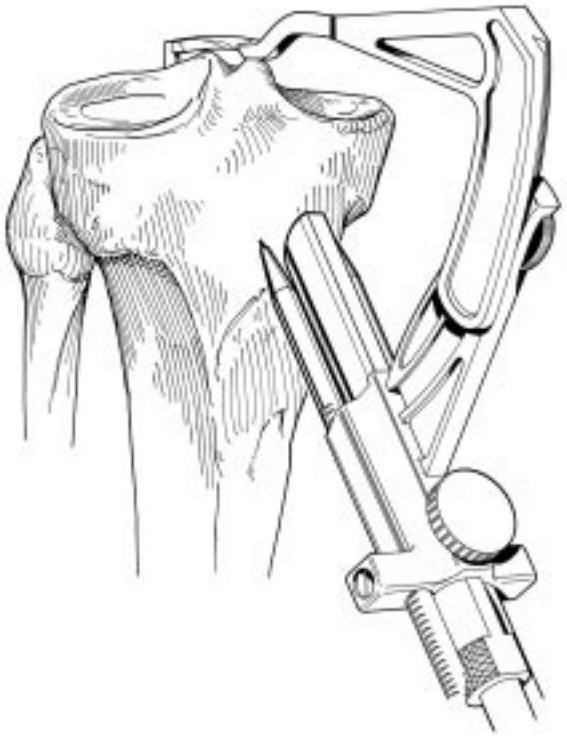
Knee Series
Technique Guide

smith&nephew
TUNDRA◇
ACL/PCL Aimer System

ACL/PCL reconstruction using the Smith & Nephew TUNDRA◇ Aimer System

David A. McGuire, MD



ACL/PCL reconstruction using the Smith & Nephew TUNDRA® Aimer System

The importance of tunnel placement in ACL reconstruction

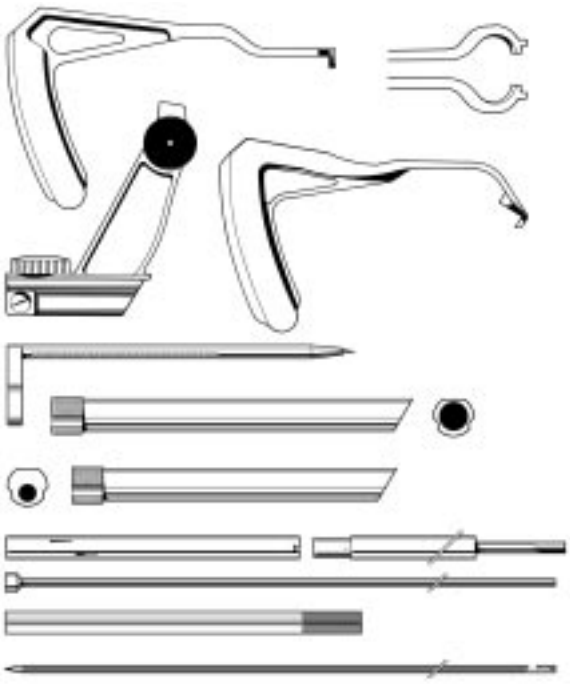
There is widespread recognition of the importance of the accurate placement of the femoral tunnel. To that end, the "over-the-top" position has become well recognized and used as a guide for the placement of the femoral tunnel.

Tibial tunnel placement, however, is not often recognized as a cause of failure during ACL reconstruction and only recently has the placement of the tibial tunnel come to be viewed as equally important. Heretofore, the placement of the tibial tunnel has generally been accomplished by soft-tissue references. Soft tissue references are generally not as accurate as bony references and therefore a certain degree of "art" is required to achieve accurate tibial tunnel placement. Smith & Nephew's TUNDRA® ACL/PCl Aimer System is designed to remove the art from tibial tunnel placement.

We have found that referencing the posterior aspect of the tibia can significantly improve the accuracy of tibial tunnel placement. This reference point is termed the over-the-back (OTB) position due to its similarity to the over-the-top position in the femur and is a constant anatomical feature of the human knee. By referencing the OTB, the TUNDRA arthroscopic drill guide is used to place the tibial tunnel at the approximate anatomic center of the native ACL. Placement of the tunnel either posterior or anterior to this position will result in failure due to either excess graft laxity or graft impingement, respectively.

