

Double Bundle ACL Reconstruction using the Smith & Nephew ACUFEX[®] Director Set for Anatomic ACL Reconstruction

French Anatomic ACL-R Study Group

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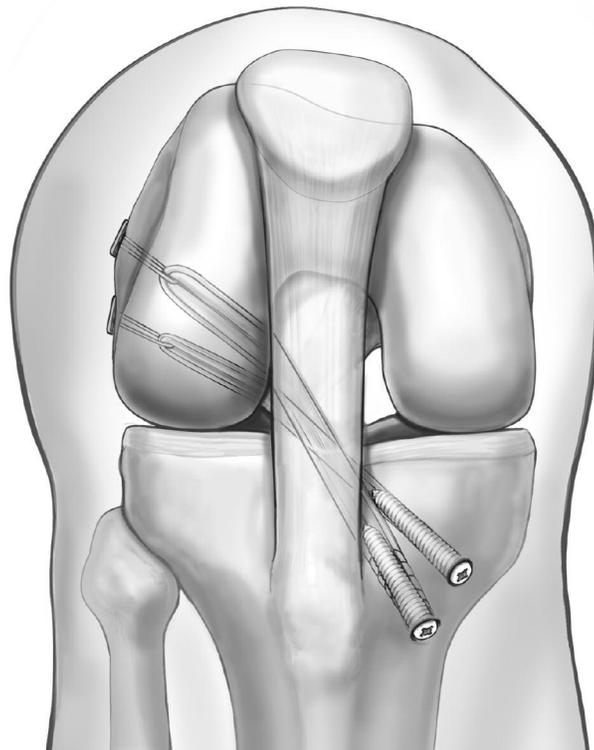
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Anatomic ACL Reconstruction using the Smith & Nephew ENDOBUTTON® CL Fixation System

Introduction

Anatomical and biomechanical studies have shown that the anterior cruciate ligament (ACL) consists of two main fiber-bundles, anteromedial (AM) and posterolateral (PL), each having different functions (Figure 1). While the AM bundle is more dedicated to anterior tibial translation control, the PL bundle, due to its orientation, better controls tibial rotation.

Traditional ACL reconstruction is based on the reconstruction of the AM bundle only. However, laboratory studies, gait analysis and intraoperative navigation measurements have all demonstrated that single-bundle ACL reconstruction does not fully restore the rotational stability of the knee joint. This may account for the long term degenerative changes which have been observed following traditional single-bundle ACL reconstruction.

These considerations have drawn our interest to a more physiologic ACL reconstruction based on the anatomy of the native ACL. A study of ACL footprints allowed measurement of their characteristics and location in relation to the bony landmarks of both femur and tibia. Smith & Nephew has developed instrumentation based on these measurements to drill the femoral and tibial tunnels at the proper locations.

The technique described below is based on the performance of two femoral and two tibial tunnels for which the centers correspond to the center of the anatomical AM and PL attachment sites. The femoral tunnels are created independently from the tibial tunnels. By drilling the femoral tunnels through the AM portal, the anatomic location with regard to the native femoral footprint can be ensured. While the AM bundle is reconstructed with an autogenous double or triple stranded semitendinosus graft, the PL bundle is reconstructed with a double- or triple-stranded gracilis graft. According to their availability, other tendon allografts may be used. Graft fixation is achieved with two ENDOBUTTON® CL on the femoral side and two CALAXO® Osteoconductive interference screws on the tibial side.

Knowledge of the ACL footprint anatomy and practical experience with transportal femoral drilling is a prerequisite for this technique.



Figure 1

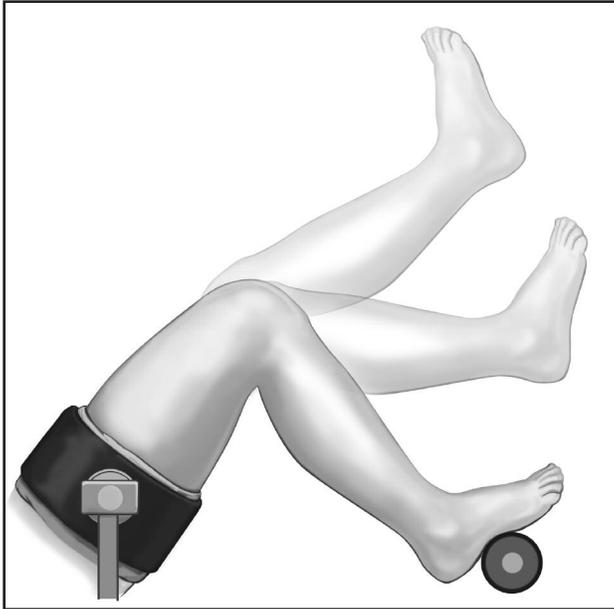


Figure 2

Patient Preparation

Place the patient supine on the operating room table. Apply a pneumatic tourniquet (optional) to the operative leg after the limb is exsanguinated. Secure a lateral thigh post, which allows movement from full extension to full flexion and ensures that the foot is supported (Figure 2). Prepare and drape the leg in normal sterile fashion. Identify and mark the tibial tubercle, the patella, the medial and lateral borders of the patellar tendon, and the medial and lateral joint lines.

