Technical Note

Posterior Lateral Meniscal Root Repair Through Lateral Tunnel and Anterior Cruciate Ligament Revision: How to Avoid Tunnel Overlapping

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Abstract: Posterior lateral meniscal root (PLMR) tears are commonly observed in conjunction with anterior cruciate ligament (ACL) injuries. The presence of PLMR tears exacerbates knee instability, increasing stress on ACL grafts and accelerating joint degeneration if left untreated. Anatomical repair of PLMR tears is therefore crucial for restoring native knee kinematics and reducing tibiofemoral contact pressures, thereby safeguarding the ACL graft. However, the standard use of a single medial tunnel approach for concomitant PLMR and revision ACL reconstruction may require reconsideration to prevent the potential risks of tunnel overlapping, which could undermine graft anatomical integrity. This article, to prevent the risk of tunnel overlapping, introduces a surgical approach that employs an additional lateral tibial tunnel for PLMR repair, instead of the typically used single medial one, for PLMR repair during simultaneous revision ACL reconstruction.

Posterior lateral meniscal root (PLMR) tears frequently are associated with anterior cruciate ligament (ACL) rupture, ranging from 4.8% to 12% in patients undergoing primary anterior cruciate ligament reconstruction (ACLR) and approximately 40% for revision anterior cruciate ligament reconstruction (Rev-ACLR).[1] In the event of a PLMR tear, there is an increase in both rotational and anterior laxity of the knee, which results in greater stress on the reconstructed ACL grafts. Recent studies suggest that an anatomical root repair of the PLMR can normalize tibiofemoral contact pressures and restore native kinematics, both in situations with an ACL deficiency as well as in cases involving simultaneous ACLR.[2]

Not treating or detecting PLMR tears can have detrimental effects to the knee, with rapid articular cartilage degeneration, loss of the meniscus as a secondary stabilizer, and increased stresses on the ACL graft.[3,4] PLMR tears repair typically is conducted using a transtibial pull-out technique, which entails drilling either a single or double tunnel in the tibia to enable anatomical root reattachment. However, the proximal tibia's limited bone mass presents a challenge when this procedure is combined with Rev-ACLR, as it raises the risk of tibial tunnel convergence or overlapping, potentially undermining the integrity of the graft, and causing damage to fixation devices. The purpose of this study was to describe a technique, using a lateral tunnel placement for posterior lateral meniscus root repair, designed to avoid the risk of tunnel convergence specifically in cases in which concomitantly Rev-ACLR is performed (Fig 1).

Surgical Technique

The surgical technique can be seen in Video 1 and is described herein.

Patient Evaluation

In preparation for the revision, it is essential to clinically evaluate the patient and obtain dedicated imaging (anteroposterior and lateral knee and full-leg radiograph; computed tomography and magnetic resonance imaging).

The most reliable magnetic resonance imaging finding of a meniscal root tear is represented by the presence of a "ghost sign," characterized by the nonvisualization of

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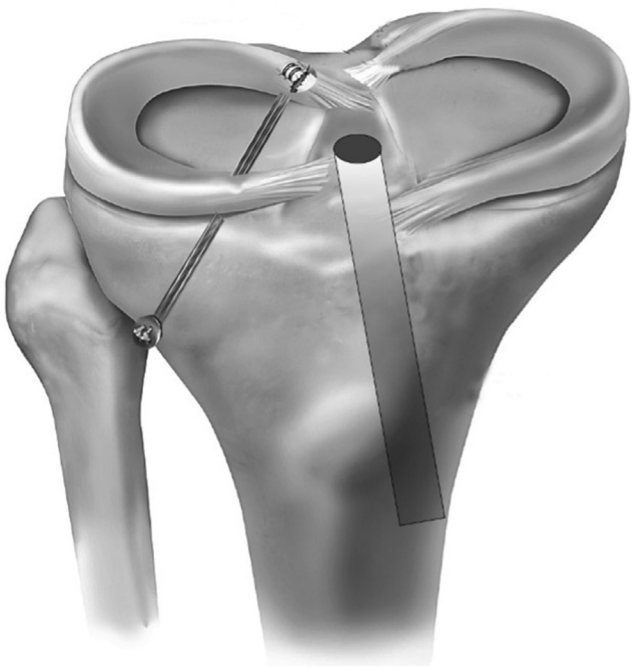

Fig 1. Final graphic illustration of the surgery, with the lateral tunnel placement for posterior lateral meniscus root repairs. Shown is how this configuration is designed to avoid the risk of tunnel overlapping.

the meniscus in either sagittal or axial sequences. Furthermore, meniscal extrusion, defined as displacement of the meniscus beyond the joint margin by more than 3 mm, can be observed in coronal sections at the level of the medial collateral ligament (Fig 2). The diagnostic workflow is completed with a computed tomography scan with a dedicated study protocol of the tunnel's position and diameter (Fig 3).

