

# Circumferential Suture Repair of Isolated Horizontal Meniscal Tears Augmented With Fibrin Clot



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**Abstract:** Traditionally, horizontal cleavage meniscus tears have been associated with osteoarthritis, indicative of the degenerative process. Recent treatment measures have focused on maintaining as much meniscal tissue as possible, despite the routine extension of these tears into the central white-white zones. In the absence of tunnel drilling for cruciate ligament reconstructions, the use of an exogenous fibrin clot is a useful adjunct to increase the local growth factors at the tear repair to aid in healing. This surgical technique is to describe the use of an all-arthroscopic tied circumferential suture repair of horizontal meniscal tears augmented with exogenous fibrin clot to treat all locations of horizontal meniscal tears.

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The meniscus is a crucial fibrocartilage, which aids in normal joint function, including shock absorption, force transmission by increasing contact area, and joint lubrication.<sup>1-3</sup> Horizontal meniscal tears are many times associated with the arthritic knee environment and have routinely been resected, leaving the dominant leaflet intact with the thought that this will help with force dispersion.<sup>4</sup> However, recent evidence suggests that even keeping the superior leaflet and resecting the inferior leaflet of medial horizontal meniscus tears, there is still a significant increase in the amount of contact pressure and decrease in contact area in the medial compartment.<sup>5</sup> Thus the importance of meniscal repair for horizontal cleavage meniscal tears is paramount for restoring the contact areas and pressure to near normal levels.<sup>6</sup> By placing circumferential sutures around the meniscus, this can stabilize the meniscus; however, unless the tear extends to the periphery,

there is a concern for adequate healing. The addition of exogenous fibrin clot can be a useful adjunct at the time of meniscal repair to provide a more conducive healing environment.<sup>7,8</sup> Kamimura et al. detailed the use of exogenous fibrin clot in the repair of a horizontal meniscal tear with all-inside meniscal repair devices.<sup>9</sup> This study revealed that on second-look arthroscopy, the horizontal meniscal cleft had not only healed but had also restored the meniscus to a normal anatomic shape as best as possible. In an effort to limit the cost of meniscal repairs, the use of an all-inside self-capture meniscal repair device, where the sutures are pre-placed, and the addition of exogenous fibrin clot, which is shuttled into the horizontal meniscal tear cleft, have been proposed as a reproducible surgical technique.

## Technique

### Arthroscopic Evaluation

Standard knee arthroscopy portals are established for a meniscal repair and suture/instrumentation passage. A diagnostic knee arthroscopy is performed per routine, and the meniscal tissue is evaluated by probe. A 4.0-mm shaver (Stryker, Kalamazoo, MI) and standard arthroscopic meniscal biters are used to adequately debride any free edge meniscal tissue to better visualize the tear configuration. If a horizontal cleavage meniscus tear is appreciated, with viable superior and inferior leaflets, then the surgical technique described below can be used to repair the meniscus.

### Fibrin Clot Creation

Given the time it takes for the exogenous fibrin clot to be created, this process is immediately started once a

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*This study received a research support grant provided by the Ceterix Company to UVA Medical Center for investigational use of the Ceterix Novostitch device.*

*The authors report that they have no conflicts of interest in the authorship and publication of this article. Full ICMJE author disclosure forms are available for this article online, as [supplementary material](#).*

