Technical Note

Arthroscopic Centralization Using Knotless Anchors for Extruded Medial Meniscus

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Abstract: The load-distributing function is most critical in meniscal function, and meniscal extrusion suggests failure of this function, leading to the progression of osteoarthritis. The arthroscopic centralization technique has been developed to reduce meniscal extrusion; however, existing arthroscopic techniques sometimes fail to reduce the most extruded region, especially in cases with a medial meniscus (MM) posterior root tear, in which the most extruded region is on the posterior border of the medial collateral ligament, which is very difficult to approach. This Technical Note describes an arthroscopic technique for extrusion of the MM in which a centralization technique using knotless anchors efficiently reduces the MM extrusion at the posteromedial part and consequently restores the MM function. This technique efficiently reduces MM extrusion and restores its function, thus preventing the progression of osteoarthritis.

The meniscus plays an important role in the knee joint, and the load-distributing function is most critical in meniscal function. Meniscal extrusion suggests failure of this function, and it is associated with the development of osteoarthritis (OA)[1,2] and knee pain in patients with OA.[3] Therefore, recent studies regarding meniscal repairs have emphasized the reduction of meniscal extrusion, and several techniques have been developed to efficiently reduce meniscal extrusion.[4-6]

Among these techniques, the arthroscopic centralization technique has recently been developed to restore and maintain meniscal function by repairing or preventing extrusion of the meniscus by centralizing the midbody of the meniscus onto the rim of the tibial plateau. This technique was first developed for extrusion of the lateral meniscus, and because good clinical and radiographic outcomes of this procedure were reported,[4,7] it was further applied to medial meniscus (MM) extrusion, especially to augment repair of MM posterior root tears (MMPRTs).[8-10] However, existing arthroscopic techniques sometimes fail to reduce the most extruded location in cases with MMPRTs, in which the most extruded location is the posterior border of the medial collateral ligament (MCL),[10] which is very difficult to approach. This Technical Note describes an arthroscopic technique for extrusion of the MM in which a centralization technique using knotless anchors is performed to efficiently reduce the extrusion of the posteromedial part of the MM and consequently restore MM function.

Indications

This technique is indicated for cases with MM extrusion, and the best indications are cases with the most extruded site in the posteromedial part, such as MMPRTs, posterior horn tears, and other degenerative tears at the posterior segment. This technique can be applied in combination with repair of the corresponding tear and can be combined with high tibial osteotomy in cases with varus lower-extremity alignment.

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Surgical Technique

The patient is positioned supine on a standard operating table (Video 1). A nonsterile tourniquet is applied to the upper thigh of the operated leg.

In cases of MMPRTs and/or combined high tibial osteotomy, release of the superficial MCL is performed before arthroscopy to provide sufficient working space and easier access to the posterior segment of the MM. The medial proximal tibia is exposed by an oblique incision, and the superficial MCL is released on the distal tibial side using a rasp. In other cases with MM extrusion, the outside-in pie-crusting technique of the MCL is used during arthroscopy.[11]

Standard arthroscopic examination is performed via routine anteromedial and anterolateral portals. Other injuries, including osteochondral lesions, are managed according to the status of the injury. The meniscal status is then confirmed. Extrusion of the MM is confirmed by pushing the midbody of the meniscus out of the rim of the medial tibial plateau using a probe (Fig 1 A and B). Irreparable meniscal tears, such as flap tears and degenerative tears, are resected. Reparable meniscal tears, such as radial tears and horizontal tears, that cause meniscal extrusion are repaired after centralization using the all-inside suture technique and/or the inside-out suture technique. Exceptionally, in cases with MMPRTs, MMPRT repair without final fixation is performed before centralization (Fig 1C); however, at this point, reduction of the torn posterior root to the anatomic insertion site, as well as reduction of the meniscal extrusion at the posteromedial part, is not achievable (Fig 1D) in most cases, especially chronic cases.

