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Outcomes of chronic distal biceps reconstruction with tendon grafting: a matched comparison with primary repair

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A R T I C L E I N F O

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Level of evidence: Level III; Retrospective Cohort Comparison; Treatment Study

Background: The purpose of this analysis was to analyze outcomes of distal biceps reconstruction with soft tissue allograft in the setting of chronic, irreparable distal biceps ruptures. The outcomes of these cases were then compared with a matched cohort of distal biceps ruptures that were able to be repaired primarily.

Methods: Retrospective review of an institutional elbow surgery database was conducted. All cases of distal biceps repairs were identified by Common Procedural Terminology, ICD-9, and ICD-10 codes from January 2009 to March 2018. A direct review of operative reports was then conducted to identify which cases required allograft reconstruction. After identification of this population, a 2:1 manually matched cohort of patients who underwent primary repair was generated using age, gender, body mass index, and age-adjusted Charlson Comorbidity Index. Finally, the allograft reconstruction and matched primary repair cohorts were compared for reoperation, range of motion, and patient-reported outcomes scores.

Results: There were 46 male patients who underwent distal biceps reconstruction with allograft (14 Achilles tendon, 32 semitendinosus) and they were matched to 92 male patients that underwent primary distal biceps repair. Mean patient age (46.9 ± 10.3 vs. 47.0 ± 9.8 years, $P = .95$), BMI (31.3 ± 5.3 vs. 31.3 ± 4.8 kg/m^2, $P = .60$), and Charlson Comorbidity Index (1.2 ± 1.1 vs. 1.3 ± 0.9, $P = .64$) were similar between allograft reconstruction and primary repair groups. Disability of the Arm, Shoulder and Hand score (7.4 ± 18.0 vs. 1.6 ± 4.1, $P = .23$), Mayo Elbow Performance Score (92.1 ± 19.7 vs. 97.3 ± 6.4, $P = .36$), and Oxford Elbow Score (43.4 ± 11.0 vs. 46.8 ± 3.2, $P = .25$) were not significantly different between groups at mean 5.1 years (range, 1.5-10.9 years) after surgery. There were 1 of 42 (2.2%) allograft patients who require revision compared with 3 of 92 (3.3%, $P = .719$) in the primary repair group. In addition, one primary repair required reoperation for scar tissue excision and lateral antebrachial cutaneous neurolysis. Final range of motion data (twelve-week follow-up) for the allograft reconstruction group was similar to primary repair group in flexion (136.1° ± 5.3° vs. 135.9° ± 2.7°, $P = .81$), extension (0.8° ± 2.9° vs. 0.4° ± 1.7°, $P = .53$), pronation (78.0° ± 9.0° vs. 76.4° ± 15.4°, $P = .50$), supination (77.4° ± 10.7° vs. 77.5° ± 11.9°, $P = .96$).

Conclusion: Patients who underwent distal biceps reconstruction with a graft had similar failure rates, reoperation rates, final range of motion, and patient-reported outcomes scores as those treated without a graft. Patients can be consulted that direct repair in the acute setting is preferred; however, even in the setting of a distal biceps reconstruction with graft augmentation, they can expect low complications and good functional results.

Investigation performed at the Rothman Institute of Orthopaedics, Methodist Hospital-Thomas Jefferson University Hospitals, Philadelphia, PA, USA.
Thomas Jefferson University Institutional Review Board approved this study (IRB#: 19D.379).

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There is no agreed on timeline to define a chronic distal biceps rupture, but such tears have been reported from 3 weeks[1,7,15] to 3 months[16,19] from injury. In chronic ruptures the degree of tendon retraction and scarring is not solely predicted by time from injury to repair. If the bicipital aponeurosis is intact, it can limit the degree of tendon retraction into the proximal arm.[17,21] There have been reports of successful direct anatomic repair in injuries treated greater than 4 weeks from time of injury.[5,9,24,29] When the tendon retraction and adhesions preclude the length required for direct anatomic repair, anatomic reconstruction with tendon graft to the radial tuberosity can restore strength and endurance in both elbow flexion and forearm supination.[2,20] Graft options that have been described include semitendinosus autograft,[11,12,18,25,31] tensor fascia lata autograft,[3,13,14,26] palmaris longus autograft,[24,26,30] flexor carpi radialis autograft,[16] and Achilles tendon allograft.[8,22,27,32]

Reports comparing acute versus delayed (surgical delay range, 14-28 days) primary repair of distal biceps ruptures have shown higher complication rates with delayed repair.[4,6,15] The current literature on outcomes, reconstruction failures, and reoperation rates after irreparable distal bicep tears that require reconstruction with tendon grafting is limited to case reports and small case series.[8,10,11,23,28,31] It is unclear whether cases that require grafting lead to similar outcomes as those that can be primarily repaired.

