Comparison of treatment of unstable intertrochanteric fractures by intramedullary and extramedullary implants

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Background
To achieve union and restore the normal biomechanics of the hip region after unstable trochanteric fractures, surgical intervention is necessary. There are two options for internal fixation: extramedullary and intramedullary. Dynamic hip screw (DHS) as extramedullary fixation was and is still widely used to surgically treat intertrochanteric fractures. However, it sometimes fails to give good results. Intramedullary fixation methods include gamma nail placement, which is considered by some surgeons to be a better choice as it can avoid complications occurring with extramedullary fixation. Our study aimed to conclude which is better to be used to manage unstable intertrochanteric fractures by either DHS or gamma nail regarding the operation requirements (hospital stay, need for blood transfusion, wound complications, and soft tissue damage) and later on evaluate which is better regarding the fracture healing radiologically and functionally.
Patients and methods
This is a retrospective study of 52 patients with recent unstable intertrochanteric fractures between January 2020 and December 2020. A total of 40 patients continued the study till the last follow-up, where 20 of them were fixed by intramedullary gamma nails as a group I and the other 20 patients were fixed by extramedullary DHS as a group II. The mean age for the group I was 50.05 (20–83) years and the mean age for group II was 60.5 (22–91) years. A total of 14 patients from group I were males and 12 from group II were males. All fractures were classified according to Evan's classification to be unstable (Evan's types III, IV, and V).
Results
Overall, 19 (95%) patients of group I achieved full union and one patient had nonunion with nail breakage. No patients in group I had malunion. A total of 17 (85%) patients of group II achieved good union with one patient having nonunion with implant failure. Moreover, two (10%) patients of group II had femoral shaft medialization and varus malunion.
Conclusion
This study supported the previous series in the literature, which proved that unstable intertrochanteric fractures can be fixed by intramedullary gamma nails or extramedullary DHS but intramedullary fixation gives better results than extramedullary fixation.

Keywords:
dynamic hip screw, failed internal fixation, gamma nail, intertrochanteric, nonunion

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Introduction

Intertrochanteric fractures are considered a serious public health issue confronting both patients and surgeons [1]. They can lead to long-term immobilization, which affects the life of the elderly [2]. These fractures are more common in osteoporotic people who mostly experience multiple comorbidities that make prolonged immobilization catastrophic. So, early surgical intervention became mandatory [3–5]. Intertrochanteric fractures are considered unstable when the fractured osseous fragment cannot share weight-bearing such as reverse obliquity fractures, fractures with the posteromedial fragment which indicates loss of calcar buttress, and fractures with subtrochanteric extension [6]. When the calcar support is lost, the femoral shaft tends to medialize and shorten. This medialization, in case of unstable fractures, is difficult to be controlled by extramedullary implants. This reduces the area of bone-to-bone contact, alters the hip biomechanics, slows fracture healing, and may

