European Review for Medical and Pharmacological Sciences 2022; 26: 113-118

Treatment options for proximal periprosthetic femoral fractures in Total Hip Arthroplasty: a single center experience

S. MARINO[1,2], A. GIULIANI[1,2], D. DE MAURO[1,2], G. ROVERE[1,2], A. SMAKAJ[1,2], G.M. SASSARA[1,2], L. ARE[1,2], G. MACCAURO[1,2], F. LIUZZA[1,2]

[1]Department of Aging, Neurological, Orthopedic and Head-Neck Sciences, Fondazione Policlinico Universitario Agostino Gemelli IRCCS, Rome, Italy
[2]Department of Geriatrics and Orthopedic Sciences, Università Cattolica del Sacro Cuore, Rome, Italy

Abstract. – OBJECTIVE: Proximal periprosthetic femoral fractures (PPFFs) are gradually increasing and surgical management is often associated with high risk of complications, due to elderly population and associated comorbidities.

PATIENTS AND METHODS: We retrospectively assessed 39 patients at least at 2-years follow-up. We identified two study groups, similar for demographic data. Group A included patients surgically treated without involving prosthetic implants, whereas Group B included patients in which an implant revision was performed.

RESULTS: Data were recorded from January 2017 to February 2020, and 39 patients were included: 30 females (76.9%) and 9 males (23.1%), with a confirmed diagnosis of periprosthetic fracture of the proximal femur. 23 (58.9%) patients were treated with Open Reduction and Internal Fixation (ORIF), 12 (30.7%) with revision surgery and 4 (10.3%) were treated by modular megaprosthesis.

CONCLUSIONS: The treatment options considered in the study, revision arthroplasty and internal fixation had shown no significant differences as a matter of clinical outcomes and postoperative complications.

Key Words:
Total Hip Arthroplasty, Periprosthetic fractures, Revision arthroplasty, Internal fixation, Proximal femur.

Introduction

Periprosthetic fractures are a well-documented, serious complications of joint arthroplasty, occurring in up to 11% of hip replacements[1,2]. Proximal periprosthetic femoral fractures (PPFFs) are the second most common reason for hospital readmission within 30-days since the discharge in patients with total hip replacement (THR)[3] and the third most common reason for reoperation after aseptic loosening and dislocation in patients who had THR[4]. PPFFs are set to increase because of higher life expectancy age and the related estimated growing incidence of THR by 174% by 2030[5].

This complication is often related to higher mortality rate, higher costs of hospitalization and a huge social and economic burden due to incomplete functional recovery of the patient. The most used classification for PPFs is the Vancouver classification, which describes the location of the fractures, stability of the stem and femoral bone quality[6]. Periprosthetic fractures are usually associated with low energy trauma, often related to a higher risk of falls in elderly patients. For example, a fall from sitting or standing position or a "spontaneous" fracture, is commonly caused by bone osteolysis or loose prosthesis. Major trauma as the main cause is rare[4-7]. Some of the grounds behind this problem are also determined by the predominantly cementless design of the modern implants because they may have higher early rates of periprosthetic fracture[8]. This underlies the growing need for a comprehensive understanding of the potential outcomes and sequelae of PPFFs.

For the treatment, the surgical option is often the most indicated, due to the poor outcome of the conservative option, leading to a longer immobilization and related complication[9]. Among the surgical treatments available for these conditions, only two are commonly used, according to fracture patterns, implants stability and bone stock: open reduction and internal fixation (ORIF) or

Corresponding Author: Amarildo Smakaj, MD; e-mail: amarildo.smakaj@gmail.com

total hip replacement, mainly stem revisions[10-12]. Based on current indications, an ORIF can be performed only if the implants are stable and not loosened, otherwise a stem revision must be taken into account. Clearly, clinical outcomes are different between them, due to the late expected recovery in the ORIF group compared to the Implants revision. Anyway, the possibility of saving and sparing bone stock, avoiding a stem revision, still has to be considered when the surgery comes to mind. Hybrid solution can be the use of both options together, first performing an open reduction and internal fixation, and then revising the stem[10]. Nowadays a different type of implants, more used in musculo-skeletal oncology rather than in traumatology, is often chosen, but it can also find an indication in this kind of condition[13].

