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Outcomes of distal biceps tendon repair using a dual incision, cortical button technique: a single surgeon study

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Background: The purpose of this study was to evaluate patient-reported outcomes, function, complication rates, and radiographs in a series of patients with distal biceps tendon repair using the dual incision cortical button technique by a single surgeon. By having a single surgeon perform the surgery, the technique is standardized to all patients. Twenty-two patients consented to participate in the study. The average time from surgery to review was 2.2 years. Patient satisfaction was assessed using the DASH, Oxford, and Mayo Elbow Performance Scores.

Methods: Range of movement was assessed and compared to the unaffected limb using a goniometer. Isometric flexion and supination strength was tested using a standardized dynamometer—both measurements taken by a single physiotherapist. Radiographs were discussed at the time of the review by 2 orthopedic surgeons to check for heterotopic ossification.

Results: The mean DASH score was 6.3 postsurgery at the time of follow-up. There was no significant difference in active range of movement between the repaired and nonrepaired arm in flexion, extension, supination, or pronation. Four radiographs showed evidence of heterotopic ossification (HTO)—none showed synostosis. For patients with HTO, there was evidence that supination was inhibited compared to those patients who did not have HTO.

Conclusion: Our study found that at an average of 2 years of follow-up these patients had good outcomes clinically with no major complications. HTO was present in only 4 patients, and there was a significant difference in supination compared to those who did not have HTO. These patients had an average DASH of 14 compared to a score of 4.5 in those who did not have an HTO. The study showed that the dual incision cortical button repair remains a procedure with excellent patient outcomes at the risk of HTO.

The vast majority of patients with distal biceps tendon rupture are middle aged men with a reported incidence of 1.2/100,000 patients.[2,19]

This can cause a significant reduction in supination and flexion strength of the affected arm.[10] Operative intervention is therefore undertaken unless patients are willing to accept some loss in endurance and strength.[22]

Injury to the tendon has been shown to significantly reduce supination strength by up to 60% in the neutral forearm, thus making it a potentially hindering injury in a relatively active subgroup.[20] Schmidt et al discuss how this potential loss may make it difficult to perform day-to-day tasks such as turning a car key or swinging a golf club. This is one of the reasons for our study to evaluate functional outcomes using Patient-Reported Outcome Measures.

Clinical diagnosis is easy with the help of the "Hook" test as described by O'Driscoll with sensitivity and specificity nearing 100 [EO1] %. Ultrasound and magnetic resonance imaging modalities are also used as an aid to diagnosis with good sensitivity and specificity.[9,16,17]

Surgical repair of the distal biceps tendon remains a key intervention for managing these patients in order to improve strength and ultimately function. The single incision technique described historically was associated with a high incidence of posterior

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interosseous nerve (PIN) injuries. Boyd and Anderson then proposed a solution to this by limiting the anterior dissection required by creating a second posterolateral incision to avoid the PIN. Other nerve injuries such as injury to the lateral antebrachial cutaneous nerve can also occur. Studies, however, show that the dual incision technique is not without its shortcomings, with complications such as heterotopic ossification (HTO) and synostosis. [1,3,10,15]

Distal biceps tendon repair uses suture anchors, interference screws, or the EndoButton.[10,18,21] In their systematic review, Watson et al concluded there was no real statistical difference between rate of complications between the single and dual incision techniques. However, they did show that the bone tunnel and cortical button technique had the lowest incidence of complications.[23]

In this paper, we aim to discuss the role dual incision technique plays in distal biceps tendon repair almost 70 years following its introduction. At our institution, all our distal biceps tendon ruptures were repaired with a dual incision technique and endobutton. Our hypothesis was that despite the higher incidence of synostosis and HTO associated with this technique our patients had no compromise in function, as shown through DASH and other functional scores.

Materials and methods

Study design

The retrospective cohort study was conducted at a district general hospital over multiple clinics. Permission for this study was obtained via the research department of the hospital. Patients were given informed consent forms to sign before participation in the study.

All patients in this study were adults who had a complete distal biceps tendon repair performed by a single surgeon at 1 hospital using the same dual incision technique. Patients were identified using the logbook of the surgeon and contacted via telephone and text message. Those who refused or did not respond were excluded from the study.

Radiographs were taken using a standardized method. Radiographs were taken of the forearm from the wrist to the elbow joint. These were then looked at by 2 orthopedic surgeons to determine whether there was any synostosis or HTO.

Patient satisfaction was assessed using the Disabilities of the Arm, Shoulder and Hand (DASH) score, Oxford Elbow Score (OES), and Mayo Elbow Performance Score (MEPS).

Functional outcomes were assessed in terms of strength and range of motion, compared to the contralateral unaffected arm.

Range of motion was tested using a standardized goniometer. Flexion and extension were measured in supination. Supination and pronation were measured from neutral.

