



# Küntscher Society Annual Meeting

A joint organisation with the Belgian  
Orthopaedic Trauma Association



## Osteosynthese International 2015



# ABSTRACTS

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**In the footsteps of Louis Joseph Seutin, Albin Lambotte, Jean Verbrugge, Robert Danis,  
Robert Soeur and Robert Lacroix**  
The Belgian contribution to fracture care

**Thursday 10 September 2015**

**Auditorium Albert**

**08.30-10.10**

**Infections & Non-Unions I**

**08.30 IL Infected non-unions**

Lammens J.

*Department Orthopaedic Surgery, Katholieke Universiteit Leuven, Leuven, Belgium*

Objective: to give an overview of treatment possibilities in infected non-unions

Material-methods: Infected non-unions are challenging problems due to the absence of a normal biological repair process in an infected environment. This leads to extensive bone destruction, instability and failure of osteosynthesis material, the latter also being a trigger for maintenance of the infection, due to biofilms that are formed on the metal devices by microorganisms.

A two step approach is usually indicated to eradicate the infection, followed by the reconstruction of the bone defect. The first step of eliminating the infection should not be guided by the reconstruction possibilities afterwards as this might lead to insufficient debridement with remnants of dead bone and recurrent infections.

This means that a thorough debridement should be performed with the removal of the internal fixation devices and the resection of sequestrums and dead fragments of bone till freshly bleeding bone ends. For the majority of cases a stabilisation with external devices is recommended to maintain stability and allow the subsequent reconstruction.

There are several ways to fill bone defects for which autologous bone grafts are still the gold standard. However for large defects there is a lack of quantity of grafts necessitating other techniques for which the bone transport technique is very appropriate as it allows to replace the bone loss but also addresses concomitant deformities and limb length inequality. This method has a learning curve with its own tricks and pitfalls, especially regarding the final healing of the docking site as will be demonstrated. Other solutions such as the Masquelet and RIA technique are discussed as well as future options of tissue engineering.

Conclusion: The treatment of infected non-unions remains a challenging problem for which complex treatments based on each individual case should be chosen

**08.45 Bone segment transport over an intramedullary nail driven by hydraulics**

Reynders P., Reynders-Frederix C.

*Department Orthopedics & Traumatology, University Hospitals Brussels, Brussels, Belgium*

Introduction: The use of hydraulics for lengthening was first described by Götz and Schnellmann in 1975.

Material & methods; The pressure medium used to push down the bone segment can be any sterile liquid. In this series we used sterile refined arachis oil because of its better rheology properties and the excellent resistance against bacterial growth. Daily distraction was applied by external means.

Until now twenty-five bone-segment transport procedures were done, sixteen tibiae and nine femora. In all except two cases the indication was a post-traumatic or post-infectious bone-healing problem. In four cases a femoro-tibial arthrodesis nail was used after removal of an infected knee prosthesis. To cover the bone defect at the knee joint a bone segment transport over the nail was done.

Results; Bone healing was possible in all non-infected cases. When there was a previous bone infection, only ten out of fourteen healed with eradication of the infection. Of the four knee arthrodesis nails, only two healed.

Seven serious complications were seen; 4 non-unions, 3 plastic tube breakage. In three cases infection recurred. All nails were removed.

Conclusion; We feel that bone segment over a nail by hydraulic means is feasible with an acceptable complication rates. Patient comfort seems better than with previous external devices.

**08.55 Tibio-talo-calcaneal arthrodesis using a curved intramedullary nail in patients presenting severe preoperative risk factors for delayed union or non-union**

Maldague P., Devos Bevernage B., Deleu P.-A., Gombault V., Leemrijse T.

*Foot & Ankle Institute, Clinique du Parc Léopold, Brussels, Belgium*

**Objectives:** The main objective of the present study was to evaluate the success and clinical outcome of a tibio-talo-calcaneal arthrodesis using a curved intramedullary nail in patients presenting severe preoperative risk factors (diabetes, obesity, smoking, ...) for delayed union or non-union.

**Material and Methods:** This retrospective cohort study includes a total of 43 patients who underwent a tibio-talo-calcaneal arthrodesis using a curved intramedullary nail between 2007 and 2014. All patients were reviewed on a regular basis through chart review, clinical examination and radiological evaluation. The following variables were analyzed: pre- and postoperative Meary angle, union rate, time to union, type of bone graft and complications. The mean time to final follow-up was 17.16 months. Kolmogorov Smirnov test was used to determine whether the chosen variables were normally distributed. For comparisons of non-normally and normally distributed data, Wilcoxon tests, Mann-Whitney U tests or Student paired t-tests were used.

**Results:** Thirty-five of the 43 tibio-talo-calcaneal arthrodeses (81.40%) were considered radiographically fused after the first attempt in a mean time of 3.9 months. Bone graft was used in 30 patients. The most important complications include 2 superficial and 4 deep infections, 5 wound related problems, one tibial stress fracture, 5 delayed unions and 3 non-unions. The median Meary angle of the hindfoot was improved from pre-operatively 0.1 (range 26.7 varus to 25 valgus) to 4 degrees of valgus post-operatively (range 1.4 varus to 19.6 valgus) (p-value < 0.05).

**Conclusion:** Tibio-talo-calcaneal arthrodesis is a challenging procedure and has a reported union rate above 80% for open and arthroscopic procedure. Despite the presence of severe preoperative risk factors for delayed union or non-union, the results of the present series compare favourably with the literature.

**09.05 Treatment of aseptic diaphyseal nonunion of the lower extremities with intramedullary nailing and blocking screws without autografting**

Bilgili M.G., Ercin E., Tanriverdi B., Edipoglu E., Kucukkaya M., Avkan C.

*Orthopaedics and Traumatology, Bakirkoy Dr. Sadi Konuk Research and Training Hospital, Istanbul, Turkey*

**Objectives:** Treatment of diaphyseal long bone nonunions is a challenging issue in orthopaedic practice. Iliac crest bone harvesting may cause pain and some sensorial deficiencies. Our hypothesis is that by increasing mechanical stability nonunions of long bones can be treated by intramedullary nailing alone.

**Material and Method:** In this study we treated 24 lower extremity (20 tibia, 4 femur) aseptic non-union with intramedullary nailing and blocking screws between 2010-2014. In last control we evaluate patients in terms of pseudoarthrosis union, union time, radiological malalignment and functional status.

**Results:** The average age of patients was 33.2 (23-56) years and mean follow up time was 21 months (14-48). Bony union was achieved in all patients within 3.2–10 months (average, 5.6 months). In two tibial nonunion patient osteomyelitis had developed and these two patient were treated by debridement and antibiotics. In one patient with femur pseudoarthrosis there was 10 degree recurvatum deformity. There are some mild ankle range of motion deformities in 3 patients.

**Conclusion:** The therapeutic method of nailing combined with blocking screws is effective for aseptic nonunion of the lower extremity. Blocking screws increase mechanical stability of the system. Infection is a major problem in these type of patients and antibiotic coated nails are better options for these group of patients. Reaming and minimal invasive surgery provide a healthy environment for union.

**09.15 IL Bacteriophages as targeted antimicrobial in septic orthopaedics**

Rose T.

*Department Head Burn Unit, Laboratory for Molecular & Cellular Technology, Human Skin- and Keratinocyte Bank, Queen Astrid Military Hospital, Brussels, Belgium*

**09.25 Bone marrows concentrate and demineralised bone matrix in the treatment of non unions**

Fonkoue L., Tribak K., Putineanu D., Delloye Ch., Cornu O.

*Orthopaedic and Trauma department, Cliniques universitaires Saint-Luc, Université Catholique de Louvain, Brussels, Belgium*

**Objectives:** Non unions are difficult to treat situations. Iliac crest bone autografting represents a reference procedure when biological environment of the non-union is impaired. We wonder if iliac crest bone autografting can be replaced by autologous bone marrow concentrate (ABMC) implanted with demineralised bone matrix (DBM).

**Material and methods:** 53 patients have been treated for long bone non unions on a 6 year period with ABMC and DBM. Factors (patient comorbidities, tobacco use, fracture history, location, type of non-union, infection, bone resection with massive allograft, cellularity of the ABMC,...) influencing healing were registered. Fusion was assessed clinically (full weight bearing without complaints), radiographically by two independent observers and in case of doubt by a scanner. Statistical analysis has been performed with SPSS.

**Results:** fusion was observed in 72.7% after 17 +/- 9 months. Radiological assessment of fusion was well correlated between the two observers (kappa coefficient 0,925 ;  $P < 0,001$ ). Fusion was negatively influenced by smoking (Odds ratio 3,4 ;  $p < 0.016$ ). The delay between fracture and non-union treatment was the only negative independent factor ( $p < 0.033$ ). No complication was observed after iliac crest bone marrow aspiration.

**Conclusion:** ABMC and DBM appeared to be a good candidate to replace iliac crest autografting with a reasonable success rate and no morbidity of the donor site.

### **09.35 Endoscopic guided Tibiotalocalcaneal arthrodesis after failed osteosynthesis of pilon fractures**

Burssens A.<sup>1</sup>, Putzeys G.<sup>2</sup>, Devos Bevernage B.<sup>1,3</sup>, Van Der Bauwhede J.<sup>2</sup>, Michels F.<sup>2</sup>

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**Background:** Pilon fractures are difficult to treat because of the fracture pattern and are usually associated with significant soft tissue injury. Patients with systemic disorders causing sensory neuropathy are at even greater risk of fixation failure, skin flap necrosis and deep infection.

**Objective** To present two cases treated with an endoscopic guided tibiocalcaneal arthrodesis after of failed pilon osteosynthesis compromised with infection in patients with a neuropathy.

**Methods:** Case 1 A 35-year-old male patient with Charcot-Marie-Tooth disease sustained two failed pilon osteosynthesis with recurrent luxation of the talus. The second osteosynthesis showed a S Aureus infection. After a thorough debridement and antibiotic therapy an endoscopic guided tibiocalcaneal arthrodesis was performed. Case 2 A 68-year old woman with diabetic neuropathy sustained three failed osteosynthesis. The third one showed a S Epidermidis deep infection. After a thorough debridement and antibiotic therapy an endoscopic guided tibiocalcaneal arthrodesis was performed.

**Study design** Case study

**Results:** After 2 years of follow-up, the patients still have a good function with a plantigrade foot in orthopaedic shoes and no complaints. The AOFAS hindfoot score was 68 in case 1 and 61 in case 2 after two years of follow up 60. CT scan confirmed bony fusion after one year follow up in both cases.

**Conclusion and clinical relevance:** The use of an endoscopic guided tibiotalocalcaneal arthrodesis is a valid option after an infected failed pilon fracture osteosynthesis. The technique minimizes new soft tissue damage and favours wound healing which is beneficial in patients with systemic disorders compromising soft tissue repair. Level of evidence: Level IV

### **09.45 Supra-malleolar osteotomy and retrograde tibial nail for lower extremity correction**

Saccone C.<sup>1</sup>, Seligson D.<sup>2</sup>, Negran L.<sup>3</sup>

<sup>1</sup>Department of Podiatric Surgery, <sup>2</sup>Department of Orthopedics, University of Louisville, Louisville, KY, United States; <sup>3</sup>Vienna Accident Hospital, Department of Orthopaedic Surgery, Vienna, Austria

**Objectives:** The use of a retrograde tibial nail in combination with a supra-malleolar osteotomy is an effective and powerful technique to correct lower extremity deformity. We describe a surgical technique of correcting lower extremity deformities, subsequent to traumatic etiologies, using a posterior sub-muscular surgical approach and retrograde tibial nail fixation.

**Material/Methods:** The cases were performed at the University of Louisville Hospital in Louisville, Kentucky, USA. The total population consisted of five patients, who were selected by the author D.S. based upon both clinical and radiographic variables. All patients underwent supra-malleolar osteotomies with retrograde tibial nailing for correction of lower extremity deformity secondary to traumatic etiologies. Radiographic interpretation was performed by the principle investigator (C.S), which consisted of calculating the total angular deformity correction at the supra-malleolar osteotomy site as well as the hindfoot. Additionally, the percentage of osseous fusion achieved at the supra-malleolar fusion sites was calculated.

Results: We observed an average supra-malleolar osteotomy correction of 5.0 degrees. We found an average hindfoot correction of 10.0 degrees. We found a 100% fusion rate at the supra-malleolar osteotomy site 4 months after surgery.

Conclusion: Lower extremity correction using a supra-malleolar osteotomy in combination with a retrograde tibial nail is an effective technique to correct lower extremity deformities. By fashioning a stable intramedullary construct, patients are able to weight bear sooner, limiting post-operative immobilization. The fusion rates using a retrograde tibial nail make this technique an efficacious procedure to correct lower extremity angular deformities.

#### **10.00 IL The use of massive allografts in diaphyseal reconstruction**

Cornu O., Van Cauter M., Schubert T., Libouton X., Barbier O., Yombi J-C.

*Orthopaedic and Trauma Department, Cliniques universitaires Saint-Luc, Université catholique de Louvain, Brussels, Belgium*

The most important element in treating infected non unions is debridement to remove sequestra and other devitalized tissues. The radical resection of the necrotic bone needs further reconstruction with massive iliac crest autograft transfer, vascularised transfer or distraction osteogenesis. The use of autologous free non vascularised transfer exposes the patient to the loss of this precious material in case of infection recurrence. A free vascularised transfer or the Ilizarov technique are technically demanding and careful postoperative follow-up are necessary to minimize complications and improve outcome. The overall duration of treatment is in both cases long lasting and patients are exposed to high number of secondary procedures. The results in patients who have an infected tibial defect or non-union longer than 3 cm are so severe that an amputation might be considered.

Large bone allograft transplants have been successfully used to reconstruct skeletal defects created by tumor resections and failed arthroplasties, but little has been reported on their use in traumatic defects.

We report our experience with the treatment of infected non unions with massive bone allografts. A two stage protocol is applied: infected bone resection, death space management with antibiotic loaded cement and soft tissue coverage during the first step, followed at the second stage by massive bone allografting and definitive fixation.

This salvage method allowed the preservation of the limited valuable bone autograft stock in potentially still infected patients, less restriction in the bone resection and immediate stable fixation allowing rapid return to function. The threat of infection which is the greatest concern when using allografts was not justified.

**Auditorium Albert**

**10.10-10.25**

**Honorary lecture**

#### **10.10 Limits of external fixation**

**Schuind F.**

*Department of Orthopaedic Surgery, Erasme University Hospital, Université libre de Bruxelles, Brussels, Belgium*

External fixation is considered the best technique to fix open, contaminated fractures. There is no internal implant at the fracture site, decreasing the risk of infection. The wounds are easily accessible for care. Flap surgery remains possible if indicated. The mounting can be modified to improve if necessary the reduction, to apply distraction or compression or to stimulate bone healing by increased elasticity. External fixation is also the technique of choice to stabilize in emergency the fractures in polytrauma patients, following the principles of damage control care. Finally, external fixation is an excellent technique to perform progressive three-dimensional corrections of complex deformities.

External fixation has many other possible applications. It may be used to treat closed fractures. Avoiding an internal implant at the fracture site significantly reduces the risks of nonunion as demonstrated in a study of our Department of diaphyseal humeral, femoral and tibial fractures. External fixation may be combined to navigation for virtual reality fracture reduction. Comminuted distal radius fractures can be easily treated by transarticular distraction maintained by radio-metacarpal external fixation. The same principles may be applied at other joints. In pilon tibial fractures, using an external fixator avoids the implantation of a bulky internal implant which could lead to skin necrosis and subsequent infection. External minifixation used at the hand to stabilize small fractures allows early active finger mobilization, reducing the risks of stiffness and CRPS. In wrist arthrodesis, avoiding a plate by choosing for osteosynthesis a fixator prevents the usual tendon complications. External fixation allows small bones lengthening, for example of the capitate in Kienböck's disease. External

fixation is a good technique in children, not only in traumatology but also to fix percutaneous osteotomies or for rare indications of arthrodesis (obstetrical brachial plexus secondary surgery). Finally, external fixation allows keeping the length of the limb after tumoral or osteitis resection, before reconstruction by vascularized bone transfer.

The main drawbacks of external fixation are the reactions to the implanted percutaneous pins and soft-tissue transfixion problems.

**10.55 IL Late reconstruction after proximal tibial fractures**

Krettek C.

*Trauma Department, Hannover Medical School, Hannover, Germany*

**11.07 Combination of platelet rich plasma with exchange intramedullary nailing in treatment of long bone atrophic non-unions**

Duramaz A.<sup>1</sup>, Ursavas H.T.<sup>2</sup>, Bilgili M.G.<sup>1</sup>, Karaali E.<sup>1</sup>, Ones H.N.<sup>1</sup>, Avkan M.C.<sup>1</sup>

<sup>1</sup>*Department of Orthopedics and Traumatology, Bakırköy Dr Sadi Konuk Education and Research Hospital, Istanbul, Turkey;* <sup>2</sup>*Department of Orthopedics and Traumatology, Van Military Hospital, Van, Turkey*

**Objectives:** Nonunion is a problem that can still be reported though all recent treatment approaches. In treatment of long bone fractures, nonunion may be encountered. In that condition, exchange intramedullary nailing (EIN) is a commonly preferred treatment method. It was investigated that whether the combination of platelet rich plasma (PRP) with EIN (1) increases the union rates and (2) shortens the union time in treatment of long bone atrophic non-unions.

**Materials and Methods:** 14 consecutive patients (8 male and 6 female) who were treated for long bone non-unions with EIN together with percutaneous PRP application between August 2008 and January 2012, were included in the study. Control group included 15 consecutive patients (8 male, and 7 female) who were treated with only EIN without percutaneous PRP application in the same period. The inclusion criteria were age >18 years, starved of clinical and radiological bone healing in 6 months after the first treatment, atrophic non-union and platelet count >100.000 cell/ml. In postoperative period, all patients were controlled in every 2 weeks clinically and in every 4 weeks radiologically. Patients were evaluated with visual analog scale-pain (VAS) in preoperative and postoperative periods.

**Results:** The mean healing time was shorter in PRP group as 16,71±2,4 weeks compared with that of 19,07±3,67 weeks in control group (p=0,053). At the end of the follow-up, union is achieved in 92.8% (13/14) of the cases in PRP group. This ratio was 86.6% (13/15) in control group. The mean VAS values in preoperative and postoperative periods were similar in both groups (p>0,05). In PRP group, the mean VAS alteration percentage between preoperative and postoperative periods was higher but the difference was not statistically significant (p=0,617).

**Conclusions:** We have determined that though combination of percutaneous PRP with EIN increases union rates in treatment of atrophic non-unions after intramedullary nailing of long bone fractures, it does not affect the union time significantly.

**11.17 IL Hyperbaric Oxygen Therapy in Crush injury and compartment syndrome**

Germonpre P.

*Center for Hyperbaric Oxygen Therapy, Military Hospital - Queen Astrid, Brussels, Belgium*

**11.29 IL Safety of nailing after external fixation**

Koulalis D., Schuind F.

*Department of Orthopaedic Surgery, Erasme University Hospital, Université libre de Bruxelles, Brussels, Belgium*

**11.41 Post-traumatic amputations of the lower-limb 2005-2015 at the University Hospital of Liège**

Berger M.J., Valcu A.

*Department of Orthopaedic surgery, Liège University, Liège, Belgium*

**Objectives:** This is the first Belgian study undertaken to look at reasons for post-traumatic amputation. The aim of the study was to review all patients having undergone post-traumatic amputation of the lower limbs and find out if any of the amputations could have been avoided. It also aims to find out the reasons for post-traumatic amputation in the included patients.

**Materials and Methods:** This is a retrospective study of 51 patients having undergone amputation following lower limb injury. Of these 40 patients were included in the study. Patients were divided into three groups: immediate, intermediate and late amputation. The immediate amputation group contains 16 patients, intermediate 9 patients, late amputation 16 patients.

**Results:** In the early amputation group the procedure was chosen because of the gravity of the initial injury. For the two other patient groups amputation was undertaken mainly for infection, musculo-cutaneous flap problems and pseudarthrosis.

**Conclusion:** Limb salvage patients undergo more surgical procedures than patients amputated early. The main long-term complications of high energy trauma to the lower limb are infection and pseudarthrosis.

### **11.53 Will I walk again? The challenge of rehabilitation in lower limb amputation**

Brienza S., Prist V., Gierasimowicz-Fontana A., Hatem S.M.

*Physical Medicine and Rehabilitation Clinic, Brugmann University Hospital, Brussels, Belgium*

Lower limb amputation is a major life event profoundly affecting the patient's psychological integrity and body image. A structured biopsychosocial and multidisciplinary approach is needed for the management of this condition.

Mr. D.B., a 59-year-old man with diabetes mellitus type II and a history of alcohol dependence, was admitted at the Emergency department for the necrosis of two toes and a phlyctena of the right instep. An ilio-femoral arterial bypass had been performed one year earlier. Computerized tomography showed an advanced gangrene of the foot and a right-sided below-the-knee amputation (BKA) combined with a fasciotomy was carried out.

An intensive rehabilitation program was started after amputation, but initially the patient demonstrated a negative attitude with help-rejecting behavior. The comprehensive and holistic approach of the multidisciplinary team led the patient to gain in motivation and autonomy. Upon discharge of the rehabilitation unit, the patient walked with an adapted BKA prosthesis and reintegrated his everyday life.

Amputation can be a devastating event which is difficult to manage for the patient and for the care team. The immediate postoperative psychological coping behavior is variable. Depression and anxiety are the most frequent psychiatric complications which may be aggravated by residual pain. Treatment after amputation involves a multidisciplinary rehabilitation regimen including pain management and psychological support to improve the patient's quality of life.

