Morphometric study of glenoid cavity of scapulae in north Indian population with clinical significance

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Abstract
Introduction: Shoulder arthroplasty offers pain relief and improvement in patients of shoulder arthritis. It need proper fixation of glenoid cavity to prevent loosening, a common cause for surgery. As glenoid cavity is small, it permits only a tight spot for limited fixation devices. So, knowledge of the morphological data of various parameters of glenoid cavity is of utter importance.
Materials and Methods: An observational cross-Sectional study was done on 66 unpaired human scapulae. They belong to adult population of North India and of unknown sex. Superior-inferior diameter and Anterior-posterior diameter of maximum distance at the glenoid cavity were measured and based on these measurements index of glenoid cavity calculated.
Result and Discussion: The shape of the glenoid cavity was classified on basis of the presence or absence of a notch on the glenoid rim as pear shaped, inverted comma shaped and oval shaped. All the parameters exhibit a greater value for the right side. The ethnic and racial variations could be the explanation for difference seen between the values of present study and that of other workers. The above mentioned parameters may be taken into consideration while doing shoulder arthroplasty and designing glenoid prostheses for North Indian population.
Conclusion: Extensive and detail knowledge of various data of the glenoid cavity measurements is important for the anatomists, orthopaedicians, prosthetists, and anthropologists.

Keywords: Glenoid cavity, Glenoid notch, Shape of Glenoid cavity, Glenoid prostheses, Shoulder arthroplasty.

Introduction
The scapula is a flat, large, triangular bone, which lies on the chest wall at the posterolateral aspect, extending from second to seventh ribs. The glenoid cavity which articulates with the head of the humerus at the shoulder joint (glenohumeral joint) presented at lateral angle of scapula as truncated and broad and may be considered as the head of the scapula.[1] The glenoid cavity is highly variable morphologically. A notch is presents on the glenoid rim in its upper and front part.[2] This glenoid notch on glenoid rim give various shapes to glenoid cavity like pear-shaped, oval or inverted comma shaped.[3,4]

The small, shallow glenoid cavity and the disproportionate sizes of the head of the humerus united with a lax articular capsule give this joint a wide range of movements but at the cost of its stability.[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 glenohumeral 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.[8] 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 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. Despite of this knowledge not much work has been done in North Indian population. Therefore, the present study was carried out which provides important parameters which would help for better understanding and management of shoulder pathology to the anatomists, anthropologists, orthopaedicians and prosthetists.

Materials and Methods
An observational cross-Sectional study was conducted in the department of Anatomy, Rama Medical College, Hapur during September 2014-April 2015. A total of 66 dry unpaired scapula bones were studied. Of the 66 scapulae, 30 were from the right side and 36 were from the left side. The bones belonged to adult specimens but the exact gender and ages of the specimens were not known. Dry, complete and with normal anatomical features scapulae selected for study. Specimens with osteoarthritic changes, showing any previous trauma sign or skeletal disorders were rule out for the study.

All the measurements were taken with the help of a digital Vernier caliper. Three readings were taken for each parameter at different times and the average was recorded. T-test calculation was also done to establish the significance of the study. The data were analyzed using the Statistical Package for the Social Sciences (SPSS). Comparison of all values was tabulated with series of other workers to draw the correlation and conclusions.

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. 1).

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. 2).

Glenoid Cavity Index (GCI)
It was calculated from the observed values of Anterior-Posterior Glenoid Diameter (AP) and Superior- Inferior Glenoid Diameter (SI) of the glenoid cavity. The formula for calculating the GCI is AP/ SI x 100.

