Razi Med J. 2026;2(2):339-346
https://doi.org/10.69667/rmj.26226

Razi Medical Journal
https://razi.edu.ly/rmj/index.php/hm

Original article

Management of Trochanteric & Subtrochanteric Femoral Fractures by Proximal Femoral Nail: Current Experience at Misurata Medical Center in Libya

Hussein Alhalloup*, Ali Zaggout, Ali Glaisa, Emad Swayeb, Alhadi Alsaghaier

Orthopedic Department, Faculty of Medicine, Misurata University, Misurata, Libya
Corresponding email. *hussienmohammad1987@gmail.com*

Abstract
Extra-capsular proximal femur fractures are prevalent, particularly among the elderly population with osteoporosis, typically resulting from low-energy trauma. In younger adults, these fractures are often associated with high-velocity trauma. The incidence of these fractures is escalating due to the increasing demographic of senior citizens afflicted with osteoporosis. Proximal femoral fractures are associated with substantial morbidity and mortality, malunion, implant failure, and various co-morbid medical conditions. Consequently, this has driven the development and adoption of intramedullary devices for the management of proximal femoral fractures. This study aims to analyze the efficacy and functional outcomes associated with the use of proximal femoral nails (PFN) in the treatment of proximal femoral fractures. A retrospective cohort study was conducted involving 143 adult patients who presented with proximal femoral fractures and were treated with proximal femoral nailing at Misurata Medical Center, Libya, between 2014 and 2019. The study included trochanteric and subtrochanteric fractures, which were classified according to the Boyd & Griffin and Seinsheimer classifications, respectively. All patients underwent regular follow-up assessments as per the study protocol. Functional outcomes were evaluated using the Harris Hip Score. The study cohort comprised 90 cases of trochanteric fractures and 53 cases of subtrochanteric fractures, all of which underwent surgical fixation with a proximal femoral nail. Functional outcomes, as assessed by the Harris Hip Score, demonstrated excellent results in 62 cases (43%), good in 42 cases (29%), fair in 24 cases (17%), and poor in 15 cases (10%). Complications encountered during the study were meticulously tracked and managed with appropriate interventions. The findings of this study indicate that the proximal femoral nail is a reliable implant for the management of proximal femoral fractures. Its application leads to a high rate of bone union, restoration of anatomical alignment, and a reduced incidence of implant failure or deformities. Intramedullary fixation offers biological and biomechanical advantages, contributing to decreased morbidity and an improved functional quality of life for patients.
Keywords. *Proximal Femoral Nail, Trochanteric Fractures, Subtrochanteric Fractures.*

Received: *19/03/26*
Accepted: *16/05/26*
Published: *24/05/26*

Introduction

Proximal femoral fractures constitute a significant proportion of fractures occurring around the hip joint, exhibiting a bimodal distribution in incidence. In younger adult populations, these fractures are typically attributed to high-velocity trauma, whereas in elderly individuals, they are frequently a sequela of osteoporosis [1]. These fractures commonly occur at the junction between trabecular and cortical bone, a region subjected to maximal mechanical stress within the femur, which often accounts for their comminuted nature. The reported incidence of proximal femoral fractures ranges from 10% to 34% of all hip fractures [2].

With advancing age, there is a notable increase in the occurrence of pathological fractures in the hip region. Proximal femoral fractures encompass both trochanteric and subtrochanteric fracture patterns. The axial loading forces transmitted through the hip joint generate substantial momentum, leading to significant lateral tensile stresses and medial compressive loads, alongside shearing forces. During routine activities of daily living, forces up to six times the body weight is transmitted across the proximal femoral region. The primary objective of surgical management is to achieve anatomical restoration of the normal abductor lever arm mechanism of the hip joint.

