Anatomical Single-Bundle Anterior Cruciate Ligament Reconstruction With a Transtibial Technique

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Abstract

To position a single-bundle anterior cruciate ligament reconstruction anatomically on the femoral side while still using a transtibial technique, we recommend performing a posterolateral notchplasty, inserting the tibial aimer through an accessory inferomedial portal, using a more proximal tibial starting point, removing bone from the posterolateral corner of the tibial tunnel, and externally rotating the over-the-top guide.

Recent literature has emphasized the importance of anatomical reconstruction of the anterior cruciate ligament (ACL) with the suggestion that the ACL is composed of 2 discrete ligamentous bundles[1,2] and that nonanatomical single-bundle reconstructions may fail to restore adequate rotational stability to the knee.[3,4]

In this report, we present 6 key tips for obtaining an anatomical position on the lateral wall of the intercondylar notch using a single-bundle reconstruction with a transtibial technique, a method that has been recently shown to simultaneously reconstruct portions of both ACL bundles.[5]

Tip 1. *Perform a posterolateral notchplasty*. After the wall of soft tissues is cleared with a radiofrequency device and a shaver, a bony notchplasty is initiated with a quarter-inch osteotome through the anteromedial portal. The bone resection is started along the anteromedial aspect of the lateral femoral condyle, where a mark is made 10 mm from the lateral aspect of the posterior cruciate ligament (PCL), corresponding with roughly 2 to 3 mm of bone removal from the anterior part of the notch. After resection with the osteotome is initiated, a spherical burr is used to complete the resection from anterior to posterior, gently contouring the roof and superolateral corner of the notch from a triangular configuration to one with more of an acute angle to its corner—resembling a Roman arch (Figure 1). The best resection is performed from the posterolateral notch, as this removes bone that might otherwise prevent the "over-the-top" guide from later being placed at the lowest possible position. This maneuver reduces the tendency of the aimer to slide "higher" in the notch and facilitates rotation of the aimer (see tip 4). Afterward, the surgeon should be able to easily hook a probe around the posterior wall.

Tip 2. *Insert the tibial aimer through an accessory inferomedial portal*. We use a more distal and lateral accessory portal for insertion of the tibial aimer. A spinal needle is inserted through the patellar tendon approximately 1 cm lateral and distal to

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Figure 1. Intercondylar notch appearance after adequate notchplasty. Note clear visualization of entire anterior cruciate ligament course and smooth right-angle corner of "Roman arch" bony notchplasty in this left knee reconstruction. Removal of bone principally from posterolateral aspect of notch opens up space for later positioning of over-the-top guide. Probe is used to confirm easy hooking of back wall.

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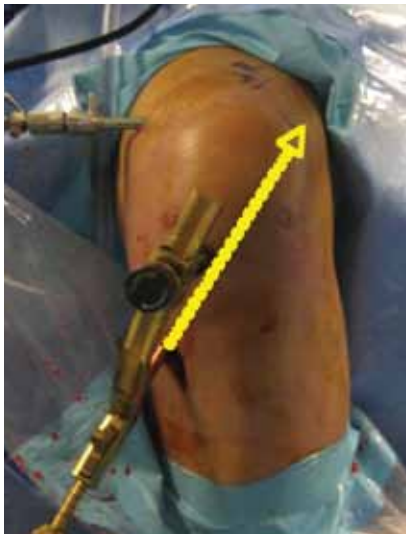

Figure 2. Tibial aimer is inserted through accessory intramedullary portal, which allows a more distal starting point and a more horizontal orientation to the guide pin. Note oblique coronal plane angle that pin makes relative to joint line, with tip of pin pointing roughly to 1:30 position (left knee) on external clockface.

the traditional inferomedial portal. If positioned correctly, the needle should be at the tibial joint line, but not so low that it cannot be translated proximally. Insertion of the aimer through this portal allows the aiming arm to be more easily rotated. This allows a guide-pin trajectory that is slightly more horizontal relative to the lateral wall of the notch—roughly the 1:30 position (left knee) on an external clockface—which in turn allows a slightly lower notch position for the over-the-top guide (Figure 2). If the tibial aimer is positioned appropriately, the tip of the guide pin should penetrate the joint in the center of the tibial insertion with a trajectory that points to the same 1:30 position (left knee) along the lateral wall of the notch.

