SCIENTIFIC ARTICLE

Diagnosis, Etiology and Outcomes of Revision Distal Biceps Tendon Reattachment

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Purpose To evaluate the incidence, etiology, and clinical outcomes after revision distal biceps tendon repair. We hypothesized that re-ruptures are rare and can be reattached with satisfactory results.

Methods Cases were identified from the case log of the senior author. Demographic information, details regarding the primary repair and subsequent injury, time between reinjury and reattachment, and operative findings were recorded. Clinical outcomes were assessed using the Disabilities of the Arm, Shoulder, and Hand (DASH) and American Shoulder and Elbow Surgeons−Elbow (ASES-E) functional outcome scoring systems. Range of motion, strength, and ability to return to work were recorded.

Results We identified 10 patients with re-rupture, all of whom were men. Average age was 46 years (range, 35−57 years). Four ruptures occurred in the dominant arm. Three patients had a history of bilateral ruptures. Incidence of primary failure was 1.1%. In 6 patients, re-rupture occurred 6 days to 11 months after the primary surgery. Three patients described a sense of ripping or tearing after a specific traumatic event. Four others had persistent pain after the primary reattachment. Re-rupture resulted from the loss of fixation owing to technical error, the suture pulling out from the tendon, or suture breakage. Two patients required an allograft. The hook test was abnormal in 3 patients. Magnetic resonance imaging results did not affect the operative plan. Nine patients returned to their former occupation. Five returned for follow-up evaluation and completion of the DASH and ASES-E self-assessment examinations. Average DASH score was 4.4 (range, 0−19) and average ASES-E was 93.2 (range, 74−100). Postoperative average elbow flexion was 141° (range, 135° to 145°), elbow extension was −12° (range, −5° to −30°), pronation was 70°, and supination was 80°. Postoperative average supination strength was 87.8% of the nonsurgical arm (range, 79% to 106%); average pronation strength was 79.2% of the nonsurgical arm (range, 50% to 110%).

Conclusions Revision reattachment resulted in acceptable functional outcomes. *(J Hand Surg Am. 2019;■(■):1.e1-e9. Copyright © 2019 by the American Society for Surgery of the Hand. All rights reserved.)*

Type of study/level of evidence Therapeutic V

Key words Distal biceps tendon, reattachment, revision, rupture.

Online Exclusive

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Received for publication August 20, 2018; accepted in revised form May 3, 2019.

No benefits in any form have been received or will be received related directly or indirectly to the subject of this article.

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0363-5023/19/■■-0001$36.00/0
https://doi.org/10.1016/j.jhsa.2019.05.006

A DISTAL BICEPS TENDON RUPTURE is a relatively uncommon injury with an estimated incidence of 1.2 to 2.55 per 100,000.[1,2] Nonsurgical treatment results in a 40% loss of supination strength and possibly a 30% loss in elbow flexion strength.[3,4] There are multiple methods of fixation, each providing acceptable results.[5–13] Complications of distal biceps tendon repair include nerve injury, heterotopic ossification, radioulnar synostosis, loss of forearm rotation, and, uncommonly, tendon re-rupture.[14–23] Re-rupture has been reported to have an incidence of 1.2% to 6% but few articles[20,21] describe the clinical symptoms, physical signs, and radiographic findings in patients who have re-ruptured the primary distal biceps repair. Hinchey et al[20] reported on 3 re-ruptures that occurred within 2 weeks of the primary repair. The re-ruptures were attributed to forceful muscle contraction; 2 were associated with proximal muscle migration. Grewal et al[7] reported on 4 re-ruptures that occurred in the early postoperative period as a result of noncompliance or reinjury. Other re-ruptures were case reports or were mentioned in articles addressing surgical technique.[15,21–23]

The purpose of this study was to evaluate the presentation of patients who re-ruptured a primary distal biceps repair and outcomes in patients who underwent revision surgery. We hypothesized that re-ruptures can be reattached with satisfactory results.

