INTRODUCTION:
Although MRI is a well-established adjunct to confirm clinical diagnosis of a distal biceps rupture, to our knowledge, the post-repair appearance of the distal biceps tendon on magnetic resonance imaging has not been previously examined. The purpose of this study was to characterize the MRI appearance of a repaired distal biceps tendon and to determine whether MRI appearance of the tendon correlated with clinical outcome.

METHODS: Nineteen patients were randomly recruited from a single surgeon series of distal biceps repairs to undergo FABS protocol magnetic resonance imaging of the involved elbow an average of 4.1 years after repair (range 1.0-6.3 years). The biceps tendon was reattached to cortical bone at the insertion site with the aid of a cortical button. All patients were men, with an average age of 49 (range 33-67). There were 11 dominant and 8 nondominant extremities involved, and in all but one case, a discrete injury involving forceful or eccentric contraction of the biceps was identified. A musculoskeletal radiologist read each MRI and characterized each repair independently. Specifically, the integrity of the repair (healed or not healed), the amount of heterogeneity within the tendon substance (greater or less than 50%), and the presence or absence of heterotopic ossification were recorded for each patient.

Additionally, seventeen of the nineteen patients underwent isometric supination strength testing with a custom made portable testing device. at three forearm positions: 60° of supination, neutral, and 60° of pronation. Patients were asked to stand and grasp a handle with their arm at 90° of elbow flexion and 0° of shoulder abduction. All nineteen patients also completed Disabilities of the Arm, Shoulder, and Hand (DASH) and Visual Analog Scale (VAS) scores.

The coronal images for each patient were imported into Mimics 11.0 (Materialise, Leuven, Belgium) 3D image processing software. The proximal radius was segmented from the imaging, and a center point for each radius cross section was calculated using the built-in centerline tool. The furthest point on the cortical outline of the radius from the corresponding center point was determined for each image using the software’s measurement tools. The apex of the tuberosity was chosen as the image/point with the greatest distance from the center point. Further, a predicted native tendon center was chosen to be 2.9 mm anterior from the apex point as this has been shown to be an average location of the native tendon. Next, the image with the largest cross-section of the repaired tendon footprint was found. The center of the repair was determined as midpoint of the footprint on this image. The predicted native and repair points as well as their corresponding radius cross-section center points were used to define two vectors. The angle between these two vectors, as shown in Figure 1, provided an estimate of the healed tendon orientation.

Figure 1: Diagram showing key anatomic points and repaired tendon position measurement for Patient #17.

Supination strength at each forearm position for the injured and contralateral sides was compared using paired t-tests with Bonferroni correction. Additionally, the strength data was segmented into subgroups based on the presence of heterotopic bone and degree of heterogeneity from the MRI. Paired t-tests were used to examine whether the MRI appearance correlated to patient strength outcome. The Pearson correlation coefficient was calculated to determine if strength outcome was related to the functional outcome measures of DASH and VAS scores as well as the repaired tendon position on the tuberosity.

RESULTS: All of the repairs healed to cortical bone. There was wide variability in the appearance of the repaired tendon with respect to footprint dimensions and overall morphology, with nine of the patients (47%) having intra-substance heterogeneity involving greater than 50% of the tendon. Eight patients (42%) had heterotopic bone present within the tendon substance as detected by MRI. Average DASH was 7.7 (0-49.2) and VAS 0.7 (0-5). No patient had an elbow or forearm range of motion deficit of greater than 10° at final follow up and there were no permanent nerve injuries. With the forearm in neutral and 60° of pronation, average supination torque of the injured side was 90% and 99% of that of the contralateral side respectively. Statistically significant difference in supination strength between injured and uninjured sides was found with the forearm in 60° of supination (average 77% of uninjured side p=0.01). The average supination values are listed in Table 1.

Table 1. Average supination torque values for injured and contralateral sides (avg± stdv. (N-m)) (* - significant difference)

<table>
<thead>
<tr>
<th></th>
<th>Injured</th>
<th>Contralateral</th>
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</thead>
<tbody>
<tr>
<td>*60°/S (N-m)</td>
<td>4.17 ± 1.67</td>
<td>2.12 ± 2.00</td>
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<tr>
<td>0°/N (N-m)</td>
<td>8.40 ± 2.71</td>
<td>9.63 ± 2.65</td>
</tr>
<tr>
<td>60° /P (N-m)</td>
<td>12.52 ± 3.34</td>
<td>12.66 ± 3.59</td>
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Comparisons of subgroups based on the categories in the MRI assessment did not yield statistically significant differences in supination strength measures, DASH, or VAS scores.

The average angular position of the healed tendon on the tuberosity was 82° ± 20.47° (32°-121°) from the estimated native tendon insertion center. The angular position did not exhibit a significant correlation with percent supination strength difference at all three positions, DASH, or VAS scores.

DISCUSSION: In this study of distal biceps repairs, tendon morphology did not correlate with functional outcome as measured by DASH, VAS, and isometric supination strength. Eleven of nineteen patients had either heterogeneity or heterotopic bone. Clinical decisions for reoperation of a painful distal biceps repair should not be solely based on MRI appearance of the tendon. We also observed that the distal biceps tendon predictably heals to cortical bone, suggesting that the creation of a bone trough in the proximal radius may not be necessary. The fact that a decrease in strength was only observed at 60° of supination could be an effect of the tendon reattachment location.

REFERENCES:

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