Biomechanically, intramedullary devices are considered a superior choice for the fixation of proximal femoral fractures. The intramedullary nail provides crucial support to the postero-medial cortex, thereby preventing varus collapse at the fracture site. Optimal positioning of surgical implants is paramount for achieving favorable outcomes and minimizing the risk of complications. However, proximal femoral nails are not without potential complications, including implant failure, which can manifest as Z-effect, reverse Z-effect, screw backout, cut-through of the implant,

Razi Med J. 2026;2(2):339-346
https://doi.org/10.69667/rmj.26226
Razi Medical Journal
https://razi.edu.ly/rmj/index.php/hm

or implant breakage [3]. This study was conducted to analyze the efficacy and functional outcomes of proximal femoral nailing in the treatment of proximal femoral fractures.

Materials and Methods

Health Care Setting

This study was conducted at a tertiary care hospital, specifically Misurata Medical Center, Misurata, Libya.

Duration and Type of Study

The study spanned from 2014 to 2019 and was designed as a retrospective cohort study, providing Level IV evidence.

Sample Size and Sampling Technique

A total of 143 adult patients were included in the study, selected using a convenience sampling technique.

Radiological Assessment

Radiological assessment involved anteroposterior views of the pelvis with bilateral hips, lateral views, and traction radiographs with 15° internal rotation of the affected hip.

Functional Assessment

Functional outcomes were assessed using the Harris Hip Score.

Follow-up Protocol

Clinical and radiological analyses were performed at immediate post-operative periods, at 2 weeks, and subsequently at 1, 2, 6, 12, and 18 months post-surgery.

Inclusion Criteria

Patients aged between 30 and 80 years with clinically and radiologically diagnosed trochanteric and subtrochanteric fractures were included in the study.

Fracture Classification

Trochanteric Fractures: Classified according to Boyd & Griffin's classification (Table 1).

Tables 1. Fracture Classification

Class	Description
I	Undisplaced fracture; fracture line extends along the intertrochanteric line from the greater trochanter to the lesser trochanter.
II	Displaced fracture; fracture along the intertrochanteric line with postero-medial comminution.
III	Displaced fracture; fracture line extending to the subtrochanteric plane.
IV	Displaced fracture: a fracture occurring in at least two planes.

Subtrochanteric Fractures: Classified according to Seinsheimer's classification (Table 2).

Table 2. Subtrochanteric Fractures

Class	Description
I	Fracture with less than 2cm displacement.
IIA	2-part transverse fracture.
IIB	2-part spiral fracture with the lesser trochanter attached to the proximal fragment.
IIC	2-part spiral fracture with the lesser trochanter attached to the distal fragment.
IIIA	3-part spiral fracture with the lesser trochanter as a separated fragment.
IIIB	3-part spiral fracture with butterfly fragment.
IV	Comminuted fracture with 4 or more fragments.
V	Fracture with proximal extension into the greater trochanter.

Razi Med J. 2026;2(2):339-346
https://doi.org/10.69667/rmj.26226
Razi Medical Journal
https://razi.edu.ly/rmj/index.php/hm

Proximal Femoral Nail (PFN) Characteristics

(Table 3) provides a comparison of long versus short PFN characteristics.

Table 3. Proximal Femoral Nail (PFN) Characteristics

Features	Long PFN	Short PFN
Length	320 to 420mm	180mm
Proximal Diameter of Nail	15mm	15mm
Distal Diameter of Nail	9, 10, 11, and 12mm	9, 10, 11, and 12mm
Anteversion	10°	10°
Medio-lateral Angle	6°	6°
Neck Shaft Angle	130° and 135°	130° and 135°
Proximal Screws	6.4 mm anti-rotation proximal stabilizing screw & 8mm distal compression screw	6.4 mm anti-rotation proximal stabilizing screw & 8mm distal compression screw
Distal Screws	4.9mm both static and dynamic (10mm dynamization) locking bolts	4.9mm both static and dynamic (10mm dynamization) locking bolts

Advantages of Proximal Femoral Nail

Proximal femoral nails offer several advantages, including: * Efficient load transfer. * Shorter lever arm, which can decrease tensile strain on the implant and reduce the risk of implant failure. * Maintenance of controlled fracture impaction. * Acts as a buttress to prevent shaft medialization. * Shorter operating time and less soft tissue dissection. * Proximal screws provide improved resistance to varus collapse and rotational control of the head and neck fragment. * Long PFNs allow for length and rotational control even in the absence of the lesser trochanter. * The presence of a longitudinal slot throughout accelerates the regeneration of endosteal bone. * A 6% medio-lateral angle facilitates easy nail insertion, and a flexible distal tip prevents stress generation and fracture.

