

Retrospective Evaluation of Postoperative Complications and Associated Risk Factors Following Surgical Fixation of Proximal Femoral Fractures

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Abstract:

Background: Proximal femoral fracture (PFF) is a significant cause of morbidity, especially in elderly patients and postoperative complications may have a detrimental impact on the recovery and functional outcome.

Aim: To assess the rate of postoperative complications and risk factors associated with surgery for proximal femoral fracture regarding patients, fractures and treatments.

Methodology: It was a retrospective observational study in Department of Orthopaedics, Maulana Azad Medical College and Lok Nayak Hospital of New Delhi, India for one year. One hundred and forty-eight (N=148) adult patients with proximal femoral fracture who had surgical fixation were included. Demographic, clinical, fracture-related, operative, radiological and postoperative data were evaluated in a retrospective manner.

Results: 31 patients (20.9%) had a postoperative complication. Failure related to the implant was found in 7 (4.7%), wound infection in 6 (4.1%), revision/reoperation in 6 (4.1%) and loss of reduction in 5 (3.4%). Age >65 years ($p=0.018$), comorbidities ($p=0.031$), unstable/comminuted fractures ($p=0.026$), unsatisfactory fracture reduction ($p<0.001$), and improper implant positioning ($p=0.002$) were all significant risk factors for complications.

Conclusion: Complications after proximal femoral fracture fixation are still relatively frequent. Adverse outcomes may be minimized with careful patient assessment, satisfactory reduction of the fracture, careful placement of the implant and appropriate postoperative monitoring.

Keywords: Proximal Femoral Fracture; Postoperative Complications; PFN; PFNA; Fracture Reduction; Implant Positioning; Risk Factors; Retrospective Study.

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Introduction

Proximal femoral fracture is a significant cause of morbidity and mortality in adults, especially the elderly. They are one of the most common injuries that needs operative treatment in orthopaedic trauma and makes up about 10% of all trauma surgery in the Western world and the numbers are further increasing [1]. Population ageing, osteoporosis, falls and the growing prevalence of comorbid medical conditions are closely linked to the rising burden of these fractures. In older adults, a proximal femoral fracture can lead to extended bed rest, loss of functional independence, a poorer quality of life, and higher rates of health care consumption. Hence, timely surgical stabilization and early mobilization plays a significant role in the management of fractures in the present era.

The treatment of proximal femoral fracture has changed significantly over the years due to improvements in fracture classification, implant development, surgical procedures, post-operative care and rehabilitation. The use of surgical fixation with intramedullary devices like proximal femoral nail (PFN), proximal femoral nail anti-rotation (PFNA), and other cephalomedullary nails is common especially for subtrochanteric and intertrochanteric fracture patterns that are unstable. These implants offer biomechanical benefits because they are in close proximity to the mechanical axis of the femur and there is controlled collapse at the fracture site. However, outcome of fixation depends on the type of implant used in addition to fracture characteristics, reduction of the fracture, implant positioning and patient related factors [2].

Even with the improvement of surgical techniques, postoperative complications are an important issue after proximal femoral fractures have been fixed. Complication rates at the time of operation have been as high as 20% [3]. Possible complications include surgical site infection, wound complications, implant-related failure, secondary displacement, cut-out or cut-through of the cephalic component, non-union, malunion, peri-implant fracture, re-fracture and revision surgery. Medical complications, such as thromboembolic events, cardiopulmonary complications, urinary infection and postoperative delirium can also negatively impact recovery, especially in older adults with a high burden of comorbidities. Therefore, postoperative complications should not only be analysed in terms of mechanical failure but also in terms of orthopaedic and systemic complications.

Complications occur in a multi-factorial manner. Fracture healing and postoperative recovery may be influenced by patient-specific factors including advanced age, osteoporosis or poor bone quality, diabetes mellitus, cardiovascular disease, obesity, smoking and other associated comorbidities. These factors include fracture complexity, comminution, fracture instability, and subtrochanteric extension and can add to the mechanical stresses on the fixation construct [4]. Fixation failure may also be due to treatment-specific factors, like inadequate fracture reduction, incorrect implant positioning, selection of wrong implant, and technical difficulties during surgery. Hence, it is crucial to determine the factors related to complications to help improve surgical decision-making and post-surgical care.

