

Arthroscopic Repair of Double Radial Tears of the Lateral Meniscus



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Abstract: Double radial tears of the lateral meniscus are rare injuries that typically occur in the setting of an acute anterior cruciate ligament rupture. Full-thickness radial tears of the meniscus body and root render the meniscus nonfunctional from a loss of hoop stress resistance. Repair of these tears can normalize contact pressures in the lateral compartment and delay arthritic changes. We describe our technique for repairing a lateral meniscus body radial tear and concomitant posterior root tear, via inside-out suture repair and transtibial suture repair, respectively. This investigation was performed at Mayo Clinic.

The lateral meniscus (LM) is vulnerable to injury with acute anterior cruciate ligament (ACL) ruptures because of the subluxation of the lateral femoral condyle posteriorly on the tibia. Medial collateral ligament (MCL) tears (with or without concomitant ACL disruption) also place the LM at risk of injury because of the valgus mechanism and direct impact of the LM. A radial tear of the LM is the most common variant with associated MCL tears¹; however, various types of

LM tears occur along with ACL and MCL disruptions. These tears are most commonly located within the meniscus body or at the meniscocapsular junction.

It is estimated that radial tears or avulsions at the posterior LM root are found in up to 7% to 12% of patients with ACL tears.^{2,3} These tears present unique surgical challenges with particular biomechanical consequences.⁴ LM root tears are likely underrecognized because they are easily missed in preoperative magnetic resonance imaging (MRI) scans.⁵ It is critical to have a high suspicion of tears in the setting of ACL injury, particularly in patients with greater tibia varus angles, increased tibial slopes, higher body mass index, contact injuries, and concomitant medial meniscus tears.^{3,6} Although uncommon, it is possible to have coexisting radial tears of the posterior horn or root and of the body of the LM secondary to a combined ACL-MCL injury.

More than one-half of the contact force is transmitted by the larger medial compartment of the femur, with 40% to 70% of the total weight being absorbed through the menisci alone.⁷ Complete radial tears of the LM result in increased contact pressures and decreased contact area in the lateral compartment, leading to detrimental effect on load transmission. The tear disrupts the circumferential fibers and results in meniscus extrusion and complete dissipation of hoop stress resistance that is biomechanically comparable to complete meniscectomy.⁸ These factors ultimately predispose the knee to premature osteoarthritis. Cadaveric and retrospective clinical studies show that repair of these meniscus injuries can improve these mechanical factors, restoring contact pressures and

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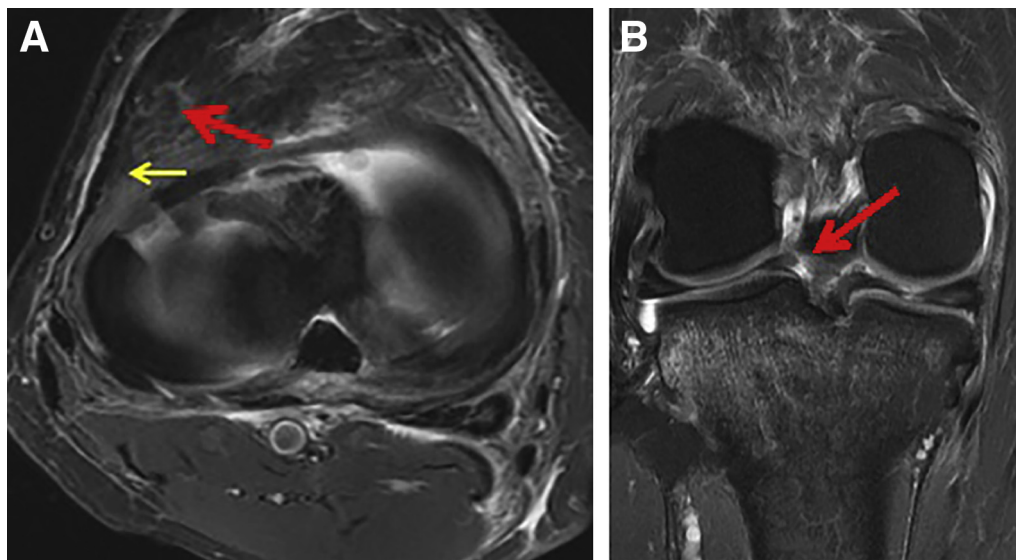


