Original Article

A Clinico-Radiological Comparative Study of Functional Outcome of Short Vs Long Proximal Femur Nail in Pertrochantric Femur Fractures

Shreyas Satish Bhonde[1], Sanjay VitthalPopere[2], Padmakar Premchand Shinde[3]

[1]Junior Resident 3rd year, Department of Orthopedics, Vedantaa Institute of Medical Sciences, Dahanu, Palghar, Maharashtra, India. [2]Associate Professor, Department of Orthopedics, Vedantaa Institute of Medical Sciences, Dahanu, Palghar, Maharashtra, India. [3]HOD, Department of Orthopedics, Vedantaa Institute of Medical Science, Dahanu, Palghar, Maharashtra, India

Abstract

Background: One of the most prevalent osteoporotic fractures occurring in elderly individuals is the pertrochanteric femur fracture, which contributes to considerable morbidity, mortality and functional disability. As the PFN fixation has biomechanical benefits and allows the early mobilization, it has become the preferable treatment modality. Both short and long PFN are widely used; however, there is some controversy about the relative effectiveness in terms of operative efficiency, fracture healing and functional recovery. This study aimed to compare the functional and radiological result of Short Proximal Femoral Nail and Long Proximal Femoral Nail for treatment of pertrochanteric femur fractures. **Material and Methods:** This prospective randomized comparative study was conducted in the Department of Orthopaedics of a tertiary care teaching hospital over a period of 18 months. A total of 44 patients with fresh closed pertrochanteric femur fractures meeting the inclusion criteria were enrolled and randomly allocated into two groups: Group A (Short PFN, n=22) and Group B (Long PFN, n=22). Demographic variables, fracture characteristics, operative parameters, radiological outcomes, and functional outcomes were assessed. Functional evaluation was performed using the Harris Hip Score (HHS), while radiological assessment included fracture union, implant position, and complications. Statistical analysis was performed using Student's t-test, Chi-square test, and Fisher's exact test. A p-value <0.05 was considered statistically significant. **Results:** The mean age of the study population was 68.77 ± 8.03 years, and females constituted 61.4% of patients. Fall from standing height was the most common mode of injury (81.8%). AO 31-A2 fractures accounted for 52.3% of cases.The Short PFN group demonstrated significantly shorter operative duration (69.55 ± 5.02 vs 103.55 ± 5.72 minutes, p<0.001), lower blood loss (147.23 ± 7.70 vs 182.00 ± 9.80 ml, p<0.001), and reduced fluoroscopy time (43.55 ± 4.49 vs 61.59 ± 5.30 seconds, p<0.001) compared with the Long PFN group.Radiological union was achieved in all patients (100%). Mean time to union was 15.50 ± 0.51 weeks in the Short PFN group and 14.41 ± 0.50 weeks in the Long PFN group (p<0.001). No cases of varus collapse, screw cut-out, implant failure, or nonunion were observed. Functional outcomes were excellent in both groups. The mean Harris Hip Score was 90.77 ± 0.81 in the Short PFN group and 91.41 ± 2.34 in the Long PFN group (p=0.236). Excellent HHS outcomes were observed in 100% of Short PFN patients and 90.9% of Long PFN patients (p=0.488). Mild thigh pain occurred in only two patients in the Long PFN group. **Conclusion:** Both Short PFN and Long PFN provide excellent functional and radiological outcomes in the management of pertrochanteric femur fractures. Short PFN offers significant perioperative advantages, including reduced operative time, lower blood loss, and decreased fluoroscopy exposure. Although Long PFN demonstrated slightly earlier fracture union, functional outcomes and overall complication rates were comparable between the two groups. Implant selection should therefore be individualized based on fracture pattern, bone quality, patient factors, and surgeon preference.

Keywords: Pertrochanteric femur fracture; Proximal Femoral Nail; Short PFN; Long PFN; Harris Hip Score; Radiological union; Intertrochanteric fracture.

