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# MORPHOMETRY OF HUMAN SCAPULA GLENOID FOSSA AND ITS SURGICAL ANATOMY: AN OBSERVATIONAL STUDY IN EASTERN ODISHA

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**Keywords:**

Glenoid fossa, Morphometry, Goniometer, Prosthesis

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**ABSTRACT: Introduction:** Scapulae bear a shallow articular concave fossa commonly known as glenoid cavity that accommodates the head of the humerus to form a shoulder joint. The size and shape of glenoid fossa is highly variable; hence, knowledge about morphological measurements is invariably essential for surgery and artificial prosthesis pertaining to shoulder joint pathology. **Aim:** Glenoid fossa morphometry to study its various shapes and diameters in dry human scapulae. **Materials and Methods:** Dry bone scapulae were obtained from the bone room of the post-graduate department of Anatomy S.C.B Medical College Cuttack. Ninety-seven samples were studied, out of which 45 belonged to the right side and 52 left sides. All the measurements were carried out by verniers caliper for the height of glenoid fossa (A =A1+ A2) and breadth (B = B1+B2). A Goniometer measured the glenoidal version. **Observation:** The oval shape was the most common glenoid fossa observed, amounting 42(43.3%). The mean value for length with Standard Deviation was 31.5±3.16 millimeters and the mean and standard deviation Breadth was 21.99±2.76 millimeters, respectively. The glenoidal versions were 0.822±3.120 (range +6 to -6) for right side, 0.134±2.63 (range +5 to -8) left side and 0.30±2.89 (range +6 to -8) in total. **Conclusion:** The knowledge of glenoidal dimensions is very helpful to hand surgeons and orthopedic surgeons for surgical treatment of shoulder joint and properly designing the prosthesis. The glenoidal anatomy is also essential for physiotherapist to select appropriate exercise as a noninvasive procedure for glenohumeral disease.

**INTRODUCTION:** Scapula bone is also called the shoulder blade in the posterior aspect of the thoracic wall. It forms the shoulder girdle in vertebrates. It is almost triangular and presents superior, inferior, and lateral angles. Glenoid fossa is present on the lateral angle of the scapula bone, contributing to the glenohumeral joint formation, a synovial multiaxial spheroidal joint [1]. Glenoid fossa is a shallow pyriform articular surface directed laterally forwards and upwards to accommodate the humeral head [1] gray's anatomy.

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The word glenoid is derived from the Greek word glene means shallow socket. The subscapularis tendon grooves the anterior margin to provide its typical pear shape appearance [2]. The vertical diameter is longer than the horizontal. Two elevated areas at the upper and lower ends are called supraglenoid and infraglenoid tubercles, respectively.

Supra glenoid tubercle is intracapsular, whereas infraglenoid tubercle is extracapsular in disposition [3]. The supraglenoid tubercle attaches to the biceps muscle's long head and supports the shoulder joint's superior aspect. In contrast, the long head of the triceps is weak support from infraglenoid tubercle. The articular surface is lined by articular (hyaline) cartilage and further deepened by glenoid labrum (Fibrocartilage) for the

proper accommodation of the humeral head. During the process of evolution, the stability is sacrificed for mobility in the primates' shoulder joint, making it vulnerable for dislocation and fracture.

Hence, the shoulder joint is strengthened by its orientation, bony, cartilaginous, and muscular supports. Their disorders are most commonly called SLAP lesions Taylor S A *et al* [4].

The anterior margin glenoid fossa is notched by spinoglenoid ligament, which forms the anatomical basis of various types. Different authors study three major types: oval shape, pear-shaped and inverted comma-shaped glenoid fossa Churchill RS *et al* [5].

Shoulder instability pertaining to glenoid fossa and rotator cuff disease is the 3rd most common cause of musculoskeletal disorders seen in our community. Christina Garving *et al* [6].

The morphometric anatomy of glenoid fossa is essential for managing various medical and especially surgical management of diseases pertaining to shoulder joint. The present study was designed to evaluate the morphometric anatomy of glenoid fossa, which will be helpful to orthopedic surgeons for the management of various shoulder disorders and providing suitable prosthesis as well [7].

The glenoidal anatomy is also essential for physiotherapist to select appropriate exercise as a noninvasive procedure for glenohumeral disease [8].

**MATERIALS AND METHODS:** Dry bone scapulae were obtained from the bone room of the post-graduate department Anatomy S.C.B Medical College Cuttack. Ninety-seven samples were studied, of which 45 belonged to the right side and 52 left side.

