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Original Article

Direct repair of chronic distal biceps tendon tears☆

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ABSTRACT

Objective: To present the results from direct tendon repair using EndoButton and interference screws in patients with lesions of the distal biceps that had evolved over a period of more than 28 days.

Methods: Between January 2012 and November 2013, eleven patients (all male) with a torn distal biceps and a time interval between injury and surgery of more than 28 days were evaluated. The patients' mean age was 46 years and the most common mechanism of injury was eccentric loading with the elbow flexed and supinated.

Results: A subjective analysis on pain and function was conducted using a visual analog scale of pain (VAS) and the Mayo Elbow Performance Score (MEPS), before and after surgery. The VAS showed a decrease of 5 points to 0.8 points on average. The MEPS improved from 69.3 points before the operation to 97.5 points afterwards. The mean flexion was 133.1° on the operated side, versus 134.3°. The mean extension was −2.5° and 0° (operated side versus non-operated). Supination was 88.2° versus 89.5° and pronation was 82.5° versus 84.1°, comparing the operated side versus the non-operated side. Flexion and supination strengths were evaluated with the aid of a dynamometer, and the mean flexion and supination strengths were found to be respectively 78.57% and 89.65% of the strength of the non-operated limb.

Conclusion: Use of the technique of direct tendon repair using EndoButton and interference screws was shown to be a safe and effective alternative for repairing chronic lesions of the distal biceps.

Reparo direto das lesões distais crônicas do tendão bicipital

Palavras-chave:
Traumatismos dos tendões
Tenodese

RESUMO

Objetivo: Apresentar os resultados do reparo direto do tendão com EndoButton e parafuso de interferência nos pacientes com lesão do bíceps distal com evolução maior do que 28 dias.

☆ Study conducted in the Department of Orthopedy and Traumatology, Hospital Santa Casa de Misericórdia de Vitória, Vitória, ES, Brazil.

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Transferência tendinosa
Medicina física e reabilitação

Métodos: Entre janeiro de 2012 e novembro de 2013, 11 pacientes (todos do sexo masculino) com ruptura do bíceps distal com intervalo da lesão e cirurgia maior do que 28 dias. A idade média foi de 46 anos e o mecanismo de trauma mais comum foi uma carga excêntrica com o cotovelo em flexão e supinação.
Resultados: Foi feita uma análise subjetiva da dor e função com a Escala Visual Analógica de Dor (EVA) e o Mayo Elbow Performance Score (MEPS) pré e pós-operatório. Houve uma diminuição da EVA de 5 pontos para 0,8 ponto em média. O MEPS melhorou de 69,3 pontos no pré para 97,5 pontos no pós-operatório. A média de flexão foi de 133,1° do lado operado contra 134,3°. A média de extensão foi de −2,5° e 0° (lado operado × não operado). Supinação foi de 88,2° × 89,5° e pronação 82,5° × 84,1° quando comparado o lado operado versus o lado não operado. A força de flexão e supinação foi avaliada com o auxílio de um dinamômetro e verificamos que a força média de flexão e supinação correspondia, respectivamente, a 78,57% e 89,65% a força do membro não operado.
Conclusão: A técnica do reparo direto do tendão com o uso de EndoButton e parafuso de interferência mostra-se como uma opção segura e eficaz para o reparo direto das lesões crônicas do bíceps distal.

Introduction

Distal bicipital tendon injuries are relatively rare, representing only 3% of biceps injuries; the most frequent is the involvement of the long head of the biceps tendon in its proximal portion (96%).[1] Often, the injury mechanism is an eccentric load with the elbow in flexion and supination in male patients between the fifth and sixth decade of life. Its pathophysiology is little understood, but it is known that degenerative tendinopathy, mechanical impact, some endocrinous diseases, and the use of anabolic steroids are involved in the onset of this entity.[2]

Although the clinical findings are classic, the rarity of the injury and the good movement arc presented by the patients lead to a late presentation and diagnosis. Historically, conservative treatment was suggested for the management of acute injuries. However, after biomechanical studies demonstrated loss of flexion and supination forces of up to 30% and 40%, respectively, many authors recommended that the acute anatomical repair should be preferred to the non-anatomical repair with the brachial tendon.[3] With results of loss of supination force of around 50% after transfer technique with the brachialis tendon, new techniques emerged, making the direct repair the treatment of choice, primarily in patients who aim for a full return to their activities.[4]

