Technical Note

# Medial Meniscus Root Repair in Patients With Open Physes

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**Abstract:** Meniscal root tears have become increasingly recognized in the past decade. Lateral meniscus root tears typically occur in active, younger patients who sustain acute anterior cruciate ligament tears. Conversely, medial meniscus root tears typically occur in isolation and affect middle-aged patients. However, recent reports have described the incidence of meniscal root tears occurring in pediatric populations who are skeletally immature. The purpose of this technical note is to describe the authors' surgical technique for medial meniscal root repair for patients with open physes.

Meniscal root tears have become increasingly recognized in the past decade. As a result, the reported consequences of unaddressed meniscal root tears have been well established, including increased tibiofemoral contact forces, meniscal extrusion, increased knee kinematics in the setting of anterior cruciate ligament (ACL) deficiency, and risk of developing rapid end-stage osteoarthritis.[1-3] Because of their intimate relationship, it has been reported that lateral meniscus root tears typically occur in active, younger patients who sustain acute ACL tears.[4] Conversely, medial meniscus root tears typically occur in isolation and affect middle-aged patients.[5] However, recent studies have described the incidence of meniscal root tears in skeletally immature populations.[6,7]

It has been reported that up to 1 in 6 pediatric or adolescent patients who sustain acute meniscus tears will have a meniscal root tear.[7] It is unknown whether the detrimental consequences of meniscal root tears that have been reported in adult populations are similar in pediatric populations. However, with the high incidence of meniscal root tears that do occur in pediatric populations, it is imperative that surgeons establish satisfactory surgical techniques for repairing the meniscus root anatomically in skeletally immature patients.[8] Therefore, this technical note describes the authors' surgical technique for medial meniscal root repair for patients with open physes.

**Table 1.** Pearls and Pitfalls

| Pearls | Pitfalls |
|---|---|
| Use of fluoroscopy to aid in tibial tunnel drilling to avoid crossing or potentially damaging the open physis | Disrupting the tibial physis may result in physeal arrest or other growth disturbances |
| Preparation of the anatomic attachment site of the medial meniscus posterior root is essential in reestablishing the anatomic position and subsequent biomechanical restoration of the root | Failure to relocate meniscus to anatomic center may result in early failure or continued meniscal extrusion, leading to altered tibiofemoral contact pressures and kinematics |
| Tie the root repair over a button to allow for secure fixation and postoperative visualization of the root repair above physeal line | Avoid tying sutures directly over the tibia, as the bone can cut the sutures and cause laxity in the root repair fixation |
| A detailed understanding of meniscal root anatomy, both arthroscopically and radiographically, is key for successful anatomic repair | Avoid placing fixation device across open physis if possible |

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**Table 2.** Advantages and Disadvantages

| Advantages | Disadvantages |
|---|---|
| Anatomic technique for restoration of posterior meniscus root tears | Obliquity of angle during transtibial reaming due to need of placing tibial tunnel superior in the epiphysis |
| Use of a single transtibial tunnel for repair | Technically challenging |
| Use of titanium implant, which allows direct visualization of fixation device to ensure that the physis is avoided | Potential need for second surgery involving hardware removal of fixation device owing to deep hardware irritation or to avoid growth disturbances |

## Surgical Technique

Details of the technique are shown in the Video 1. Pearls and pitfalls and the advantages and disadvantages of this approach are described in Tables 1 and 2, respectively.

