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Original Article

Study of Morphological and Morphometric Variations in Dry Adult Human Scaphoid Bone with its Clinical Implication in the Population of Haryana

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Abstract

The osteological description of the scaphoid bone in anatomical texts is virtually confined to articular facets. Scaphoid bone is most commonly injured among the carpal bones. Scaphoid fractures heal slowly due to the limited circulation of the bone. Scaphoid fractures have to be identifying on time to avoid the malunion of fractures. The present study included 60 dry human scaphoid bones (30 right and 30 left). The morphometric parameters included length of scaphoid, width of scaphoid, primary and secondary height of tubercle, and waist circumference were studied and measurements were taken with the help of Vernier caliper. The present study showed the mean values of all parameters observed higher on the right sided scaphoid in comparison to left-sided scaphoid which explains the fact that most of the populations of Haryana are right dominant. Detailed knowledge of the above parameters of scaphoid bones plays a significant role in better understanding of injury patterns and carpal kinematics and also helpful for orthopedicians, hand surgeons, clinical anatomists, and morphologists.

Key words: Anatomists, Fracture, Human, Length of scaphoid, Scaphoid

INTRODUCTION

The scaphoid is the largest element in proximal carpal row. It has a long axis that is distal, radial, and slightly palmar in direction. A round tubercle on the dorsolateral part of its palmar surface is directed anterolaterally.[1] Scaphoid articulates with other carpal bones, namely, lunate, trapezium, and capitate. It is connected with lunate bone by mean of the scapholunate ligament and instability can occur when scapholunate ligament get disrupted.[2]

The scaphoid is most commonly fractured carpal, accounting for approximately 60% of all carpal fractures and an estimation incidence of 1.5 fractures per 100,000 person years. The injury occurs predominantly in young health adults.[3,4] Unfortunately, these fractures are associated with high incidence of delayed union, non-union, and avascular necrosis because of the tenuous blood supply.[5,6] In particularly, radial artery is the major blood supply to the scaphoid bone. There is excellent collateral circulation through the dorsal and volar branches of anterior interosseous artery.[7] The middle and distal portions of the scaphoid bone are supplied bone which are supplied by the lateral and distal branches of the radial artery through its palmar and dorsal branches, whereas the proximal portion of the bone has poor blood supply.[8]

Fracture of scaphoid takes place at any age, even in children. In males, it may occur between age groups of 20 and 30 years of age.[9] Surgeons performing operative fixation of scaphoid fractures using a headless compression screw such as the Herbert screw and corticocancellous bone grafting for non-union need to be familiar with these morphological and morphometric variations of the scaphoid bone.[10]

The purpose of this study was to establish the normal range of morphometric data for the human scaphoid bone with reference to screw fixation. In addition, we wanted to

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examine the morphological variation between two sides in different individual.

MATERIALS AND METHODS

A total of 60 dried adult scaphoid bones (30 right and 30 left) were obtained from the Department of Anatomy, Pt. B.D Sharma Postgraduate Institute of Medical Sciences (PGIMS), Rohtak, Haryana. The scaphoid bones were of unknown sex, age, religion, and race. The bones which had previous signs of fracture were excluded from the present study. The side determination of the bones was done by anatomical features to identify the possible morphological and morphometrical variations. Measurements were obtained using the digital Vernier caliper.

Instruments Used for the Present Study Were

1. Vernier calipers of 0.02 mm accuracy for measuring the length and breadth of scaphoid
2. A non-stretchable thread for measuring circumference
3. A hand lens was used to count the number of foramina.

Morphological Parameters

1. The scaphoid tubercle was assessed based on its shape (either conical or pyramidal)
2. Dorsal sulcus was assessed by the presence primary and secondary sulci
3. Presence of nutrient foramina on the tubercle and sulci
4. The shapes of scapholunate articular surface, that is, half-moon shaped or crescentic were recorded.

Morphometric Parameters

The following morphometric parameters were studied:

Scaphoid length

The length of the scaphoid was calculated as the distance between the most prominent points on its proximal articular surface and that on the tubercle.

Width of waist

The width of the scaphoid waist was measured as the narrowest part of the scaphoid across its capitate articular surface in direction perpendicular to the longitudinal axis (narrowest angle of waist) [Figure 2].

Primary height of scaphoid tubercle

Primary height of the tubercle was defined as the distance between the most prominent point the tubercle to the intersection of the anterior and superior ridges of the scapholunate articular surface [Figure 3].

Secondary height of scaphoid tubercle

Secondary height of the tubercle was defined as the distance between the most prominent points of the tubercle to the deepest point of the waist [Figure 4].

Circumference of waist

Circumference was measured by placing a non-stretchable thread around its base [Figure 5].

