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Radiological and functional outcome of unstable intertrochanteric fractures treated with proximal femoral locking plate

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ABSTRACT

Background: Intertrochanteric fracture is a common orthopaedic injury sustained in elderly population because of osteoporosis and trivial fall. Life threatening systemic complications occur mainly due to immobility.
Methods: We included 62 patients (40 males and 22 females) of unstable intertrochanteric fracture (AO 31 A2 and A3) attending Department of Orthopaedics. They were all subjected to surgical treatment with proximal femoral locking plate. Patients were followed up at 3rd, 6th and 12th month for outcomes variables i.e.; functional (Harris hip score, Palmer and Parker mobility score) and radiological outcomes (neck shaft angle, loss of reduction, union and implant related complications). Statistical analysis was done using Friedman's test after calculating the data in terms of mean and median using SPSS 20 software.
Results: Mean age of our patients was 64 years, 40 were males and 22 females. 50 patients sustained fracture due to trivial fall and 12 due to RTA. 35 out of 62 patients had medical co-morbidites. 26 patients needed open reduction of fracture and 36 were close reduced. 22 of patients had severe comminution (AO A 3 III type). Average blood loss was 254 ml. Mean degree of loss of reduction was 5 degrees in 6th month and 4 degrees in 12th month. Union was achieved in 48 out of 50 patients at 12th month. Most of the patients achieved fair to good functional outcome scores at 12th month of follow up. We noticed difficulties in fracture reduction as well as complications related to implant.
Conclusions: PFLP is an effective implant in comminuted intertrochanteric fractures with broken lateral wall. Complications can be minimised by following principles of locking plate meticulously.

Keywords: Unstable intertrochanteric fracture, Proximal femoral locking plate, Functional outcome

INTRODUCTION

Intertrochanteric fractures constitute a majority of proximal femoral fractures in the elderly population and are associated with a significantly higher rate of morbidity and mortality.[1] Twenty to thirty percentage of elderly patients with limited physiological capacity die in first 12 months after intertrochanteric fracture.[1] Osteoporosis of proximal femur predisposes elderly females. The high-velocity injury is the commonest cause in young adult.[2]

The incidence of intertrochanteric fracture is increasing in young because of increased number of motor vehicle accidents and in elderly.[3,4,11] The preferred mode of treatment of an intertrochanteric fracture is surgical stabilization of fracture and early mobilization of the patient to prevent complications of decumbency such as deep vein thrombosis (DVT), pulmonary embolism, respiratory infection, urinary tract infection, urinary calculi and pressure sores.[4]

Orthopaedic surgeon faces a major challenge in treating these fractures due to high variability in fracture pattern. Extreme bone fragility adds to the difficulties and severely jeopardizes the strength of the final construct. Difficult fracture patterns have comminution of the posterolateral

cortex, greater trochanter comminution, loss of medial cortical buttress, reverse oblique pattern, subtrochanteric extension, and loss or communition of lateral cortex.[5] Acceptable reduction and stable internal fixation are the main prerequisites for uncomplicated osteogenesis and good functional recovery.[10]

The lateral trochanteric wall is believed to be a very important factor in the stability and healing of peri trochanteric fractures.[8] Keeping lateral wall intact or stabilized can assist fracture healing and greatly reduce the rate of mal union and non-union. An extramedullary device such as Proximal femoral locking plate (PFLP) acts as buttress support to the lateral cortex and provides stress shielding and lateral migration of fracture fragments and prevents collapse and change in neck shaft angle during fracture healing.[6,8]

There are other extramedullary and intramedullary devices described in the treatment of intertrochanteric fracture, but several systematic reviews and meta-analysis have failed to provide insight into the suitable treatment options.[6,9] The inconsistency of findings and diversity of implant devices have made it challenging to identify the ideal treatment option.

METHODS

A prospective study was conducted at our Institute after obtaining clearance from Research Committee and Institute Ethics Committee. This was a single centre study carried out between Dec 2015 to Apr 2019 in which patients with isolated displaced unstable intertrochanteric fractures were included. 62 consecutive cases of unstable intertrochanteric fracture (AO/ASIF 31 A2, 31 A3) presenting to OPD/Emergency services of department of orthopaedics with fresh fracture (1-week duration) were identified after evaluation of their medical records and radiographs. The patient was enrolled in this study after obtaining informed written consent and underwent surgical intervention in the form of open reduction (OR)/closed reduction (CR)+PFLP fixation.

