

Tips and Pearls for All-Inside Medial Meniscus Repair



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Abstract: The medial meniscus is one of the most commonly injured structures in the knee. When the importance of its proper function is well understood, an adequate management in meniscus tear is a key issue for whole knee joint well-being. Although it has been proven that meniscal repairs have better long-term results than meniscectomy, there is still no consensus as to which suturing technique is the best. An all-inside technique seems to allow for the most anatomic repairs with the greatest preservation of surrounding soft tissues. Our aim is to show that there are no technical limits for all-inside meniscal repairs with nonabsorbable sutures. We describe the technique and some tricks for medial meniscus repair in this Technical Note.

Meniscal surgeries are one of the most commonly performed procedures in the knee. Since the role of the meniscus has become better understood, the importance of meniscus preservation is strongly emphasized, and currently, repair of meniscal tears is recommended when possible, regardless of a patient's age.^{1,2} It also has been proven that long-term outcomes of arthroscopic meniscal repair are significantly better than outcomes after partial meniscectomy in terms of slowing osteoarthritis progression and return to pre-injury activity level.³ Moreover, meniscal repair is a more cost-effective procedure than meniscectomy, as indicated by long-term observation, and it has been associated with a lower failure rate.^{4,5} Although the inside-out technique has been considered the gold standard for meniscal repair, the all-inside technique seems to have some advantages over the inside-out technique in terms of anatomy with respect to

surrounding soft tissues; it also allows for the introduction of a more aggressive rehabilitation protocol with early full range of motion. The all-inside technique is usually associated with use of special devices and implants, but it can also be performed with a suture hook and simple nonabsorbable vertical sutures. Our aim is to show that there are no technical limits for all-inside meniscal repairs with nonabsorbable sutures in different types of vertical longitudinal medial meniscus (MM) tears.

Surgical Technique

Indication

The indication for the procedure is symptomatic vertical longitudinal MM tears with the potential to heal, as an isolated procedure or a 1-step procedure with ligament reconstruction.

Contraindications

Contraindications for the procedure include degenerative meniscus body tear (Fig 1), meniscus extrusion, diffuse chondral lesions $>2^\circ$ according to the International Cartilage Repair Society, varus/valgus knee $>5^\circ$, and knee instability without ligament reconstructions.

Patient Positioning

The surgery is performed after induction of general or regional anesthesia. The patient is positioned supine. The operative leg is placed in a leg holder and then prepared and draped in sterile fashion. The nonsterile thigh tourniquet is not used to allow observation of bleeding from the meniscus during refreshing.

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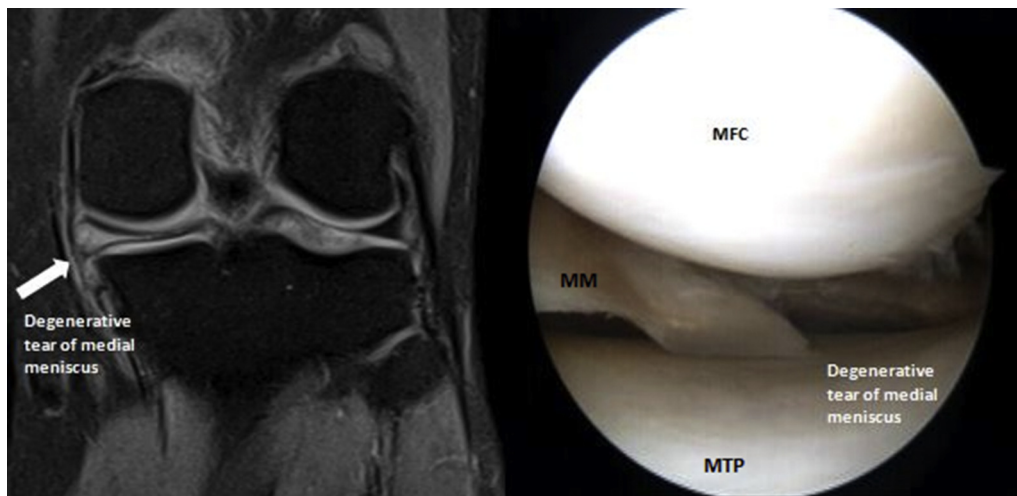


Fig 1. Degenerative medial meniscus (MM) tear revealed on the magnetic resonance imaging scan (empty meniscus body indicated by arrow) and during arthroscopy in the left knee joint with the arthroscope introduced through the anterolateral viewing portal. (MFC, medial femoral condyle; MTP, medial tibial plateau.)

Diagnostic Arthroscopy

Diagnostic arthroscopy is performed through standard anterolateral and anteromedial portals with a 30° arthroscope (Conmed, Warsaw, Poland). To facilitate visualization and maneuvering, medial

parapatellar and additional posteromedial portals can be made if necessary ([Fig 2](#)). The diagnosis of MM injury is made based on the visualization and confirmation of the tear with an arthroscopic hook probe ([Video 1](#)).

