

Percutaneous Medial Ligament Reconstruction for Valgus and Rotational Knee Instability



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Abstract: The following surgical technique is intended for patients with chronic valgus laxity and rotational knee instability. It is a percutaneous 2-bundle ligament reconstruction method that uses the semitendinosus tendon, allowing it to remain pedicled to its distal tibial insertion. The aim is to correct the laxity without otherwise limiting the motion of the knee.

Injuries to the stabilizing structures on the medial aspect of the knee are common, and often occur in combination with an anterior cruciate ligament (ACL) injury. Surgical treatment is indicated for instability that persists after 6 weeks of conservative treatment, consisting of immobilization with a hinged splint along with a specialized rehabilitation protocol.¹ When the knee joint can be opened by placing a valgus load on a nearly fully extended knee and the anteromedial drawer test, foot in external rotation, elicits a soft endpoint (also known as anteromedial rotary instability), multiple anatomic structures are likely injured: the superficial medial collateral ligament (MCL) bundle, which mainly controls external tibial rotation, along with the deep MCL bundle and the posterior oblique ligament, which mainly control laxity in valgus.^{2,3}

To address this laxity, a superior-to-inferior and posterior-to-anterior reconstruction is needed to

control external tibial rotation, and a more vertical reconstruction is needed to control the valgus. These 2-bundle procedures are often called “anatomic” MCL reconstruction.⁴ Our technique, shown in [Video 1](#), consists of percutaneous 2-bundle reconstruction using a pedicled semitendinosus tendon ([Fig 1](#)).

Surgical Technique

Patient Setup

The patient's leg can be left to hang using stirrups at the thigh, or with the foot resting on the table with a lateral support at the thigh. The setup must allow full knee flexion and easy access to the medial side of the knee ([Fig 2](#)).

Skin Landmarks

It is vital to palpate the bone landmarks because this is a percutaneous technique. Palpation is used to identify the medial epicondyle of the femur, the superior edge of the medial tibial plateau and the contour of the semitendinosus tendon at the pes anserinus ([Fig 3](#)). In case of large knees, the use of fluoroscopic imaging may be helpful to improve medial epicondyle identification, as was recently demonstrated for identifying the lateral collateral ligament origin in clinical practice.⁵

Graft Preparation

The semitendinosus tendon is harvested with a tendon stripper through an anteromedial tibial incision while keeping its distal attachment intact. The free end of the tendon is woven using nonabsorbable No. 1 Ethibond suture (Ethicon, Somerville, NJ) ([Fig 4](#)).

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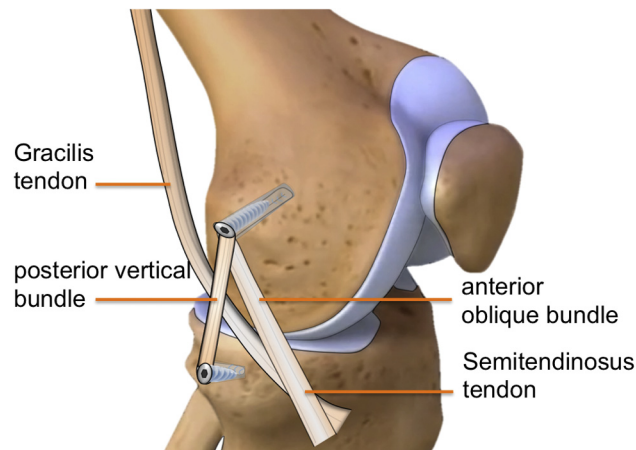


Fig 1. Anteromedial view of a left knee. The semitendinosus tendon is pedicled to its distal attachment and provides an anterior oblique bundle and a posterior vertical bundle.

Positioning and Drilling of the Femoral Tunnel

The femoral tunnel will be located 1 cm proximal and posterior to the medial epicondyle (Fig 5). The tunnel is angled forward and upward and emerges above the lateral condyle (Fig 6). Once the guidewire is in place, the construct's isometry is verified (Fig 7) and then a blind tunnel is drilled (Fig 8). A K-wire is used to retrieve the traction suture left in place (Fig 8).

Positioning and Drilling of the Tibial Tunnel

The K-wire is inserted at the posterosuperior aspect of the medial tibial plateau. It takes a transverse path and

is directed slightly downward and forward to emerge in front of the fibular head (Fig 9). A bicortical tunnel is drilled and a relay suture positioned using the beath pin (Fig 9).