Statistical Analysis

The mean and standard deviation were calculated. The data were analyzed using SPSS software 20.0.

RESULTS

The scaphoid bone is a unique carpal bone in its shape, function, and its three-dimensional orientation. It interconnects the proximal and distal rows of carpal bones on the radial aspect of the wrist to perform various functions. The morphometrical comparison was done on both sides of the bone.

Morphological Feature of Scaphoid Bone

Morphological variation was seen in the scaphoid bone with references of shape of tubercle, dorsal sulcus, number of nutrient foramen on tubercle, ridge for SCIL, and sulcus for FCR tendon given in Table 1.

The comparison of morphometric parameters was done on both sides of the bone. The mean values of all the parameters were found to be higher in right-sided scaphoid in comparison to left-sided scaphoid except the secondary height of tubercle. The mean values and standard deviation of all parameters are shown in Table 2.

Table 1: Morphological parameters of the right and left scaphoid bone (mm)

S. No.	Parameters	Left sided (*n*=30)	Right sided (*n*=30)
1	Shape of tubercle		
	Conical	22	26
	Pyramidal	8	6
2	Dorsal sulcus		
	Single	22	25
	Double	8	5
3	Presence of ridge for SCIL	27	28
4	Presence of sulcus for FCR	20	25
5	Nutrient foramen range	2–16	2–14

Table 2: Morphometric parameters of the right and left scaphoids (mm)

S. No.	Parameters	Left sided (*n*=30)	Right sided (*n*=30)	*P*-value
		Mean±SD (mm)	Mean±SD (mm)	
1.	Scaphoid length SL	26.10±2.53	26.22±2.25	0.86
2.	Scaphoid width SW	9.57±1.15	9.86±1.11	0.27
3.	Primary height of tubercle	12.84±1.51	13.31±1.10	0.23
4.	Secondary height of tubercle	9.25±0.72	9.13±1.00	0.64
5.	Waist circumference	34.78±2.85	34.99±2.56	0.77

DISCUSSION

Morphology and morphometry of scaphoid have a clinical significance in the management of scaphoid fractures.[11] It has unique three-dimensional orientations and connects the proximal and distal rows of carpal bones on the radial aspect of the wrist to perform various functions.[12] In acute scaphoid fractures, internal fixation is the only well-established line of treatment alternative to casting.[13] In healthy young individuals, the only carpal bone of the wrist to get fractured is scaphoid.[14]

Figure 1: Measurement of scaphoid length

Figure 2: Measurement of width of waist

Morphological Parameter

In the present study, we observed that all scaphoid bone has particular anatomical features, that is, presence of scaphoid tubercle, dorsal sulcus, waist, and validate articular surface for the attachment of lunate bone and also passage for the tendon of flexor carpi radialis.

The number of nutrient foramina over the tubercle on the left scaphoid was ranging from 2 to 14 on left side and 2–16 on right side which was in consonance with the previous study done by Babu *et al*.[15]

Shapes of scaphoid tubercle on the left side were conical in 22 (40%) and 24 (53%) on the right side. On the other hand, pyramidal on the left and right sides was 8 (60%) as well as 6 (47%). This parameter is compared in Table 1 with the previous authors. The above comparison of parameter shows that the percentage prevalence of change in shapes of tubercle in the present study was comparable to those recorded by Khullar *et al*.[18] The tubercle gives attachment to the flexor retinaculum and few fibers of abductor pollicis brevis.[17] The force exerted by this muscle may explain the varied shapes of the tubercle [Table 3].

The presence of sulcus on dorsal aspect was noted on 60 bones shows 22 single sulcus and eight double sulcus on the left side, and on the right side, 19 bones have single and 11 have double sulcus; these were near to equivalent with Babu *et al*.[15] [Table 4].

In the present study, ridge was found and was measured 27 on the left side and 28 on the right side; the absence

Table 3: Comparison of the prevalence of the various shapes of the tubercle in the present study with the previous studies

Workers	No. of scaphoids studied (*n*)	No. of scaphoids with conical tubercle *n* (%)	No. of scaphoids with pyramidal tubercle *n* (%)	No. of scaphoids with round tubercle *n* (%)
Ceri *et al*.[16]	200	142 (71)	55 (27.5)	0 (0)
Purushothama *et al*.[17]	100	58 (58)	42 (42)	0 (0)
Khullar *et al*.[18]	50	36 (72)	13 (26)	1 (2)
Present study (2022)	60	44 (73)	12 (26)	0 (0)

Table 4: Comparison of the percentage prevalence of the sulcus on scaphoid bone in the present study with the previous studies

Workers	No. of scaphoids studied, (*n*)	No. of scaphoids with single sulcus on dorsal surface, *n* (%)	No. of scaphoids with double tubercle on dorsal surface, *n* (%)
Babu *et al*.[15]	100	54 (58)	46 (50)
Present study (2022)	60	31 (53)	29 (47)

of ridge determines the weak attachment of SCIL ligament or even absence of ligament which results in dislocation of scaphoid bone. The comparison is showing in Table 5.

