



Research Article

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Functional Evaluation After Cortical Button Fixation for Distal Biceps Ruptures - Does Time to Surgery Matter?

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Abstract

Background: Rupture of the distal biceps tendon is a rare injury, more common in middle-aged men and usually involving the dominant arm. Many studies show loss of supination and flexion strength without reparative surgery. Several techniques and approaches have been described as well as their related complications.

Methods: To compare results between patients who suffered a distal biceps tendon rupture, operated before and after 30 days since injury, using a single-incision technique with a cortical button fixation coupled with an interference screw. We present the results of 58 cases, with a minimum follow-up of 3 months.

Results: The mean VAS pain was 14.04 (0.00 - 10.00) and the mean overall satisfaction score was 4.62 (1 - 5). Mean QuickDASH and the Mayo Elbow Performance (MEPS) scores were 5.16 (0 - 65.90) and 94.46 (45 - 100), respectively. When comparing patients who underwent surgery ≤ 30 days since the injury (39) with those whose surgery was performed > 30 days (17), we found a statistically significant difference regarding QuickDash and MEPS, with better outcomes in the former group (p=0.031 and p=0.024, respectively). The overall complication rate was 62%: 13 patients had heterotopic ossification and 23 patients reported transient neuropraxia of the lateral antebrachial cutaneous nerve without repercussion over the clinical results. The elapsed time since injury to surgery was not significantly correlated to complication occurrence.

Conclusion: According to clinical evaluation and postoperative scores, the performed surgical procedure provides good to excellent mid-term functional results nevertheless a non-significant complication rate. A superior result was found when surgery has been performed in the first 30 days.

Keywords: Distal Biceps, Cortical Button Fixation, Time to Surgery, Distal Biceps Injury, Functional Outcome, Surgery

Introduction

Distal biceps tendon rupture is a rare injury with an estimated incidence of 1.2-2.55/ 100000 per year, representing 3% of all bicep's injuries [1-10]. It is more common in middle-aged men and usually involves the dominant arm [1,4,5,8,9,11-15]. It is often related to sports practice or heavy work, but it can also affect older and less active people in their daily life [4]. Tobacco [2,4-8,12,14,16], anabolic steroids use [2,4,6-8, 12,] and statin drugs [5,8,12] are known to be associated with an increased risk for distal biceps tendon ruptures.

Distal biceps rupture occurs when the biceps muscle contracts against unexpected resistance or during heavy-lifting with the elbow flexed at 90 degrees [2,3-9,12-14,16-18]. Most commonly, distal biceps tendon avulses from the radial tuberosity, although ruptures within tendon substance or at the myotendinous junction may also occur [1,3,15,18]. The superiority of the surgical treatment compared to a non-operative approach has been established in the literature, concerning functional outcome, evaluation scores and the ability to resume work. Several studies show a loss of up to 40% in supination and 30% in flexion strength with conservative treatment [2,4,5,7-10,14-17,19-22]. In this study, we use a technique that allows full return to work and sports-practice with no limitations and low rate of permanent complications. It consists of a single incision and fixation with a cortical button fixation coupled with an interference screw. We try to verify if the outcomes could be influenced by the elapsed time since injury to surgery, taking a 30-day period as a cut-off. Additionally, we analyze the complication rate and if its occurrence will affect the outcomes.

Material and Methods

Study Design and Population

Retrospective comparative case study which includes patients admitted sequentially in the same institution with the diagnosis of distal biceps tendon rupture between 1st January 2010 and 31st December 2021.

Data Source

All study activities were approved by the institutional research ethics board, and all patients signed an informed consent form prior to study participation. All events were confirmed by consulting the individual casefile. Query was performed using Glintt HS® (Glintt, Lisboa, Portugal) and the imaging studies review by Xero® (Agfa Healthcare, Greenville, SC).

Case Definition

All patients in the database with the diagnosis of distal biceps tendon rupture were screened. Only those who were managed by a single-incision approach and cortical button fixation were included. Other inclusion criteria are: minimum of 3 months follow-up, post-op x-ray, signed informed consent for the investigation and functional evaluation. Patients who have had previous surgery on the assessed limb, and those who have refused to participate or did not answer the clinical evaluation were excluded.

