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Original Research

Morphometry of the Glenoid Cavity of Dry Scapulae of Human Adults

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ABSTRACT

Objective: The shoulder joint is considered the most unstable in the human body and this is due to the measurement relationships between the bone surfaces of its components. This joint is subject to frequent dislocations, which can result in acute fracture or gradual bone loss, which can lead to recurrent instability, additional injury and pain. In this study, it was aimed to carry out a study of the maximum height and width measurements of the glenoid cavity of dry scapulae, correlating them with sex and dimidium.

Methods: Measurements of the maximum heights and widths of 90 dry scapulae glenoid cavities were performed using a 0.01 mm precision digital caliper, 54 were males and 36 were females, with a mean age of 51.9 years. Values of $p<0.05$ were considered statistically significant.

Results: In general, the height and width measurements of the glenoid cavity, as well as the correlation between these measurements in relation to gender, were slightly higher in the right side ($p>0.05$). When we correlated the mean height and width of the GC with respect to homologous sides and sexes, they were also higher in males, but this finding was statistically significant ($p<0.05$).

Conclusion: The findings of these measurements of the glenoid cavity represent a contribution not only for anatomy, but especially for orthopedists, when planning shoulder arthroplasty procedures, as well as helping the industry to develop more accurate and functional joint prostheses for the Brazilian population.

Keywords: Glenoid cavity; arthroplasty, replacement, shoulder; shoulder joint; surgery; anatomy; anthropometry.

INTRODUCTION

The scapula is a flat triangular bone located posterolaterally in the rib cage in the projection of the second to seventh rib. Its lateral angle is truncated and is characterized by the presence of the glenoid cavity (GC), which articulates with the head of the humerus, forming the glenohumeral joint. This joint is more prone to dislocation than other joints in the human body, (1) where there is a discrepancy between the morphology of the GC and the humeral head (2).

In a joint, the relationship between the bone surfaces of its components is very important. This is essential for its stability and the understanding of its biomechanical behavior during loading and movement, in terms of the forces transmitted by this joint and its kinematics (2). Considered as the most unstable in the human body, the glenohumeral joint is subject to frequent dislocations, which can result in acute fracture or gradual bone loss, which can lead to recurrent instability, additional injury and pain (3,4).

The scenario of loss of more than 20% of the scapulae GC width is considered a significant bone deficiency (5,6). Thus, bone augmentation procedures are necessary to restore glenohumeral stability, minimizing the risk of recurrence of instability and bone loss by friction (6,7). As far as we know, measurement parameters such as GC height and width are of great importance when planning sizing, positioning, and prosthetic design for total shoulder arthroplasty (8-10). Therefore, our objective was to carry out a study of the maximum height and width measurements of the GC of dry scapulae, correlating them with sex and dimidium.

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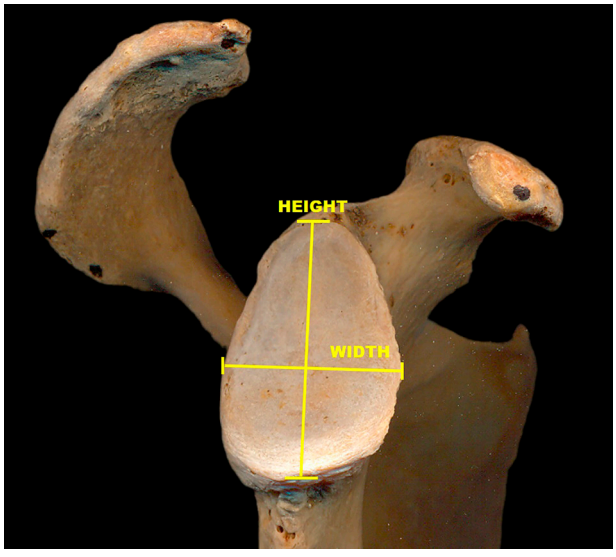
METHODS

Measurements were taken of the maximum heights and widths of 90 GC of scapulae, 54 were male (27 right and 27 left) and 36 female (18 right and 18 left), with a mean age of 51.9 years, all belonging to the Laboratory of Anatomy.

The maximum height of the GC was measured from the supraglenoid tubercle to its lower margin (largest vertical axis), and its maximum width was measured below the notch of the GC, in its longest transverse axis (**Figure** 1). All these measurements were performed using a 0.01 mm precision digital caliper.