Passage and Fixation of Graft

Alligator forceps are inserted in the subcutaneous layer and used to retrieve the graft through the femoral incision (Fig 10). The graft is then folded in half and the loop introduced in the femoral tunnel using the traction suture (Fig 10). An interference screw (Arthrex, Naples, FL) is used to secure the graft in the tunnel. For optimal



Fig 2. Patient setup must allow easy access to the medial side of the left knee. This can be accomplished by placing the contralateral leg in stirrups.

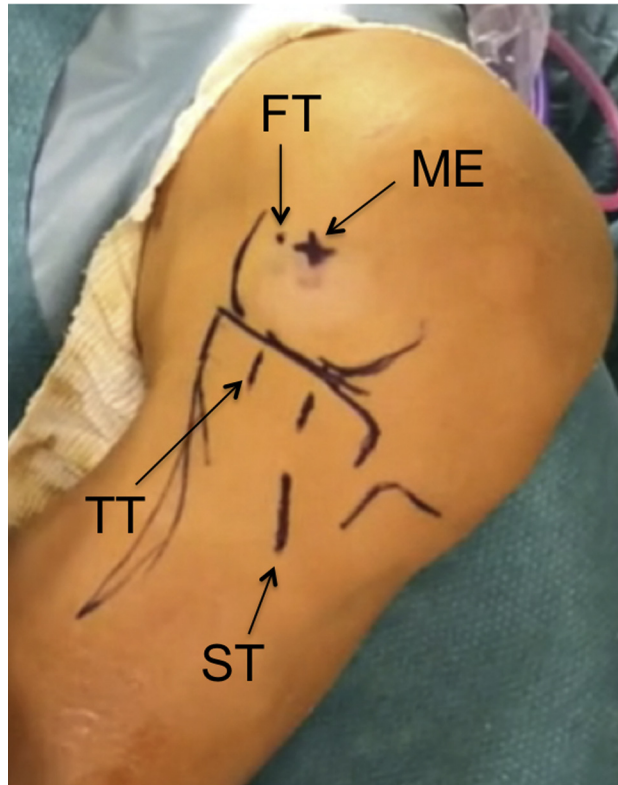


Fig 3. Skin landmarks. Anteromedial view of a supine patient's left knee. There are 3 important skin landmarks: the entry point for the femoral tunnel (FT) will be located 1 cm proximal and posterior to the medial epicondyle (ME); the entry point for the tibial tunnel (TT) is 1 cm below the joint line, at a point one-third posterior and two-thirds anterior from the edge of the medial tibial plateau; the distal attachment of the semitendinosus tendon (ST).

isometry, the graft is secured with the knee near full extension and in neutral rotation (Fig 11).

Using the same technique, the graft is retrieved from the femoral incision to the incision over the tibial tunnel. It is pulled through the tibial tunnel using the traction suture (Fig 12). The graft is long enough to be externalized through a short skin incision at the exit of the tibial tunnel on the lateral side of the tibia. The isometry and valgus neutralization are verified by pulling on the woven suture while flexing and extending the knee, and placing valgus loads on it (Fig 13). The graft is secured in the tibial tunnel using an absorbable interference screw (Arthrex) with the knee near full extension and in neutral rotation (Fig 13).

Postoperative Course

A 20° flexion splint is used day and night for the first 3 weeks, with touch-down weight bearing allowed. The day after surgery, early rehabilitation is initiated: mobilization from 0° to 90° and isometric quadriceps contractions. Full weight bearing and muscle strengthening, while avoiding valgus loads, are initiated 1 month after surgery. In-line sports can be restarted gradually after 6 weeks and pivot sports after 4 months.

Discussion

It has been shown that minimally invasive percutaneous hip and foot surgery results in less postoperative pain, fewer major intra- and postoperative complications, shorter hospital stays, and faster recovery times.^{6,7} We can expect the same benefits of percutaneous knee surgery. Additionally, preserving existing structures and reducing adhesions with neighboring tissues may allow better restoration of joint kinematics. Advantages and disadvantages of percutaneous medial ligament reconstruction are summarized in Table 1.

