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Short-Term Outcome of Unicortical, Intramedullary Repair of Distal Biceps Ruptures – A Retrospective Cohort Study

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MetroHealth Medical Center institutional IRB approval was obtained prior to conducting the current study (IRB ID: STUDY00000067).
Abstract:

Background: Modern distal biceps reconstruction techniques have generally satisfactory outcomes however are not without complications. Posterior interosseous nerve (PIN) palsy is a rare but potentially devastating complication of bicortical metal button fixation. Recently a unicortical, intramedullary, repair technique utilizing a suture anchor has been described. The primary aim of this study was to compare short-term functional and patient-reported outcomes, and complication rates in patients receiving unicortical intramedullary repair (UR) with suture anchor against those receiving bicortical repair (BR) with metallic button. We hypothesized that UR would have equally satisfactory outcomes without the complication profile.

Methods: Retrospective chart review was conducted for all patients undergoing operative fixation of distal biceps tendon ruptures from 2015-2021 at our tertiary referral center. Twenty patients received BR and eight received UR. Patient demographics and surgical complications were compared. QuickDASH scores at two-month and latest in-person and telehealth postoperative visits, as well as elbow and forearm range of motion at last clinical visit were collected and analyzed.

Results: Average patient age in the BR & UR cohorts were 49.3 ± 9.3 and 42.1 ± 6.2 years respectively with a male predominance. There was no statistical difference in patient age, sex, hand dominance, injury laterality, injury chronicity, and follow-up duration. Range of motion was comparable and excellent in both groups. Latest follow-up was 3.0 ± 0.5 years in the BR and 1.5 ± 0.4 years in the UR cohorts. QuickDASH scores improved between the two-month and latest timepoints in each cohort however did not differ significantly in head-to-head comparison. Complications included a case of PIN palsy, distal biceps tendon re-rupture, and LABC neuropraxia in the BR group and two cases of LABC neuropraxia in the UR group. The number-
needed-to-treat (NNT) for the prevention of one additional case of PIN palsy using UR is 22
patients.

**Discussion:** Short-term functional and patient-report outcomes in traditional BR and newly-
reported UR of distal biceps tendon ruptures are comparable and excellent. UR did not have
higher failure rate despite follow-up periods beyond what is typically reported for tendon re-
ruptures. In this limited retrospective cohort study, UR also did not encounter postoperative PIN
palsy and had a NNT of 22 patients. In the appropriate clinical setting, this provides early
evidence supporting the utilization of unicortical intramedullary suture anchor fixation of distal
biceps tendon ruptures as well as associated peri-operative interventions such as preoperative
nerve blocks.

**Level of Evidence:** Level III; Retrospective Cohort Comparison; Treatment Study

**Keywords:** distal, biceps, repair, intramedullary, unicortical, outcome

Bicortical, metallic button fixation through the bicipital tuberosity is a well-characterized
and popular technique for the repair of distal biceps tendon ruptures. Biomechanically, cortical
button repair has been reported to achieve excellent fixation strength. Clinically, these
procedures achieve satisfactory outcomes. Despite these advantages, a notable shortcoming of
bicortical fixation is the risk of iatrogenic injury to the posterior interosseous nerve (PIN), which
is reported to occur in approximately 1% to 8% of cases. Techniques have been described
to minimize this risk including drill trajectories within safer corridors and unicortical button
fixation. It is noted however, that anatomic variations in the location of patients’ PIN
unfortunately precludes complete avoidance of PIN palsy. Unicortical metallic button
fixation has also been reported. Despite similar benefits and promising outcomes, intramedullary deployment within the unpredictable size of certain patients’ radial canal presents a challenge.\(^6\)

To address these challenges, our group recently described a unicortical, intramedullary technique utilizing a suture anchor for distal biceps tendon repair.\(^4\) Outcomes for this procedure have to-date not been described. The primary aim of this study was to compare short-term functional and patient-reported outcomes, and complication rates in patients receiving unicortical intramedullary repair (UR) with suture anchor against those receiving bicortical repair (BR) with metallic button. We hypothesized that UR would have equally satisfactory outcomes without the complication profile.

**Materials and Methods:**

After obtaining institutional review board approval for this study, a retrospective chart review was conducted for patients who underwent repair for distal biceps tendon repair by two fellowship-trained orthopedic hand and upper extremity surgeons at our tertiary referral center (A.L. & B.T.B). Patient charts were identified by a search of Current Procedural Terminology (CPT) code 24342 (reinsertion of ruptured distal biceps tendon) between January 2015 and June 2021. Exclusion criteria included triceps rupture, concomitant fracture or nerve injury at time of surgery, and follow-up duration shorter than six months. Patient demographics, operative technique, surgical complications, and postoperative patient-reported outcomes (QuickDASH score) and range of motion were collected and analyzed. QuickDASH scores were obtained at both the two-month and latest in-person and telehealth postoperative visits.

