

Original Research Article

Hoffa fracture: analysis of factors affecting the final outcome after treatment with partially threaded screws

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ABSTRACT

Background: Coronal fractures of the femoral condyles are rare injuries.

Methods: This retrospective case series included patients with coronal fractures of the femoral condyles managed operatively. The surgeries were performed by authors NJ, RL and VB. A total of 11 patients with Hoffa fracture were operated between May 2011 and July 2012.

Results: We report the outcome of open reduction and internal fixation using partially threaded screws in 11 patients with Hoffa fracture. There were 10 male and 1 female patient operated at a mean age of 37 years. The average duration of follow up was 15.6 months. Fractures in all the patients united with a mean 115.45° range of flexion at knee at final review. The final outcome had a poor correlation with the shear angle of the fracture but fracture comminution and open nature of injury had a negative effect on the final outcome achieved. The number of screws used and the type of rehabilitation followed post operatively also had no bearing on the final range of motion achieved.

Conclusions: Partially threaded screws offer consistently good results in coronal fractures of the femoral condyles and the outcome is dictated only by perioperative factors like comminution and open nature of injury.

Keywords: Hoffa fracture, Coronal fractures, Femoral condyles, Outcome, Partially threaded screws

INTRODUCTION

Coronal fractures of the femoral condyles are rare injuries. These injuries are usually the result of shear stress transmission from the tibial plateau to the femoral condyles in varying degree of knee flexion. The element of high energy impact is common to all injuries with this fracture pattern.¹ Being intraarticular and intrinsically unstable, these fractures warrant open reduction.¹⁻³ Furthermore the peculiar location subjects the fracture and the fixation to shear forces both during weight

bearing and flexion-extension of the knee potentially increasing the chances of fixation failure and non-union.

Numerous fixation techniques have been described; however there is no consensus on the optimum size, number and configuration of screws needed for fixation. The clinical reports described in the world literature pertaining to the fracture are limited to one or a very small number of cases.²⁻¹⁰ The studies which have been done to elucidate the optimal fixation strategy are either biomechanical or cadaveric ones.^{11,12} The information derived from such studies is invaluable; however the

fraction which really translates into clinical utility is unknown. Furthermore there is paucity in the world literature on the role of fracture morphology and other perioperative factors in the outcome in such rare injuries. This retrospective study is aimed at evaluating the functional and radiological outcome of Hoffa fracture managed operatively and discusses the impact of fracture configuration and other factors including fixation and rehabilitation protocol on the final outcome.

METHODS

This retrospective study included patients with coronal fractures of the femoral condyles managed operatively at Sawai Man Singh Medical College, Jaipur. The surgeries were performed by authors NJ, RL and VB. A total of 11 patients with Hoffa fracture were operated between May 2011 and July 2012. Cases with concomitant fractures in ipsilateral femur or proximal tibia were excluded.

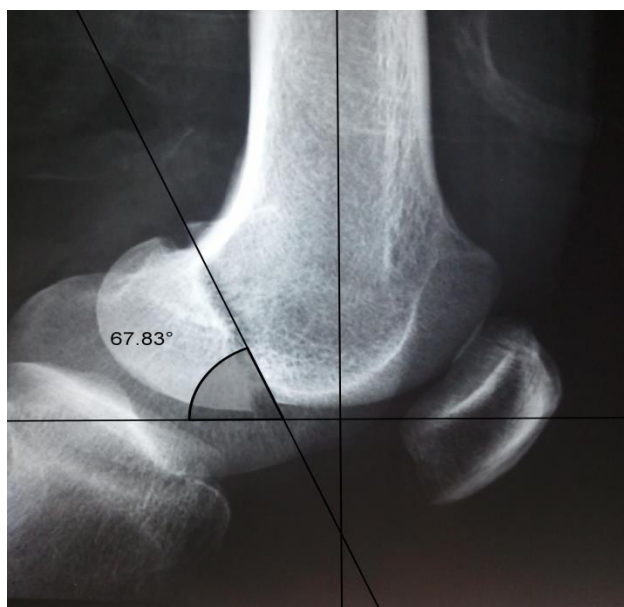


Figure 1: Method employed to calculate shear angle in plain radiographs.

