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Case Series

Distal Biceps Tendon Reconstruction with Achilles Tendon Allograft: A Case-Series

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Abstract

Background: Chronic, complete ruptures of the distal biceps tendon are often difficult to surgically repair due to significant fibrosis and retraction. The use of a graft is recommended, with recent literature suggesting that an Achilles tendon allograft leads to superior clinical outcomes. The purpose of this study is to present the surgical technique and retrospectively review the clinical outcomes of a distal biceps reconstruction technique that utilizes an Achilles tendon allograft with an Endobutton bicortical fixation system through a single S-shaped incision.

Methods: Seven male patients and eight cases of distal biceps reconstruction with Achilles tendon allograft were identified between January 2017 and March 2022. The mean age was 48.3 ± 8.9 years with a mean time from initial injury to surgery of 6.1 ± 3.8 months. Charts were retrospectively reviewed for patient demographics, procedural technique, preoperative and postoperative evaluation, and complications.

Results: The cohort had a mean follow-up of 4.6 ± 2.0 months (range, 1.4-8.2). At the final office visit, full range of motion had returned for all patients except one, who had a persistent 10° extension deficit. Flexion strength had returned to equal preoperative and preinjury gross strength out of 5 (4.7 ± 0.5 preoperatively *vs.* 4.4 ± 0.5 postoperatively) and supination improved from preoperative strength (2.2 ± 1.1 preoperatively *vs.* 3.6 ± 1.2 postoperatively). Four out of eight cases resulted in a new neuropraxia identified in postoperative care: two lateral antebrachial cutaneous nerves, one superficial branch of radial nerve, and one ulnar nerve, with insufficient follow-up duration to determine resolution. One patient reported excessive scar formation; otherwise, there were no major complications.

Conclusion: Reconstruction of the distal biceps tendon using an Achilles tendon allograft is a technically challenging, yet effective approach for the treatment of complete distal biceps tendon ruptures that are chronic in nature, resulting in an improvement in preoperative disability with few postoperative complications.

Keywords: Distal biceps; Reconstruction; Achilles tendon allograft; Distal biceps tendon rupture

Introduction

A complete rupture of the distal biceps tendon is a rare musculoskeletal injury that can lead to a significant amount of morbidity for a patient [1-4]. These injuries typically occur in working-age males, especially those that perform heavy labor or work in positions that require forceful lifting. A common injury mechanism for these patients is a sudden force applied to a fully extended and supinated arm, such that a maximal force is applied to the insertion of the biceps tendon at the radial tuberosity [1,4]. Complete rupture is typically noted and evaluated immediately, with subsequent surgical intervention and primary repair to reattach the ruptured distal biceps tendon.

A chronic distal biceps injury, resulting from failed primary repair or delayed initial management, is typically defined as greater than four weeks after initial injury and presents a challenging surgical decision with higher risk of complications [1,5,6]. The biceps tendon is often poor quality, severely retracted, and accompanied by a significant amount of scar tissue, leading to a more difficult procedure. Several novel surgical techniques using graft material have been developed to reconstruct these chronic distal biceps ruptures, with functional outcomes comparable to that of acute distal biceps repairs [7]. These include Achilles, semitendinosus, gracilis, and tibialis anterior allografts, among other less common approaches [1,2,7,8]. Several studies have found the Achilles tendon grafts to be a superior allograft technique when compared to others [1,8,9].

The use of an Achilles tendon allograft was first described by Sanchez-Sotelo et al. [10], and since then there have been several case reports and small case-series detailing variations of techniques and approaches using exclusively Achilles allografts [11-14]. These studies have consistently demonstrated good results in strength, Range of Motion (ROM), and patient satisfaction with the procedure, with most patients able to return to preinjury activity level and employment [15]. However, even within the case-series studies that focus on Achilles tendon allografts, there exist differences in proximal and distal fixation, incisions, and other surgical minutiae. Snir et al. [1] published a case-series study of 18 patients, the majority of which underwent single-incision approaches with variation in the type of allograft used. Another study published by Phadnis et al. [15] reviewed 21 cases using an Achilles tendon allograft, each using a two-incision approach. To our knowledge there has not been a cohort of exclusively Achilles tendon allograft patients using a single-incision technique.

The purpose of this study is to present the surgical technique and retrospectively review the clinical outcomes of a distal biceps reconstruction technique that utilizes an Achilles tendon allograft

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with an Endobutton bicortical fixation system through a single S-shaped incision.