Fig 1. (A) Axial MRI image of a right knee demonstrating a radial tear of the lateral meniscus body (red arrow) and extrusion of the meniscus (yellow arrow). (B) Coronal MRI image of a right knee demonstrating detachment of the posterior root of the lateral meniscus (red arrow).

minimizing the risk of developing arthritis.⁹⁻¹¹ In addition, studies have shown ACL reconstruction patients with a meniscus root tear have a decreased lateral joint space and trend toward a worse functional score¹²; therefore, it is important to recognize and treat these tears in the young knee with intact articular cartilage. It was once believed that radial meniscus tears did not have capacity to heal, but studies have demonstrated similar results to repair of classic bucket-handle meniscus tears.¹³

Depending on location of the body tear, either an inside-out or all-inside repair technique may be used. Two main repair techniques have been described for posterior root tears/avulsions: suture anchors (direct fixation) and sutures pulled through the tibia (indirect fixation).^{14,15} Suture anchor repair requires posterior portals and is technically challenging. We prefer the transtibial technique, which facilitates an anatomic repair that is accurate, reproducible, and shown to significantly improve lateral compartment joint contact pressures.¹⁶ We present techniques for concomitant repair of LM double radial tears using an inside-out technique for the body tear and a transtibial technique for the posterior root tear.

Surgical Technique

A thorough review of preoperative imaging is paramount to surgical planning. [Figure 1](#) shows typical MRI scans depicting double radial tears of the LM. We have found that these double radial tears of the LM typically occur with concomitant combined ACL-MCL injuries. Equipment necessary to perform this surgery is provided in [Table 1](#).

Patient Positioning and Diagnostic Arthroscopy

We begin by performing an examination under anesthesia, evaluating the patient's Lachman, pivot shift, dial test, posterior sag/drawer, and varus/valgus stability. The patient is placed in a supine position and the injured leg is prepped and draped in the usual sterile manner ([Fig 2](#)). A 3-portal diagnostic arthroscopy evaluates for cartilage damage, loose bodies, and integrity of the cruciate ligaments and menisci.

LM Radial Tear Preparation

Any medial meniscus tears are treated appropriately before directing attention to the LM. The knee is placed in a figure-of-4 position to open the lateral compartment. The edges of the tear are debrided using a 3.5-mm full-radius shaver (Stryker, San Jose, CA) and

Table 1. Equipment Required for Lateral Meniscus Double Radial Tear Repair

Type of Equipment	Manufacturer
Standard arthroscopy equipment including zone-specific cannulas	Linvatec, ConMed (Largo, FL)
Full-radius shaver	Stryker (San Jose, CA)
Double-sided rasp	Linvatec, ConMed
Spoon retractor	Nonbranded (sterilized)
No. 2-0 nonabsorbable suture on long, flexible needles	Ethicon (Summerville, NJ)
Arthrex meniscus root repair tibial guide	Arthrex (Naples, FL)
6.0-mm FlipCutter	Arthrex
No. 2 FiberStick suture or a wire loop	Arthrex
Self-retrieving suture passing device	Knee Scorpion; Arthrex
0-FiberLink suture and 0-TigerLink suture	Arthrex
4.75-mm BioComposite SwiveLock anchor	Arthrex



Fig 2. Arthroscopy set up with patient in supine position and the injured leg prepped and draped in the usual sterile manner.

a double-sided rasp (Linvatec; ConMed, Largo, FL) until bleeding occurs, in effort to enhance healing. Devascularized tissue is removed to promote vascular infiltration into the adjacent areas.

