Dual High-Strength Sutures in a Cinch-Stitch Configuration is Superior to High-Strength Suture Tape: A Biomechanical Comparison of Suture Configurations for Subscapularis Repairs

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INTRODUCTION: The subscapularis is the largest and strongest rotator cuff muscle and plays a critical role in shoulder stability. While once thought rare, subscapularis tears are now recognized in up to 60% of arthroscopically repaired rotator cuff tears, with upper border tears being most common. Surgical management has shifted from open repair to arthroscopic techniques, with repair strength in the early postoperative phase relying entirely on construct integrity before biologic healing occurs. Failure most often occurs at the tissue–suture interface, making this junction the key target for improvement. Prior studies have examined various stitch configurations in animal and human models, though many techniques are better suited for open surgery due to the difficulty of arthroscopy in the subcoracoid space. Advances in technology now permit reliable arthroscopic repair, with two common knotless single-row configurations: (1) two high-strength sutures in a cinch-stitch and (2) a single high-strength suture tape. Despite their frequent use, little comparative data exists in human subscapularis tendons. This study addresses that gap by biomechanically evaluating the tissue-holding properties of these two repair techniques.

METHODS: Subscapularis tendons were dissected from 11 fresh-frozen cadaveric shoulders (6 males, 5 females; mean age 65, range 52–74 years). Subscapularis tendons were longitudinal split to reflect the size of the upper border tears. Each underwent one of two suture repair configurations: simple fixation with 2.0mm high stren or with two high strength suture link with 1.3mm suture-tape in a cinch-stitch configuration. Specimens were then mounted on a hydraulic testing system with the tendon secured in a custom clamp and the suture connected to the actuator hook. After a 5 N preload for 10 seconds, cyclic loading from 5 N to 30 N was applied for 40 cycles, followed by a load-to-failure test at 1 mm/s. Failure was defined as complete suture disengagement from the tendon. Maximum force, displacement at failure, stiffness, and toughness were calculated. Suture–tendon gapping was quantified at the end of cyclic loading and at peak tensile force.

RESULTS SECTION: The single suture tape configuration exhibited significantly greater suture–tendon gapping compared to the two suture links in a cinch-stitch configuration at the end of cyclic loading (1.10 ± 0.77 mm vs. 0.71 ± 0.77 mm, $p < 0.05$) and at peak tensile force (5.53 ± 2.64 mm vs. 3.66 ± 2.64 mm; $p < 0.05$). The dual suture links configuration demonstrated significantly higher maximum tensile force (200.63 ± 64.79 N vs. 118.85 ± 64.79 N; $p < 0.001$) and greater toughness (2057.39 ± 1210.21 N·mm vs. 760.18 ± 1210.21 N·mm; $p < 0.01$) compared to the single suture tape group.

DISCUSSION: This investigation demonstrated that incorporating two high-strength sutures in a cinch-stitch configuration produced superior biomechanical performance compared with a single high-strength suture tape. Despite the greater inherent strength of suture tape compared to suture link, the cinch-stitch construct showed higher resistance to failure, underscoring that suture configuration at the tendon–suture interface is more influential than raw material strength alone. Consistent with previous findings, the tendon–suture junction was the predominant site of failure, highlighting its role as the limiting factor in repair stability. The biomechanical profile of the cinch-stitch may also offer clinically relevant advantages beyond increased failure load. The configuration provided two distinct peaks in ultimate strength, suggesting a protective redundancy in which one suture could maintain construct integrity if the other failed during early rehabilitation. Prior work has shown that augmenting repairs with luggage-tag or self-cinching sutures improves both load to failure and contact mechanics, which may enhance tendon healing at the bone interface. These results should be interpreted within the study's limitations. The focus on the tendon–suture interface excluded the influence of anchor fixation, bone quality, and more complex in-vivo loading conditions, particularly rotational stresses on the subscapularis. Additionally, long-term biological responses to continued cinching remain unknown. Nonetheless, the findings reinforce the principle that optimal repair strength depends not only on the material properties of the suture but also on thoughtful configuration at the critical tendon–suture interface.

SIGNIFICANCE/CLINICAL RELEVANCE: Given the similarities between rotator cuff tendons of this size in behavior, this applies to subscap but possibly other tendons of similar dimension (posterior cuff) as the strategies are similar.

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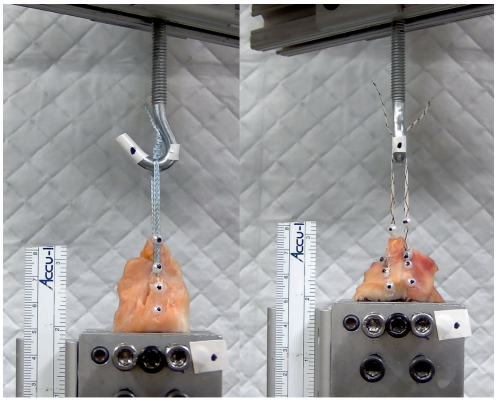

Figure 1, Experimental setup for biomechanical testing. The suture tape construct (left) and the suture link construct (right). 4 mm semi-sphere beads with center marked were adhered to the soft tissue and suture for displacement tracking via computer vision.

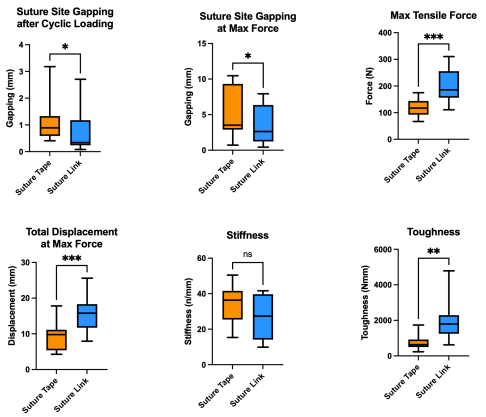

Figure 2. Biomechanical comparison of suture tape and dual suture link. Dual suture link demonstrated reduced suture site gapping after cyclic loading and at maximum force, higher maximum tensile force, greater total displacement at failure, and increased toughness, while stiffness did not differ significantly between groups. p values indicated as. *p<0.05, **p<0.01, ***p<0.001