İSTANBUL UNIVERSITY PRESS

Journal of İstanbul Faculty of Medicine
İstanbul Tıp Fakültesi Dergisi,
J Ist Faculty Med 2025, 88 (4): 280–287

https://doi.org/10.26650/IUITFD.1697385

Journal of İstanbul Faculty of Medicine
İstanbul Tıp Fakültesi Dergisi

Submitted: 14.05.2025
Revision Requested: 20.06.2025
Last Revision Received: 26.06.2025
Accepted: 04.07.2025
Published Online 30.09.2025

Research Article

Open Access

IMPACT OF THE PROXIMAL FRACTURE STARTING ORIGIN ON THE REDUCTION QUALITY AND COMPLICATIONS IN AO/OTA 31-A2 INTERTROCHANTERIC FEMORAL FRACTURES TREATED WITH PROXIMAL FEMORAL NAIL ANTIROTATION

PROKSİMAL FEMUR ÇİVİSİ ANTİROTASYON İLE TEDAVİ EDİLEN AO/OTA 31-A2 INTERTROKANTERİK FEMUR KIRIKLARINDA PROKSİMAL KIRIK BAŞLANGIÇ KONUMUNUN REDÜKSİYON KALİTESİ VE KOMPLİKASYONLARI ÜZERİNDEKİ ETKİSİ

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Abstract

Objective: This study aimed to investigate the impact of the proximal fracture starting location relative to the tip of the greater trochanter on the reduction quality and complication rates in patients with AO/OTA 31-A2 intertrochanteric femoral fractures (IFFs) treated with *Proximal Femoral Nail Antirotation* (PFNA).

Material and Methods: A retrospective analysis was conducted on 125 patients diagnosed with unstable AO/OTA 31-A2 IFFs treated by PFNA. The fractures were categorised into two subtypes based on the location of the proximal starting point of the fracture line relative to the tip of the greater trochanter: subtype 1 (medial or at the tip of the greater trochanter) or subtype 2 (lateral). The quality of reduction was assessed using the Baumgaertner reduction quality criteria, and complication rates, including lateral cortex fractures and blade cut-outs, were compared between the groups.

Results: Patients whose fractures originated medially (subtype 1) demonstrated significantly better reduction quality (78% good reduction) compared with those with lateral starting points (subtype 2) (30% good reduction). Additionally, the lateral cortex fracture rate was significantly higher in subtype 2 (16%) than in subtype 1 (0%) (p<0.001). The blade cut-out rate was also higher in subtype 2 (11%) than in subtype 1 (2%) (p = 0.042).

Öz

Amaç: Bu çalışmanın amacı, Proksimal Femural Çivi Antirotasyon (PFNA) ile tedavi edilen AO/OTA 31-A2 intertrokanterik femur kırığı (IFF) olan hastalarda büyük trokanterin ucuna göre proksimal kırık başlangıç yerinin redüksiyon kalitesi ve komplikasyon oranları üzerindeki etkisini araştırmaktır.

Gereç ve Yöntemler: PFNA ile tedavi edilen stabil olmayan AO/OTA 31-A2 IFF tanılı 125 hasta üzerinde retrospektif bir analiz yapılmıştır. Kırıklar, kırık hattının proksimal başlangıç noktasının büyük trokanterin ucuna göre konumuna göre iki alt tipte kategorize edildi: alt tip 1 (medial veya büyük trokanterin ucunda) veya alt tip 2 (lateral). Redüksiyon kalitesi Baumgaertner redüksiyon kalitesi kriterleri kullanılarak değerlendirildi ve lateral korteks kırıkları ve bıçak (blade) cut-out dahil olmak üzere komplikasyon oranları gruplar arasında karşılaştırıldı.

Bulgular: Kırıkları medialden başlayan hastaların (alt tip 1) redüksiyon kalitesi (%78 iyi redüksiyon) lateralden başlayanlara (alt tip 2) kıyasla (%30 iyi redüksiyon) anlamlı derecede daha iyiydi. Ayrıca, lateral korteks kırığı oranı alt tip 2′de (%16) alt tip 1′e (%0) göre anlamlı derecede yüksekti (p<0,001). bıçak (blade) cut-out oranı da alt tip 2′de (%11) alt tip 1′e (%2) kıyasla daha yüksekti (p=0,042).