Data Collected

Gender, age, type of professional labor (manual worker or other), injury side (dominant or non-dominant side), image studies (MRI or ultrasound scan and postoperative X-ray), time since injury to surgery and complications were recorded from the medical registry. Follow-up period was defined by the interval between surgery and the last clinical assessment. Elbow Range of Motion (ROM) (flexion, extension as well as supination and pronation at 90° of elbow flexion) from both sides, supination-pronation and flexion-extension isokinetic strength at 90° of elbow flexion with contralateral comparison using the MicroFet 2® dynamometer (Hogan Scientific, Salt Lake City, UT) were recorded. Visual analogue pain scale (VAS 0 - 10), overall satisfaction (subjective 1-5 scale), QuickDASH [23] and Mayo Elbow Performance Scores (MEPS) [24] were assessed. Concerning that group of patients who have just answered questions by phone, we were not able to measure either ROM or strength, only the demographics and functional scores. The questionnaire and functional assessment were performed by an independent investigator not involved in any surgery.

Treatment Protocol - Surgical Technique

A single anterior incision technique was performed in all patients. A transverse 3 cm incision is made 3 cm distal to the anterior elbow skin crease in every early acute case, which could be enlarged until 5 cm to best deal with a possible tendon retraction in subacute cases. Identification of the tendon stump is carried out. A whipstitch suture is made throughout the distal 2 cm tendon, and tendon stump trimmed to fit an 8 mm hole. The Lateral Antebrachial Cutaneous Nerve (LABCN) is identified and protected, lateral to the biceps tendon stump. A limited vertical dissection between brachioradialis and pronator teres, with the forearm in full supination, allows radial tuberosity identification.

Placement of two Hohmann retractors centres the 3.2 mm drill guide in radial tuberosity that should be inserted after maximal supination of the forearm in combination with a slight elbow flexion, inserted at 30 degrees angle in lateral inclination from the vertical, simulating the original biceps insertion. An 8 mm cannulated drill is inserted through the 3.2 mm drill guide, perforating only the anterior cortex. After removing the drill and the guide, care should be taken to remove all visible bony remaining debris to prevent heterotopic bone formation. After tuberosity preparation, free limbs of the biceps tendon suture are passed through the biceps button. The button is inserted in the tunnel using a dedicated introducer, flipped after reaching the posterior radius bone cortex and the tendon stump inserted through the anterior radius cortex by alternating pulling on the sutures, often with the elbow in flexion as needed (at least 10 mm should be inserted). The system is locked by passing one of the suture limbs through the tendon. Finally, a tenodesis PEEK 7 mm screw is inserted through the anterior radius cortex in a radial position to push the bicipital tendon towards ulnar position, closer to its native position and maximizing supination strength, until it seats flush in the radial cortex.

Treatment Protocol - Post-Op Rehabilitation

Our protocol comprises immediate mobilization, using a sling just for comfort in the first week followed by active motion with load limitation (up to ½ kg) in the first two weeks and strengthening exercises allowed at 6 to 8 weeks after surgery. All patients are allowed to return to unrestricted function, either involving sports or work environment, 3 months after surgery.

Statistical Analysis

We conducted a patient descriptive analysis: gender, age at injury time, type of professional labor (manual worker or other), injury side (dominant/non-dominant), image evaluation, time-lapse since injury to treatment, and complications. Clinical evaluation and clinical scores using Microsoft Excel ® were reported.

Comparison between the range of motion and strength of both sides using a Wilcoxon statistical test for paired samples was performed. We also compared patients who underwent surgery ≤ 30 days since injury to those whose surgery was undertaken > 30 days after injury for Heterotopic Ossification (HO) and paresthesia occurrence with X2 Test, and the Mann-Whitney test for range of motion, strength, VAS, Quick DASH, Mayo and satisfaction scores

(subjective 1-5 scale). All the statistical tests were performed with IBM SPSS Statistics 28.0.