Patients above 18 years of age, able to walk independently before the injury diagnosed with unstable intertrochanteric fracture (AO/OTA A2, A3) attending orthopaedics emergency or OPD services were included in study. Patients with polytrauma, pathological fracture, previous deformity, concomitant ipsilateral limb fractures, Grade 4 ASA Score were excluded from study.

Demographic details e.g. name, age, sex, occupation, laterality were recorded for all patients. Patients were classified according to AO/OTA classification and baseline investigations (Hb, total counts, differential counts, urea, creatinine, serum electrolytes, LFT, CXR, ECG, echocardiography) were done and anesthesia consultation was sought.

Under regional anesthesia, the patient was operated using PFLP. Fracture reduction was evaluated using Baumgertner criterion modified by Fogagnolo et al.[29]

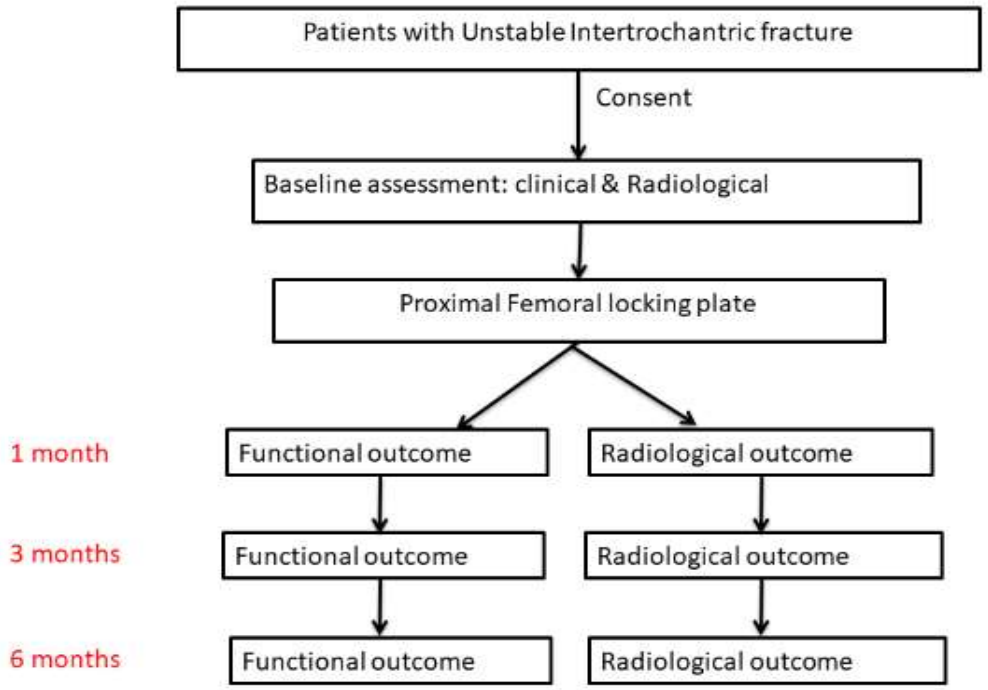

Figure 1: Study methodology flow chart.

Statistics

Sample size calculated for the study was 62 patients.

Independent variables

It included- (a) age, gender, medical co-morbidities, smoker, diabetes; (b) mechanism of injury (blunt/fall from height/forklift/ground level fall, RTA).

Outcome variables

Blood loss, duration of surgery, non-union., malunion, varus collapse, implant fracture, femoral neck screw breakage, femoral head cut out. Baseline characteristics were summarized using proportions for categorical variables and mean (SD) or median (IQR) for continuous variables. Outcome measures (non-union, mal-union, complication) were expressed in terms of proportions.

Proportions and means were compared using chi square test and Friedman test using SPSS 20 software.

RESULTS

At 12th month of follow up, two patients had an excellent outcome as per Harris hip score grading. The majority (36) of them achieved a score of 70-89 and was graded as a fair outcome. Good outcome in six patients and six patients had a poor outcome.

