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Surgical outcome of distal femur fracture by locking compression plate

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Abstract
Introduction: The following study was conducted to examine the short term clinical and radiological results particularly early complications and healing rate of distal femur fracture treated with DF-LCP.
Methodology: The study was conducted in patients treated for distal femur fracture (type A, B & C – AO classification) at ADHICHUNCHANGIRI INSTITUTE OF MEDICAL SCIENCE, BG Nagar from the month of Nov 2013 to May 2016. Fifty distal femur fracture patients were taken into the study, all were fixed with DF-LCP with Bone grafting where the distal femur fractures were associated with extensive bone loss. Patients' age ranged from 22 to 74 years with a mean of 44.
Results: The sample consisted of fifty patients with 32 males and 18 were female. The patients' ages ranged from 22-74 years with a mean age of 44 years. The causes of fractures were motor vehicle accident in 33 patients and fall in 17 patients. There were no sports or industrial accidents. 33 fractures involved the right side and 17 involved the left. The average length of hospitalization was 15 days with a range of 10 to 20 days. The average number of days from injury to surgery was 5 days with a range of 2 to 08 days. The operative time ranged from 60 minutes to 180 minutes. Patients were followed up from 01 to 24 months. Functional outcome was rated as per NEER'S RATING SCORE, we got excellent results in 19 cases, good in 20, fair in 08 and poor in 03 patients.
Conclusion: 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. We recommend use of this implant in Type A, B, C and osteoporotic fractures. Our early results were encouraging but long term studies are needed to prove definitively acceptable outcomes so that the technique can become part in the armamentarium of the orthopedic trauma surgeon.

Keywords: Distal femur fracture, bone graft, osteoporotic fracture, Neer's rating score, Distal femur - LCP

1. Introduction
The supracondylar area of the femur is defined as the zone between the femoral condyles and the junction of the metaphysic with the femoral diaphysis. This comprises approximately the distal 15 cm of the femur, as measured from articular surface. It is important to distinguish extra-articular fractures from intercondylar as the treatment and prognosis will be considerably different [2].
The incidence of distal femur fractures is approximately 37 per 1, 00, 000 person-years Distal femur fractures are complex injuries that could be difficult to treat [1]. "Few injuries present more difficult problems than those associated with supracondylar and intercondylar fractures of femur"- Sir Reginald Watson Jones. The above statement by one of the great orthopaedician aptly describes the complexity in treating these fractures. Severe soft tissue damage, comminution, intraarticular extension, injury to the Quadriceps and extra articular adhesions are some of the challenges faced by the surgeon [3]. These fractures are usually caused by high velocity trauma and trivial trauma in osteoporotic elderly patients.
The trend of open reduction and internal fixation has become evident in the recent years with good results being obtained with the AO blade plate, dynamic condylar screw, intramedullary

supracondylar nail & locking compression plates. Elderly patients with severe osteoporosis add further to the difficulties in management of fractures around knee which requires restoration of articular congruency for painless free movements of joint. Loss of stable fixation in osteoporotic bones is of great concern in such elderly patients. Nonetheless, internal fixation of the distal femur can be difficult due to thin cortices, a wide medullary canal, relative osteopenia, and fracture comminution make stable internal fixation difficult to achieve.

Internal fixation with locking plates creates a toggle free, fixed angle construct [5]. 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 [5]. The implant offers multiple points of fixed-angle contact between the plate and screws in the distal part of femur, theoretically reducing the tendency for varus collapse that is seen with traditional lateral plates. It is now well recognized that the best treatment option for distal femur fracture is open reduction and internal fixation DF-LCP allows both locking and compression screw. Fixation of the distal femur fracture along with articular surface realignment. Locking compression plates with its innumerous advantage is of great use in such circumstances. Locking compression plate has the advantage of combination of conventional compression plating and locked plating techniques which enhances the plate osteosynthesis. Anatomically precontoured built reduces soft tissue problems and acts as internal external fixator. In addition, a Locking plate has got distinct advantages of unicortical fixation and least chance of plate back out as the screw gets locked to the plate.

The DF-LCP is a further development from the LISS which was introduced in the mid to late 1990's. The main difference between the DF-LCP and the LISS is that the LISS utilizes 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. Further, Minimal soft tissue injury occurs when closed reduction is done and MIPO technique is used. The shaft holes on the DF-LCP are oval allowing for the options of a compression screw or a locking screw[4]. This leads to a more precise placement of the plate, as it is able to be compressed more closely to the bone.

The purpose of this study is to evaluate the technical requirements, clinical results, radiological results, complications and out comes in the use of these locking compression plates in distal femur fractures.

