

## In-Depth Oral Presentations and Oral Communications

### IN-DEPTH ORAL PRESENTATIONS

#### *HIP (FIRST HALF)*

##### **A new polymer for total hip arthroplasty. First Italian experiences**

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The success of a total hip arthroplasty is linked to a long survival, and this one is obtained reducing the surfaces wearing. Polyethylene material was introduced by Sir John Charnley in the 60's and has been until now the cartilage most similar material regarding the Young modulus, despite metal and ceramic ones. It has been also characterized by a good wear, especially nowadays the highly cross-linked polyethylene technology has been developed. In the last years, research has been oriented to already used materials improvement such as metals and metal alloys (steel, titanium, CrCo, tantalum), to study and product dense and bioactive ceramics (alumina), to study and product polymeric and composite materials.

The physical properties of some polymers have shown to be very similar to those of the normal cartilage. Considering that the most relevant impairment in an arthritic hip regard the articular cartilage, it's easy to figure out the importance of regaining the cartilage function in anatomical THA surgery. Years of study and laboratory tests have led to the production of a new acetabulum module made of PCU (polycarbonate urethane), which would play a buffer/plug role, as the normal cartilage of a healthy hip does. The emerging buffer characteristics consist of the mentioned optimum modulus of elasticity which results moreover as a shock absorber, and the optimum microelastodynamic lubrication which reduce the friction coefficient.

The buffer is presented as an acetabular cup to be inserted in a metal back (titanium coated CrCoMo) press-fit implanted. It can also be implanted directly in contact with the acetabular bone, previous the thin residual cartilage layer removal, allowing a more anatomical surgery and a bone stock sparing. PCU buffer is intended to be a new way of thinking total hip arthroplasty, nevertheless the acquired experience is actually confined among few Centers and further laboratory tests are going to be concluded. The path has drawn, it has just to be covered!

##### **Crosslinking and vitamin E: new polyethylenes for orthopaedic surgery**

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Ultra High Molecular Weight Polyethylene (UHMWPE) is the most widely used biomaterial for articular interface in orthopaedic joint implants, thanks to its elevated resistance to abrasion and to mechanical stresses. Nevertheless, in the past years failures of the joint prostheses due to osteolysis from polyethylene debris have been described [1].

This work is based on the study of 500 polyethylene inserts from explanted hip and knee prostheses and from more than 100 implant liners still to be implanted, in order to understand which processes occur in vivo and what is their role in implant biomechanics and failures. The goal is to understand the mechanisms of past failures and describe positive and negative characteristics of new materials.

Historically, the main cause of failure is known to be the decrease of mechanical properties of UHMWPE determined by the effect of high energy radiations used for sterilization, especially if the irradiation is conducted in the presence of oxygen [2]. The oxidative degradation which follows is the cause of the degeneration of the chemical and physical properties of the polymer. The sterilization by irradiation in an inert atmosphere or under-vacuum is not the definitive solution to the oxidation, due to the amount of oxygen which is still present in the material. On the contrary, sterilization by gas (ethylene oxide, EtO, and gas-plasma) does not affect the mechanical properties of the UHMWPE.

Moreover, oxygen permeable packaging worsens the degradation during storage. Since 2005 the Italian Ministry of Health advised not to use inserts which have been gamma-irradiated in air and stored for more than 5 years. The new crosslinked-polyethylenes (X-PE) have a greater resistance to abrasion and oxidation compared to the conventional one, but they also have other mechanical properties decreased. The X-PE of second generation tried to avoid this problem. However, the role of wear debris from X-PE is still unclear because they are smaller and more active than those from UHMWPE.

The addition of stabilizers to oxidation (in particular vitamin E) has been recently proposed to solve the problem of oxidative degradation and loss of mechanical properties. Antioxidants may also be useful for the conventional UHMWPE and also for the second generation X-PE, even if properly sterilized [1].

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##### **Debris disease and stress shielding: analysis in relation to materials and couplings in hip prostheses beyond a 10-year follow-up**

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Debris disease and stress shielding are certainly among the most important causes limiting prosthetic duration. They are, to a large extent, influenced by the materials utilized for the construction of the prostheses and by the coupling between the acetabular and femoral components. Other factors such as the design, the dimensions of the head and of the acetabulum, the potential impingements of the components in addition to those factors associated to the individual patient, including his weight, activity, age etc. albeit (we recognize that they carry) carrying a considerable importance, have not been addressed to in the present study.

Stress distribution modulates periprosthetic bone remodeling, thus influencing the life of the implant over time and the results of the prosthetic implant. The most frequent negative events are debris induced periprosthetic osteolysis and stress shielding, i.e. the sliding of loads around the implant which causes bone atrophy, on the one hand, and hypertrophy and sclerosis on the other hand.

In the present study we have evaluated the osteolytic phenomena and the remodeling changes in relation to the materials employed together with their respective coupling.

The materials investigated in the present study were titanium, ceramics (alumina) and polyethylene, as were the couplings ceramics-polyethylene and ceramics-ceramics. The couplings metal-polyethylene and metal-metal have not been addressed to in the present study.

The analysis that we have carried out refers to 32 implants that have been evaluated 10 years or longer after implantation. We performed both a retrospective assessment of the evolution of the two phenomena in their progress and a prospective appraisal of the life and the survival of the implanted prostheses with a follow-up extending beyond 10 years.

The prostheses we have evaluated were cementless and belonged to two types: the Antega designed to preserve metaphyseal cancellous bone and cervical base resection and CFP designed to preserve neck and resect it at the isthmus. A comparison was performed of the ceramic-ceramic and ceramic-polyethylene couplings (in some cases in the same subject in one hip, and respectively in the other hip) in the cases in which the Antega prostheses had been implanted. The couplings in CFP prostheses were always ceramics-polyethylene. In all the prostheses that we have investigated the diameter of the head was 28 mm and both the stem and the shell were in titanium with double coating (pure titanium and hydroxyapatite).

All the examined cases were still asymptomatic 10 years after the implant; they did not require any further surgical treatment and were therefore classified as excellent clinical results.

