Research Article

A morphometric study of glenoid cavity of adult human scapula

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Abstract

Aim of Study: The Glenoid cavity regarded as the head of the scapula has important clinical implications in the prognosis and treatment of various orthopedic pathologies like primary gleno-humeral osteoarthritis, gleno-humeral instability and the like. Similarly dimensions of the glenoid cavityare important in designing and fitting of glenoid components for total shoulder arthroplasty. Thus thorough understanding of the variations in its normal anatomy is essential for accurate diagnosis and treatment. **Methods:** The study was conducted in the Department of Anatomy, GMC, Aurangabad, Maharashtra, on 100 dry, unpaired adult human scapulae of unknown sexes, free from any pathology. Damaged scapulae were excluded from this study. Three glenoiddiameters superior-inferior, anterior-posterior diameter of the lower half and anterior-posterior diameter of the upper half of the glenoid were measured. Similarly variations in the shape of the glenoid cavity were noted and classified into three different types. **Results:** The study showed the glenoid cavity to be pear shaped most commonly. The measurements of the glenoid obtained using digital vernier calipers were found to be more on right side as compare to left. The average superior-inferior diameter on right and the left sides were 35.22±3.26mm and 34.53±3.21mm respectively. The average anterior-posterior diameter of the lower half of the right glenoid was 23.95±2.78mm and that of the left was 23.64±2.37mm. The mean diameter of the upper half of the right glenoid was 16.16±2.38mm and that of the left was 15.34±2.17mm. **Conclusion:** The average supero-inferior glenoid diameter in our study was 34-35 mm., however these anatomical specimens were non-arthritic which mean that the average supero-inferior glenoid diameter in an arthritic glenoid would be lesser due to bone loss. Moreover, the diameter would further decrease following reaming of the glenoid. The standard available smallest glenoid component in the market is 40mm which may not fit the glenoid in our study population. This fact may be taken into consideration while designing glenoid prostheses for the Indian population. Further, in this study glenoid cavities having the glenoid notch were recorded in higher percentage. This fact could be useful while evaluating lesions/defects of the glenoid cavity.
Keywords: Scapula; Glenoid cavity; Total shoulder arthoplasty; Glenoid notch.

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INTRODUCTION

Scapula is a large, flat, triangular bone which lies on the posterolateral aspect of the chest wall. The lateral angle of it is truncated and bears the glenoid cavity for articulation with the head of the humerus. This part of the bone may be regarded as the head[1]. The morphology of the glenoid cavity is highly variable, described as pear shaped, inverted-comma shaped or oval shaped in the coronal plane depending on the presence or absence of a notch on the anterior glenoid rim. It has been found that if the notch is distinct, then the glenoid labrum is not fixed to the bony margin of the notch but bridges the notch itself. This could make the shoulder joint vulnerable to dislocation[2,3,4]. The glenoid inclination is associated with full thickness rotator cuff tears, as reported by various studies[5]. Glenoid morphology has important implications in the prognosis and treatment of various orthopedic pathologies like primary gleno-humeral osteoarthritis[6],

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gleno-humeral instability and the like. Similarly dimensions of the glenoid cavity are important in designing and fitting of glenoidal components for total shoulder arthroplasty. Thus thorough understanding of the variations in the normal anatomy of glenoid cavity is essential in management of shoulder joint pathologies.

MATERIALS AND METHODS

The study was performed at the Department of Anatomy, GMC, Aurangabad, Maharashtra, a total of dry 100 unpaired scapula bones were randomly selected at the anatomy bone bank of our department. Of the 100 scapulae, 50 were from the right side, and 50 were from the left. The scapulae included in this study were completely ossified belonged to adult human, but the exact age and gender of the bones was not known. The bones were isolated and inspected macroscopically. Scapulae with damaged/deformed glenoid cavity were excluded from this study. Measurements were taken in millimeters using sliding digital varniercalliper. The mean and standard deviation of the glenoid cavity in various dimensions were calculated. The data were analyzed using the SPSS Software. The morphometric values of the two sides were analyzed using an unpaired t-test. Following parameters of glenoid cavities were measured.