The cases were evaluated with anteroposterior and lateral radiographs. Initial splintage was given in the form of bulky Robert Jones bandage. Computerised tomographic scans were obtained in each patient to study the fracture morphology. The shear angle of the fracture was calculated by drawing a line perpendicular to the long axis of femur in the sagittal plane and the fracture line through distal femur in radiographs (Figure 1). In cases with intra-articular comminution, the centre point of the comminution in CT scan (Figure 2) was taken for calculation of the shear angle.

Medial or lateral parapatellar approaches were taken for fracture fixation except in open cases where the fracture was approached through the debrided wound itself and its surgical extensions. Either two or three partially threaded

cancellous screws were used for fixation in either parallel or non-parallel configuration. Limb was either immobilised with groin to toe slab for a period of 4 weeks beyond which range of motion exercises were begun while others were mobilised immediately depending on strength of fixation. Partial weight bearing was started in all cases at 6 weeks postoperatively commencing to full weight bearing at 12 weeks. Outcome assessment was done radiologically, assessing the fracture union and implant failure if any and functionally, measuring the range of motion at the knee at final review. The effect of shear angle of the fracture and other perioperative factors on the final range of motion achieved was studied. The fixation method, number and configuration of the screws, post-operative rehabilitation protocol was noted for each case and the bearing of these parameters on the final outcome was also evaluated.



Figure 2: Method used to calculate shear angle in CT scan in comminuted fractures.

Statistical analysis was done using SPSS v.19 software (SPSS Inc., Chicago, IL, USA). Spearman’s correlation coefficient was used to evaluate the relationship between angle of shear and the final range of motion achieved. Impact of other perioperative factors like closed and open injuries, the method of fixation and the rehabilitative protocol followed were evaluated by the unpaired t test. A p-value of <0.05 was considered to be significant.

RESULTS

Ten male patients and one female patient were operated at a mean age of 37 years (range 22-73 years).

Table 1: Sex wise distribution of case.

Sex	No. of cases	Percentage (%)
Male	10	90.90
Female	1	9.09
Total	11	100

Table 2: Cause of injury wise distribution of case.

Cause of injury	No. of patients	Percentage (%)
Road traffic accident	9	81.81
Fall from height	2	18.18
Total	11	100

Nine patients were involved in a road traffic accident while 2 had a fall from height.

Table 3: Site of injury wise distribution of case.

Site of injury	No. of patients	Percentage (%)
Left site	4	36.36
Right site	7	63.63
Total	11	100

Right lower extremity was involved in seven cases while left sided Hoffa fracture occurred in four patients.

Table 4: Distribution of case according to part of condyl.

Part of condyl.	No. of patients	Percentage (%)
Lateral femoral condyle	10	90.09
Medial femoral condyle	1	9.90
Total	11	100

Coronal fracture involved the lateral femoral condyle in 10/11 (90.9%) patients while medial condyle fracture occurred in only one (9.1%) patient. Three patients had an associated intra articular comminution while one had loss of an osteochondral fragment. 3 patients had open injuries while the rest were closed injuries. The average angle of shear of fracture in the series was 76.3° (SD = 18.76°). Two screws were used for fixation in 7 patients while three screws were used in 5 patients. The mean duration of follow up at the time of final review was 15.6 months (range 8-23 months). A typical good outcome with radiographic series is presented in Figure 3.



Figure 3: Radiographic series in a representative case. Images from left, preoperative anteroposterior and lateral radiographs showing no fracture line, CT sagittal and reconstruction images showing the fracture pattern, lateral radiograph showing reduction achieved postoperatively and final image showing attainment of solid union at latest follow up.



Figure 4: Case in which screw backout occurred. Preoperative CT showing intra-articular comminution, postoperative lateral and anteroposterior radiographs, radiographs during follow up showing screw backout, CT after screw removal showing union without fracture displacement.