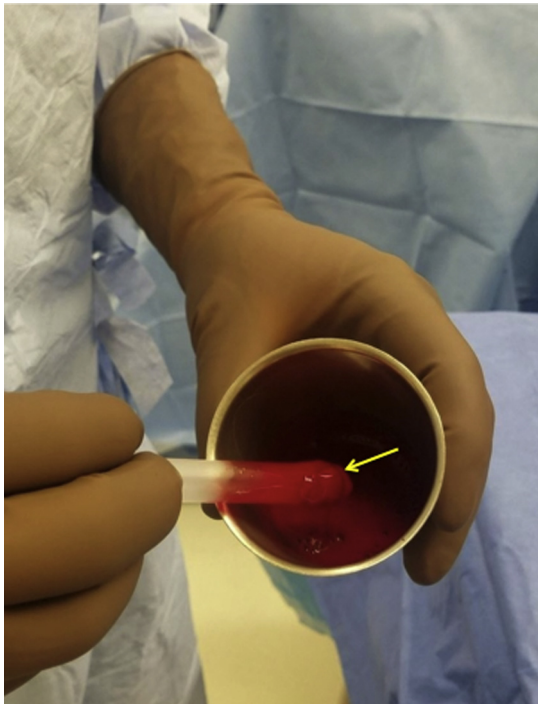
*Received March 27, 2017; accepted June 16, 2017.*

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*2212-6287/17406*

*<http://dx.doi.org/10.1016/j.eats.2017.06.031>*



**Fig 1.** Image of fibrin clot preparation. Thirty milliliters of venous blood is obtained in sterile fashion from an anesthesia IV draw and stirred slowly with a frosted glass rod (from a standard spinal tap set) until a fibrin clot starts to form (arrow). (IV, intravenous.)

decision is made to repair the tear. Thirty milliliters of venous blood is collected by anesthesia, and the blood is delivered by sterile technique into a stainless steel 50-mL bowl and a frosted glass syringe rod (routinely obtained from a generic spinal tap set) is used to stir the clot slowly and create the fibrin clot<sup>8</sup> (Fig 1). It can take several minutes for the clot to develop on the frosted rod. Once it develops, the clot is carefully delivered off the rod and then placed on a 4 × 4 gauze (Fig 2).

## Midbody Meniscus Tear

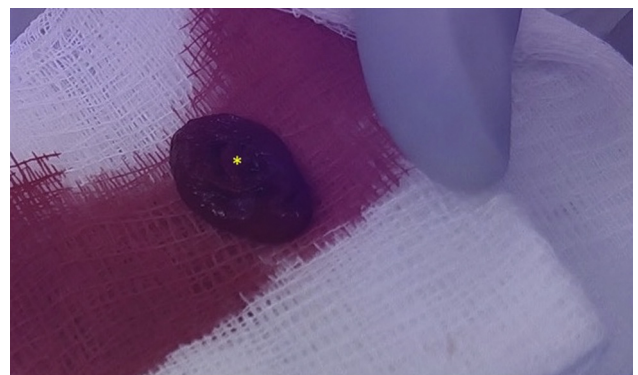
### Tear Preparation

With the knee in a standard position to gain adequate visualization of either the medial or lateral horizontal meniscus tear, the arthroscope is introduced through the ipsilateral anterior portal corresponding to the tear and will be used as the primary viewing portal. A shaver is placed in the portal opposite the pathology, which will be the primary working portal, and delivered into the tear crevice to freshen the zone of injury as deep as possible to the periphery (Fig 3). Should the working space be deemed “tight” for the safe passage of instrumentation, then a proximal medial collateral ligament fenestration is performed, roughly 1 cm above the joint line, to gently relax the medial collateral ligament and allow not only better visualization but also a safer working space. Next, a

