Functional and radiological outcome of proximal femoral locking compression plates in the treatment of unstable trochanteric fractures

Mohamed S.A. Mohamed Ismail, Mohamed A. Ibrahim

Department of Orthopaedic Surgery, Kasralainy Hospital, Cairo University, Cairo, Egypt

Correspondence to Mohamed S.A. Mohamed Ismail, MD, Department of Orthopaedic Surgery, Kasralainy Hospital, Cairo University, 6 of October City, Central Corridor, No. 6 Elfatth Buildings, Flat 3, Cairo, Egypt.
Tel: +20 100 613 2450; fax: +20 236 922 578;
e-mail: m.saidmaksoud@kasralainy.edu.eg

Received 7 November 2018
Accepted 10 December 2018

The Egyptian Orthopaedic Journal 2018, 53:103–109

Introduction
Intertrochanteric femoral fracture is extracapsular fracture of the proximal femur between the greater and lesser trochanters. They represent about 50% of all hip fractures. Considerable complications such as pulmonary embolism, deep venous thrombosis, and pneumonia are frequently seen with these fractures mainly due to prolonged immobilization and specifically in elderly patients. These fractures can be categorized into stable and unstable according to the bony construct displacement after a fracture. Approximately 35–40% will be classified as unstable three-part and four-part fractures; unstable fractures are difficult to manage with dynamic hip screw alone and are technically much more challenging and the treatment is more controversial.

Patients and methods
During the period from 1 July 2016 till 1 February 2017, 44 patients with unstable trochanteric fractures AO A2 and A3 who were admitted in the Causality Department in Kasralainy Hospital, Cairo University were randomly selected in our study to be treated by fixation with proximal femoral locking compression plate according to the standardized protocol.

Results
Patient demographics: 28 women and 16 men were included with a mean age of 61.75 years (SD 8.7); eight patients were diabetic; four patients were hypertensive, and three were cardiac. The total hospital stay was a mean of 8.95 days, mean preoperative period was 4.44 days, and the mean postoperative period was a mean of 4.73 days (SD 1.16).The mean operative time was 106 min; the mean blood loss intraoperative was 308 ml; postoperative infection was three (6.8%) cases; and all of them resolved with a single session of debridement. One case of deep venous thrombosis (DVT) was treated by conservative measures and four cases of varus malunion with no functional deficit. The mean time for fracture union was 17.9 weeks and the mean time till weight-bearing was 12 weeks. Mean harris hip score (HHS) at 6 months was 62.3 which is fair and 81.2 at 12 months which is good.

Conclusion
Proximal femoral locking compression plate was an effective treatment for unstable trochanteric fracture in terms of time to full weight-bearing. It can be used in these fractures with good functional outcomes and low complication rates. Level of Evidence: Level II randomized, prospective trial.

Keywords:
elderly patients, proximal femoral-locked compression plate, unstable trochanteric fractures

Egypt Orthop J 53:103–109

1110-1148

Introduction

Intertrochanteric femoral fracture is an extracapsular fracture of the proximal femur between the greater and lesser trochanters. They represent about 50% of all hip fractures and it is one of the major orthopedic problems among the elderly. Also this type of fracture is a serious health resource issue regarding high rate of complications and high costs required for treatment [1].

Considerable complications such as pulmonary embolism, deep venous thrombosis, and pneumonia are frequently seen with these fractures mainly due to prolonged immobilization and specifically in elderly patients in whom osteoporosis and instability of fractures restrict intensely the ambulation due to highly limited weight-bearing [2].

These fractures can be categorized into stable and unstable according to the bony construct displacement after a fracture. Approximately 35–40% will be classified as unstable three-part and four-part fractures, needing

special methods of fixation. The reported overall failure rate with internal fixation for intertrochanteric fractures is 3–16% reaching 20% in unstable fractures [3].

The problems of instability of those fractures are mostly related to discontinuity of the lateral wall of the proximal femur rather than destruction of the medial femoral component as previously thought. So the intact stable lateral wall of the proximal femur plays a key role in the stabilization of unstable trochanteric fractures [1].

Since the elderly patients are the most common age group affected by this type of fractures, early mobilization and prevention of malunion should be our goal of treatment. Osteoporosis in this age group makes higher the rates and chances of complications which makes fixation of these fractures more difficult. The goal of treatment is to achieve anatomical or nonanatomical but stable reduction, rigid fixation, and early mobilization of the patient and prevent hip deformity [4].

