

Lateral Meniscus Repairs Using Single Posteromedial Portal by All-Inside Suture-From Posterior to Anterior



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Abstract: The meniscus plays an important role in absorbing shock, sharing load, reducing contact stress, and maintaining stability of knee joint movement. We know that there are various ways to repair meniscus injuries under arthroscopy. However, we found some technical limitations during the operation, such as the risk of neurovascular injury and the long operation time of repair. On this basis, we modified the lateral meniscus suture technique. A special technique of lateral meniscus repairs using a single posteromedial portal by all-inside suture is proposed: from posterior to anterior, we believe that this technique can effectively optimize the surgical procedure and reduce the time of repair surgery resulting from angle problems, and the use of this method can effectively reduce the possibility of damage to the nerves, blood vessels, and tendons in the knee joint. Surgeons who are initially exposed to arthroscopic repair of the lateral meniscus can use this repair method, which reduces the surgical threshold for the suture of the lateral meniscus.

The meniscus is a fibrocartilaginous structure vital to the internal dynamics of the knee joint, providing shock absorption, load distribution, minimization of contact stress, and stabilization.^{1,2} Meniscal injuries can result from sports injuries along with age- or disease-related degeneration. Medial meniscal injuries are often associated with age and osteoarthritis, whereas risk factors for lateral meniscal tears include youth, sports injuries, and concomitant anterior cruciate ligament damage. Lateral meniscal injuries may involve the knee's popliteal tendons and hiatus, categorized as "popliteal hiatus meniscal tears" by Zheng et al.³ The dynamic relationship between the popliteus tendon and hiatus renders the lateral meniscus in this region particularly prone to damage as a result of high activity. There are 2 options for the treatment of meniscus

injuries: conservative and surgical treatment. Studies have shown that the prognosis of most traumatic meniscus tears is good, and in 2 randomized controlled trials that investigated surgical and nonsurgical treatment, the authors found no difference in the ability of patients to participate in sports between the 2 treatments. However, menisci tears increase the risk of developing osteoarthritis in the long run. Therefore, we focus on the surgical treatment of meniscal tears.⁴⁻⁶

Various arthroscopic repair techniques for meniscal tears exist. According to a study reviewing the all-inside suture of bucket-handle tears of the meniscus, the overall failure rate of bucket-handle meniscal tear all-inside meniscus repair is 29.3% during an average follow-up of 13 months,⁷ in which the choice of various surgical techniques is not obvious. The inside-out suture (OI) was initially considered for its biomechanical advantages. However, this portal harbors increased risks of peroneal nerve and inferolateral genicular artery damage. Although all-inside (AI) suturing is criticized for foreign body reactions, cartilage wear, and fixation displacement in earlier studies, recent advancements in AI suture devices and surgical techniques have positioned AI as increasingly popular. This popularity stems from requiring fewer incisions, potentially lessening operative time, postoperative pain, and neurovascular injury risks compared to IO suturing. Despite AI's advantage in mitigating the risk of

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damaging neurovascular structures lateral to the meniscal body, our practice found difficulty in repairing the anterior and body segment of the lateral meniscus through standard arthroscopic portals (anteromedial [AM], anterolateral [AL]), attributed to anatomic constraints and arthroscopic technique limitations.

To address this, we describe a surgical technique employing a posteromedial (PM) portal for meniscal repair, particularly suitable for lesions affecting the popliteal hiatus region of the lateral meniscus anterior horns and body. Alongside the standard anterior portals, we used a PM portal. All-inside meniscal suturing is conducted internally, whereas the posterior-anterior suture pass avoids the popliteus tendon, peroneal nerve, and inferolateral genicular artery, significantly reducing the possibility of iatrogenic damage.

Surgical Technique

Patients with meniscal tears may not present with recent trauma history. Pain typically occurs in hyperextension, often accompanied by joint locking or popping.^{8,9}

Radiographic images may not reveal isolated meniscal injuries; hence, magnetic resonance imaging (MRI) is the diagnostic modality of choice. MRI with T2-weighted sequences is the gold standard for diagnosing meniscal injuries, which is straightforward clinically but not as clear-cut when discerning complex lateral meniscal tears (Fig 1).

