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A study of functional outcome of anatomical distal femur locking plate for management of distal femur fractures

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Abstract
Introduction: The distal femur is an area that is particularly vulnerable to the dangers of our modern life styles and high velocity methods of transportation. Among young patients, fractures of the distal femur usually are a component of multiple traumas sustained through high – velocity, high-impact injuries such as motor vehicle accidents or fall from a height.
Objectives: To analyze the functional outcome of distal femoral fractures treated by distal femur locking plate.
Materials and Methods: 30 patients with distal femur fractures were managed surgically between June 2019 to November 2021 were included in this series. The mean age, gender ratio, mode of trauma, fracture union time, and complications were noted. The knee society scores were used for assessing the knee function.
Fractures were classified according to Muller's classification, 4.76% were Type A1, 13% were Type A2, 13.3% were Type A3, 23.33% were Type C1, 6.33, 30% were Type C2 and 13.33% were Type C3. All the cases were operated with distal femur locking plate.
Results: Of the 30 patients in the study, 22 were males and 8 were females. The mean fracture union (radiological) time was 14.04 weeks (range: 10–18 weeks). However knee function was excellent in 17 cases (68%) on the NEER`S score with an average Also platting gives a better result than using cannulated cancellous screws.
Conclusion: Fixation of the distal femur to reduce persistent fragment displacement, regardless of size, as well as to restore stability, may lead to improved outcomes. We conclude that distal femur fractures encountered in clinical practice need thorough assessment and meticulous surgical intervention. We achieved stable fixation and performed early mobilization of the knee joint, which limits the complications of mainly knee stiffness and have achieved excellent clinical and functional outcomes of surgically fixing the distal femur fractures. Distal femur factures with anatomical distal femur locking plate.

Keywords: Distal femur fracture, anatomical distal femur locking plate

Introduction
Fractures affecting the distal femur are very complex injuries that pose a challenge. It involves about 7% of all femur fractures. It commonly occurs during high velocity trauma in younger group of patients. In contrast to this, elderly patients with severe osteopenia might sustain distal femur fractures from trivial trauma. Such as a simple slip and fall.
Despite all these modalities, treatment of distal femur fractures are not without of complications, since most of this fractures located very proximity to traversing neurovascular structures, hence they are more prone for injury to popliteal vessels and badly comminuted fragments and bone loss, displacement of fragments all these components make this fractures difficult to fixation. Since fractures involving juxta articular location in relation to knee joint, the movement of this joint affected very early and recovery of the lost knee movement is delayed unless followed good physiotherapy and gradual mobilization exercises.
Significant advances have been made in treatment of these fractures in the past three decades. Neer[1] in 1967 concluded that these fractures were not suitable for internal fixation and treated with traction & cast bracing.

The Anatomical distal femur locking compression plates provided the means to increase the rigidity of fixation in osteoporotic bone or in the presence of periarticular fractures. It provides the good angular stability by its triangular reconstruction principle and thus helps in early mobilization.

Materials and Methods

Thirty patients with fresh distal femur fractures who attended Tertiary care Hospital, SURAT, between June 2019-June 2021 were studied.

Type of study: Prospective observational study

Duration of study: 15 to 18 months

Source of Data

The study was conducted on patients who have undergone Surgical fixation in distal femur fracture during June 2019-June 2021 in skeletally matured patients in Department of Orthopedics at Surat Municipal Institute of Medical Education and Research, Surat.

Patients were followed up at 6, 12, 24 weeks to know the clinical and functional status of the patients.

Sample size: 30

Inclusion Criteria

- Patients with age between 18 and 60 years of age
- Recent history of trauma
- Patients willing to undergo surgery and giving written informed consents.

Exclusion Criteria

- Patients with age less than 18 years distal femur more than 60 years
- Neglected fracture
- Patient not willing to undergo surgery
- Pathological fractures

Out of the total 30 cases, majority of the patients (46%) were within the age group of 30-50 years of age while only 20% were in the age group of 51-60 years. Amongst the 30 cases, number of males (22) were more than the number of females (8). All surgeries were done at the same institute. Institutional Ethical Committee approved the study.

