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TECHNICAL NOTE • ELBOW - ARTHROSCOPY

Outcomes of distal biceps tendon reattachment using the ToggleLoc™ fixation device with ZipLoop™ technology with single mini-open technique

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Abstract
Anatomical repair of distal biceps tendon ruptures has been shown to restore elbow supination and flexion strength. Here, we report the outcomes of distal biceps tendon reattachment using the ToggleLoc fixation device with ZipLoop technology through a single incision. This was a retrospective study of 38 patients with a mean age of 49.5 years. The mean follow-up time was 15 months (range 4/28). The average time to surgery was 21 days. The fixation button was introduced in a bone tunnel and the tendon passed through a bone window using the ToggleLoc™, which allows the tendon to be tensioned using sutures. The tendon was reattached in 30° elbow flexion. The mean strength deficit in supination was 23.9% in comparison with the contralateral side. We discovered four instances of heterotopic ossification on follow-up radiographs. There were seven cases of persistent lateral antebrachial cutaneous nerve paresthesia, but no damage to the posterior interosseous nerve. This new technique places the tendon in a bone tunnel using a single surgical approach. It provides the surgeon with good feedback on the tension of the repair, which is unique among endobutton-type devices. We recommend using the ToggleLoc™ with ZipLoop™ technology as it is a simple, reliable and reproducible technique for distal biceps tendon reattachment.

Keywords Distal biceps · Endobutton · ZipLoop · ToggleLoc

Introduction

Distal biceps tendon ruptures make up 3% of all biceps injuries and 10% of all tendon injuries. The incidence is 1.2/100,000 [6, 18]. The typical patient with a distal biceps tendon rupture is a middle-aged male with an injury in his dominant arm. While ruptures at the musculoskeletal junction have been described, most ruptures occur distally at the bicipital tuberosity on the radius [1, 15]. In some cases, not treating the rupture is an option. However, anatomical repair has been shown to better restore elbow supination and flexion strength, along with muscle endurance [2, 3, 15].

Surgical techniques have evolved over the years with the development of endobutton-like devices, which are appealing from a biomechanical point of view due to their fixation on the dorsal cortex of the radius. However, the positioning of these endobuttons can be challenging and not very reproducible leading to poor results. Our aim was to study a new distal biceps tendon reattachment technique using the ToggleLoc™ fixation device with ZipLoop™ technology [8] through a single incision [11] and to determine the clinical and radiological outcomes, along with the complications.

Patients

This study involved 45 patients who were operated on between January 2013 and April 2016 and later reviewed retrospectively between May and October 2016. These patients underwent distal biceps reattachment using an endo-osseous fixation. There was no formal consultant/designer relationship between Zimmer Biomet and the surgeons or examiner.

Seven of the patients who had been included in the study were later excluded because suture anchors had been used for tendon reattachment. The remaining 38 had undergone distal biceps tendon reattachment using the

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ToggleLoc™ fixation device with ZipLoop™ technology (Zimmer Biomet, Warsaw, IN, USA). The procedures were performed by nine senior surgeons (Clinique du Tonkin). Table 1 shows that in all cases the diagnosis was confirmed with either ultrasonography (US) or magnetic resonance imaging (MRI). The mean time elapsed between the injury event, and the surgery was 21 days (range 1–77); eight patients underwent surgery more than 1 month after the rupture occurred. The mean follow-up was 15 months (range 4–28).

Table 1 Patient characteristics

Patient no.	Sex	Age (years)	Follow-up (months)	Dominant arm injury (Y/N)	Time to surgery (days)	Manual laborer (yes = x)	Pre-op imaging	Tendon retractation (cm)
1	M	44	20	N	1		US	
2	M	30	4	N	43	x	US + MRI	6
3	M	47	7	N	10		US + MRI	
4	M	59	22	Y	4	x	US	
5	M	65	20	Y	3		US	6
6	M	51	20	Y	7	x	US	3.4
7	M	33	26	Y	13	x	MRI	
8	M	53	6	Y	8		US	
9	M	43	13	Y	12		MRI	
10	M	27	14	Y	16	x	US	
11	M	54	18	N	8		US	
12	M	44	8	N	10	x	US	1.7
13	M	54	13	Y	29	x	US + MRI	1
14	M	47	6	N	10		US	9
15	M	48	15	Y	14	x	US + MRI	3
16	M	46	18	N	15		US + MRI	8
17	M	35	20	N	11		US	
18	F	64	5	Y	Chronic		US	
19	M	67	16	Y	27		E et I	
20	M	50	18	Y	34		US	7
21	M	50	21	Y	77		E et I	
22	M	52	22	Y	58		US	2
23	M	42	5	N	10		US	6
24	M	43	13	Y	30	x	US + MRI	
25	M	37	5	N	15		US + MRI	
26	M	51	20	N	50	x	US + MRI	
27	M	51	28	Y	5	x	US	3.5
28	M	74	12	Y	15	x	US	
29	M	48	20	Y	15	x	US	5
30	M	48	18	N	63	x	US	
31	M	50	20	N	21	x	US	
32	M	58	23	N	7	x	US + MRI	
33	M	56	9	N	8	x	US	4
34	M	57	25	Y	7		US	
35	M	41	25	N	9	x	US	
36	M	37	4	Y	26	x	US + MRI	
37	M	34	4	Y	74	x	US + MRI	1.8
38	M	53	13	Y	17	x	US + MRI	7
Mean		49.5	15		21			

