Augmentation of Achilles tendon repair with extracellular matrix xenograft: A biomechanical analysis

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INTRODUCTION:
Achilles tendon rupture is a frequent injury in athletes of all ages. Cases of chronic rupture or poor tendon quality secondary to tendinopathy are challenging to repair primarily. Commercially available extracellular matrix materials have been utilized with increasing frequency in recent years to augment tendon repair. We hypothesized that augmentation of Achilles tendon with extracellular matrix xenograft would result in reduced repair site gapping and increased peak failure load in a cadaveric model.

METHODS:
Ten matched pairs of fresh-frozen lower extremities amputated just below the knee were obtained and each Achilles tendon was sharply tenotomized. One specimen from each matched pair was randomized to repair utilizing a four-strand Krackow technique with extracellular matrix xenograft augmentation (TissueMend Soft Tissue Repair Matrix) while the opposite tendon underwent suture repair without augmentation as a control (Figure 1). Each tendon was then subjected to 1000 sinusoidal tensile loading cycles between 10N and 86N at a rate of 0.5Hz while continuously recording repair site gapping. Following completion of the cyclic loading, the ultimate failure load of each tendon was determined by applying load at a rate of 6mm per second until gross failure occurred. The repair site gapping recorded at each time point during cyclic testing as well as the ultimate failure load were compared between the experimental and control groups utilizing a Wilcoxon matched pairs signed rank test. Statistically significant differences were defined as p < 0.05.

RESULTS:
Significantly less gapping was noted in the augmented group after 10 cycles. This difference became progressively larger as cyclic loading continued (Figure 2). The mean repair site gapping following cyclic loading was 4.02mm (range: 3.10 – 4.96mm) in the augmented group and 6.47mm (range: 4.05 – 8.58mm) in the suture-only group (p < 0.01). The augmented construct was noted to be significantly stiffer than the suture-only construct after 100 cycles. This difference became progressive larger as cyclic loading continued. The mean construct stiffness in cycle 1000 was 22.0 N/mm (range: 17.6 – 27.7 N/mm) in the augmented group and 14.2 N/mm (range: 10.0 – 21.2 N/mm) in the suture-only group (p < 0.01) The ultimate failure load was 821N (range: 613 – 1021N) in the augmented group and 392N (range: 322 – 481N) in the suture-only group (p < 0.01) (Figure 3). Failure in the suture-only group occurred by suture breakage in all cases. The augmented group failed by sutures pulling through the TissueMend (8 cases) or mid-substance failure of the TissueMend (2 cases) in association with breakage of the Krackow sutures.

DISCUSSION:
The augmentation of Achilles tendon repair with extracellular matrix xenograft decreases gapping and increases load to failure in a cadaveric model. Such augmentation may allow more aggressive early rehabilitation, particularly in cases of chronic rupture or poor tendon quality. Further work is necessary to define optimal indications for extracellular matrix graft augmentation of in vivo tendon repairs.