Bosphorus Medical Journal
Boğaziçi Tıp Dergisi
Original Article
DOI: 10.14744/bmj.2022.38358
Bosphorus Med J 2023;10(1):6–12

# Is Long Proximal Femoral Nail Antirotation Superior to Proximal Femoral Locking Compression Plate in Reverse Oblique Intertrochanteric Fractures?

## Proksimal Femoral Kilitli Plak ve Uzun Proksimal Femoral Çivi: Ters Oblik İntertrokanterik Kırıkların Fiksasyonu İçin Karşılaştırma Çalışması

Mehmet Ali Talmaç,[1] Ali Şeker,[2] Ahmet Onur Akpolat,[3] Bekir Eray Kılınç[3]

[1]Department of Orthopedics and Traumatology, University of Health Sciences, Sisli Hamidiye Etfal Training and Research Hospital, Istanbul, Türkiye
[2]Department of Orthopedics and Traumatology, Istanbul University, Cerrahpaşa Medical Faculty, Istanbul,Türkiye
[3]Department of Orthopedics and Traumatology, Health Sciences University, Istanbul Fatih Sultan Mehmet Training and Research Hospital, Türkiye

**Cite this article as:** Talmaç MA, Şeker A, Akpolat AO, Kılınç BE. Is Long Proximal Femoral Nail Antirotation Superior to Proximal Femoral Locking Compression Plate in Reverse Oblique Intertrochanteric Fractures? Bosphorus Med J 2023;10(1):6–12.

**Received:** 18.07.2022
**Revision:** 18.07.2022
**Accepted:** 01.08.2022

**Correspondence:** Dr. Ahmet Onur Akpolat. Ortopedi ve Travmatoloji Kliniği, Sağlık Bilimleri Üniversitesi, Fatih Sultan Mehmet Eğitim ve Araştırma Hastanesi, İstanbul, Türkiye
**Phone:** +90 505 914 02 30
**e-mail:** onurakpolat@hotmail.com



## ABSTRACT

**Objectives:** The aim of the study was to compare the clinical and radiological results of long proximal femoral nail antirotation (LPFNA) with proximal femoral locking compression plate (PFLCP) in fixation of reverse oblique intertrochanteric fractures that are classified as 31A3.

**Methods:** Sixty-two patients were included in the study. Fixations were performed with LPFNA in 35 patients (n group) and PFLCP in 27 patients (p group). We retrospectively reviewed all patients' pre-operative, perioperative, and post-operative data. All variables were compared between the groups.

**Results:** The mean age was 61.7 (range; 29–92) years. The mean estimated total blood loss, the mean operation and fluoroscopy times, the patient receiving the blood transfusion ratio, and the number of anatomical quality of reduction were statistically significantly higher in the p group than of the n group. The mean change of neck-shaft and femoral anteversion angles was statistically significantly higher in the N group than of the p group.

**Conclusion:** Although the LPFNA was superior in the perioperative data, the PFLCP was superior in providing and persistent of the reduction. In functional scores, both implants had similar and satisfactory outcomes. According to our results, PFLCP could be a good option for fixation of reverse oblique trochanteric fractures.

**Keywords:** Bone nails; bone plate; fixation devices; fracture fixation; hip fractures; osteosynthesis.

## ÖZET

**Amaç:** Bu çalışmanın amacı, AO kırık sınıflaması 31A3 olarak sınıflandırılan ters oblik intertrokanterik femur kırıkların fiksasyonunda uzun proksimal femoral çivi (LPFNA) ve proksimal femoral kilitli kompresyon plağı (PFLCP) ile tedavi edilen hastaların klinik ve radyolojik sonuçlarını karşılaştırmaktır.

**Yöntem:** Çalışmaya 62 hasta dahil edildi. Otuz beş hastada (n grubu) LPFNA, 27 hastada (p grubu) PFLCP ile fiksasyon yapıldı. Tüm hastaların preoperatif, perioperatif ve postoperatif verileri retrospektif olarak incelendi. Tüm değişkenler gruplar arasında karşılaştırıldı.

