

## In-Depth Oral Presentations and Oral Communications

### ORAL COMMUNICATIONS

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- S2 Shoulder and Elbow 1: Prostheses and Fractures
- S4 Shoulder and Elbow 2: Shoulder and Cuff
- S6 Knee 1
- S8 Knee 2
- S9 Shoulder and Elbow 3: Elbow and Fractures
- S12 Foot and Ankle 1: Foot and Arthrodesis
- S14 Foot and Ankle 2: Foot and Hallux Valgus

### IN-DEPTH ORAL PRESENTATIONS AND ORAL COMMUNICATIONS in collaboration with SPECIALISTIC SOCIETIES

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- S16 Biomaterials and Biotechnologies  
(in collaboration with S.I.B.O.T.)  
In-Depth Oral Presentations  
Oral Communications
- S20 Hand and Wrist  
(in collaboration with G.I.S.C.M.-G.I.M.E.T.R.A.)  
In-Depth Oral Presentations
- S21 Hip  
(in collaboration with S.I.d.A.)  
Oral Communications
- S25 Paediatric Orthopaedics  
(in collaboration with S.I.T.O.P.)  
Oral Communications
- S27 Infections  
(in collaboration with G.I.S.T.I.O.)  
Oral Communications
- S30 Trauma  
(in collaboration with SOC.I.TRA.S.)  
Oral Communications
- S38 Basic Research  
(in collaboration with I.O.R.S.)  
Oral Communications
- S39 Tumors  
(in collaboration with C.I.O.S.M.)  
Oral Communications

## ORAL COMMUNICATIONS

### SHOULDER AND ELBOW 1: PROSTHESES AND FRACTURES

#### Stemless shoulder prosthesis: multicenter retrospective study

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**Introduction** The use of less invasive prosthesis, made to preserve as much bone stock as possible, is one of the most important goals of the modern prosthetic systems. This study is focused on the clinical and radiological mid-term results of a stemless shoulder prosthesis (Eclipse-Arthrex).

**Methods** Fifty patients with concentric or nonconcentric glenohumeral osteoarthritis have been treated in three Italian hospitals, using the same surgical technique. Patients were evaluated with clinical (VAS, DASH, Constant scale, SST) and radiographic scores (CCD angle proximal migration, glenoid osteolysis, prosthesis osseointegration) at 1, 3, 6 and 12 months after surgery and once a year afterward. The mean follow-up was 41.1 months.

**Results** We had 15 drop-outs, evaluating 35 patients. All clinical scores demonstrated a significant improvement (>37.5 %) at each follow-up evaluations. Radiographic evaluations showed a good to excellent prosthesis osseointegration in all considered subgroups. Eight humeral and 5 glenoid osteolysis were detached, without clinical outcome correlations. Concentric osteoarthritis and total arthroplasties had better results than nonconcentrics and hemiarthroplasties. There were 2 intra-operative complications (1 glenoid fracture, 1 prosthesis cementation). Twenty-six percent (26 %) prosthesis had a revision surgery after a mean time of 23 months. Post-traumatic primary implants had a higher revision rate (75 %). The main revision causes were: rotator cuff tear (46 %), Glenoid cage break, glenoiditis and loosening.

**Discussion** Stemless shoulder prostheses allow an anatomical joint restoration, saving bone stock, and are easier to be implanted. The studied prosthesis demonstrated a significant and a long lasting clinical improvement, comparable with other prosthesis systems described in literature. Clinical and radiological scores evaluations were worsening over time, especially in post traumatic cases and in hemiarthroplasties, that showed a higher complication rate, mostly connected with rotator cuff tears, or glenoid bone loss. The primary bone stock saving allowed less invasive revision surgery, even though not technically easy. Our study limits are the lack of a control group and of a randomized protocol, but the high number of patients involved, the long lasting follow-up and the multicentric organization make our results highly significant.

**Conclusions** Considered the encouraging clinical and radiographic results, the studied prosthesis can be considered a good treatment option, especially in concentric symptomatic osteoarthritis.

#### The future of shoulder is stemless: 107 cases of total shoulder arthroplasty with stemless prosthesis after a mean 6.5-year follow-up

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**Introduction** A common problem in chronic fractures is the misalignment between the shaft axis and the centre of rotation, which renders the implantation of a shoulder-stemmed prosthesis more demanding and difficult. These problems lead to the development of a stemless humeral head replacement, that would enable anatomic reconstruction of the centre rotation of the humeral head independently from the shaft axis. The aim of this study is to evaluate the efficiency and the performance of stemless-metaphyseal anatomic shoulder TESS prosthesis.

**Methods** We report a prospective series of 107 (73 F, 34 M) anatomic total shoulder arthroplasty. The mean age at the time of surgical procedure was 66.2 years. Etiology was primary osteoarthritis in 87.5 %, post-traumatic arthritis in 7 cases, post-instability arthritis in 4 cases and rheumatoid arthritis in 1 case. This homogeneous, continuous and monocentric series with a minimum of 5 years follow-up and a mean follow-up of 6.5 years. The used implants are always the same: the TESS TSA with glenoid metal back (4 cases) or with cemented all-polyethylene glenoid base plate (103 cases), anatomic head and anatomic humeral corolla (HC). The group of the patients was regularly revised clinically and radiologically. Clinical evaluation based on VAS scale, ASES score, Quickdash score and Constant score. Radiographic examination allowed measuring of a glenoid TILT, humeral metaphysis angle (CD), mobilisation of prosthesis components and grade of periprosthetic osteolysis.

**Results** At the last follow-up there were 94 patients (96 cases). Post operative pain was 0.18/15 *versus* 12.83/15; the mean active anterior elevation was 160° *versus* 97°, the gain in external rotation with elbow at the side was 45° *versus* 13°, the abduction was 157° *versus* 84°. The absolute Constant-Murley score increased from 30.81 to 74.85 points. The X-rays showed at the last follow-up, the mean CD angle of 141°, 6 cases of glenoid radiolucent lines (RLL) grade 1 according to Molé class, 96 cases of humeral RLL grade 1 according to Teissier and Stamilla class. No humeral stemless prosthesis mobilization were reported in this series. The revision rate was 5.2 % (5 cases/failure of glenoid components).

**Discussion** Study shows that the results with anatomic shoulder TESS prosthesis are comparable to the data of the literature. All of TESS HC did not move. No intra-operative or post-operative complications were reported in this series. The problems relating to the stem were: peri-prosthetic fractures, shoulder arthroplasties revisions and anatomical variation and modularity. The TESS-TSA improves: reliability of implants, the humeral bone stock, decreased peri-prosthetic fractures risk, best adaptation to anatomical variation, choice of HC position (CD: 130°, 135°, 140°).

**Conclusions** The stemless prosthesis is the advantage of fusing, resurfacing shoulder prosthesis and standard stemmed prosthesis: automatic reproduction of the individual anatomy of the humeral head and of the lateral off-set, bone stock preservation, implant stability, easy revision, excellent glenoid exposure. This study confirms that this innovative implant has a very good primary fixation at 6.5 years of follow-up. In our opinion the stemless anatomic shoulder

prosthesis is the gold standard treatment in case of primary, post-traumatic and post-instability osteoarthritis with high quality bone stock.

### **Latissimus dorsi tendon transfer in reverse total shoulder arthroplasty: effect of position of attachment and humeral cup version**

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**Introduction** Reverse total shoulder arthroplasty (RTSA) is an effective solution to treat patients with cuff tear arthropathy. It relieves pain and restores anterior elevation and abduction of the arm. However, the restoration of external rotation is never achieved using only the RTSA. The *latissimus dorsi* tendon transfer (LDT-T) is performed in association with RTSA to restore external rotation. Nevertheless, factors affecting outcomes of this procedure are still unknown. The aim of the present study is to assess the biomechanics of the combined procedure of RTSA and LDT-T, to identify the best combination between humeral cup version and site of insertion of the transferred *latissimus dorsi* (tLD).

**Methods** A 3-dimensional computer model of RTSA has been used to simulate the LDT-T. Four different positions of retroversion of the humeral cup (+20°, 0°, -20° and -40°: +antiverted; -retroverted) have been combined with 3 different sites of insertion of the LDT-T (postero-lateral and anterior side of the greater tuberosity; posterior side of the humeral diaphysis, same high of the anatomical insertion). For each combination, the moment arm (MA) and the length of the tLD have been calculated considering the following movements: external rotation (-90°) and internal rotation (-90°) with the arm at 20° of abduction; external rotation (-90°) and internal rotation (-90°) with the arm at 90° of abduction; abduction (0°–110°); anterior elevation (0°–150°). Moreover, activities of daily living such as eating or drinking, brushing teeth, combing hairs, and answer to the phone have been simulated with the computer model.

**Results** The rotational MA of the tLD is influenced by both humeral version and insertion of reattachment. Placing the humeral stem between 40°–20° of retroversion and the tLD at the anterior or postero-lateral site produces the best rotational MA. The length of the tLD increases moving the insertion site from posterior to anterior and from distal to proximal, but it is not influenced by the humeral cup retroversion.

**Discussion** The best rotational MA is obtained placing the tLD at the anterior and postero-lateral site. However, the muscle is overstretched, producing inadequate function. The rotational MA at the postero-distal site is lower but the muscle is not overstretched and may represent a good compromise.

**Conclusions** The combined procedure of LDT-T and RTSA restores external rotation and anterior elevation of the arm. We recommend to place the humeral cup between 40° and 20° of retroversion and to attach the tLD at the postero-distal site.

### **Bilateral reverse total shoulder arthroplasty (RTSA): functional outcome and activities of daily living (ADLS)**

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**Introduction** Reverse total shoulder arthroplasty (RTSA) is gaining popularity in recent years. Concerns remain regarding performing

bilateral RTSA over lack of rotational movements bilaterally and resultant difficulties with activities of daily life (ADLs). The aim of this study is to evaluate the outcome after bilateral RTSA in restoration of function and ADLs.

**Methods** We prospectively collected data on 15 consecutive patients (30 shoulders, mean age 75.8 years) who underwent staged bilateral RTSA between 2007–2012 with minimum follow-up 1 year (12 females, 3 males), (14 cuff tear arthropathy, 3 rheumatoid arthritis). Patients were evaluated clinically and radiographically pre-operatively and post-operatively using the Constant score (CS), Simple Shoulder Value (SSV) and modified ADLER Score (AS).

**Results** The average time between interventions was 18.8 months (4–46 months). The Constant score increased from 18.7 (2–38) pre-operatively to 57.3 (12–87), 89 % of age/sex adjusted, at the last follow-up. The elevation improved from 57.5° to 134.6°, internal rotation (IR) from 9° to 28.6° (20 shoulders could reach above sacroiliac joint). The external rotation (ER) improved from 20° to 68.3°, in 22 shoulders we observed a complete ER in elevation. The Simple Shoulder Value increased from a baseline score of 2.1/10 to 8.6/10. The Adler mean score was 26.9/30.

**Discussion** Scarce results have been reported about the recovery of internal rotation and activities of daily living after RTSA and this justifies the lack of case studies in the literature of bilateral implants. In our study, the results are encouraging, and this may be related to the design of the prosthesis used that allows mediatisation of the centre of rotation, a smaller encumbrance of the polyethylene liner due to its particular shape and the implant at 30° of retroversion. The sample of patients is limited but it has been remarkable in our patients the ability to return to daily activities in the postoperative period.

**Conclusions** Bilateral RTSA results in marked improvement in all movements, pain, and functional outcomes, with high patient satisfaction and high AS. All patients were able to perform perineal hygiene after their RTSA. Most patients had no limitation in ADLs and their activities. Questions remain open, whether these results are dependent on the implant design or the surgical technique.

### **Stemless reverse shoulder arthroplasty: results at 2–7-year follow-up**

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**Introduction** In recent years, there is a trend towards resurfacing and use of stemless anatomic prostheses to avoid complications related to the stem. We report the 2–7 years results with unique stemless reversed TSA.

**Methods** Between 2005 to 2010, 98 patients were operated with stemless RTSA: 20 males and 78 females, mean age 74.4 years (38–93 years), 65 cuff arthropathy, 12 fracture *sequelae*, 13 rheumatoid arthritis, 3 failed RCR, 3 loosening of anatomical prosthesis, 2 acute trauma. Seventeen of these implants were revision cases.

**Results** All patients had good pain relief and were satisfied with their shoulder (8.5/10). Mean Constant Score improved from 14 to 59 (age/sex adjusted: 21 to 86,  $p < 0.0001$ ). The mean range of movement improved to 128.5° elevation, 50.8° ER and 64.6° IR. Radiographic analysis showed mild glenoid notching (grade 1 or 2) in 21 patients that appeared only after 3 to 4 years after surgery. Nineteen of these were non-progressive with sclerotic margin. Only 3 cases of grade 3 glenoid notching. No lucencies were seen around the implants and no signs of stress shielding.

**Discussion** The problems reported in the literature from the use of the reverse prosthesis are related to the restriction of movement of

internal and external rotation and the glenoid notching. This new stemless design presents several design principles that seem to result in a high elevation and rotation movements, reducing complications and their severity and a low incidence of glenoid notching.

**Conclusions** The results of this new model of inverse prosthesis are very encouraging and ensuring a saving of bone it entitle the surgeon to considerate its use in a younger group of patients as it leave open good possibilities in case of revision surgery.

## Body mass index (BMI) and rotator cuff tear

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**Introduction** Rotator cuff tear (RCT) has a multifactorial etiology. We hypothesized that adiposity may increase the risk of RCT and influence tear size.

**Methods** A case control design study was used. We studied 381 consecutive patients (180 M and 201 F; mean age  $\pm$  SD:  $65.5 \pm 8.52$  years; range 43–78) who underwent arthroscopic rotator cuff repair. Tear size was determined intra-operatively. The control group included 220 subjects (103 M and 117 F; mean age  $\pm$  SD:  $65.16 \pm 7.24$  years; range 42–77) with no RCT. Body weight, height, bicipital-tricipital-subscapularis and suprailiac skinfolds of all participants were measured in order to obtain body mass index (BMI) and the percentage of body fat (%BF). For the study purpose, 601 participants were divided into 2 groups by BMI (group A: BMI  $\geq$  25; group B: BMI < 25). Odds ratios were calculated to investigate if adiposity affects the risk of RCT. Data were stratified according to gender and age. Multiple linear regression analyses were applied to explore the association between obesity and tear size.

**Results** The highest odds ratio for both men (OR = 2.49; 95 %CI = 1.41–3.90;  $p = 0.0037$ ) and women (OR = 2.31; 95 %CI = 1.38–3.62;  $p = 0.0071$ ) were for individuals with a BMI  $\geq$  30. The 69 % (N = 303) of group A and 48 % (N = 78) of group B had a RCT. Patients with RCT had a BMI greater than subjects with no RCT in both groups ( $p = 0.031$  Group A;  $p = 0.02$  Group B). BMI and %BF significantly increased from patients with small tear (BMI: 27.85; %BF = 37.63) to those with massive RCT (BMI: 29.93; %BF = 39.43). Significant differences were found ( $p = 0.004$ ;  $p = 0.031$ ).

**Discussion** Adiposity may contribute to cause peripheral vascular deficiencies through its associations with an increased production of adipokines these molecules are able to induce oxidative stress, inflammation, thrombosis, and endothelial dysfunction. The consequent releasing of many reactive oxygen species causing oxidative stress and cell apoptosis may cause degeneration of the tendon and predispose it to rupture.

**Conclusions** Our results provide evidence that adiposity, measured through BMI and %BF, is a significant risk factor for the occurrence and severity of RCT.

## SHOULDER AND ELBOW 2: SHOULDER AND CUFF

### Anatomical variations of the trochlear notch angle: bilateral MRI analysis on 39 healthy subjects

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**Introduction** Few studies have analysed the anatomy of the distal humerus and, in particular, of the trochlear morphology. In 2012, Goldfarb described 3 morphological variations of the distal humerus and observed a mean trochlear notch angle of 126°. It is not known whether the cartilaginous layer is uniform or whether it modifies the trochlear bony contour. The aim of our study was: (1) to assess the cartilage thickness of the trochlea; (2) to calculate the bony and cartilaginous trochlear notch angle and its variability.

**Methods** We assessed 78 healthy elbows in 39 patients (19 males and 20 females) with a mean age of 28 years (21–32). High-definition MRI coronal scans at the level of the flexion–extension axis of the elbow were used. Cartilage thickness, the trochlear notch angle and the trochlear width were calculated at the level of the deepest point of the trochlear sulcus, of the edge of the lateral and of the medial trochlear ridge. Patient height was recorded as an indirect measurement of humerus length. Pearson correlation and Student’s *t* tests were used for the statistical analysis.

**Results** Mean cartilage thickness was 0.995 mm (0.627–1.046), with no significant differences between the 3 trochlear landmarks. Differences between the trochlear notch angle at the bony and cartilage layers were not significant, with values ranging from 124° to 156° (mean 142°); no correlation was found with trochlear width or patient height. Trochlear width ranged from 1.57 to 2.75 cm (mean 2.24), with a significant correlation with the patient height. The only significant difference between sexes was the width value, with a wider trochlea in males.

**Discussion** This is the first study that has shown that the trochlear cartilaginous layer does not modify the trochlear notch angle at the level examined. Furthermore, the geometric analysis of the trochlear notch angle revealed marked variations in the trochlear contour, with values ranging from 124° to 156°. These anatomical variations were independent of gender, patient height or trochlear width.

**Conclusions** The analysis of the trochlea reveals a wide morphological variability that should be taken into account when anatomical prosthetic implants are being designed.

### Experimental study on the rotator cuff of the pig. Tensile strength trial of synthetic patch sutured to the supraspinous tendon

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**Introduction** The incidence of tears of the rotator cuff is on the rise due to the increase in life expectancy and over use for sports activities, etc. The clinical results of the reconstructions have been excellent for over 10 years. In the reconstruction of massive lesions however the number of failures is very variable (from 25 to 80 %). Several surgeons are therefore in favour of tendon transpositions or reinforcement patches with synthetic or biological patches depending on the muscle atrophy of the cuff.

**Methods** In the work the tensile strength of the tendons of the supraspinous of pigs and of the synthetic patches in low density polypropylene has been determined. The patch was applied on the tendon and sutured with interrupted sutures with wire TI-Cron 3128-79 calibre USP 5 non re-absorbable polyester thread. Finally, tests were made of the tensile strength of the tendon-patch joints with sutures increasing from 5 to 8 arranged in line and staggered.

**Results** For testing we used an Instron 3367 material testing machine and Instron Bluehill 2 and software for data processing. For each number of points, the tests were repeated twice. The tests of resistance to rupture of the tendon have provided a mean value of 34.59 MPa with low dispersion and a breaking strength of the patch of 16.52 MPa. The offset arrangement of the sutures gave a breaking strength of the coupling greater than the in-line arrangement.

**Discussion** With 5:06 stitches the joints broke for loads corresponding to tensions on the tendon of 6.94 and 7.4 MPa corresponding to 20 and 21.40 % of their tensile strength. By 7/8 the break points occurred for tension on the tendon of 10.44 and 12.25 MPa corresponding to 30 and 35 % of the break. The traumas, age, tendon and muscle condition, the extent of the injury, the failure of the sutures affect the results of reparative surgery.

**Conclusions** The value of the tensile strength of the pig tendon 34.59 MPa falls within the scope of those of the human tendon (24–61 MPa). Since the tendon in human physiological conditions is stressed to the maximum up to 25 % of its breakdown resistance and the tests have demonstrated that the joints with 7 and 8 stitches ensure a higher resistance (30 and 35 %) it can be stated that the proposed technique for the tendon junction-patch already has a primary hold.

### The thoracic outlet syndrome in overhead athletes

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**Introduction** In this study we discuss the diagnostic process which has allowed to identify the thoracic outlet syndrome in two young overhead athletes affected by bilateral subclavius posticus muscle.

**Methods** Two young athletes playing volleyball and water polo, aged 23 and 25 respectively, have been evaluated for pain, paresthesia, functional disability in both upper limbs, especially in the right dominant one. Clinical examination and imaging techniques have ruled out rotator cuff tears, SLAP lesions, shoulder instability and spinal disc herniation. Conservative pharmacological approach and physiotherapy have not been successful in the two patients, who later developed deep vein thrombosis of the subclavian vein in dominant upper limb, treated with anticoagulant therapy.

**Results** Patients came to us and since we suspected thoracic outlet syndrome, we carried out clinical tests, X-ray and dynamic magnetic resonance angiography. This diagnostic procedure, which analyses neurographic and angiographic sequences in neutral position and in hyperabduction, showed in both patients bilateral subclavius posticus muscle, compressing the neurovascular bundle. Subclavius posticus muscle is a supernumerary variation of the subclavius muscle, and it has been shown during human dissections as a possible cause of this syndrome. Anterior scalenectomy and resection of the subclavius posticus were performed via supraclavicular approach; at 3-year follow-up patients are asymptomatic and play their sport at the pre-injury high-level.

**Discussion** This study characterizes in vivo by imaging and surgical data the subclavius posticus muscle, confirming its role as a predisposing factor of the thoracic outlet syndrome. An overhead athlete, complaining the above mentioned symptoms, has to be examined for thoracic outlet syndrome, especially when the other overhead shoulder pathologic conditions are excluded. If the clinical tests are

positive, dynamic magnetic resonance angiography is mandatory to definitively diagnose the syndrome and identify its cause. Early diagnosis is fundamental to reduce the rate of severe complications such as vein thrombosis or pulmonary embolism. Subclavius posticus may be silent in sedentary people. In overhead athletes, the hypertrophy of the lateral cervical muscles in dominant upper limb, due to the repetitive throwing movement, combined with subclavius posticus, reduces the space in the upper thoracic outlet, determining thoracic outlet syndrome complicated by deep vein thrombosis.

**Conclusions** In overhead athletes affected by pain, paresthesia and functional disability in the upper limb, TOS should be included in the differential diagnosis, and subclavius posticus muscle, even if unusual, can be listed among its possible concurrent causes.

### Clavicular non-unions treated by open reduction and internal fixation with plate and opposite graft: our experience and literature review

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**Introduction** Clavicle has a pivot role in the biomechanical function of the pectoral girdle and also in the function of the upper limb. Given this importance, much interest has been focused on the optimal method of treatment for patients with clavicular non-union.

**Methods** We investigate functional and radiological outcome in 57 cases of both midshaft and lateral clavicle nonunion treated with open reduction and internal fixation with plate and screws over a 13 years period. Intercalary bone graft was used in 42 patients; opposite autologous strut graft was used in 31 cases of midshaft non-union to provide mechanical support to the host bone. Thirty-seven patients were males while 20 were females, with a mean age of 35 years (17–63). All cases were of nonunion, 35 atrophic and 22 hypertrophic. Eight patient with a lateral fracture were included; 1 patient had both midshaft and lateral fracture. The dominant side was injured in 32 cases and the non dominant in 25 cases. Primarily, 43 cases were treated conservatively with a figure of eight bandage. Time between fracture and our operative treatment was on average of 44 months (13–72 months). Only those patients who were symptomatic were included in this study. We used straight reconstruction LCP, low profile precontoured plate and clavicle hook plate for 5 of the group of lateral clavicle nonunions. Patients were analysed using chart and radiological review and assessed with DASH questionnaire obtained at the latest follow-up.

**Results** All the nonunion resulted healed within 3 months but one of the lateral third, which requested a revision surgery with lateral third clavicle excision. Mean DASH score at an average of 42 months was of 16.7 and we consider this as a satisfactory result.

**Discussion** Fractures of the clavicle are common, and nonunion is a complication after both operative and non-operative treatment. Indications for operative treatment of clavicular nonunion are pain, instability, limited shoulder ROM, brachialgia, muscle weakness. Surgical management of those type of lesions is still debated.

**Conclusions** We believe that open surgery and internal fixation, using plate and screws in a compression construct should be the treatment of choice for symptomatic clavicular non-unions. Intercalary autologous or homologous bone graft should be used especially in patient with significative bone loss; opposite cortical strut graft provides absolute mechanical stability, thus assuring optimal screw purchase and allowing immediate limb movement.

## Distribution of shoulder pain rotator cuff tears

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**Introduction** The vast majority of studies regarding rotator cuff tears (RCT) is focused on etiopathogenesis and treatments; information on shoulder pain characteristics needs further investigations. We analysed the intensity and distribution of shoulder pain on patients with different sizes of RCTs.

**Methods** Two hundreds and eighty-five consecutive patients with postero-superior RCT were enrolled for this study. Tear size was intra-operatively classified. Before surgery, all patients completed an upper limb pain map (dermatome map made by Keegan). Shoulder pain intensity was assessed with a visual analogue scale (VAS). Data were submitted to statistical analysis.

**Results** Shoulder pain intensity caused by RCT resulted higher in females ( $p = 0.024$ ); it did not vary with the side and with older age. Pain intensity was lower in massive tears ( $p < 0.05$ ) and in patients whose pain was distributed to the shoulder only ( $p = 0.035$ ). Furthermore, patients whose pain persisted by more than 6 months maintained the same pain intensity. Pain was localized predominantly on dermatomes C5–C6, it was more extended in massive tears ( $p < 0.05$ ) and rarely extended beyond the elbow. In presence of intense shoulder pain, it resulted difficult to be well delimited.

**Discussion** Nowadays, information regarding shoulder pain is still scarce. It is known that patients with RCT may be painless or painful, that pain arises during the night causing sleep disturbance and that it may compromise shoulder function. However, literature does not accurately focus on RCT pain intensity and distribution.

**Conclusions** Shoulder pain characteristics in patient with RCTs may be influenced by gender and size of tear. Cuff tear pain distribution principally involves antero-lateral aspect of the shoulder with extension downwards the lateral surface of the arm until the elbow. Information about pain intensity and distribution in patients with RCT may contribute to a correct diagnosis.

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## KNEE 1

### The role of the distal femoral varus osteotomy in the valgus knee: biomechanical assessment of the procedure efficacy *in vivo* and on cadaveric models

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**Introduction** Unicompartmental gonarthrosis is often caused by malalignment of the lower extremity (valgus or varus deformities) which are surgically treated with a corrective osteotomy either on the femoral or the tibial side. Current literature presenting in details the effects of varus osteotomy on the biomechanics of the valgus knee is scanty. Still, an interesting hypothesis have risen up concerning the possible loss of the clinical and biomechanical effects achieved through this procedure following the flexion of the knee.

**Methods** Given these observations, we designed this pilot study to assess the actual biomechanical efficacy of distal femoral varus osteotomies (DFVOs) by measuring frontal plane knee moments with a gait analysis on a total of 26 patients, half of them having knee valgus deformity while the others serving as healthy controls. In a second

time, we wanted to verify the hypothesis of the eventual loss of the axial correction reached by the procedure during the progression of knee flexion through a cinematic analysis on 6 cadaveric models.

**Results** As for frontal plane knee angular impulses, both in abduction and adduction, we found a statistically relevant difference between the values assessed preoperatively and postoperatively ( $p < 0.001$ ), and the difference was significant as well when comparing values of patients preoperatively with healthy controls ( $p < 0.001$ ). However, this variance was not present anymore when values of patients postoperatively were compared to the same healthy controls. Analysis of the cadaveric models showed an actually different frontal axial correction at different degrees of articular flexion, with a progressive return of the original axial malalignment as the ROM increased from 0° to 90°.

**Discussion** The results we present confirm the key role of surgical correction of axial deformities to achieve an efficient neutralization of the aberrant frontal plane knee moments, which eventually results in normalization of the load distribution over the femoro-tibial compartments during gait. However, the data collected from the analysis on the cadaveric models demonstrate how the axial correction achieved through a DFVO gradually becomes deficient while progressing through knee flexion.

**Conclusions** All aberrant frontal plane knee moments found in knee valgus are efficiently neutralized following a DFVO. However the surgeon should have in mind the chances of non-optimal post-operative clinical outcomes related to verified biomechanical alterations occurring during gradual knee flexion. Therefore indication for this procedure in patients with high functional demands during knee flexion (i.e. particular classes of athletes) should be considered more carefully.

### Infiltrative therapy with hyaluronic acid for patellar tendinopathy

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**Introduction** Patellar tendinopathy is a common sports injury. The literature about infiltrative treatments does not provide conclusive results. The aim of this study is comparing hyaluronic acid (HA) to cortisone injections therapies.

**Methods** This prospectively randomized study identified 22 male patients affected by insertional patellar tendinopathy. They were divided into two groups. The protocol involved a therapy of three fortnightly injections of cortisone for group A and HA for group B. Sixteen patients were evaluated between January 1996 and December 2010. In group A, 5 patients, mean age 33 years, were submitted to three betamethasone injections. In group B, 11 patients, mean age 36 years, three injections of HA were administered. In all cases, a pre- and post-operative evaluation was performed using the Lysholm Score, the Visual Analog Scale (VAS) for pain and the modified Blazina Jumper's Knee Scale. Mean follow-up was 8 years. Statistical analysis was performed by Student's *t* test.

**Results** No significant benefit was observed in group A: all of them were subsequently submitted to surgical treatment. Mean Lysholm Score pre-treatment and post-treatment was 82, mean VAS pre- and post-treatment was 8, mean Blazina Scale pre- and post-treatment was 3.5. After 5 patients, cortisone injections therapy was suspended for not showing proof of benefit. In group B significant improvements in all scores were assessed. The mean Lysholm Score pre-treatment was 79, post-treatment 95. Mean VAS was reduced from pre-treatment 6 to post-treatment 2. Mean Blazina Scale pre-treatment value was 3,

post-treatment 0.5. No patient of the second group underwent surgical treatment.

**Discussion** When patellar tendinopathy does not respond to medical and physical therapies, the infiltrative treatment should be carefully taken into account. Hyaluronic acid appears to be effective and has no side effects. Instead, the use of cortisone substances does not provide positive long-term results, as emerges in current literature.

