Technique for Arthroscopically Assisted Superficial and Deep Medial Collateral Ligament—Meniscotibial Ligament Repair With Internal Brace Augmentation

Aaron K. Black, M.D., M.A., Calvin Schlepp, M.D., Matthew Zapf, M.D., and John B. Reid III, M.D.

Abstract: Deep medial collateral ligament (MCL) injury leads to meniscal lift-off and extrusion of the medial meniscus, resulting in instability and increased medial compartment pressures with subsequent cartilage damage. Repair of the deep MCL meniscotibial ligament in concert with superficial MCL repair or reconstruction is intended to restore the native anatomy, stability, and function of the medial meniscus. We present an arthroscopically assisted technique using standard arthroscopy portals and a medial open approach.

Medial knee stabilizers include the superficial medial collateral ligament (sMCL), deep medial collateral ligament (dMCL), and posterior oblique ligament and are the most common ligamentous injuries of the knee. The medial collateral ligament (MCL) is an important part of the 4-bar linkage model of the knee and primary restraint to valgus stress. The dMCL is composed of meniscofemoral and meniscotibial ligaments. Rupture of these structures leads to the arthroscopic finding of meniscus lift-off and the magnetic resonance imaging finding of meniscus extrusion.

Meniscus extrusion has been directly correlated to joint space degeneration. Normal menisci efficiently distribute physiologic hoop stresses resulting from axial load with normal extrusion of 3 mm, although recent studies suggest this value may be smaller. Meniscal extrusion indicates pathology has disrupted this mechanism, rendering the meniscus either functionally deficient or nonfunctional, resulting in force distribution over smaller surface areas increasing the susceptibility to and rate of chondral and subchondral degeneration. When meniscal extrusion is present, it is typically associated with root degeneration or tear, osteoarthritis, varus malalignment, and capsular tears. Meniscal extrusion is reported to be an independent predictor of osteoarthritis progression and strongly correlates with chondral degeneration. Such structural lesions are noted to precede radiographic degenerative signs by several years. Disruption of the deep MCL is under-recognized. Repair of this structure may prevent future meniscal extrusion and the pathology associated with it.

There is general consensus that distal sMCL injuries are a stronger indication for repair and reconstruction than proximal injuries due to possible soft tissue interposition, or Stener Lesion, as well as evidence that the blood supply is less abundant distally than proximally. Recently several studies have described techniques for improved anatomic repair and reconstruction of the medial knee stabilizers. Yet none directly addressed the intimate relationship between the meniscotibial component of the dMCL and restoration of function of the medial meniscus. We describe an arthroscopy-assisted sMCL and dMCL meniscocapsular junction meniscotibial ligament repair technique using a Knee Scorpion, FiberWire, PushLock, collagen FiberTape, and SwiveLock (all from Arthrex, Naples, FL).

Surgical Technique

The patient is placed supine on the operating table. A tourniquet is placed on the operative thigh. The leg is
prepped and draped in sterile fashion per the surgeon’s protocol. Prior to insufflation, the joint line is palpated and marked as is the medial epicondyle and the open incision for access to the medial epicondyle. Standard anterolateral (AL) and anteromedial (AM) portals are made and diagnostic knee arthroscopy is performed (Video 1). The medial compartment examination includes arthroscopic visualization during valgus stress that shows lift-off of the medial meniscus and drive through sign medially, as well as evidence of underlying injury to the meniscocapsular junction and damage to the meniscotibial ligament (Fig 1).

An open approach to the MCL is then performed. Dissection proceeds to the level of the sMCL, with care taken to avoid injury to the saphenous nerve. After exposure is adequate for reconstruction or repair, the

![Fig 1. Arthroscopic view of right knee showing meniscal lift off (*) with the patient in the supine position (camera via AL portal, probe via AM portal), with valgus stress applied to the patient’s knee. (AL, anterolateral; AM, anteromedial.)](image1)

![Fig 2. The right knee is shown with minimal flexion and valgus stress applied with the patient in the supine position with the camera through the AM portal. A Knee Scorpion is brought through the AL portal and is used to shuttle a No. 2-0 FiberWire suture from inferior to superior. (AL, anterolateral; AM, anteromedial.)](image2)

![Fig 3. The right knee is shown with minimal flexion and valgus stress applied with the patient in the supine position, with the camera through the AM portal. A Knee Scorpion is brought through the AL portal and is used to shuttle the other end of the No. 2-0 FiberWire suture from superior to inferior. (AL, anterolateral; AM, anteromedial.)](image3)

![Fig 4. The right knee is shown with minimal flexion and valgus stress applied with the patient in the supine position with the camera through the AM portal. A micro lasso is introduced at the level of the joint line and used to shuttle the No. 2-0 FiberWire sutures through the capsule. (AM, anteromedial.)](image4)
arthroscope is returned into the knee and passport cannulas are placed in the AM and AL portals (10x2-mm or 10x3-mm). Cannulas are integral to efficient suture management and preventing soft tissue entrapment. Starting with the most posterior suture, a Knee Scorpion is used to place No. 2-0 FiberWire sutures in a horizontal fashion at the red-white junction. The first pass is inferior to superior (Fig 2) and the second is the reverse (Fig 3), so both suture ends exit the inferior aspect of the meniscus.

