Distal biceps tendon reconstruction in chronic ruptures

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The purpose of this retrospective study was to evaluate the results of anatomic reattachment with reconstruction of the distal biceps tendon using an Achilles tendon allograft in 7 male patients with chronic distal biceps ruptures. Through a 1-incision anterior approach, the tendon allograft was attached to the bicipital tuberosity by using suture anchors and then secured to the biceps remnant. Follow-up averaged 29 months. Mean elbow flexion was 145°, an extension deficit of 20° was observed in 1 patient, and mean pronosupination was 170°. All patients had 5/5 strength in flexion and supination on manual testing, and all returned to their employment. Mean supination strength was 87% of the contralateral healthy extremity. Six achieved an excellent and 1 a good rating in the Mayo elbow performance score. No complications were encountered. This technique is an excellent alternative to nonanatomic reattachment to the brachialis muscle for patients with high functional demands in pronosupination. (J Shoulder Elbow Surg 2006;15:614-619.)

The biceps brachii muscle is the primary forearm supinator and a secondary elbow flexor. Distal biceps ruptures are rarer than proximal ruptures and usually affect middle-aged men. The pathophysiology of distal ruptures is still unclear, but both hypovascularity of the tendon in a zone close to its insertion and mechanical impingement have been postulated.[34] Conservative treatment of distal biceps tears is known to lead to an appreciable decrease in strength and endurance in flexion and supination.[2,14,19,24,27] Primary surgical repair with anatomic reinsertion of the ruptured tendon to the bicipital tuberosity of the radius is now favored in active individuals. Repairs through either a single anterior incision[1,3,10,18,21-23,25,26,30,31,37] or techniques with 2 incisions[2,6,16,18,24,33] have yielded satisfactory results with restoration of elbow flexion and supination strength.

Chronic distal biceps ruptures, presenting 4-6 weeks after the original injury, pose the additional problem of tendon retraction. Patients usually present late after a discrete traumatic event with dull pain and weakness in elbow flexion and forearm supination. Asymmetry in the contour of the muscle and dysesthesias in the lateral antebrachial cutaneous (LAC) nerve distribution are also noted. The diagnosis can be confirmed by magnetic resonance imaging (MRI).

When faced with a retracted distal biceps tendon, the surgeon has three options: attempt to mobilize the biceps, nonanatomic repair of the distal biceps to the brachialis muscle, and distal biceps tendon reconstruction. Biceps mobilization can be achieved by sectioning the lacertus fibrosus (if it is intact), releasing adhesions, releasing the tourniquet, performing relaxing incisions to the epimysium, and applying traction to the distal biceps stump for several minutes.[35] These measures, although helpful, are not always effective. A biceps-to-brachialis repair is the simpler salvage option in such instances, but this procedure does not restore supination strength.[5,14,17,27,38] It is thus a suboptimal solution for patients such as manual workers and athletes who have high functional demands in supination.

Our current indication for distal biceps reconstruction is the inability to approximate the biceps stump to the bicipital tuberosity with the elbow in less than 70° of flexion in a patient with high functional demands in supination. We present the surgical technique and results of distal biceps reconstruction in chronic ruptures through a single anterior approach using Achilles tendon allograft.

MATERIAL AND METHODS

The charts and radiographs of 8 male patients who underwent distal biceps reconstruction for chronic ruptures by the senior author were retrospectively reviewed. In the earliest patient in this series, autologous facia lata was used as graft, and the patient was excluded from this study. Seven men with a mean age of 38 years (range, 30-52 years) had distal biceps reconstruction through a single anterior approach with the use of an Achilles tendon allograft.

