Original article

Evaluation of outcome of proximal femur locking compression plate (PFLCP) in unstable proximal femur fractures

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ABSTRACT

Introduction: Petrochanteric fractures are most frequent fractures of the proximal femur, accounts for nearly 50% of all proximal femur fractures and are most devastating and also a major cause of disability in elderly. The aim and objective of this study was to evaluate the role of proximal femoral locking compression plate in unstable proximal femur fractures.

Material and method: A total of 20 cases were included in our study (M:F – 16:4), who suffered proximal femur fracture due to various modalities and all of them were operated using proximal femoral locking compression plate. This proximal femoral fractures included unstable – intertrochanteric with subtrochanteric extension and subtrochanteric with intertrochanteric extensions as well as one case with intertrochanteric, subtrochanteric and neck of femur fracture. Patients were followed up regularly and minimum follow-up period was 12 months. Patients were given physiotherapy and partial weight bearing was started after 6 weeks postoperatively or after union was achieved. The outcome was evaluated as per Harris Hip Score and radiological union.

Result: Among 20 cases with average age of 55.3 ± 17.9 years, treated with PF-LCP, the average time of union 18.75 ± 3.67 weeks was achieved. We got 10 excellent, 3 good, 3 fair and 4 poor result with average Harris Hip Score of 80.2 ± 28.54 with 65% good to excellent result with average Post-operative Neck Shaft Angle of 124.150 ± 17.880 and with 45% rate of complication which included four cases of superficial infection and two cases of deep infection and late complications like four cases of non-union, deformity – three cases of coxa vara and 2 cases of coxa valga, with patients having more than one complication in them.

Conclusion: PF-LCP is not recommended as a definitive implant but can be used as an alternative for the treatment of unstable proximal femoral fractures when there is no option available for other routinely used implants. Despite of its complications, PF-LCP is used where all implants fail.

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1. Introduction

Petrochanteric fractures are described as fractures occurring in the region extending from extracapsular basilar neck region and passing through or below the greater trochanter along the lesser trochanter.¹

These are the most frequent fractures of the proximal femur and account for approximately 50% of all fractures in this region. Petrochanteric fractures occur majorly in elderly patients with osteoporosis and are a result of low-energy trauma and cause severe disability in such patients.²

Hagino et al. reported that individuals above 50 years of age have a lifetime risk of hip fractures and the incidence is 5.6% for men and 20% for women.³ The incidence of per-trochanteric fractures is also increasing among younger population majorly due to high energy trauma with the increase in road traffic accidents (Figs. 1–3).

Complications secondary to these injuries produce significant morbidity and include infection, non-union, malunion, decubitus ulcers, fat emboli, deep venous thrombosis, pulmonary embolus, pneumonia, myocardial infarction, stroke, and death.

Petrochanteric fractures have always been known for their complexity and variety. The treatment has evolved and changed over a period of time, from conservative to operative, from extramedullary to intramedullary devices, from open reductions and fixations to newer minimally invasive techniques. It is well evident that new fixation devices are sought to improve the outcome of these injuries. No implant is universally fit for these

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Fig. 1. 26-Year-old male/Road Traffic Accident/Evans type R intertrochanteric four part segmented femur fracture with subtrochanteric extension. (a) Pre- and post-operative radiographs. (b) Radiographs at 13 months follow-up. (c) Range of movements at final follow-up.

fractures and the best method of surgical fixation is still debatable.⁴

The challenging goal in management of per-trochanteric fractures is to achieve anatomical reduction with a stable fracture fixation, with low morbidity and early mobilization.

The proximal femoral locking compression plate (PF-LCP) was introduced in the 21st century as a new implant that allows angular-stable plating for the treatment of complex comminuted intertrochanteric, subtrochanteric and osteoporotic stress fractures.⁵

Hence a thorough study is undertaken to assess the short-term functional outcome of complex proximal femur fractures managed by proximal femoral locking compression plate.

