Technical Note

Percutaneous Arthroscopic Assisted Knee Medial Collateral Ligament Repair

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Abstract: Medial collateral ligament (MCL) injuries are commonly encountered alongside anterior cruciate ligament injuries. Treatment modalities have ranged from conservative management to surgical repair, augmentation, and reconstruction. Various reports have reported residual valgus instability, especially in higher-grade injuries that have been treated conservatively. The MCL provides valgus stability but also is an element of anterior stability to the tibia in addition to the anterior cruciate ligament. In addition, meniscal "lift-off" and "floating" have been described as consequences after MCL injuries, and meniscal dysfunction has been shown to lead to accelerated joint degeneration; therefore, all efforts should be made to treat these injuries adequately. We describe a simple, minimally invasive technique that involves suturing the deep MCL to the medial joint capsule, allowing better MCL healing, causing less soft-tissue scarring, and preventing meniscal extrusion.

The medial collateral ligament (MCL) and anterior cruciate ligament (ACL) are the most commonly injured ligaments in the knee joint.[1] The MCL is part of a group of dynamic and static stabilizers on the inner aspect of the knee called the "medial meniscocapsular complex."[2] The ligamentous component of this complex is provided by the MCL, which is divided into 2 parts: superficial MCL and deep MCL (DMCL). The DMCL is further divided into the meniscotibial ligament, attaching to the tibia, and the meniscofemoral ligament, attaching to the femur. The DMCL originates at the medial epicondyle of the distal femur and inserts just inferior to the joint line on the medial aspect of the tibia. The region where the DMCL fibers merge with the medial meniscus is where the DMCL is divided into its femoral and tibial components (Fig 1). A new MCL injury classification proposed by Makhmalbaf and Shahpari[3] allows identification of the injury site using magnetic resonance imaging (MRI) and clinical findings. This allows better injury-site identification to plan a more focused treatment.

Treatment protocols for MCL injuries are determined by the physical demands of the patient and grade of injury. Grade I and II injuries are usually treated conservatively with bracing and rehabilitation, whereas grade III injuries are approached surgically. There is, however, literature to suggest residual valgus instability in conservatively treated patients, especially when associated with an ACL reconstruction (ACLR).[4] DMCL injuries are also associated with findings of a "floating meniscus" or meniscal "lift-off" on MRI and arthroscopic examination.[5] DMCL injuries impair the function of the meniscus and hinder its hoop stress and load distribution abilities, leading to accelerated joint degeneration.[6,7] The DMCL resists valgus stresses and is a secondary restraint alongside the medial meniscus to anterior tibial translation.[8] Cadaveric studies have shown that knees with an incompetent MCL exhibited increased loading patterns on the ACL.[9,10]

Techniques previously described to surgically address MCL injuries and their anatomic reconstruction using grafts have shown good results.[11,12] More recently, MCL repair and internal brace augmentation using FiberTape (Arthrex, Naples, FL) have been performed.[5,13,14] These techniques show reasonable results but require larger incisions and more extensive surgery. Our technique aims to address grade III DMCL injuries

