Technical Note

Nanoscopic Medial Meniscus Repair

Chad Lavender, M.D., Kassandra Flores, M.S., Tyag Patel, M.D., Galen Berdis, and Baylor Blickenstaff

Abstract: Arthroscopic meniscus repair is one of the commonly used arthroscopic surgical procedures. Open treatment was the standard for meniscus repairs and recently arthroscopic all-inside treatment has become popular. Novel and more minimally invasive techniques to common arthroscopic procedures are paving the foundation to better patient outcomes. With the use of the NanoScope and nanoinstruments, we continue to develop new minimally invasive diagnostic and treatment techniques that do not require standard portals. The nanoscopic medial meniscus repair technique described here uses a less-invasive approach to a meniscus repair.

In the twentieth century, advancement from standard open procedures to minimally invasive arthroscopic techniques changed the field of orthopaedic surgery. The use of a minimally invasive arthroscopic approach decreases the risk for surgical complications and postoperative pain and swelling, and it accelerates recovery time.[1] The number of meniscus repair procedures has doubled from 2005 to 2011, and it is believed this shift has resulted from the emphasis on preservation of the meniscal tissue and its protective action against osteoarthritis.[2] There are many factors that surgeons take into account when deciding route of treatment for knee injury, including history, physical examination, and a variety of imaging findings. Magnetic resonance imaging (MRI) scans are routinely used for the evaluation of joint spaces; however, their accuracy of intra-articular pathology is questioned.[3-6] Some data show high numbers of false-positive and false-negative reports of MRI diagnostics, specifically when evaluating deep structures like the medial meniscus.[3] From 2014 to 2017, Krakowski et al.[4] evaluated the sensitivity and specificity of MRI on medial meniscus (MM), lateral meniscus (LM), and anterior cruciate ligament (ACL) tears. For MM, LM and ACL tears, MRI showed a sensitivity of 96%, 72%, and 75% and specificity of 52%, 85%, and 92%, respectively. A meta-analysis of similar data completed by Phelan et al.[5] evaluated the accuracy of MRI on MM, LM, and ACL tears and estimated sensitivity and specificity. Their finding showed a sensitivity and specificity of 89% and 88% for MM tears, respectively, 78% and 95% for LM tears, respectively, and 87% and 93% for ACL tears, respectively.

Although MRI is considered and used frequently as an effective diagnostic tool, its questionable accuracy with deep pathology and expensive cost make us question whether there is a better way to evaluate these common injuries in real time. The NanoScope needle arthroscopy system (Arthrex, Naples, FL) can be used as a diagnostic and treatment tool for meniscus tears. Although mainly studied as an in-office diagnostic tool, the NanoScope also can be used for more minimally invasive meniscal repair procedures, as demonstrated in this technique. We also use the new FiberStitch (Arthrex) meniscus repair device through the standard NanoScope portal. By combining the FiberStitch and NanoScope, we can repair a meniscus in a very minimally invasive manner. This less-invasive approach should lead to improved patient outcomes and an earlier return to activity.

Surgical Technique (With Video Illustration)

Video 1 and Figs 1-6 demonstrate the surgical technique.

From Chad Lavender Marshall University Orthopaedic Surgery Sports Medicine (C.L.), Marshall University (K.F., T.P., G.B., B.B.), Scott Depot, West Virginia, U.S.A.

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Address correspondence to Chad Lavender, M.D., Chad Lavender Marshall University Orthopaedic Surgery Sports Medicine, Marshall University, 300 Corporate Center Dr., Scott Depot, WV 25560. E-mail: doclav@gmail.com