In all cases we carried out both a clinical assessment, achieved by means of the SIBOT-HARRIS score and a radiographic study, performed by means of antero-posterior and axial radiographic projections supplemented, in selected cases, by periprosthetic bone densitometry (DEXA). The results are reported in detail with a careful analysis of both the osteolysis, together with its relevant degree, and of the remodeling alterations.

Altogether, it is possible to predict that a number of prostheses will have an excellent further duration depending on an optimized bone-prosthesis interaction; whereas other cases present critical radiological signs which, in time, might even lead to aseptic loosening or deterioration of the clinical outcome, even if at the moment the clinical result are still good.

### Ceramic on ceramic total hip arthroplasty in patients younger than 50 years

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**Introduction** Osteolysis as a result of polyethylene wear debris remains one of the most important failure mechanisms in total hip arthroplasty (THA) and alternative bearing surfaces have been introduced in the clinical practice to minimize the negative effects of wear on implant survival; alumina-on-alumina couplings have demonstrated negligible wear rates over follow-up periods of as long as 30 years and provide an effective answer to young active patients.

**Material and methods** The purpose of this retrospective study was to report the results of a series of 102 consecutive alumina-on-alumina THAs done in 89 patients younger than 50 years; four different implants with 28, 32 and 36 mm diameter femoral heads and with two alumina ceramic bearings have been used. Clinical and radiographic follow-up was performed at 6 weeks, 3, 6 months, and 1 year after the operation and yearly thereafter: Harris hip ratings were determined preoperatively and at each follow-up examination, serial anteroposterior radiographs of the pelvis were analyzed by the same observer who was not involved in the operations.

**Results** None of the patients has been lost at the final follow-up at a mean of 7.5 years (range 1–16 years). The Harris hip score raised to a mean value of 92 points. Three anatomical cementless femoral stems were revised due to evidence of definite aseptic loosening, one cup changed for excessive abduction. None of the hip dislocate, none of the ceramic components (femoral head or acetabular inlay) broke out and osteolysis was undetectable.

**Conclusions** Our results confirm that the excellent tribological properties, the extreme hardness and the good surface finish permit ceramics to have excellent biocompatibility and allow the use of femoral heads larger than 28 mm, so providing simultaneously a low coefficient of friction, a high wear resistance, an increased range of motion and a decreased dislocation rate. This will lead to long-lasting total hip replacements.

### Relative risk of hip arthroplasty dislocation with small femoral heads (28 mm) versus larger ones (36 mm)

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**Objective** One of the worse complications of hip prosthesis is the dislocation, which occurs in 2–4% of the patients. Larger diameter femoral heads (36 mm) have been demonstrated effective in reducing dislocation rate and in increasing range of motion [1, 2]. This study compares the dislocation rate in the first year between two groups of hip prosthesis with different heads: diameter 28 and 36 mm, respectively.

**Material and methods** From 1990 to 2008, 457 hip prostheses using two different cup models were implanted: the Trilogy (Zimmer) cup, with 28 mm diameter femoral head, and the Delta (Lima-LTO), with 36 mm diameter femoral head. The average age at surgery was 65.5 years (29–84 years). The patient's type, the indication to hip replacement and the surgical technique were similar for the two groups. The patients were evaluated before surgery and then periodically with the HHS questionnaire and through radiographic controls. We calculated and compared the dislocation rate of the two groups in the first year after surgery.

**Results** 340 patients entered the study: 134 of them with a 28 mm diameter femoral head and 206 with a 36 mm diameter femoral head. In both groups all items of HHS improved from the pre-operative time to the post-operative one, without statistically significant differences ( $p < 0.05$ ) between the groups. In the first year, 4 cases of dislocation

in the group with 28 mm femoral head (2.9%) occurred, while only one case (0.5%) was found in the 36 mm group. The relative risk of dislocation using the 36 mm femoral head turned out of 0.18 ( $p = 0.14$ , Fisher's test). In both groups one case of aseptic loosening occurred, without statistically significant difference between the two groups for the survival of the system ( $p > 0.05$ ).

**Discussion** Both the cups are a good prosthetic solution in the mid term, as expected. It has been found a reduction of the dislocation's rate in the short term by using a 36 mm diameter femoral head. Although this result is not statistically significant, the relative risk is inferior to one. Using large diameter femoral head is a protecting factor towards the dislocation rate of the prosthesis.

#### References

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### Our experience with the use of TT (Trabecular Titanium) in hip arthroplasty surgery

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Trabecular Titanium is a material made by a Titanium alloy Ti6Al4 V which presents a porous hexagonal tridimensional multipolar structure obtained with an EBM (Electron Beam Melting) technique, which reproduces the cancellous bone characteristics in order to optimize the bone ingrowth and the vascularisation process. The diameter of the pores is 640  $\mu\text{m}$ , the porosity of the material is 65%.

We present our experience with the use of acetabular implants for hip arthroplasty made by Trabecular Titanium (Delta TT, Lima Lto, San Daniele del Friuli, Udine).

An important feature of these implants is that the core structure of the cup and the external structure are a continuum, and there is not a coverage of the cup.

From September 2007 we have implanted 150 Delta TT cups, 25 in 2007, 57 in 2008 and 68 in 2009, with variable diameters from 44 to 60 mm. Cups have been associated with C2 stems ( $n = 43$ ), C2 lateralized stems ( $n = 49$ ) and Modulus stems ( $n = 58$ ; Lima Lto, San Daniele del Friuli, Udine). In all cases a ceramic-ceramic bearing was used with heads of 32 mm ( $n = 61$ ), 36 ( $n = 79$ ) and 40 mm ( $n = 10$ ). In 2 cases the implant was bilateral.

The mean age of the patients was 57 years old (range 21–79), the mean follow-up 12 months.

Patients presented a mean pre-operative Harris Hip Score (HHS) of 40.2, and improved to a mean of 94.9 at final follow-up. 1 implant underwent revision at 9 months from surgery for aseptic loosening. In 7 cases radiolucent lines were seen around the cup (4 in Gruen zone 1, 0 in zone 2, 3 in zone 3). In all cases these lines were less than 2 mm and were stable at all controls.

