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Morphology and Morphometric Analysis of Glenoid Cavity of Scapula and Its Clinical Significance

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Abstract
Introduction*:A variable morphology is found in the glenoid cavityofscapula which is also regarded as the scapu lar head. The glenoid rim presents a notch in its antero-superior portion, due to which different types of glenoid cavity such as pear shaped, oval, or inverted comma are identified.*
To analyze the morphologic and morphometric characteristics of the Glenoid cavity of Scapula in 108 dry human Scapulae and to evaluate its clinical significance.
Methods*: The study was conducted on 108 dry adult human scapulae of unknown age and sex with a view to elucidate the morphological and Morphometric details. Various shapes and dimensions of the glenoid cavity were observed and compared with the previous studies.*
Results*: Oval shaped glenoid fossa was seen in 12.03% of right scapula (n=13) and 11.11% of left scapula (n=12), while pear-shaped glenoid fossa was seen in 32.40% of right scapula(n=35) and 32.40% of left scapula(n=35). Notch type glenoid fossa was observed in 5.55% of right Scapula (n=6) and 6.48% of left Scapula (n=7). The mean SI diameter of the glenoid cavity of Scapula in the present study was 38.44±2.53 mm on the right side and 36.61±2.92 mm on the left side. The mean AP diameter is 25.11±1.84 mm on the right side and 24.47±2.02 on the left side.*
Conclusion: *Morphometry and morphology of scapula at a geographical area gives a clear knowledge for making prosthesis in joint replacement surgeries.*
Keywords: Glenoid cavity, Scapula, Morphometry, Prosthesis

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I. Introduction

The paired bone of the shoulder girdle, the scapulae or the shoulder blade, is located in the postero-lateral aspect of the chest wall and extends from the second rib to the seventh rib[1]. Scapula possesses 3 processes and 3 angles, the acromion, coracoid and the spinous process; the medial, lateral and superior angles respectively. It also has medial, lateral and superior borders and 2 surfaces which are the anterior or costal surface and the posterior or dorsal surface[2]. The lateral angle is pruned and shows a cavity called the glenoid fossa[3]. The lateral angle is also the thickest part of the bone and bears the head of the Scapula. The glenoid fossa that serves as the socket for the head of the humerus is a shallow, concave fossa that is directed anterolaterally and superiorly[4]. Various studies report on the different forms of the glenoid cavity like oval, pear or inverted comma/ notch shaped based on the appearance or nonappearance of a notch at the anterior margin of the glenoid fossa. The notch is indistinct in the pear-shaped cavity, distinct in inverted comma-shaped or notched glenoid cavity and absent in oval-shaped cavity[5,6].

The inferior half of the articular surface of the glenoid cavity is 20% larger than its superior half[7]. This gives a vertical axis for the action of the head of the humerus, that slides into the smaller upper section of the glenoid fossa during the abduction. This part is again extended by the glenoid labrum, the attachment of which at the glenoid notch along with the varied shape and morphology of the glenoid cavity is essential for the normal functioning of this freely movable joint[8].

The variations in the morphology of glenoid fossa are influenced by genetic and environmental factors. The shoulder is the third most common joint that requires reconstruction following knee and hip[9]. Therefore, it is mandatory to understand its complex anatomy, which in turn facilitates prompt fabrication of Glenoid implants and screws. Thorough knowledge on the morphometry and morphology of the glenoid fossa is

essential in the understanding, investigation and management of demographic diseases pertaining to shoulder like glenohumeral arthritis, rotator cuff disorders, shoulder dislocations and fractures[10].

The objective to obtain anthropometric data of dry human scapulae and the diameters and shapes of the glenoid cavity in the south Indian population and evaluate their clinical significance.

II. Materials & Methods

A morphometric and morphological analysis of 108 adult dry and undamaged human scapulae (54-right side and 54 left sides) was conducted in the south indian population (coimbatore region of tamilnadu) to evaluate the parameters of the Glenoid fossa and its relevant clinical significance. The scapulae were selected from the Department of Anatomy, Government medical college and ESI Hospital, coimbatore, Tamilnadu. The morphological evaluation was done, and the linear measurements were taken using a Vernier Caliper and recorded in millimetre. The comparisons in the morphology of the right and left sides were made using unpaired T test. The age and sex of the Scapulae are unknown.

