

Anthropometrical characteristic of *cavitas glenoidalis* and *caput humeri*

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The study aims to be obtained morphometrical data for *cavitas glenoidalis* and *caput humeri* in order to assess the intensity of the sexual differences and study the metrical relationships between these bone structures. *Cavitas glenoidalis* is measured in 65 male and 65 female scapulae and *caput humeri* – in 65 male and 65 female humeri. Three metrical features of *cavitas glenoidalis* and three metrical features of *caput humeri* are measured. The sexual differences are assessed by Wolansky's index for inter-group comparisons. The metrical data are statistically analyzed by linear correlation analysis as well. According to the results, *cavitas glenoidalis* of male and female scapulae differs most strongly in its depth and *caput humeri* – in its diameters. The correlation matrices show well pronounced dependences between the metrical features of *cavitas glenoidalis* and *caput humeri* separately as well as between the features of both bone structures. However, the relationship between the depth of *cavitas glenoidalis* and the height of *caput humeri* is the slightest one.

Key words: *cavitas glenoidalis*, *caput humeri*, metric features, sexual differences, correlations.

Introduction

Cavitas glenoidalis is a shallow articular surface, which is located on the lateral angle of the *scapula* and forms the glenohumeral joint along with *humerus*. This joint accomplishes the greatest mobility of all joints in the body. That determined *cavitas glenoidalis* and *caput humeri* as objects of the current study in order to be obtained morphometrical data for them both to assess the intensity of the sexual differences and study the metrical relationships between these bone structures.

Material and methods

The anthropological investigation is performed on osteological material from archaeological excavations of medieval necropolises in the territory of Northeastern Bulgaria. *Cavitas glenoidalis* was measured in 65 male and 65 female *scapulae* and *caput humeri* – in 65 male and 65 female *humeri*. Only adult skeletons with preserved pairs of *scapu-*

lae and *humeri* were chosen for the analysis. Skeletal sex and age were determined by standard anthropological methods [7, 12, 13].

The anthropological investigation includes three metrical features of *cavitas glenoidalis* and three metrical features of *caput humeri*. Features with numbers in brackets are described by the classical methods of Martin-Saller:

1. Length of *cavitas glenoidalis* (12), LCG – the linear distance between the highest point on the higher margin of *cavitas glenoidalis* and the lowest point on its lower margins, sliding caliper;
2. Breadth of *cavitas glenoidalis* (13), BCG – the linear distance between the outermost points on the lateral margins of *cavitas glenoidalis*, sliding caliper;
3. Depth of *cavitas glenoidalis* (14), DCG – the linear distance from the deepest point of *cavitas glenoidalis* to the line connecting points between which is measured the length of *cavitas glenoidalis*, coordinate caliper;
4. Greatest transversal diameter of *caput humeri* (9), GTDCH – the linear distance between the outermost points on the lateral margins of *caput humeri*, sliding caliper;
5. Greatest sagittal diameter of *caput humeri* (10), GSDCH – the linear distance between the highest point on the higher surface of *caput humeri* and the lowest point on its lower surface, sliding caliper;
6. Height of *caput humeri*, HCH – the distance from the most prominent point of *caput humeri* to the line connecting points between which is measured the sagittal diameter of *caput humeri*, coordinate caliper.

The metric data are statistically analyzed using SPSS version 16,0. The established sexual differences are evaluated by the Student's t-test at $p < 0,01$ and $p < 0,001$. The quantitative assessment of sexual differences is made by Wolansky's index for inter-group comparisons [11]. The index is used to determine the sexual differences and is called Index for Sexual Differences (ISD): $ISD = 2 \cdot (x_1 - x_2) \cdot 100 / (x_1 + x_2)$, where x_1 is the mean value of the feature in males and x_2 is the mean value of the feature in females. The positive values of ISD show sexual differences in favour of the males and the negative ones – sexual differences in favour of the females.

The metrical data are statistically analyzed by linear correlation analysis. The strength of relationships is assessed by the scheme, published by Kalinov [14]: very low correlation ($r \leq 0,30$), low ($r = 0,31 \div 0,50$), moderate ($r = 0,51 \div 0,70$), high ($r = 0,71 \div 0,90$) and very high ($r \geq 0,91$). The significance of the correlations is evaluated at $P < 0,05$ and $P < 0,01$. The positive sign of correlation coefficient shows that an increase in the value of one variable indicates a similar increase in the value of the second variable. A correlation coefficient of less than 0 indicates a negative correlation.