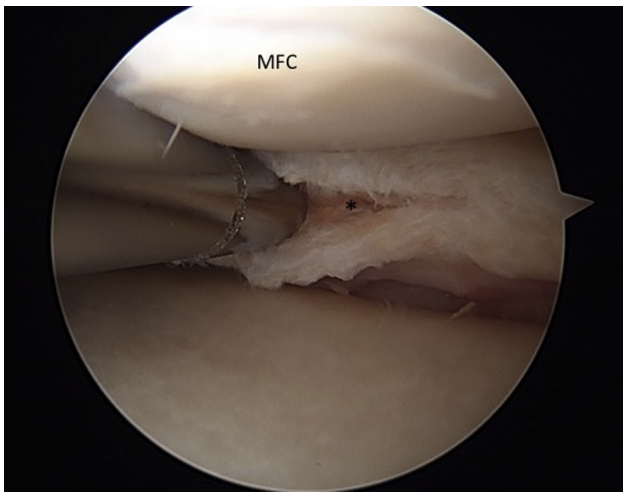
no. 0 PDS is placed, using an 18-g spinal needle, through the mid aspect of the meniscus tear and exiting through the deepest aspect of the tear/crevice. This PDS suture will be used to introduce the fibrin clot in between the 2 leaflets of the tear, and, depending on the location of the tear, the PDS may be placed using an outside-in technique, an inside-out technique by pulling the suture through the skin, or an all-inside technique pulling the suture through the superior leaflet of the tear (Fig 4). A meniscal scorpion (Arthrex, Naples, FL) is used for ease of passage of the no. 0 ethibond through the superior leaflet of the tear. This provisional suture can be shuttled through to carry a no. 0 PDS through the superior leaflet. The latter technique is shown during the repair of a midbody horizontal cleavage medial meniscal tear in Video 1.

### Suture Placement

Switching portals, an arthroscopic grasper is then used to deliver this no. 0 PDS initially through the viewing portal. This will help limit entangling the suture shuttle and the placed circumferential sutures. Viewing once again from the primary viewing portal, a generic 7-mm cannula that can easily have the external fluid valve removed is placed through the primary working portal, still keeping the valve in place at this time. Using a self-capture single-use suture passer, Ceterix Novostitch device (Ceterix, Fremont, CA), through the working portal, a 2-0 UHMPE suture is passed circumferentially from the inferior to the superior leaflets in the peripheral zone of the tear (Fig 5). The suture is retrieved through the same portal. Given the all-inside all-suture use of this device and self-capture ability, sutures can be placed circumferentially at the meniscocapsular junction, or even at the popliteal hiatus without capturing the popliteus tendon, unlike many of the all-inside meniscal repair implantable devices. This is done as many times as required working anteriorly and spacing out the sutures every 5 mm (Fig 6). Should the most anterior suture not be available to be placed by this all-inside all-suture



**Fig 2.** Image of the fibrin clot. The fibrin clot (\*) is removed from the glass rod carefully, placed on a 4 × 4 gauze, and stored on the back table.



**Fig 3.** Arthroscopic image right knee medial meniscus, anteromedial viewing portal, and anterolateral working portal. A standard 4.0-mm shaver is placed through the working portal, and the meniscal cleft (\*) is debrided, as close to the periphery as possible to help prepare the cleft for fibrin clot introduction and debride degenerative medium. (MFC, medial femoral condyle.)

technique, then an 18-g spinal needle can be used from outside-in with the needle visualized to enter the superior aspect of the anterior meniscal tissue at the red-red zone and exiting on the tibial articular side of the inferior surface. A no. 0 PDS is then passed and retrieved through the working portal, and a corresponding 2-0 suture is shuttled through the tissue. An atraumatic ring grasper is then used to retrieve the superior aspect of the shuttled suture end through the working portal. This can be tied arthroscopically at the end of the case.

### Fibrin Clot Shuttling/Suture Tying

Next, the previously placed no. 0 PDS suture, which passes through the midsubstance of the tear, is retrieved through the working cannula and the fluid valve is removed from the cannula so there is no obstacle to shuttle the fibrin clot. The no. 0 PDS is then placed through the fibrin clot by using a size-appropriate eyelet straight Keeth needle. Two stacked knots are then tied in the PDS, effectively creating a Mulberry knot (Fig 7). The clot is shuttled from outside-in through the cannula into the joint by pulling on the no. 0 PDS suture, at which time it is seated into the cleft of the horizontal cleavage tear and adjusted with use of an atraumatic ring grasper as needed (Fig 8). After the fibrin clot has been fully delivered into the meniscal defect, then each previously passed suture, which has a limb inferior and superior to the meniscus and thus the fibrin clot, is tied in successive fashion (Fig 9). The PDS suture shuttle is then removed. This can be done either before or after the sutures have been tied, but it is recommended to have at least one suture tied so that it aids in the maintenance of clot reduction. When tying,

