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Original Research Article

Retrospective Evaluation of Functional and Radiological Outcomes in Surgically Treated Intertrochanteric Femur Fractures

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Abstract:

Background: Intertrochanteric femur fractures are common in the elderly and pose challenges due to osteoporotic bone and comorbidities. Stable fixation enabling early mobilization is crucial to prevent complications.

Aim: To retrospectively evaluate the functional and radiological outcomes in patients surgically treated for intertrochanteric femur fractures, focusing on Tip–Apex Distance (TAD), fracture reduction quality, and post-operative function.

Methodology: This hospital-based retrospective study included 80 patients with Boyd and Griffin type 1 and 2 intertrochanteric fractures treated with short proximal femoral nails at Nalanda Medical College and Hospital, Patna, between March 2025 and October 2025. Post-operative radiographs were analyzed for TAD, fracture reduction, and complications. Functional outcomes were assessed using the Harris Hip Score (HHS) at six months.

Results: Most patients were males aged 60–69 years. Type 2 fractures were most prevalent (65%). Mean post-operative TAD was 22.8 ± 3.1 mm, with 81.3% achieving ≤25 mm. At six months, 77.5% achieved good to excellent HHS. Post-operative complications were low, with screw cut-out in 6.3% and delayed union in 7.5% of cases.

Conclusion: Surgical fixation using PFN provides favorable functional and radiological outcomes when key principles, including optimal TAD and fracture reduction, are adhered to. Early mobilization and meticulous technique are critical for minimizing complications.

Keywords: Intertrochanteric fracture, Proximal femoral nail, Tip–Apex Distance, Harris Hip Score, Functional outcome, Screw cut-out.

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Introduction

Intertrochanteric fractures of the femur represent one of the most common orthopedic injuries which doctors treat throughout their daily work especially among elderly patients who suffer from osteoporosis. The fractures serve as a major component of hip fractures which medical professionals find difficult to treat because of challenges presented by insufficient bone strength and existing medical conditions and the requirement to start patient movement early to stop health issues from developing [1]. The main treatment objective for intertrochanteric fractures requires medical professionals to establish a stable bone connection which enables patients to start walking early while maintaining their pre-injury abilities and reducing the risks of complications which result from extended bed rest.

The internal fixation is not new in its application in the treatment of intertrochanteric fractures as it offers immediate relief of pain, quick mobilization and rehabilitation and also independent living [2] when it comes to treating the intertrochanteric fractures. One of the fixation techniques, the proximal femur nail (PFN) has transformed the treatment of such fractures [3]. PFN provides enhanced biomechanical stability, especially where the fracture pattern is unstable because of its intramedullary positioning, which provides an opportunity to share loads and high resistance to varus collapse and rotational deformity.

The best results of surgeries are based on the attainment of optimal fracture reduction and stable fixation [4]. The most important radiological parameters include support of the anterior-medial cortex, restoration of neck-shaft angle, and the tip-apex distance (TAD), that can be used to determine the success of internal fixation [5]. The depth and the location of

the lag screw in the neck and the femoral head is known as tip-apex distance and has been widely researched in the context of dynamic hip screws (DHS), and is thought to be a good indicator of screw cut-out. Screw cut-out, which is defined as the collapse of the angle between the neck-shaft and extrusion of the screw through the femoral head, is one of the most severe perioperative complications which result in re-operation under general anesthesia and has been reported as having an incidence of 1.9% to 3.2% [6].

Past research on DHS proved that cut-outs usually have a bimodal distribution associated with the difference in tip-apex distance, and it is necessary to place screws precisely. Positioning too near the subchondral bone which appears safe, may on the contrary, cause cut-out over the femur head. Although TAD is extensively investigated in DHS, a lack of literature assessing its association with functional outcomes in proximal femoral nail fixation is present [7]. This gap has prompted the need to carry out retrospective studies to determine the role of TAD and other surgical parameters in attaining optimal functional recovery.

The quality of reduction of the fracture, fixation stability, reduction of the calcar, and repair of varus defect, posterior sag, excessive internal rotation, and limb length imbalance are significant variables in the postoperative outcomes during surgery. All of these aspects affect restoration of anatomical positioning, loading, and early mobilization, which eventually determines radiological and functional recovery [8]. The restoration of these parameters is specifically significant in unstable fracture patterns, as an inadequate reduction in the latter may lead to mechanical failure, malunion, or even nonunion that adversely impact the mobility and quality of life of the patient after the operation.

