



# Functional and radiological outcomes of distal femur fractures with more than 2 cm deficient medial metaphysis using fibular strut graft and plating

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## ABSTRACT

### Objective

To analyze the functional outcome of management of distal femur fractures with more than 2 cm deficient medial metaphysis treated using distal femur locking compression plating with fibular strut graft.

### Methods

It's a prospective study and the sample size was determined using the Fisher's formula with the selection mechanism as simple random sampling. This formula assumes a normal distribution, which is generally suitable for many studies with known populations. Twelve patients with metaphyseal comminution or metaphyseal bone loss of more than 2 cm of distal femur who presented to the emergency department at our hospital between May 2018 to May 2020 were included in this study. All patients were followed up regularly at an interval of 4 weeks, 2, 3 and 6 months, 1 year. During every follow-up, the patient was assessed both clinically by the surgeon and radiologically with the help of a radiologist. The presence of varus collapse was assessed by an angle formed between two lines i.e. frontal plane joint orientation line of knee and a line perpendicular to it. The angle formed was measured periodically during every follow-up. We have used Neer's criteria, Tegner and Lysholm score, and Knee injury and osteoarthritis outcome score (KOOS) for assessing the functional outcome of patients.

### Result

No cases of varus collapse are reported in our study. The radiological union was achieved in all of our patients with a mean of 17.75 weeks. 5 patients (41.67%) had knee flexion more than 90° and 7 patients had knee flexion less than 90° (58.33%).

### Conclusion

Distal femur Locking Compression Plating along with autologous free fibular graft helped to bridge the fragments with severe comminution, maintain limb length, without any donor site morbidities, and foster early union in patients with metaphyseal bone losses. Autologous free fibular graft also provides subchondral bone support to the medial column in patients with metaphyseal comminution.

**Key-words:** Distal femur fracture, medial comminution, fibular graft, KOOS score.

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## INTRODUCTION

Fractures in the femur are the second most common site for post-traumatic bone loss accounting for 22% of all traumatic bone losses [5]. They are often caused by high-energy trauma commonly seen in road traffic accidents. Soft tissue damage, closer proximity to the neurovascular structures, and severe comminution with intra-articular extension make distal femur fractures complex and difficult to treat. Distal femur locking compression plate (LCP) has provided the means to increase the rigidity of fixation in intra-articular fractures or the presence of osteoporotic bone by offering multiple points of fixation in the distal fragment [2]. However, distal femur LCP was found to be insufficient in fractures with metaphyseal comminution and intra-articular extension or in fractures with medial metaphyseal bone loss advocating the need for additional techniques such as double plating (medial and lateral) [1]. However, with double plating, there is extensive soft tissue stripping on both sides of the femur resulting in reduced blood supply violating the principles of internal fixation. Biomechanical deficiencies seen with distal femur LCP in certain fractures mentioned earlier can be minimized by augmentation with a fibular strut graft. Adding a fibular strut graft provides intramedullary support to the medial column and also enhances stability during reduction. [12] Using primary fibular grafting with stable rigid double plating fixation after anatomical reduction of the articular and metaphyseal fractures allowing an early range of motion and rehabilitation may decrease the reportedly high rates of nonunion, malunion, varus collapse, and the need for secondary surgery in this fragile population [7]. The combined usage of locking plates and allogenic bone struts in newly diagnosed distal femoral fractures has not been investigated in research [8]. This study aims to analyze the functional and radiological outcome in patients with >2cm medial metaphyseal comminution and bone loss of the distal femur treated with distal femur LCP and fibular strut graft.[5]

## Methods

It's a prospective study of 12 patients with metaphyseal comminution or metaphyseal bone loss of more than 2 cm of distal femur who presented to the emergency department at our

hospital between May 2018 to May 2020 with IEC number ECR/270. The sample size was determined as 12 patients using Fisher's formula with the selection mechanism as simple random sampling. This formula assumes a normal distribution, which is generally suitable for many studies with known populations. Patient's consent was obtained after being informed of the purpose, confidentiality, and nature of the treatment that would be administered to them in the study. The patient gave consent and was willing for regular follow-up. Institutional Ethics Committee clearance was obtained. Patients were explained that from the leg an extra piece of bone would be cut and placed in the fracture site for the bone to unite. Additionally, they were reassured that the bone-cut area would not sustain any damage, and walking would not pose any difficulties. Patients were further convinced by the presentation of other patients who had undergone comparable surgery. Inclusion Criteria were age above 18 Patients with AO/OTA C2 & C3 distal femur fractures. Those with ages below 18, pathological fractures, and periprosthetic fractures were excluded from the study. All 12 patients were treated using distal femur LCP with fibular strut graft to restore the deficient medial metaphysis as recommended by Peschiera et al [7] in distal femur fractures with more than 2 cm deficient medial metaphyseal fractures were classified according to the Association of Osteosynthesis / Orthopaedic Trauma Association (AO / OTA) classification of distal femur fractures. Preoperative planning was done with the help of radiographs and interpreted by an experienced radiologist.

