The American Journal of Sports Medicine

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Am J Sports Med 2009 37: 989 originally published online April 3, 2009
DOI: 10.1177/0363546508330130

The online version of this article can be found at:
http://ajs.sagepub.com/content/37/5/989

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A Combined Technique for Distal Biceps Repair Using a Soft Tissue Button and Biotenodesis Interference Screw

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Background: There are many techniques described to repair acute distal biceps tendon ruptures. The authors' objective is to report the results of a single-incision technique using a combination of a soft tissue button and biotenodesis interference screw with accelerated rehabilitation.

Hypothesis: Dual fixation of a distal biceps rupture will allow for early return to function.

Study Design: Case series; Level of evidence, 4.

Methods: From February 2004 to July 2007, 41 elbows in 40 patients had repair of an acute distal biceps tendon rupture (<6 weeks) through an anterior incision using a soft tissue button and interference screw combined technique. The patients were evaluated pre- and postoperatively with a physical examination, radiographs, and the Andrews-Carson elbow score. Nine patients were unavailable for follow-up. The remaining 31 patients (32 elbows) were contacted for a telephone interview at an average of 24 months postoperatively.

Results: The preoperative Andrews-Carson score averaged 168 and the postoperative Andrews-Carson score averaged 196 points at final clinical follow-up. There was a statistically significant difference between the pre- and postoperative Andrews-Carson scores ($P < .001$). One patient had heterotopic ossification associated with decreased pronation and supination. Two superficial radial nerve palsies completely resolved by final follow-up. The average postoperative time to resume normal activities or return to work was 6.5 weeks.

Conclusion: Repair of acute distal biceps tendon ruptures using a soft tissue button and interference screw technique through a limited anterior incision can allow for accelerated rehabilitation and early return to function.

Keywords: biceps tendon; EndoButton; biotenodesis interference screw; accelerated rehabilitation

Distal biceps tendon ruptures are uncommon injuries. Rupture of the tendon is often secondary to a forceful contraction against a sudden resistance. In the majority of cases, this results in a complete tendon avulsion from the radial tuberosity.[23] Surgical repair of these lesions has shown improved patient function compared with conservative treatment.[7,20,22] There are many described techniques to repair the distal biceps tendon.[‖] Recent reports show success using a soft tissue button to repair the biceps tendon.[20,26] A previous biomechanical study showed the soft tissue button to be the strongest repair construct when compared with 13 other techniques.[14] In a cadaveric study by Krushinski et al,[15] a biotenodesis screw was found to have better initial pullout strength than suture anchors. A combined soft tissue button and interference screw technique has been described by Mazzocca et al.[21] We hypothesize that by combining a soft tissue button and interference screw for distal biceps repair, the construct will be strong enough to allow early return to function. The purpose of this study is to evaluate patient outcome after an acute (<6 weeks) distal biceps rupture repaired through a single anterior incision with a soft tissue button and interference screw (the Mazzocca technique), followed by an accelerated rehabilitation protocol.

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No potential conflict of interest declared.

The American Journal of Sports Medicine, Vol. 37, No. 5
DOI: 10.1177/0363546508330130

‖References 1-3, 6, 15, 17-19, 23, 24, 26-28.

MATERIALS AND METHODS

From February 2004 to July 2007, 41 elbows in 40 patients underwent repair of an acute distal biceps tendon rupture (<6 weeks) through a single anterior incision, using both a biotenodesis interference screw (Arthrex, Naples, Florida) and either an EndoButton (Smith & Nephew Endoscopy, Andover, Massachusetts) or Suture Button (Arthrex) utilizing a combined technique. Nine patients were unavailable for the final follow-up telephone interview and were excluded from the study. The remaining 31 patients (32 elbows) were available for the final follow-up interview and are included in this study. All repairs were performed by 1 of 3 surgeons using the described technique. This is a retrospective study including a chart review, telephone interview, and prospectively collected data from the Andrews-Carson elbow score.

