Arthroscopic Posterior Meniscal Root Repair Using Sutures Through a Transtibial Tunnel

The menisci are fibrocartilaginous structures that play a key role in shock absorption, distribution of load, proprioception, tibiofemoral contact, and secondary stabilization of the knee joint.[1-3] The anterior and posterior roots anchor the medial and lateral menisci to the anterior and posterior tibial plateau, respectively.[4] Posterior meniscal root tears are a subset of meniscal injuries which have become increasingly recognized as a source of significant joint pathology.[5-11] They are defined as radial tears or avulsions at the posterior horn meniscal attachment to the bone. These tears often occur with concomitant ligamentous injury, including anterior cruciate ligament (ACL) ruptures and multi-ligament knee injuries.[2, 12, 13] Furthermore, unstable posterior root tears of the lateral meniscus may be identified with high-energy acute ACL tears because of the translation and impaction of the posterolateral meniscus and the tibial plateau that occur during the traumatic pivot shift.[14] In one series, posterolateral meniscal root tears were observed in 8% of anterior cruciate ligament tears.[15] Another study reported that up to 21.5% of medial meniscal tears may be located at the posterior root.[16] As well as acute injuries, posterior meniscal root pathology can be caused by chronic degeneration.

Prompt diagnosis and treatment of a tear in the posterior root of the medial or lateral meniscus is extremely important because of the biomechanical role that these attachments play in meniscal stability. Posterior root pathology leads to altered tibiofemoral contact mechanics and the inability to convert axial loads into transverse hoop stresses.[17] These tears also expose cartilage to abnormal contact forces comparable to those after total menisectomy. One study has shown that a medial meniscal posterior root tear, which is the most likely meniscal attachment to sustain injury, is functionally equivalent to a total medial menisectomy.[1] Clinically, it has been reported that rapid progression of arthritis often accompanies a posterior medial meniscal root tear because of the loss of its ability to resist hoop stresses, and the significant alteration in its load-sharing ability as a result of medial meniscal extrusion.[4, 18] In fact, imaging studies have demonstrated that meniscal extrusion greater than 3 mm is linked with substantially increased articular cartilage loss and osteophyte formation.[19] Therefore, left untreated, these injuries have been shown to result in accelerated joint-space narrowing and rapidly progressive knee arthritis.[9, 11]

Historically, partial menisectomy has been used to manage meniscal root avulsions, though it is likely that similar effects as discussed above would be seen in meniscal root avulsions treated with menisectomy.[1, 7] Therefore, preservation of meniscal tissue and restoration of meniscal continuity is becoming the standard of care for posterior meniscal root pathology.[17] However, not all patients are appropriate candidates for a posterior meniscal root

repair. Repair is indicated in active patients (typically younger than 50 years) following acute or chronic injury with no significant osteoarthritis (Outerbridge grade 3 or 4), joint-space narrowing or malalignment.[2, 20] Moon et al examined the prognostic factors for pullout repair of posterior root tears of the medial meniscus and found that patients with Outerbridge grade 3 or 4 cartilage lesions had substantially worse clinical outcomes after meniscal root repair.[20]

The improved ability to recognize these injuries [by magnetic resonance imaging (MRI) and arthroscopically] and an increased understanding of the biomechanical consequences have resulted in the evolution of various techniques for surgical repair.[9, 21-24] Over the past few years, numerous advances have been made in the development and refinement of these posterior meniscal root repair techniques. Suture anchors as well as transtibial pullout repairs have been described as alternatives to menisectomy, with the goal of restoring the meniscal root to an anatomic and secure attachment to bone.[17] In this article, the authors describe a simple and reproducible technique for posterior horn meniscal root repairs using sutures and a transtibial bone tunnel.

Posterior Meniscal Root Anatomy

The posterior meniscal root attachments can be found anatomically relative to other important landmarks in the knee such as the tibial eminence, articular cartilage of the tibial plateau and the posterior cruciate ligament attachment (PCL) on the posterolateral tibia.[2] Johannsen et al qualitatively found the posterior root attachment of the medial meniscus to be posterior from the medial tibial eminence apex, lateral from the articular cartilage inflection point of the medial tibial plateau and anteromedial from the PCL tibial attachment point. Also, it was found to be posteromedial from the lateral meniscus posterior root attachment.[10] This study also found that the lateral meniscus posterior root attachment was qualitatively posteromedial from the lateral tibial eminence apex, medial from the lateral articular cartilage edge, anterior from the PCL tibial attachment and anterolateral from the medial meniscus posterior root attachment.[10] These anatomic landmarks can therefore be used to identify the posterior root attachment centers and can be directly applied to assist in anatomic meniscal root repairs.

