

AN OBSERVATIONAL STUDY ON OUTCOME, COMPLICATIONS AND ASSOCIATED RISK FACTORS AFTER MANAGEMENT OF PROXIMAL FEMORAL FRACTURE

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ABSTRACT

Proximal femoral fractures are common fractures that often result in functional deficits and post-fracture morbidity, especially in the elderly population. The aim of this prospective observational study was to assess functional recovery, postoperative complications, radiological fracture union and clinical risk factors associated with surgical management. The total number of patients who underwent surgery for proximal femur fractures in a tertiary care hospital in Puducherry, India, was included. Functional outcome was evaluated by the Harris hip score in the immediate postoperative period and at 2, 6, 12 and 24 weeks. All patients underwent clinical examination and the Radiographic Union Score for Hip assessment for all postoperative complications and radiological healing. Many patients were over 60 years old (80%), and intertrochanteric fractures accounted for the majority of fractures (62%). Surgery was mostly performed for proximal femoral nailing (66%). 20% developed a surgical site infection, 12% implant failure and 8% pressure sores. 70% had good to excellent functional outcomes at 24 weeks. In 35 patients that were radiologically assessed, fracture union was reported in 29 patients (82.86 %), delayed union in four patients and nonunion in two patients. A favourable functional recovery and radiological healing were observed in most patients, with the postoperative complications being clinically significant in these patients.

Keywords: Hip fracture; Hip function; Complications; Bone healing; Risk factors.

1. INTRODUCTION

Proximal femoral fractures are a significant orthopaedic problem as they often result in poor mobility, independence and general health, especially in elderly people. These fractures include the fractures of the femur neck, intertrochanteric and subtrochanteric fractures, which are different in terms of anatomical characteristics, biomechanical stability and treatment. Their clinical implications don't just involve a skeletal injury, but also the length of hospital stays, disability, reliance on others and cost of treatment. Population-based studies show that hip fractures have a significant burden worldwide and are higher in certain age groups and geographical regions (Dong et al., 2022). Epidemiological studies undertaken more recently support the significance of population ageing and the rising demand for fracture management services (Feng et al., 2024). Other recent estimates in the older age group also highlight the importance of safe prevention and post-operative care (Wang et al., 2026).

Low-energy impact (from a fall) is the most common mechanism for proximal femoral fractures in the elderly, and high-energy impact is more likely in relatively younger patients. Management and recovery are complicated by osteoporosis, decreased physiological reserve and chronic medical conditions. Operative planning is impacted by fracture configuration, displacement, bone quality, preinjury mobility and burden of comorbidity. Evidence-based recommendations include early evaluation, proper surgical treatment, care around the surgery, and individual patient rehabilitation (O'Connor & Switzer, 2022). However, clinical decisions are still complex due to the variety of fracture morphology, preoperative function and mobilization capacity. Orthogeriatric approaches aim to meet these complex challenges by considering medical conditions through a multidisciplinary lens to optimize them (Khan et al., 2023).

The purpose of surgical treatment is to provide fracture stability, relieve pain and restore mobility. Common methods of treatment are intramedullary fixation of limited extracapsular fractures, and either internal fixation or arthroplasty of femoral neck fractures. Fracture stability, age of patient, bone quality and functional expectations should be considered when deciding on the procedure. Comparative evidence shows that treatment for femoral neck fractures has unique benefits and potential complications, which requires tailored decision-making between treatment options (Peng et al., 2020). When comparing the fixation and arthroplasty options, the results from a network meta-analysis also indicate the complexity of balancing functional outcomes with risks associated with treatment (Ramadanov et al., 2023). Therefore, it is important to assess outcomes through the procedures employed in everyday practice, especially if patient characteristics are diverse.

Even after surgery, complications may make it hard to heal and compromise treatment benefits. The follow-up is important because of surgical site infection, pressure sores, implant failure and disruption of fracture union. Surgical site infection is particularly significant as this may lead to longer morbidity from further treatment and delayed rehabilitation. A systematic review of peri-operative vulnerability and infection-related risk (IRR) after hip hemiarthroplasty highlights the importance of understanding the risk of infection after hip hemiarthroplasty (Silas et al., 2024). Medical comorbidities also need to be addressed. Although the relationship between diabetes mellitus and complications after hip fracture has been reported, the risk of these complications is dependent on clinical situation and diabetes control (Shen & Ma, 2022). Further evidence indicates that poor glycaemic control may help identify those patients with less favourable postoperative outcomes (Merrell et al., 2023). Other clinically relevant features such as smoking, alcohol and osteoporosis must also be taken into account in follow-up.

While fracture stabilization is a fundamental goal of surgery, other measures of surgery success are also important, such as functional recovery. Although the treatment is technically successful, postoperative pain, weakness of the muscles, balance disorders and walking difficulties can continue. Structured rehabilitation is consequently as essential as it is to restore activities of daily living and movement. The clinical practice guidance guides the individualized delivery of physical therapy and systematic evaluation of recovery in older adults who have a hip fracture (McDonough et al., 2021). Medical optimization prior to hospital admission is also relevant, and postoperative progress is linked to surgical care as well as general health (Zuelzer et al., 2023). The Harris Hip Score, combined with recovery assessment on radiographs of fracture healing, provides some complementary views on recovery.