M male, *F* female, *US* ultrasonography, *MRI* magnetic resonance imaging

Surgical technique

With the elbow extended and forearm supinated to protect the posterior interosseous nerve (PIN), an anteromedial incision was made at angle on the proximal portion of the forearm. The brachioradialis muscle belly was identified and reflected laterally to protect the motor branch of the radial nerve. The median nerve was identified and then, the lateral antebrachial cutaneous nerve (LABCN) was released and isolated with surgical tape. The arterial pedicle was carefully dissected at the elbow flexion crease. The proximally retracted tendon was retrieved. Light traction was placed on the tendon to determine whether it could be reattached to the bicipital tuberosity.

A MaxBraid suture was placed in the tendon in a Bunnell pattern to secure the tendon to the Ziploop™. The second strand was tied in a Krackow pattern to stiffen the tendon construct. The button fixation device resembles a small stick with two holes. One hole contains a traction suture, which is used to position and flatten the button after it passes through both cortices. The second hole has a round "zip" suture that slides on itself in a double loop configuration. The second suture is used to reduce the tendon in the bicipital tuberosity and to apply tension on the construct (Fig. 1).

After the cannula and cannulated obturator were inserted to protect the soft tissues, the tip of a 2.4-mm guide pin was placed in the distal and ulnar direction on the bicipital tuberosity to avoid damaging the pin. The pin's position was confirmed with AP and lateral fluoroscopy images. The hole for the proximal cortex was drilled using an 8-mm diameter drill bit with the posterior cortex hole requiring a 4.5-mm diameter drill bit.

The button was placed in the slotted inner cannula with the zip suture distal to the button; it was then pushed through the hole to the posterior cortex using a mallet and the cannulated obturator. Tension was placed on the traction suture to flip and lock the button. Tension was then applied to the zip strand to pull the biceps tendon into the transosseous tunnel in the bicipital tuberosity. The tendon was reduced with the elbow flexed 30° and the forearm in neutral position. The tendon was palpated in its socket in the radius and then, the repair locked using half hitches (Fig. 2).

Patients were immobilized using a sling with the elbow flexed at 90° for only 15 days. Rehabilitation with no limitation on the range of motion was initiated after 1 week. Muscle strengthening without resistance started after 6 weeks and against resistance commenced after 8 weeks. At this time, sport-specific therapy programs were allowed.

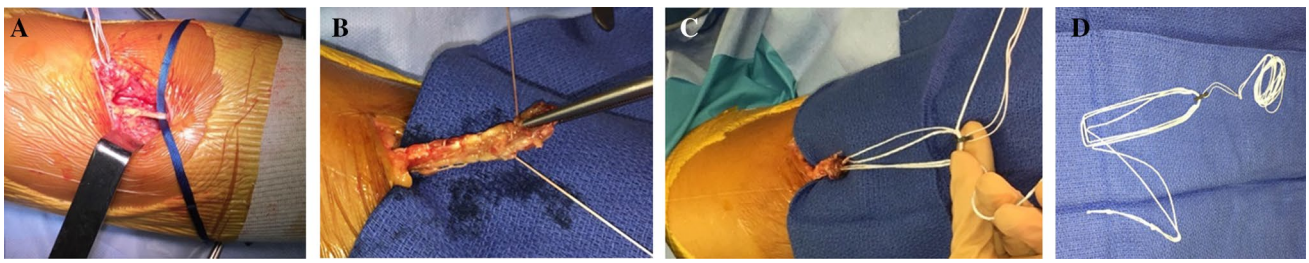

Fig. 1 Dissection and tendon preparation (**a** Lateral antebrachial cutaneous nerve and tendon fixed on the ToggleLoc, **b** Bunnel and Krachow sutures on tendon are made outside, **c** fixation of tendon to button outside with consequent distance to operative site, **d** ToggleLoc fixation device: left side, the round zip suture that slides on itself, right side, traction suture)