Surgical Technique

Diagnostic arthroscopy allows for evaluation of the knee joint and meniscal pathology. Posterior meniscal root tears can be seen on probing of the meniscus where the root anchor is avulsed from the tibia (Figure 1A). Prior to any repair, preparation of the anatomic insertion site with osseous abrasion using a shaver is performed to stimulate a vascular footprint (Figure 1B). Regardless of repair technique, the authors believe that this is an important step in the healing

process. The anatomic insertion sites of the posterior roots of the medial and lateral menisci can be found using the appropriate anatomic landmarks as previously discussed.

After preparation of the insertion site is performed of either the medial or lateral meniscal root, an Accu-Pass suture shuttle (Smith & Nephew, Andover, Massachusetts) is used through an anterior portal to pass a Cobraid or Ultrabraid nonabsorbable suture (Smith & Nephew) through the posterior root tissue. This is done under arthroscopic visualization, and an arthroscopic grasper is used through an accessory portal to firmly hold the torn root and to more effectively position it toward the suture passer. In order to loop the Cobraid through and around the meniscus, the Accu-Pass monofilament shuttle suture is passed through the anterior portal such that both the looped and free ends are accessible through the anterior cannula (Figure 2A). The shuttle suture is then used to pull the Cobraid suture through the meniscus and back out through the anterior cannula such that the looped and free ends of the Cobraid suture are also accessible outside of the same cannula (Figure 2B). The free ends of the Cobraid suture are passed through the looped end (Figure 2C) and then pulled until the Cobraid has formed a loop around the meniscus (Figure 2D). A second Cobraid or Ultrabraid nonabsorbable suture is also passed through the posterior meniscal root tissue in a similar manner, and both sutures are brought out through the anterior portal.

Next, an Acufex tibial ACL guide (Smith & Nephew) is used to drill a guide pin for the bone tunnel from the anterior tibia to the anatomic insertion point of the corresponding meniscal root (Figure 3). If the guide pin is found to be in good anatomic position under arthroscopic visualization (Figure 4A), a transtibial tunnel is reamed over the guide pin using a 4.5 mm cannulated drill bit. A Hewson suture passer (Smith & Nephew) is then passed up the bone tunnel into the knee joint where the loop is grabbed using a CrabClaw (Arthrex, Naples, Florida). The two nonabsorbable sutures are then passed through the loop and the suture passer pulled back bringing the sutures out to the anterior tibia. Tension is placed on these sutures and arthroscopic visualization is used to note that there is good reduction of the root to its native anatomic footprint as well as good tension on the repair (Figure 4B). Finally, the sutures are are tied over a button (Smith & Nephew) on the anterior tibia at the appropriate tension (Figure 5).

Postoperative Protocol

After a posterior meniscal root repair using the technique described above, patients at the authors' institution are placed in a Total Range of Motion (TROM) brace (DonJoy, Vista, California) locked at 30 degrees of flexion. They are kept toe-touch weightbearing with crutches for the first 4 weeks and are started in physical therapy for range of motion only. At four weeks postoperatively, the brace is locked straight and patients can start weightbearing as tolerated and wean off the crutches. Physical therapy is continued with emphasis on achieving full extension as well as full range of motion. Quadriceps strengthening is also emphasized at this time but no

weightbearing or strengthening activities are done past 90 degrees of knee flexion. At 2 months postoperatively, the brace is unlocked and physical therapy continues and strengthening is stressed and increased with emphasis on the quadriceps musculature and neuromuscular control. Again strengthening is done only up to 90 degrees of flexion. Patients are transitioned to a hinged knee sleeve at 3 months postoperatively and continue physical therapy. In a majority of patients, return to full activity can be achieved by 4 months unless a concomitant ACL reconstruction is performed, in which case the ligament reconstruction dictates the protocol.