TUNDRA ACL/PCL Aimer System Components

- Guide body
- Ratcheting outriggers
- Left and right guide arms
- Bone plug plunger in 7/8 mm, 9/10 mm, and 11/12 mm sizes
- Trephines in 7 mm, 8 mm, 9 mm, 10 mm, 11 mm, and 12 mm sizes
- Guide Wire Bullet Sleeves in 7 mm, 8 mm, 9 mm, 10 mm, 11 mm, and 12 mm sizes
- Trephine Adaptors in 7 mm, 8 mm, 9 mm, 10 mm, 11 mm, and 12 mm sizes
- Eccentric ACL Bullet Sleeves (gold) in 7 mm, 8 mm, 9 mm, 10 mm, 11 mm, and 12 mm
- Concentric PCL Bullet Sleeves (silver) in 10 mm, 11 mm, and 12 mm sizes



TUNDRA ACL/PCL Aimer System

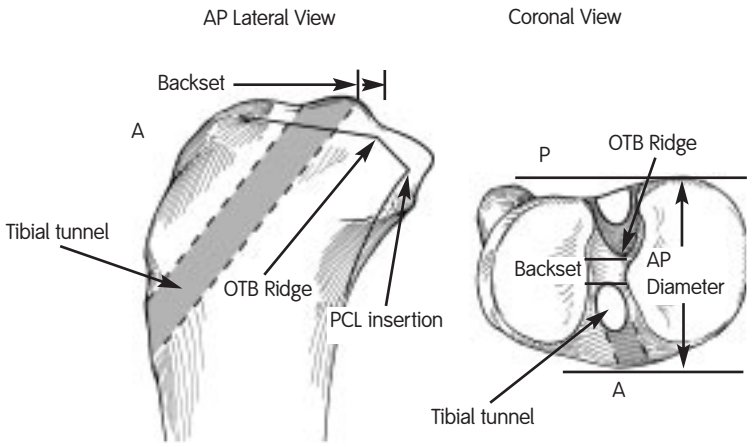


Figure 1

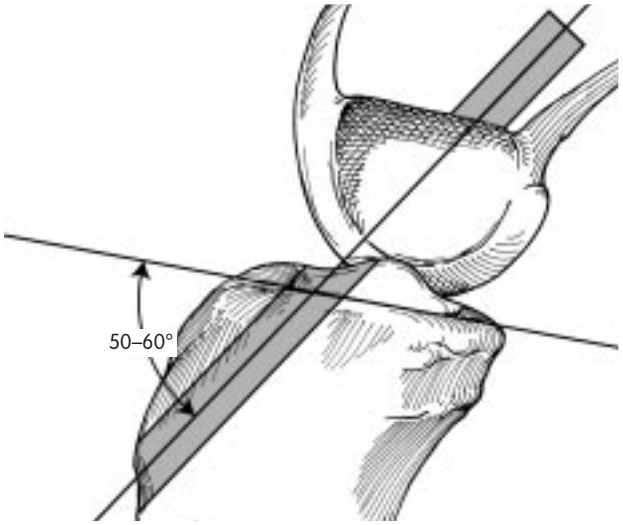


Figure 2

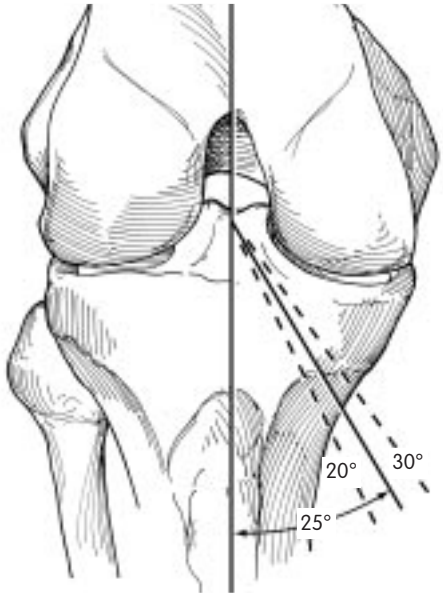


Figure 3

OTB and Backset

The OTB position is located in the AP lateral view at the transistion of the tibial plateau to the posterior plateau (Figure 1). The PCL is attached at the lower two-thirds to one-third of the posterior plateau of the tibia. The upper third of the plateau has a gap where the PCL is not attached; this is where the tang of tibial guide is placed.

The sagittal placement of the proximal end of the tibial tunnel is based on the distance from the OTB ridge to the posterior aspect of the tibial tunnel. This distance is called the backset. By referencing the OTB position to automatically determine the backset, the TUNDRA drill guide provides consistent placement of the tibial tunnel.

