristics of tibial plateau fractures to the development of compartment syndrome, and to develop a predictive model based on such presenting radiographic features. Specifically, we hypothesized that the direction and degree of initial displacement of the femur on the tibia, as well as the amount of tibial widening, were correlated with the development of compartment syndrome.

METHODS: Using institutional trauma registry, we retrospectively evaluated 158 patients with 162 tibial plateau fractures. These were divided into a group with and without compartment syndrome. To determine factors that might relate to compartment syndrome the following data were obtained: age, sex, fracture Schatzker and AO Classification, and Open/Closed status. The first radiographic parameter was the ratio of width of the tibial plateau at its widest point to the width of the femur at its widest point on the initial AP radiograph, tibial widening (TW=T/F, Figure 1). The second parameter was the absolute displacement between the anatomic axes of the tibia and femur, also on initial AP radiograph. This was normalized by dividing into femoral width (femoral displacement (FD = F/E, Figure 1). A univariate statistical analysis was performed on all variables to determine any significant differences between the two groups, followed by logistical regression analysis.

RESULTS: The overall rate of compartment syndrome in our cohort was 11%. Age, direction of displacement, sex and soft tissue grade were not significant predictors of compartment syndrome. Univariate analysis found both the TW and FD to be highly significant with respect to development of compartment syndrome (P = 0.008 and 0.0001 respectively). Higher Schatzker grades (IV-VI) as well as higher AO grades were correlated (p<0.05) with increased incidence of compartment syndrome. However, logistic regression only found femoral displacement and Schatzker grade to be significant (Figure 2).

DISCUSSION AND CONCLUSION: While there is historical data regarding tibial plateau fractures and compartment syndrome, there are no predictive criteria reported. Our study is the first to identify easily obtained radiographic parameters that seem
correlated to the occurrence compartment syndrome. The study is retrospective and thus limited by its design and subject to potential type II error. There may also be a relation between TW and FD, as noted by regression result. However, the very strong correlations support the intuitive assessment that a greater tibial widening and femoral displacement indicate much higher energy injury. This study helps assess which patients with a fracture are at higher risk for developing a compartment syndrome, which is a powerful tool for the orthopedic surgeon to possess.

PAPER NO. 540

Risk Factors of Wound Complications after Open Reduction Internal Fixation of Ankle Fractures

Adam Miller, MD, Philadelphia, PA
Andrew Margules, BA, Philadelphia, PA

INTRODUCTION: The overall rate of complication after ankle fracture fixation varies between 5 and 40% depending on the population investigated. Wound complications occur in 1.4 - 11% of patients, again a wide range. Large studies have focused on complications in terms of readmission. Few studies have examined risk factors of wound related issues in the outpatient setting with a large number of patients. METHODS: A total of 495 patients underwent open reduction internal fixation (ORIF) of an ankle fracture between 2003 and 2011 by a single surgeon at a single institution. Surgical fractures were categorized and documented as unimalleolar, bimalleolar equivalent, bimalleolar, and trimalleolar fractures of the ankle. Demographics, time to surgery, comorbidities, and postoperative care were tracked. Wound complications were identified as those requiring dressing care and oral antibiotics or requiring further surgical treatment. RESULTS: Of the 495 patients followed, 1% had wounds requiring surgical debridement. Patients required further dressing care or a course of oral antibiotics in 3% of cases. Fisher’s exact test following Chi-Square analyses demonstrated statistically significant associations between wound complication and history of diabetes (p<0.0005), peripheral neuropathy (p=0.001), wound compromising medications (p=0.01), open fractures (p=0.05) and postoperative noncompliance (p=0.01). There were nonsignificant trends of association to fracture type and previous ankle surgery. Time to surgery was not significant. DISCUSSION AND CONCLUSION: These results highlight the difficulty in treating the medically complex and noncompliant populations in follow up. With preoperative monitoring of swelling, time to surgery does not affect wound outcome. While most risk factors cannot be controlled, postoperative care is an area of significance to wound healing. Adherence to postoperative instructions should be a concern to the treating surgeon.

PAPER NO. 601

Ability of Near Infrared Spectroscopy to Isolate Muscle Compartments of the Upper Extremity

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Jonathan Heimlich, BS, Augusta, GA
Sahir Ahsan, BS, Augusta, GA
Brett Freedman, MD, APO, Armed Forces
Michael S. Shuler, MD, Athens, GA

INTRODUCTION: Near infrared spectroscopy (NIRS), a non-invasive means for monitoring muscle oxygenation, may be useful in the diagnosis of acute compartment syndrome (ACS). Currently, there is no existing gold standard against which to validate oxygenation values from specific muscle compartments. In the context of ACS diagnosis, validation is necessary to accurately identify the compartment. We hypothesized that placement of NIRS sensor pads on the forearm will produce perfusion values specific to each muscle compartment, allowing for the potential of continuous ACS monitoring. This hypothesis was tested by using exercises to alter muscle perfusion of each compartment. METHODS: Alteration of muscle oxygenation via exercise was employed to validate the anatomic placement of NIRS sensor pads over the compartments of the forearm. Sixty-three uninjured volunteers were recruited from a clinic-based setting and had NIRS sensor pads placed over the volar (V), dorsal (D), and mobile wad (MW) compartments of one forearm. Forty-nine participants also had the contralateral forearm monitored, which served as an internal control. Participants performed a series of three exercises designed to activate the muscles of each compartment sequentially. Each exercise was separated by a washout period to allow muscle oxygenation to return to baseline. Mean changes in NIRS (percent oxygenation) values of each compartment, recorded during muscle activation, were calculated from baseline values. Mean changes in tissue oxygenation were compared across compartments for each exercise. RESULTS: Mean NIRS values decreased significantly from baseline during muscle activation (V = -26.1, D = -34.4, MW = -26.8 percentage point change; p<0.0001 for all compartments); whereas mean NIRS values of muscle compartments which remained constant (D = 0.4 percentage point change; p=0.8 for all compartments). DISCUSSION AND CONCLUSION: Lack of an existing method for quantifying muscle perfusion precludes validation of this technique against a gold standard. Therefore, this study utilized the decrease in muscle oxygenation caused by exercise to validate NIRS’ ability to isolate compartments of the forearm. During muscle activation of a given compartment, percent oxygenation...
values of that compartment decreased dramatically, while values of neighboring compartments remained stable. These results suggest that NIRS can provide values that are both sensitive and specific to muscle compartment of the forearm. Future studies should investigate NIRS among patients with upper extremity injuries.

Table 1. Mean and interquartile range for near infrared spectroscopy (NIRS) values from each muscle compartment of the forearm, before and after muscle contraction, among 63 volunteers.

<table>
<thead>
<tr>
<th>Test arm</th>
<th>Control arm</th>
<th>Pre*</th>
<th>Post*</th>
<th>Pre*</th>
<th>Post*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volar</td>
<td>Volar</td>
<td>Mean</td>
<td>78.8</td>
<td>56.6</td>
<td>78.8</td>
</tr>
<tr>
<td></td>
<td>IQR</td>
<td>72.86</td>
<td>44.69</td>
<td>72.82</td>
<td>72.84</td>
</tr>
<tr>
<td></td>
<td>Difference</td>
<td>-21.7(32.12)</td>
<td>1.5(0.3)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dorsal</td>
<td>Dorsal</td>
<td>Mean</td>
<td>68.2</td>
<td>37.0</td>
<td>70.4</td>
</tr>
<tr>
<td></td>
<td>IQR</td>
<td>67.75</td>
<td>49.74</td>
<td>66.77</td>
<td>67.78</td>
</tr>
<tr>
<td></td>
<td>Difference</td>
<td>-34.8(49.24)</td>
<td>1.4(0.2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mobile Wad</td>
<td>Mobile Wad</td>
<td>Mean</td>
<td>73.9</td>
<td>50.0</td>
<td>74.2</td>
</tr>
<tr>
<td></td>
<td>IQR</td>
<td>70.79</td>
<td>43.59</td>
<td>72.78</td>
<td>72.80</td>
</tr>
<tr>
<td></td>
<td>Difference</td>
<td>-24.6(34.14)</td>
<td>0.8(0.2)</td>
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</tr>
</tbody>
</table>

*Values are presented as percent oxygenation; values from stimulated compartments are shown in bold.

PAPER NO. 603

Can it wait until Morning? A Meta-Analysis of the Six-Hour Rule of Open Fracture Management

INTRODUCTION: Existing guidelines recommend emergent surgical debridement of open fractures within six hours of injury. However, there is limited evidence to support the 'six-hour rule.' The aim of this study was to systematically review the association between time to operative debridement and infections.

METHODS: Medline, EMBASE, 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 time to operative debridement and infections were included. Descriptive and quantitative data was extracted. A meta-analysis was performed using a random effects model for cohorts who experienced early or delayed debridement. Three sensitivity analyses were performed to evaluate effects of injury severity, depth of infection, and level of evidence. Study heterogeneity, criteria of methodological quality and publication bias were also evaluated.

RESULTS: Initial search identified 885 references. Of the 712 articles further inspected by title, 16 were included (six prospective, and 10 retrospective cohort studies), and 14 offered sufficient data for the meta-analysis. The majority of studies (11) used the six-hour rule to delineate early and late debridement groups, one study used five hours, and two studies used eight hours. Meta-analysis showed no difference in infection between early and late debridement. The adjusted cumulative odds ratio was 0.93 (95% confidence interval: 0.72 to 1.21). Sensitivity analyses demonstrated no difference in infection rates between early and late debridement according to Gustilo-Anderson classification (Type I/II odds ratio: 0.58 (95% confidence interval: 0.25 to 1.33), Type III odds ratio: 0.84 (95% confidence interval: 0.31 to 2.31)), level of evidence stratification (level II odds ratio: 1.13 (95% confidence interval: 0.63 to 2.03), level III odds ratio: 1.04 (95% confidence interval: 0.65 to 1.65)), or depth of infection (deep infections odds ratio: 1.07 (95% confidence interval: 0.74-1.54)).

DISCUSSION AND CONCLUSION: The six-hour rule is an easily applicable standard, widely used, and consistent with current published evidence. However, the categorical evidence is based on Level III evidence, and the meta-analysis demonstrated no difference in infection rates between early and late debridement. Further prospective studies are needed to provide a firm foundation for this practice.
Management of Post-traumatic Osteoarthritis with an Integrated Orthotic and Rehabilitation Initiative

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Johnny Owens, San Antonio, TX
Ryan Blanck, Fort Sam Houston, TX
Kevin L. Kirk, DO, San Antonio, TX
Joseph R. Hsu, MD, San Antonio, TX

INTRODUCTION: Osteoarthritis is one of the most common and disabling conditions affecting American adults. Twelve percent of all cases in the United States are believed to have a post-traumatic origin, and these typically affect a younger, more active patient population. Current treatment options for end-stage post-traumatic osteoarthritis (PTOA) of the ankle include arthrodesis or arthroplasty, each of which has limitations when used for active individuals. At our facility we have instituted an integrated orthotic and rehabilitation initiative known as the Return to Run clinical pathway (RTR) which incorporates an energy storing ankle foot orthosis (AFO) with high-intensity rehabilitation for our military limb salvage patients. The purpose of the current investigation is to describe a series of combat wounded patients with ankle or subtalar joint PTOA who have been treated with the RTR.

METHODS: The RTR database was queried for all patients with known PTOA of the ankle or subtalar joint who did not undergo arthrosesispriorirollmentintheRTR. Demographic, surgical information and time between injury and development of PTOA was collected for all patients. Outcome measures included functional, occupational and recreational capabilities.

RESULTS: Ninety-one patients have completed or are enrolled in the RTR. Sixteen subjects (18%), 15 male and one female between the ages of 22 and 40 years were identified. All sustained their injuries in high energy trauma, with explosions being the most common mechanism. Six initially expressed a desire to undergo amputation of their injured limb but since enrollment in the RTR only one still desires an amputation. The average time between injury and first diagnosis of PTOA was 17 months (range 4-72). Eight fusion procedures have been performed on seven subjects (four ankle, four subtalar). Ninety-four percent ambulate without assistive devices, 81% can run, 75% can jump, 100% can stand for longer than one hour continuously, 69% can move with a load greater than 20 pounds, 69% participate in recreational agility sports and 44% have return to active military duty including two subjects who have deployed to combat with the Special Forces.

DISCUSSION AND CONCLUSION: The RTR is a unique clinical pathway designed for military limb salvage patients that allows significant improvements in functional performance. For those with PTOA of the ankle or hindfoot, this integrated orthotic and rehabilitation initiative may provide a viable alternative to arthrodesis or arthroplasty.

Table: Comparison of MFA Normative Data

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Mean (SD)</th>
<th>N</th>
<th>Mean (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
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<td>24.06 (19.31)</td>
<td>123</td>
<td>9.26 (8.89)</td>
</tr>
<tr>
<td>Male</td>
<td>235</td>
<td>22.04 (17.40)</td>
<td>56</td>
<td>8.24 (9.71)</td>
</tr>
<tr>
<td>Female</td>
<td>217</td>
<td>26.25 (21.01)</td>
<td>67</td>
<td>10.11 (8.18)</td>
</tr>
<tr>
<td>18-35</td>
<td>60</td>
<td>19.23 (13.81)</td>
<td>61</td>
<td>7.91 (7.56)</td>
</tr>
<tr>
<td>36-55</td>
<td>121</td>
<td>19.23 (18.96)</td>
<td>48</td>
<td>9.04 (9.54)</td>
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<tr>
<td>56-89</td>
<td>271</td>
<td>27.54 (19.28)</td>
<td>14</td>
<td>15.91 (9.62)</td>
</tr>
</tbody>
</table>

*The FDA has not cleared the drug and/or medical device for the use described in this presentation (i.e. the drug or medical device is being discussed for an off label use). For full information refer to page 14. An alphabetical faculty financial disclosure list can be found starting on page 19.
INTRODUCTION: Current combat operations have resulted in an increase in service members sustaining multiple traumatic extremity amputations. Despite the frequency, severity and disability associated with multiple extremity amputations in conflict, no reports exist concerning the resource utilization associated with their care.

METHODS: After Institutional Review Board approval, the Combat Trauma Registry (CTR) was queried for U.S. service members with major extremity amputations sustained in Operation Iraqi Freedom (OIF) and Operation Enduring Freedom (OEF) between September 2007 and December 2010. Data extracted included age, mechanism of injury, the extremity(s) amputated, number and type of associated injuries, blood products utilized, intensive care unit length of stay (ILOS), hospital length of stay (HLOS) and the Injury Severity Score (ISS).

RESULTS: A total of 685 trauma admissions were registered during the study period. The records of 113 patients with traumatic amputations were identified. Four patients had incomplete records and were excluded. Therefore the data of 109 patients were analyzed. Patients were stratified to one of two groups based on the number of amputations sustained. Sixty-three patients comprised the multiple extremity amputation (MEA) group and 46 patients comprised the single extremity amputation (SEA) group. The mean age of the MEA group was 23.5 ± 3.86 years old (range: 19-39) and the mean age of the SEA group was 22.9 ± 3.95 years old (range: 18-38). 62 (98%) of the MEA sustained injuries secondary to an improvised explosive device. Sixty-one (96%) were dismounted. Thirty-seven (80%) of the SEA injuries were secondary to an IED blast. The 63 patients in the MEA group sustained a total of 137 amputations, including two patients with four extremity amputations, seven patients with three extremity amputations and 54 patients with two extremity amputations. All of the MEA patients sustained bilateral lower extremity amputations with 31 of the 63 sustaining bilateral lower extremity amputations at a transfemoral level or higher. Three of the MEA patients eventually underwent a hip disarticulation and three patients underwent a hemipelvectomy. One patient underwent bilateral hip disarticulations. The MEA group sustained a mean of 6.6 ± 3.87 injuries versus a mean of 6.1 ± 4.1 injuries (range: 0-16) for the SEA group (P = .25). The mean ISS of the MEA group was 21 ± 7.74 (range: 9-42) and the mean ISS of the SEA group was 17 ± 9.69 (range: 9-43) (P = .019). MEA patients with associated pelvic fractures had a higher mean ISS (26 vs 17, P = .003). While the two groups did not differ significantly with respect to hospital length of stay (mean MEA HLOS 28 days, P = .059), the MEA group had a higher number of surgical encounters at a mean of 8.6 ± 3.32 (range: 3-17) versus 3.9 ± 2.9 (range: 0-13) (P = .005) for the SEA group. The mean blood product utilization was 19.5 ± 18.2 (range: 0-104) units of packed red blood cells for the MEA group and 6.1 ± 6.03 units for the SEA group (range: 0-23) (P = .005). The mean ICU LOS was 9.3 ± 13.7 days (range: 0-69) for the MEA group versus 3.7 days for the SEA group (P = .004). Increased ISS correlated with longer ICU LOS for both groups. Overall mortality was 4% (n = 5), with all deaths occurring in the multiple extremity group.
Aquatic Therapy to Facilitate Early Weight Bearing: Safety Data to Guide Therapy in Lower Extremity Trauma Patients
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Daniel S. Horwitz, MD, Danville, PA
Thomas F. Higgins, MD, Salt Lake City, UT

INTRODUCTION: Aquatic therapy is an established method for rehabilitation of injured athletes and mobilization of geriatric patients. For four years, the study authors have now been using aquatic therapy to facilitate early and controlled progressive weight bearing (WB) in our patients with lower extremity articular injuries. In order to accurately determine the weight applied at various water levels, we conducted a normalization study to validate our WB protocol. The goal of the study is to establish normalized values at easily identifiable anatomic landmarks.

METHODS: After obtaining Institutional Review Board approval, we weighed uninjured normal volunteers on dry land. The same volunteers were then measured on a submersible force plate at each of the water levels used in our aquatic weight bearing protocol: 1) at the level of the neck (C7) during (a) full inspiration and (b) full expiration; 2) at the level of the nipples; 3) and at the level of the navel. All volunteers had their body fat measurements obtained by a trained examiner.

RESULTS: Forty-five female and 18 males volunteered to participate in the study (P = 0.78). Average age in years of our volunteers was similar: females 55.0 (range 21-81) years and males 56.3 yrs (range 22-77) [P = 0.51]. Dry land body weight in pounds for females averaged 169.2 lbs versus 191.7 lbs for males: P=0.05. Body fat percentages were dissimilar between the two groups: 40.3% for females and 29.7% for males (P<0.01). Percentage of force applied to the sensor with water at level of the neck was significantly affected by inhalation and exhalation for both females, 5.5% (inhaled) to 6.9% (exhaled) [P=0.01], and males, 6.5% (inhaled) to 9.0% (exhaled) [P=0.03]. Submerged percentage of body weight applied to the force plate was different at the level of the navel for females 49.8% (33.9-59.6%) and males 55.3% (48.4-59.4%) [P<0.01]. At the level of the nipple the percentage of force applied was similar: 23% (13.9-32.3%) females versus 25% (13.0-38.6%) [P=0.20].

DISCUSSION AND CONCLUSION: Aquatic therapy helps with progression of weight bearing by controlling multiple factors. The water reduces the risk of falling and overloading the healing fracture accidently during therapy. Buoyancy supports the body, reducing the need to use the upper extremity to protect the lower extremity; this is particularly important for patients with upper extremity injuries, decreased upper extremity muscle mass, and obesity. Resistance from water may help to maintain muscle tone in the core and extremities. The results of this study establish the effective weight of patients at various depths of immersion, permitting their use in a program of graduated weight bearing. These data confirm the decreased force experienced by the lower extremity with increased immersion. The simple anatomic landmarks should be understandable for lay people and provide a guide to facilitate progressive weight bearing of the lower extremity: neck 6-9%, nipple 23-25%, and navel approximately 50%.

Magnetic Resonance Imaging in the Presence of Metallic Artifact as a Function of Distance to the Articular Surface
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Jutta Ellermann, Minneapolis, MN
Steen Moeller, PhD, Minneapolis, MN
Lisa K. Schroder, Rochester, IN
Peter A. Cole, MD, Saint Paul, MN

INTRODUCTION: Magnetic resonance (MR) has become the most important diagnostic imaging tool for noninvasive assessment of intraarticular joint abnormalities. MR inherent soft tissue contrast allows for cartilage, tendon and ligament evaluation. Ankle fractures are common injuries, which often require ORIF (open reduction internal fixation) using metal plate and screw fixation. Titanium and stainless steel introduce a substantial artifact interfering with the diagnostic value of the MRI study. The purpose of this experiment is to characterize and quantify the MR signal deterioration in the presence of stainless steel and titanium implants using current state of the art clinical MR technology.

METHODS: Six fresh bovine distal tibias were acquired from a local slaughterhouse. Three fully threaded 3.5 mm cortical bone screws, 40 mm in length were embedded into the distal tibias at distances to the articular cartilage varying between 1.4 to 12 mm using stainless steel (three specimens) and titanium (three specimens), respectively. The samples underwent imaging using a dedicated high-resolution iPAT compatible eight-channel wrist coil. Imaging parameters, such as bandwidth and resolution were adjusted to allow for the best possible clinical metallic artifact reduction. Each sample was scanned with and without screws. Normalized articular cartilage signal intensity was measured in the presence of the metallic implants and compared to the signal without artifact. The introduced signal interference was plotted as a function of distance to the articular surface (n= 18).

RESULTS: Data analysis revealed that articular cartilage signal intensity was non-measurable for all magnetic resonance images with stainless steel screws placed within 12 mm from the articular surface. Signal intensities were also non-measurable for MR images with titanium screws placed within 5 mm of the articular surface of the distal tibia. The mean normalized articular cartilage signal intensity in images with titanium screws placed greater than 5 mm (5 -10.5 mm) was 265.04 (au) (STD = 79.6). The mean normalized cartilage signal intensity for control samples without screws was 244.83 (au) (STD = 126). There was found to be no statistically significant difference between articular cartilage signal intensity measurements taken without screws and with titanium screws at least 5 mm from the articular surface (P=0.72) using best possible clinical imaging techniques at 3T.

DISCUSSION AND CONCLUSION: For the first time the experimental comparison of normalized signal intensities in distal bovine tibia articular cartilage with and without metallic implants revealed distance dependent data on image degradation. In bovine distal tibia articular cartilage with stainless steel screws (up to 12 mm from the articular surface) all images were degraded by artifact and were non-diagnostic. In tibias with titanium screws degradation of images extends up to a distance of 5 mm away from the articular surface. Results of the study as described above, using the best possible clinical imaging techniques, indicate that articular cartilage in the ankle joint can be assessed in the presence of titanium hardware, if the titanium screw is at least 5 mm away from the articular surface. This experiment may be the basis for future studies examining advancement in MR techniques.
Post-operative Infection in Low Energy Fracture Fixations

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Seo Kiat Goh, FRCS(Orth), London, United Kingdom
Merng K. Wong, MD, Singapore, Singapore

INTRODUCTION: Low energy hip fractures are one of the most common fractures in the elderly with ~1.7 million hip fractures occurring annually worldwide. In the United States, the average cost for inpatient hip fracture care is $26,000 per episode. Only a few patients regain their former level of independence after sustaining a hip fracture and mortality rates at one year have been reported at 10%-20%. Out of the possible morbidities, post-operative surgical site infections (SSIs) are one of the major complications of hip fixations. SSIs may lead to revision arthroplasties, cause an economical burden to the patients and the families, lead to a longer hospital stay and eventually impose antimicrobial resistance. Our aim was to determine the predisposing factors for SSIs.

METHODS: A case control study of hip surgeries done in a tertiary hospital conducted from 1 January 2005 to 30 June 2010. Surgeries were done from 1 January 2005 through 31 December 2007. Mean follow up for cases was 59.5 days (SD 181.9) and controls 64.9 days (SD 122.5). A total of 1,217 patients were selected with the inclusion criteria of age above 60 years, excluding pathological and high energy traumatic fractures. Fifty-nine SSIs were identified using standard infection surveillance guidelines. Age and fracture type matched controls were selected from the same cluster of patients using random number tables. Cases and controls were compared pre, intra and post operatively. Cases were separately analyzed for the relationship between infective organisms and the type of SSI.

RESULTS: The overall incidence of SSI in hip surgeries was 5.18%. Arthroplasties showed a higher number of superficial and deep infections (P <0.01). Pre-operative pyrexia of ≥37.8 degrees Celsius within 48 hours of operation (p=0.01), pre-operative chest infection (p=0.02), ASA score more than 3 (p=0.01), intra-operative time more than two hours (p=0.01), drainage for the past 24 hours more than 200ml at the time of removal of drain (p=0.05), pre operative high absolute neutrophil percentage of more than 75% (p=0.02) were the major predictors of SSIs. Gender (p=0.37), pre-morbid ambulatory state (p=0.4), preoperative total white cell counts (p=0.62), preoperative urinary tract infection (p=0.6), insertion of a drain (p=0.42) and steroid usage did not show any significance. Multi variant analysis identified ASA score and duration of operation as significant independent risk factors for SSIs. Analysis of infections revealed that the most common organism involved was MRSA, 28%. Majority of the infections (68%) which were acquired during the hospital stay were MRSA and pseudomonas. The main pathogen in deep and joint SSIs was MRSA and superficial SSIs were dominated by pseudomonas and acetobacter. Majority of the infections (81%) occurred after one week from the operation.

