Ulnar Styloid Fracture Accompanying Distal Radius Fracture Does Not Affect Hand Function, but What About Hand Dexterity?

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Abstract

Introduction Hand dexterity is not addressed in patients with distal radius fracture (DRF) accompanied with ulnar styloid fracture (USF) in literature. This study aimed to determine whether an associated USF following a DRF has any effect on hand dexterity.

Materials and Methods Patients diagnosed with DRF were included in the study and were divided into two groups according to the USF presence (USF group and non-USF group). Pain, range of motion, Quick-DASH (Quick-Disabilities of the Arm, Shoulder, and Hand), handgrip and pinch strength, Purdue Pegboard test, and Jebsen Taylor Hand Function test were measured in the sixth month.

Results A total of 125 patients, 68 females (54.4%) and 57 males (45.6%) were included in the study. The mean age of the patients was 47.15 ± 13.41 (18–65) years. There were 60 patients (48%) in the USF group and 65 patients (52%) in the non-USF group. No significant difference was found in pain, range of motion, Quick-DASH and handgrip and pinch strength between the groups ($p > 0.05$). The hand dexterity tests showed no statistically significant difference between the groups in the sixth month ($p > 0.05$).

Discussion Hand function can be determined more accurately by assessing hand dexterity. In this study, it is emphasized that concomitant USF does not lead to poorer hand dexterity.

Keywords
- ulnar styloid fracture
- hand dexterity
- distal radius fracture
- Purdue Pegboard test
- Jebsen Taylor Hand Function test

Introduction

Fracture of the distal radius (DRF) is a common musculoskeletal system injury. DRF frequently causes disability leading to functional loss in wrist and forearm.[1,2] The loss of hand dexterity is common in DRFs but it is not a major focus of the literature, or consequently, in rehabilitation programs.[3] Fracture of the ulnar styloid frequently accompanies fractures of the distal radius and is seen in 50 to 65% of these cases. Studies on the clinical relevance of USF were generally about the range of motion, pain, radiological evaluations, grip strength, and patient-rated questionnaires. The comparison of united and nonunited and also treated and untreated USFs has been discussed. As a result of these studies, the consensus is that USFs do not affect in terms of hand function.[4,5] The data from the literature is inefficient about the effect of USF in hand dexterity. By relating body function and structure and activity participation following a DRF, we can better understand how concomitant injuries are likely to affect hand dexterity.

According to the International Classification of Function framework, range of motion, pain, radiological evaluations, grip strength, and patient-rated questionnaires address body function and structure and limited part of activity participation. Performance and capacity qualifiers are provided to give essential information about the patient's ability to execute a task or an action with standardized comparable test settings.[6] On the other hand, dexterity is a subset of hand function defined as the coordination of voluntary movement to accomplish an actual or simulated functional task.[2] Due to the close relationship between dexterity and activity

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participation qualifiers, this study was planned to determine how hand dexterity was affected in patients with DRF accompanied by an USF. Also, as the second objective, we asked whether (1) there is any difference between the healed ulnar styloid and nonunion of USF and (2) whether the type of USF has any influences on hand dexterity.

Purpose

The aim of this study was to determine whether an associated USF following a DRF has any effect on hand dexterity.

Materials and Methods

Patients who are diagnosed with isolated DRF or DRF accompanied with USF and applied to hand rehabilitation unit were included in the study. The patients were divided into two groups according to the USF presence. USF group was DRF with USF; non-USF group was DRF without USF. Besides, demographic data including patient age, gender, level of education, occupation, extremity dominance, information about medications and injury were recorded.

The Medical Ethics Committee meeting dated December 10, 2016 and numbered 60116787020/62810 approved this prospective study. Clinical trials identifier number was NCT04357470. Written informed consent was obtained from all participants included in the study.

Inclusion Criteria

The criteria for inclusion in this prospective cohort study were: (1) aged between 18 and 60 years, (2) diagnosed with isolated DRF or DRF accompanied with USF, (3) primarily fixation after injury.

Exclusion Criteria

Exclusion criteria were: (1) radius shaft, ulnar head, or ulnar shaft fractures, (2) pre-existing rheumatologic diseases associated with ipsilateral extremity, (3) comorbid injuries such as tendon or nerve injuries, (4) coexisting distal radioulnar, radiocarpal, or ulnocarpal joint instability problems, (5) triangular fibrocartilage complex injury and/or ulnar complex changes, (6) secondary repair.