Graft Harvesting

Make a 3 to 4 cm skin incision over the anteromedial surface of the tibia, at the level of the tibial tubercle midway between the tubercle and the posteromedial border of the tibia. This incision is used for the harvesting and passage of the grafts as well as the creation of the tibial tunnels.

Note: In order to maintain the morphometric ratio of the AM and PL bundles, the AM graft is generally made slightly larger than the PL graft. The AM bundle uses the doubled or tripled semitendinosus graft, resulting in a 7–9 mm graft diameter. The PL bundle uses the doubled or tripled gracilis graft, resulting in a 5–7 mm graft diameter.

A minimal graft length of 26 cm for the gracilis and 28 cm for the semitendinosus tendon are recommended for double or triple preparation.

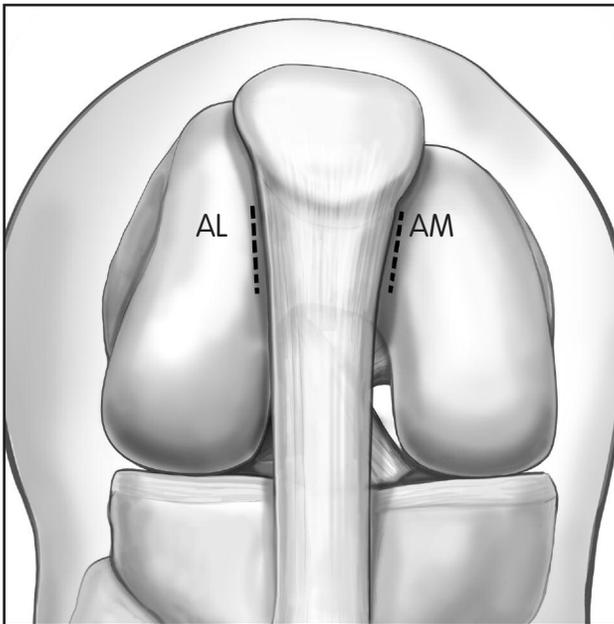


Figure 3

Portal Establishment

Establish AL (anterolateral) and AM (anteromedial) arthroscopic portals proximal enough to allow a downward view of the tibial footprint. For anatomic ACL reconstruction surgery, place these portals immediately adjacent to the lateral and medial patella tendon borders at the level of the inferior pole of the patella (Figure 3).

Perform a complete diagnostic arthroscopy and address any intra-articular pathology (i.e., meniscal or chondral injury) at this time. Leave the tibial footprint of the ACL intact in order to obtain proper landmarks for guide wire positioning.

Identify the anatomic insertion of the AM and PL bundles of the ACL on the lateral wall of the intercondylar notch. Mark these insertion sites with either an RF probe or an awl.

It may be useful to switch the scope from the AL to the AM portal to allow a better view of the lateral wall of the intercondylar notch.

Drilling and Measuring the AM Femoral Tunnel

Drill the AM femoral tunnel through the AM portal using either a 4mm or 5mm Smith & Nephew Offset Endofemoral Aimer. Bend the knee to 90° to place the guide, as you normally would in ACL reconstruction cases. Once the guide is in place, slowly flex the knee to between 110° and 120° to ensure the proper orientation of the AM tunnel (Figure 4). Advance a 2.4 mm drill tip guide wire through the offset endofemoral guide and drill through the femur until the guide wire “breaks” through the lateral femoral cortex.

