

Brief Report

Ulnar Variance in Scaphoid Nonunion

Dawood Jafari MD¹, Hooman Shariatzadeh MD¹, Farid Najd Mazhar MD¹, Mohammad Hossein Ghahremani MD¹**Abstract**

Background: Negative ulnar variance can be a risk factor in Kienböck's disease, wrist instability, and scaphoid bone fracture. This study focused on the ulnar variance in wrists with scaphoid bone nonunion.

Methods: We retrospectively reviewed posteroanterior wrist radiographs of 65 patients who were diagnosed as established scaphoid nonunion and underwent open reduction and bone grafting between 2005 and 2010. We used reference radiographs from contralateral wrists of 65 consecutive skeletally- mature patients with distal radius fracture as the control group and then measured ulnar variance and compared it in both groups.

Results: Ulnar variance was measured in standard posteroanterior wrist X-rays of 65 scaphoid nonunion and 65 normal controls. Twenty five patients (38.5%) in the scaphoid nonunion group had negative ulnar variance, and the mean value was $-0.26 (\pm 1.24)$ mm (range: -3, +2). In the control group, 15 subjects (23.1 %) had an ulnar minus wrist, and the mean ulnar variance was $+0.54 (\pm 1.47)$ mm (range: -3, +4). The difference in ulnar variance was significant between the two groups (P-value = 0.001).

Conclusion: Ulnar variance may influence developing of nonunion process in scaphoid bone fracture.

Keywords: Nonunion, risk factor, scaphoid bone, ulnar variance

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Introduction

Scaphoid bone fracture and nonunion are among the most frequent and challenging injuries of the wrist. Scaphoid nonunion can result in scaphoid nonunion advanced collapse and severe osteoarthritis of the wrist in long run. Scaphoid scant vascularity, influence of transmitted forces, and quality of reduction are among numerous suggested factors playing role in scaphoid nonunion.¹

Negative ulnar variance has been considered as a predisposing factor in developing numerous diseases such as Kienböck's disease, or instability in the wrist and carpal ligamentous disruption.^{2,3} Recently, ulnar variance has been reported as a risk factor in scaphoid bone fracture.⁴ This study was designed to compare ulnar variance in wrists with scaphoid fracture nonunion and those without it. To the best of our knowledge, this is the first study to consider a possible role for ulnar variance in scaphoid bone nonunion.

Materials and Methods

We retrospectively reviewed posteroanterior and lateral wrist radiographs of patients who were diagnosed as established scaphoid nonunion and underwent open reduction and bone grafting between 2005 and 2010. The diagnosis was made according to the classic x-ray findings.

Inclusion criteria: All cases with established scaphoid fracture nonunion in skeletally- matured adult patients who did not have exclusion criteria and had acceptable standard posteroanterior and

lateral plain radiographs.

Exclusion criteria: All cases having history of previous trauma, infection, surgery, or congenital deformities in the affected upper extremity, or neuromuscular or rheumatologic diseases. Radiographs of patients with long- standing nonunion and osteoarthritic changes were also excluded from the study (in order to overcome interference with measurements).

In our institution we use the recommended technique by Palmer and his colleagues by positioning the hand in neutral position with 90 degrees of elbow flexion and 90 degrees of shoulder abduction to take posteroanterior and lateral wrist x-rays.⁵ We routinely use this method for taking radiographs of the distal radius fracture and also the unaffected wrist as a reference in treatment process of the distal radius fractures.

To make sure that the radiograph is a true posteroanterior film without any rotation, we used the location of the extensor carpi ulnaris groove which has been proved to be valid in this regard.⁶ Consequently, posteroanterior radiographs of 65 patients which met the requirements were included in the study as the patient group. We used control reference x-rays from contralateral wrists of 65 consecutive skeletally- mature patients with distal radius fracture as the control group. We excluded persons with congenital deformities or with a history of previous trauma, neuromuscular diseases, or surgery of the uninjured extremity.

Ulnar variance was measured in radiographs by using the method of perpendiculars. According to the published data, we assumed that the perpendicular method has a better intraobserver and interobserver reliability among the different methods which are being used for ulnar variance determination.^{1,7} On a standard posteroanterior x-ray of the wrist, a line was drawn through the most ulnar point of distal articular surface of the radius, perpendicular to the long axis of the bone. The distance between this line and the ulnar dome in millimeters was considered as ulnar variance.

