

## IN-DEPTH ORAL PRESENTATIONS

### MINIMALLY INVASIVE TREATMENT FOR THE KNEE

#### MIS in total knee arthroplasty with a modular implant in 345 controlled cases

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**Introduction** Minimally invasive techniques are now a well established reality in total knee arthroplasty. Together with the creation of new instruments, the development of these techniques showed the need for new prostheses, easier to implant through small incisions: the solution was found in modularity. Since 2005 a modular tibial implant (Mini Keel, Zimmer Warsaw, Indiana) specifically designed for MIS techniques in total knee arthroplasty has been used in our institution.

**Material and methods** We evaluated prospectively 345 implants in 320 patients (25 bilateral). 200 patients were women, 120 men. The mean age at time of surgery was 68.3 years. Patients were followed with clinical and radiographic evaluation at 3–6–12 months from surgery and then each year. On the tibial side a Mini-Keel modular implant with a 45 mm drop down was used in all cases, and on the femoral side a Nex Gen (Zimmer Warsaw, Indiana) LPS or CR implant was used. Clinical evaluation was assessed with the HSS and KSS scores. KSS system was assessed for radiographic evaluation at each control. A CT scan study to evaluate cement penetration and component positioning was assessed in 30 cases.

**Results** Patients were followed-up for a mean of 2.5 years (1–4). Mean HSS at last follow-up was 95.6 (86–100). The KSS showed a mean of 95.8 (83–100) on the “knee score” and of 94.7 (81–100) on the “functional score”. On the radiographical side, CT scan showed a mean cement volume of 10.03 cm<sup>3</sup> (6.99–14.4): the measure proportionally correlates with the size of the prosthesis implanted but does not with the bone density. Cement distribution was higher posteriorly around the tibial stem and anteriorly beneath the tibial plate. The mean extra rotation of the femoral component was 3.6° (3–5). On standard X-rays mean  $\beta$  angle was 89.8° (89–91), mean  $\sigma$  angle was 84.4° (83–87) on the tibia side. Considering the femoral component positioning the mean  $\alpha$  angle was 94.3° and the  $\gamma$  angle was 5.1°. No modification of these measures, radiolucencies, radiological or clinical evidence of early loosening were found at last follow-up. 6 implants underwent revision: 3 for malpositioning (2 of the tibial implant 1 of the femoral implant), 2 for infection, 1 for a periprosthetic fracture.

**Conclusions** According to our data minimally invasive procedures performed with this modular tibial implant in total knee arthroplasty

revealed to be reliable in terms of implant accuracy and stability presenting good clinical and radiographic results at a short/mid-term follow-up. The modularity of the implant did not show any particular issue. Long term results are needed for a reliable comparison with traditional techniques and implants.

#### Suggested readings

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2. Tria AJ Jr (2003) Advancements in minimally invasive total knee arthroplasty. *Orthopedics* 26:s859
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#### Minimally invasive surgery total knee arthroplasty: pros and cons

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The topic of “MIS” (minimally invasive surgery) continues to be a polarized and debated topic in total knee arthroplasty. Patient information continue to drive the market pressure to “MIS”. Is nowadays a common opinion that approach to total knee arthroplasty must be minimally “intrusive” in terms of soft tissue respect rather than minimally invasive in terms of skin incision. It is possible to properly perform a total knee arthroplasty without extensively disrupting the quadriceps, not everting the patella, not repeatedly hyperflexing the knee, not severely damaging the suprapatellar pouch. Muscle sparing techniques, such as subvastus approaches, are desirable regardless incision length. Contemporarily, the procedure should not be overly complicated so as to compromise the excellent long-term results that can be obtained with total knee replacement performed with traditional techniques.

The advantages of MIS total knee arthroplasty should be less post-surgical pain, reduction of blood loss, faster rehabilitation and better cosmesis. Although these benefits, there are postoperative complications and disadvantages: more tourniquet time, occurrence of femoral condylar fracture and patellar tendon disruption, higher incidence of varus tibial components. Counter indication for MIS are inflammatory arthritis, restricted flexion (<80°), patella baja, morbid obesity, risk of ischemic skin complications, very severe deformities (varus or valgus malalignment >20°, flexion contracture >15°) and large muscular males.

Optimization of this kind of approach, coupled with computer navigation, improved anesthetic techniques, pain management and rehabilitation efforts combine to assure overall outcomes with accelerated return to function without affecting the excellent long-term results of total knee arthroplasty.

## Minimally invasive Oxford III in the treatment of medial osteoarthritis of the knee: mid- and long-term results

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**Objective** Introduced in September 1999, the unicompartmental Oxford III prosthesis is a further development of the phase I and II device with a fully congruent mobile meniscus bearing. The dedicated instrumentarium permits implantation by minimally invasive procedures. The minimally invasive technique has the advantage that joint function is rapidly recovered, with shorter rehabilitation time, fewer complications and lower costs. In our study we wanted to verify if our experience was in line with data reported in literature [1].

**Material and methods** From March 2001 to December 2008, 97 patients treated at the Orthopaedics and Traumatology Department of the Bolognini Hospital, Seriata (BG), for medial gonarthrosis of various severities received an Oxford III unicompartmental prosthesis. We made a long-term follow-up (1st group, from March 2001 to December 2003): 31 patients, 19 f and 12 m, 2 with bilateral implants. In this group 10 patients were younger than 65 years. We also made a mid-term follow-up (2nd group, from January 2004 to December 2006): 42 patients, 19 f and 23 m, 2 with bilateral implants. In this group 14 patients were younger than 65 years. All patients had been reviewed using HSS Knee Score. Radiographic evaluation was based on Jenny criteria (correct positioning) [2].

**Results** The long- and mid-term results were in line with the positive outcomes reported in literature. On average, recovery of joint function and self-sufficiency were attained by the fourth postoperative day. Postoperative evaluation as measured by the HSS Knee Score in the 1st group was good to excellent, with a preoperative score of 56 versus a postoperative score of 93. In the second group was good to excellent, with a preoperative score of 52 versus a postoperative score of 95. Hypercorrection occurred in 1 case; the prosthesis was removed in 1 patient due to sepsis complications.

**Conclusions** We did not find any significant clinical differences into the 2 groups, in disagreement with some authors results (more revision implants in younger patients, <60 years, rather than older ones, >60 years) [3]. Goodness of outcomes in both groups of patients confirms validity of biomechanical property of the Oxford III implant and the restored ligamentous functionality, specially for LCA. The minimally invasive technique did not diminish the precision of implant positioning in 86% of cases. The results showed that, when correctly indicated, the Oxford III prosthesis is the treatment of choice in patients with medial gonarthrosis.

### References

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## HIP SURGERY 1

### Minimally invasive surgery in hip prosthesis

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Minimally invasive surgery (MIS) in hip replacement has been gaining popularity over the past few years. Potential advantages of MIS include minimized soft-tissue trauma and thereby less operative blood loss as well as postoperative pain, resulting in a faster rehabilitation with reduced hospital stay. These advantages can be obtained using different surgical approaches such as postero-lateral, direct lateral or anterior approach. The latter is the only one that provides complete preservation of muscular integrity leading to better clinical outcomes during the first 3 months after surgery. This result has been confirmed by a gait analysis study.

Although soft tissue sparing is beneficial for clinical outcome preserving bone stock is even more important particularly for young and active patients. Improvements in implant's design and tribologic quality especially for metal-on-metal bearings have enabled a second generation of hip resurfacing techniques. Compared with a conventional hip prosthesis, this type of arthroplasty has many advantages: sparing femoral and acetabular bone stock, preservation of hip joint biomechanics (femoral offset, leg length), better recovery for high-impact sports activities, easier femoral revision, less risk of dislocation, less risk of extension to the shaft in the event of osteolysis [1].

Hip resurfacing can thus be considered as true “minimally invasive bone surgery”. There are however specific complications of resurfacing, including femoral neck fracture and avascular necrosis of the femoral head. All of the conventional approaches can be used for hip resurfacing procedures, but a precise operative technique is mandatory. Nevertheless, the key to success remains a proper position of the femoral component. Certain biomechanical rules for implantation are required in order to limit the cam effect, spare femoral bone, and maintain physiological loading. Hip resurfacing can be indicated for young and/or active subjects for whom restoration of hip biomechanics offers a real advantage over conventional total hip arthroplasty [2].

We reviewed the outcome of the first 113 consecutive Hip Resurfacings of our series. All patients were followed-up clinically and radiologically. The mean follow-up was 70 months (60–101). Revision of either component was defined as failure. There were four failures giving a survival at 5 years of 96.4%. Morphological and histological analysis of the four retrieval specimens was performed. These good medium-term results confirm the positive data from other independent centers [3].

The implantation of hip resurfacing through anterior approach represents the goal of minimally invasive surgery combining bone stock preservation and an almost complete soft tissue sparing.

### References

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2. Pollard TCB, Baker RP, Eastaugh-Waring SJ, Bannister GC (2006) Treatment of the young active patients with osteoarthritis of the hip. A five to seven year comparison of hybrid total hip arthroplasty and metal-on-metal resurfacing. *J Bone Joint Surg* 88(B):592–600
3. Hing CB, Back DL, Bailey M (2007) The results of primary Birmingham hip resurfacings at a mean of five years: an independent review of the first 230 hips. *J Bone Joint Surg* 89(B):1431–1438

## Minimally invasive posterior approach in the treatment of the posterior wall fractures of the acetabulum

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**Objective** In recent years, orthopaedic surgery has focused on ways to minimize the surgical approach and to reduce the damage caused by invasive surgery. Such approaches have proved so successful in joint replacement, that they are being employed in fracture treatment too. The classic Kocher–Langenbeck posterior approach provides access to the posterior wall and posterior column of the acetabulum. Many studies have shown that the incidence of heterotopic ossification is greater in acetabular fracture surgery. This fact has been attributed to surgical extended approaches. Our approach can be thought as the distal part of the typical Kocher–Langenbeck approach (about 12–18 cm). The purpose of this study is to report the advantages of a less invasive surgical approach in this kind of surgery, which gives the same results in terms of fracture healing as a more invasive surgery.

**Material and methods** Between 2004 and 2006 we treated 19 patients affected by a posterior wall fracture or a transverse fracture, most of which were male. The fractures were classified according to Letournel classification. All surgical procedures were performed by the first Author. The age of the patients ranged between 22 and 64 years. The most common cause of the trauma was car accident (82%); 15 patients presented hip dislocation which requires immediate reduction. These patients were studied with pre-operative X-rays and CT scan with 3D reconstruction for a better planning of the surgery. X-ray series includes AP view, iliac oblique view and obturator oblique view (Judet view). The clinical evaluation was based on the schemes of Merle d'Aubigne and Postel scoring, 11 which has been modified by Matta.

**Results** The postoperative reduction was classified as anatomical reduction in all cases. The quality of the reduction was associated with the fracture type, ninety per cent (90%) was a simple fractures type that was reduced anatomically, in three cases we had a transverse fractures. No intra-articular screws were positioned. Clinical outcomes, according to Merle d'Aubigne and Postel, were 13 (68%) patients classified as excellent, 4 (22%) very good and 2 (10%) good. At the latest follow-up X-rays were used for radiological grading according to the criteria developed by Matta. The results were excellent in 13 (68%), good in 6 (32%). Ectopic bone was either absent or slight in 15 cases (Brooker's grade 1), moderate was present (Brooker's grade 3) in one patient with head trauma and burns, without limiting of motion. Only in one case of our series postoperative peroneal-nerve palsy occurred.

