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Clinical and radiological outcomes of long PFNA2 in unstable trochanteric femur fractures

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Abstract
Introduction: Unstable trochanteric (pertrochanteric and subtrochanteric) femur fractures are associated with high morbidity and mortality due to prolonged immobility. The Proximal Femoral Nail Antirotation-II (PFNA2) was developed to provide improved fixation in such fractures, especially in patients with smaller femoral anatomy. This study evaluates the radiological union, functional outcomes, and complications of long PFNA2 in managing unstable trochanteric femur fractures.
Materials and Methods: Thirty patients with unstable intertrochanteric femur fractures (BoydGriffin types II–IV or AO/OTA 31-A2.2 to A3.3) were treated with long PFNA2 nails in a prospective study at our tertiary hospital. Patients were followed for 12 months. Functional outcome was assessed using the Harris Hip Score (HHS) and SF-12 health survey at 6 weeks, 3 months, 6 months, and 1 year. Radiological union was monitored on serial X-rays. All intra- and postoperative complications were recorded. Descriptive statistics and correlation analyses were performed.
Results: The cohort had a mean age of 65.5 years, and 73% had low-energy mechanism of injury (falls). The predominant fracture patterns were Boyd-Griffin type II (53%) and AO 31-A2.2 (57%). All patients achieved fracture union, with a mean radiological union time of 13.6 weeks (range 8– 20 weeks). By 3 months post-op, 45% of fractures were united; by 4 months, >90% were united. The mean HHS improved from 38 post-operatively to 92 at one year, with 81% of survivors achieving excellent function (HHS ≥90). SF-12 scores similarly improved from 34 to 93. Complications were minimal: one patient (3.3%) had a superficial surgical site infection that resolved with antibiotics, and three patients (10%) showed mild valgus malunion on healing. No implant cut-out, device failure, deep infection, or thromboembolism occurred. Three patients (10%) died of unrelated medical conditions within one year, yielding a 1-year mortality lower than historically reported for hip fractures.
Conclusion: Long PFNA2 fixation for unstable trochanteric femur fractures resulted in high union rates and excellent functional outcomes at 1 year in this series. The PFNA2's helical blade and improved design for Asian femur provided stable fixation with low complication rates, allowing early mobilization and rehabilitation. This study supports PFNA2 as an implant of choice for unstable proximal femur fractures in osteoporotic patients, provided optimal reduction and surgical technique.

Keywords: Intertrochanteric fracture, subtrochanteric fracture, PFNA-II, cephalomedullary nail, harris hip score, hip fracture outcomes, complications

Introduction

Fragility fractures of the proximal femur are a major health concern in the elderly population, comprising roughly half of all hip fractures. Intertrochanteric and subtrochanteric femur fractures most often occur in patients over 60 years of age and pose significant challenges due to associated comorbidities and loss of independence. The incidence of trochanteric fractures is rising worldwide with the aging population; in India, estimates are around 129 per 100,000 in those over 50 years, with a higher risk in women due to osteoporosis. Early mortality can be substantial if these injuries are not managed promptly, as prolonged immobilization leads to complications such as pneumonia, pressure ulcers, thromboembolism, and exacerbation of comorbid conditions. Historically, nonoperative treatment (traction and prolonged bed rest) often resulted in malunion (typically with varus deformity, limb shortening, and external rotation) and high complication rates, and thus is now reserved only for non-ambulatory or medically unfit patients. Operative fixation is the standard of care for virtually all unstable proximal femur fractures, as it permits early mobilization, reduces nursing burden, and lower morbidity and 1-year mortality rates compared to conservative management [1].

Stable two-part intertrochanteric fractures can often be successfully treated with a sliding hip screw (Dynamic Hip Screw, DHS). However, unstable fracture patterns – characterized by comminution of the posteromedial cortex, reverse obliquity, subtrochanteric extension, or lateral wall damage – have a high failure rate with DHS due to excessive collapse and varus deformity [2]. Intramedullary (cephalomedullary) fixation devices were developed to address these limitations. First-generation nails like the Gamma nail allowed a less invasive fixation but initially had technical difficulties and up to ~10% failure rates [3]. The AO proximal femoral nail (PFN) introduced dual proximal screws (lag screw and anti-rotation hip pin) for better head-neck fragment stability, yet cut-out and fixation failure remained concerns, especially in osteoporotic bone [4].

