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Technical Note

Arthroscopic Primary Bundle-Specific Posterior Cruciate Ligament Repair with Transosseous Fixation

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Abstract: Posterior cruciate ligament (PCL) injuries are most commonly associated with multiligamentous knee injuries. Isolated rupture can be treated nonoperatively with bracing, but with concomitant surgical injuries or high-grade instability, operative intervention may be warranted. While historically PCL injuries were surgically managed with open primary repair, contemporary surgical options include arthroscopic primary repair and reconstruction. Appropriate patient selection is critical in avoiding residual laxity following primary repair, and innovations in advanced imaging and arthroscopic technology now allow for identification of suitable patients. In this technical vote, we describe a method for anatomic bundle-specific primary PCL repair with transosseous fixation. The appropriate patient for this procedure has a femoral-sided avulsion of 1 or both PCL bundles, presents with an acute or subacute injury, and has adequate tissue quality for bundle reapproximation to the footprint. This allows for minimally invasive, anatomic restoration of tension for each bundle.

Posterior cruciate ligament (PCL) injuries commonly occur in the setting of multiligamentous knee injuries, with a reported incidence of 1% to 44% of acute knee injuries.[1,2] While PCL injuries managed nonoperatively with bracing can have satisfactory outcomes if residual laxity is minimized,[3-6] surgical management is typically indicated for grade III instability or multiligamentous injuries.

Historically, primary PCL repair was performed open.[7,8] Innovations in arthroscopic technology have expanded the minimally invasive treatment options, with techniques for reconstruction, internal fixation, and primary repair. Most PCL injuries are intrasubstance tears, and when operatively managed, are better suited for reconstruction.[9] Internal fixation may be performed in the setting of bony avulsion injuries using screws or sutures.[10] Primary repair can be considered when there is sufficient tissue quality, such as in avulsion injuries off the femoral footprint.[11]

Here we present the surgical management of femoral-sided PCL avulsion in a patient with a concomitant medial meniscus posterior root tear and high-grade medial collateral ligament injury. We describe a technique of arthroscopic bundle-specific primary PCL repair with transosseous fixation.

Indications

This described technique of primary PCL repair with transosseous fixation can be used for isolated PCL injury or in conjunction with repair of other ligamentous structures and can achieve anatomic single-bundle or double-bundle repair. In general, operative intervention for PCL injuries are reserved for grade III injuries (indicating concomitant ligamentous injury) or grade II injuries with additional intra-articular or ligamentous injury necessitating surgery.

Imaging

Preoperative magnetic resonance imaging (MRI) of the affected knee should be obtained to evaluate the patient for eligibility for treatment with this method. In addition to identifying other intra-articular pathologies, which may require operative intervention, MRI is helpful to clarify the pattern of injury to the PCL. In the appropriate patient for this procedure, the MRI

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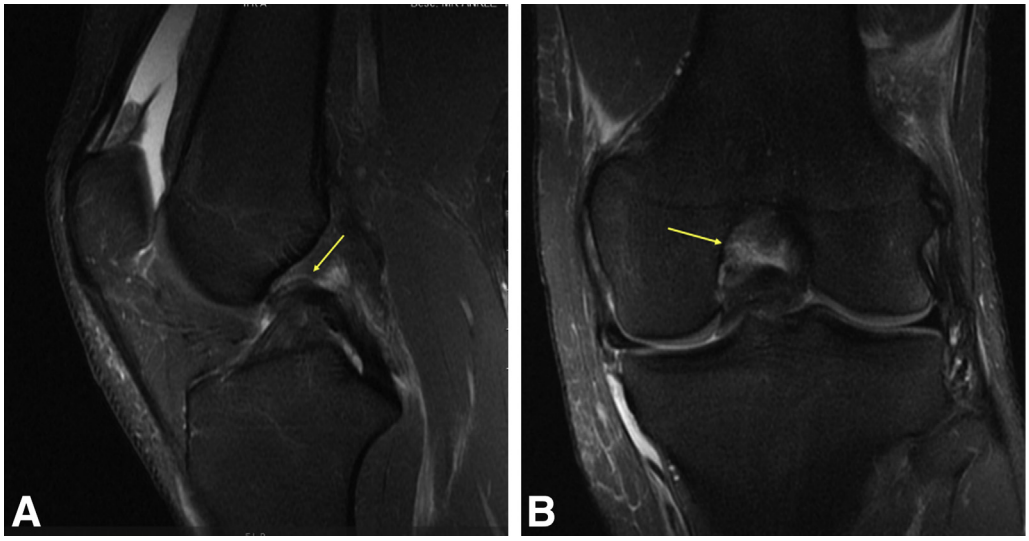

