Technical Note

Knotless Re-tensionable Direct Fixation of Medial Meniscus Posterior Root Tears

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Abstract: Over the past decade, there has been an increased awareness of the recognition and treatment of medial meniscus posterior root tears. Recent systematic reviews and meta-analyses have shown that surgical repair of medial meniscus posterior root tears is effective in improving patient-reported outcome measures and decreasing the progression of osteoarthritis when compared with nonoperative treatment or meniscectomy. The available techniques currently consist of transosseous suture fixation and direct suture anchor fixation, with transosseous repairs being the most frequently performed. Transosseous fixation relies on indirect fixation on the anterior tibial cortex, which may predispose to gap formation at the repair site. On the other hand, suture anchor fixation is technically demanding with arthroscopic placement of the anchor perpendicular to the tibial plateau at the posterior medial root insertion. Furthermore, re-tensioning of the construct is not possible with the current techniques. In this technical note, we present a knotless re-tensionable direct fixation technique using an anterior tibial tunnel, which has the advantages of direct fixation, a rip-stop suture configuration, a reproducible surgical technique, and the possibility of re-tensioning of the repaired meniscal root.

Over the past decade, increasing awareness has been paid to meniscal preservation and more specifically posterior medial and lateral root tears.[1-3] Medial meniscus posterior root tears (MMPRTs) are more commonly recognized as detrimental injuries in the early degenerative stages,[4] and surgical repair has been shown biomechanically to restore physiological tibiofemoral contact pressures and result in favorable patient-reported outcomes.[1,2,5,6]

Two surgical concepts have been used for MMPRT repair, namely transosseous and suture anchor fixation.[6,7] With the transosseous technique, sutures are passed through the avulsed medial root, pulled through 1 or 2 tibial tunnels, and fixed using various methods, which is an indirect fixation.[2] With the suture anchor technique, a suture anchor is deployed in the posterior root origin at the tibia and sutures are used to tie the meniscus into the tibia. The advantage of the transosseous technique is the ease of an anterior tibial tunnel approach, but the disadvantage is the indirect fixation with gapping after cycling of the knee shown in biomechanical studies.[6-8] The suture anchor technique has been shown to be stronger than the transosseous technique because of the direct fixation, but the surgical approach is difficult with the posterior position of the root.[6,7] Moreover, both techniques lack the possibility to re-tension the repair construct after fixation, which can lead to gapping.[6-8] In this article, we present a surgical technique that combines the advantages of direct fixation under the tibia, a knotless rip-stop construct, and the possibility to re-tension after initial fixation (Video 1).

Surgical Technique

General Preparation

The patient is placed in the supine position, and the operative leg is prepared and draped in standard fashion for knee arthroscopy, either in a leg holder or on the table with post. Standard anterolateral and anteromedial portals are created. Percutaneous release of the posterior fibers of the medial collateral ligament and/or posterior oblique ligament is performed under valgus tension

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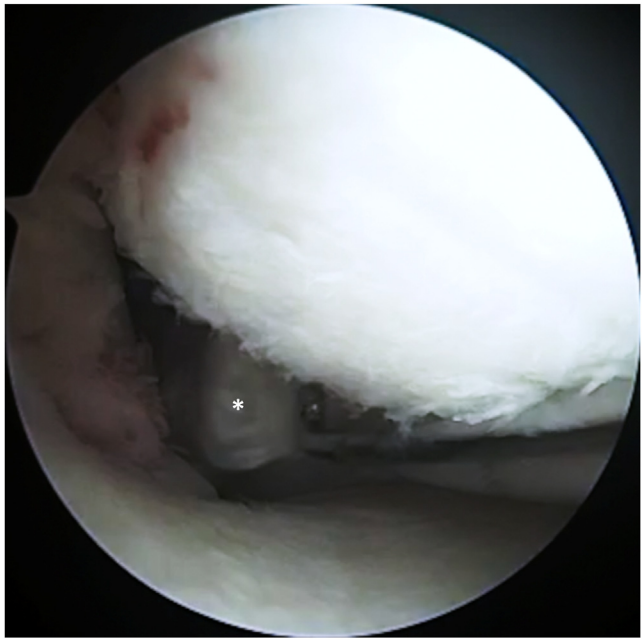

Fig 1. Arthroscopic view of right knee viewed from anterolateral portal with patient supine and knee in 90° of flexion. A probe is used to confirm the presence of a medial meniscus posterior root tear (asterisk) and mild chondromalacia, which makes this patient a candidate for medial meniscus posterior root repair.

