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Original article

Double incision repair technique with immediate mobilization for acute distal biceps tendon ruptures provides good results after 2 years in active patients

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ABSTRACT

Introduction: Surgical treatment of distal biceps tendon ruptures is recommended in an active population to avoid loss of strength, especially in supination and flexion.
Hypothesis: A double incision repair technique with immediate postoperative mobilization for acute distal biceps tendon ruptures is safe and provides good results after 2 years in active patients.
Material and methods: Seventy-four men (47 ± 7 years) with acute tears of the distal biceps tendon tears were included in this retrospective single-center study. All patients were operated using the double-incision repair technique described by Morrey. The tendon was inserted with transosseous sutures into the biceps tuberosity. Patients were allowed to perform immediate postoperative active mobilization. A minimum follow-up of two years was required including clinical and radiological evaluation.
Results: Sixteen patients were lost to follow up leaving 58 (78%) patients for analysis with a mean follow-up of 53 ± 19 months. At final follow-up, the mean evaluation for pain on the VAS scale was 0.22 ± 0.7. Mean range of motion results included extension −1° ± 2°, flexion 138° ± 6°, pronation 72° ± 16° and supination 81° ± 10°. The strength ratio in flexion was 94 ± 8% and in supination 90.5 ± 12% compared to the contralateral limb. Subjective elbow value and DASH score were respectively 94 ± 6% and 7.5 ± 9%. All patients were satisfied or very satisfied and all except one returned to their previous sport. We noticed 2 heterotopic ossifications and one patient needed a reoperation for a radioulnar synostosis. Neither re-rupture nor nerve injury were observed.
Discussion: A double incision technique for distal biceps tendon repair is a minimally invasive procedure with reliable results. Morrey's modification of the initial procedure associated with early mobilization is associated with a low rate of complications and limited the occurrence of synostosis or ossifications.
Level of evidence: IV, case series, with no comparison group.

1. Introduction

Although ruptures of the distal biceps tendon have been considered relatively rare injuries (3% of biceps injuries, 1.2/100,000 people) [1], they are being reported with increasing frequency, especially in patients performing manual labor and in weightlifting sports (up to 50%) [2,3].

The injury is often caused by a forced eccentric contraction of a pathological biceps tendon. Multiple causes of pre-existing tendon pathology have been reported such as chronic inflammation of the deep bicipital radial bursa at the radial tuberosity [4] or repetitive impingement of the tendon on hypertrophic bone on the anterior part of the radial tuberosity as often seen during surgery.

Surgical reinsertion of the biceps tendon on the radial tuberosity in an active population is widely accepted as a reliable procedure. The main goal is to avoid weakness in supination (40%) and flexion (30%). The second aim is to maintain endurance in supination (86%) [5–8]. Posterior transosseous reinsertion restores normal anatomy, normal tendon moment arm and bone/tendon contact [7,9,10].

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Several surgical methods have been described that use either a single or double incision approach. Various complications, such as nerve injury, have been associated with a single incision technique, which may be related to the difficulty in restoring the anatomy. In addition, repair devices usually used with the single incision technique, such as buttons [11,12] or anchors [13] are associated with a risk of secondary migration and posterior interosseous nerve injury [14]. Finally, a single incision is associated with heterotopic ossification (HO) [15]. A recent comparative study showed a relatively high prevalence of complications with the single-incision technique and limited force of strength during flexion of the elbow [16].

To reduce the problems of nerve injury and reinsert the biceps in its anatomical position, Boyd and Anderson described a two-incision technique [17] in 1961. Morrey later modified the procedure to decrease the rate of complications [4,18]. He used a posterior muscle-splitting approach to reduce the likelihood of radioulnar synostosis by avoiding subperiostal exposure of the ulna. Many fixation devices have been used (suture anchors [19], interference screws [20,21]) however recent biomechanical studies have shown that transosseous insertion is superior to anchors or a tenodesis screw, and almost equal to button fixation [22–25].

