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Case Report

Late Hoffa fracture of the lateral femoral condyle in an ACL reconstructed knee

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Abstract

A 33-year-old male sustained Hoffa fracture of the lateral femoral condyle 10 months after arthroscopic reconstruction of the anterior cruciate ligament in the same knee. The ligament had been reconstructed with autologous, quadrupled hamstring graft and was anchored in the femoral tunnel with a cortical suspensory device. As the fracture line did not involve the femoral tunnel, the ACL graft was spared, and the fracture was managed by open reduction and internal fixation. Fracture union was achieved by 6 months and the patient recovered uneventfully. At the 5- year follow-up, the patient had a stable pain-free knee.

This case report highlights the possibility of late lateral femoral condyle Hoffa fracture treatment via arthroscopic ACL reconstruction without extra-articular tenodesis and despite taking adequate intra-operative precautions during tunnel drilling and using a cortical suspensory device for anchoring the graft on the femoral side.

Keywords: Hoffa fracture, ACL reconstruction, Femoral condyle.

Introduction

With the rise in popularity of various sporting activities, the incidence of sports-related injuries has increased. One such injury that Orthopaedic surgeons commonly encounter is the anterior cruciate ligament (ACL) tear. The gold standard treatment for a symptomatic ACL tear is the arthroscopic, anatomic ACL reconstruction using autogenous hamstring or bone-patellar tendon-bone graft.[1,2] Of the few conditions that may complicate the post-operative period following arthroscopic ACL reconstruction, fracture of the lateral condyle of the femur, though rare, has been reported by several authors (Table-1). Stress risers due to over-drilling of the femoral tunnel, posterior cortex penetration, graft fixation screws and screws at the site of extra-articular tenodesis are some of the causes implicated for the fracture.[3-12] We report a case of late Hoffa fracture of the lateral femoral condyle that occurred 10 months after arthroscopic ACL reconstruction wherein the graft on the femoral side was anchored with a cortical suspensory device.

Case report

A 33-year-old automobile mechanic presented to our Knee clinic with pain, swelling and restriction of movement of the right knee joint associated with difficulty in bearing weight following a low-velocity road traffic accident. He reported that he was hit by a motorcycle while walking and fell with a flexed knee. A detailed history revealed that he had undergone arthroscopic reconstruction of anterior cruciate ligament (ACL) tear using ipsilateral, quadrupled hamstring graft in the same knee 10 months before the injury. The ACL tear had happened 18 months before the arthroscopic surgery. A review of the medical records revealed that an 8mm in diameter graft had been secured at the femoral isometric point on the lateral femoral condyle with a cortical suspensory device (Tightrope, Arthrex, Naples, Florida, USA). On the tibial side, the graft had been secured with a bio-absorbable screw measuring 8mm x 28mm. Following the ACL surgery, the patient had undergone supervised rehabilitation and had been back to his profession by 6 months with no residual pain, stiffness, or instability.

On clinical examination, the patient had tenderness over the lateral femoral condyle with haemarthrosis. He was unable to bear weight and walk with movements of the knee painful and restricted. Tests for knee instability were not performed in the acute setting. There were no distal neurovascular deficits, and he had no other injuries from this accident.

Standard plain knee radiographs in orthogonal planes (anteroposterior and lateral views) revealed a displaced, intra-articular fracture of the lateral femoral condyle (Figure-1). A computed tomography (CT) scan was performed to better understand the fracture morphology and evaluate the existing femoral tunnel with the ACL graft. On CT scan, the fracture line was found to run anterior to the femoral tunnel, suggesting that the tunnel was intact (Figure-2). Literature in the past suggests that such a fracture occurs due to the stress risers in and around the femoral tunnel. Tunnel lysis, tunnel expansion, drill hole for the screw for extra-articular tenodesis and the screw used for graft anchoring have all been found to contribute to the stress across the tunnel, and a CT scan is important in identifying the pathology within the tunnel.[4-6,9,13] CT scan also helps in planning the approach and fixation of such fractures.

A magnetic resonance imaging (MRI) scan was done to evaluate the status of the ACL graft. MRI revealed signal intensity changes around the ACL graft, however, there was no disruption of the fibers. It also revealed a grade 1 sprain of the lateral collateral ligament. All other soft tissue structures around the knee joint were normal (Figure-3).

The patient underwent open reduction of the Hoffa fracture and internal fixation through a lateral parapatellar approach. The fracture was reduced with a clamp and fixed antero-posteriorly with two 4 mm cannulated, cancellous screws (60mm long) (Figure-4). Care was taken not to damage the existing femoral tunnel. Following the fixation, knee was examined on a table and was found to be stable with no anterior translation (Lachman and anterior drawer tests were negative). Post-operatively, the patient was started on non-weight bearing gait training with axillary crutches. The knee was immobilised in a brace for one week. Static quadriceps and active straight leg raise exercises were encouraged. Active range of movements was encouraged after one week and unprotected weight-bearing was allowed only after three months.

