

Hoffa Fracture in Skeletally Immature Patients: A Case Report and Review of Literature

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Learning Point of the Article:

Hoffa fracture needs CT evaluation to prevent misdiagnosis and to plan for the different options of surgical intervention.

Abstract

Introduction: Hoffa fractures are the fractures of the femoral condyles in the coronal planes. These are uncommon in adults and notably rarer in pediatric population. In this fracture, either one or both the femoral condyles may get involved following the injury. Such rare clinical entity warrants a high index of suspicion with apt radiological corroboration for meticulously diagnosing and planning out the treatment.

Case Report: We report a rare case of Hoffa fracture involving the medial femoral condyle of right knee and undisplaced right patella fracture in a 6-year-old girl. The radiological investigations (radiographs and computed tomography [CT] scan) were done and her leg was immobilized by above knee posterior slab. Our treatment plan included surgical intervention to do open reduction and internal fixation using k-wires and two 4.5 mm partially threaded cannulated cancellous screws and was done with due care to prevent any damage to epiphysis. No signs of osteonecrosis, heterotopic ossification or physal growth arrest in radiograph taken at 10th month were noted. The child is still under follow-up.

Conclusion: Hoffa fracture is a rare variety and the diagnosis of the same warrant a higher index of suspicion with more watchful eye. CT-scan firmly establishes the missed diagnosis and notably provides with the detailed configuration of the fracture to guide the treatment plan. Surgical intervention (open reduction and fixation or arthroscopy based procedures) is essential over the non-operative treatment to alleviate complications.

Keywords: Hoffa fracture, femoral condyles, coronal plane.

Introduction

Coronal fracture of distal femur are is uncommon in adults and indeed rarer in children [1]. Fractures involving femoral condyles in coronal plane are referred as Hoffa fractures [2]. The fracture was firstly described by Hoffa in 1904 [3]. The Hoffa fracture may involve one or both of the condyles. Femoral condylar fractures account for about 0.65% of all the femoral fractures [4]. These fractures are classified as type B 3.2 as per the AO classification, respectively. These fractures often get missed in routine radiographs of distal femur. The treating clinician must have a high index of suspicion to diagnose these rare fractures. Computed Tomography (CT) scan is mandatory in view of not missing the diagnosis of this fracture especially in

those who have sustained high energy injury and with lipohaemarthrosis. The details on the configuration of fracture provided by CT scan is are mandatory to plan out the surgical procedures [5]. As it is an intra-articular fracture, open reduction and internal fixation is are needed for a better clinical and functional outcome. Most published data have shown inferior results for managing such fractures with non-operative treatment [4].

In current literature, Hoffa fracture in skeletally immature patients comprise only of case reports. The goal of this article, after obtaining patient's attender's informed and written consent, is to report a case of 6-year-old girl with Hoffa fracture of medial femoral condyle and to provide a systematic review of

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Author's Photo Gallery



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Figure 1: Plain radiograph of right knee (antero-posterior and Lateral) showing medial Hoffa fracture.

