Technical Note

All-Inside Repair for Radial Tear at the Posterior Horn of the Lateral Meniscus: A Figure-8 Suture Technique

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Abstract: Arthroscopic suture repair for a radial tear at the posterior horn of the lateral meniscus poses a technical procedure for surgeons. We describe an all-inside repair technique using all-inside meniscal repair devices without adding any accessory portals. This simple technique provides precise reduction and stabilization of the meniscus by pinching 2 all-inside vertical sutures consecutively across the tear site.

The radial meniscus tear causes vertical dissociation of circumference fibers that maintain meniscus hoop mechanism as the significant meniscal property.[1] Untreated complete radial tears induce detrimental effects for the lateral compartment by increasing peak pressure on the tibial plateau, which could lead to further osteoarthritis.[2] Because partial meniscectomy for this meniscus injury does not improve the functional property, the meniscal suture repairs are selected as the optimal procedures for this injury. During the repair procedure, the radial tear at the posterior horn needs to be performed with extra caution. The inside-out or outside-in repair technique at the posterior horn is deemed high risk for neurovascular injuries. Even all-inside meniscal repair techniques with penetrating posterior capsules by suture needles still have a risk of neurovascular injury[3]; hence, a pure all-inside procedure that keeps the posterior joint capsule intact is adapted as a favorable method at the site. In practice, although all-inside repair procedures at the posterior horn of the lateral meniscus were usually introduced with horizontal sutures techniques,[4,5] a horizontal suture is less reliable for maintaining enough reduction in a biomechanical study.[6] Currently, we present a new, simple all-inside lateral meniscal repair technique of the radial tear at the posterior horn that requires no added accessory portal.

Surgical Technique

The procedure is performed with the patient under the spinal block in a supine position with a pneumatic tourniquet placed to the proximal thigh. A standard anterolateral portal is created as the viewing portal to observe the intrajoint of the affected knee. A routine diagnostic arthroscopy is implemented to detect additional injuries. The radial lateral meniscus tear at the posterior horn is frequently accompanied by an anterior cruciate ligament injury.[4] While the affected leg is placed in a tailor's leg position, an anteromedial portal is created for inserting a hook probe. Then, the radial

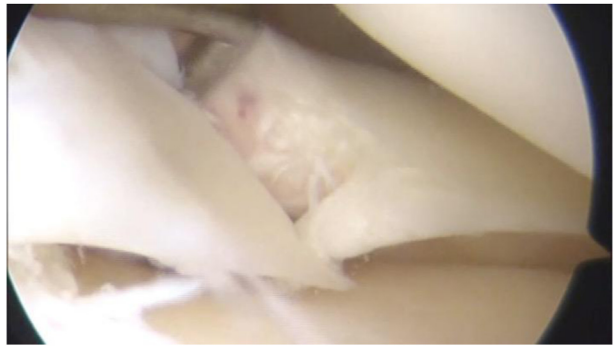

Fig 1. A radial tear at the posterior horn of the lateral meniscus in left knee. This type of tear is usually accompanied by the anterior cruciate ligament injury.

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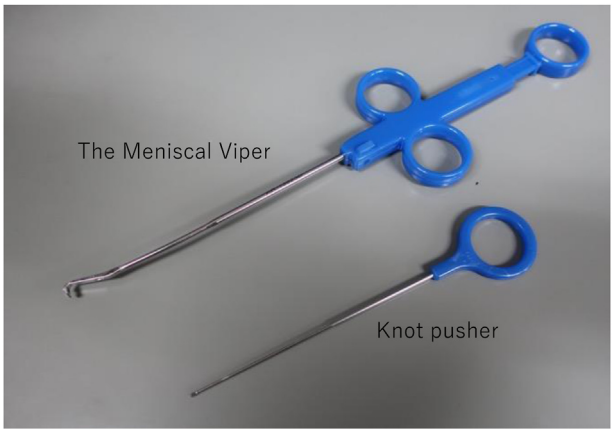

Fig 2. The Meniscal Viper Kit is an all-inside passing sutures system, repairing for the posterior segment of the meniscus without needle passage through the capsule. This system fashions the all-inside vertical suture, which is well fit for repairing the longitudinal tears. In this report, the Viper is adapted for the radial tear of the lateral meniscus.

tear of the lateral meniscus at the posterior horn is confirmed (Fig 1). No accessory portal is demanded during the whole process. Before the suture procedure is initiated, the viewing portal becomes the working portal and vice versa. After debridement of the meniscal lesion by a meniscal rasp, the Meniscal Viper (Arthrex, Naples, FL) (Fig 2) was inserted from the anterolateral portal (Fig 3). First, the Viper was positioned 5 to 10 mm apart from the tear site toward the middle segment side. A vertical stacked suture was fashioned with a no. 2-0 FiberWire (Fig 4). The FiberWire loop was retrieved through the anterolateral portal (Fig 5), then the Viper system was set using the same looped thread again (Fig 6). Second, the Viper grips on the posterior horn 5 to 10 mm apart from the tear through the same portal again (Fig 7), then the thread was