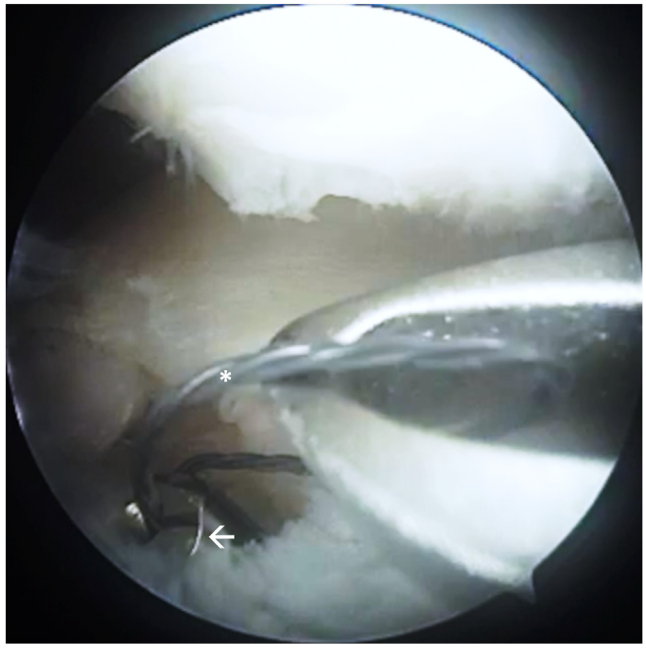

Fig 2. Arthroscopic view of right knee viewed from anterolateral portal with patient supine and knee in 90° of flexion. The 2.4-mm tibial tunnel is drilled into the insertion site of the medial meniscus, and the lasso wire (asterisk) is shuttled through the drill sleeve (arrow) and retrieved from the anteromedial portal.

using a spinal needle to open the medial compartment enough to perform posterior root repair without iatrogenic cartilage damage.[9] A standard diagnostic arthroscopy is performed including the confirmation of an MMPRT without significant osteoarthritis (OA) in the medial compartment (Fig 1). The anterolateral portal is used as the viewing portal during the entire procedure.

Repair-Site Preparation

The MMPRT is identified, and it is confirmed that the medial meniscus can be reduced to its anatomic position. The edge and inferior side of the avulsed meniscus are prepared with a shaver to ensure fresh tissue is present for healing, and the same is performed for the tibial insertion using a rasp, curette, and shaver. A tibial aimer with a Point-to-Point Marking Hook and Drill Sleeve with Insert (Arthrex, Naples, FL) is used to define the insertion of the posterior root on the tibia, and a 2.4-mm tibial tunnel with the drill sleeve and drill sleeve insert is drilled to the meniscal root insertion (Fig 2). The drill sleeve insert is removed, and a lasso wire is shuttled into the joint and retrieved with a suture grasper out through the anteromedial portal. The drill sleeve is now removed.

Knotless Direct Repair

The SutureLoc device (Arthrex) is passed through the loop of the lasso wire and shuttled through the tibial tunnel (Fig 3). The lasso wire is then removed. Resistance is felt as the sleeve is almost seated into the tibia, and only a small pull should be made to pull the all-suture construct into the tibia. Care should be taken to seat the looped portion of the device just beneath the subchondral cortical bone, rather than deep within the tunnel. Once the anchor is below the tibial plateau, the anchor is set by pulling the black-blue suture loop, and a hemostat is placed around the anchor sheet to prevent loosening of the construct or inadvertent unloading of the passing sutures (Fig 4). A Passport cannula (Arthrex) can be used for suture management at this point.

