J Surg Med. 2026;10(8):e8454.
https://doi.org/10.28982/josam.8454

JOSAM

Research Article
https://jsurgmed.com/

Journal of Surgery and Medicine
e-ISSN: 2602-2079

Early functional outcomes of proximal femur fractures treated with proximal femoral nailing in a tertiary trauma center

Kayode Odejobi, Kehinde Adesola Alatishe, Ugochuku Akpati

Department of Orthopaedics and Trauma, National Orthopaedic Hospital, 120/124 Ikorodu Road, Lagos, Nigeria

ORCID of the author(s)

KO: https://orcid.org/ 0009-0008-1018-8429
KAA: https://orcid.org/0000-0002-9564-249X
UA: https://orcid.org/ 0009-0001-0499-5776

Corresponding Author
Kayode Odejobi
Department of Orthopaedics and Trauma, National Orthopaedic Hospital, 120/124 Ikorodu Road, Lagos, Nigeria
E-mail: kaygolde500@gmail.com

Ethics Committee Approval
The study was approved by the Ethics Committee of the National Orthopaedic Hospital, Igbobi, Lagos, Nigeria (reference no. OH/90/C/IX) on January 17, 2023. All research procedures were conducted in accordance with the Declaration of Helsinki.

Conflict of Interest
No conflict of interest was declared by the authors.

Financial Disclosure
The authors declared that this study has received no financial support.

Published
2026 August 12

Abstract

Background/Aim: Proximal femur fractures are common and often debilitating, particularly in older adults with osteoporosis and a high risk of falls. In younger individuals, these injuries usually result from high-energy trauma. Proximal femoral nailing has gained acceptance as a reliable fixation method that may enable early mobilization and functional recovery. This study evaluated the early functional outcomes and complications of proximal femoral nailing in patients managed at a tertiary trauma center.

Methods: This prospective cohort included 55 patients with proximal femur fractures treated with proximal femoral nailing; 46 patients completed follow-up and were included in the final analysis. Functional outcomes were assessed over 6 months using the Lower Extremity Functional Scale and the Short Form-36 health survey, together with clinical and radiological evaluation. Data were analyzed using IBM SPSS Statistics for Windows, version 23. Continuous variables were summarized as mean (SD), and categorical variables as frequencies and percentages. Appropriate parametric and nonparametric tests were used, with statistical significance set at $P < 0.05$.

Results: The mean age was 57.9 (13.0) years, and the male-to-female ratio was 1.7:1. The radiological union rate was 91%, with a mean time to union of 3.9 (0.2) months. Lower Extremity Functional Scale and Short Form-36 scores improved progressively during follow-up. Poorer functional outcomes were associated with comorbidities, pre-injury use of walking aids, female sex, older age, higher American Society of Anesthesiologists grade, and surgery delayed beyond 48 hours. Complications occurred in 13% (n = 6) of patients, predominantly superficial surgical site infections. Surgical site infection was associated with comorbidities ($P = 0.040$) and showed a borderline association with increasing age ($P = 0.048$).

Conclusion: Proximal femoral nailing provided reliable fixation, a high union rate, and meaningful early functional recovery in this cohort. Patient baseline characteristics and timing of surgery were associated with recovery. Larger multicenter studies with longer follow-up are needed to confirm these findings.

Keywords: proximal femur fracture, proximal femoral nailing, functional outcome, lower extremity functional scale, short form-36 health survey

How to cite: Odejobi K, Alatishe KA, Akpati U. Early functional outcomes of proximal femur fractures treated with proximal femoral nailing in a tertiary trauma center. J Surg Med. 2026;10(8):e8454.

Introduction

Proximal femoral fractures encompass femoral neck, intertrochanteric, and subtrochanteric fractures, each with distinct biomechanical challenges and healing potential. They represent a major global health burden, particularly among older adults with osteoporosis and an elevated risk of falls. These injuries often mark a turning point in patients' lives, with only 40-60% of older individuals regaining pre-injury mobility and independence within a year [1]. In younger patients, proximal femoral fractures usually result from high-energy trauma, such as motor vehicle collisions, falls from height, or industrial accidents [2].

The global incidence of hip fractures varies geographically. Northern Europe and the United States report the highest rates, with Norwegian data indicating annual incidences of 920 per 100,000 in women and 399 per 100,000 in men [3]. Variations across regions have been attributed to population demographics, cultural practices, and environmental factors. In contrast, African studies remain sparse, with much lower reported incidences, ranging from 2 per 100,000 in Nigeria [4] to fewer than 90 per 100,000 in other sub-Saharan African countries [5, 6]. In Nigeria and other developing regions, the burden is compounded by delays in presentation, limited access to surgical implants, and reliance on traditional bone setters, which may contribute to poor outcomes.

