J. Anat. Sciences, 22(1): June. 2014, 11-15

Original Article

STUDY OF COMPUTED TOMOGRAPHIC MORPHOLOGY OF SCAPHOID

Vishnu Datt Pandey*,Randhir Singh, R. P. Bansal*****

*Department of AnatomyL.L.R.M. Medical College, Meerut
**Department of Anatomy, NIMS Medical College, Jaipur
***Department of Radiodiagnosis, NIMS Medical College, Jaipur

ABSTRACT

The orientation of the carpal bones is such that their irregular morphologies can be utilized to some mechanical advantage .Their design is a compromise between motion and stability, allowing a unique combination of precise positioning and stability over a large range of motion. 60 human hands of adult male and female of age group (19 - 45 yrs) were selected for Computed Tomography (CT) in the study. We found in the type one wrist the capitate head was evenly positioned between either pole of the scaphoid with the wrist in a neutral position. In the type two wrists the capitate head was proximally positioned along the ulnar aspect of the scaphoid. This was observed as a proximal pole smaller in area and shorter in length than the distal pole. This may be used to identify wrist type and therefore apply a suitable course of treatment for the type of motion the carpal bones are likely to exhibit. This may improve the post-operative outcomes of surgical procedures aimed at improving wrist dysfunction.

Key Words: Scaphoid bone, Proximal pole, Distal pole, Types of wrist, CT Scan study of wrist

INTRODUCTION

The wrist is a common region of dysfunction, yet its structure is poorly understood. The clinical importance of the wrist may attest to the large number of articles published annually that reflect investigation into wrist function and dysfunction. The wealth of information therefore available is vast, but proper statistical analysis suggests that many contradictory results are presented. Inconsistent and imprecise descriptions make inter-study comparisons difficult and limit the effective application of the results[1] The orientation of the carpal bones is such that their irregular morphologies can be utilized to some mechanical advantage[2].Their design is a compromise between motion and stability, allowing a unique combination of precise positioning and stability over a large range of motion[3,4,2,5.] The anatomy of the scaphoid and its articulation with neighboring bones is central to developing a comprehensive understanding of carpal mechanics[6,7,8,5]. The present study was conducted with the aim of a consistent and detailed description of scaphoid with the help of CT scan which provide a framework for description of related structures and whether anatomical variations of the scaphoid may influence theories of carpal motion.

MATERIAL & METHODS

A total of 60 human hands of adult male and female of age group (19 - 45 yrs) were selected for Computed Tomography (CT) in the study. Axial computed tomographs (CTs) were generated on CT scanner (Siemens Somatom Emotion 16 slice CT scan with 3D reconstruction). Computed tomographic images were reconstructed at 1mm thick and 1mm intervals, such that the angles of the tomograph will approximately perpendicular to the plane of the Scapho-Trapizio-Trapizoid (STT) joint. The scanning plane was orientated along the first metacarpal using the planning image, and hence gave an approximation of the longitudinal axis of the scaphoid. Images were selected for two types of analyses; firstly, images with complete longitudinal sections of the scaphoid were

Address for Correspondence:
Dr Vinshnu Datt Pandey
Department of Anatomy, LLRM Medical College, Meerut. Mob: 9449480929 email : vishnudattpandey@gmail.com