2. Mechanism of Injury

The mechanism of injury in most supracondylar fractures is thought to be axial loading with varus, valgus, or rotational forces. A bimodal distribution of high-energy injuries in younger patients and low-energy elderly patients is typically seen with these injuries

In younger patients, these fractures typically occur after high-energy trauma related to motor vehicle or motorcycle accidents. In these patients there may be considerable fracture displacement, comminution, open wounds, and associated injuries. On the other hand, in elderly osteoporotic patients, fractures frequently occur after a minor slip and fall on a flexed knee, leading to fragility fractures through compromised bone. Notching of the anterior cortex of the distal femur while making femoral chamfer cuts during knee arthroplasty may predispose the distal femur to fracture.

The deformities that occur after a distal femur fracture are produced primarily by the direction of the initial fracture displacement and secondarily by the pull of the local musculature. Spasm and irritability in the quadriceps and hamstrings often lead to limb shortening with varus angulation at the fracture site as a result of the strong pull of the adductor muscles. Contraction of the gastrocnemius often produces apex posterior angulation and displacement of the distal fragment.

3. Materials and Methods

The study was conducted in patients treated for distal femur fracture (type A, B & C – AO classification) at ADHICHUNCHANGIRI INSTITUTE OF MEDICAL SCIENCE, BG Nagar from the month of Nov 2013 to May 2016. Fifty distal femur fracture patients were taken into the study, all were fixed with DF-LCP with Bone grafting where the distal femur fractures were associated with extensive bone loss. Patients' age ranged from 22 to 74 years with a mean of 44.

Technique: The patients were positioned supine with a sand bag beneath the ipsilateral hip to internally rotate the leg. A direct lateral approach was used to expose the fracture site. Skin incision was longitudinal and distally was centred over the lateral epicondyle. Fractures were reduced under direct vision using manual traction. Distal femur- locking compression plate length, axial and rotational alignment were checked and then placed over the fracture site. Fixation was achieved with distal and proximal locking screws and bone grafting done for fractures associated with extensive bone loss.

4. Results

The sample consisted of fifty patients with 32 males and 18 were female. The patients' ages ranged from 22-74 years with a mean age of 44 years. The causes of fractures were motor vehicle accident in 33 patients and a fall in 17 patients. There were no sports or industrial accidents. 33 fractures involved the right side and 17 involved the left. The average length of hospitalisation was 15 days with a range of 10 to 20 days. The average number of days from injury to surgery was 5 days with a range of 2 to 9 days. According to the AO/OTA classification system, there were 16 Type A1, 06 Type A2, 03 Type A3, 12 Type C1, 08 Type C2 and 05 Type C3 fractures. Among which 28 were closed and 22 were open fractures requiring bone grafting. Successful fracture union was defined as complete bridging callus in three cortices, together with painless full weight bearing. Functional outcome was rated as per NEER'S RATING SCORE, we got excellent results in 19 cases, good in 20, fair in 08 and poor in 03 patients.

4.1 Observation and Results

Table 1: Distribution of Sample by Age

Age (Years)	Frequency	Percentage (%)
18-30	16	32
31-40	10	20
41-50	08	16
51-60	06	12
61-70	04	08
71-80	06	12
Total	50	100

Table 2: Distribution of Sample by Sex

Sex	Frequency	Percentage (%)
Male	32	64
Female	18	36

Table 3: Distribution of Sample by Side

Side	Frequency	Percentage (%)
Right	33	66
Left	17	34

Table 4: Distribution of Sample by Mechanism of Injury

Mechanism Of Injury	No. Of Case	Percentage (%)
Road Traffic Accident	33	66
Fall From Height	17	34
Total	50	100

Table 5: Distribution of Sample by Type of Fracture

Type	No. Of Fracture	Percentage
Open	22	44
Closed	28	56

Table 6: Distribution of Sample by Type of Fracture (Classification)

Type		No. of Cases	Percentage
33 A	A1	16	32
	A2	06	12
	A3	03	06
33B	B1	-	-
	B2	-	-
	B3	-	-
33C	C1	12	24
	C2	08	16
	C3	05	10

Table 7: Distribution of Sample by Type of Reduction

Technique	Frequency	Percentage
Open	35	70
Mipo	15	30

Table 8: Distribution of Sample by Operative Time

Operative Time	No. Of Fracture	Percentage
0-60 MIN	12	24
60-120 MIN	31	62
120-180 MIN	07	14

Table 9: Distribution of Sample by Time Taken For Fracture Union

Union (Weeks)	No. Of Cases	Percentage
< 16	11	22
16-18	13	26
18-20	11	22
20-22	10	20
22-24	05	10

Table 10: Distribution of Sample by Full Weight Bearing Achieved

Achieved Times (Weeks)	No. Of Cases	Percentage
< 16	15	30
16-20	20	40
20-24	12	24
24-28	02	10