DISCUSSION AND CONCLUSION: Investigation of the patients for preexisting pyrexia, optimal treatment for underlying pulmonary infection and optimization of co-morbidities should be carried out before the surgical intervention in view of preventing SSIs. Monitoring for high absolute neutrophil percentages in blood was statistically significant more than monitoring high total white blood cell counts. Reducing the intra-operative time to less than two hours and if a drain is inserted, removal of the drain should be done only if the drainage is less than 200 ml for the last 24 hours. Pertaining to the above factors could reduce the patient’s hospital stay by three-fold. In the occurrence of a SSI empirical antibiotics should be chosen to cover gram negative organisms as well as gram positives.
Using a Checklist Improves Agreement between Radiologists and Orthopaedic Surgeons about Hip Fracture Healing

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Olufemi R. Ayeni, MD, Oakville, ON, Canada
Simrit Bains, BS, MA, Ancaster, ON, Canada
Rajesh Chakraverty, MD, Toronto, ON, Canada
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Mohit Bhandari, MD, Hamilton, ON, Canada

INTRODUCTION: The assessment of fracture healing following intertrochanteric fracture fixation is highly variable with no validated standards. Accurate assessment remains critical to ensure the progression of normal healing and appropriate post-operative rehabilitation. The purpose of the present study was to determine 1) the reliability of intertrochanteric fracture healing assessment and 2) the assessment of a novel radiographic scoring system for hip fractures.

METHODS: A panel of six reviewers trained and experienced in musculoskeletal trauma management (three musculoskeletal radiologists, three orthopaedic surgeons) assessed fracture healing for 150 total cases of intertrochanteric fractures at two separate time points with a time lapse of four weeks to determine inter-rater and intra-rater agreement. Reviewers, blinded to the date of imaging, assessed overall healing from two orthogonal radiographs for each patient at a single time point. Patients included in the assessments were at various stages of healing, from immediate post-operative period to 52 weeks. Reviewers also scored each fracture on a scale from 10 to 30 using a Radiographic Union Scale for Hip (RUSH) form to determine the validity of using this scale system to quantify hip fracture healing. This involved the assessment of cortical bridging as well as the disappearance of the cortical fracture lucency at four sites (anterior, posterior, medial and lateral cortices). Two trabecular indices were also scored, one based on consolidation and the other using fracture line disappearance. The quantity of callus formation was also scored.

RESULTS: Overall, inter-rater agreement for the impression of fracture healing between reviewer groups was fair [intraclass correlation coefficient (ICC) = 0.34, 95% confidence interval (CI): 0.11-0.52]. Agreement within the radiologist group was higher than the surgeon group (0.60 vs. 0.24). Use of the RUSH score improved overall agreement between groups to substantial (ICC = 0.66, 95% CI: 0.53-0.75). Intra-rater agreement was almost perfect for fracture healing (ICC = 0.84, 95% CI: 0.74-0.91) and substantial for RUSH score (ICC = 0.69, 95% CI: 0.35-0.84). Reviewers’ subjective assessments of healing seemed to be highly correlated with the overall RUSH score and their assessment of healing of the medial cortex bridging (Pearson’s correlation (r) = 0.72 and 0.53 respectively). The medial cortex bridging was especially correlated with healing among radiologists versus surgeons (r = 0.53 vs. 0.42).

DISCUSSION AND CONCLUSION: The RUSH radiographic score achieved higher inter-observer agreement among reviewers than subjective assessments of fracture healing. Higher RUSH scores and healing of the medial cortex correlated with subjective assessment of overall fracture healing. Studies evaluating agreement with a temporal sequence of the radiographs and the addition of clinical information may further enhance agreement between reviewers.
The FDA has not cleared the drug and/or medical device for the use described in this presentation (i.e. the drug or medical device is being discussed for an off label use).

For full information refer to page 14. An alphabetical faculty financial disclosure list can be found starting on page 19.

PAPER NO. 614

Definitive Plates Overlapping Provisional External Fixator Pin Sites: Is the Infection Risk Increased?

Chirag Shah, MD, Saint Louis, MO
Olubusola Brimmo, MD, Saint Louis, MO
William Ricci, MD, St Louis, MO
Michael Gardner, MD, Saint Louis, MO

INTRODUCTION: Staged management of high energy tibial plateau and pilon fractures typically involves acute spanning external fixation followed by later definitive internal fixation. Current practice is to attempt to avoid external fixator pin placement within anticipated surgical incisions to prevent contamination of the surgical field during definitive open reduction internal fixation (ORIF). However, with the recent popularity of percutaneous plate applications, as well as the biomechanical advantages of long plates for metaphyseal fracture components, this overlap may be unavoidable. The purpose of this study was to compare the infection risk when plates either overlap or do not overlap previous external fixator pin sites in patients with bicondylar tibial plateau fractures and pilon fractures treated with a two-staged protocol.

METHODS: Over a five-year period from 2005 to 2010, all Orthopaedic Trauma Association (OTA) type 41C bicondylar tibial plateau fractures and all OTA type 43C pilon fractures that were treated via two-staged external fixation followed by ORIF were reviewed. Patients with follow up available through fracture healing were included and the incidence of a deep infection that required surgical intervention was recorded. Seventy-one OTA type 41C bicondylar tibial plateau fractures and 67 OTA type 43C pilon fractures were included in the study. The mean duration of follow up was eight months. Complete radiographic information was available on all patients. Pre-operative and immediate post-operative radiographs were evaluated to determine the positions of definitive plates in relation to external fixator pin sites. In all cases, there was no evidence of active pin site infection at the time of conversion to definitive ORIF. Patients were grouped into an “overlapping group,” which included those with definitive fixation overlapping or within 5mm of an external fixator pin site, and a “non-overlapping group.” All patient records were reviewed to determine the incidence of deep infection.

RESULTS: Overall, 19 patients developed a deep wound infection, nine in the pilon group and 10 in the tibial plateau group. For the pilon fractures, five of 17 patients (29%) who had overlapping plates and pin sites developed a deep infection, compared to four of 50 patients (8%) in the non-overlapping group (p = 0.0396). Within the overlapping group of tibial plateau fractures, eight of 35 patients (23%) had deep infections compared to two of 36 (6%) in the non-overlapping group (p = 0.0457).

DISCUSSION AND CONCLUSION: Placement of definitive plate fixation overlapping previous external fixator pin sites significantly increases the risk of deep infection in the two-staged treatment of bicondylar tibial plateau and pilon fractures. Surgeons must make a conscious effort to place external fixator pins outside of future definitive fixation sites to reduce the overall incidence of deep wound infections. Additionally, consideration must be given to the relative benefit of a spanning external fixator in light of the potential for infection associated with their use.

PAPER NO. 615

◆ Measurement of Intramuscular Tissue Oxygenation During Compartment Syndrome in a Dog Model

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INTRODUCTION: Acute compartment syndrome (CS) remains a problematic area due to difficulty of diagnosis. Continuous measurement of intramuscular tissue oxygenation (PmO2) of the leg has been shown to be feasible in humans and highly sensitive to tourniquet-induced ischemia (TI). We investigated the effect of induced compartment syndrome on PmO2 under controlled conditions in a dog model.

METHODS: This pilot non-survival animal study included six female beagles. Animals reMEd under general anesthesia. Polarographic oxygen probes were placed percutaneously into the anterolateral compartment muscle of the legs bilaterally. PmO2 was recorded every 30 seconds. In the control limb, tourniquet was...
placed on the thigh and inflated to 200mmHg. In the CS limb, Hespan was infused through an intramuscular angiocath to induce and maintain a compartment pressure 30mmHg above the diastolic blood pressure as measured by arterial line. After approximately six hours of compartment syndrome, fasciotomy was performed. Animals were euthanized at the conclusion of experiments. RESULTS: Mean duration of compartment syndrome was 5.9 hours. The averaged mean PmO2 of the CS limb was 30.71mmHg (range, 10.56-50.18) before infusion and decreased in all animals to 1.34mmHg (-0.06-3.65) during induced CS (p<0.05 by Wilcoxon ranked sums test). Immediately before fasciotomy, the averaged mean PmO2 was -0.20 (-0.50-0.41). Following fasciotomy, PmO2 rapidly increased in all animals to an averaged mean of 38.89 (2.41-90.40, p<0.05). In the control limb, PmO2 decreased to 0mmHg in all animals with use of the tourniquet.

DISCUSSION AND CONCLUSION: We demonstrated that a severe compartment syndrome using an infusion method results in substantial decrease in PmO2 to values similar to tourniquet-induced ischemia. PmO2 was responsive to changes in tissue oxygenation, as shown by the increase of PmO2 after fasciotomy. Therefore, measurement of intramuscular tissue oxygenation appears to detect pressure-induced ischemia in an animal model with high translational potential. It may represent a minimally invasive, physiologic, and continuous method of monitoring for compartment syndrome.

PAPER NO. 751

The Impact of Nerve Blocks on Opioid Use and Hospital Length of Stay in Patients with Traumatic Lower-Extremity Injury

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INTRODUCTION: The primary purpose of this study was to determine whether having a nerve block predicted total dose of postoperative opioid analgesic medication and length of hospital stay in patients with traumatic lower-extremity injury. Secondary outcomes of pain and satisfaction at hospital discharge were also examined. The hypothesis was that having a nerve block would result in a decrease in total opioid analgesics and a shorter hospital length of stay (LOS).

METHODS: This study prospectively enrolled 120 patients, 19 to 78 years of age, admitted to a Level 1 trauma center for surgical treatment of a traumatic lower-extremity injury. Patients with intracranial hemorrhage, spinal cord deficit, a Glasgow Coma Scale score less than 14, having surgery for an extremity amputation, and a LOS less than 24 hours were excluded. Surgery was performed on acute trauma (53%), reconstruction (31%), and infection (16%) from a prior traumatic injury. Participants were enrolled on the orthopaedic unit after surgery and answered questions on demographics and pre-injury health status. Times, doses, types, and routes of postoperative analgesics administered until discharge, LOS, and injury characteristics were abstracted from the medical record. All opioid analgesics were converted to oral morphine equivalents per 24 hours and a total postoperative dose was calculated. A discharge assessment measured pain intensity and interference with activity (Brief Pain Inventory) and satisfaction with pain treatment (6-point Likert scale). Chi-square, analysis of variance, and student’s t-tests assessed differences in patient variables and nerve block. Association between nerve block and total dose of opioid analgesic medication, LOS, pain and satisfaction were analyzed using multivariable linear regression techniques.

RESULTS: Sixty-one (51%) patients received nerve blocks, with 20 (33%) having a single injection and 41 (67%) a continuous infusion. The total opioid dose in oral morphine sulfate equivalents for participants ranged from 0 to 5,355 mg, with a mean dose of 809 mg (standard deviation (SD): 1025 mg). The mean daily opioid dose was 248 mg (SD: 357 mg) and length of stay was 3.8 days (SD: 3.0). Patients receiving a nerve block were more likely to have private or public insurance compared to no insurance (56% vs. 29%, p = .02) and surgery for reconstruction (73%) compared to acute trauma (44%) or infection (32%) (p = .003). No significant differences were noted for total dose of opioid analgesics (688 mg vs. 934 mg), pain intensity (4.9 vs. 5.3), pain interference with activity, (6.3 vs. 6.2), and satisfaction with pain treatment (4.9 vs. 4.8) in patients with block compared to no block, respectively (all p values >.05). However, a shorter hospital stay (3.0 days) was found for patients receiving a nerve block compared to those not receiving a block (4.6 days) (p = .002). Nerve block use reMed a significant predictor of LOS (β = -1.2; p = .03), after controlling for age, injury severity, insurance status, surgery type, and comorbidities.

DISCUSSION AND CONCLUSION: Use of nerve blocks appears to reduce length of hospital stay in patients with traumatic lower-extremity injury. Additional prospective research is needed to examine patient outcomes across types of nerve block. Research supported by an OTA grant.

PAPER NO. 752

Second Generation Locking Sliding Hip Screw Shows Catastrophic Failure in Biomechanical Testing

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Monique Bethel, MD, Indianapolis, IN
Peter G. Hogg, MD, Royal Oak, MI
Daniel Alge, PhD, Longmont, CO
Tien G. Chu, PhD, Indianapolis, IN

INTRODUCTION: There has been a recent wave of locking plates flooding the market with little evidence to support improved outcomes or even better mechanical stability to more traditional non-locking constructs. The purpose of this study was to compare the biomechanical stability of a new locking sliding hip screw (SHS) to a more traditional non-locking SHS.

METHODS: In the first arm of the study, 10 (five matched pairs) specimens were tested to cyclic loading of 20-500N at 1 Hz for a maximum of 2000 cycles. One of these specimens was fractured during testing before completion of the 2000 cycles. By contrast, only one of the second generation specimens survived the entire 2000 cycles of cyclic loading. One of these specimens was fractured. The FDA has not cleared the drug and/or medical device for the use described in this presentation (i.e. the drug or medical device is being discussed for an off label use). For full information refer to page 14. An alphabetical faculty financial disclosure list can be found starting on page 19.
during preparation; however, the other three specimens that failed early showed progressive rotational displacement of the proximal fragment (Figure 1). It appeared the failure was due to loss of engagement of the locking sleeve contained in the barrel of the second generation SHS. Due to this surprising finding, a second arm of the study was performed with sawbones to identify if the locking sleeve was not engaged initially or failed after full engagement. In the second phase of the study, it was confirmed all four specimens had fully engaged locking sleeves prior to testing. Two of the four specimens implanted with the second generation SHS failed cyclic loading early and demonstrated excessive rotation of the proximal fragment consistent with the failure mode of the cadaver specimens. DISCUSSION AND CONCLUSION: A new second generation SHS appears to be prone to rapid failure from excessive rotational instability. This is likely due to disengagement of its keyed mechanism. It may not provide an advantage over the older first generation implant.

Can We Prevent Renal Failure Using Ciprofloxacin Instead of Gentamicin for Open Fracture Treatment?

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John P. Ketz, MD, Pittsford, NY
John T. Gorczyca, MD, Rochester, NY

INTRODUCTION: Type III open fractures require an antibiotic regimen that treats both gram-positive and gram-negative bacteria. Gentamicin is commonly prescribed for gram-negative coverage, but it causes nephrotoxicity and ototoxicity, especially in older patients. We hypothesize that ciprofloxacin is equally as effective as gentamicin in preventing infection, and that it has a lower rate of acute renal failure (ARF).

METHODS: We examined the incidence of acute renal failure in all patients in our trauma registry between 2004-2010. Ninety-two consecutive patients older than 60 were treated with gentamicin for coverage of gram-negative bacteria in patients older than 60 years with open fractures does not increase the risk of infection based on this patient cohort and may prevent the development of acute renal failure.

Increased Reoperation Risk for Bipolar and Uncemented Implants; National Registration 25,913 Hemiarthroplasties

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Kristina Akesson, MD, PhD, Malmö, Sweden
Cecilia Rogmark, MD, Malmö, Sweden

INTRODUCTION: Approximately 6,500 patients yearly in Sweden sustain displaced femoral neck fractures. During the last decade there has been a shift towards more arthroplasties at the expense of internal fixation. In 2008, approximately two-thirds of the dislocated femoral neck fractures in Sweden were treated with hemiarthroplasties. Any complication that does or does not lead to additional surgery is a strain on the typically elderly and frail patients.

METHODS: In 2005, a national hemiarthroplasty registration was established as part of the Swedish Hip Arthroplasty Register (SHAR). Virtually all hemiarthroplasties performed in Sweden, including primary and salvage procedures, are registered. Surgical and patient details are recorded and re-operations are registered. Risk factors for re-operation generally are subdivided into different reasons for re-operation were investigated with Cox regression analyses. For this analysis we included only patients with a fracture related procedure (primary or secondary), contemporary implants (modular uni- and bipolar) and procedures performed with one of the most common surgical approaches (Moore, Gammer, Hardinge) (n=23,509).

RESULTS: From 2005 through 2010, a total of 25,913 hemiarthroplasties were recorded. Median follow-up time for all patients was 18 months (range 0-72) and for the patients still alive at the end of the study 24 months (0-72). During the study period, the diagnosis acute fracture of the femoral neck increased from 91 to 94%. The use of monoblock type implants decreased from 18 to 0.1%. Use of uncemented implants decreased from 10% in 2005 to 3% in 2010 and the number of procedures performed with anterolateral approach increased from 47 to 62%. Of the patients included in the Cox regression analyses, a total of 888 underwent additional surgery and the most common reason for this was dislocation (n=393). The strongest risk factors for re-operation were hemiarthroplasty due to failed internal fixation (risk ratio 2.1, 95% CI 1.7-2.6) and ≤75 years of age (rr 1.8, 1.5-2.2). Uncemented stems (rr 1.5, 1.1-2.1) and bipolar implant heads (rr 1.3, 1.1-1.5) also increased the risk of re-operation. The surgical approach did not influence the risk of re-operation generally.
but an anterolateral surgical approach (Gammer and Hardinge) decreased the risk of re-operation due to dislocation (rr 0.63, CI 0.5-0.8). Male gender also increased the risk of re-operation.

DISCUSSION AND CONCLUSION: During the first six years of this national registration of hemiarthroplasties there have been some important changes in implant choice and surgical techniques reflecting the results in the annual reports from the SHAR. We have identified a number of factors increasing the risk for re-operation, most importantly uncemented and bipolar implants. An anterolateral surgical approach decreases the risk of re-operation due to dislocation.

PAPER NO. 755
Prospective Clinical Study of Flail Chest Stabilization with Anatomic Plates and Intramedullary Splints

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William B. Long, MD, Portland, OR

INTRODUCTION: Flail chest injury occurs in 10% of patients with chest trauma. It is associated with a mortality rate of 10-15%, and over one-third of flail chest patients experience long-term disability. Surgical stabilization of flail chest injury with generic plates and wires reduces mortality and long-term disability. However, the surgical procedure remains problematic due to the need for complex intra-operative plate contouring and fixation failure. Most recently, a dedicated implant solution comprising anatomic rib plates and intramedullary splints has been introduced. This prospective observational study documented flail chest stabilization using anatomic rib plates and splints. METHODS: Twenty consecutive patients that underwent surgical stabilization of flail chest injury were prospectively enrolled at three Level I trauma centers. Rib fractures were stabilized with anatomic plates and intramedullary splints (Figure 1). Data collection included patient demographics, injury characterization, surgical procedures, and post-operative recovery. At six months follow up, functional outcome was assessed by spirometry and a chest health questionnaire. Finally, the durability of implants and implant fixation was evaluated on six-months radiographs. RESULTS: Patients had on average an injury severity score of 28±10, a chest abbreviated injury score of 4.2±0.4 and 12±4 rib fractures. Surgical stabilization was achieved on average with five plates and one splint. Surgery required 182±68 minutes, and blood loss was 338±315 ml. Post-operative duration of ventilation was 4.5±4.3 days. Total hospitalization was 15±10 days. Amputations were the only orthopedic intervention performed post-earthquake (100% pre-earthquake, 0% post-earthquake). The post-earthquake patient population was significantly older than the pre-earthquake population, averaging 61 and 25 years old respectively (p<0.001). There were also significantly fewer gangrene limbs diagnosed post-earthquake (60% pre- vs. 5.3% post-earthquake, p<0.0001), accompanied by an increase in the proportion of fractures diagnosed (0% pre- vs. to 34% post-earthquake, p<0.05). Amputations were the only orthopedic procedures performed pre-earthquake and there was a significant decrease in the proportion of amputations performed post-earthquake (100% pre- vs. to 10.1% post-earthquake, p<0.05). In the post-earthquake time period, the most common surgical interventions were: irrigation and debridements (36.7%), closed reductions (12.1%), amputations (10.1%), and open reduction and internal fixation (ORIF) (8.0%). In examining the hospital environment, 31 orthopedic personnel, 15 post-operative beds, two X-ray machines, and one clinic were added in the aftermath of the earthquake. The proportion of patients receiving orthopedic care from the local community also increased significantly post-earthquake (p<0.01). DISCUSSION AND CONCLUSION: The aftermath of the earthquake saw a surge in resources for essential and emergency

PAPER NO. 756
Improving Orthopedic Care Delivery at a Referral Hospital in Haiti: The Legacy of the 2010 Earthquake

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INTRODUCTION: Haiti was devastated in January of 2010 by an earthquake that killed more than 200,000 and left an additional 200,000 with significant orthopedic injuries. We hypothesize that the ensuing massive influx of resources from the international community permanently affected the delivery of orthopedic surgical care in Haiti. METHODS: A retrospective review of operative logs was conducted at one of the primary Haitian medical facilities providing surgical care to the earthquake victims. A segmented linear regression was used for the analysis to divide the data into pre-earthquake (15 weeks) and post-earthquake (15 weeks) segments. We analyzed the orthopedic pathologies diagnosed and surgeries performed. This data was then compared pre and post-earthquake with Fisher’s exact test for proportions. RESULTS: Surgeons performed 465 orthopedic operations during the study period (2% pre-earthquake, 98% post-earthquake) (figure 1). The post-earthquake patient population was significantly older than the pre-earthquake population, averaging 61 and 25 years old respectively (p<0.001). There were also significantly fewer gangrene limbs diagnosed post-earthquake (60% pre- vs. 5.3% post-earthquake, p<0.0001), accompanied by an increase in the proportion of fractures diagnosed (0% pre- vs. to 34% post-earthquake, p<0.05). Amputations were the only orthopedic procedures pre-earthquake and there was a significant decrease in the proportion of amputations performed post-earthquake (100% pre- vs. to 10.1% post-earthquake, p<0.05). In the post-earthquake time period, the most common surgical interventions were: irrigation and debridements (36.7%), closed reductions (12.1%), amputations (10.1%), and open reduction and internal fixation (ORIF) (8.0%). In examining the hospital environment, 31 orthopedic personnel, 15 post-operative beds, two X-ray machines, and one clinic were added in the aftermath of the earthquake. The proportion of patients receiving orthopedic care from the local community also increased significantly post-earthquake (p<0.01). DISCUSSION AND CONCLUSION: The aftermath of the earthquake saw a surge in resources for essential and emergency
orthopedic surgical care. These resources allowed a sustained increase in the diversity and number of orthopedic surgical procedures, significantly impacting orthopedic healthcare delivery in Haiti. The improved availability of needed orthopedic operations exemplifies the impact of dedicated resources in permanently affecting orthopedic care access for the local community.

Figure 1. Total number of orthopedic operations per week

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PAPER NO. 757
A Surgical Simulation Training Model for Complex Fracture Surgery
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INTRODUCTION: Operative articular fracture reduction is a basic orthopaedic skills competency. Currently most orthopedic residents acquire these skills through an apprenticeship model, training on patients in the operating room. Surgical skills training models outside of the operating room have been implemented in other areas of orthopaedics such as hand surgery1 and arthroscopy.2 The purposes of this study were to 1) develop a physical model to improve resident skills in articular fracture reduction, 2) develop objective assessment methods to evaluate residents regarding this specific surgical skill and to 3) validate the techniques by comparing the results of junior to senior residents. In this abstract we report the results of this project as a first pass at establishing the fidelity and validity of the articular fracture reduction simulation. METHODS: A surgical simulation was created in the residency skills laboratory utilizing surrogate tibial plafond fractures. Multiple three-segment fracture models were produced using a radio-opaque polyurethane foam. The fragments’ articular surfaces were coated with barium sulfate simulating the dense radiographic appearance of the subchondral plate. Fragments were lightly affixed reproducing in a fracture-representative configuration, and the construct was placed inside a Sawbones synthetic soft tissue housing. Using fluoroscopic guidance, five senior (4th or 5th year) and seven junior (1st or 2nd year) orthopaedic surgery residents reduced the fracture through a limited anterior window in the synthetic soft tissue housing. Tenaculums and other basic surgical instruments were used, and the residents focused on articular surface congruity. K-wire fixation held the reduction. The residents were assessed on time to completion, hand movements with the use of an optoelectronic motion capture system, as well as quality of the obtained reduction. Junior and senior resident scores were compared in all categories. RESULTS: All five senior residents and all seven junior residents successfully reduced and fixed the fracture fragments. Senior resident and junior resident average time to completion was 13.43 minutes and 14.75 minutes respectively. Average gross articular step-off was 3.00 mm for seniors and 3.90 mm for juniors. Cumulative hand motion was 64 meters for seniors and 390 meters for juniors. Discrete actions were 539 actions for seniors and 511 actions for juniors. By survey, all residents agreed that the exercise realistically simulated the operative experience and improved their articular fracture reduction skills. DISCUSSION AND CONCLUSION: As an initial validation of the exercise, junior residents had similar time to completion and slightly greater articular step-off. Differences in the number of discrete hand motions and the distance traveled indicate that senior residents were more precise in their hand motions. Excess cumulative hand distance by the junior residents could be interpreted as non-purposeful movements often characterized by surgical educators as “failing.” Laboratory-based models for articular fracture reduction with objective outcome assessments hold great promise to improve resident surgical skills. References: 1. Van Heest A, Putnam M, Agel J, Shaneding J, McPherson S, Schmitz C: Assessment of technical skills of orthopaedic surgery residents performing open carpal tunnel release surgery. J Bone Joint Surg Am. 2009 Dec; 91(12):2811-7. 2. Insel A, Carofino B, Leger R, Arciero R, Mazzocca AD: The development of an objective model to assess arthroscopic performance. J Bone Joint Surg Am. 2009 Sep; 91(9):2287-95.

