

Both Posterior Root Lateral-Medial Meniscus Tears With Anterior Cruciate Ligament Rupture: The Step-by-Step Systematic Arthroscopic Repair Technique

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Abstract: The occurrence of posterior root tear of both the lateral and medial menisci, combined with anterior cruciate ligament rupture, is rare. Problems may be encountered such as the difficulty to access the medial meniscal root tear, the confusing circumstances about which structure to repair first, and the possibility of the tunnel for each repair to become taut inside the tibial bone. We present the arthroscopy technique step by step to overcome the difficulties in an efficient and time-preserving manner.

The meniscal root is where the meniscus attaches to the tibial plateau, anterior and posterior, in both the lateral and medial menisci. Meniscal root injuries can affect the meniscal hoop tension and are associated with meniscal root extrusion, increasing the peak contact pressure in the joint.^{1,2} Meniscal root repair is recommended in patients without advanced osteoarthritis (Kellgren-Lawrence grade 3 or 4), to restore joint congruence and loading and to avoid the long-term effect of joint overloading to prevent cartilage degeneration.³

Posterior root lateral meniscus (PRLM) tears are associated with anterior cruciate ligament (ACL) rupture.^{3,4} The cause of posterior root medial meniscus (PRMM) tear is often degenerative, as seen in middle-aged women, but it also might be seen in an acute setting in association with multiple knee ligament

injuries.^{3,5} Posterior root tear of the lateral-medial meniscus, combined with ACL rupture, is a case rarely found. In such a case, problems will be encountered such as the difficulty to access the medial meniscal root tear, the confusing circumstances about which structure to repair first, and the possibility of the tunnel for each repair to become taut inside the tibia. Furthermore, this Technical Note outlines step by step the arthroscopy technique to repair the lateral and medial meniscal posterior root tears and to systematically reconstruct the ACL.

Surgical Technique

In the preoperative setup, we place the patient in a supine position with the affected knee at 90° flexion with the use of a pneumatic tourniquet. Spinal anesthesia or general anesthesia was used according to the patient's preference. The arthroscopy technique consists of 5 steps with a 30° arthroscope, as follows (Table 1, Video 1).

Standard Diagnostic Arthroscopy

The standard anterolateral portal was established first, followed by the creation of the anteromedial working portal. While performing standard diagnostic arthroscopy, we found total rupture of the ACL. The medial meniscus was examined with an arthroscopic probe at approximately 20° to 30° knee flexion with a valgus and external foot rotation. The torn posterior root of the medial meniscus was identified. Often, we could not easily evaluate the medial meniscal root because

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Table 1. Pearls and Tips

Surgical Step	Pearls and Tips	Pitfalls
1. Harvesting the ACL graft	<ul style="list-style-type: none">• Confirm ACL rupture preoperatively with pivot shift test under anesthesia and MRI.• Starting by harvesting the graft can give a chance for graft preparation while performing diagnostic arthroscopy.	
2. Diagnostic arthroscopy	<ul style="list-style-type: none">• Always identify both posterior lateral and medial meniscus root tears.	<ul style="list-style-type: none">• Misdiagnosis of the PRMM tear frequently occurs. Visualization of PRMM tear is often difficult in conditions such as varus malalignment. We propose percutaneous pie-crusting of the deep MCL with a needle.
3. Posterior root medial to lateral meniscus repair	<ul style="list-style-type: none">• Perform the repair from the most posterior anatomic attachment structure to the anterior. This will make the repair easy to perform, allow good visualization, and create a landmark for the next repairing procedure (posterior medial meniscal root to posterior lateral meniscal root).• Cinch stitch is easy to perform, which lowers time consumption.• A single cinch stitch is needed, which minimizes meniscal injury (only 1 bite).• The transosseous tunnel technique allows to obtain a precise anatomic attachment of the structure	<ul style="list-style-type: none">• Meniscal cut-through occurs frequently. Using a No. 5 Ultratape can prevent cut-through because of its larger width.
4. ACL reconstruction	<ul style="list-style-type: none">• Perform this procedure at last because of the most anterior anatomic tibia attachment.	<ul style="list-style-type: none">• The graft and thread impingement inside the tibia are frequent. The 3 tibial tunnels should be created at a medial site for the ACL, a middle site for the posterior medial meniscus root, and at a lateral site for the posterior lateral meniscus root to prevent these pitfalls.
5. Anterior tibia cortical fixation	<ul style="list-style-type: none">• One 6.5-mm cancellous screw and washer can be inserted in the knee joint at full extension as cortical fixation for meniscal root repair and backup fixation for ACL reconstruction.	

