Indications for 2-incision Anterior Cruciate Ligament Surgery

Ryan Breland, MD; Adam Metzler, MD; Darren L. Johnson, MD

Abstract: Two-incision anterior cruciate ligament reconstruction uses an outside-in femoral drilling technique. Advantages include anatomic femoral tunnel placement and increased versatility with regard to graft position and fixation in the femoral tunnel or distal femur. The authors believe that transtibial femoral tunnel drilling is inferior because of nonanatomic femoral tunnel placement and the requirement of the posterior footprint placement of the tibial tunnel. Indications for outside-in femoral drilling include revision anterior cruciate ligament reconstruction, drilling an all-epiphyseal tunnel in skeletally immature patients, long bone-patellar tendon-bone autografts when using more than 45 mm of tendon, and cases in which the leg cannot be hyperflexed for accessory anteromedial portal drilling.

Anterior cruciate ligament (ACL) reconstruction is one of the most commonly performed surgical procedures in the United States. According to the literature, the number of ACL reconstructions performed each year ranges from 60,000 to 175,000 per year.1-3 Multiple techniques for ACL reconstruction have been described, including transtibial, extra-articular, accessory portal, and 2-incision, or outside-in femoral drilling. The outside-in technique allows the surgeon more freedom in positioning the femoral tunnel compared with a transtibial technique, where the femoral tunnel is drilled through and is therefore dependent on the tibial tunnel. It has been shown to be extremely difficult, if not impossible, to be 100% within the center of each ACL footprint using a transtibial technique.4 The current authors propose 4 indications for outside-in femoral drilling: revision ACL reconstruction, ACL reconstructions in the skeletally immature, long bone-patellar tendon-bone (BPTB) autografts when using more than 45 mm of tendon to decrease graft tunnel mismatch, and cases in which the leg cannot be hyperflexed for accessory anteromedial portal drilling.

Surgical Technique

The patient’s operative leg is placed in the Acufex (Smith & Nephew, Andover, Massachusetts) leg holder, and the nonoperative leg is placed in a well-leg holder. The operative leg or femur should be parallel to the floor when placed in the leg holder. The graft (BPTB or quadruple hamstring autograft) is harvested and prepared in the standard fashion. Three portals are made: a high and tight anterolateral portal, a low and tight anteromedial portal, and an accessory anteromedial portal. The fat pad is debrided enough to allow full visualization in addition to a limited (3 mm) wall- and notchplasty. Complete visualization of the ACL femoral and tibial footprints is imperative. Leaving some remnant fibers of the tibial and femoral ACL stump helps in placement of the outside-in guide. The scope can alternate between the anterolateral portal and the low and tight anteromedial portal for better visualization.

Once adequate visualization has been obtained, the appropriate Acufex Pinpoint guide (Smith & Nephew) size is chosen, with options ranging from 6 to 10 mm. The scope is placed in the far ac-
cessory medial portal, and the outside-in Pinpoint guide is placed through the anterolateral portal. The intra-articular portion of the guide is placed on the anatomic position on the medial aspect of the lateral femoral condyle covering the remnant ACL fibers that were preserved (Figure 1A). Next, the trochar is placed through the handle to mark the skin incision.

The starting point for the drill is anterior and proximal to the lateral epicondyle, except for use in skeletally immature patients. In these patients, the entrance point must be distal to the femoral physis, which is directly above the epicondyle or femoral attachment of the fibular collateral ligament. Care must be taken to maintain the intra-articular portion of the guide in the anatomic position.

The trochar is removed once the skin is marked, and a 2- to 3-cm incision is made in line with the iliotibial band. Skin retractors are placed, and the trochar is advanced through the guide handle abutting the lateral femoral condyle (Figure 2). While the guide is held firmly in place, a beath pin is slowly advanced through the trochar and visualized with the scope, passing a few millimeters into the intercondylar notch (Figure 1B). The guide is removed, and the iliotibial band is split a few centimeters on each side of the beath pin to prevent the reamer from injuring the iliotibial band. Retractors are placed, and the beath pin is grabbed with a pituitary grabber via the low anteromedial portal. The appropriately sized, fully fluted reamer is drilled in an outside-in manner while an assistant holds the beath pin to prevent advancement. The pin and reamer are removed, the tunnel is debrided, and a plug is placed into the tunnel to prevent fluid extravasation (Figure 1C).

The tibial tunnel is drilled in a standard fashion. To pass the graft, a passing suture is looped and grabbed with a pituitary grabber. The passing suture is placed in a retrograde fashion through the lateral femoral condyle and passed off to another grabber through the drilled tibial tunnel. The graft can then be pulled into appropriate position (Figure 1D). If a BPTB graft is chosen, then the bone plug is fixed on the femoral side with a metal screw placed from outside in. The guidewire is placed in a retrograde manner, and the bone plug must be directly observed to prevent aberrant screw placement. The tibial side is fixed with a metal screw in standard fashion.

If a hamstring tendon graft is used, the graft is passed in a similar manner; however, a 10-mm Endobutton (Smith & Nephew) with an Xtendobutton (Smith & Nephew) attachment is used.

