

You Can Repair More Tears Than You Think—Tricks for All-Inside Lateral Meniscal Repair With Nonabsorbable Sutures



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Abstract: Since the role of the menisci has been better understood, there is a trend toward the meniscal repair rather than meniscectomy in the management of meniscal tears. Although numerous techniques of meniscal repair have been described and many authors advocate for and against each of them, no single method is universally accepted. The all-inside repair provides several advantages, such as a lower risk of neurovascular injury, the early introduction of exercises in passive range of motion, or the high strength of the repair. However, the all-inside meniscal repair with nonabsorbable suture is considered to be a technically demanding procedure with a long learning curve needed to perform it properly. The purpose of this Technical Note is to present the technique of lateral meniscus repair with nonabsorbable sutures and to provide surgical pearls to facilitate this procedure.

Tears of the lateral meniscus (LM) are less frequent than those of its medial counterpart. However, in the setting of acute anterior cruciate ligament injury, they tend to be the most frequently encountered ones.¹ The menisci participate in load distribution, shock absorption, and joint nutrition, which makes their role in proper joint function and, thereby, osteoarthritis prevention, unquestionable. Moreover, in the anterior cruciate ligament-deficient knee, meniscal contribution to the joint stability is isolated with the medial meniscus, preventing anterior tibial translation and the LM being

the major restraint against the pivot-shift maneuver.² For the aforementioned reasons, the necessity of meniscus preservation is beyond doubt.³ Meniscal preservation is especially important in the lateral knee compartment, where both tibial and femoral joint surfaces are concave, which makes the focal peak contact pressure extremely high when the LM is absent.^{4,5}

Modern arthroscopic techniques of meniscus repair include inside-out, outside-in, and all-inside repair. Although the inside-out technique remains the gold standard of meniscal repair, the all-inside technique provides several benefits, including preservation of knee blood supply and physiological mobility between the meniscus and surrounding tissues and avoidance of additional incisions.^{6,7}

Although numerous meniscal repair devices were developed to enhance the all-inside repair, their usage carries the risk of suture loosening, chondral injury, or synovitis.⁸ All-inside suturing of the LM is considered technically demanding, and for this reason, it is avoided by many surgeons. To encourage surgeons to use this method, we present the technique of all-inside LM repair using a suture hook and provide some surgical pearls and tips to facilitate this procedure.

Surgical Technique

Indications

Indications are symptomatic longitudinal LM tears with good potential to heal, as an isolated procedure, or in addition to other intraarticular procedures.

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Contraindications

Contraindications include degenerative meniscus body tear, meniscus extrusion, chondral lesions greater than grade 2 according to the International Cartilage Repair Society, and unaddressed knee instability.

Patient Positioning

The surgery is performed with either general or regional anaesthesia. The patient is positioned supine with the operated leg placed in a leg holder and subsequently prepared and draped in a sterile fashion. The nonsterile thigh tourniquet is not used to allow observation of bleeding from the meniscus during refreshing.

Diagnostic Arthroscopy (With Video Illustration)

Diagnostic arthroscopy is performed using a 30° arthroscope (CONMED, Warsaw, Poland) through standard anterolateral and anteromedial portals. Accessory medial parapatellar portal and posterolateral portal are made to facilitate visualization and maneuvering in posterolateral compartment. The tear of the LM is confirmed by traction with a probe and direct visualization of the lesion (Fig 1, Video 1).

How to Repair the Body of the LM

When the injury of the LM body is identified, the margins of the tear are refreshed using a 30° meniscal rasp with top and bottom serrations (CONMED) introduced through the anteromedial portal. Subsequently, the curved to the right 45° spectrum suture passer

(CONMED), loaded with a no. 1 PDS II suture (Ethicon, Somerville, NJ), is introduced through the same portal and the inner part of the meniscus, close to the posteromedial part of the lesion, is pierced in a downward direction (Fig 2A). The arthroscope is switched from anterolateral to the medial parapatellar portal and posterolateral compartment of the knee is visualized. The outer part of the meniscus is pierced under direct visualization, directing the suture passer upward and obliquely to the posterolateral compartment. The PDS suture is passed to the posterolateral recess (Fig 2B). The arthroscope is switched back to the anterolateral portal. The suture retriever (Arthrex, Naples, FL.) is introduced through the anteromedial portal and the PDS suture is replaced with an ETHIBOND EXCEL suture 2.0 (Ethicon) (Fig 2C). The suture is left untied.

