

## RADIOLOGICAL AND FUNCTIONAL OUTCOME OF DUAL PLATING IN COMMINUTED INTRA-ARTICULAR DISTAL FEMUR FRACTURES

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### Abstract

**Background:** Fractures affecting the distal femur are very complex injuries that pose a challenge to every orthopaedic surgeon. These severe injuries have the potential to produce significant disability. The objective is to study the Radiological and functional outcome of comminuted distal femur intra-articular fractures treated with dual plating. **Materials and Methods:** This Prospective study was conducted in BLDE (DEEMED TO BE UNIVERSITY) Shri B. M. Patil Medical College, Hospital & Research Centre, Vijayapura, from August 2022 to November 2024. **Result:** This research involved 32 patients who had fractures of the comminuted intraarticular femur. These patients received dual plating MAP (medial assisted plating) treatment, and the study evaluated their clinical results and functional outcomes. Our findings indicate a low occurrence of knee stiffness among patients. According to Neer's scoring system, the majority of cases showed good to excellent results. After surgery, there was minimal displacement of fractures and shortening of limbs. Most patients regained normal walking ability postoperatively. **Conclusion:** Our study concludes that dual fixation yields significantly better outcomes for fractures in the distal femur, likely due to improved stabilization and earlier postoperative mobility. Dual plating leads to a satisfactory union in comminuted intraarticular distal femur fractures, low supracondylar periprosthetic fractures, geriatric fractures, and non-union using a modified swashbuckler or Para patellar approach depending on the type of comminution.

## INTRODUCTION

Distal femoral fractures represent 3–6% of femoral fractures and 0.4% of all fractures. It has a bimodal age distribution, with typical occurrence in young individuals (around 20 years old, sports, traffic accidents) and older women (about 70 years old, falling at home, osteoporosis). An extra-articular, intra-articular unicondylar or intra-articular bicondylar fracture of the distal femur can be broadly categorized, with sub-classifications for specific patterns and levels of comminution. The fracture categorization system developed by AO/OTA is the most widely utilized. Treatment of distal femoral fractures has evolved from non-operative, conservative treatment to more aggressive, operative treatment. Despite the recent advances in techniques and implants, treating intra-articular

multifragmentary distal femoral fractures remains challenging. The aim is to ensure the femoral shaft is angled in a valgus position between 7° and 11°, for maintaining this alignment is essential for the limb's functionality. Fractures that heal with >15° of valgus or any degree of varus at the knee have a chance of developing Post-Traumatic Arthritis. So, these severe injuries have the potential to produce significant disability.<sup>[1]</sup> Fracture shortening with extension and varus deformities of the distal articular surface is a typical presentation. Surgical fixation in these fractures aims to achieve anatomical articular reduction, preserve the blood supply, and rigid internal fixation to start early mobilization. Since then, numerous devices such as Angle blade plates, Dynamic condylar screws, Intra-medullary nails, and Distal Femoral Locking Plates (DFLP) have been proposed for the treatment of distal femur fracture. DFLP has given good results in AO type A and type

B fractures, but for type C, the results are not as promising, particularly in C2 and C3. C2 fractures involve metaphyseal comminution, whereas type C3 fractures are characterized by metaphyseal and intra-articular comminution. The metaphyseal comminution, poor bone quality, and inadequate fixation lead to varus collapse and non-union in type C2 and C3 fractures. [2-6]

Augmentation of the lateral locked plate construct with a medial plate reduces the chances of failure. It is reported that a union of patients who had a complex intraarticular fracture (C2, C3) dual plating stabilizes the distal femur's columns and provides a stronger fixation in comminuted supracondylar femur fractures, low periprosthetic fractures, and nonunion. So, this study was conducted to evaluate the radiological and functional outcome of type C3 fracture treated with dual plating for the distal femur. [7,8]

