Technical Note

Transosseous Repair of Isolated Posterior Medial Meniscal Root Injuries in Children and Adolescents

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Abstract: The meniscal roots are critically important for maintaining knee stability, functional load distribution, and proper knee kinematics. Although adult meniscal root injuries have been a topic of increasing research, medial meniscus injuries also occur in pediatric and adolescent patients, with up to 2% of meniscal injuries involving root attachments. The purpose of this Technical Note is to demonstrate the transosseous repair of isolated posterior medial meniscal root injuries in children and adolescents, including tear visualization on magnetic resonance imaging and during arthroscopy, operative technique, and postoperative management.

The meniscal roots are critically important for maintaining knee stability, functional load distribution across the knee joint, as well as proper knee kinematics.[1-3] As such, they have been a topic of increasing research over the past decade.[4] Previous reports indicate medial meniscus root tears are most commonly degenerative injuries in middle-aged adults, specifically with a greater incidence in female patients.[5,6] However, these rare injuries also occur in pediatric and adolescent patients, with limited published literature to guide management and inform treatment outcomes. A retrospective study conducted by Shieh et al.[7] in 2013 revealed that 2% of surgically treated menisci at a single institution over the course of 5 years were meniscal root detachment injuries. In 2018, Wilson et al.[8] reported on 314 pediatric and adolescent patients with surgically treated menisci, noting 1 (0.3%) patient with an isolated lateral meniscal root injury and 3 (1.0%) patients with an isolated medial meniscal root injury (defined as no other concomitant injuries).

Given the rarity of isolated medial meniscal root injuries, there is a paucity of literature detailing the management and surgical repair of such injuries. We present repair of the posterior medial meniscal root (PMMR) in children and adolescents. The purpose of this Technical Note is to demonstrate the transosseous repair of isolated posterior medial meniscal root injuries, including tear visualization on magnetic resonance imaging (MRI) and during arthroscopy, operative technique, and postoperative management for isolated PMMR repair in children and adolescents.

Surgical Technique (With Video Illustration)

Tear Visualization on MRI and During Arthroscopy

Patients indicated for transosseous repair of isolated PMMR injuries are diagnosed on preoperative MRI (Figs 1 and 2) and confirmed arthroscopically by direct visualization (Fig 3).

Patient Positioning for Arthroscopy

Spinal anesthesia is performed with a supplementary adductor canal saphenous nerve sensory-only block. This provides adequate analgesia such that light sedation is required, which obviates the need for an endotracheal tube or laryngeal mask airway. Nonsterile

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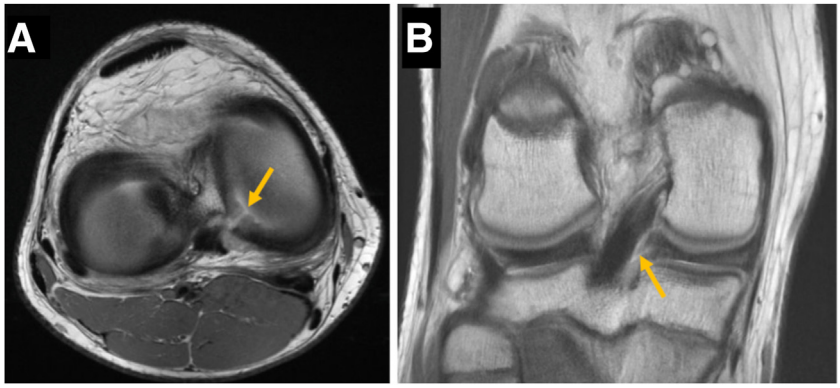

Fig 1. Preoperative magnetic resonance imaging (taken 6 days before arthroscopy) with axial (A) and coronal (B) proton density sequences demonstrating a posterior medial meniscal root tear of the right knee (arrow).

