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# RADIOLOGICAL AND FUNCTIONAL OUTCOME OF DUAL PLATING IN DISTAL FEMUR MULTIFRAGMENTARY ARTICULAR FRACTURES: A SHORT TERM STUDY

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## ABSTRACT

***Introduction:*** In this prospective cases series, we are reporting a mean 12-month follow up of the utilisation of dual plating technique for multi fragmentary articular distal femur fractures. Our technique consists of a lateral distal femoral locked plate and a low profile locked medial plate through a modified anterior (Swashbuckler) approach for the fixation of C2, C3 fractures.

***Patients and Methods:*** 15 patients (9 males and 6 females) presented with supra condylar femoral fractures type C2/C3, according to Müller long bone classification and its revision, OA/OTA classification. These fractures were treated using dual plating through swashbuckler approach. They were followed up for clinical and radiological outcomes. Secondary outcomes included post-operative complications.

***Results:*** Mean time of radiological union in studied population was 18 weeks with a range of 14-24 weeks. We did not observe any post-operative varus angulation.12 out of 14 patients had good to excellent functional outcome. Fair outcome was reported in only two patients

***Conclusion:*** The technique of Dual plating fixation using modified anterior approach (swashbuckler) for type C2,C3 distal femoral fractures is an efficient method of management. It has several advantages such as precise exposure, easy manipulation, anatomical reduction and stable fixation. However, operative indications and principles should be strictly followed. The surgical technique must be perfect and the biomechanical qualities of the implants must be understood to prevent the development of major complications

## KEYWORDS :

## INTRODUCTION

In the modernised world due to rapid industrialisation and road traffic accidents the incidence of distal femur fractures has increased which is around 37 per 100,000-person years[1]. Distal femur is defined as fractures within 9cm of the articular surface, the fractures of which account for 6% of all femoral fractures. Distal femur fractures arise from different injury patterns. In younger age group, injury is often sustained due to road traffic accidents involving high energy trauma leading to compound injuries and comminution of distal femoral condyles and metaphysis. In elderly they occur due to low energy trauma owing to osteoporosis. Restoration of knee joint function in high energy trauma due to comminution of condyles, ligamentous injury and extensive cartilage injuries is problematic while in elderly patients with osteoporotic bones implant anchorage is difficult[2].

The conservative management of displaced distal femur fractures was practiced during the early part of the century based on the work of Watson Jones[3] and John Charnley[4]. It consists of application of skeletal traction, fracture reduction through manipulation, application of cast and cast bracings. Problems such as shortening of limb, knee stiffness, mal-union, deformity, angulation, non-union, incongruity of joint, wasting of quadriceps muscle, instability of knee joint and secondary osteoarthritis were frequently observed.

Intra-articular fractures of the distal femur are challenging injuries. These require an extensive surgical approach to visualize and reduce the broken articular fragments, particularly in complex fractures. The insult to the periarticular soft tissues caused both by the initial trauma and subsequent surgical approach, causes difficulty in early postoperative rehabilitation predisposing to knee stiffness. Frequent complications are malunion, non-union, stiffness, and secondary osteoarthritis[5]

In the recent years there is a common consensus among surgeons that supracondylar fracture of femur has to be surgically treated to achieve good functional outcomes[6].The various options for operative treatment include blade plate, dynamic compression screw, non-locking condylar plate, external fixation systems and submuscular locked internal fixation systems.

At present, the distal femoral articular fractures are mainly fixed by the lateral anatomical locking plate (LCP). LCP acts as a single beam construct whose fixation strength does not depend on axial stiffness / pull out resistance of single screw, rather it is based on sum of all the screw- bone interfaces. Its biomechanical function is based upon the principle of splinting which leads to early formation of callus, flexible stabilisation and stress shielding is avoided. It is associated with lower infection rates, reduced resorption of bones and faster healing rates when applied through minimally invasive technique.