Outcome and follow-up

The patient attended regular follow-ups and during each visit, the knee was examined for range of movement and instability. Fracture union was achieved by 6 months and at one-year follow-up, the patient had full movement at the knee joint with no instability and had made a return to his profession. At five-years follow-up, the patient continues to have a pain free stable knee with IKDC score of 90.8 and Tegner-Lysholm score of 94. Plain radiographs show no evidence of arthritic changes in the knee joint (Figure-5). MRI shows the ACL graft fibres to be intact with no changes in the femoral tunnel (Figure-6).

Figure-1. plain radiographs of the knee in anteroposterior (Figure -1a) and lateral (Figure -1b) views showing displaced, intra-articular, coronal plane fracture of the lateral femoral condyle in an ACL reconstructed knee.

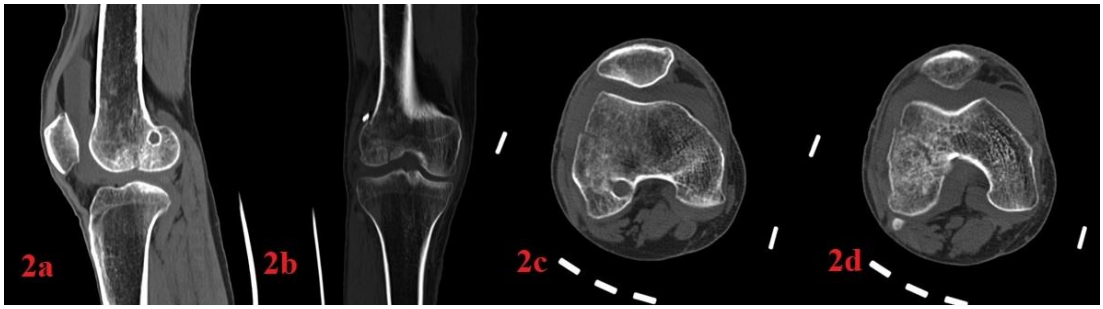

Figure-2. CT scan of the knee in three planes
2a. sagittal section showing an intact femoral ACL tunnel. **2b.** coronal section showing an intra-articular fracture of the lateral femoral condyle. **2c** and **2d.** axial sections showing a coronal plane fracture anterior to the intact femoral ACL tunnel.

Figure-3. MRI scan of the knee joint in three planes
3a. T2 weighted image in sagittal section showing a displaced intra-articular fracture. **3b.** T1 weighted image in sagittal section showing the graft fibers to be intact. **3c.** PD weighted fat saturation image in coronal plane showing the graft fibers to be intact. **3d.** PD weighted fat saturation image in axial plane showing a coronal plane fracture anterior to the femoral ACL tunnel.

Figure-4. Immediate post-op plain radiographs in anteroposterior (Figure-4a) and lateral (Figure-4b) planes showing the fracture fixed with two cannulated cancellous screws.

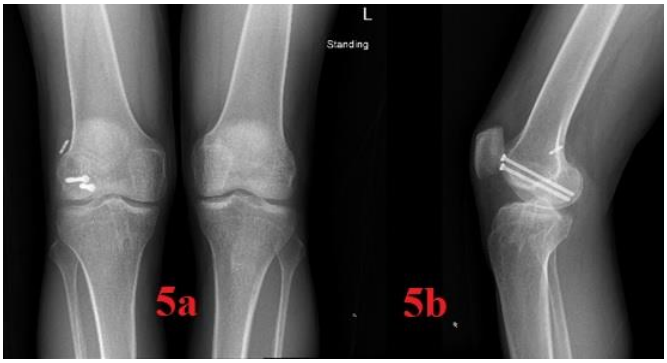

Figure-5. Plain radiographs at 5 years follow-up in weight bearing anteroposterior (Figure-5a) and lateral (Figure-5b) planes showing a united fracture with no evidence of arthritis.

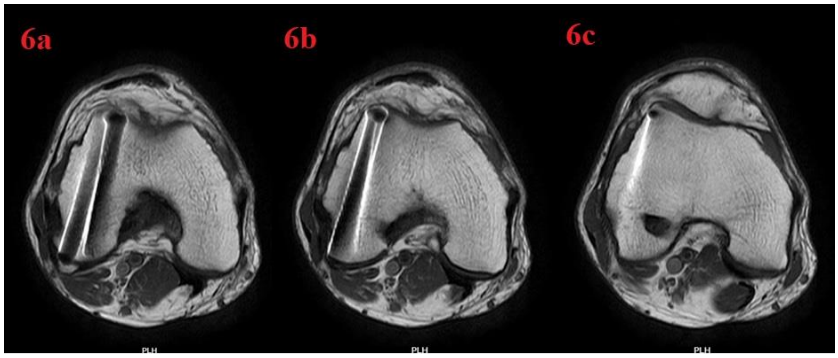

Figure-6. MRI scan of the knee joint at 5 years follow-up.
6a. T1 weighted image in the axial plane showing union of the fracture. **6b.** T1 weighted image in the axial plane showing screws directed away from the tunnel. **6c.** T1 weighted image in the axial plane showing an intact femoral tunnel.

