Editorial Commentary: Suture Type or Technique Has Little Influence on Outcome After Acute Lower-Extremity Tendon Rupture

F. Alan Barber, M.D., F.A.C.S., Editorial Board

Abstract: Operative repair of Achilles tendon rupture significantly decreases the rerupture rate, regardless of type of surgical suture technique. Likewise, regarding repair of either the quadriceps or patellar tendon, surgical repair technique does not significantly influence the generally excellent outcomes achieved, whereas too-early mobilization should be avoided. In terms of the use of suture versus suture tape, load to failure is similar. Many factors impact tendon rupture repair success, including postoperative care, the quality of the tendon, underlying medical issues, and patient compliance, but suture type or technique has little influence on outcome after acute lower-extremity tendon rupture.

See related article on page 2925

The acute surgical repair of patella, quadriceps, and Achilles tendon ruptures is associated with a low rerupture rate. A systematic review of 9 studies of acute Achilles tendon rupture treatments in 822 patients found that an operative repair significantly decreased the rerupture rate. Notably different stitch techniques (Krackow, modified Kessler, end-to-end, and interrupted circumferential stitching) made no statistical difference in these rerupture rates.[1] A systematic review of 12 studies of acute quadriceps tendon repair containing 319 patients found a rerupture rate of 2%, and again the type of surgical repair did not influence the clinical results.[2] Another review of the entire extensor mechanism evaluated 23 studies reporting 709 patients with acute tendon ruptures also found no significant difference in outcome or additional surgery rates based on the surgical technique.[3] The factor having the most significant adverse difference ($P < .001$) was the use of early mobilization, not the repair technique.

The Krackow stitch is the established gold standard for tendon repair.[4] Sakaguchi et al.[5] found the Krackow stitch superior to other needle-based techniques such as the whipstitch and baseball stitch. In addition, the Krackow stitch's mechanical behavior and security will vary depending on the suture size, number of locking loops, the stitch interval, and number of strands used.[5-8] However, the Krackow stitch, while very effective in repairing lower-extremity acute tendon ruptures, has no applicability in an arthroscopic rotator cuff tendon repair.

In the study "A Biomechanical Comparison of High-Tensile Strength Tape Versus High-Tensile Strength Suture for Tendon Fixation Under Cyclic Loading,"[9] Le, Roach, Mauntel, Hendershot, Helgeson, Colantonio, Fredericks, Slaven, Pisano, and LeClere test patella, quadriceps, and Achilles bone–tendon constructs from 8 human cadavers with a mean age of 78.5 years. Although 84 specimens were successfully harvested, 30 of these were subsequently excluded from load-to-failure testing because of failures during cyclic loading. The a priori power analysis required 6 matched pairs for each stitch technique (4 groups) to achieve a 90% power to detect a 90-N difference in maximum failure load. The actual distribution of the 54 surviving specimens among the different stitch technique groups tested to failure was not revealed, making a complete understanding of the data unavailable.

The principal findings listed in the Discussion are that a 2-mm FiberTape (Arthrex, Naples, FL) whip stitch demonstrated less displacement (elongation) during the initial 10 cycles than a No. 2 FiberWire (Arthrex) whip stitch. No difference was observed at the second data

The author reports the following potential conflicts of interest or sources of funding: royalties from Johnson and Johnson. Full ICMJE author disclosure forms are available for this article online, as supplementary material.

0749-8063/21736/$36.00

https://doi.org/10.1016/j.arthro.2021.05.046

point (250 cycles), and no displacement difference between tape and suture was observed from 250 cycles to the end of cyclic loading after 5000 cycles. At that point total displacement for all groups was about 1 mm. Other investigators have shown that the greatest displacement seen in mechanical cyclic load testing is routinely recorded in the initial assessment interval whether that is 10, 50, or 100 cycles. Using 250 cycles as the second assessment point makes it impossible to determine when the elongation actually stopped only that it occurred between 10 and 250 cycles. This elongation represents normal biomechanical creep seen with any construct. If this occurs only during the first 10 cycles, it could be eliminated clinically by intraoperatively cycling the repair or mitigated by protecting the repair postsurgery.

The second principal finding was that "…maximum load at failure were comparable between tape and suture across stitch techniques." The tape Krackow stitch (640.2 ± 27.7 N) had a greater maximum failure load than the tape whip stitch (384.9 ± 27.7N; $P < .001$), but the suture Krackow stitch (384.9 ± 27.7 N) demonstrated a lower maximum failure load than the suture whip stitch (485.6 ± 34.8 N; $P = .029$). It is puzzling that the maximum failure load of the tape whip stitch (384.9 N) is actually less than the suture whip stitch (485.6 N). These statistically significant observations do not seem "comparable," and the differences are larger than the 90 N used for the power analysis. The finding that the tape whip stitch was not as strong as the thinner suture whip stitch is inconsistent with the findings of others.[10] Also, the Krackow stitch has been shown to have better strength than the whip stitch in the bovine tendon.[11] The authors state their study demonstrates "…no difference in maximum load at failure between tape and suture when used in the whip stitch after being subjected to cyclic loading." Although the "*P*" value may not in some comparisons reach a level of < .05, the numbers suggest a beta error is occurring. Not knowing the actual numbers used in the comparison makes it difficult to assess this conclusion.

