

## Original Research Article

# Assessment of efficacy of locking compression plate in distal femur fractures

Faizal Ali A. A.\*, Govind Karunakaran, Hijas Hameed

Department of Orthopaedics, Government Medical College Ernakulam, Kerala, India

**Received:** 27 July 2021

**Revised:** 11 August 2021

**Accepted:** 12 August 2021

### \*Correspondence:

Dr. Faizal Ali A. A.,

E-mail: faizalmch@yahoo.com

**Copyright:** © the author(s), publisher and licensee Medip Academy. This is an open-access article distributed under the terms of the Creative Commons Attribution Non-Commercial License, which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

### ABSTRACT

**Background:** Distal femur fractures account for an estimated 6% of all femur fractures. Our study aims at evaluating the functional and radiological outcome in distal femur fractures treated with locking compression plate (DF-LCP).

**Methods:** Patients undergoing LCP were assessed postoperatively both functionally and radiologically. Oxford Knee Score was used to assess the functional outcome. With a maximum score of 48, a score of more than 41 is scaled as excellent, 34 to 40 as good functional status, 27 to 33 as fair and score less than 27 as poor functional result.

**Results:** Extra-articular fractures were the commonest (66.7%) type of fractures [simple-6.7%; metaphyseal wedge-20%; metaphyseal complex-40%] followed by complete articular fractures (26.7%) [Simple articular metaphyseal comminution-16.7%; metaphyseal and intra-articular comminution-10%] and partial articular fractures (6.7%) [Medial condyle-3.3%; coronal plane-3.3%]. Most of them had right sided femur injury (66.7%) and had history of fall (70%). Radiologically, 90% exhibited no complications and had united appropriately. Functionally the mean oxford knee score was  $41.53 \pm 1.69$  which ranged from a score of 38 to a maximum of 44. Highest proportion i.e., 63.3% had excellent outcome followed by good functional outcome and none showed fair or poor outcomes.

**Conclusions:** LCP has shown very good radiological and functional outcomes with hundred percent union of the distal femur fractures. Hence it can be used successfully in distal femur fractures.

**Keywords:** Locking compression plate, Distal femur fracture, Extra-articular fractures

### INTRODUCTION

Distal femur fractures especially AO Type C fractures are difficult to treat and account for an estimated 6% of all femur fractures. However, the non-union rate of distal femoral fractures lies between 0 and 34%, indicating considerable variation.<sup>1,2</sup> The annual incidence of distal femur fractures is around 37/1,00,000 people.<sup>3</sup> Two different mechanisms are responsible for such trauma, where high energy trauma is seen commonly in young adults and low energy or trivial trauma in osteoporotic population. Osteoarthritis may result when there is a diastasis of 3 or more millimetres. Previously the trend in treatment of these fractures leaned towards closed conservative management with traction, casting, or a

combination of both. The problems associated with conservative management are the limitation of reduction and difficulty of maintaining reduction. Associated complications of prolonged immobilisation and economic considerations of increased hospital stay also limit their utility. Surgical treatment can either be retrograde intramedullary nail fixation or be plate fixation, with plate fixation having a wide indication for various fractures types.<sup>4,5</sup> The treatment of these fractures has evolved over the past 50 years from closed treatment to open reduction and internal fixation with locked plating. The goal of surgical management of these fractures is anatomic reduction, maintaining the articular congruity and restoring limb alignment and early mobilization.<sup>6</sup> There are different surgical options available: Antegrade

nailing, retrograde nailing, blade-plate fixation, isolated screw fixation, locked plating, and as a part of damage control orthopaedics, external fixator use. Regarding plate fixation, basic fixation is generally recommended to achieve absolute stability using lag screws in simple fractures; however, lag screw fixation cannot be performed in transverse fractures.<sup>7</sup> Moreover, it is impossible to achieve absolute stability with rigid internal fixation in comminuted fractures. In such cases, it is necessary to use a locking plate as a bridging plate to fix the fracture site.<sup>8</sup> The optimal insertion holes for the screws on the proximal side of the locking plate (when used as a bridge) are currently debated.<sup>9,10</sup> The current trend is toward periarticular distal femoral locking plates used as minimally invasive percutaneous plate osteosynthesis (MIPPO) technique, using DF-LCP.