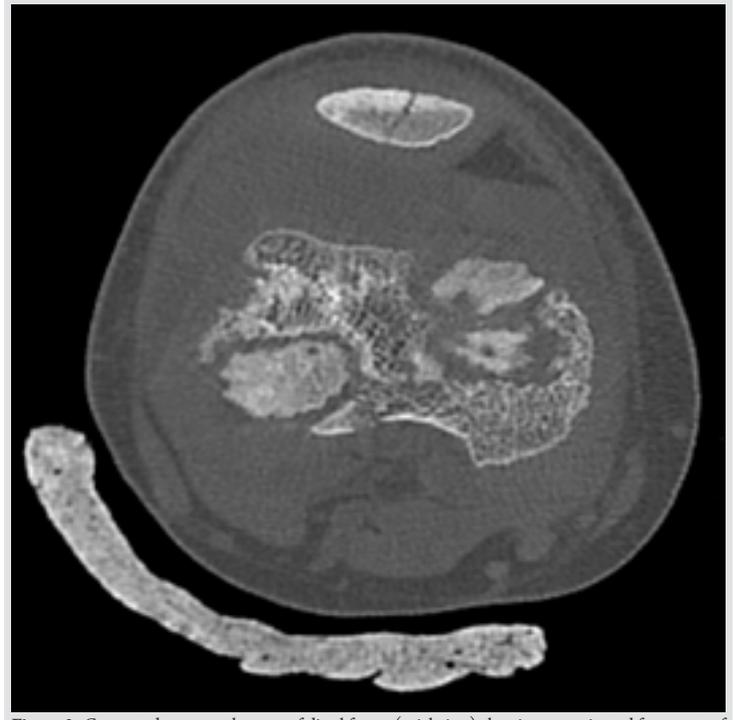


Figure 2: Computed tomography scan of distal femur (axial view) showing comminuted fragments of medial Hoffa fracture and vertical patellar fracture.

the literature on Hoffa fractures in paediatric population.

Case Report

A six 6- year- old girl presented to our emergency department with pain and swelling in the right knee along with inability to stand and walk. The attendant gave history of fall from height approximately 12 feet on her bent knees. On examination, the right knee was tender, swollen, and with multiple abrasions. The movements of her right knee were restricted and painful. Distal neurovascular status was intact. The patient was stable without any associated injuries. The patient was conscious and oriented. The plain radiograph of right knee revealed Hoffa fracture of medial femoral condyle as shown in (Fig. 1). CT scan of the right knee was performed to understand the fracture configuration, which revealed the comminutions at the fracture site as shown in (Fig. 2, 3a, 3b). The patient was immobilized with above knee posterior slab and scheduled for operative

intervention. Informed and written consent was obtained from her parents for the same.

Under general anaesthesia, the clinical examination showed varus instability in mid flexion range but there was no anteroposterior instability. Medial approach was used to access the fracture site. The fracture was reduced and held with k wires as shown in (Fig. 4a, 4b). Thereafter, the fracture was fixed using two 4.5 mm partially threaded cannulated cancellous screws as shown in (Fig. 5a, 5b). Screws were passed from posterior to anterior with due care to prevent any damage to epiphysis. Immediate post-operative radiograph was taken and the patient was kept in above knee posterior slab for initial three 3 weeks postoperatively as shown in (Fig. 6).

Gradual active knee mobilization was started after 3 weeks. The radiographs taken on 6th post-operative week showed the signs of fracture union. The patient was allowed partial weight bearing at 8 weeks and full weight bearing at 10 weeks. At 6th

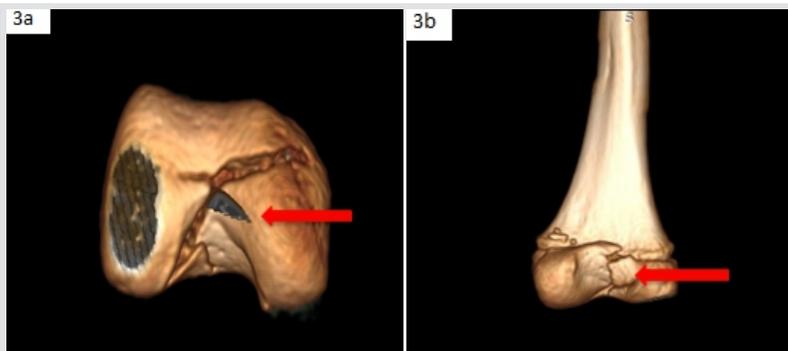


Figure 3: (a and b) Computed tomography of distal femur with three-dimensional reconstruction showing coronal split of medial femoral condyle.

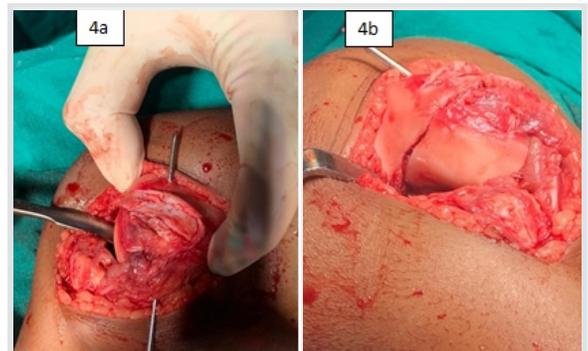


Figure 4: (a) Showing coronal split of medial femoral condyle and (b) showing reduced medial femoral condyle with K wire



