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Extensor Carpi Ulnaris Tenodesis Versus No Stabilization After Wide Resection of Distal Ulna Giant Cell Tumors

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Abstract

Background: The necessity of stabilizing the residual ulnar stump after distal ulna tumor resection remains controversial. The authors retrospectively compared the outcome of patients who underwent wide resection of distal ulna giant cell tumors (GCTs) and reconstruction with tenodesis of the extensor carpi ulnaris (ECU) or without reconstruction. **Methods:** Between 2007 and 2015, 9 patients (6 females, 3 males; mean age, 36.8 years; range, 24-65 years) who underwent distal ulna resection for GCT of bone were retrospectively reviewed. The mean resection length was 8.1 cm. Five patients had no reconstruction, whereas 4 patients had stabilization of the ulnar stump using ECU tenodesis. With a mean follow-up of 3.6 years (2-9 years), the functional outcome using the quick Disability of Arm, Shoulder and Hand (DASH) score; Musculoskeletal Tumor Society score and grip strength; as well as the oncological outcome were evaluated. **Results:** Musculoskeletal Tumor Society functional scores were more than 24 in 7 patients and 20 to 24 in 2 patients (mean, 27.6 or 92%). Quick DASH scores ranged from 0 to 27.3 (mean, 11.1). In both groups, similar scores were observed ($P > .5$). No patient had instability or pain related to the stump. There was no ulnar translation or subluxation of the radiocarpal joint. Grip strength in the operated hand, controlled for handedness, was 11% less than in the contralateral hand, although there was no difference between groups ($P > .4$). All patients were disease-free at the latest follow-up. **Conclusions:** The distal ulna may be widely resected with or without stabilization of the residual ulnar stump, yielding satisfactory local disease control and functional outcome.

Keywords: giant cell tumors, ulna, benign, reconstruction, extensor carpi ulnaris

Introduction

Giant cell tumors (GCTs) of bones are aggressive benign tumors that recur frequently and have a low metastatic potential.[32] Distal ulna GCTs are relatively uncommon,[17] and the consequence of the distal ulna resection on wrist, forearm, and elbow is undocumented. As the predominant biomechanical axis of the wrist is the radiocarpal joint, the distal ulna can be considered relatively expendable, with resection resulting in an acceptable functional loss.[14] Darrach was the first to describe distal ulna resection in the setting of posttraumatic deformity.[8] Subsequently, several modifications have been described.[10,42] Controversy exists whether the resected ulna should be stabilized, with some authors advocating against any type of reconstruction,[6,9,12,21,45] while others favoring various methods of stabilization.[2,5,14,16,18,19,22,23,25-28,35,40,46] In this retrospective study, the authors compared the clinical outcome following resection of the distal ulna for GCTs with reconstruction using the extensor carpi ulnaris (ECU) tenodesis for ulnar stamp stabilization versus no reconstruction.

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Table 1. Demographics, Treatment, and Outcome Data for Patients Who Underwent Distal Ulna Tumor Resection.

Patient	Male	Age	Length	Presentation	Location	Reconstruction	Follow-up	ROM	Grip	MSTS	DASH	Overall
1	No	44	4.5	Primary	L	No	2.5 y	Full ROM	29.7 kg R[a], 28 kg L	30	0	Excellent
2	No	25	12	Primary	L	Yes	9 y	Full ROM	28.8 kg R[a], 24 kg L	29	NR	Excellent
3	Yes	65	5	Primary	L	No	5 y	Full ROM	49.5 kg R[a], 48kg L	30	0	Excellent
4	No	40	5.5	Primary	L	No	2.5 y	Full ROM	29.7 kg R[a], 24 kg L	29	12.5	Excellent
5	No	37	10	Primary	R	Yes	2.5 y	Full ROM	18.1 kg R[a], 19.6 kg L	28	5	Excellent
6	Yes	24	11	Recurrent	R	No	2.5 y	40/50 (f/e), full s/p	NR	23	22,7	Good
7	No	24	8	Primary	L	No	5 y	Full ROM	21.6 kg R[a], 20 kg L	29	NR	Excellent
8	Yes	28	12	Recurrent	R	Yes	2 y	30/30 (f/e), full s/p	NR	21	27,3	Good
9	No	44	5	Primary	L	Yes	2 y	Full ROM	30.6 kg R[a], 25 kg L	29	10	Excellent

Note. Length = length of resection; ROM = range of motion; MSTS = Musculoskeletal Tumor Society; DASH = Disability of Arm, Shoulder and Hand; L = left; R = right; NR = not reported (missing data); f/e = flexion/extension; s/p = supination/pronation.
[a]Based on published normative values, grip strength on the contralateral side has been adjusted, allowing for a 10% deduction for right-hand dominance and no deduction for left-hand dominance.