PAPER NO. 758
Can In-hospital Medication Reviews Reduce Re-admissions, New Fractures and Death After Hip Fracture?
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INTRODUCTION: Polypharmacy is a risk factor for falls. Hip fracture patients have an average of six medications, 11 percent of Swedish individuals over 80 years have >10 medications. The purpose of this study was to see if medication reviews may decrease risk of re-admissions, new fractures and deaths after hip fractures. METHODS: In a prospective study (December 2009-May 2011), 300 hip fracture patients underwent medication reviews performed by a pharmacist and an internal medicine consultant. Dosage and indications were checked, unsuitable drugs were withdrawn. The patient’s family doctor received written information, as did the patient. Information regarding re-admissions to hospital, new falls and fractures were drawn from the medical records. Matched control groups: 1. Patients treated June 2008-October 2009, 2. Patients treated December 2009-May 2011 without medication reviews. Follow up of six months. All consecutive hip patients in two wards were offered medication reviews; no one denied participation. The catchment area is served by only two hospitals, treating all emergency cases and admissions to hospital. All medical records within these hospitals were scrutinized by the researchers. RESULTS: In May 2011, results were available for 174 study patients and 174 historical controls. There were 73% women, mean age 82 years and 59% femoral neck fractures in both groups. Each study patient had on average three to four medication related problems when reviewed. Most common faults are medication without known indication or incorrect dosage. At six months, no significant differences were seen between groups. But there

◆ The FDA has not cleared the drug and/or medical device for the use described in this presentation (i.e. the drug or medical device is being discussed for an off label use).
For full information refer to page 14. An alphabetical faculty financial disclosure list can be found starting on page 19.
PAPER NO. 759

Causes and Predictors of Early Readmission after Hip Fracture Surgery

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INTRODUCTION: Hip fractures in the elderly are associated with considerable mortality and morbidity with unplanned readmissions resulting in significant costs to healthcare institutions. Medicare payments have been shown to increase by 167% for rehospitalization following hip fracture over a four-year period. The aim of this study was to examine the rates and potential risk factors for 28-day readmission following hip fracture surgery at a high volume tertiary care hospital.

METHODS: We retrospectively reviewed data from a national database on a cohort of 467 consecutive patients with hip fractures at our institution. Details including age, sex, implant type, length of stay, comorbidities, ASA grade, haemoglobin levels, admission source, discharge destination and time to surgery were recorded for all patients. Causes for unplanned 28-day readmissions were examined. Univariate and multivariate analysis was undertaken to identify risk factors for 28-day readmission after discharge.

RESULTS: Fifty-five (11.7%) patients were readmitted within 28-days of discharge. The most common causes were pneumonia (27.3%), dehydration/renal dysfunction (18.2%) and deteriorated mobility (18.2%). There was a statistically significant difference in age (p=0.001), ASA grade (p=0.011), implant type (p=0.005), walking ability (p=0.04), admission source (<0.001), discharge destination (p=0.001) and comorbidities of musculoskeletal injury, diabetes, dementia, neurological disorders, thyroid dysfunction and syncope (p=0.001 to 0.03) between the readmission and non-readmission groups. There was no difference with respect to pre-existing respiratory disease, however a moderate correlation was found between chest infection during the index admission and a 28-day readmission with pneumonia (r=0.44). A higher one-year mortality rate was seen in the readmission group (p<0.001). Multivariate logistic regression analysis identified age, admission source, and comorbidities of diabetes and neurological disorders as the strongest predictors for readmission.

DISCUSSION AND CONCLUSION: Early admission following hip fracture surgery is predominantly due to medical causes and is associated with a higher one-year mortality. Postoperative rehabilitation should include a multi-modal approach towards minimizing neurological and endocrine risk factors in addition to optimizing respiratory function and physical mobility. Discharge planning should facilitate optimized nutrition and hydration for these patients in order to minimize chances of readmission.

PAPER NO. 760

Cemented versus Uncemented Hemiarthroplasty for Intracapsular Neck of Femur Fracture - A National Analysis

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Philip James, PhD, Alcester, Warwickshire, United Kingdom
Amar Rangan, FRCS, Middlesbrough, United Kingdom
Scott Muller, MBBS MD, FRCS, Northumberland, United Kingdom
Mike R. Reed, MBBS MD, Northumberland, United Kingdom

INTRODUCTION: Many elderly patients with intracapsular fractured neck of femur (NOF) undergo uncemented hemiarthroplasty despite the evidence suggesting that a cemented prosthesis reduces post-operative pain and leads to better mobility. However, no differences in surgical complications have been demonstrated. We aimed to compare the national data for complications following cemented and uncemented hemiarthroplasty in matched patient groups.

METHODS: Hospital episode statistics (HES) data was analyzed for 70-90 year olds with a Charlson co-morbidity score of 0 (no significant co-morbidities prior to fracture) who underwent hemiarthroplasty for intracapsular fractured NOF in the English NHS between January 2005 and December 2008. Surgical and medical complications were analyzed. Odds ratio (OR) was used to compare patient groups.

RESULTS: A total of 9,533 patients underwent an uncemented and 15,996 a cemented hemiarthroplasty. Eighteen-month revision rate was significantly higher in the uncemented group (2.63% versus 0.89%, OR=3.02, 95% CI 2.45-3.71). There were no significant differences in 30-day reoperation, readmission and 18-month dislocation rates. Lower respiratory tract infection (LRTI) 4.29% versus 3.24%, OR=1.34, 95% CI 1.17-1.54) and 90-day mortality was significantly higher in the uncemented group (7.75% versus 4.86%, OR=1.64, 95% CI 1.48-1.82). There were no significant differences in rates of venous thromboembolism (VTE), myocardial infarction or cerebrovascular events. Ninety-day mortality following LRTI was 1.09 -1.89% compared with 0.18 - 0.30% following VTE.

DISCUSSION AND CONCLUSION: Revision rates in patients with uncemented hemiarthroplasty are three times higher than those of cemented. This national data supports the published functional benefits of cemented hemiarthroplasty. The higher rates of LRTI and death in the uncemented group could be a consequence of higher pain levels and poorer mobility in the post-operative period. LRTI results in six times more deaths than VTE after NOF fracture surgery.
INTRODUCTION: Total hip replacement (THR) has been shown to outperform hemiarthroplasty and internal fixation in selected fit elderly patients with displaced hip fractures. Elective THR has been shown to result in high levels of satisfaction and large improvements in function for patients with osteoarthritis. It has not been established whether the outcomes for hip fracture patients are as good. We aimed to investigate the early outcomes and results of THR undertaken as a primary treatment for displaced hip fractures and to compare these with those for THR undertaken electively for osteoarthritis in an age and gender matched cohort of patients.

METHODS: Over a three-year period, we prospectively identified all patients treated for a displaced hip fracture with primary THR at our trauma center. Patients were selected for surgery using national guidelines. Patient records, radiographs and the hospital electronic records were reviewed to confirm this information. Patients were invited to complete a satisfaction questionnaire and validated patient reported outcome measures (the Oxford Hip score and SF-12 form) at least 12 months after surgery. Patients known to have died were removed from the dataset. Family physicians were contacted to confirm the status of non-responders and surviving non-responders were sent a second request to participate. The responders formed the study group. The medical records for non-responders were examined and compared with the study group to ensure there were no significant differences. Patients in the study group were matched for age and gender in a ratio of 1:3 with patients undergoing elective THR for osteoarthritis over the same period. Functional outcome scores, satisfaction and rates of complications were compared.

RESULTS: We identified 128 patients who underwent THR for a displaced hip fracture over this period. Of these, nine had died, two had been left incapacitated by cerebrovascular accident and were unable to respond. This left 117 patients available for recruitment. Of these, 27 (23%) did not respond leaving a study group of 90 (77%) patients. The patients were well matched for age (p = 0.790) and sex (p = 0.812). The mean patient age was 70.6 (SD 8.5, 95% CI 68.8 to 72.4) years. Patients in both groups reported excellent functional outcomes and high levels of satisfaction throughout the follow-up period. The mean SF-36 scores of the study patients were comparable to those of the normal population. Range-of-motion in degrees for the mean preoperative medialization was 10mm, glenopolar angle was 30°, double disruptions of the superior shoulder suspensory complex (SSSC) both displaced ≥10mm, glenopolar angle ≥22° degrees, and open fractures.

Clinical range-of-motion, strength and functional outcomes including DASH and SF-36 were obtained on 64 patients (84%).

DISCUSSION AND CONCLUSION: Our data suggest surgery for displaced hip fractures to outperform hemiarthroplasty and internal fixation in selected fit elderly patients with displaced hip fractures. Elective THR for osteoarthritis is appropriate and safe.
The FDA has not cleared the drug and/or medical device for the use described in this presentation (i.e. the drug or medical device is being discussed for an off label use). For full information refer to page 14. An alphabetical faculty financial disclosure list can be found starting on page 19.
Cemented fixation was used in 32%. Proximal femoral replacement was used in 2%. Non-union occurred in three cases. Sixteen patients died within three months of fracture prior to established union. There were two (2%) new deep infections and seven (7%) dislocations in the series. Further revision was required in eight (8%) cases (two revisions for infection, two aseptic loosening, two acetabular revisions, one further fracture and one stem failure). One patient is awaiting total femoral replacement. This equates to a 94% stem survival at a mean of 48 months in this relatively elderly group of patients who have sustained a significant injury.

DISCUSSION AND CONCLUSION: In this large, single center, prospective series, we report good union and low complication rates using a variety of reconstructive techniques. While the majority of these complex cases were managed using modular uncemented reconstruction, the indications and potential benefits of other reconstructive techniques are discussed.

PAPER NO. 765

Natural History of Anterior Chest Wall Numbness After Plating of Clavicle Fractures: Educating Patients

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INTRODUCTION: Recent clinical studies have demonstrated improved outcomes when displaced clavicle fractures are treated with open reduction and internal fixation (ORIF). This has led to an increased number of patients undergoing ORIF for displaced clavicle fractures. Most patients undergoing ORIF have some degree of anterior chest wall numbness which can be both concerning and troubling. The natural history of numbness, effect on patient satisfaction and functional outcome of this numbness is not known.

METHODS: We have prospectively tracked the pattern, size, and patient satisfaction/outcomes in an IRB approved prospective cohort of consecutive patients undergoing ORIF of displaced clavicle fractures. All patients, aged 18 and older, with displaced diaphyseal clavicle fractures treated were potentially included in this study. No one declined participation in the study. Thirty patients were enrolled. During standard follow-up visits, patients are evaluated for anterior chest wall, infra-clavicular, subjective (patient reported) cutaneous numbness (the primary outcome measure) with a skin map tracing, using transparency paper covered with a 1cm2 grid. Secondary outcomes include complications such as postoperative infection and time to union, malunion, or nonunion based on radiographs at these clinic visits.

RESULTS: Twenty-three of the 30 study patients completed follow up at our institution. Average area of numbness at two weeks was 27.0 cm2; SD=42.7 cm2. At six weeks, numbness decreased to 16.1 cm2; SD = 25.8 cm2. There was a significant difference between the two and six-week numbness values (p=0.04). At 12 weeks, numbness values averaged 13.9 cm2; SD=21.7 cm2. Values between two and 12 weeks were also significant (p=0.02). However, numbness changes between the six to 12 week follow ups were not significant (p=0.60). At 24 weeks, numbness averaged 12.0 cm2 (SD = 21.8 cm2). Between two and 24 weeks, numbness changes continued to show significance (p=0.05). No significance was found between numbness values presented from six weeks to the end of follow up. There was one infection and one non-union.

DISCUSSION AND CONCLUSION: Plating of diaphyseal clavicle fractures is associated with a high incidence of anterior chest wall numbness in the immediate postoperative period. This numbness decreased by approximately 50% during the first 12 weeks post-operatively. Numbness resolution is minimal after the twelfth week. Patient functional outcomes do not appear to be affected by this side effect of ORIF. Patients should be educated about this risk factor pre-operatively.
and improved syndesmotic reduction through elimination of transsyndesmotic screws. We hypothesize that this approach enhances functional outcome, minimizes complications, and decreases the need for postoperative hardware removal due to pain.

METHODS: A total of 176 operative SER IV/IV equivalent ankle fractures treated by a single surgeon were enrolled in the prospective database. Some 112 patients met inclusion criteria of one year minimum follow up with functional outcome scores. The rate of posterior malleolus and PITFL and fixation/repair were calculated. The Foot and Ankle Outcome score (FAOS) was utilized as the primary measure for functional outcome. Fracture reduction based on anterior-posterior, mortise, and lateral radiographs were determined by the medial clear space and tibiofibular clear space. Syndesmotic reduction was calculated using postoperative computed tomography (CT) analysis of the fibula in relation to the anterior and posterior aspects of the incisura fibularis. Postoperative range of motion was evaluated for all patients at the latest follow-up visit. The complications examined were hardware removal secondary to pain or infection, syndesmotic screw removal, deep wound infection, superficial wound infection, non-infectious wound complications, arthritis, synostosis, and any additional postoperative complication reported by the patients.

RESULTS: The mean age of the patients was 51.3 years old (Min: 18 Max 86). Posterior malleolus fixation was performed in 71 of 72 patients (antiglue plate or 3.5 cortical screw with soft tissue washer) Overall excellent functional outcome was seen in the subcategories of pain (78.4, std 20.10) and activities of daily living (83.37, std 18.76). Good outcomes were seen in the subcategories of sports (59.37, std 30.95), symptoms (71.12, STD 20.40), and quality of life (55.72, std 28.05). The mean range of motion was as follows; dorsiflexion of 17 degrees (± 5 degrees), planarflexion of 45 degrees (± 5 degrees), eversion of 22 degrees (± 5 degrees) and inversion of 27 degrees (± 5 degrees). Overall, the mean distance between the fibula and anterior and posterior facets clear space was 0.99 mm (STD 1.41 mm). This value is less than 2mm, the recommended valued confirming adequate syndesmotic reduction. Seventeen patients underwent removal of lateral hardware secondary to pain and discomfort. There were 10 postoperative superficial wound infections and four postoperative deep wound infections (two medial incision infections).

DISCUSSION AND CONCLUSION: The posterolateral approach to the ankle is a valuable approach for ankle fracture fixation. The low rate of complications, exposure to the posterior malleolus and PITFL for fixation/repair, and ability to posteriorly plate the fibula make this approach advantageous to the standard lateral approach. Through consistent utilization of this approach we have demonstrated good to excellent functional outcome, maintenance of reduction and most importantly a low rate of complications.

POSTER NO. P458


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INTRODUCTION: Femoral neck fractures are common and are associated with considerable morbidity, mortality, and cost. While they are nearly universally treated operatively, debate still exists regarding the preferred method of management. During the last 10 years, numerous studies, meta-analyses, and review articles have suggested the possible superiority of total hip arthroplasty (THA) over hemiarthroplasty (HA) in the elderly population. The purpose of this study was therefore to assess whether trends in management of femoral neck fractures had changed over the last decade in response to the building evidence in support of performing THA.

METHODS: The National Hospital Discharge Survey (NHDS), conducted annually by the National Center for Health Statistics, collects medical and demographic information from a sample of inpatient discharge records selected from a national probability sample of non-federal, short-stay hospitals. Data from the NHDS from 1998 to 2008 was obtained for this study. All individuals admitted with a primary diagnosis of a femoral neck fracture (ICD-9 codes 820.00, 820.01, 820.02, 820.03, 820.09, and 820.8) were selected. Those individuals who had undergone internal fixation (IF) (CPT codes 7855, 7915, and 7935), HA (CPT code 8152), and THA (CPT code 8151) were chosen as the population for this study. Patients were grouped by time period, age, hospital size, and region. Three time periods were analyzed: Period I (1998-2001), Period II (2002-2004), and Period III (2005-2008). Four age groups were analyzed: Group I (<50), Group II (50-64), Group III (65-79), Group IV (>80). Two hospital sizes were analyzed: Size I (<500 beds), Size II (>500 beds). Four regions were analyzed: Region I (Northeast), Region II (Midwest), Region III (South), Region IV (West). Data was assessed using percentiles and associations were examined using the chi squared test for independence.

RESULTS: Reviewing the entire sample, IF was performed 31%, HA 63.8%, and THA 5.3%. No significant change in the rate of THA was identified when analyzing the entire same over time (p > 0.7). When age subgroups were reviewed, rates of THA varied significantly between all age groups, except those 65-79 and >80 (P 0.001), with the highest rate among those 50-64 (8.1%) and the lowest among those <50 (4.0%). An increase in the rate of THA from time period II to III was noted among those <50 (0.8% to 8.3%, p < 0.001) and those 50-64 (4.0% to 12.7%, p < 0.001), but not in those 65-79 or >80. The rate of THA did not show any trends over time when reviewed based on hospital size or geographic region.

DISCUSSION AND CONCLUSION: This study showed an increased incidence of THA following femoral neck fracture in certain age groups over the last decade. Although recent literature has supported the use of THA for the treatment of femoral neck fractures in the elderly population, review of a national database failed to reveal a corresponding increase in THA rates in those individuals >65 in the past decade. However, the rate of THA in the younger cohorts (<65) showed an increase in incidence between 2002-2004 and 2005-2008.

POSTER NO. P459

ALTERNATE PAPER: TRAUMA II

Validation of the Re-defined Inlet and Outlet Angles Used to Evaluate Pelvis Fractures

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INTRODUCTION: Pelvic inlet and outlet views were historically defined as 45 degrees cranial and caudal to the anteroposterior view. A recent study reported 25 degrees caudal tilt for the inlet and 60 degrees cephalad tilt for the outlet image, based on measurements obtained from sagittal reconstructions of pelvic computed tomography scans. The purpose of this study is to determine the optimal angles for obtaining ideal inlet and outlet views using virtual x-rays and three dimensional (3D) computed tomographic (CT) reconstructions.

METHODS: A review was performed of 70 CT scans of non-fractured, adult pelvis. Raw data from the CT scans were used to determine the angles for the inlet and outlet views.
to generate two new three-dimensional reconstructions of each pelvis. The first CT scan reconstruction is a 3D radiolucent pelvis (sometimes called a ghost image or a virtual radiograph). The second reconstruction is solid rendering of the bony pelvis. Each of these 3D reconstructions can be rotated by the surgeon in one-degree increments about the horizontal axis, and can be used to generate inlet and outlet views. Two fellowship-trained orthopaedic traumatologists independently evaluated these reconstructions. They were blinded to the numerical value of the angle of rotation. They selected the inlet view where the anterior aspect of S1 and S2 vertebral bodies overlap, and the outlet view where the top of the pubic symphysis is at the level of the S2 body. An independent observer recorded the angle of pelvic tilt (from the AP plane) for each inlet and outlet view. A third orthopedic surgeon measured the sagittal reconstructions for each pelvis as described by Ricci. RESULTS: Twenty-six females and 44 males formed the study group. The mean age was 45.3 years (range: 19-80). The mean inlet angles that were measured with virtual x-rays and 3D reconstructions were 26.7° ± 8.5° and 24.3°±8.6°, respectively. The mean outlet angles that were measured with virtual x-rays and 3D reconstructions were 43.7° ± 6.4° and 43.8°±6.3°, respectively. The measurements obtained from the sagittal reconstructions were very similar to those reported by Ricci et al. The average inlet angle to profile the anterior bodies of S1 and S2 was 25.5°, and the average outlet angle to be perpendicular to the S1 body or S1 foramina was 60.1° and 56°, respectively. DISCUSSION AND CONCLUSION: The results of this study confirmed that 25° of caudal angle is the best angle for routine pelvic inlet radiographs. However, 60° of cranial tilt would result in inadequate outlet views in 91% of the patients and 45 degrees of cranial tilt is still the most reliable way to create an ideal outlet view.

POSTER NO. P460
Biomechanical Analysis of Syndesmotic Injury with Stress Radiography
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INTRODUCTION: By the Lauge Hansen model of malleolar fractures, the SER IV equivalent (fibula fracture only) injury should not have syndesmotic instability. Yet, several studies have suggested syndesmotic disruption is present in as many as 40% of these injuries when stressed during surgery. Both external rotation and lateral translation stress tests have been described, but it is not clear exactly what defines syndesmotic instability with these tests. Previous studies have used the medial clear space measurement, but this may be more a measure of deltoid laxity than syndesmosis. In this study, we measured various radiographic parameters following sequential sectioning of the deltoid and syndesmotic ligaments in a cadaver model of the isolated fibula fracture. We propose that widening of the medial clear space of does not always represent syndesmotic instability. Rather, the better predictor of syndesmotic disruption will be the tib-fib clear space. METHODS: Five fresh frozen human lower limbs distal to the mid-femur were used. The tibia of each specimen was secured onto a custom made frame. For standardization of measurements, a metal ball was impacted into the distal fibula at the level of the mortise. An external rotation stress test was performed by applying 130N to the mid-foot 5cm distal to the lateral malleolus creating a 7.5Nm external rotation moment. Then, a 100N lateral stress test was performed with a bone clamp placed 1cm proximal to the mortise. All forces were applied using a testing machine using a load cell with accuracy ± 2.5 N. True mortise radiographs were taken of intact ankles and after performing external rotation and lateral stress tests at each stage of sequentially sectioning the ankle ligaments. The deep and superficial deltoid ligaments were cut first, then anterior inferior tibiofibular ligament, posterior inferior tibiofibular ligament, and finally the interosseous membrane (IOM) to 10 cm proximal to the mortise. Tibio-fibular clear space, medial clear space, and lateral talar subluxation were measured on each radiograph using software by a single blinded observer. RESULTS: External rotation tests produced no significant difference in medial clear space widening between isolated deltoid injury and cut AITFL and PITFL. Lateral stress testing produced significant widening of the tib-fib clear space when the IOM was cut (p<0.010). DISCUSSION AND CONCLUSION: Recent studies by Jenkinson et al[1] and Tornetta et al[2] have drawn attention to the need for fixation for syndesmotic instability in SER IV equivalent fractures, with as many as 40% of Weber B or SER IV equivalent ankle fractures showing medial clear space widening. However, this study has shown that medial clear space widening may occur without syndesmotic ligament sectioning and therefore may not serve as an indicator of syndesmotic instability in the setting of a torn deltoid ligament. Widening of the tib-fib interval only occurred with syndesmosis disruption and therefore is a more accurate indicator of syndesmotic instability in these injuries. More clinical studies are needed to determine which of these injuries, if any, benefit from syndesmotic fixation. 1. Jenkinson, R.J., Intraoperative diagnosis of syndesmosis injuries in external rotation ankle fractures. Journal of orthopaedic trauma, 2005. 19(9): p. 604-9. 2. Stark, E., Syndesmotic instability in Weber B ankle fractures: a clinical evaluation. Journal of orthopaedic trauma, 2007. 21(9): p. 643-6.
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more surgery to achieve bony union, but had no further infection, outcomes. Of the 12 patients who failed, two required at least one

RESULTS: Eight patients (40%) had successful outcomes without fracture union without further surgery or other signs of infection.

Staphylococcus aureus

failed prior to nine months. All 20 patients were treated with a

intraoperative culture, and had at least nine months of follow

up (average f/u = 19.6 months). No patient was excluded who

in group I; and 11, five, one and one in group II (NS). One patient had premature removal of ring fixator in group I due to excessive pain and developed nonunion. One patient in group II had nonunion of fracture site despite bone grafting. All corticotomy sites healed in both groups. The transported bone carried overlying skin with it, thus, avoiding flap reconstruction. Superficial pin tract infection occurred in three patients (20%) in group I and one patient (6%) in group II. Deep pin tract infection occurred in one patient in each group. Correction of deviation of transporting fragment was required in one patient in each group. Equinus deformity developed in one patient in group I. No patient required flap. One patient in group II had skin tensioning/stretching which resolved with passage of time. The bone result was excellent, good, fair and poor in four, nine, one and one in group I; and in six, 10, one and one in group II, respectively (NS). The functional results were excellent, good, fair, and poor in five, eight, one, one in group I; and 11, five, one and one in group II, respectively (NS). DISCUSSION AND CONCLUSION: Both fixator systems achieve comparable and reliable rates of union and functional outcome in infected gap nonunion of tibia and help in treating infection, shortening, bone and soft tissue loss simultaneously without flap coverage. Pin tract infection rate was higher (but NS) in ring fixator. Patient compliance was better in rail fixation system but it was not statistically significant.

POSTER NO. P462

Outcomes in Culture-Positive Patients Undergoing Hardware Placement for Fracture Nonunions

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INTRODUCTION: Little is known regarding the outcome of nonunion surgery in which new hardware is placed and the cultures comeback unexpectedly positive after the procedure. The hypothesis was that the majority of these patients would go on to fail treatment. METHODS: A retrospective database was analyzed that contained all patients diagnosed with fracture nonunion at a single level one trauma center over eight years. From this database, 20 patients had new hardware placed to treat a nonunion, had a positive intraoperative culture, and had at least nine months of follow up (average f/u = 19.6 months). No patient was excluded who failed prior to nine months. All 20 patients were treated with a six-week course of antibiotics. The most common organism was Staphylococcus aureus (75%), which was specified as methicillin-resistant in three cases. A successful outcome was defined as fracture union without further surgery or other signs of infection. RESULTS: Eight patients (40%) had successful outcomes without further treatment, while 12 (60%) were classified to have failed outcomes. Of the 12 patients who failed, two required at least one more surgery to achieve bony union, but had no further infection, four required additional debridements for infection but successfully achieved union, and six patients were not able to achieve fracture union. Of the six patients in whom we were not able to achieve union, three eventually required amputation of the affected limb. DISCUSSION AND CONCLUSION: Our data suggests that clinicians should be aware that an unexpected positive culture at the time of nonunion repair portends a poor prognosis for uncomplicated fracture healing. More sophisticated methods of infection detection at the time of nonunion repair might be useful to prevent implantation of fixation devices into a wound bed with an occult infection.

