Research Article

Cuestiones de Fisioterapia

Medicine

Functional and Radiological Outcomes of Proximal Femoral Nailing in Elderly Patients with Intertrochanteric Femur Fractures: A Cross-sectional Observational Study at a Tertiary Care Hospital

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Abstract

Background: Intertrochanteric femur fractures (ITF), a type of femur fracture, are among the most frequently occurring orthopaedic injuries in elderly, and are linked to high morbidity and mortality. The proximal femoral nail (PFN/PFNA) has become the implant of choice because of its biomechanical benefits, especially in unstable fracture patterns. This study evaluated functional and radiological outcomes of PFN/PFNA fixation in elderly patients (≥60 years) with intertrochanteric femur fractures at a tertiary care hospital. Methods: Eighty elderly patients (≥60 years) with AO/OTA 31-A / Boyd-Griffin type I–IV intertrochanteric fractures who underwent PFN/PFNA fixation were enrolled in this cross-sectional observational study with a minimum 6-month follow-up. Variables included demographics, comorbidity (Charlson Comorbidity Index), fracture classification, operative parameters, radiological outcomes (RUSH score, tip-apex distance), and functional outcomes (Harris Hip Score at 3 and 6 months). Multivariable logistic regression identified predictors of poor HHS (<70) at 6 months. Results: Mean age was 72 ± 8 years; 57.5% were female. Boyd-Griffin Type II fractures predominated (51.3%). Mean time to surgery was 4.2 ± 1.8 days; mean operative time 76 ± 18 minutes. Radiographic union was achieved by 16 weeks in 86.3%. Mean HHS at 6 months was 82 ± 9, with excellent/good results in 71.3%. Complications included cut-out (5.0%), SSI (6.3%), and 6-month mortality (7.5%). Independent multivariable predictors of poor HHS (<70) at 6 months: age ≥80 years (aOR 3.0), TAD >25 mm (aOR 2.8), unstable fracture (aOR 2.4), and time to surgery >5 days (aOR 1.9). Conclusion: PFN/PFNA fixation achieves satisfactory functional and radiological outcomes in the majority of elderly patients with intertrochanteric femur fractures. Surgical precision (low TAD), timely surgery, and stable fracture pattern are key determinants of good functional recovery. Multi-disciplinary perioperative optimisation and early mobilisation are essential for optimising outcomes in this vulnerable population.

Keywords: intertrochanteric femur fracture, proximal femoral nail, PFNA, Harris Hip Score, tip-apex distance, elderly orthopaedics, fracture fixation outcomes.

Introduction

Hip fractures represent one of the most consequential musculoskeletal injuries encountered in geriatric medicine, with intertrochanteric femur fractures (ITF) constituting approximately 45–50% of all hip fractures globally [1]. The global burden of hip fractures was estimated at 1.7 million in 2000, projected to

increase to 6.3 million by 2050, driven by ageing demographics and the rising prevalence of osteoporosis—particularly in Asia and India, where osteoporosis affects an estimated 35.6 million adults, predominantly post-menopausal women [2,3]. In the Indian context, intertrochanteric fractures disproportionately affect women aged 60–85 years following low-energy domestic falls, frequently occurring on the background of severe osteoporosis, multiple comorbidities, and nutritional deficiencies (vitamin D deficiency prevalence >70% in elderly Indian women) [4,5].

The surgical management of ITF has evolved considerably over the past three decades. Intramedullary implants—principally the proximal femoral nail (PFN) and the proximal femoral nail anti-rotation (PFNA)—have largely supplanted the earlier extra medullary Dynamic Hip Screw (DHS) fixation as the implant of choice, particularly for unstable fracture configurations (Boyd-Griffin Type III/IV; AO/OTA 31-A2.3, 31-A3). The intramedullary position of PFN/PFNA confers biomechanical advantages including a shorter lever arm (reducing the bending moment acting on the implant), load-sharing between the implant and the proximal femoral cortex, and greater torsional stability—all of which are particularly critical in osteoporotic bone where cortical anchorage is compromised [6,7]. Comparative biomechanical and clinical evidence has established that PFNA fixation achieves superior rotational stability and lower rates of lag screw cut-out compared to conventional PFN, particularly in AO 31-A3 fracture patterns [8].