The purpose of this study was to evaluate the midterm clinical and radiological results of a double incision repair with early mobilization at 2 years minimum follow up. We hypothesized that Morrey's double incision technique associated with immediate mobilization is reliable, with a low rate of complications.

2. Material and methods

2.1. Study characteristics

This was a retrospective single-center study from December 2008 to March 2014. Between December 2008 and March 2014 all healthy (ASA 1 or 2) patients with an acute distal biceps tendon rupture were included and operated by the senior author using the same technique. Patients who presented with chronic lesions (> 30 days after injury) were excluded as were patients with a ASA score of 3 or 4. These patients were offered non-operative treatment.

2.2. Population

Seventy-four consecutive patients were operated for an acute distal biceps tear; sixteen patients were lost to follow-up leaving 58 patients with minimum of two years follow-up. Among the patients lost to follow up, 5 declined follow-up after one year, 6 did not live in France, 4 changed their address and one was deceased. Mean age was 47 ± 8 years old and the dominant side was involved in 33 patients (57%). The patients were operated on average at 8 days after the injury (3–30 days). The mean follow-up was 53 ± 7 months (Table 1). Ten patients were involved in an accident at work. Twelve patients suffered from pain around the elbow in the weeks or months preceding the accident.

Table 1
Demographics.

Men/Women	58/0
Age (years)	49 (36–67)
Dominant side	33 (57%)
Delay to surgery (days, range)	8 (3 to 30)
Traumatic mecanism	
Heavy load	−25
Resistance in supination	−11
Active supination and flexion	−15
Sport	−7
Occupation	
Strength occupation	−24
Executive	−31
Sportsman	−0
Pensioner during sport	−3

2.3. Surgical technique

Surgery was performed under general anesthesia (Fig. 1). Patients were placed supine on the operating table with a tourniquet around the arm. A 2 to 3-cm transverse incision was first made in the anterior elbow crease. The lateral cutaneous nerve was identified and held laterally from the aponeurotic expansion of the biceps. To protect the lateral cutaneous nerve the path of the future tendon was controlled posterior and medially, in order to avoid trapping the nerve. The tendon was identified through this incision followed by the biceps tuberosity by placing the forearm in full supination. A curved clamp was passed along the route of the tendon, close to the medial part of the tuberosity, through the interosseous space and progressed subcutaneously to the posterior aspect of the forearm. In full pronation, an axial 2 to 3 cm second skin incision was then made posteriorly, centered by the tip of the clamp. The radial tuberosity was then exposed by splitting the muscle belly and the clamp was used to pass a suture shuttle. A loop was left along the route of the biceps tendon between the two incisions. The hypertrophic distal part of the tendon was debrided in order to obtain a regular cylindrical shape. Two sutures of different color were passed through the tendon with a loop technique. One Fiberloop® (Arthrex©) suture and one absorbable suture Optime® (Péters surgical©) were used. The bicipital tuberosity was prepared. The radial tuberosity was debrided after which two unicortical holes were drilled with a 7-mm drill in the anterior cortex and later connected creating a regular oval cavity of 7 by 12 millimeters. Two 2.0-mm drill holes were then made 4 to 5 mm apart through the dorsal cortical margin of the tuberosity. Special attention was paid to gently removing all the bone debris produced by the drilling of the cavity. The previously placed loop was used to pass the tendon around the tuberosity. The tendon sutures were passed inside-outside through the 2 millimeter holes. The biceps tendon was pulled into the cavity, cycling in pronation-supination to obtain an adequate tensioning. Sutures were finally tied and the tourniquet deflated to make hemostasis (Fig. 1).

2.4. Postoperative care

A simple sling was used, and the patient was allowed to perform active motion immediately after surgery, avoiding any resistance. Self-rehabilitation instructions were provided before surgery. Four times a day, the patient performed a minimum of 20 rotations of the wrist at 90 degrees and 20 cycles of elbow extension and flexion, standing in front of a mirror and doing the exercises with both hands. No weight lifting was allowed and strengthening was permitted after six weeks. In case of postoperative stiffness at 2 weeks follow-up, the patient was referred to physiotherapy.