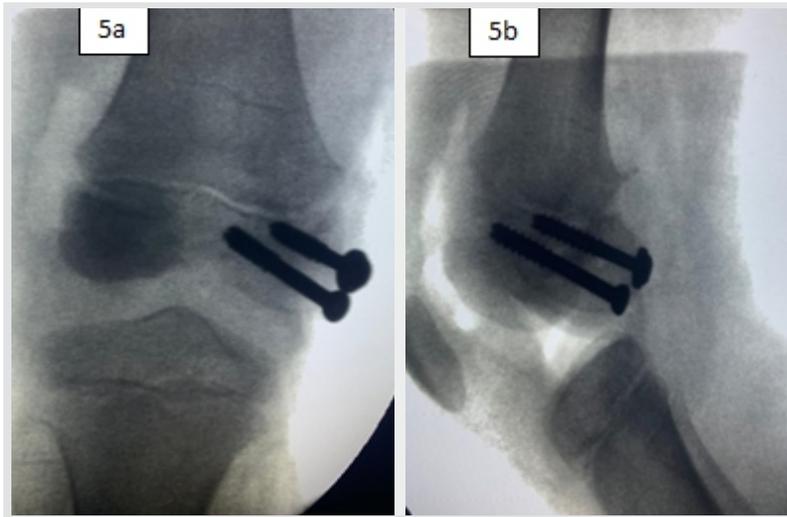


Figure 5: (a and b) Showing c-arm images of reduced medial Hoffa fracture with two 4.5 mm partially threaded cannulated cancellous screws.

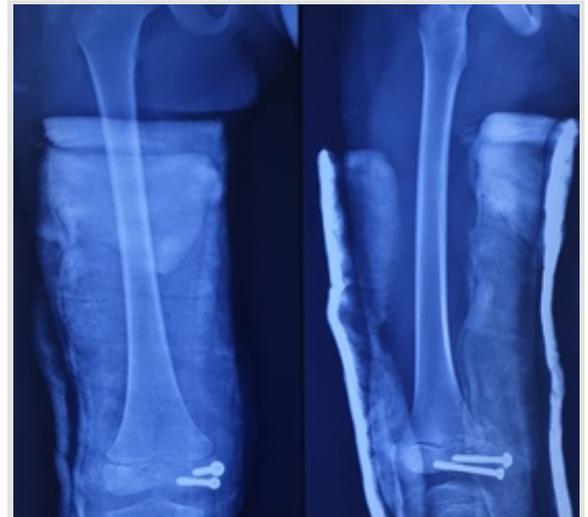


Figure 6: Immediate post-operative radiograph with reduced Hoffa fracture along with above knee posterior slab.

month follow-up, the patient had 0° to -110° of flexion with no signs of varus/valgus instability as shown in (Fig. 7). There were no signs of osteonecrosis, heterotopic ossification, or physeal growth arrest in radiograph taken at 10th month as shown in (Fig. 8). The child is still under follow-up.

Discussion

In view of review of literature on the mentioned subject, we searched following electronic databases- PubMed, Scopus, Google scholar; for “Hoffa fracture” in paediatric population using the keywords “Hoffa Fracture”, “Paediatric”, “Skeletally Immature,” and “coronal fracture of femoral condyle”. Only 13 case reports of Hoffa fracture in skeletally immature patients were found (as mentioned in Table 1). First case was reported in 2000 by McDonough in an 8- year- old child [6]. Notably, Hoffa fractures are rarer in this age group [7]. Among paediatric age group, the most common coronal fracture is lateral condyle followed by bicondylar fracture and medial femoral condyle is the least common. The aforementioned trend is similar in adults [8]. Lateral condyle is mostly fractured due to presence of physiological genu valgum [7]. Till date, only three cases of medial Hoffa fracture have been reported in paediatric age

group and hereby we aim to report the fourth case.

