A Biomechanical Analysis of Two Biceps Tenodesis Fixation Techniques

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Purpose: To assess and compare the biomechanical properties and load-to-failure of 2 biceps tenodesis fixation techniques, interference screw fixation and double suture anchor fixation. **Type of Study:** Biomechanical study. **Methods:** Eleven fresh-frozen human cadaveric specimens were used in this study. A biceps tenodesis was performed using 1 of 2 techniques, interference screw fixation or double suture anchor fixation. A 7-mm interference screw was used in 5 cadaveric trials. A double suture anchor technique was performed in 6 cadaveric specimens. The tenodesis construct in each specimen was loaded to failure using a Servohydraulic materials test system (MTS Model 858; Bionix, MTS Corp, Minneapolis, MN). Each specimen was loaded at 5 mm/second with a preload of 5 N with the vector of pull distally in line with the long axis of the humerus. Each specimen was then loaded until failure of the repair occurred. Statistical analysis of the interference screw group compared with the suture anchor group was performed using a Student *t* test. **Results:** The mode of failure of the interference screw group was variable, but the suture anchor group consistently failed at the anchor or anchor eyelet. The average pullout strength of the suture anchor group was 135.5 $\pm$ 37.8 N whereas the failure load in the interference group was 233.5 $\pm$ 55.5 N. The interference group had a significantly greater resistance to pullout than the suture anchor group ($P = .007$). **Conclusions:** Based on these results, a biceps tenodesis using an interference screw will provide greater fixation strength than a biceps tenodesis performed with a double suture anchor technique. **Clinical Relevance:** The surgeon treating biceps tenodesis may wish to choose a fixation technique with higher initial strength (interference screw instead of double suture anchor) to lessen the chance of early failure, particularly if the patient begins early active elbow flexion. **Key Words:** Arthroscopic biceps tenodesis—Implant biomechanics—Failure load—Pullout strength—Suture anchor—Interference screw.

The long head of biceps brachii (LHBB) tendon is a key stabilizer within the glenohumeral joint.[1,2] Not only is the LHBB an important anterior shoulder stabilizer but, during biceps brachii contraction, the LHBB tendon decreases superior and inferior translation of the proximal humerus and alleviates strain within the inferior glenohumeral ligament.[1,2] Injury to the LHBB may exist in isolation or it may be associated with other pathology, such as rotator cuff tears, or subacromial impingement.[3-8] Examination of the LHBB during open surgery and arthroscopic surgery has provided a wealth of information in the understanding and the diagnosis of biceps tendon pathology.[3,9-12]

LHBB pathology ranges from simple cases of tendonitis to more complex pathologies such as LHBB tendon instability (subluxation or dislocation) and tendon rupture (partial or complete). The treatment of the LHBB is essential in ensuring normal shoulder joint biomechanics. Pathologic entities of the LHBB can be treated using open[13-15] or arthroscopic techniques.[16-20] Because of recent technological advances, a trend toward the arthroscopic treatment of all shoulder maladies has evolved. Given this arthroscopic trend, the question of appropriate fixation becomes paramount. Minimally invasive techniques have been described

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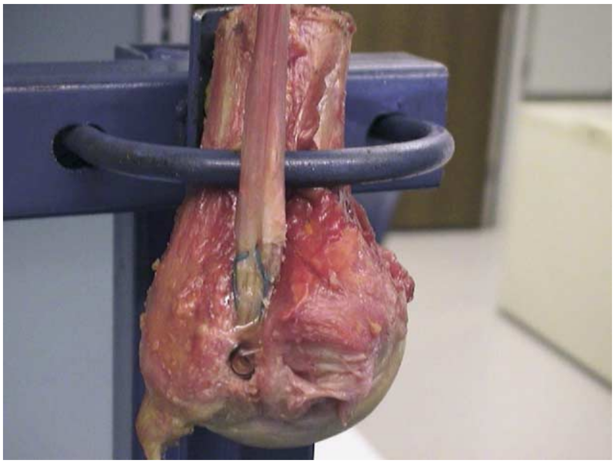

FIGURE 1. Biotenodesis screw construct in the testing apparatus.

using suture anchors[16,18] and interference screw fixation.[17-20] In the present study, the load to failure of 2 different biceps tenodesis fixation techniques, interference screw fixation and suture anchor fixation, were assessed to test our hypothesis that interference screw fixation would have superior ultimate strength.

METHODS

A biomechanical analysis of 2 different methods of fixation for biceps tenodeses was undertaken. Five pairs of fresh-frozen human cadaveric shoulders and 1 unpaired shoulder (11 shoulders in total) were used in this study. The specimens had an average age of 52 years (range, 44 to 57 years). Each specimen consisted of both the scapula and proximal humerus. Preparation of the cadaveric shoulders consisted of soft-tissue dissection to the level of the rotator cuff. At that point, the supraspinatus tendon insertion was reflected by sharp dissection and the LHBB tendon was inspected. In all 11 specimens, the LHBB tendon was intact with no evidence of pathology. The tendon of the LHBB was then sharply incised, freeing it from its intra-articular origin at the superior aspect of the glenoid as well as dividing it at the musculotendinous junction so that the biceps tendon was a free segment. One cadaveric specimen from each pair was separated into the interference screw fixation group, and the other 5 matched specimens and 1 unmatched specimen were separated into the suture anchor group. Five specimens were used to test the interference screw construct and 6 specimens comprised the suture anchor group.

Both techniques were performed in an open manner. In the interference screw fixation group, the tendon was prepared initially by placing a No. 2 Ethibond (Ethicon, Somerville, NJ) whipstitch in its proximal end (the end that would later be tenodesed) and a No. 5 Ethibond double reinforced whipstitch in the tendon's distal end for later attachment to the actuator of the testing device. The humerus was then securely fixed to the base of the Servohydraulic materials test system (MTS) (MTS Model 858; Bionix, MTS Corp, Minneapolis, MN) by means of an adjustable clamp (Fig 1). A bone socket was then drilled in the proximal humerus at the upper aspect of the bicipital groove using a cannulated headed reamer. The depth of each socket was 25 mm and the diameter of the socket was 7 mm. The prepared tendon end was then inserted into the bone socket until it reached the floor of the socket (Fig 2). It was held securely in place at the base of the socket with a cannulated biceps tenodesis screwdriver (BioTenodesis Screw System; Arthrex, Naples, FL) and then fixed within the bone socket with a 7-mm L-poly-lactic acid (L-PLA) biodegradable interference screw (BioTenodesis Screw, Arthrex). The interference screw was the same diameter as the bone socket. The No. 5 suture from the whipstitch in the distal end of the biceps was secured directly to the actuator of the MTS machine by passing the suture limbs through the holes in the horizontal bar of the actuator and tying them with a 6-throw surgeon's knot. The load was applied in line with the normal vector of the biceps, parallel to the long axis of the humerus. Each specimen was loaded at 5 mm/second, with a preload of 5

FIGURE 2. Cross-section of biotenodesis screw construct showing interference fit of the biceps tendon in a bone socket in the proximal aspect of the bicipital groove.