In addition, since the back wall of the tibial tunnel is the working surface for the ACL graft, its location needs to remain fixed whether the tunnel is 7 mm or 12 mm. To achieve this, the centers of the tibial bullets are eccentric, allowing the back wall of the tunnel to remain fixed while the front wall moves forward as the diameter of the tunnel increases. The PCL bullets are concentric and the PCL tunnels are placed in the center of the tube, regardless of size.

Note: The anterior aspect of the PCL and OTB ridge are NOT the same point when viewed coronaly (Figure 1). The backset is measured from the posterior aspect of the tibial tunnel to the V-shaped ridge of the trough and not to the soft tissue of the PCL.

The tibial tunnel should be oriented at 50–60° to the tibial plateau in the sagittal plane (Figure 2) and 25° ± 5° to the tibiofemoral axis in the frontal plane (Figure 3).

Instrument assembly

The knee side (right or left) is used to determine which guide arm is used for each patient. Bullet and trephine selection are based on the chosen tibial tunnel size. Tunnel size is dependent on patient size, graft type, and surgeon preference. This system is defined by the concept of drilling the femoral tunnel *after* and *through* the tibial tunnel. Making the tibial tunnel 1 mm larger than the femoral tunnel makes both femoral drilling and graft passage easier.

1. Select the right or left guide arm and insert it into the guide body. Position the arm at 55–60° and lock it in place by turning the compression screw clockwise until sufficiently secured.
2. Select the bullet that matches the selected trephine. Slide the bullet into the guide body and position it with its end protruding just past the body towards the arm side. Turn the compression screw clockwise until the bullet is secured.

3. Insert the ratcheting outriggers with the tabs horizontal, until their tips are just past the body towards the guide arm side so they project out about the same distance as the bullet.

   Optional: Select the correct-sized guide wire bullet sleeve.

4. Attach the selected diameter trephine to the trephine adaptor and slip-lock the trephine by turning the adaptor clockwise.
5. Select the bone plug plunger to match the trephine and insert it into the assembled trephine and trephine adaptor. The bone plug plunger's barrel should be seated in the bottom of the trephine. This device will ease the removal of the bone plug from the coring trephine so that it may be used for grafting defects or constructing a composite graft.
6. Insert the assembled trephine components into the drill chuck and secure with the chuck wrench.

Incisions

Incisions can be made as required for graft harvest. The tibial guide is easily incorporated into whatever incisions are needed for the graft harvesting incisions (Figure 4).

For an allograft, the following single incision is required for the guide insertion along with standard arthroscopic portals (Figure 5).

Placing the TUNDRA System Aimer

1. Use a 45° angled curette to clear any soft tissue between the PCL and the over-the-back (OTB) trough. This maneuver makes certain that no soft tissue is between the OTB and the tang of the guide.
2. Introduce the tang into the medial portal with the guide body rotated so it is parallel to the floor, pointing laterally.
   a. Once the tang is within the intracondylar notch, rotate the guide body medially and advance the tang to the OTB position.
   b. Continue the rotation until the assembly is vertical and the tang fits neatly into the OTB.
   c. **The position of the tang on the OTB is imperative.** Proper placement of the tibial guide requires that:
      - The guide arm tang fits neatly into the OTB;
      - the curved section of the guide arm is flush with the tibial plateau, and;
      - the plane of the guide body is at 20–30° to the tibial-femoral axis in the frontal plane (Figure 6).

