Isolated Hoffa Fracture of the Medial Femoral Condyle in a Skeletally Immature Patient
A Case Report

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Abstract
Intraarticular coronal fracture of the femoral condyle is rare, and an isolated medial Hoffa fracture in a child is extremely rare. To our knowledge, such a case has not yet been reported in the literature. Early diagnosis and prompt treatment are essential for a good long-term outcome. We report a case of 12-year-old male who suffered a traffic accident and sustained an isolated medial Hoffa fracture. Open reduction was performed using a subvastus approach and the joint surface congruity restored and secured by two large fragment partially threaded screws placed from anterior to posterior in the epiphysis. At the 36-month follow-up, the fracture was united, and the patient had full extension and approximately 130° flexion of knee. There was no varus or valgus instability or limb length discrepancy. This case highlights the importance of early diagnosis and prompt treatment in the form of epiphyseal fixation for the management of these fractures in skeletally immature individuals.

Coronal fractures of the femoral condyle are rare entities and were first described by Hoffa in 1904.\textsuperscript{1} By definition, these fractures are intra-articular and the principles of management are similar to those of typical intra-articular fractures. Lateral and bilateral Hoffa fractures are well described, but medial Hoffa fractures are extremely rare. There is only one case report\textsuperscript{2} in the English literature to the best of the current investigators' knowledge; however, a medial condyle Hoffa fracture in a skeletally immature individual has not been described in the literature. Presented here is a case report of isolated medial Hoffa fracture in a 12-year-old male, with a brief discussion of the mechanism of injury and the basic principles of management.

Case Report
A 12-year-old male sustained a motorbike accident while riding on a pillow, or back seat, as a passenger behind the driver in traffic. The mode of injury was direct impact to the right knee. He subsequently was unable to bear weight on the right lower limb. On examination, the right knee was swollen and tender. Anterior-posterior (AP) and oblique radiographs of the knee (Fig. 1) showed an isolated coronal plane fracture of the medial femoral condyle. Three-dimensional (3D) CT reconstruction (Fig. 2) performed at the same time showed little comminution, but a fracture line that almost reached the posterior cruciate ligament (PCL) insertion.

According to the Letenneur classification,\textsuperscript{2} the fracture was a type I [alternatively, a Salters and Harris type 4 and Orthopaedic Trauma Association (OTA) type 33-B3]. The patient underwent immediate operative intervention. Examination under anesthesia demonstrated significant varus instability in 30° of flexion, but there was no anteroposterior instability of the knee. Exposure of the fracture site by a subvastus approach\textsuperscript{3} revealed there was not much comminution of the medial condyle. Reduction was achieved indirectly by passing a Kirschner (K)-wire in the posterior fragment and using it as a joy stick to manipulate the posterior fragment of the Hoffa fracture. Once reduction was achieved, two large-fragment cannulated screws were passed from anterior to postero-medial in the epiphysis (Fig. 3) under image intensifier control. Special effort was made not to breach the physis of distal femur, and the screws were buried under the articular...
surface of the knee. Closure was done under negative suction.

Following open reduction and internal fixation (ORIF), the patient was kept on a plaster of Paris (POP) cast for approximately 4 weeks, after which gradual range-of-motion exercises of knee were initiated. The patient was allowed partial weightbearing at around 10-weeks postoperatively, when the radiographs showed signs of union, and was full weightbearing at 14 weeks postoperatively. At final follow-up of 36 months, the fracture was united (Fig. 4). The patient has 130° range of motion, with full extension, and there is no varus-valgus instability. Additionally, there is no limb-length discrepancy, and the distal femoral physeis has started to fuse on both the sides. The patient is pain free and ambulatory without walking aids.

**Figure 1** Lateral (A) and AP (B) radiographs of the right knee joint showing a Hoffa fracture of the medial femoral condyle (Letenneur type 1, Salter Harris type 4).

**Figure 2** Three-dimensional CT reconstruction (A), and axial (B) and sagittal (C) CT showing a displaced medial condyle Hoffa fracture. The axial cut (B) does not demonstrate involvement of the femoral posterior cruciate ligament insertion site, while the sagittal cut (C) shows presence of an unfused physeis.