Union was achieved in all patients without loss of reduction. The final range of motion achieved was 115.45° (SD =9.34°) of flexion. The two had a low inverse correlation (r =-0.439) on statistical analysis (Spearman Correlation test). The final range of motion achieved in patients with closed injuries was 119.38° (SD =5.63°) while 105° (SD =10°) of ROM could be achieved in patients with open injuries. The difference in range of

motion achieved in closed and open cases came out to be statistically significant (p=0.013, unpaired t test). The final motion achieved in patients with associated intra-articular comminution/ osteochondral fragment was 106.67° (SD =10.41°) as compared to 118.75° (SD =6.94°) in cases without these associated injuries. The difference came out to be mildly significant on analysis (p=0.049, unpaired t test).

In 7 patients two screws were used for fixation whereas three screws were used in 5 patients. The difference in the range achieved in both the groups came out to be insignificant ($p=0.155$, unpaired t test, $118.57^0 \pm 8.02^0$ in former, $111.0^0 \pm 8.94^0$ in latter). Six patients were mobilised immediately after surgery and five were subjected to a period of 4 weeks immobilisation in a plaster slab or a brace. The final range of motion achieved in these cases was 116.67^0 (SD = 8.6^0) and 114^0 (SD = 11.4^0) degrees respectively. The difference however came out to be statistically insignificant ($P=0.662$ unpaired t test).

Screws started backing out in one patient but union was achieved in anatomical position (Figure 4). Implant removal was done in this patient only.

DISCUSSION

Coronal fractures of femoral condyle first described by Hoffa, have been described traditionally to present a unique challenge to the orthopaedic surgeon both in terms of diagnosis as well as management.¹³ They are a result of transmission of force along the tibial plateau to the femoral condyles. The higher the degree of flexion at the time of impact, the higher the chances of sustaining a coronal fracture by axial transmission.⁸ Similar to observations made by other authors, we found that the injury more commonly occurs in lateral condyle of the femur.⁴ This has been postulated to be due to physiological valgus at the knee.

Diagnosis of such injuries requires a high index of suspicion especially when encountered in a polytrauma patient.⁹ They are extremely difficult to detect on standard anteroposterior and lateral radiographs presumably because of their coronal orientation and the overlapping of femoral condyles on lateral view of the knee respectively (Figure 3). True extent of the injury is judged only by a CT scan or intraoperatively. In the series of Nork et al evaluating Hoffa's fractures in association with supracondylar-intercondylar fractures, in as many as 10 cases, the coronal component was detected only intraoperatively.¹⁴ In all these cases CT scans were not obtained preoperatively. If the X ray examination remains inconclusive, one should not be hesitant in ordering CT scan to diagnose the injury.

The fracture orientation is coronal and is subject to shear stresses during mobilisation and weight bearing. This can be likened to fracture neck of femur which is subjected to similar forces. The outcome of femoral neck fracture is dependent on shear angle calculated by the orientation of fracture line. We applied the similar concept to the Hoffa fracture but found the outcome was similar in more vertical fractures as compared to the less vertical ones. Concomitant perioperative factors like loss of osteochondral fragments or comminution however had a negative effect on final functional outcome achieved. Open fractures were found to have a poorer outcome in

terms of range of motion. This might be explained by the arthrofibrotic response triggered by the injury itself in addition to one that can be attributed to the surgery.