Isometric strength was tested using the MicroFET2 dynamometer (Hoggan Scientific, LLC). As per the manufacturer's guidelines, flexion strength was tested in supine with elbow flexed to 90° and supination strength was tested against a 20 cm dowel with the forearm in neutral and flexed to 90° (Fig. 4). Further measurements, which included elbow flexion strength tested at 45° and supination strength tested from end-range pronation, were also taken to form a more comprehensive review (Fig. 3). The unit of measurement measured by the dynamometer was kilogram-force (kg-f).

All range of motion and strength testing was carried out in a standardized clinic environment and performed by a single physiotherapist. The shoulders were blocked and feet were placed against a wall during all strength tests to prevent compensation from other muscle groups. The elbow was also blocked for supination testing.

Patients performed a practice test at submaximal effort in all test positions bilaterally to ensure they had full understanding of the procedure. Testing consisted of 3 maximal effort contractions for each test position. The average (mean) of the 3 measurements taken was then used for all further analysis. Verbal encouragement was given to achieve maximal effort over a 5-second contraction.

Surgical technique

A dual incision technique was used for the patients. Each patient was positioned supine with an armboard and underwent a general anesthetic. A 3-cm transverse incision was made at or just proximal to the antecubital crease. The distal biceps tendon stump was located, mobilized, and maneuvered out of the incision. The stump was fashioned and an Arthrex #2 fiberwire was used as the suture of choice to perform a locking whipstitch. A dorsal incision, centered over the radial tuberosity, was then made. Pronation with flexion of the elbow was used to prevent injury to the PIN when passing through to the radial aspect. A Trethowan bone lever was placed under the radius but only a Langenbeck retractor was used when retracting the superior aspect of the radial tuberosity. The tuberosity was drilled and burred to smoothen the receptacle for the endobutton and washed with saline. The tendon, with whip stitch, was then pulled through from the volar to dorsal aspect of the forearm to the tuberosity and fixed using an endobutton. The button used was placed extracortical at the site of the radial tuberosity and the tendon positioned intracortical.

Postoperative rehabilitation

Postoperatively the patients were placed into a polysling. At 2 weeks, a wound review was performed and the elbow was placed into a hinged brace locked at 60° of extension and free flexion for a further 4 weeks. At 6 weeks, the brace was then extended in small increments weekly to full extension at 12 weeks and a strengthening regime then implemented.

Statistical analysis

Statistical analysis was carried out using paired sample T tests for movement and strength to see the difference in range of movement and strength between the repaired and unrepaired arms. An independent sample T test was performed to see whether there was any significant difference in pronation and supination between repaired and unrepaired arms in those who had HTO.

Results

Forty-one patients were identified from the logbook over a period from July 2015 to March 2019. We had 22 respondents (Table I).

Mean time to surgery was 40.7 days, and mean time to our follow-up clinic was 803.1 days. The mean age at surgery was 45.5 years with a standard deviation (SD) of 9.9 years. Twenty patients had the injury in their dominant arm and 2 had the injury in the nondominant arm.

Radiograph review showed no patients with synostosis. Four patients had some degree of HTO (Figs 1 and 2). The classification system described by Hastings and Graham[11] separates HTO into classes I, II, and III. Class I is radiographic HTO without functional limitation and class II is radiographic HTO with functional limitation. Patients in class III have functional and radiographic ankylosis. Our 4 patients fell into class IIB, ie, radiographic HTO with functional limitation in supination.

Figure 1 Lateral radiograph showing heterotopic ossification.

Figure 2 AP radiograph showing heterotopic ossification.

There was no significant difference in active range of movement between the repaired and nonrepaired arm in flexion, extension, supination. or pronation (Table II).

Interestingly, there was a significant difference in strength at 90° of flexion ($P = .04$), and 0° of flexion ($P = .006$). There was no significant difference in strength when the arm was at 45°. There was a significant difference in supination range of movement from end-range pronation ($P = .03$).

In those patients with HTO, there was a significant difference in supination range of movement ($P = .03$). The mean difference in supination from end-range pronation was 22.2 degrees between the repaired arm.

The mean DASH score was 6.2, mean MEPS was 93.1, and OES was 43.6.

Our study found 4 patients with HTO of mild degrees. These patients had marginally worse DASH scores comparatively, with an average mean DASH of 14 compared to 4.5 in those who had no HTO. MEPS were 92.5 compared to 93.3 and OES was 41 compared to 44.

Figure 3 Physiotherapist testing supination.

Figure 4 Physiotherapist testing flexion strengths.

The areas in which DASH score fared worst were the ability to turn a key and change a light bulb.

Discussion

Most biceps tendon ruptures in our study were due to heavy lifting and sports. All occurred in males; the vast majority of whom were middle aged. The mean age in our patient group was 45.5 years with the age range being 32-70 years old. This confirms what is already known in literature regarding the incidence of this injury in the population.[1,19]

Table I
Data characteristics.

