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Research Article

Functional Outcome Of Subtrochanteric Femur Fractures In Adults Treated With Proximal Femoral Nail.

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Abstract: ***Background:*** Subtrochanteric femur fractures are unstable, biomechanically demanding injuries that occur within 5 cm distal to the lesser trochanter. Because they involve the junction between trabecular and cortical bone, they are exposed to some of the highest mechanical stresses in the skeleton, and their management continues to be challenging for the orthopaedic surgeon. ***Aim:*** To evaluate the radiological union, functional outcome, progression of weight-bearing, and postoperative complications following fixation with a Proximal Femoral Nail (PFN) in adult patients with subtrochanteric femur fractures. ***Materials and Methods:*** A retrospective observational study was conducted on 44 adult patients with acute subtrochanteric femur fractures who underwent internal fixation with a Proximal Femoral Nail between November 2023 and June 2025. All patients were followed up for a minimum period of six months. Functional outcome was assessed using the Harris Hip Score, and radiological union was assessed on serial follow-up radiographs. ***Results:*** The mean age of the study group was 64.47 years, with a male preponderance (56%). Domestic falls were the predominant mode of injury, accounting for 75% of cases. The mean time to partial weight-bearing was 5.88 weeks and to full weight-bearing 9.32 weeks. Radiological union was achieved at a mean of 16.36 weeks. According to the Harris Hip Score, 40.9% of patients had an excellent outcome and 43.18% a good outcome, giving a combined satisfactory outcome of 84.08%. Complications were few and included superficial infection, Z-effect, screw back-out, and implant breakage in two patients each. ***Conclusion:*** The Proximal Femoral Nail provides stable, load-sharing fixation with minimal soft-tissue insult, permits early mobilization, and delivers favourable functional outcomes in subtrochanteric femur fractures. In this series, PFN proved to be a reliable implant of choice, offering results superior to conventional extramedullary devices.

Keywords: Subtrochanteric fracture; Proximal Femoral Nail; Harris Hip Score; Intramedullary nailing; Functional outcome; Femur.

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INTRODUCTION

Subtrochanteric femur fractures are defined as fractures occurring within the region extending from the lower border of the lesser trochanter to a point 5 cm distal to it. They account for approximately 10–30% of all peritrochanteric fractures and are associated with substantial morbidity and mortality, particularly in the elderly osteoporotic population. In younger adults these fractures typically follow high-energy trauma such as road traffic accidents, whereas in older adults they usually result from low-energy domestic falls superimposed on osteoporotic bone.

The subtrochanteric region is subjected to some of the highest biomechanical loads in the human skeleton. The medial and posteromedial cortex sustains large compressive forces, while the lateral cortex experiences equally large tensile forces. Additionally, the proximal fragment is displaced into flexion, abduction, and external rotation by the unopposed pull of the iliopsoas, gluteus medius, and short external rotators, whereas the distal fragment is pulled medially and proximally by the adductors and hamstrings. This complex deforming force pattern makes reduction difficult and predisposes the fracture to varus malunion, delayed union, and implant failure. (1)

The overriding goal of treatment is to achieve stable fixation that permits early mobilization, thereby avoiding the systemic complications of prolonged recumbency such as deep vein thrombosis, pulmonary infection, pressure sores, and generalized deconditioning. A wide variety of extramedullary implants have been used in the past, including the dynamic hip screw with trochanteric side-plate, the dynamic condylar screw, and the 95° angled blade plate. Each of these devices has yielded acceptable results in selected patients, but no single extramedullary device has consistently produced excellent outcomes in unstable subtrochanteric fractures. Their lateral position places them at a mechanical disadvantage because they function as a tension-band construct on the compressive side of the bone, and failure at the bone–implant interface is not uncommon.

