Technical Note

Open Anatomic Reconstruction of the Posterolateral Corner: The Arciero Technique

Nathan L. Grimm, M.D., Benjamin J. Levy, M.D., Andrew E. Jimenez, M.D., Ryan Bell, B.S., and Robert A. Arciero, M.D.

Abstract: The posterolateral corner (PLC) is an important stabilizer of the knee. This complex of ligaments and tendons functions as the primary restraint to varus and posterolateral rotation of the knee. Injury to the PLC can result in chronic instability, a varus-thrust gait, and early arthrosis of the medial compartment of the knee if left untreated. Several techniques have been designed to address injuries of the PLC. Over the last 30 years, our understanding of the posterolateral corner as well as its operative reconstruction evolved. This evolution has attempted to refine what is an "anatomic" reconstruction. With more improved techniques and new, innovative fixation devices, we hope to make a more favorable repair for recreating the native stability of the posterolateral corner.

Hughston et al.[1] were the first to describe a classification for posterolateral instability in 1975.[1] In their original article, they describe the injuries of the posterolateral corner (PLC) complex, compared with the medial structures, to be less common, more frequently missed, and producing greater disability to the patient,[1] It is true that these injuries occur to a far lesser extent than the medial structures.[2] In isolation, injuries of the PLC only make up 2.1% of patients who present with a hemarthrosis; however, when combined with other injuries such as anterior cruciate ligament or posterior cruciate ligament, injuries they make up 16%.[2]

More importantly, when these injuries are missed or left untreated in isolation, they will lead to degenerative changes of the medial compartment and medial compartment arthrosis.[1] Early reports of PLC injuries were misdiagnosed as medial knee pain due to meniscus tears and treated as such.[3] We now have a better understanding of how to diagnose PLC injuries both from a clinical and imaging standpoint. Since its early description, several surgical techniques have been described, which include arthroscopic-assisted techniques,[4] the LaPrade open technique,[5] and attempts at all-arthroscopic techniques.[6] In this article, we describe and illustrate the Arciero technique for open, anatomic reconstruction of the PLC, which was initially described 15 years ago,[7] however, now with a few modifications.

Surgical Technique (With Video Illustration)

Preoperative Planning

All patients receive a preoperative femoral nerve block with a weight-based dose of 0.5% Bupivacaine under ultrasound guidance by our anesthesiology team. The block has been a great adjuvant to the multimodal pain plan and has been shown to decrease the use of narcotics.[8] The first step in evaluation of the patient is to take a complete history, focusing on an understanding of the mechanism of the injury and the patient's primary complaint. In our experience, many times, the complaint is not pain but rather a sense of "instability" or the patient simply states, "I don't trust my knee." On clinical examination, a systematic approach is undertaken, starting with a standing overall assessment of qualitative alignment followed by a gait analysis. Many times, patients with chronic PLC injury will display a varus-thrust[9] (Video 1). Specific testing of the PLC with a dial test at 30° to isolate these structures and then at 90° to test for involvement of the posterior cruciate ligament is

From the Department of Orthopaedic Surgery, Division of Sports Medicine, University of Connecticut Health, Farmington, Connecticut (N.L.G., B.J.L., A.E.J., R.B., R.A.A.); and Idaho Sports Medicine Institute, Boise, Idaho (N.L.G.), U.S.A.

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Address correspondence to Nathan L. Grimm, M.D., Idaho Sports Medicine Institute, Team Physicians Boise State University, 1188 W. University Dr., Boise, ID 83701. E-mail: n8grimm@gmail.com

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performed. A varus and valgus load is applied to test the integrity of the collateral ligaments (Video 1). Other tests have been described as findings of PLC instability and may be added to the clinical examination.[10]

Once suspicion of a PLC injury has been identified, appropriate imaging may include standard radiographs of the knee with adjunctive stress views when appropriate (Fig 1). Views of the contralateral extremity are important to get as a comparison of patient-specific normalcy, especially with stress radiographs. Magnetic resonance imaging is also recommended for analysis of specific structures of the PLC as well as associated ligamentous and non-ligamentous injuries about the knee.