### Indications and Contraindications

Indications for meniscal root repair are clinical and radiographic evidence of complete detachment of the meniscus at or near (0 to 9 mm) the root attachment, confirmed during arthroscopy. Meniscal root tears can be classified according to the tear pattern classification described by LaPrade et al.[9] Contraindications for meniscal root repair surgery include grade III/IV chondromalacia in the ipsilateral compartment. Open physes are not a contraindication for transtibial repair, but care must be taken to avoid drilling or placing fixation hardware through the open physis. Preoperative plain radiographs, including longstanding alignment films and Rosenberg views, should be obtained in addition to the normal x-ray series to ensure the patient does not have significant unwanted genu varum or valgum, malalignment, or decreased tibiofemoral joint space.[10] Another important factor in the preoperative planning of skeletally immature patients is determining skeletal age with hand and wrist radiographs. A shorthand bone age assessment can be conducted quickly and efficiently to determine a patient's radiographic skeletal age before surgical repair.[11]

### Patient Positioning and Anesthesia

The patient is placed in the supine position on the operating table. After the induction of general anesthesia, a bilateral clinical knee examination is performed to evaluate for concurrent ligamentous instability and assess knee range of motion. A well-padded high-thigh tourniquet is placed on the operative leg, which is placed into a leg holder (Mizuho OSI, Union City, CA), whereas the contralateral knee is placed into an abduction stirrup (Birkova Product, Gothenburg, NE).

### Surgical Approach

Standard anterolateral and anteromedial portals are established adjacent to the patellar tendon. The joint is insufflated with normal saline and visualized with a 30° arthroscopic camera (Smith & Nephew, Andover, MA). An arthroscopic shaver (Smith & Nephew) is inserted into the knee, and any notable adhesions are removed. The location of the planned root repair on the tibial plateau should then be decorticated using a curved curette or curved shaver (Fig 1). When the meniscus is found to have significant extrusion, it is important to perform a sufficient release of the meniscus from the posterior joint capsule so that the meniscus body can be pulled back inside the joint when the root repair is tied down to the decorticated potion of the tibial plateau.[12] This release can be performed with rotary scissors (ACUFEX, Smith & Nephew), cutting along the posterior meniscocapsular junction both inferiorly and superiorly while leaving the midbody meniscal capsular attachments intact. A grasper should be used to assess the adequacy of the release of the extruded meniscal root and determine when the peripheral release is sufficient. In addition, for medial meniscal root tears, pie-crusting of the meniscofemoral attachment of the superficial medial collateral ligament with a spinal needle can be performed to allow for increased visualization and opening of the medial compartment for

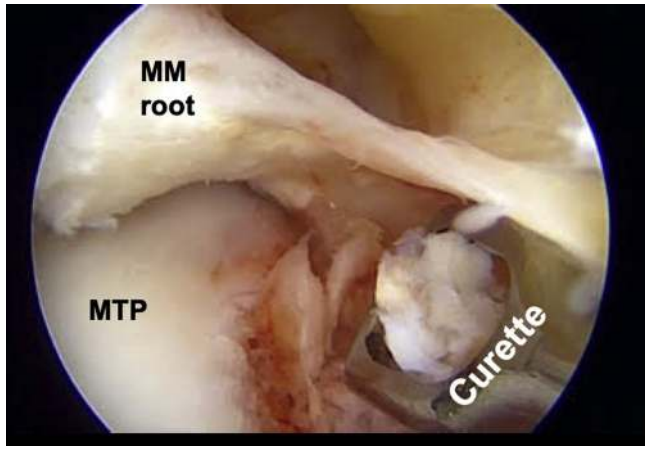


**Fig 1.** Arthroscopic view from an anteromedial portal showing decortication of the medial meniscal root attachment site using a curved curette. The footprint should be decorticated until healthy bony bleeding is observed. MM, medial meniscus; MTP, medial tibial plateau.