The suture passer is again introduced through the anteromedial portal and pierced through the LM more lateral to the previous suture. Then, the suture passer is rotated to pierce the outer part of the LM and when the specific popping sensation is felt and seen, the instrument pierces the capsular part of the LM. As previously, the arthroscope is switched to the medial parapatellar portal, and the PDS suture is passed to the posterolateral recess and replaced with an ETHIBOND suture. Then, both sutures are tied with 6 to 7 surgical knots, the posterior one first followed by the more lateral suture. Sutures should be tied as peripherally as possible; to achieve this

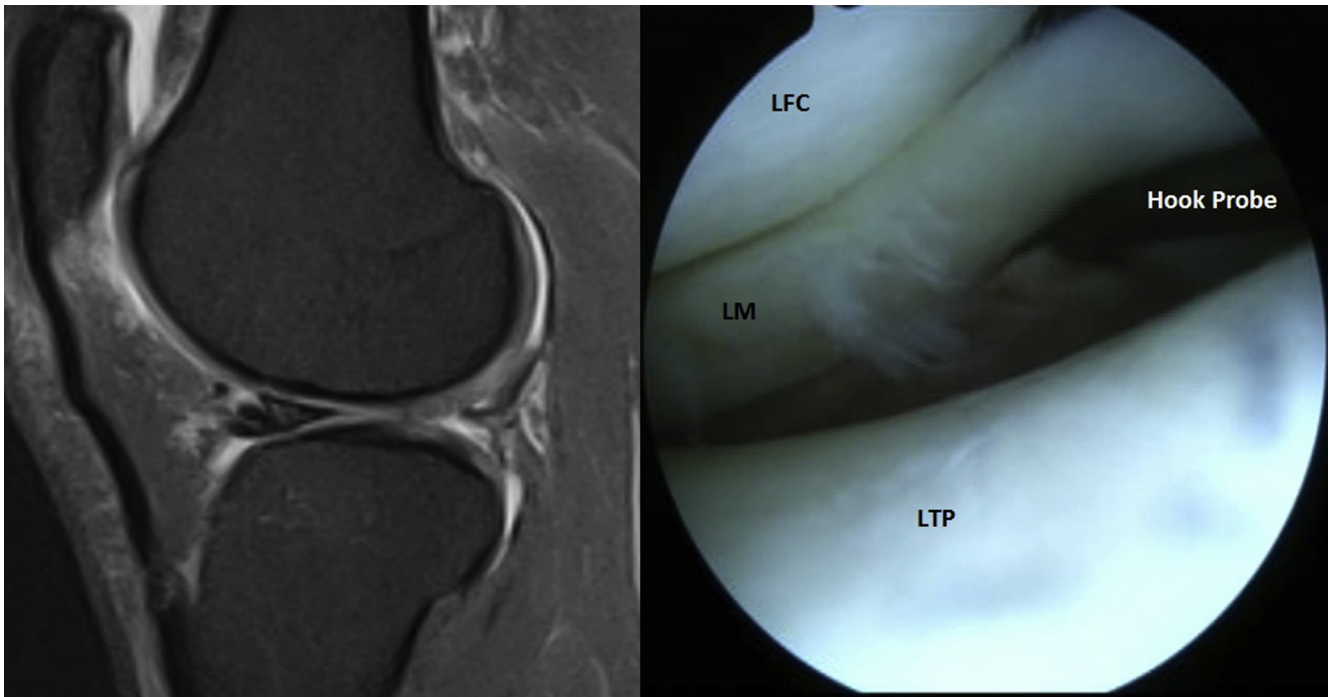


Fig 1. LM tear visible on the magnetic resonance scan and during diagnostic arthroscopy with the arthroscope introduced through anterolateral portal in the right knee. (LFC, lateral femoral condyle; LM, lateral meniscus; LTP, lateral tibial plateau.)

