Technical Note

Posterior Meniscal Root Repair With Transtibial Double Tunnel Pullout Technique and Anchor Fixation

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Abstract: Meniscus root tears are tears that occur within 1 cm of the meniscus root attachment to the tibia. If not repaired, root tears will lead to altered knee biomechanics and accelerated degenerative changes in the knee. In this surgical technique, we demonstrate repair of a meniscus root tear with an all-inside suture repair of the posterior meniscus that is then passed through 2 transtibial tunnels and then fixed with an anchor. After surgery, patients are non-weightbearing for 4 weeks and can return to activity by 6 months.

Meniscus root tears are defined as any meniscus tear that occur within 1 cm of the root attachment to the tibia.[1] Such tears have been encountered or diagnosed in 4.3% of all arthroscopic surgeries, and medial meniscus root tears account for 52% of all meniscal root tears.[2] The absence of the normal meniscus signal at the root attachment on sagittal views of T2-weighted magnetic resonance imaging (MRI) is pathognomonic for a root tear; this is commonly known as a ghost sign (Fig 1).[1] If left unrepaired, meniscus root tear tears increase the peak tibiofemoral pressure and contact area, leading to altered biomechanics and accelerated degenerative changes in the knee joint.[2,3] The objective of this article is to describe an arthroscopic technique for medial meniscus root tear repair using an all-inside meniscal repair device and 2 transtibial tunnel technique with tibial fixation with an anchor.

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Patient Evaluation

When evaluating the patients in the clinic, it is imperative to obtain a detailed history, perform a thorough physical examination, and carefully check all imaging. Common historical factors for meniscal root tears include having an injury and feeling a "pop," having pain with activity, and having a reactive effusion. History of prior knee injuries and symptoms before the injury should be clarified. Most commonly, patients will present in their 50s or 60s. On physical examination, patients may have an effusion. Other positive physical examination findings include joint line tenderness and positive meniscal provocative maneuvers, including McMurray's, and pain with hyperflexion and hyperextension.

Standard radiographs should be obtained. Our standard knee radiographs include weightbearing anteroposterior, weightbearing posteroanterior with 45° of knee flexion (Rosenberg), lateral, sunrise, and hip-knee-ankle alignment radiographs. Radiographs should be scrutinized to rule out chondrocalcinosis and any significant arthrosis in the involved compartment greater than Kellgren-Lawrence grade II. MRI should be performed. Again, the compartment should be evaluated for significant arthrosis. Meniscal root tears are identified on MRI as the absence of the normal meniscus signal at the root attachment on sagittal views of T2-weighted series.

Indications for Surgery

Surgical indications and contraindications for meniscal root repair are detailed in Table 1. We recommend

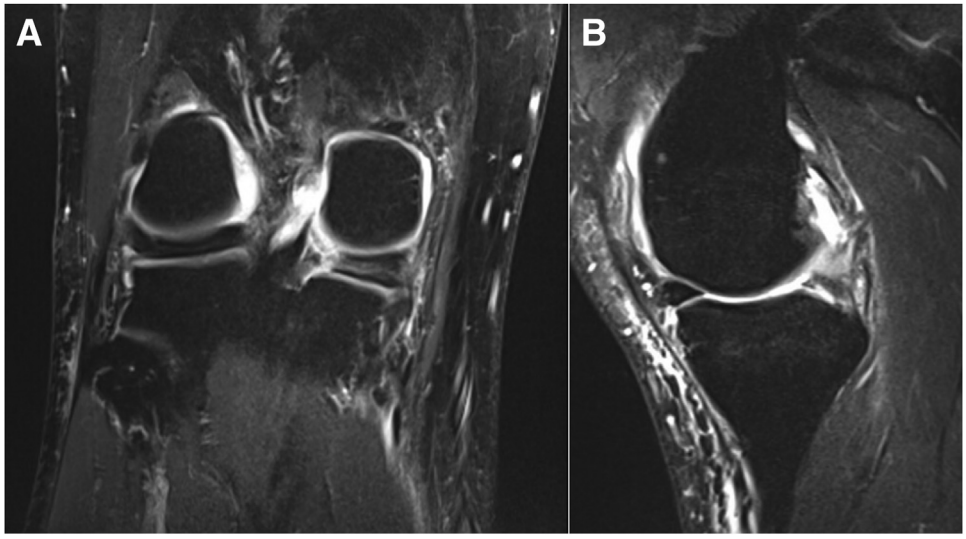

Fig 1. Preoperative T2-weighted magnetic resonance image of a right knee demonstrating a medial meniscal root tear in the coronal (A) and sagittal (B) planes. The sagittal image is representative of the "ghost sign."

