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Annual Meeting



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ABSTRACTS

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General information

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Hosting society

Gerhard Küntscher Society

Congress president

Peter H. Thaller, MD
Leading Consultant – 3D-Surgery
Department General, Trauma and Emergency Surgery
University Hospital LMU Munich
Nußbaumstraße 20 | 80336 Munich/DE

Academic organising committee Munich

Dr. med. Nikolaus Degen
Dr. med. Julian Fürmetz
Dr. med. Florian Wolf
Priv. Doz. Dr. med. Christian Zeckey, MHBA

Professional congress organiser

Conventus Congressmanagement & Marketing GmbH
Maria Pechtl
Carl-Pulfrich-Straße 1 | 07745 Jena/DE
Phone +49 3641 31 16-354 | Fax +49 3641 31 16-243
www.conventus.de

Final credits of the Congress president

Dear Members, dear Friends of the Gerhard Kuentscher Society!

Your contributions made it possible to set up our yearly meeting in Munich with participants from 20 countries around the world. Thus we could arrange an ambitious three days scientific programme and exceptional workshops. Three outstanding scientific studies were awarded in oral and poster presentations. The meeting was surrounded by inspiring social events and finally, the next day by a delightful visit to the world famous Oktoberfest.

We are looking forward to another animating Osteosynthese International Meeting 2018 in Poznan.

Peter H. Thaller

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IL 01 – Abstract not submitted

Session IV – Foot and ankle

IL 02

The retrograde circular arc interlocking nail for tibio-talo-calcaneal correction arthrodesis

T. Mittlmeier*¹, K. Klaue²

¹Rostock University Medical Center, Dept. of Trauma, Hand and Reconstructive Surgery, Rostock, Germany

²Clinica Luganese Moncucco, Dept. of Orthopaedic Surgery and Traumatology, Lugano, Switzerland

Introduction: Normal anatomy demonstrates that the alignment of the heel, the posterior subtalar facet, the talus, the ankle joint and the distal tibia corresponds to a circular arc. The purpose of the study was to optimize the technique to stabilize the hindfoot in anatomical alignment. Most presently available nails for retrograde hindfoot arthrodesis force the hindfoot into an unphysiological position which might be one of the reasons for an inferior functional outcome of this procedure.

Methods: An instrumentation was designed to create a circular arc bore hole crossing the heel, the posterior subtalar facet, the tibio-talar joint and the distal tibia metaphysis called the Arc-X nail.

The corrected and definitive position and orientation of the hindfoot was fixed temporarily intraoperatively with Kirschner wires. A guiding frame was fixed to three critical spots of the hindfoot to drill the central hole which crossed from lateral to medial and from posterior to anterior in analogy to the orientation of the trajectories of the trabecular bone. Employing a fluoroscope the hole was bored using a motor driven end cutting flexible reamer which is seated within a rigid curved hull. The nail has the same shape than the hull and is impacted up to the distal tibia. The nail allows for eventual secondary impaction without losing full contact with the surrounding bone.

27 patients have been treated so far using this technique. The patients were treated for 2 weeks post-operatively with a closed circular lower leg cast allowing for heel contact to the floor. After 2 weeks our patients did practise partial to full weight bearing using a cam walker or crutches for further 6 weeks.

Results: The mean follow-up is 12 months, now we lost 4 patients for follow-up. 3 patients deceased between 12 days and 2 years 8 months post-operatively for reasons not related to the surgical intervention. We registered 3 breakages of the tibial locking screw which allowed for more spontaneous impaction along the direction of the nail. All cases went to consolidation without malunion or other complications. One patient still has a rigid supinatus deformity of the midfoot after multiple previous operations. One diabetic patient developed a stable non-union at the midfoot joints. 3 patients underwent recurrent surgery for soft tissue consolidation.

Conclusion: The tibio-talo-calcaneal arthrodesis can successfully be performed using a central circular arc shaped interlocking nail allowing for full form fit between implant and bone. The anatomical bony alignment of the hindfoot is corrected or preserved. Due to the safe and limited approaches, the technique prevents complications such as neurological complications and non-unions. We expect a shorter period of time between surgical fixation and full weight bearing and a better functional outcome compared with current retrograde interlocking nails which do not adequately respect the preservation of an anatomically aligned hindfoot.

IL 04 – IL 08 – Abstracts not submitted.

IL 09

Corrective Proximal Tibial Osteotomy using an Intramedullary Tibial Nail for Genu Varum in Young Adults

K. I. Kim^{*1}, G. B. Kim¹, K. C. Park²

¹Kyung Hee University Hospital at Gangdong, Orthopaedic Surgery, Seoul, South Korea

²Hanyang University Guri Hospital, Orthopaedi Surgery, Guri, South Korea

The purpose of this study was to document results of a less invasive technique of open wedge PTO for varus knee in young adults using an intramedullary tibial nail to ascertain whether correction was possible with this technique and if it can facilitate bony union without changing proximal tibial and patellofemoral anatomy. We prospectively studied 24 consecutive knees in 16 young patients with varus knee deformity. Mean follow-up was 54 months (range, 36-107 months) and mean age of patients at the time of operation was 25.8 years (range, 18-40 years). The open wedge PTO was performed below tibial tuberosity using a percutaneous multiple drill holes technique. Conventional intramedullary tibial nail was used for fixation without bone graft. Radiographic evaluations were made using mechanical alignment, posterior tibial slope angle and Insall-Salvati ratio. We studied with union time, leg length, range of motion, loss of correction, implant failure and associated complications. The level of osteotomy was average 83 mm (range, 75-90 mm) below the joint line. The mean mechanical alignment was significantly changed from -9.6° preoperatively to 1.1° at final follow-up ($P<0.0001$). There was no significant change in proximal tibial anatomy as measured by proximal tibial slope angle and patellar height as measured by Insall-Salvati ratio. All patients achieved radiographic bony union at average 3.1 months without loss of correction. The average increase in leg length was 0.9 cm. The only complication was knee pain due to nail prominence in 3 patients. We found that this technique was a less invasive and effective alternative tool for correction of varus knee in young adults. However, considering relatively high incidence of outlier after correction, this is technical demanding and through preoperative planning is extremely important to determine exact degree of correction, entry point and the trajectory of the nail in proximal fragment.

IL 10

Overview on lengthening nails

P. H. Thaller¹

¹University Hospital LMU Munich, Department General, Trauma and Emergency Surgery, Munich, Germany

The history of lengthening nails is closely related to the developments of distraction osteogenesis (DO) and the progress in intramedullary nailing (IN). Some of the first to successfully apply DO were Alessandro Codivilla (1905) and August Bier (1923). The first to describe IN was Gerhard Küntscher in 1940. The first fusion of DO and IN seems to be the work of Götz and Schellmann with a hydraulic driven nail (1975). The first fully implantable lengthening nail was presented by Bliskunov in 1984. There were more systems to come which mainly diverged in various principles of actuation. We know ratchet driven lengthening nails (Bliskunov, Albizzia®, Guichet®, ISKD®, Betzbone®), electric driven nails (Fitbone® - TAA/SAA) and magnetic driven nails (Phenix®, Precice®). A shape memory alloy driven one (Synoste®) is about to come. Nearly all of those nails are no longer or not freely available. At present the most widespread and freely available implant is the magnetic driven Precice®-System. We have relevant clinical experience with five of those systems. The two Fitbone®-systems were developed in our house (1990). Although both systems are electric driven they have but have substantially different applications. While the TAA-system is a conventional telescoping (pushing) nail, the SAA-system is pulling and thus relevantly stronger. We also gathered relevant clinical experience with the ISKD®, Phenix® and Precice® nails. The lecture presents an overview on all those lengthening nails and especially on the five systems we have applied up to now. There are important advantages and/or disadvantages not only in their actuation but also in nail size (in length and diameter), mechanical stability and reliability of the actuating mechanisms. For each of the five systems various clinical applications with their full follow-up and late results are presented. Finally there will be an outlook on future possibilities.

Session X – Tibia

IL 11

The Kuntscher Legacy in South America

A. Callizo*¹

¹Universidad Nacional de Asunción, Cátedra de Ortopedia y Traumatología, Asunción, Paraguay

This paper reviews the beginning of the South American Chapter of the Kuntscher International Society, a group of enthusiastic South American Orthopaedic Surgeons committed to teach the principles and advances of intramedullary nailing technique in this part of the world. The goals, current and future educational activities are highlighted.

IL 12

Intramedullary nails - extending indications, extending areas

M. Falis*¹

¹Municipal Hospital, Orthopaedic and Trauma Department, Ostrow Wielkopolski, Poland

Introduction: Being on duty, when you hear a diagnosis "shaft fracture of tibia", most probably you immediately link it to the intramedullary nails, mini invasive operation, minimal complications, immediate rehabilitation, short period of work absence and full recovery of mobility. Usually, it is all true – you can find many confirmations of this in literature and published scientific papers. So, if we are able to obtain such good results using intramedullary nail in this particular area of the tibia, why should we not try to extend its use to other areas of the tibia?

Discussion: Intramedullary osteosynthesis of the distal and pilon tibia fracture - why not use of a calcaneal fractures?

If you see X-ray pictures showing the distal tibia fracture, probably you predict problems. The first, and most important question is - what kind of an implant should we choose? There are two well-accepted and effective methods: plate and intramedullary nail osteosynthesis, but each has been historically related to complications. The gold standard is the plate osteosynthesis (MIPO or a classical). However, often encountered issues associated with the use of this method are: healing of the wound, infection, delay of the healing fractures, starting the rehabilitation and weight bearing. Intramedullary osteosynthesis gives a lesser duration of surgery, earlier weight bearing and union rate, lesser incidence of infection and implant irritation. Unfortunately, very common complications associated with use of this method are: malalignment, malrotation and unstable osteosynthesis. Other doubts are present, such as:

- How critical the fibular fracture and its fixation are?
- Does the fibular plating improve the alignment after intramedullary nailing of distal metaphyseal tibia fracture?

In my opinion some of these questions can be answered by the use of Goldzak's Distal Tibia Classification. I got to know this guideline in 2011 during the Osteosynthese International in Thessaloniki, Greece. Mario Goldzak PhD presented this classification during this meeting. Even though it has not been published in any medical press, I use this in my daily practice and I find it very useful as it allows to obtain very good results. Therefore, having received Goldzak's permission, I decided to present it to you now taking as samples clinical cases from my department. The extraarticular distal tibia fracture is a real challenge. Yet, there is something even more challenging – an intraarticular distal tibia fracture and a special type of such a fracture – a pilon fracture. I suppose that diagnosing such cases, you do not think about treating them using the intramedullary nail. However, I recommend using this method in chosen cases. According to Goldzak's classification of DTC, you can try using an intramedullary nail whilst treating cases of the following types: 43 A1, A2, A3, C1 C2 according to AO classification. Try it – it is worth it. One of the greatest surprises in my professional endeavours was the discovery of the possibility of treating very complicated, intraarticular calcaneal fracture by using an intramedullary nail. I could not believe it until the moment in which I got familiar with Guy Uthez's classification calcaneal fractures and operative technic, described by M. Goldzak, P. Simon and T. Mittlmeier. Until today in my department we have performed more than 100

osteosynthesis and 15 subtalar arthrodesis using this method. Recent detailed results will be presented during the next meeting of the Gerhard Kuntscher Society in 2018.

Conclusion: I believe that extending the indication for using the intramedullary nails is a proper solution in many difficult clinical situations. Even though it is true that we are not always able to use the intramedullary nails, we can always consider using them. This very interesting issue of the extending indications, extending areas for the intramedullary osteosynthesis will be the main theme of the next Osteosynthese International 2018 in Poznan, Poland, for which I kindly invite all of you.

Session XI – Wrist and elbow

IL 13

New Multidirectional Angular Stable Plate Fixation in Transcondylar Humerus Fractures (Trochlii Plate)

W. Friedl*¹

¹Orthopedics and Trauma, Aschaffenburg, Germany

Keywords: Distal Humerus, Trochlea Fractures, Trochlii Plate, Surgical Therapy

Introduction The fixation of the Trochlea is very difficult if there is a fracture line between trochlea and medial column and medial epicondyle. All actual plates reach only to the distal level of the medial epicondyle. So fracture dislocation can occur. A direct transverse angle stable fixation of the trochlea and also of the entire articular block in multifragment situations can be performed only with a different plate design which have a 90 degree angulation between the articular block and the medial column fixation.

Objectives We developed a plate which allows a direct transversal multidirectional screw fixation of the trochlea and the articular block and proximal the simple anteroposterior fixation of the medial column and of isolated epicondyle fracture fragments. (Trochlii plate) For the radial column a typical anatomical adapted plate is used.

Methods In a pilot study the Trochlii plate was used in 10 patients. Right and left, small and large plates with short or long length depending on the metaphyseal extension of the fracture were used. So 4 types of plates for right and 4 for left are used. In all cases after open transulnar articular reduction and temporary K wire fixation the plates were fitting anatomically and allowed fixation even in very complex transcondylar impaction fractures. Also very ventral trochlea and capitulum can be fixed with angular stability. The Ulnar nerve is repositioned over the plate because the screw heads are in the plate level.

Results In this pilot study in no case redislocation, instability or infection occurred. In one open fracture a hematoma revision was necessary but healing was uneventful. All fractures showed a stable healing at 6-9 weeks.

Conclusions The new design of the Trochlii plate allows a very stable fixation of very difficult transcondylar, especially trochlea fractures and avoid the joint replacement in these often considered as unreconstructable fractures.

IL 15 – IL 17 – Abstracts not submitted

Session XIV – Free topics

IL 18

Fractures Around The Pelvis, Pelvic Rim and Acetabulum in the elderly

P. Reynders*¹

¹University Hospitals Brussels, Orthopedics, Brussels, Belgium

Introduction: There has been an increase of three fold in the incidence of acetabular & pelvic rim fractures over the past twenty years. Typical injury pattern in this geriatric group is the protrusion of the hip, displacing the anterior column and quadrilateral plate. Often the femoral head is bruised with an indentation of the superomedial roof of the acetabulum.

Methods and materials: We report on 35 geriatric patients with a mean age of 76 years who were operative treated in our institution with internal fixation through a retroperitoneal approach. All fractures

were the result of a low energy trauma, lateral fall. In five cases damage of the acetabulum was without repair. In these cases a percutaneous placed 7.3 mm cannulated screw from the symphysis tubercle and directed in the supra-acetabular region was placed before THP.

Results: Results were often poor because of secondary collapse of the reconstructed acetabular floor and quadrilateral wall. Overall the patients had little discomfort after the retroperitoneal approach. THP (20 patients) was not compromised by the first approach. In 10 cases we saw a temporary sensory deficit in the nervus obturatorius region. In one case we had a thrombus of the femoral artery, which was apparent immediately after surgery and dealt with. Secondary congruence was seen in 10 cases after both column fractures. Their results were satisfactory.

Conclusion: Operating geriatric patients with an acetabular fracture poses some technical difficulties. Reconstruction of the impacted acetabular floor and quadrilateral plate seems difficult because of the partial Resorption of the bone allografts placed in the bone defect seems to be the main reason for the secondary acetabular incongruence. We feel that for the moment we are lacking fixation systems to stabilize these difficult fractures. THP with simultaneous reinforcement of the acetabulum with percutaneous fixation techniques seems a better option.

Session I – Proximal femur

OP 01

How to prevent cut-out and cut-through in biaxial proximal femoral nails: Is there anything beyond lag screw positioning and tip-apex-distance?

R. Biber*¹, B. Zirngibl¹, H. J. Bail¹

¹Klinikum Nürnberg – Paracelsus Medical University, Department of Orthopedics and Traumatology, Nürnberg, Germany

Purpose Cut-out and cut-through are major complications of osteosynthesis at the proximal femur. However, there is little knowledge about the complications of biaxial fixation systems and their specific predictors. Besides re-evaluating the impact of tip-apex-distance (TAD), lag-screw position, and quality of reduction we analyzed possible associations between antirotational pin length and fixation failure.

Methods In a case-control-design we compared intraoperative radiographs of 22 cases of hip perforation to 50 randomly chosen controls showing no complications. TAD, lag-screw position according to Cleland's zones, angle between lag-screw and femoral neck axis, gliding capacity of the lag-screw, displacement and the length of the antirotational pin were investigated.

Results In patients with hip perforation we found a significantly ($p=0.001$) higher deviation comparing the angle between lag-screw and femoral neck axis. The telescoping capacity of the lag screw was significantly ($p=0.02$) lower and the TAD was significantly higher ($p=0.048$) in the complications group. We saw a significantly ($p=0.009$) higher frequency of joint perforation if the antirotational pin exceeded a line connecting the tip of the nail and the lag screw (NS line). Inadequate length of the antirotational pin resulted in an Odds ratio of 10.8 for hip perforation ($p=0.001$).

Conclusions An increased deviation angle between lag screw and femoral neck axis and a decreased gliding capacity of the lag screw seem to be relevant risk factors for hip perforation. However antirotational pin length turned out to be the most important predictor for cut-out or cut-through in biaxial proximal femoral nails.

OP 03

Does the same Cannulated screw position can be used for all femoral neck fracture treatment. An optimized finite element analysis.

M. N. Konya*¹, O. Verim²

¹Afyon Kocatepe Üniversitesi Hastanesi, Orthopedics and Traumatology, Afyon, Turkey

²Afyon Kocatepe University, Mechanical Engineering, Afyon, Turkey

Question: Femoral neck fracture (FNF) treatment modalities are vary. It generally depends on age, fracture type, time from fracture to operation and bone density. Pauwel is a well known classification about femoral neck fractures based on fracture line. Young patients's FNF generally treated with three

cannulated screw. In this study our aim is to determine the same cannulated screw position in every Pauwel type Femoral Neck Fractures can give sufficient results?

Methods: A healthy male femur CT images were processed by Mimics software (Materialise, Leuven, Belgium). The model of femur neck fracture was occurred with SolidWorks 2017, Rapidform XOR(Inus Technologies, Seoul, Korea) and Ansys Design Modeler(ANSYS Inc., USA) software. Fracture lines were drawn the anatomic axis of the femoral shaft as a guideline and an imaginary line perpendicular to this guideline. The fracture line was drawn over the femoral neck to cross this line, and Pauwels angle was defined as the angle between these two intersecting lines. In our model, fracture line angles were determined between 40° and 68°. Three cannulated screw were inserted from lateral cortex into the centre of femoral head. Angles between the screws were defined as 120 degrees. Models were transformed into Non-Uniform Rational Basis Splines (NURBS) surface format with SolidWorks 2017 and Rapidform XOR software using point cloud methods. Then, the optimization analysis is performed in the Ansys 16.0 Workbench software. Optimization parameters in this study, consist of Pauwel angles(°), screw translating(mm) from default screw position and the angle(°) of the positive X-axis of the screws. The main force (applied to the femoral head at 23° on the frontal and 6° on the sagittal planes) is taken to be 2460 N. Force of the abductor and the iliopsoas muscles were taken as 1700 N (24° on the frontal and 15° on the sagittal planes) and 771 N (41° on the frontal and 26° on the sagittal planes).

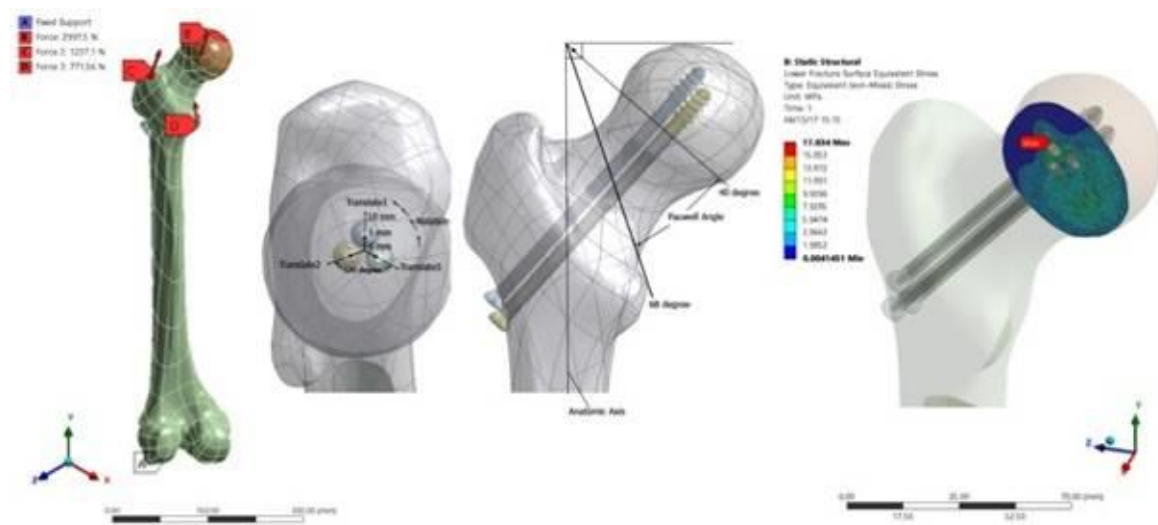
Results: In this study, equivalent von Mises stress values on the upper and lower fracture lines are respectively 17.83MPa and 16.28 MPa and stress values of cannulated screw 1,2 and 3 are 42.15Mpa, 65.67Mpa ve 65.04Mpa respectively. In this study the most effective input parameter found fracture lines' angle when comparing the o parameter such as frictional stress, pressure and lower-upper equivalent von Mises stress on the fracture surface. According to response surface optimisation, there was a positive correlation between equivalent von Mises stress value with fracture lines, rotation between the screw and the frictional stress values at the fracture surface. The translation values of Screw 1 and 2 did not effect the friction stress and equivalent von Mises stress values on fracture lines. Translation of Screw 3 helps to increase the values of friction stress and pressure values but didn't change the equivalent von Mises stress values of upper and lower fracture line surfaces. As a result of the study, five different candidate design points are shown according to minimum of friction stress values and the lower-upper equivalent von Mises stress values on the fracture line surfaces when Pauwel angle are 40 and 60(Figure 2) degree.

Conclusions: As a result of this study, fracture line angle is the most important input parameter in femoral neck fracture and screw position should be change. The third screw helps to increase frictional stress and pressure on fracture lines.

Figure 1. Boundary conditions on the femur, input parameters, and stress values on the lower surface of the fracture line.

Figure 2. Input parameters according to frictional stress values and the equivalent von Mises stress values on the lower-upper surfaces on the 40° and 68° fracture line.