Every patient could recall a specific injury to the elbow. Six dominant and 1 nondominant upper extremities were injured. Four patients sought medical attention after their injury and were initially treated conservatively. The patients

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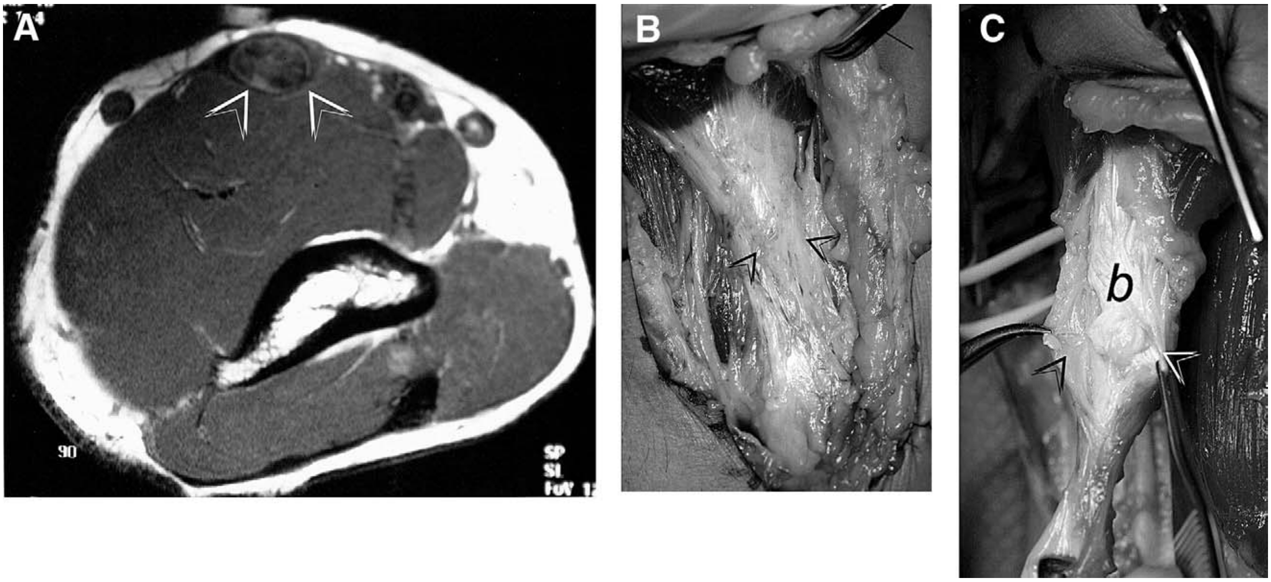


Figure 1 A, Axial magnetic resonance image at the distal arm level showing the retracted distal biceps tendon enclosed in a cocoon of connective tissue *(arrows)* in a patient with a chronic distal biceps rupture. **B,** During surgical exploration, the cocoon of connective tissue *(arrows)* gives the impression of tendon continuity to the bicipital tuberosity. **C,** The cocoon *(arrows)* is incised longitudinally to reveal the retracted biceps tendon stump *(b)*.

presented to us after a mean time from injury of 28 weeks (range, 12-45 weeks). The primary complaints at presentation were pain and weakness in 4 patients (3 of whom additionally had LAC nerve distribution dysesthesias) and weakness alone in 3. All patients had full elbow range of motion at presentation. The diagnosis was confirmed by MRI in 5 patients. Five patients were manual workers (3 electricians), and 2 were recreational athletes (1 semi-professional golfer and 1 softball player).