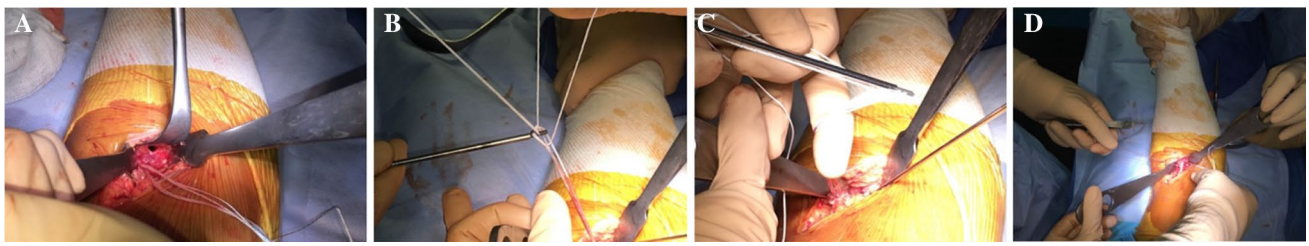

Fig. 2 Introduction of the ToggleLoc™ and tendon reduction (**a** mini-open and drilling of bone tunnel, **b** direction of button insertion with traction suture positioned distally, **c** positioning of ToggleLoc in the cannulated obturator, **d** tendon reduction in the bone tunnel by pulling on the zip strand)

Clinical cases

All patients were reviewed in person by an independent examiner who was not involved in the surgical procedures; a complete record of the results was kept. The clinical examination focused on pain levels (using a visual analog scale, VAS), joint range of motion (ROM) and grip strength together with supination and pronation (using a Jamar dynamometer). The Mayo elbow performance index (MEPI), subjective elbow value (SEV) and quick disabilities of arm, shoulder and hand (Quick DASH) questionnaires were also completed. Radiographs were taken at the review visit as well as an MRI being offered to all patients. Clinical review of patient records found a mean tendon retraction of 4.65 cm in 16 patients. Partial tendon rupture was found in four patients, in these cases it was necessary for the rupture to be completed. Intraoperatively, a more proximal counterincision was needed in these four patients to retrieve the retracted tendon. When delay for surgery was more than 1 month after rupture occurred, it was necessary to increase the flexion angle of elbow near from 60° to 90° to achieve good tendon reattachment [16].

Table 2 shows the results of the final clinical review; supination strength had decreased by an average of 23.9% in 34 of the patients and increased by an average of 30.4% in four patients. Pronation strength had decreased by an average of 14.02% in 27 patients but increased by an average of 15.05% in 11 patients. Grip strength had decreased by an average of 16.65% in 22 patients but increased by an average of 10.5% in 16 patients.

Table 3 shows that there was no significant difference between patients operated before and after 1 month.

There was one case of intramedullary button migration, four cases of heterotopic ossifications (HO) and zero cases of proximal radioulnar synostosis. Only 20 patients reviewed in person agreed to have another MRI done. There were no signs of muscle atrophy or fatty infiltration, no recurrence of rupture. In 15 cases, we found an appearance of tendinosis with mature tendon callus. A bone bruise was found in one case, bicipitoradial bursitis in one case and joint synovitis in one case (Fig. 3).

There were no cases of complex regional pain syndrome (CRPS), no sign of pin damage and three instances of postoperative hematoma requiring revision. One patient had discharge at the surgical site that was resolved with local treatment. LABCN paresthesia occurred in 42% cases, of which 56% cases resolved spontaneously.

Discussion

Distal biceps tendon reattachment using the ToggleLoc™ fixation device with ZipLoop™ technology results in good postoperative ROM, MEPI and QuickDASH scores and strength with a low complication rate: 18% persistent LABCN paresthesia, 8% hematoma and 10.5% HO. We do not report cortical fracture using the ToggleLoc™.

Our findings are consistent with prior studies of tendon reattachment using the endobutton [4, 7, 17, 19].

The ToggleLoc™ is superior to other endobutton-type devices as it is secured away from the surgical site, and the tendon is easily pulled into the intraosseous tunnel which allows a mini-open approach. Furthermore, the tension of the suture loops and repair can be adjusted [8, 12]. The intraosseous placement of the tendon increases the contact area between the tendon and bone, which contributes to better healing with no recurrence of rupture confirmed by MRI. The strong fixation on the opposite radial cortical allows early rehabilitation without limitations. Compared to the previous techniques, this system fits perfectly within the RRAC (Rapid Recuperation After Surgery) protocols [10, 20].