Under general anesthesia, the patient is positioned in a supine position with flexed knees for the operation. A

nonsterile tourniquet is used, placed higher on the limb and typically inflated to 250 mm Hg pressure.

Posterior-to-Anterior Repair Technique

Initially, 2 standard anterior portals, the AM and AL, are established to access and operate on the injured meniscus. A comprehensive arthroscopic examination is conducted using the instruments related to arthroscopic surgery, such as lenses, etc, with all findings recorded. With the scope in the AM portal, we perform a simple cleaning of the rough part of the meniscus and determine the size and location of the tear. If the patient has a bucket handle tear of the meniscus, we will also reduce the meniscus by folding the meniscus and avoid trimming the meniscus tear as the original meniscus edge. The synovial and meniscal adhesives are cleared, and the inner edge is repositioned using a hook probe (Fig 2A). After debridement with meniscal rongeurs and partial meniscectomy (Fig 2B), the inner meniscus and stability of the knee ligaments are confirmed arthroscopically.

Subsequently, a PM portal is created under direct visualization from the AL portal: with the scope through the AM portal, an exchange rod is inserted through the operational pathway between the posterior cruciate ligament and medial wall of the intercondylar notch. This allows the exchange rod entry into the PM compartment with the knee in a “figure-of-4” position. The PM compartment of the knee joint can be viewed arthroscopically. The PM portal location is determined via the arthroscopic light source, and a dural needle is used to prod the skin (Fig 3C), creating a “soft spot” without injuring nearby tendons. After a skin incision is

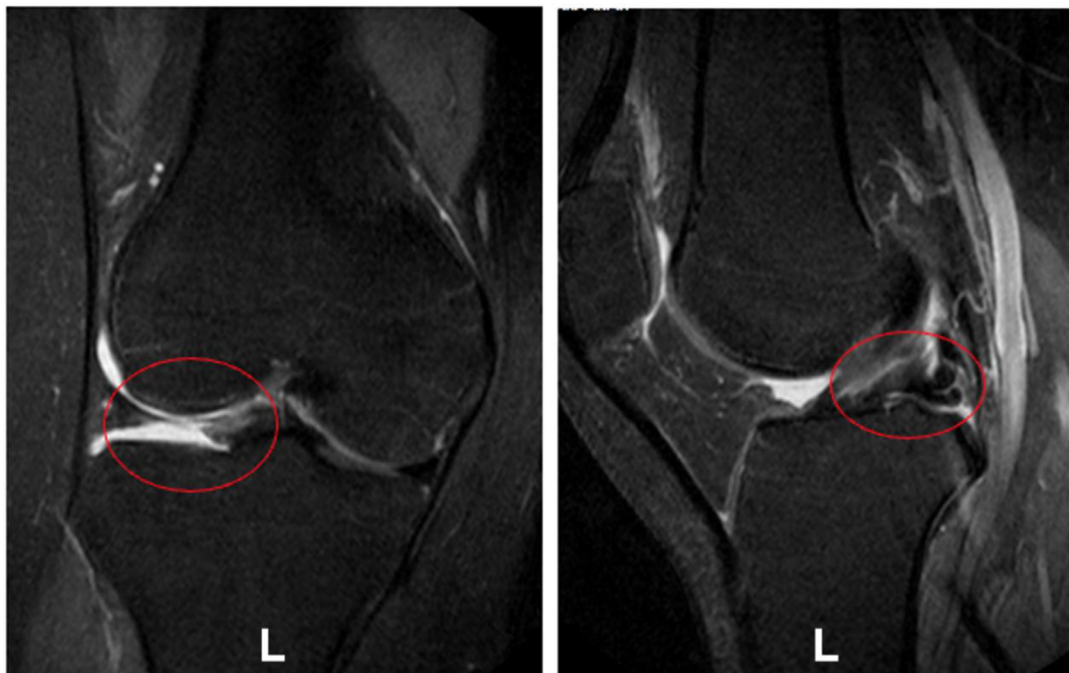


Fig 1. Preoperative magnetic resonance imaging of patients (left knee): A bucket-handle tear of the lateral meniscus can be seen. The MRI used the patient's left leg.

