

A Morphometric Study of Various Shapes of Scapular Glenoid Cavity at Jhalawar Rajasthan

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Abstract:

Background: The variations in the morphology of glenoid fossa are influenced by genetic and environmental factors. Thorough knowledge on the morphometry and morphology of the glenoid cavity is essential in the understanding, investigation and management of demographic diseases pertaining to shoulder such as glenohumeral arthritis, rotator cuff disorders, shoulder dislocations, and fractures.

Aim: To determine and analyse the morphological types and diameters of the glenoid cavity in adult scapulae.

Method: A cross sectional study was done on 60 dry scapulae obtained from the Bone Bank of Department of Anatomy, Jhalawar Medical College, Jhalawar. Shapes of glenoid cavity were classified into three groups (Oval shape, Pear shape, Inverted comma shape) on the basis of presence or absence of notch on the anterior margin of cavity. All morphometric parameters were measured by using digital Vernier caliper in millimeter with accuracy of 0.1mm.

Results: Among 60 scapulae, Most common shape of glenoid cavity was pear shape that is 58.33%) followed by oval shape in 25.0% and inverted comma shape in 16.67%. Mean values of measured parameters shows, SI diameter 31.38 ± 2.50 mm, AP- diameter 21.87 ± 2.23 mm and glenoid cavity index $69.69\% \pm 4.39$ in total scapulae. All measurement values of right and left scapulae shows no statistically significant differences as p values is greater than 0.05.

Conclusion: In the present study most common shape of glenoid cavity observed was pear shaped which followed by inverted comma shaped and oval shape. No significant differences was observed in measurement of right and left scapula.

Keywords: Cross sectional study, Glenoid cavity, Glenoid Cavity Index, Morphometry.

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Introduction

The scapula also called shoulder blade, is a triangular flat bone that lies on the posterolateral aspect of the thorax, overlying the 2nd to 7th ribs. [1] It consist of two surfaces (costal and dorsal), three borders (superior medial and lateral), three processes (coracoid, acromion and spinous) and three angles (superior, lateral and inferior). [2] The lateral/ supero-lateral angle of scapula form the pear shaped glenoid cavity, which articulates with the head of humerus at the shoulder joint. [3] Von Langer (1882) termed the glenoid notch/cavity the incisura acetabuli. The glenoid cavity which is also known as the head of the scapula is connected to the plate like body by an anatomical neck which is most distinct at its dorsal and inferior aspects. [4]

Glenoid cavity is related to supra-glenoid tubercle at the upper margin of the cavity and an infra-glenoid tubercle at the lower margin of glenoid

cavity or at the superior end of lateral border of scapula. Supra-glenoid tubercle lies inside the joint capsule of shoulder joint whereas infra-glenoid tubercle is outside the capsule. Glenoid cavity articulates with the head of humerus and forms the gleno-humeral joint. The glenoid cavity provides a shallow, and limited, socket for the humeral head. Its outline is piriform, narrower above. The cavity is directed forward, laterally and slightly upwards when arm is by the side. The cavity is directed almost straight upwards when the arm is raised above the head. The articular surface of glenoid cavity is concave and much smaller than the articular surface of head of humerus which is reciprocally convex. Both the articular surfaces are covered with articular cartilage (hyaline cartilage). The concavity of glenoid cavity is deepened by the glenoid la-

brum, attached to the margin of fossa which is fibro-cartilaginous rim. [5]

Various shapes of glenoid cavity like oval, pear and inverted comma were reported on the basis of presence or absence of notch at the anterior margin of glenoid fossa. Notch is absent in oval shape, indistinct in pear shape and distinct in inverted comma shape of glenoid cavity [6,7]. According to Fick (1904) the glenoid notch is located at the anterior margin of the glenoid cavity. The notch is situated somewhat above the middle of the anterior margin of the cavity and can be very prominent, very shallow or absent. [8] The variations in the morphology of glenoid fossa are influenced by genetic and environmental factors. [9] The shoulder is the third most common joint that requires reconstruction following knee and hip. [10]

Variations of shape and size of glenoid cavity of scapula is important for the understanding of shoulder dislocation, rotator cuff disease and to determine the meticulous size of the glenoid component in the shoulder arthroplasty and has a prognostic value on the primary gleno-humeral osteoarthritis. [11] Thorough knowledge on the morphometry and morphology of the glenoid cavity is essential in the understanding, investigation and management of demographic diseases pertaining to shoulder such as glenohumeral arthritis, rotator cuff disorders, shoulder dislocations, and fractures. [12]