Unstable fractures are difficult to manage with dynamic hip screw alone and are technically much more challenging and the treatment is more controversial. Rates of complications like screw cutout, shortening of the limb, varus deformity of the proximal femur, and even nonunion are higher in unstable fractures as compared with stable fractures [1].

Hence the need for any other better fixation device or any modifications in the design of dynamic hip screw or any add-on fixation device with DHS is needed; from the latest implants for the management of trochanteric fractures is proximal femoral nail, which is also a collapsible device with added rotational stability. This implant is a cephalo-medullary device and biomechanically more sound. It also has the advantages of small incision and minimal blood loss [1,5].

In response to the need of improving current designs, new plate designs continue to develop. The locked plates have outstanding outcomes for stabilization of challenging fractures in normal and osteoporotic bone, since they do not depend on the friction fit between the plate and the bone for stability. Locked plates have also good fixation capacity in comminution and osteoporotic bone [5].

The proximal femoral locking compression plate (PFLCP) is recommended for complex proximal femur fracture fixation. Its locking capability together with its possible minimally invasive insertion technique makes it a striking alternative to other fixation devices. It minimizes soft tissue compromise and vascular insult to the injured bone in an attempt to optimize clinical results [3].

The aim of our study is to study the results of fixation of unstable trochanteric fractures using PFLCP and the functional and radiological outcome postoperatively.

Patients and methods

During the period from 1 July 2016 till 1 February 2017, 44 patients with unstable trochanteric fractures AO A2 and A3 who were admitted in the Causality Department in Kasralainy Hospital, Cairo University were randomly selected to our study.

Inclusion criteria

(1) Age group from 50 to 70 years.
(2) Unstable trochanteric fracture femur (AO classification: 31-A2, 31-A3).

Exclusion criteria

(1) Pathologic fractures.
(2) Open fractures.
(3) Skeletally immature patients.

Patient demographics

(1) Sex: 28 women and 16 men.
(2) Age: from 50 to 70 years with a mean of 61.75 (SD 8.7).

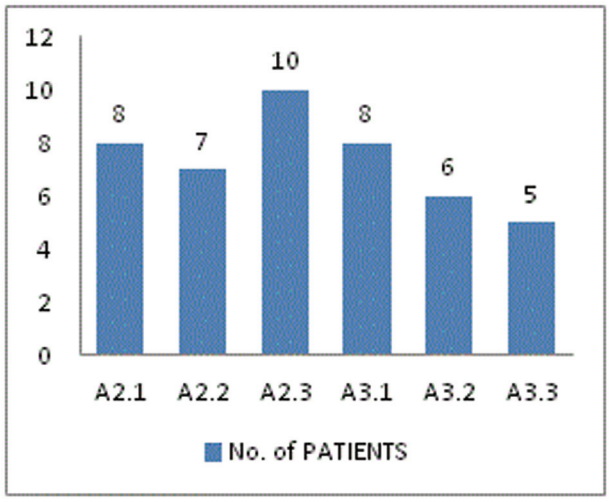
Mode of trauma was low energy in 80% of cases and 20% was high-energy trauma and 50% of those patients had associated fractures (three cases with distal radius, two cases with proximal humerus, and two cases with contralateral fracture shaft femur).

Fracture pattern according to the AO/OTA classification (Fig. 1).

All patients included in the study were managed by the following protocol:

(1) On admission, analgesics (paracetamol) were prescribed, followed by fracture fixation using skin traction and radiological evaluation of the fracture using radiographs and computed tomography scan.

Figure 1



Categorization of patients according to the fracture pattern.