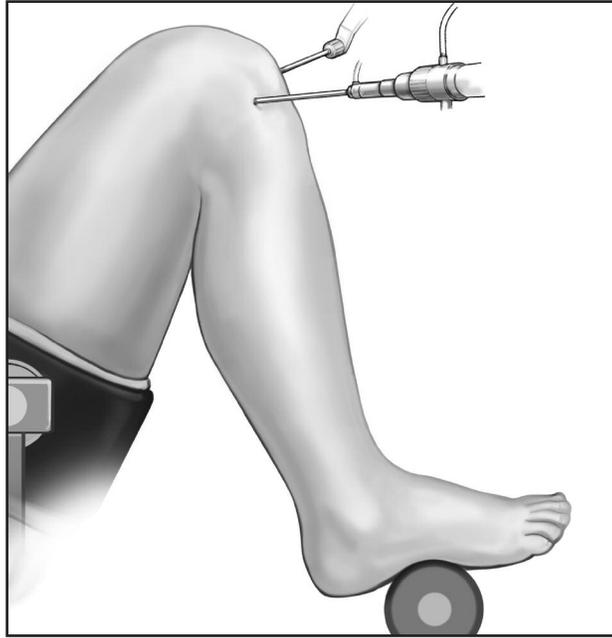


Figure 4

Feel the 2.4 mm guide wire just under the skin after it exits the cortex to determine its position. Advance a cannulated 4.5 mm ENDOBUTTON® drill bit over the passing pin and breach the lateral femoral cortex. Remove the 2.4 mm guide wire.

Use the ENDOBUTTON Depth Probe to measure the total length of the AM femoral tunnel and calculate the appropriate ENDOBUTTON CL length.

AM & PL Graft Preparation

Anteromedial Bundle

Fashion the tendon into a double or triple stranded graft with minimum length of 10 to 14 cm, depending on the size of the knee. Loop the AM bundle through the ENDOBUTTON CL device that was chosen based upon the length of the tunnel. Use Smith & Nephew graft sizing tubes to determine the diameter of the graft.

Posterolateral Bundle

Fashion the tendon into a double or triple stranded graft, ensuring that its diameter is a minimum of 5 mm. Determine the actual diameter of the PL bundle by again using the graft sizing tube. Always loop the PL bundle through a 15 mm ENDOBUTTON CL device (Figure 5).

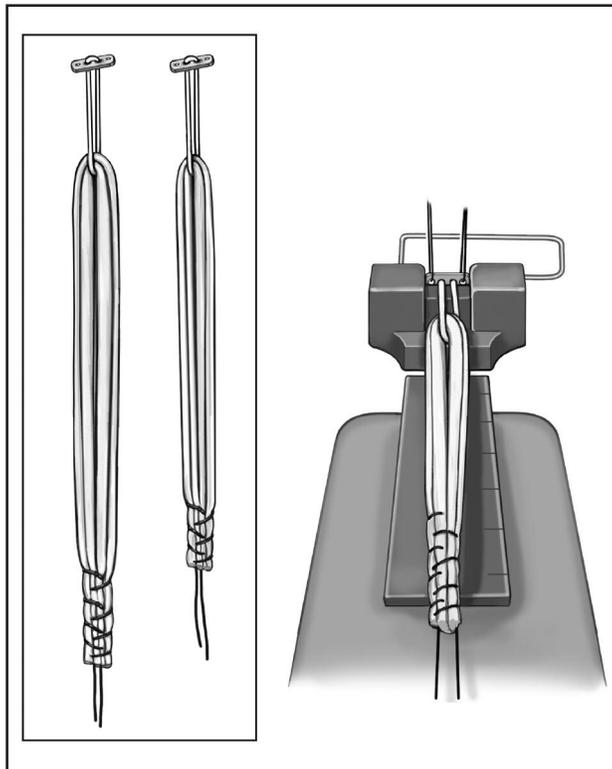


Figure 5

The Smith & Nephew GRAFTMASTER® II with ENDOBUTTON holder provides ease of preparation during this process.

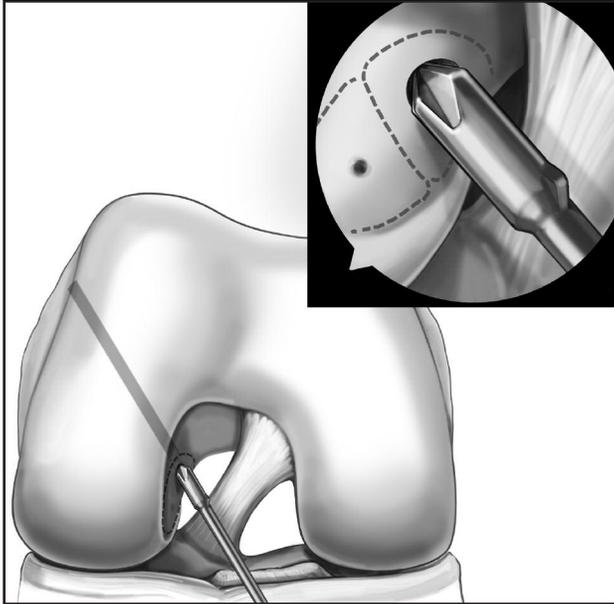


Figure 6

Drilling the AM Tunnel Socket

Anteromedial Tunnel

Select a Smith & Nephew wingless RCI router or endoscopic drill bit that matches the graft diameter and use it to produce the AM femoral socket. Depth is regulated according to the desired insertion length and should be 9 to 10 mm greater than the desired graft insertion to allow for the ENDOBUTTON flip (Figure 6).