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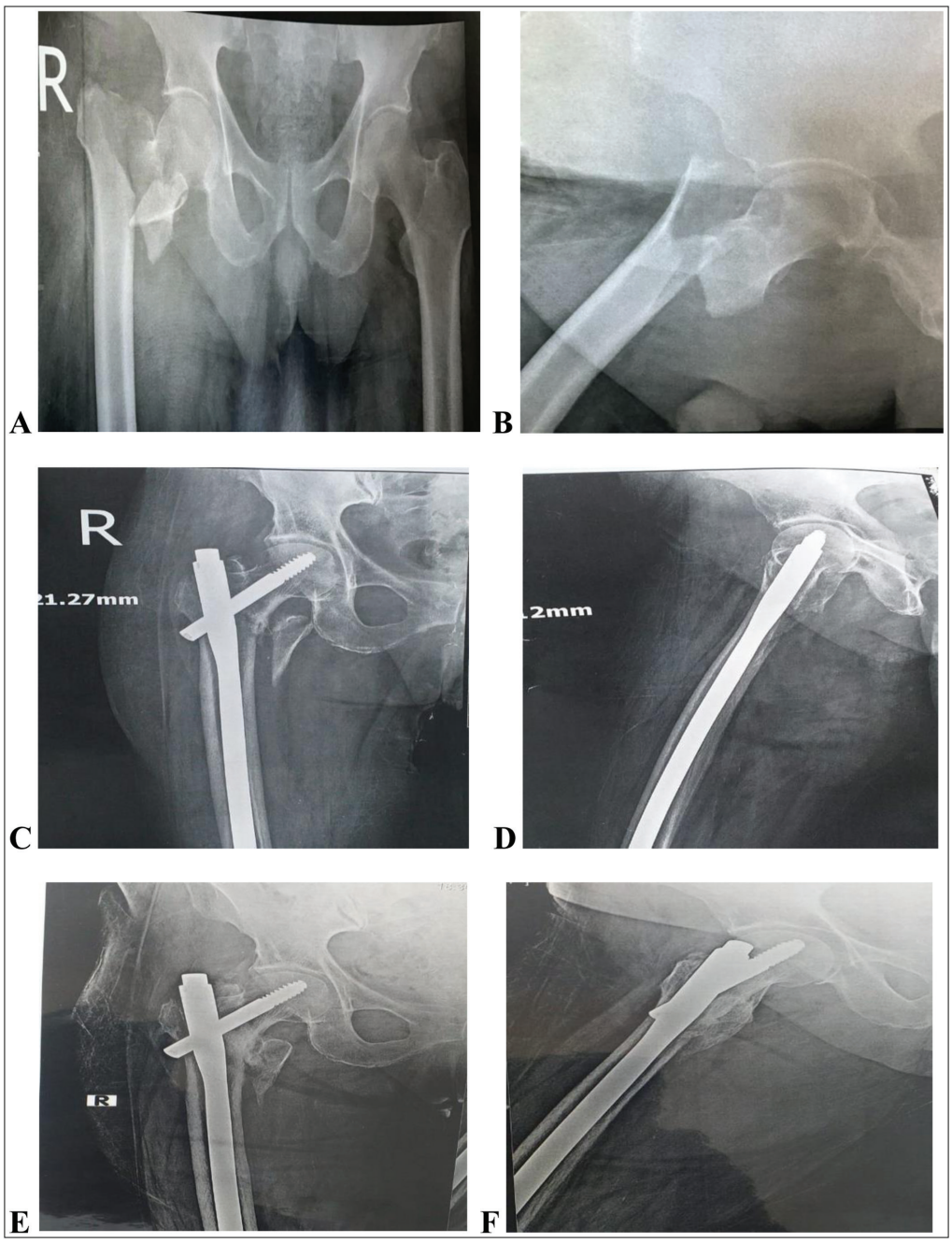
lead to implant failure [7,8]. Some surgeons insist on using extramedullary fixation for intertrochanteric fractures being either stable or unstable. However, many studies proved that intramedullary fixation gives better results with fewer complications when used to manage unstable fractures [9,10]. Most authors have stated that the lateral wall thickness is a very important factor predicting the stability of the fracture-implant construct as a weak lateral wall leads to medial femoral shaft displacement when using dynamic hip screw (DHS). They also mentioned that this can be prevented by intramedullary nailing or by trochanteric stabilization plate [11]. Moreover, they mentioned that many other factors can affect the choice of implant such as osteoporosis. We have chosen our patients regardless of these consideration to test the efficacy of both types of our implants in all circumstances. Our study aimed to conclude which is better to be used to manage unstable intertrochanteric fractures by either DHS as an extramedullary implant or gamma nail as an intramedullary implant regarding the better operation requirements and early complications (hospital stay, need for blood transfusion, wound complications, soft tissue damage, and mortality) as a primary outcome and which implant gives a better fracture healing as a secondary outcome, radiologically (in terms of osseous fracture union rate, malunion, reduction loss, and implant-related complications) and functionally through the Harris hip scores.