With the growing popularity of intertrochanteric fractures, especially in older adults, it is becoming urgent to identify the correlation between surgical methodology, radiological aspects, and outcomes in terms of functionality. Post-surgical analyses give important insights on the actual results, and may be used to optimize surgical behavior to reduce complication and enhance patient-centered recovery. The present study seeks to retrospectively assess the functional and radiological outcome of patients who have undergone surgery to fix intertrochanteric fractures of the femur with specific attention to the relationship between the tip apex distance, quality of fracture reduction and the functional outcome after surgery.

Through the systematic evaluation of these outcome measures, the research aims at giving an indication of best practice in the orthopedic surgery of intertrochanteric fracture, and emphasizing factors that affect the success and functional restoration of the implants. The knowledge of these relations is important to minimize the likelihood of mechanical failure and to inform the process of the postoperative rehabilitation and enhance the overall quality of life of patients who have experience intertrochanteric fracture fixation.

Methodology

Study Design: This study was designed as a retrospective, hospital-based observational study aimed at evaluating the functional and radiological outcomes of surgically treated intertrochanteric femur fractures. The retrospective design allowed for the assessment of clinical and radiological parameters in patients who had already undergone surgical management, thereby facilitating an analysis of post-operative results, complications, and overall efficacy of the treatment.

Study Area: The study was conducted in the Department of Orthopedics, Nalanda Medical College and Hospital, Patna, Bihar, India.

Study Duration: The study duration was from March 2025 to October 2025.

Study Participants

Inclusion Criteria

- Patients diagnosed with intertrochanteric fractures of the femur classified as Boyd and Griffin type 1 and type 2.
- Patients who underwent surgical management with short proximal femoral nailing (PFN).
- Patients with complete post-operative radiographs available for both anteroposterior (AP) and lateral views.
- Patients aged 18 years and above, irrespective of gender.

Exclusion Criteria

- Open fractures of the femur.
- Patients with associated significant medical comorbidities that could interfere with fracture healing or functional assessment.
- Patients with Boyd and Griffin type 3 and type 4 intertrochanteric fractures.
- Cases with incomplete or missing radiological records.

Sample Size: A total of 80 patients meeting the inclusion and exclusion criteria were included in this study. The sample size was determined based on the availability of complete medical records and radiographs within the study period and the need to maintain statistical validity for outcome evaluation.

Procedure: The study was carried out by retrospectively reviewing the medical records of patients who had undergone surgical fixation of intertrochanteric femur fractures with short proximal femoral nails. Post-operative radiographs of the affected hip were

analyzed in both AP and lateral views. The Tip-Apex Distance (TAD) was calculated for each patient by measuring the distance from the tip of the lag screw to the apex of the femoral head in both projections. Intertrochanteric fractures were classified according to the Boyd and Griffin system: Type 1 fractures extended along the intertrochanteric line, Type 2 fractures were comminuted along the main fracture line with multiple secondary lines, Type 3 fractures extended to or distal to the lesser trochanter, and Type 4 fractures involved the trochanteric region and proximal shaft with fractures in at least two planes. Only Type 1 and Type 2 fractures were included in the analysis. Functional outcomes were assessed post-operatively using standard scoring systems, which included evaluation of hip mobility, weight-bearing status, and patient-reported pain levels. Any intraoperative or postoperative complications, such as screw cut-out, malalignment, or delayed union, were also documented.

Statistical Analysis: All data collected were entered into Microsoft Excel and analyzed using SPSS version 27.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics were used to summarize demographic variables, fracture classification, and post-operative outcomes, presented as mean ± standard deviation for continuous variables and percentages for categorical variables. The relationship between Tip-Apex Distance, fracture type, and functional outcomes was analyzed using correlation and regression analysis where applicable. Comparative analyses between groups were performed using the chi-square test or independent t-test, with a p-value of <0.05 considered statistically significant. This statistical approach allowed for a comprehensive evaluation of factors influencing both radiological and functional outcomes in patients undergoing PFN for intertrochanteric femur fractures".

Result

Table 1 shows the demographic characteristics of the 80 study participants. The majority of participants were aged 60–69 years (37.5%), followed by 50–59 years (22.5%) and 70–79 years (18.8%), while only 8.7% were aged 80 years or above, indicating that most fractures occurred in the sixth decade of life. Regarding gender distribution, males constituted a higher proportion (65%) compared to females (35%), suggesting male predominance in the study sample. In terms of the side of fracture, the right side was more commonly affected (57.5%) than the left side (42.5%). Overall, the data indicate that elderly males, particularly those in their 60s, formed the largest group of participants, with a slightly higher incidence of right-sided fractures.

