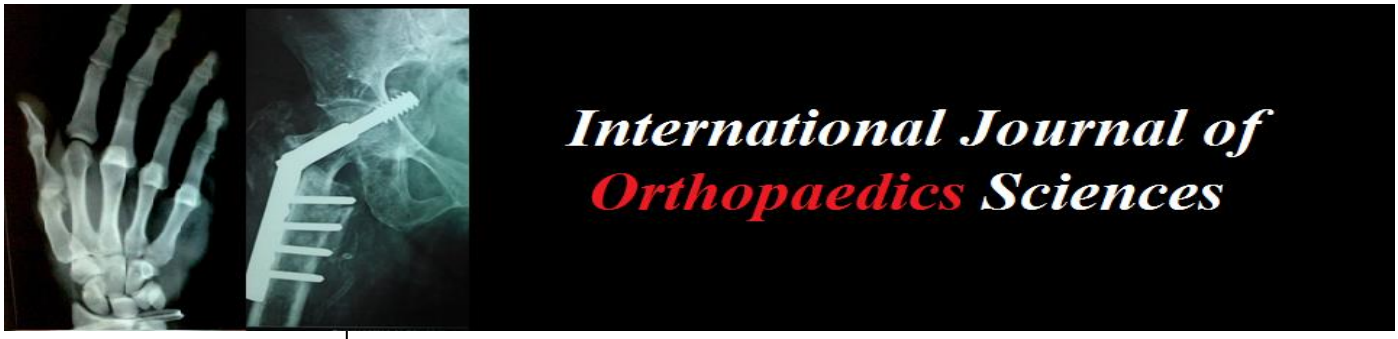

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A comparative study of proximal trochanteric contoured plate vs proximal femoral nail for unstable inter-trochanteric fracture of femur

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Abstract
Background: Unstable inter-trochanteric fractures of the femur remains one of the most challenging fractures faced by orthopaedic surgeons. This study was done to compare the proximal femoral nail and proximal femoral locking plate for the management of unstable inter-trochanteric fractures and their postoperative complications.
Material and methods: This was a prospective study of 40 patients with unstable inter-trochanteric fractures of femur who were treated with PFN (20 cases) and PFLP (20 cases). The fractures were classified according to Boyds and Griffin classification. All patients were assessed functionally by Harris Hip Score.
Results: Average duration of union was 14.75±3.52 weeks (range 14 to 16 weeks) in PFN cases and 17.70±2.00weeks (range 14 to 21 weeks) in PFLP cases, union was achieved in 100% cases except one case of PFN which goes to non union due to Z effect. Various complications were seen in both cases. As per Harris Hip score, excellent results were noted in 75%PFN and 40%PFLP cases, good in 15%PFN and 25%PFLP cases and fair in 5% PFN and 35% PFLP cases and poor in 5%PFN and 0%PFLP cases.
Conclusion: Harris hip score comparison of study suggests that functional results were better in PFN than PFLP. Less Blood loss, less operative time, early weight bearing were other favouring factors in PFN. Though blood loss and operative time was more, rigidity of fixation was better in unstable fractures in PFLP group. We conclude that PFN is the better implant for unstable intertrochanteric fractures with lesser operative time and lesser blood loss. While PFLP can be a good alternative for unstable intertrochanteric fractures with better results with slightly longer operative time and more blood loss when compared with PFN.

Keywords: Unstable inter-trochanteric fractures, Boyds and griffin classification, proximal femoral nail, proximal femoral locking plate