MATERIALS AND METHODS

This was a retrospective review of distal biceps tendon repairs identified from the case log of the senior author. The medical record for each identified patient was reviewed for demographic information, details regarding the primary and secondary injuries and repairs, time between reinjury and revision reattachment, operative findings, and whether the patient returned to work. Clinical outcomes were assessed using postoperative Disabilities of the Arm, Shoulder, and Hand (DASH) and American Shoulder and Elbow Surgeons–Elbow (ASES-E) functional outcome scoring systems. The range of motion (ROM) and strength of the affected elbow was compared with the contralateral arm.

Preoperative magnetic resonance imaging (MRI) scans were performed in the axial, coronal, and sagittal planes. The flexed abducted and supinated view was not performed. Magnetic resonance imaging scans were not obtained in 3 patients.

All re-ruptures were reattached using a modified anterior transosseous approach through an extensile incision distal to the antecubital fossa.[24] In one instance, the tendon was retrieved through a second incision made proximal to the antecubital fossa. The distal biceps tendon was identified and freed from the surrounding tissue. Previous suture material was removed and the distal end of the tendon was transected. A number 2 FiberWire (Arthrex, Naples, Florida) Krackow suture was secured to the distal biceps tendon. The radial tuberosity was removed with an osteotome and an oval trough was made in the anterior radial cortex. With the forearm in maximum supination, 2 small drill holes were made through the posterior cortex, taking care to avoid the posterior interosseous nerve. Keith needles were used to pass one of the free ends of the Krackow suture through each drill hole. The Keith needles were retrieved posteriorly through a small separate incision. The epimysium between the Keith needles was incised and the suture was tied with the forearm in maximum supination. No attempt was made to dissect down to the underlying bone. Intraoperative elbow flexion up to 90° was accepted.

Postoperative treatment for primary and revision distal biceps tendon repairs was the same. The arm was immobilized in a long-arm cast in 90° elbow flexion and maximum supination for 4 weeks. Active ROM was begun after 4 weeks in an unlocked elbow brace. Strengthening was begun at 8 weeks with 5 to 10 lb. After 3 months, patients were allowed to use the arm freely.

Demographic data, mechanism of injury, time between injury and diagnosis, original surgical technique, operative findings, and outcomes were recorded. Of the 10 patients, 5 returned at an average of 5.4 years after surgery (range 23 months to 9 years) for a follow-up evaluation that included a physical examination and administration of the DASH and ASES-E surveys.

Pronation and supination strength was measured with a pronosupination dynamometer (Baseline Hydraulic Wrist Dynamometer, American 3B Scientific, Tucker, GA). The average of 3 readings in each extremity was recorded. Range of motion was measured with a goniometer.

RESULTS

We obtained institutional review board approval for this study.

Ten cases of distal biceps tendon re-rupture were treated between 1988 and 2016. The senior surgeon had previously treated 6 employing an anterior approach, removal of the radial tuberosity, creation of a hole in the anterior cortex, and securing the sutures on the posterior aspect of the proximal radius.[24] Four cases were initially managed elsewhere with varying techniques (Table 1). The six cases initially reattached by the senior surgeon represent a failure incidence of 1.1% of the 561 distal biceps tendon repairs performed between 1988 and 2016.

All patients were male. At the time of revision surgery, average age was 46 years (range, 35−57 years). No patients admitted to using steroid supplements or appeared to have done so. Four re-ruptures occurred in the dominant arm and 6 were in the nondominant arm. Three of the 10 had a previously repaired distal biceps tendon rupture in the contralateral arm (patients 1, 3, and 7).

Four patients (patients 1, 6, 8, and 9) developed pain after the initial reattachment. The pain was not relieved with anti-inflammatory medications, peritendinous injections, therapy, and/or immobilization. In these patients, average time between the initial surgery and revision surgery was approximately 1 year (range, 4−24 months). One (patient 9) had obvious loss of fixation of a cortical button that had been previously placed at another institution, as seen on a postoperative radiograph (Table 1).

