

Radial Inclination and Palmar Tilt as Risk Factors for Kienböck's Disease

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Abstract

Radial inclination angle (RIA) and palmar tilt (PT) of distal articular surface of radius, are anatomical factors that influence force transmission across the wrist and load transfer to the lunate. The purpose of this study is to evaluate the relationship between these parameters and Kienböck's disease.

We measured and compared RIA and PT in standard posteroanterior and lateral wrist x-rays of 55 patients with Kienböck's disease and 60 controls.

The mean RIA was 25.5° in Kienböck's disease patients and 23.3° in the control group ($P = .002$). The mean PT was 11.5° and 9.4° for patients and controls, respectively ($P = .005$). All of these differences were statistically significant.

We concluded that there is an etiological association between higher degrees of RIA and PT with Kienböck's disease.

One hundred years after the first description of avascular necrosis of the lunate by Robert Kienböck's,¹ controversy still exists about the etiology of the disease despite numerous investigations.

The relationship between negative ulnar variance and Kienböck's disease, which was first suggested by Hulten,² is the only etiologic association that is widely accepted. Among other various anatomical features that were postulated as the risk factors for lunatomalacia,³⁻⁵ those that are related to the biomechanic of force transmission across the wrist and load transfer to the lunate, are more challenging and thus more attractive.⁶

According to the biomechanical analyses, radial inclination angle (RIA) and palmar tilt (PT) of distal radial articular surface, have apparent impact on the load

transfer to the lunate.^{6,7} Nevertheless, different and even paradoxical results were reported about the relationship between these parameters and Kienböck's disease.⁸⁻¹² These conflicting reports and the importance of load transmission to the lunate in pathogenesis of lunatomalacia, incited us to study the RIA and PT as possible anatomical risk factors for this disease.

MATERIALS AND METHODS

Wrist radiographs of patients diagnosed with Kienböck's disease, based on typical x-ray and magnetic resonance imaging (MRI), in our hospital between January 2001 and December 2010, were reviewed (Figure). The following diagnostic criteria based on the Lichtman classification¹³ were used: linear or compression fracture of lunate in plain radiograph or low signal intensity on MRI in the absence of x-ray changes (stage I); sclerosis and density changes (stage II); collapse or fragmentation of lunate without carpal collapse (stage III_A), or with carpal collapse (stage III_B); and all the findings of stage III plus generalized degenerative changes within the carpus (stage IV).

There were no stage I patients available to include and those patients with stage IV disease were excluded from the study to avoid interference of osteoarthritic changes with measurements. The posteroanterior wrist x-ray was considered acceptable when the cortical margin of the extensor carpi ulnaris groove was radial to the ulnar styloid,¹⁴ and this was true for the lateral view when the palmar aspect of pisiform located between the capitate and the volar surface of distal scaphoid.¹⁵ Therefore, wrist x-rays of 55 patients (41 males, 14 females) between 16 to 54 years (mean age, 27.6 years), were included in this study. Of these patients, 18 were stage II, 22 stage III_A, and 15 stage III_B.

The control group consisted of radiographs from the uninjured wrist of 60 wrist trauma patients (45 males and 15 females between 15 to 60 years; mean 29.3), that were taken in standard manner described by Palmer and colleagues.¹⁶ We were concerned about choosing individuals with any history of trauma or complain of this uninjured wrist, or generalized bone disorder. There was no significant difference between patients and controls according to age ($P = .31$).

Radiologic parameters that we evaluated in this study were RIA and PT. Angulation of distal articular surface of radius was considered in relation to the long axis of

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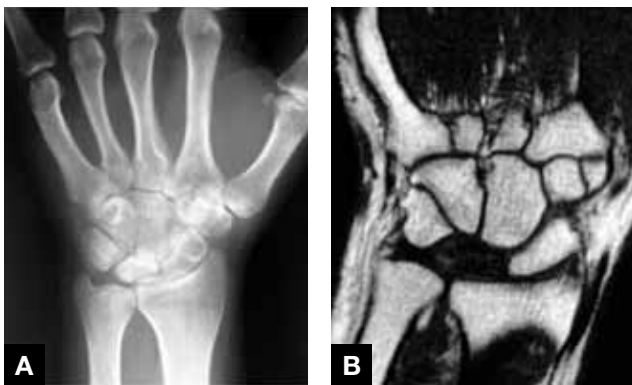


Figure. (A) A posteroanterior wrist radiograph displaying sclerosis and fragmentation of the lunate. (B) The corresponding T1-weighted coronal image MRI shows a low signal intensity necrotic lunate.

bone in posteroanterior view of wrist to measure the RIA, PT was determined by a line connecting the distal points of dorsal and volar rims of radius, in relation to another line perpendicular to the long axis of bone in lateral view of wrist.¹⁷ Student *t*-test was used to compare measurement results among Kienböck's disease patients and controls; $P < .05$ was considered statistically significant.

RESULTS

Based on our measurements, the mean RIA was $25.5^\circ \pm 3.7^\circ$ in Kienböck's disease patients (range, 18° - 34°), and $23.3^\circ \pm 3.8^\circ$ in controls (range, 12° - 32°). This difference was statistically significant ($P = .002$). This study was also revealed that the mean PT was $11.5^\circ \pm 3.9^\circ$ (range, 4° - 20°) and $9.4^\circ \pm 3.7^\circ$ (range, 0° - 18°) in Kienböck's disease patients and controls, respectively. This difference was also statistically significant ($P = .005$).

DISCUSSION

Mir and colleagues⁵ showed steeper radial inclination in patients with Kienböck's disease. Watanabe and colleagues,⁸ as well as Tsumura and colleagues^{9,10} also showed a direct relationship between radial inclination and force transmission to the lunate in biomechanical studies; these findings were supported by several clinical studies.^{6,18-20}

However, Mirabello and colleagues,³ and Tsuge and Nakamura⁴ demonstrated that RIA is flatter in patients with Kienböck's disease. Experimental studies also showed increased lunate strain by decreasing radial inclination, but no clinical correlation was demonstrated.^{10,11}

In our study, RIA was significantly steeper in patients with Kienböck's disease, compared with controls. This suggests that there may be an etiological association between high RIA and Kienböck's disease.

Lamas and colleagues⁶ proposed that lunate is under excess load, especially in dorsal pole due to palmar facing articular surface of radius, and suggested that reduction of PT decompressed the lunate in sagittal plane and increased radiolunate space. Nevertheless, according to Tsuge and Nakamura,⁴ PT was not markedly higher in lunatomalacia.

Based on the results of our study, PT of distal articular surface of radius was markedly higher in Kienböck's patients, compared with controls. Greater PT may be a risk factor for this disease.

AUTHORS' DISCLOSURE STATEMENT

The authors report no actual or potential conflict of interest in relation to this article.

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