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Introduction

Pertrochanteric femur fractures are one of the most frequently incurred injuries of the proximal femur and are a common public health issue globally. These fractures are found between the greater and lesser trochanters and are more common in the elderly, because they have osteoporosis, decreased bone mineral density and increased fall-related risk. As life expectancy continues to increase and the proportion of older people grows, the number of proximal femoral fractures will also likely increase significantly over the next decades which will have substantial impacts on healthcare systems internationally.[1]

The intertrochanteric and pertrochanteric hip fractures are responsible for almost half of hip fractures and carry a high risk of morbidity, mortality, loss of independence and decreased quality of life. Post-fracture mortality is 15-30% in the first year after the fracture predominantly in elderly patients with multiple comorbidities. So it is important to achieve early mobilization

Address for correspondence: Dr. Padmakar Premchand Shinde
HOD, Department of Orthopaedic
Vedantaa Institute of Medical Science, Dahanu, Palghar, Maharashtra, India
E-mail: padmakarshinde303@gmail.com

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and stable fixation in the treatment of these fractures.

The traditional treatments have involved conservative treatment with long-term immobilization and multiple extramedullary fixation devices, including the Dynamic Hip Screw (DHS). Conservative treatment was however linked to complications, such as deep vein thrombosis, pressure ulcers, pulmonary infection, urine tract infection and long rehabilitation period. The advent of intramedullary fixation devices changed the paradigm of the surgical treatment of a pertrochanteric fracture to a biomechanically superior device that enables early weight bearing and reduced implant related complications.[2,3]

The Proximal Femoral Nail (PFN) is one of the most popular implants used for fixation of unstable pertrochanteric fractures, thanks to the AO (Arbeitsgemeinschaft für Osteosynthesefragen). The position of the nail within the medulla reduces bending moments acting on the implant and helps to distribute the load more in a favorable manner than extra medullary devices. Moreover, minimal soft tissue dissection is needed for insertion of PFN which facilitates preservation of fracture hematoma and improves biological healing.[4-6]

There have been a number of modifications made over the years: short and long versions of PFN have been created. Insertion of short PFNs is generally a less invasive procedure, with less operating-time, less blood loss and lower doses of radiation for the patient. They are especially beneficial in older, patients with marked medical comorbidities in which an abbreviated surgical time is desired. However, several concerns have been reported about the risk of distal femoral stress concentration, peri-implant fractures and the fixability of some unstable fracture patterns. Some of these drawbacks were addressed by creating long PFNs which are extended distally into the femoral shaft, which increases biomechanical stability and decreases stress concentrations at the nail tip. They may especially be useful in cases of subtrochanteric extensions, reverse oblique breaks and osteoporotic bone. However, the insertion of long PFNs is technically more challenging, longer surgical duration, higher fluoroscopic exposure, and could be more burdensome with higher blood loss.[7-10]

Although both implants have been used, there is no clarity on the superiority of one implant over the other. There are some studies reporting similar rates of union and functional outcome between short and long PFNs, and others indicating differences in functional outcomes and complication rates. In addition, fracture type, patient age, bone quality and rehabilitation protocols are heterogeneous and result in different outcomes.

Functional outcome scoring system (using validated scores like Harris Hip Score) gives useful information about pain relief, mobility, activities of daily living and patient satisfaction. Likewise, evaluation of the radiological appearance of fracture healing is a crucial factor to judge the treatment success and implant performance.[11,12]

Further to this controversy, the present clinico-radiological comparative study was conducted to assess and compare the functional and radiological results of short and long proximal femur nails in patients with pertrochanteric femur fracture with the aim that these nails would be used in patient-specific fashion, based on the evidence.With this in mind, the present clinico-radiological comparative study was conducted to assess and compare the functional and radiological results of short and long proximal femur nails in patients with pertrochanteric femur fracture, with the objective of using these nails patient-specifically, according to the evidence.

Materials and Methods

Study Design: This is a prospective randomized comparative clinico-radiological study designed to evaluate differences between functional and radiological outcome of patients treated with Short Proximal Femoral Nail (PFN) and Long Proximal Femoral Nail (PFN). The study was longitudinal and had a 12 month follow-up period. Selection bias was minimized and comparability maximized between the intervention groups by random allocation.

Study Setting: The study was done in the Department of Orthopaedics of a tertiary care teaching hospital with advanced trauma care facilities, well equipped special orthopedic operating thears, digital radiography and full physiotherapy facilities. The institution sees high numbers of trauma patients and is a perfect place to assess the results of surgery for proximal femur fractures.

