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Functional outcome of distal femoral fractures treated with DF-LCP [Distal femur locking compression plate]

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Abstract
Introduction: Management of distal femoral fractures is a therapeutic challenge to the orthopaedic and due to its extensive soft tissue injuries, bone loss, comminution, articular extension, instability and usually treated surgically. There is no single implant that can be used for all distal femoral fractures. The introduction of DF-LCP is a welcome change that has brought a drastic change in management of these fractures.
Aim: To evaluate the functional outcome of Distal femoral fractures treated with DF-LCP
Materials and Methods: This prospective study was carried out at orthopaedics department of a tertiary care teaching hospital of Southern Rajasthan from June 2013 to December 2015. A total 34 patients of AO Type A and Type C distal femur fractures were included in the study. The method used for fixation was closed or open reduction and internal fixation with DF-LCP. All the patients were followed up for a period of one year and functional outcome was assessed according to Neer's score system.
Results: On evaluation according to Neer's criteria mean score were 87 with a range of 62-97. Out of 34 patients 21(62%) had excellent, 11(32%) satisfactory and 2(6%) unsatisfactory result.
Conclusion: We conclude that DF-LCP is a safe and reliable implant for distal femoral fractures AO Type A and Type C. However careful understanding of basic principles and identification of appropriate fracture pattern for use of DF-LCP are essential to avoid complications and to produce excellent result.

Keywords: Distal femoral fractures, locking compression plate (LCP), Neer's score.

Introduction

Throughout the historic evolution of orthopaedic surgery the treatment of distal femur fractures has not achieved clinical result with a quality comparable to the rest of the femoral fractures. Distal femoral fractures are complex injuries with potential to cause long term disabilities. Distal femoral fractures occur at approximately one-tenth the rate of proximal femoral fractures and accounts for 6% of all femur fractures [1]. These are fracture involving the distal 15 cm of femur including metaphysis and/or the articular surface. Distal femur fracture can result from high energy trauma in young or middle aged patients or low energy trauma in elderly patients. High energy trauma such as motor vehicle accidents, sports injures and pedestrian accidents are common in men aged between 15-55years and low energy trauma such as fall from standing at home are most common in osteoporotic women age 50 years and above [1] In the past two decade there has emerged another patient population having periprosthetic fractures of distal femur with previous total knee arthoplasty or distal to a total hip arthoplasty.

The fracture characteristics which pose a therapeutic challenge to orthopaedic surgeon in management of these fractures include severe soft tissue damage, extensive comminution, multiplanar articular injury or intra articular extension, internal derangement of knee including injuries to ligaments and meniscal and injuries to quadriceps mechanism. Short distal femoral block in which it is difficult to insert fixation, associated open wounds, osteoporosis. A widen canal, thin cortex and poor bone stock further makes open reduction and internal fixation difficult in this area.

Previously the trend in the treatment of these fractures leaned towards closed conservative management with plaster cast and skeletal traction due to no availability of proper technique and implants to provide stable fixation, which had associated complications like limited.

Reduction, difficulty in maintaining reduction, malalignment, joint incongruity, delayed mobilisation and increased financial burden due to prolong hospital stay. Year 1960 witnessed a paradigm shift from non-operative measures to operative measures in management of distal femoral fractures. Still there was great reluctance towards operative management of these fractures because of high incidence of infection, non-union, malunion, inadequate fixation, and lack of proper instruments, implants as well as antibiotics.

In the 1970s the AO implants, instruments and fixation techniques revolutionized the treatment of these injuries, It is now recognized that majority of surgeons approve that distal femur fractures require operative management to attain optimum patient outcome [2].While non-operative methods has largely fallen out of favour as the result of advances in techniques and implants. In the present scenario of improved techniques and implants these fractures are best treated by surgical stabilisation which opens the way for anatomic reduction of articular surface, restoration of limb alignment and early mobilisation there by achieving early union and good knee function.

Some popular devices developed to treat these fractures are condylar blade plate, Dynamic Condylar Screw (DCS), Retrograde nails, & Condylar buttress plate. In spite of these developments, numerous problems related to fixation technique failure, varus collapse etc. continued to be reported especially when a comminuted fracture was there [3]. So a need was felt to develop an implant which can overcome the potential limitation of earlier implants. To address these issues distal femoral locking compression plates has been designed.

