



Alternative Techniques for Lateral and Medial Posterior Root Meniscus Repair Without Special Instruments

Camilo Partezani Helito, M.D., Ph.D., Lucas da Ponte Melo, M.D.,
Tales Mollica Guimarães, M.D., Marcel Faraco Sobrado, M.D.,
Paulo Victor Partezani Helito, M.D., José Ricardo Pécora, M.D., Ph.D., and
Riccardo Gomes Gobbi, M.D., Ph.D.

Abstract: Improved understanding and treatment of posterior medial and lateral meniscus root tears have attracted increasing interest. These lesions significantly compromise meniscal function, which can result in an outcome resembling total meniscectomy, and are also a potential cause of knee instability. Despite facilitating repair procedures and reducing the operative time for these lesions, all-inside meniscal repair devices are not available in all circumstances or registered for use in all countries worldwide. Furthermore, all-inside arthroscopic devices can be expensive. Therefore, low-cost alternatives for the treatment of these lesions must be identified. We present 2 efficient and safe techniques: an outside-in technique for repairing medial meniscus root tears and a technique using a simple needle inserted through the transtibial tunnel for lateral meniscal root repairs, neither of which requires the use of specific instruments, thus enabling appropriate treatment of posterior medial and lateral meniscus root tears.

Since posterior medial meniscus root tears (PMMRTs) were first described in 1991,¹ better understanding and treatment of these lesions have attracted increasing interest. These lesions compromise meniscal function on a larger scale compared with other lesions of the knee.² In a biomechanical study, Allaire et al.³ showed that the effect of PMMRTs on the contact pressure of the medial compartment is similar

to that of total meniscectomy, and the repair of such lesions reestablishes the prelesion contact forces.

PMMRTs are more common in women of older age and with varus deformity⁴ and are associated with meniscal extrusion, progressive chondral degeneration, and osteoarthritis (OA).^{5,6} In a medium-term follow-up, conservative treatment did not yield satisfactory results,⁷ with worsening of clinical parameters, progression of OA, and a high rate of total knee arthroplasty (TKA) at 5 years. On the other hand, compared with meniscectomy, PMMRT repair results in a reduction in radiological progression of OA, improved Lysholm scores and International Knee Documentation Committee (IKDC) scores, and a lower rate of TKA.^{8,9}

In addition to PMMRTs, which are associated with a degenerative condition, posterior lateral meniscus root tears (PLMRTs) have gained increasing clinical significance. PLMRTs are usually traumatic injuries and occur in 7% to 12% of patients with anterior cruciate ligament (ACL) injury.^{10,11} Recent studies have provided a better understanding of the biomechanical role of the posterior lateral meniscus root. PLMRTs combined with ACL injury are associated with increased anterolateral rotational instability,¹² and repairing such lesions increases stability in cases of ACL injury.¹³

From Grupo de Joelho, Instituto de Ortopedia e Traumatologia, Hospital das Clínicas HCFMUSP, Faculdade de Medicina, Universidade de São Paulo (C.P.H., L.d.P.M., T.M.G., M.F.S., J.R.P., R.G.G.); Hospital Sírio Libanês (C.P.H., M.F.S., P.V.P.H.); Grupo de radiologia musculoesqueléticas, Instituto de Ortopedia e Traumatologia, Hospital das Clínicas HCFMUSP, Faculdade de Medicina, Universidade de São Paulo (P.V.P.H.), São Paulo, SP, Brazil.

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Address correspondence to Marcel Faraco Sobrado, M.D., Rua Dr. Ovidio Pires de Campos, 333, Cerqueira Cesar, São Paulo, SP, CEP: 05403-010, Brazil. E-mail: marcel.sobrado@usp.br

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Despite facilitating repair procedures and reducing the operative time, the all-inside meniscal repair devices developed for PMMRT and PLMRT repair are not available in all circumstances or registered for use in all countries worldwide. Moreover, all-inside arthroscopic devices can be expensive. Therefore, low-cost alternatives for the treatment of these lesions must be identified. Furthermore, because of radiologists' unfamiliarity with this condition and the likely possibility of misdiagnosis on magnetic resonance imaging (MRI), these lesions are often diagnosed only during the intraoperative period, complicating the use of special devices in some centers (they are not available within the hospital and must be requested ahead of time).

Thus, we present 2 efficient and safe techniques, an outside-in technique for repairing the PMMRTs and another technique using a simple needle inserted through the transtibial tunnel for PLMRT repair, neither of which requires specific instruments, thus reducing the cost of repairing these lesions and enabling repair even when specific devices are not available.

