

Proximal cut-out in pertrochanteric femoral fracture

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Summary. The average age of population is increasing in parallel with the worldwide incidence of fractures of the proximal femur; among all of them, 45% is represented by pertrochanteric fractures. Many other significant co-morbidity and even mortality are associated to this fractures (osteoporosis, malnutrition, decreased physical activity, reduced visual acuity, neurological deficits, asthenia, balance disorders and altered reflexes). Due to osteoporosis, the greater frequency of these fractures occurs to elderly women. Among a total of 630 patients with pertrochanteric fracture treated in the Orthopedic Clinic of Trieste from January 2003 to December 2011, 16 cases were about Cut-out (5 males and 11 females). The mean follow-up after the revision surgery was 18 months. The aim of the study was to understand if in pertrochanteric fractures the best osteosynthesis can be guaranteed by the placement of an intramedullary nail or by positioning of plate and screws. It was established that, using intramedullary nail, the best target is to have a good positioning of the method of synthesis with a "Tip-Apex Distance" (TAD) of less than 25 millimeters.

Key words: Cut-out, Pertrochanteric fractures, Tip Apex Distance

Introduction

The worldwide incidence of fractures of the proximal femur is constantly growing, in parallel with the average age of the population.

Nowadays the incidence of these fractures in the "Western World" settles on 96 cases/100,000 resident people/year, with a prevalence for female sex (male/female ratio is 1:3).

Many authors predict that the number of these fractures will increase by 300% by the year 2050 (1).

Pertrochanteric fractures account for about 45% of all fractures of the proximal femur. Next to these epidemiological data must be added the fact that this fracture is accompanied by particularly important co-morbidity and mortality especially in the elderly population: about 20% of elderly patients with fracture of the proximal femur undergoes exitus within the first 12 months of the traumatic event.

The higher incidence of this type of fracture in the elderly is related to concomitant diseases: osteoporosis, malnutrition, reduced physical activity, decreased visual acuity, neurological deficits, altered reflexes, balance disorders, and asthenia (2).

Of all the above-mentioned diseases, osteoporosis plays a predominant role, which justifies a higher frequency of these fractures in elderly women (3,4).

The reduction of bone mass in elderly people is caused by several factors: reduced replicative and biosynthetic potential of osteoblasts, increased osteoclast activity, reduced physical activity, genetic predisposition, decreased calcium intake and endocrine-metabolic disorders.

Menopausal women are particularly at risk because of the absence of estrogen, and some studies have found that after 30 years since menopause women can lose 35% of cortical bone and 50% of cancellous bone.

The presence of osteoporosis, as well as being the

most frequent contributor cause of the fracture, influences in a decisive manner the intervention of osteosynthesis and the final result of its.

The trabecular bone of the femoral neck and of the femoral head may even suffer a quantitative reduction of 50%, thus leading to a compaction of the same trabeculae and then to a collapse of these structures.

For pertrochanteric fractures, which correspond to 45% of all fractures of the proximal end of the femur, the most often used treatment is osteosynthesis with intramedullary nail: the more frequent mechanical complication in this system of osteosynthesis is the cut-out of the proximal cephalic screw that is the protrusion of the head-cephalic screw from the bone that occurs with an incidence of 1.8-7.1%(5-12).

In this regard, the biomechanical factors are certainly the most involved in the genesis of the complication, but some possible mechanical causes of cut-outs are still the subject of debate. These are characterized by the type of fracture (according to the classification AO), by the stability of the reduction and by the cervico-diaphyseal angle of implant.

All the authors believe, however, that it is essential the position of the cephalic screw. Precisely because of the fact that the majority of patients with pertrochanteric fracture presents also a not negligible osteopenia, it is extremely important that the synthesis system is positioned so that the cephalic screw is inserted in the point of the head and neck of the femur in which the bone quality is better, ie in the postero-inferior quadrant near the calcar (13,14). The Calcar is made up of compact bone which is oriented longitudinally, which originates from the posteromedial region of the shaft of the femur immediately below the lesser trochanter and the side that radiates to the posterior aspect of the greater trochanter. It strengthens then the femoral neck postero-inferiorly.

