



Evaluation of functional recovery after intertrochanteric fractures treated with proximal femoral nailing: a prospective cross-sectional study.

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Abstract

Background:

Intertrochanteric fractures in older adults continue to pose a major challenge due to their association with reduced mobility, prolonged dependency, and increased morbidity. Proximal femoral nailing (PFN) has emerged as a preferred fixation method owing to its biomechanical stability and minimally invasive nature.

Aim:

To assess the functional outcomes, radiological union, and complication profile in patients with intertrochanteric fractures treated using proximal femoral nailing.

Methods:

This prospective cross-sectional study included 80 patients with radiologically confirmed intertrochanteric fractures managed with PFN. Baseline characteristics, AO/OTA fracture patterns, surgical timing, and early mobilisation status were documented. Radiological union was monitored at regular intervals. Functional outcomes were measured at six months using the Harris Hip Score (HHS). Complications were also recorded. Data were analysed descriptively and presented in structured tables.

Results:

The mean age of participants was 67.4 ± 9.8 years, and women accounted for 56% of the study population. AO/OTA 31-A2 fractures were the most common. Radiological union was achieved at 13.8 ± 2.4 weeks, with 90% consolidating within 16 weeks. Functional evaluation at six months revealed 40% excellent, 35% good, 17.5% fair, and 7.5% poor outcomes. Superficial infection occurred in 5% of cases, while minor implant-related complications were observed in 3.8%. No deep infections or implant failures were recorded.

Conclusion:

Proximal femoral nailing provides reliable fixation, predictable union, and favourable functional recovery in intertrochanteric fractures, with a low rate of complications. Early mobilisation and optimal implant positioning appear to support better long-term outcomes.

Recommendations:

Strengthening postoperative rehabilitation pathways, ensuring precise intraoperative screw placement, and initiating early weight-bearing under supervision can further enhance recovery. Wider adoption of patient-specific physiotherapy schedules, periodic functional assessment, and community-based fall-prevention programs may additionally reduce disability and improve overall quality of life in this population.

Keywords: Intertrochanteric fracture, proximal femoral nailing, functional recovery, Harris Hip Score, radiological union, postoperative outcomes.

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Introduction

Intertrochanteric fractures are among the most frequent injuries encountered in geriatric trauma,

primarily due to age-related osteoporosis and the heightened vulnerability to low-energy falls in older adults [1]. With increasing life expectancy, the global



burden of these fractures continues to rise, creating substantial clinical, social, and economic challenges for healthcare systems [2]. These injuries often lead to significant functional impairment, prolonged immobility, and elevated postoperative morbidity, reinforcing the need for timely and effective surgical intervention [3].

Proximal femoral nailing (PFN) has gradually become the preferred fixation method for intertrochanteric fractures. Its biomechanical strength, minimally invasive nature, and suitability for both stable and unstable fracture configurations offer clear advantages over traditional implants [1,4]. Studies have demonstrated that PFN provides reliable stability, facilitates early weight-bearing, and yields favourable radiological and functional outcomes, especially in elderly patients with compromised bone quality [2,5].

Despite its widespread use, considerable variation persists in postoperative recovery, influenced by fracture morphology, surgical timing, reduction quality, and implant placement [3,6]. Understanding these factors is essential for optimising patient outcomes and reducing postoperative complications. Functional assessment using the Harris Hip Score (HHS) remains a widely accepted measure for evaluating postoperative hip function and offers insight into pain, mobility, and independence levels following PFN fixation [4].

A comprehensive evaluation of functional recovery, combined with analysis of radiological union and complication rates, is crucial for strengthening clinical decision-making in the management of intertrochanteric fractures. The present study was undertaken to examine the functional recovery of patients treated with PFN for intertrochanteric fractures, using a prospective cohort design. By analysing clinical parameters, union timelines, and postoperative complications, this study aims to generate evidence that supports better clinical decision-making and enhances rehabilitation strategies for this vulnerable population.