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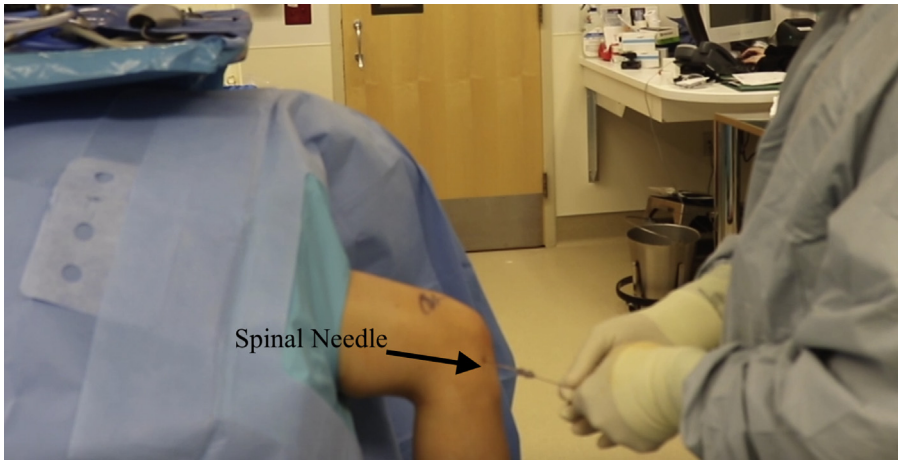

Fig 1. Viewing the right knee in 90° of flexion, the spinal needle has been inserted and a nitinol wire is placed through the needle

Patient Setup

The patient is placed in the supine position with the operative extremity in a leg holder and a tourniquet applied to the operative thigh. The nonoperative extremity is placed over a well-padded pillow in slight flexion. The operative extremity is exsanguinated, and the tourniquet is inflated.

NanoScope Insertion

A spinal needle is inserted into anterior and lateral joint space directly above the lateral meniscus while the knee is in 90° of flexion (Fig 1). A nitinol wire is inserted into the needle, and the needle is removed. A small cannula is then inserted over the wire and the wire is removed. Inflow is then placed onto the cannula, and the NanoScope is inserted for visualization of the joint. A standard diagnostic arthroscopy is then performed in the patellofemoral joint as the knee is brought into extension. The medial and lateral gutters are viewed and the knee is then brought back into flexion. The NanoScope is then redirected into the medial joint space. A medial portal is then established, in the same fashion as the anterolateral portal with a high-flow sheath for the NanoScope. A probe can be placed into the medial joint space, and the medial meniscus is found to have a tear. We then probe the anterior cruciate ligament and move the NanoScope into the lateral joint space and probe the lateral meniscus, which is stable. The NanoScope is then switched to the medial portal so we can use the lateral portal as a percutaneous portal for working.

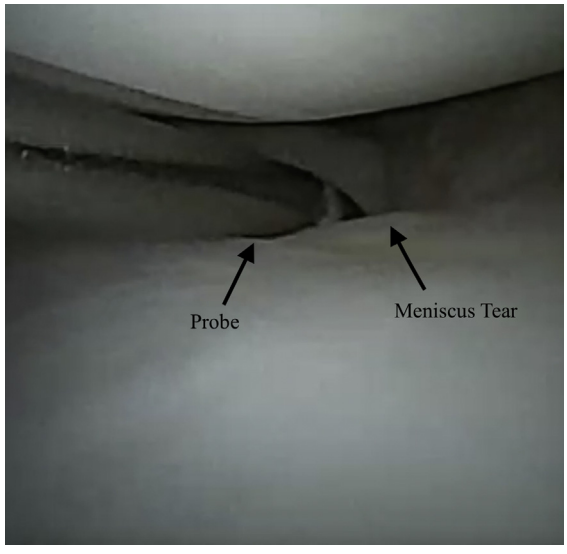

Fig 2. Viewing the right knee in 90° of flexion with the 0° NanoScope from the medial portal, the medial meniscus is probed revealing the tear at the capsular junction.