## MATERIALS AND METHODS

This Prospective study was conducted in BLDE (DEEMED TO BE UNIVERSITY) Shri B. M. Patil Medical College, Hospital & Research Centre, Vijayapura, from August 2022 to November 2024. In our study, 32 patients were involved, of whom 17(53.1%) were male and 15(46.9%) were female. 18 patients (56.3%) sustained a left-side injury, whereas 14 patients (43.8%) sustained a right-sided injury. A minimum of 6 months and a maximum of 12 months of follow-up were achieved. All middle-aged or old-aged patients who presented to the orthopedic emergency at the BLDE (DEEMED TO BE UNIVERSITY) Shri B. M. Patil Medical College, Hospital & Research Centre, Vijayapura, with comminuted distal femur intraarticular fracture.

### Inclusion Criteria

- Patient aged 18 years and above
- Closed fracture
- Patients willing for treatment and giving informed and written consent.

### Exclusion Criteria

- Patients aged below 18 years
- Compound fractures
- Polytrauma
- Segmental fracture
- Patients medically unfit for surgery.

**Sample size calculation:** With anticipated Mean±SD of time of complete radiological union in the distal femoral fracture patients  $6.0 \pm 3.5$ , [9] the study would require a sample size of 32 patients with a 95% level of confidence and a precision of 1.4 using Statulator software

$$\text{Formula used: } n = \frac{z^2 S^2}{d^2}$$

Where Z= Z statistic at  $\alpha$  level of significance

$d^2$ = Absolute error

P= Proportion rate

q= 100-p

**Statistical Analysis:** The data obtained will be entered in a Microsoft Excel sheet, and statistical analysis will be performed using statistical package for the social sciences (Verson 20).

Results will be presented as Mean ±SD, Median and Inter quartile ranges, frequency, percentages and diagrams.

**Pre-Operative work-up:** Patients with Comminuted intraarticular distal femur fractures have been clinically and radiologically confirmed and were admitted to the Orthopedics Department at the BLDE (DEEMED TO BE UNIVERSITY) Shri B. M. Patil Medical College, Hospital & Research Centre, in Vijayapura. Routine tests such as complete blood count, Blood sugar, CXR & Electro Cardiography were checked, and a pre-anesthetic examination was done.



**Figure 1: Pre-Operative X-ray and Day 2 Post-operative X ray**

Passive Range of motion up to 90° of flexion and extension from Post-Operative day 2.



**Figure 2: Post-Operative at One-year follow-up**

## RESULTS

32 patients were included in the prospective study. All middle-aged or old-aged patients who presented to the orthopedic emergency at the BLDE (DEEMED TO BE UNIVERSITY) Shri B. M. Patil Medical College, Hospital & Research Centre, Vijayapura, with comminuted distal femur intraarticular fracture. Total 32 patients diagnosed with comminuted intraarticular distal femur fracture were included in the study. 16 patients were above the age 50 years and 16 patients were below the age of 50 years.

Males sustained this injury noticeably more than females. 17(53%) of 32 operated for Comminuted intraarticular distal femur fracture in our study were males, and 15(47%) females were diagnosed with distal femur comminuted intraarticular femur fracture in our study.

**Side involvement:** Out of the 32 patients involved in the study, 18(56.3%) patients have suffered from left-

sided injury of the distal femur, and 14(43.8%) patients have suffered from right-sided injury.

**Mode of Injury:** Out of 32 patients who suffered from distal femur comminuted intraarticular femur fracture, 24 patients had a history of road traffic accidents (RTA), and 6 were elderly patients who were diagnosed with distal femur fracture after a history of trivial falls and 2 were fall from a height.

**Approach to Distal Femur:** Out of 32 patients diagnosed with comminuted intraarticular distal femur fracture, 25(78.1%) patients were operated using the modified swashbuckler approach, and 7 were operated using dual incision, which includes the lateral swashbuckler approach and medial sub vastus approach.