**Bulgular:** Ortalama yaş 61,7 yıl (dağılım; 29-92 yıl) idi. Ortalama tahmini toplam kan kaybı, ortalama operasyon ve floroskopi süreleri, kan transfüzyonu yapılan hasta oranı ve anatomik redüksiyon kalitesi sayısı p grubunda n grubuna göre istatistiksel olarak anlamlı derecede yüksekti. Boyun-şaft ve femoral anteversiyon açılarının ortalama değişimi, n grubunda p grubuna göre istatistiksel olarak anlamlı derecede yüksekti.

**Sonuç:** Perioperatif verilerde LPFNA daha üstün olmasına rağmen, PFLCP redüksiyon sağlama ve kalıcılık açısından daha üstündü. Fonksiyonel skorlarda, her iki implant da benzer ve tatmin edici sonuçlara sahipti. Sonuçlarımıza göre, ters oblik trokanterik kırıkların tespiti için PFLCP iyi bir seçenek olabilir.

**Anahtar sözcükler:** Tespit yöntemi; kırık tespiti; kalça kırıkları; osteosentez; kemik çivileri; kemik plakları.

Reverse oblique intertrochanteric fractures, which include simple oblique, simple transverse, wedge, and multifragmentary fractures, are classified as AO/OTA 31A3 according to the Orthopedic Trauma Association classification system.[1] The reverse oblique fracture is characterized by the presence of a fracture line that extends to the vastus ridge from the lateral femoral cortex distal. Numerous investigators refer to these fractures as some combination of intertrochanteric and subtrochanteric fractures, with a reported incidence of 4.3%–23% in the literature.[2]

Several implants have been advocated for 31A3 fractures.[2,3] A series of biomechanical and clinical trials reported that proximal femoral nail antirotation (PFNA) is superior to extramedullary implants for 31A3 fractures.[4,5] However, extramedullary procedures may be preferred if the medullary canal is narrow, nailing is difficult due to comminution, or the patient has obvious osteoporosis.[1,6] Although PFNA has several advantages such as increasing stability at the fracture site, promoting healing, allowing early weight-bearing and functional exercises, having shorter operation time, and requiring small incisions, proximal femoral locking compression plate (PFLCP) provides multiple angularly stable fixations and biological osteosynthesis.[6,7]

Few clinical studies have been published in the literature regarding the fixation of unstable trochanteric fractures with PFLCP; furthermore, the results have been conflicting.[6-8] In addition, a comparative clinical study on fixation of reverse oblique intertrochanteric fractures with long proximal femoral nail antirotation (LPFNA) and PFLCP is yet to be published. We aimed to compare the clinical and radiological results of LPFNA with those of PFLCP for reverse oblique trochanteric fractures.

## Methods

This study was conducted as a retrospective and case–control study following the approval of the local ethical committee permission (2139/2018) of our hospital. Informed consent from patients was obtained before study started. The study completed between June 2017 and June 2020.

We identified 147 patients aged ≥18 years who were diagnosed with a reverse oblique intertrochanteric fracture and who underwent fixation using LPFNA (Tasarımmed, Istanbul, Türkiye) or PERI-LOC® PFLCP (Smith and Nephew, Memphis, USA) between June 2017 and June 2020. An initial 82 and 65 patients were treated with LPFNA and PERI-LOC® PFLCP, respectively; of whom, 11 and 15 patients treated with LPFNA and PERI-LOC PFLP, respectively, died during follow-up, and reoperation was required for eight and four patients, respectively, due to mechanical complications during follow-up.

Our exclusion criteria were as follow: Age <18 years, AO/OTA 31A1 and 31A2 fractures, fractures that extended 10 cm distal to the level of the lesser trochanter, bilateral hip fracture, pathologic fractures, another fracture in the extremities or spine, open fractures, history of lower limb fracture or deformity, previous ipsilateral lower limb surgery, contralateral hip fracture within the past year, cognitive impairment, severe concomitant medical condition, follow-up loss, reoperation requirements due to mechanical complications, and a follow-up period of <1 year. A final total of 62 patients were included in the study. Thirty-five patients were treated with 130° LPFNA (Group n), and 27 patients were treated with PERI-LOC® PFLCP (Group p).

