Biomechanical Testing of Vertical Meniscal Tear Repair Using 0.9 mm SutureTape Sutures

Arthrex Orthopedic Research

Objective

Meniscal tears can lead to significant pain, degenerative changes, and joint instability requiring surgical treatment.[1,2] Vertical tears can be repaired using all-suture meniscus repair techniques. SutureTape (ST) is a flat-braided suture that is stronger than standard FiberWire (FW) suture and more resistant to tissue pull-through.[3]

The purpose of this testing was to biomechanically compare a novel circumferential repair of vertical peripheral meniscal tears using the Knee Scorpion system with (1) #2-0 FiberWire and (2) 0.9 mm (#2-0) Mini SutureTape. Our hypothesis was that repairs using ST would show superior biomechanical stability with regards to elongation and ultimate load.

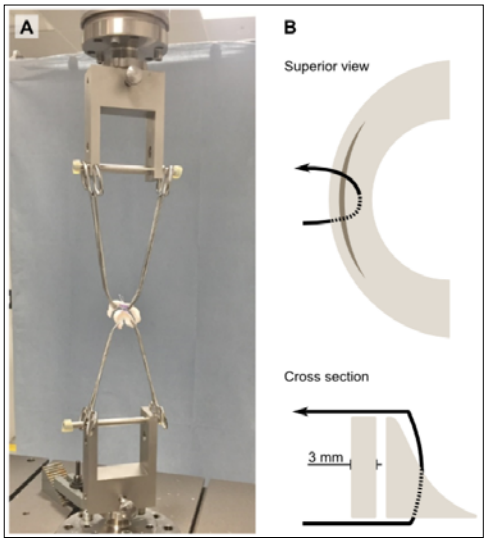
Materials & Methods

In 16 porcine menisci, a vertical cut 3 mm from the periphery of each meniscus was created with a scalpel. The cut was then repaired using the Knee Scorpion by a single stitch from inferior to superior (see Figure 1 B). This circumferential stitch repair was performed with (1) #2-0 FiberWire and (2) 0.9 mm (#2-0) Mini SutureTape (n = 8 in each group). Once the repair was completed, the initial vertical cut was extended into the anterior and posterior meniscal horns, resulting in a complete separation of the meniscus into 2 segments only interlinked by the repair.

The repaired meniscus was then placed into the tensile testing machine (E10000, Instron) with each segment fixated by 2 metal clamps (see Figure 1 A). At a preload of 5 N, the machine's displacement was set to 0. Subsequently, cyclic loading between 5 and 50 N for 200 cycles at 1 Hz was performed prior to a pull to failure at 5 mm / min. This testing protocol reflects load patterns on the meniscus during early post-operative rehabilitation exercises and activities of daily living and is consistent with previously published testing protocols.[4] Load-displacement data was recorded at 500 Hz and used to evaluate the dynamic and total elongation as well as the stiffness and ultimate failure load. The total elongation was defined as the plastic elongation that occurred between setting the displacement to 0 and completion of the last cycle. The total elongation hence included the initial displacement until the 50 N load was reached for the first time. In contrast, the dynamic elongation reflects only the plastic elongation during cyclic loading, occurring between the first and last cycle. Stiffness was measured within a linear portion of the load-displacement curve.

Statistical analysis was performed with JMP V. 15 using an unpaired t-test. The significance level was set at $p < 0.05$.

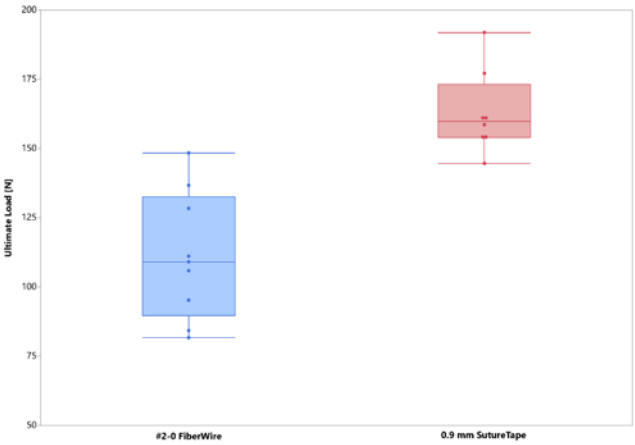
Figure 1. A: Biomechanical Testing Setup. B: Schematic Drawing of Circumferential Repair Technique. Suture Ends Were Knotted With 4 Half Hitches.



Results

The results are listed in Table 1. No significant difference was found regarding the dynamic elongation after both 100 and 200 cycles (p = 0.421 and p = 0.210). Stiffness during pull to failure was comparable for both testing groups (p = 0.142), whereas the repairs using ST revealed a significantly higher ultimate load (p = 0.0003; see Figure 2). Also measured but not listed in Table 1 is a significantly higher total elongation after 100 and 200 cycles for repairs using FW (p = 0.024 and p = 0.017).

Figure 2. Ultimate Failure Load (N) of Meniscal Repair Suture Constructs



Discussion & Conclusions

The flat-braided 0.9 mm SutureTape demonstrates a significantly higher ultimate failure load for meniscal repairs. Moreover, comparable dynamic elongation with higher total elongation indicates that the usage of ST for meniscus repairs might prevent initial cutting.

Tables and Figures

Table 1. Biomechanical Testing Results and p Values After Unpaired t-Test

Group	Dynamic Elongation [mm]		Stiffness [N / mm]	Ultimate Load [N]
	100 Cycles	200 Cycles		
FiberWire	2.14 ± 0.53	3.10 ± 0.69	22.7 ± 5.4	111.5 ± 24.5
SutureTape	1.83 ± 0.90	2.55 ± 0.95	30.8 ± 13.2	162.8 ± 14.9
p Value	0.512	0.265	0.142	0.0003

References

1. Snoeker et al., "A clinical prediction rule for meniscal tears in primary care: development and internal validation using a multicenter study". *British Journal of General Practice* 2015, 65(637):e523-e529.
2. Moatshe et al., "Comparable Outcomes After Bucket-Handle Meniscal Repair and Vertical Meniscal Repair Can Be Achieved at a Minimum 2 Years' Follow-up". *The American Journal of Sports Medicine* 2017, 45(13):3104-3110.
3. Arthrex, Inc. LA1-00038-EN_B. Naples, FL: 2017.
4. Barber et al., "Biomechanical Testing of Suture-Based Meniscal Repair Devices Containing Ultrahigh-Molecular-Weight Polyethylene Suture: Update 2011", Arthroscopy: *The Journal of Arthroscopic and Related Surgery* 2012, 28(6):827-834.

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