During the follow-up, 32 patients were assessed clinically, radiological and functionally using Neer's criteria.

During the first 6 weeks of follow-up, patients had a mean Neer score of 51.69, suggestive of a fair outcome. The mean Neer's score progressively increased to 66.56 at 3 months, 76.47 at 6 months and finally, at 12 months mean Neer's score was 79.41, suggestive of good to excellent outcome.

Neer's score was compared to the two approaches used for distal femur fracture.

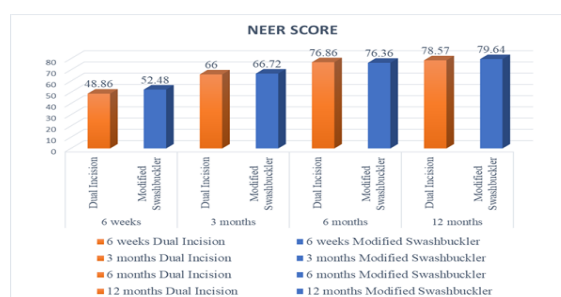
Neer's score for all the follow-up periods showed that 21 patients operated with the modified swashbuckler approach had a better functional outcome.

All 32 patients were also compared based on the mode of injury.

24 patients had a history of road traffic accident, the mean Neer score at the time of 6 weeks was around 51. On further follow up at 3 months 6 months and 12 months the mean Neer score progressively increased to 60, 76 and 80 respectively, suggestive of excellent outcome.

6 patients had a history of trivial fall (e.g. fall from a standing height), the mean Neer score at the time of 6 weeks was around 53. On further follow up at 3 months 6 months and 12 months the mean Neer score progressively increased up to 69, 77 and 78 respectively, suggestive of good outcome.

2 patients had a history of fall from height, the mean Neer score at the time of 6 weeks was around 52. On further follow up at 3 months 6 months and 12 months the mean Neer score progressively increased to 63, 74 and 79 respectively, suggestive of good outcome.



**Table 1: Age Distribution**

Age	No. of patients	Percentage
< 30	3	9.4
30 - 39	8	25.0
40 - 49	5	15.6
50 - 59	7	21.9
60 - 69	4	12.5
70+	5	15.6
Total	32	100.0

**Table 2: Sex Distribution:**

Gender	No. of patients	Percentage
Female	15	46.9
Male	17	53.1
Total	32	100.0

**Table 3: Mode of injury**

Mode of injury	No. of patients	Percentage
Fall from height	2	6.3
RTA	24	75.0
Trivial Fall	6	18.8
Total	32	100.0

**Table 4: Approach to Distal Femur**

Approach to Distal femur	No. of patients	Percentage
Dual Incision	7	21.9
Modified Swashbuckler	25	78.1
Total	32	100.0

**Table 5: Neer Score**

Follow up	No. of patients	Neer score
6 weeks	32	51.69
3 months	32	66.56

6 months	32	76.47
12 months	32	79.41

**Table 6: Neer Score comparison based on approach**

Follow up	Approach	No. of patients	Neer score
6 weeks	Dual Incision	7	48.86
	Modified Swashbuckler	25	52.48
3 months	Dual Incision	7	66
	Modified Swashbuckler	25	66.72
6 months	Dual Incision	7	76.86
	Modified Swashbuckler	25	76.36
12 months	Dual Incision	7	78.57
	Modified Swashbuckler	25	79.64

**Table 7: Neer score comparison based on mode of injury**

Follow up	Mode of injury	No. of patients	Neer score
6 weeks	Fall from height	2	52.00
	RTA	24	51.25
	Trivial Fall	6	53.33
3 months	Fall from height	2	63.00
	RTA	24	66.08
	Trivial Fall	6	69.67
6 months	Fall from height	2	74.50
	RTA	24	76.42
	Trivial Fall	6	77.33
12 months	Fall from height	2	79.00
	RTA	24	79.63
	Trivial Fall	6	78.67