Operative Technique

Anesthesia: The majority of patients underwent spinal or epidural anesthesia, with a smaller proportion receiving general anesthesia.
Reduction of Fracture: Patients were positioned supine on a fracture table with the affected limb abducted 10°-15°. Closed reduction was achieved through traction and internal rotation, confirmed by image intensifier.
Preparation: Standard hip fracture fixation preparation was performed, including prophylactic intravenous antibiotics administered 30 minutes pre-surgery.
Approach: A 3-5cm incision was made proximal to the tip of the greater trochanter. A parallel incision was made in the fascia of the gluteus medius, and the muscle was split along its fibers.
Entry Point and Guide Wire Insertion: Under image intensifier guidance, the entry point was established at or slightly lateral to the tip of the greater trochanter. In the lateral view, the guide wire position was confirmed in the center of the medullary cavity. The medullary canal was entered with a curved bone awl, guided by the guide wire.
Reaming: The proximal femur was reamed for approximately 7cm using a cannulated conical 17mm reamer. The distal femur was reamed with successive ordinary reamers, the size determined by the calculated nail diameter.
Insertion of PFN: Following satisfactory fracture reduction, an appropriately sized nail, determined preoperatively, was assembled to an insertion handle and manually inserted with slight twisting movements until the hole for the 8mm screw was at the level of the inferior margin of the femoral neck.
Insertion of Guide Wires for Neck Screw and Hip Pin: These were inserted using an aiming device attached to the insertion handle. A 2.7mm guide wire was inserted through the drill sleeve. The guide wire's position was confirmed in the lower half of the neck in the anteroposterior view and centrally in the lateral view. A second 2.7mm guide wire for the hip pin was inserted above the first, with its tip approximately 20-25mm less deep than the planned neck screw.
Insertion of Neck Screw and Hip Pin: After drilling over the guide wires, an 8mm self-tapping neck screw was inserted using a cannulated screwdriver. Similarly, an appropriate length 6.4mm hip pin, 10-15mm shorter than the neck screw, was inserted. The length and position of the screws were verified with an image intensifier.

Razi Med J. 2026;2(2):339-346
https://doi.org/10.69667/rmj.26226
Razi Medical Journal
https://razi.edu.ly/rmj/index.php/hm

Distal Locking: Distal locking was typically performed with two 4.9mm distal locking bolts, with their position confirmed by an image intensifier.
Closure: Surgical closure was performed in layers, followed by the application of a sterile dressing and compression bandage.

Complications of PFN

Potential complications associated with PFN include: * Varus Displacement: This is often linked to failure of nail fixation in the proximal fragment and inadequate stable reduction and internal fixation, leading to implant bending, breakage, head cut-out, and femoral shaft pulling. * Z-effect and Reverse Z-effect: The Z-effect, or Knife effect, occurs when the superior anti-rotation screw is longer than the inferior compression screw, increasing vertical forces on the anti-rotation screw and inducing cut-out. This results in medial migration of the anti-rotation screw and lateral migration of the compression screw. The incidence of Z-effect ranges from 0.6% to 8%. The reverse Z-effect describes the opposite phenomenon, where the anti-rotation screw migrates laterally, and the compression screw migrates medially. * Painful Hardware: This can result from backed-out compression or anti-rotation screws, or impingement of the distal nail tip in the antero-medial cortex of the femur, irritating the femoral musculature. * Femoral Shaft Fractures: These are typically associated with aggressive surgical insertion of the nail, often involving hammering. * Non-union: This complication is linked to fracture instability, loss of reduction, and inadequate immobilization. * Osteonecrosis of the Femoral Head: This has a very low reported incidence of 0.8%.