Although nonoperative treatment may be considered for patients with poor functional prospects or prohibitive medical risks, surgical fixation remains the standard of care because it enables early mobilization and reduces complications associated with prolonged immobility. Several implants are available, including dynamic hip screws and proximal femoral plates, but cephalomedullary nails, particularly the proximal femoral nail (PFN) introduced by the AO/ASIF group in 1996 [7], have gained increasing popularity. Compared with extramedullary devices, intramedullary fixation offers biomechanical advantages, reducing bending forces on the implant by 23-30% and facilitating early weight-bearing [8].

Multiple studies from Europe and Asia have demonstrated favorable outcomes with PFN, particularly in unstable fracture patterns, with durable fixation and relatively low complication rates [9, 10]. However, local data from sub-Saharan Africa are limited and focus mainly on epidemiology rather than clinical and functional outcomes. Given the rising use of PFN in our setting, evaluating its effectiveness is important. In particular, the influence of patient-related factors, such as age, comorbidities, and pre-injury functional status, on outcomes remains underexplored. This study aimed to determine the early functional outcomes of proximal femoral fracture treatment with PFN at the study center. Secondary objectives were to determine the union rate, time to union, and the most common complications associated with PFN use.

Materials and methods

This prospective cohort study was conducted at a tertiary referral center for orthopedics and trauma. Consecutive patients presenting with proximal femur fractures and managed with PFN between February 2023 and January 2024 were recruited. The study was conducted in accordance with the principles of the Declaration of Helsinki, and ethical approval (reference no. OH/90/C/IX) was obtained from the institutional review board before study commencement. Written informed consent was obtained from all participants. Inclusion criteria were adults aged 18-75 years with closed pertrochanteric or subtrochanteric fractures (AO 31-A1, A2, or A3) treated with PFN within 3 months of injury. Patients with metastatic disease, multiple or open fractures, severe cognitive impairment, inability to walk before injury, incomplete clinical records or inadequate radiographic documentation, or ipsilateral hip osteoarthritis were excluded. Sample size was calculated based on the number of cases managed at the study center in the previous year, while ensuring a power of 0.80 and a significance level of 0.05. Ultimately, 55 patients were recruited, and 46 completed follow-up and were included in the analysis. A structured pro forma captured demographic characteristics, mechanism of injury, comorbidities, intraoperative data, and complications. Pre-injury lower limb function and health-related quality of life were assessed using the Lower Extremity Functional Scale (LEFS) and the Short Form-36 (SF-36), respectively. Anteroposterior and lateral radiographs of the pelvis and femur were obtained for classification using the AO/OTA system. Follow-up assessments were performed at 6 weeks, 3 months, and 6 months, with clinical and radiological evaluation of union, function using LEFS and SF-36, and complications.

All patients underwent a comprehensive history and physical examination. Initial management followed Advanced Trauma Life Support (ATLS) protocols, with resuscitation and stabilization prioritized. Once life-threatening injuries were excluded, informed consent was obtained from patients meeting the study inclusion criteria. Baseline investigations included complete blood count, serum electrolytes, urea and creatinine, fasting blood glucose, and viral hepatitis and retroviral screening. Additional assessments were performed for patients older than 40 years and those with hypertension or diabetes, including chest radiography and electrocardiography. Patients with abnormal electrocardiographic findings or a previously abnormal echocardiogram underwent echocardiography. All patients had plain radiographs of the pelvis and ipsilateral femur in anteroposterior and lateral views for fracture classification and preoperative planning. Subcutaneous enoxaparin was withheld 12 hours before surgery and resumed 12 hours postoperatively. Preoperative fasting guidelines were observed.

Anesthesia was provided using a subarachnoid block, with or without epidural anesthesia. Prophylactic intravenous third-generation cephalosporin was administered at induction and continued for 24 hours. Patients were positioned supine on a fracture table, and closed reduction was initially attempted with traction, internal rotation, and abduction under fluoroscopic guidance. Reduction quality was confirmed on anteroposterior (AP) and lateral views, with attention to the femoral neck, inferomedial calcar, and sagittal alignment. When closed reduction was inadequate, percutaneous or open techniques using pointed forceps, bone levers, or Steinmann pins as joysticks were used.

