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Original Article

Outcome of surgical treatment of 54 periprosthetic femoral fractures after total hip arthroplasty at mid term follow-up

Ibrahim Akkawi [1], *Daniele Fabbri* [2], *Matteo Romantini* [3], *Calogero Alfonso* [4]
[1] Villa Erbosa Hospital, Bologna, Italy; [2] Hip Resurfacing Service, IRCCS Galeazzi Orthopaedic Institute, San Siro Clinical Institute, Milan, Italy; [3] Rizzoli Orthopaedic Institute, Bologna, Italy; [4] Orthopaedics e Traumatology, Department for Special Surgery and Anesthesiology, S. Orsola-Malpighi Hospital, Bologna, Italy

Abstract. *Background and aim:* The incidence of periprosthetic femoral fractures (PFF) is increasing, as the incidence of total hip arthroplasty (THA) and the longevity of patients with in situ implants are increasing. PFF are characterized by remarkably high re-operation and mortality rates and substantial loss in function. Therefore, the aim of the present study was to review the outcome of the surgical treatment of 54 PFF after THA at a mean follow-up of 45 months. *Methods:* We retrospectively reviewed 54 surgically treated patients with PFF after THA from January 2005 to Dicember 2015 at a mean follow-up of 45 months (range 12-135 months). At final follow-up, the clinical outcome was measured using the Harris Hip score (HHS), the Karnofsky score (KS), while, the radiographic results were evaluated using the Beals and Tower's criteria. *Results:* There were 13 post-operative complications that occurred in 10 patients with an overall re-operation rate of 11%. The mortality rate was 0% at 3 months and 3.7% at one year post-operatively. At final follow-up, the mean HHS was 64 (range 20-100) and the mean KS was 66 (range 30-100). The mean last HHS and KS of patients older than 75 years or with co-morbidities were lower than that of patients younger than 75 years or without co-morbidities ($p<0.05$). Fracture type according to the Vancouver classification, surgical treatment (open reduction internal fixation (ORIF) vs stem revision), complications, only re-operations and only dislocations had no effect on clinical outcome ($p>0.05$). There were no differences of the mean last HHS and KS of ORIF compared to stem revision of type B2 and B3 fractures ($p>0.05$). The radiolographic results were excellent in 89%, good in 9% and poor in 2% of patients. *Conclusions:* Although this study have shown that the surgical treatment of PFF was associated with a low re-operative rate, a good to excellent radiolographic results and a low mortality rate at 3 months and 1 year postoperatively, there was a marked functional deterioration in many patients. This decline of function could be attributed to the advanced age of patients and the presence of co-morbidities, whereas, fracture type according to the Vancouver classification, surgical treatment and complications had no effect. In this cohort of patients, ORIF could be a valid option for treating B2 and B3 type fractures with loosened stem.

Key words: Total hip arthroplasty, Periprosthetic femoral fractures, co-morbidities, advanced age, clinical outcome

Introduction

The incidence of periprosthetic femoral fractures (PFF) is increasing, as the incidence of total hip arthroplasty (THA) and the longevity of patients with in situ implants are increasing (1,2) . In primary THA, the reported annual incidence of PFF range from 0.4% to 1.1% (3), whereas in revision THA, the incidence of PFF ranges from 1.9% to 2.1% (4). These are the third most common complication of THA in patients with advanced age and multiple medical co-morbidities after aseptic loosening and recurrent dislocation (5), which typically result from low energy trauma (6,7). They require both revision hip surgery and trauma skills (8), and their management is often complex and expensive (9).

Many risk factors that raise the likelihood of PFF have been identified: female gender, advanced age, osteoporosis, rheumatoid arthritis, varus stem misalignment, loose femoral stem, prior femoral operation, osteolysis, index operative diagnosis, type of implant fixation and ASA class (3, 10-13).

The Vancouver classification is a reliable classification system for PFF, which has high intra-observer and inter-observer reliability (14). It is based on fracture location, prosthesis stability, and bone stock quality (6). This may be used for determining the treatment strategy (15), but it does not take the overall general medical condition of the patient into consideration (6).

PFF are characterized by remarkably high reoperation and mortality rates and substantial loss in function (16,17). Therefore, the aim of our study was to analyze the clinical and radiographic outcome of the surgical treatment of 54 PFF after THA at a mean follow-up of 45 months.

Materials and methods

Patients

We retrospectively reviewed 54 surgically treated patients with PFF after THA from January 2005 to Dicember 2015. They were 17 males and 37 females with a mean age at surgery of 77 years (range 47-93 years). The mean follow-up was 45 months (range 12-135 months) (Table 1). Seven patients (13%) died from reasons not related to surgery at a mean of 53 months (12 to 96 months) after surgery, with the implant still in place. Two patients died 12 months post-operatively from hepatocellular and lung carcinoma, three patients died 48, 60 and 96 months post-operatively from acute myocardial infarction, and finally two patients died 60 and 84 months post-operatively after stroke. The clinical and radiographic data for these patients were included until their most recent follow-up.