Results

We found 67 patients (68 injuries – one patient sustained bilateral injury) in our database with the diagnosis of distal biceps tendon rupture, who were surgically treated with a single incision approach and Biceps Button® (Arthrex, Naples, FL) fixation. All surgeries were performed by four different surgeons from the same center. No graft was used in any procedure. It was performed primary repair in all cases. From the 67 patients (68 cases) treated, 56 patients (57 cases) accepted to participate in this study - 47 patients have attended our clinical evaluation and 9 have answered by phone. So, 56 patients (57 cases) were included for demographic data and questionnaire responses (VAS, Subjective Scale, QuickDASH and MEPS). Moreover, for clinical assessment of range of motion and strength, only patients who attended in person to the clinics were included (47 patients / 48 cases). All patients were male. Mean age at injury time was 47 years old (27 - 76). Forty elbows were treated within the first 30 days vs. 17 after 30 days. Right side was the most affected (n=32; 56%). In 23 cases (40%), the affected side was the non-dominant one (Table 1).

Table 1: Patient demographics.

Patient Number	Age	Time To Surgery (Days)	Pre-Op Imaging	Injured Side	Dominant Arm	Manual Laborer	Participation
1	54	26	MRI	R	R	No	In person
2	39	18	Ultrasound	R	R	No	In person
3	45	37	MRI	R	R	No	In person
4	76	6	Ultrasound	R	L	Yes	In person
5	66	3	MRI	R	R	Yes	In person
6	40	8	MRI	Bilateral	R	Yes	In person
7	63	40	MRI	R	R	No	In person
8	50	13	MRI	R	R	No	In person
9	50	10	Ultrasound	L	R	No	In person
10	40	16	MRI	R	R	No	In person
11	61	14	Ultrasound	R	R	No	In person
12	33	11	MRI	R	R	Yes	In person
13	39	7	Ultrasound	L	R	No	In person
14	58	11	Ultrasound	R	R	No	In person
15	53	45	Ultrasound	L	R	Yes	In person
16	47	13	MRI	L	R	No	In person
17	51	12	Ultrasound	L	R	No	In person
18	46	21	MRI	R	R	Yes	In person
19	36	11	Ultrasound	L	R	Yes	In person
20	59	62	MRI	L	L	Yes	In person
21	50	10	MRI	L	R	No	In person
22	42	34	Ultrasound	R	R	No	In person
23	45	15	Ultrasound	R	R	No	In person
24	56	13	Ultrasound	L	L	Yes	In person

25	42	49	Ultrasound	R	R	Yes	In person
26	30	31	MRI	L	R	No	In person
27	42	10	MRI	R	R	No	In person
28	51	12	MRI	L	R	No	In person
29	57	21	MRI	L	R	No	In person
30	41	6	Ultrasound	L	R	Yes	In person
31	50	11	Ultrasound	R	R	No	In person
32	48	34	Ultrasound	R	R	Yes	In person
33	41	17	Ultrasound	L	R	Yes	In person
34	52	60	MRI	R	R	Yes	In person
35	58	84	MRI	R	R	No	In person
36	44	3	Ultrasound	L	R	No	In person
37	53	23	Ultrasound	R	R	No	In person
38	55	26	MRI	R	R	No	In person
39	52	20	MRI	L	R	No	In person
40	55	39	Ultrasound	L	R	No	In person
41	42	47	Ultrasound	R	R	Yes	In person
42	43	25	Ultrasound	L	R	No	In person
43	51	12	MRI	L	L	No	In person
44	40	133	MRI	R	R	Yes	In person
45	39	30	Ultrasound	R	R	Yes	In person
46	48	21	MRI	R	R	Yes	In person
47	58	17	MRI	R	R	Yes	In person
48	54	7	Ultrasound	L	R	Yes	By phone
49	48	35	MRI	L	R	No	By phone
50	44	11	Ultrasound	R	R	No	By phone
51	44	38	MRI	R	R	No	By phone
52	43	17	Ultrasound	L	R	No	By phone
53	51	33	Ultrasound	L	R	Yes	By phone
54	35	35	MRI	R	R	No	By phone
55	47	30	MRI	L	R	Yes	By phone
56	41	30	Ultrasound	R	R	Yes	By phone
57	53	12	Ultrasound	R	R	No	No answer
58	27	10	MRI	L	Missing	Missing	No answer
59	44	10	Ultrasound	L	Missing	Yes	No answer
60	59	20	MRI	R	Missing	Missing	No answer
61	40	11	MRI	L	Missing	Missing	No answer
62	48	53	MRI	R	Missing	Missing	No answer
63	42	18	Ultrasound	R	Missing	Missing	No answer
64	44	23	MRI	R	Missing	Missing	No answer
65	42	34	MRI	R	Missing	Missing	No answer
66	35	36	MRI	L	Missing	Missing	No answer
67	41	18	MRI	L	Missing	Missing	No answer