2. Materials and method

This is a prospective study aimed at evaluation of role of the PF-LCP in the treatment of intertrochanteric and/or subtrochanteric

Fig. 2. 61-Year-old male/Road Traffic Accident/Evans Type V – Five part Intertrochanteric with Subtrochanteric extension. (a) Pre- and post-operative radiographs. (b) Radiographs at 12 months follow-up. (c) Range of movements at final follow-up.

femur fractures or its combination. The minimum follow up period was 12 months.

All patients having radiological diagnosis as unstable intertrochanteric and/or subtrochanteric (per-trochanteric) femur fractures classified according to Evans Classification type III, IV, V and R and Seinsheimer classification III, IV and V were included in this study.

Patients were investigated for blood – chemistry, radiologically in form of roentgenograms (AP and lateral views of involved part plus routine trauma series of the X-rays) and CT scan whenever needed. Preoperative planning of fracture reduction and selection of an adequate implant length was performed with specific templates using tracing method. All patients were treated with proximal femoral locking compression plate (PF-LCP).

Under spinal or epidural anaesthesia, the patient was given supine position on the radiolucent fracture table with traction, allowing fluoroscopic imaging in both the planes. Depending upon the fracture pattern reduction was achieved with the help of close or open reduction techniques.

If closed fracture reduction was obtained before surgery under fluoroscopic view in antero-posterior (AP) and lateral views, definitive fixation was done with PF-LCP with Minimally Invasive Plate Osteosynthesis (MIPO). Lateral approach was used in all patients.

For more complex and comminuted fractures, open reduction was done using the plate as a reduction tool. In few cases, the

Fig. 3. 70-Year-old female/Fall at home/Evans Type V – four part intertrochanteric femur fracture. (a) Pre- and post-operative radiographs. (b) Radiographs at 16 months follow-up. (c) Range of movements at final follow-up.

proximal fragment was first fixed to the plate, and the plate was then reduced to the femoral shaft. This manoeuvre is possible due to the angular-stable interface between the plate and the locking head screws in the proximal fragment. To facilitate reduction, a strong K-wire or Schanz pin was temporarily fixed to the greater trochanter as a joystick to reduce the proximal segment.

Post-operatively, high sitting was done 36 h after anaesthesia with static quadriceps strengthening exercises in bed till that time. On second post-operative day, active knee range of movement exercise was done for all patients. After 3–4 days of surgery, patients were mobilized in a non-weight bearing manner with the help of a walker. Suture removal was done on the 12th post-operative day and then patients were discharged from the hospital. Partial weight bearing was started after 6 weeks and serial radiographic investigation was done there after every 4 weeks till radiographic signs of union were seen. In each follow up, patients were assessed clinically for hip/thigh pain and walking ability and radiographs were taken to assess union, neck-shaft angle, hip joint congruency and the implant status.

The functional and clinical outcome in terms of pain, ability to walk, walking distance, muscle power, range of movement of the affected hip, participation in daily routine activities, ability to squat and sit cross-legged were assessed using Harris Hip Score.

3. Result

Our study included patients of all age groups (range 23–85 years) with average age of 55.3 years. There was male predominance

Table 1

Age and sex incidence.

Age group in years	Number of patients		Total number of patients	Percentage
	Male	Female		
20–30	2	0	2	10%
31–40	2	1	3	15%
41–50	2	1	3	15%
51–60	3	0	3	15%
61–70	4	2	6	30%
71 and above	3	0	3	15%
Total	16	4	20	100%

in our study with M:F ratio 4:1 with 16 males and 4 females (Table 1).

The various fracture patterns were classified according to Evans and Seinsheimer's classification and all fractures were unstable. The most common type was Evans type V, having 14 cases (70%). Among the least common types included Evans type III, Evans type R and Seinsheimer type IIIB having one case (5%) (Table 2).

The maximum and minimum hospital stay of patients in the present study was 32 days and 7 days respectively (average stay – 18 days). The mean average operative time was 123.68 ± 19.28 min. The mean average blood loss in our study was 476.32 ml.

