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Original Article

Periprosthetic fractures of the femur: our experience

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Summary. A frequent problem in Orthopedic surgery is represented by periprosthetic fractures in Total Hip Arthroplasty (THA). The incidence of this pathology has interested 1,5% in primary THA and till 6-8% in revision prosthesis during last 10 years. About this contest, the authors performed a study on 24 patients (6 males; 18 females) surgically treated for periprosthetic femoral fracture at the Orthopedic and Traumatologic Clinic, University of Trieste, Italy, in the period from January 2006 to December 2011. Periprosthetic fractures were classified following guide-lines of the Vancouver Classification System. Even the choice of treatment was based on Vancouver Classification System, on patient clinical conditions and patients age.

Key words: Periprosthetic fracture, prosthesis, stem, revision, arthroplasty

Introduction

Periprosthetic fractures of the femur after hip prosthesis implants is a problem frequently encountered in clinical practice of the orthopedic surgeon. Over the past decade the incidence of this disease has come to affect the 1,5% of cases in the first implants and rapidly increases up to 6-8% in prosthetic for revision surgery (1,2). This increase is due to both the high number of hip prosthesis implants performed every year (in the United States are performed 120,000 prosthesis/year) and enlargement of the indications, because, thanks to the improvement of prosthetic materials and surgical technique can undergo this surgery also elderly, obese and with poor bone quality or young patients who after surgery return to their behavioral habits and therefore are likely to experience trauma of sufficient magnitude to cause a periprosthetic fracture (3).

The incidence of periprosthetic fractures ranges from 1% to 3% in cemented prostheses and from 3% to 7% in the uncemented ones.

In a prospective review of 2148 cases of primary total hip arthroplasty, the percentage of intraoperative fractures, including minimal infractions, was 6.4% in cemented prostheses and 14.9% in the uncemented ones. If in the same case series were considered only fractures that required osteosynthesis the percentage decreased respectively 3.7% and 2.3% (4). Della Rocca and others in a study published in 2011 in the Journal of Orthopaedic Trauma regarding the epidemiology and future projections of periprosthetic fractures have shown that the incidence of this type of fracture is higher after arthroplasty revision surgery and there is an increased risk of death in people with a periprosthetic fracture than patients who have a hip prosthesis implants without complications (5).

Materials And Methods

We have studied patients admitted to the Orthopedic and Traumatologic Clinic of the University of Trieste (Italy) in the period between January 2006 and December 2012 for a proximal periprosthetic fracture proximal.

Were surgically treated 24 patients with periprosthetic fracture of the femur: 18 patients were female and 6 male. We performed clinical and radiographic controls after 3, 6, 12 and 18 months after surgery and evaluated the Harris Hip Score preoperatively in case history and postoperatively.

They ranged in age between 49 and 91 years, with an average of 75.25 years.

The time elapsed since placement of the first prosthesis and the onset of fracture of prosthesis ranged from 3 months to 13 years.

The traumatic event responsible of the fracture has always been an accidental fall. Only in 3 patients the trauma was judged as a high-energy trauma. 18 patients underwent cementless arthroplasty (Fig. 1), 6 patients were carriers of cemented prosthesis (Figs. 3 and 7).

Only one patient with a fracture of type B2 had cemented endoprosthesis.

Through the radiological study we classified fractures of femur prosthesis according to the "Vancouver Classification of periprosthetic fractures". Table 1 shows the relative frequencies. According to this classification a patient presented fracture of type A, 19 patients have reported a fracture of type B, while the other 5 patients had a fracture of type C.

In all patients who underwent plate fixation were employed metal cerclages to increase the stability of the same synthesis, without ever having noticed complications arising from the use of the same.

Figure 1. Pre surgery radiography in 85 years old patient with B2 fracture

The patient with fracture B2 underwent revision surgery with Wagner implants was the bearer of a cemented endoprosthesis.

