Inside-Out Repair for Radial Meniscus Tears

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Abstract: Understanding of meniscal function through basic science, natural history, and biomechanics has highlighted the importance of preserving the meniscus to maintain normal knee biomechanics. Tears that may alter these biomechanics can contribute to the progressive nature of degenerative joint disease in the knee. Radial tears result in the disruption of the circumferential fibers causing inability of the native meniscus to resist normal hoop stresses, thereby leading to increased focal areas of pressure that cause complications such as early onset arthrosis. In this technical note, we describe our preferred operative technique to repair radial meniscal tears using an arthroscopic inside-out approach with satisfactory clinical outcomes and healing response.

Meniscal function is important for shock absorption, passive stabilization, and load transmission via hoop stresses of circumferential collagen fibers.[1,2] Depending on the nature of the tear, repair may allow for restoration of near normal knee biomechanics.[3] Specifically, radial tears have been shown to increase focal stress on the articular cartilage equivalent to *complete* meniscectomy, and therefore, have been linked to early onset arthrosis.[2-4] Although these tears are uncommon, recognition and subsequent repair can reduce these focal areas of pressure by increasing the contact surface area on the articular cartilage of the knee.

Multiple arthroscopic meniscal repair techniques have been described, but there is no consensus on the most effective way to preserve meniscus function.[5] The all-inside technique has become popular due to benefits of decreased surgical time, smaller surgical incisions, and reduced risk of neurovascular injury. Additionally, new-generation all-inside devices have comparable clinical results and fixation strength to the inside-out repairs.[6,7]

Conversely, the inside-out repair technique is technically more demanding and requires assistance in the operating room, but is significantly cheaper than all-inside devices.[8,9] This repair technique remains the current gold standard.[7,10,11] Here, the authors review the inside-out repair technique for a radial tear in the lateral meniscal body and provide a video demonstration (Video 1). Indications and contraindications along with risks, pearls, and pitfalls when performing the inside-out technique for lateral meniscal tear repair are also discussed (Table 1).

Surgical Technique

Patient Positioning and Diagnostic Arthroscopy

Equipment necessary to perform this technique is provided in Table 2. The patient is placed in the supine position with the operative leg prepped and draped free in a sterile fashion for knee arthroscopy (Fig 1). Incisions for the anteromedial, anterolateral, and superomedial portals are infiltrated with 0.2% ropivacaine. A superomedial outflow portal is created approximately 3 to 4 cm proximal to the medial pole of the patella with knee in extension. Anterolateral and anteromedial portals are created 1 cm above the knee joint laterally and medially to the patellar tendon, respectively. Diagnostic arthroscopy confirms the tear visualized on the preoperative magnetic resonance imaging (MRI) (Fig 2) and determines the ability to perform an arthroscopic repair.

Meniscus Tear Preparation

The knee is then placed in a figure-of-4 position to open the lateral compartment. Once the full-thickness

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Table 1. Indications, Contraindications, Risks, Pearls, and Pitfalls of the Inside-Out Technique

	Description
Indications	• Complex or extensive repairable tears of body and posterior horn (*consider other techniques and approaches for anterior horn tears*)
Contraindications	• Degenerative tears • Tears with minimal or no healing capacity

Risks	• Recurrent tearing
	• Neurovascular injury
	  • Popliteal vessel injury
	  • Saphenous nerve injury
	  • Peroneal nerve injury
	• Postoperative stiffness
	• Contracture formation

Pearls	• Fat pad debridement can enhance visualization along with instrument access and passage • Sutures for meniscus repair should be tied with knee close to full extension • Zone-specific cannulas should be used from a contralateral working portal to avoid dangerous needle trajectory toward midline neurovascular structures • Platelet-rich plasma can increase meniscal healing
Pitfalls	• Malreduction of the meniscus tear pattern • Iatrogenic cartilage injury

radial tear of the lateral meniscus is identified (Fig 3A), a 3.5-mm full-radius shaver (Stryker, San Jose, CA) along with a double-sided rasp (Linvatec, ConMed, Largo, FL) is used to clean edges (Fig 3B) and promote bleeding at the repair site to enhance healing. Devascularized tissue is debrided from the meniscal tear edges to obtain a maximal healing response from vascular infiltration into the adjacent areas.