Patients and methods

This retrospective study was approved by the local ethical committee of our institution and has therefore been performed following the pertinent ethical guidelines (i.e. Declaration of Helsinki, as laid down in 1964 and revised in 2008). Written informed consent was obtained from all of the patients. Between January 2020 and December 2020, 52 patients with unstable recent intertrochanteric fractures were enrolled in the study. Overall, 40 patients of them continued till the last follow-up of our study. All of their data were available. However, some data of the other 12 patients were lost. We excluded the patients with incomplete data from our study. Instability of the fractures was classified according to Evan's classification as Evan's types I and II are considered stable, but Evan's types III, IV, and V are considered to be unstable fractures [12]. A total of 20 patients, who were considered as group I, were managed by intramedullary gamma nail, and the other 20 patients, who were considered as group II, were managed by extramedullary DHS. The method of fixation was chosen randomly regardless of any factor that can affect fracture healing such as lateral wall thickness, age, osteoporosis, smoking, prefracture level of activity, and associated comorbidities to avoid selection bias. Patients with stable trochanteric fractures (Evan's types I and II), open fractures, pathological fractures, polytrauma patients, and patients with dementia or with diseases affecting walking before the fracture were excluded from our study. The age range was from 20 to 83 years for group I, with a mean age of 50.05 and 22–91 years for group II, with a mean age of 60.5 years. There were 14 females and six males in group I and 12 females and eight males in group II. In group I, six patients were classified as Evan's type III, 10 patients were Evan's type IV, and four patients Evan's type V. In group I, eight patients were classified as Evan's type III, eight patients were Evan's type IV, and four patients Evan's type V. The time-lapse from the onset of trauma to the date of surgery ranged from 1 to 14 days, with a mean of 4.24 days. All surgeries were operated on in El Hadra University Hospital. After stabilization of the general status of the patients, the operations were performed. Third-generation cephalosporin was given through an intravenous route to all patients as a prophylactic antibiotic 30 min preoperatively and continued for 3 days postoperatively. In addition, low-molecular-weight heparin (Clexane, 40 000 IU, administered subcutaneously) as thromboembolism prophylaxis was administered after the admission of the patients in our hospital, continued as a daily dose, and stopped 12 h preoperatively. Then, it was continued for 2 months postoperatively. The anesthesia specialist was responsible for the decision on the appropriate anesthesia according to the general status of the patients. All of the patients were operated on in a supine position on a traction table with the assistance of C-arm fluoroscopy guidance. The anatomic reduction was obtained. Gamma nail was used to manage the fractures of group I (Fig. 1) and DHS was used to manage fractures of group II (Fig. 2). Postoperatively, all the patients started a progressive physiotherapy program. Immediate postoperative exercises strengthen quadriceps muscles and improve the range of motion of the hip and knee joints. Full weight-bearing was allowed only when callus was observed on follow-up radiographs. Clinical and radiological follow-up was made in the third and eighth weeks and then at 3 and 6 months until radiographic and clinical healing. All complications were recorded. Union of the fracture was determined clinically by painless weight-bearing and hip movement in all directions, and radiologically by the disappearance of the fracture line in three or four cortices on the lateral and anteroposterior radiograph and complete bone trabeculae crossing the fracture site. Functional outcome was done using the Harris hip score every 3 months. Delayed union was considered if