Tip 3. *Use a tibial starting point that is roughly 15 to 20 mm from the joint line and 15 mm from the medial edge of the tibial tubercle*. A recent cadaveric study[6] suggested that a tibial starting point closer to the joint line will more closely parallel a line connecting the centers of the femoral and tibial insertions. A guide wire that connects the center of the tibial insertion to the above starting point will result in a tibial tunnel that very closely reproduces the tibial insertion and allows improved access to the femoral intercondylar notch.

Figure 3. Remove bone from entrance of tibial tunnel into joint. Chamfer reamer is used to remove bone from posterolateral aspect of mouth of tibial tunnel. Removal of cortical rim, which is usually quite thick, significantly facilitates lower positioning of over-the-top guide on lateral wall.

Tip 4. *Remove bone from the intra-articular entrance of the posterolateral tibial tunnel*. After the tibial tunnel is reamed, a chamfer reamer and a hand rasp are used to bevel the posterolateral corner of the entrance of the tibial tunnel into the joint (Figure 3). We do not recommend an overly aggressive resection, as it may unnecessarily posteriorize the graft, but we feel that removing the cortical rim at the tunnel mouth significantly improves subsequent positioning of the "over-the-top" aimer on the lower portions of the lateral wall.

Tip 5. *Externally rotate the over-the-top guide*. Once the over-the-top guide is inserted and hooked on the posterior wall, an even lower pin position may be achieved by externally rotating the guide. This brings the pin position an additional 1 to 2 mm lower on the wall (Figure 4), allowing a femoral tunnel that almost perfectly overlaps the native insertion (Figure 5).

Tip 6. *Fix the femoral plug with the cancellous portion facing anteroproximally, and the tibial plug with the cancellous portion facing posterolaterally*. If the femoral plug is fixed with the cancellous portion facing anterior and proximally and with the interference screw inserted at the top of the femoral tunnel, the liga-

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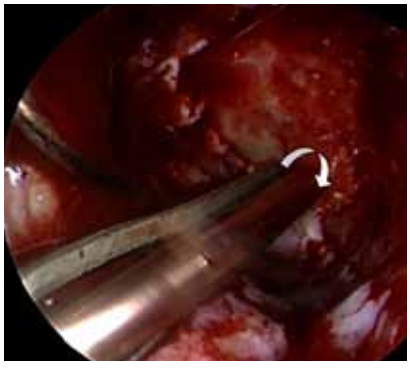

Figure 4. Externally rotating over-the-top guide lowers starting point of pin on notch wall by another 1 to 2 mm.

Figure 5. Final tunnel. An anatomical, single femoral tunnel is possible with a transtibial technique.

Figure 6. Final graft position. Note low position that graft takes on lateral wall, with restoration of normal space between anterior and posterior cruciate ligaments.

Figure 7. Radiographic appearance. Note proximal location of tibial tunnel on lateral view and its anteriorly positioned interference screw. Final graft position on tibial side is just anterior to bone plug and corresponds with center of normal tibial anterior cruciate ligament insertion.

mentous portion of the graft will be centered relative to the normal femoral insertion and will lie along the normal proximal-posterior to distal-anterior axis of the femoral insertion. Likewise, if the tibial plug is rotated 180°, such that its cancellous portion is facing posterolaterally, and is fixed with an interference screw in the anterior aspect of the tibial tunnel, the soft-tissue portion of the graft will be centered in the tibial tunnel (Figures 5-7).

By following these 6 tips, an orthopedic surgeon should be able to drill a single transtibial femoral tunnel that is very near the center of the femoral insertion of the native ACL. Results from a recent biomechanical study (D. P. Piasecki, MD, B. R. Bach Jr, MD, A. A. Espinoza Orias, PhD, and N. N. Verma, MD, unpublished data, 2009) suggested that use of the above tibial starting point creates tibial and femoral tunnels with surface areas within 10% of the normal anatomical insertions.

Our clinical experience with the technique described here has yielded predictably high success rates with consistent elimination of positive findings on the Lachman and pivot shift tests.[7,8]

Authors' Disclosure Statement

The authors report no actual or potential conflict of interest in relation to this article.

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