The Proximal Femoral Nail (PFN), introduced by the AO/ASIF group in 1997, was designed to overcome these limitations. Being an intramedullary device, the PFN lies close to the mechanical axis of the femur, shortening the lever arm and reducing the bending

moment on the implant. Percutaneous, closed insertion preserves the fracture haematoma and the periosteal blood supply, minimizes surgical trauma and blood loss, and reduces the risk of deep infection. The combination of a cephalic neck screw and an anti-rotational hip pin provides rotational stability of the head–neck fragment, which is often lacking with single-screw constructs. Together, these features permit earlier and more reliable weight-bearing after surgery.

The present study was designed to evaluate the effectiveness of the PFN in the management of subtrochanteric femur fractures in an adult Indian population, with particular reference to radiological union, functional recovery assessed by the Harris Hip Score, weight-bearing progression, and the incidence of complications.

MATERIALS AND METHODS

Study Design and Setting

A retrospective observational study was carried out in the Department of Orthopaedics of our tertiary care teaching hospital. Case records and radiographs of patients admitted with acute subtrochanteric fractures of the femur and treated operatively with a Proximal Femoral Nail were reviewed.

Study Period and Population

The study period extended from November 2023 to June 2025. A total of 44 consecutive adult patients (aged 18 years or above) who underwent PFN fixation for an acute subtrochanteric femur fracture during this period, and who completed a minimum follow-up of six months from the date of surgery, were included.

Inclusion Criteria

- Adults (≥18 years) of either sex.
- Acute closed subtrochanteric fracture of the femur.
- Patients fit for surgery and willing to comply with the follow-up protocol.

Exclusion Criteria

- Pathological fractures due to underlying malignancy or metabolic bone disease.
- Compound (open) fractures.
- Fractures associated with neurovascular deficit.
- Patients medically unfit for anaesthesia and surgery.

Operative Procedure

After appropriate preoperative work-up and anaesthetic clearance, all patients were taken up for surgery under spinal or general anaesthesia. The patient was positioned supine on a fracture table, and closed reduction was attempted first with traction, adduction, and internal rotation of the distal fragment under image intensifier guidance. When closed reduction was found to be unsatisfactory, a limited open reduction was performed to restore alignment before nail insertion. A standard entry point at the tip of the greater trochanter was used, and an appropriately sized Proximal Femoral Nail was introduced after sequential reaming. The cephalic neck screw and the anti-rotation hip pin were placed under fluoroscopic control, followed by distal locking. Wound closure was performed in layers, and a sterile dressing was applied.

Postoperative Rehabilitation

Static quadriceps and ankle-pumping exercises were begun from the first postoperative day. Sitting up in bed and hip and knee range-of-motion exercises were encouraged as soon as pain permitted. Non-weight-bearing walking with a walker was allowed from the second or third postoperative day. Partial weight-bearing was permitted after clinico-radiological evidence of early callus formation, and progression to full weight-bearing was guided by fracture pattern and radiological signs of union.

Outcome Assessment

Patients were followed up at 6 weeks, 3 months, 6 months, and thereafter as required. At each visit, clinical assessment was combined with anteroposterior and lateral radiographs of the hip and femur to assess callus formation, alignment, and hardware position. Radiological union was defined as the presence of bridging callus on at least three of four cortices with no pain on weight-bearing. Functional outcome was evaluated at the final follow-up using the Harris Hip Score (HHS), which was categorized as excellent (90–100), good (80–89), fair (70–79), or poor (<70).

Statistical Analysis

Data were entered into Microsoft Excel and analysed using descriptive statistics. Continuous variables such as age, time to weight-bearing, and time to union were expressed as mean ± standard deviation, while categorical variables such as sex, side of injury, AO classification, and functional outcome grade were expressed as frequencies and percentages.

RESULTS

A total of 44 patients with acute subtrochanteric femur fractures treated with Proximal Femoral Nail fixation were included in the final analysis. The mean age of the patients was 64.47 years, reflecting the elderly-predominant demographic profile of this injury.