Figure 1



Candidate Points					
	Candidate Point 1	Candidate Point 2	Candidate Point 3	Candidate Point 4	Candidate Point 5
P1 - Translate1 (mm)	6.5438	5	8.0873	7.4013	7.2543
P2 - Rotate_1 (degree)	112.59	0	56.3	31.544	26.974
P3 - Translate6.FD2 (mm)	5.2296	5	5.4042	9.309	9.8989
P4 - Translate8.FD2 (mm)	7.5587	10	9.879	7.1078	8.2118
P5 - Fracture_Angle (degree)	★★ 40.026	★★ 40	★★ 40.051	★★ 40.005	★★ 40.155
P6 - Frictional Stress Maximum (MPa)	★★ 1.009	★★ 5.0355	★★ 0.99238	★★ 1.1729	★★ 0.18078
P14 - Lower Fracture Surface Equivalent Stress Maximum (MPa)	★★ 20.757	★★ 20.724	★★ 20.789	★★ 20.73	★★ 20.921
P19 - Upper Fracture Surface Equivalent Stress Maximum (MPa)	★★ 16.874	★★ 16.669	★★ 17.023	★★ 17.205	★★ 16.828

Candidate Points					
	Candidate Point 1	Candidate Point 2	Candidate Point 3	Candidate Point 4	Candidate Point 5
P1 - Translate1 (mm)	9.9413	7.1868	5.9583	7.9568	5.4858
P2 - Rotate_1 (degree)	41.908	79.005	29.479	71.681	99.264
P3 - Translate6.FD2 (mm)	5.0516	9.9987	9.9294	5.0269	9.982
P4 - Translate8.FD2 (mm)	7.2332	8.9942	6.6451	8.463	6.9379
P5 - Fracture_Angle (degree)	★★ 62.702	★★ 61.041	★ 60.386	★★ 62.407	★★ 63.29
P6 - Frictional Stress Maximum (MPa)	★★ -0.69464	★★ 3.3385	★★ -0.22287	★★ 3.2265	★★ 1.2231
P14 - Lower Fracture Surface Equivalent Stress Maximum (MPa)	★★ 46.155	★★ 44.507	★★ 43.853	★★ 45.863	★★ 46.734
P19 - Upper Fracture Surface Equivalent Stress Maximum (MPa)	★ 39.56	★★ 35.88	★★ 34.913	★ 38.785	★ 40.818

OP 04

Arthroplasty or internal fixation for displaced femoral neck fractures in risk patients? Osteosynthesis by the method of BDSF in a 78 y.o. male with untreated diabetic foot and in a 102 y.o. male

O. Filipov*¹

¹Vitosha Orthopaedic Hospital, Sofia, Bulgaria

Objectives: Primary THR is strongly recommended for elderly patients with femoral neck fractures. Internal fixation (IF) could be preferred as a joint-preserving procedure for young patients and some patients above 65 years with high functional demands and without preexisting pathology of the hip. However, there are many elderly patients with high risk of complications for a large surgical procedure and thereby unfit for arthroplasty due to their polymorbidity and high mortality risk, or high risk of septic complications, where osteosynthesis is usually applied despite the risk of fixation failure. The conventional osteosynthesis of femoral neck fractures is related to 20-46% poor results, especially in osteoporotic bone. Based on clinical evidence and laboratory testing, the novel method of Biplane Double-supported Screw Fixation (BDSF) is deemed to provide better stability of the osteosynthesis construct.^{1,2}

Methods: We apply the method of BDSF for all femoral neck fractures which are generally considered to meet the indications for internal fixation based on accepted clinical algorithms. Compared to conventional methods with three parallel screws, the novel method of BDSF offers better stability by using three medially diverging cannulated screws with two of them buttressed on the calcar. The two calcar-buttressed screws are oriented with different coronal inclinations intended to provide constant fixation strength during different patient activities. Biomechanically, the most effective component is the distal screw placed at steeper angle and supported on a large area along the distal and posterior cortex of the femoral neck following its spiral anterior curve. Thereby, BDSF achieves the strongest possible distal-posterior cortical support for the fixation construct, which allows for immediate full weight-bearing. Two cases with high risk of complications for primary arthroplasty have been treated applying the BDSF-method: a 78 y.o. male with high risk of sepsis due to untreated diabetic foot, and a 102 y.o. (ASA IV:E) male with high mortality risk.

Results: Both cases recovered in full and no complications have been observed. A short supplementary video with the BDSF-operative technique is presented.

Conclusion: By providing additional cortical support, the novel BDSF method enhances femoral neck fracture fixation strength, reveals excellent clinical outcomes and extends the indications for internal fixation when osteoporosis is present.

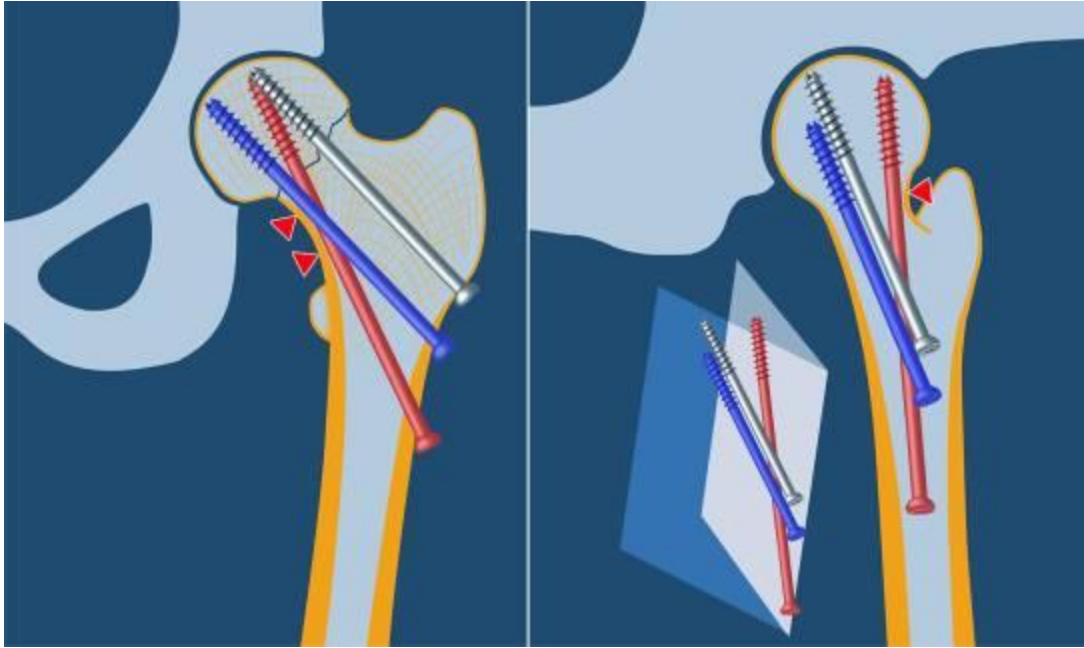
Keywords: Femoral Neck Fracture, Biplane, BDSF, Cannulated Screws, Osteosynthesis

Figure legend: BDSF implements two calcar-buttressed screws, oriented in different coronal inclinations of 150–165° and 130–140°, respectively. Their medial supporting points are located 10–20 mm apart from each other, thereby distributing the axial load over a larger cortical area. The posterior cortical support is achieved by using the obtusely placed distal screw.

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- Filipov O, Stoffel K, Gueorguiev B, Sommer C. Femoral neck fracture osteosynthesis by the Biplane Double-supported Screw Fixation method (BDSF) reduces the risk of fixation failure. Clinical outcomes in 207 patients. *J Arch Orthop Trauma Surg* 2017; DOI: 10.1007/s00402-017-2689-8.

Figure 1



OP 05

Comparison of Hemiarthroplasty and Total Hip Arthroplasty in Elderly Patients with Displaced Femoral Neck Fractures

F. C. Barishan^{*1}, B. Akesen^{*1}, T. Atici¹, S. Bilgen¹, K. Durak¹

¹Uludag University, Orthopaedics and Traumatology, Bursa, Turkey

Objective: To compare clinical and radiological outcomes based on mortality and morbidity in cases of femoral neck fractured (FNF) in the elderly that had been treated with cementless hemiarthroplasty or total hip arthroplasty (THA) methods.

Material and Method: Cases of displaced (Garden type 3-4) femoral neck fracture in the elderly (>65 years) treated with cementless hemiarthroplasty (Group I) or THA (Group II) were analyzed retrospectively. The groups were compared in accordance with their sex, ASA scores, additional systemic diseases, type of trauma-fracture, Spotorno index, preop-postop bleeding-transfusion amount, decrease in hemoglobin concentration, duration of operation, length of stay, follow up Harris Hip scores, radiological changes, Barthel activity scores, developed complications and Charlson comorbidity index relationship, and early and late follow up mortality ratios.

Results: The 22 cases in Group I had an average age of 76.9 years (65-88) and had been monitored for 31 months (16-47), while in Group II, the 16 cases had an average age of 73.6 years (65-90) and monitoring time of 30.5 months (16-48) ($p>0.05$). Differences in clinical and radiological parameters between groups ($p>0.05$) were not found. The Harris scores were 83.9 (75-97) in Group I and 83.3 (71-93) in Group II ($p>0.05$). In Group II, the amounts of bleeding volume and blood transfusions were significantly higher ($p<0.05$). Complication ratios and morbidity ratios were similar in both groups ($p>0.05$). Mortality ratios in Group I and Group II in the first month were 4.5% and 6.3%, and at the last follow-up were 18.2% and 25% respectively ($p>0.05$).

Conclusion: Displaced femoral neck fractures treated with cementless hemiarthroplasty and total hip arthroplasty in the elderly have similar short-term clinical and radiological results. The main determinant of morbidity and mortality ratios is the presence of an additional systemic disease.

OP 06

Neglected Unreduced Posterior Shoulder Dislocation: results of operative treatment

A. Callizo*¹

¹Universidad Nacional de Asunción, Cátedra de Ortopedia y Traumatología, Asunción, Paraguay

Posterior dislocation of the shoulder is an unusual injury that is commonly missed on the initial presentation, thus making its treatment a challenge. Neglected unreduced posterior shoulder dislocation causes a great deal of disability to the patients and no standard accepted treatment for this injury exists. Several surgical techniques have been described for the treatment of posterior shoulder dislocation depending on the time elapsed between injury and surgery and the size of the so called reversed Hill Sacks lesion. A group of 13 patients, including 7 men and 6 women, with neglected locked posterior shoulder dislocation were treated with the modified McLaughlin technique with no added bone graft from the iliac crest for the humeral head defect. We had 1 recurrence of dislocation. Of the study patients, 11 were pain free, 8 returned to their previous job and 2 modified their manual work. The modified McLaughlin procedure with no bone graft in our hands has been shown to be a reproducible technique allowing good results at medium term follow-up.

OP 07

Virtual Morphological Analysis of Different Intramedullary Proximal Humerus Nails in the Population of the People's Republic of China

T. Harnoss*¹, H. Luo², U. Schreiber², O. Trapp³, S. Feller², A. Lenich⁴, X. Wu⁵

¹Klinikum Kempten Allgäu, Kempten, Germany

²OT Medizintechnik GmbH, Munich, Germany

³BG Traumacenter Murnau, Murnau, Germany

⁴Helios Kliniken Pasing, München, Germany

⁵No1 Clinic Shanghai, Shanghai, China

Introduction: The treatment of proximal Humerus fractures with intramedullary nails becomes demanding with a decreasing Humerus size, especially when both Tubercles are fractured. In populations with a smaller anatomy than the Western world, e.g. China, this might be one of the reasons why intramedullary nailing is rarely used.

Objectives: The aim of the study was to virtually compare the quality of fracture treatment between 3 different intramedullary nails, focusing on small Humeri having a fracture of both Tubercles. Another objective was the evaluation if side-specific implants are superior in the treatment of these fractures compared to a universal but polyaxial nail with the possibility to freely direct the proximal screws within a cone of 20°.

Materials and methods: The CT-data basis consisted of 32 non-fractured Chinese Humeri with an average anatomical neck diameter of 43.49 mm (36.7-50.24 mm). The data significantly follows a normal distribution and therefore comprehensively represents the Chinese population. With a focus on small Humeri, we chose 14 bones with an anatomical neck diameter smaller than . The mean age of our specimens was 42.7 years (21-64 years). Using the CAD-Software Inventor Professional 2017 (Autodesk, San Rafael, USA), a simplified fracture of both Tubercles was virtually simulated for each specimen (see Figure 1 left part). Via a virtual implantation the quality of fracture treatment of three intramedullary implants, namely *DePuy Synthes MultiLoc*, *Stryker T2* and *OTM PolyAxNail PH* (see Figure 1 middle and right pictures), was evaluated. *MultiLoc* and *T2* provide a side-specific variant, *OTM PolyAxNail* is a universal, polyaxial nail. The implantation was considered successful if the distance between all four proximal screws to the fracture line was at least 5 mm. The measurement was performed in two directions anterior-posterior and medial-lateral.

Figure 1: Exemplary fracture lines on both Tubercles from lateral (upper left picture) and anterior (lower left picture), 3-D view of: *DePuy Synthes MultiLoc* Proximal Humeral Nail (middle left picture [1]), *Stryker T2* Proximal Humeral Nail (middle right picture [2]), *OTM PolyAxNail PH* (right picture [3]).

Results: For Humeri with 39.85 mm (\cong smallest 16% of the Chinese population) a satisfying fracture treatment could not be achieved with all of the tested intramedullary nails. For Humeri with 39.85 mm *MultiLoc* and *T2* managed to sufficiently treat 1 out of 9 Humeri. The implantation of *OTM PolyAxNail PH* was successful in 6 out of 9 cases.

Conclusion: There is a correlation between the Humerus size, in specific the anatomical neck diameter, and the quality of fracture treatment, using intramedullary nails, when both Tubercles are fractured. With the investigated implants it is impossible to treat very small Humeri (39.85 mm). The use of the polyaxial implant allowed to avoid the vulnerable fracture lines due to the possibility of polyaxial screw placement. A benefit of a side-specific implant variant could not be found. The limitation of this study is that the fracture lines are simulated in a simplified manner: the fractures of the Tubercle are represented as 2D straight cut offs, which therefore does not fully represent the clinical situation.

Literature

[1] DePuy Synthes - MultiLoc Humeral Nailing System, Surgical Technique

[2] Stryker – T2 Proximal Humeral Nailing System - Operative Technique

[3] OTM – company brochure

Figure 1



OP 08

Humeral head necrosis after proximal humeral nailing: What are the reasons for bad outcome?

R. Biber^{*1}, B. Zirngibl¹, H. J. Bail¹

¹Klinikum Nürnberg – Paracelsus Medical University, Department of Orthopedics and Traumatology, Nürnberg, Germany

Introduction: Humeral head necrosis (HHN) remains a major problem in fracture care. This study was designed to evaluate clinical and radiological outcomes in patients depending on the influence of HHN.

Patients and methods: 310 patients operated between 2006 and 2010 were operated with a standard Targon PH nail for an acute humeral head fracture. 32 (10.3%) patients could be obtained for follow-up including Constant score (CS), DASH score, UCLA shoulder rating scale, and Neer score. ROM as well as pain was documented. The follow-up period was 3 to 6 years after injury. HHN was detected radiologically and graded in stages 0-5.

Results All fractures had healed. HHN was found in 10 cases (31.3%). 4 patients (12.5%) showed interlocking screw perforation as part of the head collapse caused by HHN.

Median CS was 73 (range: 24-85). There was no association detectable between number of fracture fragments and CS ($p \geq 0.631$). The median DASH score was 16.4 (range: 0-74,1), UCLA score 30 (range: 9-35), Neer score 80 (range: 29-100). Three (37.5%) of the patients with a stage IV or V osteonecrosis reported about pain. All patients with pain were affected by high grade HHN and screw perforation. CS was not affected by HHN, however significantly diminished if additional implant protrusion was present. Findings for normalised CS, relative CS, DASH score, UCLA shoulder rating scale, Neer score, and ROM were analogous.

Discussion Whereas HHN itself seems to contribute only mildly to functional outcome, we identified screw protrusion as major predictor for bad clinical results. The high rate of HHN found in our study (31.3%) may be attributed to the inclusion of mild HHN and our long follow-up period, as it is known that late-onset HHN may occur more than 3 years after trauma.

OP 09

Management of Gunshot Wounds and Ballistic Fractures of the Upper Extremity: Our Experience at an Urban Trauma Center and Review Of Literature

T. P. Royals^{*1}, R. Zura¹

¹Louisiana State University Health Science Center, Department of Orthopedic Surgery, New Orleans, United States

Civilian gunshot wounds are becoming more common with approximately sixty to eighty thousand per year. As much as fifty percent of these result in fracture care. Many of these ballistic injuries affect the upper extremity resulting in ballistic fractures and often times complicated soft tissue injuries that can be challenging for the orthopedic surgeon. This review will summarize available literature on the management of gunshot wounds and ballistic fractures to the upper extremity including the humerus, forearm, wrist, and hand, as well as recommendations for antibiotic therapy. We will also highlight our experience in management of these injuries, particularly to the upper extremity. Our trauma center averaged 516 gunshot wound encounters annually over a 7 year period, accounting for 23% of our orthopedic surgery consults during that time. Ballistic injuries require evaluation and management of the soft tissue injury, antibiotic therapy, and standard fracture management in order to provide the best chance for functional recovery.

Session III – Pediatric

OP 10

Risk factors for nonunion of bone fracture in pediatric patients

R. Zura^{*1}, S. C. Kaste^{2,3}, M. J. Heffernan¹, D. Gargiulo⁴, W. K. Accousti⁴, Z. Wang⁵, R. G. Steen^{1,6}

¹Louisiana State University Health Science Center, Dept. of Orthopaedic Surgery, New Orleans, United States

²St. Jude Children's Research Hospital, Depts. Of Radiology and Oncology, Memphis, United States

³University of Tennessee School of Health Sciences, Department of Radiology, Memphis, United States

⁴Louisiana State University Health Science Center & Children's Hospital, Dept. of Orthopaedic Surgery, New Orleans, United States

⁵North Carolina State University, Dept. of Statistics, Raleigh, United States

⁶Medical Affairs, Bioventus LLC, Durham, United States

Importance: Adult fracture nonunion risk is related to injury severity and the surgical technique used, but progression to nonunion is not fully explained by these risk factors alone; biological risk factors are also important. We sought to identify whether similar biological risk factors for nonunion are important in pediatric patients.

Objective: We test a hypothesis that risk factors important in pediatric nonunion are similar to adult nonunion risk factors, especially after puberty onset.

Design: Inception cohort study in a large payer database of pediatric fracture patients in the United States.

Setting: Patient-level health claims for medical and drug expenses compiled for approximately 90.1 million patients.

Participants: Study inclusion was limited to patients age 0-17 years with a coded bone fracture in calendar year 2011. The final database collated demographic descriptors, treatment procedures as per Current Procedural Terminology (CPT) codes, co-morbidities as per International Statistical Classification of Diseases and Related Health Problems (ICD-9) codes, and drug prescriptions as per National Drug Code Directory (Red Book) codes. Logistic regression was used to calculate odds ratios (ORs) for variables associated with nonunion.

Exposure: Continuous enrollment in the database was required for 12 months after fracture, to allow time to capture a nonunion diagnosis.

Results: Among 237,033 pediatric fractures in 18 bones, the nonunion rate was 0.85%. Increased nonunion risk was associated with age, male gender, high body-mass index, severe fracture (e.g., open fracture, multiple fractures), and tobacco smoking (all, $p < 0.0001$). Nonunion rate varied with fracture location; scaphoid, neck of femur, and tibia+fibula were most likely to go to nonunion. Nonunion ORs were significantly increased for risk factors including: surgical procedure; osteoarthritis; cardiovascular disease; Vitamin D deficiency, opioid prescription (all, multivariate $p < 0.001$); and osteoporosis ($p < 0.01$).

Conclusions and Relevance: Scaphoid fractures in adolescents are at nearly the same risk of nonunion as in adults. Opioid use in pediatric fracture patients cannot be recommended, as opioids are associated with a significant and substantial elevation of nonunion risk. Risk factors that predispose children and adolescents to nonunion are similar to risk factors that predispose adults to nonunion, though pediatric nonunion risk is substantially lower.

OP 11

Surgical Treatment of displaced Radial Neck Fractures in Children with Metaizeau Technique

G. Okcu^{*1}, K. Tosyalı¹, K. Aktuglu¹

¹Celal Bayar University, Orthop and Trauma, Izmir, Turkey

Radial neck fractures constitute only 5-10 % of all elbow fractures in children. Although they are not encountered frequently, they remain a source of considerable controversy when the angular displacement exceeds 30 degrees. The purpose of this study is to report the outcome of this fracture with closed reduction and intramedullary pinning.

Patients and Methods: Thirty-eight patients with grade III and grade IV radial neck fractures according to the classification of Judet et al were managed surgically by Metaizeau technique between 2004-2015 at two university-based center. This was a retrospective study which the data were collected prospectively. Patients with previous elbow injury and follow-up time shorter than 24 months were excluded from the study. Three patients were lost to follow-up, remaining 35 patients for analysis. Between two and 10 years after injury, patients returned for clinical and radiological assessment and also evaluation of elbow function.

Results: There were 15 girls and 20 boys with an average age of 9.1 ± 2.1 years (4 – 12 years). The average follow-up time was 64.9 months (28 -120). At the latest follow-up, there were 31 (88.5 %) excellent or good results and 4 (11.5 %) fair results according to Metaizeau classification. The Mayo Elbow score was excellent and ranged between 85-100 points (Mean 98). There was an enlargement of the radial head and neck in nine patients and premature physal closure in four patients. Despite those findings only three patients had fair result in this group.

Conclusion: Intramedullary pinning, as described by Métaizeau, is a reliable technique to treat radial head fractures in children, which provides excellent or good results and has a low risk of complications.

OP 12

Youngest bilateral femoral lengthening case with the PRECICE lengthening nail

M. Kucukkaya*¹, A. Eren¹

¹Ortopedist, Istanbul, Turkey

Introduction: Lengthening nails are not commonly being used in the pediatric age group. The nail sizes produced with current technology as well as open growth plates restrict the use of lengthening nails in these patients. However, open growth plates are not an absolute contraindication in the retrograde nailing of the femur and antegrade nailing after the ages of 7-8. We are reporting the youngest patient in the literature, an achondroplasia case of bilateral 13 cm femoral lengthening with two consecutive antegrade Precice nail applications.

Objectives: Results and the surgical technique are presented. Potential risks, possible complications, and their solutions are discussed.

Patient and Method: A 7.5 year-old achondroplasia boy was admitted. Radiological evaluation revealed that available femoral medullary space was 19.5 cm. At the first stage, 165 mm long, 8.5 mm wide antegrade 10° trochanteric femoral nails (P8.5-50M165) were used bilaterally. Distraction was started at the postoperative 5th day. After 5 cm bilateral femoral lengthening (1.2 mm/day distraction rate) consolidation was obtained. This first stage took 3 months. At the second stage, 4 months after the first surgery, the first nails were removed and 245 mm long, 8.5 mm wide antegrade 10° trochanteric femoral nails (P8.5-80D245) were inserted and new osteotomies were performed. The same distraction protocol and intense physiotherapy regimen were used at both stages. However, hip joint stiffness was observed at the last one cm of the second stage. After surgical muscle releases distraction was completed. Consolidation was obtained at the distraction site of the second stage in 4 months.

Result: Consolidation was obtained bilaterally after 13 cm lengthening. Total treatment time was 8 months for both stages. There was no joint contracture, range of motion restriction, or inequality at the end of treatment.

Conclusion: Current Precice nail technology allows femoral lengthening in younger patients. However, there is always a risk of avascular necrosis of the femoral head after nailing of the femoral diaphysis in this age group. To prevent this complication, trochanteric entry nail technique should be selected and vascularization of the femoral head preserved during surgery.

OP 13

Clinical outcomes and Complications in Titanium Elastic Nailing Osteosynthesis of Pediatric Femur Fractures: Report of 47 Cases between 1995-2017

K. Kayaokay*¹, K. Aktuğlu², G. Okçu³

¹Siverek , Orthopedics and traumatology, şanlıurfa, Turkey

²ege university, ege university, izmir, Turkey

³celal bayar university, Orthopedics and traumatology, manisa, Turkey

Aim: We aimed to evaluate the relationship between different follow-up periods and angulation in children who underwent titanium elastic nailing (TEN) for extremity lengthening femur fractures.

