Research Article

Treatment of distal end of fracture femur by locking compression plate

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Abstract

Background: Treatment of distal femur fracture is challenge and usually requires to be treated surgically. Complexity of fractures needs the treatment to be changed from simple extraarticular supracondylar types to intercondylar and metaphyseal comminuted types. The locking compression plate (LCP) possesses exclusive biomechanical function that depends on splinting and not on compression, leading to flexible stabilization, quick healing, and decreased bone resorption as blood supply is conserved.

Objective: To evaluate the functional outcome and complications of distal end femur fractures treated with LCP based on rate of union, time till union, rate of infection, varus and valgus malalignment, and fixation failures.

Materials and Methods: A prospective study carried out over 1 year and enrolled totally 20 cases of fracture of lower end of the femur. Fractures were classified with the help of radiographs according to the AO-ASIF classification. Reduction of the condyles and fixation were done, and titanium plate was implanted with locking compression screws. Patients were followed up for 9 months and assessed clinically, radiologically, and functionally for functional outcome, fracture healing, and the complications of fracture and surgery.

Result: The most common age group was 51–60 years (6), with male (16) predominance. The most common type of fracture according to Müller's classification was Müller's type C1 (30%). All patients underwent surgery within 7 days of injury; 85% patients showed radiological union within 18 weeks, and 70% patients achieved weight bearing within 14 weeks. Thirteen (65%) patients achieved knee flexion more than 110° and 5 (25%) patients achieved flexion between 90° and 110°. Two patients revealed shortening of 15 mm and one patient showed shortening of 10 mm; 55% (11) achieved excellent while 25% (5) had achieved good functional results according to Neer score.

Conclusion: LCP is a significant armamentarium used in the therapy of fractures of distal end femur. However, careful understanding of its basic principles and identification of appropriate fracture pattern for use of LCP are essential to avoid complications such as generation of infections and non- and delayed unions.

KEY WORDS: Fracture of distal end of femur, locking compression plate (LCP)

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Introduction

Distal femur fractures exhibits an incidence ratio of about 37 per 1,00,000 person-years.[1] They chiefly occur from two different injury mechanisms. The most common cause is the high energy trauma majorly sustained in road traffic crashes. Intricate knee ligament injuries commonly exist in addition to widespread cartilage injuries.

Majority of surgeons approve that distal femur fractures require operations to attain optimum patient outcomes.[2] The traditional operative treatment are plating techniques that need compression of the implant to the femoral shaft (blade plate, Dynamic Condylar Screw, and nonlocking condylar buttress plate), antegrade nailing fixation, retrograde nailing, submuscular-locked internal fixation, and external fixation.[2] Nonetheless, because the difficulty of fractures requiring treatment has altered from simple extraarticular supracondylar forms to intercondylar and metaphyseal comminuted forma, these implants may not be suitable. Double plating, and in recent times, locked plating methods have been advised. However, in double plating method, generally, there exists widespread soft tissue stripping on both sides of the femur, leading to decreased blood supply and possible nonunion and failure of the implants.[3–5]

The locking compression plate (LCP) is a single beam construct in which the fixation strength is proportional to the summation of all screw–bone interfaces instead of a single screw's axial stiffness or pullout resistance as observed in unlocked plates. Its exclusive biomechanical function depends on splinting and not on compression, leading to flexible stabilization, evasion of stress defensive, and induction of callus formation. Furthermore, when it is used through a minimally invasive technique, it enables quick healing, decreased rates of infection, and reduced bone resorption as blood supply is conserved.[6]

Internal fixation with LCPs forms a toggle-free, fixed-angle construct. The implant provides numerous points of fixed-angle contact amid the plate and screws in the distal femur, hypothetically decreasing the trend for varus collapse that is observed with traditional lateral plates. The shaft holes on the distal femoral (DF)-LCP, which is an additional progress from the less invasive stabilizing system (LISS), are oval enabling for the choices of a compression or a locking screw. This enables a more accurate positioning of the plate, because it can be compressed more closely to the bone.[2,3]

Because there have been no published studies concentrating explicitly on the LCP condylar plate, this study will aid in defining the role of locking condylar plate in the treatment of distal femur fractures. In addition, the objectives of this study were to study the functional outcome for internal fixation of fractures of the distal end femur by LCP and to evaluate the effectiveness and complications of distal end femur fractures treated with LCP based on rate of union, time till union, rate of infection, varus and valgus malalignment, and fixation failures.