attempting repair of meniscal root tears to restore the mechanical properties of the meniscus and prevent advancement in degenerative changes. However, patients who are poor surgical candidates or have advanced osteoarthritis (Kellgren-Lawrence grade III or IV) of the compartment should be excluded.

Surgical Technique

Patient Positioning and Diagnostic Arthroscopy

The equipment required to perform a posterior meniscal root repair as described in our surgical technique is listed in Table 2. The key steps of the technique are summarized in Table 3. The patient is placed on the operating room table in the supine position. All bony prominences are well padded. A tourniquet is placed on the thigh, as well as a lateral post to aid in maintaining the knee in the upright position. The lower extremity is then prepped and draped in the usual sterile fashion. Twenty milliliters of 0.5% lidocaine with epinephrine is injected into the portal sites, and the remainder is injected into the knee joint. Standard portals are placed, and standard diagnostic arthroscopy is then performed. All other procedures are performed before root repair if indicated.

Table 1. Indications and Contraindications for Meniscal Posterior Root Repair With Two Transtibial Tunnels

Indications
Acute meniscal root injury, confirmed on magnetic resonance imaging
Limited osteoarthritis of the involved compartment (Kellgren-Lawrence grade I or II)
Contraindications
Poor surgical candidates
Patients unable to comply with postoperative weightbearing restrictions
Severe osteoarthritis of the involved compartment (Kellgren-Lawrence grade III or IV)
Chronic meniscal root tears

Meniscus Preparation

It is important to approach the meniscus as directly as possible. To best achieve this, portal placement is critical to ensure that the suture-passing device can deploy correctly. We recommend viewing the root tear posteriorly using the Gillquist maneuver. Once the posterior meniscal root tear has been confirmed, we then proceed to performing root repair.

To improve visualization and access to the medial meniscus root, a Smith & Nephew (Memphis, TN) Werewolf, a coblation device, and a Smith & Nephew Dyonics shaver are used to take down a portion of the tibial spine (Video 1). If visualization remains an issue, a reverse notchplasty can be performed. When addressing a medial meniscal root tear, in a tight medial compartment, percutaneous trephination of the medial collateral ligament can be beneficial to allow appropriate access for the meniscal repair. As described by Moran et al.,[4] an 18-gauge spinal needle is used to perform an outside-in technique approximately 1 cm above the joint line in line with the medial collateral ligament and medial epicondyle insertion point. Typically, 3 to 6 percutaneous trephinations are required to adequately open the medial compartment. When addressing a lateral meniscal root tear, the lateral compartment is accessed using a figure-four position, which adequately opens up the compartment.

A curette is then used to make a small trough in the insertion of the root to prepare a bleeding bony bed. Meniscus preparation is key because the goal is to provide as much biologic assistance as needed for the repair process. A rasp is used at the meniscal-capsular

Table 2. Equipment Required for Meniscal Posterior Root Repair With Two Transtibial Tunnels

General
Standard arthroscopy equipment
Smith & Nephew Dyonics Shaver
Smith & Nephew Werewolf
Drill system
Posterior Root Repair
Smith & Nephew Meniscal Root System
Smith & Nephew Novostitch Pro
Smith & Nephew 2.4 mm drill pin
Smith & Nephew monofilament black wire
Smith & Nephew 5.0 mm MultiFix knotless anchor
Smith & Nephew 5.5 mm tap
0 Vicryl suture x 2
2-0 Vicryl suture
Platelet-rich plasma

junction to improve the biological response. A rasp or shaver can also be used for synovial abrasion, which assists in the meniscal healing response. Another important consideration to evaluate is whether there is evidence of meniscal extrusion, which should be addressed with a centralization suture.[5]

