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Outcomes and Complications After Repair of Complete Distal Biceps Tendon Rupture with the Cortical Button Technique

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Background: Numerous surgical techniques have been described for the repair of complete distal biceps tendon ruptures. However, the outcome of repair with cortical button fixation has not been extensively evaluated. The hypothesis of the present study was that elbow strength and range of motion would be less than normal after repair but that ongoing disability would be minimal as measured with use of the Disabilities of the Arm, Shoulder and Hand (DASH) score.

Methods: We performed a retrospective cohort study of patients with complete distal biceps tendon rupture that was repaired with cortical button fixation via a 1-incision anterior approach. Outcome was assessed on the basis of elbow range-of-motion and strength measurements, DASH scores, and radiographs of the operatively treated elbow. Descriptive statistics were generated for patient demographics and outcome variables. Strength was assessed with limb-symmetry index, and range of motion was evaluated with paired t tests.

Results: Sixty male patients consented to this study. The average age at the time of follow-up was 49.6 ± 7.8 years, and the average time from injury to follow-up was 3.7 ± 1.7 years. The mechanism of injury included lifting heavy objects (62%) and sporting activities (25%). Elbow flexion and supination range of motion were not different between the operatively treated and contralateral arms. The operatively treated elbow demonstrated decreased flexion strength (96% of that on the contralateral side) and supination strength (91% of that on the contralateral side). The findings did not change when controlling for hand dominance. The mean DASH score was 7.9 ± 11.4, which is not significantly different from the normative value for the general population. Postoperative complications included heterotopic ossification (Brooker class I [29 patients] or II [5 patients]), neurapraxia (7 patients), and rerupture (3 patients).

Conclusions: The repair of complete distal biceps tendon ruptures with cortical button fixation was associated with decreased strength in elbow flexion and forearm supination compared with the contralateral arm, although the differences were small and likely were not clinically important. The complication rate was relatively high; however, most complications were minor and were associated with minimal disability, as reflected by the DASH scores.

Level of Evidence: Therapeutic Level IV. See Instructions for Authors for a complete description of levels of evidence.

Distal biceps tendon rupture is an uncommon musculoskeletal injury that predominantly affects middle-aged men[1,2]. The estimated national incidence in the United States was 2.55 per 100,000 patient-years in a recent epidemiological analysis[3]. The typical mechanism of injury is an eccentric extension force loaded on a flexed and supinated forearm. There is no association with hand dominance, and smoking may increase the risk of rupture by up to 7.5 times[1,3].

Repair of a complete rupture is considered the standard of care as nonoperatively treated patients may have chronic arm pain and weakened forearm flexion and supination[4-7]. Numerous surgical techniques involving a variety of fixation methods and either a 1 or 2-incision approach have been described[8-12].

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Postoperative complications include infection, neurapraxia, heterotopic ossification, radioulnar synostosis, limited elbow motion, and tendon rerupture[13-15]. In a prospective randomized controlled study comparing single and double-incision acute repair, the single-incision technique was associated with a higher rate of lateral antebrachial cutaneous nerve neurapraxia[16].

Watson et al., in a systematic review of repair techniques, reported that cortical button repair had the lowest complication rate[17]. However, a limitation of such comparison studies is the scarcity of available studies for certain procedures. According to Watson et al., the cortical button technique is the least extensively evaluated method[17].

At our institution, complete distal biceps tendon ruptures are largely repaired with a single-incision anterior approach and cortical button fixation. The purpose of the present study was to assess long-term elbow function and complications by comparing affected elbows with contralateral elbows. Our hypotheses were that there would be a decrease in range of motion and strength in the operatively treated arm as compared with the contralateral arm and that there would not be clinical disability as determined with the Disabilities of the Arm, Shoulder and Hand (DASH) score.

Materials and Methods

Study Design

The present retrospective cohort study was conducted at a sports medicine surgery clinic. All study activities were approved by the institutional research ethics board, and all patients signed an informed consent form prior to study activities.

