





# Research Paper

## Evaluating Distal Radius Radiological Indices as Scaphoid Fracture Risk Factors



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## ABSTRACT

**Background:** Scaphoid fracture is the most common wrist injury with a high rate of misdiagnosis and subsequent complications. As the morphology of the distal radius affects the load transmission through the carpal bones, radiographic wrist indices may help prevent missing occult fractures.

**Objectives:** The current retrospective case-control study compared the distal radius radiographic indices of patients with a scaphoid fracture with a control group.

**Methods:** Wrist X-rays of 129 patients with scaphoid fractures (case group) and the contralateral uninjured side of 101 patients with distal radius fractures (control group) were assessed by two orthopedic surgeons. Anteroposterior and lateral radiographs were evaluated to measure the radial height (RH), radial inclination (RI), ulnar variance (UV), and volar tilt (VT).

**Results:** The student t-test was used to compare the distal radius radiographic indices between the two groups. The average RI was 27.14 in the scaphoid fracture group and 24.35 in the control group ( $P < 0.05$ ). Mean VT, RH, and UV of the case group were, 12.32, 15.01, and -0.73, respectively; this is while in the control group, the above measures were 10.76, 13.52, and -0.11, respectively ( $P < 0.05$ ).

**Conclusion:** High values of RH, RI, and VT, and negative amount of UV are significantly correlated with scaphoid fracture after a Fall Onto an Outstretched Hand (FOOSH) injury.

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## 1. Introduction

**T**he scaphoid is the most common fractured bone in the carpus accounting for 60% to 70% of all carpal bone fractures [1-3]. In addition to the high incidence, the rate of missing cases of up to 40% makes the accurate diagnosis even more significant [2, 3]. Initial scaphoid radiographs are incorrectly interpreted as negative up to 30% of the time, contributing to the high misdiagnosis rate [2]. This can lead to progressive pain and disability because of scaphoid advanced collapse [3]. Such a high rate of missing diagnosis is despite many algorithms and precise investigations of the initial x-rays. The radiological indices of the distal radius, which represent the morphology of the distal radius, might have correlations with scaphoid fracture. If this correlation is proved, paying attention to these indices can raise the suspicion of scaphoid fracture and help diagnose scaphoid fractures.

The most likely mechanism of a scaphoid fracture is Fall- ing On Outstretched Hand (FOOSH) with maximum wrist extension and radial deviation [4, 5]. The proximal pole is locked within the scaphoid fossa, the dorsal aspect of the scaphoid engaged the dorsal rim of the radius and fractured through the waist. Mayfield and colleagues described excessive wrist hyperextension and ulnar deviation as the causative mechanism for scaphoid fracture [6, 7].

The anatomical features of the distal radius and distal ulna affect the load transferred to the carpal bones. Many studies have examined the impact of these characteristics using radiological indices, which have enhanced the diagnostic and therapeutic approaches among which Kienbock disease stands out [4]. However, some recent studies examined the morphological influence of the distal radius on the load transfer to the scaphoid bone. Few studies have evaluated load distribution to the scaphoid. Distal radius anatomy might affect the load distribution and play a role as a risk factor for scaphoid fracture.

### Objectives

The purpose of this study is to find if there is a link between wrist radiologic indices that indicate distal radius anatomic morphology and scaphoid fracture incidence.

## 2. Methods

After the Institutional Review Board approval, we conducted a case-control study on patients with scaphoid

fracture as the case group and patients with distal radius fracture as the control group.

We examined the wrist X-rays of patients with scaphoid fractures and the contralateral wrist X-rays of patients with distal radius fractures. Meanwhile, the participants met our inclusion criteria. A total of 129 individuals with scaphoid fractures and 101 with distal radius fractures were enrolled after applying our exclusion criteria, including arthritic changes, history of previous fractures of the affected upper extremity or surgery, congenital anomalies, and neuromuscular or rheumatologic diseases. Two orthopedic surgeons evaluated the posteroanterior and lateral radiographs to measure the distal radius radiographic indices, including radial height (RH), radial inclination (RI), ulnar variance (UV), and volar tilt (VT).