**Conclusions** The correlation between extended approaches and heterotopic ossification is well known in literature. Less invasive approach allowed to avoid the denervation of the gluteus muscles and therefore to have a better trophism in the post-operative period. This is also obtained because the gluteus maximus split is reduced compared with typical Kocher–Langenbeck approach. In fact a reduced muscular split gives a better hip abduction, as demonstrated by Dickson and Matta. During the surgery we observed a decrease of blood loss due to a less invasive approach.

### References

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## Minimally invasive hip replacement and blood loss

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**Objective** The aim of this study is to evaluate postoperative blood loss and transfusions after standard and minimally invasive hip replacement.

**Material and methods** The patients received an uncemented total hip arthroplasty. Standard and minimally invasive posterior surgical approaches were used in 2 groups in regional anaesthesia. Exclusion criteria were preoperative anaemia (Hb < 12 g/dL), coagulation disease, hepatopathy, previous hip surgery and not-weight bearing indication after operation. All patients had the same post-operative (PO) management including analgesia, prevention of DVT, immediate muscle exercises and physiotherapy. Vital parameters, haemoglobin (Hb) value before surgery and for 5 days PO, number of transfusions, leg circumference and adverse events were registered.

**Results** 108 cases were included in the study, 54 minimally invasive and 54 standard. Rather than simple unit measures, we analyzed the percent change in Hb from preoperative levels (%CHb). Minimally invasive had a mean %CHb of 19.12% at 1 day PO and 25.6% at 5 day PO, standard had a mean 23.06% at 1 day PO and 29.45% at 5 day PO. The incidence of transfusions (limit was set at Hb < 8 g/dL) were related to the preoperative Hb and the age. The transfusion incidence for minimally invasive was 9% and 15% for standard. Minimally invasive group had a reduction of leg swelling and post-operative pain.

**Discussion** In prosthetic hip surgery the reduction of blood loss increase functional recovery, aid the safety and the quality of the surgery. Minimally invasive surgery provides reduction of blood loss and pain.

**Conclusions** The minimally invasive surgery has great expectations and needs further development.

### Suggested readings

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## Minimally invasive total hip replacement via anterior approach

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Minimally invasive joint arthroplasties have gained in popularity in the last decade for multiple reasons. The basic premise of minimizing soft tissue disruption would be best met by going through intermuscular and internervous planes to do the procedure. In hip replacement, the direct anterior approach to the hip is the only approach with these

features. Direct anterior approach aims at reducing soft-tissue damage, diminishing blood loss and postoperative pain, shortening stay in hospital, accelerating rehabilitation, and keeping scars small. The technique is suitable for primary and secondary osteoarthritis as well as fractures of the femoral neck. Complex malalignment of the proximal femur should be exempted as well as severe dysplasia with hip dislocation. Morbid obesity (body mass index [BMI] > 30 kg/m<sup>2</sup>) can be a relative contraindication during the learning curve. Cemented and cementless implants with straight and anatomical femoral stems may be used. This method is a safe procedure, which allows correct placement of cup and stem. It may be performed in a reasonable time, preserves the muscles and blood loss is minimal. The patients are allowed to walk full weight bearing beginning on the first postoperative day, rehabilitation is accelerated. Usually patients do not suffer from pronounced pain. They therefore accept a short postoperative stay in hospital.

## HIP SURGERY 2

### Periprosthetic fractures of the femur after hip arthroplasty: revision of the stem

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Periprosthetic femoral fractures after hip replacement (HA) represent a difficult treatment challenge and often is associated with an high incidence of complications and failures. The true incidence of these fractures is uncertain ranging from 0.1 to 2.1%. With the increasing prevalence of HA and revision HA, along with an aging population, the number of these fractures can be expected to increase.

Risk factors can be general, such as osteoporosis, or more localized such as osteolysis or iatrogenic cortical defects. Not rarely stem loosening is associated. This combination can lead to a fracture with minimal trauma.

The aims of treatment should be a united fracture in anatomic alignment with a stable prosthesis.

Treatment principles depend on the localization of the fracture in relation to the femoral component, stability of the stem, quality and quantity of the bone host, age and medical comorbidities as well as surgeon's preference and experience. Vancouver classification is the most used classification system for these fractures and aids in the decision making process.

Fractures around the stem with loose implants and adequate bone stock (B2) need to be revised. In loose implants with inadequate bone stock (B3) specialized implants and technique are necessary as well as some form of bone grafting. Dislocation of the existing stem, cement removal, reaming of the femoral canal and final insertion of the implant are all potentially hazardous.

It is important to obtain adequate surgical exposure, which may involve a trochanteric osteotomy and sometimes transfemoral Wagner approach. Many surgeons suggest the use of long-stem cemented revisions. More recently, the use of uncemented prosthesis has been favoured because cement may interpose between the fracture fragments and inhibit union. Uncemented, proximally porous-coated implants have been used but this type of implant may not be stable in the femur in cases of poor proximal bone stock.

Alternatively, revision with a long cementless stem, fixed distally with porous-coating, provides both implant stabilisation and fracture

fixation. Distal fixation has also been achieved with good results using grooved or slotted long-stems like the Wagner system.

Distally locked stems have recently used, but there is little objective data on the outcome of these devices.

In these cases that need stem revision adequate reaming is essential and it is preferable to over-ream rather than to risk fracture during the insertion of press fit stems. It may be useful to strengthen the femur prophylactically with a bone clamp or using circlage wires.

### Periprosthetic femur fractures treated with revision stem

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**Background** Periprosthetic fractures around hip prostheses are difficult problems, moreover when associated with proximal femoral bone loss. They are increasing in frequency and complexity.

**Methods** We reviewed the results of treatment with Wagner and Permedica modular revision stems in geriatric patients (≥65 years old) with Vancouver type B2 and B3 periprosthetic fractures. Over a 5-year period, 16 patients with Vancouver's type B2 and type B3 periprosthetic fractures in the proximal femur were revised. The mean follow-up for these patients was 30 months (range 8–59 months). Eleven patients were available for the clinical assessment performed with Harris hip score, one died and the others 4 were not available.

**Results** 10 reconstructions showed a stable prosthesis and solid fracture union. 3 patients had excellent outcome, 7 had a good outcome, and 1 had a poor outcome because he was not able to walk and he felt pain. The mean Harris hip score was 49 (20–96) points at follow-up. Moderate limping was present in 1 patient, severe limping in two patients, while 2 patients were not able to walk (one with preexisting disability). There was no loosening or subsidence. Osteolysis seen at revision had diminished at follow-up. We noted a large reduction in bone mineral density

**Conclusions** Our series shows that the Wagner and the Permedica modular revision stems are a satisfactory prosthesis in revision of Vancouver type B2 and B3 periprosthetic fractures in geriatric patients.

## TRAUMATOLOGY

### Closed treatment of articular fractures, with external fixators

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**Introduction** The use of external fixators for the treatment of articular fractures is a conservative technique and an alternative when the open reduction is contraindicated. We can perform the treatment jumping the articulation, distracting the articular components throwing capsule and ligaments, using the techniques of arthrodiastasis and ligamentotaxis, or doing a least synthesis to mend the articular surface and later to put the fixator as if it dealt with a non articular injury.

**Material and methods** We have treated 31 cases of articular fractures of superior and inferior limbs. The affected articulations treated were: distal extreme of radio ( $n = 12$ ), supracondylar and intercondylar elbow fracture ( $n = 1$ ), supracondylar and intercondylar femur ( $n = 5$ ), tibial plateau ( $n = 2$ ), Plafond ( $n = 12$ ). The treatment of the articular fractures through external fixators jumping the articulation is based on:

*Arthrodiastasis*, a technique for distracting joint surfaces whilst maintaining joint mobility, in order to create a space between bony surface with preservation of joint function;

*Ligamentolysis*, the principle of this technique is the reduction of an articular fracture through the traction practiced for the capsule and the ligaments.

**Discussion** The terms of consolidation have been varying between those that consolidated in a short period of time distal radius lesions with an average of 54 days and the supracondylars of femur which were consolidated in a longer period of time roughly 123 days. The complications that we found were not meaningful: 3 wrist fractures exposed the mobility of distal radius articulation decreasing by 10 percent, in 2 cases of ankle, the inflammation persisted for some months improving with rehabilitation. We have observed loosening of the distal pins (talar and os calcis) in all cases of fractures of the tibial plafond. In the remaining cases alteration of the rank of mobility was not observed, inclusive in cases of supracondylar fracture of femurs that, contrarily to what is usually observed, recovered the mobility of the knee.

**Conclusions** Use of external fixators for the treatment of the articular fractures is a conservative and alternative technique to be used when the open reduction is contraindicated. It jumps the articulation, improves the load and precocious mobilization, and it succeeds in the formation of cartilage and levels irregularity and avoiding undesirable rigidity.

## LONG BONES

### Percutaneous reduction and fixation for the treatment of proximal humeral fractures using pins augmented with external fixator: a biomechanical study

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**Objective** Treatment of proximal humeral fractures with closed reduction and percutaneous pin fixation minimizes soft tissue stripping and damage of the vasculature of the humeral head. Several different pin types and configurations have been employed, but we still do not know which confers the greatest stability. We hypothesized that using fully threaded pins with the addition of an external fixator would give us the most stable construct.

**Material and methods** A 2-part proximal humeral fracture was created in epoxy composite humeri and fixed with four different modalities: 4 parallel distal to proximal pins (Box), 2 distal to proximal and 2 proximal to distal pins (Updown), 4 convergent pins (Shanghai Bridge), and a locking plate. The pin constructs used either 2.5 mm terminally threaded pins, 3 mm fully threaded pins, or 3-mm pins with the addition of an external fixator. The constructs were tested at 20 degrees of abduction with cyclical torsion (100 cycles, 2 Nm) and compression (1000 cycles, 1000 N), and ultimate load to failure in compression.

**Results** *Torsional stiffness*, the plate shown the greatest stiffness compared to all pins configuration when testes without external fixator. With an external fixation applied to the 'Box' and 'Shanghai Bridge' the torsional stiffness was similar to the plate fixation.

*Compression stiffness*, Addition of an ex-fix to all constructs improved the stiffness but the difference was not statistically significant. Locking plate did not confer greater compression stiffness compare to 'Box' and 'Shanghai' constructs.

*Load to failure*, 2.5-mm 'Shanghai Bridge' groups performed poorly, significantly worse than 'Box' configuration and locking plate fixation. However, using 3-mm pins with an external fixator, improved the load to failure to value not significantly different to the 'Box' and plate fixation.

**Discussion and conclusions** The 'Box' with an external fixator was overall the stiffest construct. The use of a locking plate does not confer biomechanical benefits compared to the stiffest pins configuration.

### Management of the humeral shaft: lateral access with MIPO technique

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**Objective** The surgical technique developed provides a lateral approach based on the identification of three major cutaneous windows in complex fractures.