Surgical Technique

Indications

We recommended PMMRT repair for all patients with complete lesions and without OA and significant varus deformity (in cases with varus deformity, consider repair combined with valgus osteotomy). Patients must be aware of the strict postoperative protocol that must be followed before undergoing surgery. Likewise, PLMRTs should be repaired when diagnosed on MRI or identified during ligament reconstruction, especially ACL reconstruction, because these lesions are associated with increased rotatory instability of the knee.¹²

Positioning of the Patient, Arthroscopic Examination, and Preparation of the Footprint

After anesthesia, the patient is placed in the supine position with lateral support at the level of the pneumatic tourniquet. The operative leg hangs off the table with a posterior cushion maintaining 90° of knee flexion. Surgery commences with complete arthroscopic examination of the knee.

For better visualization of the footprint of the posterior medial meniscus root, an assistant applies valgus force to the knee and externally rotates the ankle with the knee in a semi-extended position. If necessary, a medial collateral ligament "pie crust" is performed. The anatomic site is identified, and the footprint is prepared while ensuring an adequate blood supply to the area that will enable healing. In addition, the meniscus edge is regularized to ensure that it can be moved until the point of anatomic fixation. If necessary, the meniscus is detached from the posterior capsule.

For the lateral meniscus, the best position for visualization is the figure-4 position. Frequently, PLMRTs adhere to the posterolateral capsule, and the meniscus becomes floating. Diagnosing such lesions and recognizing them as abnormalities are important for repair to be indicated.

Technique 1: Suture Passage in the Medial Meniscus Using the Outside-In Technique

When identifying a PMMRT, the sutures are passed through the posterior horn of the meniscus using the principles of the outside-in meniscal suture technique, although in a slightly different manner. Initially, for this technique to be performed safely, axial sections on MRI should be evaluated, and any anomalous or unusual vascularization of the popliteal bundle that may be damaged with this technique must be ruled out (Fig 1).

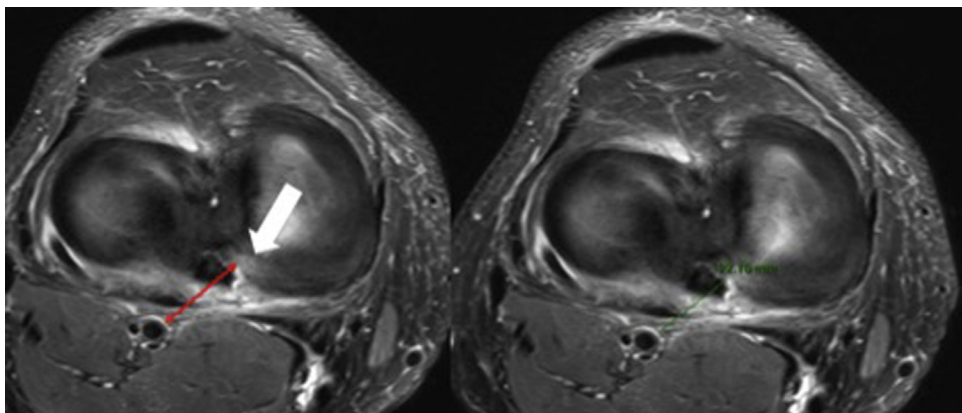
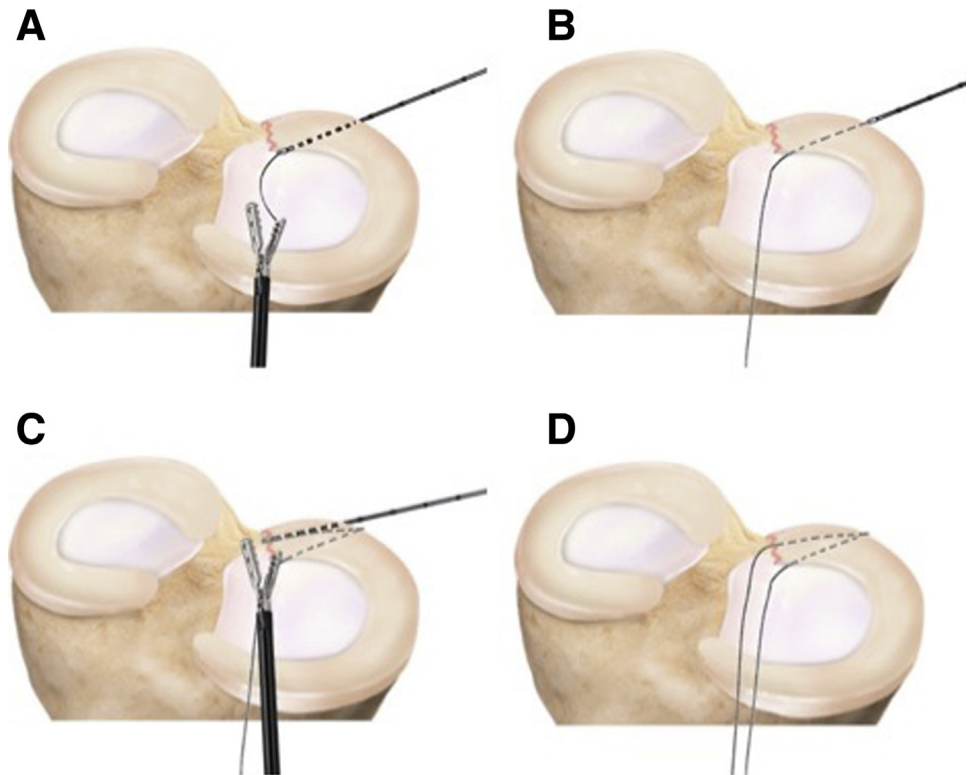


Fig 1. Right knee T2-weighted axial magnetic resonance imaging scans showing a posterior medial meniscus root tear (white arrow). The lesion is located 2.2 cm from the popliteal vessels (red arrow), and no anomalous vascularization is evident.