A midmedial portal is made with an arthroscopic view from the anterolateral portal, 1 cm proximal to the MM and just anterior to the medial femoral condyle (Fig 2A). Osteophytes at the medial tibial plateau (if they exist) are resected using an osteotome through the midmedial portal. An arthroscopic rasp, usually used for Bankart shoulder repair, is inserted through the midmedial portal. The meniscotibial capsule under the MM is then released from the medial tibial plateau for mobilization of the MM to ease reduction of the meniscal extrusion (Fig 2B). This procedure is more critical in cases with MMPRTs; releasing the

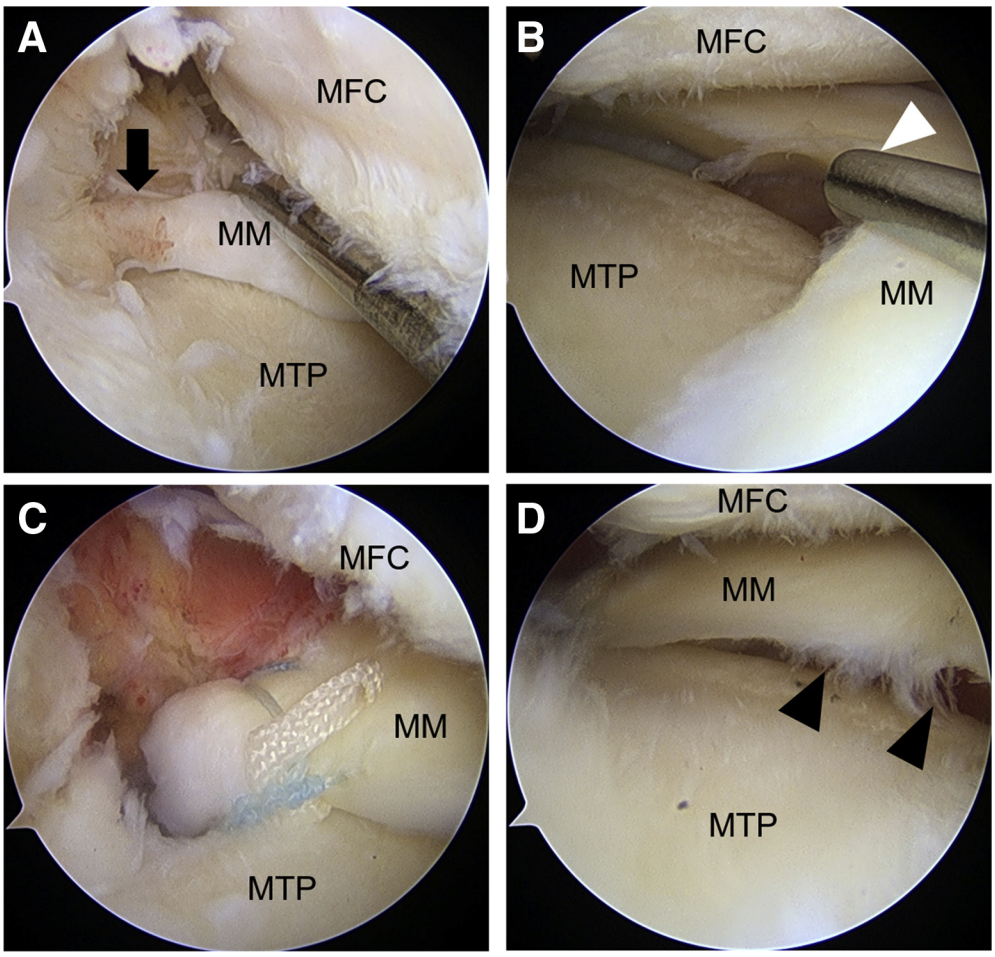

Fig 1. Medial meniscal posterior root tear (MMPRT) in right knee with patient in supine position. (A) The MMPRT, covered with scar tissue (arrow), is confirmed with an arthroscopic view from the anterolateral portal. (B) Extrusion of the medial meniscus (MM) is confirmed by pushing the midbody of the meniscus out of the rim of the medial tibial plateau (MTP) using a probe (arrowhead). (C) MMPRT repair using the transtibial pullout technique without final fixation is performed before centralization. (D) Reduction of the meniscal extrusion at the posteromedial part is hardly achieved (arrowheads). (MFC, medial femoral condyle.)