It is important to consider functional scores in addition to complications and union status, since this can help identify discrepancies between radiographic progression and patient experience, and to describe risk factors, which can help guide targeted surveillance and clinical counselling. In this context, the present prospective observational study was conducted to investigate the results of surgical treatment of proximal femoral fractures.

Objectives:

Determine functional recovery after surgery by serial Harris Hip Score assessments at 24 weeks.

Document postoperative complications and radiological fracture union during follow-up.

Investigate correlation between clinical risk factors and postoperative functional outcomes.

2. MATERIALS AND METHODS

2.1 Study Design and Setting

The study was an observational study conducted in the Department of Orthopaedics at Mahatma Gandhi Medical College and Research Institute (MGMCRI), Puducherry, India, between August 2024 to December 2025. The aim of the study was to compare the functional results, complications, radiological healing of the fractures, and other clinical risk factors after surgical treatment of proximal femur fractures. The observational design allowed assessment of the recovery after various surgical procedures, depending on the characteristics of the fracture and the patient's individual factors. Clinical and radiological examinations were performed perioperatively and at regular intervals up to 24 weeks postoperatively.

2.2 Study Population and Sample Size

The study population consisted of adult patients with a proximal femur fracture who were treated surgically at the study institution. The patients were selected from the orthopaedics outpatient department and casualty on admission to the orthopaedics ward. A total of 50 patients were studied. The sample size was calculated as $N = Z^2PQ/d^2$ with Z being a standard normal variate, P the expected prevalence, Q the complement of the expected prevalence and d the absolute precision. Patients who met the predefined criteria and signed informed consent were included in the study population. For the study population, patients with femoral neck fractures, intertrochanteric fractures and subtrochanteric fractures who met the predefined criteria and signed informed consent were recruited.

2.3 Eligibility Criteria

Patients with proximal femur fractures who were treated with surgery and were between 18 and 65 years old were included. Bilateral proximal femoral fractures, pathological fractures, a history of revision surgery or associated lower long-bone fractures of the ipsilateral femur were excluded. The patients were selected based on clinical examination, interviews and X-ray. Patients who met no exclusion criteria and only met the inclusion criteria were included for postoperative evaluation.

2.4 Preoperative Clinical and Radiological Assessment

Prior to surgery, all enrolled patients were clinically and radiographically evaluated. Demographic data (age and sex) were collected with medical history, description of fractures and mechanism of injury. Other clinical conditions associated with the disease were noted, such as diabetes mellitus, hypertension, coronary artery disease, cerebrovascular accident, and osteoporosis. Data on smoking and drinking habits were also collected to explore the possible relationship between these and postoperative outcomes. Mechanisms of injury were recorded, such as falls from height, road traffic accidents, falls from ladders and slips and falls. The patient had routine pre-operative assessments and radiographs done to assess fracture configuration and surgical management. Each participant had their fracture diagnosis recorded, and a surgical plan for treatment was made.

2.5 Surgical Management

Surgical treatment was performed based on fracture configuration and patient-specific factors. The surgical procedures involved short proximal femoral nail (PFN) fixation, long PFN fixation, cannulated cancellous screw fixation, and hemiarthroplasty. For fractures of the intertrochanteric and subtrochanteric fracture patterns that required internal fixation, proximal femoral nailing was used, and for selected femoral neck fracture patterns, clinical and fracture pattern considerations called for cannulated cancellous screw fixation or hemiarthroplasty. For all patients, the type of surgical procedure was recorded. Patients were clinically monitored and then examined after surgery for their functional recovery, fracture healing, and complications.

2.6 Postoperative Follow-up and Functional Outcome Assessment

Functional outcomes after surgery, including pain, functional ability, deformity and range of hip motion, were assessed using the Harris Hip Score (HHS), a clinical scoring system that assesses functional outcomes. Functional assessments were carried out in the immediate post-operative period and at 2, 6, 12 and 24 weeks thereafter. HHS was used to assess postoperative hip function: walking ability, functional activities, pain-related limitations and joint mobility. Using the HHS classification used in the study, functional outcomes were divided into four groups: poor, fair, good, and excellent. A serial assessment was performed to capture the functional status of patients over the follow-up period, especially at the 24-week endpoint to evaluate recovery.

2.7 Radiological Assessment of Fracture Healing

The rate of radiological fracture healing was assessed by serial postoperative radiographs obtained at follow-up. Radiological monitoring was described from the 4th postoperative week, and formalized monitoring was reported at 6, 12 and 24 weeks using the Radiographic Union Score for Hip (RUSH). RUSH system was used for the evaluation of radiological healing in intertrochanteric and subtrochanteric fractures. Scoring parameters were the presence of cortical bridging, presence of cortical fracture lines, trabecular consolidation and presence of trabecular fracture lines. A higher score was indicative of greater radiological healing, and a lower score was indicative of lesser consolidation of the fracture. Longitudinal assessment of radiological healing was performed, and final fracture union was defined as union achieved, delayed union, or nonunion. The RUSH-based analyses were reported for a subgroup of 35 patients.

2.8 Assessment of Postoperative Complications

The 24 weeks of observation were used to assess postoperative complications by clinical examination and radiological follow-up. Assessment included surgical site infection, pressure sores, implant failure, delayed union, nonunion, malunion and other reported postoperative adverse events. Surgical site complications and pressure sores were detected in the postoperative clinical evaluation, and implant-related complications and abnormalities in fracture healing were detected in the clinical evaluation and follow-up radiography. Complications were documented and stratified to describe the distribution of the complications after surgery. Radiological outcome assessment included the complications of fracture healing.

