

# **Rotator Cuff Repair Augmentation by Direct Interlocking of an Overlaid Nonwoven Polyethylene Terephthalate Patch Substantially Increases Repair Strength: A Biomechanical Comparison in Ovine Shoulders**

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## **INTRODUCTION:**

Despite advancements in surgically treating rotator cuff tears, such as the implementation of patches to reinforce repairs, the rate of re-tears remains high. Construct failure often occurs at the suture-tendon interface and within 3 to 6 months after the repair. Multiple patch materials and techniques have been explored, often achieving significant increases in ultimate load to failure. However, no patch consistently improved time-zero linear or cyclic stiffness, which reflect biomechanical integrity of the repair and are important characteristics for successful healing. In an ovine model, tendon tissue augmentation with interlocking of an overly nonwoven PET patch has demonstrated no macroscopic evidence of adverse tissue reactions to the interlocked patch fibers and a normal host healing response with minimal fibrosis.

The purpose of this study was to compare the biomechanical properties of three types of rotator cuff repairs (RCR): a non-augmented transosseous-equivalent (TOE) repair, a conventional patch-augmented TOE repair and a TOE repair augmented with a polyethylene terephthalate (PET) patch, that directly interlocks with the underlying tendon across its entire interface.

The hypothesis was that an interlocked patch augmentation of RCR is biomechanically superior to conventional TOE

## **METHODS:**

Eighteen ovine infraspinatus tendons were detached, repaired (TOE), and tested in three groups (n=6): (1) non-augmented TOE, (2) conventional patch-augmented TOE and (3) interlocked patch-augmented TOE. In the second group, a commercial synthetic polyester patch was attached to the tendon via #2 FiberWire sutures and laterally attached to the humerus using #2 FiberWire sutures and two knotless anchors. In the third group, an interwoven patch-tendon interface was created. Prior to lateral fixation, patch-tendon attachment was achieved using a technique based on physical interlocking of non-woven patch fibers into the underlying tissue by way of a reciprocating microblade (felting). The microblade features design elements (very small barbs) that catch and carry groups of loose fibers within the patch into the tendon. The microblade used for attachment runs at a frequency of 42Hz and was applied for 90 seconds, moving the instrument over the entire patch surface to achieve a roughly uniform application to the tendon surface. The patch was attached to the tendon across the entire patch-tendon interface which enhances load sharing between the tendon and the patch (compared to conventional patches which are usually sutured to specific locations on the tendon).

Each specimen underwent cyclic loading, followed by pull-to-failure testing. Ultimate tensile strength, cyclic and linear stiffness, peak-to-peak elongation and gap formation were measured.

## **RESULTS:**

Direct patch interlocking resulted in significantly higher tendon purchase during pull-to-failure ( $587N \pm 109$  vs.  $222N \pm 48$ ,  $211N \pm 55$ ) as well as cyclic stiffness testing ( $44N/mm \pm 3$  vs.  $25N/mm \pm 2$ ,  $29N/mm \pm 2$ ) compared to the conventional patch-augmented and non-augmented TOE, respectively ( $p < 0.0001$  for all comparisons). Linear stiffness was also significantly higher compared to the conventional patch-augmented TOE ( $34N/mm \pm 6$  vs.  $22N/mm \pm 2$ ,  $p = 0.0074$ ).

## **DISCUSSION AND CONCLUSION:**

The most important finding of the study was that augmentation of a conventional TOE with direct interlocking of a nonwoven PET patch yielded biomechanically superior results compared to both conventionally augmented and non-augmented TOE RCRs. The direct interlocking of patch fibers into the underlying tendon enhanced the repair's biomechanical properties: not only did this technique increase the time-zero force to failure to 265% compared to a conventional patch-augmented TOE and to 280% compared to a non-augmented TOE, but it also improved linear stiffness to 154% and 135%, respectively. Higher construct stiffness suggests that micromotion and gap formation were minimized, an aspect that is crucial for tendon-bone healing and for reducing early tendon retraction, thereby offering potential to improve re-tear rates in future clinical application.

