Anteromedial Portal Anterior Cruciate Ligament Reconstruction With Tibialis Anterior Allograft

Steven Shamah, B.S., Daniel Kaplan, B.A., Eric J. Strauss, M.D., and Brian Singh, B.S.

Abstract: In an effort to better restore normal joint function and kinematics, recent emphasis has been placed on surgical techniques that provide a more anatomic reconstruction of the anterior cruciate ligament (ACL). With femoral tunnel placement shown to play a vital role in the biomechanics, stability, and clinical outcomes after ACL reconstruction, approaches that better approximate the ACL’s native femoral origin have been adopted. The independent anteromedial portal technique is thought to better position the femoral tunnel within the native ACL footprint and leave the graft more posteroinferior on the wall of the lateral femoral condyle than the more traditional transtibial approach. This article outlines the surgical technique for an anteromedial portal ACL reconstruction with a tibialis anterior allograft fixed with the Mitek Femoral and Tibial Intrafix sheath and screw system (DePuy Synthes, Raynham, MA).

Arthroscopically assisted anterior cruciate ligament (ACL) reconstruction is widely accepted as the standard of care for active individuals with functional instability of the knee joint related to ACL injury. During the past 30 years, there has been an evolution in the techniques used for ACL reconstruction with technological advances allowing for a variety of graft choices, fixation methods, and surgical approaches.

In an effort to better restore normal joint function and kinematics, recent emphasis has been placed on surgical techniques that provide a more anatomic reconstruction of the ACL. With femoral tunnel placement shown to play a vital role in the biomechanics, stability, and clinical outcomes after ACL reconstruction, approaches that better approximate the ACL’s native femoral origin have been adopted. The independent anteromedial portal (AMP) technique is thought to better position the femoral tunnel within the native ACL footprint and leave the graft more posteroinferior on the wall of the lateral femoral condyle than the more traditional transtibial approach. In a recent cadaveric study, Tompkins et al. showed that compared with the transtibial technique, independent drilling using an AMP approach resulted in more accurate placement of the femoral tunnel. They showed that the AMP technique placed 97.7% of the tunnel within the native femoral footprint compared with 61.2% seen with transtibial drilling. The AMP method additionally secures the graft in a more horizontal orientation, providing better rotational control and anteroposterior translational stability.

The use of allografts for ACL reconstruction is a highly debated topic. Allografts have certain advantages over autografts including absence of donor-site morbidity, shorter operative times, easier rehabilitation, and decreased postoperative pain. However, multiple studies have found that allografts have a higher rerupture rate in patients younger than 25 years. Advantages and disadvantages of the AMP drilling technique and the use of allografts are presented in Table 1. This article outlines the surgical technique for an AMP ACL reconstruction with a tibialis anterior allograft fixed with the Mitek Femoral and Tibial Intrafix sheath and screw system (DePuy Synthes, Raynham, MA).

Surgical Technique

Preparation of Graft

The tibialis anterior allograft is prepared on a back table placed onto the graft preparation board with its ends held in Kocher clamps. The midpoint of the graft
and points 30 mm distal to the midpoint are marked with a surgical pen (Fig 1). The ends of the graft are whipstitched with high-strength suture material in a grasping Krackow fashion on each limb, resulting in 4 sutures that will be used for tensioning when implanted (Video 1). The graft is tubularized between the 30-mm marks with No. 2-0 Vicryl suture (Ethicon, Somerville, NJ) and tied at the midpoint and each 30-mm mark. The graft is then looped over a passing suture, sized (Fig 2), and placed back on the preparation board under tension and covered in moist gauze.

**Anteromedial Portal**

The patient is positioned supine on the operating room table, with the operative knee put in a leg holder and the foot of the bed dropped (Fig 3). Anatomic landmarks and the proposed incision sites are marked (Fig 4). The lateral and medial arthroscopic portals are localized relative to the joint line and patellar tendon. The lateral portal is created, and the arthroscope is inserted (Fig 5). The AMP is created under direct vision ensuring an adequate angle to the posterior aspect of the lateral wall of the intracondylar notch. The AMP is more inferior and medial than the typical arthroscopic medial portal (Fig 6). A diagnostic arthroscopy is then systematically performed looking to identify any comorbid meniscal or articular cartilage pathology that may be present. A small notchplasty is performed using a bone-cutting shaver (Arthrex, Naples, FL) to remove any remaining ACL from the lateral wall of the intercondylar notch (Fig 7) and improve visualization of the back wall. The shaver is then turned to the tibial footprint of the ACL, debriding any remnant tissue present (Video 1).