All cases were operated with regional or general anesthesia with a standard lateral approach to the distal femur in the majority of the cases and the Swashbuckler approach in fractures with comminuted intraarticular fractures. The condyles were reduced and stabilized temporarily with k wires and fixed with cancellous screws. Fibular graft that is. The middle third of the shaft of the fibula at least 7-8 cm from the knee and ankle joint, was harvested and inserted in the medullary cavity of the femur maintaining coronal and axial alignment. X-rays were taken to assess the reduction and stability of fixation.

Quadriceps exercises, range of movement, and hamstring exercises were started on 2nd postoperative day depending on fixation, stability, and fracture configuration.

All patients were followed up regularly at an interval of 4 weeks, 2 and 6 months, 1 and 2 years, etc. Patients were assessed both clinically and follow-up X-rays were assessed by the radiologist. The radiological union was said to be achieved when there was evidence of bridging callus on three cortices in standard AP and lateral radiographs. The presence of varus collapse was assessed by an angle formed between two lines that is the frontal plane joint orientation line of the knee and a line perpendicular to it. The angle formed was measured periodically during every follow-up. We have used Neer's criteria, Tegner and Lysholm score, and KOOS (Knee injury and osteoarthritis outcome score) score for assessing the functional outcome. [6] Neer's criteria is divided distal femur fractures as supracondylar & intercondylar while KOOS's score was between 0 to 100 where 0 is extreme knee problems and 100 is no knee problems.

## Results

Data were analyzed using SPSS software and the following descriptions were found for our descriptive study. In our study, the incidence of distal femur fractures was high in young patients (41.6%) with the age ranging between 18-29 years. Injuries were more common on the right side (75%) than on the left side. All patients sustained injury due to road traffic accidents (100%), in which 2-wheeler vs 4-wheeler (66.67%) was the most common. Fractures were classified according to AO/OTA classification in which C2 fractures (58.33%) were more common than C3 fractures. 10 patients (83.33%) showed radiological union within 20 weeks and the remaining two (16.67%) patients achieved radiological union after 20 weeks. Fourteen patients (16.67%) experienced shortening >2 cm, while three patients (25%) experienced shortening < 2 cm. The most frequent consequence was infection (41.67%). The fracture union was unaffected by the infection or the shortening problems. As per Neer's criteria, three patients (25%) got excellent results, while five patients (41.67%) had satisfactory results. as shown in Table 1

**Table 1. Classification According to Beer's Criteria**

Neer's Criteria	No of patients
Excellent	3
Satisfactory	5
Unsatisfactory	1
Failure	3

There was no significant association between functional outcome and classification with p-value > 0.05 [0.34]. There was a significant association between functional outcome and

knee flexion with p-value < 0.05 [0.008]. There was a significant association between functional outcome and shortening with p-value < 0.05 [0.034] as shown in Table 2

**Table 2 Table Showing the p Value and its Association With Actual Value**

p-value	Actual value	Association
>0.05	0.34	Not significant
<0.05	0.008	Significant
<0.05	0.034	Significant

There was no significant association between the time for bone union and the use of cancellous bone grafts with a p-value  $>0.05$ [0.235]. There was a significant association between functional outcome and the presence of associated fractures with p-value  $<0.05$ [0.04].

## DISCUSSION

Distal femur LCP has certainly enhanced stability in distal femur fractures since it provides several places of fixation and leads to an early return to function. When the fracture gap is overly big or the interfragmentary motion is very less, adequate callus formation cannot occur with a high incidence of nonunion and implant failure. Using the recommendations of Hak et al. [3] about the effect of large fracture gaps and its role in decreasing callus formation, primary bone grafting can abolish these gaps and promote healing depending on the biological properties of bone grafting that is osteogenesis, osteoinduction, and osteoconduction. Zlowodzki et al. [14] declared that one of the technical errors that have been reported for fixation failure was delayed bone grafting.

The fibula is the longest autogenous bone graft available which can be harvested with minimal donor site morbidity as seen in our series of patients. It is technically less demanding, quick, and inexpensive compared to dual plating which incurs additional implant costs. Sinking the fibula into the soft cancellous bone of the distal metaphysis of the femur aids in maintaining the length. This arrangement also promotes the early incorporation of fibula and subsequent bony union. It is also a flexible technique that can be changed according to the individual fracture pattern by changing how the fibular graft is inserted. Biological fixation has been advocated as a way to induce bone union by promoting osteogenesis in various studies. The use of fibular strut graft is to produce the best biological environment for healing rather than to achieve absolute stability of fixation i.e., dual plating of the distal femur.

Davison et al [1] found that 42% of the patients with comminuted distal femur fractures developed varus collapse. They assessed the presence of varus collapse by measuring the medial distal femoral angle, which was found to

be progressively decreasing as early as 3 months following weight bearing. We report no case of varus collapse in our study though we had a few complications like infection and implant failure.