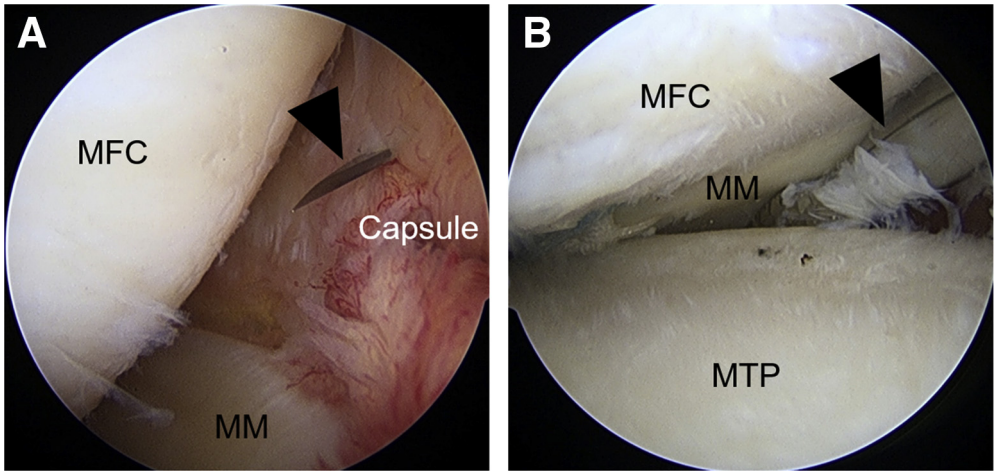

Fig 2. Right knee with patient in supine position. (A) A mid-medial portal (arrowhead) is made with an arthroscopic view from the anterolateral portal, 1 cm proximal to the medial meniscus (MM) and just anterior to the medial femoral condyle (MFC). (B) The meniscotibial capsule under the MM is released from the medial tibial plateau (MTP) from anterior to posterior using an arthroscopic rasp (arrowhead).

meniscotibial capsule sufficiently from anterior to posterior eases reduction of the torn posterior root to the anatomic insertion site.

A low posteromedial portal is made using a spinal needle; this portal is positioned just below the MM, 5 mm posterior to the posterior border of the superficial MCL (Fig 3A). A 1.8-mm Knotless FiberTak Soft Anchor (Arthrex, Naples, FL) is inserted at the edge of the medial tibial plateau, as posterior as the low posteromedial portal (Fig 3B). The knotless anchor has 3