POSTER NO. P463

A Novel Murine Model of Heterotopic Ossification

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INTRODUCTION: Traumatic injury of soft tissues with or without skeletal fractures is often accompanied by heterotopic ossification (HO), abnormal deposition of bone in soft tissues and in particular muscle. Battle field injuries including severe muscle damage, spinal cord injury, head trauma, neurological trauma and joint arthroplasty are frequently accompanied by HO. Heterotopic ossification has proven difficult to prevent and once developed is often extremely difficult to treat. A critical barrier to the development of more effective prevention and treatments is the lack of clinically relevant animal models. Our objective is to develop a new murine model of HO that incorporates muscle trauma as a critical component. METHODS: Twelve-week old adult male C57/BL6 mice received intramuscular injection of various doses of bone morphogenetic protein-2 (BMP-2) in a heparin-chitosan, ionic complex, in the form of a hydro gel at 0, 0.25, 0.5, 0.75, 1, 1.5 and 2 µg in the quadriceps muscles. One time muscle impaction injury was produced by dropping a metal ball of 16.8g from 100 cm high in six animals after receiving 0.5 µg BMP-2 injection. HO formation was monitored using in vivo µCT scanning for the thighs at one, two and four weeks after treatment. RESULTS: HO formation was observed two weeks after BMP-2 injection. Significant HO formation was observed in mice receiving 1, 1.5 and 2 µg BMP-2 injection (Figure 1, N=6, *, P<0.05 compared to the control (0µg BMP-2) group). Mice with muscle injury showed significantly more HO than those who received the same amount of BMP-2 (0.5µg) injection but no muscle injury (Figure 2). µCT scanning showed that these mice with muscle injury have nearly 10 times more heterotopic bone volume compared to those without injury (Figure 3, N=6, *, P<0.05 compared to the non-injured group). DISCUSSION AND CONCLUSION: Most previous models of HO rely on the use of excessive bone morphogenetic protein-2 (BMP-2), various genetic models such as fibrodysplasia ossificans progressiva (FOP), and growth factor-doped matrices or carriers such as collagen gels, tricalcium phosphate mixtures and hydrogels in the form of implants. However, the development of HO in these models is not trauma-dependent. Muscle trauma alone has not been shown to induce HO in normal animals. In our new mouse model, we show that muscle trauma combined with a sub-threshold dose of BMP-2,can induce HO. This novel model will serve as a powerful tool to study the mechanisms responsible for HO and to devise preventative measures and effective treatments for HO.
Evolution from Beads to Coated Interlocking Nails (RABC): Infected Non Union of Long Bones

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INTRODUCTION: Management of infected non-union is one of the most difficult clinical situations despite major advances in the fixation techniques, soft tissue management and antibiotic therapy. There are two main methods to treat an infected nonunion, the “conventional” or classic method and the second “active” or the modern method. Advantages of antibiotic impregnated PMMA cement include the local release of high levels of antibiotic; cement rod fills dead space and simultaneously provides mechanical support for the bone. We review the evolution of this method from beads to coated interlocking nailing and present our results using this method for management of infected non-union of long bones.

METHODS: This is a study comprising 19 cases of established infected nonunion of long bones managed at our institution. The procedure involved removal of any metal work, debridement of the nonunion site including the intramedullary reaming. RABC was prepared using 40 g of PMMA mixed with 4 g of Vancomycin powder. Insertion of the rod was performed using the standard procedure. The outcome was assessed on the basis of control of infection, bony union and complications.

RESULTS: Nineteen patients who had an infected nonunion of the long bone were treated using a reinforced antibiotic bone cement (RABC) rod. Eight femora, nine tibiae and two humerus were treated. Ten patients had positive cultures from wound/sinus. The study group included 10 infected interlocking nailing, three with infected plating and six external fixations. The rod was fabricated over steel Kuntscher nail in 11, steel wire in five and interlocking nail in three. Thirteen patients experienced no recurrence of infection. Fracture union occurred at six months or earlier in 11 cases and within eight months in two cases. Three cases had union after external fixation. However, three patients continued to have an infected nonunion and in these cases the RABC rod was removed and patient given external fixator.

DISCUSSION AND CONCLUSION: Management of infected non-union of long bones is a difficult problem. The treatment with reinforced antibiotic bone cement using interlocking nail is a satisfactory and effective method in Indian setting but we need a larger study to validate the results.

POSTER NO. P465
Immediate Weight Bearing in Comminuted Tibial Shaft Fractures

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INTRODUCTION: Comminuted tibial shaft fractures are commonly treated with statically locked intramedullary nails. Patients are frequently given restrictions for protected weight bearing postoperatively until fracture callus is evident. The purpose of this investigation was to assess the effect of immediate unrestricted weight-bearing following intramedullary nailing of AO/OTA 42B and 42C injuries on fracture union, hardware failure, and need for secondary procedures. Our hypothesis is that immediate weight bearing does not increase the incidence of fracture nonunion or hardware failure.

METHODS: A retrospective review of patients who underwent an intramedullary nailing procedure for tibial shaft fractures at our Level I trauma center was performed between January 2002 and December 2009. Patients were identified using a billing database query using CPT (Common Procedural Terminology) database query using CPT (Common Procedural Terminology) for treatment of tibial shaft fractures by intramedullary implant.

Injury radiographs were reviewed and fractures were classified according to the AO/OTA classification system. Inclusion criteria were: Type 42-B and 42-C type fractures, Skeletal maturity, and minimum 12 weeks clinical follow up. Exclusion criteria included (1) head, spine, pelvic ring, or ipsilateral lower extremity injury that precluded full weight bearing after intramedullary nail placement, (2) primary treatment of delayed or non-union, or (3) conversion of treatment to casting or external fixation before fracture union. Patient records and radiographs were reviewed pertaining to postoperative weight bearing instructions, time to fracture callus formation, time to fracture union, hardware failure, and need for secondary procedures. The primary outcome measure was hardware failure. Secondary outcome measures included time to fracture callus formation, time to fracture union, and the need for secondary procedures. Fischer exact tests were calculated with a level of significance of P <0.05.
RESULTS: Fifty-two patients had isolated AO/OTA type 42B and 42C fractures. Thirty fractures had sufficient follow up for inclusion in the study. Fifteen patients in the study population were given instructions for immediate full weight bearing (WBAT) postoperatively while the remaining patients were considered non weight bearing (NWB). There were 19 (63%) AO/OTA type 42B fractures and 11 (37%) type 42C fractures. Twenty-one fractures (73%) were open. The primary outcome measure was hardware failure. There was one case (7%) of hardware failure in the WBAT group and another (7%) in the NWB group. Radiographic evidence of callus was identified at a mean of 9 weeks in the WBAT group and 8.9 weeks in the NWB group. This difference was not statistically significant (p = 0.79). Fracture union occurred on average at 27.7 weeks for the WBAT group and 19.1 weeks for NWB group. This difference was not statistically significant (p = 0.17). Two patients (13%) in the WBAT developed a nonunion that was managed with a reamed exchange nailing procedure. Three patients (20%) in the NWB developed a nonunion requiring a secondary procedure. This difference was not statistically significant (p = 0.1284).

DISCUSSION AND CONCLUSION: In our study population, immediate weight bearing in cases of comminuted shaft fractures with less than 50% cortical contact did not increase the incidence of hardware failure, nonunion, or time to fracture union. This may facilitate mobilization of multiply injured patients in the early postoperative period.

POSTER NO. P466
Correlation of an Immunomodulatory Diketopiperazine with Positive Bacterial Cultures on Extracted Implants
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INTRODUCTION: This study analyzed biofilms on extracted orthopedic devices to determine if the presence of an immunomodulatory diketopiperazine correlated with bacterial colonization. Bacteria use small molecular weight N-acylhomoserine lactones and diketopiperazines to initiate biofilm formation and regulate colony growth. An Aspartate, Alanine-Diketopiperazine (DA-DKP) formed by the cleavage and cyclization of the N-terminal amino acids of human serum albumin has previously been demonstrated to be immunomodulatory for memory but not naive human T lymphocytes. We hypothesized that patients with culture positive implants at the time of extraction will have elevated DA-DKP levels in their biofilms.

METHODS: This was an IRB-approved study. Twenty-two patients undergoing hardware removal were enrolled. The removed orthopedic devices were stripped of surface biofilm using methanol/ammonium formate. The <3kD MW material was collected and diketopiperazine levels analyzed using anion exchange high pressure liquid chromatography coupled to negative electrospray ionization mass spectrometry.

RESULTS: The 22 patients ranged in age from six to 91 years, with a mean of 55. There were nine males and 13 females. Four devices were reported by the clinical laboratory to be culture positive. In three cases the main organism was Staphylococcus aureus. In one of the three cases Bacteroides and Streptococcus species were also isolated. In all 22 cases detectable amounts of DA-DKP were identified with a mean level of 169 ng/ml. Higher amounts of DA-DKP (33.5 - 235 ng/ml) were detected in the four culture positive devices vs. the culture negative (3.03 - 70.4 ng/ml). In addition, one device removed from a case with osteomyelitis had a DA-DKP content of 3,063 ng/ml.

DISCUSSION AND CONCLUSION: DA-DKP is an important immune modulator in biofilm formation on orthopedic implants. Its presence in biofilms found on extracted orthopedic devices suggests innate physiologic mechanisms conferring tolerance to the implanted device possibly correlated to the presence of inflammation/rejection reactions.

POSTER NO. P467
The Incidence and Significance of L5 Transverse Process Fractures in Adult Blunt Trauma Patients
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INTRODUCTION: Unlike the other lumbar transverse processes, fractures of the transverse process of the fifth lumbar requires high energy because strong iliolumbar ligaments connect it to ilium, deep seated position within the pelvis provides protection from direct trauma. Tile et al stated that L5 TP fractures are almost always associated with posterior pelvis ring injuries. However, to date no study has specifically examined transverse process fractures of the fifth lumbar vertebrae in a large number of patients. The purpose of this study is to describe the incidence of L5 transverse process fractures in an adult blunt trauma population and determine associated injuries.

METHODS: A database review was performed in a Level I trauma center between May of 2008 to June of 2010. Inclusion criteria were age>18, non-penetrating blunt trauma patients, having abdomino-pelvic CT scan at the time of admission. Two trauma trained orthopedic surgeons reviewed the studies. The radiology reports were also reviewed for associated injuries. Specifically, incidence of L5 transverse process fractures, lumbar transverse process fractures (1-4), posterior pelvic ring injuries, spine fractures were reviewed. In addition, visceral injuries were reviewed. RESULTS: A total of 813 patients qualified for the study. There were 40 (4.9%) L5 transverse process fractures, 83 (10.2%) lumbar 1 to 4 transverse process fractures, 124 (15.3%) posterior pelvis ring injuries, 106 (13.1%) spine fractures. The incidence of posterior pelvic ring injuries was 72.5% in the patients with L5 TP fractures, whereas it was 12.3% in the patients without L5 TP fractures. There was no association with L5 TP fractures and spine fractures. The correlation analysis revealed significant association between L5 TP fractures and pelvic ring injuries. (p<0.01, R2: 0.36) There was no significant association between lumbar TP fractures, spine fractures or pelvis fractures. DISCUSSION AND CONCLUSION: This study is the largest study to date that evaluated the incidence of L5 transverse process fractures and showed that there is 73% incidence of pelvic ring injury in the presence of an L5 TP fracture. Therefore, whenever there is an L5 process fracture noted on imaging studies, a pelvic ring injury should be searched.

POSTER NO. P468
Late Fixation of Vertically Unstable Type-C Pelvic Fractures: Difficulties and Surgical Solutions
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INTRODUCTION: Delayed fixation of unstable pelvic ring disruptions is expected to have more difficulties in achieving reduction and fixation with possible higher complications. The aim of this study is to report the difficulties and evaluate the results.
of late fixation of vertically unstable type-C pelvic ring injuries. METHODS: This study included 22 patients with unstable pelvic fractures. Inclusion criteria were vertically unstable (type-C) pelvic injuries presented three weeks or more after the initial trauma with persistent instability, and/or fracture displacement of more than one centimeter. Time since injury ranged from 3-32 weeks. There were 18 males and four females. Age of the patients ranged from 14-58 years. According to AO based fracture classification, 18 fractures were type-C1 (unilateral), and four were type-C3 (bilateral) fractures. Eight patients had associated neurological injuries. Combined posterior and anterior pelvic fracture fixation was done in 15 patients. Posterior pelvic fixation alone was performed in seven patients. Sacral root decompression was done in five patients. Bone grafting was needed in three patients. Fusion of the sacroiliac joint was done in six patients. Radiographic assessment was done using the grading system of Matta and Tornetta, and functional outcome assessment was done using the score system of Majeed. RESULTS: All fractures healed within five months. The healing time ranged from 12 to 20 weeks (average 14 weeks). Fracture reduction was considered excellent in 15 patients (68%), good in five patients (23%), and fair in two patients (9%). Complications included transient L5 palsy in two patients, ilio-femoral DVT in one, pulled out screws in two, and superficial wound infection in two. Functional result was excellent in 16 patients (73%), good in four patients (18%) and fair in two patients (9%). Neurological improvement occurred in six out of eight patients (75%). DISCUSSION AND CONCLUSION: Delayed fixation of unstable pelvic fractures creates operative difficulties such as scar tissue, callus formation, and inability to obtain anatomical reduction. Extensive surgical exposures and soft tissue dissections are required to achieve anatomical reduction. There is need for direct open reduction of the fracture with visualization and freshening of the fracture lines. Combined posterior and anterior approaches are needed to achieve reduction and rigid stabilization of pelvic ring in these delayed cases with satisfactory outcome.

POSTER NO. P469

Pain Management in the Perioperative Hip Fracture Patient

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INTRODUCTION: Management of pain in the rapidly enlarging elderly population is complicated by limitations in assessment of pain, patient co-morbidities and medication side effects. Improved pain control and minimizing adverse events related to pain medications increases functional status and decreases length of hospital stay. This study retrospectively reviewed pain levels recorded by nursing staff in hip fracture patients pre- and post- implementation of a new pain protocol. METHODS: A pain protocol specifically for elderly patients was devised by a consensus group composed of members of the division of Orthopedics, Geriatrics, Internal Medicine and Pharmacology utilizing evidence-based therapies. The protocol was selectively instituted at one of three hospital sites for all hip fracture patients admitted to the Orthopedic service. IRB approval was obtained. Clinical Looking Glass, a database repository, was used to create a cohort of patients aged greater than 65 years, admitted to a university hospital with an acute hip fracture, from 12/1/2010-2/28/2011 (pre-implementation) and from 3/1/2011-5/31/2011 (post-implementation). Demographics and pain scale measurements (using a 10 point numeric rating scale) were abstracted.

RESULTS: Prior to the implementation of the pain protocol identified 21 patients with acute hip fractures on the Orthopedic service, only 43% (9/21) had any pain scores reported at all. The average age was 78 and the average length of stay was 7.1 days. The average pain value during the hospitalization was 2.2 and 7% of those values were greater than or equal to 6. After implementation of the pain protocol, we identified 25 patients with acute hip fractures on the Orthopedic service and only 48% (12/25) had any pain values recorded at all. The average age was 87 and the average length of stay was six days. The average pain value was 1.0 and 3.4% were greater than or equal to 6. An unpaired t-test revealed a statistically significant (p <0.0001) reduction in pain scores post implementation of a pain protocol. DISCUSSION AND CONCLUSION: These early results underscore the importance of properly assessing and addressing pain in the elderly hip fracture population and despite multiple educational interventions to date, additional improvements are needed. There remains a crucial need to instruct our nursing staff to accurately and consistently assess pain. Preliminary data suggests that there is an improvement in pain control with the implementation of this new pain protocol. The new protocol may also lead to a decrease in the length of the hospital stay.

POSTER NO. P470

Fascia Iliaca Compartment Block for Patients with Proximal Femoral Fracture

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INTRODUCTION: Fascia iliaca compartment block (FICB) is classified as one of the anterior lumber plexus approaches. In this procedure, the local anesthetic is injected into the fascia lata compartment with subsequent infiltration into the area of the femoral nerve and lateral cutaneous nerve of the thigh. Since this technique is simple, it is expected that consistent anesthetic effect can be achieved by even inexperienced doctors. In this study, efficacy and safety of this procedure were assessed in patients with proximal femoral fracture. METHODS: One hundred consecutive patients with proximal femoral fracture were included in this study. The included patients were randomly assigned to either of two groups (with and without application of FICB). FICB was performed by the orthopaedic resident immediately after the arrival at the emergency unit. Thereafter, pain severity was assessed by Visual Analog Scale (VAS) with 15° leg lift and the amount of total oral non-steroid anti inflammatory drugs (NSAIDs) required. RESULTS: During the study period, no procedure-associated complication was encountered and anesthetic effect was confirmed for all patients. In comparative analysis between the groups, VAS scores of 100, 28.5, and 29 before administration, at 10 minutes and without application of FICB). FICB was performed by the orthopaedic resident immediately after the arrival at the emergency unit. Thereafter, pain severity was assessed by Visual Analog Scale (VAS) with 15° leg lift and the amount of total oral non-steroid anti inflammatory drugs (NSAIDs) required. RESULTS: During the study period, no procedure-associated complication was encountered and anesthetic effect was confirmed for all patients. In comparative analysis between the groups, VAS score was significantly lower in patients with FICB showing the scores of 100, 28.5, and 29 before administration, at 10 minutes and 12 hours after the block respectively. Additionally, the amount of oral NSAIDs required were significantly less in this group. DISCUSSION AND CONCLUSION: FICB is simple and easy to perform, achieving high degree of pain relief for patients with proximal femoral fracture. Less experienced orthopaedic residents can perform this procedure safely and effectively.
Surgery Improves Outcomes in Patients with Symptomatic Incomplete Bisphosphonate Induced Femur Fractures
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INTRODUCTION: Recently increasing evidence has shown a pattern of subtrochanteric femur fractures associated with long-term bisphosphonate use. The purpose of this study is to describe the ultimate outcomes for patients treated at a single institution, for incomplete bisphosphonate induced femoral fractures.

METHODS: Between 2004 and 2011, 68 patients with 101 femur fractures were identified as having radiographic findings and clinical signs of healing. Surgical intervention according to SMFA. Functional outcomes support radiographic findings and clinical signs of healing. Standardized dysfunction index from the Short Musculoskeletal Functional Assessment (SMFA). Patient demographics, initial radiographic diagnosis, treatment modality, time to healing and self-reported functional status was retrospectively documented. Healing was documented radiographically. Functional status and clinical data were analyzed by Student’s T-test and Fisher’s Exact Test.

RESULTS: This cohort had been treated with bisphosphonates for an average of 9.1 years (range of 7-15). The average healing time for all incomplete fractures was 8.2 months (range of 1.5-24 months) with two fractures failing to unite at latest follow up. Fifty percent of fractures were ultimately treated with surgery for failure of or pain refractory to nonsurgical management. Surgery was performed for fractures with refractory symptoms or failure to alter radiographs with nonsurgical treatment. Thirty-four patients with 46 incomplete fractures were identified and analyzed. Three patients with four fractures went on to complete fractures and were excluded from this study. Patients were assessed at a mean 17.7 months with the Short Musculoskeletal Functional Assessment (SMFA). Patient demographics, initial radiographic diagnosis, treatment modality, time to healing and self-reported functional status was retrospectively documented. Healing was documented radiographically. Functional status and clinical data were analyzed by Student’s T-test and Fisher’s Exact Test.

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DISCUSSION AND CONCLUSION: We found in: operative time (p value= 0.28), time to union (p Value= 0.81), and duration of hospital stay (p Value= 0.7). The final Johner and Wruh’s Criteria was: 20 excellent, seven good, three fair and five poor in Group 1 as compared to 19 excellent, nine good, six fair and one poor result in Group 2 (Plating Group). The difference was statistically insignificant (p Value= 0.8). There was however a statistically significant difference in the incidence of anterior knee pain in the nailing group with seven patients (20%) complaining of moderate to severe pain as compared to no patient with anterior knee pain in the plating group (p<0.05).

DISCUSSION AND CONCLUSION: Intramedullary interlocking nailing and minimally invasive plating (MIPO) using LCP were both found to produce comparable clinical and radiological results in closed diaphyseal fractures of tibia. However as compared to an incidence of 20% of anterior knee pain in the nailing group, no patient in the plating group complained of anterior knee pain. We conclude that minimally invasive plating using LCP is a good alternative of interlocking intramedullary nailing for the treatment of closed diaphyseal fractures of tibia.
**POSTER NO. P473**

Hydrosurgery as an Adjunct to Remove Bacteria from Orthopaedic Biomaterials

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**INTRODUCTION:** Orthopaedic infections are notoriously difficult to manage. Although the dilemma is multifactorial, bacterial biofilm is a major contributor and effective treatment often requires implant removal. Our objective in this study was to assess the efficacy of a hydrosurgery device in removing bacteria and biofilm from orthopaedic biomaterials.

**METHODS:** This study was performed in two phases. During the qualitative phase, *Staphylococcus aureus* was grown on multiple orthopaedic biomaterials (PMMA, stainless steel, titanium). These materials were then exposed to either the hydrosurgery device or an iodine scrub brush. Fluorescent microscopy was then used to evaluate and characterize the remaining bacteria. The quantitative phase of the study again involved growing *S. aureus* on different materials (PMMA, G5T2 titanium, G5T3 titanium) with subsequent exposure to hydrosurgery or the iodine scrub. Biomaterials were then sonicated and cultured on agar plates. Numbers of colony forming units were then counted.

**RESULTS:** The qualitative portion of the study demonstrated a large decrease in the amount of bacteria and biofilm in both experimental groups when compared to controls. We found that retained bacteria tended to be most frequently localized to areas of geographic irregularity, such as groove or pits. During the quantitative phase, both interventions resulted in removal of >99.9% of bacteria from all materials. The iodine scrub tended to outperform the hydrosurgery device but the difference was not statistically significant. Among different biomaterials, hydrosurgery performed significantly better on PMMA than it did on titanium (p=0.005). While there was a trend toward the iodine scrub performing better on titanium than PMMA, this finding was not statistically significant (p = 0.094).

**DISCUSSION AND CONCLUSION:** Both the hydrosurgery device and iodine scrub brush are effective means of removing *S. aureus* and its biofilm from orthopaedic biomaterials. Both interventions seem to be more effective on smooth surfaces than irregular ones. Hydrosurgery demonstrates superior performance on PMMA when compared to titanium.

**POSTER NO. P474**

Do Changes in the Economy Impact Orthopaedic Trauma Volume?

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**INTRODUCTION:** The effect of an economic recession on a population has been thoroughly studied, and, interestingly, a struggling economy is associated with overall health improvements. Human behavior also changes: as unemployment rises, job-absenteeism decreases, more time is spent working, and less engaging in leisure/recreation activities. Similarly, decreases in motor vehicle collisions have been reported as well. To our knowledge, the fluctuation of orthopaedic trauma volumes related to economic changes has not previously been reported. This study compares the changes in orthopaedic trauma patients at a level-1 regional trauma center to the dynamic health of the regional economy over a 10-year period.

**METHODS:** This retrospective analysis (2001 to 2009) of our institution’s trauma registry compared changes in general trauma admissions and orthopaedic trauma surgical volumes, to select local economic indicators (unemployment, building permits, and number of construction employees in the metropolitan area) and regional population growth.

**RESULTS:** For the decade, the local county population experienced a steady annual growth between 0.9% and 2.9%. During that same period, all economic indicators showed extreme variability. The unemployment rate peaked in 2002 at 5.4% and bottomed out at 3.3% in 2006 before the most recent recession (10.7% in 2009). Construction workers were employed at a decade high in 2006, but also underwent a steady 36% fall by 2009. Annual county building permits behaved similarly, peaking in 2005 and by 2009 dropped 80%. The changes in trauma volume were observed most accurately in relation to the county’s annual unemployment rate. Orthopaedic trauma surgical cases had a significantly negative association with the county unemployment rate of the previous year (Pearson correlation coefficient = -0.84, P=0.0098).

**DISCUSSION AND CONCLUSION:** The answer is ‘yes’: the economy does impact orthopaedic trauma volume. The unemployment rate of the previous year is the best predictor. The county unemployment rate is inversely related to our level-1 trauma center’s orthopaedic trauma surgical volume and demonstrates a one-year lag effect.
Subjective Responses and Psychometric Analysis of Three Published Pelvic Specific Outcome Instruments

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INTRODUCTION: The measurement of functional outcomes in pelvic fracture patients remains difficult for authors. We aimed to test the construct validity, respondent burden, and patient perception of three previously published pelvic outcome questionnaires METHODS: We recruited patients that were more than one year from surgical treatment of Tile B and C pelvic fractures. Subjects completed three pelvic specific outcome instruments (Majeed score, Iowa pelvic score, and Orlando pelvic score), and three general functional outcome instruments (SF-36, SMAF and WOMAC). Time of completion for each pelvic instrument was recorded, as was which score the patient felt best addressed their symptoms. Finally, patients were asked to state the three most significant impacts the pelvic fracture had on their life.

RESULTS: We recruited 33 patients, 13 Tile C and 20 Tile B fractures, who were a mean of 61 months from surgery (13-115 months). Patients cited recreational/mobility difficulty (26), emotional stress and family strain (20), employment and financial difficulty (15), sleep disturbance and anxiety (7), sexual function (4), as the most important consequences of their injuries. Each of the three pelvic outcome questionnaires showed a high correlation with the physical component summary of the SF-36 (Majeed 0.877, Iowa 0.876, Orlando 0.868). None had a high correlation with the mental component summary of the SF-36, indicating these scores do not capture psychological distress and well-being, social functioning and overall vitality. Correlations between instruments were also very high. All three questionnaires demonstrated ceiling effects, with 24%, 21% and 18% of respondents reporting the highest possible scores, on the Iowa, Majeed and Orlando scores respectively. The time for completion was 3.6 ± 0.4 minutes for the Iowa score, 7.4 ± 0.4 for the Orlando score (not including radiographic assessment), and 2.6 ± 0.2 for the Majeed score. Twelve patients each preferred the Iowa and Orlando questionnaires, and nine preferred the Majeed instrument.

