ORIGINAL CLINICAL RESEARCH – TRAUMA

acta orthopaedica belgica, 2026, 92, online-only

doi.org/10.52628/92.1.15247

A Novel C-arm Rotation and Limb-Positioning Algorithm to Obtain a Reliable Lateral Femoral Neck View in Lateral Decubitus Intertrochanteric Fracture Fixation

A. YIĞITBAY[1], G. YILDIRIM[2], H. ÇETIN[2]

[1]*Siverek State Hospital, Department of Orthopedics and Traumatology Siverek, Sanliurfa, Turkey;* [2]*Diyarbakir Gazi Yaşargil Training and Research Hospital, Baglar, Diyarbakır, Turkey.*

Correspondence at: Ahmet Yiğitbay; Ediz, Sanliurfa-Diyarbakır Road 8. Km. 63600, Department of Orthopedics and Traumatology, Siverek State Hospital, Siverek, Sanliurfa, Turkey. Phone: +90 543 639 61 62 - E-mail: ahmetyigitbay@gmail.com

ABSTRACT

This study aimed to evaluate the feasibility of proximal femoral nailing (PFN) in the lateral decubitus position using a standardized, limb-based approach without a traction table and to report early postoperative (24–72 hours) radiographic and technical outcomes, focusing on lag screw position and tip–apex distance (TAD). This single-center retrospective study included 52 adult patients (>18 years) who underwent PFN in the lateral decubitus position according to a standardized algorithm between January 2021 and December 2024. Demographic characteristics, fracture classification, operative parameters, early postoperative (24–72 hours) radiographic measurements (TAD and Cleveland–Bosworth quadrant position), and postoperative complications recorded during available follow-up were collected. Evans and Boyd–Griffin classifications were used for fracture typing. Statistical analyses evaluated the association between fracture stability and operative duration; analyses involving cut-out were interpreted descriptively due to the low event count. The mean age was 70.5 ± 13.4 years, and 59.6% of patients were male. According to the Evans classification, 69.2% of fractures were stable, 23.1% were unstable, and 7.7% were reverse oblique. The mean operative preparation time was 10.4 ± 1.8 minutes, and the mean operative duration was 43.6 ± 7.9 minutes; operative duration was longer in unstable fractures ($p < 0.001$). According to the Cleveland–Bosworth system, 73.1% of lag screws were positioned central–central, and no screws were placed in the superior–posterior quadrant. The mean TAD was 17.7 mm, and 96.2% of patients had TAD < 25 mm. Cut-out occurred in two patients (3.8%) and was observed among patients with higher TAD values; this observation was considered exploratory. We present a novel standardized, limb-based lateral decubitus PFN algorithm without a traction table. The approach yielded reproducible early postoperative radiographic parameters (24–72 hours), including acceptable TAD values and favorable Cleveland–Bosworth screw placement.

Keywords: Intertrochanteric femur fracture, Lateral decubitus position, Proximal femoral nailing, Tip–apex distance, Cleveland–Bosworth quadrant, Intramedullary nailing.

INTRODUCTION

Intertrochanteric femur fractures are extracapsular fractures of the proximal femur extending between the greater and lesser trochanters. Although they can occur in all age groups, they are most commonly seen in elderly osteoporotic patients. Surgical treatment is generally required, and proximal femoral nailing is one of the most frequently used fixation methods[1,2]. Successful surgical management of intertrochanteric fractures relies heavily on obtaining a lateral femoral neck view during the procedure. Several techniques and positioning strategies have been described to achieve this, one of which is the use of a traction table. However, traction tables have several disadvantages, including high cost, prolonged preparation time, and increased need for fluoroscopy. Moreover, traction table use has been associated with complications such as pudendal nerve injury, erectile dysfunction, and perineal skin lesions[3,4]. In addition, traction tables are not available in every surgical center. These drawbacks have encouraged surgeons to seek alternative intraoperative algorithms and limb-positioning maneuvers.

Treatment of proximal femur fractures can be performed in the supine position on a traction table, or on a standard operating table in either the supine or lateral decubitus position. In recent years, some surgeons have preferred the lateral decubitus position for treating these fractures[5-9]. While obtaining an anteroposterior fluoroscopic view of the proximal femur is relatively simple in both the supine and lateral positions, visualizing the femoral neck in a lateral femoral neck view requires specific limb-positioning maneuvers. These maneuvers also have their inherent advantages and disadvantages. The need for hip adduction as part of limb positioning to achieve entry point alignment and the dependence on an assistant to maintain reduction are among the notable limitations.

The primary aim of this study was to describe the early postoperative (24–72 hours) radiographic and technical outcomes of proximal femoral nailing performed in the lateral decubitus position without a traction table, with a focus on tip–apex distance (TAD) and Cleveland–Bosworth quadrant placement on standardized radiographs. Although lateral decubitus PFN techniques have been reported, a standardized and reproducible algorithm for obtaining a lateral femoral neck view without a traction table is not consistently described. Therefore, we present a novel lateral decubitus PFN algorithm, characterized by a defined C-arm rotation strategy combined with a specific limb-positioning sequence to achieve reliable lateral visualization of the femoral neck, and we report the early postoperative radiographic outcomes. Secondary aims were to report operative timing metrics and early postoperative complications descriptively.