The patients were evaluated pre-operatively with a physical examination, radiographs, and the Andrews-Carson elbow score (Table 1) with corresponding scoring system (Table 2). Diagnosis was routinely made from the history and physical examination. In 11 cases where the diagnosis was unclear, an MRI scan confirmed a complete avulsion. There were no postoperative MRI studies to evaluate tendon healing. The average patient age at the time of the index procedure was 48.1 years (range, 32-74 years), with 30 men and 1 woman. There were 18 right and 13 left distal biceps repaired. One patient had a bilateral repair. There were 15 laborers or farmers, 7 business/office professionals, 3 football coaches, 2 medical care providers, and 4 retired patients.

There are 2 follow-up periods—1 for a clinic visit and the other a telephone interview. First, all patients were seen and evaluated in the clinic at an average of 12 weeks (range, 4-16 weeks) after surgery with a physical examination, radiographs, and a complete objective/subjective Andrews-Carson elbow score. Range of motion was compared with the opposite side through a visual assessment by 1 of the operative surgeons and differences were recorded. Strength of pronation, supination, and initiation of flexion were assessed compared with the opposite side through a manual test by the operative surgeon and graded. As well, all patients (32 elbows) were interviewed by telephone at an average follow-up of 24 months (range, 7-46 months). The telephone interview consisted of the subjective portion of the Andrews-Carson rating scale and a series of questions (Table 3). All patients were specifically questioned as to when they returned to normal activities, which was compared with records documented in the chart. Normal activities or work included, but was not limited to, heavy and light manual labor, shoveling gravel, hammering nails, lifting of 20 to 30 lb with the injured arm, and throwing a football overhead 20 to 30 yards.

Surgical Technique

Anesthesia is provided by interscalene block, general anesthesia, or both. The patient is positioned supine and a tourniquet is not used. A 3-cm transverse anterior incision is made in the elbow flexion crease. The elbow is flexed and the skin overlying the biceps muscle is freed from the underlying biceps by blunt finger dissection. The avulsed end of the biceps tendon is located and the tendon delivered into the wound (Figure 1). Pulling on the most distal end of the tendon, full length is restored by freeing surrounding adhesions. An absorbable No. 1 PDS (polydioxanone) traction suture (Ethicon, Somerville, New Jersey) is placed in the myotendinous junction of the distal biceps. A whipstitch is placed beginning at the area of normal tendon, usually 1 cm proximal to the damaged stump, going toward the myotendinous junction for at least 2 cm and back to the end of the normal tendon. The damaged portion of the tendon is then resected. A 4-mm × 12-mm soft tissue button is then

TABLE 1
Objective/Subjective Rating Scale of Andrews and Carson[a]

Criteria	Points
Subjective	
Pain	
None	25
Occasional	20
With moderate activity	10
With ADLs	5
Swelling	
None	25
With occasional heavy activity	20
With moderate activity	10
With any activity	5
Locking/catching	
None	25
Rare	20
Occasional	10
Frequent	5
Activities	
No limit	25
Occasional	20
Partial activity only	10
Difficulty with work/ADLs	5
Objective	
Flexion contracture	
<5°	25
5° to 15°	20
16° to 35°	10
>35°	5
Sagittal arc of motion	
>130°	50
120° to 130°	40
110° to 119°	30
100° to 109°	20
75° to 99°	10
60° to 74°	5
<60°	0
Pronation/Supination	
Normal	25
<30° decrease total arc	20
<50° decrease total arc	10
>50° decrease total arc	5

[a]Reproduced with permission from Andrews JR, Carson WG. Arthroscopy of the elbow. *Arthoscopy.* 1985;1:97-107. ADLs, activities of daily living.

TABLE 2
Scoring System[a]

Score	Subjective	Objective	Overall
Excellent	90 to 100	90 to 100	180 to 200
Good	80 to 89	80 to 89	160 to 179
Fair	60 to 79	60 to 79	120 to 159
Poor	<60	<60	<120

[a]Reproduced with permission from Andrews JR, Carson WG. Arthroscopy of the elbow. *Arthoscopy.* 1985;1:97-107.

