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Original Research Article

A Prospective Assessment of the Outcome in Terms of Radiology and Functions after Open Reduction and Internal Fixation of Distal Femur Fractures by Locking Compression Plate

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Abstract

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

Methodology: A prospective study was carried out where all the patients enrolled in the Department of Orthopaedics, Darbhanga medical College and Hospital, Bihar from July 2019 to June 2020 were included in the study based on the inclusion and exclusion criteria during the period of 1 year . The study involved both male and female patients with a supracondylar femur fracture. In present series 50 consecutive patients of supracondylar femur fracture operated with locking compression plate, satisfying the inclusion criteria were included. The study included those above 18 years with stable or unstable, comminuted or intra-articular fractures of the distal femur with no distal neuro-vascular complication and managed surgically. The Locking compression plate and screws are manufactured from 316 L stainless alloy with gun drilling technique were used. They are anatomically pre-contoured plate. Pre-operative work-up was done as required for fitness and anesthetic evaluation. 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, cortical and cancellous screws after subtraction of the magnification factor. All patients were followed up at 4^{th} 10^{th} 14^{th} 18^{th} week, 6 weeks, 6^{th} month, 9^{th} month and 1 year after surgery. During the follow up, patients were assessed clinically, radiologically and functionally by NEERS criteria.

Results: Out of 50 patients, 31 patients were males and 19 were females. The patients' ages ranged from 18 to 70 years with a mean age of 41 years. 32 fractures involved the right side, and 18 involved the left side. The causes of fractures were motor vehicle accident in 29 patients and a domestic fall in remaining 21. According to Muller's classification of distal femur, 9 were Muller's type A1; 14 Muller's type C1; 16 Muller's type C2; and 11 Muller's type C3. 36 of them had closed fracture and 14 open type fractures. Of 50 patients, 43 Patients (86%) showed radiological union within 20 weeks.Full weight bearing was started on an average 3-4 months after surgery. Average flexion in this study was 116 degrees with more than 66% patients having knee range of motion more than 110°. The functional outcome was assessed at the end of one year using Neer's scoring system as excellent in 31

(62%), good in 11 (22%), fair in 6 (12%) and poor in 2 (4%). Out of 50 patients, 42 patients had an excellent to fair results with no major complications.

Conclusion: From the present study, it can be concluded that LCP in distal femoral fractures promotes early radiological union and good knee range of motion. In our opinion, open reduction and fixation by LCP, in skilled hands can achieve normal anatomy of the articular surfaces, allows early ambulation and joint mobilization.

Keywords: Locking Compression Plate (LCP), Femoral fracture, Open reduction.

Introduction

The distal femur fractures are generally due to high velocity trauma particularly form road traffic accidents and fall from height [1]. 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 [2]. 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 incidence of these fractures is 0.5% of all fracture and 3% of all femoral fractures.The distribution of fractures is higher in woman of age more than 75 years and in adults ranging between 15-25 years [3].

The management of distal femur fracture imposes a high challenge to surgeons. Restoration of complete knee range of motion and function is highly challenging since these fractures are very close to the knee joint [4]. The management of distal femur fractures has both conservative as well surgical method for the treatment. The treatment of distal femur fractures has evolved from conservative to operative to fixation of both lateral and medial columns of femur [5]. The main aim of these methods techniques is to restore the normal anatomical functions of joints, accurate and stable fixation and to avoid varus or valgus angulation. In patients who have been treated by double plating there is an increased risk of need of bone grafting whereas single plating may be associated with less risk of need for subsequent bone grafting [6].

There are different surgical options available: Ante grade nailing, retrograde nailing, blade-plate fixation, isolated screw fixation, locked plating, and as a part of damage 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 [7]. 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

A prospective study was carried out where all the patients enrolled in the Department of Orthopaedics, Darbhanga medical

College and Hospital, Bihar were included in the study based on the inclusion and exclusion criteria during the period of 1 year (July 2019 to June 2020). The study involved both male and female patients with a supracondylar femur fracture. In present series 50 consecutive patients of supracondylar femur fracture operated with locking compression plate, satisfying the inclusion criteria were included. The study included those above 18 years with stable or unstable, comminuted or intra-articular fractures of the distal femur with no distal neuro-vascular complication and managed surgically. The Locking compression plate and screws are manufactured from 316 L stainless alloy with gun drilling technique were used. They are anatomically pre-contoured plate. Pre-operative work-up was done as required for fitness and anesthetic evaluation. 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, cortical and cancellous screws after subtraction of the magnification factor. The limb to be operated was prepared. One gm of third generation cephalosporin was injected 10 minutes before surgery.

Surgery was carried out in a supine position on a radiolucent table with a pillow below the knee, the entire injured extremity and ipsilateral iliac crest are prepared and draped. Tourniquet applied and inflated. The lateral approach to distal femur was taken. Minimal Stripping of soft tissue necessary for the application of the plate and reduction of the articular surface was done. Firstly, the condylar reduction was made with the aid of a Steinmann pin and levering it to restore the articular surface and patella-femoral groove. They were fixed with a 6.5 mm cancellous screws from lateral to medial, taking care not to interfere with the subsequent path of other cancellous screws of locking compression plate. Secondly, the condyles were reduced with respect to the shaft. When using the plate as a reduction aid, the compression screw draws the bone towards the plate and uses the contour of the plate to reduce the fracture in the coronal plane. Once the fracture was reduced, supplemental locking screws were then added to create a fixed-angle construct. Post-operatively, the patient's vitals were monitored. Splints were removed, and mobilization was started on 3rd or 4th day post-op which included non-weight bearing walking till 8 weeks, followed by partial weight bearing was recommended after signs of early callus till fracture union. All patients were followed up at 4th 10th 14th 18th week, 6 weeks, 6th month, 9th month and 1 year. During the follow up patients were assessed clinically, radiological and functionally by NEERS criteria.

