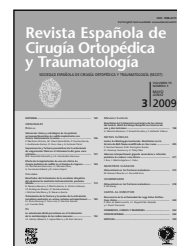




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### ORIGINAL PAPERS

## Results of surgical treatment of ruptures of the distal biceps brachii tendon by means of one and two-incision techniques

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#### KEYWORDS

Elbow;  
Biceps tendon;  
Ruptures;  
Surgical treatment;  
Suture anchors

#### Abstract

**Purpose:** To compare the results achieved by one- and two-incision techniques in the reattachment of the distal biceps tendon.

**Materials and methods:** Review of 59 patients with an acute rupture of the distal biceps brachii tendon diagnosed over a 14-year period (1990-2004). All patients were male, of a mean age of 46 years. In most cases the rupture had been brought about by a forceful flexion of the elbow in combination with resisted supination. Fifty-seven patients were subjected to surgery: tendon detachment was found in 50 cases, a fully ruptured tendon at 1-2 cm of the attachment site in 5 cases and a partial rupture in 2. Henry's anterior approach was used in 36 cases and Boyd and Anderson's combined approach in 21. The use of suture anchors facilitates reattachment. Results were assessed by means of Broberg and Morrey's scale.

**Results:** The most usual complications were radial nerve lesions, wound dehiscences and complex regional pain syndrome type 1. No significant differences were found between the two approaches in terms of complications. Mean time to work resumption was 21 weeks. None of the cases resulted in occupational disability. The final result was rated as excellent in 54 patients and good in 3.

**Conclusion:** Surgical treatment affords good results in ruptures of distal biceps brachii, although it is not exempt from complications.

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## PALABRAS CLAVE

Codo;  
Tendón del bíceps;  
Roturas;  
Tratamiento quirúrgico;  
Anclajes  
instrumentados

## Resultados del tratamiento quirúrgico de las roturas del tendón distal del bíceps braquial con técnicas de una y dos incisiones

### Resumen

**Objetivo:** Comparar los resultados de las técnicas de una y dos incisiones para la reinserción ósea del tendón distal del bíceps.

**Material y métodos:** Serie de 59 sujetos diagnosticados de rotura aguda del tendón distal del bíceps braquial durante 14 años (desde 1990 hasta 2004). El 100% eran varones y su edad media era de 46 años; en la mayoría, la rotura se había producido por flexión forzada contra resistencia asociada a supinación. Se intervino quirúrgicamente a 57 sujetos, en los que se encontraron 50 desinserciones óseas, en 5 sujetos se encontró rotura completa a 1 o 2 cm de la inserción, y en 2 sujetos se encontró rotura parcial. En 36 casos se utilizó la vía anterior de Henry y en 21 casos se utilizó la doble vía de Boyd y Anderson. El uso de los anclajes instrumentados facilitó la reinserción. Los resultados se valoraron según la escala para codo de Broberg y Morrey.

**Resultados:** Las complicaciones más frecuentes fueron las lesiones del nervio radial, las dehiscencias de la herida y los síndromes de dolor regional complejo tipo I. No se encontraron diferencias significativas entre los 2 abordajes en cuanto a la incidencia de complicaciones. El tiempo promedio para la reincorporación laboral fue de 21 semanas. Ningún caso derivó a incapacidad laboral. Se valoró el resultado final como excelente en 54 sujetos y como bueno en 3 sujetos.

**Conclusión:** El tratamiento quirúrgico consigue buenos resultados en la rotura distal del tendón del bíceps braquial, aunque no está exento de complicaciones.

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## Introduction

The distal biceps tendon plays a key role in elbow flexion and forearm supination. It may be injured acutely as a result of abrupt biceps contraction or overstrain when the elbow is flexed and the forearm supinated.

Clinically, injury starts with sudden pain on the anterior aspect of the elbow. Physical examination usually reveals loss of strength as well as limited flexion and above all supination of the forearm. There may be proximal displacement of the biceps muscle (fig. 1), although this is not a consistent finding; hematoma or ecchymosis may also be present on the anterior aspect of the elbow. The course



Figure 1 Proximal displacement of biceps.

of the tendon cannot be palpated with the elbow flexed against resistance.

