Int J Burn Trauma 2025;15(4):159-170
www.IJBT.org /ISSN:2160-2026/IJBT0165775

Original Article

Short versus long proximal femoral nail anti-rotation-II (PFNA-II) in the management of unstable intertrochanteric fractures

Latif Zafar Jilani[1], Mohd Saleh[1], Mohammad Baqar Abbas[1], Sohail Ahmad[1], Abdul Qayyum Khan[1], Asad Khan[2]

[1]*Department of Orthopaedic Surgery, J. N. Medical College, Faculty of Medicine, A.M.U., Aligarh, India;* [2]*Department of Orthopaedic Surgery, B.R.D. Medical College and Nehru Hospital, Gorakhpur, U.P., India*

Received May 1, 2025; Accepted July 8, 2025; Epub August 15, 2025; Published August 30, 2025

Abstract: Objectives: Unstable intertrochanteric (IT) fractures, particularly in elderly patients with low bone mineral density, pose significant treatment challenges. Proximal femoral nail anti-rotation-II (PFNA-II) is widely used, but the optimal implant length (short vs. long) remains debated. The objective of this study was to compare the clinical and functional outcomes of short versus long PFNA-II implants in unstable IT fractures. Methods: A prospective comparative study was conducted at a tertiary hospital from November 2018 to November 2020. Adult patients (age ≥18) with recent (≤3 weeks) unstable IT femur fractures were included. Unstable fractures were defined by comminution of the posteromedial cortex, a compromised lateral wall (including reverse obliquity), or subtrochanteric extension. Patients with pathological fractures (other than osteoporosis), open fractures, polytrauma, pre-existing ipsilateral hip pathology, or non-ambulatory status were excluded. Patients were allocated to short PFNA-II (n=38) or long PFNA-II (n=40) groups based on the surgeon's intraoperative judgment (no randomization). All patients underwent standard reduction on a fracture table and fixation with PFNA-II. Postoperative mobilization and weight-bearing protocols were adjusted according to fracture stability and fixation quality. Outcome measures included fracture union time, complications, and the Harris Hip Score (HHS). Statistical significance was set at P<0.05. Results: Both groups had similar demographics, fracture types, and surgical durations (P>0.05). Fracture union was achieved in 94.7% (36/38) of short-nail patients and 90% (36/40) of long-nail patients, with no significant difference in union rates or time to union (mean ~14 weeks, P>0.05). The short PFNA-II group demonstrated a significantly higher final HHS (87.2±7.1 vs. 82.3±7.8, P=0.03), with 89.5% achieving good/excellent outcomes vs. 62.5% in the long-nail group. Postoperative complications differed in pattern: anterior thigh pain was more frequent in short nails (15.8% vs. 2.5%), whereas mechanical complications (varus collapse >5°, helical blade lateral migration) were more common in long nails (15% vs. 5.3% varus collapse; 10% vs. 2.6% blade migration). However, overall complication rates were not significantly different between groups (P=0.17). No deep infections, implant breakage, or cut-out occurred in either group. Conclusion: PFNA-II fixation is effective for unstable IT fractures with high union rates and low major complication rates in both implant groups. Short PFNA-II nails yielded superior functional outcomes and fewer mechanical complications compared to long nails in similar unstable fracture patterns. These findings suggest that implant length plays a crucial role in optimizing patient outcomes. In most cases of unstable IT fractures, a short PFNA-II appears advantageous, though patient anatomy (e.g. extreme femoral curvature) and fracture morphology should be considered when selecting implant length.

Keywords: Intertrochanteric fracture (IT), proximal femoral nail anti-rotation-II (PFNA-II), implant length, NSA (neck shaft angle), Harris Hip Score

Introduction

With increasing life expectancy, intertrochanteric (IT) hip fractures are becoming more common. Research in the 1990s by Cooper et al. and Gullberg et al. predicted that between 4.50 and 6.26 million hip fractures will occur worldwide by 2050, with roughly half of these in Asia [1, 2]. Unstable IT fractures are characterized by comminution of the posteromedial cortex, a compromised lateral wall (including reverse obliquity patterns), or subtrochanteric exten-

https://doi.org/10.62347/LRTZ6852

sion of the fracture [3]. These unstable patterns are more common in elderly patients with low bone mineral density. Among the many challenges in managing these fractures, choosing the appropriate implant for fixation remains a significant question. One debated aspect is the optimal length of the intramedullary device (short versus long) for unstable fractures.

The primary goal in treating IT fractures is to achieve early mobilisation, thereby restoring the patient to their pre-injury functional state. To achieve this, various intramedullary nailing and extramedullary plating systems have been developed, incorporating either a single compression screw or a compression screw coupled with an anti-rotation screw. The Proximal Femoral Nail (PFN) has gained popularity for unstable IT fractures. PFN devices have demonstrated superior biomechanical stability and outcomes compared to extramedullary devices in unstable IT fractures; however, postoperative complications, such as screw cut-out, hardware migration, varus collapse, and rotational instability, remain significant concerns, with reported complication rates of up to 31% in some series [4].

The PFNA-II (Proximal Femoral Nail Antirotation II) was introduced to address these issues, particularly in osteoporotic patients and those of smaller stature (e.g., Asian populations). Key design features of PFNA-II include a reduced proximal nail diameter (16.5 mm vs. 17 mm in the original PFNA), a decreased mediolateral neck angle (5° vs. 6°), and a flattened lateral surface to avoid impingement on the lateral cortex of the femur during insertion [5, 6]. One of its most significant features is the use of a single helical blade for head-neck fixation, which eliminates the bone loss associated with drilling for a traditional sliding hip screw. The helical blade compacts cancellous bone around it during insertion, increasing the bone-implant interface and providing enhanced purchase - thereby reducing the risk of rotation and varus collapse under load [5]. Furthermore, the PFNA-II nail's flexible tip helps ease insertion and dissipates stress at the distal tip, which decreases the risk of cortical damage and implant failure (such as nail or distal locking screw breakage) in the femoral shaft [7].

Currently, both short and long versions of the PFNA-II are used for IT fracture fixation, each with its advantages and drawbacks. Short PFNA-IIs offer benefits such as easier insertion, less operative time, and reduced intraoperative blood loss [8]. They also preserve more of the femoral shaft and avoid potential mismatch with femoral bowing. However, short nails concentrate stress at the distal tip, which can potentially lead to shaft fractures just distal to the nail tip (a concern in osteoporotic bone) [9]. Long PFNA-IIs extend farther down the femoral shaft and provide distal locking, which may confer more stability in very distal fracture extensions and might protect against postoperative subtrochanteric femur fractures. But longer nails require more extensive reaming, longer surgical exposure, increased blood loss, and can risk anterior cortical impingement in bowed femurs [10]. To date, there are no clear guidelines on choosing between short and long PFNA-II for unstable IT fractures, and practice varies by surgeon preference. The purpose of this study is to compare the functional outcomes of short versus long PFNA-II in patients with unstable IT fractures.