The aim of this article is to compare clinical outcomes in patients with PPFFs surgically treated with or without implants revision and, as second endpoint, to analyze epidemiology and data of periprosthetic femoral fractures in a high volume first level trauma center.

Patients and Methods

The present study is a retrospective analysis of patients with PPFFs admitted in the Orthopedic Department in I level trauma center in Rome, Italy. An ethical approval was not requested for this retrospective analysis. All procedures were performed following written informed patient consent and in accordance with the ethical standards of the institutional and/or national research committee and the 1964 Declaration of Helsinki and its subsequent amendments or comparable ethical standards.

All patients older than 65 years with PPFFs were identified from trauma databases and included in the present investigation if surgically treated. Patients were excluded in case of incomplete radiological or clinical data, pathological fractures, and a follow up shorter than two years. Moreover, patients with previous fixation of PPFFs did not enter the study.

Clinical notes and hospital records were reviewed in order to collect patient demographics, Vancouver Grade fracture classification, surgical treatment, type of implants, hospitalization, peri and post-operative complications.

Clinical outcomes were recorded with Patients Reported Outcomes Measures (PROMs) and Clinical completed scores. Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC), Hip disability and Osteoarthritis Outcome Score (HOOS), Activities of Daily Living (ADLs) score and Brody Instrumental Activities of Daily Living Scale (IADL) were performed. Radiological assessments were made through plain radiographs of the pelvis in Antero-posterior view to analyze before the surgery the fracture type and the eventual loosening, and during the follow-up after surgery, to examine bone healing and the radiological outcome. Vancouver classification was used to identify the diagnosis.

As already stated, the treatment choice included two alternatives: open reduction and internal fixation (ORIF) or total hip replacement, mainly stem revisions. Therefore, we identified two study groups, similar for demographic data. Group A included patients surgically treated without involving prosthetic implants, whereas Group B included patients in which an implant revision was performed.

During hospitalization, all patients received continuous multidisciplinary team care from the trauma team, the geriatric team and the physiotherapists throughout their inpatient stay. Post-operative indications for group A were no weight bearing for 45 days, then progressive weight bearing through uses of crutches. During this period, active and passive mobilization of the hip on the bed were suggested. For group B, an earlier weight bearing was achieved and strongly encouraged. Each clinical and radiological follow-up was planned at 1, 3, 6 and 12 months, then yearly for both groups, with clinical examination and X-rays of the Pelvis in Antero-posterior view.

Statistical Analysis

Data were analyzed for descriptive statistics as mean or median for continuous variables and frequency distribution (%) for categorical variables. Further inferential analysis was not possible because data were not homogeneous.

Results

Data were recorded from January 2017 to February 2020, before the SARS-CoV-2 pandemic in Italy significantly changed the trauma department in our hospital[14]. A retrospective analysis of the Hospital database was performed, the demographic data were recorded and are shown in Table I. 39 patients were included: 30 females

Table I. Demographic data and injury mechanism of the patients involved in the study.

Age (years)	84.4 ± 7.9
BMI (Kg/m^2)	21.7 ± 8.4
Gender	n (%)
Female	30 (76.9%)
Male	9 (23.1%)
Side affected	n (%)
Right	15 (38.5%)
Left	24 (61.5%)
Injury Mechanism	n (%)
Low Energy Trauma	35 (89.7%)
High Energy Trauma	1 (2.56%)
No trauma	2 (5.12%)
During surgery	1 (2.56%)

(76.9%) and 9 males (23.1%), with a confirmed diagnosis of periprosthetic fracture of the proximal femur, more specifically 15 involving the right femur (38.5%) and 24 (61.5%) the left one. The mean age was 84.4 ± 7.9 years, the mean BMI value was 21.7 ± 8.4.