The injury may occur in a healthy tendon or in a previously degenerated one. In the latter case, less force is needed to cause the lesion. Because of the torque experienced by the tendon fibers at their attachment, this area is exposed to repeated friction with the bone on pronosupination, which favors the onset of degenerative processes. Seiler et al report that tears occur chiefly in an area with scarce blood supply located 10-12 mm away from the insertion point<sup>1</sup>.

Although the first surgical repair of the distal biceps tendon is attributed to Acquaviva (1898), it was Dobbie who, in 1941, published the first series, made up of 51 cases. The treatment consisted in suturing the avulsed tendon to the brachialis muscle. A good functional result was obtained, albeit with significant loss of strength. In 1948, Debeyre performed the first bony reattachment of the distal biceps tendon to the radial tuberosity.

The available surgical approaches for this condition are those developed by Henry (single incision) and Boyd and Anderson (two incisions). Since the single incision technique increased the incidence of radial nerve injuries, use of the 2-incision technique became widespread, although it can also injure the radial nerve and, in addition, provoke radioulnar synostosis. The technical modification introduced by Bourne and Morrey has reduced the prevalence of the latter complication<sup>2</sup>. More recently, instrumented anchors have facilitated manipulation of the tuberosity, so that Henry's approach can be used with fewer complications.

The purpose of this review was to compare the results of one and 2 incision techniques for the bony reattachment of

the distal biceps tendon, as well as to determine whether instrumented anchors can decrease the risk to injure the radial nerve.

## Materials and methods

We retrospectively reviewed the records of 59 subjects diagnosed with a rupture or detachment of the distal biceps tendon from 1990 until 2004. Mean age was 45 years (range: 30-58). All patients were male with a predominance of the right side (32 cases). The majority of patients were manual workers with extremely burly arms and forearms. In 36 of these patients (63%), the injury was caused by forceful elbow flexion against resistance, with a supinated forearm (table 1).

Supplementary tests carried out included 42 x-rays, 47 sonograms and 11 magnetic resonances (MRI).

We obtained informed consent from all patients before treatment and follow-up.

Two cases were excluded: the first one (diagnosed clinically and by MRI) was administered conservative treatment because a diagnostic sonogram revealed a non-tendinous myotendinous rupture; the second patient (diagnosed clinically and sonographically) was subjected to surgery, with tendon intactness being revealed intraoperatively.

Time to surgery was a mean of 8 days (range: 0-28) from injury. In the 57 subjects operated there were 55 full and 2 partial tears. Of the 55 full tears, 50 were detachments or avulsions of the tuberosity and 5 ruptures occurred at 1 or 2 cm from the insertion point.

Henry's approach (single incision) was used in 36 subjects (64%). In 3 of these the tendon was reattached with transosseous sutures (drilling of a bony trough, perforation of a transosseous tunnel and passage of a non-resorbable suture) and in 33 subjects instrumented anchors were used (suture materials or screws).

The two-incision approach promoted by Boyd and Anderson was applied in 21 cases (36%); in 11 subjects the reattachment was carried out with transosseous stitches and in 10 subjects with instrumented anchors.

During the post-operative period, patients had to wear a brachio-antebrachial cast with the elbow at 90° flexion for 5 to 6 weeks. This was followed by an 11-week (range: 4-48 weeks) rehabilitation program consisting in gentle active and passive mobilization exercises where range of motion was gradually increased. At 8 weeks, the muscle

strengthening phase was started, also in a progressive way, until full recovery was achieved. Only in a few isolated cases did we use, after 3 weeks' immobilization with a plaster splint at 90°, articulated orthoses for active and passive mobility for 3 additional weeks, as described by Morrey<sup>3</sup>.

Mean follow-up was 3 years (range: 6 months-15 years). Results were assessed on the Broberg and Morrey's scale<sup>4</sup>.

## Results

Complications occurred in 31 subjects (table 2). The most usual complication was radial nerve involvement (8 cases, 14%). Four of these patients (7%) went on to develop radial nerve palsy. Among the subjects operated through an anterior approach there were 5 cases with radial nerve problems (14%). Among those operated with transosseous sutures there was one case of dyesthesia (33%) and among the 33 subjects treated with instrumented anchors there was one case of nerve palsy (3%) and 3 cases of dyesthesia (9%). Among the subjects operated through a combined approach there were 3 subjects who developed radial nerve palsy (14%); in all of them transosseous sutures were applied. All nerve lesions recovered spontaneously after variable periods of time.