Chronic injuries are often difficult to treat due to tendon retraction, muscular atrophy, and associated fibrosis. However, the conservative treatment presents unsatisfactory results. Although there is no consensus on the definition of the chronic injury time interval, the use of tendon graft is recommended in chronic ruptures to restore the length and prevent flexion contracture of the elbow.[5] The autologous graft can cause donor-site morbidity, and the use of an allograft still presents risks of infection and high costs in some places. The literature features countless repair techniques for acute injuries and graft reconstruction techniques for chronic injuries. However, there are few studies assessing the results of graftless direct repair treatment for chronic injuries.[1,2,6,7]

This study aimed to present the results of the modification of the technique by Bain et al.,[8] which consists of direct tendon repair with EndoButton and interference screw in patients with distal biceps injury with evolution longer than 28 days.

Material and methods

From January of 2012 to November of 2013, eight patients (all males) with distal biceps rupture and interval between injury and presentation longer than 28 days were operated by a single elbow specialist, after approval by the ethics committee of the institution. The diagnosis was performed based on the clinical history, physical examination, and additional exams (Figs. 1–3).

The mean age of the patients was 47.5 years, and the most common trauma mechanism was an eccentric load with the elbow in flexion and supination. Two patients were injured during weightlifting (tractor tire and loaded weightlifting bar) and one during a fall to the ground. The mean interval from the day of the trauma to surgery was 71.8 days.

The Mayo Elbow Performance Score (MEPS) and a visual analog scale for pain (VAS) were applied in the pre- and post-operative periods. The assessment of the flexion and supination forces was performed only in the post-operative period; the contralateral side was used for comparison.

To assess flexion and supination forces, a digital dynamometer (Lafayette Manual Muscle Testing System model 01165, Lafayette, IN 47903) was used, with help of a properly marked wooden stick to facilitate the measurement of the supination and avoid interference with the momentum of the applied forces (Figs. 4–7). Four measurements were taken, always by the same evaluator, and the mean of the last three was calculated. The first measurement was disregarded to avoid bias caused by the patient's awareness of the

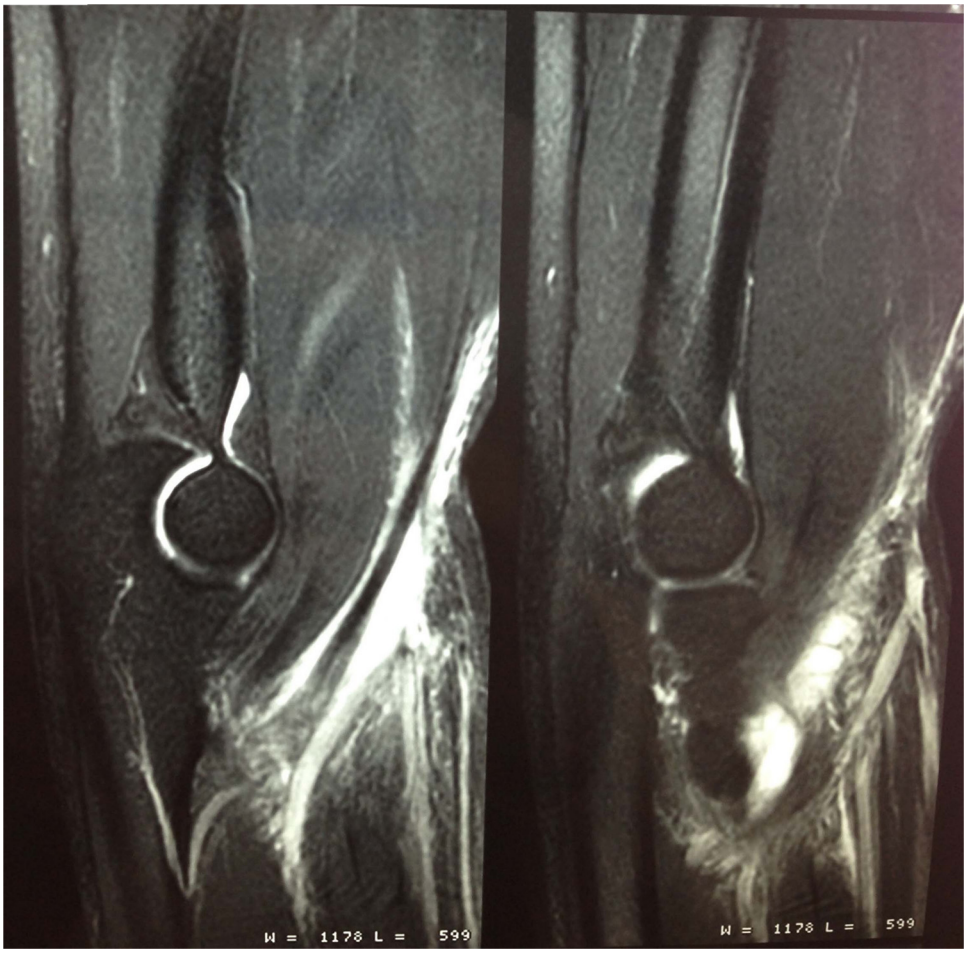

Fig. 1 – Magnetic resonance sagittal cut showing the distal biceps injury.

