



# Anterior-Horn Repair Using Conventional All-Inside Repair Device and Standard Arthroscopic Portals for Bucket-Handle Medial Meniscal Tear

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**Abstract:** The bucket-handle tear, characterized by its oblique longitudinal and vertical pattern, poses challenges in meniscal repair, particularly when addressing the anterior horn. Although conventional outside-in techniques are common, all-inside approaches face limitations. This article proposes an alternative technique using the Infinity AIM all-inside repair device (ConMed, Utica, NY), which allows deployment after increasing the bend in the device's tip.

The bucket-handle tear represents a complex tear characterized by an oblique longitudinal and vertical tear pattern.<sup>1,2</sup> This pattern leads to the displacement of a torn portion into the intercondylar notch, resulting in mechanical blocking symptoms.<sup>3</sup> Bucket-handle tears often initiate at the posterior horn of the meniscus and may extend to the anterior horn, necessitating advanced surgical techniques for successful repair.<sup>4,5</sup>

The conventional approach for addressing an anterior-horn bucket-handle tear typically involves use of the outside-in technique.<sup>6,7</sup> When using all-inside techniques for repair of the anterior horn of the meniscus, challenges arise owing to limitations inherent to the standard portal's working range. Previously published surgical procedures using all-inside repair techniques have either required additional

ports or demanded a significant level of surgical proficiency to effectively address anterior-horn meniscal tears.<sup>8,9</sup> To address this issue, we use the Infinity AIM all-inside repair device (ConMed, Utica, NY), which allows deployment after increasing the bend in the device's tip.

## Surgical Technique

### Patient Position and Portal Placement

After spinal anesthesia administration, the patient is placed in the supine position on the operating table. A tourniquet is wrapped around the thigh and inflated to 300 mm Hg to control bleeding during surgery. Thereafter, the operative leg is prepared and painted in a sterile manner. The surgeon sits on a chair beside the operative knee. The hip is abducted, and the surgeon holds the foot against his or her thigh. Standard anteromedial and anterolateral portals are created adjacent to the patellar tendon at the level of the joint line.

### Reduction and Tissue Preparation

Initially, an arthroscopic examination is conducted to assess any accompanying intra-articular lesions. To facilitate the reduction of the displaced bucket-handle medial meniscal tear (Fig 1A, Video 1), the superficial medial collateral ligament is punctured from outside the knee (pie-crusting technique), while an assistant applies a valgus force to create space in the medial compartment. Subsequently, the surgeon uses a probe to push the displaced meniscus (Fig 1B, Video 1),

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gently extending the knee as needed. Finally, an arthroscopic rasp is used to open the vascular channel, promoting an enhanced healing process (Fig 1C, Video 1).

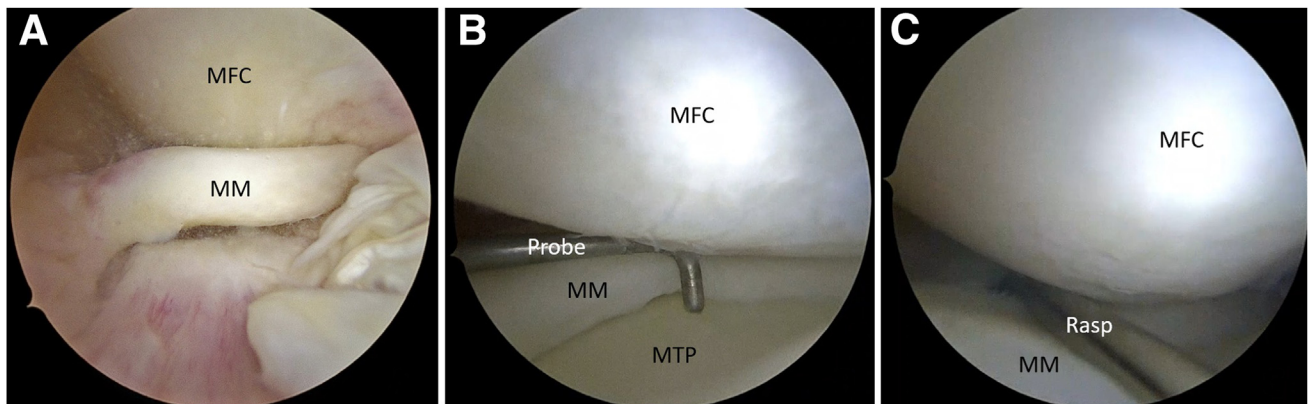
### Meniscal Body Repair

The arthroscope is inserted through the anteromedial portal, with the anterolateral portal serving as the working portal. Initially, the first repair stitch is applied to secure the body of the meniscus. Subsequently, the Fast-Fix all-inside repair device (Smith & Nephew, Andover, MA) is used to fix the body of the meniscus to the capsule in a horizontal mattress fashion (Fig 2A,