Surgical Procedure

Patients were treated with the volar locking plate system (Acu-Loc 2, Acumed, Hillsboro, Oregon, United States). Surgery was performed with the standard volar approach by the same hand surgeon.[7] In some cases, with USF, ulnar styloid was not fixed and for the remaining cases, ulnar styloid was fixed with K-wire or screw.

Conservative Procedure

Circular short arm plaster was applied. Weekly anteroposterior and lateral radiographs were followed. At sixth week according to fracture healing, plaster was removed.[8]

Hand Therapy

The patients were admitted to 12-weeks rehabilitation program and were called upon once a week for follow-up appointments. Hand therapy continued as a home program between 12th week and sixth month. Outcome measurements were performed at sixth month.

None of the patients received orthotic devices, mobilization techniques, or additional electrotherapy. No distinction was made between the patients whether the USF is present or not in terms of the hand therapy program. The same physiotherapist managed all hand therapy programs and evaluations.

Outcome Measurements

Pain

The severity of pain was assessed with a visual analogue scale (VAS) in sleep, rest, and activity.[9]

Range of Motion

Patients' forearm and wrist joints ROM or range of motion (pronation, supination, flexion, extension, radial and ulnar deviation) were measured with a universal goniometer.[10]

Grip and Pinch Strength

The handgrip and pinch strengths were measured according to standard strength measurement method suggested by American Society of Hand Therapists, respectively using a hand dynamometer and a pinch meter (Baseline Evaluation Instruments, 7-piece Hand Evaluation Set, 12–0100).[11]

Quick-The Disabilities of the Arm, Shoulder, and Hand

It was used as a shortened version DASH (Disabilities of the Arm, Shoulder, and Hand) outcome measure. Instead of the 30 items, the Quick-DASH uses 11 items to measure physical function and symptoms in people with any or multiple musculoskeletal disorders of the upper limb.[12]

Purdue Pegboard Test

Four subtests of the Purdue Pegboard test (1–800–428–7545, Model 32020, Lafayette Instrument Co., Illinois, United States) (right hand, left hand, both hands, and assembly) were performed to measure fine manual dexterity of the hands after DRF.[13]

Jebsen Taylor Hand Function Test

The seven individual subtests of JTHFT (Sammons Preston Ability One, #8063) including writing, card turning, picking up small common objects, stacking checkers, stimulated feeding, moving light objects, and moving heavy objects were performed in a standardized procedure.[14]

Statistical Analysis

The Statistical Package for the Social Sciences (SPSS) version 21.0 was used for statistical analysis. Descriptive statistical data are presented as means ± standard deviation (x ± SD) or percentages (%). The compatibility of all data to normal distribution was determined by the Shapiro-Wilk Normality test. Measures of shape, skewness, and kurtosis were taken into account. Parametric tests were used since the data were suitable for normal distribution. Independent samples t-test and Mann-Whitney U test were used for

intergroup comparisons and subgroup analyses, respectively. Statistical significance level was accepted as $p < 0.05$.

Results

A total of 125 patients, 68 females (54.4%) and 57 males (45.6%) were included in the study. The mean age of the patients was 47.15 ± 13.41 (18–65) years. Of the patients, 65 (52%) had isolated fracture of the DRF (non-USF group) and 60 (48%) had a concurrent USF (USF group). Immobilization period of the USF group and non-USF group were 40.44 ± 6.10 and 43.15 ± 6.15 days, respectively. There was no difference between groups in terms of age and immobilization period ($p > 0.05$). Descriptive data of the patients and the fracture type distributions for distal radius (according to AO/OTA Fracture and Dislocation Classification) and ulnar styloid are presented in ►**Table 1**. DRF treated conservatively in 73 patients (58.4%) and surgically in 52 patients (41.6%). While fixation was not applied to the USF fracture in 55 patients (91.7%), screw fixation was performed in five patients (8.3%). Bone union occurred in 25 patients (41.6%) and nonunion of fracture seen in 35 patients (58.3%). DRFs were unioned in all patients. No radiological or clinical findings were observed in any of the patients neither in USF group nor non-USF group regarding distal radioulnar joint (DRUJ) instability.

Injury was investigated on four spots as home ($n = 45$, 36%), work ($n = 21$, 16.8%), sport ($n = 8$, 6.4%), and other ($n = 51$, 40.8%). A total of 102 patients (81.6%) have had fallen and 23 patients (18.4%) were injured due to traffic accidents. The type of injury was open in three patient (2.4%) and closed in 122 patients (97.6%).

