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Original Research Article

A Study of Radiological and Functional Outcomes of Dual Plating in the Treatment of Distal Femur Fractures

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Abstract

Background: In distal femur fractures stable fixation can be achieved by using two plates on the distal femur. The presence of a medial plate, in addition to the lateral plate, is recommended for specific cases, such as when there is bone loss in the medial supracondylar region, low trans-condylar bicondylar fractures, medial Hoffa fractures, peri-prosthetic distal femur fractures, non-union following unsuccessful fixation with a single lateral plate, poor bone quality, and comminuted distal femur fractures (AO type C3). We in the current study tried to analyze the outcomes of distal femur fractures treated with dual plating.

Methods: The selected cases were examined clinically for abnormal mobility and crepitus. Anteroposterior and lateral X-rays of the femur with the knee are part of the radiological examination, coupled with a pelvic X-ray to rule out proximal femur fractures. Three-dimensional reconstruction of CT images was carried out. The Distal femur multi-fragmentary intra-articular fractures were fixed with a distal femur locking compression plate on the lateral side and a locked medial plate using the subvastus approach was used in the cases of the study.

Results: In this study out of n=20 cases of distal femur fractures treated with dual plating showed, n=1 out of 20 patients had a range of motion less than 70º, n=2 patients had flexion up to 70º, n=4 patients between 70º to 90º of maximum flexion and n=14 patients had 90º or more of flexion. A knee score of 70 and above is considered as good and in our study, n=15 out of n=20 patients had a score of more than 70 and the remaining n=5 patients had fair and poor results. The overall mean score in our study was 73.4 ± 5.5.

Conclusion: The utilization of dual plating in treating complex distal femur articular fractures is a feasible option that is both safe and efficient. It should be considered an essential technique for surgeons. This approach offers several advantages, including achieving anatomical reduction, providing a stable fixation, enabling early mobilization of patients, and reducing the risk of varus collapse.

Keywords: Distal Femur Fractures, Dual-Plating, Medial Plate Fixation, Clinical Outcome.

Introduction

The incidence of distal femur fractures has increased in the modern world and now stands at about 37/100,000 person-years as a result of increasing industrialization and traffic accidents. [1] Fractures of the distal femur, which make up 6% of all femoral fractures, are those that occur within 9 cm of the articular surface. Different types of injuries can result in distal femur fractures. Younger age groups are frequently injured in traffic accidents, where high-energy trauma causes complex injuries and fractures of the distal femoral condyles and metaphysis. Distal femur fractures in older people occur as a result of low-energy trauma brought on by osteoporosis. Restoration of knee joint function after high-energy trauma is challenging because severe cartilage damage, the comminution of condyles, and ligament damage make it difficult to attach implants in older patients with osteoporosis. [2] The major objectives of surgical therapy in the treatment of distal femur fractures are articular surface reconstruction from an anatomical standpoint, rotational and axial alignment restoration, stable fixation, early mobility, and functional rehabilitation. Before the 1970s, traction was used to treat the majority of distal femoral fractures, which resulted in extended bed rest and problems from recumbency. [3] The techniques of therapy have improved as a result of poor anatomical reduction and loss of knee mobility. Due to poor outcomes from conservative management, the shift to surgical intervention was increased, and surgical treatment used various modalities of fixation such as condylar buttress plates, dynamic condylar screw fixation, locking compression plates, fixed angle condylar blade plates, and retrograde interlocking nails. [4]

The lateral anatomical locking plate (LCP) is now one of the primary techniques used to treat distal femoral articular fractures. The LCP functions as a single-beam construct whose fixation strength is dependent on the total of all the screw-bone contacts rather than on the axial stiffness or pull-out resistance of a single screw. [5] Its biomechanical function is based on the splinting principle, which promotes early callus development, flexible stability, and the avoidance of stress shielding. When used in conjunction with a minimally invasive approach, it is linked to lower infection rates, less bone resorption, and quicker healing rates. [6] The fixed-angle design of LCP results in a toggle-free fixation. Locked screws improve the stiffness of fixation in osteoporotic bone and are especially useful in periarticular or in fractures involving tiny epiphyseal segments in juxta-articular fractures. [7] However, in intraarticular fractures with several pieces, the lateral plate might not be able to hold the multiple fragments, which would result in poor, unstable fixation and a higher risk of varus collapse. Therefore, medial and lateral double-plating fixation is advised to address the aforementioned issues. With double plating, fixation stability is enhanced, patients can be moved sooner, and the likelihood of knee stiffness is reduced. [8] The current study aimed to find the functional outcome of double plating for the distal femur fractures using a condylar locking compression plate through a lateral approach and a buttress plate using a medial subvastus approach.