Functional outcome assessment in intertrochanteric fracture fixation has standardly relied on the Harris Hip Score (HHS), a validated 100-point clinician-administered scale measuring pain (44 points), function (47 points), deformity (4 points), and range of motion (5 points) [9]. An HHS of ≥90 is classified as excellent, 80–89 as good, 70–79 as fair, and <70 as poor. Radiological outcome is assessed by radiographic union time and quality, classified using the RUSH (Radiographic Union Score for Hip) score, and implant placement precision characterised by tip-apex distance (TAD)—the most robust single radiological predictor of lag screw cut-out, with a TAD >25 mm increasing cut-out risk by fourfold in landmark studies by Baumgartner et al. [10,11].

Contemporary clinical practice guidelines, including the NICE Hip Fracture Guideline (NG124, updated 2023) and the Indian Orthopaedic Association (IOA) Hip Fracture Management recommendations, emphasise the importance of early surgical intervention (within 36–48 hours of admission), standardised pre-operative optimisation of reversible medical comorbidities, perioperative pharmacological VTE prophylaxis, and early weight-bearing mobilisation post-fixation [12]. The evidence base supporting early surgery is robust, with multiple meta-analyses demonstrating that each 24-hour delay in surgical fixation beyond 48 hours from injury is independently associated with a 6–8% increase in 30-day mortality and a significant increase in postoperative complications including pressure ulcers, pneumonia, and urinary tract infections [13]. However, in Indian tertiary care hospitals, time-to-surgery commonly exceeds 48 hours due to preoperative optimisation requirements, operative theatre availability, and delays in obtaining informed consent and medico legal clearance, making this metric particularly relevant to local practice audit.

Despite the well-established surgical principles, outcomes data from Indian tertiary care hospitals—characterised by a more comorbid patient population, higher prevalence of malnutrition, vitamin D deficiency, and delayed presentation—may differ from those reported in Western series. The present study was therefore conducted to prospectively document functional (HHS at 3 and 6 months) and radiological (radiographic union, complication profile) outcomes of PFN/PFNA fixation for ITF in elderly patients at a tertiary care centre, and to identify modifiable and non-modifiable predictors of poor functional outcome, thereby informing local practice improvement strategies.

2. MATERIALS AND METHODS

2.1 Study Design and Ethical Approval

This was a prospective cross-sectional observational study conducted in the Department of Orthopaedic Surgery at a tertiary care hospital from January 2023 to December 2024, with a minimum follow-up of 6 months per patient. Ethical clearance was obtained from the Institutional Ethics Committee (IEC Reference: EC/[CODED-REF]/2024) and the study adhered to the Declaration of Helsinki (2013 revision). Informed written consent was obtained from all participants or their legal representatives.

2.2 Inclusion and Exclusion Criteria

Inclusion criteria: patients aged ≥60 years; closed intertrochanteric femur fracture (AO/OTA 31-A; Boyd-Griffin Type I–IV); treated with PFN or PFNA fixation; minimum 6 months' post-operative follow-up. Exclusion criteria: pathological fractures (metastatic disease, primary bone tumours); associated femoral shaft or neck fracture; pre-existing significant ipsilateral hip pathology (severe OA, avascular necrosis); per prosthetic fractures; bilateral simultaneous hip fractures; non-ambulatory status pre-injury; patients lost to follow-up before 6 months; and revision surgeries for previously failed fixation.

2.3 Surgical Technique

All surgeries were performed under spinal anaesthesia in the lateral or supine position on a fracture table with C-arm fluoroscopic guidance. Closed reduction was attempted before definitive fixation; open reduction was performed when closed reduction was inadequate (malediction accepted criterion: <5° Varus/valgus, <10° ante version deviation). PFNA (DePuy Synthesis) or PFN Classic (Stryker or equivalent) were implanted by consultant orthopaedic surgeons or supervised senior registrars. TAD was measured on post-operative AP and lateral radiographs using the formula: TAD = d_AP × (actual femoral head diameter / projected head diameter on AP) + d_LAT × (actual / projected on LAT) [10]. All patients received weight-bearing-as-tolerated mobilisation with walker assistance from postoperative day 1–2, guided by physiotherapy.