Table 11: Distribution of Sample by Knee Flexion

Knee Flexion (Degrees)	No. Of Cases	Percentage
< 90	03	06
91-119	12	24
> 120	35	70

Table 12: Distribution of Sample by Complications

Complication	No. Of Cases	Percentage
Stiffness	15	30
Delayed Union	04	08
Infection	05	10
Shortening	03	06
Knee Pain	07	14

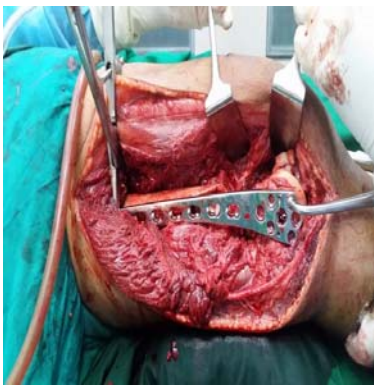
Table 13: Functional Rating as per Neer's Rating Score

Rating (In Points)	No. Of Cases	Percentage
Excellent (More Than 85)	19	38
Good (70-85)	20	40
Fair (55-69)	08	16
Poor (Less Than 55)	03	06

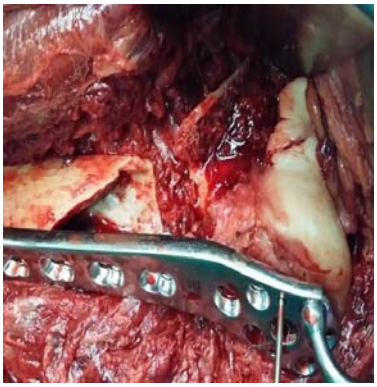
Case Series 01.

Pre Op Xray: Ap View

Pre Op Xray: Lateral View



Intra Op Plate Fixation



Intra Op Screw Fixation

Fibular Graft

Open Wound

Post Op Xray: Ap View

Post Op Xray: Lateral View

Follow Xray: Ap View

Follow Xray: Lateral View

Healed Operative Wound

Healed Compound Wound

Knee Flexion At 3rd Month

Full Extension At 3rd Month

Case Series 02.

Pre Op Xray: Ap View

Pre Op Xray: Lateral View

Follow Up Xray: Ap View

Follow Up Xray: Lateral View

Xray Showing Union

Follow Up Knee Extension

Follow Up Full Knee Flexion

5. Discussion

Our study comprised of fifty patients with Distal end Femur Fractures who were treated by Locking Compression plate. Overall final outcome was assessed in terms of regaining the lost knee function using NEER'S Score.

Out of fifty case series we had 28 closed fractures and 22 open fractures. 32 patients were males and 18 patients were females. The median age was 44 years ranging from 22-74 years, 33 of the fractures were caused by road traffic accidents and 17 were due to fall. 33 patients were with fracture on right side and 17 on left side.

Comparing our results with standard studies, In a study by Schutz M, Muller M *et al* [7]. Internal fixation using the LISS was performed at an average of 5 days (range: 0–29 days) after the injury. 48 fractures were operated on within the first 24 hours. Revision operations were required for 2 cases of implant breakage. 4 cases of implant loosening and 7 debridments to deal with infections. The study showed clearly that when working with LISS, pri*mary cancellous bone grafting was* not necessary. The total follow up rate was 93%. 5% non-union was observed.

Our results are comparable to the study with similar rates of infection although no cases of implant breakages and non-union were seen. Open reduction and bone grafting was performed for patients with extensive bone loss, unless in cases of simple metaphyseal fractures like 33 A1 where MIPO technique of reduction was done.

Weight and Collinge [10] retrospectively evaluated the use of the LISS locked plating construct in 22 distal femur fractures in 21 patients. All fractures achieved union at a mean of 13 weeks (range, 7 to 16 weeks) without the need for secondary intervention. There were no implant failures in this patient

cohort; at a mean of 19 months of follow-up, knee range of motion was 5 to 114 degrees.

In a similar retrospective evaluation of LISS plate fixation for 103 distal femur fractures, Kregor *et al* [6] reported a 93% union rate without secondary bone grafting. The remaining 7 cases went on to uneventful union subsequent to bone grafting procedures. At a mean follow-up of 14 months, the mean knee range of motion in this cohort was 1 to 109 degrees. Implant failure in the form of proximal screw loosening occurred in 5 cases, each requiring revision surgery.

In our study we treated 50 cases of distal femoral fractures with an average age of 44 years. The average union time was 18 weeks. In our study average time for union is slightly more when compared to the above studies this maybe in accordance with the fact that our cases were treated with open reduction and bone grafting for patients with extensive bone loss with incidence of infection (superficial) which is higher since we used open reduction and internal fixation.

