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TO COMPARE THE FUNCTIONAL OUTCOME OF INTER-TROCHANTERIC FRACTURES MANAGED BY LONG FEMORAL NAIL VERSUS SHORT FEMORAL NAIL

Orthopaedics

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ABSTRACT

Introduction: Intertrochanteric fractures of the femur are common injuries, particularly among the elderly population, and are associated with significant morbidity and functional impairment. Proximal femoral nailing (PFN) has become a widely accepted method of fixation due to its biomechanical advantages and minimally invasive nature. However, the choice between short and long PFN remains a subject of debate. The present study was conducted to compare the functional and radiological outcomes of short versus long proximal femoral nails in the management of intertrochanteric fractures. **Material And Methods:** This prospective comparative study included 30 patients with intertrochanteric fractures admitted to a tertiary care center. Patients were randomly allocated into two groups: Group A (short PFN, n=15) and Group B (long PFN, n=15). All patients underwent surgical fixation and were followed up clinically and radiologically at regular intervals. Parameters assessed included duration of surgery, intraoperative blood loss, time to union, complications, and functional outcome measured using the Harris Hip Score. **Results:** The mean duration of surgery and intraoperative blood loss were lower in the short PFN group compared to the long PFN group. Radiological union was achieved in the majority of patients in both groups within a comparable time frame. Functional outcomes assessed by the Harris Hip Score showed good to excellent results in most patients, with no statistically significant difference between the groups. Complication rates were minimal and comparable. **Conclusion:** Both short and long proximal femoral nails provide effective fixation and satisfactory functional outcomes in intertrochanteric fractures. Short PFN offers advantages of reduced operative time and blood loss, while overall union rates and functional recovery are comparable between the two techniques.

KEYWORDS

Intertrochanteric fracture; Proximal femoral nail; Short PFN; Long PFN

INTRODUCTION

Intertrochanteric fractures are extracapsular fractures of the proximal femur occurring between the base of the femoral neck and a line drawn at the level of the lesser trochanter, just proximal to the medullary canal. This metaphyseal region consists predominantly of cancellous bone with intersecting compressive and tensile trabecular patterns and a relatively thin cortical shell, rendering it particularly susceptible to injury and displacement under traumatic forces. Following internal fixation, the fracture site and surrounding musculature are exposed to multidirectional mechanical stresses throughout healing and rehabilitation, influencing stability and functional outcomes [1,2].

The global burden of proximal femoral fractures is steadily rising, largely attributable to increasing life expectancy, population ageing, and the growing prevalence of osteoporosis. While low-energy falls are the predominant mechanism in elderly individuals, high-energy trauma such as road traffic accidents accounts for a substantial proportion of cases among younger patients [3]. Intertrochanteric fractures significantly compromise mobility, independence, and quality of life. Epidemiological projections estimate that hip fractures may reach approximately 1.6 million cases by 2025 and nearly 2.5 million by 2050, underscoring their expanding public health impact [4].

Anatomically, the intertrochanteric region plays a crucial role in hip biomechanics. The greater trochanter provides attachment for key abductors such as the gluteus medius and minimus, while the lesser trochanter anchors the iliopsoas muscle. The dense trabecular architecture facilitates efficient load transmission; however, osteoporotic bone loss weakens this framework, predisposing to unstable fracture patterns. Despite this vulnerability, the rich metaphyseal blood supply generally promotes reliable fracture healing and contributes to a lower incidence of avascular necrosis compared with intracapsular femoral neck fractures [5,6].

In elderly populations, most intertrochanteric fractures result from low-energy lateral falls with direct impact on the greater trochanter. Osteoporosis and cortical thinning increase the likelihood of comminution and instability, particularly involving the posteromedial cortex. Extensive comminution in this area often leads to varus collapse and retroversion deformity, which heighten the risk of fixation failure and postoperative complications [7]. Mortality remains considerable, with nearly 20% of elderly patients with unstable fractures dying within one year of surgery, despite advances in surgical techniques and perioperative care [8].

Clinical and radiographic evaluation focuses on fragment number, size, displacement, and overall fracture stability. Classification systems, such as the Evans classification, categorize fractures based on displacement and comminution, thereby guiding implant selection and predicting prognosis. Ongoing refinements in classification reflect advances in understanding fracture biomechanics and fixation strategies [9].