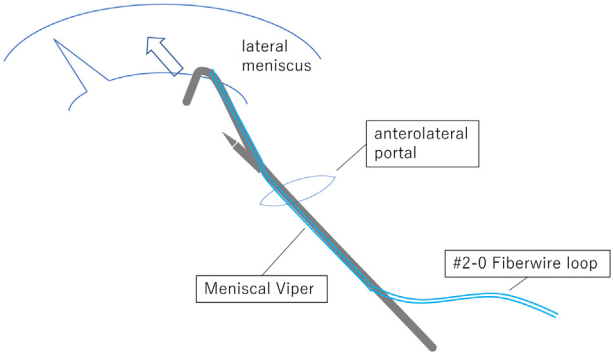

Fig 3. Insert the Meniscal Viper through anterolateral portal while inserting the arthroscope from the anteromedial as a viewing portal. The Viper is set with a looped no. 2-0 FiberWire. Although a cannula is not ordinarily required for use, it can be used to aid insertion of the Viper and avoid fat pad interference during the procedure.

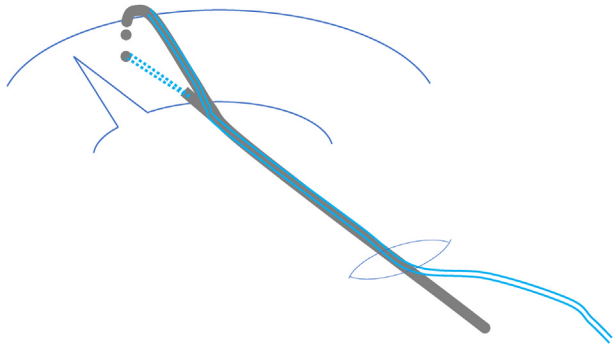

Fig 4. The tip of the Viper is inserted and rotated down into the position. The primary suture is positioned 5 to 10 mm apart from the tear site toward the middle segment side. The Viper hook is gripped along the meniscal outer rim, and the needle is inserted. The hook should hang deep, and the needle insertion should be near the anterior margin of the lateral meniscus to bundle the circumference fiber of the meniscus more. By pushing the needle toward the hook through the substantial meniscus, the needle tip captures the looped no. 2-0 FiberWire.

retrieved and extracted from the same portal (Fig 8). By drawing the 2 ends of a consecutive looped thread through the portal, a single oblique thread runs over the reducing radial torn meniscus (Fig 9). The 2 ends are tied by a modified racking hitch by drawing the knot into the joint, a cross thread reduces the torn meniscus in the anatomic position. A couple of half hitches were additionally applied to secure the knot. A "figure-8" configurated suture was fashioned where the thread is crossed on the femoral meniscal side, with 2 paralleled vertical routes in substantial meniscus (Fig 10).

Rehabilitation

For the first 4 weeks, the knee range of motion is limited up to 90° of the knee flexion. Partial weight-bearing started in toe-touch gait for the initial 2 weeks then up to 50% weight bearing for the following

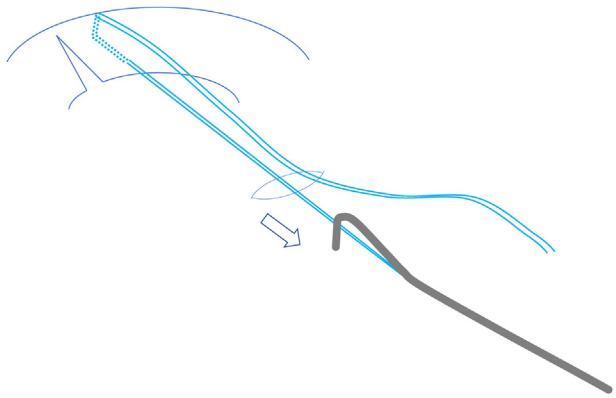

Fig 5. The needle retrieves the suture loop, and the Viper is extracted from the joint.

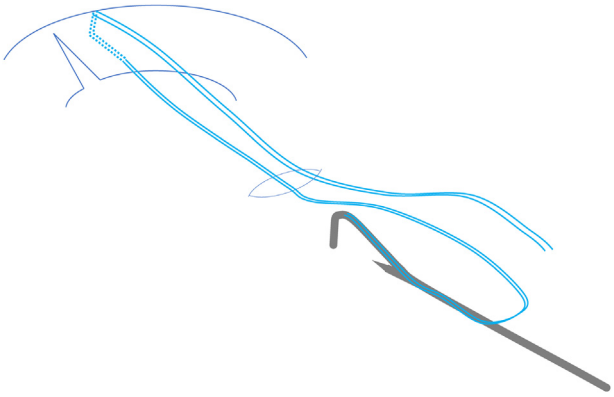

Fig 6. The Viper system is set with the same loop suture again.

