Technical Note

# A Reverse Suture Anchor Technique for Arthroscopic Medial Meniscus Root Repair

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**Abstract:** Injuries of the posterior root of the medial meniscus can be accompanied by damage to the anterior cruciate ligament or often occur independently in cases of degenerative meniscal injury in older individuals. Anchor suture repair can achieve favorable biomechanical effects and clinical outcomes. However, anchor placement is technically challenging and requires a posterior medial approach, which increases the risk of iatrogenic injury. To address these issues, we have utilized the reverse anchor technique to repair the posterior root of the medial meniscus. This technique offers advantages such as reduced surgical time, simplified operation, and reduced risk of the "bungee effect" and iatrogenic injury.

The medial meniscus posterior root plays an important role in the stability of the knee joint and protection of the articular cartilage.[1-3] Isolated injuries to the posterior root of the medial meniscus are commonly seen in older individuals and should be actively treated surgically.[4,5] Common surgical treatment methods include complete suture, pull-out through bone tunnel, gracilis autograft, and anchor fixation.[5-9] Although literature suggests that pull-out techniques can achieve good clinical outcomes, the biomechanical efficacy may be compromised due to the "bungee effect" associated with this method.[10,11] Biomechanical experiments have also shown that anchor fixation of the posterior root of the meniscus can achieve better biomechanical efficacy.[5,10,11] Suture anchor repair has the advantage of reducing the risk of micromotion between the meniscus-suture complex, thereby lowering the likelihood of repeated injury. Additionally, this technique minimizes the chance of suture material abrasion, which can further enhance the long-term stability and durability of the repair.[10] However, anchor fixation techniques present technical challenges, including that they are technically demanding, need an additional high posteromedial working portal, and require specialized instruments.[6] By applying the reverse anchor technique for fixation of the posterior root of the medial meniscus, we have reduced the technical difficulty associated with anchor fixation.

## Technique

### Patient Positioning, Surgical Approach, and Arthroscopic Examination

The patient is positioned supine with the knee flexed at 90°. Arthroscopy surgery is performed using a 30° scope (Smith & Nephew) and a standard approach through the medial and lateral portals of the knee joint. Another portal is established 0.5 cm below the medial portal (Fig 1). An arthroscopic examination is then conducted (Video 1). Under arthroscopy, the medial collateral ligament is released through the magic point[12] to expose the medial compartment (Fig 1, Table 1). The findings reveal a type 2 tear according to the Christopher classification in the posterior root of the medial meniscus, with the root detached from its attachment point (Fig 2).

### Suture Anchor Placement

The posterior root attachment point is located, and a bone curette (Smith & Nephew) is used to freshen the

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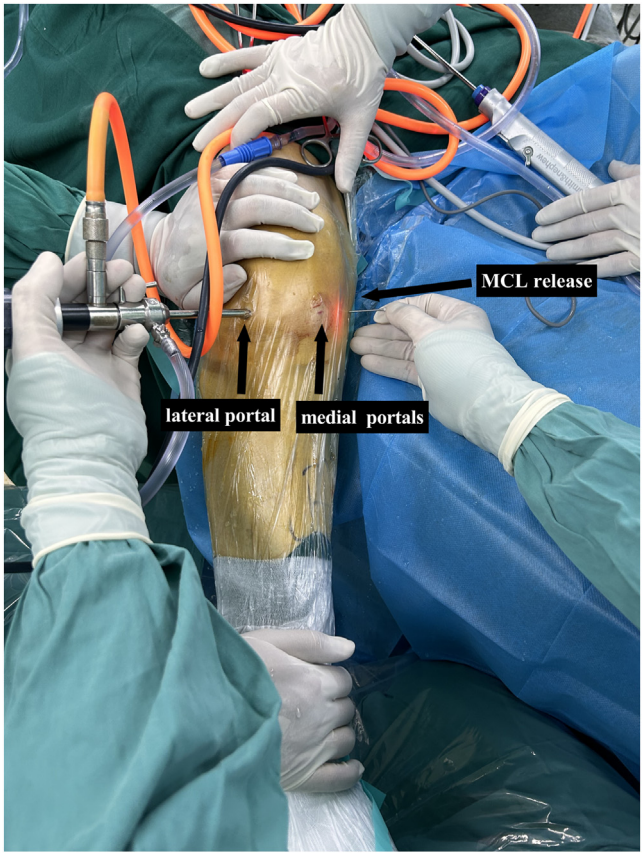