The long axis of the glenoid cavity i.e. its vertical diameter is the longest and it is broader below than the above. The shoulder joint is one among the most commonly dislocated joints in the body. The fractures of glenoid with dislocations are very common in the trauma. The detail knowledge about variation of glenoid cavity is important for total shoulder arthroplasty. The different anatomical parameter of the glenoid cavity relevant to prosthesis design includes shape, size, height and width. [13]

Aims and Objectives:

The objective of the study was to evaluate the morphology and morphometry of glenoid cavity in adult scapulae. The present study was done to determine and analyse the morphological types and diameters of the glenoid cavity in adult scapulae to improve the efficacy and minimize the failure rates in shoulder arthroplasty.

Materials and Methods:

A cross sectional study was done on 60 dry scapulae obtained from the Bone Bank of Department of Anatomy, Jhalawar Medical College, Jhalawar(Raj).

Out of which 31 were of right side and 29 were of left side. The age and sex of each pair of scapulae were not known. Shapes of glenoid cavity were classified into three groups on the basis of presence or absence of notch on the anterior margin of cavity.

These are:

1. Oval shape- absence of notch on anterior margin,
2. Pear shape- presence of indistinct notch on anterior margin and
3. Inverted comma shape- presence of distinct notch on anterior margin of glenoid cavity.

Exclusion criteria- damaged scapulae were excluded.

All morphometric parameters were measured by using digital Vernier caliper in millimeter with accuracy of 0.1 mm. Superior-Inferior diameter of glenoid cavity (SI)-was measured as maximum distance from superior margin to inferior margin of glenoid cavity. Antero-Posterior diameter of glenoid cavity (AP)-was measured as maximum distance between margin of glenoid cavity, perpendicular to superior-inferior diameter.

Glenoid Cavity Index (GCI %) is calculated by

$$\text{GCI (\%)} = \frac{\text{Antero-posterior diameter}}{\text{Superio-inferior diameter}} \times 100$$

Statistical Analysis

All data was collected through pre validated performa and instruments and entered in MS - Excel. All the data were tabulated and analysed by using SPSS version 23.0 (Trial version). Mean, minimum and maximum values of all parameters were derived with standard deviation. The values of right and left side were analysed and compare by using student t-test. The p-value <0.05 was taken as statistically significant.

Results:

In this study, glenoid cavities of 60 scapulae were studied. Out of which, 31 were belongs to right side and 29 were of left side. On the basis of presence or absence of the notch on anterior margin of glenoid cavity, three shapes were observed-pear, oval, comma. Most common shape of glenoid cavity was pear shape that is 58.33% (54.84% on right side and 62.07% on left side) followed by oval shape in 25.0% (25.80% on right side and 24.14% on left side) and inverted comma shape in 16.67% (19.35% on right and 13.79% on left side).

Table 1: Different shapes of glenoid cavity.

SHAPE	RIGHT SIDE	LEFT SIDE	TOTAL
Pear	17 (54.84%)	18 (62.07%)	35 (58.33%)
Inverted comma	6 (19.35%)	4 (13.79%)	10 (16.67%)
Oval	8 (25.80%)	7 (24.14%)	15 (25%)
Total	31 (100%)	29 (100%)	60 (100%)

Table 2 Observation of superoinferior (SI) and anteroposterior diameter(AP), index of glenoid cavity.

DIAMETER	RANGE		MEAN \pm STANDERED DEVIATION		TOTAL MEAN \pm STANDERED DEVIATION	t-Value	p-Value
	RIGHT	LEFT	RIGHT	LEFT			
Superio-inferior (SI) Glenoid Diameter	24.5 - 37.6	26.8 - 37.6	31.15 \pm 2.77	31.62 \pm 2.20	31.38 \pm 2.50	0.725	0.4717
Antero-posterior (AP) Glenoid Diameter	16.4 - 27.8	17.5 - 26.5	21.63 \pm 2.39	22.13 \pm 2.05	21.87 \pm 2.23	0.867	0.3895
Glenoid cavity Index (%)	61.56 - 76.84	61.21 - 81.09	69.42 \pm 4.55	69.98 \pm 4.26	69.69 \pm 4.39	0.491	0.6251

Mean values of measured parameters shows, SI diameter 31.38 ± 2.50 mm, AP- diameter 21.87 ± 2.23 mm and glenoid cavity index $69.69\% \pm 4.39$ in total scapulae. In right scapula the range of SI diameter was 24.5 to 37.6 mm with mean of 31.15 ± 2.77 , range of AP diameter was 16.4 to 27.8 mm with an average of 21.63 ± 2.39 and average glenoid cavity index in right scapula was 69.42 ± 4.55 . In left scapula the range of SI diameter was 26.8 to 37.6 mm with an average of 31.62 ± 2.20 , range of AP diameter was 17.5 to 26.5 mm with an average of 22.13 ± 2.05 and average glenoid cavity index in left scapula was 69.98 ± 4.26 . In all the above measurements values of right and left scapulae shows no statistically significant differences as p values is greater than 0.05.