Fig 1. (A) Sagittal T2-weighted magnetic resonance imaging (MRI) of the left knee. The MRI demonstrates proximal avulsion of the anterolateral bundle of the posterior cruciate ligament (PCL). The yellow arrow indicates the avulsed PCL fibers. (B) Coronal T2-weighted MRI of the left knee. There is proximal avulsion of the anterolateral bundle of the PCL with edema at the medial intercondylar notch, indicated by the yellow arrow.

demonstrates femoral-sided PCL avulsion (Fig 1) and may include 1 or both bundles. While nonoperative management of an isolated PCL injury may be considered, associated meniscal or ligamentous pathology could indicate operative intervention.

Surgical Technique

The patient undergoes preoperative regional blockade and general anesthesia. The patient is positioned supine with lateral thigh positioner and a heel foam roll.

Diagnostic arthroscopy is performed using standard anterolateral and anteromedial portals. Following inspection of all compartments, the avulsed PCL bundle is examined. The distal remnant ligament tissue is probed, and a grasper is used to reapproximate the anterolateral PCL bundle to its footprint high on the medial notch, to ensure sufficient length for primary repair. This maneuver also establishes the target bone tunnel position for either the anterolateral or posteromedial bundle.

Figure 2 A and B illustrates avulsion of the anterolateral bundle from the medial intercondylar notch. With the anterolateral bundle retracted, the posteromedial bundle can be visualized and is found to be intact with appropriate tension (Fig 2C).

An outside-in tip-aiming guide is introduced through the anteromedial portal, and the ring target is placed at the femoral footprint of the anterolateral bundle (Fig 3A). A 10-mm incision is made on the medial distal femur, corresponding to the external drill guide and ensuring the anterior to posterior position is extra-articular with sufficient bone posteriorly. A 2.7-mm guide pin is advanced through the guide from outside into the footprint (Fig 3B) followed by a 4.5-mm cannulated reamer to dilate the tunnel.

A self-capturing suture passer (Knee Scorpion, Arthrex, Naples, FL) is introduced through the anteromedial portal, and a nonabsorbable size 0 suture (FiberWire, Arthrex) is passed in a running, locking configuration through the PCL bundle (Fig 4). The suture is passed through the ligament stump, reloaded outside the skin, and then passed through the loop created in a Krackow-type fashion.

The sutures passing through the stump are shuttled through the femoral bone tunnel using a MicroSuture Lasso (Arthrex) and delivered through a 4.0 × 12 mm titanium suspensory fixation button (EndoButton, Smith & Nephew, Andover, MA). The sutures are tensioned medially while visualizing the PCL bundle arthroscopically and applying an anterior drawer force at 90° of flexion (Figs 5A and 5B). The bundle reduces anatomically to the footprint, and the sutures are tied over the button (Fig 6). Careful retraction of surrounding soft tissues minimizes tissue interposition under the button.

Following fixation, the bundle is arthroscopically examined and found to be anatomically reduced. The posterior drawer has been normalized to grade 0. If fixation of the posteromedial bundle is necessary, the same process can be used with drilling to the femoral anatomic footprint of the bundle. We suggest fixation of the posteromedial bundle first for ease of visualization.

