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## A prospective study on functional and radiological outcome of distal femur fracture treated with distal femur locking compression plate (DF-LCP) in adults

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### Abstract

**Introduction:** Distal femur fractures are one of the most fractures encountered by orthopaedic surgeons in routine practice. These fractures pose therapeutic challenges of fracture treatment because they are usually compound, comminuted, readily deformed because of muscle forces acting on the distal fragment, prone to result in functional impairment of the knee joint because of the injury to quadriceps system. There is no single implant that can be used for all distal femoral fractures. The introduction of DF-LCP is a welcome change that has brought a drastic change in the management of these fractures due to its contouring to the distal femur with combiholes in the proximal pattern.

**Aim:** Evaluation of the functional and radiological outcome of Distal femoral fractures treated with DF-LCP.

**Materials and Methods:** This prospective study was carried out at orthopaedics department of a tertiary care teaching hospital of Southern Rajasthan from January 2019 to June 2020. A total of 30 patients of AO Type A and Type C distal femur fractures were included in the study. The method used for fixation was closed or open reduction and internal fixation with DF-LCP. All the patients were followed up for a period at the end of 6 months and functional outcome was assessed according to the Knee Society Scoring System.

**Results:** Fracture union was seen in all patients. On evaluation, according to Knee's criteria mean score were 73.76. Out of 30 patients, excellent in 19 patients (63.33%), good in 09 (26.67%), fair in 02(6.67%) and poor in 01(3.33%).

**Conclusion:** DF-LCP is an effective and reliable implant in treating distal femoral fractures AO type A and type C with minimal complications. However, careful understanding of basic principles and identification of appropriate fracture pattern are essential to produce an excellent result.

**Keywords:** Distal femur fractures, locking compression plate (LCP), Knee Society Scoring System

### Introduction

The fractures involving distal 15 cm of the femur including distal femoral metaphysis (supracondylar) and articular surface (intercondylar) are classified as distal femur fractures [1]. Throughout the historic evolution of orthopaedic surgery, the treatment of distal femur fractures has not achieved clinical results with a quality comparable to the rest of the femoral fractures. The incidence of distal femur fractures is approximately 37 per 1,00,000 person years [2]. Distal femoral fractures occur at approximately one-tenth the rate of proximal femoral fractures and accounts for 6% of all femur fractures [3]. They follow bimodal age distribution. In young adults, it occurs due to high-velocity trauma like road traffic accidents. These patients often sustain multiple and compound injuries. Older patients sustain distal femur fractures mostly due to trivial falls occurring in elderly osteoporotic bone. Fractures of the distal femur are very complex injuries. These injuries are severe and have a potential to produce long-term disability. These fractures need to be rigidly fixed to allow early mobilisation of the knee. Any method of strong biological fixation after anatomical reduction is expected to achieve good results. The options for operative treatment are traditional plating techniques A: blade plate, Dynamic Condylar Screw, non-locking condylar buttress plate, B: antegrade nailing fixation, retrograde nailing, and C: external fixation [4].

However, as the complexity of fractures needing treatment has changed from simple extra-articular supra-condylar types to inter-condylar and metaphyseal comminuted types, these implants may not be ideal. Double plating, and more recently, locked plating techniques have been advocated. However, with double plating there is often extensive soft tissue stripping on both sides of the femur, resulting in reduced blood supply and potential non-union and failure of the implants [5-7]. The 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 or pullout resistance as seen in unlocked plates. Its unique biomechanical function is based on splinting rather than compression resulting in flexible stabilization, avoidance of stress shielding and induction of callus formation. Further, when it is applied via a minimally invasive technique, it allows for prompt healing, lower rates of infection and reduced bone resorption as blood supply is preserved [8]. The introduction of plates with the option of locked screws has provided the means to increase the rigidity of fixation in osteoporotic bone or in the presence of periarticular or juxta-articular fractures with a small epiphyseal segment [9]. The implant offers multiple points of fixed-angle contact between the plate and screws in the distal part of the femur, theoretically reducing the tendency for varus collapse that is seen with traditional lateral plates [9].

