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Original Article

Proximal Femoral Locking Compression Plating in Trochanteric and Subtrochanteric Fractures of Femur

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Abstract

Background: Intertrochanteric and subtrochanteric fractures are very common and difficult to treat specially the unstable types. Controversies still exist regarding the choice of implant for the fixation of these fractures. For the last 15 to 20 years different modifications of both the extramedullary and intramedullary devises have been done.

Objectives: Evaluation of results of intertrochanteric and subtrochanteric fractures fixed with proximal femoral locking compression plate.

Materials and Methods: In our study forty cases (26 males and 14 females) of intertrochanteric and subtrochanteric fractures were managed with proximal femoral locking compression plate. Among the forty patients 32 had intertrochanteric and eight had subtrochanteric fractures.

Results: Average time of union was 14.9 weeks (range 12-24 weeks); in 87.5% cases union occurred in12-16 weeks. Final results analyzed based on Modified Schantzker-Lambert score out of 40 cases, excellent to good results were found in 35 cases (87.5%) [excellent 57.5%, good 30%]. fair results were in 12.5%.

Conclusion: In view of the above observations, the proximal femoral locking compression plating may be suggested as one of the options for the treatment of intertrochanteric and subtrochanteric fractures of femur, specially the unstable type of fractures.

Key words: Intertrochanteric fracture, Proximal femoral locking plate, Subtrochanteric fracture

INTRODUCTION

Hip fractures are a leading cause of death and disability in the elderly. Epidemiological studies have suggested that the incidence of fractures of proximal femur is increasing, not unexpectedly, since the general life expectancy of the population has increased significantly during the past few decades. These fractures are associated with substantial morbidity and mortality; approximately 15–20% of patients die within 1 year of fracture.[1]

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Fractures of the proximal femur are relatively common injuries in adults, especially in the elderly. Approximately 50% of proximal femoral fractures are intertrochanteric fractures, a large percentage of which are unstable[2,3] and 5–11% are subtrochanteric fractures; they constitute about 73.3% and 26.7% of extracapsular proximal femur fracture, respectively.[4]

Intertrochanteric fractures of the femur readily unite no matter what treatment is used because most of it is the cancellous bone, have a good blood supply and covered by muscles. These fractures usually unite and satisfactory results obtained if reduction and fixation are adequate, otherwise complications are frequent especially in unstable type of fractures. If non-union occurs, it is always due to interposition of soft tissues. On the other hand, subtrochanteric fractures have long been recognized as the most difficult to treat[4] and remain technically challenging,

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even to experienced fracture surgeons till date. These fractures are associated with high rates of nonunion and implant failure because of the cortical bone and high stresses in this region.[5]

Stable trochanteric femur fractures can be treated successfully with conventional implants. However, comminuted and unstable inter- or subtrochanteric fractures and fractures with extension into the pyriform fossa are challenging injuries that are prone to complications.[6-8] Despite improved techniques and devices, failure of fixation is still a problem with unstable intertrochanteric and subtrochanteric fractures. A high incidence of secondary implant failure ranging between 3% and 17% has been reported.[9-14] The complication rate for unstable fractures treated with a dynamic hip screw, dynamic condylar screw plate or intramedullary nails has shown to be as high as 3–15%.[9-14] Ongoing efforts to find an acceptable implant have resulted in a wide variety of implants having some advantages and disadvantages. Many new devices, both extramedullary and intramedullary, had been introduced but still there is lack of a single implant of universal acceptance which can be used with confidence and full reliability.

In recent years, the minimally invasive surgical techniques have led to a wide spread use of many new implants which can reduce operative complications and post-operative morbidity.[9,15,16,17] The locking compression plates were introduced in the 21st century as a solution that allows angular-stable plating for the treatment of complex comminuted and osteoporotic fractures.[18-22] Despite promising results with the use of the locking compression plate for complex fractures in different anatomic regions, until recently locked plating had not been applied to treatment of unstable proximal femur fractures.