**Revision Anterior Cruciate Ligament Reconstruction**

Revision ACL reconstructions are increasing in frequency secondary to patients’ desire to return to sport and the increase in primary ACL reconstructions. Often, revision cases present technical challenges that can prevent anatomic graft placement, such as previous inaccurate tunnel placement, tunnel osteolysis, and previous hardware. Significant tunnel osteolysis that would affect graft fixation may require a staged surgery with initial hardware removal and bone grafting followed by definitive reconstruction at a later date.

The lateral distal femur incision of the 2-incision technique allows the guide pin to enter at a more anatomic angle, thus permitting anatomic placement of the new femoral tunnel. Therefore, using an outside-in technique can create a virgin anatomic tunnel (ie, a tunnel with 360° of intact bone) (Figure 3). This new cortically intact femoral tunnel obviates the need for a staged reconstruction because stable graft fixation can be achieved. This decreases the patient’s exposure to a second surgery and potentially prevents pro-
gressive cartilage and meniscal damage in the interim.\(^1\)

Occasionally, in a revision setting, some tunnel overlap remains after drilling the new outside-in tunnel if the previous femoral tunnel was partially anatomic. The outside-in technique allows the surgeon the advantage of multiple options of femoral fixation if interference screw purchase is not believed to be optimal. Fixation outside the tunnel on the distal femur works well in this situation.

Epiphyseal Drilling for Skeletally Immature Patients

Anterior cruciate ligament tears are being recognized with increasing frequency in the pediatric population, likely secondary to a combination of an increase in competitive sports participation among today’s youth and the increased recognition among athletic trainers and physicians. Historically, ACL injuries in the skeletally immature were treated nonoperatively secondary to increased risk of growth disturbances after iatrogenic physeal injury.\(^1\) However, the decision to surgically treat these ACL injuries has increased after the literature documented poor outcomes after nonoperative treatment.\(^1\) This has led to the emergence of various physeal-sparing procedures.\(^1\) Compared with a transtibial technique, the outside-in technique allows surgeons to avoid iatrogenic physeal injury by placing the tunnel in an all-epiphysial location (Figure 4). Furthermore, transtibial and physeal-sparing extra-articular techniques risk nonanatomic graft placement. Using the outside-in technique, the physeal is spared and the normal intra-articular ACL anatomy is accurately restored.\(^1\)

Long Bone-Patellar Tendon-Bone Graft (Graft-Tunnel Mismatch)

Graft-tunnel mismatch can occur when the patellar tendon graft is too long, especially when the tendon portion is greater than 45 mm in length. When securing a graft in the femoral tunnel using an all-endoscopic technique, placing the bone block more proximally in the femur risks graft abrasion on the tunnel opening or damage during blind insertion of an interference screw. Therefore, the proximal bone block is usually secured flush with the intra-articular femoral tunnel entrance.

When the surgeon is presented with a long tendon portion of graft, the distal bone block is at risk of being outside the tibial tunnel. This necessitates use of staple fixation outside the tunnel instead of bone-to-bone fixation with an interference screw inside the tunnel. However, the 2-incision outside-in technique can readily accommodate a long BPTB. The outside-in trajectory of the interference screw allows the surgeon to move the bone block more proximally (laterally) in the femoral tunnel, decreasing tibial graft extrusion while maintaining stable fixation (Figure 5).\(^1\) Preoperatively, one can measure the length of the patellar tendon with magnetic resonance imaging to plan for the 2-incision technique.

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Figure 3: Anteroposterior (A) and lateral (B) radiographs showing a virgin tunnel drilled via the outside-in technique.

Figure 4: Anteroposterior (A) and lateral (B) radiographs of the outside-in femoral tunnel avoiding the physis in a skeletally immature patient.

Figure 5: Anteroposterior (A) and lateral (B) radiographs of the outside-in technique for a long bone-patellar tendon-bone autograft during revision anterior cruciate ligament surgery.
Inability to Hyperflex the Leg
The ability to hyperflex the leg while drilling through an accessory anteromedial portal is necessary for anatomic placement of the femoral tunnel.15 If experienced assistants are not available to hyperflex the leg, the outside-in technique provides an anatomic technique that can be reliably reproduced without having to hyperflex the leg during femoral tunnel drilling. The outside-in technique can also be used in patients where a larger body habitus prevents the leg from being hyperflexed and drilled via an accessory anteromedial portal.

CONCLUSION
The outside-in femoral tunnel drilling technique remains a preferred method for revision ACL reconstructions, ACL reconstructions in the skeletally immature, ACL reconstructions using a long BPTB autograft, and in cases in which the leg cannot be hyperflexed for accessory anteromedial portal drilling. In revision ACL reconstruction, outside-in femoral drilling allows the surgeon a potentially virgin tunnel, which is ideal for graft fixation and does not require a second surgery. Outside-in femoral drilling also avoids the immature physiology and prevents potential growth alignment from iatrogenic cartilage damage. Lastly, outside-in femoral drilling allows the surgeon to perform more proximal femoral interference screw fixation of a BPTB bone block and gives them the ability to make sure the tibial bone block is secure within the tibia for intra-articular fixation.

REFERENCES