CASE REPORT

Surgical Treatment and Rehabilitation for Hoffa Fracture Nonunion: Two Case Reports and a Literature Review

Peng Zhang MD¹, Xiu-zhen Zhang BS², Fu-lin Tao MD¹, Qing-hu Li MD¹, Dong-sheng Zhou MD¹, Fan-xiao Liu MD¹

¹Department of Orthopaedics, Shandong Provincial Hospital affiliated to Shandong First Medical University, Jinan and ²Department of Neurology, Gaomi Hospital of Traditional Chinese Medicine, Weifang, China

Background: A coronal fracture of the distal femoral condyle, known as a Hoffa fracture, seldom occurs and is easy to misdiagnose. Surgery treatment, including open anatomic reduction and internal fixation, is the primary method of treatment. However, cases involving nonunion are extremely rare.

Case Presentation: We reported two cases in a 56-year-old female who visited our outpatient clinic with complaints of locking sensation, swelling, and pain, and a 64-year-old male patient who need additional care after having undergone surgery for a distal femur fracture. They presented with nonunion of a Hoffa fracture (Letenneur type II), and these cases of nonunion were resolved surgically with debridement, two cannulated lag screws, a lateral extra-articular buttress plate, and the liberal use of autologous bone grafts. After surgery, the two patients were allowed to bear partial weight and perform exercises. They were allowed to walk with full weight-bearing after 3 months. No early complications, such as infection and loss of reduction, were noted after the revision surgery. At the one-year follow-up, both patients had excellent function and reported minimal pain, with a Lysholm score of 94.

Conclusions: Our case reports highlight the importance of the liberal use of autologous bone grafts, which allow stable reconstruction of the affected femoral condyle, thereby restoring joint congruence. A lateral extra-articular buttress plate in combination with two cannulated lag screws is recommended for nonunion in Hoffa fracture patients, and they need to be closely followed up to detect complications promptly, especially those related to nonunion.

Key words: Hoffa fracture; Nonunion; Open reduction and internal fixation

Introduction

Coronal fractures of the femur, also known as Hoffa fractures, are extremely rare intra-articular injuries and are easily misdiagnosed and missed in anteroposterior X-rays since the unfractured condylar part of femur obscures the fractured condyle. These fractures cannot be seen in cases of undisplaced Hoffa fractures, which explain why the computerized tomography scans should be performed for suspected cases. Surgical treatment with open anatomic reduction and internal fixation is the primary method of treatment. However, cases involving nonunion are extremely rare. Hoffa fractures mostly result from direct high-energy trauma, which cause a shear force on the posterior femoral condyle. The types of treatment used for Hoffa fractures include conservative management and surgical treatment. The results of conservative management are poor because conservative treatment is associated with a risk of displacement of the fracture fragment, nonunion, and avascular necrosis. This

Address for correspondence Fan-xiao Liu, MD, Department of Orthopaedics, Shandong Provincial Hospital Affiliated to Shandong First Medical University, No.324, Road Jing Wu Wei Qi, Jinan, Shandong, China 250021 Tel: +86-0531-68773195; Fax: +86-0531-68773195; Email: woshi631@126.com

Disclosure: The collection, analysis, and interpretation of the data in the study were financially supported by the Shandong Provincial Natural Science Foundation (ZP, No.: ZR2013HM069). The design of the study was supported by Shandong Key R&D Program (ZP, No.: 2017GSF218089) and China Scholarship Council (LFX, No.: 201808080126).

Received 24 April 2020; accepted 18 June 2020
risk might be due to pressure from the posterior plateau in flexion in combination with a relaxed posterior capsule. As these fractures are intra-articular, most of them remain free in the joint when fixation is not performed. Surgical treatment has been shown to yield satisfactory clinical outcomes. According to the current literature, few cases of nonunion of Hoffa fractures have been reported. Letenneur et al. proposed a classification system that consists of three subtypes, including Type I, II, and III. In cadaver studies, Type I and Type III Hoffa fractures have been shown to have soft tissue attachments that provide blood flow to the fracture fragment. However, Type II fractures are completely intra-articular and without any soft tissue attachments, making this fracture susceptible to nonunion.

