Technical Note

Arthroscopic Centralization of the Extruded Meniscus With Posterior Root Tear: A Technique Using Meniscotibial Ligament Fixation

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Abstract: Meniscal root tears have been shown to significantly impact tibiofemoral mechanics and contribute to accelerated development of osteoarthritis. A common finding in conjunction with a meniscal root tear is extrusion of the meniscus. Meniscal extrusion is an independent risk factor for tibiofemoral cartilage loss and the progression of osteoarthritis. Meniscus centralization was first introduced to directly address extrusion alongside root repair techniques. To date, reported techniques for meniscus centralization generally involve anchoring the meniscus directly to the tibia in some fashion, which can limit the normal anatomic motion of the meniscus. We present a technique for meniscus centralization that aims to maintain natural meniscal motion by utilizing the meniscotibial ligaments.

Meniscus centralization has been developed as a technique to curb the progression of knee osteoarthritis as a result of a functionally deficient, extruded meniscus. Meniscus extrusion is characterized by displacement beyond the border of the tibial plateau on magnetic resonance imaging, with more than 3 mm being considered pathologic.[1] Extrusion frequently occurs with degeneration or disruption of meniscal continuity. Most commonly, this is associated with complete radial tears, posterior root tears, or degenerative changes as a result of an arthritic process. In the absence of such pathology, disruption of the meniscotibial (MT) ligaments can also lead to an extruded meniscus.[1,2]

Interestingly, repair of the meniscus to restore continuity (e.g., root repair) does not reliably eliminate extrusion.[3] To combat this, open and arthroscopic techniques have been developed to restore meniscus anatomy, location, and biomechanics.[4,5] Arthroscopic management is sought after for its minimally invasive approach and has been shown to have satisfactory outcomes for meniscus centralization in the setting of posterior root tears when paired with root repair.[6] However, there is a theoretical concern that previous centralization techniques can lead to constraint of the natural meniscus motion as they directly secure the meniscus to the tibia. The purpose of this Technical Note is to describe an arthroscopic technique for meniscus centralization designed to preserve natural meniscal motion by advancing and securing the meniscus indirectly via the meniscotibial ligaments (Video 1).

Surgical Technique

The patient is positioned supine on the operating table. A standard examination under anesthesia provides an understanding of the range of motion and ligamentous stability. The knee is then prepped and draped in the usual sterile manner. A standard 3-portal (anteromedial, AM; anterolateral, AL; and superomedial outflow) diagnostic arthroscopy is performed to evaluate for cartilage lesions, loose bodies, and integrity of the cruciate ligaments and menisci.

To address a medial meniscus posterior root tear with extrusion, an accessory AM portal is made 2 cm medial to the standard AM portal, anterior in location to the medial collateral ligament (MCL) (Fig 1). The

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Received July 11, 2024; accepted August 29, 2024.

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2212-6287/241128
https://doi.org/10.1016/j.eats.2024.103274