A micro lasso is then brought into the medial compartment beneath the medial meniscus at the level of the previously placed suture and is used to pass the sutures (Fig 4). This is repeated for the remaining sutures progressing anteriorly. Reduction is confirmed with manual traction. The sutures are docked and maintained with hemostat clamps.

The sMCL injury is then identified underneath the pes anserinus distally and is mobilized from 6 cm below the joint line (Fig 5). Care must be taken not to disrupt the deep repair at this point. The sMCL is then whip-stitched in Krakow fashion with No. 0 FiberWire sutures. Two FiberWire sutures are used, 1 each in the anterior and posterior portions to the ligament. The bony bed is prepared first with a rasp, then trephinated with a drill bit. The sMCL FiberWire sutures are passed through the eyelet of a 4.75-mm PEEK (polyether ether ketone) SwiveLock that is preloaded with collagen-coated FiberTape. A guidepin is placed in the center of the distal insertion of the sMCL 6 cm distal to the joint line and overdrilled with a 4.5-mm drill to a depth of 20 mm. The pilot hole is tapped and the SwiveLock is partially inserted (Fig 6). The sutures are then individually tensioned and the anchor advanced with the knee in 30° of flexion and under a varus stress.

A second guide pin is then placed at the proximal sMCL attachment, just proximal and posterior to the medial epicondyle. The tails of the collagen FiberTape are then wrapped around the pin and the knee is taken through a range of motion to confirm isometry (Fig 5). The FiberTape is then affixed in neutral coronal stress at 0° to 20° of flexion with a second 4.75-mm PEEK SwiveLock in a fashion similar to that in the tibial side. The FiberTape should be slightly loose compared with the repaired ligament to prevent stress shielding.

The arthroscope is reintroduced in the knee, and tension necessary for reduction of the deep MCL is confirmed (Fig 7). The anchor sites for the dMCL repair are then prepared 15 mm distal to the joint line on the tibia. The anchors are symmetrically spaced from
anterior to posterior. The punch for the 3.5-mm PushLock is then placed at the determined anchor sites and the sutures are loaded through the eyelet in the anchor. The PushLock is seated in the hole and tension is again evaluated during final anchor impaction under direct arthroscopic guidance, restoring both the dMCL and proximal sMCL tibial attachments (Fig 6). At this point, both the drive-through and the meniscal lift-off should be eliminated (Fig 7).

Discussion

The medial knee stabilizers include the dMCL, sMCL, and the posterior oblique ligament. These act primarily to resist valgus stress. The dMCL is composed of the meniscotibial and meniscofemoral ligaments. Rupture of these structures leads to medial meniscal destabilization and extrusion (Fig 8). This is visualized arthroscopically as meniscal lift-off.

A recent study by Emmanuel et al.2 showed that medial meniscal extrusion is related to the incidence of knee osteoarthritis in a dose-dependent progression, corroborating results of prior work.3-9 Techniques have been described for centralization of the medial meniscus following root or radial tearing to address this issue.13 The central tenet of these techniques is to restore the normal contact pressures and contact area to the compartment.

Repair of grade 3 sMCL injury is most often indicated with tibial-sided injuries as a result of both the occurrence of a Stenerlike lesion and diminished blood supply distally.10 In a recent biomechanical study by Wijdicks et al.,14 the sMCL has been shown to have a much higher load to failure than the dMCL, and the forces necessary to disrupt the sMCL are very likely to also damage the dMCL. As such, in an attempt to anatomically address the medial structures of the knee, a complete approach includes the dMCL.

This technique offers many advantages (Table 1). It allows for efficient anatomic repair of the sMCL and dMCL through an arthroscopically assisted technique using standard AM and AL portals and a conventional AM open approach. By using separate SwiveLocks for reapproximation of the sMCL with augmentation and protection from internal bracing and separate PushLock fixation of the dMCL repair, the surgeon can control the tensioning and isometry of each structure independently. The goal of this technique is to restore normal

| Table 1. Advantages and Disadvantages of Technique for Arthroscopically Assisted Superficial MCL and Deep MCL Meniscocapsular Junction Repair With Collagen FiberTape Internal Brace |
|---|---|
| **Advantages** | **Disadvantages** |
| Efficient, anatomic repair of the meniscotibial attachment of the medial meniscus | Cost of additional implants |
| Decreased risk of meniscal extrusion and subsequent joint degeneration | |
| Requires only standard MCL approach | |
| Uses standard outside-in techniques | |