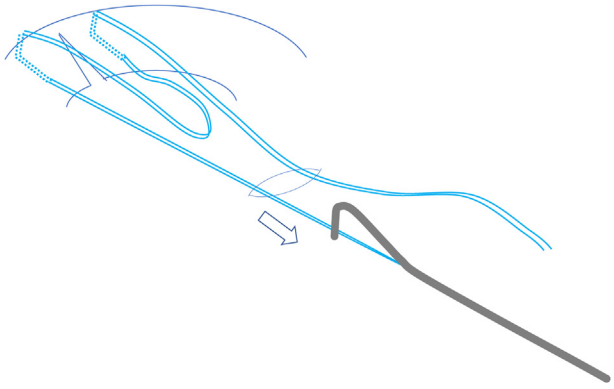

Fig 8. The Viper needle retrieves the suture loop, and the viper, with the looped suture end, is extracted out through the anterolateral portal. A consecutive vertical suture at the site of the radial tear is confirmed.

2 weeks. After 4 weeks, full weightbearing walking was tolerated, and range of motion was gradually increased to full motion at 8 weeks after surgery. The proper brace is not demanded for solely a meniscal injury; however, the injury is usually accompanied with anterior cruciate ligament injury; hence, a hard brace for the anterior cruciate ligament injury is usually applied. After 8 weeks, the rehabilitation protocol for the meniscus shifts to the anterior cruciate ligament reconstruction rehabilitation protocol. In the case of a solitary meniscal injury, returning to playing sports is typically initiated at 4 months after surgery.

Discussion

The original technique of our procedure features using the original Meniscal Viper system that was produced as an all-inside suture device for mending of longitudinal tears into a modified repairing device for the radial meniscal tear. The conventional simple horizontal suture that runs parallel to the circumferential fiber does not secure adequate strength to restore the natural hoop stress in radial tears.[6] Concerning clinical outcomes via the horizontal suture procedures for radial tears, Choi et al.[7] reported that postoperative magnetic resonance imaging proved the radial tears healed in 35.1% of the cases, partially healed in 57.1%, and not healed in 7.1%. Winkler et al.[8] reported that all-inside horizontal sutures using UltraFast-Fix (Smith and Nephew, London, UK) for a posterior horn radial tear significantly reduced the lateral meniscal extrusion when compared to preoperative condition; however, it still had significantly greater extrusion than the uninjured knee.

To improve the outcomes of the repair procedure, Nakata et al.[9] introduced the "tie-grip suture," which involves inside-out of 2 vertical mattress sutures and two horizontal sutures passed over the vertical mattress sutures. The tie-grip suture reinforces reduction and stability by primary vertical sutures that bundle the circumference fibers to prevent the meniscus from ripping after the secondary horizontal sutures are fashioned. This suture indicates superior mechanical property compared to a double horizontal suture or a

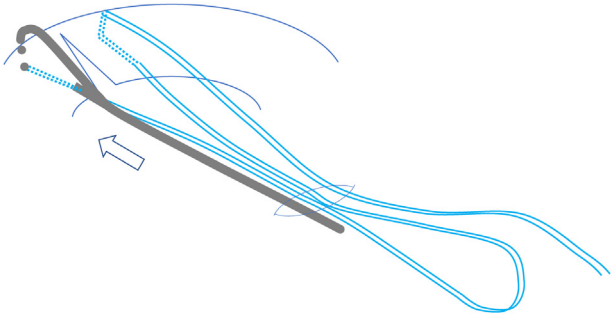

Fig 7. The second suture refrains the same vertical stitch as the primary one at the other side of the posterior horn of the radial lateral meniscus tear. The tip of the Viper's hook is positioned near the tibial insertion of the posterior cruciate ligament. The needle tip of the second suture captures the looped no. 2-0 FiberWire again.

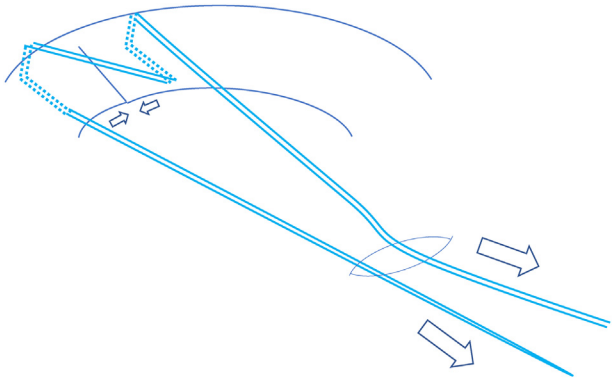

Fig 9. By pulling the 2 suture ends simultaneously little by little, the tear in the meniscus is reduced. An oblique running thread on the tear site is observed.