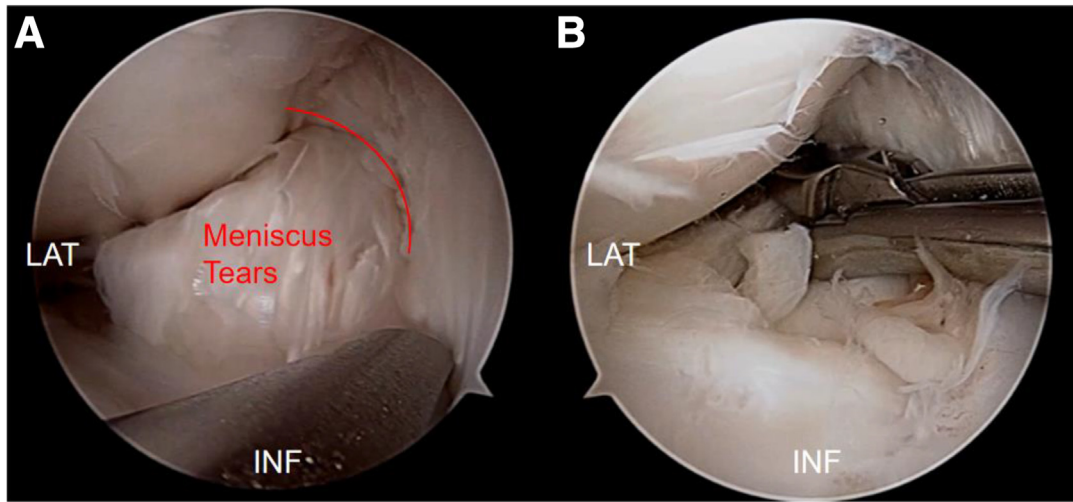


Fig 2. (A) A bucket-handle tear of the lateral meniscus is observed under arthroscopy. (B) Meniscal molding is performed. A-C shows what we observed through the AL portal. (AL, anterolateral; INF, inferior; LAT, lateral.) We operated on the left knee joint of the patient. In this legend, only pictures A and B are involved, and there is no picture C.

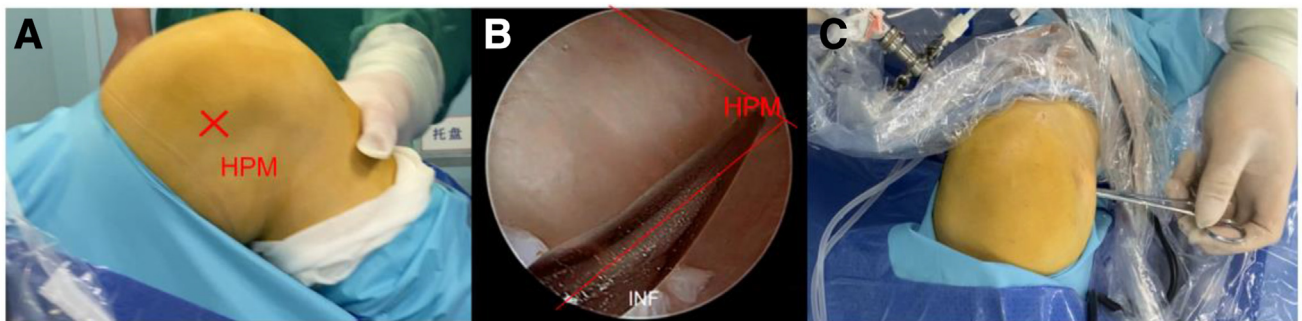


Fig 3. (A) When creating the posteromedial portal, we can open the portal a little higher. (B) Use of the exchange rod to gain entry into the posteromedial compartment. (C) After a skin incision is made with a scalpel, the portal is dilated using hemostatic forceps. The patient's leg is the left leg. (HPM, The center of the soft point of the triangle formed by the posterior internal margin of the femoral condyle, the posterior internal margin of the tibia and the semitendinosus is generally located 1 cm above the posterior internal joint line space.)

made with a scalpel, the portal is dilated using hemostatic forceps (Fig 3C).

