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What is the implication of scaphoid ring sign in advanced Kienböck's disease? Is it a sign of advanced carpal collapse or rotary scaphoid subluxation?

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Summary *Objective*: To discuss the clinical implication of scaphoid ring sign in Lichtman's X-ray III_B stage of the lunate avascular necrosis.
Methods: In a series of 17 cases of advanced Kienböck's diseases, carpal height (CH) and carpal height ratio (CHO) were measured in posteroanterior X-ray view (PA) preoperatively, which included seven cases in stage III_A and 10 cases in stage III_B. Radioscaphoid angles were also measured in the lateral X-ray view. All these measurements above were to study what were the differences between stages III_A and III_B. In addition, five fresh normal wrist specimens were dissected to observe the ligaments stabilizing the proximal pole of scaphoid.
Results: The results of CH and CHR between stages III_A and III_B were similar, which illustrated no significant difference in carpal collapse between two substages, however, the results of RSA were significantly different between two substages, which implied the position of the proximal pole of scaphoid changed in two substages. Based on the results of anatomical observation, three ligaments were important to stabilize the proximal pole of scaphoid, namely the radioscaphocapitate (RSC) ligament, long radiolunate (LRL) ligament and scapholunate interosseous ligament (SLIL). The function of RSC ligament was to restrict palmar subluxation of the proximal pole of scaphoid; LRL and SLIL were to restrict dorsal transposition of the proximal pole of scaphoid.
Conclusion: Based on the results, we suppose the scaphoid ring sign is the implication of rotary scaphoid subluxation in stage III_B, which was caused by destructions of LRL and SLIL ligaments. All procedures aimed at stage III_B must account for this important factor.

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Kienböck's disease is one of the frequent causes of wrist pain in young adults, but the aetiology is unclear. At present, many procedures are designed to replace the necrotic lunate by different methods, and the choice of procedures is based on the Lichtman's X-ray stage. Based on whether or not a scaphoid ring sign exists in the posteroanterior (PA) X-ray view, stage III can be subdivided into two substages. However, what is the implication of the scaphoid ring in advanced Kienböck's disease? There are two possible answers: the first is passive flexion of the scaphoid due to more advanced carpal collapse from stage III_A to III_B, the second is scaphoid subluxation due to destruction of ligaments stabilizing the proximal pole of scaphoid. If the first answer is correct, the scaphoid ring sign clinically is not useful, but if it is the second answer, the subluxated scaphoid must be corrected.

Materials and methods

Clinical data

In the series, 17 preoperative X-ray films were included, which consisted of 16 males and one female. The age distribution ranged from 16 to 48 years old (mean 24 years old). The pain occurred in 11 right wrists and six left wrists. The duration was from 7 months to 7 years (mean 114 months). The clinical diagnosis was based on symptoms, physical examinations and X-ray films. The preoperative films demonstrated sclerosis and fragmentation of the lunate, on which Kienböck's disease in stage III were diagnosed. The differential criterion of substage was based on the scaphoid ring sign in PA film, which was differentiated by three consultants. In the series, seven cases in stage III_A and 10 cases in III_B were included.

Parameters of measurement in X-ray films

Carpal height (CH) and carpal height ratio (CHR) were measured in PA film, which were to compare the carpal collapse. Radioscaphoid angle (RSA) was measured in the lateral view to compare the palmer flexion of scaphoid.

Methods of measurement of CH, CHR, and RSA are as follows: CH is defined to be the distance between the third metacarpal base and subchondral sclerotic line of the distal radial articular surface, which is measured along the axis extended from the third metacarpal. The method of CHR measurement applies to Stahelin's and Nattrass's methods.[1,2] CHR by Stahelin's method is to divide the CH by the length of the third metacarpal. CHR by Nattrass's is to divide CH by the capitate's length, which is measured as the distance from the intersection point of the capitate articular facets between the second and third metacarpal bases to the proximal subchondral osseous cortex of the capitate, along the line that passes through the centre of the capitate head. RSA is the angle between the axis line of the radius and the tangent line of the proximal and distal poles of scaphoid in the lateral film.

Observation of the ligaments stabilizing the proximal pole of scaphoid

Five fresh specimens were included, which were thawed for 24 h at room temperature. The anatomical study consisted of two steps. Firstly, wrist capsule was exposed in two specimens, and was incised along the dorsal edge of distal radius. Under traction and palmar flexion of the wrist, the radiopalmar ligaments were exposed, and every extrinsic ligament was stripped of its bony insertions under magnification. Based on our observations, there were two extrinsic ligaments important to the stability of the proximal pole of scaphoid, i.e. radioscaphocapitate (RSC) ligament, long radiolunate (LRL) ligament. In the second step, the bony insertions of the RSC and LRL were preserved and the rest of scaphoid was cut in the other three specimens, which will further illustrate the ligaments stabilizing the proximal pole of scaphoid.

Statistical analysis

All data were expressed using mean $\pm$ SD. Homoscedasticity was performed using *F*-test. Differences between stages III_A and III_B were compared using Student's *t*-test and *t'*-test.

Results

The results of X-ray measurements

The results of CHR in both groups were less than the normal wrist, which indicated carpal collapse (Table 1). There were no significant differences of CH and CHR between stages III_A and III_B, which indicated no advanced carpal collapse from stage III_A to III_B. Results of RSA between stages III_A and III_B