Surgical technique

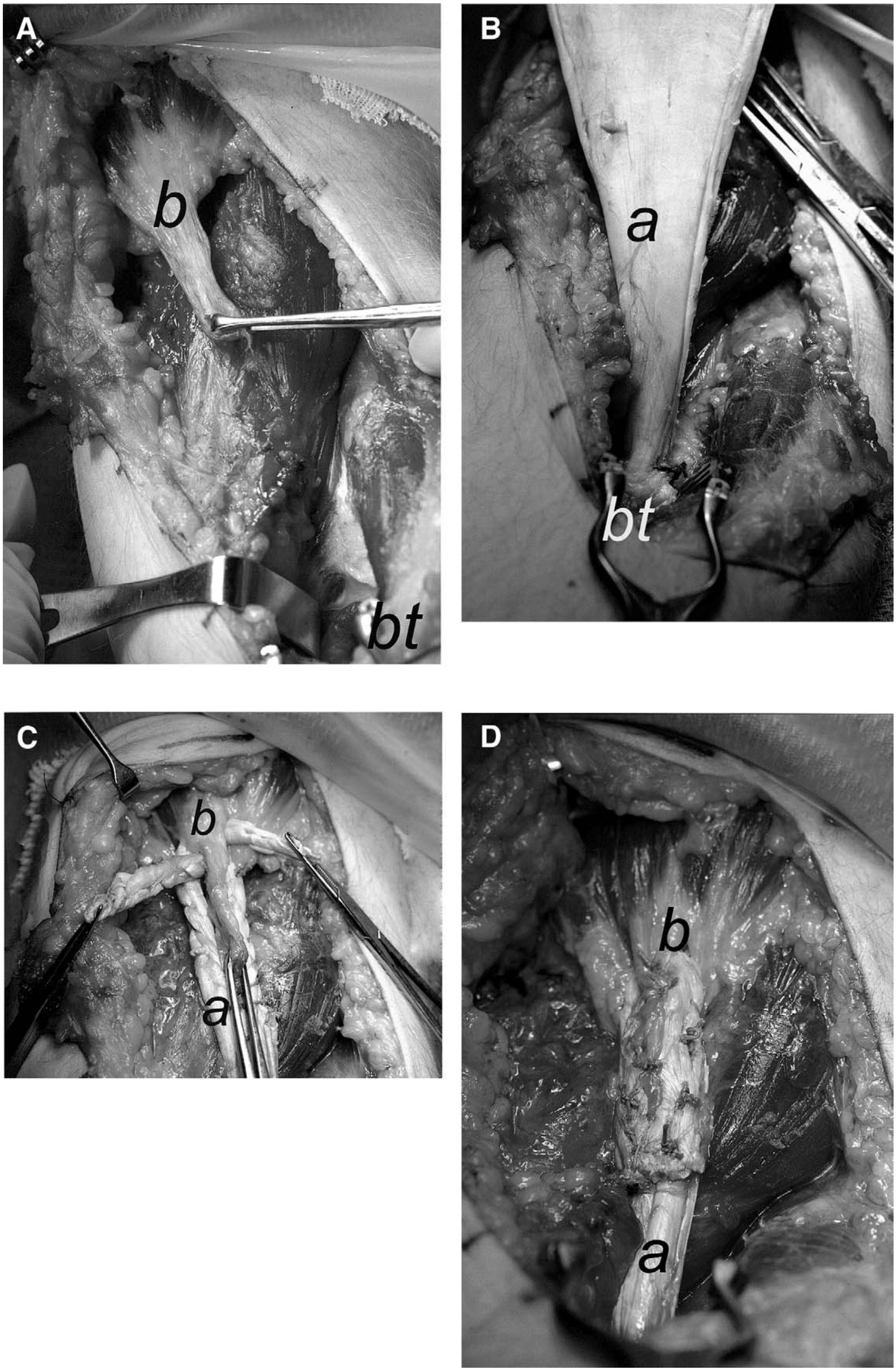
Under tourniquet control, an anterior Henry incision to the elbow is used for the procedure. The proximal limb of the incision is lateral to the biceps tendon. After dissecting through the subcutaneous fat and ligating the superficial veins as necessary, the superficial fascia is incised. The LAC nerve is identified as it emerges lateral beneath the biceps tendon. Neurolysis of the LAC is often undertaken because it is entrapped in scar tissue underneath the ruptured biceps tendon. In chronic cases, the tendon may be enclosed in a cocoon of connective tissue that might give the impression of tendon continuity to the bicipital tuberosity (Figure 1*A* and *B*). That cocoon should be incised longitudinally to determine if the retracted tendon stump is still present (Figure 1*C*). If present, a primary repair should be attempted.