Positioning

The patient is positioned in the supine position on a flat-top table with the leg portion of the table flexed to 100°, such that the operative leg is able to flex to 90°. The contralateral leg is abducted, the hip flexed to 20 to 30°, and the knee flexed to 60° in a well-leg holder (Fig 2). A non-sterile tourniquet is applied to the proximal thigh of the operative extremity and this is insufflated to 250 mm Hg during the surgical procedure. The operative thigh, distal to the tourniquet but proximal to the knee, is placed in a circumferential arthroscopic leg holder (AliMed, Dedham, MA). This stabilizes the knee from varus or valgus displacement during the case. The extremity is then prepped with Chlorhexidine scrubs and wiped clean with alcohol dampened gauze. An impermeable stockinette is placed over the foot and rolled to the level of the mid-tibia. Coban self-adherent wrap (3M, St. Paul, MN) is rolled over the stockinette to secure it to the patient's foot and leg. A sterile, split extremity is applied around the sterile extremity and then an extremity drape is applied over the leg.

Fig 1. Right knee. Incompetent lateral collateral ligament with manual varus stress radiograph.

Surgical Approach

This surgical approach is adapted from a previous published Technical Note by Robert Arciero.[7] We start the surgical case by marking out the anatomic landmarks of Gerdy's tubercle, the outline of the fibular head, and the lateral epicondyle. Following, this a hockey-stick incision is made from 2 to 3 cm proximal to the medial epicondyle and then extending distally between Gerdy's tubercle and the fibular head—cheating more toward the fibular head (Fig 3). The incision is carried down through the subcutaneous tissue and full-thickness flaps are elevated posteriorly and anteriorly along the incision from proximal to distal to help with exposure. The next sequence of steps involves a systematic creation and subsequent dissection starting with three fascial incisions. This has previously been described by LaPrade and Terry.[11]

Fascial Incision #1

This is made at the inferior aspect of the biceps femoris tendon, which will expose the common peroneal nerve. The complete neurolysis just distal to the anterior fibula is carried out and the nerve is inspected and protected posterior and laterally for the remainder of the case (Fig 4). Through this same exposure interval, distal to the biceps femoris tendon, a Cobb instrument can be used to tease off tissue from the posterior aspect of the fibula as well as the lateral gastrocnemius muscle. Removing this tissue is important such that a finger can easily be placed around the posterior fibula and palpation of the tibiofibular joint can be palpated. We then turn our attention to the lateral aspect of the fibula.

A small vertical incision is made over the lateral aspect of the proximal fibula with the goal of exposing the insertion of the lateral collateral ligament (LCL) and its footprint. Once the footprint is identified, we then use a guidewire aimed in a posteromedial direction. As we point out in a previous publication,[7] this is a subtle but important difference in tunnel trajectory as it helps reproduce the normal anatomy of the PLC (Fig 5). Once this guidewire is in an acceptable position, we then over-drill this with a 7-mm cannulated reamer to create the tunnel for graft passage. A passing suture is then passed through the tunnel and a snap is placed on this suture so as not to lose its placement for later use.

Fascial Incision #2

This incision is made at the interval between the inferior aspect of the iliotibial (IT) band and the anterior aspect of the biceps femoris tendon (Fig 6). We then develop this interval proximally and slightly distally to expose the deeper posterolateral joint capsule creating a