Fig 2. Schematic drawing showing the outside-in passage of sutures for repair of the posterior medial meniscus root. Initially, a needle containing a high-strength suture is inserted from the outside to the inside of the knee, passing through the upper surface of the meniscus (A). Then, the suture is pulled through the medial portal with a grasper (B). The same needle is removed from the skin and is then inserted again on the inferior surface of the meniscus (C). The suture is pulled through the medial portal again with a grasper, and the suture is placed on the prepared meniscus (D).



A 16-G needle containing a high-strength suture (Ultrabraid; Smith & Nephew, Andover, MA) is introduced from the outside of the posterior horn of the

meniscus near the root. For this procedure, a posteromedial portal is not necessary, and only percutaneous insertion is required. The needle should be directed

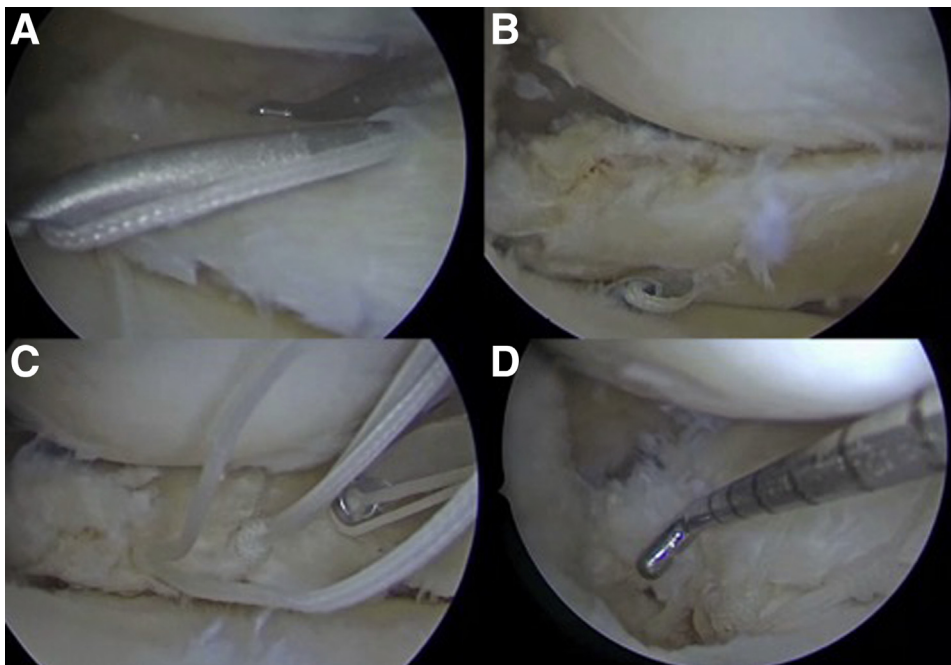


Fig 3. Right knee; anterolateral portal view; 30° knee flexion with valgus stress. For outside-in passage of sutures for reinsertion of the posterior medial meniscus root, a needle containing a high-resistance suture is initially threaded from the outside into the superior surface of the meniscus (A) and on the inferior surface (B). After the passage of 2 to 3 sutures, the sutures are tied to the meniscus with arthroscopic knots to increase the stability of the suture and prevent the meniscus from tearing (C). After the tunnel is completed, the sutures are pulled in to complete meniscal repair (D).

