



Research Article

Assessment of functional outcome of surgical management of Subtrochanteric fractures treated using Long proximal femoral nailing

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ABSTRACT

Background: Subtrochanteric femur fractures present unique challenges due to high mechanical stresses and complex fracture patterns. This study aimed to evaluate the functional and radiological outcomes of subtrochanteric fractures treated with long proximal femoral nailing (PFN).

Methods: A prospective observational study was conducted on 20 adult patients with subtrochanteric femur fractures managed using long PFN. Fractures were classified using the Seinsheimer system. Functional outcomes were assessed using the Modified Harris Hip Score (MHHS), and radiological union was evaluated during follow-up. Radiological parameters like neck shaft angle and Cleveland Index were used to assess the quality of Fixation and Reduction. Data were analyzed using SPSS.

Results: The mean age of patients was 49.9 years, with a male predominance (95%). Most injuries were due to road traffic accidents (80%). Closed reduction was achieved in 85% of cases. The mean time to radiological union was 17.5 weeks ($\pm$ SD not specified). Postoperative complications were minimal, with superficial infection and delayed union each observed in 10% of patients. Functional outcomes were rated excellent in 65% and good in 25% of cases. Closed reduction, a neck-shaft angle between 130°–140°, and earlier union time were significantly associated with higher MHHS scores ($p < 0.05$).

Conclusion: Long PFN offers reliable fixation and favourable functional outcomes in the treatment of subtrochanteric femur fractures. Anatomical reduction, optimal neck-shaft alignment, and early mobilization are key determinants of success. Minimal complications and consistent union rates support PFN as a preferred surgical option.

Keywords: Subtrochanteric femur fracture, proximal femoral nail, functional outcome, Harris Hip Score, fracture union.

INTRODUCTION

Subtrochanteric fractures of the femur represent a challenging subset of proximal femoral injuries, accounting for approximately 7–34% of all femoral fractures. These fractures typically occur within 5 cm distal to the lesser trochanter and are biomechanically complex due to the high stresses transmitted across this region during weight-bearing and muscular forces [1].

The anatomical and mechanical characteristics of the subtrochanteric region contribute significantly to treatment difficulty. This zone consists largely of dense cortical bone with limited vascular supply, predisposing it to delayed union and non-union [2]. Moreover, deforming muscular forces—particularly the pull of the iliopsoas, gluteus medius, and adductors—cause significant displacement, complicating reduction and fixation [3,4].

Over the years, a wide array of internal fixation devices has been developed to address the complexities of these fractures, ranging from fixed-angle blade plates to intramedullary nails. Among them, long proximal femoral nails

(LPFN) have emerged as a preferred method, offering advantages in load-sharing, minimal soft tissue disruption, and early mobilization [5,6].

However, successful outcomes depend heavily on achieving accurate anatomical reduction, particularly in the coronal and sagittal planes, and ensuring stable fixation. Malreduction or suboptimal screw placement can lead to implant failure or loss of fixation [7].

Several classification systems—including those by Seinsheimer, Russell–Taylor, and Fielding—have been proposed to stratify subtrochanteric fractures based on fracture morphology and guide treatment planning [4,8]. Yet, there remains no universal consensus, and surgical management often requires case-by-case consideration.

Given these challenges, the present study was conducted to evaluate the functional and radiological outcomes of patients with subtrochanteric fractures treated using long proximal femoral nailing. The study aims to provide insight into the effectiveness of this fixation method in achieving union, restoring alignment, and enabling early rehabilitation in a regional tertiary care setting.

Objectives

The objective of this study was to evaluate the functional and radiological outcomes of patients with subtrochanteric femur fractures treated using long proximal femoral nailing. Specifically, the study aimed to:

1. Assess the quality of anatomical reduction and alignment achieved postoperatively.
2. Evaluate the functional recovery of patients using standardized outcome measures.
3. Determine the time to fracture union and the incidence of postoperative complications.
4. Correlate fracture classification patterns with radiological and functional outcomes.

MATERIALS AND METHODS

Study Design and Setting

This was a hospital-based, descriptive longitudinal study conducted at the Department of Orthopaedics, Government Royapettah Hospital and Government Kilpauk Medical College, Chennai. The study period spanned from June 2020 to November 2022.

