

# An Arthroscopic-Assisted Radial Meniscal Tear Repair Using Reinforced Suture Tape Rebars and Suture Tapes



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**Abstract:** A radial tear of the meniscus can lead to significant loss of meniscus function, resulting in deleterious cartilage changes. Repair of radial meniscus tears has several challenges, including suture pull-out, which can reduce healing success. We present an arthroscopic repair technique in a complete radial lateral meniscus tear using vertical reinforced bars (rebar) of suture tapes to reduce suture pull-out and approximate the radial tear.

The functions of the menisci are load distribution, shock absorption, and joint stabilization.<sup>1</sup> Loss of function or injury to the meniscus can result in change in contact area and lead to cartilage degeneration.<sup>2,3</sup> Radial tears, which occur perpendicular to the deep edge and extend superficially toward the rim, are considered less common but more complex injuries that result in large meniscal extrusion and increased peak compressive and shear stress in both the menisci and cartilage.<sup>2</sup> This stress is shown to increase with meniscectomy.<sup>1</sup> Therefore, preserving and repairing a damaged meniscus has become the new standard to achieve better long-term outcomes for the patient.<sup>4</sup>

Past techniques for radial meniscus tear repair used single, double, or crossed horizontal mattress sutures.<sup>3,5</sup> A relevant consideration for meniscus repairs is the

orientation of the sutures relative to the collagen fibers of the meniscus. Given the longitudinal parallel orientation of meniscus collagen fibers, vertical mattress suture configurations provide greater resistance to suture pullout and load-to-failure.<sup>6</sup> The challenge with radial meniscus tears is the line of pull for the horizontal mattress suture during parallel side-to-side repairs often is in line with the torn meniscus fibers, and, hence, prone to pullout. Recently, reinforced suture bars (rebar) placed on both sides of the radial meniscus tear have been shown to increase load-to-failure and reduce suture pullout.<sup>7</sup> Furthermore, the advent of suture tape technology and its application to meniscus repairs have also shown suture tape's ability to reduce cut out within meniscus tissue.<sup>8</sup> In this surgical technique, we describe an arthroscopic inside-out meniscus repair technique that uses rebar suture tapes to effectively repair a torn radial lateral meniscus tear. This technique uses advances in suture material and configuration to minimize pullout during challenging radial meniscus tear repairs.

## Surgical Technique (With Video Illustration)

### Patient Positioning and Preparation

The lateral meniscus repair is performed with the patient under general anesthesia (Fig 1). A preoperative regional blockade, including an adductor and interspace between popliteal artery and capsule of the posterior knee (IPACK), can be performed to assist with post-operative pain control and permit examination of peroneal nerve motor function after the procedure. The patient is placed supine with a pneumatic tourniquet