Auditorium Albert

12.05-13.00

Short oral presentation of posters

### **12.05 P1 Treatment of long bone non-unions with Allomatrix**

De Wouters S.<sup>1</sup>, Traore S.<sup>1</sup>, Tribak K.<sup>1</sup>, Putineanu D.<sup>1</sup>, Lecouvet F.<sup>2</sup>, Cornu O.<sup>1</sup>

<sup>1</sup>Orthopaedic and Trauma Department, <sup>2</sup>Department of Radiology, University Hospital St-Luc, Université Catholique de Louvain, Brussels, Belgium

**Objectives:** We wonder if Demineralised bone matrix (DBM) (AllomatrixR) is able to promote healing without autografting procedure in the treatment of long bone non-unions.

**Material and methods:** 36 long bone non unions treated with DBM were retrospectively reviewed. Previous surgical treatment was performed more than 6 months before DBM implantation. Injectable DBM was placed percutaneously in 12 cases and with a surgical exposure in 24, associated with a new plate osteosynthesis in 8 cases. Union was considered when no new surgical procedure has to be done and when fusion can be observed on at least 3 corticals with x-rays or scanner by two independent observers, one surgeon and one radiologist.

**Results:** 21 patients (59%) healed within a mean delay of 9.5 months. 2 patients had aseptic flow the first days after percutaneous implantation but without other complication. 3 infections (8%) and 4 hardware failures needed further surgical procedures and were therefore considered as failures. Persistent non union was noted in the remaining 8 patients at the last follow up. Percutaneous DBM implantation was associated with higher failure rate ( $p < 0.01$ ).



Conclusions: the result obtained in these series did not reach the level expected with an autograft or with recombinant bone morphogenetic proteins (rh-BMP). A high rate of failure was observed in percutaneous implantation, when the procedure did not allow debridement of the non-union. Poor contact was reported to correlate negatively with union. Though we did not find a correlation between co-morbidities, previous infection or infection occurrence, these have been reported by other authors. Variations in growth factors concentration for each DBM batch without osteoinductive assessment of the product and potential negative effect of sterilization method represent potential limitations to their use and these aspects should be addressed by tissue providers.

#### **12.09 P2 The RIA harvesting system; higher than expected peri-operative morbidity?**

Reijen van N.<sup>1</sup>, Derksen R-J.<sup>2</sup>, Boer C.<sup>3</sup>, Zuidema W.P.<sup>1</sup>

<sup>1</sup>Department of Trauma surgery, VU Medical Center, Amsterdam, The Netherlands;

<sup>2</sup>Department of Trauma surgery, ZMC, Zaandam, The Netherlands; <sup>3</sup>Department of Anaesthesiology, VU Medical Center, Amsterdam, The Netherlands

Objective: In the treatment of non-union fractures in long shaft bones the use of autologous spongiosa has been shown to be the superior treatment in comparison to demineralized bone and therefore remains the golden standard. Spongiosa harvesting can be performed from different locations as the iliac crest, proximal tibia or intramedullary from femur or tibia. The latter proved to be a good alternative especially if larger volumes of autologous bone are necessary. Previous research concluded that the donor site morbidity is lower and clinical outcomes are better in using the RIA system than the iliac crest. However the per operative morbidity in intramedullary harvesting of spongiosa is relatively unknown. Therefore the objective of this study is to obtain an overview of peri-operative clinical outcomes whilst using the 'Reamer-Irrigator-Aspirator' (RIA) - system for obtaining intramedullary spongiosa.

Material and methods: We performed a retrospective descriptive study on the period of May 2011 until September 2014 of patients who underwent reconstructive bone surgery in the VU medical center Amsterdam whilst using the RIA system in order to obtain intramedullary spongiosa. We evaluated multiple peri-operative parameters in order to obtain an overview of the status of the patient during the operation.

Results: We included a total of 19 patients. 16 male and 3 female with a median age of 48 years (range 22-76). One patient underwent two RIA procedures in the aforementioned period. The operation indication was non-union (77,7%), osteomyelitis (5.6%) or traumatic loss of bone (16.7%). The average bloodloss during operation was 556 cc (range 150 to 1400cc). This concurred with a haemoglobin drop per-operatively of 2.33 mmol/L (range 0 – 5.5) and hematocrit drop of 0.09 l/l (range 0 – 0.17). In one patient the cell saver was used and return administration of 722cc of red blood cells was performed. All other patients did not receive any blood transfusion peri-operatively. No fractures were seen on the donor long bone site. Donorsite wound infection did not occur, in the recipient localisation wound infection occurred in two cases. There were no further intra-operative complications. The average number of days of admittance in this treatment group was 8.8 days.

Conclusions: The usage of the RIA system appears to be a safe way to obtain intramedullary spongiosa. There were no per-operative complications in this case serie. Moreover there appears to be in general ample need for blood-transfusion in this group and the Hb drop peri-operatively is limited.

#### **12.12 P3 Long term follow-up and PROMS of patients with a medial clavicle fracture**

Zuidema W.P., Poelemeijer Y.Q.M.

*Department of Trauma surgery, VU University Medical Center, Amsterdam, The Netherlands*

Objectives: Clavicle fractures are a common fracture and often occur in younger individuals and elderly patients. Most of these fractures occur in the middle third and are treated non-operatively. The fractures in the medial part are less frequent and are believed to have a higher rate of non-union just like the lateral clavicle fracture and might require operative treatment. The goal of the study is to evaluate the long-term (> 2 years) patient reported outcome measures in patients with a medial third clavicle fracture.

Material and methods: 534 patients were included from January 2007 to July 2012. Patients characteristics were retrieved from our trauma registry and hospital information system. Clinical results were assessed with the DASH, and a demographic questionnaire. Plain radiographs were reviewed and scored. The data were analyzed with IBM® SPSS® Statistics 20.

Results: Eleven medial clavicle fractures (2.1%) in 7 male and 4 females. Traffic accidents where the cause of injury in 5 patients followed by fall from height in 3 patients. Right sided fracture in 4 patients. A multi fragment fracture was present in 2 cases, there were no open fractures. There were two delayed unions. None of the fractures were operated upon. The cosmetic result was experienced as reasonable till good. Pain during

activities, sleeping disorders because of pain and limitations in ADL existed in more than one fifth of the patients after 2 years.

Conclusion: Although patients suffering from medial clavicle fractures are a relative small group. After 2 years follow up a substantial number of these patients still experience limitations in ADL and persistent pain.

#### **12.15 P4 Unexpected prolonged activity of DBX on PET-CT six years after implantation**

Reijen van N., Zuidema W.P.

*Department of Trauma surgery, VU University Medical Center, Amsterdam, The Netherlands*

Case Report: Introduction: In the treatment of bone loss after complicated fracture healing in long shaft bones one of the elements is filling the bone cavity. This is mostly conducted whilst using allograft spongiosa harvested from the iliac crest or intramedullary harvested spongiosa from shaft bones. If there is not a sufficient amount of spongiosa available demineralized bone (DBX) can be used additionally. The follow up after this treatment consists mostly of conventional X-rays and CT-scans to evaluate the progress of bone healing. We discuss a case with late follow up by PET-CT.

Description: The patient entered treatment with a closed proximal tibial fracture at 4 years of age which resulted in a tibial abscess 20 years later and was drained multiple times. After this the cavity was excavated and treated with gentamicin bead chains and prolonged intravenous antibiotics and afterwards filled with autologous spongiosa. Nine and 13 years later this treatment was repeated. . Biopsy showed no growth of micro-organisms in multiple bone samples. During the last operation the cavity was filled with spongiosa harvested from the iliac crests which was mixed with demineralized bone matrix. The patient recovered well, showing clinically and in blood analysis no signs of persistent infection. A PET-CT showed high fluoride uptake 11 months after the last surgery in the area of the autologous spongiosa placement. More than four years later the patient was again examined whereby physical examination and blood values again showed no signs of active infection. A new PET-CT however still showed reasonable activity strictly confined to the spongiosa/DBX site. The scan was repeated in 2 years later still showing activity although lower in intensity at the spongiosa/DBX site more than six years after the last surgery.

Discussion: In the medical literature demineralized bone matrix has shown activity on FDG-PET-CT during the first eight weeks after implantation, with strong diminishment of activity after this period. Longer PET CT follow up off the activity of DBX is not well known. Demineralized bone is osteo-conductive in nature and studies have shown none to very minimal osteo-inductive characteristics in DBX. In our case however return to normalised activity was still not reached after six years. On the PET-CT the area of increased uptake is strictly limited to the administered spongiosa/DBX site. Since there are no signs of recurrent infectious disease in this case report the kind of activity we are actually looking at six years after the operation may well be DBX.

#### **12.18 P5 Visualization of the lateral tibial plateau: a cadaveric study**

Garner M.R., Martin C.R., Mount L.E., Klingler C.E., Thacher R.R., Warner S.J., Helfet D.L., Lorch D.G.

*Orthopaedic Surgery, Hospital for Special Surgery, New York, United States*

Objectives: The study purpose was to quantify the lateral tibial plateau articular surface visualized using an anterolateral approach, a fibular head osteotomy, and femoral distraction.

Materials and methods: Six cadaveric lower extremity matched pairs (12 specimens) were divided into two groups. The AL cohort (6 left-sided specimens) underwent standard antero-lateral approach, and the MAL cohort (6 right-sided specimens), underwent a modified antero-lateral approach was performed with a digastric fibular head osteotomy. For each cohort, the visualized portion of the articular surface was marked with acrylic paint, applied with a needle tip. 5.0mm Schantz pins were then placed into the tibia and femur and a distractor was applied. A varus force was applied and the visualized lateral tibial plateau was again marked with an alternate paint color (AL-FD and MAL-FD). Each knee was disarticulated and calibrated digital photographs were obtained to calculate surface areas using the mean of 3 separate measurements through IMAGEJ software.

Results: Average total surface area of the lateral tibial plateau was 9.3cm<sup>2</sup> on the left and 9.6cm<sup>2</sup> on the right. With an AL approach, a mean of 14% of the articular surface could be visualized with superior meniscal retraction. After varus force application through a femoral distractor (AL-FD), that value was increased to 48%(p < 0.05). The MAL cohort demonstrated average visualization of 30% and MAL-FD resulted in 74% visualization (p < 0.05).

Conclusions: Maximum lateral tibial plateau exposure with a submeniscal arthrotomy and meniscal retraction is limited to the anterolateral 14% of the articular surface. This value can be increased to 48% with application

of varus force through a femoral distractor and to 74% with fibular osteotomy. For injuries where anatomic reduction of the lateral tibial plateau articular surface is in question, femoral distraction or digastric fibular osteotomy can improve visualization.

#### **12.22 P6 The diagnostic accuracy of radiographs and magnetic resonance imaging in predicting deltoid ligament ruptures in ankle fractures**

Warner S.J.<sup>1</sup>, Garner M.R.<sup>1</sup>, Fabricant P.D.<sup>1</sup>, Schottel P.C.<sup>2</sup>, Loftus M.L., Hentel K.<sup>3</sup>, Helfet D.L.<sup>1</sup>, Lorch D.G.<sup>1,3</sup>

<sup>1</sup>Orthopaedic Surgery, Hospital for Special Surgery, New York, NY, USA; <sup>2</sup>University of Texas, Houston, TX, USA; <sup>3</sup>New York Presbyterian Hospital - Cornell, New York, NY, USA

**Objectives:** Despite the importance of assessing deep deltoid ligament injuries supination external rotation (SER) ankle fractures, the accuracy of common diagnostic tests has not been established. The objective of this study was to compare the ability of injury and stress radiographs and magnetic resonance imaging (MRI) to diagnose deep deltoid ligament ruptures in SER ankle fractures.

**Materials and methods:** Patients who underwent fixation of SER ankle fractures were identified from a prospective registry. Inclusion criteria consisted of patients with an injury mortise ankle radiograph, manual stress test radiographs if the medial clear space (MCS) was less than 5mm on injury radiographs, preoperative ankle MRI, and intraoperative assessment of deep deltoid integrity by direct visualization. Fifty-three patients were included.

**Results:** Based on intraoperative direct visualization, forty-six patients (87%) had a complete rupture of the deep deltoid. Using intraoperative visualization as the gold standard, MCS measurements diagnosed a deep deltoid ligament rupture with 91% sensitivity, 14% specificity, a positive predictive value (PPV) of 88%, and a negative predictive value (NPV) of 20%. MRI had a sensitivity of 78%, specificity of 100%, PPV of 100%, and NPV of 41% to diagnose a deep deltoid rupture. Both assessments had an overall accuracy of 81%. In patients with an MCS of less than 5mm on injury radiographs, MCS measurements had decreased accuracy (53%) compared to MRI (80%).

**Conclusions:** This study suggests that MCS measurements have high sensitivity and MRI has high specificity for detecting deep deltoid ruptures. In patients with injury MCS measurements less than 5mm, MRI may have improved accuracy with a decreased false positive rate for detecting deep deltoid ligament injuries. Understanding and improving our ability to diagnose deltoid ligament ruptures will contribute to effective treatment algorithms for patients with SER ankle fractures.

#### **12.26 P7 Removal of broken interlocking screws**

Zamora R., Maniar H., Seligson D.

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On occasion the screws used in interlocking nailing are broken. this problem may be identified preoperatively or intraoperatively. we describe a simple technique for removal of the broken far end of the screw which does not require special equipment and which facilitates implant extraction. As a particular point, with a broken proximal tibial interlocking screw which has been inserted from anteromedial to posterior lateral, the peroneal nerve is not actually at risk.

the broken screw(s) is extracted first by removing the screw head with a screw driver or a small needle holder, then the far portion of the screw can be extracted by inserting a stiff, stout (4mm) smooth Steinmann's pin into the hole in the nail and driving the broken portion out of the nail into the subcutaneous tissues on the far side where it can be cut down on and extracted. The screw is not driven too far so it does not become loose in the soft tissues. (For the proximal tibia screws, analysis of the cross-sectional anatomy of the proximal tibia shows that the peroneal nerve is not at risk unless the nail has been sunk too deeply into the tibia or malrotated.)

The suggested sequence is to remove all but one of the unbroken screws to provide rotational control of the nail, then extract the broken screw pieces, next attach the extractor to the nail, remove the remaining intact screw and pull the nail out.

#### **12.29 P8 Plastic blocking screw for tibia fractures with proximal or distal short fragments**

Zamora R., Polley N., Himschoot K., Seligson D.

*Department of Orthopedics, University of Louisville, Louisville, KY, United States*

Fractures of the tibia with short proximal or distal fragments are more difficult to nail than mid-shaft fractures. One solution to this problem is to narrow the diameter of the medullary canal with blocking screws (so called poller screws), guiding the nail and translating proximal or distal tibia fragments while correcting mal-

alignments.

Objective/Hypothesis: Plastic screws instead of metal screws can be used to restore the axis alignment for proximal or distal fractures of the tibia.

Materials and Methods: Retrospectively, we reviewed 8 consecutive patients with fractures classified, as: OTA/AO 41-A2, A3, 43-A1, A2 and A3, treated between 2013 and 2014 with intramedullary nail and snub screws.

Results: Patients range from 23 to 73 years, there were one intraoperative failures, the protocol was not followed correctly. The post-operative varo/valgus deformity less was than 7 degrees in 95% of cases. No inflammatory reaction was observed in any of the patients. There were no infections. After three months of follow up, the reduction was maintained in 95% of the patients. No reoperations were required for mal-alignment correction.

Conclusions: Plastic can be used for tibia fractures with short proximal or distal fragments with satisfactory correction of the alignment and reduction is maintained after surgery. Benefits are that the plastic screws are not necessary to remove, and they are drillable if required.

### **12.33 P9 Vertebral artery dissection as a complication in wiplash traumata in young adults**

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Introduction: This article reports four cases of posterior circulation stroke due to vertebral artery dissection after a low energy whiplash injury in three females (22, 29, 56 y) and one male (52 y) . These patients were seen at the trauma unit in Leuven Hospitals, Belgium.

Trauma mechanisms were three car accidents, one fall while dancing. They all experienced an immediate discomfort in the posterior cervical region and sought medical attention at the emergency department and were diagnosed with a mild whiplash injury. No neurological deficits were present initially. Respectively 10, 15, 27, 42 days later they suffered an acute episode of vertigo and nausea, followed. Upon arrival at the hospital two patients were dysarthric and two had paresis and numbness on the left side of body. MRA showed vertebral artery dissections at the V2 (2 cases) V3 (2 cases) level upon which anticoagulation was started. Recovery was complete in only two of the four patients

Discussion: Vertebral artery dissection is rare and an often misdiagnosed pathology that can occur spontaneously or following trauma. The exact incidence of vertebral artery dissection is estimated to be 1 in 15 million. Traumatic dissections however occur more often. This article focuses on traumatic dissections and discusses whether a systematic screening protocol for vertebral artery dissection is warranted following minor neck trauma.

Literature review showed that vertebral artery dissection has been described following varying degrees of blunt trauma such as osteopathic manipulations, motor vehicle accidents and sports injuries. Seven other cases of vertebral artery dissection have been reported specifically following whiplash injury.

Complications such as vertebral artery dissection can only be suspected if there is an aberrant neurological examination. However, this often manifests itself days to weeks after the initial trauma and clinical signs of stroke at time of initial presentation are rare. A second argument why VAD diagnosis is difficult are the aspecific symptoms. Whiplash injuries cause neck pain, neck stiffness and headache. A posterior circulation ischemia registry noted headache in 51% and neck pain in 46% of patients as initial stroke symptoms. Therefore solely relying on patient history and clinical examination make it impossible to differentiate between whiplash and stroke unless other neurological abnormalities are present.

Unfortunately this is not a condition that can be prevented or predicted since not every whiplash leads to dissection and not every dissection leads to stroke. CT angiography or MR angiography are the most sensitive examinations for detection of vertebral artery dissection but would raise the cost of treatment significantly if every patient with whiplash was screened. We suggest informing patient of warning signs such as non-diminishing pain after 7-10 days or signs of posterior circulation stroke: nausea, vomiting, vertigo, paralysis. If any of these symptoms develop the patient must immediately return to the hospital for further investigations and treatment.

Conclusion: The significance of these cases is that common whiplash injuries without serious initial complications can result in sudden onset stroke days to weeks post-trauma without any warning signs. Prevention of misdiagnosis by raising awareness for these rare complications can improve outcome.

### **12.37 P10 Pelvic support osteotomy**

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We present a case of an 22 year old female with a chronically dislocated hip probably due to poliomyelitis , treated by a technique which is denominated the pelvic support osteotomy. With this double osteotomy of the femur there is a medial shift of the anatomical axis compared to the mechanical axis. This restores the abductor muscle length and improve the gait.

Classically the reconstruction is held by an Ilizarov external frame. In this case the proximal Schanz osteotomy was fixed by a conventional bended plate, whereas the distal varus osteotomy was held by an internal lengthening device correcting her leg length discrepancy. Because of the small diameter of the femur and the proximal femoral osteotomy, the lengthening device was used as an internal fixator, attached to the bone.

In the reported case we could improve the gait with reduced limping and equalizing her leg length discrepancy.

#### **12.41 P11 About a complex femoral fracture, a plate fracture and a non-union: a case report** **Bhogal H., Lambert J.**

*Service d'orthopédie-traumatologie, Centre hospitalier Epicura, Hornu, Belgium*

Introduction: The case report is about an obese 69 years old lady who fell on October 2013. Closed supra- and intercondylar displaced right femoral fracture, classified as AO 33 C1, is seen. Option of a locked peri-articular lateral plate was chosen.

At 8 weeks, no post operative complication had been seen.

At 3 months, functional impotence is suddenly seen without any fall. Diaphyseal femoral fracture above the locking plate is showed.

Given that the distal femoral fracture didn't show complete healing, we decided not to remove the initial plate but only the proximal screws in order to slide a short proximal antegrade nail.

At 1 month after nailing, there was no sign of bone healing on the latest fracture zone and a healing delay on the initial fracture zone.

At 2 months after nailing, we decided to dynamize the nail by taking off the static position screw on the proximal part of the nail and to treat distal femoral non union by curetage and grafting.

At 2.5 months after dynamization, X-rays showed a hint of healing.

At 14 months after dynamization, control showed an acquired healing.

Discussion: This case is about initial treatment of distal femoral fracture by plating, which is maybe too long. A fracture around implant without any fall is seen at 3 months. Is our osteosynthesis too rigid ? For the second fracture, we were confronted to different surgical options. In fact, we could have put a second plate in anterior position, or take out the first one and then put a longer one, we could also use an external fixator. We choosed nailing. As complication, non union is noted. Treatment of non union is made by dynamization of nail and grafting of the distal fracture site

#### **12.45 P12 A randomized trial on the effect of Botulinum Toxin A in decreasing thigh pain or improving range of motion during the distraction osteogenesis of femur**

**Lee DH., Ryu KJ., Kim HW., Hwang JH., Sung MK.**

*Severance Children's Hospital, Yonsei University College of Medicine, Orthopaedic department, Seoul, South Korea*

Objectives: During femoral lengthening, distraction-induced muscle pain, contracture of the hip and knee joints are bothersome problems which requires taking excessive pain killers, strenuous physiotherapy, or sometimes surgical interventions. We aimed to investigate the effect of botulinum toxin A in decreasing thigh pain or improving ROM of the hip and knee joints during femoral lengthening.

Methods: This study is a randomized controlled trial. From January 2011 to December 2014, we evaluated 44 patients (88 segments) undergoing bilateral femoral lengthening who met pre-specified inclusion criteria. The mean age was 26.5 years (range, 18-36 years). All patients underwent bilateral femoral lengthening with intramedullary lengthening devices (ISKD® and PRECICE®). Patients with implant-related obstacles or implant-related complications were excluded. Botulinum toxin A (BtX-A, 200IU, mixed with 20mL normal saline) was injected at seven spots on anterior thigh and this was made for only one leg at each patient. Selection of the leg receiving BtX-A was randomized intra-operatively by computer-based random number generation. Same amount of sterile normal saline was injected into the other leg as a control. Clinical evaluation included thigh pain VAS, ROM of the hip and knee joints, and maximal thigh circumference. Serial side-to-side differences with 2-4 weeks' time interval were analyzed between the two legs within each patient with minimum follow-up of 12 months. Distraction rate, percentage lengthened, and healing index showed no significant differences between the two groups (BtX-A group vs Placebo group).