2.5. Clinical and radiological evaluation

The follow-up was prospective, performed by an independent assessor, at 3, 6, 12 and 24 months, and every two years. The clinical examination was bilateral and comparative and evaluated range of motion, and arm circumference. Satisfaction of the patient and subjective elbow value (SEV) were also analyzed. The SEV score is defined as the patient's subjective overall assessment of their elbow expressed as a percentage of an entirely normal elbow which would score 100%. SEV below 90% was estimated as a "poor result". Biceps strength in flexion and supination were measured, with the elbow positioned at 90° of flexion in neutral forearm rotation. Both the involved and uninvolved sides were assessed, with an AREX® dynamometer, four times each, with a period of rest of

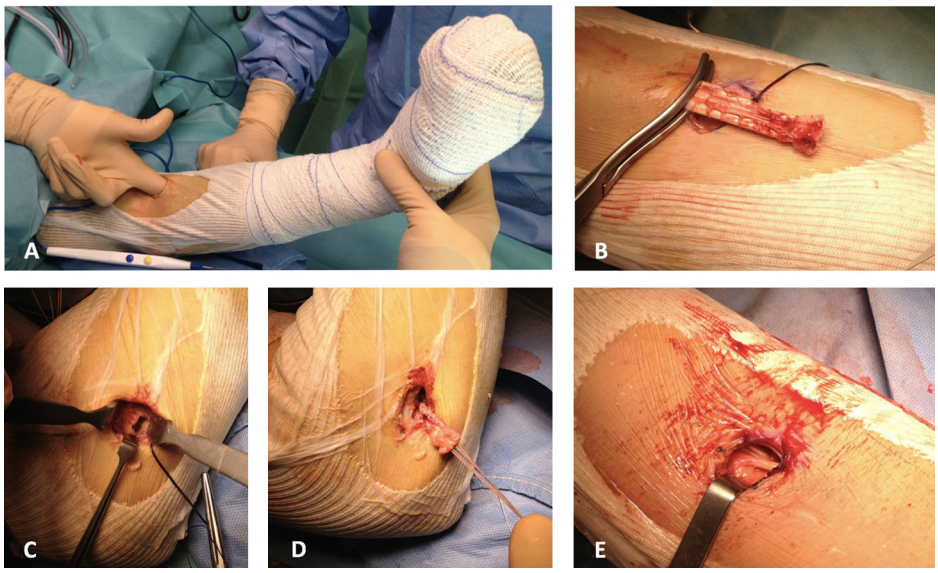

Fig. 1. A). After transverse incision, palpation of the biceps tendon. B). Reduction of the hypertrophic distal part of the tendon to obtain a regular cylindrical shape. C). Preparation of the bicipital tuberosity: cavity was made with two unicortical holes. D). Biceps tendon passage around the tuberosity. E). Tendon placing into the cavity, in prono-supination to obtain an adequate tensioning.

30 seconds, with calculation of the mean value. Strength and range of motion measurements were then indexed to the uninvolved elbow. The DASH (disabilities of the arm, shoulder and hand) and the MEPS score (Mayo elbow performance score) were calculated. Mayo Elbow Performance Score (MEPS) assigns a maximum of 100 points, which would correspond to a normal elbow. It includes the following objective elements: measurement of the arc of flexion (20 points), evaluation of varus-valgus instability (10 points), and evaluation of the ability to perform activities of daily living (25 points). It also includes pain as a subjective element, worth 45 points. We also ask to the patient if they had biceps pain days or weeks before tendon rupture.

The radiological evaluation was made with standard AP and lateral views of the elbow every year during the first two years and in each consultation after. The manuscript has been read and approved by the Ethical Committee and Institutional Review Board of the hospital.