1. Introduction
Inter trochanteric fractures of femur occur in the area between the greater and lesser trochanter and may involve these two structures. Inter trochanteric fractures make up 45% of all hip fractures. This region consists of weight bearing trabeculae and has a good amount of cancellous bone and vascularity thus minimizing the risk of avascular necrosis and non-union. Gulberg *et al*. has predicted that the total number of hip fractures will reach 2.6 million by 2025 and 4.5 million by 2050, whereas this figure could rise to 37% in 2025 and 45% in 2050 [2]. In younger patients, intertrochanteric femoral fractures are usually the result of high energy physical trauma and usually occur in the absence of disease. In elderly patients these are often pathological, usually resulting from minimal to moderate physical trauma to areas of bone significantly affected by osteoporosis. However pathological fractures can occur at any age, typically these fractures result from low energy injuries and may be characterized by unusual fracture patterns [4]. Inter trochanteric fractures can be classified in many ways *viz*. Evan's classification, AO classification, Boyd and Griffin classification. All of them divide this fracture into stable fractures and unstable fractures (reverse oblique and coronal split fractures) [3]. Patient with an intertrochanteric hip fracture present with an external rotation deformity with shortened extremity.

As most of these patients are elderly they often need Medical optimization. On the other hand, timing of surgical intervention is critical. Unstable inter trochanteric fractures are notorious for their complications and high failure rates following treatment with conventional methods. The trick is to identify unstable fracture patterns and use specific design implants for their management.Treatment can be in form of operative or non-operative. The standard of care today is operative reduction and internal fixation and early rehabilitation. Short term operative goals are to provide (A) Stable construct enough to withstand early mobilization (B) Mobilization in early post-op period(C) Minimize complications associated with long term recumbency of the fracture. Many treatment options are described aiming for stable fixation, which allows early mobilization of the patient as they are unable to even partially restrict weight bearing [6]. Generally, intramedullary fixation and extra medullary fixation are the 2 primary options for treatment of such fractures. Proximal femoral nail (PFN) is commonly used devices in the intramedullary fixation. However, both benefits and technical failures of PFN have been reported [9]. A number of studies have reported decreased blood loss and operating time with the use of intramedullary systems, but none of them report an improved functional outcome with these implants. One of the major criticisms of intramedullary systems has been the risk of femoral shaft fractures distal to the implant. The greater trochanter fragment and the lateral trochanteric wall play an important role in stability after implant fixation of unstable intertrochanteric fractures. The PFLP can be a feasible alternative for the treatment of unstable intertrochanteric fractures because it provides proper fixation of the lateral fragments and prevents the lateral migration of proximal fragments. The proximal femur locking plate is the kind of stable and effective internal fixation for treating unstable intertrochanteric hip fractures which has the advantage of stable fixation especially for the lateral femoral wall fracture. PFLP is an implant plate with a stable angle for management of comminuted fractures. The PFLP is stated to be more suitable for unstable intertrochanteric fractures. Although the effects of PFN and PFLP in treatment of intertrochanteric fractures have been reported, the results and conclusions are not consistent. Therefore, we conducted this comparative study to investigate whether there is a significant difference between PFN and PFLP fixation in treatment of intertrochanteric fractures in terms of various clinical parameters like blood loss, duration of surgery and Harris Hip Score.PFN or PFLP, the ideal implant!! The discussion regarding which one of these is implant for intertrochanteric femoral fracture is continuing and controversial.The purpose of our study was to evaluate the results, complications and functional outcomes of PFN VS PFLP in the management of unstable inter-trochanteric femur fractures.

2. Material and Methods

This prospective study was conducted on 40 patients with unstable inter-trochanteric fractures of femur who were treated with PFN and PFLP 20 cases each. The objectives and importance of this study was explained to the patients recruited in the study. All patients signed an informed consent form. The study proposal and ethical procedures were approved by the Ethics Committee of Government Medical College, Patiala. Pathological fractures, fractures in patients <18 years, old fractures>2weeks, compound fractures were excluded from the study. The fractures were classified according to Boyds and Griffin classification. Evaluation of the patient was started with general physical examination and local examination to rule out any neurovascular deficit or compartment syndrome. X-ray of the affected hip carefully viewed to look for comminution, instability, quality of bone, fracture extension etc. X-rays of other body parts and other radiological investigation if needed are done to rule out any associated injury. CT scan was not done routinely. Till the day of surgery, patient was kept on skeletal/skin traction. Pre-operative antibiotics are given to the patients. Pre-operative planning will be done to decide the type and length of implant to be used. The choice of anaesthesia will be general or regional/spinal/epidural.

