Editorial Commentary: Repair of Posterior-Medial Meniscal Root Tears: One More Potential Tool in Your Box

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Abstract: No topic in meniscal surgery has generated as much interest over the past decade as meniscal root tears. These rather simple tears, if left untreated, act biomechanically equivalently to a complete meniscectomy. As a result, many investigators have championed the treatment of this injury through the innovation of various surgical techniques designed to restore the biomechanical function of the meniscus to prevent the long-term clinical effects of a complete meniscectomy. Most procedures to repair the posterior meniscal root to its tibial attachment can be broadly grouped into using either a suture anchor or a transtibial bone tunnel for tibial fixation. There are obvious pros and cons to both methods, and most surgeons become comfortable with one "go-to" technique depending on their level of experience with meniscal root repair and their comfort level with various arthroscopic techniques. Most surgeons prefer the transtibial technique in which the sutured meniscus is anchored to its anatomic tibial attachment via a tunnel through which the sutures pass before being secured with either a suture anchor or screw post to the anterior tibial cortex. This technique has considerable biomechanical and clinical evidence to support its use. Unfortunately, there are drawbacks to the transtibial method that must be considered, such as the technical difficulties of accurately and safely drilling the tibial tunnel, the risk of suture failure or attenuation through the tunnel, and the challenge associated with placement of the tunnel in the setting of a concurrent anterior cruciate ligament reconstruction. Therefore, further advances in meniscal root repair are always welcomed by the arthroscopic community. However, as with any surgical innovation, 3 factors must be considered before a new repair procedure can be widely recommended: (1) it must be technically "doable" by most surgeons treating the clinical problem; (2) it must have biomechanical evidence to support its use; and (3) it must result in clinical outcomes that are at least as good as, and preferably better than, current techniques.

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Posterior meniscal root tears have garnered considerable attention in recent years. Despite the fact that meniscal avulsion was first described as early as 1934,[1] the literature remained silent until 1991, when case reports recognized the associated meniscal ossicle (indicative of a chronic root avulsion) on arthroscopy[2] and meniscal extrusion on magnetic resonance imaging.[3] Concurrent research espousing the biomechanical benefits of meniscal allograft horn fixation[4,5] supported radiologic studies in 2004 that linked meniscal root tears with meniscal extrusion and subsequent articular cartilage degeneration.[6-9] Various arthroscopic techniques to repair meniscal root avulsions were described around this time to address a problem whose significance was not yet fully understood.[10-14] However, subsequent cadaveric biomechanical studies showed that posterior-medial meniscal root tears are biomechanically equivalent to a complete meniscectomy owing to extrusion of the meniscal body, which results in an inability of the meniscus to absorb the hoop stress associated with weight bearing.[15-17] This work provided a biomechanical correlate to the clinical finding that disruption of the posterior-medial meniscal root is associated with increased degenerative osteoarthritis of the medial compartment.

As the menisci play an important role in shock absorption, load distribution, proprioception, joint stabilization, and ultimately protection of the articular

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The author reports the following potential conflicts of interest or sources of funding: M.J.M. receives research grant support from Arthrex and Breg and is a consultant for Arthrex, Breg, and Schwartz Biomedical, outside the submitted work. Full ICMJE author disclosure forms are available for this article online, as supplementary material.

0749-8063/201049/$36.00

https://doi.org/10.1016/j.arthro.2020.06.018

cartilage, the importance of their preservation is now well appreciated. Repair of posterior meniscal root tears, when possible, has been advocated to re-establish the anchoring function of the posterior meniscal root. Techniques to repair the posterior meniscal root can be broadly categorized based on their means of tibial fixation in that they depend on either suture anchors or a transtibial tunnel. Most surgeons (myself included) tend to prefer one technique over the other. I have found the transtibial tunnel method to be reproducible and effective. If one thing is certain, innovation is the rule in the field of arthroscopic surgery, with new techniques and implants constantly developed to meet surgeons' needs. However, with innovation comes responsibility. Every surgical advancement has 3 requirements that must be fulfilled before it can be widely recommended to the surgical community: (1) it must be technically "doable" by most surgeons treating the clinical problem; (2) it must have biomechanical evidence of its efficacy; and (3) it must result in clinical outcomes that are at least as good as, and preferably better than, current techniques.