Locking plate and screw systems have advantages over the conventional screw systems. DF-LCP has a smaller application device and allows both locking and compression screw fixation of the femur shaft. Conventional plate/screw systems require precise adaptation of the plate to the underlying bone. Without this intimate contact, tightening of the screws will draw the bone segments toward the plate, resulting in alterations in the position of the osseous segments and the occlusal relationship. Locking plate/screw systems offer certain advantages over other plates in this regard. The most significant advantage may be that it becomes unnecessary for the plate to intimately contact the underlying bone in all areas. As the screws are tightened, they "lock" to the plate, thus stabilizing the segments without the need to compress the bone to the plate. This makes it impossible for the screw insertion to alter the reduction. Another potential advantage in locking plate/screw systems is that they do not disrupt the underlying cortical bone perfusion as much as conventional plates, which compress the under surface of the plate to the cortical bone. A third advantage to the use of locking plate/screw systems is that the screws are unlikely to loosen from the plate. This means that even if a screw is inserted into a fracture gap, loosening of the screw will not occur. Similarly, if a bone graft is screwed to the plate, a locking screw will not loosen during the phase of graft incorporation and healing. The possible advantage to this property of a locking plate/screw system is a decreased incidence of inflammatory complications from loosening of the hardware. It is known that loose hardware propagates an inflammatory response and promotes infection. For the hardware or a locking plate/screw system to loosen, loosening of a screw from the plate or loosening of all of the screws from their bony insertions would have to occur.

Locking plate/screw systems have been shown to provide more stable fixation than conventional nonlocking plate/screw systems. Minimally invasive percutaneous plate osteosynthesis (MIPPO) has been widely applied to treat long bone shaft fractures in recent years because of its technical advantages and satisfactory clinical

outcomes. The plate is inserted by a percutaneous approach with separate proximal and distal incisions. This method causes less soft tissue disruption and preserves the fracture haematoma and blood supply to the bone fragments.

### **Objectives**

Objectives of the study were to assess the functional and radiological outcome in DF-LCP.

### **METHODS**

The present study was conducted in the department of orthopaedics, government medical college, Ernakulam after the institutional research committee and ethics committee approval. Patients who presented to the department of orthopaedics, government medical college, Ernakulam with distal femur fractures from February 2018 to July 2019 were included in the study.

### **Inclusion criteria**

All patients above the age of 18 years of either sex with closed or compound fractures of distal femur up to grade II or patients with osteoporotic bones were included in the study.

### **Exclusion criteria**

Head injury, chest injury, pathological fractures, ASA criteria >3, and patients with Gustilo type III compound injuries or previously treated fractures were excluded from the study.

### **Sample size**

A sample size of 30 was taken at conveniences.

### **Study procedure**

All patients who were operated for distal femur fractures (closed/upto Gustilo Anderson type 2/osteoporotic) with locking plates from Feb 2018-July 2019 in Government medical college Ernakulam was selected. The study included 17 males and 13 females. After giving the spinal anaesthesia, patient in supine position on c-arm compatible table with a sandbag below the knee, the entire injured extremity is prepared and draped with tourniquet application. Lateral incision parallel to the femoral shaft (from Gerdy's tubercle towards proximally). Often the shaft of the femur is wedged between two condyles; if so, by applying with traction and counter traction method the anatomical fracture reduction is achieved.

Treatment of fractures was performed utilising the lateral approach in all patients. Fractures were reduced under direct vision using manual traction. A knee roll assisted the procurement and maintenance of reduction. The plate

length, axial and rotational alignment were checked under image intensification. Temporary fixation was achieved through the use of Kirschner wires. Inter-condylar type fractures were converted to a single condylar block before DF-LCP fixation. Minimally invasive techniques were utilised where possible for insertion of proximal screws.<sup>11</sup> Where applicable, compression screws were used to approximate the plate to the femoral shaft.

Fracture reduction achieved by traction and counter traction with gentle manipulation during surgery, in few cases Steinmann pin was used for reduction as joystick method. Condyles were fixed with 2 mm Kirschner wires initially along with plate after reduction and fixed with 6.5 mm cancellous screws into the condyles and 4.5 mm locking screws into the shaft this has been confirmed intraoperatively under image intensifier.