Student's t – test was used for comparing the results in both

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Table 1. Ulnar variance distribution

Ulnar Variance (mm)	Control Group	Scaphoid Nonunion Group
-3	1 (1.5%)	3 (4.6%)
-2	5 (7.7%)	8 (12.8%)
-1	9 (13.8%)	14 (21.5%)
0	17 (26.2%)	22 (33.8%)
1	16 (24.6%)	14 (21.5%)
2	11 (16.9%)	4 (6.2%)
3	5 (7.7%)	0 (0%)
4	1 (1.5%)	0 (0%)

groups. A *P*-value less than 0.05 was considered as statistically significant.

Results

All of the patients were males, between 15 to 55 years of age (mean: 27.0). All subjects in the control group also were males with a mean age of 29.1 (range: 16 – 59 years). The age distribution of the patients and normal controls were similar and didn't differ significantly (*P*-value = 0.21).

The measurements demonstrated that in the scaphoid nonunion group, 25 (38.5%) patients were ulnar minus, 22 (33.8%) were ulnar neutral, and 18 (27.7%) were ulnar plus (Table 1). The mean ulnar variance was $-0.26 (\pm 1.24)$ mm. In the control group, 15 (23.1%) subjects were ulnar minus, 17 (26.2%) were ulnar neutral, and 33 (50.8%) were ulnar plus. The mean ulnar variance was $+0.54 (\pm 1.47)$ mm (Table 1). This difference in the ulnar variance was significant between the two groups (*P* = 0.001).

Discussion

Biomechanical studies have shown that ulnar variance is very important in load bearing in the wrist and it was emphasized that changes of as little as 2.5 millimeters significantly change the load borne across the wrist.⁸

The scaphoid bone lies in radial aspect of the midcarpal joint, where it acts as a stabilizer for the highly unstable midcarpal joint.⁹ Normally, compression of the scaphoid between the radius and the trapezium results in flexion of the scaphoid bone. This flexion force will be transferred to the lunate by the scapholunate ligament. On the other hand, the triquetrum has a tendency to extend under load and both of these bones through their ligamentous attachments try to influence the angulation of the lunate, but in opposite directions.¹⁰ Under the influence of these forces one can expect both angulation and displacement in the proximal and distal fragments of the scaphoid. It is believed that scaphoid nonunion is the result of these mechanical forces across the wrist, deficient vascularity of the bone, and failure in achieving adequate fracture reduction and immobilization.¹¹

Ramos-Escalona, et al. retrospectively reviewed radiographs of 66 scaphoid fractures and found that 31.8% of the patients had an 'ulna neutral' wrist, 9.1% had an 'ulna plus', and 59.1% had an 'ulna minus' wrist. So, they concluded that there was a significant difference in the distribution of ulnar variance in wrists with scaphoid fracture compared to other studies in the literature.⁴

In our study, we compared ulnar variance in wrists with scaphoid nonunion and normal ones. The measurements demonstrated that in the scaphoid nonunion group, 38.5% of the patients were ulnar minus, 33.8% were ulnar neutral, and 27.7% were ulnar plus. The mean ulnar variance in this group was $-0.26 (\pm 1.24)$ mm. In the control group, 23.1% of the subjects were ulnar minus, 26.2% were ulnar neutral, and 50.8% were ulnar plus. The mean ulnar variance was $+0.54 (\pm 1.47)$ mm. So, in our study ulnar variance was significantly more negative in wrists with scaphoid fracture nonunion than in those without it. The results of our study reinforce the previous findings regarding the role of the ulnar variance in scaphoid fracture.

There was a shortcoming for this study; it is unclear that higher incidence of association of ulnar minus wrist with scaphoid nonunion is the result of higher incidence of scaphoid fracture in these wrists or it can be attributed to the different force and load distribution in this kind of wrist which can lead to nonunion after fracture, or both of them. This is the subject of an ongoing prospective study and we will follow the union process of scaphoid fracture in wrists with different ulnar variance.

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