2.9 Assessment of Associated Clinical Risk Factors

The relationship of a number of patient-related and injury-related factors to postoperative functional results was analyzed. The factors evaluated were diabetes mellitus, smoking, alcohol intake, osteoporosis, and mechanism of injury. Clinical data pertinent to the procedure were gathered from the medical history and preoperative evaluation and correlated with categories of postoperative functional outcome. Patients with the documented risk factors were assessed based on their functional results, and the distribution of favourable and unfavourable postoperative recovery in the selected clinical subgroups was analyzed. No causal relationships could be inferred from the analysis, which was designed to detect possible relationships between clinical features and outcome after surgical treatment.

2.10 Study Outcomes

Postoperative functional recovery, complication rates, radiological fracture healing and relationships between selected clinical risk factors and functional outcomes were evaluated. Strategies for functional recovery were determined using HHS measurements taken at 2, 6, 12 and 24 weeks after surgery, and final functional outcome at 24 weeks. Follow-up complications were recorded on during the follow-up period, including surgical site infection, pressure sores and implant-related complications. In the fracture subgroup, radiological healing was assessed by serial radiographs and RUSH assessments, and healing was recorded at the final follow-up. Patients with diabetes mellitus, different types of osteoporosis, smoking habits, alcohol consumption, and various mechanisms of injury were also compared in terms of distributions of functional outcomes.

2.11 Statistical Analysis

The data obtained from the study were entered into Microsoft Excel and analysed using IBM SPSS Statistics, Version 22. Demographic characteristics, fracture patterns, surgical procedures, clinical risk factors, postoperative complications, functional and radiological outcomes were summarised using descriptive statistics. Quantitative variables were described using mean and standard deviation, while categorical variables were described using frequencies and percentages. Where appropriate, chi-square and Student's t-tests were employed to examine the statistical relationships and differences among variables. Two-sided p-value < 0.05 was considered statistically significant. Analysis emphasized description of postoperative clinical outcome distributions and association of the clinical characteristics recorded with functional outcome.

2.12 Ethical Considerations

The study was done after the approval from the Institutional Human Ethics Committee of Mahatma Gandhi Medical College and Research Institute, Puducherry, India (Approval No. MGMCRI/Res/01/2023/20/IHEC/122). All participants gave written informed consent prior to participation. The purpose of the study, the clinical evaluations, postoperative follow-up, and the voluntary nature of participation were explained to participants. They had the option to withdraw at any time, without interfering with their usual medical care. Patient-related information was treated confidentially, and personal identifiers were not meant to be published in scientific papers. The study was undertaken with the approved observational research plan and institutional ethical requirements.

3. RESULTS

This study involved 50 patients who were treated surgically for proximal femoral fractures. Patients were evaluated at the time of surgery and 2, 6, 12 and 24 weeks thereafter. The results are reported by baseline characteristics, fracture patterns, surgical treatment, postoperative complications, functional outcome, radiological healing and related clinical risk factors.

3.1 Demographic and Baseline Clinical Characteristics

Of the 50 patients, 40 (80%) were older than 60 years, while 10 (20%) were aged between 41 and 60 years. No records were found for the age range of 18- 40 years. The study included 28 males (56%) and 22 females (44%). 50% (25) of patients had osteoporosis. Diabetes mellitus, hypertension and coronary artery disease were recorded in 9, 8 and 6 patients, respectively, (18%, 16% and 12% respectively), and coexisting diabetes mellitus and hypertension were recorded in 7 patients (14%). Twenty (40%) patients reported no comorbidities. A total of 8 (16%) of the patients were smokers, and 4 (8%) were drinkers. The demographic and baseline clinical features are provided in Table 1.

Table 1. Demographic and baseline clinical characteristics of patients with proximal femoral fractures (N = 50)

Characteristic	Frequency (n)	Percentage (%)
Age (years)		
18–40	0	0
41–60	10	20
>60	40	80
Sex		
Male	28	56
Female	22	44
Comorbidities		
Diabetes mellitus	9	18
Hypertension	8	16
Coronary artery disease	6	12
Diabetes mellitus with hypertension	7	14
None	20	40
Additional clinical factors		
Osteoporosis	25	50
Smoking	8	16
Alcohol consumption	4	8

Values follow the recorded categories. Diabetes mellitus and hypertension listed separately refer to the original standalone comorbidity categories, distinct from combined diabetes mellitus and hypertension.

3.2 Fracture Characteristics and Surgical Management

The most common pattern of injury was intertrochanteric fracture (62%, n = 31) followed by femoral neck fracture (34%, n = 17) and subtrochanteric fracture (4%, n = 2). Slip-and-fall injuries were most common, occurring in 42 patients (84%), while falls from height and road traffic accidents occurred in 6 (12%) and 2 (4%) patients, respectively. The surgical management included short proximal femoral nail (PFN) fixation (19 patients, 38%), long PFN fixation (14 patients, 28%), hemiarthroplasty (16 patients, 32%), and cannulated cancellous screw fixation (1 patient, 2%). The characteristics of fractures, mechanisms of injury and surgical treatment are summarized in Table 2. Figure 1 shows the distribution of surgical procedures.

