



# All-Inside Meniscus Repair Method for Injury of the Margin of the Anterior Segment of the Meniscus

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**Abstract:** Although the outside-in method has been used to treat injuries to the anterior segment of the meniscus, this method has drawbacks including the need to make a skin incision and portals for arthroscopy, pain caused by strangulation of the subcutaneous tissue and joint capsule, and protrusion of the knots. To resolve these problems, we present an all-inside method that enables simple suture of injuries to the anterior segment of the meniscus through arthroscopic portals placed only on the anteromedial and lateral sides without using a specific instrument. This simple, low-cost, low-invasive technique may be useful for suturing marginal injuries to the anterior segment of the meniscus.

The meniscus buffers the femorotibial load on the knee joint, as well as being involved in knee joint stability, proprioception, lubrication, and nutrient supply to the cartilage.<sup>1</sup> Therefore, leaving an injury to the meniscus untreated or resecting it partially or totally can increase the risk of osteoarthritis of the knee.<sup>2</sup> Repair of a meniscus injury can improve long-term outcomes compared with resection, as well as preventing the development and progression of osteoarthritis of the knee, emphasizing the importance of conservation of the meniscus. Meniscus repair methods differ depending on the injured site. This study described a newly devised method of repairing injuries to the margin of the anterior segment of the meniscus.

The contact pressure of the femorotibial joint increases on the medial and lateral sides when the anterior segment of the lateral meniscus is injured, with the contact pressure normalized by repair of this injury.<sup>3,4</sup> Repair of the medial and lateral anterior segments of the meniscus is important for the knee to retain its normal function.

The development of instruments for arthroscopic surgery and the progression of arthroscopic techniques have led to the application of sutures to meniscus injuries. Although the outside-in method has been used to repair injuries to the anterior segment of the meniscus, it has drawbacks including the necessity of making a skin incision in addition to portals for arthroscopy, pain caused by strangulation of the subcutaneous tissue and joint capsule, and protrusion of the knots. To resolve these problems, we report an all-inside method that enables simple suture of the injury to the anterior segment of the meniscus through only arthroscopic portals on the anteromedial and lateral sides without using a specific instrument.

## Methods

### Surgical Technique

This surgical procedure is indicated for knees diagnosed with injuries to the margins of the anterior and middle segments of the meniscus based on preoperative local findings and imaging examination or arthroscopically, in which the morphology of the injury is a longitudinal tear in the red-red zone. Surgery is performed in the supine position under general anesthesia. After disinfection of the lower limb, an air

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**Table 1.** Pearls of the All-Inside Meniscus Repair Method

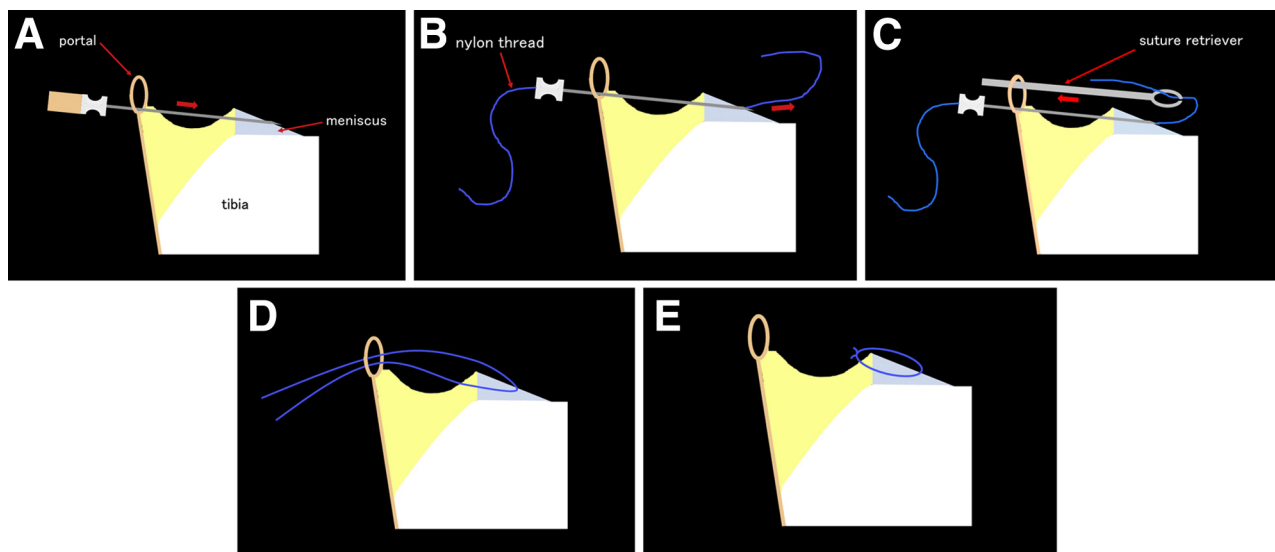
1. This surgical procedure is indicated for knees diagnosed with injuries to the margins of the anterior and middle segments of the meniscus
2. Portal on the injured side is at a slightly higher level
3. To prevent tangling of the suture thread, the synovial membrane around the portal is cleaned using a shaver or thin cannula