Patient's care was done as per hospital protocol which includes antibiotics, analgesics, vitals monitoring, input output charting, along with foot end elevation were given as per the patient compliance. Blood transfusion was given depending upon the preoperative general condition and intraoperative blood loss. Patient was mobilized on 3<sup>rd</sup> or 4<sup>th</sup> day postoperatively with knee exercises. Non-weight bearing was started after first post-operative week till 6 weeks depending on the fracture pattern. Partial weight and full weight bearing exercises started depending on healing process till fracture union respectively.

Follow-up data were taken routinely for all patients at 2 weeks, 6 weeks, 12 weeks, and 6 months postoperative was collected from the patient's case sheets and documents. The follow up data which including serial knee x-rays and oxford knee scores was used to assess the radiological and functional outcome respectively. Radiological outcome was analyzed using X-rays in AP and lateral views. Oxford Knee Score was used to assess the functional outcome.

Oxford knee score was used to assess the functional outcome. It is based on a questionnaire consisting of 12 questions which assesses the functional status of the patient. With a maximum score of 48, a score of more than 41 is scaled as excellent, 34 to 40 as good functional status, 27 to 33 as fair and score less than 27 as poor functional result.<sup>12</sup>

### Statistical analysis

Descriptive and inferential statistical analysis has been carried out in the present study which included sex distribution, age distribution, cause of injury side affected, type of fracture, outcome of radiological union, functional outcome of the patients and complications results. Data was entered into Excel sheet. The data collected in the present study was analyzed statistically by SPSS version 17 software appropriate statistical test were used to determine the efficacy of outcome. Categorical variables were expressed as proportions and

quantitative variables was expressed as mean and standard deviation. Chi-square test for categorical variables and Students t test for quantitative variables were used. Non parametric tests were used for skewed distributions.

## RESULTS

The sample consisted of 30 patients with the mean age of the study participants were 52.30±13.68 years ranging from 23 to 78 years. Seventeen patients were male and thirteen patients were female. Majority i.e., 30% were in the age group of above 60 years and 56.7% were males. Based on Muller AO-classification, the extra-articular fractures were the commonest (66.7%) type of fractures [simple-6.7 %; metaphyseal wedge-20.0 %; metaphyseal complex-40.0 %] followed by complete articular fractures (26.7%) [simple articular metaphyseal comminution-16.7%; metaphyseal and intra-articular comminution-10%] and partial articular fractures (6.7 %) [medial condyle - 3.3 %; coronal plane-3.3 %]. Most of them had right sided femur injury (66.7 %) and ten patients (33.33%) involved the left side fracture. The cause of the fractures was road traffic accident in nine patients (30%) and a fall in 21 (70%) patients (Table 1).

Successful fracture union was defined as complete bridging callus in three cortices, together with painless full weightbearing. Radiologically, 90% exhibited no complications and had united appropriately. Majority of the patients i.e., 27 (90%) had united radiological outcome, followed by 2 (6.7%) patients had delayed union and 1 (3.3%) patient had superficial infection respectively which was controlled before the patients were discharged from the hospital (Table 2).

**Table 1: Socio demographic and clinical details of the patients.**

Variables	Frequency (n)	Percentage (%)	
Age group (years)	<40	06	20
	41-50	08	26.7
	51-60	06	20
	>60	10	33.3
Gender	Males	17	56.7
	Females	13	33.3
Type of fracture	Type 33.A (A.1+A.2+A.3)	20	66.7
	Type 33.B (B.2+B.3)	02	6.7
	Type 33.C (C.2+C.3)	08	26.7
Side of injury	Right	20	66.7
	Left	10	33.3
Mode of injury	Road traffic accident (RTA)	09	30
	Fall	21	70

Functional outcome was measured using the Oxford knee score. The mean Oxford knee score was  $41.53 \pm 1.69$  which ranged from a score of 38 to a maximum of 44. Highest proportion i.e., in 19 (63.3%) patients had excellent outcome followed by good functional outcome in 11 patients (36.7%) and none showed fair or poor outcomes. All patients were able to bear full weight. (Table 3). The operative surgery, postoperative radiographs and range of motion of the leg postoperatively is presented in Figure 1.

