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# Medial Portal Technique for Anterior Cruciate Ligament Reconstruction

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## Introduction

Anatomic graft placement is critical to the success and clinical outcome of anterior cruciate ligament (ACL) reconstruction. Nonanatomic bone tunnel placement is the most common cause of a failed ACL reconstruction. Single-incision ACL reconstruction has traditionally been performed using the transtibial tunnel technique. In the transtibial tunnel technique, the ACL femoral tunnel is drilled through the tibial tunnel. Advantages of the transtibial tunnel technique are that it is familiar to most surgeons, it is simple and quick, and it does not require the knee to be flexed beyond 90° of flexion when the femoral tunnel is drilled. The major disadvantage of the transtibial tunnel technique is that it is not possible to independently drill the ACL femoral tunnel in the notch since the femoral tunnel is drilled through the tibial tunnel, therefore the two tunnels are linked. Anatomical and clinical studies have demonstrated that the transtibial tunnel technique tends to place the tibial tunnel too posterior and the femoral tunnel too high and deep in the intercondylar notch. These tunnel placements result in a vertical ACL graft. A vertical ACL graft may restore AP translation but often fails to control tibial rotation, resulting in the patient having a positive pivot shift test and symptoms of giving way.

Figure 1

In the medial portal technique the femoral tunnel is drilled through the anteromedial or an accessory medial portal. The medial portal technique allows independent drilling of the ACL femoral and tibial tunnels, which facilitates anatomic placement of the ACL graft. Advantages of the medial portal technique are listed in **Table 1**. Disadvantages of the medial portal technique are listed in **Table 2**. Most of the disadvantages of the anteromedial portal technique are related to the fact that the femoral tunnel must be drilled with the knee in hyperflexion. **(Figure 1)**

**Figure 1:**
The medial portal technique requires the knee to be maintained in > 130° of flexion when drilling the femoral guide pin and ACL femoral tunnel.

This is necessary to prevent the femoral guide pin from exiting the thigh in an inferior location which places the peroneal nerve at risk for injury. The need to drill the femoral tunnel with the knee in hyperflexion makes it difficult to use the positioning technique commonly used when performing transtibial ACL reconstructions, in which a circumferential leg holder is used and the foot of the operating room table is flexed. This positioning technique limits the surgeon's ability to flex the knee to 120° or higher. The numerous disadvantages of the medial portal technique may deter some surgeons comfortable with the transtibial tunnel technique from changing their surgical technique and can present formidable challenges to surgeons who wish to make the transition from the transtibial tunnel technique to the medial portal technique. The purpose of this article is to present my current surgical technique for performing ACL reconstruction using the medial portal technique and to present tips and pearls which may which may be helpful to surgeons who are considering changing from the transtibial tunnel technique to the medial portal technique.


Figure 2A


Figure 2B

**Indications and Contraindications**

The medial portal technique is versatile and can be used with any graft type and for any primary, revision, single- or double-bundle ACL reconstruction. The medial portal technique is particularly useful in the setting of partial ACL tears, allowing isolated reconstruction of the posterolateral bundle (PLB) or anteromedial bundle (AMB) with preservation of the remaining intact native ACL fibers. **(Fig 2A, B)**

**Figure 2:**
**(A)** Partial ACL tear with intact AMB. The torn PLB was reconstructed with a tripled semitendinosus graft preserving the intact AMB fibers. **(B)** Partial ACL tear with intact PLB. The torn AMB was reconstructed with a tripled semitendinosus graft preserving the intact PLB fibers.

The only contraindication to the anteromedial portal technique is the inability to flex the knee to at least 120°. This limitation is most likely to be encountered in obese patients.