3. Results

3.1. Clinical evaluation

Clinical results are presented in Table 2. The mean follow-up was 53 months (24–61), clinical scores (MEPS and DASH) were presented in Table 3. Mean SEV score was 94% (85–100). Twelve patients (21%) had an SEV below 90%.

No side-to-side differences between the operated and non-operated side were noted. The average results of the range of motion are shown in Table 3. At last follow-up, strength in flexion was mean 94 ± 8% and strength in supination was 90.5 ± 12%, compared to the contralateral side. Thirteen patients had at least equal or greater strength in supination (> 100% compared to the contralateral side), and 15 patients had the same results for flexion.

Table 2
Clinical results at last follow-up ($n = 58$).

	Average
Extension (°)	−0.5 ± 1.8 (−10 to 0)
Flexion (°)	138 ± 6.5 (130 to 150)
Pronation (°)	72 ± 15.7 (60 to 90)
Supination (°)	81 ± 9.5 (70 to 90)
Flexion strength (%)	94 ± 8.6 (70 to 110)
Supination strength (%)	90 ± 12.3 (60 to 120)
Back to work (days)	46 ± 26 (1 to 95)
Outplacement	4

Table 3
Subjective results at last follow-up ($n = 58$).

	Mean (range)
Follow up (months)	53 ± 7 (24 to 61)
MEPS (/100)	97 ± 3 (85 to 100)
DASH (pts)	7.5 ± 9 (5 to 13)
VAS (/10)	0.07 ± 0.3 (0 to 2)
SEV (%)	94 ± 6 (85 to 100)

3.2. Complications and revision

There was no biceps tendon re-rupture and no nerve injury was observed. A radioulnar synostosis occurred in one patient and required reoperation. Three patients were still painful, one of them with VAS of 2 and the two others with VAS of 1 during mobilization of the elbow. One patient had heterotopic ossification along the biceps tendon, without functional impairment.

3.3. Specific analysis of the 12 patients with "poor results"

Twelve patients (21%, mean age 51 years) presented with "poor results" (SEV < 90%). Mean flexion strength in this group was 78% ± 5 and supination strength was 77% ± 5.

All 12 patients were manual workers comparable to the rest of the series, and had previous pain on the biceps tendon before the day of the rupture. They all returned to work but 7 (58%) had adapted their work to decrease their strength exercises.

4. Discussion

After a minimum follow-up of 2 years following double-incision distal biceps repair, patients regained good elbow range of motion, strength, with a low rate of complications. Patients returned to work by two months with only four patients requiring a change of work. Eighty percent of patients achieved an SEV score greater than 90% with the average MEPS and DASH scores being very

satisfactory. No biceps tendon re-ruptures and no nerve injuries were identified during or after surgery. A radioulnar synostosis occurred in one patient and needed a reoperation but at final follow-up his elbow had good function. No functional impairments were present in the patient with proximal radio-ulnar synostosis or in the patient with heterotopic ossification. The majority of our study patients had no pain issues postoperatively. Only patients with worker compensation claims had mild-moderate pain (VAS < 3). It was manual worker with a professional activity for more than 20 years. The twelve patients with an SEV score below 90% had pain several days or weeks before the rupture suggesting bicipital tendinopathy pre-rupture and were all manual workers. All returned to work but most of them adapted their work to decrease their demand on the elbow. This group was no different compared to the rest of the series for age and activity.