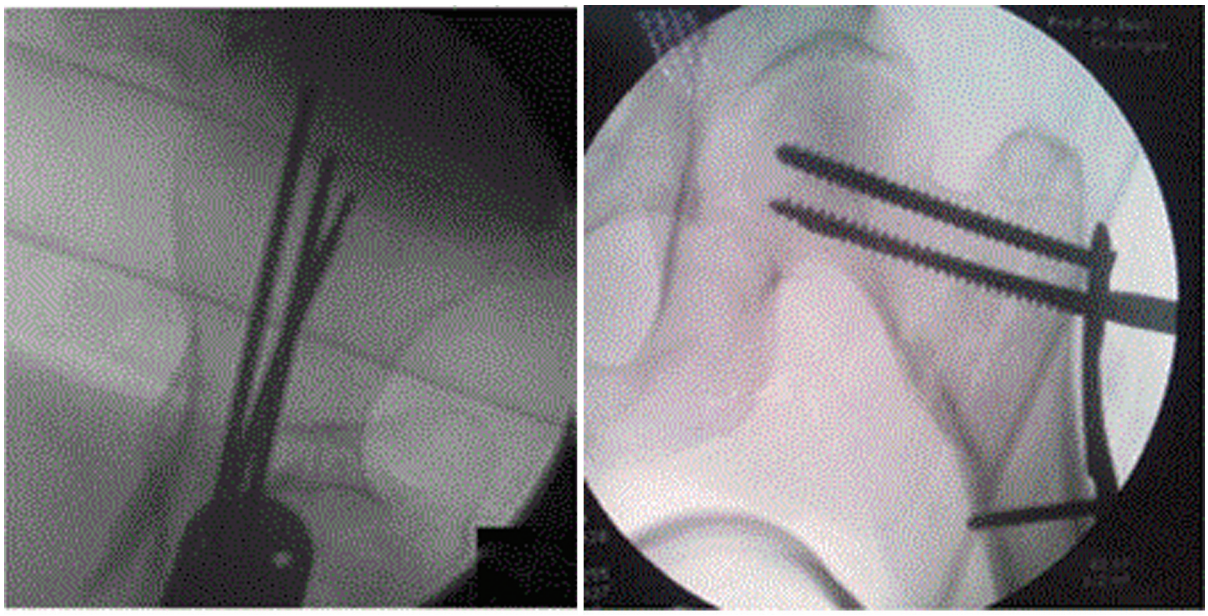
(2) Preoperative optimization of the patient's condition from any comorbidity, preparation for fixation, preoperative medication adjustment for comorbidity, pain management, and deep venous thrombosis (DVT) prophylaxis and family education about the procedure and postoperative plan. The preoperative delay was from 2 to 7 days with a mean of 4.43 days.

(3) Operative details.
All patients were under spinal anesthesia. Prophylactic antibiotic third-generation cephalosporin was given to all patients 30 min before the surgery, with the patient in the supine position on the traction table. A longitudinal incision, beginning over the middle of the greater trochanter and extended down the lateral side of the thigh over the lateral aspect of the femur was done. The length of the incision varied according to the fracture pattern and extension; the fascia lata was incised in line with the skin incision. At the upper end of the wound, the distal portion of the tensor fasciae latae was splitted in line with its fibers to expose the vastus lateralis. The proximal vastus origin was released off of the vastus ridge of the greater trochanter and intermuscular septum 'sub-vastus approach.' After exposure of the fracture site, gross skeletal alignment using applied longitudinal traction was used and preliminary fixation of the fracture fragments was carried out using 2.0 mm K-wires or reduction forceps. Reduction aids were placed so as not to interfere with the final plate placement figure.
The PFLCP is a limited-contact stainless steel plate. The proximal portion of the plate is precontoured for the proximal femur. The four proximal screw holes accept 6.5 mm cannulated and noncannulated locking and 6.5 mm cannulated conical screws. The remaining screw holes are combiholes which combine a dynamic compression unit hole with a locking hole. This gives the surgeon the flexibility to gain axial compression and angular stability throughout the length of the plate. This plate can be safe to osteopenic bone or to the bone where there is a cortical defect [6].
The PFLCP is placed against the lateral aspect of the greater trochanter. Distally, the plate was lined up along the lateral cortex of the femoral shaft. It was more important to properly place guide wires in the proximal femur (considering the desired screw positions) than it was to precisely match the contour of the plate to the anatomy of the femur. The ability to lock the screws to the plate obviates the need for precise plate contouring and compressing the plate to the bone. For preliminary plate positioning, we used the guide wire technique under fluoroscopic image control in the anteroposterior and lateral view.
An additional trick is to insert a partially threaded nonlocked 6.5 screw through the proximal holes to achieve compression. This screw is to be changed with locking head 6.5 screw at the end of the operation (Fig. 2).
Intraoperative radiograph time had a mean±SD of 2.40±0.3 min.