Materials and Methods

The authors retrospectively searched their Tumor Registry between 2007 and 2015 for patients who underwent distal ulna resection for GCTs. Patients with intralesional tumor resection were excluded. There were 9 patients, 3 males and 6 females. Their mean age was 36.8 years (range, 24-65 years). The mean length of resection was 8.1 cm (range, 4.5-12 cm). Two of these 9 patients had a recurrent tumor. Demographics were similar between groups regarding age (P = .6, independent-samples t test), resection length (P = .2, independent-samples t-test), and male/female ratio (P = 0.6, Fisher exact test), while there was 1 recurrent case in each group. Patient data on demographics, treatment, and outcome measures are summarized in Table 1.

Follow-up examination was done at 3, 6, and 12 weeks; 6, 9, and 12 months; and at 6-month intervals thereafter. All patients underwent radiographic imaging and a clinical examination, including assessment of range of motion, pain, grip strength, and the ability to return to previous activities. The quick version of the Disability of Arm, Shoulder and Hand (DASH) score[41] and the Musculoskeletal Tumor Society (MSTS) score[11] were used to evaluate physical function and symptoms. Wrist range of motion was evaluated with a goniometer. Grip strength, both in the operated hand and on the contralateral side, was evaluated with a hydraulic hand dynamometer (Digital Hand Dynamometer-3; Saehan Medical, South Korea). Three consecutive measurements were performed and the mean was calculated; data were finally adjusted for hand dominance (10% deduction for right-hand dominance and no deduction for left-hand dominance, based on published normative values).[7,34] SPSS software (version 19.0; SPSS, Inc, Chicago, Illinois) was used for statistical analysis; mean values were compared using the paired or independent-samples t test. Informed consent was obtained from all patients.

Surgical Technique

The dorsal/ulnar approach was performed, and clear surgical margins were obtained in all patients. One surgeon (P.J.P.) used ECU tenodesis routinely after tumor resection, whereas another surgeon (I.D.P.) did not perform any type of stabilization (Figures 1 and 2). Four patients had ECU tenodesis with a modified Goldner and Hayes technique.[18] After tumor resection, ECU tendon was split in half near its insertion to the base of fifth metacarpal to just proximal the osteotomy site. A hole was drilled in a dorsal-volar direction close to the edge of the ulnar stump with the forearm in maximum supination. The hemitendon was passed through the hole and then sutured to itself, as well as the main body of the tendon in an effort to maximize stability and avoid the possibility of painful convergence of the 2 forearm bones that has been described in the literature[1,4] (Figures 3 and 4). Rehabilitation protocols were different between the 2 groups; in the ECU tenodesis group, splint immobilization was more prolonged (4-6 weeks) compared with the non-reconstruction group (2 weeks).