**Operating Room Set-up and Patient Positioning**

Full unrestricted knee flexion is required during the procedure. Therefore, it is difficult to use a conventional circumferential arthroscopic leg holder and flexing the foot on the operating room table since this positioning method restricts knee flexion. The technique is mostly easily performed by keeping the operating room table flat and using a thigh post and one or two foot rests. A padded thigh post and padded lateral hip positioner are attached to the operating room table at the level of the pneumatic tourniquet. The padded lateral hip positioner stabilizes the patient's pelvis and the padded thigh post supports the thigh and acts as a fulcrum permitting application of a valgus torque to the knee allowing the medial compartment to be opened while performing medial meniscus surgery. Lateral meniscus surgery is performed by placing the knee in a figure-four position. Opening of the lateral compartment can be facilitated by placing the knee in the figure-four position with the patient's foot on a padded Mayo stand. This allows the figure-four position to be maintained without manual assistance and the weight of the operative

Figure 3A

Figure 3B

Figure 3C

Figure 3D

leg assists in opening the lateral compartment. Although a sandbag or rolled blanket can be taped to the foot of the operating table allowing the knee to be maintained in flexion, we have found it easier and more practical to use two padded L-shaped foot rests that can be adjusted by moving the rail clamp along the side rail of the operating room table. The most distal foot rest is adjusted to maintain the knee between 70 – 90° of flexion during most of the procedure. A second foot rest is placed proximal at the mid-thigh level and adjusted to maintain the knee in hyperflexion during drilling of the ACL femoral tunnel. The patient's foot is placed under the proximal foot rest allowing the hyperflexion position to be maintained during drilling of the femoral tunnel. **Figures 3 (A, B, C, D)**

**Figure 3:**
Operating room set-up **(A)** The padded thigh post is placed at the level of the tourniquet and the distal foot rest adjusted so that the knee is maintained between 70 - 90° of flexion during the procedure. **(B)** The patient's pelvis is stabilized on the operating table by the padded thigh post and a padded lateral hip positioner. These positioning aids allow the patient's knee to be maintained between 70 - 90° of flexion during the procedure without the need for an assistant. **(C)** The proximal foot rest is adjusted to maintain the knee in greater than 130° of flexion when the femoral guide pin and ACL femoral tunnel are drilled. **(D)** The relative height of the two foot rests can be adjusted so that the knee is maintained at a known flexion angle during graft tensioning. The knee flexion angle can be increased or decreased by raising or lowering the proximal foot rest.

Securing the knee in this fashion eliminates the need for an assistant to hold the leg and eliminates the risk of bending the femoral guide pin which can occur when the flexion angle of an unsupported knee inadvertently changes. A bent femoral guide pin will create metal debris as the reamer is advanced over the guide pin, or prevent advancement of the endoscopic drill bit.

A thigh-length anti-embolism stocking and a foam heel protector are applied to the nonoperative leg. A padded pneumatic tourniquet is placed high on the operative leg but is rarely used during the procedure as adequate joint visualization can be obtained using the DYONICS® 25 Fluid Management System. Typically, the pump flow rate is set at 2.5 liters/min and the joint pressure at 60 – 80 mm Hg while performing diagnostic arthroscopy, meniscal surgery, preparation of the ACL insertion sites, and during passage of the ACL graft. Increasing the pump pressure to 100 – 120 mm Hg when the knee is bent into hyperflexion enhances visualization in the notch during drilling of the femoral tunnel.

**Arthroscopic Portals**

In the traditional medial portal technique two standard portals are used, the anterolateral and the anteromedial, and the femoral tunnel is drilled through the anteromedial portal. The height of the standard anteromedial portal above the medial joint line results in a more horizontal orientation of the femoral guide pin, causing the guide pin to exit the distal femur and thigh distally and posteriorly, resulting in a shorter femoral tunnel. A shorter femoral tunnel length limits the amount of ACL graft that can be inserted into the femoral tunnel when suspensory cortical femoral fixation devices such as the ENDOBUTTON® Fixation Device CL are used. Drilling the femoral tunnel through the anteromedial portal also increases the risk of injury to the articular cartilage of the medial femoral condyle, because the guide pin starts higher above the medial joint line which places the endoscopic drill bit closer to the medial femoral condyle.

ACL reconstruction using the medial portal technique is facilitated by using three portals. The anterolateral portal is used as the viewing portal to perform diagnostic arthroscopy and meniscal surgery. The anteromedial portal is used as both a working and viewing portal, and the accessory medial portal is used to insert instrumentation in the notch and for drilling the femoral tunnel. Drilling the femoral guide pin through a low accessory medial portal close to the medial joint line results in the guide pin exiting the distal femur and thigh more proximally and anteriorly, as compared to drilling through the anteromedial portal. A more proximal exit of the guide pin produces a longer femoral tunnel length. A longer femoral tunnel length is advantageous when using an ENDOBUTTON® CL Fixation Device as the femoral fixation method. Using a low accessory medial portal also results in the femoral guide pin traveling from a low entry point at the level of the portal to a higher level in the notch. When the knee is placed in hyperflexion, the trajectory of a guide pin inserted through a low accessory medial portal results in the guide pin diverging away from the medial femoral condyle, decreasing the risk of injury to the articular cartilage of the medial femoral condyle during drilling of the femoral tunnel.