The remaining 6 patients were pain-free until they experienced a specific postoperative traumatic event that caused the re-attached biceps to contract against resistance. This event caused sudden antecubital pain. In 3 of the 6 patients, the trauma occurred anywhere from 6 days to 6 weeks after the initial surgery. Only 3 of the 6 patients experienced a sense of ripping or tearing in the antecubital fossa (Table 1).

An allograft was used in 2 of the 10 patients. The allograft was employed to gain length because the distal stump of the ruptured biceps tendon would not reach the bicipital tuberosity even with the elbow flexed 90°. One of the 8 patients (patient 7) who was not revised with an allograft re-ruptured after slipping on ice. An allograft was used at the second revision and the patient eventually returned to work without restrictions. The postoperative DASH and ASES-E scores were 19 and 74, respectively.

Another patient may have re-ruptured the first revision reattachment 7 years later while pulling shrubs out of the ground. He felt a snap and experienced pain with flexion and supination. The tendon was still palpable in the antecubital fossa. The hook test was normal. A repeat magnetic resonance scan showed that the tendon was not attached to the tuberosity, suggesting a re-rupture. He had excellent postoperative DASH and ASES-E scores and elected not to proceed with further revision surgery.

Only 3 patients had an abnormal hook test.[25] The remaining 7 patients had a palpable tendon in the antecubital fossa.

Upon exploration, 4 patients had loss of suture or allograft purchase in the distal biceps tendon (Fig. 1), 3 had suture failure (Fig. 2), and 2 had a technical failure (Fig. 3). In 1 patient, the mechanism of failure could not be determined. The tendon was lax and appeared to be attached to the radial tuberosity by a pseudotendon.

Revision surgery may be associated with complications. Scarring from the previous surgery can make the dissection more difficult. Transient irritation of the lateral antebrachial cutaneous nerve frequently occurred. Heterotopic ossification and injury to the posterior interosseous nerve were not experienced in this series.

Nine of the 10 patients returned to their former jobs.

All 10 patients were contacted by telephone. Only 5 patients agreed to return for a follow-up evaluation; average age of those patients was 43.8 years (range, 36−53 years). They were evaluated an average of 5.4 years after the most recent surgery (range, 23 months to 9 years). Three of the 5 patients described no pain after the revision surgery. One patient (patient 2) reported no pain after the revision surgery, but 7 years later developed pain with resisted biceps flexion and supination when he probably sustained a partial re-rupture. One patient (patient 7) re-ruptured the first revision and had mild persistent pain after the second revision surgery. He was eventually able to return to work without restrictions. The pain was 0 out of 10 on a visual analog scale at rest and 1 to 2 out of 10 with activity.

Postoperative elbow flexion, extension, pronation, and supination in both the operated and unoperated arms are shown in Table 2.

DISCUSSION

The diagnosis of re-rupture can be subtle. Although all 10 patients experienced recurrent or persistent pain after the primary repair, only 3 described a ripping or tearing sensation after a specific traumatic postoperative event. Hinchey et al[20] suggested that re-ruptures occur within 3 weeks of the primary repair, but this was not our experience. Only 2 of the patients in this report re-ruptured within 3 weeks after the primary reattachment. One re-ruptured at 5 to 6 weeks, one at 6 months, and 2 closer to 1 year after the primary repair. Most troubling were the 4 patients who had no specific postoperative traumatic event but

