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Original Article

Evaluation of Results of Locking Compression Plate in Distal Femur Fractures

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Abstract

Aim of Study: The aim of this study is to treat distal femur fractures with locking compression plate (LCP) in 30 cases and to evaluate their functional and radiological outcome.

Materials and Methods: The present study was conducted in the Department of Orthopedics Surgery of SRMS-IMS, Bareilly, from November 2015 to July 2017. A total of 30 cases with 22 males and 8 females, fulfilling the inclusion criteria, with distal femur fractures were treated surgically with distal femoral-LCP using a direct lateral approach. 4.5 mm LCP, either of titanium or stainless steel, was used. All surgeries were done in supine position with a knee bolster under the affected limb and a tourniquet was used in all cases. Manual traction was used to reduce the fracture. Post-operatively, Oxford Knee Score was used to assess the functional outcome.

Results: At 6 months' final follow-up, 10 patients (33.33%) achieved range of motion between 120 and 140°, 17 cases (56.67%) achieved a read-only memory between 100 and 120°. 23 out of 30 cases (72.67%) showed a radiological union at 3 months' follow-up. 7 cases (23.33%) had radiological union at 6 months (24 weeks) of follow-up. In the present study, 56.67% of cases that is 17 of 30 cases had Oxford Knee Score of more than 41, 12 cases that is 40% had a score between 34 and 40, and only 1 had score between 27 and 33. In the present study, 17 cases, i.e., 56.67% showed excellent functional outcome, while 12 cases showed good and 1 case had fair outcome.

Conclusion: LCP in distal femoral fractures promotes early radiological union, good knee range of motion, decreased the post-operative hospital stay, with lesser infection rate as there is minimal soft tissue dissection. Finally, it can be concluded that the use of LCP provides good functional and radiological outcome in distal femur fractures.

Key words: Direct lateral approach, Distal femur fracture, Locking compression plate

INTRODUCTION

Distal femur fractures account for an estimated 6% of all femur fractures. The annual incidence of distal femur fractures is around 37/1,00,000 people.[1] 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. The treatment of these fractures has evolved over the past 50 years from closed treatment to open reduction and internal fixation with locked plating.

In the 1990s, it became well established that an internal fixation construct with flexibility leads to secondary bone healing. The method of plating using minimal invasive technique also preserved fragment vascularity and primary bone grafting was not required.[2]

The goal of surgical management of these fractures is anatomic reduction, maintaining the articular congruity and restoring limb alignment and early mobilization.[3] There are different surgical options available: Antegrade nailing, retrograde nailing, blade-plate fixation, isolated screw fixation, locked plating, and as a part of damage

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control orthopedics, external fixator use. The current trend is toward periarticular distal femoral locking plates used as minimally invasive percutaneous plate osteosynthesis (MIPPO) technique, using locking compression plate (LCP).

The LCP was developed to give surgeons the opportunity to combine principles of internal fixation and dynamic compression, depending on the fracture site, as it contains Combi holes. It 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 strength as seen in unlocked plates.[3]

These plates are anatomically contoured to fit the distal femoral flare, and as they are used by MIPPO technique, they allow prompt healing, lower rate of infection, and reduced bone resorption as blood supply is preserved.

The aim of this study is to evaluate the radiological and functional outcome of distal femoral LCP used in these patients.

MATERIALS AND METHODS

The present study was conducted in the Department of Orthopedics of SRMS-IMS, Bareilly, from November 2015 to July 2017, on a total of 30 cases of distal femur fractures treated with LCP, after obtaining approval from the Hospital Ethics Committee. 22 male and 8 female patients were taken in this study.

The patients were initially evaluated in the emergency department according to the ATLS guidelines. Once other injuries were ruled out and a patient was hemodynamically stabilized, and then, the injured limb was immobilized on a Bohler-Braun frame. The patients were then sent to the radiology department and X-ray was taken of the affected limb, thigh with knee in anteroposterior (AP) and lateral views, and the fracture pattern was decided. The fracture was classified according to the AO classification of fractures. All patients above the age of 18 years of either sex with closed or compound fractures up to Grade II or patients with osteoporotic bones were included in this study. Patients with head injury or chest injuries and pathological fractures were excluded from this study. Similarly, patients were medically not fit for surgeries, and patients with Gustilo Type III compound injuries or previously treated fractures were not taken into this study. 4.5 mm LCP was used which has 50° of longitudinal screw angulation and 14° of transverse screw angulation with uniform hole spacing. 4.0 mm and 5.0 mm self-tapping locking screws with 3.2 mm and 4.3 mm drill bits, respectively, along with threaded sleeves are available. Both titanium and SS plates were used according to the patient affordability.