Table 1. Demographic Characteristics and Mode of Injury

Variable	Category	No. of Patients (n=44)	Percentage (%)
Sex	Male	25	56.00
	Female	19	44.00
Mode of Injury	Domestic fall	33	75.00
	Road traffic accident	11	25.00

Males (n=25, 56%) slightly outnumbered females (n=19, 44%). Low-energy domestic falls were the mode of injury in 33 patients (75%), while the remaining 11 patients (25%) sustained their fracture in a road traffic accident, reflecting the mixed elderly-osteoporotic and young high-energy patterns characteristic of this fracture (Figure 1).

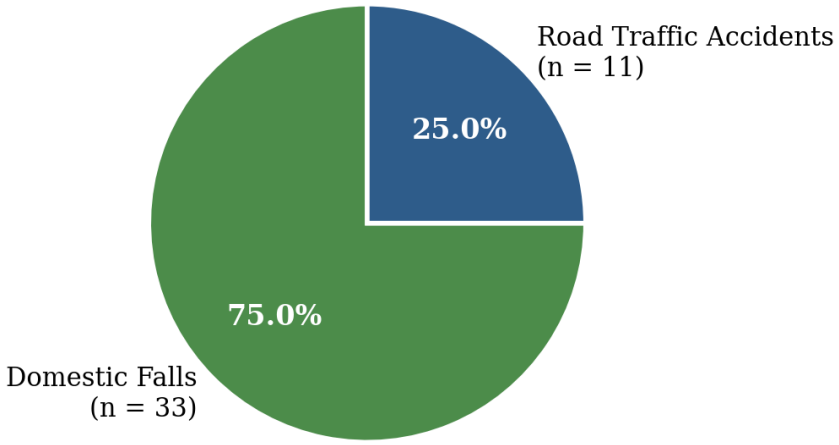


Figure 1. Distribution of Mode of Injury (n = 44)

Table 2. Side of Injury and AO Classification of the Fractures

Variable	Category	No. of Patients	Percentage (%)
Side	Right	23	52.28
	Left	21	47.72
AO Classification	31-A3.3	21	47.73
	31-A3.2	11	25.00
	31-A3.1	2	4.54
	32-A1.1	5	11.36
	32-A3.1	1	2.27
	32-B1.1	3	6.82
	32-B2.1	1	2.27

The right side was involved in 23 patients (52.28%) and the left side in 21 patients (47.72%). According to the AO/OTA classification, the reverse-oblique/transverse subtrochanteric pattern 31-A3.3 was the commonest morphology, encountered in 21 patients (47.73%), followed by 31-A3.2 in 11 patients (25%). The remaining fractures were distributed among 31-A3.1, 32-A1.1, 32-A3.1, 32-B1.1, and 32-B2.1 patterns (Figure 2).

