Suture anchor reinsertion of distal biceps rupture: Clinical results and radiological assessment of tendon healing

D. Gallinet\textsuperscript{a,}*, E. Dietsch\textsuperscript{b}, B. Barbier-Brion\textsuperscript{b}, J.-M. Lerais\textsuperscript{b}, L. Obert\textsuperscript{c}

\textsuperscript{a} Saint-Vincent Private Hospital, 40, Chemin des Tilleroyes, 25000 Besançon, France
\textsuperscript{b} Radiology Department C, Jean Minjoz University Hospital, Boulevard Fleming, 25030 Besançon cedex, France
\textsuperscript{c} Department of Orthopedics, Traumatology, Reconstructive and Hand Surgery, Jean Minjoz University Hospital, Boulevard Fleming, 25030 Besançon cedex, France

Accepted: 18 November 2010

Summary

Introduction: The present study consisted in a clinical follow-up of patients with distal rupture of the biceps brachii tendon managed by suture anchor reinsertion to the radial tuberosity. Tendon apposition on the cortical bone is the least resistant reinsertion technique according to biomechanical studies. A parallel radiological (X-ray and MRI) study was therefore performed to assess the exact quality of tendon healing and its correlation to clinical results.

Patients and methods: Twenty-eight patients were followed up retrospectively at a mean 22 months (minimum FU: six months) with clinical examination (mobility, force, satisfaction, residual pain, and return to work) and radiological assessment (standard X-ray exploration for heterotopic ossification, and MRI for quality of healing of the tendon apposed to the cortical bone).

Results: Forty percent of cases showed complications (mainly neurological) which resolved without sequelae under medical treatment. Mobility was normal in all but eight patients who showed $-5^\circ$ to $-20^\circ$ supination loss. Force in flexion-supination was 91\% of that on the contralateral side. On X-ray, only 46\% of patients were free of ossification. On MRI, reinsertion was judged anatomic in 19 patients (70\%), moderate in six and poor in two, with one iterative rupture. Statistical analysis revealed that the greater the number of suture tacks through the tendon, the greater the force in patients with less than two weeks’ interval to surgery and satisfactory reinsertion on MRI.
Discussion: Many reinsertion techniques have been reported, giving clinical results similar to one another and to the present findings. The complications rate, in contrast, varies according to technique and surgical approach. Radiologically, 70% of reinsertions were satisfactory: healing with the tendon apposed on the cortical bone is thus a reliable technique. Heterotopic ossification is considered benign in the literature. The present radiological study refined this notion by identifying three types of ossification: pure asymptomatic intratendon ossification; pure asymptomatic tuberosity ossification without impact on healing on the radial tuberosity; and tuberosity ossification with associated boney metaplasia of the terminal part of the reinserted tendon, impairing healing and leading to less satisfactory clinical results. To ensure anatomic healing of the distal biceps tendon, we recommend less than two weeks’ interval to surgery and at least two suture tacks to obtain good apposition on the radial tuberosity.

Level of evidence: Level IV: Retrospective therapeutic study.

Introduction

Distal biceps brachii tendon rupture is rare, at 1.2 per 100,000 patients per year in 40 to 50 year-old males [1]. The mechanism is usually trauma, with eccentric biceps contraction leading to disinsertion from the radial tuberosity [2]. The underlying trauma may be minor, as histologic changes in the tendon are observed as of 35 years of age, weakening the insertion [3], with a hypovascularized region in the terminal part of the tendon [4].

Without surgical reinsertion, the clinical result is unsatisfactory, with loss of force in flexion and supination of the forearm and sometimes disabling residual pain [5–7].

Surgical reinsertion to the radial tuberosity usually gives complete satisfaction, but is not without complications [8]. The quality of biceps tendon cicatrization on the cortical bone of the radial tuberosity, however, has never been studied, whatever the reinsertion technique: transosseous, suture anchor, EndoButton or endoscopy.

The present study analyzed clinical results with suture anchor reinsertion in distal biceps brachii tendon rupture. A parallel MRI study assessed the quality of tendon cicatrization on the radial tuberosity.