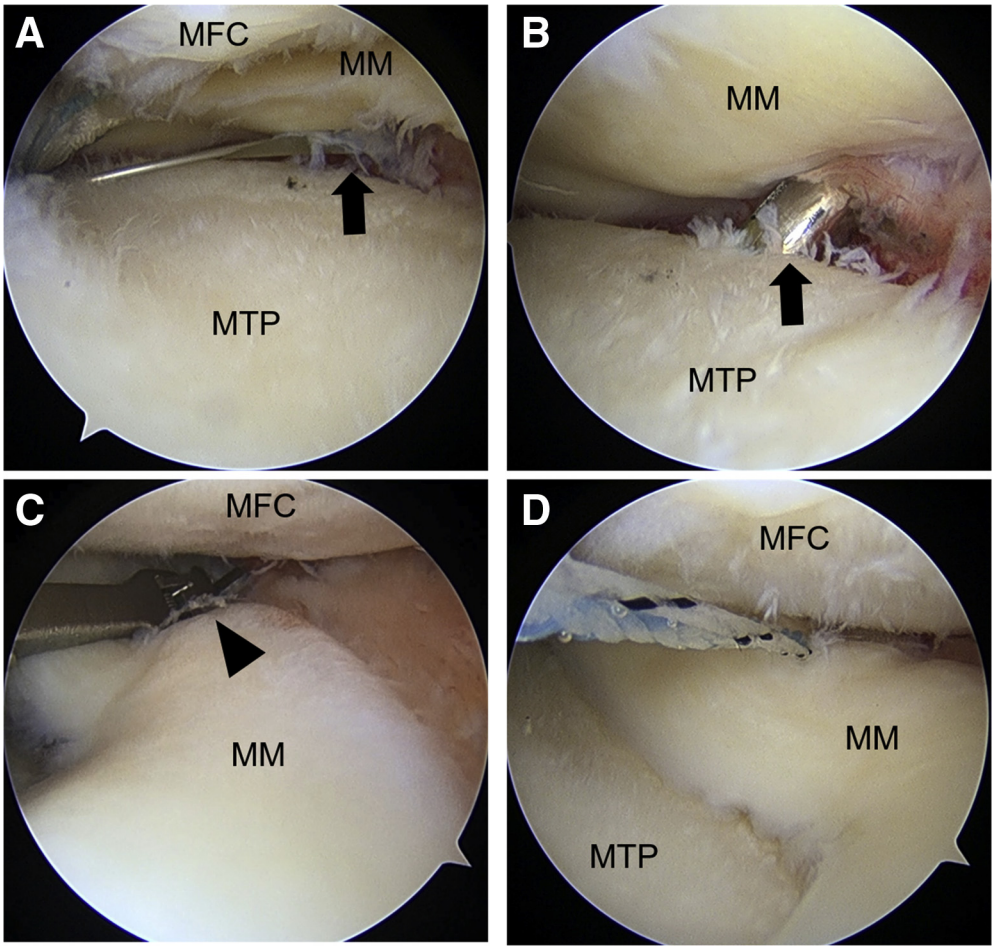

Fig 3. Right knee with patient in supine position. (A) A low posteromedial portal (arrow) is made with an arthroscopic view from the anterolateral portal, using a spinal needle just below the medial meniscus (MM) and 5 mm posterior to the posterior border of the superficial medial collateral ligament (MCL). (B) A Knotless FiberTak Soft Anchor (arrow) is inserted at the edge of the medial tibial plateau (MTP) through the low posteromedial portal. (C) A Knee Scorpion Suture Passer (arrowhead) is inserted through the anterolateral portal with an arthroscopic view from the anteromedial portal, and the straight end of the FiberLink is passed through the capsule at the margin between the meniscus and the capsule. (D) A repair suture and a shuttling suture loop are passed using a suture relay.

sutures, a repair suture, a shuttling suture loop and a shuttling suture, and repair suture and the shuttling suture loop (except the shuttling suture) are retrieved from the anterolateral portal. A Knee Scorpion Suture Passer (Arthrex), preloaded with a FiberLink suture (Arthrex) into the bottom jaw of the instrument at the straight end of the FiberLink suture, is inserted through the anterolateral portal. The straight end of the suture is passed through the capsule at the margin between the meniscus and the capsule, at the same level as the insertion point of the anchor (Fig 3C). Once the straight end of the suture is passed, it is grabbed with the Scorpion device and pulled out of the portal. The 2 retrieved sutures are loaded into the loop end of the FiberLink, and the straight end of the FiberLink is pulled to pass the 2 sutures (the repair suture and the shuttling suture loop) from interior to superior (Fig 3D).

A second 1.8-mm Knotless FiberTak Soft Anchor is inserted at the edge of the medial tibial plateau, 1 cm anterior to the first anchor, through the midmedial portal (Fig 4A). A Micro SutureLasso (Small Curve with nitinol wire loop; Arthrex) is then inserted through the midmedial portal. The tip of the Micro SutureLasso penetrates the capsule from superior to inferior at the margin between the meniscus and the capsule, at the same level as the insertion point of the anchor (Fig 4B). All 3 sutures from the second anchor are passed into the wire loop, and the other limb of the wire loop is pulled to pass the sutures from inferior to superior.