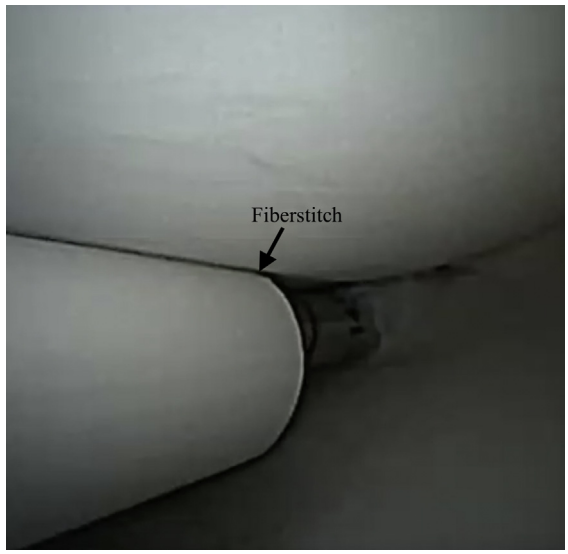

Fig 3. Viewing the right knee in 90° of flexion with the 0° NanoScope from the medial portal, the FiberStitch has been brought in from lateral and is placed through the superior capsule for the first stitch.

Fig 4. Viewing the right knee from outside the joint, the FiberStitch device is seen outside of the joint as we deploy the anchors by using the deployment wheel. The NanoScope is also seen viewing through the medial portal.

Meniscus Repair

The medial meniscus is probed from the lateral portal and a rasp is used to create bleeding for healing purposes (Fig 2). At this point, the FiberStitch (Arthrex) is brought in from the lateral portal percutaneously after setting the depth stop to 14 to 16 mm, and the needle pierces through the superior joint capsule above the tear (Fig 3). The deployment wheel is rolled backwards to a hard stop to deploy the first implant. The wheel is then rolled forward to a hard stop and the needle is brought back into the joint. At this point, the needle is pierced through the joint capsule inferior to the meniscus tear and the deployment wheel is rolled back to the hard stop again and then forward to a hard stop (Fig 4). After both have been deployed, the loop of suture coming out of the knee is pulled to provisionally tension the repair, and then the remaining stitch is pulled for final tension (Fig 5). The stitch is cut and the final repair is visualized (Figs 6 and 7).

Discussion

The NanoScope provides possibilities for cheaper, in-office, direct evaluation of intra-articular pathology by the surgeon. Direct visualization of the joint space with standard arthroscopy is considered the gold standard for diagnosis of intraarticular pathology, but this can be considered invasive and costly.[6] More recent studies have been evaluating the effectiveness of in-office needle arthroscopy compared with MRI and standard arthroscopy as a diagnostic tool. In a prospective, blinded and multicenter clinical trial, Gill et al.[6] compared the diagnoses of knee pain of 110 patients using the 3 diagnostic techniques. In-office needle arthroscopy performed with VisionScope needle-based diagnostic

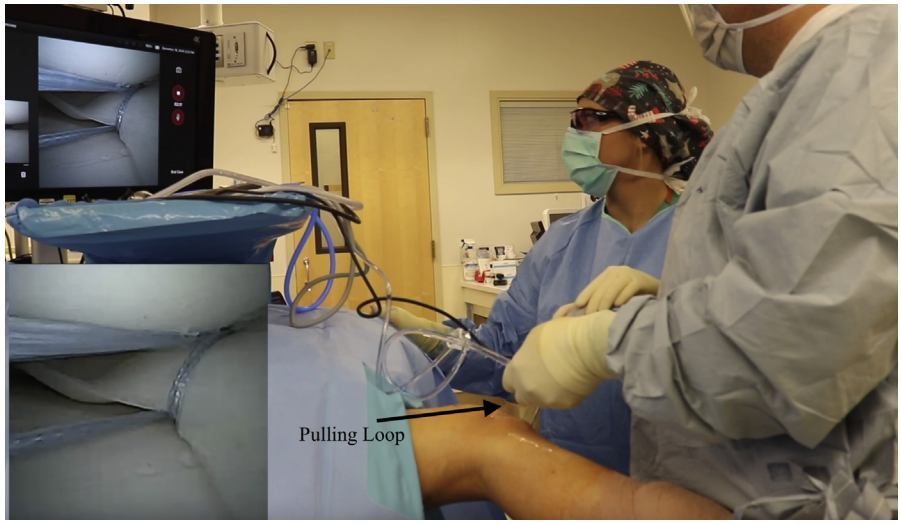

Fig 5. Viewing the right knee in 90° of flexion, the view on the left bottom of the screen is with the 0° NanoScope from the medial portal and the outside of the joint view on the right shows provisional tensioning performed by pulling the loop stitch.

