Original Article

Functional Outcome of Proximal Femoral Locking Compression Plate (PF-LCP) for the Treatment of Comminuted Subtrochanteric Femoral Fractures by Minimum Invasive Plate Osteosynthesis Technique

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Abstract

Background:
The incidence of proximal femoral fractures has increased significantly in recent years, and is expected to continue to rise with increasing life expectancy. Comminuted subtrochanteric fractures are difficult fractures associated with high incidence of complications. Traditional extramedullary implants are associated with higher rate of implant failure while intramedullary nails are technically demanding.

Objective:
This study was done to evaluate the functional outcome of proximal femoral locking compression plate for the treatment of comminuted subtrochanteric femoral fractures by MIPO technique.

Methods:
This descriptive observational study was conducted over a period of two year at Rangpur Medical College Hospital, Rangpur. There were 25 men and 5 women with a mean age of 41.35 years. Seinsheimer types III–V fractures were included in this study. Majority of cases belonged to Seinsheimer type IIIA (40.0%).

Results:
Harris Hip Score was used for clinical assessment, 22 patients had excellent outcome (73.3%), 5 patients had good (16.7%), with 3 fair (10%) and no poor result. So, satisfactory outcome was 91.50%.

Conclusion:
Fixation of comminuted subtrochanteric femoral fractures with PF-LCP by MIPO technique provided stable fixation with high union rate and fewer complications.

Keywords: Comminuted subtrochanteric fracture, Proximal femoral locking compression plate, Minimum invasive plate osteosynthesis

Introduction:

During the last decade, techniques for internal fixation shifted from direct reduction and rigid fixation to biologic internal fixation using indirect reduction techniques. Biologic internal fixation is characterized by the preservation of bone and soft tissue vascularity and relative rather than absolute mechanical stability.[1] The incidence of proximal femoral fractures has increased significantly in recent years, and is expected to continue to rise with increasing life expectancy. Projection studies estimate that in 2050 approximately 6.3 million people will sustained this type of fracture. Despite this frequency, the optimal method of management of these fractures remains a matter of debate. A number of issues concerning the best treatment options for each proximal femoral fracture type and optimal aftercare are still to be answered.[2]

These fractures account for 10% to 34% of all hip fractures. They have a bimodal age distribution and different mechanism of injury. Older patients typically sustain low-velocity trauma, where as in younger patients these fractures commonly result from high-energy trauma and often are associated with other fractures and injuries.[3] The management of these fractures is challenging for two reasons: (1) the inherent instability of the fracture pattern and (2) the forces of the muscles acting on the proximal and distal fragments. Often the medial calcar is comminuted, giving the fracture a tendency to collapse into varus. The powerful abductor and iliopsoas muscles insert on the proximal fragment and force it into abduction, flexion, and external rotation. This makes closed reduction of this fracture difficult and pushes the proximal fragment into a mal reduced position.[4] Although closed intramedullary nailing techniques have been successful in treating subtrochanteric femur fractures and have allowed for nail insertion via a small access incision, there are some disadvantages of this technique. Significant insertion site morbidity has been reported including trochanteric pain, abductor weakness, and heterotrophic bone formation.Furthermore, intramedullary fixation transiently ablates the endosteal blood supply is technically demanding with proximal fracture extension involving the nail insertion site, can lead to iatrogenic fracture or propagation of the fracture, and has a concerning risk of varus malunion, if not correctly addressed intraoperatively.[5] All intramedullary nails are thicker in their proximal end, and the greater trochanter insertion point must be reamed to 17 mm of diameter for the PFNA. The diameter of the PFNA helical blade is 11 mm. Therefore, reaming the medullary cavity and drilling a large hole in the lateral cortex in an unstable proximal femoral fracture with comminution of the greater trochanter and/or lateral cortex might cause the fracture to become even more unstable.[6] Over the last few years, there has been a shift in the principles of management of these fractures from rigid anatomic reduction to relative biological fixation which preserves the vascularity of bone fragments and enhances their callus-forming abilities. Screws are locked to the plate. So stability is maintaining at angular-stable screw plate interface & it is difficult for one screw to pull out or fail unless all adjacent screws fail.Biological fixation, in comparison to traditional open plating, has produced good results for these fractures.[7] Biological plating is the concept that is particularly useful in comminuted metaphyseal fractures that cannot be nailed. This technique described by Leunig M et al. uses “indirect reduction”, which minimizes direct exposure and muscle stripping, reducing the fracture by distraction using either a distractor, tension device, or lamina spreader. In 1997, Wenda and Krettek introduced a percutaneous plating technique called “minimally invasive plate osteosynthesis (MIPO)””. MIPO has gained popularity and has continued to evolve in the last decade.[8] Thus, the MIPO technique allows biological fracture healing by preserving the vascularity of all bone fragments, thus serving as a living bone graft. Therefore, primary bone graft is not necessary in severely comminuted fracture. So this is an important alternative to the standard methods of internal or external fixation in this fracture.[9]

