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ORIGINAL ARTICLE

One- Versus Two-Incision Technique for Distal Biceps Tendon Repair

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Abstract There are several techniques that have been described for distal biceps tendon repair but there is still controversy regarding the optimal technique. Our hypothesis is that the single-incision technique will have a similar complication rate and functionally equivalent restoration of function compared with the two-incision approach. A retrospective review of consecutive biceps tendon repairs was performed at one institution over a 5-year period. Thirty-six patients met the inclusion criteria and 26 were available for follow-up including subjective assessment, physical examination, and strength testing. Patients were divided into two groups based on the surgical approach utilized: 12 patients underwent single-incision repair and 14 had a two-incision repair. The average follow-up was 33 months (minimum 13; maximum 75). There were no statistically significant differences in regards to flexion strength or endurance, supination strength or endurance, or complication rates between the two techniques. In conclusion, both surgical techniques led to adequate restoration of strength with a low complication rate. Both techniques are safe to perform and should be guided by surgeon comfort with the approach.

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Introduction

Distal biceps tendon injury is the most common acute tendinous injury around the elbow [1]. The typical patient is male between 40 and 60 years of age. The mechanism of injury is usually a single traumatic event in which the biceps brachii is eccentrically loaded with the elbow in a flexed position [1–2]. Complete avulsion of the distal attachment of the biceps brachii from the radial tuberosity is most common [3]. In this setting, current literature supports acutely repairing the distal biceps tendon to the radial tuberosity in order to optimally restore elbow and forearm function [4–11].

The initial historical attempts at repair of the distal biceps tendon were performed through a single anterior incision with an extensive volar dissection. However, the incidence of radial nerve palsy after this approach was unacceptably high [7, 12–14]. Boyd and Anderson [15] reduced this risk by developing a two-incision approach that exposed the radial tuberosity through a second posterolateral incision with subperiosteal elevation of the common extensor muscle mass off the ulna. While effective in restoring function of the biceps, this technique was complicated by postoperative proximal radioulnar synostosis [10, 16, 17]. A modification of the Boyd–Anderson technique was then performed using a muscle-splitting approach through the common extensor. This modification, combined with early passive range of motion, has led to favorable results and reduced the risk of synostosis [2, 10, 17].

The introduction of suture anchors has led to a resurgence of interest in the single-incision technique. Suture anchors

have made the anterior approach easier and reduced the risk of radial nerve injury compared to that of previous single-incision approaches [18]. Furthermore, early studies of the single-incision technique with suture anchors have yielded outcomes similar to those reported in studies of the modified Boyd–Anderson approach [18–23].

Proponents of the single-incision approach argue that it allows for a more cosmetic result, less blood loss, and decreased surgical time. Proponents of the modified two-incision approach argue that exposure of the radial tuberosity is easier and safer and leads to a better functional outcome. The decision between the different techniques is currently guided by surgeon preference and comfort with the approach. A previous study demonstrated that the two-incision technique had fewer complications and a slightly more rapid recovery of flexion strength compared with the single-incision technique [24]. Based on the experience at our institution, our hypothesis was that the single-incision technique would lead to functionally equivalent results compared to the two-incision technique. The purpose of this study was to report our experience using one- versus two-incision technique in order to determine which technique is better in terms of subjective outcomes, strength and endurance testing, and complication rates including the risk of developing heterotopic ossification.

Materials and methods

We performed a retrospective review of consecutive biceps tendon repairs from January 1995 to August 2000 by 12 surgeons at our institution. To be included in this study, all patients had to have had a history of a complete, acute distal bicep tendon rupture that was repaired within 4 weeks from the time of injury. To be included, the repair had to entail reattachment of the tendon to its anatomic insertion using either the one-incision technique with suture anchors or the two-incision technique employing a bony trough in the tuberosity without anchors (modified Boyd–Anderson) without tendon augmentation. Exclusion criteria included chronic biceps ruptures (>4 weeks duration), bilateral injuries, a history of inflammatory arthritis (e.g., lupus, rheumatoid arthritis, etc.), utilization of grafts to augment the repair, concomitant procedures at the time of distal biceps repair, or distal bicep repair using techniques besides the modified Boyd–Anderson technique. All procedures were performed under regional anesthesia.