Pre- and perioperative patient characteristics were collected following consent; these included the age, sex, body mass index (BMI; $kg/m^2$), affected side, fracture etiology, AO/OTA classification of fractures, bone mineral density (BMD; $g/cm^2$), Singh index, Charlson comorbidity index,[9] ASA grade of the operative risk,[10] pre-operative hemoglobin (g/dL) and hematocrit (mm/h) values, estimated total blood loss (mL), patients receiving blood transfusion, pre-operative time (days), operation time (minutes), fluoroscopy time (seconds), quality of reduction, and length of hospital stay (days). Post-operative data of the patients included the following: Union time (weeks), local or systemic complications evaluated during the whole follow-up period, and clinical and radiological evaluation criteria evaluated only on the final follow-up. The latter included the Harris hip score (HHS),[11] Salvati and Wilson score system (SWS),[12] Parker-Palmer mobility score (PPMS),[13] change in neck-shaft angle (NSA) (degrees), change in femoral anteversion angle (FAA) (degrees), and leg-length discrepancy (LLD).

All patients were classified as AO/OTA 31A3.1, 31A3.2, or 31A3.3 according to the Orthopedic Trauma Association classification system using pre-operative anteroposterior and lateral radiographic views (Fig. 1). The Singh index and BMD were determined using DPX (Prodigy, GE Lunar, WI) within 1–7 days after operation in all patients. The estimated total blood loss (mL) was calculated from the total volume of intraoperative aspiration fluids, drains, and blood on the gauze pad. The blood transfusion criterion was a hemoglobin level <9 g/dL. Anteroposterior and lateral radiographic views (Fig. 2) of the affected hip were evaluated within 1–7 days after the operation and at each follow-up visit in all patients. Patients in both groups were followed up in the 6th week, 3rd month, 6th month, 9th month, and 1st year postoperatively. We also classified the quality of reduction as follows: Poor (>10° of varus, valgus, anteversion, or retroversion), acceptable (5–10°), or anatomic (≤5°).[14]

The clinical and functional outcomes of patients were determined by SWS. Evaluations of function and mobilization were assessed using HHS.[11] The patients' walking ability was assessed by PPMS. Bilateral computed tomography (CT), bilateral lower limb orthoroentgenograms, and X-ray views were used for evaluation (Fig. 3). The changes in NSA and FAA were analyzed (Fig. 4). LLD was deemed to be present if the affected and non-affected sides' mechanical axis length difference measured by orthoroentgenogram was >20 mm. All variables were compared between the groups.