**Conclusions** In multimodal therapy, when conservative treatments are ineffective, the infiltrative therapy with hyaluronic acid can be performed before proceeding with the surgical treatment.

### Anterior cruciate ligament reconstruction using flexible reamer with double bundle technique *versus* single bundle technique: a retrospective observational study

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**Introduction** Anterior cruciate ligament reconstruction, using double-bundle technique, allows better joint stability in flexion and extension. To evaluate this technique, we planned a prospective randomized study which compared short-term clinical results of an anatomic anterior cruciate ligament reconstruction with single-bundle technique and double-bundle technique.

**Methods** Seventy four patients with chronic injury of anterior cruciate ligament were included in this study. In 37 patients the reconstructions with double-bundle technique were performed (group A, mean age 32 years); in 37 a single-bundle technique was considered as the treatment (group B, mean age 35 years). The mean follow-up was 18 months (6–23 months). For both techniques, flexible reamers have been used to perform the femoral tunnel through an antero-medial approach. Femoral fixation was achieved by using a suspension system (G-Lock Stryker) while a re-absorbable screw was used for tibial fixation. IKDC, ACL and HSS score have been used for post-operative clinical evaluation.

**Results** Five patients were lost at follow-up (2 from group A and 3 from group B). Good or excellent results were obtained in 97 % of cases in group A and in 95 % of cases in group B ( $p$  value  $>0.005$ , not significant difference). In group A, IKDC showed higher values of sport activity recovery, while HSS and ACL showed no difference between group A and group B. Ninety-three percent (93 %) of patients resumed sport activity, 60 % in 3–4 months and 33 % in 4–6 months.

**Discussion** In our study, we achieved excellent functional results with sport activity recovery in most patients, regardless of surgical technique. These results are confirmed by other studies that compared the two techniques, when single-bundle technique was performed with anatomical placement of the femoral tunnel. Possible bias of the study could be due to a lack of professional athletes with high functional requirements that could make obvious differences between the two techniques. The system has allowed anatomical reconstruction in all cases making repeatable and effective surgery. We had no failures of fixation system with a short follow-up.

**Conclusions** The results confirm the effectiveness of the technique of anatomical reconstruction of the anterior cruciate ligament with no obvious clinical differences between single-and double-bundle technique in a population of non-competitive sports considering a study with short follow-up.

### Valgus high tibial osteotomy and bone-marrow-derived cells transplantation: clinical and radiological results after a 3-year follow-up in varus osteoarthritis of the knee

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**Introduction** The early degeneration of the medial compartment of the varus knee can be approached with different surgical techniques, according to the functional requirements of the patient. In young and sporty, the high tibial osteotomy (HTO) is compatible with high functional demands, even if the positive results tend to deteriorate over time. Therefore it can be useful to associate a regenerative treatment of cartilage. Aim of this study was to determine the clinical outcomes of valgus HTO after a three-year of follow-up in association to bone-marrow-derived cells transplantation (BMDCT) one-step technique in young patients with medial compartment chondral pathology and varus malalignment.

**Methods** Twenty-nine consecutive patients with medial unicompartmental osteoarthritis in the varus knee were treated with valgus HTO and BMDCT with one-step technique. The mean age of patients was 47.3 years (range 22–69). All patients were clinically and radiologically evaluated (X-rays and MRI) in the pre-operative and at serial follow-up, up to 36.3  $\pm$  14.9 months. The pre-operatively IKDC was 35.3  $\pm$  12.5; pre-operative KOOS score was 27.8  $\pm$  15.4. The degree of osteoarthritis according to Kellgren Lawrence was 3 for 16 patients, while 13 patients showed grade 4. The patients were treated to valgus tibial osteotomy stabilized with titanium plates and screws and with apposition of homologous bone tissue. In the same surgical time, with arthroscopic technique, was positioned on the osteochondral lesion a collagen membrane loaded with autologous mesenchymal stem cells, taken from the posterior iliac crest after debridement of the articular surface.

**Results** The IKDC score showed a gradual improvement up to 2 years, reaching in the final follow-up of 3 years a plateau of 64.3  $\pm$  18.8 points. The final KOOS score showed an average of 70.5  $\pm$  20.2 points. At the final follow-up, the degree of osteoarthritis according to the Kellgren and Lawrence score was 3 for 23 patients and 4 to 6 patients. The osteochondral lesions evaluated with MRI Mocart score showed good integration of the regenerate, with adequate filling of the defect in 26 cases.

**Discussion** In selected patients, the HTO associated with BMDC showed satisfactory clinical and radiological results at a final follow-up of 3 years. The lower results were recorded in patients with serious osteoarthritis and advanced deeper osteoarthritic lesions.

**Conclusions** The HTO can be advantageously associated with BMDC, leading to interesting clinical and radiological outcomes to 3 years. However, a most greater follow-up is necessary to validate the technique in the medium-long term.

### High tibial osteotomy with new iBalance system: clinical results

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**Introduction** High tibial osteotomy (HTO) with medial opening-wedge technique is a well-established procedure for the correction of varus malalignment of the symptomatic knee with medial

degenerative chondral lesions, capable to delay or even avoid the necessity of a knee replacement. A new system for the execution of open-wedge high tibial osteotomy (HTO) (iBalance HTO System-Arthrex) has been recently developed, in order to make the surgery more reproducible and safe. The aim of this study was to determine the short-term outcomes of iBalance technique in medial compartment osteoarthritis and varus malalignment of the knee.

**Methods** Fifteen consecutive patients with a mean age of 50.7 (SD 5.09) years, mean BMI 27.1 (SD 13.7), affected by varus symptomatic knee, with medial compartment osteoarthritis, were treated with iBalance HTO system between July 2011 to February 2012 and retrospectively evaluated. The HTO was performed, in all cases, with iBalance Medial Opening Wedge HTO system. The post-operative care were the same in all cases. Medial osteoarthritis was documented by Ahlbäch grading scale upon the X-rays. Patients evaluation included: subjective IKDC (International Knee Documentation Committee) score, KOOS (Knee injury and Osteoarthritis Outcome Score), VAS for pain and TEGNER scores, X-rays and MRI, pre-operatively and after 2 years follow-up. The results was statistically analysed.

**Results** No severe intra-operative complications or implant failure were found. The mean pre-operative IKDC subjective score was 66.8 (SD 1.18) and KOOS score was 61.3 (SD 0.86), while at follow-up these scored 73.6 (SD 1.01) and 88.1 (SD 1.23) respectively. The mean pre-operative VAS for pain and Tegner score were 8.6 (SD 1.72) and 4.1 (SD 2.06) while these scored 2.9 (SD 2.35) and 3.1 (SD 1.83) at follow-up. The BMI did not affect the results. The degrees of correction were all included between 3° and 8°. After 4 months, all patients showed a complete recovery of range of motion and almost complete disappearance of pain. All patients showed no loss of correction, no substantial variation of A/P slope (maximum variation 1.5°) and no hardware problems.

**Discussion** iBalance has been shown to be effective and safe with scoring good overall results. Consolidation and osseointegration of the system took place rapidly, while the recovery was precocious, comparable with traditional methods and with no severe complications. The system proved to be much tolerable. In addition, the new system has made it possible to perform MRI to assess cartilage or meniscal repair in some cases carried out.

**Conclusions** Based on to our study of the iBalance proved, at short term, to be equivalent to other techniques of high tibial osteotomy while offering many advantages.

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## KNEE 2

### Use of membrane Hyaff-11 in the treatment of articular cartilage lesions of the knee

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**Introduction** The articular cartilage lesion still represent a problem of considerable interest in orthopaedic practice. For several years is attributed to the mesenchymal stem cells (MSCs) in the bone marrow, a high regenerative potential, with a capacity of chondrocyte differentiation, under appropriate growth conditions. The use of scaffolds which can promote and direct the MSC towards the chondrocyte line is an innovative therapeutic option in the treatment of chondral lesions of the knee. The aim of this prospective study was to evaluate the short term objective and subjective outcomes of the use of a membrane of hyaluronic acid as a carrier for mesenchymal stem cells of the bone marrow, which collect on the site of injury after microfractures.

**Methods** We studied 19 patients (15 M, 4 F) with mean age 27 years (18–46) underwent arthroscopic implantation of a membrane of

hyaluronic acid (Hyaff-11, Anika Therapeutics Ltd.) after microfractures, for the treatment of symptomatic osteochondral defects of the knee. All patients were evaluated pre- and post-operatively using VAS score, Lysholm score and IKDC score with a mean follow-up of 24 months. Pre-operative and post-operative MRI were performed for the assessment of joint profile.

**Results** There were no early or late complications related to the technique. The average size of the chondral defect was 3.5 cm<sup>2</sup>. All defects were classified as grade IV according to the Outerbridge classification. Clinical evaluation showed statistically significant improvement in all the scales studied ( $p < 0.01$ ). The post-operative MRI examination showed from a moderate to a complete filling.

**Discussion** The described technique is a one-step procedure which allows to treat the chondral and osteochondral lesion in a single intervention, using the microfractures to collect the mesenchymal stem cells in the area of the defect and stabilizing the medullary clot and promoting differentiation into chondrocyte through a membrane of hyaluronic acid.

**Conclusions** Arthroscopic implantation of Hyaff-11 membrane proved to be a safe and effective technique for the treatment of symptomatic articular cartilage defects of the knee, with good short term clinical results. However, further studies with longer follow-up are necessary to confirm the effectiveness of treatment and in particular to assess the inner endurance of reparative tissue and its structural integrity over time.

### Anterior pain following knee arthroprosthesis. A comparison between two different capsule-ligamentous suturing techniques

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**Introduction** Anterior pain after knee arthroprosthesis with or without patellar resurfacing is a problem in 8 % of patients. The causes of such symptomatology may be multifactorial, divided into functional and mechanical. Among the mechanical causes, external hyper-pressure of the patella emerges. Avoidance of iatrogenic damage of MPFL, MPML and MPTL ligaments, and an accurate capsular-tendinous reconstruction, are compelling to avoid such complication. Our study objective is a comparison of two different techniques and of different capsule-ligamentous reconstruction materials, following TKA.

**Methods** Between 2010 and 2013 two different surgeons implanted 160 Vanguard knee prosthesis, without patellar resurfacing (100 CR and 10 PS), in patients with knee arthrosis. In the first group (70 % of patients), a standard capsular-ligamentous suturing technique with absorbable thread was used, while in the second group (30 % of patients), a non-absorbable monofilament suturing thread was used with Mason Allen technique, modified for the MPFL ligament. All patients have been evaluated with standard A-P and L-L knee X-ray projections and Merchant projection and with QoL protocols, pre-operatively and post-operatively at 1, 3, 6 and 12 months and, to follow, yearly.

**Results** Three patients out of the first group suffered from anterior pain within the first year. Merchant projection showed an external hyper-pressure in two of those patients, emerged from the first months after surgery, while the third evidenced an excessively rotated tibial plateau. No anterior pain or radiographic positivity was evidenced in the second group of patients.

**Discussion** A mistake in the choice of materials and technique adopted for the capsular and medial patellar ligaments suture, may be



a cause of failure, even with a correctly implanted knee prosthesis. From an analysis of the literature, it emerges that an absorbable thread, assures a constant resistance for few weeks before the consumption initiates, which is an insufficient time for a complete healing of the mentioned structures, especially if the continuous stresses of the post-operative rehabilitation are taken into account. A lateralization of the patella hardly may be solved with rehabilitation only, therefore, in presence of such complication, the only option is resorting again to surgery.

**Conclusions** The capsular structure and MPFL ligament, majorly, but also MPML and MPPL, are essential elements, which must not be undervalued in capsule-ligamentous reconstruction following TKA. It is our opinion that an absorbable thread only is not a sufficient assurance for a correct surgical closure, and, therefore, a use of non-absorbable thread ensures a constant support in capsular suture and medial patellar ligament reconstruction, even if subjected to possible complications.

### PSI: critical issues and solutions after 4 years of experience

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**Introduction** The recent international literature has questioned the effectiveness of patient-matched technology, not finding in it an advantage in terms of accuracy. Considering the time and resources required to produce the cutting blocks, then they wonders whether there is a real advantage. This report has the purpose of analysing the reasons that may cause a reduction in terms of accuracy, providing solutions and ensuring the best results.

**Methods** The report is based on the analysis of measurements taken on the surgical field. We analysed 30 cases were divided into 3 subgroups corresponding to 3 upgrades of set-up of the pre-op planning, required to the engineers. For each patient were measured femoral distal (FD-M/L) and posterior cuts (FP-M/L) and the tibial proximal cuts (TP-M/L). Each measurement was compared with that described by the pre-operative planning.

**Results** For the three subgroups, the standard deviation of the FD-M was respectively 0.21, 0.0 and 0.20, FD-L 0.22, 0.19 and 0.20; the standard deviation of the FP-M was respectively 0.87, 0.76 and 0.31, respectively FP-L 0.82, 0.72 and 0.29; the standard deviation of the TP-M was 0.41, 0.20 and 0.21, TP-L 0.37, 0.22 and 0.19. The measured data have a normal distribution and have been studied with the Student's *t* test: for values FP, the differences found in groups 1 and 3 were statistically significant for  $p < 0.01$ ; TP values for a significant difference for  $p < 0.05$ . There is no significant difference between the medial and lateral measurements in any subgroup and resection.

**Discussion** The corrections made on the development of pre-operative planning was effective. It's important to emphasize that these corrections have a significant influence on the posterior femoral resections; unchanged instead of the distal femoral resection, with a very good standard deviation of about 0.2 mm. The tibial resections have also gotten better, with values very close to the then desirable. Instead there is no significant difference between the medial and lateral deviations, a sign that the cutting angle is guaranteed.

**Conclusions** The system-matched patient continues to be an effective, reliable and reproducible. The exchange of information with the engineers is crucial to ensure a perfect congruence in the operating room. In our opinion, the organizational effort required to get the masks PM, considering the ease of use, the savings in terms of

surgical time and the results obtained after 4 years of experience, is fully justified.

### Autologous chondrocytes implant (ACI) in treatment of cartilage lesion of the knee: evaluation at 12 years follow-up

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**Introduction** Autologous chondrocytes implant (ACI) can be defined as the first regenerative technique introduced with the aim of reproducing, through a hyaline-like tissue, a biologically and mechanically valid articular surface. The aim of this study was to evaluate clinical results in a group of patients at a mean follow-up of 12 years (range 9–16) after a first/second generation ACI.

**Methods** Thirty-two patients underwent first/second generation ACI in the period between January 1999 and December 2005 for chondral lesion or osteochondritis dissecans. Localisation of lesions was variable and mean size of the lesion was 5 cm<sup>2</sup>. Fourteen patients were treated with Carticel technique (1 generation ACI) and 18 underwent Hyalograft C (2 generation ACI). All patients were evaluated before surgery with IKDC (International Knee Documentation Committee) scale, Tegner Activity Scale and EQ-VAS and underwent periodical evaluation at a regular follow-up (min 9 years, max 16 years).

**Results** A significant increase of all scores were noticed in all patients at the final evaluation. Mean IKDC increased significantly from 40.2 before surgery to 74.1 at 1 year follow-up ( $p < 0.00001$ ) and 85.2 at 5 years follow-up ( $p < 0.001$ ). Tegner Activity Scale values showed a significant increment from average score of 3 pre-operatively to 4.3 at 1 year follow-up and 6.2 at 5 years follow-up. Also EQ-VAS values showed a progressive increase at all the evaluations. All the evaluations performed at the last follow-up (mean 12.3 years) were superposable if compared to 5 years follow-up evaluation. Best results were noticed in young patients and sportsmen, with lesions localized to femoral condyles.

**Conclusions** Autologous chondrocytes implant represent a valid regenerative technique for treatment of chondral and osteochondral lesions in a heterogeneous for age, sex and activity level population, associated with conservation of achieved results after 15 years from the implant.

### SHOULDER AND ELBOW 3: ELBOW AND FRACTURES

#### The terrible triad of the elbow: prospective study on 26 patients surgically treated

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**Introduction** We performed a prospective study in a series of consecutive patients with terrible triad (TT) to investigate whether the application of the current diagnostic and therapeutic guidelines yields

satisfactory outcomes in most cases. We hypothesized that although the application of current guidelines improves clinical results, a significant number of complications unrelated to surgery continue to affect the prognosis.

**Methods** We analysed 26 patients with a mean age of 52 years. Radiographs and 2-3D CT scans were obtained pre-operatively in all patients. Radial head osteosynthesis was performed with screw or mini-plate, while radial head prosthesis was applied in non-synthesizable fractures. Transosseous suture and/or osteosynthesis with two or more threaded K wires was carried out depending on the size and comminution of the coronoid fracture. Capsule-ligament and tendinous injuries of the lateral compartment were repaired in all cases; in cases of persistent instability, MCL and/or hinged fixator was repaired and applied, respectively. Functional assessment was performed using the MEPS, DASH score and m-ASES.

**Results** The mean follow-up was 30 months. The mean MEPS was 94 points, with 18 excellent, 5 good and 3 fair results; the mean DASH and m-ASES scores were 9 points and 90 points, respectively. Mean flexion, extension, pronation and supination were 136°, 11°, 78° and 77°, respectively. Five cases of elbow stiffness, followed by 4 re-operations, were observed: 3 were cases of proximal radioulnar synostosis and 1 of radial head malunion. Asymptomatic resorption of the proximal radial neck was observed in 13 out of 16 radial prosthesis cases; 5 cases of grade 1 osteoarthritis, 4 of grade 2, and 1 of grade 3 were observed.

**Discussion** The current diagnostic and therapeutic guidelines yield satisfactory clinical outcomes in the majority of cases, though a high number of unpredictable and ineluctable complications persist. In our experience, gender, low compliance, obesity, relevant co-morbidities and a high-energy trauma with extensive damage of soft elbow tissues represent unchangeable prognostic factors that negatively affect the final clinical outcome. The strict application of current guidelines instead appears to improve the results by reducing the influence of other predictable negative prognostic factors, such as the incomplete recognition of all injuries, delayed treatment, inadequate treatment of bony and ligamentous injuries, prolonged immobilization and, last but not least, an inexperienced surgeon.

**Conclusions** TT represent a very complex pattern of complex elbow instability, which remains a challenging lesion to manage.

### Recovery of functional range of motion after surgical treatment of complex elbow instability: prospective study on 76 patients

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**Introduction** It is well known that one of the key requirements regarding complex elbow instability (CEI) surgical treatment is an early rehabilitation program to avoid elbow stiffness caused by a long period of immobilization. However, no study has ever examined how, and to what extent, the functional range of motion (ROM) is recovered during the various stages of prompt rehabilitation. Our aims were: (1) to prospectively analyse the pattern of ROM recovery in a series of patients with CEI who underwent early rehabilitation; (2) to identify the period of time required to obtain a functional elbow ROM (E/F: 30°–130°, P/S: 50°–50°); (3) to determine how many patients recovered a functional elbow at the end of rehabilitation.

**Methods** A total of 76 patients (78 elbows) with CEI were followed for 2 years. All patients underwent anatomical and stable osteosynthesis of all the fractures, radial head replacement in Mason III fractures, ligament injuries reconstruction as well as early rehabilitation that started 2 days after surgery. Two surgeons evaluated the ROM with a hand-held goniometre every 3 weeks for the first 3 months, then at 6, 12 and 24 months after surgery.

**Results** At the 3-week follow-up, the mean flexion (F), extension (E), pronation (P) and supination (S) were 113°, 29°, 60° and 62°, respectively. At the 6- and 9-week follow-up, F, E, P and S were 119°, 23°, 70° and 69° and 123°, 24°, 72° and 71°, respectively. At the 3-month follow-up, these values were 131°, 18°, 76° and 72°, while at the 6-month follow-up they were 136°, 15°, 79° and 77°, respectively. Thereafter, ROM improvement was not significant.

**Discussion** This study shows that the first 6 months of rehabilitation are critical for obtaining a functional elbow; indeed, 70 % of patients recovered functional ROM between the third and sixth months, though the recovery of flexion proved to be slower than that of the other elbow movements. Thereafter, improvement continued, though at a lower rate, until the end of the first year, when approximately 80 % of the patients had recovered functional ROM.

**Conclusions** Following CEI surgical treatment, a rehabilitation programme needs to be started promptly and continued for at least 6 months because a significant improvement in ROM occurs prevalently in this period, which should be considered the critical time period for obtaining a functional elbow in a majority of patients.

### Contribution of cartilage to shape and diameter of radial head circumference: MRI analysis of 78 elbows

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**Introduction** Several anatomical studies have assessed the morphology of the proximal radius, though none have analysed the correlation between cartilage thickness and the underlying bone dimension. Indeed, it is not yet known whether cartilage thickness modifies the bone shape of the radial head. The aim of this study was to analyse the influence of cartilage on the anatomical shape and size of radial head circumference.

**Methods** We performed high-definition MRI on 78 healthy elbows in 19 men and 20 women, with a mean age of 28 years (21–32). All measurements were calculated on the axial plane just below the fovea radialis. Maximum (Mbd) and minimum (mbd) bone diameters, maximum (Mcd) and minimum (mcd) cartilage diameters, cartilage thickness (ct), whole area (WA), bone area (BA) and cartilage area (CA) were calculated. The subjects' height was used as an indirect measure of the length of the radii. Pearson correlation and Student's *t* test were used for the statistical analysis.

**Results** Mean Mbd, mbd, Mcd and mcd were 22.24, 21.52, 24.02 and 23.24 mm, respectively. All differences were significant. At the level of maximum diameter, no measurable ct was found at the side of the safe zone, whereas at the level of the articular side mean ct was 1.75 (0.5–3.5). The mean ct at the minimum diameter was 0.86 mm (0.2–1.8) with no significant difference at the two opposite sides. Mean BA, WA and CA were 3.71, 4.33 and 0.61 cm<sup>2</sup>, respectively, with differences being significant. A significant correlation emerged between Mbd and mbd and between Mcd and mcd. No significant correlation was detected between bone diameters and ct, or between BA and CA. No significant correlation emerged between the subjects' height and ct or CA; by contrast, a significant correlation emerged between the subjects' height and bone/cartilage diameters, BA or WA.

**Discussion** The radial head is not circular but has two different diameters whose sizes increase in proportion to the height of the subjects. Moreover, the cartilage surface significantly increases the size of the radial head circumference, thereby changing the bone shape. Cartilage thickness at this level varies from subject to subject and does not correlate with bone size.

**Conclusions** Our study shows that cartilage thickness circumference modifies the shape and size of the radial head significantly. Furthermore, as cartilage thickness varies from subject to subject, it cannot be inferred from the measurements performed on the bone.

## Elbow arthroplasty in complex osteoporotic fractures

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**Introduction** Elbow fractures (EF) represent 2–7 % of all fractures in adults. These fractures are often comminuted and intra-articular. Because of the complex anatomy of the elbow joint and in case of elderly osteoporotic patients, achieving good results become more challenging. In literature there is still a debate about the best treatment of such fractures. Open reduction and internal fixation is hard to achieve due to poor mechanical bone properties and for this reason elbow arthroplasty (EA) is increasingly popularity in case of fragmented fractures of the distal humerus. Although EA is associated with a rapid recovery of elbow motion and comfort, there are several complications such as prosthetic infection, failure of the triceps mechanism and activity limitations. The aim of this study is to retrospectively evaluate clinical outcomes of our series.

**Methods** From September 2007 to March 2013 we performed 29 EA in 28 patients; 25 females and 3 males. All patients had poor bone quality with a distal humeral fracture or a complex elbow fracture or a consequence of terrible triad of the elbow. The surgical approach used was a universal posterior incision with triceps preservation. At each follow-up we performed X-rays of the elbow and clinically evaluated pain, function, range of motion and stability with the Mayo Elbow Performance Score.

**Results** The mean age was 72 years (range 45–94). The diagnoses were: an isolated distal humeral fracture in 15 cases, a complex elbow fracture in nine and a result of terrible triad of the elbow in five. In two cases was necessary using an homologous bone graft. In 27 cases a linked semi-constrained Total EA; one patient received an hemiarthroplasty (latitude humeral component) and in another case a custom-made prosthesis was implanted. In two cases a supplementary osteosynthesis was performed. Excellent to good functional results were reported in 22 cases and only in seven cases fair and poor results were recorded.

**Discussion** Despite the poor biomechanical properties of the osteoporotic bone in elderly patients, our results are satisfactory and this can be probably attributed to the surgical approach that preserves both the olecranon and the triceps extensor mechanism when possible.

**Conclusions** In case of complex elbow fractures, especially of the articular pillars, in osteoporotic patients we prefer to use cemented elbow prosthesis with a preserving triceps approach. However, to confirm these results it is necessary to perform a randomized controlled trial with osteosynthesis in order to confirm the effectiveness of the arthroplasty in elbow complex fractures.

## Role of endoscopic neurolysis in the treatment of cubital tunnel syndrome

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**Introduction** The cubital tunnel syndrome (CTS) is the second most common entrapment neuropathy of the upper limb, due to the anatomical course of the nerve and its superficial location in the cubital

tunnel. This work aims to verify the effectiveness of a minimally invasive endoscopic technique in treating CTS, through the study of clinical and functional outcomes.

**Methods** All patients came with the diagnosis of CTS between June 2011 and January 2014 were included in this retrospective mono-centric study. The used operative technique was described by Hoffmann and Siemionow. In this technique a skin incision of about 2 cm is practiced in correspondence of the arcuate Osborne's ligament, the subcutaneous tissue is moved thanks to a special speculum, which allows to do neurolysis of ulnar nerve under endoscopic control. The functional evaluation of nervous involvement is accomplished as described by J.C. Mac Dermid in 2013, evaluating pre-operative deficit and post-operative outcome.

**Results** Thirty-two patients were treated with endoscopic technique, including 27 with a mean follow-up of 15.7 months (4–35), 4 untraceable and 1 excluded from the study due to radicular symptoms. Among these 27 patients, 24 (92.59 %) said they were full satisfied with an improvement in functional score, 2 (7.4 %) have declared dissatisfaction with improvement in functional score and only 1 had worsening in functional score. It was noticed only a delay in wound healing, however healed after local treatment. No other complication was observed during the study.

**Discussion** A minimally invasive technique should allow neurolysis of several centimetres downstream and upstream the elbow, as is possible with the open technique. The visual control provided by the endoscopic technique allows accurate execution and reduces the risk of a lot of peri-operative complications. This is in line with the existing literature.

**Conclusions** In comparison with conventional open technique the endoscopic technique is equally reliable, with a comparable success rate and functional improvement, having at the same time the advantages of a minimally invasive technique.

## The safe zone for avoiding suprascapular nerve injury in bone block procedures for shoulder instability: a cadaveric study

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**Introduction** In the anterior gleno-humeral instability, the glenoid bone loss greater than 25 % should be managed with reconstruction procedures using bone graft, such as Bristow or Latarjet procedures. The bone graft is usually fixed to the antero-inferior aspect of the glenoid with bicortical screws with possible injury to the suprascapular nerve. The aim of the study was to identify the safe zone in which the surgeon can place the screws for the graft fixation during Bristow or Latarjet procedures to prevent suprascapular nerve injury.

**Methods** Twelve fresh frozen shoulders (M:F = 6:6, mean age 59, range 52–82) were dissected according to a standard posterior approach to the gleno-humeral joint. The suprascapular nerve and its branches for the infraspinatus muscle were identified at the spinoglenoid notch region. The distance between the glenoid and the suprascapular nerve at the spinoglenoid notch region was measured by using a ruler with the shoulder at 90° of internal rotation (IR) and 90° of external rotation (ER).

**Results** The average distance between the glenoid and the suprascapular nerve was 12 mm (range 6–15) with the shoulder at 90° of IR, and 19 mm (range 11–23) with the shoulder at 90° of ER. The distance between the glenoid and the suprascapular nerve was significantly greater with the shoulder in 90° of ER ( $p = 0.002$ ). There

was no statistically significant difference between the male and female samples both in IR and ER of the shoulder. The distance between the glenoid and suprascapular nerve did not correlate with the length of the upper edge of the scapula and the antero-posterior diameter of the glenoid in both IR ( $r = 0.07$  and  $r = -0.15$ , respectively) and ER position ( $r = 0.18$  and  $r = -0.14$ , respectively) of the shoulder.

**Discussion** The extension of the safe zone in the posterior surface of the neck of the scapula varies with the rotation of the humerus. Although the safe zone is greater with the shoulder at 90° of ER, the minimum detected distance was 11 mm. The distance between glenoid and suprascapular nerve at the spinoglenoid notch region does not correlate with the gender and scapula size.

**Conclusions** The suprascapular nerve is furthest away from the glenoid with the shoulder at 90° of ER. Therefore, the placement of screws with the humerus in ER during glenoid reconstruction procedures with bone graft likely reduces the risk of iatrogenic injuries of the suprascapular nerve.

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## FOOT AND ANKLE 1: FOOT AND ARTHRODESIS

### Correction of complex deformities of the foot: indications for osteotomy or arthrodesis

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**Introduction** Correction of complex deformities of the foot requires many different strategies, including corrective osteotomies and arthrodesis. Our work aims at describing the indications and the algorithm used to choose the treatment for the correction deformities or instability of the foot using the Ilizarov technique.

**Methods** Our work included 84 patients, meanly aged 29.4 years, divided into 2 groups: in the first group (49 patients) we performed open arthrodesis and correction, while in the second group (35 patients) we performed osteotomy and progressive distraction for deformities correction. Deformities were due to trauma (28 cases), hemimelia (14 cases), poliomyelitis (11 patients), Charcot-Marie-Tooth disease (8 patients), myelomeningocele (8 cases), idiopathic cavus-varus foot (6 cases), spastic hemiplegia (3 cases), Charcot diabetic foot (2 cases), idiopathic flat foot (2 cases), paralytic foot (1 case), syringomyelia (1 case). In the first group of patients we performed arthrodesis of the ankle, subtalar, calcaneocuboid joints; in some cases an osteotomy of the calcaneus was performed. In the second group of patients we performed V- or Y-shaped osteotomy associated with correction by distraction.