An anterior approach to the cubital fossa as described by Henry was used to identify, retrieve, and tag the ruptured end of the distal biceps tendon in all cases [25]. If a single-incision technique was employed, the distal tract of the biceps tendon was explored and the radial tuberosity exposed through a transverse anterior incision two finger breaths (3 cm) distal to the antecubital fossa. With the arm in maximum supination, suture anchors were placed into the tuberosity and the torn tendon reapproximated to the anchors [20, 22, 23] (Fig. 1a,b). In the majority of cases, two suture anchors were used (Mitek GII, Mitek Surgical Products Inc., Norwood, MA, USA) loaded with sutures (Number two Ethibond, Ethicon, Inc., Somerville, NJ, USA). The suture technique varied depending on the surgeon, but the Krakow technique was the most commonly utilized. Other techniques included the Kessler, Bunell, and modified Mason–Allen technique.

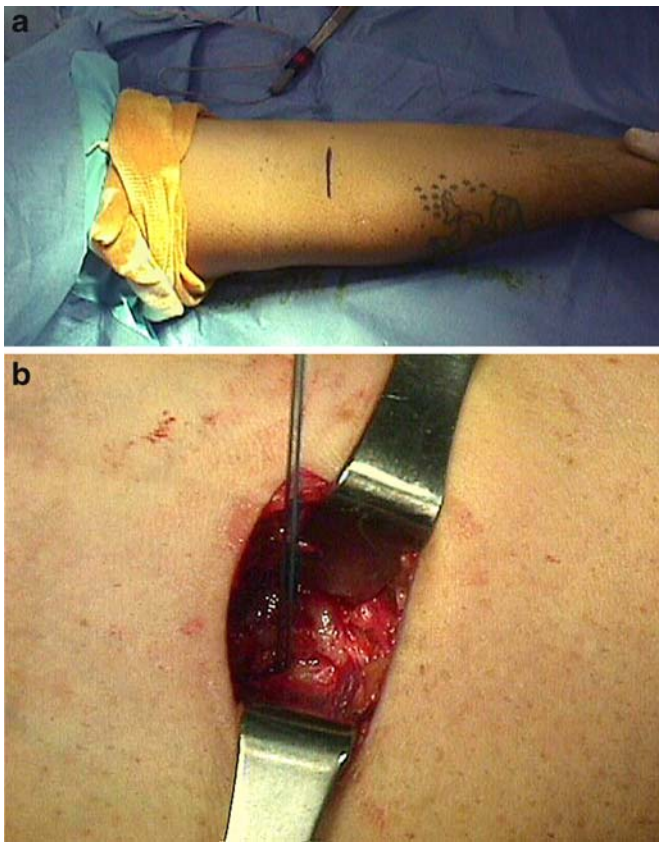

Fig. 1. **a** The single-incision technique for biceps tendon repair can be more cosmetically appealing than the two-incision technique. **b** Exposure of the tuberosity through a single anterior incision with placement of a suture anchor

If a two-incision approach was used, exposure of the radial tuberosity was performed through a second incision located on the proximal forearm. This incision was targeted by inserting a curved hemostat through the anterior incision, into the distal tract of the biceps tendon. The instrument was passed along the medial border of the radial tuberosity such that its tip was palpable on the dorsolateral aspect of the forearm. The second incision was then made directly over the clamp and the tuberosity was exposed through a split in the common extensor muscles with the arm in full pronation [26] (Fig. 2a,b). Depending on surgeon preference, the tendon was tagged using the Krakow, Bunnell, or Kessler suture technique (number 2 Ethibond, Ethicon, Inc., Somerville, NJ, USA) and then inserted into an excavated bony trough and tied over a bone bridge.

Postoperative care for both groups consisted of elbow immobilization in 90° flexion and neutral forearm rotation for 7 to 10 days followed by passive flexion and extension to 45°. This was advanced in order to obtain full extension and flexion at 6 weeks. Active motion began at 6 weeks and then strengthening over the next 6 weeks. A flexion-assisted brace (Bledsoe, Grand Prairie, TX, USA) was used in most cases for 6 to 8 weeks.