### Aim

The aim of the present study was to assess the functional and radiological outcome of the distal femur fracture treated with a locking compression plate.

### Materials and Methods

This prospective study was conducted in the department of orthopaedics of a tertiary care teaching hospital of southern Rajasthan from January 2019 to June 2020 with a minimum follow-up period of 6 months.

Permission from the ethical committee was taken prior to commencement of the study and preoperative counselling and informed consent of all the patients included in the study regarding the treatment, operation and study was obtained. All patients were operated on by the same surgical team.

### Inclusion criteria

1. All adult patients with AO type A and type C distal femur fractures (close or open upto grade IIIA)
2. Patient who are fit for surgery and willing to give consent.

### Exclusion criteria

1. Type III B and C open distal femur fracture.
2. Patients with associated head, chest, visceral and injuries and patients with any fracture other than the distal femur in the ipsilateral limb.
3. Pathological fractures

4. Patients with non-union, delayed union and compartment syndrome.

In this study, we included 30 patients of distal femur fracture who presented to the Orthopaedics emergencies and outdoor department. On admission, all patients were evaluated clinically and were stabilized hemodynamically. Radiological evaluation was done to assess the type of fracture, included an anteroposterior and lateral X-Ray of the femur along with a pelvic X-ray to rule out proximal fractures and above knee slab was applied. CT scan was done as per requirement. Splinting of the fractured limb was a preliminary measure. Routine laboratory investigations were carried out and fitness for anaesthesia and surgery were obtained. Patients were operated on under spinal anaesthesia or under general anaesthesia after obtaining written informed consent. Tourniquet applied where fracture site permitted. In the case of 33A type fractures, closed reduction was achieved using various instruments like clamps or ST pins using as a joystick to manipulate fracture fragments and fixation done by MIPO technique with DF- LCP. In cases of 33C type fractures, closed reduction is attempted and if anatomically reduced fixed with MIPO technique, otherwise swashbuckler's approach is used to expose fracture fragments. All intraarticular fragments are reduced anatomically. In cases of medial wall comminution, medial side also augmented with plates and screws to prevent Varus collapse. After a thorough wound wash, closure is done in layers and aseptic dressing is done. The suction drain was used in some of the cases.

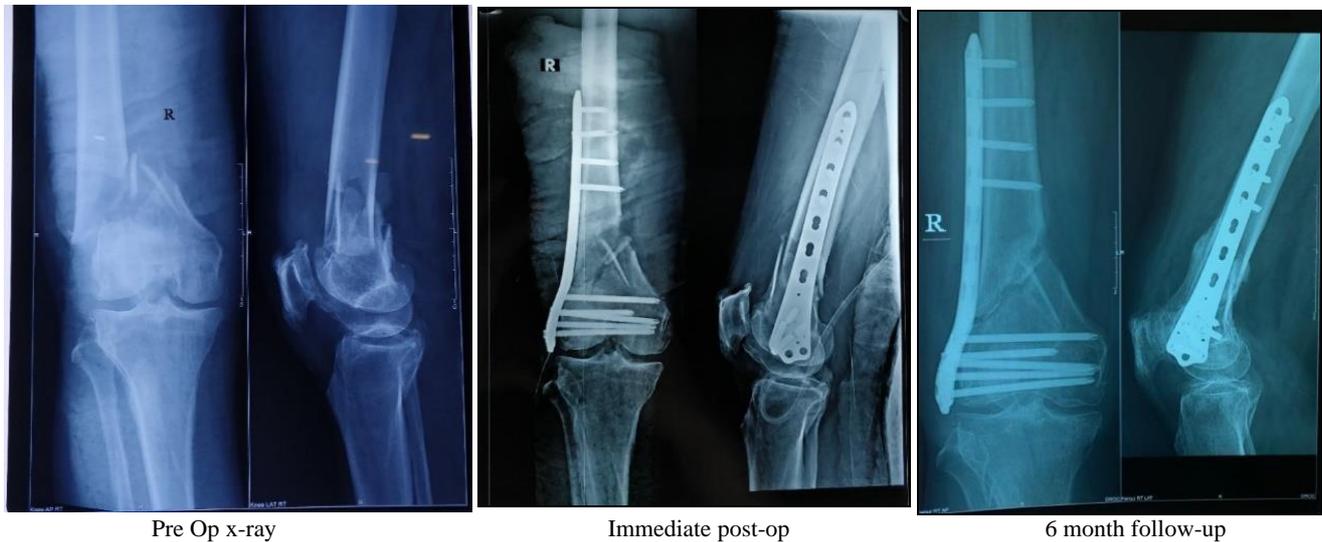
### Postoperative protocol and follow-up