Patients were separated into two cohorts based on their operative technique: Bicortical metallic button repair (BR) and unicortical intramedullary suture anchor repair (UR). At our
institution, BR was historically used for distal biceps repair. By the year 2019, the UR implant was introduced, tested in cadaveric settings, and ultimately adopted for clinical application in 2020. All subsequent distal biceps tendon repairs were performed using this technique by the surgeons in the current study (A.L. & B.T.B). All UR was performed based on our previously described technique. In brief, upon exposure of the radial tuberosity, a unicortical hole was drilled, followed by deployment of the intramedullary all-suture anchor. The two accompanying sutures were run through the biceps stump in locked Krackow fashion, then used to reduce and lock the tendon back to the radius.

Statistics were expressed as mean and SDs. Continuous outcome measures were assessed using t tests. Categorical outcomes were compared using chi-square and exact tests of goodness-of-fit. P values of less than .05 were considered statistically significant. All statistical analyses were conducted utilizing SPSS Statistics (IBM Corp, Armonk, NY, USA).

Results:

From an initial query of 50 patients, thirteen were excluded as erroneously coded triceps ruptures, three excluded for concomitant fracture, and six excluded for follow-up duration shorter than six months. Final cohort comprised of 20 patients in the BR group and 8 patients in the UR group. Average patient age in the BR & UR cohorts were 49.3 ± 9.3 and 42.1 ± 6.2 years respectively with a male predominance. No statistically significant difference was found in patient age, sex, hand dominance, nor injury laterality. Patients in both groups had comparable injury chronicity, both in relation to time between injury and initial presentation in clinic and between injury and date of surgery. Postoperative follow-up durations were also similar. Latest follow-up was 3.0 ± 0.5 years in the BR and 1.5 ± 0.4 years in the UR cohorts (Table 1).
Postoperative Outcomes:

At final follow-up, elbow and forearm range of motion was comparable and excellent in both BR and UR groups (Table 2). Elbow flexion and extension as well as forearm supination and pronation were close to full in both cohorts. Generally, QuickDASH scores improved in both the BR and UR groups between the two-month and latest follow-up visit (22.5±10.7 and 9.1±13.7 at the two-month and latest follow-up visits respectively for the BR group, p=0.01; and 14.2±10.9 and 2.6±4.2 for the UR group, p=0.03). With the available data, QuickDASH scores were improved in the UR cohort at both time points however the difference was not statistically significant.

Complications:

In the BR cohort, three separate patients sustained postoperative PIN palsy, re-rupture, and LABC neuropraxia. Patients in the UR cohort did not experience PIN palsy, however two had LABC neuropraxia (Table 2). The number-needed-to-treat (NNT) for the prevention of one additional case of PIN palsy using UR is 22 patients.

Discussion:

In the current retrospective cohort study, short-term outcomes of UR were comparable to that of BR, without the risk of PIN injury. Patients with UR were able to achieve postoperative elbow and forearm range of motion on-par with that of BR counterparts. At eighteen months to three years postop, patient-reported QuickDASH scores in the UR cohort was 3.2±4.4. This, as well, was not inferior to patients with BR. Notably, PIN injury was not encountered in patients receiving UR. Based on this limited study therefore, the number-needed-to-treat (ie. the number of patients needed to be treated to prevent one additional negative outcome) for the prevention of
one additional case of PIN palsy using UR is 22 patients. This finding is not surprising as it has been hypothesized that direct injury, owing to dorsal radial cortex penetration of drills, guidewires, and implants in traditional bicortical fixation, is the main culprit of PIN palsy. Despite generally satisfactory functional and patient-reported outcomes using BR in the literature, the incidence of PIN palsy has been reported to range from 1-8%. In addition to comparable clinical outcomes, UR with suture anchor’s ability to reliably avoid PIN injury, has the potential to benefit other areas of clinical practice including safely utilizing preoperative nerve blocks for patient analgesia.

At latest follow-up, no tendon re-ruptures were encountered in the UR group. While this is almost certainly a reflection of limited sample size, it is reassuring that follow-up duration for the UR group in the current study is well-beyond what is reported as the time frame for most re-rupture to occur. Previous studies examining metallic button fixation of distal biceps tendon ruptures have described that re-rupture most frequently occurs within the first two-months of surgery. The novelty of the current intramedullary suture anchors utilized in this study however renders conclusions regarding clinical re-rupture rate inconclusive at the present time.