Materials and methods

Study design and patient selection

Between November 2018 and November 2020, a prospective comparative study was conducted at our tertiary healthcare facility. Institutional ethics committee approval was obtained (Reference: D.No. 242/FM/IEC), and all subjects provided informed written consent. Adult patients (age ≥18 years) presenting with a recent (≤3 weeks) unstable IT femur fracture were enrolled. Unstable IT fractures were defined as those with comminution of the posteromedial cortex and disruption of the lateral wall (AO/OTA type 31A2.2, 31A2.3), reverse obliquity patterns (31A3), or IT fractures with subtrochanteric extension. The choice of treating with a short or long PFNA-II was made by the attending surgeon based on intraoperative assessment of fracture pattern and patient anatomy (this study was not randomised). Patients with fractures limited to the intertrochanteric region without subtrochanteric extension, relatively straight femoral canals, and no excessive anterior bowing were typically selected for short PFNA-II. Conversely, patients with subtrochanteric extension, narrow medullary canals, significant anterior bowing, or concerns for distal stress concentration were preferentially treated with long PFNA-II nails. We divided them into two groups based on implant length: short PFNA-II (n=38) and long PFNA-II (n=40).

Inclusion and exclusion criteria

Inclusion criteria included all patients with unstable IT fractures (as defined above) who were ambulatory prior to injury. Exclusion criteria included patients with pathological fractures (other than due to osteoporosis), open fractures, polytrauma, pre-existing ipsilateral hip pathology evident on preoperative radiographs, or non-ambulatory status prior to injury. Patients younger than 18 years were also excluded.

Surgical procedure

All patients were admitted and underwent clinical and radiological examinations according to a pre-defined study protocol. Preoperative radiographs of the affected hip, including anteroposterior (AP) and lateral views, were obtained to assess the fracture pattern (classified by AO/OTA and Evans criteria) to aid in preoperative planning. The appropriate neck shaft angle (centre-column diaphysis angle) was determined by comparing radiographs of the injured and contralateral uninjured hip, and the femoral canal diameter was measured using a radiographic ruler to guide nail size selection.

Prior to surgery, a third-generation cephalosporin antibiotic was administered 30 minutes before incision. Under spinal or general anaesthesia, patients were positioned supine on an orthopaedic fracture table. Closed reduction of the fracture was achieved by applying traction and internal rotation under fluoroscopic guidance; if satisfactory alignment could not be achieved closed, a limited open reduction with percutaneous clamps or a small incision was performed in a few cases. A longitudinal incision was made from the tip of the greater trochanter extending ~5 cm proximally. The entry point for the PFNA-II was established at or just medial to the tip of the greater trochanter in the AP view (accounting for the nail's 5° mediolateral proximal bend) and in line with the central axis of the medullary canal on the lateral view. A cannulated awl was used to open the canal, and a guidewire was advanced across the fracture into the distal femoral canal. The femoral canal was then reamed in increments to accommodate the chosen nail diameter. Care was taken during reaming and nail insertion to avoid unnecessary force that could displace fracture fragments; if the fracture line extended into the lateral trochanteric region, gentle manual pressure was applied to the lateral cortex during nail insertion to prevent lateral wall blowout.

The PFNA-II nail (either a short length of 180 mm or 240 mm and long length depending on patient's limb length) was attached to the insertion handle and gently introduced, rotating the handle slightly back and forth to negotiate the canal curvature until the proximal hole aligned with the femoral neck. A guidewire was placed into the femoral neck/head for the helical blade, aiming for the centre-centre position on AP and lateral fluoroscopic views. The helical blade length was measured so that its tip would be ~5-10 mm from the subchondral bone. The blade was inserted using the impaction device; intraoperative compression across the fracture was achieved by tapping the blade further after it engaged in the femoral head, which also compacts the bone. For both short and long PFNA-II nails, distal locking was then performed under fluoroscopy. For short nails, a single distal locking screw was used in static mode. For long nails, two distal locking screws were placed (static or one static/one dynamic as per surgeon preference to allow micromotion). The surgical wound was irrigated, and layers were closed in the standard fashion.

Postoperative care and follow-up

Postoperatively, all patients received IV antibiotic prophylaxis (cefoperazone) for 48 hours. Deep vein thrombosis prophylaxis with low-molecular-weight heparin was given as indicated. Patients were encouraged to sit upright in bed by the second postoperative day. Static quadriceps exercises were begun on day 2, and non-weight-bearing mobilisation with a walker or crutches was allowed as tolerated. Stitches were removed after 10-12 days. The decision on when to initiate weight-bearing was individualised based on fracture stability and the quality of fixation. If the postoperative radiographs showed a stable construct (anatomic or near-anatomic reduction, intact lateral buttress, and good helical blade position with Tip-Apex Distance <25 mm), patients were advanced to partial weight-bearing (toe-touch to 25% body weight) as early as 2-4 weeks post-surgery. In

Table 1. Patient demographics of short and long PFNA-II groups

Demographic Parameter	Short PFNA-II (n=38)	Long PFNA-II (n=40)	*p*-value
Mean Age (years)	59.8±16.7	63.9±16.7	0.046
Range	23-88	43-92	NA
Sex			
Male	24 (63.2%)	30 (75%)	0.328
Female	14 (36.8%)	10 (25%)	0.372
Mode of Injury			
Low-energy falls	24 (63.2%)	29 (72.5%)	0.469
Road traffic accidents	10 (26.3%)	7 (17.5%)	0.416
Falls from height	5 (13.2%)	4 (10%)	0.731
Fracture Classification			
31A2.2 fractures	17 (44.7%)	14 (35%)	0.487
31A2.3 fractures	16 (42.1%)	19 (47.5%)	0.664
31A3 fractures	5 (13.2%)	7 (17.5%)	0.749
Time from injury to surgery (days)	8.7±5.4	9.3±5.1	0.605
Open reduction required	5 (13.2%)	7 (17.5%)	0.755

Table 2. Outcome comparison between short and long PFNA-II groups

Parameter	Short PFNA-II (n=38)	Long PFNA-II (n=40)	*p*-value
Operative duration (minutes)	55±13.6	60±9	0.076
Tip-Apex Distance (mm)	21.3±3.5	22.1±3.7	0.294
Neck-shaft angle (final follow-up, °)	131.5±5.1	129.3±4.9	0.331
Union time (weeks)	14.2	13.4	0.285
Harris Hip Score (final follow-up)	87.2±7.1	82.3±7.8	**0.03**

Value in bold indicates statistically significant with p<0.05.

