

Morbidity and mortality following surgical treatment in periprosthetic femoral fractures. Is time to surgery the key?

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SUMMARY

Objective. Total hip replacement is one of the most successful surgeries in recent years. The increase in total hip replacement procedures for the extension of indications, from primary/secondary arthrosis to medial femoral neck fractures, is associated with an increase in the average age of the population leading to an inevitable increase in complications, such as periprosthetic proximal femoral fractures (PPFF), even if rare. However, the importance of this complication lies in the high mortality, poor outcomes, and often incomplete recovery. The objective of our study is to investigate whether time to surgery was a prognostic element in the treatment of these fractures, considering that these patients are often fragile and will require timely treatment like patients who fall within the native hip fracture protocol.

Methods. 112 patients suffering from PPFF, classified with x ray according to Vancouver Classification were selected from 2007 to 2022 in two different hospitals in Rome. The minimum follow-up was 1 year and mortality, post-operative complications, and outcome were assessed in relation to time to surgery.

Results. There was a significant correlation between mortality and time to surgery and each hour of delay to surgery the risk of mortality increased by 2%. Moreover, a statistical significance was found between the inability to restore walking ability in the early postoperative period and one year mortality.

Conclusions. Patients with PPFF should be surgically treated with the same timing of patients with femoral neck fracture, in order to improve clinical outcomes, reduce post operative complications, restore walking ability, and reduce mortality.

Received: January 28, 2024
Accepted: September 1, 2024

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How to cite this article: Alonzo R, Giuliani V, Nicolosi I, et al. Morbidity and mortality following surgical treatment in periprosthetic femoral fractures. Is time to surgery the key? Lo Scalpello Journal 2024;38:45-49. <https://doi.org/10.36149/0390-5276-305>

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Introduction

Total hip arthroplasty (THA) is one of the most common and successful methods of treating patient with hip osteoarthritis of varying etiologies as well as intracapsular femoral neck fractures¹⁻⁶. Because of demographic changes, the indications for THA have broadened and expanded⁷⁻⁹. Therefore, patients are more likely to require THA and the number of implanted THA has increased^{8,10-12}. Furthermore, the indication for THA has increased, both in younger patients due to the longer duration of the implant and the improvement of prosthetic designs and in elderly patients due to increased functional

demands. At the same time, an increase in life expectancy has led to an increase in periprosthetic femoral fractures (PPFF)^{13,14}. This implicates the increasing incidence of complications after primary or revision THA including PPFF^{1,4,5,7,10-12,15-20}.

Even if it seems to be a rare complication after THA, PPFF is one of the major complications^{5,10,11,17-20}. This particular complication is especially important and clinically relevant because it is typically costly and associated with a poor outcomes, high mortality, and incomplete functional recovery^{3,4,20}.

The Vancouver classification is the most widely used classification for PPFF and also provides guidance between different surgeries. This classification divides periprosthetic fractures into three groups: type A fractures are limited to the greater (AG) or lesser trochanter (AL); type B fractures are diaphyseal fractures, around the stem or immediately distal to it, and are divided into three subtypes: B1, B2 and B3 (depending on whether the stem is stable or unstable and based on the bone stock); type C fractures are distant from the stem. According to the authors of the classification, type A fractures can be treated conservatively or surgically, depending on the stability of the fracture. Type B1 fractures are best treated using open reduction and internal fixation (ORIF); type B2 fractures should be treated by long-stem revision. B3 type fractures usually require complex reconstruction. Type C fractures are best treated using ORIF.

Due to the complexity of the patients and of the surgical procedure often there is a delay to surgery.

Some studies have shown that early surgery is helpful in improving outcomes for individuals with native hip fractures in the elderly population. Patients who sustain a periprosthetic fracture have been shown to have similar demographics and outcomes to those with native hip fractures¹⁴. Moreover, PPFF represent a challenging surgical problem, requiring combined arthroplasty and trauma skills in a potentially compromised surgical bed with the problems of implant loosening, bone loss, osteoporosis, and the possibility of concurrent infection²¹. Patients also may present significant anaesthetic and surgical risks, with complex comorbidities and frailty given an old age. Mortality and morbidity following surgery for PPFF is relatively high in the literature, certainly in the range of what would be expected following neck femur fracture^{22,23}. Due to the complexity of the patients and of the surgical procedure there is often a delay to surgery. In the literature there is no current evidence on the effect of delay to surgery on prevalent post-operative complications or 1-year mortality²⁴. The aim of this study was to investigate retrospectively clinical and functional outcomes, complications, and mortality in a population of 112 patients operated in our institutes for PPFF, with particular emphasis to time elapsed from injury to surgery.