Extensive biomechanical studies have shown inferior stiffness and lower load to failure for extramedullary devices compared to intramedullary devices.[23] However, technical difficulties are common with the cephalomedullary nail because of the flexion, abduction, and external rotation of the proximal fragment in subtrochanteric fractures and comminution of the entry point in unstable trochanteric fractures. Traditional blade plate fixation is a suitable option for the subtrochanteric femur fracture. However, this technique demands expertise and allows a narrow margin of error, requiring precise plate placement in all planes.[24,25] Moreover, chances of failure are higher with extramedullary devices (sliding hip screw) especially in unstable, comminuted osteoporotic peri-trochanteric fracture.[26-29] To combat the technical difficulties of the nail and promising results with the use of the locking compression plate for complex fractures in different anatomic regions, recently locked plates are being used to treat extracapsular proximal femur (peri-trochanteric) fractures. The development of the LCP introduced a new treatment option for unstable and highly comminuted fractures and for periprosthetic fractures.[18,30-41]

MATERIALS AND METHODS

We have conducted a longitudinal observational study comprising 40 patients of 20 years and above from 2011 to 2015, all having closed intertrochanteric and subtrochanteric fractures, who were treated by internal fixation with proximal femoral locking plates. Patients who were having pathological fractures, open fractures, polytrauma, neglected fractures of more than 4 weeks old, fractures with neurovascular compromise, and unfit for anesthesia were excluded from our study.

Protocol

Patients were evaluated regarding preinjury mobility status on the basis of their ability to walk within their place of residence, their ability to walk outside, and their ability to go shopping and each activity was assigned a score on the basis of its level of difficulty. History of any other comorbid disease was obtained.

Each patient was thoroughly evaluated to rule out any associated intra-abdominal, intra-thoracic, head and neck injuries, and to rule out other associated osteoporosis related fractures such as a distal radius or proximal humeral fracture. The affected limb was thoroughly examined to rule out vascular or neurological insufficiency. The ipsilateral knee was examined for associated injury. Anteroposterior radiograph of pelvis showing both hips and lateral view of involved proximal femur obtained, though it was not always possible to take true lateral view preoperatively.

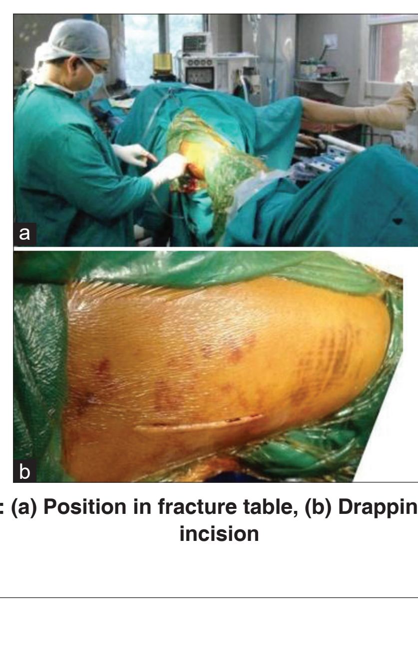


Figure 1: (a) Position in fracture table, (b) Drapping and skin incision

Figure 2: (a) Exposure and plate placement, (b) Provisional fixation with k-wires, (c) Closure