Shape of the Glenoid Cavity
It was recorded whether the shape was inverted comma shaped, oval or pear shaped. (Fig. 3-5)

Results and Discussion

The measurements of the glenoid cavity were taken in 66 scapulae shown in Table 1. The shape of the glenoid cavity was observed as shown in table 2. (Fig. 4,5)

After taking the measurements of the glenoid cavity, the observations of the present study tabulated were compared with the results of the other authors. (Table 1-3). In the present study the average superior-inferior (SI) diameter of the right glenoid was 33.71 ± 3.26 mm and the average superior- inferior diameter of the left glenoid was 33.33 ± 2.77 mm. Though the right glenoid value was slightly more than the left, it was not statistically significant. 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 24.19 ± 2.56 mm while that of the left glenoid was 23.11 ± 2.31 mm. The left glenoid cavity was found to be narrower than the right side. The combined average of both sides came out to be 23.70 ± 2.54 mm. The combined mean of the Glenoid Cavity Index (GCI) in the present study came out to be 70.55 ± 4.22. Polguj et al.[9] noted the combined GCI to be 72.35 ± 5.55, which was higher than that recorded by us.

Various shapes of glenoid cavity were noted and recorded in present study along with their percentages of incidence depending upon the presence or absence of a notch on the glenoid rim. 66.6% of the right and 38.8% of left glenoids were inverted comma shaped, 20% on the right side and 44.4% on the left side were pear shaped and, 13.3% on the right side and 16.7% 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 Klumpen[4] noted that 55% of the scapulae had a notch and in 45% the notch was absent. Coskun et al.[10] 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.

Glenohumeral instability in young individuals and athletes and rotator cuff pathology in the elderly was 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.[4] This can be a predisposing factor in anterior dislocation of shoulder joint. The ethnic and racial variations could be possible explanation for difference seen between the values of present study and that of other workers. Thus knowledge of the variation in the shape and dimensions of the glenoid is important in better understanding of the shoulder pathology and in designing and fitting of glenoid components for total shoulder arthroplasty. The morphometric analysis of the glenoid cavity may not only help the prosthetists and orthopaedicians but also helpful in studying about the evolution of the bipedal gait by the anthropologists.

Fig. 1: Measurement of the Superior- Inferior (SI) Glenoid Diameter

Fig. 2: Measurement of the Anterior-Posterior (AP) Glenoid Diameter

Fig. 4: Oval shaped

Fig. 3: Pear shaped/Tear drop shaped

Fig. 5: Inverted comma shaped

Table 1: Comparison of measurements of right and left glenoid cavity

S. No.	Parameter	Mean ± SD		P value
		Right	Left	
1	SI diameter	33.71 ± 3.26	33.33 ± 2.77	0.889
2	AP diameter	24.19 ± 2.56	23.11 ± 2.31	0.679
3	GC index	71.76 ± 4.08	69.34 ± 4.36	0.058

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

S. No.	Shape of Glenoid Cavity	Incidence of Shape	
		Right N (%)	Left N (%)
1	Inverted Comma	20 (66.6)	14 (38.8)
2	Oval	4 (13.3)	6 (16. 7)
3	Pear	6 (20.0)	16 (44.4)

Table 3: Comparison of SI and AP diameters of Glenoid Cavity

S. No.	Authors	Year	No. of Specimen	Mean (mm)	
				SI Diameter	AP Diameter
1	Von Schroeder et al.[11]	2001	30	36 ± 4	29 ± 3
2	Frutos LR[12]	2002	Male-65	36.08 ± 2.0	26.31 ± 1.5
			Female-38	31.17 ± 1.7	22.31 ± 1.4
3	Taser and Basaloglu[13]	2003	Male-13	37.1 ± 3.4	26.6 ± 2.1
			Female-39	34.1 ± 2.9	25.0 ± 2.7
4	Ozer et al.[14]	2006	Male-94	38.71 ± 2.71	27.33 ± 2.4

			Female-92	33.79 ± 3.08	22.72 ± 1.72
5	Coskun et al.[10]	2006	90	36.3 ± 3	24.6 ± 2.5
6	Karelse et al.[15]	2007	40	35.9 ± 3.6	27.2 ± 3.0
7	Mamatha et al.[16]	2009	Right-98	33.67 ± 2.82	23.35 ± 2.04
			Left-104	33.92 ± 2.87	23.02 ± 2.30
8	Rajput et al.[17]	2012	Right-43	34.76 ± 3	23.31 ± 3.0
			Left-57	34.43 ± 3.21	22.92 ± 2.80
9	Kavita et al.[8]	2013	Right-67	35.2 ± 3.0	25.0 ± 2.7
			Left-62	34.7 ± 2.8	24.9 ± 2.4
10	**Present Study**		Right-30	33.71 ± 3.26	33.33 ± 2.77
			Left-36	24.19 ± 2.56	23.11 ± 2.31