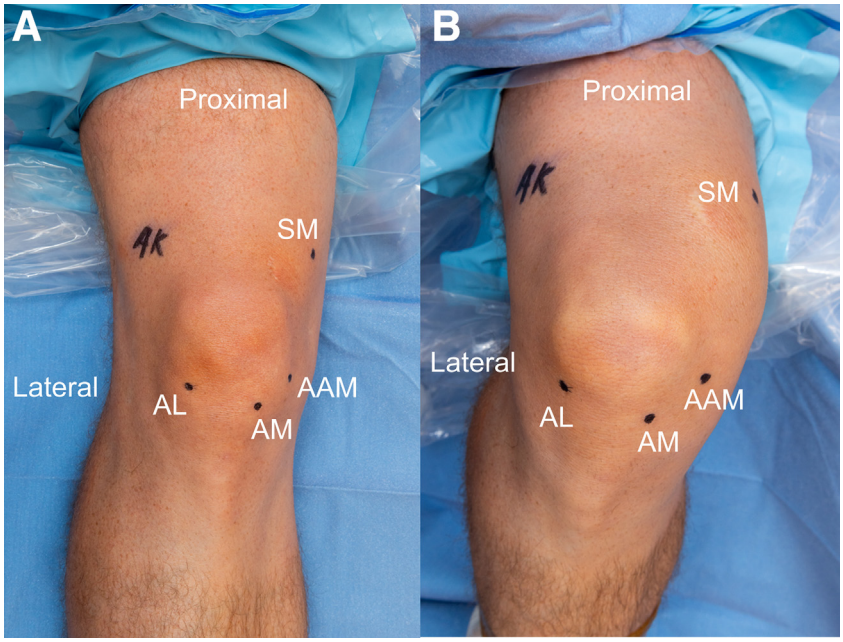

Fig 1. View of the recommended portals marked on a right knee in extension (A) and flexion (B). Labeled portals include anterolateral (AL), anteromedial (AM), accessory anteromedial (AAM), and superomedial (SM) outflow.

medial compartment is entered with the knee under valgus load to maximize compartment working space. Percutaneous MCL lengthening can be performed at the proximal origin of the MCL using an 18-gauge spinal needle to perforate the ligament. This can aid in further maximizing working space and minimizing the risk of iatrogenic cartilage damage. A curved Bankart elevator can be introduced via the AM or accessory AM portal to elevate the MT ligaments off the tibia to enhance meniscus excursion for centralization (Fig 2). Mobility of the meniscus can be checked with an arthroscopic grasper to ensure the root can also be restored to an anatomic point of fixation.

While viewing from the AM portal, a knotless FiberTak curved drill guide (Arthrex) is inserted into the accessory AM portal (Fig 3). A pilot hole is drilled and a 1.8-mm knotless FiberTak all-suture, suture anchor (Arthrex) is inserted and deployed into the peripheral tibial plateau. Typically, the authors recommend a final construct with 2 points of fixation with anchors inserted in the tibial plateau periphery near the midportion of the MCL and just posterior to the MCL. The shuttling sutures of the knotless mechanism from the anchor can then be retrieved and parked in the AL portal. Subsequently, a 1.5-mm FiberStitch (Arthrex) all-inside meniscus repair device is introduced via the AL portal and aimed toward the repair stitch of the previously placed tibial suture anchor. A horizontal mattress is placed inferior/distal to the undersurface of the meniscus on either side of the repair stitch (Fig 4). The capsule/MT ligament is pierced, and the suture device is deployed, which, in effect, tethers and staples the repair stitch to the MT ligament. This creates a point of fixation that can centralize the meniscus after the repair stitch is loaded into the tibial anchor. For added fixation in larger knees, a second tibial suture anchor paired with another all-inside repair stitch can be used by repeating the steps. Final tensioning should be done at the conclusion of the case.

Attention is then turned to the posterior root tear. Initially, an intrameniscal vertical mattress ripstop is placed at the margin of the meniscus root tear. This can be done with a self-retrieving suture passing device (Knee Scorpion; Arthrex). The knot can be tied using the posterior limb as the post to keep the knot as peripheral as possible on the meniscus surface. Afterward, a transtibial technique is performed using an anatomic root guide (Arthrex) to drill a cannulated drill pin into the anatomic site of fixation. A suture-retrieving nitinol wire loop is inserted (Fig 5) and retrieved out of the AM portal to load up the authors' preferred implant for root repair (SutureLoc; Arthrex). The implant is fed into the drilled tunnel and, once dunked into the subchondral bone, is deployed by pulling on the sutures. The first of 2 repair stitches built into the implant are then passed using a self-retrieving suture passing device (Knee Scorpion; Arthrex) on the opposite side of the ripstop (Fig 6). The repair stitch is then fed into the shuttling knotless mechanism of the implant. This is