At this point, the shuttling suture loop from the first anchor and the repair suture from the second anchor are retrieved from the anteromedial portal. The repair suture is inserted into the shuttle suture loop, and the shuttling suture of the first anchor is gently pulled to pass the repair suture through the first anchor without tensioning yet (Fig 4C). This procedure is performed at this point to reduce the number of sutures. A third 1.8-mm Knotless FiberTak Soft Anchor is inserted at the edge of the medial tibial plateau, 1 cm anterior to the second anchor, through the midmedial portal, and the same procedure used for the second anchor is repeated (Fig 5A).

The shuttling suture loop from the second anchor and the repair suture from the third anchor are retrieved from the anteromedial portal. The repair suture is inserted into the shuttle suture loop, and the shuttling suture of the second anchor is gently pulled to pass the repair suture through the second anchor. The repair suture of the third anchor is then tightened by pulling it (Fig 5B). The repair suture of the second anchor is also tightened.

Finally, the shuttling suture loop from the third anchor and the repair suture from the first anchor are retrieved from the anteromedial portal. The repair suture is inserted into the shuttle suture loop, and the shuttling suture of the third anchor is gently pulled to pass the repair suture through the third anchor. The repair suture of the first anchor is then tightened by pulling it to complete the centralization (Fig 5C). In cases with MMPRTs, reduction of the repaired posterior root to the anatomic insertion site can also be achieved after the final fixation (Fig 5D).

The extruded MM is reduced and centralized with this centralization procedure. The tips and pitfalls of this technique are described in Table 1.

Postoperative Rehabilitation

After surgery, the patient undergoes a routine postoperative protocol for meniscal repair. Range-of-motion exercises without restriction are encouraged immediately after the surgical procedure. Partial weight bearing with a knee immobilizer and crutches is allowed for the first 4 weeks. After 4 weeks, partial weight bearing without the knee immobilizer is permitted, which progresses to full weight bearing at 6 weeks. Deep squatting over 90° is allowed after 3 months. Running is permitted after 3 months, and full athletic activities are allowed 6 months after surgery.

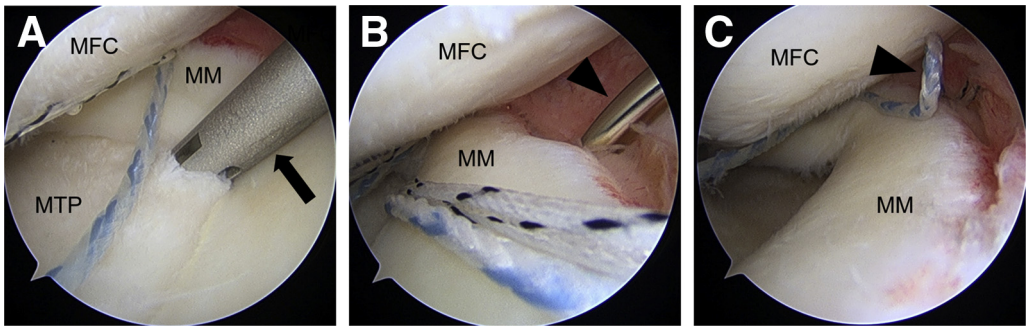

Fig 4. Right knee with patient in supine position. (A) The second anchor (arrow) is inserted 1 cm anterior to the first anchor, through the midmedial portal, with an arthroscopic view from the anterolateral portal. (B) A Micro SutureLasso (Small Curve) device (arrowhead) is inserted through the midmedial portal and penetrates the capsule to pass all 3 sutures from the second anchor. (C) The repair suture (arrowhead) from the second anchor is passed through the first anchor without tensioning yet. (MCL, medial collateral ligament; MM, medial meniscus; MTP, medial tibial plateau.)