Table 3. Comparison of Neck shaft angle (NSA) in individual fracture patterns seen in short and long PFNA-II groups

Nail Subtype	Mean NSA (Immediate post-op)	Mean NSA (Final follow-up)
Short PFNA-II		
31A2.2	126.6	125.4
31A2.3	128.2	125.8
31A3	129.6	126.7
Long PFNA-II		
31A2.2	122.6	120.2
31A2.3	133.2	127.2
31A3	127.6	120.6

cases where fixation was considered suboptimal or the fracture highly comminuted (e.g., medial cortex not restored), weight-bearing was delayed until signs of early callus formation. All patients were followed at regular intervals: every 6 weeks for the first 3-4 months, then every 3 months until radiographic union. At each follow-up, AP and lateral hip radiographs were taken to evaluate fracture alignment and healing (cortical bridging, trabecular consolidation) and to detect any hardware complications or failure.

Outcome measures

The primary outcomes assessed were fracture union time, functional outcome, and complication rates. Fracture union was defined clinically by the absence of pain at the fracture site and radiographically by the presence of bridging callus across at least three of four cortices on AP and lateral views. Any instance of delayed union or nonunion (failure to progress to union by 9 months or need for revision surgery) was recorded. Functional outcome was evaluated using the Harris Hip Score (HHS) at the final follow-up. The HHS was categorised as excellent (90-100), good (80-89), fair (70-79), or poor (<70). Postoperative neck-shaft angles (NSA) were measured on immediate postoperative and final radiographs to assess maintenance of reduction (varus collapse was defined as >5° change in NSA from initial surgery to healing). Complications were documented in detail, including intraoperative events (e.g., iatrogenic fractures) and postoperative complications such as infection, thromboembolism, implant failure (cut-out of helical blade from the femoral head, helical blade "back-out" or lateral migration, nail breakage), secondary femoral shaft fracture, malunion (varus malalignment >5°), or hardware irritation (thigh pain).

Statistical analysis

Data were compiled and analyzed using Microsoft Excel and SPSS (v22, IBM, Armonk, NY). Continuous variables were compared between groups using a Student's t-test (for approximately normal distributions) or Mann-Whitney U test (for non-parametric data). Paired t-tests were used for within-group compari-

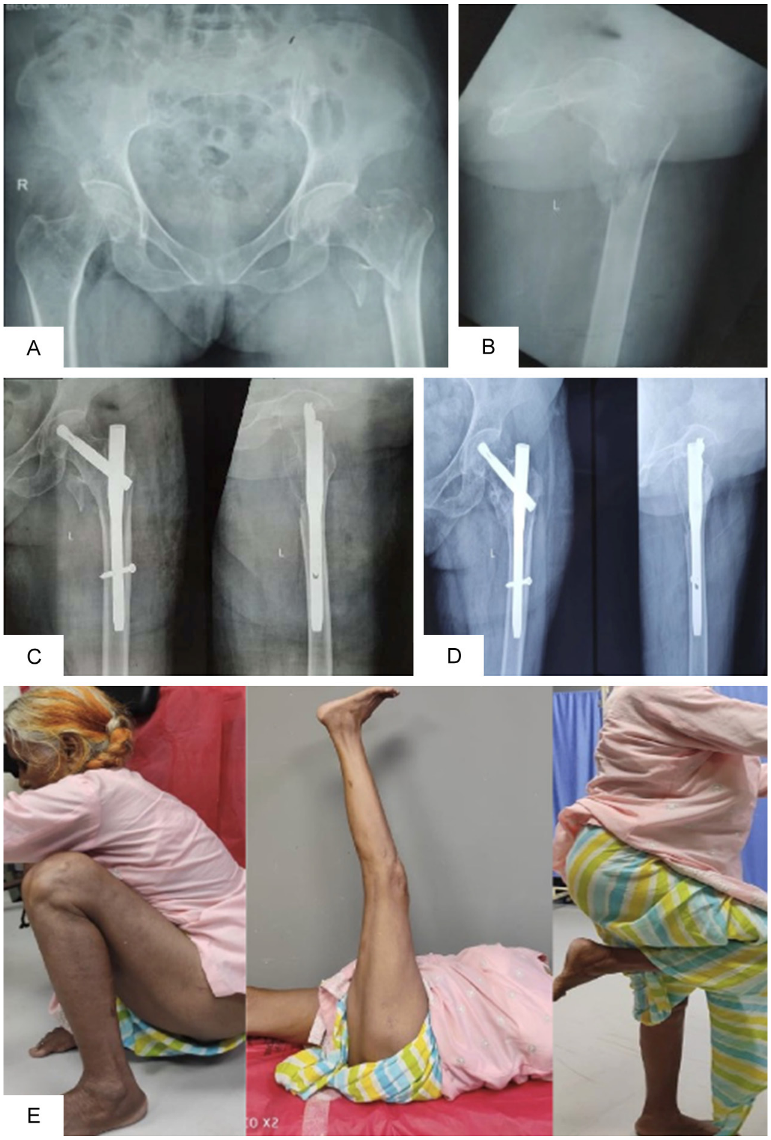

Figure 1. Clinico-radiological outcomes of unstable intertrochanteric fracture treated with short PFNA-II. A: Pre-operative radiograph (AP and lateral) showing comminuted left intertrochanteric fracture (31A2) (unstable). B: Post-operative radiograph showing neutral-medial cortical support without anterior cortical support with center-inferior blade position. C: Follow-up radiograph at 6 months showing union. D: Final follow-up radiograph at 12 months. E: Clinical outcomes of patient at final 12 months follow-up: standing, squatting and standing on affected limb.

sons (e.g., change in NSA). Categorical variables were compared using chi-square tests or Fisher's exact test if any expected cell count was <5. A *p*-value <0.05 was considered statistically significant.

Results

Patient characteristics

Of the 38 patients treated with a short PFNA-II, 24 (63.2%) were men and 14 (36.8%) were women. Their ages ranged from 23 to 88 years (mean 59.8±16.7 years). The mechanism of injury in this group was predominantly low-energy falls in 24 patients (63.2%), road traffic accidents in 10 (26.3%), and falls from a height in 5 (13.2%). According to the AO/OTA classification, 17 patients (44.7%) had 31A2.2 fractures, 16 patients (42.1%) had 31A2.3 fractures, and 5 patients (13.2%) had 31A3 fractures. The average time from injury to operation was 8.7±5.4 days (range 1-20 days). A minimal open reduction was required in 5 patients (13.2%). The mean surgical duration was 55±13.6 minutes (range 40-90 minutes).