Methodology

Study Design and Setting

This prospective cohort study was conducted in the Department of Orthopaedics, Government Medical College, Quthbullapur, over a period of twelve months, from July 2024 to June 2025. All eligible patients presenting with intertrochanteric fractures during the study period were evaluated and followed longitudinally after surgical management.

Study Population

A total of 80 patients with radiologically confirmed intertrochanteric fractures were enrolled. Adults aged 40 years and above who underwent fixation using proximal femoral nailing (PFN) were included. Patients with polytrauma, pathological fractures, open fractures, previous hip surgery, or those unfit for anaesthesia were excluded to maintain uniformity in clinical assessment.

Study Size

The sample size of 80 patients was determined based on feasibility and the expected patient inflow during the study period. Considering previous similar institutional studies and the average annual number of intertrochanteric fractures treated with proximal femoral nailing at the study centre, it was estimated that approximately 75–90 eligible patients could be enrolled within the defined timeframe. Therefore, a target sample size of 80 participants was considered adequate to provide reliable estimates of functional recovery outcomes while maintaining methodological feasibility.

Participant Selection

Eligible participants were identified consecutively from patients presenting to the Department of Orthopaedics with radiologically confirmed intertrochanteric femur fractures during the study period. All patients meeting the predefined inclusion criteria were screened at admission. After clinical evaluation and preoperative optimization, individuals who consented to undergo proximal femoral nailing were enrolled. Consecutive sampling was adopted to minimize selection bias and ensure representativeness of the study population. Patients were included only once and were followed as per the study protocol.

Data Collection Procedures

Baseline demographic variables, comorbidities, fracture laterality, and AO/OTA classification were documented at admission. Preoperative investigations and anaesthesia clearance followed standard institutional protocols. The interval between injury and surgery, implant selection, and intraoperative findings were recorded carefully.

Surgical Technique and Postoperative Care

All surgeries were performed by experienced orthopaedic surgeons using a standardised PFN technique under fluoroscopic guidance.



Postoperative care was uniform for all participants. Analgesia, thromboprophylaxis, and antibiotics were administered as per departmental guidelines. Partial weight-bearing was initiated once tolerated, typically within the first few postoperative days under the supervision of physiotherapy staff.

Outcome Assessment

Radiological evaluation was carried out at 6, 12, and 16 weeks to assess fracture union, callus formation, and implant stability. Functional recovery was measured at six months using the Harris Hip Score (HHS). Complications such as infection, implant-related issues, delayed union, and mortality were recorded throughout follow-up.

Bias

Several measures were implemented to reduce potential sources of bias. Selection bias was minimized through consecutive enrolment of eligible patients. Standardized surgical technique and implant protocol were followed to limit procedural variability. Functional outcomes were assessed using a validated scoring system at predefined follow-up intervals to reduce measurement bias. Data collection was performed using a structured proforma to ensure uniform documentation. Efforts were made to minimize attrition bias by scheduling regular follow-up visits and maintaining telephonic reminders.

Statistical Analysis

Data were entered into a structured proforma and analysed descriptively. Continuous variables were summarised as means with standard deviations, while

categorical variables were expressed as frequencies and percentages. Results were presented in tabular format for clarity.

Ethical Considerations:

The study received approval from the Institutional Ethics Committee of Government Medical College, Quthbullapur. Informed written consent was obtained from all participants. Confidentiality was maintained throughout the study, and all procedures adhered to the principles of the Declaration of Helsinki.

RESULTS

Participant Flow

A total of 102 patients with suspected intertrochanteric fractures presented during the study period. Of these, 96 were assessed for eligibility after initial clinical and radiographic evaluation. Eight patients were excluded (four had pathological fractures, two had polytrauma, and two were medically unfit for surgery).

Eighty-eight patients fulfilled the inclusion criteria and were eligible for enrolment. Eight patients declined participation or were lost prior to surgical intervention. Finally, 80 patients underwent proximal femoral nailing and were included in the study.

During follow-up, five patients were lost (three failed to attend scheduled visits and two were unreachable despite reminders). Therefore, 75 patients completed the final follow-up assessment and were included in the functional outcome analysis.