tourniquet is attached and 300 mm Hg pressure is applied. Fifty milliliters of saline is injected into the articular cavity through the suprapatellar bursa. Portals are prepared on the medial and lateral sides below the patella, although the operation is easier to perform when the portal on the injured side is at a slightly higher level. Meniscal tears are initially evaluated by routine arthroscopy. If the medial meniscus is injured, valgus stress is added at 30° flexion and surgery is performed under arthroscopic view on the lateral side. If the lateral meniscus is injured, varus stress is added in the figure-of-four position and surgery is performed under arthroscopic view on the medial side. To prevent tangling of the suture thread, the synovial membrane around the portal is cleaned using a shaver or thin cannula (Table 1). The necessary instruments include an 18-gauge spinal needle or Meniscal Mender II (Smith & Nephew, Andover, MA), a rasp, an arthroscopic retriever, a knot pusher, a suture cutter, 2-0 nylon thread, and strong sutures. First, rasping is applied to promote healing of the tear region. If the anterior segment is injured, the needle is inserted through the portal, avoiding entangling with the soft tissue. The needle is inserted into the peripheral rim portion of the meniscosynovial junction in the knee joint. After viewing the tip of the needle in the knee joint arthroscopically, the direction of the needle is

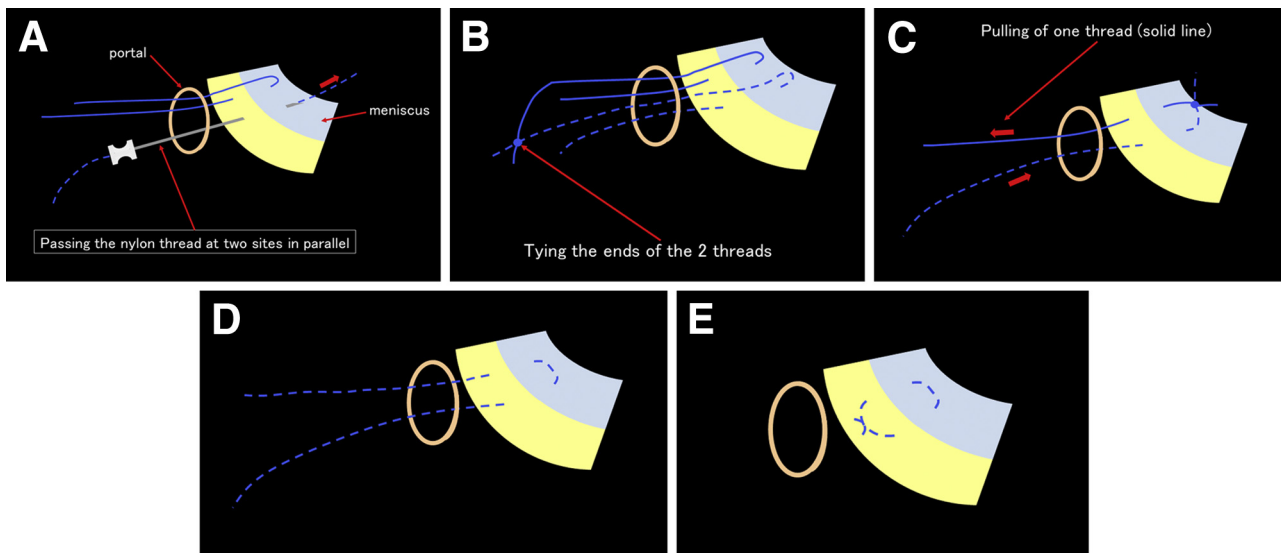
altered to slightly downward to penetrate the outer segment of the torn meniscus, with the needle advanced through the tear to the femoral surface of the inner segment (Fig 1A). Nylon thread is passed through the needle and guided into the joint (Fig 1B). A suture retriever is inserted through the portal, and the end of the nylon thread is held and pulled out of the portal (Fig 1C). When the needle is pulled out, both ends of the nylon thread exit the joint and come out of the portal (Fig 1D). Using a sliding knot technique, the suture is applied to the joint (Fig 1E). One end of the nylon thread is tied to the strong suture, relayed, and exchanged to strengthen the suture thread. Our technique is demonstrated in Video 1.

