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Risk factors for nonunion of ulnar styloid fractures associated with distal radius fractures

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ABSTRACT

Objectives: A major complication of ulnar styloid fractures (USFs) associated with displaced distal radius fractures (DRFs) is nonunion, which can result in pain and instability of the distal radioulnar joint (DRUJ). This study aimed to identify the risk factors influencing the healing of USFs in cases of displaced DRFs, when treated using different methods - either surgically with plate-screw fixation, or conservatively with closed reduction and a plaster cast.

Methods: A total of 41 patients with USFs associated with DRFs, treated either surgically or conservatively, were retrospectively evaluated. Fractures were classified based on the treatment modality (surgical/conservative), demographic data, and radiographic characteristics. The Fernandez classification system was used to categorize DRFs. USF displacement was stratified into two groups: displacement >2 mm and <2 mm. Union and nonunion rates were compared across all parameters.

Results: Of the 41 cases included, 12 DRFs were managed surgically with plate-screw fixation, while 29 were treated conservatively with closed reduction and casting. Union was achieved in 35 cases, whereas nonunion was observed in 6. A statistically significant correlation was found between USF displacement >2 mm and nonunion. No significant association was observed between nonunion and other variables, including treatment modality, age, sex, laterality, or fracture classification.

Conclusions: The development of nonunion in USFs accompanying DRFs is not significantly influenced by treatment modality, age, sex, fracture classification, or side of involvement. However, a displacement of the USF greater than 2 mm is associated with a significantly increased risk of nonunion.

Keywords: Ulnar styloid fractures, distal radius fractures, fracture healing, radioulnar joint, risk factors

Ulnar styloid fractures (USFs) are observed in approximately 70% of DRFs [1, 2]. The ulnar styloid serves as the ulnar attachment site for the triangular fibrocartilage complex (TFCC), a critical structure for the stability of the DRUJ. Extending from the sigmoid notch of the radius to the base of the ulnar styloid, the TFCC helps maintain the anatomical relationship between the distal radius, the ulnar head, and the proximal carpal row. Consequently, nonunion of USFs may compromise DRUJ stability, resulting in pain and impaired clinical outcomes [3-5].

DRFs represent the most frequently encountered

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fractures of the upper limb, and among the complications seen with accompanying USFs, nonunion is the most common. This study aims to investigate the factors associated with nonunion of USFs in patients with displaced DRFs.

METHODS

This study was conducted retrospectively with approval from the institutional ethics committee (HNEAH-GAEK/KK/2924/150). It included patients treated at our clinic between 2017 and 2020 for USFs associated with displaced DRFs, managed either surgically with plate-screw fixation or conservatively with closed reduction and casting. Radiographic data were retrieved and evaluated using the Picture Archiving and Communication System (PACS). All surgical interventions were performed by orthopedic surgeons trained at the same institution, utilizing a standardized surgical approach within a consistent clinical setting.

Patients who achieved complete union of the DRF were subsequently contacted for follow-up, during which the incidence of USN was evaluated. The minimum follow-up duration was 12 months. The diagnosis of nonunion was based on the absence of bony trabeculation across the fracture line on anteroposterior and lateral wrist radiographs obtained at six months post-treatment.

Radiographic assessment at the final follow-up included measurements of radial height, volar tilt, radial inclination, and ulnar variance. Patients presenting with distal radius malalignment, such as radial shortening or altered volar tilt, were excluded from the study. Additional exclusion criteria included loss of fracture reduction, a history of prior wrist fractures, or concomitant ipsilateral upper extremity fractures.

USFs were anatomically classified as either base or tip fractures. Displacement was stratified as greater than or less than 2 mm. Demographic data (age, sex, and laterality), radiographic measurements, and nonunion status were recorded for each patient. DRFs were classified according to the Fernandez classification system. Treatment modalities included conservative management with closed reduction and casting, or surgical intervention using plate-screw osteosynthesis. All clinical and radiographic parameters, along with healing outcomes (union vs. nonunion), were statistically analyzed and compared.