MATERIALS AND METHODS

In this single-center retrospective study, adult patients (age >18 years) who presented to the emergency department of a secondary-level state hospital with an intertrochanteric femur fracture between January 2021 and December 2024 and were treated with proximal femoral nailing (PFN) in the lateral decubitus position using a standardized lateral decubitus PFN algorithm without a traction table were screened. The inclusion criteria were: (i) age >18 years, (ii) PFN performed in the lateral decubitus position according to the standardized algorithm without a traction table, and (iii) availability of postoperative clinical and/or radiographic data in the hospital information system and outpatient records. A total of 52 patients met the eligibility criteria and were included.

After diagnosis in the emergency department, patients were admitted to the orthopedics and traumatology service for surgical management. All procedures were performed within five days of admission by three experienced surgical teams. Demographic data and fracture-related variables were extracted from electronic medical records. Fracture patterns were classified according to the Evans and Boyd–Griffin classifications using preoperative radiographs, with computed tomography used when available. Operative preparation time was defined as the interval from the patient's arrival in the operating room to skin incision, and total operative time as the interval from skin incision to skin closure (minutes).

Postoperative complications were identified from inpatient and outpatient records throughout the entire available follow-up period and included cut-out, mechanical failure, reoperation, surgical-site infection, thromboembolic events, peri-implant fracture, and other clinically relevant adverse events.

Postoperatively, patients were followed at regular intervals at the outpatient clinic. Weight-bearing was restricted during the first three weeks. Partial weight-bearing was allowed after the third week for appropriately fixed stable fractures, whereas patients with unstable fractures were allowed weight-bearing after six weeks, according to clinical and radiographic assessment by the treating team.

Radiographic evaluation for the primary technical and radiological outcomes was performed using standardized anteroposterior pelvic radiographs and lateral femoral neck radiographs obtained in the early postoperative period (within 24–72 hours after surgery). Tip–apex distance (TAD) was measured in millimeters on anteroposterior and lateral femoral neck radiographs according to the method originally described by Baumgaertner et al.[10]. All measurements were performed using the hospital's digital picture archiving and communication system (PACS). Radiographic magnification was corrected by calibrating measurements to the known diameter of the implanted cephalic screw using digital measurement tools. Cephalic element positioning was assessed according to the Cleveland–Bosworth quadrant classification[11]. Radiographic measurements were performed by one experienced orthopedic surgeon and subsequently verified by a second experienced orthopedic surgeon; both reviewers were blinded to clinical outcomes. In case of discrepancies, images were jointly re-reviewed to reach consensus.

This two-step blinded review process was used to enhance measurement reliability and reduce observer-related bias. The primary technical and radiological outcomes were TAD and Cleveland–Bosworth quadrant placement; secondary outcomes included operative preparation time, total operative duration, and postoperative complications.

Clinical follow-up was structured according to predefined time intervals. Early postoperative complications were defined as events occurring within the first 30 days after surgery and included surgical-site infection, thromboembolic events, and early mechanical failure. Intermediate-term complications were assessed between 1 and 6 months postoperatively and included cut-out, implant-related mechanical failure, and peri-implant fracture. Reoperations were recorded throughout the entire available follow-up period and were categorized according to the time of occurrence as early (≤30 days) or late (>30 days). The final follow-up evaluation was based on the most recent outpatient visit documented in the hospital information system and outpatient records.

Surgical Technique

Following anesthesia, all patients were positioned on a radiolucent standard operating table in the lateral decubitus position with the injured side up. The pelvis and trunk were stabilized, and cushions were placed under the abdomen and lumbar region to prevent pressure-related complications while allowing sufficient hip motion for fluoroscopic imaging. A C-arm fluoroscope was draped and positioned to obtain standardized anteroposterior (AP) hip/pelvis and lateral femoral neck views by rotating the C-arm around the patient. The surgical team consisted of one orthopedic surgeon, one scrub nurse, and one technician; all personnel wore protective lead aprons and thyroid shields. After sterile preparation and draping, the procedure was initiated.

A standard proximal incision was made over the tip of the greater trochanter for insertion of the proximal femoral nail (PFN-135°). After blunt dissection through the soft tissue planes, the entry point was established at the tip of the greater trochanter under fluoroscopic guidance. The position of the guidewire and the entry point were confirmed using AP imaging and a lateral femoral neck view, obtained by rotating the C-arm and, when needed, gentle limb-positioning maneuvers to achieve a lateral projection. After satisfactory confirmation, sequential reaming was performed, and the appropriate nail size was selected and inserted intramedullary.

Closed reduction was achieved using longitudinal traction and controlled rotational limb-positioning maneuvers as required. Reduction quality was assessed fluoroscopically, aiming for acceptable alignment on AP imaging and confirmation of sagittal alignment on lateral femoral neck imaging. In cases where reduction or stability was suboptimal, reduction and imaging steps were repeated, and provisional percutaneous fixation (e.g., a temporary K-wire or joystick maneuver) was used at the surgeon's discretion to maintain alignment during subsequent steps.