The management of these fractures is unequivocally surgical. Non-union rates are high if the fractures are treated conservatively and the overall outcome has been reported to be poor.^{2,10} Cannulated partially threaded cancellous screws offer uniform and predictable compression at the fracture site making them the implant of choice.⁴ Screws are needed to be placed at right angles to the fracture site to offer highest degree of compression and avoid shear stresses during fixation, but in some cases fracture geometry and the size of fragments may not allow this. We found that there was no difference in the outcome in terms of range of motion and loss of fixation as regards the number of screws used. Biomechanical studies using cadaveric femora by Jarit et al recommended the orientation of screws to be postero-anterior as these have been shown to have more strength to failure than antero-posterior directed screws.¹² The study however had the limitation of testing axial forces only which are rarely encountered in clinical practice. Moreover the study estimated the ultimate axial strength of anteroposterior screws to be 1025 N after 100000 cycles of loading; such massive amounts of forces are seldomly encountered in the rehabilitating knee and henceforth we believe the screws can be used in either direction according to surgeon's preference or convenience. Screws heads must be countersunk if they are inserted from a cartilage bearing surface. Some authors have also advocated the application of screws from posterior aspect just above the fracture site to prevent posterior migration of the fracture in response to shear stresses during knee movements (a procedure similar to kapandji's intrafocal pinning in distal radius fractures).⁵ In our view placement of such screws is not feasible since the exposure of posterior aspect of condyles from parapatellar approach is difficult. Also, the proximity of vital structures to the proposed site of insertion of screws, keeping in mind the variability in regional anatomy may prove to be disastrous.

Parapatellar approach remains the best for such fractures.⁴ Knee flexion is recommended as it takes away tension from posterior capsule and hamstrings, thereby assisting fracture reduction. The neurovascular bundle also falls back reducing chances of an iatrogenic injury. Atypical approaches like the direct lateral or anterolateral approaches may be taken for direct access to the fracture or in cases of non-union. It is imperative to respect the soft tissue attachments to salvage the already jeopardised blood supply of the fragment. A few reports have emerged employing minimally invasive arthroscopically assisted fracture reduction and fixation, but the evidence of favourable outcome of such a method over the conventional open technique is still lacking.¹⁵ Avascular necrosis although not frequently reported, is one complication where the available options for further joint preservation are very few. There are a few proposed

preoperative prognostic markers for avascular necrosis, but their utility has been found to be doubtful.^{2,16} We did not encounter avascular necrosis in any of case in our series.

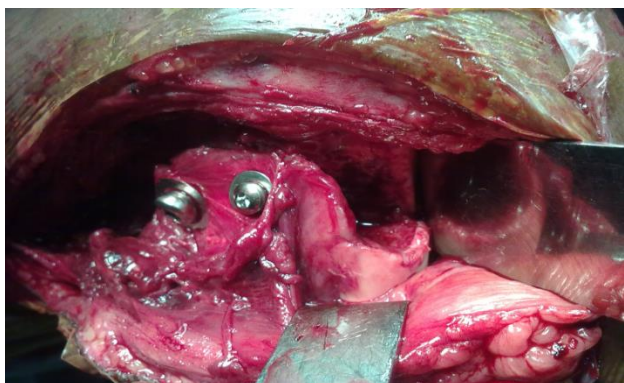


Figure 5: Intraoperative photograph showing the loss of osteochondral fragment in an open case.

Anatomical reduction does not seem to be a problem except in cases where open fractures present as primary bone loss. In one of our case with osteochondral defect, an anatomical reduction was obtained (Figure 5) and the result at 19 months was found to be reasonable with a range of motion of 95° in spite of the defect, implying the primary grafting of a small defect may not be advisable. In symptomatic cases, secondary osteochondral grafting seems to be a reasonable option.

The period of activity restriction following fixation has been a topic of debate. Lewis recommended a period of immobilisation of 3-6 weeks while others advise immediate mobilisation.^{2,3,5} The final range of motion and functional results obtained after both the protocols were found to be comparable. A smaller sample size is a potential limitation of the study, however considering the rarity of the injury, 11 cases do present a sufficient size to draw inferences. We also feel that since the follow up period is not long term, this study does not permit comment on the incidence of osteoarthritis and its relation to peri-operative factors.

CONCLUSION

Hoffa fracture although rare, can impart significant disability if mismanaged. These injuries can be adequately managed with partially threaded screws and the angle of shear has no bearing on the final outcome. The method of postoperative mobilisation has no effect on the final range of motion achieved. However factors like intra-articular communication adversely affect functional outcome.

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