(4) Postoperative:
All patients were transferred to the ward and the following protocol was done: intravenous broad-spectrum antibiotic was given for all patients for 5 days and then oral antibiotics were continued. Low molecular weight heparin was given 12–24 h postoperatively to all patients for 28 days as prophylaxis against DVT and pulmonary embolism. Suction drain was evacuated every 24 h and removed when it drained less than 100 ml in last 24 h. Mobilization is allowed in bed and without weight-bearing using crutches from the third day. All patients were discharged from the hospital when they can mobilize freely from the bed which was from 3 to 7 days with a mean of 4.7 days on oral broad-spectrum antibiotics and low molecular weight heparin for 28 days.

(5) Follow-up: the period of follow-up was from 12 to 18 months with a mean of 14 months according to the following protocol.
(a) After 2 weeks: for wound condition and removal of stitches.

Figure 2



(a) Preliminary fixation using guide wires and (b) start fixation using screws.

(b) 6 weeks: the patients were screened for any signs of infection, follow-up radiography was done and allowed to start controlled toe touch weight-bearing.
(c) 3, 6, and 12 months: complications (nonunion, malunion, infection, device failure), range of motion of hip joint, signs of union of fracture and functional evaluation according to the Harris hip score.

Statistical analysis of the results was done using SPSS 22 (Microsoft, Luiziana, 2017).

Results

During the period from 1 July 2016 till 1 February 2017, 44 patients with unstable trochanteric fractures AO A2 and A3 who were admitted in the Causality Department in Kasralainy Hospital, Cairo University were randomly selected in our study; four patients were missed in the follow-up due to remote original domestry and the rest of the patients were followed up for a minimum of 12 months.

Patient demographics: 28 women and 16 men were included with a mean age of 61.75 years (SD 8.7); eight patients were diabetic, four patients were hypertensive, and three were cardiac.

The total hospital stay was a mean of 8.95 days (SD 1.85); the mean preoperative period was 4.44 days (SD 1.43) and the mean postoperative period was a mean of 4.73 days (SD 1.16).

The mean operative time was 106 min (SD 16.6); mean blood loss intraoperative was 308 ml; mean drain loss was 196 ml; and the mean postoperative transfusion was 180 ml.

Postoperative complication was (a) infection in three cases (6.8%) and all of them resolved with a single session of debridement, (b) one case of DVT and was treated by conservative measures and anticoagulants, (c) four cases of varus malunion with no functional deficit.

The mean time for fracture union was 17.9 weeks and the mean time till weight-bearing was 12 weeks (Fig. 3).

Mean harris hip score (HHS) at 6 months was 62.3 which is fair and 81.2 at 12 months which is good (Fig. 4).

There was a significant relation between operative time and wound infection, and there was an insignificant relation between operative time and wound infection and fracture pattern and radiological union and functional outcome.

Discussion

Trochanteric fracture femur is a major challenge in the orthopedic community, not only for achieving fracture union, but for the restoration of optimal function in the shortest possible time and to minimize complications.

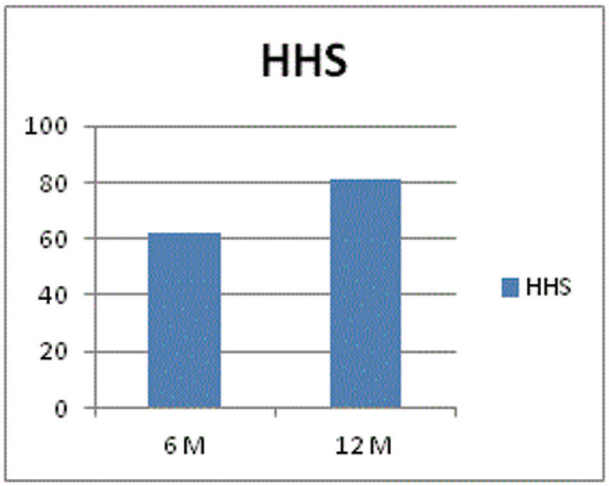
Figure 3

Results of a patient with A2.1 pertrochanteric fracture, (a, b) preoperative, (c, d) 6 months postoperatively, and (e, f) 12 months postoperatively.

The postoperative aim is to achieve early mobilization, rapid rehabilitation, and quick return to premorbid home and work environment as a functionally and psychologically independent unit. Extramedullary devices (e.g. dynamic hip screw (DHS), dynamic condylar screw (DCS)) have high complication rates (6–18%), for example, excessive sliding of the lag screw that results in limb shortening and medialization of the shaft which leads to secondary limb shortening after weight-bearing. Other drawbacks like varus collapse and implant failure in the form of cutout of the femoral head screw are common. These complications led to the development of new devices wither extramedullary, for example, PFLCP and intramedullary devices, for example, proximal femoral nail (PFN). These have been found to increase fracture stability and have less intraoperative complications [7].