Based on a cadaver study, Lo et al. [13] recommended drilling into the radius at 90° to its longitudinal axis and at a 0° to 30° ulnar angle with patient's forearm in full supination to increase the margin of safety for the pin. Using a single incision helps to reduce the risk of radioulnar synostosis [9].

Two studies reported on use of the ToggleLoc in four and 13 elbows, respectively [8, 12]. Kodde et al. [12] reported 100% flexion strength recovery and 95% supination strength recovery with a 23% HO rate; however, only a small number of patients were studied and the follow-up was relatively short at 22 months.

We found consequent percent of persistent LABCN paresthesia. It may be due to a persistent fibrosis near to the nerve or an important traction on retractors.

One of the strengths of our study was that all patients were reviewed in person and all had follow-up radiographs taken. The main limitations of our study are its retrospective design and its relatively short follow-up. The sample size was also relatively small, but larger than other published studies with this technique.

Distal biceps tendon reattachment using the ToggleLoc™ device with ZipLoop™ technology is a reliable, reproducible technique. Endobutton and suture anchors techniques

Table 2 Results of clinical examination

Patient No.	VAS pain	MEPI	Quick DASH	Satisfaction[a]	SEV (%)	Flexion–extension ROM (°)	Supination strength ratio (%)[b]	HO	LABCN paresthesia
1	0.5	100	4.55	5	85	165	88.89	No	Yes + P
2	0.5	65	31.81	4	70	155	48.65	No	Yes + P
3	0	100	0	5	100	150	83.71	No	Yes
4	0	100	0	5	95	150	126.05	Yes	No
5	0.5	100	2.27	5	100	140	87.54	Yes	No
6	0	100	0	5	100	140	98.16	No	No
7	2.5	55	27.27	3	80	135	88.24	No	No
8	1	100	2.27	5	100	135	95.51	Yes	Yes
9	0	100	0	5	50	140	57.65	No	No
10	0	100	0	5	100	130	91.67	No	Yes + P
11	0	100	0	5	100	140	79.17	No	Yes + P
12	2.5	100	0	5	85	135	75.68	No	No
13	0	100	0	5	80	140	100	No	No
14	0	100	0	5	100	140	66.66	No	Yes
15	5	75	29.55	4	60	140	76.38	No	No
16	0	100	0	5	120	135	91.57	No	Yes
17	1.5	100	11.36	5	85	100	92.06	No	Yes
18	0	100	9.09	5	100	140	102.17	No	No
19	0	100	0	5	98	150	81.01	No	No
20	0	100	0	5	100	140	98.9	No	No
21	0	100	0	5	100	140	100	No	No
22	3	85	52.27	4	70	85	35.29	No	No
23	1	100	4.55	5	60	135	62.88	No	No
24	0	100	0	5	90	140	100	No	Yes
25	1	100	9.09	5	80	140	176	No	No
26	1.5	100	0	5	90	130	83.33	No	Yes
27	0	100	0	5	95	145	73.95	No	No
28	0	95	4.55	5	85	135	80	No	No
29	8	100	6.82	4	80	140	68.57	No	No
30	4	95	15.90	5	50	120	38.46	No	Yes
31	1	100	6.82	5	90	140	70.37	No	Yes
32	0	100	2.27	5	100	140	70.45	No	No
33	0	100	2.27	5	90	130	83.78	Yes	No
34	2	100	0	5	90	130	117.51	No	No
35	7	80	37.81	5	50	140	58.14	No	Yes + P
36	0	100	2.27	5	100	140	94.73	No	Yes + P
37	3	50	75	5	40	110	23.07	No	Yes + P
38	5	50	52.27	3	50	105	43.03	No	Yes
Mean	1.32	93.4	4.16		85	135	81.82		

HO heterotopic ossification, *LABCN* lateral antebrachial cutaneous nerve, *P* persistent

[a]Satisfaction level: 5—very satisfied, 4—satisfied, 3—neither satisfied or dissatisfied, 2—unhappy, 1—very unhappy

[b]Supination strength ratio: % injured side/uninjured contralateral side

Table 3 Comparison of the results between those who underwent surgery less than 1 month after injury and those over 1 month