Materials and Methods

A prospective study carried out at City Hospital, Research and Diagnostic Center, Mangalore, Karnataka, India, from October 2011 to December 2012. The permission from institutional ethical committee was taken before starting the study. Patients admitted to hospital with all types of fracture of lower end of femur were included in the study. For inclusion in the study, fractures of lower end of femur with AO classification of A, B, and C with or without osteoporotic changes and closed fractures that were managed surgically were considered. Patients with open fracture, pathological fracture, and pediatric patients in whom growth plate is still open were excluded from the study. Patients who were lost to follow-up were also excluded from the study.

The enrolled patients underwent general and systemic examination and local examination. Thorough assessment of patient was done to rule out head, chest, abdominal, spinal, or pelvic injury. Evaluation of patients was performed in terms of mode of trauma, period between injury and arrival, and musculoskeletal examination of patient to rule out associated fractures. Radiological assessment such as anteroposterior and true lateral views of injured limb including complete knee joint and distal femur/proximal leg was done. Fractures were classified with the help of radiographs according to the AO-ASIF classification. Preoperative calculation was done on radiographs to ascertain the size of the plate, accurate size of locking, and cortical and cancellous screws. The implants used were the plate and the screws manufactured from 316L stainless alloy with gun drilling technique. The LCPs were available from 8-holed to 14-holed types, with 4.5 mm thickness precontoured plate head with soft edges for lower end of femur. Locking screws were in the head of the plate for a secure support. The head of the locking screw was threaded, which gets locked to the plate as it is tightened. LCP combiholes in the plate shaft were for intraoperative choice between angular stability and/or compression; 4.5-mm LCPs with 50° longitudinal screw angulation and 14° transverse screw angulation with uniform hole spacing.4.0- and 5.00-mm self-tapping locking screws with 3.2- and 4.3-mm drill bits, respectively, along with threaded drill sleeves are available.

Reduction of the condyles and fixation was done multiple 2-mm Kirschner wires. Plate was implanted with locking compression screws. Patients were monitored postoperatively, and splints were removed with mobilization of the limb started on the 3rd or 4th day postoperatively.

All patients were followed up at 4th, 10th, and 18th weeks and 6 weeks thereafter till fracture union was noted and subsequently at 4th, 6th, and 9th months. During follow-ups, patients were assessed clinically, radiologically, and functionally by Neer criteria.[7]

Results

Totally, 20 patients with fractures of the supracondylar femur were included during the study period of 1 year according to inclusion and exclusion criteria. Gender-wise distribution showed that 16 patients were men and 4 patients were women. As seen in Table 1, the patients were ranging from 22 to 68 years with maximum (6) between 51 and 60 years of age, and the median age was 44 years.

Eight patients revealed fractures on right side and 12 on left side. The cause of the fracture showed that 15 patients experienced fractures caused by road traffic accidents and 5 owing to fall. Table 2 shows the relation between age and

Table 1: Age distribution

Age (years)	Fracture lower end femur, *n* (%)
21–30	3 (15)
31–40	5 (25)
41–50	5 (25)
51–60	6 (30)
Above 60	1 (5)
Total	20 (100)

Table 2: Relationship between age and mechanism of injury

Age (years)	Vehicular accidents, *n* (%)	Fall, *n* (%)
>50	4 (20)	3 (15)
<50	11 (55)	2 (10)
Total	15 (75)	5 (25)

Table 3: Functional results according to Neer's criteria

Grade	No. of cases	Percentage
Excellent	11	55
Good	5	25
Fair	3	15
Poor	1	5

cause of injury, which shows the common cause of fracture of lower end of femur below 50 years of age to be vehicular accident and, above 50 years, to be fall.