The mode of failure can impact revision surgery. The failure mode was reported for all specimens including those that were excluded from destructive testing because of failure during the cyclic loading. The suture whip stitch repairs failed by tissue pull through in 47.6%, whereas the tape whip stitch repairs failed by tissue pull through in 61.9%. This may reflect the cheese-wiring effect often seen in this type of suture.[12,13] Suture breaking was more common in the suture Krackow stitch. Clinically, a shredded tendon presents a greater challenge than a broken suture line.

The data generated in this study should not be considered representative of other sutures or tapes. This study evaluated only FiberWire and FiberTape. It is possible that other tape products such as PermaTape (DePuy Synthes Mitek, Raynham, MA), Hi-Fi tape (ConMed, Largo, FL), XBraid TT (Stryker, Kalamazoo, MI), ULTRATAPE (Smith & Nephew, Andover, MA), or BroadBand Tape (Zimmer Biomet, Warsaw, IN) and other high-strength sutures such as OrthoCord (DePuy Synthes Mitek), Hi-Fi (ConMed), Force Fiber (Stryker), ULTRABRAID (Smith & Nephew), or MaxBraid (Zimmer Biomet) would demonstrate different cyclic loading behavior. A comprehensive comparison of all these products is required.

There are many factors that impact tendon rupture repair success, including postoperative care, the quality of the tendon, underlying medical issues, and patient compliance. This biomechanical study is limited in scope and compares a tape and suture from one company. This data should not be extrapolated to rotator cuff tendon tears or any clinical setting. Increasing the amount of synthetic material used in a time zero construct should result in a greater failure load and possibly less displacement. This does not translate into improved healing or a better clinical outcome.

References

1. Reda Y, Farouk A, Abdelmonem I, et al. Surgical versus non-surgical treatment for acute Achilles' tendon rupture. A systematic review of literature and meta-analysis. *Foot Ankle Surg* 2020;26:280-288.
2. Ciriello V, Gudipati S, Tosounidis T, et al. Clinical outcomes after repair of quadriceps tendon rupture: A systematic review. *Injury* 2012;43:1931-1938.
3. Serino J, Mohamadi A, Orman S, et al. Comparison of adverse events and postoperative mobilization following knee extensor mechanism rupture repair: A systematic review and network meta-analysis. *Injury* 2017;48:2793-2799.
4. Krackow KA. The Krackow suture: How, when, and why. *Orthopedics* 2008;31:931-933.
5. Sakaguchi K, Tachibana Y, Oda H. Biomechanical properties of porcine flexor tendon fixation with varying throws and stitch methods. *Am J Sports Med* 2012;40:1641-1645.
6. Hong CK, Lin CL, Kuan FC, et al. A biomechanical evaluation of various double Krackow suture techniques for soft-tissue graft fixation. *Arthroscopy* 2018;34:663-668.
7. Hapa O, Erduran M, Havitcioglu H, et al. Strength of different Krackow stitch configurations using high-strength suture. *J Foot Ankle Surg* 2013;52:448-450.
8. Michel PA, Domnick C, Raschke MJ, et al. Soft tissue fixation strategies of human quadriceps tendon grafts: A biomechanical study. *Arthroscopy* 2019;35:3069-3076.
9. Le AH, Roach WB, Mauntel TC, et al. A biomechanical comparison of high-tensile strength tape versus high-tensile strength suture for tendon fixation under cyclic loading. *Arthroscopy* 2021;37:2925-2933.

10. Gnandt RJ, Smith JL, Nguyen-Ta K, et al. High-tensile strength tape versus high-tensile strength suture: A biomechanical study. *Arthroscopy* 2016;32:356-363.
11. Barber FA, Howard MS, Piccirillo J, et al. A biomechanical comparison of six suture configurations for soft tissue-based graft traction and fixation. *Arthroscopy* 2019;35:1163-1169.
12. Williams JF, Patel SS, Baker DK, et al. Abrasiveness of high-strength sutures used in rotator cuff surgery: Are they all the same? *J Shoulder Elbow Surg* 2016;25:142-148.
13. Deranlot J, Maurel N, Diop A, et al. Abrasive properties of braided polyblend sutures in cuff tendon repair: An in vitro biomechanical study exploring regular and tape sutures. *Arthroscopy* 2014;30:1569-1573.