Methods:

Between January 2018 to December 2019, 30 patients with clinical and radiological evidence of comminuted subtrochanteric fracture was admitted in Rangpur Medical college Hospital, Rangpur, were selected for this study.Cases were selected for study from emergency or OPD after x-ray examination, then admitted to hospital. After counselling for surgical technique then taking consent for thesis enrolment, preoperative data were collected. After discussing the technique with the surgical team, operations done methodically, per operative and postoperative data were recorded. Each patient was followed up for at least 24 weeks, clinical, radiological and functional scoring done and recorded for final outcome evaluation.

Proximal Femoral Locking Compression Plate:

The LCP Proximal Femoral Plate is a limited-contact stainless steel plate. The proximal portion of the plate is precontoured for the proximal femur. The two proximal screw holes are designed for 7.3 mm cannulated cancellous locking head screws and third locking hole is designed for 5.0 mm cannulated cortical locking screws (Figure-1 & 2). The remaining screw holes in the plate shaft are combi-holes.[9]

Biomechanically, the locked plate system is designed to convert the shear forces experienced at the implant with the application of load into compressive forces at the screw bone interface. This force conversion is beneficial in fracture

fixation because cortical bone is stronger against compressive loads than shear loads. Additionally, the angular stability of locked screws allows the applied load to be more evenly distributed amongst the component screws, avoiding significant load concentration at a single screw-bone interface. This leads to the overall fixation strength of the locked plate system, equaling the sum of fixation strengths of all screw-bone interfaces instead of that of a single component screw as in conventional plating[11].





Figure-1&2: Position of proximal and distal screws in A/P view.

Surgical Technique:
Surgery was performed with the patient supine on a fracture table. Length restoration and fracture reduction was done by indirect method. In cases where a closed reduction is successful and less-invasive plating technique feasible, the plate is slid distally in the submuscular plane by the use of a distal counter incision at the level of the tip of the plate. The most distal hole of the plate can be used to attach a suture that is pulled through the distal counter incision to facilitate the correct distal alignment of the plate to the bone, which must be visualized under C-arm. The plate can be held to the shaft by percutaneous K-wire. The plate was then distally fixed with at least 3 bicortical locking head screws. After proper haemostasis a drain was placed at appropriate site and wound was closed in layers with vicryl (Figure-3). The skin was closed with skin stapler.



Figure-3: Wound closure with drain tube

Postoperative period and follow-up: The drain was removed after 48 h. Patients were mobilised on the second postoperative day allowing only toe touch weight bearing. Partial weight bearing was allowed at 4 weeks and was gradually increased as tolerated. Patients were followed up at 4th weeks, 12th weeks, 24th weeks and evaluated with the Harris Hip Score.

Results:
Table-I showed the socio-demographic features of the patients. The youngest patient in our study was 18 years old and the oldest was 70 years. Majority were in 31-40 years and the mean age was 44.3 ±16.5 years. Like all trauma cases comminuted subtrochanteric fracture is more common in male (83.3%) due to more activities and traveling. The main occupation was service holder (40.0%) followed by business (16.7%), housewife (16.7%), student (16.7%) and farmer (10.0%).

Table-I: Socio-demographic characteristics of the participants (n=30)

Variable	Frequency	Percentage
Age group (Years)		
18-20	3	10
21-30	3	10
31-40	8	27
41-50	5	17
51-60	4	13
61-70	7	23
Mean ± SD	44.3 ±16.5	
Sex		
Male	25	83.3
Female	5	16.7
Occupation		
Service holder	12	(40.0%)
Business	5	(16.7%)
Housewife	5	(16.7%)
Student	5	(16.7%)
Farmer	3	(10.0%)

Out of 30 cases, 23 (76.7%) cases of injury were due to RTA followed by fall from height (13.3%) and fall on slippery ground (10.0%). Right and left limb was affected in 60.0% and 40.0% cases respectively. A majority of cases belonged to Seinsheimer type IIIA (40.0%) followed by type IIIB (30.0%), type IV (23.3%) and type V (6.7%). (Table-II)