TABLE 1. Summary of Patient Data

Patient	Age	R/L	Dominant Arm?	History of Bilateral Ruptures?	Partial or Complete	Time from Injury to First Surgery	1° Fixation	When Re-rupture Possibly Occurred	Mechanism of Possible Re-rupture
1	55	R	No	Yes	Complete	5–6 wk	2 anchors	Unknown	No specific incident. Persistent postoperative pain
2	49	L	No	No	Partial	3 wk	Modified anterior approach with bone tunnel	6 d	Caught falling object. Felt tear. Increased pain in antecubital fossa
3	46	L	No	Yes	Complete	4 d	Modified anterior approach with bone tunnel	3 wk	Lifted suitcase, felt ripping sound. Pain in antecubital fossa
4	35	R	Yes	No	Complete repaired with allograft	3 wk	Modified anterior approach with bone tunnel	6 mo	Repeatedly using a shake weight. Felt pain in antecubital fossa
5	49	R	Yes	No	Complete	23 d	Modified anterior approach with bone tunnel	5–6 wk	Tripped over puppy, grabbed railing. Felt tear. Pain in antecubital fossa
6	44	L	No	No	Complete	3–4 wk	Sutured to bone using Boyd Anderson approach	Unknown	No specific incident. Persistent postoperative pain
7	38	L	Yes	Yes	Partial	1 mo	Modified anterior approach with bone tunnel	11 mo	Slipped on ice. Persistent pain in antecubital fossa
8	41	L	No	No	Complete	3 wk	Tenodesis screw	Unknown	No specific incident. Persistent postoperative pain
9	57	L	No	No	Complete	22 d	Cortical button	Unknown	No specific incident. Gradual increase in postoperative pain
10	48	R	Yes	No	Partial	5 d	Modified anterior approach with bone tunnel	10 mo	Moving 500-lb machine. Felt pain in antecubital fossa

TABLE 1. Summary of Patient Data (Continued)

Physical Findings	MRI Reading	Time From Possible Re-rupture to Revision Surgery	Mode of Failure	Allograft Used at First Revision?	Result
Tendon thickened. Muscle migrated proximally. Puckering of skin proximal to antecubital fossa suggesting dermis adherent to underlying tendon or scar tissue. Positive hook test	Tendinopathy No evidence of tear or retraction	24 mo from first to second surgery	Grasping suture tore through tendon	No	Pain relieved. Returned to work full time with no limitations or problems
Tendon intact. Tender over tendon	MRI not done	4 d	Grasping suture tore through tendon	No	Pain relieved. Returned to all activities without limitation. 7 y later, pulling shrub, felt snap. Felt as if he re-tore biceps. Now has pain with resisted flexion and supination. MRI scan suggests tendon not attached to tuberosity. Not revised
Small ecchymosis. Tendon intact, some proximal migration of muscle	Tendon separated from tuberosity by 3 cm	2–3 wk	Grasping suture tore through tendon	Yes: semitendinosis	Returned to work full time with no limitations or problems
Tendon not palpable. Positive hook test. Biceps muscle retracted	MRI not done	1 y	Previous semitendinosis allograft tore through musculotendinous junction	Yes: another semitendinosis	Pain relieved. Returned to work full time with no limitations or problems
Tendon palpable. Pain over tendon at insertion	Tendon avulsed from tuberosity	1 mo	Suture torn at entrance to bone tunnel.	No	Pain relieved. Returned to work full time with no limitations or problems
Tendon intact. Tender over tendon. Some proximal migration of muscle	Edema about tendon. Tendon not attached to tuberosity	9 mo from first to second surgery	Suture torn at entrance to bone tunnel.	No	Pain relieved. Slight decrease in supination. Laid off from work.
Tendon intact. Pain with resisted biceps flexion and supination	Postoperative changes. Tendon not clearly seen	9 mo	Suture torn at entrance to bone tunnel.	No	Persistent pain after revision. Workup negative for infection. Second revision showed tendon scarred to brachialis. Tendon not attached to tuberosity. Allograft used at second revision. Pain relieved. Eventually returned to work without restrictions
Tendon intact. Tender over tendon. Pain with resisted supination	No fluid. Attachment not clearly seen	10 mo from first to second surgery	Tenodesis screw still in radius but sutures had pulled out. Sutures no longer held between bone and tenodesis screw	No	Returned to work full time with no limitations or problems
Tendon not palpable. Positive hook test. Biceps muscle retracted	MRI not done X-ray showed cortical button had been inserted in tuberosity and had pulled out	4 mo from first to second surgery	Drill hole made in weaker radial tuberosity and not stronger cortical bone. Cortical button pulled out. Lost fixation	No	Pain relieved. Returned to work full time. Reported decreased strength
Tendon intact. Tender over tendon. Pain with resisted supination	Tendon thickened but not retracted	3 mo	Unknown mechanism. Tendon was lax and appeared to be attached to tuberosity by pseudotendon	No	Pain relieved. Returned to work full time with no limitations or problems

