



RESEARCH ARTICLE

Morphometric Evaluation of Glenoid Cavity Dimensions and Its Relevance in Shoulder Arthroplasty

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ABSTRACT

Background: The glenoid cavity is an important component of the shoulder joint, providing articulation with the head of the humerus and contributing to joint stability and mobility. Accurate knowledge of its morphometric dimensions is essential for successful shoulder arthroplasty, prosthesis design, and the management of glenohumeral disorders. Population-specific anatomical data are valuable for improving surgical outcomes.

Objectives: To evaluate the morphometric dimensions and morphological variations of the glenoid cavity in adult human scapulae and assess their clinical significance in shoulder arthroplasty.

Materials and Methods: A descriptive cross-sectional osteometric study was conducted in the Department of Anatomy, Government Medical College, Yadadri (Bhuvanagiri) Telangana, Government medical college, Vikarabad, Telangana and Sree Uthradom Thirunal Academy of Medical Sciences, Thiruvananthapuram, Kerala on 100 dry adult human scapulae (50 right and 50 left). The maximum superoinferior diameter, maximum anteroposterior diameter, upper anteroposterior diameter, and Glenoid Index were measured using a digital Vernier caliper. The glenoid cavity was classified into pear, oval, and inverted comma shapes. Data was analyzed using descriptive statistics, and side-wise comparisons were performed using the independent t-test, with $p < 0.05$ considered statistically significant.

Results: The mean superoinferior diameter was 36.8 ± 3.2 mm, the mean maximum anteroposterior diameter was 27.4 ± 2.6 mm, and the mean Glenoid Index was 74.5 ± 5.8 . Pear-shaped glenoid cavities were the most common (52%), followed by inverted comma (30%) and oval (18%). No statistically significant difference was observed between the right and left sides ($p > 0.05$). The findings demonstrated anatomical variations that may influence prosthetic sizing and surgical planning.

Conclusion: The present study provides valuable morphometric data on the glenoid cavity in the Telangana population. These findings can assist orthopedic surgeons in preoperative planning, appropriate prosthesis selection, and improving the outcomes of shoulder arthroplasty while serving as a useful reference for anatomists and biomedical engineers.

Keywords: Glenoid cavity, Morphometry, Scapula, Shoulder arthroplasty, Glenoid index, Anatomy, Prosthesis, Telangana.

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INTRODUCTION

The shoulder joint is the most mobile synovial joint in the human body and derives its wide range of motion from the articulation between the head of the humerus and the glenoid cavity of the scapula. The glenoid cavity is a shallow, pear-shaped articular surface whose dimensions and morphology are essential for maintaining shoulder stability and normal biomechanics. Variations in the size and shape of the glenoid cavity influence joint congruity and are of considerable importance in the diagnosis and management of shoulder disorders, particularly in shoulder arthroplasty and the treatment of recurrent dislocations (1).

Morphometric evaluation of the glenoid cavity has become increasingly important with the growing number of shoulder replacement surgeries. Accurate measurements of the superoinferior diameter, anteroposterior diameter, and Glenoid Index are essential for selecting appropriately sized prosthetic components and ensuring optimal implant

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positioning. Improper prosthesis sizing may result in complications such as implant loosening, instability, restricted range of motion, and early prosthetic failure (2,3).

Several studies have demonstrated that glenoid dimensions vary among different populations, ethnic groups, and sexes. Most commercially available shoulder prostheses are designed using morphometric data obtained from Western populations, which may not accurately represent the anatomical characteristics of the Indian population. Therefore, region-specific anatomical data are essential for improving prosthesis design and achieving better surgical outcomes (4).

In addition to orthopedic applications, morphometric studies of the glenoid cavity are valuable in anatomy, forensic science, radiology, and biomedical engineering. Knowledge of glenoid morphology assists in skeletal identification, interpretation of radiological images, and the development of anatomically compatible implants (5).

Considering the limited morphometric data available from the Telangana and south Indian population, the present study was undertaken in the Department of Anatomy, Government Medical College, Yadadri Bhuvanagiri, Telangana, Government medical college, Vikarabad, Telangana and Sree Uthradom thirunal Academy of Medical Sciences, Thiruvananthapuram, Kerala and to evaluate the dimensions and morphological variations of the glenoid cavity in adult human scapulae. The findings are expected to provide baseline anatomical data that will aid orthopedic surgeons in preoperative planning, prosthesis selection, and improving the outcomes of shoulder arthroplasty (6).

MATERIALS AND METHODS

Study Design

A descriptive, cross-sectional osteometric study was conducted to evaluate the morphometric dimensions and morphological variations of the glenoid cavity in adult human dry scapulae.

Study Period

The study was carried out over a period of 6 months, from January 2026 to June 2026, in the Department of Anatomy, Government Medical College, Bhongir, Telangana.

