Association between the capitate-triquetrum distance and carpal collapse in static scapholunate instability

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Long-standing scapholunate instability frequently leads to progressive deterioration of the adjacent joint cartilages in a consistent repetitive sequence of arthritis. The purpose of this study was to investigate whether the capitate-triquetrum distance is related with the occurrence of carpal collapse in cases of static scapholunate instability. In this retrospective study, 41 patients formed two groups based on the capitate-triquetrum distance; twenty-four with distance of less than 5mm and 17 with distance of 5mm or more. No significant difference was detected with respect to age, sex distribution, dominant hand involvement, initial treatment and time from injury to final x-rays. Three patients (3/24, 12.5%) of the C-T < 5mm group and 10 patients (10/17, 58.8%) of the C-T ≥ 5mm group had no sign of carpal collapse. This difference was statistically significant (p=0.017). Capitate-triquetrum distance could reliably contribute in the decision making process in difficult cases of static scapholunate instability.

Keywords : Scapholunate instability ; capitate-triquetrum distance ; carpal collapse.

INTRODUCTION

Long-standing scapholunate instability frequently leads to progressive deterioration of the adjacent joint cartilages in a consistent repetitive sequence of arthritis. This form of post-traumatic arthritis and carpal collapse has been termed "Scapho-Lunate Advanced Collapse" (SLAC) *(12)*. Whether SLAC wrist is an inevitable consequence of any scapholunate instability is an issue still causing disagreement among surgeons. An association between the type of the lunate and dorsal intercalated segment instability (DISI) pattern in cases of scapholunate instability *(9)* and scaphoid nonunion *(3, 5)* has been suggested. Type 1 lunate has a single distal facet articulating with the capitate only, while type 2 lunate has a second smaller, medial facet articulating with the hamate. The minimum

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distance between the capitate and triquetrum (C-T distance) on the postero-anterior plain radiograph with the wrist in neutral deviation determines the type of the lunate. C-T distance of 2 mm or less is indicative of type 1 lunate whereas C-T distance of 4mm or more is indicative of type 2 lunate. Intermediate values cannot reliably determine the type of the lunate *(4)*.

In this retrospective study we attempted to investigate whether any association exists between the lunate type and carpal collapse (DISI pattern, SLAC wrist) in cases of static scapholunate instability. Rather than strictly determine the type of the lunate, we categorized our patients according to the direct measurement of the C-T distance.

MATERIALS AND METHODS

Selection criteria and radiological assessment

From May 1995 to May 2012 we retrospectively evaluated 48 patients who had been treated for static scapholunate instability. All of them had been initially treated conservatively or had not been treated at all. So, after excluding those who had been operated on in the acute phase, we finally evaluated the aforementioned 48 patients. The most important inclusion criterion was the ability to estimate the time from injury to the final evaluation at the latest follow-up or to the final preoperative evaluation for those patients who had finally undergone surgery. We excluded six patients with no clear medical history of a single traumatic event and one patient with concomitant distal radius fracture. The final study population was 41 patients. Thirty-five of them had been suffered a single major trauma. Twenty-two of these 35 patients had normal trauma series x-rays and had been initially treated with splint immobilization for two weeks, whereas the other 13 patients had not sought medical advice in the acute phase. For the remaining six of the 41 patients, acute trauma x-ray series revealing the static scapholunate dissociation were available, but they had refused surgery and had been treated with casting for three weeks and splinting for another three weeks. The flow-chart of our study population is presented in figure 1.
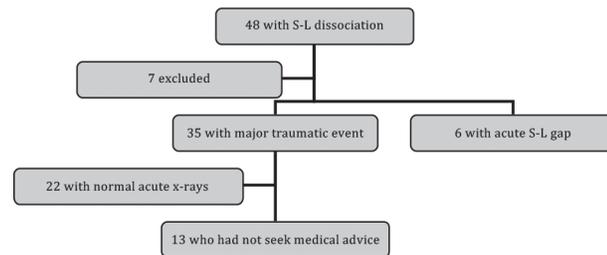

Fig. 1 – study flow chart

An orthopaedic hand surgeon conducted the assessment of the radiographs while blinded to the purpose of the study. He had not been involved in the treatment. The C-T distance was measured on the postero-anterior radiograph of the uninjured neutral deviated wrist. It is common practice, and our practice too, to take x-rays of the contralateral wrist for comparison. A digital caliper (Absolute Digimatic Caliper, Mitutoyo America Corporation, Aurora, IL) was used for the accurate measurement of this distance. We did not take into account the possible magnification because the focus film distance has been traditionally set at 100cm for all wrist x-rays. The observer also assessed the final x-rays for signs of carpal collapse. We considered as final x-rays the preoperative ones for patients who finally underwent surgery and the x-rays taken at the latest follow-up for those who had not. The stages of carpal collapse in scapholunate instability are presented in table I.