Materials and methods

112 patients hospitalized in Sant'Andrea Hospital from January 2007 to May 2017 and in San Paolo Hospital from April 2018

to December 2022 were selected retrospectively for this study.

Fractures were classified with X-ray in AP and LL according to the Vancouver classification by Duncan and Masri²⁵ and reconfirmed in the operative room in order to have a real idea of the type of the fracture and stability of the implant.

Patients who received conservative treatment were excluded from this study.

As routine follow-up included clinical evaluation at 1, 3, 6 and 12 months and, for this study, the 12-month follow-up was considered the end point.

Data included age, sex, ASA grade, type of fracture, time to surgery, type of treatment, complications, and clinical outcome with special emphasis to ambulation. Variables of the study were statistically analyzed using a standard post hoc analysis in Excel using the Wilcoxon-Mann Whitney test. For this type of study formal consent is not required. Informed consent was obtained from all participants included in the study.

Results

At one year follow-up four patients were lost because of poor compliance. Therefore, a total of 112 patients were eligible for this study.

There were 80 females and 32 males, with an age at the time of PPFF of 77.3 years (range 59-92). In all cases, fracture occurred after a previous primary THA.

Primary arthroplasty was performed for hip arthrosis in 88 cases and for femoral neck fracture in 24 patients.

In all cases, a cementless stem was used and no patient had a history of possible pre-existing loosening. In all patient fracture occurred following low energy trauma.

The average time elapsed from arthroplasty to the fracture was three years (11 months to 11 years).

The Vancouver classification of the PPFF is presented above. There were 12 type A fractures (10.7%), 26 type B1 fractures (23.2%), 30 type B2 fractures (26.7%), 26 type B3 fractures (32.2%), and 18 type C fractures (16%) (Tab. I).

The mean ASA score was 2.76.

The mean time to surgery was 3.7 days (min 1-10 days)

The treatment of PPFF was performed in 56 cases with a plate and cable wire, in 36 with cable wires, and in 20 with revision of the stem, plate, and cable wires. The 12 type A fractures

Table I. Vancouver Classification of fractures.

Vancouver classification	N	Percentage
A	12	10.7%
B1	26	23.2%
B2	30	26.7%
B3	26	32.2%
C	18	16%

were treated with cable wire in 9 cases (75%) and plate with cable wire in 3 cases (25%). For the Vancouver type B fractures: 22 B1 were treated with cable wire (84.6%) and 4 with plate and cable wire (15.4%); 27 B2 were treated with plate and cable wire (90%) and 3 with cerclage alone; 20 type B3 were treated with revision of the prosthetic stem (76.9%) and 6 with plate and cable wire (23%). The 18 type C fractures were treated in 16 cases (88.8%) with a plate and cable wire and 2 with cable wire (11.2%). In no cases strut grafts were used. Immediate mobilization and protected weight bearing were allowed to all patients.

There were two early local complications (failure of fixation requiring reoperation); in no cases infection occurred.

Complications following surgery in this population are outlined in Table II.

At one year of follow-up 82 patients were alive and 68 of these were ambulant (56 able to walk with crutches and 26 without help), while 30/102 had died (26, 7%), 22 were bedridden, and 8 were assisted in ambulation (6 patients were able to walk with crutches, 2 without help).

There was no significant difference between those who died postoperatively and those who did not with regards to age, preoperative ASA score, and postoperative complications. ($p > 0.002$)

There was a significant correlation between mortality and time to surgery ($p < 0.002$) and each hour of delay to surgery increased the risk of mortality by 2% (OR = 1.02; CI 1.00-1.004) (Tab. III).

Moreover, statistical significance was found between inability to restore walking in the early postoperative period and one year mortality ($p < 0.001$).

At one year of follow-up, patients who were bedridden had a risk of death that was increased by 13 times.

Discussion

PPFF are associated with clinically important complications after primary and revision THA and have poor outcomes, a high mortality, and often incomplete functional recovery^{3,4,20}.

The incidence of PPFF appears to be increasing as a result of increased longevity, more demanding activity levels that persist in advanced age for some patients and as a result of the increasing rate of revision arthroplasty that accompanies increasing patient longevity⁸. However, in our consecutive series there were no cases of PPFF after THA revision.