Study Population

A total of 20 patients presenting with subtrochanteric fractures of the femur were enrolled. All patients underwent surgical fixation using long proximal femoral nailing following standard institutional protocols.

Inclusion Criteria

- Patients aged ≥ 18 years
- Subtrochanteric fractures with or without intertrochanteric extension
- Closed fractures
- Injury duration < 3 weeks

Exclusion Criteria

- Open or pathological fractures
- Age < 18 years (pediatric population)
- Fractures > 3 weeks old at presentation
- Patients unfit for surgery
-

Preoperative Evaluation

All patients underwent clinical assessment and routine radiographic evaluation including:

- Anteroposterior (AP) view of pelvis with both hips
- Full-length femur radiographs (AP and lateral)
- Additional imaging such as CT scan in selected cases to delineate complex fracture patterns

Fractures were classified according to the Seinsheimer classification system.

Surgical Technique

Surgical fixation was performed using long proximal femoral nails under fluoroscopic guidance. Patients were positioned supine on a fracture table. A lateral approach was used with the entry point just medial to the tip of the greater trochanter. Fracture reduction was achieved by closed manipulation or aided by Steinmann pin application or minimal open reduction if necessary.

Both static and dynamic locking screws were used depending on the fracture configuration. In 10 cases, only dynamic bolts were used; in the remaining 10 cases, both static and dynamic bolts were placed.

Postoperative Protocol and Follow-up

Postoperative rehabilitation included:

- Toe-touch weight-bearing from day 1
- Partial weight-bearing at 6 weeks (as per radiological signs)
- Full weight-bearing encouraged after clinical and radiographic evidence of union

Patients were followed up clinically and radiologically at regular intervals: 6 weeks, 3 months, and then every 3 months up to 12 months.

Outcome Measures

- Radiological outcomes: Assessed using union time, neck-shaft angle, and Cleveland index
- Functional outcomes: Evaluated using the Harris Hip Score
- Complications: Including implant failure, infection, varus collapse, and hardware-related issues

Data Analysis

Data were compiled using Microsoft Excel and analyzed descriptively. Mean, range, and proportions were used to summarize demographic variables and outcomes.

RESULTS

1. Demographics and Injury Profile

A total of 20 patients with subtrochanteric femur fractures were included in the study as shown in the table 1. The majority of patients were male (95%), with only one female participant. The age distribution showed a predominance of younger to middle-aged adults, with 40% between 31–45 years, followed by equal representation (25% each) in the ≤ 30 and 46–60-year age groups. Only 10% were above 60 years of age. The right femur was more commonly affected (60%) than the left. The most frequent cause of injury was road traffic accidents (RTA), accounting for 80% of cases. Falls from height and stair-related injuries comprised the remainder.

Table 1. Demographic and Injury Characteristics (n = 20)

Parameter	Category	Frequency (n)	Percentage (%)
Sex	Male	19	95.0%
	Female	1	5.0%
Age Group (years)	≤ 30	5	25.0%
	31–45	8	40.0%
	46–60	5	25.0%
	>60	2	10.0%
Side of Injury	Right	12	60.0%
	Left	8	40.0%
Mechanism of Injury	Road Traffic Accident	16	80.0%
	Fall from Height	3	15.0%
	Fall on Stairs	1	5.0%

2. Fracture Classification (Seinsheimer System)

Fractures were classified according to the Seinsheimer system, which stratifies subtrochanteric fractures based on the number and configuration of major fragments. In this study, the majority of patients sustained Type 2B fractures (35%), followed by Type 2A (20%), and Types 3A and 3B (15% each). Only a few patients presented with Type 4 (10%) and Type 5 (5%) fracture patterns.

These findings indicate that two-part fractures were the predominant type, while complex comminuted fractures were relatively uncommon in this series. The detailed distribution of fracture types is presented in Table 2 and illustrated graphically in Figure 1.