A horizontal mattress suture can be applied using the same technique by passing the nylon thread at 2 sites in parallel (Fig 2A), followed by tying the ends of the 2 threads to relay them into a single thread (Fig 2 B-D). Using the sliding knot technique, the suture is applied to the joint (Fig 2E). To prevent injury due to impingement of the knot by the femoral cartilage, the suture is made above the meniscosynovial junction, not above the meniscus.

This method was also applied to injuries to the middle segment of the meniscus. A needle is inserted percutaneously and nylon thread is passed through the needle and guided into the joint (Fig 3A). A suture



**Fig 1.** All-inside meniscus repair method. (A) Advancing of the needle through the tear to the femoral surface of the inner segment. (B) Passing of nylon thread through the needle and guiding the thread into the joint. (C) Insertion of a suture retriever through the portal, with the ends of the nylon thread held and pulled out of the portal. (D) Pulling out of the needle, with both ends of the nylon thread exiting the joint and coming out of the portal. (E) Using a sliding knot technique, the suture is applied to the joint.



**Fig 2.** Application of a horizontal mattress suture. (A) Passing the nylon thread at 2 sites in parallel. (B) Tying the ends of the 2 threads. (C) Pulling of one thread (solid line). (D) Relaying of both threads into a single thread (dashed line). (E) Using the sliding knot technique, the suture is applied to the joint.

retriever is inserted through the portal, and the end of the nylon thread is held and pulled out of the portal (Fig 3B). Referring to the arthroscopic light spot, the needle is inserted from a level slightly higher than the injured meniscus. Both ends of the nylon thread are held with a suture retriever, pulled out of the joint and exposed from the portal (Fig 3 C and D), and sutured similar to that for the anterior segment (Fig 3E).

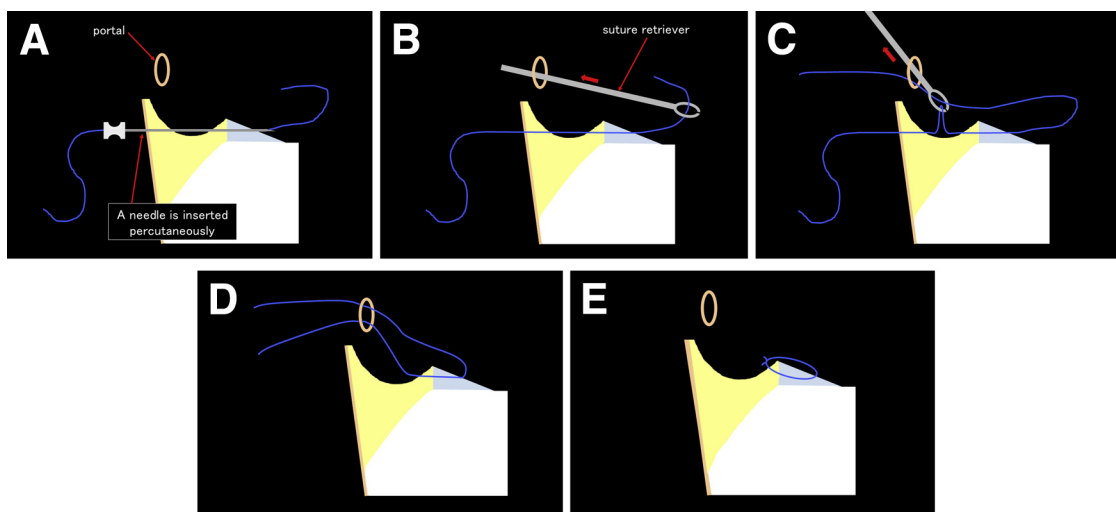
#### Aftertreatment

Partial weight bearing was initiated after 2 weeks of postoperative non-weight-bearing, with full weight

bearing initiated 4 weeks after surgery. Range of motion training was initiated 1 week after surgery, but it was limited to approximately  $-20^{\circ}$  to  $-30^{\circ}$  extension until 2 weeks after surgery. Jogging was initiated 8 weeks after surgery, and the patient returned to competition 3 months after surgery.

#### Discussion

Meniscus injuries are often treated by arthroscopic resection or suture. However, resection has been reported to reduce meniscal function decreases and to



**Fig 3.** All-inside meniscus repair method to the middle segment of the meniscus. (A) A needle is inserted percutaneously. (B) Insertion of a suture retriever through the portal, with the ends of the nylon thread held and pulled out of the portal. (C, D) Holding of both ends of the nylon thread with a suture retriever, followed by pulling the thread out of the joint and exposure through the portal. (E) Using the sliding knot technique, the suture is applied to the joint.