Pre-operative Planning

Pre-operative planning for proximal femoral nailing involved determining the nail diameter at the isthmus level by measuring the femoral diameter on an anteroposterior X-ray. The neck-shaft angle was measured on the unaffected side using a goniometer on an anteroposterior X-ray.

Post-operative Protocol

Intravenous antibiotics were administered for 5 days post-surgery. Active and passive exercises were initiated within 48 hours. Partial weight-bearing was permitted on the 5th post-operative day. Patients with severe osteoporosis received Tablet Risedronate 35mg once weekly for 12 weeks to enhance bone mineral density. Full weight-bearing was advised after 10-12 weeks post-operatively. Follow-up assessments, including radiographs of the upper femur and hip, were conducted at 1, 2, 6, 12, and 18 months to evaluate fracture union and identify complications. Functional results were calculated using the Harris Hip Score.

Results

A total of 143 cases of proximal femoral fractures, comprising 90 trochanteric and 53 subtrochanteric fractures, underwent surgical management with proximal femoral nailing in accordance with the study protocol. Descriptive statistics, including mean (±SD) for continuous variables and frequencies (percentages) for categorical variables, were reported. Statistical analysis was performed using IBM SPSS Statistics.

Demography

Of the 143 cases, 77 (54%) were male, and 66 (46%) were female. All patients were within the age range of 30 to 80 years, with an average age of 57.37 ± 7.12 years. Patient demographics by age group are presented in (Table 4).

Table 4. Patients demographics

Age Group (years)	Group A (Trochanteric, n=90) Males	Group A (Trochanteric, n=90) Females	Group B (Subtrochanteric, n=53) Males	Group B (Subtrochanteric, n=53) Females
31-40	4	1	4	5
41-50	11	9	8	6
51-60	11	14	7	5
61-70	15	11	6	8
71-80	8	6	2	2
Total	49	41	27	26

Mode of Injury

Among the 143 cases, road traffic accidents accounted for 57 cases (39%), falls from height for 36 cases (25%), and trivial falls for 50 cases (35%).

Type of Fracture Pattern

According to the Boyd and Griffin classification, among the 90 trochanteric fractures, 6 cases were Type I, 24 cases were Type II, 49 cases were Type III, and 11 cases were Type IV. For the 53 subtrochanteric fractures, classified by Seinsheimer, 3 cases were Type I, 6 cases were Type II, 16 cases were Type III, 26 cases were Type IV, and 2 cases were Type V.

Closed vs. Open Reduction of Fractures

Of the 143 cases, 117 (82%) were managed with closed reduction and internal fixation using proximal femoral nailing, while 26 cases (18%) required open reduction and internal fixation. Open reduction was necessitated by factors such as delayed presentation, inadequate immobilization, interposition of soft tissues, or failed closed reduction due to fibrous union.

Details of Surgery

All surgical procedures were performed within one week of admission. The length of the nails was individualized based on the diameter of the isthmus. No intraoperative complications were recorded.

Duration of Fracture Union

Serial clinical and radiological examinations were conducted as per the study protocol. The mean radiological union time for trochanteric fractures was 16 ± 3 weeks, and for subtrochanteric fractures, it was 20 ± 3 weeks. one case of trochanteric fractures and one case of subtrochanteric fracture showed signs of established non-union after 9 months post-procedure.