Methods: The study included 47 pediatric femur fractures treated with TEN between 1995 and 2017. The following parameters were considered as gender, age, damaged side, fracture type, fracture mechanics, AO classification, lengthening, angulation (anterior-posterior), varus or valgus, skin irritation, hip and knee range of motion (ROM), radiologically union. Finally, it was evaluated based on Flynn's criteria.

Results: 11 of all fractures were subtrochanteric, two supracondylar fractures. The mean age was 8.32 years (3-15 years) and the mean follow-up was 22.8 months (range 6-166 months). According to the AO classification, 21 fractures were A1, seven were A2, 12 were A3, two were B1, three were B2, and two were C1. Radiologically, the union time was 8.3 weeks (range 5-13 weeks). All patients except two patients had full range of motion on the knee and hips. In addition, these two patients with a limitation of motion had short follow-up period. Skin irritation was observed in six patients (12.7%). No patient infected. Coronal, sagittal, posterior-anterior angulation was observed in 20 patients. the angulation was 5-10 degrees in 12 of these, over 10 degrees in only 4 patients. According to Flynn's scoring

criteria, 23 patients were assessed excellent (48.9%), 20 were successful (42.6%) and 4 were bad. In 4 patients who were assessed bad according to Flynn's criteria, angulation was over 10 degrees, there were lengthening of extremity over 1 cm in two patients. Lengthening of extremity was seen in 13 patients. eight of them were 1 cm or longer in elongation. 1 of the patients who had extremity elongation had bad score according to Flynn's score, 1 had excellent and 6 had successful. The elongation rates of 2 patients which were the longest follow-up period (166, 114 months) were 1.79 cm and 1.96 cm, respectively.

Conclusion: Clinical results of TEN application in pediatric femur fractures are successful. Angulation (Sagittal, coronal, anterior-posterior), hip knee range of motion, and extremity extension were most important factors for assessing success. The number of patients who had extremity lengthening increases as the follow-up period increases ($p < 0.001$). Flynn's score of patients who had extremity elongation was successful. In patients with angulation, the amount of angulation was reduced after repeated controls, but the flynn's scores were bad. TEN applications in pediatric femur fractures require good reduction at the time of operation. much more valuable data on clinical outcomes and complications will be gained with evaluation of follow-up results over 10 years of TEN applications.

Key words : Titanium elastic nailing, Pediatric femur fractures, Intramedullar nailing

Figure 1

		n	%
AO-OTA classification	A1	21	44,7%
	A2	7	14,9%
	A3	12	25,5%
	B1	2	4,3%
	B2	3	6,4%
	C1	2	4,3%
Fracture Location	Proximal	11	23,4%
	Middle	34	72,3%
	Distal	2	4,3%
Femoral side	Left	23	48,9%
	Right	24	51,1%
skin irritation	none	41	87,2%
	yes	6	12,8%
Open reduction	none	45	95,7%
	yes	2	4,3%
Extremity lengthening	none	29	61,7%
	lengthening	6	12,8%
	Shortening	12	25,5%
Flynn score criteria	Satisfactory	20	42,6%
	Poor	4	8,5%
	Excellent	23	48,9%
	N	Average±SS.	Median (Max. / Min.)
Non-weight-bearing(weeks)	47	5,74±1,03	6 (8 / 4)
Radyological union time(weeks)	47	8,02±2,05	8 (13 / 5)
Follow-up time(months)	47	22,81±30,04	12 (166 / 4)
Time to take surgical operations	47	2,30±1,71	2 (10 / 0)
operation time(minutes)	47	52,02±11,00	50 (72 / 30)
associated injury	47	2,15±1,18	2 (5 / 1)
coronal varus angulation	47	2,85±4,78	0 (15 / 0)
coronal valgus angulation	47	0,77±1,80	0 (7 / 0)
Sagittal angulation	47	2,02±4,54	0 (25 / 0)
Extremity lengthening	47	0,26±0,65	0 (1,96 / -1)

SD.: Standard Deviation -Max. Maximum -Min. Minimum

Gender	Age				p
	n (%)	Average±SS.	Maximum	Minimum	
Female	22 (46,8)	8,77±3,15	14,0	3,0	0,354
Male	25 (53,2)	7,92±3,00	15,0	4,0	
Total	47 (100)	8,32±3,07	15,0	3,0	

Independent T Test(Bootstrap) / SS.: Standard sapma

Figure 2

	Age	Non-weight-bearing(weeks)	Radyological union time(weeks)	Follow-up time(months)
	Median (Max. / Min.)	Median (Max. / Min.)	Median (Max. / Min.)	Median (Max. / Min.)
Limb length discrepancy				
none	8 (15 / 3)	6 (7 / 4)	7 (13 / 5)	11 (59 / 4)
lengthening	8 (9 / 6)	6,5 (7 / 5)	8 (8 / 6)	46 (166 / 14)
shortening	7 (13 / 5)	6 (8 / 4)	8 (12 / 5)	12 (81 / 5)
P Value	0,723	0,263	0,519	0,002
Flynn skor				
Satisfactory	7,5 (13 / 3)	6 (8 / 4)	8 (12 / 5)	14,5 (166 / 6)
Poor	8,5 (13 / 5)	6,5 (7 / 5)	8 (12 / 8)	21 (48 / 6)
Excellent	8 (15 / 4)	5 (7 / 4)	7 (13 / 5)	10 (59 / 4)
P Value	0,929	0,198	0,249	0,071
Kruskal Wallis Test(Monte Carlo) - Post Hoc Test : Dunn's Test / Max. Maximum - Min. Minimum				
	varus angulation	valgus angulation	Sagittal angulation	Limb length discrepancy
	Median (Max. / Min.)	Median (Max. / Min.)	Median (Max. / Min.)	Median (Max. / Min.)
AO-OTA				
A1	0 (15 / 0)	0 (5 / 0)	0 (25 / 0)	0 (1,96 / -1)
A2	0 (15 / 0)	0 (7 / 0)	0 (10 / 0)	0 (1,1 / -0,6)
A3	0 (7 / 0)	0 (5 / 0)	0 (6 / 0)	0,15 (1,81 / 0)
P Value	0,760	0,754	0,639	0,122
Fracture location				
Proximal	0 (15 / 0)	0 (5 / 0)	0 (25 / 0)	0 (1,79 / -0,72)
Middle	0 (15 / 0)	0 (5 / 0)	0 (10 / 0)	0 (1,96 / -1)
P Value	0,519	1	0,704	0,515
Kruskal Wallis Test(Monte Carlo) - Post Hoc Test : Dunn's Test / Mann Whitney U Test(Monte Carlo) / Max. Maximum - Min. Minimum				

OP 14

Forearm compartment pressures in children with supracondylar fractures of the humerus

S. Togac¹, B. Sarisozen^{*1}, T. Atici¹, B. Akesen¹, K. Durak¹

¹Uludag University, Orthopaedics And Traumatology, Bursa, Turkey

Objective: We evaluated the effect of reduction type, preoperative duration time and operation time on the forearm preoperative and postoperative compartment pressures of patients with type 3 supracondylar humerus fractures.

Material and Method: A total of 31 patients records type 3 supracondylar humerus fractures were evaluated. Pressures were measured before and after reduction in deep volar compartments at the volar proximal 1/3rd forearm. During the first 24 hours postoperatively, a volar compartment catheter was placed to continuously measure the compartment pressure. Percutaneous pinning was performed in 20 (%64.5) patients by closed reduction, in 11 (%35.5) patients by open reduction. Mean time from trauma to operation was 20.1 (6-60) hours and mean operation time was 69.7 (30-120) minutes.

Results: Mean preoperative compartment pressure of patients was 15.0 ± 5.9 mmHg and mean early postoperative compartment pressure of patients was 27.9 ± 7.5 mmHg ($p < 0.05$). Average postoperative compartment pressure in open reduction group was 31.1 ± 9.0 mmHg and in closed reduction group was 26.1 ± 6.2 mmHg ($p < 0.05$). When the duration of surgery is more then 1 hour, the early compartment pressure was 30.7 ± 8.7 mmHg, and when it is less than 1 hour, the early compartment pressure was 25.8 ± 6.1 mmHg ($p < 0.05$). When the time from the onset of injury to surgery was examined, the average preoperative compartmental pressure of those who were operated in the first 12 hours was 12.4 ± 4.8 mmHg, the average preoperative compartmental pressure of those who were operated after 12 hours was 17.7 ± 5.8 mmHg ($p < 0.05$).

Conclusion: Preoperative compartment pressures can be used as a quantitative value to determine the severity of soft tissue injury and additional injury criterias like edema. The results of this study show that compartment pressures are at the highest level after manipulation and reduction. Early postoperative period is the time when patients are the most sensitive to soft tissue edema and compartment syndrome and at that period the close follow-up is needed.

Session IV – Foot and ankle

OP 16

Peritalar Dislocations: Mid-term clinical, radiological and pedographic results

M. Savvidis^{*1}, A. Konstantinidis¹, G. Markopoulos¹, A. Eleftheropoulos², G. Gkouvas¹

¹424 General Military Hospital, Orthopaedic, Thessaloniki, Greece

²Naoussa General Hospital , Orthopaedic, Naoussa, Greece

Background: Peritalar dislocations(PD) are uncommon and potentially devastating injuries. Their complications range from early soft tissue and vascular injuries to chronic pain and late subtalar arthrosis or talar avascular necrosis.

Purpose: The purpose of this retrospective study was to evaluate the clinical, radiological and pedographic results in a consecutive series in our tertiary hospital.

Methods: During the last 12 years, six patients (4 men/2women, mean age 36) have sustained a peritalar dislocation. There were 4 with medial dislocation, 1 with lateral dislocation and 1 with isolated talo-navicular dislocation. After closed reduction, they were all treated with a cast, except one in whom the dislocation was stabilized with an external fixation.

Results: The mean follow-up was 63 months (12-132) and the mean AOFAS hindfoot score was 82(64-100). In all but one patients, there were minor clinical symptoms and subtle changes in pedographic examination, despite the decreased subtalar ROM and the radiological signs of arthritis. An arthroscopic subtalar arthrodesis was performed in one patient with constant pain and subtalar arthritis.

Conclusion: Peritalar dislocations are severe injuries with unpredictable outcome, even if immediate and accurate reduction were achieved. Close follow-up of these patients is mandatory and in the case of daily pain and limp, arthroscopic subtalar arthrodesis is a valuable solution.

OP 17

Arthroscopy assisted fixation of depression type intraarticular fractures of the distal tibial plafond

O. Poyanlı^{*1}, M. S. Söylemez², A. T. Özkut³, I. Esenkaya¹, M. E. Uygur¹

¹Istanbul Medeniyet University, Orthopaedics and Traumatology, Istanbul, Turkey

²Bingöl State Hospital, Orthopaedics and Traumatology, Bingöl, Turkey

³Göztepe Training and Research Hospital, Orthopaedics and Traumatology, Istanbul, Turkey

Introduction: Plafond fractures are intra-articular fractures of the distal tibia and usually characterized by the presence of articular comminution and severe soft tissue injury. Anatomical reduction of the articular surface should be the main target and the surrounding soft tissue envelope must be taken into consideration. Open reduction and internal fixation (ORIF) may yield problems such as wound dehiscence, infection and osteomyelitis. To overcome the complications, techniques that combine minimally invasive fixation with external fixation were developed.

Objectives: In this study our surgery technique in treatment of AO/OTA type 43-B2 and B3 tibial pilon fractures that involves accurate reduction of the joint surface with the use of arthroscopy is presented.

Patients and methods: Over the period from January 2016 to December 2016 three patients sustaining distal tibial plafond fracture (One AO/OTA type 43-B2 and two 43-B3) were operated by senior author with arthroscopic assisted internal fixation technique.

The following is a detailed description of the technique. The tourniquet is inflated, and ankle arthroscopy is performed through the standard anteromedial and anterolateral portals. A modified form of the drill guide (which is smoothed using a rasp) C ring used for anterior cruciate ligament surgery (Arthex®, Naples, FL) is adjusted to reach the centre of the deepest point of the fracture line. A Kirschner wire is passed antegradely through the extraarticular end of the drill guide in the supramalleolar area at about 40° to the coronary tibial axis (Fig. 1). The exit point of the Kirschner wire is checked arthroscopically, and then it is advanced 1 mm past the joint (Fig. 1). After the Kirschner wire is measured in the bone, the appropriate 7, 8, or 9 mm drill is used to drill a hole approximately 1 cm from the subchondral bone line (or fracture fragment) over the Kirschner wire. As the guide is removed from the joint, the displaced articular fragment is reduced with gentle tapping using a Tunnel Dilator (AR-1854; Arthrex®). Simultaneously, a probe is used to apply a counterforce to the areas with displacement potential. Joint restoration and reduction are checked arthroscopically and fluoroscopically (Fig. 2). The Tunnel Dilator is then used to push the bone graft harvested from the ileum to above the fractured fragment in the tunnel. With the other end of the guide at 40° to the tibial axis in the tunnel and the C ring adjusted to 130°, a cannulated bioabsorbable screw is sent through the guide over a Kirschner wire passing through the plate in close proximity to the graft to prevent redisplacement. Because the guide is set at 130°, a screw can be easily placed parallel to the joint line through the plate to support the graft (Fig 2). Finally, the tourniquet is deflated and the external fixator is removed. A similar technique is used for AO/OTA classification type B3 tibial pilon fractures.

Results: Initial postoperative CT scans showed perfect reduction in all patients. All patients had gained full ROM of their ankle at postoperative 3 months.

Conclusion: This method causes fewer complications than the open reduction technique, such as wound dehiscence and infection, and allows accurate fracture reduction while maintaining joint congruity under direct visualisation.

Figure 1

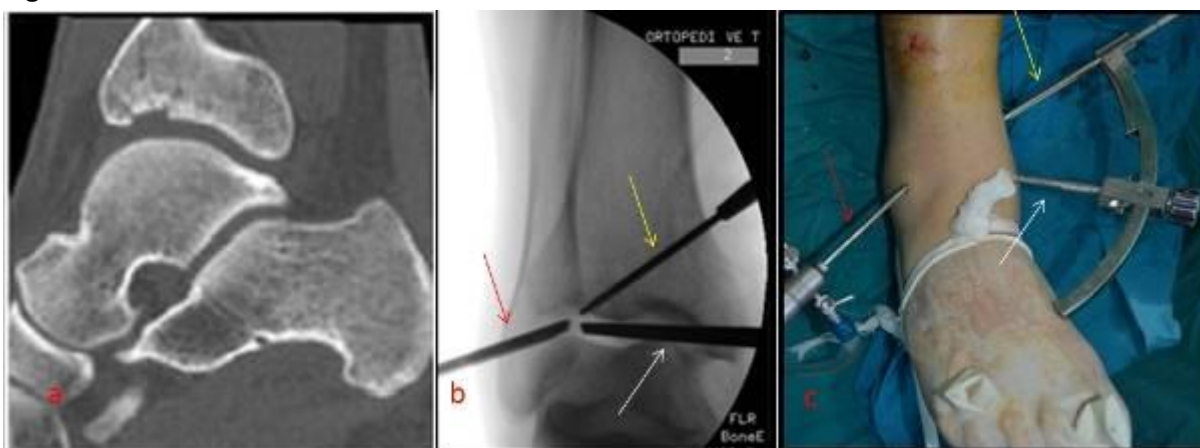
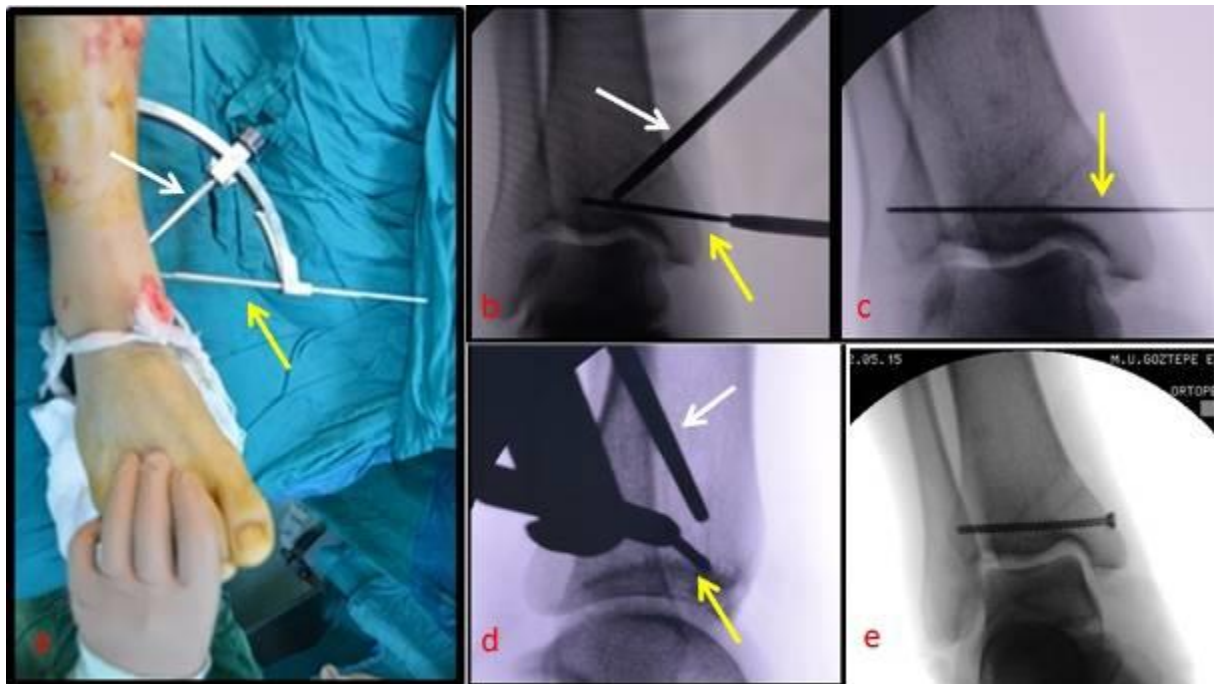


Figure 2



OP 18
Posterior mini open approach of talar fractures

G. Nusran*¹, R. Tiskaoğlu¹

¹Çanakkale Onsekizmart University, Orthopaedia and Traumatology, Çanakkale, Turkey

Introduction: The most common talar neck fractures are caused by axial loading in dorsiflexion and high-energy trauma. Due to the limited soft tissue support nutrition is provided directly via the extraosseous veins. For this reason, there is an increased possibility of developing avascular necrosis after fracture and luxation. The avascular necrosis rate can range from 0 to 100% from level I to IV of the Hawkins classification. We used a mini open technique of fixation with a posterior cannulated screw in order to minimize Skin And Soft Tissue Damage And To Decrease Morbidity In The Postoperative Period.

Aim: To assess the morbidity and complication rate following management of talus fractures using a posterior cannulated screw technique.

Material Method: Seventeen patients who were treated in the orthopedics and traumatology clinic between 2010 and 2016 were included in the study. Of the patients, 13 were male and 4 were female, four of the patients had isolated talus fractures and the remaining 13 patients had non- talus fractures. **Surgical procedure:** All patients were given spinal anesthesia. The fracture reduction was done under fluoroscopy. An incision was performed 3 cm posterior to the ankle joint and the Achilles tendon and the flexor hallucis longus was retracted medially. The talus was reached by passing a suitable sized K-wire through the ankle joint capsule. Talus reduction was controlled with fluoroscopy. With the K-wires placed appropriately and with image intensification verifying accurate reduction, two cannulated screws were placed over the K-wires. The screws were sent as close as possible to the talonavicular joint. The compressive function of the lag screws were used to achieve reduction. The stability of the fracture was again assessed using fluoroscopy.

Result: Preoperative and postoperative neurovascular examination of all patients were normal. All patients were put in a short leg cast postoperatively. On the 14th day postoperatively the short leg cast and sutures were removed. Passive Ankle and active range of motion exercises were started. Patients were allowed partial weight- bearing at the 8th week postoperatively and gradually increased the load until the 12th week postoperatively. At the 6th month control of the patients, it was seen that there was no pain on movement weight bearing, and there was full fracture healing radiologically. None of the patients had wound infection or postoperative neurological complications.

A lateral radiograph of the right ankle and foot. The image shows the tibia, fibula, talus, calcaneus, and the metatarsals of the foot. A circular marker with the letter 'R' is visible in the center of the image, indicating the right side. The bones appear well-aligned with no obvious fractures or dislocations.

OP 19

A new interlocking nail vs. standard locking plate for calcaneal fracture fixation - a prospective matched-pairs study

A. Herlyn^{*1}, A. Brakelmann¹, P. Herlyn¹, T. Mittlmeier¹, G. Gradl²

¹University of Rostock, Medical Center, Dept. of Trauma, Hand and Reconstructive Surgery, Rostock, Germany

²Klinikum München Harlaching, Dept. of Trauma, Orthopedic and Reconstructive Surgery, Munich, Germany

Introduction: Plate fixation of displaced calcaneal fractures using a standard lateral extended approach is complicated by infections and wound healing complications. This matched-pairs analysis evaluates prospectively the new minimally-invasive calcaneal interlocking nailing technique in terms of complication rates, reduction capacities and functional outcome compared to standard locking plate fixation.

Methods: 40 feet (20 feet/group; mean patient age 53 years, range 27-78) with displaced intraarticular calcaneal fractures were either treated with a calcaneal locking nail (LN) or locking plate (LP) and observed clinically and radiologically after 1.6 years. Follow-up included CT-based radiological assessment of reduction and reduction retention as well as functional evaluation including the AOFAS Ankle-Hindfoot- Score and Foot Function Index (FFI).

Results: Time for surgery did not differ between both techniques (LN 93 min vs. LP 96 min). Inpatient treatment time was significantly reduced in the LN group (7.6 days vs. LP 11 days). Postoperative and follow-up radiographs revealed adequate restoration of the calcaneal body in both groups. The remaining defect of the posterior facet was significantly smaller in the LN group (0.7 mm vs. LP 1.6 mm). The mean AOFAS Score was slightly better for the LN group with 71.6 points vs. 66.1 points (LP). Also, the FFI revealed better results for the LN group (27.3 points) than for the LP group (30.8 points). No intraoperative complications but two postoperative infections with wound healing complications were observed in the LP group.

Conclusions: The new minimum-invasive interlocking nailing technique shows promising results in terms of reduction capacities and safety. Infection complications were reduced whilst superior function was found applying the interlocking nail compared with standard locking plate fixation via a lateral extended approach.

OP 20

Cost Savings Using ITS Small Fragment Plating in Lateral Malleolus Ankle Fractures: Our Experience at an Urban Trauma Center

T. P. Royals^{*1}, R. Zura¹

¹Louisiana State University Health Science Center, Department of Orthopedic Surgery, New Orleans, United States

Lateral malleolus ankle fractures are routinely treated at our trauma center open reduction internal fixation with either an anatomic locked plating construct with or without interfragmentary screw fixation or small fragment plating. We present our early cost savings experience using ITS for lateral malleolus ankle fracture fixation compared to our other routine vendors. Included ankle fractures were Weber B or Weber C lateral malleolus ankle fractures. Fixation methods were grouped into anatomic locked plating or standard small fragment plating groups. Both groups included fractures that were treated with or without interfragmentary screw fixation and with or without syndesmosis fixation. We compared 10 fractures treated with locked plating and 10 fractures with non locked small fragment plating from other vendors with 3 locked plating and 2 non locked plating constructs from ITS. When comparing ITS small fragment locked plating compared to anatomic locked plating from other vendors, there was an average cost savings of 66.14%. When comparing ITS small fragment non locked plating to other vendors non locked plating constructs, there was an average savings of 9.48%. In conclusion, using ITS locked plating constructs is saving our institution 66% in cost compared to other vendors locked plating constructs.

