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Original Article

# The Glenoid Cavity: its morphology and clinical significance.

**Gandhi Kusum Rajendra, Siddiqui Abu Ubbaida, Verma Virendra Kumar**

*MD, Department of Anatomy, Rural Medical College, PIMS, Loni, Maharashtra*
*MD, Department of Anatomy, AIMS Raipur, Chhattishgarh.*
*MS, Dept of Orthopedics, PCMSRC, Bhopal, MP.*

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**ABSTRACT**

Title: The Glenoid Cavity: its morphology and clinical significance. Introduction: Size and shape of the glenoid cavity (GC) is directly related to the dislocation of shoulder joint and may affect the results of total shoulder arthroplasty and rotator cuff surgeries. Hence, we planned this study to note the percentage of normal and variable morphology of the glenoid cavity and discuss its clinical correlation in detail. On reviewing the literature, we came across that though the anatomy of glenoid cavity is described by previous authors but there is lack of correlation between morphometry of glenoid cavity and dislocation at shoulder joint. Methods: A total of 123 dry human scapulae were included in the study. The maximum length and width of the scapula were taken. Shape of the glenoid cavity was observed. Three measurements were defined and collected for every GC: maximal length, maximum width and transverse diameter at the level of glenoid notch. Results: Of the 123 scapula included, 64 belonged to right and 59 to left side. The maximum length and width of the GC was 38.78 ± 4.43 and 26.97± 3.79 cm respectively. The width of the GC at the level of glenoid notch was 20.2± 3.80 cm. The maximum length and width of the scapula was 136.43±13.31 and 99.14± 8.21 cm respectively. Conclusion: These exact measurements of the glenoid cavity will guide the surgeon in selection of appropriate prosthesis during shoulder arthroplasty in order to gain full congruency at shoulder joint.



## INTRODUCTION

Lateral border of the scapula terminates superiorly at glenoid cavity (GC) which articulates with the head of the humerus to form gleno-humeral joint1. The articular surface of GC is pear shaped, with its inferior half being 20% larger than the superior half2. The GC provides a vertical axis for the movement of the head of humerus during abduction and when the arm is raised to the shoulder height, the head slides into the smaller upper part of glenoid cavity which is deepened by glenoid labrum3. The variations in the shape and size of GC and attachment of glenoid labrum at the glenoid notch are important for normal functioning of this most freely movable joint of the human body. Many a times the glenoid labrum is not firmly attached to the margins of GC particularly when it is comma shaped. This arrangement simulates a labral tear, sublabrum foramen or Buford complex during arthroscopy. Sublabral foramen occurs when the antero-superior labrum is congenitally unattached to the adjacent glenoid and is present in almost 12% of individuals. The Buford complex consists of an absent anterosuperior labrum and a thick cord like middle glenohumeral ligament which originates from the superior labrum near the attachment of the long head of biceps tendon. It is present in about 1.5% of individuals4.

The knowledge of exact dimensions of the scapula and GC are of fundamental importance in understanding the recurrent shoulder dislocation and pathomechanics of rotator cuff disease1, 3. The parameters of GC are of great importance while planning for prosthetic sizing, positioning and design for total shoulder arthroplasty. Unfortunately, these procedures are not free from complications and the presence of anatomical variations such as bony defects of anterior or posterior rim of glenoid fossa has been reported to increase the risk of failure to achieve full congruency at this joint1, 2, 5-8. The purpose of this study is to investigate various morphologic features of scapula and glenoid cavity in dry scapula.

* Corresponding Author : **Dr. Kusum Rajendra Gandhi**
Assistant Professor, Department of Anatomy,
Rural Medical College, PIMS, Loni, Maharashtra, India.
Phone number- 09689484225
E mail- gandhikusum.r@gmail.com

## Methods

Data was collected from 123 (64 right and 59 left) dry, unpaired scapula. The age and sex of the scapula were unknown. The scapula maintaining their normal anatomical features were included in the study. The specimens which were partially broken or had any deformity were excluded from the study.

The measurements of the scapula and the articular face of glenoid cavity were taken with the help of sliding vernier calliper with an accuracy of 1 mm, by keeping it directly on the bony surface. The measurements were taken thrice and the mean was taken in order to prevent any observational error.

Measurements of the scapula

The anatomical length of the scapula (i.e. the distance between the highest point of the superior angle and the lowest point of the inferior angle) and the anatomical width (distance from the centre of glenoid cavity to the midpoint between two lips of the spine of scapula) were determined (fig 1).

Measurements of the Glenoid Cavity

a. The shape of the glenoid cavity was observed by lining the outer raised margin of GC (fig 2 a, b, c, d).

b. Length (superior-inferior diameter) was taken from most prominent point on the supraglenoid tubercle to the inferior margin of GC (fig 3 L1).

c. Width (antero-posterior diameter) was measured at two level (fig 3);

i. the maximum width of GC (fig 3 W1)

ii. the width at the level of glenoid notch (fig 3 W2)

The mean and standard deviation of various dimensions were calculated.

