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Original Research Article

A Prospective Study on Functional Outcome of Double Plating for Distal Femur Fractures

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Abstract:

Background: Nonunion, varus collapse, and implant failure are frequent complications in the treatment of distal femur fractures. The lateral plate might not be able to hold the multiple fragments, which would result in a poor, unstable fixation and a higher risk of varus collapse. Dual plating provides a more stable and anatomically aligned fixation and lowers the likelihood of knee stiffness**.**

Materials & Methods: This prospective study was conducted among 30 patients of distal femur fractures who were operated with double plating. The patients were followed up at every 6 weeks until the bony union was achieved and the subsequent follow-up were done every 3 months till 6 months. Patients were assessed for range of motion, fixed deformity, and extension lag at every follow-up. At the 6-month follow-up, the patient's functional status was evaluated using the American Knee Society Scoring System (KSS).

Results: Total 20 (66.7%) patients had motion range of 90° and above. Knee score more than 70 was observed in 21 (70.0%) patients. Mean duration of union was 18.8 ± 4.34 weeks. Complication was noted in 7 patients (23.4%). Excellent and good outcome was reported in 8 (26.7%) and 13 (43.3%) patients. Remaining 6 (20.0%) and 3 patients (10.0%) had fair and poor outcome respectively.

Conclusion: The double plating method for unstable distal femur fractures offers several advantages such as increasing the stability of fixation, improving the healing rate and allows early weight bearing, enabling early mobilization of patients and reducing the risk of varus collapse.

Keywords: double plating method, femur fractures, outcome, union, varus collapse

Introduction

The incidence of distal femur fractures is about 37/100,000 person-years due to increased industrialization and road traffic accidents. [1] Fractures of the distal femur occur within 9 cm of the articular surface, which make up 6% of all femoral fractures. High velocity trauma, comminution, soft tissue damage, instability, and articular surface extension are usually associated to these fractures. [2] Younger age groups are frequently injured in road traffic accidents, where high energy trauma causes compound injuries and comminution of the distal femoral condyles and metaphysis. They occur in older people 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, comminution of condyles, and ligament damage make it difficult to anchor implants in elderly patients with osteoporosis. [3]

The main objectives of surgical treatment include articular surface reconstruction, rotational and axial alignment restoration, stable fixation, early mobilisation, and functional rehabilitation. [2] Nonunion, varus collapse, and implant failure are frequent complications in the treatment of distal femur fractures with metaphyseal comminution. The accepted treatment is lateral plating with a distal femur-locking compression plate. [4]

The lateral anatomical locking plate (LCP) functions as a single beam construct whose fixation strength is based on the total of all the screw-bone contacts rather than on the axial stiffness or pull-out resistance of a single screw. Its biomechanical

function is based on the splinting concept, which promotes early callus development, flexible stabilisation, and the avoidance of stress shielding. When used with a minimally invasive approach, it is linked to lower infection rates, less bone resorption, and faster healing rates. The fixed-angle design of LCP results in a toggle-free fixation. Locked screws increase the stiffness of fixation in osteoporotic bone and are especially useful in periarticular or in fractures involving small epiphyseal segments in juxtaarticular fractures. [5] However, in intraarticular fractures with several pieces, the lateral plate might not be able to hold the multiple fragments, which would result in a poor, unstable fixation and a higher risk of varus collapse. Without altering the vascular supply, the insertion of an additional medial plate to the lateral plate may increase mechanical stability. [6] Patients can be mobilised sooner, which lowers the likelihood of knee stiffness. [7] We assessed the results of fixing a distal femur intraarticular multifragmentary fracture with dual plating. [6]

Materials & Methods

This prospective study was conducted among 30 patients of distal femur fractures who were operated with lateral and medial double plating in the Department of orthopaedics in collaboration with department of Radiology of tertiary care hospital, Gujarat. Patients of age > 18 years with Muller type A2, A3 and type C2, C3 distal femur fractures and those were willing to give informed consent were included in the study. Exclusion criteria: a) Pathological fractures b) Muller type A1, type B1, B2, B3, and type C1 distal femur fractures c) Open fracture d) Fracture in a limb with the prosthesis e) Ipsilateral long bone fractures f) Associated secondary causes of muscle weakness such as osteoarthritis, malignancy, immune compromised states.