Fig. 2 – Magnetic resonance sagittal cut showing the distal biceps injury.

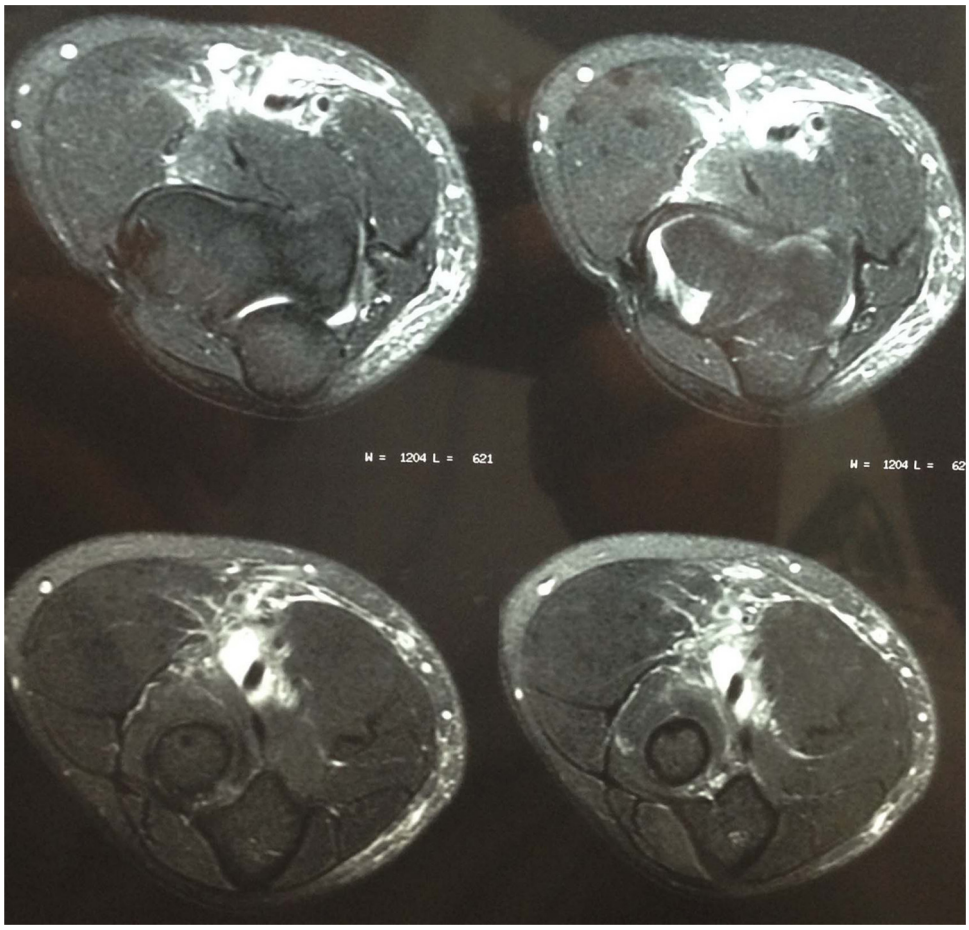

Fig. 3 – Magnetic resonance axial cut showing the distal biceps injury.

measurement process. The mean follow-up time, with clinical evaluation and scores, was 14 months (12–19).

A descriptive analysis of the studied variables was performed. Due to non-normality of data, the non-parametric test was used for data analysis. For the comparison between the pre- and post-surgical moments through VAS and MEPS, and for comparison between the operated and non-operated sides in flexion, extension, supination, and pronation arcs, as well as supination and pronation forces, the Wilcoxon non-parametric test was used. For the entire statistical inference, a *p-value* of 0.05 was considered. SPSS for Windows version 20.0 was used.