Complications

The most frequently observed complication was pain, reported in 26 cases (18%). Other complications included delayed union in 1 case (0.65%), malunion in 7 cases (5%), non-union in 2 cases (1.4%), varus angulation in 4 cases (3%), nail breakage in 3 cases (2%), screw cut-out in 3 cases (2%), Z-effect in 3 cases (2%), reverse Z-effect in 2 cases (1.4%), and avascular necrosis of the femoral head in 1 case (0.65%). Pain at the fracture site was managed with oral analgesics. The case of delayed union, a trochanteric fracture presenting at 6 months, was treated with dynamization. Non-union cases were offered secondary surgical procedures, such as a dynamic hip screw or hemiarthroplasty for intertrochanteric fractures, and nail removal with compression plating and bone grafting for subtrochanteric fractures. Nail breakage cases were monitored and offered nail removal and re-nailing. Varus angulation cases corrected during bony remodeling after nail removal. Screw cut-out, Z-effect, and reverse Z-effect cases were under sentinel surveillance, with nail removal offered upon clinical and radiological confirmation of established fracture union. Avascular necrosis of the femoral head was treated with cemented total hip replacement.

Table 5: The complications observed

Complication	Trochanteric Fractures	Subtrochanteric Fractures
Pain	16	10
Delayed union	1	-
Malunion	5	2
Non-union	1	1
Varus angulation	2	2
Nail breakage	2	1
Screw cut-out	2	1
Z effect	2	1
Reverse Z effect	1	1
Avascular necrosis of femoral head	1	-

Functional Assessment with Harris Hip Score

All patients underwent training with active and passive joint mobilization exercises following clinical signs of fracture union. Functional assessment was performed using the Harris Hip Score. Of the 143 cases, functional outcomes were classified as excellent in 62 cases (43%), good in 42 cases (29%), fair in 24 cases (17%), and poor in 15 cases (10%). The poor range of movements (n=15) was attributed to non-union (2 cases), nail breakage (3 cases), screw cut-out (3 cases), Z-effect (3 cases), reverse Z-effect (2 cases), and avascular necrosis of the femoral head (1 case).

Discussion

Proximal femoral fractures present a considerable challenge to orthopedic surgeons, primarily due to the technical difficulties associated with fracture reduction and the potential for implant failure during primary fixation. The medial and posteromedial fracture fragments are critical determinants of the severity of trochanteric fractures. Contemporary research indicates that the integrity of the lateral femoral wall is a significant predictor for re-operation following trochanteric fractures [4]. Cephalo-medullary femoral reconstruction nails, particularly those with a trochanteric entry point, demonstrate superior biomechanical strength compared to extramedullary implants [5]. In unstable proximal femoral fractures, achieving control over axial telescoping and ensuring rotational stability are paramount. Intramedullary implants offer the advantage of being a less-invasive procedure, which is generally better tolerated by elderly and osteoporotic individuals [6]. Various intramedullary devices, including Gamma nails, proximal femoral nails (PFN), proximal femoral nails anti-rotation (PFNA), and Intertan integrated nails, have been employed for the fixation of these fractures [7, 8]. The PFN effectively compensates for a posteromedial defect by acting as a buttress to prevent medialization; however, it may not provide adequate lateral stability if the lateral wall is compromised. Compromise of the lateral wall can lead to a situation where only the femoral head resists medial deforming forces. To avert varus collapse, the protection and restoration of the abductor lever arm forces must counteract the deforming forces. Therefore, the restoration of the lateral wall is of paramount importance in preventing varus collapse and subsequent complications [9]. In this study, a novel cephalo-medullary PFN was utilized for proximal femoral fractures. These nails are designed to prevent rotation and collapse of the head-neck fragment, and their smaller distal shaft diameter minimizes stress concentration at the nail tip. The anti-rotation screw at the proximal aspect of the nail further enhances the biomechanical stability of the fracture fixation.

The Z-effect phenomenon, characterized by the sliding of proximal anti-rotation and compression screws in opposite directions during the post-operative weight-bearing period, was observed in 3 cases, and 2 cases of reverse Z-effect were noted in unstable intertrochanteric or subtrochanteric fractures treated with PFN [10]. The reverse Z-effect is defined as the movement of the hip pin laterally, often necessitating early removal.