| AM, anteromedial; AL, anterolateral; MCL, medial collateral ligament. | AM, anteromedial; AL, anterolateral; MCL, medial collateral ligament. |

| Table 2. Pearls and Pitfalls of Technique for Technique for Arthroscopically Assisted Superficial MCL and Deep MCL Meniscocapsular Junction Repair With Collagen FiberTape Internal Brace |
|---|---|
| **Pearls** | **Pitfalls** |
| Confirm pathology | When elevating intact sMCL, take care to leave meniscal sutures intact |
| Use PassPort cannula in the AM/AL portal for ease of instrument and suture passage | |
| Use anatomic landmarks for the sMCL and dMCL attachments □ 6 cm distal to joint line for distal sMCL □ posterolateral to medial epicondyle for proximal sMCL □ 15 mm distal to joint line and just anterior to sMCL for dMCL | |
| Prepare bed with rasp and drilling | |
| Pass sutures inferior to superior then superior to inferior at red-white junction using Knee Scorpion | |

| AM, anteromedial; AL, anterolateral; dMCL, deep medial collateral ligament; sMCL, superficial medial collateral ligament. | |
anatomy and minimize the risk of accelerated degeneration of the knee due to meniscal extrusion and abnormal joint contact pressures.

Limitations of this technique include the need for extended exposure and prevents the possibility of percutaneous or limited exposures. There is also the risk of overconstraint and medialization of the meniscal body out of the joint if the sutures are placed too tightly. These can be mitigated by ensuring arthroscopic visualization during reduction.

This is a straightforward technique, involving steps already familiar to most orthopaedic surgeons for meniscal repair, which can be used to address the meniscal lift-off and instability often encountered during MCL surgery (Table 2).

References
1. Wijdicks CA, Griffith CJ, Johansen S, Engebretsen L, LaPrade RF. Injuries to the medial collateral ligament and associated medial structures of the knee. J Bone Joint Surg Am 2010;92:1266-1280.
2. Emmanuel K, Quinn E, Niu J, et al. Quantitative measures of meniscus extrusion predict incident radiographic knee osteoarthritis—Data from the Osteoarthritis Initiative. Osteoarthr Cartil 2016;24:262-269.
3. Costa CR, Morrison WB, Carrino JA. Medial meniscus extrusion on knee MRI: Is extent associated with severity of degeneration or type of tear? AJR Am J Roentgenol 2004;183:17-23.
4. Boxheimer L, Lutz AM, Treiber K, et al. MR imaging of the knee: Position related changes of the menisci in asymptomatic volunteers. Invest Radiol 2004;39:254-263.
5. Crema MD, Roemer FW, Felson DT, et al. Factors associated with meniscal extrusion in knees with or at risk for osteoarthritis: The Multicenter Osteoarthritis Study. Radiology 2012;264:494-503.
6. Crema MD, Guermazi A, Li L, et al. The association of prevalent medial meniscal pathology with cartilage loss in the medial tibiofemoral compartment over a 2-year period. Osteoarthr Cartil 2010;18:336-343.
7. Roemer FW, Kwoh CK, Hannon MJ, et al. Risk factors for magnetic resonance imaging-detected patellofemoral and tibiofemoral cartilage loss during a six-month period: The Joints on Glucosamine study. Arthritis Rheum 2012;64:1888-1898.
8. Roemer FW, Kent Kwoh C, Hannon MJ, et al. What comes first? Multitissue involvement leading to radiographic osteoarthritis: Magnetic resonance imaging-based trajectory analysis over four years in the osteoarthritis initiative. Arthritis Rheumatol 2015;67:2085-2096.
9. Roemer FW, Zhang Y, Niu J, et al. Tibiofemoral joint osteoarthritis: Risk factors for MR-depicted fast cartilage loss over a 30-month period in the multicenter osteoarthritis study. Radiology 2009;252:772-780.
10. Ambacher T, Jurowich C, Nachtkamp J, Paar O. Microangiographic evaluation of vascular supply of the medial collateral ligament of the knee joint. Unfallchirurg 2000;103:208-214 [in German].
11. Laprade RF, Wijdicks CA. Surgical technique: Development of an anatomic medial knee reconstruction. Clin Orthop Relat Res 2012;470:806-814.
12. Lind M, Jakobsen BW, Lund B, Hansen MS, Abdallah O, Christiansen SE. Anatomical reconstruction of the medial collateral ligament and posteromedial corner of the knee in patients with chronic medial collateral ligament instability. Am J Sports Med 2009;37:1116-1122.
13. Koga H, Watanabe T, Horie M, et al. Augmentation of the pullout repair of a medial meniscus posterior root tear by arthroscopic centralization. Arthrosc Tech 2017;6:e1335-e1339.
14. Wijdicks CA, Ewart DT, Nuckley DJ, Johansen S, Engebretsen L, Laprade RF. Structural properties of the primary medial knee ligaments. Am J Sports Med 2010;38:1638-1646.