Table 2. Fracture characteristics, mechanisms of injury, and surgical interventions (N = 50)

Characteristic	Frequency (n)	Percentage (%)
Fracture type		
Intertrochanteric	31	62
Femoral neck	17	34
Subtrochanteric	2	4
Mechanism of injury		
Slip and fall	42	84

Fall from height	6	12
Road traffic accident	2	4
Surgical procedure		
Short PFN	19	38
Long PFN	14	28
Hemiarthroplasty	16	32
Cannulated cancellous screw fixation	1	2

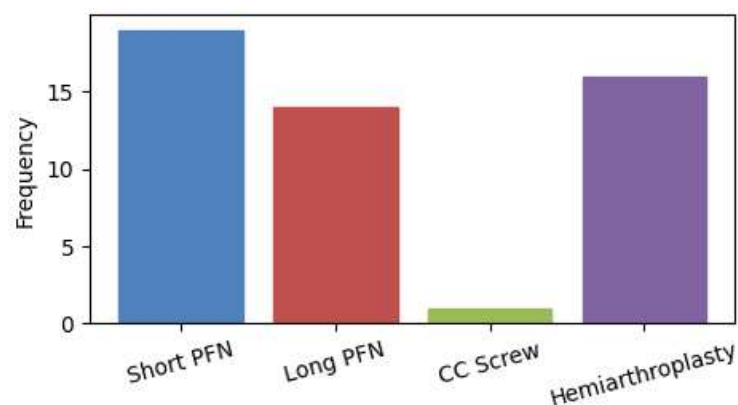


Figure 1. Distribution of surgical procedures performed for proximal femoral fractures

3.3 Postoperative Complications

In 20 patients (40%), postoperative complications were recorded, but 30 patients (60%) did not have complications recorded in the recorded types. The most common complication reported was surgical site infection (10 patients, 20%), followed by implant failure (6 patients, 12%) and pressure sores (4 patients, 8%). The postoperative complications are shown in Table 3 and graphically in Figure 2.

Table 3. Distribution of postoperative complications following surgical management (N = 50)

Postoperative complication	Frequency (n)	Percentage (%)
Surgical site infection	10	20
Implant failure	6	12
Pressure sores	4	8
No complication recorded	30	60
Total	50	100

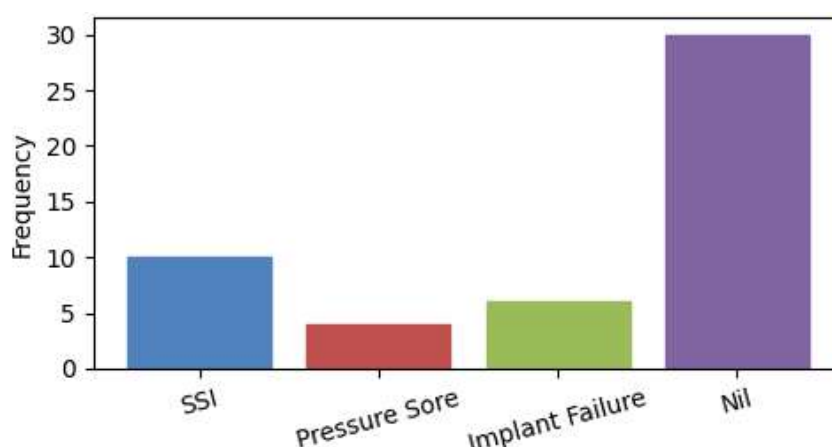


Figure 2. Distribution of postoperative complications following surgical management of proximal femoral fractures

3.4 Longitudinal Functional Outcomes Assessed Using Harris Hip Score

The Harris Hip Score (HHS) was used to assess postoperative functional recovery at successive follow-up time periods. Forty-two patients (84%) had poor functional outcomes and 8 (16%) had fair functional outcomes immediately after surgery. At the second week after surgery, 30 patients (60%) had poor functional outcomes, 15 patients (30%) had fair

functional outcomes, and 5 patients (10%) had good functional outcomes. At the sixth week, only 24% of patients had poor outcomes, 56% had fair and 20% had good outcomes.

Good functional outcome was obtained in 24 patients (48%) and excellent outcome in 8 (16%), with fair outcome in 16 (32%) and poor in 2 (4%) at 12 weeks. Excellent (34%), good (36%), fair (20%), and poor (10%) results were seen in 17, 18, 10, and 5 patients, respectively, who were available for follow-up at the end of 24 weeks. At 24 weeks, 35 patients (70%) had good-to-excellent functional outcomes. The distribution of functional outcome categories along the entire course is shown in Table 4, and the final 24-week distribution in HHS is shown in Figure 3.