Radial Tear Repair of Lateral Meniscus

A posterolateral approach to the knee is made for knot tying over the capsule with the inside-out technique.[12] With the knee flexed between 30° and 45° a 3-cm vertical incision is made at the joint line, posterior to the fibular collateral ligament, with approximately one-third of the incision above the joint line and two-thirds of the incision below the joint line. The inferior border of the iliotibial band is palpated, and the interval between the biceps femoris posteriorly and the iliotibial anteriorly is developed bluntly. The interval between the lateral head of the gastrocnemius and the posterolateral capsule is developed via blunt dissection for adequate exposure necessary when passing the sutures (Fig 4).

Table 2. Equipment Required

- 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 (sterilized, nonbranded)
- No. 2-0 nonabsorbable suture on long, flexible needles (Ethicon, Summerville, NJ)

Fig 1. The patient is placed in the supine position with the operative leg prepped and draped free in a sterile fashion for knee arthroscopy.

Zone-specific cannulas (Linvatec, ConMed) are then used to place 5 inside-out No. 2-0 nonabsorbable Ethibond sutures (Ethicon, Summerville, NJ) using flexible long preloaded sutures in a horizontal

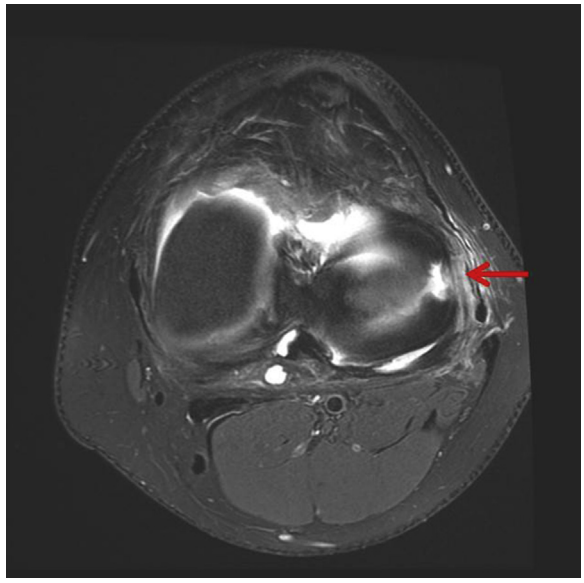

Fig 2. T2-weighted axial image of the left knee showing a large radial tear of the midbody of the lateral meniscus (arrow).

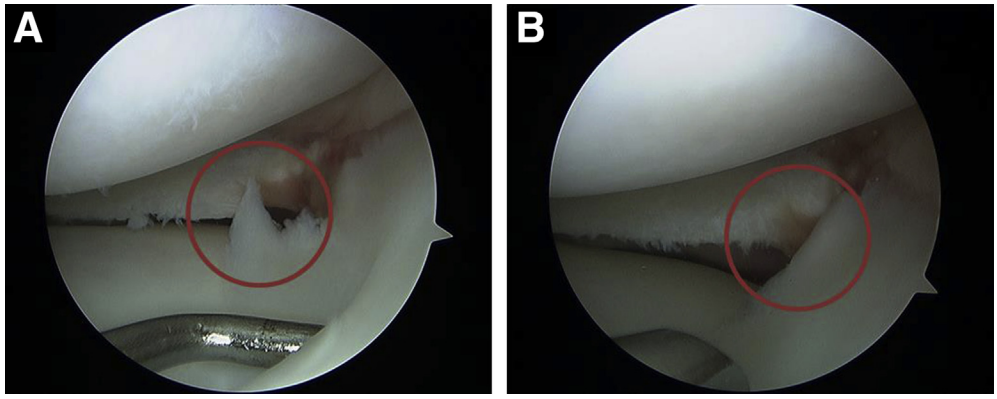

Fig 3. (A) Arthroscopic photograph from the anterolateral portal confirming radial tear of the midbody of the lateral meniscus (circled). (B) Arthroscopic photograph from the anterolateral portal after debridement of the tear (circled).

mattress fashion to reduce the tear anatomically (Fig 5). While placing sutures, care should be taken to avoid gaps of more than 3 to 5 mm as the needle is driven through the lateral meniscus. A spoon retractor (sterilized, nonbranded) is used to protect the neurovascular structures when passing sutures from the posterior to anterior fashion such that needles piercing the posterior capsules are deflected laterally. The sutures are passed through the meniscus, retrieved, and tied sequentially.

