

Complications of Distal Biceps Tendon Repair

A Meta-analysis of Single-Incision Versus Double-Incision Surgical Technique

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Background: Anatomic reinsertion of the distal biceps is critical for restoring flexion and supination strength. Single- and double-incision surgical techniques have been reported, analyzing complications and outcomes measures. Which technique results in superior clinical outcomes and the lowest associated complications remains unclear.

Hypothesis: We hypothesized that rerupture rates would be similar between the 2 techniques, while nerve complications would be higher for the single-incision technique and heterotopic ossification would be more frequent with the double-incision technique.

Study Design: Systematic review and meta-analysis; Level of evidence, 4.

Methods: A systematic review was conducted using the PubMed, MEDLINE, Cumulative Index to Nursing and Allied Health Literature (CINAHL), SPORTSDiscus, and the Cochrane Central Register of Controlled Trials databases to identify articles reporting distal biceps ruptures up to August 2013. We included English-language articles on adult patients with a minimum of 3 cases reporting single- and double-incision techniques. Frequencies of each complication as a percentage of total cases were calculated. Fisher exact tests were used to test the association between frequencies for each repair method, with $P < .05$ considered statistically significant. Odds ratios with 95% CIs were also computed.

Results: A total of 87 articles met the inclusion criteria. Lateral antebrachial cutaneous nerve neurapraxia was the most common complication in the single-incision group, occurring in 77 of 785 cases (9.8%). Heterotopic ossification was the most common complication in the double-incision group, occurring in 36 of 498 cases (7.2%).

Conclusion: The overall frequency of reported complications is higher for single-incision distal biceps repair than for double-incision repair. The frequencies of rerupture and nerve complications are both higher for single-incision repairs while the frequency of heterotopic ossification is higher for double-incision repairs. These findings can help surgeons make better-informed decisions about surgical technique and provide their patients with detailed information about expected outcomes and possible complications.

Keywords: distal biceps repair; complications; distal biceps nerve injuries

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Distal biceps brachii tendon ruptures are a relatively uncommon injury, with a reported incidence of 0.9 to 1.8 per 100,000 people per year. The dominant arm is most commonly affected in the majority of cases, with a greater prevalence in males aged 30 to 50 years.³⁶ Pathophysiology of the injury has been attributed to advancing age, hypovascularity of the tendon, and inflammation within the radial bursa, all often with an acute eccentric load on the tendon; however, definitive etiology remains unclear.^{30,45}

When the distal biceps tendon detaches from the radial tuberosity, several surgical techniques have been described to repair the ruptured tendon.^{4,37} Traditionally, the surgery is performed through either a single anterior incision or a double-incision approach.^{6,9} Along with different surgical approaches, numerous methods of

reattachment have been used, including sutures through bone tunnels, suspensory fixation, suture anchors, and interference screws.** Although surgical reinsertion of the distal biceps tendon has favorable outcomes in strength and range of motion restoration, complications are not uncommon.^{5,6,9,12,23,34,36,43}

Surgical anatomic reinsertion of the distal biceps tendon may restore functional outcome; however, complications from surgery such as heterotopic ossification, rerupture, superficial wound infection, synostosis, and nerve injury can occur. A nerve palsy, exhibited by paralysis of the muscles supplied by a particular nerve, may be considered a major complication due to the functional effects associated with a lack of muscle function. The most common nerves involved are typically the lateral antebrachial cutaneous (LABC) nerve, anterior interosseous nerve (AIN), posterior interosseous nerve (PIN), median, radial, and ulnar nerves.^{2,3,7,9,18,24,28,39,41}

The purpose of this meta-analysis was to compare the complication rates of single-incision versus double-incision distal biceps fixation procedures, particularly the rates of nerve injury, heterotopic ossification, and rerupture. We hypothesized that single-incision repairs would have greater rates of nerve injury, double-incision repairs would have greater rates of heterotopic ossification, and that there would be no difference in rerupture rates.

METHODS

This meta-analysis reviewed the literature to compare the complication rates of distal biceps tendon repairs in single- versus double-incision surgical techniques. A systematic review was conducted using the MEDLINE database to identify articles reporting distal biceps tendon ruptures from 1950 through August 2013. The following keywords were used in searches to identify all available articles: *distal biceps tendon*; *distal biceps tendon repair*; *distal biceps tendon rupture, complications*; and *elbow injuries and distal biceps complications*. The study encompassed English-language publications based on adult patients with a minimum of 3 cases as the inclusion criteria, including level 1, 2, 3, and 4 studies. Any study with unclear inclusion or exclusion criteria was reviewed by all authors of this study and a final decision was made. The references within the articles were analyzed to ensure inclusion of all relevant manuscripts that were not gathered by the initial data-based criteria. If an article was published with identical subjects in either different journals or different years, the most current article was included in the study. For the purpose of this review, complications were defined as any unforeseen adverse event and/or finding found postoperatively not anticipated prior to surgical intervention. Single- and double-incision technique studies were incorporated.

