

Augmentation of unstable pertrochanteric fractures in the osteoporotic elderly patient: operative technique for 1 or 2 head screw systems

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Abstract. The incidence of proximal femoral fractures has substantially risen in the elderly. This rise has been attributed to an increase in their life span and the underlying poor bone stock and osteoporosis. One of the main reasons for revision surgery, reported to be as high as 19%, is the cut-out of the fixation device at the apex of the femoral head. Augmentation, facilitated by injecting cement (PMMA) around the apex of the proximal screw of the fixation device is considered a useful method with regards to the increased purchase between the bone and implant interface. The aim of this study is the description of the cement Augmentation operative technique for unstable osteoporotic pertrochanteric fractures with 1-2 femoral head screw devices. (www.actabiomedica.it)

Key words: augmentation, the locker system, pertrochanteric fractures, osteoporosis, singh index, intramedullary nail, cut-out

Introduction

The incidence of proximal femoral fractures has substantially risen over the past years in the world population due to an increase in the life span of the population, associated with an increase in the life expectancy of the elderly (1). Furthermore, advanced age is directly correlated to an increase in the degree of osteoporosis. These factors, combined with lower motor coordination and a lower degree of attention, lead to more frequent falls and banal traumas on the lateral femoral surface that can lead to fractures. Available statistics expect the annual incidence of proximal femoral fractures to at least double by 2014 and identify the post-menopausal elderly woman as the most affected subject (2-4). These lesions are often characterised by a comminution of fragments and instability and these characteristics pose a challenge for the

orthopaedic surgeon when deciding which therapeutic option to choose. Among the most frequent complications worth mentioning are the cut out of the head screws in relation to technically incorrect implants, in particular osteoporotic bones or in situations of particular biomechanical instability. Cut-out, which is a complication widely described in the literature, presents an incidence of 4-19% and is responsible for the high 2-16% rate of re-operations in patients with pertrochanteric fractures (5-10). Numerous options exist to reduce the incidence of this disorder: treatment using more elastic implants, double head screw systems with the same or different diameter, plates with dynamic locking systems, but none of these presents immediate optimal stability under load, especially when we face the synthesis of unstable fractures characterised by a high degree of osteoporosis, as demonstrated by the fact that the cut-out is still present in all cases.

Improvement of synthesis devices over the past years has not run in parallel with an improvement of the bone quality of the elderly subject; on the contrary, the increase in the average age has inexorably led to having to deal with lesions characterised by marked osteoporosis.

Progressive mutations and micro-lesions at the level of the trabecular structure of the bone, as well as age, influence hold and elasticity.

In vitro and in vivo biomechanical studies have shown how the degree of damage severity is directly correlated to the trabecular structure of the bone: thin and rectilinear trabeculae, more oriented towards the main load axis, are predictive of low mechanical resistance (11).

Some in vitro and in vivo studies have tested the use of acrylic cement made from Polymethyl Methacrylate (PMMA) or calcium phosphate for the Augmentation support of the internal synthesis of these fractures (12, 13). The hypothesis we wanted to check was whether the Augmentation, obtained by injecting a few millilitres of cement around the apex of the head screw or screws, increases the resistance of the synthesis device to the shear stress that comes about during the load, preserving the implant from the cut-out complication. Recent in vitro biomechanical studies on cadaveric proximal femoral epiphysis treated with traditional implants supported by Augmentation have highlighted 50% lower synthesis failure rates than compared to the cemented ones suggesting that the Augmentation method increases the purchase of the osteoporotic bone synthesis device (14-17).

Objectives

The aim of this study is to describe the operative technique in the treatment of unstable pertrochanteric fractures in the elderly osteoporotic patient with Augmentation in support of an intramedullary synthesis with 1 or 2 head screws.

Materials and methods

The study was carried out at the Orthopaedic and Traumatology Clinic of the G.B. Rossi Polyclinic in

Verona between January 2006 and March 2012. 65 patients (29 males) presenting unstable pertrochanteric fractures and a high degree of osteoporosis (Singh 1-2 index) were treated (31 A2.2, A2.3 and A3 according to Ao classification).