2.1 Operative technique for PFLP

The operation was carried out with the patient lying supine on fracture table. Traction will be used for reduction and realignment of comminuted fracture and reduction will be assessed by image intensifier in both anteroposterior view and lateral view. After reducing the fracture surgery was performed with the patient lying supine over operating fracture table. Lateral approach using a straight incision extending from greater trochanter to 5-10 cm distally, according to fracture configuration was used. In cases where anatomically satisfactory reduction was achieved preoperatively, the plate was inserted using the less invasive technique, while in others open reduction technique was used primarily. Plate was temporarily fixed to shaft by k-wires, and both, alignment of plate and reduction was checked in antero-posterior & lateral views. Proximal hood has 5 holes which take purchase in head and neck of femur (5 mm). Most proximal screw is inserted at an angle of 95^0. The second and third screws are inserted at an angle of about 90^0 in anterior & posterior planes respectively. The fourth screw is inserted at an angle of 120^0 and the fifth at an angle of 135^0 which acts as medial buttress screw (preventing varus collapse).The remaining distal screw-holes (5-13 holes) in PF-LCP are fixed to the femoral diaphysis and are like the holes in the classical locking plates, which allow either conventional (4.5 mm) or locking head screw (5 mm) at the level of shaft. Distal tip of plate is tapered for percutaneous insertion. In comminuted fractures 3-4 holes of plate were left empty at the level of fracture to increase working length. All comminuted fractures with calcar commination were additionally bone grafted. Soft tissue was closed in layers with negative suction drain in situ. Patients were given post-op antibiotics for adequate duration. First post-op dressing was done on 3rd day to assess wound condition and exercises of hip and knee were started on the same day. Quadriceps exercise and non-weight bearing ambulation was allowed day after surgery. Second post-op dressing was done on 7th day. Stich removal was done on 11th post-op day after assessing the condition of incisional wound. Discharge of patient from hospital was done in satisfactory condition & physiotherapy started. Partial weight bearing was started at 3 weeks & full weight bearing at around 8 weeks, subject to union criteria (evidence of sufficient callus in 3 out of 4 cortices on AP and lateral view.

For PFN, closed reduction was done and checked under image intensifier. A 5 cm incision is made starting from tip of greater trochanter extended proximally. Entry portal made at the tip of greater trochanter using the awl after checking under image intensifier and a guide wire will be passed through the trochanter distally, followed by trochanteric reaming over the guide wire. The nail (length: 240-420 mm; size: 9-12 mm; proximal portion: 15 mm) was implanted manually. Length and size of nail was decided depending upon fracture pattern

and individual bone characteristics. The 8.0-mm cervical screw and the 6.4-mm stabilising screw were introduced after the position of the guide wires had been confirmed and then assembled on the aiming device on the antero-posterior and lateral views. Depending upon the fracture configuration and stability, the distal static and dynamic holes were then locked. Patients were given post-op antibiotics for adequate duration. First post-op dressing was done on 3rd day to assess wound condition and range of motion exercises of hip and knee was started on the same day. Second post-op dressing was done on 7th day. Stitch removal done on 11th post-op day after assessment if there was no gaping. Discharge of patient from hospital was done after satisfactory stitch removal, wound condition & physiotherapy achieved. All patients were regularly followed up in OPD at an interval of 2 weeks till full weight bearing is started and then after an interval of 4 weeks for 6 months. Unstable inter-trochanteric fracture cases treated with PFN, partial weight bearing will be started at 6 weeks while those treated with PFLP partial weight bearing will be started between 6-10 weeks depending upon reduction and stability of fracture. Full weight bearing will be started in all cases only after radiological union.

Clinico-radiological assessment of the patient was done and comparison was done in terms of Duration of surgery, Total amount of blood loss (during surgery + drain output), Duration of hospital stay, Timing of early mobilization and full weight bearing, Assessment of mobility at the end of 3 months and 6 months (Wheel chair bound/walking frame/ stick/ no aide), Radiological assessment for fracture union. Complications associated with internal fixation, Harris hip score for clinical and radiological assessment at end of 6 months. The result of the study will be compared using standardized statistical test for different variables. P value <.05 is considered significant. All data were analysed using 22v of SPSS software and Pearson chi square test.