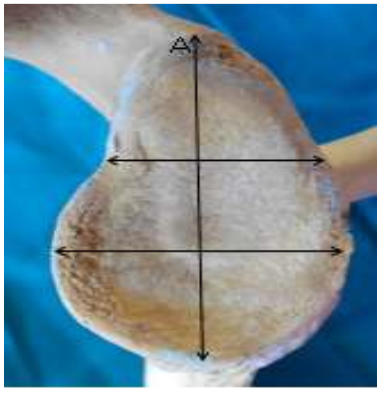

Figure 1: Showing various diameters of the glenoid cavity. A-B: Superior-Inferior diameter (SI), C-D: Anterior-Posterior diameter 1 (AP-1), E-F: Anterior-Posterior diameter 2 (AP-2)

Superior-Inferior glenoid diameter (SI) A-B

It is the maximum distance from inferior point on the glenoid margin to the most prominent point of supraglenoid tubercle, which is also the maximum height of glenoid cavity.

Anterior-Posterior glenoid diameter-1 (AP-1) C-D

Represents the maximum breadth of articular margin of the glenoid cavity perpendicular to glenoid cavity height

Anterior-Posterior glenoid diameter-2 (AP-2) E-F

It is the anterior-posterior diameter (breadth) of the top half of the glenoid cavity at the mid-point between the superior rim and the mid equator.

Figure 2: Photograph showing method of measuring superior-inferior diameter of glenoid cavity

Shape of the glenoid cavity

"Shape made by the slightly raised rim of the glenoid cavity". Variations in the shape of the glenoid cavity were noted and classified into three different types, such as, inverted comma, pear and oval. Shapes were confirmed in the following way. A piece of white sheet was placed on the glenoid cavity and held firmly in position to trace the shape of the glenoid cavity on paper. The side of the point of a lead pencil was rubbed along the rim of the glenoid cavity to get a tracing of the shape of the glenoid cavity on the paper.

Figure 3: Photograph showing various shapes of the glenoid cavity

RESULTS

In the present study, the mean value of Superior-Inferior diameter of the glenoid cavity on the right side was 35.22±3.26 mm with a range of 27.38-40.35mm. On the left side the mean Superior-Inferior diameter was 34.53±3.21mm with the range of 27.22-39.97mm. The mean Anterior-Posterior glenoid diameter-1 (AP-1) was 23.95±2.78 mm on right side and 23.64±2.37mm on left side with the range of 17.4-28.93 mm and 18.05-27.32 mm respectively. The mean Anterior-Posterior glenoid diameter-2 (AP-2) was 16.16±2.38 mm on right side and 15.34±2.17 mm on left side while the range on right side was 11.4-21.76 mm and on left was 11.31-19.76 mm. (Table 1)

Table 1: Measurements of various diameters of right and left glenoid

Parameters	Range		Mean		Standard Deviation		Statistical Significance		P Value
	Right	Left	Right	Left	Right	Left	Right	Left	
SI diameter	27.38-40.35	27.22-39.97	35.22	34.53	3.26	3.21	No	No	0.293
AP-1 diameter	17.4-28.93	18.05-27.32	23.95	23.64	2.78	2.37	No	No	0.547
AP-2 diameter	11.4-21.76	11.31-19.76	16.16	15.34	2.38	2.17	No	No	0.077

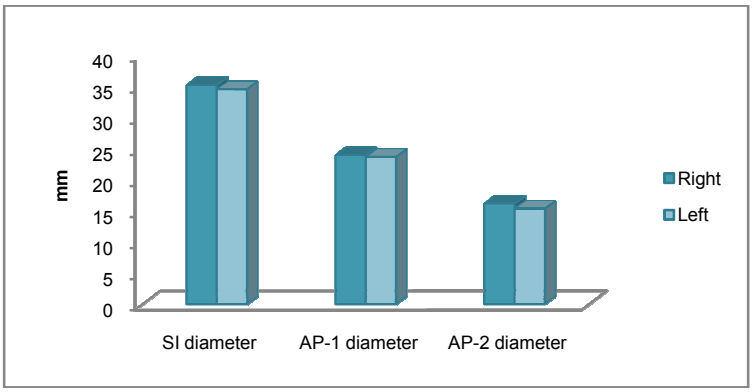

Figure 1: Mean diameters of the glenoid cavity. A-B: Superior-Inferior diameter (SI), C-D: Anterior-Posterior diameter 1 (AP-1), E-F: Anterior-Posterior diameter 2 (AP-2) (mm)