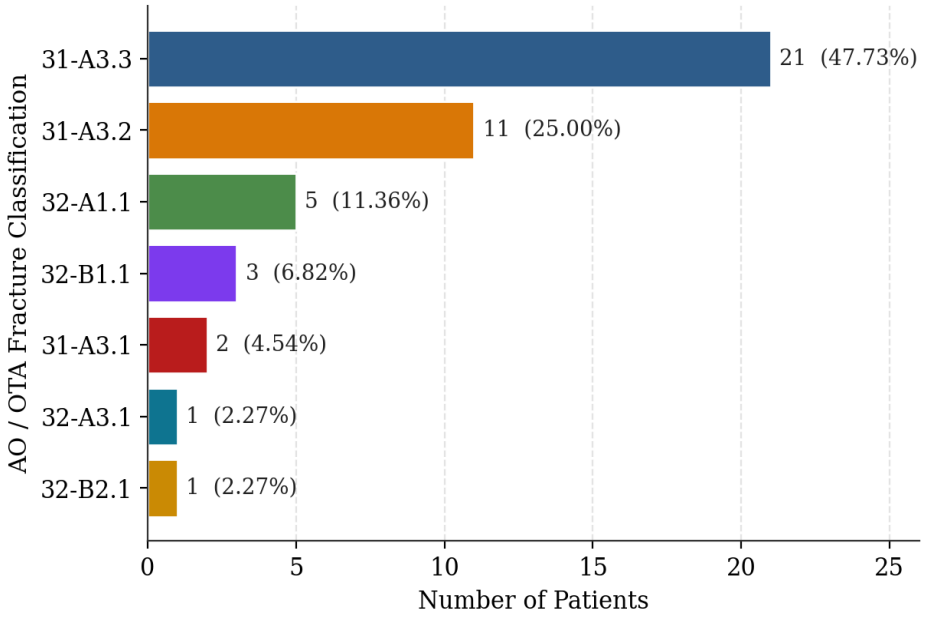


Figure 2. Distribution of Fractures by AO/OTA Classification

Table 3. Operative Details and Postoperative Milestones

Variable	Category	No. of Patients	Percentage / Value
Injury-to-surgery interval	≤5 days	37	84.10 %
	>5 days	7	15.90 %
Type of anaesthesia	Spinal	37	84.10 %
	General	7	15.90 %
Partial weight-bearing	Mean time	—	5.88 weeks
Full weight-bearing	Mean time	—	9.32 weeks
Radiological union	Mean time	—	16.36 weeks

Thirty-seven patients (84.1%) were operated upon within five days of injury, while the remaining seven (15.9%) required more than five days due to comorbidities that had to be optimized preoperatively. Spinal anaesthesia was used in 37 patients (84.1%) and general anaesthesia in 7 patients (15.9%). Partial weight-bearing was achieved at a mean of 5.88 weeks and full weight-bearing at a mean of 9.32 weeks after surgery. Radiological union was documented at a mean of 16.36 weeks (Figure 3).

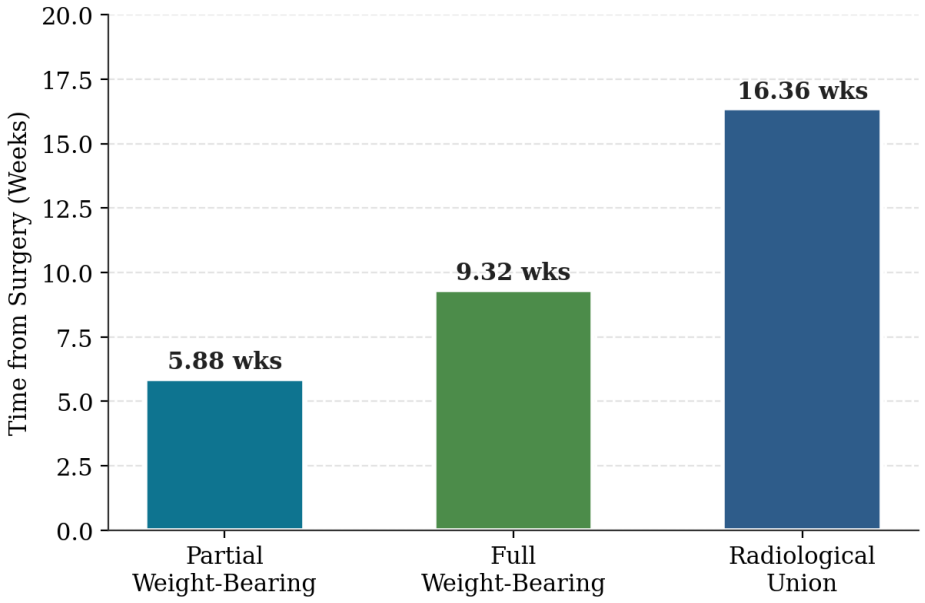


Figure 3. Mean Time to Weight-Bearing and Radiological Union

Table 4. Functional Outcome According to the Harris Hip Score

Outcome	Score Range	No. of Patients	Percentage (%)
Excellent	90 – 100	18	40.90
Good	80 – 89	19	43.18
Fair	70 – 79	5	11.36
Poor	< 70	2	4.54

At the final follow-up, the Harris Hip Score classified 18 patients (40.9%) as excellent and 19 patients (43.18%) as good, giving an overall satisfactory outcome (excellent + good) in 37 patients (84.08%). Five patients (11.36%) had a fair outcome, and two (4.54%) had a poor functional outcome (Figure 4).