Various case reports have suggested that cases of nonunion of Hoffa fractures should be treated with debridement, and open reduction and internal fixation. In the present case study, the combination of a lateral extra-articular buttress plate, two cannulated lag screws, and autologous bone grafts was used for the treatment of Hoffa fractures in patients with nonunion.

**Case Presentation**

**Case 1**

A 56-year-old female visited our outpatient department with complaints of locking sensation, swelling, and pain in her left knee. She had sustained a Hoffa fracture of her right medial femur condyle after falling down the stairs. Her left knee had not been evaluated by X-ray. It had been diagnosed as normal, and she had been treated conservatively. After 3 months, she was able to return to her job. She complained of severe pain in her left knee and poor knee function. In the physical examination, the range of motion was (flexion/extension) 100°/90°/0°. There was no valgus or varus instability, and neurovascular examination findings were normal. The radiographs and magnetic resonance imaging (CT) scans indicated the nonunion of a fracture of the medial femoral condyle (Letenneur type II) (Fig. 1A). Because her symptoms related to nonunion were worsening, operative treatment was planned.

The patient was placed in the supine position. A thigh tourniquet was placed and inflated. The patient's leg and

![Fig. 1](image_url)
anterior iliac crest were prepped and draped. The lateral parapatellar surgical approach was performed. The knee was then flexed to 45° on a knee support. A Hohmann retractor was placed on the posterior aspect of the distal femur. A second Hohmann retractor was placed anteriorly over the distal femur, medially subluxating the patella (Fig. 1B). The nonunion region was gently opened with a broad osteotome, and interposed fibrous tissue was removed from the nonunion site. There was no soft tissue attached to the distal fragment, which was essentially “free-floating” in the knee. Multiple drill holes were made with a small K-wire until blood was noted to regress from the bone marrow. A cancellous bone graft was harvested from the patient’s iliac crest and was tightly packed into the nonunion site (Fig. 1C). Anatomic reduction was confirmed fluoroscopically and by direct visualization of the articular surface. The case of nonunion was then stabilized using two compression screws from the anterior to posterior direction, which resulted in excellent compression. The screws were positioned to be approximately perpendicular to the nonunion line. The heads of the screws were buried under the cortical bone of the suprapatellar capsule (not the articular surface). One precontoured reconstruction plate was placed on the nonarticular surface posteromedially as a buttress plate (Fig. 1D).

Postoperatively, only toe-touch weightbearing was allowed for 6 weeks, and then, weightbearing as tolerated was gradually allowed. At 3 months, the radiographs showed that the fracture had healed with good anatomical restoration. At 1 year after surgery, the patient was working part-time and performing moderate-intensity physical activity. The patient did not have pain, and her knee function was good, with a range of motion of (flexion-extension) 130°/0°/
0° and a Lysholm score of 94. The control radiograph demonstrated that the fracture healed, with a small amount of heterotopic ossification around the plate (Fig. 1E).

Case 2

A 64-year-old male presented to our outpatient clinic for additional care after having undergone surgery for a distal femur fracture elsewhere. He had sustained a Hoffa fracture (Letenneur type II) of his right medial femur condyle after a motor vehicle accident 4 months ago. In this case, the medial approach was used during surgery, and the fragment was reduced and stabilized with two screws and plates. Unfortunately, 4 months later, the patient continued to have pain, and the computed tomography (CT) scan showed nonunion with implant loosening (Fig. 2A). The range of motion was (flexion/extension) 60°/0°/0°. A revision procedure was planned to provide stable fixation and promote the healing of this intra-articular fracture.

The patient was positioned as described above for case 1. The prior medial approach was used for exposure of the nonunion. The nonunion site was debrided after the old fixation instrumentation was removed. Again, at this time, the ununited condylar fragment was noted to be “free-floating” in the knee. The overlying articular cartilage on the fragment was not intact (Fig. 2B). The fragment was repositioned as described above, and stabilization was achieved with two compression screws placed from the posterior to anterior direction. However, a small gap persisted at the nonunion site, probably due to bone loss; for this reason, two 3.5 mm reconstruction plates were placed as buttress plates for additional stability. The fixation procedure did not cause damage to the articular cartilage. Again, the gap was filled with a cancellous bone graft from the patient’s iliac crest.