Surgical management is the standard of care, with cephalomedullary (CM) nailing widely adopted due to its biomechanical superiority and capacity for early mobilization [10]. Historically, sliding hip screws and side-plate constructs yielded satisfactory outcomes in stable fracture patterns but were inadequate for reverse oblique or subtrochanteric extensions, prompting the transition to intramedullary devices. Contemporary CM nails are available in short and long variants, each offering distinct advantages and limitations [11].

Short CM nails are technically less demanding, require reduced operative time, and minimize blood loss and fluoroscopic exposure. These features make them particularly suitable for elderly or high-risk patients. However, they have been associated with complications such as postoperative anterior thigh pain and peri-implant fractures occurring near the distal tip of the nail [12,13]. Conversely, long CM nails extend further along the femoral shaft, distributing mechanical stresses more evenly and reducing stress concentration at the distal tip. This design may decrease the incidence of secondary femoral fractures and provide enhanced stability, particularly in fractures with subtrochanteric extension. Nevertheless, their insertion often entails prolonged operative time, greater blood loss, increased radiation exposure due to distal locking, and potential mismatch with femoral curvature leading to cortical impingement or perforation [14,15].

Wright RC, et. al; 2011, compared short and long proximal femoral nails remains inconclusive. While some studies report reduced operative duration and intraoperative blood loss with short nails, others emphasize the biomechanical benefits and potential reduction in secondary fractures with long nails. Consequently, no universal consensus exists regarding the optimal implant choice. Decision-

making should therefore be individualized, taking into account fracture morphology, patient comorbidities, bone quality, and surgeon expertise to achieve optimal functional recovery and minimize complications [16,17].

The aim of this study is to evaluated the functional outcomes of intertrochanteric fractures managed with long femoral nails compared with short femoral nails. The primary objectives are to assess pain levels, evaluate the patient's gait, and determine the ability to perform daily activities following treatment. The secondary objectives include assessing and comparing the extent of functional recovery, identifying and comparing the rates of post-operative complications such as peri-implant fracture, infection, and implant failure, and comparing both the operative time and the amount of blood loss between the two treatment methods.

MATERIALAND METHODS

This prospective observational study was conducted at the Department of Orthopaedics, Rajshree Medical Research Institute, Bareilly (U.P.) from 2023-2026. Ethical approval has been obtained from the Ethical Approval Committee of Rajshree Medical Research Institute, Bareilly (U.P.).

Study Population

The study population comprised skeletally mature patients of both sexes presenting with fresh femoral intertrochanteric fractures sustained within three weeks and located more than 5 cm above the lesser trochanter on radiographic assessment. Patients were excluded if they had pathological fractures other than osteoporotic, were receiving chemotherapy or radiotherapy, had compound or open fractures, polytrauma, ipsilateral femoral shaft fractures, or fractures situated below 5 cm from the lesser trochanter.

Data Analysis

All collected data were recorded in a predesigned case record form and entered into Microsoft Excel version 10.0 for compilation, and statistical analysis was performed using SPSS version 23.0 (IBM Corp., Armonk, NY, USA). Continuous variables were expressed as mean ± standard deviation with minimum and maximum values, while categorical variables were presented as frequencies and percentages. Group comparisons were conducted using the independent t-test, Chi-square test or Fisher's exact test, and repeated measures ANOVA, with 95% confidence intervals estimated where applicable and p-values < 0.05 considered statistically significant.

RESULTS

This prospective randomized comparative study included 30 patients with fresh intertrochanteric femoral fractures, equally allocated into short PFN and long PFN groups, with 15 patients in each cohort. All patients underwent standardized clinical and radiographic follow-up until fracture union was achieved. Baseline demographic characteristics were comparable between the groups, with no statistically significant differences in mean age, gender distribution, mechanism of injury, side of involvement, or associated comorbidities. Most patients were between 60 and 70 years of age, and low-energy falls were the predominant mode of injury, reflecting the osteoporotic nature of fractures in the elderly population. Right and left side involvement was evenly distributed, and more than half of the patients in both groups had no associated comorbidities, while hypertension and diabetes mellitus were the most common medical conditions among those affected. Fracture patterns, classified according to the AO/OTA system, were also similar in both groups, with 31-A2 fractures being the most frequent type, followed by 31-A1 and 31-A3 patterns, indicating comparable fracture severity at baseline. Preoperative hemoglobin levels were largely within the 11–13 g/dL range in both cohorts, and although the short PFN group demonstrated slightly higher mean hemoglobin values, the difference was not statistically significant, confirming similar hematological status prior to surgery. Intraoperative assessment revealed a significant difference in operative duration between the two groups. The majority of short PFN procedures were completed within 90 minutes, whereas a substantial proportion of long PFN surgeries exceeded 110 minutes. The mean operative time was significantly lower in the short PFN group compared to the long PFN group, demonstrating greater surgical efficiency with the shorter implant. Overall, the findings indicate that both groups were well matched in terms of demographic, clinical, and fracture-related variables, thereby allowing reliable comparison of intraoperative and postoperative outcomes, with operative time emerging as a key distinguishing parameter favoring short PFN.