Repair of LM Body Radial Tear

We use an inside-out or an all-inside technique to repair the LM body depending on the location of the tear ([Video 1](#)). The advantage of using an inside-out

technique is the small meniscus perforations that allows multiple sutures to be placed across the repair site, compared with the large bore needle for an all-inside technique. Flex the knee to 30° to 45° and make a 3-cm vertical incision at the joint line, anterior or posterior to the fibular collateral ligament (depending on radial tear location), with approximately one-third of the incision above the joint line and two-thirds of the incision below the joint line. Create an interval between the lateral head of the gastrocnemius and posterolateral capsule with blunt dissection to gain adequate exposure for passing the sutures for a more posterior tear.

Place 6 to 8 inside-out No. 2-0 nonabsorbable, horizontal mattress sutures using zone-specific cannulas (Linvatec) to reduce the tear anatomically. Pass the sutures through the meniscus, retrieve, and tie sequentially. We prefer a crisscross suture configuration on the superior and inferior meniscus surfaces ([Fig 3](#)).¹⁷

Repair of LM Root Tear

For the meniscus root repair ([Video 1](#)), we use a transtibial technique.¹⁸ Return the knee from the figure-of-4 position back to a normal flexed position. We use an adjustable meniscus root repair tibial guide (Arthrex). Advantages of this guide are outlined in [Table 2](#). Insert the guide through the inferolateral portal and hook the guide on the posterior aspect of the tibia, directly behind the root attachment site ([Fig 4](#)). Measure the distance from the posterior aspect of the tibial plateau to the anatomic footprint of the meniscus root and then adjust the guide for accurate drilling ([Fig 5](#)). Swivel the drill guide to the anteromedial tibia. Create a tibial socket by retrodrilling with a 6.0-mm FlipCutter (Arthrex). Insert the 3.5-mm-diameter FlipCutter pin through the tibia to exit at the predetermined mark on the tibial guide. Convert the FlipCutter to a 6.0-mm reamer under direct

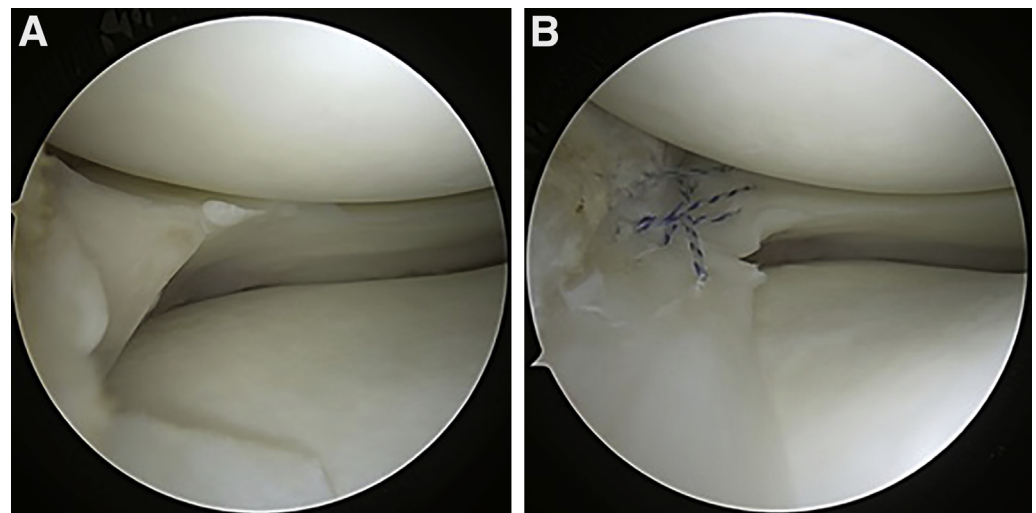


Fig 3. (A) Before and (B) after the lateral meniscus body repair.