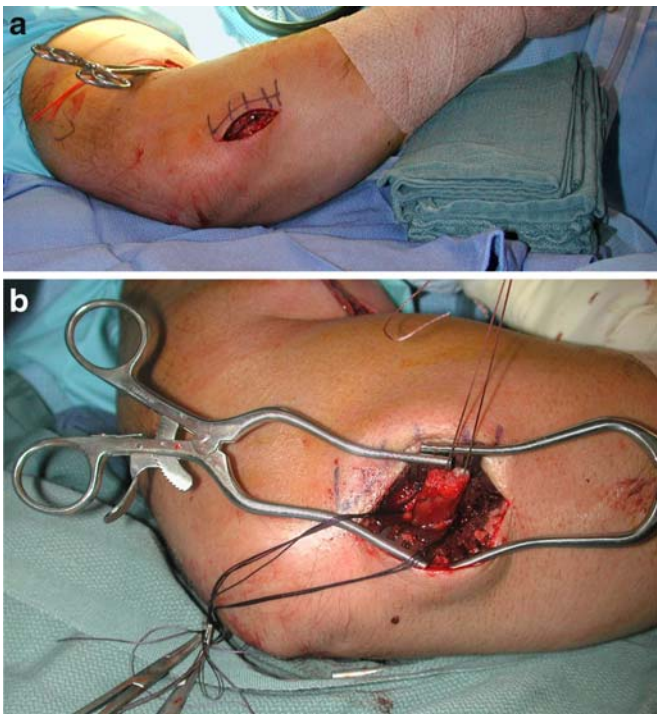

Fig. 2. **a** In the two-incision approach, an accessory incision is made on the ulnar side of the forearm to expose the tuberosity. **b** The biceps tendon is then passed from the anterior incision through the interosseous membrane to the ulnar side of the forearm

Seventy-three distal biceps tendon repairs were performed during the investigation period. Thirty-six of these met all of the inclusion criteria. Of those who met the inclusion criteria, 26 were available for follow-up. Average follow-up was 33 months (minimum 13; maximum 75). Subjects were assigned to one of two groups. Group 1 consisted of 12 patients who had undergone distal biceps repair through a single incision. Ten patients had involvement of the dominant extremity. Group 2 consisted of 14 patients that had a repair using the two-incision technique. Ten patients had involvement of the dominant extremity. There was no statistically significant difference in age or average length of follow-up between groups (Table 1).

All patients completed a simple subjective survey that evaluated if patients were satisfied with the outcome of their surgery and with their surgical scar. They were also asked to compare their ability to perform their activities of daily living before injury with their current ability. Furthermore, we asked them to evaluate their ability to return to their preinjury level of function and other information relevant to the injury such as use of anabolic steroids or fluoroquinolones.

The objective assessment consisted of a physical examination as well as isokinetic tests performed for evaluation of forearm supination and elbow flexion. Each test was performed at two velocities, 60°/s and 180°/s. Physical examination was performed by one of two authors (DCJ or TSJ). Active and passive range of motion in all planes of elbow motion was documented as well as motor and sensory function of the upper extremity. Anteroposterior and lateral radiographs were performed to evaluate heterotopic ossification and radioulnar synostosis. Isokinetic strength and endurance testing of the biceps brachii was performed in both supination and flexion. Strength was quantified as the peak torque generated among five repetitions on the testing apparatus. Endurance was quantified as the total work generated after 15 repetitions. Each test was performed at two speeds; 60°/s and 180°/s. Results were recorded at each speed and tests were performed bilaterally using the uninjured arm as a control. Patients were allowed one warm-up session prior to each test to become accustomed to the exercise.

Descriptive statistics included means and standard deviations for continuous variables and frequencies and percentages for discrete variables. Inferential analysis consisted of the Mann–Whitney *U* test because the outcome variables were not normally distributed. The measurements were normalized using previously reported isometric elbow strength measurements in normal individuals in order to adjust for natural differences due to dominance versus due to deficit from the injury and subsequent surgery [27]. A critical *p* value of 0.05 was used for all hypothesis testing. All analyses were performed using SPSS version 11.0 for Windows (Chicago, IL, USA).

Table 1 Study group demographics

Group	Single incision	Double incision
N	12	14
Mean age	49 [10]	42 [7]
Dominant arm	10	10
Sex	2 F, 10 M	0 F, 14 M
Mean follow-up	26 [14]	31 [21]