Of the 20 lower end of femur fractures, 4 were Müller's type A3; 2, Müller's type B1; 6, Müller's type C1; 4, Müller's type C2; and remaining 4, Müller's type C3 [Figure 1]. All fractures were closed types. Eight patients showed associated injuries. Of them, two patients revealed comminuted fracture of contralateral tibia, two patients showed fracture of ipsilateral tibia, and two patients showed fractures of the acetabulum. One patient revealed fracture distal end radius and one patient ipsilateral patellar fracture. There were no cases of any major systemic injuries.

Five (25%) patients underwent surgery within 3 days of injury while other [75% (15)] patients underwent surgery between 4 and 7 days of injury. Average time duration of surgery was 124 min. The size of plate was selected based on the type of fracture. Ten to 12 holes plate were used in 12 (60%) patients, while 7 to 9 holes plates were used in 8 (40%) patients.

Radiological union was defined as presence of bridging callus across three cortices. Of 20 patients, 17 patients (85%) showed radiological union within 18 weeks, and 14 (70%) patients achieved weight bearing within 14 weeks.

Normal knee flexion is 140°. Laubethal has demonstrated that average motion required for normal sitting is 93°, for stair climbing is 100°, and for squatting is 117°. Thus, acceptable knee flexion compatible with daily activity would be 110°. In this study, 13 (65%) patients achieved knee flexion more than 110° and 5 (25%) patients achieved flexion between 90° and 110°. Only three (15%) patients showed knee extensor lag of more than 10°. Most of the patients [12 (60%)] revealed extensor lag between 0° and 5°. Of 20 patients, three revealed shortening—2 patients with shortening of 15 mm and 1 patient with shortening of 10 mm. In this study, very few patients showed significant varus/valgus malalignment. Five patients experienced varus and four patients valgus malalignment. However, it was <5% only.

As seen in Figure 2, 50% (10) patients revealed no any deterioration in work capacity and were same as before accident. Figure 3 shows complications of surgery. Only five patients developed complications, with four (20%) patients experiencing superficial infection at the surgical wound and one (5%) patient delayed union [Figure 3].

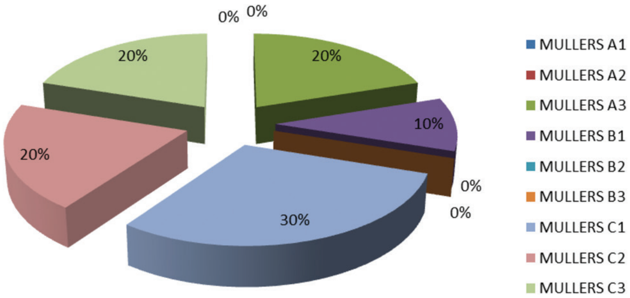

Figure 1: Fracture type according to Müller's fracture type.

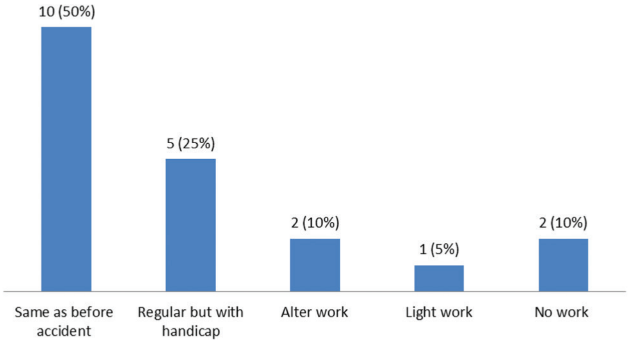

Figure 2: Work capacity after surgery.

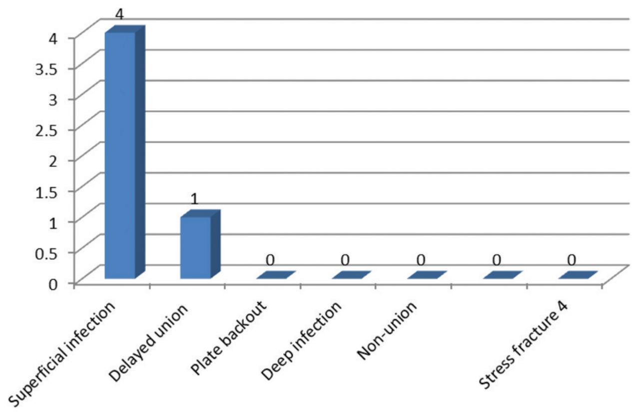

Figure 3: Complications of surgery.