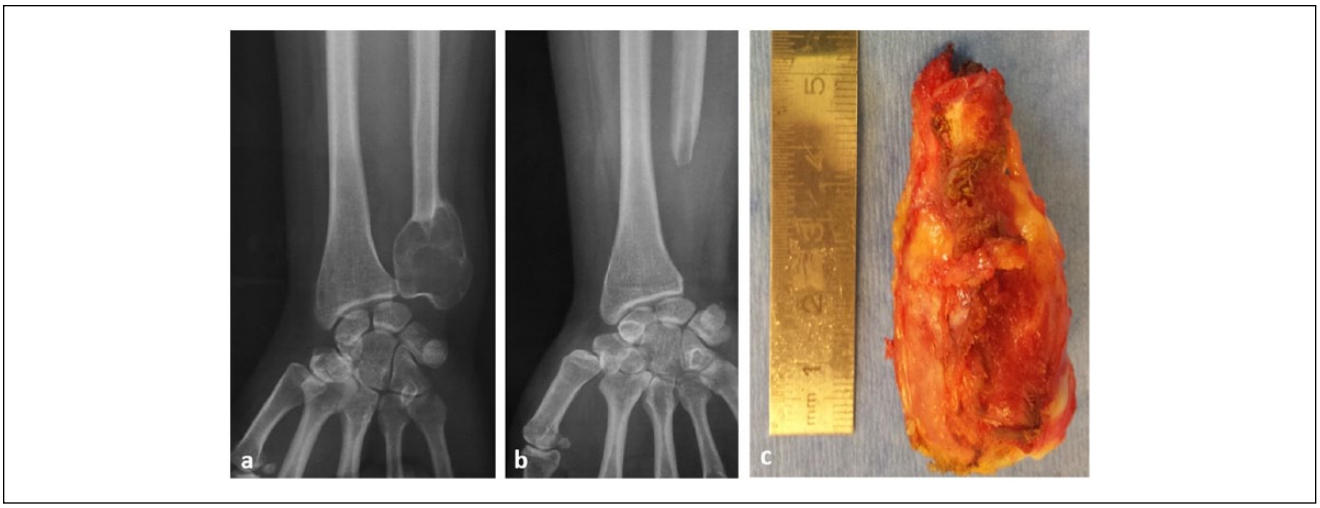

Figure 1. Anteroposterior radiographs of a 40-year-old female patient with a giant cell tumor of the left distal ulna who underwent a 5.5 cm resection: (a) preoperative, (b) postoperative at 2.5 years follow-up, and (c) photograph of the surgical specimen.

Figure 2. The photographs show the functional outcome of the same patient (as in Figure 1): (a) flexion, (b) extension, (c) supination, and (d) pronation.
Note. The patient expressed high satisfaction and functional scores.

Results

No patients were lost at the latest follow-up (mean, 3.6 years; range, 2-9 years). Musculoskeletal Tumor Society scores ranged from 21 to 30. The mean score was 27.6 points (92%), and the median was 29. Seven of the 9 patients had scores of 26 to 30, corresponding to the "excellent" designation of the MSTS 93 system. Most patients had high scores on functional evaluation with only the 2 patients who presented with a recurrent tumor yielding moderate outcome. There was no difference between groups (26.7 in the reconstruction vs 28.2 in the non-reconstruction group, $P > .5$, independent-samples t test, mean difference = −1.45, SE = 2.26, 95% confidence interval [CI] = −6.79 to 3.89).

Figure 3. (a) Preoperative and (b) postoperative radiographs of a 37-year-old female with a giant cell tumor of the right distal ulna that underwent a 10-cm resection and extensor carpi ulnaris reconstruction.

Quick DASH scores ranged from 0 to 27.3 (mean, 11.1). Again no significant difference was noted (14.1 in the reconstruction vs 8.8 in the non-reconstruction group, $P > .5$, independent-samples t test, mean difference = 5.3, SE = 8.61, 95% CI = −16.83 to 27.43).

In all cases, the proximal ulnar stump was stable during supination, pronation, wrist extension or flexion, or grip. There was no snapping or skin attenuation over the bony prominence. No cases of radioulnar convergence were noted at the final follow-up. None of the patients complained of significant residual pain or instability after tumor resection. None underwent subsequent operative procedures for proximal ulna stabilization. Two patients had minor sensory disturbances in the distribution of the dorsal branch of the ulnar nerve that were well tolerated; the rest of the patients did not have any postoperative neurologic loss. Patients expressed high levels of satisfaction during follow-up. Seven of the 9 patients had full range of motion compared with the contralateral side. Only the 2 patients with the recurrent tumors yielded suboptimal results with full pronation/supination but restriction of flexion/extension (40° flexion/50° extension for the sixth patient and 30°/30° for the eighth patient; Table 1). One of these patients (patient 8) had to seek new employment because his work required heavy manual labor. Grip strength was compared with that of the contralateral hand, and a mean difference of 3.2 points (11%) was found after adjusting for hand dominance ($P = .006$, paired t-test, mean difference = −3.2, SE = 0.77, 95% CI = −5.09 to −1.31). However, there was no difference between groups (4 points [13.3%] in the reconstruction vs 2.7 points [8.6%] in the non-reconstruction group, $P > .4$, independent-samples t test, mean difference = −1.34, SE = 1.60, 95% CI = −6.79 to 3.89). Oncological outcome was satisfactory in all patients, without any evidence of disease at the latest follow-up (local recurrence or pulmonary metastasis).

