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ORIGINAL ARTICLE

FUNCTIONAL OUTCOME OF LOCKING COMPRESSION PLATE IN DISTAL FEMUR FRACTURES

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ABSTRACT

Introduction: *Distal femur fracture is common in young people with high velocity injury. Management of distal femur fractures is a therapeutic challenge in orthopedics practice due to its extensive soft tissue injuries, bone loss, comminution, articular extension, instability.Open reduction with internal fixation replaces previous trend of closed conservative management and external fixation. Distal femoral locking compression plate (DF-LCP) requires both locking and compression screw fixation of the femur shaft. DF-LCP has been rapidly adopted as an alternative to intramedullary nails, blade plates and non-locking condylar screw.*

Materials and Methods: *Prospective interventional study was done in department of orthopedics at National Medical College and Teaching Hospital, Birgunj for one year among 45 patients of age more than 18 years with post traumatic closed or open GA Type I, II distal femur fractures, AO Muller type A and C fractures. Ethical approval was obtained from institutional review committee and proper informed consent was taken. Type of implant used was DF-LCP.NEER'S scoring system was used for functional outcome.*

Results: *Out of 45 patients, 42 patients with distal femur fracture were treated by DF-LCP.Three patients lostduring follow up hence removed from study. Out of 42 patients, mean age of the patients was 36.62 years. Most of them 31, (73.8%) were male. Predominant fracture was on right side 29 (69%).The study finding showed that 30 (71.4%) sustained injury due to road traffic accidents. Most of the patients 18 (42.9%) had type A2 fracture according to AO Muller distal femur fracture classification. Complications like surgical site infection observed in 3 cases. 100% union rate achieved with an average union time of 17.26 weeks. On evaluation according to Neer's criteria mean score was 82.1 (Range: 48-96). Out of 42 patients 24 (57%) had excellent, 14 (33%) had good, 3 (7.2%) had fair and 1 (2.4%) had poor result.*

Conclusion: *The study concluded DF-LCP is effective treatment for distal femur fracture. It provides stable construct for fracture union with excellent functional outcome.*

Keywords: *DF-LCP, Distal femoral fracture, AO Muller classification, Neer's Scoring*

INTRODUCTION

The femur is the longest bone of the body and one of the principal load bearing bones in the lower extremity. Distal femur includes the supracondylar and condylar regions and is defined as the zone from the femoral condyles to junction of the metaphysis with femoral shaft. This ranges from 10-15 cm of the femur.[1]

Fractures of distal femur account for roughly 3- 6% of all femoral fracture and result from direct and indirect trauma. The most common mechanism involves direct trauma to a flexed knee, typically seen in dash board injuries during motor vehicle accident. Distal femoral fractures occur in a bimodal distribution at 15 and 50 years of age. It occurs predominantly in the male population on sustaining high energy trauma. Above 50 years it occurs predominantly in the female population.

The incidence of distal femur fractures is approximately 37 per 1,00,000 persons per year showing bimodal distribution.[2,3] One group include patients below 40 years of age (nearly 40% of cases), predominantly males, sustaining high-energy trauma such as road traffic accident or a fall from heights and the other group consists of patients more than 50 years, (nearly 60% of cases) predominantly females, with osteoporosis, who sustain relatively low energy trauma.[4] However, in both instances, axial load to the leg is the most common cause. Epidemiologic studies show these injury patterns

peaks in incidence in elderly women and young males.[3]

These fractures are associated with meniscal or ligamentous injury while the incidence of neurovascular injury remains rare.[4] Approximately 0.2% of these fractures are associated with damage of the femoral or popliteal artery.[5] Nevertheless, because of the low quantity and quality of collaterals, vascular injury threatens the vitality of the whole extremity and therefore must be carefully ruled out.

Management of distal femoral fractures remains a challenge to orthopaedic surgeons. They are often difficult to treat because they usually result from high velocity trauma, producing comminution and unstable fracture pattern. These fractures if requiring total knee replacement poses a special problem, which need a high level of expertise.[6] Challenges associated with these types of fractures are adequate exposure of articular surface, particularly of medial femoral condyle and coronal plane fractures is challenging, In setting of medial comminution and short distal segment, there is high incidence of loss of fixation and varus collapse.[7,8] These types of fractures are associated with higher incidence of infections, joint stiffness, early onset of osteoarthritis.[8,9]