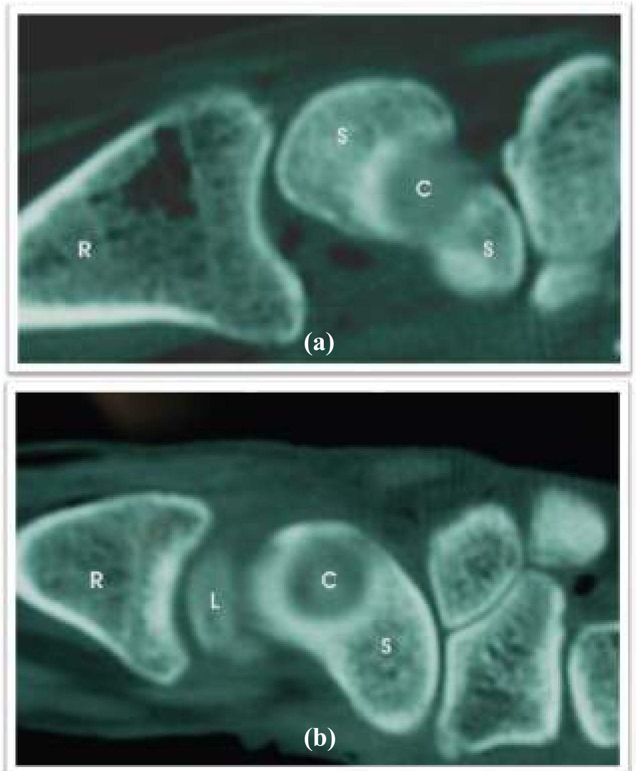

Figure.1 - Scaphoid angle computed tomographs. a-type one scaphoid (S) with capitate head (C) emerging evenly between the two poles; b-type two scaphoid (S) with capitate head (C) emerging proximally against the scaphoid; R-radius, L-lunate.

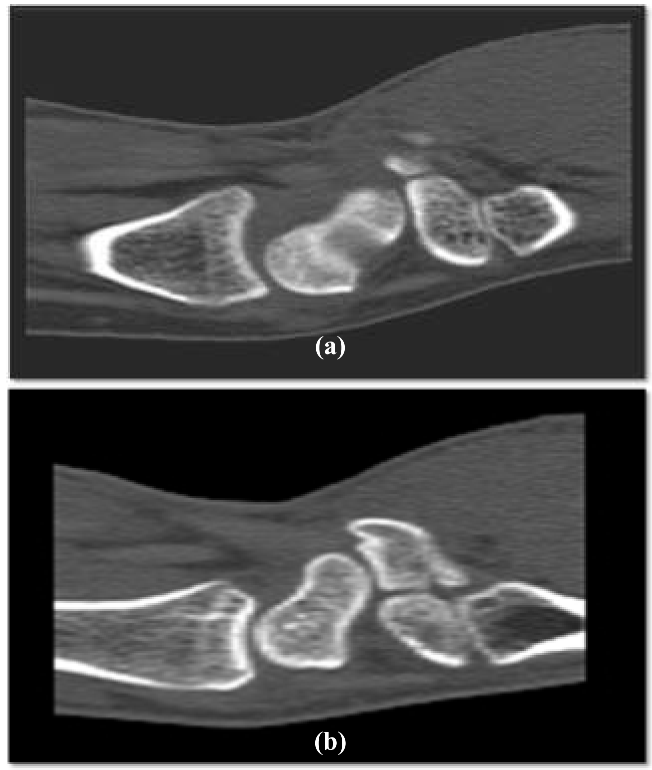

Figure 2- Computed tomographs selected for measurement. a-sections in which the capitate head (C) could be observed between the proximal (PP) and distal (DP) poles of the scaphoid were used to determine the position of the capitate head relative to the scaphoid.
b-sections with the complete scaphoid (S) were used to measure scaphoid dimensions;