The following parameters were assessed in the study:

1. Various morphologies of the Glenoid Fossawere observed (Pear, Oval and Notch type)
2. Length- Supra inferior diameter as measured from supra-glenoid to infra-glenoid tubercle in millimetre.
3. Width- Widest Anteroposterior diameter in millimetre.

The mean, standard deviation and the P-value correlating the shape and morphometry were calculated separately for the right and the left glenoid cavity.

III. Results

In this study, 108 dry human scapula of unknown age and sex were studied, of which 54 were right Scapula and 54 were left Scapula. Oval shaped glenoid fossa was seen in 12.03% of right scapula (n=13) and 11.11% of left scapula (n=12), while pear-shaped glenoid fossa was seen in 32.40% of right scapula(n=35) and 32.40% of left scapula(n=35). Notch type glenoid fossa was observed in 5.55% of right Scapula (n=6) and 6.48% of left Scapula (n=7). The glenoid cavity can be classified into 3 categories, based on the presence of a notch along its anterior margin.

Type 1- Absence of a visible notch along the margins (Oval type)
Type 2- Presence of a deep notch in the anterior margin of the upper one third (inverted comma/notch type)

Type 3- A less evident notch in the anterior margin of the upper one third (pear-shaped)

The mean superoinferior and anteroposterior diameters of the right and left glenoid cavity can be seen in table-1. The mean morphometric values of the oval, notch and the pear-shaped glenoid cavity can be seen in tables-2 & 3. The mean comparisons of the SI and AP diameters of the individual glenoid cavity shapes are seen in Tables-4, 5 & 6. Majority of the glenoid cavity was pear-shaped, followed by oval and notched types.

Tab-1

Side		Mean	Std. Deviation	P-value
SI_Diameter	Right	38.44	2.53	0.001
	Left	36.61	2.92	
AP_Diameter	Right	25.11	1.84	0.089
	Left	24.47	2.02	

Tab.2 MORPHOMETRY OF RIGHT GLENOID CAVITY

Right Side		N	Mean	Std. Deviation	P-value
SI_Diameter	Oval	13	38.06	2.33	0.806
	Notch	6	38.81	1.45	
	Pear	35	38.52	2.77	

AP_Diameter	Oval	13	25.27	1.90	0.694
	Notch	6	24.51	1.62	
	Pear	35	25.16	1.88	

Tab.3 MORPHOMETRY OF LEFT GLENOID CAVITY

Left Side		N	Mean	Std. Deviation	P-value
SI_Diameter	Oval	12	36.49	2.35	0.618
	Notch	7	37.64	2.79	
	Pear	35	36.45	3.14	
AP_Diameter	Oval	12	24.99	1.90	0.598
	Notch	7	24.01	2.42	
	Pear	35	24.39	2.00	

Tab.4 MORPHOMETRIC COMPARISON OF RIGHT AND LEFT OVAL SHAPED GLENOID CAVITY

Side		N	Mean	Std. Deviation	P-value
SI_Diameter	Right	13	38.06	2.33	0.107
	Left	12	36.49	2.35	
AP_Diameter	Right	13	25.27	1.90	0.715
	Left	12	24.99	1.90	

Tab.5 MORPHOMETRIC COMPARISON OF RIGHT AND LEFT NOTCH SHAPED GLENOID CAVITY

Side		N	Mean	Std. Deviation	P-value
SI_Diameter	Right	6	38.81	1.45	0.379
	Left	7	37.64	2.79	
AP_Diameter	Right	6	24.51	1.62	0.675
	Left	7	24.01	2.42	

Tab.6 MORPHOMETRIC COMPARISON OF RIGHT AND LEFT PEAR SHAPED GLENOID CAVITY

Side		N	Mean	Std. Deviation	P-value
SI_Diameter	Right	35	38.52	2.77	0.005
	Left	35	36.45	3.14	
AP_Diameter	Right	35	25.16	1.88	0.103
	Left	35	24.39	2.00	