After preparation with chlorhexidine, povidone-iodine, and methylated spirit, sterile draping was applied from the anterior superior iliac spine to the knee. A 3-5 cm proximal incision was

made above the greater trochanter and extended as required in patients with obesity or for open reductions. The fascia lata was divided in line with the incision. For open reductions, a longer incision allowed direct visualization while preserving periosteal integrity. Entry was made with an awl through the tip of the greater trochanter. Guidewire placement was confirmed in both planes: centrally on the anteroposterior view and slightly anterior to the trochanter-shaft axis on the lateral view. The entry was reamed while avoiding eccentric widening of the trochanter. The nail, preassembled with its targeting device, was introduced over the guidewire under fluoroscopic control. The lag-screw guidewire was advanced into the femoral head and neck, aiming for a center-center or slightly inferior position on the anteroposterior view and a central position on the lateral view. Position was adjusted to achieve a tip-apex distance <25 mm. After measurement and reaming, the lag screw and antirotational hip pin were inserted. Distal interlocking was performed in static mode for unstable or multifragmentary fractures and in dynamic mode for transverse or stable configurations. Traction was released before distal locking to prevent iatrogenic limb lengthening in intertrochanteric fractures and after locking in subtrochanteric fractures to allow impaction.

The proximal femoral nails used at the study center (NEBULA, Gujarat, India) were available in short (200 mm) and long (up to 440 mm) configurations, with diameters of 10, 11, and 12 mm. All nails incorporated a 6° proximal mediolateral bend to facilitate lateral entry. Fixation of the femoral neck was achieved with an 8.0 mm load-bearing lag screw (80-120 mm) complemented by a 6.5 mm antirotational hip pin (60-110 mm). Distal fixation was achieved by static or dynamic locking with 4.9 mm bolts, depending on fracture morphology.

Wounds were irrigated, and hemostasis was secured. The fascia was closed with absorbable sutures, and the skin was approximated with staples. Wound drains were placed selectively for open reductions, patients with obesity, or extensive soft tissue dissection. Final implant position was confirmed fluoroscopically.

Immediate postoperative AP and lateral radiographs were obtained, and reduction quality was graded using the Chang reduction quality criteria [11]. Analgesia consisted of intravenous pentazocine (30 mg every 6 hours) and paracetamol (1 g every 6 hours) for the first 48 hours. Intravenous antibiotics were continued for 24 hours. Drains, when used, were removed at 48 hours, and skin staples were removed 2 weeks after surgery. Deep vein thrombosis prophylaxis was continued for 2 weeks postoperatively using pharmacologic agents and early mobilization. Isometric quadriceps, hamstring, and gluteal exercises commenced on the first postoperative day. Patients were mobilized with a walking frame within 24 hours and permitted weight-bearing as tolerated under physiotherapist supervision.

Discharge criteria included medical stability and independent ambulation with support, typically achieved by the fifth postoperative day. Rehabilitation continued in outpatient physiotherapy clinics.

The primary outcomes were functional outcome, assessed using the Lower Extremity Functional Scale (LEFS), and quality of life, assessed using the Short Form-36 (SF-36) health survey. Both instruments were administered preoperatively and at 6 weeks, 3 months, and 6 months postoperatively. Higher scores indicated better functional status and quality of life, respectively. Secondary outcomes included time to radiological union and complications. Radiological union was defined as bridging callus across at least three cortices on AP and lateral radiographs.

Statistical analysis

Data were analyzed using IBM SPSS Statistics for Windows, version 23 (IBM Corp., Armonk, NY, USA). Continuous variables were summarized as mean (SD), and categorical variables as frequencies and percentages. Comparisons were performed using paired t-tests, chi-square tests, and analysis of variance, as appropriate. Pearson correlation analysis was used to assess the relationship between lower extremity function and quality of life. A *P*-value < 0.05 was considered statistically significant.

Results

A total of 55 patients underwent proximal femoral nailing during the recruitment period. Seven patients older than 75 years and two patients lost to follow-up were excluded. Forty-six patients were therefore included in the final analysis. The mean age was 57.9 (13.0) years, with a male-to-female ratio of 1.7:1. Most patients (59%, n = 27) were young or middle-aged adults, and 87% (n = 40) were independent ambulators before injury. Baseline demographic characteristics are summarized in Table 1. The distribution of fracture classes is shown in Figure 1, and perioperative characteristics are summarized in Table 2.

Table 1. Demographic and baseline clinical data (n = 46)

Age group	Frequency, n	Percentage, %
25-34	1	2.20
35-44	7	15.20
45-54	8	17.40
55-64	11	23.90
>64	19	41.30
Sex		
Female	18	39.10
Male	28	60.90
Laterality		
Right	29	63
Left	17	37
ASA grade		
I	23	50.00
II	15	32.60
III	8	17.40

ASA: American Society of Anesthesiologists.

Table 2. Descriptive perioperative statistics

Variable	Minimum	Maximum	Mean (SD)
Preoperative days of admission	1.00	12.00	4.50 (2.10)
Duration of surgery (min)	94.00	190.00	121.60 (17.90)
Blood loss (mL)	80.00	950	235.90 (185.80)
Time to ambulation (days)	1.00	21.00	3.60 (2.95)
Postoperative days of admission	5.00	28.00	9.60 (4.70)

Figure 1. Distribution of fracture classes according to the AO/OTA classification.