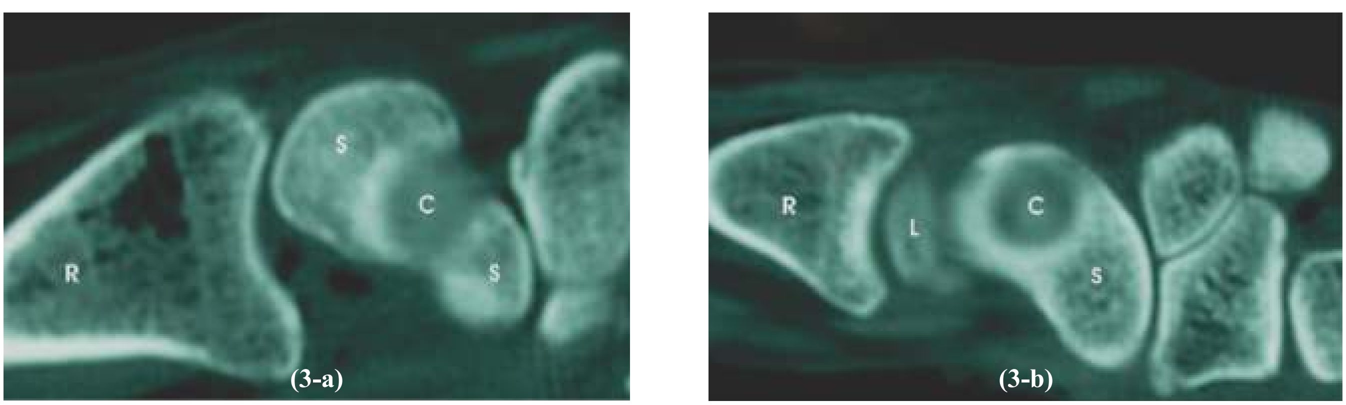

Figure 3 - Scaphoid angle computed tomographs. a-type one scaphoid (S) with capitate head (C) emerging evenly between the two poles; b-type two scaphoid (S) with capitate head (C) emerging proximally against the scaphoid; R-radius, L-lunate.

TABLE-1: Measurements of Scaphoid bone

Parameter	Type of wrist	Number	Mean	S.D.	T-test
Length of scaphoid (mm)	1	48	22.67	2.36	3.151
	2	12	24.99	1.92	
Length of Proximal Pole (mm)	1	48	8.25	1.00	3.535
	2	12	6.98	1.47	
Length of Distal Pole (mm)	1	48	7.33	1.07	2.017
	2	12	8.26	2.44	
Length of Scaphoid (mm)	Male	30	24.23	2.47	3.847
	Female	30	22.03	1.91	
Length of Proximal Pole (mm)	Male	30	8.71	1.01	5.068
	Female	30	7.29	0.94	
Length of Distal Pole (mm)	Male	30	7.75	1.53	1.266
	Female	30	7.27	1.39	
Area of Proximal Pole (mm^2)	Male	30	75.78	7.92	5.236
	Female	30	62.44	11.48	
Area of Distal Pole (mm^2)	Male	30	58.99	11.58	1.496
	Female	30	54.77	10.23	
Length Of scaphoid (mm)	Right wrist	30	23.24	2.56	0.325
	Left wrist	30	23.03	2.39	
Length of Proximal Pole (mm)	Right wrist	30	7.99	1.10	0.019
	Left wrist	30	8.02	1.32	
Length of Distal Pole (mm)	Right wrist	30	7.43	1.33	0.458
	Left wrist	30	7.60	1.28	
Area of Proximal Pole (mm^2)	Right wrist	30	68.33	11.70	0.504
	Left wrist	30	69.88	12.17	
Area of Distal Pole (mm^2)	Right wrist	30	57.55	11.61	0.465
	Left wrist	30	56.22	10.60	

used to assess the dimensions of the scaphoid. Secondly, images in which the capitates head were visible between the proximal and distal poles of the scaphoid were used to assess the position on the scaphoid in which the capitate head articulate.[10]

The measurements were done with the aid of software Radiant Dicom Viewer in which tool is provided, by using the tool length (length of scaphoid, proximal pole length and distal pole length) were measured in centimeter and then it converted in millimeters. Area were also measured by software in centimeter squire and then converted in millimeter

Table-2: Various indices of scaphoid bone

Parameter	Type of wrist	Number	Mean	S.D.	T-test
Proximal Scaphoid Pole Length/Distal Scaphoid Pole Length	Type 1 Type 2	48 12	1.137 1.041	0.144 0.895	0.724138
Proximal Scaphoid Pole Area/Distal Scaphoid Pole Area	Type 1 Type 2	48 12	1.37 0.796	0.203 0.098	9.47729
Proximal Pole Length/Length of Scaphoid	Type 1 Type 2	Type 1 Type 2	0.365217 0.278189	0.038521 0.047813	6.74
Distal Pole Length/Length of Scaphoid	Type 1 Type 2	Type 1 Type 2	0.323668 0.333836	0.038406 0.097606	0.397

squire.

Data are presented as mean ± S.D. Analysis of correlation is tested by Pearson's correlation. Comparison has been done in inter and intra groups, t-test with 95% confidence were used whenever 'p' value (<0.05) was considered significant.

