Coronally Oriented Intra - Articular Distal Femur Hoffa Fracture - How We Deal with It

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ABSTRACT

BACKGROUND
Hoffa fractures are intra-articular femoral condyle fractures in the coronal plane. These are very uncommon injuries. The purpose of this study was radiologic and functional outcome assessment of surgically managed Hoffa fractures with headless compression screws.

METHODS
We prospectively studied 11 patients with isolated Hoffa fractures who were treated with open reduction and internal fixation using two or more headless compression screws. Antiglide plate was used only in one case. We used the midline parapatellar approach for all cases. All patients had gone through aggressive physiotherapy after the operation. All patients were evaluated radiologically and functionally on a regular interval. The functional outcome was recorded in terms of Lysholm score, Knee society score (KSS), Range of motion (ROM) and VAS score.

RESULTS
All fractures united radiologically with an average time of 3.3 months with no evidence of subsequent fixation failure. The mean Lysholm score and KSS at final follow-up were 88.6±7.1 and 86±7.6 respectively. The mean knee range of motion was from 0° to 120.5° ± 9.3°. At the final follow-up, the mean VAS score dropped significantly to 0.63±0.8.

CONCLUSIONS
Operative management of Hoffa fractures with at least two headless compression screws can yield satisfactory functional and radiologic outcomes. Stable fixation and timely physiotherapy are the keys to success.

KEY WORDS
Hoffa, Coronal, Fixation, Functional Outcome
**BACKGROUND**

Intra-articular unicortylar fractures of the lower end of the femur occurring in the coronal plane also known as Hoffa fractures (figure 1) are uncommon injuries and most often affect the lateral condyle.[1] In 1904, Hoffa[2] first reported these injuries. It is considered type 33-B3.2 according to AO/OTA fracture classification.[3] These fractures are frequently associated with other injuries, i.e. Supracondylar, Intercondylar femur and patella fractures. Though the main cause is high energy trauma,[4,5] low energy injury in osteoporotic and skeletally immature people can also result in Hoffa fracture.[6] The exact mechanism of this injury is not well established.[7,8] Currently the most accepted mechanism of injury has been reported to be an axial force in varus/valgus direction in ≥90˚ flexed knee resulting in massive shear stress between the femoral condyle and the tibial plateau.[11,12] Incidence of lateral condyle Hoffa is more common as the lateral condyle is often damaged before the medial condyle because of the physiologic genu valgum of the knee joint.[13,14]

Conservative management of Hoffa fractures results in poor outcomes, even non-displaced fractures are prone to displacement.[15,16] So, early open anatomical reduction and rigid internal fixation are the aims of these types of fractures for early mobilization and long-term satisfactory outcomes.[15,17] There is a lack of literature regarding surgical approach, fixation implants and methods according to fracture configuration. The rarity of this type of fracture probably explains this. At our institution, we prefer a direct midline approach for both condyle Hoffa fractures, medial parapatellar for medial condyle & lateral parapatellar for the lateral condyle Hoffa fractures. This incision can also be used for total knee replacement surgery if needed in the future. We fixed all our cases with at least two headless compression screws, perpendicular to the fracture surface. Additional 2-3 headless screws in a different direction and reconstruction plate in antiglide mode were used depending on fracture comminution and fracture fragments. In this prospective study, we describe our treatment results for 11 patients with isolated Hoffa fractures and review the existing literature.

**METHODS**

11 patients with isolated Hoffa fractures without associated supracondylar and intercondylar components were included in this prospective study and had been treated with ORIF between May 2017 and Jan 2020 at N. R. S. Medical College & Hospital in the Department of Orthopaedic Surgery. We used the anterior midline approach for all patients. Among them, 8 patients had lateral condyle fractures & 3 patients had medial condyle fractures. All patients were evaluated with standard AP and lateral radiographs. We asked for a CT scan with 3D reconstruction views for all the patients, not only to confirm our diagnosis but also to assess fracture configuration, comminution and metaphyseal extension. Associated bony and soft tissue injuries were assessed thoroughly in all patients. Grade III posterior drawer test with posterior sag sign was present in one patient, in whom the posterior cruciate ligament was avulsed off along with the fractured fragment (Figure 2). Two patients had associated bone fractures of both forearms and one patient had Jones fracture which was treated by operative intervention accordingly.