Discussion

The distal radioulnar joint serves an important biomechanical role, with significant load transmission to the forearm unit via the triangular fibrocartilage complex. Anatomic relations between the distal radius and ulna and the carpus are precise, and even minor modifications lead to significant load-pattern changes.[30] Palmer et al[31] showed that up to 20% of axial load may be transmitted through the distal ulna. Hence, excision of distal ulna could be expected to significantly increase radial loading. In addition, distal ulna excision moves the distribution of load centrally to the radio-lunate articulation, reducing load not only to the ulnolunate ariculation (as expected) but also to the radio-scaphoid articulation.[31] The extent to which these in vitro observations are reflected in vivo is unknown.

In the current study, the authors analyzed their experience with the excision of distal ulna tumors to determine the necessity of ulnar stabilization for ensuring good functional outcomes in these patients. Darrach first described distal ulnar excision in 1913, primarily for arthritis; the subperiosteal dissection is performed, then the distal 3 cm of the ulna is resected, while the ulnar styloid process is preserved.[8] This procedure may very well result in clinical success, as noted extensively in the literature.[3] Potential problems include reductions in grip and torsional strength,[4,15] ulnocarpal translocation,[29] and painful convergence instability, with the ulnar stump impinging against the radius.[1,4] Many soft tissue procedures have been described to mitigate these potential complications: flexor carpi ulnaris (FCU) tenodesis,[14] ECU tenodesis,[18] FCU/ECU tenodesis,[5] lasso tenodesis with palmaris longus graft,[16] fascia lata,[14] and pronator quadratus interposition stump,[23] among others. However, biomechanical studies have shown no clear benefits.[33,37] Petersen et al[33] stated that soft tissue reconstruction failed to restore natural joint stability, whereas Sauerbier et al[37] found that these operations did not reduce the radioulnar convergence or anteroposterior translation after ulna resection. In distal ulna tumors where more extensive osseous resection is needed, one would expect an even greater potential for instability; hence, defining the specific intraoperative criteria for instability that warrant some type of reconstruction would be an area of further clinical and biomechanical research.