Results: There were no differences in thigh pain VAS and ROM of the hip and knee joints throughout follow-up between the two groups (BtX-A group vs Placebo group). Maximal thigh circumference showed no differences

at each time point postoperatively.

Conclusions: Local application of BtX-A (200IU) at anterior thigh in adult has no effect on decreasing thigh pain or improving ROM of the hip and knee joints during distraction osteogenesis of femur. However, different dosages with multiple or multi-level injections of the toxin and trial for different age group are required.

#### **12.49 P13 Epidemiology, demographics and treatment of pelvic ring fractures: a comparative retrospective register study**

Van Den Wyngaert T., Putineanu D., Tribak K., Van Cauter M., Kaminski L., Banse X., Cornu O.

*Orthopaedic and Trauma Department, University Hospital St-Luc, Université Catholique de Louvain, Brussels, Belgium*

Introduction: Pelvic fractures can be divided into high-energy trauma cases (car accidents, falls from great heights...) and low energy trauma cases (after a fall in elderly or osteoporotic patients). The overall incidence of pelvic fractures is relatively low with incidences in literature varying from 2% to 10% of all fractures. However the incidence of pelvic fractures in multiple-trauma cases rises to about 25%. The mortality of these lesions vary enormously between studies (3-30%) but has significantly decreased over the last two decades. The low energy group (fragility fractures of the pelvis or FFP) is increasing in prevalence although they are still less frequent than proximal femoral fractures. With the increasing elderly population we expect them to be more and more encountered in everyday practice. Their coverage/care and treatment is still poorly described, the complications of different therapeutic methods are still not clear and the functional outcome is potentially more limited than generally imagined.

Objective: The purpose of this study is to adequately describe the evolution of number, type, population, complications, treatment and outcome of patients of every patient diagnosed with a pelvic ring fracture in the Saint-Luc university hospital. A second objective is to compare this data to other similar hospitals in terms of incidence, method of injury, severity, treatment and mortality.

Methods: We retrospectively collect data from all patients admitted and treated at the Saint-Luc university hospital between January 2008 and December 2014 with a pelvic ring fracture. The medical files are coded into the Belgian Pelvic Trauma registry, part of an international multicentre database (German pelvic trauma registry database). The type of fracture will be determined using the Judet and Letournel classification for all acetabular fractures and the Tile and OTA (Orthopaedic trauma association) classifications for all pelvic ring fractures. The analysis of the evolution of this data and it's comparison, is an automated part of the registry. The comparison with other clinical centers is also done with an algorithm, part of the registry.

#### **12.53 P14 Opioid Abuse - Medication assisted therapies**

Easley D. Polley N., Kibbe S.

*White Lattice, Inc, Louisville, Kentucky, United States*

Various strategies are used for opioid abuse disorders many of which begin in exposure to opioids after trauma. Abstinence Therapy (AT) has a high rate of relapse. Medication assisted therapies (MAT) include Methadone Maintenance (MM) therapy and Office Based opioid therapy (OBOT) using buprenorphine-naloxone are more successful. Buprenorphine-naloxone has the advantage of reduced tolerance, minimal euphoria and less craving for narcotic. Patients are seen monthly rather than daily as with MM. The government regulated OBOT program is structured to reduce diversion, promote counseling, and reduce addictive drug- seeking behavior. The program includes limitation on the number of patients that can be treated by each provider, urine screening, provider patient-contracts, and oversight by drug enforcement agents.

#### **12.56 P15 Opioid abuse disorder, report of a case**

Easley D.

*White Lattice, Inc, Louisville, Kentucky, United States*

Introduction: Restrictions on the use of narcotic pain medications in Kentucky has lead to an increase in illicit drug use particularly the use of heroin which has led to a concomit rise in acquired immune disorders, and hepatitis. Polytrauma patients are given opioid narcotic in hospital and become addicted.

Case Report: This 28 year old factory employee became addicted to opioid pain medication after a polytrauma. He required increasing doses of narcotics that could not be prescribed by his trauma doctors. He turned therefore to heroin use. This individual is a poor candidate for abstinence treatment because of non-opioid drug use prior to his accident. He is being successfully managed with legally prescribed buprenorphine maintenance therapy. The buprenorphine maintenance program requires a patient-physician contract, urine

screening for substances and compliance with a counselling program. He has returned to work and has not relapsed. Learning points: Abstinence programs have an unacceptably high relapse rate. A structured replacement opioid program (suboxone therapy) allows trauma patients with opioid abuse disorder to function successfully.

Auditorium Albert	
14.00-15.30	Tibia

#### **14.00 IL Plate osteosynthesis of the proximal tibia**

Raschke M.

*Department of Trauma-, Hand- and Reconstructive Surgery, University Hospital Münster, Münster, Germany*

#### **14.22 Fluoroscopic imaging of tibial plateau depression: a cadaveric study**

Garner M.R., Halvorson J.J., Fabricant P.D., Schottel P.C., Warner S.J., Wellman D.S., Lorch D.G., Helfet D.L.

*Orthopaedic Surgery, Hospital for Special Surgery, New York, United States*

**Objectives:** The purpose of this study was to assess the utility of fluoroscopy alone when attempting to identify a depressed articular fragment of the lateral tibial plateau.

**Materials and methods:** Five fresh frozen cadaveric knee specimen were stripped of soft tissue with the exception of medial and lateral collateral ligaments. The extensor mechanism was also preserved and a quadriceps turndown was performed. Using an 8mm autograft transfer system harvester, a core was created centrally within articular surface of the lateral tibial plateau. AP and lateral fluoroscopic images were taken after reapproximation of the extensor mechanism. This process was repeated after removal of the core, resection of its caudal portion, and reinsertion to create depressions of 2.5mm, 5mm and 10mm. Images were randomized and rated by five blinded orthopaedic surgeons (two senior residents and three attending surgeons) to determine if a clinically significant depression was present (>2mm) on either the AP or lateral projections.

**Results:** The sensitivity of fluoroscopy in the assessment of an isolated, depressed articular fragment of the lateral tibial plateau is 1.0. Specificity is 0.6, resulting in a positive predictive value of 0.88. Negative predictive value is 1.0. Interobserver reliability is acceptable (0.73).

**Conclusions:** The use of fluoroscopy in the assessment of articular congruency of the lateral tibial plateau has 100% sensitivity, making it an excellent first line assessment of reduction. However, the use of fluoroscopy alone may result in false positives and it does not permit assessment of soft tissue injuries.

#### **14.32 Distal tibial fractures – Intramedullary nailing versus MIPO**

Savvidis M., Konstantinidis A., Bisbinas E., Georgiannos D., Kapoutsis D., Gkouvas G.

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**Introduction:** Distal tibial fractures pose a challenge for every orthopaedic surgeon dealing with trauma patients. Intramedullary nailing and MIPO are the two most preferred methods, since both offer minimal invasion to a poor vascularized region, crucial to promote healing of the fracture. The purpose of this study is to compare the clinical, radiographical and functional outcomes of both methods.

**Methods:** Between January 2007 and March 2014 in our institution, 39 isolated extra-articular distal tibia shaft fractures (AO 43 A) were treated with locked IM (Group 1) and 23 same fractures were treated with MIPO (Group 2). 32 of them (82 %) (24 men – 8 women, Mean Age of 42,7 years (25-67)) in Group 1 and 20 of them (84 %) (16 men – 4 women, Mean Age of 41,3 years (16-70)) in Group 2, were clinically and radiologically examined at a mean follow – up of 52 months. All patients were radiologically evaluated for fracture healing, anatomical reduction and ankle range of motion comparing to the contralateral tibia and ankle. Time to initial weight-bearing, to full weight-bearing, to return to work and to regain all previous leisure activities were recorded. The rates of union, malunion, malalignment, infection and removal of implants were compared according to final outcomes. Foot Function Index (FFI) questionnaire was completed. Finally, they were evaluated with a static and dynamic pedography in order to detect changes in patterns of foot loading and to correlate them with the clinical outcomes.

**Results:** Age and gender were similar in both groups. There were no deep infection, but one nonunion (6,25 %) and 3 acceptable malalignments without functional impairment (15 %) in Group 2. In 2 patients in Group 1 (6,25 %) mild arthritis to the ankle joint was detected radiologically and in other 2 patients in Group 2 (10%)

moderate stiffness to the subtalar joint was detected clinically. Knee and ankle pain were more frequent to unemployed not related to plate or nail fixation. Pedographic results correlated well with clinical outcomes detecting changes in 5 (62,8%) of them. 1 patient has changed occupational demands and 4 have given-up some free-time activities.

Conclusion: Surgical treatment of displaced distal tibia fractures yields reliable results with either IM or MIPO. Intramedullary nailing seems to offer earlier full weight-bearing and earlier union time, but satisfaction rates of patients and functional recovery are similar in both groups. Unemployed patients had worse functional outcome scores.

#### **14.42 IL IM nailing of methaphyseal fractures**

Krettek C.

*Trauma Department, Hannover Medical School, Hannover, Germany*

#### **14.54 Biomechanical comparison of distal interlocking methods at sheep tibia models, used in fixation of distal tibia shaft fractures with intramedullary nails**

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*Abant Izzet Baysal University, department of Orthopaedy and Traumatology, Bolu, Turkey*

We compared distal interlocking (DI) methods biomechanically to find which one is most resistant and stable against axial loading.

16 pieces of tibia were extracted from sheeps slaughtered for consumption. We osteotomized these tibias 6 cm proximal from tibiotalar joint to make up a transverse fracture model. The proximal portions of tibias were excluded from the study. We divided 16 distal tibia portions into 4 groups. 8 mm solid intramedullary nails were implanted to tibias without reaming and locked distally with different methods in each groups. We used 2 screws (2 mediolateral, ZIMED) in group 1; 3 screws (two mediolateral, one anteroposterior, ORTHOFIX) in group 2; distal bolt locking screw (DSBLS,TST) in group 3; 3 screws with smaller diameter (two mediolateral, one anteroposterior , TIPMED) in group 4.

Axial load was applied to all experimentals by Universal TractionDistraction Test Machine in CadCam laboratuary, Technical Education Faculty, Kocaeli University. Tests were ended with screw breakage. Force, time and deformation datas were recorded and compared statistically.

Resistance to axial loading forces of DSBLS (group 3) was statistically higher than double (group 1) or triple (group 2, 4) screw DI methods. Beside this, resistance of triple screw locking method (group 2, 4) was statistically higher than double screw locking method (group 1). When we compared triple screw locking methods, group 2 with larger diameter screws was more resitant than group 4.

There is no concensus about superiority of DI methods of intramedullary nailing. With early postoperative weight-bearing, failure of the distal locking screws is an important complication. Contemporarily studies about new distally interlocking methods are still in progress. DSBLS is a new distally interlocking method which is improved recently. According to our results DSBLS is more stable to axial loading that can allow early range of motion excersizes and early postoperative full weight bearing.

#### **15.04 Intramedullary nailing of the tibia: the semi-extended surgical approach improves final nail position compared with the conventional medial parapatellar approach – A prospective multicentre RCT**

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<sup>5</sup>*Medizinisches Zentrum StadteRegion Aachen, Wurselen, Germany*

Introduction: Proximal third and segmental tibial shaft fractures remain a challenge to treat with intramedullary nails (IMN) using a conventional medial parapatellar (CMPP) approach due to the risk of creating a malunion. The semi-extended (SE) approach may reduce this risk.

Hypothesis: The SE surgical approach permits more accurate placement of the guide wire (GW) and the IMN compared with the CMPP approach.

Methods: A multicentre RCT comparing the CMPP and SE approaches. 94 patients with isolated tibial shaft fractures were recruited. Standardised AP and lateral perioperative and postoperative X-rays were used to assess (i) GW and (ii) IMN alignment with the long axes of the tibia, (iii) the starting point of the GW on the proximal tibia in both planes, and (iv) the final position of the proximal end of the nail in both planes within the



proximal tibia. One experienced assessor, blinded to the treatments, performed all measurements. Statistical analysis was undertaken using a Mann-Whitney U test, significance set at  $P < 0.05$ .

Results: Overall alignment of (i) the GW and (ii) the IMN with the long axes of the tibia, and (iii) the GW starting point and (iv) the final position of the IMN in the proximal tibia, were all improved by using the SE approach. Of significance, IMN alignment (coronal plane),  $p = 0.0061$ ; IMN alignment (sagittal plane),  $p = 0.0032$ ; and final position of the proximal end of the IMN within the proximal tibia (sagittal plane),  $p = 0.0294$ ; all favouring the SE approach.

Conclusions: This multicentre RCT confirms that GW and IMN position is improved when the SE approach is used compared with the CMPP approach and infers that the SE approach is the preferred one for treating proximal third and segmental tibial fractures where the potential for malunion is anticipated.

#### **15.16 IL Role of bone substitutes and adjuvant strategies**

Garcia P., Raschke M.

*Department of Trauma-, Hand- and Reconstructive Surgery, University Hospital Münster, Münster, Germany*

Auditorium Albert

### **16.00-16.50 Deformity correction-limb lengthening**

#### **16.00 IL Reconstructing long bone deformities by nails. Simple solutions for complex problems?**

Thaller P.H.

*3D-Surgery, Department of Trauma Surgery, Ludwig-Maximilians University, Munich, Germany*

#### **16.20 The End Point First (EPF) planning method for deformity correction of the lower extremity**

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Objectives: Preoperative planning is crucial for precise results in deformity correction. The End Point First (EPF) planning method considers specific demands for internal fixation and lengthening with intramedullary devices.

Materials and Method: The EPF planning method was applied in our group since 1999 for limb lengthening by intramedullary devices with and without simultaneous deformity correction. The method was also used for deformity correction with plating, nailing or external fixation.

Analysis of mechanical and anatomical joint angles and axis is the basic requirement for the EPF planning method to localize the deformity and to indicate the operative method.

Main principle of EPF planning is the graphical construction of a New Mechanical Axis (NMA). The End Point (EP) of the correction is the new position of the ankle or hip joint's center after correction and has to be located on the NMA. At wedge osteotomies, the "free" fragment is fitted to the EP by rotation around the osteotomy hinge, which leads graphically to the wedge size.

In planning for lengthening nails, the telescoping part is fitted to the EP of the lengthening and after that, copied and transferred to the Starting Point along the lengthening nails axis, which leads to the correct nail position and stroke.

Results: After more than 1000 planning procedures the End Point First planning method proved to be a safe and comprehensive method to determine correction parameters and implant position for the surgical procedure. The method could be applied on translucent paper and with a conventional layer based graphic computer program (Corel Draw).

Conclusion: By its graphical approach the EPF planning method is highly comprehensible. Absolut condition for a safe application of EPF planning is a precise radiological analysis of the deformity and clinical correlation for feasibility.

### **16.30 Management of limb-length discrepancy and deformity using PRECICE**

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**Background:** Over the last two decades, telescopic nails containing mechanical, implantable motorized mechanisms have been used in extremity lengthening surgery as the technology has improved. Magnetic lengthening nails such as the Phenix M21 bone-lengthening nail (Phenix Medical, France) and the PRECICE nail (Ellipse Technologies, Inc, Irvine, CA, USA) have recently been developed. The PRECICE nail was first used for limb-lengthening in a femoral shortening case carried out by our team on July 08, 2011. We present our experience of this device from the very first application until the present time.

**Methods:** Between the years 2011 and 2014 we have lengthened 6 tibiae and 21 femora of 23 (15 female and 8 male) patients using PRECICE lengthening nails. While 15 of these cases had various etiologies, 7 had idiopathic shortenings and 1 case had undergone cosmetic lengthening. The mean age of the patients was 23.56 years. The average follow-up period was 20.72 (5–45) months.

**Results:** The mean limb lengthening was 48.20 (34–120) mm and the mean acute angular correction was 15.5 degrees (7–25). The time taken to reach full weight-bearing (the consolidation time) was 5.15 months and the consolidation index was 1.12 (0.87–1.71  $\pm$ 0.28) months/cm. The mean maturation index was 0.78 (0.47–1.38  $\pm$ 0.28) months/cm. The preoperative hip and knee range of motions were obtained again at the end of treatment in all cases.

**Conclusions:** In conclusion, the PRECICE magnetic lengthening nail can be safely used for extremity lengthening by experienced surgeons and allows sufficient consolidation compared to other previously developed telescopic nails such as Fitbone and ISKD.

### **16.40 Is the PRECICE® nail better than the Intramedullary Skeletal Kinetic Distractor (ISKD®)? - A comparative cohort study**

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**Objectives:** We aimed to compare implant-related or non-implant-related complications between the two intramedullary lengthening devices (ISKD® and PRECICE®)

**Material and Methods:** This is a retrospective study with prospectively collected data from two cohorts. From March 2010 to June 2014, we evaluated 110 segments of bones undergoing femoral or tibial lengthening which met pre-specified inclusion criteria. All patients underwent lower limb lengthening for stature lengthening or limb length discrepancy with two intramedullary lengthening devices (ISKD® and PRECICE®). The author switched the lengthening nail from ISKD® to PRECICE® on the middle of the study period, and the two groups (ISKD® group vs PRECICE® group) were compared on (1) accuracy of distraction, (2) pain in three circumstances (rest, physiotherapy, distraction motion), (3) implant-related complications and (4) non-implant-related complications encountered. The mean age was 28.8 $\pm$ 8 years in ISKD group and 29 $\pm$ 7 years in PRECICE group with no significant difference. Femur to tibia ratio was 26:9 in the ISKD group and 65:10 in the PRECICE group with no significant difference. Final length gain and consolidation showed no significant differences.

**Results :** Accuracy of distraction showed significant difference with more accurate distraction rate control in PRECICE nails. Pain VAS during rest and physiotherapy showed no significant differences. But, pain VAS during distraction motion showed significant difference with better pain VAS score in PRECICE group (5.7 $\pm$ 1.4 in ISKD group vs 3.5 $\pm$ 1.5 in PRECICE group). Overall, implant-related and non-implant-related complications showed no significant differences. However, they showed significant differences on the type of implant-related problems and obstacles. For implant-related problems, runaway nail (17%) and difficult-to-distract nail (34%) were only in ISKD, whereas bent nail (13%), nail with broken rotation coupling (19%), and nail with running back phenomenon (1%) were only in PRECICE. For implant-related obstacles, non-distracting nail (9%) was only in ISKD, whereas nail with failure of lengthening/shortening mechanism (8%) and broken nail (1%) were dominant (vs 3% in ISKD) or existed only in PRECICE.

**Conclusions:** The PRECICE nail showed less pain during distraction and predictable rate control than the ISKD nail. Overall complication rates showed no significant difference. Most of implant related problems and obstacles of ISKD® were from uncontrollable distraction rate, whereas the most common problems in PRECICE nail were related to the mechanical strength of the nail.

**16.50 IL Treating humeral fractures. Current strategies**

Verbruggen J.

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**17.02 Proximal humerus fracture treated with transdeltoid lateral (MIPO) approach**

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Objectives: The locking plating of proximal humerus treated by DP approach leads many complications.

Material and method: For a period of 3 years, 90 patients at the average age of 71 /26 – 90/. Fracture spread was as follows: 25(28%) 3-part and 22(23%) 4-part varus dislocated; 22(23%) 3-part and 23(25%) 4-part valgus impacted. We applied PHVariax locking plates. The mean operative time was 55 min, X-ray exposure 2 min and blood loss 200 ml. In 32(36%) patients ABG was used.

Results: The observed complications were: varus deformation 5(6%); impingement 14(15%); AVN 3(4%); screws cut-out 5(6%); fixation failure 2(3%); no injury n. axillaris. An additional operative procedure 24(27%) and the CS was 81. FU mean 12 months.

Conclusion: MIPO decreasing the mean operative time and the blood loss and preserved soft tissue and humeral head nutrition. The disadvantages of the method are the X-ray exposure, danger of neurological injury (n. axillaris) and impingement of the shoulder. The range of complications may be lower than DP approach.

**17.12 Interest of fibula allograft in the management of 4-parts proximal humerus fracture?**

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Objective: The 4-parts proximal humerus fractures still prove to be a therapeutic challenge nowadays due to the high rate of complications encountered. We explored if a fibula allograft could improve fracture reduction and stability.

Methods: 13 patients were operated for 4-parts proximal humerus fracture through a deltopectoral approach and reduction was performed with a fibula allograft. Osteosynthesis was completed either by screws, sutures or plate.

Results: while the fibula was helpful during surgery to reduce, maintain bone fragments and improved screws fixation, a high rate of complications (bone necrosis) was observed. 4 patients needed further surgery.

Conclusion: Fibula allograft appeared to be helpful in facilitating fracture reduction and stability but was associated, as other techniques of fixation in this kind of fracture, with a high rate of complications. Its main interest is in the restoration of the medial column stability and in the increased screw pull out strength.

**17.22 Our experience with humeral nailing**

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Introduction: Proximal humeral fractures are often seen in elderly patients with osteoporosis after a low energy trauma. There is no real consensus in the literature concerning the treatment of this fracture. We decided to treat all proximal and humeral shaft fracture using only one type of nail (MultiLoc), implanted in a minimal invasive manner. A two centimeters incision is made close to the anterior angle of the acromion and the nail is introduced after closed reduction. Our goal is to minimize the trauma caused by the surgery and to permit early mobilization after a stable fixation.

Method: Our study is observational retrospective: pre and postoperative radiographs of 50 consecutive patients were reviewed by two surgeons. We analyzed the type of fracture and the postoperative reduction. We noted any implant related complication and if union or malunion was encountered.

Results: The minimal invasive method gives good results in case of shaft fracture or in the 2-part proximal fractures. The reduction is also possible in some 3-part fractures without bone loss when reduction of a large fragment is achieved by the large headed screws. In 3 and 4-part fractures with bone loss after fracture

impaction the closed reduction is poor and there are many hardware related complications.

