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CASE REPORT

Proximal Tibia Fracture After Anterior Cruciate Ligament Reconstruction Using Bone-Patellar Tendon-Bone Autograft: A Case Report

James E. Voos, MD · Mark C. Drakos, MD · Dean G. Lorich, MD · Stephen Fealy, MD

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Abstract The optimal operative management of anterior cruciate ligament (ACL) injury continues to be debated. Many complications can occur, but fracture is often not routinely discussed. We present a complex intra-articular tibia fracture in a patient who had an autologous, ipsilateral bone-patellar-bone ACL reconstruction. While still advocating early, aggressive physical therapy, this case reminds us of the inherent susceptibility to injury in the immediate post-operative period.

Key words ACL · tibia fracture · bone-patellar tendon-bone

Introduction

Bone-patellar tendon-bone (BTB) and hamstring autografts for the treatment of anterior cruciate ligament (ACL) reconstruction are performed with predictable, successful outcomes [1–3]. Complications including arthrofibrosis, loss of fixation, fracture, and infection have all been mentioned in the literature. Fracture of the tibial tunnel resulting in a tibial plateau after ACL reconstruction is an uncommon complication that has been reported [4–11]. There are several cases published of tibia fractures after undergoing BTB autograft ACL reconstruction, and only one prior article has discussed the use of locked plate technology for fixation. Recently, fracture through the tibial tunnel of a four strand gracilis-semitendinosus autograft has also been reported [9]. Other sites of fracture of ACL reconstruction include the femoral tunnel and patella.

It has been proposed that the tibial tunnel and tibial harvest site for the graft act synergistically as stress risers to reduce proximal tibia bone strength [6, 7, 10]. Use of bioabsorbable screws have recently been implicated in the weakening of the proximal tibia as well [12]. We report the case of a 47-year-old woman who suffered a proximal metaphyseal tibia fracture with extension to the articular surface of the left knee 9 weeks after undergoing arthroscopic reconstruction of the ACL with bone patellar-tendon bone autograft requiring open reduction and internal fixation using a locked plate.

Case report

A 43-year-old female physical therapist initially presented with left knee pain 4 weeks after sustaining a twisting injury while roller blading. Past medical and surgical history was significant for multiple blood clots, a right open menisectomy 20 years prior, and a right ACL reconstruction with a BTB autograft 4 years before presentation. Physical exam revealed a 2B Lachman, 2+ pivot shift test, and 2+ anterior drawer. Magnetic resonance imaging scan disclosed a complete disruption of her ACL as well as a medial collateral ligament grade II sprain and a medial meniscus tear. Given the nature of the injury and patient's high level of athletic activity she was indicated for surgery.

The patient underwent arthroscopic ACL reconstruction with the use of BTB autograft as well as debridment of an undersurface medial meniscus tear in zones A–B. The autograft had two 23-mm bone blocks 9.5 mm in width. The patella graft was 9 mm in width. Ten-millimeter femoral and tibial tunnels were drilled over a guide wire. Interference screws of 7×20 and 9×20 mm were used for graft fixation. Intraoperative exam confirmed graft stability, and radiographs confirmed correct graft placement.

J. E. Voos, MD (✉) · M. C. Drakos, MD · S. Fealy, MD
Department of Sports Medicine,
The Hospital for Special Surgery,
535 East 71st Street, New York, NY 10021, USA
e-mail: voosj@hss.edu

D. G. Lorich, MD
Orthopedic Trauma Service,
The Hospital for Special Surgery, New York, NY, USA

Fig. 1. AP radiograph of a metaphyseal fracture of the proximal tibia after ACL reconstruction