It is interesting that in our series none of the implants were cemented as is usual in our area; our rate of PPFF is in line with the literature that reports a higher rate of PPFF in non-cemented THA compared with cemented THA²⁰.

Few studies have examined the clinical results of PPFF after 1 year of follow-up^{23,24}.

The most important finding of the study is the statistical correlation between time to surgery and mortality. It is well known

Table II. Post-operative complications.

Early failure of fixation	2
Low respiratory tract infection	10
Congestive heart failure	6
Acute coronary syndrome	6
Acute kidney failure	2
Abdominal perforation	4

that PPFF are associated with a high rate of complications. In our study, complications occurred in 26% of cases similar to other studies²⁴.

Jonson et al. performed a study on the same topic. They reported an in-patient mortality of 11% that increased to 17% at one year and no correlation with delayed surgery. Even if mortality at one year in our series seems to be slightly higher than that reported by Jonson, we had a lower in-patient mortality in our series.

On the basis of these results, we can speculate that early surgery may reduce mortality²⁴.

Moreover, it is well known that reducing the delay to surgery is one of the key factors to reduce morbidity and mortality in patients affected by fracture of the femoral neck and patients with PPFF represent a similar group with multiple medical comorbidities. In a systematic review by Lamb et al. in 2022, 4841 patients from 35 cohort studies were evaluated and it was highlighted that mortality within 90 days was 4.8%, similar to that experienced by patients after neck of femur fracture which within one year was 13.4%²⁶.

A possible explanation of this difference is that the present study was performed in a high-volume center for hip surgery with a dedicated surgical and anesthesiological team. Johnson reported that is safe to delay surgery in patients affected by PPFF in order to have the correct team and surgical expertise, because these fractures represent a challenging surgical problem requiring combined arthroplasty and trauma skills⁵. For this reason in our center, patients underwent surgery as soon as possible similar to patients with femoral neck fracture.

In our series, immediate mobilization and protected weight bearing was allowed early after surgery because PPFF was treated with the goal to obtain a stable osteosynthesis or a stable revision implant²⁷.

Mortality was significantly related to surgical timing with an increase in the risk of mortality of 2% for hour of delaying surgery (OR = 1.02; CI 1.00-1.004). Our results contrast with those reported by Johnson-Lynn et al. that in their multicentric study, reported that delaying surgery reduces the rate of complications. However, based on these results, when an adequate team is available, early surgery is advisable as in femur neck fractures. Nevertheless, the two publications deal with the same topic: Jonson et al. performed a multicentric study of dif-

Table III. Delay to surgery.

	N	Mean	Std dev	Stder	50 th pctl	25 th pctl	75 th pctl	Min	Max	Wilcoxon-Mann-Whitney test
ALIVE	82	70.24 h	41.36	6.46	72.00	48.00	72.00	24.00	192	0.0021
DEATH	30	110.40h	47.83	12.35	96.00	96.00	120.00	48.00	240.00	

ferent hospitals, and stated that often delay to surgery was due to technical organization. For this reason, comparison of the results of the two studies is difficult.

Conclusions

On the basis of the results of the present study, we can speculate that the reported lower rate of mortality is correlated to the reduced time from fracture to surgery; for this reason, patients with PPFF should be surgically treated with the same timing protocol of patients with femoral neck fracture, in order to improve clinical outcomes, reduce postoperative complications, restore walking ability, and reduce mortality.

The limitations of the study are the heterogeneous nature of the patient population, lack of comparison with preoperative conditions, and its retrospective; furthermore, a CT scan was not performed on all patients. There are, however, notable limitations to the existing literature, so further appropriately designed large-scale studies are needed to confirm these findings. Delaying surgery in patients with periprosthetic fractures has a deleterious impact on mortality and outcomes.

The lower incidence of mortality related to reduced delay to surgery reported in our series suggests that these patients should be treated with the same timing protocol as those with a fracture of the femoral neck.

In order to reduce the high mortality rate, the time to get the adequate equipment and obtain the surgical expertise in traumatology and prosthesis should be as short as possible.

Conflict of interest statement

The Authors declare no conflict of interest.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Author contributions

The Authors contributed equally to the work.

Ethical consideration

This study was approved by the Institutional Ethics Committee University of Rome La Sapienza (protocol number 128/2018). The research was conducted ethically, with all study proce-

dures being performed in accordance with the requirements of the World Medical Association's Declaration of Helsinki.

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