Operating technique

All patients were positioned in horizontal dorsal decubitus and underwent plexus block anesthesia + sedation. An Esmarch tourniquet was applied to the root of the limb. A single curvilinear incision (Fig. 8) of approximately 7 cm was made lightly distal to the antecubital fossa. The Henry approach was used to expose the radial tuberosity in supination and a bicortical hole was made with a 4.5-mm drill. A fine-tip gouge was used to extend the entry point (proximal) according to the thickness of the tendon extremity. If necessary, a second small incision was performed approximately 5 cm proximal to the elbow flexure to isolate the retracted tendon stump. The retracted tendon stump usually presented itself surrounded by a fibrotic tissue along with its sheath; it was decided not to preserve the *lacertus fibrosus*. The muscle-tendon junction was identified after dissection and release of peritendinous fibrous tissue. This procedure allowed for a length gain of around 2–3 cm. Two high-resistance threads were passed through the tendon using the Krackow technique with 1-cm intervals between them, in order to be coupled to the EndoButton.

A blunt dissection was performed with the finger to release the biceps muscle belly from the deep fascia and from the deeper brachialis muscle. Special care was taken in the identification of the lateral cutaneous nerve of the forearm (branch of the musculocutaneous nerve) that passes between the biceps and the brachialis (Fig. 9). Then, the tendon repaired with the EndoButton was passed through the original tunnel below the anterior antecubital fossa up to the radial tuberosity. The authors avoided exposing the lateral side of the ulna as much as possible due to complications such as heterotopic ossification.

In practically all cases, despite the release of the tendon stump and of the muscular belly from the fibrotic tissue and from a constant tension in the tendon for length gain, it was only possible to pass the EndoButton through the holes in the tuberosity with the elbow in flexion of approximately 90–120°. The extremities of the EndoButton were connected

Fig. 4 – Dynamometer used for force measurements.

to two threads of Ethibond, which, in turn, were tied to the extremity of the EndoButton's drill guidewire and were exteriorized through the mobile dorsal compartment of the forearm. Then, the EndoButton was flipped and control was performed through fluoroscopy (Fig. 10).

Fig. 5 – Marked stick used to aid supination force measurement.

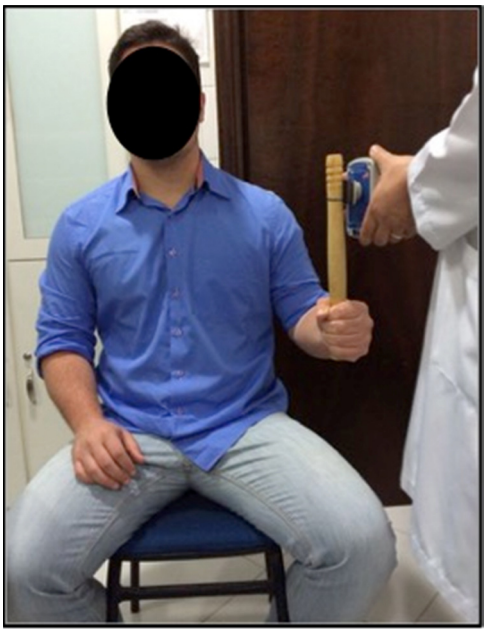

Fig. 6 – Supination force measurement.

After confirmation of the correct positioning of the EndoButton, an absorbable interference screw (Smith & Nephew, Andover MA) was used to increase the contact of the tendon with the proximal hole in the maximum extension position achieved by the elbow at that moment (Figs. 11–13).

Post-operative protocol

A Velpeau sling was placed on the patient in the immediate post-operative period. If it was observed that the patient presented some difficulty in understanding the rehabilitation

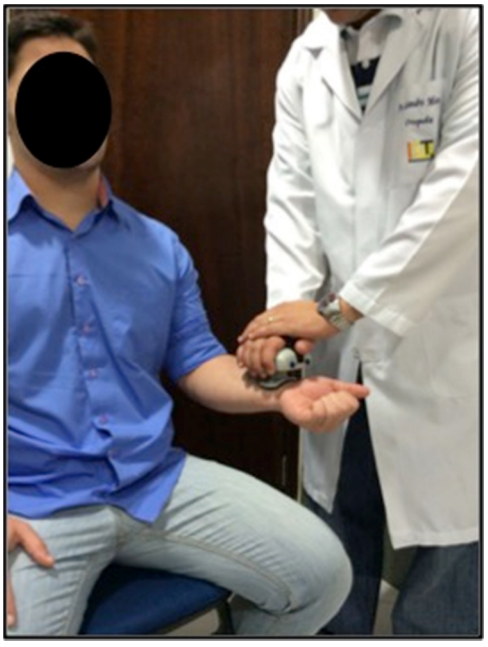

Fig. 7 – Flexion force measurement.