Parameter	Value
Time to surgery (days)	40.7 ± 45.7
Time to follow-up (days)	803.1 ± 433.3
Age at surgery (yr)	45.5 ± 9.9
Dominant arm (right:left)	20:02
Smoker (yes:no)	6:16
Side of Injury (right:left)	10:12
XR review (No HTO:HTO)	18:04
Diagnosis	
Clinical	8
MRI	11
USS	3
Mechanism of injury	
Heavy lifting	14
Sports	3
Other	2

Table II
Strength testing.

	Repaired arm (kg-f)	Unrepaired arm (kg-f)
Flexion at 90°	30.0 ± 7.4	34.0 ± 8.4
Flexion at 45°	26.8 ± 6.7	28.2 ± 8.3
Supination at 0°	2.4 ± 0.7	3.3 ± 1.0
Supination from end-range pronation	4.6 ± 1.1	5.3 ± 1.5

Table III
Analysis on the effect of HTO on movement and independent sample T test.

	Mean difference	95% confidence interval of the difference		*P* value
		Lower	Upper	
Flexion repaired	−0.2	−8.0	7.6	.959
Extension repaired	−2.9	−7.8	2.1	.235
Supination repaired	22.2	8.6	35.9	.003
Pronation repaired	9.1	−0.5	18.8	.061

Patient-reported outcome measures were excellent. Van der Vis et al[22] described most patients having a perfect QuickDASH score in 53% of patients that they studied, and a perfect Mayo Elbow Performance Score in 83% of subjects. Our results are similar with MEPS scores ranking in the highest quartile for all patients (85-100) range with 12/22 having perfect scores. While in their study the QuickDASH was used, we had a further breakdown of DASH scores for work and sports. DASH[12] scores for work (mean of 11) fared better than sports (with a mean of 24).

None of our patients developed radial nerve palsies. Three patients complained of numbness around the antecubital skin incision and in the distribution of the lateral antebrachial cutaneous nerve. Grewal et al noted similar findings in their study comparing single vs double incision technique in which the incidence of neuropraxias was much higher in the single incision group than that in the double incision cohort.[10]

Similar findings in other studies have shown the risk of PIN palsy and LACBN palsy in single incision anterior approach techniques.[6] Boyd and Anderson described a double incision approach first in 1961 to minimize the risk of nerve palsies.[3]

A double incision approach is of course, not without risks. HTO has been the most significant and widely documented complication arising from the dual incision approach.[5,6,8,15]

DASH scores were excellent in this study. At an average of 6.2 these were among the lowest of other studies measuring such outcomes.[15] Huynh et al reported an average of 7.9 and compared this to the normative values for the general population in the United States which was an average of 10.1.[13,14]

Our patients had only slightly worse patient-reported outcome scores but significantly different range of movement of supination. The mean difference in supination was 22 degrees. Independent T test showed a significant difference in supination ($P = .003$).

We had no re-ruptures in our cohort. Dunphy et al and Huynh et al noted re-rupture rates of 1.9% and 5%, respectively, both using a cortical button technique.[7,14]

Cain et al studied 148 patients and found a complication rate of 36% with 26% LACBN palsies.[4] Our study showed a 13% LACBN palsy rate.

Strengths of the study are that this is a single surgeon study using exactly the same technique.

All measurements have been carried out by the same physiotherapist in a standardized clinic environment.

Limitations in this study are the relatively small sized cohort and sample size. Strength of the repaired arm was compared with the unrepaired side to compare strength—this invariably means that there will be an effect of hand dominancy. Wittstein et al did show the dominant and nondominant extremities demonstrate similar peak torque and endurance, and hence, the contralateral limb can be used as a matched control in strength and endurance measurement.[24] Another limitation was the time to our follow-up clinic; this varied due to patients being selected as far back as 2015. This was a retrospective study. Each patient's rehab and compliance therefore is different.

Our results demonstrate loss of supination range of motion in those with HTO (Table III). However, they show very little effect on patient quality of life and patient-related outcomes and satisfaction.

Future studies should aim to be prospective in nature using a larger population group so that an adequate sample size can be obtained.

Conclusion

Dual incision biceps tendon repair has a higher rate of synostosis and HTO according to literature, however a lower rate of PIN palsy. Our study confirmed previous literature showing no nerve palsies and 4 patients with varying degrees of HTO. Encouragingly this had little effect on patient-reported outcomes and excellent Mayo and DASH scores. Our study demonstrated a low rate of complications even when including lateral antebrachial cutaneous nerve paraesthesias. Active flexion and extension remained unchanged whereas there was some evidence that supination was limited.

Considering the results of this study, we continue dual incision repairs using the cortical button technique at our institution.

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