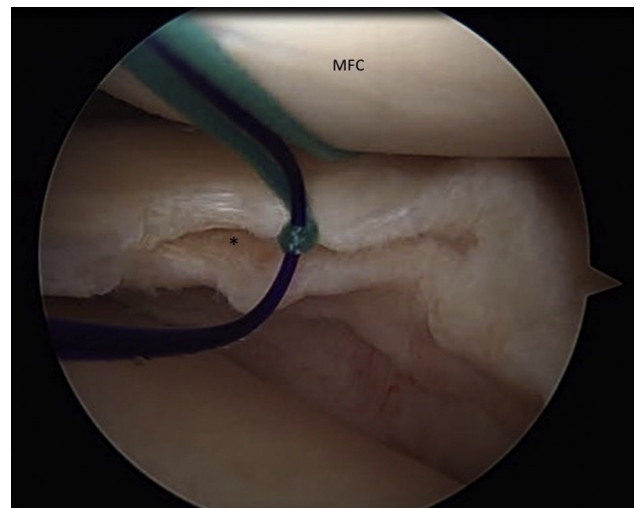
great care is taken to ensure the knots are on the inferior tibial articular surface of the meniscus and as peripheral as possible. Final adjustments are made to the clot as needed as the sutures are each individually tied and the construct is probed (Video 1; Table 1).

### Rehabilitation

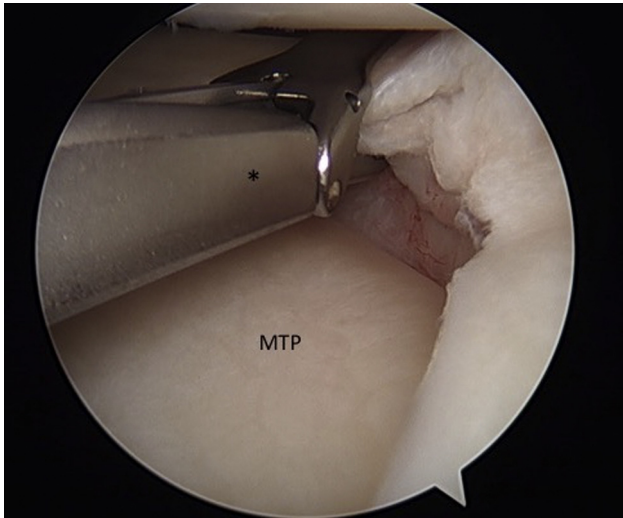
A meniscal repair protocol is employed post-operatively. Routinely, we place the patient in a knee brace, limit the patient's weight-bearing status to 25%, and allow knee range of motion from 0° to 90° during the first 6 weeks. After this initial timeline, a progression to full, unrestricted range of motion is allowed and the patient begins weight bearing as tolerated with a goal of return to sports by 4 to 6 months after satisfactory peri-knee reconditioning.

### Posterior Horn Meniscus Tear

We find it easier to switch portals as the ipsilateral portal to the meniscal pathology provides a better working portal with in-line access to horizontal cleavage tears in the posterior meniscal zones. The portal opposite the pathology becomes the primary viewing portal in this instance. The same self-capture device can be used to place the definitive repair sutures. An outside-in 0 PDS is difficult to place in this fashion given the posterior location of the tear, so a meniscal scorpion's (Arthrex, Naples, FL) lower jaw can be inserted into the tear itself and suture passed, preferably a no. 0 suture, and retrieved through the working portal. As described above, this suture is traded by shuttle technique for a no. 0 PDS, which allows an easier introduction of the