Trabecular Titanium showed very good osteointegration with good results at a short term follow-up.

### HIP (SECOND HALF)

#### Short hip prosthesis: reality or fashion?

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**Objective** This study describes the indications to the use of short stem hip prosthesis and show the differences between different types of “conservative hip prosthesis” and their application with a very good outcome not only in young patients but also as a primary implant in elderly patients. Considerations from personal experience and literature on this field will be exposed.

**Material and methods** Personal experience is based on 40 cases of Two-step hip (type 1: implant total neck preserving), 60 cases of CFP (type 2: partial neck preserving hip), 32 cemented high neck cut short stem (Friendly short), 464 Proxima hip (type 3: seamless anatomic implants with horizontal high neck cut and lateral flare support).

**Results** In the CFP implant (type 2) we obtained good results only with good bone stock and we had 3 cases of thigh pain. Fair results were obtained with the Two step (type 1), although we had a not negligible rate of failure. Very good results were obtained in the 464 cases treated with the Proxima hip with no aseptic loosening and two septic loosening, and the same indications as of a traditional stemmed implants.

**Discussion** The short femoral stem in hip replacement is nowadays a reality. The young and high demanding patients with a good bone stock are the ideal target for this kind of prosthesis that can count on a large variety of designs although most of them show a common feature: the fixation occurs below the lesser trochanter in a three points way. This fact results sometimes in a no physiological load forces' distribution with a consequent stress-shielding although with rare tight pain. The Proxima implants are characterized by the presence of a lateral flare and a circumferential load distribution in metaphysal femur; features that allow their use in elderly and osteoporotic patients as well.

**Conclusions** While the conventional conservative femoral implants are a successful reality in young patients, Proxima seamless implants can provide very good results in the osteoporotic ones as well.

#### Fitmore stem: short term results

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**Introduction** As the number of young and active patients undergoing THA is increasing, there is greater need of using new uncemented prosthetic designs which may allow both contemporary restoration of the length and offset and the saving of bone stock. We report the preliminary results of our experience with Fitmore Stem (Zimmer), which has a design planned to preserve the bone stock and allows the saving of the trochanteric region and the soft tissues with an optimal

restoration of the anatomy through the perfect combination of the medial bending and the offset. The purpose of the study was the evaluation of intra-operative and early post-operative complications, the positioning of the prosthetic components, the preliminary clinical and X-ray results and above all the surgeon's learning curve.

**Material and methods** 120 Fitmore stems were implanted at our Units from January 2008 to August 2009. We used the Durum system in 20 cases, the Trilogy cup in 80 cases and a TMT modular cup in 20 patients. Sixty-six patients were men and 54 were women, the average age was 63 (range 29–75). In all cases we performed a mini posterolateral approach. The pre- and post-operative evaluation was done using the Harris Hip Scores (HHS). The post-operative X-ray analysis was performed to evaluate the correct positioning of the components compared with the pre-operative planning.

**Results** At an average follow-up of 15 months (range 6–27 months), the clinical X-ray results were good and satisfactory in all patients. We did not detect any case of luxation, infection or aseptic early mobilization. We were always able to restore the planned length and offset during surgery. In 95% of cases the size of the stem corresponded to the planned one.

**Conclusions** The Fitmore stem represents a correct and progressive evolution of the uncemented stems used so far, even having the same initial pressfit it allows saving trochanteric bone stock, an inferior percentage of heterotopic post-operative ossifications, very good versatility with the consequential restoration of the length and offset. In our short experience the Fitmore stem represents a reliable choice and a safe procedure even if longer follow-ups are required to evaluate the long-term percentage of failure.

### Highly crosslinked polyethylene in total hip replacement: clinical results over a 10-year follow-up

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**Objective** The highly crosslinked polyethylene has become the bearing material of choice for total hip replacement (THR) over the past decade. Crosslinking is a physical process that uses high energy radiation, permitting significant reduction in wear of acetabular liners, improving strength and fatigue resistance, while reducing important other mechanical properties of the polymer. Aim of the present study is to evaluate the long term results of the "DURASUL", UHMWPE liner, used at the Orthopaedic Clinic of University of Catania.

**Material and methods** Between March 1999 and February 2010, 485 Durasul liners were implanted for both primary and revisions prostheses. The group of study comprised 227 male and 258 female, with a mean age of 69 years (range 41–81 years). Correcta and CLS were the femoral components used, while Correcta, Fitmore and Trabecular Metal were the acetabular components. A 36 mm femoral head was utilized in 74 patients to improve stability and motion range of the prosthesis. The implants were followed both clinically, using the Merlè-D'Aubigne-Postel scale (0–18 points), and through the conventional radiology with serial controls at 3, 6, 12 months and then yearly.

**Results** The average follow-up was 7 years (range 1–11 years). Clinical results were good with a mean score that increases from 6 to 15 points in primary implants and from 3 to 11 in revisions. Radiographically there were no major signs of liner wear. Only 5 implants needed revision due to septic loosening. Inserts removed from the revised prostheses were sent to specialized laboratories to undergo MICRO-FTIR spectroscopic analysis. MICRO-FITIR spectroscopic analysis found no absorption around  $1,718\text{ cm}^{-1}$ , a typical expression of oxidative degradation products.

**Discussion** The long outcome of THR with long term follow-up depends on mechanical properties and physical characteristics of the implanted material. The highly crosslinked polyethylene, produced by a physical process that uses high energy radiation, is a safe and reliable material, that shows biocompatibility, reduction the amount of wear, the absence of oxidation, the possibility of using large diameter femoral heads.

**Conclusions** The highly crosslinked polyethylene has become the bearing material of choice for THR over the past decade and its use in total knee arthroplasty is increasing. Our series showed good results at long term follow-up, with a significant reduction in wear. However, clinical research should be directed to studying a new generation of polyethylene able to preserve the mechanical properties affected by crosslinking.