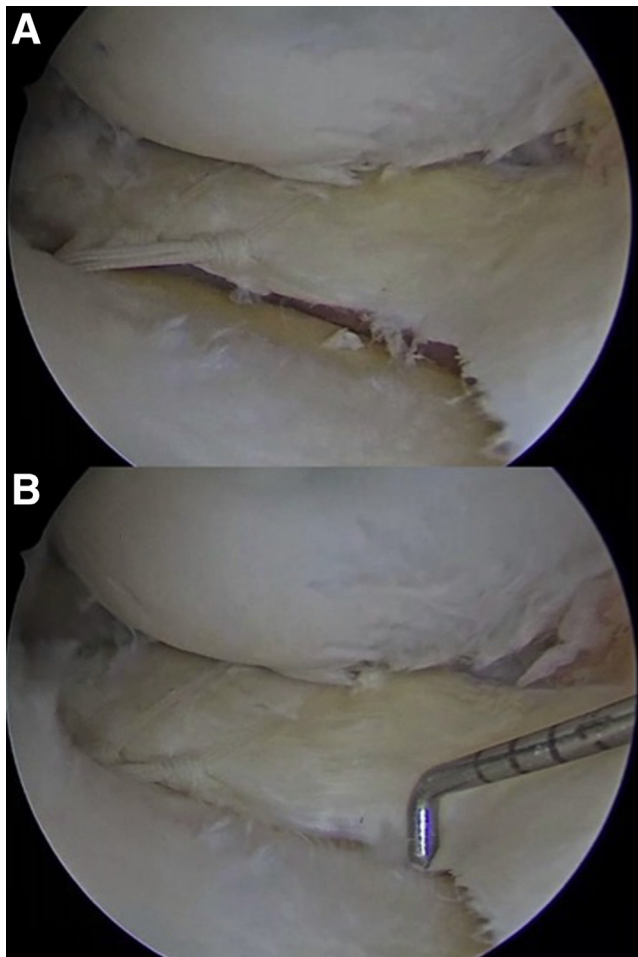


Fig 4. Right knee; anterolateral portal view; 30° knee flexion with valgus stress. An extruded meniscus due to a posterior medial meniscus root tear (A) is pulled into the transtibial tunnel in its footprint, correcting the meniscal extrusion (B). The probe is placed at the interface of the tibial plateau where the meniscus should be placed for proper repair.

toward the center of the joint or in the anterior direction, and advancement in the posterior direction should be avoided to prevent damage to neurovascular structures. Initially, the needle is advanced to the upper surface of the meniscus, and the suture is pulled using a grasper through the anteromedial or anterolateral arthroscopic portal. This same needle will be removed from the meniscus and threaded again on the inferior surface of the meniscus without removing it from the skin. The end of the suture inside the needle is pulled back into the joint with a grasper (Fig 2). The 2 ends of the suture are tied with arthroscopic knots, and the suture is then ready for reinsertion. For this technique, we recommend using 2 to 3 sutures in the meniscus.

After the sutures are passed, a tunnel in the meniscal footprint is created. Initially, a guidewire is inserted with the help of an ACL tibial guide (Acuflex tibial

guide; Smith & Nephew), and a 4.5- or 5-mm drill is used. The sutures are then pulled into the tunnel and tied on an Endobutton plate (Endobutton CL Ultra; Smith & Nephew) on the anterior cortical surface of the tibia (Fig 3). We suggest applying a slight valgus force for the medial meniscus and a slight varus force for the lateral meniscus at the time of suture fixation such that the femoral condyle does not obstruct the reduction of the meniscus in the tunnel (Fig 4 and Table 1).

Technique 2: Suture Passage Through the Meniscus Using the Tibial Tunnel of the Posterior Lateral Meniscus Root Reinsertion

This technique is performed by drilling a tibial tunnel that will be used for reinsertion of the

Table 1. Outside-In Medial Meniscus Root Repair Technique: Advantages, Pitfalls, Risks, Indications, Tips, and Pearls

Advantage	Enables medial meniscus root repair without the need for special instruments
Indications	<ul style="list-style-type: none"> • Medial meniscus root tear • Cases in which the instruments for medial meniscus root repair are not available
Tips and Pearls	<ul style="list-style-type: none"> • Check the axial sequences of MRI to evaluate any anomalous arteries in the posteromedial region of the knee • Release the posterior horn of the medial meniscus from the medial capsule • Assess whether the sutures slide smoothly inside the needle before passing it • Do not remove the needle from the skin between the first and second passages through the meniscus • Create a firm arthroscopic knot in each suture before introducing it into the tibial tunnel
Pitfalls and Risks	<ul style="list-style-type: none"> • To avoid harming the popliteus vessels, do not introduce the needles posteriorly • Be careful not to pass the sutures too close to each other to avoid tearing the meniscus • Tie the sutures firmly over the button with slight valgus force and then ensure that they are not loose under arthroscopy • Retrieve all the sutures through the same portal before introducing them into the tibial tunnel such that they do not become ensnared in soft tissue • Be careful in obese patients, as the needle can be too short to reach the meniscus; in this situation, consider establishing a small access point to dissect the subcutaneous tissue until reaching the knee capsule

MRI, magnetic resonance imaging.