**Material and methods** The surgical technique developed by the first author provides a lateral approach based on the identification of three major cutaneous windows in complex fractures, and two windows in simple fractures. Between November 2004 and November 2007, 16 patients (10 males and 6 females) with fracture of the humeral shaft, with extension to the proximal half, were treated with this technique. The first one is performed proximally to split the deltoid muscle; the second one, at the middle third, allows to control the sliding of the plate; the third one, at a distal level, is necessary to isolate and protect the radial nerve. We have reviewed this technique in 16 patients with an average age of 52.3 years. Retrospective review of charts and radiographs immediately after the surgery to latest follow-up was performed (4–16 months).

**Results** Fracture consolidation was evaluated clinically and radiologically in an average of 14.9 weeks. The recovery of shoulder and elbow mobilization resulted to be good. No cases of nerve palsy, sign of superficial or deep infection neither of implant failures or intolerance to reduction devices were found.

**Conclusions** We think this could be a valid technique to minimize soft tissues damages in a determined fractures type.

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## MINIMALLY INVASIVE TREATMENT OF FRACTURES

### MIPO or ORIF: which treatment for the distal leg fractures?

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This medical study is focused on clinical results obtained by surgical treatment with plate to angular stability LCP of the distal leg fractures, performed both with open ORIF osteosynthesis technique, both with mini-invasive MIPO technique.

Aim of the study is to define the ideal treatment and the best surgical technique to be used for each type of fracture and conditions of the soft tissues in order to reconstruct the articular surface respecting the soft tissues.

We evaluated 24 patients, treated in our U.O in 2008 with a medium follow-up of 6.3 months. 67% of the treated fractures were articular fractures (16-B and C), the remaining 33% was extra-articular (8-A); 4 patients had exposed fractures (Gustilo I-II-IIIa).

We used 2 different criteria of evaluation for the clinical results: FAOAS criteria for extra-articular fractures and Ovidia and Beals criteria for articular fractures. In conclusion, our experience suggest to privilege technique MIPO for type A fractures; in B1 and B2 type fractures the choice of the surgical technique must keep into account the experience of the surgeon, while in B3 type fractures ORIF technique should be the golden standard. In type C fractures the ORIF technique is to be preferred in order to obtain the best plafond tibial reduction. In the exposed fractures there are good and promising evidence using ORIF procedure, in combination with the advanced depression medication systems.

### Mini-invasive treatment of humeral diaphysis fracture with external fixator

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Fractures of the humeral diaphysis are an unsolved problem for the modern traumatologist because there is no clear algorithm of treatment. In fact, even the most recent literature does not explain what method of treatment should be chosen, either surgical or conservative and this is why the traumatologist treats very similar fractures in different ways. In addition to conservative treatment by pendants or functional bracing, acceptable results can be achieved for these types of fractures in the following methods: plates, nails and external fixators. Plate fixation, suggested by the Authors of the AO school, offers both good clinical and radiographic results, however, this method is highly invasive and therefore this surgical method has been approached by the MIPO technique in order to reduce invasiveness. Intramedullary nails, which are retrogrades or antegrades, have the disadvantage of difficulty in managing rotations, inability to control shortening of the humerus and can cause damage to the joints. Therefore, the clinical results are not as good as with plates, when intramedullary nails are used, despite low invasiveness. In this

scenery we can include that external fixation, that most Authors used for severe open fractures or for polytrauma patients with nervous or vascular injuries, is the best option. The external fixation technique is even less invasive than MIPO technique because of minimal damage to skin and soft parts, but also for the absence of surgical insult on the fracture stumps. It also offers an immediate mobilization, sparing of the joints and easy removal, so that, according to our experience, the external fixator is a valid and safe alternative to other surgical techniques.

We present our experience in treating fractures of the humerus with external fixator. We treated more than 70 diaphyseal humeral fractures, from 2001 up to present date, making a critical evaluation of the obtained results, by clinical and radiological criteria. We also show many complications, but only one case of non-union which required further surgical treatment and three cases of angular defects. We did not have any case of infection, re-fracture, phlebitis, DVT, mobilization. Consolidation time is similar to plates and intramedullary nails, while ROM and DASH score were better in patients treated with external fixation than in those ones treated with other surgical techniques.

### The use of biophysical stimulation in the treatment of hip periprosthetic fractures: rational application and clinical cases

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Periprosthetic fractures are becoming increasingly important in the orthopaedic practice. The incidence of this disease 1.5% in the primary implant, and concerns 6–8% of revision's cases. The reasons are to be found mainly in the progressive increase of the number of hip prostheses implanted every year, and in clinical characteristics (patient age, weight, quality of bone tissue). The main risk factors for periprosthetic fractures are: (1) systemic, due to osteoporosis or neurological disorders, (2) local, such as periprosthetic osteolysis or stem mobilization, (3) environmental, such as carpets or pets.

The use of biophysical stimulation (in particular the inductive systems) to modulate the osteogenetic response and promote the healing of fractures is becoming established and validated by a large number of clinical trials: is mainly used to improve the process broken down in recent fractures risk and no-consolidation. The mechanism through which acts a physical stimulation, the cell membrane plays a key role for recognition and transfer to different cellular metabolic pathways, with consequent release of calcium ions and cell proliferation.

In vitro experimental studies with biomaterials have shown an increase in proliferation of human osteoblasts cultured on scaffold of polyurethane, and an increase in the synthesis of growth factors and proteins crucial in bone matrix deposition. In vivo, biophysical stimulation is able to significantly accelerate the osteointegration between bone and a cylinder of hydroxyapatite implanted into rabbit femur, increasing the microhardness in the vicinity of. In clinical medicine finally, inductive systems are used in patients undergoing operations for primary hip prostheses and revisions in order to make

faster the process of osteointegration, improve functional recovery and reduce pain.

These and other results represent the rationale for the use of bio-physical stimulation in the presence of periprosthetic fractures.

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## VERTEBRAL SURGERY

### Surgical mini-invasive treatment of pathological spine fractures in multiple myeloma patients

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Spine vertebral compression fractures are a frequent occurrence in multiple myeloma (MM).

We treated 20 patients affected by MM for a total of 40 pathological fractures. 7 patients underwent a posterior pedicular stabilization while 13 had a vertebral augmentation procedure by using a vertebro or kyphoplasty. We reviewed 33 surgical procedures: 15 vertebroplasty (group A) and 18 kyphoplasty (group B), on 13 patients affected by MM with a minimum follow-up of 12 months. Vertebroplasty procedure was always done with a monopedicular technique while kyphoplasty was performed with a mono and bipedicular approach.

Both kyphoplasty techniques lead to a better postoperative improvement of the vertebral height and kyphotic deformity if compared with the vertebroplasty, with a statistical significance only for the body height restoration ( $p = 0.0066$ ). The unipedicular and the bipedicular kyphoplasty have similar results in term of kyphotic deformity correction and height restoration.

The 92% of the patients (12/13) had an immediate improvement of the pain and no difference in between the two groups was observed regarding the pain. We observed a 38% of cement leakage with no clinical evidence and we found that the risk of extravasation was higher in multilevel treatment and in patients not submitted to a bone marrow transplantation. No differences in cement leakage were observed in between the two groups. No major complication were observed.

In conclusion both vertebroplasty and kyphoplasty are effective in treating vertebral compression fracture due to MM. Vertebroplasty could be indicated if you have a single level to treat, especially in the thoracic spine, kyphoplasty could give better results in multiple levels disease, when you need to restore the sagittal alignment of the spine and the height of the vertebral body especially at the thoraco-lumbar and lumbar spinal segments.

## FOOT

### Hallux valgus mini-invasive surgery: comparison of two techniques

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**Background** Distal osteotomy of the first metatarsal is indicated for the surgical treatment of mild-to-moderate hallux valgus deformity. Since over 13 years we have used the Boesch procedure [1, 2], modified by us with a capsulotomy and capsuloplasty, to correct the deformity. Usually the correction and the stabilization of the distal metatarsal osteotomy is kept by a Kirschner wire introduced from the apex of the finger and then pulled in the proximal metatarsal diaphysis passing paracortical by the phalanx. Sometimes the use of K-wire may create a decubitus ulcer or superficial infections. To avoid these complications in stabilization of the osteotomy we started to use a new system (Endolog) which consists in a titanium stem produced in three different curves inserted in the proximal metatarsal diaphysis and fixed to the first metatarsal head by a titanium screw after the lateral “tilt” of the head. With this device no hardware came out of the cutis.

**Material and methods** From January 2008 to June 2008 we implanted 10 Endolog devices. To compare the results obtained with the traditional technique with K wire stabilization we used two samples of patients similar by clinical characteristics. Then we choose for the evaluation 10 patients operated with the traditional technique and 10 patients operated with Endolog system.

**Results** The results valued with AOFAS score (92 points for traditional procedure and 94 for Endolog) and with the angular measures are superimposable in the two methods with a little better control of the angular values of the MP valgus angle, of the first IM angle, of PASA and sesamoides bones positions achieved by the titanium device. Also the subjective satisfaction results to be better in the patients operated with the internal titanium device.

**Conclusions** From these early clinical evidences we can notice a little increase of positive results in the patients treated with the titanium device as concerning the better angular control of the deformity and the subjective satisfaction influenced by a rapid return to the daily activities and by the absence of device rising out of the skin.

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### Mini-invasive technique in the treatment of Morton’s neuroma

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**Objective** We introduce a mini-invasive technique for the treatment of Morton’s neuroma.

**Material and methods** We bring our experience in the treatment of the Morton's neuroma with a mini-invasive technique. Considering such pathology as a canalicular syndrome this technique allows "to release the nerve" effecting an incision of the intermetatarsal ligament. The technique foresees two mini-incisions back and an interdigitally as in the original technique of S. Barrett, but without the use of the endoscope and therefore avoiding the third plantar incision. After having engraved the intermetatarsal ligament the neurolysis is performed for the whole length of the nerve.

**Results** With this technique we performed 24 interventions from 2003 to 2009 (17 females and 7 males, mean age 42 years). The principal valued parameters were: pain, functional resumption and compliances. The reduction of pain (more than 90%) is obtained in most of the patients. In a patient we had excessive bleeding with formation of a hematoma that lengthened the resumption time. The functional resumption was obtained in most of the patients in 15 days, also facilitated by proprioceptive exercises.

**Discussion** Such mini-invasive technique has indeed many advantages. The interventions can be performed in regime of Day Surgery with the employment of techniques of distal troncular anesthesia (ankle block). At the end of the intervention the patient is sent to his own domicile granting the load after some days with jogging shoes. It is a technique that foresees a curve of brief (few interventions can provide the sensibility in isolating the intermetatarsal ligament) learning and a technique that does not exclude other techniques in case of failure.

**Conclusions** To the light of the obtained results (more than 85% of success percentage, the possibility to maintain the interdigital sensibility, low percentage of compliance, rapid functional resumption, good patient's degree of satisfaction), we suggest such technique as an alternative for the treatment of the Morton's neuroma although a large casistics should be performed.