**Creation of Femoral Tunnel**

The femoral tunnel is localized using an AMP over-the-top drill guide (Arthrex) hooked behind the back wall as the knee is hyperflexed to 120° to avoid a short tunnel, as well as back wall blowout, and to allow for oblique tunnel placement low on the femoral wall (Fig 8). As the knee is hyperflexed, the surgeon’s hand is directed posteriorly to keep the guide hooked against the back wall of the notch. Through the drill guide, a guide pin is inserted with the goal of a relatively horizontal lateral thigh exit point just anterior to the intermuscular septum. Pin position relative to the back wall is assessed using an arthroscopic probe to confirm that no back wall blowout will occur (Fig 9). Next, by

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**Table 1. Advantages and Disadvantages of Using Anteromedial Femoral Versus Transtibial Tunnel Drilling Technique and Allograft Versus Autograft**

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<th>Advantages</th>
<th>Disadvantages</th>
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<tr>
<td>Anteromedial vs transtibial tunnel</td>
<td>More anatomic tunnel placement</td>
<td>Shallow tunnel</td>
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<td>Secures graft in more horizontal orientation</td>
<td>Tunnel drilled with knee in hyperflexion</td>
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<td>Allograft vs autograft</td>
<td>Absence of donor-site morbidity</td>
<td>Higher rerupture rate</td>
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<td>Shorter operative time</td>
<td>More costly</td>
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<td>Easier rehabilitation</td>
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**Fig 1.** The tibialis anterior allograft is prepared on a back table. The graft is placed onto the graft preparation board with its 2 ends held in Kocher clamps. Once the graft is secured, markings are made with a surgical pen at its midpoint and 30 mm distal to the midpoint on both ends.
use of an appropriately sized low-profile reamer (Smith & Nephew, London, England) to avoid injuring the medial femoral condyle, the femoral tunnel is reamed over the guide pin (Fig 10). The head of the reamer is buried and then retracted to confirm maintenance of the back wall during the reaming process. Once the presence of an adequate back wall is confirmed, the femoral tunnel is reamed to a depth of 28 to 30 mm (Fig 11). When the reaming process is complete, the reamer and guide pin are removed from the knee. An arthroscopic shaver (Arthrex) is used to remove any remaining debris and to smooth the anterior aspect of the femoral tunnel, to facilitate ease of graft passage. The arthroscope can then be inserted into the AMP for an in-line direct view of the femoral tunnel, confirming an intact back wall (Fig 12).

**Creation of Tibial Tunnel**

With the femoral tunnel complete, a distal incision is made on the tibia 2 fingerbreadths distal to the joint line, midway between the tibial tuberosity and the posteromedial aspect of the proximal tibia (Fig 13). With an elbow aimer set at 55°, the guide pin for tibial tunnel placement is inserted (Fig 14). Before tunnel reaming, the position of the guide pin is checked relative to the remnant ACL footprint, the posterior cruciate ligament,
**Fig 4.** Anatomic landmarks and the proposed incision sites are marked on the operative knee.

**Fig 5.** The arthroscope is inserted through the lateral portal.

**Fig 6.** The anteromedial portal is created under direct vision ensuring an adequate angle to the posterior aspect of the lateral wall of the intracondylar notch. The anteromedial portal is more inferior and medial than the typical arthroscopic medial portal.
Fig 7. A small notchplasty is performed using a bone-cutting shaver to remove any remaining anterior cruciate ligament (ACL) from the lateral wall of the intercondylar notch.

Fig 8. With the knee hyperflexed, an anteromedial portal over-the-top drill guide is hooked behind the back wall of the knee. Through the drill guide, a guide pin is inserted with the goal of a relatively horizontal lateral thigh exit point. (A) Outside view. (B) Arthroscopic view.
Fig 9. The pin position relative to the back wall is assessed using an arthroscopic probe to confirm that no back wall blowout will occur.

Fig 10. With the knee kept in hyperflexion, an appropriately sized reamer is inserted over the guide pin and the femoral tunnel is drilled.

Fig 11. The femoral tunnel is reamed to a depth of 28 to 30 mm.
Fig 12. With femoral tunnel reaming complete, the arthroscope can be inserted into the anteromedial portal for an in-line direct view of the femoral tunnel, confirming an intact back wall.

Fig 13. A distal incision is made on the tibia 2 fingerbreadths distal to the joint line, midway between the tibial tuberosity and the posteromedial aspect of the proximal tibia.