In our study, 5 patients (41.67%) had knee flexion of more than  $90^\circ$  and 7 patients had knee flexion less than  $90^\circ$  (58.33%) in which 3 patients (25%) had flexion of  $20^\circ$ . The minimum flexion obtained was  $20^\circ$  and the maximum flexion obtained was  $110^\circ$  with a mean of  $52.5^\circ$ . Although a favorable outcome was achieved in a study by Imam et al. [4] via dual plating with 69% of the patients having flexion more than  $90^\circ$ , bone grafting was required in 62.5% of the patients to promote bony union.

Crushing of articular cartilage left some void even with the best articular reconstruction. This was further complicated by the presence of associated fractures, compound injuries, and medical comorbidities. Hence, the internal fixation and mobilization of the knee was delayed. In our study, we had a mean delay of 3 weeks for internal fixation. Although a good range of motion was not attained in nearly one-third of our patients, stability of the knee was achieved, making most of the activities of daily living possible. Peschiera et al [9] reported 6 cases (30%) of nonunion in distal femur fractures stabilized with a distal femur LCP with medial metaphyseal defect more than 2cm. Imam et al [4] reported a case of nonunion (6.25%) via dual plating in distal femur fractures. There was no case of nonunion in our study.

In our study, the radiological union was achieved in all of our patients with a mean of 17.75 weeks compared to 26.8 weeks by dual plating in a study by Steinberg et al [15]. This signifies that fibular graft fosters early union in addition to providing support to the medial column. In our study, 5 patients (41.67%) developed an infection, in which 3 patients developed an infection after a hospital stay. They were initially treated with appropriate intravenous antibiotics based on pus culture and sensitivity, followed by implant exit after bony union. A 63-year-old male patient developed an infection during the hospital stay for which wound debridement was done twice. Despite repeat wound debridements, the infection did not settle and hence implant removal, freshening of edges, and Ilizarov ring fixation were done.

We also report a patient with implant failure due to septic loosening of implants after 2 years. He presented with purulent sinus discharge after 6 months of surgery. He was treated with wound debridement twice and appropriate antibiotics based on pus culture and sensitivity. All these patients had a good radiological union.

Ricci et al [11] in their study on the failure of locked plate fixation in distal femur fractures, quoted open fractures and diabetes as the major risk factors for infection and implant failure. In our study, probable causes for infection could be attributed to many factors which include open fractures, poor personal hygiene, immunocompromised status, secondary to urinary tract infection, etc., while a single causative factor could not be delineated.

Two patients treated with wound debridement for infection had shortening more than 2cm. This was consistent with the findings of Rajagopal et al [10] who reported shortening as the major complication in their study of 8 patients with 2 patients (25%) having shortening  $\geq 2$ cm. Soft tissue contracture that developed as a result of a delay in internal fixation due to various factors mentioned earlier was the most probable reason explaining shortening in these patients.

#### LIMITATIONS OF THIS STUDY

Include a small number of patients, short-term duration, and the absence of a control group.

Although clinical studies evaluating the functional outcome of this technique are limited, the surgical techniques described herein are safe and effective. Larger long-term studies are required for better evaluation and to further establish distal femur LCP along with fibular graft as a reliable method in fixation in distal femur fractures with metaphyseal bone loss. However, these limitations do not undermine the results achieved by this study and by the other referenced studies.

#### CONCLUSION

Distal femur LCP along with autologous free fibular graft helped to bridge the fragments with severe comminution, maintain limb length, without any donor site morbidities, and foster early union in patients with metaphyseal bone losses. Autologous free fibular graft also provides subchondral bone support to the medial column in patients with metaphyseal comminution as evidenced by the absence of varus collapse in our study. With proper emphasis on early internal fixation and knee mobilization, an adequate range of motion can be achieved with early weight bearing.

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#### AVAILABILITY OF DATA AND MATERIALS

The datasets generated and/or analysed during the current study are not publicly available





Figure1: Pre Op XRay

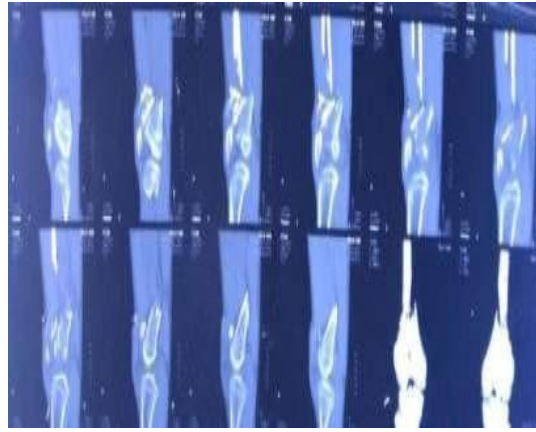


Figure 2 CT Scan



Figure 3 Immediate post op

Figure 4: 2 Years follow up



Figure 5 Pre op

Figure 6 Immediate Post Op



Figure 7: 6 months follow up



Figure 8: 2 Years follow up

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