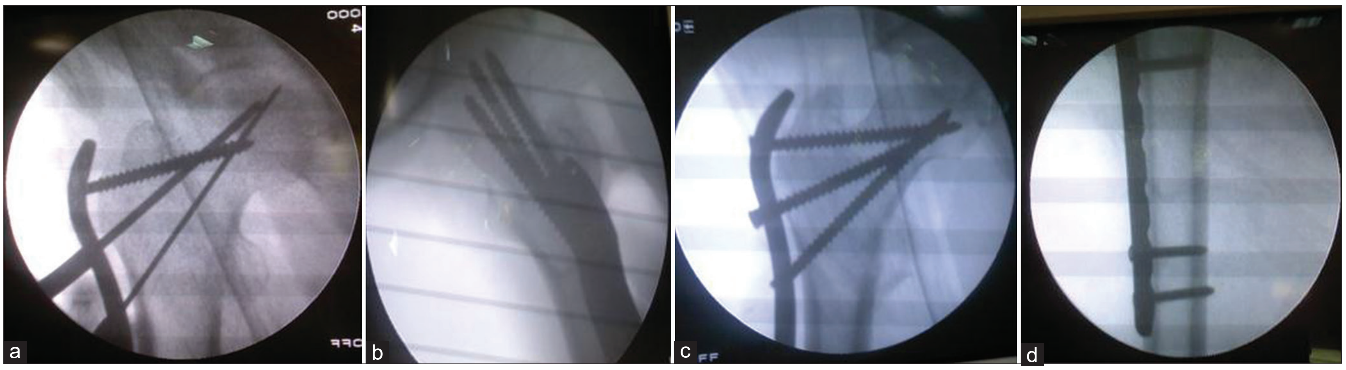


Figure 3: (a-d) Intraoperative C-arm picture AP and lateral view

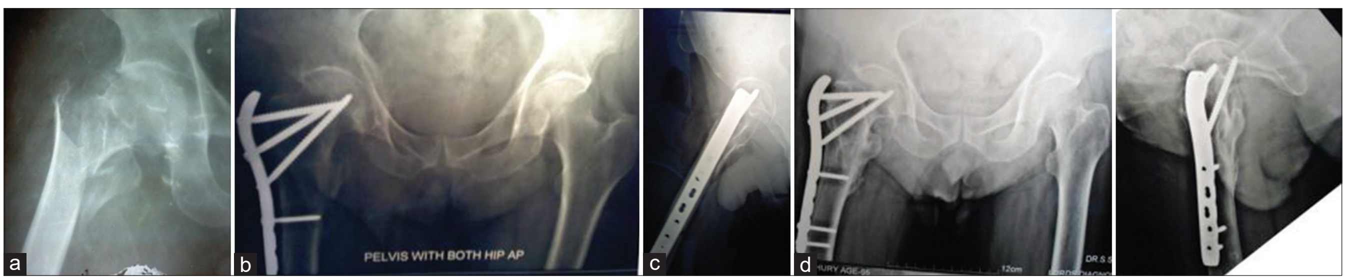


Figure 4: (a) Case 1 Pre-operative X-rayfig, (b) Immediate post-operative AP view, (c) Immediate post-operative lat view, (d) 3 months post-operative AP and lat view

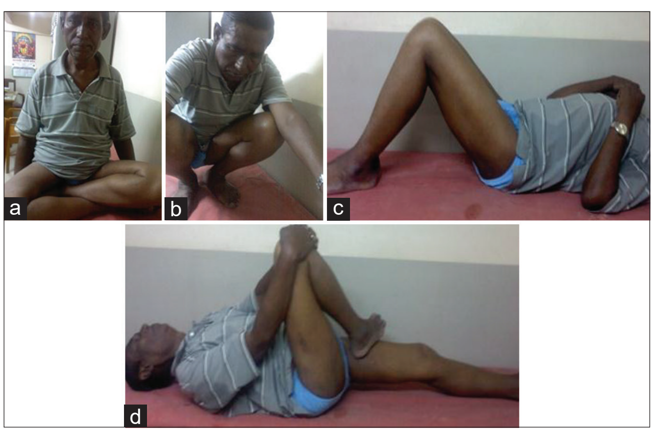


Figure 5: (a-d) Case 1 Clinical outcome at 3 months, (a) Cross legged sitting, (b) Squattingfig, (c) Hip knee flexon showing no shortening (d) Hip flexon

Surgical Technique

In cases, where a closed reduction was successful and MIPO technique feasible, the proximal part of the femur was exposed through the conventional lateral approach

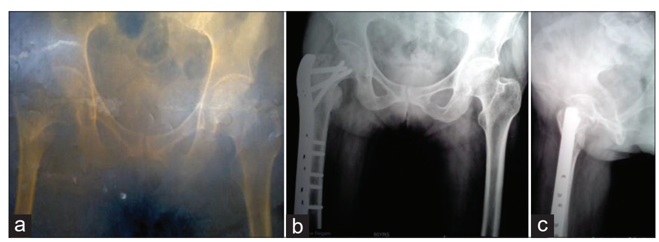


Figure 6: (a) Case 2 Pre-operative, (b) Case 2 Post-operative AP viewfig (c) Case 2 Post-operative lat view