Sonuç: Alt tip 1 kırıklarda, PFNA için klasik trokanterik giriş noktası etkili olurken, alt tip 2 kırıklarda redüksiyon kaybını önlemek,

Citation: Kızılkurt T, Demirel M, Demir B, Polat G, Akgül T, Erşen A. Impact of the proximal fracture starting origin on the reduction quality and complications in AO/OTA 31-A2 intertrochanteric femoral fractures treated with proximal femoral nail antirotation. Journal of İstanbul Faculty of Medicine 2025;88(4):280-287. https://doi.org/10.26650/IUITFD.1697385

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Conclusion: For subtype 1 fractures, the classical trochanteric entry point for PFNA is effective, whereas a more medial entry point is recommended for subtype 2 fractures to prevent loss of reduction, reduce the risk of lateral cortical fractures, and decrease the likelihood of cut-out complications.

Keywords Complication · Fracture Starting Point · Proximal Femoral Nail Antirotation (PFNA) · Reduction Quality · Unstable Intertrochanteric Femoral Fractures

lateral kortikal kırık riskini azaltmak ve cut-out komplikasyonları olasılığını azaltmak için daha medial bir giriş noktası önerilir.

Anahtar Kelimeler Komplikasyon · kırık başlangıç noktası · proksimal femoral çivi antirotasyonu (PFNA) · redüksiyon kalitesi · stabil olmayan intertrokanterik femur kırıkları

INTRODUCTION

Intertrochanteric femoral fractures (IFFs) are common in the elderly and often lead to high morbidity and mortality due to comorbidities and age-related functional decline. Classification systems such as Evans and the Orthopaedic Trauma Association (AO/OTA) are widely used in clinical practice, categorising IFFs as stable or unstable. Unstable fractures typically involve posteromedial cortex disruption, subtrochanteric extension, or reverse oblique patterns (AO/OTA 31-A2 and A3), whereas fractures without these features are considered stable.

Osteosynthesis remains the primary treatment for elderly patients with IFF, typically using intramedullary nails or extramedullary sliding hip screws. Compared with sliding hip screws, proximal femoral nails (PFNs) offer better resistance to varus collapse and provide greater mechanical stability in unstable fractures (AO/OTA 31-A2 and A3). Thus, PFNs are generally preferred for unstable IFFs. Although existing classification systems aid in treatment planning, they lack technical guidance, particularly regarding PFN application in unstable AO/OTA 31-A2 fractures. An ideal classification should provide such insights, especially regarding the optimal entry portal for PFNs. We propose and evaluate a practical modification of the AO/OTA 31-A2 classification that incorporates the proximal starting point.

Most PFN systems on the market have a 4° to 6° lateral proximal bend in the frontal plane, with the trochanteric entry point being the standard. The implant design and appropriate entry location are crucial for achieving proper reduction, stable fixation, and minimising complications. However, the impact of the entry point alignment on the reduction quality remains underexplored. Proximal Femural Nail Antirotation (PFNA), with its helical neck blade, offers mechanical advantages such as reduced bone loss and improved purchase in the femoral head by compacting cancellous bone during insertion. These features contribute to high union rates and low complication rates.

Despite these benefits, PFNA is associated with lateral cortex impingement, which may lead to lateral cortex fractures, loss of reduction, and increased risk of blade cut-out. This has been attributed to the round proximal nail design. However, we propose that another factor may contribute to this impingement: the spatial relationship between the nail entry point and the fracture line's proximal origin on the greater trochanter.

This study aimed to evaluate how the starting point of the fracture line, relative to the trochanteric tip in the frontal plane, influences the initial reduction quality and early postoperative complications in unstable AO/OTA 31-A2 IFFs treated with PFNA. We hypothesise that fractures beginning medial to the trochanteric tip allow for better reduction and fewer complications, such as lateral cortical fractures and blade cut-out, compared with those with a more lateral starting point.

MATERIAL AND METHODS

Study setting and participants

A retrospective chart review was conducted on all patients who underwent surgery for treating IFFs in a single tertiary referral centre. Before data collection, approval from the institutional review board was obtained. This study was approved and participant consent was obtained from the Clinical Research Ethical Committee of Istanbul University, Istanbul Faculty of Medicine (Date: 02.05.2025, No: 9). The inclusion criteria for the study were a diagnosis of unstable AO/OTA 31-A2 IFF after a low-energy trauma, treatment with the PFNA, complete medical records, and appropriate radiographic images. The exclusion criteria were as follows: a diagnosis of pathological fracture or malignant neoplasm, age 60 years, multi-trauma patients, open injuries, coexisting neuromuscular disorders, lost to follow-up, and inadequate medical and radiological data.

