Functional outcome of distal end femur fractures treated by minimally invasive plate osteo-synthesis using locking compression plate: a prospective study in 50 adults

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Abstract

Background: Distal femoral locking compression plate can be done via a minimally invasive method, overcoming the drawbacks of excessive periosteal stripping as caused by the open method. The fixed locking construct of the plate also provides stable fixation needed for early mobilization in fractures of the distal femur. Hence, we evaluated the results of the distal femoral locking compression plate done via minimally invasive technique in fractures of the distal end femur.

Material and methods: 50 cases of fracture distal end femur were treated by internal fixation with distal femoral locking compression plate via minimally invasive techniques and were evaluated radiologically for union and functionally using NEER'S Score.

Results: 50 distal end femoral fractures (29 males and 21 females) with a mean age of 51 years (range 20 to 83 years) were included in the study. The mean duration for surgery was 67 minutes (range 60 to 89 minutes), mean blood loss was 119 ml (range 100 to 140 ml) and mean union time was 14.3 weeks (range 11 to 20 weeks). 38 (76 %) patients had excellent results and 8 (16%) had satisfactory results as per NEER's scoring system with a mean NEER's score of 90.133 (range 74 to 96). Complications were knee stiffness as seen in 4 (8%) cases, 4(8%) had a superficial infection, 1 (2%) had implant failure, 2 (4%) had mal-alignment and 1(2%) had nonunion.

Conclusion: Pre-contoured distal femoral locking compression plate by virtue of its features provide stable fixation and done via minimally invasive technique, provides excellent function, high rate of bone union, and fewer complications, even in severely comminuted fractures and osteoporotic bones of distal end femur.

Keywords: Distal end femur fracture, Locking compression plate, Neer's scoring system, Minimal invasive technique

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Introduction

Distal end femur fractures account for about 4% to 7% of all femoral fractures with a bimodal age distribution. Accurate anatomic articular reduction, restoration of limb alignment, stabilization and early mobilization are the key steps in the management of distal end femoral fractures. Open reduction and stabilization with plate allow achieving these key steps. Traditional plate fixation techniques (blade plate, dynamic condylar screw-plate, non-locking condylar buttress plate) as done by open methods, leads to over compression of the plate to the femoral shaft, causing excessive additional damage to the

periosteum, along with damage caused by opening the fracture site [1].

Locking compression plate (LCP) creates toggle free, fixed angle, singly beam construct where the power of its fixation is equal to the sum of all screw-bone interfaces rather than a single screw's axial stiffness. It also offers high pullout resistance contrary to unlocked plates, especially advantageous for fixation in osteoporotic bone. It's this exclusive biomechanical property which is based on splinting rather than compression, results in flexible stabilization and avoidance of stress shielding. Further, it can be applied via minimally invasive techniques, which allows for prompt healing, lower rates of infection & reduced bone resorption as the blood supply is preserved [2,3]. A distal femoral locking compression plate (DFLCP) offers multiple points of fixed-angle contact between the plate and screws in the distal end of the femur even with a small epiphyseal segment, reducing the tendency for varus collapse, which can be a complication with traditional lateral plates [3]. We evaluated the outcome of the distal femur locking compression plate done by minimally invasive plate osteo-synthesis in distal femoral fractures.

Material and methods

This study was conducted in 50 cases of closed fracture of distal end femur treated by minimal invasive DFLCP at our centre, after obtaining ethical committee approval and written informed consent from all the patients. All cases of closed distal end femur fracture in more than 18 years age patients operated within a week of injury were included in the study. Open fractures, associated neurovascular injury, pathological fractures, and any other ipsilateral injury to the same limb were excluded from the study.

After haemo-dynamic stabilization of the patient and fitness for surgery, all patients were planned for surgical fixation by distal femur locking compression plating via minimally invasive method. All patients were operated under spinal anaesthesia in the supine position without a tourniquet on a radiolucent operating table via a lateral approach. Plate fixation was done by minimally invasive methods after achieving anatomical reduction by indirect methods using small bolsters/bumps placed underneath the distal thigh to correct sagittal plane deformities. Reduction clamps and traction were used to correct alignment in the coronal plane and to maintain leg length respectively. Once accurate reduction was obtained and checked under the C-Arm in both the views, an appropriate sized anatomically pre-contoured distal femur locking compression plate was slided in the sub-muscular plane holding one end of the plate with a sleeve and was aligned to the contour of the bone. Following this, the proximal and distal segment was fixed provisionally with the help of K-wires and then the length of the plate, alignment and reduction was rechecked under the C-Arm, and the plate was readjusted for centring the plate on the shaft (fig 1). For distal fixation, at least 5 metaphyseal locking screws without violating intercondylar notch were used. Proximal fixation was done under fluoroscopic guidance with at least four bicortical locking screws with multiple stab incisions just over the proximal holes in the plate with help of the sleeve. A combination of conventional and locking screws were used, conventional screws were inserted before locking screws to bring the plate and fragment nearer.