[Figure 1a and b]. Perfect placement of the plate was ensured (special care was taken to avoid any off ending of the plate) in both the anteroposterior and lateral views. The plate was temporarily held in this position with K-wires, one in proximal and one in the distal small "K-wire holes" [Figure 2a-c]. After ensuring perfect anatomic placement of the plate, three 2.5-mm drill tip guidewires were inserted through locking sleeves within the three proximal holes at predetermined angles of 95°, 120°, and 135°, respectively,

Figure 7: (a-d) Case 2 Clinical outcome at 3 months, (b) Hip flexon, (c) Squatting, (d) Standing

up to the subchondral bone, drilled appropriately, and followed by introduction of proximal locking head screws of appropriate length. Correct alignment of the plate with the femur, correct placement of drill bits, and screws were checked at all the steps. The plate was then distally fixed with an additional 3–4 bicortical locking screws (5 mm). All the K-wires were removed [Figure 3a-d].

For subtrochanteric fractures, where most difficulties are encountered to achieve and maintain the reduction, the plate was be used as a reduction device, by first fixing the proximal part of the plate to the proximal fragment, and then reducing the distal fragment to the plate. This manoeuver was possible due to the angle stabilized interface between the plate and the locking head screws in the proximal fragment.

The convergence of the three locking head screws in the AP plane and the divergence in the lateral plane allows an angular stable buttress that increases the stability of fracture fixation [Figure 3a-d].

In case of failed close reduction especially in unstable intertrochanteric and subtrochanteric fractures, open reduction of the same was done and supplementary iliac crest bone grafting done when there was bone loss. In metaphyseal comminution, at least 3–4 holes of the plate were left empty at the level of the fracture. This allows for a larger working length of the plate and larger area of stress distribution on the plate and simultaneously reducing the strain at the fracture.

Assessment

Pre-operative patient's demographic profile, pre-injury mobility, fracture pattern, bone quality and medical profile, and delay in operation were recorded. Intra-operative data such as type of reduction, quality of reduction, any difficulties or complication, blood loss, and time of operation were recorded. Post-operative medical complication, blood collection in drain, need for blood transfusion, infection, and post-operative hospital stay were recorded.

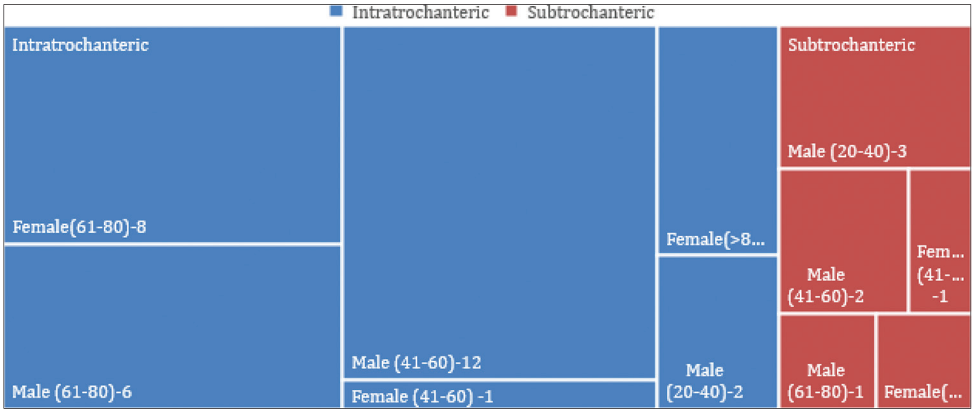
After discharge patients were assessed clinicoradiologically at 6th and 12th weeks, followed by monthly assessment till union of fracture. Then, they were asked to report every 3 months. In every follow-up visit patient was assessed for hip/thigh pain, walking ability, abnormal gait/limp (abductor lurch, and short limb gait), limb length discrepancy (shortening), any deformity, range of movement at hip and knee joint, and muscle strength. Radiographs were taken to assess union and residual angulation at fracture, change of neck shaft angle difference in respect to the normal side, hip joint congruency, and any evidence of implant failure [Figures 4-7].

