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PII: S2666-6383(22)00229-8

DOI: <https://doi.org/10.1016/j.jseint.2022.10.012>

Reference: JSEINT 696

To appear in: *JSES International*

Received Date: 18 October 2022

Accepted Date: 20 October 2022

Please cite this article as: Cheng C, Dong O, Klyce W, Lee A, Bafus BT, Short-Term Outcome of Unicortical, Intramedullary Repair of Distal Biceps Ruptures – A Retrospective Cohort Study, *JSES International* (2022), doi: <https://doi.org/10.1016/j.jseint.2022.10.012>.

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

Christopher Cheng, MD¹ Oliver Dong, BS² Walter Klyce, MD¹ Adrienne Lee, MD³ Blaine Todd
Bafus, MD³

¹ Department of Orthopaedic Surgery, Case Western Reserve University/University Hospitals
Cleveland Medical Center, Cleveland, OH, USA

² Case Western Reserve University School of Medicine, Cleveland, OH, USA

³ Department of Orthopaedic Surgery, MetroHealth Medical Center, Cleveland, OH, USA

Corresponding Author: Christopher Cheng, MD

Department of Orthopaedic Surgery 11100 Euclid Ave, Cleveland, OH 44106, USA

Christopher.cheng3@uhhospitals.org

Disclaimers:

Funding: No funding was disclosed by the authors.

Conflicts of interest:

Adrienne Lee and Blaine Todd Bafus have received financial support for education and food &
beverage from Rock Medical Orthopedics, Inc.

The other authors, their immediate families, and any research foundation with which they are
affiliated have not received any financial payments or other benefits from any commercial entity
related to the subject of this article.

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

1 **Abstract:**

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

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

16 **Results:** Average patient age in the BR & UR cohorts were 49.3 ± 9.3 and 42.1 ± 6.2 years
17 respectively with a male predominance. There was no statistical difference in patient age, sex,
18 hand dominance, injury laterality, injury chronicity, and follow-up duration. Range of motion
19 was comparable and excellent in both groups. Latest follow-up was 3.0 ± 0.5 years in the BR and
20 1.5 ± 0.4 years in the UR cohorts. QuickDASH scores improved between the two-month and
21 latest timepoints in each cohort however did not differ significantly in head-to-head comparison.
22 Complications included a case of PIN palsy, distal biceps tendon re-rupture, and LABC
23 neuropraxia in the BR group and two cases of LABC neuropraxia in the UR group. The number-

24 needed-to-treat (NNT) for the prevention of one additional case of PIN palsy using UR is 22
25 patients.

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

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

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

36 Bicortical, metallic button fixation through the bicipital tuberosity is a well-characterized
37 and popular technique for the repair of distal biceps tendon ruptures. Biomechanically, cortical
38 button repair has been reported to achieve excellent fixation strength.^{3,12,15} Clinically, these
39 procedures achieve satisfactory outcomes.^{9,10} Despite these advantages, a notable shortcoming of
40 bicortical fixation is the risk of iatrogenic injury to the posterior interosseous nerve (PIN), which
41 is reported to occur in approximately 1% to 8% of cases.^{5,8,11,17} Techniques have been described
42 to minimize this risk including drill trajectories within safer corridors and unicortical button
43 fixation. It is noted however, that anatomic variations in the location of patients' PIN
44 unfortunately precludes complete avoidance of PIN palsy.^{2,14,18} Unicortical metallic button

45 fixation has also been reported. Despite similar benefits and promising outcomes, intramedullary
46 deployment within the unpredictable size of certain patients' radial canal presents a challenge.¹⁶

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

54 **Materials and Methods:**

55 After obtaining institutional review board approval for this study, a retrospective chart
56 review was conducted for patients who underwent repair for distal biceps tendon repair by two
57 fellowship-trained orthopedic hand and upper extremity surgeons at our tertiary referral center
58 (A.L. & B.T.B). Patient charts were identified by a search of Current Procedural Terminology
59 (CPT) code 24342 (reinsertion of ruptured distal biceps tendon) between January 2015 and June
60 2021. Exclusion criteria included triceps rupture, concomitant fracture or nerve injury at time of
61 surgery, and follow-up duration shorter than six months. Patient demographics, operative
62 technique, surgical complications, and postoperative patient-reported outcomes (QuickDASH
63 score) and range of motion were collected and analyzed. QuickDASH scores were obtained at
64 both the two-month and latest in-person and telehealth postoperative visits.

65 Patients were separated into two cohorts based on their operative technique: Bicortical
66 metallic button repair (BR) and unicortical intramedullary suture anchor repair (UR). At our

67 institution, BR was historically used for distal biceps repair. By the year 2019, the UR implant
68 was introduced, tested in cadaveric settings, and ultimately adopted for clinical application in
69 2020. All subsequent distal biceps tendon repairs were performed using this technique by the
70 surgeons in the current study (A.L. & B.T.B). All UR was performed based on our previously
71 described technique.⁴ In brief, upon exposure of the radial tuberosity, a unicortical hole was
72 drilled, followed by deployment of the intramedullary all-suture anchor. The two accompanying
73 sutures were run through the biceps stump in locked Krackow fashion, then used to reduce and
74 lock the tendon back to the radius.