**Table 2: Radiological outcome of the patients.**

Radiological outcome	N	Percent (%)
United	27	90
Delayed union	02	6.7
Superficial infection	01	3.3

**Table 3: Functional outcome of the patients.**

Functional outcome in terms of Oxford knee score	N	Percent (%)
Excellent (>40)	19	63.3
Good (34-40)	11	36.7



**Figure 1 (A, C and E) shows X-ray of united fractures after 6 months; (B, D and F) shows range of movement.**

## DISCUSSION

Current fracture patterns veer towards complex comminuted types due to the prevalence of high-speed vehicles. Improved healthcare results in a longer lifespan and subsequently presents us with more osteoporotic fractures which were previously treated using conservative methods. Management of distal femoral fractures is challenging and the primary goal is to restore the axis and rotation of the femur, limb length and the articular congruity. In high-energy trauma to the lower limb there may be a combination of metaphyseal and intra-articular injuries seen frequently. Selection of implant plays a key role in treating these fractures. Mechanically, it should provide high primary stability and yet enough flexibility to allow dynamic osteosynthesis, it should be applicable in an angular stable mode, and maintain the reduction until union. One such implant with all the aforementioned features is the LCP. Distal femoral fractures are known for their perplexity in the field of orthopaedics. Open reduction with internal fixation has replaced management of closed conservative and external fixation over a period and conservative treatment hardly guarantee the results similar to surgical management.<sup>13,14</sup> DF-LCP has a smaller application device which allows both locking and compression screw fixation of the femur shaft. The DF-LCP is a single beam construct where the strength of its fixation is equal to the sum of all screw-bone interfaces rather than a single screw's axial stiffness and pull out resistance in unlocked plates.<sup>8,15</sup> Its unique biomechanical function is based on splinting rather than compression resulting in flexible stabilisation, avoidance of stress shielding and induction of callus formation.<sup>15</sup> When applied via a minimally invasive technique, it allows for prompt healing, lower rates of infection and reduced bone resorption as blood supply is preserved. The DF-LCP is a further development from the less invasive stabilization system (LISS), which was introduced in the mid to late 1990's.<sup>16,17</sup> The main difference between the DF-LCP and the LISS is that the LISS utilises an outrigger device for shaft holes, functioning essentially as a locking guide jig, which is attached to the distal part of the plate and guides the placement of the proximal locking screws. The shaft holes on the DF-LCP are oval allowing for the options of a compression screw or a locking screw. This leads to a more precise placement of the plate, as it is able to be compressed more closely to the bone. The new concept of LCP with option of locked screws has provided the means to increase the rigidity of fixation in osteoporotic bone or in the presence of periarticular fractures. The study was conducted to examine the short-term results, early complications and healing rate of distal femoral fractures treated with the DF-LCP.<sup>3</sup>

Although DF-LCP is designed to fit the anatomy of the distal femur, we were worried about the fit in our local Asian population where shorter and smaller femurs are the norm. However, thus far, our limited numbers demonstrate that this is not an issue. Our cases do not



demonstrate any irritation of the ilio-tibial tract which causes pain so severe that it necessitates removal of the implant.<sup>8,15</sup> This could be because we do not use the outrigger device, and are therefore better able to approximate the distal portion of the plate to the bone, ensuring that prominent hardware does not become an irritation to the ilio-tibial tract. In this study 30 fractures of distal femur were treated with LCP. Overall outcome of the surgical management of fracture lower end of femur using LCP was assessed in terms of regaining the lost knee function using Oxford's score.

Jhathoth in his study found the mean age of the participants to be 44 years and the age ranged from 18-74 years. In our study the mean age was slightly higher which might be due to different study setting and the different cause of fracture where RTA was commonest which marks the presence of the younger age group (18-30 years) as predominant rather in our study, above 50 years and history of fall was the commonest.<sup>13</sup> Distal femur fractures are known to show a bimodal age distribution where high-speed vehicular accidents are commonly observed in the young and middle aged especially 15 to 50 years and men and fall at home are noted to be responsible for producing fractures of distal femur in elderly osteoporotic population especially among women, the postmenopausal women.<sup>12,18</sup> Though in our study, majority were above fifty years and had fall as the common cause of fracture, males were shown to be commonly involved as nearly equal proportions in minor difference of proportions the less than 50 years were also affected in ours.