Rehabilitation

Postoperatively, the patient is placed in a hinged knee brace locked in extension with a pad behind the calf to avoid posterior translation of the tibia. For multiligamentous injuries, the patient is kept non−weight bearing for 6 to 8 weeks followed by a period of

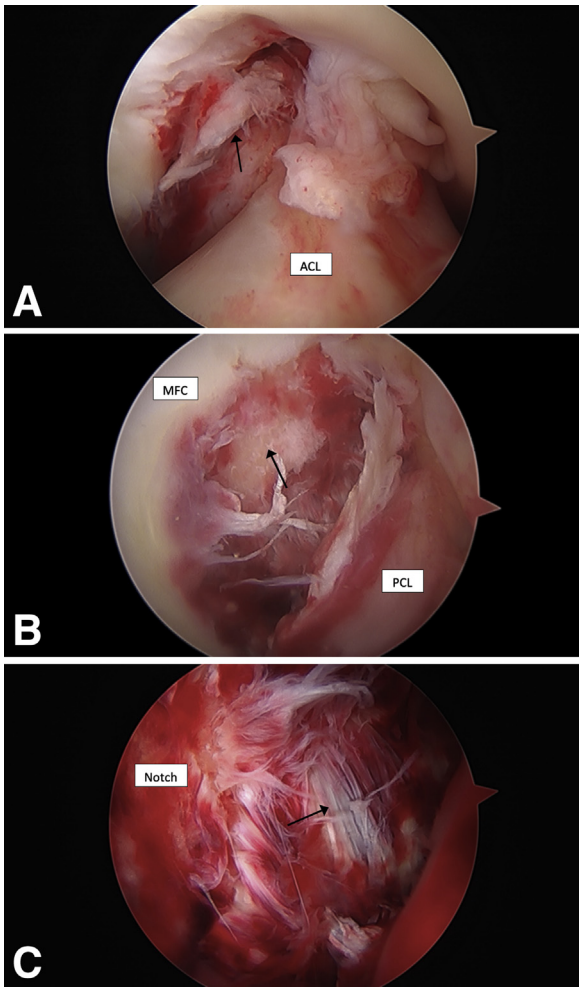

Fig 2. (A) Arthroscopic image viewing from the anterolateral portal of the left knee. The PCL anterolateral bundle has avulsed from the wall of the medial femoral condyle, indicated by the black arrow. (B) Arthroscopic image viewing from the anterolateral portal of the left knee. The black arrow indicates the PCL footprint on the medial intercondylar notch. (C) Arthroscopic image viewing from the anterolateral portal of the left knee. The black arrow indicates the fibers of the intact posteromedial bundle of the PCL. The medial intercondylar notch is labeled. ACL, anterior cruciate ligament; MFC, medial femoral condyle; PCL, posterior cruciate ligament.

weight bearing as tolerated with crutches until 12 weeks, with the brace locked at 0° while ambulating.

From weeks 12 to 16, the hinged knee brace is discontinued. A PCL functional brace is to be worn for 6 months while weight bearing. Physical therapy emphasizes reestablishing a normal gait pattern, achieving active range of motion, and strengthening.

At 6 months, jogging may be initiated on flat, straight surfaces. At 8 months a progressive return-to-sport program can be initiated including shuttle runs, cutting drills, and proprioceptive training. During months 9 to 12, the patient should focus on reconditioning and full return to sports.

Discussion

Femoral-sided avulsions of the PCL are a minority of all PCL injuries but may represent an opportunity for acute primary repair. This injury has been described by Rosso et al.[11] as a "peel-off" lesion: a soft tissue detachment from the femoral footprint that does not involve bony avulsion. Open surgical techniques for repair were initially described by Drucker and Wynne[12] and Richter et al.[8] Richter et al. reported 8-year follow-up of 53 patients who underwent open primary PCL repair; 19 patients had proximal injuries and received transosseous repair over a bony bridge with resorbable sutures. Proximal injuries had improved posterior drawer measured on a KT-1000 compared with distal injuries undergoing a similar repair.