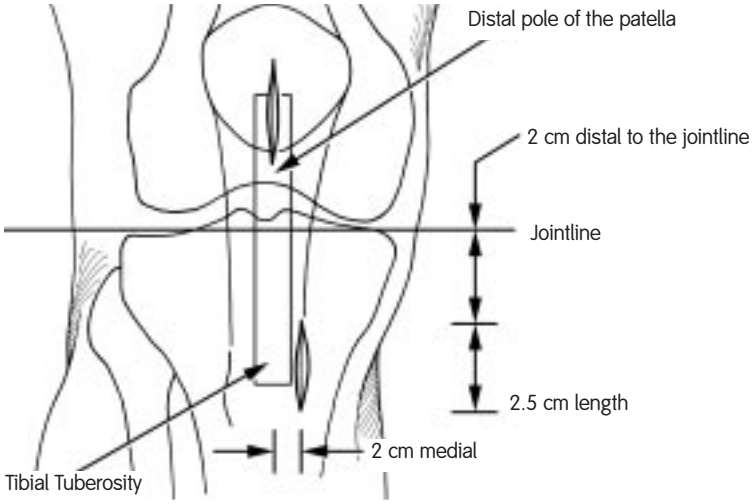


Figure 4

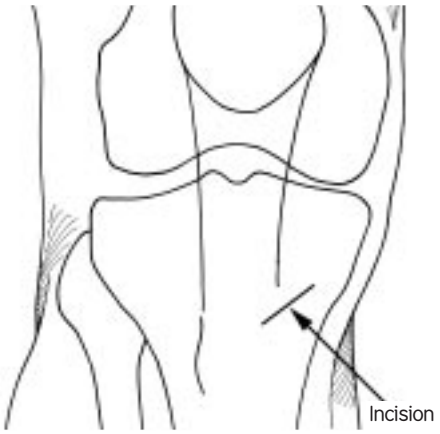


Figure 5

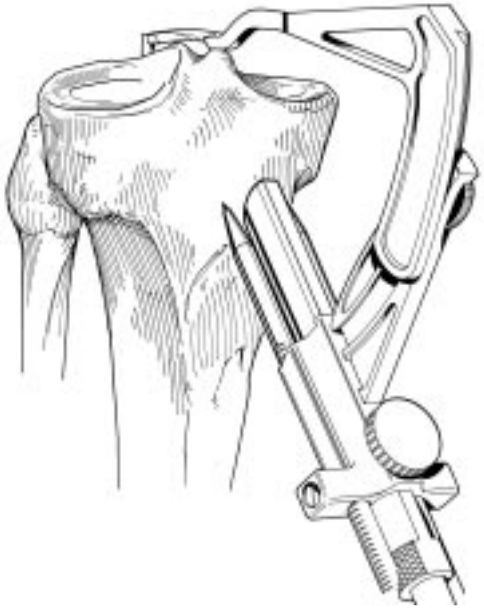


Figure 6

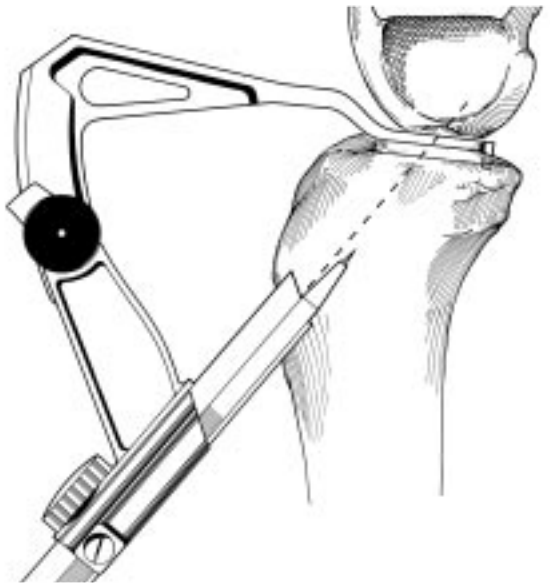


Figure 7

3. With the surgeon holding the guide at all times and verifying that the tang of the guide remains properly seated in the OTB position, the assistant advances the ratcheting pins and the core guide so that the position is not lost and the guide is placed correctly.
    a. The assistant advances the ratcheting pins onto the anterior tibia, using small retractors to displace the skin on each side of the incision laterally and then medially.
    b. Once the guide body is secure, verify the direction of the tunnel. The arm of the guide must be flush with the tibial plateau and the entire guide system must be rigid once applied. If not, remove and reapply the guide.
4. Unlock the bullet by turning the compression screw counter-clockwise. Once loose enough, advance the guide tube forward until it meets with the anterior tibia. Lock the guide tube in place by re-tightening the compression screw (Figure 7).

Drilling the tibial tunnel

1. Direct the trephine assembly to the distal portion of the tibial guide assembly and insert the coring trephine into the bullet.

   Optional: Advance the guide wire through the guide tube until the tibial plateau has been breached. If the placement is satisfactory, remove the guide wire and proceed with the coring trephine.
2. Advance the coring trephine until it breaches the tibial plateau. Remove the trephine and bone core, running the drill in the forward direction.
3. Depress the bone plug plunger to remove it and the tibial core from the coring trephine.

Removing the TUNDRA System Aimer

1. Rotate the ratcheting pin tabs to a vertical orientation to unlock them from their insertion points on the tibia and loosen the tibial guide assembly.
2. Remove the tibial guide assembly by reversing its insertion sequence.
    a. Unhook the tang from the OTB position.
    b. Extract the guide by first rotating it laterally until it is horizontal and parallel with the floor. Then withdraw it through an arc to match the contour of the guide arm as it exits out of the medial portal.