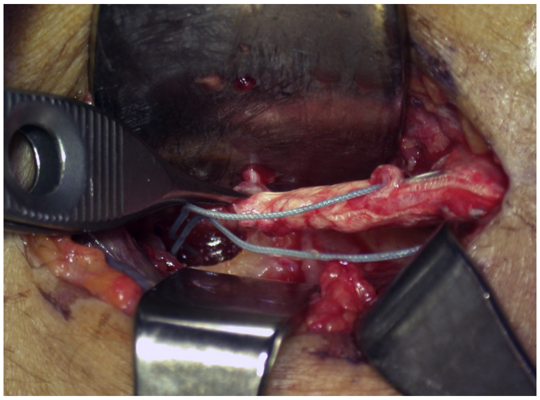

FIGURE 1: A 49-year-old man (patient 5) whose distal biceps rupture was reattached with a modified anterior approach through a bone tunnel and tied posteriorly. At 5 to 6 weeks after the primary reattachment, he tripped, grabbed a stair railing, and felt a tearing sensation associated with pain. The tendon was intact but painful to palpation and with resisted biceps function. The grasping suture is still secured to the radius but no longer secured to the distal portion of the biceps tendon. The suture is still attached to the proximal portion of the biceps tendon.

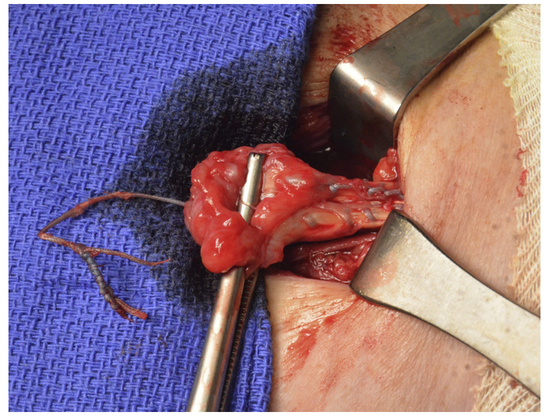

FIGURE 2: A 49-year-old man (patient 2) whose distal biceps rupture was reattached with a modified anterior approach into a bone tunnel and tied posteriorly. At 6 days after the primary reattachment, he caught a falling object and felt increased pain in the antecubital fossa. The tendon was intact but painful to palpation and with resisted biceps function. The grasping suture is still attached to the distal biceps tendon but was torn at the entrance to the bone tunnel. The tendon with the suture still attached pulled out of the bone tunnel. Note how the suture knot is still in place on one limb of the suture.

described having persistent pain after the primary reattachment. One (patient 9) can be explained by improper placement of the drill hole, which caused the cortical button to work its way out of the bone.[23] The other 3 (patients 1, 6, and 8) all had tenderness over the reattached distal biceps tendon, and 2 had a suggestion of proximal migration of the biceps muscle compared with the opposite arm.

Magnetic resonance imaging scans in the axial, coronal, and sagittal planes were not useful in diagnosing a re-rupture. The scans were obtained in 7 of 10 patients and showed postoperative radiographic heterogeneity that was difficult to distinguish from postoperative scarring. The one MRI scan that clearly showed proximal migration of the ruptured tendon occurred in a patient (patient 3) who heard and felt a ripping sound when lifting a suitcase. That patient was clinically thought to have a re-rupture and underwent revision surgery within 3 weeks. In 2 MRI scans, the tendon was not clearly attached to the tuberosity but had not retracted. In those 2 patients, the grasping suture was torn at the bone tunnel (patients 5 and 6). The other 4 MRI scans demonstrated nonspecific findings.