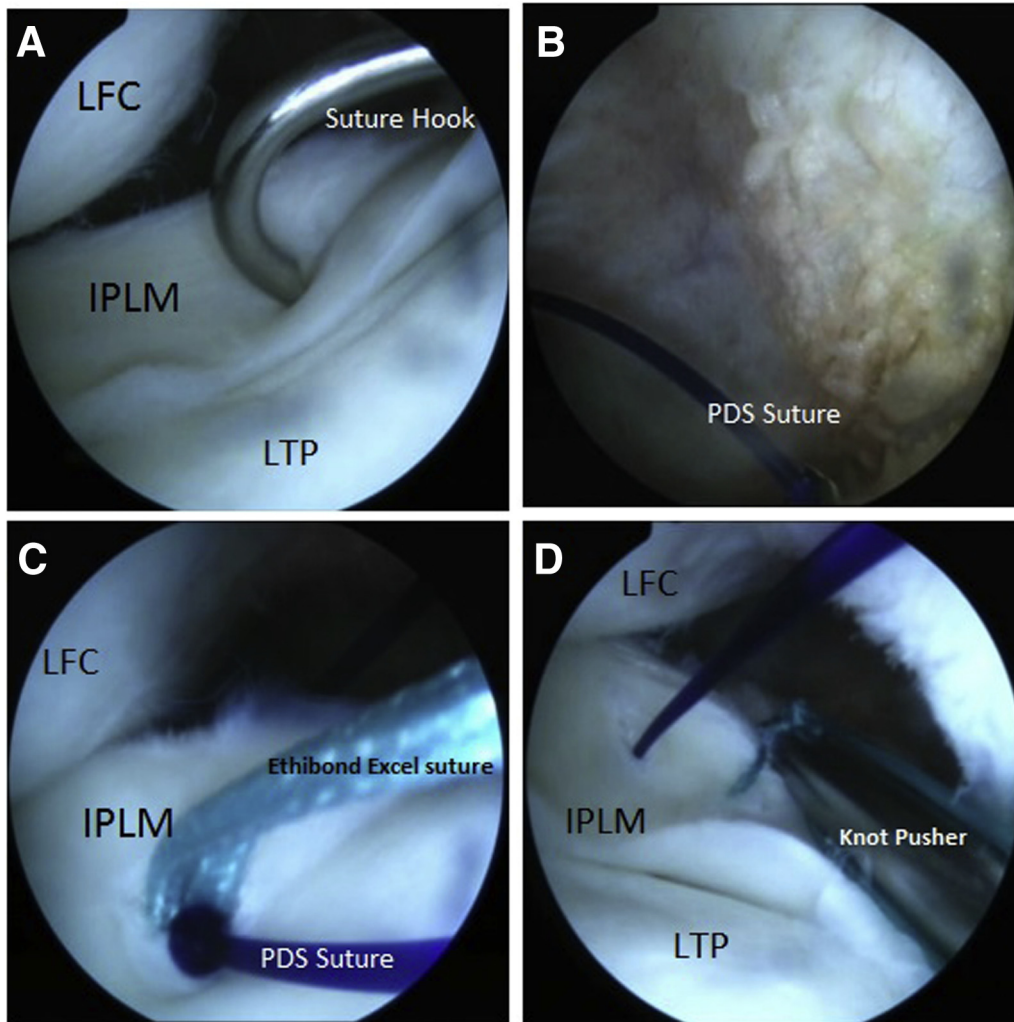


Fig 2. Arthroscopic view from the anterolateral viewing portal in the right knee joint. All-inside repair of the body of LM. Right suture hook introduced through anteromedial portal is pierced through the IPLM downward (A). The outer part of LM is pierced and the PDS suture is passed to the posterolateral recess (B). The PDS suture is replaced with the ETHIBOND EXCEL suture (C). After the last suture, sutures are tied with the knot pusher with 6 to 7 arthroscopic knots placed peripherally to avoid cartilage injury (D). (IPLM, inner part of lateral meniscus; LFC, lateral femoral condyle; LM, lateral meniscus; LTP, lateral tibial plateau.)

goal, the more peripheral limb of the suture should be treated as the post limb (Fig 2D).