As soon as the patients were brought to the casualty a complete survey was carried out to rule out significant injuries. Then the patients' radiographs were taken, anteroposterior, lateral knee joints. CT scan was taken in indicated cases. On admission to the ward detailed history was taken relating to the age, sex, occupation, address, mode of injury past and associated medical illness. Patients general condition was assessed and then they were put through a thorough clinical examination. A careful examination was needed to determine the status of the skin, soft tissues, and neurovascular structures, as well as the bones and ligaments. Combinations of tenderness, swelling, or ecchymosis over the bone, ligaments, or joint line suggest an injury. The stability of the joint should be assessed, especially when these findings are associated with normal x- rays.

On inspection, relation of femur to knee either normal, flexion or extension of knee was examined.

On palpation, all bones forming the ankle i.e., lower end of femur, patella, tibia are looked for, local bony tenderness and bony irregularities, displacement, unnatural mobility crepitus, inter relation of femur, popliteal artery pulsations were checked and noted. Active and passive movements of knee joint are noted Analgesics were given and patients were put on an above knee posterior POP slab with below knee skin traction to alleviate pain. Also antibiotics and tetanus toxoid and tetanus immunoglobulins were given as needed.

Although injury to neurovascular structures was common in an distal femur injury, massive swelling, particularly when associated with a crush or penetrating injury, or fracture or fractures of the patella or tibia, may compromise blood flow and result in ischemia; and compartment pressure measurements, Doppler imaging, and transcutaneous measurement of PO2 can be used along with clinical judgment to assess the vascular status and determine if decompression or other intervention was indicated. The standard radiographic evaluation of the knee includes, anteroposterior, lateral and views were taken. CT scan was done to exclude the intraarticular fractures of distal femur and to plan for fixation.

Surgical technique [5]

Type of anaesthesia: General Anaesthesia or spinal anaesthesia was used under appropriate anesthesia the patient was put in supine position on table. The affected limb was draped from the knee joint to the nail tip and then painted betadine solution the foot was covered with a glove.

Timing of surgery lasted around 1 to 1 ½ hours, open reduction and internal fixation of the distal femur were performed or plating with screws.

Fig 1: Supine Position

Fig 2: Superficial Dissection

Fig 3: Plate placement

Make a 6- to 8-cm longitudinal incision over the anterior half of the lateral femoral condyle, extending upward from the joint line. Make a second proximal longitudinal incision overlying the lateral aspect of the shaft of the femur.
The positioning and length of this second incision will relate to the implant being used, and the site of the incision must be determined using image intensification.
Distally make a 6- to 8-cm incision over the anterior half of the femoral condyle beginning at the joint line. Proximally make a longitudinal incision over the lateral aspect of the femoral shaft. The position and length of the proximal incision depends on the site of the pathology and the implant to be used for treatment.

Internervous Plane
Distally, the dissection explores the internervous plane between the vastus lateralis muscle supplied by the femoral nerve and the biceps femoris muscles supplied by thesciatic nerve. Proximally, no internervous plane is available for surgery, but splitting the vastus lateralis muscle usually does not result in significant denervation.

Superficial Surgical Dissection
Begin distally. Incise the skin and subcutaneous tissue in the line of the skin incision. Divide the lateral retinaculum to visualize the joint capsule. At the proximal end of the distal window, develop a plane between vastus lateralis anteriorly and the lateral intramuscular septum posteriorly. Numerous branches of the superior lateral genicular artery with associated veins cross the operating field at this point and will need to be ligated or diathermied. Proximally incise the subcutaneous fat in the line of the skin incision and then divide the deep fascia overlying the vastus lateralis also in a longitudinal fashion.
Distally incise the subcutaneous tissues in the line of the skin incision to reveal the fascia overlying the vastus lateralis and the lateral patellar retinaculum. Proximally incise the subcutaneous tissues in the line of the skin incision to reveal the fascia covering the vastus lateralis.

Deep Surgical Dissection
Distally divide the knee joint capsule and synovium longitudinally to expose the entire distal end of the femur. Retract the patella using an appropriate retractor and visualize all aspects of the joint by flexing and extending the knee. Proximally split the vastus lateralis muscle in a line of its fibers to give direct access to the periosteum on the lateral aspect of the femoral shaft.
Finally, develop an epiperiosteal plane between the two windows on the lateral aspect of the femur using a blunt dissector or the surgical implant.
Distally incise the lateral patellar retinaculum and the underlying joint capsule to enter the knee joint and expose the distal end of the femur. More proximally, incise the deep fascia to reveal the lateral aspect of the distal femur. Proximally incise the fascia overlying the vastus lateralis and split the fibers of that muscle to expose the periosteum covering the lateral aspect of the femoral shaft. Connect the two incisions by developing an epi-periosteal plane along the lateral aspect of the femur using blunt dissection.
Reduction done with plate placement. Reduction of fracture done by close reduction in extra articular fracture & open reduction for intrarticular fractures.