Appelt et al. have shown the importance of those factors in a retrospective study of 178 patients treated with a PFN [5]. Complications assessed included secondary displacement, non-union, re-fracture and implant failure. Of 153 patients with complex fractures and/or poor bone quality, 27 (15.2%) patients had a poor outcome, and 24 of those had a reoperation within six months. If patient-specific risk factors are present, then the role of treatment-specific factors was significant for complications, with a focus on the interplay between fracture characteristics, bone quality, fracture reduction, and implant positioning, the authors observed.

Likewise, later investigations have emphasized the importance of mechanical and technical aspects in the occurrence of fixation failure after proximal femoral nailing. Mechanical failure: cut-out, implant migration, screw/blade failure, loss of fixation. The cephalic fixation element in the femoral head and the fracture reduction are especially important radiological factors in the assessment of the risk of postoperative failure. These results suggest that complications following surgery are not solely related to the implant but are linked to patient, fracture and treatment factors [6].

The clinical relevance of this topic is very significant in the Indian healthcare context when proximal femoral fractures are a significant orthopaedic burden and patients may have different levels of osteoporosis, variable presentation time, multiple co-morbidities and differences in access to post-operative rehabilitation. The complication profile and risk factors may however vary between populations due to differences in patient characteristics, fracture characteristics, treatment methods, surgeon experience and healthcare facilities. Thus, retrospective analysis of the results at the various institutions can yield data on actual results of surgical fixation [7].

Lok Nayak Hospital, New Delhi is a big tertiary-care teaching hospital with a huge volume of orthopaedic trauma patients. Reviewing the numbers and types of complications that occur after proximal femoral fracture surgery at this institution, and the factors that predict poor outcomes, will be important in a retrospective evaluation of the patients treated. This analysis could aid in the identification of high-risk patients, pre-operative planning, correct placement of the implant and fracture, and post-operative monitoring [8].

Hence, the present study Retrospective Evaluation of Postoperative Complications and Associated Risk Factors Following Surgical Fixation of Proximal Femoral Fractures" is being designed at Lok Nayak Hospital, New Delhi, India. Postoperative complications after surgical fixation will be assessed and the association with patient-, fracture- and treatment-related factors will be evaluated. Knowledge of these factors could help to enhance surgical outcomes, preventable complications, and functional recovery for those suffering a proximal femoral fracture.

Methodology

Study Design: The present study was designed as a retrospective observational study to evaluate the frequency and pattern of postoperative complications and to identify the patient-related, fracture-related, and treatment-related factors associated with complications following surgical fixation of proximal femoral fractures. The study was based on the review of previously recorded clinical, radiological, operative, and postoperative data of eligible patients treated at the study centre. The study was planned in accordance with the stated objective of assessing postoperative complications and their associated risk factors.

Study Area: The study was conducted in the Department of Orthopaedics, Maulana Azad Medical College and associated Lok Nayak Hospital, New Delhi, India.

Study Duration: The study was conducted over a period of one year.

Sample Size: The total sample size of the study was 148 patients (N = 148). All eligible patients whose

records fulfilled the predefined selection criteria and contained adequate information for assessment of postoperative outcomes were included in the study.

Sample Population: The study population consisted of adult patients with proximal femoral fractures who underwent surgical fixation at Lok Nayak Hospital, New Delhi, during the study period. The study population included patients with different fracture characteristics and varying patient-related and treatment-related factors, allowing assessment of their possible association with postoperative complications.

Data Collection: Data were collected retrospectively from hospital records, including case sheets, operative notes, discharge summaries, radiological records, and postoperative follow-up records of eligible patients. Relevant information regarding demographic characteristics, comorbidities, fracture characteristics, type of surgical fixation and implant used, fracture reduction and implant positioning, postoperative course, and development of orthopaedic or systemic complications was recorded using a structured data collection proforma. Both mechanical/orthopaedic and systemic postoperative complications were considered during data collection.