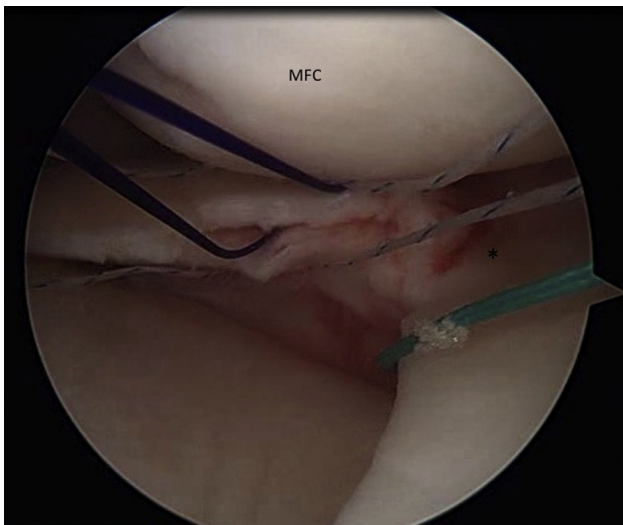


**Fig 4.** Arthroscopic image right knee medial meniscus, anteromedial viewing portal and anterolateral working portal. A no. 0 ethibond suture has been placed through the superior leaflet of the horizontal meniscus tear and is used to shuttle the smooth no. 0 PDS in through the superior leaflet. This will ultimately be used to shuttle the fibrin clot from outside-in and into the cleft (\*). (MFC, medial femoral condyle.)



**Fig 5.** Arthroscopic image right knee medial meniscus, anteromedial viewing portal and anterolateral working portal. A Ceterix Novostitch device (\*) is used to pass the 2-0 UHMPE suture circumferentially around the meniscus, at its periphery. (MTP, medial tibial plateau.)

fibrin clot. This will allow an all-inside shuttle to be used during the outside-in placement of the fibrin clot. Should switching portals be needed to gain adequate access to place the shuttle suture, then it is recommended to do so. The same process of fibrin clot development, circumferential suture placement through the ipsilateral working portal, suture fibrin clot shuttle, and suture tying is

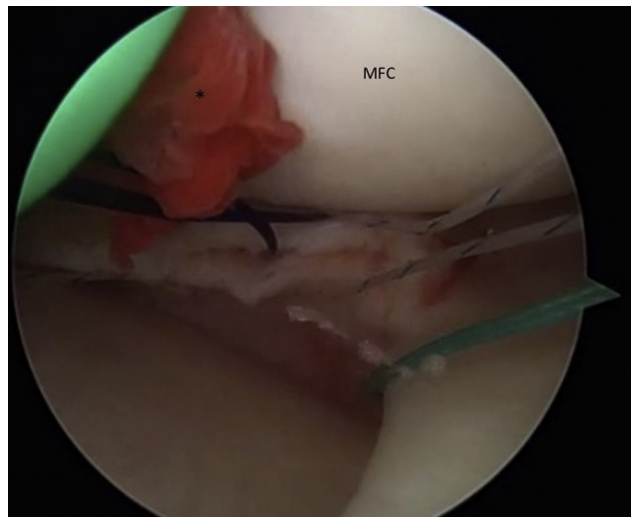


**Fig 6.** Arthroscopic image right knee medial meniscus, anteromedial viewing portal and anterolateral working portal. Preplaced circumferential sutures have been placed through the periphery of the medial meniscus (\*). Note, to help deconflict the passage of the fibrin clot, the most anterior sutures exit through the viewing portal and the posterior suture and no. 0 PDS exit through the working portal. (MFC, medial femoral condyle.)