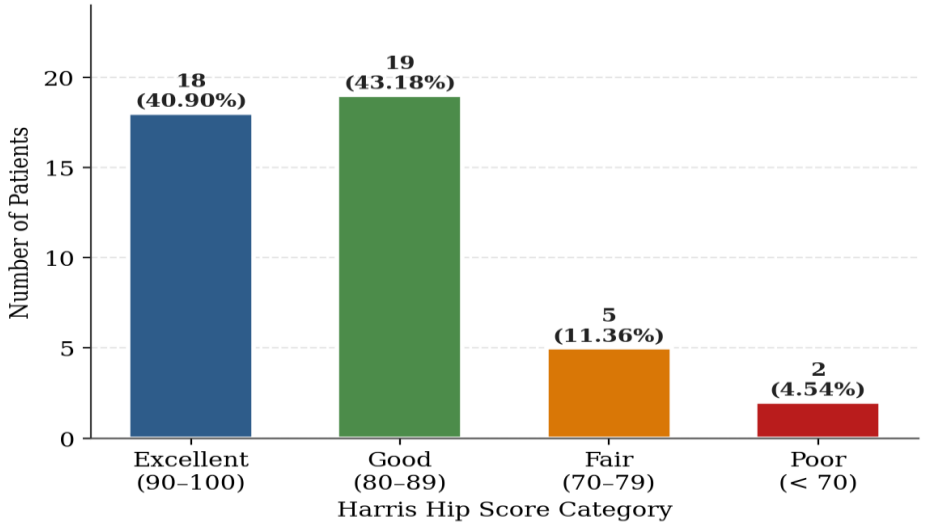


Figure 4. Functional Outcome by Harris Hip Score

Table 5. Postoperative Complications

Complication	No. of Patients	Percentage (%)
Superficial infection	2	4.54
Z-effect	2	4.54
Screw back-out	2	4.54
Implant breakage	2	4.54
Non-union	1	2.27

The overall complication rate in the series was low. Two patients each developed superficial wound infection, Z-effect, screw back-out, and implant breakage, while one patient developed a non-union. Superficial infections were managed with antibiotics and dressings and resolved without further intervention. Mechanical complications were addressed on a case-by-case basis with implant revision or exchange nailing as appropriate (Figure 5).

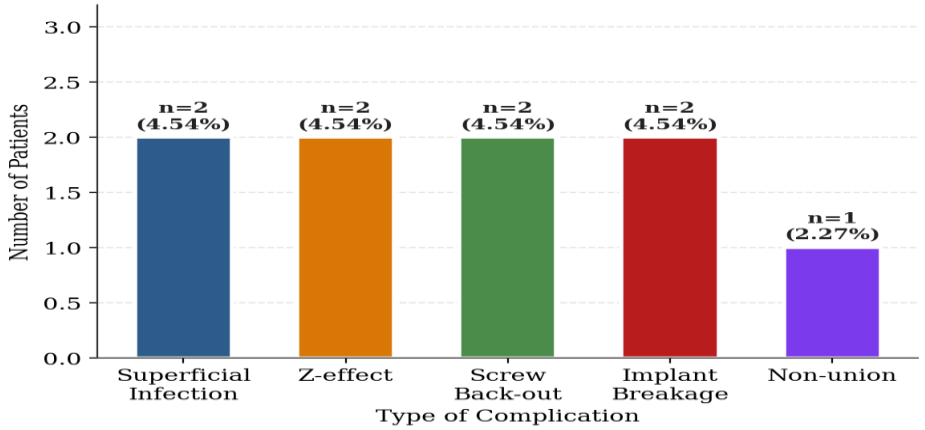


Figure 5. Distribution of Postoperative Complications

DISCUSSION

Subtrochanteric femur fractures continue to challenge orthopaedic surgeons because of the peculiar biomechanical environment of the subtrochanteric region and the wide spectrum of patients affected — from young adults injured in road traffic accidents to elderly individuals with osteoporotic bone. The present retrospective series of 44 patients treated with a Proximal Femoral Nail was undertaken to assess the radiological, functional, and complication profile of this implant in a real-world Indian setting.