Note*: MRI: Magnetic Resonance Imaging; R: right; L: left.

Mean time between injury and surgery was 25 days (3 - 133).

Mean follow-up between surgery and last visit was 33 ($\pm$ 29,5) months. Post-operative X-ray was obtained from all patients. Mean

supination strength on the affected and contralateral side was $5,7 \pm 2,4$ N and $5,9 \pm 2,2$ N, respectively (p-value=0,058). Mean flexion strength on the affected and contralateral side was $25,9 \pm 6,6$ N and

26,3 ± 6,3 N, respectively (p-value was 0,238) (Table 2). A total of 9 patients showed reduced range of motion. There were deficits of pronation in 7 patients, supination in 9 patients and extension in 3 patients. Taking into account these patients, mean loss of pronation was 10,7° (5 - 20°), mean loss of supination was 8,9° (5 - 15°) and mean loss of extension was 5°. Overall, comparing mean supination, pronation and extension of the injured limb to standard values, considering 90° for supination, 80° for pronation and 0° for extension, there were statistically differences for mean supination (88,3 ± 3,9°) and mean pronation (78,4 ± 4,6°), but not for extension.

No differences were verified in VAS and satisfaction scores. On the other hand, it was verified that a reduced range of motion was significantly correlated to a worse QuickDash score (p-value 0,031) and closely correlated to an inferior MEPS (p-value 0,051). Mean total range of motion of the affected and contralateral side was 145,2 ± 8,5° and 145,9 ± 7,9°, respectively, with no statistically significant difference between both sides (p-value=0,068) (Table 2). The mean VAS for pain was 1,04 (0,00 - 10,00) and the mean overall satisfaction score was 4,6 (1 - 5). Mean Quick DASH and the Mayo Elbow scores were 5,2 (0 - 65,9) and 94,5 (45 - 100), respectively.

Table 2: Results of clinical evaluation (in-person participants).

Patient Number	Supination (N)	CL - Supination (N)	Flexion (N)	CL - Flexion (N)	Pronation Deficit (Degree)	Supination Deficit (Degree)	Extension Deficit (Degree)	ROM (Degree)	CL - ROM (Degree)
1	7	6,4	33,3	36,6	10	No	No	150	150
2	9,3	10,2	47,1	46,8	No	No	No	130	130
3	6,1	6,1	31,7	32,7	5	5	No	130	140
4	4,3	4,8	21,5	23,3	No	No	No	150	150
5	4,3	5,5	19,2	19,7	No	No	No	150	150
6 Bilateral	4,8	5,4	24	24,2	No	No	No	140	140
7	3,9	4,2	22,9	20,3	No	No	5	140	150
8	2,2	2,5	18,8	19,1	No	No	No	145	145
9	5,1	4,6	29,2	29	No	No	No	150	150
10	3,4	4,5	28,5	32,3	No	No	No	125	130
11	4,7	4,1	22	20,3	No	10	No	140	140
12	6,9	4,1	36,1	37,5	No	No	No	130	130
13	10,4	12	28,7	26,4	No	No	No	150	150
14	4,6	3,9	19,7	22,2	No	No	No	135	135
15	9,2	10,9	29,7	26,6	No	No	No	140	140
16	4,7	5,8	29	30,2	No	No	No	150	150
17	5,1	6,3	24,7	24,5	20	No	No	130	135
18	6,9	5,2	31,6	27	No	No	No	110	115
19	9,2	9,2	33,9	33,1	No	No	No	150	150
20	5,4	5,2	20,6	23,8	5	No	5	140	125
21	3,8	4,8	27,3	28,7	No	No	No	140	145
22	7,9	8,1	25,9	26,9	No	No	No	140	140
23	4,4	4,3	36,1	39,4	No	5	No	150	150
24	4,6	4,4	34,4	36,5	No	No	No	150	150
25	15	11	23,5	22	No	No	No	150	150
26	5,7	6,4	18,5	20,8	No	No	No	150	150
27	4,5	4,6	25,2	25,9	No	No	No	150	150
28	4	5,8	27,7	30,3	No	No	No	150	150
29	3,3	4,2	19,1	20,9	No	No	No	150	150
30	6,8	8,2	31,5	28,5	No	No	No	150	150
31	7,4	2,6	29,1	24,4	No	No	5	145	150
32	2,6	4,1	10,9	19,7	10	15	No	150	150
33	6,5	6,6	24,7	29,7	No	No	No	150	150
34	2,6	3,4	20,9	20,8	No	10	No	145	150