After adequate mobilization of the biceps, the tendon stump is serially sectioned until normal appearing tendon bundles are encountered (Figure 2*A*). At this juncture, a decision on whether reconstruction of the tendon is necessary should be made. Inability to approximate the biceps stump to the bicipital tuberosity with the elbow in less than 70° of flexion in a patient with high functional demands in pronosupination is our indication for tendon reconstruction.

Next, the fresh-frozen Achilles tendon-os calcaneus composite irradiated allograft is removed from its packaging and hydrated in saline for a few minutes. The bone block that typically comes with this allograft is sharply incised and discarded. The insertion of the Achilles tendon to the calcaneus is used as the distal portion of the reconstructed biceps tendon attaching to the bicipital tuberosity. The allograft tendon generally has to be trimmed to size-match the native distal biceps tendon. The proximal wide fascial expansion of the allograft should be separated to 2 or 3 strips to facilitate weaving through the biceps tendon stump. Weaving can be further facilitated by using a whipstitch to give a cylindrical configuration to the proximal strips of the allograft (Figure 2*C*).

The bicipital tuberosity is exposed next. Through the same incision, with the forearm in complete supination, the path of the native distal biceps tendon is dissected to the tuberosity. Branches of the radial recurrent vessels often have to be ligated to facilitate exposure. The soft tissues (radial artery medially and mobile wad covering the posterior interosseous nerve laterally) are gently retracted. The soft-tissue attachments directly on the tuberosity are cleaned with a curette. Periosteal stripping of the bicipital tuberosity is not necessary. Two metal suture anchors (Mitek GII, Mitek, Westwood, MA) are then inserted after pre-drilling with a 2.4-mm drill. The size 2-0 nonabsorbable suture attached to the anchors is then passed trough the distal part of the allograft in a modified Kessler sliding stitch (Figure 3*A*), and the allograft is securely attached to bone (Figure 2*B*).

The proximal attachment to the biceps stump follows. The proximal allograft is woven through the distal biceps stump in a Pulvertaft fashion (Figures 2*C*, 3*B*) and sutured with 2-0 suture material. An entry point of approximately 1 to 2 cm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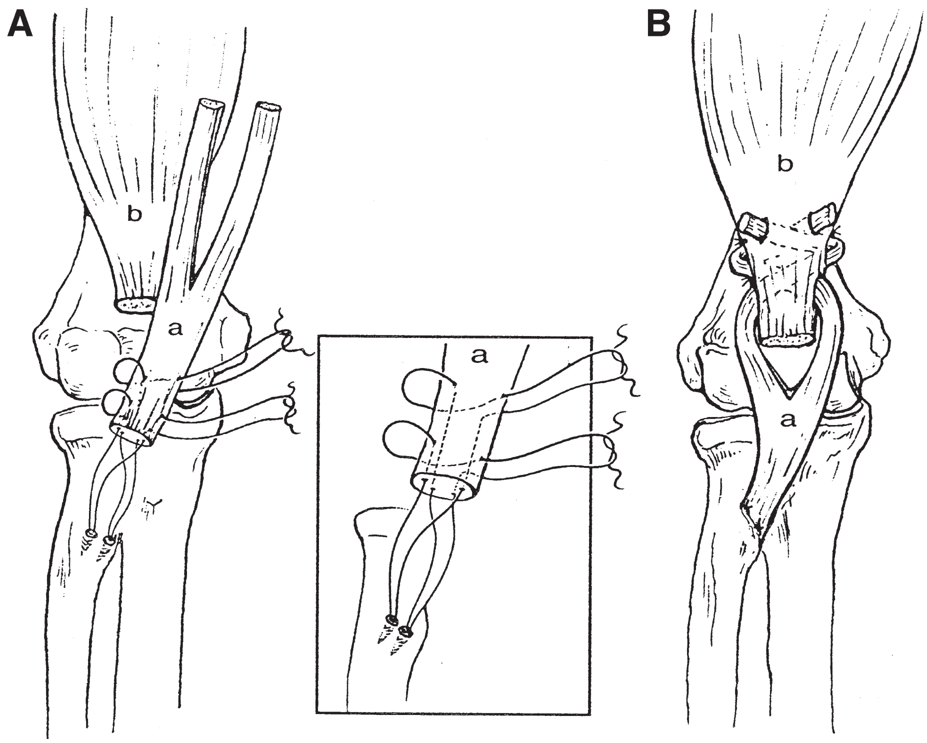