Table 4. Longitudinal distribution of functional outcomes according to Harris Hip Score (N = 50)

Follow-up interval	Poor n (%)	Fair n (%)	Good n (%)	Excellent n (%)
Immediate postoperative	42 (84)	8 (16)	0 (0)	0 (0)
2 weeks	30 (60)	15 (30)	5 (10)	0 (0)
6 weeks	12 (24)	28 (56)	10 (20)	0 (0)
12 weeks	2 (4)	16 (32)	24 (48)	8 (16)
24 weeks	5 (10)	10 (20)	18 (36)	17 (34)

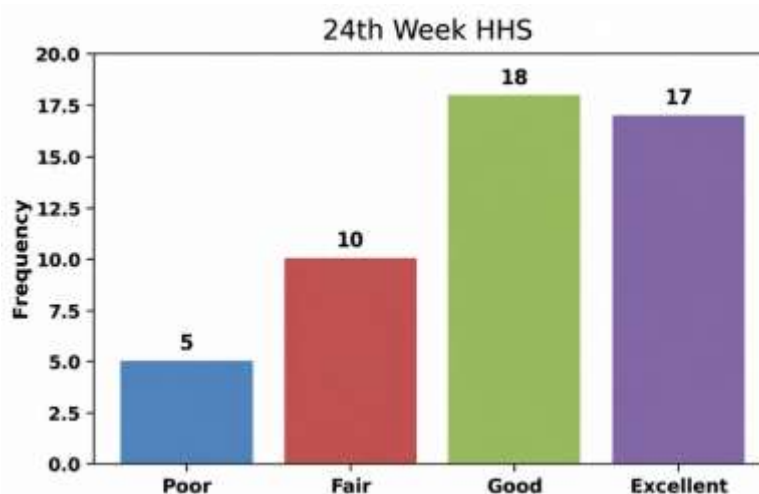


Figure 3. Distribution of Harris Hip Score categories at 24 weeks after surgical management of proximal femoral fractures

3.5 Radiological Healing and Fracture Union

Of the 35 patients for whom the Radiographic Union Score for Hip (RUSH) was recorded in the study data, radiological fracture healing was assessed. At the sixth postoperative week, RUSH scores of 10–15 were observed in 20 patients (57.14%), scores of 16–20 in 11 (31.43%), and scores below 10 in 4 (11.43%). At 12 weeks, 22 patients (62.86%) demonstrated scores between 21 and 25, whereas 9 (25.71%) had scores of 16–20 and 4 (11.43%) had scores below 16. By the final 24-week assessment, 29 patients (82.86%) recorded RUSH scores of 26–30, while 4 (11.43%) had scores of 21–25 and 2 (5.71%) had scores below 20. At the end of the radiological evaluation, 29 patients (82.86%) had a fracture union, four (11.43%) patients had delayed union, and two (5.71%) patients had nonunion. Table 5 shows the radiological healing profile and the union outcomes. The distribution of fracture union status is shown in Figure 4.

Table 5. Radiological healing progression and fracture union outcomes

Follow-up	RUSH score / Union status	Frequency (n)	Percentage (%)
6 weeks	<10	4	11.43
	10–15	20	57.14
	16–20	11	31.43
12 weeks	<16	4	11.43
	16–20	9	25.71
	21–25	22	62.86
24 weeks	<20	2	5.71
	21–25	4	11.43
	26–30	29	82.86
Final union status	Union achieved	29	82.86
	Delayed union	4	11.43
	Nonunion	2	5.71

RUSH = Radiographic Union Score for Hip. Denominator: 35 patients, as reported in the original radiological assessment tables.

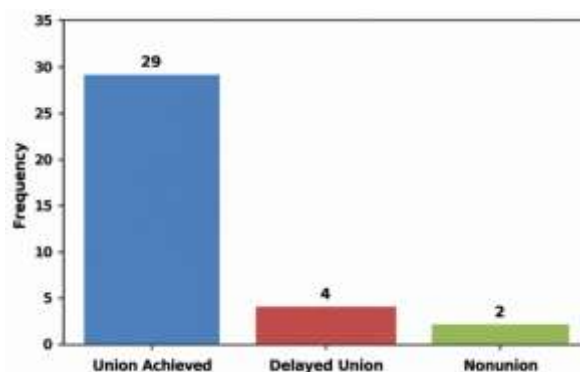


Figure 4. Distribution of radiological fracture union outcomes at 24 weeks

3.6 Clinical Risk Factors and Postoperative Functional Outcomes

The functional outcomes were assessed according to diabetes mellitus, smoking, osteoporosis, alcohol intake, and mechanism of injury. In 16 patients with DM, 9 (56.25%) had good functional outcomes, with 7 (43.75%) having poor outcomes. For 8 smokers, good and poor outcomes were equal, at 4 each (50%). The 25 patients who did have osteoporosis had a 56% good outcome and 44% poor outcome. Of 4 patients with a history of alcohol use, 1 (25%) had good functional outcome; 3 (75%) had poor functional outcome.

In terms of mechanism of injury, good functional outcome was achieved in 30/42 patients with slip-and-fall injuries (71.43%), while 12 (28.57%) had poor outcomes. Of the 2 patients injured in road traffic accidents, 1 had a good outcome, and 1 had a poor outcome. Likewise, 6 patients fell from height, 3 of whom (50%) had a good outcome and 3 (50%) had a poor outcome. Table 6 shows the distribution of functional outcomes by the clinical characteristics and injuries investigated.

Table 6. Functional outcome distribution according to selected clinical risk factors

Risk factor	Total (n)	Good outcome n (%)	Poor outcome n (%)
Diabetes mellitus	16	9 (56.25)	7 (43.75)
Smoking	8	4 (50.00)	4 (50.00)
Osteoporosis	25	14 (56.00)	11 (44.00)
Alcohol consumption	4	1 (25.00)	3 (75.00)
Mechanism of injury			
Slip and fall	42	30 (71.43)	12 (28.57)
Road traffic accident	2	1 (50.00)	1 (50.00)
Fall from height	6	3 (50.00)	3 (50.00)

Values are reported results for each risk factor group. Several factors do not have complete comparisons with the original analyses of the unexposed group. Therefore, from these summaries alone, statistically significant between-group associations cannot be made.