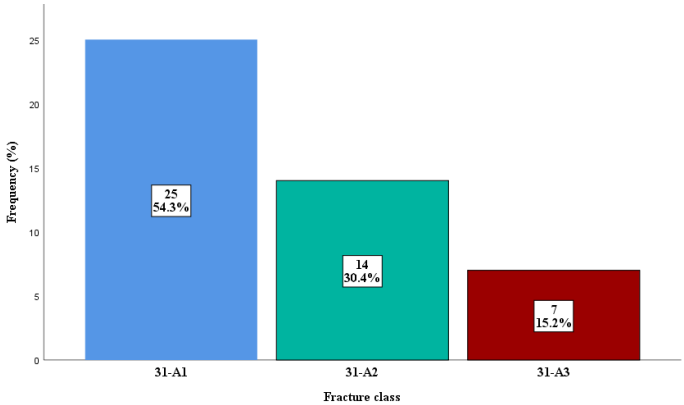
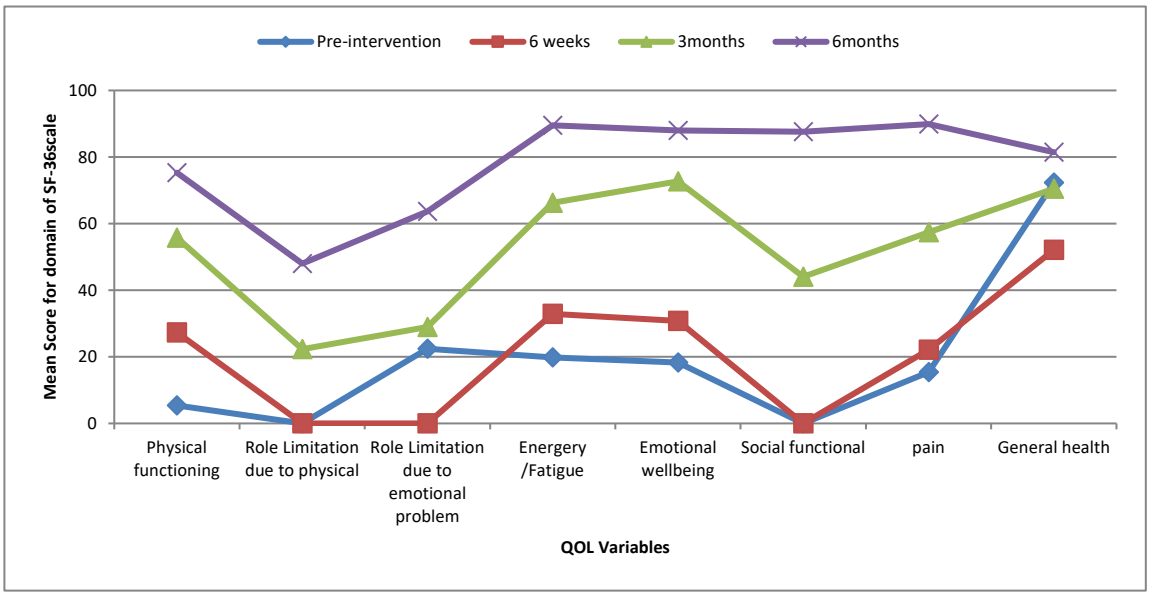


Figure 2. Quality of life of participants.



Mean Lower Extremity Functional Scale (LEFS) scores improved from 0 preoperatively to 23.80 (1.80) at 6 weeks, 43.55 (2.70) at 3 months, and 63.39 (4.50) at 6 months ($P < 0.001$). Improvement across assessment times is summarized in Table 3. Predictors of poorer LEFS at 6 months included comorbidities ($P < 0.001$), pre-injury use of walking aids ($P = 0.010$), female sex ($P < 0.001$), older age ($P = 0.020$), higher American Society of Anesthesiologists (ASA) grade ($P < 0.001$), and surgery delayed beyond 48 hours ($P = 0.020$). Fracture class and reduction quality showed no significant effect. SF-36 scores also improved in the physical, social, and emotional domains over follow-up (Figure 2).