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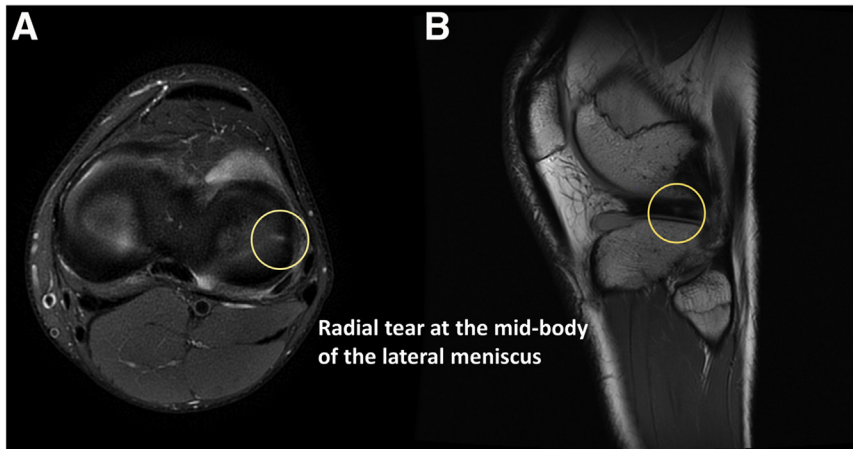
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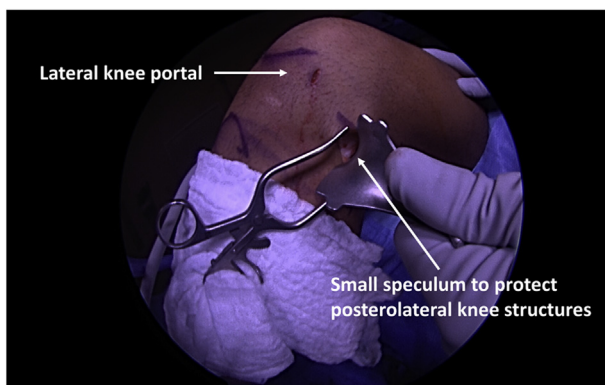
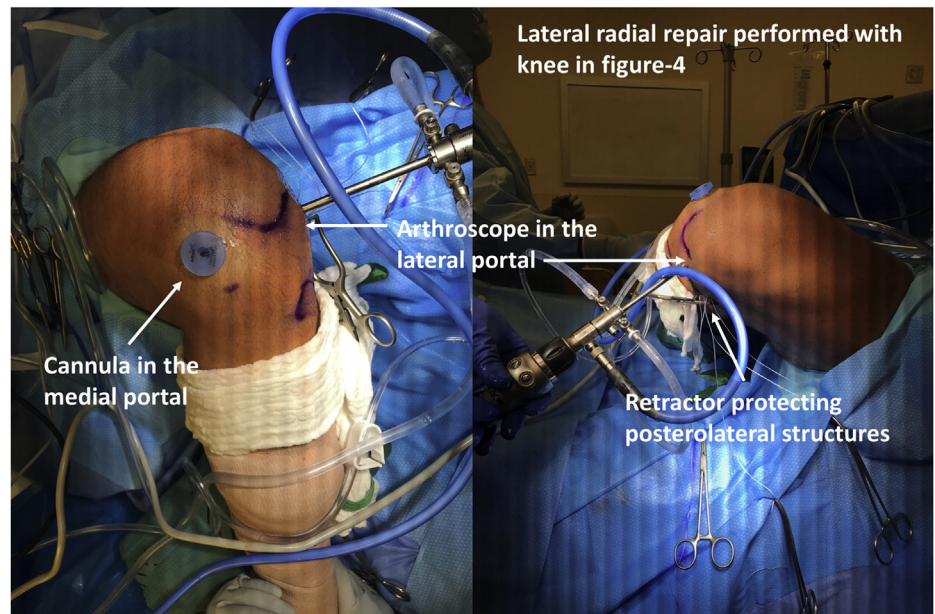
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**Fig 1.** Magnetic resonance imaging of the knee demonstrating a high-grade complex radial tear of lateral meniscus (yellow circle) on axial (A) and sagittal (B) views.

**Fig 2.** Patient and portal positioning for the lateral meniscus repair. The lateral meniscus radial tear repair is performed with the patient's leg in a figure-four position. This position permits ease for both knee flexion and varus stress intraoperatively, which are critical for access and instrumentation of the lateral compartment of the knee. A medial portal with an arthroscopic cannula is used for placement of all the suture tapes for repair. A cannula is important for suture placement, management, and tying.