The postoperative radiographs showed the restoration of the femoral condyle surface (Fig. 2C). The patient was allowed to bear partial weight, and he started range of motion exercises of the knee joint. He was free to walk with full weight-bearing after 3 months. No early complications, such as infection or loss of reduction, were noted after the revision surgery. After 1 year, he ambulated without pain, and his function was excellent, with a range of motion of (flexion/extension) 120°/0°/0° (Fig. 2D).

Discussion

Coronal fractures of the femoral condyle, also known as Hoffa fractures, are uncommon and account for fewer than 1% of distal femoral fractures1–4. These fractures mostly result from direct high-energy trauma, which cause a shear force on the posterior femoral condyle. Letenneur et al. proposed a classification system that consists of three subtypes1. In cadaver studies, Type I and Type III Hoffa fractures have been shown to have soft tissue attachments that provide blood flow to the fracture fragment. However, Type II fractures are completely intra-articular, without any soft tissue attachments making this fracture susceptible to nonunion5, 6. In our study, the reason why both cases of Hoffa fractures gave rise to nonunion might be that both cases were Type II Hoffa fractures that did not have any soft tissue attachments.

Hoffa fractures seldom occur and are easily to misdiagnose. Therefore, a suspected case should be carefully examined. The fracture might be easily missed in anteroposterior X-rays since the unfractured condylar part of the femur obscures the fractured condyle. Moreover, these fractures cannot be seen in cases of undisplaced Hoffa fractures, which explains why the CT scans should be performed for suspected cases.

The treatments used for Hoffa fractures include conservative management and surgical strategy. Conservative treatment is associated with a risk of displacement of the fracture fragment, nonunion, and avascular necrosis5, 5. This risk might be due to pressure from the posterior plateau in flexion in combination with a relaxed posterior capsule. Close follow-ups and hence early detection of nonunited fractures allow for prompt intervention.

Operative treatment with open anatomic reduction and internal fixation is the primary method of treatment. Positioning the knee in flexion during surgery is beneficial because knee flexion relaxes the gastrocnemius muscle and reduces its deforming force. The surgical approach was performed with a medial parapatellar arthroscopy incision via a midline incision in our index operation to reduce soft tissue disruption via percutaneous fixation. This approach allows the visualization of the old fracture line and the articular surface, avoiding the need for a more invasive procedure, such as an osteotomy. Patel et al. reported that coronal-plane Hoffa fractures of the distal femoral condyle can be treated using the anterior approach7. Hoffa fractures are treated using the principle of absolute stability, which was achieved in our index operation. Various case reports have suggested that cases of nonunion of Hoffa fractures should be treated with debridement, and open reduction and internal fixation8–10. In our index operation, the fracture fragment is held with K-wires before the fracture fragment is secured with a screw inserted in the anterior to posterior direction.

Regarding the method of fixation, the placement of one 6.5 mm lag screw is superior to one or two 3.5 mm screws. Studies in the literature have also suggested that screws placed in the anterior to posterior direction may offer biomechanical advantages and improve rotational stability; however, the placement of these screws might be difficult, and it must be ensured that screw heads are countersunk if they are inserted from a cartilage-bearing11, 12. However, cancellous lag screws placed from the posterior to the anterior direction have a disadvantage because the screw breaks the joint surface, despite the screw heads being located beneath the cartilage. In our first case study, the Hoffa fracture was fixed with a minimally invasive surgical technique, and two percutaneous, 6.5 mm, partially threaded cannulated cancellous screws were inserted in the anterior to posterior direction, perpendicular to the fracture plane. The heads were buried under the cortical bone of the suprapatellar capsule (not articular surface). The addition of reconstruction plate fixation did significantly alter the rigidity of the construct,
which offered extra-articular fixation. The fixation procedure did not cause damage to the articular cartilage.