Results by Pipal et al, showed A.O. type C2 fractures (40 %) as commonest type of fractures as commonest and Saumya et al found type C1 as the commonest and in ours it was type A3 and the two study settings are different which might have led to this difference in the findings.<sup>14,19</sup> Patel et al, found similar findings to ours wherein type A was commonest followed by type C which accounted for most of the fractures.<sup>20</sup> Also their study showed right sided predominance similar to ours.<sup>20</sup>

We did not find any case of non-union among thirty of them though only two of our patients showed delayed union and one had superficial infection. Ramu et al, also found the results in line with ours where 2 of theirs among thirty showed malunion 1 showed superficial and 1 deep infection and they also found valgus and varus deformities among one each.<sup>6</sup>

In our study the functional outcome was measured in terms of Oxford knee score and the mean was 41.5 and similarly Lal et al., reported mean Oxford knee score of 40.6 which is in concordance with our findings and also majority showed excellent functional outcome similar to ours.<sup>21</sup> In consideration to biology, it is of utmost importance that the muscle and periosteal bone cover are preserved. In case of comminution, free fragments must be left untouched. With a biological fixation technique

and a fixed-angle implant, the periosteal blood flow remains intact and bone healing is not much disturbed. In consideration to biomechanical principles, the aim should be on using long plates, to apply bicortical screws, to leave two to three screw holes empty around the fracture gap in order not to create a too rigid construct, and to position the screws adjacent to a comminuted fracture as close as possible to the fracture gap. Although the follow-up period of our series was short, studies have shown that early function is comparable to final long-term outcome.<sup>22</sup> The outcome seems to correlate with fracture severity, anatomic reduction, aetiology, bone quality, length of time elapsed from injury to surgery, concomitant injuries, and exact positioning and fixation of the implant.<sup>23</sup> Study limitation included its retrospective design and the relatively small sample size.

## CONCLUSION

High incidences of distal femur fractures are seen in young patients with high velocity injuries and accidental falls in older patients. The new concept of LCP with option of locked screws has provided the means to increase the rigidity of fixation in osteoporotic bone or in the presence of periarticular fractures. The DF-LCP is a good implant to use for fractures of the distal femur. However, accurate positioning and fixation are required to produce satisfactory results. DF-LCP has shown very good radiological and functional outcomes with hundred percent union of the distal femur fractures with excellent to good functional outcomes in our setting with very minimal side effects that could be easily addressed. Our study results are encouraging and long-term studies are needed to prove definitively acceptable outcomes so that the technique can become part in the armamentarium of orthopaedic trauma surgeon. Hence it can be used successfully in distal femur fractures.

*Funding: No funding sources*

*Conflict of interest: None declared*

*Ethical approval: The study was approved by the Institutional Ethics Committee*

## REFERENCES

1. Ricci WM, Streubel PN, Morshed S, Collinge CA, Nork SE, Gardner MJ. Risk factors for failure of locked plate fixation of distal femur fractures: an analysis of 335 cases. *J Orthop Trauma*. 2014;28(2):83-9.
2. Gwathmey WF, Jones-Quaidoo SM, Kahler D, Hurwitz S, Cui Q. Distal femoral fractures: current concepts. *JAAOS-J Am Academy Orthop Surgeons*. 2010;18(10):597-607.
3. Borthakur B, Hanse B, Haque R, Jindal S, Talukdar M. Results of Locking Compression Plate fixation in Distal Femur Fractures: A Prospective Study. *J Med Thesis*. 2016;4(1):31-6.
4. Ehlinger M, Ducrot G, Adam P, Bonnomet F. Distal femur fractures. Surgical techniques and a review of