The arthroscopic portals are marked and created with the knee at 90° of flexion. A high anterolateral portal at the level of the interior pole of the patella, adjacent to the lateral border of the patellar tendon is created using a No. 11 knife blade. This portal is used as the routine viewing portal, since it allows a complete view of the patellofemoral and the medial and lateral compartments. The height of this portal above the lateral joint line places the arthroscope above the fat pad and provides an excellent “look down” view of the ACL tibial attachment site. However, the view from this portal gives a frontal view of the notch and ACL femoral insertion site and provides limited spatial information with respect to shallow-deep placement of the ACL femoral tunnel along the lateral wall of the notch.

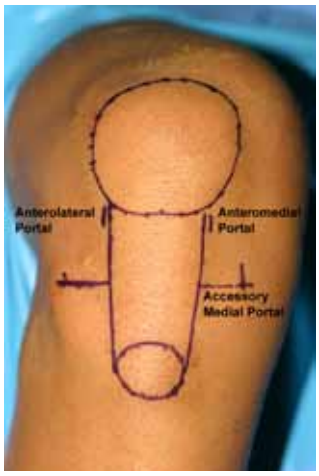


Figure 4

The anteromedial portal is created at the level of the inferior pole of the patella, adjacent to the medial border of the patellar tendon. This portal is used both as a working and viewing portal. Placing this portal high above the medial joint line provides adequate spatial separation from the accessory anteromedial portal, minimizing instrument crowding when these two portals are used simultaneously as the viewing and working portals. **(Figure 4)**

**Figure 4:**
Arthroscopic portals. Use of 3 portals facilitates surgery when using the medial portal technique. Portals are marked and made with the knee at 90° of flexion. The anterolateral portal is placed adjacent to the lateral border of the patellar tendon at the level of the inferior pole of the patella. The medial portal is placed adjacent to the medial border of the patellar tendon at the level of the inferior pole of the patella. The accessory medial portal is made under direct arthroscopic vision and is placed as low as possible avoiding the anterior horn of the lateral meniscus. The medial-lateral placement of this portal is customized based on the femoral fixation method and the length of the ACL graft.

**Preparation of the ACL Tibial Insertion Site**

The arthroscope is placed in the anterolateral portal and a motorized shaver with a DYONICS® 4.5 mm straight or curved INCISOR® PLUS ELITE® shaver blade is inserted into the joint through the anteromedial portal, and remnants of the torn ACL are resected. An attempt is made to preserve some of the ACL fibers at the tibial insertion site to aid with placement of the tibial tunnel. A SAPHYRE® bipolar 90° high profile ablation thermal probe is inserted through the anteromedial portal and the outline of the tibial insertion site marked.

**Creation of the Accessory Medial Portal**

An 18 gauge spinal needle is used to determine the optimal position for the accessory medial portal. This portal is created under direct vision and should be located as low as possible above the medial joint line while avoiding the anterior horn of the medial meniscus. Medial-lateral placement of this portal is dictated by the method of ACL femoral graft fixation and the length of the ACL graft. A more medial placement of the accessory medial portal produces a more horizontally-oriented femoral tunnel, resulting in a shorter femoral tunnel length (< 40 mm). However, placement of the portal too far medially risks injury to the medial femoral condyle during drilling of the femoral tunnel. Shorter femoral tunnel lengths are acceptable when interference screws are used as the femoral fixation method. However, when cortical suspensory fixation methods such as the ENDOBUTTON® CL Fixation Device are used, longer femoral tunnel lengths in the range of 40 – 45 mm are desirable. To achieve these femoral tunnel lengths, the accessory medial portal must be started closer to the medial edge of the patellar tendon. After determining the optimal location, the accessory medial portal is created under direct vision with a No. 11 knife blade with the knife blade directed away from the anterior horn of the medial meniscus. Dilating the skin portal and the underlying fat pad using the blunt arthroscope obturator followed by spreading the tips of a pair of Metzenbaum scissors helps stretch the portal and fat pad, easing future instrument passage into the knee joint.