An accessory medial portal is then made to aid in suture management approximately 1 cm medial to the standard anteromedial portal under direct visualization using an outside-in technique with a spinal needle. To pass sutures through the meniscus, we use a Smith & Nephew Novostitch Pro, an all-inside meniscal repair device that creates a unique locking suture. To facilitate use of the Novostitch Pro, we recommend enlarging the working portal for ease of passing the device and suture management. Our technique in using the Novostitch pro for meniscal root repairs, the upper jaw is held in the down position to allow easier access to the posterior meniscus. The upper jaw is designed to flex down during entrance into the knee joint. Once the upper jaw has been opened, the curvature of the jaw allows for easier access to the upper surface of the meniscus, minimizing iatrogenic injury to the femoral condyle cartilage. On reaching the meniscus, the bottom jaw is deployed to allow appropriate grasping of the meniscal tissue at the depth determined by the surgeon. A 0 Vicryl suture is placed within 7 mm from the root attachment. Once the suture is deployed, it is grasped in the upper jaw. The lower jaw is then retracted, and the upper jaw is held in the down position as the device is removed from the knee joint. A second 0 Vicryl stitch is placed in a similar fashion. A 2-0 or 0 Vicryl suture is placed in between the 2 previously placed locking sutures, which acts as a traction suture (Fig 2). Using a grasper, the sutures are then passed out through the accessory medial portal. One set of sutures is marked with ink to aid in identification for later suture passage.

Table 3. Key Steps of Meniscal Posterior Root Repair with Two Transtibial Tunnels

1. Ensure portal placement allows direct access to the meniscal root.
2. Obtain adequate visualization of the posterior root.
3. Debride the bed of the root until a bleeding bony bed is achieved.
4. Establish an accessory anteromedial portal to facilitate suture passage.
5. Using the Smith & Nephew Novostitch Pro, place sutures through the meniscus.
6. Make a 3 cm incision from Gerdy's tubercle toward the tibial tubercle, taken down the fascia, and elevate the anterolateral compartment subperiosteally.
7. Using the Smith & Nephew Meniscal Root system, drill 2.4 mm tunnels approximately 5 mm apart in the footprint.
8. Remove the drill bit and place a Smith & Nephew monofilament black wire retrograde up the tibial tunnel.
9. Pass sutures through the monofilament and pull out tibial tunnel. Repeat with second suture.
10. Tie sutures over the bony bridge.
11. Place Smith & Nephew MultiFix knotless anchor to back up fixation, approximately 1 cm distal to the bony bridge.

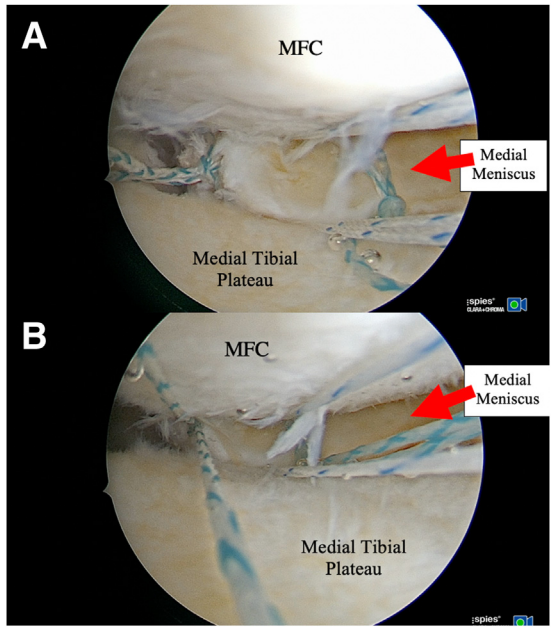

Fig 2. Arthroscopic images of a right knee viewing the medial compartment from the anteromedial portal of the final suture configuration within the meniscal root before being passed through an accessory anteromedial portal (A) and afterward (B).