Discussion:

The present study was done on 60 dry scapulae present in Department of Anatomy Jhalawar Medical College, Jhalawar. Various other studies have been done all over the world in different medical colleges on morphology of glenoid cavity by different methods like radiographic measurement of living, direct measurement in scapula taken from cadavers or in dry scapula. In this study the measurement was done on dry scapulae. The data obtained from present study was compared with different studies, we found many similarities and differences in the shape and measurement of glenoid cavity diameters.

Shape of Glenoid Cavity

In this study we observed that the most common shape of glenoid cavity was pear shape-which was

found in 54.84% of the right side and 62.07% of the left side scapulae, and second most common type was oval which was found in 25.80% right side and 20.30% in left side. And third type - inverted comma shaped (on the basis of distinct notch on anterior border of glenoid fossa) was found in 19.35% right side and 13.79% in left side.

Similar to our study the most common shape observed by Akhtar MJ et al [13], Archana Singh et al [14], Gamal Hamed El-Sayed Hassanein [15], Mamatha et al [17], Divya et al [18], Gursharan Singh Dhindsa [20], was pear shaped. While as per Azhagiri et al [16] the Inverted comma shape was most commonly present and according to Wael Amin Nasr El-Din et al [19] oval shaped glenoid cavity is most commonly found.

Oval shaped glenoid cavity was second most common type in present study as similar to Archana Singh et al [14] and Divya et al [18]. While inverted comma shapes observed as second most common shape by Akhtar MJ et al [13], Gamal Hamed El-Sayed Hassanein [15], Mamatha T et al [17] and Gursharan Singh Dhindsa [20]. Pear shape is observed as second most common by Wael Amin Nasr El-Din et al [19] and Azhagiri, et al [16]. Third type observed in present study was Inverted comma shape similar to Archana Singh et al [14], Divya et al [18], Wael Amin Nasr El-Din et al [19]. Oval shape is observed as third type by Akhtar MJ et al [13], Gamal Hamed El-Sayed Hassanein [15], Azhagiri et al [16], Mamatha T, et al [17], Gursharan Singh Dhindsa [20]. Pear shaped were not seen as least common in any study we compare.

Author	No. Of specimen studied	Pear shape	Inverted comma shape	Oval shape
Akhtar MJ et al ¹³	Right -126 Left-102	65(51.59%) 50(49.02%)	44(34.92%) 38(37.25%)	17(13.49%) 14(13.73%)
Archna Singh et al ¹⁴	Right-56 Left-44	24(42.9%) 20(45.5%)	12(21.4%) 10(22.7%)	20(35.7%) 14(31.8%)
Gamal Hamed El-Sayed Hassanein ¹⁵	Right-38 Left-30	17(44.74%) 14(46.67%)	12(31.58%) 9(30%)	9(23.68%) 7(23.33)
Azhagiri, et al ¹⁶	Right-52 Left-48	16(30.77%) 14(29.17%)	28(53.85%) 26(54.17%)	8(15.38%) 8(16.67%)
Mamatha T,et al ¹⁷	Right-98 Left-104	45(46%) 45(43%)	33(34%) 34(33%)	20(20%) 25(24%)
Divya et al ¹⁸	Right-74 Left-62	49(66.22%) 36(58.06%)	11(14.86%) 10(16.13%)	14(18.92%) 16(25.81%)
Wael Amin Nasr El-Din et al ¹⁹	Right-80 Left-80	28(35%) 22(27.50%)	13(16.25%) 16(20%)	39(48.75%) 42(52.50%)
Gursharan Singh Dhindsa ²⁰	Right-41 Left-39	20(48.78%) 18(46.15%)	12(29.26%) 14(35.89%)	9(21.95%) 7(17.94%)
Present study	Right-31 Left-29	17(54.84%) 18(62.07%)	6(19.35%) 4(13.79%)	8(25.80%) 7(20.30%)

Comparison of mean supero inferior diameter, Anteroposterior diameter and Glenoid cavity Index by different researchers