In the past years we have also used the Mennen plate which, while not guaranteeing absolute stability of the fracture, allowing a reduced surgical time for his installation compared to other techniques. Applied when the patient's general condition didn't allow prolonged periods of exposure and surgery regardless of the type of fracture and bone stock (6-9).

The various types of surgery that we have used for treat our patients are described in detail in tab. 2, and they were in most revision prosthesis with modular stems in the majority.

Results

During the review of the cases four patients had died from causes unrelated to the fracture. All patients started to walk with the help of a rollator or Cana-

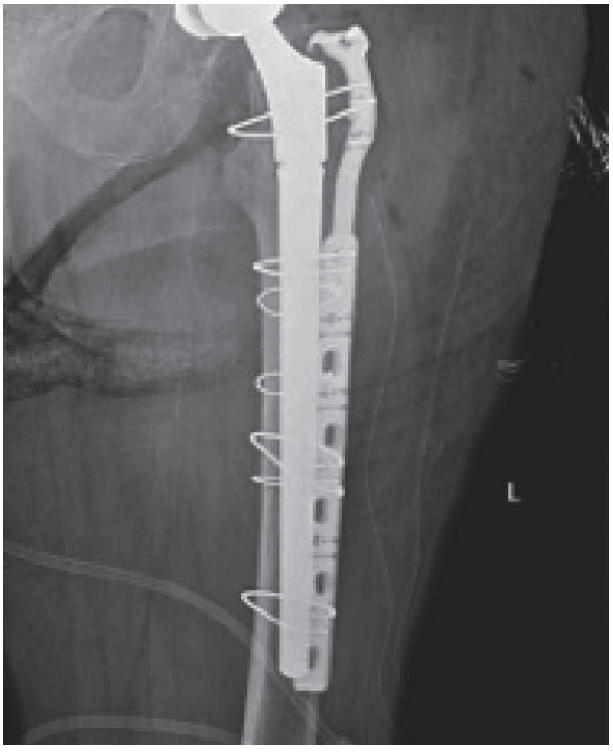

Figure 2. Same patient as in Fig.1; after surgery radiographic control

Table 1. Fractures distribution in our experience

Type of periprosthetic fracture	N of patients	Frequency (%)
A-type fracture	1	4,2%
B-type fracture	19	79,1%
B1	5	26,3%
B2	10	52,6%
B3	4	21,1%
C-type fracture	4	16,7%

Table 2. Type of surgery

Type of surgery	N of cases
Zimmer Plate	2
Dall-Miles Cable-Ready Plate	5
O'Nill Iron-Lady Plate	1
Revision Arthroprosthesis	16

Table 3. Vancouver Classification of periprosthetic fractures

Type and subtype	Characteristics
A-type fracture	Trochanteric Region
AG	Greater Trochanter
AL	Lesser Trochanter
B-type fracture	Around or just Distal to the Stem
B1	Stem well fixed
B2	Stem loose
B3	Stem loose, poor Bone Stock
C-type fracture	Well Below the Stem

dian sticks (among them we also include a patient with type C fracture treated in 2007 that was hospitalized in 2009 for a compound fracture of the iliac wing on same side of periprosthetic fracture occurred after an accidental fall) with good residual function of the operated limb being able to perform all ADL (Activities of Daily Life). About one patient we cannot provide data on functional outcome as the periprosthetic fracture was due to an accidental fall from a wheelchair.

The consolidation of the fracture occurred in the average of 4.6 months (3-8 months) with complete bone-ingrowth stem both proximal and distal. In one case, in our opinion quite interesting, is also appeared an effective and integrated cortical bone, completely absent at the time of surgery because of severe periprosthetic osteolysis not replaced by homologous bone (Figs. 3-6). In one case we had a dislocation after about 15 months after a movement of hyperflexion of the hip in a patient, however, affected by previous infection periprosthetic. No infection occurred in follow-up.

The average Harris hip score before the fracture was about 80 (65-100) and during follow-up has reached about 75 (60-95).