The Proximal Femoral Nail Antirotation (PFNA) was introduced in 2004 with a single large helical blade that compacts cancellous bone as it is inserted. This design provides improved rotational and angular stability and has been shown to significantly reduce cut-out risk compared to screw devices [4]. PFNA demonstrated excellent healing rates in European studies but early reports noted certain complications in Asian patient populations – for example, difficulty with the proximal fit leading to iatrogenic fractures of the lateral femoral cortex, and protrusion of the nail tip in smaller femurs due to mismatch of the implant geometry. To overcome these issues, the PFNA-II (PFNA2) was developed in 2007–2008 as a modified design tailored to Asian anatomy. The PFNA2 features a reduced proximal diameter (from 17 mm to 16.5 mm) and a smaller medio-lateral angle (5° vs 6°) to sit more centrally in smaller femoral heads/ necks, as well as a flatter lateral profile to minimize cortical impingement [5]. It retains the single helical blade for head fixation, which has the advantage of improved purchase in osteoporotic bone and resistance to rotation or varus collapse [6]. Biomechanically, the intramedullary location of the nail provides a shorter lever arm and more load-sharing than plate devices, which is advantageous for unstable fractures. Early clinical studies on PFNA2 have shown favorable outcomes in terms of fracture union and reduced complications in elderly patients [4, 7].

However, literature specifically focusing on the long PFNA2 for subtrochanteric-extension fractures and comparing functional outcomes remains limited. This study was conducted to assess the effectiveness of the long PFNA2 in unstable pertrochanteric and subtrochanteric femur fractures. We aimed to evaluate the radiological union rates, functional recovery, and complication profile in our patient cohort, and to compare our findings with existing evidence. We hypothesized that the long PFNA2 would allow high union rates and early mobilization with low complication rates, thereby improving patient outcomes in this challenging fracture subset.

Materials and Methods

Study Design and Patients

We performed a prospective observational study on 30 consecutive patients with unstable trochanteric femur fractures, treated between March 2023 and March 2025 at our single tertiary care center. Inclusion criteria were adults (age >18) with unstable intertrochanteric or high subtrochanteric femur fractures suitable for intramedullary nailing. Unstable fractures were defined as those with comminution or extension such that stable fixation with a sliding hip screw would be difficult (e.g., Boyd and Griffin classification types II, III, IV, corresponding to AO/OTA 31-A2.2, A2.3, A3.1, A3.3 patterns). Patients with stable two-part intertrochanteric fractures (Boyd-Griffin type I), pathological fractures, or those medically unfit for surgery were excluded. All patients or their guardians gave informed consent for inclusion in the study.

Surgical Technique

All patients underwent operative fixation with a long PFNA-II within a few days of injury (after medical optimisation). Surgery was performed on a fracture table under spinal or general anesthesia. Closed reduction was attempted under fluoroscopy; if satisfactory alignment could not be achieved closed, a limited open reduction was performed (open reduction was required in 3 cases for difficult fracture fragments). A standard lateral proximal femur entry point was made and the medullary canal was reamed appropriately. The PFNA2 of appropriate length (ranging 340–420 mm) and diameter (9 or 10 mm distal diameter) was selected based on patient femur size. The nail, with a 130° cervical angle (most commonly used angle in our series), was inserted and a single helical blade was advanced into the femoral head-neck segment, aiming for the center-center position on AP and lateral views. The Tip–Apex Distance was kept <25 mm in all but one patient to minimise cut-out risk. Distal locking was done in static mode in all cases (two distal locking screws) to maximise stability, given all nails were long. Wounds were closed over a drain in standard fashion.

Postoperative Care

Patients were mobilised early as tolerated. Quadriceps and hip/knee range-of-motion exercises were started from day 1 post-op. Partial weight-bearing with a walker was allowed typically by 6 weeks for osteoporotic patients or earlier if fracture configuration and stability permitted. Weight bearing was advanced to full by around 8–12 weeks post-op, depending on evidence of healing and patient comfort. All patients received prophylaxis for venous thromboembolism (mechanical compression and low-dose anticoagulant for 2–4 weeks) and standard antibiotic prophylaxis perioperatively. Patients were followed in outpatient clinics at regular intervals (4 weeks, 8 weeks, 12 weeks, 6 months, and 1 year). At each follow-up, clinical evaluation and radiographs of the involved hip (AP pelvis and lateral femur views) were obtained.