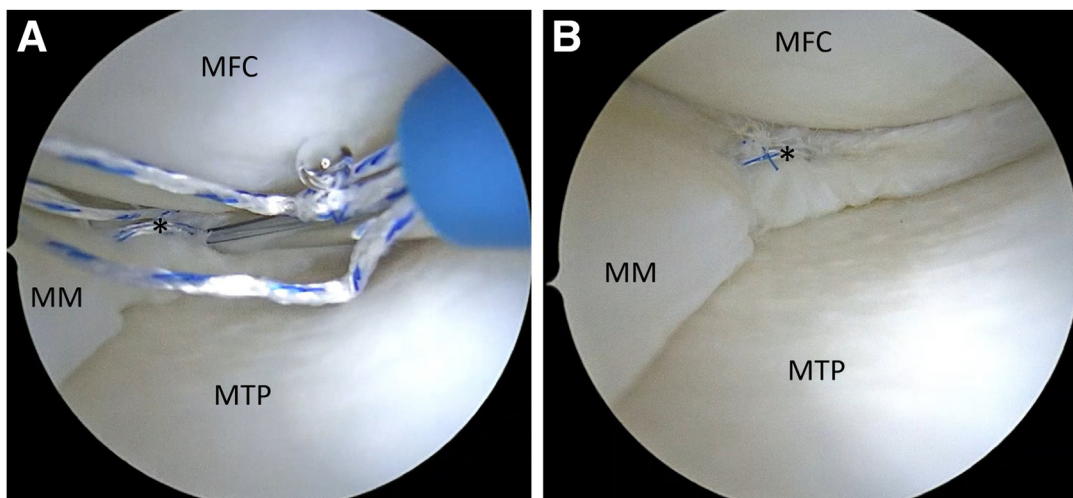
Video 1). The repair stitch is tensioned adequately, and the excess suture is cut flush with the meniscus (Fig 2B, Video 1).

### Bending of All-Inside Meniscal Repair Device Tip

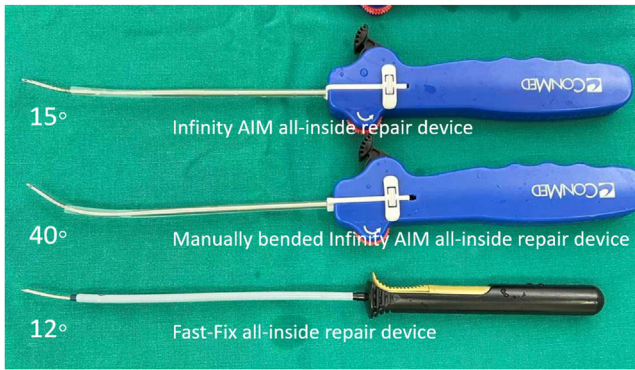
Once the body of the meniscus is secured, the repair process extends both anteriorly and posteriorly. However, when addressing the anterior horn of the medial meniscus, conventional all-inside repair devices pose challenges because of their positioning and angle requirements. To overcome this, we recommend using the Infinity AIM all-inside repair device and manually bending the tip of its needle to the desired angle. In this



**Fig 1.** Left knee, supine position. (A) Arthroscopic examination reveals a displaced bucket-handle tear of the medial meniscus (MM), incarcerated in the intercondylar notch, with viewing from the anterolateral portal. (B) After release of the superficial medial collateral ligament, a probe is used to gently reposition the displaced meniscus as the knee is slowly extended, with viewing from the anterolateral portal. (C) An arthroscopic rasp is used to open the vascular channel, promoting an enhanced healing process, with viewing from the anteromedial portal. (MFC, medial femoral condyle; MTP, medial tibial plateau.)



**Fig 2.** Left knee, supine position, viewing from anteromedial portal. (A) The Fast-Fix all-inside repair device is used to fix the body of the meniscus to the capsule in a horizontal mattress fashion. (B) The repair stitch is tensioned adequately, and the excess suture is cut flush with the meniscus. The asterisks indicate the all-inside repair stitch. (MFC, medial femoral condyle; MM, medial meniscus; MTP, medial tibial plateau.)