**Results** Mean treatment time was 5.1 months. Follow-up time was 24 months to 10 years. Plantigrade foot was gained in 94 % of patients. Final functional scores were calculated by AOFAS ankle-hind foot scale and they were excellent in 64 patients, good in 17 patients and poor in 2 patients. We had 63 complications in 43 patients, which were all successfully treated. In 1 case we had an arterio-venous shunt. No patients had neurological damage.

**Discussion** The Ilizarov technique can be an option in the treatment of complex deformities of the foot that present axial deviations, though it can be hard to choose the right indication between osteotomy or stabilization by arthrodesis.

**Conclusions** Osteotomy and progressive correction with bone regenerate by distraction are indicated for rigid foot, that can be post-traumatic, associated with hemimelia or can be the consequence of previous surgeries. If instability, muscular imbalance or neurologic conditions are present, stabilization by arthrodesis should be preferred.

### Posterior tibial tendon rupture (PTTR) grade III: benefits of double medial arthrodesis in large deformities

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**Introduction** The double arthrodesis (subtalar and talonavicular) is indicated in cases of severe rigid valgus hind foot, typically posterior tibial tendon rupture grade III according to the classification of Johnson and Strom. The medial approach, in surgeon at the end of the learning curve, it offers a good exposure of the articular surfaces, without the risk of dehiscence of the surgical wound (most common complication in triple arthrodesis performed with dual access, one medial and one lateral). It is also demonstrated that the fusion of the calcaneocuboid has no functional significance to the exclusion of cases with severe abduction of the mid foot-fore foot, which appears to be associated with graft required for correction of the deformity (Myerson classification of 3-B).

**Methods** This is a retrospective study of 40 consecutive cases of double arthrodesis with medial access. From 2011 to 2013 at IRCCS Galeazzi Orthopaedic Institute in Milan (Equipe CTS foot and ankle) have come under our observation of 40 cases of grade III A PTTR according to the classification of Bluman and Myerson with an average age of patients at 55 years. The patients were subjected to an X-rays weight-bearing and to a CT study of the foot. They were subsequently subjected to the intervention of a double arthrodesis by immobilization with medial leg cast for 60 days with a renewal of the same intermediate to 30 days.

**Results** The mean time to radiographic consolidation was 16 weeks. Symptomatic cases of nonunion were 4 for which it was necessary to perform an operation to remove fixation and a new arthrodesis with a bone graft from the bank. There were no complications related to the healing of the surgical wound. In all cases there was a significant change in the index of Meary and the calcaneal pitch angle and also there was a significant increase of AOFAS hind foot score at follow-up at 3 months compared to preoperative values.

**Discussion** In our experience double arthrodesis (subtalar and talonavicular), with medial access, is a viable alternative to the intervention of triple arthrodesis, without the risk of morbidity and nonunion calcaneal-cuboid joint.

**Conclusions** The realignment of an adult acquired flatfoot with double arthrodesis (subtalar and talonavicular) due to medial access allow a stable correction of the deformity similar to that obtained with a triple arthrodesis, reducing the number of complications related to this surgical procedure.

### Lateral peritalar instability type 2: the role of the second reconstruction Brostrom-Gould versus minimally invasive repair with allograft

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**Introduction** The lateral peritalar instability is a pathological complex entity with multifactorial etiology that includes axial deviation, ligament injuries and functional instability. The ankle is a functional unit with the subtalar joint. In the classification we have recently proposed (printed in Foot and Ankle Surgery) consider the instability of the ankle and subtalar joint as a single disease entity: lateral

peritalar instability, which can have causes skeletal, ligamentous or both associated. Therefore distinguish: a lateral peritalar instability type 1A, 1B and 1C, in which deviations are observed axial loading of the ankle or the hind foot or both, type 2A and 2B, in which an instability is observed ligamentous load to the ankle or the ankle and subtalar and type 3, in which an instability is observed functional. The purpose of the study is rationalize the treatment of type 2 lateral peritalar I instability (ligamentous instability): ankle 2A, 2B ankle and subtalar joint.

**Methods** From 2011 to 2013 at the Institute of Milan, IRCCS Galeazzi Orthopaedic Equipe CTS Foot and Ankle came to our observation of 800 cases of ankle sprain, of these 30 cases have hesitated in an lateral peritalar instability type 2 (2A 20 cases and 2B 10 cases), requiring reconstructive surgery. The treatment of ligament injuries isolated or associated with osteochondral lesions is based on three therapeutic options: anatomic repairs; non-anatomic repair; arthroscopic repairs. The anatomical reconstruction does not provide the sacrifice of noble anatomical structures for the joint. According to our protocol technique Brostrom-Gould has been reserved for cases of lateral peritalar instability type 2A. A minimally invasive technique, which involves the use of allograft or the alternative of plantar-gracile was reserved for cases of lateral peritalar instability type 2B, in which we observe an association between ankle instability and subtalar instability. This technique involves the reconstruction of the anterior talus peroneal ligament (stabilizer of the ankle) and the calcaneal peroneal ligament (stabilizer ankle and subtalar joints) with the use of two interference screws (one in the talus and one in the heel), a transbone tunnel in the fibula and 4 mini-incisions of the skin. The patients, the object of our observation, were subjected to execution of bilateral ankle and foot weight-bearing radiographs to identify any deformities skeletal hind foot and accordingly to address the etiological classification and subsequent treatment. The study MRI of the ankle was performed in all patients to assess any underlying conditions (the peroneal tendon and osteochondral lesions). Patients subjected to two types of surgical treatment were immobilized with a leg cast for 30 days and then began a rehabilitation standards.

**Results** With the use of our therapeutic algorithm for lateral peritalar instability (ligamentous instability) we have not recorded post-operative complications. No recurrence at an average follow-up of 12 months. The patients all came back to the previous functional and sports activity.

**Discussion** Lateral peritalar instability is a pathological complex with a multifactorial etiology. We believe that our classification represents a solid clinical framework for the assessment and treatment of this condition. Only by correction of all pathology causing the instability will the best results be achieved.

**Conclusions** The lateral peritalar instability side involves complex anatomical structures. The possibility to define and systematize within a classification allows us a reliable therapeutic approach.

### Treatment algorithm for osteochondral lesions of the talus, basing on clinical and radiological outcomes with T2 mapping

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**Introduction** Osteochondral lesions of the talus (OLT) have low possibilities of self-repairing. Aim of surgical procedures is restoring a continuous and long lasting chondral layer. Among the many techniques available, microfractures are successful procedures with a reparative aim. Regenerative techniques, restoring hyaline cartilage,

have been emerging; in particular bone marrow derived cells transplantation (BMDCT) achieved good clinical and radiological outcomes. Aim of this study is comparing the clinical and radiological outcomes of microfractures and BMDCT in OLT with different size.

**Methods** Twenty-eight patients, with an average age of  $30 \pm 12$  years, underwent microfractures: in 16 the lesions' size was inferior than  $1.5 \text{ cm}^2$  (type I according Giannini's classification) and in 12 wider than  $1.5 \text{ cm}^2$  and no more than 5 mm deep (type II). Thirty-two patients, with a mean age of  $29 \pm 18$  years, underwent BMDCT. In 11 cases the lesions sized less than  $1.5 \text{ cm}^2$  and 21 had type II lesions. Both the techniques were arthroscopically performed. The BMDCT was carried out in a unique surgical session (one step), harvesting the nucleated cells from the iliac crest and loading them on a collagen membrane.

**Results** Microfractures for type I lesions recorded a pre-operative value of  $63 \pm 10$ , reaching a stable plateau of  $85 \pm 13$  points at 48 months. In type II lesions, decreasing values were achieved, with a final outcome of  $78 \pm 10$  at 48 months. T2 mapping evaluation showed hyaline like values in the 60 % of type I lesions, and results compatible with fibrocartilage in the 65 % of the type II lesions. BMDCT achieved a final outcome of  $91 \pm 8$  points in the type I lesions, with comparable results in the type II lesions ( $90 \pm 9$  points) at 48 months. T2 mapping revealed a larger presence of hyaline like tissue in the type I and II lesions (70 %).

**Discussion** Microfractures achieved good outcomes in I type lesions: this procedure succeeded in restoring a viable tissue with long-lasting results, reducing the costs and the time to resume sport (4 months). BMDCT is preferable in larger lesions, where a hyaline regeneration could dramatically improve the long term follow-up. Nevertheless, a longer rehabilitation before sport resumption and higher costs have to be faced.

**Conclusions** Although both the techniques achieved satisfying results, in small OLT (type I) and every time a fast sport resumption is mandatory, microfractures are desirable, whereas larger lesions (type II) require a regeneration technique, as BMDCT, to obtain a full and durable recovery.

### Corrective osteotomies of the ankle: 8-year results

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**Introduction** Fractures involving the distal portion of the tibia and/or the fibula often lead to sequelae such as malunion and malalignment which in time lead, if not corrected, to the development of early ankle osteoarthritis. In order to limit the development of osteoarthritis in young and active patients, a surgical treatment for ankle realignment can be performed, delaying the need of further surgery such as an arthrodesis procedure, a prosthesis or an allograft.

**Methods** Fifty-three patients (mean age 45 years) were treated with a corrective osteotomy of the distal portion of the tibia and/or the fibula. Inclusion criteria were: alteration of the loading axis, articular incongruity, pain and stiffness in patients below 60 years old in the absence of severe osteoarthritis and soft tissue damage, patients under 30 years old with osteoarthritis in order to delay as much as possible other major surgical procedures.

**Results** At 8 years mean follow-up 24 cases showed excellent results, 25 good results (moderate pain after deambulation and reduced range of motion (ROM)  $<15\%$ ) and 4 fair results (moderate pain and reduced ROM  $>15\%$ ). No progression of degenerative osteoarthritis was observed in patients with osteoarthritis of grade I or II treated with supramalleolar osteotomy. In patients with a grade II osteoarthritis treated with osteotomy involving the articular surfaces, imaging showed in all cases a moderate articular deterioration; 5 of

these patients required a revision surgery with an arthrodesis procedure or an allograft.

**Discussion** Different types of corrective osteotomies of the ankle have been described: supramalleolar (extra-articular), malleolar (intra-articular) and combined. Supramalleolar osteotomies can be performed at different levels on the tibia, on the fibula or both, in plus or minus, improving and rebalancing the distribution of load forces. Intra-articular malleolar osteotomy (joint reconstructions) can be performed by a medial or a by a lateral approach, allowing to correct malunions, to restore articular congruity and sometimes to repair ankle cartilage defects.

**Conclusions** Corrective osteotomies of the ankle showed satisfactory results, allowing to restore joint alignment and avoiding, or at least delaying, further surgical procedures.

## FOOT AND ANKLE 2: FOOT AND HALLUX VALGUS

### Calcaneal osteotomy for adult acquired flatfoot: what type of synthesis?

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**Introduction** Adult acquired flatfoot deformity shows typical clinical manifestations such as pain and deformity, depending on the stage of the disease. In adult patients the treatment is surgical and exclusively reserved for hyperpronated painful feet. Medializing calcaneal osteotomy (MCO) is the gold standard surgical procedure with the aim to modify the anatomy and biomechanics of foot and ankle in the early stages. The postoperative complications are infrequent and less disabling than those that occur in arthrodesis. The purpose of this study was to evaluate the clinical outcomes of MCO synthesized with different hardware in painful adult flatfoot.

**Methods** Between September 2001 and February 2012, 40 procedures of MCO were performed in 34 patients (6 bilateral). For the synthesis were used screws in 26 patients, K-wires in 6 and plates in 7 patients. AOFAS score for hind foot and SEFAS were used for clinical assessment.

**Results** The mean follow-up was 66.1 months. Comparing before and final follow-up, growth rates of AOFAS and SEFAS scores are 145 and 93 %, with an increasing of the scores from  $34.9 \pm 22.7$  to  $85.8 \pm 20.4$  and from  $21.1 \pm 10.6$  to  $40.8 \pm 8.7$ . Complications observed were sural paresthesia in 3 plates and 2 screws, one lymphoedema treated by plate, wound discomfort in one patient treated with K-wire. All patients recovered at follow-up.

**Discussion** The various hardware used demonstrated to be valid. The K-wire was the only devices removed.

**Conclusions** Pain is the parameter with greatest improvement confirming that has to be considered the main indication for MCO treatment of the adult acquired flatfoot. Screws resulted to be the hardware with less complications and higher compliance.

### Juvenile evolute flat foot deformity treatment: calcaneo-stop procedure and endorthesis screws. A comparison of different techniques

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**Introduction** Flatfoot deformity treatment could be non-surgical with orthotics and kinesiotherapy or surgical with calcaneo-stop procedure, on a lateral plane or endorthesis screws, or with a tenoligament medial reconstruction.

**Methods** From January 2000 to June 2013, 221 flat feet were surgically treated, 206 feet (113 patients) were treated with a lateral approach procedure, 48 were treated using calcaneo-stop procedure with Pisani screw (18 pt I type; 30 pt II type). In 138 cases was used an endorthesis (72 cases with Giannini absorbable endorthesis; 86 Kalix II). Only flatfoot deformity stage III and IV was treated. Patients' age ranges from 9 to 14 years. In patients treated with calcaneo-stop technique, we allowed weight-bearing 48 h after surgery. In patients treated with endorthesis weight-bearing was allowed 15 days after surgery. Neither plaster casts nor braces were applied.

**Results** Results were evaluated according to clinical parameters (pain, reduced function, return to sports activity, orthotics forbearance, Achilles tendon shortening) and instrumental parameters (Costa Bertani angle, photopodogram) at least 6 months after surgery. Results showed no significant differences between the two procedures: 92 % excellent-good results with calcaneo-stop; the 88 % excellent-good results with Giannini endorthesis, were compromised by the number of implant removal; 94 % with Kalix II implant. No Achilles tendon shortening was shown. In both Giannini endorthesis and Kalix II no implant migration was registered. Two complications, an infection and an implant rupture, were registered with Pisani screws; in 10 cases the screw was removed. In 16 cases with Giannini endorthesis removal of what was left of the absorbable implant was performed due to implant intolerance. Three Kalix screws were removed. Normal gait pattern was recovered in about 30 days in calcaneo-stop surgery patients and 40 days in those with endorthesis.

**Discussion** Symptoms showed by patients not tolerating Giannini endorthesis disappeared after fragments' removal. Results did not change after implant removal. The calcaneo-stop procedure is more respectful of the tarsal sinus' anatomy, and less expensive. The endorthesis is extremely easy to implant and allows good results even in patients near the end of skeletal development. The endorthesis, especially Kalix, is a quiet invasive implant and in some cases pain persists longer than with other implants.

**Conclusions** The two techniques showed similar outcomes, they both allow excellent results in treatment of evolute flat foot deformity.

### Percutaneous distal osteotomy (PDO) for recurrent hallux valgus

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**Introduction** Recurrent hallux valgus can be treated by traditional open techniques as metatarso-phalangeal and tarsometatarsal arthrodesis or revisioning the metatarsal osteotomy. These techniques adversely affect all functional aspects of the first ray and also require a long postoperative care. The purpose of this study is to evaluate the mid-long term results obtained with a minimally invasive percutaneous distal osteotomy (PDO) of the first metatarsal for recurrent hallux valgus.

**Methods** From 1997 and 2010, 32 PDO of the first metatarsal were performed for the treatment of recurrent hallux valgus in 26 patients. Patients were assessed with radiographic protocol and clinically by the American Orthopaedic Foot and Ankle Score (AOFAS) hallux-metatarso-phalangeal-interphalangeal scale and SEFAS (Self Reported Foot and Ankle Score).

**Results** Mean AOFAS score varied from  $17.86 \pm 46.94$  pre-operatively to  $14.89 \pm 85.22$  at the follow-up. Pre-operative SEFAS score

was  $10.19 \pm 32.88$  and shifted at  $4.76 \pm 44.66$  at the follow-up. Radiographic parameters at the follow-up was significant ( $p < 0.05$ ) compared with the pre-operative values, in the mean hallux valgus angle, first intermetatarsal angle. We obtained good results in 28 of cases (87.5 %). Complication was one recurrence of hallux valgus (3.13 %), two reduced of ROM below  $30^\circ$  (6.25 %) and one delay of consolidation (3.13 %).

**Discussion** Results of PDO of the first metatarsal for recurrent hallux valgus appear to be comparable with those of traditional open techniques, with the advantages of a minimally invasive procedure, a substantially shorter operating time, and a reduced risk of complications related to surgical exposure.

**Conclusions** The PDO can be considered a viable alternative to the rescue techniques used to date in the recurrence of hallux valgus surgery.

### Influence of isolated lesions of the syndesmotic ligaments on ankle joint stability: a cadaveric study

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**Introduction** Several isolated ligament injuries of the syndesmosis and deltoid ligament (DL) have been described in the literature. The present study aimed to investigate the effect of the combination of these lesions on the stability of the ankle.

**Methods** Ten fresh-frozen ankles were dissected by removing soft tissues except the joint capsule, ligaments of the syndesmosis and the interosseous membrane (IM) and DL. The opening of the tibiofibular syndesmosis was measured on sagittal and coronal planes, and during external rotation of the ankle by applying a force of 5, 10, 15 and 20 N. In group 1 ( $n = 5$ ), the ligaments were injured in the following order: anterior-inferior tibiofibular ligament (AITFL), superficial component of the DL (SDL), deep component of the DL (DDL), posterior-inferior tibiofibular ligament (PITFL) with lesion of 10, 50 and 100 mm of the IM. In group 2 ( $n = 5$ ), the ligaments were injured in the following order: AITFL, PITFL with lesion of 10 and 50 mm of the IM, SDL, DDL and injury of 100 mm of the IM. The measurements were performed on each sample both before and after the each type of lesion.

**Results** In both groups, increasing the number of the injured ligaments a progressive diastasis of the tibiofibular syndesmosis was found on coronal and sagittal planes, and during external rotation of the ankle. Compared with the values measured in the non-injured ankle, a lesion of 100 mm of the IM determined the maximum increase of diastasis on coronal (20 N; G1: 34.2 mm,  $p < 0.01$ ; G2: 35 mm,  $p < 0.01$ ) and sagittal planes (20 N; G1: 33.2 mm,  $p < 0.01$ ; G2: 31 mm,  $p < 0.01$ ). The maximum increase of external rotation was found with the injury of the DDL (20 N; G1:  $47.4^\circ$ ,  $p < 0.01$ ; G2:  $68.4^\circ$ ,  $p < 0.01$ ).

**Discussion** Isolated lesions of the SDL, AITFL or PITFL and combined injuries of AITFL, PITFL and up to 50 mm of the IM does not cause instability of the ankle in sagittal and coronal planes, and external rotation. In these patients, conservative treatment is recommended. The combined lesion of AITFL, PITFL and more than

50 mm of the IM leads to instability of the ankle only in the coronal plane. Isolated lesions of the DDL cause instability of the ankle in sagittal and coronal planes, and external rotation. In both cases, surgery is recommended.

**Conclusions** Different patterns of lesions of the syndesmosis and DL affect variably the ankle stability requiring different managements.

### Hallux valgus surgery in professional athletes patients: results with SERI technique

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**Introduction** Many surgical techniques have been described for the treatment of hallux valgus, with the tendency towards minimally invasive approaches to reduce complications and recovery times. The SERI technique consists of a distal linear osteotomy of the first metatarsal. Due to the possibility to treat different types of deformity with a minimally invasive procedure characterized by low complications rate, this technique was performed in a cohort of professional athlete patients.

**Methods** Sixty-three professional athlete patients were surgically treated with SERI technique. Inclusion criteria were predefined as follows: deformity  $<40^\circ$  and inter-metatarsal angle (IMA)  $<18^\circ$ . This technique is performed from a medial approach through a 1 cm medial incision just proximal to the medial eminence, at the level of the neck of the first metatarsal bone under direct visual control. The osteotomy is stabilized by a 2 mm diameter K-wire inserted into the diaphyseal channel of the first metatarsal bone up to the base of the metatarsal. Ambulation is allowed immediately using post-operative shoes that transfer weight-bearing to the hind foot. After 30 days, the dressing, the suture, and the K-wire are removed and gradual recovery of normal walking is allowed. Progressive rehabilitation is then performed with passive and active exercises, proprioceptive re-education with a return to sport activity at 12 to 16 weeks.

**Results** Patients were clinically and radiographically evaluated using the AOFAS score and through standard and weight-bearing radiographs at a 11 years mean follow-up. Correction of IMA, hallux valgus angle (HVA), proximal articular set angle (PASA) and hallux rotational defects were obtained. It was also possible to modulate the length of the first metatarsal and the pronation or the supination of the metatarsal head. At the last follow-up 87 % of excellent/good results, 8 % of poor results and 5 % of unsatisfactory results were obtained. The average correction of the HVA angle was of  $10.6^\circ$ , the average correction of the IMA angle was of  $8^\circ$  and the average correction PASA angle was of  $8.2^\circ$ . Of 63 patients, 60 returned to their previous sports activity level and 3 to a lower activity level.

**Discussion** Many surgical techniques have been described for the treatment of hallux valgus, but only few of them are able to correct all the parameters of the deformity and to offer the same results in high-function-demand patients, with very low morbidity and low complications rate.

**Conclusions** The SERI technique is indicated for the correction of hallux valgus in professional athlete patients. Although functional demands were higher than in the general population, most of the operated athletes were able to return to their previous sports activity level as prior to surgery, with reduced morbidity.

## IN-DEPTH ORAL PRESENTATIONS AND ORAL COMMUNICATIONS in collaboration with SPECIALISTIC SOCIETIES

### BIOMATERIALS AND BIOTECHNOLOGIES (in collaboration with S.I.B.O.T.)

#### IN-DEPTH ORAL PRESENTATIONS

##### Cost-effectiveness of tibial non unions treatment: a comparison between BMP-7 and autologous bone graft in Italy

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**Introduction** Current evidences indicate that recombinant human bone morphogenetic protein 7 (rhBMP-7) can be considered an alternative to autologous bone graft (ABG) in the treatment of tibial non-unions. However so far, few studies have analysed the costs of the two alternative treatments and none of them considered the Italian situation. The main objective of the present study was to capture, through an observational retrospective study, the direct medical costs associated to the treatment of tibial non-unions with rhBMP-7 or ABG in Italy and to compare the cost effectiveness of the two interventions. Its secondary objective was to perform a cost-reimbursement analysis for hospitalizations associated to the two treatments.

**Methods** Data of 54 patients, 26 treated with ABG and 28 with BMP-7 for tibial non-unions and followed-up until the union was achieved or for at least 12 months, were collected from existing data sources. The study captured the direct medical costs for treating each tibial non-union, considering both inpatient and outpatient care. The hospital reimbursement was calculated from Discharge Registries, based on DRG values. A subgroup of patients ( $n = 30$ ) was also interviewed, using EQ-5D questionnaires, to capture perceived health during the follow up. Based on these indexes Quality Adjusted Life Years (QALY) were computed in each treatment group.

**Results** The two groups were similar for what concerns baseline characteristics. The medical costs incurred during the hospitalization associated to treatment were on average 3,091.21 Euros higher ( $p < 0.001$ ), in patients treated with rhBMP-7. On the contrary the costs incurred during the follow-up were on average 2,344.45 Euros higher ( $p < 0.02$ ) in patients treated with ABG.

**Discussion** Considering all costs incurred from the treatment until the end of the follow up, the Regional Health System sustains comparable costs when treating a tibial non-union with ABG and rhBMP-7, with an evidence of an average difference equal to 795.42 Euros. The average cost to reach a success case was 488.96 Euros lower in patients treated with rhBMP-7 and the cost per QALY gained was below the cost utility threshold of 40,751 Euros. Considering an hospital perspective, the hospital undergoes significant losses ( $p = 0.003$ ) when using rhBMP-7 instead of ABG.

**Conclusions** In contrast to these losses, in Italy, the average cost to achieve a successful outcome was 488.96 Euros lower in patients treated with rhBMP-7 and, additionally, the cost per QALY gained was below the cost-utility threshold of 50,000 Euros.

##### Monotherapy vs. polytherapy in the treatment of forearm non-unions and bone defects

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**Introduction** The 5–10 % of all fractures is associated with healing problems resulting in delayed union or nonunion development. Recently, studies have focused on a new strategy for biological stimulation that can speed up the healing process. This new strategy, called polytherapy, would use simultaneously all three key components of the diamond concept. The aim of this study is to assess what might be the most appropriate therapeutic strategy in the treatment of nonunions and bone defect of the forearm.

**Methods** In our study we enrolled 52 patients. An assessment of the case history, the execution of radiographs and in some cases of a CT scan were fundamental in order to classify the patients with the NUSS score. This score allowed us to divide the patients into four classes that define a different prognostic factor of nonunion. The patients were subsequently divided in two groups that are defined based on the type of treatment. We distinguished a group of patients treated according to the principles of monotherapy (33 patients) and a group of patients treated according to the principles of polytherapy (19 patients).

**Results** In the monotherapy group 21/33 nonunion (63.64 %) went on to develop a radiographic and a clinical healing in 12 months; the DASH score calculated at the follow-up of 12 months showed a value of 55.15 points. In polytherapy group 17/19 (89.47 %) non-union went on to develop clinical and radiographic healing at 12 months; the DASH score measured at 12 months showed a value of 45.47 points. The average time of clinical recovery detected are respectively 3.65 months in patients treated with polytherapy and 5.29 months in patients treated with monotherapy; the time to radiographic healing reported are 6.18 months in patients treated with polytherapy and of 8.43 months in patients treated with monotherapy. The statistical analysis of this results, showed a superiority of treatment with polytherapy in terms of radiographic and clinical healing at 12 months ( $p = 0.0431$ ) and in terms of the result of the DASH score at 12 months ( $p = 0.0477$ ). Also from the point of view of the time of radiographic ( $p = 0.0105$ ) and clinical healing ( $p = 0.0267$ ) treatment with polytherapy show a statistically significant superiority.

**Discussion** Our study has some limitations: there was a great diversity of fracture patterns and a too small number of patients were enrolled in the polytherapy group.

**Conclusions** The treatment with polytherapy is superior to treatment with monotherapy in patients who have a high NUSS score.

##### Experimental study *in vivo* of a new porous cement: research line

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**Introduction** Finding a biocompatible material, which, for its chemical-structural characteristics, promised a biomechanical strength adequate till to its complete re-habitation by the neo-formed bone tissue, the need was felt. The purpose of this study is the analysis of a new acrylic bone cement (Calcemex) based on polymethyl-methacrylate (PMMA) and  $\beta$ -tricalcium phosphate (TCP).



**Methods** From May 2007 to now at the Department of Orthopaedics and Traumatology, University of Verona, we have tested the new porous cement into 3 phases: the first, on which it was evaluated the biocompatibility on 8 New Zealand rabbits, the second, in which we have analysed osteoconduction and osteointegration on 12 New Zealand rabbits and the third, to test the biomechanical strength on large animals, 5 pigs. For each sample analyses were conducted macroscopic, microscopic with suitable colours for bone, X-ray and electron microscopy (SEM).

**Results** The first phase of the study has demonstrated the excellent biocompatibility of the cement due to the low polymerization temperature and a valid osteointegration at the cement-bone contact surface. The second phase of the study showed that the Calcemex was characterized by macroscopic porosity, with pores of 200–500 µm that create a structure similar to that of trabecular bone. The increase of the contact surface cement-bone and the formation, not only at the interface level, of newly formed trabeculae, demonstrated the excellent osteointegration of this cement. The formation of neotrabecole within the cement, which involves all the material surface after 12 months, is entirely determined by the re-absorption of the β-TCP that releases calcium ions and phosphorus, osteoconductive factors. The last phase of the study is providing encouraging results on the biomechanical strength of the Porosectan: the material implanted on the femur and tibia of large animals that were on average 220 kg of weight is plotted periodically with standard radiographs, has shown weight-bearing biomechanical resistance 5 times high than trabecular bone.

**Discussion** The high polymerization temperature and the absence of osteointegration make the PMMA as a foreign body which tends to isolate with the formation of a fibrous layer cement-bone interface. The preliminary results lead us to think that the Calcemex can be a viable alternative to PMMA cements.

**Conclusions** The almost total re-housing by newly formed bone in Calcemex with partial-progressive re-absorption of the cement, making this an ideal material in the daily practice of orthopaedic surgery. Further studies should be conducted on this material but the applications seem to be promising for the future.

### Can the ceramic on ceramic couplings release chromium ions?

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**Introduction** BIOLOXdelta (CeramTec GmbH) is actually the most commonly used ceramic composite in hip prostheses couplings. It is known to achieve a strong fracture strength, excellent wear resistance and high biocompatibility. BIOLOXdelta is composed by a matrix of aluminium oxide in solid solution with the chromium oxide, toughened with zirconium oxide. The toxicological effects of chromium released from metal-on-metal hip devices are well known and a high level of attention is recently addressed to this metal ion. Considering that BIOLOXdelta material contains chromium, the aim of this study was to detect any in vivo release of chromium ions from BIOLOXdelta bearings in patient's blood, erythrocytes and urine.

**Methods** Twenty total hip arthroplasty patients with BioloX delta-BioloXdelta couplings (patients) and 21 subjects with no implanted prostheses (controls) were enrolled, once excluded other forms of exposure to chromium. Patient group consisted of 10 females and 10 males, mean age 59.9. Fifteen of them had a 32 mm head and 5 a 36 mm one. Follow-up ranged between 6 and 63 months. Control group consisted of 7 females and 14 males, mean age 57.2, wearing no implant. Inductively coupled plasma mass spectrometry (ICP-MS) was used for the ions dosage.