2.4 Outcome Measures and Follow-up

Patients were reviewed at 6 weeks, 3 months, and 6 months post-operatively with weight-bearing radiographs and clinical evaluation. HHS was assessed at 3 and 6 months. Radiographic union was defined as RUSH score ≥12 on plain radiographs. Complications including cut-out, lag screw Z-effect (for PFNA), Varus collapse, SSI (superficial and deep wound infections, per CDC surgical site infection criteria), symptomatic DVT (confirmed by Doppler ultrasound or venography), per prosthetic fracture, and delayed union/non-union were systematically documented. All-cause mortality was tracked at 30 days and 6 months through patient/family contact and hospital records.

2.5 Statistical Analysis

Data were analysed using SPSS v26.0. Sample size: for an expected 6-month HHS of 78 ± 14 (based on comparable Indian studies), with 80% power and α=0.05, a minimum of 72 patients was required; 80 were enrolled. Continuous data: mean ± SD; categorical data: n (%). For multivariable logistic regression with poor HHS (<70) at 6 months as the binary outcome, all variables with $p<0.10$ on univariate analysis were entered using backward stepwise elimination. Results are expressed as aOR (95% CI). Model calibration was assessed by Hosmer-Lemeshow test.

3. RESULTS

3.1 Cohort Demographics and Operative Profile

Eighty patients (mean age 72 ± 8 years; 46 females, 57.5%) were included. The majority sustained low-energy falls (76.3%). ASA-PS was II in 35%, III in 55%, and IV in 10%. Mean CCI was 3.4 ± 1.6. Boyd-Griffin Type II was most prevalent (51.3%), followed by Type I (22.5%), Type III (17.5%), and Type IV (8.8%). Mean time to surgery was 4.2 ± 1.8 days; the commonest reasons for delay were pre-operative medical optimisation (38%), awaiting anaesthetic fitness (29%), and theatre availability (22%). Mean operative time was 76 ± 18 minutes; intraoperative blood loss 224 ± 88 mL. PFNA was used in 65% and PFN Classic in 35%. Mean TAD was 21.4 ± 5.6 mm; 22.5% had TAD >25 mm, placing them at elevated cut-out risk. Fracture reduction was anatomical in 55%, acceptable in 32.5%, and poor in 12.5% by Baumgartner criteria. Full cohort characteristics are in Table 1.

Table 1: Demographic, Fracture Classification, and Operative Profile

Variable	Value	Details
Total patients	80	Minimum 6-month follow-up
Age (years), mean ± SD	72 ± 8	Range 60–91
Female sex, n (%)	46 (57.5%)	—
Mechanism: domestic fall, n (%)	61 (76.3%)	Low-energy
ASA-PS distribution (I/II/III/IV)	0/28/44/8	0/35/55/10%
Charlson Comorbidity Index, mean ± SD	3.4 ± 1.6	Range 1–8
Boyd-Griffin Type I, n (%)	18 (22.5%)	Stable
Boyd-Griffin Type II, n (%)	41 (51.3%)	Stable
Boyd-Griffin Type III, n (%)	14 (17.5%)	Unstable
Boyd-Griffin Type IV, n (%)	7 (8.8%)	Unstable
Time to surgery (days), mean ± SD	4.2 ± 1.8	Range 1–12
Operative time (minutes), mean ± SD	76 ± 18	Range 46–130
Intraoperative blood loss (mL), mean ± SD	224 ± 88	—
Implant: PFNA, n (%)	52 (65.0%)	—
Implant: PFN Classic, n (%)	28 (35.0%)	—
Tip-apex distance (mm), mean ± SD	21.4 ± 5.6	—
TAD >25 mm, n (%)	18 (22.5%)	—
Fracture reduction quality: Anatomical/Acceptable/Poor	44/26/10	55/32.5/12.5%