### Femoro-acetabular impingement. Classification, diagnosis and treatment

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**Introduction** The femoro-acetabular impingement (FAI) is the result of a number of congenital or acquired pathologies of the hip and it has as main pathogenetic element: an abnormal contact between the two joint components (acetabulum and proximal femoral epiphysis). Mainly male young adults, often athletes, are affected because of the repetition of gestures responsible for the conflict in these subjects.

**Classification** FAI has specific clinical and radiological characteristics and can be classified into three types: (1) CAM type (femoral); (2) Pincer type (acetabular); (3) CAM-Pincer mixed-type.

**Diagnosis** It is based on medical history (young and active patients, diseases or previous hip surgery), physical examination (reduced hip flexion and internal rotation) and on two classical tests:

- Provocative test for anterior impingement: flexion and internal rotation of the hip with the patient supine;
- Provocative test for posterior impingement: hip extension and external rotation with the patient prone.

The instrumental confirmation of the diagnosis relies on:

- Radiography (antero-posterior hip view, 45° axial view of the hip, "false profile" Lequesne view);
- Computed Tomography: useful for assessing the centering of the femoral head in respect to the acetabulum and eventual bone prominences, but does not show fibro-cartilaginous alterations;
- Magnetic Resonance Imaging an Arthro-MRI: more useful, compared to CT, for evaluating the intra-articular space, labral and cartilaginous lesions, and the presence of subchondral cysts.

**Treatment** If the conflict has already produced an overt arthritic degeneration, the only justified treatment is prosthetic replacement. If the disease is identified early it is possible indeed a conservative surgical treatment of articular heads in order to eliminate the causes of conflict and to re-delineate the anatomy of the joint.

In particular, the aim of this surgery is:

1. Recreating a proper off-set head of the femur neck with removal of bone formation in the neck;
2. Eliminating neck retroversion;
3. Repairing any associated injuries of the acetabular labrum and treating, where possible, other joint injuries.



**Conclusions** FAI is a condition to suspect, recognize and diagnose in all its aspects at an early stage, because when addressed in time, it can be treated surgically with conservative techniques. Conservative surgical treatment becomes useless in case of excessive joint degeneration.

### The use of Vivostat autologous fibrin sealant in femoro-acetabular impingement surgery. Preliminary experience on 250 cases

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We describe our experience on the first 250 cases of Ribas Mini Open Anterior femoro-acetabular osteoplasty in which we used an autologous fibrin sealant to manage the bleeding at the remodeled head-neck interface. The Vivostat System is a biotechnological process that enables reliable and reproducible preparation of autologous fibrin sealant without using cryoprecipitation and without the need for a separate thrombin component. The system provides the surgeon with up to 7 min of constant spraying from only 5 ml of fibrin sealant, giving the surgeon freedom to place the solution very accurately on the head-neck interface. Previous described complications with bone wax, like deep infections or formation of granulomas, led us to search another system to manage the bleeding on the femoral side after FAI Surgery. We did not observe any complication after the use of the autologous fibrin sealant spray. Even if we present an experience on a limited number of cases, the use of an autologous fibrin sealant spray in FAI surgery could give very good results in terms of control of bleeding on the remodelled head-neck interface.

## ORAL COMMUNICATIONS

### PAEDIATRIC ORTHOPAEDICS 1

#### Surgical hip dislocation for anatomic reorientation of moderate and severe slipped capital femoral epiphysis (SCFE)

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**Background** Significant controversies exist in the literature regarding the best treatment for SCFE. In fact a variety of surgical procedures have been described and they can be divided into fixation in situ, compensatory osteotomies and direct corrections of the deformity at head-neck junction. The first and the second group of procedures have, so far, not gained optimal control over the risk of avascular

necrosis or can not achieve an anatomically aligned epiphysis with normal blood supply, on the contrary the third techniques can obtain this target and prevent the residual pistol-grip deformity of the proximal femur. Subcapital reorientation of the epiphysis trough by surgical dislocation has been described as a safe and effective technique in the recent literature.

**Material and methods** A series of 20 SCFE which had been treated by subcapital osteotomy and a re-orientation trough a hip surgical dislocation was reviewed retrospectively. In four hips the slip was unstable and a reorientation without osteotomy was performed. Pre-operatively and at the time of this study, both groups of patients were clinically examined according to the Harris hip score and, only post-operatively, to WOMAC score test. Radiological follow-up examinations were carried out before the surgical procedure and on the more recent post-operative X-rays, preoperative and postoperative AP and LL Southwick angles were measured; the alfa angle were measured only in post-operative films. This case series was compared with other published case studies.

**Results** The average follow-up time was 10.7 months (6–96 months). Mean age at surgery was 14.2. The mean WOMAC score was 2.80 post-operatively (0.60 points for pain's items and 2.20 for function items). Mean pre-operative slip angle was 40.2 degrees in antero-posterior view and 50.65 degrees in lateral view. Post-operatively mean values were 7.20 degrees in anteroposterior view and 9.45 degrees in lateral view. Post-operative average alpha angle was 43.11 degrees. No avascular necrosis was reported. One hip required revision due to pin penetration into joint.

**Discussion** Reported short term results are similar to clinical and radiographic test outcomes published in recent literature. The rate of complications seems favourably compared with the surgical complexity of this technique. Surgical dislocation and the preparation of an extended retinacular flap offers sufficient advantages in assessing and treating these complex deformities, and although the technique is demanding, a judicious application provides the prerequisites for a favourable long term outcome.

#### Surgical treatment of foot and knee deformities in arthrogyposis

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We review the experience of the Department of Paediatric Orthopaedics and Traumatology of Rizzoli Orthopaedic Institute of Bologna and the literature concerning surgical treatment for knee and foot deformities in patients with arthrogyposis.

Arthrogyposis is a descriptive term that encompasses a group of heterogeneous disorders presenting with multiple congenital joint contractures.

Knee deformities are present in about 60–85% of patients with Arthrogyposis Multiplex Congenita. Among these, knee flexion contractures are more common and disabling, and show significant resistance to treatment and rate of recurrence. Surgical procedures vary with the severity of contracture and the age of patient, and include release of posterior soft tissues with tendon lengthening, femoral extension and shortening osteotomy, and progressive correction by means of Ilizarov external fixation methods.