**Results** In the patient group the Cr ions mean values were: in blood 0.21 µg/l (±0.09), in serum 0.21 µg/l (±0.12), in erythrocytes (normalized to  $4.7 \times 10^6$  cells) 0.13 µg/l (±0.09), in urine 0.14 µg/l (±0.18) and in normalized urine 0.12 µg/g creatinine (±0.13). In the control group the Cr ions mean values were: in blood 0.22 µg/l (±0.14), in serum 0.17 µg/l (±0.08), in erythrocytes (normalized to  $4.7 \times 10^6$  cells) 0.13 µg/l (±0.11), in urine 0.10 µg/l (±0.12) and in normalized urine 0.07 µg/g creatinine (±0.08). The laboratory reference values were 0.1–5.0 µg/l for blood, 0.1–0.5 µg/l for serum, 0.14–4.58 µg/l for normalized erythrocytes and 0.05–2.2 µg/l for urine.

**Discussion** All samples both in patient and control groups resulted in having chromium levels within the internal reference range.

**Conclusions** Therefore this study has shown that the BIOLOXdelta ceramic does not release chromium ions in vivo.

### Optimization of external fixation treatment in pelvic ring lesions by three-dimensional modelling and finite element analysis

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**Introduction** External fixation is commonly practiced for pelvic ring fractures management. Many parameters influence mechanical performances of external fixators. Prior literature shows that the state of the art in pelvic fixator modelling has been mostly based on analysis of real prototypes made of either synthetic bone or other materials, or on cadaver specimens. Those works, although well performed, intrinsically lack in mechanical reliability due to many simplified assumptions.

**Methods** This study proposes a virtual 3D model of the pelvic ring with an external fixator in a 4 pins and 4 bars configuration, on which finite elements method (FEM) analysis was run. Our virtual 3D model of the pelvic ring introduces the advantage of differentiating the mechanical properties of cortical and cancellous bone along with the complex boundary conditions of major ligaments. The 3D model was crafted from a real CT scan. We first assessed stiffness variations by increasing fixator pins depth, then we evaluated dislocation related to load intensity and sitting angle. FEM analysis was run on the model, reproducing a Tile's classification C1 fracture. A 600 N load was applied with a 40, 50 and 60 mm pins depth configuration, simulating both sitting and standing conditions. We considered relative dislocation between bone interfaces as stiffness index, taking sacro-iliac joint as principal target.

**Results** Our results show that rising pins depth significantly influences the stabilized pelvis stiffness: 60 mm depth reduces dislocation up to 30 %. Dislocation values also tend to decrease along with sitting angle and initial weight. Between 90° and 45° of trunk flexion none of the simulations managed to maintain adequate reduction. At 45° it

was achieved only for patients under 50 kg, while at 30° a satisfactory stability was obtained for 70 kg patients. At 15° reduction was acceptable for all the weights tested.

**Discussion** Our results confirm that even a best-performed pelvic external fixation is still inadequate to allow weight-bearing; actually, in most of the sitting angles usually allowed, pelvic reduction seems insufficient. Moreover, both patients' sitting angle and initial weight have great influence in dislocation of the fractured hemi-pelvis.

**Conclusions** Hence, this work refined our post-operative care protocols for patients treated with external fixation, in order to minimize the risk of reduction failure.

### Treatment of osteochondral lesion of the knee with Maioregen biomimetic osteochondral scaffold: midterm follow-up results

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**Introduction** Osteochondral lesions of the knee are relatively common both in young and senior population. The very disabling clinical symptoms, in association to the scarce regenerative capacity of the articular cartilage and the increased risk of developing a secondary osteoarthritis make an effective treatment mandatory.

**Methods** From December 2008 to January 2013, 34 patients (35 knees), 24 males and 10 females (mean age 36.2 years (range 14–66) underwent implant of Maioregen (Finceramica Faenza SpA, Italy) biomimetic osteochondral scaffold. In 17 cases the osteochondral lesion was caused by an osteochondritis dissecans (acute or sequela), in 13 cases by a spontaneous osteonecrosis and in 4 cases the etiology was traumatic. Patients were evaluated with subjective IKDC and Tegner Lysholm scores, VAS and Tegner Activity Scale before surgery and at regular follow-up (mean follow-up 38.4 months, range 13–63 months).

**Results** Both Lysholm and IKDC Subjective scores significantly increased from 57.5 and 48.2 before surgery to 89.7 and 76.3 at 1 year follow-up. Mean VAS scale score decreased from 6.3 to 2 at 1 year follow-up. At 3 years follow up 20 evaluated patients showed an increment on both scales (Lysholm 92.38, IKDC 84.7). Only 4 patients were evaluated at 5 years follow-up with mean subjective IKDC 92.5, Lysholm 98.75 and VAS 1.

**Discussion** Maioregen biomimetic osteochondral scaffold showed very good results as surgical treatment option in treating ICRS grade 3–4 osteochondral lesions whatever the etiology.

**Conclusions** In particular, the implant showed good results also in treatment of osteonecrosis and could provide an alternative to unicompartmental arthroplasty in young and active patients.

### ORAL COMMUNICATIONS

#### Non-union and critical size bone defects of the humerus: the role of biotechnologies

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**Introduction** Non-union and critical bone defects of the humerus are a very debilitating complication in trauma of the upper limb. The localization of the disease (proximal epiphyseal, diaphyseal or distal epiphyseal), the general condition of the patient, soft tissue and bone quality determine the choice of treatment and the possible application of biotechnology. In proximal epiphyseal cases it is possible to perform a reconstruction with plate and biotechnologies implantation in polytherapy (scaffold + mesenchymal cells + growth factors). In those diaphyseal it is necessary to quantify the bone defect and if it is less than 4 cm, it is possible to make a shortening of the segment by an oblique osteotomy and applying a compression plate, if the biological conditions are poor, it is always possible to apply polytherapy with allograft to increase the stability of the system. In distal epiphyseal cases it is often necessary to reconstruct the articular surface, even in these cases, the implantation of biotechnology in polytherapy, and an osteosynthesis with dedicated devices seem to be an excellent choice. The aim of this study is to analyse the cases of non-union and critical bone defects of the humerus treated in our department with or without biotechnologies dividing them according to the topography of the lesion.

**Methods** We analysed 28 non-unions and bone defects of the humerus, 14/28 patients (3 proximal epiphyseal, 8 diaphyseal, 3 epiphyseal distal) were treated without biotechnologies (group A) and 14/28 (4 proximal epiphyseal, 9 diaphyseal, 2 epiphyseal distal) treated with biotechnologies (group B). The results were analysed by a clinical and radiographic evaluation with a mean follow-up of 24 months.

**Results** The healing rates were 71.4 % in group A from a clinical and radiographic point of view against 85.7 % in group B. All (4/14) failures of group A showed a diaphyseal localization. The failures of the group B (2/14), however, were located: the first at distal epiphysis level and the second at diaphyseal level.

**Conclusions** Based on our results we conclude in favour of a surgical treatment by shortening the segment performing an oblique osteotomy, in order to reduce the bone loss, in association with biotechnology in polytherapy (rhBMP-7 + MSC + ev Allograft) in the treatment of non-union and critical diaphyseal bone defects of the humerus. In those cases proximal and distal epiphyseal, given the paucity of cases treated, it is not possible to conclude whether or not in favour of biotechnologies application, further investigations are needed to validate its effectiveness.

#### Treatment of avascular necrosis of the femoral head with biotechnologies

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**Introduction** Osteonecrosis of the femoral head at an early stage is still a challenge for the orthopaedic surgeon, especially cause often it affects young patients (between the third and fifth decade of life). The total hip arthroplasty remains the gold standard treatment despite being a drastic choice that does not spare the affected joint by this disease. In the past various alternative techniques have been proposed (arthrodiastasis, Mont technique, transplantation of vascularised fibula, core decompression with or without implantation of synthesis devices or growth factors) in order to save the femoral head.

**Methods** Starting from the idea of core decompression we wanted to develop a new surgical technique with a dedicated instrument that combines the removal of necrotic tissue (core decompression) the implantation of growth factors (rhBMP-7) and an equine flexible bone scaffold enriched with autologous mesenchymal cells. We treated 38 patients with this method for a total of 40 affected hips, all patients

had at most one stage IIIc according to the classification of Ficat. Each patient was investigated preoperatively by clinical evaluation, radiographic, MRI and CT. Patients were then followed up clinically and by imaging (X-rays, CT and/or MRI) at 1, 3, 6, 12, 24, 36 months.

**Results** We obtained in 35 cases out of 40 excellent clinical and imaging results (non-progression of necrosis, conservation of the femoral head shape, absence of structural collapse and good articulation) at 24-months follow-up average, 5 cases of failure with persistence of the symptoms and progression of necrosis, 1 case of subtrochanteric fracture as a result of accidental trauma.

**Conclusions** The technique appears to offer excellent results, especially in view of the short surgical time, the simplicity of the surgical technique and the ability to save a joint still healthy in young patients but already symptomatic.

### Osteogenic capacity of stem cells: comparative *in vitro* study between cells from adipose tissue and bone marrow

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**Introduction** The technological progress in the development of new biomaterials and molecular and cell biology techniques gave a great urge to research and clinical application of bioengineered bone tissue. In particular, the use of stem cells in combination with biomaterials had an increasing interest. The aim of our study was the comparison of the *in vitro* osteogenic potential of stem cells isolated from bone marrow (hBMSCs) and adipose tissue (hASCs), cultured in the presence of two demineralised bone matrices (DBM) (TBM e DBX) to assess the osteoinductive capacity. We also tested the safety of the procedures and materials evaluating possible genetic alterations.

**Methods** Cells isolated from bone marrow and adipose tissue (hBMSCs and hASCs) were characterized by immunohistochemistry. BMSCs and ASCs were then seeded onto a osteoconductive scaffold of hydroxyapatite of bovine origin, alone or in the presence of TBM or DBX, both in not differentiative and differentiative medium. The biocompatibility of the materials was verified by MTT assay. The osteoinductive capacity of the matrices was assessed analysing the expression of some genes typical of osteoblasts by RT-qPCR. The safety of the method was verified with the CGH-array.

**Results** The isolated cells expressed stem cell markers. The MTT assay showed that the cells proliferated both in not differentiative and differentiative medium. The RT-qPCR revealed a greater expression of target genes in hBMSCs and hASCs cultured in the presence of TBM. Minor expression, however, was detected in populations cultured with DBX. There were no gene alterations.

**Discussion** The isolated cells met the criteria of stemness. The viability test confirmed the ability of the cells to proliferate and amplify in the presence of DBM that, therefore, were biocompatible. The osteogenic markers were expressed, confirming that the cells acquired the correct phenotype. Finally, the absence of chromosomal alterations ensured the safety of both the materials and the cells.

**Conclusions** hBMSCs and hASCs showed equal ability to differentiate. Both DBM tested stimulated the osteogenic differentiation of stem cells, though with different efficacy. There were no genetic alterations at any stage of the study, ensuring the safety of the procedures and materials used in the perspective of future clinical applications.

### RIA system vs. iliac crest graft in the treatment of non-unions and bone defect

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**Introduction** Clinical management of delayed healing or non-union of long bones fractures and segmental bone defect is a challenge for orthopaedic surgeons. The use of autologous bone substitute is always considered the gold standard of treatment. Traditional technique for harvesting autologous bone graft (ABG) from iliac crest usually involve several complications. The reamer-irrigator-aspirator (RIA) is an intramedullary reaming system; with this system a large volume of cortico-cancellous bone material is generated in a single step reaming process and can be collected and potentially used as an autologous bone graft source. The study protocol include two different outcomes; the primary end-point is to compare in the two groups the complications at the donor site and the second end-point is the evaluation of blood loss of RIA system ABG versus iliac crest ABG.

**Methods** We studied a database of 70 patients with long bone non-unions; we divided the patients in two group according with the surgical harvesting technique received: RIA system ABG (35 patients) and iliac crest ABG (35 patients).

**Results** At the follow-up of 12 months, in the group treated with RIA system ABG we found no pain at the donor site (100 %); in the group iliac crest ABG the pain at the donor site was found in 5/35 (14.28 %) patients. There were no local infections at the donor site in RIA system ABG group but there were 5/35 (14.28 %) cases of infection in iliac crest ABG group. As regards cases of fractures were only detected in iliac crest ABG group with 2/35 (5.71 %) case of ASIS dislocation. None systemic infections were detected in both groups. The average pre-operative haemoglobin in RIA system ABG group was  $13.78 \pm 0.80$  g/dl, the post-operative value was of  $12.12 \pm 1.30$  g/dl; during the surgery were lost  $572.85 \pm 195.66$  cc of blood. The evaluation of the haemoglobin show a decrease of 1.66 g/dl between before and after surgery. The average pre-operative haemoglobin in iliac crest ABG group was  $13.55 \pm 0.83$  g/dl, the post-operative value was of  $12.91 \pm 0.78$  g/dl; during the surgery were lost  $243.42 \pm 132.93$  cc of blood. The evaluation of the haemoglobin show a decrease of 0.64 g/dl between before and after surgery.

**Discussion** We have analysed the scientific literature concerning the use of RIA technique in order to collect autologous bone graft to utilize in patients with anthropic-oligotrophic non-unions; we focalize our attention in the complications derived from the use of this technique.

**Conclusions** RIA bone graft for the treatment of non-unions and segmental bone defect of long bones seems to be safe and efficient procedure with low donor site morbidity.

### Preliminary experience with the use of leap motion gesture control to manage imaging in the operating room

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**Introduction** In the operating room, the direct contact between surgeon and computer is disadvantageous, as it involves frequent

changing of gloves and exposes to an increased risk of infection. Consequently, touch-free systems are ideal solutions to reduce surgical time and minimize the risk of infection. Preliminary intra-operative experience with a new image control device is reported.

**Methods** Leap Motion controller (Leap Motion, Inc., San Francisco, CA, USA) is a small device which is designed to allow gesture recognition. Basically, computers may be controlled in a new way with a wave of a hand or lift of a finger. This device, which was connected with OsiriX (OsiriX Foundation, Geneva, Switzerland) Dicom Viewer, was used to control and move CT scan with multi planar reconstruction and volume 3D reconstruction intra-operatively. The investigation started in September 2013 and included five physicians, three orthopaedic surgeons and two hand surgeons. The Leap Motion was arranged close to the operating table in a sterile sheet and was connected with a USB cable to the computer and monitors.

**Results** The average training time for surgeons required approximately 5 min. In orthopaedic procedures, the ability of the device to move the 3D reconstruction was impressive in numerous articular fractures, as knee and wrist lesions and especially in pelvic involvement.

**Discussion** All the surgeons experienced a quick and easy familiarization with the device and the three gestures. Undeniable advantages were provided by the touch-free gesture control system. Finally, the tool was very cost-effective.

**Conclusions** In this preliminary report, Leap Motion gesture control and OsiriX proved out to be effective touch-less technologies to manage imaging in orthopaedic surgery.

## HAND AND WRIST (in collaboration with G.I.S.C.M.-G.I.M.E.T.R.A.)

### IN-DEPTH ORAL PRESENTATIONS

#### The use of Ishiguro technique in a mallet finger fractures: our experience and considerations

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**Introduction** The mallet finger fractures is an injury of the extensor *digitorum* tendon of the fingers at the distal interphalangeal joint (DIP) with bone avulsion associated. The closed treatment is indicated in uncomplicated mallet finger; but surgical fixation is necessary when the lesion is unstable for example if is involved more than one third of the base of distal phalanx. Various techniques have been described for this purpose.

**Methods** We treated 9 displaced mallet finger fractures (January 2013 to March 2014) by a two extension block Kirschner-wire technique. The mean joint surface involvement was 25 %, two patients also had an open fracture with condylar fracture. All the patients were male and the average age was 24 years old (19–31). Seven patients were treated acutely (less than 10 days), two subacutely (10–30 days), no one chronically. All patients were treated under local anaesthesia. The intra-operative mean time was 17 min (13–24) and there were no technical problems. Using the Wehbe and Scheider classification there were 3 type IIIB, 3 type IIB, 2 type IA, 1 type IIIA. The clinical and radiological outcomes were evaluated at a mean follow-up of 12 months (5–16). Clinical evaluation involved range of motion (ROM) test with a goniometre; was assessed also pain on a Visual Analog Scale.

**Results** All 9 fractures healed with a mean time to union of 35 days (32–37), congruent joint surfaces and anatomical reduction were seen in all cases. There were no non-union, no re-displacement or re-

dislocation occurred in the postoperative period. The mean flexion of the distal interphalangeal joints was 82° (77°–90°) and the mean extension loss less 1° (0°–3°). No digit had a prominent dorsal bump or a recurrent mallet deformity. There were no major or minor complications (breakage of the fragment, bad reduction, infections). Patients satisfaction was high, with return to previous levels of activity. The mean score on the Visual Analog Pain Scale, at final follow-up, was 1 (VAS range between 0–10).

**Discussion** The our indications for this technique were the presence of a large bone fragment, palmar subluxation or the loss of joint congruity of the distal interphalangeal joint.

**Conclusions** This technique it is easy to apply, fast and allows a good range of motion in a short period of time; it allows to obtain high functional results, presenting almost no complications. We believe that this technique, when properly applied, produces satisfactory results both clinically and radiologically.

#### RE-MOTION wrist implant: results on 34 patients

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**Introduction** Up today TWI is still a developed procedure. We refer our experience about RE-MOTION implant.

**Methods** We have implanted 34 devices since 2005 to 2013: 14 implants for AR, 3 for primitive arthrosis, 10 in SLAC–SNAC and 7 in post-traumatic arthrosis. Average age was 65 years (leaving a patient 25 years old); patients were 20 males and 14 females.

**Results** The follow-up was on average 6 years (2–9). The best results were in the primitive arthrosis and post-traumatic rather than in AR. DASH score changed from 82 to 60; there was a 12° ROM recovery. VAS changed from 8.5 to 3. In the complication field we had: 2 instability, 2 infections, 1 painful impingement treated by ulnar head resection.

**Discussion** In our experience, as in literature, the ROM recovery is limited in respect at the beginning, but useful and partial pain resolution. There is a moderate strength recovery.

**Conclusions** In the light of our results—not always included in the excellent-good range—we believe that in arthrotic, painful, restricted wrists is better a prosthesis than an arthrodesis.

#### Carpal navicular non-union treated with a modified Murray technique: long-term incidence of wrist osteoarthritis

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**Introduction** Carpal navicular non-union may be treated by various surgical techniques, although most authors adopt the Matti-Russe technique, using a volar approach. The aim of our study was to report the long-term follow-up results in 29 patients operated on for non-union of the carpal navicular using a modified Murray technique, performed with a lateral approach.

**Methods** The mean age at surgery was 22.5 years. The average length of time from the injury to surgery for non-union was 18 months. In five cases, mild signs of osteoarthritis of the radio-scaphoid joint were present before surgery, while in two cases, radiographic signs of avascular necrosis of the proximal non-union fragment were evident. In all cases, a cortico-cancellous non-vascularised bone graft taken from the distal part of the ipsilateral radius was used.

**Results** The mean follow-up was 11.2 years. Non-union had healed in 93.1 % of the cases. At follow-up, the two patients in whom non-union had not healed presented severe painful osteoarthritis of the wrist. Twenty patients were completely asymptomatic, while 5 complained of occasional pain in the wrist. The wrist ROM was restricted in all patients in comparison to the contralateral side. The mild osteoarthritis of the radio-scaphoid joint, already present in five patients before the operation, remained unchanged at follow-up. Mild osteoarthritis was also observed in one of the two patients with avascular necrosis. No osteoarthritis of the wrist was observed in the other patients. The average value of the DASH score was 8.7/100.

**Discussion** There is general agreement that post-traumatic non-union of the carpal navicular must be treated surgically even in asymptomatic cases, because degenerative osteoarthritis of the wrist is likely to occur. The Matti-Russe surgical technique is adopted by several surgeons but it requires a more extensive exposure of the articular surfaces of the carpal navicular if compared with the Matti-Russe surgical technique. The extension of the exposure as well as the time interval between fracture of the carpal navicular and surgery for the non-union could jeopardize the articular surfaces of the carpal navicular, predisposing to the development of degenerative osteoarthritis.

**Conclusions** The modified Murray technique performed through a lateral approach is reliable for treating non-union of the carpal navicular. The union rate is high, and the incidence of wrist osteoarthritis is low, comparable with other studies. Early diagnosis and early treatment of non-union (a short interval between fracture and surgery) minimize the risk of degenerative joint disease. Avascular necrosis of the proximal fragment is not an absolute contraindication to surgery.

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## HIP (in collaboration with S.I.d.A.)

### ORAL COMMUNICATIONS

#### Dual mobility acetabular hip arthroplasty in the treatment of femoral neck fractures: a 6-year experience

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**Introduction** Total hip arthroplasty is widely used in the treatment of femoral neck fractures. Especially dual mobility hip prosthesis gives excellent outcomes because the head is free to move inside the new cotyle without impingement between the head, the cup and the cotyle and the head has a greater coverage so that the dislocation rate is reduced.

**Methods** Authors present their series of cases treated with dual mobility hip prosthesis for a neck femoral fracture since 2009. A total of 727 patients were treated. Mean age was 84 years. Regional anaesthesia was performed in all cases but very few ones (0.3 %). In all patients rehabilitation started on the first day post-operative in bed and then, progressively, on standing and walking next days.

**Results** Peri-operative mortality was 0.7 %, morbidity 14 %. Most common complications were: infections (3.2 %); dislocations (2.1 %); cardiovascular failure (2.7 %); hepatic-renal syndrome, HRS (1.2 %); thromboembolism (0.9 %). Revision was needed only in 1.4 % cases—generally for infection or dislocation.

**Discussion** Joint motility and stability are highly preserved with a dual mobility hip prosthesis. From a biomechanical point of view, outcomes are comparable to a large-diameter femoral head prosthesis, but complications rate, especially dislocation rate, are lower. It is extremely important that patients are allowed to stand and walk in a

couple of days post-operative because of the prosthesis mechanical stability.

**Conclusions** According to our 6-year experience the use of a dual mobility acetabular hip prosthesis is really worthwhile in the treatment of femoral neck fractures highly reducing morbidity and mortality rates.

### The role of arthroscopy in hip synovial diseases

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**Introduction** Primary synovial diseases of the hip are rare and mostly represented by pigmented villonodular synovitis (PVNS), synovial chondromatosis (SC) and coxarthrosis. Hip arthroscopy is not only diagnostic (through direct biopsy), but also therapeutic, through loose bodies removal and synovectomy. Aim of this study is to evaluate its mid-term results.

**Methods** Twelve cases of suspect synovial hip disease (2 PVNS, 5 SC, 5 arthrosynovites of unknown origin) underwent hip arthroscopy from 2008 to 2013. Multiple synovial biopsies, extended synovectomy, possible loose bodies removal were performed in all cases. In one SC case the central compartment was not accessible for insufficient joint distraction, and synovectomy was limited to the peripheral compartment. Patients were followed-up with X-ray/MRI and physical examination at 1, 2, 4 years after surgery.

**Results** All the procedures led to histopathological diagnosis, that in three cases was different from the pre-operative one (4 PVNS, 3 SC, 4 seronegative monoarthritis): a suspect SC and a suspect monoarthritis turned out to be PVNS, a suspect SC was found to be a focal labral degenerative hypertrophy and was excluded from the group. All the arthritis were aseptic and seronegative. While SC and PVNS showed a clinically and statistically significant increase of mHHS, arthritis had no benefits from surgery in 3 cases out of four. At a mean 26-month follow-up, no case of SC or PVNS relapsed, while a patient affected by PVNS underwent THA within the first post-operative year due to severe secondary osteoarthritis.

**Discussion** Hip arthroscopy showed to be effective and reliable both for diagnostic confirmation and for treatment. As for diagnosis, it changed the preoperative diagnosis in 25 % of the cases. As for treatment, despite the limited access to the posterior aspect of the peripheral compartment and to the caudal end of the central compartment, synovectomies performed in both cases of PVNS and SC proved to be effective. Obviously the absence of recurrences might depend only on the small sample size and on the short follow-up. Although no true benefits were obtained for seronegative arthritis, this unfavourable result may have been influenced by the severe chondral damage found in this subgroup of patients. However ruling out infections (especially mycobacteria) impacted positively the subsequent medical treatment.

**Conclusions** In conclusion arthroscopy seems to have a definite and relevant role in the management of hip synovial diseases.

### Co-morbidities in patients with hip osteoarthritis and treated with ecoguided infiltrations of hyaluronic acid: study of the effectiveness of the treatment

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**Introduction** The ecoguided infiltrative therapy with hyaluronic acid (HA) showed particularly effectiveness in the treatment of patients with mild or moderate hip osteoarthritis (OA) (Kellgren grade 1–2).

**Methods** Between February 2009 and June 2013, in Orthopaedic and Traumatologic Clinic of the University “P. Giaccone”, Palermo, we studied 224 patients with hip OA treated with 3 intra-articular ultrasound guidance infiltration of HA 30 mg/2 ml high pm, every 45 days. Each patient was assessed at baseline (T0) and during infiltrations (T1 and T2); then to follow-up at 6 (T3) and 12 months (T4) and submitted to the VAS scales, the Harris Hip Score (HHS) and the Lequesne Index; we evaluated also the ROM, the test of Faber, Thomas and Trendelenburg. Finally, we investigated the following co-morbidities: heart diseases, diabetes, thyroid diseases, smoking effects.

**Results** The data analysis showed that the hip affected were 96 left and 128 right. All subjects improved pain symptoms and the hip functional with substantial differences between the smokers as shown the VAS [the average value of VAS were 7.1 (rest) and 6.6 (movement) for smokers, for the other without co-morbidity were 3.4 and 4.9; in cardiac, diabetic and thyreopathic patients the value were similar], Lequesne Index, HHS and ROM.

**Discussion** Study’s analysis would consider the smoke as a negative factor to the effectiveness of the infiltrative therapy respect both the population of control and the subjects with others co-morbidities.

**Conclusions** The study is, however, in a initial phase and ask a confirmation with a higher number of patients. Main point would be to extend the evaluation to co-morbidities, not considered in this analysis.

### Minimally invasive anterior approach in the supine patient for the anterior approach without capsular release

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**Methods** The approach is performed 2 cm below and distal to the line joining the anterior superior iliac spine to the Gerdy’s tubercle. This intramuscular approach passes between the rectus femoris and tensor fascia latae and requires lowering the fibres of the tensor muscle, ligation of the lateral circumflex artery, acetabular capsulotomy and double osteotomy of the femoral neck to remove the head. The femoral stem is prepared by abducting the limb under the contralateral leg, tilting and lowering the distal segment of the operating table by at least 40°, and externally rotating the limb. This manoeuvre allows the posterior capsule to be relaxed so that unless the capsules and tendons of the external rotators are retracted, the femur can be broached without having to perform a capsular release.

**Results** The authors have adopted the no capsular release approach in over 500 cases; out of a total 700 cases using the anterior approach, the total incidence of early and late complications was 3.1 %.

**Discussion** When a capsular release is needed, it must be as superficial as possible to avoid over-extending the posterior capsule and severing the superior and posterior recurrent arteries, which are difficult to cauterise. A specific instruments set is required, which must include a curved retractor and a dual-offset broach handle.

**Conclusions** With this technique it has been possible to achieve excellent early patient performance, especially hip hyper-flexion at kneeling and, in the authors’ experience, reduced blood loss.

### Ceramic-on-metal bearings in total hip replacement: metal ion release and clinico-functional evaluation

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**Introduction** Ceramic-on-metal (CoM) total hip arthroplasty (THA) theoretically combines both the advantages of ceramic-on-ceramic (CoC) and metal-on-metal (MoM) bearings: negligible rupture risk of the liner with a limited ion release. As primary endpoint, we asked whether serum cobalt (Co), chromium (Cr) and molybdenum (Mo) concentrations in CoM-THA patients at an average of 3 years follow-up were higher than those measured in the pre-operative population. As secondary endpoint, we wanted to verify whether ion levels in CoM-THA patients were different from those obtained in a similar cohort of 29 MoM-THA patients at the same average follow-up.

**Methods** Ion values were measured by atomic absorption spectrometer in 20 CoM-THA patients at an average of 3 years follow-up and compared with those measured in the pre-operative population; functional outcome was assessed with Harris Hip Score (HHS) and University of California Activity scale (UCLA). These results were then also compared with from those obtained in a similar cohort of 29 28 mm head MoM-THA patients at the same average follow-up.

**Results** Cr and Co Serum levels in CoM-THA patients were significantly higher ( $p < 0.001$ ) at 3 years follow-up than before surgery. Mo concentrations were not significantly different ( $p = 0.45$ ). No signs of implant loosening were recorded. Functional outcome was excellent with HHS and UCLA scale rising from 50 and 3.6 pre-operatively to 90.8 and 6.3 respectively at 3 years follow-up ( $p < 0.001$ ). Cr serum levels were significantly lower in CoM-THA than in MoM-THA group ( $p = 0.02$ ) while Co values, even if lower, did not reach statistical significance ( $p = 0.054$ ).

**Discussion** In recent years the incidence of hip replacements in young patient strongly increased, together with the interest in new couplings that can satisfy high functional demands, with a reduced wear and a better implant survival over time. Despite theoretical advantages and success in hip simulator studies, limited clinical data on the performance of CoM bearings exist and little is known about ions release over time.

**Conclusions** Our results show that CoM-THA patients achieve excellent clinical outcome with a limited chromium release at 3 years follow-up.

### Differential diagnosis of avascular necrosis of the femoral head (AVN) and transient hip osteoporosis (THO): role of MRI

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**Introduction** Avascular necrosis of the femoral head (AVN) and transient hip osteoporosis (THO) could represent a differential diagnostic problem as both are responsible, in their earliest stage, of acute hip pain.