The patient underwent an aggressive postoperative rehabilitation course that was initially uneventful. At 6 weeks post-op, the patient had 130° of knee flexion, no extension lag, 4+/5 quadriceps strength and minimal quad atrophy. The patient was advised at this time to start light running and agility training under the supervision of a therapist. Nine weeks post ACL reconstruction, the patient presented to the emergency department with severe left knee pain and an effusion. This developed acutely after a fall while jogging on a treadmill. Distal neurovascular exam was intact. Radiographs and computed tomography (CT) revealed oblique metaphyseal tibia fracture with extension from the tibial donor site into the articular surface (Fig. 1). The proximal extension of the fracture did not violate the tibial tunnel on CT scan (Figs. 2 and 3). The patient subsequently underwent open reduction internal fixation of the left tibial plateau using an eight-hole proximal tibia peri-articular locking plate (Synthes Paoli, PA, USA; Figs. 4 and 5). Intraoperative visualization of the fracture site confirmed radiographic findings. The proximal extension of this fracture exited approximately 1 cm lateral to the tibial tunnel. The graft remained intact, and the interference screws appeared well fixed. An intraoperative Lachman test was negative. On postoperative day 0, the patient was started on a continuous passive motion machine for gentle range of motion. A hinged knee brace was worn at all times, and physical therapy begun, toe touch weight bearing for 6 weeks, with the use of crutches. By eight weeks, the patient was bearing full weight. At 12 months time follow-up, the patient had a stable, intact ACL and regained full knee range of motion.

Discussion

BTB graft has been the gold standard for the treatment of the reconstruction of the ACL-deficient knee. Fractures of the tibial tubercle, patella, tibial tunnel, tunnel widening, femoral tunnel, and tibial tendon avulsion have all been reported [4–11, 13–15]. Four-strand gracilis-semitendinosus autograft has also been shown to result in excellent outcomes [1–3]. The likelihood of tibia fracture in hamstring autografts is theoretically lower because of the lack of bony disturbance during harvest, although Sundaram et al. [9] recently reported one isolated case. The synergistic effect of the tibial tunnel and tibial graft harvest as stress risers in ACL reconstruction has been well described [12, 16]. Fauno and Kaalund [17] concluded that the position of the fixation sites and type of fixation device are major

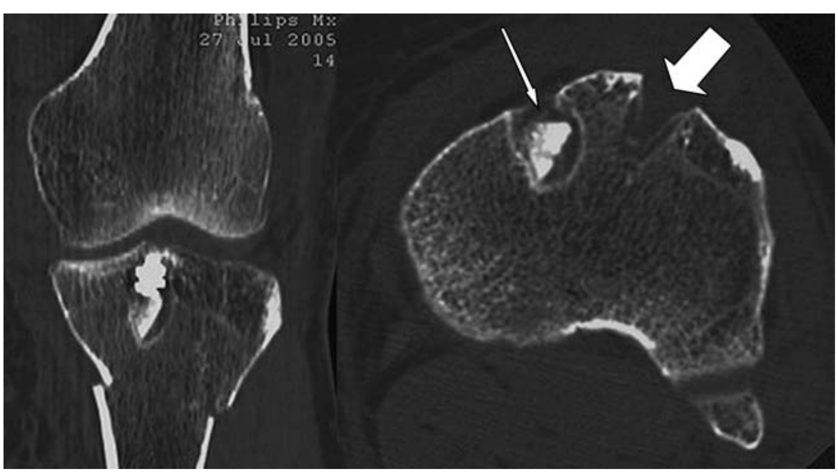

Fig. 2. Coronal and axial CT images of the proximal tibia. Notice on the axial image that the fracture through the donor site (*thick arrow*) does not violate the tibial tunnel (*thin arrow*)

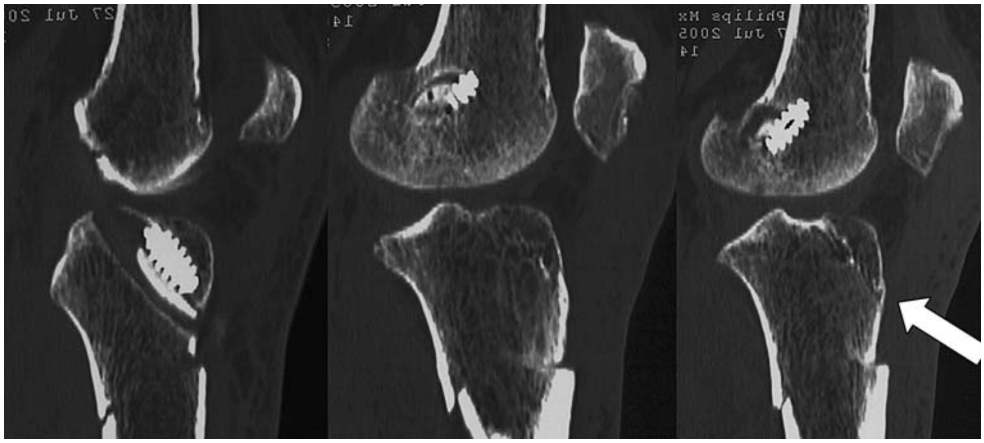

Fig. 3. Sequential CT scans showing sagittal images of tibial bone tunnel, uninvolved tibia, and proximal extension of fracture through the donor site (*arrow*)