Statistical Analysis

Descriptive statistics were presented as mean, standard deviation, median, minimum, maximum, frequencies, and percentages. The Kolmogorov–Smirnov test was employed to assess the normality of data distribution. Independent quantitative variables were analyzed using the independent samples t-test or the Mann-Whitney U test, depending on the distribution. Categorical variables were compared using the chi-square test, and the Fisher's exact test was applied when expected frequencies were insufficient for the chi-square test assumptions. All analyses were performed using SPSS version 27.0 (IBM Corp., Armonk, NY, USA). A post hoc power analysis demonstrated that the sample size of 41 patients was sufficient to detect statistically meaningful differences with a power level exceeding 80%.

RESULTS

A total of 41 patients were included in the study, with a mean age of 50 years (range: 27-66). Of the participants, 16 (39%) were male and 25 (61%) were female. The fracture involved the right wrist in 19 (46.3%) cases and the left in 22 (53.7%) cases. The mean follow-up duration was 15.6 months, with a minimum of 12 months and a maximum of 18 months (Table 1).

Among the USFs, 13 (31.7%) were classified as tip fractures and 28 (68.3%) as base fractures. DRFs (DRFs) were categorized according to the Fernandez classification: 29 (70.7%) cases were type I, 1 (2.4%) case type II, 10 (24.4%) cases type III, and 1 (2.4%) case type IV. Surgical fixation with plate and screws was performed in 12 (29.3%) patients, while 29 (70.7%) patients were managed conservatively with closed reduction and casting. Radiographic assessment confirmed complete anatomical healing of the distal radius in all cases.

The effect of radiologic and demographic parameters on union and nonunion was evaluated (Table 2). A statistically significant correlation was found between USF displacement >2 mm and nonunion. No significant association was observed between

nonunion and other variables, including treatment modality, age, sex, laterality, or fracture classification.

DISCUSSION

The most common complication associated with USFs is nonunion. This condition may lead to increased stress and strain on the DRUJ, manifesting as pain during forearm rotation, ulnar deviation, or translational joint movements. Additionally, symptoms may result from associated TFCC tears or mechanical irritation caused by the unhealed bone fragment. USFs accompany approximately 6% to 70% of DRFs [1, 2]. However, the clinical relevance of USF displacement in terms of treatment planning and long-term functional outcomes remains a subject of debate. In a prospective study involving 272 patients, May *et al*. [3] reported that USFs with displacement greater than 2 mm were associated with DRUJ instability in 166 cases. Consistent with these findings, our study demonstrated a significantly higher nonunion rate in cases with USF displacement exceeding 2 mm.

Several studies in the literature have addressed the

Table 1. Radiographic and demographic parameters of the patients

	Median (min-max)	Mean±SD	n (%)
Age (years)	50.0 27.0-66.0	49.3±9.7	
Sex			
Male			16 (39.0%)
Female			25 (61.0%)
Follow-up time (months)	7.0 (4.0-11.0)	7.4±1.5	
Ulnar styloid fracture size (mm)			
>2			34 (82.9%)
<2			7 (17.1%)
Ulnar styloid fracture			
Tip			13 (31.7%)
Base			28 (68.3%)
Classification (Fernandez)			
I			29 (70.7%)
II			1 (2.4%)
III			10 (24.4%)
IV			1 (2.4%)
Treatment			
Plate			12 (29.3%)
Conservative			29 (70.7%)
Side			
Right			19 (46.3%)
Left			22 (53.7%)
Union			35 (85.4%)
Nonunion			6 (14.6%)

n=number, SD=standard deviation, min=minimum, max=maximum

Table 1. The effect of radiologic and demographic parameters on union and nonunion

	Union		Nonunion		P value
	mean±SD (median)	n (%)	mean±SD (median)	n (%)	
Age (years)	50.5±9 (50)		42.3±11 (38)		0.057[t]
Sex					
Male		13 (37.1%)		3 (50.0%)	0.551[x2]
Female		22 (62.9%)		3 (50.0%)	
Follow-up time (months)	7.2 ± 1.5 (7)		8.2±1.7 (8)		0.234[m]
Ulnar styloid fracture size (mm)					
>2		33 (94.3%)		1 (16.7%)	
<2		2 (5.7%)		5 (83.3%)	**<0.001[x2]**
Ulnar styloid fracture					
Tip		11 (31.4%)		2 (33.3%)	1.000[x2]
Base		24 (68.6%)		4 (66.7%)	
Classification (Fernandez)					
I		24 (68.6%)		5 (83.3%)	
II		1 (2.9%)		0 (0%)	
III		9 (25.7%)		1 (16.7%)	
IV		1 (2.9%)		0 (0%)	0.651[x2]
Treatment					
Plate		10 (28.6%)		2 (33.3%)	
Conservative		25 (71.4%)		4 (66.7%)	1.000[x2]
Side					
Right		18 (51.4%)		1 (16.7%)	
Left		17 (48.6%)		5 (83.3%)	0.115[x2]