**Methods** In the period between December 2011 and October 2013 we evaluated with magnetic resonance imaging (MRI) 80 patients aged between 25 and 44 years suffering from acute hip pain.

**Results** In 37 cases was verified, on the basis of symptomatology, a bone distress with altered signal of subchondral bone; of these 28 had typical features of NAV and 9 characteristics of THO. In particular, the MRI showed, in patients affected by NAV a diffuse oedema in the early phase and, as a characteristic element, a serpiginous line of low signal intensity in the subchondral bone with a central fat zone, which is indicative of the initial collapse of the subcortical trabecular bone. In THO MRI has instead highlighted, besides the presence of diffuse oedema and extended from the head of the femur until the intertrochanteric region, a lack of images related to defects and/or collapse of subcortical bone trabeculae. In both diseases there is a common factor: the frequent presence of abundant endo-articular effusion. After 8 months of the onset of symptoms, different is the evolution of the MRI picture: in subjects suffering from NAV it can be observed a growing bone collapse, while in those suffering from THO bone oedema tends to resolve completely.

**Discussion** NAV, cause of coxalgia much more common than THO, is a condition of vascular suffering which has a worsening evolution that requires an early surgical intervention in order to prevent a hip deformity. THO is instead a spontaneous bone disorder characterized clinically by acute hip pain that runs out in 6–8 months: it is commonly associated with pregnancy but was also seen in middle-aged individuals. Its therapy requires functional drainage and anti-inflammatory drugs, requiring no surgery.

**Conclusions** MRI plays an important role in early diagnostic identification of NAV differentiating it from THO (and other pathological entities), thus allowing a correct therapeutic approach.

### Surgical drainages in total hip replacement

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**Introduction** Wound low-vacuum suction drains are largely used after total hip arthroplasty, however there is no unanimous agreement in literature on their efficacy and on their using protocol. Aim of this study is to introduce a standard protocol for surgical drainages usage. **Methods** Eighty patients, age between 42 and 76 years old, affected by primary osteoarthritis, underwent unilateral total hip arthroplasty, divided in 4 groups of 20 people: the first group was undrained, the second group was treated with one wound drainage removed after 24 h, the third group was treated with one wound drain for 48 h and the fourth group was treated with one wound drain for 72 h. Patients suffering from altered coagulation status were excluded. Every patient was evaluated by mean of blood loss, need for blood transfusion, number of needed wound dressings, functional results, length of hospitalization, peri-prosthetic and surgical wound infection and postoperative hematoma.

**Results** There were no statistically relevant evidences in favour of using wound drains as concerns of blood loss, although they are slightly more elevated in wounds drained for 48 and 72 h. The 34 % of drained patients required blood transfusions (with no difference between the three groups), whereas only 27 % of undrained patients required the later. Number of needed wound dressings was statistically higher in the undrained group (76 %), while length of hospitalization was higher for patients who kept drainages for 48 and 72 h, even though there were no differences among groups as concerns functional results. There were no statistically relevant differences among groups by mean of peri-prosthetic and surgical wound infection, although they were slightly higher in patients

drained for 48 and 72 h. The 52 % of undrained patients presented post-operative hematoma, whereas only 20 % of drained patients for 72 h presented it.

**Discussion** The higher number of needed dressings associated to the higher incidence of post-operative hematoma are the most relevant factors in favour of using surgical drainages. In addition the longer hospitalization, related to late removal of drains, which led to delayed start of the rehabilitation programme, is a significant factor in advantage of short removal of wound drains.

**Conclusions** According to our study, positioning wound suction drainages after total hip replacement surgery and removing them after 24 h is preferable than not using them or removing them later.

### Core decompression and injection of autologous bone marrow concentrate combined with demineralized bone matrix and platelet rich fibrin for femoral head osteonecrosis: results at 3-year follow-up

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**Introduction** Avascular osteonecrosis of the femoral head is a disease that mainly affects young adults between 20 and 40 years. When not resulting from trauma, is associated with steroid use, alcoholism, blood disorders and autoimmune diseases, but a considerable amount of osteonecrosis is idiopathic. If left untreated, it leads to the collapse of the femoral head with severe functional limitation and early progression to osteoarthritis. There are many possible approaches is that bloodless surgery with mixed results.

**Methods** From September 2008 we treated 30 osteonecrosis in 29 patients (21 males, 8 females), mean age 35 years (min 17, max 55) with core decompression and injection of bone marrow concentrate, platelet gel and demineralized bone matrix. In 8 patients the necrosis was idiopathic, in 17 due to steroids, 3 post-traumatic, 1 case alcohol-related. We used the Ficat classification; in 18 cases was found to be stage II (12 cases IIa, IIb 6 cases), while in the remaining 12 cases were stage III–IV (8 cases III, IV 4 cases). The primary outcome was survival (failure); secondary outcomes were the functional clinical outcome assessed by Harris Hip Score (HHS) as well as radiographic progression.

**Results** The mean follow-up was 36 months (min 12, max 60 months). The failure was recorded in 8 cases (27 %) who required prosthetic replacement at 14 months after the first procedure. In the remaining 22 cases we have seen a trend of HHS to increase (average from 58 to 89.5); patients with stage II necrosis Ficat had a better clinical response (61 to 96.5) compared with patients with stage III–IV (54 to 82.5), but with a higher rate of conversion to total hip replacement (stage IIb).

**Discussion** Local conditions require that the treatment stimulates tissue regeneration while preserving the integrity of anatomical structures. The rationale of our method is to provide the bone regeneration (decompression and growth factors) and osteoblastic precursors, with a minimally invasive technique which does not alter the vascularization or the articulation, leading to good clinical-radiographic results.

**Conclusions** Core decompression with bone marrow concentrate, platelet gel and demineralized bone matrix infiltration is a good alternative to other rescue therapies of the femoral head. The clinical and radiographic results are satisfactory and promising, although they should be considered preliminary.

## Megaprosthesis in critical size bone defects: the bridge between orthopaedics and trauma

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**Introduction** The development of new megaprosthesis for the treatment of large bone defects has offered important opportunities to orthopaedic oncologic surgeons for the replacement of skeletal segments such as the long bones of the upper and lower limbs and the relative joints. Our experience, treating non-union and severe bone loss, has brought us, sometimes, to be confronted with the reality of some failures after unsuccessful attempts to reconstruct. Faced with certain radiological and/or clinical drastic situations we wanted to apply the principles of Biological Chamber and oncologic surgery with megaprosthesis replacement solutions. We implanted megaprosthesis with either 1 step or 2 steps (previous antibiotated spacer) technique depending on the septic patient conditions. The aim of this study is to retrospectively evaluate both clinical and radiological outcomes in patients underwent to a lower limb megaprosthesis implant and complications were recorded.

**Methods** In total, we treated 32 patients with megaprosthesis mono- and bi-articular subdivided as follows: proximal femur, distal femur, proximal tibia and total femur. The mean follow-up of patients is about 18 months (min 3 months, max 5 years) with clinical and serial radiographic revaluations with standard methods (X-ray in 45 days, 3, 6, 12, 18, 24 months) as well as monitoring of blood parameters of inflammation for at least 2 months.

**Results** Despite the follow-up average is not so long, the first patients have now reached 5 years of monitoring and in all cases we have had encouraging clinical results with good articulation of the segments, no somato-sensory or motorial deficit and acceptable functional recovery. During surgery and, even more, in the pre-operative planning much attention should be given to the evaluation of the extensor apparatus preserving it and, when necessary, reinforcing it with tendon substitutes.

**Discussion** Megaprosthesis in traumatic and prosthetic failures can therefore be considered, in extreme cases appropriately selected, as a solution available to the orthopaedic surgeon? In oncological surgery the opportunity to re-give a function, although not *ad integrum*, to the patient is certainly an element of great fascination for the surgeon and an opportunity for the patient. Unfortunately, the high mortality associated with this disease does not allow us to have long-term follow-up. This then creates a lack of certainty about the survival of this type of prosthesis and the medium and long-term complications that may occur. Nevertheless, the patients treated by us should be considered as a oncologic patient, not because of the disease but for the limited therapeutic options available.

**Conclusions** We can consider megaprosthesis as a valuable opportunity to restore functionality to patients who are, despite themselves, to deal with highly disabling diseases.

## Total hip arthroplasty in haemophilic patients: a mid- to long-term experience with modern cementless implants

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**Introduction** Haemophilia is a recessive inherited blood disorder characterized by frequent haemorrhages and haemarthrosis:

nowadays, the modern hematologic approach has significantly limited the risk of bleeding, but still often remain the haemarthrosis causing arthropathy. The hip joint is not affected as often as knee, ankles and elbows, but it's common a severe degeneration of the hip joint, where arthroplasty is the only solution of treatment. In literature there is only a short series of cemented old generation implants reported; the aim of this study is a clinical and radiological mid- to long-term evaluation of the outcomes of the THA with modern cementless implants in haemophilic patients and their high tribological performance.

**Methods** We retrospectively evaluated 14 uncemented total hip arthroplasty (13 patients) performed from 2000 to 2013 in haemophilic patients affected by a severe haemophilia (12 type A, 1 type B). All patients were males and mean age was of 40.6 years (28–60). Eight patients presented a non-active hepatitis C infection. Surgical procedures were performed by three orthopaedic surgeons with the same lateral access and same technique. Haematological prophylaxis and rehabilitation were the same for all patients and were performed in the same dedicated institution. We employed a TMT monoblock cup and a PPF stem in 8 patients; a Regenerex cup and a Taperloc stem in the remaining five patients. The clinical and radiological evaluation was performed before and after surgery respectively by Haemophilic Joint Health Score (HJHS) and Petterson score.

**Results** No patients were lost and the mean follow-up was 6.3 years (1–10 years). There were no post-surgery complications. The mean blood loss was about 500 ml (300–1,200 ml), comparable with non haemophilic patients. The average HJHS score was 12.5 points (10–22) pre-operatively, about 1 after rehabilitation at 6 months and 1.5 at last follow-up.

**Discussion** Haemophilic hip arthropathy causes loss of joint function, pain and worse quality of life in patients affected, making worse their precarious balance due to impairment of other joints. Despite the short number of cases reported, our is the first consistent series of modern cementless total hip replacements.

**Conclusions** Thanks to the new generation cementless implants and a multidisciplinary approach by haematologists, orthopaedic surgeons, and rehabilitative physicians, THA is becoming the first choice treatment in advanced stages of haemophilic arthropathy, resulting in pain relief and restoration of joint function with a significant improvement of life quality.

## Effects of treatment with tranexamic acid in patients undergoing primary hip and knee arthroplasty: complications and cost considerations

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**Introduction** Tranexamic acid administered during major surgery has been shown to reduce peri-operative blood loss and blood transfusions. The purpose of this study is to evaluate the benefit of tranexamic acid on blood transfusions rates in patients undergoing primary hip and knee arthroplasty and to analyse complications and cost-benefits.

**Methods** A total of 300 patients with anaesthetic ASA score I–II–III and no suspected thromboembolic risk, admitted between January 2013 and February 2014, who received standardized dosage of tranexamic acid in the peri-operative period, were retrospectively clinically analysed and compared with the clinical course of 300 patients with similar surgical risks and peri- and post-operative DVT prophylaxis who did not receive tranexamic acid and were hospitalized between January 2011 and December 2012, evaluating post-operative complications, blood transfusions percentage, time and cost of hospitalization.



**Results** Retrospective analysis of the data shows a 45 % reduction in blood transfusions rate as 75 % of patients who were not given tranexamic acid required at least one blood transfusion compared with 41 % in the tranexamic group. Transfused blood units were decreased by 25 % and no increase in thromboembolic complications was associated. Hospitalization cost was shot down by 3 % against 8 % pharmacy cost increase.

**Discussion** The results of this study showed that tranexamic acid reduces the amount of blood loss, preventing anaemia complications and transfusion risks, reducing average time and cost of hospitalization. Careful selection of suitable patients for this treatment protocol reduced side-effects of this medication.

**Conclusions** Although the routine use of tranexamic acid seems to be safe and effective and contributes to cost reduction, it requires a careful selection of the patient.

### Oblique femoral shortening osteotomy in THA for high dislocation in patients with hip dysplasia

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**Introduction** The anatomic abnormalities associated with hip dysplasia, particularly in high dislocation, increase the complexity of THA. In severely dysplastic hips (Crowe type IV), repositioning of the hip into the anatomic centre of rotation is essential to ensure durable results and correct function of the abductor muscles; however, it is associated with an elevated risk of complications due to limb lengthening. Lengthening of more than 4 cm can endanger the integrity of neurovascular structures. Moreover, stretching of peri-articular structures can lead to joint stiffness and early loosening of the implant. Femoral shortening osteotomy can reduce these tension forces by facilitating reduction of the hip joint, reducing the risk of neurologic traction injury and leg length discrepancy. Aim of this study is to evaluate outcomes after implantation of THA for developmental dysplasia with high dislocation of the hip using conical stems combined with oblique subtrochanteric shortening osteotomy.

**Methods** We retrospectively reviewed the functional scores, radiographic results, and complications in a consecutive series of 16 hips (12 patients) with Crowe type IV developmental dysplasia of the hip (mean age at surgery 53.2 years) operated on between 1999 and 2008. Cementless press fit cups were used in combination with conical stems.

**Results** The average Harris Hip Score improved from 37.2 to 83.7 at a mean follow-up of 8.7 years. All cups were inserted into the true acetabulum and all prosthetic components were stable at the last follow-up visit. No neurovascular damage was recorded. Complications arose in 6 hips (37.5 %): intra-operative fracture of proximal femur requiring fixation (n = 2); dislocation (n = 3); and asymptomatic non-union of the osteotomy (n = 1). The osteotomy healed within less than 6 months in all the remaining cases.

**Discussion** As compared with transverse osteotomy, this type of bone cutting can improve rotational stability and can favour bone healing by increasing the contact surface of the fragments. The technique is quite easy to execute with two parallel cuts. Another advantage is that the amount of resection can be easily and gradually increased by removing more bone with a parallel cut. The main goal of this shortening osteotomy is to minimize the risk of the neurological or vascular damage and soft tissue tension, which inevitably lead to joint stiffness, whereas the effect of reduced leg length discrepancy is only secondary. The factors influencing the amount of resection are the need to avoid joint

stiffness and to achieve good joint stability without excessive soft tissue release around the hip.

**Conclusions** In this series oblique femoral shortening osteotomy proved quite simple and effective in avoiding major lengthening-related complications. The conical stems provided stable and durable fixation to the bone at mid-term follow-up.

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### PAEDIATRIC ORTHOPAEDICS (in collaboration with S.I.T.O.P.)

#### ORAL COMMUNICATIONS

#### Management of congenital hip dislocation with open reduction in walking patients

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**Introduction** The incidence of congenital hip dislocation is decreased in the last years in the industrialized countries due to ultrasound screening introduced by Graaf. The increase of immigration in our country leads to late diagnosis of this condition in walking patients. The aim of the present study is to present our case series of walking patients with congenital hip dislocation managed by open reduction and cast immobilization.

**Methods** Between 2009 and 2013, 10 walking patients with congenital hip dislocation were managed with open hip reduction thorough Ludloff access. Mean age was 18 months. Surgical treatment consisted in open reduction and plaster cast immobilization for 3 months followed by Atlanta cast immobilization for other 6 months. Mean follow-up is 24 months. Clinical evaluation, and X-ray (acetabular index, tear drop distance and epiphysis necrosis) were performed at the final follow-up.

**Results** All patients showed good results at the final follow-up: hip abduction and walking were normal in all the patients, acetabular Index was normal or nearly normal compared to the healthy hip in all the patients, one case of central epiphysis necrosis was detected. No cases of re-luxation, neurological complications or infections were detected.

**Discussion** Management of late diagnosed congenital hip dislocation is challenging as walking patients are involved. Many therapeutic options exist like pelvis osteotomies, open hip reduction and femoral skin traction associated with tendon or capsular release. Femoral skin traction is a good therapeutic option but is very self constricting for children that must stay at bed for long time and is not accepted by parents. Also pelvis osteotomy is a valid therapeutic option even though we showed that open hip reduction alone leads to acetabular remodelling and normalization of acetabular index.

**Conclusions** Open hip surgical reduction is a valid therapeutic option for the management of congenital hip dislocation in walking patients below 3 years old.

#### Pelvic ring injuries in children

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**Introduction** Pelvic ring injuries account for 1–2 % of childhood trauma. Many lesions can be treated conservatively. Surgical indications are restricted to cases with vertical dislocation of 2 cm or

greater and for lesion of the triradiate cartilage with dislocation greater than 2 mm.

**Methods** We retrospectively evaluated all pelvic ring injuries in children aged 2 to 9 years, admitted to our institution and treated either conservatively either surgically. In all cases we analysed defects of growth around primary and secondary growth nuclei of the pelvis. We evaluated: pelvic and acetabular geometric aspects using the Keshishyan method, the length of the legs, the pelvic relative and absolute obliquity, the presence of secondary curves of the spine, muscular functional deficits and the presence of neurovascular injury. X-ray, CT and MRI scan were taken. The lesions were classified used the system of Torode and Zieg and the classification of Tile. The average follow-up is 4 years.

**Results** Our series is limited, including 12 cases, being this a rare traumatic pathology. In all cases followed we have seen a normal growth of the pelvic ring, even in 1 case of fracture of the iliac wing caused by weapon. We did not observe any osteonecrosis of the femoral head nor ossification of the soft parts.

**Discussion and conclusions** The pelvis is organized around 6 primary ossification centres growing as radiant sun and other 10 accessories nuclei, that are linear or oval in shape, rapidly evolving during growth. Torode and Zieg classification system is reliable only in an age group restricted between birth and 12–14 years, a period in which the cartilage triradiate mature. After this age pelvic bones are more rigid and change its patho-mechanical behaviour. The cases we observed confirm that the biomechanics of the pelvis is very variable, depending on the age this variability influences the pattern of fractures and the sequent remodelling of the ring.

## Bone healing and pulsed electro-magnetic fields

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**Introduction** The objective of our study is to evaluate the course of post-operative rehabilitation, according to range of motion, quality of life and fracture healing, in patients affected by osteogenesis imperfecta, surgically treated by Fassier-Duval telescopic nail (FDTN), then exposed to application of pulsed electro-magnetic fields (PEMFs) during the immediate post-operative period.

**Methods** Our sample consist of 11 patients aged between 5 and 13 years old, presenting fractures or deformities at their inferior limb, which required surgical treatment. We treated totally 25 bone segments (17 femoral, 8 tibial), dividing patients in two groups. Group 1 included patients underwent endomedullary nailing surgery with FDTN and group 2 patients underwent the same surgery then exposed to PEMFs. We made clinical evaluation measuring range of motion, functional evaluation by the Gross Motor Function Classification System (GMFCS) and we supplied the POSNA questionnaire to estimate quality of life. Moreover, we measured the bone callus area on X-rays imaging performed 21 days after each surgery.

**Results** In both groups we observed that all patients improved their GMFCS at the end of follow-up, except for one patient in group 1, and all patients had an improvement in the POSNA score. The bone callus area was 13.17 mm<sup>2</sup> in group 1 and 21.8 mm<sup>2</sup> in group 2. The clinical assessment of pain 21 days after surgery through the Visual Analogic Scale (VAS) has evidenced in group 1 a VAS score of 2 in 3 cases, 3 in 4 cases, 4 in 1 case, 5 in 5 cases, 6 in 3 cases, and 7 in 1 case. Among 17 bone segments in group 1, 12 were painless (70.6 %) at the evaluation 40 days after surgery. Among group 2 6 patients on 8 (62.5 %) showed pain lack 21 days after surgery. All patients declared a VAS score = 0 at the evaluation 40 days after surgery.

**Discussion** We considered that the 90° knee flexion was a substantial value to evidence the joint ROM, because this value corresponds to the motion level essential to go up and down on stairs and be seated comfortably on a chair. All patients in both groups reached this objective in the same period, that was on average 5 weeks for femoral nailing and 6 weeks for tibial nailing. We consider this result depending from the device, because the Fassier-Duval telescopic nail is inserted by a one way surgical access in anterograde direction, not requiring any knee or ankle arthrotomy. However, among patients in group 2, because of their more significant pain decrease, a better compliance during physical therapy was evidenced and this allowed them to reach 90° knee flexion in a less traumatic and easier way.

**Conclusions** The results observed showed that endomedullary nailing with FDTN and further treatment with PEMFs are able to improve quality of life and motion in patients affected by OI, supporting more prematurely their reintegration in everyday life and reducing the immobilization period.

## Unstable fractures of the acetabulum's triradiate cartilage in a 14-year-old male treated surgically

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**Introduction** Acetabular fractures are rare in children, some of them in the paediatric age group are the cause of premature partial or complete epiphysiodesis of the triradiate cartilage and the subsequent acetabular dysplasia. The early diagnosis and treatment of these lesions could be extremely difficult. We report a case of displaced fracture of the triradiate cartilage that was treated surgically.

**Methods** A young male of 14, following high-energy road accident, complained of a moderate pain in the right gluteal and inguinal regions, increasing with joint movements associated with a large hematoma. A pelvic X-ray showed a mild diastasis in the triradiate cartilage zone on the right side, that was later confirmed by the CT-scan. The lesion has been assessed by 2D MPR and 3D reconstructions: a diagnosis of Salter-Harris type I physeal fracture was formulated. Due to the wide separation of the triradiate cartilage's growth plate, an ORIF was performed via Kocher-Langenbeck approach 72 h after the trauma. Fifteen days after the surgery the patient started a protocol of passive mobilization with a progressive gradual weight-bearing successively.

**Results** After 3 months, the patient has resumed his normal daily activities without limping gait and after 6 months he recovered an intensive sport's activity. At one-year follow-up, we found no significant differences in volume, shape and size of both right and left acetabulum. Radiologically, it has documented the complete healing of the fracture and the epiphysiodesis of the triradiate cartilage's growth plate.

**Discussion** The complete arrest of the growth of the triradiate cartilage is more likely to appear after unstable pelvic fractures, which are therefore an absolute indication for surgical treatment with ORIF. In our case, the lesion involved over 50 % of the articular surface; an open reduction surgery has become necessary and therefore it has been done avoiding any type of compression that could hinder the fracture's healing and cartilage's tropism.

**Conclusions** The triradiate cartilage lesions in children are often occult lesions which require a precise diagnosis and a correct orientation in both conservative and surgical treatment. ORIF should be conducted considering the evolutionary potential of cartilage tissue during the growth period.

## Olecranon fractures in children affected by osteogenesis imperfecta

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**Introduction** Displaced isolated olecranon fractures are rare in paediatric population, but they may occur more often in children affected by osteogenesis imperfecta (OI). The aim of this study is to compare the outcome of two different techniques, the tension-band wiring (TBW) and the screw fixation, in olecranon fractures in children with OI.

**Methods** Between 2006 and 2013, 22 isolated olecranon fractures were surgically treated in 18 children affected by OI. The mean age at time of injury was 12 years. All the patients had OI at the time of the injury (10 type I, 5 type III, and 3 type IV). A bilateral fracture occurred in four patients. Mechanism of injury included avulsion fracture in 14 cases, direct blow in 6 cases, and indirect trauma in 2 cases. The fractures were classified according to Mayo classification. The surgical technique adopted was a tension-band wiring in 10 cases, and a screw fixation in 10 cases. The other two composed fractures were treated through cast immobilization. The average follow-up time was 2.5 years. Range of motion, elbow's axial alignment, muscle strength and joint stability were estimated. POSNA questionnaire was used. Radiographic evaluation was performed focusing on bone healing. Radiographic follow-up was based on post-operative radiographs, X-rays performed 3 weeks, 4 and 12 months after treatment. Clinical follow-up was after 2, 3, 6 weeks, 4 and 12 months after treatment.

**Results** Among 10 cases treated with lag screw, 4 patients underwent surgery for the second time for migration of the screw and one patient required removal of the device for pain. Regarding patients treated with tension band wiring we had radiographic bone healing and satisfactory clinical outcome (elbow extension/flexion: 0°/145°, forearm pronation/supination 70°/85°, no alteration of carrying angle) in 100 % of cases. The POSNA score improvement was observed to be higher for patients treated with TBW rather than lag screw.

**Discussion** Through this study we observed that 70 % of olecranon fractures occurs without injury, for avulsion of the olecranon during a contraction of the triceps brachii. Data show that TBW can be considered the safer surgical treatment in OI patients because it helps prevent elbow stiffness through an earlier ROM recovery. Comparing clinical and radiographic outcomes to Z-score of each patient we verified that cases successfully treated with lag screw had higher Z-score than the average of the sample.

**Conclusions** Internal fixation with lag screw is an effective treatment, but the risk of failure increases if patients have low bone mineral density.

## Proximal femoral resection arthroplasty for patients with cerebral palsy

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**Introduction** Quadriplegia in cerebral palsy patients is commonly associated with hip dislocation and subluxation. Several factors have been related to this complication including muscle imbalance, spasticity, acetabular dysplasia and valgus deformity of femoral neck. Hip dislocation in cerebral palsy may be associated with several problems such as pain, difficulties with perineal hygiene and sitting position, complicating patients management by caregivers.

**Methods** From 2000 to 2014, 45 patients (25 males and 20 females) affected by severe forms of infantile cerebral palsy were treated surgically with a proximal femoral resection (as a whole, 65 resection). None of the patients had ever been ambulatory. Twenty patients were affected by bilateral hip dislocation while 25 were unilateral. Mean age at first surgery was 17 years (14–27). Recovery from pain symptoms, improvement of hygienic care and sitting position were retrospectively evaluated.

**Results** Final results were quite satisfactory in 40 patients in whom pain completely disappeared while 5 patients had instead less pain than at first surgery. All patients with sitting difficulties were able to sit in appropriate manner into the wheelchair, confirming that femoral resection provides a marked improvement in sitting ability. Patients who had problems with perineal hygiene, mainly because of adduction contracture, reached an high improvement of perineal care. Post-operative complications were proximal migration of the femur, with skin decubitus, in two cases, excessive shortening of the limb in three patients, infection in two cases, heterotopic ossification in three cases. All this complications did not invalidate our surgical results.

**Discussion** Surgical treatment of painful dislocated hip in non-ambulatory child affected by severe forms of cerebral palsy is still controversial. Open reduction with pelvic and femoral osteotomies, indicated for moderate femoral head deformities, has affected in young patients but is not suitable for severe form of spastic quadriplegia characterized by severe deformities of femoral head.

**Conclusions** Proximal femoral resection according to Girdleston, modified by authors, is the elective treatment for painful dislocated hip in non-ambulatory older patients affected by severe form of cerebral palsy.

## INFECTIONS (in collaboration with G.I.S.T.I.O.)

### ORAL COMMUNICATIONS

#### Clinical outcomes in patients treated with osteotomy of anterior tibial tuberosity during knee prosthetic revision in two stages after infection (follow-up: 2–11 years)

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**Introduction** The osteotomy of the anterior tibial tuberosity (ATT) for knee prosthetic revision because of peri-prosthetic infection is performed mainly for 2 reasons: to have a easier surgical approach to the prosthesis; to correct patella height abnormalities in order to get an easier replacement of the ATT after prosthesis replacement increasing also the range of flexion. These two reasons are often linked each others. So, in this study we present this technique as the favourite one (than other tendinous elongation technique) since it could make possible a better restoration of range of motion.

**Methods** Thirteen female patients (21 ATT osteotomy performed at our UO from 2000 to 2013, age from 62 to 79 years), who underwent a knee prosthesis revision, were clinically evaluated.

**Results** The follow-up was from 2 to 11 years. In all patients we collect the following data: all the patients had the fusion at the site of the osteotomy; the mean ROM was of 80° of flexion and 0° of extension; quadriceps strength was the same of the contralateral lower limb; no case of painful syndrome at the ATT; no case with needing

of screws removal (and no case of piezoelectric interference of the screws with the prosthesis).

**Discussion** To our experience, we consider ATT osteotomy as a very performing technique, since: it allows a better placement of revision prosthesis; it prevents complications linked to patellar height abnormalities; it allows a restoration of range of motion, also considering the values of the previous prosthesis; it allows a better restoration of quadriceps strength compared to other tendinous elongation technique; with this technique, we could place the ATT in a better position in order to decrease the pressure between patella and prosthesis, above all when patellar articular surface cannot be replaced.

**Conclusions** This technique can be considered effective when treating knee revision prosthesis with a difficult surgical articular approach or with abnormalities in patella height or with a stiffness in extension since we found an absence of late complications and good clinical outcomes.

### The Brodie's abscess pathogenesis

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**Introduction** Brodie's abscess is a sub-acute osteomyelitis localized more frequently in juxta metaphyseal area of children and adolescent's long bones, usually classified as hematogenous osteomyelitis. In literature these infections from outside contamination are rare, so we consider these our two cases of exogenous infection very exceptional.

**Methods** The first case is a 14 year old patient who came to our hospital 2 years after percutaneous fixation with two Kirschner wires of a closed fracture of the humerus, with swelling, erythema of the proximal region of the right arm, shoulder stiffness and spontaneous and pressure pain. The X-ray images showed, in the proximal metaphyseal region, osteolytic area surrounded by a sclerotic margin with medial diaphyseal cortex interruption. Early treatment with antibiotics has allowed the acute wound healing resolution. In the second case, an adult patient with distal third thigh pain and swelling showed an osteolytic lesion of the femur at radiological examination, unrecognized in childhood (16 years), after post-traumatic patella open fracture, evolved slowly in circumscribed osteomyelitis during the last 4 years. We performed a resection of the necrotic bone and a debridement with wound healing. The culture tests were positive for *Staphylococcus aureus* in both cases. Follow-up of both cases was 2 years.

