

Outcome Analysis of Open Reduction and Internal Fixation with Calcaneal Plate: An Observational Study Among Unicondylar Fracture of Distal Femur

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ABSTRACT

Introduction: Open reduction and internal fixation (ORIF) is strongly recommended in literatures for unicondylar fracture of femur and specifically designed implant for isolated medial or lateral condyle fracture is lacking. Objective: Find out therapeutic outcome of distal femur unicondylar fracture fixed with D-shaped calcaneal plate.

Material and Methods: Study was conducted on 17 skeletally mature patients of unicondylar fracture femur (AO type 33B1, 33B2, 33B3) without neurovascular deficit operated during June 2011 to May 2014. Standard medial or lateral surgical approach was chosen. D-shaped calcaneal plate was applied with help of 3.5 mm cancellous and locking cortical screws after restoring articular congruency. Functional outcome was evaluated at 12 months by Neer scoring system.

Result: Excellent results were observed in nine cases (Neer score > 85 units). Satisfactory outcome was observed in five cases (Neer score 70-80 units). Only one case show unsatisfactory outcome with Neer score of 58 units and two cases were considered as failure with Neer score less than 55 units.

Conclusion: Calcaneal plate is a good modality to fix femoral condyle fracture as it can be used to fix any pattern of fracture and also it provides absolute stability, thereby achieving early mobilization and excellent function outcome.

Keywords: D-shaped calcaneal plate, Hoffa's fracture, Neer score and Unicondylar fracture femur.

INTRODUCTION

Unicondylar femoral fractures accounts for less than 1% of all femoral fractures.^{1,2} It is defined by avulsion of one femoral condyle with the other intact condyle remaining in continuity with femoral metaphysis.³ Literatures regarding description of these fractures and their management are scarce. These fractures are usually associated with other injuries in the limb. Unicondylar fractures show great anatomical variability resulting in different radiological evaluation and therapeutic approaches. They have almost always been included in the generic group of distal third femoral fractures.^{2,4} Usually occurring following direct impact, avulsion, or action of shear force on the knee, generally in the sports activity or traffic accidents, particularly dashboard trauma.^{2,5-7} The lateral condyle involvement is three times more frequently than the medial condyle due to physiological valgus causes an abduction component which explains the greater frequency of lateral condyle fractures.^{7,8} In these injuries, non-operative management has often led to unsatisfactory results due to resultant deformities (varus and valgus malangulation), varying incidence of delayed union and non-union, joint contracture, knee instability, and posttraumatic arthritis.⁹⁻¹¹

Therefore open reduction and internal fixation is strongly recommended in literatures for all kind of unicondylar femur fractures.¹² Various types of implants were used to fix these fractures like cannulated cancellous screws, DCS screws and plates.³ The main drawback was that most of these implants were contoured to fit lateral condyle only and medial fracture fragments were addressed with indirect reduction as there is no specific implant design for medial femoral condyle fractures. The advantage of calcaneal plate is that they are mouldable and can be used for either side as well as either condyle irrespective of fracture pattern. Hence this study was done for outcome analysis of unicondylar fracture of distal femur by fixation with D shaped locking calcaneal plate.

MATERIAL AND METHODS

Subjects

After receiving approval from research review board of SMS Medical College Jaipur, skeletally mature patients with unicondylar fracture of distal femur, without neurovascular deficit were admitted from emergency and outpatient department and written consent for study was taken from each patient. This study was carried out at SMS hospital Jaipur during June 2011 to May 2014. Skeletally immature patients and patients with open injuries and compromised neurovascular status were not included in study design.

Material

D-shaped locking calcaneal plate (Figure-1) made of stainless steel or titanium alloy was chosen and fixed with help of 3.5 mm locking cortical and 4 mm cancellous screws using principles of fracture fixation. Pre-operative radiograph (Figure-2) and CT scan (Figure-3) with 3D reconstruction was done in each patient.

Procedure

All surgeries were done in supine position with tourniquet, under spinal anesthesia. For lateral condyle fractures (sagittal or coronal) incision of approximately 10 cm starting in mid-lateral line to curve it anteriorly over lateral femoral condyle, towards tibial tubercle was made. Vastus lateralis muscle

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incised from lateral intermuscular septum and elevated anteriomedially. Joint capsule was incised over anterior one third of lateral femoral condyle to facilitate exposure of the articular surface. After anatomical reduction under direct vision fracture was temporarily fixed with k-wires. Similarly for medial condyle fractures (sagittal or coronal) incision was made on medial aspect of knee approximately 10 cm proximal to joint line in the line of posterior border of tendon of adductor magnus and extended distally toward tibial tuberosity. Adductor magnus muscle and tendon retracted posteriorly and vastus medialis retracted anteriorly to expose the joint. The capsule and synovium incised at the joint over anterior one third of medial femoral condyle in the line of skin incision. This incision extended proximally enough to expose the medial femoral condyle, the Patellofemoral groove and the intercondylar area. After anatomical reduction fracture is temporarily fixed with k-wires.