Conclusion: Minimal invasive surgery it's not fitted for 3 and 4-part fractures of the proximal humerus whenever there is bone loss. In these cases open reduction is mandatory. This technique gives good results in shaft fractures.

### **17.32 Temporary glenohumeral fixation in select cases of instable shoulder dislocation: a viable option?**

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We report the case of a 71-year-old woman, who was treated for an instable shoulder dislocation with a temporary glenohumeral fixation. An intrathoracic migration of the Steinmann pin occurred and a thoracotomy was necessary to retrieve the pin. A review of the literature shows very little information regarding temporary glenohumeral fixation. The merits of this method in select cases (e.g. patients with recurrent epileptic insults, patients in intensive care) and the potential serious complications are discussed.

### **17.42 Lateral plate-osteosynthesis in the treatment of spiral diaphyseal humeral fractures with a proximal component through an extended deltoid-split approach**

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Background: Surgical treatment of proximal diaphyseal humeral fractures is controversial. Intramedullary nailing has the disadvantage of violating the rotator cuff, of indirect reduction techniques with high risk on malreduction, especially in spiral fractures, and postoperative sequelae as nonunion, malunion or frozen shoulder. (Kurup et al; Dynamic compression plating versus locked intramedullary nailing for humeral shaft fractures in adults. Cochrane Database Syst Rev.2011.)

Alternatively plating of proximal diaphyseal humeral fractures is classically performed via an anterior or anterolateral approach through the deltopectoral interval but is technically demanding with risk of iatrogenic nerve injury. Zlotolow et al; Surgical exposures of the humerus. (J Am Acad Orthop Surg. 2006.) Based on our experience with the deltoid split approach for plating of proximal humeral fractures, we extended the approach distally to surgically treat diaphyseal humeral fractures with a proximal component with direct reduction techniques combined with a molded neutralization plate.

Objectives: Our goal was to improve the reduction and enhance fixation while making the surgical procedure technically more manageable, and allows for early postoperative motion.

Our second goal was to remove the plate safely afterwards by leaving the radial nerve and in some cases the axillary nerve underneath the molded plate.

In this article we describe in detail the surgical technique used at our institution and the accompanying clinical and radiographic results.

Patient and methods: Since December 2013 we treated 12 patients with a diaphyseal humeral fracture with or without a proximal extension (AO classification 12-C1).

We use a lateral deltoid split approach, starting from the acromion. The axillary nerve is identified during this portion of the dissection. The incision is subsequently lengthened or we use a two window technique depending on the level of the diaphyseal fracture. The distal part of the lateral approach allows identification of the radial nerve and its sensory branch. The spiral fracture is exposed, reduced with Weber clamps and fixed by two lag screws. A long anglestable plate, in some cases molded proximally and in all cases molded distally to bridge both nerves, is laterally applied as a neutralization plate. Fixation of the plate is performed proximally and distally with one cortical screw and additionally stabilised with dispersed locking screws.

Postoperatively all patients get a thoracobrachial adduction sling and mobilisation is started direct postoperatively, guided by the patient's pain.

Results: This cohort includes 4 male and 8 female patients with an average age of 66 years (range, 51–93). The minimum follow up was at least 6 months. All injuries were the result of a simple fall or trauma. One patient had a pathological fracture. There were all closed fractures. 7 patients had a bifocal and 4 patients an unifocal fracture. No patient had preoperative radial nerve palsy.

There were no observed cases of wound infection, intra-articular screw penetration or avascular necrosis of the humeral head. There were no patients with permanent radialis or axillaris paralyse postoperatively. Average postoperative shoulder active range of motion was good to excellent.

In two cases the plate was removed because of irritation of the hardware without nerve damage. The pathological fracture showed secondary displacement and there was one nonunion of humeral neck

component of a bifocal fracture. Both were revised with a subsequent good clinical result.

Conclusion: Diaphyseal fractures of the humerus with a proximal component are difficult to manage. The surgical technique presented here uses an approach to address all aspects of the fracture and provided mindful handling of the axillary and radial nerves. We prefer a plate osteosynthesis over a nail because of better reduction, less pain and earlier mobilization postoperatively. Furthermore with this technique we can safely remove the hardware without secondary complications.

These techniques can result in good clinical outcomes despite the complexity of this fracture pattern.

#### **17.52 Objective outcome measures in distal radius fractures treated with a volar locking plate: are they out of sync with patients?**

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Objectives: Little consensus exists regarding the best methods for predicting patient recovery following distal radius fractures. We aimed to identify if any objective outcomes correlated with patients' perception of pain and function.

Materials and Methods: Using a prospective cohort study, we evaluated 84 consecutive patients treated with volar locking plate fixation (VLP) for displaced distal radius fractures. We documented age and hand dominance, patients' perception of pain and function using Visual Analogue Scores (VAS), and objectively measured ROM (wrist flexion, extension, radial and ulnar flexion, pronation, supination), grip and pinch strength, at 6 and 12 months post-operatively.

Results: 41 patients sustained dominant wrist injuries. Spearman rank correlation coefficient revealed a negative correlation between VAS function and pain at 6 and 12 months, (-0.475 and -0.427 respectively). No correlation was found between age and VAS function, or VAS pain. Also, there was essentially no correlation with hand dominance and with VAS function (0.117, 0.132), and VAS pain (0.073, 0.079), at 6 and 12 months respectively. None of the objective movements correlated with VAS function or VAS pain. Using Linear Forward Regression, we identified that pronation and supination were independent factors in determining VAS function at 6 months, with only pronation being an independent factor at 12 months ( $p \leq 0.05$ ). No outcome domains could predict VAS pain.

Conclusions: Our study has shown that objective ROM, pinch and grip strength, and age and hand dominance correlate poorly with patients' perception of recovery at 6 and 12 months following injury. Only, pronation and supination may be of some use to clinicians in assessing wrist function. Crucially, patients' own self-reporting of pain correlates best with their perception of function, placing their own perception above any objective test.

#### **18.02 Closing the gap: a novel technique for humeral shaft nonunions using cup in cone reamers**

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Objectives: Nonunion following closed treatment of humeral shaft fracture is estimated to be 5.5%. Many surgical techniques have been described including: open reduction, internal fixation (ORIF) with compression plating and bone graft, dual plating, cortical strut allograft and autograft, and adding biologic augmentation (BMP). The current standard of care includes ORIF with compression plating and bone grafting, but even this technique has an approximated 10% failure rate. We describe a novel surgical technique using cup and cone reamers (originally designed for metatarsophalangeal or metacarpalphalangeal arthrodesis) for operative treatment of mid-shaft, transverse humeral nonunions to achieve apposition of healthy, bleeding bone.

Methods: We retrospectively reviewed 3 patients with nonunion of the midshaft humerus which were treated with the cup and cone technique and a large fragment LCDC plate. An anterolateral approach was used in 2 cases and a posterior in the other. After exposure of fracture ends, 24-mm cup and cone reamers were then used to ream the proximal and distal ends in order to create a cup and cone articulation of the fracture ends. All patients were followed for a minimum of 6 months with a mean follow-up of 12 months.

Results: All patients treated with this technique achieved union, reported zero pain and full functional outcome. Specifically, patients had a mean age of 39.5 and the mean interval between injury and time to surgery was 11.5 months. Two of the patients presented with nonunions after attempted closed treatment and the other patient had 3 prior surgeries for infected nonunion. Union was achieved at a mean of 12 weeks.

Conclusion: We describe a simple and effective technique for humeral shaft nonunions which has been successful in both septic and hypertrophic nonunions, as well as from multiple approaches-both anterolateral and posterior.

**16.00 IL Management of severe pelvic trauma**

Krettek C.

*Trauma Department, Hannover Medical School, Hannover, Germany***16.12 Custom-made lateral femoral hemiarthroplasty for traumatic bone loss: a case report**Stuyts B.<sup>1</sup>, Peersman G.<sup>2</sup>, Thienpont E.<sup>3</sup>, Van den Eeden E.<sup>1</sup>, Van der Bracht H.<sup>1</sup><sup>1</sup>*Sint-Augustinus Hospital, Wilrijk, Belgium;* <sup>2</sup>*ZNA Stuivenberg, Antwerp, Belgium;* <sup>3</sup>*University Hospital Saint Luc, Brussels, Belgium*

We report the case of a 32-year-old male patient involved in a road traffic accident in which he sustained a grade II open supra- and intercondylar fracture of the left distal femur with substantial bone loss of the lateral femoral condyle and trochlea (AO classification type 33 C3). Normal knee function was no longer possible, as the patella was trapped within the bony defect.

Existing reconstructive options such as unicondylar osteoarticular allograft, arthrodesis, and arthroplasty were considered. However, as all these techniques present significant disadvantages, particularly in young and active patients, a custom-made lateral hemiarthroplasty was designed and implanted as an alternative treatment.

Follow-up at 24 months revealed an excellent, pain-free level of function and radiographs showed no signs of implant loosening or migration.

This technique offers the most anatomical means of reconstruction with maximal preservation of the bone stock, thereby better facilitating any revisions that may be necessary in the future.

This is an experimental technique reserved for rare indications, and currently has no long-term follow-up results associated with its use. Additional research is therefore needed before widespread adoption of this technique can take place.

**16.22 The effect of computer-assisted surgery training in the placement of iliosacral screws**Hubbard E.W.<sup>1</sup>, Templeton E.<sup>1</sup>, Eward W.C.<sup>1</sup>, Green C.<sup>1</sup>, Nousiaainen M.T.<sup>2</sup>, Zura R.D.<sup>1</sup><sup>1</sup>*Duke University Medical Center, Department of Orthopaedic Surgery, Durham, North Carolina, United States;* <sup>2</sup>*Holland Orthopaedic and Arthritic Center, Sunnybrook Health Sciences Centre, Toronto, Ontario, Canada*

**Objectives:** Percutaneous placement of iliosacral screws for posterior pelvic ring injuries is the standard treatment to achieve rigid stabilization. However, this is a complex procedure and hardware malposition can result in significant neurovascular complications. This study attempts to determine if computer navigation assisted simulation training can be used as a tool to help surgical novices learn this complex technique.

**Materials and Methods:** A prospective randomized controlled study was conducted using surgical trainees with no prior experience at percutaneous iliosacral screw placement for pelvic ring injuries. After a training session, participants underwent a pre-test which involved using fluoroscopy to place guidewires for S1 and S2 iliosacral screws. Participants were then randomized to surgical training that involved either fluoroscopic or computer navigation assisted guidance, followed by a post-test using the assistive modality by which each participant had been trained. Participants returned 4 weeks later to perform retention and transfer tests.

**Results and Conclusions:** No significant improvement was seen in the overall frequency or grade of guidewire perforation for S1 and S2 iliosacral screws was seen, regardless of whether fluoroscopy or computer navigation training was used. Participants who trained using computer navigation were able to perform the procedure faster, with fewer attempts and less overall exposure to radiation. The results suggest that computer navigation is a safe and efficient training modality.

**16.32 Anterior subcutaneous internal plate fixation as part of a 360° degrees treatment of unstable pelvic injuries**Cootjans K., Putzeys G.*Department of Orthopaedic Surgery, AZ Groeninge Kortrijk, Kortrijk, Belgium*

**Objective:** The treatment of some unstable pelvic injuries has evolved recently to include the use of a subcutaneous anterior pelvic fixator. The most common described technique consists of single anterior supra-acetabular pedicle screws connected with a subcutaneous rod. Major disadvantages of this technique are the steep learning curve, the bulky subcutaneous connection and the risk of injury to the femoral nerve(s).

We present 6 cases of unstable pelvic injuries treated with a subcutaneous locking plate instead of a rod and fixed between the ipsilateral spina iliaca anterior superior (SIAS) and the contralateral pubic symphysis or contralateral SIAS with the aim to avoid the previously mentioned disadvantages.

Design: Retrospective chart review. Case series.

Methods: We retrospectively reviewed 6 patients who incurred an unstable pelvic injury treated with an anterior internal fixator and posterior fixation at our trauma center. We assessed (1) how well they tolerated the implants (2) healing by callous formation on radiograph and (3) complications during the observation period. The mean follow up was 15 months (range: 6-30 months).

Results: All 6 patients were able to sit, stand, and lie on their sides with the device in place. All patients attained radiographic union, no patient had nonunion at last follow up.

There were no complications due to irritation of the lateral femoral cutaneous nerve, no infections or aseptic loosening. All hardware was removed between 2 and 3 months in this study population. There were no problems with implant removal at any site.

Conclusions: The anterior subcutaneous internal plate fixation provided high rates of union for the anterior injury in unstable pelvic fractures. We used the same principle than the rod but with a different implant and different anterior pelvic fixation sides. We observed no problems secondary to irritation of the lateral femoral cutaneous nerve. Further research is recommended.

#### **16.42 Mortality-analysis on a 5 year period registration ( 2009-2013) in the German Pelvic Injury Register : comparison between a Belgian hospital and a pool of German hospitals**

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Objectives: The study objectives were: 1) to determine the all-cause in-hospital mortality after a pelvic injury in a single Belgian hospital assessing its time-trend over a 5-year period; 2) to compare these mortality rates to the data from German “reference” hospitals; 3) to reveal risk factors of mortality.

Materials and methods: All patients with pelvic trauma admitted in 2009-2013 at our Belgium hospital were included in the analysis. Additionally, all such patients from four German Trauma “reference” centres were included in the analysis.

A linear multivariate regression was performed to assess time-trends of mortality in the Belgian hospital. Subsequently, a propensity score based 1:1 matched case-control analysis was performed comparing mortality rate between the Belgian and German samples. Logistic regression model was built to reveal risk factors of mortality in the overall population.

Results: In 728 identified Belgian patients the mortality after pelvic trauma was 5.8%. It did not show significant time-trend ( $p=0.60$ ). Matching to 2802 patients from the reference hospitals resulted in 715 pairs without residual significant differences. The mortality rate in the Belgian hospital (5.6%) was higher than that in the reference hospitals (2.9%;  $p=0.013$ ). Higher age (odds ratio 1.04 per year; 95% confidence intervals 1.03-1.05), higher ISS (1.08 per point; 1.07-1.10), polytrauma (3.23 vs. isolated pelvis; 1.88-5.57), complex trauma (2.48 vs. none; 1.56-3.94), no pelvic fracture (2.74 vs. type B-C; 1.69-4.45), B-type fracture (2.28 vs. A-type; 1.32-3.93), C-type fracture (3.44 vs. A-type; 1.89-6.25), surgery (11.74 vs. conservative; 7.48-18.42), primary treatment (2.18 vs. no; 1.44-3.30), and treatment year (1.13 per year; 1.01-1.26) were increasing the risk of mortality ( $p>0.028$ ).

Conclusions: The mortality rate in our hospital is significantly higher than in the reference hospitals and is stable yet. The identified risk factors shall help in increasing awareness of this outcome.

#### **16.52 Operative treatment of acetabular fractures in the elderly in presence of osteoporotic bone** Molenaers B.<sup>1</sup>, Vanlommel J.<sup>1</sup>, Vanderschot P.<sup>1,2</sup>

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Due to an increased longevity and active lifestyle, acetabular fractures are becoming more frequent in the elderly population. The combination of osteoporotic bone, comminuted fractures and associated comorbidities challenge the orthopedic surgeon to get the best results. In the literature, the use of cable fixation and acute total hip replacement (THA) for acetabular fracture in the elderly is increasingly advocated.

We present our first experience and initial results of 17 cases with a comminuted osteoporotic acetabular fracture, treated with cable fixation and an acute THA. The mean age was 70 years (range: 58-89). Most often, the ‘typical geriatric’ fracture, anterior column with extension to the quadrilateral plate was present. Also T-

shaped fractures and both column fractures were noticed. In all cases, a Tri-radiate approach was preferred.

6 patients died at follow-up. The remaining 11 cases were followed for an average of 48.3 months (range: 12-105). 4 patients had a good clinical outcome, 5 patients sustained a dislocation of the THA, requiring revision surgery. 3 infections occurred, conservatively treated with AB therapy. 1 patient underwent a 2 stage revision due to infection with acceptable outcome. Another patient underwent a resection of ectopic bone in combination with a single dose of radiotherapy (7 Gy). Radiographic assessment showed healing of the fracture and a satisfactory alignment of the THA.

Along the literature this surgical technique provides a good primary fixation, stabilizes complex acetabular fractures in elderly patients with osteoporotic bone and permits early postoperative mobilization. Our initial results show a high complication rate due to dislocation of the THA. We advise the use of a constrained liner to minimize the risk of dislocations probably due to the extensive release during the operative procedure by means of a Tri-radiate approach.

## **17.02 Current imaging guidelines in evaluating periprosthetic complications**

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**Objectives:** To provide ready-to-use guidelines, in daily practice, for choosing the best available imaging modalities in diagnosing periprosthetic complications.

**Materials and methods:** Based upon literature review and multi-hospital experience we provide an overview of standardized current imaging modalities in evaluation of periprosthetic complications, revealing their strengths and weaknesses in diagnostic accuracy.

**Findings:** The elderly population is vastly larger than it ever was and is still growing, resulting in an increase of specific pathologies, in particular fractures and associated prosthetics.

Major complications after prosthetic implantation can occur, resulting in prolonged hospital stay, increased mortality and an increased cost to healthcare. Therefore an early and accurate diagnosis is mandatory based on thorough clinical examination and using relevant imaging studies.

Conventional X-ray remains the gold standard as it is readily available, cheap and has the possibility of depicting the implants and their relation to bony structures; however small lesions can be missed.

Computed tomography is increasingly used, providing detailed information of implants, the surrounding bone, and adjacent soft-tissue. With the aid of computer software different reconstructions can be achieved. Furthermore we can change some acquisition parameters in order to minimize artifacts caused by metal implants. Because of costs, acquisition time and magnetic susceptibility artifacts magnetic resonance imaging is no standard in imaging of prosthetics. However it can be useful in differentiating different post-implant complications, especially in the surrounding soft tissues. Current high-end software and the use of modified acquisition techniques reduce the metallic artifacts and are very useful in depicting 'silent' fractures or loosening and evaluating the bone-implant interface.

**Conclusion:** A multidisciplinary approach is key in diagnosing complications after arthroplasty. Moreover, using the most accurate imaging modalities in diagnosing periprosthetic pathology will improve overall quality of care and efficient use of available resources.

## **17.12 Pipkin fractures and dislocations: treatment and long-term results**

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**Objectives:** To present our experience with treatment of Pipkin fractures and dislocations, and analyse the long term clinical results.

**Material and Method:** For a period of 12 years we treated 18 patients with Pipkin fractures of the femoral head. The fractures were distributed according to classification of Pipkin: Type I- 4, Type II- 5, Type IIIA- 1, Type IIIB-3 and Type IV-6. 3 patients were treated nonoperatively. Smith-Peterson (distal part) approach was used for 7 fractures Pipkin I,II, for fractures Type Pipkin IV was chosen Kocher –Langebeck (5 cases) and 1 with "Flip osteotomy". Watson-Jones and Hardinge approaches was used for Pipkin IIIA (1 case) and Pipkin IIIB (2 cases). 11 fractures were reduced and fixed, 3 were treated by primary THA and 2 fragments from the femoral head were excised.

**Results:** All patients were followed up (2-10 years). From 18 patients with 19 fractures of the femoral head assessed by HHS, we obtained 10 excellent and good, 5 fair and 4 poor results. The distribution of the results according to the type of the fracture is as follows: Pipkin I – 2 excellent, 1 good and 1 fair, Pipkin II- 2



excellent, 1 good, 1 fair and 1 poor, Pipkin IIIA – 1 excellent, Pipkin IIIB- 2 excellent, 1 poor, and Pipkin IV- 1 excellent, 3 fair and 2 poor. With iatrogenic temporary nerve dysfunction (n. ischiadicus) was 1 patient, 4 achieved avascular necrosis of the femoral head, Type I,II (Brooker) ectopic ossifications developed 4 patients and 4 with osteoarthritis.

Conclusion: The long term results after Pipkin fractures dislocations are directly connected to the correct choice of approach, method of treatment and type of the fracture.

### **17.22 Fluoroscopic-assisted percutaneous anterior column screw in lateral position: a surgical technique**

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Introduction: Percutaneous fixation of the anterior column in acetabular fractures has become increasingly popular. Although this procedure has been described in the literature, there is a paucity of literature that provides adequate visual illustration of this surgical technique in regards to proper patient and fluoroscopic positioning. Our goal is to describe and illustrate intraoperative fluoroscopic imaging required for safe percutaneous fixation of the anterior column in lateral position.

Surgical Technique: The patient is placed in the lateral position on a radiolucent table and peg board with radiolucent posts. The arms require positioning as cephalad as possible to minimize interference with imaging. The insertion point is marked 3-4 cms proximal and 1-2 cms posterior to the greater trochanter. A 1 cm incision is made in the skin and a 3.2mm by 300mm drill bit is utilized. The entry point for the cephalad/caudal position of the drill bit is confirmed by an obturator oblique pelvic view. (OOV) This view also serves to confirm the drill is extra-articular. The anterior/posterior position is confirmed by an inlet view of the pelvis. This view aids in directing the drill centrally within the anterior column and pubic ramus away from the anterior neurovascular structures. The drill bit is slowly advanced at full speed while taking serial images using the above views. Once the drill bit is verified within the anterior column and pubic rami, the outer cortex of the pelvis is tapped and a 6.5 mm screw can be safely placed.

Conclusion: Utilization of the above method is safe and effective treatment for anterior column stabilization in the lateral position.

### **17.32 Implant augmentation of the proximal femur**

Sermon A.

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Objective: It is the objective of this study to present the novel technique of implant augmentation of the proximal femur. This technique aims to increase the implant to bone surface and to reduce the stresses on the trabecular structures in the femoral head. The additional stability achieved by augmentation has been shown in numerous biomechanical investigations on Proximal Femoral Nail Antirotation augmentation. The decision for augmentation is made after implantation of the helical blade and is based on the clinical judgement of the bone strength of the femoral head during blade insertion by the surgeon.