The underlying principle of our technique is to correct the instability without negatively affecting the knee's motion in the other planes. Anteromedial rotary instability is addressed by the oblique portion of the reconstruction, which is oriented in a manner that prevents external tibial rotation (Fig 14). Its vertical portion neutralizes the valgus because it is in the joint separation axis (Fig 14). The common anchoring point of both bundles at the femur, located proximal and posterior to the knee's transepicondylar rotation axis (which passes through the medial epicondyle), places

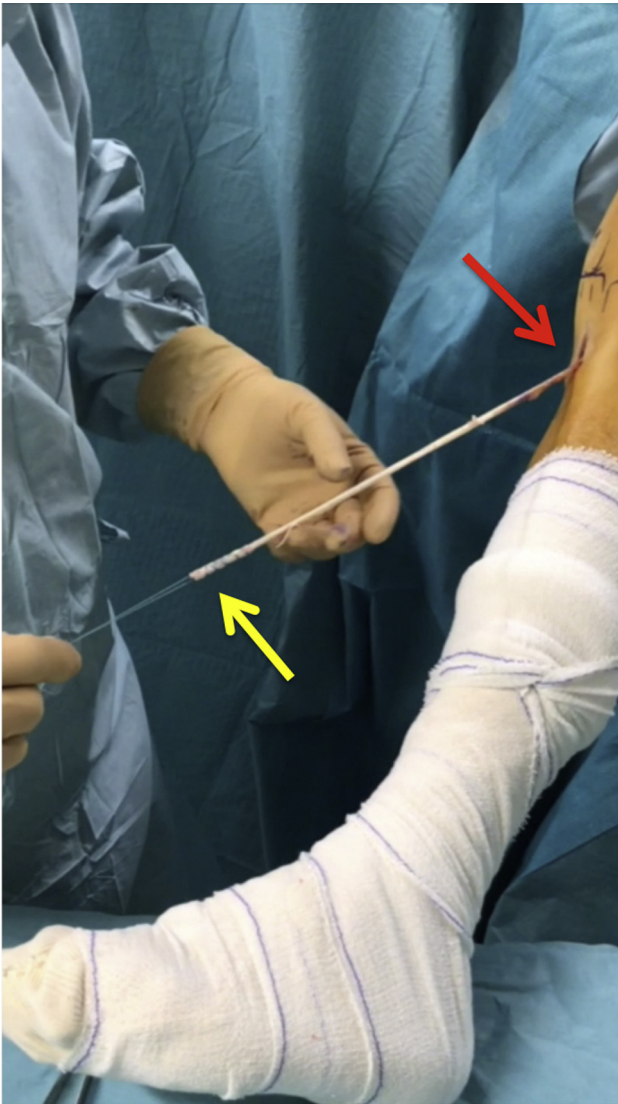


Fig 4. Graft preparation. Anterolateral view of left knee, flexed 90°, with patient supine. The semitendinosus tendon remains attached at its distal insertion (red arrow). A traction suture (No. 1 Ethibond; Ethicon) is woven through its free end (yellow arrow).

the bundles under tension when the knee is extended and releases the tension when the knee is flexed.^{8,9} This corresponds to normal knee kinematics in which axial rotation and frontal laxity are locked in extension and then released in flexion.¹⁰

At the tibia, anchoring the vertical bundle at the point one-third posterior and two-thirds anterior from the medial edge of the tibial plateau (Fig 5) places it in the vertical axis of its femoral insertion, which ensures its effectiveness when the knee is near full extension. By placing it 1 cm below the tibia, the construct is shorter, thereby reducing the risk of secondary loss of tension due to a bungee cord effect.

Two-bundle techniques using a pedicled semitendinosus graft^{11,12} aim to reproduce the anatomy of the superficial bundle of the MCL and posterior oblique ligament. In these techniques, the femoral insertion of the anterior graft bundle is located on the epicondyle or anterior to it, to preserve the proximal insertion of the MCL (Fig 14). However, this configuration does not allow the graft to release during knee flexion.⁸ The posterior bundle aims to reproduce the posterior oblique ligament. Its front-to-back orientation makes it less effective at controlling valgus but provides better control over tibial internal rotation, which is not a concern from a clinical point of view.