**Table 2.** Benefits and Limitations of the Procedure

Benefits	Limitations
No additional skin incision is necessary	Injury of the posterior segment of the meniscus is not indicated
No specific instruments are required	A sliding knot technique is required
Pain caused by strangulation of the subcutaneous tissue and joint capsule and protrusion of the knot is less likely	If the synovial membrane entangles with the knot, the rupture portion cannot be drawn together firmly

damage the joint cartilage, increasing the risk of osteoarthritis of the knee.<sup>5</sup> Therefore, current guidelines recommend repairing meniscus injuries as much as possible, with favorable outcomes reported in knees treated with various surgical procedures, including the inside-out, outside-in, and all-inside methods.<sup>6</sup> Procedure selection is based on the position and morphology of the torn region of the meniscus and the preference of the surgeon, with the outside-in method generally used for suturing the anterior segment of the meniscus. However, this method is difficult to perform, with a mean operative time significantly longer than those of the inside-out and all-inside methods using commercial fixators.<sup>7</sup> Moreover, the conventional method requires making an additional skin incision to bury the suture thread, and pain can result from strangulation of the subcutaneous tissue and joint capsule or protrusion of the knot. These problems may be resolved by suturing of the anterior segment of the meniscus using an all-inside method. One such method uses suture hooks, but suture hooks may be expensive and inappropriate for suturing the meniscus because their tips are thick and blunt.<sup>8</sup> This method also requires an extreme far medial portal, which would be another disadvantage. Another all-inside technique that did not include an additional skin incision was described, but that method involved percutaneous insertion of a spinal needle, thus requiring acquisition of skills to insert the needle accurately.<sup>9</sup> Moreover, the thread can be cut by the needle tip. An all-inside method using various commercial fixators has been used to suture the middle segment of the meniscus, but repeated stimulation with the nonabsorbable anchor and thread may induce mucoid degeneration of the soft tissue and ganglion formation, causing pain.<sup>10</sup>

We have presented a new all-inside method using a generally used, low-price spinal needle that requires no specific instruments. In addition, no additional skin incision is necessary, and the sutures can be inserted through normal anteromedial and lateral portals. Furthermore, this method was applicable to suturing the middle segment via percutaneous insertion of the needle. The needle can be inserted while arthroscopically confirming the position of the needle tip, enabling accurate penetration of the injured region. Because the suture thread knot is located inside the joint, pain caused by strangulation of the subcutaneous tissue and

joint capsule and protrusion of the knot is less likely. This simple, low-cost, low-invasive technique may be useful for suturing marginal injuries to the anterior segment of the meniscus. However, there are some limitations of this technique. First, a sliding knot technique is required. Second, if the synovial membrane entangles with the knot, the rupture portion cannot be drawn together firmly, so the synovial membrane around the portal is cleaned using a shaver or thin cannula (Table 2).

## References

1. Fox AJ, Wanivenhaus F, Burge AJ, Warren RF, Rodeo SA. The human meniscus: A review of anatomy, function, injury, and advances in treatment. *Clin Anat* 2015;28:269-287.
2. Beamer BS, Walley KC, Okajima S, et al. Changes in contact area in meniscus horizontal cleavage tears subjected to repair and resection. *Arthroscopy* 2017;33:617-624.
3. Chen L, Linde-Rosen M, Hwang SC. The effect of medial meniscal horn injury on knee stability. *Knee Surg Sports Traumatol Arthrosc* 2015;23:126-131.
4. Walker PS, Arno S, Bell C, Salvatore G, Borukhov I, Oh C. Function of the medial meniscus in force transmission and stability. *J Biomech* 2015;48:1383.
5. Paradowski PT, Lohmander LS, Englund M. Osteoarthritis of the knee after meniscal resection: Long term radiographic evaluation of disease progression. *Osteoarthritis Cartilage* 2016;24:794-800.
6. Moulton SG, Bhatia S, Civitarese DM, Frank RM, Dean CS, LaPrade RF. Surgical techniques and outcomes of repairing meniscal radial tears: A systematic review. *Arthroscopy* 2016;32:1919-1925.
7. Hantes ME, Zachos VC, Varitimidis SE, Dailiana ZH, Karachalios T, Malizos KN. Arthroscopic meniscal repair: A comparative study between three different surgical techniques. *Knee Surg Sports Traumatol Arthrosc* 2006;14:1232-1237.
8. Kim SJ, Jung KA, Kim JM, Kwun JD, Baek SH, Han JN. Arthroscopic all-inside repair of tears of the anterior horn of the lateral meniscus. *Arthroscopy* 2005;21:1399.e1-1399.e4.
9. Lee CK, Suh JT, Yoo CI, Cho HL. Arthroscopic all-inside repair techniques of lateral meniscus anterior horn tear: A technical note. *Knee Surg Sports Traumatol Arthrosc* 2007;15:1335-1339.
10. Kang HJ, Chun CH, Kim SH, Kim KM. A ganglion cyst generated by non-absorbable meniscal repair suture material. *Orthop Traumatol Surg Res* 2012;98:608-612.