3.7 Summary of Principal Findings

The study showed that most patients who had surgical treatment of the proximal femur fracture had good recovery after surgery. There were 40% postoperative complications, most of which were surgical site infections. 70% of patients had good to excellent functional results at 24 weeks, and 82.86% of patients in the radiologically evaluated subgroup had fracture union. The postoperative observation and assessment of the clinical risk factors are significant, especially diabetes mellitus, smoking, osteoporosis, alcohol consumption and mechanism of injury, affecting functional outcomes.

4. DISCUSSION

This study aimed to assess the outcomes, complications and related clinical factors after surgery for fractures of the proximal femur. Most of the participants were older adults, most of the fractures were intertrochanteric, and most of the falls occurred as a result of falling. While satisfactory functional recovery and radiological union were obtained in most patients by 24 weeks, significant postoperative morbidity remained. These observations indicate the synergistic role of fracture stabilization, medical optimization, complication surveillance, and rehabilitation. Modern guidelines also focus on a multiparameter approach with a conservative, patient-oriented therapy instead of surgical fixation (Switzer & O'Connor, 2022).

This imbalance in the age of the patient is clinically meaningful: physiological reserve, nutritional status and frailty may impact recovery from hip fracture. Functional vulnerability can occur together with undernutrition and sarcopenia and supports a comprehensive preoperative assessment and post-operative care (Inoue et al., 2020). Orthogeriatric models can be used to tackle these needs through integrated surgical, medical and rehabilitation care, but this may depend on the service setting (Van Heghe et al., 2022).

The majority of interventions were proximal femoral nailing (66%), including both short and long nails. Patients were treated according to the type of fracture and the patient's characteristics, not in a random manner between different implant types. So, for the present observations, it is not possible to draw conclusions about the superiority of one fixation method.

Comparative evidence has been reviewed for short vs long intramedullary nails, and the choice of treatment will depend on factors such as fracture stability and the risks associated with the surgery (Domenech et al., 2024). Other analyses of the length of the cephalomedullary nails and other intramedullary devices reinforce the importance of understanding what is in the case when evaluating outcomes with the device (Zhang et al., 2025; Miller et al., 2025). Intramedullary fixation versus dynamic hip screws is also compared to guide individual management of unstable intertrochanteric fractures (Protásio et al., 2025).

32% of procedures were hemiarthroplasty, which is consistent with selected femoral neck fractures. This cohort study, however, did not aim to make comparisons of approaches to arthroplasty. Randomized-trial syntheses have explored the comparison of THA with hemiarthroplasty and identified trade-offs for function and complications (Ekhtiari et al., 2020; Saleem et al., 2024). Additionally, registry analysis of routine practice can be used to support comparisons, and analysis of cemented versus uncemented hemiarthroplasty can be used to address additional considerations related to implant selection (Donnelly et al., 2026; He et al., 2023).

The postoperative complications were surgical site infection 20%, implant failure 12%, and pressure sores 8%. The infection rate is of special interest as it can interfere with mobilization and extend recovery. Importantly, available results yield no evidence of overlapping complications, nor of adjusted predictors of infection. More comprehensive evidence identifies postoperative medical complications, such as pneumonia, as significant issues after hip fracture surgery (Han et al., 2022). Results from those patients treated nonoperatively reinforce the fragility of this group, though it would not seem appropriate to compare these results with the present surgically treated group (Winfield et al., 2025).

Functional outcomes were better in Harris Hip Score functional outcome categories of good to excellent, at 24 weeks (70%). This trend highlights the clinical relevance of ongoing rehabilitation, but not that any specific therapy was responsible for the improvement. A review indicates that physical activity and balance-oriented rehabilitation may benefit the functional and physical abilities of people after hip fracture (Hulsbæk et al., 2022; Chang et al., 2024). Integrated rehabilitation approaches may also have some benefits over more extended recovery periods (Lim et al., 2025).

Of the subset of patients assessed, radiological union was reported in 82.86%; delayed union and nonunion continued to be clinically relevant. Before the definitive interpretation, the radiological denominator should be reconciled with the counts of fracture types reported. The functional outcome distribution of categories was different for osteoporosis, diabetes, smoking, and alcohol consumption, although there was not a reliable inference of independent risk effects in the case of incomplete comparison groups. Fragility fractures constitute an important opportunity for secondary osteoporosis prevention (González-Quevedo et al., 2024). Likewise, the difference in proportions of poor functional classifications at 12 and 24 weeks should be studied on a patient-by-patient basis. It is not possible to know if this pattern is the result of new complications or type differences without paired trajectories.

The advantages of this study are the prospective follow-up and combined functional, complication and radiological evaluation. Some limitations are a small number of patients at a single centre, heterogeneity of the procedures, short follow-up, lack of validated comparative statistics, and variability of radiological denominators. In addition, assessments of guideline-concordant care should be based on documented processes and not outcomes; by using automated guideline interpretation to assess care, the need to confirm the suggestions with authoritative sources is reinforced (Kim et al., 2024). Studies with a greater number of subjects, standardized outcomes, and adjusted analyses are required to define the associations with prognosis and to determine outcomes over longer follow-up.