Table 3 shows the functional capacity achieved during follow-up according to Neer criteria: 55% (11) achieved excellent while 25% (5) achieved good capacity. Only one patient was poor in achieving it.

Discussion

Constant design changes and enhancements have been observed in plate and screw fixation of fractures. Several distinguishing types and designs of plates according to their functional category are neutralization plates, buttress plates, compression plates, and bridge plates. Each has its own advantages and disadvantages. LCPs are fracture fixation devices with threaded screw holes, which allow screw to thread to the plate and function as a fixed-angle device.

In this study, 20 patients with distal end femur fractures were treated by locking condylar buttress plate. Overall final outcome was assessed in terms of regaining the lost knee using Neer score.[7] In this study, all patients underwent surgery within 7 days of injury, with 5 (25%) patients within 3 days of injury. Compared with a study by Schütz et al.,[5] internal fixation using the LISS was performed at an average of 5 days (range, 0–29 days) after the injury, which is similar with this study. However, revision operations were required for two cases of implant breakage in that study. While in this study, no patient required any revision of surgery. Average follow-up done in this study for each patient was 8 months, and during this time, patients were watched for time of reunion, functional achievement and regaining of work, implant failure, and other complications of surgery. Weight and Collinge[8] retrospectively evaluated the use of the LISS-locked plating construct, and nearly, all fractures achieved union at a mean of 13 weeks (range, 7–16 weeks) without the need for secondary intervention. While the study by Kregor et al.[6] reported a 93% union rate, without secondary bone grafting, within 12 weeks. In this study, average time for union was slightly more, i.e., 18 weeks, when compared with the abovementioned studies; this may be in accordance with the fact that all our cases were treated with open reduction. About 5% nonunion was observed in study by Weight and Collinge.[8] While in this study, no case of nonunion and only one case of delayed union was found. On analyzing it retrospectively, the reason for delayed union was believed to be owing to inappropriate use of locking screw at places where compression through plain screws should have been used.

The incidence of infection was on higher side, i.e., 25% (4), in this study, which were mainly superficial. The reason for higher incidence of infection were believed to be open reduction and internal fixation treatment. The study by Zlowodzki et al.[2] reported deep infection (2.1%), which was not found in this study. Kregor et al.[6] reported implant failure in the form of proximal screw loosening that occurred in 5 cases of 103 patients and each required revision surgery. However, no patient was found to reveal implant failure in this study, while Schütz et al.[5] reported four cases of implant loosening. Kregor et al.[6] reported mean range of motion knee to be 1°–109°. However, in this study, all patients achieved good movement with 13 (65%) patients showing knee flexion more than 110° and 5 (25%) patients achieving flexion between 90° and 110°, which is compatible with daily activity. This study reported that 11 patients showed excellent, 5 good, and 4 fair results, and only 1 showed poor result, while study by Yeap and Deepak[9] showed that, of 11 patients, 4 patients showed excellent results, 4 good, 2 fair, and 1 failure.

Strengths and Limitations of Study

The use of LCP was not utilized commonly for fracture around knee. This study can give basic data for management of this type of fracture and will help other orthopedic surgeons to manage their patients. However, the limitations were less patient population and short length of follow-up. The study could be extended with more patients and longer follow-up.

Conclusion

LCP is a significant armamentarium used in the therapy of fractures of distal end femur, especially when fracture is severely comminuted and in situations of osteoporosis. Surgical exposure for plate placement requires significantly less periosteal stripping and soft tissue exposure than that of normal plates. However, careful understanding of its basic principles and identification of appropriate fracture pattern for use of LCP are essential to avoid complications such as generation of infections and non- and delayed unions.

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