Drilling the femoral tunnel

1. Position an endoscopic femoral aimer (EFA) slightly anterior to the over-the-top position at the junction of the intercondylar roof and the intercondylar notch.
2. Once the EFA is in place, advance a guide wire through the EFA and femur.
3. Advance an appropriately-sized drill approximately 4–6 mm to create a pretunnel "footprint." Withdraw the drill and inspect the footprint. A posterior cortical margin of 1–2 mm indicates accurate anatomic femoral tunnel placement.
4. Once appropriate placement is achieved, drill the tunnel at least 5 mm deeper than the length of the bone plug.

   Note: The femoral tunnel can be drilled to the lateral femoral cortex or through the lateral femoral cortex with no adverse consequence.
5. Place an eccentric guide through the tibial tunnel into the femoral tunnel. The eccentric guide allows notching of the superolateral aspect of the femoral tunnel, which facilitates insertion of the interference screw. Creating a notch reduces the tendency of the screw to "walk" around the periphery of the tunnel as it is inserted.

Inserting the graft

The two-pin passer is a slot-eyed trocar, which allows simultaneous insertion of an interference screw guide wire and retrograde passage of the graft. Both femoral and tibial fixation is accomplished with bioabsorbable interference screws. Drilling the tunnels as described, in conjunction with selection of a graft of appropriate length, virtually assures the ability to fix the tibial portion of the graft with an interference screw.

1. Advance the two-pin passer through the lateral puncture on the thigh, pulling the suture attached to the graft out the lateral aspect of the thigh.
2. Advance the graft through the tibial tunnel and into the femoral tunnel. The femoral portion of the graft is secured by advancing the bio-screw over the guide wire already in place.
3. Affix the femoral bone plug and check the graft isometry. There should be no "pistoning" of the graft during flexion and extension of the knee with traction on the tibial portion of the graft. Axial motion of the graft is usually caused by inappropriate tunnel placement and should be corrected before proceeding further.
4. Apply traction of approximately 5 kg to the tibial suture/wire and place a bioabsorbable screw over a guide wire placed anterior to the graft.

ACL Postoperative Care

1. Postoperative hinged bracing is used for up to eight weeks. The brace range of motion (ROM) is set to coincide with the continuous passive motion (CPM) ROM achievements until 0–120° is reached. Thereafter the brace setting is maintained at 0–120° during use.
2. Weight bearing begins with touch down progressing to full weight bearing as tolerated.
3. Continuous passive motion is used for the first five days. CPM ROM is increased from 10°/90° (ext/flex) initially to 0°/120° as tolerated.
4. A compressive cold therapy cuff is used for the first two weeks. Cold therapy is applied continuously for the first four days and then as needed until week two.
5. Postoperative pain and inflammation are controlled with oral medication. Typically, Toradol is administered intra-operatively and orally 10 mg every six hours. Narcotics such as Narco can be used supplementary. This regimen has largely eliminated the need for PCA devices. However, in some cases these can be used as well.
6. Heel slides and straight leg raises are the mainstay of rehab. Protect the patella and extensor mechanism. Careful rehabilitation requires restoration of motion and quadriceps strength without producing pain in the knee.