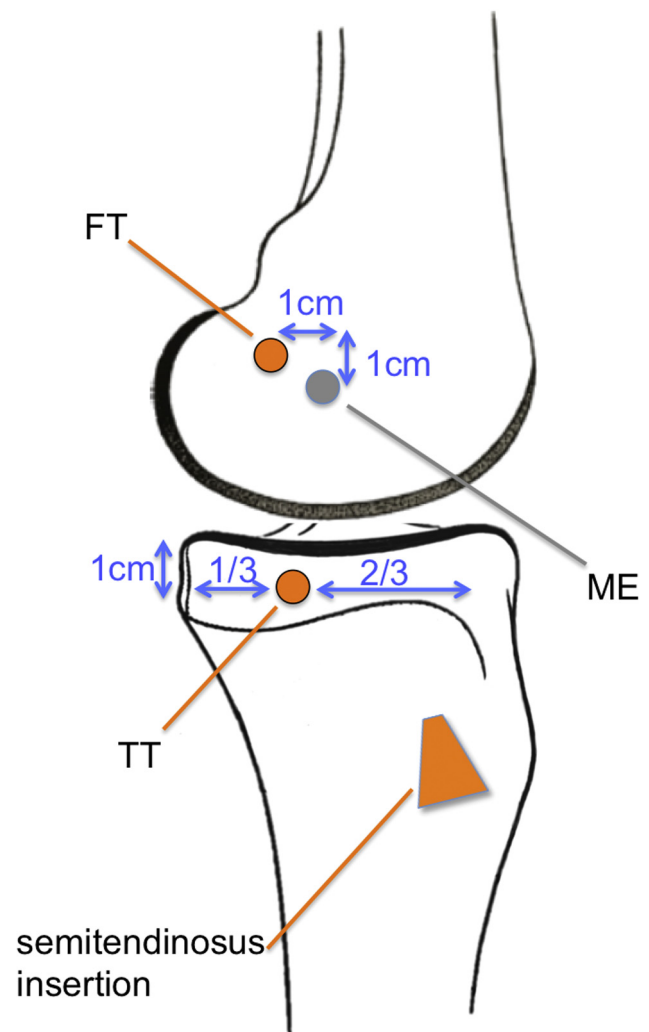


Fig 5. Positioning of the entry points for the femoral and tibial left knee tunnels (graft in orange). At the femur, the entry point is 1 cm proximal and posterior to the medial epicondyle (ME). At the tibia, the entry point is 1 cm below the joint line at the one-third posterior and two-thirds anterior junction of the medial tibial plateau. (FT, femoral tunnel; ME, medial epicondyle; TT, tibial tunnel.)