Studies were excluded if they were scientific conference and meeting abstracts; articles classified as biomechanical, cadaveric, in vitro, or background studies; case series with

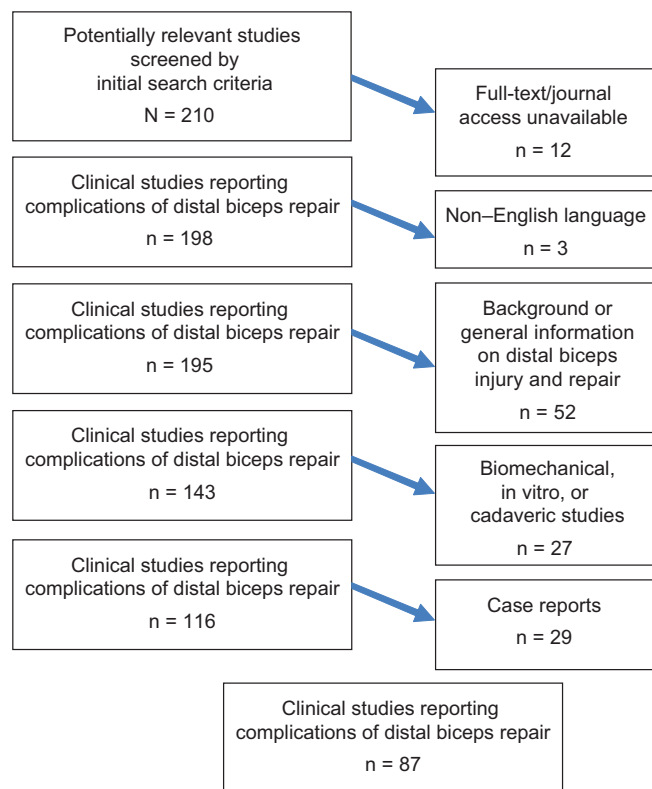


Figure 1. Flowchart of study inclusion.

less than 3 cases reported; case reports; review articles; or technique articles. Additionally, non-English language studies and imaging-only studies were also excluded from the review (Figure 1).

Demographic and outcome data of all studies were retrieved and pooled. A meta-analysis on the pooled data was then conducted to determine the effects of the surgical technique on complication rates. The number of reported complications was culled out of each included study, and the incidence of heterotopic ossification, radioulnar synostosis, rerupture, superficial wound infection, nerve dysesthesia and paresthesia, and palsies of the radial, ulnar, median, anterior interosseous, posterior interosseous, and lateral antebrachial cutaneous nerves were calculated, as reported in the literature. Several terms were used to describe complications related to nerve function (neuropathy, neuritis, paresthesia, and dysesthesia), which were grouped together by nerve when this information was available and put into a generic category of “nerve injury” when the nerve was not specified. In addition, any other complications that did not fall under one of the previously mentioned distinctions were also recorded.

Data were compiled and proportions of complications in each group (single- and double-incision) were calculated. Statistical significance was tested using the Fisher exact test, and $P < .05$ was set as the threshold for statistical significance. Statistical analysis was performed using open-source R statistical software (<http://www.r-project.org/>).

**References 1, 2, 10, 13, 14, 18, 24, 25, 27, 29, 35, 38-40, 42.

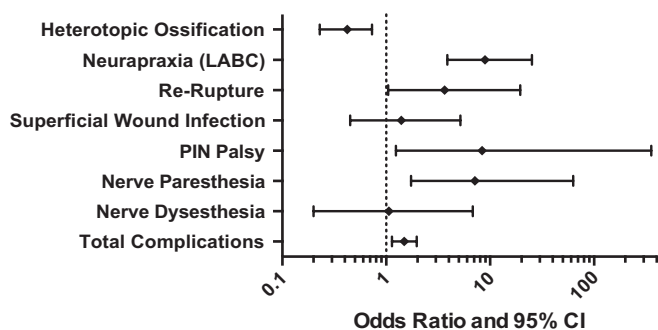


Figure 2. Forest plot of distal biceps repair complications. The plot shows the odds ratio (OR) with a 95% CI for single-incision versus double-incision distal biceps repair. An OR <1 indicates that double-incision was associated with a greater complication rate; an OR >1 indicates that single-incision was associated with a greater complication rate. LABC, lateral antebrachial cutaneous nerve; PIN, posterior interosseous nerve.

