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REVIEW ARTICLE

DISTAL BICEPS TEARS: DOUBLE APPROACH VS ANCHORS VS ENDOBUTTON – CASE SERIES AND LITERATURE OVERVIEW

ZERWANIA DALSZEGO ŚCIĘGNA MIĘŚNIA DWUGŁOWEGO RAMIENIA: PODEJŚCIE DWUNACIĘCIOWE VS KOTWICE VS ENDOBUTTON – SERIA PRZYPADKÓW I PRZEGLĄD LITERATURY

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ABSTRACT

Introduction

Treatment of a ruptured distal biceps tendon is mostly surgical, however there is still a debate and controversy about the surgical approach and the fixation method.

Purpose

Our purpose is to review the literature and our own cohort regarding single or double incision technique, different types of fixation methods and their clinical outcomes.

Materials and methods

In our review study we included only the complete distal biceps ruptures. A comprehensive search was made in the current literature regarding the surgical treatment of distal biceps tears. Numerous studies were found comparing single incision versus double incision approaches, as also for the type of fixation. Besides the literature found we also reviewed our own cohort between 2019–2024. The range of motion (ROM), Disabilities of the Arm, Shoulder and Hand (DASH) scores, Mayo Elbow Performance Score (MEPS) scores were assessed, as also the complications.

Results

In our cohort, we only used single incision (long „lazy S", or small horizontal). We did not perform double incision in none of the cases. Also, surgeons' preference was to use anchor or cortical button fixation. Small incision technique and cortical button fixation had better cosmesis, better MEPS score and lower complication rate (heterotopic ossification, pain, supination).

Conclusions

Regarding the literature, there was no significant difference between single or double incision technique. If using anchors, it is advisable to use two anchors, whcih have the same results as endobuttons.

Keywords: single incision, double incision, cortical button, anchor, heterotopic ossification, neuropraxia, posterior interosseus nerve

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STRESZCZENIE

Wstęp

Leczenie zerwania dalszego ścięgna mięśnia dwugłowego ramienia jest najczęściej operacyjne, jednak nadal istnieje debata i kontrowersje dotyczące wyboru dostępu chirurgicznego oraz metody fiksacji.

Cel

Celem naszej pracy jest przegląd literatury oraz analiza naszego własnego materiału dotyczącego techniki pojedynczego i podwójnego nacięcia, różnych metod fiksacji i ich wyników klinicznych.

Materiał i metody

W naszym przeglądzie uwzględniono wyłącznie całkowite zerwania dalszego ścięgna mięśnia dwugłowego ramienia. Przeprowadzono kompleksowe wyszukiwanie aktualnej literatury dotyczącej chirurgicznego leczenia tych urazów. Znaleziono liczne badania porównujące podejście jedno- i dwunacięciowe oraz różne metody fiksacji. Oprócz przeglądu literatury przeanalizowaliśmy również naszą własną kohortę pacjentów operowanych w latach 2019–2024. Oceniano zakres ruchu (ROM), wskaźnik DASH (Disabilities of the Arm, Shoulder and Hand), wynik MEPS (Mayo Elbow Performance Score) oraz powikłania.

Wyniki

W naszej kohorcie stosowano wyłącznie dostęp jednonacięciowy (długie nacięcie typu „leniwe S" lub małe poziome nacięcie). W żadnym przypadku nie wykonano techniki dwunacięciowej. Preferowaną metodą fiksacji było użycie kotwic lub guzika korowego. Technika małego nacięcia i fiksacja guzikiem korowym zapewniały lepszy efekt kosmetyczny, wyższy wynik MEPS oraz niższy odsetek powikłań (heterotopowe kostnienie, ból, osłabienie supinacji).

Wnioski

Na podstawie przeglądu literatury nie stwierdzono istotnych różnic między techniką jedno- i dwunacięciową. W przypadku stosowania kotwic zaleca się użycie dwóch kotwic, które dają wyniki porównywalne z guzikiem korowym.