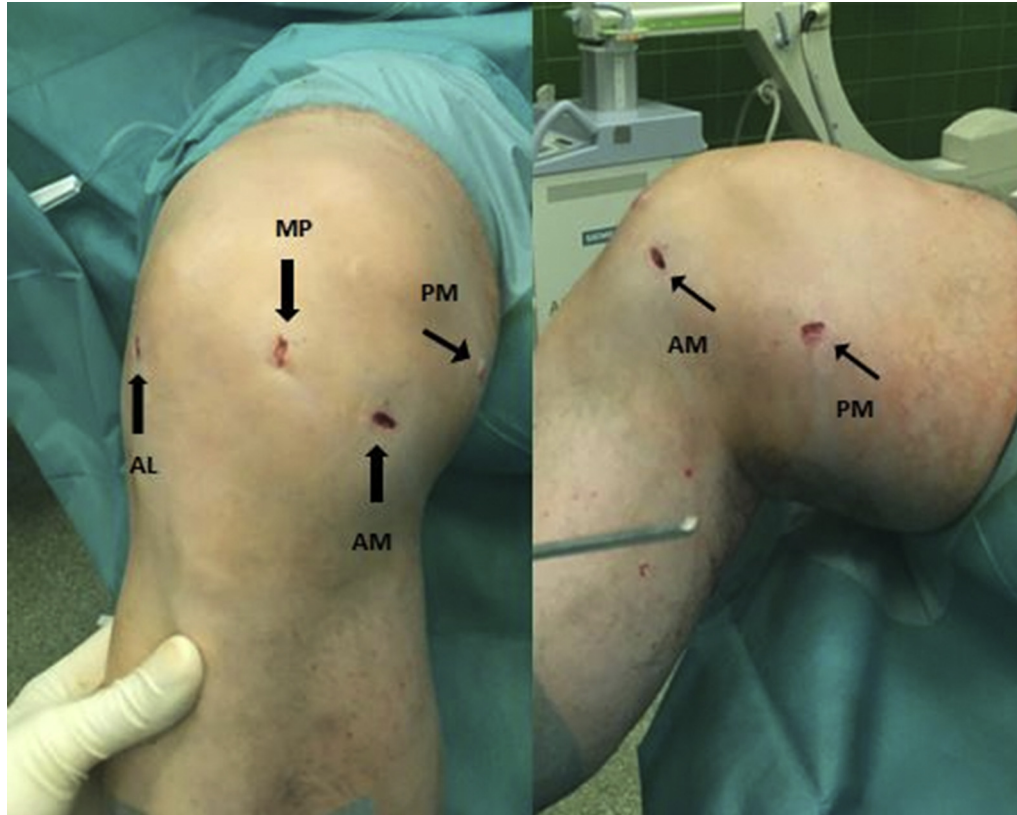


Fig 2. View on the right knee with positions of all arthroscopic portals that can be used in medial meniscus all-inside repair: AL, MP, AM, and PM portals. (AL, anterolateral; AM, anteromedial; MP, medial parapatellar; PM, posteromedial.)

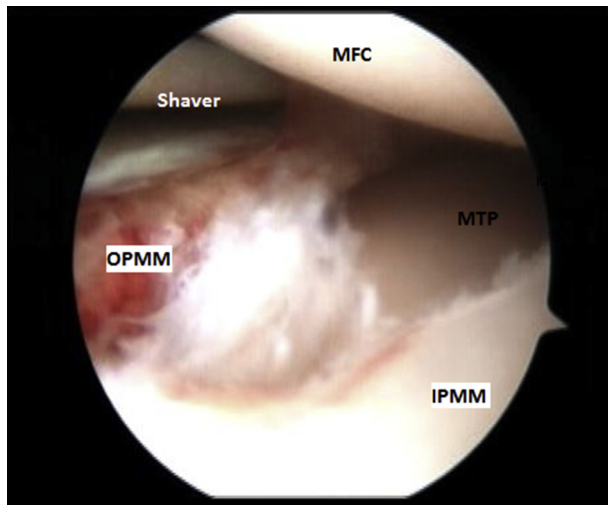


Fig 3. Arthroscopic view from the anterolateral viewing portal in the left knee joint. The OPMM and the IPMM tears are refreshed with a shaver introduced through the anteromedial portal. (IPMM, inner part of medial meniscus; MFC, medial femoral condyle; MTP, medial tibial plateau; OPMM, outer part of medial meniscus.)