TABLE 3
Telephone Interview

- The subjective portion of the Andrews-Carson score
- Do you have any limitations?
- Have you returned to work?
- Are you performing your normal activities?
- When did you return to normal activities?

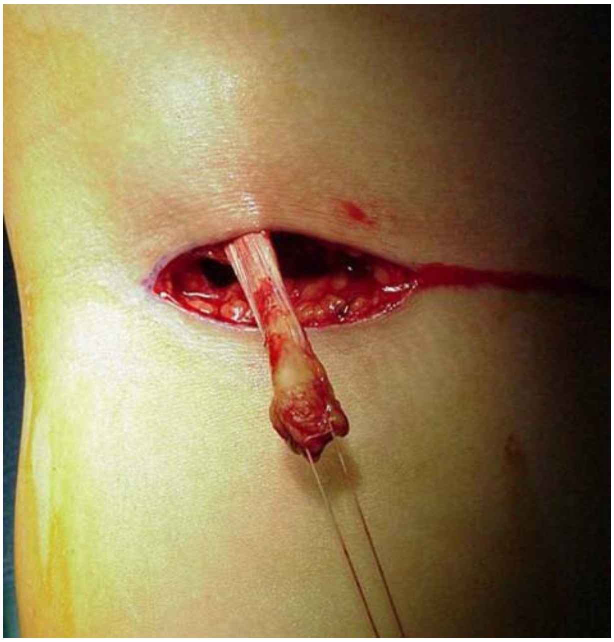

Figure 1. Single anterior incision with exposed distal biceps. (Reproduced with permission from John CK, Field LD, Weiss KS, Savoie III FH. Single-incision repair of acute distal biceps ruptures by use of suture anchors. *J Shoulder Elbow Surg.* 2007;16:78-83.)

tied to the tendon end by a passage of each suture through and back so the knots are on the tendon side of the soft tissue button (Figure 2). Two different soft tissue buttons were used: the EndoButton or the Suture Button.

Blunt Hohmann or Chandler retractors are carefully placed subperiosteally to expose the radial tuberosity. With the arm in full supination, a Beath pin is advanced into the

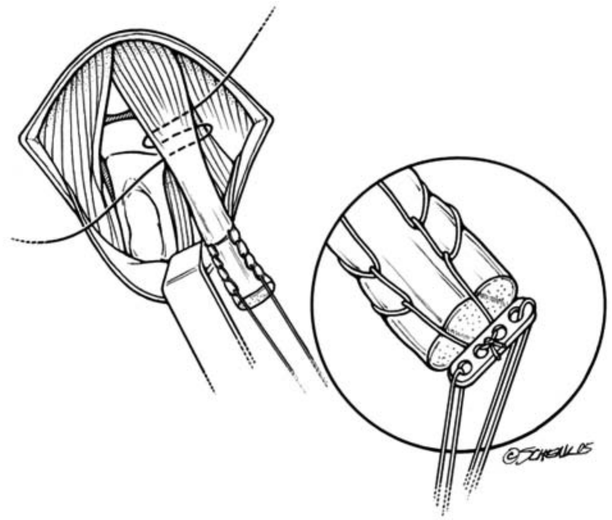

Figure 2. A No. 1 PDS (polydioxanone) safety stitch at the myotendinous junction and a No. 2 FiberWire (Arthrex) running locking stitch with soft tissue button attached. (Reproduced with permission from Michael Schenk, Biomedical Illustrator.)

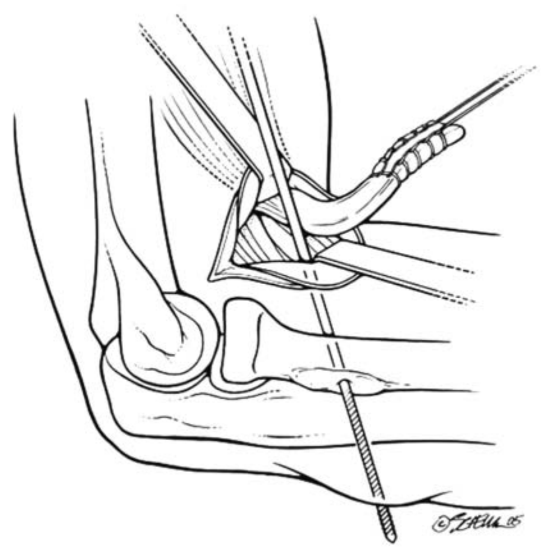

Figure 3. Beath pin placed through the radial tuberosity. (Reproduced with permission from Michael Schenk, Biomedical Illustrator.)