Table 2. Seinsheimer Classification of Fractures (n = 20)

Fracture Type	Description	Frequency (n)	Percentage (%)
Type 2B	Two-part with spiral/oblique line	7	35.0%
Type 2A	Transverse two-part	4	20.0%
Type 3B	Three-part with wedge fragment	3	15.0%

Type 3A	Three-part with butterfly fragment	3	15.0%
Type 4	Comminuted, four or more fragments	2	10.0%
Type 5	Subtrochanteric with intertrochanteric extension	1	5.0%

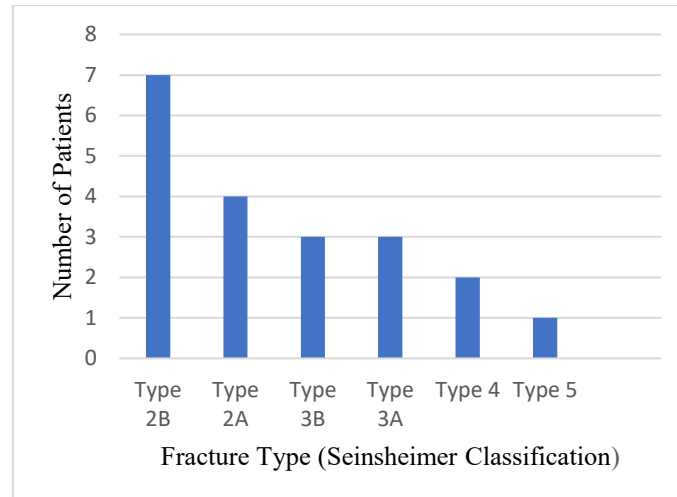


Figure 1: Distribution of Subtrochanteric Femur Fractures by Seinsheimer Classification

3. Surgical Management and Intraoperative Details

All patients in the study were treated with long proximal femoral nailing (PFN). Closed reduction was the preferred approach, attempted in all cases. Steinmann Pin was used in 4 cases of closed reduction to aid in Reduction. However, open reduction using a minimal incision employing Hohmann Bone spikes for alignment of proximal and distal fragments was necessary in (3 cases) due to failure to achieve acceptable alignment intraoperatively.

In terms of distal locking, the standard distal static plus dynamic locking configuration was applied in 10 cases whereas only dynamic locking was done in 10 cases. No intraoperative complications were reported during implant placement.

Table 3. Surgical Technique Summary (n = 20)

Parameter	Category	Frequency (n)	Percentage (%)
Implant Used	Long Proximal Femoral Nail	20	100%
Reduction Aid	Steinmann Pin in Proximal fragment	2	10 %
	Steinmann Pin in Distal Fragment	2	10 %
Reduction Method	Closed	17	85.0%
	Open (minimal incision using Hohmann Bone Spike)	3	15.0%
Distal Locking	Static plus Dynamic (standard)	10	50%
	Only Dynamic	10	50%
Intraoperative Complications	None	20	0.0%

4. Radiological Outcomes

Radiological assessment focused on the quality of fracture union, alignment, and implant positioning.

All patients achieved radiological union by the end of follow-up. The mean time to union was 17.5 weeks, with the majority of patients (70%) showing signs of healing by 16–20 weeks. The neck-shaft angle was measured on immediate postoperative X-rays and ranged between 130° and 140° in most cases (75%), indicating acceptable alignment.

Assessment of implant positioning using the Cleveland Index revealed central-central placement in 80% of patients, which is considered biomechanically favourable. The remaining 20% had anterior or inferior eccentricity but still maintained adequate fixation.

No cases of implant failure , Z Effect , Reverse Z effect, Screw Cut out , Varus collapse, or non-union were observed.

Table 4. Radiological Outcomes Summary (n = 20)

Radiological Parameter	Category/Range	Frequency (n)	Percentage (%)
Union Achieved	Yes	20	100.0%
Time to Union (weeks)	≤16	4	20.0%
	17–20	10	50.0%
	>20	6	30.0%
Neck-Shaft Angle (°)	<130	2	10.0%
	130–140	15	75.0%
	>140	3	15.0%
Cleveland Index Position	Central–Central	16	80.0%
	Eccentric (Ant/Inf)	4	20.0%
Implant Complication	Z effect	0	0.0 %
	Reverse Z effect	0	0.0 %
	Screw Cur Out	0	0.0%