The purpose of this analysis was to analyze outcomes of distal biceps reconstruction with soft tissue allograft in the setting of chronic, irreparable distal biceps ruptures. The outcomes of these cases were then compared with a matched cohort of distal biceps ruptures that were able to be repaired primarily. We hypothesized that patient-reported outcomes scores would be lower for chronic reconstructions and that the reconstruction failure and reoperation rate after chronic repairs requiring tendon grafting would be higher.

Materials and methods

Patient selection

After approval by our Institutional Review Board, a retrospective review of all distal biceps repairs was performed. These cases were collected from our institutional elbow surgery database from January 2009 to March 2018. All distal biceps reconstructions or primary repairs were performed by one of seven shoulder and elbow fellowship-trained surgeons. The primary database was assembled by Common Procedural Terminology codes. The code utilized to identify all distal biceps repairs was 24342 (Reinsertion of ruptured biceps or triceps tendon, distal, with or without graft). Direct chart review was then conducted to ensure that a distal biceps repair or reconstruction was performed. Patients were excluded if they underwent a revision procedure or concomitant procedure. Operative reports were searched directly to identify all cases of reconstruction with an allograft.

Population characteristics/matching process

Chart review was performed on all patients identified for preoperative variables including age, gender, body mass index (BMI), and age adjusted Charlson Comorbidity Index (CCI). We then analyzed the patient population that underwent consecutive primary reconstruction with use of allograft and performed a 1:2 match with corresponding patients who underwent nonconsecutive primary repair. The first set of criteria was to match equivalent gender. Once gender was matched, we evaluated BMI, age, and CCI concurrently. Our criteria for a positive match for each pair was to have the same gender, the same procedure, BMI within five points, age within five years, and CCI within one point (when possible). In addition to matching each pair individually, a running average of age, BMI, and CCI was recorded for both the allograft reconstruction group and the primary repair group. This was done in an effort to dynamically monitor how these variables were changing for each subpopulation as a whole and thus the individual matching process could be tailored to maintaining similar overall subpopulations.

Evaluation for symmetry of the matched cohorts

There were 46 consecutive distal biceps reconstructions performed with allograft (14 Achilles and 32 semitendinosis) with full demographic and clinical data performed over the study period. No distal biceps reconstructions were excluded. After generation of a matched cohort of 92 patients who underwent primary repair, the groups were analyzed for similarity. For continuous variables (age, BMI, CCI), a two-sample t-test assuming unequal variance was performed. For proportional variables (percentage of male patients), a two-sample z-test for comparing proportions was calculated.

Surgical technique

Distal biceps reconstructions with allograft were performed with two-incision radial bone tunnel technique in 35 patients (76%) versus 11 patients (24%) with single-incision suture anchor or suture button technique. Primary repair was performed with two-incision radial bone tunnel technique in 60 patients (65%) versus 32 patients (35%) with single-incision suture anchor or suture button technique.

Outcomes analyzed

All patients were then assessed for reoperation, repair or reconstruction failure, range of motion (at twelve-week follow-up), and patient-reported outcomes scores at final follow-up. Reoperation and revision rates were identified by direct chart review for all patients within 90 days of surgery (most patients do not follow-up long term after a distal biceps repair or reconstruction at our institution and they are usually discharged from our care at approximately the twelve-week visit). In addition, 26 allograft reconstruction patients (57%) and 71 primary repair patients (77%) were contacted via phone call to assess for reoperations and patient-reported outcomes scores, including the Disability of the Arm, Shoulder and Hand (DASH) score, Mayo Elbow Performance Score (MEPS), and Oxford Elbow Score at mean 5.1 years (range: 1.5-10.9 years). Final range of motion data were recorded by the primary surgeon by visualization at the final (12 week) visit in flexion, extension, pronation, and supination. Reoperation and revision rates were compared between groups by a two-sample z-test for proportions. Range of motion data and patient-reported outcomes scores were compared between groups by two-sample t-test assuming unequal variance. All statistics were calculated with Microsoft Excel (2013; Redmond, WA).

Results

Patient population

During the study period, 613 primary distal biceps repairs and 46 primary distal biceps reconstructions with allograft were performed. There were 46 male patients who underwent distal biceps reconstruction with allograft (14 Achilles tendon and 32 semitendinosus). These were matched to 92 male patients that underwent primary distal biceps repair. The average age, BMI, and CCI were very similar between both groups (Table I). Although these parameters were controlled, the time to surgery from injury was not (as this often accounts for why a graft was needed in a primary setting). The graft population underwent reconstruction significantly later than the direct primary repair population (Table I). The number of distal biceps reconstruction with allograft performed at specified time intervals from date of injury to surgery were as follows: 2 to 6 weeks (n = 17), 6 to 12 weeks (n = 10), 12-26 weeks (n = 13), >6 months (n = 6).