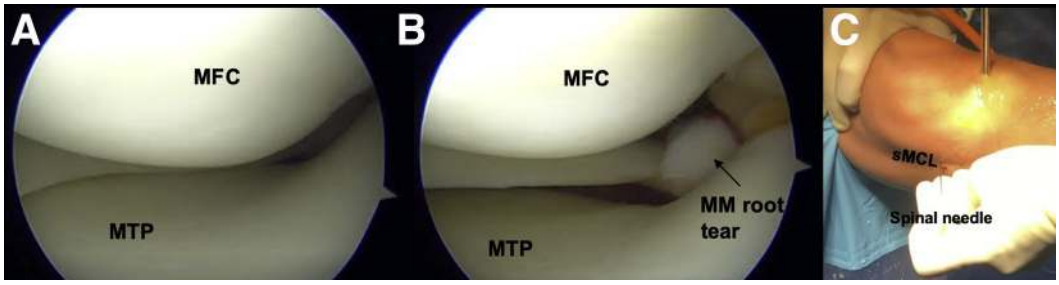


**Fig 2.** Images showing trephination, or pie-crusting, of the meniscofemoral attachment of the superficial medial collateral ligament (sMCL) to improve visualization of the medial meniscal root. A, Arthroscopic view of the medial meniscus from an anteromedial portal before trephination. B, Arthroscopic visualization after trephination of the sMCL with improved visualization of the medial compartment and posterior medial meniscus (MM) root tear. C, The external location of the pie-crusting technique using the authors' preferred technique of a spinal needle. MFC, medial femoral condyle; MTP, medial tibial plateau.

improved root repair access and to avoid iatrogenic damage to the medial femoral condyle joint surfaces (Fig 2).[13]

### Transtibial Tunnel

An initial incision for the transtibial tunnels is made just medial to the tibial tubercle, ~5 cm distal to the joint line. To best restore the footprint of the repair and increase the chance of biologic healing, 1 transtibial tunnel is created at the location of the meniscal root attachment, which can reliably be identified under fluoroscopic guidance.[14] A tibial tunnel guide (Smith & Nephew) is used to ream a 2.4-mm tunnel (along the posterior aspect of the posterior root attachment site) with the entry point located superior to the physis. The location of the tibial tunnel is then checked with fluoroscopy to ensure the tibial physis has not been violated (Fig 3). The surgeon can lift their hand while holding the guide and while reaming the transtibial tunnels to help avoid violating the tibial physis. This system has a 2.4-mm cannula that stays in place while the drill pin is removed, which facilitates direct visualization of the transtibial tunnel location during fluoroscopy to ensure the physis is not violated. The transtibial tunnel is then visualized arthroscopically to verify correct tunnel placement, and the drill pin is removed, leaving the single cannula in place for passing the suture (Fig 4).

### Suture Passing

A suture-passing device (Mini-FirstPass, Smith & Nephew) is used to pass a single suture tape through the far posterior portion of the detached meniscal root, ~5 mm medial to its lateral edge for the medial meniscus (Fig 5).

The suture-passer is first used to place the suture tape in the posterior meniscus root from tibial side to femoral side and is pulled through the anteromedial portal. The same end of the suture tape is then reloaded into the suture-passer. With the suture-passer inverted, the suture tape is placed again in the posterior meniscus root ~2 mm away from the first location, passing from the femoral side to the tibial side. This creates a double-loaded suture construct with a single suture in the posterior meniscal root, with both ends of the single suture exiting at the inferior meniscus. The suture-retrieving mechanism allows the device to pull out the suture tape through the anteromedial portal (through a cannula, to avoid soft tissue bridges) as the device is removed. The suture tape is then shuttled down through the tibial tunnel, and care is taken to