**Results and discussion** We consider these two cases very important for the pathogenesis of infection by external cause, because, for a long time, Brodie' evolution, characterized by circumscribed osteolysis, was related primarily to its hematogenous origin. However the possibility that the same 3D morphology and site of the lesion, that is observed in spontaneous endogenous forms, occurs even in case of external contamination suggests that in children, the morphological characteristics of this infection does not depend so much on the route of entry, rather than the biological general and local characteristics. In fact, in children prevail the high local vascularisation and immune excellent resource. The delimitation of the osteomyelitis area is triggered when you create a state of balance between bacteria and immune defences of the host, allowed the excellent balance blood perfusion. The abscess is walled off from the system.

**Conclusions** The contamination from outside in the two cases presented confirms the possibility that the Brodie's abscess has an origin not only endogenous (hematogenous), but also exogenous. They offer us the opportunity to discuss the pathogenesis of the lesion whose circumscribed character of osteolysis are determined mainly by bone physiology and immune profile of the child, rather than the route of infection.

### Factors related to outcome of patients with PJI undergoing two-stage exchange

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**Introduction** Prosthetic joint infections (PJI) still represent a disease with high morbidity and mortality. In order to improve the outcome of patients with PJI subjected to two-stage procedure, we performed an analysis of the data from a cohort of patients to identify factors related to therapeutic response.

**Methods** Cases with PJI undergoing two-stage surgical procedure, consecutively observed at our Department of Infectious Diseases in a period of 3 years, were evaluated. For each case, we considered the demographic, clinical, and microbiological data in respect to treatment. PJI was defined by clinical and laboratory evidences. Cure was defined by the disappearance of evidence of infection during the 6-month follow-up period after the two-stage replacement was performed. The statistical analysis of the factors related to the therapeutic response was performed using the Mann–Whitney U test and Fisher's exact test. The variables found to be significant on univariate analysis were simultaneously investigated by multivariate analysis.

**Results** Seventy-five cases of PJI were evaluated [median age 68 years (range 41–83), 38 % males]; co-morbidities were reported in 16 cases; diabetes mellitus and chronic hepatitis were reported more frequently. *S. aureus* was isolated in 15 cases (7 cases resistant to methicillin, 3 cases rifampicin resistant). Coagulase-negative staphylococci were isolated in 27 cases (18 methicillin-resistant, 6 rifampicin-resistant). By univariate analysis, a favourable outcome was achieved in 64 (85 %) cases and was correlated to: (i) bacterial growth from cultures obtained from operative specimens (58/64 vs 5/11,  $p = 0.001$ ); (ii) growth of Gram-positive cultures (48/64 vs 2/11,  $p = 0.0005$ ); (iii) use of oral therapy (45/64 vs 3/11,  $p = 0.009$ ); (iv) use of combination antibiotic protocols containing rifampicin (36/64 vs 2/11,  $p = 0.02$ ). In multivariable analysis, growth of Gram-positive bacteria from cultures (RR 3.3, 95 % CI 1.48–4.81,  $p = 0.012$ ) and administration of oral antibiotics in the antibiotic treatment (RR 1.7, 95 % CI 1.05–2.35,  $p = 0.048$ ) were associated with a favourable outcome.

**Discussion** In our series, a favourable outcome in PJI subjected to two-stage procedure was related to microbiological identification of the etiologic agent and to the growth of Gram-positive by the cultures. Use of protocols containing rifampicin and the possibility to administer oral antibiotics have also been associated to a favourable outcome because of the increase of therapeutic compliance and the therapeutic efficacy of rifampicin.

**Conclusions** PJI infection outcome may be improved after careful evaluation of microbiological findings and use of an appropriate antimicrobial therapy.

### Tuberculous infection in atypical localizations: look for it to find it

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**Introduction** Tuberculous infection (TI) is gaining new presence in industrialized countries. Localization in atypical sites are described and the authors suggest that an explicit search is needed whenever the slightest clinical suspect arouses.

**Methods** Authors pursued a specific search for TI whenever an intra-operative macroscopic aspect appeared which was not easily correlated with the initial preliminary diagnosis. In 3 out of 10 cases, tuberculous infection was evidenced in atypical localizations and clinical courses.

**Results** Case 1: caucasian, non-migrant, 53-years old woman, with higher education and social condition. She presented a mildly painful wrist. An arthritis was rapidly evolving towards a massive destruction. Open arthrotomy showed an extremely aggressive synovitis with whitish deposits. TI was resolved by appropriate pharmacological therapy and a wrist fusion was performed. Case 2: caucasian, non-migrant, 56-years old woman, with good education and social condition. She presented X-ray and MRI evidences of bilateral chondroma of the metadiaphyseal distal femur, with no progression beyond the former growth cartilage line. Intra-operative biopsy showed no chondroid tissue; a particulate fluid with whitish deposits was present instead. TI was resolved by appropriate pharmacological therapy. Case 3: caucasian, non-migrant, 44-years old man, with history of past drug addiction. After 2 months of inflammatory condition of the wrist, unresponsive to FANS therapy, the patient suffered a distal radius fracture which received a minimally invasive percutaneous osteosynthesis. Despite bone healing, inflammation and destruent arthritis ensued where no antibiotic therapy proved effective. TI was treated by appropriate pharmacological therapy.

**Discussion** In these three cases, the pre-operative picture was little suggestive for TI and the localizations were not typical. The intra-operative picture was judged by the authors to be elective for a specific laboratory search for the TI. This was done even in the light that the majority of similar cases can result negative (as 7 out of 10 negatives in our series).

**Conclusions** The higher cost introduced by the specific TI search and the expectation of a majority of negative cases, should not prevent the specific search for TI when an intra-operative picture cannot fit in the pre-operative diagnosis.

### Surgical site infections in bone and soft tissues tumour surgery: epidemiology and experience in a single specialized centre

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**Introduction** A limb-sparing surgery is the mainstay for treatment of musculoskeletal tumours thanks to advances in surgical techniques, imaging modalities and multimodal therapies. As patients survive longer, plastic reconstructive procedures and revision surgery are increasingly required after tumour excision. Infection rate is reported up to 20–44 % after prosthetic replacement and more than 30 % for pelvic resection. Bone and soft tissue cancer patients can have a wide variability of risk factors, as they are immunosuppressed and undergo long surgical exposure with haematomas, loss of soft tissue coverage and large wounds. The purpose of the study was to investigate the epidemiology of surgical site infections (SSI) from the beginning of

the activity in a single specialized centre, identifying possible predisposing factors related to specific surgical procedures.

**Methods** We retrospectively reviewed 723 interventions performed from 2007 to 2013 for oncological disease conditions. Non-neoplastic lesions, aseptic wound complications, non skeletally mature patients were excluded. The same antibiotic prophylaxis regimens were used for specific surgical procedures and maintained until surgical drains were removed.

**Results** Without consideration of tumour types and surgical site, the overall infection rate was 8.7 % (63/723). Considering different surgical procedures, rate of infection following prosthetic reconstruction was similar to literary data, whilst a high rate of pelvic infection (almost 50 %) was registered and 20 % of infected spinal surgical procedures. Age, pelvic resection, repeated surgery, lack of soft tissue coverage and wound breakdowns were statistically significant predisposing factors for SSI ( $p < 0.001$ ).

**Discussion** Oncologic orthopaedic surgery is complicated by SSI because of extensive soft-tissue dissection, long operative times, poor skin conditions, requiring prostheses, bone grafts, meshes for reconstruction. Patients are immunosuppressed and often have comorbidities predisposing to SSI.

**Conclusions** Care of wound complications, monitoring of nosocomial infection and multicentre collaboration for consensus in guidelines for antibiotic prophylaxis are mandatory.

### An observational study on epidemiology and risk factors of peri-prosthetic joint infection

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**Introduction** Peri-prosthetic joint infection (PJI) is one of the worst complications of arthroplasty. Furthermore it is associated with elevated health care cost and lower quality of life. Our purpose was to evaluate PJI incidence and risk factors in a single centre.

**Methods** We retrospectively evaluated 180 patients submitted to total hip (THA) or total knee arthroplasty (TKA) since July 2012 to December 2012 at Sarno Hospital Orthopaedic Department. Demographic, clinical and laboratory data were collected. There were included only those patients with a minimum follow-up of 6 months.

**Results** A total of 165 patients of initial 180 meet inclusion criteria [median age was 72 years (range 65–78), 36 % were male and 64 % female, 64 were total hip arthroplasty and 101 total knee arthroplasty]. Co-morbidity were observed in 54 % of patients. The most common disease observed in those patients were diabetes mellitus, heart and liver disease. At a follow-up of 6 months 8 patients (4.8 %) developed a PJI. Of these patients 1 was submitted to joint replacement for a femoral head avascular necrosis, 3 patients for a fracture and 4 patients were submitted to a revision arthroplasty. In all cases there were some co-morbidity associated. Organisms isolated were methicillin-resistant *Staphylococcus aureus* (MRSA) (2 cases), coagulase negative *Staphylococcus* (1 case); *Acinetobacter baumannii* (1 case), *Enterobacter* spp. (1 case) and *Candida parapsilosis* (1 case). In 2 patients cultures were negative. In our data PJI was associated with age (a mean of 69 years in infected vs 73), glycemia (148 mg/dl in infected vs 116 mg/dl) and hospital stay (17.2 days in infected vs 6.7).

**Discussion** Joint replacement surgery is continually rising. Peri-prosthetic joint infection is one of the most devastating complications of joint arthroplasty and it is associated with higher rate of revision, aseptic loosening and of course higher health care costs.

**Conclusions** Several risk factors are associated with peri-prosthetic joint infection. It could be important to reduce its incidence to know and correct them.

## TRAUMA (in collaboration with SOC.I.T.R.A.S.)

### ORAL COMMUNICATIONS

#### Chronic biceps distal tendon ruptures: is primary repair still possible?

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**Introduction** Ruptures of the distal tendon of the biceps brachialis are successfully treated by direct repair in the first 3 weeks from the trauma. The treatment is controversial when the rupture is diagnosed after this period. Aim of this study is to evaluate the results obtained by direct repair in a group of patients treated on a medium delay from trauma of 34 days.

**Methods** Eighteen patients, all men aged between 25 and 64 years, were operated for distal biceps tendon rupture at an average time from trauma of 34 days (limits 23–46). All patients were operated through a single anterior approach. In 16 cases a direct repair by re-insertion at the biceps tuberosity of the radius with one or two anchors was performed; in 2 cases a direct reconstruction was not possible and a tenodesis to the brachialis tendon was executed. Patients were reviewed at a mean follow-up of 8 months (limits 5–14); ROM of the elbow, muscle strength and Dash score were evaluated.

**Results** All 16 patients who underwent a direct repair obtained a full ROM of the elbow; biceps muscular strength was 87 % respect to the unaffected side (limits 70–100 %). Dash score varied from 0 to 9.1 (mean score 3); 2 patients had clinical signs of re-rupture with deformity of the volar aspect of the arm and negative hook test.

**Discussion** It is commonly believed that after 3 weeks from a distal biceps tendon rupture direct repair of the tendon is no more indicated in consequence of retraction and loss of elasticity of the tendon. Our data suggest that satisfactory results with return to previous activity in 14 on 16 patients can be obtained by direct repair after that time.

**Conclusions** Even after 30 days or more from trauma direct re-insertion of the ruptured distal tendon biceps is possible in most cases and lead to better functional results respect to conservative treatment.

#### Results of open reduction and internal fixation in tibial avulsion fractures of posterior cruciate ligament

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**Introduction** Tibial avulsion fractures of the posterior cruciate ligament (PCL) are uncommon injuries. The aim of this retrospective observational study was to evaluate the results of open reduction and internal fixation performed at our centre between 2007 and 2013.

**Methods** Nineteen patients (14 males and 5 females) with an avulsion fracture of tibial insertion of PCL underwent ORIF through a modified Burks and Schaffer approach. The mean age was 42 years (range 17–75). The clinical assessment was performed with use of the International Knee Documentation Committee form and the Knee Injury and Osteoarthritis Outcome Score. The patients underwent a KT-1000 (Medmetric, San Diego, CA) examination and a series of stress radiographs that included a radiographic posterior drawer test with Telos (Telos, Weiterstadt, Germany) at 90° of knee flexion.

**Results** At 30 months mean follow-up (range 6–47 months) we are able to review 15 patients. Radiologic assessment showed solid union in all patients. The mean IKDC score was 68, the subscales of KOOS form were respectively 77, 79, 86, 58 and 68. The objective IKDC final scores showed 8 patients graded as “normal”, 6 patients graded as “nearly normal” and 1 patient graded as “abnormal”. The mean tibial posterior translation measured with KT-100 was 2 mm (range 0–6). Stress radiography performed with Telos showed an average posterior tibial displacement of 2.7 mm. We found a SSD >5 mm in 1 patient.

**Discussion** Accordingly to the literature we found a reasonable outcome (good or fair) in a large majority of patients undergoing ORIF for PCL avulsion fractures of tibia.

**Conclusions** Treatment of tibial PCL avulsion fractures by ORIF through a modified Burks and Schaffer’s approach is a successful technique to restore tibial avulsion injuries of the PCL with good subjective and objective results.

#### Temporary external fixation of unstable ankle fractures

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**Introduction** In the treatment of articular fractures of the distal third of the leg, resulting from high-energy trauma or otherwise characterized by soft tissue damage in bone unstable lesions, an emergency management with external fixation temporary bridge remains the treatment of choice to reduce complications. The aim of our study was to evaluate the clinical and radiological results of fractures of the distal third of the leg treated with temporary bridge external fixation in urgency, followed by removal of the same in the subsequent definitive treatment. The results obtained were then compared with a new cohort of patients in whom external fixation temporary bridge was maintained even after definitive treatment for replacing restraint systems such as plasters and/or braces.

**Methods** Between January 2010 and January 2013, we evaluated 40 patients with fracture of the distal third of the leg. Twenty-five cases, group A (15 fractures involving the tibial pilon and 10 bi-tri-malleolar fracture-dislocations) were treated with a bridge external fixator in urgency, then removed after definitive treatment. In the remaining 15 cases, group B (10 fractures involving tibial pilon and 5 bi-tri-malleolar fracture-dislocations) we have instead kept external fixation during the period of immobilization after definitive treatment. All patients were evaluated clinically and radiographically with AOFAS score of 3.6 and 12 months.

**Results** In group A, we observed the following scores in reference of AOFAS Score: 65 at 3 months, 70 at 6 months and 71 at 12 months, for tibial pilon fractures; 75 at 3 months, 83 at 6 months and 85 at 12 months, for unstable bi-trimalleolar fracture-dislocations. In group B at 3 months 70, 72 at 6 months and 75 at 12 months, for tibial pilon fractures and 80 at 3 months, 85 at 6 months and 85 at 12 months for the bi-tri-malleolar fracture-dislocations. Among the complications reported, we had 4 suffering in wound healing, 2 reflex sympathetic dystrophy and 1 early osteoarthritis, in group A, 1 suffering wound and 1 early arthritis in group B.

**Discussion** The two stages protocol of treatment, already widely accepted in literature, it has the advantage of optimizing the management of soft tissues, decreasing the rate of infection than ORIF in tibial pilon fractures.

**Conclusions** The new protocol of treatment, keeping external fixation with contemporary ORIF during the first phase of bone healing, seems to be a good method of treatment with a low rate of complications associated in the management of soft tissues.

## Factors associated with mortality and complications after hip fracture

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**Introduction** Hip fractures are associated with excess mortality and disabling complications.

**Methods** The objective of this prospective multicentre study was to evaluate the complications and mortality rates in elderly patients surgically treated for a hip fracture and to ascertain which factors predict the observed outcomes. The study included 568 patients (mean age = 78.3 years; 439 females, 129 males) who sustained a femoral neck (241), trochanteric (311), or subtrochanteric (16) fracture and were surgically treated with hip prosthesis (232) or osteosynthesis (336). Outcomes of interest were the length of hospital stay as well as the in-hospital, 4-month, and 1-year mortality, morbidity (complications), and re-operations. The age, gender, pre-fracture co-morbidity (CIRS scale and ASA score), cognitive status (MMSE scale), functional ability (ADL scale), fracture type, surgical delay, and treatment adopted (prosthesis or osteosynthesis) were evaluated as explanatory variables. The effect of these variables on the selected outcomes were studied by multiple logistic regression analysis.

**Results** The median length of hospital stay was 8 days (IQR 6–11). The 30-day, 4-month, and 1-year mortality rates were 4.2, 11.1, and 18.3 %, respectively. In-hospital, 4-month, and 1-year general complications occurred in 33.5, 16, and 5.3 % of the patients, respectively. Local complications were recorded in 5.5 and 2.6 % of the patients at the four-month and 1-year follow-up, respectively. A re-operation was reported by 3.0 % of the patients at 4 months and by 2.9 % at 1 year. General complications predicted mortality at any time interval (in-hospital: OR 18; 95 % CI 4.1–80.0; 4-month: OR 4.4; 95 % CI 2.3–8.5; 1-year: OR 3.6; 95 % CI 1.6–8.3) and also an increasing ASA class was directly associated with excess death (OR 2.6–4.6). General complications were inversely related to the MMSE score (OR 0.9; 95 % CI 0.9–1.0) and to surgery performed within 72 h (OR 0.5; 95 % CI 0.3–0.9), whereas they were directly associated with the CIRS score (OR 1.2; 95 % CI 1.1–1.3).

**Discussion** The mortality and complication rates found in our cohort at the various time intervals falls within the range of data reported by other investigators. The time to surgery is a potentially modifiable negative factor to reduce complications and improve patients’ survival after hip fracture.

**Conclusions** Our results can be fruitfully used to improve and individualize the surgical treatment of hip fractures.

## Minimally invasive plate osteosynthesis in type B fibular fractures versus open surgery

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**Introduction** In distal fibular fractures, plate osteosynthesis, often performed after open reduction, may present complications of the surgical wound, especially in old patients and poor skin conditions. In this paper we compared two group of patients treated with open technique (ORIF) and with minimally invasive

approach (MIPO) to evaluate advantages and disadvantages of the two techniques.

**Methods** Two homogeneous groups of patients (18 + 18) received LCP for distal fractures of the fibula, type B, according to AO. Group A patients underwent open surgery whereas group B patients received plates applied with MIPO technique. Both group were examined physically, radiographically and with functional assessment according to Olerud and Molander.

**Results** The mean time from trauma to surgery is longer in group A (2.4 days) than group B (1.7 days) because with MIPO technique we could approach fractures even with poor skin conditions. The mean surgical time is longer in group A (89.4 min, group B 58.2 min) while mean radiology time is shorter in group A (87.4 min, group B 95.6 min). We found wound complications only in the group A patients. Healing time were even. We believe that extending MIPO technique to more complex type of fractures, difference in surgical time would be in favour of the MIPO fixation. One limit of the MIPO technique is to harm the superficial fibular nerve when using 9 holes plates.

**Conclusions** We believe that the MIPO technique for distal fractures of the fibula should be used more often, especially if soft tissue is in a critical condition. Healing times should be reduced in the more complex cases. It is important that the learning curve should be improved, to minimize exposure to radiology and possible damage to the superficial fibular nerve.

## Surgical removal of fibular-calcaneal impingement after articular calcaneal fracture

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**Introduction** The calcaneal-fibular impingement as sequela of articular calcaneal fracture is defined as a painful limitation to the ankle motion, caused by a bone expansion of the calcaneus lateral wall, which cause a conflict with the lateral malleolus. Stephens and Sanders’ malunion classification was used and we treated impingement by surgical removal of the bone formation alone or in association with subtalar fusion in malunion types II and III. The aim of this study was to evaluate the clinical results of this for calcaneal fracture sequela.

**Methods** Between November 2002 and November 2012, 24 procedures were performed in 21 patients treated for calcaneal fracture malunion: 15 impingement removal and 9 impingement combined with subtalar fusion. AOFAS (American Orthopaedic Foot and Ankle Society) SCORE and SEFAS (Self-reported Foot and Ankle Score) were used for clinical assessment before surgery and at final follow-up.

**Results** The average follow-up was 57.7 months. In 65.5 % of cases (12 impingement removal and 5 impingement and arthrodesis) we found a marked improvement of symptoms and function. In the remaining 34.5 % (3 impingement removal and 4 impingement combined) there was less improvement. The average AOFAS score increased from  $37.4 \pm 18.96$  to  $72.3 \pm 17.88$ . The average SEFAS increased from  $16.5 \pm 12.06$  to  $33.8 \pm 11.85$ .

**Discussion** A statistically significant increase in used score was pointed out in 80 % of patient treated by impingement removal and in 55.5 % treated by combined procedure.

**Conclusions** Pain is the symptom that improves the most and it’s confirmed as the main indication to surgery.

## Mortality rate at 1 year after osteosynthesis for proximal femoral fractures. Does early weight-bearing play a role?

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**Introduction** Proximal femoral fractures represent an impelling health problem, owing to their increasing incidence and association with relevant co-morbidities and mortality in the elderly population. The aim of this study was to evaluate the mortality rate at 1 year in a consecutive series of patients, who had undergone osteosynthesis for proximal femoral fractures. The influence of timing in weight-bearing and of other variables was also investigated.

**Methods** We included in this study all the patients aged  $\geq 65$  years treated with osteosynthesis for extracapsular fractures of the proximal femur between January 2006 and December 2011 at a single institution. Demographic and clinical data were retrieved from the hospital database. Patients treated before January 2009 were allowed to full weight-bearing 2 months after surgery, while patients treated after January 2009 started full weight-bearing as soon as possible after the operation. The two groups of patients were compared according to the following variables: sample numerosity, age, gender, hospital stay from admission to surgery, hospital stay from operation to discharge and one-year mortality. The mortality rate at 1 year was considered the primary outcome and it was obtained by consulting the Civil Certificates of all patients. We applied a logistic regression statistical analysis to search relations between 1-year mortality and the variables that characterized both groups.

**Results** A total of 975 patients were included (77 % females, 23 % males; average age  $84 \pm 7$  years): 448 were treated before January 2009 and 527 after January 2009. The total mortality rate at 1 year was 24 %. In the delayed weight-bearing group of patients the mortality rate was 21.5 % whereas in the early weight-bearing group was 25.5 %; the difference was not statistically significant ( $p > 0.05$ ). Female gender, age  $\geq 85$  years and pre-operative hospital stay were related with higher mortality rates ( $p < 0.05$ ).

**Discussion** Even though the sample numerosity is not negligible and produces useful data about the raw mortality rate at 1 year, this study does not allow to draw conclusions on the role played by specific factors, since many clinical variables influencing the prognosis of these patients were definitely overlooked. Limits of this study could be overcome with a proper study design and a sample size which consider the reduced mortality observed at our institution, lower than those observed in literature.

**Conclusions** The mortality rate did not show a sufficient correlation with timing of weight-bearing, while other variables (female gender, age  $\geq 85$  years and longer preoperative stay) seem to play a more important role.

## Proximal humeral fracture. Proposal of a new diagnostic and therapeutic algorithm in a second referral trauma centre

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**Introduction** Aim of this study was to determine if accuracy of pictures taken from radiographs of proximal humeral fractures by a

last generation phone camera is comparable to traditional X-ray film. By using new digital devices and based on the AO/ASIF classification, we propose an algorithm for the management of patients with proximal humeral fracture in a second referral trauma centre.

**Methods** Radiographs taken to patients who addressed to our Emergency Department for shoulder trauma and performed by a specific trauma series, were made available in digital DICOM format and in traditional X-ray films. Radiographs were then photographed with a last generation phone camera. All images were afterwards anonymously, randomized and retrospectively analysed in all its forms (X-ray film, DICOM and JPEG from the camera) by four orthopaedic surgeons.

**Results** Observers made diagnosis of proximal humeral fracture; in cases of positive diagnosis, fractures were classified according to the AO/ASIF criteria. Based on fracture type and other specific radiographic factors, observers indicated a conservative or surgical treatment. Treatment option was determined based on a specific therapeutic algorithm. Staged analysis of the same images was then performed by the same observers after 1 month. Preliminary results demonstrate that evaluation of DICOM or JPEG format has the same inter- and intraobserver reliability of traditional X-ray films.

**Discussion** Radiographic evaluation of a fracture by experienced staff often depends on a verbal description made by general practitioners, especially when the orthopaedic surgeon or radiologist are on call, as in a second referral emergency centre. Eventual descriptive or interpretative mistakes could lead to an erroneous conservative treatment of the fracture, as well as the inexperience or fear of underestimating some trauma can lead to defensive practice that mobilize operating personnel or instrumental examinations in an improper way. Opposite if orthopaedic surgeon had regular access to the X-ray images, even if at a remote site, this could permit accurate and prompt diagnosis and commence optimal treatment, still complying with costs and medico-legal issues.

**Conclusions** Recent advances in digital imaging technologies have made possible the production of radiographic images that are easily shareable. Better standardization of the diagnostic and therapeutic approach could lead to a better use of human and technological resources with a secure savings in economic terms.

## The importance of early rehabilitation in proximal humeral fracture: a randomized controlled clinical trial of efficacy and safety of endomedullary Diphos nail

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**Introduction** The early rehabilitation is the key of success in any shoulder pathologies, especially after trauma. After surgery the major trouble is represented by fracture stability: the used device usually could not allowed a good primary stability in cases of greater comminution of proximal metaepiphiseal area. The objective of this randomized controlled clinical trial is to investigate the effects of an early rehabilitation program (ERP), with a passive mobilization started 2 days after surgery, in patients with a proximal humeral fractures treated with a new multiplanar stability endomedullary nail: these results were compared to the standard rehabilitation program (SRP) used in our Traumatologic Department before, with a shoulder mobilization started 3 weeks after surgery.

**Methods** In February 2014 medical records of patients under 65 years old who had a proximal humeral fractures treated with Diphos nail in 3 years before were retrospectively evaluated. All patients had no functional disorders before trauma. Thirtyeight patients in ERP group and 33 patients in SRP group were enrolled. We evaluated the



fracture consolidation timing and migration screws signs with a radiographic examinations and the recovery of function with Constant Scoring System (CSS) at 1, 2, 3, 6 and 12 months after surgery follow-up. The primary safety outcome was a complete consolidation of fracture in 3 months without complication like screws migration, lose of function or residual shoulder pain.

**Results** A statistic difference (confidence interval >95 %) between the CSS values averages of ERP and SRP groups was demonstrated at 6 months after surgery follow-up (82.26 to 80.82; standard deviation 3.01). The mean of fracture healing time was 1.8 months ( $\pm 1.1$ ), we had no screws mobilization.

**Discussion** We had modified the standard physiotherapeutic program used before in our Traumatologic Department when surgeon had noticed the excellent primary stability of intra-operative fracture with Diphos nail, after an initial experimental period of it only. The multiplanar property of the new proximal humeral nails is an important and necessary requirement to fixate the tuberosities to the humeral head with a good primary stability; angular stability prevents the screws migration risk. These measures have made possible an early rehabilitation and better functional outcome.

**Conclusions** The new humeral nail Diphos is safe, because thanks to its biomechanical properties of humeral head socket ensures excellent primary stability that becomes a secondary stability after mobilization, and effective, allowing a quick and better functional recovery.

### Spaghetti wrist lesion: is it a disabling injury? This is our experience

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**Introduction** Spaghetti wrist lesion is a complex traumatic injury of the volar aspect of the wrist with involvement of tendons, vessels and nerves. Although there is no clear definition in the literature, it is commonly accepted that the injury must affect one major nerve and vessel. It is perhaps the most disabling injury in traumatology of the hand, with a slow and difficult recovery and return to work. It occurs as a result of cutting injuries, motorcycle accidents, suicide attempts. **Methods** We treated 4 patients between January 2013 and March 2014; all male, aged between 33 and 54 years: two cases of accidents at work and one during hobby activities, a case of stab wound by aggression. In all cases there were complete injuries of the ulnar nerve and artery; one case associated with median nerve lesion. The FCU in all patients resulted dissected, in three cases the FDS and palmaris longus, in two cases the FCR, in one case the FDP. The surgical procedures started on average 3 h after the trauma (duration between 2 and 5 h) without the use of band ischemic. Individual rehabilitation programs were initiated early. It was performed a careful tendon and nerve examination; were administered periodically the DASH and the VAS scale, the electromyographic examination performed at 6 months.

**Results** The high-energy trauma caused a severe lesion of the affected tissues: the complete section also worsened by the degeneration of the injured extremity due to the heat produced. Despite this sensory and functional recovery was generally good. It has not been necessary proceed to secondary tenolysis. Patients in the clinical check at 30 days, did not report pain; remained, however, areas of paresthesia. The results obtained after administration of the DASH questionnaire showed continued improvement with return to work on average at 3 months.

**Discussion** Analysing the literature is important a preoperative planning with the execution of the surgery within a few hours after the trauma, the use of loupes 4 $\times$ , the strong motivation of the patient and an early physiotherapy.

**Conclusions** These injuries are difficult to manage even for experienced surgeons; in order to reduce the disabling outcomes, we stress the importance of proper pre-operative clinical examination, the knowledge of the lesion district (check list of structures). Are also important the quality of the sutures, and the patient’s age.

### Surgical treatment for type III acromio-clavicular dislocation

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**Introduction** The acromio-clavicular dislocations account for 12 % of all traumatic dislocations of the shoulder. Generally occur in young active patient who need a quick functional recovery to perform usual activities (work, sports, etc.) prior to trauma. The diagnosis is fairly easy, and is based on clinical examination and radiographic examination routine antero-posterior and lateral. Even staging appears now well standardized in clinical practice according to the well-known Rockwood’s classification. The pathological anatomy appears quite clear when asserts that by the third grade are witnessing the complete loss of articular acromion-clavicle with rupture of the ligaments acromion-clavicular and coraco-clavicular. Less obvious is to determine the surgical technique to reduce and stabilize the injury. The international literature is in fact thriving methods of comparison, but not elect the best result in surgical technique, less invasive, more ease of use, and why not, in times of spending review, more economical.