Fracture union was defined as that period between injury and full weight bearing with a roentgenographical evidence of healing of fracture (characterized by ¾ cortical bridging and fading of fracture lines on two views) and absence of pain. Delayed union was considered present if roentgenographs did not demonstrate fracture consolidation by 9 months. Malunion was defined as limb shortening or lengthening greater than 1 cm, 10° angulation in any plane or rotational malignment greater than 15° and neck shaft angle difference of more than 5 degree.

RESULTS AND ANALYSIS

In our study, 53.13% of intertrochanteric fractures were in the age group of >60 years and 46.87% were < 60 years age. Average age was 66.41 years and male:female was (1.7:1).

Table: 1 Age and sex distribution



However, the ratio was (M: F= 1:1.84) in more than 60 years age group.

In our study, 75% of subtrochanteric fractures were in the age group of 60 years or less and average age was 49.89 years and male:female = 3:1. Taking both the intertrochanteric and subtrochanteric fractures together average age were 63.1 years (range 26–86 years) and male:female was 1.86:1. [Table 1].

In our study, 80% of the extracapsular proximal femoral fractures were intertrochanteric and 20% were subtrochanteric variety.

Average perioperative blood loss was 171.56 ml and 213.75 ml in intertrochanteric fractures and subtrochanteric fractures, respectively.

Average follow-up period was 10.78 months (minimum 6 months, and maximum 18 months). There was no loss of follow-up within 6th post-operative months, but seven cases (3 deaths, and 4 loss of f/u) were lost to follow-up after their 6th post-operative months.

Average time of union was 14.9 weeks and majority of the cases (87.5%) union occurred in 12–16 weeks. In intertrochanteric fractures, average tine of union was 14.4 weeks. In subtrochanteric fractures, average tine of union was 16.5 weeks [Table 2].

Significant shortening of more than 1 cm occurred in two (5%) cases.

Average neck shaft angle in the injured hip [in final X-ray of pelvis (AP)] was 131.2° [range 127°–137°].

Average neck shaft angle difference was (−1.25°). Excluding the two 10° varus malreduction, the neck shaft angle differences were in the range (−4°) to (+3°). There was no change of the neck shaft angle difference when the final X-rays were compared with the patients' immediate post-operative X-rays [Table 3].

Table 2: Time taken for union of fracture

Time taken for union of fracture	Intertrochanteric	Subtrochanteric	*P* value
≤16 weeks	13	4	
More than 16 weeks	19	4	
Total	32	8	

Table 3: Varus/valgus malreduction

Difference of neck shaft angle from opposite side	No.	Percentage
No change	7	17.5
0–5° varus	23	57.5
0–5° valgus	8	20
More than 5° varus or valgus angulation	2	5
Total	40	100

Table 4: Results of inter and subtrochanteric fractures

Inter trochanteric fractures			Sub trochanteric fractures		
Results	No.	Percentage	Results	No.	Percentage
Excellent	19	59.38	Excellent	4	50
Good	8	25	Good	4	50
Fair	5	15.62	Fair	0	0
Poor	0	0	Poor	0	0

Table 5: Overall results of extracapsular proximal femur fractures

Results	No.	Percentage
Excellent	23	57.5
Good	12	30
Fair	5	12.5
Poor	0	0
Total	40	100

All fractures united, though there were malunion in four cases (two cases of Varus and two cases of shortening >1 cm.)

In our study, excellent and good results were obtained in 87.5% of the cases [Tables 4 and 5].

DISCUSSION

The sliding hip screw is a tried and tested device for fixation of stable intertrochanteric fractures with excellent results reported.[42] However, the complication rate for unstable fractures treated with a dynamic hip screw or dynamic condylar screw plate has shown to be as high as 3–15%. Primary or secondary varus collapse and hardware failure by "cut-out" of the femoral head screw are the most frequently reported complications.[9,11,43] Jacobs *et al*.[26] have reported an average sliding of 5.3 mm in stable fractures and 15.7 mm in unstable fractures. Steinberg *et al*.[27] have reported an average sliding of 9.3 mm in his study and sliding more than 15 mm is associated with higher rate of fixation failure. Parkar *et al*.[28] have reported that medialization of the femoral shaft of greater than 1/3rd diameter of the femur is associated with 7 times increase in fixation failure.