## DISCUSSION

Fractures of the distal femur are challenging due to the proximity to the knee joint and the effect of deforming forces, which need to be countered during reduction and fixation. Utilization of appropriate and effective reduction techniques is vital for achieving desirable clinical and functional outcomes, which would involve the preservation of vascularity and soft tissue in the vicinity of the fracture.<sup>[3]</sup>

Due to the predominance of high-velocity injuries in distal femur fracture, comminution of the fracture is common and proves to be a major deciding factor when it comes to the implementation of an appropriate method of reduction and fixation and would also dictate the need for bone grafting depending on the bone loss present.

Dual plating, also referred to as medial assisted plating (MAP), in distal femur fractures, has been implemented in the treatment to address the above-mentioned challenges. Dual plating achieves a more rigid and anatomical fixation due to the nature of the stabilization.

The primary concerns for medial plating are unfamiliar approach and proximity to the neurovascular bundle. Most vascular insult secondary to open reduction and internal fixation of the distal femur occurs because of lateral locked plating and not from the addition of a medial plate.

After a detailed analysis of the studies, the indications of dual plating in the distal femur fracture are clear. AO classification is used for the distal femur fractures. Similarly, few studies opted for the dual plate in very low periprosthetic fracture and non-union following previous plate fixation for the above

type of comminuted metaphyseal or articular fractures.

Very few studies show the radiological and functional outcomes of dual plating for the distal femur. There are studies comparing the treatment parameters for comminuted intraarticular distal femur fracture.

In our study, 32 patients were included, of which 25 were operated with a single modified swashbuckler approach, and 7 were operated on dual incision using medial and lateral approaches.

The modified swashbuckler approach was preferred compared to dual incision as it decreases the duration of surgeries, and the medial approach is not preferred due to the close approximation to descending genicular branches along with arterial anastomosis to vastus medialis. If the muscular branches are not identified and cauterized, they get retracted, and it is difficult to stop the bleeding. Other studies have also reported a safe medial interval (up to about 16 cm proximal to the adductor tubercle) for plating with little danger to the femoral artery, nerve, and branches.<sup>[4]</sup>

In our study, we noted that the mean duration of surgery for the dual incision approach group was greater than the swashbuckler group. The mean ROM in the swashbuckler group was 120° compared to 100° in the dual approach group. The mean Neer score was 78.57 in the dual approach group compared to 80 in the swashbuckler approach group.

This study was done to determine the clinical and functional outcome of dual plating of distal femur fractures. A total of 32 patients with fractures of the distal femur underwent fixation with dual plating during the time frame from August 2022 to August 2023. In our study, 53.1% of the patients were male,

and 46.9 % were female, with 17 and 15 cases, respectively. In the study by Rekha et al., 70% of the cases were male, with 30% being female. In the study by Bai et al., the female-male ratio was 1:1. a ratio comparable to ours.<sup>[5]</sup>

The observed average age of patients with distal femur fracture was 39, with the majority of the cases being between 21 and 40 years of age, accounting for 64% of the total cases, supporting that the majority of the cases are that of high-energy trauma in a younger population. The average age documented in the study by Kregor et al. was 49, while in the study by Yeap et al., it was 44.<sup>[6]</sup>

RTA accounted for 60% of the total cases, contributing to the majority of the cases, while falls contributed to the remaining 40%. In the study by Rekha et al., 73% of the cases were due to RTA, and 27% were due to domestic falls <sup>[5]</sup>. In our study, AO type C3 was the pattern of fracture, accounting for all the cases. Hence, 68% of our cases were of AO type C fracture pattern, while Kregor et al. noted 50% of their cases were AO type C. In the study by Rekha et al., 46.7% of their cases were AO type C <sup>[5]</sup>.