**Discussion**

The Hoffa fracture refers to an isolated, coronally-oriented fracture of either femoral condyle, with intra-articular extension. This rare injury corresponds to Salter and Harris type 4 and OTA type 33-B3 fractures (frontal, partial articular fracture of the distal femur). While these injuries were previously classified by Letenneur, the classification was originally described for lateral Hoffa fractures. Type 1 fractures extend from an extra-articular location at the junction of the posterior femoral shaft and the proximal aspect of the femoral condyle to the posterior aspect of the condylar articular surface, inferiorly, such that the popliteus tendon insertion and the lateral head of the gastrocnemius origin remain attached to the condylar fragment. The anterior cruciate and lateral ligament insertions may be attached to
either the condylar or shaft fragment. Type II originate posterior to the posterior femoral shaft-condylar junction and are therefore potentially entirely intra-articular. Compared to type I fractures, the aforementioned ligamentous insertions are less likely to be attached to the condylar fragment. In type III fractures, all of the ligamentous insertions remain attached to the condylar fragment. According to this classification, our patient’s fracture was type I.

The mechanism of injury of this fracture pattern is controversial. Some investigators have postulated direct impact with the knee in a flexed position as the mechanism of injury, while others have attributed the fracture to simultaneous vertical shear and twisting forces. Lewis and colleagues proposed that direct impact, leading to an axial loading force to the femoral condyle, with the knee in 90° or more of flexion and possibly with an element of abduction, results

Figure 3 Postoperative lateral and AP views of the fracture showing internal fixation achieved with two large-fragment partially threaded screws inserted from anterior to posterior.

Figure 4 Lateral and AP views at 3-years follow-up. Fracture shows solid union, while the physis has almost fused.
in a typical Hoffa fracture. Most of these injuries are a result of motor vehicular accidents. The normal riding posture of the motorcyclist involves sitting with the knee flexed at or beyond 90°. In this position with slight abduction, the lateral femoral condyle is the leading part of the knee to receive a direct impact.

In this case report, the mode of injury to the patient was by collision with another vehicle while riding as a passenger on a motorbike. Due to sudden deceleration, the inner side of the knee hit the handle of the motorbike. Medial impact occurred directly to the medial femoral condyle while the affected knee was in greater than 90° flexion with an element of abduction and internal rotation, which led to a medial Hoffa fracture.

The treatment of a Hoffa fracture is similar to that of any intra-articular fracture. However, such an injury in a skeletally immature individual poses special problems due to the presence of an open physis. McDonough and Bernstein reported a case of Hoffa fracture of the lateral femoral condyle that subsequently went on to nonunion in an 8-year-old child. ORIF with bone grafting was performed and the fracture achieved union. Although the long-term natural history of this nonunion is unknown, chronic pain, disability, and early degenerative arthritis might be expected, as with any intra-articular nonunion involving a weight-bearing joint. Thus, we believe that open reduction is mandatory for good long-term function.

The articular surface is exposed through a medial or a lateral approach, depending on which condyle is involved. Anatomic reduction of the joint is essential and temporary fixation with K-wire is followed by permanent fixation with interfragmentary lag screws of either 6.5 mm partially threaded cancellous screws or 4.0-mm partially threaded cancellous screws, depending on the size of the fragment. A minimum of two screws is mandatory to provide rotational stability. The insertion of screws through the articular cartilage is necessary to achieve the lag effect and should be placed as far laterally as possible, but be medial for medial Hoffa fractures. The presence of the physis in children mandates physis-sparing surgery, and adequate fixation can be achieved by partially threaded cancellous screw fixation in the epiphysis.

Following surgery, full knee range of motion is encouraged, but weightbearing must be delayed until fracture union occurs (up to 12 to 14 weeks in most cases). Since these fractures do not heal by formation of much external callus and vascularity of these fractures is impaired because of the large bone surface covered with articular cartilage, delayed union, nonunion, or avascular necrosis are not unexpected complications of these fractures, especially in type II fractures.

To conclude, we believe that a medial condyle Hoffa fracture is extremely rare in children, and the diagnosis can often be missed. ORIF using partially threaded cancellous screws in the epiphysis provides stable fixation and can lead to a good functional outcome in the long term.

Disclosure Statement

None of the authors have a financial or proprietary interest in the subject matter or materials discussed, including, but not limited to, employment, consultancies, stock ownership, honoraria, and paid expert testimony.

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