Słowa kluczowe: pojedyncze nacięcie, podwójne nacięcie, guzik korowy, kotwica, heterotopowe kostnienie, neuropraxia, nerw międzykostny tylny

Introduction

Distal biceps tears are relatively uncommon injuries, approximately 1.2–2.2 per 100.000 person per year. Patients are almost exclusively middle-aged men between 30–60 years (Miyamoto *et al.,* 2010). They occur after excentric load, lifting heavy items with a popping sound. Complete rupture of the distal tendon is mostly easy to diagnose just by physical examination, like Hook test described by O'Driscoll (O'Driscoll *et al.,* 2007, Luokkala *et al.,* 2020). Partial ruptures may need additional special tests, like pronation provocation test and diagnostic imaging like FABS view on MRI (Caekebeke *et al.,* 2021). There is a consensus, that these patients most likely need surgical intervention, since it yields better functional outcomes. Baker and Bierwagen identified decrease in supination strength, supination endurance, in elbow flexion strength, and elbow flexion endurance compared with the operated patients (Baker & Bierwagen, 1985, Cuzzolin, *et al.,* 2021). Surgery is only not

indicated if the patient is not fit for surgery, or low demand patients, who doesn't want intervention (Cuzzolin, *et al.,* 2021).

There are two main determining question regarding the surgery, and these are the chosen approach and the fixation method. Patient must be informed about possible complications, that can occur and are more frequent related the approach or fixation method. These too are the predictors of our anatomic or non-anatomic intervention. The aim of this literature review is to help in decision making regarding the evidence.

Regarding the surgical approach, we can make a single incision, with is on the anterior aspect of the arm. This can be an extended „lazy S" type which can give an excellent view to the surgical field. It is now a bit out of fashion, but still an option, particularly for chronic cases, where grafting is necessary.

A modification is a minimal invasive, limited anterior approach, which can be either a continuation of the Henry approach, so a longitudinal one, or a vertical approach which respects the Langer's lines. This limited approach is positioned over the bicipital tuberosity. In case we can't find or are unable to reach or find the stump of the distal biceps tendon, we can make an accessory incision 5–7 cm above the elbow flexion crease, but making so, our main approach will be still a single incision technique.

Other option is the double incision technique, which was introduced by Boyd and Anderson (Boyd & Anderson, 1961), they referred to the "normal point of insertion on the radial tuberosity". Later modified by Morrey *et al,* described the insertion as the posterior aspect of the radial tuberosity (Morrey *et al.,* 1985). The first incision on the volar aspect of the elbow to reach the tendon stump, and the second incision is a muscle splitting approach on the posterolateral side of the proximal forearm. After exploring the torn distal biceps, a 5–7 cm incision is made through the extensor mass. In this way, it is easy to reach the bicipital tuberosity, and the anatomic insertion.

The main difference is reaching the insertion site is the pro-supination position of the forearm to stay away and not to violate the PIN (Posterior Interosseus Nerve) (van den Bekerom *et al.,* 2016).

After we have made our approach to the distal biceps, we must choose our fixation method, which can be either an onlay, or inlay fixation, metal or metal-free implant.

Since anchors are available on the market, torn ligaments and tendon fixations are made easy. Anchors can be metal, or all-suture anchors which can get stuck in the bone cavity or in the cancellous bone, and they are loaded with sutures. Other option is using a cortical button. Of course, drill holes, and transosseous suture are still an option as well as interference screws.

Purpose

The purpose of this paper is giving a review in the literature of the state of art in the distal biceps tendon fixation considering approaches, fixation methods and complications.

Methods and materials

According to our database, between 2019 and 2023 we treated 21 patients with distal biceps ruptures surgically, and 6 patients conservative. Surgery was either not indicated, or the patient did not want the operative approach. Out of those patients, who underwent surgical intervention 16 agreed in follow-up. 7 patients with cortical button fixation and 9 with metal suture anchor (Mitek GII, Johnson & Johnson).

We checked Mayo Elbow Performance Score (MEPS), pain, paresthesia, and radiologic control looking for heterotopic ossification or radioulnar synostosis. Suture anchor fixation was done by 3 shoulder and elbow experts, of which 2 always uses an extended anterior approach. Limited anterior single incision was done by 1 surgeon, as the cortical button fixation too.

Results

In the suture anchor group, we were able to follow up only 9 patients. They were operated

by three experts in the field. All of them had a single incision technique with a lazy "S" type approach, and a fixation method of one metal suture anchor.

7 patients had 100, 1 had 85 and 1 had 80 points in MEPS score. Regarding the complications 8 patients developed heterotopic ossifications, of which 3 were severe. 2 patients had decreased supination, and supination strength.