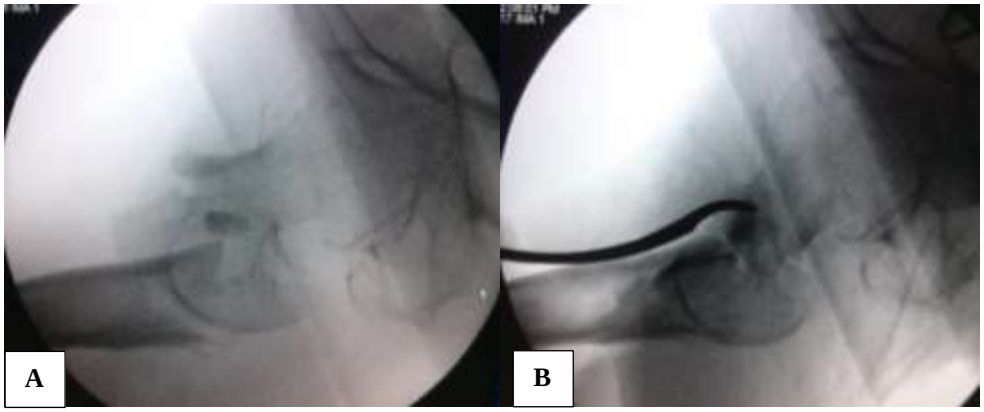

Figure 2: (A) Intra-operative pre-reduction image; (b) reduction of neck fragment with Homan's retractor.

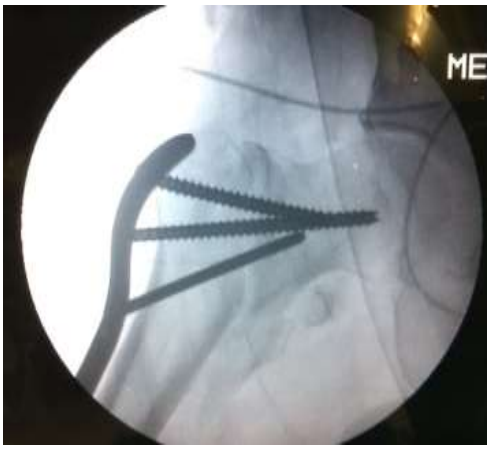

Figure 3: Intra-operative fluoro image.

Table 1: Demographic details.

Parameters		Observations
Age	Mean (64.65±14.97)	
Sex	M: F	40: 22
Unilaterality	Right: left	26: 36
Mechanism of injury	RTA: fall	12: 50
ASA grade	I: II: III	26: 30: 6

Continued.

Parameters		Observations
Fracture type	A2I: A2II: A2III	10: 6: 16
	A3I: A3II: A3 III	4: 4: 22
Type of reduction	Open: closed	26: 36
Neck shaft angle (degrees)	Median 134 (122-140)	
Pre-op HB	Median 10.5 (6-15.6)	
AV blood loss (ml)	200 (130-640)	
Mean duration of surgery (mins)	A2	169.37±47.57
	A3	214±65.19
Comorbidities	Yes/no	26:27
	Asthma	2
	Diabetes	6
	Hypertension	12
	Diabetes+hypertension	10
	Diabetes+hypertension+CKD	6

Note: CKD-Chronic kidney diseases.

Table 2: shows follow-up loss of reduction, harris hip score and palmar score at 3rd, 6th month and 12th month in all cases.

Follow-up (months)	Degree of loss of reduction median (inter-quartile range)	Harris hip score median (inter quartile range)	Palmar and parker mobility score median (inter-quartile range)
3rd	5 (2-7.5)	59 (53.50-63.50)	3 (3-4)
6th	4 (0-12)	68 (63.50-71.50)	5 (5-6)
12th	0 (0-8)	74 (72-78)	7 (7-7.75)
P value	0.00	0.01	0.00

Note: Friedman test, degree of freedom=2.

Table 3: Shows summary of various study parameters at 3rd, 6th and 12th months follow-up in AO II vs AO III group.