Study Duration: This study lasted for a period of one year and six months. Patient recruitment and enrolment was conducted for the first 6 months. All participants were then followed after surgery for at least a year to evaluate the rate of fracture healing, functional outcomes and post-operative complications.

Study Population: The study population comprised patients presenting with pertrochanteric femur fractures to the Orthopaedics Department during the study period.

Inclusion Criteria

Patients fulfilling all of the following criteria were included:

- Age between 40 and 85 years.
- Skeletally mature individuals of either sex.
- Fresh closed pertrochanteric femur fractures presenting within three weeks of injury.
- Patients medically fit for surgery under spinal or combined spinal-epidural anesthesia.
- Patients willing to provide informed written consent.

Exclusion Criteria

Patients meeting any of the following criteria were excluded:

- Pathological fractures secondary to malignancy.
- Open fractures.
- Polytrauma patients with major associated injuries.
- Ipsilateral femoral shaft fractures.
- Old neglected or malunited fractures.
- Patients unwilling to participate or unable to comply with follow-up.

Sample Size Calculation

The sample size was calculated using standard statistical methodology for comparative studies.

Assumptions used were:

- Confidence level = 95%
- Expected success rate = 95%
- Margin of error = 5%
- Study power = 80%

Based on these assumptions, the minimum required sample size was calculated as 44 participants. Accordingly, 44 eligible patients were enrolled and randomized equally into two treatment groups.

Sampling Technique: Consecutive sampling was employed for patient recruitment. Eligible patients admitted during the study period were screened and invited to participate.

Randomization was performed using a sealed-envelope chit method. Allocation concealment was maintained by preparing sequentially numbered opaque envelopes containing treatment assignments.

Study Groups

Group A: Short PFN Group

Patients underwent fixation using a Short Proximal Femoral Nail with available lengths of:

- 170 mm
- 200 mm
- 240 mm

Group B: Long PFN Group

Patients underwent fixation using a Long Proximal Femoral Nail with lengths ranging from:

- 300 mm to 420 mm
- Incremental sizing at 20 mm intervals
- Standard radius of curvature: 1500 mm

Preoperative Assessment

A detailed evaluation was performed before surgery, including:

Clinical Assessment

- Detailed history of injury
- Mode of trauma
- Side involved
- Comorbid conditions
- Physical examination

Laboratory Investigations

- Complete blood count
- Blood glucose profile
- Renal function tests
- Liver function tests
- Coagulation profile
- Blood grouping and cross-matching

Radiological Assessment

- Anteroposterior pelvis radiograph
- AP and lateral views of affected hip
- Fracture classification according to AO/OTA system

Surgical Procedure

All surgeries were performed under image intensifier guidance by experienced orthopedic surgeons.

Operative Steps

1. Patient positioned supine on fracture table.
2. Closed reduction achieved under fluoroscopic guidance.
3. Standard entry point established through the tip of greater trochanter.
4. Guide wire insertion followed by reaming as required.
5. Appropriate nail selected according to randomization.
6. Proximal lag screw and antirotation screw inserted.
7. Distal locking performed.
8. Wound closure performed in layers.

Postoperative Protocol

All patients received standardized postoperative care.

Early Rehabilitation

- Sitting up in bed from postoperative day 2.
- Static quadriceps exercises.
- Ankle pump exercises.
- Knee mobilization exercises.

Ambulation

- Non-weight-bearing ambulation with walker initiated from second postoperative day.
- Progressive weight-bearing based on radiological healing and fracture stability.

Wound Care

- Wound inspection on postoperative day 2.
- Suture removal on postoperative day 14.

Outcome Measures

Primary Outcome

Functional Outcome

Measured using the Harris Hip Score (HHS), evaluating:

- Pain
- Function
- Activities of daily living
- Gait
- Range of motion
- Absence of deformity

Secondary Outcome

Radiological Union

Union was assessed using serial radiographs based on:

- Bridging callus formation
- Obliteration of fracture line
- Cortical continuity
- Absence of implant failure

Follow-Up Schedule

Patients were reviewed at:

- 6 weeks
- 3 months
- 6 months
- 12 months

At every follow-up:

- Clinical examination performed
- Harris Hip Score recorded
- AP and lateral radiographs obtained

Data Collection

A structured Case Record Form (CRF) was used for systematic data collection.