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## MINI-INVASIVE SURGERY OF THE KNEE

### TSS: mini-prosthesis. Reality or failure?

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Over the past few years tissue sparing surgery has become widely accepted in its aim to reduce to a minimum the area to be prosthesised in the arthritic knee. Definitely a desirable goal directed towards the improvement in the quality of life in symptomatic arthritic patients in whom the disease does not require axial correction. To date the indication is reserved to a limited number of patients. Despite the casistics reported in various publications, the real efficacy and the durability over time of this surgical solution has yet to be verified in well structured clinical and functional evaluations. The acronym TSS in every branch of surgery has, as its common denominator, function preservation.

Therefore, these surgical solutions are reality where a limited and modified return to function is needed for localized damage whereby prosthesisation will contribute to recovery when the joint is not mechanically compromised. Tissue sparing prostheses fit in well where the aim is to reduce replacement surgery and regain a physiological condition. In the light of this the use of mini-prostheses is undoubtedly a very interesting alternative and a path to follow, without forgetting that only with a correct indication, as well as the careful clinical and functional evaluations of the patient, can the best results be achieved.

### MIS/TSS and computer

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Mal-alignment can adversely affect the longevity of the knee prostheses with early wear and implant loosening both linked to sub-optimal implant position.

Greater than 3° varus or valgus mal-alignment can result in higher failure rates whilst correct alignment has been associated with improved clinical outcome. Computer-aided alignment in TKR appears to produce superior results compared to hand-guided techniques. These computer-assisted systems have been shown to improve mechanical alignment. During all the surgical phases the surgeons always can prevent any bone cutting errors through a continuous feedback from the navigation.

Recently mini-invasive joint replacement has become one of the hottest topics in the orthopaedic world. However, these terms have been improperly misunderstood as a "key-hole" surgery where traditional components are implanted with shorter surgical approaches, with few benefits and several possible dangers such as malpositioning and only a computer assisted technique can help the surgeon to achieve a correct alignment.

Likewise small implants as unicompartmental knee prostheses, patello-femoral prostheses and bi-unicompartmental knee prostheses might represent real less invasive procedures and association of both small implants and CAS could represent a new frontier for a "custom-made" treatment of the arthritic knee.

We present our experience in CAS in over 600 knee implants including UKR, PFR, and bi-UKRs going through a Tissue Sparing Surgery: the Italian way to MIS.

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## ORAL COMMUNICATIONS

### SESSION 26

#### Early fracture healing PTH(1-34) mediated: improvement of callus formation

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The use of PTH(1-34) for stimulating early bone healing and fracture repair has not yet been stated as a defined therapeutical approach.



despite its wide utilization as an anabolic factor in osteoporosis. Clinical experience and sporadic patient observations suggest that PTH(1-34) can play a major role in new bone formation. To support them, we propose a basic experimental research to clarify the timing and mechanisms of pharmacological enhancement of bone healing, that means shortening of time of consolidation and quality of bone callus. This type of research needs a reliable and reproducible animal model, avoiding any artifact due to internal osteosynthesis. Moreover, the possibility to establish a correlation between PTH administration (timing and doses) and the dimension and quality of the newly formed bone are compulsory. Therefore, we set up a closed fracture murine model intentionally avoiding any surgical intervention, aimed to observe the natural history of bone healing and validated it with/without PTH(1-34) treatment.

Highly reproducible midshaft closed tibial fracture was performed in mice. Five days/week mice received 40 µg/kg body weight of PTH(1-34) or saline (in control animals). Bone formation was labelled by tetracycline administration. At day 28th after fracture, legs were X-rayed, processed and sliced for histomorphometrical studies. Callus area and fluorescence intensity of newly formed bone were considered. A higher bone turn over characterized PTH(1-34) receiving mice, where we found larger callus and higher tetracycline incorporation. We also considered effect on healing of different PTH(1-34) doses and timing of administration.

We present our results with the aim to establish a new comprehensive clinical approach to PTH(1-34) mediated bone healing induction. Further developments of this project will involve the application on osteoporotic bone, whose fracture represents a frequent and critical clinical problem.

### The employment of the PRP (platelet rich plasma) in the high sepsis risk in orthopaedic surgery

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**Objective** Many and serious implications for the patient's life (physical, psychic, economic, social) and expensive employment of resources (many admissions to hospitals, expensive and demanding drug therapies, repeated surgical operations) make the infections treatment one of the hardest challenges for the orthopaedic surgeons. The effectiveness of the therapy is due to timeliness of the intervention itself, but it is outstanding opinion that prevention is the gold standard. Recently, studies in vitro and in vivo (Hernigou 2008; Gerlach 2008; Yuan 2008; Guo 2008) have shown PRP antimycotic and antibacterial effects, particularly towards *Staphylococcus Aureus* and *Escherichia Coli*. On the light of these data a retrospective study has been carried out concerning surgical cases with high sepsis risk either for multiple previous surgical treatments (>2), or for typology (hip prosthesis re-revision, hip prosthesis after Girdlestone, recalcitrant nonunions), or for comorbidity (diabetes, alcohol, smoking, immunodeficiency), treated by employing autologous or omologous PRP.

**Material and methods** 30 patients (14 hip prosthesis re-revisions, 1 hip prosthesis after Girdlestone for sepsis, 15 recalcitrant nonunions) were treated from 2003 to 2008 at the Orthopaedic Department, CTO, Milan, by employing autologous or omologous (from 2006 in case of lack or disease of platelets, coagulopathy, therapy with ASA-TAO-FANS) PRP to activate osteogenesis in bone grafts. All the patients received an antibiotic prophylaxis followed by antibiotic therapy in case of prolonged surgical time (>60') or bladder catheter persistence. Patients were monitored by checking the pre- and post-operative

phlogosis hematochemical parameters and after 1, 3, 6 weeks and 3 months. Rx evaluation was performed pre and post-operatively and at last check. No unfavourable event, no local or systemic allergic reaction, no acute or delayed infection were recorded. The clinical and radiological recovery resulting steady after checking.

**Discussion** The employment of PRP showed safety and simplicity and also in our cases it seems to minimize sepsis risk. The selection procedure of donors enable us to obtain a uniform product as concerning activity and concentration and to increase the availability hypothetically extensible to bank-like allotment.

**Conclusions** We think that PRP should be employed for the prevention of sepsis also in the less serious orthopaedic surgical treatments.

### Gene expression and protein analysis in ruptured human Achilles tendons. A comparison between ruptured and healthy area of the same tendon

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**Introduction** We studied the extracellular matrix (ECM) of 19 ruptured human Achilles tendons, comparing the tissue composition of specimens taken from area close to the rupture with specimens harvested from an apparently healthy area in the same tendon. Aim of this study was to analyze gene expression and ECM molecules as well as MMPs and TIMPs involved in ECM turnover, in order to assess the cellular activity and what might happen in Achilles tendon rupture. The hypothesis was that in the same tendon there are many differences in gene expression of ECM molecules and metalloproteinases activity between ruptured and macroscopically healthy areas.

**Material and methods** We compared the gene expression and the protein localization of the main ECM molecules (collagen type I and IX, decorin and versican) including enzymes involved in their metabolism as matrix metalloproteinases (MMP2 and 9) and tissue inhibitors of metalloproteinases (TIMP 1 and 2) using a real time RT-PCR, zymography and Fluorophore Assisted Carbohydrate Electrophoresis analysis.

**Results** We did not observe any collagen IX gene expression. The gene expression of collagen type I, proteoglycans GAGs, MMPs and TIMPs was more represented in the area close to the tendon rupture ( $p < 0.05$ ). The expression of MMPs was confirmed by zymography analysis, showing a marked increase of MMP9 activity in area close to the tendon rupture ( $p < 0.05$ ). The chemical composition of tendon changed showing that in the healthy area the GAGs content was higher than the ruptured area ( $p < 0.05$ ).

**Conclusions** The lack of gene expression of collagen IX testifies that there was not any fibrocartilaginous metaplasia as described in tendinopathy. In the ruptured area, the tenocytes tried to restore the normal proteoglycan pattern increasing the protein synthesis but without the normal glycosaminoglycan production. The low amount of GAGs in the ruptured area indicates that the catabolic processes prevail over the synthetic activity. Our data support the hypothesis that, in human tendons, the tissue in the area of rupture undergoes marked rearrangement at molecular levels based on the MMP's activity, and support the role of MMPs in the tendon pathology.

## Experimental evidences supporting the use of nasal chondrocytes for the regeneration of articular cartilage

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Autologous Chondrocyte Transplantation (ACT) techniques typically rely on the isolation of autologous articular chondrocytes (AC) from a small biopsy of articular cartilage. Both donor site morbidity and the limited number of chondrocytes that can be isolated limit the application of these techniques. To overcome these limits other cell sources have been proposed: bone marrow, synovial membrane, fat tissue, periosteum, non-articular cartilage. In particular, nasal septum represents a perfect cell source as it is made of differentiated chondrocytes which synthesizes a large amount of collagen II and its harvesting is an easy procedure characterized by a low morbidity. Many studies focused on the properties of neocartilage based on nasal chondrocytes (NC) and demonstrated the higher and less age-dependent chondrogenic potential compared to that of AC. Additionally, engineered cartilage based on NC demonstrated to be positively affected by dynamic compression resembling joint loading, similarly to AC-based constructs. The aim of this study is to evaluate the response of NC-based engineered cartilage to the pro-inflammatory chemokine IL-1 at physiological concentration. Constructs based on AC from matched donors served as controls. AC and NC isolated from 6 donors were expanded in monolayer and then seeded ( $70 \times 10^6$  cells/cm<sup>3</sup>) onto scaffolds of collagen I/III (ChondroGide<sup>®</sup>, Geistlich), esterified hyaluronic acid (Hyaff-11<sup>®</sup>, FAB) and cultured for 2 or 4 weeks under chondrogenic conditions and then exposed to IL-1 for 3 days. At the end of culture time, samples were analyzed with histology (Safranin-O), immunohistochemistry (IHC) for collagen type I and II, biochemistry (GAG and DNA). Constructs based on NC always showed a higher extent of cartilaginous matrix, as shown by Safranin-O and collagen II stainings. Matrix synthesized by AC was damaged by IL-1 at both experimental times while that synthesized by NC was less degraded at 2 weeks and not significantly damaged at 4 weeks. These results demonstrate that engineered constructs based on NC are characterized by a higher quality of the neocartilage and a better response to pro-inflammatory signals compared to constructs based on AC. This study, together with those already published in literature, suggests a possible clinical application of ACT techniques based on NC.

## Effects of electromagnetic and ultrasonic waves onto SAOS-2 osteoblasts grown in a gelatin-based cryogel scaffold

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The modification of a gelatin-based cryogel surface plays an important role in bone tissue engineering [1]. We have followed a biomimetic strategy [2, 3] where electromagnetically and ultrasonically stimulated SAOS-2 osteoblasts proliferated and built extracellular matrix on a gelatin-based cryogel surface. Moreover, increasing evidence suggests that an electromagnetic or an ultrasonic stimulus can modulate bone histogenesis and calcified matrix production in vitro and in vivo. Our aim was to investigate the effects of an electromagnetic wave (intensity of magnetic field, 2 mT; frequency, 75 Hz) and of an ultrasound wave (power, 149 mW; frequency, 1.5 MHz) (Igea, Carpi, Italy) on human SAOS-2 cells in terms of proliferation and matrix production.