Current generation of distal femoral locking compression plate has the advantage of combination of conventional compression plating and locked plating technique which enhances the plate osteosynthesis [4, 5, 6]. Anatomically pre contoured built forms a toggle free fixed angle construct, reduces soft tissue problems and act as internal external fixator [5, 7] provide more stable fixation which is a key factor in the successful treatment of these fractures. The placement of plate is such that there is no contact with bone directly which helps in preservation of periosteal blood supply. [8, 9] They can be used in metaphyseal comminution. It also provides useful choice for extra articular fractureof distal femur. [10] In addition it does unicortical fixation and there are least chances of plate back out as the screw gets locked to plate [11, 12]. The pull out strength of locking screw is higher than conventional screw and is particularly useful in osteoporotic bone. These plates are designed to apply in minimal invasive fashion to preserve local biology and avoid problems with fracture healing and infection [13, 14]

.Thus achieving high union rates and generally good functional outcome.

This study was conducted to evaluate the Functional and clinical outcome of fracture distal femur in patients treated by open reduction and internal fixation with distal femur "Locking compression plate" (LCP). We also looked for any complication if occurred during study.

Materials and Methods

This prospective study was conducted in department of orthopaedics of a tertiary care teaching hospital of southern Rajasthan from June 2013 to December 2015 with a minimum follow up period of one year. Permission from ethical committee was taken prior to commencement of study and Preoperative counselling and informed consent of all the patients included in the study regarding the treatment, operation and study was obtained. All patients were operated by same surgical team.

A total of 34 patients with distal femoral fractures were included in study. The fractures were classified as per AO-OTA system. Patients of age 18 years and above of both sexes who have sustained distal femoral fractures AO-OTA classification type (A1, A2, A3, C1, C2, C3) were included in study. Patients who were less than 18 years of age, distal femoral fractures, AO-ATA classification (B1, B2, B3), pathological fractures, patients with periprosthetic fractures, patients with associated head, chest, visceral and vascular injuries (which precluded early surgery and interfere in early postoperative mobilisation) and patients with any fracture other than the distal femur in the ipsilateral limb, and who did not give consent were excluded from the study. Open fractures were not excluded from the study.

All the patients were initially managed in emergency department according to advanced trauma life support guidelines. All patients were evaluated clinically and proper history of the incident was elicited. The fractured limb was splinted in a Bohler Braun frame with the application of skin traction. Patients with open wounds received immediate wound lavage and were put on intravenous antibiotics, which continued post operatively according to requirement. Intravenous Metronidazole was administered in open fractures where anaerobic contamination was suspected. Radiological evaluation was done to assess the type of fracture, included anteroposterior and lateral X-Ray of the femur along with a pelvic X-ray to rule out proximal fractures. CT scan was done as per requirement. Preoperative investigations were done consist of complete blood count (CBC), serum electrolyte, renal function test, coagulogram, fasting or random blood sugar, viral markers. A blood group cross match of patient was sent to the blood bank prior to surgery. A chest X-ray and ECG were done for anaesthesia team. After getting all preoperative evaluation and fitness for surgery patients were operated with distal femoral locking compression plate (DF-LCP).

Surgeries were planned under spinal anaesthesia in most of cases on radiolucent operative table. Tourniquet applied where fracture site permitted, after templating limb was stabilized using various leg stabilizers and sand bags. In case of 33A type fractures closed reduction achieved using various instruments like clamps or ST pins using as joy stick to manipulate fracture fragments and fixation done by MIPO technique with DF- LCP. In cases of 33C type fractures closed reduction attempted and if anatomically reduced fixed with MIPO technique, otherwise swashbuckler's approach used to expose fracture fragments. All intraarticular fragments reduced anatomically. Extra articular components of fracture were managed by indirect reduction and bridge plating using TARPO technique (Trans articular approach and retrograde plate osteosynthesis). In cases of medial wall comminution, medial side also augmented with plates and screws to prevent Varus collapse.