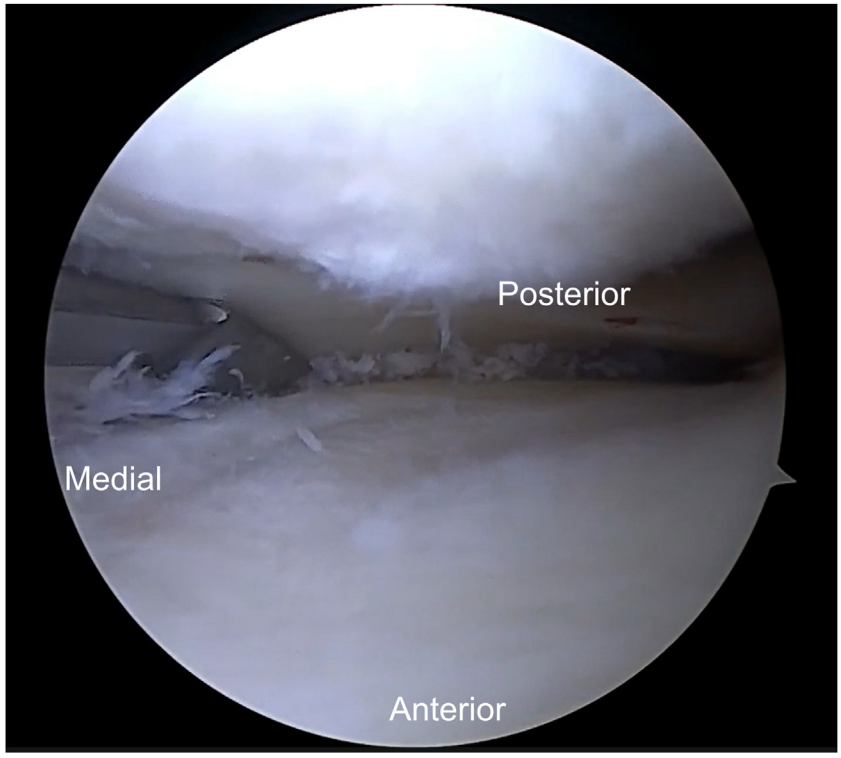

Fig 2. Following standard diagnostic arthroscopic evaluation of a torn meniscus posterior root leading to meniscus extrusion, the bone and capsule are treated with a synovial rasp to optimize fixation and a Bankart elevator is used to elevate the meniscotibial ligament to promote excursion.

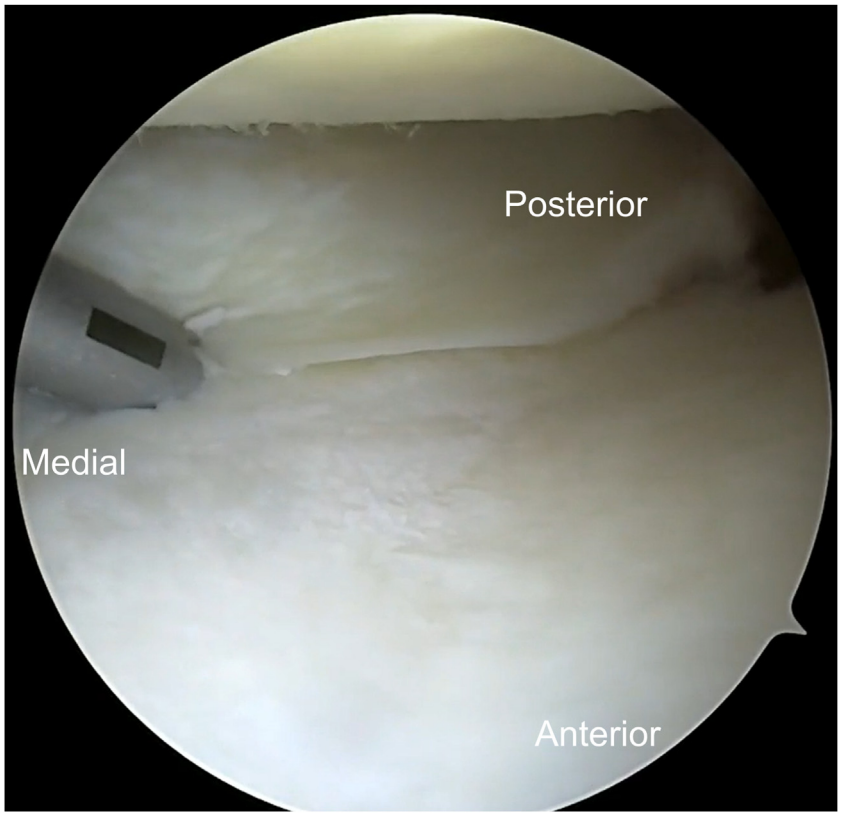

Fig 3. A curved drill guide is introduced via the accessory anteromedial portal. The pilot hole is drilled, and the all-suture suture anchor is inserted and deployed afterward using the drill guide.