After meniscal repair, microfracture perforations are made in the intercondylar notch to encourage bleeding and promote healing of the meniscus tear (Fig 6). Platelet rich plasma can also be infiltrated to enhance meniscal healing, particularly if tear extends into the avascular zone.[13] The posterolateral incision is closed with interrupted No. 2-0 Monocryl subcutaneous and running No. 3-0 Monocryl subcuticular sutures (Ethicon). Steri-Strips are applied to the portals followed by a sterile dressing. Figures 2 and 7 include the preoperative and postoperative MRI of a patient providing convincing evidence of adequate tear healing with the inside-out technique. The senior authors (M.J.S., B.A.L., and A.J.K.) have treated 8 patients in high school and college athletics with a similar injury using this repair technique. All patients treated (in sports of football, basketball, baseball, and wrestling) currently remain pain free with full function, return to his or her own respective sport, and MRI demonstration of interval healing.

Postoperative Rehabilitation

The patient is initially kept nonweight bearing in a hinged knee brace (Fig 8) locked in full extension (Donjoy, Vista, CA). For the first 4 to 6 weeks, knee flexion is limited to 90°. After brace use is discontinued, the patient is allowed to be weight bear as tolerated with range of motion as tolerated, while avoiding knee loading at angles greater than 90° of flexion. Knee loading at flexion angles greater than 90° is prohibited until 4 months postoperatively, after which the patient is typically allowed to return to activity as tolerated.

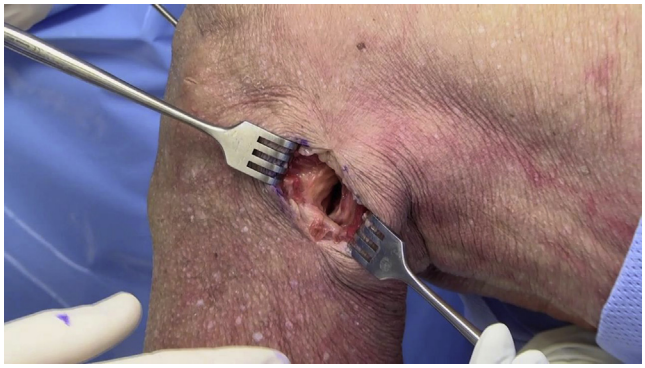

Fig 4. The interval between the lateral head of the gastrocnemius and the posterolateral capsule developed via blunt dissection is necessary when passing the sutures using an inside-out technique.

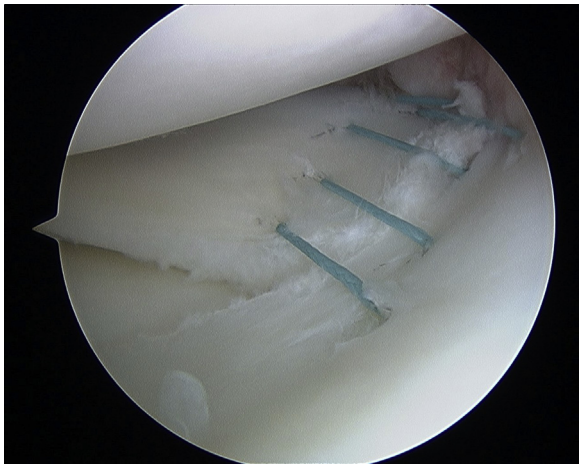

Fig 5. Arthroscopic photograph from the anterolateral portal showing anatomic reduction of radial tear using horizontal mattress sutures.

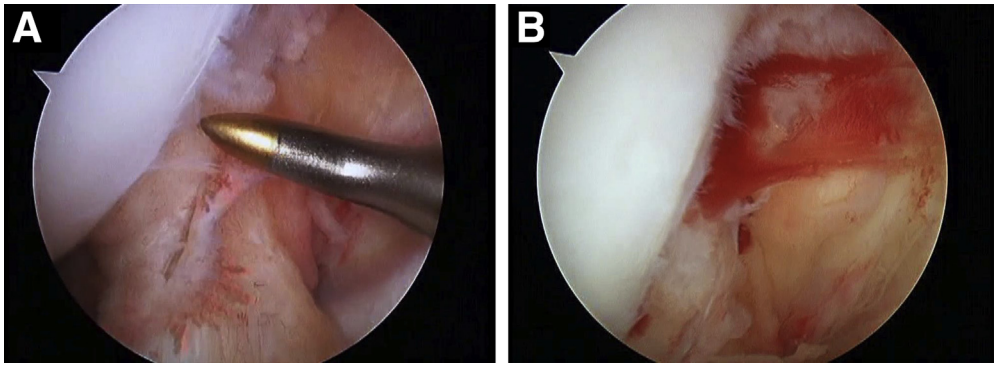

Fig 6. (A) Microfracture of the intercondylar notch is performed with an arthroscopic awl, penetrating the subchondral bone to a depth of approximately 3 mm, with holes placed every 2 to 3 mm. (B) Bleeding from the subchondral bone is confirmed from the microfracture site to promote meniscal healing.