Different modalities of management have been tried in the past such as conservative management, external fixation, intramedullary (IM) nailing, condylar blade plating (CBP) and dynamic condylar screw (DCS). However, every method had some pros and cons. Conservative management consists of skeletal traction or splinting. The major drawback of these procedures included long term bed rest which increased the incidence of deep vein thrombosis, pulmonary and urinary tract infections, inadequate reduction, and pin tract infections with external fixation. These drawbacks were addressed by IM nailing but it was associated with loss of fixation during loading. CBP had an advantage of better fixation but it was again associated with inadequate fixation in osteoporotic bone. DCS had an advantage that it provided better inter fragmentary compression in osteopenic bone but since it required removal of large amount of bone it necessitated a revision surgery due to non- union.[5]

Relatively slow rate of healing of distal femur fractures as well as extensive need for bone grafting, led to the clinical need for improved soft tissue handling around fractures. This led to the concept of “Indirect reduction” and “Biological fixation” of fractures is based on following factors[16] Preservation of vascularity and soft tissue integrity to the bone fragments, Anatomic restoration of articular surface, Restoration of the appropriate length, rotation, and alignment of metaphyseal-diaphyseal region without much stress on anatomical restoration of this region.[8]

Taking all the merits and the demerits of the previous management approach locking compression plate (LCP) was developed which provides multiple points of fixation of plate by screw to bone, generating greater stability than is provided by a single lateral construct, which potentially reduces the tendency for varus collapse. The locking screws also provides stronger fixation of the plate in the proximal fragment by eliminating any potential for toggle and sequential screw loosening. This could have advantage in osteoporotic bone and have a possible biological advantage over conventional plates.[10,11]

The purpose of this study is to determine the efficacy of locking compression plate in distal femur fracture in both genders along with postoperative complications and outcome.

Definitive management of distal femoral fracture requires maintenance or restoration of articular congruity and distal femoral alignment to preserve the function of the extremity. Coronal plane alignment has been shown to be the most difficult factor to control and the most crucial step for overall outcome.[5] Posttraumatic arthritis has been reported to develop in fractures that heal with >15 degree of valgus or any degree of varus deformity at the knee.[12] Malalignment in the axial and sagittal planes also affects knee kinematics and range of motion (ROM), and articular incongruity further contributes to the development of degenerative arthritis.

MATERIALS AND METHODS

A prospective interventional study was conducted in department of orthopedic surgery, National Medical College and Teaching Hospital, Birgunj, Nepal from 10th December 2021 to 9th December 2022 among 45 patients. Sample size was calculated using the formula n=Z2×p (1-p)/m2 and estimated prevalence of distal femur fracture in previous year in this institute was p=0.032 (3.2%).[13] Purposive sampling technique was used.

Patients with age above 18 years, both sexes, post traumatic closed or open GA Type I, II distal femur fractures, AO Muller type A and C fractures, patient fit for surgical procedure and who gave consent for study was included. Open wound like GA type III and AO Muller type B fractures. patient age less than 18 years, Pathological fractures, late presentation (>3 weeks),peri-prosthetic fractures, patients with associated head, chest, visceral and vascular injuries, Patients with any other fracture in addition to distal femur in the same limb,Preoperative neurovascular injury, Patients with definite major illness like malignancy, chronic major system illness, patients not willing and medically not fit for surgical procedure was excluded from study.

Ethical approval was obtained from the institutional review committee (IRC Ref. F-NMC/561/078-079). Proper informed consent was taken from those patients who were fit for surgery. Radiographs were taken in appropriate views and diagnosis was established by clinical and radiological means.Fractures were classified according AO Muller classification. Patients were immobilized either with skin or skeletal traction until complete pre-operative workup and fitness for surgery was obtained. Postoperatively patients were given prophylactic intravenous antibiotics 8 hourly for 72 hours followed by oral antibiotics. Patients were followed up clinically at first, third, and sixth month. Functional outcome was assessed by Neer's Functional Rating Score. All data were processed, analyzed, and disseminated by MS office and statistical package for social sciences (SPSS) version 26.

RESULTS

Based on inclusion criteria total of 45 patients were enrolled in this study at National Medical College, Birgunj in Orthopaedic Department from 10th December 2021 to 9th December 2022.These patients were followed up for 6 months post-surgery. Three patients lost during follow up in subsequent visit so were excluded from this study result. In this study out of 42 patients, average age of patients was 36.62±10.85 years. The range was 19 to 65 years. Most of the patients (13 out of 42) were between 31- 40 years of age. There was male predominance among the patients. Out of 42 patients, 31 (73.8%) were male and 11 (26.2%) were females. The right side was affected more commonly.