Table 2. Advantages of Arthrex Transtibial Guide

The guide hooks onto the posterior aspect of the tibia, increasing stability and facilitating anatomic socket placement.
The 5-, 7.5-, and 10-mm markings on the tip of the guide ensure that the pin will exit at the anatomic footprint of the posterior meniscus root.
The concave curvature allows clearance of the femoral condyle.
The swivel handle creates the anteromedial start position and avoids tunnel convergence.
The locking mechanism fixes the guide during portal insertion.

arthroscopic visualization and retrodrill for 10 mm. Advance the FlipCutter back into the joint, convert back to a 3.5-mm-diameter pin, and remove. Advance a No. 2 FiberStick suture (Arthrex) or a wire loop through the tibial tunnel and retrieve the passing suture through the inferomedial portal.

Place a 0-FiberLink suture (Arthrex) through the meniscus root using a self-retrieving suture passing device (Knee Scorpion; Arthrex) in the ipsilateral portal. Withdraw the suture from the portal and pass the free end through the loop to create a cinch-type suture. Place the next suture several mm lateral to the initial position, using a 0-TigerLink suture (Arthrex). Shuttle the meniscus sutures back through the tibial tunnel using the passing suture (Fig 6).

Fixation of Sutures to Tibia

Insert a 2.4-mm guide pin 1 cm distal to the Flip-Cutter hole on the anteromedial tibial, drill to a depth of 20 mm using the 4.5-mm cannulated drill, and tap the tibial cortex. Cycle the knee from 0° to 90° 10 times to remove creep from the system. Pass the free ends of the meniscus sutures through the eyelet of the SwiveLock and apply tension. Confirm with arthroscope that the meniscus root is well reduced in the tibial socket. Fix the sutures to the anteromedial tibia using a 4.75-mm BioComposite SwiveLock anchor (Arthrex) with the knee in 90° of flexion (Figure 7). Table 3 outlines key steps, pearls, and pitfalls of the surgical technique.

Rehabilitation

The rehabilitation protocol depends on concomitant injuries and surgery, such as an ACL reconstruction. Most of our patients have ACL reconstruction at the time of their double LM radial repairs. We utilize a complex meniscus protocol: quad sets and straight leg lifts, toe-touch weightbearing in full extension for 6 weeks, knee flexion to 90 degrees maximum for 4 weeks, then range of motion as tolerated. They transition to a more typical ACL rehabilitation protocol after 6 weeks. Jogging and other impact activities are delayed until 6 months instead of the typical 3 months in a standard ACL rehabilitation protocol.

Discussion

Double radial tears of the LM are rare injuries that typically occur in the setting of an acute ACL rupture. Full-thickness radial tears of the meniscus body and root render the meniscus nonfunctional from loss of hoop stress resistance, which is biomechanically comparable to complete meniscectomy.⁸ Repair of these tears can return peak contact pressures of the affected compartment back to their normal state and delay the onset of arthritic changes.

We prefer inside-out repair of the LM body tear because this cost-effective technique allows for a more anatomic reduction that is essential when repairing a concomitant meniscus root tear. The strong fixation in the setting of concomitant ACL reconstruction results in low clinical failure rate with equivalent healing on MRI compared to all-inside repairs.^{13,19,20}

Disadvantages of the inside-out technique include suture passage through the posterior capsule resulting in possible neurovascular injury, postoperative knee stiffness, and needle stick risk to the surgical team members.²¹ The inferior lateral geniculate artery is particularly at risk with the inside-out technique compared with all-inside repair. The risk of injury is