The solid blue suture is now retrieved using a suture grasper, and a Knee Scorpion suture passer (Arthrex) is used to pass the first solid blue suture through the meniscus without significantly tensioning the suture (Fig 5). Our preferred technique is to use a horizontal mattress technique for the initial suture to spread the surface area for tension of the meniscus and allow for a rip-stop configuration. A FiberLink device (Arthrex) is used to shuttle the suture from superior to inferior to achieve the horizontal mattress configuration. Alternatively, the Knee Scorpion device can be used upside-down to pass the suture from superior to inferior, but interference with the tibial surface can make this passage method more cumbersome. The solid blue suture is channeled out of the Passport cannula and is shuttled

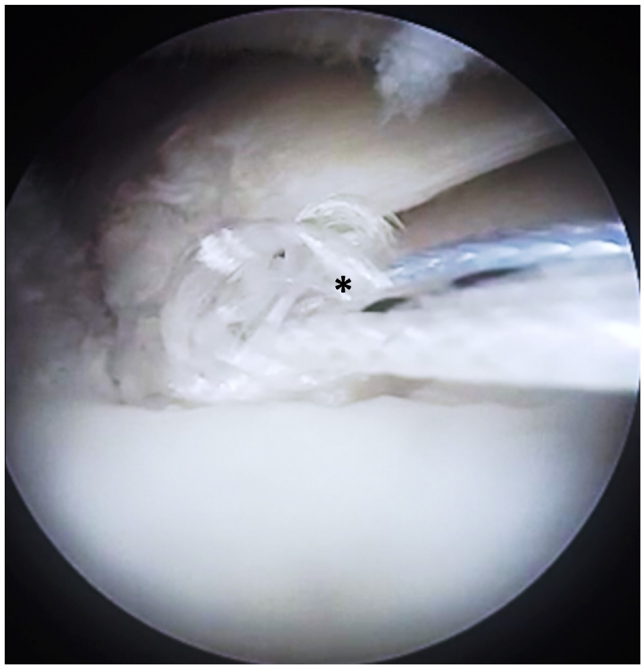

Fig 3. Arthroscopic view of right knee viewed from anterolateral portal with patient supine and knee in 90° of flexion. The SutureLoc device (asterisk) is passed through the tibia using the lasso wire, and the final pull into the tibia is met with resistance as expected. One should be careful to only pull gently (e.g., using a hand-roll technique).

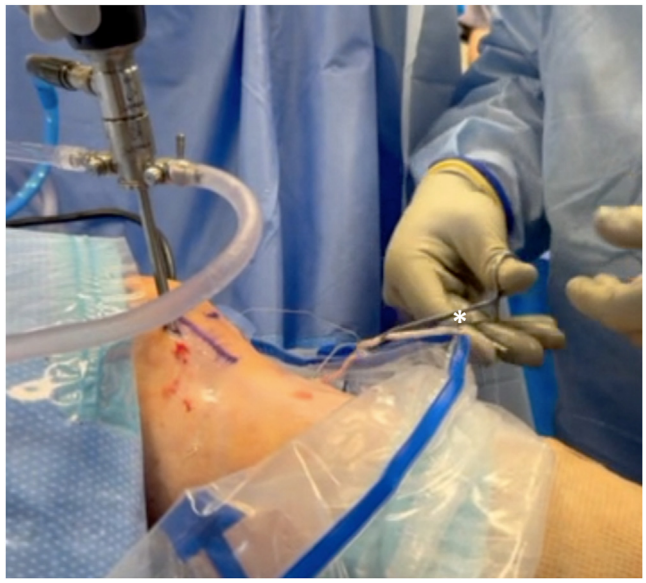

Fig 4. The SutureLoc system is seen with the femur on the left and the arthroscope in the anterolateral portal in a right knee. After the SutureLoc system is passed through the tibia, the anchor is set by pulling the black-blue sutures and a hemostat is placed on the sleeve (asterisk) to prevent this anchor from losing its fixation, which is an essential step.

through the loop of the blue-white conversion suture. The hemostat is released from the anchor sheet, and the conversion suture is used to pull the solid blue suture through the SutureLoc device (Fig 6). The solid blue suture should be shuttled all the way so that there is no slack of the suture around the meniscus, but it should not be tensioned yet. The hemostat is then placed back on the anchor sheet to prevent unloading of the second passing suture.

The same procedure is repeated for the second white suture. The solid white suture is retrieved using a suture grasper and is passed through the meniscus using the Knee Scorpion suture passer (Fig 7). Our preferred technique is to use a single white suture pass medial to the previous horizontal suture, allowing it to work as a rip-stop. The white suture is retrieved and is passed through the loop of the white-black conversion suture and is then passed through the anchor sheet after the hemostat is released.