**Figure 1**. PA X-RAY view.

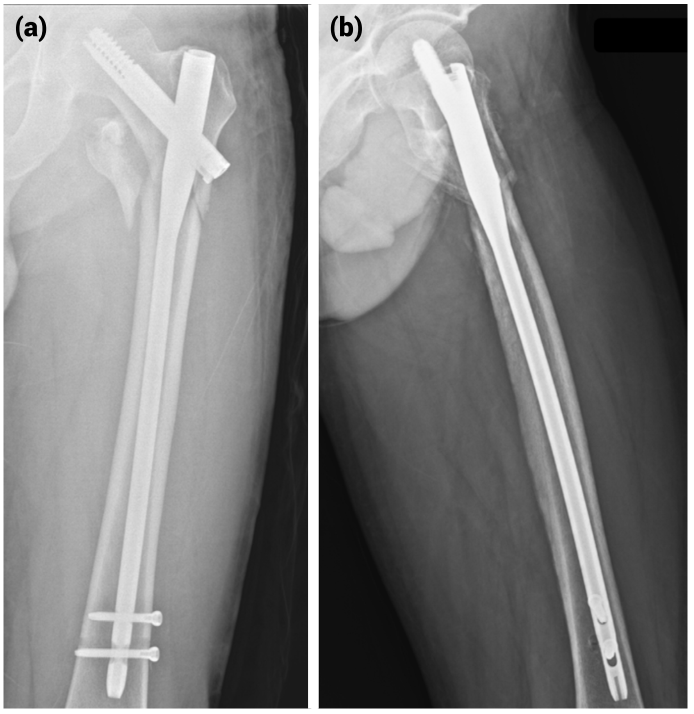


**Figure 2**. AP and Lateral X-RAY views of LPFNA.

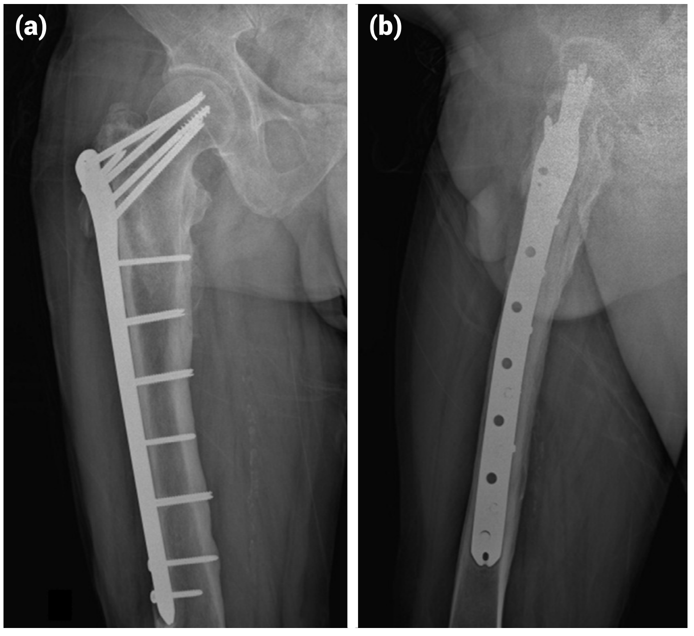


**Figure 3**. AP and Lateral r X-RAY views of PERI-LOC® PFLCP.

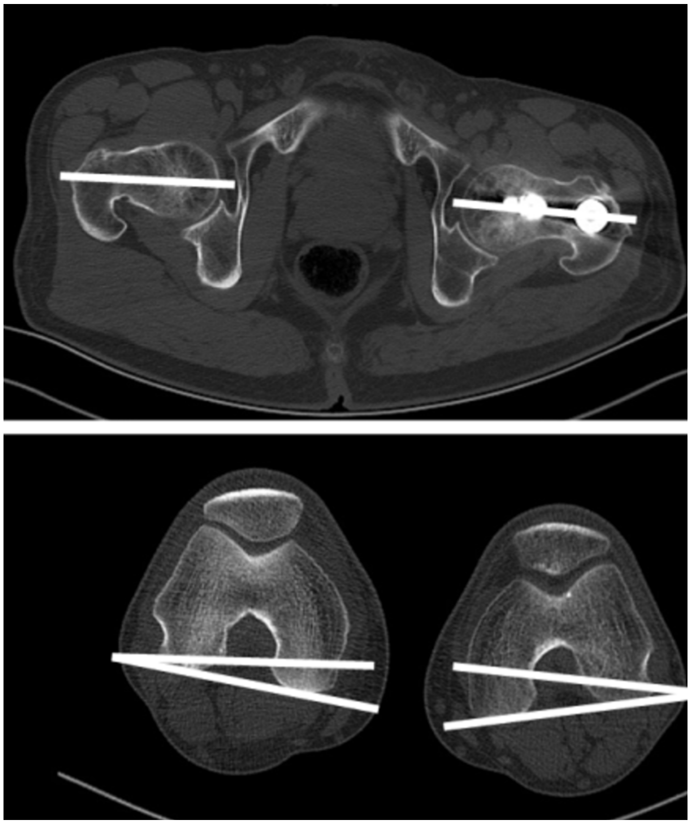

**Figure 4**. Measurements of femoral anteversion degree on axial CT view.

### Statistical Analysis

SPSS 20.0 for Windows 7 (IBM, Inc., Armonk, NY, USA) was used for statistical analysis. Categorical variables are reported as numbers and percentages, while numerical variables are reported as means and minimum-maximum ranges. When the numerical variables provided a normal distribution condition, the independent two group comparisons were compared using the Student's t-test, and when the normal distribution condition was not met, the independent two group comparisons were compared using the Mann–Whitney U test. The ratios in the groups were compared with the Chi-square analysis. For all tests, the statistical significance was defined as an alpha level of $p<0.05$.

