

A STUDY OF MORPHOLOGY OF THE GLENOID CAVITYGursharan Singh Dhindsa¹, Zora Singh²**HOW TO CITE THIS ARTICLE:**

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ABSTRACT: AIM: A morphometric study of the glenoid cavity of 80 adult dry human scapulae in North Indian Population was done to evaluate the various parameters of the glenoid cavity. **MATERIAL AND METHODS:** This study was done on 80 dry, unpaired adult human scapulae (41 right & 39 left) of unknown sex belonging to the North Indian population. Maximum superior-inferior diameter and Maximum anterior-posterior diameter of the glenoid cavity were measured and Glenoid cavity index was calculated. The shape of the glenoid cavity was classified as inverted comma shaped, pear shaped and oval shaped depending upon the presence or absence of a notch on the glenoid rim. **RESULTS:** The average superior-inferior diameter on right and the left sides were 34.13 ± 3.16 mm and 34.11 ± 2.57 mm respectively. The average anterior-posterior diameter of the right glenoid was 24.05 ± 2.86 mm and that of the left was 23.36 ± 2.22 mm. The average glenoid cavity index on the right was 70.37 ± 4.08 and that of left was 68.59 ± 4.36 . All values were compared with series of other workers to draw the conclusions. **CONCLUSIONS:** All the parameters showed a greater value for the right side. The difference seen between the values of present study and that of other workers could be explained on the basis of ethnic and racial variations. This fact may be taken into consideration while performing shoulder arthroplasty and designing glenoid prostheses in North Indian population. The current study recorded 80% of glenoid cavities having the glenoid notch, which could be useful while diagnosing different pathologies of the shoulder joint. Thus a sound knowledge of various parameters of the glenoid cavity is important for the anatomists, anthropologists, orthopaedicians and prosthetists.

KEYWORDS: Glenoid cavity, Scapula, Glenohumeral joint, Morphometry.

INTRODUCTION: The scapula is a large, flat, triangular bone which lies on the posterolateral aspect of the chest wall, covering parts of second to seventh ribs. Its lateral angle, truncated and broad, bears the glenoid cavity which articulates with the head of the humerus at the glenohumeral joint and may be regarded as the head of the scapula.¹The morphology of the glenoid cavity is highly variable. The glenoid rim presents a notch in its upper and front part.²Due to presence of this glenoid notch, various shapes of glenoid cavity are found like pear-shaped, oval or inverted comma shaped.^{3,4} The disproportionate sizes of the head of the humerus and the small, shallow glenoid cavity combined with a lax articular capsule give this joint a wide range of movements but make the joint inherently unstable.⁵ The shoulder joint is the most frequently dislocated joint in the body. Dynamic factors of the rotator cuff muscles and the static factors of the gleno-humeral ligaments, the labrum and the joint capsule play a role in glenohumeral joint stability. Alignment of the humerus and the glenoid articular surfaces is one of the predisposing factors for glenohumeral joint instability which is one of the predisposing factors for rotator cuff pathology.^{6,7} Dislocations may also be associated with fracture of the glenoid cavity. For the management of this, prostheses and arthroplasty are required. The knowledge of normal anatomical features and variations of the shape and size of glenoid cavity

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are prerequisites for complete understanding of the mechanics of shoulder joint. This information has clinical application in shoulder arthroplasty, gleno-humeral instability and rotator cuff tear management. Therefore, the knowledge on shoulder joint would be complete if the dimensions of glenoid cavity are also incorporated. In spite of this not much work has been done in North Indian population. Therefore, the present study was carried out which provides valuable parameters which would help the anatomists, anthropologists, orthopedicians and prosthetists.

OBJECTIVE: To study morphometry of the glenoid cavity in 80 adult dry human scapulae (41 right & 39 left) in North Indian population to:

1. Evaluate various parameters of the glenoid cavity.
2. Study the various shapes of the glenoid cavity.

MATERIAL AND METHODS: The study was performed in the Department of Anatomy, GGS Medical College, Faridkot, Punjab. A total of 80 dry unpaired scapula bones were studied from teaching collection of the Anatomy department. Of the 80 scapulae, 41 were from the right side, and 39 were from the left side. The bones belonged to mature specimens, but the exact ages and gender of the specimens were not known. All the scapulae selected were dry, complete and showed normal anatomical features. Specimens showing osteoarthritic changes, evidence of any previous trauma or skeletal disorders was excluded from the study.

All the measurements were taken with the help of a digital vernier caliper (fig.1) and recorded in millimeters. Three readings were taken for each parameter at different times and the average was recorded. Range, mean, standard deviation and p-value were determined for each parameter. All values were compared with series of other workers to draw the conclusions.

1. SUPERIOR- INFERIOR GLENOID DIAMETER (SI): It is described as the maximum distance from the inferior point on the glenoid margin to the most prominent point of the supra -glenoid tubercle (fig. 2).



Fig. 1: Digital Vernier Caliper

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Fig. 2: Showing measurement of the Superior- Inferior (SI) Glenoid Diameter

2. ANTERIOR-POSTERIOR GLENOID DIAMETER (AP): It is described as the maximum breadth of the articular margin of the glenoid cavity perpendicular to the glenoid cavity height (fig 3).