When the groove of the extensor carpi ulnaris was radial to the ulnar styloid process, we recognized a posteroanterior radiograph of the wrist to be a standard X-ray [8]. If the palmar edge of the pisiform was placed between the capitate and the volar surface of the distal scaphoid, the lateral X-ray was approved as a valid lateral radiograph [9].

We routinely obtained an X-ray of the contralateral uninjured side of the patients with distal radius fractures in our institute, which we used as controls. At our center, the wrist X-rays are taken according to the standard criteria described by Palmer et al. [6, 7].

The student t-test was used to compare the groups and the P of less than 0.05 was considered statistically significant.

## 3. Results

We included 129 cases in the scaphoid fracture group and 101 individuals in the control group. The mean age of the patients in the scaphoid fracture group and the control group was 26.4 (17-46) and 25 (18-50), respectively. Almost 95% of the scaphoid fracture patients were males, while 60% were males in the distal radius fracture group. A total of 63% of the scaphoid fractures occurred in the waist, while 29% and 8% were located in the proximal and distal scaphoid, respectively. We summarized the data of distal radius radiographic indices of both groups in Table 1. There was a statistically significant difference between all the distal radius indices, including RH, RI, VT, and UV with a P of less than 0.05.

**Table 1.** Distal radius radiographic indices of both groups

	Groups 1 <sup>1</sup>	Group 2 <sup>2</sup>
Mean RI	27.14 (10-35)	24.35 (14-32)
Mean VT	12.32 (2-20)	10.76 (4-18)
Mean RH	15.01 (8- 19)	13.52 (6-20)
Mean UV	- 0.73 (-5 - +4)	-0.11 (-5 - +5)

1: Scaphoid fracture group; 2: Control group without scaphoid fracture.

Journal of Research in  
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RH: radial height; RI: Radial inclination; UV: Ulnar variance; VT: Volar tilt.

## 4. Discussion

A total of 22% percent of scaphoid fractures are missed on initial X-ray studies, but diagnosed on advanced imaging [2]. Scrutinizing the distal radius indices while reading the X-rays might help in making the correct diagnosis [8, 9]. Little modifications in the correlation of the distal radius, ulna, and carpal bones can have significant impacts on load-bearing forces across the wrist [1]. Ramos suggested paying attention to negative ulnar variance in suspected cases of scaphoid fractures in addition to soft tissue swelling [8].

The relevance of distal radius anatomical indices as a potential risk factor in carpal bone fracture and wrist instability has been investigated. New insights and knowledge of wrist biomechanics can contribute to a better understanding of the pathophysiology of many injuries and disorders [8, 10, 11].

Some studies have evaluated the correlation between the distal radius indices and wrist injuries, among which the ulnar variance is the most studied parameter [8, 9, 12].

According to Jafari et al., UV affects the development of scaphoid non-union scaphoid bone fracture patients [10]. Ramos demonstrated a higher probability of scaphoid fractures in wrists with negative ulnar variance [8]. Turan observed that high values of RH, RI, VT, and negative UV contribute to scaphoid fracture after FOOSH injuries [9].

We also observed that there is a higher risk of scaphoid fracture after FOOSH injuries in patients with higher RH, RI, and VT values and ulnar negative wrists. Our study supports the findings of previous studies on this subject, which all emphasized the importance of paying more attention to distal radius indices following FOOSH injuries.

This study has some limitations. Although all the patients had a history of FOOSH injuries, the exact position of the hand at the time of trauma, the degree of hyperex-

ension, and the exact force vectors are not determined. In addition, even though we tried to enroll patients who had enough amount of energy to cause a fracture and a young population to minimize the probability of osteoporosis, there are still some factors to be considered, such as body mass index and osteoporosis risk factors. As our study was a retrospective study, we did not have the chance to evaluate the above-mentioned issues. We recommend conducting a prospective study on the role of distal radius indices on scaphoid non-union in patients with acute scaphoid fractures.

## Ethical Considerations

### Compliance with ethical guidelines

There were no ethical considerations to be considered in this research.

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### Authors' contributions

Conception and design: Hooman Shariatzadeh; Conception and design: Farid Najd Mazhar; Data collection, writing the article: Meysam Fathi Choghadeh; Data collection and analysis: Farhad Soltani, Maziar Rajei, Mohammad Hasanzadeh, Hossein Gholampour.

### Conflict of interest

The authors declared no conflict of interest.

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