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ORIGINAL RESEARCH

Morphological Variations of the Glenoid Cavity in the Rajasthan Population: A Descriptive Observational Study

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Abstract

Introduction: The scapula, or shoulder blade, plays a key role in upper limb mobility through its attachment points for muscles, and the glenoid cavity forms a critical part of the shoulder joint by articulating with the Humerus. This study aims to explore the morphological variations of the glenoid cavity, drawing on data from various studies to assess regional differences and their clinical relevance.

Materials and Methods: A descriptive observational study was conducted in the Anatomy Department of S.M.S. Medical College, Jaipur, between 2022 and 2024. The sample comprised 200 dry adult human scapulae collected from medical colleges across Rajasthan. The glenoid cavity shapes were classified as pear, inverted comma, or oval shape. Statistical analysis was performed using SPSS version 26.0.

Results: The most common glenoid cavity shape was pear-shaped, observed in 57% of the total samples, followed by inverted comma (29.5%) and oval (13.5%). The study found no statistically significant difference between the right and left sides of the scapula ($p = 0.907$), indicating symmetry in shape distribution.

Conclusion: The pear-shaped glenoid cavity is the predominant form, followed by inverted comma and oval shapes. This study confirms regional anatomical variability, with significant implications for clinical practices like shoulder surgeries and prosthetic design. Understanding these variations is crucial for surgeons and anatomists, enhancing surgical precision and patient outcomes.

Keywords: Glenoid cavity, scapula, shoulder joint, morphometry, anatomical variations, surgical planning, prosthetic design.

INTRODUCTION

The scapula, commonly known as the shoulder blade, plays a crucial role in the functioning of the upper limb by providing attachment points for muscles that facilitate movement of the arm (1). The glenoid cavity, a shallow socket in the scapula, articulates with the head of the Humerus to form the shoulder joint, making it vital for upper limb mobility (2).A notch located on the front upper part of the glenoid cavity (GC) influences its shape. If the glenoid notch is not well-defined, the GC tends to look pear-shaped or piriform. When the notch is clearly visible, the GC takes on an inverted comma shape. However, if the glenoid notch is completely missing, the GC appears oval in shape (3,4).Therefore, a detailed understanding of the morphology of the glenoid cavity is essential for clinicians and anatomists, as variations in its structure can influence shoulder joint function, surgical planning, and injury diagnosis (5).

Research has demonstrated that there are significant regional differences in the shape of the glenoid cavity, which can be attributed to genetic, environmental, and lifestyle factors (6). Numerous studies have focused on the morphology of the glenoid cavity, examining its shape, size, and variations across different populations such as Vidarbha and Odisha populations (7,8)respectively, highlighting distinct regional patterns. Similarly, research in Maharashtra (9,10) and other regions of India, such as Sikkim (11) and Punjab (12), further emphasizes the variability in the anatomical features of the scapula.These studies not only aid in anthropological research but also provide critical insights for surgical practices, particularly in shoulder

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surgeries, where precision is required for successful outcomes. However lack of data related to morphology of glenoid shape was noted among Rajasthan population. Therefore this study aimed to explore the variations in the shape of the glenoid cavity, drawing from existing studies to examine regional differences and their implications for both clinical and anatomical knowledge.

MATERIAL AND METHOD

The present descriptive observational study was conducted in the Anatomy Department of S.M.S. Medical College, Jaipur, and included 200 dry adult human scapulae collected from various medical colleges across Rajasthan between 2022 and 2024 to ensure a diverse and representative sample. Ethical clearance and necessary approvals were obtained from the Departmental Research Committee (DRC), Clinical Trial Screening Committee (CTSC), and Institutional Ethical Committee (IEC).

The study focused on scapulae with intact glenoid cavities, excluding damaged specimens or those showing pathological, degenerative, or traumatic changes. The sample size was calculated based on a 44% prevalence rate of pear-shaped glenoid cavities, with a 7% margin of error and 95% confidence level, leading to a final sample size of 200 (13). Specimens were labeled numerically with laterality (right 'R' or left 'L').