## Results

Mortality rates during the follow-up period of our patients who underwent osteosynthesis surgery using LPFNA or PERI-LOC® PFLCP between June 2017 and June 2020 were 13.4% and 23%, respectively. In addition, we found that the reoperation rates due to mechanical complications were 9.8% and 6.2%, respectively. The reoperation requirements due to mechanical complications were as follows: Six patients who underwent LPFNA had cut out of the lag screw, one had varus deformity, and one had nonunion; three of those who underwent PFLCP had implant failure with nonunion, while one had non-union with a deep wound infection. These data were valid for the 82 and 65 patients who underwent LPFNA or PERI-LOC® PFLCP, respectively, before exclusion from the study.

The mean age of the 62 patients included in this study was 61.7 (29–92) years. The mean BMI was 28.3±3.8 (20.6–34.2), and 31 (50%) patients were male. The mean estimated total blood loss (mL), mean operation and fluoroscopy times (minutes, seconds), blood transfusion ratio, and number of anatomical quality of reduction were significantly higher in the p group than in the n group (Table 1). There was no statistically significant difference between both groups with respect to other pre- and perioperative properties of the patients (Table 1).

Although the mean changes of the NSA and FAA angles were significantly higher in the n group than in the p group, there was no statistically significant difference between both groups with respect to other post-operative properties (Table 1). Patients who developed superficial wounds, pulmonary or urinary tract infections, and deep venous thrombosis during the follow-up period were treated medically; no surgical treatment was required for these complications.

## Discussion

AO/OTA 31A3 fractures are different from 31A1 and 31A2 fractures with respect to the fracture patterns. In addition, challenging reduction during operation, medial displacement of the distal fragment, and loss of fixation are more common in 31A3 fractures.[1,15] For this reason, the aims of osteosynthesis in these fractures are to maintain fixation and achieve the highest possible functional quality. Although numerous investigators have recommended treating 31A3 fractures with an intramedullary nail (IMN),[16,17] no clinical study has compared LPFNA with PERI LOC® PFLCP for these fractures. We therefore evaluated the pre-, peri-, and post-operative properties of patients who underwent either LPFNA or PERI LOC® PFLCP.

In the literature, the mortality rate remains between 20% and 30% in the year following a hip fracture.[2,18] He et al.[19] reported that proximal femoral locking plates had high failure rates. Before the inclusion of patients in this study, we found that the mortality rate of patients who underwent