Furthermore, sulcus for FCR was recorded and was showed 20 scaphoid bones contain sulcus for FCR on the left side and 25 bones on the right side out of 60 bones; the present study may be related to the greater carpal instabilities in such cases Khullar *et al*.[18] Table 6.

Figure 3: Primary height of scaphoid tubercle

Morphometric Parameters

In the present study, the mean length of scaphoid was 26.22 ± 2.25 mm and 26.10 ± 2.53 mm on the right and left side scaphoid, respectively, which was similar to the findings of Khullar *et al*. while findings of the previous studies of Chandra *et al*.,[10] Purusthothama *et al*.,[17] Babu *et al*. (2018),[15] and Aparna *et al*.[19] were not similar. Knowledge of the mean values of the length of the scaphoid bones is very helpful to assess the screw length for internal fixation preoperatively. The present study showed that the mean length of right sided scaphoid was higher than the left-sided scaphoid which explains the fact that most of the population in Haryana is right -handed dominant [Table 2].

The mean value of width of waist, and secondary height of tubercle and circumference of waist were found to be similar to the Khullar *et al*.[18] while findings of the previous studies of Chandra *et al*.,[10] Purusthothama *et al*.,[17] Babu *et al*. (2018)[15] and Aparna *et al*.[19] were not similar [Table 7].

The mean value of primary height of tubercle showing in Table 2 was found to be similar with Khullar *et al*.[18] and Babu *et al*. (2018),[15] on the other hand, higher than the previous author due racial variation or differentiation in mode of taking the parameter.

Table 5: Comparison of the percentage prevalence of the ridge for SCIL on scaphoid bone in the present study with the previous studies

Workers	No. of scaphoids studied, (*n*)	No. of scaphoids with presence of ridge for SCIL, *n* (%)	No. of scaphoids with absence of ridge for SCIL, *n* (%)
Ceri *et al*.[16]	200	163 (81.5)	37 (18.5)
Purushothama *et al*.[17]	100	81 (81)	19 (19)
Khullar *et al*.[18]	50	37 (74)	13 (26)
Present study (2022)	60	45 (75)	15 (25)

Table 6: Comparison of the percentage prevalence of the sulcus for FCR on scaphoid bone in the present study with the previous studies

Workers	No. of scaphoids studied, (*n*)	No. of scaphoids with presence of sulcus for FCR, *n* (%)	No. of scaphoids with absence of sulcus for FCR, *n* (%)
Ceri *et al*.[16]	200	158 (79)	42 (21)
Purushothama *et al*. (2011)[17]	100	80 (80)	20 (20)
Khullar *et al*.[18]	50	38 (76)	12 (24)
Present study (2022)	60	45 (75)	15 (25)

Table 7: Comparison of findings of the present study with the previous studies

Parameters	Purushothama *et al*.[17]		Chandra *et al*.[10]		Babu *et al*. (2018)[15]		Aprana *et al*.[19]		Khullar *et al*.[18]		Present study	
	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right
Length	22.33	22.65	21.97	22.42	23.7	24.1	23.1	23.29	25.76	26.65	26.22	26.11
Width waist	6.88	7.06	6.97	6.91	6.2	7.4	7.46	7.88	10.55	10.35	9.86	9.57
Primary height of tubercle	9.41	9.18	9.34	9.34	13.1	13.1	10.73	11.17	13.99	14.11	13.31	12.84
Secondary height of tubercle	6.45	5.96	6.52	6.31	6.4	6.9	7.98	8.18	9.32	9.99	9.13	9.25
Waist circumference	30.06	31.35	30.5	30.47	32.4	41.2	27.91	28.17	33.1	33.93	34.99	34.78

Figure 4: Secondary height of scaphoid tubercle

Figure 5: Waist circumference measurement

The differences in the morphometric parameters of scaphoid bone between the present and previous studies are due to age, gender, race, native place, and living habits of the population.

CONCLUSION

Knowledge of the morphometric data obtained from the present study is useful for the orthopedicians, hand surgeons, radiologists, and clinical anatomists for surgical reduction with internal fixation to follow-up the reunion of fractured scaphoid bones also to necrosis factor. When designing new implants for scaphoid fixation, manufactures should be cognizant of the dimensions of scaphoid. Knowledge of the average length of screws may be helpful in planning operating room inventory.

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