Patient Positioning

The equipment to perform knee arthroscopy in a stable and controlled environment is listed in Table 1 and the 10 steps of the technique, along with positioning, are listed in Table 2. After spinal anesthesia, prophylactic antibiotic treatment is initiated with 2 g of intravenous cefazolin. The patient is positioned supine with the tourniquet applied at the proximal thigh. A double holder is employed (one at the level of the affected thigh and the other one on the contralateral iliac crest) to avoid patient lateral shifting during surgery and stress maneuvers. A roller is placed at the end of the operative table to maintain the affected knee at 90° of flexion.[5,6]

Graft Harvesting

The choice of graft for the revision procedure is influenced by the type used in the initial ACLR and the extent of the bone defect. Depending on these factors, either an autograft (patellar tendon, quadriceps tendon, semitendinosus, and gracilis) or an allograft may be selected. This approach allows for a tailored solution that addresses the unique challenges presented by each case, ensuring optimal outcomes for the patient.

Standard Arthroscopy

A diagnostic knee arthroscopy is performed using standard anterolateral and anteromedial (AM) portals with a 30° arthroscope. The medial compartment is inspected with the knee at 20° to 30° of flexion with a

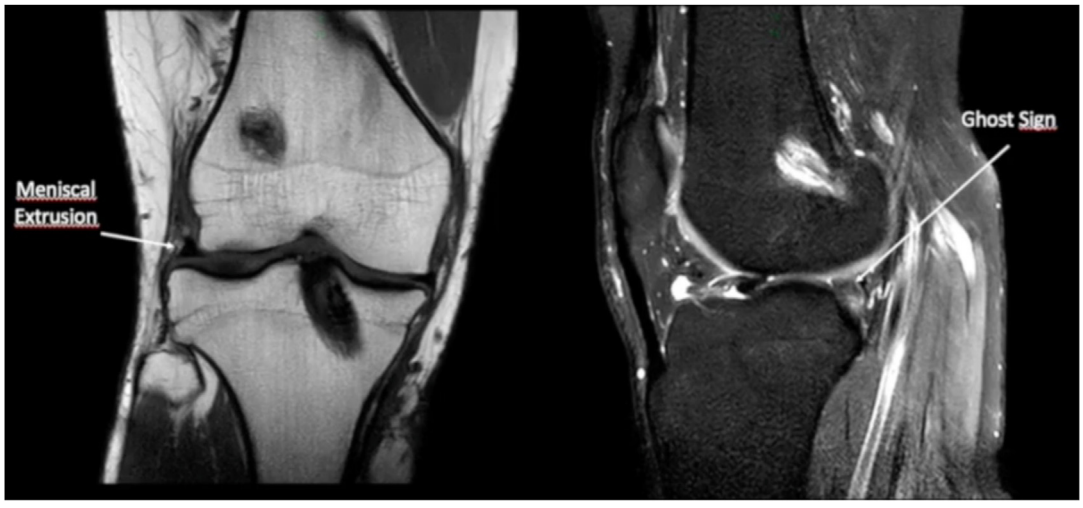

Fig 2. Preoperative coronal and sagittal magnetic resonance imaging sections depicting lateral meniscal pathology. The coronal view reveals lateral meniscal displacement outside of the joint by more than 3 mm, indicative of significant meniscal extrusion. In the sagittal view, the "ghost sign" is evident, characterized by the absence of an identifiable meniscus, serving as an indirect sign of a tear in the lateral posterior horn. These images were obtained with the patient in a supine position, highlighting the right knee.