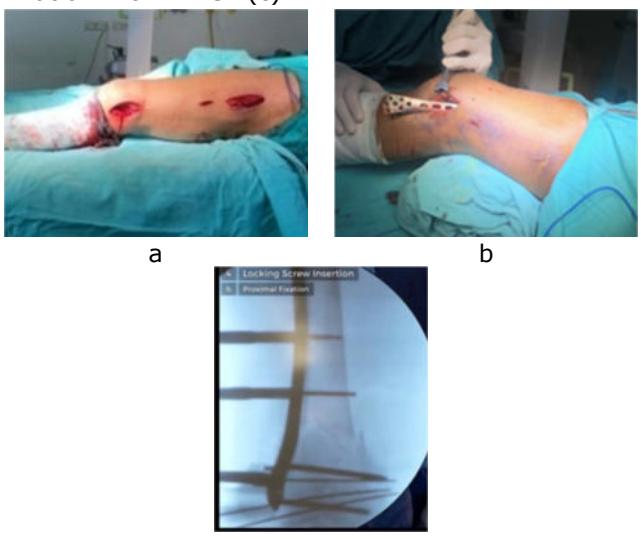
Postoperatively, the limb was kept elevated with the knee in 10º to 15º of flexion. Active hip & knee mobilization and static quadriceps exercises were allowed from postoperative day one. Suture removal was done at 2 weeks. Patients were mobilized on crutches/walkers with toe-touch weight-bearing at 6 weeks. Full weight-bearing was initiated depending on the radiological evidence of bony union and was not permitted until the consolidation of the fracture site was seen. Patients were followed regularly at 4 weekly intervals up to 6 months, then every 3 months up to one year, and 6 monthly thereafter. Patients were assessed functionally using NEER's score and progress of healing was assessed with routine antero-posterior and lateral radiographs.

Result

50 distal end femoral fractures were treated in our study via minimally invasive technique by distal femoral locking compression plate. 29 cases were males and 21 were females. The mean age was 51 years (range 20 to 83 years). 38 cases sustained trauma due to road traffic accident, 11 due to fall from height and 1 sustained injury due to industrial accident. 34 cases had a fracture of the right side and 16 on the left side. 40 (80%) cases had A3, 5 (10%) had A2, 3 (6%) had A1 and 2 (4%) had B1 type of fracture as per AO classification. 4 (8%) cases had associated diabetes mellitus, 10 (20%) had hypertension and 1 (2%) had mitral stenosis.

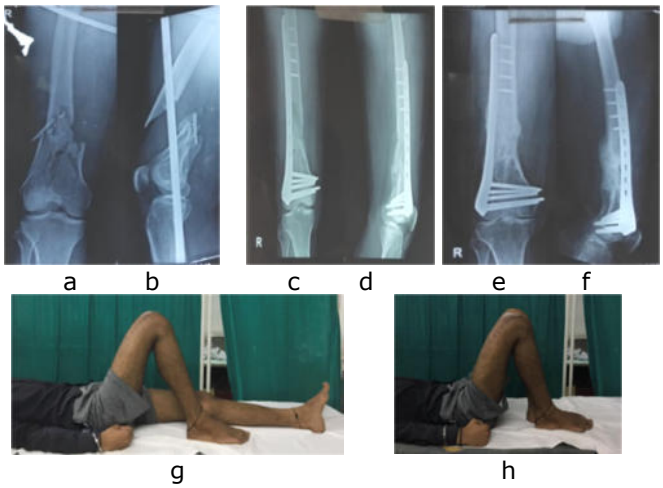
The mean duration for surgery was 67 minutes (range 60 to 89 minutes) and the mean blood loss was 119 ml (range 100 to 140 ml). 38 (76%) patients had excellent results and 8 (16%) had satisfactory results as per NEER's scoring system with a mean NEER's score of 90.133 (range 74 to 96) at a mean follow-up of 1 year. Only 4 (8%) patients had poor or unsatisfactory results. Mean union time was 14.3 weeks (range 11 to 20 weeks) (fig 2). There were 10 (20%) patients who had a radiological union between 11-12 weeks, 15 (30%) patients had a union between 13-14 weeks, 20 (40%) patients had a union between 15-16 weeks, 3 (6%) patients had a union between 17-18 weeks and 2 (4%) patients had a union between 19-20 weeks. Complications were knee stiffness as seen in 4 (8%) cases, 4 (8%) had a superficial infection, 1 (2%) had implant failure, 2 (4%) had mal-alignment and 1 (2%) had non-union.