Once acceptable reduction was obtained and maintained by the assistant, a guidewire was introduced into the femoral neck. Its position was first optimized on the AP view, targeting a center–center or inferior–center position, and then confirmed on the lateral femoral neck view. To facilitate lateral visualization of the femoral neck in the lateral decubitus position, the hip was gently adjusted (typically 80–100° flexion, 30–40° abduction, and 10–20° external rotation) while the fluoroscopy unit was rotated accordingly (Figures 1–2). If reduction or guidewire positioning was deemed unsatisfactory in either plane, the steps were repeated until an acceptable position was achieved.

After guidewire confirmation, reaming was performed and the lag screw was inserted. Final screw position was verified on both AP and lateral femoral neck projections. Proximal and distal locking screws were then placed, and the wound was irrigated and closed in layers. A sterile dressing was applied, and the patient was returned to the supine position and transferred to the postoperative recovery unit after anesthesia evaluation.

To minimize variability, all procedures followed a standardized lateral decubitus PFN algorithm for patient positioning, fluoroscopy setup, and PFN implantation steps. The operations were performed by three experienced orthopedic trauma teams familiar with intramedullary nailing techniques, and the same implant type (PFN-135°) and postoperative rehabilitation protocol were applied throughout the study period. Key intraoperative checkpoints (entry point confirmation, reduction assessment, and cephalic element positioning) were systematically verified on fluoroscopic imaging in both AP and lateral femoral neck projections before definitive implant placement. In all cases, a proximal femoral nail with a lag screw (PFN-135°) was used; helical blade devices (e.g., PFNA) were not used in this cohort.

The study protocol was approved by the Ethics Committee of Harran University (Approval date:

