Management of unstable intertrochanteric fractures using proximal femur nail versus proximal femur locking compression plate

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Background
Intertrochanteric fractures are one of the most prevalent insults occurring mainly in patients older than 50 years. The aim of this study is to compare the functional outcomes of management of unstable intertrochanteric fractures using proximal femur nail (PFN) and proximal femur locking compression plate (PFLCP).

Patients and methods
A total of 40 patients with unstable intertrochanteric fractures entered this randomized prospective study. Overall, 20 patients in group A were treated using the PFN, whereas 20 patients in group B underwent open reduction and internal fixation of their fractures using PFLCP.
Functional assessment was done using the Harris hip score. In addition, the incision length, operative time, intraoperative bleeding, fluoroscopy exposure time, length of hospital stay, time interval required from surgery to fracture union, and postoperative complications were documented and compared between both groups.

Results
The mean follow-up periods were 14.25 (range, 12–18) and 14.75 (range, 12–19) months for group A and group B, respectively. The PFN group showed statistically significant shorter incision lengths, operative times, time intervals required for fracture union, and less intraoperative blood loss ($P<0.001$). No statistically significant differences existed between both groups regarding the mean postoperative Harris hip scores or the incidence of postoperative complications.

Conclusion
Unstable intertrochanteric fractures can be successfully treated using both PFN and PFLCP with comparable functional outcomes. However, PFN is better than PFLCP in terms of less incision length, operative time, intraoperative blood loss, and the time interval required to achieve fracture union.

Level of evidence
This was a level III, prospective comparative study.

Keywords:
Harris hip score, intertrochanteric fracture, proximal femur locking plate, proximal femur nail

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Introduction

Intertrochanteric fractures are one of the most prevalent insults occurring mainly in patients older than 50 years. The most common mechanism of injury of these fractures is minor fall and is more popular in osteoporotic women [1]. Intertrochanteric fractures can be classified according to the Arbeitsgemeinschaftfür Osteosynthesefragen/Orthopaedic Trauma Association (AO/OTA) system into either stable (AO/OTA 31.A1-1 to 31.A2-1) or unstable (AO/OTA 31.A2-2 to 31.A3.3) [2,3].

The lateral cortical wall in conjunction with the posteromedial cortex shares in the stability of intertrochanteric fractures. The instability becomes more evident with profound comminution of the posteromedial cortex as it leads to less support for axial loading through cortical contact. The lateral cortex below the vastus ridge gives the last buttress to fracture impaction following fixation enhancing fracture stability and preventing fracture collapse [4,5].

As conservative management of intertrochanteric fractures has higher mortality rates than surgical fixation ranging from 4.5 to 22%, conservative measures should be reserved only for patients with anesthesia contraindications prohibiting surgery [6]. Early surgical fixation of intertrochanteric fractures is recommended to minimize the hazards of prolonged immobilization such as deep vein thrombosis, pulmonary embolism, urinary tract and pulmonary infections, and bed sores [7].

Surgical fixation of intertrochanteric fractures can be achieved using either intramedullary (IM) or extramedullary (EM) implants [8]. The dynamic hip screw (DHS) was the most popular device involved in fixation of intertrochanteric fractures [9]. Both mechanical and technical failures exist in ~6–18% of the patients with unstable intertrochanteric fractures fixed with DHS [10]. The prime reasons for these failures are medialization of the distal fragment and limb shortening as a result of the increased lag screw sliding inside the DHS plate barrel [11,12].

The high failure rate associated with DHS introduced the concept of fixation of intertrochanteric fractures using proximal femur nail (PFN) or proximal femur locking compression plate (PFLCP). PFN is an alternative popular method of fixation of intertrochanteric fractures resulting in favorable outcomes as it accomplishes stable fixation particularly in unstable fractures [13–16]. Furthermore, PFLCP is used for surgical fixation of complex, comminuted, and osteoporotic proximal femoral fractures as it permits angular stable fixation [17–19].

The aim of this study is to compare the functional outcomes and postoperative complications of unstable intertrochanteric fractures managed with PFN and those treated with PFLCP. Our hypothesis is that both PFN and PFLCP are efficient internal fixation methods of unstable intertrochanteric fractures with comparable functional outcomes.

Patients and methods

This research design was as a single-center prospective randomized study. The study was approved by the institutional ethics committee in Cairo university teaching hospitals, Cairo, Egypt. The study encompassed 40 patients who underwent fixation of their unstable intertrochanteric fractures between September 2014 and June 2016 at Cairo University (Kasr Al Ainy) Hospital. Informed consent was obtained from all patients.