ulnar side of the tuberosity in a distal and slightly radial direction exiting out the dorsal skin (Figure 3). It is important for the pin to have adequate bone on both the radial and ulnar borders of the tunnel to accommodate future biotenodesis screw placement; otherwise, fracture of the proximal radius may occur. A 4- or 5-mm reamer is passed bicortically for passage of the soft tissue button. Next, a reamer of appropriate size (7 or 8 mm) for the biotenodesis

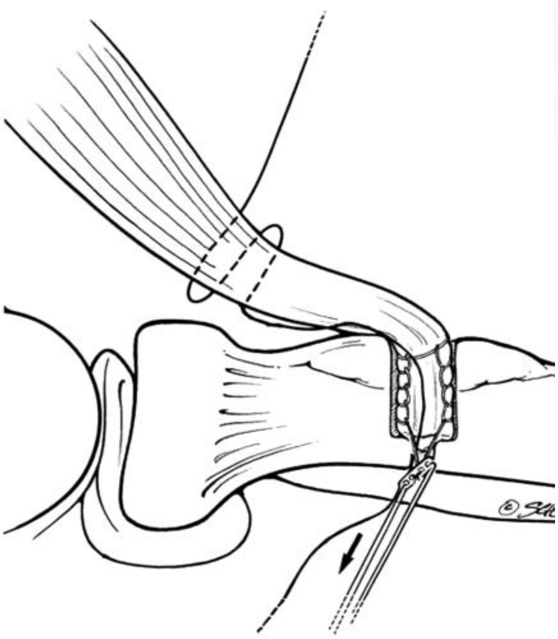

Figure 4. Insertion of the tendon into the radial tuberosity with "flipping" of the soft tissue button. (Reproduced with permission from Michael Schenk, Biomedical Illustrator.)

Figure 5. Fluoroscopic image of the soft tissue button in place.

screw is used to open the radius from the anterior cortex to the intramedullary border of the far cortex, with care taken not to breach the far cortex. The sutures attached to the soft tissue button and one of the absorbable sutures are pulled through the radius and out the dorsal flare. The tendon is pulled into the tuberosity (Figure 4). Under fluoroscopic control in all cases, the soft tissue button is anchored on the outer cortex of the radius (Figure 5). A unicortical biotenodesis screw is then placed on the radial side of the tendon. The free end of the absorbable suture that passed through the radius is pulled around the radial border of the radius in a subperiosteal fashion and tied to

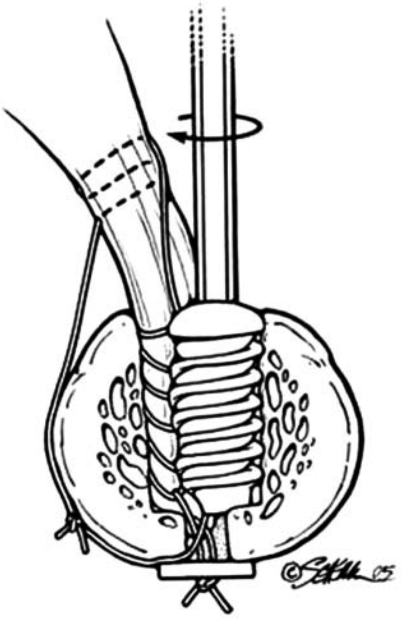

Figure 6. Biotenodesis screw placement into radial tuberosity adjacent to tendon. (Reproduced with permission from Michael Schenk, Biomedical Illustrator.)

the other limb through the anterior incision (Figure 6). This suture is designed to be a safety checkrein, not a significant portion of the fixation. The wound is then irrigated and closed using a 2-0 Vicryl (Ethicon) and a running subcuticular 4-0 PDS (Ethicon). A well-padded posterior splint at 90° of flexion and full forearm supination is applied.