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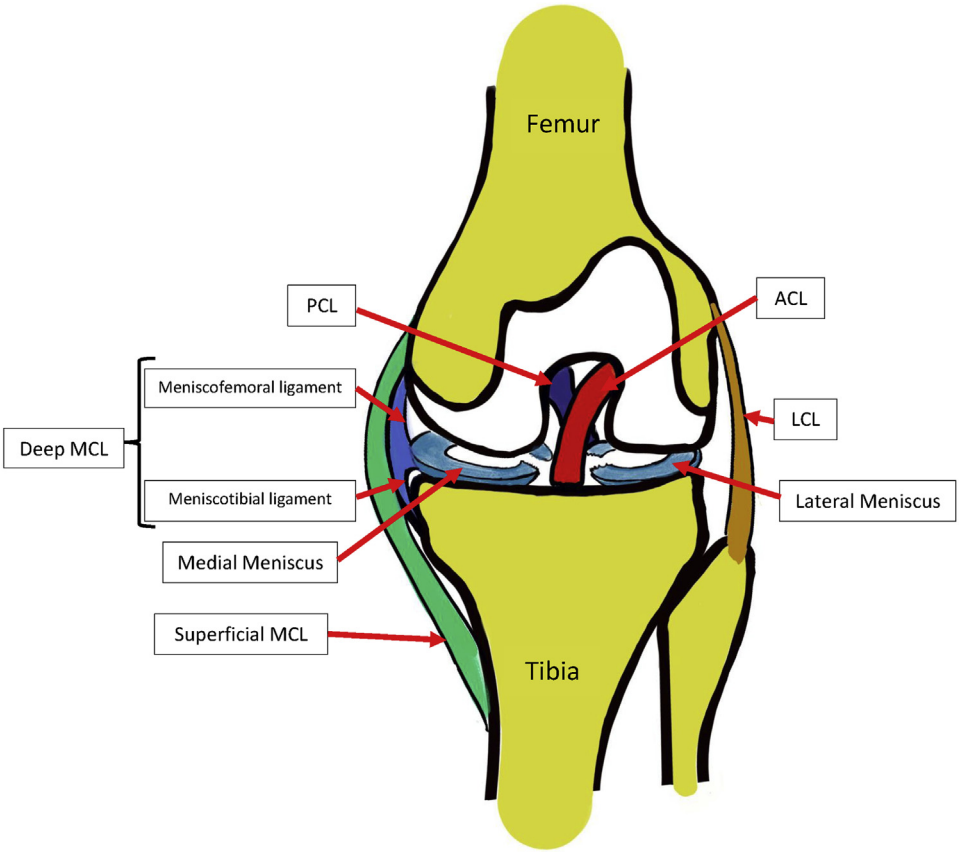

Fig 1. Anatomy of left knee joint and attachments of deep medial collateral ligament (MCL) above and below medial meniscus. (ACL, anterior cruciate ligament; LCL, lateral collateral ligament; PCL, posterior cruciate ligament.)

by approximating the DMCL tissues to the joint capsule percutaneously with the assistance of arthroscopy to be less invasive, promote better healing, and cause less joint scarring, with early restoration of normal joint biomechanics.

Surgical Technique

A preoperative MRI study is performed to identify the MCL injury site and determine where the inside-out sutures should be placed. The patient is placed in the supine position with the injured knee flexed to 90°, a lateral post fixed just proximal to the knee joint, and a tourniquet applied to the thigh. The knee is then prepared and draped according to the surgeon's protocol. Diagnostic arthroscopy is performed through standard anteromedial and anterolateral portals. After visualization of the anterior horn of the medial meniscus and the distal and posterior chondral surfaces of the medial femoral condyle, the knee is extended to 30° and the assistant performs a valgus stress test to establish whether the MCL injury is within the femoral or tibial fibers. This is determined by meniscal lift-off: If a femoral-side tear is present, the meniscus moves inferiorly with the tibia, whereas if the tibial fibers are injured, the meniscus moves superiorly with the femur.

For femoral-side tears (Fig 2), No. 2-0 FiberWire sutures (Arthrex) are passed in an inside-out manner above the meniscus at the meniscocapsular junction using a Meniscal Stitcher Double-Lumen Cannula (Smith & Nephew, Andover, MA). The curvature of the cannula is aimed toward the proximal end of the distal MCL stump. The suture needles are aimed into the medial joint capsule depending on the site of injury predetermined by the preoperative MRI study. Next, by holding the FiberWire taut outside the knee joint, the site-specific reduction is confirmed arthroscopically. If there is no longer abnormal meniscal movement, satisfactory reduction is confirmed. An incision is then performed near the femoral epicondyle, and the FiberWire sutures are retrieved percutaneously to the incision over the medial femoral epicondyle using straight artery forceps. The sutures are threaded into the eyelet of a 4.75-mm PEEK (polyether ether ketone) SwiveLock (Arthrex). The SwiveLock is then fixed onto the medial epicondyle of the femur with the knee in 30° of flexion.