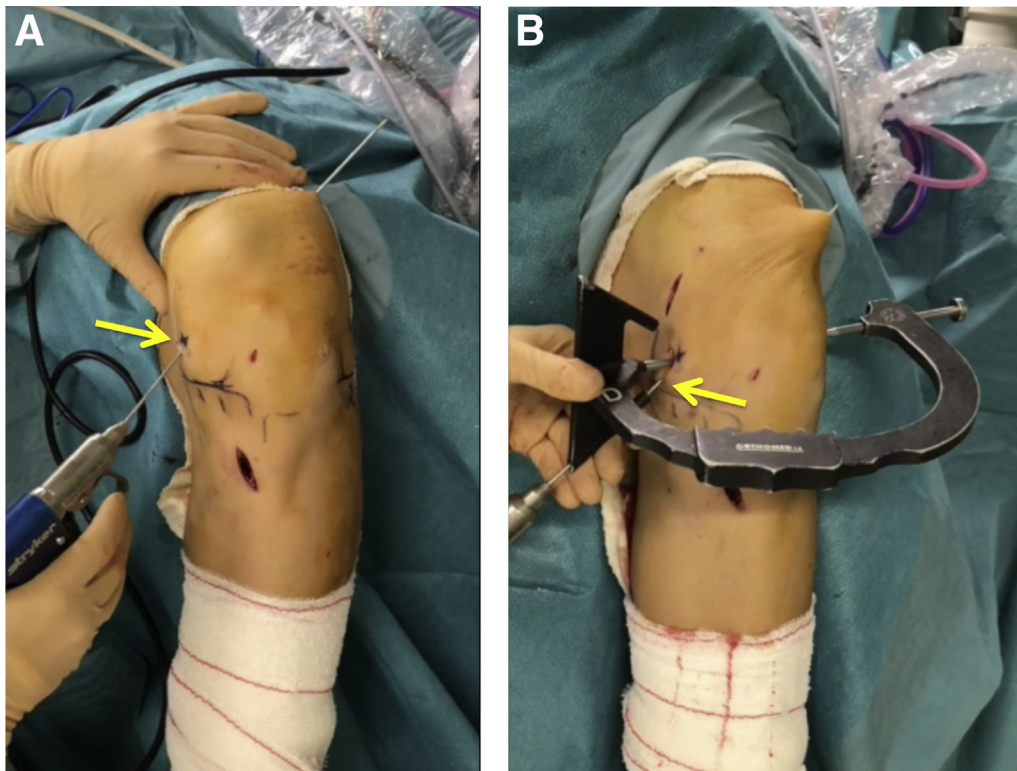


Fig 6. Positioning the femoral tunnel. Front view of left knee, flexed 90°, with patient supine. The semitendinosus tendon is buried at its harvest site. The entry point for the femoral tunnel is 1 cm proximal and posterior to the medial epicondyle (yellow arrow). It angles up at 45° in the frontal plane and forward at 45° in the transverse plane. The tunnel can be drilled either freehand (A) or using a drill guide (Orthomed, Saint-Jeannet, France) stabilized on the epicondyles (B).