Once the PM portal is established, an exchange rod is used to gain entry into the PM compartment, and direct vascular forceps are used to bluntly pierce the knee's posterior septum to form a pathway (Fig 4A). The exchange rod is then entered into the PM compartment and guided anterolaterally across the septum. With the scope transferred to the AL portal, we observed the rod's penetration to confirm its trajectory toward the damaged meniscal segment. A cannula should follow the rod's path from the PM portal. The meniscal rongeurs are used to remove any remaining irregular meniscal fragments, and a smooth finish is achieved with a shaver (DYONICS BONECUTTER; Smith & Nephew, Andover, MA). As a result of scar tissue formation on the healed tear, a meniscal rasp is used to freshen it, fostering postoperative healing. Then, the cannula (LEADRUN F02533001) is reinserted, aiming

at the anterior and body sections, and all-inside meniscal suturing devices (FAST-FIX 360 Curved Needle Delivery System; Smith & Nephew) are aligned for repair using a vertical mattress suture. Vertical mattress stitches are applied—pushing out the suture at the meniscus's posterior edge, followed by the second knot. The suture device is removed, and the knot is tightened with a knot pusher, then cut short. Additional sutures are placed for the anterior horn, and upon inspection of stability, one more suture is added to reinforce the meniscal body segment. Suturing is now complete (Fig 4 B and C). After ensuring meniscal stability with a probe and confirming the absence of other knee pathologies, the arthroscopy system is retracted, and the patient's surgical wound is sutured and dressed.

Postoperative Rehabilitation

The postoperative rehabilitation program depends on the surgical portal, with immediate weight-bearing

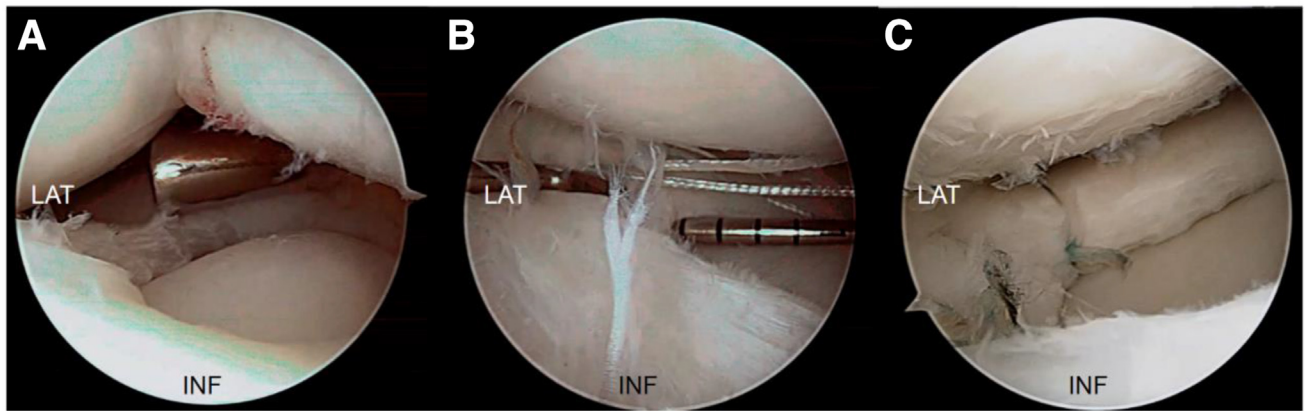


Fig 4. (A) Passing through the posterior septum to the lateral compartment of the knee joint. (B) The lateral meniscus is sutured using an all-inside suture. (C) The meniscus is stable and in good shape after suture. A-C shows what we observed through the AL portal. (AL, anterolateral; INF, inferior; LAT, lateral.) We operated on the left knee of the patient.

