PERIPROSTHETIC FEMORAL FRACTURES – EVALUATION OF RISK FACTORS

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PERIPROSTHETIC FEMORAL FRACTURES – EVALUATION OF RISK FACTORS (Abstract): Endoprosthetic hip arthroplasty is a surgical intervention that significantly improves the quality of the patient’s life, with excellent long term results, but with an increased risk of major complications. One such complication is the periprosthetic femoral fracture, which may occur in both young and old patients due to several risk factors typical to the elderly (osteoporosis, fall risk), cementless press-fit implants, implant loosening, and revision arthroplasty. Material and methods: This study tries to evaluate the risk factors for periprosthetic femoral fractures treated at the Orthopedics and Trauma Department of the Iași Rehabilitation Hospital. Retrospective evaluations were conducted on 3454 patients with primary hip arthroplasty and 167 patients with revision hip arthroplasty, the surgical procedures being performed between January 1994 and March 2012. The study was conducted on 47 patients (17 males and 30 females, mean age 68 years) with periprosthetic fracture. Results: The incidence of periprosthetic femoral fractures in primary arthroplasty group was 0.89% (0.63% intraoperative and 0.26% postoperative), with a considerably higher incidence for cementless implants (81.39%), and 9.58% in revision arthroplasty group (8.38% intraoperative and 1.19% postoperative). Vancouver type B was the most frequent, both in operative and postoperative revision arthroplasty and in postoperative primary arthroplasty. 88% of the fractures were surgically treated, with a satisfactory postoperative course both in early and long-term follow-up. Conclusions: Periprosthetic femoral fractures result in increased morbidity and mortality rate, are difficult to treat, and require complex therapeutic strategies depending on risk factors, fracture type, bone stock, and implant stability. Key words: HIP ARTHROPLASTY, PERIPROSTHETIC FRACTURES, REVISION ARTHROPLASTY

The improvement in lifestyle entailed the necessity to improve the quality of patient’s life up to an advanced age by means of pain relief and a normal functioning of the hip joint, two goals achieved by endoprosthetic hip arthroplasty. There is an increase in the number of postoperative complications directly proportional to the number of arthroplasties performed given the extension of its indications in both aged and young patients suffering from congenital dysplasia or aseptic necrosis of femoral head. One of the major complications is periprosthetic femoral fracture, with an increased incidence in both age groups, due to the significant risk of osteoporosis in the elderly, high-energy trauma in the young patients who are physically very active, and to a rise in the number of revision arthroplasties (1).

The risk factors for these fractures share
a common feature, namely a poor bone quality and reduced mechanical strength. An etiological classification of these risk factors as local and systemic is generally useful, although they often coexist.

Periprosthetic femoral fractures are more frequent in patients suffering from rheumatoid polyarthritis and severe osteoporosis, but may also occur against the background of other diseases such as osteomalacia, Paget’s disease, osteogenesis imperfect, thalassemia, and some neuromuscular disorders such as poliomyelitis or Parkinsonism. Local risk factors for operative fractures include the use of cementless press-fit femoral components, proximal femur deformity, and revision arthroplasty.

Local risk factors for postoperative fractures are osteoporosis, periprosthetic osteolysis, femoral component loosening (2), femoral component malalignment, cortical perforation undetected during surgery, and infection. The most frequent cause of periprosthetic femoral fracture is a minor trauma caused by a same height fall. Adolphson et al. have reported a low-energy trauma in 88% of the fractures studied, (28 out of 35) (3). Cooke and Newman have reported a major trauma only in 8% (6 out of 75) of the cases (4). The incidence reported for periprosthetic femoral fractures is of 0.1% - 7.8%, depending on the reported series (1, 5, 6, and 7). Berry noted an incidence of postoperative periprosthetic femoral fractures of <1% after primary arthroplasty and of >7.8% after revision arthroplasty (5). Mayo Clinic reported an incidence of 0.6% in cemented total hip arthroplasty and 0.4% in the cementless ones (6). Lindahl et al. reported an incidence of 0.4% after primary arthroplasty and 2.1% after revision arthroplasty (1). In a study of 1442 cemented primary arthroplasties with a risk factor of 2.5%, Löwenhielm et al. reported an annual incidence between 0% and 1.2% (7). During primary arthroplasties, intraoperative periprosthetic fractures have been estimated to approximately 1% of the cemented stems (8, 9, 10) and between 3% and 20% of the cementless ones (11, 12, 13). During revision arthroplasties, periprosthetic fractures seem to follow similar patterns, but their occurrence is more frequent, the incidence of operative fractures being of 6.3% (14) for the cemented cases and 17.6% for the cementless ones (15).