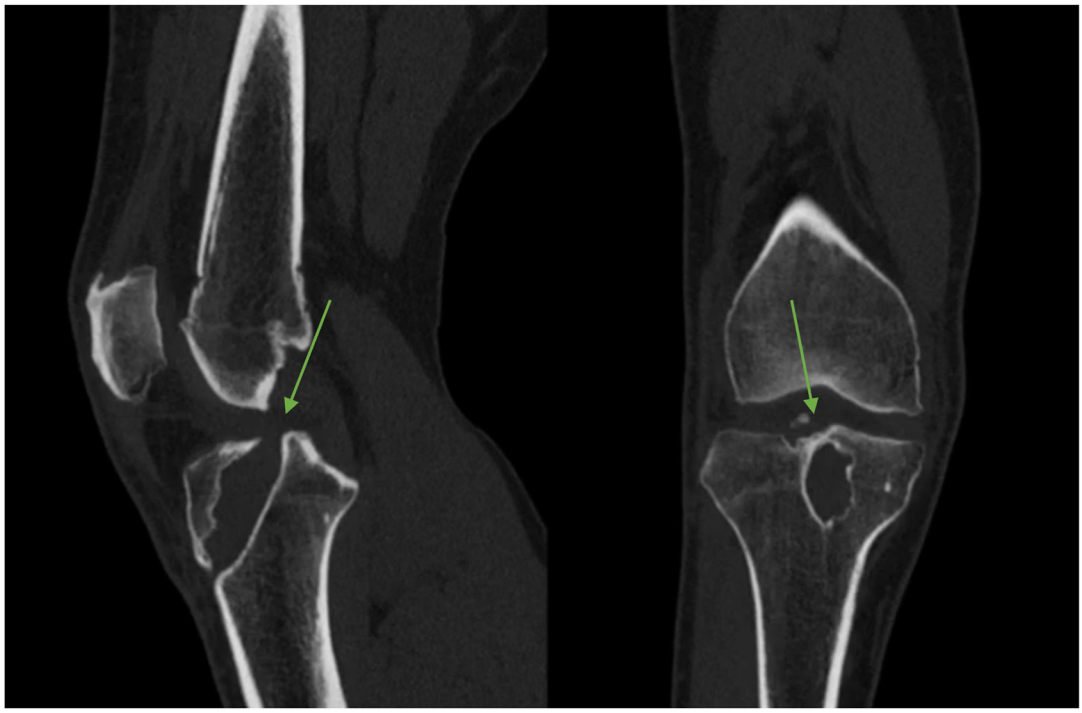

Fig 3. Preoperative computed tomography scan of the knee in both sagittal and coronal views, showing a significant tibial tunnel widening (green arrows), which indicates a high risk of tunnel overlapping when performing the tunnel required for the posterior lateral root repair. These images were obtained with the patient in a supine position, highlighting the right knee.

valgus and external foot rotation to rule out any underlying pathology. Lateral compartment is checked in a figure of 4 position, effectively opening the lateral joint space to ensure optimal visualization and facilitate procedural maneuvers.

PLMR Repair

The lateral meniscus is checked and inspected for other associated combined tears and a type 2 complete tear of the posterior root of the lateral meniscus observed, with a complete lift-off of the meniscal root from the tibial plateau (Fig 4). The reducibility of the meniscus is checked using a grasper to assess the reposition of the meniscus at its anatomical attachment without tension. In case of scar tissue or adhesion, a release is necessary to mobilize the meniscus and restore its anatomic position. The bony footprint of the PLMR is refreshed and debrided using an arthroscopic shaver or curette.

Table 1. General Preparation

1. Spinal anesthesia and antibiotic prophylaxis
2. Supine position
3. Tourniquet applied at the proximal thigh
4. Double holders:
• one positioned at the level of the affected thigh
• the other placed on the contralateral (opposite) iliac crest
5. Roller at the end of the operative table to maintain the knee at a 90° of flexion

Table 2. Ten Steps of the Technique and Positioning

1. Graft harvesting (BPTB or QTB)	Supine position, knee 90° flexion
2. Standard AM/AL portal and diagnostic arthroscopy	
3. Inspection of lateral root (lift the meniscus, reducibility)	"Figure-of-4" position
4. Footprint refreshening with a shaver or curette	
5. Pass first suture to meniscal root with device (cinch configuration) through AM portal	
6. Pass second suture to meniscal root (cinch configuration) through AM portal	
7. Small lateral incision and detachment of tibialis anterior	Knee 90° of flexion
8. Drill tibial tunnel from lateral cortex using the ACL tibial guide (K-wire 2.4 and drill 4.5 mm)	
9. Pull out the suture from the AM portal into the tibial tunnel with a carrier wire	
10. Knot the suture against a metallic button	

ACL, anterior cruciate ligament; AL, anterolateral; AM, anteromedial; BPTB, bone–patellar tendon–bone; QTB, quadriceps tendon–bone.

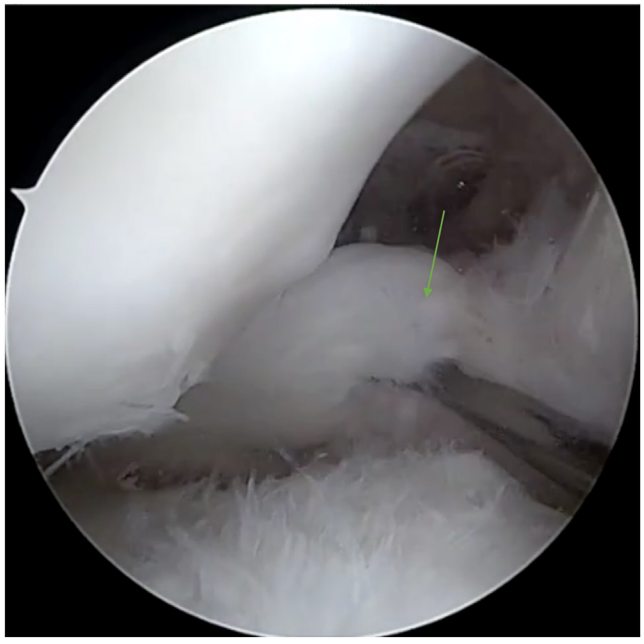

Fig 4. Arthroscopic view with the leg in a figure-of-4 position, the lateral compartment is inspected and a type 2 complete tear of the posterior root of the lateral meniscus is observed (green arrow). Stability of the meniscus is checked and a complete lift-off of the meniscal root from the tibial plateau can be observed.