Figure 3 A, Schematic of the modified Kessler sliding stitch used to secure the Achilles tendon allograft *(a)* to the bicipital tuberosity. **B,** Schematic of the Pulvertaft weave used to secure the Achilles tendon allograft *(a)* to the distal biceps stump *(b)*.

from the end of the stump is preferred, if the length is sufficient.

The graft is tensioned with the elbow at 40° to 60° of flexion and the forearm in supination (Figure 2*D*). Slightly over-tensioning the graft is preferred to under-tensioning. The viscoelastic properties of the biceps muscle will permit stretching in full extension of a slightly over-tensioned graft, whereas under-tensioning will result in a slack graft. The wound is then copiously irrigated to remove any bone debris from drilling, meticulous hemostasis is obtained after tourniquet deflation, and the wound is closed.

A posterior, long arm splint with the elbow in 90° of flexion is applied for 2 weeks and then replaced with a hinged elbow brace with an extension block. Extension is gradually added, so that the patient reaches full extension in the brace by 8 weeks. The elbow brace is then discontinued. The patient begins progressive strengthening in physical therapy until full loading is permitted at 6 months.

Figure 2 A, Intraoperative image of retracted distal biceps stump *(b)*. The stump cannot be approximated to the bicipital tuberosity *(bt)* with the elbow at 70° of flexion. **B,** The Achilles tendon allograft *(a)* is secured first to the bicipital tuberosity *(bt)* using 2 suture anchors. **C,** The Achilles tendon allograft *(a)* is woven through the distal biceps stump *(b)* in a Pulvertaft fashion. Note that a whipstitch was used to give a cylindrical configuration to the proximal strips of the allograft facilitating weaving. **D,** Appearance of the completed proximal repair with multiple sutures securing the Pulvertaft weave of the Achilles tendon allograft *(a)* through the distal biceps stump *(b)*.

Assessment of study patients

At the final follow-up, subjective and objective data were collected. Elbow range of motion was measured, and the patients were assessed for stability and their performance in the 5 activities of daily living that are included in the Mayo elbow performance score.[9] Elbow supination and flexion strength were assessed by manual testing with the elbow at 90° of flexion and neutral rotation and compared with the contralateral healthy extremity by an experienced physical therapist. Next, supination strength was assessed as the maximum torque in isometric supination of the elbow using a BTE work simulator (Baltimore Therapeutic Equipment, Hanover, MD). Three measurements of both upper extremities were performed, and the mean was calculated. Supination strength was expressed as a percentage of the uninjured side without adjustment for dominance.

RESULTS

Follow-up averaged 29 months (range, 14-48 months). All patients had a palpable distal biceps insertion to the biceps on physical examination. The neurovascular status of all the patients was intact. All patients were pain free at rest, and 1 complained of discomfort with strenuous activities. The mean elbow flexion was 145° (range, 130°-155°). One patient had an extension deficit of 20°; in the remaining patients, extension was noted to be full. The mean pronation was 83° (range, 70°-90°), and the mean supination was 86° (range, 75°-90°).

Manual testing produced 5/5 strength in elbow flexion and supination. One patient complained of subjective weakness in supination, although he stated that it was significantly improved compared with preoperatively. The mean maximum torque in supination (using the BTE work simulator) was 87% (range, 65%-118%) compared with the contralateral uninjured extremity.

The mean Mayo elbow performance score was 97 points (6 patients with a score of 100 points and 1 score of 85). Six patients were rated as excellent and 1 as good. All patients returned to their previous occupations, 1 with duty restrictions. All patients were satisfied with the procedure, although 1 expressed reservations concerning the prolonged rehabilitation time.

