



International Journal of Orthopaedics Sciences

ISSN: 2395-1958

IJOS 2019; 5(3): 637-641

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www.orthopaper.com

Received: 20-05-2019

Accepted: 24-06-2019

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Outcome of locking compression plate fixation of distal femoral fracture in adults: A prospective study

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DOI: <https://doi.org/10.22271/ortho.2019.v5.i3k.1604>

Abstract

Background: Distal femur fractures have always posed a challenge to orthopaedic surgeons. Different implants and modalities of fixation have been developed over the years for management of these fractures. The aim of this study was to analyze the complications and clinical outcomes following fixation with LCP as the treatment for distal femoral fractures.

Methods: In this prospective study, 30 patients with distal femur fracture were treated using distal femur locking plate at Department of Orthopaedics, Hassan Institute of Medical Sciences, Hassan, during 2017 to 2019. Extra-articular fractures were fixed with minimal invasive technique without exposing the fracture site and intra-articular fractures were treated by open technique. Neer's criteria was used for functional assessment.

Results: In our series majority of the patients were males 24(80%), predominantly with AO type C fracture, 26(86.6%). RTA was the major mode of trauma 22(73.3%). Average injury-surgery interval was 3.16 days. Average union time was 17.34 weeks and average range of motion was 102 degrees. According to Neer's criteria 17 patients had excellent results, 6 patients had good results, 3 patients had fair results and 4 patients had poor results.

Conclusions: We conclude that this implant should be used in distal femur fractures especially in, fractures with articular extension and combination. Locking compression plate allows early weight bearing which is an additional advantage for good vocational, mental, social and physical health.

Keywords: Distal femoral fracture, MIPPO, Distal femoral locking compression plate

Introduction

Fracture lower end of femur are often difficult to treat and they are associated with many complications. In the last few decades due to rapid industrialization and fast pace of life, have brought both comforts and catastrophe like road traffic accidents and crippling many young lives.

The incidence of distal femur fractures is approximately 37 per 1, 00,000 person-years [1]. Distal femoral fractures mainly arise from two different injury mechanisms. They are often caused by high energy trauma mainly sustained in road traffic accidents. Open injuries with considerable comminution of condyles and metaphysis are frequently seen, as is low energy trauma, relating to elderly patients with severe osteoporosis frequently seen as periprosthetic fracture.

Most surgeons agree that distal femur fractures need to be treated operatively to achieve optimal patient outcomes [2, 3, 4]. Although good internal fixation results have already been reported with these fractures over 30 years ago the number of revisions for non-union, loss of reduction and implant failure has been high [5]. The options for operative treatment are traditional plating techniques that require compression of the implant to the femoral shaft (blade plate, Dynamic Condylar Screw, non-locking condylar buttress plate), antegrade nailing fixation, retrograde nailing, sub muscular locked internal fixation and external fixation [2, 3, 6].

Most commonly used implant for the fixation of distal femur fractures are Fixed angle devices, usually in the form of Dynamic Condylar Screw (DCS) [7] system, which is a supracondylar plate combined with a lag screw. This two piece device is more forgiving and allows correction in the sagittal plane after the lag screw is inserted [8, 9].

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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 [9, 10].

Materials and methods

The study was conducted in the Department of Orthopaedics, Hassan Institute of Medical Sciences, Hassan, Karnataka, for a period of two years from 2017 to 2019. This is a prospective study in which thirty (30) consecutive cases of fracture of distal femur, aged 18-70 years, irrespective of sex were subjected to ORIF with locking compression plate fixation after obtaining written informed consent.

The following protocol was observed for patients with fracture lower end of femur

1. General and systemic examination as well as local examination of the patient.
2. Thorough assessment of patient to rule out head/ chest/ abdominal/spinal or pelvic injury.
3. Evaluation of patients in terms of:
 - a) Age
 - b) Sex
 - c) Mode of trauma
 - d) Period between injury and arrival.
4. Musculo-skeletal examination of patient to rule out associated fractures.
5. Stabilization of patient with intravenous fluids, oxygen and blood transfusion as and when required.
6. Careful assessment of injured limb as regards to neurovascular status.
7. Primary immobilization of involved limb in Thomas splint with a cotton pad below the distal fragment and transport of patient to the Department of Radiodiagnosis in the same.
8. Radiological assessment: Anteroposterior and true lateral views of injured limb including complete knee joint and

distal femur/proximal leg.