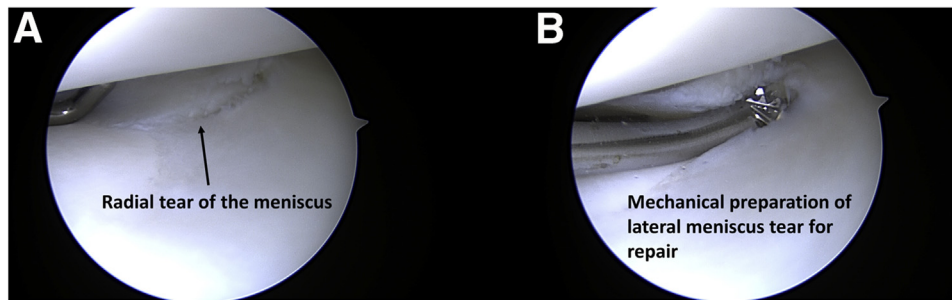


**Fig 3.** A posterolateral incision is made with placement of the speculum to protect the posterolateral knee structures. This is used to retrieve the inside-out meniscus suture tapes.

placed on the upper thigh. However, we have found that excellent hemostasis can be typically maintained without the need to inflate the tourniquet. A supine position with a lateral hip post is preferable for lateral meniscus work where the leg can be placed in a figure-four position without the need of an assistant to maintain varus force to open the lateral compartment.

### Portal Placement

Standard anterolateral and anteromedial portals are made for the diagnostic portion of the arthroscopy. Once the radial tear of the lateral meniscus is identified, one should carefully evaluate the location of the radial tear in relation to the rest of the lateral meniscus. The repair of a radial tear of the lateral meniscus is done



**Fig 4.** Identification (A) and preparation (B) of lateral meniscus tear (arrow) for repair. Mechanical agitation and trephination of the lateral meniscus tissue are necessary given radial tears often traverse segments of the meniscus that may have relatively poor vascular supply. In this illustration, the radial tear involves the inner one third to the peripheral one third of the lateral meniscus.

with the knee in a figure-four position (Fig 2, Video 1). An accessory medial portal may need to be made with knee in the figure-four position to obtain a straight in-line approach to the lateral meniscus tear, particularly if a meniscus suture passer (Knee Scorpion Suture Passer; Arthrex, Naples, FL) will be used to perform an all-inside repair for the inner one-third portion of the radial tear. An arthroscopic cannula (PassPort Cannula; Arthrex) is then placed in this optimally positioned medial portal for the meniscus repair (Fig 2). We then visualize the torn lateral meniscus arthroscopically and identify the corresponding external location to the tear by palpating along the lateral joint line and visualizing the ideal external incision location relative to the radial tear. An accurate placement of this counter-incision allows one to make a very small incision.

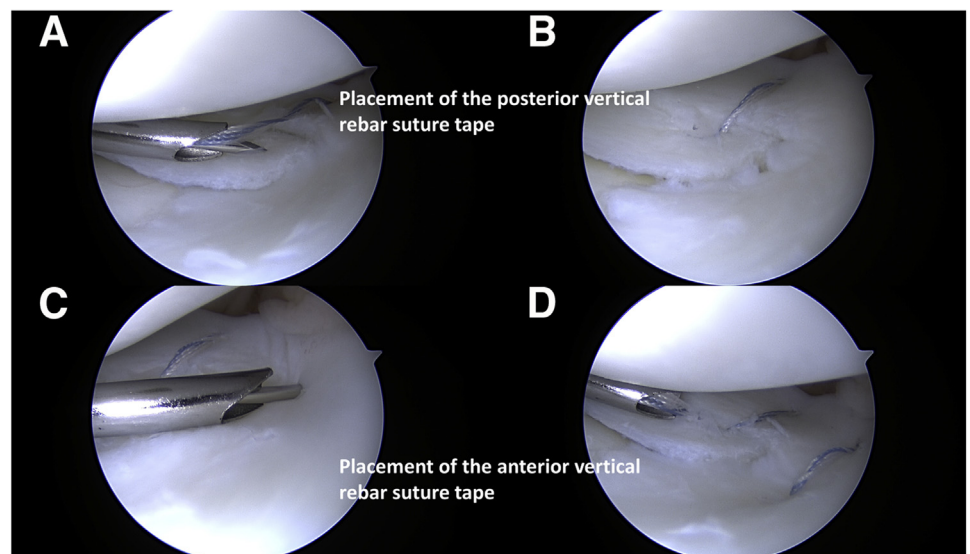
Once the most optimal external location is identified that corresponds to the site of the intra-articular meniscus tear, an accessory posterior lateral incision (typically 2-3 cm) is made (Fig 3). The iliotibial band will usually need to be split and elevated to place a

retractor between the joint capsule and the more superficial posterolateral structures.