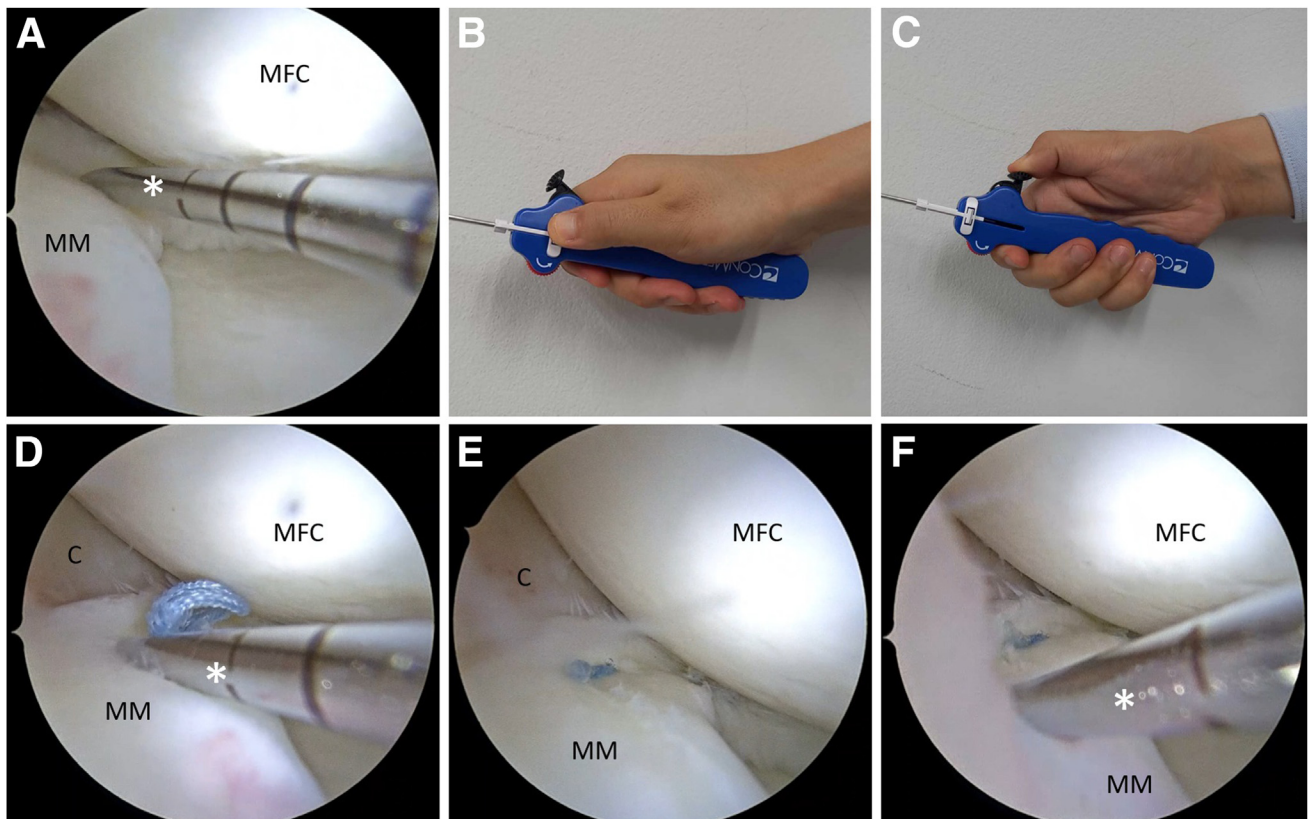


**Fig 3.** The Infinity AIM all-inside repair device has a 15° tip curve, and the original Fast-Fix all-inside repair device has a 12° tip curve. To address the anterior horn of the medial meniscus effectively, the tip of the Infinity AIM device is manually adjusted to a desired 40° angle.

particular instance, the tip is adjusted from 15° to 40°, facilitating easier penetration of the anterior horn of the medial meniscus (Fig 3, Video 1).