ACL, anterior cruciate ligament; MCL, medial collateral ligament; MRI, magnetic resonance imaging; PRMM, posterior root medial meniscus.

the medial joint space was too narrow, especially in genu varus or impingement in the internal compartment. If this circumstance occurred, we could perform an outside-in selective deep medial collateral ligament pie-crusting release technique applied with

percutaneous punctures with controlled valgus force and constant arthroscopic display. The lateral meniscus was examined in a figure-of-4 position. We found both the lateral and medial posterior root detached from each anatomic attachment (Fig 1).

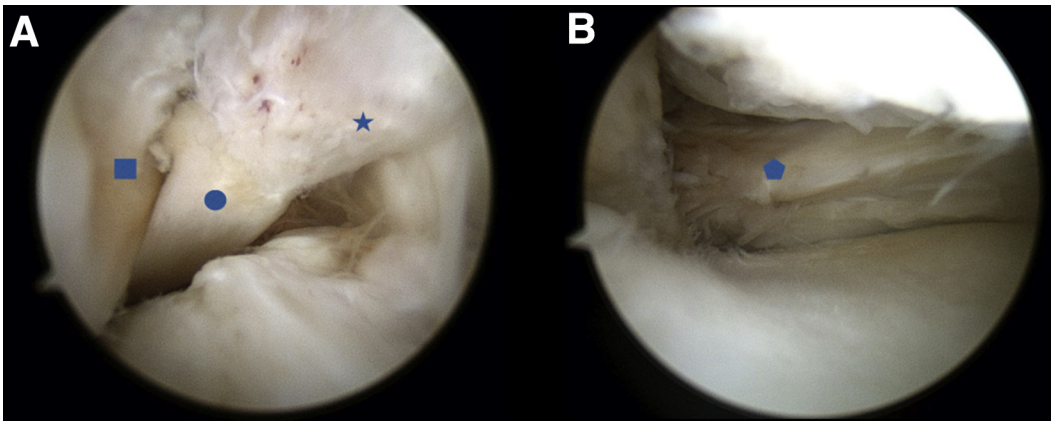


Fig 1. Diagnostic arthroscopy of the right knee. The patient is in supine position with the right knee joint at 90° flexion. The anterolateral portal is the viewing portal. (A) Detached posterior lateral meniscus root (round), meniscofemoral ligament (star), and medial wall of the lateral condyle femur (rectangular). (B) Detached posterior medial meniscus root (pentagon).

PRMM Repair

We performed the procedure in a valgus and external rotation position. The anterolateral portal was used as the viewing portal and the anteromedial portal as the working portal. The bony footprint of the PRMM was refreshed by an arthroscopic shaver. An arthroscopic curette was used to debride the normal root attachment on the posteromedial tibia for the medial meniscus. The posterior meniscal root would pull backward as a result of the intact attachment of the meniscal-capsular. The location of the root attachment should be anterior from the displaced PRMM. We tried to repair aiming to cover the posterior articular cartilage surface of the tibia as much as possible. The hip joint guide pin (Acufex Director Drill Guide; Smith & Nephew), used in this case because of its low-profile construction, was inserted through the anteromedial portal, while viewing from the anterolateral portal. Then, we drill a 2.5-mm-diameter guide pin from the anteromedial aspect of the proximal tibia through the meniscal root footprint, followed by reaming of the tibial tunnel with an EndoButton 4.5-mm drill (Smith & Nephew). We inserted the loop suture relay (PDS II suture; Johnson &

Johnson) and retrieved with the suture retriever to the anteromedial portal (Fig 2A).

