

Review Article

The Hoffa fracture: Coronal fracture of the femoral condyle a review of literature

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ABSTRACT

This article aims to provide a systematic review of the limited literature and clinical knowledgebase available on the Hoffa fractures. It is inclusive of the normal anatomy, pathology, diagnosis, treatment options comprising of non-operative and operative protocols, and postoperative findings.

1. Introduction

The Hoffa fracture of the distal femur is a rare injury described as a coronal fracture of the femur involving one or both of the condyles. The distal, condylar end of the femur has a trapezoid shaped anatomy and articulates with both the tibial plateau and the patella. Before Albert Hoffa described the fracture pattern in 1904, the initial descriptions of this fracture can be traced back to 1869 where it was first documented by Busch.⁶ These fractures are quite rare and often go unobserved during the routine assessment of distal femur fracture. The surgeon must have a high index of suspicion to investigate for coronal plane fracture.² In fact, the occurrence of isolated femoral condylar fractures is about 0.65% of all femoral fractures.⁷ Among the different possible types of Hoffa fractures, lateral condylar and bilateral condylar fractures are more common than medial condylar fractures.⁸ Lateral condylar fractures account for about 78%–85% of Hoffa fractures.^{5,8} After radiographic identification of the Hoffa fracture, the injury should be classified. As per the AO/OTA classification, Hoffa fractures are Type 33-B3 injuries, and according to Letenneur these are classified as Type I injury.⁹ The Letenneur classification scheme illustrates the different fractures (Fig. 1).

Hoffa fractures tend to be associated with high-energy trauma injuries such as motor vehicle accidents, which exert an axial load on a flexed knee. They involve the intra-articular portion of a major weight-bearing joint, and are at significant risk of displacement.¹⁰ Due to the

nature and location of the injury, the fracture tends to be missed on initial standard radiographic evaluation. For example, in 82% of distal femoral condylar fractures, the fracture line was sagittal, which could be identified easily on an anteroposterior (AP) radiograph, whereas 18% of fractures were coronal and not readily apparent.¹¹ Therefore, a computed topography (CT) scan is required to understand fully the anatomy of the distal femur and investigate for coronal fracture lines.^{2,12} Interestingly the current literature available on the Hoffa fracture is comprised mostly of case reports and single-center studies. The goal of this article is to provide a systematic review of the literature on Hoffa fractures.

2. Anatomy and injury assessment

Isolated occurrences of the Hoffa fracture are quite rare, as they tend to be associated with high-energy impacts and involve other bone and soft tissue injuries. Motor vehicle collisions accounted for four out of five cases in one study, and they are a major mechanism that result in Hoffa injuries partly due to the flexed knee position of a driver.¹³ Nork et al reports that from 77 supracondylar-intercondylar fractures, 80.5% were associated with motor vehicle collisions, whereas only 9.1% resulted from falling from a height.⁸ However, sports and other activities where combined rotational and axial forces are applied to the knee joint may also contribute to the injury. Arastu et al suggest that a possible reason for the fracture could be the application of force in the vertical

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Fig. 1. The Letenneur classification scheme for Hoffa fractures.

plane on the posterior femoral condyle corresponding to varying degrees of a flexed knee.³ Another study by Manfredini et al indicates that the trochlear-condylar groove may be a potential structurally unstable point where the fracture could originate and spread into other planes. The normal valgus physiology of the knee joint may further contribute to an abduction force against the tibial plateau, which could explain the higher frequency of lateral condylar fractures.^{7, 13} However, the exact mechanism of the injury remains unclear.

Assessment of injuries associated with motor vehicle collisions often fails to diagnose Hoffa fractures. One study of 95 Hoffa cases indicates that only 69% of them were identified on radiographs, while 10 of them (without use of CT scan) were identified intra-operatively.⁸ About 25% of Hoffa fracture are undiagnosed on initial exam with plain radiographs.⁸ It is important to have a high index of suspicion in order to diagnose the fracture. Of the six patients evaluated by Dhillon et al, only one was diagnosed without the use of CT scan, and one patient required x-ray, CT, and MRI for diagnosis.⁵ Figs. 2 and 3 illustrate the presence of Hoffa fractures on CT imaging as well as AP and lateral radiographs. In one instance, an AP radiograph obtained to assess the cause of knee pain and tenderness looked normal until the lateral view revealed a coronal fracture.¹⁴ A report by Thakar identified a trauma patient that was evaluated by routine radiographs and surgically treated for forearm and humerus fractures. However, the consistent pain and effusion observed in the patient's knee lead to the discovery of a Hoffa fracture in the left knee two day postoperatively.¹² Patients with a Hoffa fracture should also be diagnosed for trauma to the pelvis, hip, patella, tibial plateau, femur shaft, popliteal vessels, and ligament tears of the knee.^{2, 3, 12}