Pre-operative assessment: Patients were evaluated pre operatively by clinical examination, baseline blood investigation, anteroposterior and lateral X-rays of the femur with knee with a pelvic X-ray to rule out proximal femur fractures and computed tomography (CT) scans with three-dimensional reconstruction.

Surgical approach: Distal femur multifragmentary intra-articular fractures were fixed with a distal femur locking compression plate on the lateral side and a locked medial plate using the swashbuckler approach. All procedures were carried out under combined spinal and epidural anesthesia.

Patients were in supine position and a roll under the knee. A midline incision made from above the fracture laterally to across the patella (Swashbuckler approach). The incision extended directly down to the fascia, overlying the quadriceps muscles. This fascia was split in line with the skin incision and lifted off the underlying vastus lateralis muscle belly. Quadriceps fascia incised and sharply dissected off the vastus lateralis muscle laterally to its inclusion with the iliotibial band. The septum was 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 was 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 could be done. Both lateral and medial distal femoral plating could be done through the same incision. Reduction in small condylar fragments was made with pointed bone reduction clamps. The lateral column reconstructed with bony fragments. Thereafter preliminary wires fixation and cannulated inter-fragmentary screws of 4 mm were recruited to restore anatomical congruity. Definitive fixation was initiated by countersunk cannulated cancellous 6.5 mm/4 mm screws, followed by applying for 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. The medial column of the distal femur was reconstructed as much as possible and preliminarily secured with K-wires and 4 mm screws, after which locked medial plate was applied to stabilize the medial column. The closure was done using absorbable sutures after ensuring hemostasis. The skin was closed using staples. Postoperatively, all patients were immobilized in hinged knee brace for 3 weeks and were advised non-weight bearing ambulation. After 3 weeks, patients were mobilized 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.

The drain line was removed 48 hours after surgery or if there was less than 50 mL of drainage in 24 hours. The sutures were removed on12 days after surgery. The main objective for the first four weeks was full range of motion. Starting with isometric quadriceps exercises, passive and active range of motion exercises was performed. Walking without bearing any weight was allowed for four weeks. Partial weight bearing was permitted after post-operative X-rays revealed a callus in the fractured end. Full weight bearing was allowed after the radiological union.

The patients were underwent clinically examination at the time of discharge from the hospital to check

for any malrotation or limb length discrepancy. A limb malrotation of less than 5° and a limb length difference of less than 5 mm were considered as normal. Following surgery, all patients had a post-op x-ray femur with knee in anteroposterior and lateral view. They were reviewed on suture removal 6th, 12th, and 24th week, and then once in 3 months. The radiographic examination was performed on all follow-ups in order to evaluate fracture alignment in the sagittal and coronal planes, fixation stability, fracture healing, and fixation failure. Any loss of reduction, collapse, plate lift off, implant breakage, screw loosening, or wound complication were all recorded. A 5°–10° valgus angle was considered as normal as in the KSS. Sagittal plane angulation within 5° of the opposite side was considered normal.

Follow-up:

The patients were followed up at every 6 weeks until the 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. Patients were assessed for range of motion, fixed deformity, and extension lag at every follow-up

Outcome measures

Clinical outcome

At the 6-month follow-up, the patient's functional status was evaluated using the American Knee Society Scoring System (KSS). A KSS 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.

Statistical analysis: The data was entered and analysed in Microsoft Excel 2016. Continuous data was presented with mean and standard deviation while categorial data was presented with frequency and percentage. Results will be graphically represented where deemed necessary.

Results:

Total 30 patients with distal femoral fracture who fit into inclusion and exclusion criteria were included in the study. Mean age of the patients was 33.4 ± 6.78 years.

Majority of patients were in 31 to 40 year age group (12, 40.0%) followed by 21 to 30 year age group (11, 36.7%). Out of 30 patients, 23 (76.7%) were males.