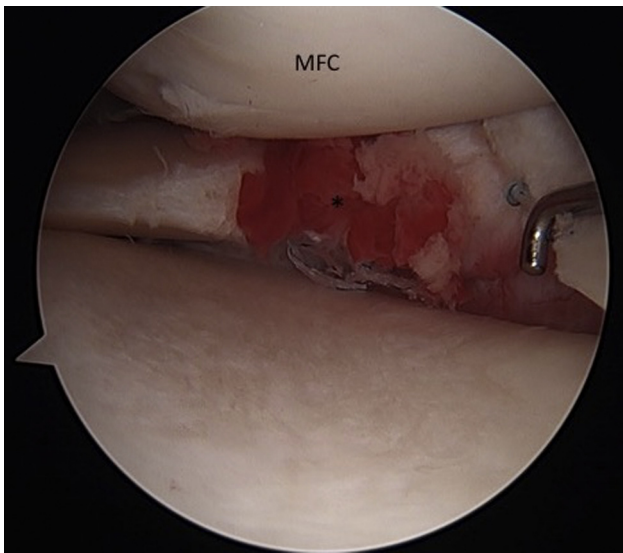


**Fig 7.** Image of a right knee with fibrin clot woven onto the no. 0 PDS suture by Keeth needle and a Mulberry knot tied behind it to help guide it into the joint while shuttling it into the meniscal cleft. Of note, the cannula is in the working portal, and the external fluid valve has been removed (arrow) at this point so that it does not interfere with the passage of the clot.

performed. Should the cleavage tear not be deep enough to accommodate the fibrin clot or the superior leaflet not be viable to place a no. 0 PDS suture shuttle, then a no. 0 PDS can be used to advance the fibrin clot by standard inside-out zone-specific meniscal cannulas/needles for a posterior horn medial meniscal tear. We prefer to use the all-inside no. 0 PDS suture shuttle technique for posterior horn lateral meniscal horizontal cleavage tear to limit injury to the peroneal nerve. The no. 0 PDS suture shuttle can then be removed either before or after suture tying, with the recommendation that it be done after the first suture is tied to help maintain the fibrin clot in a reduced position and still allow for ease of removal.



**Fig 8.** Arthroscopic image right knee medial meniscus, anteromedial viewing portal and anterolateral working portal. The fibrin clot (\*) is shuttled into the horizontal meniscal cleft by pulling on the no. 0 PDS. Note the green cannula is introduced into the medial compartment. (MFC, medial femoral condyle.)



**Fig 9.** Arthroscopic image right knee medial meniscus, anteromedial viewing portal and anterolateral working portal. Final arthroscopic image reveals the horizontal medial meniscus cleavage tear (\*) has been repaired with exogenous fibrin clot with circumferential sutures tied with the arthroscopic knots on the tibial articular surface of the meniscus. (MFC, medial femoral condyle.)

### Anterior Horn Lateral Meniscal Tear

These tears at many times can be difficult to manage at baseline given the difficulty in visualizing the zone of injury. However, by viewing from the portal opposite the pathology and working through the portal on the same side as the zone of injury, the definitive circumferential 2-0 sutures can be shuttled in by standard outside-in suture PDS suture shuttle passage as described above for far anterior suture placement in midbody tears. Again, a no. 0 PDS is placed in an outside-in manner through the horizontal tear defect and retrieved and the fibrin clot is fashioned onto the suture shuttle. Switching portals at this time and viewing from the primary working portal on the side of meniscal injury, the fibrin clot is shuttled through the portal opposite the tear in an outside-in manner. The 2-0 sutures are then tied in standard fashion, again placing the knots on the tibial articular side of the meniscus and at the periphery of the meniscus as best as possible to limit chondral abrasion.

### Discussion

With the need to better restore baseline meniscal anatomy and provide a more conducive environment to meniscal healing, studies have continued to expand the role of meniscal repair to historically complex meniscal tears. Noyes et al. recommended the preservation of meniscal tissue whenever possible in both of their studies reviewing patients undergoing meniscal repair in the avascular zone with and without anterior