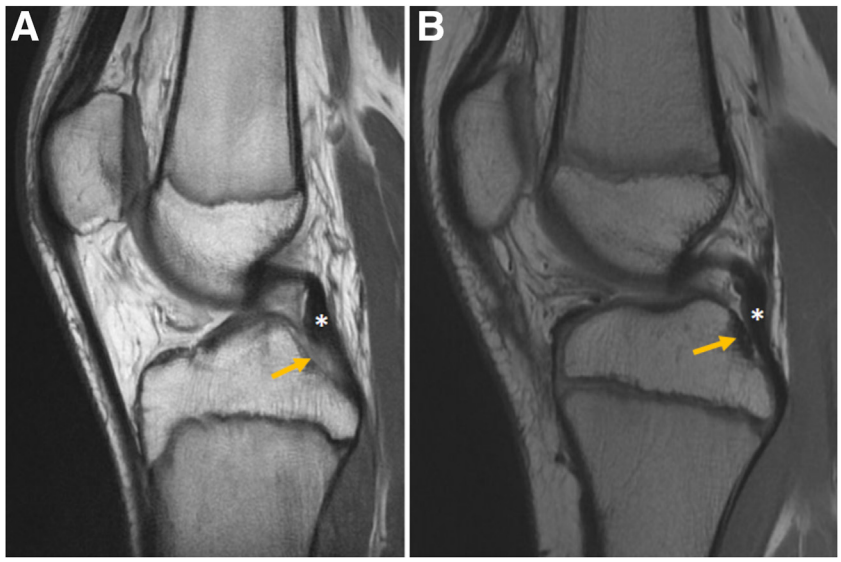

Fig 2. Sagittal proton density magnetic resonance imaging sequences showing a right posterior medial meniscal root tear, with the absence of tissue directly anterior to the tibial footprint of the posterior cruciate ligament (A, arrow), and normal meniscus morphology in a 10-year-old pediatric patient (B, arrow). *Posterior cruciate ligament.

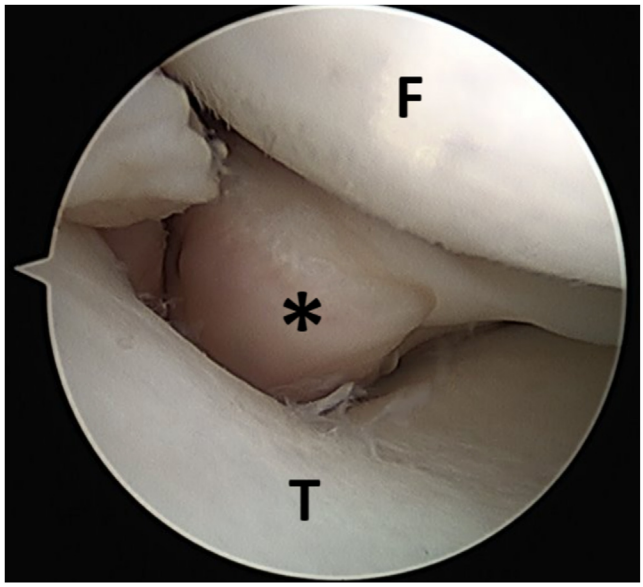

Fig 3. Arthroscopic photograph of a posterior medial meniscal root avulsion (asterisk) in a right knee before surgical root repair oriented with the femur (F) superiorly and the tibia (T) inferiorly.

thigh tourniquets are applied but infrequently used. Patients are positioned supine with a lateral post to allow for application of valgus stress to the knee and visualizaition of the medial compartment during arthroscopy (Fig 4).

Diagnostic Arthroscopy and Preparation for Repair

Standard diagnostic arthroscopy is performed. In order to optimize visualization of the PMMR tear, we perform routine medial cruciate ligament trephination with an 18-gauge spinal needle to increase access to the posterior part of the medial compartment while avoiding iatrogenic cartilage injury.