Data recorded included:

Demographic Variables

- Age
- Gender
- Side affected

Clinical Variables

- Mechanism of injury
- Fracture classification
- Comorbidities

Operative Variables

- Duration of surgery
- Blood loss

Outcome Variables

- Hospital stay
- Time to union
- Functional score
- Complications

Statistical Analysis: Data were entered into Microsoft Excel and analyzed using appropriate statistical software.

Descriptive Statistics

- Mean ± Standard Deviation
- Frequency
- Percentage

Inferential Statistics

- Student's t-test for continuous variables.
- Chi-square test for categorical variables.
- Fisher's exact test where applicable.

A p-value <0.05 was considered statistically significant.

Ethical Considerations: Ethical approval was obtained from the Institutional Ethics Committee before initiation of the study.

The following ethical principles were maintained:

- Written informed consent obtained from all participants.
- Confidentiality of patient information ensured.
- Voluntary participation emphasized.
- Right to withdraw at any stage without affecting treatment.
- Compliance with the Declaration of Helsinki guidelines.
- No additional financial burden imposed on study participants.

RESULTS

A total of 44 patients with pertrochanteric femur fractures were included in this prospective comparative study. Twenty-two patients underwent fixation with Short Proximal Femoral Nail (PFN), while twenty-two patients were treated with Long PFN. All patients completed the follow-up period and were available for final clinical and radiological assessment.

Table 1: Baseline Demographic and Clinical Characteristics of Patients (n=44)

Variable	Frequency (n)	Percentage (%)
Female	27	61.4
Male	17	38.6
Age ≥70 years	22	50.0
Age 60–69 years	14	31.8
Age 50–59 years	8	18.2
Fall from standing height	36	81.8
AO 31-A1	15	34.1
AO 31-A2	23	52.3
AO 31-A3	6	13.6
Hypertension	32	72.7
Osteoporosis	40	90.9

The study population predominantly consisted of elderly osteoporotic females. Half of the participants were older than 70 years, and more than 90% had osteoporosis. The majority of fractures resulted from low-energy falls, emphasizing the importance of bone fragility as a causative factor. AO 31-A2 fractures represented over half of all fractures, indicating a predominance of unstable fracture patterns.

Table 2: Comparison of Operative Parameters Between Short PFN and Long PFN Groups

Operative Parameter	Short PFN (n=22) Mean ± SD	Long PFN (n=22) Mean ± SD	p-value
Surgery Duration (minutes)	69.55 ± 5.02	103.55 ± 5.72	<0.001*
Estimated Blood Loss (ml)	147.23 ± 7.70	182.00 ± 9.80	<0.001*
Fluoroscopy Time (seconds)	43.55 ± 4.49	61.59 ± 5.30	<0.001*

Comparison of operative parameters revealed statistically significant differences between the two treatment groups. The mean duration of surgery was significantly lower in the Short PFN group (69.55 ± 5.02 minutes) compared with the Long PFN group (103.55 ± 5.72 minutes) (p<0.001). Similarly, mean intraoperative blood loss was significantly lower in patients treated with Short PFN (147.23 ± 7.70 ml) than those treated with Long PFN (182.00 ± 9.80 ml) (p<0.001). Fluoroscopy exposure time was also significantly reduced in the Short PFN group (43.55 ± 4.49 seconds) compared with the Long PFN group (61.59 ± 5.30 seconds) (p<0.001). Overall, patients treated with Short PFN experienced approximately 33% shorter operative duration, 19% less blood loss, and 29% lower fluoroscopy exposure, indicating significantly greater perioperative efficiency compared with Long PFN fixation.