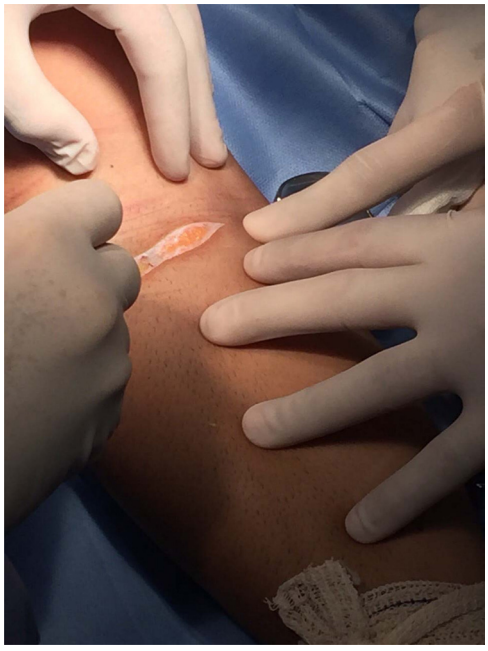

Fig. 8 – Intraoperative image of the incision.

protocol, a plaster cast with the elbow in 90° flexion and neutral position was placed. Passive flexion and active extension movement arcs were initiated on the second day after surgery, at the pain threshold. The sling was used for comfort only. After three weeks, the sling was discontinued; active flexion exercises and passive extension exercises began at four weeks. Strengthening exercises were initiated at eight weeks and counter resistance exercises, at ten weeks. The return to sports activities was allowed after approximately four to six months, after well-performed training of the sport movement.

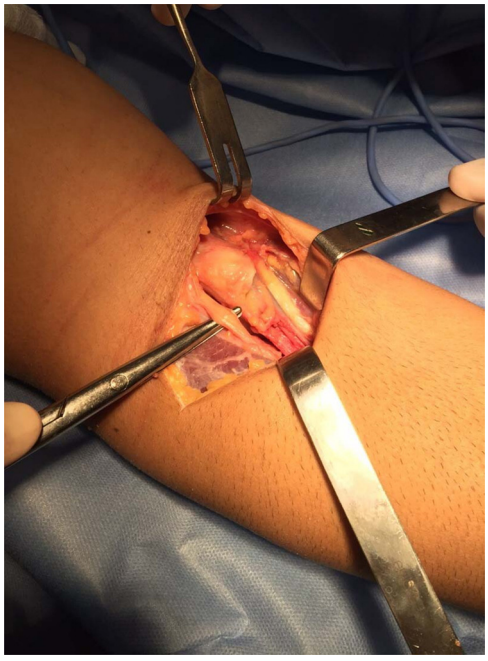

Fig. 9 – Intraoperative image of the musculocutaneous nerve.

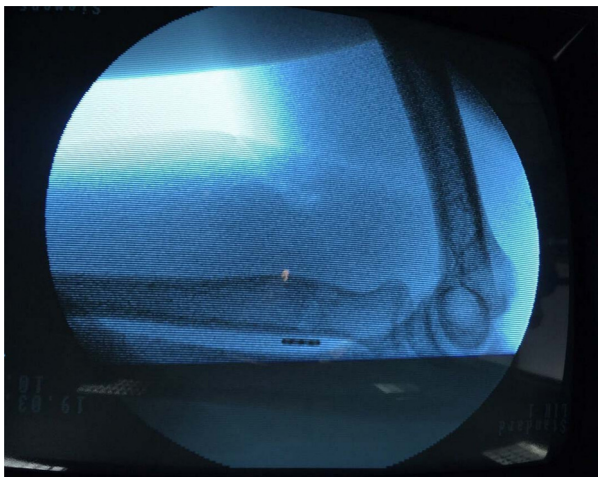

Fig. 10 – Intraoperative fluoroscopic image of the positioning of the EndoButton.