Material and Methods

The present study was carried out in the Department of Orthopedics, Rajiv Gandhi Institute of Medical Sciences (RIMS), Adilabad, Institutional Ethical approval was obtained for the study. Written consent was obtained from all the participants of the study after explaining the nature of the study in the vernacular language.

Inclusion Criteria

1. Age between 20 - 50 years.
2. Fractures less than 2 weeks.
3. Simple and compound grade I fractures (Gustilo and Anderson classification)
4. Muller type A2, A3 and type C2, C3 distal femur fractures

Exclusion criteria

1. Age less than 20 years and more than 50 years
2. Compound grade II and III fractures.
3. Muller type A1, type B1, B2, B3, and type C1 distal femur fractures Associated with Distal neurovascular deficit.
4. Systemic conditions such as osteoarthritis, malignancy, and immunocompromised states.

The selected cases were examined clinically for abnormal mobility and crepitus. Distal vascularity was assessed by anterior and posterior tibial artery pulsations, capillary filling, pallor, and paraesthesia at the tip of the toes. Anteroposterior and lateral X-rays of the femur with the knee are part of the radiological examination, coupled with a pelvic X-ray to rule out proximal femur fractures. Three dimensional reconstruction of CT images was carried out. The Distal femur multi-fragmentary intra-articular fractures were fixed with a distal femur locking compression plate on the lateral side and a locked medial plate using the subvastus approach was used in the cases of the study.

At the time of hospital discharge, the patients had a clinical examination to check for any malrotation or differences in limb length. A limb malrotation of less than 5° and a limb length difference of less than 5 mm was formerly thought to be normal. At the point of complete fracture healing, a second clinical examination was conducted to look for any additional changes in limb length and rotation.

Following surgery, AP and lateral radiographs of the femur with the knee were obtained and checked for fracture alignment in both the coronal and sagittal planes. The valgus angle between the anatomic axis of the femoral and tibial shafts is used to calculate the alignment of fractures in the coronal plane.

The sutures were removed after 12 – 15 postoperative days. Continuous passive mobilization exercises with a range of motion started at 30 degrees and then advanced daily. Non-weight-bearing using a walker after 2 weeks. Partial weight-bearing using underarm crutches after 6 weeks. Full weight-bearing after radiological evidence of bony union (minimum of 12 weeks postoperatively)

Follow-up: Patients were instructed to come in for follow-up visits at 4 weeks, 8 weeks, and then every 3 months after that. A thorough clinical examination was performed at each follow-up visit, and patients were evaluated subjectively for symptoms such as pain, edema, and restricted joint motion. Exercises that involved active flexion and extension without loading were used as part of the patients' physiotherapy.

Clinical outcome: The KSS is documented at the 6-month follow-up, along with the knee and functional subgroups. KSS of 80 to 100 is considered exceptional, 70 to 79 is considered acceptable, 60 to 69 is considered average, and 60 or less is considered bad.

Radiological Outcome: Advancement of fracture union and callus development. Each visit included the taking of AP and lateral radiographs of the femur with the knee. A bridging callus is referred to as a union when it forms in 3 of the 4 cortices.[8]

Statistical analysis: Results for categorical measures are reported in number (%) whereas results for continuous measurements are shown as mean and standard deviation (Min-Max). In a

nonparametric setting for the analysis of qualitative data, Fisher's Exact test has been used to determine the significance of research parameters on a categorical scale comparing two or more groups.

Results

In this study, n=20 cases of distal femoral fractures were included as per the inclusion and exclusion criteria. Out of the n=20 cases n=15(75%) were males and n=5(25%) were females. The male-to-female ratio was 3:1. The range of age of the patients included in the study was from 22 years to 49 years. The maximum number of cases was in the age group of 31 – 35 years with 30% of cases (Table 1). The mean age of the cohort was 35.5 years.