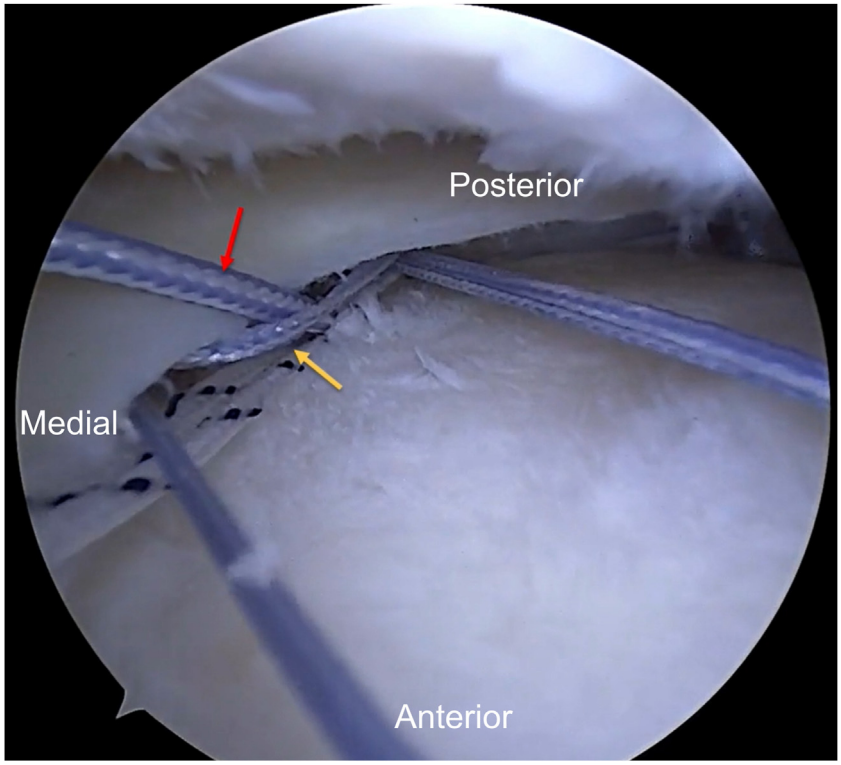

Fig 4. After the shuttling sutures (black and white striped suture) are parked out the anterolateral portal, a horizontal mattress (yellow arrow) is placed on either side of tibial anchor repair stitch (red arrow) on the undersurface of the meniscus through the capsule and meniscotibial ligament to create a point of fixation without piercing the meniscus or meniscocapsular junction.