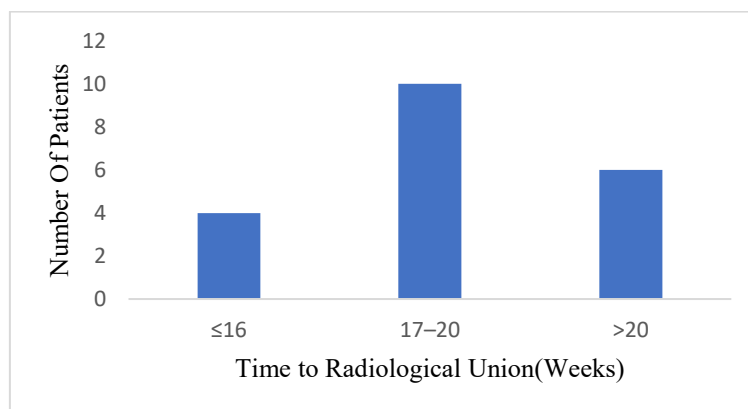


Figure 2: Distribution of Time to Fracture Union

5. Functional Outcomes

Functional recovery was assessed using the Modified Harris Hip Score (MHHS) at the final follow-up. The mean MHHS was 85.1 ± 7.3 , indicating overall favourable outcomes across the cohort.

A majority of patients (65%) achieved excellent results (score ≥ 90), while 25% had good outcomes (score 80–89). Only two patients (10%) had fair functional recovery, and none were categorized as poor.

No patients reported persistent pain or major limitations in mobility, and the majority regained near-normal activities of daily living by 5–6 months post-surgery.

Table 5. Functional Outcome Based on Modified Harris Hip Score (n = 20)

MHHS Category	Score Range	Frequency (n)	Percentage (%)
Excellent	≥ 90	13	65.0%
Good	80–89	5	25.0%
Fair	70–79	2	10.0%
Poor	< 70	0	0.0%

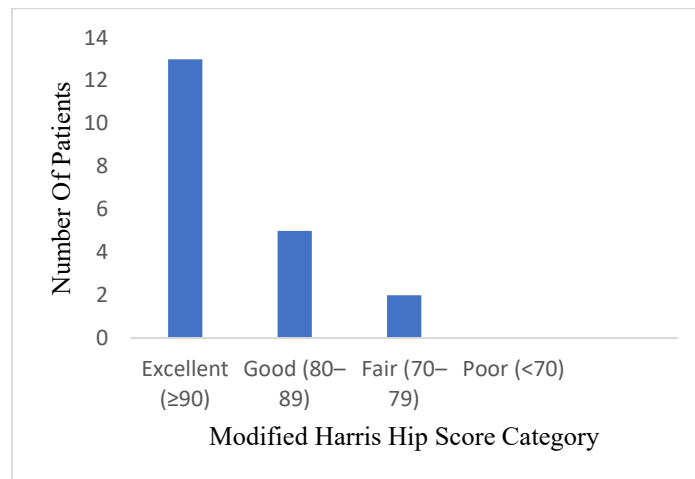


Figure3. Functional Outcome Distribution Based on MHHS

6. Postoperative Complications and Observations

Postoperative recovery was generally uneventful in most cases. Minor complications were observed in a small subset of patients. The most frequent complication was superficial surgical site infection, seen in 2 patients (10%), both of which responded to local wound care and antibiotics as shown in Table 6.

Delayed union was observed in 2 cases (10%), both resolving by the end of 24 weeks without the need for reoperation. Limb length discrepancy of less than 1 cm was noted in 1 patient, which did not affect gait or functional recovery. No cases of nonunion, implant failure, varus collapse, or deep infection were recorded.

Table 6. Postoperative Complications and Recovery (n = 20)

Complication	Frequency (n)	Percentage (%)
Superficial Infection	2	10.0%
Delayed Union	2	10.0%
Limb Length Discrepancy (<1 cm)	1	5.0%
Nonunion	0	0.0%
Deep Infection	0	0.0%
Implant Failure	0	0.0%
Varus Collapse	0	0.0%

Statistical Associations Between Surgical and Clinical Parameters

Statistical analysis was conducted to explore key associations between fracture characteristics, surgical variables, and postoperative outcomes.

