Biomechanical Comparison of WhipLock™ Stitch and Krackow Stitch

Objective

The purpose of testing was to compare biomechanical characteristics of a new WhipLock™ stitch to a traditional Krackow stitch. This testing specifically evaluated ultimate failure load, a key bench metric associated with clinical success of a suture method.[1]

Test Groups

The Krackow stitch is a running locking stitch that has long been the gold standard for creating secure soft tissue suture constructs.[2] However, it can be time consuming and requires the surgeon to stitch up one side of the tissue then back down the other to complete a stitch series. The new WhipLock™ stitch, enabled by EasyWhip®, achieves the same locking mechanism of the Krackow, but it requires 50% fewer needle holes through the tissue, as depicted in Figure 1.

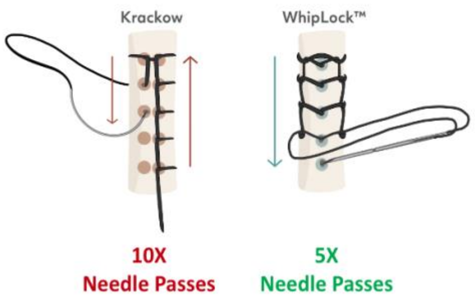

Figure 1: Illustration of the number of needle holes required for a Krackow stitch (left) versus a WhipLock™ stitch (right).

Methods

Quadriceps tendons were dissected from human cadaver specimens and standardized to the same size (70 x 12 x 8.5 mm). Tendons were divided into two test groups of 8, for a total sample size of 16. WhipLock™ samples were stitched with EasyWhip®, a novel two-part needle. Krackow samples were stitched with a conventional FiberWire® curved needle (Arthrex). Graft constructs were prepared by two fellowship-trained orthopedic surgeons then underwent biomechanical testing.

Testing was performed on an MTS Bionix with a 5kN load cell. Samples were preconditioned to normalize viscoelastic effects. Thereafter, the samples were loaded to 50-200 N for 500 cycles at 1 Hz and then were ramped to failure at 20 mm/min. Ultimate failure load was recorded for each sample and compared across groups.

Results[3]

Ultimate failure load results are summarized in Figure 2. Average ultimate failure load for WhipLock™ and Krackow were 343.2N and 369.1N respectively. WhipLock™ samples did not have significantly different ultimate failure loads than the Krackow counterparts ($p=0.072$). It was also noted that all 16 samples across the groups failed by suture breakage, shown in Figure 3, as opposed to tendon damage.

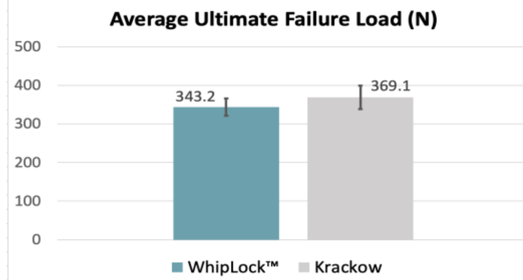

Figure 2: Ultimate failure load (N) results for WhipLock™ and Krackow on cadaveric quadriceps tendon.[5]

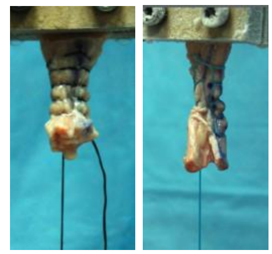

Figure 3: Representative images of WhipLock™ (left) and Krackow (right) samples after reaching failure due to suture breakage.[5]

Discussion

The WhipLock™ had comparable ultimate failure load and failure mode compared to the Krackow. The data showed no significant difference between the ultimate failure load (N) for the WhipLock™ and Krackow, suggesting that the two methods are biomechanically equivalent.

A key benefit of the WhipLock™ over a Krackow is that it requires fewer needle holes and provides evenly distributed circumferential load. Fewer needle holes cause less disruption in soft tissue longitudinal fibers[4] while evenly distributed circumferential load increases the resistance to gapping and improves mechanical strength.[5]

Conclusion

The EasyWhip® WhipLock™ is a promising new stitch method that produces a biomechanically equivalent ultimate load to a Krackow, while resulting in less tissue damage from fewer needle holes based on bench testing of ex-vivo tissue. Correlation to clinical results in humans is unknown.

References

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