Study parameters	Follow up (N=62)					
	3rd month (N=62)		6th month (N=54)		12th month (N=50)	
	AO type II (N=32)	AO type III (N=30)	AO type II (N=32)	AO type III (N=30)	AO type II (N=24)	AO type III (N=26)
Clinical signs and symptoms	12	12	8	7	2	5
Screw backout	2	1	3	3	2	1
Degree of loss of reduction	8.19±8.72 5.5 (0-30)	7.33±6.82 6 (0-23)	5.31±7.73 4 (0-27)	7.71±7.508 7.5 (0-25)	1.58±3.118 0 (0-8)	0±0.00 0 (0-0)
Harris hip score	59.56±7.89	56.33±5.765	66.77±10.31	66.93±6.354	73.25±10.67	74.92±3.59
Palmar and parker score	3.44±0.892	3.33±0.488	5.46±1.45	5.21±1.051	6.82±1.60	6.92±0.760
Union			20	22	24	24
Malunion			20	22	7	6

DISCUSSION

Demographic parameters

In our study median age of the patient population was 69 years with a range of 26 to 90 years. This is in concordance with various other studies in the literature.[1,6,9-12,14,17,19,21,25,30] Ageing is a natural phenomenon and leads to decreased bone mineral density and weakening of bone. This results in higher chances of fracture in the elderly population. With advancing age, gradual deterioration occurs in the musculoskeletal and neuromuscular system leading to delayed reflexes and balance impairment.[2] Decreased visual acuity, proprioception, transient circulatory embarrassment and impaired sensory-motor functioning are the other age-related changes in elderly population are predisposing them to falls. There were 40 male and 22 female patients in our study. Different studies

have reported a higher incidence of intertrochanteric fracture in females.[2,6,9,14,18,25] This discrepancy in finding may be due to small sample size of our study or traditionally higher number of female patients preferring native treatment in a rural setting. They are usually attended by non-medical practitioners and remain unreported to the hospital. Twenty-six patients sustained right side fracture, and thirty-six patients had involvement of left hip among thirty-one patients in our study. A higher incidence of intertrochanteric fracture on left hip as compared to the right has been reported.[25] However, this could be an incidental finding.

In our study, 80% of patients suffered an inter trochanteric fracture due to trivial fall at ground level and 20% due to road traffic accident in our study. Fall from height (axial loading), direct trauma to the hip are other reported mechanisms.[2] In elderly individuals, osteoporosis is a major factor causing weakening of bones. We did not attempt to quantify osteoporosis in our patients. Fear of fall, lack of outdoor activities, poor nutrition, emotional distress, unstable mental status, medications, poor housing condition and alcoholism are some of the problems in the geriatric age group which can increase chances of sustaining a trivial fall. A strong association between low body mass and increased risk of fracture has been reported.[2] Older females with small body size are more likely to have low bone density and poor soft tissue coverage over the lateral aspect of the hip than their normal counterparts making them more susceptible to intertrochanteric fractures.

Owing to the advanced age of patients, co-morbidities play an important role in overall management and outcome of the intertrochanteric fracture. Elderly patients have a higher incidence of co-morbidities and are on multiple drug treatment. Alteration in drug doses, variation in bioavailability of drug due to missed doses, timing with food intake, change in urine output and mutual drug interactions, etc. may cause altered blood concentrations. These can cause fluctuation in hemodynamic parameters, electrolyte imbalances, giddiness, syncope, altered mental status and drowsiness. All of this can precipitate a fall and increase chances of intertrochanteric fracture.

Six of our patients had diabetes, twelve had hypertension, ten suffered from both hypertension and diabetes, six patients suffered from hypertension, diabetes, and chronic kidney disease together and one was an asthmatic. Twenty-six patients were free of co-morbidities. Patients preoperative status has an important bearing on the perioperative events. Pre-injury functional status of the patient, cardiovascular fitness, the extent of end organ damage and functional capacity of various vital organs are important factors which help in rapid recovery from direct mechanical trauma or surgical stress.