Drilling the PL Tunnel and Socket

Posterolateral Tunnel

Keeping the knee flexed to 120°, insert the Smith & Nephew Anatomic ACLR PL Femoral Aimer with an appropriately-sized post into the AM tunnel. Ensure that the shoulder of the AM post is in contact with the lateral wall of the intercondylar notch. Rotate the aimer until the laser mark on the aimer is aligned with the center of the RF probe/awl mark previously made for the PL bundle insertion site. The aimer should be 2 or 3 mm from the cartilage surface (Figure 7).

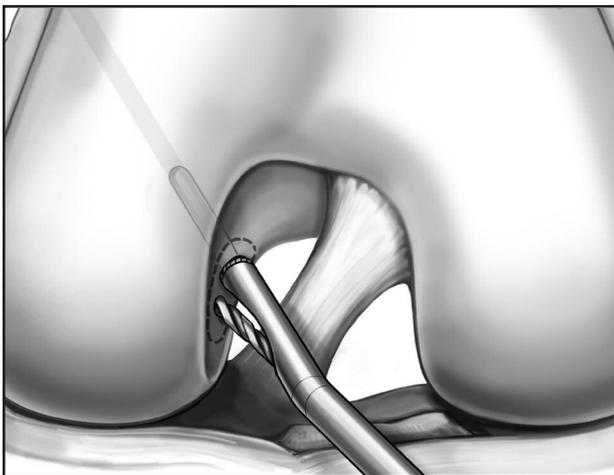


Figure 7

Proper placement of the aimer is critical to achieving an adequate bone bridge.

Once the aimer is properly placed, insert a 4.5 mm non-cannulated drill bit and drill through the lateral femoral cortex (Figure 8). Remove the PL femoral aimer and measure the length of the PL tunnel with the ENDOBUTTON depth probe. Insert a 2.4 mm drill tip guide wire through the PL tunnel.

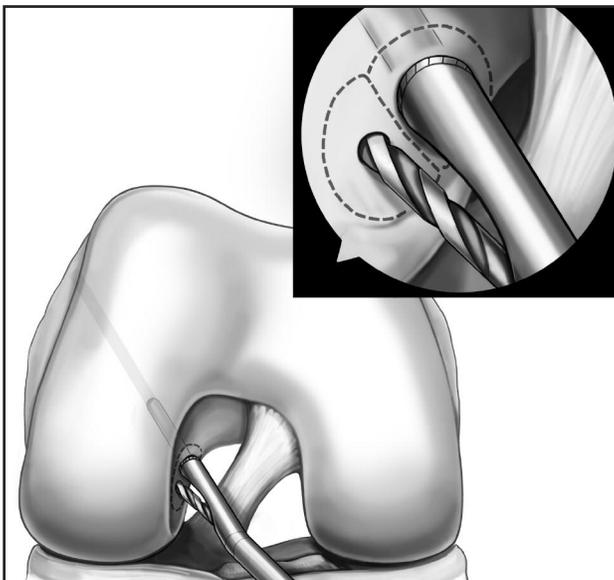


Figure 8

Select a Smith & Nephew wingless RCI router or endoscopic drill bit that matches the graft diameter and use it to produce the PL femoral socket. Depth is regulated according to the desired insertion length and should be 9 to 10 mm greater than the desired graft insertion to allow ENDOBUTTON device rotation.

Caution: Ensure the router does not breach the lateral femoral cortex, otherwise femoral fixation with the ENDOBUTTON CL System will be compromised.

Drilling the Tibial Tunnels

Anteromedial Tunnel

Identify the anatomic insertion of the AM and PL bundles of the ACL on the tibia. Mark these insertion sites with either an RF probe or an awl.

Use the familiar Smith & Nephew ACUFEX® Director ACL Tip Aimer (REF 7205519) set at 55 degrees for the placement of the anteromedial guide wire. Pay attention to the placement of the anteromedial guide wire, which should exit in the center of the AM bundle and not in the center of the ACL. The AM tibial tunnel in the anatomic reconstruction technique is more anteriorly located than in traditional single bundle reconstruction (Figure 9).

Advance a 2.4 mm drill tip guide wire through the tibia (Figure 10). Once acceptable placement of the tibial guide wire is obtained, advance the appropriately-sized cannulated drill bit into the joint space. Alternatively, undersize the tunnel by 1 mm and use dilators to expand the tunnel to the desired diameter.