Table 1: Demographic Characteristics of Study Participants (n = 80)

Variable	Frequency	Percentage (%)
Age (years)		
40–49	10	12.5
50–59	18	22.5
60–69	30	37.5
70–79	15	18.8
≥80	7	8.7
Gender		
Male	52	65
Female	28	35
Side of Fracture		
Right	46	57.5
Left	34	42.5

Table 2: Distribution of Intertrochanteric Fracture Types (Boyd and Griffin classification) shows the frequency and percentage distribution of fracture patterns among 80 patients. The majority of cases were classified as Type 2 fractures, accounting for 52 patients (65%), while Type 1 fractures were observed in 28 patients (35%). This indicates that Type 2 intertrochanteric fractures were more prevalent in the study population, representing nearly two-thirds of the total cases, whereas Type 1 fractures constituted just over one-third of the cases.

Table 2: Distribution of Intertrochanteric Fracture Types (Boyd and Griffin Classification)

Fracture Type	Frequency	Percentage (%)
Type 1	28	35
Type 2	52	65
Total	80	100

Table 3: Tip–Apex Distance (TAD) Post-Operatively shows the distribution of post-operative TAD among 80 patients. The majority of patients, 40 (50%), had a TAD between 20–25 mm, while 25

patients (31.3%) had a TAD <20 mm, and 15 patients (18.7%) recorded a TAD >25 mm. The overall mean TAD was 22.8 ± 3.1 mm, with values ranging from 15 to 28 mm. These findings indicate that most patients achieved a TAD within the clinically acceptable range (≤25 mm), suggesting satisfactory implant positioning in the majority of cases.

Table 3: Tip-Apex Distance (TAD) Post-Operatively				
TAD (mm)	**Frequency**	**Percentage (%)**	**Mean ± SD**	**Min–Max**
<20	25	31.3		
20–25	40	50	22.8 ± 3.1	15–28
>25	15	18.7		
Total	80	100	22.8 ± 3.1	15–28

Table 4 shows the functional outcome based on the Harris Hip Score (HHS) at 6 months among 80 patients. The majority of patients demonstrated favorable results, with 32 patients (40%) achieving a good outcome (HHS 80–89) and 30 patients (37.5%) attaining an excellent outcome (HHS 90–100). A smaller proportion had fair results, observed in 12 patients (15%) with scores between 70–79, while only 6 patients (7.5%) experienced poor outcomes with scores below 70. Overall, 77.5% of patients achieved good to excellent functional recovery at 6 months, indicating satisfactory postoperative hip function in most participants.

Table 4: Functional Outcome Based on Harris Hip Score (HHS) at 6 Months			
Outcome Category	**HHS Score Range**	**Frequency**	**Percentage (%)**
Excellent	90–100	30	37.5
Good	80–89	32	40
Fair	70–79	12	15
Poor	<70	6	7.5
Total	–	80	100

Table 5 shows the distribution of post-operative complications among the 80 patients studied. The majority of patients (60; 75%) experienced no complications, indicating a generally favorable surgical outcome. Among the reported complications, delayed union (>16 weeks) was the most common, observed in 6 patients (7.5%), followed by screw cut-out in 5 patients (6.3%) and malalignment (>5° varus/valgus) in 4 patients (5%). Superficial infection was noted in 3 patients (3.7%), while deep vein thrombosis was the least frequent complication, occurring in 2 patients (2.5%). Overall, the complication rates were relatively low, suggesting satisfactory post-operative recovery in most cases.

Table 5: Post-Operative Complications		
Complication	**Frequency**	**Percentage (%)**
Screw Cut-Out	5	6.3
Malalignment (>5° varus/valgus)	4	5
Delayed Union (>16 weeks)	6	7.5
Superficial Infection	3	3.7
Deep Vein Thrombosis	2	2.5
No Complications	60	75
Total	80	100

Discussion

The current research examined both functional outcomes and radiological results in elderly patients who received surgical treatment for intertrochanteric femur fractures through surgical fixation. Our demographic study showed that patients aged 60 to 69 years constituted the largest group while more men than women made up the patient population. This finding supports Balachandran et al. (2020) [9] , which showed that 62% of their study group with unstable intertrochanteric fractures were male patients between the ages of 60 and 70, because elderly men who engage in active jobs sustain more fractures. The research by Zehir et al. (2015) [10] showed that women experienced a slightly higher rate of occurrence, which reached 53%, because different populations exhibit distinct patterns of bone density and life span".