Among these patients, 36 (92.3%) had direct trauma to the hip, in 35 cases (97.2%) the cause was a low energy trauma. One patient had a PPFF during a primary total hip replacement surgery. 7 (17.9%) patients had only one comorbidity, 32 (82.1%) have more than one comorbidity.

According to the Vancouver classification of periprosthetic femoral fractures, we found 6 (15.4%%) type AG fractures; 17 (43.6%) type B1; 12 (30.7%) type B2; 4 (10.3%) type B3 (Table II).

Chosen surgical options and therefore the two groups, A and B, are detailed in Table III, 23 (58.9%) patients were treated with Open Reduction and Internal Fixation (ORIF); 12 (30.7%) with revision surgery and 4 (10.3%) were treated by modular megaprosthesis. Posterolateral approach was used in 22 (56.4%) patients, while lateral approach in 17 (43.6%). Average total length of hospitalization was 16.8 ± 8.8 days.

Table II. Vancouver Classification - n (%).

Group A	Group B
AG	6 (15.4%)
B1	17 (43.6%)
B2	12 (30.7%)
B3	4 (10.3%)

Table III. Surgery performed in patients from Group A and B.

Surgical treatment	N (%)
Group A	23 (58.9%)
Among them: ORIF	23 (58.9%)
Group B	16 (41.1%)
Revision Surgery	12 (30.7%)
Modular megaprosthesis	4 (10.3%)

Table IV. Evaluation score at the last follow-up (Mean ± SD).

	Group A	Group B
HOOS Score	54.11 ± 23.55	60 ± 28.28
WOMAC score	57.84 ± 23.27	69.1 ± 22.77
ADL	4.14 ± 1.77	5.5 ± 0.71
IADL	3.33 ± 1.41	4.5 ± 2.12
Clinical Frailty Score	5.14 ± 1.34	4.5 ± 0.71

Patients were evaluated using 5 scales: HOOS and WOMAC scales to assess pain, hip function, and quality of life; ADL, IADL and Clinical frailty score to assess the degree of autonomy in the activities of daily life. These scores were assessed at the last follow-up for each patient. Mean follow-up was 26.3 months. The results are shown in Table IV. No significant differences between the two groups were recorded. Most of the clinical scores were similar in Group A and B, with a mild superiority in the HOOS score and a better result in the WOMAC score for Group B. Radiological evaluation showed a good bone healing at last follow-up X-rays without loosening of the implants for all the patients from both groups.

About the intraoperative complications, one casa suffered from periprosthetic damage during surgery: a patient with B1 fracture, during surgery for open reduction and internal fixation, had intraoperative complications, resulting in a B2 fracture. For this reason, the patient was treated through stem revision surgery and ORIF.

Postoperative complications were similar in both groups, with a total of 2 (5.12%) surgical wound infections, 10 (25.6%) postoperative anemia (they both received blood transfusions during hospitalization), 1 (2.56%) acute intestinal ischemia. 10 patients (25.6 %) died within less than 3 years from surgery. Results for different group are shown in Table V.

Table V. Post Operative Complications - n (%).

	Group A	Group B
Wound infection	1 (3.44%)	1 (10%)
Postoperative anemia	7 (24.1%)	3 (30%)
Acute intestinal ischemia	1 (3.44%)	0 (0%)

Discussion

PPFFs occurring in up to 11% of Total Hip Replacements (THR) and in 7% of hip hemiarthroplasties[15]. The number of PPFFs is enhanced due to the increased quantity of hip replacements[16]. Risk factors of PPFFs, as reported in actual literature, include old age, rheumatoid arthritis, osteoporosis, and low energy falls[16,17]. Using a cementless stem can increase the risk of PPFFs of up to 14 times[18,19]. The risk of patient falling is also associated with some neuromuscular diseases, such as Alzheimer, Parkinson and Dementia, but there is not a direct correlation with the risk of PPFFs[20,21]. Füchtmeier et al[22] found an association between higher mortality and old age, higher ASA grades and dementia. In another study, Drew et al[23] confirmed the higher mortality rates at 1 year in elderly patients with high BMI. PPFFs have poor clinical outcomes and generally involve unwell, frail, and elderly patients[24]. They do not return to their pre-injury functional level and bed rest, and that is associated with the onset of systemic complications and further limited mobilization[25,26]. Females are 40% more likely to have a PPFF[27]. 76.9% of our patients was female.