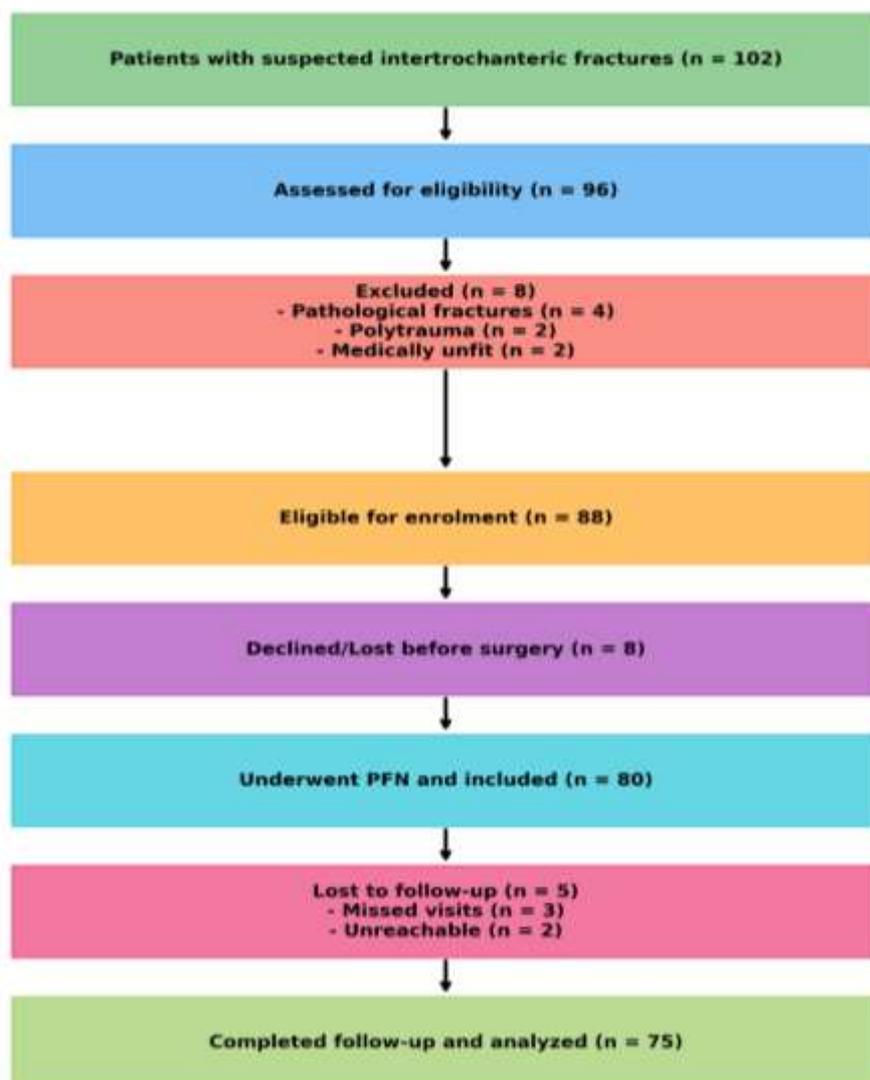


Figure 1: Participant Flow Diagram

A total of 80 patients with intertrochanteric fractures were included in the final analysis. The mean age of the cohort was 67.4 ± 9.8 years, and females constituted 56% of the study population. Right-sided fractures were slightly more frequent than left-sided

injuries. According to the AO/OTA classification, Type 31-A2 fractures represented the largest subgroup, followed by A1 and A3 patterns. The complete baseline profile is presented in Table 1.

Table 1. Baseline Demographic and Clinical Characteristics (N = 80)

Parameter	Value
Mean Age (years)	67.4 ± 9.8
Gender – Female	45 (56%)
Gender – Male	35 (44%)
Side of Fracture – Right	47 (58.7%)
Side of Fracture – Left	33 (41.3%)



AO/OTA Type 31-A1	26 (32.5%)
AO/OTA Type 31-A2	37 (46.2%)
AO/OTA Type 31-A3	17 (21.3%)

The average interval from admission to surgery was 3.2 ± 1.1 days, and early partial weight-bearing was initiated in 95% of patients. Radiological union was observed at a mean of 13.8 ± 2.4 weeks, with 90%

achieving consolidation within 16 weeks. Delayed union and early varus collapse were documented in a small proportion of cases, as summarised in Table 2.