Based on the above eligibility criteria, 135 consecutive patients diagnosed with unstable AO/OTA 31-A2 IFF and treated by a PFNA between 2009 and 2013 were retrospectively identified. After ten patients were excluded (three were lost to follow-up, three had insufficient medical records, one had multi-trauma injury, and three had neuromuscular disorders), the remaining 125 patients (125 IFFs; 71 female, 54 male; mean age = 79 years, age range=60-95) who met the inclusion criteria were included in the study.

Modification of the AO/OTA 31-A2 IFF

The AO/OTA 31-A2 fracture pattern was categorised into two sub-types based on the location of the proximal starting point of the intertrochanteric fracture line relative to the tip of the greater trochanter on preoperative traction-internal rotation anteroposterior (AP) hip radiographs. The fractures with a proximal starting point medial or at the tip of the greater trochanter were defined as subtype 1. The fractures with a proximal starting point located on the lateral aspect of the tip of the greater trochanter were defined as subtype 2 (Figure 1). Radiographic subtyping was performed by a single consultant orthopaedic trauma surgeon, who was blinded to all clinical data to minimize potential bias.

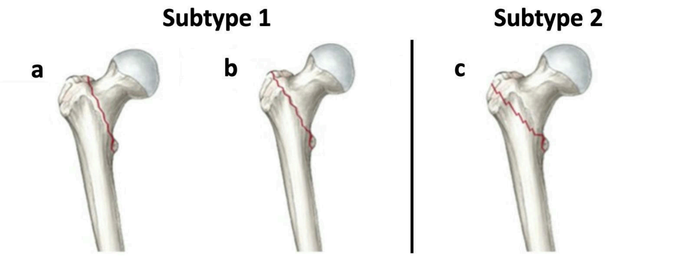

Figure 1. The AO/OTA 31-A2 fracture pattern is categorised into two subtypes based on the proximal starting point of the intertrochanteric fracture line in relation to the tip of the greater trochanter. Subtype 1 includes fractures in which the proximal starting point is either medial to or at the tip of the greater trochanter (a and b). Subtype 2 comprises fractures where the proximal starting point is located lateral to the tip of the greater trochanter (c).

Patients enrolled in the study were then categorised into two groups as per the modified subtypes of AO/OTA 31-A2 IFFs: Group 1, including patients with subtype 1 IFFs, and Group 2, including those with subtype 2 IFFs.

Operative procedure

All the operations were performed by the same group of orthopaedic surgeons according to the standard protocol at our department. All the patients were operated on a traction table in the supine position under general or spinal anaesthesia. With fluoroscopic guidance, an acceptable closed reduction of IFFs in the AP and lateral views was obtained with proper longitudinal traction in line with the axis of the femur and internal rotation of the lower limb.

The tensor fascia lata and gluteus medius muscle were longitudinally divided approximately 5 cm proximal to the tip of the greater trochanter following a 5-cm longitudinal incision. PFNA™ (DePuy Synthes, Solothurn, Switzerland) was implanted to obtain osteosynthesis in all patients. A 3.2-mm guide wire was initially inserted into the medullary canal, across the tip of the greater trochanter. A 17.0-mm entry reamer over the guide wire was then used to open the proximal femur, and a proper length of the PFNA was manually inserted into the femur with the insertion handle apparatus. The 130° aiming arm was attached to the insertion handle, and the guide wire of the PFNA blade was introduced through a 3-cm lateral incision at the middle of the femoral head in both the AP and lateral projections. The external cortex was accessed with an 11.0-mm drill, and the femoral head and neck were reamed using an 11.0 mm cannulated reamer. Afterward, a proper length of the PFNA blade was inserted with an impactor device was impacted gently using a mallet. Following the accurate placement of the PFNA blade within the femoral head, the impactor was turned in a clockwise direction to secure the blade, thereby inhibiting any rotation of the femoral head and PFNA blade. Distal locking was executed via an aiming arm equipped with a screw.

Postoperative follow-up protocol

Postoperatively, partial weight-bearing with a crutch started 2 weeks post-surgery, with full weight-bearing permitted following complete fracture healing. Elderly patients with advanced osteoporosis were prohibited from bearing weight prematurely. Radiographic follow-ups were scheduled on the first post-operative day, 2nd week, 6th week, and 3rd month, and every month thereafter until evidence of fracture healing.

Patients were monitored for a minimum of six months until fracture union or the emergence of a problem.