Figure 1



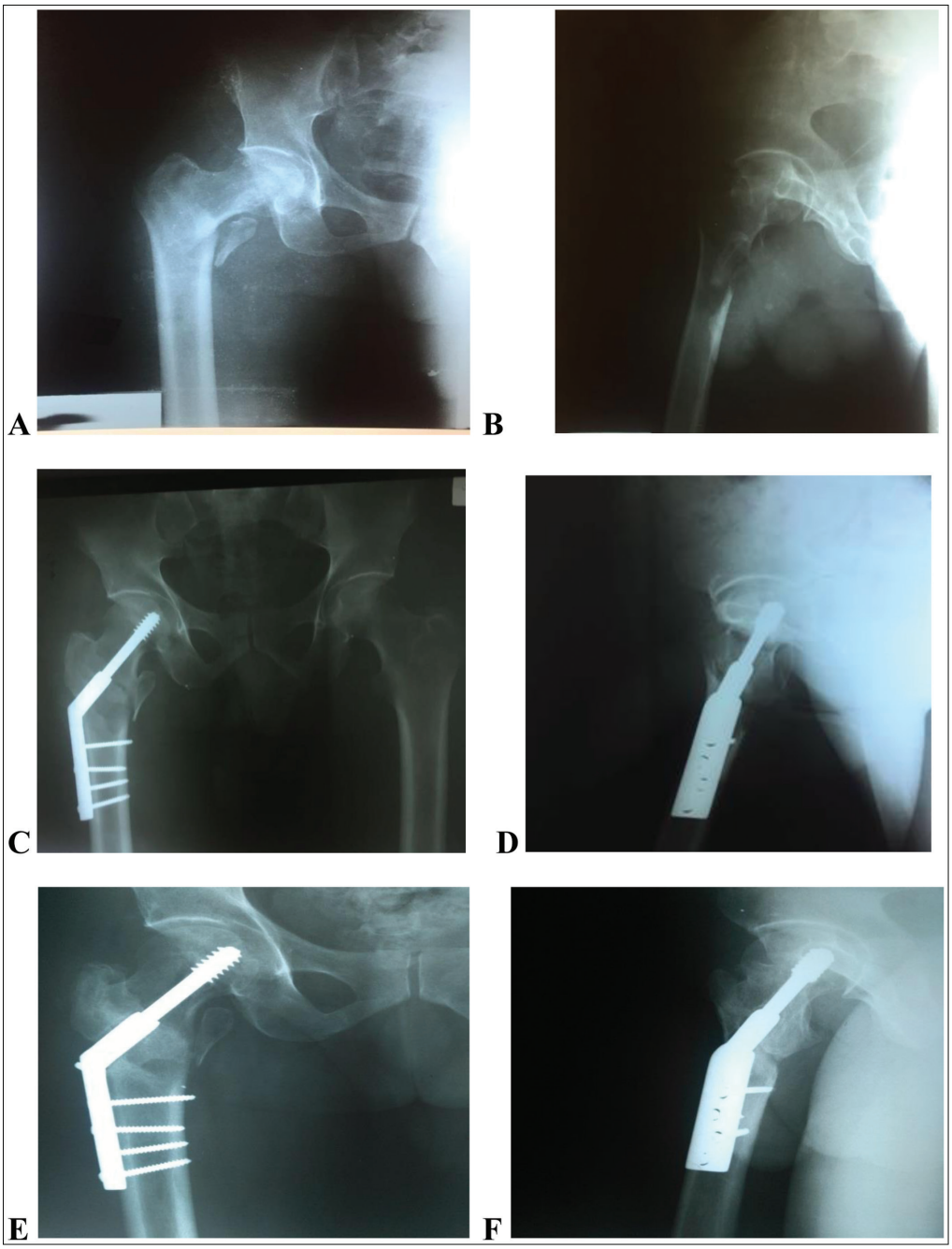
An 82-year-old man with right Evan's type IV intertrochanteric fracture: (a) preoperative AP view, (b) preoperative lateral view, (c) immediate postoperative AP view of the fracture fixed by gamma nail, (d) immediate postoperative lateral view of the fracture, (e) 6-month follow-up postoperative AP view showing full union, and (f) 6-month follow-up postoperative lateral view.

no radiological union occurred at the end of 3 months, and nonunion was considered when no union occurred at the end of 6 months. Shortening in the femoral neck and the shaft neck angle were compared between the first postoperative radiographs and those at the 6-month follow-up, and femoral shortening and varus were measured. Malunion was defined as more than 20 mm femoral shortening compared with the contralateral side or varus collapse of more than 15° [13]. In addition to femoral shortening and varus collapse, reduction loss or implant failure was also evaluated. The clinical outcome was evaluated using the Harris hip score [14].

Statistical analysis

Data were analyzed using SPSSR software (Statistical Package for the Social Sciences for personal computers; IBM, Armonk, New York, USA) using the Pearson χ^2 test and comparing means. Qualitative data were described using numbers and percentages. Quantitative data were expressed as mean±SD. *P* value less than 0.05 was considered significant.

Figure 2



A 60-year-old man with left Evan's type IV intertrochanteric fracture: (a) preoperative AP view, (b) preoperative lateral view, (c) immediate postoperative AP view of the fracture fixed by DHS, (d) immediate postoperative lateral view of the fracture, (e) 6-month follow-up postoperative AP view showing full union, and (f) 6-month follow-up postoperative lateral view. DHS, dynamic hip screw.

Results

At the end of the follow-up period, 19 (95%) patients of group I achieved full union and 17 (85%) patients of group II achieved union. The time to full bony union ranged from 10 to 22 weeks (mean: 14.38 weeks) in group I, but in group II, the time to full bony union ranged from 10 to 24 weeks (mean: 16.12 weeks). There was no significant correlation between the age or sex of the patients and the net results. We found no statistically significant difference regarding fracture union between both groups.