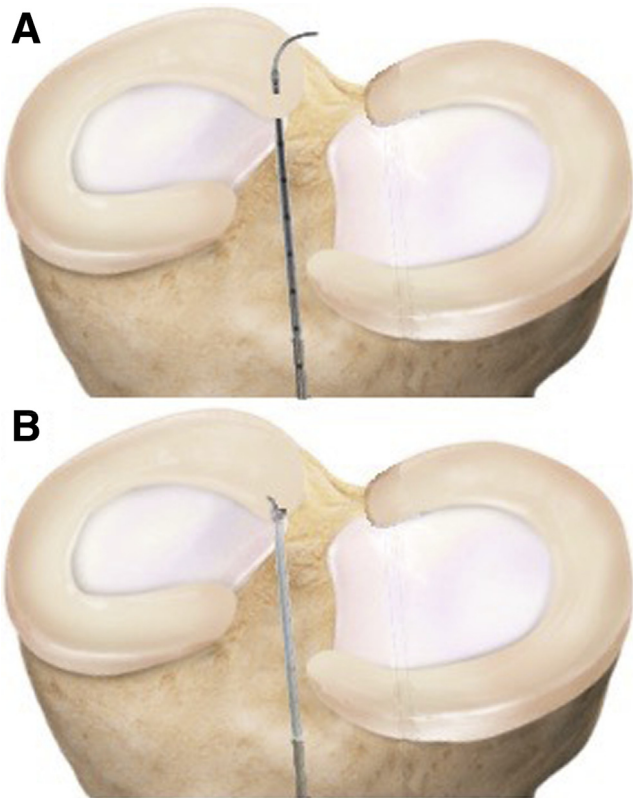


Fig 5. Schematic drawing showing how a needle containing a high-strength suture is passed through the transtibial tunnel at the footprint of the meniscus root and pierces the posterior horn of the meniscus (A). This suture is pulled with a grasper and then introduced back into the tunnel, reducing the meniscus in its footprint and completing the repair (B).

meniscus before the meniscus sutures are passed. To perform this technique, the meniscus must be mobile and able to tour half the thickness of its posterior horn at the site where the tunnel will be created (Fig 5). The tibial tunnel is created as described above in the center of the footprint of the meniscus root using a flat guide (Acufex Pinpoint; Smith & Nephew) to place the tunnel in the correct location without interfering with the femoral condyle (Fig 6). A long needle containing a high-strength suture is introduced into the tunnel. The posterior horn of the meniscus is pulled to the tunnel region with a grasper such that it is above the prepared tunnel, and then the needle is passed through the posterior horn of the meniscus. After passage of the needle, the suture is pulled through the surface of the meniscus with a grasper, and this suture is subsequently reintroduced into the tibial tunnel (Fig 7). Fixation is performed on an endobutton plate as described above (Figs 8 and 9, Table 2, and Video).

Rehabilitation/Postoperative Protocol

The use of a brace oriented for knee extension is recommended for 6 weeks. Progressive gains of passive flexion should be observed, with 0° to 30° in the first 2 weeks, 0° to 60° in 2 to 4 weeks, and 0° to 90° in 4 to 6 weeks. We avoid flexion >90° with weightbearing or squatting for 4 to 6 months. After 6 months, the patient returns to adaptation training and can resume sports activities.

Regarding weightbearing, we recommend non-weightbearing in the first 2 weeks. Proprioceptive weightbearing is permitted 2 to 4 weeks after surgery, when a progressive partial weightbearing regimen is started if tolerated.

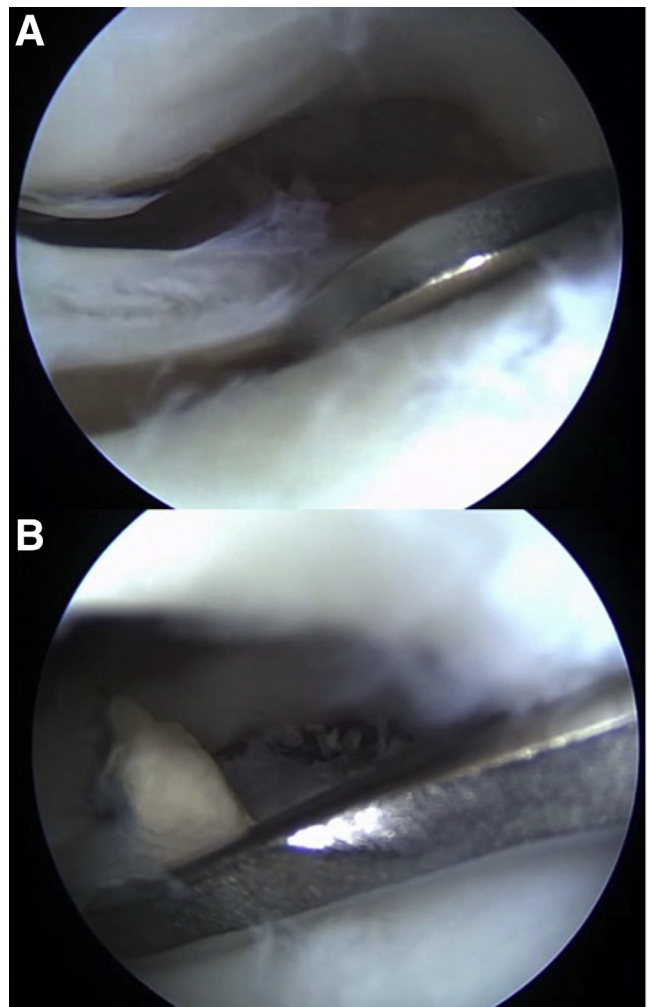


Fig 6. Right knee; anterolateral portal view; figure four position with varus stress. To repair the posterior lateral meniscus root, the guide must have a low profile to avoid interfering with the lateral femoral condyle. The guide is placed in the footprint of the posterior meniscus root (A), and a guidewire is placed inside to prepare the tunnel (B).