Discussion

Although this procedure is fairly straightforward, there are a few key points to note. In cases where a meniscal root tear is seen concomitantly with an ACL tear, the meniscal root sutures can get damaged or mixed up in graft passage. For this reason, the authors recommend passing the meniscal root sutures and bringing them out over the anterior tibia before the ACL graft is passed. Furthermore, the meniscal root repair bone tunnel is drilled after the ACL tibial tunnel using the same Acufex tibial ACL guide (Smith & Nephew).

Various transtibial tunnel sizes have been discussed in the literature,[1, 5, 25, 26] but the authors' preferred method is to use a transtibial tunnel with a diameter of 4.5 mm because of the ease with which both sutures can be pulled out of the tunnel. In addition, this technique involves the use of 2 nonabsorbable sutures. Several different suture techniques for meniscal root tears have been evaluated biomechanically and well described in the literature.[27, 28] The authors believe that the ability to resist displacement of the root is the most clinically important parameter[27-29] because as little as 3 mm of nonanatomic displacement is known to significantly alter meniscal function.[30] Therefore, the technique described above uses two simple sutures and is advantageous because of the ability to increase pullout strength and resist displacement. Furthermore, the passage of simple sutures is easier technically especially when working in a small space arthroscopically.

In regards to suture fixation on the anterior tibia, cortical button fixation[17] as well as screw and washer fixation[26] have been described in past studies. As an alternative to cortical button fixation, the repair could be anchored by simple passage of sutures through the anterior tibia. This method of fixation would be less invasive and avoid the need for any additional hardware or any possible hardware irritation postoperatively. In thin patients or where there is a concern for the quality and thickness of the anterior tibial soft tissues, the authors favor a less invasive technique of fixation such as the periosteral anchor.

The suture anchor technique has also been described for posterior meniscal root repairs with good clinical results.[17] However, the authors' feel that the the described technique is technically less difficult and more effectively facilitates an anatomic root repair with a high degree of accuracy and reproducibility. Emphasis should be placed on anatomic placement of

the transtibial tunnel because this will best restore native knee kinematics and decrease translation on the repair, as well as stress on the meniscus and ultimately the knee joint. Therefore, anatomic landmarks should be used and good arthroscopic visualization should be achieved before a repair is attempted.

Conclusion

The repair of a posterior meniscal root tear is important because of the role the menisci play in shock absorption, proprioception and stabilization of the knee. These types of tears dramatically alter the biomechanics of the knee and have deleterious effects on the knee joint. The technique presented offers an effective and highly reproducible method of repairing these tears and restoring native meniscal anatomy. Special attention should be placed on anatomic placement of the transtibial tunnel to decrease stress on the repair and eliminate any nonanatomic displacement following repair. Future biomechanical studies should focus on optimizing the stability of the repair without increasing stress on the meniscus. Further outcomes studies are also necessary to further evaluate this technique as well as other posterior meniscal root repair techniques. This will allow for critical evaluation and improvement of these repairs in this important subset of meniscal tears.

Figure Legends

Figure 1. Arthroscopic views of Avulsed Meniscal Roots

A: Arthroscopic view of an avulsed posterior medial meniscal root.

B: Avulsion of the posterior lateral meniscal root attachment from the bone.

Figure 2. Shuttling of Sutures Through the Meniscal Root

A: An Acupass monofilament shuttle suture has been passed through the meniscal tissue and is pulled back through the anterior portal such that looped and free ends are accessible through the same cannula.

B: The shuttle suture has been used the pull the Cobraid nonabsorbable suture through the meniscus with both the free and looped ends available from the same cannula.

C: The free ends of the have been passed through the looped end.

D: The Cobraid suture has been tensioned to form a loop through and around the meniscus.

Figure 3. Drilling of the Tibial Bone Tunnel

Acufex tibial ACL guide (Smith & Nephew) placed at the anatomic insertion site of the lateral meniscal root and used to drill a guide pin for the transtibial tunnel. Placement of the guide is done according to important anatomic landmarks; in this case the guide is placed medial from the lateral articular cartilage edge, posteromedial from the lateral tibial eminence apex, anterolateral from the medial meniscus posterior root attachment and anterior from the PCL tibial attachment.