Table 14: Distal Femur Comparison Studies

Study	No of cases	Mean follow- Up	Average time of Union	Implant failure
Weight and Collinge	22	19 months	13 weeks	None
Kregor *et al*	103	14 months	12 weeks	5
Yeap and Deepak	11	9.7 months	18 weeks	1
Present study	50	12 months	18 weeks	None

Yeap, E.J., and Deepak, A.S [8] conducted a retrospective review on eleven patients who were treated for Type A and C distal femoral fractures (based on AO classification) between January 2004 and December 2004. All fractures were fixed with titanium distal femoral locking compression plate. The patient's ages ranged from 15 to 85 with a mean of 44. Clinical assessment was conducted at least 6 months post-operatively using the Schatzker score system. Results showed that four patients had excellent results, four good, two fair and one failure.

Zlowodzki *et al* [9]. combined these series (n=327) and evaluated the outcomes as part of a systematic literature review. Average nonunion, fixation failure, deep infection, and secondary surgery rates were 5.5%, 4.9%, 2.1%, and 16.2% respectively. Some of the technical errors that have been reported for fixation failure have involved waiting too long to bone graft defects, allowing early weight bearing, and placing the plate too anterior on the femoral shaft.

Vallier *et al* [12] in his study concluded that locking plates should only be used when conventional fixed-angle devices cannot be placed. They noted the significant added cost of locking plates. To decrease the risk of implant failure with locking plates, they recommended accurate fracture reduction and fixation along with judicious bone grafting, protected weight bearing, and modifications of the implant design.

In our study, outcome in the form of regaining the lost knee function is assessed using NEER'S Score as shown below.

In 50 fractures around knee, 19 patients showed excellent result. 20 Patients showed good outcome 08 patients fair and 03 patients showed poor result.

6. Conclusion

1. Locking compression plate is a good fixation system for distal end femoral fractures particularly intra-articular type.
2. Operative time is certainly reduced when working with Locking Compression Plate since surgical dissection is kept to a minimum.
3. The device provides good angular stability by its triangular reconstruction principle and thus helps in early mobilization, even in communited fractures where other modes of fixation often tend to delay the process of mobilization because of lack of stability.
4. Perhaps one of its greatest applications, is in osteoportic fractures were it may provide a solution to the age old problems of screw cut out, late collapse, and malalignment since the stability of the construct does not entirely depend on the quality of the bone.
5. In contrast to other studies were LCP was used, our study used the plate through open reduction technique. However, when compared with other techniques of plating through open reduction technique the soft tissue damage is considerably less, since periosteal stripping and soft tissue exposure can be kept to a minimum. Use of Locking Compression Plate through LISS and Minimally Invasive Percutaneous Plate Osteosyntheses would probably further decrease the amount of soft tissue trauma
6. Our rates of knee stiffness, perhaps are slightly more than other standard studies.
   This maybe in accordance to the fact that patient mobilization was delayed due to non-complainant nature of the elderly patients.
7. There was one delayed-union in our study. Which we believe was due to technical errors in the fixation. This goes further to say that understanding the basic principles of fixation and the appropriate indications for use of LCP in fractures of distal end femur is a must, before its use.
8. We used bone graft in most comminuted fractures with extensive bone loss with a belief that open reduction warrants use of bone graft unlike MIPPO where results without bone graft are effective
9. There was not much difference in individual fracture type healing and weight bearing.

Thus, locking compression plate is an optimal tool for supracondylar fractures of femur. It provides rigid fixation in the region of femur, where a widening canal, thin cortices and frequently poor bone stock make fixation difficult. Surgical exposure for plate placement requires significantly less periosteal stripping and soft tissue exposure than that of normal plates. Orthopedic surgeons experience with locking compression plating technique will find it a useful technique. However careful understanding of its basic principles, identification of appropriate fracture patterns for use of LCP is essential to avoid complications like *generation of non-union.*

To conclude, Locking Compression Plate is an important armamentarium in treatment of fractures of distal end femur, especially when fracture is severely comminuted and in situations of osteoporosis. However a more comprehensive study with longer follow up periods is essential to throw more light into the advantages, complications and possible disadvantages of the use of Locking Compression Plate with special attention to the long term outcomes.

The distal femur- locking compression plate is a good implant

to use for fractures of the distal femur. However, accurate positioning and fixation are required to produce satisfactory results. We recommend use of this implant in Type A and C, osteoporotic fractures. Our early results are encouraging but long term studies are needed to prove definitively acceptable outcomes so that the technique can become part of the in the armamentarium of the orthopaedic trauma surgeon.

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