LCP with its fixed angle construct creates a toggle free fixation. In osteoporotic bone, locked screws increase the rigidity of fixation and are particularly helpful in peri-articular or in the presence of small epiphyseal segment in juxta-articular fractures.[7]However in multi-fragmented intra articular fractures, lateral plate alone may not be able to hold the said multi-fragments leading to inadequate unstable fixation and increased risk of varus collapse. Thus, medial and lateral double plating fixation is suggested to tackle the above said problems. With double plating, stability of fixation is increased, patient can be mobilised early leading to decreased incidence of knee stiffness .[8]

The purpose of this study is to evaluate the outcomes of medial and lateral double plating fixation of distal femur intraarticular multifragmentary fracture.

## AIMS AND OBJECTIVES OF THE STUDY

1. To study the union rates with double plating assessed radiologically
2. Functional outcome by Knee Society Score (KSS) system
3. To study the complications in this treatment modality

## MATERIALS AND METHODS

It is a prospective study done from May 2018 to March 2020. It includes 15 patients of distal femur multifragmentary intra articular fractures (AO/OTA 33-C2, C3) who were operated with lateral and medial double plating in Department of orthopaedics, Bangalore medical college and Research institute, Bengaluru.

Out of 15 patients, 11 were male and 4 were female. AO/OTA classification was used to classify the fracture. Road traffic accident was the most common mode of injury accounting for 90% of the cases.

## INCLUSION CRITERIA

1. Distal femur multifragmentary fractures (C2,C3)
2. Age group 18-75
3. Patients willing to give informed consent

## EXCLUSION CRITERIA

1. Type III open fractures
2. Pathological fractures
3. Fracture in a limb with prosthesis
4. Ipsilateral long bone fractures
5. Associated secondary causes of muscle weakness

## METHODOLOGY:

15 Patients, after obtaining written informed consent, admitted as in-patients of Department of Orthopaedics after fulfilling the inclusion criteria were selected. Radiological evaluation includes anteroposterior and lateral X-rays of the femur with knee, along with a pelvic X-ray to rule out proximal femur fractures. Computed tomography (CT) scans with three-dimensional reconstruction was done. Distal femur multifragmentary intra-articular fractures were fixed with a distal femur locking compression plate(DFLCP) and a locked medial plate using swashbuckler approach.

The patients were clinically examined at the time of discharge from hospital for any malrotation or limb length discrepancy. A limb malrotation <5° and a limb length discrepancy <5 mm is difficult to detect clinically and were considered as normal. A repeat clinical examination was be done at the final fracture healing to note any further change in limb length and rotation. AP and lateral radiographs of the femur with knee, taken immediately after surgery and were evaluated for fracture alignment, both in the coronal and sagittal planes. Fracture alignment in the coronal plane is measured by the valgus angle between the anatomic axes of the femoral and tibial shafts. A 5°–10° valgus angle was considered as normal as in the Knee Society Score (KSS). The alignment in the sagittal plane is measured by noting the angulation between the anterior cortices of the proximal and distal fragments. Sagittal plane angulation within 5° of the opposite side were considered as normal.

The patients were followed up at every 6 weeks until bony union was achieved at both the articular and metaphyseal fracture sites, and the subsequent follow up were done every 3 months till 6 months.

## OUTCOME MEASURES

### Clinical outcome:

At 6month follow up, the KSS is recorded, including the knee and functional subsets. A Knee Society Score between 80 and 100 is regarded as excellent, between 70 and 79 is regarded as good, between 60 and 69 is regarded as fair, and <60 is regarded as poor.

### Radiological outcome:

Callus formation and progression of fracture union. AP and lateral radiographs of the femur with knee were taken at each visit. Union is defined as bridging callus formed in 3 out of 4 cortices.[13]

### Surgical approach

**Fig.1 - Pre op X ray and CT images**

All procedures were carried out under combined spinal and epidural anaesthesia. With the patient lying supine, knee flexed. A midline anterior knee incision is made. Proximally, the incision angles slightly laterally.