In our study, both trochanteric (n=90) and subtrochanteric (n=53) fractures were surgically managed using load-sharing proximal femoral nailing. Among the 90 trochanteric fracture cases, 45 patients were in the 41-60 years age group. The most common type of trochanteric fracture treated with PFN was Boyd and Griffin's Type III (displaced fracture with the fracture line extending to the subtrochanteric plane). The mean radiological union time for trochanteric fractures was 16 ± 3 weeks. Complications in trochanteric fractures included pain (16 cases), delayed union (1 case), malunion (5 cases), non-union (1 case), varus angulation (2 cases), nail breakage (2 cases), screw cut-out (2 cases), Z-effect (2 cases), reverse Z-effect (1 case), and avascular necrosis of the femoral head (1 case). Functional assessment using the Harris Hip Score showed excellent outcomes in 38 cases (42%), good in 23 cases (26%), fair in 17 cases (19%), and poor in 12 cases (13%).

Among the 53 subtrochanteric fracture cases, 27 patients were in the 41-60 years age group. The most common type of subtrochanteric fracture treated with PFN was Seinsheimer's Type IV (comminuted fracture with four or more fragments). The mean radiological union time for subtrochanteric fractures was 20 ± 3 weeks. Complications in subtrochanteric fractures included pain (10 cases), malunion (2 cases), non-union (1 case), varus angulation (2 cases), nail breakage (1 case), screw cut-out (1 case), Z-effect (1 case), and reverse Z-effect (1 case). Functional assessment using the Harris Hip Score revealed excellent outcomes in 24 cases (45%), good in 19 cases (35%), fair in 7 cases (13%), and poor in 3 cases (5%).

Across all 143 cases, the overall functional outcome was excellent in 62 cases (43%), good in 42 cases (29%), fair in 24 cases (17%), and poor in 15 cases (10%). The poor range of movements (n=15) was attributed to non-union (2 cases), nail breakage (3 cases), screw cut-out (3 cases), Z-effect (3 cases), reverse Z-effect (2 cases), and avascular necrosis of the femoral head (1 case).

Proximal femoral nailing offers significant biological advantages, such as enabling closed reduction, minimizing soft tissue dissection, reducing surgical time, decreasing blood loss, and facilitating early patient mobilization post-operatively. Mechanically, it aids in restoring the abductor-lever-arm mechanism, reducing tensile strain on the implant, and maintaining controlled fracture impaction.

Conclusion

Proximal femoral fractures continue to present a substantial management challenge for orthopedic surgeons. However, with the advancements in load-sharing devices featuring anatomical pre-bending and angulation, effective internal splinting of these fractures has become achievable. This study advocates for the proximal femoral nail as the implant of choice for both trochanteric and subtrochanteric fractures of the proximal femur. Its biomechanical compatibility with various fracture patterns, coupled with a minimal complication rate, underscores its efficacy. The utilization of the proximal femoral nail, a load-sharing device, significantly reduces patient-related morbidity during both intra- and post-operative periods, thereby enhancing the functional status and overall quality of life for patients.