Of the 40 patients treated with a long PFNA-II, 30 (75%) were men and 10 (25%) were women. Ages ranged from 43 to 92 years (mean 63.9±16.7 years). Mechanisms of injury included low-energy falls in 29 patients (72.5%), road traffic accidents in 7 (17.5%), and falls from a height in 4 (10%). In this group, 14 patients (35%) had AO/OTA 31A2.2 fractures, 19 (47.5%) had 31A2.3 fractures, and 7 (17.5%) had 31A3 fractures. A minimal open reduction was performed in 7 patients (17.5%). The mean time from injury to surgery was 9.3±5.1 days (range 1-21 days). The mean surgical duration was 60±9 minutes (range 45-80 minutes).

There were no significant differences between the short-nail and long-nail groups in terms of age, sex distribution, mechanism of injury, fracture type, time to surgery, or operative duration (P>0.05 for all) (**Tables 1** and **2**). Tip-Apex Distance (TAD) was achieved within acceptable limits for both groups: the mean TAD was 22.1±3.2 mm in the short PFNA-II group and

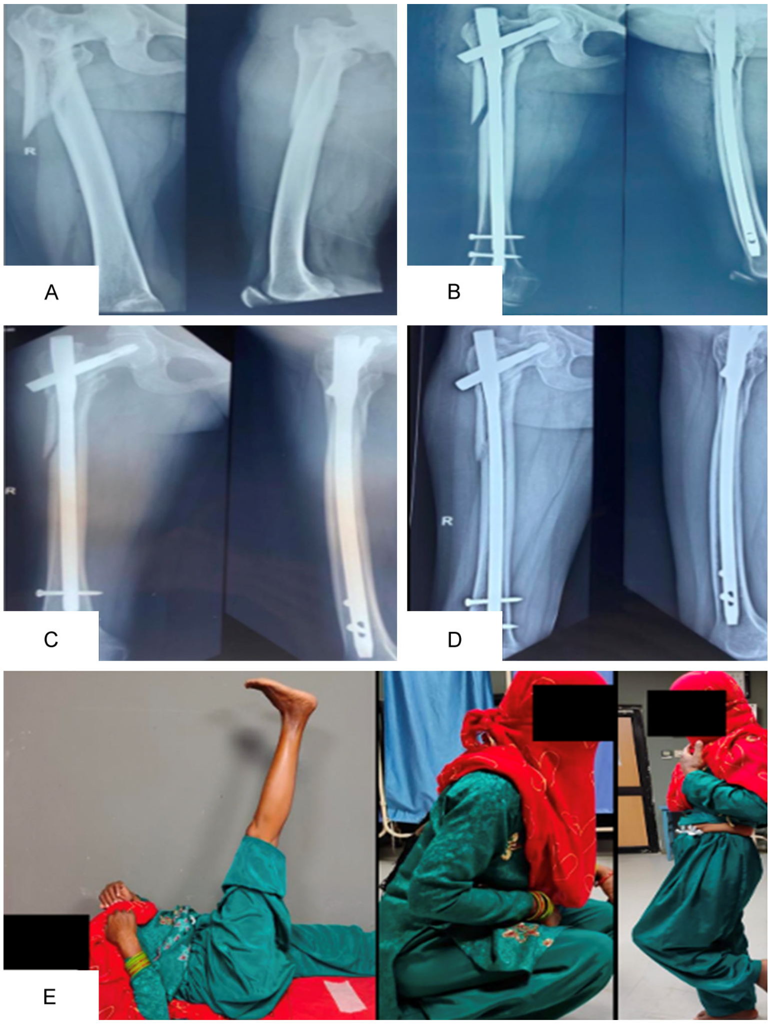

Figure 2. Clinico-radiological outcomes of unstable intertrochanteric fracture treated with long PFNA-II. A: Pre-operative radiographs (AP and pelvis) showing right intertrochanteric fracture with subtrochanteric extension (AO 31A3) (unstable). B: Post-operative radiograph showing negative-medial cortical support, with anterior cortical support and Centre-Centre blade position (fixed in varus). C: At 3 months follow-up X-ray showing union with maintained alignment. D: Final follow up radiograph at 12 months. E: Clinical outcome of the patient at final follow-up showing straight leg raise, squatting and standing on the affected leg.

21.8±3.5 mm in the long PFNA-II group, both well below the recommended 25 mm threshold for cut-out risk. Neck-shaft angle (NSA) maintenance was also similar between groups initially. In the short PFNA-II group, the mean NSA for 31A2.2 fractures was 126.6° immediately post-op and 125.4° at final follow-up; for 31A2.3, 128.2° post-op and 125.8° final; for 31A3, 129.6° post-op and 126.7° final. In the long PFNA-II group, for 31A2.2 fractures, NSA was 122.6° post-op and 120.2° final; for 31A2.3, 133.2° post-op and 127.2° final; for 31A3, 127.6° post-op and 120.6° final. These changes indicate a tendency toward slight varus settling in both groups by final follow-up, more pronounced in the long-nail group (**Table 3**).

Radiographic outcomes and fracture union

In the short PFNA-II group, 36 of 38 fractures (94.7%) achieved union, with an average union time of 14.2 weeks. In the long PFNA-II group, 36 of 40 fractures (90%) united, with an average union time of 13.4 weeks. The union rates and time to union were statistically similar between groups (P>0.05) (**Table 2**).

Figures 1 and **2** shows complete union and functional outcome by short and long PFNA-II respectively at 12 months follow-up.

Functional outcomes

At the final follow-up (average 15.2 months for short PFNA-II, 16.3 months for long PFNA-II), the short-nail group had a mean Harris Hip Score (HHS) of 87.2 (range 72-96). By HHS criteria, 11 patients (28.9%) had an excellent outcome, 24 (63.2%) had a good outcome, 1 (2.6%) had a fair outcome, and 2 (5.3%) had a poor outcome. In the long-nail group, the mean HHS was 82.3 (range, 65-94), with 10 patients (25%) reporting an excellent outcome, 15 (37.5%) a good outcome, 10 (25%) a fair outcome, and 5 (12.5%) a poor outcome. Thus, 89.5% of short-nail patients achieved excellent or good results, compared to 62.5% of long-nail patients. This difference in the proportion of satisfactory outcomes significantly favored the short PFNA-II (P=0.03) (**Table 2**).