Inclusion Criteria

- Adult patients aged 18 years or above.
- Patients diagnosed with a proximal femoral fracture.
- Patients who underwent surgical fixation of the fracture at Lok Nayak Hospital.
- Patients treated during the defined one-year study period.
- Patients whose medical records contained sufficient information regarding the fracture, operative treatment, postoperative course, and follow-up for assessment of complications.

Exclusion Criteria

- Patients below 18 years of age.
- Patients managed exclusively by conservative treatment.
- Patients with fractures involving sites other than the proximal femur.
- Patients with pathological fractures due to a primary bone tumour or metastatic disease, where applicable.
- Patients who underwent fixation at another hospital and were referred subsequently.
- Patients with inadequate or incomplete medical, operative, or follow-up records that did not permit assessment of postoperative complications.
- Patients whose postoperative outcome could not be reliably determined from the available records.

Procedure: Eligible patient records were identified and screened according to the predefined inclusion and exclusion criteria. Relevant demographic, clinical, radiological, operative, and postoperative information was extracted and documented for all 148 patients using a structured data collection proforma. Details of fracture characteristics, surgical procedure, implant used, quality of fracture reduction, implant positioning, and postoperative course were recorded. Postoperative complications were assessed from the available follow-up records and categorized into orthopaedic/mechanical complications, such as loss of reduction, implant failure, cut-out or cut-through, non-union, malunion, peri-implant fracture, re-fracture and revision surgery, and systemic complications such as thromboembolic, cardiopulmonary, urinary and other documented medical complications. The recorded complications were subsequently evaluated in relation to patient-related, fracture-related, and treatment-related factors.

Statistical Analysis: The collected data were entered into a statistical software package and analyzed using appropriate descriptive and inferential statistical methods. Continuous variables were summarized using mean $\pm$ standard deviation or median with interquartile range, according to data distribution, whereas categorical variables were presented as frequencies and percentages. The Chi-square test or Fisher's exact test was used to assess associations between categorical variables, while appropriate statistical tests were applied for continuous variables depending on their distribution. Where appropriate, logistic regression analysis was used to evaluate factors associated with postoperative complications, and associations were expressed as odds ratios with 95% confidence intervals. A p-value <0.05 was considered statistically significant.

Primary Outcome: The primary outcome of the study was the frequency and pattern of postoperative complications following surgical fixation of proximal femoral fractures. The complications evaluated included both orthopaedic/mechanical and systemic medical complications.

Secondary Outcome: The secondary outcome was to determine the association of postoperative complications with patient-related, fracture-related, and treatment-related factors, including relevant comorbidities, fracture complexity and instability, fracture reduction, implant selection, and implant positioning.

Study Framework: The study therefore involved retrospective identification of eligible patients, extraction of relevant clinical and operative data, documentation of postoperative complications, and statistical assessment of factors associated with adverse outcomes. This approach was intended to

provide an institution-specific evaluation of postoperative complications following surgical fixation of proximal femoral fractures at Lok Nayak Hospital, New Delhi.

Result

Table 1 presents the demographic characteristics of the 148 patients included in the study. The majority of patients belonged to the 61–80 years age group

(51.4%), followed by patients aged 41–60 years (24.3%). Patients above 80 years accounted for 16.2%, while only 8.1% were aged 18–40 years. The mean age of the study population was 68.7 ± 13.2 years. Regarding sex distribution, 82 (55.4%) patients were male and 66 (44.6%) were female, indicating a slight male predominance in the study population.

Table 1: Demographic characteristics of the study population (N = 148)

Variable	Category	n	%
Age (years)	18–40	12	8.1
	41–60	36	24.3
	61–80	76	51.4
	>80	24	16.2
Sex	Male	82	55.4
	Female	66	44.6
Mean age	—	68.7 ± 13.2 years	—

Table 2 shows the clinical and fracture-related characteristics of the study population. Comorbidities were present in 91 (61.5%) patients, while 57 (38.5%) patients had no documented comorbidity. Diabetes mellitus was present in 38 (25.7%) patients and hypertension/cardiovascular disease in 52 (35.1%) patients. Among the fracture types,

intertrochanteric fractures were most common, accounting for 63.5% of cases, followed by subtrochanteric fractures (21.6%) and other proximal femoral fractures (14.9%). Fracture instability or comminution was observed in 81 (54.7%) patients, whereas 67 (45.3%) had stable fractures.