MATERIAL AND METHODS

The study was conducted on 3454 patients with primary endoprosthetic hip arthroplasty and 167 patients with revision arthroplasty admitted to the Orthopedics and Trauma Department of the Iași Rehabilitation Hospital between January 1994 and March 2012. The retrospective evaluation was done on 47 patients with periprosthetic fractures, 36 intraoperative and 11 postoperative. This study investigated the incidence of periprosthetic fractures in relation with various local and general risk factors, type of arthroplasty, pathology requiring the primary surgical intervention, demographic data (age and sex), and time of postoperative fracture.

Periprosthetic fractures were assessed based on standard radiographs and categorized according to the Vancouver Classification System. Operative periprosthetic femoral fractures are divided into three types based on fracture location: A – proximal metaphyseal without diaphyseal impaction; B – diaphyseal; C – diaphyseal-metaphyseal distal fracture, further subdivided into three subtypes: 1). cortical perforation, 2). non-displaced fracture, and 3). displaced unstable fracture.
Postoperative periprosthetic fractures are classified into:

- **A** - trochanteric region with A(G) - Greater trochanter and A(L) - Lesser trochanter;
- **B** - around or distal to the stem, further divided into: B1 (stable prosthesis), B2 (unstable prosthesis), B3 (bone stock inadequate);
- **C** - well distal to the stem tip.

Other classification systems were used to assess the stability of the cemented and cementless femoral stems. Stability of cemented stem was evaluated according to the classification criteria defined by Harris et al. (16), while Engh and Massin (17) classification was used to assess stability of the cementless stem. According to these classifications, *loosening* is defined as stem displacement, visible on radiograph plates by means of either radiotransparent lines between the cement or the femoral stem and bone, or the presence of cement fracture, and/or the presence of a radiotransparent area which comprises 50 to 100% of the bone-cement gap size.

**RESULTS**

The prevalence of periprosthetic fractures was 1.29% of the total number of primary and revision arthroplasties, with an incidence of 0.89% (31 cases) in primary arthroplasty and 9.58% (16 cases) in revision arthroplasty. According to the time of occurrence, in primary arthroplasty there were 22 intraoperative (0.63%) and 9 postoperative periprosthetic fractures (0.26%). As to revision arthroplasty of the hip, 14 operative (8.38%) and 2 postoperative fractures (1.19%) were found. These results are in agreement with the statistical data reported in the literature (5).

The etiological assessment of hip arthroplasty showed degenerative pathology in 31 cases (65.95%), stage III-IV aseptic necrosis in 5 cases (10.63%), and femoral neck fracture in 11 cases (23.40%).

According to the type of implant used, periprosthetic fractures occurred in 37 total hip arthroplasties (THA) and in 10 hemiarthroplasties of which 4 bipolar and 6 cerveophalic (unipolar). The incidence of periprosthetic fractures was significantly higher in cementless (cless) arthroplasty – 81.39% (38 cases) compared with cemented (cem) arthroplasty – 18.7% (9 cases), as can be seen in the graphical representations below (fig. 1, 2).

![Graph](image)

**Fig. 1.** Incidence of fractures in primary arthroplasty according to the implant type
The time of occurrence of postoperative periprosthetic fractures was: early in 5 cases (the first six weeks), 1-3 years in 3 cases, and after 6 years in 3 cases. In all these 13 cases fractures were caused by low-energy trauma, by same height falls.

In addition, the following associated risk factors have been monitored: osteoporosis in 19 cases (40.42%), rheumatoid polyarthritis in 5 cases, ankylosing spondylitis in 3 cases. Early or late postoperative periprosthetic fractures have the following local risk factors: cementless press-fit stems with cortical perforation undetected during surgery, osteolysis and loosening. Operative periprosthetic fractures occur as a result of press-fit femoral components, local osteoporosis, and brutal manipulation. In revision arthroplasty the most frequently met are osteolysis and loosening with a more or less severe associated cortical defect. Another cause is a specific infection (TB) (fig. 3).