Table 2: Various shape of right and left glenoid

Shape of glenoid	Incidence of shape	
	Right	Left
Inverted comma (Distinct notch)	24%	20%
Pear (Indistinct notch)	56%	64%
Oval	20%	16%

On the right side total 50 glenoid cavities were examined out of which 12 were found to have inverted comma shape the incidence of this shape was found to be 24%. The number of glenoid cavities having pear shape on the right side was 28 and the incidence was found to be 56%. Oval glenoid cavities were 10 in number on the right side and the incidence was 20%. On the left side, glenoid cavities with the inverted comma shape were observed to be 10 in number out of the total 50 scapulae examined. The incidence of inverted comma shaped glenoid was 20%. The pear shape glenoid cavities were observed to be 32 similarly 8 were oval on the left side. Incidence of pear shaped glenoid was 64% and that of oval glenoid cavities was 16% respectively.
(Refer Table 2 and Figure 3).

DISCUSSION

Many studies have attempted to determine the glenoid diameters in a variety of ways, including direct measurement of dry scapulae, direct measurement of fresh or embalmed cadavers, radiographic measurement of scapulae harvested from cadavers and radiographic measurement in living patients. The present study was done on dry human scapulae obtain from cadavers. The results of present study were compared with those of previous workers. In the present study the mean superior-inferior diameter of the right glenoid was 35.22±3.26 mm and the mean superior- inferior diameter of the left glenoid was 34.53±3.21mm. Though the left glenoid value was slightly more and was statistically not

significant. The mean values of present study were compared to the values recorded in other studies (refer Table 3). Mallon *et al* (1992)[7] studied 28 glenoid cavities they found mean SI to be 35 ± 4.1mm. Similarly, Karelse *et al* (2007)[10] found mean SI to be 35.9 ± 3.6mm. Both these values were nearly same as that of present study. Iannotti *et al*. (1992)[8] and Von Schroeder *et al*. (2001)[9] reported the superior-inferior diameter of the glenoid to be 39 ± 3.5mm and 36 ± 4mm respectively which were more than the present study. Mamtha *et al*(2011)[11] in their study performed on 98 right and 104 left sided scapulae found that mean SI diameter on right and left side were 33.67 ± 2.82mm and 33.92 ± 2.87mm respectively which were comparatively lower than present study. (Refer Table 3)

Table 3: Comparison of Superior-Inferior diameter by various studies

Observers	No of specimens	Mean SI diameter
Mallon *et al* (1992)[7]	28	35 ± 4.1mm
Iannotti *et al* (1992)[8]	140	39 ± 3.5mm
Von Schroeder *et al* (2001)[9]	30	36 ± 4mm
Karelse *et al* (2007)[10]	40	35.9 ± 3.6mm
Mamtha *et al*(2011)[11]	Right-98	33.67 ± 2.82mm
	Left-104	33.92 ± 2.87mm
Present Study(2013)	Right-50	35.22 ± 3.26mm
	Left-50	34.53 ± 3.21mm

In present study the mean anterior-posterior diameter (AP-1) of the lower half of the glenoid of the right side was 23.95 ± 2.78mm and that of the left side was 23.64 ± 2.37mm. The right glenoid was broader than the left glenoid. This was very close to what was observed in the study of Mamtha *et al*(2011)[11] in which the workers found that the mean AP-1 diameters on right and left sides were 23.35 ± 2.04mm and23.02 ± 2.30mm respectively. Studies carried out by Iannotti *et al* (1992)[8] on 140 scapulae, Von Schroeder *et al*(2001)[9] on 30 scapulae and Karelse *et al* (2007) [10] on 40 scapulae found AP-1 diameter to be 29 ± 3.2mm, 28.6 ± 3.3mm and 27.2 ± 3.mm. All these three values were higher than our combined mean of both right and left sides which was 23.79 ± 2.57mm. However Ozer *et al* (2006)[12] conducted study on 94 male and 104 female scapulae. They found that the mean AP-1 in male was 27.33 ± 2.4mm which was higher than present study but in female the mean AP-1 was 22.72 ± 1.72mm which was lower than our study. (Refer Table. 4)