Table 2: Clinical and fracture-related characteristics

Variable	Category	n	%
Comorbidity	Present	91	61.5
	Absent	57	38.5
Diabetes mellitus	Present	38	25.7
	Absent	110	74.3
Hypertension/cardiovascular disease	Present	52	35.1
	Absent	96	64.9
Fracture type	Intertrochanteric	94	63.5
	Subtrochanteric	32	21.6
	Other proximal femoral fractures	22	14.9
Fracture instability/comminution	Present	81	54.7
	Absent	67	45.3

Table 3 summarizes the treatment-related characteristics of the patients. Proximal femoral nail (PFN) was the most frequently used fixation device, accounting for 48.6% of cases, followed by proximal femoral nail anti-rotation (PFNA) in 36.5% and other cephalomedullary nails in 14.9% of patients.

Fracture reduction was satisfactory in 119 (80.4%) patients, whereas 29 (19.6%) had unsatisfactory reduction. Similarly, satisfactory implant positioning was observed in 125 (84.5%) patients, while 23 (15.5%) had unsatisfactory implant positioning.

Table 3: Treatment-related characteristics

Variable	Category	n	%
Type of fixation	Proximal femoral nail (PFN)	72	48.6
	PFNA	54	36.5
	Other cephalomedullary nail	22	14.9
Fracture reduction	Satisfactory	119	80.4
	Unsatisfactory	29	19.6
Implant positioning	Satisfactory	125	84.5
	Unsatisfactory	23	15.5

Table 4 demonstrates the pattern of postoperative complications observed among the study participants. Overall, 31 out of 148 patients (20.9%) developed one or more postoperative complications. Implant-related failure was the most frequently recorded orthopaedic complication, occurring in 7 (4.7%) patients, followed by surgical-site/wound infection and revision/reoperation, each occurring in 6 (4.1%) patients. Loss of reduction or secondary

displacement was observed in 5 (3.4%) patients, while cut-out/cut-through occurred in 4 (2.7%) patients. Among systemic complications, urinary infection was reported in 5 (3.4%) patients, cardiopulmonary complications in 4 (2.7%), postoperative delirium in 3 (2.0%), and thromboembolic complications in 2 (1.4%) patients. Since some patients developed more than one complication, the individual complication percentages do not sum to 100%.

Table 4: Postoperative complications among study participants

Postoperative complication	n	%
Any postoperative complication	31	20.9
Surgical-site/wound infection	6	4.1
Loss of reduction/secondary displacement	5	3.4
Implant-related failure	7	4.7
Cut-out/cut-through	4	2.7
Non-union	3	2
Peri-implant/re-fracture	2	1.4
Revision/reoperation	6	4.1
Urinary infection	5	3.4
Cardiopulmonary complication	4	2.7
Thromboembolic complication	2	1.4
Postoperative delirium	3	2

Table 5 presents the association between selected patient-related, fracture-related, and treatment-related factors and the occurrence of postoperative complications. Patients aged >65 years had a significantly higher complication rate (27.0%) compared with those aged ≤65 years (8.3%), with a statistically significant association ($p = 0.018$). Similarly, patients with comorbidities had a higher complication

rate (26.4%) than those without comorbidities (12.3%), and this association was statistically significant ($p = 0.031$). Although complications were more frequent among patients with diabetes mellitus (28.9%) than those without diabetes (18.2%), the difference was not statistically significant ($p = 0.112$).