Discussion

Fractures around the knee joint have been reported to occur following arthroscopic ACL reconstruction. Most of these fractures happen in the patella when bone-patellar tendon-bone autografts are used. Stein et al reported an incidence of 1.3% of patella fracture in a retrospective study of 618 patients.[14] Fractures of the femoral condyles following arthroscopic ACL reconstruction have also been sporadically reported (Table-1).

Distal femoral fractures following arthroscopic ACL reconstruction are believed to occur due to stress risers from the fixation of ligament augmentation device,[12] extra-articular tenodesis of the iliotibial band,[3] or femoral post-fixation.[15] Lateral femoral condyle fracture has also been described to occur through the femoral ACL tunnel in the absence of additional stress risers.[6] Here, the femoral tunnel itself was thought to act as a stress riser. It has been postulated that bone tunnels and screw holes cause bone defects that reduce the ability of the bone to absorb torsional load.[19,20] Manktelow et al hypothesized that a similar effect may be predicted with femoral tunnels of diameter 10mm or greater not filled with bone.[4]

Table-1. Review of literature on distal femur fractures complicating arthroscopic ACL reconstruction

Author (date)	Time of fracture since arthroscopic ACL reconstruction	Type of graft used	Graft fixation method in the lateral femoral condyle	Site of distal femur fracture	Mechanism of injury leading to fracture
Noah et al.[3] 1992	6 months	Bone-patellar tendon-bone autograft with iliotibial band tenodesis	Metal interference screw	Supracondylar fracture at the level of iliotibial band screw	Fall
Berg et al.[15] 1994	2 months	Bone-patellar tendon-bone autograft	Traction sutures tied over a screw post. Posterior cortex perforated during tunnel drilling.	Coronal plane fracture in the posterior half of the femoral condyle involving the tunnel	Fall due to knee instability
Manktelow et al.[4] 1998	2 years	Hamstring autograft with iliotibial band tenodesis	Not mentioned	A coronal plane fracture involving the femoral tunnel and the site of extra-articular tenodesis	Fall from bicycle
Wilson et al.[6] 2004	8 months	Bone-patellar tendon-bone autograft	Metal interference screw	Fracture through the femoral tunnel	Fall while walking
Mithoefer et al.[7] 2005	5 months	Bone-patellar tendon-bone autograft	Metal interference screw	Supracondylar femoral fracture through an enlarged femoral tunnel	Fall from a mountain bike

Merk et al.[5] **2009**	18 months	Bone-patellar tendon-bone allograft	Bioabsorbable interference screw	Intra-articular condylar fracture through a cystic region in the femoral tunnel with extension into the distal third shaft	Twisting injury while stepping off a curb
Coobs et al.[16] **2009**	3 weeks	Revision ACL reconstruction with bone-patellar tendon-bone autograft placed in a separate femoral tunnel than the original one	Metal interference screw	Intra-articular lateral femoral condyle fracture through the second femoral tunnel	Manipulation of his Sacro-iliac joint that involved axial distraction of the operated lower limb
Polyzois et al.[9] **2009**	2 weeks	Hamstring autograft	Metal interference screw	Intercondylar fracture with extension to the medial femoral condyle	Road traffic accident causing multiple fractures
Keyhani et al.[10] **2010**	Intra-operative during revision ACL reconstruction	Posterior tibial tendon allograft	ACL reconstruction was deferred until fracture fixation	Intra-operative iatrogenic Hoffa fracture across the femoral tunnel while passing the tendon graft	Intra-operative
Julien et al.[13] **2010**	11 years	Hamstring autograft with notchplasty	Bone mulch screw	Coronal fracture through the posterior aspect of lateral femoral condyle through the cross-pin tunnel	Twisting injury to the knee
Werner and Miller.[17] **2014**	Intra-operative	Hamstring autograft	PEEK (polyether ether ketone) interference screw	Coronal fracture of the lateral femoral condyle through the femoral tunnel	Intra-operative during tunnel drilling and dilation
Montgomerry and Evans.[18] **2008**	6 weeks	Bone-patellar tendon – bone autograft with notchplasty	Bioabsorbable interference screw	Fracture of the medial femoral condyle	Fall from stairway.
Index case	10 months	Quadrupled ipsilateral Hamstring autograft	Cortical suspensory device	Coronal plane fracture of the lateral femoral condyle anterior to and sparing the tunnel	Fall on flexed knee following a low-velocity accident

