Does delay to theatre influence morbidity or mortality in femoral periprosthetic fractures?

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Aims

Femoral periprosthetic fractures are rising in incidence. Their management is complex and carries a high associated mortality. Unlike native hip fractures, there are no guidelines advising on time to theatre in this group. We aim to determine whether delaying surgical intervention influences morbidity or mortality in femoral periprosthetic fractures.

Methods

We identified all periprosthetic fractures around a hip or knee arthroplasty from our prospectively collated database between 2012 and 2021. Patients were categorized into early or delayed intervention based on time from admission to surgery (early = ≤ 36 hours, delayed > 36 hours). Patient demographics, existing implants, Unified Classification System fracture subtype, acute medical issues on admission, preoperative haemoglobin, blood transfusion requirement, and length of hospital stay were identified for all patients. Complication and mortality rates were compared between groups.

Results

A total of 365 patients were identified: 140 in the early and 225 in the delayed intervention group. Mortality rate was 4.1% at 30 days and 19.2% at one year. There was some indication that those who had surgery within 36 hours had a higher mortality rate, but this did not reach statistical significance at 30 days ($p = 0.078$) or one year ($p = 0.051$). Univariate analysis demonstrated that age, preoperative haemoglobin, acute medical issue on admission, and the presence of postoperative complications influenced 30-day and one-year mortality. Using a multivariate model, age and preoperative haemoglobin were independently predictive factors for one-year mortality (odds ratio (OR) 1.071; $p < 0.001$ and OR 0.980; $p = 0.020$). There was no association between timing of surgery and postoperative complications. Postoperative complications were more likely with increasing age (OR 1.032; $p = 0.001$) and revision arthroplasty compared to internal fixation (OR 0.481; $p = 0.001$).

Conclusion

While early intervention may be preferable to reduce prolonged immobilization, there is no evidence that delaying surgery beyond 36 hours increases mortality or complications in patients with a femoral periprosthetic fracture.

Take home message

- Femoral periprosthetic fractures carry a high morbidity and mortality rate.
- Surgery within 36 hours has not been shown to reduce mortality or complication rates.
- The benefits of early surgery should be balanced against the need for medical optimization and identification of the correct surgeon.

Introduction

Periprosthetic femoral fractures are increasing in frequency,[1,2] and are associated with significant morbidity and mortality rates.[3,4] This is in part due to the patient cohort often being elderly, with

the accompanying comorbidities and frailty that comes with an ageing population.[5] Furthermore, the management strategies are often complex. As such, it is important that we consider what modifiable factors we can address to improve outcomes.

There are many similarities between patients presenting with femoral periprosthetic fractures and those with fragility fractures of the proximal or distal femur.[3,6] In the latter group, it has been established that delaying surgery contributes to greater morbidity and mortality,[6-8] leading to UK guidelines recommending surgery within 36 hours of admission.[9,10] However, no such recommendations are in place for femoral periprosthetic fractures. Given there is often a need for specific implants and specialist surgeons, this can lead to significant delays to surgical intervention in this group. At present, it is uncertain whether time to theatre is a modifiable factor that can influence outcomes. The aim of this study, therefore, was to determine whether aligning with the UK hip fracture guidelines of performing surgery within 36 hours of admission could improve morbidity or mortality in femoral periprosthetic fractures.

Methods

Institutional approval was obtained for this study. Our prospectively collated database (Bluespier, UK) was analyzed to identify all patients undergoing surgical intervention for a femoral periprosthetic fracture from January 2012 to January 2021. This enabled a minimum of two years' follow-up. Only fractures around a hip or knee arthroplasty were included. Any fractures around an intramedullary nail, plate, or other internal fixation device were excluded.

Date and time of both admission and surgery were identified to calculate time to theatre. Patients were then divided into those who had early (≤ 36 hours) and delayed surgical intervention (> 36 hours). Age, sex, American Association of Anesthesiologists (ASA) grade,[11] BMI, existing implants, Unified Fracture Classification type,[12] Rockwood Clinical Frailty Scale,[13] presence of acute medical issues, preoperative haemoglobin, blood transfusion requirement, surgical procedure, and length of hospital stay were collected for all patients. Follow-up occurred postoperatively at regular intervals until fracture union was achieved, and annually thereafter with clinical and radiological assessment. Complications and survival of implant and patients were recorded.