Construct Tension

The only sutures out of the anchor sheet are now the solid blue and solid white sutures, and these are tensioned gradually to reduce the meniscus to its insertion (Fig 8). This can be repeated multiple times, before and after cycling of the knee, and one should note that significant tension can be created using this direct fixation. Caution should be paid to not overtension the construct because this can cause ripping of the sutures through the meniscus. The anchor sheet can now be cut short flush with the tibia because it

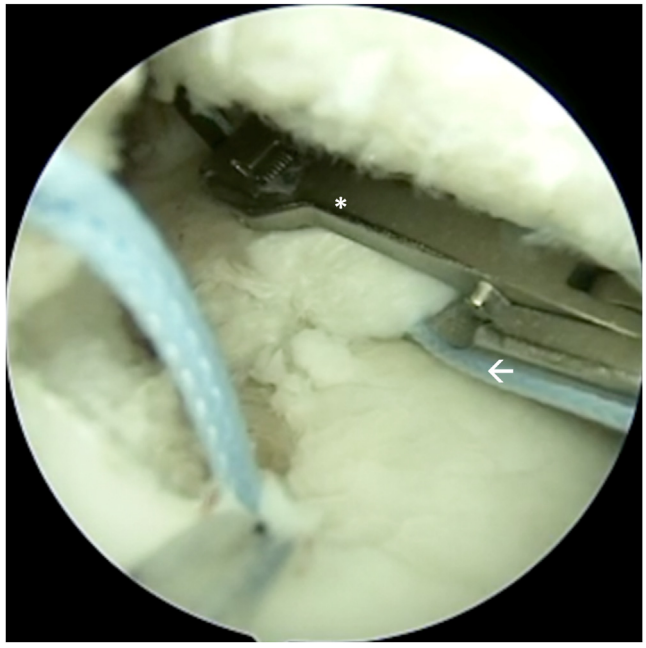

Fig 5. Arthroscopic view of right knee viewed from anterolateral portal with patient supine and knee in 90° of flexion. A Knee Scorpion (asterisk) is used to pass the solid blue suture (arrow) through the meniscus.

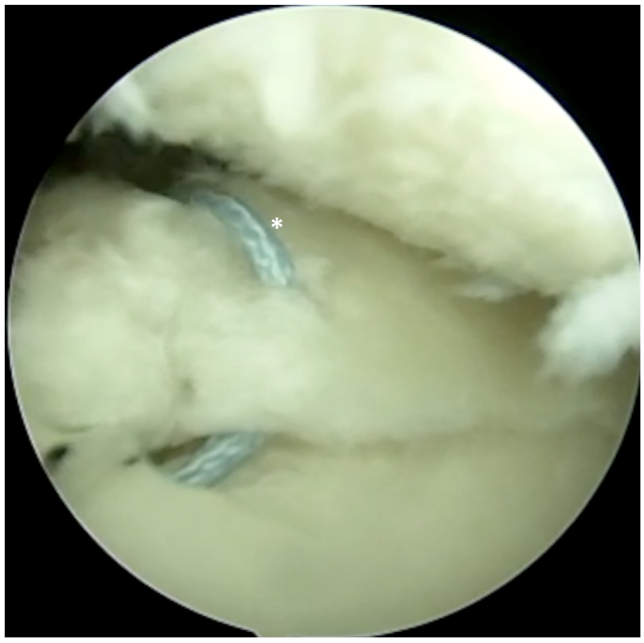

Fig 6. Arthroscopic view of right knee viewed from anterolateral portal with patient supine and knee in 90° of flexion. The blue suture is shuttled through the SutureLoc system after the hemostat is removed from the sheet. The blue suture in this example is placed in a horizontal mattress configuration (asterisk). The hemostat should be placed on the sheet after this step.

Fig 7. Arthroscopic view of right knee viewed from anterolateral portal with patient supine and knee in 90° of flexion. A Knee Scorpion suture passer (asterisk) is used to pass the solid white suture through the meniscus. A simple suture (arrows) is used in this case.

does not need additional fixation. If required, backup fixation can be performed for the whole construct using a 4.75-mm SwiveLock anchor (Arthrex) or to open the sleeve and fix the remaining sutures over a suture button.