Figure 5A

Figure 5B

**Preparation of the Intercondylar Notch**

The view of the intercondylar notch and ACL femoral insertion site changes significantly depending on the arthroscopic portals utilized. Viewing the notch through the anterolateral portal provides a frontal or tangential view of the notch and ACL femoral insertion site. This approach does not allow accurate assessment of shallow-deep placement of the ACL femoral tunnel along the lateral wall of the intercondylar notch. Viewing the ACL femoral insertion through the anteromedial portal gives an orthogonal view of the lateral wall of the notch, allowing accurate assessment of shallow-deep and high-low placement of the ACL femoral tunnel. **(Figure 5A, B)**

**Figure 5:**
Anterolateral versus anteromedial portal view of the notch. **(A)** Anterolateral portal view of the notch and ACL femoral footprint. This portal gives a tangentially view of the notch making it difficult to assess shallow-deep placement of the femoral tunnel. **(B)** Anteromedial portal view of the notch and ACL femoral footprint. This portal gives a two dimensional view of the ACL femoral insertion site allowing both shallow-deep and high-low placement of the ACL femoral tunnel to be accurately assessed.

Notchplasty has traditionally been done to enhance visualization of the ACL femoral insertion site. However, viewing the notch through the anteromedial portal gives excellent visualization of the ACL femoral insertion site, eliminating the need to perform a notchplasty for visualization purposes.

Figure 6


Figure 7

A SAPHYRE® bipolar 90° high profile ablation thermal probe is inserted through the accessory medial portal and is used to remove soft tissue from the lateral wall of the notch. Removing the soft tissue from the lateral wall of the notch using a curette or motorized shaver blade or burr destroys the native soft tissue and underlying bony anatomical landmarks, leaving no reference points for femoral tunnel placement. In acute cases, the remnants of the torn ACL can provide guidance for positioning the femoral tunnel. **(Figure 6)**

**Figure 6:**
Acute ACL tear. View through the anteromedial portal. The ACL femoral footprint can clearly be seen and used to assist with placement of the femoral tunnel.

However, in patients with chronic ACL tears, soft tissue landmarks may be unreliable. The lateral intercondylar ridge ("resident's ridge") can be identified in most knees and it represents the superior limit of the ACL femoral insertion site. In many knees it is possible to identify a second bony ridge, the lateral bifurcate ridge which, separates the insertion sites of the AMB and PLB. If present, the lateral intercondylar and bifurcate ridges can serve as useful anatomical landmarks to assist with placement of the femoral tunnel. **(Figure 7)**

**Figure 7:**
Lateral wall of the intercondylar notch, anteromedial portal view with the knee at 90° of flexion. The notch ridges can clearly be seen after removal of the soft tissue from the lateral wall of the notch using a thermal probe. The lateral intercondylar ridge (arrows) represents the superior border of the ACL insertion. The lateral bifurcate ridge (arrowheads) is nearly perpendicular to the lateral intercondylar ridge and separates the anteromedial (AM) and the posterolateral (PL) femoral insertion sites.

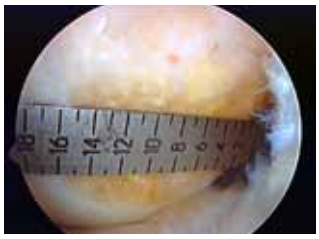

Figure 8

**Femoral Tunnel**

Femoral tunnel placement is most accurately accessed with the knee at 90° of flexion and viewing the ACL femoral insertion site with the arthroscope in the anteromedial portal. The ACL Anatomic Template is bent and inserted into the joint through the accessory medial or anterolateral portal along the lateral wall of the notch. The length of the ACL femoral insertion site is measured at a level halfway between the lateral intercondylar ridge and the inferior margin of the articular cartilage border, which represents the lower limit of the ACL. **(Figure 8)**

**Figure 8:**
The ACL Anatomic Template is used to measure the length of the ACL femoral insertion site.

There is controversy regarding the optimal femoral tunnel placement for a single-bundle ACL reconstruction. Placing the femoral tunnel in the center of the ACL femoral insertion site currently seems to be favored. A central ACL femoral tunnel will allow a single-bundle ACL graft to cover parts of both the AMB and PLB insertion sites. An ACL graft placed in this manner will reproduce fiber-length changes of parts of both the AMB and PLB. A central femoral tunnel also places the femoral tunnel further away from the posterior outlet of the notch, minimizing the risk of a cortical "blowout" when drilling the femoral tunnel.