Other complications included 2 heterotopic ossifications (fig. 4) and one instance of hardware avulsion; none of these had functional repercussions. Two patients developed radioulnar synostosis; both experienced functional repercussions and required secondary surgery to resect the bony bridge. Additional surgery was also necessary in cases of tendon escharifications and bone perforations resulting from secondary tendonitis. Six subjects developed type I reflex complex regional pain syndrome, which evolved favorably with pharmacological treatment with calcitonin, calcium, anxiolytics, gabapentin and mild rehabilitation. No nerve or intravenous blocks were necessary.

Mean time off work was 38 weeks (range: 8-195), with all patients going back to their previous jobs. No subject developed any permanent disability.

Ten subjects experienced a decrease in strength and mobility, quantified on Broberg and Morrey's scale (table 3), which does not reflect extension lags. According to this

**Table 1** Mechanisms of injury in this series

Mechanism of injury	N. of cases
Overstrain when lifting weight	36
Be hanging by one arm	7
Sudden muscle strain	7
Fall	4
Direct concussion	2
Elbow hyperextension	1

**Table 2** Complications in this study

Complication type	N. of cases	Evolution
Radial nerve lesion	8	Resolved
Reflex sympathetic dystrophy	6	Resolved
Delayed healing	7	Resolved
Ectopic calcifications	2	Resolved
Wound infections	2	Resolved
Hematoma or seroma	2	Resolved
Radioulnar synostosis	2	Required surgery
Hardware avulsion	1	Resolved
Secondary tendonitis	1	Surgery

**Table 3** Broberg and Morrey's scale<sup>4</sup>

Mobility	Flexion	0,2 × ARC		
	Pronation	0,1 × ARC		
	Supination	0,1 × ARC		
Strength	Normal	Mild loss No limitation 80%opposite side	Moderate loss Limits everyday tasks 50%opposite side	Severe loss Disability
	20	13	5	0
Stability	Normal	Mild loss	Moderate loss	Severe loss
	5	4	2	0
Pain	None	Mild With activity	Moderate With and after activity	Severe Disability, medication
	35	28	15	0
	Result			
	95-100	Out of 100 Excellent		
	80-94	Good		
	60-79	Fair		
	0-59	Poor		

ARC: range of motion (in degrees).

scale, final results were excellent in 54 cases and good in 3 cases.

## Discussion

Distal biceps tendon ruptures are rare injuries, accounting for 3% of all brachial biceps lesions<sup>6-8</sup>; their incidence is 1.2 cases per 100.000 subjects a year<sup>8</sup>. This low incidence explains the low number of cases in the published series, most of them including 20 to 30 subjects<sup>7,9-11</sup>, although there is also a multicenter study of 43 patients<sup>12</sup> and a series of 53 cases<sup>13</sup>. We only found one series that was larger than the one reported herein (74 cases)<sup>2</sup>.

This injury commonly occurs in middle-aged workers who do strenuous manual work, generally characterized by brawny arms and forearms, such as truck-drivers, locomotive drivers, polishers, stevedores, etc.

