Current Arthroscopic Concepts in Repairing Posterior Cruciate Ligament Tibial-Sided Avulsions

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Abstract: Posterior cruciate ligament (PCL) injuries are extremely rare and most commonly occur in the trauma setting. They can lead to instability, pain, diminished function, and eventual arthrosis. Several techniques of arthroscopic PCL repair for tibial-sided bony avulsions have been described in the literature; however, no single technique has emerged as the gold standard to predictably restore posterior knee stability, PCL function, and knee biomechanics. The authors believe that the best results will come from procedures that re-create the normal human anatomy and knee kinematics. In this article, 3 arthroscopic methods of PCL avulsion repairs performed at 2 academic institutions are analyzed. The techniques described here provide good options for the treatment of these injuries. [Orthopedics. 2015; 38(9):563-569.]

The basic understanding, management, and surgical treatment of posterior cruciate ligament (PCL) injuries has classically lagged behind that of injuries to the anterior cruciate ligament (ACL). This can be attributed to the much lower incidence of PCL injuries in sports and everyday life. Posterior cruciate ligament injuries account for an estimated 3% to 16% of all knee injuries today. The incidence is as low as 3% in the outpatient setting and as high as 37% in the trauma setting. In a retrospective cohort of 494 patients with PCL insufficiency, Schulz et al found traffic accidents (45%) and athletics (40%) to be the most common causes of injury. Additionally, this cohort showed that skiing and soccer were the sports with the highest incidences of PCL injuries.

In recent years, better diagnosis and evaluation of PCL injuries has spurred research into finding the optimal method for repairing and reconstructing this ligament, but the treatment of PCL injuries currently remains a controversial topic in orthopedic surgery. However, recent biomechanical and clinical data have highlighted the importance of the PCL in knee stability and function. Injury to the PCL, which acts as the primary restraint to posterior tibial translation, may lead to instability, pain, diminished function, and eventual arthrosis.

Several techniques of arthroscopic PCL repair have been developed; however, no single operation has emerged as the gold standard to predictably restore posterior knee stability, PCL function, and ultimately anatomic knee biomechanics, and alignment. The authors believe that, as with other procedures in orthopedic surgery, the best results stem from procedures that re-create normal human anatomy. In this article, some arthroscopic techniques for the repair of tibial-sided bony avulsions of the PCL are reviewed. The authors discuss 3 case examples, from 2 institutions, of PCL tibial-sided bony avulsions from diagnosis to management.

Posterior Cruciate Ligament Anatomy and Kinematics

The PCL originates at the posterolateral aspect of the medial femoral condyle, insert-
ing extrasynovially in a central sulcus located 1 cm distal to the posterior edge of the tibial plateau. The ligament itself consists of a large anterolateral and smaller posteromedial portion each with a distinct and consistent footprint, in addition to the meniscofemoral ligaments, which can be variable. These portions are named for their attachments on the posterior edge of the tibial plateau. The meniscofemoral ligaments originate from the lateral meniscus and insert anterior and posterior to the PCL on the medial femoral condyle. These ligaments (ie, Humphrey and Wrisberg) commonly remain intact following PCL rupture and provide some accessory posterior stability to the knee. The posteromedial portion or bundle of the PCL consists of shorter fibers and is taut in extension. The anterolateral bundle is thicker in diameter, and is taut with flexion of the knee. The anterolateral portion of the PCL provides the greatest tensile strength and resists posterior tibial translation beginning at 30° of flexion.

**Arthroscopic Posterior Cruciate Ligament Repair Techniques**

The authors’ case series consisted of 3 patients, from 2 academic institutions, who sustained isolated tibial-sided PCL avulsion fractures. All cases involved traumatic mechanisms of injury. The preoperative management of these injuries was similar, consisting of evaluation of the knee with physical examination, radiographs, and magnetic resonance imaging (MRI). In all 3 cases, the physical examination and the diagnostic imaging (radiographs and MRI) were consistent with a tibial-sided PCL avulsion fracture and the patients were deemed to be appropriate candidates for arthroscopic repair.

**Case Reports**

**Patient 1**

A 17-year-old girl was involved in an all-terrain vehicle accident where her flexed knee hit the handlebar. After a standard preoperative work-up (Figures 1-2), diagnostic arthroscopy was performed using standard high and tight anterolateral and tight anteromedial portals, followed by a reverse notchplasty using an arthroscopic shaver and electrocautery. The purpose of this notchplasty was to create a tunnel to the back of the knee through the notch just below the PCL to adequately visualize the fracture site (Figure 3A).

Once the posterior aspect of the knee joint was visualized, the 30° arthroscope was exchanged for a 70° arthroscope (modified Gillquist view) and a posteromedial portal was established under direct visualization with the arthroscope and the aid of a spinal needle. An 11-mm plastic cannula was then inserted through the posteromedial portal. A combination of electrocautery and arthroscopic shaver were used to clean off the soft tissue surrounding the bony fragment to better identify the fracture. Special attention was given to this step to best visualize the PCL footprint and the medial and lateral borders of the bony avulsion. The 70° scope was then placed into the posteromedial portal and a rasp was used to debride the bony avulsion and fracture site. A tibial-sided ACL guide was placed through the anteromedial portal to reduce the fracture down to its anatomic position.