Table 3: Comparison of Radiological Outcomes Between Short PFN and Long PFN Groups

Radiological Parameter	Short PFN (n=22)	Long PFN (n=22)	p-value
Time to Union (weeks)	15.50 ± 0.51	14.41 ± 0.50	<0.001*
Union Achieved, n (%)	22 (100.0%)	22 (100.0%)	NS
Optimal Screw Position (Center-Center), n (%)	22 (100.0%)	22 (100.0%)	NS
Varus Collapse, n (%)	0 (0.0%)	0 (0.0%)	NS
Screw Cut-Out, n (%)	0 (0.0%)	0 (0.0%)	NS
Implant Failure, n (%)	0 (0.0%)	0 (0.0%)	NS
Loss of Reduction, n (%)	0 (0.0%)	0 (0.0%)	NS

Radiological assessment revealed excellent fracture healing in both treatment groups. All fractures achieved complete union, resulting in a 100% union rate in both the Short PFN and Long PFN groups. The mean time to union was significantly shorter in the Long PFN group (14.41 ± 0.50 weeks) compared with the Short PFN group (15.50 ± 0.51 weeks) ($p<0.001$). However, the absolute difference of approximately one week is unlikely to be clinically significant, as all fractures united within 14–16 weeks. Optimal screw placement was achieved in all patients, and no cases of varus collapse, screw cut-out, implant failure, or loss of reduction were observed. These findings indicate that both implant designs provide excellent radiological stability and reliable fracture union.

Table 4: Comparison of Functional Outcomes and Complications

Variable	Short PFN n (%)	Long PFN n (%)	p-value
Excellent HHS	22 (100.0%)	20 (90.9%)	0.488
Good HHS	0 (0.0%)	2 (9.1%)	0.488
Mean HHS	90.77 ± 0.81	91.41 ± 2.34	0.236
Mild thigh pain	0 (0.0%)	2 (9.1%)	0.488
Implant failure	0 (0.0%)	0 (0.0%)	NS
Nonunion	0 (0.0%)	0 (0.0%)	NS

Functional outcomes were excellent in both groups. All patients in the Short PFN group achieved excellent Harris Hip Score outcomes, while 90.9% of patients in the Long PFN group had excellent outcomes and 9.1% had good outcomes. The difference was not statistically significant ($p=0.488$). Mean Harris Hip Score was also comparable between groups ($p=0.236$). Mild thigh pain was reported only in 2 patients in the Long PFN group, but this difference was not statistically significant. No implant failure or nonunion was observed in either group.

Overall, the findings of this study demonstrate that Short PFN offers significant perioperative advantages, including shorter operative time, reduced blood loss, and lower fluoroscopy exposure, whereas Long PFN may provide marginally earlier radiological union. Nevertheless, both implants achieved comparable functional outcomes and 100% fracture union rates.

Discussion

Pertrochanteric femur fractures are a major orthopedic problem due to their rising prevalence in elderly osteoporotic patients and high mortality and morbidity rates associated with them. Main goals of modern management are to obtain stable fixation, early mobilization and recovery of pre-trauma function level. Minimally invasive and biomechanically superior, intramedullary fixation devices as the Proximal Femoral Nail (PFN) have become the preferred method of treatment. This study compared the functional and radiological results of Short PFN versus Long PFN for 44 patients with pertrochanteric femur fractures.

The demographic profile observed in the present study showed a predominance of elderly female patients. Females constituted 61.4% of the study population, while half of all patients were aged 70 years or older. These findings are consistent with the epidemiological observations reported by Johnell and Kanis, who demonstrated that hip fractures occur predominantly in elderly women due to postmenopausal osteoporosis and declining bone mineral density.[1] Likewise, Cummings et al. reported that increasing age and osteoporosis are major predictors of fragility fractures involving the proximal femur.[2]

The mechanism of injury in the present study further supports this observation, as 81.8% of fractures resulted from simple falls from standing height. Similar findings have been reported by Parker and Handoll, who noted that most extracapsular hip fractures occur following low-energy trauma in elderly osteoporotic patients.[3] The high prevalence of osteoporosis observed in our study (90.9%) reinforces the importance of bone fragility in the pathogenesis of pertrochanteric fractures.