Fig. 4. AP radiograph after open reduction and internal fixation of tibia fracture

factors in the development of tunnel widening after ACL surgery. Ito et al. [13] suggest that it is more significant to analyze the area of sclerotic change around the bone tunnel than bone-tunnel enlargement for clinical evaluation. They

Fig. 5. Lateral radiograph after open reduction and internal fixation tibial fracture

also recommend that CT, with which it is possible to analyze the sclerotic area, be used to evaluate bone-tunnel changes and clinical results. Additionally, our patient was over the age of 40 where the presence of osteoporosis may contribute to decreased bone mineral density and the propensity to fracture. Evaluation of bone mineral density before surgery may have altered the choice of graft selected; although, we do not routinely obtain dual energy x-ray absorptiometry scans in this population.

Compliance with rehabilitation protocols is paramount for satisfactory outcomes of ACL reconstruction. Recently, in a study of 65 patients undergoing four-stranded hamstring allograft ACL reconstruction with two different rehabilitation protocols, Yu et al. [15] concluded that more aggressive rehabilitation after ACL reconstruction is one of the reasons for tunnel widening, although there were no differences in clinical outcomes between the two groups. No study has reported the effect of rehabilitation on tunnel widening and potential increase in stress riser effect in BTB grafts. At our institution, running is initiated in supervised rehabilitation between weeks 6 to 14 when adequate quadriceps strength is achieved and the patient is cleared by the surgeon [18]. Because of the motivation and occupation of the patient in this report, she was advanced to running at an early stage. Surgeon, physical therapist, and patient should be cautious in advancing activity after ACL reconstruction to avoid complications.

Graft selection between allograft and autograft is included in the discussion of treatment options in older patients undergoing ACL reconstruction. Heier et al. [19] and Plancher et al. [20] have both published the successful use of BTB autograft in patients over the age of 40. Recent studies have also reported the effective use of hamstring autograft in older patients [21]. Allografts have been considered an option in adult ACL reconstructions because of decreased donor site morbidity, preservation of extensor/flexor mechanisms, decreased operative time, and low incidence of arthrofibrosis [22]. This advantage is offset by the low risk of infection and graft cost. Ultimately, it is the cooperative decision between the surgeon and the patient to select the most ideal graft option in each individual case. This particular patient was adamantly opposed to allograft tissue; therefore, BTB autograft was chosen.

Of the seven total cases in the literature, all fractures occurred between 6 weeks and 4 years postoperatively. In three prior case reports, open reduction and internal fixation of the fracture were employed. Mithofer et al. [6] reported the use of a Less Invasive Stabilization System (Synthes, Paoli, USA) for treatment of a bicondylar fracture resembling a Schatzker type VI tibial plateau fracture. Delcogliano et al. [4] and el-Hage et al. [5] used a plate and screws for fixation of displaced tibial plateau fractures. All three fractures occurred at 7 months postoperatively, whereas our patient suffered the injury at 2 months. Use of locked plate technology with minimal soft tissue dissection appears to be an affective treatment for these fractures and allows for graft protection, early range of motion, and return to activity. Four other reported cases were treated with the use of a cast or brace because of minimal fracture displacement.

Fracture of the tibia after ACL reconstruction is a relatively rare event. However, this case emphasizes that particular care must be taken in the first several months after surgery. Historically, this has been because of the inherent weakness of the donor and bone tunnel sites. This case presents a metaphyseal fracture pattern that extends proximally because of the tibial bone donor site. Bone patella bone autografts theoretically weaken the proximal tibia bone more so than allograft or hamstring tendon autograft. This is supported by the number of fractures reported after BTB autograft compared with fractures with other graft choices. Fortunately, in our case, the graft itself was unaffected, circumventing the need for ACL revision surgery.

Patients and surgeons should be aware of this potential complication when discussing graft options. Furthermore, although reported previously we affirm that fixation with the use of locked plates for displaced fractures is an appropriate surgical intervention, may successfully protect the reconstructed graft, prevent the need for revision graft reconstruction, and potentially aid in a quicker return to activity.

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