Sutures in the root of the medial meniscus could be placed from the anteromedial portal. A No. 0 Ultrabraid (Smith & Nephew), folded in its midportion, was loaded into the lower jaw of the True Pass (Smith & Nephew). The True Pass was placed under the root of the medial meniscus near its normal bony attachment. The trigger of the device was deployed and the upper jaw captured the suture. The True Pass was then pulled out of the joint and the No. 0 Ultrabraid suture was brought out of the anteromedial portal (Fig 2B). Next, the True Pass was fired again to release the No. 0 Ultrabraid suture as a U-shaped loop outside the portal. Then, the Ultratape was inserted into the loop and the No. 0 Ultrabraid pulled as a shuttle. The 2 free ends of the Ultratape suture were passed through its own loop, creating a cinch configuration as the 2 free ends were pulled to slide the cinch down to the PRMM (Fig 2C). The cinch suture was retrieved with a suture retriever device above the posterior horn of the medial meniscus and pulled out of the anteromedial portal. The cinch suture was inserted into the loop shuttle relay and pulled out

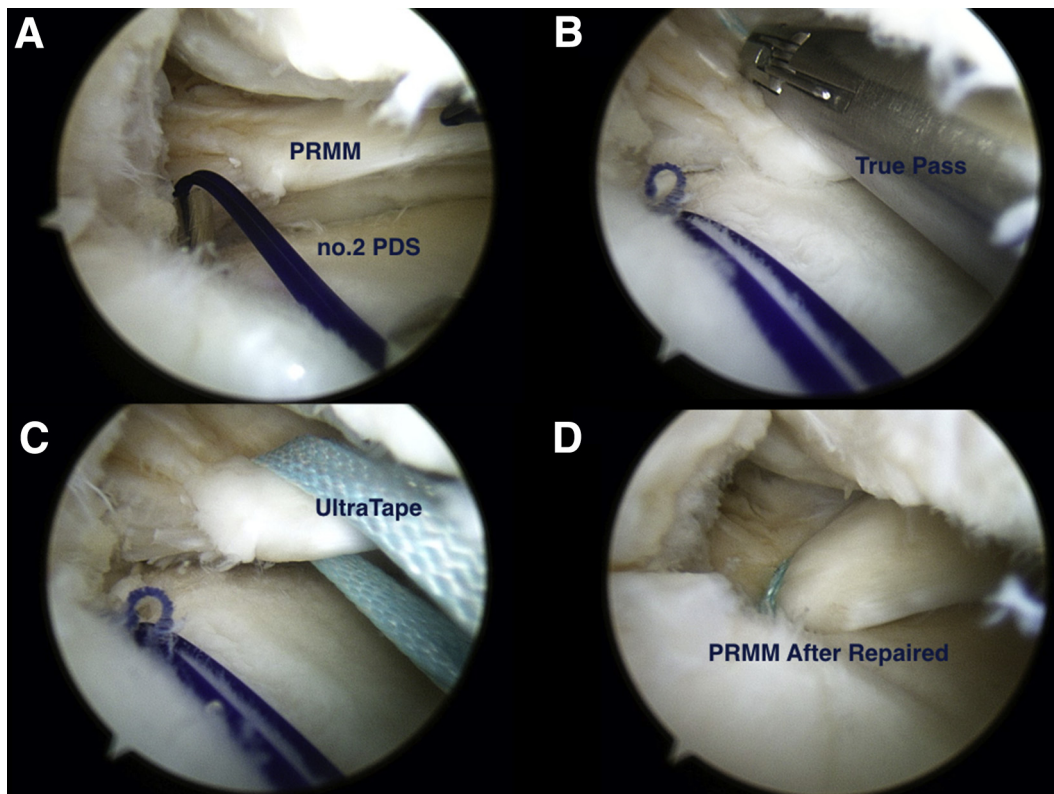


Fig 2. Posterior medial meniscal root repair. The patient is in supine position with the right knee extended, valgus, and slightly externally rotated. The anterolateral portal is the viewing portal. The anteromedial portal is the working portal. (A) Inserting No. 2 PDS suture through a 4.5-mm EndoButton reamer with a hip joint drill guide instrument (Acufex). (B) Insertion of a No. 0 Ultrabraid through the posterior root medial meniscus (PRMM). (C) Insertion of Ultratape through the PRMM using Ultrabraid as a shuttle suture. (D) PRMM repair with a cinch stitch to its anatomic attachment through the transosseous tibial tunnel.

of the transtibial tunnel (Fig 2D). The cortical fixation is performed once all procedures have been performed.