Surgical Technique

A patient was taken in supine position on the O.T. Table. Fracture reduction was done under direct vision using manual traction. A knee roll or bolster was placed to assist in procurement and maintenance of reduction. A tourniquet was applied to get a bloodless surgical field. The posterolateral margin of the lateral femoral condyle was palpated. The incision given was 5 cm for MIPPO technique. The vastus lateralis muscle was blunty dissected from the lateral intermuscular septum. Using the periosteal elevator, the lateral femoral condyle cleared of soft tissue. The plate length and axial and rotational alignment were checked under image intensifier. Provisional use of K-wires was done to build the articular block. Intercondylar type was first converted to single condylar block. The K-wires were placed in such a way that they did not obstruct the part of distal femur where plate had to be fixed. Then, the plate was inserted and they were held in place using K-wires through the slot given for the k-wires to pass. Position of the plate was confirmed in both AP and lateral X-rays under image intensifier. Then, the distal central cancellous screw was placed first and then other screws. Proximal screw insertion was done using minimally invasive technique. Compression screws were used to approximate the plate to the femoral shaft. Tourniquet was removed, and after achieving hemostasis, closure was done in layers and sterile dressing was then applied [Figures 1-7].

Post-operatively, the foot end of the limb was elevated using pillows. Antibiotics and analgesics were given according to the hospital protocol. Knee mobilization was started the next post-operative day. Stitch removal was done on the 14th post-operative day in all cases. The patient was kept non-weight bearing for 10–12 weeks.

Follow-up was taken at 2 weeks, 6 weeks, 12 weeks, and 6 months to assess the functional and radiological outcome. Radiological outcome was checked using X-rays in AP and lateral views. Oxford Knee Score was used to assess the functional outcome. It is a questionnaire consisting of 12 questions assessing the functional status of the patient.

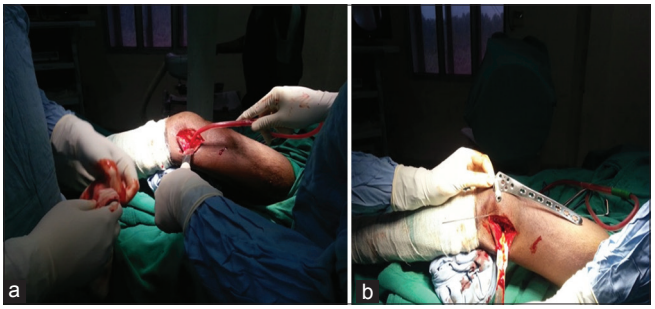

Figure 1: Intraoperative photographs showing the incision taken for MIPPO plating and estimation of length of the plate to be used

Figure 2: Case 1 - Pre-operative X-ray

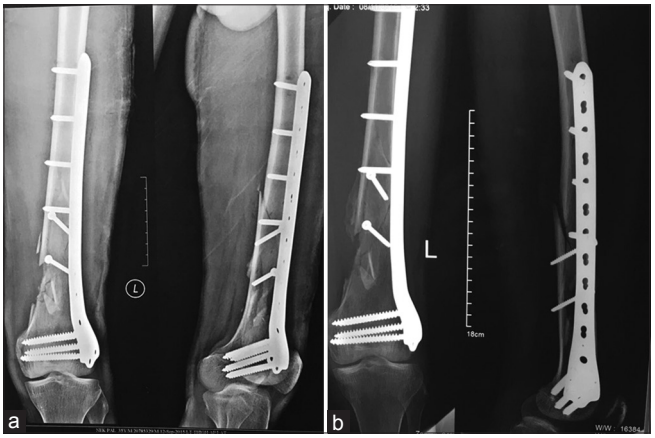

Figure 3: Case 1 - (a) Immediate post-operative X-ray. (b) Post-operative at 6 months

Figure 4: Case 1 - (a and b) Clinical photo showing full extension and flexion

Maximum score given is 48. Score of >41 is excellent; 34–40 is good functional status; 27–33 is fair; and score of <27 is considered poor functional result.

RESULTS

The present study consisted of a total of 30 patients with an average age of 44.8 years ranging from 18 to 82 years. The maximum number of cases (27%) was in the age group below 30 years owing to the high-velocity trauma, whereas low-velocity trauma was seen in only 1 case, where the age of the patient was above 70 years. Right side was commonly involved than the left. Distal femur fractures due to road traffic accidents made the bulk of this study, while only 2 cases were due to trivial fall at home. AO classification has been used in this study to classify the fracture pattern, which helped in deciding the fracture pattern. Distal femur is numbered 33 according to AO group. It is further divided into 3 types: Type A - extraarticular fracture, Type B - partial articular fracture, and Type C - intraarticular fractures, each class is then further divided into 3 types. In this study, there were 12 cases belonging to Type 33A, 2 cases in Type 33B, and 16 cases belonging to Type 33C, which made the maximum number of cases in this study.