The inclusion criteria were as follows:

(1) Patients with closed, unilateral, and unstable intertrochanteric fractures.
(2) Patients over 18 years.

The exclusion criteria were as follows:

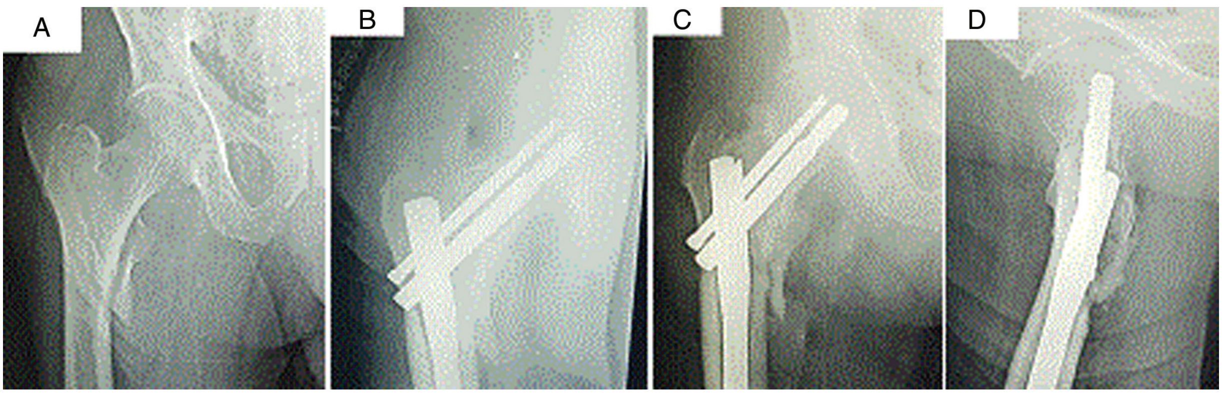
(1) Bilateral or open fractures.
(2) Pathological fracture or polytrauma patients.
(3) Patients unfit for surgery with anesthesia contraindications.
(4) Concomitant neurovascular injury.
(5) Skeletally immature patients.
(6) History of previous surgery to the affected hip or concomitant advanced hip osteoarthritis.

The random assignment of all patients to enter either group was computerized using simple randomization. Patients in group A had surgical fixation of their intertrochanteric fractures using PFN, whereas patients in group B underwent open reduction and internal fixation of their intertrochanteric fractures using PFLCP.

Radiological evaluation

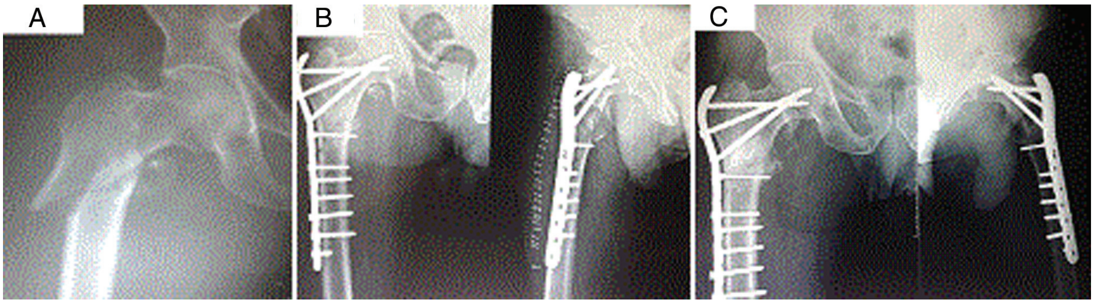
Preoperative radiological evaluation included standard radiographs [including anteroposterior (AP) and lateral views] of both hips with proximal femur (Figs 1a and Fig. 22a). The AO/OTA system was used to classify fractures.

Figure 1



(a) Preoperative standard radiograph (AP view) showing intertrochanteric fracture of the right hip, (b) immediate postoperative standard radiograph (AP view) showing fixation by PFN, (c) standard radiograph (AP view) 3 months after surgery showing bone union, (d) standard radiograph (lateral view) 3 months postoperative showing united fracture. AP, anteroposterior; PFN, proximal femur nail.

Figure 2



(a) Preoperative standard radiograph (AP view) showing intertrochanteric fracture of the right hip, (b) immediate postoperative standard radiograph (AP and lateral views) showing fixation by PFLCP, (c) Postoperative standard radiograph (AP and lateral views) 4 months after surgery showing fracture union. AP, anteroposterior; PFLCP, proximal femur locking compression plate.