Meniscus Repair Technique

In our technique, we approach from the lateral side for easier passage. A 3 cm incision is made over Gerdy's tubercle aiming toward the tibial tubercle and taken down to the fascia (Fig 3). The anterolateral compartment is elevated subperiosteally with a key elevator. Using the Smith & Nephew Meniscal Root System with the guide set at 55° and a multi-holed drill, 2 parallel

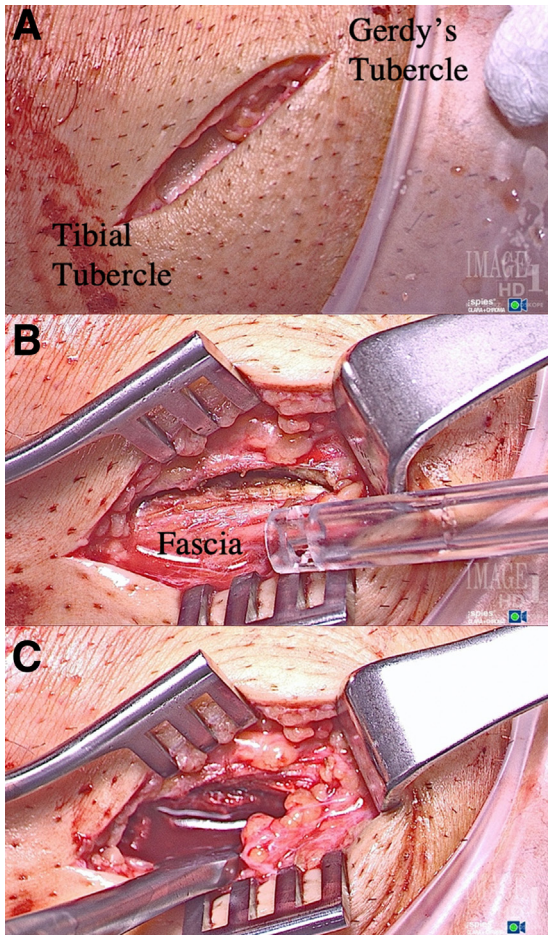

Fig 3. Photographic images of the tibial incision extending Gerdy's tubercle to the tibial tubercle, measuring approximately 3 cm in length (A), after incising the anterolateral compartment fascia (B), and after elevating the anterolateral compartment musculature (C).

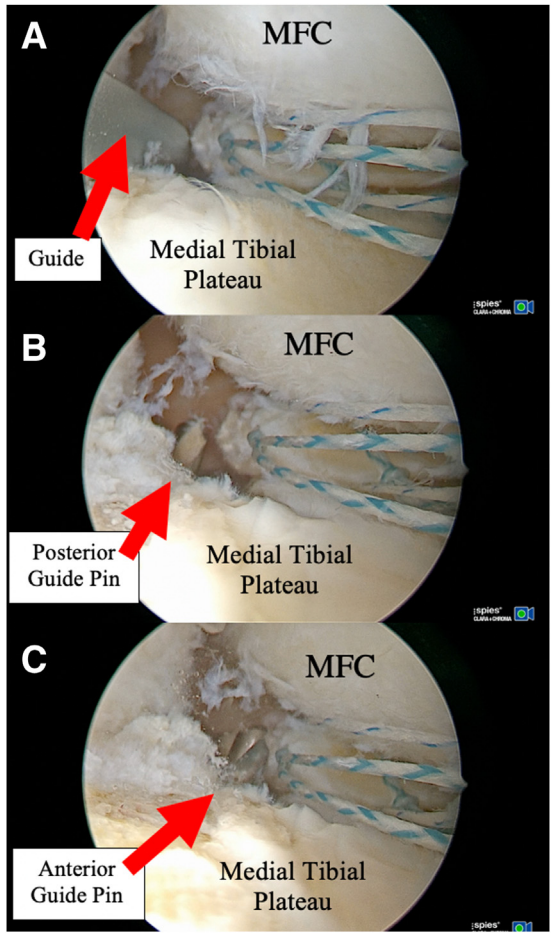

Fig 4. Arthroscopic images of a right knee viewing the medial compartment from the anteromedial portal of the placement of the Smith & Nephew Meniscal Root System with the guide set at 55° at the medial meniscus root repair site (A), the placement of the posterior guide pin within the medial meniscal root insertion (B), and the anterior guide pin within the medial meniscal root insertion (C).