Posterolateral Tunnel

Place the appropriately-sized post on the Smith & Nephew Anatomic ACLR PL Tibial Aimer. Once the post is secured, insert it into the AM tibial tunnel until the distal end is flush with the tibial surface. Ensure that the post is not protruding into the joint nor recessed in the tunnel. The tibial aimer has a slot at the tip of the AM tunnel post. This slot should be oriented to align with the anticipated center of the PL bundle (Figure 11).

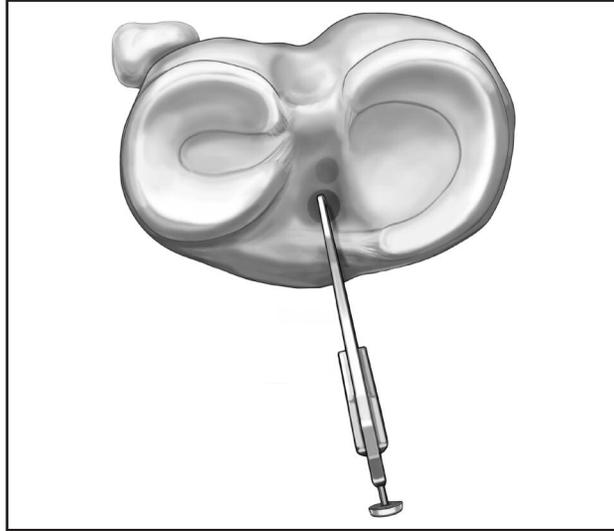


Figure 9

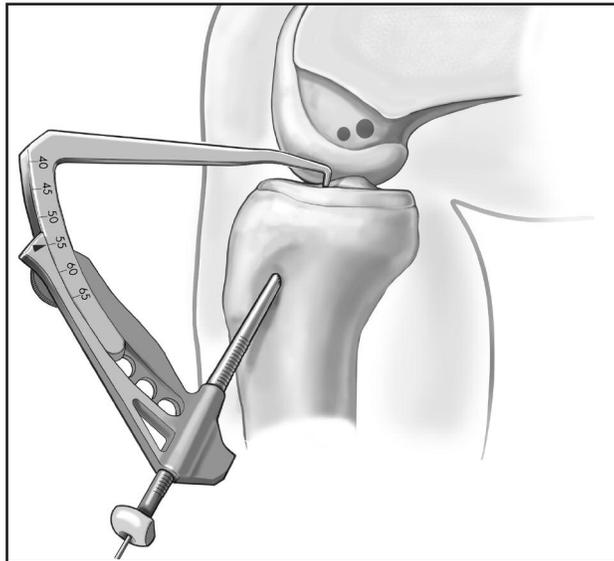


Figure 10

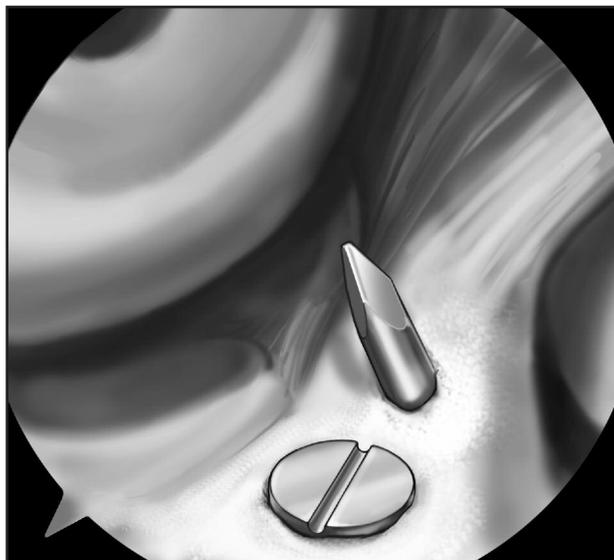


Figure 11

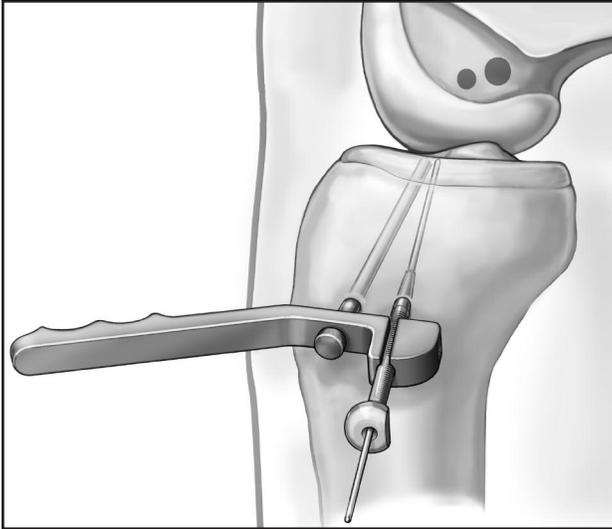


Figure 12

Once proper alignment is achieved, advance the bullet against the tibia. The tip of the bullet is located on the anterior edge of the superficial fibers of the medial collateral ligament (Figure 12).