The injury mechanism of Hoffa fracture ranges from low energy trauma to high energy trauma; however, it is not well understood specifically [17]. Road traffic accident is the most common cause of this type of fracture in children as likewise in adults. Fall from height, athletic injuries are other modes of such injury. It has been hypothesized that an axial load to the femoral condyle with the knee in 90 degrees or a greater amount of flexion produces coronal fracture of femoral condyle [2]. As mentioned above, lateral condyle femoral fractures are most commonly witnessed due to physiological genu valgum in comparison to medial condyle [7]. On the other hand, Hoffa fractures involving both the condyles have no correlation with knee valgus, rather occurs due to forces directed posteriorly and upward [18].

In few patients, Hoffa fracture may also be associated with fracture of the patella occurring as an impact of combination of direct trauma and plausible sudden quadriceps injury witnessed indirectly. Apart from this, skeletally immature and osteoporotic population may have Hoffa fracture following low-energy trauma [11]. However, in our case, the child had a Hoffa fracture involving right medial femoral condyle and

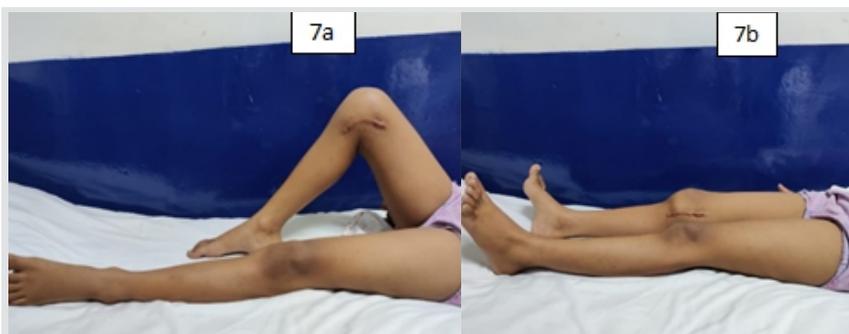


Figure 7: (a and b) Active flexion of up to 110° and no evidence of hyperextension in the right knee, respectively, at 10 months follow-up.



Figure 8: Ten months follow-up radiograph showing complete union of the fracture.



Table 1: Review of the literature on Hoffa fracture in pediatric population

S. No.	Author and Year	Cases	Location of fracture	Mode of injury	Surgical approach	Outcome
1	McDonough <i>et al.</i> , 2000 [6]	8-year-old child	Lateral femoral condyle (Non-union 5 years)	Road traffic accident	Open reduction and internal fixation and fixed with two posterior to anterior partially threaded cancellous lag screws without the usage of bone graft	Knee ROM is 0–130°, no coronal instability and no evidence of growth disturbance
2	Kumar <i>et al.</i> , 2001 [9]	17-year-old female	Lateral femoral condyle	Fall from ladder	Open reduction and internal fixation with 2 anteroposterior lag screws	Full range of knee movements with no ligamentous instability
3	Flanagin <i>et al.</i> , 2011 [10]	14-year-old male	Lateral femoral condyle	Wrestling	Arthroscopic evaluation followed by open arthrotomy and fixation with four headless screws	Pain free range of knee movements, returned to all sporting activities
4	Tripathy <i>et al.</i> , 2013 [8]	12-year-old child	Lateral femoral condyle	Fall while playing	Posterolateral approach of knee using two partially threaded AO cancellous lag screws	Normal gait with a full range of knee movements without any ligamentous instability
5	Potini <i>et al.</i> , 2015 [11]	14-year-old male	Lateral femoral condyle	Direct blow over knee	Open reduction and rigid fixation with countersunk interfragmentary screws along with augmentation of allograft for the articular damage	Knee ROM 5°–110° without pain
6	Elazab <i>et al.</i> , 2019 [12]	12-year-old male	Lateral femoral condyle	Motor vehicle accident	Diagnostic arthroscopy followed by open arthrotomy using anterolateral approach for excision of pseudoarthrosis with application of two reduction forceps, open reduction, and internal fixation of the fracture with lag screws	Satisfactory with full ROM
7	Lal <i>et al.</i> , 2011 [7]	9-year-old child	Conjoint	Fall from height onto a flexed knee	Arthroscopy assisted fracture fixation with 4.5 mm anteroposterior cannulated cancellous screws	No radiological evidence of osteoarthritis
8	Kondreddi <i>et al.</i> , 2014 [13]	17 year old	Conjoint	Road traffic accident	Lateral parapatellar arthrotomy with 4 mm cancellous screws (two for each condyle anteroposteriorly through the non-articular surface)	Complete flexion of the knee without any ligamentous instability
9	Harna <i>et al.</i> , 2017 [3]	7-year-old male	Conjoint	Hit by a speeding motor vehicle	Swashbuckler approach with 2.9 mm Herbert screw	Full, painless range of knee motion
10	Julfiqar <i>et al.</i> , 2019 [1]	12 year male	Conjoint	Fall from height when his left knee in flexed position	Open reduction and intraepiphyseal internal fixation using 4.5 mm cannulated cancellous screw and bone to tendon repair	0°–120° painless range of knee movements without any limb length discrepancy
11	Bali <i>et al.</i> , 2011 [14]	12-year-old male	Medial femoral condyle	Motorbike accident while riding on a pillion	Subvastus approach with two large fragment, anterior to posteromedial cannulated screws	130° ROM, with full extension, without varus-valgus instability and without any limb length Discrepancy
12	Salunke <i>et al.</i> , 2015 [15]	16-year-old female	Medial femoral condyle	Car accident	Subvastus approach with two cannulated cancellous screws	No limb length discrepancy
13	AlKhalife <i>et al.</i> , 2018 [16]	12-year-old male	Medial femoral condyle	Fall of heavy object over knee	Medial parapatellar approach	15°–130° painless range of knee movements
14	Current Study, 2020	6-year-old female	Medial femoral condyle	Fall from 12 feet height	Medial parapatellar approach with 2 mediolateral, cannulated cancellous screws	Full, painless range of knee motion

