The Effect of Biceps Reattachment Site on Moment Arm

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INTRODUCTION

Avulsion of the distal biceps tendon from the tuberosity occurs mostly in middle-aged males resulting from eccentric loading of the flexed, supinated forearm [1]. When non-operative treatment is chosen, supination strength decreases by 50% and flexion strength is reduced by 35-40% [2]. Surgical repair has been shown to be a better alternative than non-operative treatments for restoration of strength and endurance [2, 3].

Current surgical methods include one and two incision repair techniques in which the tendon is reattached to the anterior or posterior aspect of the tuberosity respectively. Methods of attachment of the tendon include using sutures, suture anchors and cortical buttons. Although studies have examined the fixation strength of these types of repairs, little has been done to examine the effect that attachment location has on functional outcome of the repair [4].

The objective of this project is to determine the impact that the reattachment location has on torque generating ability of the forearm described as its moment arm. The results of this study can help surgeons gain a better understanding of how to optimize the repair and thereby improve the expected outcome of patients with distal biceps injuries.

METHODS

A total of 6 frozen upper extremity cadaveric specimens (5 male), with an average age of 60 (36-83) years, were used. The specimens included the full forearm from the hand to the mid-humerus proximally. Specimens with medical histories of rheumatoid arthritis, degenerative joint disease or any orthopaedic anomaly were excluded. Prior to the day of testing, each specimen was allowed to thaw overnight at room temperature and kept moist with normal saline.

An elbow simulator, that includes computer controlled actuators to exert known loads on the forearm applied through the biceps tendon, was adapted to a device capable of measuring isometric forearm torque generated by cadaveric elbows [5]. The device has an adjustable shaft that attaches to a plate mounted on the distal radius. The other end of the shaft transmits load to a torque sensor (Transducer Techniques, Temecula, CA) which is wired into a computer data acquisition system.

Each specimen was mounted in the elbow simulator with the humerus and ulna fixed firmly to the frame at 90° of flexion. The proximal end of the distal biceps tendon was attached to an actuator using 80lb test line. The adjustable shaft was attached to the distal radius plate. The forearm was then rotated and locked into three positions: 60° supination, neutral and 60° pronation. The biceps tendon was loaded to 15 lbs, and the torque was measured for the native tendon attachment. Then the biceps tendon was detached and attached at four different locations. For each forearm position, each test was repeated three times.

With the arm fully supinated, the borders of the radial tuberosity were identified and marked as shown in Figure 1. A line connecting the two midpoints of the borders was used to define the center axis line. The highest point (apex) on the tuberosity at the tendon-bone interface was identified using calipers. A medial to lateral line, parallel to the tuberosity border lines, was drawn to define the apex diameter line. Using these markings as a guide, four reattachment points were systematically placed in the radius as shown in Figure 1.
A regression line was fitted to the torque vs. load data for each test. The moment arm for each tendon attachment was defined as the slope of the regression line. A positive moment arm value indicated that the biceps generated a supination torque.

Statistical analysis consisted of two-way repeated measures analysis of variance with Tukey’s post-hoc testing to compare the means of individual treatment groups with one another.

**RESULTS AND DISCUSSION**

Tendon location and forearm position significantly affected the moment arm of the biceps (p<0.05). The native tendon had a mean moment arm of 5.67 ±2.86 and 10.44 ±1.45 (mm) in 60° supination and neutral respectively. Reattachment to Location (A) in all forearm positions showed no significant difference from the native. Location (ACA) was significantly lower in supination (0.15 ±3.48) and neutral (7.65 ±1.95), while Location (PCA) was significantly higher in supination (7.21± 3.02) compared to the native. Location (PA) (4.69 ±2.75) was significantly higher than (ACA) in supination. No difference was observed between all tendon locations in pronation. Figure 2 summarizes the results.

**CONCLUSIONS**

This biomechanical study provides support for the importance of anatomic restoration of the native tendon moment arm during the repair of ruptured distal biceps tendons. The surgeon needs to pay particular attention to the geometry of the tuberosity and be mindful of the location of tendon reattachment as it could play a critical role in maximizing the functional outcomes of patients.

**REFERENCES**