Figure 9A

Figure 9B

A microfracture awl is inserted through the accessory medial portal and used to mark the location of the femoral tunnel. For a central ACL femoral tunnel placement the center of the tunnel should be located at a shallow-deep position 50% of the measured insertion site length from the posterior outlet of the notch, and the high-low placement should be half-way between the lateral intercondylar ridge and the inferior articular cartilage border. **(Figure 9 A, B)**

**Figure 9:**
View of the ACL femoral insertion site through the anteromedial portal with the knee at 90° of flexion. **(A)** The microfracture awl is positioned at 50% of the length of the ACL femoral insertion site. In this case, the tip of the awl is seen to lie just behind the lateral bifurcate ridge. **(B)** The lateral intercondylar ridge (solid line) and lateral bifurcate ridge (dotted line) are shown. The blue circle represents the hole created by the microfracture awl and can be seen to lie in the center of the ACL femoral insertion site.

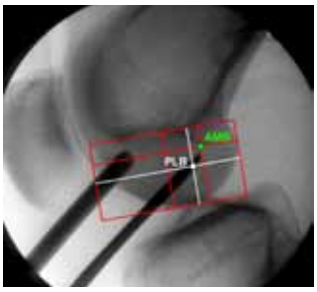


Figure 10

Confirmation of the desired femoral tunnel placement can be made by measuring with the ACL Anatomic Template and/or using a C-arm image. **(Figure 10)**

**Figure 10:**
True lateral c-arm image. The radiographic quadrant method can be used to determine and specify the position of the femoral tunnel. The center of the AMB (green circle) and the center of the PLB (white circle) are shown. The tip of the microfracture awl can be seen to lie midway between the centers of the two bundles.

Using the above guidelines eliminates the need to an offset guide to determine the location of the femoral guide pin in the notch. Rather than having the offset guide choose the proper location for the femoral guide pin, the surgeon picks the location and verifies it using the available local anatomic landmarks, ACL template and or C-arm images.

Figure 11

After selecting and confirming the desired location for the ACL femoral tunnel, an ACL Director 0 mm offset guide is inserted through the accessory medial portal and placed at the previously selected location for the femoral guide pin. At this point in the procedure, it is necessary to flex the knee to > 130° which can result in the fat pad being dragged into the field of view, obscuring visualization in the notch. This problem can be prevented by resecting slightly more of the fat pad during notch preparation earlier in the procedure. Further resection of the fat pad can be performed at this time if necessary by inserting a motorized shaver through the anterolateral portal. Visualization in the notch can also be enhanced by increasing the pump pressure. The knee is slowly flexed while keeping the tip of the 0 mm offset aimer positioned at the previously selected location in the notch. Once the desired degree of hyperflexion is reached the foot of the operative leg is hooked under the proximal foot rest maintaining the knee in hyperflexion without the need for an assistant to manually hold the leg. A 2.7 mm guide pin is inserted through the 0 mm offset aimer and tapped into the bone until the drill-tip part of the pin is flush with the cortex. **(Figure 11)**

**Figure 11:**
View through the anteromedial portal with the knee in hyperflexion. The lateral intercondylar ridge is seen. The guide pin is seen to lie just behind the lateral bifurcate ridge in the center of the ACL femoral insertion site.

The handle of the ACUFEX® DIRECTOR® offset drill guide is then angled laterally. This maneuver will increase the length of the femoral tunnel approximately 5 mm and orients the drill bit more obliquely with respect to the lateral wall of the notch producing a more elliptically-shaped bone tunnel. An elliptically-shaped bone tunnel spreads the fibers of a soft-tissue graft out over the ACL femoral footprint and covers a larger area of the ACL insertion site versus a more circular tunnel. The femoral tunnel is drilled through the femoral cortex using a 4.5 mm ENDOBUTTON® drill bit. The length of femoral tunnel can be determined by noting the length on the drill bit at the time of cortical