Methods

Patients who underwent distal biceps tendon reconstruction using an Achilles tendon allograft at a single institution between January 2017 and March 2022 were identified using a database search of the Electronic Medical Record (EMR) system. After the patient list was identified, medical charts and imaging studies were then carefully reviewed. Descriptive statistics were used to report results.

Patients

An initial search of the EMR database was performed with the keywords "Tendon Repair Biceps (At Elbow)". Results were then filtered to those that utilized an Achilles tendon allograft, yielding the study cohort. Patient charts were then thoroughly reviewed. Patient characteristics included: patient age at surgery, BMI, date of original injury, mechanism of injury, prior injury workup, pertinent past medical history, and smoking status. Procedure and recovery descriptors included: date of surgery, laterality, graft and fixation type, procedure length, and complications. Pre- and post-reconstruction follow-up data included: visit date, subjective strength (standard 1-5 scale), subjective Range of Motion (ROM), pain, sensation, special maneuvers such as hook test and presence of Popeye deformity, and any other pertinent workup or recovery characteristics. Dynamometers and goniometers were unable to be utilized for objective strength and ROM measurements. Patient-Reported Outcomes Measurement Information System (PROMIS) scores were collected at preoperative and postoperative visits. Informed consent for patient information and images to be published was waived per the study IRB.

Surgical Indication and Graft Availability

The decision to perform a reconstruction *vs.* primary repair was made based on clinical history, clinical examination, and imaging findings (Figure 1). Time from original injury, tendon retraction and scarring, functional limitation, and patient preferences were all considered. In each case, the native tendon was initially examined intraoperatively for primary repair viability prior to proceeding with reconstruction. An Achilles allograft was made available for all distal biceps repairs, regardless of time since injury due to the variable nature of native biceps tendon quality and logistical difficulty of performing an unplanned reconstruction surgery.

Surgical Technique

Regional anesthesia was provided and the patient was placed in the supine position. A sterile tourniquet was placed proximally following exsanguination of the upper extremity. Surgical approach utilized a single-incision approach with an S-shaped incision for broad exposure. Pertinent anatomy was identified and protected, including the lateral antebrachial cutaneous nerve, and tissue was carefully dissected to identify the retracted distal biceps tendon stump and original insertion on the radial tuberosity (Figure 2A). After inspection of native tendon quality, a decision was made to either continue with primary repair or utilize an allograft. Grafts were fresh-frozen and sterilized through the AlloTrue™ cleansing process [16], with subsequent irradiation with a dose range of 9 kGy-15 kGy. The Achilles tendon allograft (AlloSource, Centennial, CO, USA) was then opened and prepared on a back table by removing the bony fragment of the calcaneus and carefully downsizing the tendon to fit through an 8 mm tendon sizer and placing No. 2 FiberWire sutures in a Krakow fashion to stabilize the graft (Figure 2B). Insertion of the Achilles tendon allograft distally was completed prior to proximal fixation to native biceps tendon in all cases, as it allowed for the proper tension to be set. An 8 mm hole was drilled and reamed bicortically through the radius. At this point an Endobutton was secured with fluoroscopy confirmation for proper positioning (Figure 3). The graft was then secured to the distal biceps tendon muscle tendon unit using multiple independent and a running locked 3-0 FiberWire sutures, ensuring appropriate tension such that flexion, extension, pronation, and supination of the arm were preserved (Figure 2C). The incision was closed primarily (Figure 4), and all patients were placed in a hinged elbow brace restricting motion from 30 to 90 degrees of flexion.

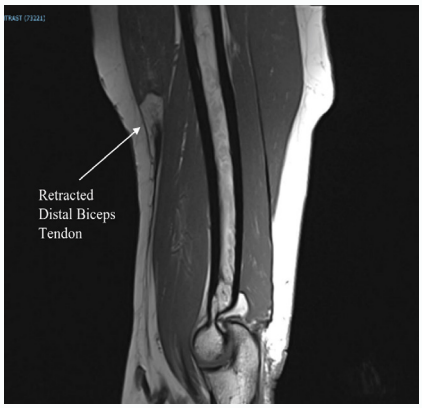

Figure 1: MRI evidence of distal biceps tendon retraction.