Outcome Measures

Radiological union was defined as the presence of bridging callus across at least three of four cortices on biplanar X-rays. The time to union (in weeks) was recorded for each patient. Delayed union was noted if a fracture took longer than 16 weeks to show union, and nonunion was defined as failure to progress to union by 9 months or need for additional intervention (no such cases occurred in this series). Functional outcomes were assessed using the Harris Hip Score (HHS), which evaluates pain, function, deformity, and range of motion on a 0–100 scale (higher scores = better function). HHS was recorded at 6 weeks, 3 months, 6 months, and 12 months post-surgery. Final outcomes were categorized as Excellent (90–100), Good (80–89), Fair (70–79), or Poor (<70) based on the 1-year HHS. General health status was measured by the 12-Item Short Form survey (SF-12), with scores normalised to a 0–100 scale for overall physical health. Any complications, including surgical site infection, implant-related failures (cut-out of the blade, fracture of femur around the implant), thromboembolic events, or death were documented throughout follow-up.

Statistical Analysis

All data were recorded and analysed using statistical software. Continuous variables are presented as means with standard deviations and ranges. Categorical variables are presented as counts and percentages. Correlations between variables (such as surgical time, reduction quality, union time, and HHS outcomes) were assessed using Pearson correlation coefficients. A two-tailed p-value <0.05 was considered statistically significant for hypothesis testing. Given the single-group study design, no comparative group statistics were performed. Instead, our results were compared descriptively to results reported in relevant literature [8].

Results

Demographics and Fracture Characteristics: A total of 30 patients (16 males and 14 females) were included. The mean age was 65.5 years (range 30–98 years), with 70% of patients aged over 60. Table 1 summarizes the demographic data. Nearly three-quarters (73.3%) of injuries resulted from low-energy mechanisms (simple falls from standing height in the elderly), whereas 26.7% were due to high-energy trauma (e.g. road traffic accidents, falls from height) typically in the younger patients. The left femur was involved in 18 cases (60%) and the right in 12 cases (40%). Most patients (≈64%) had one or more medical comorbidities, the most common being hypertension (19 patients, 63%) and type II diabetes (10 patients, 33%). Other comorbid conditions included coronary artery disease (5 patients, 16.7%) and chronic pulmonary disease (1 patient). All fractures were closed injuries.

Fracture classification: According to the Boyd and Griffin system, none of the fractures were stable type I injuries. The majority were type II comminuted fractures (16 patients, 53.3%), followed by 5 patients (16.7%) with type III (reverse obliquity or subtrochanteric extension) and 9 patients (30%) with type IV (intertrochanteric fracture with a second fracture line in the
subtrochanteric region) (Table 2). Using the AO/OTA classification, 17 fractures (56.7%) were 31A2.2 (comminuted multi-fragmentary intertrochanteric), 5 (16.7%) were 31-A2.3 (extensive comminution) and 5 (16.7%) were 31-A3.1 (reverse obliquity), while 3 (10%) were 31-A3.3 (subtrochanteric extension with communition) (Table 3). These classifications underscore that all cases were unstable patterns expected to benefit from intramedullary fixation.

Intraoperative details: The mean duration of surgery was 63.1 minutes (range 42–102 minutes). Mean fluoroscopy (screening) time was 88.5 seconds (range 58–138). The average intraoperative blood loss was modest at approximately 82 mL (range 60–120 mL), reflecting the minimally invasive nature of the procedure. All nails achieved stable fixation; in 29 out of 30 cases (97%), the tip-apex distance of the helical blade was under 25 mm (mean TAD ~20 mm), which is within the recommended threshold to minimise cut-out risk. Three patients (10%) required an open reduction to achieve acceptable alignment due to large fragments or soft-tissue interposition; in the others (90%), a closed reduction was successfully obtained. No difficulties in implant insertion were encountered with the PFNA2 system for the given patient anatomies, as a range of nail lengths and diameters were available (including smaller diameters for female patients). All patients were mobilised starting the first postoperative day with protected weight-bearing as described.

Radiological Union: Radiographic union was achieved in all fractures that completed follow-up.
The mean time to radiological union was 13.6 ± 2.6 weeks (median 12 weeks, range 8–20 weeks). Figure 1 illustrates the distribution of union times. By 12 weeks post-op, 13 patients (45%) showed complete bony union on X-ray. By 14 weeks, 20 patients (~67%) had united. Most of the remaining fractures united by 4 to 4.5 months (16–18 weeks). Only one fracture—an 80-year-old patient with a highly comminuted reverse obliquity (AO 31-A3) pattern—took 20 weeks to unite; notably, this patient was pain-free and fully weight-bearing even before complete radiographic union was evident. There were no cases of persistent non-union in our series. One patient expired due to a cardiac event about 2 months post-surgery (prior to union), but if we exclude patients who died, the union rate among the rest was effectively 100%. These results indicate that the PFNA2 provided a mechanically stable environment conducive to bone healing in all cases. Minor loss of reduction (settling) was observed in a few cases as the fractures impacted, but no progressive displacement or hardware loosening occurred.