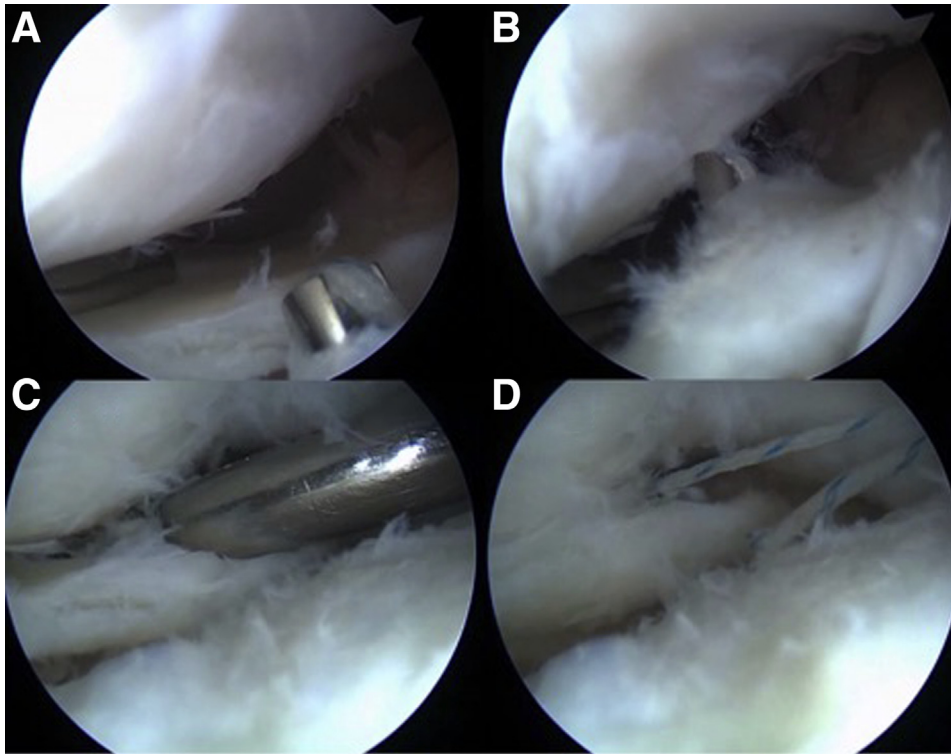


Fig 7. Right knee; anterolateral portal view; figure four position with varus stress. To repair the posterior lateral meniscus root, a tunnel is drilled, and a guidewire is placed at the exit of the tunnel to assess whether the meniscus can reach that site (A). A needle containing a high-strength suture is then passed through the tunnel and the posterior horn of the meniscus (B). The suture is pulled from within the needle (C) and out from the knee with a grasper through the medial portal (D).

The advantages, disadvantages, pearls, and pitfalls of techniques 1 and 2 are summarized in [Tables 1](#) and [2](#), respectively.

Discussion

PMMRTs are associated with meniscal extrusion, overload of the medial compartment, and the development of progressive OA,¹⁴ thus resembling the outcome of total meniscectomy.³ Because this orthopaedic condition is still considered new, limitations to a better understanding and treatment of these lesions exist, such as diagnostic difficulties and nonrecognition of such lesions by some professionals, evolving indications and contraindications for repair, and the need for advanced surgical techniques, which increase operative time.² Despite facilitating the procedure, the use of specific arthroscopic devices increases associated costs. We propose a surgical technique that is easy to perform, does not require specific instruments, reduces the costs of the procedure, and allows proper treatment of lesions that are diagnosed during the intraoperative period.

Although we have not found studies with long-term follow-ups that can confirm the role of PMMRT repair in the process of joint degeneration, a radiological study

has shown that these lesions are independent risk factors for chondral degeneration on MRI.¹⁵ In a 5-year follow-up, Chung et al.⁸ showed better Lysholm and IKDC scores for patients undergoing PMMRT repair versus meniscectomy. In addition, OA progression was delayed; however, repairing the PMMRTs did not completely prevent OA progression.

Although improved clinical parameters are evident after PMMRT repair,^{9,16,17} the impact of this procedure on the radiographic progression of OA remains controversial. Although a meta-analysis showed favorable results for PMMRT repair, no statistically significant reduction in meniscal extrusion was noted after repair, as the investigated procedure could not completely prevent the progression of chondral degeneration and OA.¹⁸ Kaplan et al.¹⁹ observed increases in meniscal extrusion and progression of chondral degeneration on MRI despite improved clinical parameters. Significant varus deformity and medial OA are poor prognostic factors, and a different approach should be considered in these cases.^{16,17} The best strategy to successfully convey the indications for surgery and potential surgical outcomes is to explain to patients that although clinical results are encouraging, long-term results related to the progression of OA are not very predictable.