Postoperative Care

Patients were evaluated postoperatively by the treating surgeon. At the two-week follow-up time point, repeat evaluation was performed and ROM was advanced to 0-90 degrees flexion. At six-week follow-up, physical therapy for ROM was started with discontinuation or weaning out of the brace. At the two to three-month follow-up timeframe, strengthening exercises were started with physical therapy until reaching full weight bearing status through open-chained exercises. Physical therapy was continued until maximum medical improvement was determined at each patient's final follow-up. At each visit, hook and supination tests were performed to evaluate the integrity of reconstruction. Patients were also asked about functional status and cosmetic concerns at postoperative visits.

Results

Patient population

EMR database search returned 90 cases of distal biceps tendon repairs and reconstructions within the specified timeframe. Of these, eight were performed using an Achilles tendon allograft on seven unique patients, five on the left and three on the right. Patient and injury demographics are demonstrated in Tables 1-3. Patient contact included at least one preoperative appointment followed by a mean of 3.9 ± 1.2 postoperative appointments (range, 2-6), with one patient lost to follow-up after the second postoperative visit. The cohort had a mean follow-up of 4.6 ± 2.0 months (range, 1.4-8.2). The mean interval between initial injury and reconstructive surgery was 6.1 ± 3.8 months (range, 0.6-12.4). Five of the eight cases were referred from an outside provider after initial evaluation and management. Two patients had previously had primary repairs attempted, with two failed repairs in each patient. The times between the initial attempted repairs and reconstruction surgery was 59 and 209 days, respectively. One additional patient had an aborted primary repair due to poor tendon

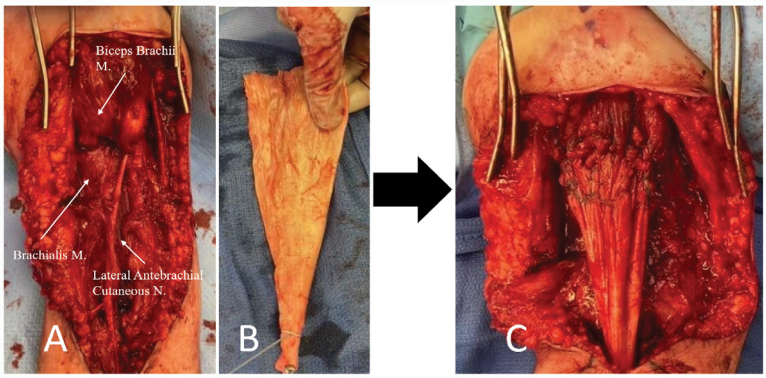

Figure 2: (A) Surgical exposure and retracted distal biceps, (B) Achilles tendon allograft, and (C) completed reconstruction.

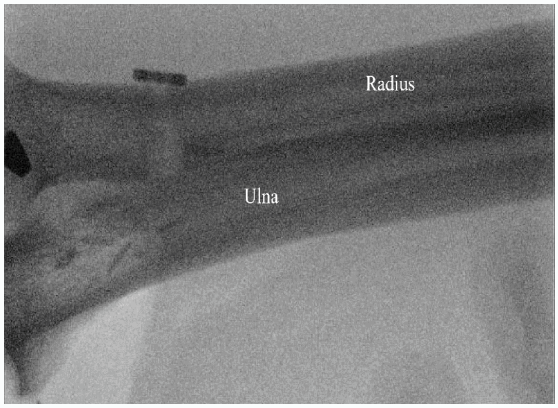

Figure 3: Intraoperative fluoroscopic confirmation of Endobutton positioning.

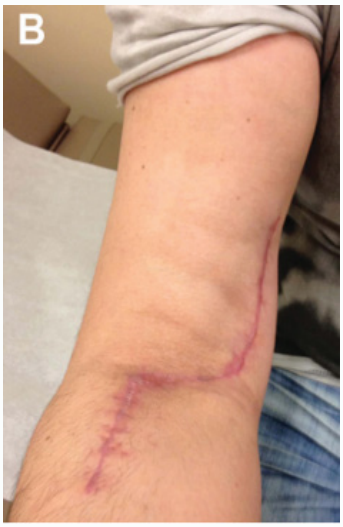

Figure 4: S-shaped single incision scar appearance.

quality. There was no significant difference in preoperative strength between those that had previously attempted primary repairs, though one patient did have a 30 degrees extension ROM deficit noted while all other patients were able to fully extend preoperatively. Six of the eight cases were found to have corresponding preoperative PROMIS scores; though only two had matching postoperative scores (Table 3). It was also determined that different versions of the form were used, resulting in incomplete patient-reported outcome data.