5. CONCLUSION

This prospective observational study was designed to assess functional recovery, surgical complications, radiological healing and other clinical parameters associated with surgical treatment of proximal femur fractures. The mean age was >60 years, and the most common fracture type was intertrochanteric (slip and fall was the most common cause). The most frequently used procedure was proximal femoral nailing. Functional outcome scores generally improved at the 24-week follow-up, and 70% of patients were judged to be scoring good–excellent in the Harris Hip Score categories at the end of the study. Radiological union was reported in 82.86% of the evaluated subgroups; delayed union and nonunion were also observed. Forty per cent of patients had postoperative complications, with surgical site infection, implant failure, and pressure sores being the main ones recorded. There were descriptive differences in functional outcome distributions among patients with diabetes mellitus, osteoporosis, smoking habits, alcohol consumption, and various injury mechanisms, but these differences do not necessarily indicate independent or causal relationships. These results highlight the need for personalized surgical planning, attention to comorbidities, monitoring for complications, and a planned rehabilitation protocol. Interpretations are still limited due to the small, single-centre study, moderate follow-up, and inconsistent results that need to be confirmed in the radiological and risk factor analyses. More prospective studies with valid measures are needed to further define prognostic factors and longer-term outcomes from various fracture and treatment categories.

REFERENCES

1. Chang, H., Luan, C., & Li, C. (2024). Effect of comprehensive rehabilitation training based on balance function on postoperative recovery and function of hip fracture in the elderly: a systematic review and meta-analysis. *Geriatric orthopaedic surgery & rehabilitation*, 15, 21514593241261506.
2. Domenech, P., Mariscal, G., Marquina, V., & Baixauli, F. (2024). Short versus long intramedullary nails for intertrochanteric hip fracture: meta-analysis. *Revista espanola de cirugia ortopedica y traumatologia*, 68(4), 373–382.
3. Dong, Y., Zhang, Y., Song, K., Kang, H., Ye, D., & Li, F. (2022). What was the epidemiology and global burden of disease of hip fractures from 1990 to 2019? Results from and additional analysis of the global burden of disease study 2019. *Clinical orthopaedics and related research*, 481(6), 1209.

