The Effect of Suture Caliber and Number of Core Strands on Repair of Acute Achilles Ruptures using a Mini-open Repair: A Biomechanics Study

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Background: Achilles ruptures

- The Achilles is the largest tendon in the body
- 3rd most commonly ruptured
- Controversy still exists in treatment, as modern aggressive non-operative rehabilitation protocols yield similar functional results
  - Re-rupture rate is lower with non-operative treatment \(^1,^2\)

Previous Research Findings

- Material Properties
  - Polyblend (FiberWire) suture has shown superior strength over braided polyester (Ethibond) suture \(^3\)
- Techniques
  - No significant difference in repair strength between a double Bunnell, double Kessler, and double Krackow stitch \(^4\)
  - Suture loops must be thrown in healthy tendon to decrease the risk of gapping following repair \(^5\)
  - Epitenon stitch seems to significantly improve repair strength \(^6,^7,^8\)
Hypothesis

• Varying the number of core strands or suture caliber used in Achilles repair would significantly improve repair strength and decrease elongation in response to cyclic loading representative of an early rehabilitation protocol
  – Varying core strand and suture caliber significantly affect the strength of repair in flexor tendon repairs of the forearm \(^9\) and rotator cuff repair\(^{10}\)

• Null hypothesis: Suture caliber and number of core strands will not affect repair strength
Methods

- Achilles was exposed, lacerated, and repaired with a modified Kessler mini-open technique with one of 4 suture caliber/core strand constructs:
  
  a. Compared data to 9 prior specimens repaired with No. 2 FiberWire and 6 core strands
  
  b. No. 2 FiberWire with 4 core strands and two 2mm Fibertape sutures (2T)
  
  c. No. 2 FiberWire for 2 core strands and four 2mm FiberTape sutures (4T)
  
  d. No. 2-0 FiberWire and 12 core strands (12S)
Methods

• Specimens tested in the Instron E10000 under prior published techniques

• Cyclic loading stages of 250 cycles each at 1 Hz: (1) 20-100 N, (2) 20-200 N, (3) 20-300 N, and (4) 20-400 N

• Repaired grafts that survive all 1000 cycles were then pulled to failure

• Data were compared using a non-parametric Kruskal-Wallis ANOVA test and the Nemenyi post-hoc procedure
Results

Area survival rate graph demonstrating the number of surviving repairs from each construct over the four loading blocks.

Both the 2T and 12S repairs survived a significantly greater \((p < .05)\) number of cycles to failure.
Results

Maximum load at failure for the native state and all repair methods. Dark horizontal lines represent the median, with the box representing the 25th and 75th percentiles. Vertical bars represent the largest and smallest observed values. Lowercase letters indicate statistical significance P<0.05.
Results

Cyclic displacement at the end of the first loading block (250 cycles, 20-100 N) for all repair methods. Dark horizontal lines represent the median, with the box representing the 25th and 75th percentiles. Vertical bars represent the largest and smallest observed values. No repairs were statistically different from each other.
Conclusions

- 2T and 12S repairs have greater ultimate strength than a standard 6-core-strand No 2. FiberWire repair with similar elongation.
  - Mean 918 vs 828 vs 439 cycles to failure respectively
- Load to failure is higher in the 2T and 12S repairs when compared to the standard repair
  - Mean 625N vs 468N vs 200N
  - Max loads 859N vs 729N vs 300N
Limitations

- Time zero, ex vivo biomechanical investigation
  - May over simplify Achilles rehabilitation
- Difficult to recreate “mop-ended” Achilles rupture ex-vivo
- FiberTape knots may be too bulky for actual clinical repair
- System measures elongation, not gapping
  - Elongation occurs through the tendon as well as the repair site
References