The opinion that the screw should be placed in the central position on two floors or slightly lower and rear, is a common opinion, because the bone of the worst quality is located in the anterior-superior quadrant of the head and of the neck.

Another important factor highlighted by Baumgaertner et al. (15), is the tip-apex distance (TAD = Tipex-Apex Distance): this value is the sum of the distance in millimeters between the tip of the cephalic

screw and the apex of the femoral head in two projections AP and axial; it is believed that if the TAD is less than 25mm the risk of cut-out is almost zero (Fig. 1).

Our experience leads us to believe that proper fracture reduction and the choice of the most appropriate means of synthesis are also crucial, so that the synthesis neutralize the forces that tend to decompose the fracture and is capable of withstanding an early load. And then, to reach this goal, the most common techniques include encirclements, nails/plates and prosthesis:

- we consider to use encirclements for less stable fractures (but this is not our first choice), but seldom used because of bad quality of obtaining synthesis;
- prosthesis, following the goal to have a quick “standing up” of patient and an easier rehabilitation of bone function, but our disappoint against a common use of this technique is due to the most stress that cut muscles have to provide after surgery (this technique includes even a re-insertion of trochanters);
- nails, more used than plates, because have a better lever arm.

Objective of the study

This retrospective study was proposed to evaluate the clinical and functional results of revision for cut-out interventions with intramedullary nailing or through screw-plate. Were also compared the different systems of revision based on the type of fracture, the earliness of the load and the stability of the implant.

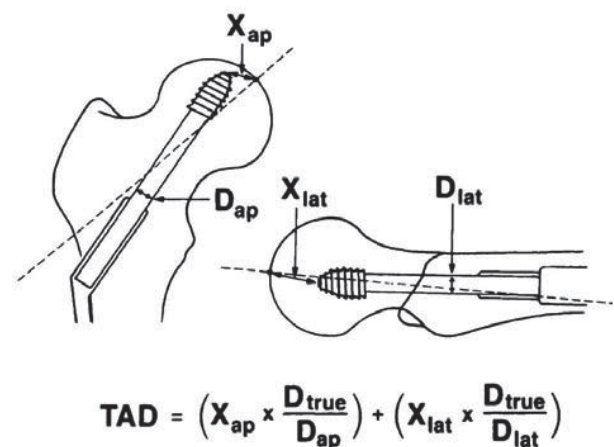


Figure 1. How to calculate TAD distance

Materials and Methods

The study examines patients with cut-out of the cephalic screw in previous osteosynthesis intervention with intramedullary nail or screw-plate after pertrochanteric fracture in the Orthopaedics-Traumatology Clinic of University of Trieste from January 2003 to December 2012. A total of 630 patients were operated on with pertrochanteric fracture in this period.

In the same period there were 16 cases of cut-out (5 males and 11 females). The average age of the patient at the time of the second operation was 83 years ($+ / - 5.02$) and the average time elapsed since the first osteosynthesis operation was 6.2 months. In particular, among 16 cases of cut-out, 4 patients were treated with PFN nail, 4 patients with Gamma3 nail and 8 patients with IMHS CP nail.

The highest number of cut-out of IMHS-CP is due to the fact that 70% of patients were treated with this type of intramedullary nail. In 8 cases in which radiographically the fracture had characteristics of successful consolidation was carried out by removing the cephalic screw; in cases where the fracture was not consolidated was carried out by replacing the system in its entirety with the positioning of total arthroplasty (4 cases), or by replacing only the cephalic screw (3 cases) or by performing a partial extraction of the screw (1 case). The mean follow-up after the revision surgery was 18 months.