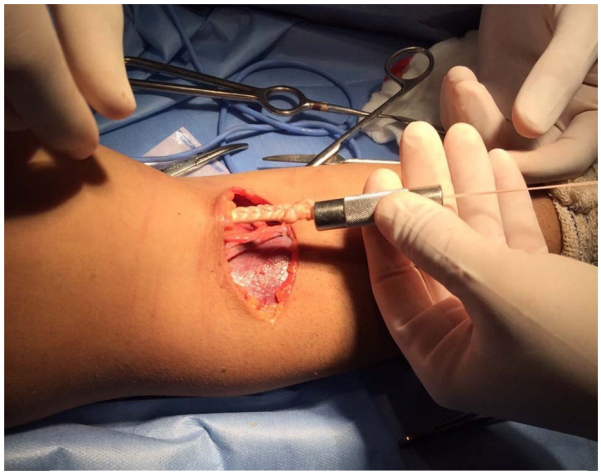

Fig. 11 – Measurement of the diameter of the biceps tendon stump.

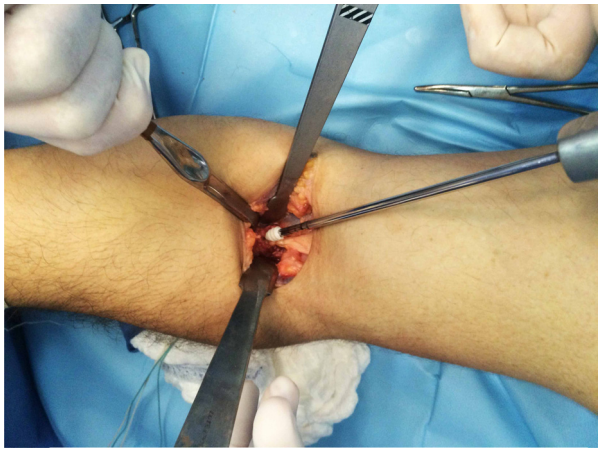

Fig. 12 – Placement of the interference screw.

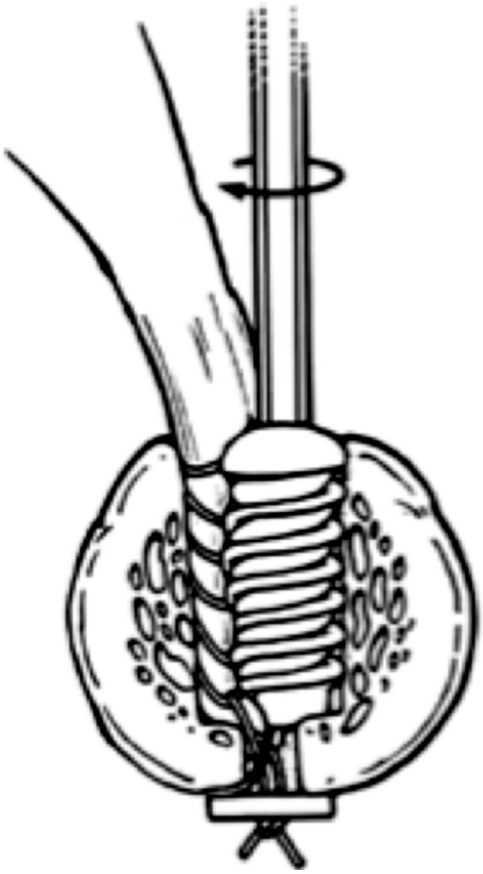

Fig. 13 – Schematic drawing showing two implants.

Patient assessment

The movement arc was measured with a manual goniometer by an examiner (surgeon) following the criteria of the American Academy of Orthopedic Surgeons (AAOS). All patients were assessed using the MEPS and the VAS.[9]

Results

The results are presented in Tables 1–3. Throughout the months, all patients increased the movement arcs. The mean flexion was of approximately 133°, corresponding to 99% of that of the non-operated limb. The mean extension was of 2.5° of flexion. Two patients remained with a flexion contracture of approximately 10°. The mean supination was of 88° and mean pronation was of 82.5°, which corresponded to 98.5% and 98% of that of the contralateral limb.

All patients obtained excellent results in the MEPS, scoring over 90°. The mean VAS decreased from 5 to 0.8 in the post-operative period: a statistical difference was observed in both functional scores ($p < 0.05$).

The mean flexion force was of 17.6 N, corresponding to 79.25% of that of the non-operated side. The mean supination force was of 2.6 N, corresponding to 89.75% of that of the non-operated side.

Complications such as paresthesia in the lateral face of the forearm, corresponding to neuropraxia of the lateral cutaneous nerve of the forearm, were observed in one patient and were resolved within three months. There were no cases of re-rupture of the tendon, fracture of the radial cortex, and heterotopic ossification.