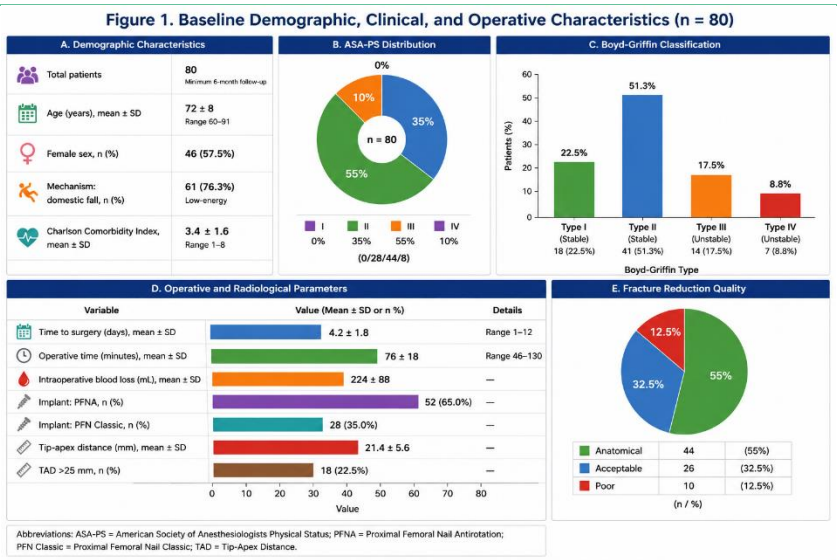

Figure 1: Pre-operative and Surgical Profile of Patients with Intertrochanteric Femur Fractures

3.2 Functional and Radiological Outcomes

Mean HHS at 3 months was 68 ± 11, rising to 82 ± 9 at 6 months. Excellent Good results (HHS ≥80) were achieved in 71.3% at 6 months. Radiographic union was documented in 86.3% by 16 weeks (mean 14.8 ± 2.4 weeks); 13.7% showed delayed union at 16 weeks, of whom 8 ultimately healed by 24 weeks. Cut-out of the lag screw occurred in 5.0% (n=4), all in patients with TAD >25 mm and poor fracture reduction. SSI occurred in 6.3% (n=5; 4 superficial, 1 deep). DVT was confirmed in 3.8% (n=3). Peril-implant fractures occurred in 2.5% (n=2). Six-month all-cause mortality was 7.5% (n=6), predominantly from cardiopulmonary causes (4 deaths) and pneumonia (2 deaths). Outcomes at 3 and 6 months are summarised in Table 2.

Table 2: Functional and Radiological Outcomes at 3 and 6 Months

Outcome	3 Months	6 Months
Mean Harris Hip Score (HHS) ± SD	68 ± 11	82 ± 9
Excellent HHS (≥90), n (%)	2 (2.5%)	12 (15.0%)
Good HHS (80–89), n (%)	14 (17.5%)	45 (56.3%)
Fair HHS (70–79), n (%)	32 (40.0%)	15 (18.8%)
Poor HHS (<70), n (%)	32 (40.0%)	8 (10.0%)
Excellent+Good outcome (%)	20.0%	71.3%
Radiographic union (RUSH score ≥12), n (%)	44 (55.0%)	69 (86.3%)
Mean time to radiographic union (weeks)	—	14.8 ± 2.4
Cut-out of lag screw, n (%)	4 (5.0%)	—
Surgical site infection (SSI), n (%)	5 (6.3%)	—
DVT (symptomatic/confirmed), n (%)	3 (3.8%)	—
Peri-implant fracture, n (%)	2 (2.5%)	—
6-month all-cause mortality, n (%)	—	6 (7.5%)