Fig. 3: Showing measurement of the Anterior-Posterior (AP) Glenoid Diameter

3. GLENOID CAVITY INDEX (GCI): It was calculated from the observed values of SI and AP of the glenoid cavity. The formula for calculating the GCI is $AP / SI \times 100$.

4. SHAPE OF THE GLENOID CAVITY: It was noted whether the shape was inverted comma shaped, oval or pear shaped. (fig.s 4, 5, 6)

**Fig. 4: Pear shaped****Fig. 5: Oval shaped****Fig. 6: Inverted Comma shaped**

RESULTS: The measurements of the glenoid cavity were taken in total of 80 scapulae, of which 41 were of right side and 39 of left side as shown in table 1. The SI diameter of the glenoid cavity ranged between 41.01mm - 28.03 mm on the right side and between 39.6mm - 29.77 mm on the left side. The mean value of the SI diameter was found to be 34.13 ± 3.16 mm on right side and 34.11 ± 2.57 mm on left side. It was observed that the AP glenoid diameter of the right side ranged between 31.51mm - 19.26mm, with a mean of 24.05 ± 2.86 mm. The AP glenoid diameter of the left side ranged between 28.4mm - 19.66mm, with a mean of 23.36 ± 2.22 mm.

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After doing the calculations, mean of Glenoid cavity Index (GCI) of the right side came out to be 70.37 ± 4.08 and 68.59 ± 4.36 on the left side. The GCI of right side varied between 83.31- 63.28 and between 76.26- 55.72 on the left side.

Parameter	Mean		Standard Deviation		Range		P value
	RT	LFT	RT	LFT	RT	LFT	
SI diameter	34.13	34.11	3.16	2.57	41.01-28.03	39.6-29.77	0.976
AP diameter	24.05	23.36	2.86	2.22	31.51-19.26	28.4-19.66	0.218
GC index	70.37	68.59	4.08	4.36	83.31-63.28	76.26-55.72	0.058

Table 1: Comparison of measurements of Right and Left Glenoid Cavity

The shape of the glenoid cavity was observed as shown in table 2. Out of the 41 scapulae of the right side, 9(21.95%) had oval shaped, 20(48.78%) had pear shaped and 12(29.26%) had inverted comma shaped glenoid cavity. Out of the 39 scapulae of the left side, 7(17.94%) had oval shaped, 18(46.15%) had pear shaped and 14(35.89%) had inverted comma shaped glenoid cavity.

Shape of Glenoid Cavity	Incidence of Shape (Percentage)	
	Right	Left
Oval	21.95	17.94
Pear	48.78	46.15
Inverted Comma	29.26	35.89

Table 2: Comparison between the shapes of Right and Left Glenoid Cavity

Chi- square score= 0.46, P- value is 0.794.

The result is not significant.

DISCUSSION: After taking the measurements of the glenoid cavity, as described in material and methods, the results of the present study were compared with the results of the other authors. (Table No. 3)

Author	Year	No. of Specimen	Mean SI Diameter(mm)	Mean AP Diameter(mm)
von Schroeder et al ⁸	2001	30	36 ± 4	29 ± 3
Frutos LR ¹⁴	2002	Male-65	36.08 ± 2.0	26.31 ± 1.5
		Female-38	31.17 ± 1.7	22.31 ± 1.4
Taser F & Basaloglu H ¹⁵	2003	Male-13	37.1 ± 3.4	26.6 ± 2.1
		Female-39	34.1 ± 2.9	25.0 ± 2.7
Ozer et al ¹⁶	2006	Male-94	38.71 ± 2.71	27.33 ± 2.4
		Female-92	33.79 ± 3.08	22.72 ± 1.72
Coskun et al ⁹	2006	90	36.3 ± 3	24.6 ± 2.5
Karelse et al ¹⁰	2007	40	35.9 ± 3.6	27.2 ± 3.0

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Mamatha et al ¹¹	2009	Right-98	33.67 ± 2.82	23.35 ± 2.04
		Left-104	33.92 ± 2.87	23.02 ± 2.30
Rajput et al ¹²	2012	Right-43	34.76±3	23.31±3.0
		Left-57	34.43±3.21	22.92±2.80
Kavita et al ¹³	2013	Right-67	35.2±3.0	25.0±2.7
		Left-62	34.7±2.8	24.9±2.4
Present Study	2014	Right-41	34.13±3.16	24.05± 2.86
		Left-39	34.11± 2.57	23.36 ± 2.22

Table 3: Comparison of SI and AP Diameters of Glenoid in Present study and previous studies

In the present study, the average superior-inferior (SI) diameter of the right glenoid was 34.13±3.16 mm and the average superior- inferior diameter of the left glenoid was 34.11±2.57 mm. Though the right glenoid value was slightly more than the left, it was not statistically significant. Von Schroeder et al⁸, Coskun et al⁹ and Karelse et al¹⁰ reported the SI diameter to be 36±4mm, 36.3±3 mm and 35.9±3.6 mm respectively. All these values are higher than what was recorded in our study. Mamatha et al,¹¹ Rajput et al¹² and Kavita et al,¹³ measured the SI diameter of right and left side separately.