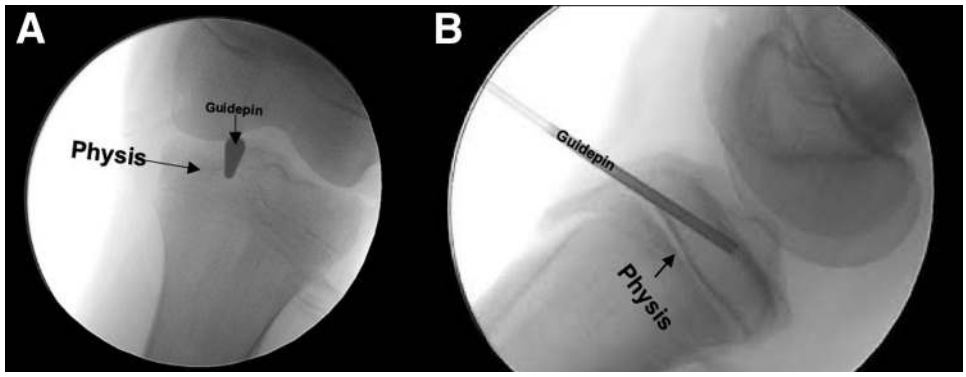


**Fig 3.** Anteroposterior (A) and lateral (B) intraoperative fluoroscopy views of the tibial tunnel location with a guidepin placed superior to the open physis.

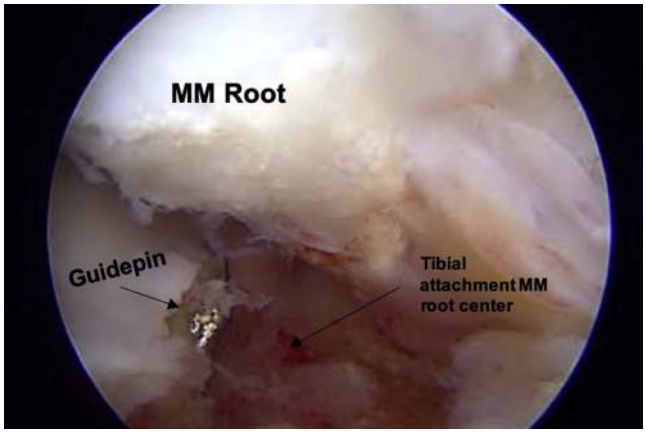


**Fig 4.** Arthroscopic view from an anteromedial portal showing the location of the tibial tunnel at the anatomic footprint of the medial meniscal (MM) root. Care is taken to avoid breaching the articular surface of the tibial plateau with a shallow trajectory.

avoid intra-articular suture tangling. To accomplish this, a looped nylon passing suture is placed up the tunnel cannula, and the suture is shuttled down the tibial tunnel (Fig 6).

### Root Fixation

The suture tape is tied down over a cortical fixation device (Endobutton, Smith & Nephew) on the anteromedial tibia for the medial meniscal root repair, while the posterior root of the respective meniscus is visualized arthroscopically to confirm a secure repair (Fig 7). Finally, the fixation device is checked with fluoroscopy

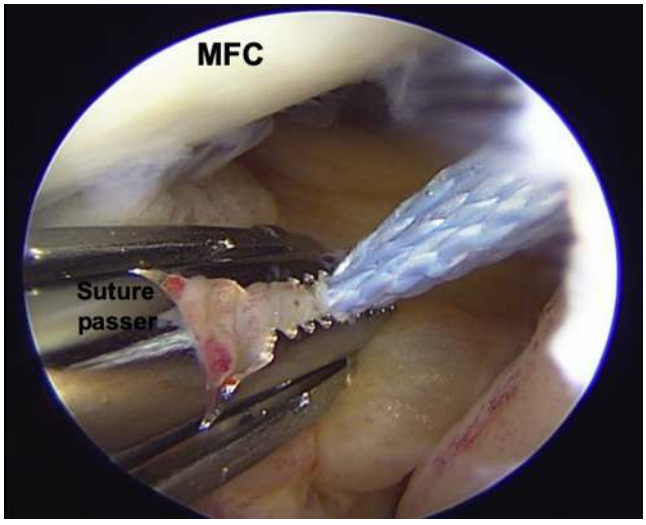


**Fig 5.** Arthroscopic view from an anterolateral portal of the first suture tape being placed using a suture-passing device (Mini-FirstPass, Smith & Nephew). This suture is placed ~5 mm medial to the lateral edge of the posterior medial meniscus. MFC, medial femoral condyle.