Figure 4. Tibial Bone Tunnel

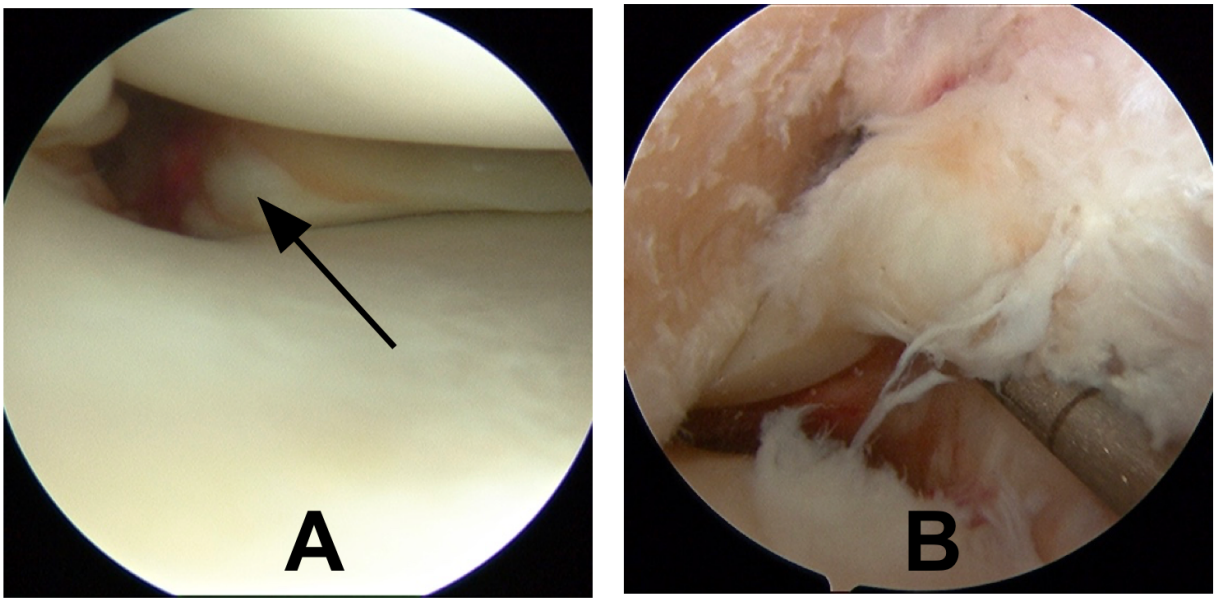
A: Guide pin drilled for the transtibial bone tunnel using the tibial ACL guide.

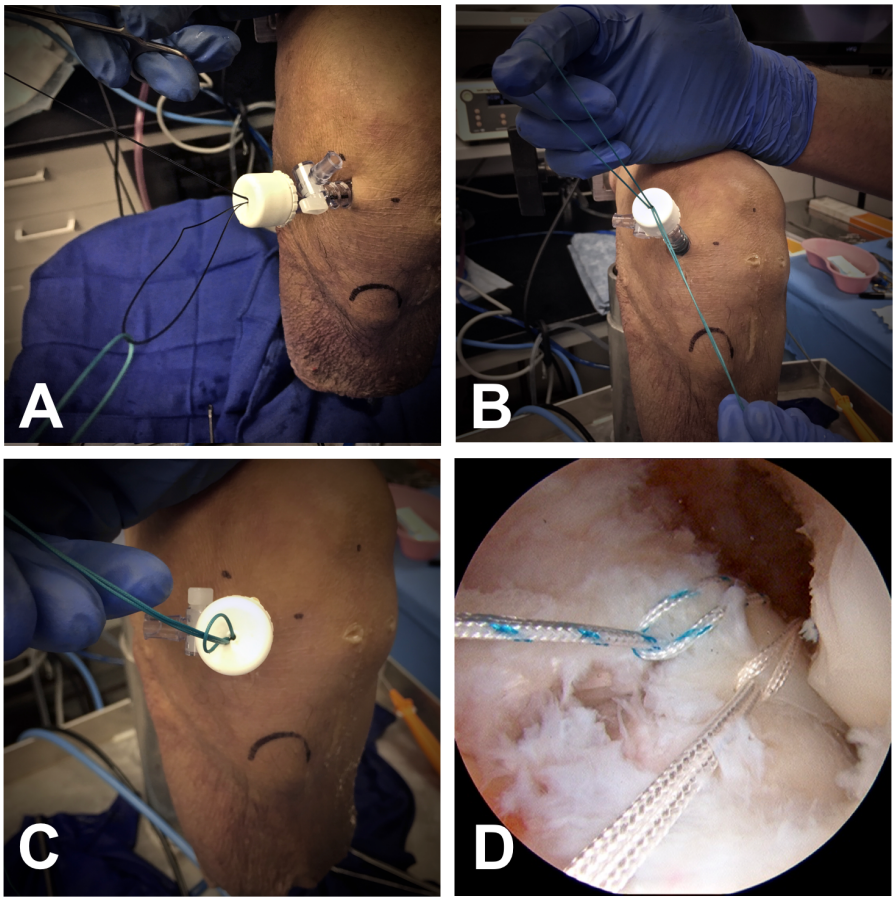
B: Tension placed on the meniscal root sutures allows arthroscopic visualization of appropriate reduction of the lateral meniscal root to its native anatomic footprint.