Inclusion criteria

1. The fractures of the distal femoral metaphyseal, metaphysiodiaphysal with or without intraarticular extension.
2. Age > 18 yr

Exclusion criteria

1. Fracture in patients of age < 18 years.
2. Any pathological fracture (except due to osteoporosis)
3. Associated with neurovascular injury.

Surgical technique

Treatment of fractures was performed utilizing the lateral approach in all patients. Fractures were reduced under direct vision using manual traction. A knee roll assisted the procurement and maintenance of reduction. The plate length, axial and rotational alignment were checked under image intensification. Temporary fixation was achieved through the use of Kirschner wires. Inter-condylar type fractures were converted to a single condylar block before DF-LCP fixation. Minimally invasive techniques were utilized where possible for insertion of proximal screws. Where applicable, compression screws were used to approximate the plate to the femoral shaft. Per op ROM, stability, alignment and limb length checked and recorded. The wound was closed in layers after attaining haemostasis. Pre operative intravenous broad spectrum antibiotic was started and continued the same till 5th day of surgery. Check X-ray (AP/Lat) of the limb was taken. Patients were put on static quadriceps exercises from the next day of surgery. Active assisted and active ROM along with active quadriceps and hamstring strengthening exercises were added from the 3rd day of surgery. Sutures were removed on 10th day and patients were allowed non-weight bearing walking for 6 weeks. Patients were followed up at regular intervals clinically and radiologically.

Osseous healing was defined radiographically as the presence of at least three of four healed cortices, with bridging callus formation and crossing trabeculae on AP and lateral radiographs. Clinical healing was defined as the absence of functional pain and local tenderness at the previous fracture site. Assessment of result was done by Schatzker and Lambert criteria. (Table 1)

Table 1: Schatzker and Lambert criteria for supracondylar fractures

Result	Criteria
Excellent	Full extension, No varus, valgus or rotational deformity, No pain, Perfect joint congruency
Good	Not more than one of the following. Loss of length not more than 1.2 cm, Less than 10° valgus or varus deformity, Flexion loss more than 20°, Minimal pain
Fair	Any of two criteria in good category
Poor	Flexion to 90° or less, Varus or valgus deformity more than 15°, Joint incongruency, Disabling pain no matter how perfect the X-ray.

Results

In our study 30 patients were included. All cases were fresh, ranging from few hours to 7 days. There were 24 male and 6 female. The age range was from 25 to 75 years. Maximum number of patient 17 (66.6%) was from age 30-50 years. 24 (80%) were males and 6 (20%) were females. Major cause of injury was road traffic accident 22 (73.3%) followed by self-fall 8 (26.6%) (Table 2) Road traffic accident was common in younger males and self-fall was seen in elderly female patients. 16 (53.3%) patients had fracture on left side and 14 (46.7%) on right side.

According to Muller's classification of distal femur, 3(10%) were A1 type, 1 (3.3%) was B1 type, 7 (23.3%) were C1 type,

8 (26.7%) were C2 type and 11 (36.7%) were C3 type. Mean union time in our study was 17.34 weeks. Associated injury was seen in 4 patients with 2 having patella fracture, 1 patient with ipsilateral posterior hip dislocation and 1 had Colle's fracture. Average injury-surgery interval was 3.16 days. 1 (3.3%) patient developed infection and subsequently plate was removed and fracture united in 24 weeks with discharging sinus and knee became stiff. There were no intraoperative complications. There were 2(6.67%) nonunion out of which one presented with implant failure and plate was broken, which required revision surgery with iliac crest bone grafting. Other nonunion was managed by bone grafting alone. Both cases united well after secondary procedure. 2