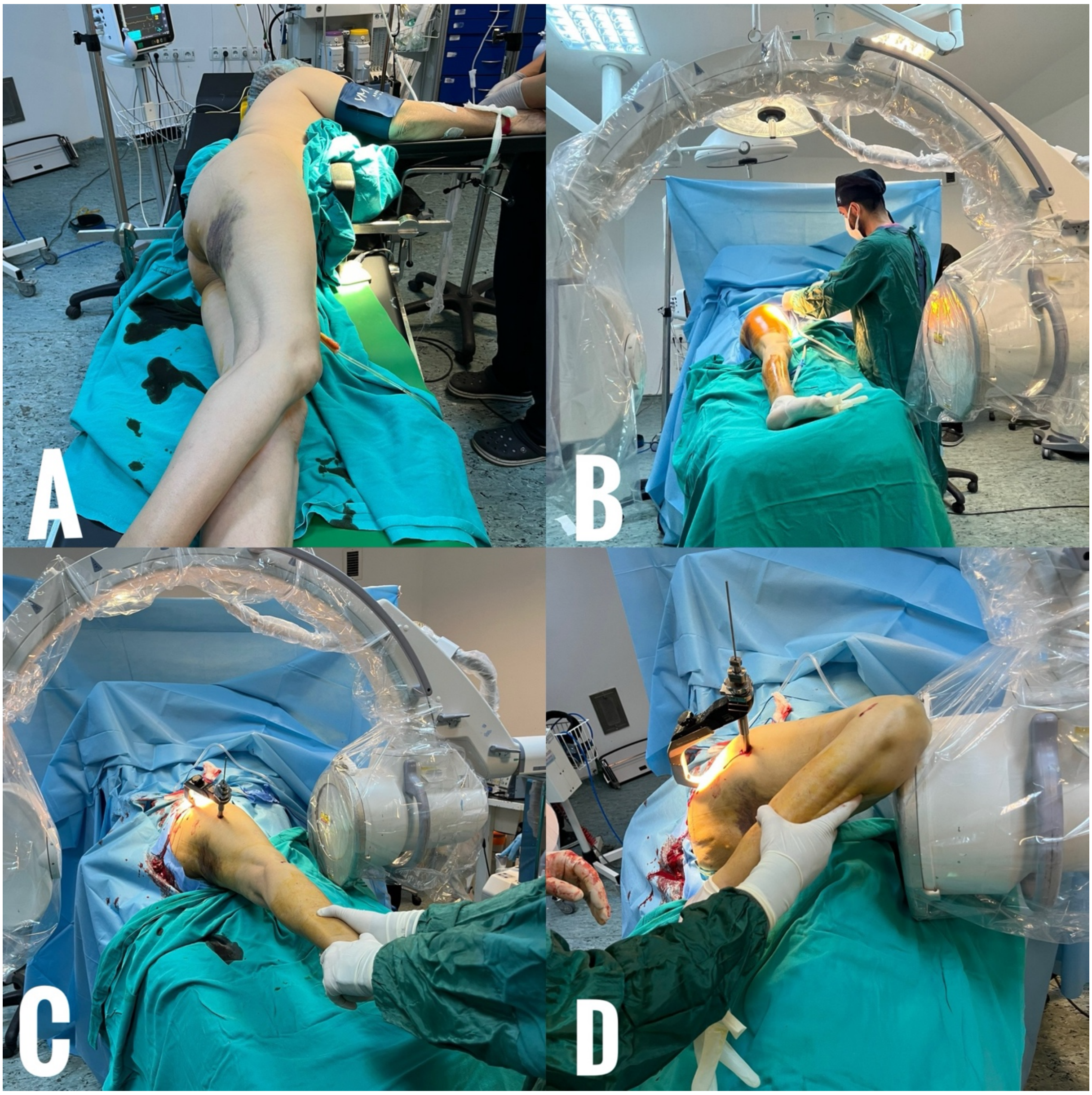

Fig. 1 — A: Lateral decubitus positioning of the patient with a right hip fracture on the operating table.
B: Fluoroscopic positioning.
C: Reduction maneuver performed by applying traction to the ankle.
D: Lateral visualization of the femoral neck achieved by placing the hip in 80–100° flexion, 30–40° abduction, and 10–20° external rotation.

August 26, 2024). All procedures were conducted in accordance with the ethical standards of the institutional research committee and the principles outlined in the Declaration of Helsinki.

Statistical Analysis

All statistical analyses were performed using IBM SPSS Statistics for Windows, Version 26.0 (IBM Corp., Armonk, NY, USA). Continuous variables were summarized as mean ± standard deviation for approximately normally distributed data and as median (interquartile range [IQR]) for non-normally distributed data; ranges were reported when appropriate. Normality was assessed using the Shapiro–Wilk test. Comparisons between two independent groups with non-normally distributed variables were performed using the Mann–Whitney U test. Accordingly, operative duration was compared between stable and unstable fractures according to the Evans classification. Differences in operative duration across the four Boyd–Griffin fracture categories were evaluated using the Kruskal–Wallis H test; when significant, pairwise comparisons were conducted with Bonferroni-adjusted Mann–Whitney U post-hoc tests. The association