Tricks for All-Inside Repair of an MM Bucket-Handle Tear

How to Repair the Body of the MM

The procedure is performed with the knee flexed to 20° to 90°, depending on which part of the MM is being repaired. When the diagnosis is confirmed, outer and inner parts of the MM tear are refreshed with a shaver introduced through the anteromedial portal ([Fig 3](#), [Video 1](#)). Then the left 45° Spectrum suture passer (Conmed), loaded with a PDS II suture No. 1 (Ethicon), is introduced through the anteromedial portal and pierces the inner part of the detached MM downward, in the place just anterior to the medial collateral ligament (MCL) ([Fig 4A](#), [Video 1](#)). The Spectrum suture passer is moved out of the joint, and the PDS II suture is replaced with an Ethibond Excel suture 2.0 (Ethicon) ([Video 1](#)). In the next step, the right 45° Spectrum suture passer, loaded with a PDS II suture No. 1, is introduced through the anteromedial portal; pierces the outer, capsular part of the MM downward; and is moved back, leaving the PDS II suture inside ([Fig 4B](#),

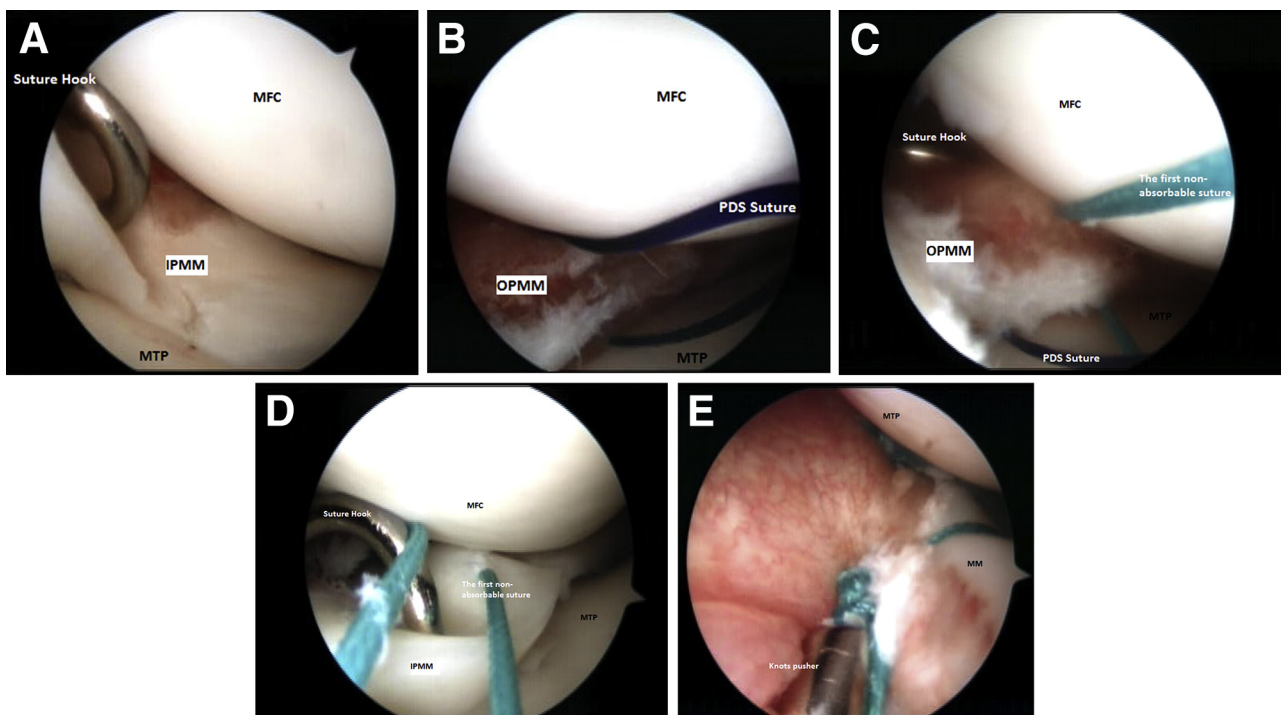


Fig 4. Arthroscopic view from the anterolateral viewing portal in the left knee joint. All-inside repair of the body of medial meniscus. (A) Left suture hook introduced through anteromedial portal is pierced through the IPMM downward. Then the PDS II suture is passed into the joint and replaced with a nonabsorbable suture. (B) The PDS II suture passed through the OPMM with right suture hook. The PDS II suture is used as a shuttle for nonabsorbable strand. (C) The second vertical suture is placed 5 to 8 mm anteriorly by piercing the right suture hook downward through the OPMM at first, sliding the PDS suture into the joint and replacing it with nonabsorbable suture. (D) The second vertical suture is finished by piercing the right suture hook through the IPMM downward, passing the PDS II suture and replacing it with the nonabsorbable suture passed earlier through the outer part of tear. (E) The sutures are tied with the arthroscopic knot pusher with 6 to 7 surgical knots placed outside the MM body to avoid cartilage injury. (IPMM, inner part of medial meniscus; MFC, medial femoral condyle; MM, medial meniscus; MTP, medial tibial plateau; OPMM, outer part of medial meniscus.)