Complications

There were no intraoperative complications reported. In several instances, operations were noted to be more technically difficult due to extensive scar tissue in the antecubital fossa, severely retracted distal biceps tendons, and adhesion to adjacent tissue. The majority (5/8) of patients reported minimal to no residual pain at two weeks, with two more reporting moderate pain controlled with nonprescription pain medications. One patient reported substantial pain but also admitted to not using his brace and excessive arm usage.

Postoperative complications can be seen in Table 1, the most common being nerve palsies. Two patients reported Lateral Antebrachial Cutaneous nerve (LABC) involvement characterized by numbness and paresthesia along the lateral forearm. One patient had persistent numbness in the distribution of the superficial branch of the radial nerve at the dorsolateral hand. Two patients complained of ulnar nerve involvement, though one had known ulnar nerve palsy and concurrent ulnar nerve decompression performed at the time of surgery. One patient was diagnosed with eosinophilic fasciitis, complicating post-operative care and recovery. Two patients had significant psychosocial stressors during their care, including incarceration/release and homelessness. Other common complaints included limited ROM and biceps muscle spasms. One patient reported excessive scar formation with consideration of future scar revision. There were no other major cosmetic complaints noted.

Clinical Evaluation

All but one patient completed at least one preoperative assessment and three follow-up visits at two weeks, six weeks, and three months. After surgery, ROM steadily improved, with the maximal improvement noted between the six week and three-month mark coinciding with physical therapy work. Strength improvement lagged behind that of ROM, steadily improving with maximal improvement seen between three and five months postoperatively. Preoperative and postoperative strength and ROM assessment results are shown in Table 2. At the final office visit, flexion strength had returned to equal preoperative and preinjury gross strength out of 5 (4.7 ± 0.5 preoperatively *vs.* 4.4 ± 0.5 postoperatively, p=0.37) and supination improved from preoperative strength (2.2 ± 1.1 preoperatively *vs.* 3.6 ± 1.2 postoperatively, p=0.02). Palpation and hook test of the distal biceps tendon confirmed integrity of the reconstruction throughout the postoperative period, and there were no instances of reconstruction failure or revision.

Table 1: Patient/Injury Characteristics and Outcomes (N=7 Patients, 8 Injuries).

Patient No.	Sex	Age	Mechanism of Injury	Attempted Primary Repair	Injury to Surgery, mo	Follow-up, mo	Complications[1]
1	Male	45	Heavy lifting	Yes (aborted)	1.4	7.2	
2	Male	49	Stopping heavy object momentum	Yes (failed)	3.3	8.2	Eosinophilic Fasciitis; known prior ulnar nerve palsy
3	Male	38	Heavy lifting	No	6.5	4.9	Dimished ulnar nerve sensation
4	Male	41	Heavy lifting	No	7.3	1.4	Incarceration; lost to follow-up
5	Male	50	Unspecified	Yes (failed)	8.8	3.7	Homelessness; Diminished LABC nerve sensation
6	Male	39	Stopping heavy object momentum	No	0.6	4.2	Diminished superficial branch of radial nerve sensation
7R*	Male	62	Heavy lifting	No	8.4	4.3	Cosmetic concerns with excessive scar formation
7L*	Male	62	Heavy lifting	No	12.4	3.3	Diminished LABC nerve sensation

[1]Unable to determine if transient due to follow-up time
*Right and left arms on the same patient

Table 2: Pre- and Post-Operative Strength Evaluation[1]

	Flexion		Supination			
Patient No.	Preop	Postop	Preop	Postop	Postop Flexion ROM	Postop Rotation ROM
1	4	5	4	5	Full	Full
2	4+	4	2	2	10°-130°	Full
3	5	4	NT	2	Full	NT
4	4	NT	3	3	Full	NT
5	5	4	1	4	Full	NT
6	NT	5	NT	5	Full	Full
7R*	5	5	2	5	Full	Full
7L*	5	4	1	3	Full	Full

[1]Measured at final follow-up using standard 0 to 5 scale
NT - not tested
*Right and left arms on the same patient

Table 3: Patient Reported Outcomes.