The quantification of the degree of osteoporosis using the Singh index is a method, with limitations, broadly supported by the literature; it is not intended to replace dedicated investigations such as bone densitometry or similar investigations but can be a valid tool for immediate evaluation and especially without extra costs for the estimate of the mechanical bone purchase (18, 19).

The mean age of our patients at surgery was 86.27 (range 80-96).

Treatment consisted in the use of the Augmentation technique carried out with PMMA cement, The Locker Tecres associated with intramedullary nailing with a Gamma3 Stryker nail in 49 cases and a Veronail Orthofix in the remaining 14 patients (Figure 1). It is of fundamental importance to follow the correct instructions when using the Augmentation technique in pertrochanteric fractures and are therefore, limited to a particular type of fracture and to the type of patient. So-called stable fractures, such as the 31 A1 and the 31 A2.1, according to the AO classification and patients with a low degree of osteoporosis (Singh 3-5) are not indications for the use of this operative technique as the intrinsic stability of the fracture, reduced correctly,



Figure 1. Augmentation Tecres Kit

and good bone quality make this internal synthesis without Augmentation sufficiently safe and stable.

Operative technique

The correct positioning of the patient on the radiotransparent fracture bed is of fundamental importance: flex and abduct the contralateral leg as much as possible, placing it on a special support so that fluoroscopic monitoring can be carried out freely; abduct the upper part of the body by 20° to the contralateral side and adduct the affected leg by 15°, this will allow to access the intramedullary canal without obstructions even in heavily overweight patients.

Once the patient has been positioned, a closed reduction of the fracture is carried out with the help of an image intensifier: reduction should be achieved as anatomically as possible. Were this not achievable, semi-invasive manoeuvres and the use of ancillary equipment (levers, hooks) are recommended.

After having prepared a sterile field, the ideal skin incision must be minimally invasive: approximately a 3 cm skin incision extending cranially 2 cm from the tip of the great trochanter (GT). Once the apex of the GT has been reached through a longitudinal split of the muscular fibres of the gluteus medius muscle and after having located the entry point of the nail with a special tip, at the apex of the GT or in a slightly lateral position in the antero-posterior projection of the image intensifier and aligned along the intramedullary canal in the axillary projection, once penetrated into the intramedullary canal with a guide wire, the surgeon, according to the characteristics of the femur in question and the diameter of the synthesis device, will decide whether or not to proceed to bore with a power drill a 1.5 cm hole in the canal that has a greater diameter than that of the intramedullary nail in order to position it at such a depth so that the guide wire of the head screw reaches the inferior quadrant of the femoral neck at the level of the calcar in an antero-posterior projection and at the centre of the neck itself in the axillary position under fluoroscopic monitoring. Once the guide wire has been positioned correctly, the technique consists of different steps according to the synthesis device used, in our case the Gamma3 Stryker system or the Veronail Orthofix system.

Gamma3 version (Stryker)

Once the measurement of the screw to be used has been completed, one proceeds directly with the preparation of the femoral neck using a dedicated perforator, making sure that the guide wire does not migrate medially thus perforating the femoral head by regularly monitoring using an image intensifier. If this were to happen, in order to avoid the terrible complication of an overflow of the cement into the articular cavity, the Augmentation technique is not possible. In order to create a wider area around the screw head, so as to receive a greater quantity of cement, it is advisable to advance with the perforator approximately 2-3 mm beyond the limit of the guide wire. Once the screw has been inserted and locked into the femoral neck, the guide wire is removed and a special 50 cm long cannula, still hooked to the handle, through which the cement is injected, is inserted inside the screw (Figure 2). At the end of this procedure, the cement is prepared mixing it for approximately 1 minute. The homogeneous mixture obtained, which is introduced into a graduated manual pressure gun and connected via a tube to the cannula previously placed inside the screw, is injected into the femoral head (3-4 cc). The procedure must be carefully monitored using the image intensifier in order to produce a homogeneous cementation of the apex of the head screw (Figures 3, 4, 5). Once augmentation is