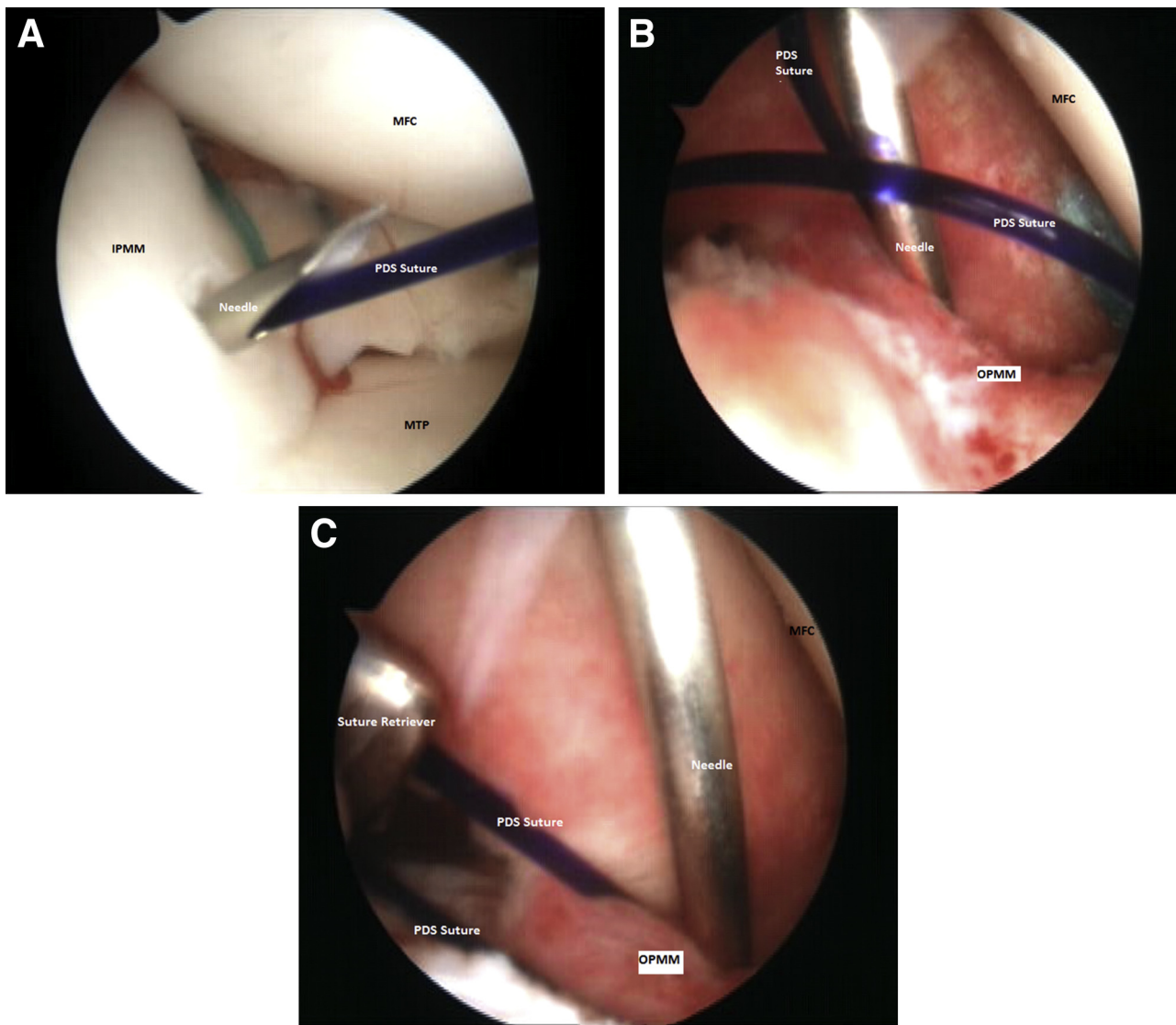


Fig 5. Arthroscopic view from the medial parapatellar portal in the left knee joint. Anterior horn of medial meniscus all-inside repair. (A) The needle is introduced through the anteromedial portal and pierces the IPMM upward; the PDS II suture is passed into the joint. (B) Then the same needle is moved back and pierces the OPMM upward; the PDS II suture is pushed forward to form a loop. (C) The PDS II suture loop and PDS free end are caught together with suture retriever, pulled out of the joint through anteromedial portal and used as a shuttle for nonabsorbable sutures. (IPMM, inner part of medial meniscus; MFC, medial femoral condyle; MTP, medial tibial plateau; OPMM, outer part of medial meniscus.)

Video 1). The ends of the PDS II suture and the Ethibond Excel suture 2.0 facing the MM tear are caught together, moved out of the joint with a suture retriever (Arthrex), and tied together. The end of PDS II suture, which was passed through the outer part of the MM, is then pulled out of the joint, and the Ethibond Excel suture 2.0 is introduced in its place (**Video 1**). The second vertical suture is placed 5 to 8 mm frontward and can be placed in the same way as the first vertical suture or by changing the sequence in which MM parts are pierced (the outer part at first and then the inner part) (**Fig 4 C and D**, **Video 1**). At this time, the sutures are tied outside the meniscus body and cartilage with 6

to 7 surgical knots (**Fig 4E**, **Video 1**). Presented maneuvers allow suturing of most tears of the anterior and medial parts of the MM.