Participants

All patients who were screened for this study were diagnosed with a complete distal biceps tendon rupture that was repaired within 4 weeks after the injury by 1 of 5 fellowship-trained orthopaedic surgeons at the institution. Participants were recruited on the basis of the surgical billing databases of the surgeons, which have been available since the inception of electronic medical records at the participating clinic from 2011 onward. Identified patients were contacted by telephone and were sent a letter describing the study. To be eligible, patients had to have had the procedure a minimum of 12 months previously and had to have been managed with a 1-incision approach with cortical button fixation. Exclusion criteria included partial tendon ruptures, previous ipsilateral elbow surgery, injuries or surgical procedures involving the contralateral elbow, inability to return for postoperative follow-up, or any major medical condition that would affect functional assessment.

Surgical Technique

Each patient was positioned supine and received general anesthesia and/or a regional block. With use of a proximal Henry approach, a 3-cm longitudinal incision was made distal to the antebrachial elbow flexion crease. The ruptured tendon was mobilized and was followed proximally to the myotendinous junction under direct visualization. Adhesions were released to restore full length, and the tendon was pulled through the wound. Throughout the procedure, the lateral antebrachial cutaneous nerve was protected by minimizing retraction on the radial aspect of the incision. The avulsed tendon end was debrided and was secured with use of braided, nonabsorbable sutures in a whipstitch fashion. The free suture ends were then passed through the cortical button. With the arm extended and maximally supinated, the radial tuberosity was exposed and was drilled bicortically. The elbow was slightly flexed to relieve tension on the biceps tendon as the cortical button was delivered through the drill-hole and past the posterior radial cortex. It was flipped blindly to secure the tendon on top of the tuberosity. Confirmation of proper button engagement was not routinely confirmed with fluoroscopy. Once the tendon was secured, the surgeon noted the maximum angle of elbow extension permitted by the repair and splinted the elbow in this position after wound closure.

After 2 weeks of immobilization, patients started the rehabilitation protocol, which included progressive increase in elbow extension by 10° every week and did not permit strengthening exercises until 3 months postoperatively.

Outcome Measures

Elbow range of motion was measured with use of a goniometer with the forearm in supination for flexion-extension measurements and starting in neutral for supination-pronation measurements. Isometric strength was measured with JTECH Commander Echo (JTECH Medical) and Baseline Evaluation Instruments (Baseline Evaluation Instruments) dynamometers. Flexion and extension strength were measured with the elbow flexed to 90° and with the forearm in supination. Supination and pronation strength were measured with the elbow flexed to 90° and with the forearm in neutral. All range-of-motion and strength measurements were performed by the principal author (T.H.).

Patient satisfaction was assessed with use of the DASH outcome measure, a valid, responsive, and reliable 30-item questionnaire that evaluates the function and symptoms experienced by patients with upper-extremity disorders. The DASH score ranges from 0 to 100, with a high score indicating the most disability. Patients were considered to have satisfactory outcomes if the DASH score was not higher than the normative score from their age and sex-stratified group in the general population. Comparative normative scores were previously collected by the American Academy of Orthopaedic Surgeons for the purpose of assessing the effectiveness and outcomes of treatment regimens[18]. The mean normative DASH score (and standard deviation) for the general population was determined to be 10.10 ± 14.68 on the basis of 1,706 responses; this value was used for comparisons with the outcomes in the current study.

Anteroposterior and lateral radiographs were made with the affected elbow in a neutral position. The radiographs were used to confirm appropriate placement of a cortical button against the far cortex of the radial tuberosity and to assess for heterotopic ossification. Radiographic interpretations were based on consensus agreement by the principal author (T.H.)