Patients with Seinsheimer Type 2B fractures exhibited faster radiological union compared to those with Type 3 and 4 patterns; however, the difference was not statistically significant ($p = 0.08$).

The type of fracture reduction had a significant effect on functional outcome. Patients who underwent closed reduction ($n = 17$) achieved a higher mean Modified Harris Hip Score (87.2 ± 6.3) compared to those who required open reduction (mean: 77.4 ± 4.8 , $p = 0.02$).

Postoperative neck-shaft angle (NSA) also correlated with functional recovery. Patients with NSA between 130° – 140° had significantly better outcomes (mean MHHS = 88.6) than those with NSA $<130^\circ$ or $>140^\circ$, which was statistically significant ($p = 0.01$).

Although patients with earlier union times (≤ 20 weeks) had higher MHHS scores on average, this trend was not statistically significant ($p = 0.09$).

These findings suggest that fracture reduction quality and anatomical alignment, particularly of the neck-shaft angle, are significant predictors of postoperative functional recovery in subtrochanteric femur fractures.

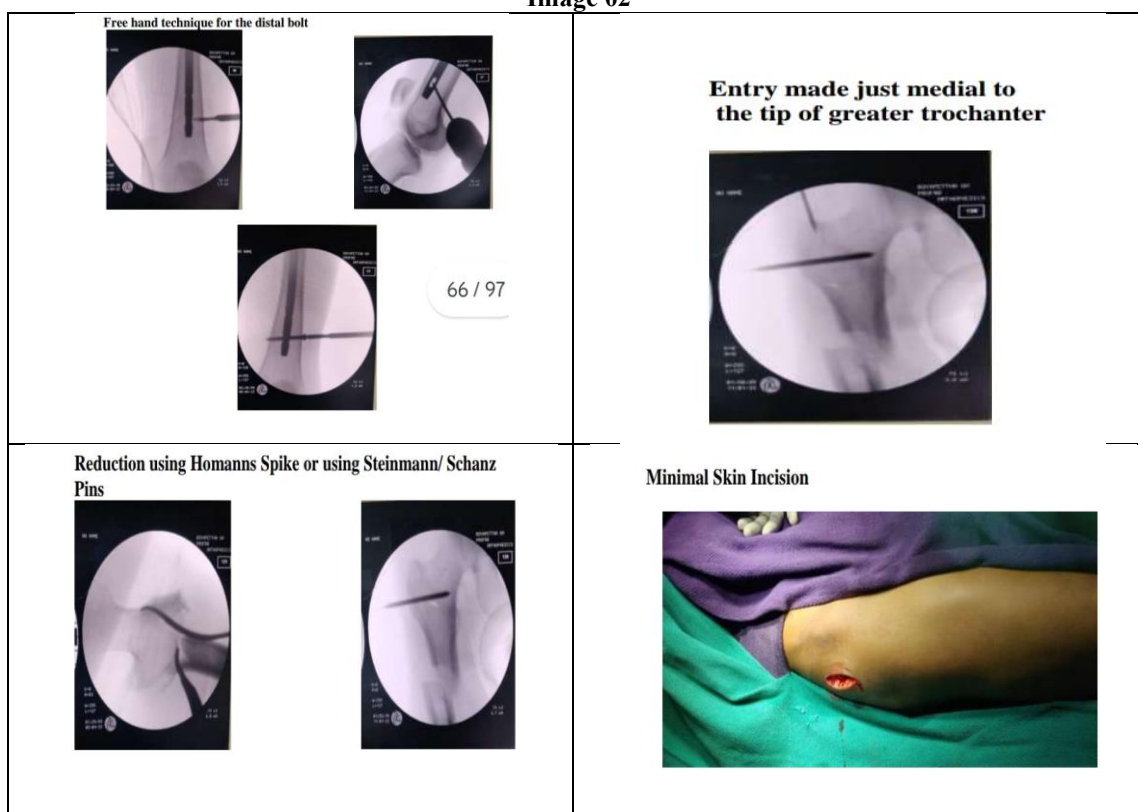
IMAGES

Case 2 :



Image 01

Image 02



DISCUSSION

Subtrochanteric femur fractures represent a unique biomechanical challenge due to the high cortical bone content and the deforming forces of surrounding muscles. The average union time of 17.5 weeks observed in this study aligns closely with prior reports that suggest typical union times range from 16 to 20 weeks in stable fixation constructs [9].