How to Repair the Anterior Horn of the MM

An example of a less accessible area for all-inside meniscal repair is the anterior horn of the MM. In this case, the arthroscope is introduced through the medial parapatellar portal, and a needle loaded with a PDS II suture No. 1 is inserted through the anteromedial portal. The needle pierces the inner part of the torn MM; the PDS II suture is passed into the joint and retrieved through the anteromedial portal (**Fig. 5A**,

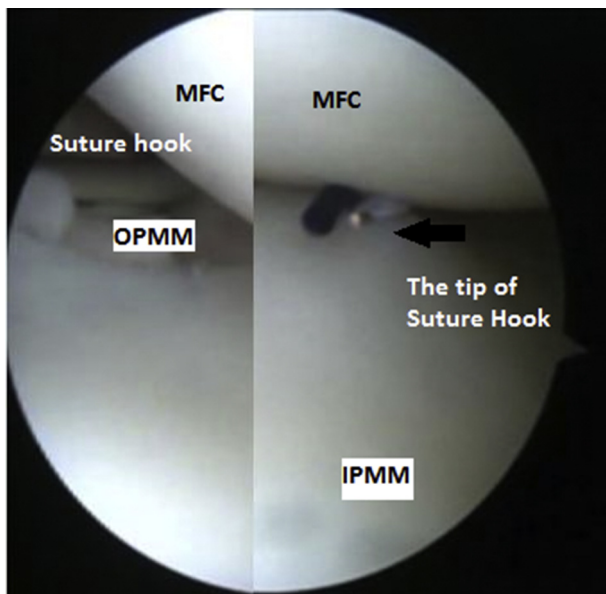


Fig 6. Arthroscopic view from the anterolateral viewing portal in the left knee joint. The suture hook pierces the OPMM and the IPMM at once; the PDS II suture is passed into the joint and used as a shuttle for a nonabsorbable suture. This maneuver allows for shorter duration of surgery. (IPMM, inner part of medial meniscus; MFC, medial femoral condyle; OPMM, outer part of medial meniscus.)

Video 1). Then the needle is slowly pulled back and pierces the outer part of the torn MM (Fig. 5B, Video 1). The PDS II suture is passed forward, forming a loop, which is caught together with the pierced end of the PDS II suture with an arthroscopic suture retriever and moved out of the joint through the anteromedial portal, while the needle is simultaneously moved back (Fig. 5C, Video 1). The PDS II suture is then replaced

with an Ethibond Excel suture 2.0, and the suture is tied (Video 1).

How to Reduce the Duration of Surgery

When possible, the Spectrum suture passer with the PDS II suture should be passed through both (outer and inner) parts of the MM at once (Fig. 6, Video 1).

How to Repair a Posterior Horn/Ramp Lesion of the MM

Transnotch visualization of the posteromedial compartment is achieved by passing the arthroscope from the anterolateral portal through the triangle formed by the posterior cruciate ligament (PLC), medial femoral condyle (MFC), and medial tibial spines. Under visual control, an additional posteromedial portal is made and used to introduce the 30° Meniscal Rasp Top/Bottom Serrations (Conmed) and refresh the MM posterior horn lesion (Fig. 7A, Video 1). Then the left 45° Spectrum suture passer, loaded with a PDS II suture No. 1, is introduced through the posteromedial portal, passed first through the inner part of the injured meniscus downward, and then through the outer part upward and replaced with the Ethibond Excel suture 2.0, as described previously for an MM body tear (Fig. 7B, Video 1). The next vertical sutures can be placed in the same way or by piercing the inner and outer parts of the MM at once. The sutures are tied with 6 to 7 surgical knots placed outside the MM tissue to avoid chondral damage (Video 1).

How to Provide Proper Stability for MM Repair

We observed that in a bucket-handle MM tear, the suture placed at the level of the MCL plays a key role in proper MM stability (Fig. 8A, Video 1). To achieve