Hyperextension deformities have a better prognosis for walking ability. Percutaneous quadriceps tenotomy, quadriceps plasty with anterior capsulotomy or femoral shortening and flexion osteotomies may be performed.

Knee dislocations should be reduced early and usually require surgery.

Foot deformities are present in 80–90% of patients with arthrogyposis. The most common deformity is talipes equino-varus clubfoot, which shows a more significant stiffness and resistance to conservative (casting) treatment with respect to idiopathic clubfoot and a considerable rate of relapse. Surgical management is needed (some recent works report encouraging experiences with the Ponseti method, particularly in cases of distal arthrogyposes), generally requiring an early and extensive soft-tissue release.

For relapsed clubfoot, surgical procedures include the same operations performed for recurrences of idiopathic clubfoot (soft-tissue releases, shortening osteotomy of the lateral column, etc.) and also talectomy and progressive correction with Ilizarov procedures.

Congenital vertical talus is less common and requires circumferential soft-tissue releases.

## PAEDIATRIC ORTHOPAEDICS 2

### Idiopathic toe-walking in children: orthopaedic or neuromuscular problem? Clinical and ultrasound study

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Toe-Walking (TW) in children may be caused by neurological (for example, distal patterns of cerebral palsy) or neuromuscular diseases (for example, peripheral neuropathy or muscular dystrophy). In some patients no specific underlying pathology may be found (idiopathic TW), and in most of these patients this is associated with a limited dorsiflexion or Short Achilles Tendon (SAT).

Some authors have hypothesized that this is a congenital anomaly (Congenital SAT), in which the tendinous portion is shorter than normal and the muscle fibers of the soleus extend farther down than usual, as commonly seen in surgical procedures performed for this condition. Yet, some patients show a normal early ambulation and a progressive worsening with development of TW, suggesting a progressive contracture.

With the intent of contributing to a better clinical characterization of idiopathic TW in children, we examined a paediatric population referring to the Neuromuscular Clinic of the Rizzoli Orthopaedic Institute in Bologna, focusing attention on neurological deficit and contractures extent.

Fifty-nine (TW) children aged 22 months to 12 years with an otherwise normal personal history, psychomotor development and CK were included in the study.

In 12 patients, subtle distal neurological deficit was present and a diagnosis of cerebral palsy, SPG, mild SMA, or CMT disease was obtained after appropriated diagnostic tests. We defined the remaining 47 patients as PURE-TW.

Two PURE-TW subgroups were identified on the basis of extent of contractures in other joints (jaw, spine, elbow, wrist, fingers, hip, knee; TW-PLUS, 13 patients) or only affecting Achilles tendon (ISOLATED-TW, 34 patients). Evolution of TW-PLUS was more rapidly progressive and severe (77%) than ISOLATED-TW (50% relatively stable; mean follow-up: 4 years).

A deep neurological examination and characterization of contractures extent in TW children may contribute to better define diagnosis and prognosis in relation to management. Our hypothesis was that PURE-TW due to SAT may represent, mainly when extended to other joints

as in TW-PLUS, a distinctive feature of subclinical hereditary myopathies characterized by early onset joints contractures.

### Orthopaedic surgery in neuromuscular diseases, our experience with Charcot-Marie-Tooth disease

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**Introduction** The Charcot-Marie-Tooth disease (CMT) is a sensorimotor polyneuropathy that leads to degeneration of nerve fibers and a consequent weakening of muscles.

More than half of patients with this disease manifest foot at the ankle problems such as pain, fatigue, paresthesia, and deformity. The club foot and the cavovarus foot are among the most common deformity in these patients and these may be associated to deformity of the fingers.

**Material and methods** We have described several techniques for the treatment of deformity in CMT such as tendon transpositions, the elongation and release of the soft parts, osteotomies and arthrodesis. In our experience, in the presence of correctable deformities we performed tendon lengthening, while for structured deformities we performed osteotomies and arthrodesis. In this study we treated 12 patients, 7 male and 5 female, mean age 25 years (maximum 46 years, minimum 14 years) with CMT and equinus, cavo-varus foot. We performed tendon elongation (Achilles), osteotomies (calcaneus, metatarsal) and arthrodesis (finger) depending on the severity of the disease. The average follow-up period was 28 months for a maximum of 38 months and a minimum of 6.

**Results** No recurrence, abandoning the brace in half the cases, safer walking in all cases.

**Discussion** In this disease, patient evaluation as concerning the choice of the best surgical procedure is very important because more than in other diseases there are many variations in soft tissue and skeleton. The evolution of disease over time should also not discourage the surgeon but rather should be an incentive to closely monitor the progress of their work.

### Surgical treatment of foot congenital malformations

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**Objective** Congenital malformations of the lower limb are extremely frequent with an incidence of 15 on 10,000 born lives. The club foot and the flat foot are the most common ones, but many other different conditions can occur, which can be assimilated to hand congenital malformation as for as treatment and etiopathology are concerned. These last conditions, similarly to hand anomalies, prejudice function and morphology. In literature we do not find either wide revision of series or evaluation scales concerning the study of the different congenital anomalies of the foot. We propose an evaluation scale for the analysis of function, motion, morphology, and patient and family satisfaction.

**Materials and methods** Since January 2002 till December 2009, 41 babies with foot deformity were treated in our Unit, with the following pathologies:

- n = 29 abnormal formation defect (triphalangial allux, polydactylies, macrodactylies);
- n = 3 defect of formation (ipoplasty, brachydactylies e brachimetatarsy, symbrachidactylies, cleft, agenesy);
- n = 8 Ring Constriction Syndrome;
- n = 1 Syndromic condition (Apert Syndrome—Epidermolysis bulosa).