The treatment of PPFs is influenced by the Vancouver classification[28]. As shown in the review of Stoffel et al[29], there are no significant differences between revision and fixation, as also reported in our study, and the most significant indication toward one or the other is given by fracture type, stem stability and bone stock. Scalici et al[30] made a comparison similar to ours, with a larger population size but a lower minimum follow-up (12 *vs.* 24 months). Their conclusion has shown a possible advantage for revision arthroplasty (RA), even if some limitations of the study made the statement less evident. Even in this case, the main indication toward ORIF or RA was not on the surgeon, but on the fracture type and implants loosening.

In the present study, we had fair clinical results at least at 2-years follow-up after surgical management of PPFFs (Table IV). We also considered the number of comorbidities of the patients, which also affects the length of stay; in fact, patients with more than 5 comorbidities are more likely to have a longer length of stay than those with 0 to 2 comorbidities with a higher total cost[10].

Limitations and Strengths

A main limitation in our study is the population size; in fact, patients with PPFFs diagnosis came to our attention are not enough to do any proper statement about epidemiology and treatment options. Moreover, multiple methods of fracture fixation were used, such as plates, cerclage, and screws, according to the fracture patterns and surgeon experience; therefore, it is hard to generalize about the ORIF outcome without considering a single-implant evaluation. In the end, retrospective designed study and mid-term follow-up are correct, but they do not allow strong evidence for our findings.

However, this study presents strong findings taking into account that the experience of a high-volume center is precious when a particular condition has to be investigated, representative of the regional population. Surgical techniques were performed by high-experienced and high-skilled surgeons, reducing the surgeon-related bias. Our experience with a multidisciplinary team, involving specialized doctors with ortho-geriatrics curricula, is a strength of our study, because it is still a rare occurrence, despite the high level of evidence linking better outcomes in elderly patients and ortho-geriatric approach[31].

Conclusions

The current study shows that PPFFs are a devastating event for the patient and may be challenging for the surgeon. The treatment options considered in the study, revision arthroplasty and internal fixation had shown no significant differences as a matter of clinical outcomes and post-operative complications, confirming evidence already present in literature. The main indications for the surgical choice are: fracture type, implant stability and bone stock. Further and larger studies are needed to better evaluate these treatments and to produce stronger evidence.

Conflict of Interest

The Authors declare that they have no conflict of interests.

Acknowledgements

None.

Funding

Publication costs are funded by Orthopedic and Traumatology School of Università Cattolica del Sacro Cuore – Rome. The funders did not play any role in the design of the study, collection, analysis, and interpretation of data, or in writing of the manuscript.

Data Availability
The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

Ethics Approval
The study was conducted according to the guidelines of the Declaration of Helsinki and approved by the Institutional Review Board of Orthopedic and Traumatology Institute.

Informed Consent
All procedures were performed following written informed patient consent.

ORCID ID
Silvia Marino: 0000-0003-0078-2308; Alessandro Giuliani: 0000-0003-4838-8203; Domenico De Mauro: 0000-0002-4484-0963; Giuseppe Rovere: 0000-0001-7375-1479; Amarildo Smakaj: 0000-0002-7566-6785; Giulia Maria Sassara: 0000-0002-3003-2391; Lorenzo Are: 0000-0002-0106-6509; Giulio Maccauro 0000-0002-7359-268X; Francesco Liuzza: 0000-0003-3602-8155.