Postoperative radiographic assessment was done using AP and lateral views of standard radiographs of the involved hip with proximal femur immediately after surgery, then every month until bone union was achieved (Figs 1b-d, 2b, c).

Functional evaluation

Functional assessment of both groups was done using the Harris hip score (HHS) [20]. Functional outcomes were graded according to HHS as follows: excellent, 90–100 points; good, 80–89 points; fair, 70–79 points; and poor, less than 70 points.

In addition, the incision length, operative time, intraoperative blood loss, intraoperative fluoroscopy exposure time, length of hospital stay, the time interval from surgery to bone union, and the postoperative encountered complications were recorded and compared between both groups.

This study was composed of two groups

Group A (PFN) included 20 patients, comprising seven males and 13 females. The mean±SD age was 61.05±5.55 years. The right hip was involved in nine patients, whereas injury affected the left hip in 11 patients. The mean±SD time from injury to surgery was 5.2±0.95 days. Fall to the ground was the mechanism of injury in 16 patients whereas four patients had road traffic accidents. The mean±SD follow-up period was 14.25±1.68 months.

Group B (PFLCP) included 20 patients, comprising six males and 14 females. The mean age±SD was 60.95 ±5.76 years. The right hip was affected in eight patients, whereas the left hip was injured in 12 cases. The mean±SD time from injury to surgery was 5.3±1.22 days. The mechanism of injury was fall to the ground in 15 patients, whereas five patients had road traffic accidents. The mean±SD follow-up period was 14.75±1.94 months. There was no preoperative statistically significant difference between both groups (Table 1).

Statistical methods

Data were coded and entered using computer program IBM SPSS (statistical package for the social science), version 25 for Microsoft Windows (SPSS Inc., Chicago, Ill., USA). Data were summarized using mean, SD, minimum, and maximum for quantitative variables and frequencies (number of cases) and relative frequencies (percentages) for categorical variables. Comparison between both groups was done using unpaired *t* test [21]. For comparing categorical data, χ^2 test was performed. Exact test was used instead when the expected frequency is less than 5 [22]. *P* values less than 0.05 were considered as statistically significant.

Surgical technique

Proximal femur nail group

The implant used in this study was a standard short PFN with the following criteria: 17-mm proximal diameter, variable (10–12 mm) distal diameter, 6° mediolateral angle, 6.5-mm diameter hip pin, 11-mm diameter femoral neck screw, 130° center-collum diaphysis angle, and 4.9-mm distal locking bolt.

All patients were placed in the supine position on traction table after administration of either spinal or general anesthesia. The involved limb was positioned in 10°–15° of adduction while the contralateral limb was abducted and flexed. Traction and gentle rotation was done to obtain closed reduction of the fracture under image intensifier guidance. Open reduction was done in two (10%) patients in whom acceptable closed reduction could not be achieved. Approximately a 5-cm longitudinal skin incision was done proximal to the tip of the greater trochanter, which was deepened through the subcutaneous tissue. The fascia lata was then incised in line with the skin incision followed by splitting of the gluteus medius muscle in line with its fibers.

Table 1 Comparison of the preoperative data between the proximal femur nail and the proximal femur locking compression plate groups

	PFN (*N*=20)	PFLCP (*N*=20)	*P* value
Age	61.05±5.55 (52–73)	60.95±5.76 (51–72)	0.956
Male	7 (35)	6 (30)	0.736
Female	13 (65)	14 (70)	
Side			
Right	9 (45)	8 (40)	0.749
Left	11 (55)	12 (60)	
Time from injury to surgery in days	5.2±0.95 (4–7)	5.3±1.22 (4–8)	0.774
AO classification			
A2.2	6 (30)	5 (25)	1
A2.3	4 (20)	5 (25)	
A3.1	4 (20)	3 (15)	
A3.2	3 (15)	4 (20)	
A3.3	3 (15)	3 (15)	
Mechanism of injury			
Fall to the ground	16 (80)	15 (75)	1
Road traffic accident	4 (20)	5 (25)	
Follow-up period in months	14.25±1.68 (12–18)	14.75±1.94 (12–19)	0.39

Values are expressed in the form of mean±SD, range, and number of patients and their percentage within the group. PFLCP, proximal femur locking compression plate; PFN, proximal femur nail.