The bioabsorbable interference screw that is commonly used to secure the graft is also a potential risk factor for fracture, especially if resorption or bony integration of the screw is incomplete.[5,21,22] There is also a case-report of fracture occurring opposite to the femoral tunnel in the medial femoral condyle which defies the stress riser theory.[9] Montgomerry [18] reported a case of fracture of medial femoral condyle 6 weeks following arthroscopic ACL reconstruction. These two reports contribute to the understanding that the fracture may happen away from the ACL femoral tunnel and independent of the technique used for ACL reconstruction. There is, however, no reported case of Hoffa fracture of medial femoral condyle occurring after arthroscopic ACL reconstruction.

Of all the femoral condyle fractures reported to have happened after arthroscopic ACL reconstruction, only a few case reports describe coronal plane fractures of the lateral femoral condyle, and in all the cases, the fracture involved the femoral tunnel.[4,13,15] There are, however, a couple of case reports depicting intra-operative iatrogenic Hoffa fracture of the lateral femoral condyle during ACL tunnel drilling and dilation. The authors hypothesized that if the tunnel is drilled too close to the distal femoral articular surface then a Hoffa fracture can occur during passage of graft through the tunnel or fixation of the graft.[10,17] Our case is unique because,

There were no intra-operative complications such as over-drilling the femoral tunnel, posterior cortex perforation or intra-operative fractures

There were no additional stress risers such as ligament augmentation device, extra-articular tenodesis or femoral post-fixation

A cortical suspensory system was used for graft anchoring on the lateral femoral condyle and not an interference screw

The fracture was a coronal plane 'Hoffa' fracture occurring anterior to and sparing the femoral tunnel

A CT scan done at the time of fracture did not show cystic changes within the tunnel to suggest tunnel lysis

'Hoffa' fractures are fractures of the femoral condyles occurring in the coronal plane. Hoffa fractures are usually caused by high-velocity trauma and it is believed that axial force on a flexed knee joint results in shear stress between the tibial plateau and the femoral condyles that leads to fracture.[23,24] In the index case, the patient gives a history of falling on a flexed knee that led to the fracture. As stated by Brooks et al,[19] drill holes can reduce the bone strength, especially in torsion, to up to 55%. It is possible that in our patient the lateral femoral condyle was weakened not only in the tunnel but also in its surrounding. Though the fall was a low-velocity injury, the shear stress on a supposedly weakened lateral femoral condyle probably resulted in a fracture.

It has been shown that there is 20% decrease in bone mineral density in an ACL reconstructed knee.[25] Another possibility is that the Hoffa fracture is unrelated to the ACL reconstruction as,

The patient had made full recovery from the ACL surgery and was completely asymptomatic before sustaining the fracture.

The fracture did not arise from or involve the ACL femoral tunnel and there were no other stress risers.

CT scan done at the time of fracture did not show evidence of tunnel lysis.

Irrespective of the possible cause of fracture, we feel that the tunnel and hence the graft was spared because the injuring force was completely dissipated anterior to the tunnel leading to the fracture. An MRI done showed the graft fibers to be intact within the tunnel.

Being an intra-articular fracture, Hoffa fractures warrant an anatomic reduction with rigid fixation. This is usually achieved by open reduction of the articular surface and internal fixation with cannulated cancellous screws.[23,26] The index patient too underwent open reduction and internal fixation with two 4mm cannulated cancellous screws. Adequate compression was achieved, and stability was confirmed throughout the range of movement with fluoroscopy imaging. After fixation, the stability of graft was also confirmed by performing physical examination on the table. With early active mobilization and delayed weight-bearing, the patient recovered with the complete union of fracture by 6 months and no signs of instability.

Conclusions

Fracture of the distal femur, though a recognized complication of arthroscopic ACL reconstruction, may happen independent of the femoral tunnel with sparing of the graft.

Such fractures may happen despite taking all intra-operative precautions concerning tunnel drilling, and in the absence of known stress risers.

When Arthroscopic ACL reconstruction is complicated by a fracture in the post-operative period, it is imperative to investigate with advance imaging techniques such as CT scan and MRI to look for the status of the femoral tunnel and the graft respectively.

Hoffa fracture happening in an ACL reconstructed knee need not always be a complication of ACL and may happen as a new event.

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None

Authors' Contribution

All authors pass the four criteria for authorship contribution based on the International Committee of Medical Journal Editors (ICMJE) recommendations.

Conflict of Interests

The authors declared no potential conflict of interests with respect to the research, authorship, and/or publication of this article.

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