Cells were seeded onto gelatin-based cryogel surfaces, and stimulated ("electromagnetic" and "ultrasonic" cultures) or not ("control"). At the end of the culture period, the following parameters were studied: cell proliferation (by DNA assay), matrix production (by ELISA assay), and matrix distribution (by confocal laser microscopy for specific bone markers, such as type-I collagen, decorin, and osteopontin). Confocal microscope analysis revealed that the stimulation improved the cell distribution on the gelatin surface and caused significantly higher fluorescence intensity. DNA and ELISA assays quantitatively confirmed the preceding observations.

Taken together these data seem to suggest that the physical stimulations could be used to improve osteoblast growth and calcified matrix development in vitro.

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## SESSION 27

### Engineering a functional osteochondral graft

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We aimed our study at developing a tissue engineered osteochondral (OC) graft suitable for clinical use. In particular, we focused on assessing the functionality of the graft through the characterization of the cartilaginous layer and its integration with the bony substrate. We determined whether a pre-culture of chondrocytes-seeded matrices before their combination with the bony substrate would modulate the extent of cartilage differentiation and the integration among the two layers of the OC constructs. Human articular chondrocytes (HAC) isolated from 5 donors (mean age 57 years) were expanded in monolayer and then seeded onto collagen I/III membranes (ChondroGide<sup>®</sup>, Geistlich) ( $70 \times 10^6$  cells/cm<sup>3</sup>) in a fibrinogen solution (Tisseel<sup>®</sup>, Baxter). The bony scaffolds (Tutobone<sup>®</sup>, Tutogen) were pre-wetted in a thrombin solution and then combined to the cell-seeded membranes immediately (group-A) or after 3 days (group-B) or 14 days (group-C) of preculture of the chondral layer. Constructs were cultured with chondrogenic supplements for a total time of 5 weeks and assessed with histology, immunohistochemistry (IHC), biochemistry and quantitative gene expression (Real Time PCR). Additionally, the mechanical strength of integration was quantitatively assessed using novel mechanical method called “90°-peel-off” test. The quality of the cartilaginous layer was remarkably higher in samples of Group-B as shown by histology and IHC as well as the chondrogenic differentiation assessed with Real Time PCR. Peak force and total energy of integration in group-A and group-B constructs were significantly higher than group-C constructs (up to 2.5- and 3.2-fold, respectively). Biochemical analysis of the delaminated cartilaginous layers after “90°-peel-off” test demonstrated higher DNA and GAG contents in group-B constructs as compared to Group-A and Group-C constructs (up to 2.3- and 3.1-fold, respectively). Our study indicates that functional OC grafts can be generated using HAC and scaffolds currently used in clinical practice. Pre-incubation of HAC for 3 days in the chondral scaffold allows increasing cartilaginous matrix formation without reducing integration between the two layers. Further studies with different cell sources and anatomical scaffolds are ongoing in order to make the model ready for clinical application.

### Biological enhancement of autologous bone graft with BMP-7 in the treatment of a lumbar instrumented PLF non-union: morphology of the newly formed bone

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The BMP are pleiotropic peptides that regulate growth, differentiation and the apoptosis of osteoblasts, chondroblast, and epithelial cells. They are divided into 4 subgroups based on aminoacid sequence. Although they are structurally linked each other, the function and activation in the process of ossification are specific. In addition, the combined action of BMP-4/7 and BMP-2/7 determines the increase in osteoinductive capacity, and also the proliferation and differentiation of mesenchymal cells towards osteoblasts.

In 2003 at our Department a patient with chronic low back pain underwent a L4-S1 instrumented PLF, that evolved into nonunion at L5-S1. For this reason, and for the recurrence of subjective symptoms in 2005, pedicle screws in S1 were changed and a new instrumentation from L4 to S1 obtained. Biologically enhanced with BMP-7 (Osigraft, Stryker, USA) autologous bone graft was set in place. Satisfactory fusion was achieved, both clinically and at CT scan evaluation.

Adjacent level pathology at L3–L4 subsequently developed, and the patient in January 2008 underwent a new surgical procedure for the stabilization of L3–L4 level.

Contextually, while removing previously implanted hardware a sample of newly formed bone tissue was harvested 36 months after graft. After histological preparation of the slides, morphological evaluation at light microscopy showed bone mature architecture in all samples of the newly formed tissue and the absence of inflammation and abnormalities in the tissues.

### The NeuroBox concept: a new approach for the in vivo regeneration of nerves

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**Introduction** It is about 20 years that tubular nerve guides have been introduced into clinical practice as a reliable alternative to autograft, in gaps not-longer-than 20 mm, bringing the advantage of avoiding donor site sacrifice and morbidity. There are limitations in the application of tubular guides. First, tubular structure in itself makes surgical implantation difficult; second, stitch sutures required to secure the guide may represent a site of unfavourable fibroblastic reaction; third, maximum length and diameter of the guide correlate with the occurrence of a poorer central vascularisation of regenerated nerve.

**Methods** We developed and tested a new concept of nerve-guide, named NeuroBox, which is double-halved, not-degradable, rigid, and does not require any stitch, employing acrylate glue instead (patent WO/2008/029373). Five male Wistar rats had the new guide implanted in a 4 mm sciatic nerve defect; two guides incorporated a surface constituted of microtrenches aligned longitudinally. Further five rats had the 4 mm gap left without repair. Contralateral intact nerves were used as controls.

**Results** After 2 months nerve regeneration occurred in all animals treated by the NeuroBox; fine blood vessels were well represented. There was no regeneration in the un-treated animals.

**Conclusions** An easy surgical technique was associated with the box-shaped guide and acrylate glue was easily applied; an adequate intra-neural vascularisation was found concurrently with the regeneration of the nerve and no adverse fibroblastic proliferation was present.

### Genetic effects of pulsed electromagnetic fields (PEMF) on human osteoblast-like cells (MG-63) in vitro

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Pulsed electromagnetic fields (PEMF) have been widely accepted in the clinical community for the treatment of several pathologies of the bone and recently of the cartilage. Although therapeutic properties of PEMF are well known, the sequence of events by which electromagnetic stimulation can lead its desirable effects on bone healing and cartilage are not completely understood. Here we are testing the effect of PEMF on osteoblast-like cells (MG63) by using DNA microarrays containing 20,000 genes. We identified several genes covering a broad range of functional activities whose expression was significantly up- or downregulated. PEMF seem to exert an anabolic effect and act on cell behavior setting the cell in a proliferative way and inducing both osteoblastogenesis and differentiation of osteoblasts. Moreover, PEMF promote extracellular matrix apposition and mineralization while at the same time decrease the degradation and absorption processes of extracellular matrix. The data come out from this study, constitute the first genetic portrait of PEMF effects on human osteoblast-like cells in vitro. They permit a detailed description of the effects of electromagnetic stimulation and give a better explanation of the observed clinical effect suggesting the possibility of using them in other fields like regenerative medicine.

## SESSION 28

### Embryonic stem cells for resurfacing full thickness defects in the sheeps: follow-up at two years

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**Background** Stem cells are self renewing, unspecialized cells that can give rise to multiple cell types of all tissue of the body. They can be derived from the embryo, foetus and adult. The aim of our study was to verify if stem cells, seeded on fibrin glue, maintain their properties, and grow and form cartilage in chondral defects, when used for repair the lesion.

**Material and methods** Pluripotent cells derived from inner mass cell of embryos (ES) at the first stages of development (blastocysts) and

mesenchymal stem cells (MSC) isolated from bone marrows aspirates, are investigated.

**Results** The ES, being rapidly proliferating can be maintained in vitro for an infinitely long time and can differentiate into all cells of adult organisms; the MSC have a limited capacity for differentiation and probably, a limited proliferative potential. Specific attention was directed toward the determination of the presence of teratoma in the reparative tissue but this positive labeling was not found in the specimens from defects that underwent to stem cells cartilage procedures. Two years after transplantation, in each group, the cells were largely distributed on the area of defect and were round and arranged in numerous small clumps. In the control group the repair tissue implanted was fibrous with prevalence in extracellular matrix of Type II collagen. **Conclusions** MSC represent an important and easily available source of non-hematopoietic stem cells and can be isolated from different sources. This repair tissue manifests neither a arcade-like organization of its fibers nor a well-define zonal stratification of its chondrocytes but detection of Type I collagen rendering the pluripotent-cells-fibrin glue complex a possible candidate for the repair of cartilage lesions. Moreover, in contrast to embryonic stem cells, the utilization of these cells avoids most of the ethical, religious and political questions and concerns.

### Anatomical description and biomechanics of the anterior cruciate ligament in the goat knee

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**Aim** The aim of this study was to perform a detailed qualitatively and quantitatively assessment of the goat ACL, its bundles, its insertion sites and to describe the biomechanical function of the different bundles in order to evaluate its use for a double bundle ACL reconstruction model.

**Material and methods** Ten non-paired adult goat knees were used. We measured the insertion site area of each bundle. We analyzed the ratio between the femoral and tibial insertion site areas and the midsubstance cross-sectional area of the ACL. Microscribe 3D and 3D-laser camera were used to record the data. A CASPAR Stäubli RX90 robot with a six degree-of-freedom load cell was used for measurement of anterior tibial translation (ATT) [mm] and in situ forces [N] at 30° (full extension), 60°, 90° as well as rotational testing at 30° in 14 paired goat knees before and after each bundle was cut. **Results** Three bundles could be clearly identified in each ACL: anteromedial (AM), intermediate (IM) and posterolateral (PL) bundle. On the tibial side, the insertion of the IM and PL bundles could not be identified separately. On the femur, the area of insertion site, represented as a percentage of the entire footprint, was  $54.3 \pm 7.8\%$  for AM,  $9.9 \pm 3.8\%$  for IM and  $35.8 \pm 4.4\%$  for PL bundle. The area of tibial insertion was  $68.6 \pm 4.7\%$  for AM and  $31.4 \pm 4.7\%$  for IM/PL bundle. The differences between the entire femoral ( $51.9 \pm 4.6 \text{ mm}^2$ ) and tibial ( $81.1 \pm 11.9 \text{ mm}^2$ ) footprint areas and between each bundle were statistical significant ( $p < 0.05$ ). All insertions had significantly larger areas than the ligament midsubstance cross-sectional area ( $21.76 \pm 7.26 \text{ mm}^2$ ) ( $p < 0.05$ ). When the AM-bundle was cut, the ATT increased significantly at 60° and 90° of flexion ( $p < 0.05$ ). When the PL-bundle was cut, the ATT increased only at

30°. However, most load was transferred through the big AM-bundle while the PL-bundle shared significant load only at 30°, with only minimal contribution from the IM-bundle at all flexion degrees.

**Conclusions** The precise knowledge of the ACL anatomy in the goat knee is necessary when a goat model is planned. Though anatomically discernible, the IM-bundle plays only an inferior role in ATT and might be neglected as a separate bundle during reconstruction. The goat ACL shows some differences to the human ACL, whereas the main functions of the ACL bundles are similar.