The PL tunnel has a more medial and distal entry point on the tibial cortex than a standard ACL tibial tunnel.

Advance a 2.4 mm drill tip guide wire through the tibia. Once acceptable placement of the PL tibial guide wire is obtained, advance the appropriately-sized cannulated drill bit into the joint space. Alternatively, undersize the tunnel by 1 mm and use dilators to expand the tunnel to the desired diameter. An osseous bridge of approximately 2 to 3 mm should remain between the two tunnels inside the joint (Figure 13).

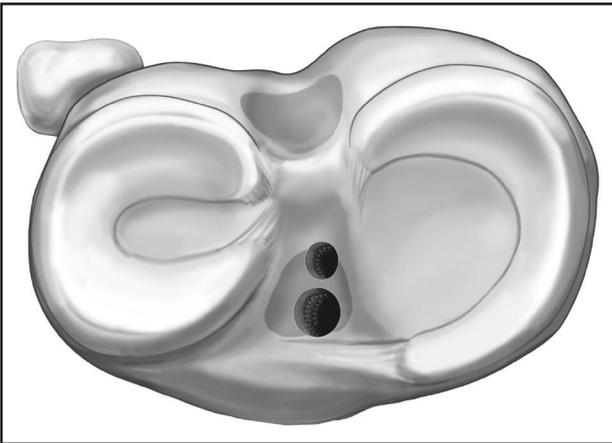


Figure 13

Final Graft Passage and Fixation

Use a 2.7 mm ENDOBUTTON® passing pin through the AM portal to insert two passing sutures of different colors through the AM and PL femoral tunnels. Use grasping forceps to retrieve the sutures through the corresponding tibial tunnels.

Attach a #5 polyester braided suture to one outside hole of the ENDOBUTTON device to lead and pass the device. Attach a trailing #2 polyester braided suture to the opposite outside hole of the ENDOBUTTON device to rotate, or “flip”, the ENDOBUTTON device as it exits the femoral cortex (Endobutton flip) (Figure 14).

Pass the graft for the PL bundle until it breaches the femoral cortex and flip the ENDOBUTTON. Pull back on the graft to ensure proper fixation of the ENDOBUTTON.

Next, follow the same procedure to pass the graft for the AM bundle. Flip the ENDOBUTTON device and test the fixation.

While holding the grafts, cycle the knee through a full range of motion from 0° to 120° approximately 20–30 times (Figure 15).

Mark the grafts that lie external to the tibia with a skin pen, close to the tunnel entrances. Visualize the variation of each bundle from full extension to full flexion. Generally speaking, the length variation

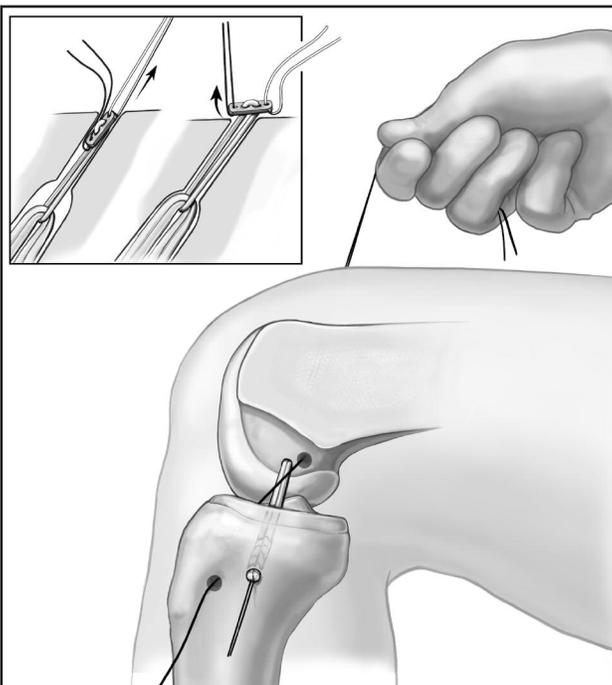


Figure 14

on the AM bundle should range between 0 mm and 1 mm while the PL bundle length variation ranges between 4 mm and 6 mm. Push backward on the tibia, apply tension and fix the AM bundle between 45° and 60° of flexion (Figure 16). For fixation, use a Smith & Nephew CALAXO® Osteoconductive Interference Screw 1 mm larger than the tunnel diameter and the longest screw possible (Figure 17).

Apply tension and fix the PL bundle. The larger the length variation of the graft in full range of motion, the closer to full extension that fixation should be performed. Generally fixation should occur between 30° and 10°.