Patients and methods

Between 2003 and 2008, 31 patients presented with traumatic rupture of the distal biceps brachii tendon, reinserted to the radial tuberosity by suture anchor using a single surgical technique. Patients were installed in dorsal decubitus, with the upper limb lying on an arm table. The pneumatic tourniquet was positioned as high as possible on the arm so as to avoid the reinsertion region.

The singular anterior approach was via a cutaneous bayonet incision starting in the medial bicicipital groove and then moving laterally into the elbow flexion fold. The distal branch of the incision descended along the medial edge of brachioradialis muscle. Superficial veins were retracted and the lateral antebrachial cutaneous nerve was located. The biceps brachii tendon was then located and released.

The trajectory to the radial tuberosity was disclosed by progressive dissection by blunt dissector, between the medial edge of brachioradialis muscle and the lateral edge of the pronator teres. The forearm was then positioned in forced supination, to give access to the radial tuberosity. The elbow was then positioned in 60° flexion and the radial tuberosity was exposed using Langenbeck retractors (Hohmann retractors on either side of the radial neck not being recommended) (Fig. 1) so as to:

- release the motor branch of the radial nerve;
- reduce reinsertion tension, and to increase the contact between tendon and radial tuberosity.

The suture anchors were positioned on the radial tuberosity without prior rasping. The biceps brachii tendon was then tacked to and fro with a single suture. This technique enhances the solidity of the assembly while allowing the suture to slide by means of the free strand (Fig. 2). Mechanically solid reinsertion was thus obtained, with optimal tendon/bone contact.

Figure 1 Radial tuberosity approach.

Figure 2 Suture anchor reinsertion and to-and-fro tacking of distal biceps brachii tendon.
Table 1  description of anchors.

<table>
<thead>
<tr>
<th>Type of suture anchor</th>
<th>Resorbable</th>
<th>Number of tacks</th>
<th>Type of suture</th>
</tr>
</thead>
<tbody>
<tr>
<td>Panalok 3.5 mm (Depuy Mitek®)</td>
<td>Yes</td>
<td>2</td>
<td>Slow resorption</td>
</tr>
<tr>
<td>GII Quickanchor 2.4 mm (Depuy Mitek®)</td>
<td>No</td>
<td>1</td>
<td>Non-resorbable, high mechanical resistance</td>
</tr>
<tr>
<td>Super Quickanchor 2.9 mm (Depuy Mitek®)</td>
<td>No</td>
<td>2</td>
<td>Non-resorbable, high mechanical resistance</td>
</tr>
<tr>
<td>Bio-suture Tack 3 mm (Arthrex®)</td>
<td>Yes</td>
<td>1</td>
<td>Non-resorbable, high mechanical resistance</td>
</tr>
<tr>
<td>Bio-corkscrew 5 mm (Arthrex®)</td>
<td>Yes</td>
<td>2</td>
<td>Non-resorbable, high mechanical resistance</td>
</tr>
</tbody>
</table>

After abundant lavage to remove bone powder left from the preparation of the anchor insertion holes, the incision was closed by resorbable intradermal suture. The postoperative protocol comprised immobilization in a Neofrakt removable cast/splint in $60^\circ$ to $90^\circ$ elbow flexion depending on the peroperative findings, and neutral pronosupination. Rehabilitation was passive, with elbow flexion in the sector protected by the orthosis. Active work and recovery of elbow extension were initiated on removal of the cast/splint (between postoperative days 30 and 45).

Four patients could not be followed up: three lost to follow-up and one who refused to come back in consultation on the grounds that there was nothing wrong. Finally, 27 patients (i.e., 28 reinsertions) were retrospectively reviewed at a mean 22 months' FU (range, 6—55 mo) by an investigator who had been the surgeon for 25% of the patients.

All patients were male: mean age, 49 years (range, 36—60 yrs). Twenty-six were working at the time of the trauma, 70% of whom in heavy manual jobs; 54% were work accidents. The dominant side was involved in 57% of cases. Mean interval to surgery was nine days (range, 1—50 days). One patient was treated for chronic (50 months) and the others for acute (< 21 days) rupture.

Clinical assessment

Mobility was measured in flexion/extension and pronosupination.
Force was measured at $90^\circ$ elbow flexion and complete supination.
Force could not be measured in pure supination as the apparatus was lacking in the department.
Results were expressed as percentages of contralateral values and grouped according to dominant side involvement.
Subjective satisfaction, residual pain, patient’s apprehensions and return to work were collected.