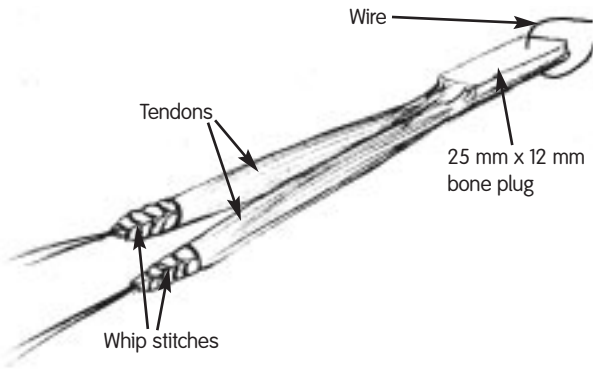


Figure 8

Figure 9

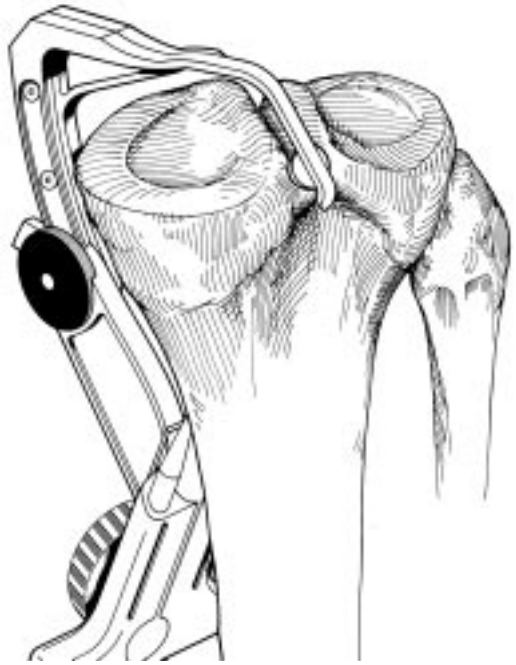
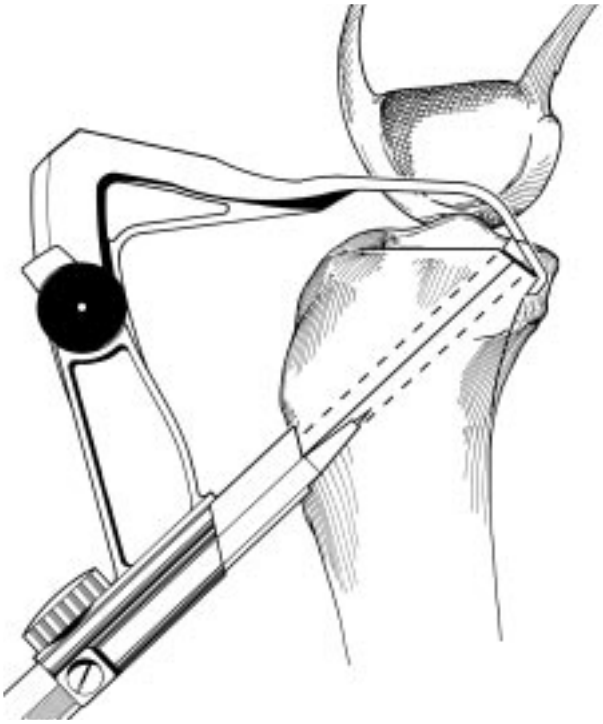


Figure 10

PCL surgical approach

1. Prepare a double bundled achilles tendon allograft at a side table. Divide the tendonis portion of the graft into two, 7 mm bundles. Place a 5 cm long series of whip-stitches at the end of each bundle to provide for advancement of the graft. The bony portion of the graft is typically trimmed to a length of 25 mm and sized to fit a 12 mm tunnel. Once trimmed, attach a wire suture to the bone plug to allow for positioning and tensioning (Figure 8).
2. Establish standard anteromedial, posteromedial, distolateral, and proximal anterolateral arthroscopic portals.
3. Position the posteromedial portal approximately 13–15 cm proximal to the joint line and anterior to the hamstring tendons at the posterior margin of the vastus medialis muscle. From this position, direct the portal towards the tibial PCL attachment (Figure 9). Place a 10 mm cannula through the posteromedial portal.
4. Resect the torn PCL using an arthroscopic shaver. Next, place the shaver through the posteromedial portal and debride the stump of the PCL.
5. Initiate a 2.5 cm vertical incision 1 cm medial to the crest of the tibial tubercle and extend it distally.
6. Use the Smith & Nephew TUNDRA® PCL Drill Guide to place the tibial tunnel. This specialized drill guide incorporates a circular backsplash that limits trephine advancement, thereby protecting the posterior structures of the knee. Place the drill guide through the anteromedial portal and direct it to the anatomic insertion of the PCL on the posterior tibia (Figure 10).

7. Position the distal end of the drill guide over the medial tibial incision and lock it firmly in place. Using fluoroscopic visualization, carefully advance the trephine until it exits through the tibia posteriorly and contacts the backsplash (Figure 11).
8. Flex the knee to 90°. Approach through the extreme distolateral portal and place two chisel-point, slot-eyed Beath pins (Smith & Nephew Trocar or Chisel-Tip Passing Pins with eyelet) near the distal and proximal margins of the femoral footprint of the PCL (posterior and anterior margins when the knee is extended). Direct the pins proximally and medially so that they exit the thigh medially, approximately 7–10 cm proximal to the joint line.
9. Advance a cannulated 7 mm trephine over the previously placed slot-eyed pins (Figure 12). Grasp the chisel tip of each pin prior to drilling. Drill through the medial femoral cortex. Use the grasper to hold the slot-eyed pin in place while backing out the trephine. Repeat the procedure for the second femoral tunnel, leaving the second pin in place.
10. Advance each pin until its slot eye is drawn into the joint space and protudes slightly from its respective femoral tunnel. Reposition the graspers flush with the skin to prevent the slot-eyed pins from shifting or falling out while the sutures are threaded.
11. Advance the tendons portion of the Achilles allograft through the tibial tunnel one bundle at a time. Orient the graft so that the tendons side of the bone block is oriented posteriorly with one bundle exiting medially and one bundle laterally.