The morphological shape of the glenoid cavity was classified into three types (Figure 1): inverted comma-shaped (type 1), pear-shaped (type 2), and oval (type 3). Statistical analysis was performed using SPSS version 20, applying Chi-square tests for associations, with significance set at $p < 0.05$.

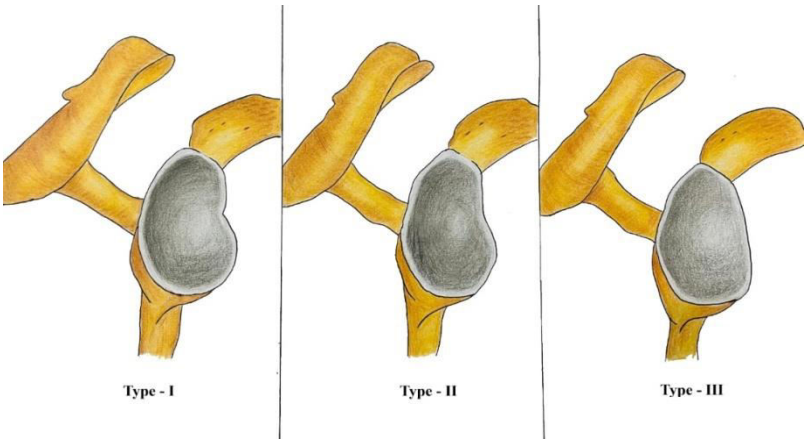

Figure 1: Various types of the Glenoid Cavity (a) Type-I: (inverted-comma-shaped) with a distinct glenoid notch at the anterior margin. (b)Type-II: (pear-shaped) with slight glenoid notch. (c) Type-III: (oval-shape) without glenoid notch.

RESULT:

TABLE 1: SHAPE OF THE GLENOID CAVITY

Shape of glenoid cavity	Right Side n (%)	Left Side n (%)	Total n (%)	Chi Square value	P-value
Pear	63 (56.75)	51 (57.3)	114 (57)	0.195	0.907
Inverted	32 (28.82)	27 (30.33)	59 (29.5)		
Oval	16 (14.41)	11 (12.35)	27 (13.5)		
Total	111 (55.5)	89 (44.5)	200 (100)		

Table no. 1 reveals the shape of the glenoid cavity across 200 samples, with 111 (55.5%) from the right side and 89 (44.5%) from the left side. The most common shape observed was the pear shape, accounting for 57% of the total cases (63 on the right side and 51 on the left side). The inverted shape was the second most prevalent, comprising 29.5% of the total (32 on the right side and 27 on the left side). The oval shape was the least common, noted in 13.5% of cases (16 on the right side and 11 on the left side).The chi-square value (0.195) and P-value (0.907) indicate no statistically significant difference in the distribution of glenoid cavity shapes between the right and left sides. This suggests that the shape distribution of the glenoid cavity is symmetrical between the two sides.

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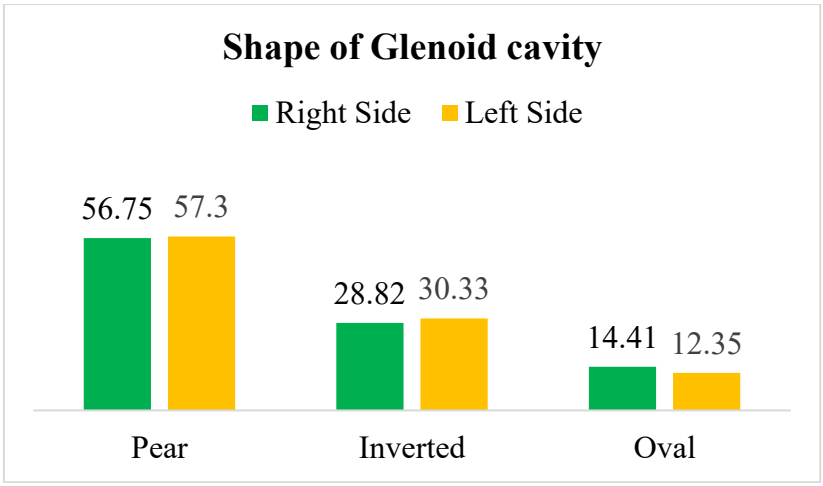