Posterior Root Lateral Meniscus (PRLM) Repair

We performed the procedure in a figure-of-4 position, with the aim to open the lateral joint space and allow clear visualization. The anterolateral portal was used as the viewing portal and the anteromedial portal as the working portal. We performed PRLM repair with sequences similar to those previously described in PRMM repair. The anatomic location of PRLM should be 1 to 2 mm more anterolateral than the anatomic location of PRMM. The anterior tibial cortex location for the PRLM tibial tunnel was located more lateral than the PRMM tibial tunnel to prevent tautness inside the tibial tunnel (Fig 3).

ACL Reconstruction

The graft can be harvested from the medial hamstring, quadriceps tendon, patellar tendon, or peroneal longus tendon. The graft was brought to the back-table and prepared. We performed this procedure before conducting the diagnostic arthroscopy after the cruciate ligament rupture was clinically confirmed.

Thus, the graft preparation could be performed concomitant with the diagnostic arthroscopy.

The fibrous tissue including the ACL stump on the superior posterior half of the lateral wall of the intercondylar notch was thoroughly removed using a radiofrequency device. After cleaning up, a resident's ridge, the anterior border of the femoral attachment area, was visualized. The femoral tunnel could be prepared in the usual technique.

A tibial drill guide was placed in the anteromedial portal and used to facilitate anatomic pin placement. We then identified the posterior aspect of the anterior horn of the lateral meniscus as a marker to find the anatomic tibial footprint of the ACL. We started drilling for the tibial tunnel with the tibial guide aimer set to 55°.

The graft was passed from the tibial tunnel to the femoral socket with 2 leading sutures. Once the marking on the graft was at the insertion of the femoral tunnel and we felt the EndoButton flip to the lateral femoral cortex, the graft had cycled appropriately. Afterward, we used the interference screw to fixate the graft at the tibia aperture in 30° knee joint flexion (Fig 4).