Fig 14. With an elbow aimer set at 55°, the guide pin for tibial tunnel placement is inserted.
and the posterior border of the anterior horn of the lateral meniscus. The tibial tunnel is then reamed using an appropriately sized fully fluted reamer, with the tip of the guide pin protected intra-articularly with a curette (Video 1). The aperture of the tibial tunnel is debrided intra-articularly with the arthroscopic shaver, removing any bone and cartilage debris. The shaver is then inserted into the tibial tunnel for additional debridement and beveling of the posterolateral aspect of the tunnel to allow for easy graft passage.

**Femoral Fixation**

With the tunnels created, a Beath pin (Arthrex) with a loop of suture placed into its eyelet is inserted through the AMP and into the previously drilled hole within the femoral tunnel (Fig 15). The Beath pin is grasped laterally and pulled completely through, allowing the limbs of the passing suture to be clamped at the lateral aspect of the distal thigh. Next, by use of an arthroscopic grasper inserted into the tibial tunnel, the loop is grabbed intra-articularly connecting the femoral and tibial tunnels (Fig 16). The prepared allograft is then passed through the loop of the passing suture, bringing the graft into the intra-articular space, seating it into the femoral tunnel (Video 1). With tension held on both the passing suture and the sutures from the distal ends of the graft, the Mitek Femoral Intrafix sheath trial is introduced through the AMP (Fig 18). With the knee hyperflexed, the sheath trial is impacted between the 2 limbs of the seated graft. Once completely seated, the sheath trial is removed from the knee by gently tapping backward on the trial with a

**Fig 15.** A Beath pin with a loop of suture placed into its eyelet is inserted through the anteromedial portal and into the previously drilled hole within the femoral tunnel.

**Fig 16.** By use of an arthroscopic grasper inserted into the tibial tunnel, the loop is grabbed intra-articularly connecting the femoral and tibial tunnels.
**Fig 17.** The prepared allograft is passed through the loop of the passing suture and orientated so that the limbs are in a proximal-distal position.

**Fig 18.** With tension held on both the passing suture and the sutures from the distal ends of the graft, the Mitek Femoral Intrarfix sheath trial is introduced through the anteromedial portal. With the knee hyperflexed, the sheath trial is impacted between the 2 limbs of the seated graft.

**Fig 19.** An appropriately sized Mitek Femoral Intrarfix sheath (0.5 mm smaller than the size of the graft) is inserted with the knee maintained in the hyperflexed position.
mallet. Next, an appropriately sized Mitek Femoral Intrafix sheath (0.5 mm smaller than the size of the graft) is inserted in similar fashion with the knee maintained in the hyperflexed position (Fig 19). The sheath is impacted into a slightly recessed position in the femoral tunnel, followed by the inserter being gently tapped backward and out of the intra-articular space. A nitinol wire (Arthrex) is inserted through the AMP and seated within the sheath. A malleable graft protector is then positioned between the nitinol wire and the graft material. With tension held on both the passing suture and the sutures from the distal ends of the graft, an appropriately sized Mitek Femoral Intrafix PEEK (polyether ether ketone) interference screw (DePuy Synthes) (0.5 mm smaller than the size of the graft) is inserted over the nitinol wire. The screw is advanced until a small collar of blue sheath is visible circumferentially around the head of the screw (Fig 20). The graft protector and nitinol wire are removed, and final screw and sheath position is confirmed visually (Video 1). Adequacy of fixation strength is then checked with a few strong pulls on the distal aspect of the graft. The knee is cycled 20 times with tension applied to the distal sutures, allowing for any creep to be removed from the graft (Fig 21).

**Tibial Fixation**

Tibial fixation is then achieved using an appropriately sized Mitek Tibial Intrafix sheath and screw. A small back table is brought into the field, and the knee is brought to near full extension (Fig 22). The graft limbs can be rotated such that the anteromedial bundle is
**Fig 22.** For tibial fixation, a small back table is brought into the surgical field and the knee is brought to near full extension.

**Fig 23.** The Mitek Tibial Intrafix sheath is impacted into position until the inserter is flush. With significant tension applied to the distal traction sutures and a posterior drawer force applied to the knee, the Mitek Tibial Intrafix interference screw is inserted until it is flush with the anterior cortex of the proximal tibia.

**Fig 24.** After graft fixation, an intraoperative Lachman test is performed to assess knee stability.
positioned anterior to the posterolateral bundle. A Mitek Tibial Intrafix trial is then impacted into position between the graft limbs until it is flush with the tibial cortical surface. The Mitek Tibial Intrafix sheath is similarly impacted into position until the inserter is flush (Fig 23). With significant tension applied to the distal traction sutures and a posterior drawer force applied to the knee, the Mitek Tibial Intrafix interference screw is inserted until it is flush with the anterior cortex of the proximal tibia.