With the fracture reduced, a longitudinal incision was made over the proximal tibia just medial to the tibial tubercle. This was used to place a guidewire through the tibia into the fracture. The first guidewire was placed into the posterior aspect of the fracture and was used to preserve the reduction. A second guidewire was then placed just 2 mm anterior to the first using a parallel guide. Once this second drill hole was made, the

![Figure 1: Preoperative anteroposterior (A) and lateral (B) radiographs showing the posterior cruciate ligament avulsion fracture of Patient 1.](image1)

![Figure 2: Preoperative axial (A, B), sagittal (C), and coronal (D) magnetic resonance imaging sequences showing the posterior cruciate ligament tibial-sided avulsion fracture of Patient 1.](image2)
second guidewire was removed and a Hewson suture passer (Smith & Nephew, Andover, Massachusetts), was introduced through this tibial tunnel with the passing nonabsorbable suture. The passing suture was visualized in the posterior aspect of the knee joint and brought out through the posteromedial portal. The suture passer was then removed and an Endobutton (Smith & Nephew) was brought to the surgical field. The suture strands of the Endobutton were passed through the posteromedial portal using the suture passer and down through the tibial tunnel. The Endobutton was then pulled into the back of the knee joint and on top of the avulsed tibial bony fragment (Figures 3B-C). Fracture reduction was held with the Endobutton, the original guidewire was removed, and then the 4 strands of suture were tied over a 14-mm fixation button (Figure 3D) at the anteromedial aspect of the proximal tibia.

Good reduction of the PCL tibial attachment and bony fragment was visualized arthroscopically and the patient was placed in a knee immobilizer locked at 30° of flexion postoperatively. She was made non-weight bearing with appropriate postoperative follow-up (Figure 4).

Patient 2
A 13-year-old boy was involved in a dirt bike accident where he landed on his flexed knee and plantarflexed foot. The preoperative management was similar to that of Patient 1, involving a thorough physical examination, appropriate radiographs (Figure 5), computed tomography (CT) scans (Figure 6), and MRI (Figure 7). The diagnosis of a tibial-sided PCL avulsion fracture was made and the patient was
deemed to be a good surgical candidate.

Regarding operative treatment, the arthroscopic repair was similarly performed using the same standard anterolateral and anteromedial portals as previously described. Following a reverse notchplasty (Figure 8A), adequate visualization and space for working in the posterior aspect of the knee joint was acquired.

The modified Gillquist view was achieved by exchanging the 30° scope for a 70° scope. Two portals—a very high posteromedial portal for visualization (Figures 8B-D) and a lower portal for instrumentation and suture passage—were then created in the posteromedial aspect of the knee joint under direct visualization with the arthroscope and the aid of a spinal needle. Appropriately sized cannulas were then inserted through these portals respectively. Again, the arthroscopic shaver and electrocautery were used to adequately visualize the PCL bony fragment and also allow for mobilization (Figures 8B-C).

A Suture Pass system (Smith & Nephew) was used to pass 4 looped nonabsorbable sutures around the PCL tissue and the bony fragment (Figure 8E). These were individually brought out of the working portal at the posteromedial aspect of the knee. The PCL guide was inserted through the anteromedial portal and placed at the fracture bed on the posterior aspect of the tibia. Two pins were then drilled through the proximal tibia into the appropriate position in the fracture bed. These were over-drilled using a 4.5-mm Endobutton drill bit (Smith & Nephew). A suture passer was then placed up through the tibial tunnels, and the sutures on the medial and lateral aspects of the fracture bed were passed through the respective 4.5-mm drill holes.

An anterior drawer maneuver was performed and the knee was held at approximately 90° of flexion. A pituitary rongeur was used through the posteromedial working portal to grab the bony fragment and reduce it down into the fracture bed on the proximal aspect of the posterior tibia. The sutures were then tied down over the bony fragment and knots were made through the incision at the anteromedial aspect of the knee. An anterior drawer maneuver was performed with the knee flexed at 90° to ensure that the PCL was under appropriate tension.
Reduction of the bony avulsed fragment at the anatomic PCL insertion site was visualized arthroscopically (Figure 8F). As in the first case, the patient was placed into a hinged knee brace locked at 30° of flexion postoperatively and made non-weight bearing.

**Patient 3**

A 19-year-old man was involved in an all-terrain vehicle accident and sustained a knee injury. Similar to the 2 previous patients, preoperative management consisted of a thorough physical examination, appropriate radiographs (Figure 9), CT scans (Figure 10), and MRI (Figure 11). The patient was diagnosed with a tibial-sided PCL avulsion fracture and the decision was made to proceed with arthroscopically assisted PCL avulsion repair.

Diagnostic arthroscopy was initiated using standard inferolateral and inferomedial portals. A pseudolaxity of the ACL was visualized in the notch. The cartilage in all compartments as well as both menisci appeared intact and stable.