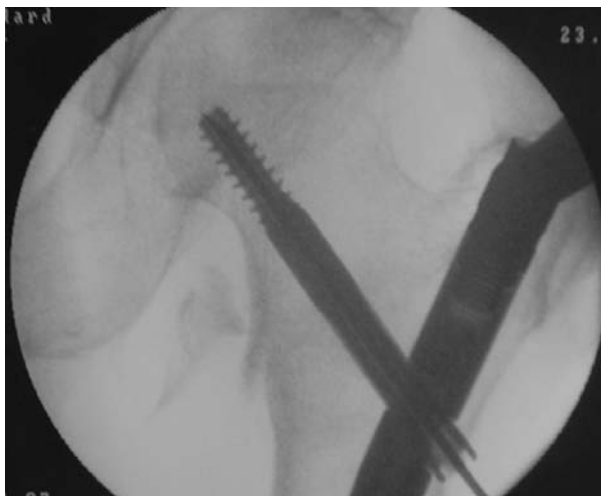


Figure 2. Fluoroscopic monitoring of the introduction of the cannula for augmentation

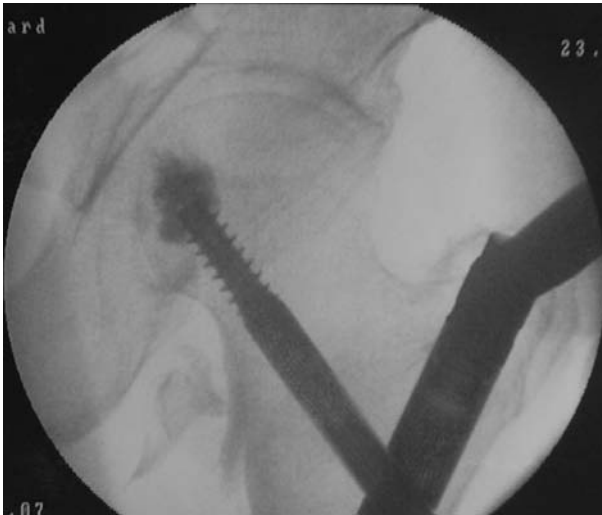


Figure 3. Fluoroscopic monitoring of the augmentation phase

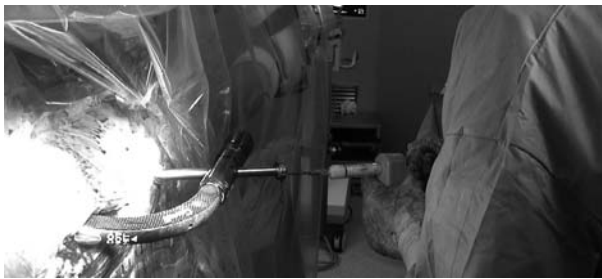


Figure 4. Augmentation phase

completed, one proceeds with the distal locking of the nail using a conventional technique.

Veronail Version (Orthofix)

When using a Veronail Orthofix nail, once the guide wire for the measurement of the head screws has been placed correctly (Fig. 6), one proceeds with the measurement of the length of the screws that will be used in a parallel or convergent configuration according to the degree of instability of the fracture. Having selected the most proximal of the two and having inserted its special insertion knob, one proceeds with drilling. Once perforation has been completed, and the cement has been prepared following the technique described previously, the shaft along which the screw will be introduced is cemented (Fig. 7), immediately after, the screw is inserted, repeating the procedure



Figure 5. AP x-ray of the Gamma3 system with augmentation

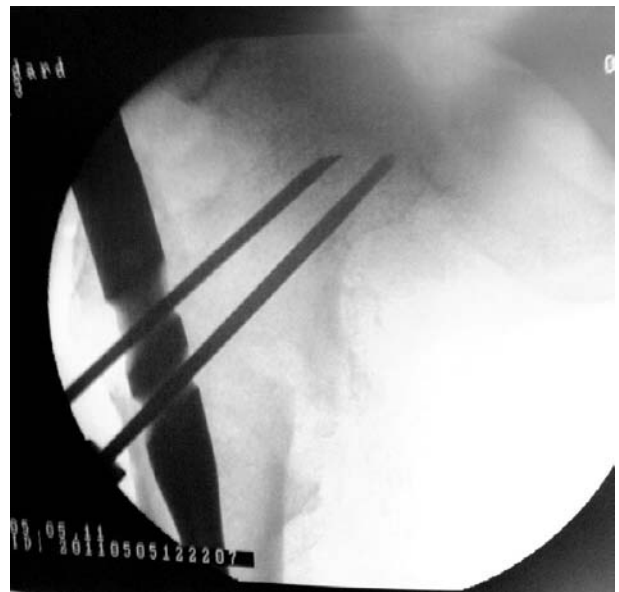


Figure 6. Fluoroscopic image of reduction and stabilisation with 2 guide wires of the head screws