**Study Design:** Observational study.

**Place of Study:** Department of Anatomy S.C.B. Medical College Hospital, Cuttack, Odisha, India.

**Period of Study:** 14th November 2021 to 14th February 2022.

**Inclusion Criteria:** All the dry scapulae in good condition displaying intact Glenoid fossa were measured.

**Exclusion Criteria:** The scapulae displaying the damage to glenoid fossa were excluded from the study.

**Ethical Issues:** Ethical clearance of the present study was obtained from the Institutional Ethics Committee (IEC) S.C.B Medical College Cuttack, 753007, Orissa, as per the World Medical Association Declaration of Helsinki.

**Statistical Analysis:** TheGraphPad program for Windows (Graph Pad Software) was used for data analysis, and Statistical significance was accepted when p- value is $\leq 0.05$.

**Measurements:** The height of the glenoid fossa (A) is the maximum distance from the prominence below the supraglenoid tubercle to the inferior margin of glenoid cavity. The breadth of the glenoid cavity (B) is the maximum anteroposterior (AP) distance in the lower half of the fossa. Both A and B intersect perpendicular to each other inside the cavity. A1 and A2 represent the distance in the lower part and upper part of the intersection, respectively **Fig. 1**. B1 and B2 are the measurements anterior and posterior to the point of intersection **Fig 1.**


**POINT OF INTERSECTION**

**FIG. 1: VARIOUS MEASUREMENTS OF THE GLENOID FOSSA**

The glenoidal version is the angle of orientation in the transverse plane of the scapula having anteversion or anterior tilt denoted by a positive (+) sign and retroversion or posterior tilt denoted by negative (-) sign, respectively.

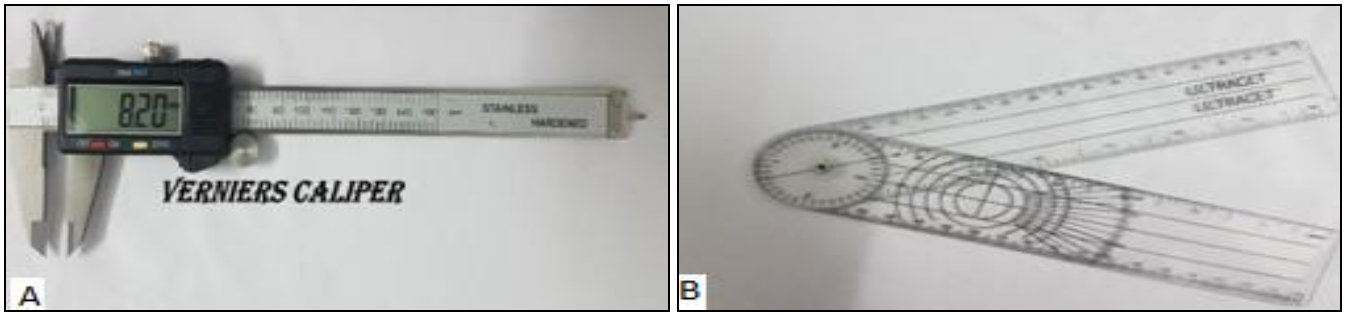


**FIG. 2: VERNIERS CALIPER (A) AND GONIOMETER (B)**

All the measurements were carried out by verniers caliper for the height of glenoid fossa (A, A1, A2) and breadth (B, B1, B2). **Fig. 2** The glenoidal version was measured by a Goniometer.

**Observations:** The glenoid fossa of Ninety-seven unpaired scapulae of unknown sex were measured in the present study available in the museum of Anatomy department, S. C. B Medical College Cuttack.

Different diameters measured by Digital Verniers Caliper and Goniometer were mentioned below **Fig. 3**.

**FIG. 3: DIFFERENT TYPES OF GLENOID FOSSA**

**Observations:** There were 97 scapulae with good quality glenoid fossa taken for anthropometry in the present study having 45 from the right side and 52 from the left side. Three shapes were seen during the observation according to the variable presence of glenoidal notch. The most common shapes observed were oval shape 42(43.3%), pear shape 33 (34.02%), and inverted Comma Shape 22(22.68%), respectively. Details of right and left side observations are given in **Table 1.**

**TABLE 1: FREQUENCY DISTRIBUTION OF DIFFERENT SHAPES OF GLENOIDAL FOSSA**

| Shape | Right n-45 | Percent | Left n - 52 | Percent | Total n-97 | Percent |
|---|---|---|---|---|---|---|
| Pear | 23 | 57.8% | 26 | 50% | 49 | 50.5% |
| Comma (I) | 12 | 26.66% | 15 | 28.84% | 27 | 27.8% |
| Oval | 10 | 22.22% | 11 | 21.15% | 21 | 21.6% |

**TABLE 2: SHOWING THE SUMMARY OF GLENOIDAL HEIGHT (SI-SUPERIOR- INFERIOR DIAMETER)**

| Glenoid height (mm). | Right side (n-45) | | | Left side (n-52) | | | P value | T value |
|---|---|---|---|---|---|---|---|---|
| | Mean ±SD | Max | Min | Mean ±SD | Max | Min | | |
| A1 | 11.25±1.65 | 15.4 | 18.5 | 11.35±1.78 | 17.00 | 8.6 | 0.77 | 0.28 |
| A2 | 20.70±2.11 | 25.5 | 17.26 | 20.55±2.37 | 26.6 | 16.6 | 0.74 | 0.32 |
| A1+A2=A | 31.5±3.16 | 38.2 | 26.22 | 31.40±3.58 | 42.5 | 26.3 | 0.88 | 0.14 |

In the present study, A was considered as the Glenoidal Height (Superior- Inferior Diameter), whereas A1 and A2 were the lengths taken from the most dependent point in the glenoid fossa.