Postoperatively, the operated limb was kept in elevation on a splint with the knee in 10-15 degree of flexion. The suction drain was removed after 24 hours and first wound inspection was done on same day. Intravenous antibiotics were continue for 24 hrs. In closed fractures and 72 hours in open fractures or according to requirement for more duration. Postoperative physiotherapy regime was tailored according to the fracture pattern, fixation achieved. Static quadriceps exercise with active hip and knee mobilization were started from the next

day of surgery. Active assisted ROM along with active quadriceps and hamstring strengthening exercises were added from 5-7th day of surgery, sutures were removed between 10th-14th days.

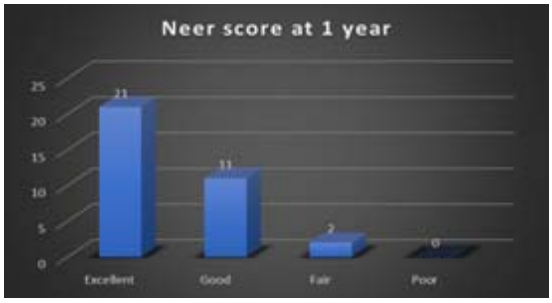
After discharge from the hospital, these patients were called for the first follow up at 2ndweeks and subsequent follow upwere done at 6wks, 3months, 4months, 6months, and 9months and at one year and bi annually thereafter. Patients were educated to report earlier for follow up if required.

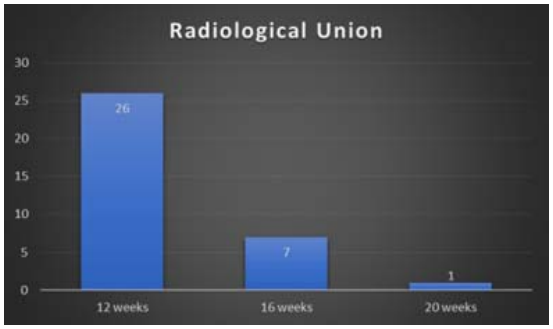
Check x-rays were taken in immediate postoperative period and on follow up visits. Any loss of reduction plate, plate lift off, screw back out or screw/plate breakage was recorded. Any other complication such as superficial or deep infection if encountered was also noted. During follow up visits clinical and radiological union was assessed. Initially patients were allowed non weight bearing crutch walking for 6 weeks. Gradual weight bearing was started on the evidence of bridging callus on follow up radiographs. Full weight bearing was permitted at approximately 3 months in majority of cases when signs of radiological union were present. On clinical examination if fracture site was stable and pain free, clinical union was considered satisfactory. Radiological union was considered satisfactory when plain x-ray showed bone trabeculae or cortical bone crossing the fracture site. Non-union was defined as failure of fracture union at 9 months follow up. All the patients had their final assessment at one year. No patients were lost to follow up. Clinical and functional outcomes were assessed by using Neer's Score [11]. Neer's criteria were used for over all functional rating and knee society score was used to quantitate the functional status of knee.

Result

Total 34 patients were included in our study, 25 patients were male, and 9 were females. Ratio male: female were around 3:1.Age ranged from 18 to 82 years where mean age of patients was 44.94 years. In most of young patients (26) RTA was the cause of injury while in old patients (08) cause was due to fall. Medical comorbidity was present in old age group like HTN, DM, and IHD.

In our study most of the cases due to high velocity RTA associated injuries were also present in 17 cases.24 cases were closed fracture, while 10 were compound type fractures. Length of hospital stay was from 4 to 28 days depending upon associated injuries and type of fractures, average duration was 12 days. Compound injuries required more than one procedures. Patients were operated within 1-12 days, few with compound injuries and unfit for anaesthesia were delayed for surgery. Operative time ranged from 1to 3 hours with average time 1.15 hours. Total blood loss ranged was 50 to 300 ml, average was 142 ml. 5 Patients in our study were affected with ACL injuries and 2 were having PCL tears. Ligament reconstructions were planned for 2nd stage surgeries after bony union. Primary bone grafting were done in 6 patients where bone defect was large. Successful fracture union was defined as complete callus formations at least 3 cortices and full wait bearing without pain.