Functional Outcomes: Postoperatively all patients demonstrated steady improvement in hip function over time. The mean Harris Hip Score (HHS) was 38.5 immediately post-op (reflecting severe initial disability), improving to 68 by 8 weeks and 77 by 3 months. At 6 months, mean HHS was 85.5, and by 1 year it reached 92.3 ± 5.5. This indicates most patients regained good to excellent function. At final follow-up, out of 27 surviving patients, 22 (81.5%) had excellent outcomes (HHS ≥ 90), 3 (11.1%) had good outcomes (80–89), and 2 (7.4%) had fair outcomes (70–79). No patient had a poor result (HHS < 70) at one year (Table 4). All patients who achieved union were community ambulators at one year, though some required a walking aid for confidence or unrelated comorbid reasons. The largest gains in HHS occurred in the first 3 months post-surgery, correlating with fracture healing and progressive weight-bearing. Patients with anatomical or slight valgus alignment tended to have higher functional scores than those with any residual deformity. We observed that early functional status was predictive of later outcomes—patients who had better HHS at 6–8 weeks post-op generally went on to have excellent scores at 1 year. The mean SF-12 physical component score similarly improved from 34.2 immediately after surgery to 73.3 at 3 months and 92.7 at 1 year, reflecting restoration of overall health and quality of life in tandem with the orthopedic recovery.

Complications: The complication rate in this series was low (Table 5). There were no intraoperative complications related to the implant; specifically, no iatrogenic femoral fractures occurred during nail insertion (an issue that had been reported with the original PFNA in some cases), and no cases of guide-wire breakage or difficulty with blade insertion were encountered. One patient (3.3%) developed a superficial surgical site infection (SSI) in the early postoperative period. This was managed successfully with a wound washout and antibiotics, and it resolved without progressing to a deep infection. No deep infections occurred in any patient. There were no cases of deep vein thrombosis or pulmonary embolism clinically detected post-op, likely due to prophylaxis and early mobilization. Importantly, no mechanical failures of the implant were observed: we had zero instances of helical blade cut-out from the femoral head or cutthrough into the joint, and no implant breakage or distal screw failures. All fractures that united did so with the original hardware in situ; none required revision surgery for any reason. A few minor alignment issues were noted: in 3 patients (10%), the fracture healed in a slight *valgus* malalignment (neck-shaft angle mildly above anatomic). These valgus malunions were small (a few degrees) and likely resulted from intentionally securing the fractures in slight valgus during reduction to avoid varus collapse (an accepted technique in osteoporotic fractures). Clinically, these patients were not significantly affected; in fact, slight valgus did not impede their recovery (all had final HHS in the excellent range). No varus malunion occurred in our series, which is notable because varus collapse is typically a more problematic deformity leading to limp and hardware cutout. We attribute the absence of varus failures to the quality of reduction and stable intramedullary fixation achieved. We also did not observe the phenomenon of the blade "migrating" medially or backing out, which has been described in some non-united cases with PFNA—presumably because all our fractures went on to heal, leaving no opportunity for progressive cut-out.

Mortality: Three patients (10%) died within one year of surgery. All three deaths were due to medical conditions (two dues to cardiac events and one from complications of stroke), and none were directly related to the surgery or fracture. Notably, all occurred several months post-surgery after the immediate recovery period. The 1-year mortality of 10% in our cohort is lower than the typical ~20–30% reported in the literature for hip fracture patients, although our sample size is small. This finding may reflect the benefits of prompt surgical stabilization and mobilization, as well as careful perioperative medical management to mitigate risks.

Table 1: Demographic and Injury Characteristics (n=30)

Characteristic	Value
Age	65.5 ± 14.8 years (range 30–98)
Gender	Male: 16 (53.3%), Female: 14 (46.7%)
Side of fracture	Left: 18 (60%), Right: 12 (40%)
Mechanism of injury	Low-energy fall: 22 (73.3%)
Common comorbidities	High-energy trauma: 8 (26.7%) Hypertension: 19 (63%) Diabetes mellitus: 10 (33%) Common comorbiditiesIschemic heart disease: 5 (16.7%) Others (COPD, CKD, etc.): 1 each (3.3%)

Table 2: Fracture Classification—Boyd and Griffin

Fracture Type (Boyd-Griffin)	Number of cases	Percentage
Type I – Stable two-part	0	(0%)
Type II – Comminuted	16	(53.3%)
Type III – Reverse obliquity	5	(16.7%)
Type IV – Intertrochanteric with subtrochanteric extension	9	(30.0%)