Drains were removed within 24-48 hours of surgery. Antibiotics and analgesics medication were given as per patient's requirement. Sutures were removed after 12-14 post-operative day. Mobilization was started as soon as possible even from the first post-operative day. Joints should be mobilized by active or active-assisted movements. In the case of articular fractures, continuous passive motion may be helpful in restoring joint motion. Follow-up was done at 2 weeks, 6 weeks, 3 months and finally at 6 months postoperative period. On each follow-up visit, the radiological and functional assessment was done by Knee Society Scoring System [10, 11]. Non weight bearing ambulation was started as soon as possible, followed by gradual partial weight-bearing once the radiological union was noted on radiographs. After fracture consolidation, full weight-bearing was allowed.

### Goals of Rehabilitation

- About 65°-70° flexion is required during the swing phase of normal gait.
- About 90° flexion is required to ascend and descend stairs.
- About 105° flexion is required to rise early from a low chair and to tie one's shoes.

To achieve this, CPM was recommended daily for 2-3 weeks, till the patient achieves more than 100° flexion.



**Results**

In this study, 30 cases of distal femur fracture (closed or open upto grade IIIA) were treated with DF-LCP. The age of the patients ranged from 25 to 72 years, with an average of 45.9 years.

**Table 1: Age Distribution**

Age (in years)	No. of patients	Percentage
20-40	14	46.66
41-60	10	33.37
61-80	6	20

Among 30 cases, a total number of male cases were 20(66.66%) and female cases were 10(33.37%). The high male to female ratio in 11 (36.67%) patients on the left side. Right side involvement dominated over left, probably because right side is the dominant side in most people and during road traffic accidents the brunt of injury falls on the most active limb.

**Table 2: Side Distribution**

Side	No. of patients	Percentage
Right	19	63.33
Left	11	36.67

Out of 30 patients, there were 9 (30%) patients who had Muller type A1, 3 (10%) patient had A3 type, 8 (26.67%) patients had C1 type, 7 (23.33%) patients had C2 type and 3 (10%) patients had C3 type of fractures. our study may probably be due to males

involved more in outdoor activities hence, exposed to high-energy trauma.

**Table 3: Sex Distribution**

Sex	No of patients	Percentage
Male	20	66.66
Female	10	33.37

**Table 4: Classification of Fractures**

Muller type	No. of patients	Percentage
A1	9	30
A3	3	10
C1	8	26.67
C2	7	23.33
C3	3	10

In our study, the most common mode of injury was found to be RTA which affected 20 (66.67%) patients, followed by fall at home, in which there were 7 (23.33%) patients and fall from stairs which had 3 (10%) patients.

**Table 5: Mode of Injury**

Mode of injury	No. of patients	Percentage
RTA	20	66.67
Fall at home	7	23.33
Fall from stairs	3	10

In the present study, out of 30 patients, only 1 patient had developed the complication i.e. superficial infection. The

patient having a superficial infection was treated successfully with oral antibiotics.