RESULTS

Length of Scaphoid

The scaphoid in the selected slices was measured and statistical analysis was done(by software SPSS). The data suggest that the mean maximum length of the type 1 wrists (22.67±2.36mm) was significantly less than the mean length of the type 2 wrists (24.99±1.92mm; $p < 0.05$; figure2).

Computed tomographic images were selected that displayed the capitate head between the proximal and distal pole (extremities) of the scaphoid (figure 2). The lengths of the proximal and distal poles, separated by the emergence of the capitate head, were measured by the help of software Dicom works.

These measures were then divided by the total length of the scaphoid (maximal distance between proximal and distal poles) to yield relative lengths of either poles.

The various measurements and indices were tabulated in Table-1 andTable-2

DISCUSSION

Differentiation of scaphoid landmarks is difficult on standard roentgenographs (Compson et al, 1997)[6], making a distinction between scaphoid types unlikely. Variation in wrist position and film orientation may alter the perception of the film, such that erroneous conclusions are met. However, computed tomographs reveal the distinct differences in the orientation of the capitate facet when specific scaphoid angle tomographs are taken in accordance with Bain et al (1995)[10]. Computed tomographic images through the longitudinal axis of the scaphoid reveal the capitate head within the capitate facet of the scaphoid as the ulnar margin of the scaphoid is approached.

Fogg Q. A.[1] classified wrist in 2 types. The type one wrists had scaphoid that were shorter, had greater proximal areas and greater proximal lengths than the type two wrists. The relative pole length and area indices of the type one wrists were significantly greater than those of the type two wrists. These suggest that the values of proximal length and proximal area contribute more to the scaphoid in the type one wrists than in the type two wrists. Understanding the degree of variation in the morphology of the scaphoid is an important step in understanding carpal kinematics[3,6]

The suggestion of a lesser structural relationship between the scaphoid and the lunate in the type two wrists may indicate less uniform movements between the two bones, or even opposite movements. Similar suggestions are found in the kinematic literature (Craigen and Stanley, 1995; Moojen et al, 2003; Moritomo et al, 2000; Nakamura et al, 2000; Wolfe et al, 2000)[11,7,14,15,9].

The potential motion of the scaphoid in the two types of wrist was also suggested by the position of the capitate head. The head of the capitate in the type one wrists was evenly placed between the two poles of the scaphoid. The head of the capitate in the type two wrists was positioned more proximally along the ulnar aspect of the scaphoid. A difference in scaphoid may be suggested based on these results. The scaphoid with in a type one wrist may be moved in any direction about the head of the capitate. It therefore may be flexed/extended, where the point of articulation with the capitate head need not change (the head acting as a fulcrum). The scaphoid may also be rotated about its longitudinal axis, where it would be moved palmarly around the capitate head in internal rotation, and dorsally around the capitate head in external rotation. The large proximal pole also suggests that the scaphoid in the type one wrists may be translated ulnarly. In order to be translated ulnarly, as may happen in radial deviation of the wrist (Craigen 1995; Moojen et al, 2003)[7,11], the scaphoid must not impact upon the styloid process of the radius, and therefore cannot rotate about a point on the capitate head.

The position of the capitate head against the scaphoid may determine the movement of the scaphoid (figure 1 a). The capitate head may act as a fulcrum about which the scaphoid is rotated. For such a movement to occur force must be directed to either side of the fulcrum in order to displace either pole. Radial deviation of the wrist may be initiated by proximally-directed force from the trapeziotrapezoid complex (Berger, 1996)[3] forcing the radial side of the carpus to compress. Such a force on a scaphoid with a more distally orientated capitate head, such as in the type one wrists, may be conducive to translation of the scaphoid. The force may be directed proximal the fulcrum (point of contact with the capitate head) and therefore move the proximal pole of the scaphoid about the capitate head. Conversely, if the head of the capitate were positioned more proximally on the scaphoid, such as in the type two wrists, the proximally directed force may pass distal to the fulcrum (point of contact with the capitate head), resulting in flexion of the scaphoid Flexion may be the only movement that can ccur at the scaphocapitate joint without translation due to the position of the radial styloid process and the body of the capitate (Berger, 1996)[3].