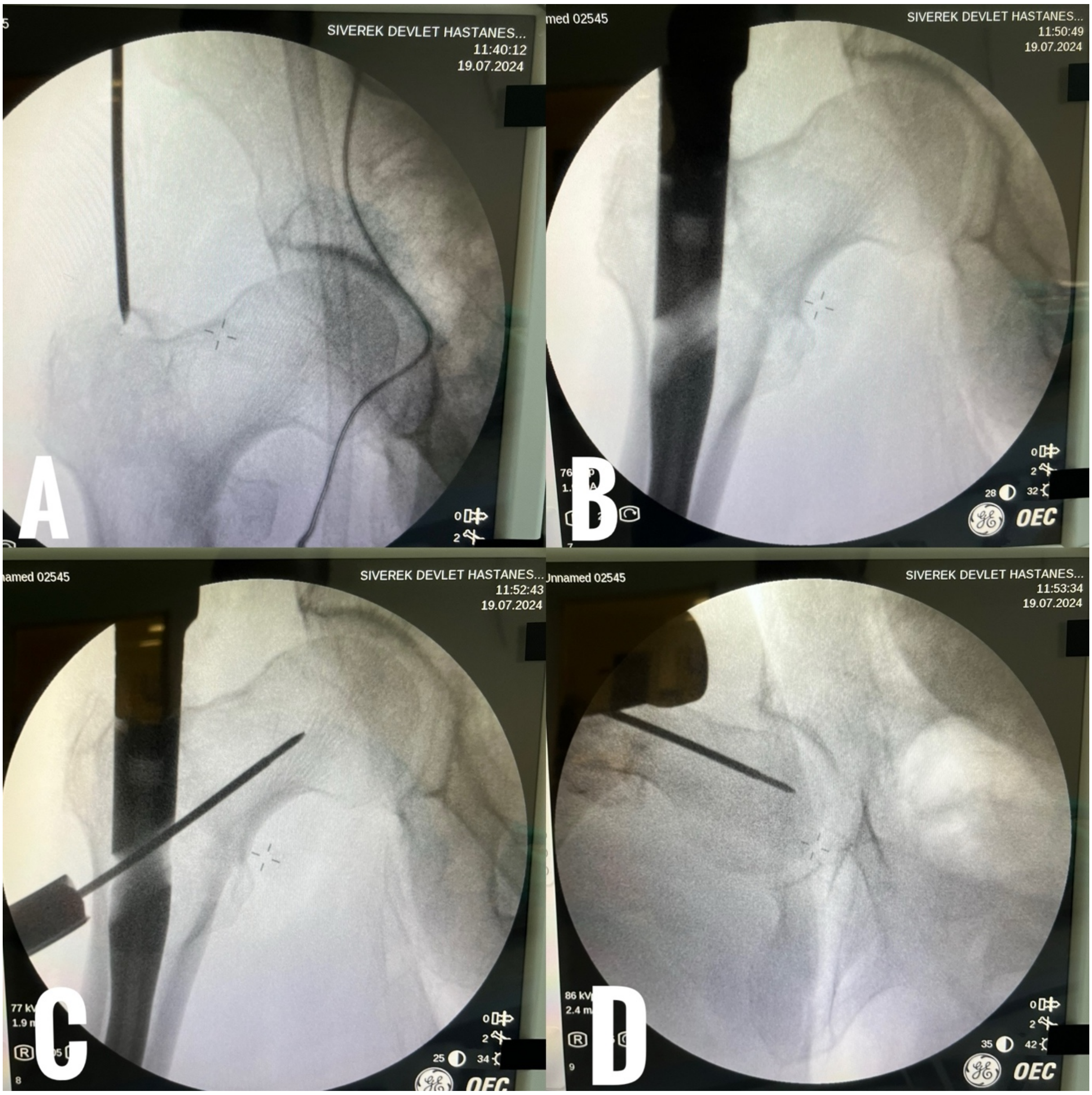

Fig. 2 — A: Anteroposterior fluoroscopic view of the right hip during preparation of the initial K-wire entry point.
B: Fluoroscopic image showing the intramedullary nail inserted after canal reaming.
C: Fluoroscopic view of the guide K-wire advanced into the femoral neck for lag screw placement.
D: Lateral fluoroscopic projection of the femoral neck obtained by positioning the hip in 80–100° flexion, 30–40° abduction, and 10–20° external rotation.

between tip–apex distance (TAD) and cut-out was assessed descriptively and treated as exploratory due to the very low number of cut-out events; therefore, this comparison was not used for confirmatory inference. Categorical variables were presented as frequencies and percentages. A two-sided p-value < 0.05 was considered statistically significant.

RESULTS

The mean age of the cohort was 70.5 ± 13.4 years, with a median age of 71 years (range, 24–90). The mean follow-up duration, available for secondary outcome ascertainment, was 14± 5.4 months (range, 7–30). Of the 52 patients included, 31 (59.6%) were male and 21 (40.4%) were female. The fracture was located on the right side in 27 patients (51.9%) and on the left side in 25 (48.1%). According to the Evans classification, 36 fractures (69.2%) were stable, 12 (23.1%) were unstable, and 4 (7.7%) were reverse oblique. Based on the Boyd–Griffin classification, 30 patients (57.7%) were classified as Type 1, 14 (26.9%) as Type 2, and 4 patients each (7.7%) as Type 3 and Type 4. During follow-up, one patient developed deep vein thrombosis and two patients (3.8%) experienced cut-out (Table I).

The mean preoperative preparation time was 10.4 ± 1.8 minutes (median, 10; range, 7–15), and the mean operative time was 43.6 ± 7.9 minutes (median, 44.5; range, 25–65). Operative duration differed significantly according to fracture stability. Procedures performed for unstable fractures were markedly longer than those for stable fractures (Mann–Whitney $U = 0.0$, $p < 0.001$). Similarly, operative time varied significantly across Boyd–Griffin fracture types (Kruskal–Wallis $H = 13.10$, $p = 0.004$), with post-hoc analysis indicating that Type 4 fractures required significantly longer operative times compared with Type 1 fractures (adjusted $p = 0.018$) (Table II).

The mean tip–apex distance (TAD) was 17.7 mm (range, 8–27). TAD was <20 mm in 31 patients (59.6%), between 20–25 mm in 19 (36.5%), and >25 mm in 2 patients (3.8%). Cut-out occurred in 2 patients (3.8%), and both cases were observed among patients with higher TAD values. Although an exploratory Mann–Whitney U test showed a between-group difference in TAD ($U = 98.0$, $p = 0.023$), this finding should be interpreted cautiously given the very small number of cut-out events and should be considered hypothesis-generating rather than confirmatory (Table III).

Lag-screw positioning according to the Cleveland–Bosworth classification revealed that the majority of screws were placed in the central–central quadrant (n = 38, 73.1%). Central–anterior and central–posterior positions were each observed in four patients (7.7%). Superior–central and inferior–central positions were observed in two patients each (3.8%). Superior–anterior and inferior–anterior positions were observed in one patient each (1.9%). No screws were placed in the superior–posterior or inferior–posterior quadrants (Figure 3).

DISCUSSION

The primary contribution of this study is the description of a standardized, reproducible, limb-based algorithm for obtaining a lateral femoral neck view during proximal femoral nailing performed in the lateral decubitus position. By standardizing limb positioning—typically 80–100° of hip flexion, 30–40° of abduction, and 10–20° of external rotation—this algorithm directly addresses one of the main technical challenges of lateral decubitus fixation without a traction table. The early postoperative assessment of tip–apex distance and Cleveland–Bosworth quadrant distribution provides objective radiographic benchmarks for evaluating technical accuracy using this approach.