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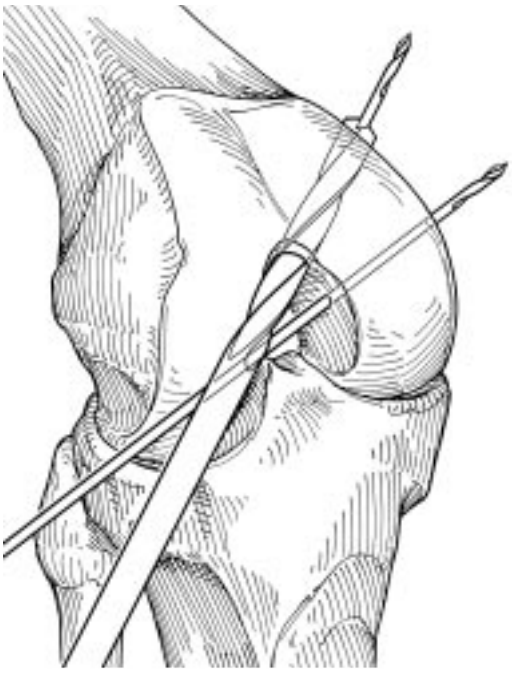

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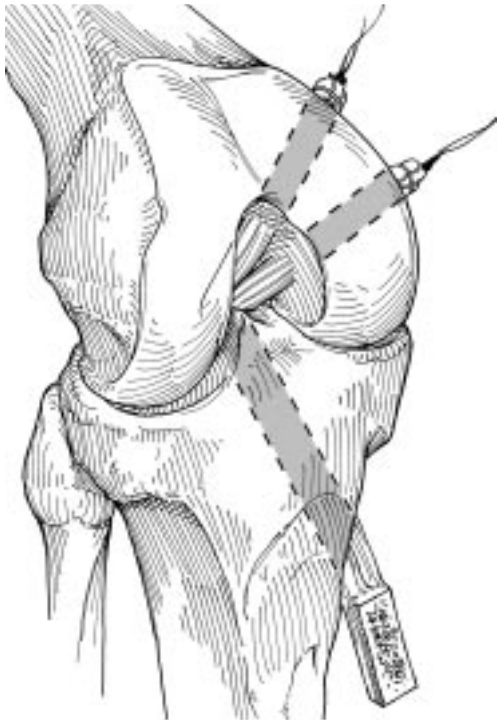

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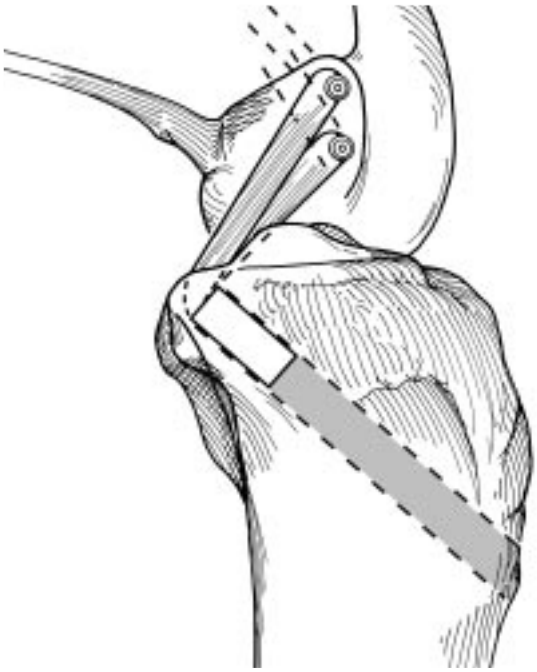

Figure 14

12. Pass the medial bundle first. Grasp the leading sutures through the anteromedial portal and loop them through the slot-eyed pin in the distal femoral tunnel. Advance the pin to bring the sutures attached to the bundle through the skin on the medial side of the femur. Hold them in place with a clamp. Repeat the procedure to direct the lateral bundle into the proximal femoral tunnel and pass the sutures (Figure 13).
13. Adjust the distal/proximal position of the graft so that the proximal end of the bone block is flush with the proximal orifice of the tibial tunnel (Figure 14).