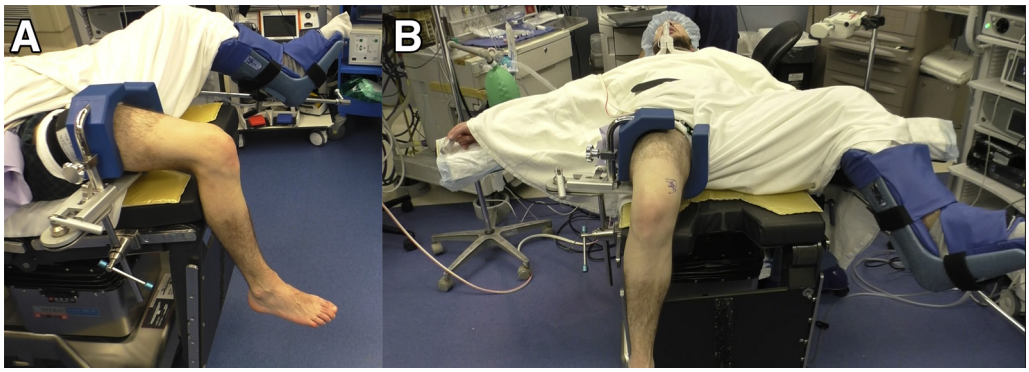

Fig 2. Right knee. Side (A) and front (B) of our preferred set-up for positioning for posterolateral corner reconstruction. Note tourniquet on proximal thigh, arthroscopic circumferential leg holder on operative extremity, and well-leg holder flexed and abducted away from the operative field.

window to aide in passing of the graft. Additionally, through this window, in some cases, this posterolateral capsule is attenuated and we will perform a reefing of the posterolateral capsule with 0 VICRYL suture (Ethicon, Somerville, NJ).

Fascial Incision #3

This is made through the IT band, at the mid-point and centered over the lateral condyle (Fig 7). It is important to carry this incision ~2 to 3 cm anterior and distal so that an anterior arthrotomy can be performed. Once through the IT band, you will frequently encounter a thickened or inflamed bursa that will protrude out. Careful excision of this bursa will aid in visualization tremendously. We use a self-retaining instrument such as a Weitlaner to hold the limbs of bisected IT band apart for better exposure (Fig 8). Once the bursa is removed, we turn our attention to identifying the underlying femoral footprint of the LCL. Once found it helps to mark this with either a sterile marking pen or a simple cauterization mark with the electrocautery. Next, we turn our attention to identifying the femoral footprint of the popliteus tendon (PT), which is an intra-articular structure. We begin this by making a 2-cm vertical arthrotomy. This will expose the distal, lateral condylar. The posterior limb of the arthrotomy can easily be reflected posterior to expose the popliteus sulcus and tendon. Again, we will mark this with either a sterile marking pen or electrocautery.

Now that the footprints for the LCL and PT are exposed and marked, the tunnel for the LCL limb is established. A guidewire is driven from lateral to medial through the femur, aimed in a slightly proximal and anterior trajectory. This trajectory will allow for safe tunnel placement, especially in the case of a concurrent anterior cruciate ligament reconstruction (Video 1). Of note, it is important that this guidewire have an eyelet at the blunt end to aide in passing of a shuttling suture. With the guidewire in place we then over-drill these with an 8 mm cannulated reamer, making sure to exit the medial cortex of the femur. A #2 nonabsorbable suture is typically used as a shuttling suture and is passed into the eyelet of the guidewire and the 2 free-ends of the suture are pulled through the medial side

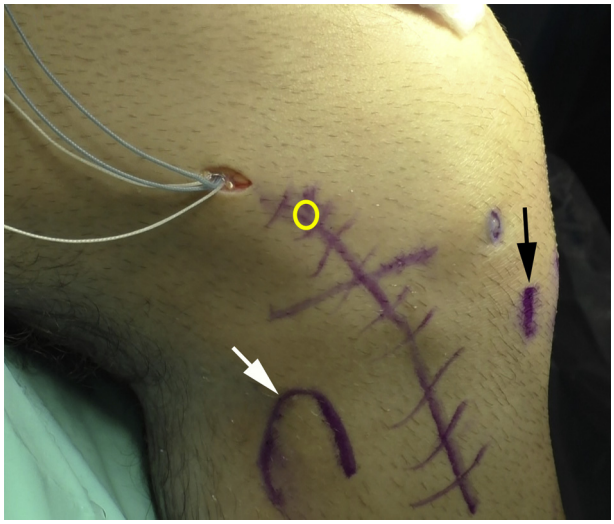

Fig 3. Right knee. Marked-out incision started centered over the lateral epicondyle (yellow circle), then extending distally between Gerdy's Tubercle (black arrow) and closer to the fibular head (white arrow).