Follow up
Elevation of the affected limb was done x-rays anteroposterior, lateral and mortise views were taken. Wounds were inspected on 3rd day. Sutures were removed on 15th post operative day on an average. Above knee pop cast was given and discharged with instruction of non-weight bearing crutch walk for a period of 6 weeks and to come for follow-up after 3 weeks and the patient were followed up by the same operating surgeon Weight bearing was restricted for 6 weeks. If the bone condition and other factors prevented secure fixation, the fracture was protected and longer. At 4 weeks the POP was removed. Clinical examination was done regarding tenderness and movement of knee. At 6 weeks x- ray of the distal femur was taken both AP and lateral views and looked for signs of fracture union and then were advised partial weight bearing for further period of 6 weeks with elastocrepe bandage and elevation of the limb at night times and active movements of knee joints. After radiological signs of healing, a rehabilitation program was started. The aim was to gain full mobility, muscular strengthening and proprioception as soon as possible. The total rehabilitation period depends on the individual patient's progression. The final goal is to restore ache free functional to full range of motion and strength. The union time and complications were noted. Patients were allowed full weight bearing on the affected limb. Regular follow up was done at 6, 12 and 24 weeks after discharge till the fracture united.
Functional and radiological results were analyzed using the knee society scoring system. The evaluation was based on physical and radiological examination. Physical examination included the measurement of SLR and KNEE flexion of injured limb compared with the uninjured limb, with forepart of knee in neutral position.
Final scores were based on the combined point scores from seven categories of subjective objective and radiographic evaluation. Results were designated as excellent good fair and poor. A score of 96-100 points was considered excellent; 91 to 95 good; 81-90 points fair and zero to 80 points.

Results
Out of the total 30 cases, majority of the patients (46%) were within the age group of 30-50 years of age while only 20% were in the age group of 51-60 years. Amongst the 30 cases, number of males (22) were more than the number of females (8)., Road Traffic accidents were the most common cause of distal femur fractures with a peak incidence in third decade of life.

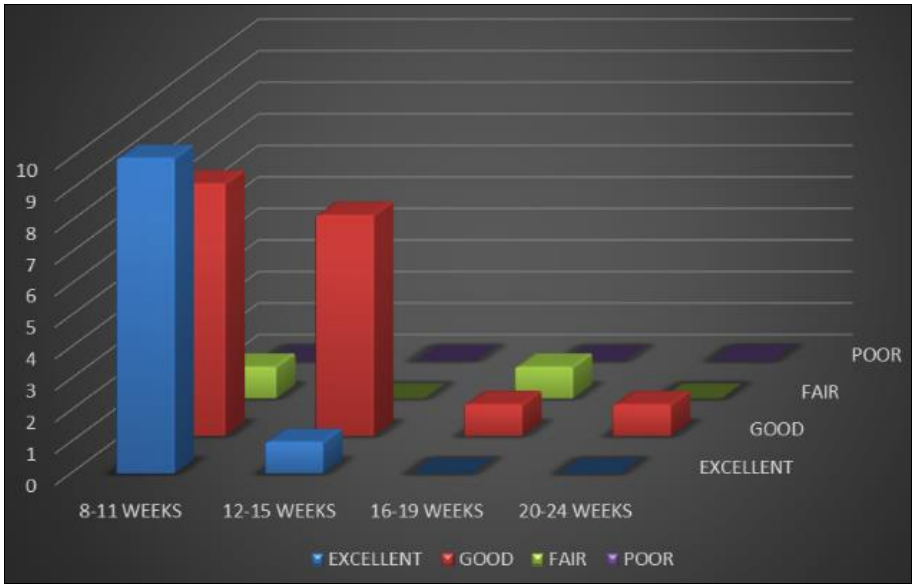

Fig 4: Time for union

It was observed that the maximum number of patients with time taken for union is 8-11 weeks. In our study here p value is less than 0.05. It signifies that, patients with a low time of union have excellent NEER'S KNEE SCORE