**Table 1.** Data of the patients

| Variable | n group (n=35) | p group (n=27) | p |
|---|---|---|---|
| Pre-operative properties | | | |
| Age (years) (mean; range) | 60.8 (29–92) | 63.3 (37–88) | 0.572 |
| Sex M/F (n) | 17 / 18 | 14 / 13 | 0.798 |
| BMI (kg/m²) (mean; range) | 27.6 (21.8–33.2) | 29.1 (20.6–34.2) | 0.065 |
| Side R/L (n) | 16 / 19 | 10 / 17 | 0.492 |
| Fracture etiology SF/FFH/MVA (n) | 26 / 3 / 6 | 19 / 1 / 7 | 0.611 |
| AO/OTA classification 31A3.1/31A3.2/31A3.3 (n) | 14 / 12 / 9 | 9 / 5 / 13 | 0.155 |
| BMD (g/cm²) (mean; range) | 0.55 (0.29–0.75) | 0.52 (0.33–0.72) | 0.099 |
| Singh index (mean; range) | 4.14 (1–6) | 3.93 (1–6) | 0.397 |
| Charlson comorbidity index (mean; range) | 1.31 (0–3) | 1.37 (0–4) | 0.860 |
| ASA grade I/II/III/IV (n) | 20 / 9 / 4 / 2 | 15 / 9 / 1 / 2 | 0.732 |
| Pre-operative time (days) (mean; range) | 2.89 (1–7) | 3.11 (1–8) | 0.856 |
| Pre-operative hemoglobin (g/dL) (mean; range) | 11.6 (7.3–15.6) | 12.4 (7.8–15.1) | 0.201 |
| Pre-operative hematocrit (mm/h) (mean; range) | 34.9 (22–46) | 37.6 (24–46) | 0.150 |
| Perioperative properties | | | |
| Estimated total blood loss (mL) (mean; range) | 166.3 (125–225) | 519.6 (400–650) | < 0.001 |
| Patients receiving the blood transfusion (n; %) | 3 (8.6) | 10 (37) | 0.006 |
| Operation time (minutes) (mean; range) | 62.4 (51–78) | 89.7 (74–104) | < 0.001 |
| Fluoroscopy time (seconds) (mean; range) | 71.4 (52–92) | 101 (84–112) | < 0.001 |
| Quality of reduction Anatomical/Acceptable/Poor (n) | 1 / 32 / 2 | 12 / 15 / 0 | < 0.001 |
| Length of hospital stay (days) (mean; range) | 5.1 (2–10) | 5.8 (2–12) | 0.263 |
| Post-operative properties | | | |
| Union time (weeks) (mean; range) | 15.9 (12–40) | 17.8 (14–45) | 0.141 |
| Harris hip score (mean; range) | 80.8 (59–93) | 77.6 (63–89) | 0.080 |
| SWS Excellent/Good/Fair/Poor (n) | 15 / 7 / 11 / 2 | 13 / 6 / 7 / 1 | 0.952 |
| PPMS (mean; range) | 6.11 (0–9) | 6.41 (0–9) | 0.327 |
| Change of NSA (degrees) (mean; range) | 3.97 (1–12) | 1.74 (0–11) | < 0.001 |
| Change of FAA (degrees) (mean; range) | 5.49 (2–14) | 1.30 (0–7) | < 0.001 |
| Leg-length discrepancy (n; %) | 9 (25.7) | 2 (7.4) | 0.094 |
| Complications | | | |
| Superficial wound infection (n; %) | 1 (2.9) | 2 (7.4) | 0.575 |
| Pulmonary infection (n; %) | 1 (2.9) | 0 (0) | 1.000 |
| Urinary tract infection (n; %) | 1 (2.9) | 0 (0) | 1.000 |
| Deep venous thrombosis (n; %) | 2 (5.7) | 3 (11.1) | 0.645 |
| Follow-up period (years) (mean; range) | 3.74 (1–8) | 4.41(1–8) | 0.233 |

Values are expressed as means and minimum–maximum ranges, as numbers of patients (n), or as numbers of patients (n) and percentages (%). M; Male, F: Female, BMI: Body mass index, R: Right, L: Left, SF: Simply falling, FFH: Falling from a high, MVA: Motor vehicle accident, BMD: Bone mineral density, ASA: American society of anesthesiologists, SWS: Salvati and Wilson score system, PPMS: Parker-Palmer mobility score, NSA: Neck-shaft angle, FAA: Femoral anreversion angle.

PERI LOC® PFLCP was higher than those who underwent LPFNA, while the reoperation rate due to mechanical complications in patients who underwent LPFNA was higher than PERI LOC® PFLCP. We believe that the low mortality and reoperation rates of our patients were related to the inclusion of young patients and patients without osteoporosis.

Kovalak et al.[6] reported that 90% of their patients had an acceptable or higher quality of reduction with PERI LOC® PFLCP. In addition, Min et al.[20] reported that all of their patients had acceptable or higher quality of reduction with IMN. In the present study, two patients demonstrated poor quality of reduction in the n group, and the number of anatomical reductions in the p group was significantly higher. In accordance with the literatüre,[19-22] we found that the mean estimated total blood loss, blood transfusion ratio, and mean operating and fluoroscopy times were significantly higher in the p group than in the n group; there was no statistically significant difference between both groups with respect to the duration of hospitalization. This study demonstrated that although LPFNA was superior in most of the perioperative properties, PERI LOC® PFLCP was superior with respect to the quality of reduction. We believe that these results were attributed to the fact that PFLCP allowed limited open reduction in multi-fragmented fractures.

The previous reports have stated that union time for 31A3 fractures with various implants was 15–25 weeks.[23-25] The average union time in the present study was 15.9 and 17.8 weeks in the n and p groups, respectively, in accordance with the literature. However, there was no statistically significant difference between both groups.