The results in our study support the double incision technique with early mobilization as being safe with efficient return of functional range of elbow motion and satisfactory results after 53 months in young and active population. Morrey [28] et al. described an average loss of supination and flexion strength respectively of 40% and 30% if patients had non-operative treatment. Freeman and al. found a significant difference in supination strength in favor of surgical treatment versus non-operative treatment [6]. Even though some authors favor single incision repair [8,10,25–28], the two-incision procedure remains minimally invasive. A partial or total arthroscopic approach has been described, but needs to be evaluated in larger series [2,29]. The largest experience of the two-incision procedure was reported by the Mayo clinic [24] with 78 patients, Austin [30] with 84 patients, Hartman [31] with 33 patients and Bisson [32] with 45 patients. According to these studies, nerve injuries are quite rare with the double incision technique. A safe anterior approach should not be lateral, but rather centered at the middle of the anterior aspect of the elbow, otherwise the dissection might damage the radial nerve. The musculo-cutaneous nerve is more exposed and should always be left medial to the tendon proximally, as it passes over it distal part in a lateral direction (Fig. 2). The posterior approach to the radial tuberosity allows posterior fixation of the tendon, on the anatomical site of insertion. This may be more efficient than the anterior approach, which has a tendency to re implant the tendon on the anterior aspect of the tuberosity. Moreover, pinning the bicipital tuberosity by an anterior approach has an increased risk to damage the posterior interosseous nerve (PIN) which is very close to the posterior cortical bone (Fig. 3). Lo Ey et al. [14] found a mean distance of 11.2 ± 3.2 mm between the drill tip and the nerve, aiming 90° across the radius. But the distance was only 2.0 ± 2.2 mm aiming the drill 45° distally. Duquin et al. [33] found in an anatomic study that one third of the patients had a high risk of nerve branch injury because the distance of nerve branches to the bicipital tuberosity is less than 5 mm. Legg et al. [33] in their series found excellent clinical results with a single incision and anchor despite 26% of lost of follow-up. There are a significant number of complications with 2 transient PIN palsies and 8 injuries of the lateral antebrachial cutaneous nerve of the forearm. Radiological complications without clinical incidence were also identified: ostoelysis of the bony tunnel in 4 patients and 14 heterotopic ossifications.

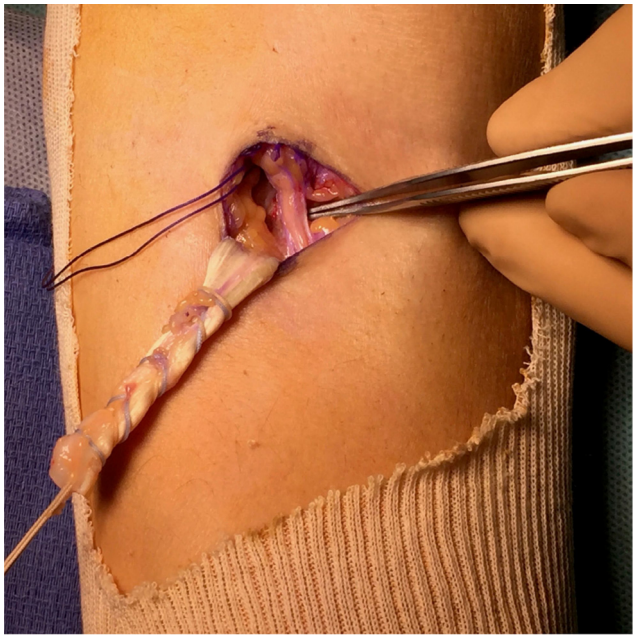

Fig. 2. Visualization of the musculo-cutaneous nerve, which must remain in the medial position in relation to the tendon.

