

Radiographic analysis of anatomic risk factors for scapholunate dissociation

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The aim of this study was to identify anatomic risk factors for scapholunate dissociation. On a PA view of the wrist, in zero position, the scaphoid and lunate diameter and height, lunate tilting angle, lunate uncovering index, lunate fossa inclination, radial inclination and ulnar variance were measured ; on a lateral view the scapholunate angle and palmar tilting angle were measured.

In a control group (N = 126) first left to right were compared which showed low correlations for radial inclination (r = 0.26), palmar tilt (r = 0.60) and ulnar variance (r = 0.68). These parameters were then measured on the affected hand in the study group, since they are not influenced by the dissociation, and no arthritic changes were seen.

A statistically significant difference was found for a low lunate fossa inclination (p = 0.0001) and a low radial inclination (p = 0.0002). These factors may predispose to scapholunate dissociation.

INTRODUCTION

Many articles have been published on the issue of scapholunate dissociation and the evolution to DISI-deformity and SLAC-wrist (2, 3, 5, 20, 24, 26, 28, 30, 44, 52, 53). Different solutions have been proposed to solve this problem with soft tissue procedures (2, 5, 24, 32) or carpal fusions (47, 50, 51). Few articles however have been published on possible risk factors for developing scapholunate dissociation (8, 11, 48). The aim of this study was to identify these anatomic risk factors by radiographic analysis of the wrist.

MATERIALS AND METHODS

We measured 11 parameters on radiographs of 41 patients with scapholunate dissociation, proven by arthroscopy or open surgery. We compared the results with the findings in both hands of a control group of 126 healthy subjects without a history of trauma or skeletal disease.

On a standard PA radiograph in 'zero position' for ulnar variance (14) and in unloaded conditions (16, 17, 18, 39) with the shoulder abducted at 90°, the elbow flexed at 90° and the forearm placed on the X-ray table (14, 33), and on a standard lateral view, we measured the following parameters (fig 1) :

The scaphoid diameter (SD) and height (SH) measured from the baseline of the scaphoid : this baseline (a') is drawn from the ulnar tip of the distal ulnar corner to the radial tip of the distal radial corner (fig 1d).

The lunate diameter and height : measured from the baseline on the lunate (a) which runs from the ulnar tip of the distal facet to the radial tip of this facet (fig 1a).

The lunate tilting angle (LTA) : This is the angle between a perpendicular line (a) drawn to the base of the lunate (a) and the axis of the radius (b) (fig 1a).

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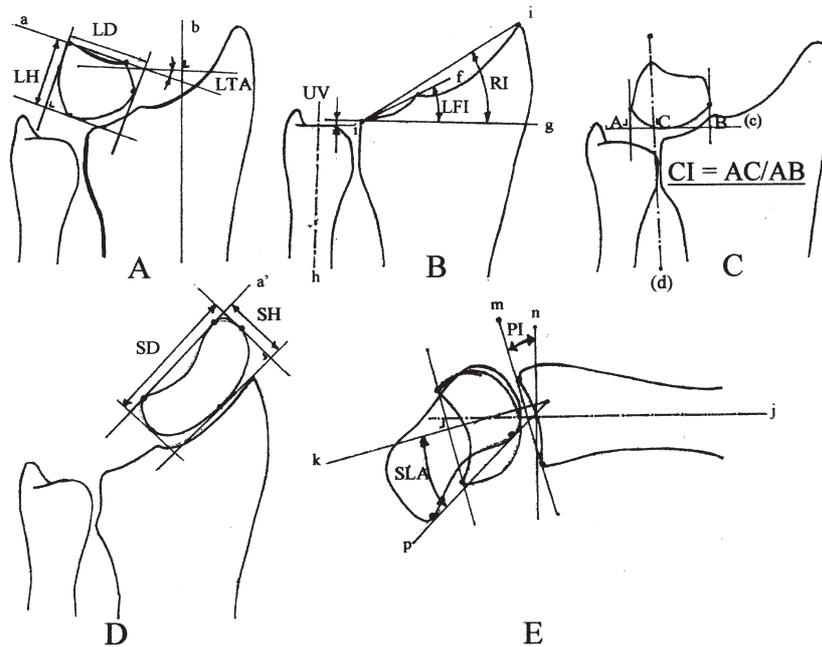


Fig. 1. :

- 1. A). LD/LH : Lunate diameter and height (a : baseline of the lunate)
- 1. A) LTA : Lunate tilting angle
- 1. B) UV : Ulnar variance
- 1. B) LFI : Lunate fossa inclination
- 1. B) RI : Radial inclination
- 1. C). LCI = AC/AB : Lunate uncovering index
- 1. D) SD/SH : Scaphoid diameter and height (a' : baseline of the scaphoid)
- 1. E) PTA : Palmar tilting
- 1. E) SLA : Scapholunate angle

The lunate uncovering index : The index between the uncovered portion of the lunate (AC) on a line perpendicular (c) to the longitudinal axis of the radial side of the DRUJ (d) and the projection of the entire lunate on the same line (AB) (fig 1c).