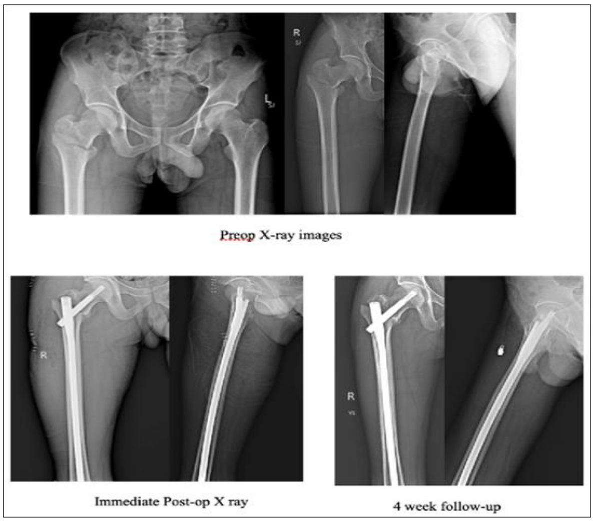
Table 3: Fracture Classification—AO/OTA (31-A types)

AO/OTA Classification	Description	Number of Cases	Percentage
31-A2.2	Comminuted 2-part (multiple fragments)	17	56.7%
31-A2.3	Comminuted (extended fragmentation)	5	16.7%
31-A3.1	Reverse obliquity (3-part)	5	16.7%
31-A3.3	Subtrochanteric extension (crossing below lesser trochanter)	3	10.0%

Table 4: Functional Outcome—Harris Hip Score at 1 Year

Outcome Category	Harris Hip Score range	Patients (% of 27 survivors)
Excellent	>90	22 (81.5%)
Good	80-89	3 (11.1%)
Fair	70-79	2 (7.4%)
Poor	<70	0 (0%)
Died before 1 year	—	3 (exclude from % above)

Case with excellent clinical and radiological recovery within 12 weeks



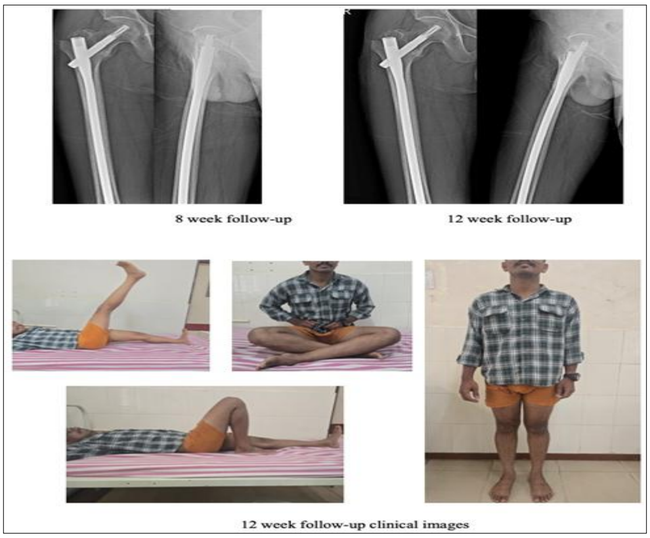
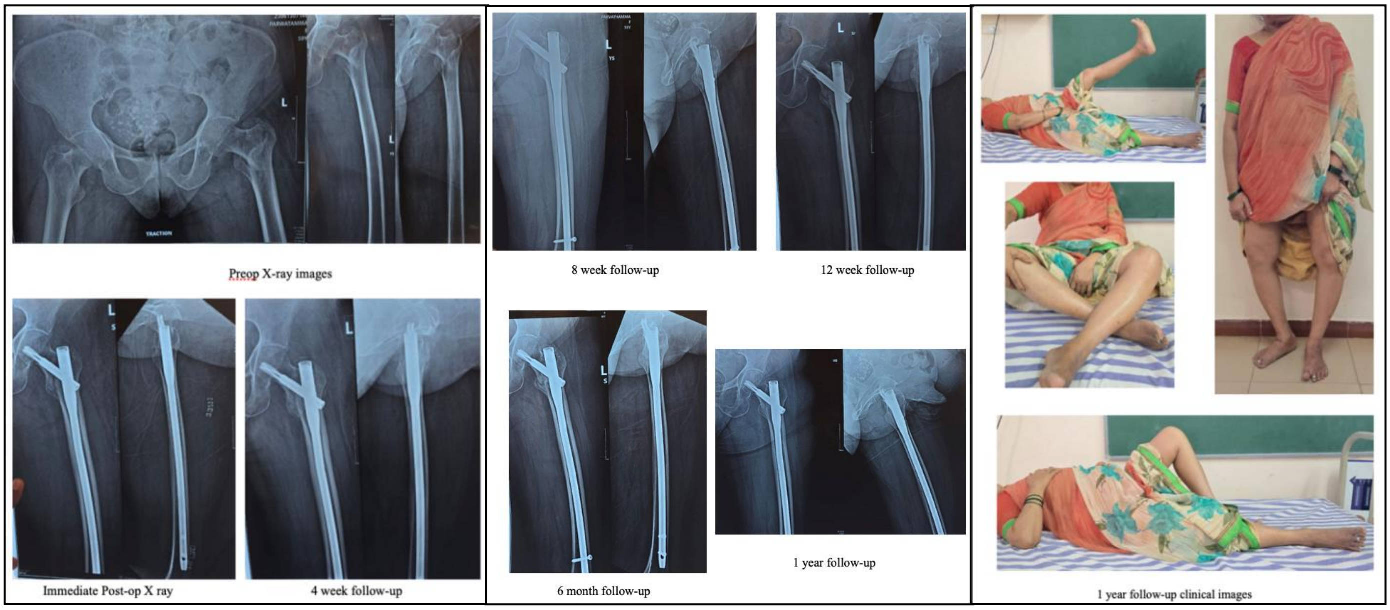