## Results

The maximum length varied from 107-164 cm and width of the scapula range from 78-117 cm (figure 1). The length (L1), maximum width (W1) and width at the level of notch (W2) of glenoid cavity are shown in figure 3 and described in Table 1 and 2.

The shape of the GC was found as inverted comma, pear, triangular and oval. The most common shape observed was of pear shaped GC in 69 (56.09%) of 123 scapula. 43 (34.95%) were of inverted comma shape, 9 (7.31%) of oval shape and 2 (1.62%) were triangular. We did not found any case belonging to classification type 5 in our specimens.

We propose that the shape of glenoid cavity can be classified into five categories depending upon presence of notch along its margins (fig 2; a, b, c, d) .

Type 1: the anterior margin shows a well defined deep notch in its upper one third (inverted comma shaped).

Type 2: the anterior margin shows a less evident notch in its upper one third (pear shaped).

Type 3: both, the anterior and posterior margins of glenoid cavity are indented with evident notches.

Type 4: notch is absent along the margins of glenoid cavity.

Type 5: a variation from the above mentioned morphology of glenoid cavity.

**Table1: Various morphometrical measurements of Glenoid cavity (Fig 3)**

| Various parameters of glenoid cavity | Range (cm) | Right (n=64) Average with SD (cm) | Left (n=59) Average with SD (cm) |
|---|---|---|---|
| Max Length (L1) | 28-53 | 38.78 ± 4.43 | 40.30 ± 5.12 |
| Max Width (W1) | 17-37 | 26.47 ± 3.79 | 27.85 ± 3.86 |
| Width at the level of Glenoid Notch (W2) | 14-23 | 20.28 ± 3.80 | 21.28 ± 4.33 |

**Table 2: Measurements of Scapula (Fig 1)**

| Measurements of Scapula | Range (cm) | Right (n=64) (cm) | Left (n-=59) (cm) |
|---|---|---|---|
| Length of Scapula | 107-164 | 136.43 ± 13.31 | 140.27 ± 13.20 |
| Width of Scapula | 78-117 | 99.14 ± 8.27 | 102.13 ± 9.99 |

**Table 3: Comparision of the length (supero-inferior diameter) of glenoid cavity by various authors.**

| Authors | Year | No. of Scapula | Supero-inferior diameter(mm) |
|---|---|---|---|
| Iannotti et al | 1992 | 140 | 39 ± 3.5 |
| Churchill et al | 2001 | Male-200<br>Female-144 | 37.5 ± 2.2<br>32.6 ± 1.8 |
| Luis Rios Frutos | 2002 | Male-65<br>Female-38 | 36.08 ± 2.0<br>31.17± 1.7 |
| Mamatha et al | 2009 | Right-98<br>Left- 104 | 33.67 ±2.82<br>33.92 ± 2.87 |
| Present study | 2013 | Right-64<br>Left-59 | 38.78 ±4.43<br>40.30 ± 5.12 |

**Table 4: Percentage of distinct notch at Glenoid Cavity: comparison between different countries.**

| Authors | Country | Specimens Studied | Distinct notch present | No notch observed |
|---|---|---|---|---|
| Prescher A. And Klumpen T. | Germany | 236 | 129 (55%) | 107 (45%) |
| Mamatha et al | India | 202 | 68 (34%) | 42(24%) |
| Maman et al | Brazil | 200 | 161 (79.5%) | 39 (19.5%) |
| Present Study | India | 123 | 69 (56.09%) | 8 (6.4%) |

**Figure 1:** Left scapula showing the maximum length (L-L'), the distance between the highest point of the superior angle and the lowest point of the inferior angle and the maximum width (W-W'), distance from the centre of glenoid cavity to the midpoint between two lips of the spine of scapula.

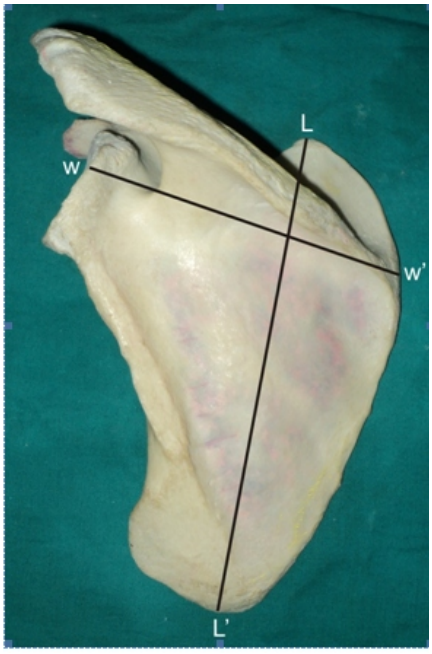



**Figure 2:** The four types of glenoid cavity (GC) depending upon the presence of notch along its borders. a- inverted comma shaped with a well defined deep notch along upper third of anterior border of GC , b- pear shaped having a less evident glenoid notch, c- triangular with notches along both anterior and posterior border, d- oval, absence of the glenoid notch.