Our study is in support of:-

Garcia-Elias, M (2001)[12] But a similar study was performed of adult normal dry scaphoid bones in sikkimese population of North East India of about 100 dry human scaphoid bones (C Purushothama et. al, 2011)[13]. Perhaps because of the age, gender and geographical foot print of dry adult scaphoid was not known.

In sikkimese dry scaphoid studies right scaphoid is significantly longer than the left scaphoid but there is no significant difference in right and left scaphoid in our study.

CONCLUSION-

Variation in the scaphoid articulation with the capitate between wrists can be observed in situ with the aid of computed tomography. The difference can be observed as a change in the position of the head of the capitate between the proximal and distal poles of the scaphoid. In the type one wrist the capitate head was evenly positioned between either poles of the scaphoid with the wrist in a neutral position. In the type two wrist the capitate head was proximally positioned along the ulnar aspect of the scaphoid. This was observed as a proximal pole smaller in area and shorter in length than the distal pole.

The observed variation between wrists may be suggestive of variable carpal motion. The in situ variations may therefore be observed in a clinical environment. This may be used to identify wrist type and therefore apply a suitable course of treatment for the type of motion the carpal bones are likely to exhibit. This may improve the post-operative outcomes of surgical procedures aimed at improving wrist dysfunction.

REFERENCES

1. Fogg Q A. (2009) Effect of scaphoid and triquetrum excision after limited stabilisation on cadaver wrist

movement. Journal of Hand Surgery 34(5) 614-7.
2. Kauer, J and Landsmeer, J (1983) Functional anatomy of the wrist. In The Hand, Tubiana, R, editor. pp. 142-157 WB Saunders, Philadelphia.
3. Berger, R (1996). The anatomy and basic biomechanics of the wrist joint. Journal of Hand Therapy9, 84-93
4. Bogumill, G (1988) Anatomy of the wrist. In The Wrist and its Disorders, Lichtman, D, editor. pp. 14-26 WB Saunders, Philadelphia.
5. Lewis, O, Hamshere, R and Bucknill, T (1970) The anatomy of the wrist joint. Journal of Anatomy 106, 539-552.
6. Compson, JP, Waterman, JK and Heatley, FW (1997) The radiologic anatomy of the scaphoid. Part 2: radiology. Journal of Hand Surgery22B, 8-15.
7. Moojen, TM, Snel, JG, Ritt, M, Venema, HW, Kauer, J and Bos, KE (2003) In Vivo Analysis of Carpal Kinematics and Comparitive Review of the Literature. Journal of Hand Surgery28A, 81-87
8. Nuttal, D, Trail, I and Stanley, J (1998) Movement of the scaphoid in the normal wrist. Journal of Hand Surgery 23B, 762-764.
9. Wolfe, SW, Neu, C and Crisco, J (2000) In vivo scaphoid, lunate, and capitate kinematics in flexion and in extension. Journal of Hand Surgery25A, 860-869.
10. Bain, GI, Bennett, JD, Richards, RS, Slethaug, GP and Roth, JH (1995) Longitudinal computed tomography of the scaphoid: a new technique. Skeletal Radiology.24, 271-273.
11. Craigen, M and Stanley, J (1995) Wrist kinematics. Row, column or both? Journal of Hand Surgery20B, 165-170
12. Garcia-Elias, M (2001) Anatomy of the wrist. In The Wrist, Watson, H and Weinzweig, J, editors. pp. 7-20 Lippincott Williams and Wilkins, Philadelphia
13. C Purushothama (et. al). Morphological and morphometric features of scaphoid bone in north eastern population. India Nepal Med Coll J 2011; 13(1): 20-23
14. Moritomo, H, Viegas, S, Elder, K, Nakamura, K, DaSilva, M and Patterson, R (2000) Thescaphotrapezio-trapezoidal joint. Part 2: a kinematic study. Journal of Hand Surgery25A, 911-920
15. Nakamura, K, Beppu, M, Patterson, R, Hanson, C, Hume,P and Viegas, S (2000) Motion Analysis in Two Dimensions of Radial Ulnar Deviation of Type I Versus Type II Lunates. Journal of Hand Surgery25A, 877-888