It is in this setting that Saltzman, Habet, Rao, Trofa, Corpus, Yeatts, Odum, Garcia, Varkey, Piasecki, and Fleischli[18] are to be congratulated on their recent publication, "Biomechanical Evaluation of an All-Inside Posterior Medial Meniscal Root Repair Technique via Suture Fixation to the Posterior Cruciate Ligament." Their in vitro study measured tibiofemoral contact mechanics in 8 cadaveric knees with a mean age of 48 years (range, 44-49 years)—an age appropriate for biomechanical analysis of meniscal root fixation. Three testing conditions were studied: (1) an intact meniscus, (2) a root tear, and (3) all-inside suture repair. Each specimen was axially loaded at 1,000 N at 4 flexion angles (0°, 30°, 60°, and 90°) to measure relevant contact parameters. The primary difference between this study and prior studies evaluating meniscal root repair techniques is that the current repair consisted merely of 2 No. 2-0 nonabsorbable sutures tied in a Mason-Allen configuration between the meniscal root (4 mm from the tear) and 5 mm lateral to the most medial edge of the posterior cruciate ligament (PCL). This rather novel technique was performed in an open fashion for this study, but it could theoretically be performed arthroscopically by those surgeons adept at other methods of meniscal root fixation. The authors found a 26.3% reduction in contact area after the root tear but a 31.6% increase from the root tear to the repaired state. Similarly, there was a 24.3% increase in contact pressure after the root tear and a 31.1% decrease in contact pressure after the repair. Finally, they noted a 10.6% increase in peak contact pressure with the root tear but a 12.4% decrease in this parameter after the root repair. These results are similar to those of Allaire et al.,[15] Marzo and Gurske-DePerio,[16] and LaPrade et al.[19] that showed that anatomic root repair was successful in restoring joint biomechanics to normal conditions. The methodology of using uniaxial compressive forces, although similar to prior studies,[15,16,19] allowing for comparisons between experimental conditions, does not reproduce the complex 6 degrees of motion exemplified by the knee during normal dynamic activities.

In performing this study, Saltzman et al.[18] were faithful to the time-zero biomechanical model used by previous investigators studying meniscal root mechanics.[15-17,19] It should be noted that cyclic loading was not performed in this study as would occur in the clinical setting, and this is a potential area of concern for the clinical stability of this repair construct over time. Prior work by Feucht et al.[20] showed displacement of the meniscal root repair with cyclic loading irrespective of fixation method. This point should not be dismissed because recurrent symptoms ultimately develop in many patients who undergo a "successful" meniscal root repair owing to failure of the repair over time due to either suture pullout from the meniscus or suture failure within the tibial tunnel. Brophy et al.[21] showed that an elevated body mass index (>35) was associated with worse clinical outcomes and a higher rate of subsequent surgery. It should also be noted that 13 of 22 patients (59%) in their series were older than 50 years.

Prior studies,[22-24] including one by our group,[24] have shown that the type of suture configuration used to grasp the meniscus is paramount to a successful repair. "Locking"-type sutures, similar to the Mason-Allen construct used in the current study,[18] have been found to possess the highest tensile strength, likely owing to their ability to grasp the circumferential collagen fibers of the meniscus. These findings are similar to ours in that (1) no repair method replicated the strength of the native meniscal root and (2) a locking loop suture construct provided the strongest repair over simple sutures because of its ability to grasp the meniscal fibers. The current study does not provide any biomechanical evidence of suture strength provided by the PCL. This is important because suturing the meniscal horn to a viscoelastic ligamentous structure (PCL) without the biological advantage of marrow elements released with bone fixation may compromise healing and, ultimately, meniscal function.

It is also unclear how the described suture construct would be affected by knee flexion combined with weight bearing given that it depends on a stable PCL. This technique would obviously not be feasible in the repair of lateral meniscal root tears and in those patients with a PCL tear (partial or complete). Performing this procedure in conjunction with a PCL reconstruction, although theoretically possible, is beyond the scope of the current study and may not provide the same biomechanical results as suturing of the meniscus to the native PCL. Further clarification of the actual suture construct in the form of a

more defined drawing or other detailed figure would have also been helpful to surgeons interested in reproducing this technique arthroscopically. Future work from these authors to describe exactly how they would perform this suture configuration using an arthroscopic technique would be welcome because an open repair (as performed in this cadaveric study) would not be acceptable in the normal clinical setting. It should also be made clear that this technique faces the same challenges and limitations as other arthroscopic root repair methods in the middle-aged patient population (Brophy et al.[21]). These patients often have degenerative meniscal root tears with poor meniscal tissue in conjunction with medial-compartment articular cartilage degeneration and elevated body weight.

In conclusion, I congratulate Saltzman et al.[18] on presenting us with a novel technique to repair posterior-medial meniscal root tears. Their proposed method is conceptually straightforward, relatively inexpensive, and without undue surgical risk. However, for this technique to become widely accepted by the arthroscopic community, the authors still must fulfill 2 of the 3 aforementioned criteria. First, they must show that their technique can be performed safely and effectively in an arthroscopic fashion by most surgeons treating this condition. Second, they must show that this all-inside method is effective, from a clinical standpoint, in maintaining meniscal root stability to prevent meniscal extrusion over time. If not, meniscal function will be lost and articular cartilage degeneration will likely ensue. I look forward to future work from this group that will, hopefully, show that their proposed suture technique is doable and effective.

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