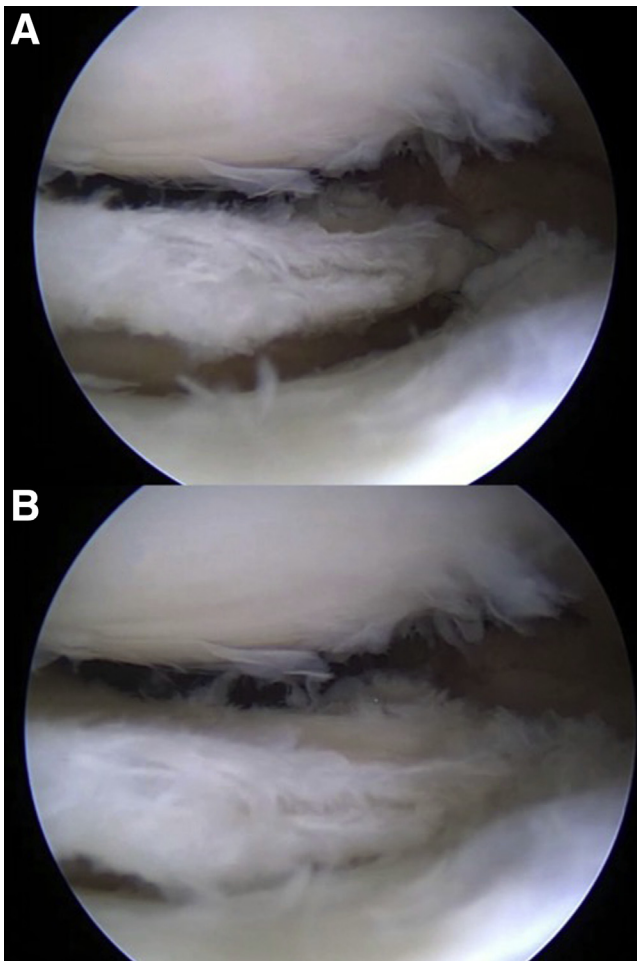


Fig 8. Right knee; anterolateral portal view; figure four position with varus stress. After the sutures are inserted into the tibial tunnel (A), they are pulled for reduction of the meniscus in its footprint (B) and tied on an Endobutton plate.

A recent systematic review of laboratory biomechanical studies²⁰ showed no difference between transtibial pullout repair and suture anchor repair in terms of outcomes. Fixation at the anatomic point using both techniques improves the contact forces on the articular surface. We selected transtibial repair with a single tunnel because we can use the same instruments used for ACL reconstruction and complete fixation to the tibia with different devices (Endobutton, screw post, anchors). When using the transtibial technique, no benefit was evident with the use of either 1 or 2 tunnels.²⁰

Few publications have evaluated the kinematic and biomechanical effects of a PLMRT compared to a PMMRT¹³; however, interest in this subject is increasing. A recent study²¹ evaluating 3956 patients undergoing ACL reconstruction performed an

epidemiological analysis of PLMRTs, which were identified in 6.6% of the cases. In addition, multivariate analysis showed that participation in contact sports and associated medial meniscus tears are independent risk factors for PLMRTs. A better understanding of PLMRTs is essential for adequate management of these lesions, which have already been shown to have an impact on knee stability, especially when associated with ACL reconstruction.^{12,13}

Another interesting point is the difficulty of diagnosing PLMRTs, especially in acute post-traumatic conditions in which hemarthrosis reduces MRI accuracy,^{14,22} further emphasizing the importance of our technique due to its versatility, which allows appropriate treatment of previously undiagnosed lesions as it does not require the use of specific instruments.

The novelty of our techniques is that specific instruments and arthroscopic devices are not required. These instruments tend to increase costs or render repair procedures unfeasible when unavailable. We used conventional needles with an outside-in technique to suture the posterior root of the medial meniscus. The safety of the outside-in technique for suturing the posterior horn of the medial meniscus was shown in an anatomic dissection study in which the distance to the popliteal vessels was 2.4 cm, and 4.6 cm for the saphenous nerve.²³ During surgical planning for this technique, axial MRI scans are examined to exclude anomalous vascularization of the popliteal artery or its branches that may render the procedure unfeasible. A thorough MRI examination should be performed to avoid possible severe complications.²⁴⁻²⁶ Notably, the passage of sutures through the inside of the meniscus using needles without removing them from the skin is not extremely simple and requires the surgeon to have previous experience and training in the outside-in suture technique. This technique is not indicated for PLMRTs owing to a possible risk of damaging the common peroneal nerve, as it is not isolated and protected,²⁷ and the more anterior location of the lateral root, which complicates the procedure and increases the likelihood of complications.