ROM: Range of motion

undisplaced vertical fracture of right patella due to sustained high-energy trauma (fall from height) without any significant open injury in either leg or any other systemic injury. In addition, it can also result as an iatrogenic injury during surgical reconstructive procedures of anterior cruciate ligament and thereby this aspect too requires significant attention of operating team [17].

Notably, the diagnosis of Hoffa fracture is exquisitely challenging. The earliest diagnosis of such rarer clinical entities

solely relies on the vigilant eyes and alert mind of the treating surgeon who meticulously relate presented history of trauma and positive clinical signs with apt findings of radiological investigations. The clinical manifestations locally noted in Hoffa fracture are pain, swelling, change in skin color with or without any skin defect, and limited mobility of the knee joint [19]. In some patients, positive floating patella test, anterior and posterior drawer test, and medial or lateral stress test were reported positive [17]. Moreover, it has also been reported that



Configuration of Hoffa fracture	Surgical approach	Remark
Lateral femoral condyle Hoffa fracture	Patellar anterolateral approach commonly with lateral incision and Gerdy tubercle osteotomy for open reduction and internal fixation	Renders advantage by fully exposing the fracture without risk of damaging neurovascular structures; Beneficial approach to treat comminuted or complex Hoffa fractures
Medial femoral condyle Hoffa fracture	1. Medial parapatellar approach for open reduction and internal fixation	Renders advantage by providing scope for future arthroplasty surgery; does not permit visualization and treatment if any posterior comminution
	2. Extensile medial subvastus approach for open reduction and internal fixation	Better exposure of field of surgery; protects blood supply of the bone in comparison to medial parapatellar approach
	3. Medial to medial-posterior distal femur approach for open reduction and internal fixation	Exposure of fragments via interval space between the gracilis muscle and medial of gastrocnemius; clear exposure and protection of the medial collateral ligament
Bicondylar Hoffa fracture	Simultaneous exposure of both the condyles with Gerdy osteotomy combined with anterior lateral parapatellar approach for open reduction and internal fixation	Allow proper reduction
Hoffa fracture with patella dislocation	Swashbuckler approach for open reduction and internal fixation	Protection of quadriceps femoris abdomen during surgery; offers quick postoperative recovery of muscle strength and motion
Hoffa fracture with cruciate ligament, lateral collateral ligament or meniscus injuries	Arthroscopic surgery	Minimal invasion; less effect on blood supply; Early postoperative return to exercising functionally; effective prevention of non-union and joint stiffness

people with Hoffa fracture presents with instability when flexed at 30° but not witnessed in straightened leg while being examined under general anaesthesia [20]. With respect to our case, child's right knee was tender, swollen with multiple abrasions and movements were restricted and painful. Indeed, her distal neurovascular status was intact and none of the stated tests were found positive. However, examination under general anaesthesia showed varus instability in mid flexion range but there was no anteroposterior instability.