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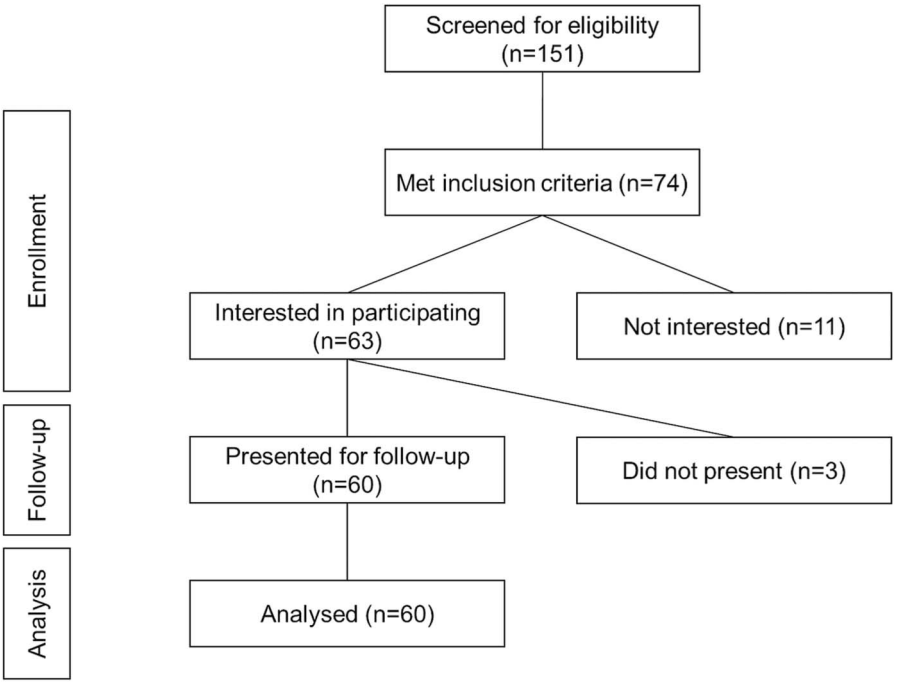

Fig. 1
Patient screening and recruitment protocol.

and a fellowship-trained elbow surgeon (J.M). Heterotopic ossification was graded on the basis of the Brooker classification system, which has been similarly applied in previous studies[19-21].

Statistical Analysis

Descriptive statistics were generated for demographic data, age at the time of injury, time from injury to follow-up, strength, range of motion, and DASH scores. Frequencies were calculated for the mechanism of injury, sex, arm dominance, affected side, smoking status at the time of injury, smoking status at the time of surgery, Workers Compensation Board (WCB) status, complications, presence of heterotopic ossification, and Brooker classification. Paired t tests were used to determine side-to-side differences in range of motion, and strength was evaluated based on a limb-symmetry index (affected/unaffected). The DASH score was compared with the normative score for a general population by comparing the mean of the study sample to a known mean value. All analyses were performed with use of SPSS 24.0 (IBM). Statistical tests were considered significant at $p < 0.05$.

Results

One hundred and fifty-one patients were screened for eligibility, and 74 patients met the inclusion criteria on the basis of a retrospective chart review. Sixty eligible patients (81%) participated in the study (Fig. 1); demographic information is summarized in Table I. The mean age at time of follow-up was 49.6 ± 7.8 years, and the mean time from injury to the latest follow-up was 3.7 ± 1.7 years. All participants who consented coincidentally were male, which is consistent with other studies that have demonstrated that distal biceps ruptures are far more common in males[22].

The range of pronation was smaller in the affected limb than in the contralateral limb, with a mean difference

TABLE I Demographic Information

Parameter	Value
Male:female ratio *(no. of patients)*	60:0
Age at time of surgery* *(yr)*	46.1 ± 7.6
Age at time of follow-up* *(yr)*	49.6 ± 7.8
Time from injury to follow-up* *(yr)*	3.7 ± 1.7
Handedness (right:left) *(no. of patients)*	53:7
Injured side (right:left) *(no. of patients)*	31:29
Smoking status at time of injury (yes:no) *(no. of patients)*	8:52
Smoking status at time of surgery (yes:no) *(no. of patients)*	8:52
Workers Compensation claim (yes:no) *(no. of patients)*	13:47
Mechanism of injury *(no. of patients)*	
Heavy lifting	37
Sports	15
Fall	7
Assault	1

*The values are given as the mean and the standard deviation.

TABLE II Mean Range of Motion and Strength of the Affected and Unaffected Elbows

	Affected Elbow*	Unaffected Elbow*
Range of motion *(°)*		
Flexion	134 ± 11	134 ± 10
Extension	0 ± 3	1 ± 4
Supination	87 ± 9	88 ± 11
Pronation	81 ± 16	86 ± 15
Strength† *(kg)*		
Flexion	25 ± 7	26 ± 9
Extension	17 ± 4	16 ± 5
Supination	168 ± 42	187 ± 34
Pronation	186 ± 40	192 ± 38

*The values are given as the mean and the standard deviation. †The strength on the affected side as a percentage of that on the unaffected side was 96% ± 17% in flexion, 103% ± 19% in extension, 91% ± 19% in supination, and 98% ± 20% in pronation.