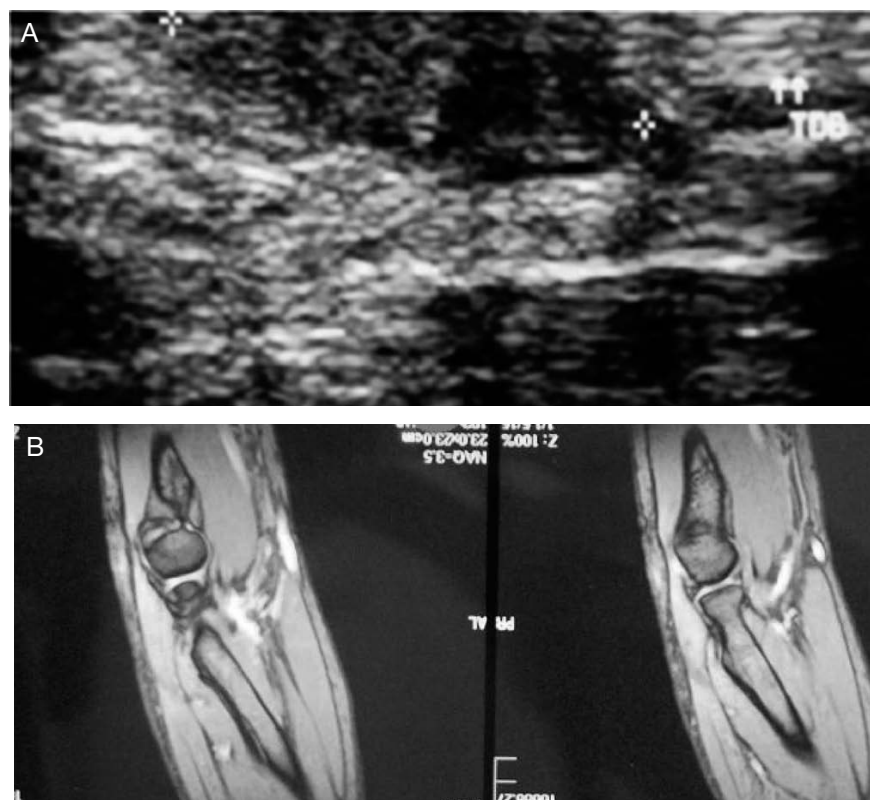
In the series presented herein, all cases were acute. In acute cases there may be a previous subclinical degenerative process that weakens the tendon and promotes its rupture<sup>7,14</sup>. This degenerative mechanism may result from continuous friction between the tendon and the radius and ulna during pronosupination movements in cases of maximum effort, which could lead to impingement associated to hypovascularization of the distal-most 2 cm<sup>1</sup>. Another factor that may influence this continuous friction is hypertrophy of the bicipital tuberosity<sup>3,15</sup>. It has been reported that in smokers the risk is 7.5 times higher<sup>10</sup>.

Diagnosis of these ruptures is basically clinical: the bulging tendon disappears into the antecubital fossa when the elbow is flexed against resistance. The most common

diagnostic test is ultrasound, which is economical, easily performed and acceptably reliable<sup>8</sup> (fig. 2A). In the event of diagnostic doubt, MRI offers greater accuracy when defining the injury, its location and the tendon characteristics<sup>11,16</sup> (fig. 2B). A plain film must always be performed to rule out associated diseases and bony avulsions.

Treatment of young patients in the occupational setting has consisted chiefly in distal biceps tendon reattachment. Surgery is performed at a mean of 8 days after injury, with maximum surgical delay at 28 days. These injuries may go unnoticed at the beginning and be diagnosed later during their evolution, which is why surgery may at times be delayed more than it should. No significant differences have been found regarding time-to-surgery in cases where the tendon has been properly reattached, although in some cases the tendinous canal may be obliterated, complicating its identification. Tendon retractions and tendinous canal obliteration may preclude reattachment, making it necessary to resort to other techniques such as suturing the tendon to the brachialis muscle or using semitendinosus or Achilles tendon allografts<sup>17,18</sup>.

Different approaches and techniques have been reported in the literature, although the most popular ones seem to be Henry's anterior approach and Boyd and Anderson's approach. Other approaches have been described, such as the posterior approach for treatment of partial tears<sup>25</sup> and mini-incisions for full tears<sup>26</sup>, but their use is rather limited. The main advantage of the anterior approach is ease of access to the tuberosity, but it has the disadvantage of using a narrow passage that complicates the reattachment maneuvers, with the added risk of injuring the radial nerve<sup>5,7,11</sup>. On the other hand, the combined approach



**Figure 2** Ultrasound showing a ruptured brachial biceps (A) and magnetic resonance of another biceps rupture (B).

permits a much broader access to the tuberosity, greatly facilitating the reattachment maneuvers<sup>8,9</sup>.

The combined approach is allegedly associated to a lower risk to injure the radial nerve, although our own experience has not borne out this contention: 3 instances of radial nerve palsy were detected among subjects subjected to a combined approach. The radial nerve lesion can be caused by the retractors or when reaming the tunnel that the tendon must follow until the external incision<sup>2</sup>. Comparatively, 5 instances of nerve involvement (4 dysesthesias and 1 palsy) appeared in the subjects operated with an anterior approach. The total number of palsies detected following surgery is equivalent to an incidence of 7% which is close to that reported in the literature<sup>24</sup>. Fortunately, all injuries have recovered spontaneously. For that reason, this type of surgery is not exempt from complications, the most usual and severe one being a lesion to the posterior interosseous branch of the radial nerve<sup>3,4,6,10,24</sup>.