Table 1. Patients demographics and comorbidities

Periprosthetic femoral fractures	54
Female/Male	37/17
Mean age at surgery	77 (47-93) years
Mean age at follow-up	80 (55-98) years
Mean follow-up	45 (12-135) months
Disease	No. of patients
Kidney failure	4
Stroke	4
Acute myocardial infarction	4
Neuropathy	10
Diabetes	10
Dementia	9
Chronic obstructive pulmonary disease	8
Atrial fibrillation	13
Hepatopathy	3
Venous insufficiency	2
Arteriopathy	5
Hypertensive cardiopathy	15
Heart transplant	1
At least one comorbidity	33
Multiple comorbidities	24

According to the Vancouver classification (15) there were 6 type AL, 14 type B1, 18 type B2, 11 type B3, and 5 type C fractures (Table 2). PFF occurred in 48 cases after primary THA. Among these, there were 8 cemented and 40 uncemented THAs. Moreover, PFF occurred in 6 cases which had been revised previously. Among these, there were one cemented and five uncemented THAs.

Clinical and radiographic evaluation

At last follow-up, patients were assessed clinically using the Harris hip score (HHS) and the Karnofsky score (KS), and radiographically to assess fracture union and implant loosening using the Beals and Tower's criteria (7). The HHS was designed to evaluate the results of hip surgery. A total score of <70 is considered a poor result; 70–79 is fair, 80–89 is good, and 90–100 is excellent (18). The KS is structured to assess independent function and as a measure of overall physical status (19) . A total score of >70% means that patients were able to carry on normal activities and needed no special care, 70% means that patients were unable to perform normal activity or to do active work, but can care for self, and <70% means that patients required assistance due to symptoms relating to injury, in some cases unable to care for self, and institutional or hospital care are required (19). Fracture healing was determined radiographically through obliteration of the fracture line in both views.

Surgical strategy

Our therapeutic strategies were not always based on the Vancouver classification. When there was any doubt regarding stem's stability on the pre-operative radiographs, we checked the stability of fixation of the prosthesis intra-operatively. Moreover, in patients with a loosened stem that have advanced age and multiple medical co-morbidities that do not withstand a prolonged and complex revision arthroplasty procedure, we treat them with open reduction and internal fixation (ORIF) (Table 2). All the stems of the 3 type B2 fractures treated with ORIF were uncemented, while of the 8 type B3 fractures treated with ORIF, 2 stems were cemented and 6 stems were uncemented. All the stems used for the index surgery were anatomical proximally hydroxyapatite-coated stem with press-fit metaphyseal fixation, while all patients treated with stem revision received an uncemented tapered, fluted, and distally fixed stem (Link MP Reconstruction Hip Stem, Waldemar Link GmbH & Co, Barkhausenweg, Hamburg, Germany).

Statistical analysis

A non paired (Independent) Student's t test (two tailed) was used to test if fracture types according to the Vancouver classification, surgical treatment (ORIF vs stem revision), complications, only re-operations, only dislocations, advanced age (>75 years old) and the presence of medical co-morbidities were associated with low values of clinical scores. A value of $p<0.05$ was considered significant.

Table 2. Vancouver classification and type of treatment

Vancouver classification	ORIF	Revision of the stem	Total
AL	1	5	6
B1	12	2	14
B2	3	15	18
B3	8	3	11
C	5	0	5
Total	29	25	54

Results

At last follow-up, a total of 7 patients did not complete the HHS and KS due to poor health status. The remaining 47 PPFs with complete HHS and KS were: 5 type AL (one ORIF and 4 stem revision), 12 type B1 (10 ORIF and 2 stem revision), 15 type B2 (2 ORIF and 13 stem revision), 11 type B3 (8 ORIF and 3 stem revision) and 4 type C fractures (4 ORIF). Radiographic data were available for all the 54 patients included in the analysis.

Complications, re-operations and mortality rates

The mean time from the index surgery to the peri-prosthetic fracture was 93 months (range: 2-240 months). Thirty-three patients (61%) had at least one co-morbidity and twenty-four patients (44%) had more than one co-morbidity (Table 1). Overall, there were thirteen implant-related complications that occurred in 10 patients (Table 3). Five patients (9%) treated with stem revision for type B2 fractures had 7 dislocations (2 recurrent) and were managed successfully by a closed reduction under a general anesthesia. Six patients required re-operation (11%), of these 4 patients (7.4%) required stem revision. One patient with type B2 fracture treated with stem revision had