Surgical technique

The decision on which surgical procedure to perform (i.e. fixation or revision arthroplasty) was decided based on fracture configuration and surgeon preference. If plate fixation was performed, implants used were the NCB system (Zimmer Biomet, USA), AxSOS (Stryker, UK), and LCP (Depuy Synthes, USA). Retrograde femoral nailing was performed with the T2 nail (Stryker). Revision hip implants included Restoration (Stryker), GMRS proximal femur replacement (Stryker), ZMR (Zimmer Biomet), or Reclaim (Depuy Synthes). If cement-in-cement revision was performed, the Exeter stem (Stryker) or C-stem AMT (Depuy Synthes) were used. The LPS system was used for distal femur and total femoral arthroplasty (Depuy Synthes).

Statistical analysis

Relationships between qualitative variables were investigated using chi-squared tests. Quantitative variables were compared between outcomes using paired two-sample *t*-tests or Mann-Whitney tests. Z-test was used to compare proportions between groups. Logistic regression analysis was used to determine independent predictors of outcome. All analyses were done using Minitab v. 18 (Minitab, USA) at a 5% significance level.

Results

A total of 365 patients were identified who matched the inclusion criteria. Mean time to theatre was 67 hours (6 to 351). Dividing patients by time to theatre, there were 140 in the early and 225 in the delayed intervention group. Patient demographics and fracture subtype for both groups are presented in Table I. There were no significant differences noted between groups. At least one acute medical issue was present on admission for 195 patients (53.4%), the most common of which was anaemia (Table II). There was no difference in the rate of acute medical issues between groups ($p = 0.2357$, chi-squared test). Surgical intervention involved revision arthroplasty in 158 patients, and internal fixation in 207. The proportion of patients delayed to surgery in the revision group compared to internal fixation was significantly higher for both total hip arthroplasty (THA) ($p = 0.046$, chi-squared test) and total knee arthroplasty (TKA) ($p < 0.001$, chi-squared test).

Combined mortality rate was 4.1% at 30 days and 19.2% at one year. There was some indication that those who had surgery within 36 hours had a higher mortality rate, but this did not reach statistical significance at 30 days ($p = 0.078$, chi-squared test) or one year ($p = 0.051$, chi-squared test). Further analysis with time to theatre as a continuous variable also did not demonstrate an associated with 30-day ($p = 0.695$, Mann-Whitney U test) or one-year ($p = 0.365$, Mann-Whitney U test) mortality. Univariate analysis demonstrated age, preoperative haemoglobin, acute medical issue on presentation, and the presence of postoperative complications influenced 30-day and one-year mortality. Using a multivariate model, age was independently predicative of 30-day mortality (odds ratio (OR) 1.085; $p = 0.006$, logistic regression), while age and preoperative haemoglobin were predictive of one-year mortality (OR 1.071; $p < 0.001$ and OR 0.980; $p = 0.020$, logistic regression).

At least one complication was experienced by 41.6% of patients. There was no association between timing of surgical intervention and postoperative complications ($p = 0.879$, chi-squared test). Complications were more likely with increasing age (OR 1.032; $p = 0.001$) and revision arthroplasty compared to internal fixation (OR 0.481; $p = 0.001$) in the univariate and multivariate models. While there was a trend towards a higher transfusion rate in the delayed intervention group (62.7% vs 37.3%), this did not reach statistical significance ($p = 0.5755$, chi-square). The delayed intervention group had a shorter length of hospital stay, but this did not reach statistical significance (39 vs 45 days; $p = 0.084$). There was no difference in reoperation rates between the early and delayed group (17.1% vs 16.9%; $p > 0.999$, chi-squared test). Indications for further surgery are listed in Table III. There was no difference in median Rockwood Clinical Frailty Score between

Table I. Patient demographics in both groups.