The difficulty in using MRI to evaluate the distal biceps tendon after reattachment is well-documented. The reattached tendon rarely assumes the morphology of the native tendon, which makes accurate interpretation of the postoperative MRI scan challenging. Hechtman et al[26] determined that for the first year after reattachment, MRI demonstrated heterogeneity and signaling characteristics that lagged behind the clinical examination. Schmidt et al[27] noted that radiographic abnormalities may persist for 6 years after the biceps tendon is reattached. This persistent heterogeneity makes it difficult to diagnose a re-rupture of the distal biceps tendon confidently with an MRI scan.

The hook test is thought to diagnose distal biceps tendon ruptures accurately.[25] In this particular series, the hook test was unhelpful in diagnosing a re-rupture. Only 3 of the 10 patients had an abnormal hook test with no palpable tendon in the antecubital fossa. The remaining 7 patients had a palpable tendon that was tethered distally. Six of these 7 patients had pain in the antecubital fossa that was typically exacerbated with resisted biceps motion.

This series documents 3 potential reasons for re-rupture after what was thought to be a successful primary reattachment: loss of suture or allograft purchase in the distal biceps tendon, suture failure, and technical failure. Loss of purchase may result from poor suture technique or an inherently weak tendon. If the issue is the integrity of the distal biceps tendon, an allograft should be considered to supplement the construct. Suture failure occurred at the entrance to the bone tunnel and probably occurred as

FIGURE 3: A 57-year-old man (patient 9) whose distal biceps rupture was reattached with a cortical button. The drill hole was placed peripherally through the radial tuberosity and not centrally through strong cortical bone. For 3 weeks, there was a gradual increase in postoperative pain with no specific traumatic event. The cortical button has pulled out of the bone and is now resting in the anterior soft tissues.

a result of mechanical abrasion between the edge of the bone tunnel and the suture material. This can be addressed by ensuring the tendon has been delivered into the intramedullary cavity, so the distal limbs of the suture are not rubbing against the edges of the bone tunnel. Technical failure can be corrected by adhering to proper technique. In at least 6 instances, patient activity (patients 2–5, 7, and 10) probably contributed to the failure. Postoperative patient noncompliance or inadvertent forceful biceps contraction was noted by others[16,18,20,21,23] to cause re-rupture of the distal biceps tendon.

It is difficult to measure the success of a revision distal biceps repair. At the time of their last office visit, 9 of 10 patients had returned to work. Nine returned to their former job without modification; 1 patient was laid off and did not return to work. Patients who did return for evaluation were satisfied with the procedure and had postrevision elbow ROM that was generally comparable to that of the opposite arm. Supination strength averaged just over 87% of the contralateral uninjured elbow whereas pronation strength averaged nearly 80% of the contralateral uninjured elbow.

It is common for patients to believe they have torn a primary repair. Unless the tendon is clearly absent, this study has shown that an MRI scan or hook test is not particularly helpful in diagnosing re-rupture of a previously repaired distal biceps tendon. Persistent pain with resisted distal biceps function is worrisome and suggests a re-rupture. If the painful tendon is still tethered, revision surgery is not urgent. Our experience has shown that if the re-ruptured tendon is tethered and not retracted, it can be reattached with satisfactory results up to 2 years after the event.

The 1.1% rate of re-rupture identified in this series is a minimum estimate. Other authors[7,15,20,22] reported an incidence of 1% to 6%. The number could be higher because patients with a re-rupture may not have been bothered by recurrent symptoms or might have sought treatment elsewhere. It is also possible that patients who initially presented with a history and examination that suggested a re-rupture eventually became asymptomatic and did not seek additional treatment.

Limitations of this retrospective study were its small size, dependence on subjective symptoms, and incomplete follow-up. Although all 10 patients were contacted by telephone, only 5 agreed to return for a physical examination and completion of the DASH and ASES-E. Consequently, we do not know whether the 5 who were not examined actually did as well as they reported or whether their objective measurements were comparable to those of the 5 who returned for an examination. Typical of a retrospective study is the lack of preoperative DASH and ASES-E scores. Consequently, the recorded DASH and ASES-E scores may not accurately reflect the improvement afforded by the revision surgery. This was underscored by the different scores from the 2 patients who re-ruptured their primary revision. One (patient 7) was involved in a workers' compensation case and took a long time to return to work. His DASH and ASES-E scores were the worst of the 5 who returned for reevaluation. The second (patient 2) did not occur at work; he probably re-ruptured the first revision and elected not to proceed with a second revision. He had excellent DASH and ASES-E scores. This raises the questions of secondary gain, whether a second revision is necessary, and what functional purpose the revision surgery would achieve.