[Standard deviation]
M Male, *F* female

Table 2 Subjective assessment

	Single incision	Double incision	*p* value
Number of patients	12	14	
% satisfied	83.4	100	0.20
% that recovered preinjury level of function	50	42.9	0.99
% that recovered ADL	91.7	100	0.20
Time until recovery (weeks)	18.2	19.3	0.81
% satisfied with scar	75	92.9	0.31
Supination peak torque deficit 60°/s (%)	20.43	−7.96	0.19
Supination endurance deficit 60°/s (%)	29.97	−6.32	0.09
Supination peak torque deficit 180°/s (%)	23.21	−13.37	0.06
Supination total work deficit 180°/s (%)	32.37	−10.24	0.09
Flexion peak torque deficit 60°/s (%)	16.28	8.15	0.43
Flexion total work deficit 60°/s (%)	13.43	1.10	0.23
Flexion peak torque deficit 180°/s (%)	6.06	5.11	0.71
Flexion total work deficit 180°/s (%)	15.92	4.63	0.86

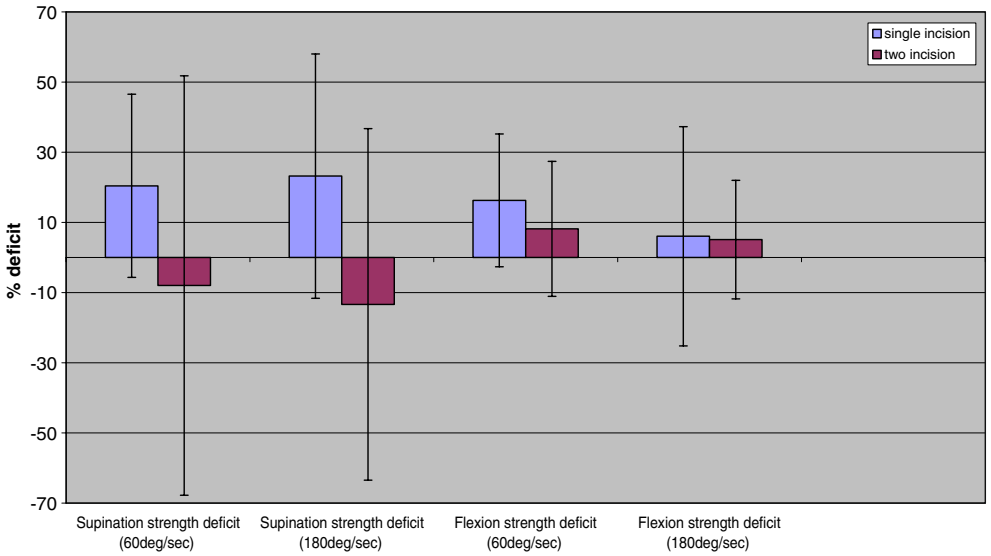

Fig. 3. Isokinetic strength testing is compared as a function of time following surgery. The *arrow bars* represent 1 standard deviation

Results

Subjective assessment revealed overall patient satisfaction of >92% (Table 2). There was no statistical difference between groups with regard to satisfaction with surgery, the ability to recovery, preinjury level of functioning, the ability to return to activities of daily living, the time interval until total recovery, and rate of satisfaction with the surgical scar.

There were no differences detected when comparing isokinetic biceps muscle testing between the groups. This was true for both strength and endurance testing at both testing velocities. However, there was a trend across every isokinetic test that suggests that two-incision patients restore strength and endurance better than single-incision patients. For example, although not statistically significant, the *p* value for supination endurance (60°/s) was 0.095 and for supination strength (180°/s) was 0.060. Isokinetic strength data and endurance data are depicted graphically in Figs. 3 and 4, respectively.

With regard to complications, one patient was noted to have a sensory deficit in the distribution of the lateral antebrachial cutaneous nerve. This patient underwent a one-incision repair. There were no other postoperative complications. Postoperative radiohumeral synostosis was not present in any patient from either group. Four patients had evidence of heterotopic ossification of the distal biceps tendon. None of these were symptomatic. Three of these were in the two-incision group.