Table 1: Age-wise distribution of cases included in the study.

Age	Frequency	Percentage
21 – 25	3	15.0
26 – 30	3	15.0
31 – 35	6	30.0
36 – 40	3	15.0
41 – 45	3	15.0
46 – 50	2	10.0
Total	20	100

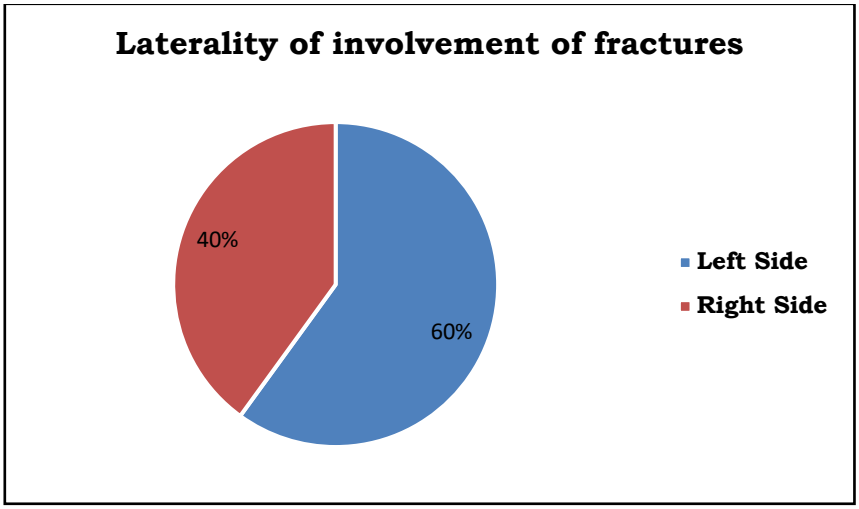

Figure 1: Laterality of involvement of femur fractures in the cases of the study

In the current study, we found the left lower limb was involved in 60% of cases and the right lower limb was involved in 40% of cases of fractures (Figure 1). In this study, the majority of cases were open fractures 60% and the most common fracture was C2 type followed by C3 and A2 type distal femur fractures (Table 2).

Table 2: AO classification of fractures in the cases of the study

Fracture type	Frequency	Percentage
A2	4	20.0
A3	3	15.0
C2	8	40.0
C3	5	25.0
Total	20	100

In the current study, we found the cause of injury in 80% of cases was road traffic accidents (RTA) and the remaining 20% of cases were due to accidental falls. The associated injuries were seen in 35% of cases which have been depicted in Figure 2. The remaining 65% of cases were without any injuries.

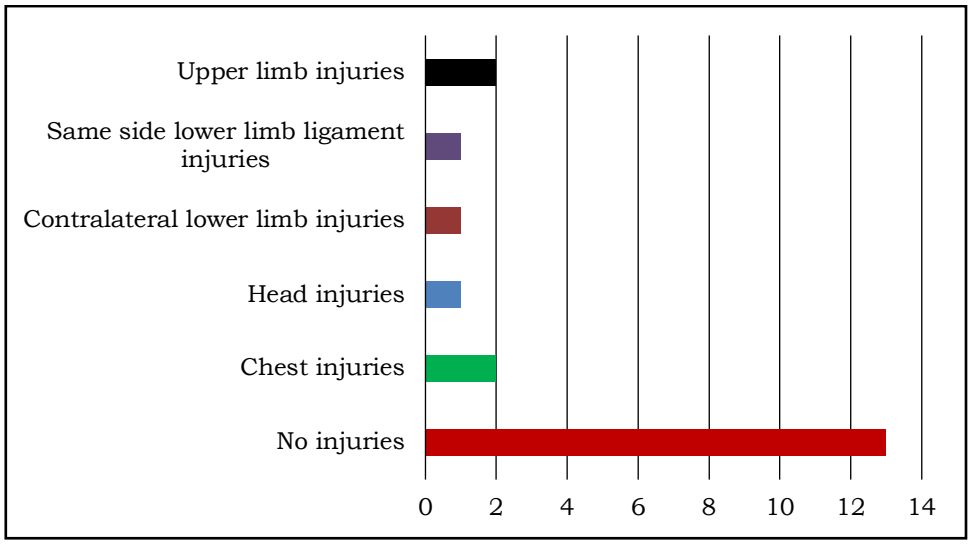

Figure 2: Associated injuries in the cases of the study.