The 2 patients repaired with an allograft may also have affected the clinical results; the patients were included because they underscored the clinical presentation. In this series, most patients could undergo reattachment without the use of a tendon allograft.

Of the 10 patients, 3 had a history of bilateral distal biceps tendon ruptures. Previous studies[28] noted that a prior distal biceps rupture tended to predispose the patient to a contralateral distal biceps tendon rupture. If the incidence of distal biceps ruptures is estimated to be 1.2 to 2.55 per 100,000, it is unusual that this

TABLE 2. Postoperative Elbow Flexion, Extension, Pronation, and Supination in Both Operated and Unoperated Arms*

Patient	Elbow Extension/ Flexion After Revision	Unoperated Elbow Extension/ Flexion	Pronation/ Supination After Revision	Unoperated Elbow Pronation/ Supination	Measured Pronation Strength Nonoperative Elbow, lb	Measured Pronation Strength After Revision, lb	Predicted Pronation Strength After Revision Based on 15% of Nonoperative Elbow, lb	Measured Supination Strength Nonoperative Elbow, lb	Measured Supination Strength After Revision, lb	Predicted Supination Strength After Revision Based on 15% of Nonoperative Elbow, lb	Percent Pronation Strength Revised/ Nonoperative	Percentage Pronation Strength Revised/ Nonoperative Using Predicted Pronation Strength	Percent Supination Strength Revised/ Nonoperative	Percent Supination Strength Revised/ Nonoperative Using Predicted Supination Strength	DASH	ASES
1	−15°/140°	−15°/145°	70°/80°	70°/80°	200	220		210	222		110	(110)	106	(106)	0	100
2	−5°/145°	−10°/140°	70°/80°	70°/80°	193	195	160	210	178	166	101	83	85	79	2	100
3	−10°/140°	−10°/140°	70°/80°	70°/80°	190	130	138	152	153	128	68	73	101	84	1	100
7	−30°/145°	−50°/140°	70°/80°	70°/80°	115	57		232	203		50	(50)	88	(88)	19	74
8	0°/135°	−5°/130°	70°/80°	65°/75°	162	150	130	210	205	173	93	80	98	82	0	92
											Average = 84.4%	Average = 79.2%	Average = 95.6%	Average = 87.8%	Average = 4.4	Average = 93.2

*Average flexion was 141° (range 135° to 145°). Average extension was −12° (range, 0° to −30°). All patients had full rotation. Supination strength averaged 95% (range, 84.7% to 105.7%) of the contralateral uninjured elbow. Pronation strength averaged 84% (range, 49.6% to 110%) of the contralateral uninjured elbow. Patients 1 and 7 were left-handed and injured the right arm. Patients 2, 3, and 8 were right-handed and injured the left arm. In right-handed individuals, the dominant limb is assumed to be 15% stronger than the nondominant left arm. This is not thought to be the case in left-handed individuals.[29] Predicted pronation and supination strength was calculated for 2, 3, and 8. The strength comparison between the revised limb and the nonoperative limb used the predicted strength in the right-handed patients who injured the nondominant left arm. No such correction was made for the left-handed patient who injured the nondominant right arm. Unoperated indicates that the opposite arm was uninjured and therefore had no surgical procedure.

was observed in 3 of 10 patients in this study.[1,2] The high rate of bilateral distal biceps tendon ruptures in patients who experience a re-rupture suggests there may be a systemic etiology contributing to the development of the re-rupture.

It can be difficult to diagnose patients who present with a re-rupture caused by loss of fixation after reattachment of a distal biceps tendon, but symptomatic re-ruptures generally do well with revision surgery.

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