Popliteal Hiatus Sutures

With the arthroscope introduced through the anterolateral portal, the curved to the right 45° spectrum suture passer (CONMED) is inserted through the anteromedial portal and the inner part of the LM is pierced downward in the same manner as described previously (Fig 3A). Then, the suture hook is pushed posteriorly during the same rotation to pass around the outer part of the LM. Due to the 45° inclination of the suture hook, this posterior push results in a more lateral exit of the suture hook tip in the popliteal hiatus, directly on the articular side of the popliteal tendon (Fig 3B). The arthroscope should be localized in the popliteal recess to assist this

maneuver (Video 1). Attention must be paid to not pierce the popliteal tendon. Then, the PDS suture is passed from the suture passer, positioned on the articular side of the popliteal tendon (Fig 3C). Finally, the PDS suture is replaced with an ETHIBOND suture and tied with the same method previously reviewed (Fig 3D). To facilitate the tying of the knots in the popliteal hiatus region, the portals may be switched with the anteromedial portal being the viewing portal and the anterolateral portal used as the working portal.

How to Repair the Anterior Part of the LM With a Needle

In case of lesions in the anterior horn of the LM, an all-inside repair may be facilitated by using a needle. If the repair of the meniscal tear is combined with a

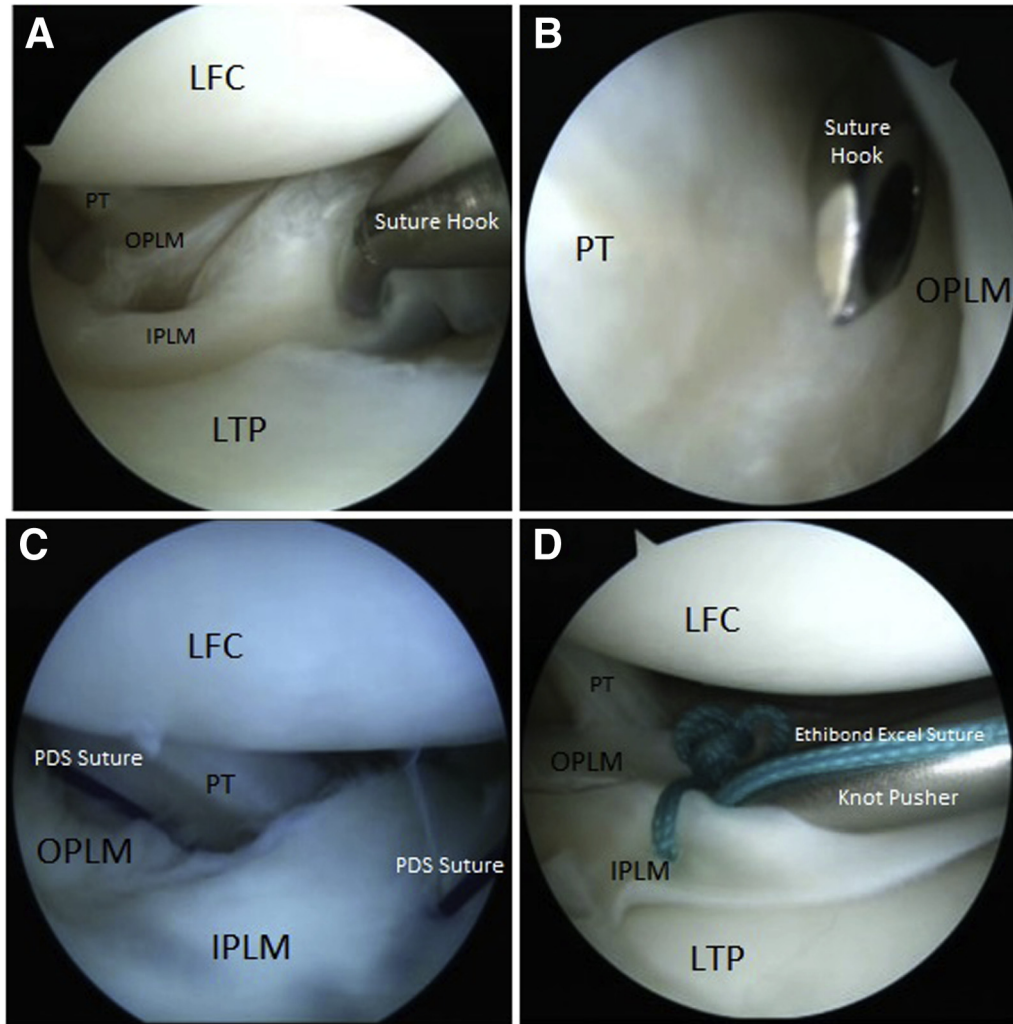


Fig 3. Arthroscopic view from the anterolateral viewing portal in the right knee joint. All-inside sutures in the proximity of popliteal hiatus. Right suture hook introduced through anteromedial portal is pierced through the IPLM downward (A). Then, it is rotated to exit between the PT and the OPLM (B). Attention must be paid not to pierce the PT. The PDS suture is passed to the joint (C) and replaced with ETHIBOND EXCEL suture. The suture is tied with 6 to 7 arthroscopic knots (D). (IPLM, inner part of lateral meniscus; LFC, lateral femoral condyle; LTP, lateral tibial plateau; OPLM, outer part of lateral meniscus; PT, popliteal tendon.)

partial meniscectomy due to the meniscal tear complexity, a circumferential stitch is used instead of conventional penetrating stitch to obtain the reduction of the torn meniscus. Visualization is provided through the medial parapatellar portal. A 12-gauge needle loaded with a No. 1 PDS II suture is pierced through the skin and is directed to pass beneath the torn anterior horn of the LM (Fig 4A). Then, the PDS suture is sent through the needle to the joint and retrieved from the joint using the suture retriever introduced through anteromedial portal. The needle loaded with the PDS suture is subsequently withdrawn, passed around the capsular side of the meniscus, and placed above the meniscus (Fig 4B). The PDS suture is retrieved from the needle to the joint. Then, the second limb of the suture is retrieved outside the joint to make a loop

surrounding the meniscus and the stitch is tied using 6 to 7 surgical knots (Fig 4C).

How to Repair the Anterior Part of the LM With a Suture Hook

The all-inside repair of the anterior horn of LM may be performed using a suture hook as well. The right 45° spectrum suture passer (CONMED) loaded with a PDS suture is introduced through the anterolateral portal and passed between the capsular side of the meniscus to the tibial surface of the meniscus. The free margin of the LM is elevated by the suture retriever introduced through medial parapatellar portal to facilitate the passage of the PDS suture from the suture passer. Then, the PDS suture is replaced with ETHIBOND suture and tied. Again, the circular stitch instead of a penetrating