### Functional evaluation and RM of shoulder rotator cuff: heritability estimates in monozygotic and dizygotic twin pairs

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**Purpose** The aim of our study is to establish if the shoulder’s functionality and the morphology of the coraco-acromial arch are genetically determined parameters.

**Material and methods** In the Italian Twin Registry, we identified 50 twin pairs with average age similar to that of patients with rotator cuff tear. We examined 29 twin pairs, 15 MZ (10 males; 5 females) mean aged 63 years (range 53–72) and 14 DZ (4 males; 8 females; 2 opposite sex) mean aged 63 years (range 60–66), without disease of the shoulder. All subjects underwent in order to: functional and subjective evaluation of the right shoulder (Constant Score; Simple Shoulder Test) and MR. On the MR images, we measured: acromio-humeral distance, angle of glenoid retroversion, area of the supraspinatus muscle; and we evaluated: degree of acromio-clavicular arthropathy, rotator cuff condition and Goutallier’s stage.

**Results** Data were analysed with the “twin design”. Correlations of the three morphometric parameters were greater in MZ compared to DZ. The correlation of the acromio-humeral distance has been the highest (0.95 MZ; 0.23 DZ). Similar results have been obtained for the CS (MZ = 0.7; DZ = 0.5) and SST (MZ = 0.8; DZ = 0.6). From these correlations derived heritability estimates of 32% and 34% for the CS and the SST, respectively. Higher values of heritability included: glenoid retroversion (56%) and acromio-humeral distance (91%). The correlation of the variable (degeneration/tear of the infraspinatus tendon) resulted greater in MZ (0.91) compared to DZ (0.44).

**Conclusions** This study is the first that uses the “twin design”. Results suggest that the variability inside each twin pair for the morphology of the coraco-acromial arch and the degeneration/tear of the infraspinatus tendon depend more from genetic than environmental factors.

**Level of evidence** Level IV, prognostic case series.

### TRUFIT system™ for osteochondral lesion of the knee

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**Objective** The TRUFIT system™ (Smith&Nephew) is a bone graft substitute made of sour poly glycolide (50%), calcium sulfate (40%) and PGA fibers (10%). Aim of the study was to evaluate its clinical effectiveness.

**Material and methods** Twelve patients were treated for osteochondral lesion of the femoral condyle of the knee. Six cases were women,

the average age was 46 years, seven cases were left side. Indication for surgery was osteochondritis dissecans of the lateral femoral condyle in 6 cases, post traumatic chondral lesion (4° Outerbridge) of the medial femoral condyle in 6 cases. Chondral lesions were from 10 to 12 mm<sup>2</sup>. Nine cases were implanted an 11 mm scaffold and, in 3 cases a 9 mm.

**Results** The average time for surgery was 45 minutes. Continuous passive motion of the knee was started the first postoperative day, full weight bearing was allowed 6 weeks after surgery. At seven, 5, 3, and 2 months, respectively, of follow-up the knees joint were pain free, full range of motion, and all patients were back to their ordinary lifestyle.

**Conclusions** The TRUFIT system™ showed to be a reliable treatment for osteochondral lesion smaller than 12 mm.

### SESSION 29

#### Arthroscopic treatment of acute acromio-clavicular joint dislocation with double flip button: two- to four-year follow-up

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**Introduction** The ideal treatment for acromio-clavicular (AC) joint dislocation is controversial, both in terms of indications and surgical technique. The present study evaluates the clinical and radiological outcomes at a minimum follow-up of two years in a group of patients with acute AC dislocation, arthroscopically repaired with two flip buttons and braided polyethylene sutures.

**Material and methods** We treated 16 patients affected by acute AC joint dislocation, types III-V according to Rockwood. The bony tunnels in the clavicle and coracoid will host the coraco-clavicular retention system, which consists of two flip buttons (inferior and superior) fixed at the coracoid base and at the superior aspect of the clavicle, respectively, with polyethylene sutures looped around the internal eyelets. The mean follow-up was 31 months (range 24–48 months). At final follow-up patients were assessed using Constant score. AC joint comparative X-ray evaluations were also obtained at rest and under stress.

**Results** The mean Constant score at final follow-up was 96.8 points (range 82–100), with full recovery of shoulder range of motion in all patients. All patients returned to all daily activities at mean 3.2 months post-operatively (range 3–4 months). At final follow-up, 12 shoulders (75%) maintained a complete reduction and four shoulders (25%) showed a partial loss of reduction, with a mean coraco-clavicular distance of 150% (range 136–172%) compared to the uninjured shoulder. Nevertheless, the functional outcomes of all these four patients were excellent, with a mean Constant score of 99 (range 97–100) and complete range of motion. Concomitant lesions observed at arthroscopy included three (18.75%) type 2 SLAP lesions and one (6.25%) Bankart lesion.

**Discussion** The clinical results of the presented arthroscopic technique at an average follow-up of two years were excellent in terms of mean Constant score. From a radiological point of view one-fourth of

the patients presented with a partial loss of reduction. It was associated to the migration of the superior flip button into the clavicle secondary to the penetration of the superior cortex that never progressed beyond the upper third of the collarbone. Nevertheless, all of these patients reported excellent functional outcome and were satisfied with the procedure despite a slight prominence of the lateral profile of the clavicle.

**Conclusions** The presented technique proved to be safe and minimally invasive, delivering good clinical and aesthetic results while allowing the treatment of associated gleno-humeral lesions. Data will be presented.

### Quantification of glenoid erosion in shoulder hemiarthroplasty: radiographic analysis and clinical considerations

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Radiographic analysis is essential to depict complications of shoulder prostheses [1]. Aim of the current study is to quantify glenoid erosion and verify its correlation with Constant–Murley score in patients who underwent shoulder hemiarthroplasty for displaced proximal humerus fractures. We selected 21 patients according to the following radiographic criteria: (a) type A<sub>1</sub> glenoid morphology as described by Walch [2]; (b) acromio-humeral interval lower than 7 mm. Investigation included measurement of coraco-glenoid angle (CGA) in true AP view and gleno-humeral line space (GHL) in axillary view [3]. We identified group I and II. Group I included 11 patients, 5 males and 6 females, mean age 65.3 years (range 58–71), dominant arm in 6 cases; the mean radiographic follow-up was performed at 4.1 years (range 3.8–4.4). The group II (control group) included 10 patients, 5 males and 5 females, mean age 62.5 years (range 56–69), dominant arm 4 cases; the mean radiographic follow-up was performed at 4 months (range 3.8–5.1). The mean values of CGA were  $3.9 \pm 1.49$  in the group I and  $0.4 \pm 0.2$  in the group II. We recorded GHL values of  $1.94 \pm 1.45$  in the group I and  $3.9 \pm 0.7$  in the group II. In the patients of group I with CGA equal or greater than  $4.9 \pm 0.9$  and GHL equal or lower than  $1.4 \pm 0.3$  the mean Constant score was lower ( $40.4 \pm 7.6$ ,  $p < 0.05$ ) than Total Constant score ( $62.3 \pm 6.9$ ). In conclusion we can assert the strong correlation between the severity of glenoid erosion and worsening quality of life in patients with shoulder hemiarthroplasty. When the pain is persistent with poor range of motion, the conversion in total arthroplasty or in reverse prostheses should be considered.

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### Ulnar nerve regeneration in an elderly patient assessed by roof-opening of a degradable nerve-guide

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**Introduction** The rate of unsuccessful recovery from peripheral nerve gap-lesions in the elderly is high. Artificial nerve guides showed to perform at least as good as autografts in nerve gap-injuries bringing the significative advantage of avoiding donor site sacrifice and morbidity.

**Methods** We report a 70-year-old patient who suffered from a chainsaw lesion which resulted in transection-avulsion of the ulnar nerve at the wrist with a gap of about 8 mm. A cross-linked collagen nerve-guide was implanted.

**Results** After 8 months the Tinell's sign already reached the distal palmar crevice and motor and sensory recovery was nearly complete. Revision took place a month later; the guide was evidenced by a spongy structure wrapped around the nerve and, despite its structural alteration, it had maintained its full integrity and shape. The nerve was affected by a mild stenosis.

**Conclusions** This study reports that the use of a degradable nerve guide and its removal after a clinical recovery both proved beneficial in treating a nerve-gap lesion in an elderly patient.

## SESSION 30

### S3 Hand-Innovation plates in the treatment of proximal humeral fractures: our experience and case review

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**Introduction** The aim of this study was to estimate the outcome after internal fixation of displaced proximal humerus fractures with the Hand-Innovation<sup>®</sup> system plate.

**Material and methods** Forty-six patients (34 females, 12 males) with a mean age of 70.3 years (range 41–88) at the moment of the evaluation, and with displaced fractures of the proximal humerus divided into two-, three- and four-part (Neer classification) were examined clinically and radiologically. The minimum follow-up was 6 months and allowed a good consolidation of the fracture; the mean follow-up was 20.8 post-operative months. Functional results were analysed with two scores: the Constant one and the Dash one (Disabilities of the Arm, Shoulder and Hand score).

**Results** The mean Constant score was 69.9 (range 47.0–87.0), while the mean Dash score was 16.3 (range 0.8–60.3). One implant was removed because of re-fracture after a trauma: in this case the implant was substituted by Hand Innovation long plate. Overall only two plates were removed: one was that just described above, the second was because of intolerance to the implant.

**Conclusions** These results demonstrate the high stability of the Hand-Innovation<sup>®</sup> system plate that allowed early mobilization of the shoulder. This fixation system seems to be an excellent alternative treatment of displaced proximal humerus fractures.

## Use of pre-contoured plates in the treatment of the C2–C3 distal humeral fractures: experience and review

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**Introduction** Open reduction and internal fixation is the treatment of choice in distal humerus fractures. The key-points of the treatment are intended to obtain anatomic reconstruction of the elbow's geometry with a stable internal fixation. The treatment should give the possibility of immediate rehabilitation, the starting point to a complete recovery of functionality.

**Material and methods** Acumed Distal Humerus Plates are pre-contoured to fit the natural anatomy of the elbow. Also in case of complex fractures they can give a guide for the anatomic restoration of the distal humerus. The two plates are placed parallel with "interdigitated" screws locked together so to create a fixed angle in the distal fragments and great stability to the entire distal humerus. Our experience include patients from 2003 to 2009. We examined the C2–3 fractures clinically and radiologically. The minimum follow-up was 6 months.

**Results** We obtained a good consolidation of all the fractures. Using this method we obtained good results according to the Mayo Elbow performance Score (MEPS) and the Dash score (Disabilities of the Arm, Shoulder and Hand score).

**Conclusions** With Acumed Distal Humerus Plates we are able to reduce the incidence of complications and to obtain a good consolidation of the fractures with an immediate rehabilitation. Pre-contoured plates in a parallel position can give a great help to the surgeon obtaining an anatomical reduction of distal humeral fractures and especially the recovery of the anatomical antversion of the articular surface.

## Case report: shoulder inveterate dislocation with fracture of articular glenoid. Alternative treatment with a screw synthesis and Latarjet transposition of coracoid

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The inveterate dislocations of the shoulder are extremely complex, with uncertain and difficult treatment. In many cases there are glenoid associated articular lesions, which cause permanent instability with recurrent dislocation in the bandage, and that often remain unknown.