Most of the leg length discrepancies were in form of shortening, none of the patients had lengthening. The minimum shortening observed was of 0.5 cm and maximum shortening was of 5 cm. Out of 20 cases, 12 cases (60%) did not have any limb length discrepancy.

The mean average neck shaft angle of our study was $125.9^\circ \pm 16.4^\circ$. Among the 20 cases, we got 2 cases of coxa vara and 2 cases of coxa valga (Table 3).

The average union time was 18.75 ± 3.67 weeks (Table 4). There were 4 (20%) cases of non-union, out of which 1 case had coxa vara with non-union and 1 case had infected non-union (Table 3). One case of non-union and infected non-union resulted with implant failure. We got 4 (20%) cases of superficial infection which was taken care of with the help of higher antibiotics. There were 2 cases (10%) of deep infection which were managed by debridement. Overall rate of complication was observed to be 45%.

At final evaluation, we got 10 excellent, 3 good, 3 fair and 4 poor results with average Harris Hip Score of 80.2 ± 28.54 (Table 5).

Table 2

Distribution and evaluation of cases according to fracture classification.

Fracture classification	No. of fractures	Result in percentage	Result as per HHS
Evans type III	1	5%	E1, G0, F0, P0
Evans type R	1	5%	E1, G0, F0, P0
Evans type V	14	70%	E5, G2, F3, P4
Seinsheimer type IIIB	1	5%	E1, G0, F0, P0
Seinsheimer type V	3	15%	E2, G1, F0, P0
Total	20	100%	E10, G3, F3, P4

Table 3

Radiological union.

Time of union	Number of patients	Percentage
Up to 16 weeks	5	25%
17–20 weeks	8	40%
20–24 weeks	3	15%
Non-union	4	20%

Table 4

Post-operative complications.

Complications	Number of cases	Percentage
Superficial infection	4	20%
Deep infection	2	10%
Coxa vara	2	10%
Coxa valga	2	10%
Coxa vara with non-union	1	5%
Non-union	2	10%
Infected non-union (implant failure)	1	5%

Table 5

Final result according to Harris Hip Score.

Harris Hip Score	Result	Number of patients	Percentage
>90	Excellent	10	50%
80–89	Good	3	15%
70–79	Fair	3	15%
<69	Poor	4	20%

4. Discussion

Over the past few years, inter and sub-trochanteric fractures were predominantly treated by implants, such as dynamic hip screw, dynamic condylar screw, angular blade plates and cephalomedullary nails. Out of these fractures, 35–40% were unstable three and four part fractures with displacement of postero-medial cortex. The failure rates of these unstable fractures fixed with sliding hip screws averages approximately 6–32%.^{6–10} Intramedullary devices, such as the gamma nail (GN) and proximal femoral nail (PFN) have some theoretical advantage over the DHS. However, gamma nail (GN) has a failure rate ranging from 12.7% to 15% in various studies.^{11,12} As for PFN, Fogagnolo et al. found that the intraoperative technical or mechanical complication rate is as high as 23.4%.¹³

Many internal fixation devices have been used in treatment of per-trochanteric fractures because of high incidence of complications reported after surgical treatment with these implants. Lack of satisfactory implant in surgical treatment of per-trochanteric fractures has led to series of evolution in design of a perfect implant.

Stable fractures of the proximal femur can be easily treated with osteosynthesis with conventional implants with predictable results. However management of unstable fractures is a challenge for the surgeon because of difficulty in obtaining anatomical reduction. Traditionally, the medial and posteromedial fracture fragments have been considered to be important elements in determining the severity of the peritrochanteric hip fractures. However, the importance of the lateral trochanteric wall in stabilizing the peritrochanteric fractures has been recognized by several authors.^{14–19} Several plate designs have been developed over the last decades for the treatment of unstable fractures.¹⁸