Contemporarily, multiple authors have described arthroscopic techniques for repair of femoral-sided PCL avulsions. Wheatley et al.[13] first described arthroscopic repair of femoral avulsions using a monofilament suture passed through 2.4-mm drill holes on the medial femoral condyle tied over a bone bridge. At a mean follow-up of 51 months, all 11 patients were able to return to competition and had acceptable knee function. Difelice et al.[14] described a similar technique of

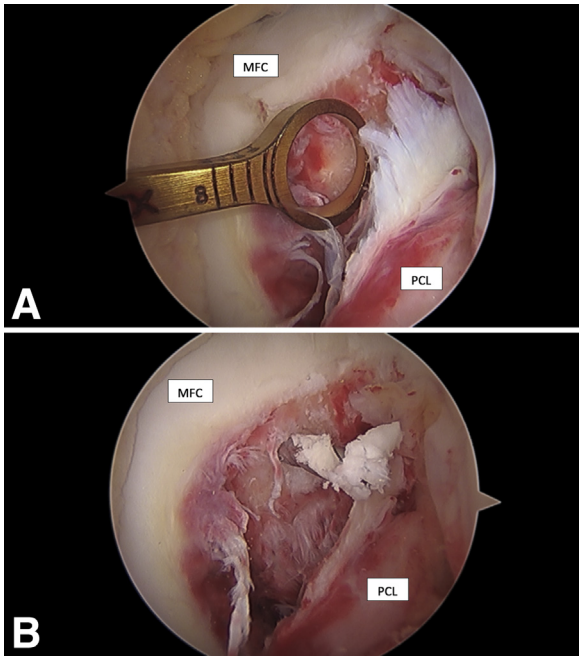

Fig 3. (A) Arthroscopic image viewing from the anterolateral portal of the left knee. The tip-aiming guide is inserted through the anteromedial portal to allow for accurate drilling of the transfemoral tunnel from the outside in. The guide is placed on the footprint of the anterolateral bundle. (B) Arthroscopic image viewing from the anterolateral portal of the left knee. A 2.7-mm guide pin is advanced through the tip-aiming guide, and the guide is removed. The pin is then overdrilled with a 4.5-mm reamer (not shown). MFC, medial femoral condyle; PCL, posterior cruciate ligament.

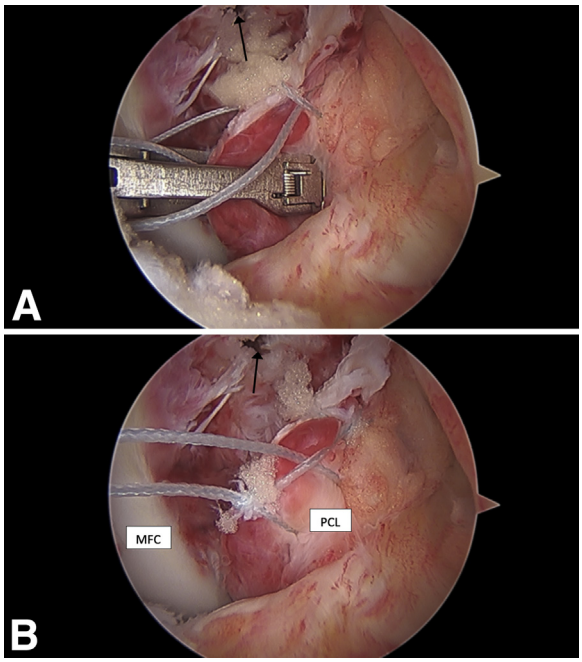

Fig 4. (A) Arthroscopic image viewing from the anterolateral portal of the left knee. A self-capturing suture passer is used to place a running, locking stitch with nonabsorbable size 0 suture into the substance of the PCL stump. Care is taken not to penetrate the previously placed sutures. Drill hole can be visualized at the arrow marker. (B) Arthroscopic image viewing from the anterolateral portal of the left knee, following placement of running, locking size 0 nonabsorbable suture into ligament stump. The drill hole can be visualized at the arrow marker. MFC, medial femoral condyle; PCL, posterior cruciate ligament.

transosseous primary PCL repair, and at an average 68-month follow-up in 3 patients, posterior drawer testing was negative and MRI confirmed healing.