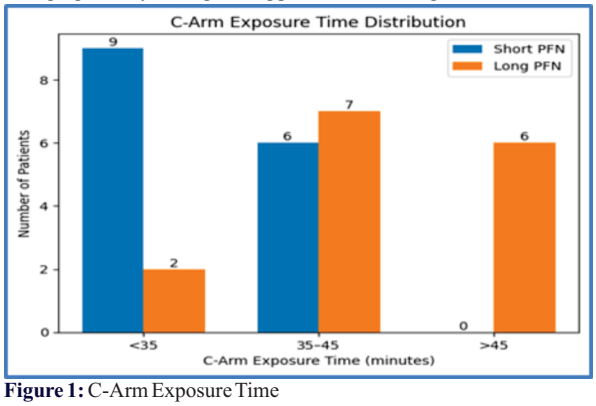

Figure 1: C-Arm Exposure Time

C-arm exposure time was significantly lower in the Short PFN group (mean 32.5 ± 5.4 min), with most cases under 35 minutes, whereas the Long PFN group showed longer exposure (mean 41.9 ± 6.3 min), including 40% exceeding 45 minutes; this difference was statistically significant (p = 0.001), indicating reduced radiation exposure with Short PFN.

Table 1: Intraoperative Blood Loss

Blood Loss	Short PFN	%	Long PFN	%	Total	%
<150 ml	12	80%	1	6.7%	13	43.3%
150–250 ml	3	20%	4	26.7%	7	23.3%
>250 ml	0	0%	10	66.7%	10	33.3%
Mean ± SD	**135.5 ± 28.4**	-	**344.5 ± 32.6**	-	-	-
p-value	**0.001***					

Intraoperative blood loss was significantly lower in the Short PFN group (mean 135.5 ± 28.4 ml), with 80% losing less than 150 ml, whereas the Long PFN group had substantially higher loss (mean 344.5 ± 32.6 ml), with 66.7% exceeding 250 ml; this difference was statistically significant (p = 0.001).

Table 2: Quality Of Fracture Reduction

Quality of Fracture Reduction	Short PFN	%	Long PFN	%	Total	%
Good	11	73.3%	9	60%	20	66.7%
Acceptable	3	20%	4	26.7%	7	23.3%
Poor	1	6.7%	2	13.3%	3	10%
Total no. patients	**15**	**100.0%**	**15**	**100.0%**	**30**	**100.0%**
p-value	**0.430**					

Good fracture reduction was achieved more frequently in the Short PFN group (73.3%) compared to the Long PFN group (60%), though the overall distribution of good, acceptable, and poor outcomes did not differ significantly between groups (p = 0.430).

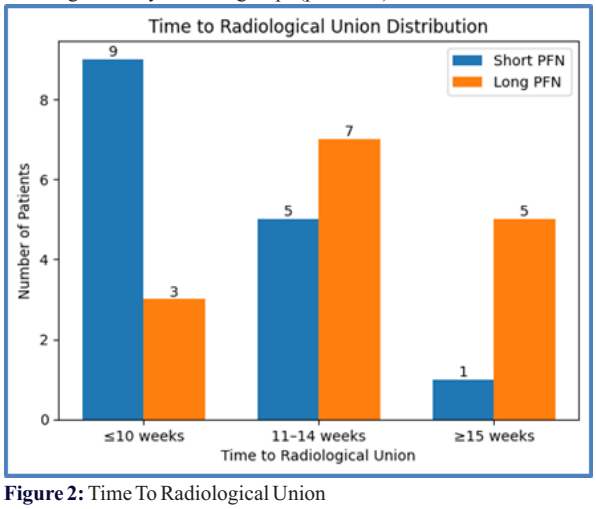

Figure 2: Time To Radiological Union

Radiological union occurred earlier in the Short PFN group, with 60% achieving union within 10 weeks and a lower mean union time (10.1 ± 2.2 weeks) compared to the Long PFN group (12.8 ± 3.1 weeks), where

delayed union was more common; the difference was statistically significant (p = 0.021).