**Methods** The authors propose a surgical technique for the treatment of dislocations AC grade III. The technique is percutaneous under guidance of image intensifier, and consists in the introduction of a cannulated screw in the acromial process and from it the collarbone to empathize the joint. The authors present, with a mean follow-up of 36 months a series of 14 patients with average age of 39 years, 10 men and 4 women. The surgery was performed by the eighth day after the trauma.

**Results** In the 14 operated patients we obtained a 100 % satisfaction aesthetic result. Twelve out of 14 patients have resumed their normal activities with an average of 40 days after surgery (30 to 50 days), 1 screw removed after 6 months for mobilization and decubitus subcutaneous, 1 lost in the follow-up.

**Discussion** The surgical technique described provides a rapid functional recovery and a physiological gliding motion of the clavicle and scapula rotation of the seventh post-operative day. The mobilization of the limb to be favoured already in second to third day, allowing the patient to return to work activities play both manual and sports activities.

**Conclusions** The authors described a surgical technique, effective, simple, repeatable, and with a small learning curve. The technique is minimally invasive to the patient and low economic impact. The functional results are encouraging, as well as patient satisfaction, so much so that to consider this intervention as a first choice in case of traumatic dislocation of the acromio-clavicular grade III.

### Endoprosthesis in radial head fractures

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**Introduction** The radial head has the function along with the other components of bone, ligament and tendon to stabilize the elbow joint.

In case of fracture, is shown osteosynthesis in the presence of a decomposition of more than 2 mm and when the affected area is greater than 30 %, while in the fracture of Mason type 3, decomposed and comminuted with more than three fragments is indicated resection or replacement with endoprosthesis.

**Methods** In our clinic we have in the past used silicone implants and endoprostheses alumina in over 100 cases. Over the past 6 years we have treated 15 cases of isolated fractures of the radial head and 12 cases of fractures associated with other fractures or dislocations (coronoid, olecranon, distal humerus): in 18 cases we used non-modular endoprosthesis in 9 cases while those modular.

**Results** The Morrey score was used to evaluate the results. 16 patients reached excellent results, 5 patients good results, 3 and 3 bad enough. Complications were: removal of the endoprosthesis for joint stiffness and 3 heterotopic ossification.

**Discussion** We prefer to treat the fracture of the radial head is not otherwise summarized with an endovascular rather than resection alone to prevent the shortening of the radius, the distal ulnar subluxation of the radius and the instability of the elbow.

**Conclusions** The replacement of the radial head endoprosthesis with guarantees stable results over time in non-associated fractures. You should always evaluate the presence of lesions associated with CT or MRI and intra-operative control the ligamentous stability. If there is a lesion of the MCL synthesis of the fracture of the radial head replacement with endoprosthesis or prevents the revision of the MCL. It' always necessary to reconstruct the coronoid. The replacement with endoprosthesis allows rapid mobilization and a fast recovery.

### High energy dyaphyseal tibial fractures treated by circular external fixator

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**Introduction** Aim of this study is to present the outcomes of our experience in bifocal dyaphyseal tibial fractures (BDTF) treated by circular external fixator according to the Ilizarov's technique.

**Methods** From January 2004 to December 2010, 14 males and 4 females, mean age 45 years (range 32–55) with BDTF were treated. All fracture were a consequence of car accidents. Ten fractures were open (8 type II and 2 type IIIb according Gustilo); in all cases fibula fractures was present. In 2 patients fracture of the femur was concomitant, treated by nailing. Patients were treated by Ilizarov external fixator controlled intra-operatively by an image intensifier. Open fractures underwent immediate surgery, whereas close fractures were treated within 3 days (preliminary heel-bone traction). In 6 cases a connected leg-foot frame, maintained for 40 days, while in 12 cases a simple leg fixator was applied. In 5 patients stability of the reduction was obtained by a minor internal fixation using K-wire connected to the frame and removed after 1 month. According to patient's pain tolerance immediate weight-bearing was allowed.

**Results** The mean follow-up was 28.2 months (15 to 32). Mean hospitalization was 5 days (range 3–7). No patient had pain around the knee, medial or lateral instability. Knee range of motion after frame removals was 0° to 100°. Frame was removed at a mean of 5.8 months (4–11) and a cast was applied for 3 weeks after. Two patients had delayed union treated by autologous bone graft; 2 had nonunion treated by trifocal surgical revision with the complete healing of all them four; 4 patients had pin track infection. No

neurological complications were observed. Our clinical final results, according to Olerud and Molander Scoring System and mainly on a patients' self rated ankle and knee function were excellent in 5 cases (27.7 %), good in 8 cases (44.4 %), fair in 4 cases (22.2 %) and poor in 1 case (8.5 %).

**Discussion** Treatment of high energy complex extra-articular fractures is a well known indication to external fixation with also advantages for management of any complication.

**Conclusions** Ilizarov's technique for the treatment of bifocal dyaphyseal tibial fracture is easy to apply and when associated with meticulous pre-operative planning and frame selection, offers good clinical outcomes and results without further complications and non significant differences between leg plus foot fixation and simple leg fixation.

### The polyaxial locking plate osteosynthesis in proximal humeral fractures: our experience with a 4-year follow-up

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**Introduction** The proximal humeral fractures are the most frequent of the shoulder joint; having an incidence of 4–5 % of all fractures and mainly affect elderly people after low-energy trauma. In 20 % of cases are displaced and require surgical treatment: the surgical choice depends on the type of fracture and by factors inherent to the patient. The alternatives are surgical prosthetic replacement or internal fixation with plate. The aim of this work was to evaluate clinically and radiographically patients with these fractures surgically treated by internal fixation with plate and screws.

**Methods** We have assessed 154 patients (98 women and 56 men), aged between 43 and 88 years (mean 67 years) patients with fracture of the proximal humerus; of which, according to the AO classification, 58 were type 3.1-A, 77 were 3.1-B and 19 3.1-C. The patients were treated surgically by a single operator with a ORIF technique (NCB plate and screws) from January 2009 to December 2013. In 27 cases we performed grafting with autologous bone bank. The clinical and radiographic follow-up, through the board of Constant, was performed at 1, 3, 6 and 12 months after surgery. All patients were treated by trans-anterior-medial deltoid surgical approach. After this the upper limb was immobilized through an arm support (Gilchrist) for 21 days, followed by appropriate rehabilitation protocol.

**Results** The mean follow-up of 10 months showed at radiographic checks, the complete consolidation in 127 cases, delayed consolidation in 17 cases and aseptic osteonecrosis of the humeral head in 10 cases. From the clinical point of view we have had 21 cases of joint stiffness with moderate functional impairment. There were no surgical infections manifested; none was necessary conversion prosthetic.

**Discussion** The ORIF technique we use allows a small incision and the possibility of using polyaxial screws, so as to provide a high stability even in osteoporotic bone. Furthermore, the periosteal vascularity is not altered and biological recovery times are faster.

**Conclusions** The treatment of the proximal humerus fractures should always be preceded by a correct diagnosis and a careful evaluation of the quality of the bone. This technique provides excellent stabilization in the treatment of this fractures even in the case of elderly osteoporotic.

## Petrochanteric fractures in elderly patient: death rate in 30 days after surgery evaluation

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**Introduction** Petrochanteric fractures are serious lesions affecting elderly people, frequently females, due to a low-energy trauma. Essential aim is the treatment of these lesions within 24–48 h after trauma in order to reduce operative and post-operative complications due to a late surgical approach. Purpose of this study was evaluate the death rate in 30 days after surgery in two groups of patients treated for a petrochanteric fracture.

**Methods** In two-year period 2011–2012, 294 patients affected by petrochanteric fracture with a range of age between 65 to 99 years have been treated. We excluded patients with a petrochanteric fracture or a cancer into previous 2 years, transferred from other hospital, not inhabitant in Italy, affected by polytrauma. Patient were discerned in two uniform-characteristic groups. Group I included 140 patients, 91 females (65 % of totality) and 49 males (35 %), with mean age 84.3 years (range 65–98), with median delay of 5 days to be processed with a surgical treatment. Group II included 154 patients, 98 females (64 %) and 56 males (36 %), with mean age 84.9 years (range 67–99), with median delay of 3 days to be processed with a surgical treatment. Every patient of two groups has been treated with proximal femoral intramedullary nailing and for everyone we evaluated death rate in 30 days after surgery and waiting days for surgery, modified by risk adjustment process.

**Results** In group I the modified median delay was 5 days for 90 % of patients and 3 days for 66 % of patients; mortality in 30 days was 17.7 %. In group II modified median delay was 3 days for 98 % of patients and 2 days for 63 % of patients; mortality in 30 days was 7.2 % (Italian average: 6 %).

**Discussion** In elderly people bed-ridden syndrome, chronic pathologies, anaesthesia stress, anaemia, cause increasing operative and postoperative mortality. An early and multidisciplinary approach to the fracture-affected patient achieves a better postoperative outcome in the middle and long term.

**Conclusions** study results reveal a early and multidisciplinary approach and the/a well-timed/prompt surgical treatment being essential to obtain the decrease of mortality in 30 days after surgery.

## Cement augmentation method for proximal epiphyseal humeral fracture in osteoporotic elderly patients treated by intramedullary nailing and plates and screws: a 4-year follow-up

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**Introduction** Proximal epiphyseal humeral fractures are common in elderly people and their treatment has a rate of complications due to technical failure (cut out, head rotation).

**Methods** We studied 24 patients (15 females, 9 males) with an average age of 79.42 years (range 69 to 83 years) and severe osteoporotic bone (1 or 2 Singh score). They all had proximal epiphyseal humeral fracture, classified as type II-III following Neer classification, defined as fractures of the surgical humeral neck. Sixteen patients were treated with T2 proximal humeral nail (Stryker Srl) and 8 with Philos plate and screws (Synthes Srl) with a modified technique consisting in augmentation of the proximal screws.

Augmentation was done with The Locker system (Tecres SpA) inserted through the tunnel for the cephalic screws. The evaluation is based on: operating time, early functional recovery using the Constant-Murley score, X-ray evaluation, mechanical and biological complications.

**Results** The Constant-Murley average score was 71.3 after 1 month post-operation, 73.4 after 3 months, 76.7 after 12 months, 75.4 after 48 months. No other complications (infection, cut out and humeral head necrosis) have been reported at the follow-up.

**Discussion** The review of the recent literature highlights the augmentation's method benefits in support of fractures due to osteoporosis. Due to the poor quality of the bone tissue, this is not able to provide sufficient substrate in which the means of synthesis can be anchored stably, leading to complications in the subject.

**Conclusions** The observations based on the reported results allow to conclude that the cement augmentation of proximal screws in severe osteoporotic bone treated with T2 nail and Philos plate could improve the mechanical stability of the implant, ensuring early functional recovery.

## MIPO vs. ORIF in tibial-pilon fractures: a retrospective multicentric study on 23 cases, preliminary results

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**Introduction** The purpose of this study was to retrospectively compare two different techniques for the treatment of tibial-pilon fractures and to lay the foundations for a pilot study.

**Methods** We treated 15 cases of type AO 43 fracture with ORIF technique and 8 cases with MIPO technique. We proceeded to follow up patients radiologically at 1, 3, 6 and 12 months. The patterns we used are the same used in literature: (1) union was defined as the bridging of three of the four cortices; (2) delayed union: union occurs between 6 and 11 months; (3) non-union was defined as a fracture that did not heal after 11 months; (4) malunion was defined as a malalignment greater than 5° in any plane. The inclusion criteria for MIPO were: non-articular fracture, type 43 A, unexposed and exposed up to grade 2 Gustilo. Fractures treated by ORIF technique were never exposed. Statistical analysis was performed using Fisher's test.

**Results** MIPO technique resulted in 6 cases of union at 6 months, 1 case of nonunion and 8 cases of union at the 3rd month. ORIF technique resulted in 5 cases of union at 6 months, and 3 cases of union the 3rd month. No shortening or malunion. Test Ho:  $p = 0.92$ .

**Discussion** The two techniques appear to be similar in performance except for a greater percentage of healing at 3 months in favour of the MIPO technique.

**Conclusions** Higher level of evidence is needed to compare the two techniques. There are different limits and has no statistical value. Despite these limitations we believe that the data we observed are sufficient to define a protocol for a perspective study in the future.

## Surgical treatment of different outcomes of traumatic amputation of foot

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**Introduction** Treatment of an amputation of a right foot in an important outcome of traumatic dystrophy with scarring, lesions and

ulcers in the stump, atrophy of the muscles of the leg side and rear of the leg presents a challenge for the surgeon who must implement techniques associated to obtain a result harmonic and functional acceptable also improving the quality of life.

**Methods** Under local anaesthesia with light sedation in Day Surgery, we have treated a young woman with traumatic amputation of the right foot with results cicatricial with ulcerations and skin lesions with fat transplantation, lipodystrophy of the right leg with modelling with a cannula and atrophy of the 3rd lower with calf implants. We use the skin expander and an implant expansion in cohesive silicone gel to add volume in the region of the muscle, a transplantation of adipose tissue tropism, and to give an adipose layer in the scar, shaped the region posterior and anterior with a cannula at the bottom of the 3rd.

**Results** The results as very satisfying for the young woman and it is encouraging for the treatment of major deformities that can be solved with careful planning.

**Discussion** Although the treatment of complex changes of shape and volume requires more operative time and is associated with different techniques, it is necessary to achieve a clinical improvement and an acceptable aesthetic in front of serious conditions that are often the basis of a limited existence.

**Conclusions** Satisfactory results in complications have usually followed with adequate solutions in technique and implant. The problem rate has dropped markedly with more careful techniques and better patient selection.

### Retrograde intramedullary nailing in the treatment of distal femur fractures in elderly patients

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**Introduction** Retrograde intramedullary nailing is a widely validated technique in the treatment of fractures of the distal femur. Although the results reported in the literature show excellent healing rates and few complications, its use is generally restricted to conditions in which the antegrade technique is inconvenient or unfeasible (large obese, ipsilateral fracture of the pelvis or hip, etc.). The required knee arthrotomy and the reported rates of anterior knee pain generate some concern, especially in young patients. The aim of this study is to report the clinical and radiographic results of the use of retrograde nailing in femoral fractures in elderly patients, highlighting how the versatility of the device and the reduced surgical time are well adapted to the fragility of the patient over 75.

**Methods** All patients older than 75 years old, with supracondylar fracture of the distal femur (33-A) or with articular fracture (33-C) (only in cases of severe co-morbidity or poor functional demands) admitted at the ASO S. Croce di Cuneo, between 2012 and 2014, were included in the study. A mini-transpatellar access under fluoroscopic guidance was used. In all cases we used a ZNN-Zimmer nail. All patients were re-evaluated clinically and radiographically at regular intervals.

**Results** The study included 25 patients (11 males), mean age 82.5 years (range 75–98), with fractures of type 33-A in 18 cases and 33-C in 7 cases. ASA class was III in 15 patients and IV in 10. All patients were operated later than the second day from admission. The mean duration of surgery was 44 min and the estimated intra-operative blood loss was <200 ml in all cases. Three patients had an ipsilateral hip arthroplasty, 1 an ipsilateral knee replacement, 1 patient had a post-actinic limb elephantiasis. The mean follow-up is 12.12 months (range 6–24). At last follow-up, we recorded a healing rate of 96 % (1 non-union), an average VAS pain of 2.4 (range 0–7), 88 % of patients were satisfied or very satisfied and 76 % of them were able to return to previous activities. We recorded 3 cases of not disabling anterior knee pain (12 %). No re-operation was necessary.

In the sample 3 deaths occurred, including one for malignancy and 2 for heart disease.

**Discussion** The small surgical invasiveness and the reduced operative times make retrograde nailing an useful technique in the elderly patients. The device is useful even in special cases, such as the presence of ipsilateral hip replacement or when it is necessary to avoid more invasive surgeries in fragile patients.

**Conclusions** Retrograde nailing for distal femur fractures in elderly patients represents a reliable and versatile surgical technique.

### Treatment of complex tibial plateau fractures with Ilizarov external fixator

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**Introduction** The tibial plateau complex fractures and the proximal tibia's fractures are currently a challenge for trauma surgery with an increase in their incidence and a high risk of post-traumatic arthritis.

**Methods** Between 1993 and 2002 and between August 2011 and February 2014 we treated a total of 70 patients with high-energy fractures of the tibial plateau (Schatzker type IV, V and VI) with an Ilizarov, 24 women and 46 men aged between 23 and 63 years. Six fractures were open (8.6 %), 49 (70 %) were treated by limited open reduction. Fifteen (21.4 %) were treated by percutaneous fixation and ligamentotaxis. The remaining 10 (14.3 %) by open reduction. Of all these, 39 patients had isolated tibial fractures while the remaining had other skeletal segments fractures (11 metaphyseal/diaphyseal/pilon fractures, 8 femoral, 1 hip, 1 radial).

**Results** The mean time of treatment was 115 days (65–153 days). Fifteen patients presented an uncompleted knee active range of motion (from 20° to 120°); from them, one needed arthroscopic release and one Judet's quadricepsplasty. The remaining showed good joint stability and good alignment with ROM >120°. Three patients are still in treatment. There were no cases of post-operative osteomyelitis or septic arthritis. Two cases of post-traumatic stupor of the common peroneal nerve were observed, one resolved spontaneously, and two cases of DVT. Post-operative mobilization begins immediately and as soon as there were sufficient signs of consolidation we allowed partial load.

**Discussion** External fixation has an absolute indication for open fractures. Since these are fractures involving an articular surface reduction must be as anatomical as possible with a stable fixation. In our experience we believe that this method ensures excellent fixation stability with the option of a minimum soft tissues trauma which are often compromised.

**Conclusions** The Ilizarov circular external fixation is the ideal method of treatment for this type of fractures, especially when internal fixation and dissection is contraindicated due to the loss of bone and tissue, as well as the comminution. It also ensure the possibility of arthrodiastasis.

### Surgical treatment of delayed acetabular fractures

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**Introduction** Acetabular fractures require anatomic reduction and stable synthesis. An anatomical reduction and a correct internal

fixation in the first 14 days after trauma, guarantee more than 80 % of optimal results. Matta (2006) defines as anatomical a reductions that are not present within 1 mm of residual decomposition. If not properly treated, these fractures rapidly evolving in post-traumatic osteoarthritis. A malunion should be treated by osteotomy of the fracture and subsequent as far as possible anatomical reduction and synthesis.

**Methods** We analysed 11 patients with inveterate acetabular fractures hospitalized from 2010 to 2013 (mean age 45.5 years), these patients underwent reduction and fixation with a time from trauma between approximately 45 days on average. One patient had a transverse fracture involving posterior wall and inveterate dislocation of the hip 6 weeks after the injury. Patients are evaluated radiographically post-operative and from a functional point of view to follow-up. In all patients we performed heterotopic ossification prophylaxis post-operative.

**Results** The quality of the reduction was excellent in 63 % of cases (<1 mm), good in 28 % (breakdown <2 mm) and poor in 9 % (split between 2–5 mm). Post-operatively, we found two lesions of the sciatic nerve, with partial recovery in one patient and a complete recovery in the other patient within 12 months. We observed no post-operative infections or avascular necrosis. The mean follow-up was 26 months (range 6–38). Were found minor heterotopic ossification in two cases. At follow-up no patient developed post-traumatic osteoarthritis.

**Discussion** We got an anatomic reduction only in 63 % of patients. This fact is due to surgical difficulties often related to the advanced state of consolidation of the fractures; these difficulties are likely to have some neurological complications. The limitation of this study is the short follow-up.

**Conclusions** Surgical treatment of inveterate acetabular fractures show lower results than the fresh fractures but still require an adequate surgical treatment to minimize the occurrence of post-traumatic osteoarthritis. This type of operations should be considered as definitive treatment. A good result depends on the quality of the reduction; it is therefore advisable to be carried out in specialized centres by experienced surgeons in this type of surgery.

### The MIPO technique in tibial-pilon plurifragmented fractures. Indications, advantages and limitations

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**Introduction** Tibial pilon fractures are rare injuries and are still a challenge for choosing the best method of management. The involvement of the ankle joint and the vulnerability of the surrounding soft tissues, frequently complicate these fractures often already compromised when multifragmented. The MIPO technique (minimally invasive plate osteosynthesis) seems to be the most effective solution to reduce the occurrence of a significant number of complications after ORIF in the treatment of tibial pilon fractures.

**Methods** Fifteen patients with closed tibial pilon fractures were treated by using contoured locked compression plates with MIPO technique. All patients were first clinically examined to evaluate, according to Tscherny and Gotzen classification, the conditions of the soft tissues. X-rays were performed in antero-posterior, lateral, and coronal views of the tibial pilon and CT with 3D reconstruction to assess the joint damage. Patients were operated within 3 days after the trauma.

**Results** All patients had a good functional recovery in weight-bearing and walking morphologically correct without crutches. Two patients had moderate articular pain during rehabilitation which was

controlled by analgesics. One patient complained of ankle mild pain and of functional restrictions when he resumed his sporting activity, which disappeared after the plate and screws removal 12 months after surgery.

**Discussion** Patients underwent to ORIF with MIPO technique after the improvement of soft tissue conditions. Nevertheless, we appreciated that the larger the articular involvement was, the longer was the time for soft tissue healing. The MIPO technique has certainly reduced the appearance of severe complications, but this approach must be used only when the surgeon has the certainty of being able to reach the anatomic reduction that ensures the ankle's functional recovery.

**Conclusions** MIPO technique confirmed to be a safe and effective method in the treatment of tibial pilon fractures. The best outcomes were obtained when the articular surface was only marginally affected by the fracture. This method minimizes the surgical soft tissue damage promoting the fracture's healing and leading to an early resumption of joint function.

### Blood loss evaluation in proximal femoral fractures: multivariate analysis and comparison between dynamic hip screw and cephalomedullary nail

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**Introduction** Blood loss after fixation of proximal femur fractures depends on different factors, conditioning hospitalization, early mobilization and complications risk. Blood loss can be influenced by internal fixation technique. The aim of this study was to compare blood loss in patients treated with dynamic hip screw (DHS) or cephalomedullary nail.

**Methods** Intra-operative, peri-operative blood loss and red blood cells (RBC) transfusions were evaluated in 417 patients after internal fixation of proximal femoral fractures. The formula including blood loss (BL), RBC and total blood volume described by Foss was adopted. The results were analysed according to internal fixation device (DHS vs cephalomedullary nail); fracture type (AO-A1 vs AO-A2); time to surgery (<24 h vs >24 h); antiaggregant/anticoagulant drugs vs no therapy. A multivariate analysis was performed.

**Results** Blood loss was significantly ( $p < 0.05$ ) reduced in the following comparisons using univariate analysis: fixation with DHS ( $\neq 825.9 \text{ ml} \pm 47$ ); A1 fracture ( $\neq 549.7 \text{ ml} \pm 43.7$ ); time to surgery >24 h ( $\neq 260.5 \text{ ml} \pm 59$ ); no antiaggregant/anticoagulant therapy ( $\neq 122.5 \text{ ml} \pm 47.5$ ). Using multivariate analysis blood loss was significantly ( $p < 0.05$ ) reduced in: A1 fractures treated with DHS fixation (92 patients,  $674.8 \text{ ml} \pm 321.3$ ,  $p < 0.05$ ) than cephalomedullary nail (116 patients).

**Discussion** Limitations of this study were its retrospective design and discrepancy between internal fixation devices due to better mechanical properties of the nail (317 nails vs 100 DHS). However, multivariate analysis demonstrated that considering the other variables blood loss was reduced with DHS. Lesser blood loss in patients treated after 24 h could be ascribed to a potential packing effect or to a different percentage of cases in the 2 groups (<24 h 76 % vs >24 h 24 %). Minimal difference between antiaggregants/anticoagulants vs no therapy (122.5 ml) could be attributed to a more frequent use of antiaggregants than anticoagulants (85 vs 15 %).

**Conclusions** In A1 proximal femoral fractures, DHS fixation determines reduction in blood loss compared to cephalomedullary nail.

## BASIC RESEARCH (in collaboration with I.O.R.S.)

### ORAL COMMUNICATIONS

#### Ovine animal model in the study of artificial nerve regeneration in brachial plexus lesions

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**Introduction** Surgery in brachial plexus lesions is still poor in good results. One of the main problem is the correct characterization of the different localization and severity of the lesions. Another problem, in our opinion, is the lack of a suitable animal model for a possible translation of experimental results in humans.

**Methods** Authors reproduced some of the animal models most reported in the literature. Their final aim was to study the possibility of nerve regeneration in post-radicular lesions by the support of artificial devices, like the neural-guides already in use for single peripheral nerves.

**Results** Authors were not able to reproduce many of the results described in the rat. Its dimensions were extremely small in the light of a possible translation of results in humans. The rabbit was better suited, in respect, but still too small. The pig presents with a wide brachial plexus but its standardization is difficult in serial experiments, since its dimensions continue to vary with growth. The sheep was good as far as dimensions of the plexus are considered. The surgical access was easy because of the lack of the clavicle. In the unusual occurrence of a complete transection of all the roots, a difficulty ensues in regaining the erect stance.

**Discussion** The translation of results from the sheep to the human is feasible. More localized experimental lesions should be studied first, to avoid the limitation imposed to the animal in gaining the erect stance.

**Conclusions** Dimensions, reproducibility, easy surgical access, affordable costs are among the advantages of the sheep animal model in the study of artificial nerve regeneration in brachial plexus lesions.

#### Enthesis and enthesopathy: analysis of the observed ultrastructural differences in correlation to a different risk factor exposure

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**Introduction** The osteotendinous junction or enthesis is the anatomical structure that allows the tendons and ligaments to attach into the bone, transducing the action of muscle movement. The repetitive and tiring activities, especially in the presence of biological and personal determinants, according to many authors predispose to the onset of enthesopathy. The purpose of this study is to demonstrate a correlation between these risk factors and the detection of early anatomical and structural alterations in the enthesis of patients at risk.

**Methods** Samples from 30 patients were examined (19 M, 11 F). They underwent surgery for other pathologies (anterior cruciate ligament-plastic with patellar tendon or three compartment prosthesis of the knee). A questionnaire, designed to identify any exposure to risk factors (gender, age, smoking, diabetes, dyslipidemia, sports or strenuous work, previous trauma, peripheral vascular disease, prolonged steroid therapy and autoimmune disorders), was given. During the main surgical procedure, after obtaining informed consent, with a 3 mm Jamshidi needle, a portion of the patellar enthesis was sampled. The resulting sample was then divided into two equal parts, which were prepared for subsequent optical and electronic microscopy. Patients were classified according to the risk factors which were exposed, and the data thus obtained were examined through histological examination and statistical analysis, in order to interpret and validate the results.

**Results** Microscopic examination allowed us to observe the presence, in some subgroups of patients with some alterations comparable to those found in the course of enthesopathy: moderate thinning of the collagen fibres (those exposed to overload); increased vascularity and presence of granulation tissue (patients suffering from diabetes, autoimmune diseases or exposed to prolonged therapy with corticosteroids); accumulation of lipids in the extracellular matrix (dyslipidemia) and calcium (advanced age or previous trauma to the junction). Enthesis from the other patients were found to be undamaged.

**Discussion** The above alterations, observed during the structural examination, can be interpreted as an early alterations of the healthy enthesis. The patients had no clinical signs of enthesopathy at the time of collection. The microscopic and ultrastructural changes observed were then interpreted, according to the authors, as the early damage that intervenes during the pathogenetic mechanism of the enthesopathy.

**Conclusions** A recent review of the literature showed that this study in vivo is singular for the goals and the methodologies that authors employed and thus it may serve as a start point for further studies, if possible with larger number of samples tested and donor sites.

#### Evaluation of nanomechanical characteristics of regenerated bone tissue by implanting magnetic scaffolds

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**Introduction** Tissue regeneration with controlled three-dimensional architecture capable of reproducing biological and mechanical characteristics of native bone is a challenge of bone tissue engineering. Nanoindentation provides new assessments of the regenerated bone maturation. The aim of our study is the assessment of nanomechanical properties of newly formed bone tissue at 4 and 12 weeks from the magnetic scaffolds and NdFeB permanent magnet implantation in the lateral femoral condyle of rabbit.

**Methods** Two different scaffolds were implanted: MAG-MNP (hydroxyapatite/collagen 70/30 scaffolds with magnetic nanoparticles) and MAG (control group). Mechanical properties of newly formed bone tissue, either immature and mature, and native bone tissue were evaluated in both groups. Potential correlations between elastic modulus and hardness were examined also in relation to the state of maturation of regenerated bone tissue. On each sample multiple measurements at different isomagnetic lines

were performed to assess the effects of the magnetic field on bone regeneration.

**Results** Obtained results show that regenerated bone in group MAG-MNP presents mechanical properties more similar to native bone if compared to control group, already after 4 weeks from implantation.

**Discussion** Analysis of mechanical properties of elastic modulus and hardness, did not show a correlation between newly formed bone, either immature and mature, and native bone. On the other hand, a good linear correlation was found between mechanical properties of immature and mature newly formed bone.

**Conclusions** These results highlight the effectiveness of nanoindentation tests for the assessment of newly formed bone maturity, not evaluable through conventional analysis.

## Muscle tissue can be a predictor of the quality of bone tissue

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**Introduction** Systemic tissue aging is a multifactorial process associated with a natural decline of the physiological functions of the organism. The muscle tissue, in the course of time, undergoes considerable and constant changes that induce a progressive deterioration from a quality and quantity point of view. The resulting condition is the so called sarcopenia, considered as a gradual loss of mass, strength and muscle performance the progressively compromise the biomechanical stimulation on bone tissue with a consequent increased skeletal fragility. Osteoporosis would seem, therefore, closely linked to muscle deterioration.