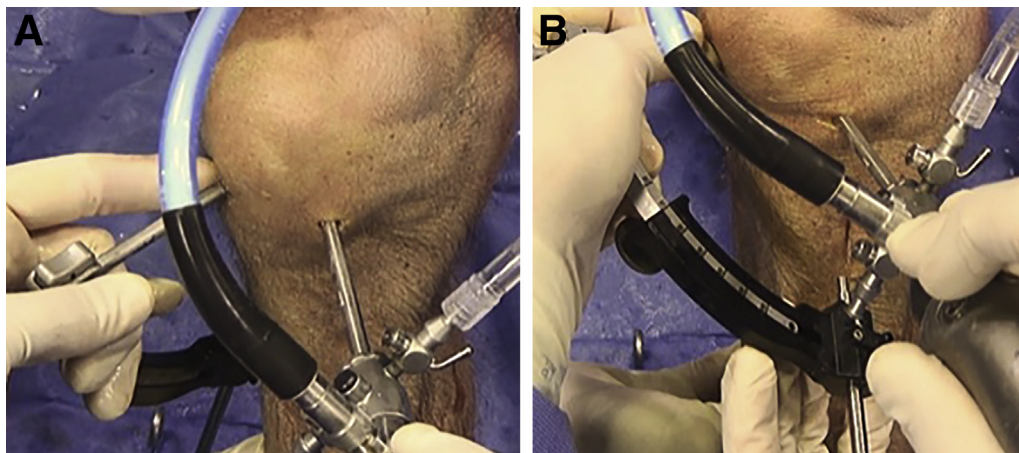


Fig 4. (A) Arthrex tibial guide inserted in the inferolateral portal of a right knee, (B) demonstrating its ability to swivel to an anteromedial location on the tibia.

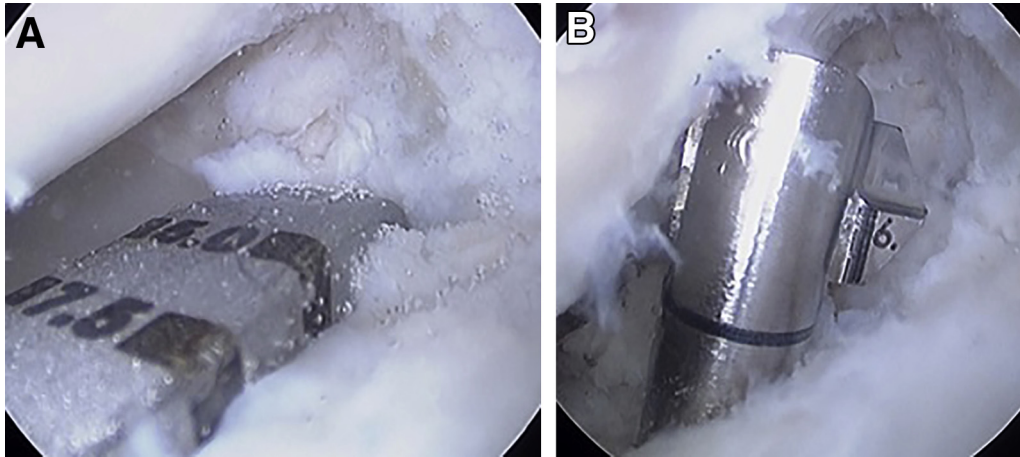


Fig 5. (A) With the guide inserted in the inferolateral portal, viewing from inferomedial portal, the markings (5, 7.5, and 10 mm) on the guide allow dialing in the exact location of the meniscus root footprint in comparison to the posterior tibial plateau for anatomic repair. (B) The Arthrex FlipCutter, when flipped, creates a 6-mm socket.



Fig 6. (A) Viewing from inferomedial portal, (B) the posterior root repair using 2 cinch sutures is (C) anchored through the transtibial tunnel.