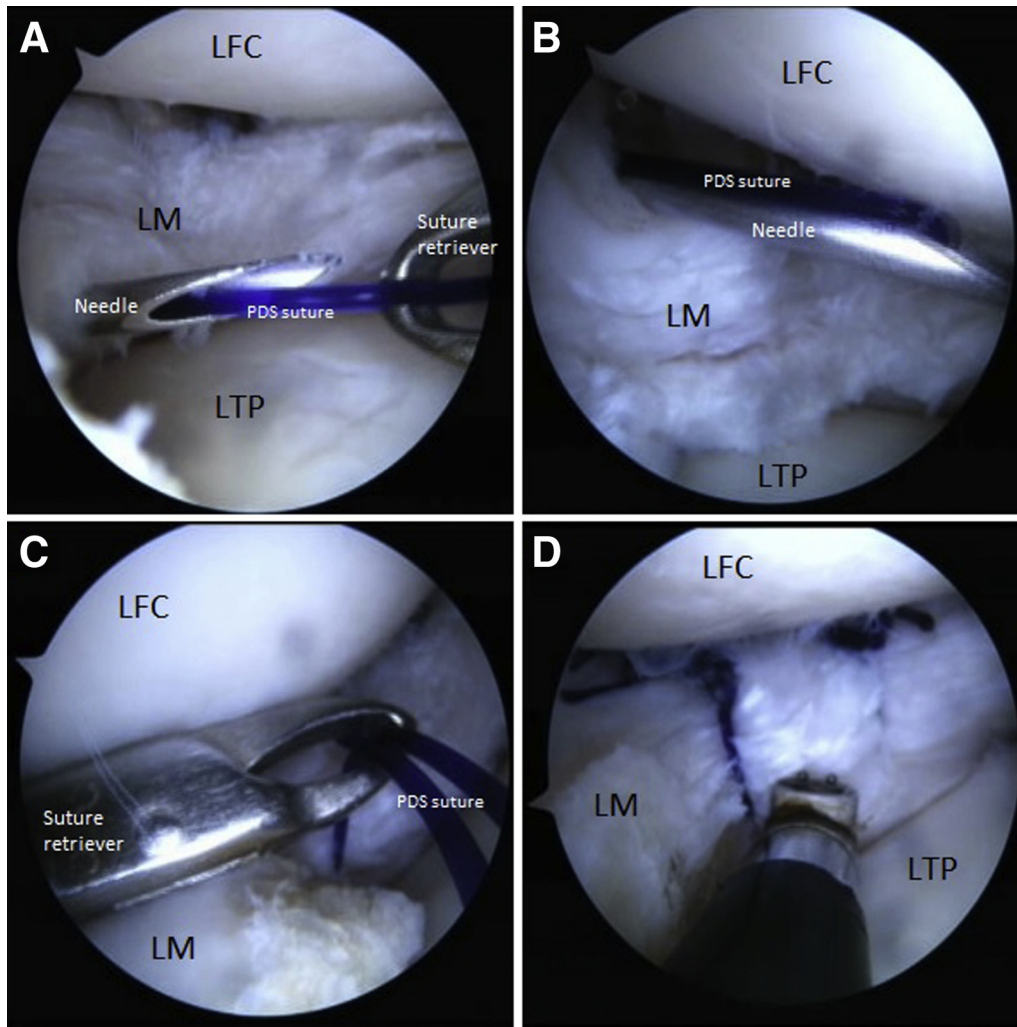


Fig 4. Arthroscopic view from the medial parapatellar viewing portal in the right knee joint. All-inside repair of the anterior horn of LM with a needle. A 12-gauge needle loaded with a PDS suture is pierced through the skin and is passed beneath the LM. The PDS suture is passed through the needle (A). Then the needle is passed around the capsular side of LM and placed above the LM (B). The PDS suture is passed to the joint and withdrawn with the suture retriever (C). The suture is tied in the circumferential fashion (D). (LFC, lateral femoral condyle; LM, lateral meniscus; LTP, lateral tibial plateau.)

suture may be used due to the partial resection of the meniscus.

How to Repair a Chronic Dislocated Bucket-Handle Tear of the LM

A deformed, chronically dislocated bucket-handle tear may be only temporarily reducible and keeping it in place during a repair may be difficult. Under such circumstances, both parts of the tear have to be pierced in a dislocated position and reduced during tying of the sutures.

The first suture is placed close to the LM posterior root with visualization through the anteromedial portal. The 45° spectrum suture passer loaded with a no. 1 PDS II suture is introduced through the medial parapatellar portal and a dislocated inner part of the LM is pierced. Then, the suture hook is passed through the tear and