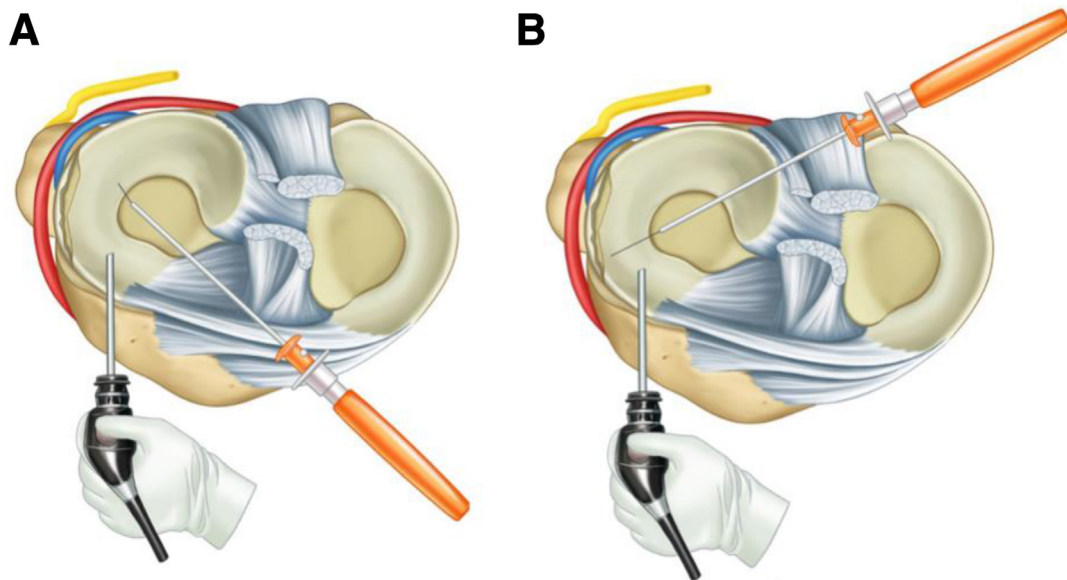


Fig 5. Schematic diagram of this surgical technique. (A) When we use the anterolateral portal for suturing, the suture device will point toward the posterior vessels and nerves of the knee joint during the operation. (B) If we adopt the posteromedial surgical technique mentioned in the text, the suture device will point anterolaterally, allowing the suture to be placed without encountering the posterior vessels and nerves of the knee joint.

and knee range of motion exercises allowed in patients who undergo meniscectomy and molding only.¹⁰ After the meniscus suture surgery, patients should avoid weight-bearing on the surgical side for 3 weeks, limit the range of motion of the knee joint from 0° to 90°, do partial weight-bearing from 3 weeks, and then are permitted full weight-bearing from 6 weeks. At 1 month after operation, hyperextension of the operated knee joint is avoided and excessive flexion activity is reduced. After the knee motor function score and MRI evaluation at 6 months after the operation, the doctor decides whether the patient may return to sports.¹¹

Discussion

Various surgical techniques exist for treating lateral meniscal tears in the knee, most of which prioritize securing the tear. However, reducing the risk of neurovascular injury during surgery often relies on the surgeon's experience rather than improved techniques. Our technology leverages a PM knee entry to minimize neurovascular damage risks effectively.