Discussion

The menisci play many functions that maintain the overall health of the knee, including improved joint congruity, proprioception, shock absorption, lubrication, and nutrition of the articular cartilage. Meniscal tears can be a source of pain, swelling, and activity limitation. A full-thickness radial tear of the meniscus results in complete loss of hoop stress resistance that is biomechanically comparable with a *complete* meniscectomy.[2,3] Reliable repair methods for radial tears of the meniscus can restore contact pressures in the knee joint and minimize the risk of future complications such as early arthrosis.

All-inside repair techniques have become the technique of choice for many types of meniscal repairs. They often have shorter surgical times, are less invasive, and provide less risk for neurovascular damage.[7,8] In addition, a study has recently shown a new all-inside technique using the vertical suture configuration to have lower displacement, higher load to failure, and grater stiffness compared with inside-out repairs of radial meniscal tears. Still, human studies have not reached a definitive conclusion.[14] All-inside repairs also have potential disadvantages; these include increased local irritation because of extra-articular implants, implant migration, and failure.[7] All-inside repairs also have larger-diameter insertion needles compared with an inside-out technique, and this increases the risk for iatrogenic meniscal and chondral damage, an important consideration in complex meniscal tear repairs.[8,9,15] Although modern all-inside implants have been shown to have similar fixation strength and clinical results as an inside-out technique, all-inside repairs lack long-term outcome data, especially with regard to new techniques in human patients.[6,7]

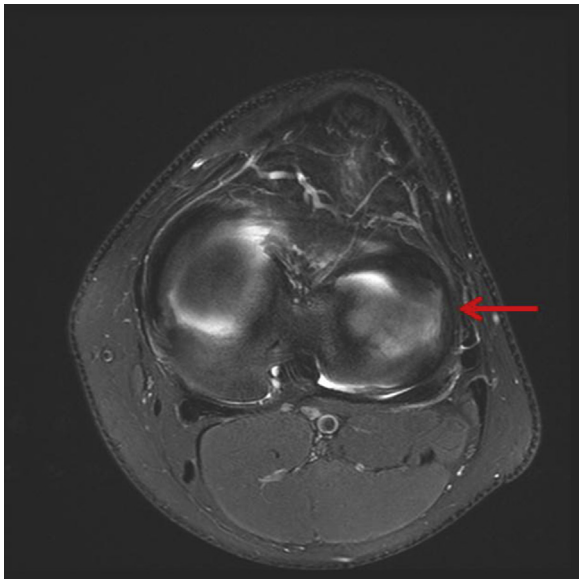

Fig 7. T2-weighted axial image of the left knee at 6 months postoperatively showing interval healing of radial tear of lateral meniscus (arrow).

Fig 8. The patient is initially kept nonweight bearing in a hinged knee brace (shown above, Donjoy, Vista, CA) locked in full extension. For the first 4 to 6 weeks, knee flexion is limited to 90°. After brace use is discontinued, the patient is allowed to be weight bear as tolerated with range of motion as tolerated, while avoiding knee loading at angles greater than 90° of flexion.

We prefer inside-out repairs in the setting of more complex or extensive tears, as it can be more cost effective and allow for a more anatomic reduction of the tear pattern. The inside-out repair has been the gold standard for meniscal repair due to its fixation strength and low clinical failure rate.[7,10,11] Inside-out repairs offer a success rate varying from 85% to 90% in concomitant anterior cruciate ligament reconstruction, and 60% to 80% for isolated meniscal repairs.[9,16] Similarly, it has also been shown to have equivalent healing when compared with all-inside repairs in the setting of meniscal repairs with concomitant anterior cruciate ligament reconstruction on MRI.[17]

The inside-out technique is not without its disadvantages both to the patient and to the surgical team. The technique requires passage of needles through the posterior capsule, putting the patients' neurovascular structures at risk. Other patient complications include postoperative stiffness and contracture. Risks to the surgical team, on the other hand, include needlestick injury (due to lack of clear visualization of passing sutures).[7] Conversely, unlike the all-inside technique, the inside-out technique uses smaller diameter needles that allow the surgeon to place a greater number of sutures in a similar space. Although the technique requires an experienced assistant and surgeon, it is more cost effective than an all-inside repair.[7]

Full-thickness radial tears of the meniscus are rare, but potentially devastating injuries. Recognition and an appropriate repair technique are critical to restore meniscus function. Although both the inside-out and all-inside repairs have potential advantages and disadvantages, we show the inside-out technique to be simple, reproducible, and capable of good clinical results.

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