OP 21

The effect of different preoperative planning methods on the proximal femoral angles in correction of the deformities of femur

A. Sari¹, İ. Karakoyun¹, M. F. Erol^{*1}, B. Günaydin¹, M. Küçükkaya²

¹Namik Kemal University School of Medicine, TEKIRDAG, Turkey

²Orthopedist Private Clinic, Istanbul, Turkey

Introduction: Center of rotation and angulation (CORA) and end point first (EPF) methods are two well known methods used in the preoperative planning of the treatment of femoral deformities. The objective of our study was to compare the changing effects of CORA and EPF methods on the proximal lateral femoral angle (PLFA) and proximal medial femoral angle (PMFA) during the preoperative planning phase of the distal femoral deformities.

Material and Methods: The measurements for CORA and EPF methods were carried out on the preoperative long standing X-rays (LSR) of 8 femurs of 8 patients which were treated for distal femoral deformities. First of all, the LRS images of the cases were uploaded CorelDRAW® Graphic Suite X8 software package (Corel, Inc., Ottawa, Ontario, Canada) software. Initial PLFA and PMFA were measured. After that deformity planning according to both CORA and EPF methods were applied on each case. PLFA and PMFA were measured on the corrected drawings of each femur and compared to the initial values of the same angles.

Results: The mean corrected angular deformity was 7.4° (range: 5°-17°). The mean PMFA change in correction with CORA method was 3.8° (range: 1°-7°). The mean PMFA change in correction with EPF method was 3.6° (range: 3°-4°). There was no change in the PLFA when the initial and final measurements were compared. the difference in changes in the PMFA with CORA and EPF methods were not statistically significant (p>0.005).

Conclusion: Correcting the distal femoral angular deformities both with CORA AND EPF methods have similar effects on the PMFA. PLFA is not changed in both methods.

OP 22

Does the Position of the Patella Change during the Distraction Osteogenesis of the Femur?

D. Lee^{*1}

Introduction: Iliotibial band and quadriceps muscle produce distraction-resisting force during femoral lengthening. A tight iliotibial band through its attachment of the lateral retinaculum into the patella could cause lateral patella tracking, patella tilt and compression. A tight quadriceps muscle which is directly attached to the patella could cause patella alta. We asked (1) Does the position of the patella changes during femoral lengthening?, (2) What are contributory factors associated with the changes?

Method: From Jan. 2011 to Nov. 2015, total 51 patients(99 femurs) of femoral lengthening with lengthening nail had full regular follow-up for at least 1 year. We checked the position of the patella using plain radiograph obtained before surgery and at each follow-up. CT scan was done preoperatively to evaluate the rotational alignment. We evaluated the amount of patella tilt by lateral patellofemoral angle and congruence angle, the patella shift by lateral patella shift, and the patella height by Insall-Salvati ratio and Blackburne-Peel ratio. Patient-associated factors including the tightness of the soft tissues checked by Obers test or Ely's test and Distraction-associated factors including final length gain were analyzed for the contributory factors

Results: Based on linear mixed model, the change of lateral patellofemoral angle, congruence angle and lateral patella shift, was significant as time pass (p<0.001). These values were significantly larger than preoperative ones, and continued after one year of surgery. These differences were largest during 8 to 12 weeks after surgery (Mean difference 9.62, SD 8.89, p<0.001). Patients with increased preoperative femoral anteversion more than 25°, or increased lateral patellofemoral angle more than 3° showed more distinguishable changes (p=0.016). Blackburne-Peel ratios were also increased during lengthening. But, the average BP ratios after 1 year of operation was 0.83 which is not enough to define as patella alta. Other distraction- or patient- related factors including Ober or Ely test didn't affect the position of the patella.

Conclusions

Our results show the possibility of the adverse effect of femoral lengthening on the patellofemoral joint. Preventive release of lateral retinaculum or iliotibial band could be considered to avoid over-pressure on patellofemoral joint during femoral lengthening, specially when preoperative femoral anteversion is more than 25°, or lateral patellofemoral angle more than 3°. Further studies are in need.

OP 23

Is there an increase in valgus deviation in tibial distraction using the intramedullary lengthening nail technique?

D. Lee*¹

¹Severance Hospital, Seoul, South Korea

Introduction: The muscles of the posterolateral compartment of tibia produce distraction-resisting force during tibial lengthening with Ilizarov methods, which cause valgus angulation. Valgus deformity of the tibia, which develop during treatment with the Ilizarov approach to tibial lengthening, also occurred in the lengthening over nail technique. We aimed

- 1) To determine whether valgus deviation occurs during the tibial lengthening with the intramedullary lengthening nail
- 2) Investigate the factors affecting the valgus deviation with the intramedullary lengthening nail
- 3) Evaluate the amount of valgus deviation over the amount of distraction

Material and Method: This study was of a retrospective comparative design. We performed 32 tibial lengthening using the lengthening nail from March 2010 to May 2015. Patients were categorized into 3 groups by the type of lengthening nail applied. There were 7 ISKD, 6 PRECICE 1, and 19 PRECICE 2 patients. One patient had LLD due to fibula hemimelia and the others had familial short stature. Weve analyzed the overall valgus deviation by measuring change in medial proximal tibial angle (MPTA), mechanical femorotibial angle (mFTA). Valgus deviation of each proximal and distal segments during lengthening were assessed by measuring the distance between the lateral margin of the intramedullary nail and the inner margin of the lateral cortex in plain radiographs obtained before lengthening, immediately after lengthening, every 1cm lengthening and completion of lengthening. The amount of bending of the nail were measured by the axis of the proximal and distal nail, at each time points. And the amount of valgus deviation, gap change, and nail bending were analyzed over the amount of distraction. For the factors affecting the valgus deviation, (1) type of device; (2) diameter of the intramedullary nail; and (3) the presence of blocking screw were analyzed.. Uni- and multivariate analyses were conducted.

Results: The tibial lengthening nail cause valgus deviation with 2.6 degrees in average. Proximal gap, distal gap, and nail bending were significantly changed with lengthening($p < 0.05$). The type of device was the only contributing factor affecting the valgud deviation; the overall valgus changes, Distal gap transition and nail bending were were significant in PRECICE1 and PRECICE2 group than ISKD; Proximal gap transition was significant regardless the kind of lengthening nail. The amount of valgus deviation was not related to diameter of the nail and the presence of blocking screw. Most significant proximal gap transition was observe until 1cm distraction, and most significant nail bending was between 1 and 2cm distraction.

Conclusions: Valgus deviation does occur during tibial lengthening using the lengthening nails due to gap transition or nail bending; the result of this study may help physicians to plan the final alignment after lengthening. A stronger lengthening nail against bending force would be better for more predictable alignment in tibial lengthening

Session VI – Intramedullary nailing 1

OP 27

Is there time difference between unions in the femurs of bilateral femoral nailing procedure applied at the same session?

C. İ Üstün¹, E. Öçalan^{*2}, K. Aktuğlu¹, G. Okcu³

¹Ege University, Izmir, Turkey

²Turgutlu State Hospital, Manisa, Turkey

³Celal Bayar University, Manisa, Turkey

Introduction: Bilateral femur fractures are frequently result of high energy traumas and they have high rates of morbidity and mortality.

Objectives: The purpose of this study is to evaluate the union of the bilateral femur fracture cases, performed on the same day, to determine the factors affecting the union.

Patients and methods: Between 2000 and 2015, 21 patients; 14 (66.7%) male, and 7 (33.3%) female were treated on the same session due to bilateral femoral fractures. The mean age of the patients was 41.38 (18-82) and the mean follow up time was 66.86 (12-166) months. Erythrocyte suspension and colloid amounts, sign of infections, durations of second surgery and union were reviewed retrospectively from patients files, including trauma type, fracture type, associated injuries, time to surgery, hospitalization, injury severity score and whether reaming procedure was applied.

Results: The cause of trauma for these patients were, four (19%) simple falls, six (28.6%) motor accidents, two (9.5%) gunshot injuries and nine (42.9%) car traffic accidents. 17 (40, 4%) of these 42 femurs were fixed by reamed intramedullary nailing (IMN), and the rest 25 were by unreamed IMN. There were 4 nonunions, also 2 patients had delayed union. Reamed IMN procedure was applied to 2 nonunion femurs, unreamed IMN procedure was applied to the other 2 nonunions and the 2 delayed-unions. There was no difference in union rate, union time and delayed union between reamed and unreamed intramedullary nailing ($p=0.240$). All nonunion cases happened to less-used extremities and nail was changed and union is achieved in all of them. The process of union observed as 5,7 (4-8) months for dominant femurs. On the other hand for the femurs less used the process observed was, 7.35 (5-12) months in average ($p=0.015$). The two nonunion fracture types were 32A3 while the other two were 32B1. It is observed that the fracture type has no effect on union ($p>0.05$). Also, the cause of fracture, associated injuries, time to surgery, hospitalization time and amount of transfusions have no effect on union ($p>0.05$).

Conclusion: When the operated cases of bilateral femoral fractures mobilized, their dominant extremities undertake more pressure of weight. In this case it is identified that earlier union occurs to the femur undertaking more pressure of weight. Morbidity and mortality rates don't vary by the cases which are being operated at the same session or separate sessions. It is recommended to operate the cases at the same session because; it decreases the cost and reduces the hospitalization duration.

OP 28

Reduction in intramedullary nailing: from axis to rotational control and blocking screws to frame assisted nailing

C. Zeckey^{*1}, C. Neuerburg¹, D. Schray¹, W. Böcker¹, C. Kammerlander¹

¹Klinikum der Universität München, Dept. of General, Trauma and Reconstructive Surgery, Munich, Germany

Proper alignment in intramedullary nailing remains a great challenge for the responsible surgeon. Due to the intact soft-tissue envelope, indirect reduction techniques have been developed in order to limit the amount of soft tissue dissection. However, frontal and sagittal alignment and rotation are more difficult to determine. To control rotational malalignment, intraoperative techniques such as the lesser trochanter sign and the cortical step sign have been developed. In addition, the contralateral hip test is a useful tool to reduce incidence of significant rotational malalignment. Axis control is performed by using the cable technique or the axis board, reduction is guaranteed using indirect techniques such as blocking screws or frame assisted nailing.

In this talk, a comprehensive review of the literature will be provided and own cases will be demonstrated. An algorithm including timing and management of malalignment will be presented.

OP 29

Can treating Femur fractures caused by gunshot injury (GSI) with Intramedullary Nailing at the first session be a reliable procedure?

E. Öçalan^{*1}, C. Üstün², K. Aktuğlu², G. Okcu³

¹Turgutlu State Hospital, Manisa, Turkey

²Ege University, Izmir, Turkey

³Celal Bayar University, Manisa, Turkey

Introduction: Patients who have femur fractures as a result of gunshot type of injuries are strenuous to treat, and have high rates of mortality and morbidity. **Objectives:** The aim of this study is to determine whether it is a safe method to apply immediate intramedullary nailing (IMN) procedure for patients who have femur fractures caused by low-velocity gunshot injuries without neurovascular damage

Patients and methods: Between 2013-2015, twentyone femoral fractures caused by low-velocity gunshot injuries were treated with intramedullary nailing at the first session within the first 4 (1-4) days. All patients were male. The average age was 31,76 (19-55). The definition and classification of shaft fractures were based on the Arbeitsgemeinschaft für Osteosynthesefragen/Orthopaedic Trauma Association (AO/OTA) classification system. There were also three patients with multiple injuries. Two of these were ipsilateral tibia fractures and other was humerus fracture. The fractures included three (14.3%) proximal shaft, fifteen (71.4%) mid-shaft and three (14.3%) distal shaft fractures.

Results: Mean follow up time of the patients was 21.38 (12-34) months, mean fracture union proceeds 21 (18-28) weeks. There was no infection occurred. Two of the patients had 2 cm shortness. Four (19%) patients had delayed union. Eleven patients (52,4%) were treated by reamed IMN, ten were treated by unreamed IMN. Two of delayed union fractures (50%) were applied reamed IMN, the other two of them were applied unreamed IMN. It is determined that reaming procedure has no effect on union time ($p>0.05$).

Conclusion: Reaming provided the possibility of inserting a larger nail, resulting in similar results with unreamed IMNs, despite providing more stable fixation. It is a reliable method that is recommended by us because of the decent outcomes of immediate femoral IMN, absence of infection and the reduction of costs by lessening the length of stay in the hospital.

P 30

Distal Locking of IM Nail in Trochanteric Femur Fractures Treatment: How Many Screws should be Used?

A. Kalashnikov^{*1}, V. Malyk², I. Lazarev¹, Y. Stavinsky¹

¹SI The Institute for Traumatology and Orthopedics by NAMSU, Department for Traumatic Injuries and Matters of Osteosynthesis, Kyiv, Ukraine

²Poltava Regional Clinical Hospital, Traumatology Department, Poltava, Ukraine

Introduction: PFN is the method of choice for 31A2, 31A3 trochanteric fractures. Although, nail's distal fixation remains underestimated. A different amount of screws applied in the nails distal part for similar fractures is typical. Incorrect choice thereof could lead to extensive loading on fixator, and subsequently to breakage and/or dislocation of implants.

Material and methods: We studied loading on fixators in different variants of locking screws in distal part thereof using biomechanical simulation, depending on trochanteric fracture type. Elastically deformed fixator's features in fractures A1.2, A2.1, A2.3, A3 have been compared to the same of an intact bone; special attention was paid on loading levels in proximal and distal parts of nails and screws, and on the index of sliding screws' movement along the fracture line.

Results: Minimal loading indexes are typical of A1 fractures. A1.2 fracture with undamaged greater trochanter's back wall requires DHS system or IM nail without any distal screws; A2.2 and A2.3 fractures, less stable and complicated with bone fragments need both distal screws for better stabilization. A3 fractures are only rotationally unstable; one screw in the lower part of oval hole and use of long PFN is quite enough to enable patient's early use of the limb.

Our approach was applied to 103 patients with trochanteric fractures. The average age was 69 years old. We haven't got any distal interlocking problem, neither lateral migration, nor medial protrusion of hip screws. Average Harris Hip Score in 4 weeks was 56.5, in 4 months - 64.4, in 1 year - 71.2.

Conclusion

Differentiated approach to the quantity of screws for distal fixation of trochanteric nail eliminates the majority of complications relating to trochanteric IM nailing.

Session VII – Defect and pseudarthrosis

OP 31

Nonunion and Unplanned Reoperation Rates in Adult Distal and Diaphyseal Femoral Fractures: A Systematic Review and Meta-analysis

R. Nomides¹, C. Terhoeve², R. G. Steen^{2,3}, R. Zura^{*2}

¹UT Health San Antonio, San Antonio, United States

²Louisiana State University Health Sciences Center, New Orleans, United States

³Bioventus LLC, Durham, United States

Introduction: Nonunion is a serious complication after surgical fixation of distal femur fractures and femoral shaft fractures. Nonunion not only prolongs pain and disability but also increases costs to the patient and healthcare system. However, femur fractures can be slow to heal, making it difficult to determine which fixation methods are most likely to result in healing.

Objectives: The aim of this study was to evaluate the modern rate of healing, nonunion and other operative complications after fixation of distal and diaphyseal femur fractures.

Patients & Methods: A systematic review and meta-analysis of all published records in PubMed, Embase and Cochrane Review system was performed. Inclusion criteria were: > 20 consecutive patients 18 years or older with distal or diaphyseal femur fractures treated with primary internal fixation. Excluded were studies on abnormal patient populations, unusual fracture types (i.e. Hoffa's fracture), external fixation, traction, or cement/bone graft use. Data was analyzed using Z score with significance set at $p < 0.001$.

Results: Thirty-eight studies on 2,829 femoral shaft fractures and 11 studies with 505 distal femur fractures were included (Figure 1). Healing occurred in 93.7% of shaft fractures as opposed to 86.6% of distal fractures ($p < 0.00001$). Distal fractures also had higher total reoperation rates ($p < 0.00001$) than shaft fractures. In particular, revision for mechanical failure ($p < 0.00001$) and deep infection ($p = 0.0001$) were more common in distal fractures than shaft fractures.

Nonunion was the most common complication for both fracture types, occurring in 4.8% of distal femur fractures and 3.1% of femoral shaft fractures. Femoral shaft fractures had a similar rate of healing after fixation with an antegrade (94.5%) or retrograde nail (93.2%, $p = 0.60$). Nearly 3% of antegrade nailed fractures and 4.5% of retrograde nailed fractures developed nonunion ($p = 0.60$). Similarly, nonunion was the most frequent cause of reoperation in unreamed shaft fractures (6.1%) and reamed shaft fractures (2.9%, $p = 0.02$). In distal fractures, nonunion occurred in 4.5% of plate-fixed fractures and 5.4% of nailed fractures ($p = 0.42$). There was no difference between the LISS plate and nails or other plates.

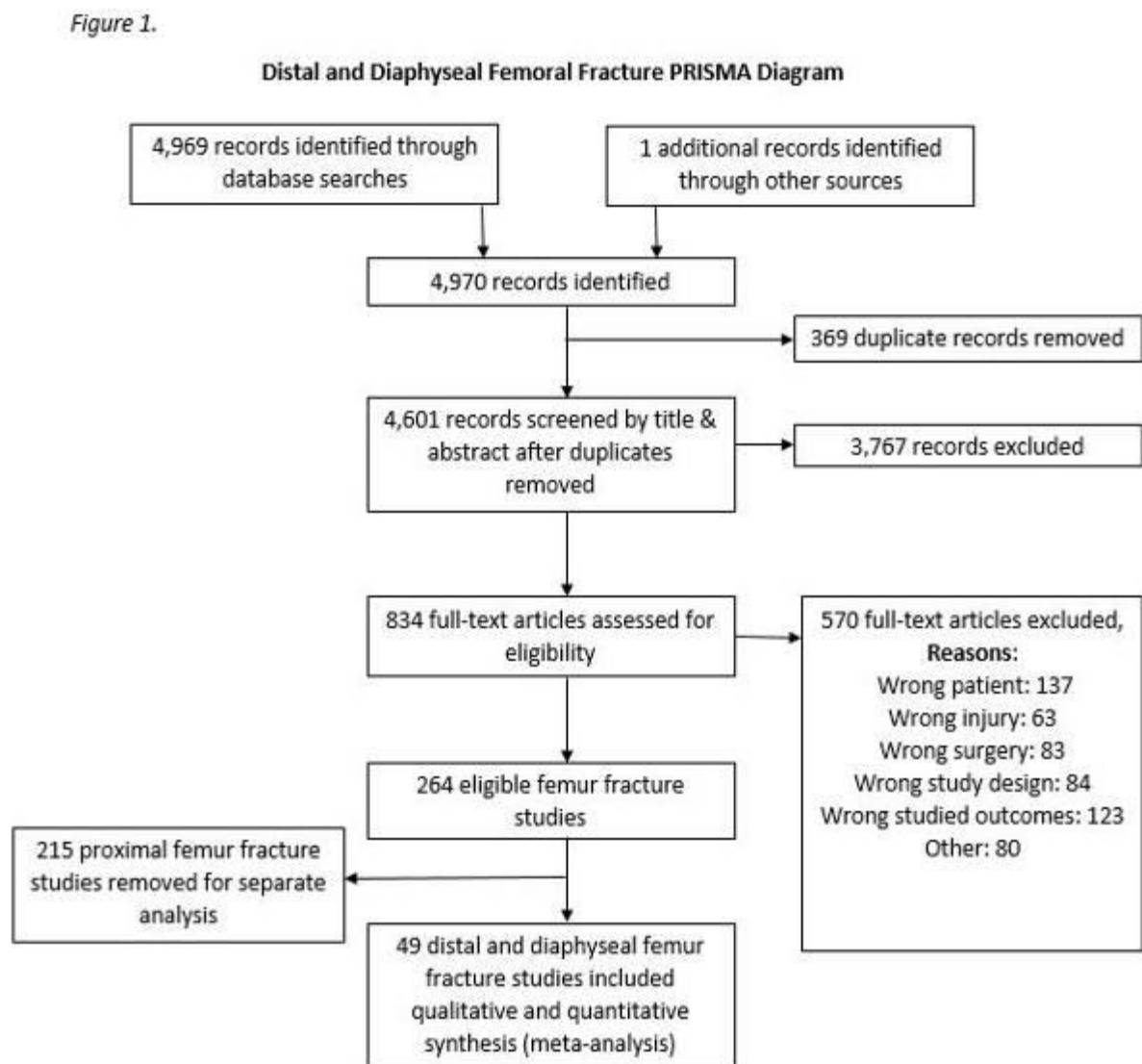
Conclusion: Nonunion is the most prevalent and critical threat to fixation of distal femur and femoral shaft fractures. Distal femur fractures in particular have high rates of complication, resulting in reoperation in approximately 1 out of every 8 patients. These findings indicate a serious need for further research directed towards improving outcomes in distal femur fractures.

Figure 1

Table 1. Diaphyseal vs. Distal Femur Fracture Fixation Outcomes								
	All Studies				2000-2015			
	Distal	Diaphyseal	Z score	P value	Distal	Diaphyseal	Z score	P value
Number of Fractures	505	2,829			402	2,323		
Uncomplicated Healing (%)	440 (87.1)	2,637 (93.2)	4.72	< 0.00001	348 (86.6)	2,176 (93.7)	5.03	< 0.00001
Total Reoperations (%)	65 (12.9)	187 (6.6)	4.90	< 0.00001	54 (13.4)	142 (6.1)	5.24	< 0.00001
Nonunion (%)	24 (4.8)	88 (3.1)	1.89	0.059	19 (4.7)	69 (3.0%)	1.84	0.066
<i>Causes of Reoperation</i>								
Nonunion (%)	24 (4.8%)	83 (2.9%)	2.14	0.032	19 (4.7)	64 (2.8)	2.12	0.034
Mechanical Failure (%)	18 (3.6)	17 (0.6)	6.02	< 0.00001	17 (4.2)	16 (0.7)	5.99	< 0.00001
Malunion (%)	3 (0.6)	8 (0.3)	1.12	0.263	2 (0.5)	3 (0.1)	1.59	0.112
Delayed Union (%)	8 (1.6)	61 (2.2)	0.83	0.407	6 (1.5)	41 (1.8)	0.39	0.697
Deep Infection (%)	12 (2.4)	18 (0.6)	3.81	0.00014	10 (2.5)	18 (0.8)	3.14	0.002

Table 1. Distal femur fracture more frequently underwent reoperation, particularly for mechanical failure, than diaphyseal femur fractures. Uncomplicated healing (not requiring reoperation) occurred in more patients with femoral shaft fractures than distal femur fractures. Outcomes from recently published studies (2000-2015) are similar to historic data.

Figure 2



OP 32

Revision of atrophic femur shaft non-unions- Reamed intramedullary nailing versus additional application of bone morphogenetic protein (BMP) and spongiosa

L. Hellinger^{*1}, S. Hackl¹, V. Bühren¹, M. Perl¹

¹BG Unfallklinik Murnau, Murnau, Germany

Aim: Stimulation of bone remodelling is a center goal in the treatment of atrophic femur shaft non-unions. This can be achieved through reamed intramedullary nailing or through (additional) application of BMP or spongiosa. Aim of our retrospective study was to evaluate the stimulating effects of BMP and spongiosa on bone remodelling and fracture healing.