DISCUSSION AND CONCLUSION: In this cohort, all three previously published pelvic outcome instruments demonstrated strong construct validity based on correlation with the physical component summary of the SF-36. Similar patient preference was observed for each instrument. Subjects identified mental and emotional outcomes as important consequences of their injury; however, none of the pelvic questionnaires measure these domains, as they all correlate poorly with the mental component summary of the SF-36. Ceiling effects and respondent burden limit the utility of the current instruments, and their reliability and responsiveness remain unknown. No currently available outcome instrument appears to capture all of the important consequences of these injuries.

Surgical Preferences of Patients at Risk of Hip Fractures

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INTRODUCTION: The optimal treatment of displaced femoral neck fractures in patients over 60 years is controversial. While much research has focused on the impact of total hip arthroplasty (THA) and hemiarthroplasty (HA) on surgical outcomes, little is known about patient preferences for either alternative. The purpose of this study was to elicit surgical preferences of patients at risk of sustaining hip fracture using a novel Decision Board.

METHODS: We developed a Decision Board for the surgical management of displaced femoral neck fractures. The Decision Board was presented to 81 elderly patients at risk for developing femoral neck fractures identified from an osteoporosis clinic. The participants were faced with the scenario of sustaining a displaced femoral neck fracture and were asked to state their treatment option preference and rationale for each operative procedure.

RESULTS: Eighty-five percent of participants were between the age of 60 and 80 years; 89% were female; 88% were Caucasian; and 49% had some post-secondary education. Ninety-three percent (95% Confidence Interval [CI]: 87% to 99%) of participants chose THA as their preferred operative choice. Participants identified several factors important to their decision, including the perception of greater walking distance (63%), less residual pain (29%), less reoperative risk (28%) and lower mortality risk (20%) with THA.

DISCUSSION AND CONCLUSION: The majority of patients preferred THA to HA for the treatment of a displaced femoral neck fracture when confronted with risks and outcomes of both procedures on a Decision Board.

A Method for Detecting Fibular Malrotation Using Conventional Fluoroscopy

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INTRODUCTION: When treating ankle fractures with associated syndesmotic injury, failure to anatomically reduce the syndesmosis may lead to poor outcome. While shortening, subluxation and distraction of the distal fibula are readily detected by intraoperative fluoroscopy, the ability of fluoroscopy to detect rotational malreduction is unknown. The purpose of this study was to investigate the reliability of a method for detecting fibular rotation using fluoroscopy alone.

METHODS: Distal fibula fractures with complete syndesmotic injury were created in three pairs (six) of cadaveric ankles. Two Kirschner wires were used to fix the fibula in neutral, 10°-20° of external rotation (ER), and 10°-20° of internal rotation (IR). Thirty pairs of fluoroscopic mortise views of the ankles in the different positions were obtained.
fibular rotation positions versus the normal contralateral ankle were evaluated by two orthopaedic trauma surgeons. The observers were asked weather the fibula was in neutral, in IR or in ER using the following radiographic criteria: for IR - tibiofibular clear space widening and/or a more spoon shaped fibula; for ER - divergence of Shenton’s lines and/or a more pointed blade shaped fibula (figure 1).

RESULTS: Overall accuracy for detecting fibular malrotation was 73% (Exact 95% CI 60% - 84%). Accuracy for detecting 20 degrees of IR or ER was 96% (Exact 95% CI 79%-99%). Overall agreement adjusted for chance was moderate (Weighted Kappa=0.44, p=0.002).

DISCUSSION AND CONCLUSION: Using the above-mentioned criteria during intraoperative fluoroscopy it is possible to detect a high percentage of 10 degree and most 20 degree malrotations of the fibula with moderate interrater reliability.

Figure 1: fluoroscopic images of distal fibula rotational malreductions

POSTER NO. P478
Prehospital Mortality of Trauma: An Analysis of Patients Declared Dead on Arrival
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INTRODUCTION: Prehospital deaths following contemporary trauma account for 45% of the overall trauma mortality. The existing evidence regarding this large cohort of cases is scarce. It is excluded from large databases as the US-NTDB, or the UK-TARN. Aim of this study is to investigate key contributing factors to deaths in trauma patients found alive at the scene but pronounced dead-on-arrival at the hospital (DOA).

METHODS: Retrospective cohort analysis of data collected from the Forensic Department of Athens-Greece referring to trauma fatalities between a five-year period. Demographics, transportation time-to-definitive care, total-survival-time, mechanism of injury according to ICD-9, injuries according to the abbreviated injury scale (AIS-98), injury severity score (ISS), results of toxicology, and co-morbidities were recorded for all cases. Descriptive statistical analysis as well as univariate and multivariate logistic regression analysis was conducted. RESULTS: A total of 618 cases met the inclusion criteria, males 74.4%, with median age 40 years (1-99), median ISS 34 (3-75), median transfer time 40 min (8-125). Injuries were sustained in an urban environment (504, 81.6%), with road traffic collisions being the commonest mechanism (504, 81.6%), followed by falls (73, 11.8%). Toxicology was found to be positive in 37.7% of these casualties, predominantly alcohol (average 101mg/ml). Co-morbidities were recorded in 24.4%, with ischaemic heart disease in 7.8%. Subgroup analysis for urban vs. rural casualties identified prolonged transfer times, different causative mechanisms, and incidence of alcohol intoxication. Fatalities in patients with predominantly head injuries vs. polytrauma cases without severe head trauma differed significantly to their ISS, mechanism, post-injury survival time, while demographics and comorbidities were comparable.

DISCUSSION AND CONCLUSION: Autopsy of the trauma fatalities remains an important tool for the evaluation of trauma services and injury prevention strategies. Patterns of organ injuries, age, as well as location of the accident appear to influence survival times and should be taken into consideration from health authorities making strategic decisions.

POSTER NO. P479
An Algorithm to Avoid Releasing the Posterior Compartment of the Leg in Acute Compartment Syndrome
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INTRODUCTION: Our purpose is to report on a prospective series of patients in whom an algorithm was used to attempt to avoid releasing the posterior compartments, and the safety of such a practice.

METHODS: Patients with compartment syndrome (CS) were brought to the OR emergently. A standard anterior and lateral compartment release was performed. The superficial and deep posterior compartments were then measured using a portable device. Using the preoperative DBP, a P < 30 was considered to be a positive finding warranting a medial incision for posterior release. If the P was ≥30, the posterior compartments were not released.

RESULTS: A consecutive series of 37 patients (28 male, nine female patients) aged 37 (18 - 70) with nine open, three GSW, and 25 closed tibial shaft (25) or plateau (12) fractures was managed by one surgeon for CS using this protocol. Twenty-one of 37 (57%) had preoperative signs or pressures suggesting posterior compartment involvement, of whom 16 had preoperative pressure measurements with an avg CP of 41mm Hg and an avg P of 38. After anterior and lateral release, only 3/37 (8%) required a posterior release. The CPs in the superficial and deep compartments decreased by 22 mm Hg and 24 mm Hg. None of the patients who had only an anterolateral release developed sequelae of a missed posterior compartment syndrome. DISCUSSION AND CONCLUSION: We describe a protocol of anterior and lateral release followed by a posterior release only if the P indicates the presence of a posterior compartment syndrome.
vessels has not been previously reported. This study seeks to define
the arterial supply to the patella using a combination of gadolinium-
enhanced magnetic resonance imaging (MRI) and subsequent
arterial gross dissection following infusion of urethane compound.
Through these methods, both qualitative and quantitative
information on the overall arterial contributions was assessed.
METHODS: In 16 fresh-frozen cadaveric knees, arterial cannulas
were placed into the superficial femoral artery, anterior tibialis
artery, and posterior tibialis artery. Gadolinium (Gd-DPTA) was
injected, and MRI was performed. For volumetric analysis, high
resolution fat suppressed 3D gradient echo sequences were collected
and analyzed using custom software. The gadolinium uptake was
compared between pre- and post-contrast imaging. Discrepancies
between superior pole and inferior pole enhancement were
taken from the MR images shows the largest
measured on the medial aspect of the inferior pole in
the uptake in the inferior 50% in seven specimens; 75% greater
enhancement was found in the superior pole (p = 0.04592).
DISCUSSION AND CONCLUSION: Quantitative and qualitative
enhancement was found in the inferior pole (p = 0.04592).
DISCUSSION AND CONCLUSION: Analysis of the MR images shows the largest
contributing artery to the patella entering at the inferior pole in
100% of specimens. In 75% (12/16) of knee specimens, this
artery entered on the medial aspect of the inferior pole. In 19%
(3/16) of knee specimens, the dominant vessel entered on the
superior aspect of the inferior pole. One knee had equally dominant
medial and lateral inferior vessels. A dorsal artery anastomotic
network contributed secondarily to the patella. An average of
five vessels per knee penetrated the anterior cortex on MRI. No
single dominant artery supplied this network. Smaller, secondary
vessels were also noted to enter inferomedially (81%; 13/16),
inferolaterally (69%; 11/16), superomedially (75%; 12/16),
and superolaterally (6%; 1/16). Quantification of gadolinium
uptake in the superior 50% of the patella was then compared to
the uptake in the inferior 50% in seven specimens; 75% greater
enhancement was found in the inferior pole (p = 0.04592).
DISCUSSION AND CONCLUSION: Quantitative and qualitative
data from this study confirm that the dominant arterial system
enters the patella at the inferior pole. In 75% of knee specimens, the
dominant flow entered inferomedially. Arthrotoomies, especially
medially should be made with the inferior polar contribution in
mind. The deep arterial ring should be preserved, including the
infrapatellar anastomotic network. This would theoretically allow
lateral arterial flow to feed the dominant artery if the medial
contributions from the geniculate arteries are compromised. Soft
tissue flaps should stay superficial to the periosteal layer covering
the anterior surface of the patella, as this is where the dorsal
anastomotic network is located. Also, in a fracture scenario, inferior
pole patellectomy should be avoided to preserve vascularized bone.
This study serves as a model for future studies analyzing the affects
of fractures and approaches on quantitative patellar enhancement.

POSTER NO. P481
Endosteal Strut Augment Reduces Complications
Associated with Proximal Humeral Locking Plates
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INTRODUCTION: The introduction of locking plate technology
has fostered a renewed interest in plate osteosynthesis for treating
displaced proximal humerus fractures (PHF). The biomechanical
properties of these implants provide a theoretical advantage toward
maintaining stable fixation in osteoporotic bone. Complication
rates associated with these devices have been higher than expected
however. The most frequent are screw cut-out with intraarticular
penetration and varus collapse. Establishing a second column of
support can minimize these complications and optimize clinical
outcome. The purpose of this study is to report the clinical
outcomes of patients treated for displaced PHFs with an endosteal
fibular allograft augment and lateral proximal humeral locking
plate inserted through a minimally invasive anterolateral approach.
METHODS: Thirty-eight patients having displaced proximal
humerus fractures with comminution of the surgical neck were
treated with this technique and followed for an average of 75.4 weeks.
There were seven two part, 19 three part and 12 four part fractures.
RESULTS: All patients healed their fracture. The mean DASH
Score at latest follow up was 15.2 +/- 17 (range 0 - 66). The
mean Constant score was 86.8 +/- 7 (range 51 - 95). No patient
suffered complete osteonecrosis (0%). One patient suffered
partial osteonecrosis (2.6%). There was no intraarticular screw
penetration or cut-out. One patient lost reduction (2.6%).
DISCUSSION AND CONCLUSION: Consistently high clinical
outcome scores can be achieved when treating complex proximal
humerus fractures with plate osteosynthesis using an endosteal
fibula augment. Use of this implant reduces the most common
complications associated with proximal humeral locking plates,
 improves the biomechanical strength of fixation and clinical
outcomes.
**Natural History of Anterior Chest Wall Numbness After Plating of Clavicle Fractures: Educating Patients**

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**INTRODUCTION:** Recent clinical studies have demonstrated improved outcomes when displaced clavicle fractures are treated with open reduction and internal fixation. This has lead to an increased number of patients undergoing open reduction and internal fixation (ORIF) for displaced clavicle fractures. Most patients undergoing ORIF have some degree of anterior chest wall numbness which can be both concerning and troubling. The natural history of numbness, effect on patient satisfaction and functional outcome of this numbness is not known.

**METHODS:** We have prospectively tracked the pattern, size, and patient satisfaction/outcomes in an IRB approved prospective cohort of consecutive patients undergoing ORIF of displaced clavicle fractures. All patients, aged 18 and older, with displaced diaphyseal clavicle fractures treated where potentially included in this study. No one declined participation in the study. Thirty patients were enrolled. During standard follow-up visits, patients are evaluated for anterior chest wall, infra-clavicular, subjective (patient reported) cutaneous numbness (the primary outcome measure) with a skin map tracing, using transparency paper covered with a 1cm² grid. Secondary outcomes include complications such as postoperative infection and time to union, malunion, or nonunion based on radiographs at these clinic visits.

**RESULTS:** Twenty-three of the 30 study patients completed follow up at our institution. Average area of numbness at two weeks was 27.0 cm²; SD = 42.7 cm². At six weeks, numbness decreased to 16.1 cm²; SD = 25.8 cm². There was a significant difference between the two and six-week numbness values (p=0.04). At 12 weeks, numbness values averaged 13.9 cm²; SD=21.7 cm². Values between two and 12 weeks were also significant (p=0.02). However, numbness changes between the six to 12 week follow ups were not significant (p=0.60). At 24 weeks, numbness averaged 12.0 cm² (SD = 21.8 cm²). Between two and 24 weeks, numbness changes continued to show significance (p=0.05). No significance was found between numbness values presented from six weeks to the end of follow up. There was one infection and one non-union.

**DISCUSSION AND CONCLUSION:** Plating of diaphyseal clavicle fractures is associated with a high incidence of anterior chest wall numbness in the immediate postoperative period. This numbness decreased by approximately 50% during the first 12 weeks postoperatively. Numbness resolution is minimal after the twelfth week. Patient functional outcomes do not appear to be affected by this side effect of ORIF. Patients should be educated about this risk factor pre-operatively.

**Stabilization of Distal Femoral Fractures with a Polyaxial Locking Plating System: Indications and Pitfalls**

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**INTRODUCTION:** This study is to evaluate the results of treatment of distal femur fractures stabilized with a polyaxial locking plating system.

**METHODS:** Over a three-year period (2007-2009) all patients admitted with distal femur fractures were selected to participate. Inclusion criteria were patients stabilized with the polyaxial locking plate system. Exclusion criteria were pathological fractures and other methods of internal fixation. Data collected and analyzed were patient demographics, fracture pattern (AO), perioperative local and systemic complications, mode of mobilization, time to union, loss of reduction, length of hospital stay, and failure of metal work. The minimum follow up was 12 months.

**RESULTS:** Out of 43 patients, 34 met the inclusion criteria with a mean age of 69 (55-92). Fracture classification included 15 x 33A1, 10 x 33A2, 2 x 33A3, 4 x 33B1, 1 x 33C1 and 2 x 33C2. Nineteen of 34 patients had an underlying degree of osteoporosis. Average time to union was 4.9 months (3-6). Complications included one superficial wound infection, one fracture above the plate requiring revision to a supracondylar nail, two delayed unions requiring bone graft augmentation and one early plate breakage (within six weeks) (non-compliant patient). The mean hospital stay was nine days (7-35).

**DISCUSSION AND CONCLUSION:** The polyaxial plating system is user friendly and its overall performance is comparable to the performance of other implants.

**Compartment Syndrome Increases the Incidence of Infection and Time to Union of Operatively Treated Tibial Fractures**

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**INTRODUCTION:** This study is to evaluate and compare the rates of union and secondary complications in patients treated with and without fasciotomy for acute compartment syndrome in operatively managed tibia fractures. Our hypothesis is that the presence of fasciotomy for compartment syndrome increases the risk for complications associated with the treatment of tibial fractures. METHODS: Level 1 regional trauma center. This study is a retrospective review of prospectively collected data between January 2000 and August 2010 on 149 patients with acute compartment syndrome and concomitant operatively treated tibial fractures (Group One). Patients were excluded from the study if they were skeletally immature, Gustilo IIIC, or had incomplete medical records and insufficient follow up to determine time at union. Nineteen patients with a tibial fracture and 19 patients with a fracture of the diaphysis were included in the analysis. A 1:4 matched control cohort was constructed for comparison against patients with similar fracture patterns without compartment syndrome or fasciotomy (Group Two). Tibial plateau fractures were treated with plate fixation and tibial shaft fractures were treated with intramedullary nail fixation.
All fasciotomies were four compartment and two incisions with early internal fixation and staged closure of the fasciotomy sites. Data recorded included age, OTA fracture classification, Gustilo classification, time to union, presence of non-union, secondary operations, incidence of infection and smoking status.

RESULTS: All results were internally controlled for age, injury pattern and method of fixation. Group One tibial plateau fractures demonstrated union on average at 28 weeks; 48% with delayed union and 11% with non-union. Group Two tibial plateau fractures demonstrated union on average at 15 weeks; 12% with delayed union and 6% with non-union. Late infection developed in 10% of Group One tibial plateau fractures versus 5% in Group Two. Tibial shaft fractures in Group One demonstrated union at 30 weeks; 67% with delayed union and 22% with non-union. Tibial shaft fractures in Group Two demonstrated union at an average of 19 weeks; 28% with delayed union and 1% with non-union. Late infection developed in 17% of Group One tibial shaft fractures versus 2% in Group Two. All reported differences between Group One and Group Two were statistically significant (p<0.05). Smoking status was strongly correlated with delayed union in both groups independent of presence or absence of compartment syndrome.

DISCUSSION AND CONCLUSION: The presence of acute compartment syndrome and the need for fasciotomy in patients with either tibial shaft or tibial plateau fractures is associated with a significant increase in the rate of delayed union, non union and deep infection.

POSTER NO. P485
Clinical Evaluation of Mini-fragment Fixation for the Treatment of Olecranon Fractures

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INTRODUCTION: Mini-fragment plating systems with 2.4 mm and 2.7 mm screws have the ability to gain multiple sites of fixation in short segments of bone with an overall lower profile than traditional 3.5 mm screw and plate constructs. Concern over the durability of these smaller plate and screw constructs have limited their use in the long bones of the upper extremity. Our hypothesis was that mini-fragment plate fixation in olecranon fractures would provide sufficient strength for union and reduce implant prominence, optimizing postoperative range of motion and outcome scores. This study reports a consecutive series of patients with olecranon fractures at two institutions treated with mini-fragment constructs.

METHODS: Established trauma registries at one level one trauma center and one tertiary care hospital were screened for olecranon fractures treated between January of 2007 and May of 2010. One of two senior, fellowship-trained orthopaedic surgeons performed each surgery. Patients were excluded from the study if they had associated humerus fractures, pre-existing upper extremity pathology, or fractures treated with traditional 3.5 mm plates. Fifty patients were identified. Fourteen patients were lost if they had associated humerus fractures, pre-existing upper extremity pathology, or fractures treated with traditional 3.5 mm plates. Fifty patients were identified. Fourteen patients were lost if they had associated humerus fractures, pre-existing upper extremity pathology, or fractures treated with traditional 3.5 mm plates. Fifty patients were identified. Fourteen patients were lost to follow up, leaving 72% of all eligible patients included in the study. Some 92% of these patients completed outcome scores. All patients were treated with a posterior approach and either a 2.7 or 2.4 mm reconstruction plate placed on the dorsal cortex and contoured to allow passage of either a 2.7 or 3.5 mm ‘home run’ screw through the plate down the shaft of the ulna. In 10 patients, an additional 2.4 mm plate was placed either medially or laterally to control comminution; one of these patients required two additional plates. Bone grafts were not used. Each patient was asked to fill out DASH and Mayo Elbow Performance Scores.

RESULTS: Thirty-six patients with a mean age of 62 and a mean follow-up time of 22.4 months were included in the study. Twenty-four of the patients in the series displayed comminuted fracture patterns (AO/OTA 21-B1(2), 21-B1(3), and 21-B2). One patient had a Bado 1 Monteggia fracture pattern. All fractures united at an average of nine weeks (range 6-18). Average extension deficit was 5 degrees and average flexion angle was 141 degrees. Average DASH score was 4.48, and average Mayo Elbow Performance Score was 96.21. Hardware was removed in 19 patients; three patients required a separate manipulation under anesthesia to improve range of motion. Five patients displayed heterotropic bone on postoperative follow up. One patient complained of transient ulnar nerve symptoms and one patient had a bursitis requiring PO and IV antibiotics, but no surgical intervention. There were no hardware failures, no nonunions, and no infections requiring return to the OR.

DISCUSSION AND CONCLUSION: All patients in this series, including those with postoperative complications reported their outcomes as good or excellent. In fractures of the proximal ulna, mini-fragment constructs provide sufficient strength and fixation to achieve high rates of union and patient satisfaction.
trends in utilization of intertrochanteric fracture fixation devices from 1993 to 2007. We compared utilization across hospital type, trends in procedure time, and trends in outcomes such as secondary surgery, and trends in reimbursement.

RESULTS: Since 2005, intramedullary nailing (IMN) of intertrochanteric hip fractures has become the most common treatment in government, non-profit, and for-profit hospitals. Prior to 1999 the mean surgical time was longer for IMN than for plate-and-screw (124.1 vs. 87.9 minutes) but became similar after 2000 (71.4 vs. 70.2 minutes). Complications and one-year mortality were significantly higher for the IMN prior to 2000 (HR 2.48 and 1.42, respectively), but became similar to plates since 2000. Reimbursement was consistently higher for nailing throughout this time period.

DISCUSSION AND CONCLUSION: Intramedullary nailing of intertrochanteric fractures has become safer and shorter since 2002. These data argue against the reimbursement difference as the sole driving force for the shift to intramedullary nails.

| Risk of Complications and Mortality Associated with IMN vs. Plate-and-Screw Fixation |
|-----------------------------------------------|-------------------------------------------------------------|-------------------------------------------------------------|
| Hazard Ratio, 1993-1999 (95% Confidence Interval) | Hazard Ratio, 2000-2007 (95% Confidence Interval) | Hazard Ratio, 1993-2007 (95% Confidence Interval) |
| Complications | 2.48 (1.37 to 4.48) | 1.11 (0.82 to 1.51) | 1.25 (0.97 to 1.61) |
| 30 day mortality | 1.30 (0.64 to 2.65) | 0.90 (0.73 to 1.12) | 1.17 (0.96 to 1.42) |
| One year mortality | 1.42 (1.01 to 1.99) | 0.96 (0.86 to 1.07) | 1.20 (1.09 to 1.33) |

POSTER NO. P487

Efficacy of Silver Nandressing in Eradication of Staphylococcus aureus Biofilms
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INTRODUCTION: Although the rate of infection following orthopaedic surgery is usually low, the morbidity and financial burden associated with musculoskeletal infections can be high. Biofilm infections indicate a particularly poor prognosis for patients as a hallmark of biofilms is their resistance to antimicrobials and the host immune response. Silver dressings are marketed for their ability to prevent and treat infections but limited research has been conducted to examine the efficacy of silver dressings in preventing and eradicating existing biofilm infections. In this study we used a clinically relevant in vitro model of orthopaedic biofilm infection to test the efficacy of a silver dressing in the treatment of an implant-associated infection.

METHODS: Biofilms were grown on polymethylmethacrylate (PMMA) disks using a clinical isolate of Staphylococcus aureus for four days. Varying amounts of silver dressing were then incubated with the disks for an additional 24 hours. Biofilms were stained, imaged and analyzed.

RESULTS: Upon the addition of any amount of the silver nanodressing, the total biovolume on each PMMA disk decreased by at least 93.5% when compared to unexposed cells. In the control disks, the biofilm covered the surface almost entirely (lawn coverage). In the disks exposed to silver dressing, the biofilms were small and sparsely scattered across the surface. With increasing amounts of silver dressing, the number of living cells remaining within the biofilm decreased from 66% to nearly 1%.