Table 1: Distribution of patients according to baseline characteristics

Baseline Characteristics	Frequency	Percentage (%)
Age group (years)		
21 to 30	11	36.7
31 to 40	12	40.0
41 to 60	8	26.7
Mean ± SD	33.4 ± 6.78	
Gender		
Male	23	76.7
Female	7	23.3

Table 2: Distribution of patients according to characteristics of injuries

Characteristics of injuries	Frequency	Percentage (%)
Mode of injury		
RTA	24	80.0
Fall	6	20.0
Laterality		
Left side	17	56.7
Right side	13	43.3
AO classification		
A2	5	16.7
A3	7	23.3
C2	12	40.0
C3	6	20.0
Associated injuries		
Upper limb injuries	9	30.0
Same side lower limb ligament injuries	6	20.0
Contralateral lower limb injuries	3	10.0
Head injuries	2	6.7
Chest injuries	1	3.3
No injury	9	30.0

Majority of patients (24, 80.0%) had fracture due to motor vehicle accident and remaining 6 patients (20.0%) had fracture due to accidental fall.

Left side femoral fracture was reported in 17 (56.7%) patients and right side femoral fracture was reported in 13 patients (43.3%). AO type A2, A3, C2, and C3 fractures were observed in 5 (167%), 7 (23.3%), 12(40.0%) and 6 (20.0%) patients respectively. Associated injury was reported in 21 patients (70.0%).

Most common associated injury was upper limb injury (9, 30.0%) followed by same side lower limb injury (6, 20.0%) and contralateral lower limb injury (3, 10.0%).

Table 3: Distribution of patients according to post-operative characteristics

Post-operative characteristics	Frequency	Percentage (%)
Range of motion		
0 to 120	1	3.3
0 to 110	2	6.7
0 to 100	12	40.0
0 to 90	5	16.7
0 to 80	3	10.0
0 to 70	3	10.0
0 to 50	2	6.7
0 to 30	1	3.3
Knee score		
< 70	9	30.0
> 70	21	70.0
Rate of complication		
Superficial infection	2	6.7
Implant loosening	2	6.7
Knee stiffness	3	10.0
Nil	23	76.7
Time to union (weeks)		
< 20	21	70.0
20 to 24	19	63.3
> 24	0	0.0
Mean ± SD	18.8 ± 4.34	

Total 20 (66.7%) patients had motion range of 90° and above. Only one patient had motion range up to 30°. Knee score more than 70 was considered good and it was observed in 21 (70.0%) patients. Mean duration of union was 18.8 ± 4.34 weeks. Out of 30 patients, 21 (70.0%) fractures united within 20 weeks. Complication was noted in 7 patients (superficial infection – 2, 6.7%; Implant loosening – 2, 6.7%; knee stiffness – 3, 10.0%). 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 two 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.

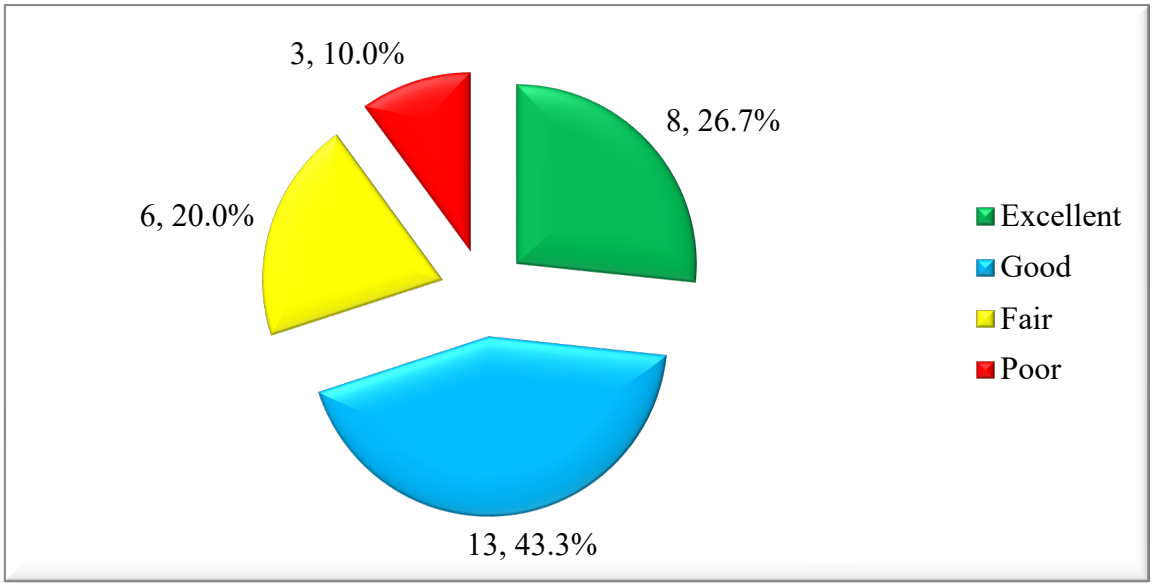

Figure 1: Distribution of patients according to Outcome

Excellent and good outcome was reported in 8 (26.7%) and 13 (43.3%) patients. Remaining 6 (20.0%) and 3 patients (10.0%) had fair and poor outcome respectively.