Figure 12

Figure 13

breakthrough. Knowing the length of the femoral tunnel allows the femoral socket to be drilled to the femoral cortex. Drilling the femoral socket to the cortex will allow room for the ENDOBUTTON® Fixation Device to flip in all situations, eliminating the need to calculate how deep to drill the femoral socket. The femoral socket is drilled using an endoscopic drill bit corresponding to the diameter of the ACL graft. **(Figure 12)**

**Figure 12:**
Central femoral tunnel.

**Tibial Tunnel**

In contrast to the transtibial tunnel technique the starting position and angulation of the tibia tunnel are not critical to the success of the anteromedial portal technique. Therefore, the surgeon is free to choose these parameters as desired. In the case of long ACL grafts, a steeper and thus longer tibial tunnel can be drilled, maximizing the amount of graft material inserted into the tibial bone tunnel. In revision cases, the surgeon is free to position the location of the new tibial tunnel anywhere along the anteromedial surface of the tibia bypassing previous tunnels and previous tibial fixation hardware. For soft-tissue grafts the ACL tibial aimer is typically set at 55° and the tunnel started 1 cm medial to the crest of the tibia.

Viewing the ACL tibial attachment site through the anteromedial portal provides a more direct view of the anterior horn of the lateral meniscus and ACL tibial attachment site, allowing better assessment of anterior-posterior and medial-lateral guide pin and tunnel placement. **(Figure 13)**

**Figure 13:**
View of the tibial insertion site with the arthroscope in the anteromedial portal. The anterior horn of the lateral meniscus is clearly visible.

Figure 14

Figure 15

In general, the tip of the tibial guide pin should be positioned 2 – 3 mm anterior to the anterior horn of the lateral meniscus and 2 – 3 mm lateral to the border of the medial articular cartilage margin. Placement of the guide pin posterior to the anterior border of the anterior horn of the lateral meniscus will result in the tibial tunnel being centered in the center of the PLB, producing a vertical ACL graft in the sagittal plane. Positioning the tibial guide pin too far laterally in the tibial insertion site can result in impingement of the ACL graft against the lateral wall of the notch. Ideally, the tibial guide pin should be placed in the medial half of the ACL tibial insertion site. While viewing through the anteromedial or anterolateral portal, a DIRECTOR® ACL tip aimer is inserted through the accessory medial portal and a 2.4 mm drill-tip guide pin drilled into position. **(Figure 14)**

**Figure 14:**
Anteromedial portal view. The tibial guide pin can be seen to lie anterior to the anterior horn of the lateral meniscus.

Due to the large amount of variability of the intercondylar notch roof angle and the degree of knee hyperextension from patient to patient, it is extremely helpful to use fluoroscopy to insure correct anterior-posterior placement of the tibial guide pin. The knee is placed in maximum extension and a true lateral view of the knee with the femoral condyles overlapping is obtained. For hamstring and soft tissue grafts which will be centered along the guide pin line, the ideal placement for the tibial guide pin is parallel and approximately 3 mm posterior to Blumensaat's line. **(Figure 15)**

**Figure 15:**
The C-arm is used to document correct placement of the tibial guide pin. The knee is placed in maximum extension and a true lateral image of the knee is obtained. For hamstring tendon and soft tissue ACL grafts the tibial guide pin should be positioned to lay parallel and 3 mm posterior to Blumensaat's line.

Figure 16

Figure 17

For patellar tendon grafts the ideal guide pin placement is 2 mm posterior to Blumensaat's line since the ligament graft fibers are offset from the bone block and will come to lie posterior to this line. The most common error made by surgeons who have recently converted from the transtibial tunnel technique is to position the tibial guide pin too posterior. **(Figure 16)**

**Figure 16:**
The most common error made by surgeons who have recently converted from the transtibial tunnel technique is to position the tibial guide pin too posterior. In this case the initial tibial guide pin was too posterior and placement of a second guide pin was required.

Once proper placement of the tibial guide pin is confirmed, the tibial tunnel is drilled in the conventional fashion using a fully fluted cannulated drill bit. **(Figure 17)**

**Figure 17:**
Correct placement of the tibial tunnel in the center of the ACL tibial insertion site. The central femoral tunnel can also be seen.