Materials and methods: In the actual study, an overview of the indications for proximal femoral nail augmentation is given, followed by a description of the surgical technique. Secondly, an overview of the first clinical results is presented, illustrated by numerous cases and tips and tricks to avoid complications. Finally some extended indications are illustrated by some case reports.

Results: Despite the small clinical experience, the first results of implant augmentation of the proximal femur are promising. All fractures showed callus formation, no osteonecrosis of the femoral head has been noticed nor any implant migration like cut-out or cut-through.

Conclusion: Implant augmentation of the proximal femur is a feasible technique with a low complication rate.

### **17.42 IL High tech trauma: current modalities and navigation techniques**

Varga E.

*Department of Trauma Surgery, University of Szeged, Albert Szent-Györgyi Clinical Center, Szeged, Hungary*

### **17.54 IL The iliopectic plate for anterior pelvic fractures**

Gerich T.

*Traumatologie des Centre Hospitalier de Luxembourg, Luxembourg, Luxembourg*

**18.06 IL Chest wall fixation. Is it advantageous ?**

Varga E.

*Department of Trauma Surgery, University of Szeged, Albert Szent-Györgyi Clinical Center, Szeged, Hungary*

**Friday 11 September 2015**

**Auditorium Albert**

**08.30-10.00**

**Hip & Femur**

**08.30 IL Why we should not always nail hip fractures**

Chesser T.

*Trauma and Orthopaedic Department, North Bristol NHS Trust, Bristol, United Kingdom*

**08.42 Factors affecting postoperative death in patients above 65 years-old who were operated for hip fracture**

Ocalan E., Ozkayin N., Aktuglu K.

*Department of Orthopedic And Traumatology, Ege University, Izmir, Turkey*

**Objectives:** A statistical retrospective research was carried out to find factors affecting post-operative death in a population of patients above 65 years-old who were operated for intertrochanteric hip fracture.

**Materials and Methods:** 131 patients who were above the age of 65 were included in a study between the years of 2010-2013 who were admitted to Ege University Department of Orthopedics and Traumatology for the treatment of intertrochanteric hip fracture. The average age of patients was 77.85 (65-98), 72 (55%) of which were women and 59 (45%) were men. The average preoperative hospitalization time of these patients was 5 days (1-22). ASA distribution included 9 patients with ASA1, 69 with ASA2, 38 with ASA3 and 15 with ASA4. The anesthetic distribution of the population included 121 patients (92.4%) who were operated under spinal anesthesia, 8 (6.1%) under epidural and spinal anesthesia and 2 (1.5%) under general anesthesia. The effects of ASA score, age, preoperative hospitalization time, the type of anesthesia on post-operative death was analysed statistically. Chi-square test was used in the statistical assessment of the population.

**Results:** It was found out that 43 of the 131 patients died who were operated for hip fracture. Distribution included 11 deaths in the first month post-operatively, whereas 15 in the third month and 24 in the first year post-operatively. Of those who died in the first 12 months post-operatively, 7 were (29.2%) ASA2 whereas 8 (33.3%) were ASA4. ASA scores and deaths showed a statistically significant relation ( $p = 0.028$ ).

A statistically significant difference was identified between the ages and the ASA scores of the population ( $p < 0.05$ ). Age increased in direct proportion with the ASA Scores.

The effect of preoperative hospitalization time on initial mortality was analysed. It was found out that the preoperative hospitalization time for those patients who died in the first 12 months was 5.46 (2-12) days on the average, whereas it was 5.92 (1-22) days who lived. The effect of preoperative time on mortality was not statistically significant ( $p > 0.05$ ). No statistically significant difference was identified between the type of anesthesia administered and the mortality ( $p = 0.66$ ).

**Conclusions:** Postoperative mortality is a condition encountered in the elderly patients. In this study we searched for those factors affecting mortality. As a result, while we statistically found out the ASA score to be the most significant factor on mortality, and we also statistically identified that the ASA score increased as the age increased. No significant relation was observed between the preoperative hospitalization time and mortality. As a result, we concluded that if the elderly patients with hip fractures are operated within an optimal time during which the disadvantages of the systemic diseases are eliminated as much as possible, this will effectively reduce mortality.

**08.52 In comparison to posterolateral approach, does direct anterior approach on orthopaedic table reduce the dislocation rate after bipolar hemiarthroplasty for neck fracture?**

Jayankura M., Bloemers N., Koulischer S., Clegg E., Matriche C., Schuind F.

*Department of Orthopaedic surgery and Traumatology, Erasme University Hospital, Brussels, Belgium*

**Background:** Bipolar hemiarthroplasty for femoral neck fractures performed by posterolateral approach (PL) is a well-recognized procedure which is yet associated to a high rate of dislocation (7-14%). Differently, the mini-invasive direct anterior approach (DAA) for hip arthroplasty ensures theoretically a low dislocation rate. This

study aims to evaluate if DAA in bipolar hemiarthroplasty for femoral neck fractures is effectively associated to a better stability without an unacceptable complications rate.

**Patients and Methods:** Since the use of DAA for hip arthroplasty in our institution, all patients operated by bipolar hemiarthroplasty for neck fracture either by PL (N=106) or DAA (N=46), have retrospectively been reviewed with at least a 6 months follow-up. Posterior approaches were classically performed with tendino-capsular repair. Anterior approaches were performed supine with traction table. The choice of the approach was related to the surgeon practice. Dislocation rate and other complications were investigated.

**Results and conclusion:** PL and DAA groups were comparable for age, gender, BMI and ASA score repartition. Seven patients in the PL group suffered at least one dislocation (6,6%); (4 hips revised). No dislocation was observed in the DAA group. Two peroperative proximal femoral fractures occurred in the PL group for 1 in the DAA group. Deep infections was observed in 2 patients in the PL group and 1 in the DAA group.

Our findings indicate that DAA on orthopaedic table is a safe technique applicable to bipolar hemiarthroplasty for fracture. In this specific indication, the dislocation rate (< 1%) is low in comparison to that observed by posterior approach in our study (6,6%) or generally in the literature (6-20%). This can be a major advantage for DAA in this often debilitated population moreover if a faster recovery is also confirmed by further studies.

## **09.02 Clinical results for surgical treatment of femoral neck fracture with Targon FN**

Takigawa N., Yasui K., Eshiro H., Adachi S., Fukai A., Komatsu T., Kinoshita M.

*Department of Orthopedics, Nishinomiya Kyoritsu Neurosurgical Hospital, Nishinomiya, Hyogo, Japan*

**Objectives:** The Targon® FN (BBRAUN AESCULAP, Germany) consists of a plate with four telescopic locking screws and two distal locking screws. It is effective as an internal fixation device for femoral neck fractures to prevent femoral head rotation. However there are some difficulties in its surgical procedure. We developed a new instrument and have used it to solve them. We report evaluation of our clinical results on this study.

**Material and methods:** Femoral neck fractures in 102 patients were treated with Targon® FN since June 2011. We evaluated 77/102 cases (male 15 cases, female 62 cases) who could be followed during this period. Mean age of patients was 71.0 years (range 36-100 years). They consist of Garden stage 1&2, undisplaced fractures (51cases) and Garden stage 3&4, displaced fractures (26cases). Mean follow-up was 15.5 months. We surveyed the mobility (before and after operation) and complication after operation.

**Results:** We found that the cases more than 1 grade of reduction in mobility were 4/51 cases (7.8%) in undisplaced fractures and 5/26(19.2%) cases in displaced fractures. Postoperative complications in undisplaced fractures were 5/51 cases (9.8%), and 4/26 cases (15.4%) in displaced fractures. These complications included AVN (3cases) and periprosthetic fractures (2cases) in undisplaced fractures, and AVN (4cases) in displaced fractures. There wasn't pseudarthrosis and cut-out.

**Conclusions:** Internal fixation with Targon® FN has less complication rate in both undisplaced and displaced fractures compared to the other contemporary studies. No complications like pseudarthrosis or cut-outs prove the Targon® FN as effective internal fixation device for treating femoral neck fractures. However, as follow-up is not so long, we need further evaluation.

## **09.12 Rotational malalignment of the femur after intramedullary nailing in femoral shaft fractures - Incidence and long term functional effects**

Savvidis M.<sup>1</sup>, Konstandinidis A.<sup>1</sup>, Koutroumanidis K.<sup>2</sup>, Bisbinas I.<sup>1</sup>, Georgiannos D.<sup>1</sup>, Kapoutsis D.<sup>1</sup>, Gkouvas G.<sup>1</sup>

<sup>1</sup>1st Orthopaedic Department and <sup>2</sup>Radiology Department, 424 G.M.H. Thessaloniki, Greece

**Objectives:** Rotational malalignment is an insidious intra-operative complication in femoral shaft fractures when treated with intramedullary nailing. Incidence and gravity of the clinical problem are not well defined yet. The purpose of this retrospective study was to assess the incidence and functional effects of this complication in our institution.

**Methods:** 43 patients with an uneventful, well-united after antegrade intramedullary nailing, isolated close femoral shaft fracture were assessed with a minimum follow-up of 12 months. Patients with other associated lower limb injuries or pre-existed comorbidities were excluded. Hip rotational movements and foot progression angles were measured, Function Knee Society and Oxford 12-item outcome scores were assessed. All patients underwent a torsion-difference computed tomography (CT) of their upper leg and a static/dynamic pedography.

**Results:** Clinically, 5 patients had side to side difference in rotational motion more than 20°. The mean CT-detected malrotation of the fractured femur was 12 degrees (0 to 29) and no external malrotation was found. Nine patients had internal malrotation more than 10 degrees and only 5 of them had changes in dynamic

pedography. The outcome scores for the entire group were mean Oxford: 45 (37 – 48) and mean Function Knee Society Score: 98 (60-100). In those 9 patients with malrotation more than 10 degrees the mean scores in both Oxford: 41(37-47) and Function Knee Society Score: 82 (60-100) were substantially lower.

Conclusion: The meticulous use of image intensifier before nail insertion and before locking and the appropriate pre-operative assessment of femoral neck anteversion is an effective method of avoiding femoral malrotation. Malrotation is an independent factor impairing the patient's functional outcome postoperatively and dynamic pedography cannot assess it adequately even in high malrotation angles.

#### **09.22 A new surgical solution to prevent contralateral hip fracture: feasibility and safety**

Vienney C.<sup>1</sup>, Reynders P.<sup>2</sup>, Rigal J.<sup>1</sup>, Domezon H.<sup>1</sup>, Le Huec J.C.<sup>1</sup>, Gunzburg R.<sup>3</sup>

<sup>1</sup>Hopital Xavier Arnozan, PTIB, Hyprevention; Pessac, France; <sup>2</sup>Department Orthopedics & Traumatology, University Hospitals Brussels, Brussels, Belgium; <sup>3</sup>Department Orthopedics & Traumatology, Edith Cavell Clinic, Brussels, Belgium

Introduction: The second fracture of the upper part of the femur is associated to dependency and to a dramatic increase of the mortality rate (from 20 to 50% depending of the studies). Therefore, it is clearly important to prevent this second fracture. The purpose of this study is to evaluate the impact of a new prevention dedicated osteosynthesis implant (PDOI) in its use for osteoporotic fracture prevention in terms of safety and effectiveness.

Methods: This study to prevent osteoporotic fracture (POF) is an on-going prospective series of 15 PDOI. To date, 4 patients female were implanted. The PDOI was implanted into the contralateral hip during the same surgery time of fractured hip gamma nail implantation. Clinical evaluation includes the Oxford Hip Score, the WOMAC scores, plantar pressure measurements and imagery. Two (2) patients have 2 years follow-up. Five (5) years follow-up is planned.

Results: Mean Age and BMI of patients were 83±3 years and 25±7 kg/m<sup>2</sup>. Mean duration of implantation was 48 (35-65) minutes and 46 (22-90) minutes for POF and contralateral hip fracture fixation respectively. Mean cement quantity was 7cc (6-10) for POF. At 3 weeks and 3, 6 and 12 months, comparison between the two legs' plantar pressures revealed no differences. At 3 months, Womac scores for pain and functionality were 9 and 36 respectively, and 2 and 10 at 12 months. OHS score was 41 at 12 months. No osteolysis or implant loosening was observed at the different follow-ups.

Conclusion: Preliminary results of this prospective study demonstrated the feasibility and safety of the implantation of this new PDOI to prevent contralateral hip fracture. Further data are required to confirm this preliminary experience.

#### **09.32 Quartets of elastic stable intramedullary nails in pediatric femur fractures**

Nickel B.T., Blizzard D.J., Willimon S.C., Busch M.T.

*Department of Orthopaedic Surgery, Duke University Medical Center, Durham, North Carolina, United States*

Objective: The insertion of two elastic stable intramedullary nails (ESINs) in the classic 2C shape is a common treatment for pediatric femur fractures. Higher complication rates (10-50%) are reported in length-unstable fractures, metadiaphyseal location, and older, heavier children. To improve stability, the addition of a third ESIN has been assessed biomechanically and clinically, but a forth nail has only been evaluated biomechanically. The purpose of this study is to report our surgical technique and patient outcomes using four ESINs in pediatric femur fractures.

Materials and Methods: Between 2008 and 2013, fourteen pediatric patients with length-unstable femur fractures were treated with four ESINs. They were followed clinically and radiographically until union, removal of hardware, and end of healing. Retrospectively, fracture union and alignment were measured and complications identified.

Results: All fractures achieved union. Hardware was removed at a mean duration of 9.5 months (range 3-14) from implantation. At final follow-up, all patients reported full hip and knee range of motion. No children required additional surgery, leg length discrepancies or malalignment (coronal or sagittal) on final radiographs. Two patients experienced complications: one obese patient experienced knee irritation secondary to nail migration, and another older patient fell resulting in a stable, nondisplaced refracture which required no further intervention. The average age was 9.8 years (range 4-14.5) and weight was 45.5 kg (range 21-95).

Conclusion: Length-unstable femur fractures can successfully be treated with a quartet of ESINs. This modification to traditional elastic nailing technique is an option for the orthopaedist to consider as an alternative to rigid intramedullary nailing, submuscular plating, or external fixation.

**09.42 IL Supracondylar Femur fractures, salvage tips & tricks**  
 Krettek C.  
*Trauma Department, Hannover Medical School, Hannover, Germany*

**09.57 IL Arthroplasty in Proximal Humerus Fractures**  
 Nijs S.  
*Department of Trauma Surgery and Department Development and Regeneration, University Hospitals Leuven, Leuven, Belgium*

		Marble Room
08.30-10.05	Ankle & Foot	

**08.30 Intramedullary osteosynthesis of ankle fractures with a straight locked nail: XS Nail**

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<sup>1</sup>*Klinikum Aschaffenburg, Unfallchirurgie, Orthopädie und Handchirurgie, Aschaffenburg, Germany;*

<sup>2</sup>*Metropol Medical Center, Centre for Orthopaedics, Neurosurgery and Trauma Surgery (ONTC), Nürnberg, Germany*

Clinical Problem: Because of soft tissue problems in the ankle area and higher loading capacity of intramedullary implants with length and rotation stability the straight XS Nail was introduced 2000 for ankle fracture osteosynthesis in our Hospital.

Material and Methods: the XS nail is a 4.5mm and the XXS a 3.5mm straight nail which is locked by threaded wires which are placed with an aiming device and allows also dynamic fracture site compression with a set screw. From 05/2000 to 03/2002 214 ankle fractures were stabilised with a XS or XXS nail (locked straight nail of 4,5 and 3,5mm). The mean age was 51 year, 59% were woman. 35% were Weber B and 25% type C fractures. The re-examination after 6 months could be performed in 91 Patients and was evaluated according to the Ovidia score (clinical and radiological).

Results: In the ankle fractures study in 2 patients haematoma revisions and in 2 patients with the primary used oblique insertion of the nail a proximal fibula fracture occurred. In one case a split skin graft was needed. In no case infection of the bone was seen, in no case fracture or implant dislocation occurred. At re-examination 71% showed an excellent and 25% a good result. Only 3 Patients were classified as fair (1) or unsatisfactory; in 1 due to algodystrophia.

Conclusion: The XS nail is a new option for ankle stabilisation. It improves the stability and reduces the complication of ankle osteosynthesis due to the lack of implant under the skin on the bone surface and due to the higher biomechanical stability of intramedullary implants.

**08.42 Predictors of failure for delayed surgical treatment of closed ankle fracture-dislocations**

Matson A.P., Zura R.D.

*Duke University Medical Center, Department of Orthopaedic Surgery, Durham, North Carolina, USA*

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

Methods: Following IRB approval, a retrospective chart review identified patients with closed, isolated, bi- and tri-malleolar ankle fracture-dislocations treated operatively between 2008-2012 at a single, Level 1 trauma center. All patients were managed initially with closed reduction and splinting in the Emergency Department, followed by operative treatment. Patient characteristics, as well as pre- and post-reduction radiographic injury characteristics were recorded. Closed reduction was considered to be successful when delayed ORIF was performed, and unsuccessful when urgent surgery was required. Statistical analysis was performed using the Student t-test with significant set at P value <0.05.

Results: After exclusion criteria were applied, there were 55 patients included in the statistical analysis. There were 20 successful closed reductions (36%) and 35 unsuccessful closed reductions (64%). Successful closed reduction was more common in patients without a posterior malleolus fracture (58%) than in patients with a posterior malleolus fracture (29%). When compared to patients with unsuccessful closed reductions, patients who underwent successful closed reduction had less fibular shortening (4.1mm vs 9.4 mm) and smaller

posterior malleolus fracture fragment size (5.5mm vs 8mm) on average. Post-reduction radiographic characteristics were not associated with reduction success rate.

Conclusion: Larger posterior malleolus fracture size and greater fibular shortening are associated with higher rates of closed reduction failure in ankle fracture-dislocations. Consideration of these characteristics during initial evaluation and management may assist the surgeon in operative planning.

#### **08.52 Primary tibio-talar-calcaneal arthrodesis with intramedullary nailing for severe non-reconstructible tibial pilon fractures**

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*Orthopaedic and Trauma Department, Cliniques universitaires Saint-Luc, Université catholique de Louvain, Brussels, Belgium*

Objectives: Review the results after primary tibio-talar-calcaneal arthrodesis with Intramedullary Nailing for severely comminuted tibial pilon fractures, non-reconstructibles according to articular fractures treatment principles. Assess time-to-heal and fuse (fracture and arthrodesis) and intra and postoperative complications.

Materials and method: The retrospective study was performed on 27 pilon fractures operated at UCL Hospital Brussels, (October 2011- January 2015) out of which 23 had open reduction and internal fixation and 4, with severe comminution of the articular surface received primary tibio-talar-calcaneal arthrodesis with an intramedullary nail. These were reviewed, regarding age, sex, injury type, previous musculo-skeletal conditions, need for temporary external fixation, time to second surgery (nailing), arthrodesis type (open / arthroscopic), bone grafting /additional soft tissue reconstruction, complications, time to bone healing, need for revision surgery, radiological alignment of the hindfoot.

The average period of follow up was 10 months (4.5-20). Out of the 4 patients with primary arthrodesis, 1 had high-energy (good bone stock) and 3 low energy trauma (poor bone quality).

Provisional external fixation was needed in 3 cases. 1 case with severe post-traumatic soft tissue loss needed a free flap. 1 case had arthroscopic tibio-talar arthrodesis, 3 were operated with an open technique. 1 autograft from iliac crest and 1 allograft were used. All fixations were performed with an intramedullary nail.

Results: No intraoperative problems were recorded, 1 delayed healing of surgical wound was encountered. No postoperative infection was recorded. Average time to bone healing was 21 weeks (19-24). No revision surgery or additional procedures were needed to obtain healing.

Conclusions: Primary tibio-talar-calcaneal arthrodesis with fracture reduction and stabilisation is a valuable option for selected cases (severe comminution of joint surface in pilon fractures, poor bone stock), when failure of anatomic reduction and stable internal fixation is highly predictable.

#### **09.02 The measurement and clinical significance of syndesmotic reduction after operative fixation of rotational ankle fractures**

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<sup>1</sup>Orthopaedic Surgery, Hospital for Special Surgery, New York, NY, USA; <sup>2</sup>University of Texas, Houston, TX, USA

Objectives: Multiple studies have focused on methods to assess syndesmotic reduction; however, the clinical significance of anatomic syndesmotic reduction remains unclear. The purpose of this study was to determine if the quality of syndesmotic reduction influenced clinical outcomes following operative treatment of ankle fractures with unstable syndesmotic injuries.

Materials and methods: Patients were included from an institutional trauma registry who had sustained rotational ankle fractures with intraoperative evidence of syndesmotic instability requiring syndesmotic reduction and stabilization. Patients with at least twelve months of disease-specific, patient-reported clinical outcomes were included. Bilateral ankle computed tomography (CT) imaging was performed within two days postoperatively on all patients. Four previously utilized methods of assessing syndesmotic reduction using axial CT images of the operative and contralateral ankle were used.

Results: A total of one-hundred and fifty-five patients met study criteria and underwent analysis. The four methods used to assess syndesmotic reduction had reliabilities ranging from moderate to almost perfect (intraclass correlation coefficient ICC(2,1) range = 0.544-0.821). Measurements of the uninjured syndesmoses were consistent with several previous studies of normal syndesmotic morphology, and the four methods of syndesmotic assessment had strong internal consistency. The mean measurement differences between the injured and normal ankles ranged from 1.32mm to 1.80mm of displacement and 5.75° of rotation. There were no correlations noted between any of the four syndesmotic reduction assessment methods and any Foot and Ankle Outcome Score (FAOS) domains.

Conclusions: Within the range of syndesmotic malreductions studied, the quality of syndesmotic reduction did not significantly influence clinical outcomes. These results challenge previous definitions of syndesmosis malreduction and the clinical significance of minor syndesmosis changes. It remains unclear, however, whether greater magnitudes of syndesmotic malreduction than seen in this cohort would lead to inferior patient-reported outcomes.