The common causes of fixation failure are instability of the fractures, osteoporosis, lack of anatomical reduction, failure of the fixation device, and incorrect placement of the lag screw in femoral head.[44-47]

For example, when a fracture extends to the piriformis fossa or greater trochanter, intramedullary nails are unsuitable because it is difficult to achieve stable fixation of the proximal bony fragment. The surgical technique with the nails has been known to be demanding particularly for the less experienced surgeons with high intra-operative and post-operative complications.[48,49]

The development of the LCP introduced a new treatment option for unstable and highly comminuted fractures and for periprosthetic fractures.[18-22,30,31]

The PFLCP system is an extramedullary internal fixator which combines the advantages of both interlocked intramedullary nailing techniques and the early advances of the so-called biological plating technique into one system. Biomechanics are inherently different from conventional plating techniques since it does not rely on friction at the bone-plate interface for compression of the plate to bones unlike conventional plates and hence periosteal blood is not compressed and vascularity of the fracture is maintained. It acts as a stable fixed angle plate. Moreover, by supporting the lateral trochanteric wall especially in unstable trochanteric fracture it prevents significant fixation failure (22% fixation failure reported by Henrik *et al*.[29]). The PFLCP does not allow collapse at the fracture site (excessive collapse is a major cause of fixation failure in SHS) thus minimize the risk of implant failure.

The plate is anatomically precontoured to lateral wall of proximal femur. The contour of proximal femur in Indian population especially female patients was found to mismatch with that of the plate. In such cases, when the tip of the plate was flushed with the tip of greater trochanter, guidewire through 120° hole of the plate passed below the neck or along the inferior border of neck of the femur. In an attempt to put all the three head screws perfectly through neck into the head of femur, in some cases, especially in four-part intertrochanteric fractures having greater trochanteric fragment, the tip of the plate was shown to be higher up than the tip of the greater trochanter.

Hip and knee physiotherapy in bed started within 2–5 days toe-touch partial weight bearing with the help of a pair of axillary crutches or walker was started as per pain tolerance usually 2 weeks onward. Unsupported full weight bearing was allowed after clinic-radiological evidence of healing/union and absence of pain.

In our study, all fractures were united with an average duration of 14.9 weeks (range 12–24 weeks), majority of the cases (87.5%) union occurred in 12–16 weeks. In the Sodowski series[11] union occurred within 16 weeks in 36.84% and 60% cases, within 16–24 weeks in 15.78% and 25% cases, within 24–36 weeks in 10.52% and 10% cases, and nonunion in 36.84% and 5% cases of intertrochanteric and reverse oblique fractures treated with sliding hip screw and proximal femoral nail, respectively. There was no case of back out and breakage of head screw, head screw cut-out, hip joint penetration of screw, plate breakage, or shaft –screw back out/breakage. In the study of Boldin *et al*.[49] "Z" effect in PFN group and head screw cut out in DHS group were 5.45% and 3.63%, respectively. In our study, 57.5% excellent, 30% good, and 12.5% fair functional results were obtained based on Modified Schantzker-Lambert score. Overall, excellent and good results were obtained in 87.5% of the cases and they could achieve their pre-injury locomotor activity. The PFLCP we used did have some limitations (1) the plate was found not to be well fitted for all the patient, especially short height Indian females, (2) non-cannulated devices, head screws insertion were more time consuming, and (3) when using long plate, it was necessary to bend the distal portion to adapt the femur well.

We are also aware of some limitations of our study. The sample size was small. We had not compared the results with the patients having similar fractures treated with alternative fixation during the same study periods. We had included the patients of wide age groups. No attempt had been made in our study to compare the results between young patients and the old patients and also results obtained in individual types of fractures because of short sample size. The longer-term outcome analysis is not there in our study. Additional prospective and randomized comparative studies are needed to fully describe the role of this method in the treatment of patients with trochanteric or subtrochanteric femoral fractures.

SUMMARY

In view of the above observations, the proximal femoral locking compression plating may be suggested as one of the options for the treatment of intertrochanteric and subtrochanteric fractures of femur, specially the unstable type of fractures, combining the benefits of intramedullary and angle stable implant but avoiding the complications of a surface implant.

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