Table 3. Post-operative complications

Complications	No
Deep infection	1
Superficial infection	1
Dislocation	7
Rifracture	1
Non union	1
Aseptic mobilization of the stem	1
Superficial Hematoma	1

a trauma to the hip, thus developed hematoma and subsequently deep infection (1.8%) 38 months post-operatively treated with debridement and removal of all prosthetic components. The patient refused further treatment. One patient with type C fracture, developed non-union (1.8%) and was treated successfully 7 months post-operatively with debridement and autologous iliac bone grafts. One patient with type B1 fracture treated with ORIF had a new type B1 fracture (1.8%) 58 months post-operatively and was treated with a longer plate with screws and autologous iliac bone grafts. One patient with type B2 fracture treated with stem revision developed superficial wound infection (1.8%) and was treated successfully with debridement and antibiotic therapy. One patient with type B2 fracture treated with stem revision required wound hematoma assessment (1.8%) and the wound healed uneventually. Finally, one patient (1.8%) with type B3 fracture treated with ORIF developed aseptic loosening of the stem 44 months post-operatively and was treated with removal of the plate and screws and revision of the stem.

There were no deaths at 3 months post-operatively and a 3.7% mortality rate at 1 year postoperatively was observed.

Clinical and radiographic outcome

The mean HHS at the final follow-up of the 47 patients was 64 (range 20-100). Among them, 19% were excellent, 11% were good, 17% were fair and 53% were poor. The mean KS at the final follow-up was 66 (range 30-100) which means that patients required occasional assistance. Among them, 34% had a KS >70%, 21% had a KS of 70%, and 45% had a KS <70%.

The mean final HHS and KS of patients older than 75 years were statistically lower than that of patients younger than 75 years (61, 63 and 76, 77 respectively) ($p<0.05$). The mean final HHS and KS for patients with co-morbidities were statistically lower than that of patients without co-morbidities (57, 61 and 77, 76 respectively) ($p<0.05$).

The mean final HSS and KS of: type AL fractures were 78 and 80 respectively, type B1 fractures were 54 and 56 respectively, type B2 fractures were 66 and 71, type B3 fractures were 62 and 64 and type C fractures were 77 and 73. The mean final HSS and KS of all ORIF and stem revision cases were 64, 66 and 63, 72 respectively. The mean final HSS and KS were not different neither between fracture types according to the Vancouver classification nor between the surgical treatment (ORIF vs stem revision) ($p>0.05$).

The mean final HSS and KS of patients with and without complications were 59, 61 and 66, 68 respectively. The mean final HSS and KS of patients with only dislocations and only re-operations were 48, 53 and 61, 63 respectively. The final HHS and KS of patients with complications, only dislocations, and only re-operations were not statistically different compared with patients without complications ($p>0.05$).

The mean final HSS and KS of type B2 fractures treated with ORIF and stem revision were 75,5, 70 and 65, 71 respectively ($p>0.05$). The mean final HSS and KS of type B3 fractures treated with ORIF and stem revision were 58, 56 and 72, 83 respectively ($p>0.05$)

At the final follow-up, the radiographic results of the 54 patients according to Beals and Towers' criteria were excellent in 89%, good in 9% and poor in 2%. All fractures, except one, healed (98.2%) at an average time of 5 months (range, 3-8 months).

Discussion

The main findings of the present study were that the surgical treatment of PFF was associated with a low re-operation rate, a low rate of mortality at 3 months and 1 year post-operatively and excellent radiographic results. Despite these results, PFF were associated with a poor clinical outcome and a functional decline of patients at the last follow-up.

In the present study, six complications (11%) needed re-operation that compares favorably with that reported by many studies (range 12-33%) (2,7,15-20). Drew et al. (2) reported an overall re-operation rate of 16.8% over a range of follow-up of 1-10 years of 291 surgically treated patients for PFF. Füchtmeier et al. (15) reported a re-operation rate of 22% at a mean follow-up of 57 months of 121 patients treated surgically for PFF.

The non-union rate (1.8%) observed in this study was very low compared to other studies (7,20-22).

Park et al. (21) and Zuurmond et al. (20) reported a non-union rate of 7.4% and 17% respectively. Moreover, the rate of infection (1.8%) we report is also low compared to that observed in other studies (range 2.3-26%) (16,20,23-27). These differences, in the authors' opinion, are attributed to our careful operative technique in treating these fractures that avoid extensive muscle and periosteum stripping to prevent devascularization of the fracture fragments.

It has been reported that PFF are associated with a high mortality rate (2,27). Also, it has been stated that the short term mortality (≤ 3 months) is mostly linked to the injury itself or to complications related to the early phase after injury and surgery (28). Spina et al. (29), Langenhan et al. (30) and Bhattacharyya et al. (27) reported a 1.6%, 4% and 8% mortality rate three months after surgery respectively. In this study we did not have any death at 3 months postoperatively. On the other hand, the one year mortality rate is affected by some intrinsic patient-related factors as older age and higher ASA (15). In this study we observed a 3.7% mortality rate at 1 year that compares favorably with that published (range 11-17%) (8,15,27).