Next, the modified Gillquist view was used to enter the posterolateral aspect of the knee. A posterolateral portal was started with the aid of a spinal needle and a PassPort cannula (Arthrex, Naples, Florida) was placed; a posteromedial portal was also started using a similar technique. The arthroscope was inserted through the posterolateral portal to identify the PCL tibial-sided avulsion injury (Figure 12A). A Freer elevator (Sklar, West Chester, Pennsylvania) and shaver were used to mobilize the fracture fragments (Figures 12B-C). It appeared that the PCL footprint was attached to the fracture fragment, and that there was a good bony bleeding bed at the fracture site. An accessory posterolateral portal was also established superior to the earlier posterolateral portal.

For the PCL avulsion repair, the EXPRESSEW (Arthrex) and rigid suture passers were used to pass strong non-absorbable sutures through the PCL in a figure-of-8 method (Figures 12D-E). Two of the suture limbs were brought out through the posterolateral portal and 2 were brought out through the posteromedial portal.

A small incision was then made over the anteromedial aspect of the proximal tibia to allow for use of the PCL tibial tunnel guide. The guide was used to drive a guidewire into the lateral aspect of the fracture bed from the anterior tibia, and a Hewson suture passer was used through this tunnel to pass the 2 lateral suture limbs to the anterior aspect of the knee. This process was repeated with a second tunnel located more medially in the fracture bed, and the medial sutures were passed to the anterior aspect of the knee with the Hewson suture passer. Sutures were then tied over the bony bridge anteriorly with the aid of a maximal anterior drawer maneuver on the knee.

Reduction of the fracture was visualized arthroscopically and the knee was stable to posterior drawer testing. Postoperatively, the knee was placed...
in a hinged knee brace locked in full extension and appropriate follow-up was performed (Figure 13).

**Discussion**

All of the procedures described in this article exemplify unique options for the arthroscopic repair of tibial-sided PCL avulsions involving suspensory fixation as well as suture fixation. Many open procedures have also been discussed for the treatment of these injuries using limited posteromedial incisions as well as extensile curvilinear posterior incisions. However, far fewer all-inside arthroscopic procedures have been described.

An arthroscopic fixation device such as the Endobutton can be useful for the arthroscopic treatment of these injuries. Because it is small, the Endobutton is easy to handle and useful for working in a small space such as the posterior aspect of the knee joint, which is necessary in PCL repairs. In their case series, Wajsfsz et al described an arthroscopic repair of an isolated PCL avulsion fracture using an Endobutton device without bone tunnels. They concluded that the Endobutton offered sufficient compression, restored the anatomic length of the PCL, and could be used to fix avulsion fragments of any size.

Also, screws and sutures can aid in the arthroscopic fixation of PCL avulsions. Shino et al described bony union at 4 months postoperatively with both a single cannulated screw as well as sutures and a pullout button. These procedures were both done arthroscopically. Several authors have also noted good results with arthroscopic suture fixation for PCL tibial-sided bony avulsion injuries. Kim et al used a high posteromedial portal and a posterolateral portal in addition to the standard parapatellar anteromedial portal to achieve suture fixation of the PCL avulsion fracture through 2 bony tunnels. They found rigid fixation using this technique. In addition, Gui et al arthroscopically treated 28 patients with PCL avulsion fractures using 2 posteromedial portals. They concluded that a single-tibial tunnel technique using suture fixation was a reproducible and effective method for treating these injuries. Furthermore, Zhao et al used suture fixation and Y-shaped tibial bone tunnels in the arthroscopic treatment of these injuries. Their case series showed that the fixation technique was able to restore the stability and function of the joint in most patients.

There are few studies comparing open fixation with arthroscopic fixation for tibial-sided PCL avulsion injuries. Sasaki et al compared an arthroscopic suture technique with an open posterior screw fixation by use of mechanical testing. Findings showed no differences between the groups in terms of tibial posterior displacement and stiffness. Thus, they concluded that the arthroscopic suture technique was as reliable as open screw fixation for the treatment of these injuries. However, an arthroscopic technique can potentially minimize some complications that can occur with
open techniques, such as bleeding, scarring, and infection.

**CONCLUSION**

The techniques described in this article provide good arthroscopic options for the treatment of PCL tibial-sided bony avulsion injuries. All of the cases involved unique techniques that allowed for good visualization of the fracture site with the aid of the posterior portals while working in a small space. Also, the fixation used in each case provided excellent reduction and alignment of the bony avulsion fracture.

The optimal treatment of PCL tibial-sided bony avulsion injuries remains unclear. Studies with more subjects and long-term follow-up will help to better define the indications for the different treatment options. Further research regarding arthroscopic techniques, as well as comparisons of arthroscopic and open techniques, is needed to direct future PCL repair options. Randomized and prospectively designed studies with controlled variables and clear outcomes that will allow orthopedic physicians to draw definitive conclusions are needed; however, small sample size due to low incidence is likely one of the biggest difficulties in PCL study design and research. Multicenter trials can possibly overcome this and be used to achieve the necessary power to direct future treatment recommendations. Future studies should focus on providing adequate data and information to define the best treatment options for these injuries.

**REFERENCES**