The mean value for Superior- Inferior Diameter (A) with Standard Deviation was 31.5±3.16, followed by A1 had 11.25±1.65 and A2 at 20.70±2.11 millimeters with its maximum and minimum value in **Table 2.**

**TABLE 3: SHOWING THE SUMMARY OF GLENOIDAL BREADTH (ANTEROPOSTERIOR DIAMETER)**

| Glenoid breadth (mm) | Right side (n-45) | | | Left side (n-52) | | | P value | T value |
|---|---|---|---|---|---|---|---|---|
| | Mean ±SD | Max | Min | Mean ±SD | Max | Min | | |
| B1 | 10.79±1.37 | 13.6 | 7.36 | 10.20±1.73 | 16 | 5.9 | 0.0001 | 0.57 |
| B2 | 11.60±1.9 | 16.35 | 8.21 | 12.65±1.99 | 21.45 | 10.1 | 0.0095 | 2.64 |
| B1+ B2=B | 21.99±2.76 | 28.4 | 16.36 | 22.17±2.55 | 28 | 18 | 0.73 | 0.33 |

Glenoidal Breadth (Antero- Posterior Diameter) was described as B. B1 and B2 were the breadth taken from the most dependent point in the glenoid fossa. The mean and standard deviation B was 21.99±2.76 followed by 10.79±1.37 for B1 and 11.60±1.9 millimeters for B2, respectively. The maximum and minimum values was given in **Table 3.**

**TABLE 4: SHOWING THE SUMMARY OF GLENOIDAL VERSION**

| Glenoid Version (degrees) | Number | Mean ±SD | Maximum | Minimum |
|---|---|---|---|---|
| Right | 45 | 0.822±3.120 | +6 | -6 |
| Left | 52 | 0.134±2.63 | +5 | -8 |
| Total | 97 | 0.30±2.89 | +6 | -8 |

The mean value with standard deviation of glenoidal version in degrees were 0.822±3.120 (range +6 to -6) for right side, 0.134±2.63 (range +5 to -8) left side and 0.30±2.89 (range +6 to -8) in total.

**DISCUSSION:** The frequency Pear-shaped glenoid fossa was seen highest (50.6%) in the present study followed by inverted commas 27.8% and Oval 21.6%, respectively. It is compared with the findings of various authors in India. Our study is similar to Neeta *et al* 2015 [9,] as per Archana S *et al* 2019, [10] the 2nd commonest type was oval shape > 30% followed by inverted comma shape glenoid fossa. Shalom Elsy Philip 2021 [11] was observed with the highest value in pear shape > 60% and lowest in inverted comma shape around 10%.

The results were highly variable and inconsistent shown in **Table 5.** Hence the knowledge of glenoid fossa morphometry is essential for arthroplasty and implantation of correct prosthesis Shalom Elsy Philip *et al.* [11] **Table 1** and **5.**

**TABLE 5: FREQUENCY OF VARIOUS SHAPES OF GLENOID FOSSA WITH OTHER AUTHORS**

| S. no. | Authors | No of specimens | Pear (%) | Inverted comma (%) | Oval (%) |
|---|---|---|---|---|---|
| 1 | Archana S *et al* 2019 [10] | Right-56 | 42.9 | 21.4 | 35.6 |
| | | Left -44 | 45.5 | 22.7 | 31.8 |
| 2 | Rajani Singh 2020 [13] | Right-43 | 49.45 | 21.98 | 28.57 |
| | | Left -47 | 50.62 | 18.52 | 30.86 |
| 3 | Neeta *et al* 2015 [9] | Right-55 | 47 | 31 | 22 |
| | | Left -71 | 55 | 32 | 13 |
| 4 | Azhagiri R *et al* 2022 [12] | Right-48 | 29.16 | 45.83 | 16.66 |
| | | Left -52 | 26.92 | 53.84 | 14.38 |
| 5 | Shalom E P 2021 [11] | Right-52 | 65 | 5 | 28 |
| | | Left -48 | 62 | 10 | 27 |
| 6 | Present study | Right-45 | 57.8 | 26.66 | 22.22 |
| | | Left -52 | 50 | 28.84 | 21.15z |