Table 5: Association of selected risk factors with postoperative complications

Risk factor	Complications, n/N (%)	No complication, n/N (%)	p-value
Age >65 years	27/100 (27.0)	73/100 (73.0)	0.018
Age ≤65 years	4/48 (8.3)	44/48 (91.7)	
Comorbidity present	24/91 (26.4)	67/91 (73.6)	0.031
Comorbidity absent	7/57 (12.3)	50/57 (87.7)	
Diabetes mellitus present	11/38 (28.9)	27/38 (71.1)	0.112
Diabetes mellitus absent	20/110 (18.2)	90/110 (81.8)	
Unstable/comminuted fracture	22/81 (27.2)	59/81 (72.8)	0.026
Stable fracture	9/67 (13.4)	58/67 (86.6)	
Unsatisfactory reduction	12/29 (41.4)	17/29 (58.6)	<0.001
Satisfactory reduction	19/119 (16.0)	100/119 (84.0)	
Unsatisfactory implant positioning	10/23 (43.5)	13/23 (56.5)	0.002
Satisfactory implant positioning	21/125 (16.8)	104/125 (83.2)	
PFN/PFNA vs another fixation	29/126 (23.0)	97/126 (77.0)	0.084
Other cephalomedullary nail	2/22 (9.1)	20/22 (90.9)	

Discussion

We reviewed 148 patients who had surgery for proximal femur fractures, of which 31 patients (20.9%) had one or more complications. This complication rate shows that adverse events are still clinically significant despite the advances in

intramedullary fixation techniques and peri-operative management. The observed rate is similar to that of Boldin et al who reported 12 complications in a prospective series of 55 patients treated with proximal femoral nail (PFN) (21.8%). Their results indicated that PFN offers good stabilization for unstable proximal femur fractures, but that technical

considerations can have an impact on the postoperative outcome. Their results are similar to our 20.9% complication rate and indicate that complications following proximal femoral fixation using contemporary intramedullary screws is still quite high". (Boldin et al., 2003) [9].

Similar results were reported by Fogagnolo et al. who assessed 47 pertrochanteric fractures treated with the short AO/ASIF proximal femoral nail and found a mechanical complication in 10 patients (21.3%). The complications involved implant-related complications related to fixation of unstable pertrochanteric fractures. In our study, 7 patients (4.7%) had an implant related failure, 4 patients (2.7%) had a cut out/cut through and 6 patients (4.1%) underwent revision/re-operation. The total incidence in our series was similar to that described by Fogagnolo and colleagues, but the incidence of each mechanical complication was lower. This discrepancy could be due to variability in the studies in terms of fracture characteristics, implant systems, surgical procedure, and post-surgical monitoring. (Fogagnolo et al., 2004) [10].

The results can also be correlated with the retrospective series of Hohendorff et al. with 139 PFN osteosyntheses and with an overall complication rate of 31.7%. The explanation for their greater complication rate was that non-mechanical complications as hematoma and heart failure were included. Even if only mechanical complications were taken into account, the rate reported was still considerable. In our study, orthopaedic and systemic complications were evaluated, and the rate of complications was 20.9% in total. This lower rate could be explained by differences in the population studied, in the length of follow-up, in the nature of the fracture, and/or in the definition of "complication". However, the lack of long-term implant survival, secondary displacement and other mechanical complications in both studies highlight the need for careful fixation technique. (Hohendorff et al., 2005) [11].

The important finding of the present study was the very close relationship between the quality of fracture reduction and postoperative complications. Complication rates were 41.4% in patients with an unsatisfactory fracture reduction and 16.0% in patients with a satisfactory reduction ($p < 0.001$). This is confirmed by the study of Koyuncu et al., in which 152 patients who underwent PFN were followed up. They had 27 patients (17.7%) with late postoperative complications and 14 patients (9.2%) who underwent revision surgery for mechanical complications. They concluded that the quality of reduction was an important factor in determining revision rates and functional outcome. These results are very similar to ours and indicate that poor reduction is not simply a radiologic flaw, but it is an

important modifiable risk factor for mechanical failure. (Koyuncu et al., 2016) [12].

Another important treatment related factor in our cohort was implanting positioning. The complication rate was 43.5% in the patients who had unsatisfactory implant positioning and 16.8% in the patients who had satisfactory implant positioning ($p = 0.002$). This result is consistent with that of Zhang et al. who studied mechanical failure after PFNA-II fixation in a Southeast Asian population. They found that good quality fracture reduction was a significant predictor of no mechanical failure (OR 0.147, 95% CI 0.030-0.733; $p = 0.019$) and that posterior blade position on the lateral radiograph was an independent predictor of mechanical failure (OR 12.12, 95% CI 1.583-92.825; $p = 0.016$). These observations are very similar to our finding of a strong correlation between postoperative complications and improper implant positioning. (Zhang et al., 2021) [13].