The time taken for surgery varies from less than 120 minutes to 210 minutes per surgery. In this study, we found n=11(55%) of cases took more than 150 minutes to complete the surgery. A knee score of 70 and above is considered as good and in our study, n=15 out of n=20 patients had a score of more than 70 and the remaining n=5 patients had fair and poor results. The overall mean score in our study was 73.4 ± 5.5. The distribution of scores have been depicted in Table 3.

Table 3: Score results in the cases of the study

Score result	Frequency	Percentage
Excellent	6	30.0
Good	9	45.0
Fair	3	15.0
Poor	2	10.0
Total	20	100.0

In this study only n=1 out of 20 patients had a range of motion less than 70°, n=2 patients had flexion up to 70°, n=4 patients between 70° to 90° of maximum flexion, and 14 patients had 90° or more of flexion.

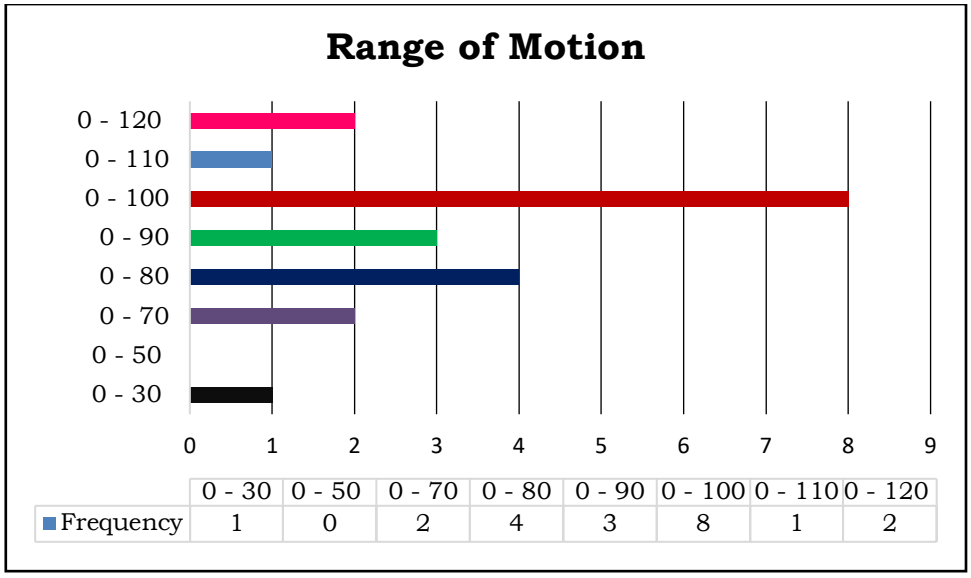

Figure 3: Range of Motion in the cases of the study

The average healing time in this study both clinically and radiologically ranged from 18 weeks to 24 weeks with a mean healing time of 20.9 weeks and n=11 out of n=20 cases healed both clinically and radiologically within 20 weeks. In this study, we found the rate of complication was n=4(20%) out of which n=1(5%) each was superficial infection and implant loosening and n=2 cases had severe knee stiffness (Table 4). The knee stiffness was managed with continuous passive motion and physiotherapy, and they could not achieve knee flexion of more than 50 degrees. The implant loosening occurred in one both of which were osteoporotic the non-locking screw of the medial buttress plate was out and the screw was taken out with a small incision at the end of 12 weeks.

Table 4: Rate of complications in the study

Associated injuries	Frequency (n=20)	Percentage
Superficial Infection	1	5.0%
Implant loosening	1	5.0%
Knee stiffness	2	10.0%
Total	4	20%

Discussion

Distal femur Fractures present significant difficulties because they are located close to the knee joint and are affected by deforming forces. These forces need to be countered during the process of realigning the fractured bones and securing them in place. It is crucial to use appropriate and effective techniques for reducing the fracture to achieve positive clinical and functional outcomes. This involves preserving the blood supply and soft tissues surrounding the fracture. Distal femur fractures often result from high-velocity injuries, leading to multiple fragmented bone pieces, which greatly influences the choice of reduction and fixation methods. Depending on the extent of bone loss, bone grafting may be necessary. [9] One approach to address these challenges in treating distal femur fractures is the implementation of dual plating. Dual plating provides a more stable and anatomically aligned fixation due to its inherent characteristics.