cruciate ligament reconstruction, regardless of age.<sup>10,11</sup> It is well understood that meniscal repairs in the setting of anterior cruciate ligament reconstructions leads to improved healing rates secondary to an improved milieu for potential healing.<sup>12,13</sup> The use of a fibrin clot, as described by Rodeo and Warren as well as Henning et al., reveals the potential benefit of this additional adjunct in the repair of complex meniscal tears with improved healing rates compared with no use of a fibrin clot.<sup>8,14</sup> Furthermore, van Trommel et al. reported on the success of treating radial tears in the avascular zone of the lateral meniscus with fibrin clot.<sup>7</sup> In their study, the majority of patients had excellent healing and the remaining patients had incomplete healing upon repeat arthroscopy, with patient clinical follow-up reporting no symptoms.<sup>7</sup> Horizontal meniscal repairs, by suture repair devices augmented by a marrow-stimulating technique, have shown promise, with 73% complete meniscal healing upon second-look arthroscopy.<sup>15</sup> In the setting of horizontal cleavage meniscal tears repaired with exogenous fibrin clot, Kamimura et al. reported the beneficial effects of the clot placement acting as a scaffold during meniscal healing.<sup>9</sup> Furthermore, Kamimura et al. reported follow-up International Knee Documentation Committee scores, at a mean of 40 months postoperatively, that not only showed statistical significance for overall improvement but also that a second-look arthroscopy at the 12-month postoperative point showed 70% complete meniscal healing.<sup>16</sup>

Our proposed surgical technique uses the same preparation techniques as initially reported by Rodeo and Kamimura; however, this reported technique is different from Kamimura et al. given the lack of use of formal

**Table 1.** Pearls and Pitfalls

#### Pearls

- Immediate exogenous fibrin clot development to be performed on the back table while arthroscopic meniscal tissue preparation is performed.
- Deliver the outside-in no. 0 PDS suture shuttle, which will be used for fibrin clot advancement, by shuttling it through the superior leaflet of the horizontal meniscal tear and retrieving it through the primary viewing portal.
- Pristine suture management is paramount given the multiple untied 2-0 UHMPE sutures through the working portal.
- Shuttle and seat the fibrin clot completely into the cleavage tear prior to tying the sutures.
- Tie circumferential sutures to hold fibrin clot in place. Additional far anterior sutures can be placed by outside-in suture meniscal repair circumferential technique if needed to complete tear repair. Ensure adequate tension to close the tear.
- Carefully pull out provisional suture used to shuttle the fibrin clot without disturbing the repair site.

#### Pitfalls

- Improper suture management, resulting in suture entanglement and difficult suture tying.
- Inadequate fibrin clot introduction into the cleavage tear.
- Inadequate suture knot tension resulting in gapping repair.

meniscal implantable devices.<sup>8,9</sup> Depending on the implantable device cost, this has the potential benefit of being less costly, especially in a time of implant-related cost containment. The augmentation of fibrin clot contains growth factors that can aid in meniscal healing. By preplacing the repair sutures in anticipation of clot delivery, this can safely maintain the horizontal cleft in a maximally open position to be ready to receive the fibrin clot. Additionally, with the use of a simple self-capture all-suture passage device, this has the potential to reduce the chondral-associated injuries commonly encountered with the routine use of these needle-tipped meniscal repair implantable devices. Furthermore, this reported technique provides circumferential suture placement in a vertical fashion all-inside, which limits additional posteromedial or posterolateral exposures as would be routinely used for inside-out meniscal repair techniques. Finally, with the use of the all-suture circumferential meniscal repair, these sutures can be placed at the popliteal hiatus, only capturing meniscal tissue and not incorporating any of the popliteus tendon. This is in contradistinction to implantable devices, where many times the implant will not be used at that zone secondary to popliteus tendon entrapment with the device. Our technique does have the potential limitation of suture placement on top of the meniscus during the repair, which is nonabsorbable; yet previous studies commenting on second-look arthroscopy report the relative synovialization of the suture material and lack of chondral abrasions.<sup>9,16</sup> Additionally, this surgical technique does not have reported clinical data thus far, but a second-look arthroscopy is to be considered for these patients in the future at an appropriate timeline of follow-up to correlate to patient symptoms should they be present. However, given this technique's similarity to that of Kamimura et al., we suspect that similar results will be appreciated.<sup>16</sup>

### Summary

We propose that this reported circumferential suture repair of horizontal meniscal cleavage tears with the augmentation of exogenous fibrin clot is a reproducible surgical technique and should provide a favorable healing environment for meniscal healing as has been reported in previous studies.

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