Regarding the functional outcome, the 3-month Harris hip scores in the group I were as follows: three (15%) patients did excellent, five (25%) patients did good, three (15%) patients did fair, and nine (45%) patients did poor. However, in group II, the scores were as follows: one (5%) patient did excellent, five (25%) patients did good, three (15%) patients did fair, and 11 (55%) patients did poor. There was no significant statistical difference between group I and group II (P=0.470).

The 6-month Harris hip scores in group I were as follows: nine (45%) patients did excellent, six (30%)

Table 1 Comparison between the groups with perioperative variables

	Group I [mean (range)]	Group II [mean (range)]	*P*
Need for blood transfusion (U)	0 (0–1)	2 (0–3)	<0.001
Postoperative hospital stay (days)	2 (1–4)	5 (2–11)	<0.001

patients did good, one (5%) patients did fair, and four (20%) patients did poor. However, in group II, the scores were as follows: seven (35%) patients did excellent, six (30%) patients did good, three (15%) patients did fair, and four (20%) patients did poor. There also was no significant statistical difference between group I and group II (*P*=0.590). However, there was a statistically significant increase in 6-month Harris hip scores for both groups more than the 3-month scores (*P*<0.001).

Only two (10%) patients of the group I needed 1 U of packed red blood cells as a blood transfusion and 16 (80%) patients of the group II needed a mean of 2 U of blood transfusion. The mean postoperative hospital stay in group I was 2 days, but in group II, it was 5 days. We found a statistically significant difference between the two groups with respect to the blood replacement amounts and the need for postoperative hospitalization (*P*<0.001). Group I was found to have statistically significantly better values than group II (Table 1).

Group I had one (5%) infected case, and one (5%) case with nonunion and nail breakage. However, group II had three (15%) cases with infection, one (5%) case with nonunion and implant failure (Fig 3), two (10%) cases with varus malunion and femoral shortening, and one (5%)of them developed lag screw cut through (Table 2). The two patients with nonunion of both groups and the patient who had a lag screw cut-through were managed by total hip replacement, but the other patient with varus malunion and femoral shortening refused to have more surgeries. We found that there was a statistically significant increase in the rate of complications in group II more than in group I (*P*<0.001).

Discussion

Trochanteric fractures are very common injuries that affect mainly the elderly population more than young people. Many implants can be used to manage trochanteric fractures and most of them give excellent results when fixing stable trochanteric fractures. However, when dealing with unstable fractures, the results are different. DHS and intramedullary nails can both be used to manage unstable trochanteric fractures, but they mostly have different outcomes [13].