All patients were operated on under fluoroscopic guidance by our most experienced trauma surgeon. All surgeries were done in a supine position under tourniquet control. Appropriate broad-spectrum antibiotics were used before the surgeries and continued till the 2nd postoperative day. Through a direct anterior midline approach (medial and lateral parapatellar arthroscopy done according to medial and lateral Hoffa respectively), the fracture site was reached. After thorough joint inspection, the fracture surfaces were identified and the presence of any comminution, meniscal injury, or collateral ligament injury was addressed. Then fracture fragments were debrided, anatomically reduced and held with one or two towel clips. Full flexion of the knee helps to maintain the reduction. Fragments were then fixed using at least two Herbert screws placed perpendicular to the fracture surface from posterior to anterior direction. Additional Herbert screws were used in different directions according to the fracture fragments and comminution. Reconstruction plate augmentation was needed in two patients due to metaphyseal extension. After satisfactory fixation, the tourniquet was released, meticulous haemostasis was secured and the wound closed in layers over the suction drain which was removed after 48 hours during the first dressing change. Postoperatively, limb elevation, ice compression and NSAIDs started to decrease pain and swelling. Isometric quadriceps exercise started on the first postoperative day. Initially, range of movements, exercise and quadriceps strengthening exercise were continued. Partial weight-bearing started from 6-8th postoperative weeks and full weight-bearing started from 10-12 th postoperative weeks.

All patients were evaluated at 1, 2, 6, 12, and 18 months postoperatively, clinically and radiologically to assess union, any displacement or loss of reduction during every follow-up. The minimum follow-up period was 12 months.
RESULTS

11 patients (9 male & 3 female) were operated on between 2016 and 2019. Patients’ average age and average follow-up period were 28.5 years (18-44) and 14 months (12-18) respectively. The incidence of associated injuries was 45.5% (5/11). Road traffic accidents were the most common mode of injuries (72.7%) followed by falls from height (27.3%). The average interval between fracture and surgery was 5 days (2-14 days). The average operative time was 95 minutes (70-125 min). The whole perioperative parameters are summarized in Table 1.

There was no failure of instrumentations and no patients required revision surgery during the follow-up period. Radiographic union was achieved in all cases without further intervention with an overall average time of 3.3 months. All patients had an acceptable reduction of the fracture (± 2 mm), except for one patient (9.09%) who had an articular step off of ≥ 2 mm, which was probably due to extreme comminution at the fracture site. The functional outcomes were recorded in terms of Lysholm score, KSS score and VAS score.

The mean Lysholm score at final follow-up was 88.6±7.1 with 3 excellent, 7 good, and 1 patient fair results and the mean knee society score was 86±7.6 (Fig 3). We recorded a gradual improvement of Lysholm score over time (Fig. 4). The mean knee range of motion was from 0° to 120.5° ± 9.3°. 10 out of 11 (90.9%) patients resumed their pre-trauma day-to-day life. At the final follow up the mean VAS score dropped significantly to 0.63±0.8. The detailed comparison of results between medial and lateral condyle Hoffa fracture is depicted in Table 2. Poor outcome predictors were fracture comminution, delay in surgery and noncompliance to post-operative physiotherapy protocol.

There was no evidence of any deep infection. One patient developed a superficial wound infection which subsided later with regular aseptic dressing under IV antibiotic coverage. No patient developed osteonecrosis or post-traumatic arthritis of the involved femoral condyle within the follow-up period. None of the patients had an extensor lag at the knee joint.

| Variables                      | Medial Condyle | Lateral Condyle | P-Value |
|--------------------------------|----------------|----------------|---------|
| No (%)                         | 6 (72.7)       | 3 (27.2)       |         |
| Operative time in minutes      | 95 (70-125)    | 92 (70-115)    | > 0.05  |
| Lysholm score                  | 87.5±4.6       | 89.75±5        | > 0.05  |
| Knee society score             | 83.3±13.9      | 85.6±12.1      | > 0.05  |
| Range of motion                | 116.67±15.28   | 121.87±7.04    | > 0.05  |
| VAS score                      | 0.67±0.15      | 0.66±0.91      | > 0.05  |
| Complications                  | Articular step off 1 Superficial wound infection | |

Table 2: Comparison between Medial & Lateral Condyle Hoffa Fractures

![Figure 3. Mean (± Standard Deviation) Lysholm Score & KSS at Final Follow-up](image)

![Figure 4. Mean (± Standard Deviation) Lysholm Score at 6th Month & Final Follow-up](image)

![Figure 5. Comparison between Lateral Condyle Hoffa Fracture and Medial Condyle Hoffa Fracture in Terms of Lysholm Score and KSS](image)
Intra-articular coronal plane distal femur Hoffa fractures are infrequent injuries. This explains a limited number of studies on this fracture. Literature is mainly limited to the case reports and case series. As per our knowledge, no standardized management protocol and rehabilitation protocol has been postulated to date.