Outcome measures

Patient demographic characteristics, including age at the time of surgery, gender, and fracture side, were obtained from the hospital's electronic database. The reduction quality of IFFs was determined by the Baumgaertner reduction quality criteria (BRQC) (18) on early postoperative AP and lateral hip radiographs retrieved from the picture archiving and communication system (Table 1). The first criterion used was a neutral collodiaphyseal angle (125–135°) and a lateral angulation of < 20°. The second criterion used was the presence of < 4-mm displacement of any fragments in the AP and lateral views. Reduction was deemed satisfactory if both requirements were fulfilled, acceptable if only one condition was satisfied, and inadequate if neither criterion was reached. The collodiaphyseal angle is defined as the angle between the femoral neck axis and the femoral shaft axis on the AP radiograph. The tip-apex distance (TAD) was calculated on early postoperative radiographs using the method described by Johnson et al. (19).

Intra- and post-operative technical and mechanical complications such as intra-articular or lateral migration of the blade, cut-outs, fixation failures, lateral cortex fracture, and non-unions were examined on post-operative and follow-up radiographs. Fracture healing was evaluated on radiographs taken at least six months after surgery.

Table 1. The Baumgaertner reduction quality criteria

Criteria	Parameters
I. Alignment	a. Anteroposterior view: neutral (125-135°) or slight valgus neck-shaft angle*
	b. Lateral view: <20° of angulation
II. Displacement	a. Anteroposterior view: less than 4-mm displacement of any fragments
	b. Lateral view: less than 4-mm displacement of any fragments
Reduction quality	Good → both criteria met Acceptable → only one criterion met Poor → none of the criteria met

*Slight valgus refers to ≤10°

Two experienced orthopaedic surgeons independently evaluated the reduction quality. In cases of disagreement, a consultant orthopaedic surgeon was consulted, and a consensus was reached through a cooperative evaluation. This process was implemented to enhance the accuracy and reliability of the results. The same two orthopaedic surgeons independently assessed TAD and its complications.

Statistical analysis

The chi-square test (or Fisher's exact test where applicable) was employed to assess qualitative factors, including reduction quality, complications, and reoperation rates between the two independent groups. The variables' distribution was assessed using the Kolmogorov–Smirnov test. The Mann–Whitney U test was employed in the comparative study of the quantitative independent variables. The Cohen's Kappa and intraclass correlation coefficient (ICC) techniques were used to assess the inter-rater reliability for the BRQC and TAD measurements, respectively. A p-value < 0.05 was considered statistically significant. All statistical analyses were performed using the SPSS software for Windows, version 29.0. The agreement (ICC and Cohen's Kappa) was considered excellent for ICC > 0.80, very good for 0.70 to 0.80, good for 0.60 to 0.70, fair for 0.40 to 0.60, and poor for <0.40.

RESULTS

The average follow-up duration was 13 months, with a range of 4–36 months. There were 59 patients (48%; 32 female, 27 male; mean age = 77 years, age range= 60 - 92) in group 1 and 66 patients (52%; 39 female, 27 male; mean age = 79 years (range, 60–95)) in group 2. TAD was measured with an overall mean of 25.5 mm (range=5 - 36 mm). There was no statistically significant difference in TAD between the two groups (Group 1: 27 mm vs. Group 2: 24 mm, p = 0.356). Excellent inter-rater reliability was obtained for the TAD measurements (ICC = 0.96).

Distribution of the reduction quality

The inter-rater reliability was excellent for BRQC assessments (Cohen's Kappa = 0.91). In group 1, the reduction quality of IFFs was good in 46 patients (78%), acceptable in 5 patients (8%), and poor in 8 patients (14%) based on the BRQC. In group 2, the reduction quality was good in 20 patients (30%), acceptable in 27 patients (42%), and poor in 19 patients (28%) (Figure 2). The distribution of the reduction quality categories differed significantly between the two groups (p<0.001). Group 1 had a higher proportion of good reductions. Whereas Group 2 showed a higher proportion of both acceptable and poor-quality reductions (Table 2).

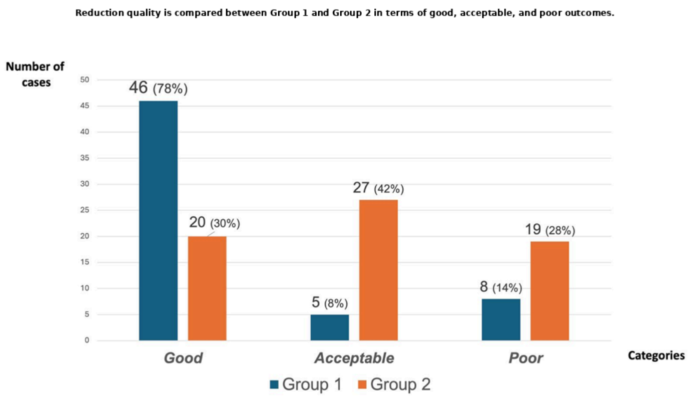

Figure 2. Comparative bar charts illustrate the distribution of reduction quality between groups according to the Baumgaertner Reduction Quality Criteria (BRQC).