Study Setting

The study was conducted in the Department of Anatomy, Government Medical College, Bhongir, Telangana, Government medical college, Vikarabad, Telangana and Sree Uthradom thirunal Academy of Medical Sciences,

Thiruvananthapuram, Kerala using dry adult human scapulae available in the departmental osteology museum.

Sample Size

A total of 100 dry adult human scapulae, comprising 50 right-sided and 50 left-sided specimens, were included in the study.

Inclusion Criteria

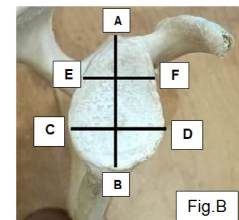
- Dry adult human scapulae with intact glenoid cavities.
- Well-preserved scapulae without any visible deformity.
- Both right and left-sided scapulae available in the Department of Anatomy.

Exclusion Criteria

- Broken or damaged scapulae.
- Scapulae showing pathological lesions, fractures, or congenital deformities involving the glenoid cavity.
- Incomplete or eroded specimens affecting accurate morphometric measurements.

METHODOLOGY

Each scapula was examined for side determination and morphological assessment. The following parameters were measured using a digital Vernier caliper with an accuracy of 0.01 mm:



- Maximum superoinferior diameter (glenoid height) (A-B)
- Maximum anteroposterior diameter (glenoid width) (AP1,C-D)
- Upper anteroposterior diameter (AP2 -E-F)
- Glenoid Index (Maximum AP diameter ÷ Superoinferior diameter × 100)

The morphology of the glenoid cavity was classified into pear-shaped, oval, and inverted comma-shaped based on the presence or absence of the glenoid notch. All measurements were taken twice by the same observer, and the average value was recorded to minimize observer bias.

Since the study involved dry human bones obtained from the departmental osteology collection without any patient information, informed consent was not applicable.

Statistical Analysis

The collected data was entered into Microsoft Excel 2021 and analyzed using IBM SPSS Statistics version 26.0. Descriptive statistics were expressed as mean $\pm$ standard deviation (SD), frequencies, and percentages. Comparison between right and left-sided scapulae was performed using the Independent Student's t-test. A p-value < 0.05 was considered statistically significant.

RESULTS

A total of 100 dry adult human scapulae (50 right and 50 left) were analyzed for morphometric measurements of the glenoid cavity. The morphometric parameters measured included the maximum superoinferior diameter (SI), maximum anteroposterior diameter (AP1), upper anteroposterior diameter (AP2), and Glenoid Index (GI). The morphology of the glenoid cavity was also classified into pear, oval, and inverted comma types.

Interpretation

Table 1 compares the morphometric dimensions of the glenoid cavity between the right and left scapulae. The mean superoinferior diameter was 36.92 ± 3.18 mm on the right side and 36.68 ± 3.25 mm on the left side. Similarly, the mean maximum anteroposterior diameter, upper anteroposterior diameter, and Glenoid Index showed only minor variations between the two sides. The independent Student's t-test demonstrated no statistically significant

difference in any of the measured parameters ($p > 0.05$), and the 95% confidence intervals included zero for all comparisons. These findings indicate bilateral symmetry of the glenoid cavity dimensions in the studied specimens.

Interpretation

Table 2 presents the overall descriptive statistics of the morphometric dimensions of the glenoid cavity in all 100 scapulae. The mean superoinferior diameter was 36.80 ± 3.21 mm, while the mean maximum anteroposterior diameter and upper anteroposterior diameter were 27.40 ± 2.60 mm and 19.53 ± 2.11 mm, respectively. The mean Glenoid Index was 74.50 ± 5.76 . The relatively narrow 95% confidence intervals indicate good precision of the measurements and suggest that these values reliably represent the morphometric characteristics of the study population.

Interpretation

Table 3 illustrates the distribution of morphological types of the glenoid cavity. The pear-shaped glenoid cavity was the most common, accounting for 52% of the specimens, followed by the inverted comma-shaped type (30%) and the oval type (18%). The predominance of the pear-shaped morphology is consistent with previous anatomical studies and has important clinical implications in shoulder arthroplasty, prosthesis selection, and the management of glenohumeral instability.