One of the advantages of our study was the detailed radiological evaluation on the final follow-up. In general, the previous studies have only assessed the change in NSA during radiological follow-up of hip fractures.[20,22] In the present study, in addition to change in NSA, we evaluated the LLD and change in FAA. The previous literature has reported mean NSA changes of 3.1 and 2.45 with PERI LOC® PFLCP and IMN, respectively.[6,20] This was in contrast to the mean NSA changes of 3.97 and 1.74 in the n and p groups, respectively, in the present study. In addition, we found that the mean changes of NSA and FAA were significantly higher in the n group than the p group, although there was no significant difference between both groups with respect to the LLD ratio. Based on our evaluation of these results and the quality of reduction on early post-operative period, we believe that PERI LOC® PFLCP is superior in terms of providing and maintaining reduction; however, this superiority does not affect the LLD ratios.

The previous studies reported that patients who had 31A3 fractures may have very different functional outcomes following fixation with various implants.[20,23] The present study demonstrated that the functional outcomes in both groups were similar and satisfactory, according to the HHS, SWS, and PPMS. Furthermore, the post-operative complication ratios of both groups were similar and consistent with the literature.

Despite our informative findings, this study has some limitations, including its retrospective study design, relatively small sample size, a wide range of age groups, as well as the lack of subgroup analysis of patients according to obvious osteoporosis and fracture pattern, and lack of post hoc power analysis. In addition, approximately 1/4 of the patients could not be evaluated on the final follow-up due to mortality or reoperation during follow-up. Furthermore, if possible, a prospective, randomized, and controlled trial with larger sample size may be conducted to enhance the statistical power.

Although LPFNA was superior in the perioperative data, PFLCP was superior in providing and maintaining reduction. Both implants were similar and satisfactory in functional outcomes. Unlike published literature, our findings demonstrated that PFLCP can be considered as a good primary option, rather than an alternative to intramedullary implants.

**Disclosures**

**Ethics Committee Approval:** This study was conducted as a retrospective and case–control study following the approval of the local ethical committee permission (2139/2018) of our hospital. Informed consent from patients was obtained before study started. The study completed between June 2017 and June 2020.

**Peer-review:** Externally peer-reviewed.

**Conflict of Interest:** None declared.

**Authorship Contributions:** Concept – M.A.T.; Design – A.S.; Supervision – A.O.A., B.E.K.; Materials – M.A.T.; Data collection &/or processing – M.A.T., A.S.; Analysis and/or interpretation – A.O.A., B.E.K.; Literature search – M.A.T., B.E.K.; Writing – M.A.T., A.O.A.; Critical review – A.S., B.E.K.

## References

1. Haidukewych GJ, Israel TA, Berry DJ. Reverse obliquity fractures of the intertrochanteric region of the femur. J Bone Joint Surg Am 2001;83:643–50.
2. Katsoulis M, Benetou V, Karapetyan T, Feskanich D, Grodstein F, Pettersson-Kymmer U, et al. Excess mortality after hip fracture in elderly persons from Europe and the USA: The CHANCES project. J Intern Med 2017;281:300–10.
3. Chitnis AS, Ray B, Sparks C, Grebenyuk Y, Vanderkarr M, Holy CE. Intramedullary nail breakage and mechanical displacement in patients with proximal femoral fractures: A commercial and medicare supplemental claims database analysis. Med Devices (Auckl) 2021;14:15–25.
4. Ozturan B, Erinc S, Oz TT, Ozkan K. New generation nail vs. plate in the treatment of unstable intertrochanterıc femoral fracture. Acta Ortop Bras 2020;28:311–5.
5. Kilinc BE, Oc Y, Kara A, Erturer RE. The effect of the cerclage wire in the treatment of subtrochanteric femur fracture with the long proximal femoral nail: A review of 52 cases. Int J Surg 2018;56:250–5.
6. Kovalak E, Ermutlu C, Atay T, Başal Ö. Management of unstable pertrochanteric fractures with proximal femoral locking compression plates and affect of neck-shaft angle on functional