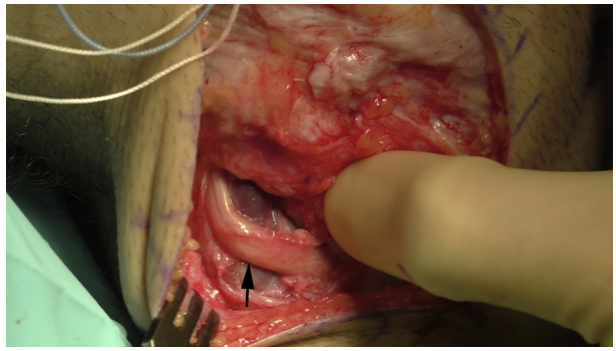

Fig 4. Right knee. Common peroneal nerve (black arrow) proximal to the fibular head and just posterior to biceps femoris tendon.

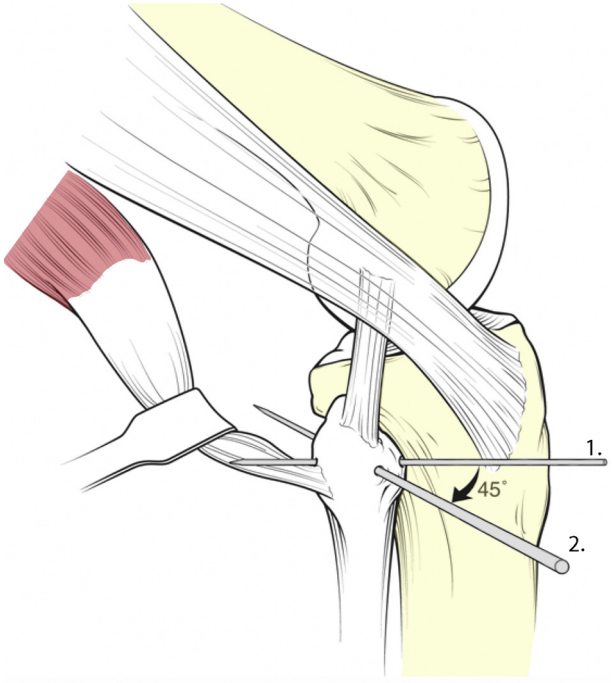

Fig 5. Right knee. Illustration of a key trajectory change from the traditionally described anterior to posterior direction (1) to the more anatomic anterolateral to posteromedial (2).

with the guidewire such that a loop remains on the lateral side for shuttling the graft into the femur (Video 1). Next, the PT limb tunnel is established. A guidewire is driven into the insertion point of the previously marked footprint. An 8-mm cannulated reamer is then over-drilled to a depth of 30 to 40 mm (Fig 9).

Graft Preparation and Placement

At this point in the procedure, we have created our fibular tunnel in an anterolateral to posteromedial direction, we have created our LCL femoral tunnel, we have created our PT femoral tunnel, and have shuttling sutures in place for passing of our graft. For graft choice, we typically use an allograft; however, autogenous graft can be used. Allograft choices may include semitendinosus, anterior tibialis, and posterior tibialis. More important than the type of graft, however, is the length of the graft. You will need ~24 to 26 cm length, as this technique uses a single graft. The graft is prepared by simply creating a baseball-type stitch up and then back down each end of the suture and should span ~20 mm for greater strength when tensioning the graft.

The sequence of passing the graft is as follows. We start by pulling the graft through fibular tunnel from

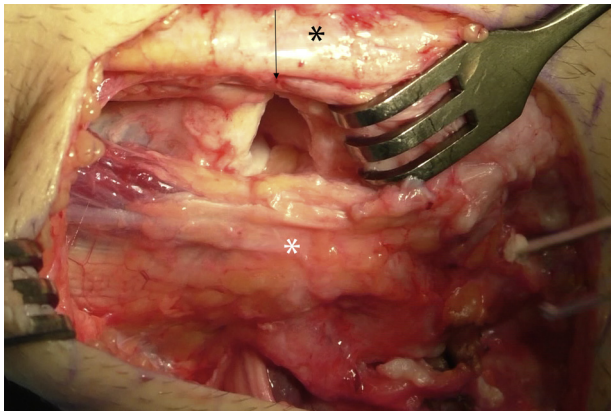

Fig 6. Right knee. Intraoperative photo (oriented with proximal to the left of the image) demonstrating the second fascial incision (black arrow). The fascial incision is made between the posterior aspect of the IT band (black asterisk) and anterior to the biceps femoris (white asterisk).