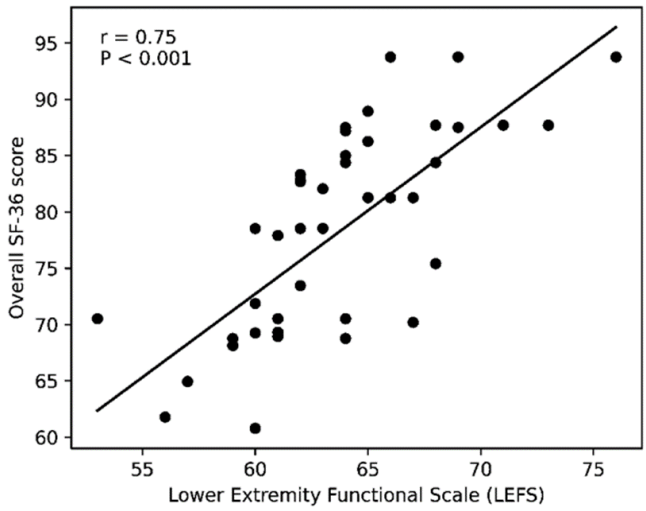
LEFS correlated positively with most SF-36 domains (r = 0.75 overall; $P < 0.001$), except social functioning, which showed a weak negative correlation (Figure 3).

Table 3. Mean Lower Extremity Functional Scale scores at assessment points

Time point	Mean (SD)	F	*P*-value
Preoperative	0.00	6913.17	<0.001
6 weeks postoperative	23.80 (1.80)		
3 months postoperative	43.55 (2.70)		
6 months postoperative	63.39 (4.50)		

LEFS: Lower Extremity Functional Scale, SD: standard deviation. *$P < 0.05$ was considered statistically significant.

Figure 3. Correlation between Lower Extremity Functional Scale and quality-of-life scores



Complications occurred in six patients (13%), predominantly superficial surgical site infections. One patient developed deep vein thrombosis. Surgical site infections were managed successfully with antibiotics and local wound care, whereas deep vein thrombosis was managed with anticoagulation and prolonged bed rest. Surgical site infection was associated with comorbidities ($P = 0.040$) and showed a borderline association with increasing age ($P = 0.048$). No reoperations, nonunion, or implant failures were reported.

By 6 months, 91% (n = 42) of patients achieved radiological union, with a mean union time of 3.9 (0.2) months. The remaining patients were considered to have delayed union and were not followed beyond the 6-month follow-up period. Sex, comorbidity, ASA grade, and reduction quality did not significantly affect time to union.

Discussion

Proximal femur fractures remain a major public health issue because of their association with disability, loss of independence, and increased mortality. With the aging global population, their incidence is expected to rise further. In this prospective cohort, proximal femoral nailing was associated with a high union rate and improvement in functional outcomes and quality of life within 6 months of surgery. Although proximal femur fractures predominantly occur in older populations, the study cohort was restricted to patients aged 75 years or younger to minimize confounding from age-related physiological decline. Despite this restriction, most participants were middle-aged or older adults. Road traffic crashes were the predominant mechanism of injury, consistent with the relatively younger profile of this cohort. This pattern reflects the burden of high-energy trauma in developing countries, where rapid urbanization and increased motor vehicle use have contributed to road traffic injuries. Consequently, trauma systems in these settings must increasingly address fractures traditionally associated with older populations but occurring in younger, economically active individuals, with implications for workforce productivity and healthcare resource use. Low-energy falls accounted for nearly one-quarter of cases and were more common among older female

participants, reflecting established associations with osteoporosis. These patterns contrast with large epidemiological studies by Zelenka et al. [12] and Bartoníček et al. [13], which reported mean ages above 75 years and a female predominance of 70-73%, largely because their cohorts included older populations with osteoporotic fractures. Comparable findings were reported by Hantouly et al. [14] in a retrospective epidemiological study of proximal femur fractures in younger patients (<60 years). They reported that 89.9% of their cohort was male, with falls from height and motor vehicle accidents as the most common mechanisms of injury.

Most fractures in this cohort were stable patterns (AO 31-A1 and A2), whereas unstable AO 31-A3 fractures were least frequent, similar to reports by Chang et al. [15] and Haslhofer et al. [16], both of which found A3 fractures to be relatively uncommon. As expected, A3 fractures were associated with longer operative times and greater blood loss in this series. This is consistent with findings from Song et al. [17] and Wang et al. [18], who noted that more complex fractures increase surgical complexity and intraoperative morbidity. These observations underscore the importance of preoperative planning, anticipating longer procedures, and optimizing perioperative support for complex fracture subtypes.