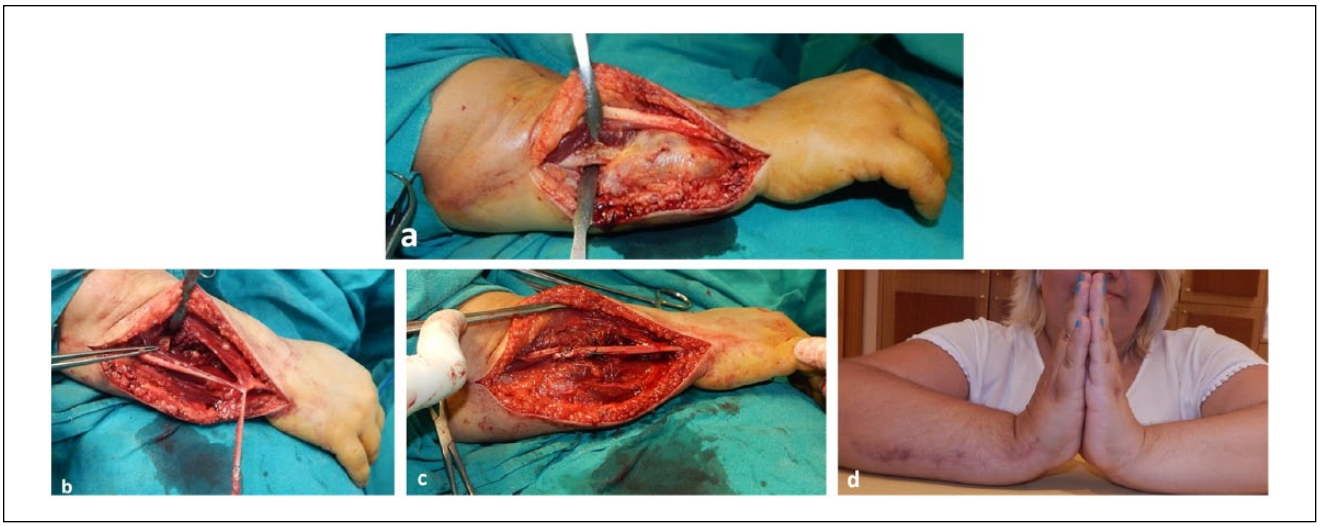

Figure 4. Intraoperative photographs of the same patient (as in Figure 3) show extensor carpi ulnaris (ECU) reconstruction following wide distal ulna resection: (a) before ulnar osteotomy, after the tumor has been exposed and ECU dissected; (b) longitudinal splitting of the ECU tendon; (c) reattachment of the hemitendon after it has been passed through a 3-mm hole, drilled near the end of the ulnar stump. Postoperative photograph of the patient (d) shows full range of motion.

Extensor carpi ulnaris tenodesis has been initially described by Goldner and Hayes back in 1979.[18] Other authors have later reported successful results with this procedure.[13,24,38] The authors share the same experience with their modified technique. In the current study, good oncological and functional results can be obtained without the use of prostheses for ulnar stabilization. None of the patients needed subsequent operation, and both functional results and patient satisfaction were good. Soft tissue stabilization (ie. ECU tenodesis) may be performed; however, no evidence was found to establish the necessity of distal ulna stabilization. Reconstruction with ECU tenodesis may provide better stability in shorter resections with longer residual ulnar stump.

Some authors have suggested prosthetic replacement after ulna resection, primarily for arthritis.[3,43,44] Results with the silicone rubber ulnar head were discouraging.[36,39] Although preliminary results with newer designs and materials (eg, ceramic, cobalt-chrome, pyrolytic carbon) are promising,[2,3,19,25,43,44] long-term studies have yet to be published. Furthermore, as noted by Berger,[3] excessive loss of ulna length and insufficient muscle coverage are contraindications for ulna prosthetic replacement. Patients with distal ulna tumors are not good candidates for this type of reconstruction due to poor soft tissue envelope.

Previous reports suggest that wide excision of the distal ulna without reconstruction for aggressive tumors can have very good results. Cooney et al[6] reported a series of 8 patients with excellent or good results and a mean grip strength loss of only 15%. Harness and Mankin (3 patients),[21] Wolfe et al (2 patients),[45] and Exner et al (2 patients)[12] have also reported good results with only minor complications. Dhillon et al,[9] in a uniform series of 4 giant cell tumors, advocate against any type of reconstruction. However, Feraccini et al,[14] in 9 patients with different tumors, propose that some form of soft tissue stabilization should be performed. None of the patients in the present study experienced painful ulnar impingement, a complication of the Darrach procedure that has been mentioned frequently in the literature.[6,45] A longer follow-up beyond the decade could reveal late complications affecting stability and range of motion or causing pain. We are hopeful that the results reported in the present study will translate into long-term success for these patients.

The present study has several limitations. Most notably, it is a retrospective study with a small number of patients in each group. However, given the low incidence of distal ulna giant cell tumors, this is a relatively large series of patients treated in a consistent fashion. To our knowledge, the literature on distal ulna resection consists of smaller series or case reports except from 1 recent heterogeneous series with combined distal radius/ulna tumors focusing on oncological outcome.[47] Larger series report resection of the distal ulna for arthritis; however, compared with the present study, the former studies include different patient population of older patients with lower functional demands and shorter ulna resections.[14,20]

In conclusion, the distal ulna may be widely resected for aggressive tumors with excellent oncological and good functional outcomes. Stabilization of the ulnar stump with tendon reconstruction may be performed, but based on the results presented herein, this type of reconstruction does not appear to be mandatory. Larger series with longer follow-up are needed to confirm the findings of the present study.

Ethical Approval

This study was approved by our institutional review board.

Statement of Human and Animal Rights

All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2008.

Statement of Informed Consent

Informed consent was obtained from all individual participants included in the study.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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