After obtaining a satisfactory fracture reduction, a 2.8-mm guide wire was inserted under fluoroscopic guidance at or just lateral to the tip of the greater trochanter in the AP view. While in the lateral view, the guide wire should be placed centrally in the femoral medullary canal. The proximal femur was then manually opened using a cannulated 17-mm drill bit. The distal femoral canal was reamed according to the intraoperatively measured PFN.

The PFN was then inserted manually using the insertion handle. This was followed by insertion of two 2.8-mm guide wires for the hip pin and femoral neck screws respectively using an aiming device tightly secured to the insertion handle under image intensifier guidance. Care was taken to place the femoral neck guide wire in the lower half of the femoral neck. The hip pin was introduced first followed by the femoral neck screw. This was followed by insertion of one or two distal locking screws. Wound closure was done in layers.

Proximal femur locking compression plate group

The implant used in this study was a stainless steel 4.5/5 mm PFLCP anatomically precontoured to approximate the lateral aspect of the proximal femur. The three proximal locking holes of the plate were designed for 6.5-mm locking head screws that were inserted at angles of 95°, 120°, and 135° respectively, in relation to the femoral shaft.

All patients were placed supine on the fracture table after administration of spinal or general anesthesia. A standard lateral approach was used by making a straight skin incision from the tip of the greater trochanter and extended distally depending on the distal fracture extent. This was followed by incision of the subcutaneous tissue and tensor fascia lata in line with the skin incision to expose the vastus lateralis muscle. The proximal portion of the vastus lateralis muscle was peeled off the vastus ridge of the greater trochanter and the intermuscular septum (subvastus approach) exposing the greater trochanter and the fracture site. Care was taken to identify and cauterize the perforating vessels to minimize intraoperative bleeding.

Open reduction of the fracture was achieved followed by temporary fixation using 2-mm k-wires away from the anticipated plate position. The plate was then temporarily fixed to the femoral shaft by k-wires. After ensuring satisfactory fracture reduction, three guide wires were inserted through guide sleeves in the proximal plate holes under image intensifier guidance. The proximal guide wire was inserted in the midportion of the inferomedial quadrant of the femoral head in the AP view. Three proximal fully threaded locking screws were used at 95°, 120°, and 135° to obtain proximal fixation. Distal fixation was then achieved by four 4.5-mm bicortical locking screws distal to the fracture line. Wound closure was done in layers over a suction drain.

Postoperative rehabilitation protocol

All patients were advised to start knee and ankle exercises immediately postoperatively. Patients started nonweight bearing walking with bilateral axillary crutches as tolerated. Drain was removed after 48 h from surgery, whereas removal of stitches in uncomplicated wounds was done 14 days after surgery. Full weight bearing was delayed until complete fracture union was achieved in the PFLCP group, whereas partial weight bearing was allowed in the PFN group and progressed to full weight bearing according to callus formation in the follow-up radiographs.

Results

The mean follow-up periods were 14.25 (range, 12–18) and 14.75 (range, 12–19) months for the PFN and the PFLCP groups, respectively.

The outcomes of both the PFN and the PFLCP groups are shown in Table 2. Compared with the PFLCP group, the PFN group showed statistically significant shorter incision lengths, shorter operative times, shorter fracture union time intervals, and less intraoperative blood loss. The functional outcomes assessed by the HHS showed no statistically significant differences between both groups.

The postoperative encountered complications in this study are shown in Table 3. The complications observed in the PFN group included the following: one (5%) patient had deep wound infection which improved after surgical debridement and antibiotics. One (5%) patient had fracture varus collapse and limb shortening more than 2 cm, and one (5%) patient had lateral thigh pain as a result of hip pin prominence which was removed after fracture union.

The complications encountered in the PFLCP group included the following: two (10%) patients had deep wound infection which resolved after surgical debridement and antibiotics. Two (10%) patients had fracture varus collapse and limb shortening more than 2 cm, and plate breakage was observed in one of them who was treated with total hip replacement. No other complications were detected in both groups.

Table 2 Comparison between the results of the proximal femur nail and the proximal femur locking compression plate groups

	PFN (*N*=20)	PFLCP (*N*=20)	*P* value
Incision length (cm)	6.18±1.58 (5–11)	11.75±2.15 (10–18)	<0.001
Operative time (min)	66.75±11.84 (55–110)	90.75±12.28 (75–120)	<0.001
Intraoperative blood loss (ml)	150±51.71 (110–300)	300.5±63.53 (180–400)	<0.001
Fluoroscopy exposure time (min)	3.1±0.55 (2–4)	2.85±0.4 (2–4)	0.11
Hospital stay length (days)	11.1±2.53 (8–20)	12±3.24 (9–21)	0.334
Time interval to fracture union (weeks)	13.5±1.57 (12–18)	16.21±2.44 (14–22)	<0.001
Postoperative Harris hip score	85.15±5.44 (73.7–94)	83.65±6.45 (66.5–92)	0.432
Functional outcomes			
Excellent	5 (25)	4 (20)	1
Good	13 (65)	12 (60)	
Fair	2 (10)	3 (15)	
Poor	0	1 (5)	

Values are expressed in the form of mean±SD, range, and number of patients and their percentage within the group. PFLCP, proximal femur locking compression plate; PFN, proximal femur nail.