**Discussion** This complex conditions require a global approach by an experienced team, well trained on congenital conditions, who can manage completely the pathologies, the different anomalies which determine the condition and the evolution and the management of subsequent correction during growth. Polydactylies (central, lateral or medial) treatment includes the ablation of the supernumerary ray and the reconstruction of all the structures of the dominant digit, in order to prevent deviation of the axes. Epiphysiodesis or in severe cases significant defatting or even ray amputations are the possible solution in cases of macrodactylies. Bone lengthening is advised in brachymetatarsy. Toe syndactylies usually do not require separation, despite in cases of allux-2nd toe involvement. In constriction band syndrome the treatment could vary from simple interruption of the band to early salivation procedure, which must be performed in the first days of life.

**Results** In our series all the patients showed good results with a significant satisfaction of the family. No patient required second corrective procedure; walking was never compromised.

**Conclusions** The treatment of feet malformations similarly to hand congenital conditions, requires a complex approach by an oriented and well trained team.

### Orthopaedic experience in the treatment of the Marfan syndrome: age-dependence of skeletal features and genotype/phenotype correlation

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Marfan syndrome (MFS, MIM 154700) is a multiorgan pathology involving connective tissue, caused by a mutation of Fibrillina 1 gene, transmitted by an autosomic dominant fashion. Skeletal characteristics often drive patient to a screening for the syndrome; our experience suggested to check age-dependence of phenotypic manifestation of Ghent skeletal criteria and to value the accuracy of international diagnostic criteria for the MFS diagnosis during the growth of young people. Our study aims to verify if the presence of greater skeletal criteria is related with a more severe phenotype of the other organs interested and if there is a relation between the site of mutation and the age of skeletal characteristics manifestation, their clinical severity and the contemporary presence of the other Ghent characteristics.

We selected 307 patients affected by a mutation of Fibrillina 1 gene who were exposed to a clinical evaluation and to a multidisciplinary follow-up. Data were collected in a appropriate database, statistically analysed and compared with the literature.

In 273 (89%) out of 307 patients affected by Fibrillina 1 gene mutation, MFS was diagnosed by Ghent criteria. The presence percentage of diagnostic criteria reveals an age-related development: 82% in patients younger than 10 years and 95% in adolescents. Skeletal greater criteria were present in 24% of patients. Skeletal characteristics show greater incidence in adolescents. Some

characteristics, like scoliosis and cifosis, increase in adults. As concerning the genotype/phenotype correlation, we observed an increase of missense mutations interesting cysteina in the paediatric patients with greater skeletal criteria.

Our study demonstrated that the importance of greater skeletal criteria is related to the diagnosis of *de novo* mutations, it was fundamental in the 23.5% of children, in 28.5% of adolescents and in 18% of adults. We confirmed the elevated variable phenotype of Marfan syndrome, that manifest itself also in genetically identical patients, like homozygotes twins, and the age-related development of the phenotype. Our experience also showed some gaps in the international diagnostic Ghent criteria, that failed the diagnosis in 18% of children and in 5% of adolescents affected by MFS in our series; furthermore these criteria do not include cifosis, instead present in 25% of our patient. These data show the need of a strict follow-up in patient with doubtful MFS in paediatric age and the development of new diagnostic criteria for an early diagnosis.

### HIP 5

#### Use of HMSCS during hip replacement and hip revision surgery

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Long-term stability of total hip arthroplasty (THA) depends on the integration between osseous tissue and the biomaterial implant. Integrity of the osseous tissue requires the contribution of mesenchymal stem cells and their continuous differentiation into an osteoblastic phenotype.

Some studies, like Wang ML et al., show that chronic exposure to titanium and zirconium oxide wear debris may contribute to decreased bone formation at the bone/implant interface by reducing the population of viable human mesenchymal stem cells (hMSCs) and compromising their differentiation into functional osteoblasts.

On the basis of our good experience in the use of Exeter technique in revision surgery of THA (GIR II-III), 2 years ago we started to utilize bone grafts mixed with growth factors in order to improve grafts incorporation and implant fixation. At the moment we are studying the use of hMSCs during hip revision surgery, employing polyethylene cup to reduce the possible titanium and zirconium oxide debris. hMSCs are obtained with MarrowsStim Concentration Kit (Biomet Biologics Europe) by 60 ml of patient's bone marrow.

Clinical outcomes and quality of life are evaluated on the basis of Harris Hip Score, Womac score and SF-36 score, while bone graft incorporation features are assessed with post operative computed tomography (CT) examination and further CT controls at 2, 4, 8 months after surgery.

#### Our experience with modularity in hip prosthetic surgery

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We present our experience with modular implants with a conical stem and a proximal modularity in primary and revision total hip replacement surgery.

The choice of a conical shaft that can be assembled on its own axis with various modular necks is motivated by the need to adapt to an anomalous anatomical condition and to reconstruct (if not to build *ex-novo*) a correct dynamic balancing of joint kinematics, avoiding the forcing and compromises that can result from a monoblock stem.

Modular necks with engagement along the axis are useful to correct the leg length discrepancies and the offset, and to counterpart a suboptimal positioning of the cup. In the Modulus system the modular neck is assembled along the axis of the shaft, enabling the version to be corrected without limitations.

Essentially, the conical shaft with modular neck enables management of joints which are morphologically and functionally markedly altered for various reasons (DDH, outcomes of osteotomies, traumas) in which a traditional implant (monoblock, with anatomical conformation) would force the anatomy to adapt itself to the stem.

The stem/neck modularity and the independence of choice between the diameter of the stem and the length/version of the neck allow easy adaptation of various anatomical variations without the use of custom-made implants. It also offers the possibility of easily carrying out surgical procedures such as lowering the centre of rotation, muscle retension, osteotomy for femoral shortening, with the aim to restore a correct joint function.

Also in revision cases the concept of conicity introduced by Wagner becomes very useful and enables an easier management of severe bone losses of the proximal femur thanks to the distal fixation of the stem.

We evaluated the results of 239 primary total hip replacements performed using a conical stem combined with modular necks of different length and inclination (Modulus System, Lima Lto. San Daniele Del Friuli, Udine, Italia), in 222 patients (50 male, 172 female) who underwent the surgical procedure between October 2001 and December 2006. We also performed 75 revision implants with a similar modular system (Revision, Lima Lto.) in 75 patients (15 male, 60 female) between September 2004 and March 2009.