35	6,8	6,2	29	24,6	No	No	No	150	150
36	5,2	7,2	11,8	15,3	No	No	No	150	150
37	5	6	21	19,9	No	5	No	150	150
38	6	4,5	23,8	22,2	No	5	No	150	150
39	4,4	5,4	22,1	22,7	No	15	No	150	150
40	4,4	6	23,5	24,2	No	No	No	150	150
41	5	5,2	20,8	21,3	No	10	No	150	148
42	5,4	5	16,6	18,5	No	No	No	150	150
43	3,6	5,4	29,3	29,3	No	No	No	150	150
44	3,7	4,2	26,6	24,5	No	No	No	150	150
45	8,4	8,5	28,3	29,2	No	No	No	150	150
46	7,1	7	26,3	26,5	No	No	No	150	150
47	7,5	7,3	29	28	5	No	No	150	150

Note*: N - Newton (strength); CL - contralateral; ROM: range of motion.

The overall complication rate was 52%: 10 patients had Heterotopic Ossification (HO) and 20 patients reported LABCN neuropraxia; one had both complications. All patients who presented HO were asymptomatic and no range of motion restriction was noted. Those who reported LABCN neuropraxia had full recovery, with all but one referring no significant impairment on daily activities. The occurrence of any complication did not affect VAS ($p=0,488$), overall satisfaction ($p=0,786$), Quick DASH ($p=0,356$) and Mayo Elbow ($p=0,177$) scores (Table 3). Comparison between patients who un-

derwent surgery ≤ 30 days since injury (39 patients, 40 elbows) and those whose surgery was undertaken > 30 days (17 patients) after the injury is presented on table 4. A statistically significant difference regarding QuickDash (4,0 vs. 7,8) and MEPS (96,7 vs. 89,4), with better outcomes for patients treated earlier, was verified ($p=0,031$ and $p=0,024$, respectively). No statistically difference was found concerning HO or neuropraxia occurrence, impaired range of motion or strength, and VAS and satisfaction scores.

Table 3: Scores and complications (In-person and by-phone participants).

Patient Number	Heterotopic Ossification	LABCN Pares-thesia	VAS	Overall Satisfaction	Quick-Dash	Mayo
1	Yes	No	0	5	2,3	100
2	No	No	0	5	0	100
3	Yes	No	0	5	0	100
4	No	No	0	5	0	100
5	No	Yes	0	5	0	100
6	No	Yes	0	5	0	100
7	No	No	1	4	2,5	85
8	No	No	0	4	0	100
9	No	No	0	5	0	100
10	No	No	1	4	2,3	100
11	Yes	Yes	0	5	2,3	100
12	No	No	1	4	2,3	100
13	Yes	No	0	5	2,3	100
14	No	No	0	5	0	100
15	No	No	1	5	2,3	85
16	No	No	0	5	0	100
17	No	No	0	4	4,5	85
18	No	Yes	2	5	13,6	80
19	Yes	No	0	5	0	100
20	No	Yes	1	4	6,8	85
21	No	Yes	0	5	2,5	100