IV. Discussion

The findings of the study indicate that the most frequently occurring glenoid type is pear-shaped, followed by oval and notched types. The findings by many other authors are also similar to the results of this study. Rajput HB et al., Akhtar MJ et al., Mamatha T et al., and D Santoshkumar A et al., noted pear-shaped glenoid cavity as a prevalent aspect in their study observed by notch type and oval shape in Indian population [11,12,13]. A study in Indian scapulae by Sinha P et. Al also summarised pear shape as a prevalent shape followed by oval shape[14]. Prescher A et al. studied German scapulae and also observed a similar result [15]. The

mean SI diameter of the glenoid cavity of Scapula in the present study was 38.44±2.53 mm on the right side and 36.61±2.92 mm on the left side. The mean AP diameter is 25.11±1.84 mm on the right side and 24.47±2.02 on the left side. These values of SI diameter are almost similar to the study results of Akhtar MJ et al., D Santhoshkumar A et al., and Mahto AK et al. **[16,17,18]**.

A definite comprehension of the normal and variational anatomy of the Scapula is important, to avoid complications when open, arthroscopic, or arthroscopically assisted procedures are done. This helps in obtaining an absolute congruency of the glenohumeral joint after total shoulder arthroplasty**[19,20]**. Poppen and Walker mentioned in their study that when the arm is elevated, the head of the humerus slides upward and when the arm is lowered, the humeral head is received by the lower part of glenoid. Poppen correlated the morphology of the glenoid cavity with its purpose and this explains well the method of abduction. This finding suggests that when the arm is elevated, the small upper portion of the glenoid cavity is suitable for the humeral head so that the range of movement is confined to the side of the trunk and eventually when the arm is lowered, the broad lower part of the glenoid cavity is suitable for the humeral head so that it is easily rotated in the front of the trunk **[21,22]**.

The average length of the glenoid cavity was estimated by Luis RF as 31,17 mm, while we measured th is as 38.44 mm in the present analysis. The proportions of the glenoid cavity in various parts of the world are sli ghtly different, as seen in Table 7. During complete shoulder arthroplasty, the SI width of the glenoid cavity will be properly calibrated to the size of the prosthesis in order to maintain maximum concordance[23,24,25].

Table 7

S.no	Authors	Year	No. of Scapula	Supero-inferior diameter(mm)
1.	Iannotti et al	1992	140	39 ± 3.5
2.	Churchill et al	2001	Male-200 Female-144	37.5 ± 2.2 32.6 ± 1.8
3.	Luis Rios Frutos	2002	Male-65 Female-38	36.08 ± 2.0 31.17± 1.7
4.	Mamatha et al	2009	Right-98 Left- 104	33.67 ±2.82 33.92 ± 2.87
5.	Present study	2020	Right-54 Left-54	38.44±2.53 36.61±2.92

Glenohumeral dysfunction in young people and athletes are the prevalent causes of shoulder pain, inclu ding rotator cuff disease in the elderly.When the glenoid notch is distinct, the glenoid labrum is not attached to t he rim of the glenoid at the site of the notch. This can is a prognostic marker in the anterior shoulder joint disloc ation[26]. There can be differences in nationality and race. Accordingly, correct knowledge of the variations in gl enoid morphology and morphometry is critical for a better understanding of shoulder pathology and also for the design and fitting of glenoid components for shoulder arthroplasty. The above details on glenoid cavity structure and proportions that support orthopedics and prosthetists, and may also be of interest to anthropologists in studi es related to the evolution of the bipedal gait.

The limitations of the study are that the present study had a smaller sample size and was not of the same skeleton. Further, clear seperation of sex and age cannot be made.

V. Conclusion

The glenoid fossa is largely pear-shaped because the upper transverse diameter is less than the lower transverse diameter. Morphological and morphometric observations of the glenoid cavity are important in glenoid fossa prosthesis design and demography of other shoulder diseases. Morphology and morphometry of the glenoid fossa of Scapula might show variations among different population groups for which further studies are needed. These observations are of prime importance in shoulder implant manufacturing and surgical interventions at the shoulder joint.

The diameters and morphology addressed in the present study helps to determine the size of the variable glenoid cavity in particular geographical area, used in shoulder arthroplasty.

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