Variable	Early intervention (n = 140)	Delayed intervention (n = 225)	p-value
Mean age, yrs (range)	78 (38 to 97)	77 (27 to 99)	0.276*
Sex F:M, n	1.69:1	1.30:1	0.231†
Mean BMI, kg/m² (range)	26.5 (14 to 56)	26.4 (16 to 49)	0.957*
Median ASA grade (IQR)	3 (3 to 3)	3 (3 to 3)	0.261†
Existing metalwork, n (%)	Primary THA = 82 (58.6)	Primary THA = 135 (60.0)	
	Primary THA = 82 (58.6)	Primary THA = 135 (60.0)	
	Primary TKA = 33 (23.6)	Primary TKA = 40 (17.8)	
	Revision THA = 3 (2.1)	Revision THA = 14 (6.2)	0.6674†
	Revision TKA = 3 (2.1)	Revision TKA = 3 (1.3)	
	Resurfacing = 6 (4.3)	Resurfacing = 6 (4.3)	
	Hemiarthroplasty = 13 (9.3)	Hemiarthroplasty = 30 (13.3)	
Fracture type, n (%)	B = 97 (69.3)	B = 174 (77.3)	
	C = 30 (21.4)	C = 32 (14.2)	0.1772†
	D = 13 (9.3)	D = 19 (8.4)	

*Paired two-sample *t*-test.
†Chi-squared test.
ASA, American Association of Anesthesiologists; IQR, interquartile range; THA, total hip arthroplasty; TKA, total knee arthroplasty.

Table II. Acute medical issues on presentation. There was no significant difference in the overall rate between groups.

Variable	Early intervention, n (%)	Delayed intervention, n (%)
Atrial fibrillation	0 (0.0)	2 (0.9)
Acute kidney injury	4 (2.9)	3 (1.3)
Alcohol withdrawal	0 (9.0)	1 (0.4)
Anaemia	62 (44.3)	112 (49.8)
Delirium	4 (2.9)	6 (2.7)
Hyperkalaemia	0 (0.0)	1 (0.4)
LRTI	1 (0.7)	9 (4.0)
Metastatic malignancy	0 (0.0)	1 (0.4)
Pulmonary embolism	0 (0.0)	1 (0.4)
Sepsis	1 (0.7)	3 (1.3)
Upper GI bleed	0 (0.0)	1 (0.4)
Urinary tract infection	0 (0.0)	3 (1.3)

GI, gastrointestinal; LRTI, lower respiratory tract infection.

Table III. Indication for reoperation; there was no difference in rate between the early and delayed intervention group.

Indication for reoperation	Data, n (%)
Dislocation	14 (3.8)
Periprosthetic fracture	14 (3.8)
Infection	18 (4.9)
Aseptic loosening	1 (0.3)
Nonunion	15 (4.1)
Removal of metalwork	1 (0.3)

groups, with both demonstrating an increase from 4 preoperatively (p = 0.907, chi-squared test) to 5 (p = 0.450, chi-squared test) at time of discharge.

Discussion

Femoral periprosthetic fractures represent a significant complication following hip or knee arthroplasty. The mortality rate at one year has been reported as 22%,[14] which is comparable to that of fragility fractures of the proximal femur.[15,16] Indeed, there are many parallels between femoral periprosthetic and hip fragility fracture cohorts, as both groups typically consist of elderly comorbid patients at high risk of perioperative complications.[5] There is a sufficient body of evidence supporting expedient management of hip fractures,[6-8] with resulting UK guidelines recommending surgery within 36 hours of admission.[9,10] Despite their similarities, it is unclear whether femoral periprosthetic fracture patients would similarly benefit from early surgery, given conflicting reports in the literature. The aim of this study was therefore to investigate whether aligning femoral periprosthetic fracture patients with the UK hip fracture guideline of 36 hours to surgery would influence morbidity or mortality.