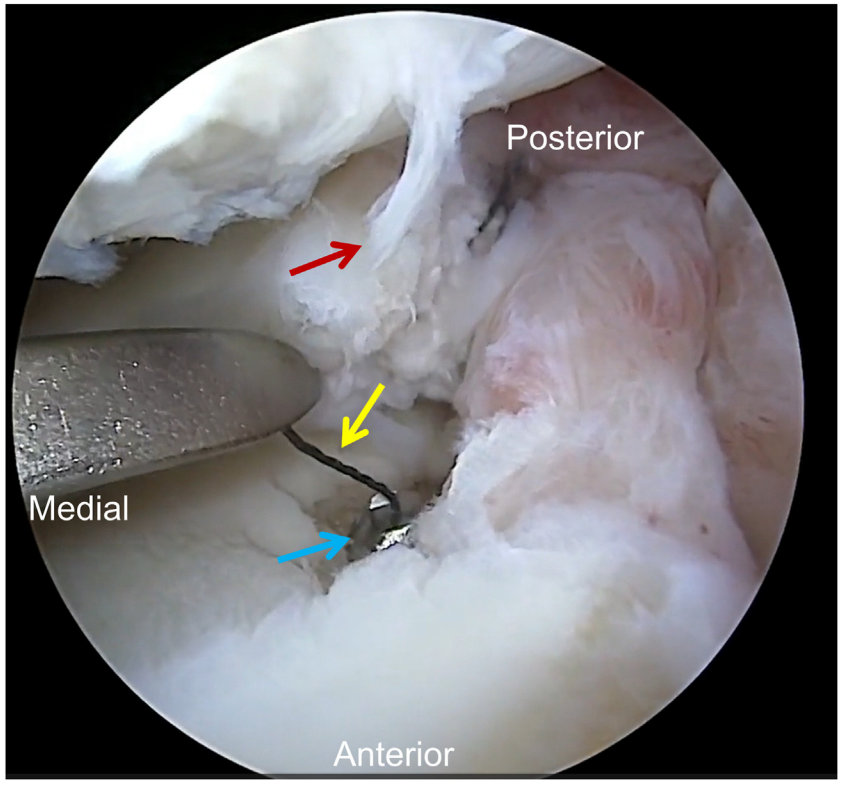

Fig 5. To repair the torn posterior meniscal root (red arrow), a transtibial tunnel is drilled using a cannulated drill pin (blue arrow). A looped wire (yellow arrow) used for suture retrieval/shuttling is passed through the cannulation and retrieved using a suture grasper out of the anteromedial portal.

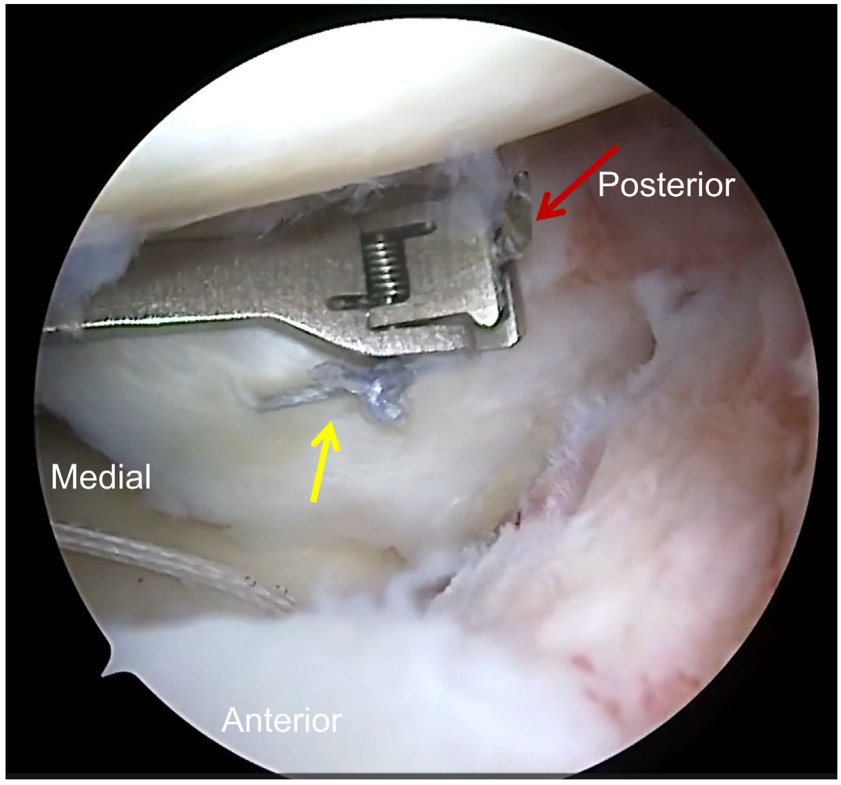

Fig 6. The first of 2 repair stitches built into the implant are then passed using a self-retrieving suture-passing device (red arrow) on the opposite side of a previously placed intrameniscal vertical mattress suture, which functions as a ripstop (yellow arrow).