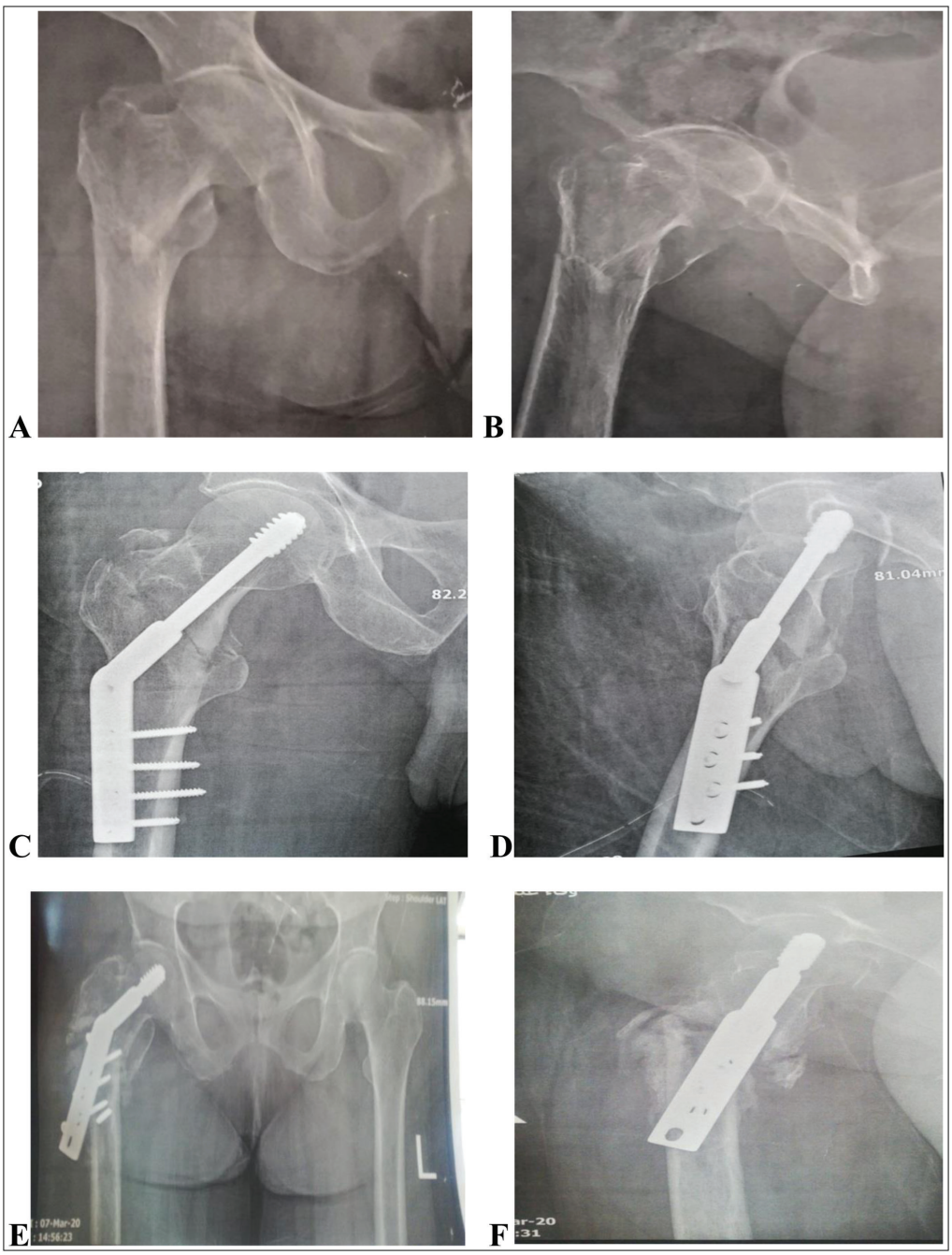
In our study, we tried to discuss the results of managing unstable trochanteric fractures by both DHS and gamma nail regardless of the factors that can affect the final results such as lateral wall thickness, age, osteoporosis, smoking, prefracture level of activity, and associated comorbidities. We tried to discover which gives less operative requirements and less early complications as a primary outcome, and which is better regarding bone healing, radiologically and functionally, and less late complications as a secondary outcome.

Regarding our primary outcome, we found that intramedullary fixation has several advantages over fixed angle screw plate fixation, including a shorter operating time, smaller wounds, less soft tissue damage, easier fracture reduction, less blood loss, fewer units of blood transfused, and a shorter hospital stay. Only 10% of the group I needed blood transfusion and 80% of the group II needed blood transfusion with a mean of 2 U. There was a statistically significant difference with respect to the blood replacement amounts and postoperative hospitalization. Parker and Cawley [15] had nearly similar results. This can be explained as the nail can be applied by closed fracture reduction through smaller incisions.

In this study, we had good results in managing unstable intertrochanteric fractures by both intramedullary gamma nail and extramedullary DHS regarding radiological union and functional outcome measured by the Harris hip score as 95% of the gamma nail group achieved full union and 85% of the DHS group achieved union. Duymus *et al*. [13] had 100% union with the nail group and 94% union with the DHS group. Our Harris hip scores in group I were 45% as excellent, 30% as good, 5% as fair, and 20% as poor. However, in group II, the scores were 35% as excellent, 30% as good, 15% as fair, and 20% as poor. There was no significant statistical difference (*P*=0.590) between group I and group II. Matre *et al*. [16] reported nearly same results, with no difference between DHS and intramedullary nails with respect to the Harris clinical scores. Liu *et al*. [17] and also Aros *et al*. [18] reported the same results. Better union with nails may be owing to preservation of the natural biomechanics and stresses over the trochanteric region better than DHS.

Group I had 5% infection and 5% nonunion and nail breakage. However, group II had 15% infection, 5% nonunion and implant failure, 10% varus malunion

Figure 3



A 58-year-old man with right Evan's type III intertrochanteric fracture: (a) preoperative AP view, (b) preoperative lateral view, (c) immediate postoperative AP view of the fracture fixed by DHS, (d) immediate postoperative lateral view of the fracture, (e) 6-month follow-up postoperative AP view showing nonunion with implant failure, and (f) 6-month follow-up postoperative lateral view. DHS, dynamic hip screw.