#### **09.12 Gait analysis and functional outcome after calcaneal fractures**

Leenstra B.<sup>1</sup>, van Hoeve S.<sup>1</sup>, de Vos J.<sup>1</sup>, Verbruggen J.P.A.M.<sup>1</sup>, Willems P.<sup>2,3</sup>, Meijer K.<sup>2,3</sup>, Poeze M.<sup>1,3</sup>

<sup>1</sup>Department of Surgery, division of Trauma surgery, <sup>2</sup>Department of Movement Sciences, Maastricht University Medical Center, Maastricht, The Netherlands; <sup>3</sup>NUTRIM, School for Nutrition, Toxicology and Metabolism, Maastricht University, Maastricht, The Netherlands

Introduction: Calcaneal fractures are associated with significant morbidity and socio-economic impact, frequently leading to limited functional outcome and high economic costs. To evaluate this outcome questionnaires, physical examination and radiographic findings are used regularly, although the relationship between radiographic parameters and functional outcome is inconsistent. Gait analysis after calcaneal fractures may provide the link between radiographic parameters and functional outcome. The Oxford foot model (OFM) has been reported as a valid and reproducible addition to the biomechanical examination of the foot. The aim of this study was to evaluate gait analyses in patients after operative repair of calcaneal fractures in relationship with functional outcome and radiographic findings.

Methods: Thirteen patients with calcaneal fractures (>6 months after open reduction and internal fixation) underwent gait analysis with the VICON-MX3-system, making use of the OFM. Intersegment joint angles were measured to evaluate range of motion (ROM) during gait. Results were compared with healthy subjects and patients after subtalar arthrodesis. Patient reported questionnaires (FADI, VAS, SF-36) and radiographic images (including CT scans) were evaluated before and after surgery.

Results: Inversion/eversion ROM in the ankle/subtalar joint after calcaneal fractures was significantly correlated with functional outcome parameters ( $R^2=0.5$ ,  $P<0.05$ ). Also the fracture step-off ( $>2$  mm) in the subtalar joint ( $R^2=0.7$ ,  $P<0.004$ ) and the sagittal subtalar joint axis ( $R^2=0.6$ ,  $P<0.02$ ) after surgery were significantly correlated with the ROM in the hindfoot.

Conclusion: Gait analysis after calcaneal fractures provides the link between the anatomic reconstruction and functional outcome and may be used to monitor patients after surgery.

#### **09.22 3D imaging and calcaneus fracture osteosynthesis**

Misselyn D.

*Department of Traumatology, UZ Leuven, Leuven, Belgium*

Calcaneus fractures are challenging injuries: painful with long disability, seldom with steep learning curve, comminuted with difficult surgery.

Calcaneus has an odd anatomy, and it is often difficult to see the full extend of the fracture lines on classical X-Ray pictures. CT was a major improvement as diagnostic tool. Several CT-based classifications of calcaneus fracture are available, but none is perfect: easy to remember and to use, helping to decide the best treatment and predicting outcome. The most used one is the Sanders classification, which suffers from fair inter-observer variability.

Most surgeons treat intra-articular and displaced calcaneus fractures (DIACF) surgically, trying to restore the anatomy as good as possible.

The treatment of this fracture remains controversial, with no proven advantage of operative treatment, probably because of his difficult surgery, but also because of his highly comminuted character, which is difficult to understand even on the classical 2D CT slices.

3D reconstruction after segmentation of the hindfoot bones (calcaneus, talus and cuboid) offers a highly realistic view of the shattered bone and seems very useful in decision making. The first results – images and measurements - of a specific application will be presented.

#### **09.32 Number and type of fractures on CT imaging is not a predictor for stability in Lisfranc injuries**

Stollenwerck G.A.N.L., Poeze M.

*Department of surgery and trauma surgery, Maastricht University Medical Center, Maastricht, The Netherlands*

**Objectives:** Lisfranc injury is frequently accompanied with fractures of the metatarsal and/or tarsal bones. These fractures may vary from clearly visible on conventional radiographs to subtle small avulsion fractures on detailed CT imaging. It is unknown whether this CT imaging can be used to predict stability of the Lisfranc complex and subsequent determine the treatment plan. Gold standard for testing instability is the intra-operative stress testing. The objective of this study is to determine whether the number and type of fractures on CT imaging can be correlated with the stability.

**Material and method(s):** Retrospective analysis of 36 subsequent patients between 2007 and 2014 with a Lisfranc injury through CT scan (coupes 0.7-1mm), 18 women and 17 men, median age 42 years (13-84 years). After standard radiographs and CT scanning, a weight-bearing radiograph or intra-operative stress testing evaluated stability. One-way ANOVA and Chi-Square test was used.

**Results:** After stress testing 10 injuries were classified stable and 26 injuries unstable. There was a significant difference in incongruency on CT scan for stable injuries 3/10, and unstable injuries 17/24 ( $p=0.035$ ). However, in 30% (in)congruency was not correlated with (in)stability. The number of fractures was on average 3.4 (34/10) in the stable group and 4.5 in the unstable group (117/26) (NS). Regarding the localization of the fractures over the tarsal and metatarsal bones, only a significant difference in the involvement of the cuboid was present, 1/10 in the stable group versus 12/26 in the unstable group ( $p=0.046$ ).

**Conclusion:** In conclusion, incongruency on CT scan of the Lisfranc injury is correlated with instability, whereas the number of fractures does not correlate. Regarding the type of fractures the existence of tarsal fractures seems to matter but is not a good predictor for stability in Lisfranc injuries.

#### **09.42 Nailing as a new option in calcaneal fracture treatment**

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<sup>1</sup>Department of Polytrauma, Sklifosofsky Clinical and Research institute, Moscow, Russia; <sup>2</sup>Ural Scientific Research Institute of Traumatology and Orthopaedics, Ekaterinburg, Russia

**Background:** Choice of operative treatment of calcaneal fractures is still a challenge due to high incidence of complications. However poor functional outcomes after conservative treatment enforce orthopaedic surgeons to search new solutions. Minimally invasive surgery can be a key to solve these problems.

**Objectives:** To evaluate preliminary results of calcaneal nailing.

**Material and methods:** Treatment of 36 patients in 2013-2014 with calcaneal fractures was retrospectively analyzed in two trauma centers (UNIITO and NIISP). 42 operations of calcaneal nailing were carried out. All patients were treated according to the same protocol. Mean age was 40.4 and 32,6 years old. There was a difference in fracture morphology between two groups (Sanders III, IV in UNIITO serie and Sanders I, II, III (1 patient) in NIISP serie). 4 of 6 in NIISP serie had polytrauma.

**Results:** No infection complications, skin necrosis or loss of fixation noted in both series. Union achieved in all cases.

**Conclusion:** Due to short period of follow up, only preliminary results are available. There was a trend to low infection rate and good mechanical stability. Nailing of calcaneus appear to be safe and effective alternative to classic methods.

#### **09.52 Absorbable polydioxanone suture provides fewer wound complications in acute tendo-achilles rupture repair**

Baig M.N., Din R.

Department of Orthopaedics, Kerry General Hospital, Tralee, Ireland

**Background:** We prospectively studied acute Achilles tendon rupture in patients over a 2 year period and reviewed the causes, clinical outcomes and complications.

**Method:** There were 53 consecutive patients included in our study, who attended a district general hospital with an acute Achilles tendon rupture. We prospectively collected their bio-data, medical history, cause of injury and mode of treatment. They had a minimum follow up period of 6 months, clinical outcome was measured using Boyden score and complications incurred were recorded.

**Results:** We randomised the 53 patients into two groups according to admitting consultant. Out of fifty three 53 Achilles tendon ruptures, 19 patients were repaired using Polyester (Ethibond) and 34 patients were repaired using Polydioxanone (PDS) suture. The functional Boyden score, in the excellent category, was greater for patients treated in the PDS suture group compared to the Ethibond suture group, this was statistically significant  $p<0.05$ .

There were 6 surgical infections of the operative site and all infected cases had a suture repair using the polyester (Ethibond) suture. There were no infections in the polydioxanone (PDS) repair group. This was statistically significant  $P<0.05$ , when the two suture groups were compared for post op infections.



Conclusion: On the basis of this study, we suggest that the surgical repair of the Achilles tendon with monofilament non-braided absorbable suture polydioxanone (PDS) is superior, in respect of lower post-operative wound complications.

		Auditorium Albert
10.30-10.45	Gerhard Küntscher Honorary Lecture	

- 10.30 The development of intramedullary nailing in the United States**  
**Seligson D.**  
*Department of Orthopedics, University of Louisville, Louisville, KY, United States*

The development of nailing in the United States began when repatriated servicemen appeared from the war zone. The first case was done in Boston. Following, the US Military commissioned a study of the method because of its potential strategic interest. American nails were developed by Hansen, Street, Lottes and trialed in comparison to cloverleaf nails. Although Kuentcher visited in Boston and Chicago his method did not gain favor until it was introduced in Seattle by Kay Clawson and then popularized by Hansen and Winquist. American innovations included closed section gundrilled nails.

		Auditorium Albert
10.50-13.00	Pelvis-Acetabulum	

- 10.50 IL Acute management of the haemodynamically unstable pelvic ring injury patient**  
Wanner G.  
*Department of Surgery, Division of Trauma Surgery, University Hospital Zurich, Zurich, Switzerland*
- 11.05 IL Spino-pelvic injuries, surgical treatment options**  
Lehmann W.  
*Department of Trauma, Hand and Reconstructive Surgery, University Medical Center Hamburg-Eppendorf, Hamburg, Germany*
- 11.20 IL Surgical options in pelvic ring insufficiency fractures**  
Rommens P.  
*Department of Orthopaedics and Traumatology, University Medical Center, Johannes Gutenberg University of Mainz, Mainz, Germany*
- 11.35 IL Late results after acute pelvic ring dislocations**  
Holstein J.  
*Department of Trauma, Hand & Reconstructive Surgery, University of Saarland, Homburg, Saar, Germany*
- 11.55 IL Acetabulum fractures in the elderly**  
Peter R.  
*Division of Orthopaedics and Traumatology, Geneva University Hospitals, Faculty of Medicine, University of Geneva, Geneva, Switzerland*
- 12.10 IL New implants for acetabulum fracture fixation**  
Lehmann W.  
*Department of Trauma, Hand and Reconstructive Surgery, University Medical Center Hamburg-Eppendorf, Hamburg, Germany*
- 12.25 IL Periprosthetic acetabulum fractures**  
Jayankura M.  
*Department of Orthopaedic surgery and Traumatology, Erasme University Hospital, Brussels, Belgium*
- 12.40 IL What's new in acetabulum fracture fixation**  
Tosounidis T.  
*Leeds General Infirmary, Leeds, UK*

### 10.50 Characteristics and management of orthopaedic trauma patients in Médecins Sans Frontières trauma centres in Afghanistan and Haiti

Trelles M.<sup>1,2</sup>, Van den Bergh R.<sup>1,3</sup>, Santiago L.<sup>1,4</sup>, Qasemi A.Q.<sup>1,5</sup>, Habibullah S.S.<sup>1,5</sup>, Nyaruhirira I.<sup>1,2</sup>, Dominguez L.<sup>1,2</sup>

<sup>1</sup>Médecins Sans Frontières, Operational Centre Brussels, MSF-OGB, <sup>2</sup>Surgical Unit, Operational Centre Brussels, <sup>3</sup>Operational Research Unit, MSF Luxembourg, <sup>4</sup>MSF-OCB Haiti, <sup>5</sup>MSF-OCB Afghanistan

Injury remains a leading cause of death worldwide, and many cases of trauma are amenable to surgical intervention; however, the vast majority of trauma cases occur in low- and middle-income countries (LMICs). Orthopaedic trauma surgery has been shown to be cost-effective in LMICs, but surgical capacity in such settings remains limited. Here, we assessed whether quality care could be provided free-of-charge to orthopaedic trauma patients in two LMIC settings: the trauma centres of MSF in Kunduz, Afghanistan (an active conflict setting) and Tabarre, Haiti (an urban violence setting).

Routine programme data of patients with fractures admitted through the Emergency Department (ED) from January to April 2015 were analysed.

4,660 cases with fractures were seen in the two EDs. 463(10%) were the result of violent trauma; 830(18%) had open fractures and 63(1%) had mixed open/closed fractures. 1,360(29%) cases were admitted. Out of the admitted cases; 1,025(75%) underwent surgery, accounting for a total of 1,904 interventions (mean 1.9 per case) and 2,529 surgical procedures. The most common procedures were wound debridement (31%) and simple wound treatment (19%) – specific orthopaedic procedures included external fixation (14%), internal fixation (11%), and fracture reductions with plaster and/or traction (11%). 136(10%) cases required stabilisation in the intensive care unit (ICU). Physiotherapy was offered in ICU and in general hospitalisation: 74% of all patients in both services benefited from physiotherapy.

Mean pain reduction on a 1-5 scale was 0.7 and mean functional recovery of upper and lower limb (0-100 score, 50/50 for upper/lower limbs) was 5.6. Overall, out of all hospital exits over the study period (n=1,231) 1,159(94%) were discharged, 16(1%) were referred, 33(3%) died, and 23(2%) defaulted.

By providing minimum quality standards free-of-charge, it is possible to have good outcomes in orthopaedic trauma care in LMIC.

### 10.57 Treatment and outcomes of periprosthetic fractures after total knee arthroplasty multicentre retrospective analysis of 56 cases

Kyriakidis T.<sup>1</sup>, Tsiridis E.<sup>2</sup>, Zorman D.<sup>1</sup>

<sup>1</sup>C.H.U. Tivoli, Orthopaedic Department, La Louvière, Belgium; <sup>2</sup>Academic Orthopaedic Unit "Papageorgiou" General Hospital, Aristotle University Medical School, Thessaloniki, Hellas

**Introduction:** The periprosthetic supracondylar fractures is a relatively rare, but very demanding complication of TKA. Retrograde supracondylar nails and locking plates are the two main osteosynthesis procedures to treat such fractures with controversial results. The aim of this study is to compare the outcomes obtained from these treatment modalities, regarding fracture healing, functional results and treatment related complications. **Materials and Methods:** In this retrospective multicentre analysis, 56 supracondylar periprosthetic knee fractures, treated by internal fixation between January 2003 and December 2013, were reviewed and analysed. Thirty cases were treated by locking plates whilst 26 by retrograde nails. Out of the latter, 14 underwent the traditional intramedullary technique and 12 the nailed cementoplasty.

**Results:** The median of the union time for the group of nails was 6 months while for the plates it was 4,5 months without statistical significance (p=0.878). No difference was found either between the median values of the cemented and uncemented nails with 5 and 6 months respectively (p=0.297). Postoperative flexion was similar between the two main groups (p=0.432) as well as between the cemented and uncemented nails (p=0.160). No statistical correlation was found for the Oxford Knee Score neither between the two main groups (p=0.919) nor between the groups of cemented and uncemented nails (p=0.813). There were three delayed unions or non-unions in the retrograde intramedullary nail group, whilst eight were found in the locked plate group (p=0.785).

**Conclusion:** Plates and nails could equally treat Rorabeck and Taylor's Type I and II fractures as long as they are applied properly to allow healing. Locking plates lead to faster union compared to nails and are usually applied in younger patients. Intramedullary nails augmented with cement increase stability and healing capacity compared to uncemented nails.

#### 11.04 Periprosthetic fractures of the femur - Shift of the treatment paradigm?

Chelnokov A.<sup>1</sup>, Piven I.<sup>1</sup>, Shlykov I.<sup>1</sup>, Piastopulo K.<sup>1</sup>, Semenistyy A.<sup>2</sup>

<sup>1</sup>Ural Scientific Research Institute of Traumatology and Orthopaedics, Ekaterinburg, Russia; <sup>2</sup>Hospital N 13, Moscow, Russia

**Introduction:** Current treatment of fractures around hip implants has focused on locked plating in well-fixed stems, and revision to a long stem combined with plates, cerclage and grafting, or even total femoral replacement in loose stems. These treatment modalities are invasive, expensive, and result with high complication and reoperation rates.

**Aim of our study** was to design a technique of less invasive intramedullary fixation in periprosthetic fractures and deformities of the femur to provide primary stability of the stem and the femur.

**Methods:** We designed a modification of an industrial solid titanium femoral locked nail. Its design provides tight fit of the distal part of the femoral stem. The nails were individually custom-made to fit the particular stem design and size. Since 2007, fixator-assisted internal fixation was used in the treatment of 71 femoral periprosthetic fractures: Vancouver B1 - 23 cases (8 cemented), Vancouver B2 - 24 (2 cemented), B3 - 17 (3 cemented), C- 7 (2 cemented). Simplified Ilizarov frames were used to gain alignment and length acutely in 63 cases or gradually (5 - 14 days) in 8 cases. In 29/41 case (5 cemented) of B2/B3 fractures femoral stems were subsided 10 mm and more.

**Results:** Frame application allowed to restore length and alignment of the segment in all 30/71 cases of stable stems (B1 and C). With fixator-assisted nailing it appeared attainable to reduce subsided stem position relatively to the major trochanter and the acetabulum in all 29/41 cases. In 9 of them also acute lengthening of the femur was performed to 1-3,5 cm.

Three frame types were defined depending on two factors: injury type according to Vancouver classification, and position of the stem tip inside or outside medullary canal.

64 patients (90%) were available for follow up in 1 year. 62 healed (4 after secondary procedures). Two have asymptomatic nonunion. In 32 cases of non-cemented loose stems available for follow-up healing occurred along with intact distal locking screws up to 6 years of observation which was recognized as reintegration of the stem. There were no signs of stem loosening revealed in all cases (24) of subsided non-cemented stems that were reduced. In loose cemented stems where reintegration can not be expected elective revision was performed with use of primary femoral stem (3/5), and two patients with low functional demands are being observed. Major complication included 2 case of deep infection (two stage revision was performed) and 2 cases of slim stem breakage treated with revision to a long stem. All these complications occurred in patients with cemented stems.

**Discussion and Conclusion:** For elderly patients with severe comorbidities the technique provides less invasive treatment option with rapid recovery. Immediate unrestricted weight-bearing appears safe regardless of stem loosening. In case of loose displaced stems the presented approach provides not only strong primary fixation but also correction of subsided stem position along with restoration of limb length and alignment. A new option of acute femoral lengthening over existing femoral stem was introduced.

In patients with uncemented loose stems secondary stem stabilization can be expected so formal revision with stem replacement renders unnecessary. So the current approach with plating in stable stems and revision in loose ones can be replaced by the introduced approach in vast majority of cases.

#### 11.11 Atypical periprosthetic subtrochanteric femur fractures during bisphosphonates therapy. A case report

Baig M.N., Rice J.

*Department of Orthopaedics, Kerry General Hospital, Tralee, Ireland*

**Introduction:** Bisphosphonates are a group of medication widely used for postmenopausal and glucocorticoid induced osteoporosis, Paget's disease of bone and malignant hypercalcemia. Bisphosphonates are drugs that inhibit mineralization or resorption of the bone by blocking the action of osteoclasts. In the medical literature there have been reports of increasing incidence of atypical femoral fractures in patients being treated with bisphosphonates.

**Case description:** We report a case of a 82 year old lady who sustained a NOF fracture. She was treated with DHS 2 hole plate for NOF fracture. She came with another low energy fall and had a Vancouver B2 femoral shaft periprosthetic fracture while being on bisphosphonates therapy. Her 2 hole plate was replaced by long 8 hole DHS plate after reduction of fracture. After 4 months of that she came with another periprosthetic fracture with non healing of fracture and was treated with IM nail.

**Clinical relevance and learning point:** Although bisphosphonates play an important role in preventing pathologic fractures in patients with cancer, these subtrochanteric stress fractures associated with prolonged

use of alendronate should not be ignored. Presence of prodromal pain, thickened cortex with cortical beaking may be an early clue for predicting the atypical fractures. High risk patients need periodical skeletal survey and a close follow up for early detection of cases.

#### **11.18 Fixator-assisted nailing with dome-osteotomy enables early full weight bearing in corrective Osteotomy for proximal tibial valgus deformity**

Lee DH., Ryu KJ., Kim HW., Hwang JH.

*Severance Children's Hospital, Yonsei University College of Medicine, Orthopaedic department, Seoul, South Korea*

**Objectives:** Proximal tibial valgus is a relatively uncommon deformity which causes genu valgum. Although they often requires surgical treatment such as proximal tibial varization osteotomy, less-invasive technique designed for minimizing complications from extensive soft tissue exposure has not been tested in the setting of correcting such proximal tibial valgus deformity. We aimed to (1) investigate the ability of this technique to achieve desired alignment correction, and (2) assess the complications associated with use of fixator-assisted less-invasive intramedullary nailing technique in the treatment of proximal tibial valgus deformity

**Methods:** From January 2011 to December 2014, a total of 38 segments of tibia undergoing proximal tibial osteotomy with our fixator-assisted less-invasive technique for proximal tibial valgus deformity were evaluated. No limbs were excluded. During the period in question, no other techniques were used for the same deformity. The surgical procedures included application of a temporary mono-external fixator, dome-shaped proximal tibial osteotomy, correction of deformity, temporary fixation using external fixator, and final fixation with intramedullary nailing. Complications were assessed by chart review and the alignment in both coronal and sagittal planes was compared pre- and postoperatively. Radiographic review to confirm osseous union and alignment was performed by two of the authors not involved in clinical care of the patient. Immediate full weight-bearing was allowed for all patients

**Results:** Overall five segments out of 38 tibiae (13%) showed complications, all of which turned out to be mild anterior knee pain which resolved without leaving any sequel. There was no soft tissue infection. In the coronal plane, the difference between the amount of real correction and the amount of target correction in coronal mechanical axis was  $1 \pm 0.8$  degrees. In the sagittal plane, the difference between pre- and postoperative posterior proximal tibial angle was  $0.4 \pm 0.6$ . All osteotomies healed within 4 months with no delayed or nonunion. There was not any complication from the immediate full weight-bearing after surgery.