In the Endobutton group we were able to follow up 6 patients, with one surgeon using the limited anterior approach according to the lines of Langer. All patients had 100 points in MEPS, with great patient satisfaction. Regarding the complication 1 patient developed a minor HO, one had a neuropraxia to LABCN, and one had a transient PIN palsy, which has spontaneously recovered.

Discussion

Complete rupture of the distal biceps is mostly easy to diagnose and is treated with surgery. Athwal *et al.* proved (Athwal *et al.,* 2007), that biceps tendon insertion is located on the extreme ulnar margin of the tuberosity, and as it approaches the insertion it thickens in length and width, thus attaches in an actual footprint. Also, it has been shown, that it is not a round, cylindrical shape, rather than oval. It's unique in orientation, origination as lateral (long) and medial (short) head, and inserting 90-degree rotation, so that short head inserts distally. From this short head, lacertus fibrosis is originating (Baker & Bierwagen, 1985). The biceps tendon passes over the ridge of the tuberosity to insert on its ulnar aspect; the footprint does not include the ridge, which functions as a pulley, where the tendon is spanned, increasing the mechanical advantage. Forthman *et al.* (Forthman *et al.,* 2008) evaluated the insertional anatomy and orientation of the radial tuberosity and biceps brachii tendon.

Radiographic images showed that the mean bicipital tuberosity axis of orientation is 65-degree, but 11 form 30 cadaveric specimens had more pronated tuberosity, thus, would not be repairable anatomically with the current 1-incision techniques.

They concluded that decreased tuberosity height reduces the biceps supination moment arm, and so limiting the peak supination torque. Their recommendation is to assess the orientation of the bicipital tuberosity through the anterior approach, and if the apex is found to be oriented more than 60-degree from anterior, a second posterior muscle-splitting incision is considerable. The fixation method can be the conventional method with burr and drill holes or with suture anchors. If the first method is used, the height should be maintained to maximize the supination moment arm of the biceps (Athwal *et al.,* 2007, (Forthman *et al.,* 2008). Hasan *et al.* investigated the repair site position, where the mean tunnel occupancy of the original footprint between the 2 approaches was significantly different (Hasan *et al.,* 2012). The virtual bone tunnels made from an anterior approach were mostly outside the original footprint area. An anterior approach would thus lead to a lateralized repair of the tendon, almost completely outside the original footprint area. The posterolateral approach, in contrast, led to the placement of the tunnel mostly inside the original footprint. A tendon repair thus would be more anatomically situated through the posterior approach. 2-incision technique using a posterolateral muscle-splitting approach to the bicipital tuberosity allows for a more anatomic repair of a ruptured distal biceps tendon as compared with a repair through a single anterior incision (Hogea *et al.,* 2023, Ernstbrunner *et al.,* 2023).

These studies adumbrate our fixation methods to achieve strong, as anatomic as possible fixation. Anchors are one of the most reliable methods to fix tendons, ligaments to the bone. These techniques fix the distal biceps on the cortical surface. Cortical buttons abut either the outer or the inner surface of the cortex of the radius. No significant differences exist between the IM and EM techniques in loss of force and tendon gap formation under cyclic loading or load to failure conditions

(Aditi *et al.,* 2021). IM fixation may adequately facilitate optimal bone-tendon apposition, with less risk of iatrogenic injury to the PIN. With the cortical buttons, we mostly insert our tendon in the bone (Bain *et al.,* 2000), but also, we can do an onlay fixation too (Bellringer *et al.,* 2020). There was no significant difference in bone-tendon healing in onlay or inlay technique, suggesting no need to put the stump of the distal biceps in the bone cavity (Pierreux & Carlier, 2023).