Table 2. Distribution of the reduction quality of the AO/OTA 31-A2 IFF subtypes

Reduction Quality According to BRQC*	Group 1 (n = 59)	Group 2 (n =66)	Overall
Good	46 (78%)	20 (30%)	66
Acceptable	5 (8%)	27 (42%)	32
Poor	8 (14%)	19 (28%)	27
Complications			
Lateral cortex fracture	– (%)	11 (16%)	11
Blade cut-out	1 (2%)	7 (11 %)	8

*BRQC: Baumgaertner reduction quality criteria. The chi-square test revealed a significant difference in reduction quality outcomes between the two groups (p<0.001). The rates of lateral cortex fractures (p<0.001) and blade cut-outs (p=0.042) were both significantly higher in Group 2 than in Group 1.

Complications

In terms of intraoperative complications, a lateral cortex fracture of the proximal femur occurred in 11 patients (16%) in

Group 2, whereas no such complication was observed in Group 1 ($p<0.001$) (Figure 3). Additionally, the cut-out of the blade from the femoral head developed in 1 patient (2%) in Group 1 and 7 patients in Group 2 (11%) ($p=0.042$) in the early post-operative period of 6 months (Figure 4). The rates of lateral cortex fractures and blade cut-outs were both significantly higher in Group 2 than in Group 1 (Table 2).

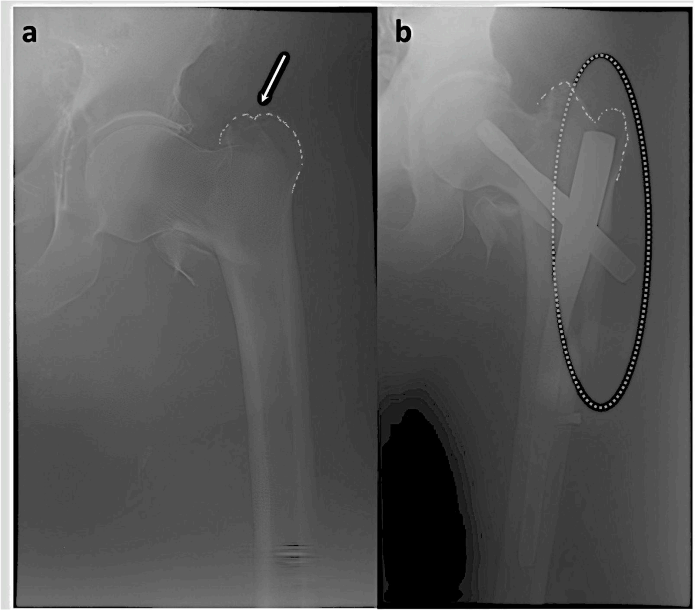

Figure 3. Radiographs illustrate the development of a lateral cortical fracture following PFNA implantation. The preoperative radiograph (a) demonstrates a subtype 2 AO/OTA 31-A2 intertrochanteric femoral fracture, with the proximal starting point (indicated by a white arrow) located on the lateral aspect of the tip of the greater trochanter. The early postoperative radiograph (b) shows the formation of a lateral cortical fracture (marked by dashed lines), which is associated with the classical entry point of the PFNA.

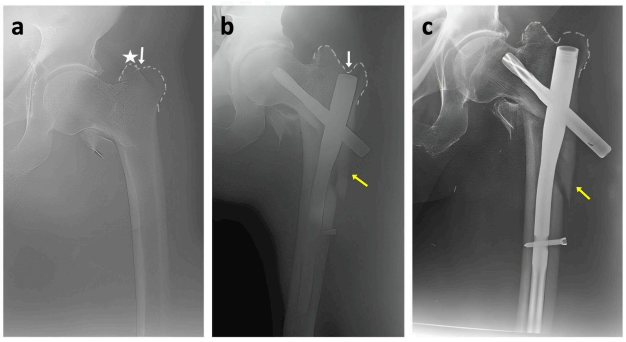

Figure 4. Radiographs illustrate the development of a lateral cortical fracture and subsequent blade cut-out. The preoperative radiograph (a) shows a subtype 2 AO/OTA 31-A2 intertrochanteric femoral fracture, with the proximal starting point (white arrow) located on the lateral aspect of the tip of the greater trochanter (asterisk). The early postoperative radiograph (b) demonstrates a lateral cortical fracture (yellow arrow) associated with the classical entry point of the PFNA. The postoperative follow-up radiograph (c) reveals both the lateral cortical fracture and blade cut-out.