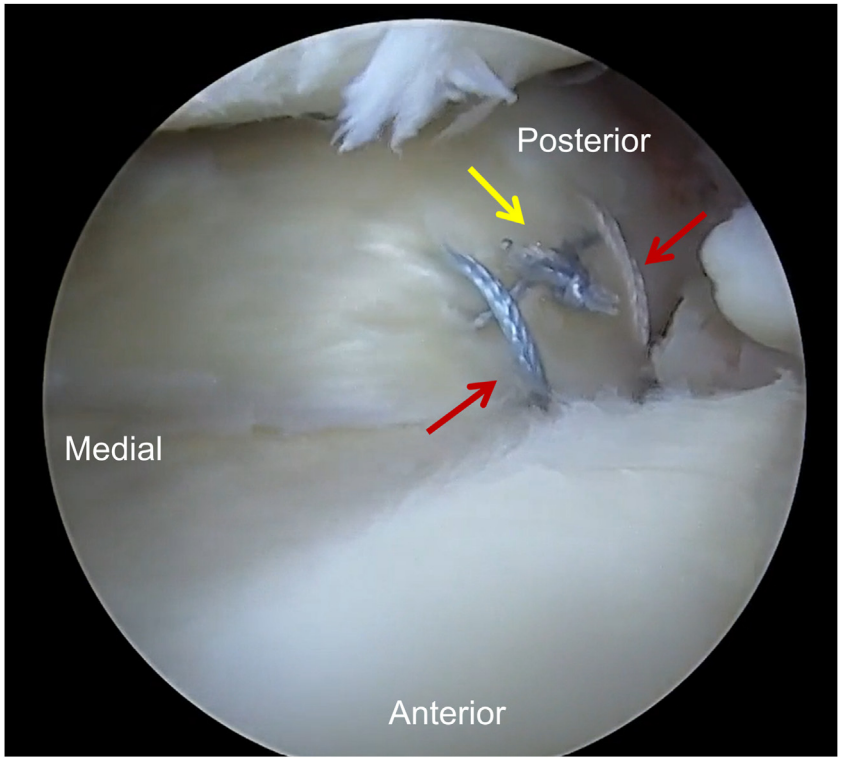

Fig 7. The root repair stitches (red arrows) can be seen placed on the opposite side of the ripstop stitch (yellow arrow) and maximally tensioned within the knotless root repair implant to complete the root repair.

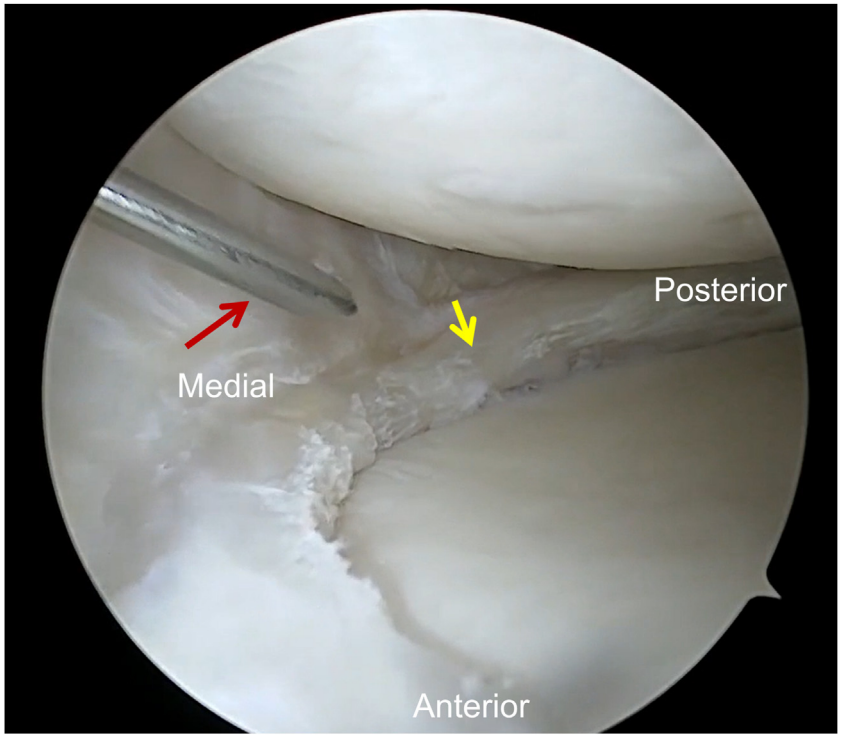

Fig 8. In the setting of a meniscus transplant, the remnant meniscus (yellow arrow) is resected to a 1- to 2-mm rim in preparation for meniscus allograft repair. A spinal needle (red arrow) is utilized to localize an accessory anteromedial portal to introduce the drill guide for anchor placement.

repeated with the second repair stitch. The repair is maximally tensioned (Fig 7) and can be retensioned after range of motion. Once the posterior root is repaired, the centralization knotless construct can be maximally tensioned as well. The suture limbs are cut, and the portals are closed in the standard fashion.