*t test / [m] Mann–Whitney U test / [x2] Chi-square test (Fisher's exact test)

impact of USF displacement and nonunion on clinical outcomes. Ayalon *et al*. [4] observed that the presence of USFs correlated with poorer functional scores and increased wrist pain in a cohort of 315 patients. Yılmaz *et al*. [5] reported reduced supination strength while Belloti *et al*. [6] found higher levels of wrist pain and worse DASH scores. Daneshvar *et al*. [7] noted more persistent pain, slower improvement in grip strength, and limited wrist flexion over time. Walenkamp *et al*. [8], in a prospective study of 312 cases, found significantly lower PRWE scores in the early recovery period.

The causes of pain related to USF nonunion have been explored extensively. Lindau *et al*. [9] reported a significantly higher incidence of TFCC injuries in DRFs accompanied by USFs, emphasizing their influence on clinical outcomes. Abid *et al*. [10] also linked poor clinical results in USFs to TFCC tears. Other authors have attributed persistent wrist pain to extensor carpi ulnaris tendon impingement caused by fibrous tissue at the site of nonunion [11-14]. Tsukazaki and Iwasaki [15] identified 17 USF nonunions in 109 patients, noting ulnar instability in 13. Nakamura *et al*. [16] achieved favorable outcomes with surgical fixa-

tion. On the other hand, the literature reported that USFs accompanying DRFs resulted symptomatic and were treated surgically. Hauck *et al*. [12] reported successful results in 20 symptomatic cases of USF nonunion treated surgically. Although some studies suggest that nonunion does not significantly affect outcomes, limitations in methodology weaken these conclusions. We believe that nonunion can have a negative impact on clinical outcomes and that prospective studies involving MRI or wrist arthroscopy will clarify the relationship between fracture healing and wrist pain.

Previous studies have reported no significant association between demographic factors and ulnar styloid nonunion in cases of DRFs. In line with previous research, our findings showed no correlation between age, sex or affected limb and the occurrence of nonunion. Similarly, the Fernandez classification of DRFs had no apparent effect on the rate of nonunion. The influence of treatment modality on ulnar styloid healing has also been investigated. Ayalon *et al*. [4] found no significant difference in nonunion rates or functional outcomes between the conservative and surgical management of DRFs.

Limitations

The retrospective design and relatively small sample size, particularly in the nonunion group, are the main limitations of this study. Additionally, functional outcomes and advanced imaging were not evaluated, which may limit the assessment of clinical impact.

CONCLUSION

Age, gender, side, and fracture classification have no effect on the development of nonunion in USFs associated with DRFs. Whether the treatment is surgical or conservative does not influence the risk of ulnar styloid nonunion. The risk of nonunion is significantly higher in cases with fracture displacement greater than 2 mm. These findings suggest that displacement magnitude should be a key consideration in clinical decision-making and follow-up planning for patients with associated USFs.

Ethical Statement

This study was approved by the Haydarpaşa Numune Training and Research Hospital Non-Interventional Clinical Research Ethics Committee. (Decision no. HNEAH-GAEK/KK/2924/150, Date: 19.11.2024).

Authors' Contribution

Study Conception: EK, NAA; Study Design: EK, LK; Supervision: EK, LK; Funding: N/A; Materials: N/A; Data Collection and/or Processing: EK, AG; Statistical Analysis and/or Data Interpretation: AG, NAA; Literature Review: LK, EK; Manuscript Preparation: EK, LK and Critical Review: EK, AG.

Conflict of interest

The authors disclosed no conflict of interest during the preparation or publication of this manuscript.

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