2.4 mm drill pins are placed within the meniscal root attachment site where the trough was previously made, typically 5 to 6 mm apart (Fig 4). The Smith & Nephew Meniscal Root System also include a cannulated set for drilling if preferred. Once the surgeon is pleased with the placement of the guide pins, one guide pin is removed, and a Smith & Nephew monofilament suture passer is passed retrograde up the tunnel through the tibial incision into the joint. The more central 0 suture is passed with the 2-0 Vicryl through the posterior guide pin tunnel, and the more peripheral suture is passed through the anterior pin tunnel. Once all sutures have been passed through the tibial tunnels, the reduction can be assessed (Fig 5). With traction on the 2-0 Vicryl traction suture, the 0 Vicryl locking sutures are tied over the bony bridge at approximately 20° to 30° of knee flexion (Fig 6). With the knee in full extension, a Smith & Nephew MultiFix anchor, a knotless, all-peek implant, is placed about 1 cm distally from the exit point of the sutures from the tibia, fixing everything down to bone to achieve excellent tension of the meniscal root repair back to its bony bed. Other forms of fixation exist, including cortical fixation devices, but this is our preferred technique.[6]

Biologic Augmentation

A notchplasty is then performed to increased bleeding and healing response. The knee joint is copiously irrigated. Once all of the fluid has been drained from the knee, platelet-rich plasma is injected at the site of the root repair because recent studies have demonstrated increased healing with platelet-rich plasma.[7,8] The portal sites incisions are closed with 3-0 nylon, and the tibial incision is closed with 2-0 Vicryl deep subcutaneous and a running subcuticular 3-0 Monocryl stitch. Sterile dressing, an ace bandage, a cooling unit, and a hinged knee brace locked in extension are applied.

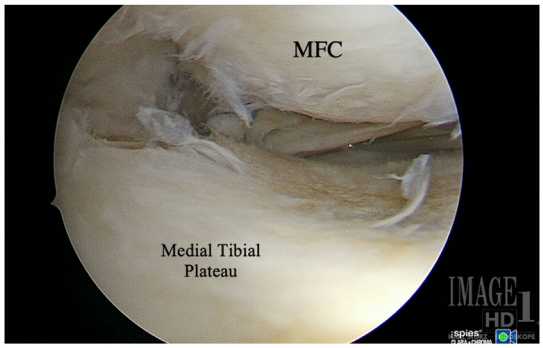

Fig 5. Arthroscopic images of a right knee viewing the medial compartment and the medial meniscus from the anteromedial portal of the final repaired and reduced meniscal root tear.

Postoperative Management and Rehabilitation

Patients follow a standardized postoperative and rehabilitation protocol. The patient is non-weightbearing for a total of 4 weeks to allow the repair site to heal. The brace is locked in extension for 2 weeks and then removed for range of motion exercises. After the incisions heal, the patient goes into a medial unloader brace and starts weightbearing at 4 weeks after surgery.

Rehabilitation continues in progressive phases to ensure adequate joint protection. About 4 weeks after the initial weightbearing phase, axial loading with squats and lunges can be performed with up to 70° of knee flexion. After an additional 4 weeks, knee flexion can be increased to 90°. Finally, agility training can be initiated once the patient can tolerate 4 weeks of axial loading with 90° of knee flexion.[2]