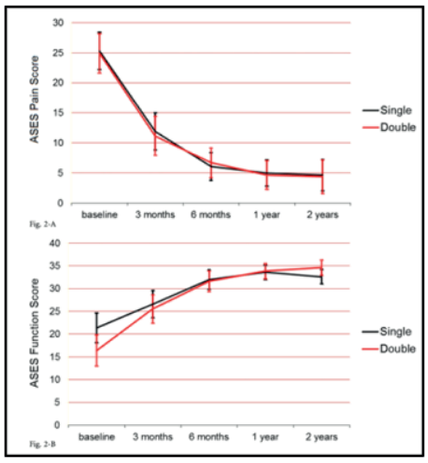
Endobutton fixation was first promoted by Bain *et al.* from a single anterior approach bone (Bain *et al.,* 2000). The cortical button was delivered through the far cortex and lock it there. The later Phadnis and Bain suggested a more anatomic reconstruction with an onlay technique and endobutton fixation, but on the anterior cortex (Bellringer *et al.,* 2020). Siebenlist *et al.*18, 19 concluded in their study that double intramedullary cortical button fixation provides significantly higher loads to failure than single intramedullary or extramedullary cortical button reconstruction in a biomechanical setup (Siebenlist *et al.,* 2019, Siebenlist *et al.,* 2011).

The other fixation method is the suture anchor, where the most frequently used implant was Mitek GII, but unfortunately this had the highest rerupture and failure rate (Citak *et al.,* 2011). However, the number of anchors required for a stable fixation remains unclear, as most studies use two or even more anchors for tendon refixation, Weißenberger *et al.* reported a case repost with bilateral tendon rupture, where one side was treated with one, the other with two anchors (Weißenberger *et al.,* 2020). They found that one-point fixation might provide enough tendon healing, a safe and stable fixation technique with both patient-related and economic benefits. Also, there was no significant difference in the type of anchor used. More recently metal-free anchors are favorable. A recent study by Otto *et al.* showed no significant difference in mean peak failure load or repair construct stiffness between titanium suture anchor and all suture anchors (Otto *et al.,* 2019). A recent meta-analysis demonstrated no significant difference in postoperative strength ratio to the uninjured limb with flexion and supination strength when comparing cortical buttons, suture anchors, and transosseous suture. Citak *et al.* compared Corkscrews, Mitek anchors or transosseous sutures, where they found comperable results to the other techniques (Citak *et al.,* 2011). Lappen *et al.* presented their study using all-suture anchors, where they found good-to-excellent results in terms of clinical outcome, ROM, and restoration of strength (Lappen *et al.,* 2023). Colantonio *et al.* presented their study on twenty paired fresh-frozen human cadaveric elbows, where they were randomized to onlay distal biceps repair (Colantonio *et al.,* 2022). The authors concluded that distal biceps repair with 2 all-suture anchors has similar maximum strength to repair with an intramedullary button and that both are viable options for fixation.

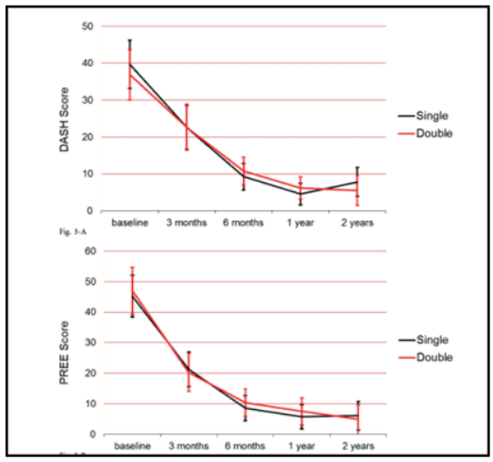
Complications

Different surgical approaches and fixation methods have different complications. Higher complication rate in 1-incision techniques as compared with 2-incision techniques, and most of these complications are minor and transient. The most frequent complication for the single incision is the neuropraxia of the lateral antebrachial nerve (LABCN) (Matzon *et al.,* 2019). Single-incision technique had a greater rate of overall nerve palsy (PIN, LABC nerve, and radial nerve) and rerupture rates compared with the double-incision technique. The double-incision technique had greater rates of heterotopic ossification compared with the single-incision approach (Amin *et al.,* 2016).

Bucci *et al.* reported a fracture of the proximal radius, which appears to be very rare. Because the fracture was undisplaced, and the tendon repair had its integrity, conservative treatment was chosen. At 3 months' follow-up, the fracture had successfully healed with anatomic alignment on radiographic studies (Bucci *et al.,* 2020).



Mean ASES elbow scores over time for the two groups. Pain subscale (p = 0.89). Function subscale (p = 0.46) (Grewal *et al.*, 2012).



Patient-reported pain and disability over time for the two groups. Mean DASH score (p = 0.89). Mean PREE Score (p = 0.73) (Grewal *et al.*, 2012).