After attaining articular congruency D-shaped calcaneal plate was chosen and moulded to fit the contour of condyle. Plate was fixed with 3.5 mm locking cortical and 4 mm cancellous screws. Hemostasis achieved by electrocautirization after tourniquet release and thus drain was not use. Capsule Closure done with absorbable sutures and skin and subcutaneous tissues closed in a routine manner.

Post operative x ray was taken (Figure-4). Post operatively a posterior splint or articular splint was applied for 2 days. For initial 48 hours active toe movements and quadriceps

strengthening exercises was done. On post operatively 3rd day assisted active knee mobilization was started. Partial weight bearing was started at 10-12 weeks and progressed to full weight bearing as tolerated. Regular follow-up was done at 2 weeks, 1 month, 3 months, 6 months and 12 months.

Evaluation at final follow up

Functional outcome was analyzed by Neer¹⁰ scoring at 12 months as follows;-

Excellent- more than 85 points

Satisfactory-70-85 points

unsatisfactory-55-69 points

Failure- less than 55 points

STASTICAL ANALYSIS

Data were arranged in form of mean and S.D. These were analyzed by analysis of variance (ANOVA) tests. Final outcome data were expressed in form of proportions. Difference in proportions were analyzed using chi square test. The level of significance was kept 95% for all statistical analysis.

RESULTS

Total 21 cases of unicondylar fracture of distal femur cases reported at SMS hospital during June 2011 to May 2014, out of these 17 cases met eligibility criteria of study. Out of 17 treated patients 16 were male and only one patient was female. Average age was 36.76 (21-65) years. All patients



Figure-1: D-shaped locking calcaneal plate

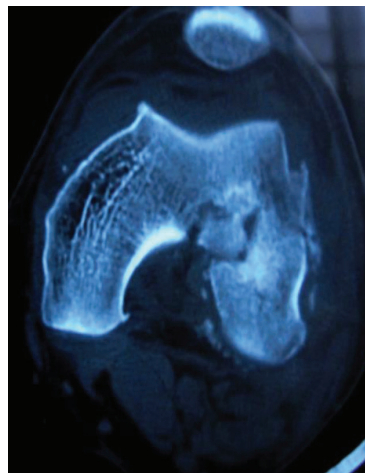


Figure-3: CT-Scan



Figure-2: Anteroposterior and Lateral view of X-ray



Figure-4: Post operative X-ray

sustain their fracture from severe direct trauma i.e. motor vehicle accident (14 cases), slip on ground (one case), fall of heavy weight (one case) and assault (one case). Out of 17 cases five cases were classified as AO 33B1, five cases as AO 33B2, and seven cases as AO 33B3 (Hoffa’s fracture) according to the AO-ASIF system.

There was a significant improvement in range of motion from 22.82(±11.25) to 108.52(±35.72) from 2 weeks to 1 year post operative period (P=<0.001) (Table-1). This improvement in range of motion was not associated with type of fracture statistically (P>0.05) (Table-2).

Out of total 17 cases, majority (14/17=82.35%) has good (excellent and satisfactory) outcome of the procedure whereas in only 3 cases it was either unsatisfactory or poor. Overall outcome was not significantly associated with type of fracture (P=0.109) (Table-3).

One patient with unsatisfactory result was of communitated lateral condyle Hoffa’s fracture. At follow-up of 12 months his fracture was healed but he had limited range of motion of knee joint. Other four patients with Hoffa’s fracture maintain satisfactory reduction overtime with three excellent and one satisfactory result; moreover no avascular necrosis of the fracture fragment was observed. There was no angular

displacement, no infection or non -union of unicondylar fractures during follow-up.

Rest of five lateral condyle fractures (AO 33B1) and five medial condyle fractures (AO 33B2) were having excellent to satisfactory results. Patient with satisfactory results had moderate to mild pain, together with mild loss of ROM at knee joint.