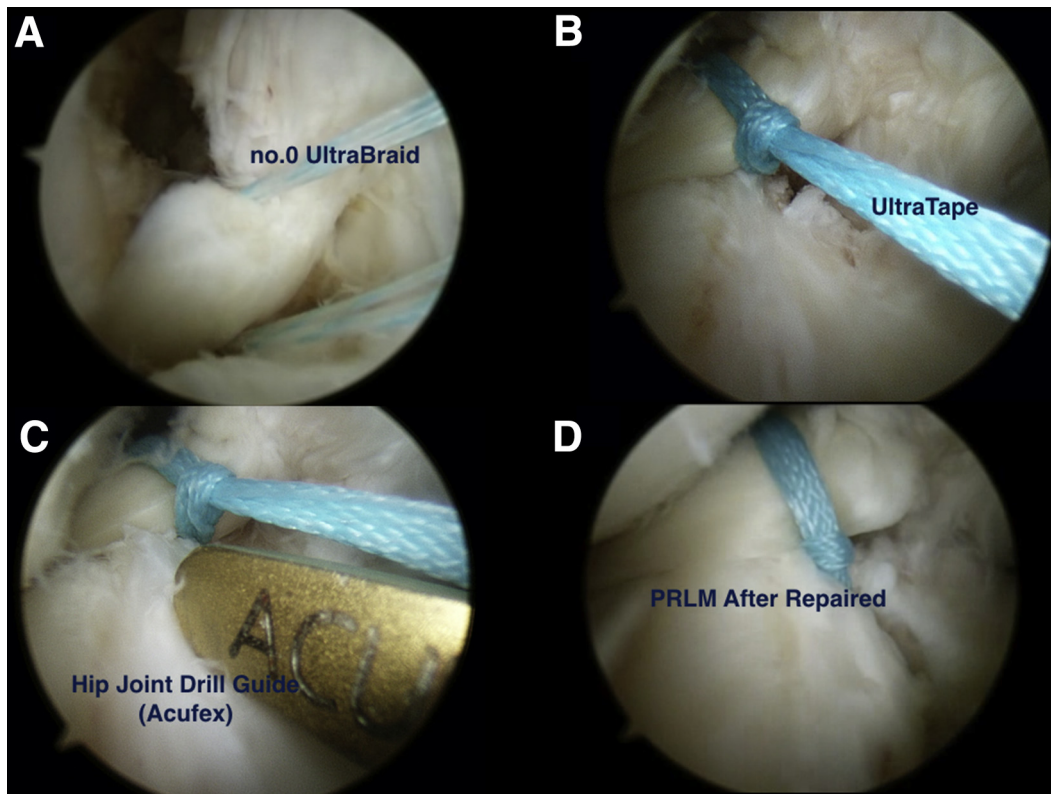


Fig 3. Posterior lateral meniscus root repair. The patient is in supine position with the right knee in a figure-of-4 position. The anterolateral portal is the viewing portal, and the anteromedial portal is the working portal. (A) Insertion of a No. 0 Ultrabraid through the posterior root lateral meniscus (PRLM). (B) Cinch suture configuration of Ultratape on the PRLM. (C) Insertion of a No. 2 PDS through a 4.5-mm EndoButton reamer with a hip joint drill guide instrument (Acufex). (D) PRLM repair with a cinch stitch to its anatomic attachment through the transosseous tibial tunnel.

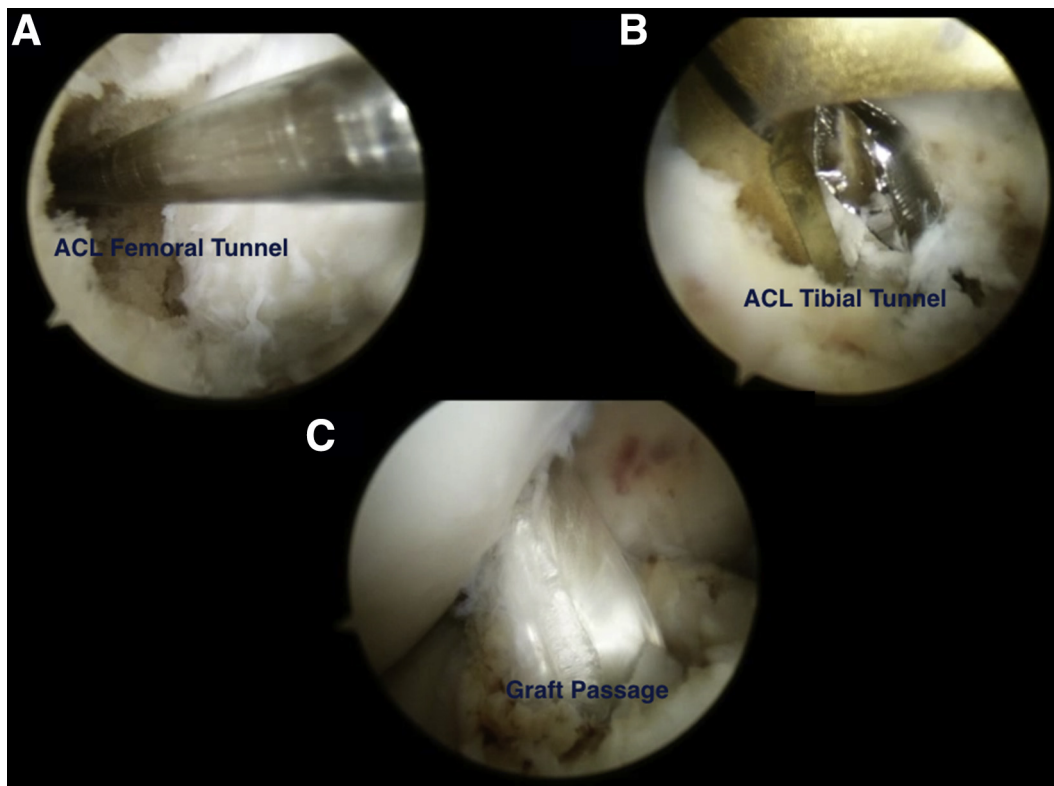


Fig 4. ACL reconstruction. The patient is in supine position with the right knee in hanging flexion. The anterolateral portal is the viewing portal, and the anteromedial portal is the working portal. (A) Femoral tunnel preparation performed with the knee in 120° flexion. (B) Tibial tunnel preparation. (C) Inserting graft through the tibia and femoral tunnel. (ACL, anterior cruciate ligament.)