In the case of a tibial-side tear (Fig 3), a 2.4-mm FASTak suture anchor (Arthrex) is anchored through the capsule at a point 1 cm subarticular, near the tibial insertion of the DMCL. With the help of a 1.8-mm SutureLasso (Arthrex), the sutures are taken through the torn tibial MCL fibers and, with a mini-incision, are

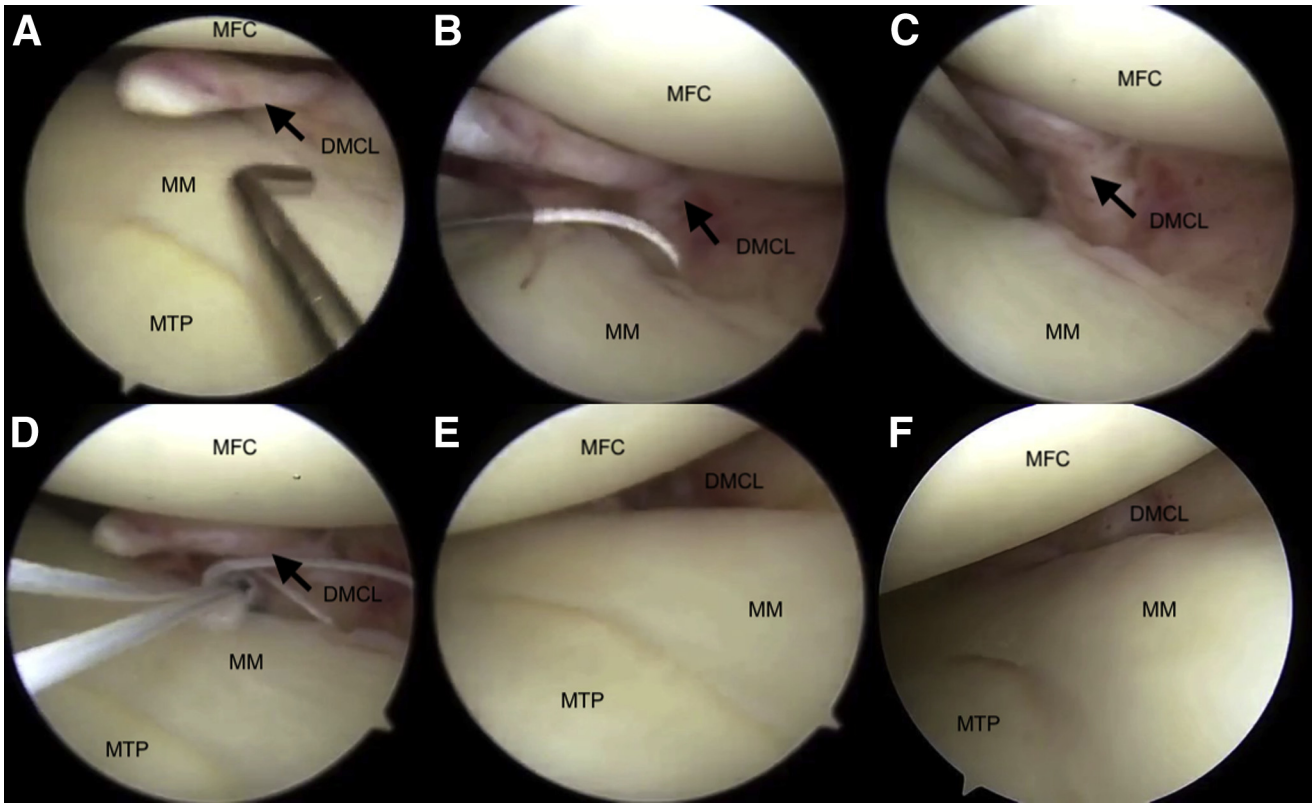

Fig 2. Arthroscopic percutaneous medial collateral ligament (MCL) repair for femoral-side tears. With the patient in the supine position, the knee is positioned in 90° of flexion, hanging at the edge of the operating table, and a lateral post is fixed just proximal to the knee joint. Diagnostic arthroscopy is performed through standard anterolateral and anteromedial portals. The assistant then performs a valgus stress test with the knee in 30° of flexion, and the medial compartment of the knee is examined arthroscopically to look for abnormal medial meniscal movement. In the case of a femoral-side deep medial collateral ligament (DMCL) tear, the medial meniscus will be noted to move inferiorly with the tibia. By use of a Meniscal Stitcher Double-Lumen Cannula, No. 2-0 FiberWire sutures are passed through the contused DMCL tissue above the meniscus at the meniscocapsular junction. The valgus stress test is performed again while the sutures are held taut outside the knee joint. Abnormal meniscal lift-off should cease, and the meniscus should be reduced to its anatomic position. The sutures are then retrieved percutaneously through an incision made over the femoral epicondyle and fixed onto the epicondyle using a 4.75-mm PEEK (polyether ether ketone) SwiveLock with the knee in 30° of flexion. The wounds are closed in a standard fashion. Approximating and suturing the MCL fibers to the joint capsule gives the MCL fibers better structural support to heal and scar. The meniscus is reduced and no longer exhibits abnormal movement, and the tension