RESULTS

A total of 87 articles met the inclusion criteria, and 1283 patients were included in the study. The complication rate in the single-incision group was 28.3% (222/785) versus 20.9% (104/498) in the double-incision group ($P = .003$) (Figure 2). Neurapraxia was the most common complication in the single-incision group at 9.8% (77/785; $P < .001$) versus in the double-incision group at 2.2% (11/498). Heterotopic ossification was the most common in double-incision cases at 7.2% (36/498; $P < .001$) versus in the single-incision group at 3.2% (25/785). Rerupture and failed reattachment occurred in 2.5% (17/785) of single-incision cases versus 0.6% (3/498) of double-incision cases ($P < .034$). Within the rerupture rate complications, 8 single-incision cases used a suture anchor, 6 single-incision cases used an Endobutton fixation method, and 3 single-incision cases used a biotenodesis screw. The 3 failed double-incision cases were repaired by a transosseous technique. PIN palsy occurred in 2.7% (13/785) of single-incision procedures versus 0.2% (1/498) in the double-incision group ($P < .001$). When combining heterotopic ossification and synostosis rates, the double-incision group demonstrated complications in 9.8% (47/498) of cases versus 3.2% (25/785) for single-incision cases ($P < .001$). Additional complications in the single-incision group included superficial wound infection (11/785), nerve paresthesia (22/785; $P < .001$), nerve dysesthesia (5/785), median nerve palsy (1/785), and other complications ranging from screw fractures to persistent elbow pain (49/785). In the double-incision group, additional complications included superficial wound infection (5/498), nerve paresthesia (2/498), nerve dysesthesia (3/498), AIN palsy (1/498), ulnar nerve palsy (1/498), and other complications ranging from sterile stitch abscesses to LABC neuritis (30/498).

Based on the inclusion and exclusion criteria, all evidence level 1, 2, 3, and 4 studies were statistically analyzed using odds ratios and presented the following statistical results: single-incision technique had a higher percentage of complications per case. It was found that the incidences

TABLE 1
Proportion of Each Complication Found in the Included Literature Compared by Single- or Double-Incision^a

	Single-Incision (n = 785)	Double-Incision (n = 498)	P Value
Heterotopic ossification	3.2 (25)	7.2 (36)	<.001 ^b
Neurapraxia (LABC)	9.9 (77)	2.2 (11)	<.001 ^b
Rerupture	2.1 (17)	0.6 (3)	.035 ^b
Superficial wound infection	1.4 (11)	1.0 (5)	.61
Synostosis	0	2.2 (11)	<.001 ^b
PIN palsy	1.7 (13)	0.2 (1)	.012 ^b
Radial nerve palsy	0.6 (5)	0	.163
Nerve paresthesia	2.8 (22)	0.4 (2)	<.001 ^b
Nerve dysesthesia	0.6 (5)	0.6 (3)	>.999
AIN palsy	0	0.2 (1)	n/a
Median nerve palsy	0.1 (1)	0	n/a
Ulnar nerve palsy	0	0.2 (1)	n/a
Total complications	28.2 (222)	20.9 (104)	.003 ^b

^aData are presented as % (n). AIN, anterior interosseous nerve; LABC, lateral antebrachial cutaneous nerve; n/a, not applicable; PIN, posterior interosseous nerve.

^bStatistically significant difference between groups ($P < .05$).

of LABC neurapraxia, rerupture, superficial wound infections, nerve paresthesia, nerve dysesthesia, and PIN palsy were statistically significant with odd ratios with single incisions. Heterotopic ossification was more likely to occur with the double-incision technique (Table 1).

DISCUSSION

Surgical intervention for distal biceps tendon rupture can help restore function to an active individual; however, this procedure is not without the risk of complications. The single-incision technique has a greater rate of failed reattachment and rerupture compared with the double-incision technique.

The greater rates of complications occurred in the single-incision group at 28.3% (222/785) versus 20.9% (104/498) in the double-incision group. The most common reported complication in the single-incision group was neurapraxia at 9.8%, while the double-incision group had greater rates of heterotopic ossification at 7%. Rerupture and failed reattachment occurred in 2.5% of single-incision cases versus 0.6% of double-incision cases. Chavan et al⁹ reported a complication rate of 16% for the double-incision technique versus 18% for the single-incision technique; however, they did note forearm rotation loss was significantly greater with the double-incision technique. Watson et al⁴⁴ recently published a systematic review with overall complication rates of 24.5%, further reporting a complication rate of 23.9% in the single-incision technique versus 25.7% for the double-incision technique, although neither systematic review found a statistical difference.