Proximal femoral nailing has traditionally been performed in the supine position using a traction table; however, standard operating tables are also widely used in both the supine and lateral decubitus positions. Regardless of patient position, the primary

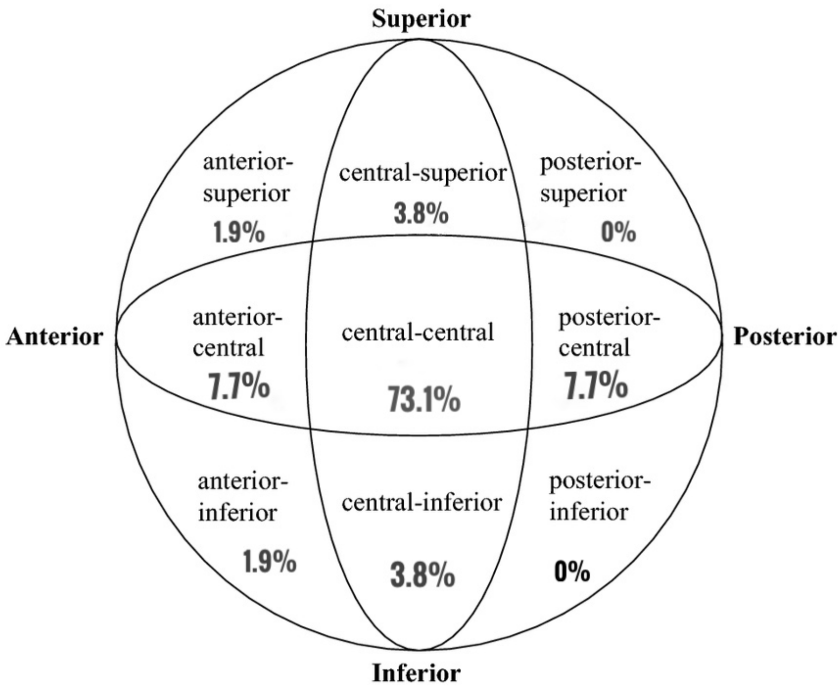

Fig. 3 — Distribution of the lag screw according to the Cleveland–Bosworth classification.

Table I. — Demographic and Clinical Characteristics of the Patients

Variable	Value
Number of patients	52
Mean age (years)	70.5 ± 13.4
Median age (years)	71 (range, 24–90)
Sex – Male, n (%)	31 (59.6%)
Sex – Female, n (%)	21 (40.4%)
Follow-up duration (months)	14 (range, 7–30)
Fracture side – Right, n (%)	27 (51.9%)
Fracture side – Left, n (%)	25 (48.1%)
Evans classification – Stable	36 (69.2%)
Evans classification – Unstable	12 (23.1%)
Evans – Reverse oblique	4 (7.7%)
Boyd–Griffin Type 1	30 (57.7%)
Boyd–Griffin Type 2	14 (26.9%)
Boyd–Griffin Type 3	4 (7.7%)
Boyd–Griffin Type 4	4 (7.7%)
Early DVT	1 patient
Cut-out	2 patients (3.8%)

This table summarizes baseline demographic and clinical characteristics of all patients included in the study.

Table II. — Operative Times and Statistical Comparisons.

Parameter	Mean ± SD	Median (Range)	Statistical Test	p-value
Preoperative preparation time (min)	10.4 ± 1.8	10 (7–15)	-	-
Operative time (min)	43.6 ± 7.9	44.5 (25–65)	-	-
Evans: Stable vs. Unstable operative time	-	-	Mann–Whitney U = 0.0	< 0.001
Boyd–Griffin comparison (all types)	-	-	Kruskal–Wallis H = 13.10	0.004
Post-hoc: Type 1 vs Type 4	-	-	Adjusted Mann–Whitney	0.018

This table presents operative preparation and surgical times along with statistical comparisons based on Evans and Boyd–Griffin classifications.

Table III. — Distribution of Tip–Apex Distance (TAD) and Relationship With Cut-out.

TAD Category	n (%)
< 20 mm	31 (59.6%)
20–25 mm	19 (36.5%)
> 25 mm	2 (3.8%)
Mean TAD (mm)	17.7 (range, 8–27)
Cut-out cases	2 (3.8%)
Comparison: Cut-out vs. no cut-out	Mann–Whitney U = 98.0
p-value	0.023

This table shows the distribution of TAD measurements and compares TAD values between patients with and without cut-out.

objective across techniques is to achieve stable anatomical reduction and accurate implant placement. The lateral decubitus position was initially described by Küntscher and later adapted for proximal femoral fractures[12]. The present study demonstrates that when the lateral decubitus approach is combined with a standardized limb-positioning algorithm, optimal tip–apex distance and safe screw placement can be achieved, supporting the feasibility of this method in centers without access to a traction table.

The surgical management of intertrochanteric femur fractures in osteoporotic patients is challenging due to the increased risk of mechanical complications, most notably cut-out[9]. In addition to poor bone quality, suboptimal placement of the lag screw within the femoral head is a well-established risk factor for cut-out[13]. To standardize assessment of cephalic screw positioning, Cleveland and Bosworth divided the femoral head–neck region into nine quadrants, defining optimal placement as central or inferior on anteroposterior radiographs and central on lateral views[10-15]. The superior–posterior quadrant has consistently been identified as the most unfavorable zone[16]. In the present study, the lag screw was most frequently positioned in the central–central quadrant (73.1%), with no screws placed in the superior–posterior quadrant. These findings suggest that the lateral decubitus algorithm facilitates controlled screw trajectory and supports placement within recommended safe zones. However, as a lag-screw cephalic element was used rather than a helical blade, comparisons with blade-specific studies should be interpreted with caution.