Radiological assessment

All patients underwent:

- AP and lateral elbow X-ray to explore for heterotopic ossification and possible radioulnar synostosis;
- MRI, to study tendon/cortical bone cicatrization quality.

All examinations used Signa Excite HDx 3-Tesla MRI (General Electric Medical Systems, Milwaukee, WI, USA) and a dedicated HR-quadrature transmission-reception antenna. Acquisition used two weightings: T1 (TR between 800 and 1,000 ms, TE between 15 and 25 ms) and fat-saturated proton-density (TR between 2,600 and 3,500 ms, TE between 30 and 60 ms). Slices were strict axial and oblique sagittal in the tendon plane, 3 mm thick, with matrix 512 × 512. A 15-minute maximum was set for examination time, as the position is very uncomfortable for the patient (pronocubitus, arm in complete anteversion and forearm in supination), inducing a risk of movement artifacts if examination is too long. Images were analyzed together by a radiologist with training in osteoarticular imaging and the surgeon who performed the review. Cicatrization quality was arbitrarily graded as satisfactory, moderate or poor according to the contact between the biceps tendon and the radial tuberosity, there being no previous studies focusing on this parameter.

Statistical analysis

Correlations between qualitative variables were analyzed by maximum likelihood chi-square test or Fisher’s exact test, depending on the distribution. Quantitative variables were analyzed by analysis of variance: Duncan test for multiple (> 2 mean values) comparisons and non-parametric Spearman test for two variables. The significance threshold was set at 5%.

Results

Surgical data

In 25 cases, two anchors were fitted in the radial tuberosity; in one case, one anchor; and in two cases, three. In eight cases, there were two suture tacks through the biceps brachii tendon; in five cases, three; and in 15 cases, four. The anchors and their characteristics are detailed in Table 1.

Clinical assessment

A 40% complications rate was found:

- cases of lateral antibrachial cutaneous nerve paresthesia and three of radial sensory nerve paresthesia, which all resolved spontaneously;
- two reflex sympathetic dystrophy syndromes, which resolved after six months’ medical treatment;
- one radial motor palsy, which had resolved completely by one year’s follow-up.

Mobility values are presented in Table 2.
Suture anchor reinsertion of distal biceps rupture

Table 2 Mobility.

<table>
<thead>
<tr>
<th></th>
<th>Normal</th>
<th>Deficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flexion</td>
<td>26</td>
<td>2 (−10°)</td>
</tr>
<tr>
<td>Extension</td>
<td>27</td>
<td>1 (−5°)</td>
</tr>
<tr>
<td>Pronation</td>
<td>28</td>
<td>0</td>
</tr>
<tr>
<td>Supination</td>
<td>20</td>
<td>8 (−10°, 7 cases; −20°, 1 case)</td>
</tr>
</tbody>
</table>

- overall, mean flexion-supination force was 91% (range, 121–66%) of the contralateral value;
- in case of dominant side involvement, 92% (121–66%);
- and of non-dominant side involvement, 87% (105–66%).

Subjectively, 96% of patients were very satisfied with their operation and wished the same technique to be applied in case of contralateral lesion. None showed residual pain.

On the other hand, 75% of patients reported apprehension carrying heavy loads, remembering their initial trauma.

Return to work was at a mean four months (0–8 mo), in all cases to the pre-trauma job.

Radiologic assessment

On standard X-ray (Fig. 3):

- 13 patients (46%) showed no ossification;
- 10 (35%) showed radial tuberosity ossification facing the anchorages;
- seven (19%) showed intratendon ossification without contact with the radial tuberosity (or radial tuberosity ossification).

On MRI (Fig. 4):

- 19 tendon reinsertions (68%) were considered anatomic, and the result satisfactory;
- six (21%) showed thin contact between the reinserted tendon and the radial tuberosity, but with an enlarged tendon greatly remodeled by the tuberosity ossification invading its distal part, and the result was considered moderate;
- two patients showed very thin insertion without radial tuberosity ossification and 1 (with the longest interval to surgery) had iterative rupture, and these results (11%) were considered poor.