Methods: In a retrospective study we included all patients from 2006- 2015 with an atrophic non- union of the femoral shaft who received exchange of the reamed intramedullary nailing (n=36). We compared groups with just reamed intramedullary nailing (MN-) to additional application of BMP and/ or spongiosa (MN+). Furthermore we analysed the distribution of risk factors and the impact of microbes found in the non-union. Statistical analysis was performed with SPSS (U- Test; p<0,05)

Results: In 44,4% (n=16) reamed intramedullary nailing was performed without additional intraoperative application of BMP and/or spongiosa. In 43,8% (n=7) of this group microbes were detected. Time to healing was 17,6 months. 55,6% (n=20) of our cohorte received an exchange of the intramedullary nailing with reaming and application of BMP and/ or spongiosa. In this group microbes were found in 30% (n=6). Healing time in this group was 20,9 months. Regarding the healing time there was no statistical significance. Also AO- classification showed no statistical difference between the two groups. Risk factors as soft tissue injury, smoking, diabetes, NSAID were equally distributed in both groups. Furthermore detected microbes in the non- union didn't show significant negative influence on the healing time (20,6 months). Time to healing in atrophic non-unions without positive microbiology was 18,1 months.

Conclusion: Regarding the healing time single use of intramedullary nailing is as effective as additional application of BMP and spongiosa. Risk factors could equally be found in both groups. Single performance of exchanging reamed intramedullary nailing without using biological drugs in comparison to the group with additional BMP and/ or spongiosa seems to be a cost- effective and successful option for operative revision in atrophic femur shaft non- unions. Reaming during exchanging the intramedullary nailing seems to be a sufficient stimulus on bone remodelling in our cohorte.

OP 33

Low-grade-infection in the pathogenesis of primarily aseptically classified nonunion of the lower extremity

S. Hackl^{*1}, L. Hellinger¹, C. von Rüden^{1,2}, J. Friederichs¹, V. Bühren¹, M. Perl¹, C. Hierholzer³

¹BG Unfallklinik Murnau, Murnau, Germany

²Paracelsus Medical University, Institute of Biomechanics, Salzburg, Austria

³Universitätsspital Zürich, Klinik für Traumatologie, Zürich, Switzerland

Aim: The pathogenesis of nonunion is multifactorial. Pathobiological factors, mechanical factors, and low-grade-infection contribute to impaired bone healing. Aim of this study was to determine the rate of low-grade-infection in patients with long bone nonunion of the lower extremity without signs of acute infection, the influence of CRP (C-reactive protein) and the outcome.

Methods: In a retrospective study (2003-2014), all patients who underwent surgery for treatment of tibial- or femoral-shaft-nonunion without any clinical evidence of infection were assessed. Bacterial cultures harvested during nonunion revision, the CRP and WBC (white blood cells) values at hospital admission, the outcome, and epidemiological data were analyzed.

Results: In 88 patients with tibial-shaft-nonunion without any clinical signs of infection, bacterial samples remained negative in 51 patients (46 yr; 33% open fracture; 33% nicotine abuse; 8% diabetes mellitus; revision of nonunion 10.9 months following primary osteosynthesis). In 37 patients (46 yr; 54% open fracture; 42% nicotine abuse; 11% diabetes mellitus; revision of nonunion 15.2 months) microbiological diagnostic studies after long-term-culturing demonstrated positive bacterial cultures whereas after short-term-culturing for 2 days only 17 positive cultures were observed. Among patients with negative bacterial cultures bone healing was achieved after 13.2 months, whereas in

29% additional surgical interventions (1.3 procedures) were necessary. Nonunion with positive bacterial cultures required 22.9 months (p-value<0.01) until bone healing, and even 57% of these patients required additional operations (2.9 procedures; p-value<0,01). Hematological studies performed at hospital admission demonstrated no significant difference regarding CRP (negative vs. positive culture: 0.8 mg/dl vs. 1.9 mg/dl) and WBC (negative vs. positive culture: 7.6/nl vs. 7.8/nl). Comparable results were observed in 86 patients with femoral-shaft-nonunion (38 patients with positive bacterial cultures after long-term-culturing and 18 patients after short-term-culturing) with an increased number of required operations (0.8 vs. 1.6 procedures; p-value<0.05) and a longer time period until bone healing (18.2 months vs. 27.2 months; p-value<0.05) in the group with positive bacterial cultures. In contrast to tibial-shaft-nonunion, a significant difference of the CRP level was observed (negative vs. positive culture: 0.8 mg/dl vs. 2.7 mg/dl; p-value<0.01).

Conclusions: The pathogenesis of nonunion may originate from low-grade-infection even in patients without any signs of infection and may result in increased number of required surgical interventions. Therefore, during any nonunion revision surgery, multiple bacterial samples should be harvested for long-term-culturing. Possibly, increased CRP levels may be a predictor for low-grade-infection in femoral - but not in tibial-shaft-nonunion.

OP 34

Management of impending and pathologic fracture in the femur

R. A. Zamora^{*1}, L. R. Douglas¹, D. Seligson¹

¹University of Louisville, Orthopedics, Louisville, United States

With the increase of cancer rates the number of bone metastatic disease is also rising. Long bones are a frequent location for metastatic bone lesions (MBL). Most of the time, cure of cancer is not possible when tumor cells reach or grow in the bone.

The improvement in the quality of life is the main goal of surgery on patients with MBL. In the femur, most metastatic lesions present with pain being the principal indication for surgery.

Intramedullary nailing with or without cement augmentation is the preferred technique to prevent or treat MBL in the femur. Different alternatives of treatments are offered to some patient depending on estimation of overall survival. Conventional hip or knee replacements and large tumoral replacements are other option on selected cases. Radiation therapy is indicated in most cases after surgery.

Conclusion: The rate of impending and pathologic fractures is increasing and is correlated with raise in the rate of cancer in general.

Intramedullary nailing fixation with or without cement augmentation on the femur is the most common technique to prevent or treat fractures due to MBL.

Radiation therapy is required after surgery to prevent complications associated with bony fixation.

OP 35

One-step approach for the augmentation of osteoporotic fractures using adipose derived progenitor cells - from mice to men

F. Saxer^{*1}, A. Scherberich², A. Todorov², P. Studer¹, S. Miot², S. Schreiner¹, S. Güven², L. Tschang³
M. Haug³, M. Heberer², D. Schäfer³, D. Rilkli¹, I. Martin¹, M. Jakob¹

¹Universitätsspital Basel, Orthopädie/Traumatologie, Basel, Switzerland

²Universitätsspital Basel, Biomedizin, Basel, Switzerland

³Universitätsspital Basel, Plastische, Rekonstruktive, Ästhetische und Handchirurgie, Basel, Switzerland

Introduction: Stromal vascular fraction (SVF) cells from adipose tissue are an abundant source of mesenchymal/endothelial progenitors. Studies on non-expanded isolates have demonstrated their osteogenic and vasculogenic properties, which could be beneficial in cases of dysfunctional bone metabolism like osteoporosis (as opposed to osseous autograft). After demonstration of their biologic contribution to bone healing in an orthotopic rodent model, we aimed at investigating safety and feasibility of SVF application as cellular component for augmentation of osteoporotic fractures.

Methods: Autologous human SVF-cells were implanted as cellular component of an hydroxyapatite (HA) graft in segmental femoral defects in immune-compromised rats after locking-plate osteosynthesis (RatFix, RISystem, CH), with cell-free grafts as control. Mechanical, microCT and histological analysis was performed after six weeks. For clinical use lipoaspirates were processed in an automated device (Celution®800CRS, Cytori, USA) the cellular output was directly implanted as part of an HA graft to augment low-energy fractures of the proximal humeral after locking-plate fixation in 8 elderly patients. The SVF was assessed for cell characteristics, viability and differentiation potential. Follow-up was performed for 6 month. In case of plate revision or removal, a bone biopsy from the grafted area (n=6) was analyzed using microCT and histology. The safety of the approach was defined as the absence adverse reactions (AR), feasibility as the absence of protocol deviations.

Results: In the animal model, only SVF cell-treated defects healed mechanically stable and displayed mature bone with osteocytes and vascular structures of human origin. Clinically the intra-operative processing from 272 ± 63 ml abdominal lipoaspirate yielded 121.4 ± 72 million SVF-cells, manufacturing of the graft was feasible, standardized and reproducible. The procedure was safe, without AR during the trial or follow-up (max. 39 months). The duration of hospitalization and the course of rehabilitation were uneventful. MicroCT and histology of the repair tissue from clinical biopsies demonstrated the formation of ossicles as early as 6 weeks postoperative. Newly formed bone was spatially disconnected and morphologically distinct from osteoconducted bone, suggesting the osteogenic nature of implanted SVF cells. Highly vascularized areas were present at the interface.

Discussion & Conclusions: These trials suggest that the non-expanded SVF without exogenous priming but within a fracture-micro-environment, can safely promote de novo generation of vascularized bone. The efficacy of the proposed approach should be evaluated in controlled trials with larger patient cohorts.

Registrations/Permits: ClinicalTrials.gov # NCT01532076, EKBB, Ref.#348/10, BAG Ref.# Bk2010-nTx-Z046-N0-V00, KVet Basel-Stadt, permission no. 2357

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OP 36

Fragility fractures of the ankle in the elderly: Open reduction and internalfixation versus tibio-talo-calcaneal nailing: Short-term results of a prospective randomized-controlled study

M. Savvidis^{*1}, D. Georgiannos¹, V. Lampridis¹, I. Bisbinas¹, G. Gkouvas¹

¹424 General Military Hospital, Orthopaedic, Thessaloniki, Greece

Introduction: The management of ankle fractures in the elderly remains unpredictable, secondary to their various co-morbidities. Although tibiototalcalcaneal (TTC) nailing has been an effective option for anklearthrodesis due to ankle arthritis or Charcot arthropathy there are few reports regarding the use of TTC nail for the treatment of ankle fractures. Purpose: Aim of this study was to compare the results of ORIF versus TTC nailing for the treatment of unstable ankle fractures in the elderly. We hypothesized that the elderly may benefit from TTC nailing, as it allows the patient to be mobilized immediately after surgery and minimizes the risk of wound or bone problems.

Patients and methods: This was a prospective, randomized-controlled, comparative study. Between 2009 and 2015, 43 patients were treated with a TTC nail (Group A) and 44 with ORIF (Group B). The Olerud-Molander ankle score was obtained and intraoperative-postoperative complications, length of hospital stay, mobility status and reoperation rate were recorded. The nail fixation was performed with the TrigenR hindfoot nail after closed reduction. ORIF was performed, using a 1/3 tubular plate and 3.5 mm screws for the lateral malleolus and two 4.0 mm cannulated screws for the medial.

Results: Mortality rate at one year was 13.9% for Group A and 18.1% for Group B. Mean follow-up was 14 months (12–18 m). There were no intraoperative complications. Three complications in Group A (8.1%) and twelve (33.3%) in Group B were encountered postoperatively ($p < 0.05$). There was significant shorter hospital stay in Group A ($5.2 \pm 3.1d$) than in Group B ($8.4 \pm 5.2d$). In Group A, 28 patients returned to their pre-injury mobility status (75.6%) while 9 declined one level of the mobility scale (24.3%). In Group B, 26 patients remained at the same mobility level (72.2%) and 10 declined one level (27.7%). There was no significant difference between the postoperative OMAS scores in the two Groups (56.9 ± 9.85 and 56.6 ± 9.3 respectively).

Conclusions: We believe that TTC nailing is a safe and effective method of treatment of unstable ankle fractures in the elderly because it has a low risk of complications and restores function and mobility allowing an immediate return to full weight-bearing.

Figure 1



OP 37

Die Bedeutung und Simplizität der osteologischen Diagnostik am Beispiel einer Femurschaftfraktur

D. Schray^{*1}, U. Stumpf¹, D. Pfeufer¹, W. Böcker¹, C. Neuerburg¹, C. Kammerlander¹

¹Ludwig-Maximilians-Universität München, München, Germany

Fragestellung: Obwohl eine ausgeglichene Kalziumhomöostase wesentliche Voraussetzung der Frakturheilung ist, wird die osteologische Behandlung neben der unfallchirurgischen Therapie oftmals vernachlässigt. Der folgende Fall soll die Simplizität der osteologischen Diagnostik und deren Bedeutung als essentieller Bestandteil der unfallchirurgischen Behandlung verdeutlichen.

Methodik: Eine 55-jährige Patientin wurde bei atraumatischer Femurfraktur rechts (AO-Typ 32-B2) mit einer antegraden, aufgebohrten Marknagelosteosynthese versorgt. An Vorerkrankungen lag ein Multiples Myelom mit Z.n. mehrfacher, autologer Stammzelltransplantation vor. Intraoperativ zeigte sich eine suspekta Verdickung der lateralen Femurkortikalis auf Frakturhöhe. Die entnommene Markraumprobe ergab keinen Anhalt für Malignität und laborchemisch zeigt sich ein insuffizienter 25-OH-Vit. D Spiegel (12,7 ng/ml). Erst auf genaue Nachfrage, gab die Patientin an bereits seit einem Jahr Beschwerden in dem betroffenen Bein zu haben wegen derer bereits 3 Monate zuvor ein CT durchgeführt worden war. Ferner erfolgte seit acht Jahren aufgrund des Multiplen Myeloms eine i.v. Bisphosphonat-Therapie mit Zometa.

Ergebnisse und Schlussfolgerung: Unter Zusammenschau der Befunde handelt es sich in dem vorliegenden Fall um eine atypische Femurfraktur. Die Identifikation der zugrundeliegenden Fraktorentität konnte dabei anhand einer intraoperativen Beurteilung der Knochenbeschaffenheit, einer osteologischen Risikofaktoranalyse und genauen Anamneseerhebung sowie unter Berücksichtigung der histo-pathologischen Befunde gesichert werden. Durch die Komplettierung eines Osteoporose Basislabors einschließlich 25-OH Vit. D Spiegel wurde die bestehende Basistherapie mit einem höher dosierten Vit. D-Supplement angepasst und nach Diskussion der Befunde mit den Onkologen eine Therapiekarenz der Bisphosphonat-Therapie bei stabilem Verlauf des Multiplen Myeloms indiziert. Oftmals kann bereits ohne komplexe apparative Diagnostik oder fundierte osteologische Kenntnisse, unter einer aufmerksamen, simplen Zusammenschau der Befunde, eine osteologische Grunderkrankung identifiziert werden. Die Anpassung der osteologischen Behandlung wie in dem vorliegenden Beispiel einer atypischen Femurfraktur ist dabei entscheidend zur Prävention etwaiger Komplikationen wie der Pseudarthrose oder Sekundärfrakturen. Insbesondere bei Hochrisikopatienten sollte eine weiterführende osteologische Basisabklärung daher essentieller Bestandteil der unfallchirurgischen Therapie sein zur Identifikation möglicher Risikofaktoren und Ätiopathogenese der Fraktur wie einer atypischen Femurfraktur in dem vorliegenden Fall.

OP 38

Orthogeriatric patients with proximal femoral fractures benefit from inpatient rehabilitation

C. Stadler¹, D. Pfeufer^{*1}, C. Neuerburg¹, S. Mehaffey¹, D. Schray¹, W. Böcker¹, C. Kammerlander¹

¹The university Hospital of Munich, Department of General, Trauma and Reconstructive Surgery, München, Germany

Background: The number of proximal femur fractures in geriatric patients is rising globally. Due to the challenging complexity of these patients' treatment, fragility fractures are becoming a major burden to health care systems all over the world.

Previous studies have investigated the short-term effects of an inpatient rehabilitation designed for geriatric patients. Only few studies however have analyzed the long-term outcome over twelve months regarding the functional status of orthogeriatric patients suffering from proximal femur fractures.

Objective: We studied the short- and long-term effects of an inpatient rehabilitation on the functional status of orthogeriatric patients with surgically treated proximal femur fractures.

Material and methods: We included 135 patients older than 80 years with surgically treated proximal femur fractures in this study. We excluded patients with an initial Barthel Index lower than 30 points.

The patients were assigned randomly to one of this study's subgroups depending on the availability of treatment spots at the rehabilitation center. No other item was used to discriminate between the

groups. Group A (n=85) stayed an average of 21 days at an inpatient rehabilitation center specialized in geriatric patients. Group B (n=50) received the standard postsurgical aftercare.

We chose the Barthel Index as main outcome parameter regarding the patients' functional status and evaluated it on day of discharge as well as during checkups after three, six and twelve months for each patient.

Results: On the day of discharge Group A had an average Barthel Index of $56,82 \pm 14,45$ points while Group B's mean Barthel Index was $53,70 \pm 17,52$ points ($p=0,290$). In the three-months-checkup, the average Barthel Index was $81,66 \pm 18,56$ points for Group A and $72,70 \pm 21,76$ points for Group B ($p=0,017$). After six months Group A's average Barthel Index was $83,12 \pm 19,42$ points while Group B's mean Barthel Index was $74,10 \pm 20,82$ points ($p=0,014$). The twelve-months-checkup revealed an average Barthel Index of $80,29 \pm 21,43$ points for Group A and $68,90 \pm 26,08$ points for Group B ($p=0,011$).

Conclusion: This study reveals a significant better outcome regarding not only the short- but also the long-term functional status of orthogeriatric patients who received a treatment in a rehabilitation center.

To restore the patient's preoperative quality of life and independence in activities of daily life, a treatment in a rehabilitation center specialized on geriatric patients could be a feasible approach for many orthogeriatric health care providers.

OP 39

The importance of posterior femoral cortex reaming during insertion of the lengthening nails

M. Kucukkaya^{*1}, O. Karakoyun², M. F. Erol², S. Sokucu³, Y. Kabukcuoğlu²

¹Ortopedist, Istanbul, Turkey

²Tekirdağ Namık Kemal University, Tekirdağ, Turkey

³Aydın Üniversitesi, Orthopaedics, Istanbul, Turkey

Introduction: One of the reported complications related with lengthening nails fractures around the locking screws. The shape of the femoral medullary cavity is not straight and the posterior part of the inner femoral cortex is thicker. Insufficient reaming of the posterior wall of the medullary canal inclines the tip of the straight lengthening nail or rigid reamer during reaming anteriorly. This might cause perforation or weakening of the anterior cortical femur. We postulate that this is an important cause of fractures around the locking screws during an operation or follow-up.

Objectives: The question was What is the effect of reaming of the posterior cortical wall on the incline of the tip of the nail to the anterior femoral cortex?

Patient and Method: We worked on drawing paper and with the Coreldraw program. In our model, the nail was 245 mm long, 11 mm wide. The osteotomy was performed on 8 cm of the intercondylar notch and bulged inner femoral cortex started from 10 cm of the intercondylar notch. We worked on various scenarios for understanding the relation between the tip of the nail inclination and cortical thickness and localization.

Result: In this scenario the measurements and calculations on the healthy femur revealed that the protruding part of the nail on the proximal anterior cortex was 6 mm in length, with an unreamed retrograde nail application. Posterior displacement of the nail tip was 6 mm when the posterior cortex was reamed by 3 mm at 10 cm proximal to the intercondylar notch. After the osteotomy, a recurvatum deformity occurred after the nail was inserted, contributing to the posterior movement of the nail tip, and the final nail tip posterior displacement was found to be >6 mm; this was sufficient for the prevention of the impingement.

Conclusion: Reaming of the dense posterior cortical wall is extremely important for smooth and easy insertion of the lengthening nail and for the prevention of fracture complications.

OP 41

Management of Tibia fractures using Expert Tibia Nail (ETN), suprapatellar vs. infrapatellar Approach

R. Aldeeri^{*1}, M. C. Tanner¹, U. Brunnemer¹, A. Moghaddam-Alvandi², C. Rehnitz³, G. Schmidmaier¹
M. Miska¹

¹Heidelberg University, department of Orthopaedic and Trauma surgery, Heidelberg, Germany

²Klinik Aschaffenburg Alzenau, Chirurgischer Klinik II, Traumazentrum, aschaffenburg, Germany

³Heidelberg University, Radiology Department, Heidelberg, Germany

Introduction: Intramedullary nailing of tibia shaft fractures is a standard surgical procedure worldwide. Using the classical infrapatellar portal poses many challenges: localizing the correct point of entry, manipulating the calf from extension to flexion and inserting the nail without loss of reduction. Insertion of the nail via a suprapatellar approach facilitates the surgical procedure markedly, but it is theoretically associated with risk of iatrogenic injuries to the intra-articular structures of the Knee joint. The aim of this study is to evaluate these different approaches based on the clinical and radiological outcome and the iatrogenic injuries possibly incurring with the suprapatellar approach.

Methodology: Of a total of 38 patients treated between November 2014 and December 2015, 15 Patients received a suprapatellar approach (Group A) and 23 Patients an infrapatellar (Group B). All patients were treated with an Expert Tibia Nail (ETN, Synthes, West Chester, Pennsylvania, USA). All Patients have been examined clinically and radiologically in our out-patient clinic during regular follow-up, which included answering a standardized questionnaire with clinical scores (Knee Osteoarthritis Outcome Score, Lysholm Knee Score, Tegner activity score, SF12). All patients with suprapatellar approach additionally received an MRI of the affected Knee joint.

Results: 1 year postoperative follow up showed consolidated Tibia fractures in both groups. The KOOS in Group A showed better results than in Group B in all categories. 13% of the patients in Group B have retropatellar pain and 43.4 % have tenderness of the patellar tendon. Group A showed no such complaints. Group A showed markedly faster return to work within 3 months after the surgery (66% vs. 31%) and within 6 months after surgery more were active in sports (47% vs. 22%). MRI of the Knee in Group A showed possible iatrogenic cartilage injury in 10 Patients (66.6%), which at the time of follow up showed no clinical correlation.

Discussion: The suprapatellar approach offers easier localization of the entry point to the tibia medullary cavity and easier insertion of the nail. Additionally our study showed that patients with suprapatellar insertion have better functional results and no significant complaint. On the other hand we discovered that despite the use of protective sleeves, possible iatrogenic cartilage injuries were seen in these patients, albeit without any clinical correlations.

OP 43

The innovative limited-flexible BoneHelix® - a totally new principle for longbone fracture stabilization tops the stiff intramedullary nail

R. Labitzke*¹

¹Emiratus der Uni Witten Herdecke, Schwerte, Germany

For decades stiff intramedullary nails have been used for shaft fractures of long bones. Their disadvantage: nails have to be driven in with a heavy hammer and must be removed later with the use of significant force. In cases of hollow (reamed) nails, the bone marrow has to be drilled out in order to give room to the nail. The destruction in the bone marrow adds to the damages of the fracture. Healing takes considerably longer or even fails to happen at times. In collaboration with H&R Medizintechnik I have developed a bone spring that, in comparison to intramedullary nailing, allows a gentle stabilization of the fracture zone. The BONEHELIX® works on the principle of a calculated coil spring with slight lateral flexibility. It actively encourages the callus formation while providing sufficient stability. This is in accordance with Wolffs law. As a result the healing process of the patients is remarkably accelerated. An external brace (at the lower extremity) is in most cases unnecessary. Studies show that operation times are shortened. After a long and successful approval process of the BONEHELIX® models C1, C2 and C3, the HELIX can now also be used for children. A new system for shaft fractures with an osteoporotic bone and for non-unions is currently in the clinical test phase.

At the Annual Meeting of the Gerhard Küntschler Society 2017 in Munich I will present the BONEHELIX® and provide exciting insights into the use, functioning and advantages of this extraordinary intramedullary stabilizer.