Outcomes

Of the 46 patients that underwent distal biceps reconstruction with allograft, one (2.2%) required revision reconstruction. There were no other reoperations in the graft cohort. Comparatively, 3 of 92 (3.3%, $P = .719$) of the matched cohort of primary repair patients underwent revision repair or reconstruction. There was one additional reoperation in the primary repair cohort, a scar excision and lateral antebrachial cutaneous neurolysis. Final range of motion data were similar between both groups at 12-week follow-up and no significant stiffness was reported (Table II).

Patient-reported outcome scores were collected at a mean of 5.1 years (range, 1.5-10.9 years) follow-up. There were 26 patients (57%) that underwent distal biceps reconstruction with allograft with outcome scores and these were compared with 71 primary repair patients (77%) with outcome scores. There was no significant different in dash, Mayo, or Oxford Elbow Scores (Table II). Both groups demonstrated good to excellent functional scores.

Discussion

This study was a single-institution experience of 46 distal biceps reconstructions with tendon allograft for chronic, irreparable distal biceps ruptures. One patient (2.2%) required reoperation. These patients were matched to 92 patients that underwent primary distal biceps repair—of which 4 patients (4.4%) required reoperation.

Our study found distal biceps reconstruction in the setting of a chronic, irreparable tear can achieve a similar patient-assessed, subjective result to primary repair. Similarly, reoperations are uncommon in both cohorts. Distal biceps reconstruction with soft tissue allograft is a reliable alternative to primary repair in challenging clinical situations.

We observed one patient (2.2%) in the allograft reconstruction group that required revision reconstruction and found this to be consistent with previous reported reoperation rates in the literature. Table III compares number of cases, graft used, fixation to radial tuberosity, reoperation and nerve injury rate of the present study to previous reports in the literature. Frank et al[10] reported on 19 patients with chronic distal biceps rupture treated with semitendinosus autograft looped through transosseous tunnels in the radial tuberosity, they reported 3 patients (16%) with transient lateral antebrachial cutaneous neuropraxia and one case (5%) of early graft failure at the muscle-tendon graft interface due to trauma from patient noncompliance—no patients underwent reoperation. Two smaller case series of 9 and 7 patients undergoing semitendinosus autograft reconstruction for irreparable distal biceps rupture reported no graft failure, reoperation, or complication at final follow-up.[11,31] Phadnis et al[23] evaluated 21 distal biceps reconstruction with Achilles allograft and reported 2 cases (10%) of transient lateral antebrachial cutaneous neuropraxia—no reoperation or cases of graft failure. Snir et al[28] evaluated 18 patients that underwent late distal biceps reconstruction with allografts and reported 2 transient posterior interosseous neuropraxias (11%) and no reoperations or graft failure. Darlis et al[8] evaluated 7 cases of Achilles allograft reconstruction and reported one case of clinically insignificant heterotopic ossification—otherwise no complication at final follow-up were reported.

The present study found functional elbow range of motion was reliably restored in patients undergoing allograft reconstruction or direct primary repair. This is consistent with previous reports on elbow range of motion after graft reconstruction.[8,10,23,28] Although the present study did not evaluate postoperative elbow strength—previous studies have reported similar restoration of postoperative supination strength between graft reconstruction and direct primary repair. Frank et al[10] evaluated patients with chronic distal biceps ruptures, defined as surgical treatment >21 days from injury, of which 19 underwent semitendinosus autograft reconstruction and compared with 43 patients treated with primary repair—at final follow-up (mean 47 months) supination strength (Isometric supination strength [% of uninjured]: 78 vs. 78; $P = .98$) and elbow flexion strength (isometric flexion strength [% of uninjured]: 90 vs. 89; $P = .81$) were similar between groups. Darlis et al[8] reporting on 7 Achilles allograft reconstructions found at final follow-up (mean 29 months) mean maximum torque in supination was 87% (range, 65%-118%) compared with the contralateral uninjured extremity.