The results of VAS, ROM, Q-DASH, and strength measurements are shown in ►**Table 2**. There was no significant difference in pain between the groups ($p > 0.05$). All patients have had minimal pain levels at sleep, rest, and activity. Range of motion was higher in the non-USF group than in the USF group. This difference was statistically significant only for wrist flexion and extension ($p < 0.05$). There was no statistically significant difference in Quick-DASH score between groups ($p > 0.05$). The injured hand grip and pinch strength values in non-USF group were greater than the USF group, but the difference was not statistically significant ($p > 0.05$). The results of JTHFT and PPT are shown in ►**Table 3**. The manual dexterity and hand function tests showed that there was no statistically significant difference between the groups in the sixth month ($p > 0.05$).

No statistically significant results were found in VAS, ROM, Q-DASH, strength measurements, JTHFT, and PPT in the subgroup analysis of 60 patients in the USF group regarding fracture type ($p > 0.05$). When the patients were compared according to the union state, patients with united USF showed better results in the grip strength and turning cards and assembly subtests ($p < 0.05$) (►**Tables 2** and **3**).

Discussion

We performed this prospective study to determine whether an associated USF had an effect on hand dexterity. As a result of this research, it was observed that USF accompanying DRF did not affect hand dexterity compared with isolated DRF. It was also found that the type of USF (tip or base) did not affect the dexterity, while it was affected by union state (union or nonunion).

Several studies have compared the existence of USF with DRF. It has been reported that the USF causes relatively slow recovery, less grip strength, and wrist flexion.[15] In this study, there was more pain, less flexion, extension, and grip strength in the USF group in accordance with the literature. While extension, pronation, supination, and Q-DASH in our patient group were worse than results in some studies,[16,17] it was observed that we had similar pain, ROM, and grip strength results in other studies.[18,19] The variation in patient numbers and follow-up times of studies may have caused differences in outcomes. In recent systematic reviews, it has been concluded that the difference in pain, ROM, grip-pinch strength, and patient-rated outcomes are not statistically significant.[4,5] Consistent with the literature, there was no statistically significant difference in pain, grip-pinch strength, and Q-DASH score between groups in this study.

Limited numbers of studies were encountered about PPT in literature.[13] The results of the PPT showed no significant differences between the groups. Patients with bilateral fractures were excluded from statistical analysis in order not to mislead the results of the assembly subtest due to the impact of bimanual activities. PPT results indicate that the patients in both groups similarly improved their compensatory strategies for digits and their use in daily life activities.

JTHFT required time, kit, and staff but this test is known to be an important indicator of impairment and disability.[20,21] The results from JTHFT showed no significant differences in seven subtests. However, the relatively less pronation, flexion, and extension motions in the USF group affected the results in JTHFT against the non-USF group. We consider that it is essential and significant to observe the function of each patient to make clinical reasoning about activity participation to ADL from the therapist's perspective.

It has been indicated that fixation, union state, and fracture type have no effect on outcome measures in USFs in systematic review and meta-analysis.[4,5] Intervention to the ulnar styloid is only recommended for pain relief, osseous and soft tissue stability.[18,22,23] In our study, the majority of the patient group with USF consisted of the nonunion base fractures of ulnar styloid without intervention. Base and displaced USFs were associated with instability of the DRUJ.[24] However, DRUJ instability has been reported not to affect DRF results in recent studies.[16,25,26] In this research, no statistically significant difference was found in VAS, ROM, Q-DASH, and pinch strengths in the comparison of base fracture versus tip fracture and united USF versus nonunited USF. Also, there was no difference in hand dexterity according to fracture type, but nonunion of the fracture caused a decrease in assembly and turning card subtests along with reduced grip strength. Some studies have reported that the pronation-supination force decreases in patients with USF.[27,28] Relatively decreased wrist ROM, grip strength, and rotational forces may have led to poor results in dexterity tests in DRF patients with USF.

Table 1 Descriptive data of the patients

Variables	USF group		Non-USF group		*p*-Value[a]
	Mean ± SD		Mean ± SD		
Age (year)	46.68 ± 13.63		47.58 ± 13.29		0.70
	n	**%**	***n***	**%**	
Sex					
Female	30	50	38	58.5	
Male	30	40	27	41.5	
Injured extremity					
Dominant	23	38.3	41	63.0	
Nondominant	37	61.6	24	36.9	
Extremity dominance					
Right	57	95	62	95.4	
Left	3	5	3	4.6	
Type of distal radius fracture					
A2	15	25	28	43.1	
A3	2	3.3	2	3.1	
B1	4	6.7	7	10.8	
B2	13	21.7	18	27.7	
B3	12	20	5	7.7	
C1	6	10	3	4.6	
C2	8	13.3	2	3.1	
Intervention type for distal radius fracture					
Conservative	27	45	46	70.8	
Surgery	33	55	19	29.2	
Type of ulnar styloid fracture					
Tip	22	36.7			
Base	38	63.3			
Intervention type for ulnar styloid fracture					
Conservative	55	91.7			
Surgery	5	8.3			

Abbreviations: SD, standard deviation; USF, ulnar styloid fracture.
[a]Independent samples *t*-test.