TABLE III Differences Between Affected and Unaffected Elbows in Terms of Range of Motion and Strength

	Mean Difference and Standard Deviation	95% Confidence Interval	P Value
Range of motion *(°)*			
Elbow flexion	0.2 ± 10.2	−2.5 to 2.8	0.930
Supination	−1.2 ± 10.6	−3.9 to 1.6	0.397
Pronation	−4.7 ± 13.4	−8.1 to −1.2	0.009
Strength *(kg)*			
Elbow flexion	−1.8 ± 5.1	−3.1 to −0.4	0.010
Elbow extension	0.5 ± 2.9	−0.3 to 1.2	0.196
Supination	−19.1 ± 37.4	−28.9 to −9.4	<0.001
Pronation	−5.4 ± 37.1	−15.1 to 4.4	0.274

of −4.7° ± 13.4° (p = 0.009) (Tables II and III). Elbow flexion and supination were not different between the involved and contralateral limbs. Only 1 participant had a measurable side-to-side difference in elbow extension, with 12° less extension in the affected limb; therefore, a paired t test was not appropriate.

Elbow flexion strength was significantly greater in the unaffected arm than in the affected arm (mean difference, 1.8 ± 5.1 kg; p = 0.010) (Tables II and III). Supination strength was also significantly greater in the unaffected arm (mean difference, 19.1 ± 37.4 kg; p < 0.001). These outcomes were not affected when controlling for limb dominance. There was no difference in terms of pronation and extension strength.

The mean DASH score was 7.9 ± 11.4, which not significantly different from the normative value for the general population. Seven patients (11.7%) had lateral antebrachial cutaneous nerve paresthesia. Thirty-four patients (56.7%) had heterotopic ossification, which was classified as Brooker class I in 29 patients and Brooker class II in 5 patients. Reoperation to remove heterotopic bone was not required for any patient.

Three patients (5.0%) experienced a rerupture. The reruptures were diagnosed with magnetic resonance imaging (MRI) and were classified as either complete (complete dissociation of the tendon stump from the radial tuberosity) or partial (partial detachment). In all cases, the cortical button remained well positioned. The first patient experienced a partial rerupture 2 weeks postoperatively after lifting a heavy object. He regained 39% flexion strength and 74% supination strength in comparison with the contralateral side and had a DASH score of 0.8. The second patient presented with a complete tendon rerupture after an altercation 3 weeks postoperatively. His flexion and supination strength measured 92% and 83% of those on the contralateral side, and his DASH score was 50.8. The third patient experienced a complete tendon rupture after lifting a heavy object 4 weeks postoperatively. His flexion and supination strength were 86% and 94% of those in the contralateral side, and his DASH score was 5.

Discussion

The most important finding of the present study is that postoperative flexion and supination strength were minimally decreased and range of motion was not affected. Postoperatively, the mean flexion and supination strength of the affected elbow were 96% and 91% of those of the contralateral elbow, respectively, whereas extension and pronation strength were comparable between sides. Greenberg et al. followed 14 patients after single-incision cortical-button technique and determined that flexion and supination strength of the involved elbow were 97% and 82% of those of the contralateral elbow, respectively[23]. In a similar study, Peeters et al. determined that flexion and supination strength were 80% and 91% of the those on the contralateral side[24]. Data from the present study contribute to evidence demonstrating that patients regain the majority of strength postoperatively but that some deficits remain. For most patients, the minimal differences in strength were not clinically relevant.