Table 2 Complications developed in the postoperative period

	Group I [*n* (%)]	Group II [*n* (%)]
Infection	1 (5)	3 (15)
Nonunion	1 (5)	1 (5)
Malunion	0	2 (10)
Implant failure	1 (5)	1 (5)
Lag cut-through	0	1 (5)

and femoral shortening, and 5% lag screw cut-through. Duymus *et al*. [13] had 3% infection with the nail group and 16% infection with the DHS group.

More crucially, the intramedullary nail resulted in a considerably decreased rate of implant failure and delayed healing, reducing the need for reoperation. The same results were concluded by Bong *et al*. [19].

DHS is thought to have two disadvantages in comparison with an intramedullary nail. First, it has a higher risk of damaging the lateral cortex of the femur and causing a fracture which leads to, in conjunction with posteromedial comminution, more instability of the construct. Second, DHS causes

dynamic compression of the fracture, and this makes the axial loading lead to lateralization of the proximal fragment and medialization of the distal one with distancing from the physiological axis. Therefore, biomechanically, gamma nail is superior to DHS [20].

Unstable intertrochanteric fractures are sometimes difficult to be managed by orthopedic surgeons. Compression strains on the proximal femur are much higher than tension strains, according to Rudman *et al*. [21]. The loads on the medial cortex are much higher in the peritrochanteric region. Therefore, during the fixation of the unstable intertrochanteric fracture, cortical restoration is mandatory to avoid cyclic loading and device failure on the tension side of the femur. According to these biomechanical and anatomical concerns, Velasco and Comfort [22] mentioned that individuals with extensive medial cortical comminution consistently have had a higher rate of failure. Stress causes torsional consequences in the peritrochanteric area, according to Toridis. This could be prevented by the creation of static interlocking nails, which were intended to lessen rotational shear stresses that cause implant failure [23].

Using intramedullary nails makes the vertical loads transferred from the femoral head central axis to the shaft intramedullary physiological axis with the thick lag screw of the implant design. Although there is a low possibility of failure associated with the intramedullary nails, the reasons for the failures seen are generally poor reduction, incorrect positioning of the implant in placement, osteoporosis, and loss of posteromedial support because of the fracture [24]. The new nail designs have reduced valgus curvature, longer length, and smaller diameter, which have led to lower complication rates and better results [25].

In this study, we had some limitations. It is a nonrandomized retrospective study, as there was a bias in the implant choice by the surgeons as the implant was chosen regardless of the factors affecting unstable trochanteric fracture healing such as the lateral wall thickness. Moreover, the age of the operated patients had a wide range (from 20 to 91 years), which means that we have both young active patients and old osteoporotic patients with multiple comorbidities. The bad bone quality of osteoporotic comorbid patients alters fracture healing with more possibility of nonunion and varus malunion [26]. Moreover, this may lead to the increasing need for hip replacement to manage these complications, which occur more with old osteoporotic patients as reported by Kim *et al*. [27].

Conclusion

Both extramedullary and intramedullary implants can be used to fix unstable intertrochanteric fractures, but intramedullary implants give superior results with fewer complications, and this supports the previous series in the literature.

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Nil.

Conflicts of interest

There are no conflicts of interest.

References

1 Pelvic girdle, gluteal region, and thigh chapter 80, pg 1347. Grays Anatomy The Anatomical Basis of Clinical Practice: Clinical Gate. [cited 2021 Apr 16].

2 Cooper C. The epidemiology of fragility fractures: Is there a role for bone quality?. Calcif Tissue Int 1993; 53:S23–S26.

3 Dequeker J, Gautama K, Roh YS. Femoral trabecular patterns in asymptomatic spinal osteoporosis and femoral neck fracture. Clin Radiol 1974; 25:243–246.

4 Zain BS, Olerud S, Karlstrom G. The influence of age on the morphology of trochanteric fracture. Arch Orthop Trauma Surg 1984; 103: 156–161.

5 Rapp K, Büchele G, Dreinhöfer K, Bücking B, Becker C, Benzinger P. Epidemiology of hip fractures. Systematic literature review of German data and an overview of the international literature Electronic supplementary material. Z Gerontol Geriat 2019; 52:10–16.