A meniscal root self-capture suture passing device (FIRSTPASS Mini; Smith & Nephew; Watford, England) is introduced through AM portal loaded with a No. 2 high-resistance suture (FiberWire; Arthrex, Naples, FL) (Fig 5).

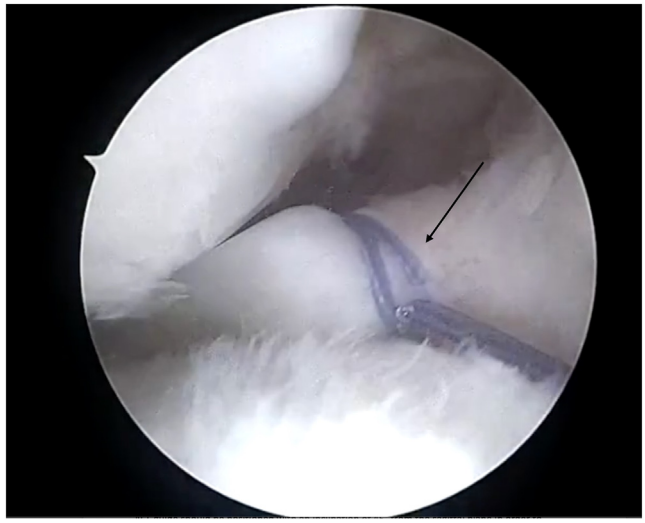

Fig 6. Arthroscopic view showing the 2 free ends of the suture passed through its own loop and pulled to slide into the meniscal root creating a chinch configuration stich (black arrow).

The suture passer is first used to place the suture at 5 mm lateral to the free edge of the posterior root from the tibial to the femoral side. The suture-retrieving mechanism allows the device to pull out the suture through AM portal, avoiding soft-tissue bridges. The 2 free ends of the suture are then passed through its own loop and pulled to slide into the meniscal root, creating a chinch configuration stich (Fig 6) A second stitch, using the same technique, is positioned 5 mm laterally to the first one (Fig 7).

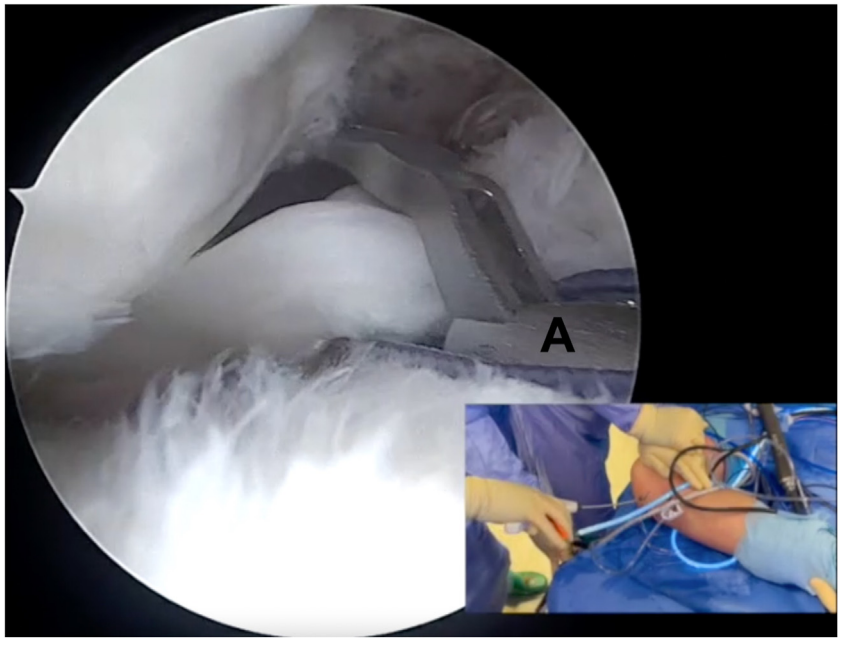

Fig 5. Arthroscopic view showing the meniscal root self-capture suture passing device (FIRSTPASS Mini; Smith & Nephew) (A), which is introduced through the anteromedial portal loaded with a No. 2 high-resistance suture (FiberWire).