Out of 30 patients, there are 19 (63.33%). Out of 30 patients, we found that minimum time for the radiological union was found to be 16 (20%) weeks, then followed by 18 to 20 weeks (43.33%), 2 patients took 22 weeks (6.66%) and 9 patients took more than 22 weeks (30%).

In our study, there were 18 patients who achieved >100 degrees of knee flexion, 9 patients achieved >80 degrees and 3 patients achieved >60 degrees of knee flexion.

Patients who got affected on the right side and in our study, 19 (63.33%) of patients had excellent results according to knee society score, 8 (26.67%) had a good result, 2 (6.67%) had fair and 1(3.33%) had poor results.

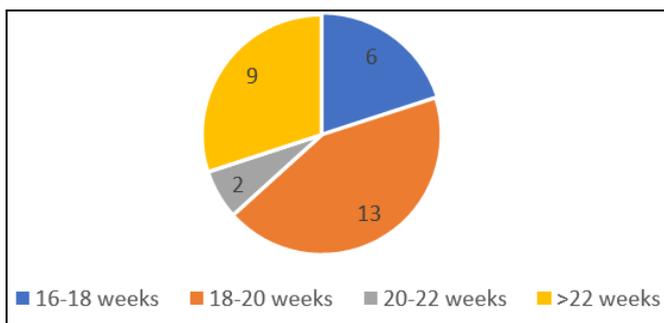


Fig 1: Radiological union

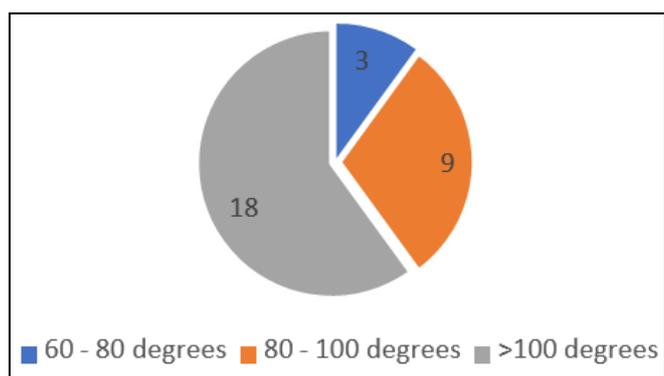


Fig 2: Knee Flexion

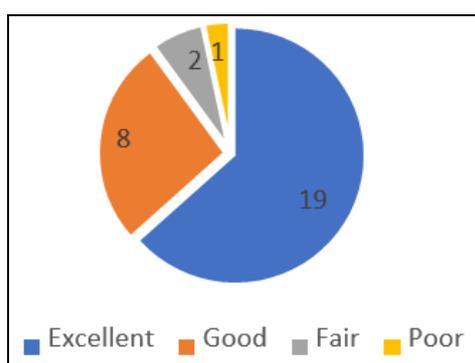


Fig 3: Outcome

## Discussion

The evolution of management of distal femoral fractures has come a long way from totally conservative management in the 1960's to definitive surgical treatment at present. There is an increasing incidence of comminuted distal femur fractures due to high-velocity motor vehicle accidents in younger population and increased life expectancy resulting in fractures following trivial fall due to osteoporotic bone. In both the groups our aim is to restore the function and near-normal

anatomy similar to the pre-injury status. There are many surgical alternatives for distal femur fractures, each with its own pearls and pitfalls. After the introduction of locking compression plate (LCP) by AO in 2000, the trend is shifting towards it due to its added advantages like,

- Providing both angular and axial stability
- Applied in both locking and compression mode
- Better hold in osteoporotic bone

The 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 [12]. Its unique biomechanical function is based on splinting rather than compression resulting in flexible stabilization, avoidance of stress shielding and induction of callus formation. It can also be used as a biological fixation without disturbing the fracture site [13]. The shaft holes on the Distal Femur-LCP are oval considering the alternatives of a pressure screw or a locking screw. This prompts a more exact position of the plate, as it can be compacted all the more near the bone.