DISCUSSION AND CONCLUSION: Although antibiotics are useful in planktonic conditions, a bacterial biofilm can be up to 1,000 times more resistant to antibiotics. In contrast, these experiments demonstrate that silver impregnated nanodressing was highly effective in eliminating the majority of the existing biofilms and in killing the cells remaining within the biofilms.
INTRODUCTION: Infix has recently been introduced as an alternative to external fixation of the anterior pelvic ring following pelvic fractures. The purpose of the current study was to compare different configurations of InFix to external fixation in an unstable sacral fracture with anterior ring injury model. METHODS: 27 synthetic sawbone pelvis (Sawbones, Vashon, WA) were divided into three groups, each of which would receive one of the following posterior fixation methods: a single 7.0mm transsacral screw through the S1 body (TS), a single iliosacral screw through the S1 body, terminating 1.5cm past the mid-sagittal plane (IS), and two iliosacral screws terminating 1.5cm past the midsagittal plane in the S1 and S2 bodies (S1S2). A 5mm gap through the sacral foramina was created along with an ipsilateral pubic ramus fracture. The following four anterior fixation techniques were investigated: Group I (ExFix): Supra-acetabular external fixation with 6.0mm pins, Group II (InFix): Supra-acetabular InFix with 7.5mm pedicle screws, Group III (Double InFix): Supra-acetabular Infix with two 7.5mm pedicle screws bilaterally, each connected by a rod, and Group IV (Double InFix w/ CC): the addition of three cross connectors to the Double InFix configuration. This created 12 unique fixation constructs to be tested. All anterior fixation groups were tested on each specimen with nondestructive loading by means of a single leg stance model. The specimens were subjected to 25 cycles of cyclic loading between 100 and 200N and then loaded in displacement control to a maximum load of 300N. Three dimensional displacement and rotation was measured using an optical tracking system. Peak to peak (P2P) displacement and rotation, as well as condition displacement (CD), or settling, was calculated. P2P displacement was defined as the average peak to valley displacement of the 23rd, 24th, and 25th cycles while CE was defined as the difference in displacement from the 1st to the 25th peak. Differences between outcome metrics between the anterior fixation was analyzed using the non-parametric repeat measures test with Dunn's post hoc comparison with p<0.05 considered significant. RESULTS: The ExFix group failed during cyclic loading in 8/9 TS specimens, 7/9 IS specimen, and 0/9 S1S2 specimens with average ultimate loads of 175.4±79.3N, 195.3±71.2N, and 289.4±10.2N, respectively. This high rate of failure limited ExFix displacement and rotation comparisons to the S1S2 group. All specimens in the InFix groups survived the cyclic loading and the compression to 300N, with the exception of two InFix specimen in the IS group, which failed during cyclic loading. There were no differences in CD or P2P elongation or displacement for any of the anterior fixation configurations (p>0.05). The CD and P2P elongation were less than 2mm at the sacrum and less than 3mm at the pubis, respectively, in all fixation groups that withstood cyclic loading (p>0.05). DISCUSSION AND CONCLUSION: There is no advantage to using hybrid screw fixation when utilizing the pre-contoured clavicle plates in the superior position. Both fixation methods displayed less stiffness after cyclic loading, indicating that neither method is as strong as the uninjured clavicle.

POSTER NO. P490
Complications with Open Reduction and Internal Fixation of Calcaneal Fractures: Static versus Dynamic Retraction
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INTRODUCTION: Wound complications can be a major problem following open reduction and internal fixation (OLIF) of calcaneal fractures. The rate of serious infections following surgical treatment of closed fractures ranges from 0-20%,1,2 with an even higher incidence of 19-31% associated with open fractures.1,3,4 Traditionally, two types of retraction (static and dynamic) have been used for surgical exposure. Static retraction is performed by placing Kirschner wires into the lateral process of the talus to retract the soft tissue flap. Dynamic retraction is performed by an assistant retracting the soft tissue flap
The purpose of this study was to test the biomechanical properties of periarticular plates and locking plates for ankle fractures. The advancements in plate technology include pre-contoured Heidi Israel, PhD, St Louis, MO.

Interventions: All fractures requiring surgical treatment were classified as closed or open (utilizing the Tscherne or Gustilo classification) and fracture type. Patient variables, including diabetes mellitus, tobacco use, history of corticosteroid use, or peripheral vascular disease were documented at the time of presentation. The time from injury to surgical intervention, as well as total tourniquet time was also documented. All patients received perioperative antibiotics and all open fractures were treated emergently with surgical irrigation and debridement, and intravenous antibiotics. Main Outcome Measurements: The incidence of wound complications following ORIF of calcaneal fractures was determined through a systematic, retrospective chart review. The wound complications were subdivided according to type of treatment required; oral antibiotics and local wound care only versus surgical irrigation and debridement with intravenous antibiotics. In addition, the incidence of wound complications based on retraction type was determined.

RESULTS: Wound complications developed in 30 (17%) of the 177 patients treated with open reduction and internal fixation. Of the 68 patients treated with dynamic retraction, six (8.8%) developed post-operative wound complications. Of the 109 patients treated with static retraction, 24 (22%) developed wound complications. The difference in wound complications after dynamic and static retraction was noted to be statistically significant, with p<0.028. Overall, patients treated with static retraction were 2.9 times more likely to develop wound complications. This was independent of patient risk factors, including smoking history or systemic disease. Wound complications ranged from wound necrosis requiring local wound care and oral antibiotics, to deep infection requiring surgical irrigation and debridement with prolonged intravenous antibiotics. DISCUSSION AND CONCLUSION: Wound complications are likely to develop wound complications. This was independent of patient risk factors, including smoking history or systemic disease. Wound complications ranged from wound necrosis requiring local wound care and oral antibiotics, to deep infection requiring surgical irrigation and debridement with prolonged intravenous antibiotics.

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The distribution of values is shown in chart 2. The mean value for femoral rotation for the neck was measured. This angle represented the femoral rotation. Were obtained. The angle between the table and the femoral rotation and to quantify the differences between sides on each pair. Analyzed to define a normal population value and range of femoral rotation. Lead to Rotational Deformities in Femoral Fracture Fixation

Anch Skalak, MD, Greenville, NC.

Michael Casale, Cary, NC.

Daniel R. Cooperman, MD, Cleveland, OH.

Paul Toogood, MD, San Francisco, CA.

INTRODUCTION: In this study, 2,605 skeletal femur specimens were analyzed to define a normal population value and range of femoral rotation and to quantify the differences between sides on each pair. METHODS: Femoral rotation was determined by placing each femur supine towards the edge of the table so that lesser trochanter, medial and lateral posterior condyles were touching the table. The femurs were then abducted so that the femoral necks were parallel to the edge of the table. Axial digital photographs were obtained. The angle between the table and the femoral neck was measured. This angle represented the femoral rotation.

RESULTS: Overall, the average value for femoral rotation for the 5210 femurs was 14.1°. The distribution of values is shown in chart 1. Differences in femoral rotation between sides averaged 9.9°. A difference of greater than 10° was seen in 37.6% of the pairs. A difference of greater than 15° was seen in 22.2% of the pairs. The distribution of values is shown in chart 2. The mean value for and that locking plates provide stronger fixation than non-locking plates in an osteoporotic distal fibula fracture model.

METHODS: Twenty-four cadaveric specimens free of gross ankle pathology were tested. The bone mineral densities (BMD) of all specimens were obtained using dual x-ray absorptiometry (DEXA) scans of the proximal femur. All specimens used were osteopenic or osteoporotic. The fracture model simulated the Lauge-Hansen supination-external rotation stage IV injury (OTA 44-B2.1). The four constructs tested included: 1. Non-locking one-third tubular plate (NTT); 2. Locking one-third tubular plate (LTT); 3. Non-locking periarticular plate (NPA); and 4. Locking periarticular plate (LPA). Each construct was tested in six specimens. The one-third tubular plates were applied as lateral fibular plates; so they were placed in the same location as the periarticular plates. The specimens underwent axial loading followed by torsional loading to failure. Statistical analysis was performed using Kruskal-Wallis testing, and further analysis with Mann-Whitney testing (p ≤ 0.05).

RESULTS: The periarticular plates outperformed the one-third tubular plates in both the non-locking and locking constructs in terms of axial stiffness, rotational stiffness and torque to failure (p>0.05, NS). The non locking periarticular plate had greater axial stiffness, rotational stiffness, and torque to failure than the LPA (NS). The NTT had greater axial and rotational stiffness than the LTT, as well as greater torque to failure (p=0.03). The mode of failure differed between all four constructs. Four of the six constructs in the NPA group did not fail.

DISCUSSION AND CONCLUSION: In biomechanical testing of axial stiffness, rotational stiffness, and torque to failure, periarticular plates provided superior fixation to one-third tubular plates for OTA 44-B2.1 fractures in an osteoporotic model. Both the non-locking periarticular and non-locking one-third tubular plates performed better in biomechanical testing than their locking counterparts in our model. Periarticular plates should be considered when treating osteoporotic distal fibula fractures, but non-locking plate models may provide adequate fixation for these injuries. More extensive biomechanical testing and subsequent clinical trials are needed to support these results.

POSTER NO. P492

Variations and Differences in Femoral Rotation Can Lead to Rotational Deformities in Femoral Fracture Fixation

Anthony Skalak, MD, Greenville, NC.

Michael Casale, Cary, NC.

Daniel R. Cooperman, MD, Cleveland, OH.

Paul Toogood, MD, San Francisco, CA.

INTRODUCTION: In this study, 2,605 skeletal femur specimens were analyzed to define a normal population value and range of femoral rotation and to quantify the differences between sides on each pair. METHODS: Femoral rotation was determined by placing each femur supine towards the edge of the table so that lesser trochanter, medial and lateral posterior condyles were touching the table. The femurs were then abducted so that the femoral necks were parallel to the edge of the table. Axial digital photographs were obtained. The angle between the table and the femoral neck was measured. This angle represented the femoral rotation.

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femoral rotation of the left femur was 13.1° and the mean value for femoral rotation of the right femur was 15.1°. The average difference between the sides on each pair (right - left) was 2.1°. The difference between the average femoral rotation on the right and left sides was determined to be statistically significant (p<0.001).

DISCUSSION AND CONCLUSION: This study establishes the variation of femoral rotation in a normal population. The side-to-side differences for femoral rotation need to be considered by the surgeon when locking femoral rotation. A substantial portion of the study population had a difference of greater than 10° between sides. When performing fracture fixation of the femur, matching the rotation to the contralateral limb could result in a rotational malreduction of greater than 15° in one of five cases.

INTRODUCTION: Patients greater than 65 y/o will soon become the largest segment of the population. Currently this age group represents about 25% of trauma patients. They have unique characteristics including higher rates of medical comorbidities and a lower metabolic reserve which makes them significantly different from their younger cohorts. The purpose of this study was to determine if orthopaedic trauma patients greater than 65 y/o are at higher risk for mortality, number and severity of injuries, complications, and longer hospital stays. METHODS: After IRB approval, a three-year retrospective chart review of all orthopaedic trauma patients was done to evaluate the effect of age on the above outcomes. A database was created to capture the following data points: patient demographics, mechanism of injury, comorbidities, procedures, complications, and outcomes. RESULTS: A total of 963 patients were identified and 870 had sufficient data available for review. Elderly patients (>65y/o) made up 13% of the population. Elderly patients were more likely to have injuries resulting from falls and were more likely to wear seatbelts when involved in motor vehicle crashes. They had a higher rate of medical comorbidities. However, they had a significantly higher ISS, and significantly longer hospital and days in the ICU. They accounted for 29% of total hospital days. Mortality rate was not significantly different. DISCUSSION AND CONCLUSION: A recent ACS review of our institution revealed that 50% of our trauma patients are age 55 or older. Nationally, 25% percent of trauma patients are over the age of 65. As the largest segment of the population continues to get older, we will see more and more elderly patients. As our review shows, lower energy mechanisms occur more commonly in these patients. Although mortality does not differ between age groups, ISS and length of hospital and ICU stays are higher in the elderly. No difference in mortality rate is likely due to the success of aggressive trauma and critical care protocols that reduce the risk of mortality by up to 50%. Since elderly patients account for a disproportionate amount of cost and resources, it justifies the continued need to more closely evaluate this demographic to identify the unique challenges they provide and improve their care such as management of osteoporotic fractures, medical comorbidities, and challenging physical rehabilitation protocols.

POSTER NO. P493
The Effect of Age on Outcomes in Orthopaedic Trauma Patients
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INTRODUCTION: Patients greater than 65 y/o will soon become the largest segment of the population. Currently this age group represents about 25% of trauma patients. They have unique characteristics including higher rates of medical comorbidities and a lower metabolic reserve which makes them significantly different from their younger cohorts. The purpose of this study was to determine if orthopaedic trauma patients greater than 65 y/o are at higher risk for mortality, number and severity of injuries, complications, and longer hospital stays. METHODS: After IRB approval, a three-year retrospective chart review of all orthopaedic trauma patients was done to evaluate the effect of age on the above outcomes. A database was created to capture the following data points: patient demographics, mechanism of injury, comorbidities, procedures, complications, and outcomes. RESULTS: A total of 963 patients were identified and 870 had sufficient data available for review. Elderly patients (>65y/o) made up 13% of the population. Elderly patients were more likely to have injuries resulting from falls and were more likely to wear seatbelts when involved in motor vehicle crashes. They had a higher rate of medical comorbidities. However, they had a significantly higher ISS, and significantly longer hospital and days in the ICU. They accounted for 29% of total hospital days. Mortality rate was not significantly different. DISCUSSION AND CONCLUSION: A recent ACS review of our institution revealed that 50% of our trauma patients are age 55 or older. Nationally, 25% percent of trauma patients are over the age of 65. As the largest segment of the population continues to get older, we will see more and more elderly patients. As our review shows, lower energy mechanisms occur more commonly in these patients. Although mortality does not differ between age groups, ISS and length of hospital and ICU stays are higher in the elderly. No difference in mortality rate is likely due to the success of aggressive trauma and critical care protocols that reduce the risk of mortality by up to 50%. Since elderly patients account for a disproportionate amount of cost and resources, it justifies the continued need to more closely evaluate this demographic to identify the unique challenges they provide and improve their care such as management of osteoporotic fractures, medical comorbidities, and challenging physical rehabilitation protocols.

POSTER NO. P494
Inflatable Bone Tamps Improve Reduction and Mechanical Properties of Impacted Tibial Plateau Fractures
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INTRODUCTION: Restoration of joint congruity and mechanical properties of subchondral bone are compared between reduction and fixation of an articular fracture model treated by a conventional bone tamp (CBT) versus an inflatable bone tamp (IBT). METHODS: Standardized lateral tibial plateau split-depression fractures were created in 14 pairs of fresh-frozen cadavers and reduced under fluoroscopy with either an IBT or a CBT, filled with calcium phosphate bone void filler, and stabilized with a buttress plate. Articular reduction was assessed by blinded observers using fluoroscopic images, 3-D CT scans and visual inspection of the articular surfaces. Observers judged each reduction as good/fair/poor, and the left side of each pair by rating as better/equivalent/worse than the right side. A 1-proportion Z-test (α=0.05) was used to test if a majority of IBT-reduced specimens were rated as better than their CBT-reduced control. Volumetric analysis using image processing software was used to calculate the volume of the depressed and residual defect, respectively. Malreduction was quantified as the total under-reduced and over-reduced volumes, expressed as a percentage of the depressed volume. A paired t-test (α=0.05) was used to test if the average malreduction was less for IBT-reduced vs. CBT-reduced fractures. To measure mechanical properties cyclic axial compressive loading was applied to each reduced fracture. The maximum displacement at each cycle was recorded, and the dynamic stiffness was calculated. A Friedman's Test with treatment (IBT, CBT) as grouping factor and cycle intervals as blocking factor was used to compare these dynamic variables (α=0.05). After dynamic loading, each specimen was loaded in position control to failure at a rate of 0.5mm/sec. The static stiffness in a physiologic loading range (250-450N) was calculated via linear regression and compared between the
two treatments using Wilcoxon Signed-Rank Test (α=0.05). RESULTS: The majority of IBT-reduced fractures were rated better than their CBT-reduced contralateral with seven of 14 (50%) IBT-reduced fractures rated as good reductions compared to only three of 14 (21%) for CBT-reduced fractures. The average malreduction for IBT-reduced fractures (28.1±18.7%) was significantly (p=0.04) less than for CBT-reduced fractures (52.5±35.2%). The median maximum displacement of IBT-reduced fractures was significantly (p=0.02) less than CBT-reduced fractures at 100, 1000, 2000, and 3000 cycles. Dynamic stiffness was significantly higher for IBT-reduced fractures throughout loading (p=0.001). Static stiffness during loading was significantly (p=0.05) higher for IBT-reduced specimens (880±298N/mm) than for CBT-reduced specimens (717±411N/mm).

DISCUSSION AND CONCLUSION: Fractures treated with an IBT had qualitatively and quantitatively better reduction than CBT treatment, typically resulting in a smoother articular surface with less residual defect volume. In addition, IBT-reduced fractures possessed superior mechanical properties compared to their CBT-reduced contralateral controls during both cyclic and static loading. Given these findings, a clinical comparison study is warranted.

POSTER NO. P495

Indirect Versus Direct Reduction of the Posterior Malleolus: Validation of Sutton's Rule

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INTRODUCTION: Seven percent of ankle fractures involve the posterior malleolus. These can be treated with either direct, open reduction or indirect reduction with clamps and percutaneous anterior-to-posterior (A-P) screw fixation. Malreduction of the posterior malleolus and, therefore, the articular surface and syndesmosis may adversely affect functional outcome. To our knowledge, there are no published reports reviewing the quality of posterior malleolus reduction after percutaneously placed anterior to posterior (A-P) screw fixation compared to open reduction with fixation of the posterior malleolus. The purpose of this study is to evaluate and compare the quality and maintenance of posterior malleolar reduction using indirect methods versus formal open reduction and internal fixation. Our hypothesis was that both methods would be equivalent. METHODS: Retrospective chart and radiographic review of 71 patients with operatively treated tri-malleolar ankle fractures was performed. Patients were placed into two groups: Group 1 - direct open reduction and internal fixation of the posterior malleolus, with the patient either in the lateral or prone position and Group 2 - indirect percutaneous reduction and A-P screw fixation with the patient in the supine position. Quality of reduction was assessed on initial post-operative and final follow-up lateral radiographs. The fracture was healed, and graded as either anatomic or incongruous.

RESULTS: Group 1 consisted of 31 fractures, while Group 2 consisted of 40 fractures. Twenty-eight fractures (90%) in Group 1 demonstrated an initial post-operative anatomic reduction. Conversely, only 17 (42%) fractures in Group 2 demonstrated an initial post-operative anatomic reduction (p<0.001). No fracture in Group 1 lost the position of reduction at final follow up, however, three fractures (8%) in Group 2 that were initially anatomically reduced, subsequently lost reduction during the post-operative period (p=0.05).

DISCUSSION AND CONCLUSION: Based on these radiographic analysis, our hypothesis was disproven. The ability to achieve and maintain an anatomic reduction of the posterior malleolus was significantly superior with direct open reduction and internal fixation. Although the functional sequelae of this are yet to be determined, direct reduction appears to offer the patient the best chance for the restoration of a congruous joint.
Pure Transosseous Suture Fixation of Olecranon Fractures: A Novel Surgical Technique and Biomechanical Comparison

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INTRODUCTION: Tension band technique is commonly used for surgical treatment of olecranon fractures. The purpose of this study was to determine if the fixation strength of tension band with purely transosseous sutures (Ticron and Fiberwire) was competent to the modified AO tension-band technique with Kirschner’s wires and stainless steel wires.

METHODS: Thirty custom-made artificial proximal ulna models were used in this study. A transverse olecranon osteotomy was done in each ulna with the same cutting jig. These prepared ulnae were randomly divided into five groups. Six ulnae in the group 1 were fixed by our new technique with No.5 Ticron. The same technique was applied in the group 2 with No.2 Ticron, in the group 3 with No.5 FiberWire, in the group 4 with No.2 FiberWire. Ulnae in the group 5 were fixed with AO modified tension band with two 1.6mm intramedullary Kirschner’s wires (K-wires) and a figure-of-eight 18-gauge stainless wire. Each ulna was put on the custom-made inverted distal humerus. Loading force was transmitted from the material testing system (MTS) via a metal cable hanging on the protruding hook on the olecranon. Each ulna experienced 15N pre-tension force before testing. The loading force and displacement of the olecranon fracture were recorded by real-time videos, the MTS machine and the extensometer.

RESULTS: A one-way ANOVA showed that differences in loading forces between the tested groups were significant (p < 0.001). Results from the Tukey HSD multiple comparison test showed significant differences between group 3 and other groups since the displacement greater than 0.75mm. (P=0.013). The mean force to achieve failure (displacement > 2.0 mm) in Group 3 (857.9N, No.5 FiberWire) was of great significant difference compared with group 1 (581.2N, No.5 Ticron), group 2 (474.2N, No.2 Ticron), group 4 (588.5N, No.2 FiberWire) and group 5. (531.7N, TBW). There were no significant differences between group 1, 2, 4 and 5.

DISCUSSION AND CONCLUSION: The braided polyester sutures and FiberWires had been proven in many studies with excellent biomechanical strength and biocompatibility. We have tried to design a new technique to treat olecranon fractures without any metal implant to avoid hardware complications. Our idea derived from Lotke et al.12 and the modified Wagoner’s Hitch technique which was used for the treatment of patellar fractures. This study proved that this new technique by using braided polyester sutures or FiberWires provided comparable, even superior, fixation strength with metal wire tension band. Our new surgical method can provide equivalent fixation power compared with the modified AO tension band wiring technique for olecranon fractures without using any metal implant. This technique prevents hardware complications and a second operation of removal implants is not required. It may be an alternative surgical option for the orthopedic surgeons to treat olecranon fractures.
site, purpose (acute vs. reconstructive), type of supplemental bone graft used, associated wound factors (open fractures, soft tissue injury requiring coverage, or history of infection), signs of infection (seroma, erythema, prolonged drainage, abscess), the need for re-operation secondary to wound complication, and union. These cases were then compared to 1:1 matched cohorts for age, type of case (acute/reconstructive), anatomic site, open injury, and soft tissue reconstruction. RESULTS: A total of 193 BMP-2 cases were reviewed. There were 138 nonunions and 56 open fractures. Sixty patients (31%) had documentation of at least one post-operative wound concern. There was no difference between the acute traumatic and reconstructive groups. The most commonly documented (29%) wound concern was prolonged serous drainage. Seventeen patients (9%) required post-operative antibiotic therapy longer than would routinely have been prescribed. Six patients (3%), required re-operation for presumed wound infection secondary to prolonged drainage and erythema. Four of the six patients (2%) had infection and two (1%) had a sterile seroma/hematoma. Age, sex, anatomic site, acute trauma, open fracture, and the need for soft tissue reconstruction did not correlate with the need for return to the operating room for presumed or actual wound infection. There were 182 patients in the matched control cohort. Thirty-three patients (18%) had documentation of at least one wound concern; significantly less than with BMP-2 use (p=0.004). The most common concern was wound drainage (22 out of 33). Fifteen patients (8%) required a re-operation for wound infection after prolonged drainage or wound dehiscence; significantly higher than the BMP-2 group (p=0.04). Among the wound concern subgroups, the reoperation incidence in BMP-2 patients was significantly lower (p<0.0001). The most common anatomic site that required a re-operation was the distal tibia (11 out of 13). DISCUSSION AND CONCLUSION: The use of BMP-2 in both acute and reconstructive extremity surgery increased the incidence of prolonged serous drainage requiring additional antibiotic therapy that typically resolves. This does not appear to be indicative of a post-operative infection requiring a re-operation. Important re-operations for presumed wound infection were significantly lower than in the matched group of cohorts. We suggest that when post-operative drainage is seen after the use of BMP-2, treatment should be limited to antibiotic coverage until the wound resolves.

POSTER NO. P499

The Systemic Stimulation of Mesenchymal Stem Cells in Bone Marrow in Response to Trauma

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INTRODUCTION: Fracture healing represents a physiological process regulated by a variety of signalling molecules, growth factors and osteogenic progenitor cells. Bone healing following trauma is associated with increased serum concentrations of several pro-inflammatory and angiogenic growth factors. Platelet-derived growth factor (PDGF) has been shown to stimulate mesenchymal stem cell (MSC) proliferation in vitro. However, the in vivo relationship between the levels of PDGF and the numbers of MSCs in humans has not yet been explored. The aim of this study was to investigate PDGF release in the peripheral circulation following trauma and to correlate it with the numbers of MSCs in iliac crest bone marrow (BM) aspirate and in peripheral blood.

METHODS: Trauma patients with lower extremity fractures (n=12, age 18-63 years) were recruited prospectively. Peripheral blood was obtained on admission, and at one, three, five and seven days following admission. The serum was collected and PDGF was measured using the enzyme-linked immunosorbent assay (ELISA) technique. Iliac crest (BM) aspirate (20ml) and peripheral blood (PB) (20ml) was obtained on days 0-9 following admission. MSCs were enumerated using standard colony-forming unit fibroblasts (CFU-F) assay.

RESULTS: We observed a gradual increase in serum PDGF levels following fracture (r²=0.79, p=0.005, n=8), which reached up to two-fold on day 7. In five out of eight patients recruited for CFU-F study, an increase in iliac crest BM CFU-F per millilitre of aspirate was similarly observed, which reached an average six-fold post-fracture (ranging from day 3 to day 9). No CFU-Fs were observed in PB at any time-point in all patients studied. In three patients, for which PDGF and CFU-F were measured in parallel, a strong positive correlation was observed between CFU-F numbers per millilitre of BM aspirate and circulating PDGF levels (r²=0.98, p<0.01).

DISCUSSION AND CONCLUSION: Our data demonstrate, for the first time, that BM MSC pool in humans is not static and can be stimulated following trauma. This is not a result of mobilization of MSCs into systemic circulation. Rather, MSC activation at remote sites, like iliac crest BM, can be due to systemic up-regulation of several cytokines and growth factors, including PDGF, in peripheral circulation. This data therefore enable a more comprehensive understanding of MSC dynamics in response to trauma and can inform the design of a clinical trial aimed to optimize the location and timing of BM harvest for use in bone regeneration following fracture.

POSTER NO. P500

ALTERNATE PAPER: TRAUMA VI

Current National Trends in Total versus Hemi-Arthroplasty in the Treatment of Femoral Neck Fractures

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INTRODUCTION: Femoral neck fractures are a common injury that may require arthroplasty acutely. Comparative data examining national trends in the treatment of femoral neck fractures with arthroplasty is lacking. This study aims to characterize and compare national trends in the treatment of these fractures with either total (THA) or hemi-arthroplasty (HA).