Complications

In the short PFNA-II group, there was 1 intraoperative fracture of the femoral shaft during nail

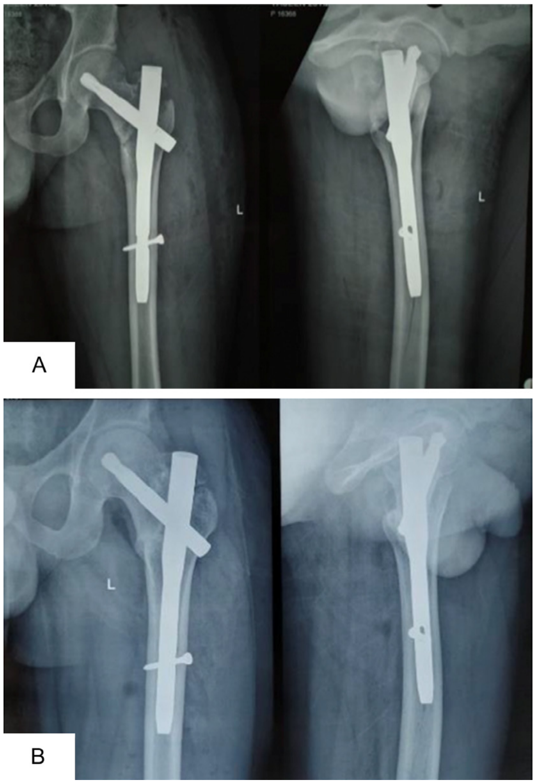

Figure 3. Intraoperative complication seen with PFNA-II. A: Intra-operative complication of fracture shaft femur (undisplaced) seen with short PFNA-II. B: Radiograph at 6 months follow-up, showing both intertrochanteric and shaft femur fracture united.

insertion (managed conservatively as shown in **Figure 3**). Postoperative complications in this group included anterior thigh pain in 6 patients (15.8%), varus collapse of >5° in 2 patients (5.3%), varus malunion in 1 patient (2.6%), and helical blade back-out (migration of the blade laterally) in 1 patient (2.6%) as shown in **Figures 4**-**6**. There were no instances of deep infection, implant breakage, blade cut-out through the femoral head, or screw/blade penetration into the joint in the short-nail group.

In the long PFNA-II group, no intraoperative fractures occurred. Anterior thigh pain was noted in 1 patient (2.5%), and pain over the fascia lata (greater trochanteric region) in 2 patients (5%). Varus collapse >5° occurred in 6 patients (15%), one of whom progressed to varus nonunion as shown in **Figure 7** and the patient underwent revision with a DCS; an additional patient had varus malunion. Helical blade back-out occurred in 4 patients (10%) in the long-nail group, a higher incidence than in the short-nail group. No cases of deep infection, implant breakage, or intra-articular blade penetration were observed. None of the patients in either group required a blood transfusion postoperatively.

Although the overall complication rates did not differ significantly between groups (P=0.369), the pattern of complications did. The long PFNA-II group experienced more mechanical issues related to fracture alignment and hardware (varus collapse and blade migration). In contrast, the short PFNA-II group reported more complaints of thigh pain. Notably, the short PFNA-II group had better preservation of the neck-shaft angle (on average) and fewer cases of blade migration (**Table 4**).

Discussion

IT fractures are one of the most common types of hip fractures, and unstable patterns comprise a substantial subset of these. Unstable fractures tend to occur in older patients with osteoporotic bone, and achieving stable fixation in such cases is challenging. The PFNA-II (a second-generation cephalomedullary nail) was developed with specific modifications to address these challenges in the Asian population and osteoporotic bone generally. These modifications include reducing the proximal nail diameter from 17 mm to 16.5 mm, decreasing the nail's mediolateral angle from 6° to 5°, and adopting a flat lateral surface on the proximal part of the nail to prevent cortical impingement on the lateral femur [6]. Additionally, the use of a single helical blade for head-neck fixation (instead of the dual screw design of the original PFN) minimises bone removal. It dynamically compacts cancellous bone, thereby enhancing purchase in the femoral head and improving rotational stability. Biomechanically, the helical blade has been shown to resist cut-out, rotation, and varus collapse more effectively than a traditional lag screw in osteoporotic bone [5]. Our study's favorable outcomes with PFNA-II support these theoretical advantages.

Prior research has indicated that intramedullary nailing yields better functional outcomes in unstable IT fractures compared to extramedullary fixation (like dynamic hip screws), largely because nails provide a shorter lever arm and more stable medial support in comminuted

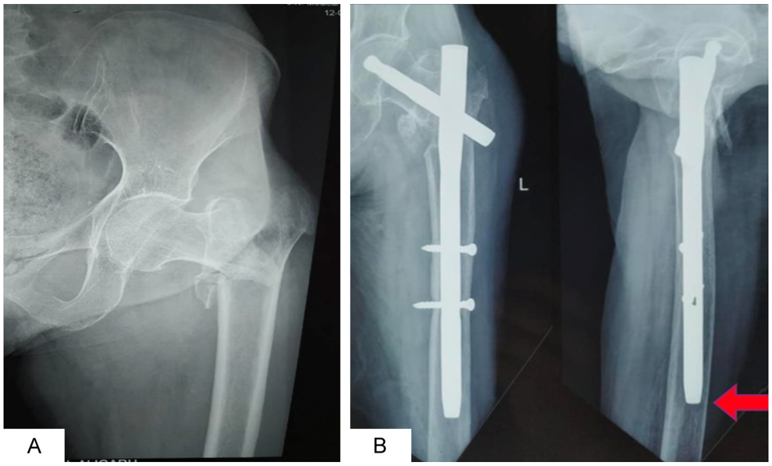

Figure 4. An 80-year-old female with left, comminuted intertrochanteric (31A2) fracture (unstable) (A) treated with short PFNA-II at 12 months follow-up (B) showing united fracture with nail end impingement at anterior cortex causing anterior thigh pain (marked with red arrow).

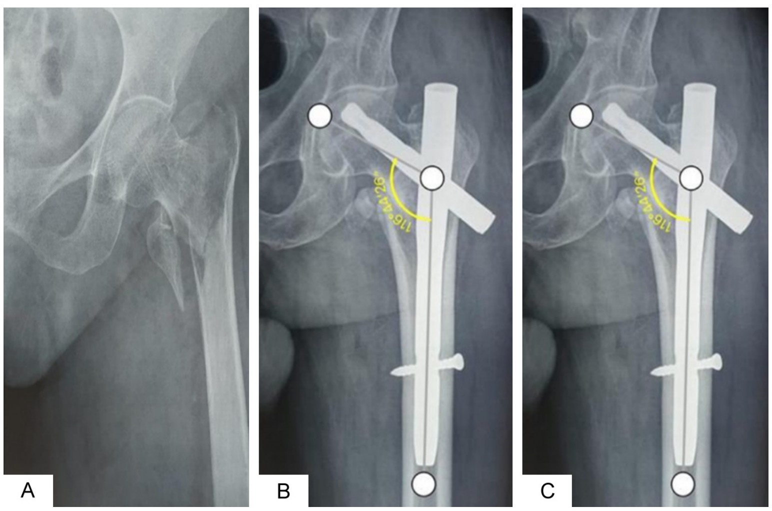

Figure 5. A and B: A 65-year-old male with left, comminuted intertrochanteric fracture (31A2) (unstable) fixed with neutral reduction and centre-centre blade position with neck-shaft angle 125 degrees. C: Radiograph at 8 months follow up showing united fracture with secondary varus collapse (neck shaft angle of 116 degrees).

fractures [11]. However, few studies have directly compared short versus long versions of PFNA-II in the management of unstable IT fractures. Our study is one of the few to investigate the impact of implant length on outcomes in this context. Previous comparative studies have reported mixed findings: for example, Luque Pérez et al. found no significant functional differences between short and long Gamma3 nails in unstable (31A2) fractures, although long nails were associated with higher blood loss and a trend toward more reoperations [10]. Similarly, a randomised trial by Shannon et al. noted that short PFN constructs could be used even in some fractures with slight subtrochanteric extension (up to 3 cm) without higher failure rates [12], supporting the viability of short nails in many unstable patterns.