Table-II: Distribution of patients according to etiology, site and classification of injury (n=30)

Variable	Frequency	Percentage
Cause of injury		
RTA	23	76.7
Fall on slippery ground	3	10.0
Fall from height	4	13.3
Affected side		
Right	18	60.0
Left	12	40.0
Seinsheimer's classification		
Seinsheimer's type IIIA	12	40.0
Seinsheimer's type IIIB	9	30.0
Seinsheimer's type IV	7	23.3
Seinsheimer's type V	2	6.7

Majority of the patients were operated within ten days of trauma. Average time interval between injury to surgery was 9.70±3.27 days, mean operative duration was 80.8±15.8 minutes, intra operative average blood loss about 302.8±60.1 ml. Eleven patient need per-operative blood transfusion and two patients need post operative blood transfusion. Intra-operative problems encountered with proximal screw insertion (36.7%), followed by plate position (20%). The precontoured nature of the PF-LCP avoids varus mal-reduction. The perfect fit of the implant to the proximal part of the femur with its tip flush with the tip of greater trochanter allows restoration of normal neck shaft angle relationship. We did not encounter any case of varus malalignment. In three patients 1 to 1.5 centimeter shortening was seen. No patient had significant rotational malalignment as determine by clinical examination. There were no cut-outs or pull-out of screws but only one had breakage of proximal screw. There were no re-operations, in any of the patients during the study. Mean duration of hospital stay 13.7±2.4 days (Table-III).

Table-III: Distribution of patients related to different parameters of operation (n=30)

Parameter	Frequency	Percentage
Time interval (Day)		
0-5	1	3.3
6-10	19	63.4
11-14	10	33.3
Mean± SD	9.7± 3.27	
Per-operative blood loss (ml)		
150- 200	1	3.3
201-250	5	16.7
251-300	13	43.3
301-350	5	16.7
351-400	4	13.3
401-450	2	6.7
Mean ± SD	302.8 ± 60.1	
Per- operative technical problem		
Reduction problem (malalignment)	5	16.7
Proximal screw insertion	11	36.7
Plate position difficulty	6	20.0
Broken hard wire(guide wire)	2	6.6
Operative procedure duration (mins)		
00- 60	7	23.3
61- 90	18	60.0
91-120	5	16.7
Mean ± SD	80.8 ± 15.8	
Postoperative complication		
Infection	1	3.3
Proximal screw breakage	1	3.3
Screw cutout	0	0.0
Implant failure	0	0.0
Post operative BT	2	07
Further operation	0	0.0
Limb shortening 1-2cm	3	10
Hospital stay (Days)		
5-10	2	6.7
11-15	22	73.3
16-20	6	20.0
Mean ± SD	13.7 ± 2.4	

Table-IV showed, 93.3% of fractures united within 24 weeks. Average fracture union time was 17.1 ±4.1 weeks. Harris Hip Score was used for final clinical assessment.[11] 73.3% of patients had Harris Hip Score 90-100, 16.7% had 80-89 and 10.0% had 70-79. Mean Harris Hip Score was 91.50 ± 7.79. So, satisfactory outcome was 91.50%.

Table-IV: Distribution of patients related to different parameters of treatment and functional outcome (n=30)

Treatment outcome	Frequency	Percentage
Status of fracture union at 24 weeks		
United	28	93.3
Un-united	2	6.7
Bony union time and rate		
12 – 18 weeks	25	83.3
19 – 24 weeks	3	10.0
25 – 30 weeks	2	6.7
Mean ± SD (weeks)	17.1 ± 4.1	
Functional outcome according to modified Harris Hip Score		
Harris Hip Score	Mean ± SD	
Pain	41.53 ± 4.29	
Limp	7.90 ± 1.67	
Support	11.00 ± 0.00	
Distance walk	9.10 ± 2.16	
Stairs	2.73 ± 1.11	
Socks/Shoes	4.00 ± 0.00	
Sitting	5.00 ± 0.00	
Public transport	1.00 ± 0.00	
Absence of Deformity	4.00 ± 0.00	
Range of motion scale	5.00 ± 0.00	
Total	91.50 ± 7.79	
Harris Hip Score (Functional outcome)	Frequency	Percentage
90-100 (Excellent)	22	73.3
80-89 (Good)	5	16.7
70-79 (Fair)	3	10.0
<70 (Poor)	0	0.0
Total	30	100