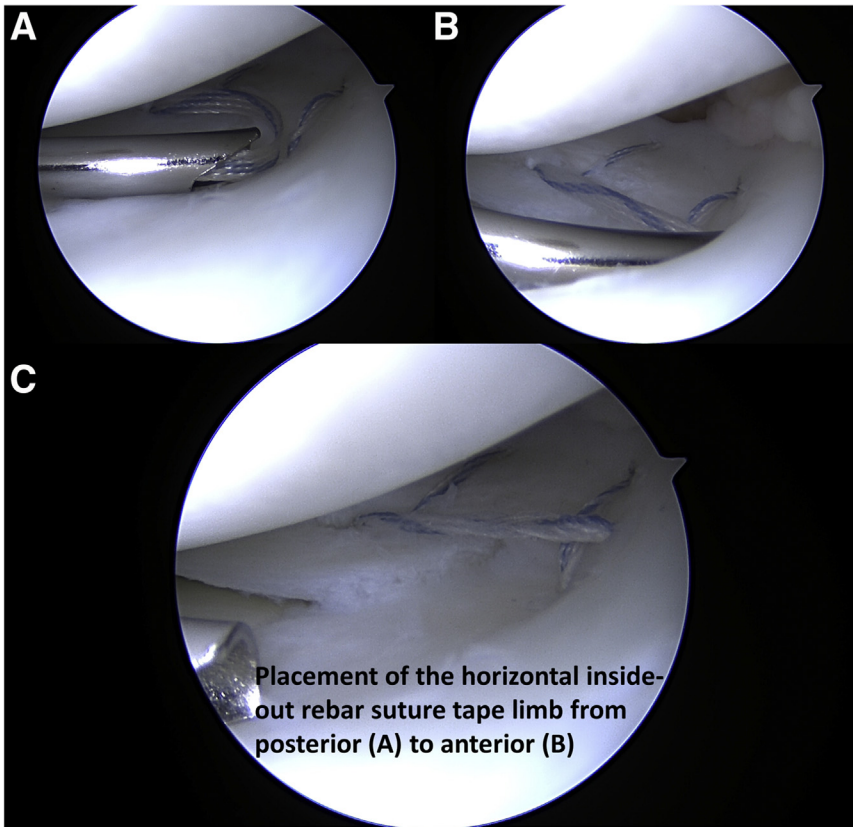
### Reinforced Suture Rebar Radial Tear Repair

The torn lateral meniscus tissue is then mechanically prepared (Fig 4). We abrade the torn meniscus tissue and the adjacent synovium with a meniscus rasp to optimize the local environment for healing. Given radial tears traverse often poorly vascularized portion of the meniscus, we also trephinate the meniscus tear to induce localized bleeding using an 18-G spinal needle. A single or double lumen zone-specific arthroscopic meniscus repair cannula can be used to place the vertically orientated parallel suture tape rebars (2-0 Mini SutureTape Meniscus Repair Needles; Arthrex) approximately 5 mm from on either side of the radial tear (Fig 5). A horizontal mattress is then placed just anterior or posterior to the rebars in the anterior and posterior portion of the torn meniscus respectively (Fig 6). Depending on the depth of the radial tear (either complete or partial), usually only 1 or 2 horizontal mattresses can be placed in