Regarding the suture technique in which a needle is passed through the tunnel and pierces the meniscus from the bottom up, the steps for loosening the posterior root of the capsular tissues should be followed to ensure good mobility to the region of the tibial tunnel. A calculation error related to excursion of the meniscus may prevent the meniscus from reaching the aperture of the tunnel, rendering the procedure unfeasible. The need to build another tunnel in such a small space can also render the procedure unfeasible.

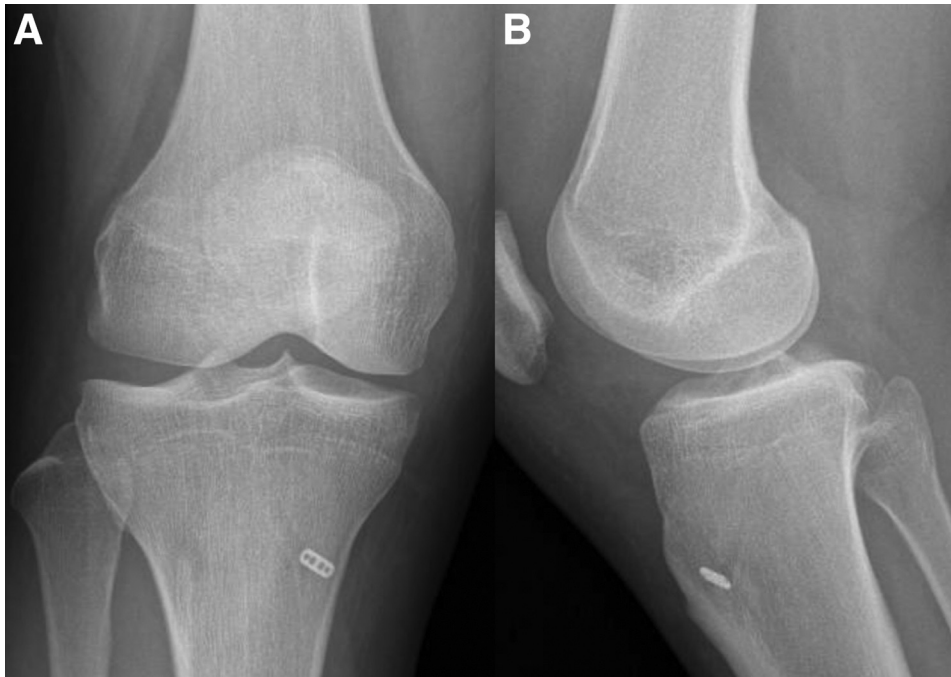


Fig 9. Postoperative anteroposterior (A) and lateral (B) x-rays of a right knee posterior lateral meniscus root repair fixed in the anterior tibial cortex over an endobutton.

Another important factor is the use of a thinner needle that can carry the suture to create the smallest possible hole in the meniscus. The goal is to drill the meniscus in a single attempt and therefore damage this region as little as possible. Creating multiple holes in already degenerated meniscal tissues may hinder repair. Although described for the lateral meniscus in this article, this technique can also be applied to the medial meniscus.

In line with the growing interest in PMMRTs/PLMRTs and in understanding the importance of repairing these lesions to reestablish the biomechanics of the medial and lateral compartments of the knee, we present low-cost and safe techniques. We recommend these techniques as strategies to expand access to repair procedures and allow more knee surgeons to perform repair procedures in cases with a precise clinical indication. We emphasize that we are not opposed to

Table 2. Transtibial Tunnel Lateral Meniscus Root Repair Technique: Advantages, Pitfalls, Risks, Indications, Tips, and Pearls

Advantage	Enables lateral meniscus root repair without the need for special instruments
Indications	<ul style="list-style-type: none"> • Lateral meniscus root tear • Cases in which the instruments for lateral meniscus root repair are not available
Tips and Pearls	<ul style="list-style-type: none"> • Release the posterior horn of the lateral meniscus from the posterolateral capsule • Evaluate root mobility and ensure that the central part of the root can reach the tibial tunnel • Assess whether the needle is sufficiently long to enter the tunnel from the anterior part of the tibia and reach the meniscus • Assess whether the sutures slide smoothly inside the needle before passing it • Use the thinnest possible needle that allows suture loading to create the smallest possible hole in the meniscus • Use a flat guide to place the tunnel in the correct location without interfering with the femoral condyle
Pitfalls and Risks	<ul style="list-style-type: none"> • Avoid ticker needles to protect the meniscus • Tie the sutures firmly over the button with slightly varus force and then ensure that they are not loose under arthroscopy • Create a tunnel far from the anterior cruciate ligament tunnel if the patient has a combined lesion

the use of special meniscal devices for this type of repair, and we even prefer to use them when available, but we believe that repair alternatives that do not rely exclusively on technological innovations that are not always available in all locations should be developed.

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