14 Advance a guide wire anteriorly within the tibial tunnel, positioning it between the cancellous side of the bone block and the tibial tunnel wall. Advance a 7 x 25 mm cannulated bio-absorbable screw along the guide wire until the screw makes solid purchase with the bone block and tibial tunnel wall. This maneuver can be flouroscopically monitored.

15. Manipulate the knee vigorously with traction maintained on both bundles. The posteromedial bundle is tensioned and fixed near extension, typically about 20° of flexion. Direct a guide wire through the distal anterolateral portal and position it anterior to the bundle in the distal femoral tunnel. With traction applied to the posteromedial bundle located in the distal femoral tunnel, advance a 7 x 20 mm cannulated bioabsorbable screw over the guide wire through the distal anterolateral portal alongside the graft until it is seated completely within the tunnel, thereby providing direct tendon-to-bone fixation.
16. The anterolateral bundle, located in the proximal femoral tunnel, is tensioned and fixed in flexion, typically 90°. Fixation is accomplished with a 7 x 20 mm cannulated bioabsorbable screw also directed through distal anterolateral portal over its respective guide wire (Figure 15).
17. Inject Marcaine at the surgeon's preferred percentage. Close the arthroscopic portals, including the posterior portal, using Steri strips. Close the tibial tunnel incision with 2-0 Vicryl subcutaneously; 3-0 Vicryl subcuticularly; and Steri strips.

PCL Postoperative Care

1. Postoperative hinged bracing is used for eight weeks. The brace range of motion (ROM) limits progress from 10°/45° (ext/flex) during the first week to 0°/60° during week two; 0°/90° during week three; and 0°/120° from week four on.
2. The knee is maintained in extension *except* during range of motion exercises. Range of motion exercises should initially be limited to a continuous passive motion (CPM) device and progress to passive assisted heel-slides at day six. The brace is locked in extension which keeps the hamstrings from loading the graft when walking, thereby protecting the graft during the eight weeks of assigned brace use.
3. Non-weight bearing for the first week. Partial weight bearing in extension until week three.
4. Continuous passive motion is used for the first five days. CPM ROM is increased from 10°/45° (ext/flex) initially, to 5°/60° at day three.
5. A compressive cold therapy cuff is used for the first two weeks. Cold therapy is applied continuously for the first four days and then as needed until week two.
6. Postoperative pain and inflammation are controlled with oral medication. Typically, Toradol is administered intra-operatively and orally 10 mg every six hours. Narcotics such as Narco can be used supplementary. This regimen has largely eliminated the need for PCA devices. However, in some cases these can be used as well.
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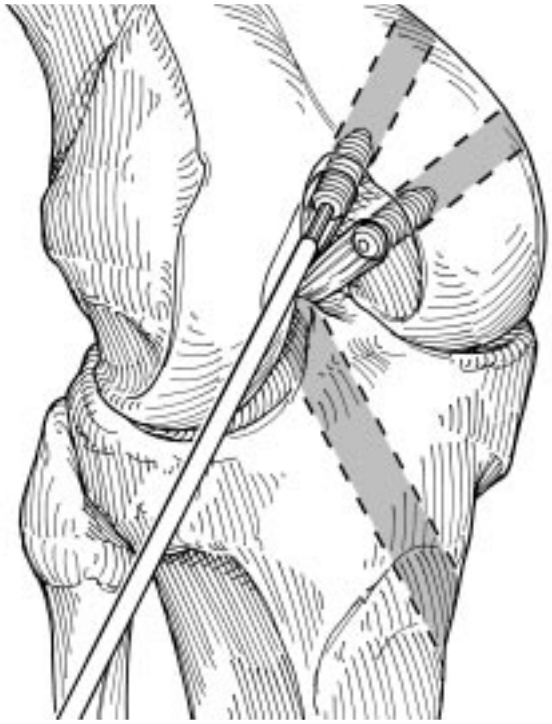

Figure 15

Additional Instruction

Prior to performing this technique, consult the Instructions for Use documentation 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.

Endoscopy
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Andover, MA 01810
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978 749 1000
978 749 1108 Fax
800 343 5717 U.S. Customer Service

Printed in USA 10/04 1061519 Rev. A