DISCUSSION

PFN systems on the market today typically use the trochanteric entry portal for easy insertion into the medullary canal, and the optimal entry point on the greater trochanter's frontal plane plays a crucial role in obtaining good quality of reduction, stable fixation, and preventing implant-related complications (8-10, 20, 21). However, the relationship between the correct entry point and the reduction quality remains underresearched. The existing classification systems do not provide adequate data in terms of perioperative technical considerations of PFN application, particularly for unstable AO/OTA 31-A2 IFFs. An ideal classification system should provide some technical hints about PFNs, especially the starting portal location.

Therefore, the current study modified the AO/OTA 31-A2 fracture pattern into two subtypes based on the proximal starting point of the intertrochanteric fracture line relative to the tip of the greater trochanter. We considered that if the proximal starting point of the fracture line is located to the lateral of the trochanteric tip, inserting the nail through the classical entry point of the tip of the greater trochanter could separate the main fracture fragments, resulting in the loss of initial reduction and lateral cortex fracture. Moreover, PFNA has been associated with lateral cortex impingement, leading to lateral cortex fracture, loss of fracture reduction, and increased risk of post-operative blade cut-out. This impingement has been linked to the geometric discrepancies between the proximal femur and the PFNA. However, we assumed that another factor contributing to lateral cortical impingement during implantation may be the entry point of the nail in relation to the proximal starting point of the fracture line on the greater trochanter in the frontal plane. Accordingly, based on our modified AO/OTA 31-A2 fracture patterns, this study hypothesised that the PFNA could provide better reduction quality with lower rates of lateral cortical fracture and further post-operative cut-out in fractures with the starting point of the fracture line located to the medial of the trochanteric tip than those located laterally.

The results of this study have supported the hypothesis, indicating that the subtype 1 AO/OTA 31-A2 IFFs starting medially relative to the tip of the greater trochanter exhibited significantly better reduction quality according to the BRQC and lower complication rates. Conversely, the subtype 2 IFFs starting laterally relative to the tip of the greater trochanter developed more lateral cortex fractures and blade cut-outs. These complications are likely due to the separation of the main fracture fragments when the classical entry point at the tip of the greater trochanter is used (Figure 5).

Figure 5. The illustration demonstrates the loss of reduction resulting from an inappropriate entry point. In subtype 2 intertrochanteric femoral fractures (IFFs), where the fracture line starts lateral to the tip of the greater trochanter, insertion of the PFNA through the classical entry point (the tip of the greater trochanter) may cause separation of the main fragments and lead to varus displacement of the proximal fragment.

The primary design of the PFNA comprises the helical neck blade, which minimises the risk of bone loss and confers enhanced purchase in the femoral head by the compaction of cancellous bone around the blade during implantation. In addition, the intrinsic locking mechanism blocks the rotation of the head-blade combination and provides more fracture stability (11, 12). The PFNA provides high union rates with low significant complication rates owing to these mechanical advantages (13-16). However, one major concern with using PFNA is that it causes lateral cortex impingement, resulting in lateral cortex fracture, loss of fracture reduction, and further varus displacement of the head-neck fragment. Lateral cortex impingement eventually decreases stability and increases the risk of cut-out. The lateral cortical impingement has been attributed to the geometric discrepancies between the PFNA system and proximal femur secondary to the round profile of the nail. To overcome these medical disadvantages, the PFNA II was developed as an enhanced design of the PFNA, including the flat lateral shape of the proximal part and a decrease in the mediolateral bending angle from 6° to 5°. Further clinical studies demonstrated that PFNA II could prevent lateral cortical impingement, thereby ensuring better fixation for unstable IFFs (4-17).

The PFNA implant offers a distinct advantage due to its 6° lateral bend, which facilitates nail insertion, reduces stress on the lateral cortex, and aligns more naturally with the femoral canal. Compared with other proximal femoral nails lacking this anatomical bow, PFNA may provide smoother instrumentation and better cortical conformity. Although this study specifically evaluated the PFNA, the same principles may also apply to other cephalomedullary nails that share a similar lateral bend design.