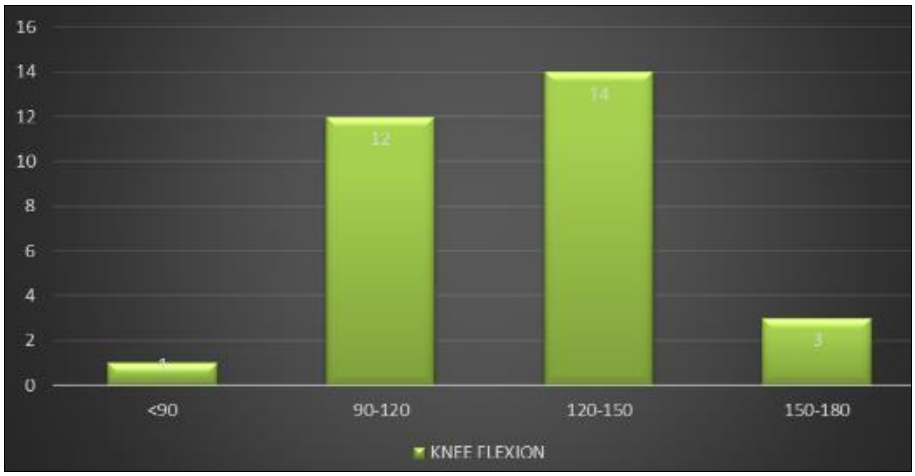

Fig 5: Knee flexion

A majority of 46% of patients, had achieved a forward flexion up to 150 degrees at 6 months of follow up.

Case 1

Fig 6: Pre operative radiographs

Fig 7: Immediate post operative

Fig 8: 6 Month follow up

Fig 9: Straight leg raising

Fig 10: Knee Flexion

Case 2

Fig 11: Pre op xray

Fig 12: Immediate post op xray

Fig 13: 6 month follow up

Fug 14: Straight leg raising

Fig 15: Knee Flexion

Discussion

The aim of our study was to assess and present the injury characteristics and the clinical and functional outcome of results of surgical treatment of distal femur fractures and compare with published studies and to know the complications of internal fixation in distal femur fractures.

Early surgical stabilization can facilitate care of the soft tissue, permit early mobility and reduces the complexity of nursing care. Open reduction and internal fixation has been advocated, using implants, including angled blade plate, fickle devices, Rush rods, Ender nails, Dynamic condylar screw, condylar buttress plate and interlocking nails, anatomical locking compression plate.

An anatomical locking compression plate decreases the screw-plate toggle and motion at the bone-screw interface and provides more rigid fixation. Rigid fixation is felt to be one key to the successful treatment of these fractures. The conventional plates are associated with their own demerits such as screw pullout, implant failure and unstable fixation needing postoperative immobilization.

Delay in postoperative mobilization results in stiffness of the knee which is an indicator of poor outcome. Fixation in osteoporotic and comminuted fractures which was difficult

previously was addressed with the invention of locking condylar buttress plate. So now with the evolution of locking compression plating for distal femoral fractures especially for the comminuted intra – articular fractures many of the older demerits could be addressed which includes the increased stability due to locking compression plating principle, multiple screw options in the distal fragment providing option for fixing the multiple fragments restoring the anatomical congruity and providing stable fixation of the distal fragment with the proximal fragment with resulting increased stability allowing for early mobilization.

Current fracture patterns which we encounter are complex comminuted types due to the prevalence of high-speed vehicles mainly due to the high two-wheeler population in countries like India. Improved healthcare results in a longer life span and subsequently presents us with more osteoporotic fractures which were previously treated using conservative methods.

Its unique biomechanical function is based on splinting rather than compression resulting in flexible stabilization, avoidance of stress shielding and induction of callus formation. It can also be used as biological fixation without disturbing the fracture site.

However, with the aim of getting anatomically accurate reductions, rapid healing and early mobilization and early restoration of function of the knee joint, which is a demand of today's life, open reduction and internal fixation is the preferred modality of treatment for the distal femur fractures.

The Anatomical Distal Femur LCP is a further development, which was introduced in the mid to late 1990. Anatomical Distal Femur-LCP is designed to fit the anatomy of the distal femur. The shaft holes on the Distal Femur-LCP are oval allowing for 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.