Discussion

This series of distal biceps rupture cases presents the classic epidemiological profile of active middle-aged males, in which the conservative treatment leads to high functional deficit. The surgical repair of the distal biceps injuries demonstrates superior results when compared with the conservative treatment. Baker et al. compared the conservative and surgical treatment, observing a reduction in supination force and resistance of 55% and 86%, respectively.[10]

There are several surgical options for the repair of distal biceps ruptures. Acute injuries can be treated with primary repair to the radial bicipital tuberosity or non-anatomical repair with tendon transfer to the brachialis. Klonz et al.[11] compared the transfer to the brachialis tendon with the anatomical correction through suture with anchor. Although flexion resistance was restored, half of the patients of the indirect repair group had a reduction of 50% in the supination force. De Carli et al.[12] also reported the results from indirect repair in 23 patients, observing a reduction in flexion resistance of 12%, supination resistance of 13%, and total work in supination of 25%. In the present study, direct repair showed a flexion and supination force of approximately 80% and 90%, respectively, when compared with the contralateral side.

Distal biceps injuries can be repaired through a single extended anterior access route (Boyd–Anderson[13] approach),

Table 1 – Pre- and post-surgical comparison, according to VAS and MEPS.

	N	Mean	SD	Median	Min	Max	*p*-Value
VAS							
Pre	8	5.0	2.3	4	3	8	0.012[a]
Post	8	0.8	1.4	0	0	4	
MEPS							
Pre	8	69.3	15.6	67.5	40	85	0.011[a]
Post	8	97.5	4.6	100.0	90	100	

Significant differences were observed between pre- and post-surgical values in both evaluation tools used.

[a] p-Value < 0.05.

Table 2 – Comparison of the movement arcs between the operated and non-operated sides.

	N	Mean	SD	Median	Min	Max	*p*-Value
Flexion							
Operated side	8	133.1	5.9	130.0	125	140	0.581
Non-operated side	8	134.3	7.2	137.5	120	140	
Extension							
Operated side	8	−2.5	4.6	0	−10	0	0.157
Non-operated side	8	0	0	0	0	0	
Supination							
Operated side	8	88.2	6.4	90.0	80	100	0.581
Non-operated side	8	89.5	7.2	90.0	80	105	
Pronation							
Operated side	8	82.5	4.6	80.0	80	90	0.285
Non-operated side	8	84.1	5.2	82.5	78	90	

Significant differences were not observed between the operated and non-operated sides in the assessed movement arcs.

with two accesses (modified Boyd–Anderson approach), or even a modified endoscopic access. The authors used an anterior approach with an incision lightly distal to the elbow flexure, and there was no need for a second proximal incision to isolate the retracted tendon stump. Special care must be taken when isolating the sensory branch of the musculocutaneous nerve.

Direct fixation methods range from the traditional bone trough to the repair with modern devices, such as anchors, EndoButton, and interference screws. The choice of rehabilitation protocols will depend partially on the strength of the reconstruction or repair. Weinstein et al.[14] monitored 32 patients treated using the technique of two incisions with bone anchors. The post-operative protocol established four weeks of immobilization with a splint and four months of protected activities. Nonetheless, the movement amplitude was restored and a DASH score of 4 ± 7 was obtained. Cil et al.[15] also reported the results of the two-incision approach in 21 patients, excluding chronic ruptures. Their post-operative protocol stimulated the start of amplitude of movement in the first or second post-operative day, with the resistance limited to one pound for the first six weeks and two pounds for the first three months. Flexing and pronosupination were restored, with movement arcs from 0° to 145° and from 74° to 75°, respectively. The mean DASH score in that study was 3.6 ± 3.6. The present patients were immobilized only with a sling for three weeks. Active movement of wrist and fingers was allowed in the first post-operative day and, after the third week, passive flexion and active extension exercises as tolerated. The flexion-extension and pronosupination movement arcs ranged from 2.5° to 133° and from 82.5° to 88.2°, respectively.

The technique with EndoButton, described for the first time by Bain et al., was efficient in the acute repair, with superior pullout strengths when compared with equivalent methods.[13,14] That, in a certain way, allows for mobilization in the immediate post-operative period and promotes an early, gradual extension gain, with practically complete extension recovery. Despite this theoretical advantage, the studies published on the technique with EndoButton had rehabilitation programs with limited or staged return to movement.[3,15,16] In the present study, the patients with a sling were allowed to begin mobilization around the third week. That allowed the patients to recover almost total extension in five weeks; the authors believe that this contributed to the excellent movement amplitude obtained. In two cases, a plaster cast was left for two weeks as a precaution measure due to the cognitive difficulty presented by the patients.