Fig 7. Verifying isometry. Anteromedial view of left knee, flexed 90°, with patient supine. The tendon's position relative to the K-wire is used to confirm the construct has the correct isometry. A mark placed when the knee is flexed 90° and in neutral rotation (yellow arrow) should move distally away from the K-wire (red arrow) during knee extension and during internal tibial rotation.

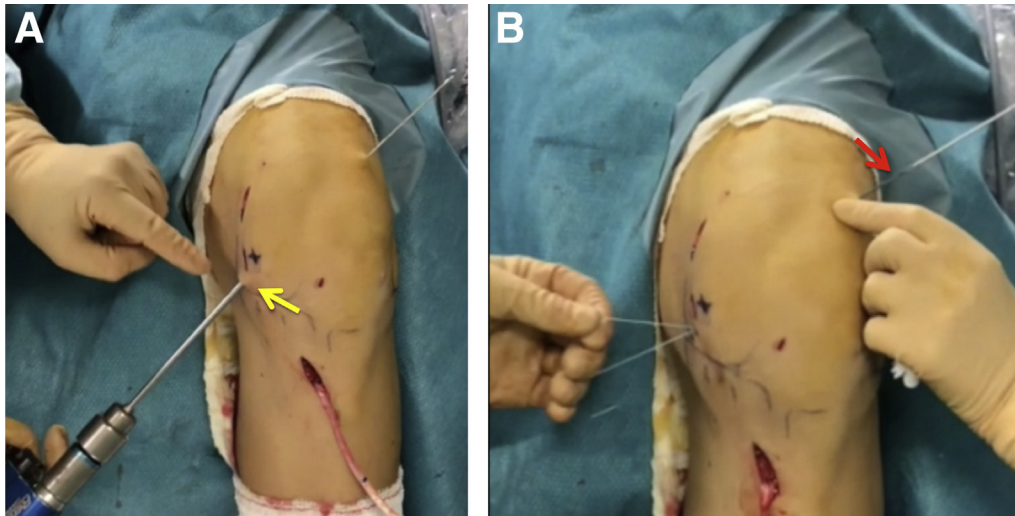
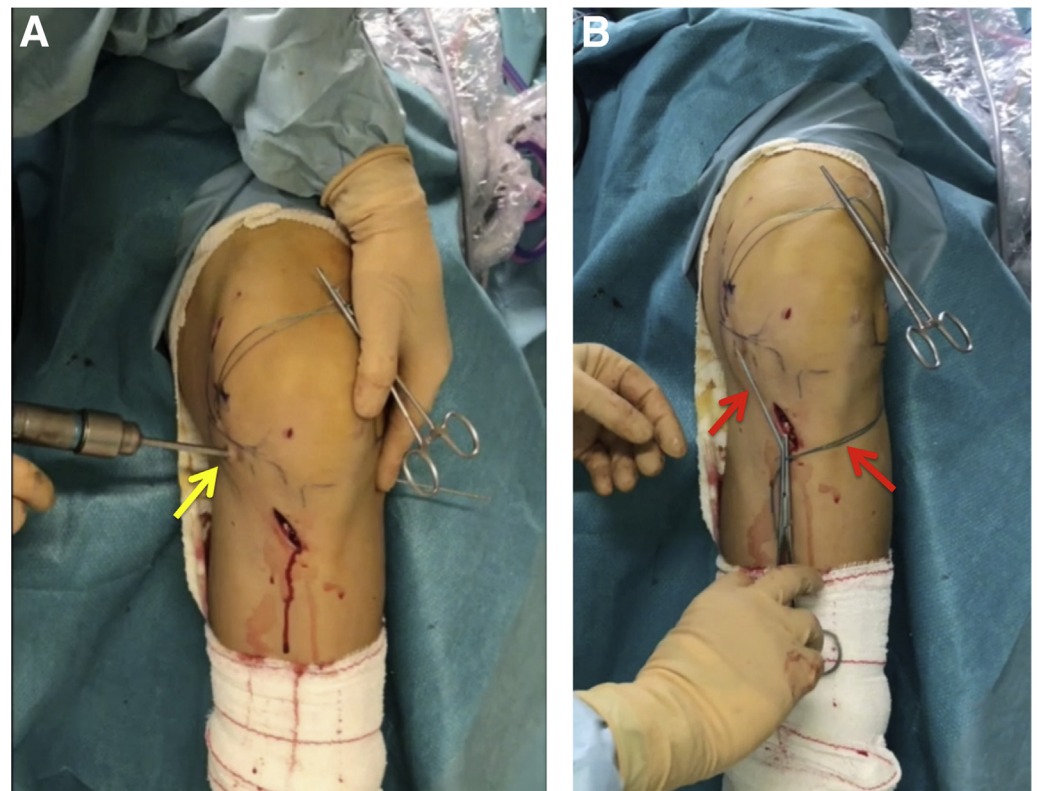