The authors acknowledge several important methodological limitations to the current study. Most importantly, sample size in both cohorts is limited as a result of the rarity of this injury. The current study does not have sufficient power to detect differences in outcome, and thus conclusions drawn to-date must be taken in an observational context. Comparison of the rate of PIN palsy in particular would benefit from larger analyses. Despite promising early results, follow-up studies will be required to provide long-term outcomes of UR for distal biceps tendon ruptures with a particular interest in re-rupture rate. Utilization of the same implant for subpectoral biceps tenodesis indications have shown ultimate failure loads commensurate with
that of metallic button fixation. Recent biomechanical comparison between intramedullary all-suture anchors and bicortical metallic button anchors have also found equivalent maximum load to failure and lower maximum displacement with the all-suture anchor, albeit with a dual-suture-anchor construct. The current study also did not have the sufficient data to compare other outcome measures of interest, including but not limited to elbow flexion and forearm supination strength and endurance. Finally, this study was also performed at a single institution, with two surgeons’ patients, which may limit generalizability of these findings. Even amongst unicortical suture anchor fixation there exists implant- and provider-dependent technique variations, such as the use of single versus double-loaded sutures to reinforce fixation, which may confound outcomes.

Conclusion:

Short-term observational results from this study support unicortical, intramedullary suture anchors as a promising alternative for repair of distal biceps tendon ruptures. Functional and patient-reported outcomes are comparable with commonly used bicortical, metallic button fixation without associated risk of PIN injury. Further investigation is required to determine long-term viability and any complications unique to this treatment technique.

References:


**Legends:**

**Table 1:** Patient demographics, symptom and follow-up duration

**Table 2:** Postoperative outcomes and complications
<table>
<thead>
<tr>
<th></th>
<th>Bicortical metallic button (n=20)</th>
<th>Unicortical suture anchor (n=8)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>49.3 ± 9.3</td>
<td>42.1 ± 6.2</td>
<td>0.06</td>
</tr>
<tr>
<td>Sex (M/F)</td>
<td>19/1</td>
<td>8/0</td>
<td>0.52</td>
</tr>
<tr>
<td>Hand Dominance (R/L)</td>
<td>16/3</td>
<td>7/1</td>
<td>0.83</td>
</tr>
<tr>
<td>Injury Laterality (R/L)</td>
<td>9/10</td>
<td>4/4</td>
<td>0.90</td>
</tr>
<tr>
<td>Time between Injury &amp; Initial Presentation (weeks)</td>
<td>4.6 ± 8.1</td>
<td>3.2 ± 4.5</td>
<td>0.65</td>
</tr>
<tr>
<td>Time between Injury &amp; Surgery (weeks)</td>
<td>7.8 ± 10.6</td>
<td>4.9 ± 6.0</td>
<td>0.47</td>
</tr>
<tr>
<td>In-Office Follow-Up Duration (weeks)</td>
<td>18.3 ± 9.6</td>
<td>12.7 ± 4.2</td>
<td>0.13</td>
</tr>
</tbody>
</table>

M/F: male/female, R/L: right/left
### Results

<table>
<thead>
<tr>
<th></th>
<th>Bicortical metallic button (n=20)</th>
<th>Unicortical suture anchor (n=8)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-month QuickDASH</td>
<td>22.5 ± 10.7</td>
<td>14.2 ± 10.9</td>
<td>0.08</td>
</tr>
<tr>
<td>Latest QuickDASH</td>
<td>9.1 ± 13.7</td>
<td>2.6 ± 4.2</td>
<td>0.38</td>
</tr>
<tr>
<td>Change in QuickDASH</td>
<td>-13.4 ± 11.7</td>
<td>-11.6 ± 8.8</td>
<td>0.01</td>
</tr>
<tr>
<td>Final Flexion (degrees)</td>
<td>135.5 ± 5.4</td>
<td>139.4 ± 5.6</td>
<td>0.10</td>
</tr>
<tr>
<td>Final Extension (degrees)</td>
<td>3.0 ± 7.3</td>
<td>1.3 ± 3.5</td>
<td>0.53</td>
</tr>
<tr>
<td>Final Supination (degrees)</td>
<td>69.0 ± 6.8</td>
<td>64.4 ± 16.1</td>
<td>0.29</td>
</tr>
<tr>
<td>Final Pronation (degrees)</td>
<td>70.3 ± 8.2</td>
<td>70.0 ± 11.7</td>
<td>0.95</td>
</tr>
<tr>
<td>Complications (number):</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PIN palsy</td>
<td>1</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Re-rupture</td>
<td>1</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>LABC neuropraxia</td>
<td>1</td>
<td>2</td>
<td></td>
</tr>
</tbody>
</table>

PIN: posterior interosseous nerve, LABC: lateral antebrachial cutaneous nerve