**Methods** We selected, after the signature of an informed consent, 50 women (aged 50–90 years) who underwent surgery for total or partial hip arthroplasty for osteoarthritis (group A) or after fracture of the medial femur (group B). All patients underwent assessment of bone mineral density (BMD) by DEXA. We performed on all the patients a biopsy of the vastus lateralis muscle. From each biopsy were obtained two samples: one was analysed by MRI at 9.4 Tesla DTI (DTI-protocol with b-value = 400 and 700 s/mm<sup>2</sup>, using the imaging sequences PGSTE); the other was fixed, collected, processed and embedded in paraffin for histomorphometric evaluation.

**Results** Magnetic resonance imaging showed that the muscle tissue of subjects with osteoporosis is highly disorganized and muscle fibres are atrophic with a reduced rate of adipocyte infiltration. In group B, the MD is increased while the FA is reduced. The histomorphometry confirmed this finding. The slides scanned showed the disarray of the muscular component and the reduction of the area occupied by adipose tissue compared to muscle tissue in group B.

**Discussion** The comparative evaluation of muscle tissue in patients with osteoporosis and osteoarthritis showed that osteoporosis is strongly associated with global impairment of muscle tissue. In particular, the contractile portion is reduced: this affects negatively the bone quality, with an increased risk of fall and fracture. In addition, the proportion fat in osteoporotic patients is low compared to the osteoarthritic subjects, indicating the lack of the estrogenic fat action in post-menopausal.

**Conclusions** To fully understand the patho-physiological mechanisms involved in the genesis of musculoskeletal disorders is essential to plan intervention strategies taking into account the close relationship between muscle atrophy and osteoporosis. The development of new diagnostic models can promote an integrated planning of therapeutic strategies in order to reduce the risk of falling and skeletal disability.

## TUMORS (in collaboration with C.I.O.S.M.)

### ORAL COMMUNICATIONS

#### When neurovascular complications in multiple exostoses disease require a surgical solution

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**Introduction** Multiple exostoses disease (MED) is a variant of osteochondroma, a benign cartilaginous tumour, characterized by bony excrescences covered with hyaline cartilage. It represents 20–50 % of all benign lesions diagnosed in patients under 30 years. About 90 % develops in metaphyseal region of long bones, typically distal femur and proximal humerus but also in scapula, ribs and vertebral arch. MED is hereditary in 2/3 of cases, with incomplete penetrance and male/female ratio of 2:1. It's characterized by multiple and often symmetrical distribution, with frequent shortening of the limbs and/or axial deformity. **Methods** Authors present a series of 72 MEDs, observed from January 1983 to January 2013. Mean age was 19.5 years (range 9–30) with a confirmed male/female ratio of 2:1. Diagnosis was always histological, but a strong suspect derived from X-rays and CT scans. Surgery was carried out to avoid neurovascular complications. Some cases required a multidistrict approach and several stages for radical removal.

**Results** In our experience all patients presented multidistrict lesions at X-rays examination. Characteristic radiographic appearance of MEDs varied from pedunculated, with a thin pedunculus that usually extends in the opposite direction to the nearby physis, to broad based (sessile) lesion with a large base of implant and cortical bone infiltration. None of the patients treated had local recurrence, neurovascular deficit or functional impairment at last follow-up (at least 2 years).

**Discussion** In our case series MED always manifested as a bony excrescence, typically in paediatric age. It was clinically painless, with low volumetric increasing-rate, that sometimes caused vascular and/or neural problems. In most cases detection occurred accidentally, when patients performed X-ray examination of the affected district for other causes. In selected cases a CT-scan was performed to better investigate the base of implant. The great majority of patients had lesions at the knee, adjacent to vessels and nerves.

**Conclusions** MED requires a long-term follow-up, because the risk of malignant degeneration in chondrosarcoma. Surgery consist in a lesion al radical excision to avoid neurovascular complications, growth defects and functional impairment. Clinical results of our series at last follow-up were good.

#### Results of Mutars modular tumor prostheses: the experience of two centres

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**Introduction** Limb salvage with prosthetic reconstruction is the most frequent type of reconstruction after resection of bone tumour in the extremities because of its versatility, modularity, ease of use, immediate stability and low incidence of complications. However, the incidence of failures remains high compared to conventional arthroplasty. Aim of this study is to analyse the results of Mutars modular tumour prosthesis to assess incidence and types of failure, functional results and implant survival at long term follow-up.

**Methods** Between 2000 and 2013, 111 Mutars modular tumour prostheses were implanted: 38 upper limb and 73 lower limb reconstructions, 96 primary implants and 15 revision implants. Causes of endoprosthetic failure were classified according to Henderson et al. in five types. Functional results were analysed according to the MSTs system, Kaplan–Meier curves of implant survival defined comparing primaries and revisions.

**Results** At last follow-up, 73.9 % of patients (82/111) had retained their implant. The overall failure rate in our series was 26.1 % (29/111): 3 type 1 failures, 6 type 2 failures, 3 type 3 failures, 12 type 4 and 7 type 5 failures. The overall implant survival to all complications was 55 and 33 % at 5 and 10 years respectively with no significant difference between upper and lower limb ( $p = 0.22$ ) and between primary and revision implants ( $p = 0.69$ ). Functional results, assessed according to MSTs system, were evaluated in 81 of 111 patients, the average score was 23.4.

**Discussion** Indications for the use of modular prosthesis are well defined in orthopaedics oncology, while their possible use in non-oncologic patients is yet to be assessed carefully. Infection remains the most common complication.

**Conclusions** The most frequent cause of failure was infection, however long term survival and functional result were satisfactory.

### The extra-articular Tikhoff–Linberg shoulder resection: a Rizzoli Institute experience

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**Introduction** Aim of the study was to evaluate complications and functional results in patients with tumours around the shoulder girdle treated with extra-articular Tikhoff–Linberg (T-L) resection.

**Methods** Between 1985 and 2011, 51 patients were treated with Tikhoff–Linberg (T-L) resection: 32 males and 19 females, mean age of 45 years (15–84 years). Thirty-one tumours involved proximal humerus, 16 were in scapula and 4 in soft tissue surrounding shoulder. The diagnosis was chondrosarcoma in 19 cases, osteosarcoma in 15, solitary metastasis in 6, synovial sarcoma in 2 and other histotypes (angiosarcoma, chondroblastoma, fibrosarcoma, pleomorphic sarcoma, aggressive fibromatosis, lymphoma, liposarcoma, giant cell tumour, Ewing's sarcoma) in 1 each. According to the MSTs staging system, malignant lesions were in stage IIB in 39 cases and in stage III in 10 cases, while all benign lesions were in stage 3. T-L resection was performed in 14 cases as type IV, in 19 cases as type V and in 18 cases as type VI. Shoulder reconstruction was performed in all patients with a modular prosthesis anchored to the remaining clavicle (32 cases) or scapula (19 cases). Were analysed: (a) oncologic results with Kaplan–Meier curves; (b) complications, according to Henderson et al. classification; (c) functional result (MSTs system).

**Results** At a mean follow-up of 6 years (range 6 months–25 years), 19 patients were continuously disease free (NED), 4 were with no

evidence of disease after treatment of relapses and 28 were dead of disease (DWD). Overall survival was 44 and 39 % at 10 and 20 years respectively. Complications occurred in 31.4 % of patients at a mean time of 1.4 years. Complications were summarized according to Henderson et al. in: soft tissue failure (type 1 in 5 case), structural failure (type 3 in 3 cases), infection (type 4 in 1 case) and local recurrence (type 5 in 7 cases). Survival to all complication was 63 % at 10 and 20 years; survival to major complications (type 2, type 3 and type 4) was 86 % at 10 and 20 years. Functional results (MSTs system) were good or excellent in all cases: mean score was 25 (range 17–30).

**Discussion** The Tikhoff–Linberg resection is indicated in treatment of tumour around the shoulder girdle and provided reasonable function of the elbow and of the hand.

**Conclusions** The Tikhoff–Linberg procedure is an alternative to forequarter amputation for extended tumours of the shoulder girdle without neurovascular involvement. Oncologic and functional results were superior to forequarter amputation.

### Lower limb core scale: a new method to evaluate functional results in orthopaedic oncology reconstructive surgery

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**Introduction** Several methods have been developed to evaluate functional results after oncologic resection. They usually evaluate only oncologic patients and this represents a big limitation. We used the Lower Limb Core Scale (LLCS) to overcome this issue. The aim of this study is to evaluate the functional and the subjective results of the lower limb reconstruction using LLCS in orthopaedic oncology.

**Methods** A retrospective analysis of the patients who underwent surgery with tumour resection and subsequent reconstructive surgery at a national reference centre. The scores obtained with LLCS were compared with other functional tests (QoL, EQ-5D, EQ-VAS, SF-36v.2, MSTs, TESS). Statistical analysis performed: average, median, standard deviation, odd ratio,  $r$  correlation test.

**Results** Forty-four patients were enrolled in the study (22 males, mean age 54 years, range 16–93, 36 coverage flaps and 8 functional flaps). No demographic variable is related to the scores of the functional and quality of life (HRQoL) tests, except for the genre where males have better functional scores. The correlation between LLCS and the other tests is positive ( $r^2: 0.77$ ).

**Discussion** Reconstructive techniques are often the only solutions to obtain the limb salvage after an oncologic resection with adequate margins. The progress of the microsurgical reconstructive techniques permits a more rapid recovery with better functional results. LLCS test shows comparable results to other tests using only oncologic patients without any condition by the anatomical operated site.

**Conclusions** The scores related to the quality of life showed good results. The scores of the functional tests showed that LLCS test is a valid instrument for the general and specific evaluation of the reconstruction of the lower limb. LLCS test can be used for the evaluation of the post-oncologic reconstructions in the lower limb not considering the specific anatomical site. Further studies are necessary to confirm these results.



## Allograft reconstructions in upper limb: our considerations on 102 cases

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**Introduction** Since the beginning of orthopedic oncology, bone massive allograft (BMA) seemed to be effective as limb-salvage procedure both alone or in combination with prosthesis for restoration of bone stock and anatomical reconstruction of soft tissues. We reviewed our cases of allograft reconstruction in upper limb, in order to analyse outcome, complications and survival of allograft.

**Methods** A consecutive series of 102 allograft reconstruction in the upper limb from June 1996 to December 2013 was analysed: 52 osteoarticular allograft-OA (23 distal radius, 19 proximal/total humerus, 6 scapula, 4 hand reconstructions), 41 allograft prosthetic composites-APC (36 proximal humeral reconstruction, 4 elbow reconstruction, 1 scapula), 3 intercalary allograft alone and 6 intercalary allograft + vascularised fibular graft (8 humerus). Average age was 35 years (range 4–79). In 96 cases allograft reconstruction was used after tumour resection, while in 6 cases was used in revision surgery.

**Results** At an average follow-up of 62 months (range 2–175), we observed 14 allograft failures (14 %). Allograft survival at 5 years was 82 and 75 % at 10 years. The limb survival rate was 100 % at 5 and 10 years. Eleven patients (11 %) suffered an allograft fracture. Eight were surgically treated by allograft revision. We observed two infection (2 %), and all occurred in proximal humerus APC, treated conservatively in one case and with surgical revision in one case. There were 23 nonunions and allograft resorptions (22.5 %). Fifteen occurred in proximal humeral reconstruction, four in distal radius osteoarticular allograft, two in humeral intercalary allograft, one in intercalary allograft + vascularised fibular graft and one in elbow reconstruction. In eight OA occur articular deterioration. Four aseptic loosening of proximal humerus APC was observed.

**Discussion** Reconstructions of extensive loss of substance are always a complex problem and solutions designed to deal with change case by case. The use of bone massive allografts, possibly combined with vascularised fibular grafts or prosthetic implants, is often crucial. Failure in the long-term stability (fracture, resorption, non-union) was the prevalent problem in our series. Instead degeneration of articular bone and joint implants is undoubtedly better tolerated than lower limb. The use of allograft-prosthetic composite can be a valuable resource to further improve this aspect. Resurfacing or APC of the proximal humerus and OA allograft of distal radius seems to offer the best long-term results.

**Conclusions** Despite the high rate of possible complications, allograft reconstruction in upper limb represent a viable option for major reconstructions.

## Massive osteoarticular allograft reconstruction after bone tumor resection of the knee in paediatric patients

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**Introduction** Osteoarticular allografts represent a reconstructive option after bone tumour resection around the knee in growing children. The major advantage is the chance to preserve the growth plate of the remaining bone, but the disadvantage is the high failure rate eventually requiring definitive prosthetic replacement at skeletal maturity.

**Methods** We retrospectively reviewed 23 patients who underwent osteoarticular allograft reconstructions of the distal femur (16) or proximal tibia (7). There were 13 females and 10 males with an average age at surgery of 11 years (7–17). The diagnosis was osteosarcoma in 20 cases and Ewing sarcoma in 3. All patients underwent pre- and post-operative chemotherapy.

**Results** At an average follow-up of 97 months (12–167), 18 patients (78 %) were disease free, 1 was alive with disease, 3 were dead of disease and 1 of leukaemia. We observed 10 allograft failures requiring prosthetic replacement: 8 fractures (5 proximal tibia, 3 distal femur) and 2 articular degeneration (2 distal femur). At last follow-up 13 allografts (56 %) were still in place. Overall allograft survival was 74.3 % at five and 45 % at 10 years. In distal femur, allograft survival was 85.1 % at five and 63.8 % at 10 years. In proximal tibia, allograft survival was 51.4 % at 5 years and 25.7 % at 67 months. Average limb shortening was 3.5 cm (2–5) in 9 evaluable patients with the allograft still in place and 1.8 cm (0–4) in 10 patients after prosthetic replacement. Average MSTs functional score in 16 evaluable patients was 25 (11–29).

**Discussion** Reconstructions of knee joint in children can be performed using extending prostheses, massive osteoarticular allografts or allograft-prosthetic composite. Our experience confirms that osteoarticular allografts are a viable temporary reconstructive option of knee in children and can ensure the maintenance of the bone stock, useful in a subsequent definitive prosthesis.

**Conclusions** In conclusion, osteoarticular allograft reconstruction of the knee after bone tumour resection in paediatric age can be considered a temporary solution with the aim to limit limb length discrepancy. Proximal tibial allografts showed a higher failure rate than distal femur. Allograft-prosthesis composite might improve implant durability and reduce the risk of failure.

## Osteosarcoma of the sacrum: an analysis of 20 patients treated at Rizzoli Institute

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**Introduction** Specific experiences about treatment of sacral osteosarcomas have never been reported. Patients require systemic chemotherapy plus surgery when feasible. Objective of this study was to evaluate the role of surgical treatment in sacral osteosarcomas.

**Methods** We retrospectively reviewed 20 patients with sacral osteosarcoma treated in our institute (1985–2012). Six patients received surgery plus chemotherapy (wide margins in 5 cases, focally intralesional in one), 13 were treated with chemotherapy and in 6 cases radiotherapy was added. One patient refused hemipelvectomy and was treated with chemotherapy only. Four patients had metastases at diagnosis and the others had stage IIB osteosarcoma.

**Results** At a mean follow-up of 40 months 2 were continuously disease free (10 %), 2 alive with disease (10 %) and 16 died with disease (80 %). Overall survival was 25 % and 5 % at 5 and 10 years respectively. Three out of six patients who underwent surgery developed local recurrence at a mean of 2.4 years. Twelve patients developed metastases during follow-up. Overall survival of patients treated with chemotherapy plus/without surgery was not statistically significant. On univariate analysis, none of the followed factors influenced significantly survival: patients that complained of 3 months or less before initial presentation, osteoblastic subtype and age at presentation. Selection bias in treatment and the small number of cases may confound the result of analysis.

**Discussion** The findings of our study show that the survival of patients with osteosarcoma of the sacrum is not related to age, local treatment used, nor to the detection of metastases at diagnosis. The data do not allow to determine the actual efficacy of local radiotherapy and surgery.

**Conclusions** Our analysis confirms poor survival for patients with sacral osteosarcoma compared with other primary locations. Prognosis remained poor despite modern multimodality treatment regimens. Oncologic outcome of patients who underwent surgery is similar to that treated only with chemotherapy.

## Impact of margin status and local recurrence on soft-tissue sarcoma outcome

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**Introduction** Soft-tissue sarcomas are a very rare and heterogeneous group of malignant tumours and the clinical impact of surgical margins or local recurrence are still under discussion. Aim of our retrospective study was to evaluate the oncological outcome (local recurrence free and disease specific survival) in a selected group of adult patients with high grade soft tissue sarcomas of the extremities.

**Methods** We reviewed 389 adult patients treated in our hospital from 1990 to 2005; they were all affected by a primary localized high grade soft tissue sarcoma of the extremities. Distinctive histotype such as angiosarcomas, epithelioid sarcomas, rhabdomyosarcomas, cellular sarcoma and alveolar sarcoma were excluded. The mean age was 55 years (range 16–89) with a median follow-up of 8 years (range from 3 months to 19 years). In 94 % of the cases the tumours were

deeply seated. Surgical excision was performed in all patients and wide margins were obtained in 77 % of extremities sited sarcomas and in 66 % of girdle sited sarcomas. Radiotherapy was administered in 76 % of the patients and chemotherapy in 41 %.

**Results** Disease specific survival was 69 % after 5 years (CI 64–73 %) and 60 % after 10 years (CI 55–65 %). Local recurrence free survival was 78 % after 5 years (CI 74–83 %) and 75 % after 10 years (CI 70–80 %). Relapse rate (local recurrence, LR, or distant metastases, DM) was 44 %; LR occurred in 39 % of the patients, DM in 41 % and LR + DM in 20 %. Ten-years post-relapse survival was 53 % (CI 40–67 %), 24 % (CI 11–35 %) and 15 % (CI 5–29 %) for patients with LR, DM and LR + DM respectively. Negative prognostic factors for disease specific survival were tumours size >10 cm ( $p = 0.0001$ ), girdle sited tumours ( $p = 0.0019$ ) and local recurrence ( $p = 0.0007$ ). Adequate margins showed to be a protective prognostic factors on local recurrence ( $p = 0.0267$ ). The use of radiotherapy did not influence survival rate ( $p = 0.5960$ ) but increased local control in case of inadequate margins ( $p = 0.0506$ ).

**Discussion** Adequate margins showed to be a protective prognostic factors on local recurrence ( $p = 0.0267$ ). The use of radiotherapy did not influence survival rate ( $p = 0.5960$ ) but increased local control in case of inadequate margins ( $p = 0.0506$ ). Disease specific survival is negatively influenced by large sarcomas (>10 cm) of the girdles and in case of local recurrence.

**Conclusions** Adequate surgical margins improve local control on soft-tissue sarcomas. Radiotherapy does not seem to influence disease specific survival but improves local control. Pattern of relapse influences post-relapse free survival with poor prognosis in patients with distant metastases.

## Prosthetic reconstruction for the osteosarcoma of the extremities: the Rizzoli Institute experience

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**Introduction** Aims of this study were to retrospectively analyse results of a modular reconstructive tumour prosthesis for the upper and lower limb after resection of osteosarcoma of the extremities.

**Methods** Between 2000 and 2010, 266 modular prostheses were implanted: 43 in the upper limb and 223 in the lower limb. Sites were: distal femur (154), proximal tibia (50), proximal femur (10), total femur (6), extra-articular knee resection (3), proximal humerus (40) and distal humerus (3). Most frequent prostheses used were: 111 GMRS, 94 HMRS, 33 MRS. Functional results were assessed with MSTs system and implants survival were analysed with Kaplan–Meier curves, comparing primary and revision implants.

**Results** At a mean oncologic follow up of 4.6 years (range 2–10 years), 141 patients were continuously NED, 58 NED after treatment of relapse, 3 AWD, 64 DWD. Local recurrence occurred in 5.6 % of cases. The overall survival of patients with osteosarcoma was 70 % at 10 years. Major complication occurred in 17 % (45/266) of cases at a mean of 2.4 years. Infection occurred in 10 % of cases (27/266), all in lower limb reconstruction. Aseptic loosening occurred in 6.7 % of cases (18/266): 4 in the upper limb and 14 in the lower limb. Implant survival to all major complication was 81 % at 5 years and 69 % at 10 years with no significant difference between upper and lower limb ( $p = 0.155$ ). Breakage of prosthetic components did never occur. The mean

MSTS scores for upper limb reconstruction was 23.8 and for the lower limb was 25.1.

**Discussion** After resection for sarcoma of the limbs, reconstruction with modular prostheses is the reconstructive option most widely used because of its versatility, modularity, ease of use, immediate stability and low incidence of complications.

**Conclusions** Survival of patients with osteosarcoma of the extremities was good. Reconstruction with modular prostheses after resection of osteosarcoma in upper and lower limb showed satisfactory functional results and relatively low rate of complication.

### Juvenile solitary bone cyst of the femur and the proximal humerus: personal series and treatment evolution over the last 30 years

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**Introduction** Over the past few decades the treatment of juvenile bone cyst has undergone a significant evolution, which has seen an increasing trend to limit the invasiveness for the patient. In the last decade, the introduction of growth factors and stem cells obtained by bone marrow aspiration or preparation of PRP, have given a further contribution to the treatment of these lesions which, if untreated, may lead to complications not negligible.

**Methods** From 1980 to 2013, 137 patients (81 M and 56 F) came to our observation. They were aged between 8 and 25 years and they presented with simple bone cysts in the meta-epiphyseal region of the proximal humerus and femur. The treatment chosen was: in 91 patients, infiltration of methylprednisolone (repeated 3–6 times after 4 months); in 23 patients, infiltrative cortisone cycle followed by 3 cycles of infiltrative growth factors and stem cells from bone marrow aspirate; in 23 patients, infiltration of PRP.

**Results** Of the 137 patients treated, 91 healed after infiltration with cortisone; 23, by failing to respond to treatment with cortisone infiltration, underwent bone marrow aspiration and subsequent infiltration (up to three times in 18 months); in the remaining cases, the infiltration of PRP was used as first level adjuvant technique. In seven of these cases, it was necessary to repeat the treatment. All cases recovered.

**Discussion** It is known that juvenile bone cysts, after pathologic fracture, can obtain varying percentages of recovery (15–80 %), and treatment with curettage and bone grafting, as well as being particularly invasive, is subject to a variable rate of recurrence (33–40 %) and that the subtotal resection presents a discrete index of recurrence (5–8 %). The infiltration of intracystic methylprednisolone acetate, however, in addition of being minimally invasive, shows high percentage of recovery (up to 90 %). Finally, therapy with growth factors and stem cells is an additional weapon for the orthopaedic surgeon, whose effectiveness needs to be quantified and scientifically validated.

**Conclusions** The analysis of the authors' series, in accordance with the international literature, conclude that the technique proposed by

Scaglietti still represents the gold standard of therapy, although the most innovative infiltration with growth factors and stem cells bone marrow will lead to even better results when carried out according to the scientific criteria.

### Allograft prosthesis composite versus conventional megaprotheses for reconstruction of proximal tibia: bias, sureness, and long term results

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**Introduction** After bone tumour resection of the proximal tibia, allograft prosthesis composite (APC) are introduced to obtain biologic tendinous reattachment (with functional improvement of patellar tendon), and better bone stock (with homogeneous distribution of mechanical load and stress torque), compared to conventional megaprotheses (CMP). We analysed our experience focusing on complications rate and functional results of both techniques.

**Methods** From January 2001 to January 2013 we reconstructed the proximal tibia in 41 cases. In all patients we used the modular lower limb Megasystem C Link. A CMP was employed in 23 patients, an APC in 18. A cemented stem was employed in 8/23 (35 %) of CMP and in 4/18 (22 %) of APC; a rotational flap of medial gastrocnemius was utilized for coverage and reinforcement of extensor apparatus in 23 cases (54 %). Adjuvant radiotherapy was used in 4/23 (17 %) of CMP group and in 1/18 (5 %) of APC group.

**Results** At an average follow-up of 60 months, 9/41 (22 %) failures occurred, classified according to Henderson classification (JBJS 2011). Type 1 soft tissue failure occurred in 2 (9 %) of CMP group and in 1 (6 %) of APC group; in 4 more CMP patients we observed a mobilization of the plate used to fix the patellar tendon, but function of the extensor apparatus was not compromised; we considered this type of event as a minor complication and not a failure. Type 4 infection failure occurred in 3 (13 %) of CMP group and in 1 (6 %) of APC, while type 5 local recurrences failure occurred in 1 of both groups (4 and 6 %). The overall survival rate of implants was 80 % after 10-years follow-up.

**Discussion** Current reconstructive possibilities of proximal tibia (simple or composite prosthesis) show to be effective in medium-long term. Failure of reconstruction is mainly relate to the extensor mechanism for septic complication or mechanical failure. The lower infection rate of APC seems to be due to use of antibiotic-loaded cement into the allograft, and better soft tissue reattachment to the allograft surface, preventing biofilm formation. Rotational gastrocnemius flap seems to minimize the differences between both reconstructions.

**Conclusions** Both CMP and APC appear to be satisfactory reconstructive options of proximal tibia massive bone defects, with lower complications in APC. APC finds preferential indication in patients with more functional request (i.e. young) and in those who do not need radiotherapy.

## Extraskelatal osteosarcoma: a review of 10 patients treated with multimodal therapy

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**Introduction** Extraskelatal osteosarcoma is a rare high grade soft tissue neoplasm and a more aggressive biologic behaviour than classic osteosarcoma has been reported. In this study we analysed the clinical outcome of our series of patients treated with different associations of surgery, chemotherapy and radiation therapy.

**Methods** We analysed 10 patients affected by extraskelatal osteosarcoma treated from 1998 to 2013. They were 8 males and 2 females with a mean age at diagnosis of 51 years (18–82). The lower limb was involved in 6 cases and upper limb in 4. All patients but one were treated by limb sparing surgery. Surgical margins were wide in 5 patients and marginal in 5. One patient received only surgery. One patient received surgery and adjuvant RT. Eight patients received surgery + CT (2 pre-operative and 6 post-operative) + RT (2 pre-operative and 6 post-operative). In 3 cases brachytherapy was employed. Chemotherapy was done with Epirubicin and Ifosfamide for 3–5 cycles.

**Results** At an average follow-up of 44 months (3–170), 4 patients were continuously disease free, 2 had no evidence of disease after treatment of local relapse, 1 was alive with disease, 1 was dead of disease and 2 dead of another cause. Local recurrence occurred in 2 cases treated by new excisions. Two cases developed metastases. No surgical complications was observed.

**Discussion** In our experience extraskelatal osteosarcoma affected an adult population and adequate surgical margins could be achieved in 50 % of cases.

**Conclusions** In conclusion, multimodal treatment combining surgery, radiation therapy and chemotherapy showed a low morbidity allowing disease control in half of the patients.

## 20-year experience with stem fixation in pre-pubertal children with distal femur mega-prostheses. Cemented or press-fit?

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**Introduction** Megaprotheses after distal femur resection in sarcoma patients became popular in the 1980s. Stem fixation is achieved by cemented or uncemented stems but scarce data have been produced about this issue in paediatric patients. The authors review their 20-year experience in pre-pubertal children using both uncemented or cemented stems.

**Methods** Radiographic evolution of femoral stems in 88 children below 13 years of age (range 5–12), with sarcomas of the distal femur, that had a megaprosthesis implanted in the period 1984–2013 was analysed. Uncemented stems were used in 53 patients (median

age 11) with modular implants: three designs were used along the period. Cemented custom-made stems were implanted in 32 children (median age 8) with different custom-made megaprotheses: in 25 cases the canal was over-reamed with a complete mantle of cement all around the stem, in 7 cases a polished stem with HA collar was inserted with minimal reaming and cementation. In 3 children the femur was short and a segment of femur allograft was used to elongate the canal in a composite fashion. Diaphyseal remodelling around the stem was evaluated during follow-up modifying the Capanna system for KMFTR implants.

**Results** Intense cortical atrophy with bone lysis became evident in 46 uncemented stem (86 %) and in 21 heavily cemented stem (84 %) while no atrophic changes appeared in the minimally cemented cases with no loosening and excellent clinical results.

**Discussion** The cementation of the femoral stems may affect the transmission of loads and the phenomena of stress-shielding in patients who are subjected to resection of the distal femur for oncological diseases, especially if they are in the period of skeletal growth.

**Conclusions** Minimally cemented stem seems to allow better stress transmission to cortex in young children preserving the bone stock and minimizing the loosening.

## Psychosocial care during follow-up of musculoskeletal tumor patients

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**Introduction** In survivors even many years after the end of active treatments were detected a high prevalence of psychosocial problems and educational needs. These aspects are often not recognized and treated with appropriate specialized interventions. This gap has both impact on clinical outcomes and quality of life and on an adequate recovery of life after cancer. The integration of psychosocial care within care plans for follow-up is needed. Psychosocial care should include: the treatment of psychological distress, the promotion of healthy lifestyles and the management of the symptoms shared by the survivors which may benefit from evidence-based psychosocial interventions. In sarcomas ambulatory psychologist is integrated with the oncologist and the orthopaedic surgeon in the same setting of care in order to ensure psychosocial care to patients in follow-up.

**Methods** The psychological counselling, the EORTC-QLQ-C30 questionnaire for quality of life assessment and distress thermometer (DT) for psychological distress evaluation have been proposed to all ambulatory patients. The present study investigates 130 patients (64 males and 66 females, range 15–79 years) who have performed more than a psychological evaluation.

**Results** In the revaluations during the follow-up patients show high levels of psychological well-being and quality of life and low levels of psychological distress. In particular, there was an improvement in the general health, role, emotional and social functioning scales and a stability in global quality of life and physical functioning scales. The DT shows levels of distress below the cut-off.

**Discussion** The DT shows levels of distress below the cut-off.

**Conclusions** The preliminary results of this study show that the psychosocial intervention in patients during follow-up improves psychological distress and quality of life.