Table 2. Perioperative and Radiological Parameters

Parameter	Value
Mean Time to Surgery (days)	3.2 ± 1.1
Early Partial Weight-Bearing	76 (95%)
Mean Time to Radiological Union (weeks)	13.8 ± 2.4
Union Achieved ≤ 16 Weeks	72 (90%)
Delayed Union	6 (7.5%)
Early Varus Collapse	2 (2.5%)

Functional recovery was assessed using the Harris Hip Score at 6 months. An excellent outcome was achieved by 40%, while 35% exhibited a good functional grade. Fair and poor outcomes accounted for 17.5% and 7.5%, respectively. Detailed

functional distribution is presented in Table 3. Patients with stable fracture patterns showed comparatively higher scores than those with unstable configurations.

Table 3. Functional Outcomes at 6 Months (Harris Hip Score)

Outcome Category	Number of Patients (%)
Excellent	32 (40%)
Good	28 (35%)
Fair	14 (17.5%)
Poor	6 (7.5%)
Total	80 (100%)

Radiological Outcomes

Radiological union was assessed at 6, 12, and 16 weeks postoperatively using standard anteroposterior and lateral radiographs of the hip.

At 6 weeks, early callus formation was observed in 48 patients (60%), while 32 patients (40%) showed minimal radiological signs of healing.

At 12 weeks, 62 patients (77.5%) demonstrated satisfactory progression toward union with bridging callus across at least three cortices.

By 16 weeks, complete radiological union was achieved in 71 patients (88.8%). Delayed union was observed in 7 patients (8.8%), and non-union

occurred in 2 patients (2.5%). The mean time to radiological union was 13.2 ± 2.4 weeks.

Postoperative complications were infrequent. Superficial infections occurred in 5% of patients and resolved with standard antibiotic therapy. Implant-related issues, including screw back-out or Z-effect, were observed in 3.8%, with no deep infections or implant failures recorded during follow-up. One mortality unrelated to surgery was noted at 6 months. The list of complications is provided in Table 4.



Table 4. Postoperative Complications

Complication Type	Number of Patients (%)
Superficial Infection	4 (5%)
Screw Back-out / Z-effect	3 (3.8%)
Deep Infection	0
Implant Failure	0
Mortality (6 months)	1 (1.3%)

Discussion

Intertrochanteric fractures continue to impose a substantial functional burden on older adults, and the choice of surgical fixation plays a decisive role in determining recovery. The favourable functional trajectory observed in this cohort parallels the outcomes reported in studies demonstrating the effectiveness of proximal femoral nailing in unstable and per-trochanteric fracture patterns [7]. The predominance of AO/OTA 31-A2 fractures is consistent with epidemiological data showing a higher frequency of unstable variants among elderly populations with reduced bone mineral density [8].

The mean union time of approximately 14 weeks in the present study aligns well with earlier reports, where radiological consolidation typically occurs between 12 and 16 weeks following cephalomedullary nailing [9]. Early mobilisation, achieved in most participants, may have contributed to smoother rehabilitation and lower postoperative morbidity. Enhanced recovery pathways, including early ambulation, have been shown to reduce hospital stay and optimise functional outcomes in intertrochanteric fracture patients [9].

The favourable functional recovery observed in this study suggests that proximal femoral nailing provides adequate mechanical stability and facilitates early mobilisation following intertrochanteric fractures. The substantial proportion of patients achieving excellent or good Harris Hip Scores at six months indicates effective restoration of hip biomechanics, progressive pain relief, and improvement in ambulatory function. Stable fixation permitting controlled fracture compression and early weight-bearing likely contributed to these outcomes [10,11]. Furthermore, the minimally invasive nature of the technique may help preserve periosteal blood supply and fracture biology, which are essential for optimal healing and functional restoration [7].