Discussion

Due to medial cortical loss, comminution, intraarticular extension, and muscular load on the fracture fragments, managing distal femur fractures is difficult. [6]

To obtain successful clinical and functional outcomes, it is essential to reduce the fracture using methods that are appropriate and efficient. The choice of reduction and fixation techniques is highly influenced by the fact that high velocity accidents frequently cause distal femur fractures, which result in several fragmented bone fragments. Bone grafting can be required, depending on how much bone has been lost. [8] 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 study, 30 patients were treated with dual plating of the 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. Complex C2, C3 fractures provide a technical challenge for ORIF.

A medial plate can be added to a lateral plate to strengthen stability and resist deformation, much as distal humerus fixation. There is a high prevalence of fixation loss and varus collapse when the conventional fixation utilised for other forms of distal femur fractures is applied for anatomic articular surface reduction. [9]

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, two distal femur fracture of the C3 type that had double plating required immobilisation during the postoperative phase in this research. Intraosseous 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. [9]

In the present study, mean age of the patients was 33.4 ± 6.78 years and 76.7% were males. About 80.0% fractures were due to RTA, 56.7% fractures in left side femoral fracture, 40.0% and 20.0% fractures of C2 and C3 type. Most common associated injury was upper limb injury (30.0%). In the study of Reddy PS et al. [10], mean age was 35.5 years and 75% patients were males. There were 80.0% fractures due to RTA, 60% left femoral fracture, and 40.0% C2 type fracture with 14.0% upper limb injuries. In our research, 66.7% patients had motion range of 90° to 120°. Only one patient had motion range up to 30°. Motion range more than 90 was reported 66.7% patients in the study of Imam et al. [7] , 70% patients in Arivoli G et al. and in the study of Reddy PS et al. [10]

In our study, about 70.0% patients showed excellent to good outcome and only 10.0% showing poor outcome. Imam et al. [7], reported 68.7% patients had well-to-excellent functional outcome and poor outcome was reported in only 12.5% patients. In the

study of Arivoli G et al. [2], 65% of patients had good-excellent functional outcome. Reddy PS et al. [10] reported 75% patients with excellent or good outcome, and 25% patients with fair or poor outcome.

In the present study, complication was noted in 23.3% patients (superficial infection – 6.7%; Implant loosening – 6.7%; knee stiffness – 10.0%). Mean duration of union was 18.8 ± 4.34 weeks without any varus deformity and maluninion. Arivoli G et al. [2] and Reddy PS et al. [10] reported a similar result with union rate of 100% and mean healing time of 20.9 weeks (5 months) with no cases of varus deformity or malunion. Imam et al. [7] observed mean union time of 6 ± 3.5 months with 12.5% non-union rate and without any varus or valgus deformity.[7] In the study of Jose E et al. [11] The mean time for fracture union was 13 weeks for dual plating with one case (10.0%) patient went for infective non-union after 1-year follow-up. In the study of Reddy PS et al. [10] complication rate was 20%. About 5% patients had superficial infection and implant loosening and 10% patients had severe knee stiffness. Non uninon rate was 10% in the study of Jose E et al. [11], 19% in Ricci et al. [12] , 23% in the study of Peschiera et al. [13]

Conclusion

In our study though there were complications in 23.3% patients, the union rate is 100% without any varus deformity or malunion and functional range of movements were good in 66.7% of cases and excellent to good outcome in 70.0%% cases, so double plating in treating complex distal femur articular fractures is one of the better option to achieve bony union and better functional outcome.

Based on our study, the double plating method for unstable distal femur fractures offers several advantages such as increasing the stability of fixation, improving the healing rate and allows early weight bearing, enabling early mobilization of patients and reducing the risk of varus collapse.

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