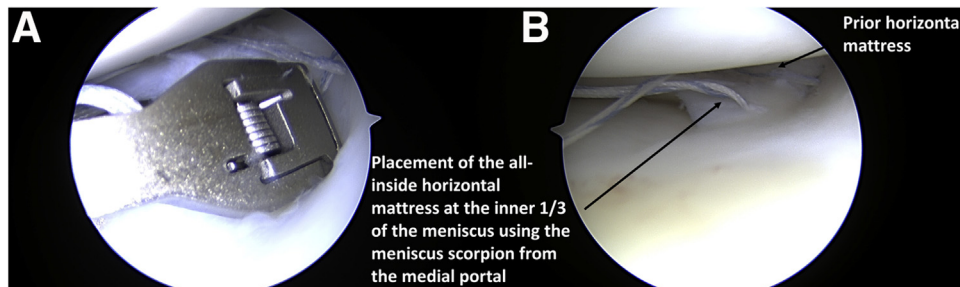
**Fig 5.** Placement of inside-out posterior suture tape rebar (A and B) and anterior suture tape rebar (C and D). These tapes are placed using a zone-specific meniscus cannula approximately 5 mm from the radial tear edges. An assistant is necessary to help retrieve the needles from the posterolateral incision as it exists the joint capsule.





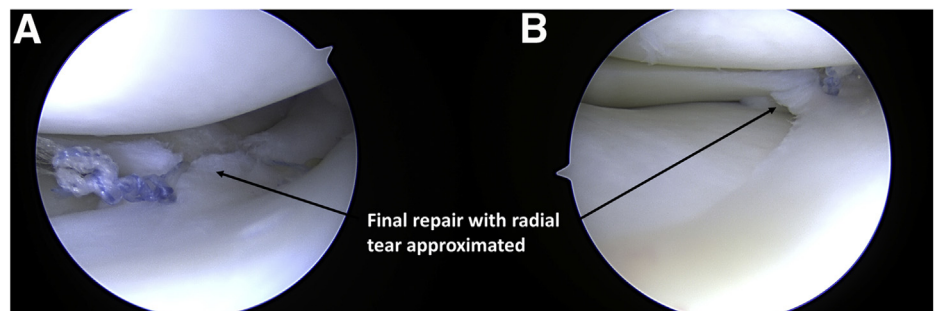


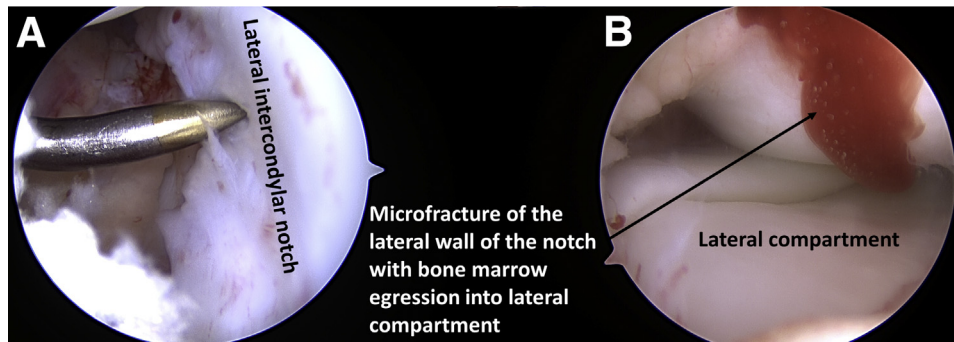
**Fig 6.** Placement of inside-out horizontal mattress suture tape just outside of the rebar tapes. The horizontal mattress suture tape is placed just anterior (B) and posterior (A) to the anterior and posterior rebar tapes respectively. As the horizontal mattress suture is tied, both the rebar suture tapes resist pull-out of the horizontal mattress suture tape (C).



**Fig 7.** (A) Passage of the horizontal mattress limb to reapproximate the inner one third of the lateral meniscus radial tear using the Arthrex Knee Scorpion. While healing in the inner zone of the meniscus is unpredictable, reapproximating the prior horizontal mattress (B) in this inner portion not only preserves more meniscus tissue, but it may help shield the more peripheral horizontal mattress stitches and prevent gapping of the repair during early knee motion after surgery.

**Fig 8.** (A, B) Arthroscopic view of the complete lateral meniscus repair with all suture tape limbs tied demonstrating complete approximation of the tear edges following the repair.