**Conclusions:** Fixator-assisted nailing with dome-osteotomy is a valid option for correcting proximal tibial valgus deformity which enables proper coronal and sagittal alignment controls and immediate full weight-bearing. However, comparative studies are necessary to compare it with other techniques.

#### **11.25 Salvage procedures of distal tibiofibular fractures by using a retrograde Expert Tibia Nail**

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Treating a complex tibiofibular fracture is not always simple. Due to concomitant factors such as poor bone quality, soft tissue injuries and co-morbidities standard techniques and implants sometimes fall short.

We report 2 cases of distal tibiofibular fractures treated as a salvage procedure by retrograde insertion of a Expert Tibia Nail (ETN, Synthes ®), designed for antegrade placement. In both cases a regular retrograde arthrodesis implant was deemed too short to provide the required stability.

Patient A, a 92-year-old, frail woman sustained a Grade IIIa open distal tibiofibular fracture. Due to her extremely osteopenic bone, poor soft tissues and extensive comorbidities the leg was stabilized with a retrograde inserted ETN (11x345mm). Because of the fragility of this patient a free flap cover was not an option, therefore the tibia was shortened by 2 centimeter and the wound was closed by transposition of the musculus tibialis anterior. She was discharged after two weeks without fracture related complications.

Patient B, a 34-year-old, woman sustained multiple fractures on all extremities and pelvis. One leg sustained a complex Gustillo grade 3B open two stage intra-articular tibial fracture and closed fractures of the femur, talus, calcaneus and metatarsi. The leg was stabilized with an external fixator after which a temporary arthrodesis of the ankle joint was performed by retrograde placing of a tibial nail (9x375mm ETN). The soft tissues were reconstructed with a free latissimus dorsi muscle flap. One year later a full arthrodesis was carried out and the tibial nail enlarged to an 11 mm nail. The patient is now full weight bearing with good soft tissue cover and complete consolidation of all fractures.

In conclusion one should not hesitate to think in an “out-of-the-box” concept and using unusual procedures to salvage a limb.

### **11.32 Suprapatellar nailing of the tibia and the use of a dedicated trocar sleeve system as a way to avoid cartilage damage in the knee**

Vandesande W., Feyen J., Meeuwssen E., Smits P, Iudicello A., Feyen H.

*Department of Orthopaedic and Trauma Surgery, AZ St Dimna Geel, Geel, Belgium*

The objective of this study was to examine the feasibility of using the suprapatellar (SP) entrance portal to the tibia for every tibia fracture which is amenable for tibia nailing. Can we use this portal in every tibia nailing and can we avoid cartilage damage using a dedicated trocar and sleeve system?

**Material and methods:** For four months, between February and May 2015, all tibia fractures which were amenable for tibia nailing in our institution were done via the SP portal. A total of ten consecutive patients were included in this prospective study. In every case a Synthes expert tibia nail was used and a dedicated trocar for reaming and a dedicated sleeve for insertion of the nail was used. At the beginning and end of each case an arthroscopy was performed of the patella-femoral joint and possible cartilage damage was examined. This study will continue and we expect to have doubled our series at the time of the Kuntschner Kreiss in September 2015.

**Results:** In all cases the suprapatellar portal was perfectly feasible and in no case a conversion to an infrapatellar portal was needed. Going suprapatellar facilitates using the image intensifier in both planes and it is a lot easier to do reduction manoeuvres, Poller screws etc in my personal experience as opposed to nailing through the infrapatellar portal.

Cartilage damage was noted in one case at the time of arthroscopy immediately after the procedure. It consisted of a 5 by 5 mm area of bare bone at the most proximal limit of the patellar trochlear groove which had been damaged by the reamers. We can only explain this complication through lack of attention of holding the trocar sufficiently down during reaming because both trocar and sleeve were intact in that particular case.

**Conclusion:** Use of the suprapatellar portal is possible in every type of tibia fracture, has no adverse effects on reduction and fixation. This approach has the advantage of ease in use over the Infrapatellar approach. Patella-femoral cartilage damage is not seen when using the dedicated trocar and sleeve system correctly. However if the technique is not carried out meticulously, and the trocar is not held firmly down during reaming, cartilage damage in the knee can occur, as I learned the hard way in one case.

### **11.39 A new device for intraoperative bending of intramedullary nails**

Eilers T., Wolf F., Fürmetz J., Thaller P.H.

*3D-Surgery, Department of Trauma Surgery, Ludwig-Maximilians Universität, Munich, Germany*

**Objectives:** In intramedullary nailing - despite precise analysis and planning - the intraoperative result in terms of alignment and/or position may become suboptimal or even insufficient due to various reasons. In such cases, intraoperative bending of the nail might be considered.

**Materials and Methods:** In more than 20 cases, a specially designed, sterilizable bending press has been used with common femoral and tibial intramedullary nails. The bending press fits into standard sterile containers and is able to produce forces higher than 40 kN. Nails up to 15 mm in diameter have been successfully bent. All nails have been customized intraoperatively under sterile conditions and immediately within the operating theater.

**Results:** The intraoperative customization of intramedullary nails has improved or even saved the outcome of the respective surgery. Not a single failure of a customized implant related to the bending process has occurred.

**Conclusions:** Intraoperative customization of intramedullary nails by means of a bending press is a valuable option in specific cases. Detailed knowledge of the material properties and the specific geometry is essential for a successful bending process.

### **11.46 Intraosseous impacted steel sleeves for a minimally invasive approach to the medullar cavity**

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**Objectives:** A set of steel sleeves was designed to protect tissue at the nails entry point in case rigid reamers are used for implantation of lengthening nails. Clinical experience showed, that the steel sleeves could also be applied in several other procedures.

**Materials and Method:** The manufactured instrument set (current version 2.0) mainly consists of a set of steel sleeves with a wall thickness of 1mm, a triple cannulated centering trocar and impaction devices. Basic

principle of the sleeves is their impaction into the bone to protect the tissue at the nails entry point. To illustrate the potential of the system a retrospective case study was performed.

Results: From 07/2009 to 05/2013 the steel sleeve system was used in 94 procedures. It was applied in 47 procedures for the implantation of lengthening nails (femoral antegrade (fa): 22, femoral retrograde (fr): 8, tibial (t): 17), in 25 cases for deformity correction with nails (fa= 4; fr= 5; t= 16), in 18 procedures for complex implant removal (fa= 6; fr=9; t=3) and in 5 cases for treatment of intramedullary infections (fa=1; t=4). Minimally invasive approaches could be realized by application of the steel sleeve system. The dissemination of debris into the soft tissue or into the joints is prevented. There was no case, where its application resulted in complications or prolongation of the procedure. By application of the steel sleeve system, new techniques, e.g. harvesting intramedullary cancellous bone or protected approaches for the treatment of intramedullary infections, could be performed.

Conclusion: The custom-made steel sleeve system was established in our team as an operative standard. Besides the preparation of the intramedullary cavity with rigid reamers, the system offers various options for a minimally invasive approach to the bone cavity of the long bones.

### **11.53 Decreased bone density in geriatric patients does not lead to inferior outcomes after open reduction and internal fixation of tibial plateau fractures**

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*Orthopaedic Surgery, Hospital for Special Surgery, New York, United States*

Objective: It was the purpose of this study to determine if geriatric patients with decreased bone density had worse outcomes after ORIF of tibial plateau fractures when compared to younger patients with greater bone stock.

Materials and methods: A prospective clinical registry of operatively treated tibial plateau fractures by a single surgeon was queried. Procedures were performed between 2003 and 2013 and all patients had a minimum of one-year clinical outcomes scores including Visual Analog Scale (VAS), Knee Outcome Survey Activities of Daily Living Scale (KOSADLS), the Lower Extremity Functional Scale (LEFS), and Short-Form (SF)-36. For patients with preoperative computed tomography scans, Hounsfield Unit (HU) measurements were calculated by two reviewers by creating three regions of interest on consecutive axial slices within the metaphyseal region of the distal femur. Values were averaged to generate a mean HU measurement, which was compared to available bone mineral densities (BMD) for the femoral neck as determined by bone densitometry (DXA). Clinical outcomes and HU measurements were analyzed between geriatric (age > 65) and non-geriatric cohorts.

Results: 93 patients were included: 28 geriatric (mean age = 73) and 65 non-geriatric (mean age 48). Cohorts had similar Schatzker classifications and medical comorbidities( $p>0.05$ ). HU measurements demonstrated an almost perfect interclass correlation( $ICC = 0.97$ ) and correlated with femoral neck T-scores and BMD( $r = 0.6-0.7$ ,  $p < 0.05$ ). HU measurements for non-geriatric patients were significantly greater than geriatric patients (136.4 v. 101.1,  $p < 0.005$ ), and there was no statistical difference seen between the two cohorts with regard to articular subsidence or one-year clinical outcomes.

Conclusions: Using Hounsfield Units as a measure of BMD, geriatric patients do not experience inferior clinical outcomes after ORIF of tibial plateau fractures when compared to younger patients with greater BMD.

### **12.00 Lengthening with one PRECICE nail more than its capacity**

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Background: Intramedullary(IM) lengthening nails generally have mechanisms allowing only expansion( fitbone ISKD). Such nails have the capacity of maximum 8 cm. When a lengthening more than the capacity of the nail is necessary a second osteotomy is made and a new lengthening nail is inserted after the first consolidation phase is completed. The Precise lengthening nail which as magnetic lengthening mechanism has the ability to be shortening after lengthening. This property usually is used in cases of uncontrolled over- lengthening. We present in this paper that it is possible to lengthen an extremity whit one nail more than the nails lengthening capacity.

Case: 37 year old female patient presented to our clinic with 15 cm discrepancy of the left lower extremity. the etiology of the shortening was congenital pseudoarthrosis of tibia in which the union was obtained with a circular external fixator in another center. A succesful arthrodesis of th left ankle of the patient was also made previously. the left tibia was measured as 18 cm and the medulla was measured as 8mm in its narrowest site in the direct X-rays.

according to preoperative measurements a 185 mm x 8.5 mm Precice nail was inserted to the left tibia under anesthesia. A proximal tibial osteotomy and a fibular osteotomy was made. On the postoperative 6th day the

patient was taught to lengthen the nail 1mm per day with the external control unit (ECU) of the Precice nail. the lengthening of the nail was completed on the postoperative 56th day. After that a unilateral external fixator was applied with one Schanz screw to each proximal and distal site of the tibia and the distal interlocking nails of the Precice nail was extracted under anesthesia. the first part of the procedure completed and the patient was taken in in to her room. After that the ECU was programmed to shorten to its initial length. After two days when the nail shortening was completed the distal interlocking screws placed and the unilateral external fixator was extracted under anesthesia. The second lengthening period was completed in 50 days. A total lengthening of 100mm was obtained. The patient is now in the consolidation phase. There is no limitation of the knee range of motion. The decision will be made about the 5 cm residual discrepancy after the consolidation will be completed.

Conclusions: This case showed that the Precise nail mechanism allow shortening after the lengthening is completed and a second lengthening can be performed with the same nail safely. This is the first case in the literature involving limb lengthening with one nail more than its capacity.

## **12.07 Pathologic recurrent fractures on bone cysts in children: a new minimally invasive approach**

Meirlaen S.<sup>1</sup>, Glorion Ch.<sup>2</sup>, Cornu O.<sup>1</sup>, Docquier P.L.<sup>1</sup>

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Objectives: Bone cysts are one of the main pathologic fractures providers in children.

Several minimally invasive treatments have shown equivalent cyst recurrence rates to the invasive techniques. This study challenges a new minimally invasive approach applicable to both simple and aneurysmal bone cysts: Demineralized Bone Matrix (DBM) mixed with autologous bone-marrow.

Material and Methods: The first group, treated in the Cliniques Universitaires Saint-Luc, has been analysed on a prospective basis. Starting September 2008, 8 Aneurysmal Bone Cysts (ABC) and 16 Unicameral Bone Cysts (UBC) received the new percutaneous treatment. The second group, studied on a retrospective basis, comes from the Hôpital Universitaire Necker. ABC were injected with absolute alcohol and UBC with Methylprednisolone Acetate. A third group operated in Paris underwent resection or a combination of both minimally invasive and open approaches. 121 children were selected to compare the injections: 24 from Brussels and 97 from Paris. 58 were identified for inclusion in the open surgical comparison.

Results: Of the 7 ABC, 6 (86%) healed after the first injection versus a 10/61 (16%) ratio reached in Paris ( $p < 0.001$ ). Among UBC, equivalent healing rates (25%) followed the first injection in both hospitals. With the second injection, 7 UBC out of 12 (58%) healed with DBM and marrow compared to 4 out of 21 (19%) in Paris ( $p < 0.02$ ). The patients who underwent one resection as their only treatment healed in 17/38 (45%) of the ABC ( $p < 0.05$  with group one) and in 14/20 (70%) of the UBC (NS).

Discussion: DBM and marrow showed significantly higher healing rates in shorter delays. No fracture recurred in any of the cysts cured with DBM and bone marrow injection. No secondary epiphysiodesis were observed with this percutaneous treatment.

## **12.14 New semi-automatic detection method of joint penetration during triple-screw internal fixation for femoral neck fractures**

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<sup>1</sup>Computer Assisted and Robotic Surgery, Institut de recherche expérimentale et clinique, Université catholique de Louvain, Brussels, Belgium; <sup>2</sup>Service d'orthopédie et de traumatologie de l'appareil locomoteur, Cliniques universitaires Saint-Luc, Brussels, Belgium

Objective: To study the feasibility of a new semi-automatic detection method of joint penetration during triple-screw internal fixation of femoral neck fractures.

Materials and Methods: The method uses intraoperative antero-posterior and lateral 2D radiographs and enables the 3D computation of the tip-to-surface distance (TSD) defined as the distance in mm between the tip of an inserted screw and the articular surface of the femoral joint.

Three cases of triple-screw internal fixation of femoral neck fractures were simulated using synthetic bone models. The three TSDs corresponding to each simulated case were computed mechanically using a coordinate measuring machine to serve as reference measurements.

For each case, two operators were asked to perform the manual identification of the three screw tips on antero-posterior and lateral 2D radiographs. TSDs were computed from the manual identifications of the screw tips and the average value (semi-automatic measurements) was compared to the corresponding theoretical

TSDs (reference measurements). Correlation coefficient between the two operators was computed.

Results: Correlation coefficient between the two operators who identified the screw tips for the three simulated cases was 0.99. Mean difference between reference and semi-automatic measurements was  $0.72 \pm 0.51$  mm. All penetrating screws have been detected. No unpenetrating screw was considered as a penetrating screw.

Conclusions: This study showed the feasibility to detect joint penetration during simulated internal screw fixation of femoral neck fractures by using 2D radiographs to identify the position of the inserted screw tips and compute the 3D distance relative to the articular surface of the hip joint. These results have to be validated clinically, and may be useful to assess the level of accuracy the detection method needs to be provided with, particularly in terms of the screw tip identification performed intraoperatively by the operator.

#### **12.21 Superior outcomes after patella fracture fixation with a novel cage plate construct: a prospective cohort study**

Warner S.J.<sup>1</sup>, Lazaro L.E.<sup>1</sup>, Thacher R.R.<sup>2</sup>, Sauro G.<sup>2</sup>, Garner M.R.<sup>1</sup>, Helfet D.L.<sup>1</sup>, Lorich D.G.<sup>1,2</sup>

<sup>1</sup>Orthopaedic Surgery, Hospital for Special Surgery, New York, NY, USA; <sup>2</sup>New York Presbyterian Hospital - Cornell, New York, NY, USA

Objectives: The purpose of this prospective cohort study was to determine if a new patella fracture fixation construct resulted in improved clinical and functional outcomes compared to tension band techniques.

Materials and methods: A prospective cohort study was performed on consecutive patients with isolated, unilateral patellar fractures. During the initial study period, patients were treated with traditional tension band constructs. During the subsequent study period, a novel cage plate construct was used that spans half of the patella circumference laterally and provides multiplanar fixation through a low profile plate. Thirty patients treated with a tension band and eleven patients treated with the novel cage plate construct were included in the study. Subjective clinical outcomes and objective functional and strength outcomes were collected at three, six, and twelve months postoperatively.

Results: The two cohorts had similar baseline characteristics. Patients with the cage plate construct had clinically and statistically significant superior clinical outcome scores using the Activities of Daily Living Scale of the Knee Outcome Survey (ADLS-KOS) at both three months (58.7 versus 72.2,  $p = 0.016$ ) and twelve months (74.9 versus 84.2,  $p = 0.024$ ). Closed and open kinetic chain functional testing demonstrated significantly better scores in the cage plate cohort compared to the tension band cohort ( $p$ -values  $< 0.001 - 0.045$ ). Thigh circumference difference was significantly decreased at twelve months in the cage plate cohort (1.31cm versus 0.25cm,  $p = 0.007$ ). Anterior knee pain at final follow up was significantly decreased in patients with the cage plate (80% versus 9%,  $p < 0.0001$ ).

Conclusions: In this prospective cohort study, the use of a novel fixation construct with multiplanar fixation and minimal disruption to patella vascularity has led to improved clinical and functional outcomes.

#### **12.28 Local bone density influences clinical outcomes after ankle fracture fixation**

Warner S.J., Garner M.R., Nguyen J.T., Helfet D.L., Lorich D.G.

*Orthopaedic Surgery, Hospital for Special Surgery, New York, NY, USA*

Objectives: Whether bone density alters clinical outcomes after fracture fixation is unknown. The purpose of this study was to determine whether local bone density correlates with clinical outcomes after ankle fracture fixation.

Materials and methods: All patients included in the study underwent operative fixation of an ankle fracture and had preoperative computed tomography (CT) imaging of the injured ankle and postoperative CT imaging of the contralateral ankle. Hounsfield unit (HU) values were determined by placing an elliptical region of interest confined to the cancellous metaphyseal region of the distal tibia and fibula. The primary clinical outcomes included Foot and Ankle Outcome Scores (FAOS). Included patients had at least 12 months of clinical outcomes. Sixty-four patients were included.

Results: Interobserver reliability for HU measurements was almost perfect (ICC = 0.987). Perioperative DXA scores significantly correlated with ankle HU values ( $r = 0.76$ ,  $p < 0.0001$ ). HU values were highly correlated between the injured and contralateral distal tibia ( $r = 0.81$ ,  $p < 0.00001$ ) and fibula ( $r = 0.82$ ,  $p < 0.00001$ ). Decreased HU values of the injured distal tibia significantly correlated with worse outcomes in the FAOS domains of Pain ( $r = 0.29$ ,  $p = 0.02$ ), Activities of Daily Living (ADLs) ( $r = 0.39$ ,  $p = 0.001$ ), Sports ( $r = 0.37$ ,  $p = 0.002$ ), and Quality of Life ( $r = 0.31$ ,  $p = 0.012$ ). In addition, injured distal fibula HU values significantly correlated with FAOS ADLs ( $r = 0.32$ ,  $p = 0.01$ ) and Sports ( $r = 0.25$ ,  $p = 0.046$ ) outcomes.



Conclusions: Our results suggest that decreased local bone density significantly correlates with inferior short term clinical outcomes after ankle fracture fixation. These results could have significant implications for integrating bone density measurements into fracture treatment algorithms and fixation strategies.

### **12.35 Real-time intramuscular pH measurements: overcoming the limitations of intracompartmental pressure measurements in diagnosing acute compartment syndrome**

Johnstone A.J., Elliott K.G.B.

*Department of Trauma & Orthopaedics, Aberdeen Royal Infirmary, Aberdeen, Scotland, UK*

Background: Acute compartment syndrome (ACS) remains an insidious limb and potentially life threatening complication following trauma. The real problem lies in making the diagnosis in a timely fashion so that fasciotomies can be performed before significant irreversible tissue damage has occurred. However, even the most sensitive pressure monitoring systems (ICP) are limited by interpretation of the pressure findings. By comparison, measuring intramuscular pH (IMpH) directly measures tissue ischaemia and is directly quantifiable.

Hypothesis: IMpH is a more sensitive and specific method for diagnosing ACS compared with currently acceptable ICP measures.

Methods: A prospective clinical trial comparing continuous ICP and regular clinical assessment with IMpH monitoring in patients at risk of developing ACS following limb trauma. 62 patients with lower limb injuries (predominantly tibial shaft fractures) underwent continuous monitoring of the affected limb using (i) ICP monitoring, (ii) IMpH monitoring, and (iii) regular clinical monitoring, every 30 minutes. ACS was diagnosed acutely using currently acceptable ICP and /or clinical criteria. In addition, patients were reviewed at 6 and 12 months post-injury to identify previously undiagnosed patients who had features of a missed compartment syndrome.

Results: The difference in IMpH readings between patients with ACS and those without (no acute or long-term evidence of ACS) was highly significant ( $p < 0.001$ ). Whereas, ICP only identified 65% of the patients with ACS (sensitivity of 65% and specificity of 60%).

Conclusions: In terms of diagnostic accuracy, IMpH significantly outperformed all pressure variables (absolute pressure and delta pressure) and had a sensitivity of 95% and a specificity of 80%; considerably better than regular clinical assessment or any pressure variable tested.

### **12.42 Subcutaneous mini-invasive fasciotomy in acute lower limb compartment syndrome: a cadaveric study**

Vandergugten S., Zemmour L., Lengelé B., Nyssen-Behets C.

*Pôle de Morphologie, Institut de Recherche expérimentale et Clinique, Université catholique de Louvain, Brussels, Belgium*

Objectives: Study a less invasive alternative to open fasciotomy in acute compartment syndrome of the leg.

Materials and methods: Acute lower limb compartment syndrome was reproduced by progressive injection of physiologic serum in the anterior compartment of 23 fresh frozen cadaveric legs with monitoring of intramuscular pressure (IMP), in order to reach a maximal stabilised IMP higher than 30 mmHg. Subcutaneous mini-invasive fasciotomy was performed on 14 legs through 5 transversal mini-incisions of the skin (2 cm) along the axis from the tibial tuberosity to the posterior aspect of the lateral malleolus. Standard open fasciotomy was performed on the remaining 9 legs as control. IMP was measured after the skin incisions and after every fasciotomy through skin incisions in the first group and after skin and fascia incisions in the control group.