Functional recovery measured by LEFS improved steadily and meaningfully across follow-up points, reaching approximately 63 of 80 points at 6 months. The approximately 20-point difference between successive follow-up periods exceeded the minimal clinically important difference of 9 points reported by Mehta et al. [19] in their review of LEFS measurement properties. This result is comparable to the findings of Chopra et al. [20], who reported a mean LEFS of 70 after proximal femoral nailing. Predictors of higher LEFS scores in this study included younger age, male sex, pre-injury independent ambulation, ASA grade I, absence of comorbidities, and early surgery (<48 hours). These observations align with reports by Korkmaz et al. [21], Zahoor et al. [22], and van der Sijp et al. [23], which demonstrated the influence of baseline health and functional status on outcomes. Fracture class and reduction quality did not significantly affect LEFS, a finding also reported by Korkmaz et al. [21] but differing from Balachandran et al. [24], who identified reduction quality as an important determinant. These differences may reflect variation in surgical technique, sample size, and outcome assessment intervals across studies.

Quality of life improved across SF-36 domains, particularly pain and energy/fatigue, supporting the role of PFN in restoring not only limb function but also broader well-being. Verma et al. [25] reported similar improvements across multiple SF-36 domains. Although Guyver et al. [26] reported persistently low postoperative SF-36 scores, their cohort was older, included pathological fractures, and compared postoperative scores with normative values rather than preoperative baselines, which may account for the discrepancy. The strong relationship between LEFS and SF-36 underscores the interdependence of functional recovery and perceived quality of life. Pre-injury independent ambulation was also associated with better SF-36 outcomes, consistent with findings by Abdulkasem et al. [27].

Complications in this cohort were predominantly superficial surgical site infections. The observed infection rate was higher than the 3-4% reported by Haslhofer et al. [16] and Altintas et al. [28]; however, differences in sample size, surgical expertise, and institutional infection-control practices may explain this variation. Advanced age, comorbidities, and prolonged operative times were identified as important risk factors in this cohort. Older patients may have impaired immune responses, reduced tissue perfusion, and multiple chronic conditions that predispose them to postoperative infection and delayed wound healing. Diabetes mellitus, in particular, is associated with an increased risk of surgical site infection because of impaired leukocyte function and microvascular disease. Perioperative optimization strategies, such as glycemic control, appropriate antibiotic prophylaxis, meticulous surgical technique, and minimization of operative time, may help reduce infection risk in vulnerable patients [29, 30]. A recent systematic review and meta-analysis of orthopedic trauma surgery identified male sex, elevated body mass index, current smoking, open injury, higher wound class, and prolonged operative duration as risk factors for deep surgical site infection, while age was not significantly associated [31]. These findings reinforce the importance of early identification of high-risk patients and targeted perioperative optimization. The single case of deep vein thrombosis was managed successfully with anticoagulation and did not impede fracture union. No implant failures or reoperations were recorded, suggesting satisfactory implant performance in this cohort.

Ninety-one percent of patients achieved radiological union by 6 months, with a mean time to union comparable to reports by Patel et al. [32] and Gupta et al. [33], who reported mean union times of 10-18 weeks. A trend toward slower healing in unstable fracture types was noted, although it did not reach statistical significance. Time to union is multifactorial and may be influenced by patient demographics, comorbidities, fracture pattern, and perioperative management. Recognizing these variables can guide rehabilitation and help set realistic patient expectations.

Limitations

This prospective cohort study has several limitations. First, it was conducted at a single center with a relatively modest sample size, which may limit generalizability. Second, the 6-month follow-up period may underestimate late complications or longer-term functional decline. In addition, excluding patients older than 75 years resulted in a relatively younger cohort with better physiological reserve, which may partly explain the low complication rate. Hip fractures predominantly affect older adults with frailty and multiple comorbidities, factors associated with poorer functional recovery and higher postoperative complication rates [1, 23, 34]. Therefore, caution is warranted when extrapolating these findings to the oldest-old population. Finally, heterogeneity in patient characteristics, including age, fracture type, comorbidities, and pre-injury functional status, may have influenced functional outcomes.

Conclusion

This prospective study demonstrates that proximal femoral nailing provides reliable fixation for pertrochanteric and subtrochanteric fractures, with improvement in functional outcomes and quality of life within 6 months. Younger age, independent pre-injury ambulation, lower ASA grade, and absence of comorbidities were associated with better recovery.

The high union rate and overall complication profile support the effectiveness of this technique in the study population. Larger multicenter studies with longer follow-up are required to validate these findings.

