Patellar Stress Fracture After Transosseous Extensor Mechanism Repair

Report of 3 Cases

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Extensor mechanism injuries are unusual and require early operative intervention to optimally restore extensor mechanism continuity, strength, and function. Quadriceps tendon ruptures typically occur in patients older than 40 years1 and can be associated with degenerative tendon changes, obesity, systemic illnesses, and trauma.11 Patellar tendon ruptures are usually seen in younger patients as a result of eccentric trauma. In the acute setting, primary repair is usually undertaken. For tears within the quadriceps or patellar tendon substance, direct repair can be performed, with or without augmentation. When the rupture occurs at the junction of the tendon and the patella, transosseous sutures or suture anchors can be used to reapproximate the tendon-bone interface.

Stress fractures of the patella are reportedly rare.1,4,5,7,9,15 They can be seen in association with knee arthroplasty, anterior cruciate ligament (ACL) surgery, and rarely after impact sports. The fracture pattern is usually transverse. Longitudinal stress fractures do not typically disrupt the extensor mechanism and have not, to our knowledge, ever been identified as a postoperative complication of extensor mechanism repair. One instance of a traumatic transverse patellar fracture and extensor mechanism disruption after patellar tendon repair has been described, and a transosseous suture technique was used in that case.16 No instances of patellar fracture after quadriceps tendon repair have been reported. We report 3 cases of longitudinal patellar stress fractures after extensor mechanism repair using a transosseous suture technique, 2 of which occurred after quadriceps tendon repair and 1 of which occurred after patellar tendon repair.

CASE REPORT

Case 1

A 51-year-old obese, nonsmoking, diabetic man sustained an injury to his left knee after a fall and was diagnosed with an acute left quadriceps tendon rupture. He underwent non-augmented primary repair 5 days after injury and was noted to have a complete avulsion of his quadriceps tendon from the proximal pole of the patella. Surgical repair was recommended. Locking No. 5 Tevdek (braided, nonabsorbable) sutures (Teleflex Medical OEM, Kenosha, Wisconsin) were placed in the quadriceps tendon, and a transosseous repair technique was utilized. Three 2.5-mm drill holes were made from the proximal pole of the patella at a 45° angle, exiting out the anterior cortex. During preparation of the third drill hole, the drill bit broke off and could not be retrieved. A new drill hole was created, the sutures were passed, and then they were tied with the knee in 35° of flexion. The extensor retinaculum was closed with No. 2 Tevdek sutures (Teleflex Medical OEM), and a flap was closed over the tendon itself. The leg was immobilized in a locked knee brace postoperatively. A graduated passive motion recovery protocol (0°-30°, 0°-60°, and 0°-90° of motion progressing every 2 weeks postoperatively) was used, and the patient was allowed to bear weight as tolerated with the brace locked in extension. A supervised physical therapy program was instituted at 6 weeks postoperatively, and the patient recovered uneventfully.
The patient subsequently was seen 10 years later at age 61 years for treatment of a quadriceps rupture of the contralateral right leg sustained after a fall on ice at work. He underwent primary repair using 3 suture anchors. Ten months postoperatively, the patient continued to have right quadriceps weakness that persisted despite extensive physical therapy and maintenance of the integrity of his quadriceps repair. Radiographs were obtained, which showed that the right patella remained intact. An incidental, displaced, longitudinally oriented oblique fracture was noted through the left patella, through which the transosseous repair had been performed 10 years previously (Figure 1). The patient was asymptomatic on the left knee and maintained full knee extension. No further intervention was undertaken.

Case 2

A 52-year-old 6-ft 7-inch, 260-lb, diabetic, nonsmoking man slipped while on a cruise and sustained an acute quadriceps tendon rupture. He underwent an open nonaugmented primary repair 8 days after the initial injury. The tendon was noted to be avulsed from the proximal pole of the patella. Running No. 2 FiberWire (braided, nonabsorbable) sutures (Arthrex, Naples, Florida) were placed in the quadriceps tendon stump, and a transosseous repair technique was utilized. Three drill holes (3/32 inches) with a smooth K-wire were made longitudinally in the patella from proximal to distal, and the sutures were passed and tied with the knee in approximately 35° of flexion. The retinaculum was also repaired. His leg was placed in a hinged knee brace locked in extension, and the postoperative protocol used in case 1 was instituted.