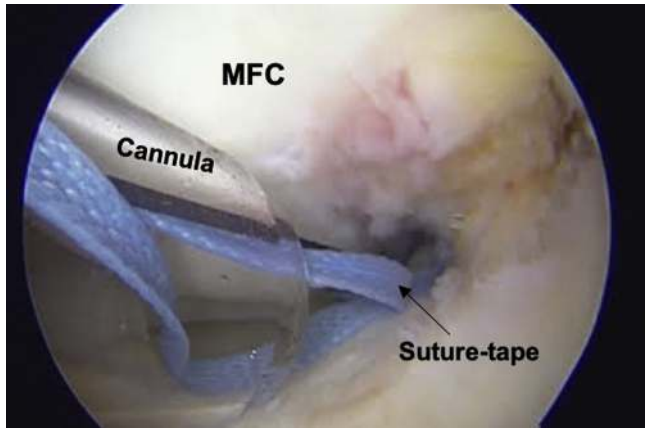


**Fig 6.** Arthroscopic view from an anterolateral portal showing passage of the suture tape from the anterior medial portal down through the posterior tibial tunnel. This system allows the surgeon to easily pass the suture tape through the tibial tunnel.

to ensure it is not directly violating the tibial physis (Fig 8).

### Postoperative Protocol

After the procedure, the patient is to remain nonweightbearing for 6 weeks on crutches. The patient is placed into a knee immobilizer during the entire nonweightbearing period of 6 weeks. Physical therapy begins on postoperative day 1 with an early focus on pain control, reducing edema, and knee motion. Knee range of motion is limited from 0° to 90° for the first 2 weeks to protect the meniscal root repair. From there, motion is progressed as tolerated. Weightbearing is initiated at 6 weeks postoperatively along with low-resistance cycling on a stationary bike. If a patient is in genu varum alignment, a medial unloader brace (Ossur Americas, Foothill Ranch, CA) is used once weightbearing begins until a minimum of 4 months postoperatively, to allow for adequate healing and unloading of the root repair. Once patients can tolerate 20 minutes of walking with a nonantalgic gait pattern, a periodized strength program may be initiated, which focuses on the sequential development of muscular endurance, strength, and power. Knee flexion during weightbearing exercise is limited to 70° until 16 weeks postoperatively, to avoid excessive strain on the meniscal root repair. Patients may begin a gradual return to activity progression around 5 months postoperatively. Clearance for return to all activities is determined after passing a functional sports test and clinical examination with plain radiographs at 6 to 7 months postoperatively.[10,15]

## Discussion

This technical note describes our surgical technique for addressing medial meniscal root tears in pediatric or adolescent patients with open physes. A detailed

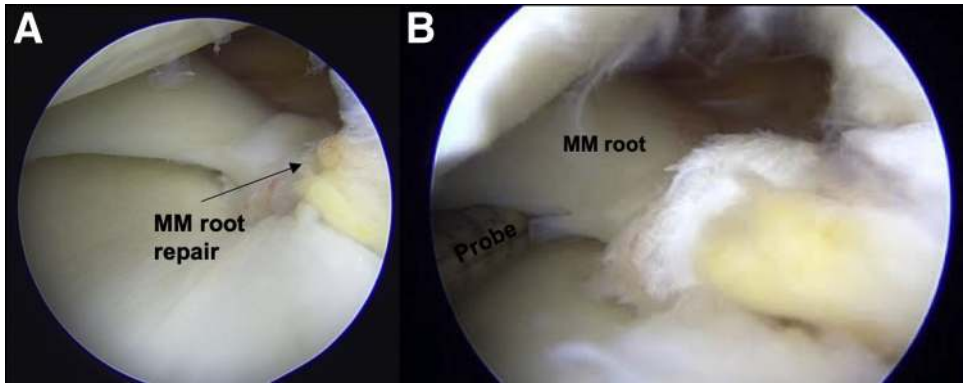


**Fig 7.** Arthroscopic visualization from an anterolateral portal of secure fixation of anatomic medial meniscus root repair with transtibial technique. The root can be tied under direct visualization (A), and the meniscus can be probed to ensure adequate fixation (B).