Results

Our cut-out cases represent 2.5% of the total, in line with the data available in literature. All 8 patients with consolidated fracture, after removal of the cephalic screw showed a discrete functional recovery and no cases of refracture. In the three cases in which it was replaced the single cephalic screw (Figs. 2-5) and in patients undergoing partial extraction of the screw, results have not been satisfying, with persistent pain in the hip or severe functional limitation. The 4 patients who underwent removal of the nail and positioning in arthroprosthesis (Figs. 6-8) have demonstrated the best results from a functional point of view with recovery, in all cases, in a normal gait. The indication for early loading after the revision surgery has been considered in all patients.

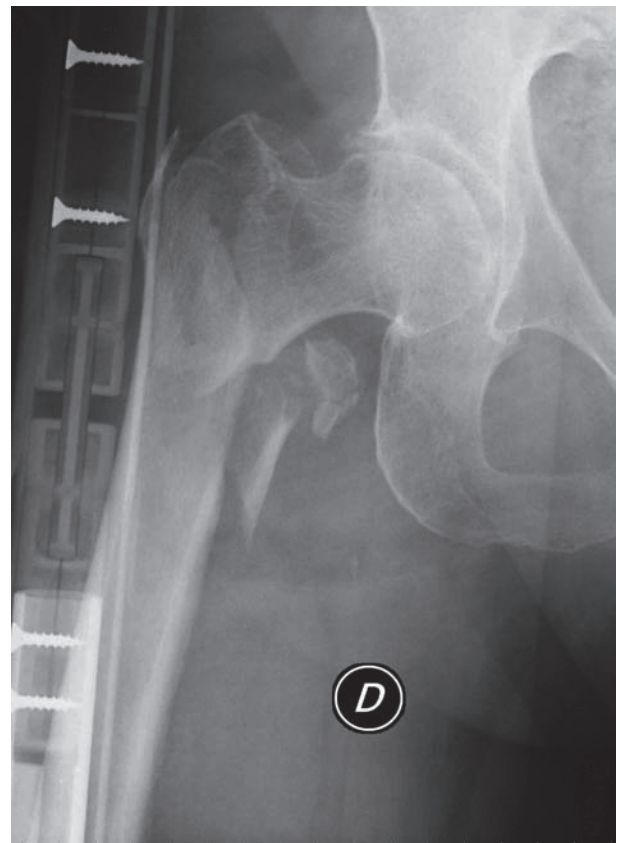


Figure 2. 76 years old woman - before surgery radiography



Figure 3. 76 years old woman - radiographic check after surgery - surgery with IMHS

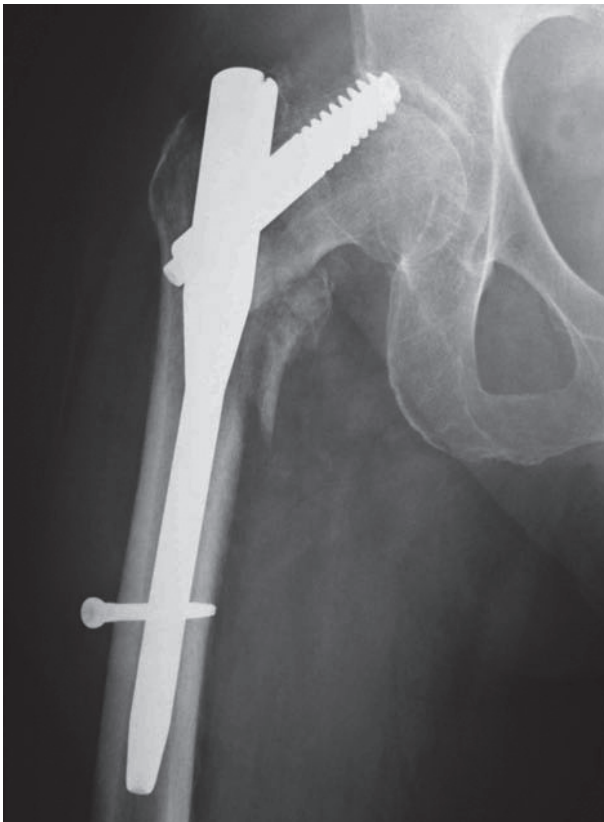


Figure 4. Cephalic screw cut-out (same case of Fig.2 and Fig.3)

Discussion

The most common mode of failure of osteosynthesis in a pertrochanteric fracture are represented by the cut-out of the cephalic screw, from loosening and failure of fixation. The cut-out is the most frequent cause of failure of osteosynthesis, being present in 84% of failures.