Arthroscopic suture anchor repair has also been described by Rosso et al.[11] and van der List and DiFelice[15] for femoral avulsion PCL injuries. Direct comparative studies of suture anchors versus suspensory fixation with a button are not available for this procedure. Some biomechanical studies have suggested that titanium button suspensory fixation has improved pullout strength relative to suture anchor fixation,[16-20] although there are no high-quality clinical studies demonstrating superiority.

The advantages of this technique include highly accurate placement of the tunnel with the tip-aiming guide without reliance on arthroscopic portal trajectories, allowing for anatomic repair of both bundles, unlike suture anchor fixation. Furthermore, bone tunnels are lower profile than those used in reconstruction. No bony bridge is necessary with the use of a titanium suspensory fixation button. Pullout strength is not a concern with suspensory fixation. The disadvantages of this technique include the need for an extra incision for the transfemoral tunnel. Additionally, the indications are limited to patients with proximal avulsion injuries and appropriate tissue quality; having a reconstruction system available is prudent in case of poor tissue quality. Table 1 list the indications, Table 2 lists the pearls and pitfalls, and Table 3 lists the advantages and disadvantages of this technique.

In summary, we present a technique for arthroscopic anatomic primary repair of a proximal femoral-sided PCL avulsion, with the option for bundle-specific repair (Video 1). Patient selection using both history (acuity) and imaging (location of tear) is paramount, and surgeons should be prepared to reconstruct should the tissue quality be insufficient for repair.

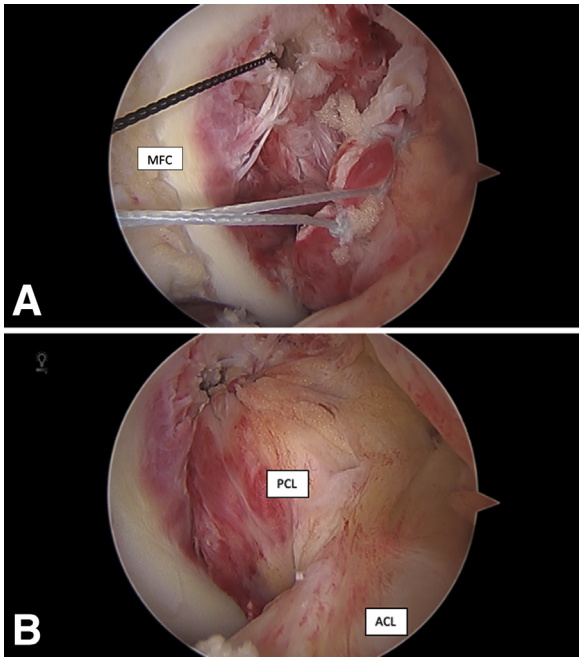

Fig 5. (A) Arthroscopic image viewing from the anterolateral portal of the left knee. A suture shuttling device (MicroSuture Lasso, Arthrex) is passed through the bone tunnel and pulled out the anteromedial portal along with the nonabsorbable size 0 suture. (B) Arthroscopic image viewing from the anterolateral portal of the left knee. The size 0 suture is then advanced through the bone tunnel. The sutures are tensioned with the knee in 90° with an anterior drawer applied and tied over a titanium button. Reduction of the PCL anterolateral bundle to its footprint is appreciated. ACL, anterior cruciate ligament; MFC, medial femoral condyle; PCL, posterior cruciate ligament.