Table 4: Comparison of the anterior-posterior (AP-1) diameter by various studies

Observations	No of specimens	Mean AP-1 diameter
Mallon *et al* (1992)[7]	28	24 ± 3.3mm
Iannotti *et al* (1992)[8]	140	29 ± 3.2mm
Von Schroeder *et al*(2001)[9]	30	28.6 ± 3.3mm
Ozer *et al* (2006)[12]	Male -94	27.33 ± 2.4mm
	Female -92	22.72 ± 1.72mm
Karelse *et al* (2007)[10]	40	27.2 ± 3.mm
Mamtha *et al*(2011)[11]	Right-98	23.35 ± 2.04mm
	Left-104	23.02 ± 2.30mm
Present study(2013)	Right-50	23.95 ± 2.78mm
	Left-50	23.64 ± 2.37mm

The mean anterior-posterior diameter (AP-2) of the upper half of the right glenoid was 16.16 ± 2.38mm and that of the left glenoid was 15.34 ± 2.17mm in the current study. The right glenoid cavity was slightly broader than the left glenoid cavity. The combined mean on both sides was 15.75 ± 2.27mm. This was much lower than what was observed by Iannotti *et al* (1992)[8], they found it to be 23 ± 2.7mm. Study conducted by Mamtha *et al*(2011)[11] found that mean AP-2 of the right glenoid was 16.27 ± 2.01mm and that of the left glenoid was 15.77 ± 1.96mm, these values were similar to the present study. Various types of glenoid cavity depending on their shape were observed in the present study. The percentage of occurrence of various shapes of the glenoid cavity was noted. It was found that on the right side 24 % of the glenoid cavities had a distinct notch and were inverted comma-shaped, while on the left side inverted comma shape was of 20 %. 56 % glenoid cavities on the right side were pear-shaped with an indistinct notch and 64 % on the left side were pear-shaped. On the right side 20% were oval and on the left side 16 % were oval without any recognizable notch. On comparing between right and left it was found that more glenoid cavities on the left showed notch and were pear in shape. In present study it was also noted that on right side 80% glenoid cavities were with notch (both distinct andindistinct) and 20% were without notch. Similarly on left side 84% glenoid cavities have notch and 16 have no notch. On comparing present study with that of previous studies it was found that our study was nearly similar to the study of Mamtha *et al*. (2011)[11] in which they found on right side 80% glenoid cavities were notched and 20% were without notch. Similarly on left side 76% were with notch and 24% were without notch. Prescher and Klumpen(1997)[2] found that incidence of glenoid cavities with notch was 55% and without notch was 45%.

Table 5: Comparison of the shape of the glenoid cavity by various studies

Observers	Notched (both distinctandindistinct)	No notch
Prescher *et al*(1997) [2]	55%	45%
Mamtha *et al* (2011)[11]	Right-80% Left-76%	Right-20% Left -24%
Present study(2013)	Right-80% Left-84	Right-20% Left -16%

CONCLUSION

The average supero-inferior glenoid diameter in our study was 34-35mm, however these anatomical specimens were non-arthritic which mean that the average supero-inferior glenoid diameter in an arthritic glenoid would be lesser due to bone loss. Moreover, the diameter would further decrease following reaming of the glenoid. The standard available smallest glenoid component in the market is 40mm which may not fit the glenoid in our study population. This fact may be taken into consideration while designing glenoid prostheses for the Indian population. Further, in this study glenoid cavities having the glenoid notch were recorded in higher percentage. This fact could be useful while evaluating lesions/defects of the glenoid cavity.

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