OP 44

Evaluation of an Intracorporeally Ultrasonic Welded PEEK IM Nail System

P. Bonutti¹, J. Beyers*¹, T. Bierman¹, M. Cremens¹

¹Bonutti Research, Effingham, United States

Introduction: We investigated a novel procedure for non-loadbearing fixation of a long bone by ultrasonically welding Polyether ether ketone (PEEK) tacks to a PEEK molded Intramedullary (IM) nail implanted in an ulna. This innovative technology advances traditional fixations by allowing for nearly infinite fixation locations, limiting C-arm exposure, and reducing procedure time.

Objectives: This study verified the safety and efficacy of an intracorporeally welded IM nail system as an alternative treatment to traditional IM nails. Thermal and mechanical testing was performed on the IM nail and tack to verify the temperatures during welding stay within a safe range and the mechanical strength of the rod withstands the required forces. The torque strength of the welds directly compares to the mechanical strength of the traditional IM nails and is capable of withstanding newton metre (Nm) of force.

Materials and Methods: *Ultrasonic Welding and Implants*

The OsteoWeld Ultrasonic Fixation System comprises a generator with digital signal processing to dynamically compensate the drive signal for use in arthroscopic and endoscopic environments, a footswitch to activate the system, and an autoclave safe hand piece used to convert the ultrasonic

waveform into vibratory energy to consistently weld the implant. The implants consist of a PEEK intramedullary nail and tacks. The nails have a titanium core with a PEEK overmold. The tacks are constructed out of PEEK. The implants are specific to the ulna and offer torsional stability, axial control and rotational alignment. Other implant configurations can be developed for other anatomical locations.

Temperature Testing

Temperature testing was performed on cadaveric ulna bone. The PEEK IM nail was inserted into the ulna medullary canal and access holes were reamed and cleared of debris for insertion of the tacks. Tacks were ultrasonically welded to the IM nail. Thermocouples were placed at the implant and on the bone surface near the weld site during the ultrasonic welding process.

Mechanical Testing

Mechanical Testing was performed on cadavers. The PEEK IM nail was inserted into the reamed ulnar medullary canal with the help of a guide and proximal distal locking for stabilization. Tack access holes were reamed and cleared of debris. Once cleared of debris, the tacks were ultrasonically welded to the IM nail and cut flush to the bone surface. Mechanical torque testing was then performed.

Results: Temperature Testing

Temperature testing was performed on 4 cadaveric samples. The mean initial implant temperature was 21.5C and increased to 28.4C during the welding process. Additionally the mean peak bone temperature reached 27.4C and the mean time for the implant to return to initial temperature was 40 seconds.

Mechanical Testing

The IM nail and tacks were successfully implanted in the cadaver ulna. During the torque measurement the bone was tack was displaced at 1.69Nm, which was above the 1Nm requirement.

Conclusion: This study confirms that ultrasonically welding PEEK tacks to PEEK molded nails offers a safe and effective alternative to traditional IM nails.

Figure 1



Figure 2



OP 46

A prospective randomized study on operative treatment for simple distal tibial fractures: Minimally invasive plate osteosynthesis versus minimal open reduction and internal fixation

K. C. Park^{*1}, O. J. Shon², K. I. Kim³

¹Hanyang University Guri Hospital, Orthopaedic surgery, Guri, South Korea

²Yeungnam University Hospital, Daegu, South Korea

³Kyung Hee University Hospital at Gangdong, Seoul, South Korea

Question: We hypothesized that minimal ORIF allows anatomical reduction without increasing soft tissue problems, including infection, because it involves minimal soft tissue dissection and preserves the vascularity of the soft tissue. This technique is a combination of anatomical reduction (ORIF) and biologic fixation (MIPO). The purpose of the present study was to compare minimally invasive plate osteosynthesis (MIPO) and minimal open reduction and internal fixation (ORIF) in the treatment of simple distal tibial fractures by assessing complications and secondary procedures.

Methods: Fifty-eight patients with simple and distal tibial fractures were randomized into a MIPO group (treatment with MIPO; n = 29) or a minimal group (treatment with minimal ORIF; n = 29). The 2 groups were matched with respect to age and sex. The clinical outcome measurements included operative time, radiation exposure time, and soft tissue complications. To evaluate a patient's function, the American Orthopedic Foot and Ankle Society ankle score (AOFAS) was used. Radiological measurements included fracture alignment, delayed union, and union time.

Results: All patients acquired bone union without any secondary intervention. The mean union time was 17.4 weeks in the MIPO group and 16.3 weeks in the minimal group. There was 1 case of delayed union and 1 case of superficial infection in each group. The radiation exposure time was shorter in the minimal group than in the MIPO group. Coronal angulation showed a difference between the 2 groups. The AOFAS scores were 86.0 and 86.7 in the MIPO and minimal groups, respectively.

Conclusions: For simple distal tibial fractures, both MIPO and minimal ORIF have a high union rate and good functional outcomes. Minimal ORIF has advantages over MIPO on radiation time and coronal alignment.

OP 47

Comparison of intramedullary nailing versus plate fixation in distal tibia shaft fractures

K. Durak¹, T. Atici¹, B. Akesen¹, A. Durak^{*1}, B. Sarisozen¹

¹Uludag University, Orthopaedics And Traumatology, Bursa, Turkey

Objective: To compare clinical and radiological results of intramedullary nailing and plate fixation techniques in distal tibia diaphyseal fractures

Material and Method: Thirty-six patients with extraarticular distal tibial fractures were enrolled in this retrospective study. Twenty one patients (58.3%) were treated with closed intramedullary nail (Group I) and 15 patients (41.6%) were treated with plate fixation (Group II). Union time and, complications with union problems were evaluated.

Results: Mean age was 44 years (Group I: 61 (17-90) and Group II: 39.9 (20-63), p<0.05) and 88.8% were men (32 patients). Sixteen patient (44.4%) had open fractures (Group I/II: 7/9). The average follow-up period was 37.3 months (9-81) for Group I and 41.3 months (9-85) for Group II. The mean union time was 4.9 months (2-10) for all patients (Group I: 4.5 months and Group II: 5.1 months, p>0.05). Angular malalignment (<10°) was determined in 8 patients (Group I:5 (23.8%) and Group II:3 (20%), p>0.05). Malunion was more common after open fracture (6 patients). Four patients had nonunion (Group I/II: 2/2). One patient developed implant failure in Group II. Implants were extracted and intramedullary nailing and autografting was performed for this patient. Union was 6 months. In 4 patients (Group I/II:2/2) the implants extracted. two of these extractions were performed due to infection.

Conclusion: The treatment of distal tibia fractures with closed reduction and nails or plates are an easy, effective and safe biological fixation method with minimal damage to surrounding tissues, In these fractures, when the surgical technique is implemented carefully which are intramedullary nailing

or plate fixation means appropriate treatment methods. Cost-benefit analyzes to be carried out in subsequent studies will provide additional information on the method which used in the treatment of these fractures

OP 48

An arthroscopy assisted reduction and fixation technique of complex postero-lateral tibial plateau fractures

O. Poyanlı^{*1}, M. S. Söylemez², Y. İyetin³, M. E. Uygur¹, K. Akan⁴

¹Istanbul Medeniyet University, Orthopaedics and Traumatology, Istanbul, Turkey

²Bingöl State Hospital, Orthopaedics and Traumatology, Bingöl, Turkey

³Private Pendik District Hospital, Orthopaedics and Traumatology, Istanbul, Turkey

⁴Private Tuzla Medical Park Hospital, Orthopaedics and Traumatology, Istanbul, Turkey

Introduction: Tibial plateau fractures are challenging for orthopedic surgeons as excellent anatomical reduction and stable fixation is mandatory for satisfactory clinical and radiological results. Although open reduction and internal fixation (ORIF) of these fractures is the traditional surgery technique, assessment and perfect reduction of the articular surface under fluoroscopic guidance has been shown to be inadequate especially in complex fractures that involves postero-lateral-central region(1).

Objectives: In this study our surgery technique and preliminary clinical and radiological results in treatment of complex fractures that involves postero-lateral-central region of tibial plateau fractures that maintains accurate reduction of the joint surface with the use of arthroscopy is presented.

Patients and methods: Over the period from February 2016 to December 2016 five patients sustaining complex tibial plateau fracture were operated by senior author (Figure 1). Reduction with arthroscopic guidance and fixation through an antero-median incision was performed in all patients.

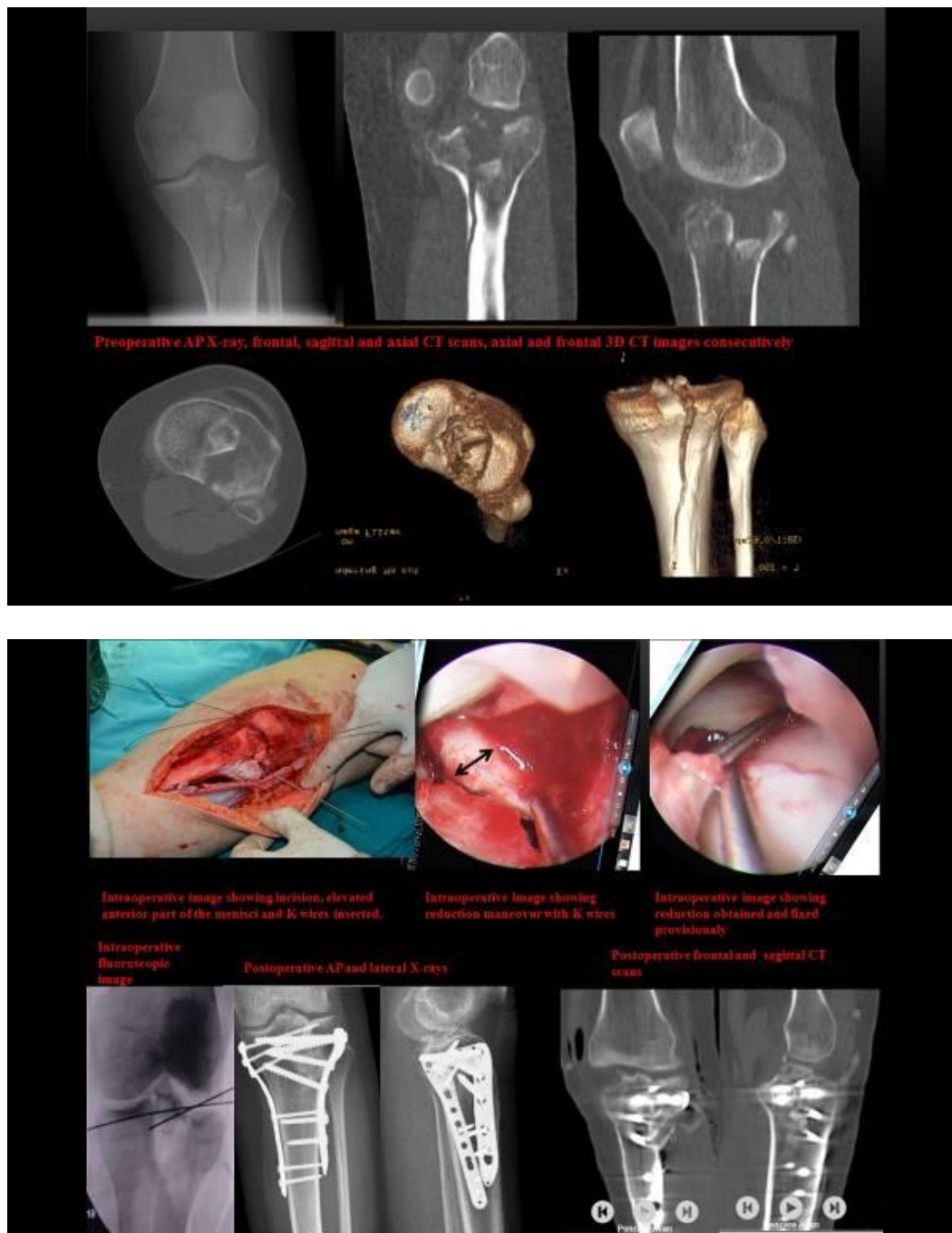
The following is a detailed description of the technique.

With the patient in a supine position, injured lower extremity and one of the iliac wings are prepared with a standard manner for surgery. A towel is placed under the knee to achieve 30° to 45° of knee flexion to facilitate maintaining the fracture alignment. The tourniquet is inflated, and an antero-median longitudinal incision is made to allow surgeon place both medial and lateral plates through the same incision. After soft tissue dissection of lateral site of the knee, anterior part of lateral menisci is detached from its tibial insertion point for K wire and arthroscope insertion.(Figure 2) Depressed or displaced fracture fragments were elevated by tapping through either anterior part of the fracture line or a small window created at lateral site of the metaphysis. Subsequently, dry arthroscopy is performed through standard antero-medial portal and gap created by detaching anterior part of lateral menisci. In all cases although elevated, articular fractures were mostly still displaced and unstable after tapping at arthroscopic assessment stage. Displaced articular fragments are reduced under arthroscopic guidance with the manipulation of K wires inserted below detached menisci and constant tapping from metaphyseal window. After obtaining anatomical reduction articular fracture fragments are fixed temporarily with K wires(Figure 2). Subchondral region is filled with cancellous autograft taken from iliac wing. Final fixation is performed by applying lateral plate and then medial plate if needed before removal of K wires. Lateral menisci is attached to its tibial insertion and incision is sutured as usual.

Results: Mean follow up time was 7 months (4-15 months.) Initial postoperative CT scans showed perfect reduction in all patients(Figure 2). No loss in reduction, nonunion or infection was detected in any of the patients. All patients had gained full ROM of their knee at postoperative 4 months.

Conclusion: Although ORIF allows direct visualisation of the fracture, complex fractures of tibial plateau mostly involves postero-lateral-central part (2). Adequate assessment of these region is impossible with either through an arthrotomy or under fluoroscopic guidance. Arthroscopic assisted reduction and fixation of these fracture possesses perfect visualisation of the articular surface which is the key point to obtain better clinical and radiological results.

Figure 1



OP 49

Collapse patterns of 23- C2, C3 fractures fixed with volar locked plates. Can the intermediate column collapse independently?

M. Rashkov^{*1}, A. Baltov¹, D. Enchev¹, D. Enchev¹

¹EMI "Pirogov", III Orthopedic trauma, Sofia, Bulgaria

Introduction: Although reliable fixation with a single volar locked plate (VLP) can be achieved in the majority of C2 and C3 fractures, "settling" of the fracture with loss of length and angular displacement is not rare after fixation with a VLP. It is still unclear if fixation compromise follows certain predictable patterns and whether "columnar" theory, that accounts for load distribution patterns across the radio carpal joint can provide a biomechanical explanation for these. Moreover, the variables of surgical technique that may predispose to collapse have not been explicitly stated.

Objectives: The objective of this study is to test the relationship between a specific pattern of fixation loss – an independent collapse of the intermediate (IM) column in a series of C2/C3 fractures fixed with a VLP and two variables in surgical technique - quality of articular reduction or number of locked screws.

Patients and methods: This is a retrospective, comparative, radiographic study of 53 patients with 54 C2/C3 fractures according to AO classification. VLP has been used as the principle fixation device. Intra-operative and final follow-up bi-planar X-rays were measured. This study was specifically directed at recording reduction loss. We defined "**reduction loss**" as change in radiographic parameters as follows: radio-ulna angle - 4°, dorso-volar angle 5°, ulna variance - 2 mm, radial deviation - 2mm. Retrospectively, we sought the link between the presence of an articular "gap or step" and the number of locking screws inserted through the plate in the intermediate column and loss of fracture reduction.

Results: The cohort includes 30 females and 23 males of mean age 54.38 years. The average follow-up is 2.55 years. 10 fractures were classified as C2 and 44 fractures as C3 according to AO. In 14 patients the threshold values of radiographic parameters were exceeded and they were diagnosed with "**reduction loss**". In a group of 8 patients, a collapse pattern that included an **increase of radio-ulna angle value, decrease of ulna variance** measurement and an insignificant change in the measurements for radial deviation and radial length attracted our attention. This reduction loss modality was named **collapse of the intermediate column**.

Overall, 25 out of 54 fractures were fixed with a step or gap (46.29%), gap/step were found in 18 out of 46 fractures without IM column collapse (39.13%) and in 7 out of 8 fractures with collapse (87.5%).

The average number of screws that a fracture in this study received in the IM column is 2.22 (SD 0.99), the average number of screws in patients with diagnosed lunate fossa collapse is 1.25 (SD 0.43) and in patients without such failure – 2.39.

Conclusion: In this material of predominantly C3 fractures, a collapse pattern of IM column is noted. It almost invariably takes place in the environment of insufficient mechanical support (lower number of locking screws) and after imperfect intra-articular reduction.

OP 51

Plate removal following distal radius fracture surgery is related to Soong grading

C. Selles^{*1}, S. Reerds², G. Roukema², K. van der Vlies², B. Cleffken², N. Schep²

¹Academic Medical Center, Surgery, Amsterdam, Netherlands

²Maasstad Hospital, Surgery, Rotterdam, Netherlands

Question: Plate fixation is an accepted method in distal radius fracture treatment offering biomechanically stable fixation and thus allowing for early rehabilitation. Incidence for plate removal ranges with a reported incidence between 3-10%. Volar plate position can be classified according to Soong. This is a classification that determines implant prominence at the watershed line of the distal part of the radius. It is suggested that a higher Soong classification is related to flexor tendinitis and tendon rupture. The primary aim of this study is to determine the relationship between volar plate removal and the Soong classification system. We hypothesize that a higher Soong grade will be

associated with plate-related complaints and thus be more common in the group of patients where plate removal has taken place. Secondary outcome measures are incidence and indications for plate removal, including dorsal and combined volar and dorsal plates following distal radius fracture treatment.

Methods: In this retrospective cohort study, all consecutive patients who had volar, dorsal or combined plate fixation for a distal radius fracture in 2011-2015 were reviewed. Patients were excluded if they underwent an alternate form of fixation, had less than one year of follow-up, or could not be reached for follow-up. Soong grade was examined on postoperative radiographs of all patients who had volar plate fixation. The higher Soong grade the more prominent the volar plate at the watershed line. Differences in Soong classification between patients who had plate removal and those who did not have plate removal were analyzed. . Additionally, the total incidence and indications for plate removal was calculated.

Results: A total of 342 patients were included. Soong classification was significantly higher in patients who had plate removal compared to those who did not ($p<0.001$). The incidence of plate removal in all patients was 17.5%. In patients with volar plating, dorsal plating and double plating the incidence was 16.4%, 37.5% and 21.4% respectively. Indications for plate removal were: pain (65%), stiffness (13.3%), malpositioned screws (5%), carpal tunnel syndrome (5%), corrective osteotomy (3.3%), extensor tendon irritation (3.3%), and extensor tendon rupture (3.3%). Patients who had plate removal were 10.2 years younger compared with patients with the plate in situ ($p<0.001$). At one year following plate removal, 85% of patients had no more complaints.

Conclusions: Soong grading is higher in patients who have undergone plate removal. This stresses the importance of accurate plate positioning. The total incidence of plate removal after distal radius fractures is 17.5%. In patients with volar plating, dorsal plating and double plating the incidence was 16.4%, 37.5% and 21.4% respectively.

Figure 1

Variable	Odds ratio	p-value, (95% CI)
Age	0.96	0.001 (0.94-0.98)
Gender	1.02	0.957 (0.47-2.24)
Soong grade		
Grade 0	(ref)	
Grade 1	1.46	0.385 (0.62-3.43)
Grade 2	6.68	<0.001 (2.74-16.24)

OP 52

Is nailing a safe procedure in forearm fractures regarding radioulnar synostosis?

E. Uygur^{*1}, İ Türkmen², S. Batıbay², F. Akpınar³

¹Istanbul Medeniyet University Goztepe Training and Research Hospital, Istanbul, Turkey

²Ümraniye Training and Research Hospital, Orthopaedics and Traumatology, İstanbul, Turkey

³Istanbul Medeniyet University Goztepe Training and Research Hospital, Orthopaedics and Traumatology, Istanbul, Turkey

Introduction: Radioulnar synostosis is one of the complications in forearm fractures. There are many risk factors for it (Table)(1–6). It is more common after plate osteosynthesis. However, though rarely predicted, synostosis after nailing has not been investigated before.

Objectives: In this study we aimed to indicate lower incidence of synostosis after intramedullary forearm nailing.

Patients and methods: In the literature, the incidence of radioulnar synostosis is proposed 1.2-10%. However we propose that synostosis would be lesser after forearm nailing. For a one-sided t test with a significance level of 0.05, assuming 2% of synostosis, a sample size of 78 patients was required to obtain 80% power. Patients who had been treated in our hospital due to both bone fractures at forearm were recruited into the study. To investigate synostosis better, fractures at the same level were included for the study. According to hospital records, patients who had follow up more than six months were included to the study. While radiographs were evaluated retrospectively, patients were invited to the hospital for physical examination. Parameters such as age, trauma energy velocity, time to fracture healing and any occurrence of synostosis were noted.

Results: The mean age of the study was 33.4 (23-71). 67.9% of the patients were male and 32% of them were female. 48 patients (61.5%) have had high velocity of trauma. To obtain 78 patients retrospectively, last four years were needed to be scanned. Clinically the average follow up duration was 26.4 (6-46) months. According to Grace and Eversman scoring system, less than 10 degree of forearm rotations are accepted as excellent outcomes(7). Three patients had 30 degree rotational impairment. Remaining patients (94.8%) were in good and excellent group. Union rate was 100%. Only one patient (1.2%) was detected with proximal radioulnar synostosis. The patient has had head injury and was operated on at 28th day after trauma, during his hospitalization in intensive care unit.

Discussion: In the treatment of forearm fractures in adults, it is recommended to perform rigid osteosynthesis, which is maintained by plate fixation(7),(8). Although plate fixation seems to be more anatomic it brings lots of complications with it. Radioulnar synostosis is one of the prominent complications of forearm plating(1).

In the literature synostosis after forearm fracture surgery has been depicted as 0-10% (1)-4. Marcheix et al. (8) postulated that 4% of their patients after plate osteosynthesis and Weckbach et al.(6) 6% of their patients with forearm fracture after nailing were complicated synostosis. The mentioned incidence has been demonstrated in all forearm fractures. However in our study we only investigated both bone fractures at the same level which is the most risky group for synostosis. This is one of the strengthen factors of our study. On the other hand, the unique patient who had synostosis has had many major risk factors; head injury, proximal forearm fracture, both bone fracture at same level and delayed operation day. Therefore, in this study it is demonstrated that synostosis is an extremely rare complication of forearm nailing. Potential causes for lower synostosis in our cases may be due to not disturbing interosseous membrane during intramedullary nailing and recommending patients early rehabilitation after the surgical procedure.

Conclusion: Intramedullary forearm nailing promotes very low incidence of synostosis.

Figure 1**Table: Risk factors for radioulnar synostosis****Patient Dependent Risk Factors:**

High energy trauma

Excessive soft tissue damage

Comminuted fractures

Both bone fractures at the same level

Both bone fractures at proximal forearm

Butterfly bone fragment

Head injury and treatment in intensive care unit

Surgical Intervention Dependent Risk Factors:**During Surgery:**

Delayed surgical treatment

Single incision

Excessive long screws (for plate osteosynthesis)

Drilling bone cortex adjacent to the interosseous membrane

Violation of interosseous membrane

Retained bone fragments at interosseous area

After Surgery:

Prolonged immobilization

Session XII – Femur**OP 53****Erich Lexer, Surgeon and Scoundrel**D. Seligson*¹, C. Dunlap¹¹University of Louisville, Orthopedics, Louisville, United States

Prof. Erich Lexer created many innovations in surgery. Early in his career he nailed the ankle from the heel. He also transplanted limbs, bridged blood vessels, and invented the face lift and breast reconstructions. He was a proud Nationalist. His death is still a mystery.