4. Donnelly, M. P. C., Guy, M. D. K., & Abdel, M. M. P. (2026). Hemiarthroplasty versus total hip arthroplasty for femoral neck fracture in the elderly: An analysis from the American joint replacement registry. *The Journal of Arthroplasty*, 41(3), 765-769.
5. Ekhtiari, S., Gormley, J., Axelrod, D. E., Devji, T., Bhandari, M., & Guyatt, G. H. (2020). Total hip arthroplasty versus hemiarthroplasty for displaced femoral neck fracture: a systematic review and meta-analysis of randomized controlled trials. *JBJS*, 102(18), 1638-1645.
6. Feng, J. N., Zhang, C. G., Li, B. H., Zhan, S. Y., Wang, S. F., & Song, C. L. (2024). Global burden of hip fracture: the global burden of disease study. *Osteoporosis international*, 35(1), 41-52.
7. González-Quevedo, D., Rubia-Ortega, C., Sánchez-Delgado, A., Moriel-Garces, D., Sánchez-Siles, J. M., Bravo-Bardají, M., ... & Tamimi, I. (2024). Secondary osteoporosis prevention: three-year outcomes from a Fracture Liaison Service in elderly hip fracture patients. *Aging clinical and experimental research*, 36(1), 103.
8. Han, S. B., Kim, S. B., & Shin, K. H. (2022). Risk factors for postoperative pneumonia in patients undergoing hip fracture surgery: a systematic review and meta-analysis. *BMC musculoskeletal disorders*, 23(1), 553.
9. He, Y., Tang, X., Liao, Y., Liu, S., Li, L., & Li, P. (2023). The comparison between cemented and uncemented hemiarthroplasty in patients with femoral neck fractures: a systematic review and meta-analysis of randomized controlled trials. *Orthopaedic Surgery*, 15(7), 1719-1729.
10. Hulsbæk, S., Juhl, C., Røpke, A., Bandholm, T., & Kristensen, M. T. (2022). Exercise therapy is effective at improving short-and long-term mobility, activities of daily living, and balance in older patients following hip fracture: a systematic review and meta-analysis. *The Journals of Gerontology: Series A*, 77(4), 861-871.
11. Inoue, T., Maeda, K., Nagano, A., Shimizu, A., Ueshima, J., Murotani, K., ... & Tsubaki, A. (2020). Undernutrition, sarcopenia, and frailty in fragility hip fracture: advanced strategies for improving clinical outcomes. *Nutrients*, 12(12), 3743.
12. Khan, A. A., AbuAlrob, H., Al-Alwani, H., Ali, D. S., Almonaei, K., Alsarraf, F., ... & Zalzal, P. (2023). Post hip fracture orthogeriatric care—a Canadian position paper addressing challenges in care and strategies to meet quality indicators. *Osteoporosis International*, 34(6), 1011-1035.
13. Kim, H. J., Yoon, P. W., Yoon, J. Y., Kim, H., Choi, Y. J., Park, S., & Moon, J. K. (2024). Discrepancies in ChatGPT's hip fracture recommendations in older adults for 2021 AAOS evidence-based guidelines. *Journal of Clinical Medicine*, 13(19), 5971.
14. Lim, S. K., Beom, J., Lee, S. Y., Kim, B. R., Ha, Y. C., Lim, J. Y., ... & Jang, S. N. (2025). Efficacy of fragility fracture integrated rehabilitation management in older adults with hip fractures: a randomized controlled trial with 1-year follow-up. *Journal of the American Medical Directors Association*, 26(1), 105321.
15. McDonough, C. M., Harris-Hayes, M., Kristensen, M. T., Overgaard, J. A., Herring, T. B., Kenny, A. M., & Mangione, K. K. (2021). Physical therapy management of older adults with hip fracture: clinical practice guidelines linked to the international classification of functioning, disability and health from the academy of orthopaedic physical therapy and the academy of geriatric physical therapy of the American physical therapy association. *Journal of Orthopaedic & Sports Physical Therapy*, 51(2), CPG1-CPG81.
16. Merrell, L. A., Esper, G. W., Gibbons, K., Ganta, A., Egol, K. A., & Konda, S. R. (2023). Poorly controlled diabetes: glycosylated hemoglobin (HA1c) levels > 8% are the tipping point for significantly worse outcomes following hip fracture in the geriatric population. *Injury*, 54(8), 110862.
17. Miller, N. D., Cho, T., Gokula, L., & Liu, J. (2025). Intertrochanteric fractures in the elderly treated with different intramedullary devices: a systematic review and Meta-Analysis based on comparison studies. *JBJS reviews*, 13(3), e24.
18. O'Connor, M. I., & Switzer, J. A. (2022). AAOS clinical practice guideline summary: management of hip fractures in older adults. *Journal of the American Academy of Orthopaedic surgeons*, 30(20), e1291-e1296.
19. Peng, W., Bi, N., Zheng, J., & Xi, N. (2020). Does total hip arthroplasty provide better outcomes than hemiarthroplasty for the femoral neck fracture? A systematic review and meta-analysis. *Chinese Journal of Traumatology*, 23(06), 356-362.
20. Protásio, J., Almeida, P. V. D., & Castro, M. G. M. (2025). Comparação de hastes intramedulares com bloqueios cefálicos e parafuso deslizante DHS no tratamento cirúrgico das fraturas transtrocanterianas instáveis em adultos—Uma revisão sistemática com metanálise. *Revista Brasileira de Ortopedia*, 60(04), 001-011.
21. Ramadanov, N., Jóźwiak, K., Hauptmann, M., Lazaru, P., Marinova-Kichikova, P., Dimitrov, D., & Becker, R. (2023). Cannulated screws versus dynamic hip screw versus hemiarthroplasty versus total hip arthroplasty in patients with displaced and non-displaced femoral neck fractures: a systematic review and frequentist network meta-analysis of 5703 patients. *Journal of orthopaedic surgery and research*, 18(1), 625.
22. Saleem, A., Lin, C. C., Anil, U., & Rivero, S. M. (2024). Arthroplasty treatment options for femoral neck fractures in the elderly: A network meta-analysis of randomized control trials. *Injury*, 55(11), 111875.
23. Shen, Q., & Ma, Y. (2022). Impact of diabetes mellitus on risk of major complications after hip fracture: a systematic review and meta-analysis. *Diabetology & Metabolic Syndrome*, 14(1), 51.
24. Silas, U., Berberich, C., Anyimiah, P., Szyski, D., & Rupp, M. (2024). Risk of surgical site infection after hip hemiarthroplasty of femoral neck fractures: a systematic review and meta-analysis. *Archives of orthopaedic and trauma surgery*, 144(8), 3685-3695.
25. Switzer, J. A., & O'Connor, M. I. (2022). AAOS management of hip fractures in older adults evidence-based clinical practice guideline. *JAAOS-Journal of the American Academy of Orthopaedic Surgeons*, 30(20), e1297-e1301.
26. Van Heghe, A., Mordant, G., Dupont, J., Dejaeger, M., Laurent, M. R., & Gielen, E. (2022). Effects of orthogeriatric care models on outcomes of hip fracture patients: a systematic review and meta-analysis. *Calcified tissue international*, 110(2), 162-184.

27. Wang, Y., Tan, L., Dong, J., Zhang, J., Zhu, J., & Zhang, Y. (2026). Global epidemiology of hip fractures in adults aged 70 years and older from 1990 to 2021: a cross-sectional analysis from Global Burden of Disease Study 2021. *Chinese Journal of Traumatology*.
28. Winfield, J., McNicoll, L., & Moppett, I. K. (2025). Epidemiology, patient outcome and complications after non-operative management of hip fracture: a systematic review. *Anaesthesia*, 80(11), 1397-1413.
29. Zhang, S., Guo, Q., Huang, K., & Zhu, H. (2025). Short versus long cephalomedullary nails for intertrochanteric femur fractures: A meta-analysis of randomized controlled trials. *PloS one*, 20(5), e0319758.
30. Zuelzer, D. A., Weaver, D., Zuelzer, A. P., & Hessel, E. A. (2023). Current strategies in medical management of the geriatric hip fracture patient. *Journal of the American Academy of Orthopaedic Surgeons*, 31(12), 620-626.