References

1. Dyer SM, Crotty M, Fairhall N, Magaziner J, Beaupre LA, Cameron ID, et al. A critical review of the long-term disability outcomes following hip fracture. BMC Geriatr. 2016;16:158. doi: 10.1186/s12877-016-0332-0.
2. Hwang LC, Lo WH, Chen WM, Lin CF, Huang CK, Chen CM. Intertrochanteric fractures in adults younger than 40 years of age. Arch Orthop Trauma Surg. 2001;121(3):123-6. doi: 10.1007/s004020000190.
3. Dhanwal DK, Dennison EM, Harvey NC, Cooper C. Epidemiology of hip fracture: worldwide geographic variation. Indian J Orthop. 2011;45(1):15-22. doi: 10.4103/0019-5413.73656.
4. Adebajo AO, Cooper C, Evans JG. Fractures of the hip and distal forearm in West Africa and the United Kingdom. Age Ageing. 1991;20(6):435-8. doi: 10.1093/ageing/20.6.435.
5. Schnaid E, MacPhail AP, Sweet MBE. Fractured neck of femur in black patients: a prospective study. J Bone Joint Surg Br. 2000;82(6):872-5. doi: 10.1302/0301-620X.82B6.10589.
6. Zebaze RMD, Seeman E. Epidemiology of hip and wrist fractures in Cameroon, Africa. Osteoporos Int. 2003;14(4):301-5. doi: 10.1007/s00198-002-1356-1.
7. Boldin C, Seibert FJ, Fankhauser F, Peicha G, Grechenig W, Szyszkowitz R. The proximal femoral nail (PFN): a minimal invasive treatment of unstable proximal femoral fractures. A prospective study of 55 patients with a follow-up of 15 months. Acta Orthop Scand. 2003;74(1):53-8. doi: 10.1080/00016470310013662.
8. Yadav S, Golhar AV, Agrawal R. Management of unstable intertrochanteric fracture by proximal femoral nail. J Evol Med Dent Sci. 2014;3(15):4084-102. doi: 10.14260/jemds/2014/2403.
9. Chopra BL, Kumar K, Khajotia BL, Bhambu R, Bhatiwal S, Shekhawat V. Proximal femoral nail: outcome and complications. A prospective study of 125 cases of proximal femoral fractures. Int J Res Orthop. 2017;3(5):973-8. doi: 10.18203/issn.2455-4510.IntJResOrthop20173673.
10. Takahashi A, Naruse H, Kitade I, Shimada S, Tsubokawa M, Kokubo Y, et al. Functional outcomes after the treatment of hip fracture. PLoS One. 2020;15(7):e0236652. doi: 10.1371/journal.pone.0236652.
11. Chang SM, Zhang YQ, Ma Z, Li Q, Dargel J, Eysel P. Fracture reduction with positive medial cortical support: a key element in stability reconstruction for the unstable pertrochanteric hip fractures. Arch Orthop Trauma Surg. 2015;135(6):811-8. doi: 10.1007/s00402-015-2206-x.
12. Zelenka L, Alt J, Knížková I, Kunc P, Lukešová D. Epidemiologická studie vlivu pohlaví, věku, mobility a doby úrazu na zlomeniny proximálního femuru [Epidemiological study of the effects of gender, age, mobility and time of injury on proximal femoral fractures]. Acta Chir Orthop Traumatol Cech. 2018;85(1):40-5.
13. Bartoníček J, Dzupa V, Fric V, Pacovský V, Skála-Rosenbaum J, Svatoš F. Epidemiologie a ekonomie zlomenin proximálního femuru, proximálního humeru, distálního radia a luxačních zlomenin hlezna [Epidemiology and economic implications of fractures of the proximal femur, proximal humerus, distal radius and fracture-dislocation of the ankle]. Rozhl Chir. 2008;87(4):213-9.
14. Hantouly AT, AlBarazanji A, Al-Juboori M, Alebbini M, Toubasi AA, Mohammed A, et al. Epidemiology of proximal femur fractures in the young population of Qatar. Eur J Orthop Surg Traumatol. 2024;34(1):21-9. doi: 10.1007/s00590-023-03664-1.
15. Chang SM, Wang ZH, Tian KW, Sun GX, Wang X, Rui YF. A sophisticated fracture classification system of the proximal femur trochanteric region (AO/OTA-31A) based on 3D-CT images. Front Surg. 2022;9:919225. doi: 10.3389/fsurg.2022.919225.
16. Haslhofer DJ, Stiftinger JM, Kraml N, Dannbauer F, Schmolmüller C, Gotterbarm T, et al. Complication rates after proximal femoral nailing: does level of training matter? J Orthop Traumatol. 2023;24(1):56. doi: 10.1186/s10195-023-00737-z.
17. Song H, Hu SJ, Du SC, Xiong WF, Chang SM. Sub-classification of AO/OTA-2018 pertrochanteric fractures is associated with clinical outcomes after fixation of intramedullary nails. Geriatr Orthop Surg Rehabil. 2021;12:21514593211056739. doi: 10.1177/21514593211056739.