The lunate fossa inclination : The angle between the sclerotic line of the lunate fossa of the radius (f) and a line perpendicular (g) to the long axis of the distal ulna (h) (fig 1b).

Radial inclination : The angle between a line from the ulnar side of the carpal surface of the radius to the tip of the radial styloid (i) and a line perpendicular (g) to the axis of the ulna (h) (fig 1b).

Ulnar variance : After identifying the longitudinal axis of the radius, a line was drawn through the distal ulnar aspect of the radius (g) that is perpendicular to its longitudinal axis (h). The distance between this line and the distal cortical rim of the ulna (i) was then measured (6) (fig 1-6).

Palmar tilting angle : The angle between a line from the dorsal lip of the carpal surface to the palmar lip (m) and a perpendicular line (n) drawn to the axis of the radius (j) (fig e).

Scapholunate angle : The axis of the lunate (k) was determined by a perpendicular line drawn to the line connecting the anterior and posterior poles, based on the technique of Sarrafian *et al* (38). The long axis of the scaphoid was determined with a line tangential to the palmar outline of the scaphoid (p) using the technique of Gilula and Weeks (20) (fig 1e).

We compared in the control group the measurements of the left and right hand to see if all parameters could be measured on the unaffected hand of the scapholunate dissociation group.

A statistical analysis was done with the Student's t-test and chi-square test. The level of significance was set at $p < 0.05$.

Table I. — Profile of both groups

| | SLD group | Control group |
|---------------------------|----------------|----------------|
| Number | 41 | 126 |
| Male/Female | 22/19 | 68/58 |
| Mean age (Years) \pm SD | 32 \pm 14.34 | 36 \pm 13.77 |
| Range (Years) | 16 - 57 | 17 - 69 |

Table II. — Correlation between left and right hand measurements

| Measurements | R |
|--------------------------|-------|
| Scaphoid diameter | 0.92 |
| Scaphoid height | 0.88 |
| Lunate diameter | 0.89 |
| Lunate height | 0.91 |
| Lunate tilting angle | 0.90 |
| Lunate uncovering index | 0.87 |
| Radial inclination | 0.26* |
| Lunate fossa inclination | 0.93 |
| Ulnar variance | 0.68* |
| Scapholunate angle | 0.90 |
| Palmar tilting angle | 0.60* |

* low correlation.

RESULTS

The intraobserver variability was studied by three measurements of each radiograph. The reproducibility was within 0.5 mm and 1°. There were no statistically significant differences in sex ($p = 0.89$) or age ($p = 0.11$) distribution between the two groups (table I). In comparing the left to the right side we found no statistically significant differences for most measurements. However the correlation between the values of the left and right hand was low for radial inclination ($r = 0.26$), palmar tilt ($r = 0.64$) and ulnar variance ($r = 0.68$) (table II). Therefore we decided to measure these parameters on the affected hand, since there were no arthritic changes, and these factors are not influenced by the dissociation itself.

In comparing the measurements of the control group with the scapholunate group we found for the latter a lower radial inclination ($p = 0.0002$) and lower lunate fossa inclination ($p = 0.0001$). There was no statistical difference in mean ulnar variance ($p = 0.63$). However the ulnar variance distribution

showed a statistically significant difference ($p < 0.05$) for ulna plus between the control and the scapholunate dissociation group. There was no significant difference for ulna minus or neutral (table IV).

DISCUSSION

We found, like Schuind *et al* (41) and Freedman *et al* (16), a difference between the left and right hand for ulnar variance ($r = 0.68$), radial inclination ($r = 0.26$) and palmar tilt ($r = 0.64$). We believe this is because with advancing age the growth plates around the wrist undergo many influences depending on the activities and possibly on the dexterity. This was proven in the gymnast's wrist (10, 13, 45, 46, 47).

A lower radial inclination and lower lunate fossa inclination suggest that these patients are at risk for a scapholunate dissociation, instead of a scaphoid fracture, because there is less containment of the proximal carpal bones which makes them act more as a 'row type' of wrist (7, 43) rather than a 'column type' (7).