Discussion

The periprosthetic fractures are often difficult to treat. In last years there is an increase in the incidence of periprosthetic fractures of the femur especially late: this increase is due to several factors, including an increasing number of elderly patients at risk of falls, an increasing number of young patients with hip arthroplasty at risk for high-energy trauma and we're still witnessing an increasing number of uncemented revisions or performed with allograft or impact grafting

Figure 3. Male, 88 years old patient; before surgery radiography with fracture of B3 and rothesys dislocation

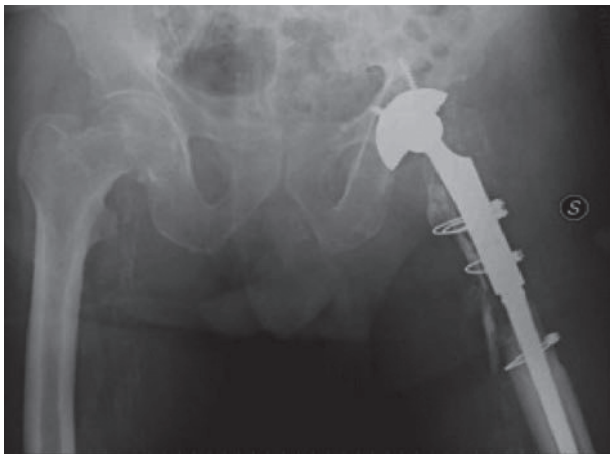

Figure 4. After-surgery radiography - complications in revision steal and metallic cerclages in same patient of Fig.3

techniques. Generally femoral periprosthetic fractures occur for low-energy trauma or due to a falls or spontaneously during activities of daily living. Despite the various classification systems and therapeutic options the ideal solution is difficult to propose and to provide, because in preparing the surgery you need to know and be able to make optimal use of many procedures. In recent years, significant improvements in the design of the prosthesis, such as modular revision prosthesis stabilized distally and the use of bone bank, have improved the healing of these fractures. Our study examined the demographics, type of fracture, treatment modalities and the failure rate in patients operated for a periprosthetic fracture of the femur.

Currently the most commonly followed classification to describe fractures of the prosthetic hip is the "Vancouver classification", already proposed by Duncan and Masri in 1955, which is based on the stability of the stem, the location of the fracture and the amount of available proximal bone stock. It's very important to classify these fractures, as it helps to guide treatment (Tab.2). Vancouver type A fractures are pertrochanteric fractures (subtypes AG-Greater and AL-Lesser). Type B1 fractures occur around or just below the tip of the stem, in which the stem is well fixed. Type B2 fractures occur at or just below the tip of the stem, but do not have a well-fixed implant. Type B3 fractures occur at or just below the stem, in which the stem is not well fixed and there is poor bone stock in

Figure 5. Same patient in Fig.5 - 8 months after surgery radiography - complete lateral bone wall reconstruction without any bone from bone-bank or growing factors

the proximal femur. Type C fractures occur well below the stem (10).

In literature all authors agree that the prevention of periprosthetic fractures is crucial: it is based on continuous clinical and radiographic checks carried out on all patients undergoing total hip replacement as suggested in 1994 by the National Consensus Conference of the American National Institute of Healh, about periprosthetic fractures of the hip.

Vancouver classification allows to plan surgical treatment (11). It is important to determine if the

Figure 6. Same patient in Fig.5 - 8 months after surgery radiography - the stem is covered by casting bone without adjuvants

stem is stable or not stable, because by this depends the choice of treatment: osteosynthesis in case of revision of a stable stem and long stem revision in case of not stable prosthetic stem.

Conservative treatment for fractures of type A, except in the event of instability of the fragments, open surgical treatment in each case added to with internal fixation with plate added to cerclages in fractures of type B1 and type C It will be appropriate replacement surgery of the prosthesis with a revision stem in fractures of type B2 and B3 (Figs. 5, 6, 9 and 10).