In orthopaedics, ASA score has been shown to be an independent and direct predictor of length of hospital stay and hospital cost [31]. 48% of our patients were ASA II, 42% belonged to ASA I and 10% were classified as ASA III in our study. Mean Harris hip score was found to be 75.58 in ASA I group, 70 in ASA II group and 60 in ASA III patient group. Similar to previous studies, our study also reflects that patients who have low ASA grade on presentation have better outcomes as compared to patients with high ASA grade.[31]

Difficulty in fracture reduction, the need of open reduction and more soft tissue stripping, loss of fracture hematoma, longer duration of surgery, more blood loss, prolonged restricted mobilisation and non-weight bearing are usually required for unstable fractures. Maximum number (38%) of patients in our study sustained AO type A3 fracture. Mean Harris hip score at the 12th month of follow-up was 73.25±10.67 in AO II fracture group as compared to 74.92±3.59 in AO III fracture group. There was no significant difference in outcome based on fracture pattern (A2 versus A3). Study by Mangram et al also did not find evidence to suggest any significant association between fracture type, medical comorbidities and injury severity score.[23]

Obtaining an accurate anatomical fracture reduction is very important. Some authors argued that open to walk independently before the injury reduction facilitates much more accurate reduction under direct vision and reduces fluoroscopic exposure. In our study, we obtained a reduction in 36 patients by the closed method and performed open reduction in 26 patients after the trial of closed reduction was given, but the reduction was found unacceptable according to Baumgartner criterion modified by Fogagnolo et al.[29] A case of AO type A3 ii displaced fracture had flexed, and abducted neck fragment, and medialised distal shaft fragment treated with open reduction. The reduction was achieved after depressing the proximal fragment with Homan's retractor and medial pulling of femoral shaft with the help of bone hook. After reduction, fragments were temporarily held with k-wires.

A study suggested that preoperative haemoglobin status is an independent factor for mortality risk after hip surgery.[34] They did not find any correlation between post operative anaemia and discharge anaemia with increased mortality risk.[34] Median preoperative haemoglobin in our patient cohort was 10.5 with a range 6 to 16.5 mg/dl. However, we did not perform a further study to find any correlation with mortality and morbidity.

Implant related concerns

We observed a discrepancy in the proximal femur anatomy and fit of the implant. When screws are positioned accurately in the neck and head of the femur, the proximal plate was not abutting against the greater trochanter and a gap was seen. One of the reasons reported for the failure of PFLP is increased the distance of plate from the bone after fixation. The free length of the screw between bone and plate increases lever arm and results in weakening of construct on bending movements.[35] This predisposes to

screw breakage, bending, loosening and backing out. When we attempted to match the curvature of the lateral wall, the distally plate was moving away from the shaft and a triangular gap was seen between the plate and the femoral shaft. The plate was found to be proud and higher than greater trochanter on accurate positioning of neck screws. This resulted in pain on terminal abduction in 12% of our patients on follow up.

The discrepancy between the contour of the plate and proximal femoral anatomy is evident in fluoroscopy image. Probably because of extensive comminution in greater trochanter, height and contour of greater trochanter were lost. Hence it caused misfit and difficulty in plate positioning.

This can be explained by the variability in the proximal femoral anatomy from patient to patient. There is no study to delineate the proximal femur anthropometric parameters in Indian population per se. Lin et al performed a study in Chinese population on anthropometric parameters of the proximal femur and concluded that anteversion is significantly higher in Chinese females as compared to Chinese males.[36] He also found that anteversion is higher in females irrespective of ethnicity. By his findings, he advocated twisted design of proximal femoral locking plate and different angulation of proximal screws.[36] The Indian implant designs are copied from the European counterparts, and the Caucasian population is anthropometrically very different from Asian population. However, we believe that it is unlikely to interfere with the outcome if neck screws are placed correctly as it is a locking plate, a rigid construct and behaves similarly to internal, external fixator.

Healing of intertrochanteric fracture occurs by abundant cancellous bone formation. In our study maximum collapse (loss of reduction) occurred at 6th month coupled with forces acting on the fracture site as patient started to progressively weight bear on the operated limb.