References

1) Finlayson G, Tucker A, Black ND, McDonald S, Molloy M, Wilson D. Outcomes and predictors of mortality following periprosthethic proximal femoral fractures. Injury 2019; 50: 438-443.
2) Rovere G, De Mauro D, D'Orio M, Fulchignoni C, Matrangolo MR, Perisano C, Ziranu A, Pataia E. Use of muscular flaps for the treatment of hip prosthetic joint infection: a systematic review. BMC Musculoskelet Disord 2021; 22: 1059.
3) Phruetthiphat OA, Otero JE, Zampogna B, Vasta S, Gao Y, Callaghan JJ. Predictors for readmission following primary total hip and total knee arthroplasty. J Orthop Surg 2020; 28: 2309499020959160.
4) Lindahl H, Garellick G, Regnér H, Herberts P, Malchau H. Three hundred and twenty-one periprosthetic femoral fractures. J Bone Joint Surg Am 2006; 88: 1215-1222.
5) Concina C, Crucil M, Gherlinzoni F. Factors influencing results and complications in proximal periprosthetic femoral fractures: a retrospective study at 1- to 8-year follow-up. Acta Biomed 2021; 92: e2021022.
6) Duncan CP, Masri BA. Fractures of the femur after hip replacement. Instr Course Lect 1995; 44: 293-304.
7) Rovere G, Perna A, Meccariello L, De Mauro D, Smimmo A, Proietti L, Falez F, Maccauro G, Liuzza F. Epidemiology and aetiology of male and female sexual dysfunctions related to pelvic ring injuries: a systematic review. Int Orthop 2021; 45: 2687-2697.
8) Colman M, Choi L, Chen A, Crossett L, Tarkin I, McGough R. Proximal femoral replacement in the management of acute periprosthetic fractures of the hip: a competing risks survival analysis. J Arthroplasty 2014; 29: 422-427.
9) Chen J, Wang X, Qian H, Ye J, Qian J, Hua J. Correlation between common postoperative complications of prolonged bed rest and quality of life in hospitalized elderly hip fracture patients. Ann Palliat Med 2020; 9: 1125-1133.
10) Ragland K, Reif R, Karim S, Sexton KW, Cherney SM, Stambough JB, Mears SC. Demographics, Treatment, and Cost of Periprosthetic Femur Fractures: Fixation Versus Revision. Geriatr Orthop Surg Rehabil 2020; 11: 2151459320939550.
11) Cohen S, Flecher X, Parratte S, Ollivier M, Argenson JN. Influence of treatment modality on morbidity and mortality in periprosthetic femoral fracture. A comparative study of 71 fractures treated by internal fixation or femoral implant revision. Orthop Traumatol Surg Res 2018; 104: 363-367.
12) De Mauro D, Rovere G, Smakaj A, Marino S, Ciolli G, Perna A, Battiato C, El Ezzo O, Liuzza F. Gibson approach and surgical hip dislocation according to Ganz in the treatment of femoral head fractures. BMC Musculoskelet Disord 2022; 22: 961.
13) Vitiello R, Ziranu A, Oliva MS, Meluzio MC, Cauteruccio M, Maccauro G, Liuzza F, Saccomanno MF. The value of megaprostheses in non-oncological fractures in elderly patients: A short-term results. Injury 2022; 53: 1241-1246.
14) De Mauro D, Rovere G, Smimmo A, Meschini C, Mocini F, Maccauro G, Falez F, Liuzza F, Ziranu A. COVID-19 pandemic: management of patients affected by SARS-CoV-2 in Rome COVID Hospital 2 Trauma Centre and safety of our surgical team. Int Orthop 2020; 44: 2487-2491.
15) Meek RM, Norwood T, Smith R, Brenkel IJ, Howie CR. The risk of peri-prosthetic fracture after primary and revision total hip and knee replacement. J Bone Joint Surg Br 2011; 93: 96-101.
16) Sidler-Maier CC, Waddell JP. Incidence and predisposing factors of periprosthetic proximal femoral fractures: a literature review. Int Orthop 2015; 39: 1673-1682.
17) Capone A, Congia S, Civinini R, Marongiu G. Periprosthetic fractures: epidemiology and current treatment. Clin Cases Miner Bone Metab 2017; 14: 189-196.
18) Abdel MP, Watts CD, Houdek MT, Lewallen DG, Berry DJ. Epidemiology of periprosthetic fracture of the femur in 32 644 primary total hip arthroplasties: a 40-year experience. Bone Joint J 2016; 98-B: 461-467.
19) Stramazzo L, Ratano S, Monachino F, Pavan D, Rovere G, Camarda L. Cement augmentation for trochanteric fracture in elderly: A systematic review. J Clin Orthop Trauma 2020; 15: 65-70.
20) Savin DD, Zamfirova I, Iannotti J, Goldberg BA, Youderian AR. Survey study suggests that re-