We found that patients treated with the short PFNA-II nail had significantly higher HHS functional scores and a greater proportion of excellent/good results than those treated with the long PFNA-II. The improved outcomes in the short-nail group may be attributed to better maintenance of the neck-shaft angle and overall hip biomechanics. In our series, the short nails appeared to control fracture impaction and collapse more effectively, possibly because the shorter nail, ending in the proximal femoral shaft, may allow a small amount of controlled subsidence while avoiding stress concentration at the tip that could lead to malalignment. The long nails, extending down the femoral shaft and locked distally, create a longer lever arm and a stiffer construct which, in osteoporotic bone with comminution, might contribute to a higher incidence of varus collapse and blade migration as we observed. Notably, our finding of superior functional outcome with short nails contrasts with some meta-analyses that report no difference in functional scores between short and long nails [13, 14]. For instance, a 2025 meta-analysis of randomized trials by Zhang et al. found no significant difference in Harris Hip Scores or overall complication rates, although short nails had clear perioperative advantages [8]. This discrepancy suggests that specific patient popula-

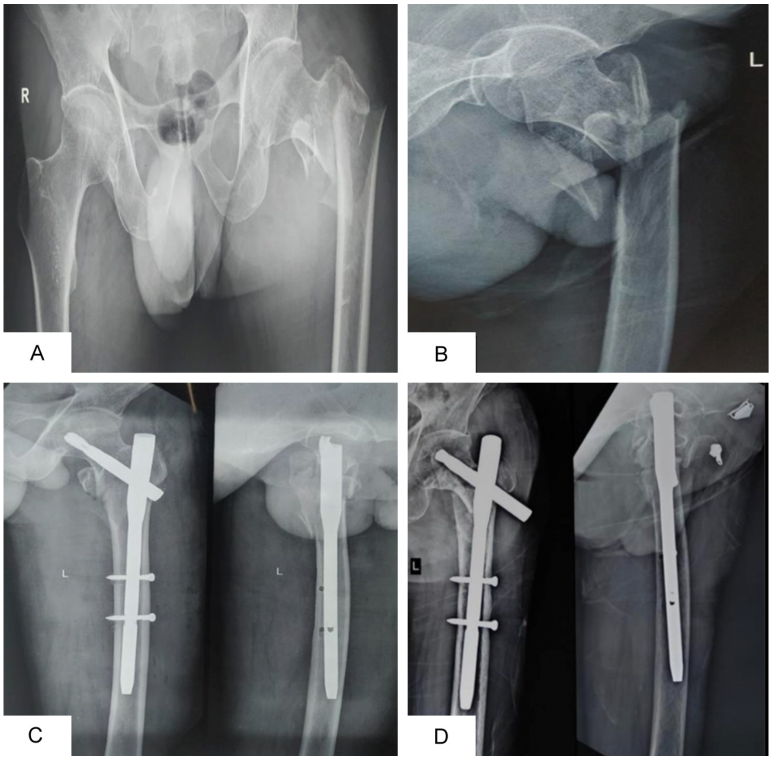

Figure 6. A 52-year-old male patient with comminuted, intertrochanteric (31A2.3) fracture left femur (AP and lateral views) (A and B). Post-operative radiograph (C) showing a positive reduction in AP view, without anterior cortex support in lateral view with blade position in anterior inferior zone. At follow-up of 10 months, radiograph showing implant failure due varus collapse non-union (D). Also, anterior cortex impingement can be noted which caused anterior thigh pain. He was planned for implant removal and re-fixation.

tions or fracture types (like the exclusively unstable fractures in our study) may derive more benefit from the short nail's characteristics.

A notable issue encountered was the impingement of the nail tip on the anterior femoral cortex. We observed anterior cortical impingement in 6 out of 38 cases (15.8%) with the short PFNA-II, compared to 1 out of 40 cases (2.5%) with the long PFNA-II. This aligns with the idea that a short, straight nail may abut a bowed femur in patients with a high degree of anterior curvature. Indian patients often have a greater femoral bow [15, 16], which can lead to the tip of a short nail contacting the anterior cortex and causing thigh pain. The long PFNA-II, which has a slight curvature and traverses further distally, can better accommodate the femoral bow when properly matched, hence the lower rate of anterior impingement in our long-nail group. Our findings mirror those of Kiran Kumar et al. and Sahin et al., who reported postoperative anterior thigh pain in 7.1% and 24.4% of cases, respectively, when using PFNA-II nails [17, 18]. Jin et al. have suggested using a longer intramedullary nail in patients with a pronounced anterior femoral curvature to mitigate this problem [19], and our results support that recommendation: notably, the single long-nail patient with anterior thigh pain had an unusually bowed femur. In contrast, short nails should be used cautiously in patients with excessive femoral curvature to avoid this complication.

We also noted lateral thigh pain in a couple of patients with the long PFNA-II, which we attributed to the slight protrusion of the helical blade through the lateral cortex (often occurring in fractures that healed with medialisation of the shaft and varus collapse). This irritation of the tensor fascia lata muscle was self-limited and occurred in cases that still went on to union with only mild varus malalignment. Sahin et al. reported lateral thigh (fascia lata) pain in 15.5% of cases in their series of unstable IT fractures treated with PFNA. In contrast, Kiran Kumar et al. reported a lower rate of around 4.5% [17, 18]. Our incidence was 5% in the long-nail group and 0% in the short-nail group for lateral thigh pain, suggesting the short nail's shorter lever arm and endpoint well above the knee may avoid this issue altogether.