Our study found that Type 2 intertrochanteric fractures represent the most prevalent fracture pattern which occurred in 65% of our cases. This observation mirrors the work of Bojan et al. (2010) [11] , who 'reported 61% of their 3,066 consecutive patients presenting with unstable intertrochanteric fractures (31.A2–A3). Chang et al. (2015) [12] showed that their study population had a higher

occurrence of Type 1 fractures because different demographic factors and fall patterns and osteoporosis levels affected the severity of fractures.

The Tip–Apex Distance (TAD) analysis showed that most patients reached ideal implant placement according to surgical standards which required less than 25 millimeters of distance. Fujii et al. (2017) [13] corroborated this, reporting that patients with TAD ≤20 mm had significantly lower screw cut-out rates (2/56 patients, 3.6%) compared to those with TAD ≥20 mm, where screw cut-outs increased to 21.4%. Caruso et al., (2017) [14] documented that patients with TAD <25 mm experienced zero cut-outs whereas TAD 25–30 mm produced 33.3% cut-outs and TAD >30 mm resulted in 78.2% cut-outs thus showing that correct lag screw placement functions as a vital factor which decreases fixation failures. The research by Nikoloski et al. (2013) [15] demonstrated that keeping TAD between 20 and 25 millimeters reduced axial screw cut-out rates in patients with osteoporotic bone which confirms the importance of our results in clinical practice.

The study showed positive results after six months when 77.5 percent of patients reached good to excellent Harris Hip Scores. Mallya et al. (2019) [16] found that 80 percent of patients with unstable intertrochanteric fractures who received proximal femoral nail treatment achieved excellent recovery results after six months. Geller et al. (2010) [17] showed that TAD ≤25 mm patients achieved better functional results while experiencing fewer mechanical failures which proved essential to the process of recovery through correct implant placement. Baumgaertner et al. (1998) [18] discovered that TAD values above 25 mm led to increased revision rates which showed that even small surgical technique variations can create major effects on patient results.

Our study found low rates of post-operative complications because 75% of patients did not experience any complications. The study found that delayed union and screw cut-out and malalignment occurred infrequently while superficial infections and deep vein thrombosis developed rarely. The results matched the findings of Balachandran et al. (2020) research, which showed 21% of their study group developed complications that included both malalignment and hardware-related failures. The study by Zehir et al. (2015) discovered the complication rate reached 28% because screw cut-out occurred in patients who had both poor bone quality and suboptimal reduction, which demonstrates the persistent difficulties faced by elderly patients with osteoporotic bone.

The research showed that patients with unstable intertrochanteric fractures need to undergo both initial fixation and subsequent movement activities to reduce their risk of developing health complications and death. Sharma (2019) reported that early mobilization combined with precise implant placement significantly reduced hospital stay and improved functional outcomes. Within the first 48 hours after a fracture occurred, Bojan et al. (2010) discovered that patients who received surgical treatment had reduced one-year mortality rates which measured at 22% compared to 31% for patients who experienced delayed fixation. The study showed that patients who need urgent medical attention should receive their treatment without delay.

The study results demonstrate their alignment with existing research because they establish three essential factors which determine functional and radiological results in elderly patients with intertrochanteric femur fractures. The results particularly highlight that maintaining a Tip–Apex Distance of ≤25 mm is crucial for reducing screw cut-out and ensuring better recovery. The study results show that different fracture patterns and demographic trends create specific population differences while the complication rates in the studies remain consistent with each other. The study results demonstrate that precise surgical planning and correct implant positioning together with thorough post-surgery monitoring create positive results for patients who belong to this at-risk group.

Conclusion

The present study concludes that surgical fixation of intertrochanteric femur fractures using proximal femoral nails in elderly patients yields favorable functional and radiological outcomes when key surgical principles are adhered to. The majority of patients achieved good to excellent functional recovery, with 77.5% demonstrating high Harris Hip Scores at six months, underscoring the importance of early mobilization and precise surgical technique. Tip–Apex Distance (TAD) emerged as a critical predictor of implant success, with values ≤25 mm significantly reducing the risk of screw cut-out and mechanical failure. Type 2 fractures were most prevalent, and demographic trends highlighted a predominance of males aged 60–69 years. Post-operative complications were relatively low, reflecting effective intraoperative management and post-operative care. Overall, meticulous fracture reduction, optimal implant positioning, and timely rehabilitation are essential for maximizing recovery and minimizing complications in this population.

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