OP 54**Antegrade nailing versus locked plating for extra-articular distal femoral fractures**E. Öçalan*¹, C. İ Üstün², K. Aktuğlu², G. Okcu³¹Turgutlu State Hospital, Manisa, Turkey²Ege University, Izmir, Turkey³Celal Bayar University, Manisa, Turkey

Introduction: The purpose of this study was to retrospectively evaluate the use of locked plating (LP) and antegrade intramedullary nailing (AIN) for treating extra-articular distal femoral fractures.

Patients and methods: From January 2000 to March 2015, 97 patients (49 male, 48 female) with extra-articular distal femoral fractures were surgically treated. The patients were divided into two groups according to the treatment method, with 69 (71.1%) patients being treated by locked plate (LP group) and 28 (28.9%) patients with antegrade intramedullary nailing (AIN group).

Fracture types, associated trauma, hospital stay, Injury Severity Score (ISS), nonunion, reoperation rate and Lysholm Functional Knee Score were assessed.

Results: The demographics of age and gender in both LP and AIN groups were similar. Nonunion was seen in sixteen patients (16,4%). Five(%5,1) patients in the AIN group and eleven(11,3%) patients in LP group with nonunion needed a secondary procedure ($p=0.773$). ISS was significantly higher in AIN group ($p=0.033$). No differences were found with respect to postoperative malreduction, deep

infection, hardware failure, reoperation rate and nonunion. However, the Lysholm Functional Knee Score was significantly higher in the AIN group (mean 67.25) compared to the LP group (mean 40.78), ($p=0.019$).

Conclusion: Both fixation methods offer good results but functional outcomes in the AIN group was significantly higher than LP group.

OP 55

Are there biomechanical benefits in augmentation of LISS plating compared to conventional LISS plating?

D. Todorov^{*1,2}, B. Gueorguiev², I. Zderic², K. Stoffel³, G. Richards², M. Lenz^{2,4}, D. Enchev¹, A. Baltov¹

¹University Multiprofile Hospital for Active Treatment and Emergency Medicine 'N. I. Pirogov, Traumatology department, Sofia, Bulgaria

²AO Research Institute, Davos, Switzerland

³Cantonal Hospital Baselland, Orthopedic and Musculoskeletal Traumatology Clinic and University of Basel, Basel, Switzerland

⁴Friedrich-Schiller University Jena, Department of Trauma, Hand and Reconstructive Surgery, Jena, Germany

Keywords: Distal Femur, LISS, Augmentation, Less Invasive Stabilization System, Fixation, Intramedullary Graft, Double Plating

Introduction: The incidence of distal femoral fractures in the geriatric population is growing and represents the second most common insufficiency fracture of the femur following fractures around the hip joint. Fixation of fractures in patients with poor bone stock and early mobilisation in feeble and polymorbid patients is challenging. Development of a fixation approach for augmentation of conventional LISS plating may result in superior long-term clinical outcomes and enhance safe weight bearing.

Objectives: The aim of this study was to investigate the biomechanical competence of two different techniques of augmented LISS plating for treatment of osteoporotic fractures of the distal femur in comparison to conventional LISS plating.

Materials and methods: Unstable distal femoral fracture AO/OTA 33-A3 was set in artificial femora with low density simulating osteoporotic bone. Three study groups, consisting of 10 specimens each, were created for instrumentation with a 9-hole LISS plate, a LISS plate with an additional 3D-printed polyactide cylindrical intramedullary graft, as well as a LISS plate plus a medial 3.5mm LCP (double plating). All specimens were non-destructively tested under axial (20-150N) and torsional (0-4Nm) quasi-static loading. Each construct was tested with two different working length (WL) configurations (long and short) of the LISS plate. Relative movements between the most medial superior and inferior osteotomy aspects were investigated via three-dimensional motion tracking analysis.

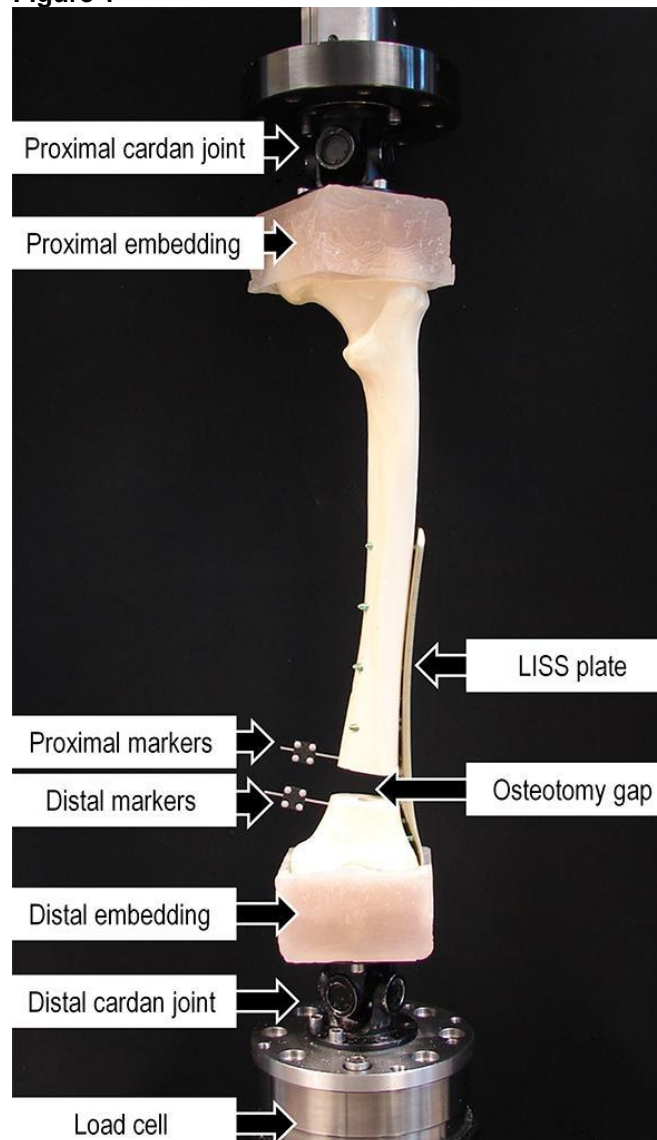
Results: Interfragmentary displacement along the femur axis (mm) under 150N axial loading was $2.03 \pm 0.23 / 1.65 \pm 0.27$ for LISS with long/short WL, $0.18 \pm 0.06 / 0.18 \pm 0.04$ for double plating with long/short WL, and $0.40 \pm 0.05 / 0.30 \pm 0.05$ for LISS plus graft with long/short WL. Shear interfragmentary displacement (mm) under 4Nm torsional loading in internal rotation was $1.16 \pm 0.17 / 0.92 \pm 0.11$ for LISS with long/short WL, $0.40 \pm 0.10 / 0.43 \pm 0.07$ for double plating with long/short WL, and $1.09 \pm 0.13 / 0.82 \pm 0.11$ for LISS plus graft with long/short WL.

Double plating revealed significantly smaller longitudinal and shear displacement compared to the other two techniques for long and short WL, respectively ($P \leq 0.010$). In addition, LISS plus graft fixation was with significantly less longitudinal displacement in comparison to conventional LISS plating for long and short WL, respectively ($P \leq 0.001$).

Long WL resulted in significantly higher longitudinal and shear displacement compared to short WL for LISS and LISS plus graft ($P \leq 0.032$), but not for double plating ($P = 1.000$).

Conclusion: Intramedullary grafting resulted in **significantly increased fracture stability** under axial loading in comparison to conventional *LISS plating*. However, it was not efficient enough to achieve comparable stability to *double plating*.

Figure 1



OP 56

Clinical outcomes of arthroscopy-assisted retrograde femoral nailing of distal femoral fractures. How much minimal invasive can it be?

O. Poyanlı*¹, E. Uygur*¹, S. Söylemez², İ. K. Ünal³, İ. Türkmen⁴

¹Istanbul Medeniyet University Goztepe Training and Research Hospital, Istanbul, Turkey

²Bingöl State Hospital, Orthopaedics and Traumatology, Istanbul, Turkey

³Tekirdağ State , Orthopaedics and Traumatology, Tekirdağ, Turkey

⁴Ümraniye Training and Research Hospital, Orthopaedics and Traumatology, Istanbul, Turkey

Question: Does arthroscopy-assisted retrograde femoral nailing promotes acceptable clinical outcomes after management of distal femoral fractures?

Methods: Between January 2013 and April 2015 patients who were operated on for distal femoral fractures by arthroscopy assisted retrograde femoral nailing were recruited for the study. 12 patients were retrospectively evaluated. All intraarticular fractures were fixed via minimal invasive techniques under arthroscopic guidance without making an arthrotomy

Preoperative and early postoperative radiographs were taken from hospital records. They were invited to the hospital for the last control visit. At least 2 years were determined for minimal follow-up. They were evaluated by Lysholm Knee score.

Results: 5 patients had AO 33 A1-2, 3 patients had AO 32A1-2 concomitant with Hoffa (AO B3) fracture, 4 patients had AO 33 C2 fractures.

5 of those 7 patients who had intraarticular fractures also had meniscal tears (3 patients, 42.8%) and chondral lesions (2 patients, 28.5%). 1 patient had an eminentia tibialis fracture (14.2%) and 1 patient had a patella fracture (14.2%) (Fig 1). Average age of the patients was 34 (17-58) years old.

In radiological assessment, average time for fracture healing was 17 (15-19) months. In clinical assessment average Lysholm knee score was 87 (83-95) points.

Conclusions: The potential benefits of an arthroscopic technique compared with the standard arthrotomy are associated with achievement of a fracture that is well-aligned as a result of using of a correct entry point; a smaller skin incision and, thus, rapid soft-tissue healing; early mobilization; early convalescence; shorter hospitalization; and earlier return to daily life [1].

Additional advantages are as follows: i) concomitant treatment of intra-articular pathologies such as chondral lesions, meniscus tears, cruciate ligament tears, eminentia, Hoffa fractures, interchondylar T fractures, and patellar fractures; ii) ability to remove intra-articular loose bodies and debris; iii) avoidance or reduction of the negative effects of ionizing radiation (fluoroscopy); and iv) ability to directly check the nail depth.

The surgeon should be aware of the risk of fluid extravasations through the nail hole and fracture site into the thigh. Although controversial, fluid extravasations may be related to the risk of compartment syndrome [2]. These complications can be avoided by being careful and paying attention to fractures that extend to the joint.

Intra-articular soft tissue injuries are expected to be more common in patients with intra-articular fractures. Though our study sample is too low, most (71.4%) of the patients with intra-articular fractures had intra-articular soft tissue injuries related with the trauma.

In conclusion, based on its advantages and disadvantages, arthroscopic retrograde femoral nailing is a safe and minimally invasive technique for the management of distal femoral fractures, especially in patients with concomitant intra-articular pathologies.

Figure 1



OP 57

Study Of The Gap Size, Fixation System And Nail Material In The Stability Of Anterograde Reamed Intramedullary Nail In Femoral Transverse Fractures

S. Gabarre^{*1}, J. Albareda^{2,3,4}, L. Gracia^{5,1}, S. Puértolas^{5,1}, E. Ibarz^{5,1}, A. Herrera^{3,4}

¹Instituto de investigación en ingeniería de Aragón. I3A, Zaragoza, Spain

²Hospital Universitario Lozano Blesa, Servicio de Cirugía Ortopédica y Traumatología, Zaragoza, Spain

³Instituto de Investigación Sanitaria de Aragón. IACS, ZARAGOZA, Spain

⁴Universidad de Zaragoza, Surgery, ZARAGOZA, Spain

⁵Universidad de Zaragoza, Mechanical Engineering, ZARAGOZA, Spain

Introduction: Femoral shaft fractures are among the most serious of the skeleton, characterized by high morbidity and mortality in addition to presenting important complications and consequences. Consequently, they must be treated considering the most appropriate treatment depending on the type of fracture and location level.

Objectives: The presented study aims to the stability of an Intramedullary Stryker femoral nail S2TM. A finite element model of the femur has been developed, analysing various types of fractures in the subtrochanteric and diaphyseal supracondylar area, stabilizing with one combination of screws, studying the mechanical strength of the nail against bending and compression efforts, to determine its maximum resistant capacity. Two materials were studied for the metallic nail: 316 LVM stainless-steel and Ti-6Al-4V alloy. A comparative analysis of the different types of osteosynthesis at different fractures was done, in order to verify the optimal solution in each case.

Materials and Methods: A three dimensional (3D) finite element model of the femur from 55 year old male donor was developed combining geometry obtained from 3D scanning and computed tomographies. Nail surgery was reproduced in I-Deas in a virtual way under surgeon supervision. Bone, nail and screws were meshed with linear tetrahedra. They were assumed for the bone linear elastic isotropic properties with variable values according with the processed tomographies. Two metallic alloys were studied for the nail: 316 LVM and Ti-6L-4V. An irregular fracture pattern was developed with three different fracture gaps: 0.5, 3.0 and 20.0 mm and three fracture localizations: proximal, medial and distal for each gap size. Only one combination of screws was studied: one oblique placed proximally and two transverse at the distal part.

This study considered fully constrained conditions at the condyles and a load case associated with an accidental support of the leg at early post-operative (PO) was quantified to be about 25% the

maximum gait load. Contact interaction was assumed between the outer surface of the nail and the inner cortex of the medullary canal of the femur (Fig. 1). Interaction between screws and cortical bone was considered to be bonded, whereas contact between screws and femoral nail was simulated.

A clinical follow-up was realized, with a sample of 55 patients, 24 males and 31 females, with mean age of 52.5 years, treated with femoral nail Stryker S2TM. Localizations of fractures were 32 in the right femur and 33 in the left femur. The comminute grade was measured according to the scale of Winquist/Hansen.

Results: There is a good agreement between clinical results and the simulated fractures in terms of gap size. Thus, non-comminuted fractures have a mean consolidation time of 4.1 months, which coincides with the appropriate mobility at fracture site obtained in the FE simulations, whereas comminuted fractures (grade 4 Winquist and Hansen) have a higher mean consolidation period estimated in 7.1 months, corresponding to the excessive mobility at fracture site obtained by means of FE simulations. Higher range of mobility is obtained for titanium nails, which produce a higher rate of strains at the fracture site, amplitude of micromotions and bigger global movements compared to stainless steel nails.

Conclusion: It can be asserted that the anterograde locked nail is particularly useful in the treatment of a wide range of supracondylar fractures with proximal extension into the femoral diaphysis.

Figure 1

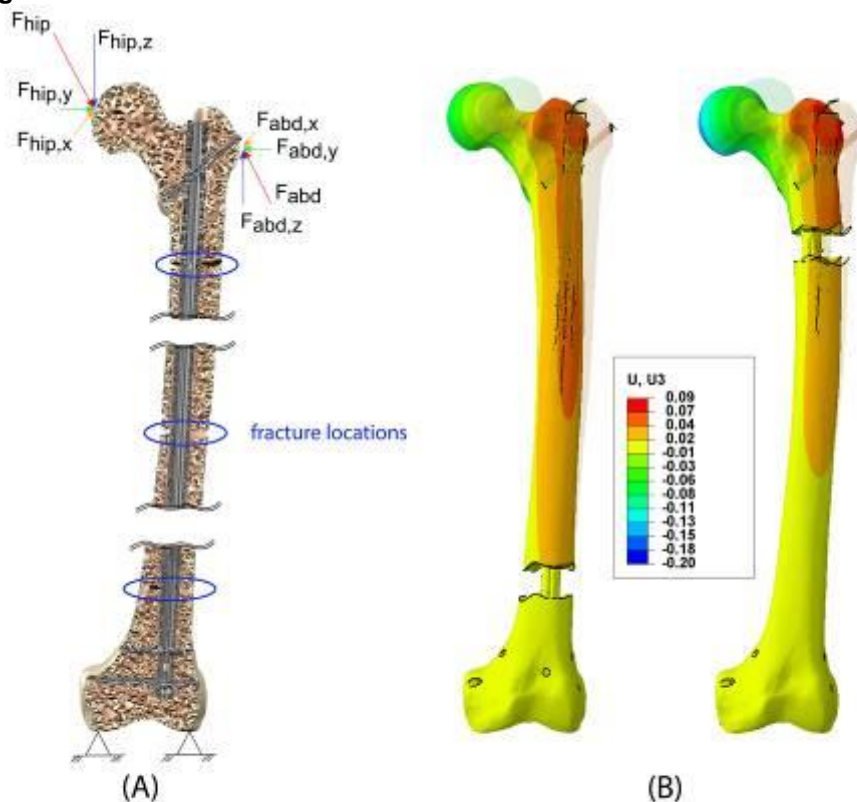


Figure 1. a) Section of the femur with de nail implanted with the three fracture locations studied and the applied boundary conditions; b) vertical displacement ($U3$) for a 20 mm fracture gap: proximal and distal locations. Deformed (amplified x50) and undeformed shape.

Figure 2**Table 1.** Amplitude of axial micromotion [μm]. Nail made of 316 LVM steel. Nail made of Ti-6L-4V.

		Maximum amplitude of micromotion [μm]		
	# Model	GAP 0.5 mm	GAP 3 mm	GAP 20 mm
Steel	Proximal	60.29	66.13	90.29
	Medial	51.96	53.77	73.39
	Distal	40.69	48.33	66.43
Titanium	Proximal	93.07	100.13	140.83
	Medial	75.88	107.81	139.80
	Distal	62.02	91.87	123.71

Session XIII – Knee

OP 59

Modification of Modified Judet Quadricepsplasty

M. G. Bilgili^{*1}, B. Tanriverdi¹, E. Edipoglu¹, İ. M. Hurmeydan¹, A. Duramaz¹, C. Kural¹

¹Bakırköy Dr. Sadi Konuk Research and Training Hospital, Orthopaedics and Traumatology Department, Istanbul, Turkey

Object: Modified Judet quadricepsplasty is a well-known successful operation for quadriceps contractures. The main disadvantage of this technique is high morbidity, especially in prolonged cases. The aim of this study was to present the results of modification of modified Judet quadricepsplasty procedure.

Methods: Sixteen patients (2 female, 14 male) were operated by modified Judet quadricepsplasty and trephination of the rectus femoris and vastus lateralis between 2010-2015. In their last follow-up, patients were evaluated by knee range of motion degrees and Judet criteria for functional capacity evaluation.

Results: The mean knee range of motion was preoperatively 25° (0-65°), in the early postoperative period it was 105° (90-110), and after 3.4 years mean follow-up it was 88° (70-110°). According to Judet criteria, 12 patients were excellent, two patients were good and two patients were fair. There was two deep infection during the early postoperative period which was healed free of problems by antibiotherapy.

Conclusion: Addition of trephination of rectus femoris and vastus lateralis to the modified Judet quadricepsplasty decreases the morbidity and results of this procedure were comparable to the previous studies. Therefore to reduce blood loss and surgical time, trephination can be preferred in these problematic patient group.

Keywords: Quadriceps, contracture, Judet quadricepsplasty, trephination, morbidity

Session XIV – Free topics

OP 60

Usage of the blocking nail as a new approach to treat patients with pubic fractures. A case series on patients with anterior pelvic ring fractures

N. Zadneprovskiy^{*1}, P. Ivanov¹

¹Skifosovsky Clinical and Research Institute for Emergency Care, Polytrauma Department, Moscow, Russian Federation

Background: Choice of optimal operative treatment of pubic bone fractures is still a challenge due to high incidence of complications and high stability requirements. New method of minimally invasive surgery can be a key to solve these problems.

Material and methods: 5 patients with pubic bone fractures treated in 2016-2017 in our institute were analyzed. Average age was 32,6 years. 2 patients had bilateral fractures (floating symphysis). All patients had polytrauma. There were no open fractures. Diagnostic procedures included roentgenography and CT scan. The injuries were rated according AO/OTA classification: 61-B1 (1), 61-B2 (2) and 61-C1/61-C2 (2). 7 operations of pubic bone nailing were carried out in 5 patients. Each operation had two stages. First one consisted of fixation of posterior pelvic ring. Second stage included retrograde nailing of pubic bone with interlocking using mini-approaches (forearm locked nail 3.5 mm, OSTEOMED Russia, Russian Federation). On 2-3 day after surgery active motions in joints and full weight-bearing were recommended. Average follow-up was 34 days. Quality of reduction was assessed by roentgenograms and CT scan.

Results: There were no surgical-site infections, skin necrosis and no loosening of the internal fixation. Stable pubic fractures fixation was confirmed in all patients clinically and roentgenologically.

Conclusion: There was a trend towards low infection rate and good mechanical stability. Blocking nails for pubic bone stabilization appears to be safe, reliable, and effective alternative to classic methods. Patients showed low pain postoperatively and quick recovery. Moreover such fixation can be

performed in patients with stomas and drainages in abdomen. Thus the method extends indications for operative treatment of anterior pelvic ring fractures.

OP 61

Managing soft tissue defects with computer assisted external fixators

B. Günaydın¹, İ Karakoyun¹, M. Küçükkaya², M. F. Erol^{*1}, A. Sari¹

¹Namik Kemal University School of Medicine, TEKIRDAG, Turkey

²Orthopedist Private Clinic, Istanbul, Turkey

Introduction: Soft tissue defects are a challenging issue in open fractures as well as in the patients with chronic osteomyelitis. The objective of the current study is to report the results of acute extremity rotation angulation with computer assisted hexapod external fixator(CAHEF) and primary wound closure followed by gradual soft tissue lengthening in patients with large soft tissue defects.

Material and method: Twelve patients with soft tissue defects on the crural region treated with acute extremity rotation angulation with CAHEF and primary wound closure followed by gradual soft tissue lengthening was the basis of the study. The mean age of the patients was 37.8 (18-69) years. Gustillo Anderson Type 3B open tibial fractures were the pathologies in 7 patients. One patient had talar chronic osteomyelitis as a complication of type 2 diabetes mellitus. The rest 4 patients had infected tibial nonunions which were previously treated with external fixators. A precise debridement of the wound of each patient was carried as a first step of the surgery. After that a computer assisted hexapod external fixator was applied and the extremity was rotated and angulated at the wound site so that primary wound closure is possible. Then the fixator was locked at the end of the surgery. On the postoperative 3rd week with the completion of the wound healing gradual correction and soft tissue lengthening was started. according to the recipe produced by the software in which skin was entered as the structure under risk. In this way the program was adjusted to allow 1 mm daily lengthening of skin. Consequently, the extremity was gradually corrected until the gross soft tissue anatomy arrived a near normal position. The mean soft tissue correction time was 10.7 (3-15)days. After the soft tissue correction was completed correction of the residual bone deformity was possible in 6 cases..In 1 patient proximal tibial lengthening osteotomy was added after defect site had been corrected and compressed. Talus resection and ankle arthrodesis was the final treatment in the talar osteomyelitis case. The final treatment was proximal tibial lengthening osteotomy with a simultaneous ankle arthrodesis. Autogenous bone grafting was necessary for bone healing in 1 case. In 2 patient the shortness was accepted and no additional intervention had been carried out. A stable bony union was achieved in all patients at the end of treatment. No recurrence of any of the soft tissue defects was observed.