(6.67%) patients had limb length discrepancy because of severe comminutions at fracture site. 3(10%) patients developed varus collapse at fracture site, but range of movement was normal and none developed any other complications related to malunion in follow up. Active range of motion was 102 degrees with >90 degree in 21 (70%) patient and poor range of motion (<75 degree) in 4 patient (13.3%). According to Schatzker and Lambert criteria 17 patients had excellent results, 6 patients had good results, 3 patients had fair results and 4 patients had poor results. (Table 3)

Table 2: Mode of Injury

Mode of Injury	Number	Percentage
Road Traffic Accident	22	73.3%
Self-fall	08	26.7%

Table 3: Functional Outcome

Result	Number	Percentage
Excellent	17	56.7%
Good	6	20%
Fair	3	10%
Poor	4	13.3%

Discussion

To maintain the fracture biology and to minimize the soft tissue trauma, minimally invasive plating techniques have been developed for the fixation of distal femoral fractures. The main goals of the above-mentioned techniques are to maintain the important anatomy and to promote early fracture healing.

The violent nature of injury in young who sustains high velocity injuries during road traffic accidents and osteoporotic bones in elderly patients makes conservative treatment unsatisfactory option, in such cases internal fixation is the better option in distal femur fractures. The goal of treatment in such cases is to achieve a painless stable joint with normal range of motion. This can be achieved by fixation with such a device which allows rigid fixation of the articular surface gives respect to soft tissues and allows early weight bearing.

The DFLCP 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 pullout resistance as in unlocked plates. When applied via a minimally invasive technique, it allows for prompt healing, lower rates of infection and reduced bone resorption as blood supply is preserved. Locking plates have biological advantages over standard plates [11]. A standard plate grips the bone by friction created by the compression of plate against the bone by screws. This leads to impaired blood supply resulting in decreased cortical thickness and cancellous transformation of bone which in contrast to locking plates, as the locking plates are more biology friendly.

In the present study 30 cases of fracture of distal femur admitted in Department Of Orthopedics, Hassan Institute of Medical Sciences were operated upon using distal femoral locking compression plate. The age incidence in the present study is average of 48.3 yrs. Horesh Z *et al.* in their study found an average age to be 40.6 year (range from 30 to 70 years) [12]. Lee JA *et al.* in a similar study found the average age to be 42 years ranging from 18 to 82 years [13]. This reflects that distal femoral fractures around knee joint are common in young adult age group who are involved in outdoor activities. In the present study the most susceptible sex is males. Blocker CP *et al.* in their study on 64 patients

had 34 male and 30 female with male to female ratio of 1.13:1 [14]. The study done by Yeap and Deepak [15] showed that 63% affected were males. The high male to female ratio in our study is probably because males are more involved in outdoor activities especially road traffic accidents.

In the present study most of the fractures were type C. This suggests that with modernization there has been a steep increase in high velocity trauma. Comminuted intra-articular fracture were more common probably because RTA was the major mode of trauma and distal femur taking most of the brunt of injury because of the flexed position of knee joint during driving. Lee JA *et al.* in a similar study reported an incidence of 80% due to RTA, 11.4% due to fall from height, 5.8% due to blow and 2.8% due to shotgun injury [13]. This suggests that distal femoral fractures around knee joint commonly occurs due to high energy trauma. In our study there were 25 simple fractures (83.3%) and 5 open fractures (16.7%). Ali *et al.* in their study of 20 patients found five cases (25%) of open fractures [16]. This suggests that with increasing incidence of high velocity trauma, the cases of open fracture are on the rise. In our study the average interval between injury and surgery was 3.16 days (ranging from 1 to 8 days). Gosling T, Schandelmaier P, Mullar M in their similar study found average time to surgery was 7.5 day (range 0 to 28 days) [17]. Lee JA *et al.* found that all patients underwent operation within a mean time of 12 days (range 1 to 30 days) [13]. The lesser delay in surgery in our study could be because our institute is tertiary care centre where patients came after primary management outside. Secondly, at the time of presentation patients had less swelling and minor abrasions around knee. The average range of motion of knee joint was 102 degrees in our series. Stannard JP *et al.* [18] in their similar study measured average range of motion of 127 deg. (range 90-145deg) [14]. Lee JA *et al.* in their similar study found overall range of motion averaged 105 degree (range 0-135 deg) [13]. Cole PA *et al.* in their study found mean range of final knee motion of 122 deg [19]. Ryan JK *et al.* in their comparative study found that the average knee flexion in locked plating patients was 109 deg. (range 75-150 deg) versus 104 deg. in external fixation patients [20]. Good range of motion at knee can be attributed to early knee motion. Open reduction increases fibrosis and thus decreases subsequent range of motion, but this difficulty is minimally seen with less invasive methods like LCP fixation. The average radiological union time was 17.34 weeks ranging from 12 to 30 week. Lee JA *et al.* in their similar study found average time to healing of the 25 fractures as 4.2 months (range 3 to 7 months) [13]. Ryan JK *et al.* in their comparative study found that average time to union with locking plating was six months (range 3 to 14 months) versus seven months (range from 3 to 15 months) in external fixation group [20]. This suggests that periarticular fractures (around knee joint) with metaphyseal extension take longer with other methods of fixations when compared with locking plate fixation. Union radiologically was defined when at least 3 cortices showed signs of union and clinically when patient was able to bear full weight.