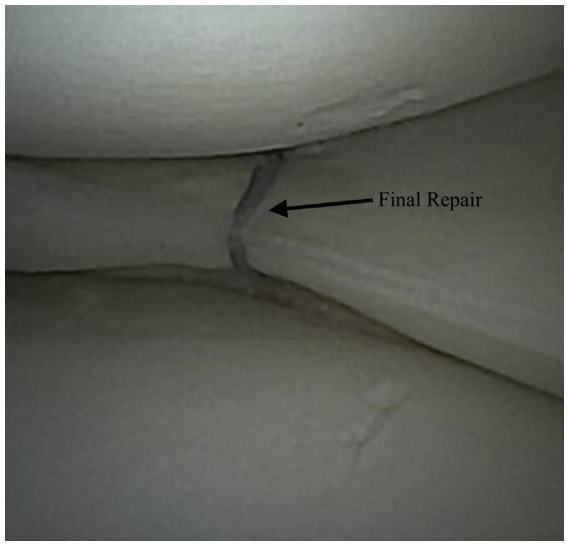

Fig 6. Viewing the right knee in 90° of flexion, the view on the left bottom of the screen is with the 0° NanoScope from the medial portal the final repair is seen.

imaging was found to be analogous to surgical arthroscopy in sensitivity, specificity, and accuracy and showed more accuracy than MRI in diagnosis of intra-articular, nonligamentous knee pathology. The use of in-office needle arthroscopy has the potential to provide more accurate real time view, save money, and be less invasive than traditional modalities.

The NanoScope can be used in the meniscus repair procedure as well as a diagnostic tool. A study conducted by Lutz et al.[7] evaluated 10 years' postoperative radiologic and clinical outcomes for meniscectomy versus meniscal repair. Mean Knee Injury and Osteoarthritis Outcome Scores (KOOS) were calculated for meniscectomies versus repair technique. At 10-year follow-up, patients who underwent a meniscal repair showed significantly better outcomes in all aspects of the KOOS score except quality of life, with the greatest outcome difference in function in sports and recreation. KOOS scores for meniscal repair versus meniscectomies were reported as follows; symptoms 98 ± 4.69 versus 77.38 ± 21.97, respectively, pain 96.89 ± 7.20 versus 78.57 ± 18.9, respectively, daily activity 99.89 ± 0.33 versus 80.88 ± 19.6, respectively, sports and recreation activity 96.11 ± 9.83 versus 54.05 ± 32.85, respectively, and quality of life 91 ± 16.87 versus 68.15 ± 37.7, respectively. Radiology scores were given for the presence and grade of osteoarthritis. Patients who underwent repair saw a significantly lower frequency and grade of osteoarthritis than meniscectomy patients.[7]

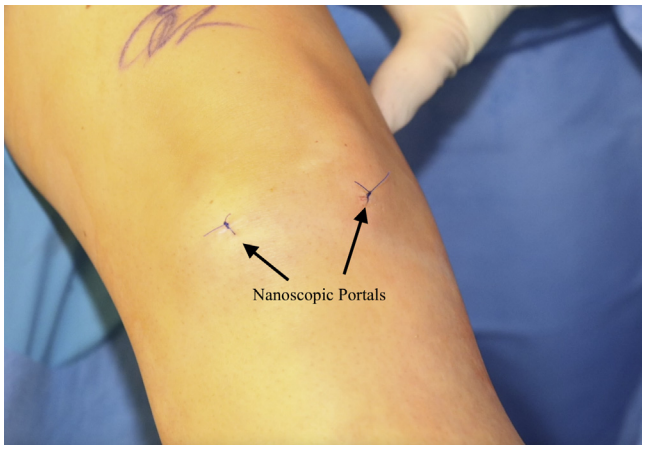

Fig 7. Viewing the right knee is extension, the small nanoscopic portal can be seen on the front of the knee.