Conclusion

Variations in the size and shape of the glenoid cavity which were observed in the present study, will be helpful for orthopaedic surgeons to decide proper size of the glenoid component for the shoulder arthroplasty and to understand the shoulder pathology better. As the present study was performed on a limited number of scapulae, further cadaveric, radiological and clinical studies are necessary.

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Conflicts of interest

No conflict of interest.

References

1. Johnson D, Pectoral Girdle. Shoulder region and Axilla, In Standring S., Borley N R, Collins P, Crossman A. R., Gatzoulis M A, Healy J C, et al, editors, Gray's Anatomy, The Anatomical Basis of Clinical Practice, 40th ed., Churchill Livingstone, 2013;p 791-822.
2. Breathnach A S. Frazer's Anatomy of the Human Skeleton, 6th ed., London, J and A Churchill Ltd., 1965;p 63-70.
3. Churchill R S, Brems J J, Kotschi H. Glenoid size, inclination and version: An anatomic study. *J Shoulder Elbow Surg* 2001;10(4):327–32.
4. Prescher A. and Klumpen T. The glenoid notch and its relation to the shape of the glenoid cavity of the scapula. *J Anat* 1997;190(3):457–60.
5. Romanes G J. Cunningham's Manual of Practical Anatomy, Volume **1**, Upper and Lower Limbs, 15th ed., Hong Kong, Oxford University Press, 1993;p63-66.
6. Brewer B J, Wubben R C, Carrera G F. Excessive retroversion of the glenoid cavity, A cause of non-traumatic posterior instability of the shoulder. *J Bone Joint Surg Am* 1986;68:724-31.
7. Ly J Q, Beall D P, Sanders T G. MR imaging of glenohumeral instability. *AJR Am J Roentgenol* 2003;181:203-13.
8. Kavita P., Singh J, Geeta. Morphology of Coracoid process and Glenoid cavity in adult human Scapulae. *Int J Analyt Pharma Biomed Sci* 2013;2(2):19-22.
9. Polguj M, Jedrzejewski K S, Podgorski M, Topol M. Correlation between morphometry of the suprascapular notch and anthropometric measurements of the scapula. *Folia Morphol* 2011;70(2):109–15.
10. Coskun N, Karaali K, Cevikol C, Demirel B M, Sindel M. Anatomical basics and variations of the scapula in Turkish adults. *Saudi Med J* 2006;27(9):1320-5.
11. Von Schroeder H P, Kuiper S D, Botte M J. Osseous anatomy of the scapula. *Clin Orthop Relat Res* 2001;383:131-9.
12. Frutos L. R. Determination of Sex from the clavicle and scapula in a Guatemalan contemporary rural indigenous population. *Am J Forensic Med Pathol* 2002;23:284-8.
13. Taser F, Basaloglu H. Morphometric Dimensions of the Scapula. *Ege J Med* 2003;42(2):73-80.
14. Ozer I, Katayama K., Sagir M, Gulec E. Sex determination using the scapula in medieval skeletons from East Anatolia. *Coll Antropol* 2006;30:415-9.
15. Karelse A, Kegels L, De Wilde L. The pillars of the scapula. *Clin Anat* 2007;20:392-9.
16. Mamatha T, Pai S R, Murlimanju B V, Kalthur S G, Pai M M, Kumar B. Morphometry of Glenoid Cavity. *Online J Health Allied Scs* 2011;10(3):1-4.
17. Rajput H B, Vyas K K, Shroff B D. A Study of Morphological Patterns of Glenoid Cavity of Scapula. *Natl J Med Res* 2012;2(4):504-7.