With graft fixation complete, the knee is examined for complete range of motion, signs of impingement, and knee stability with an intraoperative Lachman test (Fig 24) and undergoes arthroscopic assessment of graft tension. Final graft positioning can be confirmed arthroscopically (Fig 25). The aperture of the tibial tunnel is viewed to confirm that there has not been advancement of the tibial sheath and/or screw into the joint space (Video 1). Finally, excess graft is excised with a scalpel blade, and the wounds are irrigated and closed in layers (Fig 26). The operative knee is dressed, and the lower extremity is placed in a hinged knee brace locked in extension (Fig 27).

An additional assessment of this technique can be seen on postoperative radiographs. When the AMP is used, the femoral tunnel angle with respect to the femoral condyles will be more horizontal than a femoral tunnel drilled using the transtibial technique (Fig 28). Pearls and pitfalls associated with the technique can be seen in Table 2.

Fig 26. Excess graft is excised with a scalpel blade.
Discussion

The use of an AMP aids in placement of the femoral tunnel in the vital location of the anatomic footprint of the ACL origin. To better restore normal ACL anatomy, the emerging trend is to drill the femoral tunnel more centrally in the ACL footprint, slightly lower on the wall of the lateral femoral condyle and more anterior than when performing a standard transtibial technique, the presumption being that a more horizontally oriented graft, as opposed to a vertical graft, will optimize rotatory as well as translational stability. Trying to accomplish this by drilling the femoral tunnel through the use of the transtibial technique may be complicated because of improper or difficult ACL visualization and a relatively short femoral tunnel. Therefore, the use of an AMP has been proposed to drill the femoral tunnel independently in a more horizontal location, achieving adequate tunnel length for fixation and incorporation into the bone. This portal allows for precise placement of the guidewire.

Table 2. Pearls and Pitfalls Associated With Anteromedial Portal Drilling Technique

<table>
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<tr>
<td>The femoral tunnel is localized using an anteromedial portal over-the-top drill guide hooked behind the back wall as the knee is hyperflexed to 120° to avoid a short tunnel, as well as back wall blowout, and to allow for oblique tunnel placement low on the femoral wall.</td>
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<td>During reaming of the femoral tunnel, the head of the reamer is buried and then retracted to confirm maintenance of the back wall. After reaming, the arthroscope can be inserted into the anteromedial portal to obtain a direct in-line view of the femoral tunnel to ensure that blowout has not occurred over the length of the tunnel.</td>
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<td>To ensure easy graft passage through the tibial tunnel, the shaver is inserted into the tibial tunnel for additional debridement and beveling of the posterolateral aspect of the tunnel.</td>
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<td>The Mitek Femoral Infracx sheath and screw should be sized 0.5 mm smaller than the size of the graft to ensure a tight interference fixation.</td>
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<td>To avoid posterior wall blowout, the surgeon should confirm appropriate guide pin placement before reaming the femoral tunnel. This can be accomplished using the arthroscopic probe inserted through the anteromedial portal site to ensure that a distance greater than the radius of the reamer is present between the pin and the back wall.</td>
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<td>The surgeon should be careful to avoid injuring the articular surface of the medial femoral condyle as the reamer is introduced through the anteromedial portal. Placement of a graft protector between the pin and the medial femoral condyle coupled with the use of a low-profile reamer will help avoid iatrogenic injury to the articular surface.</td>
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<td>The surgeon should look out for roof and notch impingement on the graft by taking the knee through a full range of motion while visualizing arthroscopically. Any areas of potential impingement can be addressed with a bone-cutting shaver.</td>
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and proper visualization of the ACL footprint. In contrast to the traditional transtibial technique, when the tunnel is drilled through the AMP, the tunnel aperture is shallow and inferior, closer to the center of the footprint and in a more anatomic position.9

However, the learning curve for transitioning from the traditional transtibial technique to the AMP technique is steep. There are challenges and complications when using the AMP for femoral tunnel drilling. Undergoing ACL reconstruction while the knee is in hyperflexion rather than the traditional 90° of flexion can be a difficult transition and can lead to possible complications during surgery.10

The AMP aids in the placement of the femoral tunnel in the vital location of the anatomic footprint of the ACL origin. Re-establishing the anatomic femoral origin of the ACL is essential, for it may lead to better postoperative outcomes and a lower failure rate.

References