The difference arising from the dominance of the affected extremity between the groups has been emerged in the subtitle of writing and stimulated feeding, although it was not statistically significant. We think that if the extremity dominance distribution for both groups was in similar proportions, it would have affected the dexterity results. It has been reported that patients with dominant extremity injuries report greater disability and theoretically may have greater potential for improvement.[29] In the presence of USF, it will be valuable to discuss the dominance of the affected extremity in future studies.

The most important advantage of the study is that different from hand function, the hand dexterity was evaluated over different tasks. Also, it is an advantage that there is no difference in descriptive data such as age, sex, immobilization period and surgical or therapeutic intervention between groups. Although the length of follow-up was not regular in some studies, the follow-up was standardized at the sixth month in this study due to the greater part of the recovery of DRF and union of USF occurs within 6 months after the trauma.[16,30] There was a difference in the distribution of DRF type between groups. This finding, although not statistically significant, may be considered as the reason why the USF group had worse results. It has been emphasized in the literature that functional outcomes can be improved by correcting all X-ray parameters regardless of the fracture type.[31] Although we did not present radiographic parameters

Table 2 Results of visual analogue scale (VAS), range of motion (ROM), quick-DASH and strength measurements according to ulnar styloid fracture presence, type, and union state

Variables	USF group (n = 60)	Non-USF group (n = 65)	p-Value[a]	Tip fracture (n = 22)	Base fracture (n = 38)	p-Value[b]	United fracture (n = 25)	Nonunited fracture (n = 35)	p-Value[b]
	Mean ± SD	Mean ± SD		Mean ± SD	Mean ± SD		Mean ± SD	Mean ± SD	
VAS									
Sleeping	0.22 ± 0.81	0.55 ± 1.74	0.18	0.04 ± 0.21	0.32 ± 1.00	0.18	0.34 ± 1.14	0.13 ± 0.47	0.38
Resting	0.81 ± 2.01	0.72 ± 2.06	0.80	0.56 ± 1.54	0.95 ± 2.24	0.85	0.88 ± 1.92	0.76 ± 2.10	0.53
During activity	1.89 ± 2.89	1.53 ± 2.69	0.47	1.49 ± 2.28	2.13 ± 3.20	0.55	2.11 ± 2.92	1.74 ± 2.90	0.42
ROM (°)									
Pronation	78.28 ± 17.95	83.92 ± 13.66	0.05	78.04 ± 14.78	78.42 ± 19.73	0.46	78.60 ± 19.89	78.05 ± 16.71	0.52
Supination	79.83 ± 14.71	81.61 ± 14.47	0.49	80.59 ± 11.40	79.39 ± 16.45	0.63	77.32 ± 18.81	81.62 ± 10.85	0.86
Flexion	60.40 ± 14.63	65.83 ± 13.42	**0.03**	60.59 ± 14.58	60.28 ± 14.85	0.91	61.68 ± 13.91	59.48 ± 15.25	0.73
Extension	47.36 ± 20.32	54.24 ± 18.14	**0.04**	46.95 ± 19.65	47.60 ± 20.95	0.74	48.32 ± 19.47	46.68 ± 21.15	0.98
Ulnar deviation	34.60 ± 11.35	36.92 ± 10.43	0.93	36.09 ± 9.90	33.73 ± 12.15	0.55	34.72 ± 11.64	34.51 ± 11.31	0.87
Radial deviation	21.38 ± 7.47	21.27 ± 7.03	0.23	21.22 ± 5.23	21.47 ± 8.57	0.44	23.04 ± 6.99	20.20 ± 7.67	0.28
Quick-DASH									
ADL	28.90 ± 24.93	22.82 ± 20.78	0.14	30.67 ± 25.70	27.88 ± 24.76	0.61	25.01 ± 27.31	31.68 ± 23.08	0.14
Strength measurements (kg)									
Grip strength	17.44 ± 10.11	18.49 ± 10.40	0.57	19.08 ± 10.62	16.49 ± 9.83	0.42	20.86 ± 11.90	15.00 ± 7.93	**0.04**
Tip to tip pinch	2.91 ± 1.39	3.35 ± 1.90	0.14	3.05 ± 1.29	2.83 ± 1.45	0.53	3.02 ± 1.43	2.83 ± 1.37	0.69
Pulp to pulp pinch	3.54 ± 1.66	4.06 ± 1.98	0.11	4.04 ± 1.64	3.25 ± 1.61	0.05	3.75 ± 1.83	3.39 ± 1.52	0.71
Key pinch	4.96 ± 1.88	5.62 ± 2.31	0.08	5.22 ± 1.94	4.82 ± 1.85	0.49	5.21 ± 1.75	4.79 ± 1.97	0.21
3rd pulp to pulp pinch	2.69 ± 1.29	3.01 ± 1.50	0.21	2.95 ± 1.33	2.54 ± 1.26	0.52	2.78 ± 1.24	2.63 ± 1.34	0.95