Figure 7. Fluoroscopic image of the introduction of the cannula for the cementation of the proximal head

for the more distal head screw after having removed the guide wire (Fig. 8, 9). Also in this case, using the augmentation technique with a Gamma3 Stryker nail, it is fundamental not to damage the edge of the femoral head and perforate at least 2-3 mm beyond the length of the screw in order to carry out a more effec-

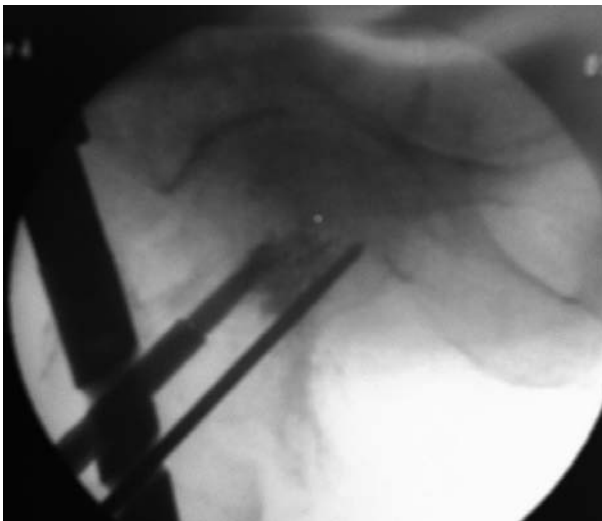


Figure 8. Fluoroscopic image of reduction and stabilisation with 2 guide wires of the head screws.



Figure 9. AP X-ray of the Veronail system with augmentation

tive augmentation. In this case, having to cement the two screw pitches, 2-3 cc of cement is recommended for each screw in order to create a homogeneous and solid purchase between the screws and the surrounding bone. As described in the technical sheet, we recommend distal locking of the implant when there is intrinsic instability of the fracture and a high degree of osteoporosis of our patients.

Discussion

The treatment of this type of fracture and its complications remains in many ways a major challenge for the orthopaedic surgeon.

The cut-out phenomenon, widely documented in the literature, takes on fundamental biomechanical relevance.

Numerous studies that have analysed it, report an excessive rigidity of the synthesis device and the reduced purchase of the osteoporotic bone, as the main culprits of implant failure (5-10).

In bones with poor bone stock, the shear stress generated at the level of the femoral head during the loading phases during regular walking, induce varus collapse of the implant and likely cut-out.

In 2005, Von der Linden P. et al. published the results of their biomechanical study carried out on cadaveric femoral heads demonstrating in vitro how the Augmentation technique protects the implant from cut-out present after just a few cycles of physiological load in conventional fracture syntheses (16).

Similar biomechanical results have also been obtained by numerous other authors like Sermone et al. who in 2012 analysed the stability of the PFNA (Synthes) in a solid structure such as expanded polyurethane miming a highly osteoporotic bone using the Augmentation technique.

The conclusions of this study are encouraging, highlighting a 225% greater resistance to the tendency of cut-out of the Augmentation implant than with a correctly positioned conventional implant and 933% resistance in implants with head screws placed in an eccentric position (20).

Interesting in vivo studies have demonstrated the efficacy of this type of treatment in highly selected cases; in 2011, Kammerlander et al. published their multicentre experience using intramedullary nailing with PFNA (Synthes) and Augmentation, with good and excellent results in 84.7% of cases in the absence of cut-out and necrosis of the femoral head (12).

The experience matured in our clinic since 2006 has led us to claim that Augmentation in unstable, pertrochanteric fractures in the elderly osteoporotic patient could be the solution to the cut-out phenomenon and allows us to have a faster recovery during

rehabilitation due to the possibility of mobilising the patient early on (13).

Despite a slight increase in initial costs, that are negligible if one considers the necessary cost of new cases of hospitalisation and re-intervention following implant failure, the Augmentation technique could represent a valid solution in the treatment of selected cases following indications and could be considered complementary to all instrumental procedures.

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