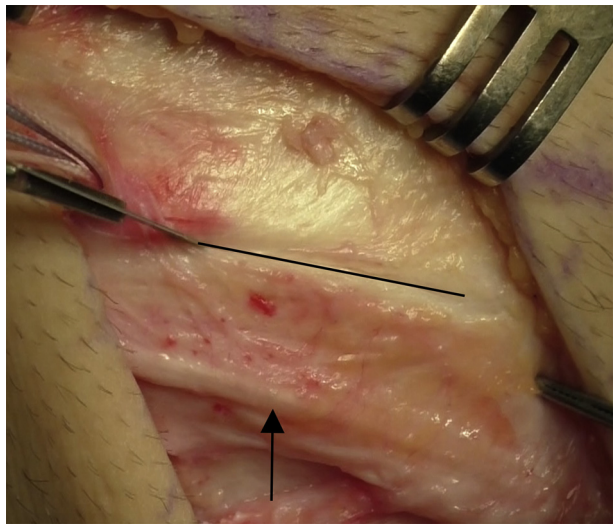

Fig 7. Right knee. Intraoperative photo (oriented with proximal to the left of the image) demonstrating the third fascial incision (black solid line) through the iliotibial band (posterior border marked by the black arrow). This is centered over the lateral epicondyle and is 2-3 cm in length.

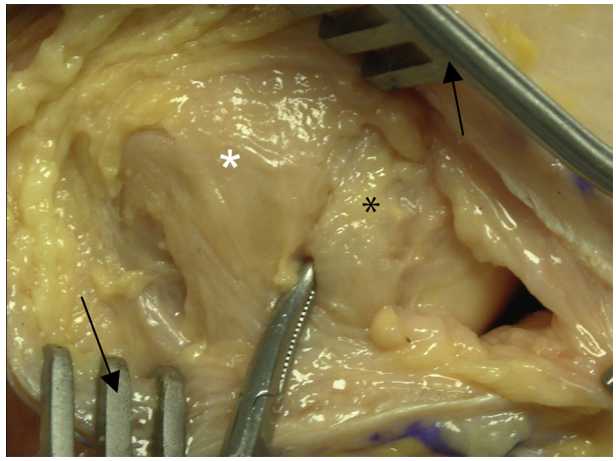

Fig 8. Right knee. Intraoperative photo (oriented with proximal to the left of the image) demonstrating the third fascial incision with the iliotibial band retracted with self-retainer (black arrows). The femoral attachments of the lateral collateral ligament (white asterisk) and popliteus (black asterisk) are visible.

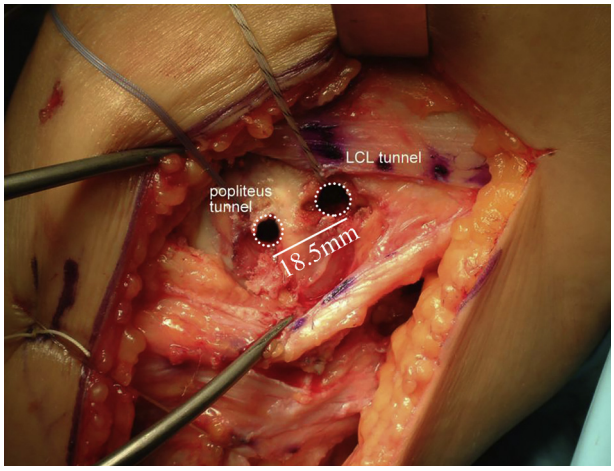

Fig 9. Left knee. Position of the more proximal LCL tunnel and, 18.5-mm distal and anterior, the popliteus tunnel. (LCL, lateral collateral ligament.)

anterolateral to posteromedial using the shuttling suture that had been retained from earlier in the case (Video 1). The posterior limb of the graft will be our PT limb and is tunneled along the posterior aspect of the proximal tibiofibular joint, through the popliteus hiatus, and into the popliteal femoral tunnel. The PT limb can then be secured with an 8-mm fork-tipped PEEK (polyether ether ketone) swivel-lock anchor.