The mean SI diameter of right side measured by these three authors was 33.67 ± 2.82mm, 34.76±3 mm and 35.2±3.0 mm respectively and of the left side was 33.92 ± 2.87 mm, 34.43±3.21mm and 34.7±2.8 mm respectively. Our readings were nearest to the readings of Rajput et al. Frutos LR,¹⁴ Taser F et al¹⁵ and Ozer et al,¹⁶ measured the SI diameter of the male and female glenoid separately. The average SI diameter of male glenoid measured by these three authors was 36.08±2.05 mm, 37.1±3.4 mm and 38.71±2.71mm respectively. All these measurements are significantly higher than that reported in our present study.

The average SI diameter of the female glenoid measured by these authors was 31.17 ± 0.17 mm, 34.1±2.9 mm and 33.79±3.08 mm respectively. The readings of the present study are close to these readings of the female glenoid recorded by Taser F and Ozer et al. As the sex of scapulae was not known to us, we could not measure male and female scapulae separately.

In the present study the average anterior- posterior (AP) diameter of the right glenoid was 24.05± 2.86 mm and the average anterior- posterior diameter of the left glenoid was 23.36±2.22 mm. The right glenoid cavity was noted to be broader than the left side. The combined average of both sides came out to be 23.70±2.54 mm. The values noted by von Schroeder et al⁸, Coskun et al⁹ and Karelse et al¹⁰ were higher than those noted by us as shown in table 3.

The value observed by us was very close to what was observed in the female glenoids studied by Frutos LR¹⁴ and Ozer et al¹⁶. Frutos LR recorded the average AP to be 22.31±1.49mm and Ozer et al got 22.72 ± 1.9mm. Taser F et al¹⁵ recorded it 25.0±2.7 mm, which was higher as compared to our value. The values recorded for the AP diameter for the male glenoids were 26.31±1.57mm by Frutos LR, 26.6±2.1 mm by Taser F et al and 27.33 ± 2.4mm by Ozer et al. All these three values were much higher than our combined average. The combined average AP diameter noted by Mamatha et al¹¹, Rajput et al¹² and Kavita et al¹³ 23.18±2.17 mm, 23.11±2.9 mm and 24.95±2.55 mm respectively, which were close to those noted by us.

The combined mean of the Glenoid cavity Index (GCI) in the present study came out to be 69.48±4.22. Polguj M et al¹⁷ noted the combined GCI to be 72.35±5.55, which was higher than that

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recorded by us. We also noted the various shapes of glenoid cavity and recorded their percentage of incidence depending upon the presence or absence of a notch on the glenoid rim. 29.26 % of the right and 35.89 % of left glenoids were inverted comma shaped, 48.78% on the right side and 46.15% on the left side were pear shaped and, 21.95% on the right side and 17.94 % on the left side were oval without any recognizable notch.

This suggests that there was no significant difference in the presence of notch on the right and left side. Prescher and Klumpen³ noted that 55% of the scapulae had a notch and in 45% the notch was absent. Coskun et al⁹ studied 90 scapulae and found that, in 72% of the specimens, the glenoid notches of the scapulae were absent or oval shaped, whereas in 28% the notch was well expressed and the glenoid cavity was pear shaped.

Mamatha et al¹¹ reported that on the right side 34% glenoid cavities were inverted comma shaped, 46% pear shaped and 20% oval shaped and on the left side they were 33%, 43% and 24% respectively. Rajput et al¹² recorded the incidence of inverted comma shaped, pear shaped and oval shaped as 35%, 49 % and 16 % respectively on the right side and 39%, 46 % and 15% respectively on the left side. Kavita et al¹³ found the inverted coma shape in 11 % of the samples, pear type 58% and oval type in 30 % of the samples. The findings of Prescher and Klumpen³ and Coskun et al⁹ are at a variation than that of the present findings.

CONCLUSION: Glenohumeral instability in young individuals and athletes and rotator cuff pathology in the elderly are common causes of shoulder pain. Studies have shown that when the glenoid notch is distinct, the glenoid labrum is often not attached to the rim of the glenoid at the site of the notch.³ This can be a predisposing factor in anterior dislocation of shoulder joint. The difference seen between the values of present study and that of other workers could be explained on the basis of ethnic and racial variations. Thus knowledge of the variation in the shape and dimensions of the glenoid are important in better understanding of the shoulder pathology and in designing and fitting of glenoid components for total shoulder arthroplasty.

The above data on the shape and various dimensions of the glenoid cavity may not only help the orthopedicians and prosthetists but also can be of interest to the anthropologists when studying about the evolution of the bipedal gait. However it should be kept in mind, that the present study had a smaller number of bones and were not of the same skeleton, it is difficult to conclude these readings as standard, in any practical appliances. So it is worthwhile to perform similar study on more number of bones for its theoretical and practical importance in the coming years.

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