under the outer part of the LM. When a tip of the hook is visible in the posterolateral recess of the knee, the PDS suture is passed, retrieved outside the joint, and replaced with a 2-0 ETHIBOND Excel suture. Attention must be paid to keep the proper orientation of the puncture, because the dislocated part of LM sometimes tends to twist along its long axis. Subsequent sutures may be placed in the same manner or with the arthroscope and the spectrum suture passer switched between anteromedial and medial parapatellar portals to obtain a better angle of attack for repair. The last suture, in front of popliteus tendon, is placed with the arthroscope in the anterolateral portal and suture hook placed with the anteromedial portal.

Each PDS suture only plays the role of a shuttle and is replaced with an ETHIBOND suture and retrieved through anterior portals without tying. When the

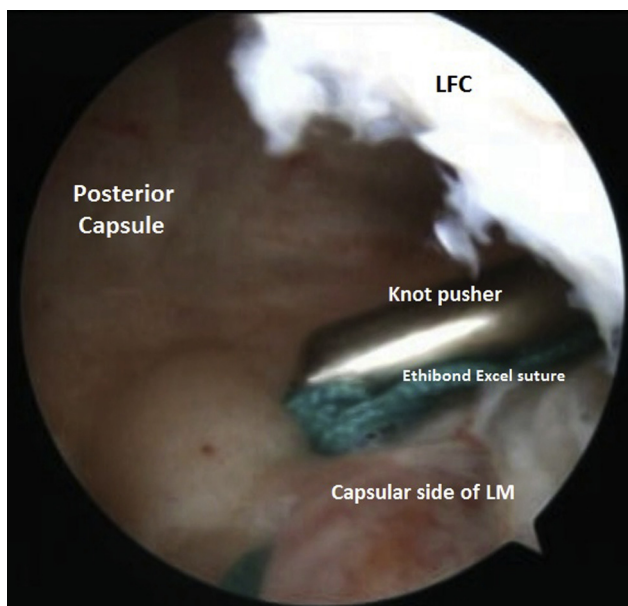


Fig 5. Arthroscopic view from the anteromedial viewing portal in the left knee joint. Trans-notch maneuver. Facilitation of the knot tying with the knot pusher introduced through posterolateral portal. (LFC, lateral femoral condyle; LM, lateral meniscus.)