Figure 1. Height and width of the glenoid cavity



This research project was approved by the Ethics Committee for Research Involving Human Beings under protocol no. CAAE 0041.0.107.000-08. No free and informed consent statement was applied because this was a study on cadavers. The scapulas were obtained in accordance with Law 8501, of November 30, 1992, which makes provisions regarding the use of unreclaimed cadavers for the purposes of scientific studies or research.

Main Points:

- The glenoid cavity is essential for its stability and the understanding of its biomechanical behavior during loading and movement.
- The glenoid cavity bone augmentation procedures are necessary to restore glenohumeral stability, minimizing the risk of recurrence of instability and bone loss by friction
- The morphometric variations of the scapula glenoid cavity are very important in the assessment of rotator cuff diseases, shoulder dislocation and in determining the appropriate size of the glenoid component in shoulder arthroplasty
- The findings were compared with those performed in different population groups, where these measurements were performed in different ways

Statistical Analysis

Variables were expressed as mean and standard deviation. To analyze the data collected, the t-Student test was used for independent or unpaired samples, to compare the values of the scapula GC measurements in relation to sex and dimidium. Values of $p<0.05$ were considered statistically significant. Data were analyzed using the Bioestat 5.3 Program (Instituto de Desenvolvimento Sustentável Mamirauá, Belém, Pará, Brasil).

RESULT

In general, the height and width measurements of the GC were slightly higher in the right side (Table 1). This finding, however, was not statistically significant ($p> 0.05$).

When correlating the height and width measurements of the GC in the same sex in relation to the right and left sides, it can be observed that these measurements, for the most part, were greater in the right side than in the left side (Table 2). This finding was not statistically significant ($p>0.05$).

Correlating the mean height and width of the GC with the homologous sides and genders, it was found that these measures were greater in males (Table 3). This finding was statistically significant ($p<0.05$).

DISCUSSION

The relationship between the anatomy of the bone elements and the stability of a joint is of great importance in understanding its biomechanical behavior during load and movement, in the forces transmitted through the joint and its kinematics, and this occurs, especially in the shoulder joint, where there is a discrepancy between the shape of the GC of the scapula and the head of the humerus.

The morphometric variations of the scapula GC are very important in the assessment of rotator cuff diseases, shoulder dislocation and in determining the appropriate size of the glenoid component in shoulder arthroplasty (11), as well as in the prognosis in glenohumeral osteoarthritis (12). In the present study, measurements of the height and width of the GC of dry scapulae were carried out in a population sample from the located in the northeast region of Brazil. The findings were compared with those performed in different population groups, where these measurements were performed in different ways: direct from embalmed corpses, direct from dry scapulae, by computed tomography of scapulae removed from corpses or using acrylic resin modems. In our study, performed on dry scapulae, the average height ranged from 25.3 to 40.04 mm in males and from 29.14 to 34.99 mm in females, while the average width in males ranged from 22.7 to 36.09 mm and in females was 19.8 to 26.2 mm, which is also in agreement with the results found by several authors where these measurements were significantly higher in males (Table 4).

After measuring the height and width of the GC in relation to the right and left sides, our results were compared with those of other authors (Table 5).

Table 1. General morphometry of the glenoid cavity according to the dimidium

	n	Dimidium	Minimum	Maximum	Mean	SD	p
Height (mm)	45	Right	31.14	43.83	36.91	3.34	0.399
	45	Left	28.48	42.39	36.73	3.34	
Width (mm)	45	Right	21.81	35.27	26.51	3.41	0.961
	45	Left	21.11	31.89	25.62	3.02	

mm – milimeter
SD – standard deviation
T-Student test; p>0,05; Differences between the averages of height and width in relation to the dimidium.

Table 2. Glenoid cavity morphometry according to sex and dimidium

	Sex	n	Dimidium	Minimum	Maximum	Mean	SD	p
Height (mm)	Male	27	Right	31.16	41.95	37.93	2.83	0.3939
		27	Left	33.52	41.72	38.05	2.69	
	Female	18	Right	31.14	43.83	35.36	2.96	0.2363
		18	Left	24.48	42.39	34.62	3.16	
Width (mm)	Male	27	Right	21.81	35.27	28.4	3.12	0.0906
		27	Left	21.11	31.89	26.95	2.72	
	Female	18	Right	21.91	31.66	24.23	2.47	0.2230
		18	Left	21.41	30.01	23.62	2.28	

SD – standard deviation
mm – milimeter
T-Student test; p>0,05; Differences between the averages of height and width in relation to the dimidium.