Table 1: Distribution of side

Side Affected	Frequency	Percentage
Right	29	69%
Left	13	31%

Majority of cases 30 (71.4%) were due to Road Traffic Accident. 10 (23.8%) cases were due to fall injury and remaining 2 (4.8%) were due to physical assault.

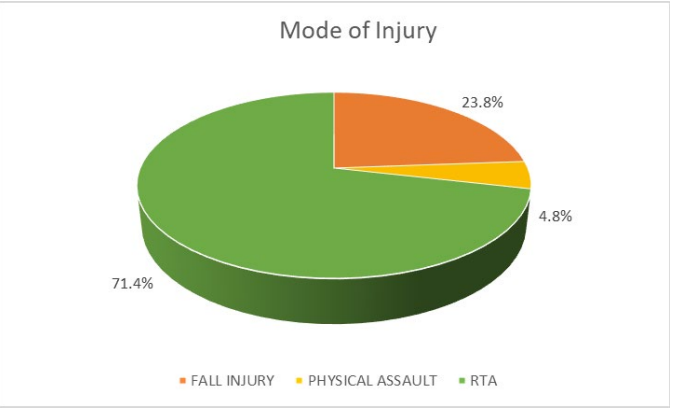

Figure 1: Mode of injury

AO Muller classification was used for fracture classification based on X-ray. 11 cases were of A1 type, 18 cases were A2 type, 3 case were A3 type, 2 cases were C1 type, 5 cases were C2 type and 3 cases were C3 type. Among fractures A2 was most common.

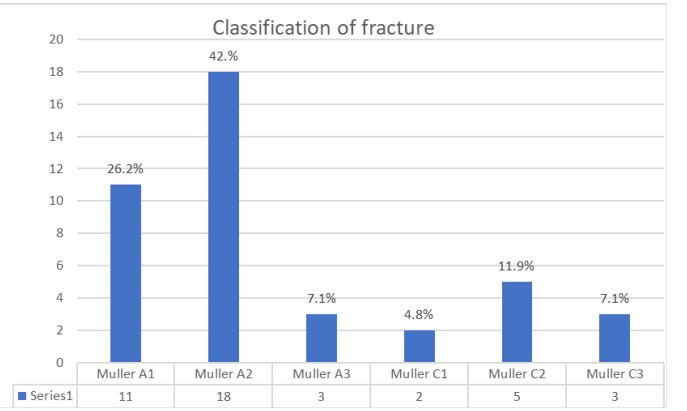

Figure 2: Classification of fracture (Muller's classification)

Mean time from injury to surgery time was 6.29±2.392 days. The range was 3 to 14 days.

The mean duration of surgery time is 121.13±3.13 minutes. The mean duration of hospital stay was 17.21±3.235 days. There was however a big variation. It ranged from 12-28 days. Majority of cases 21 (50%) had union by 16-20 weeks. Remaining 17 cases (40.5%) had union in between 12-16 weeks while 2 (4.8%) cases had union after 20 weeks and 2 (4.8%) cases had union by 12 weeks. Average duration of full weight bearing was 17.26 weeks with maximum of 23 weeks and minimum of 12 weeks.

Out of 42 patients, 11 patients (26.2%) had flexion extension arc of ≤ 90 degree, 22 (52.4%) patients had flexion extension arc of 90-110 degree and 9 patients (21.4%) had flexion extension arc of > 110 degree.7.2% cases had varus mal-alignment. Out of which 2 cases (4.8%) had less than 10 degrees of varus mal-alignment and 1 case (2.4%) had 5 degrees of varus malalignment.9.6% cases had knee extension lag. Out of which 1(2.4%) case had 5 degree of extension lag. 2 cases (4.8%) had 10 degree of extension lag and remaining 1 (2.4%) case had more than 10 degree of extension lag. The average Neer's score obtained at 24 weeks was 82.1±10.856. It ranged from 48 to 96.

Table 2: Distribution of Neer's Score

Mean	82.1
Median	87
Mode	88
St. Deviation	10.856

Functional rating as per NEER's rating score, overall

results were excellent in 24 (57.1%) out of 42 cases and were good in 14 cases (33.3%), 3 (7.2%) cases were fair and 1 (2.4%) case had poor result. The overall Neer's score in this study was 82.1.

Table 3: Complications

Complications	Frequency	Percentage %
Shortening	3	7.2
Varus Mal-alignment	3	7.2
Knee extension Lag	4	9.6
Knee stiffness	2	4.8
Pin tract infection	2	4.8
Surgical Site Infection	3	7.2

DISCUSSION

The prospective interventional Study had been undertaken with the approval of the ethical review board of National Medical College, Birgunj to analyze the functional outcome of locking compression plate in distal femur fractures in Nepalese population aged 18 years and above.