Figure 7. Male patient 75 years old - X-rays of very old B3 fracture and broken stem

In all cases with areas of osteolysis or reduced "bone stock" will need to use more or less homologous bone grafts or morselized bone graft or allograft (Fig. 8).

Conservative treatment is still considered as the best choice for incomplete fractures with stable implant. Surgical treatment is, however, indicated in displaced fractures and/or fractures associated with loosening of the prosthetic components.

The goals of treatment of a periprosthetic fracture of the hip are (12, 13):

- Restore the anatomical alignment with stable manner;
- Maintain or restore adequate bone stock;
- Promote early mobilization of the patient;
- Bringing the patient to a similar or better function than the previous fracture

AG fractures, according to the classification of Vancouver, can be composed and, in this case, do not require surgical treatment. In the case in which these fractures were to affect the region of the calcar, becoming unstable fractures, is considered necessary the

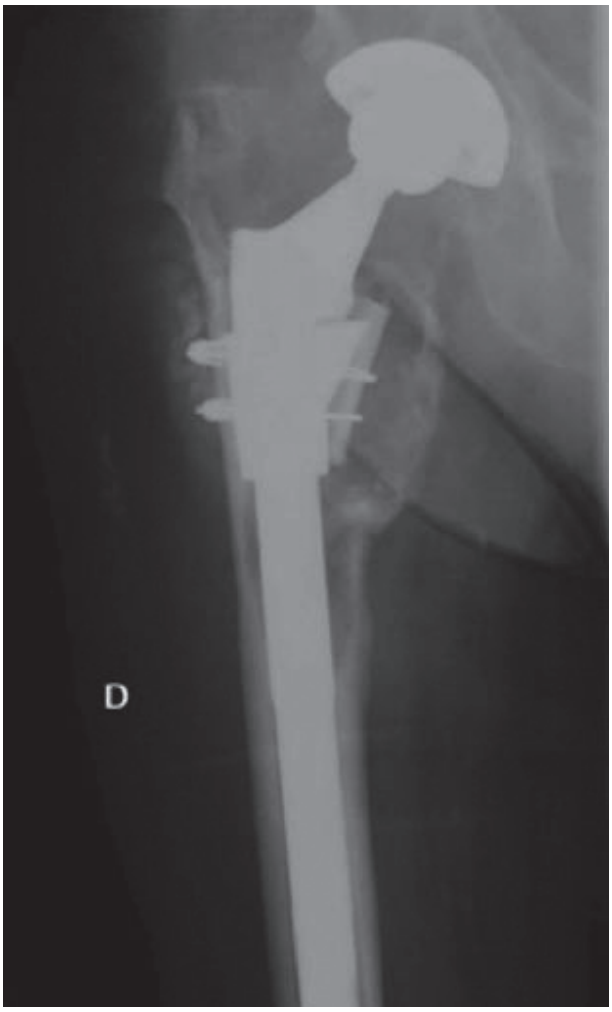

Figure 8. X-rays check of patient in Fig.7 after application of revision stem, cerclages and bone grafts

Figure 9. X-rays check of patient in fig.8 - good ossification of bone graft

application of a cerclage. In case of periprosthetic osteolysis can be purposed surgery to apply a "bone grafting" and cerclage.

Usually in these cases is prescribed a protected load for 6-12 weeks avoiding active abduction until radiographic evidence of consolidation. The treatment for fractures with displacement of fragments smaller than 2 cm is conservative, while it is surgical if the dislocation is greater than 2.5 cm or if the trochanteric nonunion manifest with pain, instability, or weakness in abduction.

AL fractures are rare, the treatment is surgical when the fragment is large and involves most of the calcar with loss of implant stability.

Type B fractures are the most frequent. Patients with B1 fractures must be treated surgically with ORIF. B2 fractures should be operated with a revision prosthesis. The choice for the systems to fix the proximal fragments depends on the preference of the surgeon and the patient's needs. In the case of unstable transverse fractures can stabilize the fracture with bone grafts and cerclage.