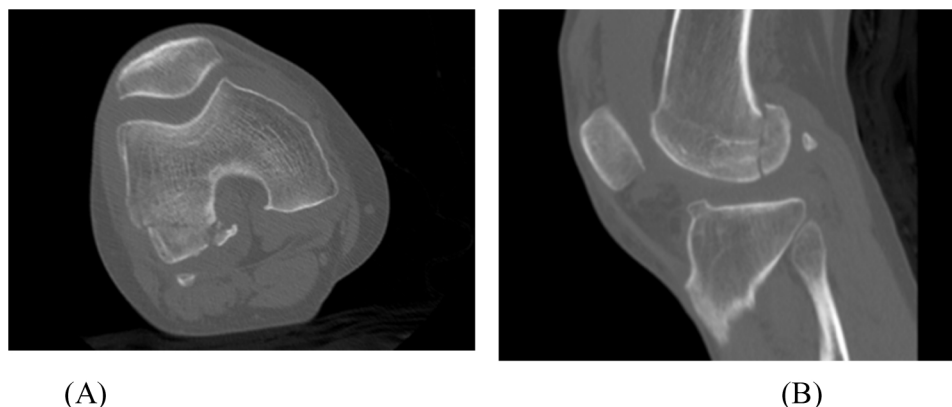


Fig. 2. A computed tomography image of the Hoffa fracture with (A) coronal and (B) sagittal planes depicting the lateral fragments.

3. Management and treatment

The location and nature of the Hoffa fracture often complicated management decisions when considering non-surgical treatment or surgical approaches. One of the first steps of management is the need to assess injury to other organ systems with general surgery colleagues before proceeding with management of distal femur fractures.¹⁵ Due to its intraarticular nature, open reduction and internal fixation is required for successful treatment of the Hoffa fracture. Most published case studies indicate that non-surgical treatment of the fragment leads to poor results. For example, one study where non-surgical approach was used for 5% of the 154 Hoffa fracture patients resulted in poor outcomes and displacement of fragment resulting from the treatment.¹¹ Nonunion may result if the nondisplaced fragment is treated conservatively.^{5, 10} However, one study reported on a medial condylar fracture treated with knee bracing and protective weight bearing which yielded a good result.¹⁶

4. Surgical techniques

Some of the general principles indicated for surgical treatment of distal femoral fractures highlight the importance of assessing whether the fracture involves intra-articular surface. If the fracture does involve a joint, the initial priority should be to reconstruct and repair the articular site. Furthermore, the rotation and length should be properly controlled while treating the condylar region in the sagittal or coronal plane.¹⁷ Open reduction and internal fixation is the dominant treatment strategy for Hoffa fractures and has yielded satisfactory results in appropriate time periods. A variety of techniques and equipment have been discussed in the literature, most of which refer to treatment of distal femur fractures. The surgical approach relies on the location of the injury and presence or absence of a posterior comminution.

Some of the approaches used and reported frequently include a medial or lateral parapatellar arthrotomy, subvastus approach, arthroscopic approach and a Gerdy's tubercle osteotomy. A summary of some of the cases described and additional cases of unicondylar Hoffa fractures is presented in Table 1.

Many studies have utilized a general lateral or a medial parapatellar incision to access the anterior femur^{10, 13} (Fig. 4). A medial parapatellar approach seems to be the most frequently reported approach.^{11, 13} Although this approach allows visualization of the anterior surface without compromising future arthroplasty surgery, it inhibits the view of the posterior femur thereby preventing treatment.³ A multicenter study of 154 patients with condylar fractures contained 18 patients with the B3 Hoffa injury. 78% of the 18 patients were treated using antero-medial or antero-lateral approach while 22% with postero-lateral or postero-medial approach. The fixation majorly relied on insertion of screws either anteriorly or posteriorly.¹¹ Dhillon et al presented

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