3. Results

In our study, 20 patients each were treated by PFN and PFLP. They were between 30 to 76 years of age group with maximum patients in 5th and 6th decade. There were 34 males and 6 females. The fractures of both sides are seen- right (45%) and left sided (55%) and fall from height accounted for most of the cases, followed by road side accidents. As per Boyds and Griffin classification the PFN group, 17 (85%) and 3(15%) patients belonged to the type 2 and 3 respectively and PFLP group, 6 (30%), 13 (65%) and 1(5%) patients belonged to the type 2, 3 and 4 respectively. Mean duration of surgery in the patients of PFN group and the PFLP group were found to be 58.25±5.20 and 74.65±10.12 minutes respectively. Significant results obtained while comparing the mean duration of surgery in between the subjects of the PFN group and the PFLP group (P- value < 0.05) which is highly significant. Mean blood loss among the patients of the PFN group and the PFLP group were found to be107.00±9.79 and377.00±41.94 ml respectively. Significant results were obtained while comparing the mean blood loss in PFN and PFLP group patients, (P- value < 0.05), which is highly significant. Mean blood loss among the patients of the PFN group and the PFLP group were found to be107.00±9.79 and377.00±41.94 ml respectively. Significant results were obtained while comparing the mean blood loss in PFN and PFLP group patients, (P- value < 0.05), which is highly significant. 2 cases had superficial infection in PFLP group. There was no malunion or nonunion, but there was delayed union in 2 cases in PFLP group and 1non union in PFN group with Z-effect at one month. Hip pain was observed one in each group with no hip stiffness. Limp was present in one case of PFLP. Knee stiffness was present in 3 cases of PFLP. Abductor lurch was seen in 1 case of PFLP. P value was 0.003 which was significant. In PFN group partial weight bearing was started earlier with 30 % of patients weight bearing by 2 weeks and 55 % by 4 weeks. Whereas none of the cases fixed by PFLP was bearing weight by 2 weeks. In PFLP group partial weight bearing was started if features of instability were not there at 6 weeks, 60 % started partial weight bearing by 6weeks. P value was 0.001 which was highly significant. Full weight bearing in PFN group was allowed with median duration of 14.85±1.04 weeks.20 % were bearing weight by 14 weeks. Full weight bearing could be started later in PFLP group .60% were bearing full weight by 18 weeks. P value was 0.001 which was highly significant. The time of union ranged from 14-21 weeks in both the groups. 95 % of PFN group showed union within 16 weeks and 20% of PFLP group showed union in 16 weeks. Union was achieved in all the patients with mean of 14.75±3.52 weeks in PFN group and17.70±2.00 weeks in PFLP group except one case in PFN which shows Z-effect at one month. P value was 0.002 which was highly significant.70 % of patients were walking with the help of walker and 30% with stick at 3 months of postoperative period .3 month mobility was almost equal in both the groups. P value was 0.417 which was non-significant. There was no significant difference between mobility after 3 month and 6 month in both PFN and PFLP groups.65 % patient were able to walk without aid after 6months from both groups. P value was 0.113 which was non-significant. In the present study, 77.50 % patients had good to excellent results with 20% having fair results and one case(2.50%) having poor result. In PFN group there were 15 excellent, 3 good and 1 fair result and 1 poor result case due to non-union, whereas in PFLP group 8 patients had excellent, 5 patients had good results and 7 patient showed fair result. P value is 0.023 which is significant.

4. Discussion

Unstable inter trochanteric fracture of femur have always been recognized as a major challenge by the orthopedics community not only for achieving fracture union, but also for restoration of optimal function in the shortest possible time and with minimal complications.

