Technical Note

All-inside Techniques for Meniscal Radial Root Tear Repair

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Abstract: Meniscal radial root tears can disrupt the load-bearing function of the meniscus and worsen instability in anterior cruciate ligament–deficient knees. Paracentral radial tears adjacent to the root (types 1, 2, and 4) repaired with a transtibial pullout suture technique can lead to over-medialization of the meniscal root and a high-tension nonanatomic repair. We propose 2 all-inside techniques for anatomic repair of medial and lateral meniscal radial root tears with (1) an all-inside meniscal repair device and (2) an antegrade suture passer. We present the technical requirements and tips for these techniques. For lateral meniscal radial root repair with an all-inside meniscal repair device, ideal viewing is from an anterolateral portal with device entry from an anteromedial portal to reduce the risk of vascular injury. We recommend at least 2 stitches across the tear, with the depth setting limited to 18 to 20 mm for a central stitch and 16 mm or less for a peripherally placed stitch. For root repair with an antegrade suture passer, viewing should be from an anteromedial portal with the passer entering from an anterolateral portal. At least 2 stitches should be placed across the tear, with 1 central and 1 peripheral or 1 superior and 1 inferior.

Radial root tears in the meniscus disrupt its load-bearing function in the knee and increase compartment pressure by more than 25%.[1] Meniscal repair can potentially restore compartment peak contact pressures to nearly normal. Lateral meniscal posterior root tears have been reported to reduce the stability of anterior cruciate ligament–deficient knees during rotational loading because they function as a secondary stabilizer of the knee under pivot-shift loading.[2] In addition, pivot-shift grades in patients with lateral meniscal posterior root tears have been found to be significantly greater on preoperative physical examination than those in controls with no root tears.[3] This finding suggests the influence of lateral meniscal root injury on rotational stability of the knee. Transtibial pullout suture repair of posterior meniscal root tears has been reported to yield improvements in function, pain, and activity level postoperatively.[4]

Not all lateral meniscal root tears are the same. In the meniscal root tear classification system of LaPrade et al.,[5] types 1, 2, and 4 are paracentral radial tears adjacent to the root and types 3 and 5 are root avulsions. Paracentral radial tears repaired with a transtibial pullout suture technique can lead to over-medialization of the lateral meniscal root and, consequently, a high-tension repair. We propose 2 techniques to repair paracentral meniscal radial root tears that allow for residual meniscal root tissue (fixed to the anatomic root) to be incorporated into the repair, preventing over-medialization and high tension.

Indications for Surgery

The described anatomic repair techniques can be used for both medial and lateral radial root tears. However, traumatic radial lateral root tears are more commonly associated with anterior cruciate ligament injuries. Patients with multiple medical comorbidities or severe chondral changes (Outerbridge grade 3 or 4) in the ipsilateral compartment are excluded from repair. In patients with significant malalignment, corrective osteotomy should be considered before meniscal repair.

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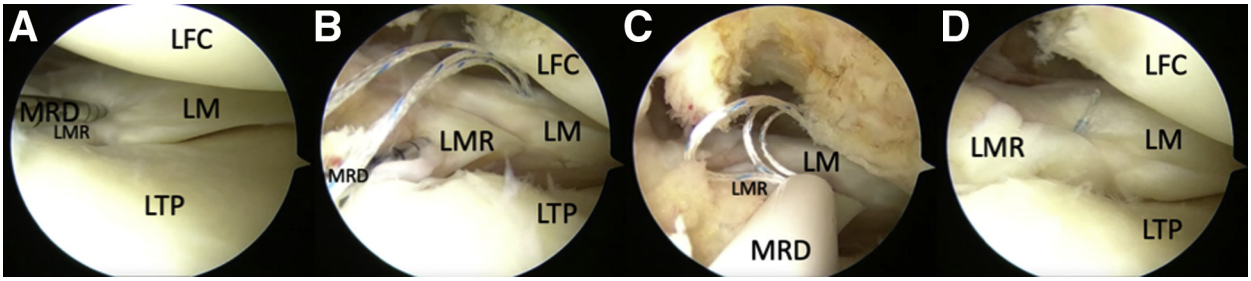

Fig 1. Arthroscopic image in a left knee from the anterolateral viewing portal, showing deployment of the all-inside meniscal repair device (MRD) from the anteromedial working portal into the lateral (A) and medial (B) parts of the paracentral lateral meniscal radial root. The suture repair is tensioned (C) and trimmed (D). (LFC, lateral femoral condyle; LM, lateral meniscus; LMR, lateral meniscal root; LTP, lateral tibial plateau.)