Anterior Tibial Cortex Fixation

All the sutures on the anterior cortex of the tibia were collected at anteromedial incision. We inserted a 6.5-mm cancellous screw and washer in knee joint full extension as a backup post screw for the ACL graft and cortical fixation for posterior root medial-lateral meniscus repair (Fig 5).

Postoperative Rehabilitation

The patient was allowed to touch weight-bear for the first 2 weeks. At this time, the knee was put in a hinged knee brace with full knee extension. From week 2 to 4, 0° to 90° range of motion with 50% weight bearing was allowed. From week 4 to 6, progressive weight bearing as tolerated was started. At week 6 postoperatively, the knee brace could be discontinued. Full weight bearing was encouraged after weaning out of the brace.

Discussion

Posterior root tear of both the lateral and medial menisci along with ACL rupture is rarely found. There are only a few published studies that discuss the steps to repair those conditions. The possibility to fix those structures simultaneously has been controversial, and no consensus exists on the surgical procedure. We proposed systematic surgical steps and techniques to

manage posterior root tear of both the lateral and medial menisci with ACL rupture. The procedures could be performed simultaneously because we believe that the presence of growth factors and possibly bone marrow mesenchymal stem cells, during femoral-tibial tunnel preparation in ACL reconstruction and tibial transosseous drilling in posterior meniscal root repair, may promote and enhance healing.⁶ The systematically controlled rehabilitation is needed to protect the repaired and reconstructed structures.

PRMM tear can cause meniscal extrusion, so the medial joint space will be narrow and the affected lower extremity will be varus. Direct visualization of the PRMM is frequently difficult. This circumstance makes it difficult to diagnose and perform repair. Performing an outside-in selective deep medial collateral ligament pie-crusting release technique, applied with percutaneous punctures with controlled valgus force and constant arthroscopic display, will be an option to overcome this issue.⁷

We proposed to perform a repair from the PRMM to the PRLM and then proceed to ACL reconstruction. The advantages of the order of these steps were to create a proper visualization and prevent the confusing circumstances because we repaired from the most posterior structure to the most anterior anatomic attachment

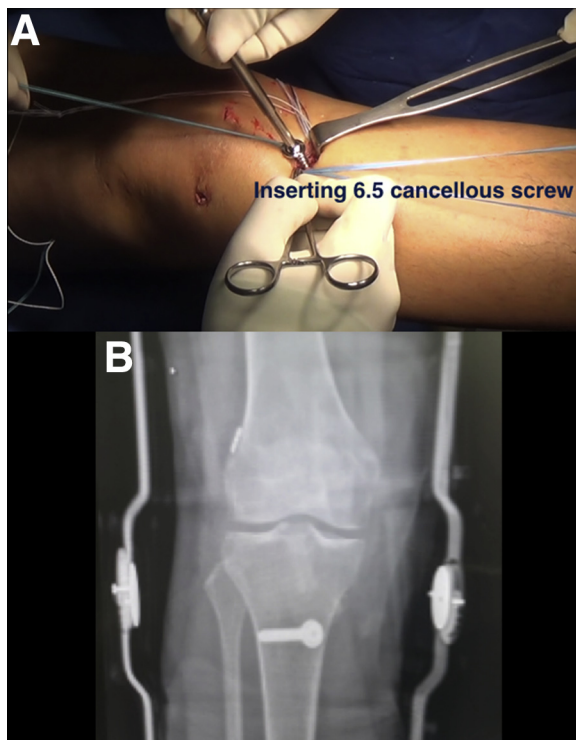


Fig 5. (A) Anterior tibial fixation in full extension of the right knee joint for posterior root repair of both medial and lateral menisci and backup fixation of ACL reconstruction with 6.5-mm cancellous screw with washer. (B) Anteroposterior radiograph of the right knee joint in supine position shows the proper position of the 6.5-mm cancellous screw with washer as anterior tibial fixation for both medial-lateral meniscus root repair and backup fixation of ACL reconstruction. (ACL, anterior cruciate ligament.)

structure. Those procedures could also create a continuing parameter as a basic landmark to obtain further anatomic footprints of the repaired or reconstructed structures.