References

1. Alyassari G, Langstaff RJ, Jones JW, AlLami M. The AO/ASIF proximal femoral nail (PFN) for the treatment of unstable trochanteric femoral fracture. Injury. 2002 Jun;33(5):395-9.
2. Tyllianakis M, Panagopoulos A, Papadopoulos A, Papasmos S, Mousafiris K. Treatment of extracapsular hip fractures with the proximal femoral nail (PFN): long term results in 45 patients. Acta Orthop Belg. 2004 Oct;70(5):444-54.
3. Pajarinen J, Lindahl J, Michelsson O, Savolainen V, Hirvensalo E. Pertrochanteric femoral fractures treated with a dynamic hip screw or a proximal femoral nail. A randomised study comparing post-operative rehabilitation. J Bone Joint Surg Br. 2005 Jan;87(1):76-81.
4. Gupta RK, Sangwan K, Kamboj P, Punia SS, Walecha P. Unstable trochanteric fractures: the role of lateral wall reconstruction. Int Orthop. 2010 Feb;34(1):125-9.
5. Chou DT, Taylor AM, Boulton C, Moran CG. Reverse oblique intertrochanteric femoral fractures treated with the intramedullary hip screw (IMHS). Injury. 2012 Jun;43(6):817-21.
6. Klinger HM, Baums HM, Eckert M, Neugebauer R. [A comparative study of unstable per and intertrochanteric femoral fractures with DHS and PFN and TSP]. Zentralbl Chir. 2005 Aug;130(4):301-6. German.
7. Toni MM, Ericka AL. Treatment modalities for subtrochanteric fractures in elderly. Techniques in Orthopaedics. 2004 Sep;19(3):197-213.
8. 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 Jun;31(3):403-8.
9. Gadegone WM, Salphale YS. Short proximal femoral nail fixation for trochanteric fractures. J Orthop Surg (Hong Kong). 2010 Apr;18(1):39-44.
10. Adams CI, Robinson CM, Court-Brown CM, McQueen MM. Prospective randomized controlled trial of an intramedullary nail versus dynamic screw and plate for intertrochanteric fractures of the femur. J Orthop Trauma. 2001 Aug;15(6):394-400.
11. Gotfried Y. The lateral trochanteric wall: a key element in the reconstruction of unstable pertrochanteric hip fractures. Clin Orthop Relat Res. 2004 Aug;(425):82-6.
12. 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 Mar;89(3):470-5.
13. Wali P, Mared S. Pro's and Con's of proximal femoral nail in Peri trochanteric fractures. Int J Orthop Sci. 2018;4(3):209-13.
14. Kashid MR, Gogia T, Prabhakara A, Jafri MA, Shaktawat DS, et al. Comparative study between proximal femoral nail and proximal femoral nail anti-rotation in management of unstable trochanteric fractures. Int J Res Orthop. 2016 Nov;2(4):354-8.
15. Sharma A, Mahajan A, John B. A comparison of the clinico-radiological outcomes with proximal femoral nail (PFN) and proximal femoral nail anti-rotation (PFNA) in fixation of unstable intertrochanteric fractures. J Clin Diagn Res. 2017 Jul;11(7):RC05-RC09.
16. Linga SS, Aithala JP, Savur A. Can proximal femoral nailing of unstable trochanteric fractures help to regain pre-injury functional status in Indian rural patients? A prospective study of functional outcome of unstable intertrochanteric fractures with proximal femoral nailing. Int J Res Orthop. 2017 Jul;3(4):728-33.
17. James B, Prasath R, Vijayakumaran. Functional outcome of proximal femoral nailing in intertrochanteric fractures of femur: A prospective study. Int J Orthop Sci. 2017;3(2):513-8.
18. Jiang LS, Shen L, Dai LY. Intramedullary fixation of subtrochanteric fractures with long proximal femoral nail or long gamma nail: technical notes and preliminary results. Ann Acad Med Singap. 2007 Oct;36(10):821-6.

19. Gadegone WM, Shivashankar B, Lokhande V, Salphale Y. Augmentation of proximal femoral nail in unstable trochanteric fractures. SICOT J. 2017;3:12.
20. Chopra BL, Kumar K, Khajotia BL, Bhambu R. Proximal femoral nail-outcome and complications: a prospective study of 125 cases of proximal femoral fractures. Int J Res Orthop. 2017 Sep;3(5):973-8.
21. Werner TW, Lajtai G, Schmiedhuber G, Lang T, Pirkl C. [Intra- and perioperative complications in the stabilization of per- and subtrochanteric femoral fractures by means of PFN]. Unfallchirurg. 2002 Oct;105(10):881-5. German.
22. Boldin C, Seibert FJ, Fankhauser F, Peicha G, Grechenig W, Soljanik I. 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 Feb;74(1):53-8.