The 4.5/5.0 mm proximal femoral locking compression plate (PF-LCP) is a limited-contact, angular, stable construct designed specifically for fractures in the proximal femoral region.¹⁹ Unlike conventional compression plate, the screw head 'locks' into the PF-LCP, thereby creating an angular, stable construct.²⁰ Thus, the PF-LCP does not fail at the screw bone interface, and provides strong anchor in osteoporotic bones.^{21,22} The multiple locking screw holes of the PF-LCP provide various options to tackle complex fracture patterns. The PF-LCP also functions as an internalized external fixator, and close plate-to-bone contact is not needed. This minimizes pressure on the periosteum enabling more biological healing.^{23,24}

Our major group of patients belonged to 61–70 years (30%) age group with mean average age 55.3 ± 17.9 years ranging from 23–85

years. This is in contrast to higher age groups as reported by western literatures. However, our study results are comparable with other Indian studies such as that of Madu et al.²⁵ and Chalise et al.²⁶

There was male predominance in our study with M:F ratio 4:1. There were 16 males and 4 females in our study. Males were found to be working outdoor, involved in manual labour, farming, working at heights, driving etc. making them more susceptible to injury. This is in contrast to female preponderance as observed by various other western authors^{27,28} as the Indian males are more active and mobile than females.

In our study of 20 cases, simple fall was the most common mode of injury with 10 patients (50%), which is in contrast to other studies having road traffic accidents to be more common mode of injury. Simple fall included fall in bathroom and fall from bed. Osteoporosis is the main cause of the fractures due to simple fall, which usually occurs in elderly people. Second most common mode of injury was road traffic accident with 8 patients (40%). The least common mode of injury was fall from height with 2 patients (10%). However, most of the fractures that occurred in patients younger than 61 years were either due to road traffic accidents or fall from height.

The maximum and minimum hospital stay of patients in the present study was 32 days and 7 days respectively. The average stay was 18 days which is almost similar to the Gunadham et al.²⁹ series.

PFLCP using MIPO technique has high rate of fracture healing with the advantage of biological fixation, simple and reliable fixation methods, strong anti-rotation effect, less surgical trauma, no stripping of periosteum and limited occurrence of complications. So it can be a feasible alternative to the treatment of peritrochanteric femoral fractures.²⁶

Operative procedure for open reduction internal fixation of proximal femur with proximal femoral locking compression plate usually leads to more blood loss. The mean average blood loss in our study was 476.32 ml which is lower than Gunadham et al.²⁹ series but quite higher than Madu et al.²⁵ and Nishikant Kumar et al.³⁰

The neck shaft angle was calculated radiographically after the fracture was united. The mean average neck shaft angle in our study was 124.15° . Out of 20 cases, 2 patients (10%) had coxa vara, 1 patient (5%) had coxa vara with non-union. Varus collapse was much higher in number in our study as compared to Gunadham et al.²⁹ and Madu et al.²⁵ series. All 3 cases where coxa vara had occurred, the positioning of implants could not be done properly. So it is of the utmost important whenever this implant is used to be more careful in placement of plate as well as to achieve 100% anatomical reduction.

There were 4 (20%) cases of non-union in our study out of 20 cases. The average union time was 18.75 weeks. Bone grafting was used in 4 cases (20%). We achieved union in 16 cases (80%) out of 20 cases which is similar to Nishikant Kumar et al.³⁰ series with 80% union and 13.5 weeks of average union time which was less compared to our study.

Most of the leg length discrepancies were in form of shortening, none of the patients had lengthening. The minimum shortening observed was from 0.5 cm and maximum shortening was of 5 cm. Out of 20 cases, 12 cases (60%) did not have any limb length discrepancy.

At final follow-up, two cases (10%) had failure of implant. Both the patients were advised for implant removal and hemiarthroplasty, but only one patient agreed for implant removal and refused further management.

Overall rate of complication was observed to be 40% which is more as compared to Gunadham et al.²⁹ series having 23.1% rate of complication with 2 broken plates, 2 varus collapse, and 1 non-union and 1 broken screw. Sun-Jun Hu et al.³¹ in their series also

had fewer complications with 2 implant failures, 2 superficial infections and 1 deep infection which were cured after oral antibiotics. Mohsen Mardani-Kivi et al.³² in their series got similar rate of complication to our series, having 10 cases of implant failures, 6 cases of limb shortening and 1 case of deep infection.