In our study, postoperative patient-reported outcomes scores (DASH, MEPS, and Oxford Elbow Score) were high and similar between allograft reconstruction and primary repair groups. Previous reports have also found high patient-reported outcomes scores after graft reconstruction (with no control primary repair group).[8,23,28] Phadnis et al reported mean postoperative Oxford Elbow Score, QuickDASH score, and MEPS were 44.7 (range, 35-48), 4 (range, 0-20.5), and 92.9 (range, 70-100), respectively, at a mean follow-up of 15 months (range, 6-35 months). Snir et al reported postoperative mean follow-up at 21 months (range, 7-68.8 months), the mean DASH score was 7.5 ± 17.9, and the mean MEPS was 94.2. Frank et al[10] found subjective outcomes were slightly better in patients treated with primary repair compared with

Table 1
Comparison of demographics between reconstruction with allograft group and direct repair group

Criteria*	Reconstruction with allograft (n = 46)	Direct repair (n = 92)	*P* value
Age (years)	46.9 ± 10.3 (17-67)	47.0 ± 9.8 (21-66)	.953
BMI (kg/m^2)	31.3 ± 5.3 (22.6-44.4)	31.3 ± 4.8 (21.2-45.2)	.596
CCI (No.)	1.2 ± 1.1 (0-5)	1.3 ± 0.9 (0-4)	.643
Time from injury to surgery (days)	116 ± 186.6 (15-1,095) Median: 61.5	35.5 ± 59.3 (3-446)	.007

BMI, body mass index; *CCI*, Charlson comorbidity index.
* Mean, standard deviation, and range reported.

Table 2
Comparison of patient-reported outcomes scores and range of motion between reconstruction with allograft group and direct repair group

Outcome measure	Reconstruction with allograft (n = 46)	Direct repair (n = 92)	*P* value
Patient-reported outcomes scores*			
DASH	7.4 ± 18.0	1.6 ± 4.1	.23
MEPS	92.1 ± 19.7	97.3 ± 6.4	.36
Oxford Elbow Score	43.4 ± 11.0	46.8 ± 3.2	.25
Range of motion*			
Extension	1° ± 3°	0° ± 2°	.53
Flexion	136° ± 5°	136° ± 3°	.81
Pronation	78° ± 9°	76° ± 15°	.49
Supination	77° ± 11°	78° ± 12°	.96

* Mean and standard deviation reported.

Table 3
Comparing the present study with previous reports in the literature

Study first author	No. of cases	Type of graft used	Type of radial tuberosity fixation	Reoperation, no. (%)	Nerve injury rate, no. (%)
Hendy et al (present study)	46	32 semiT allograft, 14 Achilles allograft	Transosseus radial tunnel (76%), Suture anchor or button (24%)	1 (2.2)	None
Frank et al[10]	19	SemiT autograft	Transosseus radial tunnel loop (100%)	1 (5)*	3 (16)†
Phadnis et al[23]	21	Achilles allograft	Suture button (100%)	None	2 (10)†
Snir et al[28]	18	15 Achilles, 1 semiT, 1 gracilis, 1 AT; (all allografts)	Suture button with interference screw (89%), transosseus radial tunnel (11%)	None	2 (11)†
Vastamäki et al[30]	14	7 Plantaris, 6 EDL, 1 palmaris longus (all autografts)	Suture anchor (50%), transosseus radial tunnel (50%)	None	None
Wiley et al[31]	7	SemiT autograft	Transosseus radial tunnel (100%)	None	None
Darlis et al[8]	7	Achilles allograft	Suture Anchor (100%)	None	None
Hallam et al[11]	9	SemiT autograft	Suture button (100%)	None	None

SemiT, semitendinosus tendon; *AT*, anterior tibialis tendon; *EDL*, extensor digitorum longus.
* Early graft failure due to trauma from patient noncompliance.
† All cases of transient lateral antebrachial cutaneous nerve palsy.

autograft reconstruction—mean postoperative patient-rated elbow evaluation (4 ± 4 vs. 14 ± 19, $P = .02$) and MEPS (95 ± 7 vs. 86 ± 14, $P = .04$) and was trending toward significance in the DASH questionnaire (3 ± 5 vs. 7 ± 9, $P = .08$).

The present study had several limitations. This was a retrospective review with all the limitations inherent of that study design. Surgical technique was not standardized. Elbow flexion and supination strength testing was not obtained in the postoperative period. Preoperative patient-reported outcomes scores were not obtained. Final follow-up was performed over the phone without a physical examination and the final follow-up was only 57% in the study group. Finally, return to work or preoperative athletics were not assessed in any standardized fashion. However, to best of our knowledge, this is the largest series of irreparable distal biceps ruptures treated with allograft reconstruction in the literature.

Conclusions

Patients with chronic, irreparable distal biceps ruptures treated with allograft tendon reconstruction can expect similar failure rates, reoperation rates, elbow range of motion, and patient-reported outcomes scores as patients that are treated with primary repair.

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