The mean age of 64.47 years and the male preponderance (56%) in our series are consistent with the bimodal age distribution reported in the literature. The predominance of domestic falls (75%) as a mode of injury emphasizes the increasing burden of low-energy osteoporotic fractures in an ageing population. The AO/OTA type 31-A3.3 pattern was the most common morphology (47.73%), highlighting the fact that reverse-oblique and transverse fracture configurations — the very patterns that fare poorly with extramedullary devices such as the dynamic hip screw — form a substantial proportion of these injuries and provide the strongest rationale for intramedullary fixation.

The mean time to radiological union in this study was 16.36 weeks, closely comparable to the 16 weeks reported by Samynathan and Noordeen (8) and shorter than the 20 weeks reported by Zeng et al. (7). Progression of weight-bearing was similarly favourable, with partial weight-bearing achieved at a mean of 5.88 weeks and full weight-bearing at 9.32 weeks. This early return to ambulation is a key clinical advantage of intramedullary fixation, particularly in the elderly, where prolonged recumbency is associated with pulmonary, thromboembolic, and pressure-related complications and with a significant loss of pre-injury functional capacity.

Functional outcomes assessed by the Harris Hip Score were satisfactory (excellent or good) in 84.08% of our patients, corroborating the results of previous series. Ballal et al. (6) and Menezes et al. (4) both reported good-to-excellent outcomes exceeding 80% following PFN fixation, and more recent studies by Karim et al. (10) and Xu et al. (11) have reproduced these findings across diverse populations. The consistency of these results supports the view that the biomechanical advantages of the PFN — its intramedullary position close to the mechanical axis, the load-sharing effect of the nail, the preservation of the fracture haematoma with closed insertion, the rotational stability offered by the anti-rotation hip pin, and the reduced operative blood loss — translate into reliable clinical benefit.

Complications encountered in our series were few and largely manageable. Superficial infection resolved with antibiotics and local wound care. The Z-effect, characterized by opposite migration of the neck screw and the hip pin, has been described in the literature and was managed by revision of the sliding component. Screw back-out was addressed by re-tightening or exchange, and implant breakage necessitated revision surgery in the affected patients. The single case of non-union was managed with implant revision and bone grafting. These findings suggest that meticulous surgical technique — including correct entry point, adequate reduction before nailing, appropriate nail length and diameter, and correct positioning of the neck screw and hip pin within the femoral head — is essential to minimize mechanical failure.

The limitations of this study include its retrospective design, the modest sample size, and the absence of a comparison arm with an alternative implant such as a proximal femoral locking plate or an intertrochanteric antegrade nail. Nevertheless, our data agree with the growing body of national and international evidence in supporting PFN fixation as an effective, biomechanically sound, and clinically reliable method for the treatment of subtrochanteric femur fractures in adults.

CONCLUSION

Proximal femoral nailing offers stable, biomechanically favourable fixation for subtrochanteric femur fractures in adult patients. In this series, the technique permitted early rehabilitation, achieved a mean radiological union at 16.36 weeks, and produced satisfactory functional outcomes (excellent or good on the Harris Hip Score) in 84.08% of patients, with a low and manageable complication profile. Given these results and the biomechanical advantages inherent to intramedullary fixation, the Proximal Femoral Nail can be considered the implant of choice for subtrochanteric femur fractures in both young and elderly adults.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest related to this study.

SOURCE OF FUNDING

None declared. This study did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

ETHICAL APPROVAL

Institutional Ethics Committee approval was obtained prior to the commencement of the study, and the study was conducted in accordance with the ethical principles of the Declaration of Helsinki.

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