The patients' final radiographs showed no change in the position of the suture anchors. In 1 patient, a clinically insignificant heterotopic ossification (Hastings and Graham class I)[13] about the biceps insertion was noted. No other complications were noted.

DISCUSSION

In chronic distal biceps rupture, tendon retraction and degeneration can render the tendon irreparable primarily. In our experience, the possibility of a primarily irreparable tendon increases 6 months after the injury, but this can certainly occur earlier, close to the 3-month interval.[11,15,33] In symptomatic patients, nonanatomic biceps-to-brachialis repair is an option. Earlier reports[14,27,38] have pointed out the inefficacy of this procedure to restore supination strength. In a recent study using isokinetic testing, Klonz et al[17] found that half of their patients with biceps-to-brachialis fixation lost more than 50% of supination strength. Flexion strength was regained, possibly because of compensation by other elbow flexors. Bell et al[5] had similar results in a smaller study. The possibility of significant loss of supination strength may be unacceptable for patients with high functional requirements in supination during their occupational or recreational activities and must be discussed with them before surgery.

Distal biceps reconstruction is an alternative to the nonanatomic biceps-to-brachialis repair for such patients. Several sources of autologous tendon or fascial tissue have been described for distal biceps reconstruction. Fascia lata,[14] the semitendinosus tendon,[11,12] the palmaris longus tendon,[32] and a slip of the flexor carpi radialis[20] have all been used in small series or case reports. A synthetic ligament augmentation device alone,[28] or in conjunction with fascia lata,[15] has been utilized. More recently, the use of Achilles tendon allograft has been reported.[33] In most of these reports,[11,14,25,29] a 2-incision technique was used. A single-incision technique in conjunction with autologous tendon grafting was reported in 2 studies.[11,20] Results from these reconstructions have been uniformly good, and this is attributed both to the resolution of pain and to the restoration of strength.

The technique we have described in this report combines the use of the Achilles tendon allograft with a single-incision technique that uses suture anchors. By using the allograft tendon, the need for additional incisions for graft harvesting and the possibility of donor site morbidity are avoided. Furthermore, the Achilles tendon allograft provides abundant tissue for reconstruction and safe proximal fixation, in contrast to some of the smaller upper-extremity autografts that have been described.

The superiority of the single vs 2-incision operative technique is still being debated in the literature.[7,16,29] Our experience from primary repairs favors the single-incision technique with suture anchors as a safe and effective technique.[35] In distal biceps reconstructions, it requires considerably less dissection because the bone block of the allograft is not used, in contrast to the 2-incision technique described by Sanchez-Sotelo et al.[33] This minimizes the risk of nerve injury and heterotopic ossification. Fixation with suture anchors alone was proven sufficient for all patients in this study and is supported in the literature for primary repairs.[3,21,23,25,31,35,37]

Six of 7 patients in this study had an excellent Mayo elbow performance score. Overall motion was maintained in most of the patients. Symptom relief was obtained in all patients who had preoperative symptoms of pain or dysesthesias. All the patients experienced subjective improvement in supination strength, and only 1 had subjective weakness in supination. Objectively, the mean supination strength was 87% of the contralateral extremity. The isometric assessment of supination strength was used in this report as a simple and reproducible method of expressing supination strength compared with the contralateral uninjured extremity. Isokinetic testing of strength and endurance is highly dependent on the testing protocols and the instruments used, and the results are not directly comparable between studies.[3] Side-to-side differences were not shown to be significant for peak torque in supination[3,8] and were not corrected for dominance in this study.

Although no significant complications were observed in this study, the possibility of nerve injury, heterotopic ossification infection,[7] and the remote possibility of disease transmission from the allograft[4,36] must be taken into consideration and explained to the patient, if such a reconstruction is anticipated. Moreover, this technique is more demanding than a biceps-to-brachialis repair and involves a prolonged rehabilitation period. The authors do not advocate this technique for cosmesis alone. The technique is an excellent alternative to nonanatomic repair in symptomatic patients who have high functional demands in supination in their occupational or athletic activities.

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