The mean age in our study was 45.9 years and compared to other studies the mean age was 44 years in the Weight and Collinge [14] study, whereas 49 years in a study by Kregor *et al.* [8] and 44 years in Yeap E.J., and Deepak, A.S [15] study. Fractures of the distal end femur are more frequent in the older age group because of osteoporosis, but incidence in the younger age group was also increasing due to rising road traffic accidents.

In our study, most of the patients were males 20 (66.66%) as compared with females 10 (33.37%). A similar male preponderance was reported by other studies [14, 16]. Increased incidence in males is probably due to their involvement in outdoor activities, riding vehicles, and heavy manual labour.

In the present study right side was involved in 19 patients and the left side was involved in 11 patients. Right side involvement dominated over left, probably because the right side is the dominant side in most people and during road traffic accidents the brunt of injury falls on the most active limb.

In the current study, the mode of injury was a road traffic accident in 20 patients (66.66%), fall in 10 patients (33.37%). A similar pattern of the mechanism of injury was reported by Rajaiiah *et al.* [16] in their study. Road traffic accident was found to be a commoner mechanism of injury in younger males and domestic fall was found to be more common in elderly females.

Majority of fractures belonged to type C fracture which was 18 (60%) and 12 (40%) belonged to type A fractures. Rajaiiah *et al.* [16] also reported 65% type C fracture and 25% type A fracture. This indicates that type C fractures occur more commonly than type A. This signifies that most of the distal femoral fractures are caused by high energy trauma. They are associated with severe comminution and are unstable.

The minimum follow-up period in our study was 6 months.

It was found that there is only 3% infection rate. The patient having superficial infection was treated successfully with oral antibiotics. There was no implant failure found in our study.

The knee range of motion was found to be 0 to 110 degrees in our study. Comparing with other studies, in a study by Kregor *et al.* [8] the knee ROM was 2 to 103 degrees whereas in a study by Weight and Collinge [14] the knee ROM was 5 to 114 degrees and Yeap *et al.* [15] found knee ROM from 1 to 107 degrees.

Successful fracture union was defined as complete callus formation of at least 3 cortices and full weight-bearing without pain. In our study, the union time was found to be 16 weeks and comparing with other studies in which one study by Yeap *et al.* [15], the union time was found to be 18 weeks. The overall final outcome was assessed at six month follow-up by using the Knee Society Scoring System (KSSS). The mean Knee score was 73.76. Results were excellent in 19 patients (63.33%), good in 09 (26.67%), fair in 02(6.67%) and poor in 01(3.33%) whereas in a study by Yeap *et al.* [15], the mean score was 63.6 and the results were excellent in 50% of patients and good in 22.7%.

Our study concludes that fixation of distal femur fracture with locking compression plate (DF-LCP) showed excellent functional outcome with early union with good knee ROM, early weight-bearing and return to normal activity without any major complications.

### Conclusion

With the evolution of locking compression plating for distal femoral fractures, especially for the comminuted intra-articular fractures many of the older demerits could be addressed, which includes the increased stability due to locking compression plating principle, multiple screw options in the distal fragment providing option for fixing the multiple fragments restoring the anatomical congruity and providing stable fixation of the distal fragment with the proximal fragment with resulting increased stability allowing for early mobilization. Fixation with DF-LCP found to be effective in osteoporotic bones and reported shorter operative duration, faster recovery, early mobilization so short period of hospitalization, faster union rate and excellent functional outcome with few complication rates. However, careful understanding of basic principles and identification of appropriate fracture pattern are essential to produce excellent results.

### Limitation

Our study had a smaller sample size and shorter follow-up period.

No conflicts of interest.

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