Results:

In our study which was prospective; consisted of 50 supracondylar femur fractures treated with locking compression plate. Patients were followed-up for 12 months. 31 patients were males and 19 were females. The patients' ages ranged from 18 to 70 years with a mean age of 41 years. 32 fractures involved the right side, and 18 involved the left side. The causes of fractures were motor vehicle accident in 29 patients and a domestic fall in remaining 21. All of them had acute fresh fractures. According to Muller's classification of distal femur, 9 were Muller's type A1; 14 Muller's type C1; 16 Muller's type C2; and 11 Muller's type C3. 36 of them had closed fracture and 14 open type fractures.

Table 1: Demographic and fracture details of patients

Variables		No.	%
Age (in years)	18-30	13	26
	31-40	8	16
	41-50	10	20
	51-60	7	14
	>60	12	24
Gender	Male	31	62
	Female	19	38
Injury side	Right	32	64
	Left	18	36
Cause of fracture	Motor vehicle accident	29	58
	Domestic fall	21	42
Classification	Muller's type A1	9	18
	Muller's type C1	14	28
	Muller's type C2	16	32
	Muller's type C3	11	22
Type of fracture	Closed	36	72
	Open	14	28

11 patients had associated injuries. 2 patients had same side 5th rib fracture and 5th - 6th ribs fractures was seen in 3 patients. One patient each of ipsilateral mandible fracture, both bones i.e. radius and ulna fracture, humerus fracture, ulna fracture. 2 patients had associated head injury. All associated injuries were treated at the same timing accordingly.

44 patients were operated within 7 days of injury. Of the 6 patients for whom surgery was delayed more than 7 days, are those patients who had an open wound which was managed initially with AO External Fixator then ORIF with locking compression plate done. The operative time ranged from 90 minutes to 270 minutes with an average of 150 min. This is because few patients had associated injuries like mandible fracture, humerus fracture, radius and ulna fracture. In addition, anesthetist gave in few patients Fascia Iliaca block for post-operative pain management after the surgery which added to surgical time. The size of the plate used for fixation varied from 4 holed to 12 holed depending on fracture pattern. But commonly used size was 7-9 holed plates. Average blood loss was 200 ml.

Table 2: Various healing parameters and functional outcome of surgery.

Variables		No.	%
Mean time of radiological union (I weeks)	<16	5	10
	16-18	31	62
	19-20	7	14
	21-22	4	8
	Delayed union	2	4
	Non-union	1	2
Achievement of Full Weight Bearing (in months)	2-3	5	10
	4-5	41	82
	>5	4	8
Knee Range of	<90	5	10

Movement (in degrees)	90-110	12	24
	>110	33	66
Functional Outcome using Neer's Score.	Excellent	31	62
	Good	11	22
	Fair	6	12
	Poor	2	4

Of 50 patients, 43 Patients (86%) showed radiological union within 20 weeks. Mean time for Radiological union was 16 weeks. Partial weight bearing was started at an average of 8 weeks after surgery when there were early signs of callus formation. Full weight bearing was started on an average 3-4 months after surgery. Average flexion in this study was 116 degrees with more than 66% patients having knee range of motion more than 110°.

The functional outcome was assessed at the end of one year using Neer's scoring system as excellent in 31 (62%), good in 11 (22%), fair in 6 (12%) and poor in 2 (4%). Out of 50 patients, 42 patients had an excellent to fair results with no major complications.

Discussion:

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 [8].

Our study consists of 50 patients with distal femur fractures who underwent surgery using a locking compression plate. The overall outcome was evaluated in terms of regaining the lost knee function using NEER'S Score. 31 patients were males and 19 patients were females. The median age was 41 years; ranging from 18 to 70 years. Out of these, 21 of the fractures were caused by domestic fall and 29 were due to road traffic accidents. Road traffic accident as a mechanism of injury was observed more commonly in younger males and domestic fall was seen commonly in elderly females. We compared our outcomes with standard studies, and found the following similarities.

A study done by Hoffman et al. [9] 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 [10].

In a study on biomechanical testing of the LCP by Ahmad M et al. [11], 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%) showed a radiological union at 18 weeks of follow-up and delayed union seen in 4% cases, which matched the study done by Kanabar et al. The callus formation was assessed in both lateral and AP radiographs [12]. The average range of motion in this study was 116°, 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. [13], 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°. [14]

The potential pitfall of this procedure is incorrect placement of the plate in the distal femur which can be in excessive valgus, plate too anterior or posterior, plate too distal, plate is too much flexed, plate is too much extended or the plate is too far from the bone and this should be avoided.

Conclusion:

From the present study, it can be concluded that LCP in distal femoral fractures promotes early radiological union and good knee range of motion. In our opinion, open reduction and fixation by LCP, in skilled hands can achieve normal anatomy of the articular surfaces, allows early ambulation and joint mobilization.

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