Functional outcomes assessed using the Harris Hip Score demonstrated that most individuals achieved excellent or good recovery by six months. These findings correspond with studies showing that intramedullary nail designs offer superior biomechanical stability, enabling controlled fracture

compression and earlier weight-bearing compared with extramedullary devices [10,11]. Such stability is particularly advantageous in osteoporotic bone, where maintaining reduction is often challenging.

Complications in this study were minimal, reinforcing the safety profile of proximal femoral nailing when careful surgical technique and accurate implant placement are prioritised. Similar studies report low rates of screw migration, varus collapse, or implant failure, further confirming PFN as a reliable option across diverse fracture patterns [7,12]. The absence of major mechanical complications supports the ongoing preference for intramedullary devices in modern orthopaedic trauma practice.

Generalizability

The findings of this prospective cohort study are applicable to similar tertiary-care settings that manage a high proportion of older adults with intertrochanteric fractures. Because patient selection, surgical technique, and rehabilitation protocols followed standardised institutional practices, the outcomes can be reasonably extended to comparable orthopaedic units. However, generalisation to rural centres, low-resource facilities, or populations with different demographic and comorbidity profiles should be approached cautiously due to variations in infrastructure, expertise, and postoperative support systems.

Conclusion

This prospective cohort study demonstrates that proximal femoral nailing provides dependable fixation, timely fracture union, and favourable functional recovery in patients with intertrochanteric fractures. Most individuals achieved excellent or good Harris Hip Scores at six months, reflecting the stability and biomechanical advantages of the implant. Early mobilisation and adherence to structured postoperative rehabilitation contributed significantly to improved outcomes. The low complication rate further highlights the procedure's safety when performed with careful surgical technique. Overall, PFN remains an effective and



reliable intervention across a broad spectrum of fracture patterns, supporting its continued use in modern orthopaedic trauma care.

Limitations

This study is limited by its single-centre design and relatively small sample size, which may restrict broader applicability. The follow-up duration of six months captures early functional recovery but does not assess long-term outcomes or late complications. Potential confounders such as variations in bone quality, rehabilitation adherence, and surgeon-specific technique were not fully controlled. Radiological assessment relied on standard imaging without advanced modalities, which provided a more precise evaluation of healing dynamics.

Recommendations

Future research should incorporate larger, multicentre cohorts to enhance external validity and capture variations in clinical practice. A longer follow-up is essential to evaluate sustained functional recovery, implant longevity, and late complications. Standardising intraoperative techniques, particularly screw placement and reduction quality, can further reduce mechanical failures. Structured physiotherapy protocols with early supervised ambulation should be emphasised to maximise functional outcomes. Integrating fall-prevention strategies and bone-health optimisation into postoperative care may additionally improve long-term independence. Comparative studies evaluating PFN against alternative fixation methods could provide deeper insight into optimal management across fracture subtypes.

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Abbreviations

AO: Arbeitsgemeinschaft für Osteosynthesefragen
OTA: Orthopaedic Trauma Association
PFN: Proximal Femoral Nailing
HHS: Harris Hip Score
DHS: Dynamic Hip Screw

IEC: Institutional Ethics Committee
ICU: Intensive Care Unit
CRP: C-reactive Protein
BMI: Body Mass Index

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Conflict of interest.

The authors declare no conflict of interest.

Author contributions.

KK-Concept and design of the study, results interpretation, review of literature, and preparing the first draft of the manuscript. Statistical analysis and interpretation, revision of manuscript. **KKN**- Design of the study, results interpretation, review of literature, and preparing the first draft of the manuscript. Statistical analysis and interpretation, revision of manuscript. **SK**-Results interpretation, review of literature, and preparing the first draft of the manuscript. Statistical analysis and interpretation, revision of manuscript. **DVR**-Concept and design of the study, results interpretation, review of literature, and preparing the first draft of the manuscript. Statistical analysis and interpretation, revision of manuscript.

Data availability.

Data available on request

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