The incision is carried down to the fascia overlying the quadriceps muscles. This fascia is split in line with the skin incision and lifted off the underlying vastus lateralis muscle belly. Separation of the iliotibial band from the vastus lateralis is carried down to the lateral intermuscular septum, which is confluent with the iliotibial band. The septum is followed to the shaft of the femur. Once the vastus lateralis has been reflected off the lateral intermuscular septum, a retractor placed under the quadriceps muscle is used to expose the femur and to evert the patella medially. The synovium was then incised in line with the capsular incision, and hematoma was washed out. The joint was thoroughly inspected to evaluate the severity of the injury and degree of intra-articular comminution of the femoral condyles. This approach allows direct exposure of both condyles and adequate reduction can be done. Both lateral and medial distal femoral plating can be done through the same incision.

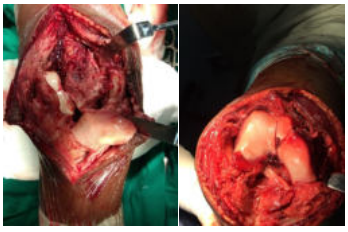

**Fig. 2 exposure of distal femur before and after reduction**

Reduction in small condylar fragments was made with pointed bone reduction clamps. Lateral column reconstructed with bony fragments

Thereafter preliminary wires fixation and cannulated inter-fragmentary screws of 4mm were recruited to restore the anatomical congruity. Definitive fixation was initiated by countersunk cannulated cancellous 6.5 mm/4mm screws ,

followed by applying a distal femoral locked plate on the lateral side and secured with locked screws through the plate. A second lateral mini open incision was used when needed to insert screws in the long plate to fix the proximal locking screws.

**Medial column of distal femur was reconstructed as much as possible and preliminarily secured with K-wires and 4mm screws after which locked medial plate was applied to stabilise the medial column.**

Closure was done using absorbable sutures after ensuring haemostasis. Skin was closed using staples.

Post operatively, all patients were immobilised in hinged knee brace for 3 weeks and were advised non-weight bearing ambulation. After 3 weeks, patients were mobilised with gradual progression of knee flexion as tolerated.

Partial weight bearing ambulation was allowed once there was radiographic evidence of callus formation.

Full weight bearing was postponed till radiological union was established

**Fig.3. Immediate post op**

**Fig.4 – post op 1 month follow up**

**Fig.5- 6 month follow up**

**Fig.6 : ROM at 6 months**

## STATISTICAL ANALYSIS

Descriptive and inferential statistical analysis has been carried out in the present study. Results on continuous measurements are presented on ***Mean and SD*** (Min-Max) and results on categorical measurements are presented in Number (%). Significance is assessed at 5 % level of significance. The following assumptions on data is made, Assumptions: 1. Dependent variables should be normally distributed, 2. Samples drawn from the population should be random, Cases of the samples should be independent Analysis of variance (ANOVA) has been used to find the significance of study parameters between three or more groups of patients Chi-square/ Fisher Exact test has been used to find the significance of study parameters on categorical scale between two or more groups, Non-parametric setting for Qualitative data analysis. Fisher Exact test used when cell samples are very small.

## RESULTS

In our study 15 patients who met the inclusion criteria were included in the study and were followed up for minimum period of 6 months. (6-19 months, mean 12.43)

One patient was lost for follow up **as patient died due to cerebrovascular accident 2 months post follow up**

The age group of maximum number of study participants was between years 40-50 years (40%) (table 1) and the majority were male (60%) (Table 2). The most common mechanism of injury was motor vehicle accidents (80%) (Table 3). The majority of participants had open fracture (9 patients, 60%) (fig 7). 67% of them were AO type C3 fractures and 33% were type C2.

**Table 1: Age distribution of patients studied**

| Age in years | No. of patients | % |
|---|---|---|
| <40 | 4 | 26.7 |
| 40-50 | 6 | 40.0 |
| 51-60 | 4 | 26.7 |
| >60 | 1 | 6.7 |
| Total | 15 | 100.0 |

Mean ± SD: 42.60±13.88

**Table 2: Gender distribution of patients studied**

| Gender | No. of patients | % |
|---|---|---|
| Female | 6 | 40.0 |
| Male | 9 | 60.0 |
| Total | 15 | 100.0 |

**Table 3: Mode of Injury distribution of patients studied**

| Mode of Injury | No. of patients | % |
|---|---|---|
| Fall | 3 | 20.0 |
| RTA | 12 | 80.0 |
| Total | 15 | 100.0 |