METHODS: Patients within the National Hospital Discharge Survey database, which were treated with either a HA or THA for a femoral neck fracture from 1990-2007, were selected for analysis. The age, pre-operative health, post-operative complication rate, post-operative disposition, and mortality rate were examined and compared between groups at six-year intervals ('90-'95, '96-'01, '02-'07).

RESULTS: A total of 174,641 fractures were treated with THA, while 1,618,103 were treated with HA. Fewer THAs were performed between groups at six-year intervals ('90-'95, '96-'01, '02-'07).

For full information refer to page 14. An alphabetical faculty financial disclosure list can be found starting on page 19.
DISCUSSION AND CONCLUSION: The number of femoral neck fractures being treated by HA is increasing while the number being treated by THA is decreasing. This may be a reflection of evolving indications that favor one procedure over the other or in response to a higher incidence of dislocation that was seen historically in the THA group. Currently, dislocation rates between these two groups have equilibrated. This may be due to increased utilization of larger femoral head sizes.

POSTER NO. P501
◆Atrophic Non-Union after Open Fracture: Are Bone Morphogenetic Proteins the Answer to the Problem?
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INTRODUCTION: Non-unions following open fractures present a difficult clinical challenge, often complicated by compromised soft tissues, lack of adequate bone stock, and an increased risk of infection compared to non-unions after closed fractures. The purpose of this study was to evaluate the efficacy of bone morphogenetic protein (BMP) versus autograft for the treatment of atrophic non-union resulting from open long bone fracture. METHODS: A retrospective review was completed at our Level 1 Trauma Center for all fracture non-unions from January 2003 to June 2009. Patients were included in the study if they were diagnosed with an atrophic non-union following treatment for an open fracture. In addition, patients had to have undergone non-union treatment with revision surgery and insertion of autograft or BMP. Medical records were reviewed for demographic data, surgery details, and radiographic follow up. RESULTS: From January 2003 to June 2009, 178 patients were treated for a fracture non-union at our institution. Of these, 30 patients had a prior open long bone fracture and met the inclusion criteria. These 30 patients had an average age of 40 (range 18-66). Twenty-one were male and nine were female. Ten were smokers and eight patients had culture positive infected non-unions. Twenty-six patients underwent deformity correction with hardware revision and insertion of bone graft during the same procedure. The remainder underwent bone graft placement alone. Eight patients were treated with autograft, 10 with rhBMP-2, and 12 with rhBMP-7. The average follow up after bone grafting procedure was 27.6 months (range 8-68). Twenty-three patients healed: 77% treated with BMP, 75% treated with autograft. The difference in rate of union (p=0.62) and time to union (p=0.50) was not significant. The seven patients who did not heal with the initial graft procedure (three rhBMP-2, two rhBMP-7, two autograft), all underwent additional procedures. The secondary procedures involved hardware revision alone in three patients, a second bone grafting procedure alone in one patient, and three had a second bone grafting procedure with hardware revision. Two patients are still not healed, with one having recently undergone a third revision procedure. Fifty-seven percent of those patients that did not heal were smokers, 43% had an infection, and all were Type III open fractures. Smoking, infection, and open fracture type were not found to be significantly associated with failure of bone grafting. DISCUSSION AND CONCLUSION: No significant difference was found between BMP and autograft with rate of union, time to union, and need for additional procedures. Smoking, infection, and type of open fracture were not found to be significantly associated with failure of bone grafting, however, all non-unions that did not heal were Type III open fractures. Atrophic non-unions after open fractures are a challenging problem, requiring hardware revision and bone graft augmentation. When treating an atrophic non-union after an open fracture there is no significant clinical advantage to the use of BMP over autograft.

POSTER NO. P502
Time Dependent Effects of Chlorhexidine on Grossly Contaminated Bone
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INTRODUCTION: The purpose of this study was to quantify the reduction in the bacterial burden of grossly contaminated bone segments using different chlorhexidine solutions. We hypothesize that 4% chlorhexidine will be the most efficient decontaminant. METHODS: Fifty-four bone segments were harvested from fresh-frozen porcine legs. Each specimen was immersed into Mueller-Hinton medium which was inoculated with Staphylococcus aureus (lux). These genetically engineered bacteria emit photons in proportion to their number, allowing for quantification. The segments were retrieved after 5 seconds. Baseline imaging provided the initial bacterial load. An equal number of specimens were soaked in normal saline (NS), 2% chlorhexidine (2%CHL) or 4% chlorhexidine (4%CHL). Specimen reimagining was completed at the 5, 10, 20, 30 and 60 minute mAK. RESULTS: The average bacterial count on the bone segments were: 2.18x10^7 for NS, 2.31x10^7 for 2%CHL and 2.00x10^7 for 4%CHL. The percent reduction in bacterial counts at the 5, 10, 20, 30 and 60 minute mAK were: NS: 0%, 0%, 0%, 29.84%, 72.23%; 2%CHL: 93.09%, 98.16%, 99.21%, 99.63%, 99.63%; 4%CHL: 94.32%, 97.60%, 99.25%, 99.63%, 99.82%. At all time intervals there was a significant difference between the 2%CHL and 4%CHL groups compared to the NS group (p<0.0001) and no difference between the 2%CHL and 4%CHL groups. DISCUSSION AND CONCLUSION: This study provides new data supporting the use of chlorhexidine to decontaminate grossly soiled bone segments. To maximize efficiency and decrease potential untoward effects, the authors recommend 20 minute soaks using 2% chlorhexidine for contaminated bone segments.

POSTER NO. P503
A New Less Invasive Anterolateral Approach to Tibial Plateau Fractures: Rationale and Early Results
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INTRODUCTION: An angiosome is a composite tissue block of bone, muscle, fascia, subcutaneous fat and skin that are three dimensionally linked together by anastomotic arteries from one source vessel. Dissection between angiosomes is considered safest. The angiosomes covering the knee are: the anterior tibial, the descending genicular and the popliteal. The traditional anterolateral approach, with detachment of the proximal insertion of the adductor magnus and the origin of the gracilis, has certain disadvantages. The new anterolateral approach of the knee, described by Perren et al., is associated with the anterolateral approach of the knee. Based on the dissection findings a new anterolateral approach is proposed that provides a wide exposure of the lateral compartment of the knee, while maintaining the blood supply to the skin and muscles. METHODS: Twenty knees were dissected to identify the blood supply to the skin and muscles. The popliteal artery and the superficial femoral artery were dissected to identify the feeding vessels to the skin and muscles. The superficial epigastric artery, lateral femoral circumflex artery, superficial circumflex iliac artery and the superficial inferior epigastric artery were identified on each side. The anterolateral approach was performed on 20 cadaveric knees. DISCUSSION: The new anterolateral approach provides an increased exposure of the lateral compartment of the knee without sacrificing the blood supply to the skin and muscles.
approach to the knee was developed and used in a consecutive cohort of 33 patients with tibial plateau fractures either in isolation or in combination with a posteromedial and or an anteromedial approach within 48 hours after injury. In the new anterolateral approach the skin incision has a 4cm horizontal arm just inferior to the lateral joint line (between the popliteal and anterior tibial angiosome) and a 3cm vertical midline arm (between the anterior tibial and the descending genicular angiosome). Internal fixation is performed with a moulded locking plate slid percutaneously over the tibialis anterior in a true internal ‘external fixator’ construct. All patients weight bore 20kg immediately after surgery. There were 20 males and 13 females with an age range between 22 and 69yrs. There were 19 Schatzker II, 3 Schatzker V and 11 Schatzker VI fractures. Complications, radiographic assessment of fracture healing and patient reported Lysholm scores were prospectively collected at 6, 12, 26, 52 and 104 weeks. RESULTS: Dissection. Traditional oblique incisions have a high risk of dividing skin perforators. All approaches that elevate tibialis anterior devascularise the lateral tibial condyle (Figure1). There were no complications. All surgical wounds healed uneventfully within two weeks despite no surgery being delayed for swelling and fracture blisters. All fractures were reduced to within 2mm of articular congruency and maintained reduction to two years. At two years limb alignment was within normal values in 30 of the 33 patients. The other three patients, with Schatzker V and VI fractures, healed in less than 6° of varus, a sign of insufficient medial condyle stability. The Lysholm knee score, available for 21 patients, improved consistently and steadily to a median of 76 (range 29-100). DISCUSSION AND CONCLUSION: Dissection between the angiosomes of the knee allows safe immediate post traumatic surgical intervention in tibial plateau fractures, even in the context of posttraumatic swelling, while not compromising articular fracture reduction. Internal fixation of these fractures with an internal ‘external fixator’ construct ensures adequate stability of these fractures that allows immediate partial weight bearing without loss of fracture reduction.
spacer to maintain the fracture gap. A semisolid molar ratio of 45:17:38 PLA:DX:PEG biodegradable polymer was used to fill the segmental defect in eight rats, which served as the experimental group. At six weeks the rats were euthanized, radiographed and then the femora were sectioned for histological analysis. RESULTS: No evidence of infection was observed in either group. Radiographs at six weeks for all rats showed 100% non-union rate. Some femora were noticed to have osteolysis radiographically, with femora in the experimental group showing statistically significant dilatation of the femur around the intramedullary pin. Histopathologic analysis showed an increase in cross-sectional area of the medullary cavity and increased inflammatory infiltrate in the polymer group compared to the control group. DISCUSSION AND CONCLUSION: This paper presents the first evidence suggesting that PLA:DX:PEG may cause tissue reactions and osteolytic effects in a segmental defect model in rats. This information should be considered when considering the use of similar materials in humans.

PAPER: The FDA has not cleared the drug and/or medical device for the use described in this presentation (i.e., the drug or medical device is being discussed for an off-label use). For full information refer to page 14. An alphabetical faculty financial disclosure list can be found starting on page 19.

POSTER NO. P505

Acute Total Hip Arthroplasty in Acetabular Fractures in Elderly Using Cementless Cage - Mid to Long Term Follow Up

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INTRODUCTION: Although most of the displaced acetabular fractures are treated with open reduction and internal fixation, acute total hip arthroplasty (THA) either alone or combined with fixation is indicated in elderly population in selected cases. The purpose of the study was to evaluate the results at a minimum of five years after acute THA using a cementless acetabular cage for treating acetabular fractures in elderly population.

METHODS: In this prospective study, all the patients older than 55 years with acetabular fractures reporting between May 2000 and July 2005 fulfilling the criteria for primary THA were included. A cementless acetabular cage system with hydroxyapatite shell and autologous morcelized bone graft was used in all the cases. No attempt was made to reduce the fracture anatomically. Patients were evaluated clinically using Harris Hip Score and radiologically at six weeks, three months, six months, one year post surgery and then once yearly.

RESULTS: Fifteen patients were available at the latest follow up. Mean age of the patients at the time of surgery was 64.53 years (range 57-69 years). There were 13 males and two females. The average follow up of the patients was 81.5 months (range 62-122 months). Mean Harris Hip Score was 91.1 (range 72-98.3). Twelve patients were walking without any support and three were using a cane for support. There was no case of acetabular or femoral component loosening or heterotopic ossification greater than Brooker’s II. There was one case of dislocation following a fall which was treated by closed reduction.

DISCUSSION AND CONCLUSION: The aim of treatment of acetabular fractures in elderly is to provide a stable hip with early pain free mobilization. While the preferred treatment of displaced acetabular fractures in the young is open reduction and internal fixation, the results of these are not encouraging in older population, as these age groups are vulnerable to fixation failures due to osteoporosis and other medical co-morbidities. Total hip arthroplasty done after fixation failures may need extensive approaches, as they are complicated by presence of heterotopic bone, scar tissue and hardware. So, primary total hip arthroplasty in elderly patients having acetabular fractures appears to be an encouraging approach in the management protocol. Primary THA in acetabular fractures is challenging because of technical difficulties with reduction and fixation of the acetabular fracture and effective anchorage of the acetabular component. Cementless acetabular cage system with hydroxyapatite shell and autologous bone graft used in this study could achieve a stable construct. This construct provided initial stability while the integration of
Analysis of Left Leg Driving Using a Survey and a Driving Simulator

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INTRODUCTION: Returning to driving following injury is of great concern to patients and physicians. Patients occasionally ask about driving with their left foot while their right leg is injured. This study has two purposes: first, to survey the driving habits of patients following isolated right leg injury; second, to evaluate the driving skills of healthy adults driving with their right versus left leg in a driving simulator.

METHODS: We surveyed 38 patient’s driving habits following isolated right lower extremity injury. This included the nature of their original injury, and driving habits before injury, during the recovery period, and at the time of survey, as well as which foot they used to control the pedals while driving. We also evaluated the driving ability of 56 healthy adults driving with their left versus right leg using a driving simulator. We measured the overall braking time, response time, deceleration time to a target speed, braking power, and the ability to maintain a constant speed.

RESULTS: A total of 35% (12) of patients with isolated right lower extremity injury used their left leg while driving. Some 24% (nine) drove using their right leg prior to being cleared by a doctor to drive. A total of 11% (four) had been in another car accident since the injury to their right leg, only one felt that the second accident was due to the previous injury. More patients were uncomfortable driving a manual transmission after right leg injury than before (p<0.05). No difference was found between right and left leg driving in the ability to maintain a constant speed.

CONCLUSION: Driving with the left leg is a common practice among our survey respondents (up to 35%). There are significant differences between right and left foot braking among healthy volunteers. Left foot braking results in slower response times and less controlled braking. This difference, however, does not necessarily correlate with “safe” or “unsafe” driving. We cannot, on the basis of this study alone, recommend for or against left foot driving.
INTRODUCTION: Supination external rotation type IV/ type IV equivalent (SER IV) injuries are the most common operative fracture pattern of the Lauge-Hansen classification. It is unclear which configuration of bony and ligamentous injuries portend the worst prognosis. The purpose of this study was to describe and compare outcomes of all possible combinations of fractures and ligamentous injuries within SER IV injuries and identify risk factors for poor outcome.

METHODS: From 2004 through 2009, all operative SER IV or equivalent ankle fractures treated by a single surgeon were enrolled in a prospective database. Preoperative MRI was performed to precisely identify and characterize ligament injuries. Postoperative CT was used to evaluate reduction. These patients with at least one year of clinical follow up were eligible for retrospective analysis. The primary outcome measure was the Foot and Ankle Outcome Score.

RESULTS: A total of 114 SER IV type fractures met inclusion criteria. The average age was 51.8 years. The following number of injury patterns were identified: 51 trimalleolar fractures, 28 bimalleolar fractures involving the fibula and posterior malleolus with a deltoid injury, 27 bimalleolar fractures involving the fibula and medial malleolus with a posterior inferior tibiofibular ligament (PITFL) injury and 27 pure SER IV equivalent fractures (fibula fracture with PITFL and deltoid injury). All fracture patterns had no clinically significant change in reduction at final follow up. There was no difference in the incidence of articular or syndesmotic malreductions between groups based on postoperative CT. SER IV equivalent fractures had superior FAOS outcome scores for sports and activity with a trend toward improved scores for symptoms, pain and quality of life compared to trimalleolar fractures. When controlling for the remainder of the fracture pattern and isolating the posterior or medial injury, ligamentous injuries had uniformly higher FAOS scores compared to their fracture counterpart (deltoid tear superior to medial malleolus fracture, PITFL tear superior to posterior malleolus fracture).

DISCUSSION AND CONCLUSION: In SER IV or SER IV equivalent ankle fractures, the presence of a fracture was associated with a worse clinical outcome compared to its ligamentous injury counterpart. This was true of both the posterior and medial injury, and its effect appeared to be additive, with trimalleolar fracture clinical outcome most severely affected.

POSTER NO. P509

Effect of Therapeutic-Dose Aspirin on Bone Healing in a Rabbit Model

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INTRODUCTION: There is evidence that NSAIDs (nonsteroidal anti-inflammatory drugs) inhibit bone healing, but there has been little study of aspirin and bone healing despite its common use following orthopaedic trauma. The limited animal studies demonstrating an inhibitory effect of aspirin on bone healing have employed supratherapeutic doses. Our objective was to determine the effect of aspirin on bone healing in a rabbit diaphyseal defect model within a dosing range comparable to human clinical dosing.

METHODS: Three millimeter osteotomies were created in the left ulnae of 60 anesthetized male white New Zealand rabbits that were separated into six equal groups of 10 rabbits each. A control group was administered placebo (group 1). Four groups received aspirin doses of 2.7mg/kg daily (group 2), 10mg/kg daily (group 3), 10mg/kg twice daily (group 4), and 100mg/kg three times daily (group 5). These doses approximated human doses of 81mg daily, 325mg daily, 325mg twice daily and an anti-inflammatory dose based on a body weight-adjusted scale. A final group served as a positive control receiving a dose of 12.5mg/kg indomethacin daily (group 6). Serial radiographs were obtained every other week. Following sacrifice the osteotomized and contralateral limb were tested for torsional strength. Radiographs were evaluated in a blinded fashion by multiple researchers utilizing a previously described radiographic grading system.

RESULTS: All experimental groups except for group 4 showed statistically significant (p<0.05) inhibition of bone healing by either serial radiography alone (groups 2 and 5) or a combination of serial radiography and torsional strength (groups 3 and 6). Statistically significant inhibition of radiographic healing was shown in groups 2 and 3 at six and eight weeks, in group 5 at six weeks, and in group 6 at four, six, and eight weeks. There was no radiographic inhibition of bone healing in group 4. Torsional strength was similar to controls in groups 2, 4 and 5, but was significantly less than controls in groups 3 and 6.

DISCUSSION AND CONCLUSION: Aspirin inhibited bone healing by radiographic criteria at multiple doses while affecting final torsional strength at only one dose. No clear dose-response relationship was demonstrated. These results have potential ramifications for the use of aspirin by patients in the setting of ongoing bone healing. Clinical studies are necessary to determine the clinical effect of aspirin on bone healing in humans.
Strength of Locking Constructs Versus Conventional Constructs in Osteoporotic Bone; An Experimental Study

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Bipin Patel, MS, CAE, Kalamazoo, MI
Joseph L. Chess, MD, Kalamazoo, MI

INTRODUCTION: The purpose of the current study is to differentiate the strength of locking and conventional plate and screw constructs. In the last decade, there has been a proliferation of locking plate technology in operative fracture care. Locked plate systems have been associated with improved stability in several biomechanical studies and have demonstrated advantages in several areas of fracture fixation. On the other hand, several recent studies have failed to consistently support the superiority of locking screw constructs compared to conventional screw constructs in osteoporotic bone and bone models. In the face of healthcare reform, the increased cost of locking plate technology makes the concept of mechanical superiority particularly pertinent. Our hypothesis is that locking screw constructs have greater strength than conventional screw constructs.

METHODS: The strength of bone plate and screw constructs was studied using a validated bone model. One bone plate type (8-hole locking plate) was mounted to a synthetic bone model by one of two screw combinations (two-3.5mm locking screws or two-locking type plate) and loaded to failure at an angle of 45 degrees to simulate physiological joint reaction force using a servo-hydraulic testing fixture and loaded to failure at an angle of 45 degrees to simulate physiological joint reaction force using a servo-hydraulic testing frame-in-line with a load cell. Load and displacement were measured. Five experiments of each construct and density were planned. RESULTS: Construct strength increased with increasing density in both the conventional and locking constructs. For the 0.09g cm⁻³ and 0.16g cm⁻³ specimens, the results show good reproducibility with regard to the stiffness and strength of the constructs. For both the 0.09g cm⁻³ and 0.16g cm⁻³ specimens, there was a statistically significant difference (P value of 0.014 and 0.033 respectively) between the two constructs which demonstrated that the conventional plate and screw construct had a greater strength than the locking plate and screw construct. For the third density, 0.32g cm⁻³, significant plastic deformation of the plate occurred due to high loads. Thus, only one experiment was completed for each construct type (locking and conventional). Interestingly, plastic deformation occurred in the locking and conventional experiments at similar measured loads: 364 N and 349 N respectively. Video observation of the experiments demonstrated that the conventional screw and plate constructs failed by pullout and the locking screw and plate constructs failed by a combination of initial pullout followed by cut out. This is also evidenced on the load-displacement curves as a sharp drop in the load (pullout failure) followed by a second, lower, sustained peak strength follow by a slow failure (cut out failure). The observed cancellous pullout failure as well as analysis of extracted material between the threads is consistent with published literature.

DISCUSSION AND CONCLUSION: The clinical significance of this study is that conventional screw and plate constructs have greater strength than locking screw and plate constructs when obliquely loading osteoporotic bone in typical screw and plate combinations. Surgeons should understand that the contributions to strength of different screw designs can be more important than angular constraint at the screw-plate interface. This work should guide clinical studies to ultimately determine the cost effectiveness and appropriate usage of locking screw technology.

Outcomes of Conservatively Managed Pelvic Ring Injuries

Dana L. Musapatika, MS, Indianapolis, IN
Renn J. Crichlow, MD, Indianapolis, IN

INTRODUCTION: Pelvic ring fractures occur in up to 8% of trauma patients, and the primary goal of treatment is to restore pre-injury function and anatomy. Historically, treatment of these injuries has consisted primarily of non-operative care, traction, external fixation, and internal fixation. However, determining which pelvic ring injuries are stable and amenable to non-operative treatment versus those that are unstable and require operative fixation is often difficult and is paramount to optimal management. The purpose of this study is to evaluate functional outcomes of patients following minimally displaced pelvic ring fractures managed non-operatively at a single institution. METHODS: Approval was obtained from our local IRB prior to the initiation of this study over a six-year period from 1999-2005. Seventy patients with pelvic ring injuries that were treated non-operatively consented participation in this study and completed both the SF-12 and Majeed Pelvic outcome score questionnaires. Charts were reviewed retrospectively by an orthopedic trauma surgeon. Radiographs were available on 50 of the 70 (71%) respondents. AP, inlet, and outlet radiographs were classified by two fellowship-trained orthopedic traumatologists who were not involved in the care of the patients using both the Tile and Young-Burgess systems. RESULTS: Utilizing the Young-Burgess classification, there were 27 lateral compression (LC) injuries, 23 anterior-posterior compression (APC) injuries, and no vertical shear (VS) injuries. The Tile classification included 17 A Types, 33 B Types and no C Type. There were 28 males and 42 females with an average age of 47.5 (± 22.9) years. Average follow up was 40.8 (± 19.3) months. The Majeed Pelvic Outcome survey revealed that there was an average Majeed score of 84.2 out of 100 among all of our patients, indicating an overall good result. Age and sex based subgroup analysis failed to show any significant differences in the Majeed score, however the groups were substantially underpowered. Patients less than 25 years of age (n=19) tended to achieve a slightly higher score, with an average of 85.6, whereby achieving a grade of excellent. Patients aged 25-65 and greater than 65 years had an average score of 84.6 and 83.5 respectively, each within the range of good outcomes. Although not statistically significant, this suggests a trend towards better overall outcomes with a younger patient population. Similarly, the normative-based data reviewed for the SF12 v2 scores demonstrated that the scores for the conservatively treated pelvic ring injuries fell well within one standard deviation of the norms. This indicates that the treatment and/or injury did not result in substantial physical or mental disability. Subgroups divided based on sex and age and fracture type failed to show significant differences in SF12 v2 scores, although numbers were small and power was not satisfied.

DISCUSSION AND CONCLUSION: The present study indicates that non-operative management to be a reliable approach to treating stable pelvic ring injuries. Outcome measures suggest that this group of patients have mental and physical functioning that compares favorably to population-based norms; and that type of fracture, gender, or age may not affect outcome.
The Fate of Patients After a Staged Nonunion Procedure for Known Infection

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Clifford B. Jones, MD, FACS, Grand Rapids, MI
Brian Mullis, MD, Indianapolis, IN
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Robert Hynes, MD, Falls Church, VA

INTRODUCTION: Patients who had prior surgery and develop an infected nonunion typically undergo a staged reconstruction including multiple debridements, hardware removal, and antibiotics. The purpose of this study is to review a large series of patients who underwent staged procedures for the treatment of infected nonunions, highlighting the course of treatment and the ultimate result with respect to union and eradication of infection.

METHODS: Patients treated for nonunion at seven academic medical centers who were treated with a staged protocol for an infected nonunion were evaluated. The course of the patients was documented including the use of antibiotics, number of debridements, hardware treatment, dead space management, coverage, definitive surgery performed, and the outcome regarding infection and union.

RESULTS: There were 137 staged procedures for infected nonunions of the tibia (92), femur (25), humerus (8), or other (14) in 94 men and 43 women with an avg age of 43.7. All patients had operative treatment of their initial fractures. A total of 104 (76%) became infected after their initial operative procedure and 33 (24%) treated initially with no internal hardware. Adjuvant defect management consisted of antibiotic beads (34), IM nail (32), or spacer (13). Patients had an average of 2.9 debridements and received antibiotics for an avg of 6.4 weeks prior to their definitive nonunion procedure.

Definitive procedures for nonunion included IM Nail (51), ORIF (48), Bone Grafting (16), Ex-Fix/Taylor Spatial Frame (10), and in four patients in whom the infection was not resolved, amputation. Closure was primary (63), vac (15), free flap (25), or STSG (5). Sixty-five (55%) were supplemented with osteobiologic products. A total of 102 patients had cultures at the definitive procedure resulting in 41 (40%) positive cultures and 61 (60%) negative cultures. The CRP and ESR prior to the definitive procedure was an avg of 6.4 weeks prior to their definitive nonunion procedure. A total of 102 patients had cultures at the definitive procedure resulting in 41 (40%) positive cultures and 61 (60%) negative cultures. The CRP and ESR prior to the definitive procedure was an avg of 6.4 weeks prior to their definitive nonunion procedure.