Analysis of results

According to number of tacks:

- two tacks: force 88% of contralateral;
- or 4 tacks: force 94% of contralateral ($P = 0.05$).

According to interval to surgery:

- > two weeks: force 84% of contralateral;
- < two weeks: force 93% of contralateral ($P = 0.05$).

According to reinsertion quality on MRI:

- satisfactory reinsertion: force 92% of contralateral;
- moderate and poor reinsertion: force 77% of contralateral ($P < 0.05$).
- in satisfactory or moderate quality reinsertions, mean time to surgery was six days;
- in poor quality reinsertion, 34 days ($P < 0.05$).
- mean tack number did not vary with reinsertion quality.

According to ossification:

- presence of ossification: force 92% of contralateral;
- absence of ossification: force 87% of contralateral ($P > 0.05$).

Discussion

Study limitations

This was a retrospective study on a small series, and therefore with low statistical power; few studies, however, have had larger series [9–12].

Force in pure supination could not be measured, as the apparatus was lacking in the department.

Types of reinsertion

The present clinical findings confirm the need for surgical reinsertion of distal rupture of the biceps brachii tendon, as compared to a conservative attitude [5–7].

Surgical fixation of the distal biceps brachii tendon may be non-anatomic, by tenodesis on the brachial muscle tendon [13], or anatomic, onto the radial tuberosity. It is now clearly agreed that the latter gives the better result. Tenodesis on the brachial muscle fails to restore the supination function of biceps brachii, leaving considerable residual loss of flexion force [14,15]. On the other hand, the associated complications rate is low [16]. The technique is therefore currently indicated in late treatment or elderly patients [9].

Transosseous reinsertion was the first anatomic reinsertion technique [17]. It uses a double anterior plus posterior approach. In biomechanical studies, it provided better resistance than other types of fixation [18]. On the other hand, it is not without complications: ossification with risk of proximal radioulnar synostosis, or loss of mobility in pronosupination [8,11,19–21].

Kelly et al. [11] reported a 31% complications rate with transosseous reinsertion; three of Davison et al.’s eight patients [22] had residual pain and one developed radioulnar synostosis requiring revision; and 27% of Bisson et al.’s 45 patients [23] experienced complications, but at rates which rose for repair performed more than two weeks after rupture.

Some teams modified the technique to be minimally invasive [12], which seemed to reduce the rate of complications, particularly for proximal radioulnar synostosis.

The technique seems to give very good results in terms of recovery of force: Cil et al. [24] reported 12% better flexion strength than contralaterally and 11% supination loss; for Catonné et al. [9], mean force loss was 5% in flexion and 15% in supination.
Suture anchors were developed, and were applied in distal biceps brachii tendon reinsertion as of the early 1990s [25,26]. Tendon/bone cicatrization is no longer transosseous, but by apposition on the cortex. Biomechanically, this is the least solid fixation [18,27], but mechanical resistance after cicatization is as good as with other techniques [28].

The main advantage of anchorage lies in doing away with the posterior approach, and associated proximal radioulnar synostosis risk, while conserving the interosseous membrane. In the present study as in the literature as a whole, there were no cases of synostosis [25,26,29–31]. The main problem, however, is a risk of neurologic lesion [32,33], to limit which some teams developed minimally invasive techniques [34] and; more recently, arthroscopic reinsertion [35,36]. In general, however, having a single anterior approach seems to limit the number of complications compared to a double incision [21].
Recovery of force seems to be generally satisfactory. Babaud et al. [29] reported 6% loss in flexion and none in supination, Sotereanos et al. 10% loss in flexion and 5% in supination. In the present series, there was a 9% loss in flexion compared to the contralateral side.

In the present study, there was a difference in force according to the number of suture tacks. Fogg et al. [37] demonstrated that distal biceps brachii tendon anatomy comprises a variable number of distinct bands connected by other oblique bands; they suggest that reinsertion using a single suture will fail to restore the anatomy by not distributing the bands around the radial tuberosity correctly. The present study tends to confirm this notion, a greater number of tacks being equivalent to a greater number of anchors and thus improved reinsertion of the various bands on the radial tuberosity. While our results are to be interpreted with caution, we recommend using two anchors and at least three tacks.