applied using the sutures allows for the fibers to heal with some degree of tension and continuity. (A) Contused DMCL tissue is noted and a space observed above the meniscus on valgus stress testing, confirming abnormal medial meniscal movement in a grade II femoral lesion. (B, C) The 2 limbs of the inside-out sutures are passed through the MCL tissue about 1 to 2 cm apart. (D, E) The sutures are pulled outside and held taut superiorly to confirm the meniscofemoral gap reduction and absence of abnormal meniscal movement. (F) The meniscofemoral gap reduction is confirmed after pulling the sutures superiorly and fixing with a SwiveLock on the medial epicondyle of the femur. (MFC, medial femoral condyle; MM, medial meniscus; MTP, medial tibial plateau.)

tied outside the joint capsule with the knee in 30° of flexion. This approximates the torn fibers to the joint capsule and reduces any meniscotibial laxity. In both scenarios, a second arthroscopy should be performed, and any degree of meniscal lift-off should no longer persist (Video 1). The surgical wounds are then closed in a standard fashion, and a medial off-loader brace is applied. The pearls and pitfalls of this technique are highlighted in Table 1.

The main goal of rehabilitation is to restore ROM, prevent stiffness, and restore a normal gait. Postoperatively, the patient wears a medial off-loader brace locked in extension to avoid valgus stress to the knee. Passive knee ROM exercises from 0-90 degrees were initiated. The patient is instructed to be non–weight bearing up to 1 month. During this period, static quadriceps contractions, ankle pumps, and straight leg–raising and patella mobility exercises are performed. At 4 to 6 weeks after surgery, knee ROM is increased up to 90° to 120°, after which a standard ACL-MCL rehabilitation program is followed. Figure 4 demonstrates an MRI of a patient's right knee taken preoperatively and postoperatively.