There were only 2 cases that showed cut out of the femoral head screw which is the most frequently reported complication in traditional implants leading to implant failure, the reason possibly being that PFLCP has mechanical advantage of three-dimensional and angular stable fixation even in unstable fractures and fractures associated with osteoporotic bone.³³

The functional status and overall result was obtained using Harris Hip Score. The mean average of Harris Hip Score in our study was 80.2 with 10 excellent (50%), 3 good (15%), 3 fair (15%) and 4 poor (20%) results. We achieved slightly lower result as compared to that of Sun-Jun Hu et al.³¹ series 86.5 ± 9.8 with 16 excellent, 22 good, 5 fair and 2 poor, Madu et al.²⁵ series having 86.25 with one excellent (12.5%), six good (75%) and one fair (12.5%) with no poor result and slightly better result than Lee et al.³⁴ series having Harris Hip Score of 76.46 ± 16.03.

Our study has one limitation; it is a case series and not a comparison between two surgical techniques in a randomized fashion. But the data analyzed here pertains to a specific type of injury; all the fractures were unstable proximal femoral fractures.

5. Conclusion

It is the impression from our study that despite of 3 different directions of proximal locking screws, PFLCP does not provide a rigid fixation, which ultimately increases the chances of developing coxa vara and implant failure.

So we feel that this implant is good for achieving and catching the reduced bone in anatomical position but it is not as rigid as other extramedullary implants.

Considering the time during surgery while fixing the plate and blood loss, which will be definitely more than other extramedullary device, this plate is to be given choice for fixation when there is no possibility of fixation of the fracture with other implants. So it is our impression that this implant is to be kept as adjuvant to other implants when fixation is not possible with other extramedullary implant and with the consideration that patient may not be able to walk without support before 4 months or before radiological union.

Conflicts of interest

The authors have none to declare.