Fig 8. Drilling tunnel and placement of a traction suture. Anteromedial view of left knee, flexed 90°, with patient supine. A 6-mm-diameter, 25-mm-long tunnel is drilled. The drill bit's progress is determined relative to the skin (tip of finger, yellow arrow; A). The K-wire is then removed, leaving the traction suture in place (red arrow; B).

Fig 9. Preparing the tibial tunnel. Anteromedial view of left knee, flexed 90°, with patient supine. The entry point is 1 cm below the joint line, at a point one-third posterior and two-thirds anterior from the medial tibial plateau (yellow arrow). The pin is angled downward 30° in the frontal plane (A). A 6-mm-diameter tunnel is drilled through the opposite cortex (A). A traction suture is left in place when the beath pin is removed (red arrows; B).



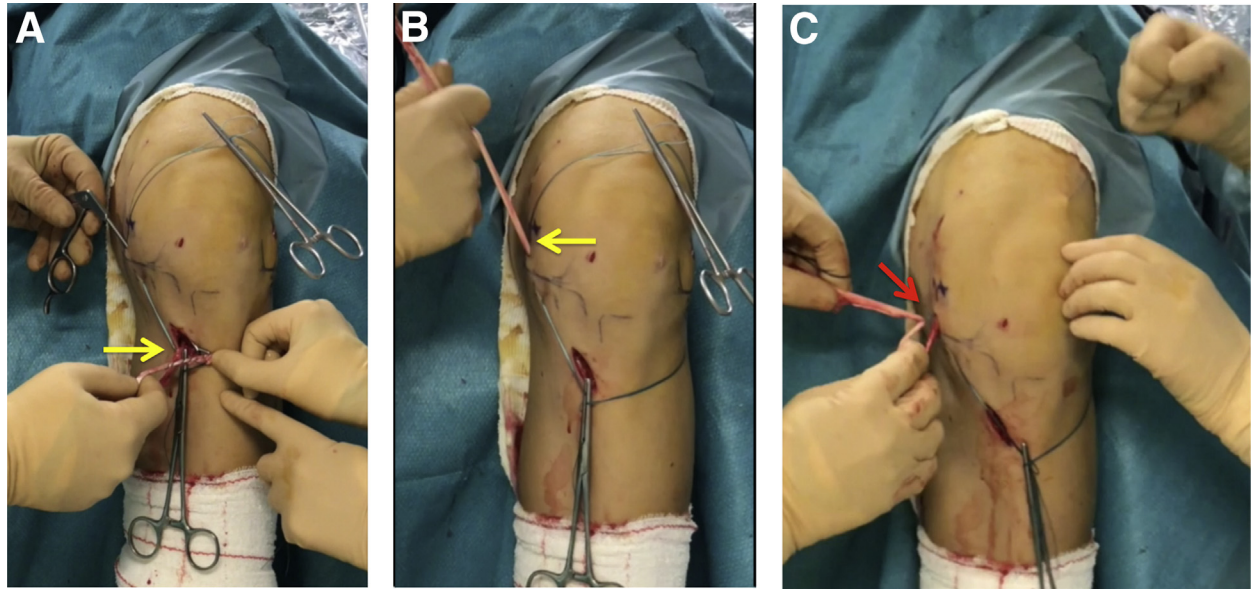


Fig 10. Passing graft through the femoral tunnel. Front view of left knee, flexed 90°, with patient supine. The graft is passed between the subcutaneous layer and the capsule-ligament layer using alligator forceps inserted through the femoral incision (yellow arrows; A, B). After folding it in half, the loop is introduced into the femoral tunnel using the traction suture (red arrow; C).

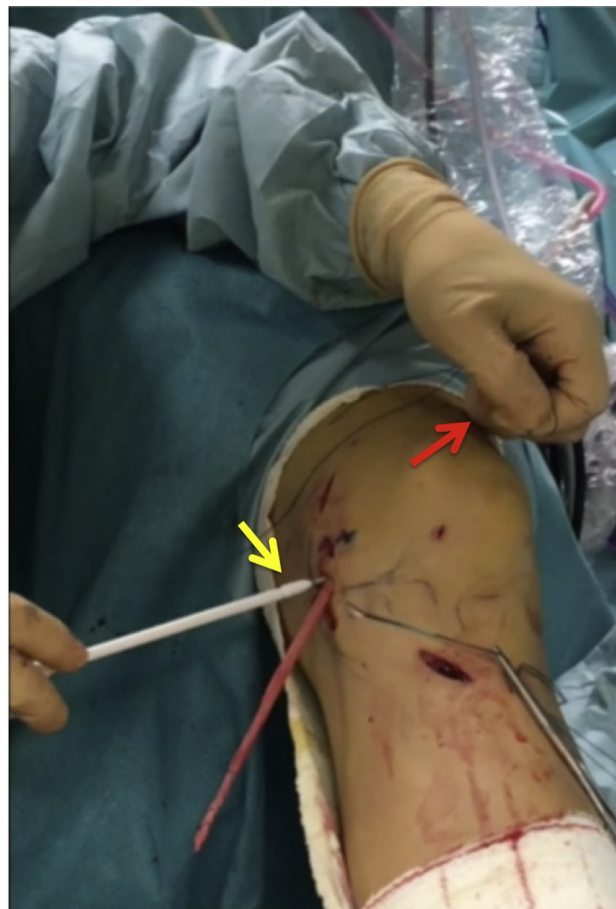


Fig 11. Graft fixation in the femoral tunnel. Anteromedial view of left knee, flexed 10°, and in neutral rotation with patient supine. The graft is secured while under tension (red arrow) using an absorbable 6×25-mm interference screw (Arthrex; yellow arrow).