We followed up our patients up to one year. Radiological union was observed in 12 weeks in 26 patients, 16 weeks in 07 patients and in one patients took 20 weeks to unite. Partial wait bearing started in between 3-12 weeks, 13 patients started in 3 weeks, 20 in 6weeks, and one patient took 12 weeks. Full wait bearing was observed in 23 patients at 12 weeks, in 10 patients at 16 weeks, and one took 20 weeks.

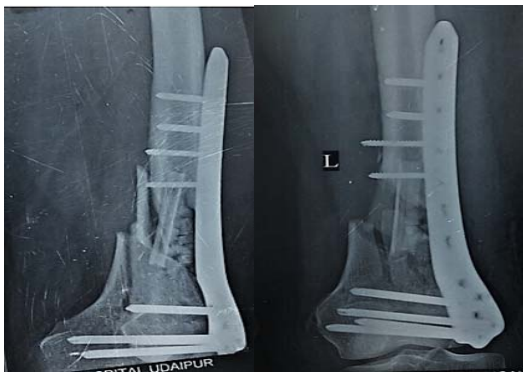
Range of movement was started within 24-48 hours of surgeries according to type of fixation achieved. Planned at least 90-degree flexion before discharge.2 patients required manipulations under GA at 6 weeks due to stiffness. 4 patients reached to flexion up to 90 degrees while rest all achieved full flexion. 12 patients having extension lag of 5-10 degrees. 2 patients had surgical site infection which were debrided meticulously, and antibiotic coverage were given according to culture and sensitivity. Limb length discrepancy of more than 5mm were noticed in 2 patients.

According to AO Classification, our patients were,

A1 -O	C1 -7
A2 -2	C2 -9
A3 -5	C3 -11

PRE OPERATIVE X-RAYS

POST OPERATIVE



SIX WEEKS

Cross Leg Sitting Range of Movments Fter Union Flexion Extension Range of Movments After Union Flexion

Discussion

Current fracture patterns presents a trend towards complex comminuted types because of rapid industrialization and fast pace of life which results in catastrophe like road traffic accidents. On the other hand improved health care results in a longer life span subsequently presenting with more osteoporotic fractures which were previously treated by conservative methods. Recently, the treatment of these fractures has evolved towards a balance between the mechanical stability of the fragments and biological viability, observing the principle of the anatomical reduction of the articular surfaces and restoration of the femur length as well as of the articular alignment and rotation.

Controversy still exists regarding the surgical treatment methods of distal femoral fractures. There has been no uniform reporting of the results of treatment of distal femur fractures. It is difficult to compare the result of different reported series in literature, because of differences in demographic characteristics and is further complicated by the use of different classification systems and functional rating systems. There is no single implant that can be used for all distal femoral fractures. Internal fixation procedures are dependent on fracture type and surgeon's preference. Locked implants are typically indicated in patients with osteoporosis, fractures with metaphyseal comminution where the medial cortex cannot be restored or with short articular segment [10].

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 and pull-out resistance as in unlocked plates. Its unique biomechanical function is based on splinting rather than compression resulting in flexible stabilisation, avoidance of stress shielding and induction of callus formation.8 when applied under proper technique, it allows for prompt healing, lower rates of infection and reduced bone resorption as periosteal blood supply is less impaired. The shaft holes on the 4.5 mm DF-LCP are oval combiholes allowing the options of a compression screw or a locking screw. This leads to a more precise placement of the plate, as it is able to be compressed more closely to the bone.

In present study with DF-LCP, we were able to achieve fracture union in all the cases along with good range of movement (ROM) at knee joint (mean ROM is 118 degree). It was attributed to the stable and sturdy construct and the early range of motion achieved with DF-LCP. Various studies using this method reported mean ROM ranging 100 degree to 111 degrees [15-18].we conclude ROM around the knee is better in patients treated with DF-LCP.