In the current study, a significantly higher rate of good reduction quality (78%) was obtained in the subtype 1 fractures compared to the subtype 2 fractures (30%). No intraoperative lateral cortical fracture and only one postoperative blade cut-out occurred in subtype 1 fractures, whereas subtype 2 fractures developed significantly higher rates of these complications. Additionally, many authors have confirmed that a TAD higher than 25 mm is one of the most important factors in predicting the cut-out risk (22-24). In our study, TAD did not differ between the groups, eliminating a potential confounding bias. These findings may indicate that the round profile of the proximal portion of the PFNA is not the only factor contributing to lateral cortical impingement. The entry point of the nail, in relation to the proximal starting point of the fracture line on the greater trochanter in the frontal plane, appears to be another determinant in the development of lateral cortical impingement during implantation.

The current study has several limitations that should be acknowledged. First, the retrospective nature of the study design may introduce selection bias. Second, the study was conducted at a single tertiary referral centre, which may limit the generalizability of the results to other settings. Third, the sample size, while adequate for the analyses performed, is relatively small, and future research should focus on larger, multicenter studies to validate these findings and explore additional factors that may influence the success of PFNA treatment. Finally, the study did not account for potential confounders such as bone mineral density, which could influence the outcomes.

Despite these limitations, the study has several strengths. The modification of the AO/OTA 31-A2 fracture classification based on the proximal starting point of the fracture line offers a novel perspective that could enhance the appreciation of IFF character and improve surgical outcomes. The use of standardised radiographic criteria and the involvement of multiple experienced orthopaedic surgeons in the evaluation process enhances the reliability and validity of the findings. Likewise, the study's emphasis on perioperative technical considerations provides practical insights that could be integrated into clinical practice, potentially reducing complication rates and improving the efficacy of PFN treatment for unstable intertrochanteric femoral fractures.

CONCLUSION

In conclusion, the classical entry point at the trochanteric tip for PFNA can be effectively employed in subtype 1 fractures, where the proximal starting point of the fracture line is medial or at the tip of the greater trochanter. However, for subtype 2 fractures, with the starting point located laterally relative to the tip of the greater trochanter, a medial entry point on the greater trochanter is recommended. This approach can help prevent the loss of reduction, reduce the risk of lateral cortical fractures, and decrease the likelihood of cut-out complications. These findings suggest that tailoring the entry point based on the specific fracture subtype can significantly enhance the outcomes of PFNA treatment in AO/OTA 31-A2 intertrochanteric femoral fractures. Modifying the AO/OTA 31-A2 classification to include the proximal starting point of the fracture line can provide valuable technical guidance that can enhance surgical protocols.

Ethics Committee Approval	Ethics committee approval was received for this study from the ethics committee of İstanbul University, İstanbul Faculty of Medicine (Date: 02.05.2025, No: 9).
Informed Consent	Consent was obtained from all participants who participated in the study.
Peer Review	Externally peer-reviewed.
Author Contributions	Conception/Design of Study- M.D., T.K., B.D., T.A.; Data Acquisition- M.D., T.K., B.D., G.P.; Data Analysis/Interpretation – M.D., T.K., B.D., A.E.; Drafting Manuscript- M.D., T.K., B.D., T.A.; Critical Revision of Manuscript- M.D., T.K., B.D., G.P., A.E.; Final Approval and Accountability- M.D., T.K., B.D., T.A., G.P., A.E.; Technical or Material Support- M.D., T.K., B.D., G.P.; Supervision- M.D., T.K., B.D., T.A., G.P., A.E.
Conflict of Interest	Authors declared no conflict of interest.
Financial Disclosure	Authors declared no financial support.