The common peroneal nerve, as one of the major tributaries originating from the sciatic nerve, follows a path along the medial border of the biceps femoris muscle, extending to the region anterior to the fibular neck. Damage to this nerve can lead to various

Table 1. Pearls and Pitfalls

Pearls
1. Using the posteromedial portal, the operating angle can make the operation of meniscus dressing occur more smoothly and reduce the operation time.
2. Reduces the possibility of lateral nerve and blood vessel injury to the knee joint and reduces the incidence of popliteal tendon injury.
3. The use of posteromedial portal to repair the meniscus reduces the threshold for surgery, so that clinicians can quickly master the surgical techniques to perform surgery independently.
Pitfalls
1. Compared with the conventional meniscus surgery portal, there is an additional surgical incision, and the incision at this position creates more bleeding, increasing the difficulty of postoperative sterile incision management.
2. For patients with obesity, this technique may not reduce the operation time and difficulty but may increase the difficulty of repair depending on the degree of obesity of the patient.

symptoms, including atrophy of the leg's extensor muscles, presenting as drooping and inversion of the affected foot, inability to evert or pronate, loss of dorsiflexion of the foot and toes, and sensory loss on the skin over the lateral calf and foot dorsum.¹² The inferolateral genicular artery courses laterally, traversing between the fabella and popliteus tendon, then wraps anteriorly around the lateral meniscus, supplying the area. Ligating this artery could diminish meniscal blood supply, impeding tear healing.

In our technique, all-inside suturing is the primary method for meniscus repair. Although earlier criticism involved unstable sutures and postoperative failure, recent developments have eradicated significant discrepancies in success rates between AI and IO techniques.⁷ In addition, using all-inside sutures with anchor devices for lateral meniscal suturing offers advantages in reduced neurovascular injury.¹³⁻¹⁵ Zheng et al.³ pointed out in their study of popliteal hiatus meniscal tears that the meniscus repair in this area should not only focus on the suture stability of the meniscus but also take into account the high mobility of the original area. The use of all-inside suture can effectively control the suture tightness of the popliteal tendon hiatus.

Setting the knee's anterior position as 12:00 o'clock, conventional surgery using the AL portal directs instruments toward the 4:00-o'clock position, risking neurovascular injury and ligation. Conversely, the PM portal via the posterior septum towards 2:30 o'clock, combined with all-inside suturing, effectively avoids angling toward neurovascular structures (Fig 5). This is applicable not just for popliteal tendon hiatus tears but also suits anterior horn and body segment injuries, especially those involving split tears. Anterior portals often miss the subtleties of the split, leaving irregular remnants. The PM portal allows precise trimming and rapid repair with all-inside suturing devices. This method also reduces the likelihood of neurovascular

Table 2. Technique Notes

1. When creating the posteromedial portal, we can open the portal a little higher, which can make the operation smoother and reduce the influence of the anatomical structure of the knee joint on the operation.
2. The operator should use an exchange rod to open the operation portal bluntly when the operator is passing through the posterior septum through the posteromedial portal, so as to avoid injury to the nerves and blood vessels of the posterior septum and improve the postoperative satisfaction and recovery speed of the patients.
3. When using all-inside suture to suture the popliteal hiatus region of the meniscus, the suture should be avoided too tightly, and the natural mobility of the region should be taken into account.
4. Before meniscus molding for patients with bucket-handle meniscus tears, the compressed meniscus should be reset, the real medial edge of the meniscus should be observed, and the tear edge of the bucket-handle meniscus should not be used as the inner edge for molding.

injury, simplifying the portal without angles that adversely affect surgical manipulation.¹⁶ In addition, repair at this angle during the operation helps to reduce the time spent on the repair of the anterior horn of the lateral meniscus. For the lateral meniscus macerated tear, we can clean and repair it in a short time, and avoid the problem that the lower layer of the meniscus is difficult to reach by using a shaver.

The advantages and disadvantages of this technology and the relevant matters that need to be paid attention to are detailed in Tables 1 and 2. Arthroscopic repair using a PM portal the lateral meniscus is a reliable technique. It streamlines the operation, drastically cutting down on potential neurovascular damage, and lowers the barrier of entry for surgical execution.

Disclosures

The authors declare the following financial interests/ personal relationships which may be considered as potential competing interests: This thesis is part of the "14th Five-Year Plan" Clinical Medicine Innovation Research Team Support Program, project number is 2022LCTD-B25. All authors (Z.S., Z.L., Z.Z., Y.N., Y.Z., L.W., J.D.) declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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