Study groups and statistical analysis

We categorized our patients into two groups according to the C-T distance. Group I included 24 patients with C-T distance of less than 5 mm, whereas group II included 17 patients with C-T distance of 5 mm or more. The cut-off value of 5 mm was chosen based on the suggestion in the literature that significant alteration in biomechanical behavior of the wrist occurs as the medial facet of the lunate exceeds 5mm in width *(14)*. We compared the two groups with respect of age, sex, dominant hand involvement, manual labor, initial treatment and time from injury to final x-rays. Finally, we attempted to investigate whether any significant

Table I. – Stages of carpal collapse in scapholunate instability (in increased severity)

Stages of carpal collapse	Definition
DISI without arthritis	Capitolunate angle > 15°
SLAC I	Radiostyloid – scaphoid arthritis
SLAC II	+ Radio (scaphoid fossa) – scaphoid arthritis
SLAC III	+ Capito – lunate arthritis

DISI: Dorsal Intercalated Segment Instability, SLAC: Scapho- Lunate Advanced Collapse

difference exists between the two groups in regard with the occurrence of carpal collapse signs.

Statistical analysis was performed with SPSS for Windows (version 13, SPSS, Chicago, IL), with use of the Student's t-test, the Fisher's exact test and the chi-squared test. Significance was defined as p < 0.05.

RESULTS

No statistical significant difference was detected between the two groups with respect to age, sex distribution, dominant hand involvement, manual labor, initial treatment and time from injury to final x-rays. Specifically, the mean time from injury to final x-rays was 39.7 months (SD =1 8.1) for the C-T < 5mm group and 40.9 months (SD = 16.5) for the C-T ≥ 5mm group, with no significant difference (p =0 .82, student's t-test) (Table II). No patient was detected with physiologically elevated capitolunate angle (>15º) on the x-rays of the uninjured wrist.

No sign of carpal collapse on the final x-rays was detected in three patients (3/24, 12.5%) of the C-T < 5mm group and 10 patients (10/17, 58.8%) of the C-T ≥ 5mm group. This difference was statistically significant (p = 0.017, CI = 95%, chi-squared test)(Table III). The distribution of the remaining patients among the various stages of collapse did not differ significantly between the two groups (p=0.99, Fisher's exact test)(Table IV, Figure 2).

Table II. – Characteristics of the two groups

	C-T < 5mm	C-T ≥ 5mm	p value
Patients	24	17	
Mean age (years) ± SD	31.5 ± 6.9	32.9 ± 7.8	p = 0.52
Sex (M/F)	21/3	15/2	p = 0.94
Dominant hand involvement (YES/NO)	16/8	12/5	p = 0.79
Manual labor (YES/NO)	20/4	15/2	p = 0.66
Initial treatment (Cast/Splint/ Nothing)	3/13/8	3/9/5	p = 0.89
Time from injury to final x-rays (months ± SD)	39.7 ± 18.1	40.9 ± 16.5	p = 0.82

Table III. – Prevalence of carpal collapse in the two groups

	C-T < 5mm	C-T ≥ 5mm	Total
No collapse	3	10	13
Collapse	21	7	28
Total	24	17	41

p = 0.017, chi-squared test

Table IV. – Prevalence of various stages of carpal collapse in the two groups

	C-T < 5mm	C-T ≥ 5mm	Total
DISI without arthritis	8	3	11
SLAC I	7	2	9
SLAC II	2	1	3
SLAC III	4	1	5
Total	21	7	28

p = 0.99, Fisher's exact test

DISCUSSION

Lunate is the keystone of the carpus. The two types of the lunate are differentiated in plain antero-posterior radiograph by measuring the shortest distance between the capitate and the triquetrum (C-T distance) *(4)*. The prevalence of each type ranges from 35 to 55% for type 1 and from 45 to 65% for type 2 *(1, 11)*. The width of the medial facet varies between 1-6mm *(11)*. The double distal facet of the type 2 lunate permits only flexion-extension of the midcarpal joint, thus restricting rotation and translation. Scaphoids articulated with type 2 lunates are not subject to rotation and translation due to their pattern of ligament attachments. These ligaments constitute radial and ulnar pivot points that define an axis of flexion and extension of the scaphoid. On the other extreme of carpal kinematics, scaphoids articulating with type 1 lunates demonstrate a different pattern of ligament attachments which facilitates rotation around the longitudinal axis of the scaphoid. As a result of this rotational movement, the scaphoid must be translated around the capitate in order to accommodate the full range of radial deviation of the wrist *(13)*. These are the two extremes of variation, but in reality a spectrum of anatomy and kinematics may be observed *(2)*.