Meniscus Root Repair

The root attachment site on the posterior central aspect of the tibial plateau is prepared by removing devitalized tissue and underlying cartilage so that there is a healing surface for the meniscal root repair (Fig 5). A suture passer (FIRSTPASS MINI; Smith & Nephew, Andover, MA) is used to pass 2 nonabsorbable link sutures (FiberLink; Arthrex, Naples, FL)

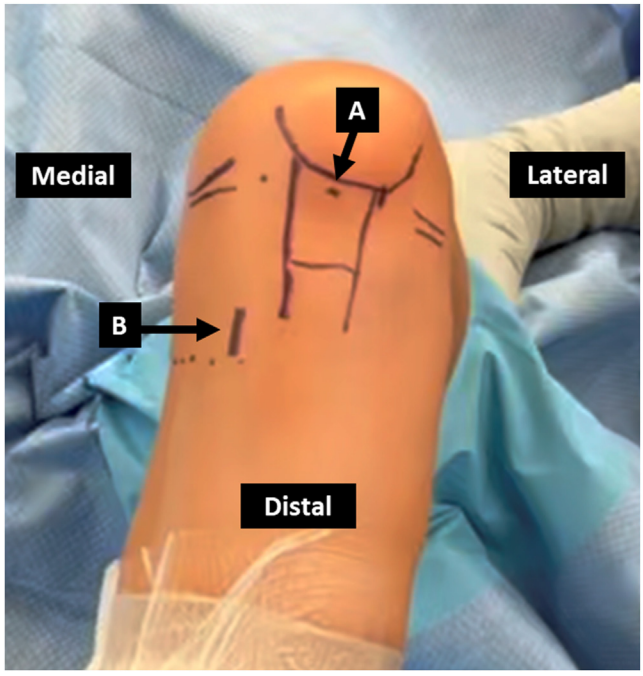

Fig 4. Patients should be positioned supine with a lateral post in place for application of valgus stress to the knee. Preoperative markings should include the location of the patellar tendon, standard anterolateral and anteromedial portals, and a transpatellar tendon accessory portal (arrow A). Also marked is the skin incision for the transosseous tunnel (arrow B), which is immediately above the pes anserinus (dotted line). This figure shows a left knee.

from the superior to inferior meniscal surface to secure the meniscal tissue with a "locking luggage tag" (Fig 6). Then, a 2-cm incision is made to access the anteromedial tibia just proximal to the pes anserinus, after which a curved targeting guide (Smith & Nephew) is used in order to drill a 2.4-mm guidewire with sheath from the anteromedial aspect of the tibia to the posterior meniscal root attachment repair site. After removing the drill but leaving the sheath in place, the repair sutures are passed down and out the tunnel using a monofilament wire with a looped end (Fig 7). The meniscal root repair is secured to the anteromedial tibia using a 3.5-mm screw-in anchor while viewing the repair tension arthroscopically (Fig 8). As backup fixation, the meniscal repair sutures are tied to the anchor eyelet suture to prevent slippage. Portals are closed in usual watertight fashion (Video 1).[9]

Postoperative Management

Postoperatively, patients generally progress through milestones at 6-week intervals. For weeks 0 to 6, patients are allowed 20% weight-bearing with a hinged knee brace locked in full extension. Knee range of motion is limited to 0 to 90° during this time to protect the repair. The patients are permitted to begin to slowly progress to full weight-bearing and range of motion as tolerated after 6 weeks. Between 6 and 12 weeks postoperative, patients are instructed to focus on range of motion and nonimpact strength training. Three months postoperatively and in the absence of pain or swelling, patients are generally encouraged to initiate jogging and start impact strength training. Patients are then progressed back to full sports activities over the subsequent 6 to 8 weeks, with full sports clearance typically occurring 5 months after surgery.