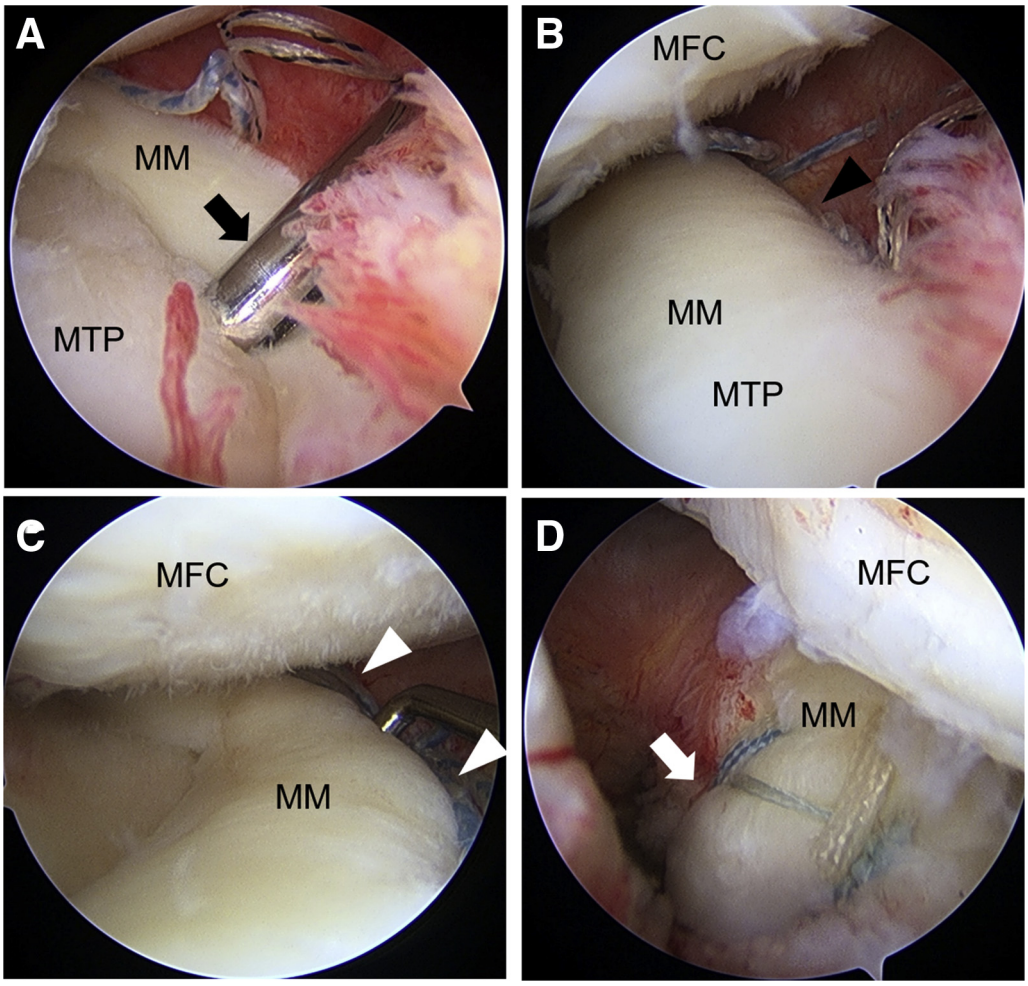

Fig 5. Right knee with patient in supine position. (A) The third anchor (arrow) is inserted 1 cm anterior to the second anchor, through the midmedial portal, with an arthroscopic view from the anterolateral portal, and the same procedure used for the second anchor is repeated. (B) The repair suture from the third anchor is passed through the second anchor; the repair suture (arrowhead) from the third anchor is then tightened. (C) All the repair sutures (arrowheads) are tightened, and the extruded medial meniscus (MM) is reduced and centralized. (D) Reduction of the repaired posterior root to the anatomic insertion site (arrow) is achieved after final fixation. (MCL, medial collateral ligament; MTP, medial tibial plateau.)