Shon et al. further illustrated the importance of reduction quality and implant position by analysing 93 patients for 94 hips that underwent PFNA surgery. Mechanical complications were encountered in 12 hips (12.8%), and there were significant differences in reduction quality, Cleveland index, fracture classification and blade sliding between patients with and without mechanical complications. The mean blade sliding distance for anatomical reduction group was 1.17 mm, for extramedullary reduction group was 3.28 mm and for intramedullary reduction group was 6.11 mm ($p < 0.001$). Mechanical complications were highly associated with excessive blade sliding. Similarly, our results show that poor reduction significantly raises postoperative complications, emphasizing the need for stable and proper reduction prior to implant final fixation. (Shon et al., 2021) [14].

In the current study, postoperative complications were also related to the complexity of the fracture. The complication rate was 27.2% in patients with unstable/comminuted fracture and 13.4% in patients with stable fracture ($p = 0.026$). This finding is in line with Liu et al., who evaluated 223 patients who underwent treatment for intertrochanteric fractures using a trochanteric femoral nail, and found mechanical complications in 20.5%. 9.4% had excessive migration of the helical blade and 6.7% had blade migration into the femoral head (typical cut-out in 3.1%). Importantly, most modes of mechanical failure were significantly predicted by the quality of calcar reduction. They conclude that fracture patterns and failure to restore the medial support are important factors that increase the mechanical load on the fixation construct. (Liu et al., 2013) [15].

Different PFN and PFNA systems have also been studied in the elderly. Baek et al. studied 158 patients over 65 years of age (73 PFN and 85 PFNA). Screw cut-out was significantly higher in PFN group (11.0%) than PFNA group (2.4%) ($p = 0.027$) and the sliding distance was also higher in PFN group (6.1 mm vs. 3.2 mm) ($p = 0.036$). PFN was employed in 48.6% of cases and PFNA in 36.5% in our study, and there was no statistically significant association between the type of fixation device and the postoperative complications ($p = 0.084$). This can be attributed to the wider spectrum of complications evaluated in our study, as well as to the different fracture patterns and patient characteristics. However, the results suggest that implant selection must be combined with fracture morphology and technical factors and not be a standalone factor to consider when deciding on outcome. (Baek et al., 2020) [16].

In our study, age and comorbidity were also significantly related to complications. Older patients (defined age >65 years) experienced complications at a rate of 27.0%, younger patients had a complication rate of 8.3% ($p=0.018$); patients with comorbidities had a complication rate of 26.4% and those without a complication rate of 12.3% ($p=0.031$). These results underscore the fragility of elderly patients with a fracture of the proximal femur, where lower physiologic reserve, underlying medical conditions, and lower bone quality can negatively impact post-fracture outcomes. Overall, present results indicate that postoperative complications are multifactorial and that age, comorbidities, fracture instability, reduction quality and implant positioning are each important factor. These factors are modifiable from a treatment standpoint and special attention may be warranted in order to minimize preventable mechanical failures and enhance postoperative recovery.

Conclusion

To summarize, this retrospective study of 148 patients showed 31 patients' postoperative complication with surgical fixation of proximal femur fracture (20.9%). Complications were multifactorial and significantly related to advanced age, the presence of comorbidities, the presence of an unstable fracture pattern, comminuted fracture pattern, unsatisfactory fracture reduction and improper implant positioning. Poor fracture reduction and poor implant position were found to be significantly related to postoperative complications, specifically, and suggest that these may be potentially modifiable treatment factors. These results indicate that careful preoperative evaluation, choosing the correct fixation method, obtaining satisfactory fracture reduction, implant position, and close postoperative monitoring are important to reduce the complication rate and to

achieve good results in patients with surgically fixed proximal femoral fractures.

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