**Fig 9.** Microfracture of the intercondylar notch (A) to induce intraarticular bleeding and bone marrow egression into the lateral compartment to augment meniscus healing. Several microfracture vents are placed along the lateral intercondylar notch to induce intra-articular bleeding (B), which may create an intraarticular environment that is more conducive to healing the radial tear.

the peripheral two thirds of the lateral meniscus due to space constraints. The most inner one third of the radial tear is fixed with an all-inside mattress suture as a capsular based fixation with another horizontal mattress may iatrogenically contract the meniscus toward the joint capsule (Fig 7). Although we recognize the healing of the inner one third of the meniscus may be unpredictable, it may help shield and protect the more peripheral portions of the repair in the middle and outer one third of the lateral meniscus by providing some resistance toward gapping during the early rehabilitation process.

The sequence of tensioning the meniscus repair usually start with tying the vertical suture tape rebars to the posterolateral joint capsule, which tensions the suture tape rebars to the torn portion of the lateral meniscus. We then tie the horizontal mattress suture tape from peripheral toward central in the meniscus. As this is tied, the horizontal mattress suture tape will converge the meniscus tissue to effectively reduce the radial tear. If a horizontal mattress was placed in the inner one third of the lateral meniscus, it is typically tied intra-articularly last in arthroscopic fashion (Video 1). The repair can then be re-examined arthroscopically (Fig 8). We typically conclude the arthroscopic repair with microfracture of the intercondylar notch to induce egress of bone marrow elements, which provides an internal milieu conducive to meniscus healing (Fig 9).

**Table 1.** General Rehabilitation for Rebar Repair of Lateral Meniscus Radial Tear

- Hinge knee brace is used locked in extension after surgery
- Toe-touch weightbearing for first 6 weeks after surgery
- 0-60° of knee flexion first 4 weeks, then progress as tolerated thereafter
- An unloader brace is used to unload the compartment of the radial tear repair after transitioning out of the hinge knee brace
- Short plyometrics and low impact activities are permitted 4 months after surgery if patient function are appropriate (i.e., good eccentric quadriceps control, 70% quadriceps-to-quadriceps strength compared with nonsurgical side)

The wounds are then typically closed in layer fashion and a hinged knee brace locked in extension is then applied. Given the propensity for these repairs to gap with early weight-bearing, we typically restrict weight-bearing for the first 6 weeks after surgery (Table 1).

## Discussion

Radial tears compromise the functional ability of the meniscal circumferential collagen fibers to transmit axial loads on the knee into hoop stress, which is critical for its ability to load bear. This leads to distortion of load dispersion, increase extrusion of the meniscus, and increased direct contact force between the femoral and tibial articular cartilages, which result in cartilage degeneration. Studies have demonstrated that satisfactory partial or complete healing can occur after radial meniscus repairs.<sup>4</sup> In light of the significant functional loss with partial meniscectomies with high-grade radial tears, repairs should therefore be considered as a first-line treatment.

**Table 2.** Advantages and Disadvantages of Rebar Repair of Lateral Meniscus Radial Tear

### Advantages

- The technique uses an inside-out meniscus repair technique, which allows flexibility with different angle cannulas that permit ease of passing sutures depending on location of the radial tear.
- The suture needles and suture tapes used in this technique result in small holes in the meniscus relative to the larger needles of all-inside meniscus repair devices

### Disadvantages

- The technique does require additional assistants (1 or 2) for suture passage and retrieval to accomplish the inside-out repair of the lateral meniscus
- Tying the all-inside meniscus repair stitch can be technically challenging. Use of a cannula and retrieval of each limb of the suture tape individually minimizes the potential for entanglement and maximizes the chance for success.
- The described technique would be difficult to perform for radial tears involving the anterior horn of the lateral meniscus. In this scenario, we use an outside-in technique to address radial tears of the anterior lateral meniscus.