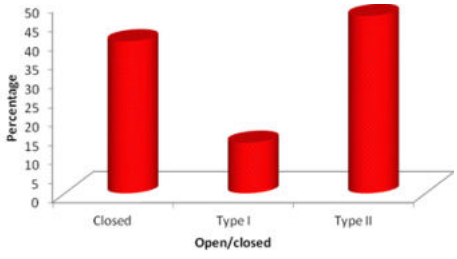


**Fig.7 Open/closed distribution of patients.**

All fractures united at mean of 18 weeks (18±4)(Table 4). 2 patients had residual pain and 2(14.3%) patients had extensor lag of 10°. 11 cases(78%) had knee ROM exercises more than 90° ( table 5 and fig 8). No patients had laxity.

**Table 4: Time to Union distribution of patients studied**

| Time to Union(Weeks) | No. of patients | % |
|---|---|---|
| <20 | 7 | 46.7 |
| 20-24 | 7 | 46.7 |
| >24 | 0 | 0.0 |
| Lost to follow up | 1 | 6.7 |
| Total | 15 | 100.0 |

**Table 5: ROM- distribution of patients studied**

| ROM | No. of patients | % |
|---|---|---|
| 0-60 | 1 | 7.1 |
| 0-90 | 2 | 14.3 |
| 90-105 | 8 | 57.1 |
| >105 | 3 | 21.4 |
| Total | 14 | 100.0 |

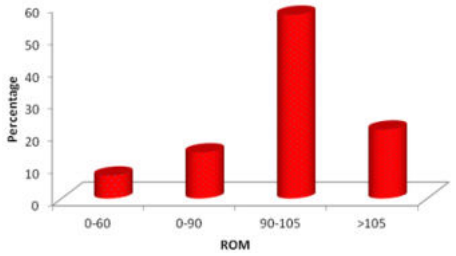


**Fig 8. Range of motion**

Knee Society score calculated by combined KSS1 and KSS2 was excellent for 7 patients (50%), good for 5 patients (36%) and fair in 2 patients (14%) (table 6, fig 9). Complication were noted in 3 patients which were Knee stiffness, peri implant fracture, superficial infection and delayed union. (table 7).

**Table 6: KSS distribution of patients studied**

| KSS | No. of patients (n=14) | % |
|---|---|---|
| KSS1 | | |
| • <60 | 0 | 0.0 |
| • 60-69 | 1 | 7.1 |
| • 70-79 | 1 | 7.1 |
| • 80-100 | 12 | 85.7 |
| KSS2 | | |
| • <60 | 1 | 7.1 |
| • 60-69 | 2 | 14.3 |
| • 70-79 | 7 | 50.0 |
| • 80-100 | 4 | 28.6 |
| KSS Total | | |
| • <120 | 0 | 0.0 |
| • 120-139 | 2 | 13.3 |
| • 140-159 | 5 | 33.3 |
| • >160 | 8 | 53.3 |

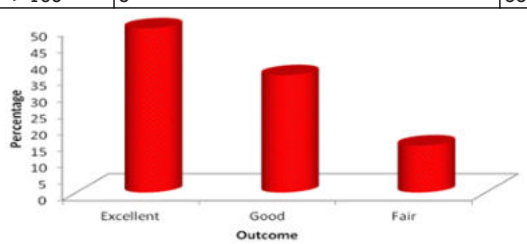


**Fig.9 Outcome distribution**

**Table 7: Complications- distribution of patients studied**

| Complications | No. of patients | % |
|---|---|---|
| Nil | 11 | 73.3 |
| Follow up lost | 1 | 6.7 |
| Knee stiffness | 1 | 6.7 |
| Peri-implant fracture at 9 months | 1 | 6.7 |
| Superficial infection, delayed union | 1 | 6.7 |
| Total | 15 | 100.0 |

## DISCUSSION

In our study, 15 patients were treated with dual plating of distal femur through modified anterior approach (Swashbuckler). The approach provides adequate exposure of both the condyles and helps in achieving adequate fixation of these complex fractures.