desired number of sutures is placed, they are tied through the anterior portals as described above. In narrow joints, tying the sutures may be performed via a posterolateral portal (Fig 5, Video 1). In old, deformed tears, placing the first suture near the popliteal hiatus is preferred to distribute the tension on the whole repaired meniscus equally.

Rehabilitation

Because repaired LM is not fixed to the capsule, passive knee motion in the range of 0° to 90° without hyperextension is safe and starts at the first postoperative day. Walking on crutches is recommended for 2 to 6 weeks. For the first 2 postoperative weeks, the patient uses crutches with toe-touch weight bearing only. Then, the Duo brace (BREG, Inc. Carlsbad, CA) dedicated for lateral osteoarthritis of the knee is recommended for walking. It unloads repaired meniscus between 0 and 30° of flexion. At that time crutches may

be discontinued if tolerated. The brace is set for 0 and 90° and after the 6th week, full active range of motion is allowed. Bracing is discontinued gradually since 6-8th week as tolerated.

Discussion

The all-inside repair with nonabsorbable sutures provides several advantages. First, the all-inside repair permits independent motion of the meniscus and other surrounding structures. It is particularly important while considering the inherently greater mobility of the LM. One consequence is that it prevents the development of a hyperstable meniscus, which leads to acute suture breakage and re-tear. Moreover, despite the early introduction of exercises with passive range of motion, the healing of the lesion would not be impaired.

Second, an all-inside arthroscopic vertical suture of the menisci is considered one of the strongest sutures, thus providing an optimal environment to heal even in case of complicated tears.⁹ Even if part of tears (especially on the border between the red and the white zones) did not undergo complete healing, sutures would maintain the integrity of the meniscus purely mechanically, maintaining accordingly its biomechanical properties.

Furthermore, the all-inside meniscal repair technique, in contrast to the inside-out and outside-in techniques, do not impair the blood supply. The cadaver study conducted by Chen et al.⁷ demonstrated a high frequency of inferior lateral genicular artery puncture with transcapsular meniscal sutures—7 of 11 with inside-out and 8 of 11 with outside-in technique. In contrast, Cuéllar et al.⁶ reported that all-inside repair of the meniscus caused no puncture nor obliteration of the inferior lateral genicular artery.

However, this technique has also several drawbacks. It increases the length of a the surgical procedure, especially compared with all-inside meniscal implants. In addition, it is a technically demanding technique, with experience needed to apply it properly. Advantages and disadvantages of the presented technique are summarized in Table 1.

The proper choice of suturing material is also a factor determining the outcome of the procedure. Although

Table 1. Advantages and Disadvantages of All-Inside Lateral Meniscus Repair

Advantages	Disadvantages
<ul style="list-style-type: none"> • Ability to repair each part of LM anatomically • Early recovery of a full range of motion • Independent mobility of LM and surrounding tissues • No LM hyperstability • Reduced risk of neurovascular injury and skin complications • Cheap and reproducible 	<ul style="list-style-type: none"> • Longer duration of surgery • Technically demanding • Possibility of suture hook breakage in “more demanding” places of LM • Chondral damage during suture hook maneuvering, especially with improper visualization

LM, lateral meniscus.