The mean age in our study was 45 years with better results obtained in both young as well as old patients. Rajaiah *et al*. [15] reported a mean age of 44 years with better result in younger age patients than older age. Virk *et al* [17] reported a mean age of 36.64 years with positive results obtained in both old as well as young patients. Charles N Cornell *Et al* [19] carried out a study on use of DF-LCP in peri prosthetic fractures with average age of patient ranging 69.4 years to 76.7 years was able to obtain 77.6%union rate with very few malunion, thus making it the implant of choice for distal femoral fractures across all age groups. Scope of DF-LCP is limited not only to isolated distal femur fractures but also in the use of peri-prosthetic distal femur fractures in patients of Total Hip Replacement (THR) and Total Knee Replacement (TKR). [20]

In present study, out of 34 patient 25 were males. Similar male preponderance was reported by other studies [15, 16]. This male preponderance in present study could be attributed due to the fact that males are mainly exposed to high energy trauma in Indian scenario.

In our study, most of the injuries were caused by road traffic accidents affecting mostly males. We had 26(77%) RTA injuries and 8(23%) fracture due to fall. Similar pattern was also observed in other studies [15-17]

Majority of fractures belonged to type C fracture which was 27(79%) and 7(21%) belonged to type A fractures. Rajaiah *et al* [15] also reported 65% type C fracture and 25% type A fracture. This indicates that type C fractures occur more commonly than type A. this signifies that most of the distal femoral fractures are caused by high energy trauma. They are associated with severe comminution and are unstable.

Average duration of hospitalization in our study was 12 days (range 4-28 days). Rajaiah *et al* [15] reported 19 days of average duration ofhospital stay. Yeap and Deepak *et al* [16] reported average duration of hospitalization of 17. 2 days (range 8-34 days). The variation in duration of hospital stay could be due to different reasons such as associated injuries, compound injuries which require debridement and external fixators need to follow the strict post-operative physiotherapy which could have affected the course of treatment and rehabilitation and some patients who preferred to stay in hospital till suture are removed due to social reasons.

Duration of union in our study ranged from 12-20 weeks. Rajaiah *et al* [15] reported 14-25 weeks, Yeap and Deepak *et al* [16] reported 6-36 weeks, Kim K J *et al*. [21] reported 13-20 weeks' time for union. Time to union in our study was less as compared to other studies can be explained by the facts that primary bone grafting was performed in 6 cases where we felt that the bone defect is large and the patient might go in delayed union and metaphyseal comminution was addressed by TARPO approach.

In our study 2 patients out of 34 had superficial infection. None had deep infection. The infection subsided completely after debridement and course of IV antibiotics according to the culture and sensitivity report. Rajaiah *et al* [15] reported no deep infection and superficial infection in 2 patients out of 20. Kim K J *et al* [21] reported 2 post-operative infections. Limb length shortening of 2cm occurred in 2 patients which were compensated by heel raise on affected limb. No implant failure occurred in our study which is similar to study by Rajaiah *et al* [15]. Yeap and Deepak *et al* [16] reported one case of implant failure.

When Evaluation was done according to Neer's criteria it showed a mean Neer's score of 87 with a range of 62 to 97.Out of 34 patients in the study 21(62%) had excellent, 11(32%) satisfactory, 2(6%) unsatisfactory result. No patient had poor result according to Neer's criteria. Rajaiah *et al* (15) showed a mean Neer's score of 82 with a range of 54 to 92. Out of 20 patients in the study 7(35%) had excellent, 8(40%) satisfactory, 4(20%) unsatisfactory, and 1(5%) poor result. Yeap and Deepak *et al* [16] reported 4 excellent result, 4 good, 2 fair, and 1 failure. Kim K J *et al* [21] reported mean Neer's score of 74 with a range of 58-97 of which 3 were excellent, 5 satisfactory and 7 unsatisfactory.

Conclusion

In our study the DF-LCP has shown excellent to satisfactory results in majority of both extra articular {type A} and intra articular {type C} fractures. It also showed better out comes in both older and younger age groups. Fixation with DF-LCP found to be effective in osteoporotic bones and reported shorter operative duration, faster recovery, early mobilization so short period of hospitalization, faster union rate and excellent functional outcome with few complication rates. So we conclude that DF-LCP is a safe and reliable implant for distal femur fractures AO type A and C. however a careful preoperative planning and case selection along with accurate positioning and fixation following all the basic principles of fracture fixation are required to avoid complication and obtaining satisfactory results.

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