In our study mean superior-inferior diameter was 31.38 ± 2.50 mm in total scapula, 31.15 ± 2.77 mm on right side and 31.62 ± 2.20 mm on left side. The values of SI diameters of right scapula in Gamal Hamed El-Sayed Hassanein [15] and Mamatha T,et al¹⁷ were almost similar with the present study, while Akhtar MJ et al [13], Archna Singh et al¹⁴, Azhagiri, et al [16], Divya et al [18], Wael Amin Nasr El-Din et al [19] and Gurusharan Singh Dhindsa [20] reported higher values in comparison to present study. Values of SI glenoid diameter of left side were similar to our study Archna Singh et al [14], Divya et al [18]. While Akhtar MJ et al [13], Azhagiri et al [16], Mamatha T et al [17], Wael Amin Nasr El-Din et al [19] and Gurusharan Singh Dhindsa [20] reported higher values in comparison to present study and Gamal Hamed El-

Sayed Hassanein¹⁵ reported lower value than present study.

In our study mean Antero-posterior diameter was 21.87 ± 2.23 mm in total scapula, 21.63 ± 2.39 mm on right side and 22.13 ± 2.05 mm on left side. The values of AP diameters of right scapula in Divya et al [18], Akhtar MJ et al [13], Mamatha T et al [17], Wael Amin Nasr El-Din et al [19] and Gurusharan Singh Dhindsa [20] were almost similar with the present study, while Archna Singh et al [14], Azhagiri, et al [16] and Gamal Hamed El-Sayed Hassanein [15] reported higher values in comparison to present study. Values of AP glenoid diameter of left side were similar to our study Divya et al [18], Akhtar MJ et al [13], Mamatha T et al [17], Wael Amin Nasr El-Din et al [19], Azhagiri, et al [16] and Gamal Hamed El-Sayed Hassanein [15] and Gurusharan Singh Dhindsa [20] were almost similar with the present study, while Archna Singh et al [14] reported higher values in comparison to present study.

Author	No. Of specimen studied	Mean SI diameter (mm)	Mean AP diameter (mm)	Mean GI (%)
Akhtar MJ et al ¹³	Right -126 Left-102	36.03 ± 3.15 35.52 ± 3.12	23.67 ± 2.53 23.59 ± 2.47	66.73 ± 7.47 66.13 ± 8.67
Archna Singh et al ¹⁴	Right-56 Left-44	34.84 ± 3.46 33.48 ± 2.88	24.25 ± 2.55 25.52 ± 2.78	69.87 ± 1.54 70.44 ± 7.59
Gamal Hamed El-Sayed Hassanein ¹⁵	Right-38 Left-30	33.1 ± 0.39 28.7 ± 0.41	24.4 ± 0.44 22.1 ± 0.44	73.67 ± 9.08 76.71 ± 8.37
Azhagiri, et al ¹⁶	Right-52 Left-48	35.17 ± 2.625 34.73 ± 2.421	24.12 ± 1.997 23.73 ± 1.647
Mamatha T,et al ¹⁷	Right-98 Left-104	33.67 ± 2.82 33.92 ± 2.87	23.35 ± 2.04 23.05 ± 2.30

Divya et al¹⁸	Right-74	34.81±2.46	24.07±2.58
	Left-62	33.37±2.96	22.75±2.45	
Wael Amin Nasr El-Din et al¹⁹	Right-80	38.88 ± 2.63	21.33 ± 2.49
	Left-80	39.01 ± 2.49	21.69 ± 2.06	
Gursharan Singh Dhindsa²⁰	Right-41	34.13 ± 3.16	24.05 ± 2.86	70.37 ± 4.08
	Left-39	34.11 ± 2.57	23.36 ± 2.22	68.59 ± 4.36
Present study	Right-31	31.15 ± 2.77	21.63 ± 2.39	69.42 ± 4.55
	Left-29	31.62 ± 2.20	22.13 ± 2.05	69.98 ± 4.26

Conclusion

For better understanding of the shoulder pathology and in designing and fitting of glenoid components for total shoulder arthroplasty it is important to know variation in the shape and dimensions of the glenoid cavity. 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.

In the present study most common shape of glenoid cavity observed was pear shaped which followed by inverted comma shaped and oval shape which is similar to more than fifty percent of compared studies. Mean values of measured parameters shows, SI diameter 31.38 ± 2.50 mm, AP- diameter 21.87 ± 2.23 mm and glenoid cavity index $69.69\% \pm 4.39$ in total scapulae. No significant differences was observed in measurement of right and left scapula. 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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