Complications such as superficial infections, deep infections, implant removal due to pain and malalignment in the form of varus malalignment was found. In 3 (10%) cases, there were coronal plane malreduction (valgus/varus). Lee *et al.* in a similar study noted malalignment of eight fractures (32%) postoperatively, in one case fracture healed in six degree of varus and in seven cases fractures had an articular angulation (in the sagittal plane) of six degree. There was no case of

secondary loss of reduction ^[13]. Cole *et al.* cited 3.9% of incidence of Malalignment ^[19]. Ryan *et al.* in their comparative study reported malunion (angulation and articular depression) in 14% of cases in locking group compared to 43% in cases of external fixator group ^[20]. There was limb length discrepancy in 2 cases. Revision due to implant failure was done in one case. One patient (3.3%) got deep infection. These findings are supported by studies by Egol *et al.* ^[12] with no reported infection, Stannard *et al.* with a 5.9% rate of infection ^[14], Cole *et al.* with an infection rate of 4% ^[19]. Ryan *et al.* with an infection rate of 7% in locking group and 13% in external fixator group ^[20] and Lee *et al.* with deep infection of 8% ^[13]. The infection rate seen in their study (4%) could be expected as distal femoral fractures are high energy injuries with high rate of soft tissue complications. The less incidence of infection in locking plate using minimal invasive technique is due to aseptic technique, minimal soft tissue handling, small invasion and minimal duration of surgery. In our series only 1 patient (3.3%) showed failure that is compatible with poor function. Rest of the patients was satisfied with the treatment outcome. Main advantage of the anatomically precontoured LISS plate

is soft-tissue protection using a limited approach and submuscular plate insertion, as well as percutaneous screw insertion facilitated by the aiming device. Fracture stabilization with the LISS system may render adequate reduction more difficult since the plate and the locking screws are not designed to approximate the fracture toward the plate ^[21]. In fact, prior to plate fixation, fracture reduction has to be performed and completed. Once a locking screw has been placed through the plate into bone, this particular bone segment can no longer be manipulated by insertion of additional screws or by using compression devices. The sequence of screw placement has to be well planned to avoid fracture malreduction. Useful tool includes "no hands" traction, femoral distractors, and percutaneous clamps ^[22]. Distal screws are inserted perfectly parallel to the distal femoral joint line. Any angulations of screws in projection to the joint line may result in increased valgus or more detrimentally, in varus deviation. The concept of bridging osteosynthesis implicates that the final fracture construct should be elastic and not too stiff to prevent formation of nonunion. Indication for DF-LCP plate osteosynthesis are as follows ^[23, 24].



Fig 1: Show the pre-operative 6 week and 3 months

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. It was also concluded that distal femoral locking compression plate can be used in treating highly comminuted fractures. Locking compression plate allows early weight bearing which is an additional advantage for good vocational, mental, social and physical health. We recommend use of this implant in Type A and C,

osteoporotic and periprosthetic fractures. Our results are encouraging but long term studies are needed to prove definitively acceptable outcomes.

Declarations

Funding: None

Conflict of interest: None

Ethical approval: Approved by Institutional Ethics Committee.

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