The posterior inveterate shoulder dislocation is generally observed more frequently; this dislocation is hard to diagnose with a common X-ray. However, an association of anterior dislocation with fracture of the antero-inferior portion of glenoid may cause an unknown inveterate anterior dislocation. The treatment of this disease is difficult and complex, and varies depending on the age of the patient. Shoulder prostheses are applied more and more often, especially in reverse variant. However, in some cases it is possible to select screw synthesis of the glenoid correcting instability and transposition of coracoid process to a glenoid reinforcement.

In this case report we present an anterior inveterate shoulder dislocation in combination with fracture of the anterior-lower third of the glenoid in a patient 80-year-old with general problems (BPCO, hypertension, heart disease).

After a direct trauma, we found an anterior shoulder dislocation, while we missed the diagnosis of a complete and displaced glenoid articular fracture. The lesion was reduced and treated with a Desault splint for 30 days. In the third day the patient felt pain and increase of deformities; the X-ray control after 30 days revealed the inveterate dislocation with significant dislocation of the articular fragment.

Given the overall condition of the patient, we chose a surgical reduction of the shoulder dislocation, a synthesis of the articular portion of the glenoid and with Latarjet transposition of the coracoid process.

The intervention was performed with deltoid-pectoral access, with immediate resection and preparation of coracoid process as Latarjet technique. The obtained shoulder reduction was impossible to be maintained because of the glenoid fracture. Thus the fragment was recovered, released from the fibrous scar tissue, and reduced and stabilized with 2 herbert titanium screws. That we performed the coracoid trasposition, with 2 titanium screws. The patient was immobilized for 15 days, then began cautious FKT passive and active. The post-operative course was complicated by accidental fall in which the patient reported somatic dorsal vertebral fractures, with no further problems in the shoulder operated.

Currently, 4 months after trauma, the patient shows a good recovery with articular ROM in abduction to 100°, no pain, and good stability. We believe that in some selected cases, this technique can be a particularly valuable tool as an alternative replacement prosthesis.

## Scapular dyskinesia and SICK scapula syndrome in patients with chronic type III acromioclavicular dislocation

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**Purpose** This study was aimed at evaluating whether scapular dyskinesia and, eventually, SICK (Scapular malposition, Inferior medial border prominence, Coracoid pain and malposition, and dyskinesia of scapular movement) scapula syndrome develop in patients with chronic type III acromioclavicular (AC) dislocation.

**Material and methods** Scapulothoracic motion was studied in 34 patients with chronic AC dislocation by use of the protocol described by Kibler et al. and Burkhart et al. An anteroposterior radiograph of the scapulae with the arms abducted was also obtained. The SICK Scapula Rating Scale was applied to patients with SICK scapula syndrome. Shoulder function was assessed with the Constant score and Simple Shoulder Test (SST).

**Results** Of the 34 patients, 24 (70.6%) had scapular dyskinesia with the arms at rest, and 14 of these (58.3%) had SICK scapula syndrome. The mean SICK Scapula Rating Scale score was 6.9 points (out of a possible 20 points). Clinical and radiographic evaluations with the arms abducted at 90 degrees confirmed scapular dyskinesia in 61.7% and 64.7% of patients, respectively ( $p > 0.05$ ). The Constant score was 83 points for the pathologic side and 91 points for the contralateral side. The Constant score value was 75 and 88, respectively, in patients with dyskinesia and those without dyskinesia ( $p < 0.05$ ); the mean value for the SST was 8 of 12 and 10 of 12, respectively.

**Conclusions** Chronic type III AC dislocation causes scapular dyskinesia in 70.6% of patients. Of the latter, 58.3% have SICK scapula syndrome develop. Dyskinesia might be due to loss of the stable fulcrum of the shoulder girdle represented by the AC joint and due to the superior shoulder pain caused by the dislocation. The values for the Constant score and SST were lower in patients with dyskinesia.

**Level of evidence** Level IV, prognostic case series.

## SESSION 31

### Surgical treatment by simple curettage in enchondromas of the hand: follow-up at 30 years

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**Purpose** The surgical treatment of the chondroma of the hand by curettage is universally performed. In literature, to date, however, there is no agree on the surgical procedures to be followed for the curettage and, particularly, whether to proceed to the filling of the lesion. With this study we show that the simple curettage, but very accurate, without executions of complementary surgical procedures results in every case in the recovery of the lesion with good results on the mobility of the treated segments.

**Material and methods** Between 1975 and 2007 we submitted 224 patients with chondroma of the hand to a very accurate simple curettage.

**Results** The simple curettage of the injury in our experience results in the constant recovery of the lesion and reconstruction of the bone stoke in a relatively little times (2–4 months), without neither post-operating rigidity, nor spontaneous fractures after curettage. Nevertheless, there are possible rare focal (2%) recidivisms.

**Conclusions** Despite the literature insists around the necessity of bony graft or biomaterial in the filling of the pathological hollow after emptying the chondromas, in our experience, these procedures not necessary since we obtained a rapid and constant spontaneous reconstruction of the local bone stoke. We also treated by simple curettage chondromas of elevated dimensions with serious cortical blowing, severe thinning of the residual bone, extreme extension of the injury, pathological fractures. The recovery in these extreme cases by simple curettage convinced us about not legitimacy of surgical accessories procedures in treatment of hand's chondromas.

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### CT-guided radiofrequency thermal ablation of osteoid osteoma. Experience of the Orthopedics Unit of G. Gaslini Institute of Genoa, Italy

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Our experience in the use of CT-guided radiofrequency thermal ablation dates back to March 2003 and, to date, we treated 32 cases of osteoid osteoma and 1 of osteoblastoma. All cases were documented by X-ray, CT and bone scintigraphy.

Localisations were femoral neck (11 cases), tibia (8), femoral diaphysis (2), acetabulum (2), radius (2), heel (2), femoral head (5). Patients' age range was 3–15 years.

Complications included 1 case of skin burn and 1 relapse successfully treated with one session of thermoablation.

We used both single active tip needles and multiple tip needles (umbrella-shaped). At first, we performed radiofrequency thermal ablation using a single needle, but in a short time we started to use LeVein electrode by Boston Scientific connected to an RF 3000 tm radiofrequency generator, characterized by stiff needle, with adjustable opening of umbrella-shaped tips and direct control of the generator, namely of the functioning of each thermocouple, ablation area and consequent 1 to 4 cm diameter necrosis.

Subsequently, we adopted RITA starbust – Medical System needle electrode connected to its generator and provided with specific insulating and non-thermoconductive introducer assuring further protection against possible burning of surrounding soft tissues. This system allows the use of stiff or flexible needle electrodes, adjustable opening of their umbrella-shaped tips, direct control of the generator, i.e. of the functioning of the 5 thermocouples. Ablation area and consequent necrosis ranges from 1 to 5 cm in diameter.

Both needles offer a very good control system to identify the end-of-treatment point: as the area progressively undergoes necrosis, impedance increases. When maximum impedance, corresponding to complete necrosis of the area, is reached, the system automatically starts a progressive decrease of alternate current.

### Treatment of primary malignant tumours of clavicle

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Clavicle is most commonly affected by fractures and inflammatory and tumour-like lesions, such as osteitis condensans, chronic sclerosing osteomyelitis and eosinophilic granuloma. On the contrary, primary tumours of clavicle are very rare, and little literature is available regarding their clinic-pathological characteristics and outcomes [1]. Malignant tumours are more frequently observed than benign lesions, and the commonest histological diagnosis of clavicular tumours has been reported as myeloma, osteosarcoma and Ewing sarcoma [2].

The aim of this study is to analyse the clinical features, imaging, histopathology, and modality of treatment of 6 patients affected by primary tumours of clavicle who came in Orthopaedic Science and Traumatology Department of UCSC in Rome from 2003 to 2007.

Two out of 6 patients had plasmocytoma; the remaining 3 patients presented, respectively, 1 PNET, 1 lymphoma and 1 high grade chondrosarcoma. Another patient was affected by a fibrosarcoma secondary to radiant therapy for a Hodgkin lymphoma. In 5 cases an incision biopsy was mandatory for diagnosis, while in 1 patient fine needle aspiration cytology (FNAC) of supraclavicular lymph nodes was sufficient for diagnosis of non Hodgkin lymphoma. In all cases Rx, CT and MRI with contrast of clavicle and/or total body were useful for staging of disease and/or surgical planning.

Four patients underwent surgical treatment, and they were treated with partial or complete cleidectomy, without reconstruction. The patient affected by PNET was also treated with neoadjuvant and adjuvant chemo- and radiotherapy; the others 2 patients presenting haematological disease underwent only chemotherapy. Surgically treated patients were followed-up by means of the Constant score and the functional evaluation form recommended by MSTs [3]. The functional and oncological results of cleidectomy were good: all



surgically treated patients are still alive without local relapse. Only in 1 patient affected by myeloma treated with chemotherapy there were severe complications because of the rapid progression of disease.

This study shows that the majority of clavicular tumors have an insidious clinical onset. Imaging based on Rx, TC and MRI and an accurately performed biopsy have a crucial role in diagnosis, staging, and therapeutics planning. We focus on the cleidectomy, partial in lateral clavicular localizations and total in medial ones, as an effective therapeutic procedure, with no severe complications and with mild functional limitations. Surgical reconstruction with plates and screws and PMMA, or allograft is useful only in intercalary localizations, burdened with a high risk of infection especially in patients candidate for adjuvant radiotherapy.

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## SESSION 32

### The treatment of the osteoid osteoma using radiofrequency thermoablation

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**Objective** In the last decade new minimally invasive techniques have been used for the treatment of osteoid osteoma (OO). Radiofrequency ablation has emerged as a promising alternative to surgery in order to delete the “nidus” with a thermal effect.

**Material and methods** From January 2006 to December 2008, 16 patients with a clinical and radiographic diagnosis of osteoid osteoma were referred to our Department. The average age at the time of diagnosis was 27.4 years (range 5–40). Among them 13 were males (81.3%) and 3 females (18.7%). In 8 cases the lesion was localized at the femur, in 5 cases at the tibia and in 3 cases at the level of carpal bones. The procedure consisted in a percutaneous ablation of the lesion performed by introducing an RF electrode in the “nidus” under CT guidance. A clinical success was defined as the complete remission of the pain, while a technical success was the correct positioning of the electrode in the “nidus” and an adequate ablation time.

**Results** At an average follow-up of 10.2 month (range 2–24) no immediate complications were encountered, in one case we observed a superficial thermal necrosis of the skin resolved in 15 days. The treatment was technically successful in all cases, while in one case the surgical removal of the “nidus” was necessary with a clinical success rate of 93.7% in the series.

**Discussion** Radiofrequency ablation is an effective, safe option for the treatment of OO. Up to now it has become the “golden standard” for the treatment of these lesions because of its high rate of success and its less invasivity if compared with surgical excision. The patient can immediately weight-bear and is discharged the day after the procedure reducing the costs related to the hospitalization. Potential disadvantage is the relative scarcity of the tissue available for the histological examination. In our series only in 4 cases we had the confirmation of the lesion’s nature, while in the remaining cases the harvested material was judged insufficient.