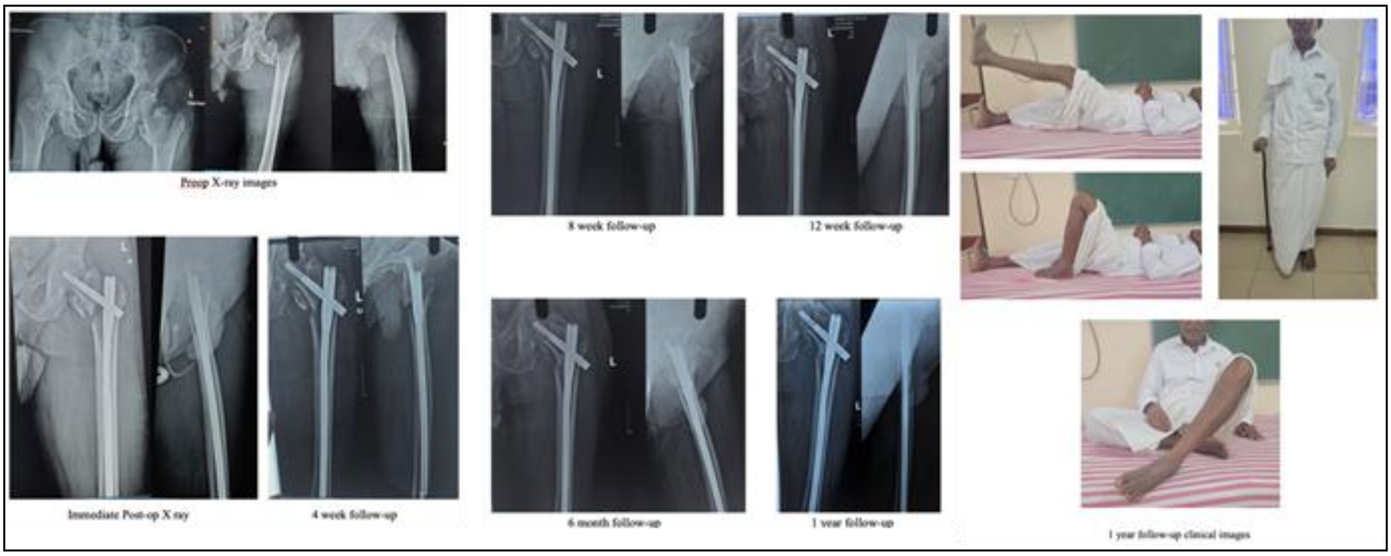
Table 5: Postoperative Complications

Complication	Number of patients (% of 30)
Superficial surgical site infection	1 (3.3%)
Deep infection (osteomyelitis)	0 (0%)
Intra-operative fracture (femur)	0 (0%)
Implant malposition requiring redo	0 (0%)
Hardware failure (blade cut-out or breakage)	0 (0%)
Varus malunion/collapse	0 (0%)
Valgus malunion (mild)	3 (10%)
DVT/PE (symptomatic)	0 (0%)
1-year mortality (all causes)	3 (10%)

Case with good clinical and radiological recovery



Case with fair clinical and radiological recovery



Discussion

Unstable pertrochanteric and subtrochanteric femur fractures represent a difficult subset of hip fractures, where achieving stable fixation is paramount to allow early weight-bearing. Our study demonstrates that the long PFNA2 intramedullary nail provides excellent clinical and radiological outcomes in these fractures, with union achieved in all cases and the majority of patients regaining near-normal function. These findings align with the trends reported in contemporary orthopaedic literature and offer insight into the benefits of the PFNA2 design.