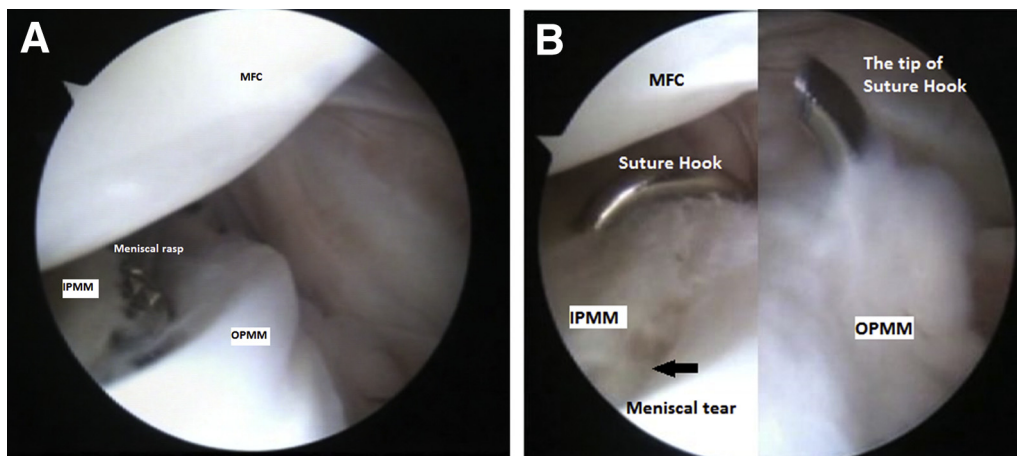


Fig 7. Arthroscopic view from the anterolateral viewing portal in the left knee joint: trans-notch maneuver. Posterior horn/ramp lesion all-inside repair. (A) The meniscal rasp, introduced through the posteromedial portal, is used to refresh both margins of medial meniscus tear. Then the suture hook is introduced through the posteromedial portal and used to pass the PDS II suture through the IPMM and the OPMM. The PDS II suture is replaced with a nonabsorbable suture and tied. (IPMM, inner part of medial meniscus; MFC, medial femoral condyle; OPMM, outer part of medial meniscus.)

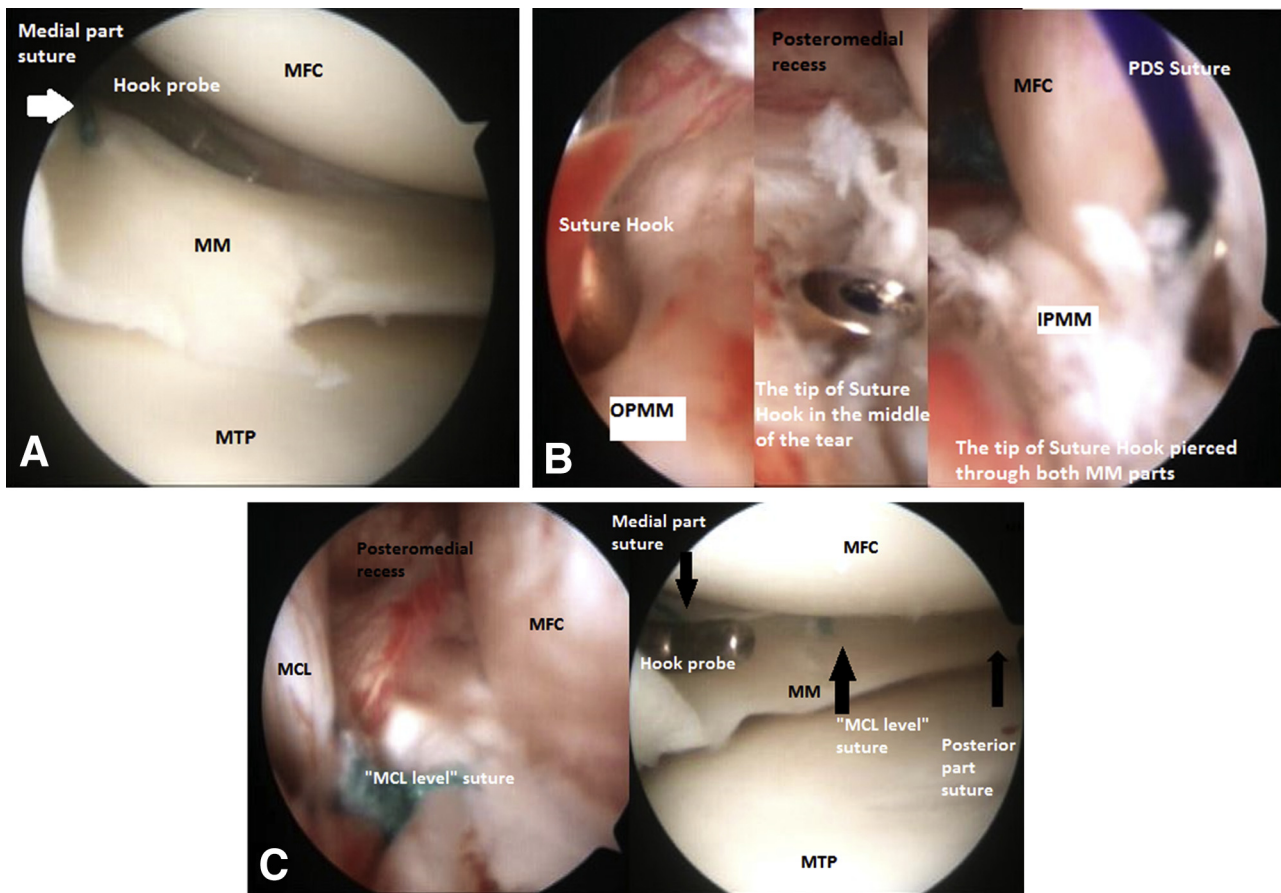


Fig 8. “MCL level” suture for providing medial meniscus stability. (A) Arthroscopic view from the anterolateral viewing portal in the left knee joint. The inspection with arthroscopic hook probe revealed MM instability at the level of the MCL. (B) Arthroscopic view from the anteromedial portal in the left knee joint. The right suture hook, introduced through posteromedial portal, is used to pass the PDS II suture through the OPMM and the IPMM. The PDS II suture is replaced with a nonabsorbable suture. (C) Arthroscopic views from the anteromedial and anterolateral portals on the MCL level suture in the left knee joint. The MM is stable. (IPMM, inner part of medial meniscus MCL, medial collateral ligament; MFC, medial femoral condyle; MM, medial meniscus; MTP, medial tibial plateau; OPMM, outer part of medial meniscus.)

