Biceps Tendon Properties Worsen Initially but Improve Sixteen Weeks Following Rotator Cuff Tears in a Rat Model

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INTRODUCTION: Pathologic changes in the long head of the biceps tendon are common clinically in conjunction with rotator cuff tears [1,2]. However, there is some debate regarding the role of the biceps at the shoulder following a cuff tear [3,4] and therefore, controversy exists regarding its treatment. A previous study in a rat model determined that the biceps tendon was detrimentally affected by the presence of rotator cuff tears [5], but biceps tendons were not evaluated beyond 8 weeks following rotator cuff detachments. A chronic animal model of this condition would be extremely valuable to evaluate treatment strategies for biceps pathology. Therefore, the objective of this study was to determine the histological, organizational, and mechanical changes in the long head of the biceps tendon in the presence of a multiple rotator cuff tendon tear over time. We hypothesized that all properties would worsen from 1 to 4, 4 to 8, and 8 to 16 weeks.

METHODS: Forty-eight Sprague-Dawley rats (IACUC approved) underwent detachment of the supraspinatus and infraspinatus tendons from their bony insertion without repair [5]. Rats were sacrificed at 1, 4, 8, and 16 weeks post detachment (n=12-15 each). After sacrifice, the long head of the biceps tendons were dissected out for mechanical testing or histological analysis.

For mechanical testing, strain lines were placed on the tendons denoting the proximal tendon insertion site, the portion of the tendon in the intra-articular space, and the portion of the tendon in the bicipital groove. Cross-sectional area at each location was measured using a laser system [6]. Tendon tensile testing was performed: preconditioning, stress-relaxation to 4% strain at 0.575 mm/sec (5 %/sec) for 600 sec, and ramp to failure at 0.3%/sec. Local strain was measured optically.

Results support our hypothesis between most of the time points examined. Area increased from 1 to 4 weeks and further increased from 4 to 8 weeks after detachments (Fig 1). However, between 8 and 16 weeks following detachment, area decreased in all locations (Fig 1). Stiffness decreased between 8 and 16 weeks in the insertion site, intra-articular space, and bicipital groove but there were no changes in modulus over time.

There were no differences in angular deviation between 1 and 4 weeks (Fig 2). Angular deviation increased in the proximal and distal bicipital groove between 4 and 8 weeks post detachments (Fig 2). Between 8 and 16 weeks, angular deviation decreased in the intra-articular space and proximal and distal bicipital groove (Fig 2). Additionally, cell shape became more elongated in the intra-articular space and proximal and distal bicipital groove (Fig 3).

DISCUSSION: Results support our hypothesis between most of the time points examined. Area increased from 1 to 4 weeks and between 4 and 8 weeks. Additionally, angular deviation increased from 4 to 8 weeks. Unexpectedly, several parameters improved from 8 to 16 weeks. Area decreased in all locations during this time period, and angular deviation decreased (improved organization) in the intra-articular space and proximal and distal bicipital groove. This increased organization might help explain the finding of a more elongated cell shape in these same regions from 8 to 16 weeks. We also found that tendon stiffness decreased from 8 to 16 weeks, but this can be explained by a decreased area, and with less tissue present, the tendon becomes less stiff.

Another study used this combined supraspinatus+infraspinatus detachment rat model to determine the long term effects on the detached tendons [7]. After 16 weeks, while supraspinatus properties were still decreased from normal, infraspinatus properties had returned to control values. It is possible that the infraspinatus properties return toward normal as the infraspinatus tendon begins to bear load. As a result, the increased load on the biceps, thought to be a result of the torn rotator cuff tears, is lessened and approaches more normal loads. The tendon would then be able to adapt to these more normal loads, resulting in decreased area and increased organization as seen after 16 weeks in this study. This concept is supported by the theory of balanced forces in the transverse rotator cuff [8], in which a tear of the infraspinatus would disrupt the balance of forces, leading to drastic changes in load and joint kinematics, while a tear of the supraspinatus tendon alone would not disrupt these forces, leading to minimal load changes on the intact tendons. These results indicate that repair of one or more of the rotator cuff tendons may lead to resolved pathology of the long head of the biceps tendon. Future studies will investigate the effect repairing either the infraspinatus tendon alone or the supraspinatus and infraspinatus tendons 4 weeks following detachment to determine if properties improve similarly to what was found in the current study.

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