Moreover, among subjects operated with a combined approach there were 2 cases of radioulnar synostosis, which required a new surgery<sup>6-8,27</sup>. Given that the combined approach is not exempt from complications, some authors claim that Henry's approach seems the most suitable one, especially since the advent of instrumented anchors<sup>5,8,10,13,23,26</sup>. Nevertheless, other authors do not see any differences between both methods and recommend the use of either technique depending on the preferences on the individual surgeon<sup>28,29</sup>.

As an attachment procedure, transosseous sutures<sup>19</sup> are used less and less often. Use of instrumented anchors is

quickly gaining ground because of they facilitate surgery and the manipulation of the whole area<sup>20</sup> (figs. 3A-E). Some studies show that there are no differences with transosseous sutures regarding mechanical strength<sup>16,21</sup>. In 2002, Bain started using the endobutton technique for these fixation maneuvers; this is a button-based anchoring system that had so far been used in anterior cruciate ligament repairs<sup>22,23</sup>. The advent of instrumented anchors, mini-burrs for reaming the bone trough and the use of sliding stitches have facilitated manipulation of the tuberosity.

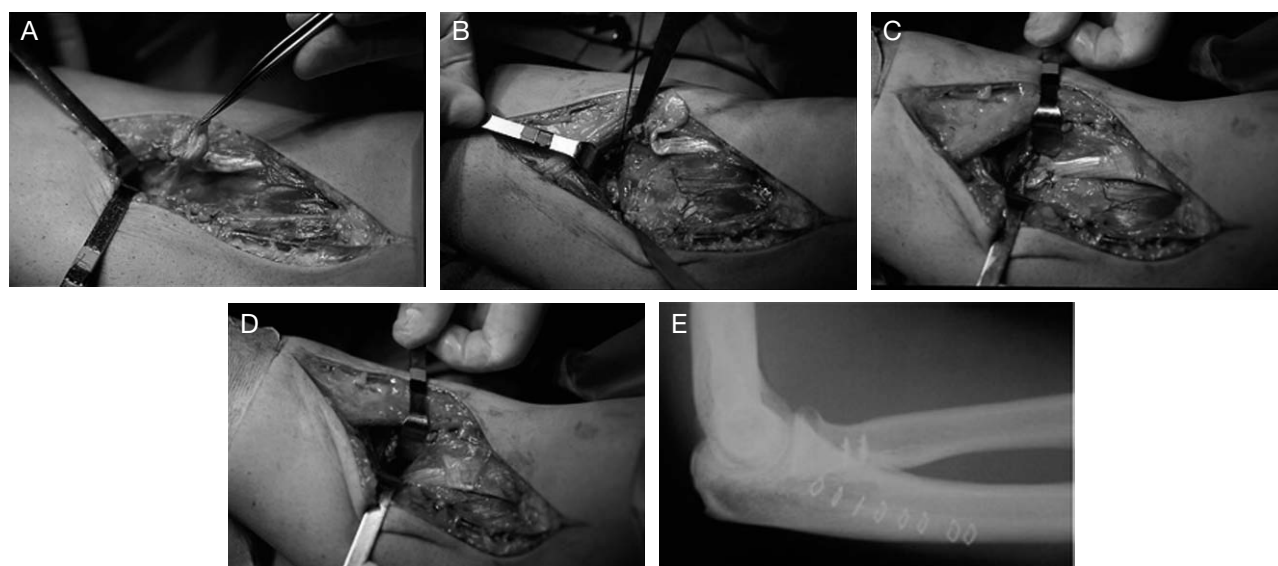
To conclude, distal biceps tendon ruptures, although infrequent, are highly prevalent injuries in the workplace. Surgical treatment, even if not exempt from complications, is indicated in the majority of cases and offers good results.

## Conflict of interests

The authors have not received any financial support in the preparation of this article. Nor have they signed any agreement entitling them to receive benefits or fees from any commercial entity. Furthermore, no commercial entity has paid or will pay any sum to any foundation, educational institution or other non-profit-making organization to which they may be affiliated.

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**Figure 3** Intraoperative views of a tendon reattachment (A, B) by means of instrumented anchors (C, D), (E) Postoperative x-ray.



**Figure 4** X-ray view of ectopic calcifications in a ruptured biceps.

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