**Fig 1.** The patient is placed in a supine position and undergoes arthroscopic surgery on the right knee. Medial and lateral portals of the knee joint. Another portal is established 0.5 cm below the medial portal. The medial collateral ligament is released through the magic point. The lateral portal is the observation portal. (MCL, medial collateral ligament.)

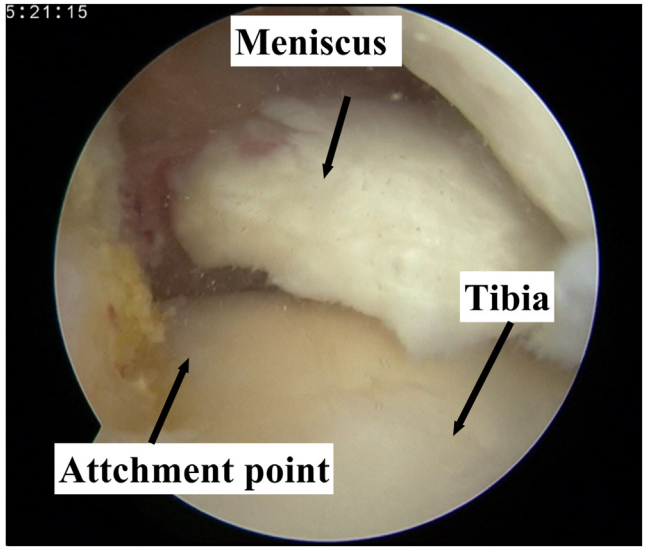


**Fig 2.** The patient is placed in a supine position with the right knee kept in a 20° flexion and valgus position. A type 2 tear happened according to the Christopher classification in the posterior root of medial meniscus, with the root detached from its attachment point.

cartilage surface for better healing (Table 1). The tibial targeting device of the anterior cruciate ligament reconstruction instrument (Smith & Nephew) is positioned at the torn attachment point, while the affected limb is maintained in a valgus position. A 2-cm incision is made on the medial aspect of the tibia, followed by the insertion of a 2.0-mm Kirschner wire (Wego). The length of the 2.0-mm bone tunnel is measured using an equivalent-length Kirschner wire. A 4.5-mm drill bit (Smith & Nephew) is used to create a broad bone tunnel, stopping approximately 1 to 1.5 cm away from the articular cartilage surface with the guidance of the equivalent-length Kirschner wire (Fig 3, Table 1). A spinal needle (Qionghua) is inserted through the bone tunnel into the joint cavity, and the PDS suture (Ethicon; Johnson & Johnson) is threaded through the spinal needle into the joint cavity. The spinal needle is then removed, and a knot is tied at the distal end of the PDS suture to secure threads of the 3.0-mm anchor (Johnson & Johnson). The anchor is inserted in a reverse direction through the PDS suture into the bone tunnel and fixed at the junction of the broad and narrow bone tunnels (Fig 4).

### Suture Passage and Knotting

Following the introduction of anchor suture threads, a modified Mason-Allen suture technique can be applied (Table 1). To ensure the stability of the posterior root of the meniscus at the insertion point, knots are tied to firmly anchor it in place. The use of a standard surgical knot for securing proved to be sufficient, as the Tennessee loop technique risks potential suture cutting (Tables 1 and 2). The stability of the repaired posterior root of the meniscus is subsequently confirmed (Fig 5). A diagram illustrating our technique is depicted in Figure 6.