DISCUSSION

Management of unicondylar fracture femur ranges from conservative to open reduction and internal fixation. Non-operative management of undisplaced distal femoral fracture consist of a closed reduction and cast completion, a prolonged period of skeletal traction, and subsequently a variable period of external immobilization, which has led to many unsatisfactory results.¹² Displaced fractures are usually treated by open reduction and internal fixation as malangulation, rotation deformity, loss of knee motion, joint contracture, and post traumatic arthritis was often associated with non-operative treatment.¹² Open reduction achieve articular congruency, rigid fixation, maintain length, alignment, rotation, and allow early mobilization. The main disadvantage of surgical procedure is damage to vascularity which may lead to non-union, malunion and infection. Most commonly used cancellous cannulated screws provide overall good result, but lack of rigid fixation and failing in maintaining congruence of articular surface with loosening of screws also has been reported. Other commonly used method of fixation by plating have disadvantage that they have predetermined screw trajectories, requires too much soft tissue dissection due to big size of implant and also the cost of implant is considerable.

Persistent exploration has evaluated surgical techniques and implant outline to alleviate these intricacies however

S. No.	Follow-up (Duration)	Range of motion
1	2 weeks	22.824±11.254
2	1 month	44.824±18.885
3	3 month	70.824±22.954
4	6 month	95.059±32.539
5	1 year	108.529±35.728

Repeated ANOVA = 30.37, P< 0.001

Table-1: Functional outcome in the form of range of motion (ROM) at knee

S. No.	Type of fracture	No. of cases (n=17)	R.O.M at 2 week	R.O.M.at 1 month	R.O.M. at 3 month	R.O.M. at 6 month	R.O.M. at 1 year
1	Lateral condyle coronal split (Hoffa #)	6	23.333 ± 13.352	43 ± 22.935	56.167 ± 27.636	83.667 ± 46.676	91.333 ± 51.624
2	Medial condyle Coronal split (Hoffa #)	*1	20	40	67	70	79
3	Lateral condyle sagittal split	5	26.2 ± 9.149	51.8 ± 20.055	89 ± 6.083	111.4 ± 7.987	125.4 ± 10.089
4	Medial condyle sagittal split	5	19.4 ± 12.992	41.0 ± 16.643	71 ± 19.416	97.4 ± 27.492	118.2 ± 23.210
5	* ANOVA Test		P=0.661, NS	P=0.107, NS	P=0.061, NS	P=0.407, NS	P=0.264, NS

*not included in calculation as n<2

Table-2: Functional outcome in the form of ROM according to type of Fracture

S. No.	Type of fracture	Excellent A	Satisfactory B	Unsatisfactory C	Poor D
1	Lateral condyle coronal (n=6)	3	-	1	2
2	Medial condyle coronal (n=1)	-	1	-	-
3	Lateral condyle sagittal (n=5)	4	1	-	-
4	Medial condyle sagittal (n=5)	2	3	-	-
5	Total (n=17)	9	5	1	2

*A and B considered good result and C and D considered poor results. Chi square=6.679 with three degree of freedom P=0.109

Table-3: Overall Functional outcome according to type of Fracture

agreement in regards to standard implant for unicondylar fracture is as yet inadequate. In absence of specific implant design for isolated condyle fracture we applied calcaneal plate in medial, lateral as well as in tangential posterior fractures of distal femur (AO 33B1, 33B2, 33B3). In our study design features make the D-shaped calcaneal plate appropriate for fixation of isolated femoral condyle fractures. This plate provide a wide area of bone coverage, increasing the surface area of fixation while the spanning structural design of the construct offers regions of intermittent fixation, which likely promotes periosteal preservation and ultimately fracture union. In appropriate setting, the plate can be used as a large washer, representing a unique management option for communitated pattern, osteoporotic or osteopenic bones. The plate design includes as many as 13 screw holes which may be strategically placed for fracture reduction depending on injury pattern. Low profile design of the plate (thickness of 3 mm) reduces the risk of irritation of the surrounding soft tissue. It can be contoured as per need of fracture pattern, while maintaining fatigue strength and durability. Numerous holes allow variety of possible fixation for communitated fractures; whereas conventional plates with predetermined screws trajections and precontured design cannot meet all demands of fracture pattern. In this study with small series of 17 cases calcaneal plate has shown promising results. Surgical dissection increase chance of infection and nonunion however none of our patient has non-union, infection or any other complication. Also it cannot be used when bi condylar fracture is present as it lacks metaphyseal stability.

CONCLUSION

Operative management with D-shaped calcaneal plate has shown promising results however a randomized control trial with large number of cases is required to validate the results.

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