The incidence in cut-out with the screw-compression plate oscillates between 1.1% and 6.3%, while in case of the intramedullary nail, it is between the 1, 5% and 6.5%.

A meta-analysis conducted by Parker (16) demonstrated a cut-out rate of 2.5% after fixation by screw-plate in compression.

Ellis and Kyle report a very high failure rate, about 25%, in osteosynthesis with compression plate in the treatment of unstable comminuted base-cervical fractures (17).

Kim has identified the instability of the fracture as the root cause of the failure of the compression plate with screw (18).



Figure 5. Check-up radiography after 2 months since cephalic screw substitution (same case of Fig.2 - Fig.4)

The best position of the screw compression is at the center of the femoral head. Kyle (17) did not find any cases of cut-out of the cephalic screws positioned with both projections in the central region of the head, while he found an incidence of 53% of the cut-out with the screws located in the peripheral regions.

As already mentioned, Baumgaertner described the TAD which happens to be the most reliable indicator in anticipation of a possible cut-out (7).

The medium TAD in the extreme upper lateral fractures of the femur successfully treated measured 24 mm and no fixation with TAD less than 25 mm produced cut-out of the femoral head. Optimum positioning of the cephalic screw is at the center of the femoral head in both projections, because in this position, the trabecular coalescence in tension and in compression provides the best protection of bone. When the values of TAD exceed the threshold of 25 mm the incidence of cut-out increases exponentially.

If we then consider the impact of the cut-out of the nails of the second generation, we can see how that



Figure 6. 82 Years old woman - Before surgery radiography

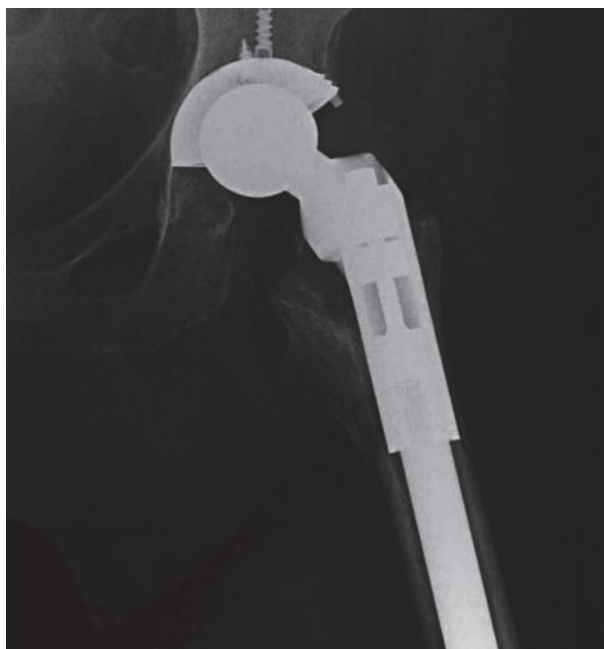


Figure 8. Total-hip replacement (same case of Fig.6)



Figure 7. Cephalic screw cut-out after pertrochanteric fracture healing (same case of Fig.6)

has remained essentially the same as the nails of the first generation, with data ranging from 2.5% to 8,3%.

Generally with the plaque occurs a greater interpenetration of the fracture and therefore a more relevant shortening of the femur (11).

In cases of unstable fractures of the loss reduction occurred more often with the compression plate. Sadowski in a prospective study compared the proximal femoral nail with proximal compression plate at 95 ° showing that the intramedullary nail has a clear clinical benefit in the treatment of fractures reverse (12). The failure rate of nonunion was 36% with the screw-plate, while 5% with the nail.