Meniscus Centralization—Other Applications

The aforementioned steps can be repeated to address a lateral meniscus posterior root tear with extrusion. Conversely, an accessory AL portal is made 2 cm lateral to the AL portal and anterior to the lateral collateral ligament. The knee should be placed in maximal varus using a figure-4 position to access the lateral compartment, instrument the tibial suture anchor(s), stitch the anchor repair suture(s) to the MT ligament using an all-inside suture device(s), and fix the posterior root. Care must be taken to avoid iatrogenic injury to the common peroneal nerve near the popliteus tendon.

In the setting of a meniscus allograft transplant, the previously mentioned centralization technique can also be implemented to centralize a medial or lateral transplantation (Video 1). The remnant native meniscus should initially be resected to a stable 1- to 2-mm rim in preparation for the graft (Fig 8). Then the sutures for the centralization procedure can be passed prior to root fixation (Fig 9). Once the anterior and the posterior root is fixed, the surgeon can then maximally tension the centralization construct. Following the centralization, the surgeon can then complete the repair of the graft to the meniscocapsular junction using any preferred technique (all-inside, inside-out, etc.).

Postoperative Protocol

The patient is made touch weightbearing with the knee locked in extension using a brace and crutches. Range-of-motion exercises are limited to 90° of flexion for the first 6 weeks. The patient progresses to weightbearing as tolerated in the knee brace from weeks 4 to 6. The knee brace is discontinued at week 6. At that time, lower extremity strengthening and light aerobic activity (stationary bike, gait training) are allowed. The patient may gradually increase loading capacity from weeks 6 to 12. At week 12, nonimpact aerobics (biking, elliptical, stair-stepper) may begin. Return to jogging program is started at week 14, with agility training beginning at week 16. Return to sport is typical at 6 to 9 months postoperatively.

Discussion

Previously described meniscus centralization techniques have been implemented to mitigate residual meniscal extrusion that can remain even following posterior root repair.[3-5] However, direct suture

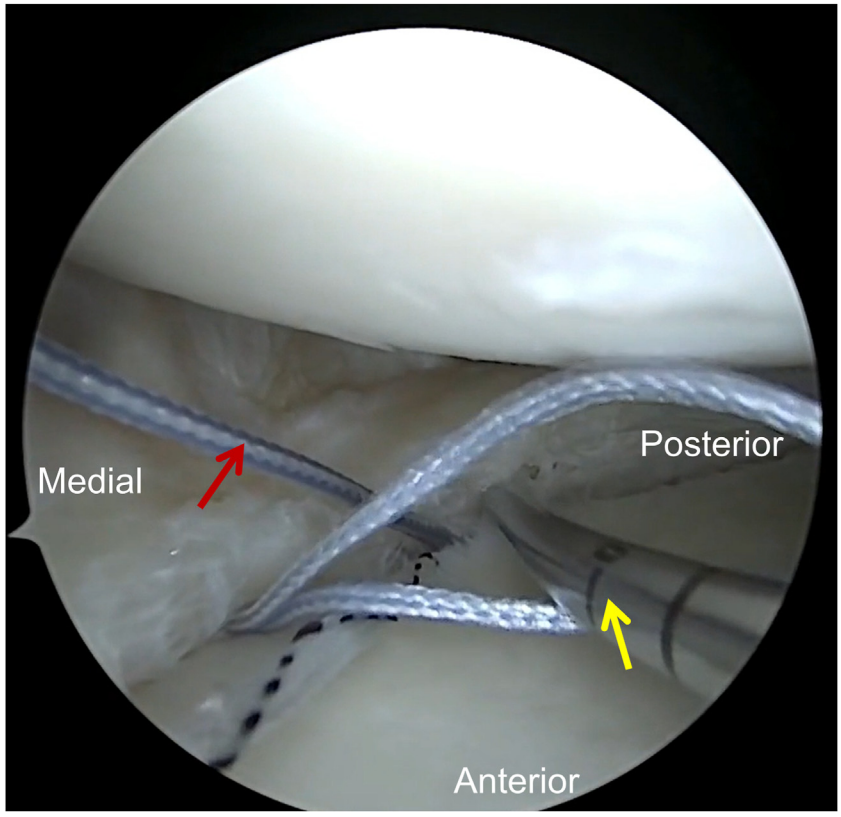

Fig 9. For a meniscus transplant application, a horizontal mattress is first placed on either side of the repair stitch (red arrow) from the tibial suture anchor using an all-inside meniscal repair device (yellow arrow), effectively stapling it to the meniscotibial ligament. This is best done prior to passing the graft into the knee to have unobstructed access to the fixation site.

placement on the meniscus or meniscocapsular junction can theoretically tether the meniscus to the tibia. This is likely better tolerated in the medial meniscus. However, the native lateral meniscus experiences more translation than its medial counterpart.[7] Traditional centralization techniques could alter the natural motion that likely maintains the homeostasis of contact pressures throughout range of motion. This Technical Note presents a technique designed to improve upon this.