Overall, open reduction and internal fixation has not yielded satisfactory results in all the institutions, but the best results are obtained if the fracture is well reduced intra-operatively and planned rehabilitation program in the post-operative period is followed.

The goals of treatment are to restore joint congruity, limb alignment, and early mobilization of joints. Aim of our study is assess functional outcome in operatively treated distal femur fractures in 30 cases. The analysis of the results was made in terms of age of the patient, sex distribution, lifestyle, mode of injury, analysis of type, modalities of treatment, complications & functional outcome at 6,12,24 weeks.

In our study, 22 male and 8 female in total study of 30 patients. These outnumbering of male patients over female is explained by the more active lifestyle and mobility of males and hence more chances of road traffic accidents.

The proportion of males in our study was more (73.33%) than female patients (26.66%) which was comparable with the findings in the studies conducted by Kregor *et al*., Schutz *et al*., Markmiller *et al*., Yeap and deepak *et al*.

Author	Number	Union Time (Wks)
Schande-Lmaire, *et al*.	54	14.3
Kregor, *et al*.	66	11
Fankhauser, *et al*.	30	12
Yeap, *et al*.	11	18
Markmiller, *et al*.	20	13.8
Present study	30	13.11

Distal femur fractures are more seen in young age group due to involvement of high energy trauma. It is extremely important to do a stable fixation and in order to regain the complete range of motion.

The majority of fractures occurred between the age of 30 to 50 years accounting for 46% of the 30 patients. Our study population was quiet young when compared to other studies and had a mean age of just at the time of trauma.

It was observed that maximum patients (75%) in the age group of 31-40 years had an excellent functional outcome at 6 months follow up whereas all the patients with poor functional outcome at 6 months were more than 60 years old. It was also observed that with increasing age, knee society score at 6 months follow up reduced. As observed from the distribution, Road Traffic accidents were the most common cause of distal femur fractures with a peak incidence in third decade of life.

It was observed that the mode of injury in most of the patients (94.88%) with an excellent to good functional outcome was road traffic accidents whereas patients (87%) had an excellent functional outcome. Occupationally distal femur fractures were seen in people with high level of activity, movement and travel. It is most commonly seen with people who travel more.

In our study mean time of union is 13.11 weeks, Kregor, *et al*. had mean time of 11 weeks in their study

It was observed that all patients(75%) in whom fracture union occurred between 8 to 11 weeks had a good to excellent functional outcome compared to the patients with union occurring after 16 weeks, who had a poor to fair functional outcome at 6 months follow up.

It was observed that most of the patients (95%) with an excellent to good functional outcome had an injury-surgery interval of less than 1 week whereas most of the patients with poor functional outcome had an injury-surgery interval of more than 2 weeks.

Hence it can be concluded that longer the injury-surgery interval, the functional outcome at the end of 6 months was poorer.

It was observed that the type of operation (plating) in most of the patients (95.23%) with an excellent to good functional outcome.

Conclusion

- The present study was done to evaluate functional outcome and complication following surgical management of Distal Femur fracture by DFLP plate.
- In DFLP system, locking of the threaded heads of the screws in the plate itself provides for a construct with angular and axial stability, eliminating the possibility of sliding of the screws in the plate holes.
- This system also allows for a more biological fixation as the underlying periosteum and blood supply to the fractured regions are much less compressed.
- Results are best when the operative method results in stable fixation. Fixation should be followed by early physiotherapy. The rehabilitation program plays important role in functional outcome of surgical management of Distal Femur fracture.
- Overall, locking compression plate is mechanically and biologically an advantageous implant in distal femur fractures particularly in comminuted fractures and in osteoporotic bones in elderly patients, thus allowing early mobilization.
- DFLP plate for the treatment of Distal Femur fractures uniformly leads to a satisfactory functional outcome over long term follow up in most of the patients. Although the results are poorer in old age individuals with osteoporosis,

they are nevertheless better than those achieved with non-locking plates.
- In conclusion, the DFLP plate is an ideal construct and a stable implant to use for fractures of the Distal Femur in AO/OTA extra-articular, complete-articular and osteoporotic fractures of the Distal Femur in elderly patients hence allowing early mobilization of the knee joint.
- Though complications are there but they are avoidable & treatable.
- However it is a small study and need longer follow up to conclude anything definitely.

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