Abbreviations: ADL, activities of daily living; DASH, Disabilities of the Arm, Shoulder and Hand; ROM, range of motion; SD, standard deviation; USF, ulnar styloid fracture; VAS, visual analogue scale.
[a]Independent Samples t-test.
[b]Mann-Whitney U test.

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Table 3 Results of Jebsen Taylor hand function test (JTHFT) and Purdue Pegboard test (PPT) according to ulnar styloid fracture presence, type, and union state

Variables	USF group (n = 60)	Non-USF group (n = 65)	p-Value [a]	Tip fracture (n = 22)	Base fracture (n = 38)	p-Value [b]	United fracture (n = 25)	Nonunited fracture (n = 35)	p-Value [b]
	Mean ± SD	Mean ± SD		Mean ± SD	Mean ± SD		Mean ± SD	Mean ± SD	
JTHFT (seconds)									
Writing	46.98 ± 33.05	35.64 ± 28.52	0.05	52.75 ± 38.16	43.85 ± 30.06	0.17	45.04 ± 25.59	48.66 ± 38.74	0.84
Turning cards	8.27 ± 3.99	7.74 ± 2.92	0.40	8.33 ± 3.87	8.24 ± 4.10	0.98	7.00 ± 2.41	9.18 ± 4.63	**0.03**
Picking up small objects	9.55 ± 4.67	9.17 ± 3.30	0.60	9.66 ± 4.02	9.48 ± 5.06	0.55	8.84 ± 3.78	10.05 ± 5.21	0.23
Stacking checkers	3.43 ± 2.10	2.79 ± 1.69	0.06	3.22 ± 1.97	3.55 ± 2.19	0.64	3.14 ± 1.95	3.63 ± 2.21	0.50
Stimulated feeding	12.29 ± 4.61	10.95 ± 2.64	0.05	12.53 ± 3.24	12.14 ± 5.29	0.16	11.49 ± 2.67	12.86 ± 5.58	0.34
Moving light objects	5.85 ± 2.17	5.46 ± 1.44	0.23	6.21 ± 2.72	5.64 ± 1.80	0.32	5.50 ± 1.92	6.09 ± 2.33	0.16
Moving heavy objects	6.31 ± 2.91	5.90 ± 1.88	0.34	6.50 ± 3.28	6.20 ± 2.72	0.48	5.71 ± 2.11	6.74 ± 3.33	0.15
PPT (seconds)									
Injured hand	13.15 ± 2.75	13.80 ± 2.51	0.20	12.73 ± 2.37	12.81 ± 3.18	0.68	13.78 ± 1.90	12.08 ± 3.27	0.05
Noninjured hand	13.94 ± 2.64	13.99 ± 2.80	0.97	13.50 ± 2.67	14.12 ± 2.66	0.38	14.37 ± 2.69	13.59 ± 2.61	0.34
Both hands	13.35 ± 5.96	13.58 ± 5.64	0.83	14.44 ± 6.96	13.06 ± 5.21	0.89	13.89 ± 5.99	13.32 ± 5.87	0.53
Assembly	25.65 ± 8.08	26.17 ± 7.78	0.73	23.97 ± 7.98	25.30 ± 8.16	0.50	26.36 ± 8.94	23.06 ± 6.98	**0.01**

Abbreviations: JTHFT, Jebsen Taylor hand function test; PPT, Purdue Pegboard test.
Note: Bold values indicate statistical significance.
[a]Independent samples t-test.
[b]Mann-Whitney U test

in this study, the exclusion of patients with concomitant complications or instability makes the study valuable.

Although there is a consensus that USF does not affect overall hand function, there is no study dwelled on the hand dexterity. Hand functioning can be determined accurately by assessing hand dexterity. In this study, the effect of USF on hand function was demonstrated by biopsychosocial methodology.

Conflict of Interest

None declared.

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