placement of the suture at the MCL level, the arthroscope is introduced through the anteromedial portal to the medial recess, and the left 45° Spectrum suture passer is introduced through the posteromedial portal and used to pass a PDS II suture No. 1 through the outer and inner parts of the torn MM at the level of the medial collateral ligament (MCL) (Fig 8B, Video 1). The PDS II suture is then replaced with an Ethibond Excel suture 2.0, and the suture is tied (Fig 8C, Video 1).

The effect of bucket-handle MM tear repair with the technique presented can be observed during second-look arthroscopy performed for other indications (Fig. 9, Video 1).

Rehabilitation

The patient starts passive knee motion in the range of 0° to 90° on the day after surgery. The patient walks using crutches for 5 to 6 weeks, depending on the knee condition.

Discussion

The most important advantage of the all-inside technique is a respect for anatomy and biology. Use of all-inside sutures, in comparison with outside-in and inside-out techniques, provides repair of the MM without fixing it to surrounding soft tissues. It makes the MM mobile independently of structures such as the MCL, capsule recesses, or muscles and allows it to heal despite the introduction of early passive range of motion. Moreover, it avoids MM hyperstability, which can lead to acute suture breakage or retearing. Another advantage of using all-inside sutures over the inside-out technique is a reduced risk of neurovascular damage and skin and soft tissue complications.¹ It has also been proven that both techniques can restore knee biomechanics to a nearly native state, but inside-out meniscal repair can restore the contact area to a nearly native state and peak contact pressure in the range of 0° to 45° knee motion, whereas the all-inside technique restores it in the range

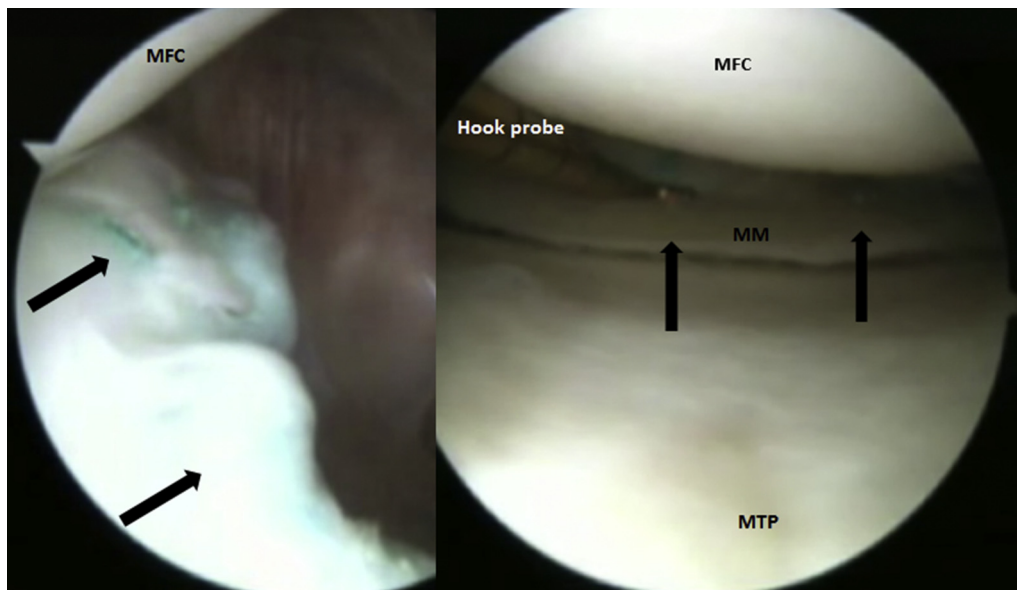


Fig 9. Arthroscopic view from the anterolateral viewing portal in the left knee joint. Second-look arthroscopy. Stable MM. The nonabsorbable sutures are marked with arrows. (MFC, medial femoral condyle; MM, medial meniscus; MTP, medial tibial plateau.)

of 0° to 60°—the angles usually used in everyday life.⁶ However, commonly reported disadvantages of the all-inside technique are implant-related symptoms such as meniscal and chondral lesions, implant migration, and foreign body reactions.^{2,7} This is the reason that we recommend use of a suture hook with nonabsorbable sutures for all-inside meniscal repairs.