The tip–apex distance (TAD) is a critical parameter in the surgical management of intertrochanteric femur fractures. Defined by Baumgaertner et al., TAD represents the sum of distances measured on anteroposterior and lateral radiographs between the tip of the lag screw and the most distant point of the femoral head. Accurate acquisition of a lateral femoral neck view is essential for reliable TAD measurement. Baumgaertner and colleagues reported that TAD was the strongest predictor of cut-out, with successful cases averaging 25 mm and failures averaging 38 mm (13,21). In our cohort, the mean TAD was 17.7 mm, and 96.2% of patients demonstrated a TAD below 25 mm. Patients who developed cut-out exhibited significantly higher TAD values, reinforcing the established association between increased TAD and mechanical failure and supporting the importance of accurate intraoperative lateral visualization.

Cut-out remains one of the most clinically significant complications associated with intramedullary fixation of intertrochanteric femur fractures. Previous studies have reported cut-out rates of up to 8% following intramedullary nailing (25). In the present study, cut-out occurred in 2 of 52 patients (3.8%), which is comparable to rates reported in the literature[9,18]. The low incidence of cut-out in our cohort may be attributed to accurate cephalic screw positioning and optimal TAD achieved using the standardized limb-based algorithm, rather than to implant-related factors alone.

A review of the literature indicates that while many studies acknowledge the importance of obtaining a lateral view during lateral decubitus fixation, detailed descriptions of a reproducible intraoperative technique are generally lacking. Previously reported approaches have focused on C-arm manipulation, trans-table imaging, or individualized positioning strategies[8,9,26–28]. In contrast, the present study introduces a predefined, limb-based positioning algorithm using specific degrees of hip flexion, abduction, and external rotation, enabling consistent acquisition of a lateral femoral neck view without additional C-arm manipulation. This structured approach distinguishes the present technique from earlier descriptive methods and enhances its reproducibility.

This study has several limitations. The absence of a control group treated using a traction table limits direct comparison between positioning techniques. The retrospective design and relatively small sample size also restrict generalizability. In addition, fluoroscopy time and the number of images required to obtain the lateral view were not prospectively recorded. Nevertheless, intraoperative observations suggested that once the limb was positioned according to the proposed algorithm, repeated fluoroscopic attempts were rarely required. Although limb positioning may theoretically affect fracture reduction, no deterioration in reduction quality was observed, likely due to temporary stabilization with a K-wire. Despite these limitations, future prospective randomized studies with larger cohorts are required to further validate the reproducibility and clinical value of this algorithm.

What is novel in this study?

- A standardized, limb-based lateral decubitus PFN algorithm performed without a traction table.
- A reproducible approach for obtaining a lateral femoral neck view using a defined limb-positioning sequence combined with controlled C-arm rotation.
- Early postoperative (24–72 hours) radiographic reference outcomes, including tip–apex distance and Cleveland–Bosworth quadrant placement, demonstrating technical feasibility.

CONCLUSION

The lateral decubitus position without a traction table represents a practical and reproducible approach for intertrochanteric fracture fixation, particularly in centers where traction tables are unavailable. Using a standardized, limb-based algorithm incorporating a defined C-arm rotation strategy and a structured limb-positioning sequence to obtain a lateral femoral neck view, reproducible early postoperative radiographic parameters were achieved, including favorable Cleveland–Bosworth quadrant placement and acceptable tip–apex distance in most patients. These findings support the technical feasibility and early radiographic performance of the proposed algorithm in lateral decubitus proximal femoral nailing.

Conflict of Interest: The authors declare that the submitted work was carried out in the absence of any personal, professional or
financial relationships that could potentially be construed as a conflict of interest.

Funding: The authors, their immediate families, and any research foundations with which they are affiliated have not received any financial payments or other benefits from any commercial entity related to the subject of this article.