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REFERENCES

1. Kumar P, Rajnish RK, Sharma S, Dhillon MS. Proximal femoral nailing is superior to hemiarthroplasty in AO/OTA A2 and A3 intertrochanteric femur fractures in the elderly: a systematic literature review and meta-analysis. Int Orthop 2020;44(4):623-33.
2. Evans EM. The treatment of trochanteric fractures of the femur. J Bone Joint Surg Br 1949;31(2):190-203.
3. Müller ME. The comprehensive classification of fractures of long bones. Berlin: Springer-Verlag; 1990.
4. Macheras GA, Koutsostathis SD, Galanakos S, Kateros K, Papadakis SA. Does PFNA II avoid lateral cortex impingement for unstable peritrochanteric fractures? Clin Orthop Relat Res 2012;470(11):3067-76.
5. Zeng C, Wang YR, Wei J, Gao SG, Zhang FJ, Sun ZQ, et al. Treatment of trochanteric fractures with proximal femoral nail antirotation or dynamic hip screw systems: a meta-analysis. J Int Med Res. 2012;40(3):839-51.
6. Kokoroghiannis C, Aktselis I, Deligeorgis A, Fragkomichalos E, Papadimas D, Pappadas I. Evolving concepts of stability and intramedullary fixation of intertrochanteric fractures–a review. Injury 2012;43(6):686-93.
7. Duramaz A, Ilter MH. The impact of proximal femoral nail type on clinical and radiological outcomes in the treatment of intertrochanteric femur fractures: a comparative study. Eur J Orthop Surg Traumatol 2019;29(7):1441-9.
8. Anastopoulos G, Chissas D, Dourountakis J, Ntagiopoulos PG, Magnisalis E, Asimakopoulos A, et al. Computer-assisted three-dimensional correlation between the femoral neck-shaft angle and the optimal entry point for antegrade nailing. Injury 2010;41(3):300-5
9. Ansari Moein C, Ten Duis H, Oey P, De Kort G, Van der Meulen W, Van der Werken C. Intramedullary femoral nailing through the trochanteric fossa versus greater trochanter tip: a randomized controlled study with in-depth functional outcome results. Eur J Trauma Emerg Surg 2011;37(6):615-22.
10. Mallya S, Kamath SU, Annappa R, Nazareth NE, Kamath K, Tyagi P. The results of unstable ıntertrochanteric femur fracture treated with proximal femoral nail antirotation with respect to different greater trochanteric entry points. Adv Orthop 2020;2020(1):2834816.
11. Windolf M, Braunstein V, Dutoit C, Schwieger K. Is a helical shaped implant a superior alternative to the Dynamic Hip Screw for unstable femoral neck fractures? A biomechanical investigation. Clin Biomech 2009;24(1):59-64.
12. Strauss E, Frank J, Lee J, Kummer FJ, Tejwani N. Helical blade versus sliding hip screw for treatment of unstable intertrochanteric hip fractures: a biomechanical evaluation. Injury 2006;37(10):984-9.
13. Xu Y, Geng D, Mao H, Zhu X, Yang H. A comparison of the proximal femoral nail antirotation device and dynamic hip screw in the treatment of unstable pertrochanteric fracture. J Int Med Res 2010;38(4):1266-75.
14. Xie Y, Dong Q, Xie Z. Proximal femoral nail anti-rotation (PFNA) and hemi-arthroplasty in the treatment of elderly intertrochanteric fractures. Acta Orthop Belg 2019;85(2):199-204.

15 Gardenbroek TJ, Segers MJ, Simmermacher RK, Hammacher ER. The proximal femur nail antirotation: an identifiable improvement in the treatment of unstable pertrochanteric fractures? J Trauma 2011;71(1):169-74.

16 Liu W, Liu J, Ji G. Comparison of clinical outcomes with proximal femoral nail anti-rotation versus InterTAN nail for intertrochanteric femoral fractures: a meta-analysis. J Orthop Surg Res 2020;15:1-15.

17 Shin WC, Seo JD, Lee SM, Moon NH, Lee JS, Suh KT. Radiographic outcomes of osteosynthesis using proximal femoral nail antirotation (PFNA) system in intertrochanteric femoral fracture: has PFNA II solved all the problems? Hip Pelvis 2017;29(2):104-12.

18 Fogagnolo F, Kfuri M, Paccola CAJ. Intramedullary fixation of pertrochanteric hip fractures with the short AO-ASIF proximal femoral nail. Arch Orthop Trauma Surg 2004;124:31-7.

19 Johnson LJ, Cope MR, Shahrokhi S, Tamblyn P. Measuring tip apex distance using a picture archiving and communication system (PACS). Injury 2008;39(7):786-90.

20 Gausepohl T, Pennig D, Koebke J, Harnoss S. Antegrade femoral nailing: an anatomical determination of the correct entry point. Injury 2002;33(8):701-5.

21 Moein CA, Verhofstad M, Bleys R, Van der Werken C. Soft tissue injury related to choice of entry point in antegrade femoral nailing: piriform fossa or greater trochanter tip. Injury 2005;36(11):1337-42.

22 Andruszkow H, Frink M, Frömke C, Matityahu A, Zeckey C, Mommsen P, et al. Tip apex distance, hip screw placement, and neck shaft angle as potential risk factors for cut-out failure of hip screws after surgical treatment of intertrochanteric fractures. Int Orthop 2012;36:2347-54.

23 Hsueh KK, Fang CK, Chen CM, Su YP, Wu HF, Chiu FY. Risk factors in cutout of sliding hip screw in intertrochanteric fractures: an evaluation of 937 patients. Int Orthop 2010;34:1273-6.

24 Yam M, Chawla A, Kwek E. Rewriting the tip apex distance for the proximal femoral nail anti-rotation. Injury 2017;48(8):1843-7.