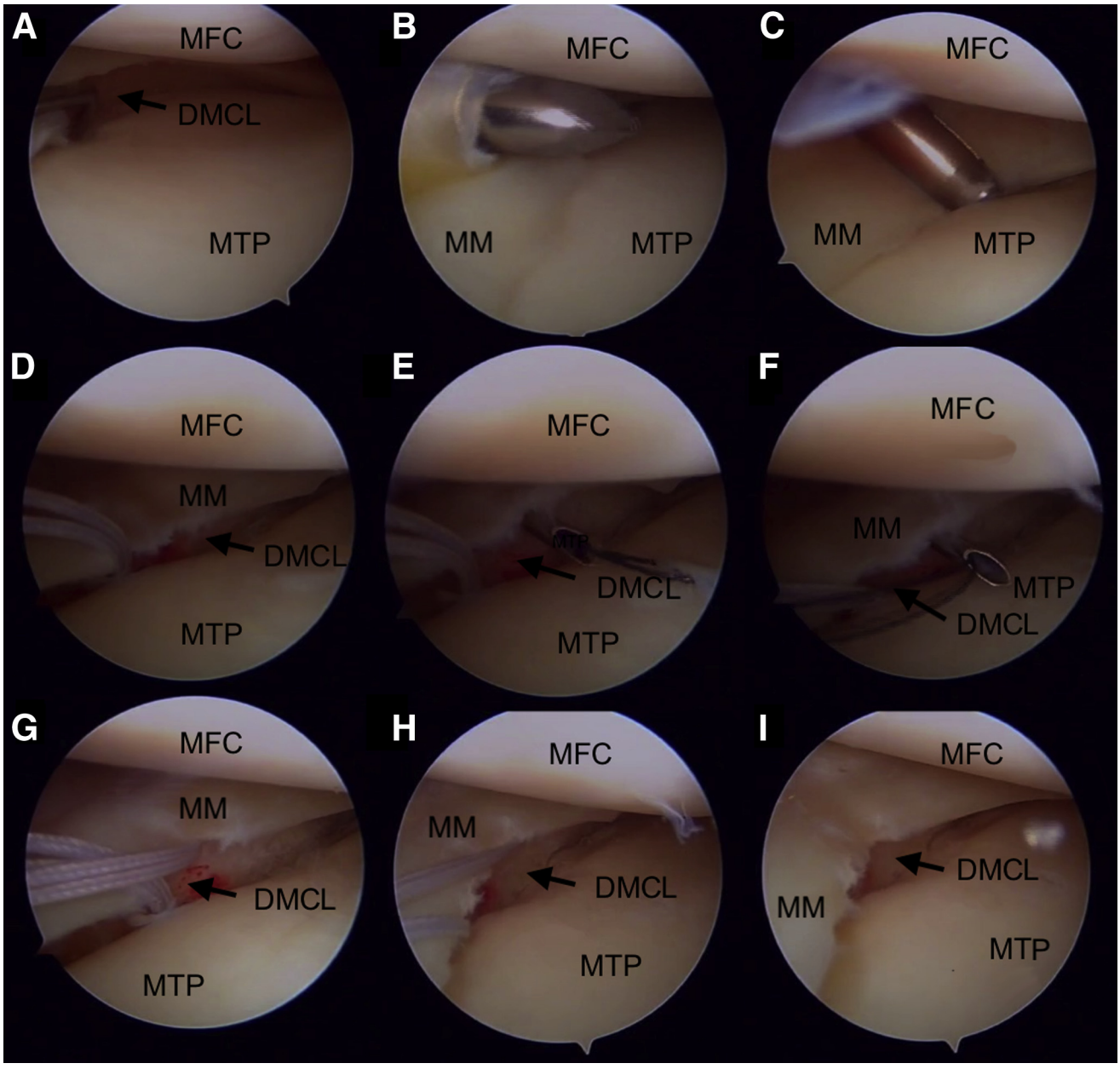

Fig 3. Arthroscopic percutaneous medial collateral ligament (MCL) repair for tibial-side tears. Standard diagnostic arthroscopy is performed with the patient in the supine position and the knee in 90° of flexion, with a lateral post just proximal to the knee. A valgus stress test in 30° of knee flexion confirms medial meniscal lift-off and movement of the medial meniscus upward with the femoral condyle. Next, a 2.4-mm FASTak suture anchor is anchored 1 cm subarticular, near the tibial insertion of the deep medial collateral ligament (DMCL). With a 1.8-mm SutureLasso, the sutures are passed through the torn tibial MCL fibers and, using a mini-incision, are tied outside the joint capsule with the knee in 30° of flexion. A second arthroscopy is performed, and any degree of meniscal lift-off should no longer persist. The wounds are then closed in a standard fashion. The meniscus no longer lifts off, and the MCL fibers are approximated. (A-C) A 2.4-mm FASTak suture anchor is inserted through the joint capsule 1 cm below the medial meniscus onto the medial aspect of the tibia. (D-F) A 1.8-mm SutureLasso is introduced through the DMCL and capsule twice underneath the medial meniscus. (G-I) The sutures are retrieved percutaneously and tied outside the capsule, reducing meniscotibial laxity and approximating the torn MCL fibers. (MFC, medial femoral condyle; MM, medial meniscus; MTP, medial tibial plateau.)

Discussion

MCL injury treatment has been a topic of debate, with a general consensus to treat grade I and II injuries (Hughston classification system) conservatively.[8,15] This is because of the superior healing potential and vascularity of the MCL in comparison to the ACL.[16] Treatment of grade III MCL injuries remains a topic of controversy, especially with concomitant ACL injury.[17-19] Some

Table 1. Pearls and Pitfalls

Pearls
The MCL injury classification of Makhmalbaf and Shahpari[3] uses MRI and clinical findings to classify and locate the injury site.
The level of injury should be confirmed by assessing meniscal lift-off while applying valgus stress to the knee under arthroscopy in 30° of flexion.
The surgeon should identify the contused tissue beyond the meniscus under arthroscopy to determine the location of the injury in the axial plane.
Care should taken to avoid the saphenous nerve by identifying the saphenous vein using inside-out illumination of the arthroscope.
The surgeon should confirm reduction of the meniscus after performing inside-out suturing by applying valgus stress in 30° of flexion.