Surgical Technique

Patient Positioning and Anesthesia

The patient is placed in the supine position on the operating table with a thigh tourniquet. After induction of general anesthesia, the foot of the table is removed, allowing the knee to be flexed at 90° and freely manipulated. The knee is examined for ligamentous stability and range of motion.

Diagnostic Arthroscopy

Standard anterolateral and anteromedial portals are made next to the patellar tendon. The knee joint is inspected with a 30° arthroscope. The root tear is probed and assessed for tear type. Root avulsions (types 3 and 5) can be repaired with a transtibial pullout suture technique. However, paracentral radial tears adjacent to the root (type 1, 2, and 4) with a significant stump are amenable to side-to-side repair techniques. We propose 2 side-to-side techniques for repair of radial meniscal root tears with a significant meniscal root stump, first with a FAST-FIX 360 all-inside meniscal repair device (Smith & Nephew, Andover, MA) and second with a Scorpion antegrade suture passer (Arthrex, Naples, FL). The first technique can be performed with any all-inside meniscal repair device. Similarly, the second technique can be performed with any available antegrade suture passer that can achieve access under the femoral condyles. The arthroscopic surgical techniques are explained in Video 1.

All-inside Meniscal Repair Device Technique

For lateral meniscal radial root repair with an all-inside meniscal repair device, the knee is placed in a figure-of-4 position. Ideal viewing of the lateral meniscus should be from an anterolateral portal with FAST-FIX 360 all-inside meniscal repair device entry guided by a slotted cannula (Fig 1) via an anteromedial portal to reduce the risk of vascular injury.[6] There may sometimes be a requirement for the meniscal repair device to be introduced from the anterolateral portal for optimal stitch placement. This brings the tip of the repair device closest to the posterior vascular structures; therefore, the surgeon must be cognizant of the depth setting in relation to stitch placement to reduce the risk of vascular injury (Table 1). The depth limiter for the device is set at 18 to 20 mm when the entry point for the first side-to-side stitch in the meniscal root is in the central part of the meniscus. For a peripheral entry point in the red-red zone, we set the depth limiter to 16 mm or less. We recommend placement of at least 2 stitches across the tear (Fig 2).

For medial meniscal radial root tear repair, viewing and device entry can be achieved from either aforementioned portal with the knee in 20° of flexion with a valgus force applied. A percutaneous medial collateral ligament release may help to improve visibility and access to the posterior horn of the medial meniscus.[7] The surgeon should be comfortable with switching between the anteromedial and anterolateral portals for viewing and introduction of the all-inside meniscal repair device.

Antegrade Suture Passer Technique

For lateral meniscal radial root repair, the knee is placed in a figure-of-4 position. Viewing should be from the anteromedial portal with the Scorpion antegrade suture passer entering from the anterolateral portal (Fig 3). Adequate access must be obtained under the femoral condyle to pass the sutures safely. The antegrade suture passer is loaded with an

Table 1. Tips on Using All-inside Meniscal Device

	Tip
Portal	Lateral meniscal root repair: view from anterolateral portal and insert device from anteromedial portal (lower risk of vascular injury) In cases with small root remnant, device may be introduced from anterolateral portal (view from anteromedial portal)
Depth setting	Central stitch: 18- or 20-mm depth setting Peripheral stitch: ≤16 mm
Stitch configuration	≥2 stitches across tear