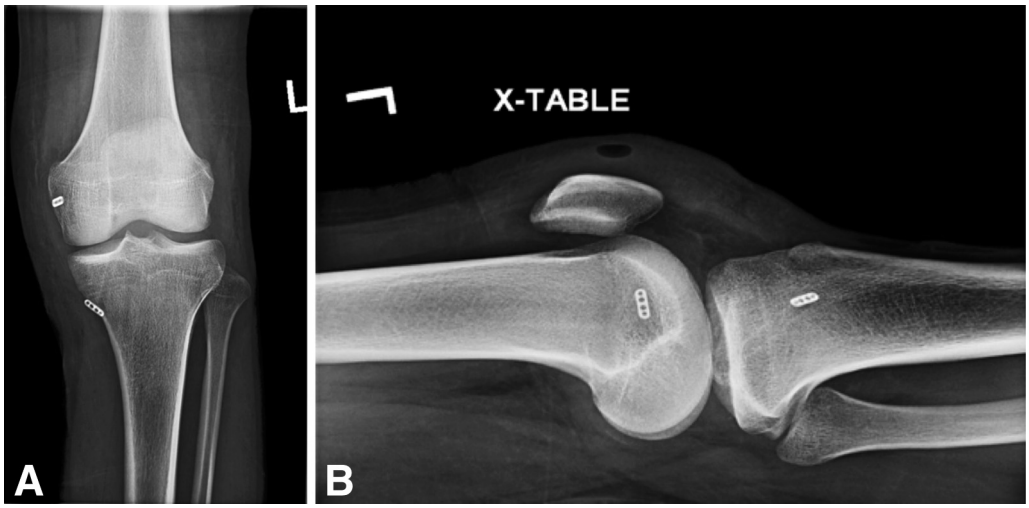

Fig 6. Anterior posterior (A) and lateral (B) radiographs of the left knee at first postoperative visit demonstrating the medial femoral condyle tunnel placement with titanium button suspensory fixation. The tibial-sided titanium button is in place for suspensory fixation of the medial meniscus posterior root repair.

Table 1. Indications and Contraindications to Transosseous Repair of Posterior Cruciate Ligament (PCL)

Indications	Contraindications
• Proximal PCL injury. • Acute or subacute injury to PCL. • Bundle-specific repair. • Good tissue quality. • Consider intraepiphyseal in skeletally immature patient. • Isolated or multiligamentous injury.	• Midsubstance or distal PCL injury. • Chronic injury. • Large bony avulsion. • Poor to fair tissue quality.

Table 2. Pearls and Pitfalls of Transosseous Repair of Posterior Cruciate Ligament

Pearls	Pitfalls
• Scrutinize preoperative magnetic resonance image to identify appropriate surgical candidates. • Inspect posterior cruciate ligament tissue quality and use a grasper to reduce tissue to the footprint to ensure tension is not too great following repair. • Evaluate each bundle arthroscopically to determine whether 1 or 2 tunnels are appropriate.	• Not tensioning ligamentous repair with knee in anterior drawer position can result in laxity. • Misassessment of tissue quality. • Titanium suspensory fixation button footprint not prepared appropriately, resulting in soft tissue interposition.

Table 3. Advantages and Disadvantages of Transosseous Repair of Posterior Cruciate Ligament

Advantages	Disadvantages
• Can be performed in a setting where reconstruction is not feasible or large tunnels are undesirable (tibial plateau fracture, skeletally immature patient). • Anatomic restoration of ligament and tension. • Maintenance of proprioceptive fibers of posterior cruciate ligament. • No autograft- or allograft-associated morbidity. • Can be used in cases of fair to poor bone quality (consider extender for titanium suspensory fixation button). • Lower cost than suture anchors.	• Reliance on proprietary surgical instruments. • Not appropriate in cases of chronic, midsubstance or distal injury. • Requires extra medial incision. • Potential of hardware irritation of titanium suspensory fixation button.

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