## Postoperative Rehabilitation

Following the surgery, a brace is utilized to immobilize the knee joint for a period of 4 weeks. For patients who undergo anterior cruciate ligament reconstruction, the brace is worn for an extended duration of 3 months. Gradual weightbearing is introduced at 4 weeks after the operation, with full weightbearing permitted at 8 weeks postoperatively. Commencing at the 4-week mark, range of motion exercises are initiated, initially restricted to within 90°. By the 6-week point, the range of motion surpasses 90°, and progressive exercises are implemented to achieve full range of motion.

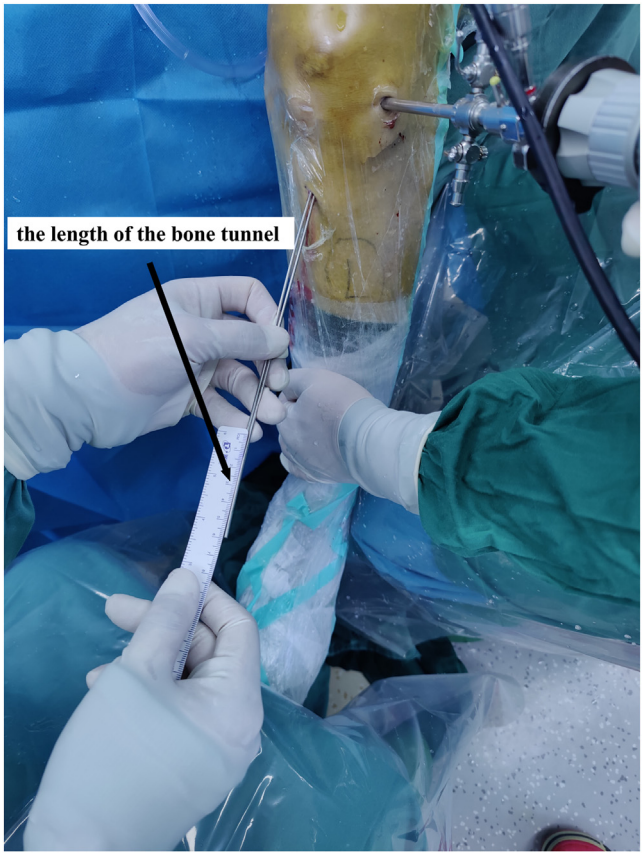


**Fig 3.** The patient is placed in a supine position and undergoes arthroscopic surgery on the right knee. The length of the 2.0-mm bone tunnel is measured using an equivalent-length Kirschner wire.

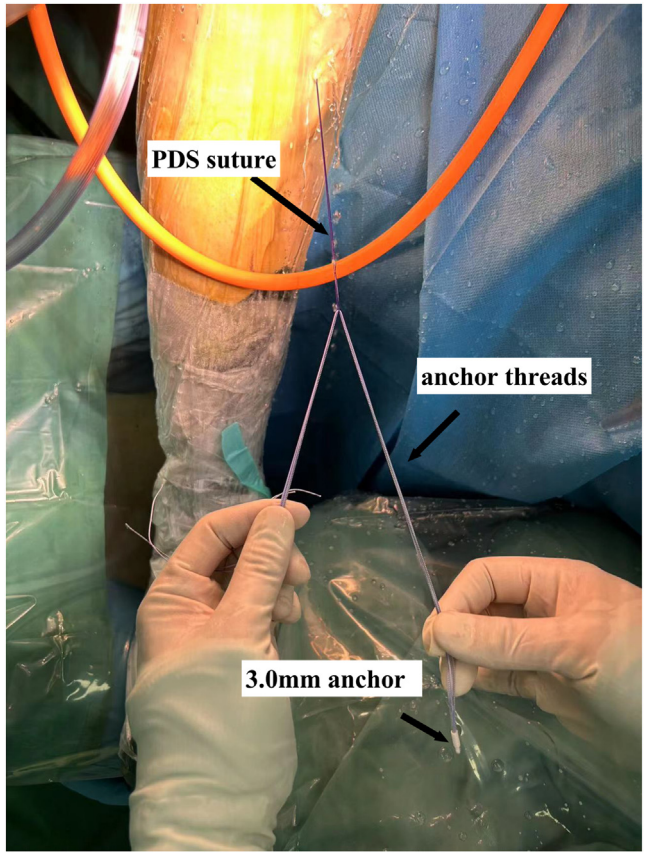


**Fig 4.** The patient is placed in a supine position with the right knee kept in a 20° flexion and valgus position. The anchor is inserted in a reverse direction through the PDS suture into the bone tunnel. The suture threads of the anchor are threaded through the loop formed at the distal end of the PDS suture. The proximal end of the PDS suture is then pulled to reverse-insert the anchor into the bone tunnel.