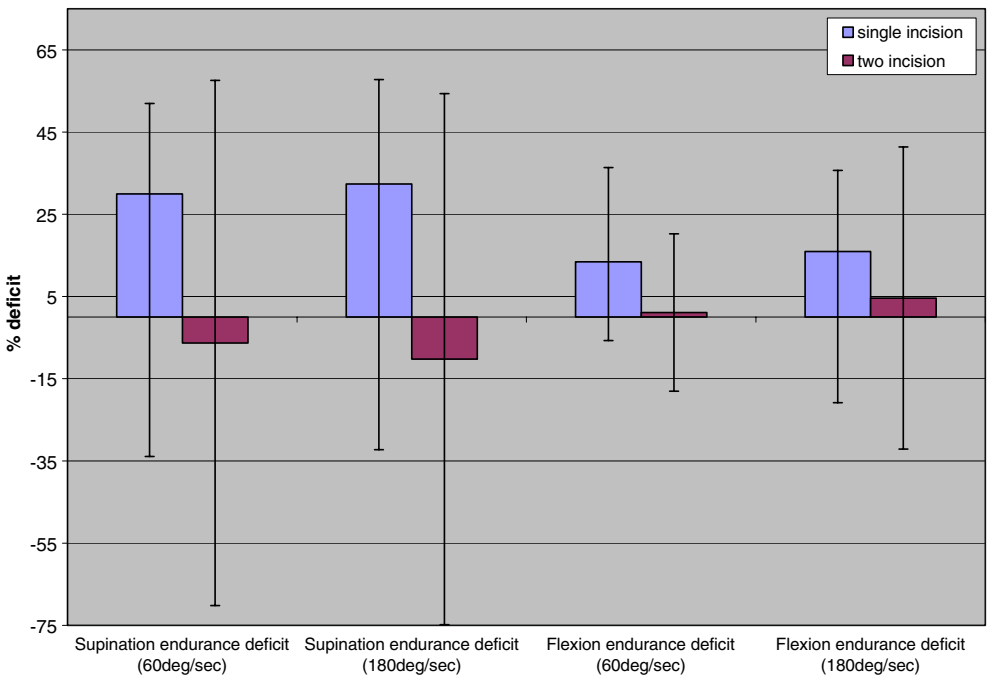

Fig. 4. This graph compares the endurance deficit in supination and flexion between the single- and double-incision patients. The *arrow bars* represent 1 standard deviation