### Orthopaedic surgery in multiple myeloma: from palliation to basic cancer research

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Multiple Myeloma (MM) is a plasma cell malignancy characterized by diffuse bone involvement and various systemic manifestations. Osteolytic lesions associated with MM are typically multifocal, but can warrant orthopaedic intervention when pathological fracture or spinal cord compression occur. Although Myeloma remains at present an incurable disease, the survival of patients has recently been greatly improved by the introduction of novel biological agents. While toxicity and primary and secondary resistance to chemotherapy remain major issues, the development of predictive and novel therapeutic strategies for this condition is still hindered by the scarceness of biological models. In this scenario, patient-derived MM cells are an extremely valuable resource for both pre-clinical and clinical research. The possibility to perform biological assays (such as in vitro drug sensitivity or functional tests), however, demands substantial amounts of neoplastic

cells, which might be difficult to obtain from bone aspirates alone. Moreover, the latter procedure only allows for the retrieval of diffusely infiltrating myeloma cells, while no information is gathered on those cells, possibly endowed with an even more aggressive phenotype, that are responsible for the development of osteolytic lesions.

We herein report our pilot experiments on intraoperative sampling and isolation of myeloma cells, which allowed us to perform *in vitro* biochemical assays as well as drug sensitivity assays.

Intralesional material or medullary blood derived from shaft reaming was collected from patients undergoing orthopaedic surgery for pathological fracture or surgical biopsy of osteolytic lesions. By mechanical processing and immunomagnetic positive selection for CD138, we obtained sufficient amounts of viable myeloma cells to assess drug sensitivity and perform problem-oriented biochemical tests, such as proteasomal activity assays, that valiantly contributed to wider studies. So far, orthopaedic surgery has played a palliative role in treating complications related to multiple myeloma. From our experience, however, the possibility arises to combine the treatment of the skeletal event with contribution to the research that eventually aims at preventing the complication itself.

### Ischemia with endovascular balloon during disarticulations and amputations of limbs

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**Objective** Limb disarticulation has been widely performed since the 18th century, especially in war surgery. Actually is infrequently done in orthopaedic and vascular surgery, and it is associated with a high mortality rate because of frequent comorbidities. Disarticulation usually is reserved for patients with malignant tumours or gangrene from severe atherosclerosis. During disarticulation, hemodynamic stability can be altered by hemorrhagic events in the femoral or humeral arteries. We propose an endovascular technique for proximal control of the artery to reduce blood loss during disarticulation. Our experience today is limited at hip disarticulation.

**Material and methods** The vascular access was percutaneous at the common femoral artery of the healthy limb. A 6 French (Fr) introducer sheath was placed using the Seldinger technique. Under fluoroscopic control, with a portable vascular C-arm capable of digitally subtracter angiogram and roadmap angiography, a 0.035 inch hydrophilic guide wire was crossed over into the opposite side iliac artery through a 5F contra angiographic catheter placed at the aortic bifurcation. After a diagnostic angiography the guide wire was replaced with an Amplatz 0.0035 inch, 260 cm long, super stiff guide wire. Then, a 7 × 20 mm Ultra-thin™ SDS balloon catheter was placed in the external iliac artery and systemic heparinization with 2500 UI was performed. The balloon catheter was inflated and femoral pulsation ceased immediately. After proximal, endovascular occlusion, hip disarticulation was accomplished without any hemorrhagic complication. At the end of procedure, the balloon was deflated and removed. Hemostasis of the surgical field completed the procedure. The femoral access in the healthy common femoral artery was controlled with a 6 Fr Angio-seal percutaneous hemostatic system.

**Results and discussion** In hip disarticulation, hemostatic tourniquets cannot be used of the location of the operating field. Therefore, control of bleeding is a major issue in this procedure. Various techniques have been proposed, femoral vessels and nerves were attached

before the disarticulation. The use of semi-compliant balloon catheters for endovascular occlusion avoids injury to the endothelium of the vessel wall during balloon inflation. However preoperative assessment, with color-duplex scanning and plain abdominal radiographs, is mandatory; coexisting atherosclerosis often is present especially in elderly patients, and severe wall calcification can lead to vessel rupture and retroperitoneal hematoma, or even balloon catheter rupture. Moreover, color-duplex scanning and radiographs will help in choosing the landing-zone for balloon inflation.

**Conclusions** Endovascular balloon assistance is a simple, safe and effective technique in preventing major arterial bleeding during amputation or disarticulation and can be routinely used.

### Diagnosis and treatment of a giant cells tumor of sacrum bone

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**Objective** The sacrum is the third most common site of involvement of the skeleton. The treatment of the Giants Cells Tumor of the Sacrum Bone (GCTs) is controversial. Although it is a kind lesion at its appearance, the anatomic zone of the onset often involves much structures, like spinal roots, iliacs vessels, bladder and womb. Patients with sacral GCTs present with localized pain in the lower back that may radiate to one or both lower limbs. Vague abdominal complaints, bowel and bladder symptoms may also be present.

**Methods** The treatment may vary: surgical with wide resection, surgical with curettages and cryotherapy, surgical with only curettage, conservative with radiotherapy. However only rarely apply to wide resections and it is performed in cases with neurological deficit and compromise of spine stability. In our case the patient was operated and a surgical procedure with curettages of the sacrum bone was performed. The sacral tumor was embolized 2 days preoperatively.

**Results** A woman 52-year-old with a GCTs of the sacrum bone, without neurological signs was treated in our Department; the patient presented slowly progressive pain, the mass in the abdomen producing feeling of heaviness. Neuroimaging work-up included advanced modalities, preferably MRI, prior to obtaining a biopsy specimen. Also X-Ray, TC, scintigraphy t.b were performed. We operated the patient in September 2008, performing surgery with curettage and bone graft. At present the patient is in good conditions and subjected to periodical follow-up.

**Discussion** Complete surgical excision is very difficult in giant cell tumors of the sacrum. Intralesional removal of as much lesion as possible followed by radiation of the tumor site has been associated with acceptable tumor control. There is concern about secondary malignancy arising in irradiated giant cell tumors. Several reconstructive methods are utilized depending on the extent of bony defect, sometimes no reconstruction is needed. Giant cell tumor has a 1–5% rate of metastasizing to the lung and may convert to a fulminating malignant variant. Chemotherapy is not used.

**Conclusions** The surgical treatment with curettage of GCTs of the sacrum bone without neurological signs has shown to be best option, in spite of the high possibility of relapsing disease (40–50%). Following surgery, patients should be made aware of the ongoing risk of local recurrence. Patients should be followed-up on a regular basis for the first 2 years at least. Local recurrence of giant cell tumor should trigger a complete work-up including CT scan of the chest, abdomen and pelvis.

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**Chronic Type III acromioclavicular dislocation as cause of cervical spine disorders**

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**Purpose** This study was aimed at evaluating if patients with chronic type III acromioclavicular dislocation develop more frequently cervical spine symptoms respect to normal subjects.

**Methods** The cervical spine of 34 patients with chronic type III AC dislocation was radiographically evaluated. Osteophytosis presence was registered. Narrowing of intervertebral disc and cervical lordosis were evaluated. Subjective cervical symptoms were investigated using the Northwick Park Neck Pain Questionnaire (NPQ). One-hundred healthy volunteers were recruited as control group.

**Results** Rate and distribution of osteophytosis and narrowed intervertebral disc resulted similar in both of the groups. Patients with chronic AC dislocation had a lower value of cervical lordosis. NPQ score was 17.3% in patients with AC separation (100% = worst result) and 2.2% in the control group ( $p < 0.05$ ). An inverse significant nonparametric correlation was found between NPQ value and lordosis degree in the AC dislocation group ( $p = 0.001$ ) while in the control group results are not correlated ( $p = 0.27$ ).

**Conclusions** Our study shows that chronic type III AC dislocation does not interfere with osteophytes formation or intervertebral disc narrowing, but that it may predispose to cervical hypolordosis. The higher mean NPQ values have been observed in patients with chronic AC dislocation, mainly in those who developed cervical hypolordosis.

**Level of evidence** Level IV, prognostic case series.

evaluate indications and outcome of distal tibial fractures treated with minimally invasive surgery (M.I.S) by plating or by intramedullary nailing [1]. Minimally invasive surgical techniques [2] have important advantages, mainly biological: limited soft tissue lesions, respect of the fracture’s haematoma and the bone’s vascular supply. These are the basic ideas in this procedure.

**Material and methods** We treated 18 patients using fixed angle stability plates and 18 using intramedullary nailing [3] leaving out the open fractures and the types C2, C3, B2 according to A.O. classification, because in these cases we preferred traditional methods. The tourniquet was not used in any patient, in order to prevent blood flow problems and to obtain a better local diffusion of antibiotics.

**Results** In the group treated with plates, we had a few complications: 1 infected wound in a diabetic patient that healed with antibiotics, 1 case of malunion with remaining 5 varus degrees and 2 cases of screw breakage. In the Naling’s group we had only 1 complication (varus deviation over 3 degrees) and, so, the outcome was satisfying. A correct surgical indication and surgeon’s experience are mandatory in M.I.S.

**Conclusions** We prefer the intramedullary nailing procedure in fracture types A and C1, while plating allows to obtain good results in type C2, but these cases need careful patient selection and skilled surgeons.

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**Radiographic risk for glenoid component loosening in shoulder arthroplasty**

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Glenoid component is the weak point in the failure of shoulder arthroplasty [1]. In this study we analyse the radiographic risk observed on 86 cemented polyethylene glenoid component and their relationship with simple shoulder test (SST) and Constant–Murley score (CS) at mean follow-up of 5.8 years [2]. X-ray were taken to assess periprosthetic radiolucency, glenoid tilt, medial displacement and polyethylene thinning. The Pearson correlation coefficient and Spearman’s ranks correlation coefficient were calculated for statistical analysis. In 61 patients (71%) radiolucent lines were less than 2 mm wide (grade 2), in 6 cases (7%) were equal or greater than 2 mm (grade 3 and 4). Thinning of polyethylene was found in 11 cases (13%), glenoid tilt in 6 cases (7%), medial migration of the component in 5 cases (6%). Complete glenoid component loosening was found in 3 cases (3.5%) associated with polyethylene wear and glenoid bone loss. The mean SST score was  $4.8 \pm 2.8$  in case of glenoid tilt and medial migration ( $p < 0.05$ ). The mean CS associated

**SESSION 33****Distal tibial fractures management. Minimally invasive surgical procedure (M.I.S) by comparison: plating versus intramedullary nailing**

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**Objective** The tibial pilon fractures are the most damaging for the joint and are very difficult to treat. The purpose of our study is to

with grade 3 and 4 of radiolucency was less than 45% ( $38.3 \pm 8.9$ ) ( $p < 0.05$ ), while a score less than 56% ( $30.7 \pm 8.7$ ) was found in patient with glenoid tilt and medial migration of the component. An exhaustive radiographic analysis is essential to depict early and late complications or risk factors of glenoid loosening. Conversion in hemiarthroplasty or in reverse prostheses is suggested in painful glenoid loosening.

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