Figure 5: Case 2 - Pre-operative X-ray

The duration between injury and surgery time ranged from 2 to 11 days with an average interval of 4.3 days. Majority of the cases, that is, 60%, were operated within the first 5 days of the injury. Cases that showed a delay were due to either late hospital presentation or because the patient had other associated injuries. Some cases had massive swelling and surgery was postponed until skin showed signs of wrinkling. The main mode of injury was high-velocity trauma and so the patient also had associated injuries. Patella fractures were seen in 4 cases, tibia fracture in 2 cases, proximal femur in 1 case, and vertebral fractures in 1 case.

The period of hospital stay varied from 7 days to 14 days. The average post-operative hospital stay was 10.9 days. 22 cases had a hospital stay of 10 days.

The radiological union time was assessed by getting X-rays on the follow-up visits. 23 of 30 cases (72.67%) showed a radiological union at 3 months' follow-up. 7 cases (23.33%) had radiological union at 6 months (24 weeks) of follow-up. The mean knee range of motion was 113.8°, with two patients showing 10° of extension loss. Flexion of at least 110° was considered satisfactory, and 2 cases had unsatisfactory knee range of motion.

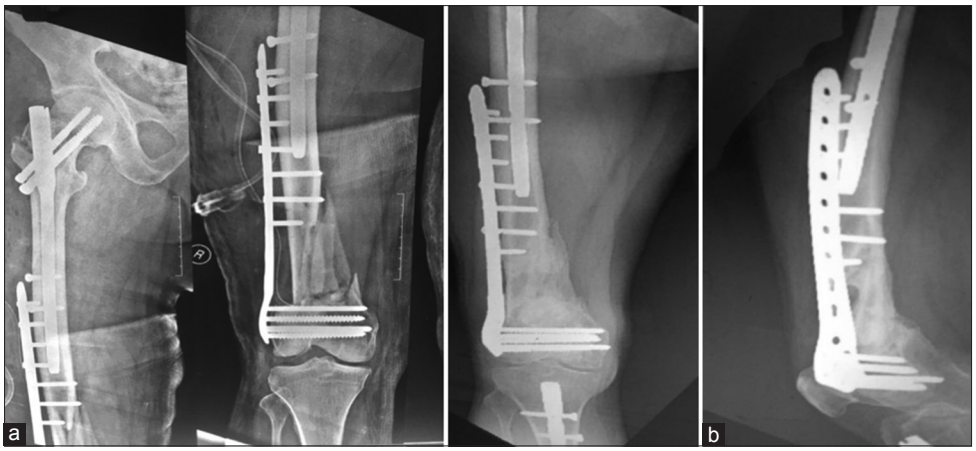

Figure 6: Case 2 - (a) Immediate post-operative. (b) Post-operative after 6 months

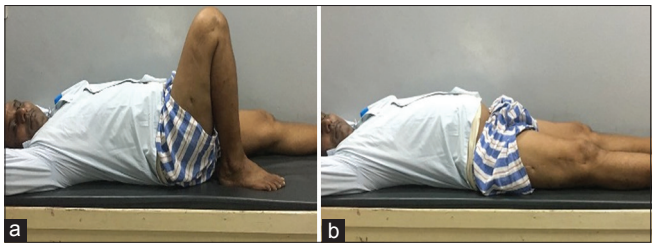

Figure 7: Case 2 - (a and b) Clinical photo showing full extension and flexio

The mean Oxford Knee Score is 40.6. The Oxford Knee Score is a functional knee score of consisting of 12 questions. Total score is taken as 48. In the present study, 56.67% of cases that is 17 of 30 cases had a score of more than 41, 12 cases that is 40% had a score between 34 and 40, and only 1 had score between 27 and 33. Grading is done according to the score. It is designated as follows: Excellent - more than 41, good - 34–40, fair - 27–33, and poor - <27. In the present study, 17 cases, i.e., 56.67% showed excellent functional outcome, while 12 cases showed good and 1 case had fair outcome. There was no case with a poor functional outcome.

Of a total of 30 cases in the present study, 13 cases had complications. There were no cases of any deep infection, malunion, or skin necrosis. 2 cases had superficial infection, 7 had delayed union, i.e., union seen at 24 weeks of follow-up, 2 had knee stiffness that is 6.67%, and 2 cases had extension lag of 20° and 10°, respectively (6.67%) [Tables 1-3].