Lee *et al*. [6] reviewed short-term outcomes of PFLCP fixation for proximal femoral fractures in terms of postoperative complications and failure rates in 26 patients with proximal femoral fractures. The PFLCP is appropriate for complex proximal femoral fractures with poor bone quality, revision surgeries, and

Figure 4



Functional outcome.

multifragmentary subtrochanteric/proximal diaphyseal fractures, but the study has a small sample size which warrants further studies with large number groups.

Wang *et al.* [8] studied the clinical outcomes of intramedulary (IM) fixation and PFLCP in trochanteric fractures in elderly patients. They concluded that incision length and operative time were shorter for the intramedulary fixation (IMF) than for PFLCP. Intraoperative blood loss, rehabilitation, and time to healing were nearly similar between IMF and PFLCP. There were fewer complications in the PFLCP group than in IMF. Yao *et al.* [9] compared less invasive stabilization system 'LISS' and PFN in the treatment of trochanteric fractures. They reported no significant differences in operative time or functional outcome.

A retrospective analysis of 16 patients treated with PFLCP was conducted by Hodel *et al.* [10] for unstable intertrochanteric and subtrochanteric femoral fractures with a mean follow-up time of 14 months (range: 4–29). They reported complications in 31.3% after PFLCP in proximal unstable intertrochanteric and subtrochanteric femur fractures.

Collinge *et al.* [11] conducted a retrospective, multicenter study of 111 cases with unstable trochanteric fractures treated with PFLCP. They reported a high complication rate frequently requiring revision surgeries or secondary procedures; 41.1% experienced major treatment failure, including failed fixation with or without nonunion, surgical malalignment or malunion, deep infection, or a combination of these. Of the patients 34% underwent secondary surgeries for failed fixation, nonunion, or both, and another study by Streubel *et al.* [12] analyzed 29 patients with unstable trochanteric fractures treated with PFLCP retrospectively. They reported 11 (37%) failures. They have defined the mechanical failure as loss of position of at least 10° or shortening of at least 2 cm. The most frequent failure mode was varus collapse with screw cutout.

Gadegone and Salphale [13] analyzed the results of 100 cases treated with PFN. They reported femoral head cut-through (4.8%), intraoperative femoral shaft fracture (0.8%), implant breakage (0.8%), wound-healing impairment (9.7%), and false placement of osteosynthesis materials (0.8%). The study suggested that patients treated with PFLCP have less greater trochanter pain and lower rate of loosening of screws than PFN. They recommend PFLCP for osteoporotic bone fracture in the elderly as it had better tensile capacity, anti-bending force, and anti-rotation force which could prevent femoral head from nail cutting.

Asif *et al.* [14] studied 27 patients with unstable trochanteric fractures treated with PFLCP versus 35 patients treated with DHS. They found that patients treated with DHS showed a higher complication rate, for example, varus collapse, medialization of the shaft and femoral head cut-through. They concluded that treatment of unstable trochanterics with PFLCP can give good healing and limited occurrence of complications.

Azboy *et al.* [15] compared the PFLCP and 95° angled blade plate in reverse obliquity trochanteric fractures. Forty four patients with reverse trochanteric fractures were retrospectively analyzed. They found that both treatment options seem to produce same results. However, they suggest that ABP still remains a good choice with less expense in such fractures.

Veeragandham *et al.* [16] studied 40 patients with intertrochanteric fracture femur treated with PFN, DHS, and PFLCP. They found that PFN was superior to PFLCP and DHS. The incidence of wound infections was found to be lower.

Parker and Handoll [17] meta-analysis of all prospective, randomized trials comparing intramedullary to extramedullary devices did not support the perceived superiority of nails. They failed to find statistically significant differences in mortality, nonunion, infection, cutout, blood loss, operative time, and radiation time in 3500 patients.

The authors of this meta-analysis concluded that the sliding hip screw was a better fixation device for intertrochanteric fractures than the intramedullary nail. But they also admitted that no concrete conclusions could be drawn from existing publications regarding unstable fractures, especially of the reverse obliquity variety. The available literature comparing the intramedullary and extramedullary techniques is limited. Most studies are based on experience with wide variability in patient characteristics and use of either an intramedullary or an extramedullary implant.