22	No	No	0	5	4,5	100
23	No	No	1	5	2,3	100
24	No	No	0	5	0	100
25	No	Yes	0	5	2,3	100
26	No	No	0	5	2,3	100
27	No	No	3	5	4,5	100
28	No	Yes	0	5	4,5	100
29	No	No	0	5	0	100
30	No	Yes	0	5	0	100
31	Yes	No	4	5	0	100
32	No	Yes	5	3	56,8	45
33	Yes	No	0	5	0	100
34	No	No	0	4	22,7	85
35	No	Yes	0	5	2,3	100
36	No	Yes	0	5	18,2	100
37	No	No	0	5	0	100
38	No	Yes	4	5	4,5	85
39	Yes	No	0	1	0	95
40	No	Yes	0	4	2,3	100
41	No	No	10	5	18,2	80
42	No	No	0	5	0	100
43	No	No	0	5	0	100
44	Yes	No	4	5	2,3	70
45	No	No	0	5	0	100
46	No	Yes	0	5	0	100
47	No	No	0	5	6,8	100
48	Yes	No	0	5	0	100
49	No	No	0	5	0	100
50	No	No	6	3	11,36	70
51	No	No	0	5	0	100
52	No	Yes	0	5	0	100
53	No	Yes	6	5	2,3	100
54	No	Yes	2	4	4,5	85
55	No	Yes	2	5	6,8	85
56	No	Yes	7	1	65,9	70

Note*: LABCN - Lateral Antebrachial Cutaneous Nerve; VAS - Visual Analogue Scale.

Table 4: Comparison of the results between patients treated ≤ 30 and > 30 days since injury.

Time to Surgery	≤ 30 Days	> 30 Days	P-Value
Supination strength (mean $\pm$ SD) (N)	5,636 $\pm$ 1,920	6,023 $\pm$ 3,321	0,932
Flexion strength (mean $\pm$ SD) (N)	26,867 $\pm$ 6,859	23,423 $\pm$ 5,461	0,113
Pronation range (mean $\pm$ SD) (degrees)	78,97 $\pm$ 3,849	76,92 $\pm$ 5,965	0,068
Supination range (mean $\pm$ SD) (degrees)	88,82 $\pm$ 3,270	86,92 $\pm$ 5,220	0,182
Extension deficit (mean $\pm$ SD) (degrees)	-0,15 $\pm$ 0,857	-0,77 $\pm$ 1,878	0,123
Range of motion (mean $\pm$ SD) (degrees)	144,86 $\pm$ 9,509	145,81 $\pm$ 6,047	0,659
VAS (mean $\pm$ SD)	0,79 $\pm$ 1,720	1,76 $\pm$ 2,862	0,116
Satisfaction index (mean $\pm$ SD)	4,64 $\pm$ 0,959	4,59 $\pm$ 0,618	0,218
QuickDASH (mean $\pm$ SD)	4,025 $\pm$ 10,964	7,771 $\pm$ 14,090	0,031

MEPS (mean $\pm$ SD)	96,67 $\pm$ 8,057	89,41 $\pm$ 14,883	0,024
LACBN Neuropraxia (%)	40	41,2	1,0
Heterotopic ossification (%)	23,3	17,6	0,740

Note*: SD - Standard Deviation; N - Newton (strength); VAS - Visual Analogue Scale; MEPS - Mayo Elbow Performance Score with p evaluated by Mann-Whitney test for quantitative variables and Qui-Square Test for qualitative variables.

Discussion

Rupture of the distal biceps tendon is prevalent among middle-aged males, affecting mostly the dominant arm which is consistent with our results and the vast published literature [4,5,7-9,17,25-28]. Its incidence is increasing and this may be due to increasing activity levels as well as the greater demands on the biceps muscle during sports and professional activities [4,14]. Although this injury usually occurs in manual laborers, only 43% of the patients included in our study could be considered so - *Siebenlist S, et al.*, presented a sample consisting of 50% of patients with this feature [29]. Time elapsed between injury and surgery was 30 days or less in 70% of patients which is shorter than the average of published results - Dilon MT. et al. reported on a case series of 26 patients in which 17 were treated earlier than 30 days (65%) [1,25].