Our paper highlights the surgical method in which a bone graft alone is used to elevate the depressed articular cartilage. Cancellous bone graft was harvested from the patient’s iliac crest and was tightly packed into the nonunion site without overstufﬁng it, which is necessary to bridge the bone ends, stimulate osteogenesis, and promote bone repair. Patients with such injuries have an increased likelihood of developing osteoarthritis following injury due to the high-energy forces incurred during the trauma. Moreover, the use of a bone graft in contact with the articular surface further increases the probability of developing heterotopic ossiﬁcation and osteoarthritis. There were no signs of osteonecrosis, which we expected to develop in the distal fragment, given that a complete lack of soft tissue attachments was noted at the time of surgery. In our case study, it was important to achieve anatomical reduction, and hence knee stability, to enable early range-of-motion and satisfactory functional outcomes.

In summary, our case reports demonstrate that a lateral extra-articular buttress plate in combination with two cannulated lag screws is recommended for cases of nonunion in Hoffa fracture patients, and they need to be closely followed up to detect complications promptly, especially those related to nonunion; moreover, it is very important to liberally use autologous bone grafts, which allow the stable reconstruction of the affected femoral condyle, thereby restoring joint congruence and yielding with good outcomes. This restoration will enable early postoperative motion of the knee, which speeds up the rehabilitation process.

References

1. Letenneur J, Labour PE, Rogez JM, Lignon J, Bainvel JV. Hoffa’s fractures. Report of 20 cases. Ann Chir, 1979, 32: 213–219.
2. Payne R, Clark D, Wall S. Union after delayed presentation of a Hoffa fracture. Injury Extra, 2005, 36: 289–291.
3. Somford MP, van Ooj B, Schafroth MU, Kloen P. Hoffa nonunion, two cases treated with headless compression screws. J Knee Surg, 2013, 26: S89–S93.
4. Bartoniček J, Rammelt S. History of femoral head fracture and coronal fracture of the femoral condyles. Int Orthop, 2015, 39: 1245–1250.
5. Jiang Y, Wang Z, Zhang D, Gu G. Twenty-seven-year nonunion of a Hoffa fracture in a 46-year-old patient. Chin J Traumatol, 2015, 18: 54–58.
6. Onay T, Gülabi D, Çolak İ, Bulut G, Gümüştaş SA, Çeçen GS. Surgically treated Hoffa fractures with poor long-term functional results. Injury, 2018, 49: 398–403.
7. Patel NB, Nadeem AL, Bhavsar NM. Coronal plane Hoffa fractures of the distal femoral condyle treated using an anterior approach. Gujarat Med J, 2014, 69: 99–102.
8. Nandy K, Raman R, Vijay RK, Maini L. Non-union coronal fracture femoral condyle, sandwich technique: a case report. J Clin Orthop Trauma, 2015, 6: 46–50.
9. Xie X, Zhan Y, Dong M, et al. Two and three-dimensional CT mapping of Hoffa fractures. J Bone Joint Surg Am, 2017, 99: 1866–1874.
10. Maheshwari V, Sharma SL, Goyal D, Qureshi P, Hussain Z. Clinical experience with management of Hoffa fractures using headless compression screw and headed screw. J Clin Orthop Trauma, 2019, 10: 934–940.
11. Lohiya R, Jindal N, Bachhal V. Hoffa fracture: analysis of factors affecting the final outcome after treatment with partially threaded screws. Int J Res Orthop, 2017, 3: 814–818.
12. Joseph CM, Rama-Prasad YS, Boopalan P, Jepegnanam TS. Long term follow-up of an open Bicondylar Hoffa fracture with a disrupted extensor mechanism: a case report. Malays Orthop J, 2019, 13: 59–62.
13. Nizegorodcew T, Palmieri G, Peruzzi M, Galli M. Allograft for the treatment of traumatic severe bone loss in the lateral femoral condyle: a case report. Injury, 2018, 49: S16–S20.