ORIF of complex C2, C3 fractures is technically challenging. The ability to supplement a lateral plate with a medial plate increases the stability and resists deformation analogous to distal humerus fixation The standard fixation used for other types of distal femur fractures is not optimum for anatomic articular surface reduction and in the setting of medial communition , there is high prevalence of fixation loss and varus collapse.[9]

Broadly speaking , the surgical options here are internal fixation or primary replacement. If the knee had been symptomatic, it may be appropriate to perform primary arthroplasty. Because of the position of the fracture, this would likely involve a distal femoral replacement with constrained articulation such as rotating hinge. However this will be a major surgery with very little bail out options[10]

Muller et al. proposed the treatment of low condylar fractures having medial comminution and loss of medial cortex with a lateral plate and medial buttress plate.[9] To enhance fixation in these fractures with poor screw purchase, cement may be used; However , extravasation into the intra-articular surface may occur and which has been reported[11]

In our study,we report no varus deformities after the operation and 78% showed good range of motion (90-120°) during follow up. 7 patients(***50%)*** showed excellent outcome and only 2 showing fair outcome.

Although favourable results have been reported using intramedullary nailing of distal femoral fractures[12], others have shown that the intramedullary nail to be inferior to plate concerning mechanical properties such as stiffness[13]. *Surgeons promoting the use of nail claim that rigid internal fixation can yield high incidence of complications such as delayed union, implant failure and infection*[14].Furthermore, intramedullary nailing cannot be used for the more severe intraarticular fractures. Distal femoral nailing cannot secure these complex fractures due to the articular comminution and requirement of screws to fix these fragments. Consequently, poor outcome, failure of nailing and other surgical complications including instability and mal-reduction in the fragments are reported in intramedullary nailing[9].

External fixators with minimal internal fixation have several problems in treating type C femur fractures. These include septic arthritis, pin site infection and osteomyelitis. Also, inadequate reduction, delayed union or non union with requirement of bone grafting , stiffness and subsequent need for manipulation under anaesthesia have been reported[15,16.]

Ziran et al assessed 19 patients with displaced AO type C3 distal femoral fractures. The patients were treated with an anterior approach and double plating. They concluded that dual plating of the distal femur can be fixed using single anterior approach[17].

Zhang et al investigated the clinical efficacy and feasibility of double plating fixation via anterior/middle approach in treating type C3 distal femoral fractures. Among them, there were eight males and 4 females with average age of 40 years (range 25-55 years). 9 cases injured in motor vehicle accidents and 3 cases by fall. After skin traction for 5-8 days, the surgery was performed by double plating via anterior/middle approach and bone grafting used as well.4 cases got excellent results, 6 good, 1 fair and 1 poor[18].

Sanders et al evaluated 9 patients with compound fracture of distal femur and a deficient medial cortical buttress. Stable fixation was inadequate with utilisation of lateral plate alone. Intra operatively , the authors noted collapse of distal fragments into varus angulation. Medial plate with bone graft was needed for extra stabilisation and it was applied in all cases. The functional results revealed 5 cases with good outcome and 4 with fair outcomes[19].

Imam et al investigated Double plating of intra articular multifragmentary C3type distal femoral fractures through the anterior approach reported mean union time of 6±3.5 months with a range of 3-14 months with mean follow up of 11.5 months[8].

In our study we have shown better outcome than other studies probably due to inclusion of C2 fractures and exclusion of type 3 open fractures. Dual plating enables more rigid fixation and hence patient can be mobilised early. It also prevents collapse. Addition of another plate adds to the operative time and increase in intra operative blood loss.

A limitation of this study is the relatively short follow up period in some of the cases. However, we plan to continue to follow up this cohort of patients. Another limitation is the relatively small number included in this study which is mainly because we have excluded multiple trauma patients that required multiple procedures.

## CONCLUSION

Dual plating of complex distal femur articular fracture is a viable option which is safe and efficient and should be in the armament of any surgeon. It has several advantages such as anatomical reduction, rigid fixation, early mobilisation and reduced varus collapse. Nevertheless proper patient selection , adequate surgical technique and diligent follow up of cases will yield better result. A bigger sample size and longer follow up period will throw more light on the outcome of this method of treating complex distal femoral fractures.

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