The system used in this study - a bicortical button paired with an interference screw - was the result of an evolution brought up by our experience in the follow-up of patients, and their complications, using different fixation methods. The main purpose of this technique is to allow patients to start rehabilitation programme immediately, which in turn decreases recovery time of either strength and range of motion, leading to a return to their previous activities in the shortest possible period of time [14]. A systematic review of repair techniques reported lower complication rate for cortical button repair [7,30] and other authors have demonstrated the association with minimal loss of elbow flexion and supination strengths and motion compared with contralateral side [5]. Our results showed a decrease in supination and pronation range in 9 cases. No differences were found regarding extension. There was no difference in range of motion between the affected and the non-affected elbow. Another meta-analysis [4] showed no differences in QuickDASH or MEPS and postoperative flexion, supination and extension range, but a wider pronation deficit in cases treated with suture anchors or cortical button.

In our study population, with a mean follow-up of 33 ($\pm$ 29,5) months, there was a mean loss of 2,8% in supination and 1,5% in flexion strength when compared to the contralateral side, which means that it is not statistically different from one another. Combining data from the studies [1, 5,25,27,28] and ours, it seems evident that patients regain the majority of strength postoperatively but some deficits remain. For the most, these minimal differences in strength were not clinically relevant. Our overall ROM was 145° which is in line with published literature [1,13,17,20,26,28] and there was no significant statistical difference between the affected side and the unaffected one. Our mean QuickDASH score was 5,16 and Mayo Elbow Score was 94,46 which are similar to other studies [3, 7,9,12]. Concerning HO, our results are consistent with the

majority of the case series, which present a great variability in incidence (2.9-56.7%) [1,5,25,26,28]. Considering the development of LACBN paresthesia, our results are also in agreement with the literature as this complication is also very heterogeneous in published papers, with records between 7% and 44% [1, 5,7,14,25,29]. We had no infections - superficial or otherwise.

None of the patients had re-ruptures and therefore there were no revision surgeries in the studied sample. Differently, reviewing the published information abroad, it is reported a 1.3-5% re-rupture rate [5,8]. No failure of implants was recorded. Studies that compared treatment of acute and chronic injuries found no significant differences related to clinical and functional outcomes or complication rates [1,7,8]. On the contrary, we have found significant differences between patients operated before and after 1 month from injury time concerning QuickDash and Mayo Elbow Performance scores. No differences were found in respect to range of motion, strength, VAS or satisfaction score. We have not found results regarding this topic in the published literature. We verified a correlation between a lower QuickDash score and a reduced range of motion. MEPS was nearly statistically different ($p=0,051$). There were no differences in respect to VAS or satisfaction rate. This study has some limitations. It is a retrospective assessment of an heterogeneous population. Only 17 patients were treated with a delay after > 30 days as opposed to 40 elbows treated earlier and this could be a lopsided comparison. Functional results (both strength and range of motion evaluation) were compared to the contralateral side which can lead to erroneous values, because usually they are not an exact comparison to pre-injury levels of the affected arm. Moreover, we did not take into account the dominant limb pre-injury values, which can alter the strength of the results, being that it is on average 10% stronger than the non-dominant hand [21]. Face-to-face evaluation of patients with objective strength measures for supination and flexion and range of motion, complemented with radiographic analysis achieved from all patients, are the strengths of our study. We have found that time from injury to the surgery could be an important aspect to get better functional outcomes, therefore, every effort should be made to operate this injury as soon as possible.

Conclusion

According to our clinical evaluation and postoperative scores, we can state that an approach of a single incision and cortical button plus interference screw fixation of the distal biceps tendon provides good to excellent functional results, with nearly full recovery to the previous biceps function, comprises low major complication rate and allows to a faster return to the previous condition. Our main finding is that time could be an important issue to get the best outcomes and an early treatment should be advised. Moreover, ad-

ditional research is warranted to study patients who have undergone distal biceps tendon repair that evaluates other variables that could influence the outcomes, such as the patient's demand, injury context (work, competition or recreational sports), innovative surgical techniques and rehabilitation programmes.

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Disclaimer

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