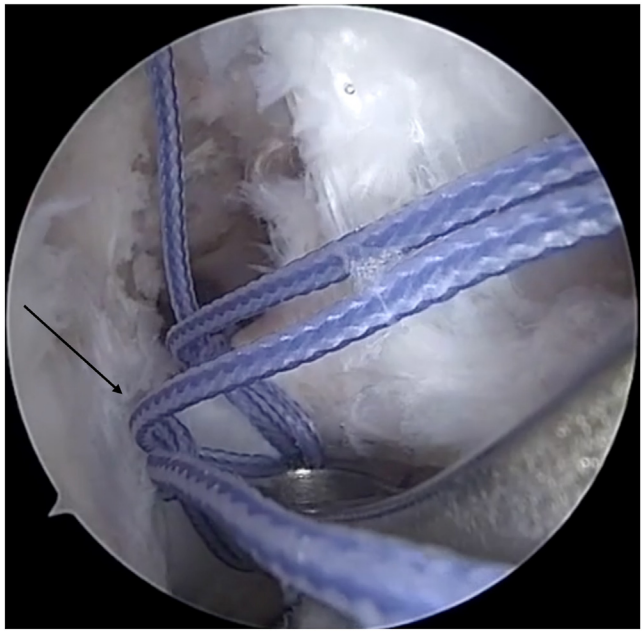

Fig 7. In this arthroscopic view, a second stitch, using the same technique, is positioned 5 mm laterally to the first one (black arrow).

In a standard position with knee at 90° of flexion and hip in neutral rotation, the tibial ACL guide is introduced through AM portal, aiming toward the anatomic posterolateral root attachment. The tibial ACL guide should be angled at 45° relative to the sagittal plane, ensuring the cannula is aligned against the lateral cortex of the proximal tibia.

A lateral skin incision of 3 to 4 cm is then performed. The fibers of the tibialis anterior are elevated (Fig 8), then the tibial cannula is inserted against the bone through the incision.

A drill of 2.4 mm is introduced from the anterolateral aspect of the proximal tibia aiming the meniscal footprint (Fig 9), followed by the use of a 4.5-mm reamer to construct the tibial tunnel (Fig 10).

The K-wire is subsequently removed, while the reamer is retained in position, serving as a guide for the introduction of a suture shuttle relay into the joint. This relay is then retrieved through the AM portal (Fig 11).

All the sutures are then untangled using a grasper introduced through the AM portal to avoid soft-tissue incarceration during the following steps. The sutures are then tied down over a cortical fixation device (Suture Button; Arthrex) against the anterolateral tibial cortex (Fig 12).

ACL Revision

The remnants of the ACL graft are debrided. Using the tibial guide, a K-wire is drilled from the anteromedial aspect of the tibia toward the anatomical tibial footprint. The aim is to establish a tunnel angled approximately 20° medially in the axial plane and 55° in the sagittal plane. Sequentially, straight reamers of increasing diameters are employed over the K-wire, starting with an 8-mm reamer and incrementally enlarging to a diameter that corresponds with the graft size. The arthroscope is inserted inside the tibial tunnel to check whether there is convergence with the tunnel of the lateral root repair (Fig 13).

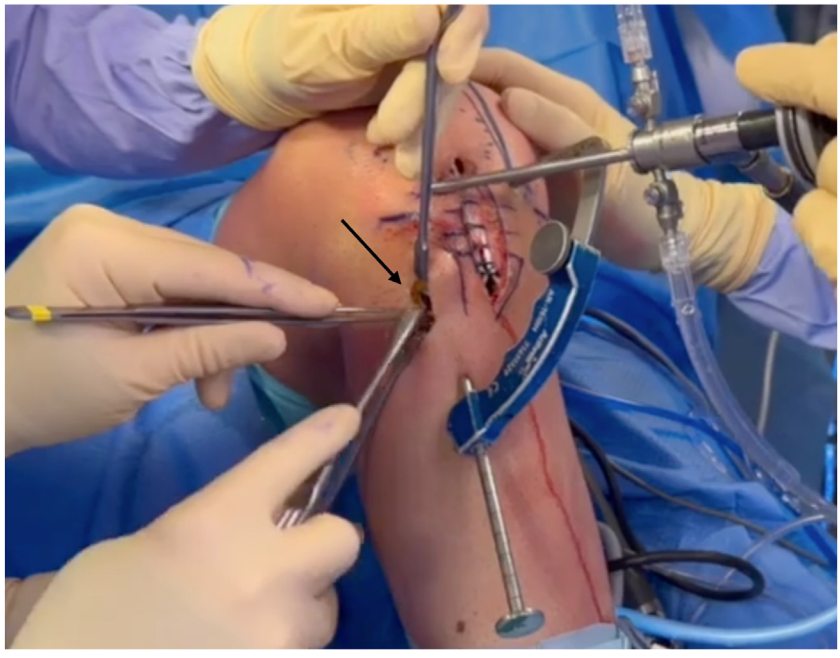

Fig 8. A small lateral incision is performed (black arrow), the anterior fibers of the tibialis anterior are elevated from the bone.