Pitfalls
The tear location and approximation are estimated.
Sutures alone cannot withstand normal loading; therefore, bracing and protection are essential.
The described technique cannot address Stener-like lesions of the superficial MCL.
The ligament tear may occur in an oblique pattern, making identification and precise approximation of the percutaneous suture difficult.
There is a possible risk of saphenous nerve injury owing to the percutaneous nature of the technique.
Sutures are not as strong as internal brace techniques such as FiberTape.

MCL, medial collateral ligament; MRI, magnetic resonance imaging.

surgeons advocate MCL surgery alongside ACLR, whereas others prefer a conservative approach.[20] In the past, residual valgus laxity was the major concern with MCL injuries[21,22]; however, MCL injuries may include the meniscotibial coronary ligaments and impair the function of the medial meniscus, resulting in a floating meniscus.[23] Both the medial meniscus and MCL are secondary restraints to anterior tibial translation,[24,25] and performing an ACLR without addressing these injuries would add more strain to the reconstructed ACL graft, increasing the chance of reinjury.[23,26] Therefore, MCL repair in higher-grade injuries is important; it will restore medial meniscal function and protect the ACL graft. There is agreement on surgical intervention for Stener-like lesions of the distal MCL tibial attachment in which the ligament becomes entrapped superficial to the hamstring insertion, preventing healing.[27-29]

In view of the important roles the MCL has in medial knee stability and supporting meniscal biomechanics, there has been renewed focus on determining the ideal treatment modality for MCL injuries. Various techniques have been described for MCL surgery, each with its own advantages and disadvantages.[30] Black et al.[5] described a technique that provides internal bracing and reconstructs the meniscotibial ligament. This is a good technique, although the authors have admitted to a few limitations such as an extended exposure and the risk of overconstraining the medial meniscus, thereby medializing it.[5] Internal bracing alongside repair of the MCL has also been recently described.[13,14] These techniques provide an internal brace using FiberTape to protect the MCL, encourage natural healing, and allow early rehabilitation without the need for a graft; however, there is the risk of overconstraining the medial side of the knee.[13] In our technique, we simply approximate the torn MCL fibers