Discussion

There has been an increased awareness of the recognition and treatment of MMPRTs.[1,5,10] Recent systematic reviews have shown that patients report significant and clinically relevant improvement after medial meniscus root repair.[1,2,5] Furthermore, a recent systematic review with meta-analysis of partial meniscectomy versus root repair of MMPRTs has shown that 22% of patients undergoing root repair had progression of OA compared with 66% of patients undergoing meniscectomy. Similarly, conversion to total knee arthroplasty was required in 10% of patients undergoing root repair at a mean of 6.9 years' follow-up compared with 36% of patients undergoing meniscectomy at a mean of 6.2 years' follow-up. Meniscal root repair is therefore recommended in patients without Kellgren-Lawrence grade 3 or 4 OA.[1-5]

Most commonly, the transosseous technique is used for root repair of MMPRTs.[2,6] Although this is a reproducible technique, this technique has been shown in biomechanical studies to result in gapping of up to 2 or 3 mm due to the indirect fixation, which may allow for meniscal extrusion.[6-8] The alternative technique for

Fig 8. Arthroscopic view of right knee viewed from anterolateral portal with patient supine and knee in 90° of flexion. The solid blue suture (asterisk) and solid white suture (arrow) are gradually tensioned one by one to reduce the meniscus to its insertion. The probe is used to confirm sufficient tension is created. The root repair is now complete.

Table 1. Pearls and Pitfalls of Arthroscopic Knotless Direct Fixation Technique for Medial Meniscus Posterior Root Tears

Pearls
Verify the correct indication and that the patient can comply with postoperative guidelines.
Consider drilling the tunnel from the anterolateral tibia to have a better pull direction for the medial meniscus posterior root.
Ensure that the final pull of the SutureLoc device against resistance into the tibial tunnel is performed carefully because the suture should be directly under the tibia and should not be pulled too far into the tibial tunnel.
Use a cannula in the anteromedial portal for suture management.
Ensure an anatomic tibial tunnel position is created.
Perform horizontal mattress suture passage to create broader compression of the meniscus on the tibia; place a vertical suture behind it if a rip-stop configuration is desired.
Pitfalls
Do not over-tension the first suture because this reduces the meniscus and can prevent suture passage of the second suture.
Be sure to keep a hemostat on the sleeve at all times, except when shuttling sutures through the device. Note that if the sleeve is not clamped, tension can be lost or the passive suture can be inadvertently unloaded.
Avoid prematurely bunching up the device by pulling on the loop suture because this can prevent passage of the device into the 2.4-mm tunnel.
Prevent over-tensioning of the meniscus because this can cause suture to rip through.
Range the knee through range of motion and place it is varus stress to check if final tension is preserved, and otherwise ensure retensioning of the construct

root repair is arthroscopic suture anchor fixation.[6-8] This technique has the advantage of direct fixation under the tibia and decreased gapping compared with the indirect fixation with transosseous fixation, but this includes a more difficult technique of placing a suture anchor perpendicular to the tibial plateau at the meniscus root insertion site. Furthermore, neither technique has the possibility of re-tensioning of the repair construct.

Our technique combines the advantages of both of the aforementioned techniques: It entails a direct fixation flush under the tibia plateau, with easy anterior tibial tunnel drilling. The most notable advantages in our experience are the direct fixation and the possibility of re-tensioning the construct. The direct fixation creates a stronger fixation and prevents the situation of fixation of the sutures through a cortical button after which some slack in the repaired system is still noted. Another advantage is that the knee can be cycled through a range of motion and the repaired root can be re-tensioned multiple times to create a solid fixation without initial gapping.

Some limitations should be mentioned. There are no studies reporting outcomes of the described technique. Furthermore, certain pitfalls should be prevented to obtain a satisfactory result (Table 1), especially making sure to have a hemostat on the sleeve between suture passages and not to over-tensioning the construct, given that the strength of fixation may exceed that of meniscal tissue and over-tensioning can result in suture cutout. This is especially relevant in chronic cases or cases of nonanatomic fixation, and the rip-stop configuration of the sutures may prevent this.

In conclusion, there has been an increased awareness of the recognition and surgical treatment of MMPRTs. Current fixation techniques consist of indirect transosseous fixation and direct suture anchor fixation with their corresponding disadvantages. With the described technique of knotless re-tensionable direct fixation, the biomechanical and practical advantages of both current techniques are combined, which leads to a reproducible and strong medial meniscus posterior root repair technique.

Disclosures

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