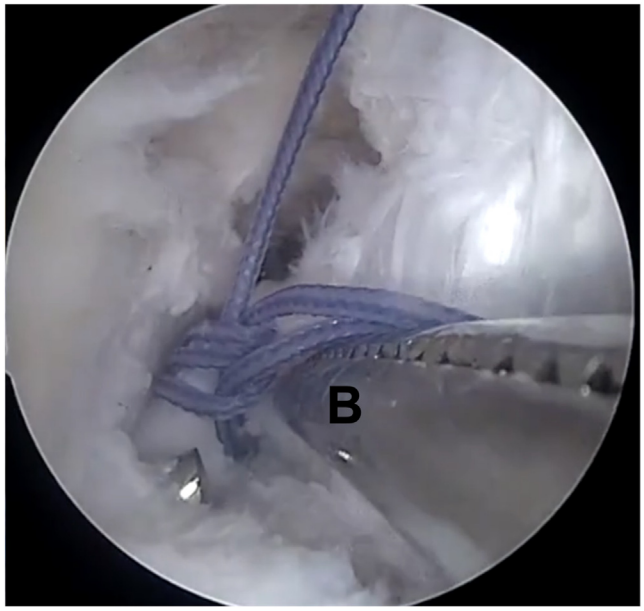

Fig 9. In this arthroscopic view, the tibial guide (B) is positioned on the center of the root footprint and a 2.4 K-wire is introduced through the guide from the anterolateral part of the proximal tibia.

Fig 11. In this arthroscopic view, the K-wire is removed, and the ream is used as a guide to introduce a metal loop suture relay (C) into the joint to be retrieved from the anteromedial portal.

Then, a half or full femoral tunnel is created using the outside-in guide according to the graft and the system of fixation employed (suspensory fixation: half tunnel; interference fixation: full tunnel) (Fig 14).

A shuttle is introduced into the femoral tunnel and retrieved from the tibial side. The graft is then pulled into the joint from the tibial tunnel until is completely seated at the desired position (Fig 15).

Additional tibial fixation can be performed by tying the metal wire carried on the bone plug to a monocortical screw which acts as a post. An anterolateral extra-articular augmentation is then performed according to the Ellison technique.

On the postoperative radiograph, clear separation between the tunnels created for the ACL revision and the posterior lateral root repair is evident, with no signs of convergence or overlap (Fig 16, Video 1).

Fig 10. Creation of the tunnel, using a 4.5-mm reamer that is passed over the K-wire (black arrow).

Postoperative Rehabilitation

Initially, the patient is advised to use crutches for the first month after surgery, with either non—weight-bearing or partial weight-bearing. The range of motion is restricted to 0° to 90° during this period. Subsequently, the rehabilitation program progresses to allow for incremental weight bearing, gradually transitioning from partial to full weight as the patient's comfort and confidence improve. The removal of crutches is recommended as the patient demonstrates sufficient quadriceps control and stability during gait.[7]

Discussion

The significance of PLMR tears repair in conjunction with Rev-ACLR is paramount for restoring knee stability and function, echoing the principle of "save the meniscus" by underscoring the preservation of meniscal tissue as pivotal in securing optimal knee health and durability.[8] Untreated PLMR tears lead to knee

Fig 12. Arthroscopic view showing the posterior root repositioned (green arrow). Surgeon applying multiple knots to the suture over an 11-mm cortical fixation device (Suture Button; Arthrex) (black arrow) placed against the anterolateral tibial cortex.

instability and increase the tibiofemoral contact pressures, thereby accelerating the development of osteoarthritis (Table 3).[9,10]

A recent systematic review has shown that PLMR repair in conjunction with ACLR resulted in significant improvement in joint contact pressures, mechanics, and stability.[11]

When meniscal root repair is performed in isolation, there is minimal concern regarding the placement of the tibial tunnel. However, when using the medial tunnel with concomitant ACLR and Rev-ACLR, there is a high risk of tibial tunnel convergence.[12]

In a recent study by Campbell et al.,[13] although not directly criticizing the use of a single-tunnel approach, concerns have been raised about the documented anatomical proximity of the lateral meniscal root tunnel to the ACL tunnel, when both are drilled medially. These findings suggest that the conventional single-tunnel approach may require a reconsideration in order to prevent the potential risks of tunnel convergence, which could undermine graft anatomical integrity and the success of concurrent PLMR and ACL repair.