**Table 3.** Pearls and Pitfalls of Rebar Repair of Lateral Meniscus Radial Tear

## Technical pearls

- Establish the anteromedial portal with the knee in the figure-four position to get an optimal in-line approach to the lateral meniscus tear
- Palpate the posterolateral joint line/capsule and visualize intraarticularly to gauge where the optimal position of the posterolateral joint incision relative to the radial tear position for inside-out repair
- Use a cannula for suture passage and management particular if an all-inside mattress will be passed and tied. Retrieve each suture limb for the all-inside horizontal mattress individually before tying so as to minimize potential twisting of suture limbs, which may prevent the knot from sliding down to the meniscus well.

## Technical pitfalls

- Not using a cannula in the anteromedial portal may result in a soft-tissue suture bridge when tying an all-inside meniscus repair tape. One way to remedy this would be to work the knot external to the portal and untie the knot, retrieve both suture tape limbs out a separate portal, place the cannula in the anteromedial portal, then retrieve both suture tape limbs out of the cannula, and then tie.
- Placement of the rebar suture tapes should be at minimum 5 mm from the radial tear edge. Placement of the suture tapes too close to the tear edge can result in potential suture migrating into the radial tear when the tear edges are approximated with the horizontal side-to-side suture tapes.

Minimizing gapping of the repaired tissue is paramount in radial meniscus repairs. Horizontal mattress sutures are classically used to reduce the torn meniscal edges and can be arranged in single, double parallel, or crossed horizontal mattresses.<sup>3,6</sup> However, due to these horizontal sutures being placed in parallel with the transected circumferential fibers, there is a tendency for suture cutout and failure.<sup>6</sup> Our technique addresses these difficulties of radial repairs in several ways. Placement of 2 vertical suture tape rebars directly adjacent to the horizontal sutures reinforces the horizontal sutures and distributes their stress to a larger surface area.<sup>7</sup> These vertical rebars also encompass more meniscal tissue into the repair, increasing the fixation strength and resist gapping. Massey et al.<sup>7</sup> showed that suture rebars resulted in a lower rate of suture cutout through the meniscus and a higher load-to-failure when compared with both parallel repair and cross-stitch repair, which they attributed to the suture bars spreading the stress over a greater meniscus surface area. In addition to the rebars, the use of the wider footprint mini suture tape also further decrease the rate of cutout of the meniscus compared with standard sutures by providing a broader and more even distribution of pressure. Suture tape has shown to increase the strength of the repair and decrease suture pullout. Robinson et al.<sup>8</sup> reported 2 times greater maximum load to failure with suture tape compared to standard sutures.

We have found that the described inside-out technique with zone-specific cannulas, which have different

curvatures, allows for a great deal of flexibility to address radial tears in different locations of the lateral meniscus with the rebar technique (Table 2). The different curvatures of the needles allow one to address radial tear in the mid-body to the posterior horn of the lateral meniscus easily. It also minimizes trauma to the meniscus given meniscus repair needles for inside-out repair are smaller than all-inside meniscus repair devices. Tears, however, involving the anterior horn of the lateral meniscus would be difficult to address with this technique. In our experience, we use an out-inside in technique to address radial tears of the anterior horn of the lateral meniscus. One of the most technical challenging aspect of the technique is associated with tying the all-inside meniscus repair stitch if it placed (Table 3). We have found that sound suture management including the use of a cannula and retrieving each suture tape limb that will be tied individually minimizes the potential for soft tissue bridge or suture entanglement during this process and maximizes success.

In conclusion, we describe a technique to repair radial meniscus tears using meniscus rebars and suture tapes. The use of rebars and wider footprint of the mini-suture tapes takes advantage of the meniscal fiber orientation and distribute stress from the horizontal suture tapes to a larger surface area, which leads to less cutout and potential loosening of the repair. Limitations in the current literature include lack of clinical studies that directly compare different radial tear repair techniques. As more radial tear repair techniques are introduced, future studies should focus on the direct comparison of these techniques as they pertain to clinical healing rates.

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