Discussion

Outcomes of meniscal root tear repairs are generally favorable due to decreased rates of progressive osteoarthritis (OA) and conversion to arthroplasty.[3] Bernard et al. have demonstrated that meniscal root repair significantly decreases osteoarthritis progression and lower rates of arthroplasty when compared to nonoperative management or partial meniscectomy.[9] A recent systematic review by Eseonu et al.[10] corroborates these results. Chang et al.[11] have demonstrated that meniscal root repairs provide a functional benefit and improve clinical outcome scores. Although such repairs slow the progression of OA, they do not eliminate the progression of OA entirely, and patients with a body mass index (BMI) of greater than 35 kg/m^2 are more likely to require repeat surgery and develop clinical OA at the time of their final follow-up.[2,3] Furthermore, the reduction of meniscus extrusion during surgery is associated with complete structural healing of root tears; conversely, high-degree meniscal extrusion is associated with incomplete healing and early progression of cartilage degeneration around 2 years after surgery.[3] Therefore favorable long-term outcomes of root tear repairs can be maximized with proper restoration of native joint biomechanics during surgery, as well as patient counseling regarding body mass index and OA progression.

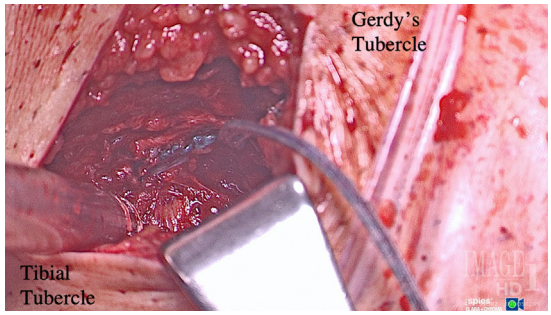

Fig 6. Images of the final repair from the tibial incision with the suture tied over the bony bridge and after fixation with a Smith & Nephew MultiFix anchor.

Table 4. Pearls and Pitfalls of Meniscal Posterior Root Repair with Two Transtibial Tunnels

Pearls
Having adequate access to the meniscal root is crucial. Access and visualization can be improved by appropriate portal placement, using a coblation device or shaver to take down a portion of the tibial spine, or percutaneous trephination of the medial collateral ligament.
Establish an accessory anteromedial or anterolateral portal for suture management.
Mark 1 set of sutures with ink for easy identification of sutures for improved suture management.
Pitfalls
Have a thorough preoperative discussion with patients regarding the postoperative weightbearing restrictions.
Ensure adequate debridement of anatomic root position until bony bleeding bed for the repair and that the location for planned tunnels is appropriate
Have the suture passer immediately available while removing the guide pin to more easily find the same tunnel.

Table 5. Risks and Limitations of Meniscal Root Repair with Two Transtibial Tunnels

Risks
Repair failure or repair not healing, potentially leading to meniscal extrusion and progression of knee osteoarthritis
Risk of infection and skin paresthesias with incision over proximal tibia
Deep vein thrombosis: we recommend starting the patient on prophylaxis for the duration of the non-weightbearing period after surgery.
Limitations
Two tibial tunnels slightly increase the risk for fracture compared to single tunnel technique
Non-weightbearing for 4 weeks after surgery
Patients must limit activities for 6 months after surgery during recovery and rehabilitation, and we recommend use of an offloader brace after repair once returning to activities.

Dzidzishvili et al.[12] demonstrated no significant difference between all-inside repair versus transtibial pullout techniques when performing meniscal tear repair. However, we feel that the transtibial pullout technique provides for additional fixation and stabilization for the repair and restores contact mechanics.[13] There are also variations that can be performed in the type of suture passage through the meniscus, but there are not significantly reported differences in outcomes.[14]

This described surgical technique to repair meniscal root tears restores anatomy and native biomechanics of the meniscus. Pearls and pitfalls of our technique can be found in Table 4. Advantages of this technique includes improved restoration of contact pressures and provides a more anatomic repair of the root. Limitations of meniscal repair and of this technique includes a period of non-weightbearing while the repair heals, creating 2 tunnels, and limiting activities 6 months after surgery (Table 5). It is important to have a thorough discussion with the patient before surgery about the postoperative restrictions, particular the weightbearing restrictions.

In this Technical Note, we describe our technique for meniscal root repair. We believe that our repair technique provides an anatomic repair, and, anecdotally, we have seen good outcomes with our patients treated using this technique.

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