Mechanical Properties of Augmented Rotator Cuff Repairs Using an Ovine Infraspinatus Model

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INTRODUCTION:

Retear rate for large and massive full-thickness rotator cuff tears remains a significant clinical problem [1,2]. Failure of the repair usually occurs within the first 6-months and is attributed to mechanical shortcomings and failure at the suture-tendon interface leading to tendon retraction and mechanical failure [3-5]. Augmentation with various scaffold technologies has recently gained great research interest. Historically, augmentation has either improved biologic healing, but cannot reinforce the repair or vice-versa, and none have proven to do both sufficiently [6,7].

Recent work using a novel biocomposite soft tissue scaffold has demonstrated rapid cellular infiltration and new tissue regeneration by 6 weeks with cuff strength at 12 weeks as strong as the native tendon using an ovine infraspinatus model [8,9]. However, load sharing at time zero to improve initial rotator cuff repair mechanical properties with augmentation has not been well investigated. Load sharing and increased repair strength may alleviate stress at the suture-tendon interface and reduce early mechanical failure. Load sharing and cyclic creep in rotator cuff repairs augmented with a biocomposite scaffold or a human acellular dermal matrix (ADM) in single row (SR) and suture bridge (SB) constructs were evaluated in an ovine infraspinatus tendon model. We hypothesized the addition of the augments will reduce creep in the cuff constructs and increase repair strengths. The null hypothesis was that are no differences between repairs augmented with the biocomposite scaffold compared to ADM.

METHODS:

Forty ovine infraspinatus tendon (IST) – humerus constructs were used. A full thickness rotator cuff tear was created by sharp dissection of the IST. SR and SB repairs were evaluated with and without augmentations using a biocomposite scaffold, ConMed, or human ADM. Both repair techniques used two 5.5mm suture anchors placed medially. The SR row repairs used the 3 sutures from each anchor to tie 6 knots across the IST. The SB repairs used 2 sutures from the anchors and were tied medially, crossed over in a suture bridge configuration and fixed laterally using two 5.5mm knotless anchors. The augmented SR and SB repair groups had 2 inverse mattress stitches medial to the repair connecting the devices to the IS tendon. Two inverse mattress stitches were added to the lateral edge of the biocomposite scaffold or ADM and secured using two 5.5mm knotless anchors to independently tension the implants laterally.

Tensile testing was performed using a cyclic loading profile (10-100N for 500 cycles at 1Hz) before pull to failure at 20mm/min [10]. Peak load to failure (N), stiffness in the linear region (N/mm), creep (mm) and failure mode were determined for all groups. Data was analyzed using a one-way ANOVA with an LSD post-hoc test.

RESULTS:

All repairs failed due to suture pull through the IST. No statistical differences were noted in the mechanical properties of the control (non-augmented) SR and SB repairs and agreed with the literature using this model [10]. Augmentation with the biocomposite scaffold increased the peak loads for SR (+33%, P=0.008) and SB (+23%) while the ADM increased the peak loads for SR (+24%) and SB (+30%) (Figure 1). Stiffness values ranged from 67.7 N/mm to 78.0 N/mm and no differences were detected across all groups (P>0.05). Cyclic creep was reduced with the biocomposite scaffold for SR (-33%, P=0.032) and SB (-26%) while the ADM reduced creep in the SR (-16%) and increased in SB (+17%) (Figure 2).

DISCUSSION AND CONCLUSION:

This study supports time zero load sharing for the biocomposite scaffold and ADM in SR and SB configurations. Both augmentation techniques increased the peak tensile loads for the repairs while the stiffness in the linear region did not change. Reduction in cyclic creep and increased peak loads supports that augmentation, as performed in this study, may alleviate stress from the tendon and potentially reduce rotator cuff repair failure at the suture-tendon interface. The addition of mattress sutures to couple the augmentation devices to the tendon medially and laterally allows the infraspinatus tendon and devices to participate together in load transfer. This improvement in mechanical properties may contribute to improved clinical outcomes of rotator cuff repairs.

References:

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Figure 1

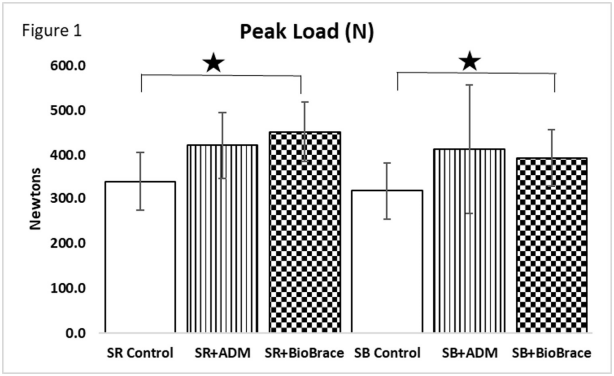

Figure 2