Patients’ mean age was 68 years (range 53 - 79 years) for postoperative fractures, 62 (range 40 – 82 years) for intraoperative fractures in primary arthroplasties, and 58 (40 - 67 years) in revision arthroplasties. Thirty patients (63.8%) were females.

Using the Vancouver Classification System the fractures were categorized as follows: 1). intraoperative in primary arthroplasties: 9 A2 fractures, 6 B1 fractures, 7 B2 fractures; 2). intraoperative in revision arthroplasties: 2 A2 fractures, 2 B2 fractures, 6 B3 fractures, and 1 C2 fracture; 3). postoperative in primary arthroplasties: 6 B1 fractures, 3 B2 fractures; and 4). postoperative in revision arthroplasties: 1 B3 fracture and 1 C fracture.

The therapeutical strategy depended on fracture type, time of fracture, implant and fracture stability, and bone stock. Consequently, 5 intraoperative B1 fractures were treated conservatively by forbidding leaning, 4 revision arthroplasties necessitated osteosynthesis with screwed plate, but most frequent was open reduction and fixation with metallic wires or Dahl Miles cables. The course was satisfactory in all cases, with consolidation and progressive regaining of articular mobility.
DISCUSSION

The management of periprosthetic femoral fractures includes the identification of local and systemic risk factors, an accurate preoperative assessment, and an adequate therapeutical indication.

The systemic risk factors determine a decrease in bone quality and mechanical...
strength and increase the likelihood of intra- and postoperative femoral fractures occurrence. Among these, the most frequent are postmenopausal and senile osteoporosis and rheumatic conditions (rheumatoid polyarthritis).

The local risk factors for intraoperative fractures include the use of cementless press-fit femoral components, proximal femur deformity, and revision surgery. The cementless femoral component may cause fracture as a result of overworking and additional forces distributed to the proximal femur during the press fit impaction. The deformities of the proximal femur, as can be seen in hip dysplasia, pseudoarthrosis, and prior surgical interventions, may also increase the risk for intraoperative fracture. Revision arthroplasty has a higher incidence of intraoperative fracture than primary arthroplasty. During revision arthroplasty the femoral bone mass is often deficient due to multiple prior interventions or following infections or osteolysis. A narrowed cortical vein in relation to the medullar duct of the femur represents a risk factor in intraoperative fractures. Revision arthroplasty requires reconstruction with prostheses larger in diameter and length, often resulting in a higher intraoperative fracture rate due to excessive femoral hole and perforation.

The unrecognized cortical perforation during hip arthroplasty is an important risk factor in postoperative femoral fractures. Accidental perforation is most likely to occur during channel preparation and drilling. The impingement of femoral stem against the endosteal cortex may also increase the stress levels. This situation can occur as a result of the varus malalignment of femoral prosthesis and impingement in the lateral cortex.

Periprosthetic osteolysis is another local risk factor associated with postoperative fractures and it has become increasingly more frequent. The loosening of the femoral component is another significant local risk factor and it has been identified in 75% of the patients with postoperative periprosthetic femoral fractures in a study conducted by Bethea et al. (2). Duncan and Masri have reported loosening in 82% of their cases (18).

CONCLUSIONS
Our study confirms the importance of risk factors assessment in periprosthetic femoral fractures in primary and revision hip arthroplasty, and points out the high risk of fracture when using cementless implants.

The main goal in the prevention of periprosthetic fractures is a rigorous preoperative planning in order to anticipate any potential trap or problem that may appear during surgery. Preparation is paramount in dealing with these problems. Meticulous history, rigorous clinical investigation (scars and articular rigidities which may require special techniques for surgical exposure and intraoperative manipulation of the limbs), as well as an accurate specific imaging examination with assessment of deformities, hip architecture and degree of osteoporosis are essential in the prevention of intraoperative fractures in primary arthroplasty.

In revision arthroplasties radiographic evaluation must focus on the degree of bone deficit, cortical vein discontinuity, and possible deformities.

Osteodensitometry scans and an adequate antiosteoporotic treatment are the
main means of preventing postoperative fractures.

The decision concerning the therapeutic strategy and surgical indications for periprosthetic femoral fractures is based on fracture level, patient’s remaining bone stock, and stem stability. The objectives of periprosthetic fracture treatment include: restoring the anatomical alignment, recovery of the adequate bone stock, creation of a stable prosthesis, early mobilization of the patient, quick consolidation of the fracture, and the return to the original function prior to fracture.

REFERENCES