### Anterior-Horn Repair

The bent-tip Infinity AIM all-inside repair device is inserted through the anterolateral portal, and the curved needle tip easily accesses the anterior horn of the medial meniscus (Fig 4A, Video 1). A horizontal mattress technique will be used for the second stitch. Before the meniscal tissue and capsule are penetrated, the white sleeve adjuster is manipulated back to the desired depth using the surgeon's thumb (Fig 4B, Video 1). Once properly positioned, the needle is advanced through the meniscus. Deploying the first implant involves pulling the black trigger; an audible click confirms its deployment (Fig 4C, Video 1). It is important to



**Fig 4.** Left knee, supine position, viewing from anteromedial portal. (A) The bent-tip Infinity AIM all-inside repair device is inserted through the anterolateral portal, and the curved needle tip easily accesses the anterior horn of the medial meniscus (MM). (B) The white sleeve adjuster is manipulated back to the desired depth using the surgeon's thumb. (C) Deploying the implant involves pulling the black trigger; an audible click confirms its deployment. It is important to note that because of the needle's bent tip, triggering may require slightly more force, particularly with a 40° bend, although deployment remains achievable. (D) The needle is carefully withdrawn from the meniscus. Subsequently, it is reinserted to pierce the meniscus at the second location. (E) Tension is applied to the suture to achieve the desired amount of tension before excess suture is cut flush with the meniscus using a suture cutter. (F) The process is repeated to repair the most anterior tear site in a vertical mattress fashion. The asterisks indicate the all-inside device's needle tip. (C, joint capsule; MFC, medial femoral condyle.)



note that owing to the needle's bent tip, triggering may require slightly more force, particularly with a 40° bend, although deployment remains achievable. The needle is then carefully withdrawn from the meniscus. Subsequently, it is reinserted to pierce the meniscus at the second location (Fig 4D, Video 1), where the process is repeated to deploy the second implant. Tension is applied to the suture to achieve the desired amount of tension before excess suture is cut flush with the meniscus using a suture cutter (Fig 4E, Video 1). This process is repeated to repair the most anterior tear site in a vertical mattress fashion (Fig 4F, Video 1).

### Posterior-Horn Repair

The arthroscope is now transitioned to the antero-lateral portal, with the anteromedial portal serving as the working portal. The conventional Infinity AIM all-inside repair device is inserted through the antero-medial portal to penetrate the posterior horn of the medial meniscus, securing it to the posterior capsule with a horizontal mattress stitch (Fig 5A, Video 1). Finally, the excess suture is cut flush with the meniscus.

### Bone Marrow Venting

A microfracture awl is used to create a bone marrow vent in the intercondylar notch (Fig 5B, Video 1). This allows access to bone marrow and stem cells, facilitating enhancement of the meniscus healing process.

### Postoperative Rehabilitation

The patient is advised to wear a knee brace locked in full extension and to remain non-weight bearing, supported by axillary crutches, for a duration of

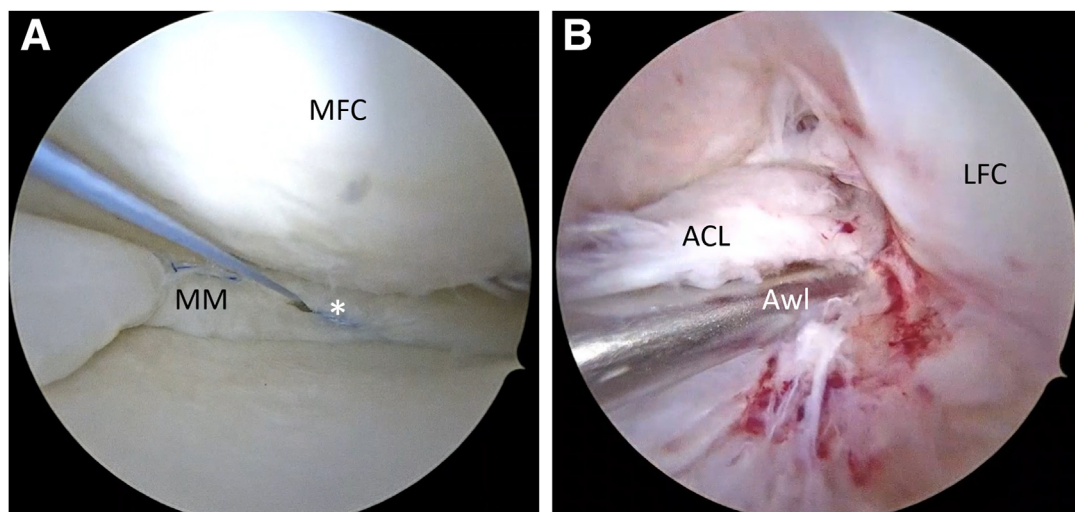
6 weeks. Beginning 1 day after surgery, the patient should perform isometric quadriceps exercises. After 6 weeks, the patient may progress to weight-bearing ambulation and range-of-motion exercises. Full return to activity is recommended after 3 months postoperatively.