In our investigation, the distal femur was dual-plated on n=20 individuals. Complex C2 and C3 fractures provide a technical

difficulty for ORIF. When a medial plate is added to a lateral plate, the stability and resistance to deformation are increased, similar to the fixing of the distal humerus. A significant incidence of fixation loss and varus collapse occurs in the setting of medial communition, and the usual fixation utilized for other forms of distal femur fractures is not ideal for anatomic articular surface reduction. [10]

Internal fixation or primary replacement is, generally speaking, the surgical choice available here. It can be prudent to undertake primary arthroplasty if the knee had previously been symptomatic. This would probably require a distal femoral replacement with limited articulation, such as a rotating hinge, due to the location of the fracture. However, there won't be many ways to avoid this significant procedure. [11] A lateral plate and a medial buttress plate were suggested by Muller et al. for the treatment of low condylar fractures with medial comminution and loss of the medial cortex. [10] Cement can be utilized to improve fixation in these fractures with inadequate screw purchase; however, extravasation into the intra-articular surface is possible and has been documented. [12] In this study, we report no postoperative varus abnormalities, and 70% of patients had a satisfactory range of motion (ROM) (90°–120°) during follow-up. N=3 patients (15%) had a fair outcome, whereas 75% of cases had excellent and good results.

In this study we found patients with Muller type A2 and C2 fractures did better than those with type A3 and C3 patients. Due to significant comminution and segmental bone loss, three distal femur fractures of the C3 type that had double plating required POP for 4 weeks during the postoperative phase in this research. Intra-osseous plating technique for instances with intra-articular comminution or segmental bone loss of the far(medial) cortex when intramedullary nails cannot be employed. Nail-plate combination approach for secure, balanced fixation permitting immediate weight bearing and early mobility. Future patients with severely comminuted intra-articular fractures (type C3), when even double plating is unable to provide secure fixation, may benefit from these two methods in terms of increasing their quality of life.

Although successful outcomes with intramedullary nailing of distal femoral fractures have been reported, [13] other studies have demonstrated that the intramedullary nail is inferior to the plate in terms of mechanical qualities like rigidity. [14] The use of nails is being promoted by surgeons who assert that strict internal fixation has a high incidence of issues such as delayed union, implant failure, and infection. [15] Additionally, the more serious intraarticular fractures cannot be treated with intramedullary nailing. Due to articular fragmentation and the need for screws to correct these pieces, distal femoral nailing cannot heal these complicated fractures. As a result, intramedullary nailing has been associated with poor results, nailing failure, and other surgical issues, such as fragment instability and malreduction. [10]

Ziran et al., [16] conducted a study involving n=19 patients who had displaced AO type C3 fractures in the distal femur fractures. These patients received treatment using a double plating technique through an anterior approach. The researchers concluded that dual plating of the distal femur can be successfully performed using a single anterior approach. Imam et al., [8] investigated the use of double plating in treating intraarticular multi-fragmentary C3-type distal femoral fractures. They utilized the anterior approach and reported a mean union time of 6 ± 3.5 months, with a range of 3 to 14 months, and a mean follow-up period of 11.5 months. In our study, we achieved better outcomes compared to

previous studies, which could be attributed to the inclusion of C2 fractures and the exclusion of type 3 open fractures. The utilization of dual plating allowed for a more rigid fixation, enabling early mobilization of the patients, and preventing collapse of the fractured bone. However, it should be noted that the addition of another plate increased the operative time and resulted in higher intraoperative blood loss.

Conclusion

The utilization of dual plating in treating complex distal femur articular fractures is a feasible option that is both safe and efficient. It should be considered an essential technique for surgeons. This approach offers several advantages, including achieving anatomical reduction, providing a stable fixation, enabling early mobilization of patients, and reducing the risk of varus collapse. However, it is important to emphasize the significance of proper patient selection, employing appropriate surgical techniques, and closely monitoring post-operative cases to achieve optimal results. Conducting studies with larger sample sizes and longer follow-up periods will provide further insights into the outcomes of using this method for treating complex distal femoral fractures.

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