Collapse is evident by the change in neck shaft angle and degree of loss of reduction on follow-up radiographs. Kim et al in 2011 reported 49 cases of radiographic failures out of 178 cases. Among 49, two were stable, and 47 were unstable fractures. More than 50% failures occurred in unstable fractures with osteoporosis. They recommended that DHS should not be used in these patients.[37]

In our study loss of reduction in open reduction group (11.4±8.79 degrees) was observed to be three times higher than closed reduction group (3.19±4.26 degrees) at follow-up visits. At 12th month, there was no loss of reduction occurring in closed reduction group, but collapse and loss of reduction continued to happen even at a 12th month in open reduction group. This may be explained by more comminution and degree of osteoporosis in open reduction group. In similar studies, Gunadham et al. reported a loss of reduction in 8% of cases and Hu et al in 15.55% of cases.[4,38] PFN is shown to be stronger than DHS as it can tolerate multifold higher static and cyclical loading.[39] In our study, we observed 6 cases of screw backout and 1 case of broken screws. Schneider et al found that plate failure occurs consistently if there is screw deviation of more than two degrees from the nominal axis.[41] This demonstrates how crucial and important is screw placement in proximal femur in overall stability and preventing failure of PFLP.

Gunadham et al. reported 23.8% cases of the broken implant and Asif et al reported 3 cases of broken implant among 25 cases.[25,38] Premature weight bearing was cited as an important cause. Due to make of the implant and biomechanics, maximum stress concentration over the implant occurs just below the trochanter. Lower neck screw and kickstand screw suffer maximum stress during axial loading. This is evident by failure occurring commonly due to plate breakage at subtrochanteric region and lower neck screw breakage.

96.7% (60) patients achieved union by six months. One patient had a nonunion following infection. 67.74% (41) patients achieved clinical and radiological union at third month with <10 degrees of loss of reduction and malunion due to collapse. Incidence of malunion was more in AO Type A 3 group as compare to A 2 group. This is easily explained by the fracture pattern and more comminution is leading to more collapse and loss of reduction in A 3 group as compared to A 2 group.

81.25% (26) of patients in closed reduction group achieved union at six months, and all of them united at twelve months follow-up. In open reduction group, there was 72.72% (16) union at six months and one patient did not achieve union even at 12th month. It got complicated with infection and warranted implant removal and external fixator application. Other studies showed, 95.55%[25] and 92% union after one year.[4]

Union was achieved in 60 out of 61 patients in our study. Hu et al showed union 43 out of 45 cases and Asif et al achieved union in 23 out of 25 cases at one year of follow up and 86% in another study.[4,25,38] Harris hip score and Palmar and Parker mobility score continued to increase from 3rd month to 12th month. The rate of increase was more in first six months as compared to next six months. This is attributed to progressive fracture healing, reduced pain and regaining range of motion at the hip.

Loss of pain and gain in range of motion occurs early in first few months of post operative period and these two factors are a major components of Harris hip score as compared to mobility component. This explains greater increase seen in first six months as compared to next six months. Harris hip score and Palmar and Parker mobility score had only minimal difference in A 2 and A 3 groups at 3rd, 6thand 12th month however in patients in A 2 group had higher value in 3rd month compare to patients in A 3 group but at subsequent visits at 6th and 12th month patients in A 3 had higher values as compared to patients

in A 2 group. This finding emphasises on the fact that outcome does not completely depends on the fracture pattern. It also depends on other systemic factors, presence of medical co morbidities, adequate rehabilitation and physiotherapy.

In our study, 1 patient suffered from implant infection. 1 out of 27 case of PFLP had superficial infection, and was treated with debridement in another study.[25] Yet another meta-analysis did not show any significant difference in the wound infection in relation to various implants used for intertrochanteric fracture.[25] No case of plate breakage was seen during follow up.

Limitations

In the present study the , follow-up was for twelve months. Further long-term follow up is required to note any delayed complications. Patients in our institute were operated upon by different surgeons in the Trauma operation theatre. This may explain early complications in the learning curve period. Study with larger sample size with randomisation to PFLP, DHS, and PFN group with extended follow-up will establish the implant of choice for trochanteric fracture healing.

CONCLUSION

The proximal femoral locking plate is a useful device in the management of unstable intertrochanteric fracture of the femur with success rate when the principles of locked plating are adhered to- (a) an accurate reduction should be achieved with the restoration of neck shaft angle before locking plate fixation; (b) guiding block was not used over plate for screw fixation. This could cause cross threading and back out of screws on follow up; (c) all the screws should be carefully locked over the plate intra-operatively; (d) the patient should be allowed gradual weight bearing, only when callus formation and evidence of union is seen on X-ray.