REFERENCES

1. Karakus O, Ozdemir G, Karaca S, Cetin M, Saygi B. The relationship between the type of unstable intertrochanteric femur fracture and mobility in the elderly. J Orthop Surg Res. 2018;13(1):207.
2. Sharma A, Sethi A, Sharma S. Treatment of stable intertrochanteric fractures of the femur with proximal femoral nail versus dynamic hip screw: a comparative study. Rev Bras Ortop. 2018;53(4):477–481.
3. Callanan I, Choudhry V, Smith H. Perineal sloughing as a result of pressure necrosis from the traction post during prolonged bilateral femoral nailing. Injury. 1994;25:472.
4. Brumback RJ, Ellison TS, Molligan H, Molligan DJ, Mahaffey S, Schmidhauser C. Pudendal nerve palsy complicating intramedullary nailing of the femur. J Bone Joint Surg Am. 1992;74:1450–1455.
5. Karpos PA, McFerran MA, Johnson KD. Intramedullary nailing of acute femoral shaft fractures using manual traction without a fracture table. J Orthop Trauma. 1995;9:57–62.
6. Wolinsky PR, McCarty E, Shyr Y, Johnson KD. Reamed intramedullary nailing of the femur: 551 cases. J Trauma. 1999;46:392–399.
7. Wiss DA, Fleming CH, Matta JM, Clark D. Comminuted and rotationally unstable fractures of the femur treated with an interlocking nail. Clin Orthop Relat Res. 1986;212:35–47.
8. Sonmez MM, Camur S, Erturer E, Ugurlar M, Kara A, Ozturk I. Strategies for proximal femoral nailing of unstable intertrochanteric fractures: lateral decubitus position or traction table. J Am Acad Orthop Surg. 2017;25(3):e37–e44.
9. Turgut A, Kalenderer O, Gunaydin B, Onvural B, Karapinar L, Agus H. Fixation of intertrochanteric femur fractures using proximal femoral nail antirotation (PFNA) in the lateral decubitus position without a traction table. Acta Orthop Traumatol Turc. 2014;48(5):513–520.
10. Baumgaertner MR, Curtin SL, Lindskog DM, Keggi JM. The value of the tip-apex distance in predicting failure of fixation of peritrochanteric fractures of the hip. J Bone Joint Surg Am. 1995;77:1058–1064.
11. Cleveland M, Bosworth DM, Thompson FR, Wilson HJ Jr, Ishizuka T. A ten-year analysis of intertrochanteric fractures of the femur. J Bone Joint Surg Am. 1959;41:1399–1408.
12. Davis PH, Frymoyer JW. The lateral position in the surgical management of intertrochanteric and subtrochanteric fractures of the femur. J Bone Joint Surg Am. 1969;51:1128–1134.
13. Mavrogenis AF, Panagopoulos GN, Megaloikonomos PD, Igoumenou VG, Galanopoulos I, Vottis CT, et al. Complications after hip nailing for fractures. Orthopedics. 2016;39:e108–e116.
14. Kane P, Vopat B, Heard W, Thakur N, Paller D, Koruprolu S, et al. Is tip-apex distance as important as we think? A biomechanical study examining optimal lag screw placement. Clin Orthop Relat Res. 2014;472:2492–2498.
15. Goffin JM, Pankaj P, Simpson AH. The importance of lag screw position for the stabilization of trochanteric fractures with a sliding hip screw: a subject-specific finite element study. J Orthop Res. 2013;31:596–600.
16. Parker MJ. Cutting-out of the dynamic hip screw related to its position. J Bone Joint Surg Br. 1992;74:625.
17. Lee PY, Lin KJ, Wei HW, Hu JJ, Chen WC, Tsai CL, Lin KP. Biomechanical effect of different femoral neck blade position on the fixation of intertrochanteric fracture: a finite element analysis. Biomed Tech (Berl). 2016;61:331–336.
18. Karapinar L, Turgut A, Kumbaraci M, Koca A. Evaluation of the quadrants of femoral neck-head in cephalomedullary fixation of intertrochanteric fractures with a helical blade. Jt Dis Relat Surg. 2021;32(1):93–100.
19. Rubio-Avila J, Madden K, Simunovic N, Bhandari M. Tip-apex distance in femoral intertrochanteric fractures: a systematic review. J Orthop Sci. 2013;18:592–598.
20. Khanna V, Tiwari M. Significance of tip-apex distance in intertrochanteric fracture femur managed with proximal femoral nailing. Orthop Traumatol Surg Res. 2021;107:103009.
21. Baumgaertner MR, Solberg BD. Awareness of tip-apex distance reduces failure of fixation of trochanteric fractures. J Bone Joint Surg Br. 1997;79:969–971.
22. Beng K, et al. Tip-apex distance measurements in patients with intertrochanteric femur fractures treated with dynamic hip screw and impact on outcomes. Kartal Train Res Hosp Med J. 2013;24(1):19–24.
23. Liu W, Zhou D, Liu F, Weaver MJ, Vrahas MS. Mechanical complications of intertrochanteric hip fractures treated with trochanteric femoral nails. J Trauma Acute Care Surg. 2013;75:304–310.
24. Aguado-Maestro I, Escudero-Marcos R, Garcia-Garcia JM, Alonso-Garcia N, Perez-Bermejo DD, Aguado-Hernandez HJ, et al. Results and complications of pertrochanteric hip fractures using PFNA. Rev Esp Cir Ortop Traumatol. 2013;57:201–207.
25. Lorich DG, Geller DS, Nielson JH. Osteoporotic pertrochanteric hip fractures: management and controversies. Instr Course Lect. 2004;53:441–454.
26. Pisoudeh K, Elahifar O, Alimoghadam S, Eslami A. Trans-table intraoperative fluoroscopic technique for obtaining a true lateral view. Arch Bone Jt Surg. 2023;11(8):531–534.
27. Ugur F. Individualized fluoroscopic lateral femoral neck view for fixation of hip fractures. J Health Sci Med. 2023;6(5):1125–1132.
28. Ekici M, Gunay AE, Kahraman M, Uluyardimci E, Ocguder DA. A novel fluoroscopy positioning for proximal femoral fixation. Jt Dis Relat Surg Case Rep. 2022;1(2):79–81.