understanding of meniscal root anatomy, both arthroscopically and radiographically, is key for successful anatomic repair.[14,16,17] Skeletal maturity should be assessed both clinically and radiographically before surgery, and transosseous repair of meniscal root tears in patients with open physes can be appropriately performed with careful presurgical and intraoperative planning.[11,18] Use of intraoperative fluoroscopy is crucial, as care must be taken to avoid drilling through the epiphyses or placing screw fixation across the epiphyses. Potential complications include growth arrest and limb length discrepancy; however, the risks are decreased with direct visualization during tunnel placement.

The detrimental consequences of unaddressed meniscal root tears have been well established.[19-22] However, until recently, the incidence of meniscal tears occurring at or near the root attachment in pediatric populations have not been well described. Wilson et al.[7] reported an 18.5% incidence of posterior meniscal root tears in a cohort of 314 children and adolescents presenting for surgery of symptomatic meniscal tears. Interestingly, $\leq$89% of pediatric patients with medial meniscal root tears displayed a LaPrade classification type 5 injury pattern, which is a bony avulsion of the meniscus root.[7] Therefore, knowledge in performing an anatomic, transtibial pullout technique is critical for orthopaedic surgeons who commonly treat pediatric or adolescent patients.[13,23-25]

## Conclusion

This technical note describes an approach for anatomic restoration of medial meniscal posterior root tears in patients with open physes. The use of intraoperative fluoroscopy aids in the avoidance of the growth plate during transtibial repair. Further clinical studies are needed to assess clinical outcomes of transtibial pullout repair for meniscal root tears in skeletally immature patients.

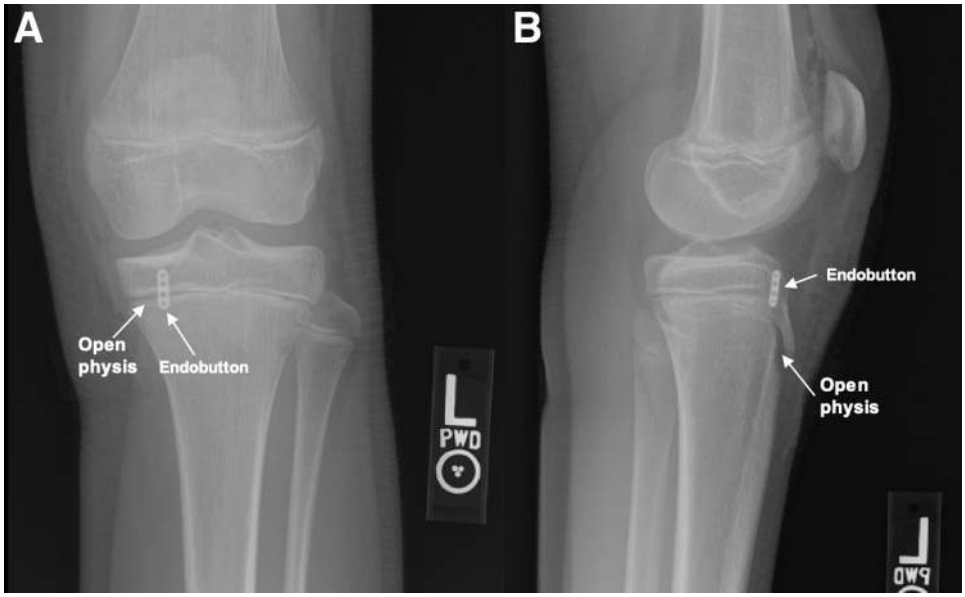


**Fig 8.** Anteroposterior (A) and lateral (B) intraoperative fluoroscopic views of the medial meniscus root repair confirming EndoButton (Smith & Nephew) fixation on the anteromedial aspect of the tibia and ensuring the hardware is not directly violating the tibial physis.

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