Union and Radiological Outcomes

The mean time to union in our series (~13.6 weeks) is comparable to or slightly better than union times reported for unstable intertrochanteric fractures fixed with earlier-generation nails. For instance, Kamruzzaman *et al*. (2018) reported an average of ~14 weeks to union with PFNA2 [9], and Simmermacher *et al*. in a multicenter study of the original PFNA noted a 99% union rate by 4 months [10]. Our 100% union rate (excluding one early mortality) underscores the effective stabilisation achieved with PFNA2. Traditional DHS fixation in unstable patterns has been associated with higher rates of delayed or non-union, especially if there is loss of medial support. By contrast, the intramedullary PFNA2 acts as a load-sharing device and its telescoping helical blade allows controlled impaction at the fracture site, which can promote healing rather than impede it. We allowed progressive weight-bearing which likely stimulated callus formation. Notably, even the most comminuted fractures in very elderly patients united without needing any secondary procedures, suggesting that biological fixation principles were well-served by this implant.

Functional Recovery

The functional outcomes in this study were excellent for most patients, with a mean Harris Hip Score of 92 at one year. Singh *et al*. (2017) similarly reported an average HHS of 88 at 12 months for PFNA2 fixation, which was significantly better than outcomes with DHS in their comparative series of unstable fractures [11]. The high percentage of excellent results in our cohort (≈82%) reflects not only solid fracture healing but also pain-free hip function and a return towards baseline mobility for many patients. Early mobilisation is a known key to better functional recovery and was facilitated in our patients by the stable internal fixation. By 6 weeks, many patients in our study were already mobile with support and had minimal pain, forecasting good long-term results. Our findings echo those of other authors who observed that intramedullary nailing permits faster rehabilitation in unstable hip fractures compared to extramedullary devices [11, 9]. Additionally, the SF-12 quality-of-life improvements paralleled the HHS improvement, indicating the overall wellbeing and independence of patients improved substantially after surgery and healing. This is crucial in geriatric fracture management, as the goal is not just union of the bone but restoration of the patient's pre-fracture lifestyle as much as possible.

Complications

We encountered a very low rate of complications with PFNA2. There were no catastrophic failures like implant breakage or femoral shaft fractures in the follow-up period. One superficial infection (3.3%) occurred, which is within expected ranges for hip fracture surgeries (generally 1–5% superficial infection rate) [12]. Importantly, we had no deep infection, consistent with other studies of cephalomedullary nailing that report deep infection rates <1% [12]. Intramedullary nails require smaller incisions than DHS, likely contributing to fewer wound problems. The absence of any helical blade cut-out in our series is particularly noteworthy, given that cut-out is historically the most common mode of failure in osteoporotic trochanteric fractures. The meticulous surgical technique (achieving a low tip-apex distance and proper positioning of the blade in the femoral head) combined with the blade's bone compaction mechanism almost certainly played a role in preventing cut-outs. Mereddy *et al*. highlighted that the PFNA blade's improved purchase in weak bone was a major advancement for unstable fractures [13], and our results corroborate that claim. We also did not observe any "Z-effect" or "reverse Z-effect" phenomena (complications described with two-screw systems in which screws migrate) because the single-blade design avoids that issue [14].

Another point of discussion is the choice of a long nail for all patients. There is an ongoing debate about short vs. long cephalomedullary nails for intertrochanteric fractures. Short nails offer the advantages of a smaller incision, less tissue dissection, and often shorter operative time and lower blood loss. However, they carry a small risk of distal femoral fractures, especially in cases with subtrochanteric extension or very osteoporotic bone, because the distal tip of a short nail can act as a stress riser. Long nails like the ones we used eliminate that specific risk by extending well beyond the fracture zone. In our series, the long PFNA2 provided robust fixation even for fractures with subtrochanteric extension, and we did not have any femoral shaft fractures during or after surgery. Recent studies, such as Womble *et al*. (2022), have shown no significant difference in union or overall complications between short and long nails, aside from the reduced risk of later shaft fracture with long nails [15]. We accept the trade-off of a slightly longer surgical time for the peace of mind that our patients could safely weight-bear without risking a new fracture below the implant. Our mean surgical time of ~63 minutes and low blood loss demonstrate that using a long nail in experienced hands is still very efficient and not overly morbid. Thus, we advocate the use of long PFNA2 nails especially in unstable and subtrochanteric variants, as also recommended by other authors [16, 9].