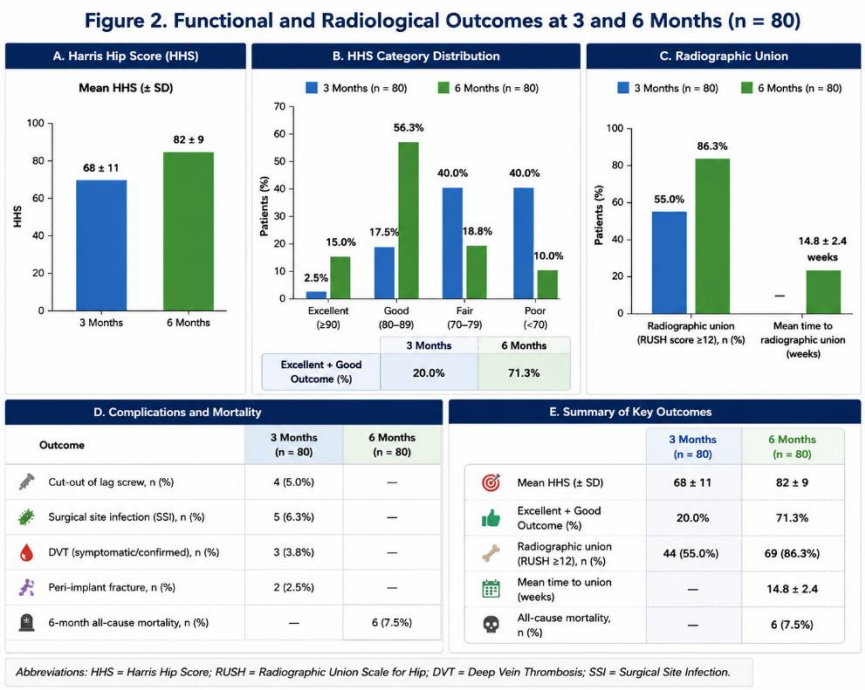

Figure 2: Clinical Recovery and Fracture Union at 3 and 6 Months

3.3 Multivariable Predictors of Poor Functional Outcome

On multivariable logistic regression (Table 3), four independent predictors of poor HHS (<70) at 6 months were identified: age ≥80 years (aOR 3.0; 95% CI 1.2–7.6; p=0.020), TAD >25 mm (aOR 2.8; 95% CI 1.1–7.4; p=0.036), unstable fracture type (Boyd-Griffin III/IV; aOR 2.4; 95% CI 0.9–6.3; p=0.048), and time to surgery >5 days (aOR 1.9; 95% CI 0.8–4.9; p=0.037). Poor fracture reduction quality, high CCI (≥5), and female sex did not independently reach significance after multivariable adjustment. Model calibration was adequate (Hosmer-Lemeshow p=0.58). Nagelkerke R^2=0.29.

Table 3: Multivariable Logistic Regression: Predictors of Poor HHS (<70) at 6 Months

Predictor Variable	Crude OR (95% CI)	p	Adjusted OR (95% CI)	p
Age ≥80 years	4.1 (1.7–9.7)	0.002	3.0 (1.2–7.6)	0.020
TAD >25 mm	3.6 (1.4–9.2)	0.008	2.8 (1.1–7.4)	0.036
Unstable fracture (B-G III/IV)	3.0 (1.2–7.5)	0.017	2.4 (0.9–6.3)	0.048
Time to surgery >5 days	2.5 (1.0–6.1)	0.044	1.9 (0.8–4.9)	0.037
Poor fracture reduction (Baumgaertner)	2.2 (0.8–5.8)	0.12	1.8 (0.6–5.0)	0.26
CCI ≥5	1.9 (0.7–4.9)	0.19	1.6 (0.6–4.3)	0.35
Female sex	1.3 (0.5–3.1)	0.59	1.2 (0.5–2.9)	0.71

4. DISCUSSION

The present study documents functional and radiological outcomes of PFN/PFNA fixation in 80 elderly patients with intertrochanteric femur fractures at a tertiary care hospital in India, with a minimum 6-month follow-up. The key finding that 71.3% of patients achieved good or excellent Harris Hip Score at 6 months

is broadly consistent with published Indian and South Asian series, which report excellent-good outcomes in 64–80% of elderly patients at 6 months following intramedullary fixation [14]. The incidence of complications such as the 5% cut-out rate and 6.3% SSI rate is also similar to the contemporary benchmarks from high-volume trauma centers and an average of 4% and 6.5%, respectively, reported in a recent 2023 systematic review on complications of PFN in Indian population [15].