18. Wang Z, Li K, Peng C. Six-part classification of femoral intertrochanteric fractures: a classification method to improve the diagnosis rate of unstable fractures. Orthop Surg. 2024;16(3):637-53. doi: 10.1111/os.13998.
19. Mehta SP, Fulton A, Quach C, Thistle M, Toledo C, Evans NA. Measurement properties of the Lower Extremity Functional Scale: a systematic review. J Orthop Sports Phys Ther. 2016;46(3):200-16. doi: 10.2519/jospt.2016.6165.
20. Chopra M, Srivastava SK, Kumar S, Mishra DK. Functional and radiological outcomes of intertrochanteric fractures treated with proximal femoral nail. Int J Res Orthop. 2020;6(5):1001-7. doi: 10.18203/issn.2455-4510.IntJResOrthop20203721.
21. Korkmaz MF, Erdem MN, Disli Z, Selcuk EB, Karakaplan M, Gogus A. Outcomes of trochanteric femoral fractures treated with proximal femoral nail: an analysis of 100 consecutive cases. Clin Interv Aging. 2014;9:569-74. doi: 10.2147/CIA.S59835.
22. Zahoor HUR, Khatana NH, Iqbal S, Mahmood U, Ahmed S, Laeeque O. Functional outcome of proximal femoral nail antirotation (PFNA) in proximal femur fracture. J Health Rehabil Res. 2024;4(1):905-10. doi: 10.61919/jhrr.v4i1.442.
23. van der Sijp MPL, van Eijk M, Tong WH, Niggebrugge AHP, Schoones JW, Blauw GJ, et al. Independent factors associated with long-term functional outcomes in patients with a proximal femoral fracture: a systematic review. Exp Gerontol. 2020;139:111035. doi: 10.1016/j.exger.2020.111035.
24. Balachandran R, Karthikeyan M, Vikram M, Pratheeban K. Analysis of factors affecting the radiological and functional outcome of proximal femoral nailing in unstable intertrochanteric fractures. Int J Orthop Sci. 2020;6(1):376-8. doi: 10.22271/ortho.2020.v6.i1g.1893.
25. Verma AK, Dhiman P, Sharma V. General health and functional improvement among patients with unstable extracapsular proximal femoral fractures managed with proximal femoral nail by using SF-36 score. Int J Res Orthop. 2022;8(5):565-70. doi: 10.18203/issn.2455-4510.IntJResOrthop20222187.
26. Guyver PM, McCarthy MJH, Jain NPM, Keenan J. The short-term functional and radiological outcome of patients treated with the Synthes proximal femoral nail antirotation (PFNA) for unstable proximal femoral fractures. Eur J Orthop Surg Traumatol. 2011;21:493-501. doi: 10.1007/s00590-010-0745-y.
27. Abdulkasem N, Phinyo P, Khorana J, Pruksakorn D, Apivatthakakul T. Prognostic factors of 1-year postoperative functional outcomes of older patients with intertrochanteric fractures in Thailand: a retrospective cohort study. Int J Environ Res Public Health. 2021;18(13):6896. doi: 10.3390/ijerph18136896.
28. Altintas B, Biber R, Bail HJ. The learning curve of proximal femoral nailing. Acta Orthop Traumatol Turc. 2014;48(4):396-400. doi: 10.3944/AOTT.2014.13.0056.
29. Owens CD, Stoessel K. Surgical site infections: epidemiology, microbiology and prevention. J Hosp Infect. 2008;70 Suppl 2:3-10. doi: 10.1016/S0195-6701(08)60017-1.
30. Anderson DJ, Podgorny K, Berríos-Torres SI, Bratzler DW, Dellinger EP, Greene L, et al. Strategies to prevent surgical site infections in acute care hospitals: 2014 update. Infect Control Hosp Epidemiol. 2014;35(6):605-27. doi: 10.1086/676022.
31. Liu H, Wang Y, Xing H, Chang Z, Pan J. Risk factors for deep surgical site infections following orthopedic trauma surgery: a meta-analysis and systematic review. J Orthop Surg Res. 2024;19:811. doi: 10.1186/s13018-024-05299-2.
32. Patel I, Amin TK, Kachhad KH, Patel KM, Senta A, Modi DR, et al. Results of proximal femoral nailing in subtrochanteric fracture of femur in adults. J Orthop Dis Traumatol. 2022;5(2):74-7. doi: 10.4103/jodp.jodp_4_22.
33. Gupta S, Gupta P, Raina GS, Kumar M, Singh G. Functional outcome of long proximal femoral nail versus short proximal femoral nail in peritrochanteric fractures. Int J Res Med Sci. 2021;9(5):1479-81. doi: 10.18203/2320-6012.ijrms20211415.
34. Haentjens P, Magaziner J, Colón-Emeric CS, Vanderschueren D, Milisen K, Velkeniers B, et al. Meta-analysis: excess mortality after hip fracture among older women and men. Ann Intern Med. 2010;152(6):380-90.