Discussion

The transosseous repair of isolated PMMR injuries demonstrates favorable short-term outcomes. In the adult literature, there have been reports of PMMR tears being treated with either a partial meniscectomy or transosseous refixation repair.[10,11] However, partial

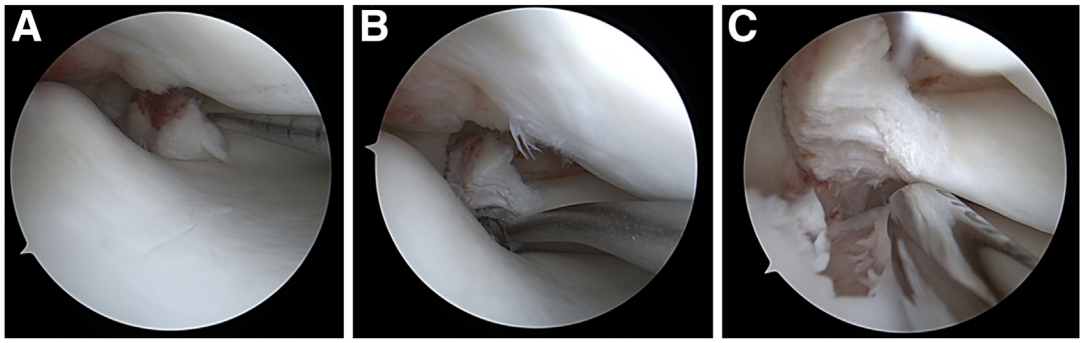

Fig 5. After medial collateral ligament trephination to improve access to the posterior medial compartment, the medial meniscus root tear can be identified (A). A curved curet (B) and shaver (C) are used to prepare the tibial footprint and underside of the meniscal root for biologic healing (right knee).

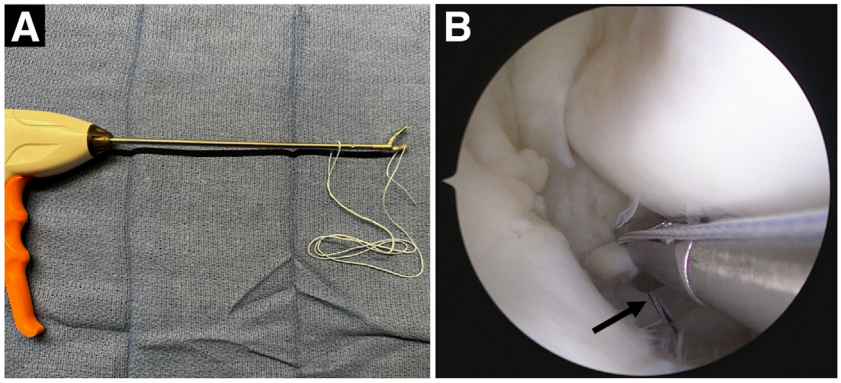

Fig 6. A nonabsorbable link suture is looped around the shaft of the suture passer (A). Then, the suture is passed from superior to inferior (B, arrow) such that after passage and instrument retrieval, a locking luggage tag suture will be applied. This figure shows a right knee.

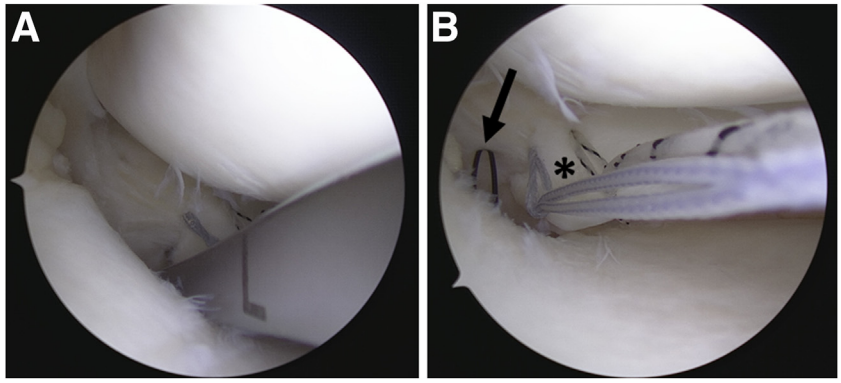

Fig 7. After suture passage, the 2.4-mm guidewire with sheath is drilled from the anteromedial aspect of the tibia immediately proximal to the pes anserinus to the posterior meniscal root footprint using a curved targeting guide (A). A monofilament passing suture is shuttled up the cannula (B, arrow) for passage of the repair sutures (asterisk). This figure shows a right knee.