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

79 **Results:**

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

89 *Postoperative Outcomes:*

90 At final follow-up, elbow and forearm range of motion was comparable and excellent in
91 both BR and UR groups (**Table 2**). Elbow flexion and extension as well as forearm supination
92 and pronation were close to full in both cohorts. Generally, QuickDASH scores improved in both
93 the BR and UR groups between the two-month and latest follow-up visit (22.5 ± 10.7 and
94 9.1 ± 13.7 at the two-month and latest follow-up visits respectively for the BR group, $p=0.01$; and
95 14.2 ± 10.9 and 2.6 ± 4.2 for the UR group, $p=0.03$). With the available data, QuickDASH scores
96 were improved in the UR cohort at both time points however the difference was not statistically
97 significant.

98 *Complications:*

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

103 **Discussion:**

104 In the current retrospective cohort study, short-term outcomes of UR were comparable to
105 that of BR, without the risk of PIN injury. Patients with UR were able to achieve postoperative
106 elbow and forearm range of motion on-par with that of BR counterparts. At eighteen months to
107 three years postop, patient-reported QuickDASH scores in the UR cohort was 3.2 ± 4.4 . This, as
108 well, was not inferior to patients with BR. Notably, PIN injury was not encountered in patients
109 receiving UR. Based on this limited study therefore, the number-needed-to-treat (ie. the number
110 of patients needed to be treated to prevent one additional negative outcome) for the prevention of

111 one additional case of PIN palsy using UR is 22 patients. This finding is not surprising as it has
112 been hypothesized that direct injury, owing to dorsal radial cortex penetration of drills,
113 guidewires, and implants in traditional bicortical fixation, is the main culprit of PIN palsy.
114 Despite generally satisfactory functional and patient-reported outcomes using BR in the
115 literature, the incidence of PIN palsy has been reported to range from 1-8%.^{5,8,11,17} In addition to
116 comparable clinical outcomes, UR with suture anchor's ability to reliably avoid PIN injury, has
117 the potential to benefit other areas of clinical practice including safely utilizing preoperative
118 nerve blocks for patient analgesia.

119 At latest follow-up, no tendon re-ruptures were encountered in the UR group. While this
120 is almost certainly a reflection of limited sample size, it is reassuring that follow-up duration for
121 the UR group in the current study is well-beyond what is reported as the time frame for most re-
122 rupture to occur. Previous studies examining metallic button fixation of distal biceps tendon
123 ruptures have described that re-rupture most frequently occurs within the first two-months of
124 surgery.^{1,7,10} The novelty of the current intramedullary suture anchors utilized in this study
125 however renders conclusions regarding clinical re-rupture rate inconclusive at the present time.

126 The authors acknowledge several important methodological limitations to the current
127 study. Most importantly, sample size in both cohorts is limited as a result of the rarity of this
128 injury. The current study does not have sufficient power to detect differences in outcome, and
129 thus conclusions drawn to-date must be taken in an observational context. Comparison of the rate
130 of PIN palsy in particular would benefit from larger analyses. Despite promising early results,
131 follow-up studies will be required to provide long-term outcomes of UR for distal biceps tendon
132 ruptures with a particular interest in re-rupture rate. Utilization of the same implant for
133 subpectoral biceps tenodesis indications have shown ultimate failure loads commensurate with

134 that of metallic button fixation.¹³ Recent biomechanical comparison between intramedullary all-
135 suture anchors and bicortical metallic button anchors have also found equivalent maximum load
136 to failure and lower maximum displacement with the all-suture anchor, albeit with a dual-suture-
137 anchor construct.⁶ The current study also did not have the sufficient data to compare other
138 outcome measures of-interest, including but not limited to elbow flexion and forearm supination
139 strength and endurance. Finally, this study was also performed at a single institution, with two
140 surgeons' patients, which may limit generalizability of these findings. Even amongst unicortical
141 suture anchor fixation there exists implant- and provider-dependent technique variations, such as
142 the use of single versus double-loaded sutures to reinforce fixation, which may confound
143 outcomes.¹⁹

144 **Conclusion:**

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

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208 **Legends:**

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

210 **Table 2:** Postoperative outcomes and complications

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

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

	Bicortical metallic button (n=20)	Unicortical suture anchor (n=8)	P-value
2-month QuickDASH	22.5 ± 10.7	14.2 ± 10.9	0.08
Latest QuickDASH	9.1 ± 13.7	2.6 ± 4.2	0.38
Change in QuickDASH	-13.4 ± 11.7		0.01
		-11.6 ± 8.8	0.03
Final Flexion (degrees)	135.5 ± 5.4	139.4 ± 5.6	0.10
Final Extension (degrees)	3.0 ± 7.3	1.3 ± 3.5	0.53
Final Supination (degrees)	69.0 ± 6.8	64.4 ± 16.1	0.29
Final Pronation (degrees)	70.3 ± 8.2	70.0 ± 11.7	0.95
Complications (number):			
PIN palsy	1	0	
Re-rupture	1	0	
LABC neuropraxia	1	2	

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