Figure 5. Final Tensioning and Fixation

A: Fixation of the Final arthroscopic picture displaying appropriate repair of the posterior meniscal root under adequate tension.

B: Cortical button used to provide fixation of sutures. Alternatively, a free needle can be used to anchor the sutures in the periosteum.

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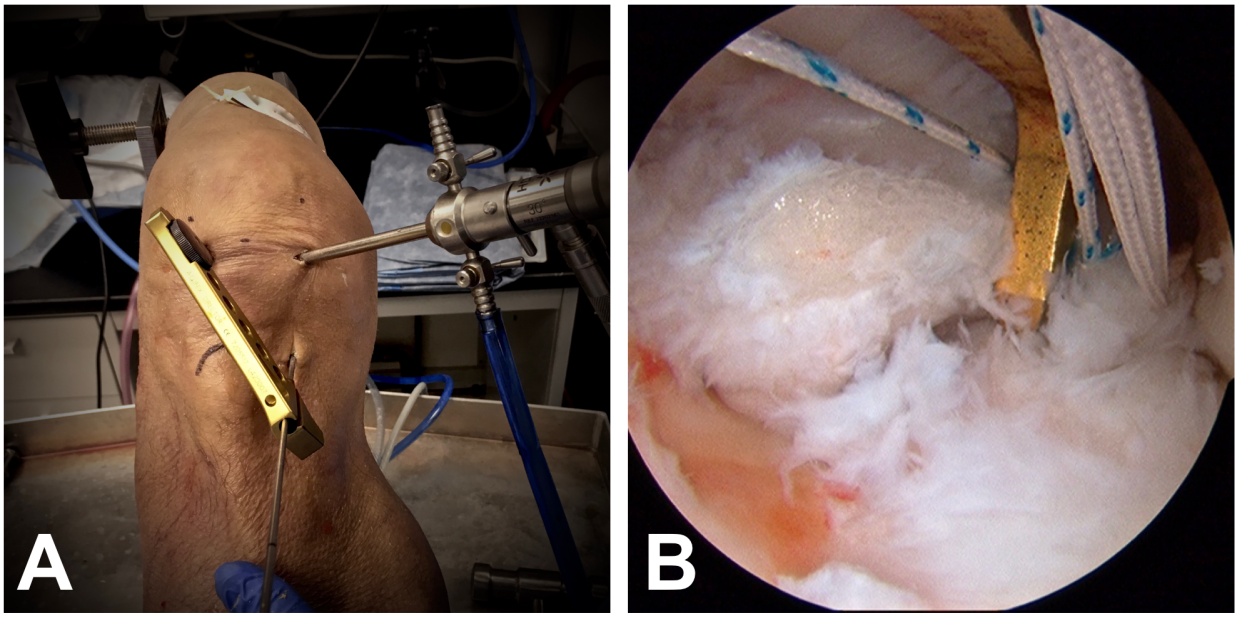