The superior-inferior diameter or glenoidal height was studied as A = (A1+A2) with a mean value with a standard deviation of 31.5±3.16 for the right side and 31.40±3.58 left side, respectively. The anteroposterior diameter or glenoidal breadth was studied as B = (B1+B2), and their mean value with standard deviation was 21.99 ± 2.76 for the right side and 21.17 ± 2.55 left side, respectively, in the present study. Both height and breadth of our study were slightly less than the observations done by Azhagiri R. *et al.* 2022 [12], Rajani Singh 2020 [13], Alkesan M. *et al* 2022 [14] and Philip S. E. *et al* 2021

[11]. The p value for both sides is almost insignificant, corroborating with Rajani Singh 2020 [13], Alkesan M. 2022 [14]. The p value is highly significant by comparing height and breadth, similar to other authors<0.0001.

Hence, there was a statistical significance between height and breadth in the present study **Table 3**, which was in favour of Pear shape, oval shape, and Inverted comma shape but not circular **Table 2, 3,** and **6**.

**TABLE 6: COMPARISON HEIGHT (A) AND BREADTH (B) OF GLENOID FOSSA WITH OTHER AUTHORS**

| Author | Sample size with side | Glenoid height A in mm (Mean ±SD) | Glenoid breadth B in mm (Mean ±SD) | P value-A | P value - B | P value A & B |
|---|---|---|---|---|---|---|
| Azhagiri R. *et al.* 2022 | Right-48 | 35.17±2.6 | 24.12±1.99 | 0.43 | 0.66 | <0.0001 |
| | Left- 52 | 34.73±2.4 | 23.73±1.64 | 0.38 | 0.29 | <0.0001 |
| Rajani Singh 2020 | R -91 | 33.4±3.0 | 24.1±3.2 | 0.32 | 0.41 | <0.0001 |
| | L -81 | 33.9±3.6 | 23.1±2.9 | 0.53 | 0.08 | <0.0001 |
| Alkesan M. 2022 | R - 20 | 35.85 ± 2.15 | 25.02 ± 1.99 | 0.75 | 0.30 | <0.0001 |
| | L - 20 | 34.41 ± 1.75 | 24.36 ± 1.45 | 0.30 | 0.03 | <0.0001 |
| Philip S. E. *et al* 2021 | R - 52 | 34.81 ± 3.50 | 23.93 ± 2.77 | 0.28 | 0.66 | <0.0001 |
| | L - 48 | 35.55 ± 3.28 | 24.18 ± 2.81 | 0.25 | 0.65 | <0.0001 |
| Present study | R - 45 | 31.5 ± 3.16 | 21.99 ± 2.76 | 0.88 | 0.14 | <0.0001 |
| | L -52 | 31.40 ± 3.58 | 21.17 ± 2.55 | 0.73 | 0.33 | <0.0001 |

The Glenoidal version in the present study is the angle sustained by the glenoid fossa with the long axis of scapulae. It is measured in degrees as retroversion and anteversion according to the posterior and anterior angle, respectively. The value observed was widely variable, ranging from +6 to -8 degrees. These findings corroborate with the study of Kate Deepali R 2016 [15] showed the mean left side version was -1.00 ± 4.06 and the right side was 3.30 ± 3.63, with the maximum and minimum values ranging from -10 to + 6 degrees, respectively. In the study of Uma S *et al.*, [16,] the mean glenoidal angle for the right side was -6.90 ± 3.48, followed by the left side was -5.02 ± 2.07 degrees. Friedman *et al* [17] compared 63 shoulder arthritis with normal and evaluated a mean anteversion 2 degrees in the normal healthy group (ranged 14 to -12 degrees) with a mean of 11 degrees in osteoarthritic cases of shoulder joint (ranged 2 degrees to -32 degrees). The widely variable glenoidal version draws attention to its morphometry in detail for proper designing of prosthesis [18] **Table 4.**

**CONCLUSION:** The small variable glenoid fossa enables the shoulder joint to be highly mobile in all directions with a changing axis. Types of glenoid fossa are typically pear shape followed by inverted comma shape and oval shape. The mean with standard deviations of length and breadth of the glenoid fossa are showing highly statistically significant <0.0001 results, favoring the above shapes and not circular in any condition. The variations observed may be due to racial and geographical. The knowledge of glenoidal dimensions is very helpful to hand surgeons and orthopedic surgeons for surgical treatment of shoulder joints and the proper designing of prosthesis. The glenoidal anatomy is also essential for physiotherapists to select appropriate exercise as a noninvasive procedure for glenohumeral disease.

**Limitations:** Small sample size and scapula of unknown age sex were responsible for some errors, but the overall observation may contribute to some knowledge in glenoid pathology.

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**CONFLICTS OF INTEREST:** None to declare.

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