Figure 2: Shape of glenoid cavity in Right and Left side

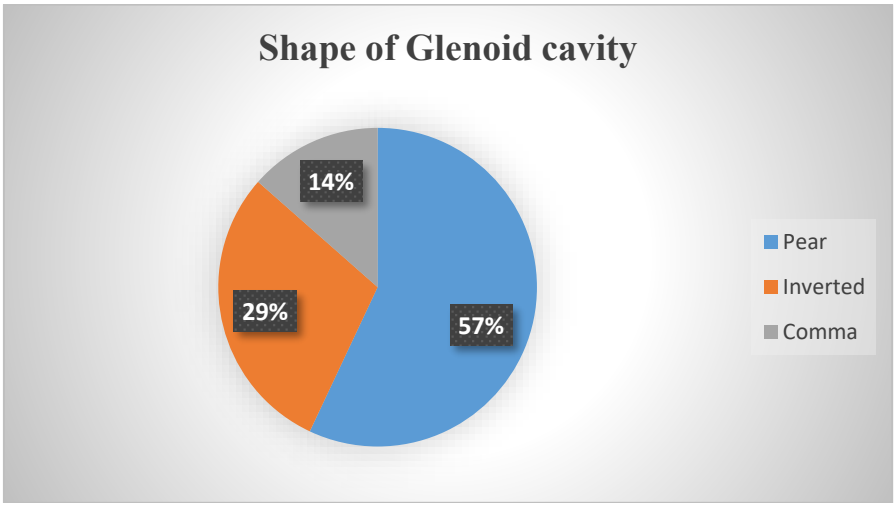

Figure 3: Overall Shape of the Glenoid cavity

DISCUSSION

The glenoid cavity, part of the scapula, plays a critical role in shoulder stability, mobility and function (1,2). Variations in its shape have significant implications for understanding normal anatomy, surgical planning, and prosthetic designs (5,13). In the present study conducted on 200 scapulae from Rajasthan, India, pear-shaped glenoid cavity was found to be the most common type on both right (56.75%) and left (57%) sides, followed by inverted comma shape (28.82% right, 30.33% left) and oval shape (14.41% right, 12.35% left). These findings align closely with several Indian studies. Sarwar et al. (2015) in Maharashtra reported a similar predominance of pear shape (56% right, 64% left), and Panigrahi et al. (2023) from Odisha also noted a higher incidence (57.8% right, 50% left) of pear-shaped cavities (7,8). Studies by Patil (2014) and Sahana et al. (2018) from Mangalore and Karnataka, respectively, have documented comparable predominance of pear shape, confirming its common occurrence in Indian populations (9,14).

However, some Indian studies have reported a relatively lower incidence of pear-shaped glenoids. Mamatha et al. (2011) from Manipal observed pear shapes in 46% (right) and 43% (left), Rajput et al. (2012) from Gujarat reported 49% (right) and 46% (left), and Dhindsa and Singh (2014) from Punjab noted 48.78% (right) and 46.15% (left). These variations may be attributed to regional, genetic, and ethnic differences(15-17). Conversely, Philip et al. (2018) from Karnataka reported a notably higher percentage of pear shape (65.3% right, 62.2% left), exceeding our observations and emphasizing inter-regional variability (18).

The inverted comma-shaped glenoid cavity, which ranked as the second most common type in our study, was observed in 28.82% (right) and 30.33% (left). These results align with several Indian studies: Dope (2017) from Maharashtra (30% right, 35% left), Parmar (2017) from Rajasthan (26.66% right, 36.30% left), and Dhindsa and Singh (2014) from Punjab (29.26% right, 35.89% left) (10,17,19). Similarly, Mamatha et al. (2011) and Patil (2014) also reported comparable proportions of inverted comma-shaped glenoids, indicating that this shape is consistently the second most common type in India (9, 15).