The radiological examination should include evaluation of anteroposterior, lateral, oblique, and stress views of the knee in purview of not missing upon the diagnosis of Hoffa fracture especially non-displaced variety. Tripathy et al. reported a case wherein patient reported to author after 4 months of injury. First treating physician missed the fracture by only getting one plane radiograph [8]. Further, it has been noted that high energy trauma causing medial condylar Hoffa fracture is frequently associated with other fractures involving tibia, both the condyles, intercondylare, supracondylare, patella, dislocation of knee, shaft of femur, or pelvis may present with excruciating pain in combination and thereby culminate into the missed diagnosis of Hoffa fracture [17].

We believe that such instances can be invariably overcome with a high index of suspicion wherein radiographs are insufficient to diagnose and therefore it is wiser to direct for the gold standard investigation, that is, i.e. CT scan for the same [21]. The CT-scan findings of our case revealed the comminutions at the fracture site, respectively. According to CT-based classification of Hoffa fracture as proposed by Chandrabose et al., [22] our case belongs to type 2b. In addition, it is worthwhile to mention that magnetic resonance imaging (MRI) will also serve as useful in paediatric Hoffa fracture provided suspecting of injury to physis and ligaments [8].

The aim of the treatment of these fractures is to reduce the

fracture anatomically and provide stable fixation for an early mobilization. This can be achieved either conservatively or surgically; however, the former generally brings about poor outcomes associated with malunion, non-union, and avascular necrosis [1, 10]. Open reduction and internal fixation is the choice for both displaced and undisplaced fracture. Surgical consideration and approach (as mentioned in Table 2) allowing complete exposure of the fracture is subjected to the location, severity, and configuration of the Hoffa fracture. Open reduction and internal fixation were done in most of the reported cases. Flangin et al. did diagnostic arthroscopy of knee and followed by open arthrotomy, reduction, and internal fixation [10]. Arthroscopic assisted reduction and percutaneous fixation were done by Lal et al. They advocated arthroscopic assisted procedure minimizes dissection of soft tissue, loss of blood, and operative time [7].

We treated medial Hoffa fracture as diagnosed in our case with open reduction and internal fixation using k-wires and two 4.5 mm partially threaded cannulated cancellous screws. Medial approach was used to access the fracture site and due care was taken for preventing any injury to epiphysis while fixing the reduced fracture. For the same reason, screws were passed from posterior to anterior. As far as our understanding, literature lacks clinical comparison on the fixation methods of Hoffa fracture. Indeed, selection of type of screws along with decision to combine with antigliding plates and direction of its application are subjected to fracture configuration and patient profile. Further, it is important to note that instability at fracture site have higher chances of non-union with chronic pain and disability [10]. McDonough et al. reported non-union of Hoffa fracture where injury took place 5 years back [6]. Be that as it may, such injury in a paediatric age group poses uncommon issues because of the nearness of an open physis [8, 17, 21].

To reiterate, a high index of suspicion is much needed in similar cases and in fact demands routine practice of evaluating for Hoffa fractures as a part of examining the lower limb and pelvis of the case irrespective of injury. Such improvised practice will extremely prove fruitful for not missing its diagnosis and will further facilitate to plan for an appropriate treatment of the case with nullified complications. Nevertheless, rehabilitative protocol with range of motion (ROM) exercises during post-operative course supplements in achieving a better functional outcome.

Conclusion

Hoffa fractures being rarer in paediatric population demands careful evaluation of all the cases involving knee joints with a

higher index of suspicion for the earliest diagnosis. CT scan serves as the mainstay and corroborate for the same. Management depends upon the fracture configuration but it is worth imbibing that open reduction and internal fixation is needed for a better clinical and functional outcome in comparison to conservative treatment plan.

Clinical Message

Hoffa fracture, the fracture of femoral condyles in coronal plane, needs CT evaluation to prevent misdiagnosis, to study the fracture configuration, and to plan for the different options of surgical intervention.

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