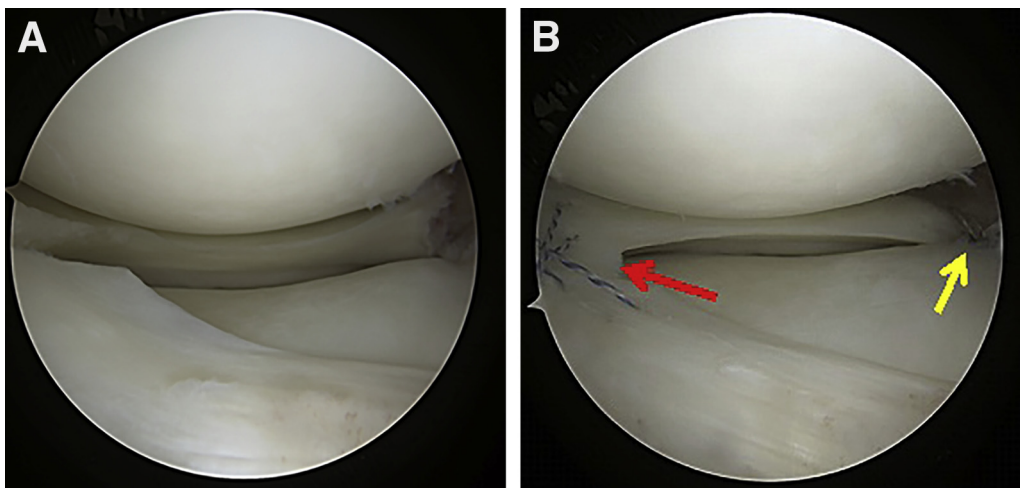


Fig 7. (A) Before and (B) after arthroscopic images of the lateral meniscus body (red arrow) and posterior root repair (yellow arrow).

Table 3. Key Steps, Pearls, and Pitfalls of Lateral Meniscus Double Radial Tear Repair

Key Steps

- Recognize the tear pattern, especially the LM root tear because these are often missed on MRI
- Reduce and repair the radial tear in the body of the LM before the root repair to prevent overreduction of posterior horn segment
- Perform the LM root repair second or the radial tear in the body may be difficult to reduce
- Restore the LM root anatomically to preserve hoop stress resistance and avoid extrusion

Pearls of Meniscus Body Repair

- Fat pad debridement enhances visualization as well as instrument access and passage
- Tie meniscus repair sutures with knee close to full extension
- Use zone-specific cannulas through a contralateral working portal to avoid a dangerous needle trajectory toward midline neurovascular structures

Pearls of Meniscus Root Repair

- The adjustable meniscus root repair tibial guide allows easy placement over the anatomic posterior horn attachment site
- Transtibial drilling before meniscus root suturing avoids suture entanglement
- PassPort cannula prevents soft-tissue bridge formation
- Self-retrieving suture passing device allows fixation through standard arthroscopy portals

Pitfalls

- Overreduction of the posterior horn root
- Coalescence of the lateral meniscus root with the ACL tibial tunnel (avoid by creating a short socket with a FlipCutter rather than a full tunnel with a standard reamer)
- Malreduction of the meniscus tear
- Iatrogenic cartilage injury
- Fixation failure if a patient is not able to follow the established rehabilitation protocol

ACL, anterior cruciate ligament; LM, lateral meniscus; MRI, magnetic resonance imaging.

lower in the posterior part of the LM because the artery is below the level of the meniscus, but increases with repair at the middle body of the LM.²² A recent systematic review found no difference in failure rates, functional outcome scores, or complication rates between all-inside and inside-out techniques for isolated meniscus body tears, however.²³ The authors note that the increased cost of all-inside suture passing devices is a reasonable consideration.

The described technique for LM root repair through a transosseous tibial tunnel has multiple advantages over previously described techniques. The procedure can be completed through standard arthroscopy portals without the need for a posterior portal. The adjustable meniscus root repair tibial guide allows drilling to be performed accurately with minimal torque on the handle. Cinch sutures provide robust capture of the meniscus root with single suture passage minimizing surgical time.

There are limitations to the transtibial technique. Feucht et al.²⁴ reported on the possible bungee effect of the transtibial pullout repair construct, in which the long length of the meniscus-suture construct yields micromotion of the root repair (up to 2.2 mm under cyclic loading in porcine model). Displacement can substantially influence meniscal function, so the bungee effect could have potential clinical implications, although these are yet to be fully elucidated. In addition, transtibial repair is weaker than the native root attachment, so postoperative rehabilitation should proceed with caution.²⁵

Despite the potential limitations, the transtibial technique has been shown to improve lateral compartment

contact pressures and clinical outcomes.^{16,26} In addition, the transtibial tunnel drilling may have the added benefit of enhanced meniscal healing resulting from the influx of progenitor cells and growth factors from the marrow to the intra-articular space.²⁴ Overall, the previously mentioned advantages of our technique for double radial tears of the LM simplify a challenging procedure and allow for familiarity and efficiency.¹⁸

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