Table 3 Comparison of the postoperative complication rates in the proximal femur nail and the proximal femur locking compression plate groups

	PFN (*N*=20)	PFLCP (*N*=20)
Wound infection	1 (5)	2 (10)
Fracture varus collapse	1 (5)	2 (10)
Limb shortening >2 cm	1 (5)	2 (10)
Implant related		
Plate breakage	0	1 (5)
Hip pin back out	1 (5)	0
Total number of complicated patients	3 (15)	4 (20)
Reoperation		
Debridement	1 (5)	2 (10)
Total hip replacement	0	1 (5)
Removal of hip pin	1 (5)	0

Values are expressed in the form of the number of patients and their percentage within the group. PFLCP, proximal femur locking compression plate; PFN, proximal femur nail.

There was no statistically significant difference in the total incidence of postoperative complications between both groups (*P*>0.05).

Discussion

Intertrochanteric fractures fixation can be achieved using IM or EM implants; each has its advantages and disadvantages [8].

Intramedullary fixation methods have several merits including being biologically stronger and can resist larger static and cyclic loading than DHS [23], and immediate weight bearing following IM fixation can be achieved, especially in elderly patients [24]. In addition, PFN prevents medialization of the distal fragment compensating for the lost medial support in unstable intertrochanteric fractures [25]. However, different technical problems and modes of failure are associated with the use of IM implants like perforation of the anterior cortex of the femur, prominence of the lag screw in the lateral thigh, weakness of the abductor muscles, and the z-effect [26,27].

Comparison of the PFN group results in this study with different literature studies is shown in Table 4 [13–16,28].

PFLCP has several advantages including proximal various angle stable screws enhancing proximal femoral fixation and more bone stock preservation [29]. Furthermore, PFLCP acts as an internalized external fixator and reduces the periosteal pressure, enhancing quick biological union [30], and supplies three-dimensional and angular stable fixation in unstable fractures in the presence of osteoporosis [17]. However, Wieser and Babst [31] deduced in their study that PFLCP should only be used in fractures with intact posteromedial support and if weight bearing could be postponed.

Comparison of the PFLCP group in this study with various literature studies is shown in Table 5 [18,19,28,32–34].

Various studies in literature compared the use of different fixation implants in treatment of intertrochanteric fractures.

A prospective randomized study was carried out by Singh *et al.* [28] to compare the functional results and complications of management of unstable intertrochanteric fractures using PFN and PFLCP. The previous study documented that the incision length, the intraoperative bleeding, and the time interval from the index procedure to full weight bearing were significantly less in the PFN group compared with the PFLCP group. However, there were no statistically significant differences in terms of the quality of the intraoperatively achieved reduction, intraoperative radiation exposure, duration of surgery, union rate, the time interval to obtain

Table 4 Comparison of the proximal femur nail group results to literature studies

	Incision length (cm)	Operative time (min)	Blood loss (ml)	Fluoroscopy exposure	Hospital stay length in days	Time interval to achieve fracture union	Postoperative HHS
Konde *et al.* [13] (*N*=25)		131.6 ±30.4	8% of the patients required blood transfusion		8.32±2.59	<16 weeks: 64% of the patients, 6–23 weeks: 20% of the patients, 24–36 weeks: 8% of the patients	83.6±14.2
Ramnarayan *et al.* [14] (*N*=25)	3.3	68±0.25	Intraoperative blood loss: 196 ±26.4, wound drainage: 20	2.84 min			86
Rao and Patil [15] (*N*=22)		94.09	115	54.6 times	5.6 (4–14) Postoperative hospital stay	12 (6–16) weeks	84.72 at 6 months postoperative
Kumar *et al.* [16] (*N*=25)		55±18	100±16.4	70±9.6 times	12.96 (11–15)		97 at 2 years postoperative
Singh *et al.* [28] (*N*=23)	4.5±1.0 (3–5.5)	56.6±12.8 (42–82)	176±90 (100–320)	2±0.8 (1–3) min	11.2±3.2 (5–15)	4.1±1.3 (3–7) months	82.8±10.5 (68–94)
This study	6.18 ±1.58 (5–11)	66.75 ±11.84 (55–110)	150±51.71 (110–300)	3.1±0.55 (2–4) min	11.1±2.53 (8–20)	13.5±1.57 (12–18) weeks	85.15±5.44 (73.7–94) at the final follow-up period

Values are expressed in the form of mean±SD, range, and percentage of patients within the group. HHS, Harris hip score.