Extrusion following meniscus allografts has been well studied recently and has been shown to negatively impact the chondroprotective effect following restoration of the meniscus.[8,9] Leite and colleagues,[8] in their review of medial meniscus allografts, reported an extrusion rate of 41.1%. Condron and colleagues[10] have shown that concomitant repair/centralization has shown improvement in postoperative extrusion of appropriately sized medial meniscus allografts. The technique used by the previously mentioned authors placed horizontal mattress sutures through the periphery of the remnant meniscus, whereas the currently presented technique aims to fix the MT ligament alone, without any sutures in the meniscus or meniscocapsular junction.

Meniscus centralization can be challenging, but careful observance of the technical considerations mentioned in this Technical Note can help maximize procedure efficiency (Table 1). Among many advantages, the proposed significance of the described technique is to centralize the meniscus indirectly with fixation of the MT ligament to the tibia, theoretically recreating the biomechanical relationship between the meniscus, MT ligament, and the tibia (Table 2). Further biomechanical and clinical studies are necessary to substantiate the outcomes of this technique.

Table 1. Advantages and Disadvantages of Using Meniscotibial Ligament Fixation for Meniscus Centralization

Advantages	Disadvantages
• Centralization helps reduce meniscal extrusion • Promotes more native meniscal motion by avoiding directly suturing the meniscus to the tibial anchor	• Associated implant costs • Increased operative time for meniscus centralization

Table 2. Pearls and Pitfalls to Consider When Performing MT Ligament Fixation for Meniscus Centralization

Pearls	Pitfalls
• Tourniquet use and fat pad debridement to assist with arthroscopic visualization • Improve access to the medial compartment with selective MCL lengthening ± medial tibial eminence partial resection • Making the AM portal with the leg in the figure-4 position can help create easy portal access for lateral posterior root repairs • A curved Bankart elevator can help elevate the MT ligament for better meniscus excursion/centralization	• Optimize visualization and access to avoid iatrogenic cartilage injury • Care should be taken with needles and sutures in proximity to the popliteal tendon (e.g., risk to common peroneal nerve) • Avoid injury to the MCL or LCL with accessory medial/lateral portal creation • Completing the posterior root repair prior to placing tibial anchor(s) and all-inside stitch(es) can limit access and view of the peripheral tibial plateau MT ligaments • Nonadherence to postoperative protocol can cause fixation failure
• Use of a synovial rasp to roughen the periphery of the tibial rim and synovium to optimize biology at the site of MT ligament fixation/meniscus centralization • Use of a cannula can aid in suture management in the portal on the ipsilateral compartment of the root tear • Provisionally tension the meniscus centralization knotless mechanism prior to root repair, with final tensioning after root repair is complete	

AM, anteromedial; LCL, lateral collateral ligament; MCL, medial collateral ligament; MT, meniscotibial.

Disclosures

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: A.J.K. is on the editorial or governing board for the *American Journal of Sports Medicine* and Springer, is a paid consultant for Arthrex, and is a board or committee member of the Arthroscopy Association of North America and International Cartilage Repair Society. M.H. is a paid consultant for DJO, Moximed, and Vericel; receives publishing royalties and financial or material support from Elsevier; and is on the editorial or governing board for *the Journal of Cartilage and Joint Preservation*. P.A.S. is a board or committee member of the American Orthopaedic Society for Sports Medicine and Arthroscopy Association of North America, is a paid consultant or paid presenter or speaker for Arthrex, receives research support from Arthrex, is on the editorial or governing board for Journal of Knee Surgery, and has stock or stock options with Spinal Simplicity. All other authors (F.M., L.K.) 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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