Double incision technique was associated with higher rates of radioulnar synostosis, which could be caused by penetrating the interosseus membrane, or the bone trough. Following tables show the most complications regarding incision or fixation method (Amarasooriya *et al.*, 2020, Amin *et al.*, 2016).

Heterotopic ossification (HO) incidence was similar for most fixation techniques: cortical button (6.1%), interference screw (5.8%), suture anchors (5.4%), bone tunnel (4.9%). The incidence of HO was lower when button and screw fixation was utilized (1.5%). This study also confirmed that the incidence of HO is higher with the double incision technique. Following tables show the most complications regarding incision or fixation method. Dave *et al.* proved, that indomethacin is not necessary to use this routinely due to its limited efficacy in preventing HO and potential risks (eg, GI upset, bleeding) associated with the medication (Dave *et al.*, 2024). Also a recent study showed, that three weeks of indomethacin was not superior to meloxicam for 1 week for the prevention of HO after single-incision distal biceps tendon repair (Wörner *et al.*, 2022).

Complications of Distal Biceps Repair by Surgical Incision[a]

	Limited Single (n = 814)		Standard Single (n = 233)		Nonspecified Single (n = 1021)		Double Incision (n = 411)	
	n	%	n	%	n	%	n	%
Major								
PIN	7	0.9	2	0.9	22	2.2	6	1.5
Rerupture	4	0.5	7	3.0	18	1.8	2	0.5
R-U synostosis	0	0.0	0	0.0	0	0.0	4	1.0
Total	11	1.4	9	3.9	40	3.9	12	2.9
Minor								
HO	28	3.4	12	5.2	34	3.3	24	5.8
LABCN	79	9.7	12	5.2	53	5.2	20	4.9
SRN	17	2.1	14	6.0	19	1.9	4	1.0
Total	124	15.2	38	16.3	116	11.4	48	11.6
Total	135	16.6	47	20.2	156	15.3	60	14.5

[a]HO, heterotopic ossification; LABCN, lateral antebrachial cutaneous nerve; PIN, posterior interosseous nerve; R-U, radioulnar; SRN, superficial radial nerve.

Complication of Distal Biceps Repair by Fixation Method[a]

	Suture Anchors (n = 865)		Cortical Button (n = 360)		Interference Screw (n = 69)		Button and Screw (n = 324)		Bone Tunnels (n = 425)	
	n	%	n	%	n	%	n	%	n	%
Major										
PIN palsy	15	1.7	12	3.3	2	2.9	3	0.9	7	1.7
R-U synostosis	0	0.0	0	0.0	0	0.0	0	0.0	4	1.4
Rerupture	15	1.7	3	0.8	1	1.5	3	0.9	5	1.2
Total	30	3.4	15	4.2	3	4.3	6	1.8	16	3.8
Minor										
LABCN paresthesia	67	7.7	67	18.6	9	13.0	26	8.0	25	5.9
SRN paresthesia	36	4.2	12	3.3	1	1.5	16	4.9	2	0.5
HO	47	5.4	22	6.1	4	5.8	5	1.5	21	4.9
Stiffness	15	1.7	2	0.6	0	0.0	0	0.0	4	0.9
Total	165	19.0	103	28.6	14	20.3	47	14.5	52	12.2
Total	195	22.4	118	32.8	17	24.6	53	16.4	68	16

[a]HO, heterotopic ossification; LABCN, lateral antebrachial cutaneous nerve; PIN, posterior interosseous nerve; R-U, radioulnar; SRN, superficial radial nerve.

Conclusion

Distal biceps tears are to be treated mostly surgical. Single incision and double incision techniques both provide excellent outcomes. No statistical difference was found in the forementioned approaches or fixation methods regarding outcomes. Some complications were more likely associated with the approach, thus those operated with single incision had more complaints about lateral antebrachial cutaneous nerve neuropraxia, double incision with radioulnar synostosis, and some with the implant used.

In our cohort, extended anterior, single incision had significantly more heterotopic ossification, pain compared to limited single incision. There was no significant difference in MEPS and DASH scores. Cosmesis although played little role, limited incision had better subjective results.

Considering all the facts and evidence, techniques, probably the most anatomic repair with the least complication rate is a double fixation onlay technique with intramedullary cortical button from single incision to reduce heterotopic ossification and synostosis.

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