Pronation was the only elbow motion that was impacted, with a mean difference of 5°. In the present study, the mean extension-flexion arc was 0° to 134°, with 87° of supination and 81° of pronation. Postoperative range of motion after other surgical techniques for distal biceps repair has been reported. In a study of 20 patients who were managed with transosseous tunnel fixation, Karunakar et al. reported an extension-flexion arc of 0° to 130°, with 77° of supination and 74° of pronation[2]. In a study of 53 patients who were managed with suture anchor fixation through a single incision, McKee et al. reported an arc of 2° to 137°, with a mean of 83° of supination and 86° of pronation[25]. The patients in the present study had minimal loss of motion compared with those in other studies. This difference may be attributable to the cortical button surgical technique and earlier range of motion following surgery.

Participants in our study had a mean DASH score of 7.9, the lowest score in comparison with similar retrospective cohort

studies. Karunakar et al. and Cheung et al. reported high scores of 52 and 43, respectively, after transosseous tunnel fixation[2,26]. Cil et al. also used the transosseous tunnel technique but reported a lower mean score of 21[27]. McKee et al. and Khan et al. measured mean DASH scores of 8.2 and 14.5, respectively, after suture anchor fixation[25,28]. No other retrospective cohort studies involving cortical button fixation assessed DASH scores.

The mean DASH score for the general population in the United States is 10.1, according to a survey conducted by the American Academy of Orthopaedic Surgeons[18]. When the normative data are stratified by sex and age group, the expected DASH score for males in the age group in the present study (mean, 49.6 years) is 9.2[18]. With a mean score of 7.9, our study demonstrates that function is not negatively affected following surgery compared with the general population. It can be inferred that most patients in this study had excellent function and satisfaction postoperatively.

In the present study, routine radiographs demonstrated a 56.7% rate of heterotopic ossification, with the majority (85.3%) of cases being classified as Brooker class I. No patient had symptomatic heterotopic ossification.

In the present study, the rate of lateral antebrachial cutaneous nerve paresthesia was 11.7%. In a retrospective study of all distal biceps tendon techniques, Dunphy et al. observed a 20.7% rate of lateral antebrachial cutaneous nerve paresthesia overall and a 25.0% rate after cortical button fixation[14]. Cain et al. reported a 26.2% rate in association with all techniques and a 27.1% rate in association with the single-incision techniques[13]. Watson et al. noted an overall 9.6% rate of lateral antebrachial cutaneous nerve paresthesia in a systematic review of all distal biceps repair techniques, with an increased rate (11.6%) associated with the use of single-incision approach[17]. The findings of that systematic review are most consistent with the rate in the present study (11.7%). The rate of lateral antebrachial cutaneous nerve paresthesia may be related more to the surgical approach to the radial tuberosity than it is to the type of fixation.

In the present study, the rate of distal biceps tendon rerupture after fixation was 5%. All cases of rerupture occurred within 2 to 4 weeks postoperatively and were related to reinjury due to noncompliance. Two of these patients required reoperation, whereas the third did not as he had a partial rerupture.

In a retrospective chart review, Dunphy et al. reported a 1.6% rerupture rate within 60 days in association with all techniques and a 1.9% rate in association with cortical button fixation[14]. Cain et al. and Watson et al. and reported overall 2% and 1.6% rerupture rates, respectively, in association with all repair techniques but did not observe any reruptures in association with the cortical button specifically[13,17]. The rerupture rate in the present study was higher than that reported in those other studies; however, that finding may be a reflection of our smaller sample size.

The present study had several limitations. The results may be affected by sampling bias as 60 patients (81%) participated but 74 met the inclusion criteria. Another limitation is the retrospective design of the study. Furthermore, 5 orthopaedic surgeons operated on the study cohort, and although cortical button fixation is the only method used at this institution, there may be slight variations in technique. However, the benefit of multiple surgeons is that the results and conclusions of the present study are more generalizable. Another strength is that all clinical measurements were performed by the same individual, the principal author. As such, there was minimal variation in data collection that may have affected results.

Our results demonstrate that repair of complete distal biceps tendon ruptures with cortical button fixation was associated with minimal loss of elbow flexion and supination strength (96% and 91% of those on the contralateral side). This technique also was associated with minimal loss of motion (5° of pronation) that was not clinically important. Our results also demonstrated a relatively high rate of complications, including lateral antebrachial cutaneous nerve paresthesia, rerupture, and heterotopic ossification. Patients reported a minimal degree of disability as reflected by the DASH scores. ■

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