Both groups in our study experienced some degree of varus collapse (defined as >5° change in NSA). The short PFNA-II group had 5.3% of patients with varus collapse, while the long PFNA-II group had 15%. The greater collapse in the long-nail group can be attributed to the long nail's relative rigidity and the fact that many of those fractures had extensive comminution (especially loss of the medial buttress). Once the medial cortex is shattered, a long nail locked distally might paradoxically allow the head-neck fragment to settle into varus if the

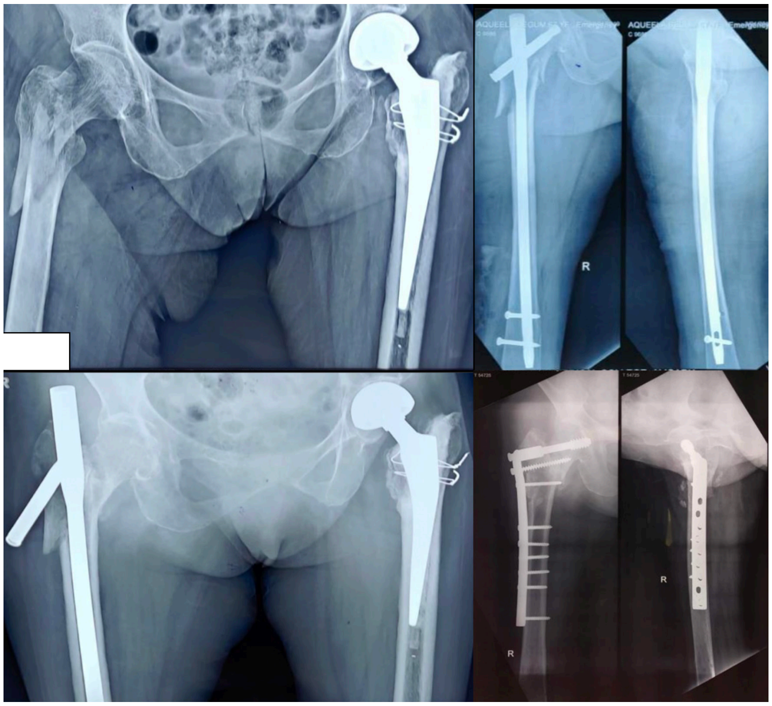

Figure 7. 67-year-old female with unstable intertrochanteric (31A3) fracture at 4 months follow-up showing back out of helical blade. The implant was removed, and the fracture was fixed with DCS.

Table 4. Comparison of intraoperative and postoperative complications between the short and long PFNA-II groups

Complications	Short PFNA-II (n=38)	Long PFNA-II (n=40)	*p*-value
Intraoperative			
Fracture shaft of femur	1 (2.6%)	0 (0)	0.487
Postoperative			
Blood transfusion	0 (0)	0 (0)	Not Applicable
Anterior Thigh Pain	6 (15.8%)	1 (2.5%)	0.049
Fascia Lata Pain	0 (0)	2 (5%)	0.494
Varus collapse (>5 deg)	2 (5.3%)	6 (15%)	0.264
Varus Malunion	1 (2.6%)	1 (2.5%)	1.000
Varus Non-union	0 (0)	1 (2.5%)	1.000
Helical Blade backout	1 (2.6%)	4 (10%)	0.359
Total	11 (28.94%)	15 (37.5%)	0.369

calcar support is lacking. Our clinical observation is consistent with biomechanical studies: a recent cadaveric investigation by Linhart et al. found no difference in construct stability between short and long nails in a reverse-obliquity A3 fracture model, supporting that a short nail can adequately stabilize such fractures without increased risk of collapse [20]. Interestingly, we observed helical blade backout (lateral migration of the blade) in only 2.6% of short-nail cases versus 10% of long-nail cases. A longer nail that is locked distally may transmit stress upward, pushing the head-neck fragment and blade laterally during cyclical loading, especially in the presence of varus collapse. The short nail, being more forgiving (with a slightly elastic construct that can shorten), possibly allowed a bit of impaction at the fracture site without as much blade migration. Nonetheless, none of our patients experienced classic "cut-out" of the blade superiorly into the joint, which speaks to the effectiveness of the helical blade design when proper TAD is maintained.

Our study has limitations

It was not randomised; implant length was chosen based on surgeon preference and intraoperative judgment, which could introduce selection bias. This is a single-centre study conducted at a teaching hospital, where all surgeries were supervised by attending surgeons; however, many were performed by senior residents. Variability in surgical skills could potentially affect outcomes. The sample size, while moderate, may not have been powered to detect all possible differences in less common complications between groups. Lastly, our follow-up, which averages around 15-16 months, may not capture very late complications, such as occult hardware failure or adjacent joint arthritic changes. Despite these limitations, our findings provide valuable insight into the influence of nail length on outcomes. Notably, the overall complication rate in our series was similar between short and long nails, consistent with prior studies that reported no significant difference in total complications at one year [8]. What differs is the type of complications: long nails tended to have more mechanical/alignment issues, whereas short nails had more localised thigh pain, as discussed.

Future research should include larger, possibly multicenter randomised trials to provide higher-level evidence on the ideal implant length for unstable IT fractures. Variables such as patient body habitus, degree of femoral bow, and fracture subtype (31A2 vs. 31A3) should be considered when tailoring the implant choice. Augmentation techniques (such as cement augmentation of the helical blade or the use of adjunct lateral wall plates) could also be explored further to improve outcomes in most osteoporotic or comminuted cases [21, 22].

In summary, our comparative study suggests that in patients with unstable intertrochanteric fractures, short PFNA-II nails can achieve excellent outcomes with a low complication rate, and they appear to provide superior functional results compared to long PFNA-II nails in similar fracture patterns. Surgeons should be mindful of patient anatomy (such as femoral curvature) and fracture morphology when choosing nail length. Proper implant positioning (achieving a low TAD and anatomic reduction) and attentive fracture reduction remain critical for success with either device. Our findings support the notion that the short PFNA-II, when used appropriately, offers the advantages of easier insertion, less surgical trauma, and sufficient stability for the vast majority of unstable IT fractures. Long PFNA-II nails may still be indicated in select cases (e.g., fractures with extensive subtrochanteric extension or very large patients where a short nail might be undersized). Still, the potential for increased varus collapse and blade migration with longer nails should be recognised. Overall, both implant lengths can yield good results, but our results favor the short PFNA-II in terms of facilitating quicker rehabilitation and patient comfort in the postoperative period. This is in line with recent meta-analyses and reviews that advocate for a patient-specific approach rather than a one-size-fits-all rule for nail length [23].