Discussion:

In this study as per Harris Hip Score 22 patients had excellent (73.3%), good 5 patients (16.7%), with 3 patients fair (10%) and no poor result (00%), which was similar to the outcome of the study of Siani et al, (2013) excellent (53.1%), good (40.6%), fair (6.25%), study of Celebi. L et al. 2006, excellent (69.9%), good (30.3%), study of Desouky et al. excellent (57%), good (33%), study of Kayali et al. excellent (80%), good (10%), poor (10%).[7,12] The treatment of the comminuted subtrochanteric fractures remains a challenge. The characteristic anatomy, the biomechanical stress and force acting at the subtrochanteric region make it difficult to manage.[13] The gama nail has a failure rate ranging from 12.7% to 15% in various study.[14] As for proximal femoral nail, Fogagnolo et al, found that the intra–operative technical or mechanical complication rate is as high as 23.4%.[15] Uzun et al. reported non union (5.7%), secondary varus displacement (25.7%), cut-out of the proximal screws (5.7%), reverse z- effect (14.3%), reoperation rate (14.3%).[16] Moreover intra- operative problems has also been reported for PFNA at a rate of 20%, femoral shaft fracture at a rate of 9.1% observed by Yaozeng et al.[17] Zha et al. found that the treatment of the subtrochanteric fractures with the PFLP could lower the rate of complications compared with the other treatment modalities. The overall complication rate for PFLP treatment was only 2.7%. Breakage of the implant as low as 1%, reoperation rate 1.9%. PFLP is more suitable for the anatomy of the proximal femur. Its locking screws could firmly joint the plate and proximal and parts of the femur as a whole. Compare to DHS and DCS, the pull-out strength of the locking screws is much higher than this of common screws, which reduces the incidence of screw migration and loosening. Moreover, the PFLP allows for use of multiple screws and the placement of this locking plate also does not require a large hole for the lag diameter screw, which reduces the amount of stress on the calcar aspect of a proximal femur fracture at the time of fixation.[18] Kinast, who compared the treatment options for subtrochanteric fractures with direct and in directed reduction, utilized condylar plate for both groups. In the direct reduction group 16.6% non union and 20.8% infection problems but fewer complications and better healing time was reported in the indirect reduction cases.[19] Comminuted subtrochanteric femoral fractures are considered as one of the most difficult fracture to treat for the Orthopaedic surgeons. It was found that indirect reduction and biological fixation

method with the dynamic condylar screw and plate is considered as a valuable cheap fixation method for the management of comminuted subtrochanteric fractures of femur especially in the young patient's populations.[20] No single treatment option has generally been accepted as the method of choice. There were high rates of delayed union, malunion, and implant failure. Classification of these fractures based on therapeutic criteria has undergone modifications through the years.[21] The precontoured nature of the PF-LCP avoids varus mal-reduction. The perfect fit of the implant to the proximal part of the femur with its tip flush with the tip of greater trochanter allows restoration of normal neck shaft angle relationship. We did not encounter any case of varus malalignment.Celebi et al. (2006) reported a 100% union rate with indirect reduction and plate fixation. They needed full-length incision in some of their cases but did not dissect the fracture site. The PF-LCP does not require reversal, can be slide easily through the sub muscular plane and provides stronger fixation through the three proximal screws. Further, the PF-LCP preserves more bone stock after implantation compared with the use of large proximal lag screws in the DCS or the blade portion of condylar blade plates.[22] Biomechanical analysis has shown the PF-LCP to be superior to the DCS, equivalent to an angled blade plate in terms of strength of the construct.[23]

Conclusion:

Our present study concludes, with proper patient selection, good instrumentation, image intensifier and surgical technique, proximal femoral locking compression plate is the implant of choice in the management of comminuted subtrochanteric fracture by MIPO technique. MIPO technique lessen the operative duration, the amount of blood loss, perioperative complication, has small skin incision, preserves the fracture biology and vascular supply of comminuted fragments, so it helps in rapid bone healing and early rehabilitation. Though the cases in the present study though were mostly young, but also a good number of cases (23%) above the age of 60 years, which also may have good results. So the proximal femoral locking plate is a good alternative and effective for the treatment of comminuted subtrochanteric femoral fractures by MIPO technique even in older age with osteoporotic bone.

Conflicts of Interest:

The authors have no conflicts of interest to declare.

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