Table 1: Comparison of morphometric dimensions of the glenoid cavity between right and left scapulae

Parameter	Right (n=50) Mean $\pm$ SD	Left (n=50) Mean $\pm$ SD	Mean difference	95% CI	P value
Superoinferior diameter (mm)	36.92 ± 3.18	36.68 ± 3.25	0.24	-1.02 to 1.50	0.708
Maximum AP diameter (mm)	27.62 ± 2.48	27.18 ± 2.71	0.44	-0.59 to 1.47	0.401
Upper AP diameter (mm)	19.74 ± 2.03	19.32 ± 2.18	0.42	-0.41 to 1.25	0.317
Glenoid Index	74.81 ± 5.42	74.19 ± 6.08	0.62	-1.68 to 2.92	0.596

Table 2: Overall morphometric dimensions of the glenoid cavity (n=100)

Parameter	Mean $\pm$ SD	Minimum	Maximum	95% CI
Superoinferior diameter (mm)	36.80 ± 3.21	30.2	43.8	36.16–37.44
Maximum AP diameter (mm)	27.40 ± 2.60	22.4	33.1	26.88–27.92
Upper AP diameter (mm)	19.53 ± 2.11	15.3	24.5	19.11–19.95
Glenoid Index	74.50 ± 5.76	63.2	86.4	73.36–75.64

Table 3: Morphological types of the glenoid cavity

Shape	Frequency (n)	Percentage (%)
Pear	52	52.0
Inverted comma	30	30.0
Oval	18	18.0

Interpretation

Table 4 presents the results of the independent Student's *t*-test comparing morphometric parameters between right and left scapulae. None of the measured variables demonstrated statistically significant differences, as all *p*-values were greater than 0.05. The highest *t*-value was observed for the upper anteroposterior diameter (*t* = 1.01), but this was also statistically non-significant. These findings indicate that the morphometric dimensions of the glenoid cavity are comparable on both sides, suggesting anatomical symmetry within the study population.

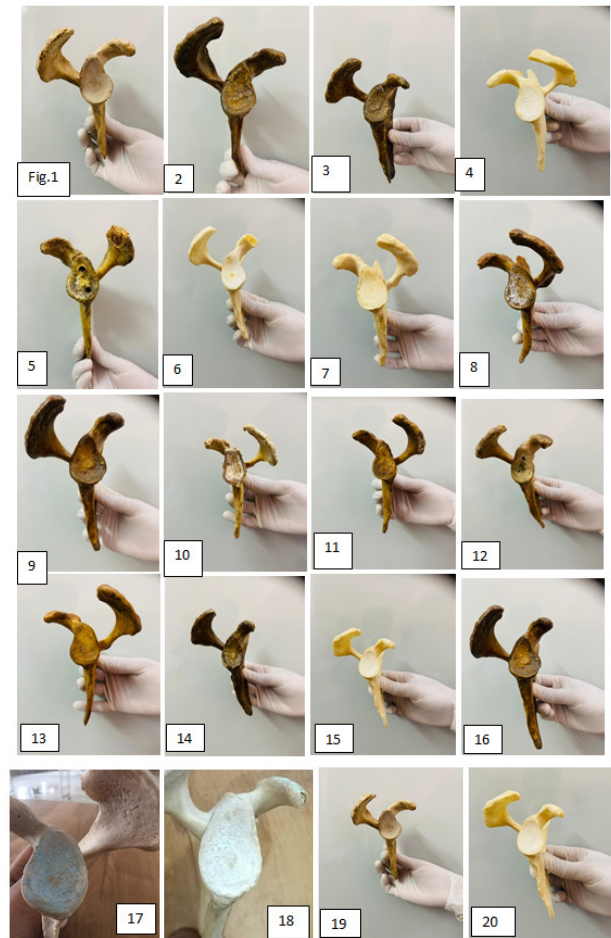
Interpretation

The descriptive statistical analysis demonstrated that the mean superoinferior diameter of the glenoid cavity was 36.80 ± 3.21 mm with a 95% confidence interval (CI) of 36.16–37.44 mm, indicating relatively low variability and consistent measurements among the studied specimens. The maximum anteroposterior diameter had a mean value of 27.40 ± 2.60 mm (95% CI: 26.88–27.92 mm), while the upper anteroposterior diameter measured 19.53 ± 2.11 mm (95% CI: 19.11–19.95 mm). The mean Glenoid Index was 74.50 ± 5.76 with a 95% CI of 73.36–75.64, suggesting a relatively uniform glenoid cavity shape in the study population.

DISCUSSION

The present study evaluated the morphometric dimensions and morphological variations of the glenoid cavity in 100 dry adult human scapulae obtained from the Department of Anatomy, Government Medical College, Yadadri Bhuvanagiri, Telangana, Government medical college, Vikarabad, Telanagana and Sree Uthradom thirunal Academy of Medical Sciences, Thiruvananthapuram,

Types of Glenoid fossae obtained in the study



Pear shaped -Fig.1,2,3,6,9,11,15,16 ,19,20

Inverted Comma Shaped – Fig.4, 5,7,8,13,17

Oval Shaped – Fig.10,12,14,18

Kerala. The mean superoinferior diameter, maximum anteroposterior diameter, upper anteroposterior diameter, and Glenoid Index were 36.80 ± 3.21 mm, 27.40 ± 2.60 mm, 19.53 ± 2.11 mm, and 74.50 ± 5.76 , respectively. No statistically significant difference was observed between the right and left scapulae (*p* > 0.05), indicating bilateral symmetry of the glenoid cavity. The pear-shaped glenoid cavity was the most common morphological type (52%),