- the literature. *Orthop Traumatol Surg Res.* 2013;99(3):353-60.
5. Smith WR, Ziran BH, Anglen JO, Stahel PF. Locking plates: tips and tricks. *J Bone Joint Surg.* 2007;89(10):2298-307.
  6. Ramu AC, Roshan SD, Hedge A, Naveen A. Functional outcome of management of fracture of distal femur. *National J Clin Orthop.* 2018;2(1):32-6.
  7. Toolan BC, Koval KJ, Kummer FJ, Sanders R, Zuckerman JD. Vertical shear fractures of the medial malleolus: a biomechanical study of five internal fixation techniques. *Foot Ankle Int.* 1994;15(9):483-9.
  8. Weight M, Collinge C. Early results of the less invasive stabilization system for mechanically unstable fractures of the distal femur (AO/OTA types A2, A3, C2, and C3). *J Orthop Trauma.* 2004;18(8):503-8.
  9. Lee CH, Shih KS, Hsu CC, Cho T. Simulation-based particle swarm optimization and mechanical validation of screw position and number for the fixation stability of a femoral locking compression plate. *Med Engineering Physics.* 2014;36(1):57-64.
  10. Hunt SB, Buckley RE. Locking plates: a current concept review of technique and indications for use. *Acta chirurgiae orthopaedicae et traumatologiae Cechoslovaca.* 2013;80(3):185-91.
  11. Schuetz M, Müller M, Krettek C, Höntzsch D, Regazzoni P, Ganz R, Haas N. Minimally invasive fracture stabilization of distal femoral fractures with the LISS: A prospective multicenter study results of a clinical study with special emphasis on difficult cases. *Injury.* 2001;32:48-54.
  12. Sahoo BS, Chand DK. Distal femur fracture fixation by DF-LCP-2-year experience. *Int J Orthop Sci.* 2017;3(1):814-8.
  13. Jhath DS. Clinical and radiological outcome of distal femur fractures treated surgically with locking compression plate. *National J Clin Orthop.* 2019;3(1):140-6.
  14. Pipal RK, Pipal DK, Yadav S, Pipal V, Kothari S. Results of locking compression plate in the management of fracture distal end of femur in adults. *Int J Orthop.* 2018;4(2):1029-33.
  15. Kregor PJ, Stannard JA, Zlowodzki M, Cole PA. Treatment of Distal Femur Fractures Using the Less Invasive Stabilization System: Surgical Experience and Early Clinical Results in 103 Fractures. *J Orthop Trauma.* 2004;18(8):509-20.
  16. Schandelmaier P, Partenheimer A, Koenemann B, Grun OA, Krettek C. Distal Femoral Fractures and LISS Stabilization. *Injury.* 2001;32:SC55-63.
  17. Frigg R, Appenzeller A, Christensen R, Frenk A, Gilbert S, Schavan R. The development of the distal femur Less Invasive Stabilization System (LISS). *Injury.* 2001;32:SC24-31.
  18. Virk JS, Garg SK, Gupta P, Jangira V, Singh J, Rana S. Distal femur locking plate: the answer to all distal femoral fractures. *J Clin Diagnostic Res.* 2016;10(10):RC01.
  19. Agarwal S, Udupudi S, Gupta S. To assess functional outcome for intra-articular and extra-articular distal femur fracture in patients using retrograde nailing or locked compression plating. *J Clin Diagnos Res.* 2018;12(3):RC21-4.
  20. Patel YC, Meghnathi UH, Patel VD, Hasan AN. Management of distal femur fractures with locking compression plate: A prospective study. *National J Clin Orthop.* 2019;3(2):105-8.
  21. Lal AK, Kaushik SK, Gupta U, Agarwal V, Anant S. Evaluation of Results of Locking Compression Plate in Distal Femur Fractures. *Int J Scientific Study.* 2018;6(1):41-6.
  22. Bolhofner BR, Carmen B, Clifford P. The results of open reduction and internal fixation of distal femur fractures using a biologic (indirect) reduction technique. *J Orthop Trauma.* 1996;10(6):372-7.
  23. Fankhauser F, Gruber G, Schippinger G, Boldin C, Hofer H, Grechenig W, Szyszkowitz R. Minimal-invasive treatment of distal femoral fractures with the LISS (Less Invasive Stabilization System) A prospective study of 30 fractures with a follow up of 20 months. *Acta Orthop Scandinavica.* 2004;75(1):56-60.

**Cite this article as:** Ali FAA, Karunakaran G, Hameed H. Assessment of efficacy of locking compression plate in distal femur fractures. *Int Surg J* 2021;8:xxx-xx.