Rehabilitation Protocol

At 3 to 5 days postoperatively, the splint is removed and a compressive sleeve is applied. Home therapy is initiated at 1 week to include gentle active pronation, supination, flexion, and extension. Pain-free strengthening with 1-lb weights is started 1 week postoperatively. By 2 to 3 weeks, patients are performing activities of daily living and active motion is allowed as tolerated. Patients are counseled to avoid excessive elbow flexion against resistance, like picking up an 80- to 100-lb weight with the injured arm for 2 to 3 months. Most patients are back doing normal activities by 4 weeks. A representation of normal activities includes using the injured arm to do the following: shoot a basketball, rake leaves, drive a car, mow the yard, and carry a gallon of milk. Workers' compensation patients go to physical therapy from weeks 4 to 8.

RESULTS

All patients were initially followed for at least 3 months or until they had resumed normal activities. All patients (32 elbows) were then recontacted for a telephone interview at an average of 24 months (range, 7-46 months) postoperatively. The preoperative Andrews-Carson score averaged

168 (range, 125-195) and the postoperative Andrews-Carson score averaged 196 points (range, 150-200) at a mean of 12 weeks from surgery. There was a statistically significant difference between the pre- and postoperative Andrews-Carson scores ($P < .001$). Postoperatively, 29 of the scores were excellent, 2 good, and 1 fair.

Supination strength was grade 5 for 28 elbows and grade 4 for 4 elbows. Initiation of flexion was grade 5 for 30 elbows and grade 4 for 2 elbows.

One patient had heterotopic ossification in the biceps tendon, associated with a decrease in pronation/supination. His final motion was 70° of pronation and 45° of supination. Despite this motion loss, the patient achieved a good outcome on Andrews-Carson scoring. Two patients had a superficial radial nerve palsy that completely resolved by final follow-up. No patients reported a subsequent avulsion event.

The average postoperative time to resume normal activities or return to work was 6.5 weeks as determined by chart review and questionnaire. Twenty-three patients returned to work or previous activity within 6 weeks, 7 by 8 weeks, and 1 by 10 weeks. The patient with bilateral repairs returned to work within 6 weeks after each surgery. Over 90% of patients resumed normal activities by 6 weeks postoperatively. No patient reported returning to power lifting or lifting loads of greater than 60 lb with the injured arm by 10 weeks postoperatively.

All 31 patients in the study (32 elbows) were contacted for a telephone interview at an average of 24 months postoperatively. All these telephone-interviewed patients reported continuing their previous activity level or employment with no deterioration or other problem. The subjective Andrews-Carson score results from the telephone interview at an average of 31 months postoperatively showed 3 patients with occasional limits to activity and 1 patient with occasional swelling with heavy activity at 31 months postoperatively. These results were consistent with their 3-month subjective data.

DISCUSSION

Rupture of the distal biceps tendon is uncommon and usually occurs in men.[2,5,7,24] It is often the result of an eccentric load to the flexed elbow. Patients usually present with deformity pain and swelling at the elbow, with weakness in flexion and supination. Sometimes a defect can be palpated in the antecubital fossa.

In most cases of complete distal biceps rupture, acute repair is the preferred method of treatment.[1,2,20,24] There have been many techniques described for acute repair, including nonanatomic and anatomic. Repair to the brachialis or lacertus fibrosis are nonanatomic repairs that have been used historically.[7] More recently, anatomic repairs have become more commonly used. Anatomic repairs can be done through 1 or 2 incisions with the use of a variety of fixation devices.

A single anterior incision was initially described, but there was concern about the high incidence of neurovascular complications.[7,10,22] A 2-incision technique was then introduced by Boyd and Anderson[6] to decrease the risk of nerve injury. They had favorable results, but radioulnar synostosis and heterotopic ossification were common complications.[9] Therefore, Morrey et al,[23] in 1985, developed a 2-incision muscle-splitting approach to reduce the incidence of radioulnar synostosis.