At this point, the anterior limb is then tunneled deep to the biceps femoris tendon insertion and then lies just adjacent to the native or remnant LCL. The shuttling suture in the LCL tunnel from earlier in the case is then used to pass the LCL limb into the tunnel (Video 1). The graft is now in place for tensioning. Before tensioning the graft, the knee is brought into 30°, internal rotation, and slight valgus. Once in this position, the graft sutures from the LCL limb is tensioned and an 8 × 30-mm biocomposite interference screw is placed within the tunnel. Because this is a single contiguous graft, tension applied on one side will tension through the entirety of the graft. Therefore, tensioning both the LCL and PT limbs.

Before closure, we irrigate the wound with copious amounts of sterile fluid. Our closure is then in a reverse order, closing the fascial incisions #1 and #2 with a 0 VICRYL suture (Ethicon). The fascial incision #3 is typically left open as part of the neurolysis and to not compress the nerve after postoperative swelling occurs. The subcutaneous tissue is then approximated with a 2-0 VICRYL suture (Ethicon). The skin is then approximated with a #2 PROLENE suture (Ethicon) in a running subcuticular fashion, which will typically be removed in clinic between postoperative days 10 and 14. Sterile dressings and a compressive wrap are applied to the knee. We like to use a hinged-knee brace locked in extension postoperatively to protect the leg.

Discussion

The PLC is a complex and important stabilizer of the knee, functioning as the primary restraint to varus and posterolateral rotation of the knee. Injury to the PLC can result in chronic instability, a varus-thrust gait, and early arthrosis of the medial compartment of the knee. Several techniques have been designed to address injuries of the PLC, which include open,[12] arthroscopic-assisted,[4] and all-arthroscopic techniques.[6] Early studies of PLC repair versus reconstruction showed superior results, with reconstruction having a 9% failure rate and repair having more than a 4 times greater failure rate of 37%.[13] Early studies of reconstruction also had high failure rates, and perhaps this is due to a less anatomic technique being employed. Our technique, as well as others,[5] offers a more anatomic reconstruction of the complex PLC.

The open technique that we describe has several advantages and disadvantages (Table 1). These advantages include a trajectory that is not only more anatomic for the reconstruction but also decreases the risk of peroneal nerve injury by aiming the fibular tunnel more medial as opposed to posteriorly based, which is in the trajectory of the common peroneal nerve. Furthermore, the advantage of changing the direction from straight anterior-to-posterior to a more anterolateral-to-posteromedial trajectory better reproduces the popliteofibular ligament while maintaining the anatomic insertion of the LCL and popliteus, independently, at their femoral insertion(Table 2). A recent biomechanical study looking at the biomechanics of the Arciero reconstruction technique and the LaPrade reconstruction technique showed that both techniques were equally effective in restoring stability to knees with PLC injuries.[14] The authors recommend, as do we, that surgeons should select a reconstruction technique based

Table 1. Advantages and Disadvantages

Advantages	Disadvantages
• Oblique transfibular tunnel better recreates normal anatomy • Anterolateral-to-posteromedial trajectory of the fibular tunnel decreases risk of common peroneal nerve injury • Reproduces 2 ligamentous structures with a single graft • Decreases risk of fracture by not using an interference screw in the fibular head	• Care must be taken to appropriately tension graft with aperture fixation • Technically demanding

Table 2. Pearls and Pitfalls

Pearls	Pitfalls
• The graft should be tensioned in slight valgus and 30° of flexion • Passing sutures can be left in the fibular tunnel after drilling to facilitate graft passage • A Cobb elevate can be placed posterior to the fibular head while drilling to prevent common peroneal nerve injury	• The fibular head should be drilled centrally to avoid fracture • Tunnels should be cleared of soft tissue to allow smooth graft passage • Leaving the interference screw proud in the femur can cause irritation to the ITB

ITB, iliotibial band.

on their experience and training to address these injuries.[14]

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