Table 2. Tricks for All-Inside Lateral Meniscus Repair

Part of LM	Viewing Portal	Working Portal	Proposed Instruments and Possible Techniques
Body	Anterolateral/medial parapatellar	Anteromedial	<p>Instruments: 30° meniscal rasp top/bottom serrations, 45° Spectrum suture passer, suture retriever, PDS II suture no. 1, ETHIBOND EXCEL suture 2.0</p> <ul style="list-style-type: none"> • Refresh the margins of the tear. • Pierce the inner part of the meniscus. • Switch the arthroscope to the medial parapatellar portal. • Pierce the outer part of the meniscus. • Replace the PDS suture with the ETHIBOND suture. • Tie all knots at the end of the procedure as peripheral as possible.
Popliteal hiatus	Anterolateral	Anteromedial	<p>Instruments: 30° meniscal rasp top/bottom serrations, 45° Spectrum suture passer, suture retriever, PDS II suture no. 1, ETHIBOND EXCEL suture 2.0</p> <ul style="list-style-type: none"> • Refresh the margins of the tear. • Pierce the inner part of the meniscus. • Rotate the suture passer to exit in the popliteal hiatus. Visualize the region between the LM and the popliteal tendon with a vision provided through anterolateral portal. • Pass the suture to the popliteal recess. • Replace the PDS suture with the ETHIBOND suture. • Tie all knots at the end of the procedure as peripheral as possible. <p>Portals may be switched to facilitate the tying of the knots.</p> <p>Instruments: 30° meniscal rasp top/bottom serrations, 12-gauge needle/45° Spectrum suture passer, suture retriever, PDS II suture no. 1, ETHIBOND EXCEL suture 2.0</p> <p>With a needle:</p> <ul style="list-style-type: none"> • Pierce the skin and pass the needle beneath the anterior horn. • Pass the suture from the needle and retrieve it from the joint. • Pass the needle around and place it above the meniscus. • Pass the rest of the suture from the needle and subsequently retrieve it outside the joint. • Tie the knot in the circumferential fashion. <p>With a suture hook:</p> <ul style="list-style-type: none"> • Pass a suture hook from the capsular side of the meniscus beneath it. • Elevate the inner margin of the meniscus with the suture retriever. • Pass the suture and retrieve it from the joint. • Pass the suture hook around and place it above the meniscus. • Pass the rest of the suture outside the joint. • Tie the knot in the circumferential fashion.
Anterior horn	Anteromedial/medial parapatellar	Anterolateral/ anteromedial	<p>Instruments: 30° meniscal rasp top/bottom serrations, 12-gauge needle/45° Spectrum suture passer, suture retriever, PDS II suture no. 1, ETHIBOND EXCEL suture 2.0</p> <p>With a needle:</p> <ul style="list-style-type: none"> • Pierce the skin and pass the needle beneath the anterior horn. • Pass the suture from the needle and retrieve it from the joint. • Pass the needle around and place it above the meniscus. • Pass the rest of the suture from the needle and subsequently retrieve it outside the joint. • Tie the knot in the circumferential fashion. <p>With a suture hook:</p> <ul style="list-style-type: none"> • Pass a suture hook from the capsular side of the meniscus beneath it. • Elevate the inner margin of the meniscus with the suture retriever. • Pass the suture and retrieve it from the joint. • Pass the suture hook around and place it above the meniscus. • Pass the rest of the suture outside the joint. • Tie the knot in the circumferential fashion.
General rules			<ul style="list-style-type: none"> • Change the viewing and working portals to achieve proper visualization and adequate access for maneuvering. <ul style="list-style-type: none"> • Refresh the margins of the meniscus tear before suturing. • Try not to use a thigh tourniquet, because it prevents visualization of bleeding in the meniscus before repair is initiated. <ul style="list-style-type: none"> • Place the knots away from joint cartilage.

LM, lateral meniscus.

numerous implants were developed to facilitate the all-inside repair, their use carries the risk of suture loosening, chondral injury, or synovitis.⁸ Moreover, during the repair of the posterior horn of LM with a meniscal repair device, the popliteal vessels are reported to be at an increased risk of injury.¹⁰ This risk may be minimized by the repair of meniscal tear with a conventional suture since a surgeon, during this procedure, maintains superior control of the extent of punctured tissues. As presented, the nonabsorbable ETHIBOND

EXCEL suture is favored over the PDS suture. During the resorption PDS suture may irritate surrounding tissues, potentially leading to meniscal cyst formation.

As was stated previously, meniscal repair knots should be placed as peripherally as possible. More central placement of PDS knots results in rapid untying of the knots under repetitive loading, whereas ETHIBOND sutures tend to solidify and may cause chondral damage. The major methods to use this technique are presented in the [Table 2](#).

To summarize, an all-inside meniscal repair with nonabsorbable sutures combines the advantages of meniscal suture repairs and an all-inside implant, reducing the invasiveness of the procedure and avoiding implant-related complications. With proper technique, the majority of LM tears may be managed by this method.

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