The mechanism that causes scapholunate dissociation is well known and comprises a fall on the outstretched hand with a movement of hyperextension, ulnar deviation and intercarpal supination (1, 24, 26-29, 36). This supination is caused when the lateral carpal row hits the ground first. Without this supination no ulnar deviation would be possible in the hyperextended wrist (20). Because of these movements, lunate and scaphoid are pushed away by the capitate (21), since they are less contained by the distal radius.

This shift of the lunate to the ulnar side (25, 32) onto the softer TFCC induces a rupture of the scapholunate ligaments (4). Since there is a lower radial inclination the scaphoid stays in a more horizontal position. We know that in this position all the forces of torque are transmitted to the scapholunate ligament (3). This torque is of course induced by the supination movement, and since the ligament is elongated by the diverging motion of scaphoid and lunate it ruptures even faster (21), because when the scapholunate ligament is taut it is twice as weak as the distal ligaments (3). Finally owing to

Table III. — Results of measurements

| | SLD group N = 41 | Control group N = 126 | P |
|----------------------|---------------------|--------------------------|-------------|
| Lunate diameter | 14.43 ± 1.70 mm | 14.61 ± 2.10 mm | p = 0.62 |
| Lunate height | 10.31 ± 1.20 mm | 10.49 ± 0.70 mm | p = 0.24 |
| Lunate tilting angle | 18.80 ± 4.6° | 17.68° ± 5.4° | p = 0.23 |
| Lunate unc. Index | 40.55 ± 10.2% | 39.33 ± 9.3% | p = 0.48 |
| Radial inclination | 20.98° ± 3.7° | 23.88° ± 4.3° | p = 0.0002* |
| Lunate fossa incl. | 10.59° ± 3.1° | 13.61 ± 4.4° μ | p = 0.0001* |
| Ulnar variance | -0.55 ± 1.48 mm | -0.42 ± 1.51 mm | p = 0.63 |
| Scapholunate angle | 53.80° ± 4.1° | 53.00° ± 3.5° | p = 0.23 |
| Palmar tilting angle | 9.80° ± 4.4° | 10.75° ± 2.8° | p = 0.11 |
| Scaphoid diameter | 13.2 mm ± 0.80 | 13.4 ± 1.1 mm | P = 0.28 |
| Scaphoid height | 21.6 mm ± 1.30 | 22 mm ± 1.5 mm | P = 0.13 |

* p < 0.05 Statistical significance for Student's T-test.

Table IV. — Ulnar variance distribution

| | SLD group | Control group | P |
|--------------|-------------|---------------|--------|
| Range | -3 to +3 mm | -4 to 3.5 mm | |
| Ulna plus | 8/41 (19%) | 49/126 (39%) | < 0.05 |
| Ulna neutral | 15/41 (37%) | 23/126 (18%) | 0.11 |
| Ulna minus | 18/41 (44%) | 54/126 (43%) | 0.95 |

P < 0.05 level of significance for chi-square test.

the ulnar deviation the radiocapitate ligament located radially from the center of rotation (49) is ruptured.

Once again (11) we could not confirm the results of Czitrom *et al* (8) and Voorhees *et al* (48) who found a relation between negative ulnar variance and lateral carpal instability.

First of all measuring ulnar variance demands a standard radiographic technique with standard positioning of the arm, since ulnar variance changes with pronation and supination (9, 14, 18, 33). Moreover we need a standard technique of measurements. Many were described (6, 19, 22, 23, 33). We used 'the method of perpendiculars' (6), since it proved to be the most reliable (42).

Finally Nakamura *et al* (31) found a significant difference between males and females and an

increasing ulnar variance with advancing age. This was also observed by other authors (12, 15, 23, 37). Therefore we used a sex/age matched group.

When all these criteria are met, we could evaluate the importance of ulnar variance. We found no significant difference for the mean ulnar variance, for ulna minus or ulna neutral, between our control group and the scapholunate dissociation group. However we found a significant difference for ulna plus between our control group and the scapholunate dissociation group (table IV).

We believe that ulna plus could be a protective factor against scapholunate dissociation since it could resist the ulnar shift of the lunate. It is known that less translation force for ulnar shift is needed with decreasing ulnar variance (4, 40). Possibly ulna plus would buttress the lunate better during its ulnar

shift than the softer TFCC (34, 35), making the scapholunate ligaments undergo less shear force (8). It may also be that positive ulnar variance resists the mechanism to develop a scapholunate dissociation, since it allows less ulnar deviation and supination. Further investigation is necessary.

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