Heterotopic ossification is one of the more common complications associated with a double-incision approach, with

little to no effect on range of motion or pain.^{4,22,23} Meanwhile, cases of heterotopic ossification have been reported in repairs using the single-incision approach, but the heterotopic bone formation was not substantial enough to cause a loss of motion.² However, substantial heterotopic ossification can cause encroachment of the ulnar periosteal surface leading to radioulnar synostosis.⁴

Radioulnar synostosis is typically found in double-incision approaches, with most cases representing a functional synostosis rather than a true synostosis as only exuberant bone was formed around the supinator muscle.^{6,23} One proposed etiology is that the damaged proximal interosseous membrane and the stimulated ulnar periosteum resulting from a subperiosteal exposure of the ulna may cause the synostosis.¹⁵ Several methods have been recommended in the literature for how to limit the risk of a synostosis, including a muscle-splitting modification of the posterior approach to avoid subperiosteal exposure of the ulna.³² In addition, several authors have claimed that placement of suture anchors through a single anterior incision limits the risk of developing a synostosis.^{26,27}

The most common minor complication associated with the single-incision approach is neurapraxia of the LABC nerve.^{11,16,19} Several investigators attribute the increased rate of LABC neurapraxias to the necessary retraction of the nerve during exposure and preparation of the bicipital tuberosity in the single anterior incision approach.^{11,14,19} This is in contrast to the double-incision technique where the LABC nerve is retracted for a brief time compared with the single-incision approach.¹⁹ One proposed method to limit LABC nerve damage is the use of a limited anterior incision and skin tension during retraction. In addition to neurapraxia, paresthesia of the LABC nerve is another commonly reported complication of the single anterior incision technique.^{14,23,40} Investigators have attributed nerve paresthesias to be a complication of repair of chronic distal biceps tendon injuries.^{8,16} Although a minor complication, it is important to counsel patients of the potential risk with a single-incision technique.

Although neurapraxia is a common complication, various nerve palsies have also been found in single-incision approaches, with the most common nerve palsy found after a distal biceps tendon repair being that of the PIN. PIN palsy has been reported previously with the use of bone tunnels, suture anchors, and suspensory button fixation.^{21,23,29,31,34} Although PIN palsy has been reported in several publications and is a major complication, this complication typically tends to resolve without intervention.^{19,33}

Another important reported complication is rerupture of the repaired distal biceps tendon.^{8,11,23,29} Several authors have debated the reason for the occurrence of rerupture after surgical repair of the distal biceps tendon.²⁰ Although rates of rerupture differ between incisional approach groups in our study, it must be taken into account that the rate of rerupture can be affected by fixation technique. Cain et al⁸ reported 4 cases of rerupture after distal biceps tendon repair with the single-incision suture anchor fixation technique. Similarly, Citak et al¹¹ reported 3 cases of rerupture with a single-incision suture

fixation as well. Silva et al³⁹ reported a partial rupture with a single-incision suture anchor fixation technique, while Frazier et al¹⁷ reported a partial rerupture with a single-incision Biotenodesis screw. In the most recent study, Hinchey et al²⁰ reported on 3 reruptures out of 193 biceps tendon repairs using a Mayo modified Boyd-Anderson double-incision technique. The reruptures were attributed to patient compliance and excessive force across the fresh repair, and all reruptures occurred in the immediate 3-week postoperative period. They recommend protecting the patient for at least 3 weeks before engaging in physical activity.²⁰ Because of the small rerupture rate with each technique, no method of fixation exhibited a statistically greater failure rate.

There were several limitations to this meta-analysis review. First, the majority of the included studies were level 3 and 4 evidence rather than randomized trials, so there may be significant differences between patients who had single- versus double-incision repair. Furthermore, there may be unreported differences in technique, such as tendon reattachment site, which have an effect on outcome in addition to the single- versus double-incision approach. Next, the period of follow-up was not consistent across all studies, and there was not consistent reporting of all types of complications by all studies. Additionally, all studies that presented patient-reported outcome scores did so in aggregate and did not stratify by category of complication. However, this information would be helpful with patient education and clinical decision making. Another limitation that should be considered is that the newer techniques of single-incision repair have a lower failure rate than suture anchor techniques. Last, because patient-level data could not be extracted from the included studies, a multivariable analysis that could account for some of this variation in the patients and the technique was not performed. Nevertheless, this series represents the largest meta-analysis to the field's knowledge that compares complication rates between single- and double-incision distal biceps tendon repair cases and reports useful findings that can be used to counsel patients prior to surgery.

CONCLUSION

The purpose of this meta-analysis was to shed light on the comparisons between complication rates of single- versus double-incision techniques, as both have been used successfully in the repair of a ruptured distal biceps tendon. We found that the 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. These complications are important for surgeons to consider and to disclose to patients deciding on operative repair. In addition, the total number of complications within the 2 techniques has never been reported. Further research is needed to assess the greater rerupture rate in single-incision techniques and the associated risks with early range of motion and rehabilitation.

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