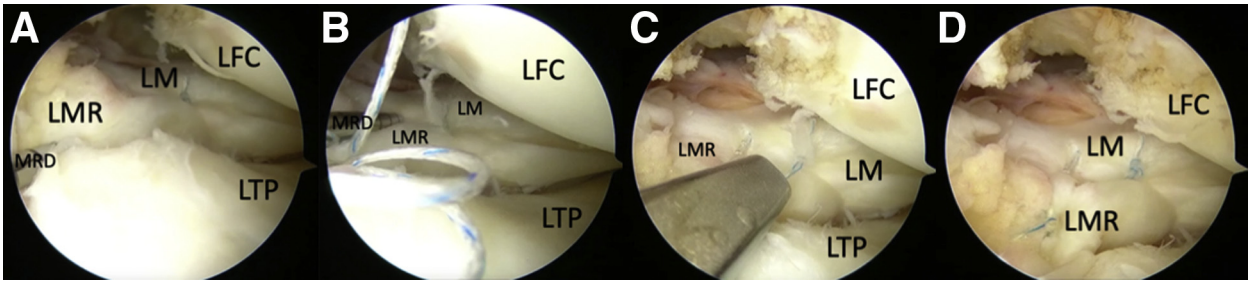

Fig 2. Arthroscopic image in a left knee from the anterolateral viewing portal, showing deployment of a second all-inside meniscal repair device (MRD) from the anteromedial working portal into the lateral (A) and medial (B) parts of the paracentral lateral meniscal radial root. The suture repair is tensioned (C) and trimmed (D). (LFC, lateral femoral condyle; LM, lateral meniscus; LMR, lateral meniscal root; LTP, lateral tibial plateau.)

No. 2 Orthocord suture (Mitek, Raynham, MA) and passed through both sides of the radial tear. The knot is tied arthroscopically to bring the edges of the radial tear together. This technique can also be combined with an all-inside meniscal repair device technique for the second stitch. At least 2 stitches should be placed across the tear, with 1 central and 1 peripheral or 1 superior and 1 inferior (Table 2). This decision is subject to access to the meniscus, tissue quality, and distance between the first and second sutures. A cannula can be used for suture and soft-tissue management during knot tying. An absorbable suture is recommended because it reduces the risk of knot interference in the knee joint. It is important to use an antegrade suture passer that is designed for use in the knee and can gain access to the lateral meniscus under the lateral femoral condyle. For medial meniscal radial root tear repair, ideal viewing is from the anterolateral portal with antegrade suture passer entry from the anteromedial portal, with the knee in 20° of flexion and a valgus force applied.

Postoperative Protocol

After radial meniscal root tear repair, patients are placed in a knee brace with range of motion of 0° to 90° to limit deep knee flexion that can compromise the repair. They are also kept on protected weight bearing (≤50% weight on the operated leg) for 6 weeks.

Discussion

We describe all-inside meniscal repair device and antegrade suture passer techniques for meniscal radial root tear repair and present the technical requirements and tips for these techniques. Meniscal root tears should be repaired to restore meniscal hoop stresses. Posterior radial root tears that extend to the capsule and posterior horn attachments of the lateral meniscus are frequently amenable to repair. Anderson et al.[8] found that 22 of 24 radial and posterior horn lateral meniscal tear repairs functioned successfully over a mean follow-up period of 58.6 months.

There are 2 main types of meniscal root tears. Paracentral radial tears adjacent to the meniscal root are more common than true root avulsions when associated with anterior cruciate ligament injuries. Meniscal root avulsions are repaired by passing sutures through the posterior root, drilling a transtibial tunnel, and securing the pullout sutures to a button on the tibial cortex. LaPrade et al.[4] reported good results with transtibial meniscal root repair using pullout sutures, with patients having significantly improved postoperative outcome scores. Paracentral radial meniscal root tears (types 1, 2, and 4) ideally should not be repaired with transtibial pullout sutures. Such repairs would be potentially under high tension, with the meniscal posterior horn and body being overly medialized. There can be excessive tibiofemoral contact