EndoButton reinsertion is a blend of transosseous and suture anchor reinsertion and combines the advantages of both (transosseous fixation with a single approach) while limiting the risk of proximal radioulnar synostosis [38–40]. Biomechanically, it provides better resistance [27] than transosseous and suture anchor reinsertion.

According to Greenberg et al. [39], the clinical results are excellent, with 97% force in flexion and 82% in supination. 30% of patients showed heterotopic ossification and 20% lateral antebrachial cutaneous nerve paresthesia which resolved spontaneously. For Peeters et al. [40], flexion force was 80% and supination force 91%; the EndoButton, however, had to be oblated in one case, due to detachment.

**Interval to surgery**

The present findings indicate that the interval to surgery impacts clinical results: at more than two weeks, there is a risk of greater loss of force. Moreover, MRI found poorer cicatrization with late reinsertion, and the sole iterative rupture was associated with a three-month interval to reinsertion; there was doubtless an error of indication in this particular case, and a tendon graft was probably needed [11,15,41].

In the literature, there are no studies of clinical result quality according to time to surgery. An elevated risk of complications, notably neurological, however, was reported, related to more difficult dissection in scar tissue [9,11]. This was not found in the present series, where complications were equivalent whatever the interval to surgery.

**Heterotopic ossification**

The ossification rate in the present series was surprisingly high: only 46% of patients were free of ossification. three types were distinguished:

- pure tuberosity ossification, exclusively on the radial tuberosity, with satisfactory tendon reinsertion on the radial tuberosity on MRI (Fig. 5);
- tuberosity ossification invading the terminal part of the tendon, which had no radial tuberosity contact (Fig. 6);
- purely intratendon ossification, along the biceps brachii tendon, which had satisfactory distal contact with the radial tuberosity on MRI.

Overall, ossification did not affect clinical results. In certain cases, however, ossification of the terminal part of the tendon prevented contact with the radial tuberosity (moderate or poor reinsertion on MRI), with lower force than in case of satisfactory reinsertion.

In the literature, heterotopic ossification is regularly reported [15,16,33,39,41]. Rates range from zero [30] to 50% [15]. However, the same authors report that presence of ossification does not affect the clinical result. It has sometimes been implicated in residual pain, but this was not really proven [16]. In the present series, all patients with ossification were pain-free at follow-up.

**Tendon/cortical bone cicatrization quality**

Generally speaking, suture anchor reinsertion of the biceps brachii tendon on the radial tuberosity restores near-normal anatomy: 60% of MRIs found satisfactory reinsertion. Only
Figure 6  Moderate tendon cicatrization due to tuberosity ossification, impairing contact between tendon and radial tuberosity.

three were poor: these were associated with the longest intervals to surgery (50, 30 and 21 days) and poorer clinical results.

Moderate reinsertion quality on MRI was associated with tuberosity ossification invading the terminal part of the tendon.

No comparison of suture anchor reinsertion to other forms of fixation can be made, as there are no published MRI assessments of tendon cicatrization quality.

Conclusion

The present study confirmed the quality of the clinical results and demonstrated that of the tendon/cortical bone cicatrization in suture anchor reinsertion of the distal biceps brachii tendon. Mobility was in most cases restored fully and forces partially but sufficiently to avoid any sequelae affecting daily life. The single anterior approach avoided the risk of proximal radioulnar synostosis by conserving the intraosseous membrane, but entailed a non-negligible risk of neurologic complications, which, however, were mainly benign (paresthesia) and spontaneously resolved.

Even from this small series, we can suggest the following recommendations to optimize the clinical result:

- there should be at least three tendon tacks, and therefore double strand anchors are to be preferred to single strand models;
- time to surgery should not exceed two weeks; otherwise, tendon graft or tenodesis to the brachial muscle tendon is to be preferred.

Heterotopic ossification is found in more than 50% of cases, but does not seem to affect the final clinical result unless tuberosity ossification invades the terminal part of the reinserted tendon, impairing contact with the radial tuberosity with resultant loss of force. Ossification was never associated with pain in the present series.

MRI found that 70% of reinsertions healed anatomically. Tendon/cortical bone cicatrization quality was thus thoroughly satisfactory.

Disclosure of interest

The authors declare that they have no conflicts of interest concerning this article.

References


