Effect of Radial Tuberosity Preservation on Supination and Flexion Strength following a Distal Biceps Repair

Brandon T. Brown¹, Michael N. Nakashian, M.D.², Benjamin Williams, M.D.², James Rubright, M.D.², Pat Schimoler¹, Daniel Schmidt¹, Andrew Pic¹, Patrick Smolinski¹, Christopher C. Schmidt, M.D.², Mark Carl Miller, PhD³.
¹University of Pittsburgh, Pittsburgh, PA, USA, ²University of Pittsburgh Medical Center, Pittsburgh, PA, USA, ³Tbd, Pittsburgh, PA, USA.


Introduction: The apex of the radial tuberosity contributes to the supination moment arm of the biceps. The purpose of this study was to evaluate the effects of two commonly performed distal biceps repair techniques. We hypothesized that a tuberosity reducing repair technique (Trough) versus a tuberosity sparing technique (Anatomic) would reduce the supination moment arm of the distal biceps tendon while flexion effects would be minimal.

Methods: The isometric supination moment arm and flexion force ratio was measured in 20 matched-paired cadaveric elbows using an anatomic elbow simulator. For the supination moment arm the forearm was placed at 90° of flexion and the biceps was loaded to 67 N while the torque produced at the distal radius was measured. The supination moment arm was defined as the slope of the biceps loading and forearm torque curves. This test was performed at three forearm angles: 60° of Pronation, Neutral (0°), and 60° of Supination. For the flexion force ratio the elbow was placed at 90° of flexion and pinned at 60° of supination, the biceps was loaded to 67 N while the vertical force produced at the wrist was measured. The flexion force ratio was defined as the load at the wrist divided by the biceps load. The native biceps tendon was first tested and then the tendons were transected at their apex insertion. The matched-pair specimens were randomized into either a Trough (apex-reducing) or an Anatomic footprint repair (apex-sparing). The specimens were then retested using the aforementioned protocol.

After testing, the geometry of the proximal radius was reconstructed using stereo-photogrammetry. The proximal radius was imaged using an optical tracking system (accuracy 0.001 mm) (Spica Technology, Kihei, HI, USA). All repair sites were three dimensionally reconstructed using stereo photogrammetry to quantify the damage of the trough to the native anatomy. The tuberosity distance was defined as the distance between the central axis of the radius and the centroid of the respective repair sites (Figure 1). For each matched-pair, the ration of the ANATOMIC tuberosity distance to the TROUGH distance normalized the loss of moment arm. A two-way ANOVA with Tukey’s post-hoc testing was applied to the supination and flexion data. An independent t-test compared the tuberosity distance between ANATOMIC and TROUGH repairs. A bivariate correlation was performed to study the relationship between supination moment arm and tuberosity distance, (alpha=0.05).

Results: Torque testing results are seen in the Figure 2. Analysis showed that forearm angle (p=0.004) and repair (p=0.031) significantly affected the moment arm and the interaction was significant.
Post-hoc testing revealed that the Trough repair had a 27% lower supination moment arm at 60° of supination (p=0.036). The average flexion force ratio was 0.17±0.02, 0.16±0.02 and 0.17±0.02 for the intact, anatomic and trough repairs, respectively. There were no significant differences for the flexion force tests (p=0.335). The average tuberosity distance for the Anatomic case was 11.02±2.05 mm and for the Trough was 8.26±1.44 mm which was significant (p=0.003). The percent distance lost from the trough was 25%. Furthermore, the supination moment arm in the supinated position was significantly correlated to the tuberosity distance, r=0.558 with p=0.011.

**Discussion:** The Trough technique, which removed part of the radial tuberosity, resulted in a 27% loss in the supination moment arm in the supinated forearm as well as a 25% reduction in radial tuberosity height. Thus, supination strength will fall as one supinates past the neutral forearm position. Furthermore, the correlation of radial tuberosity height to the supination moment arm reinforces the key role the apex of the radial tuberosity plays in the mechanics of supination. No differences at other forearm angles were found, or expected, because the biceps tendon is wrapped around the radial tuberosity at supination angles greater than neutral, causing the tendon insertion site to be less crucial. The two techniques had the same effect on flexion force and reproduced the intact case. This was expected because alterations to the radial tuberosity will relocate the distal biceps tendon in a direction nearly perpendicular to the flexion axis of rotation. Furthermore, the repairs place the distal biceps tendon at its original insertion site which will maintain the proximal and distal insertion site distances from the capitellum.

**Significance:** Distal biceps tendon repairs should focus on leaving as much of the radial tuberosity intact as possible. Doing so should allow for retention of supination strength to normal levels.
Figure 2: Supination moment arm data, significant differences are shown.