Conclusion: In the large soft tissue defects, primary wound closure with forming a deformity and consequent soft tissue lengthening with CAHEF can be make an option for the surgeons without any need for additional soft tissue coverage procedures.

OP 62

Impact of Chronic Analgesic Use on Fracture Nonunion

T. Buchheit¹, R. Zura^{*2}, T. Royals², S. Mehta³, G. Della Rocca¹, Z. wang⁴, R. G. Steen²

¹Duke, Durham, United States

²LSU, ortho, new orleans, United States

³U Pennsylvania, Philadelphia, United States

⁴Bioventus, Durham, United States

Objective: Medications used during orthopedic surgery could potentially impact bone healing. We test a hypothesis that fracture healing impairment is limited to chronic medication use.

Background: Some medications increase fracture risk and might also increase fracture nonunion risk.

Methods: Multivariate logistic regression was used in an inception cohort to calculate odds ratios (OR) for fracture nonunion associated with medication use. Patient-level health claims for medical and drug expenses were compiled nationwide. Patients were included if they had a fracture coded in 2011, with continuous enrollment for 1 month prior to and 12 months after fracture. The database contained demographic descriptors, treatment procedures per CPT codes, co-morbidities per ICD-9 codes, and

prescriptions per National Drug Codes. Chronic medication use was defined as ≥ 30 days of prescription prior to fracture with ≥ 1 day afterward; acute use was any other prescription.

Results: Overall, 45,085 fractures (14.6% of fractures) affected patients using chronic opioids. Nonunion OR was elevated for acute and chronic use of Schedule 2 opioids including acetaminophen/oxycodone, hydromorphone, oxycodone, and acetaminophen/hydrocodone bitartrate, as well as Schedule 3-5 opioids including tramadol (all, $p < 0.0001$). The highest ORs were associated with chronic administration of Schedule 2 opioids including acetaminophen/oxycodone (OR=1.944), hydromorphone HCl (OR=1.728), and acetaminophen/hydrocodone bitartrate (OR=1.706). Most non-analgesic medications were not associated with nonunion, except antibiotics, anticoagulants, and bisphosphonates in acute use ($p < 0.0001$).

Conclusions: While most medications do not increase risk of fracture nonunion, acute and chronic use of opioids was associated with impaired fracture healing. Caution should be used when prescribing opioid medications.

OP 63

Effects of an above-pain-threshold exercise in a rat model for neuropathic pain

P. Herlyn^{*1}, A. Kregel², S. Bruhn³, A. Herlyn¹, T. Mittlmeier¹, B. Vollmar²

¹Chirurgische Klinik, Universitätsmedizin Rostock, Abteilung für Unfall-, Hand und Wiederherstellungschirurgie, Rostock, Germany

²Universitätsmedizin Rostock, Rudolf-Zenker-Institut für Experimentelle Chirurgie, Rostock, Germany

³Universität Rostock, Rostock, Germany

Introduction: Neuropathic pain is a typical symptom of CRPS (Complex Regional Pain Syndrome). One of the keystones in its therapy is physiotherapy below the pain threshold. Recently, clinical studies have suggested that physiotherapy may be beneficial if it is deliberately condoning pain. In this study we applied the clinical situation to an animal model of neuropathic pain and evaluated the impact of physical exercise on the development of pain symptoms.

Methods: Rats ($n=22$) received a Chronic Constriction Injury (CCI). 13 of these were trained using a modified interval training on a treadmill. 9 rats were allowed regular ambulation in single cages as a control group. Symptoms of neuropathic pain (spontaneous pain and mechanical hypersensitivity-using von Frey filaments) were measured during 5 weeks. Statistical analysis was done using t-Test with a $p < 0.05$ considered significant.

Results: All animals developed spontaneous pain and mechanical hyperalgesia. While the trained animals demonstrated an initial exaggeration of pain symptoms (week 1 mechanical hypersensitivity: 15g filament with 53% response in the training group and 10% in the control group, $p = 0.013$), their pain rating was significantly lower at the end of the observation period (week 5: 15g filament with 8.2% in the training group and 27.7% in the control group, $p = 0.006$; spontaneous pain: 0.17 in the training group and 0.74 in the control group, $p < 0.001$).

Discussion: All rats with a neuropathic pain condition (Chronic Constriction Injury) were able to complete a modified interval treadmill training. An initial aggravation of the pain symptoms in the training group was rewarded with a better outcome at the end of the observation period. Thus, this study supports recent findings in clinical physiotherapy research. In neuropathic conditions the efficacy of physiotherapy that permits the occurrence of pain during exercise was demonstrated in the animal model.

OP 64

Prescription Opioid Use In The U.S.

D. Easley^{*1}

¹White Lattice, PSC, Louisville, United States

This overprescribing has been driven by the reimbursement rules grounded in patient satisfaction. Today authorities have begun to develop programs to halt the overuse of prescribed narcotics. Goal setting has been difficult because it is not clear whether the desired outcome is abstinence or controlled substitution therapy.

P 01

Infrapectineal Plating In Acetabular Fracture

S. Park*¹, K. Choi¹

¹Dongguk University International Hospital, Orthopaedic Surgery, Seoul, South Korea

Introduction: The ilioinguinal approach was the predominant approach for anterior acetabular fixation. However, modifications of the original abdominal approach described by Stoppa have made another option available for reduction and fixation of pelvic and acetabular fractures. Also infrapectineal plating is a good option for osteoporotic and comminuted acetabular fractures. In this study we will evaluate our results in patients with acetabulum fractures with infrapectineal plating via the modified Stoppa approach.

Methods and Results: Between December 2013 and June 2016, 6 patients with acetabulum fractures were treated operatively using modified Stoppa approach. In cases with posterior displacement, an additional approach was utilized to address a posterior wall fracture. Follow up included radiographs (pelvis inlet, pelvis out let view and pelvis CT) and Harris score for functional outcomes.

Average follow-up was 1 year with a minimum of 3 months. Mean age for patients was 58 years. Fracture pattern, operative time, blood loss during the operation, quality of reduction and postoperative complications were assessed by retrospectively analyzing the medical records and the radiographic examinations. The mean postoperative Harris score was 63. Postoperative radiological evaluation revealed anatomical reduction. On pelvic CT coronal, sagittal and axial gap reduction was observed post operatively.

Conclusion: The results of infrapectineal plating with modified Stoppa approach for acetabular fractures, showed good functional out comes with minimal complications. This less invasive technique can be efficient while minimizing patients morbidity.

P 03

LCP fixation and intramedullary augmentation with frozen fibular graft for femoral pseudarthrosis

D. Enchev^{*1}, M. Rashkov², A. Baltov^{2,3}, D. Todorov^{2,3,4}, S. Asiov^{2,3,4,5}, B. Gueorguiev^{2,3,4,5,6}

¹University hospital "N.I.Pirogov", IV th orthopaedic and trauma department, Sofia, Bulgaria

²University hospital "N.I.Pirogov", III th orthopaedic and trauma department, Sofia, Bulgaria

³University hospital "N.I.Pirogov", Sofia, Bulgaria

⁴University hospital "N.I.Pirogov", IVth orthopaedic and trauma department, Sofia, Bulgaria

⁵University hospital "N.I.Pirogov", II nd orthopaedic and trauma department, Sofia, Bulgaria

⁶AO Davos, Davos, Switzerland

Introduction. It is well known that fibular graft with vascular supply is working horse in cases with bone defects and problematic bone union. Intramedullary augmentation with frozen fibular graft (IAFG) combined with LCP fixation is a new way that can solve specific cases with problematic femoral bone union.

Objectives. To represent the operative technique and the results after LCP fixation and IAFG in cases with femoral pseudarthrosis.

Material and method. For the period of 7 years 7 patients have been treated with pseudarthrosis of the femoral bone. There were 4 women and 3 men with mean age of 58,5 (11-87) years. The average duration of follow up was 46 months. Two cases were after periprosthetic femoral fractures type C and failed fixation. One case due to Morbus Ollier which was already treated 3 times. One was after failed nonoperative treatment of the diaphyseal simple femoral fracture with 10 years history, 1 was with non-union after supracondylar femoral fracture and failed RSOM with DCS, 1 was after high-energy complex femoral fracture fixed with LCP and 4 times bone grafting. The last one was after subtrochanteric femoral fracture that was operated more than 4 times. All cases were operated with the same technique. The frozen fibular graft was inserted intramedullary in a retrograde, anterograde and through the pseudarthrosis. LCP fixation was performed in a conventional way but the goal was to insert as many screws as possible to go through the fibula. Partial weight bearing started immediately and gradually increases after 6 weeks.

Results. All cases were evaluated and analysed for the mean time to union valgus and varus malalignment, neurological complications and functional recovery of the hip and knee joint. There were 2 persisted nonunions and 2 delayed unions. There were no infections. The average volume of movement of the knee joint (Lysholm Knee score) was 85° and HHS was 85.

Conclusion. IAFG and LCP fixation in carefully selected cases with pseudarthrosis of the femur can be helpful

Figure



Figure

2



P 04

Olecranon Fractures - Are Locking Plates Better?

A. Garber*¹, T. Hsing¹, D. Seligson¹

¹University of Louisville, Orthopedics, Louisville, United States

Traditional internal fixation of the olecranon with wires is being replaced by plate fixation. Both methods have equally high rates of reoperation for implant removal. Cost analysis of 10 cases from 2016, 5 plates and 5 tension bands, show a 1000 Euro increase for the plate implant alone. It may not be worth it.

P 05

My Big Broken Implant

A. Garber*¹, L. Douglas¹, D. Seligson¹

¹University of Louisville, Orthopedics, Louisville, United States

Sometimes big implants break. Five cases of catastrophic implant failure are analyzed from preoperative X-rays - bent nail, broken compression screw, and broken plate, to identify the mechanical fallacy in the original fixation and then show the solution post op.

P 06

Injuries Associated With Clavicle Fractures

O. Pazarci*¹, İ. Tuluçe¹, S. Kilinc¹, Z. Oztemur¹

¹Cumhuriyet University School of Medicine , Orthopaedics and Traumatology , Sivas, Turkey

Introduction: Clavicle fractures are common fractures observed in the emergency service. This study aims to present an investigation of injuries associated with clavicle fractures.

Material and Method: From 2006-2016, 256 cases with clavicle fractures treated at our clinic were retrospectively investigated. Patients without follow-up x-rays were excluded from the study. For 180 clavicle fracture patients, age, gender, side, AO fracture classification, trauma mechanism and accompanying injuries were investigated.

Results: The mean age of patients participating in the study was 31.11 years (min: newborn, max: 83). Of patients, 145 were male (80.6%) and 35 were female (19.4%). Fracture classification was completed according to the AO classification with 69.4% of patients included in the AO 15.2A group. Of patients, 66 (36.7%) were treated surgically, while 114 (63.3%) were given conservative treatment. Of the 180 clavicle fractures 56 (31.1%) had associated injury. These injuries included pulmonary injury (n:6), neurovascular damage (n:3), head trauma (n:6), rib fracture (n:11), vertebral fracture (n:6), scapula fracture (n:7), femur fracture (n:6), pelvis fracture (n:7), acromioclavicular joint dislocation (n:2), forearm fracture (n:7), shoulder dislocation (n:2), ankle fracture (n:2), liver contusion (n:1), scaphoid fracture (n:1), tibia fracture (n:5) and humerus fracture (n:4).

Conclusion: Clavicle fractures are accompanied by minor or major injuries at a rate of 31.1%. While treating clavicle fractures in the emergency service, it should be remembered that these additional injuries may be present.

P 07

Hip Arthroplasty After Femoral Head Gunshot Injury

O. Pazarci*¹, S. Kilinc¹, O. Bulut¹

¹Cumhuriyet University School of Medicine , Orthopaedics and Traumatology , Sivas, Turkey

Introduction: Gunshot injury to the hip devastates soft tissue and is an injury that is difficult to treat. Due to metallic fragments and adhesion of soft tissue, surgery is difficult. It may be accompanied by neurovascular injury. Additionally, infection, cartilage damage, synovitis, foreign body reactions and lead poisoning may be observed along the track of the bullet through soft tissue. The number of cases in the literature with total hip arthroplasty due to posttraumatic arthritis developing after gunshot injury is very low. The aim of this study is to present ten patients with hip arthroplasty after femoral head gunshot injury accompanied by treatment algorithm classification.

Material and method: Patients' age, gender, side findings and postoperative complications were noted. On physical examination, the infection was checked. In patients with intra-articular lead fragments, attention was paid to lead toxicity. Preop and postop harris hip scores were measured. Patients were divided into 3 groups. Group 1 patients; Post-injury bullet remains in the joint, rapidly advancing arthrosis, and abductor muscle length preserved. Group 2 patients; After the injury, the lead passed through the bone and left the body, the femoral neck was not seen, and the trochanter was displaced upward. Group 3 patients; Patients were with femoral head or neck injuries, accompanied by injuries to the intestine.

Results: The mean age of the patients was 29,9. The average time for patients to apply to our hospital after injury is 4,9 months. The average postoperative follow-up is 2 years. All patients; The mean preop Harris hip score was 25,2, postop 65,8. Harris hip scores of the patients according to the groups were shown on the table. Rapid coxarthrosis developed in patients with intraarticular lead fragments and the synovitis was found in the joints during surgery. No evidence of lead toxicity was detected in any of the patients. None of the patients had any pre-op infection. Femoral shortening osteotomy was performed in patients with trochanter major up displacement (group 2). Postoperative infection developed in patients with accompanying intestinal injury. (Contamination of the intestinal flora into the hip joint -group 3-).

Conclusion: For treatment after hip gunshot injury, tissue adhesion, metal artifacts, articular cartilage damage, articular contracture and synovitis make surgical treatment difficult. Before starting surgical treatment, all of these should be considered. Hip arthroplasty after gunshot injury is a good treatment choice in young patients to reduce pain and regain articular functions. But patients with accompanying intestinal injury has got very high infection rate. This group of patients must be cautious in terms of infection.

Figure 1

Table: Treatment groups and pre-op, post-op Harris Hip Scores

	n	Groups	Preop Harris Hip Score	Postop Harris Hip Score
Group 1	5	Patients whose lead parts are in the joint after injury and whose abductor muscle length is preserved	29,8	80,6
Group 2	3	After the injury, the lead passed through the bone and left the body, the femoral neck was not seen, and the trochanter was displaced upward. (abductor muscle length is not preserved)	25,6	58
Group 3	2	Patients with accompanying intestinal injury (Contamination of the intestinal flora into the hip joint)	13	40.5

K. El-Adwar*¹¹ Hadra Orthopaedic Hosp, University of Alexandria, Orthopaedics, Alexandria, Egypt

Question: Do undisplaced or minimally displaced conservatively treated lateral malleolar fractures unite readily?

Methods: This is a report of 4 patients, 2 with isolated lateral malleolar fractures, 1 associated with a small posterior malleolar fracture, and 1 trimalleolar ankle fracture (with undisplaced medial and posterior malleolar fractures). All had lateral malleolar Weber type B fractures. Their average age was 45.3 years (range, 37 to 55 years) and they were treated conservatively for an average period of 2.9 months (range 2 to 4 months). All patients presented with pain at the fracture site and inability to fully weight bear. Nonunion was suspected mainly on clinical grounds and plain radiographs were inconclusive in 2 patients. Multi-slice CT scanning confirmed the diagnosis of nonunion in all 4 cases. All patients were treated by open reduction, internal fixation, cancellous bone grafting (distal tibial in 3 and from the iliac crest in 1 patient), and a below knee cast for 8 weeks with gradual weight bearing during the last 2 weeks. Third tubular plates were used in 2 patients and locked plates in 2, with the use of a single interfragmentary screw in 3 patients.

Results: All fractures united within 2 to 3 months after surgery. Patients were followed up for an average period of 13.6 months (range, 6 to 18 months). However, ankle and subtalar joint range of motion remained limited in the older 2 patients (47 and 55-year-old) after a follow up of 6 and 13 months.

Conclusions: Undisplaced and minimally displaced Weber type B fractures are not innocent fractures. If treated conservatively can end up in nonunion.

After non operative treatment if in doubt about union CT is mandatory.

Nonunions should be treated by open reduction, internal fixation and cancellous bone grafting which usually yields good results. Primary open reduction and internal fixation should therefore be the treatment of choice of these fractures.

Figure 1



Figure 2



P 11

Pelvic Support Osteotomy; Salvage procedure in chronically dislocated hips.

Technical note for the on-lay bone positioning of a lengthening nail and review of the literature.

P. Reynders*¹

¹University Hospitals Brussels, Orthopedics, Brussels, Belgium

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 gait.

Classically the reconstruction is held by an Ilizarov external frame. In our case the proximal Schanz osteotomy was fixed by a conventional plate, whereas the distal varus osteotomy was held by an internal lengthening device correcting her leg length discrepancy.

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

Introduction.

The first description of the Pelvic Support Osteotomy comes from Lance 1936. He described a subtrochanteric femur osteotomy in the surgical treatment of chronically dislocated hips.

Two types of osteotomies were described afterwards, the osteotomy according to Lorenz who believed that the proximal femoral osteotomy should support or abut against the tuber ischiadicum, fig. 1a. Unfortunately this created a loss of parallelism of both lower legs and in some cases a painful limitations of hip movements.

The other femoral osteotomy described by Schanz in which the abduction angle was less pronounced with no proximal migration of the femoral shaft,fig.1b.

Ilizarov proposed additionally a varus osteotomy of the distal femur. This allowed allowed a strong abduction osteotomy of the hip and thus less Trendelenburg gait. By including this varus osteotomy of the distal femur, parallelism of the legs was restored, fig.1c. With his external circular frame Ilizarov added also a lengthening procedure of the femur by distraction-osteogenesis. Drawbacks of this treatment were the specific complications due to this unique external fixation mode. Also patients had to spent on average 7 months in an external circular fixation frame.

In our case the lengthening procedure was done by a lengthening nail attached to the lateral side of the femur.

P 13

Assessing the potential of neurological remission at admission after TSCI: The elastic net regression approach.

R. Heller^{*1}, T. Bock¹, M. Hörner¹, K. Kunzmann², P. Grützner³, V. Daniel⁴, A. Moghaddam⁵, B. Biglari³

¹University Hospital Heidelberg, Heidelberg Trauma Research Group (HTRG), Heidelberg, Germany

²University Hospital Heidelberg, Institute for Medical Biometry and Informatics, Heidelberg, Germany

³BG Trauma Centre Ludwigshafen, Ludwigshafen, Germany

⁴University of Heidelberg, Transplantation Immunology, Institute of Immunology, Heidelberg, Germany

⁵Klinikum Aschaffenburg-Alzenau, Aschaffenburg, Germany

Introduction: The study is designed as a clinical prospective observational study estimating the initial role of serum proteins and trace elements as protective factors after acute TSCI with respect to clinical covariates.

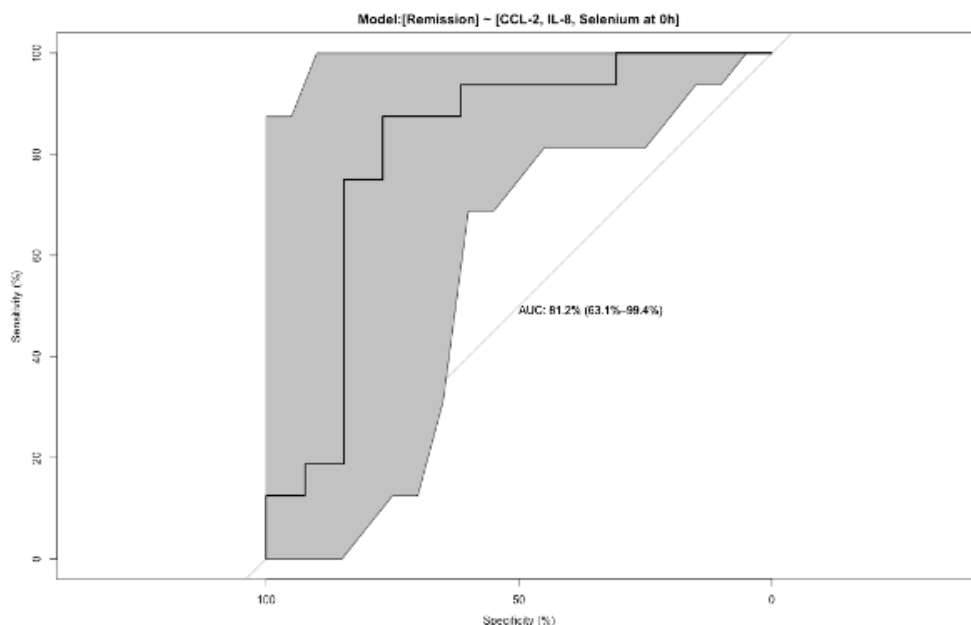
Methods: We examined the levels of 58 (14 female, 44 male) patients after TSCI at the BG Trauma Centre Ludwigshafen. Surgical decompression of the spinal cord was performed in all patients within two hours after the injury. Serum concentrations of selenium were measured with atomic absorption spectroscopy. Estimation of MMP-2, MMP-8, CCL-2, CCL-3, CCL-4, IL-8, IL-10 was performed via Luminex Cytokine Panel.

Elastic net multivariate logistic regression was used to examine the predictive value of each factor and clinical covariate with respect to neurological remission vs. no neurological remission. KNN-imputation performed on data subsets was used within the bootstrapping procedure to generate the database for elastic net regression modelling and most predictive factors were used to set up the final predictive model based on raw data.

Results: The resulted model including the clinical covariates NLI and sex as well as the initial serum levels of CCL-2, IL-10, MMP-2 and selenium presented an AUC of 86.2 % (CI: 71.1 % - 100.0 %).

Conclusion: The results strongly indicate elastic net regression modelling to be a promising procedure in the disclosure of a predictive biomarker in the field of TSCI. Based on the present data the chances of assigning a higher model-based score to patients that actually show an improvement as compared to those who do not is 86.2 %.

Figure 1



P 15

New methods of osteosynthesis in periprotective fractures using classical materials of osteosynthesis

D. N. Tarnita^{*1}, D. C. Grecu², D. Tarnita³, A. Grecu⁴, B. Capitanescu²

¹university of medicine and farmacy of Craiova, Anatomy , Craiova, Romania

²UMF Craiova, Anatomy, Ortopedy and Traumatology, Craiova, Romania

³university of Craiova, Mecanics, Craiova, Romania

⁴Emergency Hospital of Craiova, ortopedy of traumatology, Craiova, Romania

Since the beginning of the use of hip and knee prostheses in coxarthrosis and gonarthrosis therapy, periprosthetic fractures that occurred at the time of implantation of the prosthesis have been and still represent a difficulty in their treatment. Osteosynthesis methods and materials proposed over time have not been fully satisfied. Either the method was very difficult to perform, or the assembly was not very solid. Facing these problems, we tried to find other solutions for the treatment of periprotective fractures using classical osteosynthesis implants. Thus, we used the retrographic rod in the hip periprosthetic fractures as single ostesinosi or we used it as a core in osteosynthesis through cable circularization. We used retrograde osteosynthesis in the supracondylar fractures of the femur prosthetic with the primary knee prosthesis. We used the Kirschner brooch, centromedullary, in the hip periprosthetic fractures and in the periprosthetic knee fractures with revision denture. All these methods used by us proved to be easy to achieve, required minimally invasive methods for their realization, and ensured a good stability of the fracture outbreak.

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