We chose the cinch-type suture to repair the posterior meniscal root and perform transosseous tunnel repair. The main advantage of a cinch suture included ease of placement of the loop through the meniscus; this could potentially improve the strength compared with other configurations such as simple sutures.⁸ Previous studies investigated the effects of 4 different repair constructs using a No. 0 FiberWire, including a single (simple) suture, double (2 simple) sutures, a loop stitch, and a locking loop stitch. They found that although none of these constructs sufficiently replicated the native load-to-failure strength of the meniscal root, the loop stitch came the closest.⁸⁻¹⁰ In our procedure, we used a single cinch suture to minimize injury to the meniscus when inserting the suture. The sutures that we used were Ultratape, which has larger width contact than No. 0 Ultrabraid. The purpose of this suture selection was to avoid cut-through of the meniscus and to hold the

posterior root meniscus at its anatomic attachment as strongly as the 2-cinch-stitch suture.

The transosseous tibial pullout technique facilitates anatomic reduction, fixation of the meniscal root, and displaced prevention. Another study reported that an in situ pullout repair of radial tear restored the joint contact pressure and area similarly to the intact state. This technique can facilitate an accurate positioning for the posterior horns.^{3,11} Mechanical studies have found that a 3-mm nonanatomic displacement significantly alters meniscal function.^{3,11}

Moreover, we created the direction and opening aperture of the cortical tibial tunnel lateral to PRLM repair, middle to PRMM repair, and more medial to ACL reconstruction. We considered these steps necessary to prevent tautness or impingement of the suture and graft inside the tibial tunnel. Finally, we perform cortical tibial fixation for both posterior meniscal root tears with the tibial post screw and washer concomitant with the backup fixation for ACL reconstruction. Overall, this technique can simplify the complex and challenging procedure into the systematic and efficient steps of reconstruction (Fig 6).

Limitations of this technique include the inability to perform it in preexisting severe chondral lesion (Kellgren-Lawrence grade 3 or 4) or malalignment (varus or valgus). Sometimes, the chronic extrusion of the medial or lateral meniscus could not be corrected.

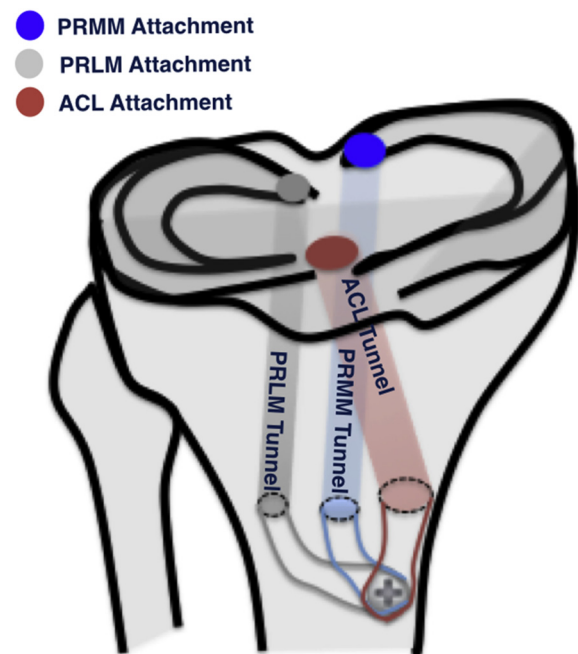


Fig 6. The 3 tibial tunnels shown are as follows: the medial site for the anterior cruciate ligament, the middle site for the posterior medial meniscus root, and the lateral site for the posterior lateral meniscus root. The aim is to prevent graft and thread impingement inside the tibia.

Table 2. Advantages, Limitations, and Disadvantages**Advantages**

- Systematic approach to perform both posterior medial-lateral meniscal root tears with ACL rupture
- Effective and lesser time consumed
- Minimal meniscal injury (only 1 bite)
- Prevents “cut-through” (larger-width material)
- Creates good visualization for the injured structures
- Creates step-by step landmarks for anatomic attachment of the injured structures
- Prevents confusing circumstances in the repairing procedure
- Prevents graft and thread impingement inside the tibia

Limitations and disadvantages

- Under postoperative coronal MRI, sometimes extrusion of the medial or lateral meniscus is not corrected
- Cannot be performed in case of chondral lesion or existing malalignment

ACL, anterior cruciate ligament; MRI, magnetic resonance imaging.

These posterior meniscal root repairs cannot be performed if the knee joint space is too narrow to insert the suture passer device (Table 2).

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