In contrast with the many studies available on the various installations, including intramedullary nails and the different kinds of plaque, in the treatment of fractures of the extreme upper stable femur side, none of them showed clear and defined clinical advantages over the plate type DHS (13-20) showed no problems in regard to the appearance of a cut-out of the screw.

About aspects of consolidation and tolerance to the load, the feedback of the extreme lateral fractures of the femur showed little difference between the

number of fixation devices currently available (21-26). The goals of a correct surgical procedure are to avoid the failure of synthesis and to prevent the onset of cephalic cut-out of the screw, so that the screw must be properly put in the most bone strength and maximum mechanical stability.

The nails have biomechanical advantages being theoretical very useful in the treatment of unstable fractures, in particular their positioning in the centre of the medullar channel of the bone and the inhibition of excessive slipping of the cephalic screw (27-29). This is no longer true if we do not get, after surgery, anatomical reduction as much as possible, with a good bone support in the trochanteric region. In this case the fracture remains unstable and the cutting forces will act at the level of the head, that being in conditions of low resistance bone, may evolve in the phenomenon of the cut-out. In the literature there is little evidence on the outcomes of pertrochanteric fracture in relation to their degree of stability, that is, if the unstable heal in the same way as stable ones (30, 31). To obtain the stabilization of the fracture, allowing to achieve healing and to avoid the phenomenon of the cut-out must try to meet defined parameters such as: the exact initial classification of the fracture, reducing as much as possible anatomical with large contact surfaces bone fracture, the Tip Apex Distance (TAD) must be less than 25 mm, the position of the cervico-cephalic screw should be about 5 mm from the subchondral bone, and if possible it should be at the center of the femoral head or better in the area of the calcar, the sliding of the screw must be less than 15 mm and there must not be the medialization of the femoral diaphysis.

“Augmentation” techniques will be more and more used; by use of cement (or bone implants), there is a reduction of: the slipping of cephalic screw, leg length reduction, oblique displacement (varus deformity), pain, postoperative complications and possibility of failure of synthesis(32). Many studies support this theory reporting even until 100 % of positive results (healed fractures) without complications at follow-up (33). But there’s even one study that underlines a really small percentage of “bad results” (8,9%) during postoperative follow-up (35). It can be anyway a good technique to be used in patients with other comorbidities. But, even if literature purposes all these

good results, in our Clinic, we never used, until now, this technique.

Conclusions

Possible mechanical causes of cut-out are still being debated, but they are certainly correlated on the type of fracture, to stability of the reduction, cervical-diaphyseal angle of the system and the positioning of the cephalic screw. To be considered as well as the earliness of the load in unstable fractures, especially in those in which we were unable to recreate stability guaranteed by the side wall of the trochanteric region, can lead to the phenomenon of cut-outs.

In the case of cut-out choice of the inspection of the failure must be based above all on the time from the first surgery, on the happened or unhappened consolidation of the fracture and the involvement of the acetabulum.

In fractures now consolidated agrees opt for the simple removal of the cephalic screw, while in cases where the fracture is still in a consolidation phase or when there is a damage to the articular surfaces should be considered the prosthetic replacement, if the patient’s general condition permit.

We have not, however, clinical experience in the method of augmentation of the synthesis with the use of acrylic cement during implantation of intramedullary nails. But, in our opinion, it is very important to prevent further complications: for this reason we always advise that there should be ensured a good positioning of the means of synthesis, in particular the cephalic screw is inserted into the point of the head and neck of the femur in which the quality bone is better, ie in the postero-inferior quadrant near the calcar with a TAD less than 25 mm, the reduction of the fracture should be as anatomical and can be with the increased surface area between the fractured zones. The only way to ensure a quick mobilization and early weight bearing to our patients, such as to greatly reduce the complications of pertrochanteric fracture, fractures affecting recovery and restoration of the health of our elderly. Moreover, it can be very important, during pre-surgery studies on the patient, keep more attention about the bone quality, even checking values of bone metabolism and mineralization.

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