Table 3: RUSH Score (Radiographic Union Score) For Hip

Grades	Short PFN	%	Long PFN	%	Total	%
<18	2	13.3%	5	33.3%	7	23.3%
18–23	5	33.3%	7	46.7%	12	40%
24–30	8	53.3%	3	20%	11	36.7%
Mean ± SD	**24.6 ± 3.1**	—	**20.8 ± 4.2**	—	—	—
p-value	**0.018***					

Higher RUSH scores were more common in the Short PFN group, with 53.3% scoring 24–30 and a significantly greater mean score (24.6 ± 3.1) compared to the Long PFN group (20.8 ± 4.2), indicating better radiological healing (p = 0.018).

Table 4: Harris Hip Score (HHS)

HHS	Short PFN	%	Long PFN	%	Total	%
<70	1	6.7%	2	13.3%	3	10%
70–80	3	20%	6	40%	9	30%
81–90	8	53.3%	5	33.3%	13	43.3%
>90	3	20%	2	13.3%	5	16.7%
Mean ± SD	**84.6 ± 6.3**	-	**79.3 ± 5.8**	-	-	-
p-value	**0.014***					

The Short PFN group demonstrated better functional outcomes, with a higher proportion of patients achieving Harris Hip Scores above 80 and a significantly greater mean HHS (84.6 ± 6.3) compared to the Long PFN group (79.3 ± 5.8), showing statistical significance (p = 0.014).

Table 5: Postoperative Complications

Complication	Short PFN	%	Long PFN	%	Total	%
Superficial Infection	1	6.7%	2	13.3%	3	10%
Screw Cut-Out	1	6.7%	1	6.7%	2	6.7%
Varus Collapse	1	6.7%	2	13.3%	3	10%
Z/Reverse Z Effect	0	0%	1	6.7%	1	3.3%
Periprosthetic Fracture	1	6.7%	0	0%	1	3.3%
Limb Shortening	4	26.7%	2	13.3%	6	20%
Total no. patients	**15**	**100.0%**	**15**	**100.0%**	**30**	**100.0%**
p-value	**0.112**					

Postoperative complications occurred in both groups, with limb shortening being the most common overall; although the Short PFN group had a slightly lower complication rate, the difference was not statistically significant (p = 0.112), indicating comparable safety profiles between the two implants.

Table 6: Overall Outcome Comparison

Outcome Parameter	Short PFN	Long PFN	p-value
Operative Time	Shorter	Longer	**0.001***
Blood Loss	Less	More	**0.001***
C-Arm Exposure	Less	More	**0.001***
Union Time	Faster	Slower	**0.021***
HHS	Better	Lower	**0.014***
RUSH Score	Higher	Lower	**0.018***
Complication Rate	Lower	Higher	0.112
Limb Shortening	Higher	Lower	0.071

The study demonstrated that short PFN was associated with significantly shorter operative time, reduced intraoperative blood loss, and lower fluoroscopic exposure compared with long PFN (p = 0.001). Radiological outcomes favored short PFN, showing faster union (p = 0.021) and higher RUSH scores (p = 0.018), indicating improved fracture healing. Functional assessment using the Harris Hip Score was also significantly better in the short PFN group (p = 0.014). Although complication rates were lower with short PFN, the difference was not statistically significant, and limb shortening was slightly more frequent. Major complications were rare and comparable, suggesting overall superiority of short PFN, with long PFN remaining beneficial in selected unstable cases.

DISCUSSION

Femoral intertrochanteric fractures constitute a significant proportion of hip fractures managed in orthopedic practice, particularly among elderly individuals with underlying osteoporosis who sustain low-energy trauma such as trivial falls. Early stable fixation and prompt mobilization are essential to restore preinjury functional status and minimize perioperative and postoperative complications. Proximal femoral nailing (PFN) is widely accepted because of its biomechanical superiority and minimally invasive application; however, the choice between short PFN (SPFN) and long PFN (LPFN) remains controversial. **Gallagher D, et. al; 2013,** compared second-generation short and long PFN with respect to operative parameters, radiological union, functional outcomes, and complications [1,17].