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REFERENCES

1. Broderick JM, Bruce-Brand R, Stanley E, Mulhall KJ. Osteoporotic hip fractures: the burden of fixation failure. ScientificWorldJournal. 2013;515197.
2. Marks R. Hip fracture epidemiological trends, outcomes, and risk factors, 1970-2009. Int J Gen Med. 2010 Apr 8;3:1-17.
3. Boyce WJ, Vessey MP. Rising incidence of fracture of the proximal femur. Lancet. 1985;1(8421):150-1.
4. Hu SJ, Zhang SM, Yu GR. Treatment of femoral subtrochanteric fractures with proximal lateral femur locking plates. Acta Ortop Bras. 2012;20(6):329-33.
5. Johnson B, Stevenson J, Chamma R, Patel A, Rhee SJ, Lever C, Starks I, Roberts PJ. Short-term follow-up of pertrochanteric fractures treated using the proximal femoral locking plate. J Orthop Trauma. 2014;28(5):283-7.
6. Zhang L, Shen J, Yu S, Huang Q, Xie Z. Percutaneous compression plate versus dynamic hip screw for treatment of intertrochanteric Hip fractures: a meta-analyse of five randomized controlled trials. Scientific World J. 2014;512512.
7. Uzun M, Erturer E, Ozturk I, Akman S, Seçkin 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(6):457-63.
8. Ozkan K, Turkmen I, Sahin A, Yildiz Y, Erturk S, Soylemez MS. A biomechanical comparison of proximal femoral nails and locking proximal anatomic femoral plates in femoral fracture fixation: A study on synthetic bones. Indian J Orthop. 2015;49(3):347-51.
9. Yu J, Zhang C, Li L, Kwong JSW, Xue L, Zeng X, et al. Internal fixation treatments for intertrochanteric fracture: a systematic review and meta-analysis of randomized evidence. Sci Rep. 2015;5.
10. Muhr G, Tscherne H, Thomas R. Comminuted trochanteric femoral fractures in geriatric patients: the results of 231 cases treated with internal fixation and acrylic cement. Clin Orthop Relat Res. 1979;(138):41-4.
11. Hill A, Chao A, Ross RK, Henderson BE. Exercise and other factors in the prevention of hip fracture: the Leisure World study. Epidemiology. 1991;2(1):16-25.
12. Knobe M, Gradl G, Ladenburger A, Tarkin IS, Pape HC. Unstable intertrochanteric femur fractures: is there a consensus on definition and treatment in Germany?. Clin Orthop Relat Res. 2013;471(9):2831-40.
13. Kumar N, Kataria H, Yadav C, Gadagoli BS, Raj R. Evaluation of proximal femoral locking plate in unstable extracapsular proximal femoral fractures: Surgical technique & mid term follow up results. J Clin Orthop Trauma. 2014;5(3):137-45.
14. Baumgaertner MR, Curtin SL, Lindskog DM. Intramedullary versus extramedullary fixation for the treatment of intertrochanteric hip fractures. Clin Orthop. 1998;(348):87-94.
15. Evans PJ, McGrory BJ. Fractures of the proximal femur. Hosp Physician 2002;38(4):30-8.
16. Evans JG, Prudham D, Wandless I. A prospective study of fractured proximal femur: incidence and outcome. Public Health 1979;93(4):235-41.
17. Gotfried Y. The lateral trochanteric wall: a key element in the reconstruction of unstable pertrochanteric hip fractures. Clin Orthop. 2004;425:82-6.