A series of wrist conditions such as lunato-hamate impingement *(10)*, scapho-trapezium-trapezoid arthrosis *(6)*, Kienböck's disease *(7)*, chondromalacia of the proximal hamate and lunato-hamate arthrosis *(8)* has been attributed to type 2 lunate. Rhee et al retrospectively evaluated 58 patients with scapholunate dissociation and found

Fig. 2 – 42-year-old male patient. Twelve years after injury. Radio(scaphoid fossa)-scaphoid arthritis (SLAC II). Capitate-triquetrum distance: 6.7mm.

that ten of 25 patients with type 1 lunate had DISI deformity, whereas only five of 33 patients with type 2 lunate had the same deformity *(9)*. Haase et al retrospectively evaluated 45 patients with established scaphoid nonunion and found that 15 of 21 patients with type 1 lunate had DISI deformity whereas only four of 24 patients with type 2 lunate had the same deformity *(5)*. Dimitriadis et al retrospectively evaluated 76 patients with established scaphoid nonunion and found that wrists with C-T distance of 5mm or more are less vulnerable to carpal collapse *(3)*.

Surgical intervention is strongly recommended in symptomatic young patients. Unfortunately, indication for surgery is not always straightforward as many patients are presented with mildly or moderately symptomatic wrists and minimal functional deficit. If this is the case, the surgeon should include the possibility of post-traumatic carpal collapse in the decision making process. In this study we attempted to evaluate whether the measurement of the C-T distance could reliably predict carpal collapse and assist in the management.

Significant drawbacks of our study are the small number of patients and the inherent selection bias of study population as all of our patients had severe enough symptoms to seek medical advice. Another

limitation is the assessment by one observer. Despite these limitations, we have concluded that wrists with C-T distance of 5mm or more are less susceptible to collapse after sustaining a scapholunate dissociation (p = 0.017). This resistance could be attributed to the flexion-extension kinematic pattern of the scaphoid in type 2 lunate wrists, but this is speculative at the moment. The protective effect of the aforementioned biomechanical behavior seems not to protect the wrist against more advanced stages of carpal collapse once the collapse occurs (p = 0.99). We believe our conclusion could assist surgeon in the decision making process in difficult cases.

REFERENCES

1. **Burgess RC**. Anatomic variations of the midcarpal joint. J Hand Surg [Am] 1990 ; 15 : 129-131.
2. **Craigen MA, Stanley JK.** Wrist kinematics. Row, column or both? J Hand Surg [Br] 1995 ; 20 : 165-170.
3. **Dimitriadis A, Paraskevas G, Kanavaros P et al.** Association between the capitate-triquetrum distance and carpal collapse in scaphoid nonunion. Acta Orthop Belg 2015 ; 81 : 36-40.
4. **Galley I, Bain GI, McLean JM.** Influence of lunate type on scaphoid kinematics. J Hand Surg [Am] 2007 ; 32 : 842-847.
5. **Haase SC, Berger RA, Shin AY.** Association between lunate morphology and carpal collapse patterns in scaphoid nonunions. J Hand Surg [Am] 2007 ; 32 : 1009-1012.
6. **McLean JM, Turner PC, Bain GI et al.** An association between lunate morphology and scaphoid-trapezium-trapezoid arthritis. J Hand Surg Eur Vol 2009 ; 34 : 778-782.
7. **Nakamura K, Beppu M, Matsushita K, Arai T, Ide T.** Biomechanical analysis of the stress force on midcarpal joint in Kienböck's disease. Hand Surg 1997 ; 2 : 101-115.
8. **Nakamura K, Patterson RM, Moritomo H, Viegas SF.** Type I versus type II lunates: Ligament anatomy and presence of arthrosis. J Hand Surg [Am] 2001 ; 26 : 428-436.
9. **Rhee PC, Moran SL, Shin AY.** Association between lunate morphology and carpal collapse in cases of scapholunate dissociation. J Hand Surg [Am] 2009 ; 34 : 1633-1639.
10. **Thurston AJ, Stanley JK.** Hamato-lunate impingement: an uncommon cause of ulnar-sided wrist pain. Arthroscopy 2000 ; 16 : 540-544.
11. **Viegas SF, Wagner K, Patterson RM, Peterson P.** Medial (hamate) facet of the lunate. J Hand Surg [Am] 1990 ; 15 : 564-571.
12. **Watson HK, Weinzweig J, Zepperi J.** The natural progression of scaphoid instability. Hand Clin 1997 ; 13 : 39-49.
13. **Watts AC, McLean JM, Fogg Q, Bain GI.** Scaphoid anatomy. In: Slutsky DJ, Slade JF III, ed. The Scaphoid. Thieme Medical Publishers, New York, 2011, 3-10.
14. **Yazaki N, Burns ST, Morris RP et al.** Variations of capitate morphology in the wrist. J Hand Surg [Am] 2008 ; 33: 660-666.