Table 1. Advantages and Disadvantages of the Nanoscopic Meniscus Repair

Advantages
Decreased fluid used during the procedure
No incisions or standard portals
Disadvantages
Technically demanding
Cost

In a meta-analysis of repair versus meniscectomy, Xu and Zhao[8] reported that repairs have better long-term outcomes and activity levels than meniscectomy. There was a recent technique described for incisionless partial meniscectomy by using the NanoScope.[9] Our current technique we describe here, a nanoscopic meniscus repair takes the advantages of the NanoScope and allows us to perform a repair of the meniscus. The advantages of this technique are less fluid delivered into the joint, decreased size of the portals, and overall less trauma to the knee. Disadvantages of this technique include it being technically demanding with a steep learning curve because of the 0° scope. Another disadvantage is the cost of the single-use scope versus the standard scope (Table 1). Pearls of the technique include carefully directing the NanoScope into the compartments and using the high-flow sheath. Pitfalls include the NanoScope is obviously more fragile because of its size and it can sometimes be difficult to see the pathology in which case going to a standard scope is a great option (Table 2). With the NanoScope-assisted procedure as described, we can provide a more minimally invasive meniscal repair, preserve tissue, promote stability, and maximize patient outcomes.

Table 2. Pearls and Pitfalls of the Nanoscopic Meniscus Repair

Pearls
Carefully redirect the NanoScope into each compartment
Use the Arthrex high-flow sheath to give adequate flow into the knee
Pitfalls
The NanoScope can be more fragile than a standard scope
Portal location can cause difficult visualization

References

1. Treuting R. Minimally invasive orthopedic surgery: Arthroscopy. *Ochsner J* 2000;2:158-163.
2. Abrams GD, Frank RM, Gupta AK, et al. Trends in meniscus repair and meniscectomy in the United States, 2005-2011. *Am J Sports Med* 2013;41:2333-2339.
3. Voigt JD, Mosier M, Huber B. In-office diagnostic arthroscopy for knee and shoulder intra-articular injuries its potential impact on cost savings in the United States. *BMC Health Serv Res* 2014;14:203.
4. Krakowski P, Nogalski A, Jurkiewicz A, Karpiński R, Maciejewski R, Jonak J. Comparison of diagnostic accuracy of physical examination and MRI in the most common knee injuries. *Appl Sci* 2019;9:4102.
5. Phelan N, Rowland P, Galvin R, O'Byrne JM. A systematic review and meta-analysis of the diagnostic accuracy of MRI for suspected ACL and meniscal tears of the knee. *Knee Surg Sports Traumatol Arthrosc* 2015;24:1525-1539.
6. Gill T, Safran M, Mandelbaum B, Gambardella R, Xerogeanes J. A prospective, blinded, multicenter clinical trial to compare the efficacy, accuracy, and safety of in-office diagnostic arthroscopy with magnetic resonance imaging and surgical diagnostic arthroscopy. *Arthroscopy* 2018;34:2429-2435.
7. Lutz C, Dalmay F, Ehkirch F, et al. Meniscectomy versus meniscal repair: 10 year radiological and clinical results in vertical lesions in stable knee. *Orthop Traumatol Surg Res* 2015;101:S327-S331 (suppl 8).
8. Xu C, Zhao J. A meta-analysis comparing meniscal repair with meniscectomy in the treatment of meniscal tears: The more meniscus, the better outcome? *K*nee Surg Sports Traumatol Arthrosc 2013;23:164-170.
9. Lavender C, Lycans D, Sina Adil SA, Kopiec A, Schmicker T. Incisionless partial medial meniscectomy. *Arthrosc Tech* 2020;9:e375-e378.