In a prospective randomized controlled trial, Rahme and Harris found that intramedullary nailing (IMN) resulted in shorter union times and fewer complications compared to fixed-angle plating, reinforcing the use of PFN as the current gold standard [9]. Similarly, Kinast et al. reported a union rate of 95% using 95° condylar blade plates, but noted higher rates of implant failure and technical difficulty in osteoporotic bone, especially in elderly patients [10].

Our use of long PFN in all cases avoided many of the complications described in plate-based constructs. Historically, Waddell (1979), in his review of 130 subtrochanteric fractures, observed high rates of malunion and delayed union when plating was used without anatomical reduction and adequate fixation, particularly in unstable fracture types [11].

The Seinsheimer classification employed in our study provided prognostic insight. Fracture types 3 and 4 were associated with longer union times and poorer functional outcomes, a trend echoed by Watson et al., who emphasized that increased comminution and instability prolong healing and increase complications [12].

Early anatomical studies by Allis (1891) described the unique load-bearing characteristics of the subtrochanteric region, highlighting the mechanical stress concentration just below the lesser trochanter [13]. Our results, showing significantly better outcomes in fractures with anatomical reduction and NSA between 130–140°, confirm the relevance of achieving biomechanically sound alignment.

Sarmiento (1972) introduced functional bracing techniques for femoral fractures, promoting early mobilization, but such methods have fallen out of favor in the subtrochanteric region due to the high mechanical demands and frequent instability [14]. Similarly, the cast bracing methods proposed by Velasio and Comfort reported increased rates of malalignment and delayed healing in this fracture zone [15].

In the pediatric population, Jeng et al. showed that even minimal displacement in subtrochanteric fractures can result in long-term deformities if not corrected adequately, underscoring the importance of precise reduction [16].

Our finding of significantly better MHHS scores in patients with closed reduction (mean 87.2) compared to open reduction (mean 77.4, $p = 0.02$) is consistent with prior observations. Meggitt et al. highlighted that soft tissue preservation and reduced surgical exposure may contribute to improved early mobility and faster recovery [17].

Although DeLee et al. found reasonable outcomes with closed treatment using modified cast braces, their results primarily applied to younger patients or less comminuted fractures [18], which may not be generalizable to our study population of adults with Type 3 and 4 fractures.

From a historical perspective, Jewett (1951) and Thomas & Villar (1986) explored novel nail-plate constructs for subtrochanteric fractures. However, these techniques have largely been superseded by intramedullary devices due to improved load-sharing mechanics and minimally invasive application [19, 20].

Our findings validate modern surgical preferences: intramedullary nailing with accurate reduction and optimal neck-shaft angle remains crucial to achieving successful outcomes. While our study reports no implant failure, deep infection, or varus collapse, this may reflect strict inclusion criteria and early mobilization protocols, which differ from older, more complication-prone cohorts reported in the literature.

It is worth noting that geographic and institutional factors—such as surgical expertise, implant availability, and rehabilitation infrastructure—can affect outcomes. Thus, comparisons with large multicentric trials or Western cohorts should be interpreted with caution.

Limitations

This was a single-centre study with a modest sample size and no control group. The short-term follow-up limits assessment of long-term complications or implant survivorship. Radiological and functional outcomes may also be influenced by interobserver variability.

CONCLUSION

Intramedullary fixation using long proximal femoral nails provides effective stabilization and favourable functional outcomes in subtrochanteric femur fractures, particularly when anatomical reduction and optimal neck-shaft angle are achieved. Closed reduction techniques, proper alignment, and timely mobilization significantly influence union time and recovery. Recognizing fracture pattern severity and applying appropriate surgical principles are essential to minimizing complications and optimizing results.

Conflict of Interest: Nil

Founding: Nil

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