Table 5 Comparison of the proximal femur locking compression plate group results to literature studies

	Incision length (cm)	Operative time (min)	Blood loss (ml)	Fluoroscopy exposure	Hospital stay length (days)	Time interval to achieve fracture union	Postoperative HHS
Himanshu *et al.* [18] (*N*=45)		100 (90–150)	650		14 (10–18)	17 (12–24) weeks in 93.33% of the patients	87.6
Asif *et al.* [19] (*N*=25)	10±2	75±5	300±50	3±5 min			HHS Excellent:56% Good: 32% Fair: 4% Poor: 8%
Singh *et al.* [28] (*N*=22)	10.2±1.5 (8.5–12)	68.1±14.8 (50–102)	298±116 (170–440)	3±1.3 (1.4–3.6) min	12.8±4.4 (6–16)	4.8±1.5 (3.4–7.6) months	81±18.8 (72–92)
Kumar *et al.* [32] (*N*=20)		66.05±10.33 (55.72–76.58)	361.5±57.52 (303.98–419.02)	70 ms (44–98)	7 (4–14)	17.8±2.04	81.15±9.59
Huang *et al.* [33] (*N*=30)	11.61 ±0.14	68.5±12.4	Intraoperative: 239.4±73.8 Postoperative drainage: 284.67±17.34	11.8±3.07 times	17.52±2.30	101.10±9.24 days	HHS Excellent:50% Good: 33.34% Fair: 16.67%
Ibrahim *et al.* [34] (*N*=21)	9 (8–16)	60	250 (operative and wound drainage)	10 min			84.5 (83–94)
This study	11.75 ±2.15 (10–18)	90.75±12.28 (75–120)	300.5±63.53 (180–400) ml	2.85±0.4 (2–4) min	12±3.24 (9–21)	16.21±2.44 (14–22) weeks	83.56±6.45 (66.5–92) at the final follow-up period

Values are expressed in the form of mean±SD, range, percentage of patients within the group. HHS, Harris hip score.

fracture union, and the functional results assessed by the HHS between both groups.

Another study carried out by Vinay and Sain [35] compared the clinical and radiological outcomes of treatment of unstable proximal femoral fractures using PFN versus PFLCP. The previous study showed that the operative time, blood loss, length of hospital stay, and the encountered complications were significantly less in the PFN group compared with the PFLCP group. In addition, the mean HHS was significantly lower in the PFLCP group compared with the PFN group.

Furthermore, a study by Veeragandham *et al.* [36] compared the use of PFN, DHS, and PFLCP in treatment of proximal femoral fractures. The previous study documented that the PFN group had several advantages such as less surgical exposure, less blood loss, and shorter operative time than DHS. In addition, the PFLCP group had the highest complication rate.

The postoperative complications encountered in both groups in this study are shown in Table 3. Variable complication rates were reported in the literature after treatment of proximal femoral fractures using PFN.

The complication rates reported by Boldin *et al.* [37] and Appelt *et al.* [38] were 21.8 and 15.2% of the patients, respectively. Fogagnolo *et al.* [39] documented a complication rate of 23.4% of the patients following management of unstable intertrochanteric fractures using PFN. However, Uzun *et al.* [40] documented a 5.7% nonunion rate, 25.7% secondary varus collapse, 14.3% requirement of a second surgery, and 5.7% proximal screw cut out.

The postoperative complication rate observed in the PFN group in this study is comparable to that reported by Appelt *et al.* [38] and less than that reported by Boldin *et al.* [37].

Different studies in literature documented variable complication rates following the use of PFLCP in intertrochanteric fractures fixation. Streubel *et al.* [41] documented a failure rate of 37% in 29 patients who were treated using PFLCP for unstable intertrochanteric fractures, and varus collapse with screw cut-out was the most common failure mode. In addition, Wieser and Babst [31] detected a failure rate of 29% of the patients who were treated using PFLCP for proximal femoral fractures. However, Zha *et al.* [17] reported only a 2% failure rate in 110 patients who underwent intertrochanteric and subtrochanteric fracture fixation using PFLCP.