Although the surgical treatment of PFF was successful as we had a low rate of re-operation (survival rate was 92.5% with stem removal and 89% with any re-operation as the end point), a good to excellent radiographic results in 98% of patients and a 0% of mortality rate at 3 months post-operatively, there was a poor clinical outcome and a considerable loss of function in many patients. In deed, at the final follow-up, the mean HHS was poor in 53% of patients and 45% of patients required occasional assistance due to symptoms relating to injury (KS <70). This decline of function is explained by the fact that our patients had an advanced age (>75 years old) and/or multiple medical co-morbidities. Similarly to our data, other studies reported a poor functional outcome and high rate of patients needing assistance in patients treated for PFF after THA especially in those with advanced age and co-morbidities (7,16,20-29,31). Märdian et al. (16) analysed functional outcome and quality of life after surgical treatment of PFF following THA. At final followup, they found a poor outcome in 41.8 % of patients and 47.8 % of patients needed assistant devices for walking. Moreover, ASA score significantly influenced clinical outcome concluding that co-morbidities predict functional outcome in these patients. Another retrospective study performed by Moreta et al. (7) to determine the functional and radiographic results of the treatment of 8 type A, 46 type B and 5 type C fractures after THA or hemiarthroplasty at a mean follow-up of 33.6 months (range, 11–133 months). They reported a mean post-operative HHS of 67.9 (range, 43–96), with a poor outcome (HHS < 70) in 44% of the patients, moreover they observed that none of the patients improved their ability to walk after these fractures and 31 patients (52%) did not regain their pre-fracture walking status. They concluded that although they observed a good radiographic results following methods of treatment in accordance with the Vancouver classification, there was marked functional deterioration in many patients. Furthermore, Kinov et al. (31) showed that advanced age correlated significantly with lower functional outcome.

In the present study, detailed subgroup analysis failed to show a significant difference of final HHS and KS between fracture types according to the Vancouver classification and surgical treatment of all cases indistinctly (p>0.05). Similarly, Mardian et al. (16) found that fracture types according to the Vancouver classification or treatment strategy had no significant impact on clinical outcome.

Also, in the present study, no significant differences were found of final HHS and KS of patients with complications, only dislocations and only re-operations compared to those without complications (p>0.05). By contrast, Zuurmond et al. (20) found that patients treated for PFF with complications had a significantly low HHS compared to those without complications.

Finally, we observed that the final HSS and KS of type B2 and B3 fractures with a loosened stem and treated by ORIF were compared with those treated by stem revision (p>0.05). In the ORIF group, at final followup, all fractures healed and all stems but one (10 out of 11) were stable. Moreover, there were more complications in the stem revision group compared to the ORIF group. In fact there was only one complication in a patient with type B3 fracture and treated with ORIF, while there were 6 complications in patients with type B2 fracture and treated with stem revision.

Thus we conclude that ORIF is a feasible option for treating B2 and B3 type fractures with a loosened stem in patients with advanced age and co-morbidities with comparable clinical and radiographic outcome to stem revision. These results are confirmed by those reported by other studies (6,32). Joestl et al. (6) reviewed 8 patients treated with ORIF and 28 patients treated with stem revision for type B2 PFF following THA and found that all fractures treated with ORIF healed uneventfully and there were no signs of secondary stem migration, malalignement or plate breakage. A total of five (14%) complications were observed, all within the group of stem revision. The clinical results were not statistically significant compared to stem revision concluding that ORIF can be a valid option for the treatment of B2 type PFF correspondingly with a loose stem.

Limitations of this study

The retrospective design, and the missing pre-operative scores values are limitations. Further prospective studies with long term follow-up and higher number of cases are needed to confirm the findings of the present study.

Conclusions

Although this study have shown that the surgical treatment of PFF after THA was associated with a low re-operative rate, a good to excellent radiographic results and a low mortality rate at 3 months and 1 year after surgery, there was a marked functional deterioration in many patients. This decline of function could be attributed to the advanced age of patients and the presence of co-morbidities, whereas, fracture type according to the Vancouver classification, surgical treatment and complications had no effect. In these patients, ORIF could be a valid option for treating B2 and B3 type fractures with a loosened stem. These findings could help the surgeons to counsel patients that even if surgery would be successful, the functional outcome would be poor due to their intrinsic factors.

Conflicts of interest: Each author declares that he or she has no commercial associations (e.g. consultancies, stock ownership, equity interest, patent/licensing arrangement etc.) that might pose a conflict of interest in connection with the submitted article.

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Correspondence:
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Ibrahim Akkawi
Villa Erbosa Hospital 50/2, 40129, Bologna, Italy
E-mail: i.akkawi@libero.it