Additionally, if desired, a fixation post can be used to back up the screw fixation.

Ensure that full range of motion is achieved after fixation of the AM and PL bundles. It is important to ensure that there is no impingement with the intercondylar notch – especially with the lateral condyle wall – in full extension, nor with the PCL in full flexion. If necessary, perform a notchplasty.

Postoperative Care

The postoperative regime is identical to single-bundle ACL reconstruction using soft tissue grafts.

Postoperatively, immobilize the knee in full extension either in a removable posterior sling or in a hinged knee brace that can be locked in full extension.

Partial weight bearing with crutches, 50 percent of the body weight, is allowed for one month.

Mobilization is started immediately, giving priority to the recovery of full extension. CPM may help for flexion. The sling or the brace will be removed when quadriceps control is re-established, after about 4 weeks. Follow standard ACL reconstruction rehabilitation protocol.

Non-cutting, non-pivoting sports are allowed after 3 months. Cutting and pivoting activities may be progressively resumed by 6 months.

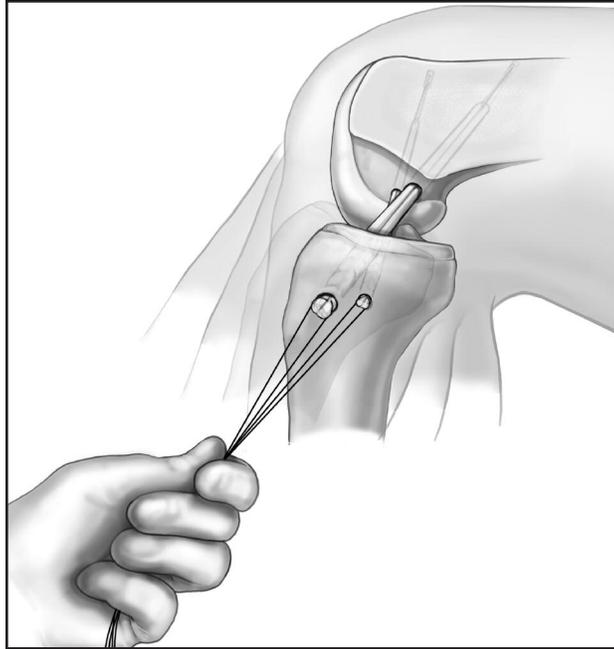


Figure 15

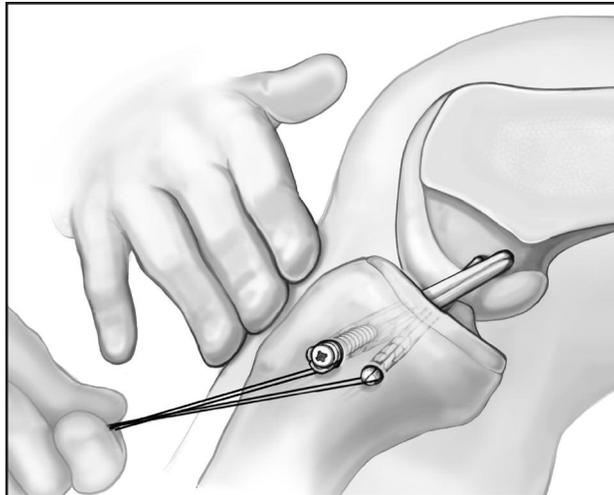


Figure 16

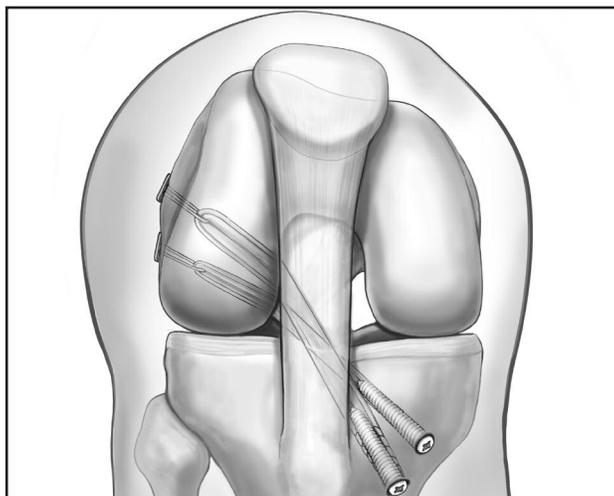


Figure 17

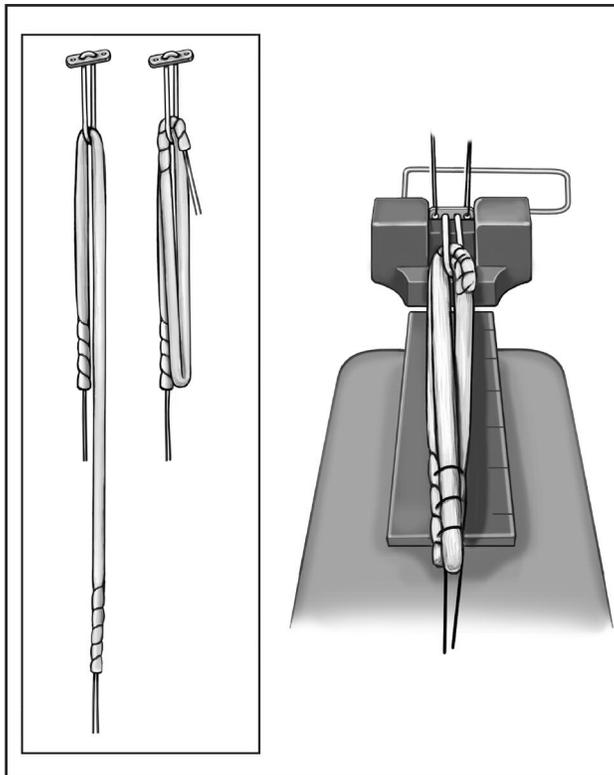


Figure 18

Tricks and Tips

Triple Stranded Graft Preparation

It is always possible to utilize a triple stranded PL graft, due to its short intra-articular length. The length of the PL graft can be as short as 70 mm.

Whipstitch each end of the graft as normal with a non-absorbable suture. Fold the graft over ENDOBUTTON® CL leaving one side twice as long as the other. Take the longer side of the graft and wrap it through the ENDOBUTTON CL again, leaving approximately 2 cm of graft hanging below the ENDOBUTTON to allow for grasping and tensioning (Figure 18). Once the graft is tensioned, whipstitch the three strands of tendon together, just below the loop of the ENDOBUTTON CL. Ensure that the 2 cm tensioning strand is securely sutured to the graft.

Portals