6 Zhang WQ, Sun J, Liu CY, Zhao HY, Sun YF. Comparing the intramedullary nail and extramedullary fixation in treatment of unstable intertrochanteric fractures. Sci Rep 2018; 8:1–8.

7 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; 471:2768–2775.

8 Haidukewych GJ, Israel TA, Berry DJ. Reverse obliquity fractures of the intertrochanteric region of the femur. J Bone Joint Surg Am 2001; 83:5.

9 Yu X, Wang H, Duan X, Liu M, Xiang Z. Intramedullary versus extramedullary internal fixation for unstable intertrochanteric fracture, a meta-analysis. Acta Orthop Traumatol Turc 2018; 52:299–307.

10 Heiney J, Battula S, Njus G, Ruble C, Vrabec G. Biomechanical comparison of three second-generation reconstruction nails in an unstable subtrochanteric femur fracture model. Proc Inst Mech Eng Part H J Eng Med 2008; 222:959–966.

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

12 Evans EM. the treatment of trochanteric fractures of the femur. J Bone Joint Surg Br 1949; 31B:190–203.

13 Duymus TM, Aydogmus S, Ulusoy İ, Kececi T, Adiyeke L, Dernek B, Mutlu S. Comparison of intra- and extramedullary implants in treatment of unstable intertrochanteric fractures. J Clin Orthop Trauma 2019; 10:290–295.

14 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 Jt Surg Am 1969; 51: 737–755.

15 Parker MJ, Cawley S. Sliding hip screw versus the Targon PFT nail for trochanteric hip fractures. Bone Joint J 2017; 99B:1210–1215.

16 Matre K, Vinje T, Havelin LI, Gjertsen JE, Furnes O, Espehaug B, *et al*. Intramedullary nail versus sliding hip screw: a prospective, randomized multicenter study on pain, function, and complications in 684 patients with an intertrochanteric or subtrochanteric fracture and one year of follow-up. J Bone Jt Surg Am 2013; 95:200–208.

17 Liu M, Yang Z, Pei F, Huang F, Chen S, Xiang Z. A meta-analysis of the gamma nail and dynamic hip screw in treating peritrochanteric fractures. Int Orthop 2010; 34:323–328.

18 Aros B, Tosteson ANA, Gottlieb DJ, Koval KJ. Is a sliding hip screw or im nail the preferred implant for intertrochanteric fracture fixation?. Clin Orthop Relat Res 2008; 466:2827–2832.

19 Bong MR, Patel V, Iesaka K, Egol KA, Kummer FJ, Koval KJ. Comparison of a sliding hip screw with a trochanteric lateral support plate to an intramedullary hip screw for fixation of unstable intertrochanteric hip fractures: a cadaver study. J Trauma 2004; 56:791–794.

20 Malkani AL, Karandikar N. Revision fixation for failed intertrochanteric fractures. Tech Orthop 2002; 17:443–447.

21 Rudman KE, Aspden RM, Meakin JR. Compression or tension? The stress distribution in the proximal femur. Biomed Eng Online 2006; 5:12.

22 Velasco RU, Comfort TH. Analysis of treatment problems in subtrochanteric fractures of the femur. J Trauma 1978; 18:513–523.

23 Toridis TG. Stress analysis of the femur. J Biomech 1969; 2:163–174.

24 Akan K, Cift H, Ozkan K, Eceviz E, Tasyikan L, Eren A. Effect of osteoporosis on clinical outcomes in intertrochanteric hip fractures treated with a proximal femoral nail. J Int Med Res 2011; 39: 857–865.

25 Han N, Sun GX, Li ZC, Li GF, Lu QY, Han QH, *et al*. Comparison of proximal femoral nail antirotation blade and reverse less invasive stabilization system- distal femur systems in the treatment of proximal femoral fractures. Orthop Surg 2011; 3:7–13.

26 Giannoudis P, Tzioupis C, Almalki T, Buckley R. Fracture healing in osteoporotic fractures: is it really different? A basic science perspective. Injury 2007; 38(Suppl 1)S90–S99.

27 Kim WY, Han CH, Park JI, Kim JY. Failure of intertrochanteric fracture fixation with a dynamic hip screw in relation to pre-operative fracture stability and osteoporosis. Int Orthop 2001; 25:360–362.