outcomes. J Clin Orthop Trauma 2017;8:209–14.
7. Berger-Groch J, Rupprecht M, Schoepper S, Schroeder M, Rueger JM, Hoffmann M. Five-year outcome analysis of intertrochanteric femur fractures: A prospective randomized trial comparing a 2-screw and a single-screw cephalomedullary nail. J Orthop Trauma 2016;30:483–8.
8. Lambers A, Rieger B, Kop A, D'Alessandro P, Yates P. Implant fracture analysis of the TFNA proximal femoral nail. J Bone Joint Surg Am 2019;101:804–11.
9. Huusko TM, Karppi P, Avikainen V, Kautiainen H, Sulkava R. Randomised, clinically controlled trial of intensive geriatric rehabilitation in patients with hip fracture: Subgroup analysis of patients with dementia. BMJ 2000;321:1107–11.
10. Shen J, Hu C, Yu S, Huang K, Xie Z. A meta-analysis of percutenous compression plate versus intramedullary nail for treatment of intertrochanteric HIP fractures. Int J Surg 2016;29:151–8.
11. Harris WH. Traumatic arthritis of the hip after dislocation and acetabular fractures: Treatment by mold arthroplasty. An end-result study using a new method of result evaluation. J Bone Joint Surg Am 1969;51:737–55.
12. Salvati EA, Wilson PD Jr. Long-term results of femoral-head replacement. J Bone Joint Surg Am 1973;55:516–24.
13. Parker MJ, Palmer CR. A new mobility score for predicting mortality after hip fracture. J Bone Joint Surg Br 1993;75:797–8.
14. Schipper IB, Steyerberg EW, Castelein RM, van der Heijden FH, den Hoed PT, Kerver AJ, et al. Treatment of unstable trochanteric fractures. Randomised comparison of the gamma nail and the proximal femoral nail. J Bone Joint Surg Br 2004;86:86–94.
15. Kregor PJ, Obremskey WT, Kreder HJ, Swiontkowski MF; Evidence-Based Orthopaedic Trauma Working Group. Unstable pertrochanteric femoral fractures. J Orthop Trauma 2005;19:63–6.
16. Ma JX, Wang J, Xu WG, Yu JT, Yang Y, Ma XL. Biomechanical outcome of proximal femoral nail antirotation is superior to proximal femoral locking compression plate for reverse oblique intertrochanteric fractures: A biomechanical study of intertrochanteric fractures. Acta Orthop Traumatol Turc 2015;49:426–32.
17. Ozkan K, Eceviz E, Unay K, Tasyikan L, Akman B, Eren A. Treatment of reverse oblique trochanteric femoral fractures with proximal femoral nail. Int Orthop 2011;35:595–8.
18. Tang VL, Sudore R, Cenzer IS, Boscardin WJ, Smith A, Ritchie C, et al. Rates of recovery to pre-fracture function in older persons with hip fracture: An observational study. J Gen Intern Med 2017;32:153–8.
19. He S, Yan B, Zhu J, Huang X, Zhao J. High failure rate of proximal femoral locking plates in fixation of trochanteric fractures. J Orthop Surg Res 2018;13:248.
20. Min WK, Kim SY, Kim TK, Lee KB, Cho MR, Ha YC, et al. Proximal femoral nail for the treatment of reverse obliquity intertrochanteric fractures compared with gamma nail. J Trauma 2007;63:1054–60.
21. Huang SG, Chen B, Zhang Y, Nie FF, Ju L, Li M, et al. Comparison of the clinical effectiveness of PFNA, PFLCP, and DHS in treatment of unstable intertrochanteric femoral fracture. Am J Ther 2017;24:e659–66.
22. Okcu G, Ozkayin N, Okta C, Topcu I, Aktuglu K. Which implant is better for treating reverse obliquity fractures of the proximal femur: A standard or long nail? Clin Orthop Relat Res 2013;471:2768–75.
23. Nag P, Chanda S. Biomechanical design prognosis of two extramedullary fixation devices for subtrochanteric femur fracture: A finite element study. Med Biol Eng Comput 2021;59:271–85.
24. Kasha S, Yalamanchili RK. Management of subtrochanteric fractures by nail osteosynthesis: A review of tips and tricks. Int Orthop 2020;44:645–53.
25. Wang HH, Shu WB, Lan GH, Zhang XB, Jiang ZQ, Xu DH, et al. Network meta-analysis of surgical treatment for unstable femoral intertrochanteric fractures. Oncotarget 2018;9:24168–77.