The present study was undertaken to compare proximal femoral nail (PFN) and proximal trochanteric contoured plate (PFLP) in the treatment of unstable intertrochanteric fractures femur in terms of blood loss during surgery (in milliliters), duration of surgery (in minutes), early mobilization, limb length shortening and number of post-operative complications in terms of wound infections, delayed union & nonunion, implant failures and medicalization. The mean age in most of the series is around 65 years and there are more number of females in most series than in our study. The mean age is around 58.58 years and there are more males in the study. This is due to the fact that only those patients were included in the study which were operated in the hospital and which are upto 2 weeks old. Male are more involved in outdoor activities in the Indian scenario and thus explaining the increased predisposition to fractures (table I).

Table 1: Comparison of different series for demographic data

Series/Study	No. of Males	No. of Females	Mean Age (Years)
Korkmaz MF *et al*. [29].	32	68	77.66
Preetesh Endigeri *et al*. [31].	32	18	57
Banan H *et al*. [21].	12	48	79
Current Study	34	6	60

During the course of our study it was observed that the more common cause of unstable intertrochanteric femur fracture was fall. 65 % of patient's sustained fracture due to fall and 35 % sustained fracture due to road side accidents. This is comparable to other studies (table II).

Table 2: Comparison of studies for mode of injury

Study	Mode of injury	
	Fall	Rsa
Shaik RB *et al*. [36].	66%	34%
Current Study	65%	35%

Fractures were classified in our study according to Boyd and Griffin classification which now is most commonly used classification. Most common type was the type 2 accounting for 57.50% of fractures followed by type 3 i.e. 40%, there was only one case of type 4 fracture i.e. 2.5% Fractures of both sides were seen in our study. On the right side in 45% of patients whereas left side was involved in 55% of cases (table III).

Table 3: Comparison of studies for side involvement

Study	Side involvement	
	Left	Right
Ravi GO *et al*. [35].	38%	62%
Shaik RB *et al*. [36].	75%	25%
Current Study	55%	45%