DISCUSSION AND CONCLUSION: Even with multiple debridements and antibiotics, 41% of patients had positive cultures at the time of their definitive management which led to a disparate union rate as compared to those with a negative culture. This large series of staged procedures for infected nonunions demonstrates the difficulty in eradicating the infection even with modern dead space management and multiple debridements. This information will be helpful in setting the expectations of patients with this complex problem.

Comparative Effectiveness of Joint Reconstruction for Femoral Neck Fracture: Inpatient and 30-Day Mortality

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Derek J. Donegan, MD, Philadelphia, PA
Samir Mehta, MD, Philadelphia, PA

INTRODUCTION: Hip fracture represents a global public health concern, and half of all hip fractures occur at the femoral neck. While joint reconstruction (hemiarthroplasty or arthroplasty) may result in superior functional outcomes compared to internal fixation, differences in mortality according to surgical procedure are poorly defined.

METHODS: We examined a retrospective cohort of patients aged 50 years or older treated for femoral neck fracture at hospitals in PA between October 2005 and September 2007 with joint reconstruction or internal fixation. We carried out adjusted logistic regressions to compare the odds of inpatient and 30-day mortality among patients according to surgery type. RESULTS: Of 12,867 patients, 8,910 (69.1%) underwent joint reconstruction. Patients undergoing joint reconstruction more frequently died during hospitalization (2.3% vs. 1.3%, P<0.0001) and at 30 days (6.5% vs. 5.0%, P<0.0001); after adjustment for patient factors alone, the odds of inpatient mortality were greater with joint reconstruction (OR 1.62, 95% CI: 1.18, 2.23, P = 0.003); however, the difference in the odds of 30-day mortality did not achieve statistical significance (OR 1.18, 95% CI: 1.00, 1.41, P = 0.053). After controlling for patient and hospital factors we found greater odds of both inpatient and 30-day mortality with joint reconstruction (OR (inpatient) 1.65, 95% CI: 1.19, 2.28, P<0.003; OR (30-day): 1.20, 95% CI: 1.02, 1.46, P=0.026).

DISCUSSION AND CONCLUSION: Joint reconstruction is associated with greater odds of inpatient mortality after femoral neck fracture. Further research is needed to quantify the risks associated with treatments for femoral neck fracture.

Mini-Mental State Examination (MMSE) and the Associated Hip Fractures

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INTRODUCTION: Hip fractures have become major concerns in recent years. It may cause chronic disability among elderly. Cognitive impairment, as well as dementia, is one of the well-known risk factors of hip fractures. Early recognition and intervention of dementia patients will probably reduce the risk of hip fractures. Therefore, it is important to have a laconic and straightforward screening test for evaluating these deficits. The Mini-Mental State Examination (MMSE), devised by Folstein and his colleagues in 1975, is widely used for evaluating these deficits. The Mini-Mental State Examination (MMSE), devised by Folstein and his colleagues in 1975, is widely used for evaluating these deficits.
used tool to detect dementia. The purpose of this study is to analyze the association of each MMSE domain and the hip fractures.

METHODS: A total of 215 patients with low-energy hip fracture were matched with 215 hospital-controlled inpatients or outpatients in the Geriatric Department. These patients were interviewed by trained interviewers with the same standardized MMSE questionnaires. Patients’ demographic data, lab exam results, image findings and follow up results were all collected. Each MMSE domain was put in a univariate analysis model and the significant ones, together with other previous studied risk factors of hip fractures, were analyzed with conditional logistic regression.

RESULTS: Of the experimental and control groups, participants who performed well on orientation to time (OR=0.892) and visual construction domain (OR=0.600) were significantly associated with lower hip fractures rates.

DISCUSSION AND CONCLUSION: MMSE is a simplified tool for dementia detecting. The orientation to time and visual construction are strongly associated with hip fracture rates. Early intervention such as visuo-spatial training may have great help for lowering hip fracture rates.

### Comparison of two groups

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### Final group analysis

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<td>MMSE_Visual construction</td>
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<td>Alcohol consumption or not</td>
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</tr>
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</table>

**POSTER NO. P515**

**Far Cortical Locking of Distal Femur Fractures: A Prospective Observational Study**

**Michael Bottlang, PhD, Portland, OR**  
**Daniel J. Phelan, BS, Portland, OR**  
**Daniel C. Fitzpatrick, MD, Eugene, OR**  
**Corey J. Vande Zandschulp, MD, Portland, OR**  
**Daniel V. Sheerin, MD, Eugene, OR**  
**Steven M. Madey, MD, Portland, OR**

**INTRODUCTION:** Recent studies show a nonunion rate of 19-22% for supracondylar femur fractures treated with conventional locked plates. The relatively high stiffness of these constructs is thought to play a role in the nonunion rate. FCL constructs have been shown to decrease construct stiffness by 80% and to yield 156% stronger healing in an ovine tibia fracture model. This prospective study documents for the first time the clinical performance of FCL constructs.

**METHODS:** In a prospective observational study, distal femur fractures (AO/OTA 33A and 33C) in 14 consecutive patients were stabilized in a percutaneous bridging approach using a titanium periarticular locking plate with four FCL screws in the diaphysis. Standard locking screws were used for metaphyseal fixation. No bone grafts or bone morphogenic proteins were administered to enhance fracture healing. Healing was assessed by the number of bridged cortices on radiographs at week 6 (n=14), week 12 (n=10), and week 24 (n=5) and by CT at 12 weeks post surgery. Periosteal callus size was objectively measured at the medial, anterior and posterior cortices using a validated computational algorithm with an error of less than 5%. Callus measurements were compared to a published series of historic control data from 66 distal femur fractures treated with standard locked plating constructs.

**RESULTS:** Average patient age was 74 years (range 55-89). Of the 14 patients, one was a smoker and four had diabetes. There was one open fracture and eight periprosthetic fractures. At week 12, bridging callus was present in 71% of medial, posterior, and anterior cortices. At week 24, bridging callus was present in 96% of medial, posterior and anterior cortices (Figure 1), whereby at least two of the three cortices were bridged in all patients. The average periosteal callus size was 113 mm2 (week 6), 154 mm2 (week 12), and 157 mm2 (week 24) compared to historic control data of 62 mm2 (week 6, p=0.01), 93 mm2 (week 12, p=0.09) and 114 mm2 (week 24, p=0.4) for standard locked plating constructs. In addition to increased callus size, FCL fixation yielded considerably symmetric callus distribution (week 6: 31% medial, 27% anterior, 42% posterior callus). There was no incidence of hardware failure. There was no failure of FCL fixation in the diaphysis. One periprosthetic fracture migrated into varus due to deficient metaphyseal fixation but did not require revision.

**DISCUSSION AND CONCLUSION:** Results suggest that FCL constructs can improve callus formation relative to historic controls of fractures treated with standard locked plate constructs in early follow up. There were no instances of hardware complications or fixation failure related to FCL screws.
**Heterotopic Ossification Following Blast Amputation in Forelimbs and Hindlimbs of a Rat Model**

David E. Jaffe, MD, Baltimore, MD  
David J. Yoo, MA, Potomac, MD  
Ebrahim Paryavi, MD, Baltimore, MD  
William L. Fourney, College Park, MD  
Jason L. Blevins, BA, Baltimore, MD  
Gregory Gasbarro, BSE, MS, Baltimore, MD  
Tyler Hughes, Severna Park, MD  
Vincent D. Pellegrini, MD, Baltimore, MD

**INTRODUCTION:** Heterotopic ossification (HO) commonly complicates extremity blast amputations in soldiers in the contemporary war theater. This injury has become more prevalent due to the increased use of improvised explosive devices in modern warfare and the use of body armor that increases victim survival. The objective of this project is to compare the frequency, quantity, and quality of heterotopic bone following blast amputation of the hindlimb and forelimb in a rat model.

**METHODS:** On an IACUC-approved protocol, 25 12-week old, anesthetized male Sprague-Dawley (SD) rats, underwent controlled extremity blast amputation with a column of propelled water after detonation of a submerged explosive. The blast-injured limb was manually irrigated with a 40:1 saline/chlorhexidine solution prior to fasiclure. Minimal skin debridement was performed to facilitate wound healing. Thirteen rats underwent forelimb and 12 underwent hindlimb amputation. The rats were followed clinically and with serial radiographs until euthanasia at 24 weeks. Half of the specimens underwent post-mortem CT imaging of the residual limb. Three independent observers quantified and classified HO on radiographs and CTs.

**RESULTS:** One rat did not survive forelimb amputation due to an anesthetic overdose. The remaining 24 rats survived blast amputation and closure until euthanasia at 24 weeks. All animals developed HO; one experienced a hindlimb wound dehiscence with bone protrusion at four weeks post blast requiring bone resection and stump closure revision. This animal subsequently developed severe HO. High interobserver reliability was seen on radiographic assessments of HO quantity and type (kappa=0.852 and 0.671, respectively). On average, hindlimbs developed moderate HO, compared to mild HO in forelimbs (p=0.0029). Moderate to severe HO was found in 8/12 hindlimbs vs. 1/12 forelimbs (p=0.009); 10/12 hindlimb amputations developed Type III HO (ectopic bony islands in surrounding soft tissue) compared to 4/12 forelimbs (p=0.036). CT evaluation of HO severity was highly correlated with radiographic grade (Spearman’s ρ = 0.9045, p<0.001), but type correlation was weak (Spearman’s ρ = 0.243, p = 0.4458).

**DISCUSSION AND CONCLUSION:** This simulated blast model produced a high prevalence of heterotopic ossification in the amputated limb stump without addition of any exogenous osteogenic agent. The radiographic grading scale developed for this animal model was a reliable means of assessing HO severity and type. Hindlimb blast amputation developed substantially more severe HO and more likely involved the surrounding soft tissues than the forelimb. The unexplained protective influence of the forelimb parallels the human clinical experience.

**PAPERS, POSTERS & SCIENTIFIC EXHIBITS**

**TRAUMA**
The FDA has not cleared the drug and/or medical device for the use described in this presentation (i.e. the drug or medical device is being discussed for an off label use).

For full information refer to page 14. An alphabetical faculty financial disclosure list can be found starting on page 19.
performed in the first two weeks post fracture lead to loss of reduction.

METHODS: Hospital records and radiographic data for a three-year period were reviewed to identify consecutive patients who presented to the emergency department of a tertiary care hospital with DRFs and were treated with CC. The following variables were retained for analysis: patient age, gender, polytrauma, fracture classification (AO), type of physician performing initial reduction and treatment, cast complication in first two weeks following reduction, type of manipulation performed (cast split, trimmed or replaced). Radiographs at the time of reduction, two weeks and six weeks post reduction underwent analysis by two independent observers who were blinded to the presence/absence of cast complications. At each timepoint, the radial inclination, ulnar variance and volar tilt were measured. A loss of fracture stability from the initial reduction at either two or six weeks was defined as the presence of any of the following: 10 degrees change in inclination, 5 degrees change in tilt, >3mm change in variance. A logistic regression was then performed to identify predictive variables for cast modifications and loss of reduction at 2 or 6 weeks.

RESULTS: A total of 317 patients presented with DRFs over a three-year period. 21 were excluded either due to receiving initial treatment elsewhere or not having complete radiological follow up. Overall, 31% of patients experienced cast related complications within the first two weeks of treatment. Twenty-two percent of patients required their cast to be manipulated. No complications necessitated immediate surgical intervention. Regression analysis revealed that only the presence of polytrauma was significantly predictive of requiring cast alterations within the first two weeks post injury. Regarding loss of reduction, only patient age and fracture classification were found to be significantly predictive. Requiring cast alterations was not found to be predictive of loss of reduction.

DISCUSSION AND CONCLUSION: Circumferential casting in cast alterations was not found to be predictive of loss of reduction. For full information refer to page 14. An alphabetical faculty financial disclosure list can be found starting on page 19.

The Orthopaedic Trauma Association (OTA) Open Fracture Study Group has developed a new classification system for open fractures (2 upper extremity and 4 lower extremity) obtained during initial debridement will be presented in combined video and PowerPoint format. Each video will contain a short history identifying the mechanism of injury, radiographs, intra-operative clinical findings of skin and muscle damage as well as a statement by the surgeon about vascular status. Participants will be asked to classify each open fracture according to the new classification and existing classification systems.

Results: The OTA Open Fracture Classification System is comprised of 5 variables that are each evaluated and graded in three levels of severity: skin injury, muscle injury, arterial injury, contamination, and bone loss. Clinical feasibility analysis has led to substantial change and clarification of several of the subcategories of injury severity rating. The resulting definitions will be presented in the exhibit. The inter-observer reliability for the classification was high (ICC = 0.99), although no component had perfect agreement across all raters. Individual categories of skin injury, arterial injury, and bone loss were found to have excellent agreement, while muscle injury and contamination had substantial agreement. The possible reasons for observer disagreement will be presented. Correlations of the classification with patient outcome are currently being analyzed using LEAP Study data.

The open fracture videos presented as part of the exhibit will provide meeting participants the opportunity to use the classification and provide feedback to the Open Fracture Study Group from a diverse, multi-national population of Orthopaedic Surgeons.

Conclusion: This exhibit will update meeting attendees on the latest information on the classification, terminology and factors most important for outcome after an open fracture and introduce them to the OTA Open Fracture Classification System. The data indicates that this new classification is reliable and valid and an improvement on currently utilized classifications.

Orthopaedic Trauma Association - Development and Assessment of the OTA Open Fracture Classification System

Andrew R. Evans, MD, Pittsburgh, PA

Introduction: The Orthopaedic Trauma Association (OTA) Open Fracture Study Group has developed a new classification system for open fractures. This exhibit will inform meeting participants about the scientific process used to create the classification and present videos of open fracture cases for meeting participants to classify according to this system and other existing classification systems. This exhibit will present the latest data on observer reliability of the new classification and on the factors in the classification that are most important for outcome after an open fracture.

Methods: A systematic review of the literature on open fractures identified 38 variables important for patient outcome. From these five were extracted through rank-order analysis and expert consensus and formed the basis of the new OTA classification system. After a clinical feasibility analysis the definitions and terminology of the classification were modified. The inter-observer reliability of the classification was studied using videos of open fractures presented to surgeons nationally and internationally. The validity of the classification is currently being assessed using the LEAP Study database.

The exhibit will allow meeting attendees to participate in an interactive video presentation. Intra-operative videos of six open fractures (2 upper extremity and 4 lower extremity) obtained during initial debridement will be presented in combined video and PowerPoint format. Each video will contain a short history identifying the mechanism of injury, radiographs, intra-operative clinical findings of skin and muscle damage as well as a statement by the surgeon about vascular status. Participants will be asked to classify each open fracture according to the new classification and existing classification systems.

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Methods: A systematic review of the literature on open fractures identified 38 variables important for patient outcome. From these five were extracted through rank-order analysis and expert consensus and formed the basis of the new OTA classification system. After a clinical feasibility analysis the definitions and terminology of the classification were modified. The inter-observer reliability of the classification was studied using videos of open fractures presented to surgeons nationally and internationally. The validity of the classification is currently being assessed using the LEAP Study database.

The exhibit will allow meeting attendees to participate in an interactive video presentation. Intra-operative videos of six open fractures (2 upper extremity and 4 lower extremity) obtained during initial debridement will be presented in combined video and PowerPoint format. Each video will contain a short history identifying the mechanism of injury, radiographs, intra-operative clinical findings of skin and muscle damage as well as a statement by the surgeon about vascular status. Participants will be asked to classify each open fracture according to the new classification and existing classification systems.

Results: The OTA Open Fracture Classification System is comprised of 5 variables that are each evaluated and graded in three levels of severity: skin injury, muscle injury, arterial injury, contamination, and bone loss. Clinical feasibility analysis has led to substantial change and clarification of several of the subcategories of injury severity rating. The resulting definitions will be presented in the exhibit. The inter-observer reliability for the classification was high (ICC = 0.99), although no component had perfect agreement across all raters. Individual categories of skin injury, arterial injury, and bone loss were found to have excellent agreement, while muscle injury and contamination had substantial agreement. The possible reasons for observer disagreement will be presented. Correlations of the classification with patient outcome are currently being analyzed using LEAP Study data.

The open fracture videos presented as part of the exhibit will provide meeting participants the opportunity to use the classification and provide feedback to the Open Fracture Study Group from a diverse, multi-national population of Orthopaedic Surgeons.

Conclusion: This exhibit will update meeting attendees on the latest information on the classification, terminology and factors most important for outcome after an open fracture and introduce them to the OTA Open Fracture Classification System. The data indicates that this new classification is reliable and valid and an improvement on currently utilized classifications.
Atypical Femoral Fractures: What Do We Know About Them?

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Introduction: An increasing number of recent reports have linked prolonged bisphosphonate use with atypical femoral fractures. While pathogenesis remains controversial, evidence suggests these rare fractures pose a newly recognized and serious adverse effect of bisphosphonate therapy. Atypical femoral fractures are associated with a number of clinical and radiological features, yet understanding of this fracture and related patient care remains limited. Recognition of at-risk patients and patients with atypical fractures is critical for osteoporosis therapy and operative intervention, as surgical outcomes may be impaired by poor bone quality associated with bisphosphonates. This scientific exhibit will present an overview of the diagnosis, epidemiology, potential pathogenesis, prevention and management of atypical fractures and patients on long-term bisphosphonate therapy.

Methods: A visual presentation of radiographic characteristics and interactive clinical vignettes of atypical fractures will be included. Animations will demonstrate the various hypotheses for atypical fracture pathogenesis. Epidemiological studies will be reviewed to assess the prevalence and risk of these fractures. Visual presentations will discuss the impact of atypical fractures on osteoporosis and surgical management. Flowcharts will review evaluation and management of patients with prolonged bisphosphonate treatment and of patients with atypical fractures. Comprehensive handouts of this information will be provided.

Results: We will present clinical and radiographic features of patients with atypical femoral insufficiency fractures as defined by the American Society of Bone and Mineral Research’s Task Force. The prevalence and the risk of atypical fractures from recent epidemiological reports will be demonstrated. The proposed pathogenesis of these atypical fractures, including alteration of collagen maturity, suppression of bone turnover, suppression of angiogenesis and accumulation of microdamage will be discussed. We will also present evidence-based guidelines for medical management in patients with prolonged bisphosphonate use (Figure 1) as well as complete atypical insufficiency fractures (Figure 2).

Discussion and Conclusion: Atypical femoral fracture is a rare, but clinically important adverse event associated with prolonged bisphosphonate therapy. Since bisphosphonates reduce fracture risk, concerns regarding the association between bisphosphonates and atypical femoral fractures should not preclude the use of these agents in the treatment of osteoporosis. Nevertheless, these drugs should be used with caution and closely monitored by clinicians. Understanding the pathogenesis of and risks for atypical fractures is critical for care of osteoporotic patients and optimal orthopaedic surgical intervention.
Background: Cervical extrication collars are applied to millions of blunt trauma victims with the intent of protecting the occipitocervical spine in the rare event that a severe injury has occurred to these structures. Up to date, there is no reliable evidence that collars can effectively protect against secondary injuries to the vital structures of the neck in the presence of a severe dissociative injury. The purpose of this study was to directly evaluate the biomechanical effects of carefully fitted rigid cervical collar application and patient maneuvering techniques on the severely destabilized cervical spine. This study focused on the motion between the vertebrae and the occiput caused by the standard protocol acute trauma patient management and maneuvering in the presence of an unstable cervical injury after perfectly fitted rigid collars were applied. We hypothesized that the routine maneuvering of patients in the pre and in hospital environment after well-fitted loose rigid cervical collars are applied can, in itself, create occipito-cervical motion that could cause a secondary injury to the patient. Based on prior successes, a whole cadaver model was employed to answer this question. Methods: CT images were taken before and during a simulated patient maneuvering in the presence of a created unstable spine injury in 7 fresh whole human cadavers. Rigid collar was applied in a neutral position and on a 10°-20° angle tilt. On two cadavers, the same maneuver was done with no collar applied. The CT scan series before and during the tilt were scaled and aligned to either the C1 or C2 vertebrae so that any relative motion of the injured area during the tilt could be measured. The aligned scans were analyzed and measured using Osirix (x). The relative displacement was measured in two planes of motion. The first motion, in the horizontal plane was measured in the axial view at the level of the middle of C2. The second motion, in the longitudinal plane, was measured in the mid sagittal or coronal views. These measurements represented the clinical effect of spinal cord compression/shear, and spinal cord traction respectively. Results: Application of cervical collars caused abnormal increased separation, at the C1-C2 level in every case. This usually occurred at the time the posterior collar piece was being applied and was caused by the in-line stabilization and lifting of the head in order to slide the posterior collar piece behind the neck and occiput. The cadaver tilting procedure caused motion in every cadaver. Measurements were made for both clinically relevant plains. The average motion in the horizontal axial plain was 7.74 mm (3.31 - 22.8, SD - 6.8). The average motion in the longitudinal plain was 2.93mm (0 - 7.79, SD - 2.51). For the two cadavers tested for motion without rigid collar applied the motion measured in the axial, horizontal plain was X, and X, and in the longitudinal plain was X. Conclusions: The current study supports several previous studies in suggesting that current extrication collar designs can, while maneuvering the patient, result in grossly abnormal displacements between the occiput and the spine in the presence of a dissociative injury to the HNS complex. Further studies are needed to assess and characterize the described neck pivot shift motion.

Semi-Extended Tibial Nailing: Review of Techniques and Indications

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Introduction: Tibial shaft fractures are the most common long bone injury, with an incidence of approximately 26 per 100,000 per annum. Intramedullary (IM) nailing is the preferred treatment for the majority of diaphyseal fractures, with a significant amount of literature suggesting high rates of union, and correct alignment and rotation with a low complication rate. Increasingly, tibial nailing is also being applied to a broader range of fracture patterns, including: open injuries, proximal and distal metaphyseal fractures, and fractures with articular extension. The techniques available for the placement of IM nails also continues to expand. In recent years there has been increased interest in use of semi-extended approaches to IM nail placement in lieu of the traditional approach with the knee in a flexed position. Methods: This study included a comprehensive review of the literature relative to the semi-extended IM nailing technique. Guidelines for the use of this technique will be presented based on the best available literature. Additionally, video demonstrations will be available which demonstrate the three most commonly used techniques for semi-extended tibial nailing: suprapatellar transtendinous, lateral parapatellar, and lateral parapatellar extra-articular. Detailed technical steps key to the successful performance of the semi-extended tibial nailing will be presented. Results: This exhibit will present comprehensive review of techniques for performing intramedullary nailing of tibia fractures in a semi-extended approach. For full information refer to page 14. An alphabetical faculty financial disclosure list can be found starting on page 19.
position. Semi-extended tibial nailing is currently an accepted technique for stabilization of proximal quarter tibia fractures but has been increasing applied to all manner of tibia fractures.

**Discussion and Conclusion:** The practicing orthopaedic surgeon is now faced with a collection of new instruments to perform this procedure. Yet when and where to perform semi-extended tibial nailing as well as the limitations of semi-extended tibial nailing has not been well delineated. The objective of this scientific exhibit is to provide the practicing orthopaedic surgeon the information and technical insights necessary to: 1) critique their current technique and 2) know, when, why and how to perform tibial nailing in a semi-extended position.

**SCIENTIFIC EXHIBIT NO. SE84**

**Handgun Injuries in 2012: What the Orthopaedic Surgeon Needs to Know**

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**Introduction:** Gunshot injuries are typically categorized as low or high energy, chiefly based on missile velocity and mass. Low energy injuries are generally treated with simple wound care with or without antibiotics regardless of the presence of fracture whereas high energy injuries are treated with aggressive debridement as in high grade open fractures. Most civilian handgun injuries in urban American trauma centers are treated as low energy injuries with minimal wound care. However, newer ammunition types which are designed to inflict greater soft tissue injury are being used increasingly. The purpose of this study is to investigate ballistics data of newer ammunition types to determine their potential for underlying soft tissue injury and to compare this with clinical experience in an urban trauma center.

**Methods:** Ballistics data were collected from forensic scientists and law enforcement officers at a major US city police department. Documentation of simulated tissue injury and missile deformation is comparatively analyzed amongst commonly seen ammunition in urban gunshot injuries. Expert opinion from criminal forensics cases was obtained to highlight the pitfalls of diagnosis of the gunshot-injured patient. Clinical cases of gunshot-induced fractures were reviewed from a single level 1 trauma center retrospectively to correlate radiographic findings with ammunition type.

**Results:** Newer ammunition has become increasingly prevalent in urban handgun violence, potentially resulting in higher degrees of soft tissue injury than is suspected by the clinician. Expanding, fragmenting, and frangible missiles can result in worse soft tissue injuries and increased kinetic energy transfer than conical missiles. Unfortunately, entrance and exit wound morphology is not routinely predictive of underlying soft tissue injury. Handgun injuries with or without fracture can result in significant soft tissue injuries resulting in compartment syndrome and infection.

**Discussion and Conclusion:** The distinction between high and low energy gunshot injuries may become blurred with increased prevalence of newer ammunition types in civilian criminal shootings. Seemingly innocuous injuries on initial inspection can potentially have significant, unrecognized underlying soft tissue injury. It is essential for the orthopedist that deals these injuries to be aware of these trends in order to pay closer attention to certain handgun injuries. Further clinical investigation is required to help the clinician identify which patients are likely to have significant underlying soft tissue injury.