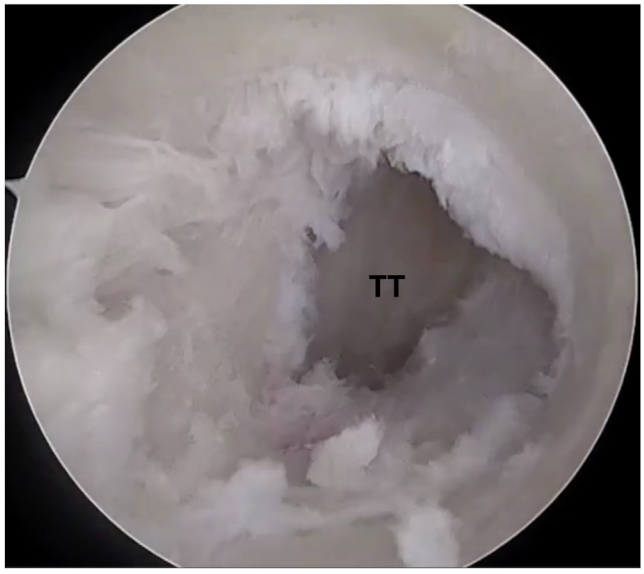

Fig 13. In this arthroscopic view, the tibial tunnel is inspected to confirm complete graft removal and the absence of convergence with the lateral root tunnel. "TT" in the image indicates the tibial tunnel.

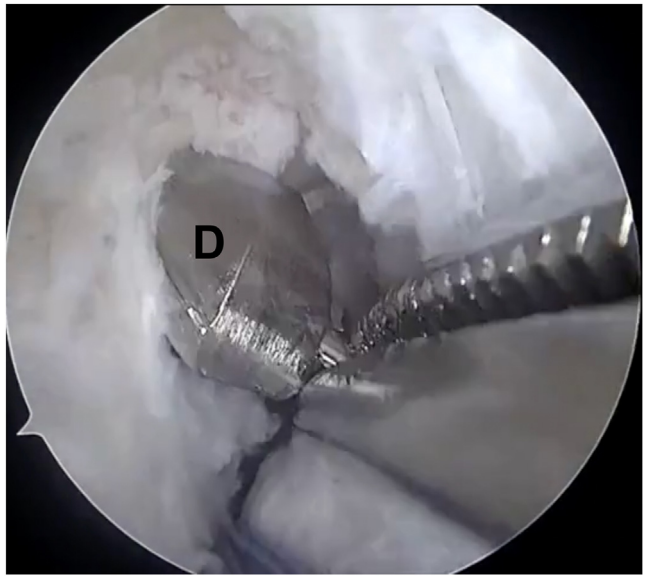

Fig 14. In this arthroscopic view, the femoral tunnel is created using an outside-in technique with progressive reamers (D).

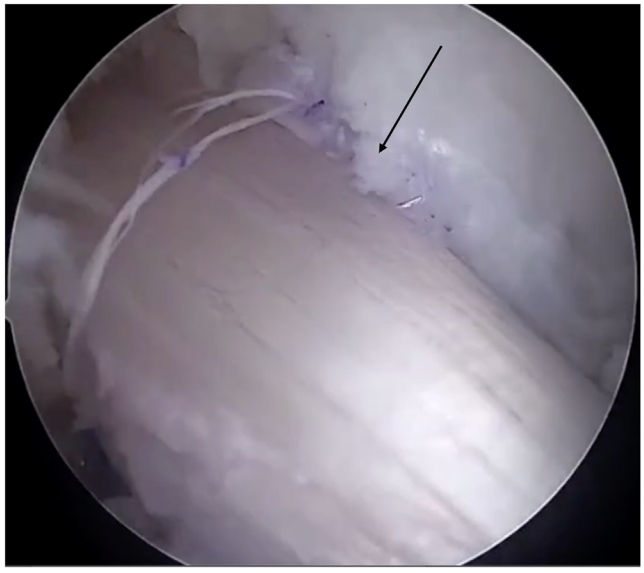

Fig 15. Arthroscopic view showing the graft being pulled into the joint from the tibial tunnel until the bone block is completely seated in the tibial tunnel (black arrow).

In a 3-dimensional model, Gursoy et al.[14] also demonstrated that there was a high risk of tibial tunnel convergence between the standard AM tunnel for lateral meniscus root and ACL tunnel, and they propose to reduce this risk by reorienting the root tunnels.

Table 3. Pearls and Pitfalls

Pearls	Pitfalls
Using a lateral tibial tunnel minimizes the risk of tunnel convergence with the ACL tunnel, optimizing anatomical space usage.	Potential for soft-tissue incarceration during suturing, necessitating careful untangling of sutures through the AM portal.
Anatomical root repair of the PLMR can normalize tibiofemoral contact pressures and restore native kinematics, reducing the risk of osteoarthritis development.	Limited bone mass in the proximal tibia can complicate the procedure, particularly in patients with extensive tunnel osteolysis.
Perform lateral root repair in a "figure-of-4 position."	Lateral incision should be in line with the incision of any other associated lateral procedure (e.g., anterolateral plasty or LCL reconstruction).
Retrieve all the suture from AM portal to avoid soft-tissue bridges.	Risk of tunnel overlapping when not carefully planning the tunnel placement.
Perform tibial tunnel at 90° of flexion and neutral hip rotation position.	
Check inside the ACL tibial tunnel with the arthroscope to rule out tunnel convergence.	
Use of nonabsorbable high-resistance suture.	