It is important to have proximal portals to ensure direct visualization of the tibial insertion points of the AM and PL bundles from above.

The medial portal should be incised immediately against the medial edge of the patella tendon. If the medial portal is too far medial there is risk of damage to the medial femoral condyle when drilling the femoral tunnels through this portal.

Femoral Tunnels

The posterior femoral cortex will be open for a few millimeters but this does not matter due to the length of the AM tunnel (i.e. approximately 50 mm) and fixation with ENDOBUTTON.

The Smith & Nephew Anatomic ACLR PL Femoral Aimer is designed to maintain an adequate bone bridge between the tunnels. The bone bridge will measure approximately 2 mm thick at the entrance of the tunnels in the joint. Proper placement of the aimer is critical to achieving an adequate bone bridge.

Ensure that the shoulder of the AM post is in contact with the lateral wall of the intercondylar notch. The divergence between the AM and PL tunnels is 15 degrees. In most cases, the length of the AM tunnel ranges between 40 mm and 50 mm and the length of the PL tunnel ranges between 30 mm and 35 mm.

The size of the ENDOBUTTON CL should be chosen to ensure that at least 15 mm of graft remains within the femoral tunnels.

Tibial Tunnels

Preserving the fibers of the AM and PL bundles on the tibia (Figure 19) will assist in proper placement of the tibial tunnels and may contribute to improved graft vascularization.

Fixation

In the case of breaking through the femoral cortex with your router, use a Smith & Nephew XTENDOBUTTON* in conjunction with the ENDOBUTTON* CL to cover tunnels between 6mm and 10mm.

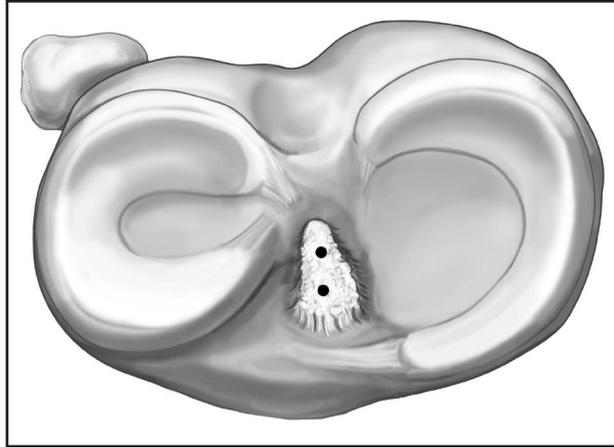


Figure 19

Additional Instruction

Prior to performing this technique, consult the Instructions for Use provided with individual components — including indications, contraindications, warnings, cautions, and instructions.

Courtesy of Smith & Nephew, Inc.,
Endoscopy Division

Caution: U.S. Federal law restricts this device to sale by or on the order of a physician.

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