At 3 months, he had full range of motion, no extensor lag, and minimal pain. Radiographs at that time demonstrated no evidence of fracture. At 8 months, he noted onset of medial joint line pain with rotational maneuvers. He denied any history of trauma. Examination revealed an effusion, medial joint line tenderness, discomfort with rotational testing, and an intact, nontender extensor mechanism. He denied any anterior knee pain and was able to climb stairs without difficulty. Based on the presumed diagnosis of a medial meniscal tear, a magnetic resonance imaging (MRI) scan was obtained. The MRI confirmed the medial meniscal tear and also demonstrated the presence of a sagittal fracture through the midportion of the patella (Figure 2A). No evidence of the previous drill holes was seen on axial MRI (Figure 2B), and the fracture line was oblique, suggesting that it did not occur along the orientation of previous drilling.

Although the patellar fracture was asymptomatic, it was markedly displaced, and the decision was made to reduce and fix the diastasis. He underwent an arthroscopic partial medial meniscectomy with concurrent arthroscopic-assisted internal fixation of the patellar fracture. The fracture was opened and debrided. The previous drill holes were not visible. Articular surface reduction was obtained arthroscopically, and the fracture was fixed with 4.0 cannulated partially threaded screws (Figure 3). The fracture was presumed to have a low risk of displacement based on the asymptomatic preoperative examination and vertical nature of the fracture line, and the patient was not prescribed a postoperative knee immobilizer. The fracture united uneventfully, and at most recent 2-year follow-up, the patient noted mild anterior knee pain and stiffness but is overall satisfied with his procedure and outcome.

Case 3

A 39-year-old athletically fit, nonsmoking man sustained a soccer-related knee injury. His medical history was unremarkable. He was given a diagnosis of acute patellar...
tendon rupture, which was surgically repaired 12 days after injury. Intraoperatively, complete tendon rupture from the distal pole of the patella was identified. This was repaired using a transosseous repair technique without augmentation. The proximal patellar tendon was mobilized and secured with 2 running No. 2 FiberWire sutures (Arthrex). Three drill holes (3/32 inches) with a smooth K-wire were placed longitudinally in the patella from distal to proximal, and the sutures were passed and tied at the proximal pole of the patella. The retinaculum was repaired using Ethibond sutures (Ethicon, Somerville, New Jersey), the patient was prescribed a hinged knee brace locked in extension, and the postoperative protocol followed in cases 1 and 2 was employed.

Postoperatively, by 3 months, he was painless, had full flexion, had no extensor lag, and was able to perform a straight leg raise. At 6 months, the patient noted a “pop” in his operative knee while performing unweighted single leg squats. On examination, he demonstrated a moderate effusion and mildly decreased flexion. He had no tenderness over the joint line or anterior aspect of the knee and was able to perform a straight leg raise without a lag. His knee was stable on examination, and his patellar mobility was normal. Radiographs were not obtained at that time. His effusion resolved, and he did well until the following year. At that time, the patient returned with a large effusion, mechanical symptoms, as well as anterolateral and posteromedial pain. He denied any specific trauma. He was able to climb stairs without difficulty. Examination revealed mild tenderness over the lateral patella, full range of motion, and intact quadriceps strength. He had mild posteromedial joint line tenderness. Radiographs revealed a displaced fracture of the lateral one fourth of the patella (Figure 4). An MRI scan demonstrated no meniscal injury but demonstrated cystic changes within the patella at the site of the previous transosseous tunnels (Figure 5).

The patient was taken to the operating room for diagnostic arthroscopy and open excision of the symptomatic patellar fracture fragment. The decision to excise the fragment was based on its size. The fracture line was noted to involve the lateral drill hole. The patient’s leg was placed in a locked knee brace postoperatively, and by 1 week, he noted full range of motion and elimination of pain and mechanical symptoms. At most recent 1-year follow-up, the patient had no complaints and had resumed full-contact soccer and strength training.

**Figure 3.** Postoperative radiograph of the left knee from case 2 reveals fracture fixation with 3 transverse cannulated screws. The arrow indicates the location of the fracture.

**Figure 4.** Radiographs from case 3 are shown. (A) Standing anteroposterior view of the bilateral knees reveals displaced sagittal fracture through the right patella. The arrow indicates the location of the fracture. (B) Axial view of the right knee shows involvement of the lateral one fourth of the patella. The arrow indicates cystic changes within the patella.