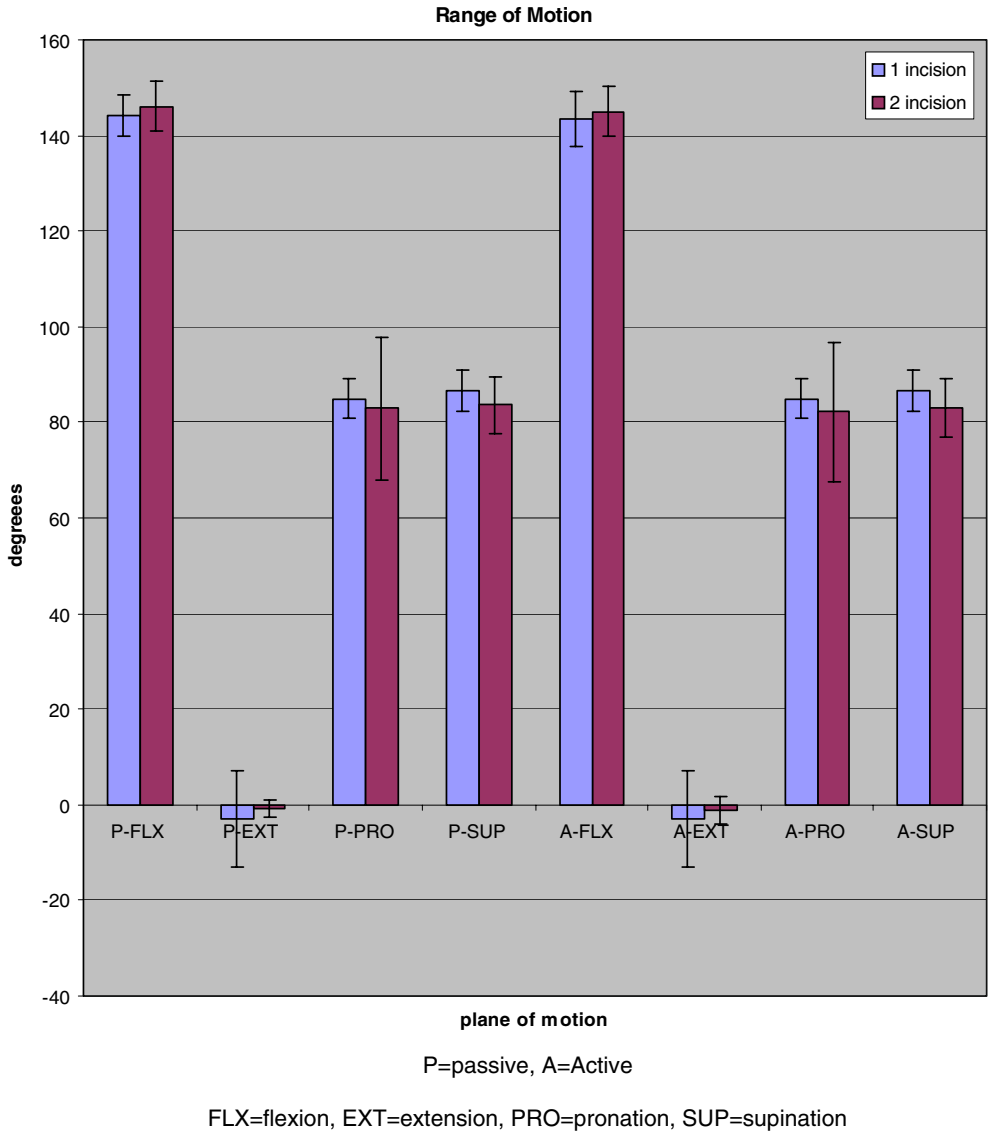

Fig. 5. A graphic comparison of the range of motion achieved in the one- versus two-incision groups

Physical examination revealed no statistically significant difference between groups with regard to active or passive elbow range of motion (Fig. 5).

Discussion

There are a number of studies reporting success with the use of both the single-incision technique and the double-incision technique for repair of the distal biceps tendon. Unfortunately, there is only one published clinical study that directly compares the two techniques [24]. The authors of this study found a more rapid recovery in patients undergoing the two-incision technique and similar functional outcomes when comparing techniques. However, they also demonstrated a 44% complication rate in those who underwent the single-incision technique. Our study is clinically relevant in that it demonstrates successful use of either technique with a relatively low complication rate and similar functional outcomes.

Satisfaction rates in the single-incision group were slightly lower than those in the double-incision group. All patients stated that they were satisfied with their surgery except for two. Both patients underwent a single-incision approach. The first patient was the patient with the lateral antebrachial cutaneous nerve injury. This patient also had a 35° flexion contracture on follow-up examination. The second dissatisfied subject involved a worker's compensation claim. Incidentally, he was also the only study patient who had a secondary procedure performed on the elbow affected by the biceps injury. This patient underwent surgical debridement and repair of the flexor–pronator origin for chronic medial epicondylitis at the time of biceps repair. He stated that he was dissatisfied because he could not return to work due to medial elbow pain when he attempted to lift patients. Physical examination of his elbow revealed full range of motion both actively and passively, but he had pain to palpation over the medial epicondyle. Functional testing of the biceps was nonpainful and consistent with functional testing of the remaining patients in the single-

incision group. An ideal study design would control for patients with secondary procedures performed on the affected elbow. Since this patient's secondary procedure did not appear to affect his functional testing, we elected to keep this patient in the study to improve sample size of the single-incision group.

This study had several limitations. This study was a retrospective study with multiple surgeons which made standardization of technique and rehabilitation difficult. In addition, even with multiple surgeons, acquiring an adequate number of patients to constitute a study of sufficient power (power>0.8) to reject the null hypothesis was an obstacle that we were unable to accomplish in this study. This can be explained by the infrequent nature of distal biceps tendon injury and the limits of a retrospectively designed study. Although reported with increasing frequency, avulsion of the distal attachment of the biceps brachii is still a rare injury [1]. To date, approximately 500 cases have been reported in the English literature. Although we found no statistical difference in functional testing between groups, the trend in the data suggests that double-incision patients had better restoration of biceps strength and endurance after repair. This seems somewhat logical if one considers the challenge in adequately exposing the apex of the tuberosity through a volar incision while avoiding neurovascular injury within the cubital fossa. The observed trend might also be explained by the different suture techniques employed. In the single-incision group, a suture anchor was used to reapproximate the tendon to the tuberosity. In the two-incision group, the tendon was embedded in a bone trough. One might argue that functional trends observed are more dependent upon "suture technique" than "incision technique." Unfortunately, we were unable to control for suture technique in this study due to surgeon preference. Both techniques of fixation have been studied in vitro and the current literature is inconclusive as to which technique is superior [28, 29].

Either single- or double-incision technique allows for safe repair of acute biceps tendon injuries with few complications, high satisfaction, and acceptable functional recovery of elbow and forearm mechanics. When compared to the single-incision technique, the two-incision technique may afford slightly greater restoration of strength and endurance in supination and flexion. However, a randomized, prospective comparison of the two techniques is needed to more conclusively document differences in outcome achievable with either technique.

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