This Technical Note describes many variants of use of all-inside vertical sutures. The choice of sutures depends on the requirements and risks associated with each type of MM tear: bucket-handle tear, ramp lesion, posterior horn tear, meniscus body tear, and anterior horn tear. Propositions of applying these suturing techniques are shown in [Table 1](#). It is possible to create 4 arthroscopic portals (anterolateral, anteromedial, medial parapatellar, posteromedial), and each one can be used as either viewing or working portal, facilitating whole medial tibiofemoral joint visualization and instrument maneuvering, which is a precondition for proper tear site reduction and perpendicular suture placement, leading to improvement in healing rates.⁸ Moreover, when a transnotch maneuver is performed, creation of a trans-septal portal for visualization of the posteromedial compartment is not necessary, reducing the risk of popliteal bundle injury.⁹ Furthermore, this technique not only avoids MCL sectioning, which causes iatrogenic medial instability, but it also allows placement of the suture at the level of the MCL, resulting in stability for the MM.

The all-inside technique of meniscus repair with nonabsorbable sutures also has some disadvantages.

First, the duration of surgery is significantly longer than procedures in which implants are applied. Second, all the maneuvers described here require some experience in the field of arthroscopic surgery and are technically demanding. The learning curve is crucial. In an inexperienced hand, repetitive meniscus puncture can lead to meniscal tissue damage, making the repair impossible. Another risk is associated with improper arthroscopic visualization as a result of an inadequate arthroscopic portal location. In such a case, there is a higher risk of creating lesions in the meniscus body, as well as in the articular cartilage, especially in places with little free space for maneuvering. An inadequate portal location can also be a cause of suture hook breakage. Moreover, although the risk of saphenous nerve damage is lower than that associated with the inside-out technique, it still exists, especially during posteromedial portal creation. There are also general surgical risks such as improper wound healing and thrombosis. Advantages and disadvantages are summarized in [Table 2](#).

Conclusions

There are no technical limits for all-inside MM repair. The key is selection of appropriate candidates for the procedure. An all-inside technique with nonabsorbable sutures is a cost-effective, efficient, and reliable method for repair of MM tears and can be performed as an isolated procedure or a 1-stage procedure with ligament reconstruction.

Table 1. Tricks for All-Inside Medial Meniscus Repair

Part of MM	Viewing Portal	Working Portal	Proposed Instruments and Possible Techniques
Body	Anterolateral	Anteromedial/medial parapatellar	Suture hook 45°, PDS II suture, nonabsorbable suture, suture retriever Knee position: $\approx 20^\circ$ of flexion, valgus stress • Use the suture hook to pierce the inner part of torn MM, pass the PDS II suture, and replace it with a nonabsorbable suture; then use the suture hook to pierce the outer part of torn MM, pass the PDS II suture, and use it as a shuttle for the nonabsorbable suture. Tie the suture. • Use the suture hook to pierce the outer part of torn MM, pass the PDS II suture, and replace it with a nonabsorbable suture; then use the suture hook to pierce the inner part of torn MM, pass the PDS II suture, and use it as a shuttle for the nonabsorbable suture. Tie the suture. • Use the suture hook to pierce both parts of torn MM at once, pass the PDS II suture, and replace it with a nonabsorbable suture. Tie the suture.
Anterior horn	Medial parapatellar	Anteromedial	Needle (or straight suture hook), PDS II suture, nonabsorbable suture, suture retriever Knee position: 90° of flexion • Use the needle to pierce the inner part of torn MM, slide the PDS II suture into the joint, and retrieve it through the anteromedial portal. Pull back the needle slowly and pierce the outer part of MM with the same PDS II suture, forming a loop around the needle. Catch the loop and the other end of the PDS II suture with the suture retriever; pull both ends of the PDS II suture out of the joint and replace it with a nonabsorbable suture.
Posterior horn/ramp lesion	Anterolateral + transnotch maneuver	Posteromedial	Suture hook 45°, PDS II suture, nonabsorbable suture, suture retriever Knee position: 90° of flexion • Techniques of vertical suture placement are similar to this for the meniscus body.
Medial collateral ligament medial suture	Anteromedial	Posteromedial	Suture hook 45°, PDS II suture, nonabsorbable suture, suture retriever Knee position: 90° of flexion, figure-of-4 position • Techniques of vertical suture placement are similar to this for the meniscus body.
General rules			• Change the viewing and working portals to achieve proper visualization and adequate access for maneuvering. • 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. • Place the knots away from joint cartilage.

MM, medial meniscus.

Table 2. Advantages and Disadvantages of All-Inside Medial Meniscus Repair

Advantages	Disadvantages
Ability to repair each part of medial meniscus anatomically	Longer duration of surgery
Early free range of motion: Medial meniscus can move independently of surrounding soft tissues.	Technically demanding: Some experience in arthroscopic surgery and creation of additional portals required
No medial meniscus hyperstability	Learning curve crucial
Reduced risk of neurovascular injury and skin complications	Possibility of suture hook breakage in “more demanding” places of MM
No need for medial collateral ligament puncture	Risk of saphenous nerve injury during posteromedial portal creation
Cheap and reproducible	Meniscal tissue lesions with repetitive puncture
	Chondral damage during suture hook maneuvering, especially with improper visualization

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