Discussion

Extrusion of the meniscus suggests failure of the load-distributing function, and correcting meniscal extrusion is critical for preserving meniscal function and, consequently, preventing the progression of OA. Causes of meniscal extrusion include posterior root tears, radial tears, or any types of tears that disrupt the meniscal hoop, and particularly in the MM, most such tears are associated with degenerative changes in middle-aged and elderly patients. Hence, solely repairing tears cannot always reduce extrusion and restore meniscal function with the reported secure fixation methods.[12-15]

Therefore, several augmentation techniques to reduce MM extrusion have been reported, such as arthroscopic centralization[4,8,16-18] and meniscotibial ligament repair.[5] The arthroscopic centralization technique centralizes the midbody of the meniscus onto the rim of the tibial plateau using soft anchors. Positive clinical and radiographic outcomes of this procedure for the lateral meniscus have been reported. However, when it comes to MM extrusion caused by tears of the posterior segment, especially MMPRTs, this technique sometimes fails to reduce the most extruded location (posterior border of the MCL) because of the difficulty in approaching the appropriate location from the mid-medial portal. Meniscotibial ligament repair can be performed at any segment of the MM. However, this technique is an extra-articular open procedure that could damage the superficial MCL; furthermore, it has a risk of constraining the superficial MCL when applied with small incisions.

The current technique has some advantages over the existing procedures (Table 2): (1) The use of a low

Table 1. Tips and Pitfalls of Technique

Tips
The midmedial portal should be created at the appropriate position to obtain the appropriate angle for the anchors.
An arthroscopic rasp should be used to release the meniscotibial capsule for mobilization of the MM to ease reduction of the meniscal extrusion.
The low posteromedial portal should be created accurately using a spinal needle just below the MM and 5 mm posterior to the posterior border of the superficial MCL so that the anchor is inserted at the appropriate position and the meniscal extrusion at the posteromedial part is reduced.
Pitfalls
The instruments, such as the Micro SutureLasso, Scorpion, and rasp, should be handled carefully to avoid chondral damage.
The surgeon should ensure that each repair suture is inserted into the shuttling suture loop from the appropriate anchor.
The Micro SutureLasso and Scorpion should penetrate the capsule at the margin between the meniscus and the capsule. Penetration of the meniscal body would result in overconstraint of the MM.

MCL, medial collateral ligament; MM, medial meniscus.

posteromedial portal under the meniscus enables the surgeon to insert the anchor at the posteromedial part, which is generally the most difficult site to approach. (2) The technique uses knotless soft anchors with a kind of suture-bridge technique. The suture-bridge technique works better than the double-row technique in rotator cuff repair by increasing the pressurized contact area[19,20]; a similar comparison can be made between the current technique and the existing centralization technique using suture anchors with knot tying. The current technique is also expected to increase the pressurized contact area between the meniscotibial capsule and the edge of the medial tibial plateau, leading to better reduction of meniscal extrusion and better healing. In addition, knotless anchors can avoid knot impingement and control suture tension without knot tying. Soft anchors can eliminate the possibility of rigid material loose bodies in the joint.

In contrast, our technique is more technically demanding and could risk limiting the normal motion of the MM during knee extension-flexion. Moreover, this is a preliminary report, and further follow-up will be necessary to investigate the long-term effects of the centralization technique using knotless anchors in terms of clinical and radiologic outcomes. Nevertheless, the centralization technique using knotless anchors can efficiently reduce MM extrusion, restore MM function, and possibly prevent the progression of OA.

Table 2. Advantages and Limitations of Technique

Advantages
Meniscal extrusion at the posteromedial part is reduced by inserting the anchor through the low posteromedial portal under the meniscus.
Use of knotless soft anchors with the suture-bridge technique enables increased pressurized contact area between the meniscotibial capsule and the edge of the medial tibial plateau and provides better reduction of meniscal extrusion and better healing.
Limitations
The technique is technically demanding.
The centralization technique could present a risk of limiting normal motion of the medial meniscus during knee extension-flexion.

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