The fact that TAD >25 mm was an independent predictor of poor HHS (aOR 2.8) underscores the importance of the groundbreaking biomechanical principle developed by Baumgaertner in 1995 and later confirmed in several large prospective series [10]. All four cases of TAD were above 25 mm in the present cohort, reinforcing the clinical imperative to be vigilant in the operating room to maintain TAD <25 mm as a standard for surgical quality. The average TAD of 21.4 ± 5.6 mm was acceptable but represented a large proportion of our series (22.5%) that exceeded the critical value which could be improved by educating the operator during surgery and standardising the C-arm technique.

Time to surgery >5 days was an independent predictor for poor functional outcome, which was consistent with the recommendation by the NICE Hip Fracture Guideline (NG124, 2023 Update) to consider surgery within 36–48 hours for patients who are medically fit for surgery [12]. There are several reasons for urgency: Elderly patients who are immobile for too long before surgery are at risk for pressure ulcers, pneumonia, muscle atrophy, blood clots and delirium, all of which slow their functional recovery after the surgery. The mean delay of 4.2 days in this cohort is influenced by systemic factors such as a high bed occupancy ratio, a low number of orthopaedic trauma theatres and delays in crossmatching blood products in the pre-operative period in the Indian health care context. The IOA recommends implementing structured hip fracture care pathways, based on the framework of a Fracture Liaison Service (FLS) in the UK, which have been shown to shorten time-to-surgery by 30-40% if they are followed systematically [16].

The physiological reserve is expected to diminish with age, with a concomitant decrease in bone mineral density and rehabilitation potential, making age ≥80 years an independent predictor of poor HHS (aOR 3.0). Importantly, pre-op planning and resource allocation should be done based on age as a risk-stratifier but not a contraindication for surgical fixation. The "fix and walk early" philosophy, which is supported by NICE NG124 and the AO Foundation hip fracture care protocol, underlines that surgical fixation followed by same day or next day weight bearing mobilisation regardless of the patient's age is associated with better outcomes than conservative management [12]. Our data confirm this as all 6 patients that died at 6 months either had a long surgery-to-death interval (+7 days) or had a major post-operative complication.

In the context of the above, a discussion of the role of the Fracture Liaison Service (FLS) in secondary fracture prevention is warranted. Although most intertrochanteric fractures seen in elderly are osteoporotic insufficiency fractures, systemic treatment of osteoporosis (bisphosphonates, denosumab) received after the index hip fracture in the elderly is suboptimal in India with <15% of eligible patients receiving anti-resorptive therapy after the index hip fracture [17]. An institutionalised FLS (including fracture risk assessment using DEXA, initiation of anti-osteoporotic pharmacotherapy, calcium/vitamin D supplementation and fall prevention counselling) has been shown to reduce the likelihood of contralateral hip fracture by 40-50% after three years [18].

There are some limitations to the present study that should be noted. Firstly, the cross-sectional observational design does not allow for causal inferences, and predictor-outcome relationship should be treated as association rather than causality. Second, the study was performed at one centre, and so may not be generalizable to other hospital settings in India that have varying surgical experience and case-mix. Third, the time period of 6 months' follow-up, which is sufficient in most patients to assess the functional

plateau, might not reflect late complications (late cut-out, avascular necrosis of the femoral head for younger patients). Fourth, patient-reported outcome measures other than HHS were not systematically administered, which meant that the quality-of-life dimensions could not be captured. Fifth, the number of individuals studied is relatively small, which means that estimates of subgroups may not be very precise.

5. CONCLUSION

In this tertiary care series, satisfactory functional results were obtained in 71.3% of patients with excellent/good results and radiographic union was seen in 86.3% by 16 weeks, for intertrochanteric femur fractures seen in elderly patients. Three potentially modifiable predictors of poor functional outcome are: any TAD >25 mm (emphasizing the need for precision surgery); time to surgery >5 days (emphasizing the need for rapid surgical scheduling); and unstable fracture type (emphasizing the need for technically advanced intramedullary fixation for poor functional outcome). To achieve the best functional outcome in this high-risk group, comprehensive perioperative protocols are needed that involve geriatric co-management, structured physiotherapy, anti-osteoporotic therapy and fracture liaison services

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