Results: A maximal IMP of  $43 \pm 9$  mmHg was obtained by injection of  $179 \pm 42$  ml physiologic serum into the anterior compartment of the leg. In the control open fasciotomy group, the skin incision alone did not lower IMP significantly, and fasciotomy lowered IMP to  $10 \pm 3$  mmHg, which is statistically different from maximal IMP ( $p < 0.001$ ). In the subcutaneous fasciotomy group, complete fasciotomy lowered statistically the IMP to  $11 \pm 4$  mmHg ( $p < 0.001$ ), which was not statistically different from the control group.

Discussion: The IMP release after fasciotomy is as efficient through mini-invasive subcutaneous incision as with control open fasciotomy. Our technique seems as effective as previous in vitro study with 10cm long fasciotomy combined with transverse fasciotomy, but even less invasive.

Limitation and Conclusion: Subcutaneous mini-invasive fasciotomy in vitro is an attractive alternative treatment in acute anterior compartment syndrome of the leg, as the IMP decrease is comparable to the open fasciotomy. Those results have to be confirmed for the other compartment of the leg and its feasibility in vivo has to be precised.

## 12.49 Systematic nail removal for mild discomfort: is it acceptable?

Vanden Bulcke D., Tribak K., Putineanu D., Cornu O.

*Orthopaedic and Trauma Department, Cliniques universitaires Saint-Luc, Université catholique de Louvain, Brussels, Belgium*

**Objectives:** The purpose of this study was to evaluate the postoperative course of systematic intramedullary nail removal (INR) with the limited indication of mild pain, barometric changes and/or little discomfort.

**Patients and methods:** Between January 2010 and January 2015, we identified 50 INR for mild pain and little discomfort. Benefit of INR was assessed by questioning the patients on their satisfaction and complications after INR and if they will consider to redo the surgery in such a case. Medical files were reviewed for any complication and to identify risk factors for complications.

**Results:** 33 patients answered the survey. 27 (82%) would not hesitate to repeat this procedure, while 6 (18%) sincerely regret having removed the nail. Postoperative complications were observed in 6 (12%) of the 50 patients. Only 3 (6%) intraoperative fractures were registered. 1 patients needed new fixation while the others were treated conservatively to healing. Two others complained of persistent pain. One infection (2%) was observed and needed wound debridement and antibiotics for 3 weeks. 30 (61%) patients reported subjective improvement after 4 weeks. No factor was identified to be associated with complication or persistent pain

**Conclusion:** INR should not be undertaken lightly due to potential severe complications, ranging from 5% to 17%. While 61% of the patients rapidly expressed a benefit and 82% would redo the surgery on a long term, 18% regret it and two (4%) were complaining of higher pain than the pain experienced before INR. We were not able to identify factors that should predict INR evolution. Therefore systematic INR should be discussed carefully with the patients weighing the potential benefit and the related costs and potential complications.

Auditorium Albert

14.00-16.00

Femur-Proximal

### 14.00 IL Keynote Lecture

#### Proximal femur fractures; what is evidence

Rommens P.

*Department of Orthopaedics and Traumatology, University Medical Center, Johannes Gutenberg University of Mainz, Mainz, Germany*

### 14.25 IL Stabilization of femoral neck fractures with the Targon FN

Gruszka D.

*Department of Orthopaedics and Traumatology, University Medical Center, Johannes Gutenberg University of Mainz, Mainz, Germany*

### 14.50 IL Do we still need the Regazzoni's DHS plate

Anthonissen J.

*Department of Orthopaedics and Traumatology, University Medical Center, Johannes Gutenberg University of Mainz, Mainz, Germany*

### 15.05 IL Reversed obliquity fractures; value of cerclage

Hofmann A.

*Department of Orthopaedics and Traumatology, University Medical Center, Johannes Gutenberg University of Mainz, Mainz, Germany*

### 15.20 IL Nailing of subtrochanteric fractures

Pairon P.

*Department of Orthopaedics and Traumatology, University Medical Center, Johannes Gutenberg University of Mainz, Mainz, Germany*

### 15.32 Influence of rotation and micromovement stable fixation on the failure rate of medial femur neck fracture osteosynthesis

Friedl W.

*Klinikum Aschaffenburg, Unfallchirurgie, Orthopädie und Handchirurgie, Aschaffenburg, Germany*

The hypothesis of these studies is that the instability of fracture fixation which allows micro movements is an important factor for the high failure rate of medial femur neck fracture osteosynthesis independent from osteoporosis, disturbed blood supply and high biomechanical load.

**Material and Methods:** from 1982-1992 85 patients with medial femur neck fractures were treated with 3 to 4 screw fixation and 46 with a 130o plate from whom 65 could be re-examined retrospectively up to 10 years after operation. In a second group 134 patients treated from 1999 to 2004 with the Gliding nail (GN) which is a intramedullary implant with a gliding femur neck component with a rotation stable I beam profile plate which is impacted and not inserted after bone removal as in screw systems (local bone graft effect) .

**Results:**The late complication rate in the screw group was 32,5% and in the 130o plate 52%. Pseudarthrosis with 10.8%, cutout and implant dislocation were observed in 13,9% and head necrosis and arthritis occurred in 15.4%. There were no complications in the 9 Pauwels I (Garden I and II) but 61% in type II(Garden III) and 36% in type III (Garden IV) fractures. In 34 % a hip prosthesis was implanted after complications occurred.

In the GN treated patients only one pseudarthrosis (0,7%) and in 8.2% head necrosis occurred. In total 10.4% secondary prosthesis had to be implanted. Surprisingly there was nearly no difference between the rate of failure and secondary hip replacement in Pauwels I to III fractures

**Conclusions:**The rate of complications after medial femur neck fractures is only in part dependent from the disruption of blood circulation.

#### **15.44 Coexisting glenohumeral arthritis increases proximal humerus fracture nonunion after nonsurgical treatment**

Nickel B.T., Klement M.R., Bala A., Zura R., Garrigues G.E.

*Departement of Orthopaedic Surgery, Duke University, Durham, NC, United States*

**Objectives:** Nonunion rate is estimated to be 1.1% to 10% following closed treatment of proximal humerus fracture, and the risk factors for this complication are poorly understood. The purpose of this study was to evaluate proximal humerus fracture nonunions and the association with coexisting ipsilateral shoulder arthritis.

**Methods:** A search of the United States Medicare database from 2005 to 2012 was performed using ICD-9 codes to identify the comorbidities and rates of nonunion. 38,754 patients sustained a proximal humerus fracture including 13,802 with coexisting ipsilateral shoulder osteoarthritis (OA) and 24,952 with coexisting diagnosis of rheumatoid arthritis (RA). A cohort of 301,987 patients who sustained a proximal humerus fracture without arthritis served as a control. Postoperative complications at 3 months, 6 months, 9 months, and 1 year after fracture were compared between the two cohorts. Incidence, Odds Ratios (OR), and 95% Confidence Intervals (CI) were calculated in comparison to the control group.

**Results:** Delayed union rates were increased in the OA and RA groups at 3 and 6 months: 0.79% (OR 2.74,  $p < 0.001$ ) and 1.74% (OR 2.18,  $p < 0.001$ ), and 0.67% (OR 2.3,  $p < 0.001$ ) and 1.86% (OR 2.33,  $p < 0.001$ ), respectively; the control cohort incidence was 0.29% and 0.81%. Non-union rates were increased in the OA and RA cohorts at 9 months and 1 year with incidences of 2.39% (OR 2.14,  $p < 0.001$ ), 2.89% (OR 2.18,  $p < 0.001$ ), and 2.59% (OR 2.33,  $p < 0.001$ ), and 3.08% (OR 2.33,  $p < 0.001$ ), respectively; nonunion in the control cohort at the same time points were 1.13% and 1.35%.

**Conclusion:** To our knowledge, this is the first study investigating this association of shoulder OA and RA and proximal humerus fracture outcomes and we report its coexistence more than doubles the odds of nonunion.

### **Auditorium Albert**

**16.30-17.45**

**Femur**

#### **16.30 The role of plastic screws in intramedullary nailing of long bones**

Onyekwelu I., Falls T., Seligson D.

*Department of Orthopedics, University of Louisville, Louisville, KY, United States*

**Introduction:** The use of plastic-bioabsorbable screws in intramedullary (IM) nailing of long bones affords valuable advantages over its metal counterparts. However, its use is yet to gain widespread acceptance in the orthopaedic community. As such, the literature on plastic screw technology and its applications is scarce. To this end we provide a brief background on the composition, indications and unique clinical benefits of plastic screws in the context of IM nailing.

- **Composition:** They are made up of bioabsorbable polymer composites, lactic/glycolic acid copolymers, which are safely metabolized in vivo to alpha hydroxy acids.
- **Mechanical properties:** they possess an elastic modulus with a close resemblance to that of cortical bone. As such, reduces the risk of stress shield and peri-implant loosening from stress loads and has unique compressive properties along its width and long axis.
- **Special indications:**

- Poller/Snub screw (blocking screw)
- Independent intercondylar screw
- Auto-dynamization
- Narrow the effective diameter of the canal in the metaphysis

Case Report: A 34 yr old Male pedestrian was struck by a motor vehicle and sustained a closed left proximal Tibia and Fibula fracture with a relatively short proximal tibia segment- valgus angulation and apex anterior displacement. Treatment: Intramedullary locking nail of the tibia with proximal segment plastic snub screws.

Learning Points: Patient Selection, operative techniques and contingency plans

#### **16.40 Intramedullary fixation with a third generation nail in complex fractures in proximal femur**

Tzachev N., Ivanov N., Hariskov N., Iotov A.

*Department Orthopaedic and Trauma, Military Hospital, Sofia, Bulgaria*

Aims: Complex femoral fractures are pertrochanteric fractures with added basicervical fracture of the femoral bone or such with subtrochanteric component. This type of fractures are caused by high energy trauma of young people or home incidents with elderly patients with poor bone quality. Intramedullary fixation offers the theoretical advantage of a shorter lever arm with a more stable construct. This has to some extent been confirmed in biomechanical studies. In addition intramedullary fixation can often be undertaken with smaller incisions and less soft tissue disruption, which may result in less blood loss, reduced incidence of infection, less postoperative pain, faster rehabilitation and fewer non-unions (biological fixation).

Materials & Methods: For a 15 year period-Retrospective evaluation of 37 patients. Average age of 55 years. These were: women - 12, men – 25 (14 patients - home incidents, 11 after crash accident, 8 after high falling trauma and 4 sport (ski) trauma. We had 9 patients with polytrauma. We used second generation implants with 4 patients - IMHS and Reconstructive Russell-Taylor nails. With 33 patients third generation implants were used - Versanail, PFNA and Fi nail. The mean operative time was 78 min. The average consolidation time - 15 weeks. In 12 of the cases open reposition of the fractures and a fixation with a screw, plate or cerclage were needed.

Results: We did not have incidents with pulmonary embolia, infection and deep vein thrombosis. We had one case of migration of the antirotation sleeve with IMHS, which led to 20 degree varus deformation. We didn't have cases of implant cut-out or non-union. One case with lower extremity short with 1 cm. One with intraoperative fractures of femoral diaphysis (In both cases we used Reconstructive Russell-Taylor nail). We followed up 37 (100%) of patients to bone union: excellent – 32 (86 %) and good – 5 (14 %). We use Sanders Trauma Hip point scale.

Conclusion: Cefalomedullary nails as osteosynthesis device offer excellent stabilization and the biological advantages of intramedullary nailing. The technical complications that we had with the second generation nails were avoided with third generation. The locked reconstruction femoral nail permitted adequate fixation of unstable proximal femoral injuries in the elderly patients.

#### **16.50 Autodynamic nailing**

Seligson D., Polley N., Zamora R., Craig Wright C., Maniar H.

*Department of Orthopedics, University of Louisville, Louisville, KY, United States*

With the common use of small calibre nails (8-12mm) interlocking with metal screws proximal and distal is performed to provide axial and rotational stability. Particularly with simple, transverse fractures minor mismatch between the free-hand distal screws can create separation at the fracture site and delay healing. We have substituted bioabsorbable plastic screws for metal distal interlocking screws to allow these fractures to settle and heal.

In isolated simple transverse fractures of the femur and tibia distal free-hand interlocking is done with solid 4.5mm fully threaded bioabsorbable screws after manual fracture impaction. The patients are allowed to weight bear as tolerated. In the first five cases there have been no problems with rotational instability and the fractures have gone on to prompt healing.

In stable transverse fracture types, the use of plastic screws for distal interlocking appears a promising method to provide adequate stability and avoid delayed healing.

#### **17.02 Results of distal femoral fracture with plate osteosynthesis**

Aktuglu K., Colak T., Ozkayin N

*Department of Orthopedic And Traumatology, Ege University, Izmir, Turkey*

Objectives: In this study we analyze that the results of osteosynthesis of distal femur with different type of plates retrospectively.

Material and methods: 69 patients with 74 extremities were analyzed who had applied Ege University

orthopaedics clinic between 2000-2013 with distal femoral fracture. Average age of patients were 48 (18-93) years. 30 (%43.5) of patient were men 39(%56.5) of patient were women. Distribution of fracture types made by AO classification. According to this 5(%7.2) extremity A1, 11(%16.9) extremity A2, 17(%24.6) extremity A3, 1(%1.4) extremity B1, 1(%1.4) extremity B3, 8(%11.6) extremity C1, 21(%30.4) extremity C2, 10(%14.5) extremity were C3 type fractures. Average follow up time was 45.44 (1-130) months. 1 patient died on postoperative second day. We grouped patients with the type of the plates. Anguler plate- group1, double plates-group2, anatomic locking plates-group3, dynamic condylar screw group4. Periprosthetic fractures were eliminated from study.

Results: There were 20(%29) patients in group1, 4(%5.8) patients in group 2, 43(%62.3) patients in group 3, 2(%2.9) patients in group 4. 60 (%87) fracture united. Rate of union in group1 was 17(%85), in group 2 4(%100), in group 3 37(%86) and in group 4 2(%100). We determined implant failure in group1( 2 patients) and group3 (1 patient). 10 patients had angulation in radiologic imaging. Allogenic bone grafts were used at 7 patients. 1 patient had osteomyelitis in our studies.

Conclusions: Distal femoral fractures are hard to treat because of narrowing the knee joint. Anguler plates and new generation anatomic locking plates were used in our study. Although the hardness of implementation of anguler plates, they are good at maintenance of fracture stability. On the other hand anatomical locking plates are easy to use, moreover they are good at stabilizing with lockin screws. We claim that the type of fracture and damage of articular surface are main significant factors that affect the results more than implant type.

### **17.14 Double plating for supracondylar femoral fractures**

De Roo K.<sup>1,2</sup>, Oosterlinck D.<sup>2</sup>, Putzeys G.<sup>2</sup>

<sup>1</sup>Department of Orthopaedic Surgery & Traumatology, University Hospital Ghent, Gent, Belgium;

<sup>2</sup>Department of Orthopaedic Surgery & Traumatology, AZ Groeninge Kortrijk, Kortrijk, Belgium

Introduction: The treatment of supracondylar femoral fractures remains very challenging, with non-union rates up to 20%. (1)

The purpose of this study was to review our results with the use of a lateral condylar plate in combination with a medial buttress plate for the osteosynthesis of unstable supracondylar femoral fractures.

Methods: Between January 2013 and December 2014, 10 patients had a supracondylar femur fracture treated with open reduction and double plating. The average age was 75 years (range, 60-91). Two were lost at follow-up, one patient deceased one month postoperatively.

Six suffered from a fracture proximal to a total knee arthroplasty.

Fractures were classified according to the AO system. Two fractures were type 33.A3.2, 3 fractures 33.A3.3, one 33.A1.2 and one 33.A2.2.

Results: The patients were followed until fracture union and full weight-bearing was achieved. Six out of the 7 fractures healed at last follow-up visit (mean follow-up: 7 months). One did not show sufficient callus on last CT-scan and is still followed. One showed symptomatic lateral hardware.

Mean range of motion of the knee was 4 degrees extension deficit and 110 degrees flexion. 1 patient was ambulatory without aid and 6 with an ambulatory aid. At last follow up 3 patients were categorized as 'as good as before', 2 as 'satisfactory', 2 as 'good preliminarily but revision surgery later' and no as 'dissatisfactory'.

Conclusion: In this small group union was seen in 6 out of 7 patients at a mean follow up of 7 months, with no important complication due to the additional medial plate. Preliminary results showed good mobility and stability with partial weight-bearing for transfers possible immediately post-operatively. Further patient enrolment is needed to confirm these findings.

### **17.24 Complications of intramedullary nailing of trochanteric fractures using the Stryker®**

**Gamma3 TM trochanteric nail. One-year experience**

Cherchi L., Ehlinger M., Taglang G., Adam P., Bonnomet F.

Service de Chirurgie Orthopédique et Traumatologique, Strasbourg University Hospitals, Hôpital de Hautepierre, Strasbourg, France

Introduction: One of the means of fixing a trochanteric fracture is intramedullary nailing using the Stryker® Gamma3 TM trochanteric nail. The aim of our study was to assess the complications associated with this osteosynthesis.

Materials and Methods: We have retrospectively analyzed the trochanteric fractures, classified as 31A in the AO classification, treated with intramedullary Stryker® Gamma3 TM trochanteric nail in our institution in 2011. Clinical and radiological data of 333 patients with a mean age of 82.5 years has been analyzed at a mean time of 25.6 month from the fixation, looking for complications during the initial hospital stay, and for later

mechanical complications.

Results: 25% of the patients were affected by at least one complication.

Medical complications during the hospital stay occurred in 60 patients (18%). Mortality rate was 3.3% during initial hospitalization, 41% at 25.6 month.

Surgical complication rate was 7.2% (n=24) or 8.7% (n=29) including peroperative technical errors; mechanical complication rate was 6.6% (n=22). They consisted of secondary femoral fractures (n=6, 1.8%), technical errors with inappropriate reduction and bad implant positioning (n=4, 1.2%) or peroperative femoral head transfixation with the cervical screw (n=1, 0.3%), secondary displacement with "cut-out" (n=5, 1.5%) and without "cut-out" (n=2, 0.6%), non-union (n=3, 0.9%), locking screw breakage (n=3, 0.9%), aseptic femoral head necrosis (n=3, 0.9%), infection (n=1, 0.3%), hematoma requiring a reoperation (n=1, 0.3%).

"Cut-out" was associated with bad cervical screw positioning and insufficient reduction on the profile X-ray.

Conclusions: Our complication rates are close to those found in previous studies concerning intramedullary nailing with Gamma TM nails and other implants. Main complications are mortality and secondary femoral fractures.

### **17.34 IlluminOss® is a new percutaneous intramedullary rod osteosynthesis using a polymerized monomer – A case series on patients with wrist fractures**

Klitsie P.J., Vegt P.A.

*Department of Surgery, Albert Schweitzer hospital, Dordrecht, The Netherlands*

Objectives: The frail, elderly patient with a displaced wrist fracture is generally treated with a cast. Restricted use of their wrist reduces the ability to return home. Photodynamic bone stabilization system (PBSS) is a new technology for intramedullary rod osteosynthesis. Following fracture reduction and stabilization, a balloon is inserted through a 8mm incision and positioned intramedullary, across the reduced fracture. The balloon is infused with biocompatible liquid monomer and cured into a polymer using a visible light curing system to form a strong, hardened bone-stabilizing rod. Application of PBSS enables patients to use their wrists from day one after surgery. The aim of this study is to evaluate the potential advantages and hazards of PBSS in wrist fractures.

Material and Methods: From July 2012 till April 2015 all patients with a wrist fracture operated with PBSS were selected. Follow up was performed in the outpatient clinic up to 2.5 years. Postoperative treatment for distal radius fractures consisted of a pressure bandage and unrestricted use of their wrist as tolerated. Postoperative treatment for distal forearm fractures consisted of two weeks softcast.

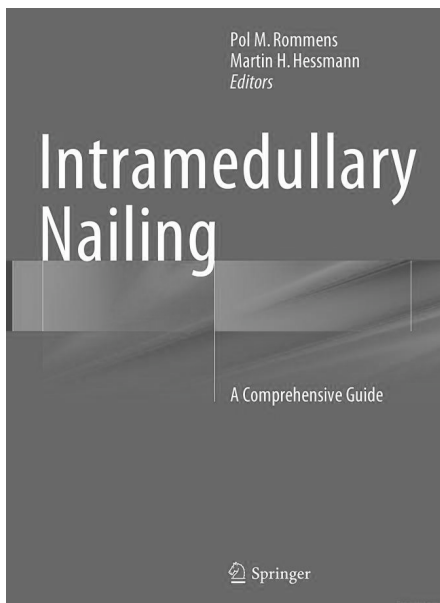
Results: 42 fractures in 38 patients were operated using PBSS. 21 Patients had an isolated distal radius fracture. Five patients had bilateral distal radius fractures. Twelve patients had distal forearm fractures. Patients were operated using PBSS. All patients demonstrated complete range of motion within three months. There were no infections, secondary procedures, or delayed unions.

Conclusion: PBSS (IlluminOss®) is a new intramedullary percutaneous technique enabling early mobilization to regain their independency. Patients showed low pain postoperatively and quick recovery.

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**Rommens PM, Hessmann MH.**

**Intramedullary Nailing.**

**A comprehensive guide**

This book contributes to the enhancement of fundamental and practical knowledge in the treatment of fractures, healing disturbances and bone disorders with intramedullary nailing. It promotes this biological and mechanical outstanding technique for appropriate indications and ameliorate the standard of care for those patients, who can profit from intramedullary nailing. Orthopedic trauma surgeons from all over the world, who work in the most different circumstances and with the most diverse technical and logistical equipment, will find this book to be an essential resource and guide for their daily practice with intramedullary nailing.

**See also:**

**<http://www.springer.com/medicine/orthopedics/book/978-1-4471-6611-5>**

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