## Discussion

The repair methods for the posterior root of the medial meniscus include partial meniscectomy, transtibial pull-out technique, anchor suture repair, gracilis autograft, and all-inside suture repair.[5,9,13-16] Compared with the commonly used transtibial pull-out technique, anchor fixation has biomechanical advantages.[10] However, it does come with technical challenges. Through our technique, we have developed an effective treatment method that is simple and easy to perform while also avoiding the need for additional portals and reducing the risk of iatrogenic injury. The traditional transtibial pull-out technique has been proven to increase the risk of failure due to the "bungee effect." Besides, this technique potentially induces the "wiper effect" since there is a nearly 6-cm suture thread in the bone tunnel, which could swing within the tunnel. The use of suture anchors not only ensures strength but also shortens the length of the suture material within the bone tunnel, thus mitigating the brushing effect to some extent. Gracilis autograft is a novel technique for repairing the root of the medial meniscus, which has been shown to enhance the healing process of the meniscus.[9] However, it might increase the surgical time, so the risk of infection might be increased. Thus, compared with other methods, our technique offers advantages such as shorter surgical time, reduced bungee effect, and avoidance of additional incisions. Additionally, the narrow tunnel enables faster bone healing, and early postoperative functional rehabilitation of the affected limb can be performed.

The application of this technique is appropriate for tears of posterior root of the medial meniscus without significant cartilage damage (Kellgren-Lawrence grade less than II).[17] We utilize the Christopher classification[18] as a primary classification of the posterior root of the meniscus tear. Our technique is highly effective for treating type 2, type 3, and type 5 tears. For type 1 tears and radial tears (type 4) with a significant amount of meniscal tissue remaining at the posterior root attachment, we recommend meniscal suture repair. By carefully selecting the appropriate treatment method for each type of tear, we aim to choose the appropriate method and promote successful recovery for patients.

**Table 1.** Technical Pearls and Pitfalls

| Pearls | Pitfalls |
|---|---|
| 1. The length of the narrow bone tunnel is approximately 1 to 1.5 cm and can be assisted by using an equivalent-length Kirschner wire for measurement.<br>2. The release of the medial compartment is necessary.<br>3. Suitable for type 2, 3, and 5 tear classifications. Kellgren-Lawrence grade less than II.<br>4. Modified Mason-Allen stitch is the best choice when surgical time permits and no additional portal is required.<br>5. The use of a spinal needle can assist in the introduction of the PDS line into the joint cavity.<br>6. The footprint area should be freshened. | 1. If encountering difficulties with the Mason-Allen stitch, simple mattress stitches can be a feasible alternative.<br>2. When tying knots, using a Tennessee loop technique may lead to cutting the suture, so it is recommended to use a standard surgical knot for securing. |

**Table 2.** Advantages and Disadvantages

| Advantages | Disadvantages |
|---|---|
| 1. Avoidance of additional portals.<br>2. Short surgical time.<br>3. Simple procedure.<br>4. Reduced bungee effect.<br>5. As close as possible to the biomechanical performance of the anchor. | 1. Sliding knots can increase the risk of suture breakage.<br>2. Reverse anchors may not provide as tight a bone integration as traditional anchors. |

During the operation, it is important to first perform a medial compartment release to achieve better exposure, suture manipulation, and low risk of direct iatrogenic cartilage damage.[12] Second, simple stitches can be used for meniscus repair to ensure strength and possibly reduce surgical time. Of note, the modified Mason-Allen stitch can achieve better healing of the meniscus and better biomechanical performance.[19,20] Thus, the modified Mason-Allen stitch is the best choice when surgical time permits and no additional portal is required (Table 1). Third, we observed that when tying the knot of suture threads, there was a certain probability of anchor thread rupture when using the Tennessee knot. We speculate that this may be due to the cutting force between the bone tunnel and the anchor, which leads to the rupture of anchor threads.