**Graft Passage**

Passing soft tissue grafts is similar to the transtibial tunnel technique. However, when the femoral tunnel is drilled using the anteromedial portal technique, the femoral and tibial tunnels are no longer collinear and it is sometimes more difficult to pass the bone block of a bone-patellar tendon-bone or quadriceps tendon-bone graft into the femoral tunnel. Because the tibial and femoral bone tunnels are no longer collinear, the femoral bone block must take a turn in the notch before passage into the femoral tunnel is possible. Changing the flexion angle of the knee often helps the tunnels line up better and make graft passage easier. Using an arthroscopic probe as a pulley or an arthroscopic grasper to redirect the bone block sutures during graft passage is also helpful. When using the anteromedial portal technique to perform a bone-tendon-bone or bone-quadriceps tendon ACL reconstruction, the femoral bone block should not exceed 23 mm, as longer bone blocks will have difficulty turning in the notch.

Figure 18

Figure 19A

Figure 19B

**Graft Tensioning**

Opposite ends of the hamstring tendon graft are applied to a Graft Tensioning Device and a 80 to 100 N preload applied to the graft. The tensioning device is designed to apply equal tension to each of the strands of multiple-stranded hamstring tendon ACL grafts. Applying equal tension to all strands of a soft-tissue ACL graft optimizes the initial strength and stiffness of the graft. The knee is cycled from 0 to 90° for a minimum of 30 cycles with a 60 – 80 N preload applied to the graft using the tensioning device. The hamstring tendon grafts are fixed under a 60 N load. If the femoral tunnel is placed at the center of the AM bundle, the graft may be fixed at a higher flexion angle (30 – 45°) since this graft position is more "isometric" and causes less graft elongation. If the femoral tunnel is placed in the center of the ACL femoral insertion site, the graft is fixed in more extension (20 – 30°).

**Tibial Fixation**

Tibial fixation does not differ from that of the transtibial tunnel technique and the manufacturer's suggested recommendations for the particular fixation technique chosen are followed. **(Figure 18) (Figure 19A, B)**

**Figure 18:**
The ACL Graft Tensioner is used to apply equal tension to all four-strands of the hamstring tendon ACL graft. In this case tibial fixation was performed using a 7 – 9 mm GTS Tapered Screw.

**Figure 19:**
Anteromedial portal view **(A)** 5-strand hamstring ACL graft **(B)** The ACL graft can be seen to connect the centers of the ACL femoral and tibial insertion sites.

## PEARLS AND PITFALLS OF THE TECHNIQUE

- Use of a padded thigh post and two foot rest simplifies patient positioning and eliminates the need for an assistant to maintain the knee in hyperflexion while drilling the femoral tunnel.
- The fat pad often interferes with visualization when the femoral tunnel is drilled with the knee in hyperflexion. This problem can be avoided by resecting the anterior-superior part of the fat pad during preparation of the notch.
- The accessory medial portal should be positioned as low as possible above the anterior horn of the lateral meniscus. Placing this portal too high above the medial joint line will result in a short femoral tunnel length (< 40 mm) and instrument crowding when the anteromedial and accessory medial portal are used simultaneously as the viewing and working portal.
- The ACL femoral insertion site is best defined by viewing through the medial portal.

Figure 20A

Figure 20B

Figure 20C

- When the knee is in hyperflexion, a more conventional view of the notch and femoral guide pin and femoral tunnel drilling can be obtained by viewing through the anteromedial portal. **(Figure 20A, B, C)**

**Figure 20:**
**(A)** Anterolateral portal view of the notch with the knee in hyperflexion. The orientation is rotated 90° from the usual view obtained when the knee is at 90° of flexion. This view can lead to confusion when attempting to position the ACL femoral tunnel. **(B)** A more conventional view of the notch can be obtained in hyperflexion by viewing through the anteromedial portal. **(C)** Viewing through the anteromedial portal allows accurate assessment of femoral tunnel placement. In this case, the femoral drill bit can be seen to lie in the center of the ACL femoral footprint. If repositioning is desired, the needle and bullet can be retracted slightly, the guide shifted, then the needle and bullet advanced once again.