Direct repair in chronic ruptures with retracted tendon was previously reported as "impossible without limiting the extension." Tendon retractions have forced some authors to use interposition autograft to recover prior elbow extension. Graft use was recommended in cases where the repair could not be reached by the native tendon beyond 70° of flexion.

Table 3 – Force comparisons between operated and non-operated sides.

	N	Mean	SD	Median	Min	Max	*p*-Value
Flexion force							
Operated side	8	17.6	2.9	18.1	13.2	21.4	0.012[a]
Non-operated side	8	22.4	2.6	22.5	18.1	25.5	
Supination force							
Operated side	8	2.6	0.5	2.6	2.0	3.9	0.327
Non-operated side	8	2.9	0.5	2.9	2.0	3.9	

Significant differences were observed in the flexion force between the operated and non-operated. The non-operated side presented bigger force.

[a] *p*-Value < 0.05.

Bain et al.[16] used EndoButton to repair 12 acute injuries and one chronic injury, through autologous semitendinosus graft to provide retraction. The movement amplitude during the follow-up was of 5–146°, with pronosupination of 81–80°. The force was measured subjectively at 5/5. Despite the evolution time of the present patients, interference screws were placed with approximately 90–110° of flexion, and yet no cases of flexion contracture or significant extension deficit were observed.

In late repairs, even with wide mobilization, the retracted tendon extremity can only be brought to the radial insertion with maximum elbow flexion.[8,15,17,18] The higher the elbow flexion, the more difficult it is to insert interference screws or to perform sutures in the volar surface. The advantage of the EndoButton is that it allows for the passage of the tendon by the radius to be done blindly, with traction on the tendon and the EndoButton maintained in the line of traction. The passage of the threads can be performed using a blunt guidewire with diameter of less than 2 mm, which makes injury of neurovascular structures unlikely. The technique with the EndoButton is safe. Cadaver studies show that the posterior interbone nerve is distal around 7–14 mm to the place of the passage of the EndoButton.[19,20] As the EndoButton is flipped, the elbow can be extended and the passage of the tendon in the bone can be seen directly for the insertion of the interference screw.

Although the authors have been able to reposition the tendon in all cases, there is the possibility of excessive fibrosis formation or poor quality residual tendon. Since that is assessed only in the intraoperative period, it is prudent to prepare an informed consent form to harvest a tendon graft if necessary. In the present operated cases, all repaired tendons managed to reach the radial tuberosity without great tension, which the authors believe to be a result of the integrity of the *lacertus fibrosus* in the vast majority of the cases.

Complication rates of up to 31% were reported after acute repair.[21,22] The main risks are injury of the lateral cutaneous nerve of the forearm and of the posterior and radial interbone nerve, in addition to surgical wound infection, flexion contracture, and heterotopic ossification. Similar complication rates were observed for one or two incisions, even though an additional synostosis risk has been reported with a second posterior approach versus the increase of the risk of paralysis of the radial nerve in the single-incision method. The earlier the repair, the lower the complication risk. Bisson et al.[23] demonstrated a complication rate of up to 40% when the repair took place 14 days or more after the injury, versus 20% in early repair. The rate of complications in the present study was lower, despite the fact that the repairs were late (28–180 days). No patient presented injury of the posterior interbone nerve. The lateral cutaneous nerve of the forearm was adhered to the deep face of the biceps and at risk when the muscle was mobilized. Despite the care taken, one patient developed transitory neuropraxia of the lateral cutaneous nerve of the forearm, which was resolved within three months.

The technique of the direct repair of distal biceps chronic injuries allows for a good fixation of the tendon, as well as movement arc recovery and good flexion and supination forces, with low rates of complication.

The small number of cases, type of study (case series without comparative sample), and the cost of the technique (due to the use of two implants) are weaknesses of the present study.

Fig. 14 – Cosmetic aspect of the incision.

The strengths of the study include the low morbidity of the procedure, avoiding use of grafts despite the fact that the injuries were chronic; the single access route, which allows for visualization and isolation of neurovascular structures; and the good cosmesis (Fig. 14). The rigid and more resistant fixation of the tendon with two implants allows for an earlier rehabilitation without plaster immobilization.

Conclusions

Chronic injuries of the distal biceps can lead to functional deficits in young adults who perform any physical or athletic activity. The use of the direct repair technique with EndoButton and interference screws is a safe and efficient option for chronic injuries of the distal biceps with over four weeks of evolution.

Conflicts of interest

The authors declare no conflicts of interest.

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