Table 3. Correlation of mean height and width of the glenoid cavity between homologous dimidiums and sexes

	Dimidium	Sex	n	Mean	SD	p
Height (mm)	Right	Male	27	37.93	2.83	*0.0028
		Female	18	35.36	2.96	
	Left	Male	27	38.05	2.69	*0.0001
		Female	18	34.62	3.16	
Width (mm)	Right	Male	27	28.4	3.12	*0.0000
		Female	18	24.23	2.47	
	Left	Male	27	26.95	2.72	*0.0001
		Female	18	23.26	2.28	

SD – standard deviation
mm – milimeter
T-Student test; *p< 0,05; Differences between mean height and width in relation to homologous dimidiums and sex.

Observing this table, it can be noted that the values of the present study were similar to those of most studies. In the present study, the mean height of the right GC of the scapula was 36.91±3.34 mm and 36.73±3.34 mm on the left. Meanwhile, the width of the right GC was 26.51±3.41 and the left 25.62±3.02. This shows that the height and width of the right GC is slightly larger than the left one, and that these differences were not statistically significant.

LIMITATIONS

The limitation of this study is the fact that there is a small number of scapulae, as well as an equal number of scapulae in both sexes.

CONCLUSION

Variations in the size of the scapula GC will be of great help for orthopedic surgeons to better understand the pathology of the shoulder and decide the appropriate size of the glenoid component for shoulder arthroplasty in northeastern Brazil. This will help establish relevant anatomical and clinical standards to improve medico-legal identification, make the diagnosis and determine the extent of orthopedic injuries, plan arthroplasty procedures, and develop more accurate and functional joint prostheses.

Table 4. Comparative table of height and width measurements of the scapula GC in relation to sex

Author	Population	Study	Sex	n	Mean height of the GC	Mean width of the GC
Polguj et al. (13)	European	Dry scapulae	Male	33	40.04±2.97	36.09±2.20
			Female	41	29.14±2.14	25.65±1.98
Mathews et al. (14)	European	Embalmed corpses	Male	14	39.5±3.5	30.3±3.3
			Female	22	34.8±2.2	26.2±1.6
Knapik et al. (15)	American	Dry scapulae	Male	813	-	29.6±2.1
			Female	181	-	24.7±1.7
Homem et al. (16)	Brazilian	Scapulae in acrylic resin model	Male	50	36.7±0.03	22.7±0.03
			Female	50	31.0±0.03	19.8±0.03
Chaijaroonkhanarak et al. (17)	Thai	Dry scapulae	Male	166	37.1±2.2	27.6±2.1
			Female	98	33.3±1.9	23.9±1.7
Jia et al. (18)	Chinese	Computed tomography	Male	55	-	29.09±2.27
			Female	29	-	25.52±1.72
Khan et al. (19)	African	Dry scapulae	Male	68	35.3±3.1	24.2±2.7
			Female	96	34.6±2.8	23.7±2.8
Present study	Brazilian	Dry scapulae	Male	54	38.04±2.71	27.49±2.95
			Female	36	34.99±3.04	23.93±2.36

Table 5. Correlation of morphometric measurements of the scapula GC in relation to the dimidium.

Author	Population	Dimidium	n	Mean height of the GC	Mean width of the GC
Mamatha et al. (20)	Indian	Right	98	33.67±2.82	23.35±2.04
		Left	104	33.92±2.87	23.05±2.30
Rajput et al. (21)	Indian	Right	43	34.76±3	23.31±3.00
		Left	57	34.43±3.21	22.92±2.80
Gandhi et al. (9)	Indian	Right	64	38.78±4.43	26.47±3.79
		Left	59	40.30±5.12	27.85±3.86
El-din, Ali, (11)	Egyptian	Right	80	38.88±2.63	28.31±2.38
		Left	80	39.01±2.49	27.99 ± 2.55
Akhtar et al. (10)	Indian	Right	126	36.03±3.15	23.67±2.53
		Left	102	35.52±3.12	23.59±2.47
Tiwari et al. (22)	Indian	Right	100	35.94±2.30	16.62±2.82
		Left	106	35.68±2.14	16.14±2.84
Raaj et al. (23)	Indian	Right	50	33.1±4.1	21.4±4.4
		Left	50	31.6±3.4	20.5±2.8
Singh, (1)	Indian	Right	91	33.4±3.0	15.4±2.0
		Left	81	33.9±3.6	15.3±2.2
Present study	Brazilian	Right	45	36.91±3.34	26.51±3.41
		Left	45	36.73±3.34	25,62±3.02

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Ethical Standards: The authors declared that the research has been performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki and its later amendments.

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