In the early days, conservative management was the principal mode of treatment for these fractures. But day by day, a better understanding of these fractures’ characteristics, leads to open reduction and rigid internal fixation are the principal mode of handling this type of fracture. Even for non-displaced fractures, conservative management is not a very fruitful option because these fractures have a high tendency to get displaced.\(^{[18]}\) So, many a time it ends up with malunion/non-union with a stiff knee. Prolonged immobilization in conservative management also augments this stiffness.

Hoffa fractures are often associated with intra-articular comminution. From our experience we saw, that the medial/lateral parapatellar approach is an excellent approach...
to address this comminution and also this approach gives a satisfactory view of fracture condyles. Besides, this incision can also be reused for total knee replacement surgery if needed in the future.

The commonly used fixation method for these fractures is cannulated cancellous screw compression with different clinical outcomes.\textsuperscript{[19,20]} Now, headless compression screws are largely available with the excellent compressive properties. Besides, recession of cannulated cancellous screw head into articular surface causes comparatively larger cartilage damage than the headless screw. For all patients, we have used at least two headless compression screws to achieve inter-fragmentary compression. But this cannot prevent vertical displacement in all cases of comminution. So, according to comminution and stability of fixation after applying two screws, we use additional one or three headless screws in selective cases to augment our fixation. For 9 of 11 patients, only headless screws were being used without any loss of reduction till final follow-up. This indicates that not only inter-fragmentary compression but also excellent stability against vertical shear and torsional force can be achieved by these headless compression screws. We applied all screws in posteroanterior direction. This is supported by a biomechanical study published by Jarit et al.\textsuperscript{[21]} Few studies suggest, the application of a locking buttress plate, yields good results.\textsuperscript{[22,23]} We applied for reconstruction plate in antigrade mode in two of our patients as there was supracondylar extension. This resulted in a satisfactory outcome with Lysholm scores 87 & 90 respectively.

Hoffa fractures are mostly caused by road traffic accidents. So, frequently these fractures are associated with additional soft tissue and bony injuries especially contralateral leg trauma, abdominal trauma, head injury, etc. So these patients should be evaluated properly and thoroughly in the emergency room. In our study, 45.5% of patients got associated injuries. Besides, it is not uncommon to overlook this fracture by seeing a conventional radiograph of the knee. So, a high index of suspicion is the key, not to miss this fracture at the emergency room. To detect these fracture alignment correctly CT scan with 3D reconstruction views should be done in all cases if facilities are available. If ligamentous injuries are suspected, MRI should be advised for better evaluation.

After any periaxicular ORIF, joint range of motion restriction is a common problem. To overcome this problem, proper rehabilitation has a huge role. It also prevents chances of DVT, postoperative swelling and chances of infection etc. In our study, we had two patients with delayed surgery. One for delayed presentation at our institution and another for type IIIA wound to heal before surgery. The former patient was noncompliant with physiotherapy protocol and ended up with knee stiffness with ROM $10^\circ-100^\circ$ at final follow-up. The latter patient was very compliant with physiotherapy and regained almost near normal ROM ($0^\circ-125^\circ$).

CONCLUSIONS

In conclusion, at least two posteroanterior headless compression screws with additional screws and/or antegrade plate according to the fracture geometry and timely proper physiotherapy can lay out a satisfactory outcome. An anterior midline approach with medial/lateral parapatellar arthotomy provides an excellent visualization of these fractures which helps a lot to achieve proper reduction and rigid fixation. Besides, this approach nearly eliminates the iatrogenic risk of collateral ligament damage.

Limitations

The drawbacks of our study were a limited number of patients, short term follow-up period and lack of control group. There were also no direct comparisons with other modalities of treatment. The rarity of these fractures explains this. This study is different from studies in published literature because here a fixed approach was applied with firm internal fixation using tactically placed headless compression screws for all the fractures. And this reproduced well to excellent radiological and functional results in our study.

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