18. Mittal R, Banerjee S. Proximal femoral fractures: Principles of management and review of literature. J Clin Orthop Trauma. 2012;3(1):15-23.
19. Miyamoto RG, Kaplan KM, Levine BR, Egol KA, Zuckerman JD. Surgical Management of Hip Fractures: An Evidence-based Review of the Literature. I: Femoral Neck Fractures. J Am Acad Orthop Surg. 2008;16(10):596-607.
20. Nordin S, Zulkifli O, Faisham WI. Mechanical failure of Dynamic Hip Screw (DHS) fixation in intertrochanteric fracture of the femur. Med J Malaysia 2001;56:12-7.
21. Kivi M, Mirbolook A, Khajeh JS, Rouhi RM. Fixation of Intertrochanteric Fractures: Dynamic Hip Screw versus Locking Compression Plate. Trauma Mon. 2013;18(2):67-70.
22. Emami M, Manafi A, Hashemi B, Nemati A, Safari S. Comparison of intertrochanteric fracture fixation with dynamic hip screw and bipolar hemiarthroplasty techniques. Arch Bone Jt Surg. 2013;1(1):14-7.
23. Streubel PN, Moustoukas MJ, Obremskey WT. Mechanical failure after locking plate fixation of unstable intertrochanteric femur fractures. J Orthop Trauma. 2013;27(1):22-8.
24. 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(3):403-8.
25. 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 JCDR 2016;10(1):9-13.
26. Balasubramanian N, Babu G, Prakasam S. Treatment of Non Unions of Subtrochanteric Fractures Using an Anatomical Proximal Femur Locked Compression Plate - A Prospective Study of 13 Patients. J Orthop Case Rep. 2016;6(1):65-8.
27. Parker MJ, Blundell C. Choice of implant for internal fixation of femoral neck fractures. Meta-analysis of 25 randomised trials including 4,925 patients. Acta Orthop Scand. 1998;69(2):138-43.
28. Yu J, Zhang C, Li L, Kwong JSW, Xue L, Zeng X, et al. Internal fixation treatments for intertrochanteric fracture: a systematic review and meta-analysis of randomized evidence. Sci Rep. 2015;5.
29. Fogagnolo F, Kfuri M, Paccola CJ. Intramedullary fixation of pertrochanteric hip fractures with the short AO-ASIF proximal femoral nail. Arch Orthop Trauma Surg. 2004;124(1):31-7.
30. LLW. Hip Fracture Mortality: Relation to Age, Treatment, Preopera: Clinical Orthopaedics and Related Research. Available at: http://journals.lww.com/corr/Fulltext/1984/06000/Hip_Fracture_MortalityRelatioAge,.8.aspx. Accessed on 22 June 2021.
31. Castelli A, Daidone S, Jacobs R, Kasteridis P, Street AD. The Determinants of Costs and Length of Stay for Hip Fracture Patients. PLoS One. 2015;10(7):133545.
32. Mangram A, Moeser P, Corneille MG, Prokuski LJ, Zhou N, Sohn J, et al. Geriatric trauma hip fractures: is there a difference in outcomes based on fracture patterns? World J Emerg Surg WJES. 2014;9.
33. Desai SJ, Wood KS, Marsh J, Bryant D, Abdo H, Lawendy AR, et al. Factors affecting transfusion requirement after hip fracture: Can we reduce the need for blood? Can J Surg 2014;57(5):342-8.
34. Zhang L, Yin P, Lv H, Long A, Gao Y, Zhang L, Tang P. Anemia on Admission Is an Independent Predictor of Long-Term Mortality in Hip Fracture Population: A Prospective Study With 2-Year Follow-Up. Medicine. 2016;95(5):2469.
35. 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(10):1281-7.
36. Lin KJ, Wei HW, Lin KP, Tsai CL, Lee PY. Proximal Femoral Morphology and the Relevance to Design of Anatomically Precontoured Plates: A Study of the Chinese Population. Sci World J. 2014;201694.
37. 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(6):360-2.
38. Gunadham U, Jampa J, Suntornsup S, Leewiriyaphun B. The outcome in early cases of treatment of subtrochanteric fractures with proximal femur locking compression plate. Malays Orthop J. 2014;8(2):22-8.
39. Jonnes C, Najimudeen S. Type II Intertrochanteric Fractures: Proximal Femoral Nailing (PFN) Versus Dynamic Hip Screw (DHS). Arch Bone Jt Surg. 2016;4(1):23-8.
40. Hsueh KK, Fang CK, Chen CM, Su YP, Wu HF, Chiu FY. Risk factors in cutout of sliding hip screw in intertrochanteric fractures: an evaluation of 937 patients. Int Orthop. 2010;34(8):1273-6.
41. Schneider K, Oh JK, Zderic I, Stoffel K, Richards RG, Wolf S, et al. What is the underlying mechanism for the failure mode observed in the proximal femoral locking compression plate? A biomechanical study. Injury. 2015;46(8):1483-90.

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