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The oval-shaped glenoid cavity, identified as the least common in our study (14.41% right, 12.35% left), shows greater variability across studies. For instance, Gosavi et al. (2014) observed a much higher prevalence of oval shapes (32.25% right, 43.75% left), and Chhabra et al. (2015) from Delhi also reported a relatively higher proportion (30.9% right, 32.40% left) (20,21).In contrast, studies by Kumar et al. (2016) and Patil (2014) reported lower percentages of oval shapes, more consistent with our findings (9, 22).

Interestingly, certain Indian studies show contrasting patterns. Yadav (2019) from Uttar Pradesh reported inverted comma shape as the predominant form (66.6% right, 38.8% left), diverging from the pear shape predominance noted in our study (23). Similarly, Sinha et al. (2016) from Sikkim found a low prevalence of pear shapes (23% right, 42% left), emphasizing strong regional variation (11). In contrast, Philip et al. (2018) and Raaj (2018) from Tamil Nadu observed an exceptionally high percentage of pear-shaped glenoids (18, 24). Recent studies, such as Sehmi et al. (2022) from Punjab (50% right, 55.17% left), Chaturvedi (2022) from Madhya Pradesh (62% right, 63% left), and Joshi and Pakhale (2023) from Maharashtra (46.66% right, 45.55% left), corroborate the predominance of pear shape, demonstrating that our findings are well-aligned with contemporary Indian data, though regional variations are evident (12,25,26).

When compared with foreign studies, both similarities and notable differences emerge. Gamal et al. (2015) from Egypt found pear-shaped glenoid cavities to be 44.47% (right) and 46.67% (left), which, while lower than our observations, still established pear shape as the predominant form in their population (27). Interestingly, their reported incidence of inverted comma-shaped cavities (31.58% right, 30% left) closely matches our findings, suggesting some regional parallels. In contrast, el din et al. (2015), also from Egypt, found oval shape to be the most common (48.75% right, 52.50% left), a finding that differs sharply from ours where oval was the least common(28). Such differences likely reflect ethnic, genetic, and environmental influences on scapular morphology. Further, Alashkham et al. (2017) from the United Kingdom reported a higher incidence of inverted comma shape, especially in males (53%) and females (26%), while pear shape was observed only in 23% of males and 31% of females, markedly lower than our study's 57% (29). This suggests population-based morphological differences. Supporting this, Ugwa et al. (2019) from Nigeria also found a higher frequency of inverted comma shapes (50% right, 36.73% left) and a lower prevalence of pear shape (28.57% right, 42.86% left) compared to our data (30). Khan (2019) from South Africa reported even lower percentages for all shapes, with pear shape (14% right, 15.2% left), inverted comma (16.5% right, 11% left), and oval (18.3% right, 25% left), suggesting a different distribution pattern, where oval shape may be relatively more common, unlike our findings(31). Additionally, Alkesan et al. (2022) from Egypt reported pear-shaped cavities in 50% (right) and 45% (left), which are comparable to our results, though they also noted a higher incidence of inverted comma shape (35% right, 40% left), indicating regional variability even within the same country (32).

In summary, pear-shaped glenoid cavity emerges as the most common type in our study, Consistent with several Indian and foreign studies like those by Gamal et al. (2015) and Alkesan et al. (2022). However, it is less prevalent in regions like the UK (Alashkham et al., 2017), Nigeria (Ugwa et al., 2019), and South Africa (Khan, 2019), where inverted comma and oval shapes are more prominent. The inverted comma-shaped glenoid, second most common in our study, is noted as predominant in the UK and Nigerian populations, reflecting morphological diversity. The oval shape, least common in our study, is reported as most frequent in some populations like in Wael Amin el din et al. (2015), highlighting regional and population-based differences.

CONCLUSION

The findings of the study shows that while the pear-shaped glenoid cavity remains the most dominant morphology, the relative distribution of glenoid cavity shapes—particularly inverted comma and oval—varies considerably across different populations. These findings not only highlight regional anatomical diversity but also hold significant clinical relevance. Understanding these morphological variations is essential for orthopedic surgeons, prosthesis designers, and anatomists, as it aids in precise surgical interventions, prosthetic fittings, shoulder joint reconstructions, and ultimately contributes to improved patient outcomes.

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