We conducted this study to evaluate PFLCP as a treatment option for unstable trochanteric fractures. Our group's mean ages were comparable to most conducted studies. Our group showed statistically significant differences in operative time, radiologic exposure time, time to union compared with some studies. The results showed that patients could recover their preoperative functions. However, their hip scores remains fair to good due to fracture site pain even after achieving full union. The incidence of wound infections was found to be lower than other studies, which results in early ambulation of the patients. Nonunion of trochanteric fracture is a rare event. We encountered many more implant-related complications. The median time to union was 18 weeks (99.1% CI=12–24 weeks). In other studies, the mean time for healing was quite longer. Our treatment protocol regarding weight-bearing was quite similar to many studies that allowed around 6 weeks, when radiological callus formation was adequate.

Our study group reported local site pain after full union that hinders their functional hip scores. This study was limited in that it was a small prospective single-center study with very small number of patients. We recommend larger, randomized controlled multicenter studies to properly evaluate and compare PFLCP with other valuable treatment options, and to clarify whether PFLCP is a valuable option in the treatment of unstable trochanteric fractures or not.

Conclusion

This study found that PFLCP was an effective treatment for unstable trochanteric fracture in terms of time to full weight-bearing. It can be used in these fractures with good functional outcomes and low complication rates.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

References

1 Johnell O, Kanis JA. An estimate of the worldwide prevalence, mortality and disability associated with hip fracture. Osteoporos Int 2004; 15:897–902.

2 Johnell O, Kanis JA. An estimate of the worldwide prevalence and disability associated with osteoporotic fractures. Osteoporos Int 2006; 17: 1726–1733.

3 Lorich DG, Geller DS, Nielson JH. Osteoporotic pertrochanteric hip fractures: management and current controversies. Instr Course Lect 2004; 53:441–454.

4 Cummings SR, Black DM, Rubin SM. Lifetime risks of hip, Colles', or vertebral fracture and coronary heart disease among white postmenopausal women. Arch Intern Med 1989; 149:2445–2448.

5 Lönnroos E, Kautiainen H, Karppi P, Huusko T, Hartikainen S, Kiviranta I, *et al.* Increased incidence of hip fractures. A population based-study in Finland. Bone 2006; 39:623–627.

6 Lee WT, Murphy D, Kagda FHY, Thambiah J. Proximal femoral locking compression plate for proximal femoral fractures. J Orthop Surg (Hong Kong) 2014; 22:287–293.

7 Chan YH. Biostatistics102: quantitative data – parametric & non-parametric tests. Singapore Med J 2003; 2003:391–396.

8 Wang Y, Yang YY, Yu ZH, Li CQ, Wu YS, Zheng XX. Comparative study of intertrochanteric fractures treated with proximal femur locking compress plate in aged. Zhongguo Gu Shang 2011; 24:370–373.

9 Yao X, Zha GC, Chen ZL, Qi XB. Treatment of pertrochanteric fractures with a proximal femur locking compression plate. Injury 2011; 42:1294–1299.

10 Hodel S, Beeres FJP, Babst R, Link BC. Complications following proximal femoral locking compression plating in unstable proximal femur fractures: medium-term follow-up. Eur J Orthop Surg Traumatol 2017; 27:1117–1124.

11 Collinge C, Liporace F, Koval K, Gilbert GT. Cephalomedullary screws as the standard proximal locking screws for nailing femoral shaft fractures. J Orthop Trauma 2010; 24:717–722.

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

13 Gadegone WM, Salphale YS. Proximal femoral nail – an analysis of 100 cases of proximal femoral fractures with an average follow up of 1 year. Int Orthop 2007; 31:403–408.

14 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.

15 Azboy I, Demirtaş A, Gem M, Çakir IA, Tutak Y. A comparison of proximal femoral locking plate versus 95-degree angled blade plate in the treatment of reverse intertrochanteric fractures. Eklem Hastalik Cerrahisi 2014; 25:15–20.

16 Veeragandham P, Sahu RK, Misra S. 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.

17 Parker MJ, Handoll HHG. Gamma and other cephalocondylic intramedullary nails versus extramedullary implants for extracapsular hip fractures in adults. Cochrane Database Syst Rev 2008; 18:CD000093.