The postoperative complication rate observed in the PFLCP group in this study is less than that reported by Streubel *et al.* [41] and higher than that reported by Zha *et al.* [17].

This study has some limitations. First, the relatively small sample size in each group. Second, this is a single-center study. Multicenter studies with larger number of patients are needed to assess the functional outcomes and complications of both implants in treatment of unstable intertrochanteric fractures.

Conclusion

Both PFN and PFLCP are reliable internal fixation methods of unstable intertrochanteric fractures with comparable functional outcomes. However, PFN is better than PFLCP in terms of less incision length, operative time, intraoperative blood loss, and the time interval required to achieve fracture union.

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Conflicts of interest

There are no conflicts of interest.

References

1 Kaufer H. Mechanics of the treatment of hip injuries. Clin Orthop Relat Res 1980; 146:53–61.

2 Marsh JL, Slongo TF, Agel J, Broderick JS, Creevey W, DeCoster TA, *et al.* Fracture and dislocation classification compendium – 2007: Orthopaedic Trauma Association classification, database and outcomes committee. J Orthop Trauma 2007; 21(10 Suppl):S1–133.

3 Lindskog DM, Baumgaertner MR. Unstable intertrochanteric hip fractures in the elderly. J Am Acad Orthop Surg 2004; 12:179–190.

4 Palm H, Jacobsen S, Sonne-Holm S, Gebuhr P, Hip Fracture Study Group. Integrity of the lateral femoral wall in intertrochanteric hip fractures: an important predictor of a reoperation. J Bone Joint Surg Am 2007; 89:470–475.

5 Im G-I., Shin Y-W., Song Y-J. Potentially unstable intertrochanteric fractures. J Orthop Trauma. 2005; 19:5–9.

6 Dobbs RE, Parvizi J, Lewallen DG. Perioperative morbidity and 30-day mortality after intertrochanteric hip fractures treated by internal fixation or arthroplasty. J Arthroplasty 2005; 20:963–966.

7 Lichtblau S. The unstable intertrochanteric hip fracture. Orthopedics 2008; 31:792–797.

8 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; 43:686–693.

9 Schipper I, Marti R, van der Werken C. Unstable trochanteric femoral fractures: extramedullary or intramedullary fixation. Injury 2004; 35:142–151.

10 Simpson AH, Varty K, Dodd CA. Sliding hip screws: modes of failure. Injury 1989; 20:227–231.

11 Rha JD, Kim YH, Yoon SI, Park TS, Lee MH. Factors affecting sliding of the lag screw in intertrochanteric fractures. Int Orthop 1993; 17:320–324.

12 Baixauli F, Vicent V, Baixauli E, Serra V, Sánchez-Alepuz E, Gómez V, *et al.* A reinforced rigid fixation device for unstable intertrochanteric fractures. Clin Orthop Relat Res 1999; 361:205–215.

13 Konde SS, Borkar SS, Shinde R, Marathe A, Kamath P. Dynamic hip screw and proximal femoral nail as a mode of surgical treatment in intertrochanteric fractures of femur in elderly patients. Int J Contemp Med Res 2018; 5:4–7.

14 Ramnarayan V, Vanchi PK, Mohan Kumar M. Intramedullary or extramedullary fixation for intertrochanteric fractures – a comparison study. IOSR J Dent Med Sci 2015; 14:2279–2861.

15 Rao GDP, Patil DSN. Comparative study between proximal femoral nail and dynamic hip screw with trochanteric stabilizing Plate (TSP) in unstable intertrochantric femur fractures. Int J Orthop Sci 2019; 4:839–844.

16 Kumar R, Singh RN, Singh BN. Comparative prospective study of proximal femoral nail and dynamic hip screw in treatment of intertrochanteric fracture femur. J Clin Orthop Trauma 2012; 3:28–36.

17 Zha G-C., Chen Z-L., Qi X-B., Sun J-Y. Treatment of pertrochanteric fractures with a proximal femur locking compression plate. Injury 2011; 42:1294–1299.

18 Himanshu H, Prasad MB, Verma AK, Manjhi LB. Proximal femur locking plate: an alternative implant for unstable proximal femoral fractures. IOSR J Dent Med Sci 2017; 16:07–14.

19 Asif N, Ahmad S, Qureshi OA, Jilani LZ, Hamesh T, Jameel T. Unstable intertrochanteric fracture fixation – is proximal femoral locked compression plate better than dynamic hip screw. J Clin Diagn Res 2016; 10:RC09–RC13.