Harris Hip Score results at final follow-up were excellent in the primary group and good in the revision group. Three stems underwent revision in the primary group, while 7 cases underwent further revision of the femoral component and 3 cases revision of the cup in the revision group.

## KNEE 1

### Optimization of posteriorly stabilized knee prostheses

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The research aims at finding the best form of tibial cam in posteriorly stabilized total knee prostheses. In particular, we want to determine the best inclination in order to verify the maximum bearable loads and reduce the forces on the lower part of the tibial component of the prosthesis.

The analysis is carried out numerically, using the method of finite elements FEM, evaluating the course of the load according to the variation in the angle of inclination of the tibial cam.

The first step in the study is the use of a 3D Comet 5 scanner to obtain the three dimensional form of the model to be used in the successive FEM analysis.

To survey the 3D form, the Comet 5 uses the technique of frange projection, which consists in projecting the image with parallel franges and sinusoidal profile varying the phase angle so that they seem to pass over the surface of the piece. At the same time a video/camera acquires a series of images in which the grey tint of each pixel varies sinusoidally in relation to those of the projected franges and a phase angle dependent on the position of the areola space of the framed surface. The accuracy of the survey data will depend on the chosen framed field connected to the lenses in use.

When the 3D model of 2 prostheses has been obtained (Stryker and Tournier) the FEM analysis is carried out using a specific numeric code that allows the break down of the continuous model into a high number of elements of finite Dimensions—finite elements—and the identification of the state of tension on the tibial component with the variation of the angle of inclination of the tibial cam, when it is subject to a definite posterior load.

A process of optimization of the tibial cam inclination follows in order to minimize the forces on the lower part of the tibial component.

### Endo-model rotating hinged knee prosthesis: long term follow-up

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**Objective** The use of rotating hinged knee prosthesis is sometimes necessary during knee arthroplasty [1]. This study is a clinical and radiographic evaluation of the results of a series of Endo-Model (Link) hinged knee prosthesis.

**Material and methods** From 1992 to 2003, 114 knee prostheses Endo-Model were implanted in 97 patients. The patients' average age was 68.8 years (34–84 years), the average follow-up was 10 years (minimum 5 years). The indication to the surgery was: 67.7% knee arthritis, 20.9% reumatoid arthritis, 6.1% outcomes of fractures and 5.3% outcomes of osteotomy. Patients underwent clinical and radiographic controls after surgery at 3 and 6 months and successively every year. We used the Hospital for Special Surgery Knee Score for the clinical evaluation (HSS) and the Knee Society Roentgenographic Evaluation System for the radiographic one.

**Results** 44 patients were lost to follow-up (20 deceased), therefore 70 cases were included into the study (61.4%). All of the HSS scores showed a statistically significant increase from the pre-operative to the post-operative. The Range of Movement increased from 89.4° to 110.3°, the total score increased from 64.4 to 82.2 points ( $p < 0.05$ ). The radiographic analysis showed the presence of progressive radiolucent lines in 11 (15.7%) out of 70 analyzed cases. 23 implanted failed (20.2%): in 13 cases we re-implanted all the prosthesis, while in the remaining 10 cases we replaced only the femoral component. The cumulative survival turned out 83.9% at 14 years.

**Discussion** The long term survival and the good clinical and radiographic results demonstrated the validity of this type of implant, even if it is an hinged prosthesis with long cemented stems [2]. One of the problems of this model was the rupture of the hinge; in this case it may be necessary a revision surgery to remove the prosthesis. Another problem was the necessity to use an extensive diaphyseal cementation that can make the removal of the prosthesis difficult in case of failure. For these reasons the literature currently recommends the use of this type of implant only in case of severe ligament deficiency or in case of revision surgery.



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## Functional assessment of patients with knee bilateral replacement joint: comparison between conservation and displacement of the posterior cruciate ligament

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This work is aimed to verify eventual clinical and functional differences in patients with medium term knee bilateral replacement joint, not only by a clinical analysis but also by a functional and instrumental analysis.

The casuistry is composed by 20 patients, suffering from primitive gonarthrosis, with knee bilateral replacement joint. The surgeries were performed by the same surgeon and by using the prosthesis SCORPIO NRG STRYKER (Stryker Orthopaedics, New Jersey, USA) with fixed meniscus. The same patient has been implanted with the prosthesis on one side by keeping the posterior cruciate ligament, and on the other side by removing the cruciate ligament.

The clinical and functional assessments of the patients have been carried out by operators other than the surgery staff, therefore in blind as to the performed surgeries, with a follow-up of about 2 years. Beside the clinical evaluation composed by the Knee Society (KSS) score, the knee range of motion (ROM) and the X-ray assessment, a walk instrumental analysis was performed through an integrated system: VICON (Vicon Motion Systems, Oxford, UK) stereo photogrammetric system with 8 infrared rays cameras, 2 Kistler dynamometric platforms (Kistler Instrument, Winterthur, Switzerland) and Zerowire surface electromyography (Aurion, Milan, Italy). Both the prosthesis models have proven excellent clinical results (KSS and ROM), with slightly higher score for the model with crusade ligament removal.

The walk analysis highlighted the typical prosthesis alterations as the normal ones. Such alterations are of slight importance in prosthesis with crusade ligament removals, which seem to have a performance closer to normality.

## Total knee arthroplasty with and without computer navigation: real advantages in a comparative prospective randomized control study

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Several Authors reported that Computer-Assisted Surgery (CAS) could improve limb and prosthesis alignment and ligament balancing in total knee arthroplasty (TKA), and that CAS could very helpful to perform a less invasive surgical procedure. In order to evaluate the real impact on

final outcome of CAS in TKA, we conducted a prospective control study comparing the outcome of CAS and conventional TKA.