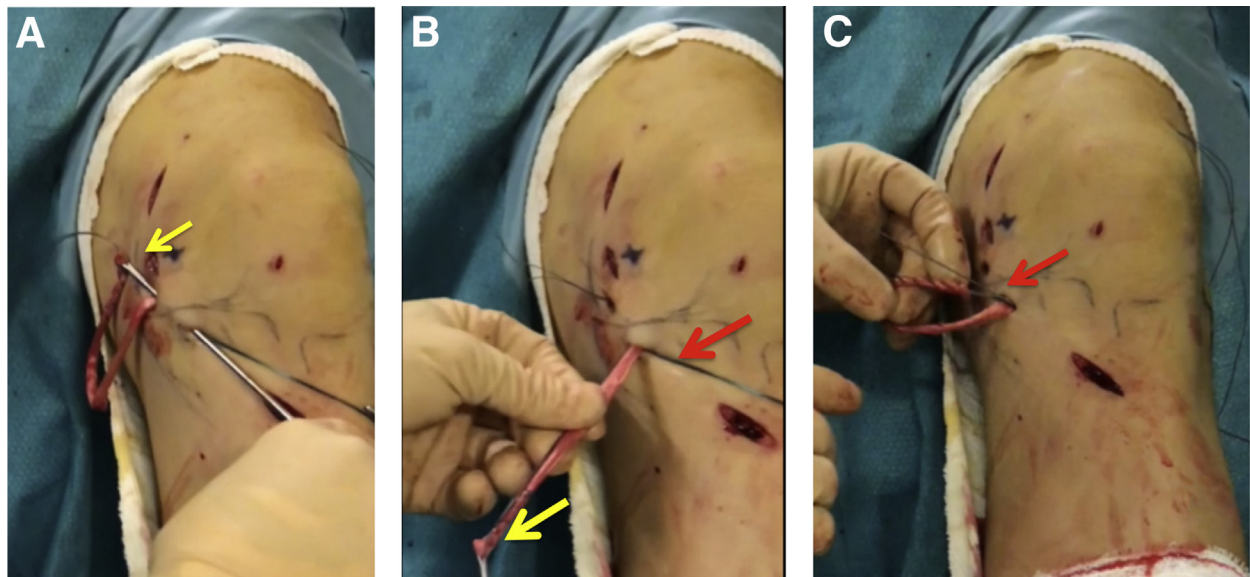


Fig 12. Passing graft through the tibial tunnel. Anteromedial view of left knee, flexed 90°, with patient supine. The graft is passed between the subcutaneous layer and the capsule-ligament layer using alligator forceps inserted through the tibial incision (yellow arrows; A, B). The traction suture is used to seat the graft in the tibial tunnel (red arrows; B, C).



Fig 13. Verifying graft isometry and fixation. Anteromedial view of left knee near full extension with patient supine. Manual traction (yellow arrow) is applied to the graft to ensure correct isometry (taut in extension and slack in flexion) and to ensure the valgus laxity has been eliminated (A). The graft is secured in the tunnel using a 7×30-mm interference screw (Arthrex; red arrow), with the knee flexed 20° and in neutral rotation (B).

Table 1. Advantages and Disadvantages of Percutaneous Medial Ligament Reconstruction

Advantages	Disadvantages
Minimally invasive, preserves soft tissues and prevents postoperative adhesions	Locating the femoral tunnel on large knees is challenging
Favorable anisometry	Cost of interference screws
Fast and easy to perform, reproducible	Tunnels alter the bone stock
Short construct with low risk of loss of tension	Uses the semitendinosus, which may not be available if it is needed for ACL reconstruction
Preserves the distal insertion of the semitendinosus tendon	

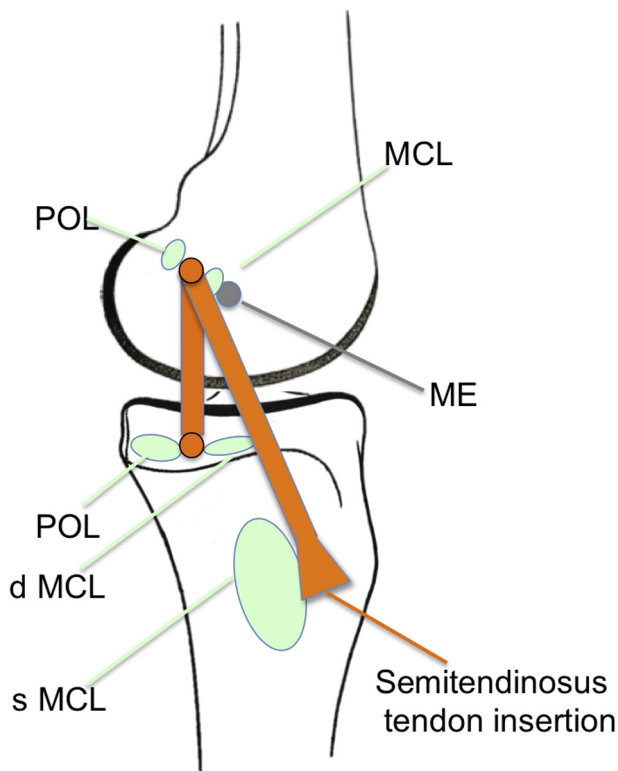


Fig 14. Position of the graft relative to other anatomic structures on the medial side of the left knee. The semitendinosus tendon attachment sites are located between those of the MCL and the POL. (d MCL, tibial attachment of the deep MCL bundle; MCL, medial collateral ligament; ME, medial epicondyle; POL, posterior oblique ligament; s MCL, tibial attachment of the superficial MCL bundle.)

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