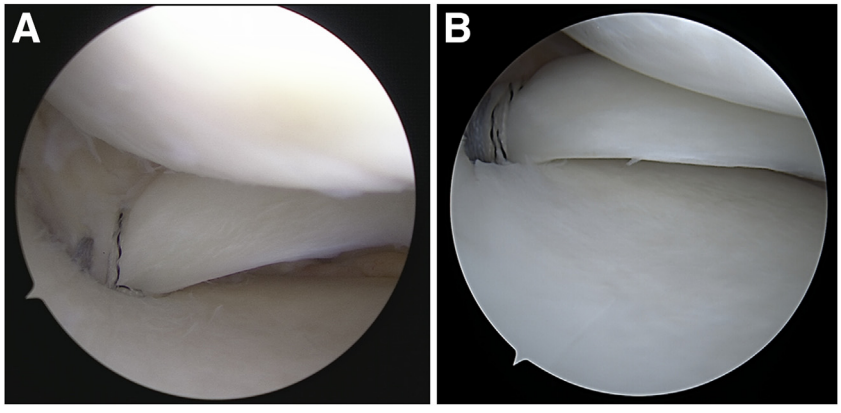

Fig 8. The repair sutures are shuttled back through the transosseous tunnel using the monofilament passing suture in order to create a stable repair (A). Global view of the medial compartment shows appropriate tension on the posterior meniscal root (B). This figure shows a right knee.

meniscectomies have been reported to result in a high proportion of patients progressing to degenerative arthritis.[12,13] Han et al.[13] conducted a retrospective review demonstrating that 35% of their 46 patients treated for complete PMMR tears with partial meniscectomy had radiographic progression of osteoarthritis at a mean follow-up of 77 months. Subsequently, arthroscopic refixation techniques were developed, which have demonstrated better clinical and radiographic outcomes for at least 5 years' follow up in

Table 1. Advantages, Limitations, Pearls, and Pitfalls

Advantages
This technique allows for maximum conservation of meniscal tissue, improving patient outcomes and minimizing the risk of degenerative arthritis.
This technique results in strong meniscal suture configuration and allows for a shallow socket for tissue healing.
A small (2.4-mm) central transphyseal tunnel with suture fixation is generally safe for skeletally immature patients.
This technique does not require additional posteromedial portal creation.
Limitations
This technique is challenging in the setting of chondroepiphyseal meniscal root avulsion with osseous tissue on the avulsed root. In these cases, the avulsed bone should be thinned to allow for suture passage but not excised as to promote bone-to-bone healing.
Pearls
By passing the link suture from the superior to inferior meniscal surface, a "locking luggage tag" is created that improves security on the tissue compared with passing from inferior to superior.
If needed, a transpatellar tendon accessory portal can be created to improve access and tissue handling. In conjunction with the standard anteromedial portal, this allows for 2 working portals while viewing from the anterolateral portal.
Pitfalls
In the setting of a combined meniscal root repair and ACL reconstruction, one should be careful not to have converging tunnels. To avoid this, begin the meniscal root repair tunnel distal to the ACL tibial tunnel aperture on the anteromedial tibia, which will prevent tunnel convergence.
One must be careful not to lose tension on the repair sutures while setting the anchor. Additionally, it is important to secure the repair suture to the eyelet suture by tying them together after anchor placement. This can be done after the anchor has been placed and the repair has been probed to confirm stability.

ACL, anterior cruciate ligament.

adults.[10] Medial meniscus posterior root repair also has been shown to result in greatly improved biomechanical outcomes.[14] The technique has several advantages and limitations described in Table 1.

Disclosures

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: D.W.G, reports a relationship with Arthrex that includes consulting and roylaties and with Orthopediatrics that includes royalties. P.D.F. reports a relationship with WishBone Medical and with Osso VR that includes: consulting or advisory. All other authors (K.K.N., R.H.J., P.W.G., P.C., D.E.C., A.M.F., H.G.G.) 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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