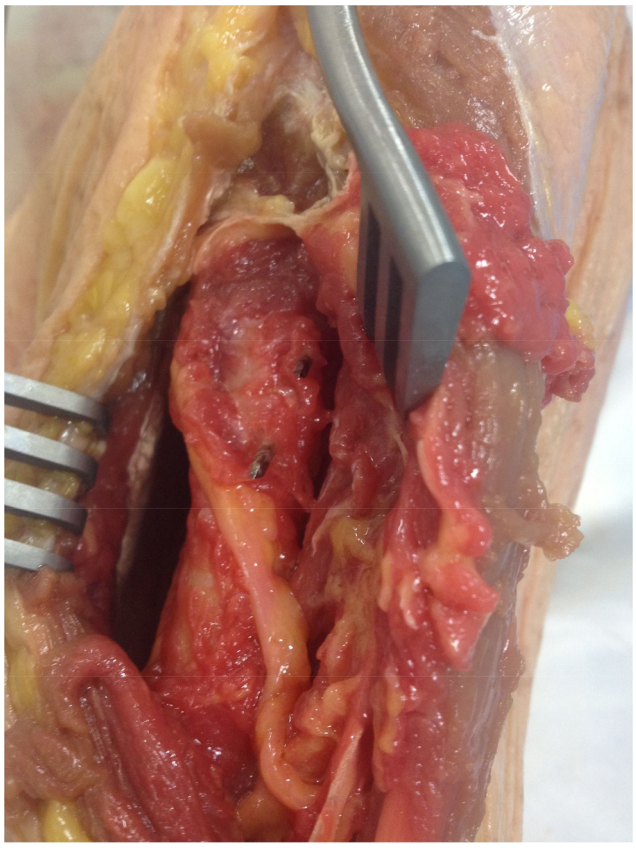

Fig. 3. Visualization of the posterior interosseous nerve. Proximity of the nerve during the preparation of the bicipital tuberosity.

Concerning the method of fixation of the tendon to the bone, several techniques have been described. Moreover, one should consider the cost of devices like anchors [19,25] or endobuttons [11,12], which are more expensive than standard sutures.

Postoperative care can substantially impact the clinical results. Indeed, as previously advocated by some authors [34–36], early active motion permits quick and reliable healing, as long as the patient is compliant. In our series, a simple sling was used, the patient being allowed to remove it in order to use the arm, with no restriction of range of motion. Forearm rotation was strongly recommended. It appears that the patients who presented with forearm rotation stiffness might have had difficulties in understanding the recommendations of the surgical staff. However, contraction of the biceps against resistance or weight lifting exceeding one kilogram was forbidden. Kodde et al. [15] published a systematic review

of the available literature on anatomic reconstruction methods for distal biceps tendon ruptures. They found fewer complications after the double-incision approach with bone tunnel fixation. Double-incision approach had significantly fewer complications than the single-incision anterior approach, in particular about a lateral antebrachial cutaneus nerve palsy. In several series, lateral antebrachial cutaneus nerve palsy is the most common complication encountered [36]. Bone tunnel fixation had significantly fewer complications than suture anchors, interference screws, and cortical buttons. In our series, we confirm the double incision approach is safe and reliable with no nerve injury or re-reputure. This procedure allows a return to work before two months with a functional elbow range of motion. As they were satisfied with the results, they did not want to return for follow-up. Six of these patients no longer lived in France. The low rate of ossifications in our series (2/58) can be explained by the immediate mobilization of the elbow [17,34], but also by the non-exposure of the periostal surface of the ulna, and the second posterior incision with muscular splitting approach [18,37]. In case of symptomatic radioulnar synostosis greater than 6 months, a resection can be performed in order to increase range of motion. The only patient in our series with synostosis recovered full range of motion after re-operation for bony resection with no functional impairment. Of course, there is a risk of injury the posterior interosseous nerve during resection which the surgeon should be aware of [18]. The limits of our study are the number lost to follow up and that it is a cohort study with no comparison group. However, this study has several strengths: the significant number of patients and the very low complication rate. All the patients were operated by the same surgeon, with the same procedure.

5. Conclusion

Surgical reinsertion of the distal biceps, using the modified Boyd and Anderson procedure, appears to be a safe and reliable way to treat patients presenting with a rupture of the distal biceps tendon. A prospective randomized study comparing our surgical technique to a simple first approach is necessary to confirm these results. Immediate mobilization enabled quick healing, with reduced stiffness and did not result in any re-ruptures in our series. We identified very few complications. We recommend a standardized procedure and also advocate immediate mobilization the day after surgery. This surgical technique and post-operative protocol may enhance the clinical results and limit the complications of this surgery.

Disclosure of interest

The authors declare that they have no competing interest.

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None

Contribution

All authors have had a role for biomechanic tests and/or the writing of the article which is issued from a SoFCOT symposium.

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