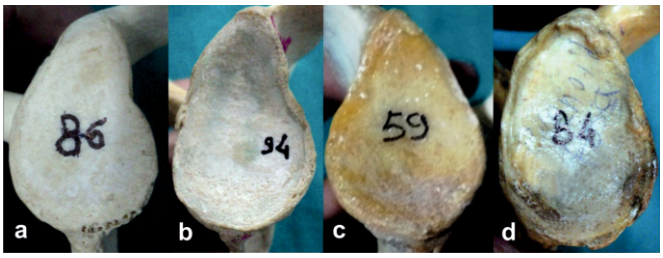
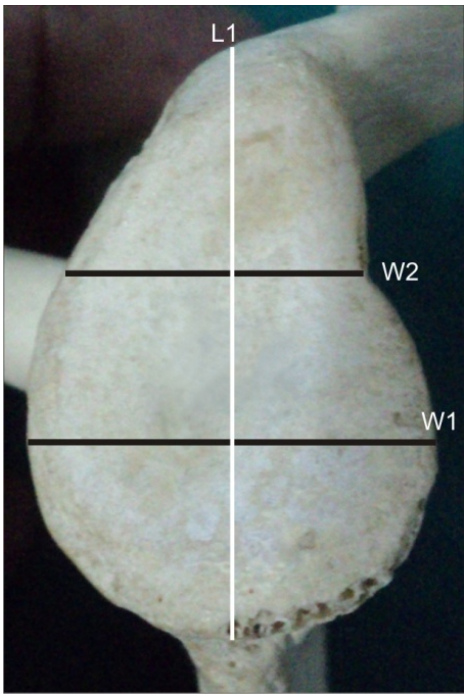



**Figure 3:** Various morphometrical measurements of glenoid cavity. Maximum length of glenoid cavity (L1), maximum width (W1), and width at the notch of GC (W2).




**Discussion**

Precise knowledge of morphology of the scapula and glenoid cavity is mandatory to avoid complications during open and arthroscopic surgery around shoulder region. The maintenance of congruency between glenoid cavity and prosthetic head of humerus is the basic requirement after total shoulder arthroplasty1, 2, 5. Recently, Poppen et al emphasized that abnormal morphology of the glenoid is associated with severe full thickness tears. 5, 6, 8 Luis RF found the maximum length of GC as 31.17 mm whereas in current study we observed this as 40.30 mm. The racial or geographical parameters may be the cause of this diference. The difference in various parameters of scapula and glenoid cavity in different parts of world is shown in Table 3. The

length of GC is an important factor which should be appropriately matched with the size of prosthesis during total shoulder arthroplasty in order to achieve full congruency1, 6, 8, 9. Previous studies showed that only a little variantion exists between men and women, but the differences between races are considerable5.

Poppen and Walker correlated well the morphology of GC with its function and explained the process of abduction in detail. They mentioned that the head of the humerus slides upward when the arm is elevated, and the lower part of the glenoid receives the humeral head when the arm is lowered. This suggests that the lower larger part of the glenoid cavity is suitable for the head when the arm is lowered and is therefore easily rotated in front of the trunk, while the upper small portion is suitable when the arm is elevated and range of movement is confined at the side of the trunk7, 8. Therefore mostly the glenoid cavity is pear shaped providing attachment to the glenoid labrum all around its borders.

The shape of glenoid cavity is directly related to dislocation at shoulder joint. Presher and Klumper stated that the glenoid labrum in the area of the notch is not fixed to bony margins of glenoid cavity but bridges the notch itself. Many a times a small recess of the joint cavity projects between the glenoid labrum and the anterior margin of GC. Such an attachment of glenoid labrum makes the shoulder joint less resistant to dislocating forces and labral tear and avulsions usually occur at the anterior margin of the GC10. In the current study, 56% of specimens were having a deep notch which suggests that in cases of shoulder dislocation, this kind of pathology should be searched for and repaired for good congruency. We propose that the oval shaped GC (fig 2d) are the most stable type as the glenoid labrum is attached all along the borders of glenoid cavity whereas triangular shaped glenoid cavity i.e. type 3 (fig 2c) is more vulnerable for shoulder dislocations as the glenoid labrum is not attached to anterior as well as posterior margins of GC. We found this in 2 (1.62%) cases (fig 2 c) and till now only Coskun et al reported this kind of shape of GC but they did not mentioned the percentage of prevalence.

We conclude that the shape and size of glenoid cavity do not only vary in races but also in same population (table 4). Hence, this information is valuable for the surgeons during operations around shoulder joint.

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