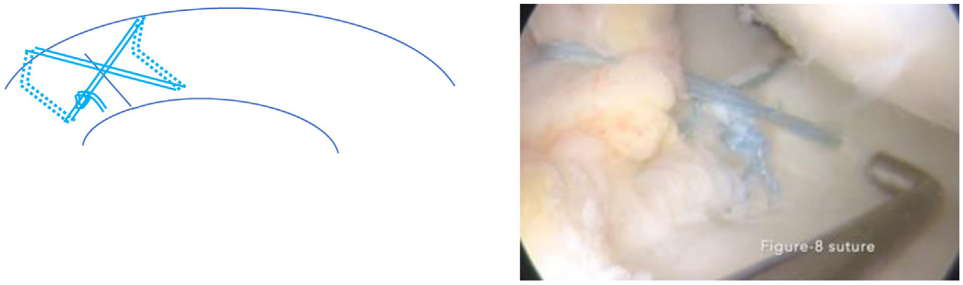

Fig 10. The suture is tied by drawing a single modified racking hitch to the meniscus, followed by a couple of half hitches to secure the knot. After the remaining no. 2-0 FiberWire is cut with the suture cutter, a figure-8 suture is run across the femoral surface and vertically through the mid-substance beside the tear site of the meniscus.

single cross suture in regard to the displacement under a cyclic loading test.[6] However, because the tie-grip suture is broadly used as an inside-out suture technique, this is not a recommended procedure for the posterior horn of the lateral meniscus because of the risk of neurovascular injury.

As a more effective procedure than the ordinal horizontal suture, we introduce a unique all-inside repair technique for radial tears, which has the ability to circumvent neurovascular injury risk. The fundamental component of our "figure-8" stitch was reinforced by double oblique and vertical vectors. A vertical suture reinforced by gripping and bundling the circumference meniscal fibers and double oblique sutures which sets the separated torn meniscus into the original position. From these reasons, we assumed that the figure-8 suture will provide a better compression load than the conventional horizontal suture.

On the other hand, Soejima et al.[10] previously modified the use of the device for repairing the radial lateral meniscus. Their all-inside repair technique is composed of triple horizontal mattress sutures with 3 knots by using the Meniscal Viper as relay threads. In contrast, our simple all-inside technique is accomplished by a single consecutive suture with a single knot while the device thread used as a direct suture.

In conclusion, the figure-8 all-inside suture technique has several advantages compared to the currently used methods for repairing a radial tear at the posterior horn of the lateral meniscus. First, this single all-inside suture technique requires no additional portal, and there is theoretically no risk of neurovascular injuries. Second, because the posterior horn radial tear of the lateral meniscus frequently coexists with the anterior cruciate ligament injury, the suture procedure is preferred as a simpler, time-saving method. Third, our suture technique consists of the cross and vertical vector thread components, which leads us to believe that it provides better suture strength compared to other all-inside horizontal suture techniques. However, the potential superiority of this unique suture technique has not been proved by any biomechanical tests or clinical outcomes.

Table 1. Advantages and Disadvantages of Surgical Technique

Advantages
Requires standard anteromedial and anterolateral portals without any accessory portals
No extra skin incision
No risk for a posterior neurovascular injury
A single suture repair without complicative thread relay
A single-knot procedure that induces less intrajoint irritation
Disadvantages
Technically demanding
A risk of meniscal ripping in making a racking hitch of the figure-8 suture when a consecutive vertical suture does not have adequate margin from the tear
Biomechanical property of the repair procedure compared to other techniques not yet proven

Table 2. Pearls and Pitfalls of Surgical Technique

Pearls
The procedure does not require accessory portals.
The Meniscal Viper is well designed to mend for the posterior segment and horn of the lateral meniscus.
A single consecutive suture produces a vertical and cross-stich thread component at once.
Suture repair is accomplished with a single knot
The figure-8 cross stich can reduce and stabilize the separated radial meniscal tear.
Pitfalls
Adequate marginal distance should be made from the tear site when making a consecutive all-inside suture with the Meniscal Viper to prevent ripping of the meniscus when drawing a racking hitch.
To secure adequate strength for reduction of the radial tear site, two mid-substance vertical suture threads should run bottom of the meniscal substance, which means that the hook of the Meniscal Viper sits deep along the meniscal rim and the Viper's needle should be inserted form near the anterior margin of the lateral meniscus.
Thread tangling at the portal or with the fat pad should be carefully avoided.

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