B3 fractures are more complex and require prosthetic replacement of the proximal femur with a combined approach of prostheses / bone graft and heterologous bone graft

Type C fractures are treated with ORIF, such as fractures of the femoral shaft.

Figure 10. X-rays check after 6 months of patient in Fig.9 - ossification of cortical graft more evident on lateral wall

Parvizi and Vergari (14), in the conclusions of their work, defining the current concepts of treatment, believe that the treatment of periprosthetic fractures of the proximal femur requires proper identification and appropriate treatment of the fracture. Also according to these authors, it can be difficult to distinguish the slight difference that sometimes lies between the fractures B1 than B2 which can lead to failures in the postoperative period and to an increase of postoperative mortality in the first year.

Also according to our experience in very rare cases may be difficult to distinguish the implant stability unless very energetic maneuvers to test the stem seal on the large femoral fragment.

The technique of "impaction grafting" may be useful in the treatment of periprosthetic fractures of femur when the "bone loss" and the geometry of the femoral canal preclude the use of "fully coated" femoral components (15).

We have various surgical techniques for the stabilization of periprosthetic fractures such as synthesis with plates and metal cerclages (like LISS, Dall-Miles Cable-Ready) and the revision prosthesis to associate or not to the system of allograft support (16-21).

In relation to revision procedure, the target is to achieve a fundamental torsional and longitudinal stability through to the system located in the distal diaphysis.

The modular uncemented long stems avoid the problem of difficult replanting in fractured femurs because the function of the distal part is to ensure a reliable primary stability while the length of the lower limb and the orientation are adjusted by the proximal component.

There are many kinds of revision prostheses and is not always easy to choose the right stem suitable to each case to be treated: there are monoblock stems and modular stems, tapered stems, blocked stems, stems covered with proximal or porous-extended coating. In our experience we used only modular stems, following the idea that this type of stems are easier to be adapted to each patient and to each type of fracture too.

In group B1 failure can be attributed to wrong interpretation of radiographs based on the classification of Vancouver, as can be seen from the fact that 4 of the B1 fractures were treated with revision stem intraoperatively due to the instability of the original stem.

In case of B2 fractures, both in cemented revisions and in uncemented ones, a good consolidation has been obtained (Figs. 2, 4, 8) except in one case.

In case of B3 fractures is essential to consider the reduced bone stock and the cortical deficit in order to obtain stable results over time.

The ideal treatment in these cases is the replacement of the stem with revision prosthesis modular and/or allograft.

In fractures of type C the ORIF is the preferred treatment and the result is comparable with other studies.

After all, the treatment must be adapted on individual basis according to the type of fracture, keeping

in mind that the long-term clinical results are compromised by complications and especially that fractures of type B show a high rate of complications: all this must be considered for future studies on periprosthetic fractures.

Conclusions

Periprosthetic fractures of the of femur are found more frequently in clinical practice of the orthopedic surgeon because of the increase in the average, the functional demands of the population and the widening of indications to the implant of total hip replacement (22-27).

Their treatment is complicated by the age and general condition of the patient who are generally elderly patients with many comorbidities and whose bone quality is poor (28-32).

The main objective is to obtain a stable synthesis of fractures and a stable positioning of the stem in the distal part of the femoral shaft so as to be able to mobilize the patient rapidly, waiting for the grant of the load that will occur anyway very early just to exploit the primary stability of the distal stem and to allow a periprosthetic bone growth. About this particular, we highlight the case of our patient 87 years old that, due to the impairment of cognitive functions has been mobilized from the bed a few days after surgery. In our opinion, this has led to a complete periprosthetic bone healing, however, obtained without any bone apposition, neither autologous nor homologous nor synthetic: this goes beyond the limit of all expectations and will surely be the subject of our further studies (Figs. 3-6).

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