References

- Penn G. Skillern: pertrochanteric fracture of the femur. *Ann Surg.* 1921;73(2): 227–228.
- Zuckerman JD. Hip fractures. *N Engl J Med.* 1996;334:1519.
- Hagino H, Furukawa K, Fujiwara S, et al. Recent trends in the incidence and lifetime risk of hip fracture in Tottori, Japan. *Osteoporosis Int.* 2009;20(4):543–548.
- Ricci WM. New implants for the treatment of intertrochanteric femur fractures. *Tech Orthop.* 2004;19:143–152.
- Sommer CH, Wullschlegler M, Walliser M, et al. An experience with locking compression plate in fracture treatment of osteoporotic bones. *Br J Surg.* 2004; 91(7):912.
- Kyle RF, Gustillo RB, Premer RF. Analysis of six hundred and twenty two intertrochanteric hip fractures. *J Bone Jt Surg.* 1979;216.
- Mariani E, Rand JA. Nonunion of intertrochanteric fractures of the femur following open reduction and internal fixation. *Clin Orthop Relat Res.* 1987;218:81.
- Haentjens P, Casteleyn PP, De Boeck H, et al. Treatment of unstable intertrochanteric and subtrochanteric fractures in elderly patients. *J Bone Joint Surg Am.* 1989; 71(8):1214–1225.
- Gundel R, Gargan MF, Simpson HRW. How to minimize failure of fixation of unstable intertrochanteric fractures. *Injury.* 1995;26:611–614.
- Simpson AHRW, Varty K, Dodd CA. Sliding hip screws: modes of failure CAF. *Injury.* 1989;20:227–231.
- Saarenpää I, Heikkinen T, Ristiniemi J. Functional comparison of the dynamic hip screw and the gamma locking nail in trochanteric hip fractures: a matched pair study of 268 patients. *Int'l Orthop.* 2009;33:255–260.
- Sehat K, Baker RP, Pattison G, et al. The use of the long gamma nail in proximal femoral fractures. *Injury.* 2005;36:1350–1354.
- Fogagnolo F, Kfuri Jr M, Paccola CAJ. Intramedullary fixation of pertrochanteric hip fractures with the short AO-ASIF proximal femoral nail. *Arch Orthop Trauma Surg.* 2004;124(1):31–37.
- Gotfried Y. The lateral trochanteric wall: a key element in the reconstruction of unstable pertrochanteric hip fractures. *Clin Orthop Relat Res.* 2004;425:82–86.
- Palm H, Jacobsen S, Sonne-Holm S, et al. Hip fracture. *J Bone Jt Surg Am.* 2007; 89:470–475.
- Gotfried Y. Percutaneous compression plating of intertrochanteric hip fractures. *J Orthop Trauma.* 2000;14:490–495.
- Gotfried Y. Integrity of the lateral femoral wall in intertrochanteric hip fractures: an important predictor of a reoperation. *J Bone Jt Surg Am.* 2007;89:2552–2553.
- Medoff RM. A new device for the fixation of unstable pertrochanteric fractures of the hip. *J Bone Jt Surg Am.* 1991;73(8):1192–1199.
- Müller ME, Allgower M, Schneider R, et al. *Technique of Internal Fixation of Fractures.* Berlin: Springer-verlag; 1991.
- Wagner M. General principles for the clinical use of the LCP. *Injury.* 2003;34:31–42.
- Freeman AL, Tornetta P, Schmidt A, et al. How much do locked screws add to the fixation of “hybrid” plate constructs in osteoporotic bone? *J Orthop Trauma.* 2010;24:163–169.
- Grawe B, Le T, Williamson S, et al. Fracture fixation with two locking screws versus three nonlocking screws: a biomechanical comparison in a normal and an osteoporotic bone model. *Bone Jt Res.* 2012;1:118–124.
- Gardner MJ, Helfet DL, Lorch DG. Has locked plating completely replaced conventional plating? *Am J Orthop.* 2004;33:439–446.
- Fulkerson E, Egol KA, Kubiak EN, et al. Fixation of diaphyseal fractures with a segmental defect: a biomechanical comparison of locked and conventional plating techniques. *J Trauma.* 2006;60:830–835.
- Neelakrishna R, Sridhar M. Study of various modalities of surgical management of unstable intertrochanteric fractures. *Int J Sci Res.* 2014;2:10.
- Chalise PK, Mishra AK, Shah SB, et al. *Nepal Med Coll J.* 2012;14(4):324–327.
- Dousa P, Bartonicek J, Jehlicka D, et al. Osteosynthesis of trochanteric fractures using PFN. *Acta Chir Orthop Traumatol Cech.* 2002;69(1):22–30.
- Pajarinen J, Lindahl J, Savolainen V, et al. Femoral shaft medialisation and neck-shaft angle in unstable pertrochanteric femoral fractures. *Int Orthop.* 2004;28: 347–353.
- Gunadham U, Jampa J, Suntornsup S, et al. The outcome in early cases of treatment of subtrochanteric fractures with proximal femur locking compression plate. *Malay Orthop J.* 2014;8(2):22–28.
- Kumar N, Kataria H, Yadav C, et al. 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):137–145.
- Hu S-J, Zhang S-M, Yu G-R. Treatment of femoral subtrochanteric fractures with proximal lateral femur locking plates. *Acta Orthop Bras.* 2012;20(6):329–333.
- Mardani-Kivi M, Mirbolook A, Jahromi SK, Rouhi Rad M. Fixation of intertrochanteric fractures. *Trauma Mon.* 2013;18(September):67–70.
- Zha GC. Treatment of pertrochanteric fractures with proximal femur locking compression plate. *Injury.* 2011;42:1294–1299.
- Wei Ting L, Diarmuid M, Fareed HYK, et al. Proximal femoral locking compression plate for proximal femoral fractures. *J Orthop Surg.* 2014;22(3):287–293.