Table 4: Independent Student's *t*-test comparing right and left scapulae

Variable	<i>t</i> -value	Degrees of Freedom	<i>P</i> value	Statistical Significance
SI diameter	0.38	98	0.708	Not Significant
Maximum AP diameter	0.84	98	0.401	Not Significant
Upper AP diameter	1.01	98	0.317	Not Significant
Glenoid Index	0.53	98	0.596	Not Significant

Table 5: Descriptive statistics of glenoid cavity measurements

<i>Variable</i>	<i>Mean</i>	<i>SD</i>	<i>Standard Error</i>	<i>95% Confidence Interval</i>
SI diameter	36.80	3.21	0.32	36.16–37.44
Maximum AP diameter	27.40	2.60	0.26	26.88–27.92
Upper AP diameter	19.53	2.11	0.21	19.11–19.95
Glenoid Index	74.50	5.76	0.58	73.36–75.64

followed by inverted comma (30%) and oval (18%). These findings provide baseline morphometric data that may assist in prosthesis design and shoulder arthroplasty planning.

The mean superoinferior diameter observed in the present study (36.80 mm) was comparable with the findings of Rajput et al., who reported a mean glenoid height of 36.1 mm in an Indian population (7). Similarly, Von Schroeder et al. reported glenoid height values ranging from 35.8–37.6 mm, which closely resemble the present observations (8).

The maximum anteroposterior diameter (27.40 mm) recorded in this study was comparable to the findings of Kavitha et al., who observed a mean width of 27.8 mm in South Indian scapulae (9). Likewise, Mallon et al. reported similar morphometric values in cadaveric scapulae and emphasized their importance in prosthetic component selection during shoulder arthroplasty (10).

The predominance of the pear-shaped glenoid cavity (52%) observed in the present study is in agreement with the findings of Tiwari et al., who also reported pear-shaped glenoid cavities as the most frequent morphological type in the Indian population (11). Similar observations have been documented by Singh et al., further supporting the consistency of glenoid morphology across different Indian populations (12).

The absence of statistically significant bilateral differences in the present study suggests anatomical symmetry of the glenoid cavity. This finding corroborates the observations of previous osteometric studies and indicates that side-related differences are unlikely to influence prosthesis selection in routine clinical practice (8,10).

Strengths of the Study

- Included 100 adult dry human scapulae, providing an adequate sample size.
- Measurements were obtained using a digital Vernier caliper for greater precision.
- Morphological classification and morphometric measurements were evaluated simultaneously.
- Statistical analysis included 95% confidence intervals and significance testing.

- Provides baseline morphometric data for the Telangana population, where such data are scarce.
- Limitations
- Sex and age of the scapulae could not be determined.
- Dry bone measurements may not completely represent in vivo anatomical conditions.
- The study was conducted at a single institution, limiting generalizability.
- Radiological and cadaveric correlations were not performed.

Future Scope

Future multicentric studies involving larger sample sizes and advanced imaging techniques such as CT-based three-dimensional morphometric analysis are recommended. Correlating glenoid dimensions with sex, age, and clinical outcomes following shoulder arthroplasty may facilitate the development of population-specific shoulder prostheses for the Indian population.

Clinical Importance

Knowledge of glenoid cavity morphometry is essential for orthopedic surgeons during total shoulder arthroplasty, reverse shoulder arthroplasty, glenoid reconstruction, and fracture fixation. Accurate anatomical measurements improve prosthetic fit, enhance joint stability, reduce implant-related complications, and contribute to successful surgical outcomes. The present findings also provide useful reference data for anatomists, radiologists, forensic experts, and biomedical engineers involved in implant design and musculoskeletal research.

CONCLUSION

The present study provides valuable morphometric data on the glenoid cavity in 100 dry adult human scapulae from the Department of Anatomy, Government Medical College, Yadadri Bhuvanagiri, Telangana, Government medical college, Vikarabad, Telanagana and Sree Uthradom thirunal Academy of Medical Sciences, Thiruvananthapuram, Kerala. The findings demonstrated that there were no statistically significant differences

between the right and left scapulae, with the pear-shaped glenoid cavity being the most common morphological type. These baseline anatomical measurements are clinically important for preoperative planning, accurate prosthesis selection, and improving the outcomes of total and reverse shoulder arthroplasty. Furthermore, the study contributes region-specific morphometric data that may aid orthopedic surgeons, anatomists, radiologists, and biomedical engineers in implant design and shoulder joint reconstruction. Future studies involving larger, multicentric populations and advanced radiological techniques are recommended to validate and expand these findings for broader clinical application.

Ethical Committee Clearance

Was taken.

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