Total of 45 patients with distal femur fracture admitted in Orthopaedic department of National Medical College, Birgunj from 10th December 2021 to 9th December 2022 meeting inclusive criteria were studied. Out of which three patients lost to follow up, so were removed from the study and the remaining 42 cases were included in study. Data was collected from patients.

During admission detail clinical history was taken focusing on mechanism of injury and co-morbidities. Radiograph was taken to confirm diagnosis and to classify fracture according to AO Muller Classification of distal femur fracture. The management of fracture of distal femur fracture has always been a challenging problem, as they are frequently associated with multiple injuries. Distal femur fractures have the potential to produce significant long-term disability due to deformity, bone loss and malunion, nonunion, infection and even fatal mortality due to massive hemorrhage and fat embolism. The mainaim for treatment of distal femur fracture is joint reconstruction which constitutes the first step along with anatomical reduction, minimal soft tissue dissection, stable internal fixation and early mobilization.

A study conducted by Kiran K.G. et al.[14] showed that mean group for distal femur fracture was 35 years. Similarly in the studies conducted by Shriharshaet al.[15], it was found to be 44 years, Yeap and Deepak [16]44 years, Zlowodzki et al.[17]40.22 years and Malik A et al.[18]32.37 year.

In our study the mean age group was 36.62 years with standard deviation of 10.85 years. The range was 19-65 years. It can be attributed to high incidence of road traffic accident in younger age group which is very common in this part of the country due to its proximity to national highway. 1 out 42 patients was of elderly age group i.e., >60 year which might be due to associated osteopenia in elderly age group.

In the study conducted by Shriharsha et al.[15] 64 percent of patients were male. Similarly, in the study conducted by Malik I et al.[19] 76 percent were male, Jha G K et al.[13] 60 percent cases were male and, in the study, conducted by Malik A et al.[18] 69.2 percent cases were male.

In this study 73.8% cases were male and 26.2% cases were female. The number of female cases may be attributed to the fact that most of the cases in our study were due to road traffic accident and there has been increased access to personal vechicles for female in the recent years.

Majority of the patients 30 out of 42 (71.4 %) were due to Road Traffic Accident, 10 due to fall injury and 2 due to physical assault. The findings were in concert with Bachu et al.[20], where out of 30 cases 23 (77.66%) of the fracture were caused by road traffic accidents, 3 (10%) were due to accidental falls, 1 (3%) was due to physical assault and 3 (10%) were due to fall from height.

A study conducted by Schutz et al.[21] showed that average duration of surgery was 85 minutes with range of 40-135 minutes. In the studies by Yeap and Deepak[16] average time was 119.2 minutes with range of 80-180 minutes, and Malik A et al.[18] 129.6 minutes. They concluded that longer duration of surgery is associated with higher incidence of complications such as infections, delayed or nonunion and impaired functional outcome.It is comparable to our study in which average duration of surgery was 121.43 20.31 minutes and range was 90-160 minutes.

A study conducted by Panchal P et al.[22] showed that 70% of patients started full weight bearing at 14 weeks. Similarly, Khurseed et al.[23] found to be 14.32 weeks.In our study it was found to be 17.71 weeks. This can be attributed to the patient factor. The patients were not compliant and started delayed weight bearing for the fear of losing stability from patient side.

A study by Krishna K et al.[24] showed that average duration of radiological union was 15.36 weeks. Similarly in the study conducted by Malik A et al.[18] showed that 96% of patients achieved radiological union by 20 weeks and 100 % achieved radiological union by 24 to 36 weeks of follow up, Panchal et al.[22] showed 85% patients achieved radiological union by 18 weeks, Weight and Collinge[25] found it to be 13 weeks, Kregor et al.[26] found it to be 12 weeks, Kiran et al.[14] found to be 14 weeks, Khurseed et

al.[23] found it to be 16.88 weeks, Shriharsha et al.[15] found it to be 18.53 weeks, Yeap and Deepak[16] found it to be 18 weeks, Malik A et al.[18] found it to be 16 weeks.

In this study mean duration of radiological union was 17.21 weeks and 45% of patients achieve radiological union by 16 weeks and 95% achieve union by 20 weeks and 100% acheived union was achieved by 23 weeks. The higher union time compared to some of the study can be attributed to the fact that majority of the cases in our study were managed by open reduction and not by minimally invasive technique.