Using a cohort of 365 patients, we were unable to identify any significant association between early surgical intervention and mortality or morbidity. Indeed, there was a non-significant trend towards a higher mortality rate in this group. The current evidence within the literature on this topic is conflicted. Sellan et al[1] found in their analysis of 180 femoral periprosthetic fractures that delay to theatre did not influence morbidity or mortality. Similarly, Johnson-Lynn et al[17] reviewed 82 patients with a proximal femur periprosthetic fracture and did not demonstrate an association between delay to theatre and postoperative outcomes. In contrast, Griffiths et al[18] found delaying surgery beyond 72 hours to be associated with higher complication rates and mortality in their analysis of 60 periprosthetic fractures. This aligns with a meta-analysis by Farrow et al.[19] In their study, there was a significantly lower risk of 30-day mortality for those with early versus delayed surgery. This was based on pooled data for three papers.[5,20,21] However, in each of these studies, the patients in the delayed intervention group were noted to be significantly older and have more comorbidities. Accordingly, on multivariate analysis the individual papers did not find an association between delay to theatre and mortality.

This conforms with our results, whereby comparing two cohorts with matched baseline demographics we identified age, and not time to theatre, to be independently associated with mortality on univariate and multivariate analysis. This is perhaps not surprising given older patients are more likely to suffer from a greater number of comorbidities, which will predispose to morbidity and mortality. This suggests that periprosthetic fracture patients are more heterogenous in nature than the hip fracture population, comprising both comparatively younger fitter patients as well as those similar in profile to the typical fragility fracture group. Taking a more individualized approach to patient care is therefore warranted. While this and other studies have identified that many factors contributing to morbidity and mortality are non-modifiable,[5,20,21] including patient age and comorbidities, there are still areas likely to infer patient benefit to focus on. This includes having the right procedure performed by the right surgeon in order to mitigate postoperative complications, particularly given that we identified complications as being associated with mortality. We also found revision arthroplasty to be independently associated with complications. This aligns with other studies comparing internal fixation to revision arthroplasty in periprosthetic fractures of the proximal femur, and is therefore worth consideration.[22,23]

Attention must also be given to preoperative care. We identified preoperative haemoglobin and acute medical issues to be associated with mortality. Given that time to theatre was not linked to mortality, consideration should instead be given to ensuring patients are optimized ahead of surgery, as well as waiting for a specialist arthroplasty or trauma surgeon who is confident managing this patient group if required. Finally, postoperative care, including orthogeriatric input, is of great importance due to the complex nature of this patient group. Other authors have advised early involvement of a multidisciplinary team to reduce the risk of hospital-acquired pneumonia, since this is associated with increased mortality in periprosthetic fractures.[24] In the hip fracture population, orthogeriatric input is associated with a reduced length of stay, in-hospital mortality, one-year mortality, and delirium,[25] and it is highly likely periprosthetic fracture patients would similarly benefit.

There are limitations to our study. First, although we used a large study period at a high-volume centre, our sample size was not large. While we were able to identify a cohort larger than many other series in the literature, we determined that 1,104 patients would be required to adequately power a study investigating 30-day mortality. There are currently no studies in the literature with this sample size. This suggests that incorporating this patient group into national databases would be beneficial given their relatively infrequent nature. Second, although we gathered ASA grades for all patients, we do not have a detailed assessment of all relevant comorbidities which may have influenced morbidity and mortality. We also do not have patient-reported outcome data to assess what effect delaying theatre has on function and satisfaction rates. Finally, we only assessed time from admission to theatre, rather than time from injury. As we do not have accurate data on the time of injury, we are unable to determine whether this may have influenced the results obtained.

In conclusion, femoral periprosthetic fractures represent a significant injury, with an associated high morbidity and mortality rate. Although early surgery has been shown to be advantageous in the native hip fracture population, we did not find delaying theatre in this cohort to be detrimental to mortality or complication rates. It is therefore important to balance the potential for harm caused by delaying surgery with the need to facilitate medical optimization and identification of a surgeon with the correct skill set for managing these complex patients. Larger national cohort studies are required to confirm these findings.

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Data sharing

The datasets generated and analyzed in the current study are not publicly available due to data protection regulations. Access to data is limited to the researchers who have obtained permission for data processing. Further inquiries can be made to the corresponding author.

Ethical review statement

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