- Increasing the pump pressure to 100 – 120 mm Hg is often necessary to maintain visualization when the knee is in hyperflexion.
- Visualization in the notch can also be enhanced when the knee is in hyperflexion by introducing a 4.5 mm curved motorized shaver blade through the anterolateral portal. The suction on the shaver can be used to maintain a clear visual field and resect parts of the fat pad obscuring visualization and restricting passage of the endoscopic drill bit.
- The length of the femoral tunnel can be increased by drilling the femoral guide pin into the bone for a distance of 5 – 10 mm and then moving the handle of the femoral offset guide laterally. This will angle the femoral guide pin more vertically and result in the guide pin penetrating the femoral cortex more proximally, creating a longer femoral tunnel length.

- Small adjustments in the final position of the tibial tunnel can be made by first using a 5 mm drill to initially drill the tibial tunnel. Adjustments in the tibial tunnel position can be made by positioning and maintaining the tibial guide pin eccentrically in the tibial tunnel using a pituitary rongeur or arthroscopic grasper. The tibial guide pin can be moved in the desired direction and the tibial tunnel sequentially drilled by 1 mm increments up to the measured size of the ACL graft.
- To prevent problems with graft passage, the femoral bone block of a bone-tendon-bone ACL graft should not exceed 23 mm.

**Summary**

In summary, the anteromedial portal technique offers many advantages over the traditional transtibial tunnel technique for ACL reconstruction. It allows the femoral tunnel of an ACL reconstruction to be placed independent of the position of the tibial tunnel, facilitating anatomic placement of the ACL femoral tunnel. The anteromedial portal technique is versatile and can be used for primary, revision, single- and double-bundle ACL reconstructions. The technique can be used with any graft type. The technique uses instrumentation commonly used during the transtibial tunnel technique and requires no additional guides or instrumentation. In the case of partial ACL tears, the anteromedial portal technique allows isolated reconstruction of the AM or PL bundles with preservation of the intact ACL fibers. Use of the anteromedial portal technique is a natural and necessary evolution in the learning curving for surgeons wishing to perform double-bundle ACL reconstruction. In the case of revision ACL reconstruction where the primary ACL reconstruction was performed using the transtibial technique, the anteromedial portal technique often allows the new femoral tunnel to be diverged from the original tunnel and drilled lower down the sidewall of the notch bypassing the original tunnel and any previous femoral fixation hardware. This can eliminate the need to remove the original femoral fixation hardware and in many cases bypass malpositioned or enlarged femoral tunnels eliminating the need for a 2-stage revision with bone grafting of the original femoral tunnel.

**Table 1: Advantages of the Medial Portal Technique**

- Femoral and tibial tunnels are drilled independently of each other.
- Femoral tunnel can be easily positioned within the anatomic ACL femoral insertion site.
- Can be used with any graft type.
- Requires no special guides or instrumentation.
- Allows preservation of any remaining intact ACL fibers, facilitating isolated reconstruction of the AM or PL bundle.
- Essential for anatomic placement of the PL bundle during double-bundle ACL reconstruction.
- Allows parallel femoral socket and interference screw placement, minimizing the risks of divergent screw placement.
- In revision cases allows a new anatomic femoral tunnel to be drilled by diverging previous misplaced femoral tunnels drilled using the transtibial tunnel technique.
- Femoral tunnel can be drilled under ideal arthroscopic conditions without loss of joint distention from fluid extravasation through the tibial tunnel.

**Table 2: Disadvantages of the Medial Portal Technique**

- Creation of shorter femoral tunnels.
- Posterior exit of the femoral guide pin, which can place the peroneal nerve at risk for injury.
- Femoral tunnel must be drilled with the knee in hyperflexion.
- Visualization in the notch is obscured when the knee is placed in hyperflexion, due to poor circulation of the arthroscopic inflow fluid and debris from drilling the femoral tunnel.
- Hypeflexion drags the fat pad into the notch, obscuring visualization.
- Hyperflexion causes the medial portal to tighten, making it difficult to pass the femoral offset guide and femoral drill bit.
- Danger of injury to articular cartilage of the medial femoral condyle as the endoscopic drill bit is advanced over the femoral guide pin with the knee in hyperflexion.
- Difficulty passing the endoscopic reamer through the fat pad into the notch with the knee in hyperflexion.
- Working with the knee in hyperflexion causes a loss of the normal anatomical relationships in the notch, leading to spatial disorientation.
- Difficulty passing the femoral bone block of bone-tendon-bone or bone-quadriceps tendon ACL grafts into the femoral tunnel.