The majority of fractures in the present study were classified as AO 31-A2 (52.3%), indicating a predominance of unstable fracture patterns. The introduction of intramedullary implants like PFN was designed to overcome these problems by offering greater biomechanical stability and to limit bending stress when compared to extramedullary implants.[5,6]

This is one of the most significant results of the current series that the use of Short PFN significantly reduces the time required for the operation. The mean surgical time was 69.55 minutes in the Short PFN group and 103.55 minutes in the Long PFN group ($p<0.001$). Boone et al. found significantly shorter operative time for short cephalomedullary nails due to ease of insertion and fewer distal locking requirements, as well as an increased operative time for long nails for increased exposure and fluoroscopic guidance and instrumentation requirements.[6] Kleweno et al. showed that the use of long nails requires more fluoroscopic guidance, instrumentation, and more surgical exposure, along with a longer time to insert the nails into the bone, requiring more operative time.[7]

The estimated blood loss in the Short PFN group (147.23 ml) was significantly lower than that in the Long PFN group (182.00 ml). Similarly, Hou et al. found that shorter implants had fewer cases of blood loss, which they believed was due to the shorter duration of the operation and less medullary instrumentation required for shorter implants.[8] This benefit is especially important for older patients who often suffer from multiple comorbidities and limited physiological reserve.

The time needed for fluoroscopy was also significantly shorter for the Short PFN group. Fluoroscopic exposure is likely to be greater because it is technically challenging to prepare the distal locking hole and place nails, especially with Long PFN. Results for the short and long cephalomedullary nails are similar and were found by Shannon et al. in their prospective study.[9]

The surgical and radiological results of the present study were excellent and the 100% union rate at both groups was reached. The conclusions obtained from the present study suggest that Long PFN showed a slightly early fracture union, but the absolute difference was approximately one week and might not be clinically important. Another group (Frisch et al.), reported similar rates of union between the short and long cephalomedullary nails, with the conclusion that implant length had no significant effect on fracture healing when a stable fixation is achieved.[10] Hong et al. also found no significant difference in the union rates between these two implants for osteoporotic pertrochanteric fractures.[11]

Functional outcomes were excellent in both treatment groups, with the Harris Hip Score. There was no statistically significant difference between the scores of PFN-short and PFN-long scores (p=0.236) and Mean HHS scores were more than 90 points in both groups. These results support those of Tan et al., who found no difference in functional parameters between short and long cephalomedullary devices for the same amount of reduction and fixation over long-term follow-up,[12] and those of Hantouly et al., who determined that the length of the implant did not affect final hip function if adequate reduction and fixation were obtained.[13]

Complications were very low in the present study. There were no cases of screw cut-out, varus collapse, implant failure, Z-effect, reverse Z-effect, or nonunion. The tip to apex distance of 17.48 mm was within the acceptable limits as previously shown by Baumgaertner et al who found that lower tip to apex distances significantly reduced the rate of fixation failure, thus they believe the absence of major complications may be attributed to carefully performed surgery, reduction, and positioning of the implants.

One caveat of the present study was the way the two treatment groups were balanced at baseline in terms of age, gender, fracture type and hypertension. Although the patients had been randomized, Long PFN patients were generally older and are more likely to have a complex fracture configuration. The differences between them might have affected some outcome measures and should be taken into consideration when interpreting the findings.

In conclusion, this study established that both Short PFN and Long PFN proved to be a good surgical option for PFN in fractures of the hip, especially the pertrochanteric femur, in terms of clinical and radiologic outcomes. While Long PFN can be beneficial in specific unstable fracture patterns that require extra biomechanical support, some perioperative benefits of short PFN include decreased length of operation, blood loss and radiation exposure. Hence, the choice of implant should be according to the fracture morphology the patient has, patient characteristics and the surgeon's preference.

Conclusion

Both Short PFN and Long PFN are good treatment options for pertrochanteric femur fracture, resulting in good fracture union and restoration of function. Short PFN provides obvious benefits during the operation, such as shortening the operation time, reducing blood loss, and reducing the exposure of X-ray during the operation. Long PFN may be useful in unstable fracture patterns, and showed early radiological union of 1 to 2 weeks. But the difference between the two groups was not significant in the aspects of final outcome and union. Thus, the type of implant must be individualised dependent on fracture configuration, bone quality, patient comorbidities and surgical experience.

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Conflicts of interest

There are no conflicts of interest.

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