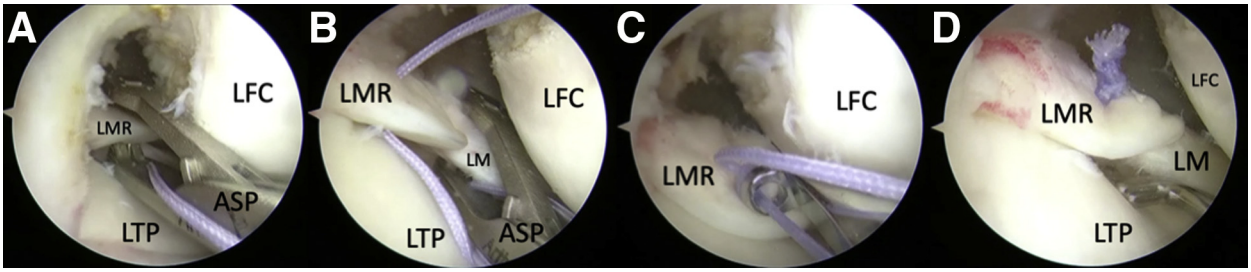

Fig 3. Arthroscopic image in a left knee from the anteromedial viewing portal, showing an No. 2 Orthocord suture passed with an antegrade suture passer (ASP) through the medial (A) and lateral (B) parts of the paracentral lateral meniscal radial root tear via the anterolateral working portal. Arthroscopic knots are tied (C) and cut with a short tail (D). (LFC, lateral femoral condyle; LM, lateral meniscus; LMR, lateral meniscal root; LTP, lateral tibial plateau.)

Table 2. Tips on Using Antegrade Suture Passer

	Tip
Portal	Lateral meniscal root repair: view from anteromedial portal and insert passer from anterolateral portal Medial meniscal root repair: view from anterolateral portal and insert passer from anteromedial portal
Stitch configuration	≥2 stitches across tear: 1 central and 1 peripheral or 1 superior and 1 inferior
Suture management	Use of cannula can be considered

Table 4. Risks, Limitations, and Advantages

Risks and limitations
Entails risk to popliteal vessels in lateral meniscal posterior root repair with all-inside repair device—requires care with choice of working portal and depth-limiter setting
Requires ability to tie knots arthroscopically
Advantages
Allows for more anatomic repair of meniscal root tears—restores tension and physiological excursion
Avoids additional incisions and/or bone tunnels that are required in transtibial pullout suture root repair

pressure after placement of pullout sutures, resulting in excessive tension and lack of normal physiological excursion.[9]

Our 2 side-to-side repair techniques for radial root tears allow for restoration of the natural meniscus position, anatomy, and tension. In meniscal repair, absorbable sutures have shown comparable healing rates to nonabsorbable sutures.[10] We use a No. 2 Orthocord partially absorbable suture, which is in contrast to the absorbable No. 0 polydioxanone (PDS; Ethicon, Somerville, NJ) suture hook (Linvatec, Largo, FL) technique used by Ahn et al.[11] This suture provides good handling and knot stability. The PDS component in Orthocord allows the knot profile to continue to diminish several months after surgery and has less bacterial adherence. We recommend placement of 2 stitches across the tear for optimal fixation.[12] In our experience, when the repair was inspected, it was stable in all cases even when hyperflexion maneuvers were used.

For ease of repair, we highlight some technical considerations for each all-inside repair technique (Table 3). These considerations include surgeon comfort with using the meniscal repair device at various depth settings depending on where it is introduced in the meniscus, the ability to tie arthroscopic knots, and comfort in working with both the anteromedial and anterolateral portals for viewing and device introduction. We outline the risks, limitations, and advantages of our technique in Table 4.

Table 3. Technical Requirements of Each Technique

All-inside meniscal repair device
Comfort with using meniscal device
Awareness of depth setting at different regions—central and peripheral—and appropriate trajectory
Ability to work with different portals
Antegrade suture passer
Comfort with using suture passer for mattress configuration across radial tear
Ability to tie arthroscopic knots
Suture management

Identification of meniscal radial root tears and awareness of repair techniques are becoming more common. We believe paracentral radial root tears with a significant stump are more anatomically repaired with side-to-side sutures with either an all-inside repair device or an antegrade suture passer.

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