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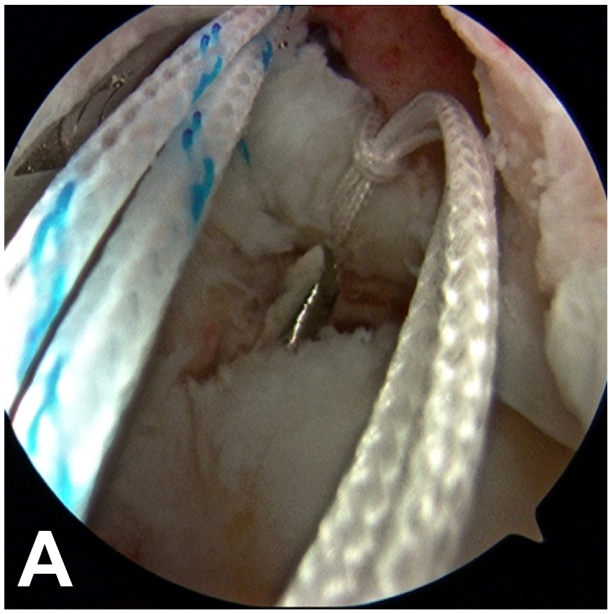
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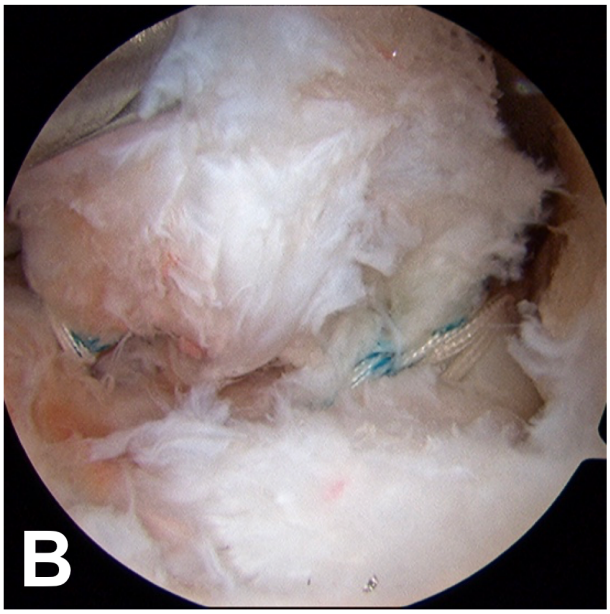
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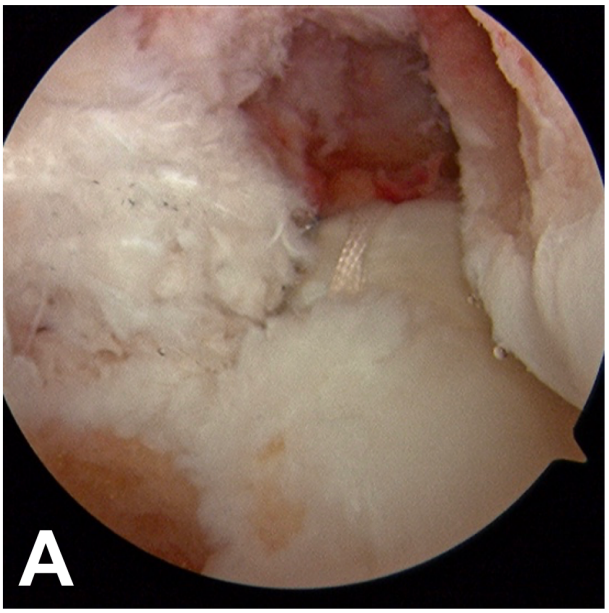
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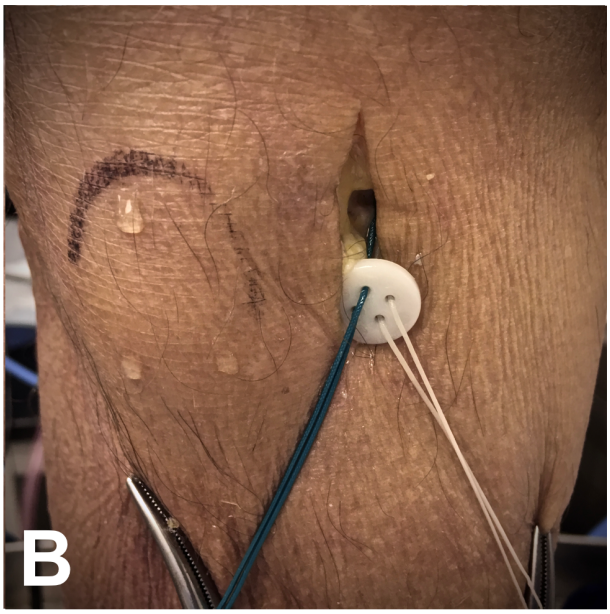
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