ACL, anterior cruciate ligament; AL, anterolateral; AM, anteromedial; LCL, lateral collateral ligament; PLMR, posterior lateral meniscal root.).

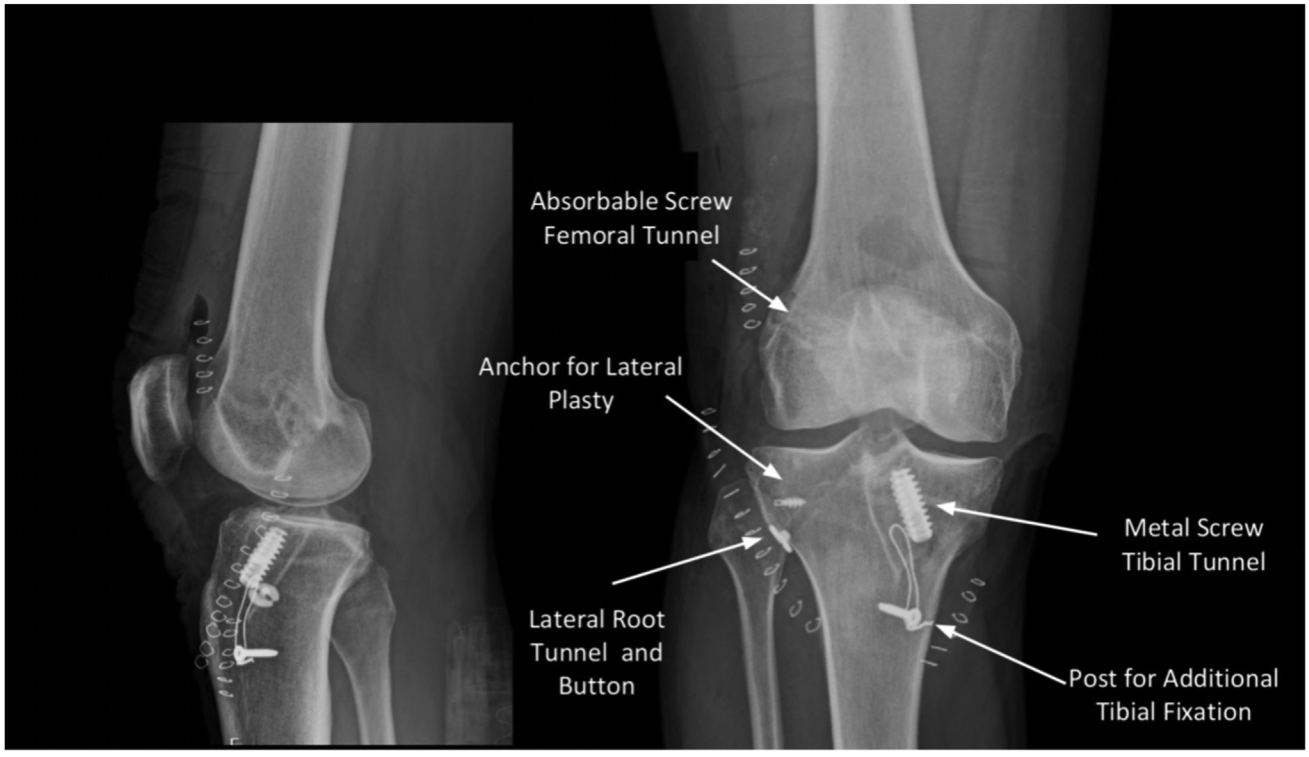

Fig 16. Anteroposterior and lateral vision of the final postoperative radiograph, showing clear separation between the tunnels created for the anterior cruciate ligament revision and the posterior lateral root repair, with no signs of convergence or overlap.

The technique we used, performing an additional tibial tunnel, drilled laterally, instead of the typically used single medial one, for PLMR repair during Rev-ACLR, is specifically designed to minimize the risk of tunnel overlapping and improve anatomical outcome of the repair.

By choosing a lateral tunnel, we use the available tibial anatomical space in a more efficient manner, significantly decreasing the potential for tunnel convergence; this, particularly when combined with ACL revision surgery, can enhance the effectiveness and safety of PLMR repair.

Disclosures

All authors (F.M., Z.A.T., A.C., A.D.M., J.C., R.C.) declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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