**Figure 5.** Axial T2-weighted magnetic resonance image of the right knee from case 3 reveals evidence of fracture through the lateral aspect of the patella. The arrow denotes cystic changes within the patella at the site of the previous transosseous tunnels.
DISCUSSION

Extensor mechanism injuries are uncommon. Even though they occur in both athletic and nonathletic patients, they are often managed in the orthopaedic sports practice. Treatment of both quadriceps and patellar tendon ruptures emphasizes early repair of the extensor mechanism with or without augmentation. Midsubstance ruptures may be repaired with sutures directly, while avulsion from the proximal or distal pole of the patella typically requires reattachment of tendon to the patellar surface. This may be accomplished with several methods, including suture anchors or a transosseous suture technique. Results of these methods have typically been good. Konrath et al demonstrated a 92% patient satisfaction rate after quadriceps tendon repair (n = 44) utilizing a transosseous suture technique for ruptures adjacent to the patella. One rerupture was noted. Other series have demonstrated similar results. Patellar tendon repair is similarly successful, including those utilizing a transosseous suture repair technique. Patellar stress fractures have previously been associated with prolonged high-impact activities in young patients. Of these, only a few cases of longitudinal stress fractures have been reported in children and highly active adults. Postsurgical patellar stress fractures have been reported after total knee arthroplasty and after ACL reconstruction with patellar tendon autograft harvest. To our knowledge, they have not been reported after extensor mechanism repair. Singh et al report 1 case of transverse patellar fracture after transosseous patellar tendon repair that appears traumatic. In that case, the patient was immobilized in a cast for 8 weeks and then sustained a twisting injury and fractured his patella 6 weeks after the cast was removed.

These cases of longitudinal patellar stress fracture occurred after extensor mechanism repair using a transosseous suture technique. In all 3 cases, the stress fracture occurred in the absence of identifiable trauma and at least 6 months after the initial surgery. The extensor mechanism remained intact in all cases, corresponding to the vertical nature of the fracture line. Two were asymptomatic incidental findings, and 1 was associated with tenderness and mechanical symptoms. The 2 patients with asymptomatic fractures both had diabetes. Treatment varied depending on the presence of symptoms, associated injuries, and size of the fracture fragment. No evidence of previous bipartite patella was noted in any patient. After treatment, all patients did well, with no complaints.

The senior author’s (B.R.B.) practice represents a 25-year period between 1986 and 2011. During that time, the author has performed over 7000 knee surgeries (no arthroplasties). A review of his computerized surgical database revealed 25 acute primary quadriceps tendon repairs (23 men, 2 women; mean age, 59 years; range, 45-88 years) and 29 primary patellar tendon repairs (27 men, 2 women; mean age, 36 years; range, 21-57 years). Acute traumatic extensor tendon repairs comprised 0.7% of this knee surgical practice. These 3 reported complications demonstrated a 5.5% incidence of minimally or asymptomatic stress fractures in this patient population. A review revealed no postoperative infections, deep venous thrombosis, or reoperations for arthrofibrosis within this patient population.

Contributing factors to patellar fractures after patellar tendon repair have been proposed to include disuse osteopenia from cast immobilization, drill holes exiting the anterior cortex of the patella, and the use of nonabsorbable sutures. We do not believe that disuse osteopenia played a role in the development of stress fractures in this case series. No patients were immobilized in a cast, and all were treated with graduated early motion protocols (0°-30°, 0°-60°, and 0°-90° at 2-week intervals), with 90° of motion obtained by 6 weeks. West et al demonstrated good and excellent results in patients treated with early motion protocols and noted no postoperative complications. Additionally, the fractures were identified greater than 6 months postoperatively, were not associated with identifiable trauma, and the patient retained full extensor mechanism function. This suggests a more chronic origin, as opposed to an acute fracture through osteopenic bone. Additionally, the longitudinal nature of the fracture line may reflect excessive lateralizing forces, as compared with the typical transverse patellar fracture.