	PROMIS Scores									
	Preop					**Postop**				
Patient No.	Pain	General	Mental	Physical	Social Activities	Pain	General	Mental	Physical	Social Activities
1	5	-	45.8	39.8	-	6	-	43.5	34.9	-
2	2	-	33.8	37.4	-	2	3	36.3	39.8	2
3	-	-	-	-	-	-	-	-	-	-
4	-	-	-	-	-	-	-	-	-	-
5	7	3	33.8	-	2	-	-	-	-	-
6	3	4	53.3	54.1	4	-	-	-	-	-
7R*	1	4	-	54.1	4	-	-	-	-	-
7L*	1	4	-	54.1	4	-	-	-	-	-

*Right and left arms on the same patient

Discussion

Chronic and previously operated on distal biceps ruptures present a challenging case for orthopedic surgeons. Without repair, the functional impairment seen in complete distal biceps ruptures can lead to significant morbidity. This is noted especially in the population where this injury is most frequently seen: male laborers who rely on the function of their hands to make a living. After an initial decision to repair is made, it must be determined whether a primary repair or surgical reconstruction is necessary. In this series of eight injuries in seven patients, we found good clinical results using an Achilles tendon allograft to repair a complete distal biceps rupture up to one year after initial injury. With these results, patients can be assured that even chronic distal biceps tendon ruptures can be reconstructed with satisfactory outcomes.

In this study we found that as early as three months postoperatively, elbow flexion returned to full subjective strength. Supination strength, while still grossly decreased postoperatively, was significantly improved compared to preoperative levels. This sustained decrease in postoperative gross strength was a surprising result, as prior studies have demonstrated up to 90% return of supination strength [12], whereas this study remained at 72%, though with a limited follow-up period of 4.2 ± 2.0 months compared to 17 months in a similar study [12]. Nonetheless, this is a superior result to alternative techniques, which have demonstrated a 40%-50% reduction in postoperative gross supination strength [17,18]. Patients with professions or hobbies that rely on supination, such as using a screwdriver or lifting, can therefore be confident that even a chronic distal biceps rupture can see improvement after reconstruction using an Achilles tendon allograft, and that this technique can lead to full return of flexion strength and the best return of supination strength.

The procedure is not without its risks, however. Given the nature of injury and time elapsed before repair, this is a technically difficult procedure. Scar tissue, significant tendon retraction, and poor tendon quality all contribute to the complexity and lend themselves to a higher risk of complications.

Nerve injury was by far the most prevalent complication postoperatively, likely due to the technical difficulty of the surgery. Though care was taken to identify and protect the lateral antebrachial cutaneous nerve and other nerve branches in the operative field, four of eight cases resulted in nerve palsies that were not present prior

to surgery. Prior studies have shown that these nerve palsies are typically transient [1,9,15,19], but in this study the follow-up period was insufficient to fully determine nerve recovery. It has been argued that a larger, single S-type incision may incur a higher risk of such injury, though a previous systematic review [20] and randomized clinical trial [19] investigating the differences in outcomes and complications between one- and two-incision approaches found negligible differences between the two, apart from a higher incidence of early transient nerve palsies with a single incision technique [19]. As such, the one incision approach was preferred and utilized in this study to maximize exposure in such a technically demanding operation, though may have resulted in a higher incidence of early transient neuropraxias.

This study had several limitations. The follow-up period of this study was shorter than most similar studies and may not have truly reflected full improvement in strength and ROM, though most patients were discharged from clinic at maximum medical improvement. Several patients had difficulty adhering to restrictions or keeping postoperative appointments due to psychosocial circumstances. Strength and ROM testing was limited to subjective assessments and clinical evaluation and would have benefitted from objective measures such as dynamometer or goniometer testing, and the retrospective nature of this study precluded the application of these devices. The subjectivity of these strength and ROM assessments, therefore, limits the reliability and repeatability of these results. There was also no utilization of additional imaging modalities such as MRI to assess graft healing and integration at follow-up. Another limitation was the lack of consistent patient reported outcomes or additional metrics such as the Mayo Elbow Performance Score (MEPS), Disabilities of the Arm, Shoulder, and Hand (DASH) questionnaire, or Oxford elbow score as reported in similar studies [1,8,10,13,15].

Future studies should further focus on clinical outcomes of an Achilles tendon allograft in larger patient cohorts. Researchers should also continue to investigate the differences between allograft types, with the goal of developing a standardized technique for the management of chronic distal biceps tendon reconstruction surgeries.

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