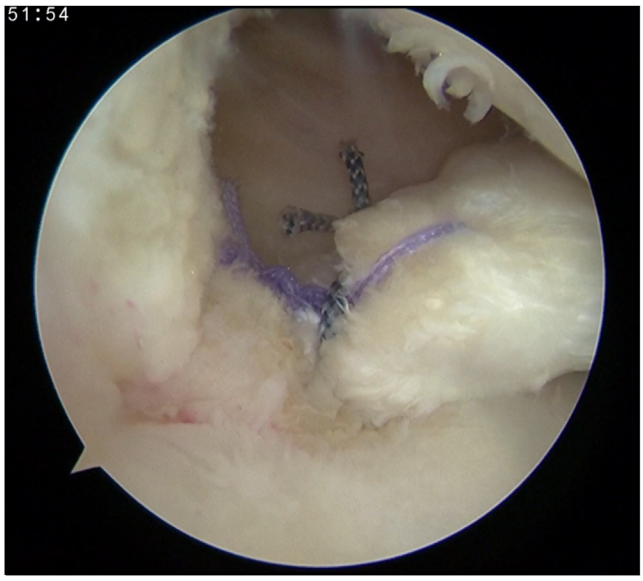


**Fig 5.** The patient is placed in a supine position with the right knee kept in a 20° flexion and valgus position. The lateral portal is the observation portal. The posterior root of the meniscus is repaired well and fixed at the attachment site.

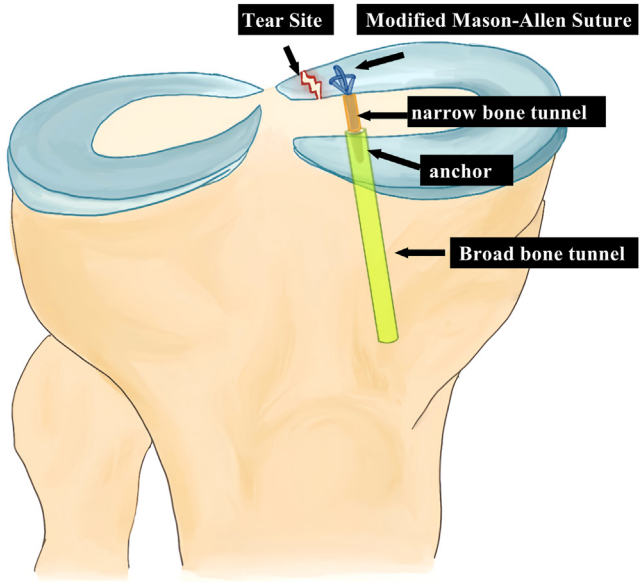


**Fig 6.** A diagram of technique on the right knee. The green site represents the broad bone tunnel, and the orange site represents the narrow bone tunnel. The blue sutures represent a modified Mason-Allen suture.

Therefore, to minimize the cutting effect of anchor threads, a regular knotting technique is used to secure the posterior root. Last, the length of the narrow bone tunnel is determined to be approximately 1 to 1.5 cm, which means that the distance between the broad bone tunnel and the surface of the tibial plateau is 1 to 1.5 cm. The average tibia cortical bone thickness is 2.8 mm.[21] To achieve greater fixation strength, the anchor is placed within cancellous bone, and there may be slippage, leading to suboptimal biomechanical performance. The ideal length of the narrow bone tunnel will be investigated.

Limitations of this technique include the need for further confirmation of its biomechanical performance and the specific length of the broad bone tunnel through biomechanical testing. While the suturing technique is simple and avoids additional surgical incisions, its biomechanical performance may not be as good as other suturing methods (Table 2). Clinical follow-up evaluations are necessary to assess the effectiveness of this technique.

## Disclosures

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