Fig 1. Intra-operative photograph (a,b) & fluoroscopic view (c) of a patient of distal end femur fracture showing patient position & minimal invasive approach (a), sliding of the plate (b) and fixation with DFLCP (c).



a b c

Fig 2. Pre-operative (a,b), immediate postoperative (c,d), and 6 months follow up (e,f) antero-posterior and lateral X-ray of 30 years male with fracture distal end femur treated with DFLCP showing sound union at 6 months and clinical photograph (g,h) at 6 moths showing a good range of motion at the knee.



a b c d e f g h

Table 1- Comparison of our results with other studies

S.No	Study	Year	Scoring	Excellent	Satisfactory	Unsatisfactory	Poor
1.	Saini et al [5]	2018	Neer	62%	32%	6%	-
2.	Girisha et al [12]	2017	Neer	24%	71%	5%	-
3.	Krishna et al [16]	2015	Neer	50%	36.6%	10%	3.3%
4.	Raoll et al [17]	2015	Neer	32%	48%	16%	4%
5.	Raghu et al [18]	2017	Neer	50%	35%	15%	-
6.	Sah et al [19]	2017	Neer	66.6	23.8	4.7	4.7
7.	Khajotia et al [20]	2019	Neer	48.8%	35.5%	11.1%	.04%
8.	Medhi et al [21]	2019	Neer	78.48%	-	16.45%	5.06%
9.	Srinath et al [22]	2019	Neer	65%	15%	20%	-
10.	Rajpal et al [23]	2019	Neer	54%	28%	22%	-
11.	Our study	2020	Neer	76%	16%	8%	-

Discussion

Various modalities used for the treatment of distal end femoral fracture ranges from conventional plates, dynamic condylar screw to intramedullary nailing. All these various treatment modalities have problems like loss of reduction, excessive soft tissue stripping and violation of joint, joint stiffness, non-union, malunion, implant failure, mal-alignment or infections etc, due to the fact that these require excessive stripping to achieve accurate anatomical reduction and prolonged immobilization due to compromised stability [1,4]. Mast in 1989 first emphasized the importance of reduced surgical dissection at the fracture site, with the aim to maintain the blood supply to the fracture ends and to thus reduce the rate of non-union and utilized the surrounding soft tissues for fracture reduction called as 'indirect reduction' of the fracture [5]. Krettek et al extrapolated the concept of obtaining relative stability rather than absolute stability for internal fixation with plate, as similar to intramedullary nails. They also suggested minimal interference with the zone of injury, which was achieved by sliding plates in the sub-muscular plane on the lateral side of the femur by a minimally invasive method [6]. Distal femoral locking compression plate overcomes both the drawbacks of excessive stripping as it can be done via minimally invasive methods and a fixed locking construct provide stable relative stability which can enhance early joint mobilization and thus prevents these complications, leading to good to excellent functional outcome [2-4].

We evaluated the outcome of distal femoral locking compression plating fixed via minimally invasive technique in 50 cases of distal end femoral fractures with a mean age of 51 years and found excellent to good results in 92 % cases in mean union time of 14.3 weeks. Our results were comparable to the studies of Saini et al, Yeap et al, Liu et al, Doshi et al, Khursheed et al and Girisha et al [7-12].

All of our cases united in mean 14.3 weeks without any augmentation except in one case, who was treated with additional secondary bone grafting alone, as the plate was well fixed. Kregor et al reported a series with 5% of the cases required bone grafting but it was unclear from the description what was the mean time to union and the indication for bone grafting [2].

The advantages and excellent outcome with the use of distal femoral locking compression plate via minimally invasive technique were also highlighted by Jain et al, El-Ganainy et al and Necmioglu et al [13-15]. All of these studies concluded that DFLCP via MIPPO is one of the best available options for the management of challenging fractures of distal end femur owing to the fact that it disrupts the femoral blood supply less than the traditional open methods and pre-contoured DFLCP fits the distal end of the femur, anatomically. Thus DFLCP is more advantageous, biologically than the traditional methods (table 1). A pre-contoured DFLCP plate provides rigid fixation in the wide distal femur with thin cortices and poor bone stock which is difficult to achieve with a conventional non-locking plate. Table 1 shows the comparative results of different series with our study.

The complications with the procedures are lesser in comparison to a traditional plate. We encountered knee stiffness, superficial infection, implant failure, mal-alignment and nonunion as complications in our study, but all these complications were within acceptable limits and comparable to known series [7-15]. Our study is limited by lack of comparative group and inherent bias due to the inclusion of all types of distal end femoral fractures in the series.

Conclusion

Pre-contoured DFLCP plate by virtue of its features provides stable fixation. It can be done via minimally invasive technique, hence is soft tissue preserving surgery which protects blood supply to fracture ends and thus provides excellent functional outcome, high rate of bone union and fewer complications, even in severely comminuted fractures and osteoporotic bones.

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