With the advent of new fixation technology that requires limited surgical dissection, there has been a successful return to the single-incision anterior repair. Linter and Fischer[17] used suture anchor fixation in 5 patients with no reported nerve palsy or heterotopic ossification at final follow-up. A larger series by John et al[13] reported 53 patients treated with suture anchor fixation. All patients had excellent or good results, no permanent nerve palsies, and early return to function.

Many biomechanical studies have evaluated the strength of the more recent repair techniques.[¶] Kettler et al[14] studied transosseous sutures, suture anchors, interference screws, and an EndoButton-based technique for repair of the distal biceps tendon. They found the EndoButton-based technique to have the highest load to failure (259 N). Mazzocca et al[20] studied 4 different repair constructs (bone tunnel, EndoButton, suture anchor, and interference screw) with cyclical loading. They found the EndoButton to have the highest load to failure (440 N). The biotenodesis screw had the lowest (232 N) after cyclical loading, but it demonstrated the least amount of tendon displacement in the bone. All reconstruction techniques were stronger than the mean failure strength of intact distal biceps tendon (204.3 N) based on a study by Idler et al.[12]

Anatomic study has shown the distal biceps tendon attaches on the ulnar side of the radial tuberosity in a comma-shaped strip.[21] During anatomic distal biceps repair, the biotenodesis interference screw is placed on the radial border of the tendon, providing fixation of the tendon to the ulnar aspect of the tuberosity. This ulnar position on the radial tuberosity may improve the biomechanical effect the biceps tendon has when performing supination of the forearm because the insertion on the radius is farther away from the origin. Therefore, the combined soft tissue button and biotenodesis screw technique allow for an anatomic repair with maximum strength.

We believe a combination technique using a soft tissue button and interference screw provides repair strength great enough to allow early aggressive rehabilitation and early return to work and normal activities. Many of our patients are driving a car, drinking a cup of coffee, tucking in their shirt, and opening and closing doors with the injured arm by 1 week, while traditional rehabilitation protocols often recommend immobilization to some degree for 4 to 6 weeks and rehabilitation for 3 to 4 months before release to unrestricted activity.[2,3,8] Not only does this put a significant limit on a patient's independence for several weeks, it makes regaining motion and strength more difficult and prolonged.

[¶]References 4, 8, 11, 12, 14-16, 21-23, 25, 26.

In this study, splints were routinely discontinued within the first week after surgery. This allowed early active range of motion, resulting in resumption of normal activity or work at an average of 6.5 weeks. Review of the postoperative Andrews-Carson objective assessment showed no flexion contracture greater than 5°. The most pronounced loss of motion was in pronation and supination, where 6 patients had a decrease in total arc motion. Only 1 of these patients lost more than 50° from the arc of motion. This patient also had significant heterotopic ossification.

This is a large series of patients with an acute repair of a ruptured distal biceps tendon treated with a combination soft tissue button and interference screw through a single anterior incision and an aggressive early rehabilitation program. The study shows good functional outcomes and return to activity or work. The repair provided enough strength for patients to participate in an accelerated rehabilitation program and allowed a return to normal activities in an average of 6.5 weeks.

The 2 patients with transient radial nerve palsies places emphasis on the risk of radial nerve injury through a limited anterior incision. Our incidence of transient superficial radial nerve palsy was 4.9% and no permanent nerve damage was seen. These findings are comparable with previous reports using a single anterior incision.[1,3,8,13]

This study has limitations. First, the patients were not seen at final follow-up. Therefore, no radiographic evidence was obtained to evaluate the radial tunnel condition, presence or absence of heterotopic ossification, or EndoButton position. Also, the telephone interview at an average 24 months postoperatively may present recall bias with regard to the calculated average time to resume normal activities. Range of motion and strength measurements were done by 1 of 3 surgeons and no standardized devices were employed. This can introduce inaccuracy and observer bias.

In summary, the use of a soft tissue button and biotenodesis interference screw for the repair of acute distal biceps tendon ruptures through a limited anterior incision can allow early return to normal activities with minimal risk of complications.

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