## Discussion

In this article, we introduce a surgical technique for repairing a bucket-handle tear of the anterior horn of the medial meniscus using the Infinity AIM all-inside repair device, which allows deployment after increasing the bend in the device's tip. This approach aims to reduce the risk of saphenous nerve injury inherent to the outside-in repair technique and offers an alternative to the use of specialized all-inside flexible needle tips.

Bucket-handle tears are complex, characterized by oblique longitudinal and vertical patterns, often causing displacement and mechanical symptoms, necessitating advanced surgical repair.<sup>1,3</sup> The traditional outside-in technique for addressing anterior-horn bucket-handle tears presents limitations.<sup>8,9</sup> Using all-inside techniques often requires additional ports or advanced implants that are costly. Proposed solutions aim for the cost-effective use of conventional devices.

When one is performing all-inside repair for certain meniscal tears, it is important to consider several key factors that can either aid in success or present challenges. First, in cases in which a displaced fragment complicates matters, releasing the superficial medial collateral ligament can be an effective strategy to



**Fig 5.** Left knee, supine position, viewing from anterolateral portal. (A) The Infinity AIM all-inside repair device is inserted through the anteromedial portal to penetrate the posterior horn of the medial meniscus (MM), securing it to the posterior capsule with a horizontal mattress stitch. The asterisk indicates the all-inside repair stitch. (B) A microfracture awl is used to create a bone marrow vent in the intercondylar notch. (ACL, anterior cruciate ligament; LFC, lateral femoral condyle; MFC, medial femoral condyle.)

reduce the displaced fragment.<sup>10</sup> When using the Infinity AIM all-inside repair device, it is crucial to manually adjust the tip to match the specific angle for each tear. However, it is worth noting that excessive bending may hinder implant deployment. To optimize success, we recommend a bend of 40°. Furthermore, surgeons should be prepared to apply slightly more force during triggering owing to the needle's bent tip, ensuring the smooth execution of the repair procedure. Finally, to promote enhanced healing within complex tear patterns, incorporating a bone marrow vent is essential. This addition creates an environment conducive to tissue repair and regeneration, ultimately contributing to improved patient outcomes. Kaminski et al.<sup>11</sup> reported a randomized controlled trial comparing meniscal repair with and without bone marrow stimulation in the intercondylar notch and found that bone marrow stimulation significantly increased the healing rate.

One notable advantage of the described technique is its simplicity and consistency in application. The procedure also yields superior cosmetic outcomes because no additional skin incisions are required compared with the traditional outside-in repair method. Furthermore, the absence of knots within the joint reduces the risk of cartilage irritation. Finally, by avoiding knot tying outside the capsule, the likelihood of saphenous nerve injury is decreased.<sup>12,13</sup> Overall, these advantages make this approach an appealing option for bucket-handle medial meniscal tear repair. The pearls and pitfalls of the procedure, as well as its advantages, are summarized in Table 1.

In conclusion, this technique offers a safe alternative method to treat patients with displaced bucket-handle medial meniscal tears. It is a simple, less invasive approach with a reduced risk of nerve injury.

**Table 1.** Pearls, Pitfalls, and Advantages of Technique

Pearls and pitfalls	
	In challenging cases with a displaced fragment, consider using the superficial medial collateral ligament.
	When using the Infinity AIM all-inside repair device, manually adjust the tip to the desired angle for each tear. Note that excessive bending may hinder implant deployment; we recommend a bend of 40° for optimal deployment.
	Be prepared to apply slightly more force for triggering owing to the needle's bent tip.
	Ensure improved healing in complex tear patterns by incorporating a bone marrow vent.
Advantages	
	Easy and reproducible
	Improved cosmetic outcome with no additional skin incision compared with outside-in repair technique
	Absence of knots within joint that could potentially irritate cartilage
	Reduced risk of saphenous nerve injury by avoiding knot tying outside capsule

## Disclosures

All authors (N.T., T.T., D.L., T.T., S.K., T.I.) 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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