Normal knee flexion is 140 degrees. Laubenthal et al.[27] has demonstrated that average motion required for normal sitting is 93-degree, stair climbing is 100 degree and squatting is 117 degrees.

In the study conducted by Krishna K et al.[24] average range of knee flexion achieved postoperatively was 113.3 degree. Similarly in studies conducted by Siliski et al.[28] it was found to be 107 degree, Scutz et al.[21] found it to be 103 degrees, Kregor et al[26] found it to be 109 degree, Shriharsha et al.[15] found it to be 99 degree, Yeap and Deepak[16] found to be 107.7 degree.

In this study average knee flexion achieved was 102.62 degree with range of 60-130 degree. Slightly less average knee flexion in some of the patients can be attributed to the fact that some patients were of older age group, and some of the patients were not regular with their physiotherapy and knee range of motion exercises.

A study conducted by Scutzet al.[21] showed 20% cases had less than 10 degrees of varus mal-alignment which is comparable to my study in which 7.2% cases had varus mal-alignment of less than 10 degrees.

A study conducted by Panchalet al.[22] showed that 15% of patients had extensor lag more than 10 degree and 60% had extensor lag less than 5 degree. Similarly in the study conducted by Scutzet al.[21] 4% patients had extensor lag of more than 5 degree. In my study 2.4% percent cases had extensor lag of less than 5 degree and 7.2% percent cases had more than 5 degree of extensor lag.

A study conducted by Krishna K et al.[24] showed that mean Neer's score was 82.20. Similarly in study conducted by Tengheng et al.[29] mean Neer's score of 82 with range of 54 to 92. It is comparable to my study in which mean Neer's score was 82.1.

A study conducted by Krishna K et al.[24] showed that excellent results were seen in 15 cases, good in 11, fair in 3 cases and 1 case of failure was seen. Similarly in the study conducted by Shriharsha et al.[15] 80% type A and 40% Type C fractures had excellent or good results. They concluded that extra articular (type A) had better outcome than intra articular (type C) fractures. In the study conducted by Yeap and Deepak et al.[16] 4 patients showed excellent results, 4 good, 2 fair and 1 failure. In the study conducted by Panchal P et al.[22] 15 patients had excellent, 5 had good, 4 had fair and only 1 patient had failure outcome. Similarly in the study conducted by Shriharsha et al.[15] 82 percent cases had excellent or good outcome, and in the study conducted by Bae et al.[30] 77.5% patients had excellent outcome.

These studies are comparable to our study in which 71.87% of type A fractures had excellent results and 70% of type C fractures had excellent or good outcome. Similarly excellent results were seen in 24 cases, good results in 14 cases, fair results in 3 cases and poor result were seen in 1 case.

Table 4: Comparision of Functional Outcome of ORIF with DFLCP

Previously published article	Excellent	Good	Fair	Poor
Krishna KR et al[24]	50%	36.60%	10%	3.40%
Sah Set al[31]	66.60%	23.80%	4.76%	4.84%
Girisha BA et al[19]	24%	71%	5%	0%
Srinath SR et al[32]	65%	15%	20%	0%
Our study	57.10%	33.30%	7.10%	2.40%

A study conducted by Baeet al.[30] showed that only 2 cases had complications of superficial infections. Similarly in the study conducted by Kiran et al.[33] no cases of infection were reported.

In this study only 3 patients had surgical site infection which was managed with regular dressing and oral antibiotic (Cefuroxime) for a week after sending swab for culture and sensitivity reporting. The incidence of infection in our case can be attributed to the fact that open reduction technique was used in our study.

CONCLUSION

At the end of the study, we concluded that Distal femoral locking compression plate produces excellent results in case of distal femur fractures, particularly intra-articular type. It is a demanding procedure, proper preoperative planning, cautious soft tissue handling, strict asepsis, proper postoperative rehabilitation, and patient education are more important to obtain good results. The operative time is less with decrease in blood loss. It provides good angular stability due to its precontoured mode. It is of great use in elderly patients with severe osteoporotic bone. Early post-operative mobilization following rigid fixation of the fractures of distal femur,

with DF-LCP lowers the incidence of stiffness. Its application produces minimal amount of surgical trauma to the patient and chances of post-operative infection are less.

This technique has a lesser chance of complications like plate or screw breakage, malunion, nonunion, extensor lag or varus/valgus malalignment but careful selection of patients and strict adherence to the basic principle of fracture fixation will go a long way in reducing the complications of fracture fixation using locking compression plates.

To conclude, distal femoral locking compression plate is an important modality in treatment of fractures around knee especially when fracture is severely communited and in situation of osteoporosis.

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