verse total shoulder arthroplasty is becoming the treatment of choice for four-part fractures of the humeral head in the elderly. Int Orthop 2016; 40: 1919-1925.

21) Thien TM, Chatziagorou G, Garellick G, Furnes O, Havelin LI, Mäkelä K, Overgaard S, Pedersen A, Eskelinen A, Pulkkinen P, Kärrholm J. Periprosthetic femoral fracture within two years after total hip replacement: analysis of 437,629 operations in the nordic arthroplasty register association database. J Bone Joint Surg Am 2014; 96: e167.
22) Füchtmeier B, Galler M, Müller F. Mid-Term Results of 121 Periprosthetic Femoral Fractures: Increased Failure and Mortality Within but not After One Postoperative Year. J Arthroplasty 2015; 30: 669-674.
23) Drew JM, Griffin WL, Odum SM, Van Doren B, Weston BT, Stryker LS. Survivorship After Periprosthetic Femur Fracture: Factors Affecting Outcome. J Arthroplasty 2016; 31: 1283-1288.
24) De Marco D, Messina F, Meschini C, Oliva MS, Rovere G, Maccagnano G, Noia G, Maccauro G, Ziranu A. Periprosthetic knee fractures in an elderly population: open reduction and internal fixation vs distal femur megaprostheses. Orthop Rev (Pavia) 2022; 14: 33772.
25) McGrory BJ. Periprosthetic fracture of the femur after total hip arthroplasty occurring in winter activities: report of two cases. J Surg Orthop Adv 2004; 13: 119-123.
26) Zheng L, Lee WY, Hwang DS, Kang C, Noh CK. Could Patient Undergwent Surgical Treatment for Periprosthetic Femoral Fracture after Hip Arthroplasty Return to Their Status before Trauma? Hip Pelvis 2016; 28: 90-97.
27) Bissias C, Kaspiris A, Kalogeropoulos A, Papoutsis K, Natsioulas N, Barbagiannis K, Papagelopoulos PJ, Savvidou OD. Factors affecting the incidence of postoperative periprosthetic fractures following primary and revision hip arthroplasty: a systematic review and meta-analysis. J Orthop Surg Res 2021; 16: 21.
28) Naqvi GA, Baig SA, Awan N. Interobserver and intraobserver reliability and validity of the Vancouver classification system of periprosthetic femoral fractures after hip arthroplasty. J Arthroplasty 2012; 27: 1047-1050.
29) Stoffel K, Blauth M, Joeris A, Blumenthal A, Rometsch E. Fracture fixation versus revision arthroplasty in Vancouver type B2 and B3 periprosthetic femoral fractures: a systematic review. Arch Orthop Trauma Surg 2020; 140: 1381-1394.
30) Scalici G, Boncinelli D, Zanna L, Buzzi R, Antonucci L, Di Maida F, De Biase P. Periprosthetic femoral fractures in Total Hip Arthroplasty (THA): a comparison between osteosynthesis and revision in a retrospective cohort study. BMC Musculoskelet Disord 2022; 23: 200.
31) Marzetti E, Calvani R, Cesari M, Tosato M, Cherubini A, Di Bari M, Pahor M, Savera G, Collamati A, D'Angelo E, Bernabei R, Landi F. Operationalization of the physical frailty & sarcopenia syndrome: rationale and clinical implementation. Transl Med UniSa 2016; 13: 29-32.