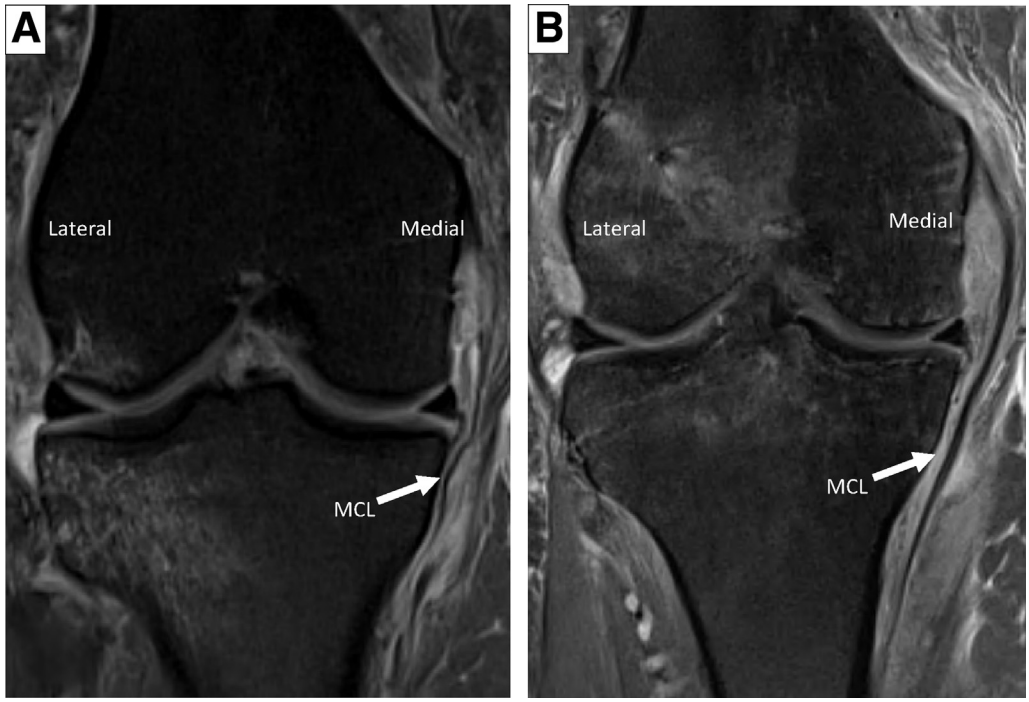

Fig 4. Magnetic resonance imaging of patient's right knee. (A) Preoperative coronal T2 magnetic resonance image showing disruption of medial collateral ligament (MCL) fibers near medial meniscal attachment: grade II injury according to classification of Makhmalbaf and Shahpari.[3] The MCL fibers are lax. (B) Two-month postoperative coronal T2 magnetic resonance image showing continuity and tautness of MCL fibers.

depending on the level of injury and suture the DMCL fibers to the medial joint capsule. This provides a natural structural support for healing. The advantages over previous techniques are that we are able to perform the technique under vision and there are no sutures taken through the meniscus; therefore, there is no risk of medializing or overconstraining it. Suturing the DMCL to the capsule brings together the tissue as a whole to abut the meniscus, preventing lift-off and extrusion. Our technique is minimally invasive, and therefore, patients have less postoperative pain, scarring, and joint stiffness. There are some risks and limitations such as possible saphenous nerve injury, and care must be taken to avoid it. In the case of an oblique MCL tear, tear identification and absolute approximation will be difficult and may be incomplete. Sutures are not as strong as internal bracing techniques, and therefore, care must be taken postoperatively to avoid breaking them. This is a simple technique with surgical steps familiar to all arthroscopy surgeons; it can be used to aid DMCL injury healing and prevent meniscal extrusion, and it can be extended to the posterior medial corner too.

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