Although it has been proposed that drill holes exiting the anterior cortex of the patella may be a risk fracture for postoperative fracture, in only 1 of our 3 cases were these oblique drill holes present. The remaining cases involved longitudinal drill holes through the length of the patella. Additionally, one would suppose that if the oblique drill holes created a stress riser at the point of exit, the fracture pattern would appear more transverse. We did not observe this; all fractures were longitudinal. As a result, our series does not support the idea that oblique drill holes predispose to fracture. Indeed, the increased length of the longitudinal drill holes may actually create a greater stress riser. To our knowledge, however, no biomechanical studies exist comparing the orientation of drill holes in transosseous extensor mechanism repair. Additionally, the use of nonabsorbable sutures has been proposed to prevent bony ingrowth into the drill holes and may leave a potential area of weakness. In all our cases, nonabsorbable sutures were utilized. In 2 cases, including 1 case with MRI, there was no evidence of the persistence of drill holes in the patella. Although the drill holes may still have caused a stress riser through which fracture occurred, the drill holes did appear to fill in on latest imaging studies. However, in 1 case, significant cystic changes were identified in the patella on MRI, and intraoperatively, the fracture line was noted to extend through the lateral drill hole. In this case, the transosseous tunnel clearly created a stress riser through which fracture occurred. However, the cystic changes in the patella suggest further bone osteolysis and subsequent weakening. The cause of these changes is unknown. We suspect that this osteolysis could represent either a foreign body reaction to the FiberWire suture (Arthrex) or possible trauma to the bone from repetitive micromotion of the suture within the tunnel. This micromotion may result from the distance between the fixation point of the suture on the superior pole of the patella and the attachment of the patellar tendon on the inferior pole. Indeed, biomechanical
studies comparing suture anchor to transosseous repair of patellar tendon ruptures note increased gap formation in those ruptures repaired with transosseous sutures.2

We would be hesitant to switch to absorbable sutures for transosseous extensor mechanism repair given the early motion protocol undertaken. Previous studies of early motion after extensor mechanism repair have shown good results using nonabsorbable sutures as well as augmentation techniques including additional suture or wire cerclage.3,19 We did not use an augmentation method in these 3 cases, although careful retinacular repair was performed. It may be argued that the lack of augmentation would likely place more stress through the transosseous repair construct, but early results in these patients were excellent. No reruptures were noted, and no extensor lag or dysfunction was noted. However, it is unknown whether use of absorbable sutures with an early motion protocol would predispose to early failure or whether they would change the incidence of patellar stress fractures.

In 2 of these cases, a smooth 3/32-inch K-wire was used to drill the longitudinal tunnels; in the first case, a 2.5-mm drill was used. The first case illustrates the importance of not using a drill bit as a subtle change in the angle of the drill bit orientation may cause drill bit breakage. This case previously served as a case report to emphasize avoiding a drill bit in favor of a smooth Kirschner pin.6 After representation 10 years after the initial surgery, the patellar fracture was noted. It was not present at the time of the initial case report. Use of a small drill bit may still be needed in some cases for very dense patellar bone, and in these cases, an appropriate soft tissue protector can help support stress on the drill bit.

As most patients are generally progressing well by 6 months postoperatively, we suspect that most surgeons do not routinely obtain radiographs beyond 6 months postoperatively. The cases in this series may therefore represent the “tip of the iceberg” and these fractures may be more common than reported. We have modified our surgical technique to use a much smaller K-wire to drill the longitudinal holes. The use of the suture-passing wire from the Bio-Tenodesis system (Arthrex) has made passage of the sutures with smaller drill holes easier than the use of a Hewson suture passer (Smith & Nephew Endoscopy, Andover, Massachusetts). The use of an ACL guide can also be considered to ensure accurate drill hole placement. Although shorter drill holes may also decrease the risk of longitudinal stress fractures, holes that exit the anterior cortex may weaken resistance to transverse stress. Further biomechanical studies about the orientation of transosseous repair holes are needed. Finally, some surgeons have resorted to the use of suture anchors as an alternative to longitudinal drill holes.3 However, increased cost and the possibility of local foreign body reaction remain concerns with this repair method.

The development of a longitudinal patellar stress fracture after transosseous extensor mechanism repair should now be considered a recognized complication of the technique. The clinical prevalence or relevance of this condition is unknown, given that it may be an incidental asymptomatic finding. Treatment varies depending on clinical scenario. The mechanism remains undefined but may involve the longitudinal drill holes used in repair. Further study is needed to better understand why this complication occurs.

REFERENCES