Most of the fractures, i.e., all the cases, were closed fractures. The study by Apostolou et al. noted that 20% of their cases were open fractures, with the remaining cases (80%) being closed fractures, which is comparable to our study.<sup>[7]</sup>

Although 84% of cases (n=26) did not have any postoperative complications on follow-up after three months, 8% (three cases) of cases had knee stiffness, 4% (one case) had non-union, and 4% (one case) had an infection. Schutz et al. noted 7% of cases had infection postoperatively,<sup>[8]</sup> while Kregor et al. noted 5% infection in his study.<sup>[9]</sup> In the study by Garg et al, 10% of cases had superficial infections, non-union, and knee stiffness each.<sup>[10]</sup>

Only 16% of cases, that is, five cases, had fixed flexion deformity, with four of them having up to 5 degrees. 68% of cases had knee flexion up to 120 degrees, while 24% of cases had a full range of motion, i.e., up to 130 degrees of knee flexion. Only 8% of cases had flexion less than 110 degrees, with the least being up to 100 degrees, which was still within functional limits. Our results were comparable to the study by Markmiller et al., where the average range of motion was 0-110 degrees.<sup>[11]</sup> Garg et al., in their study, had a mean range of flexion up to 124 degrees.<sup>[10]</sup>

Twenty-four percent of cases had excellent outcomes per Neer's scoring systems, while 94% had good outcomes. Only 6% of cases had fair and poor outcomes. In the study by Garg et al., 50% of cases had excellent outcomes as per Neer's criteria, 30% had good outcomes, and fair and poor outcomes were 10%.<sup>[10]</sup>

In this study, 78% of cases had shortening of affected limbs less than 1 cm postoperatively, while only 12% of cases had more than 1 cm shortening. In the study by Rekha et al., 10% of cases had a shortening of more than 1.5 cm. <sup>[5]</sup>

84 % of cases had postoperative fracture displacement of less than 1.5 cm, which can be correlated with the better outcome of walking. 16 % of cases had a displacement of more than 1.6 cm. Park et al., in their study, reported a postoperative mean displacement of 5.6 mm. <sup>[12]</sup>

The meta-analysis of the comparative studies reported no difference in non-union rate and blood loss between the single plate and double plate fixation groups. However, double plate fixation had a longer surgical duration and lesser fracture healing time.

Rajasekaran et al. applied an objective method for dual plate fixation. After correction of the lower limb alignment at the fracture site, if the medial void was more than 2 cm, they advised medial plating with bone grafting.

The most common fixation technique was the fixation of the plates on the medial and lateral surfaces of the distal femur. Ziran et al. and Chapman et al., in their study, placed the plates on the lateral surface and anterior surface (anteromedial) of the distal femur through the lateral Para patellar approach. Ziran et al. observed arthrofibrosis in 14% of their patients.

They believed that associated injuries in the extremities restricted early rehabilitation and associated extensive damage to the suprapatellar tissue contributed to the stiffness. However, the placement of the anterior plate beneath the quadriceps cannot be excluded as a cause for a high stiffness rate in their series. They stressed the meticulous repair of the suprapatellar pouch to prevent adhesions between the quadriceps and bone surface.

## CONCLUSION

This research involved 32 patients who had fractures of the comminuted intraarticular distal femur. These patients received dual plating MAP (medial assisted plating) treatment, and the study evaluated their clinical results and functional outcomes. Our findings indicate a low occurrence of knee stiffness among patients. According to Neer's scoring system, the majority of cases showed good to excellent results. After surgery, there was minimal displacement of fractures and shortening of limbs. Most patients regained normal walking ability postoperatively. Our study concludes that using dual fixation yields better outcomes for fractures in the distal femur, likely due to improved stabilization and earlier postoperative mobility.

This systematic review also revealed that dual plating leads to a satisfactory union in comminuted intraarticular distal femur fractures, low supracondylar periprosthetic fractures, geriatric fractures, and non-union using a modified swashbuckler or Para patellar approach depending on the type of comminution.

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