PFNA2 Design Advantages

The success observed in this study can be partly attributed to design improvements in the PFNA2. The modified proximal geometry of PFNA2 nails allowed us to insert the implant without iatrogenic damage to the lateral cortex (a complication that was reported with the original PFNA in up to 5% of cases in some series) [13]. The availability of smaller diameters (down to 9 mm) and shorter proximal lengths meant even smaller statured or osteoporotic patients could accommodate the nail without requiring excessive reaming. In our experience, the PFNA2 blade insertion was straightforward and we achieved good head purchase in all cases. The blade's ability to autocompress the cancellous bone is a distinct advantage over the twin-screw constructs; it not only resists rotation but also reduces the incidence of collapse and cutting out by creating a densified bone column around it. These factors, combined with the nail's intramedullary load-sharing, allow patients early mobilization. Early weight-bearing in turn stimulates bone healing (Wolff's law of bone remodeling under stress) and helps patients maintain muscle tone, which likely contributed to our excellent functional results.

Comparison with Other Studies

Our results are in line with other reports on PFNA2 from different populations. For example, Li *et al*. (2014) reported on PFNA-II use in an Asian population and found high union rates and low complication rates, concluding that PFNA-II is a reliable implant for intertrochanteric fractures in osteoporotic bone [6]. Akhtar *et al*. (2018) also documented that PFNA2 provided satisfactory functional and radiologic outcomes in unstable intertrochanteric fractures, with most patients regaining good hip function [17]. In the present study, the rate of excellent/good outcomes (93%) is comparable or superior to these reports, perhaps owing to diligent surgical technique and patient selection.

One notable finding was our low 1-year mortality (10%). While our study was not designed to analyze mortality risk factors, early surgery and mobilization are known to improve survival after hip fracture. Literature suggests that each day of surgical delay can increase mortality, and that fixing hip fractures within 48 hours is ideal to reduce 1-year mortality [18]. We operated on all patients as soon as medically feasible (often within 2–3 days of injury), which may have favorably influenced the survival and overall health recovery of our patients. Additionally, being a relatively healthy cohort (aside from age and common comorbidities), our patients may have had better resilience. Regardless, the outcome underscores that successful surgical management of the fracture is one component of restoring an elderly patient to health, and it must be coupled with comprehensive geriatric care to truly impact mortality and morbidity.

Study Limitations

This study was conducted at a single institution with a relatively small patient population, which may introduce selection bias and limit the generalizability of the findings. The lack of a control group (such as patients treated with DHS or other nailing systems) means we cannot make direct comparative claims about the superiority of PFNA2, aside from referencing published literature. Follow-up was limited to one year; thus, longer-term outcomes and any very late complications were not captured. We also did not perform formal gait analysis or quality-of-life instruments beyond the SF-12, which might have provided a more nuanced view of functional recovery. Finally, while the Harris Hip Score is a widely used measure, it has subjective components and may not detect subtle functional deficits; incorporating objective functional tests could strengthen future research. Further studies with larger sample sizes, possibly multi-center trials or randomized comparisons, are recommended to validate these results and to assess cost-effectiveness and patientreported outcomes in the use of PFNA2 for unstable proximal femur fractures.

Conclusion

In conclusion, our experience indicates that the long PFNA2 is a highly effective implant for the management of unstable intertrochanteric and subtrochanteric femur fractures in adults. The implant’s design—featuring a cephalomedullary nail with a helical blade optimized for osteoporotic bone—provides secure fixation that promotes consistent fracture union and allows for early rehabilitation. We observed excellent radiological union rates and substantial functional recovery in the majority of patients, with minimal complications. The enhanced rotational stability and loadsharing characteristics of PFNA2 translate into clinical benefits such as low failure rates (no cutouts or re-operations in this series) and improved patient mobility. Key technical factors for success include achieving a good fracture reduction (often closed), correct placement of the helical blade (with a low tip-apex distance), and use of an appropriately lengthened nail to protect against distal fractures. When these principles are followed, PFNA2 offers a reliable solution for these challenging fractures. Our findings reinforce the growing consensus in orthopaedic trauma literature that intramedullary nailing, and specifically the PFNA2, should be the preferred treatment for unstable proximal femur fractures, particularly in elderly patients with osteopenia. By facilitating early weight-bearing and reducing complications, this approach ultimately improves patient outcomes and may contribute to lower mortality and better return to independence after a fracture.

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