20 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; 51:737–755.

21 Chan YH. Biostatistics 102: quantitative data – parametric & non-parametric tests. Singapore Med J 2003; 44:391–396.

22 Chan YH. Biostatistics 103: qualitative data – tests of independence. Singapore Med J. 2003; 44:498–503.

23 Curtis MJ, Jinnah RH, Wilson V, Cunningham BW. Proximal femoral fractures: a biomechanical study to compare intramedullary and extramedullary fixation. Injury 1994; 25:99–104.

24 Jacobs RR, McClain O, Armstrong HJ. Internal fixation of intertrochanteric hip fractures: a clinical and biomechanical study. Clin Orthop Relat Res 1980; 146:62–70.

25 Pavelka T, Houcek P, Linhart M, Matejka J. Osteosynthesis of hip and femoral shaft fractures using the PFN-long. Acta Chir Orthop Traumatol Cech 2007; 74:91–98.

26 Egol KA, Chang EY, Cvitkovic J, Kummer FJ, Koval KJ. Mismatch of current intramedullary nails with the anterior bow of the femur. J Orthop Trauma 2004; 18: 410–415.

27 Werner-Tutschku W, Lajtai G, Schmiedhuber G, Lang T, Pirkl C, Orthner E. Intra- and perioperative complications in the stabilization of per- and subtrochanteric femoral fractures by means of PFN [in German]. Unfallchirurg 2002; 105:881–885.

28 Singh AK, Narsaria N, G RA, Srivastava V. Treatment of unstable trochanteric femur fractures: proximal femur nail versus proximal femur locking compression plate. Am J Orthop (Belle Mead NJ) 2017; 46: E116–E123.

29 Streubel PN, Moustoukas M, Obremskey WT. Locked plating versus cephalomedullary nailing of unstable intertrochanteric femur fractures. Eur J Orthop Surg Traumatol 2016; 26:385–390.

30 Egol KA, Kubiak EN, Fulkerson E, Kummer FJ, Koval KJ. Biomechanics of locked plates and screws. J Orthop Trauma. 2004; 18:488–493.

31 Wieser K, Babst R. Fixation failure of the LCP proximal femoral plate 4.5/5.0 in patients with missing posteromedial support in unstable per-, inter-, and subtrochanteric fractures of the proximal femur. Arch Orthop Trauma Surg. 2010; 130:1281–1287.

32 Kumar DY, Harshwardhan DH. Comparison of proximal femur locking compression plate and proximal femur nail in treatment of complex proximal femoral fractures. Int J Orthop Sci 2018; 4(2c):164–168.

33 Huang S-G, Chen B, Zhang Y, Nie F-F, 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–e666.

34 Ibrahim S, Meleppuram JJ. A retrospective analysis of surgically-treated complex proximal femur fractures with proximal femoral locking compression plate. Rev Bras Ortop 2017; 52:644–650.

35 Vinay N, Sain A. Comparative evaluation of clinico-radiological and functional outcome of proximal femoral locking compression plate and proximal femoral nail in unstable proximal femoral fractures. Int J Orthop Sci 2016; 2:103–107.

36 Veeragandham P, Sahu RK, Misra S, Veeragandham P, Orthop JR. Comparative study between proximal femoral nailing and dynamic hip screw with proximal femoral locking compression plates in intertrochanteric fracture of femur. Int J Res Orthop 2017; 3:339–349.

37 Boldin C, Seibert FJ, Fankhauser F, Peicha G, Grechenig W, Szyszkowitz R. The proximal femoral nail (PFN) – a minimal invasive treatment of unstable proximal femoral fractures: a prospective study of 55 patients with a follow-up of 15 months. Acta Orthop Scand 2003; 74:53–58.

38 Appelt A, Suhm N, Baier M, Meeder P. Complications after intramedullary stabilization of proximal femur fractures: a retrospective analysis of 178 patients. Eur J Trauma Emerg Surg 2007; 33:262–267.

39 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; 124:31–37.

40 Uzun M, Erturer E, Ozturk I, Akman S, Seckin F, Ozcelik IB. Long-term radiographic complications following treatment of unstable intertrochanteric femoral fractures with the proximal femoral nail and effects on functional results. Acta Orthop Traumatol Turc 2009; 43:457–463.

41 Streubel PN, Moustoukas MJ, Obremskey WT. Mechanical failure after locking plate fixation of unstable intertrochanteric femur fractures. J Orthop Trauma 2013; 27: 22–28.