The duration of surgery was calculated from the time of incision to skin closure. Our study shows that the average duration of surgery for PFN is shorter than average time required for PFLP. The range of surgery time for PFN and PFLP group respectively is 50-70min and 60-90min which is highly significant. Mean duration of surgery in the patients of PFN group and the PFLP group were found to be 58.25±5.20 and 74.65± 10.12 minutes respectively which is highly significant. Duration of surgery was shorter in PFN group by a mean difference of 16.40±4.92 min; although the duration of implant fixation was almost similar in both the groups, time required for wound closer was significantly longer in PFLP group probably due to larger incision and extensive dissection as compared to the percutaneous technique of PFN. The short duration of surgery in PFN group is also documented in Anjum *et al*. conducted study of 26 cases operated with PFN in 2009. The operating time was found to be short, less blood loss was seen during surgery. Another study conducted by Al-Yassari G *et al* of a total of 76 patients treated with PFN concluded that the majority of the procedures were reported by the operating surgeon as "easy" or "usual" and with shorter duration of time [20]. Mean blood loss in our study in the PFLP group was 377.00±41.94 ml while the mean blood loss in PFN group was 107.00±9.79ml. The difference between the two group was statistically significant (p=0.0001). The available literature also shows that fixation with proximal femoral nail is associated with less blood loss compared to fixation with PFLP.PFLP requires a relatively larger exposure, more tissue trauma and anatomical reduction. It is obvious that fixation with proximal femoral nail is associated with less blood loss. This difference can be explained that fixation with PFN is a minimally invasive process and is associated with a smaller operative incision and is confirmed from study of ZhongguoGu Shang in 2008 comparing PFN and PFLP in which PFN group was of less operation time, blood loss and drainage [30]. Schipper IB *et al* study also showed that the intra-operative blood loss was lower with the PFN average of 220 ml with p value=0.001 which is significant [49]. In the study 95% patients were discharged within 15 days of surgery. 100% cases of PFN and 90% cases of PFLP were discharged within 15 days of surgery. PFN group patients were discharged earlier then PFLP group. 13.45 days was the mean duration of hospital stay in pflp group. Ravi GO *et al* in their study of proximal femoral locking compression plate in fixation of intertrochanteric fracture femur concluded that the average duration of stay in the hospital was 25.31 days [35]. In our study, superficial infection was seen in 2 cases of PFLP group, limp was observed in 1 case of PFLP and with one case with abductor lurch in PFLP group. Delayed union was seen in 2 cases of PFLP. 1 case of hip pain was observed in PFN with 1 case of non-union with Z effect at one month in PFN group. 3 cases of knee stiffness were observed in PFLP group. No shortening, screw cut out, shaft medialisation and varus collapse were seen in any case.Werner-Tutschku W *et al* in case series of pfn operated patients found that in 18 cases, the "Z-effect" seen in 5 cases (7,1%) and the "cut-out" of the sliding-hip-screw in 6 cases (8,6%) were the most frequent complications [22]. The obvious complications in this study included non-union in 7 (7.2%) fractures, implant breakage in 4 (4.1%) fractures, varus deformity in 34(35%) fractures, and loosening of the proximal femoral screw in 21 (21.6%) fractures. Six patients received reoperations. The total failure rate in the unstable intertrochanteric fractures was 50%. Inpatients greater than 60 years old in the unstable intertrochanteric fracture, the failure rate was 60.5%.In our study in PFN group partial weight bearing was started earlier with 30 % of patients weight bearing by 2 weeks and 55 % by 4 weeks (p value <0.001) whereas none of the case fixed by PFLP was bearing weight by 2 weeks. In PFLP group partial weight bearing was started if features of instability were not there at 5 weeks, 60 % started partial weight bearing by 6 weeks. So earlier mobilization can be achieved in PFN than in PFLP. Full weight bearing in our study in PFN group was allowed earlier as 20 % were bearing weight by 14 weeks. Full weight bearing was started later in PFLP group, 20 % were bearing full weight by 16 weeks and 40% were by 18 weeks. Full weight bearing was possible earlier than PFLP group in PFN group. The time of union ranged from 14-21 weeks in both the groups. 90 % of PFN group showed union within 16 weeks and 15% of PFLP group showed union in 16 weeks. Union was achieved in all the patients with mean of 14.75±3.52 weeks in PFN group except 1 case which goes into non-union due to Z effect and 17.70±2.00 weeks in PFLP group with p value 0.002 which is highly significant. In our study, 70 % of patients were walking with the help of walker at 3 months of post-operative period of which 75% were of PFN group and 65 % were of PFLP group. 3 month mobility

was better in PFN group than in PFLP group. There was no significant difference between mobility after 3 month and 6 month in both PFN and PFLP groups.65 % patient were able to walk without aid after 6months from both groups. Overall PFN group had little higher average Harris hip score than PFLP group. In PFN group 75% have excellent Harris hip scoring as compared to 40% in PFLP group. In the present study, 77.50% patients had well to excellent results with 20% having fair results and 2.5% having poor results. In PFN group there were 15 excellent, 3 good and 1 fair result and 1 poor result whereas in PFLP there were 8 excellent, 5 good and 7 patients showed fair result and no poor result(table IV).

Table 4: Comparison of Harris Hip Score among various series

Series/Study	Harris Hip Score							
	Excellent		Good		Fair		Poor	
	PFN	PFLP	PFN	PFLP	PFN	PFLP	PFN	PFLP
Xiong L *et al*. [34].	NA	96	NA	231	NA	42	NA	11
Current study	15	8	3	5	1	7	1	0

* NA=not available

4.1 Non union

All the fractures in the PFLP group had united by 6 months.

There was one case of PFN showing implant failure z effect and non-union and need revision surgery.

5. Conclusion

Harris hip score comparison of study suggests that functional results were better in PFN than PFLP. Less Blood loss, less operative time, early weight bearing were other favouring factors in PFN. Though blood loss and operative time was more, rigidity of fixation was better in unstable fractures in PFLP group. We conclude that PFN is the better implant for unstable intertrochanteric fractures with lesser operative time and lesser blood loss. While PFLP can be a good alternative for unstable intertrochanteric fractures with better results with slightly longer operative time and more blood loss when compared with PFN.

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