Baseline demographic and fracture characteristics were comparable between the two groups, with no statistically significant differences in age, gender distribution, mechanism of injury, fracture side, or associated comorbidities. The mean age was similar in both cohorts, and most fractures resulted from low-energy falls in elderly patients, consistent with prior reports [18,19]. The majority of fractures were classified as AO/OTA 31-A2, aligning with patterns described in earlier studies. This comparability allowed outcome differences to be attributed primarily to implant-related factors rather than confounding patient variables [20].

A key finding was the significantly shorter operative duration observed with short PFN. The mean surgical time was markedly lower in the SPFN group compared with the LPFN group (p < 0.001). The reduced duration may be explained by easier nail insertion, limited distal canal preparation, and simplified distal locking. Similar reductions in operative time with short nails have been reported by **Jha U, et. al; 2022 and Bagga M, et. al; 2025**. Clinically, shorter surgery reduces anesthetic exposure and physiological stress, which is especially advantageous in elderly patients [19,21].

Intraoperative blood loss was also significantly lower in the short PFN group (p < 0.001). This difference likely reflects smaller incisions, less soft tissue dissection, and avoidance of extensive femoral canal instrumentation. Reduced blood loss contributes to lower transfusion requirements and may enhance early postoperative recovery. Furthermore, fluoroscopy exposure was significantly decreased in the SPFN cohort (p < 0.001), thereby reducing radiation exposure for both patients and operating room personnel. **Mahmoud AN, et. al; 2025 & Tan GK, et. al; 2021,** supported the intraoperative efficiency of short PFN [22,23].

Radiological outcomes demonstrated earlier fracture union in the short PFN group, with a statistically significant difference in time to union (p = 0.021). Preservation of endosteal blood supply, reduced stress shielding, and maintenance of fracture biology may account for this observation. **Gupta S, et. al; 2021,** studies have found no significant difference, suggesting that union time may also depend on fracture stability, bone quality, and rehabilitation protocols. The Radiographic Union Score for Hip (RUSH) was significantly higher in the SPFN group (p = 0.018), indicating more advanced radiological healing. Higher RUSH scores have been correlated with clinical union, early weight bearing, and improved functional outcomes in validation studies [24,20].

Functional assessment using the Harris Hip Score (HHS) revealed significantly better scores in the short PFN group (p = 0.014). Improved early functional recovery may be related to faster union, reduced postoperative discomfort, and earlier mobilization. However, some authors have reported superior long-term outcomes with long PFN in highly unstable or osteoporotic fractures, attributing this to enhanced biomechanical stability. **Bagga M, et. al; 2025,** suggested that implant performance may vary according to fracture pattern and patient factors [21].

Postoperative complication rates were lower in the short PFN group, although differences were not statistically significant. Limb shortening was observed more frequently with short PFN but without significant difference, consistent with previous studies. Other complications, including screw cut-out, varus collapse, infection, and periprosthetic fracture, were infrequent in both groups, corroborating earlier reports that both implants are generally safe and reliable when appropriately selected [18].

Overall, short PFN demonstrated significant advantages, including reduced operative time, decreased blood loss, lower fluoroscopy exposure, earlier radiological union, higher RUSH scores, and improved functional outcomes. Although long PFN may provide

biomechanical benefits in highly unstable or severely osteoporotic fractures, routine use in all intertrochanteric fractures may not be necessary. Implant selection should therefore be individualized, considering fracture configuration, bone quality, patient comorbidities, and surgeon expertise [1,24].

CONCLUSION

Intertrochanteric femoral fractures are a common cause of morbidity in the elderly and require stable fixation to allow early mobilization and functional recovery. Although proximal femoral nailing is widely accepted, the ideal nail length remains debated. In this prospective randomized comparative study, short proximal femoral nailing demonstrated superiority over long PFN, with significantly reduced operative time, blood loss, and fluoroscopic exposure. It also showed earlier fracture union, higher RUSH scores, and better Harris Hip Scores. Complication rates were comparable, indicating short PFN as a safe and efficient option for most cases.

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