Conclusions

Both short and long PFNA-II implants are effective options for unstable intertrochanteric femur fractures, with high rates of fracture union and generally low rates of significant complications. However, the choice of implant length can influence specific outcomes. In our study, short PFNA-II nails provided better functional results and fewer mechanical complications than long PFNA-II nails. Short nails were associated with less intraoperative difficulty in patients without an excessive femoral bow, and they had lower incidences of thigh pain, varus collapse, and implant migration. Long PFNA-II nails may be reserved for fractures with distal extension or in patients with very large or curved femora, but careful attention must be paid to insertion technique and postoperative alignment to minimise complications. Surgeons should consider individual patient and fracture characteristics when selecting the nail length, as optimising the implant for the patient can improve overall outcomes in unstable IT fractures. Our study provides evidence to guide implant selection for unstable IT fracture, suggesting that short PFNA-II nails may be preferable in appropriately selected patients.

Disclosure of conflict of interest

None.

Address correspondence to: Dr. Asad Khan, Department of Orthopaedic Surgery, B.R.D. Medical College and Nehru Hospital, Gorakhpur, U.P., India. Tel: +919456086779; E-mail: khanasad53@gmail.com

References

[1] Cooper C, Campion G and Melton LJ 3rd. Hip fractures in the elderly: a world-wide projection. Osteoporos Int 1992; 2: 285-9.

[2] Gullberg B, Johnell O and Kanis JA. World-wide projections for hip fracture. Osteoporos Int 1997; 7: 407-13.

[3] Raja RSB, Singh D, Parasuraman K and Manikandarajan A. Management of unstable intertrochanteric fracture by proximal femoral nailing with trochanteric buttress plating. Int J Orthop Sci 2022; 8: 47-52.

[4] Parker MJ, Handoll HH, Bhonsle S and Gillespie WJ. Condylocephalic nails versus extramedullary implants for extracapsular hip fractures. Cochrane Database Syst Rev 2000; 1998: CD000338.

[5] Sharma A, Mahajan A and John B. A comparison of the clinico-radiological outcomes with Proximal Femoral Nail (PFN) and Proximal Femoral Nail Antirotation (PFNA) in fixation of unstable intertrochanteric fractures. J Clin Diagn Res 2017; 11: RC05-9.

[6] Macheras GA, Koutsostathis SD, Galanakos S, Kateros K and Papadakis SA. Does PFNA II avoid lateral cortex impingement for unstable peritrochanteric fractures? Clin Orthop Relat Res 2012; 470: 3067-76.
[7] Thusoo V, Nagpal BS, Kudyar S, Chakrapani AS, Saini ES, Alok KV, Pathanaboina R and Palakkal N. Comparison of twin screw derotation type versus single helical blade type cephalomedullary nail in the management of unstable intertrochanteric fractures. Cureus 2024; 16: e61638.
[8] Zhang S, Guo Q, Huang K and Zhu H. Short versus long cephalomedullary nails for intertrochanteric femur fractures: a meta-analysis of randomized controlled trials. PLoS One 2025; 20: e0319758.
[9] Larose G, Tufescu T and Graham C. Periprosthetic fracture rate after short and long hip nails: analysis of a regional health database. Injury 2022; 53: 2195-8.
[10] Luque Pérez R, Checa Betegón P, Galán-Olleros M, Arvinius C, Valle-Cruz J and Marco F. Nailing unstable pertrochanteric fractures: does size matters? Arch Orthop Trauma Surg 2022; 142: 145-55.
[11] Zeelenberg ML, Plaisier AC, Nugteren LHT, Loggers SAI, Joosse P, Verhofstad MHJ, Den Hartog D and Van Lieshout EMM; STABLE-HIP Study Group. Extramedullary versus intramedullary fixation of unstable trochanteric femoral fractures (AO type 31-A2): a systematic review and meta-analysis. Arch Orthop Trauma Surg 2024; 144: 1189-209.
[12] Shannon SF, Yuan BJ, Cross WW 3rd, Barlow JD, Torchia ME, Holte PK and Sems SA. Short versus long cephalomedullary nails for pertrochanteric hip fractures: a randomized prospective study. J Orthop Trauma 2019; 33: 480-6.
[13] Domenech P, Mariscal G, Marquina V and Baixauli F. Short versus long intramedullary nails for intertrochanteric hip fracture: meta-analysis. Rev Esp Cir Ortop Traumatol 2024; 68: 373-82.
[14] Zeng C, Wang YR, Wei J, Gao SG, Zhang FJ, Sun ZQ and Lei GH. Treatment of trochanteric fractures with proximal femoral nail antirotation or dynamic hip screw systems: a meta-analysis. J Int Med Res 2012; 40: 839-51.
[15] Chang SM, Song DL, Ma Z, Tao YL, Chen WL, Zhang LZ and Wang X. Mismatch of the short straight cephalomedullary nail (PFNA-II) with the anterior bow of the Femur in an Asian population. J Orthop Trauma 2014; 28: 17-22.
[16] Maheshwari J, Goyal N and Upadhyay A. Proximal femoral geometry in Indian patients and its relevance to design of implants. Indian J Orthop 2010; 44: 264-70.
[17] Kumar GN, Sharma G, Khatri K, Farooque K, Lakhotia D, Sharma V and Meena S. Treatment of unstable intertrochanteric fractures with proximal femoral nail antirotation II: our experience in Indian patients. Open Orthop J 2015; 9: 456-9.
[18] Sahin S, Ertürer E, Oztürk I, Toker S, Seçkin F and Akman S. Radiographic and functional results of osteosynthesis using the proximal femoral nail antirotation (PFNA) in the treatment of unstable intertrochanteric femoral fractures. Acta Orthop Traumatol Turc 2010; 44: 127-34.
[19] Hwang JH, Oh JK, Han SH, Shon WY and Oh CW. Mismatch between PFNa and medullary canal causing difficulty in nailing of the pertrochanteric fractures. Arch Orthop Trauma Surg 2008; 128: 1443-6.
[20] Linhart C, Kistler M, Kussmaul AC, Woiczinski M, Böcker W and Ehrnthaller C. Biomechanical stability of short versus long proximal femoral nails in osteoporotic subtrochanteric A3 reverse-oblique femoral fractures: a cadaveric study. Arch Orthop Trauma Surg 2023; 143: 389-97.
[21] Zheng L, Chen X, Zheng Y, He X, Wu J and Lin Z. Cement augmentation of the proximal femoral nail antirotation for the treatment of two intertrochanteric fractures - a comparative finite element study. BMC Musculoskelet Disord 2021; 22: 1010.
[22] Sermon A, Zderic I, Khatchadourian R, Scherrer S, Knobe M, Stoffel K and Gueorguiev B. Bone cement augmentation of femoral nail head elements increases their cut-out resistance in poor bone quality - A biomechanical study. J Biomech 2021; 118: 110301.
[23] Tan GKY, Chong CS and Bin Abd Razak HR. Clinical outcomes following long versus short cephalomedullary devices for fixation of extracapsular hip fractures: a systematic review and meta-analysis. Sci Rep 2021; 11: 23997.