Patient No.	VAS pain	MEPI	Quick DASH	Satisfaction[a]	SEV (%)	Flexion–extension ROM	Supination strength ratio (%)[b]	HO[c]	LABCN[d] paresthesia
30 < 1 month/8 > 1 month	0.42	0.06	0.47	0.52	0.26	0.28	0.32	0.56	0.43

With *p* evaluated by Mann–Whitney test for quantitative variables and Fisher's exact test for qualitative variables

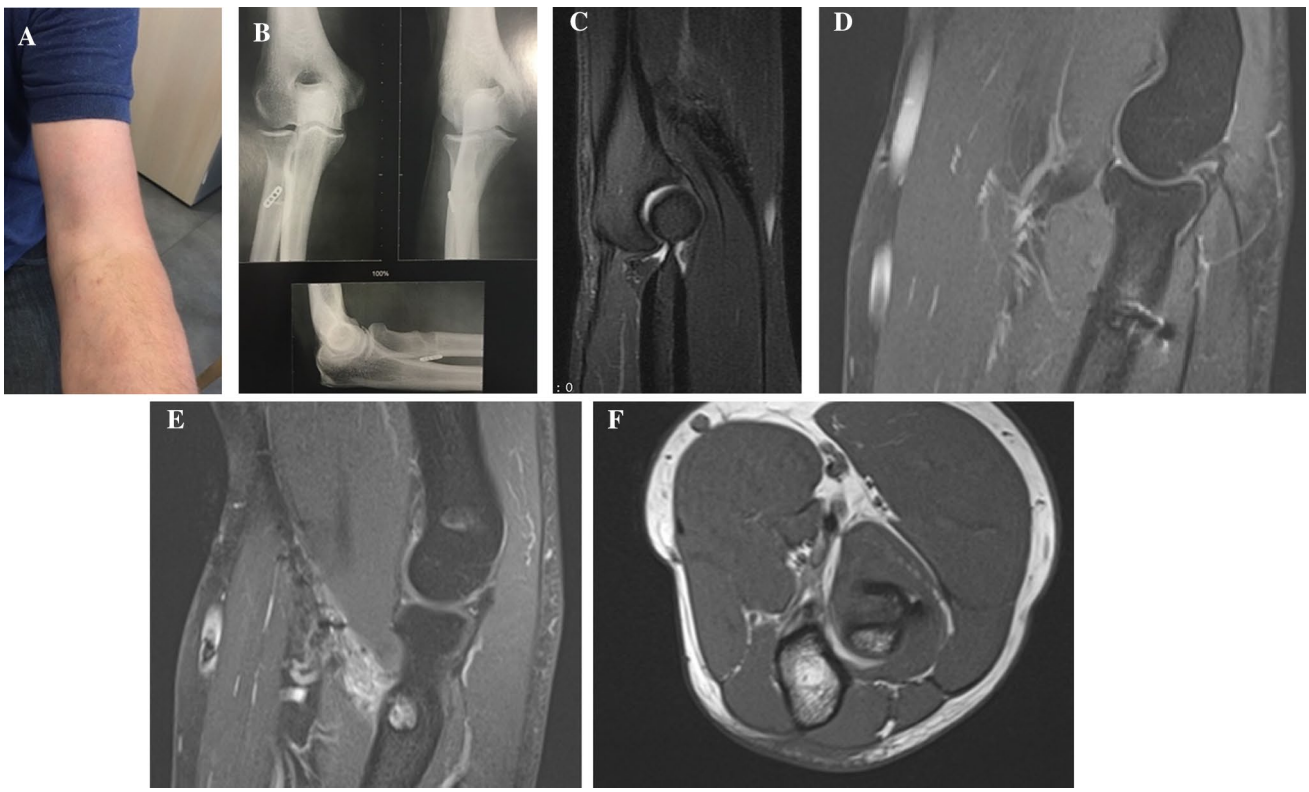

Fig. 3 Clinical and radiological outcomes of a patient at 18 months' follow-up (**a** Clinical findings, and scar, **b** AP and lateral radiographs showing the position of the ToggleLoc, **c** sagittal MRI image showing healthy muscle tissue, **d**, **e** sagittal MRI image showing the button and tendon in the bone tunnel, **f** axial MRI image showing the tendon in the intraosseous tunnel)

both provide adequate fixation, but endobutton technique needs a higher energy absorbed before failure [5, 14, 21]. Its ease of use and low complication rate make it an attractive option for ruptured tendons, and we think that it is possible to perform this procedure arthroscopically assisted.

Compliance with ethical standards

Conflicts of interest The authors declare that they have no competing interests.

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