We analyzed 60 primaries TKA, randomly divided into two cohorts: group 1 = STD and group 2 = CAS, over three consecutive years. Both cohorts included 30 cases, all of them affected by primary knee osteoarthritis. The same model of prosthesis was implanted in all case, with the same surgical technique, carried out by a single surgeon. We conducted a clinical evaluation at pre-operative moment and at the consecutive Follow-Up (FU), using the American Knee Society Score (AKSS). We scored patient's satisfaction using the Oxford and the Ranawat Center questionnaire. We also recorded the main intra-operative data, such as total blood loss, surgical time, tourniquet time, Range of Motion (ROM). Finally, we performed a radiological study to obtain a quantitative evaluation of limb and prosthesis alignment.

The intra-operative blood loss was higher in patients of group STD, with an average difference of 127 ml, statistically significant ( $p = 0.0283$ ). Component position was acceptable for all implants, but the mechanical axe error of the CAS group was ( $1.00 \pm 0.20$ ) degrees, significantly less than that of the STD group ( $2.10 \pm 0.50$ ) degrees. The mean coronal femoral alignment was 90.00 degrees (range, 89–92 degrees) in CAS group, and 91.00 degrees (range, 88–93 degrees) in the STD group. The operating time of the CAS group was longer than that of the STD group, with an average time difference of 26 min, statistically significant [ $p = 0.005$ ]. The AKSS and the questionnaire analysis revealed a faster rehabilitation and earlier return to the daily life activities in the CAS group.

We conclude that the use of navigation in TKA increases accuracy in limb and implants alignment and improve the rehabilitation phase. By obtaining more reliable artificial joint implantation, CAS could improve prosthesis duration and joint function. It, however, needs more operating time.

## KNEE 2

### Megaprotheses in the treatment of severe not oncological knee bone loss

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**Introduction** In spite of the evolution of materials used in orthopaedic surgery, today the treatment of severe loss of distal femoral and/or proximal tibial bone stock is again a challenge for the orthopaedic surgeon. The megaprotheses, developed for tumoral bone pathology, represent a good option for the treatment of severe knee bone loss (AORI III) especially in elderly patients for the possibility of immediate weight-bearing and quick functional recovery. The purpose of the study was to analyze the results of megaprotheses in the treatment of severe knee bone loss.

**Material and methods** Eighteen megaprotheses were implanted at our Units from January 1995 to December 2008 for severe non oncological knee bone loss. The indications were: osteo-synthesis failures in 2 cases, periprosthetic fractures in 5 cases, TKR failures in 10 cases, distal femur fracture in severe arthritis in one case. We used until 2001 the HMRS system (How Medica) in 4 cases, and the new C megaprotheses system in the other 14 cases. Five patients were men and 13 were women, the average age was 77 years (range 75–86).

The pre- and post-operative evaluation was done using the Knee Society Scores.

**Results** At an average follow-up of 62 months (range 12–134 months), the clinical and X-ray results were satisfactory in 70% of patients. The average K.S. Score was 77 points (range 62–96). We did not detect any case of mechanical complications. We found 2 cases of implant infection and one case of DVT.

**Conclusions** The use of a megaprosthesis represents a limb salvage option when other surgical procedures are not indicated, more complicated and require long time to recover in elderly and sedentary patients. Although considered a difficult and dangerous surgical intervention, megaprosthesis reconstructions represent a quick and safe procedure with faster rehabilitation.

### Allpoly tibial component for unicompartmental knee replacement in patients older than eighty: a 4-year minimum follow-up study

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**Introduction** After an initial scepticism, unicompartmental knee replacement has become a well accepted treatment for unicompartmental arthritis of the knee. This less invasive implant has been advocated in elderly patients even in not isolated knee arthritis and mild laxity. The aim of this prospective unique trial was to assess the clinical outcome of a series of UKR implanted in patients older than 80 years at a minimum follow-up of 4 years.

**Material and methods** Between August 1999 and September 2005, 38 patients older than 80 years undergoing to a UKR because of arthritis of the knee were enrolled in the study. The average age was 84.1 (80–92) years and there were 16 males and 22 females. Pre-operatively and at the latest follow-up all the patients were evaluated by 2 independent orthopaedic surgeons not involved in the surgery. During the assessments both the Knee Society scoring instrument and the GIUM score were used. Radiologically every implant was assessed to consider any loosening sign.

**Results** All except 8 (deceased) were evaluated at a minimum follow-up of 4 years. Pre-operatively the average Knee Society score was 48.3, the functional score was 50.7 and the average GIUM score was 52.4. The average post-operative Knee Society score was 88, the average post-operative functional score was 77 and the average GIUM score increased to 75.5. No major complication caused by the implant selection was recorded.

**Discussion** According to our experience unicompartmental knee replacement is an attractive and relative less invasive option in the treatment of arthritis in elderly patients even with a non isolated femoro-tibial arthritis and mild instability.

### KNEE 3

#### Extramedullary alignment and anterior reference in total knee arthroplasty: a different way to perform TKR

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We describe our experience on 40 cases where we implanted total knee prostheses (Triathlon Stryker) using a new device based on extramedullary alignment and anterior anatomical reference (AP axis and anterior cortical area of distal femur).

The surgical technique requires the execution of the ligaments releases contextually to the access, the opening of the narrow joint space and the alignment of the guides of cut of the femur and the tibia, in one solution, perpendicular to the mechanical axle of the limb, that is reproduced through a special extramedullary guide endowed with radiopaque tool projected to center the head of the femur with brilliance intensifier.

The size of femoral component is chosen avoiding the more common Anterior-Posterior instrumentations, but templating the different size over the femoral distal cut area.

The correct rotation and the correct position on sagittal plane of the femoral component is got through devoted devices that use the AP axis and the anterior femoral cortical area as anatomical references. With such devices we got a good correction on the frontal and sagittal plan of all the types of varus-valgus articular deformity, with the same accuracy, reproducibility, simplicity and rapidity as using the common systems for intramedullary alignment, but with a less invasive surgical technique.

The system also allows an easier and less invasive determination of femoral component size and rotation if compared with other instrumentations because it allows to execute the last four femoral cuts with the knee at 60° of flexion instead of 120° as in the posterior condyle references devices.

The proposed device also results effective in presence of important deformities, in virtue of the reliability of the anatomical references considered.