DISCUSSION

The present study consisted of 30 patients with distal femur fractures who were treated by LCP. The radiological and functional outcome was assessed using Oxford Knee Score.

Distal femur fractures have always shown a bimodal age distribution. High-speed vehicular accidents are responsible for distal femur fractures commonly observed in the young and middle aged. Low energy mechanisms such as fall at home may be responsible for producing fractures of distal femur in elderly osteoporotic population, especially post-menopausal women. Fractures of the distal part of the femur are difficult to treat and present considerable challenges in management. Pain, decreased range of motion, and compromised function of the knee joint are a common problem arising out of articular incongruity and improper fixation of articular fragments in such fractures.[4] A study done by Hoffman *et al*.[5] did not show any difference for non-union rates or hardware failure between titanium and stainless steel. This result matched to the present study where no cases of non-union were seen and both titanium and stainless steel implants have been used.

Axial stiffness and torsional rigidity of internal fixation are mainly influenced by working length. There is a fine line between flexible fixation, which enhances callus formation and improves the healing process, and a rigid fixation, which leads to non-union and/or implant failure. Short spanning segments concentrate the stress moment and may lead to failure of the construct. A 34% higher load to failure in axial loading for the less invasive stabilizing system (LISS) construct in comparison to the Amgen biosimilar candidate was demonstrated by Kregor *et al*. In the comparisons of the energy to failure in axial loading, the LISS constructs absorbed almost 2.5 times as much energy as the angled blade plate constructs and more than 5 times as much energy as the intra-medullary nailing constructs before failing.[6]

Table 1: Radiological union in weeks

Duration in weeks	Number of cases (%)
≤12 weeks	23 (76.67)
12–24 weeks	7 (23.33)
Total	30 (100)

Table 2: Range of motion at end of follow-up

Range of motion	Number of cases (%)
Up to 100	3 (10)
100–120	17 (56.67)
120–140	10 (33.33)
Total	30 (100)

Table 3: Grading according to the Oxford Knee Score at end of the follow-up

Grading	Number of cases (%)
Excellent	17 (56.67)
Good	12 (40)
Fair	1 (3.33)
Poor	0 (0)
Total	30 (100)

In a study on biomechanical testing of the LCP by Ahmad M *et al.*,[7] it was stated by increasing the distance from 2 to 6 mm and both torsional rigidity and axial stiffness decreased by as much as 10–15%. It was found that increasing the distance between the plate and the bone significantly affected the construct stability. It was concluded that LCP behaved in a mechanically similar manner when fixed either flush to the bone or at 2 mm from the bone. However, when the LCP is fixed at a distance of 5 mm from the bone, both axial stiffness and torsional rigidity are decreased significantly. In the present study, majority of the patients (72.67%) showed a radiological union at 12 weeks of follow-up and delayed union seen in 7 cases that is union seen at 24 weeks' follow-up, which matched the study done by Kanabar *et al.* of 12.5 weeks. The callus formation was assessed in both lateral and AP radiographs.[8]

The average range of motion in this study was 113.8°, which was similar to the mean read-only memory in other studies mentioned in review of literate. In a study done by Pushkar and Bhan.,[9] it was stated that normal knee flexion is 140°. Laubethal *et al.* have demonstrated that average motion required for: Normal - 93°, sitting - 100°, and squatting - 117°. The functional outcome in this study was assessed using the Oxford Knee Scoring system. The mean score in this study was 40.6. Ganesh *et al.*[10] in their study of LISS in treatment of distal femur fractures showed 8% good and 92% excellent result using the Oxford Knee Score. In our study, there excellent result was seen in 50% of cases, while 46.67 had good results.

Philips *et al.*[11] stated that the possible disadvantages of the use of the LISS fixator for distal femoral fractures include reduction difficulties of the metaphyseal-diaphyseal component of the fracture and accurate fixator placement. In addition, its use is technically demanding because fracture reduction and fixation must be obtained and performed simultaneously. In the present study, there were 2 cases of superficial bacterial infection, 7 case of delayed union where radiological union was seen at around 24 weeks, and 2 had extensor lag of 10°.

CONCLUSION

From the present study, it was concluded that LCP in distal femoral fractures promotes early radiological union, good knee range of motion, decreased the post-operative hospital stay, with lesser infection rate as there is minimal soft tissue dissection. Maximum of the patients were able to reach near normal joint motion by the end of 6 months and were assessed using Oxford Knee Score.

Finally, it can be concluded that the use of LCP provides good functional and radiological outcome in distal femur fractures.

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