Results and discussion

Basic statistics on the metrical features of *cavitas glenoidalis* and *caput humeri* are presented in Table 1. All investigated features of *cavitas glenoidalis* and *caput humeri* are larger in the male scapulae. The sexual differences are statistically significant at $p < 0,001$ and the depth of *cavitas glenoidalis* in the left scapulae is the only one which shows a difference at $p < 0,01$. The average of the length and breadth of *cavitas glenoidalis* in our study are greater than the values reported by Churchill et al. [3], Frutos [4] and Özer et al. [8], which measured these diameters in the male and female scapulae separately.

As far as the bilateral differences are concerned, *cavitas glenoidalis* and *caput humeri* are larger on the right side in both sexes. Our results for the asymmetry of *cavitas*

Table 1. Biostatistic data of measurements of male and female scapulae and humeri

Features	Side	Male			Female			Sexual difference	
		n	\bar{x}	SD	n	\bar{x}	SD	Absolute difference	t
Length of <i>cavitas glenoidalis</i> (12)	right	37	41,8	2,4	33	36,7	2,9	5,1	8,1
	left	28	40,4	2,4	32	35,6	2,0	4,8	8,4
Breadth of <i>cavitas glenoidalis</i> (13)	right	37	29,1	1,7	33	25,3	1,6	3,8	9,3
	left	28	28,4	1,7	32	24,8	1,5	3,6	8,6
Depth of <i>cavitas glenoidalis</i> (14)	right	37	5,0	0,9	33	4,2	0,6	0,8	4,4
	left	28	4,7	0,8	32	4,1	0,8	0,6	2,7
Greatest transversal diameter of <i>caput humeri</i> (9)	right	37	45,1	2,6	33	39,1	2,5	6,0	9,7
	left	28	43,7	2,6	32	38,5	2,1	5,2	8,3
Greatest sagittal diameter of <i>caput humeri</i> (10)	right	37	47,9	2,5	33	41,9	2,6	6,0	9,7
	left	28	47,9	3,1	32	41,3	2,3	6,6	9,5
Height of <i>caput humeri</i>	right	37	18,1	1,5	33	15,9	1,5	2,2	6,1
	left	28	17,7	1,9	32	15,6	1,1	2,1	5,4

- P < 0,05; ** - P < 0,01; *** - P < 0,001

glenoidalis, especially about its length, differ from these ones obtained by Mamatha et al. [6], which show greater length of the cavity on the left side, but greater breadth on the right one. But yet Sato and Noriyasu [9] also established that *cavitas glenoidalis* and *caput humeri* are larger on the right side in both sexes. According to them, this appears to point to a wider range of motion in the right shoulder joint.

According to the ISD data in the right and left scapulae, the depth of *cavitas glenoidalis* shows the strongest sexual differences among the features of *cavitas glenoidalis*. It is followed by the breadth of *cavitas glenoidalis* and the last one is the length, which shows slightest sexual differences. The ISD data for the humeral features show that the strongest sexual differences in the right *humeri* are observed for the greatest transversal diameter of *caput humeri*, and in the left ones – for the greatest sagittal diameter. The height of *caput humeri* illustrates the slightest differences on both sides.

Correlations between anthropometric features of *cavitas glenoidalis* and *caput humeri* are presented in Table 2, Table 3, Table 4 and Table 5. The correlation matrices of both sexes show that most of the correlation coefficients are statistically significant, as the significance level in majority of the dependences is high ($P < 0,01$). The results of the comparative analysis of the dependences between the investigated features in both sexes show that only positive correlations are available among the statistically significant dependences.

Table 2. Significance, direction and degree of the correlations between anthropometric features of right male scapulae and humeri

Features	LCG	BCG	DCG	GTDCH	GSDCH	HCH
LCG	1	0.66**	0.67**	0.78**	0.66**	0.25
BCG		1	0.38*	0.71**	0.66**	0.46**
DCG			1	0.44**	0.09	-0.02
GTDCH				1	0.80**	0.49**
GSDCH					1	0.61**
HCH						1
Low degree		High and very high degrees		* P<0.05; ** P<0.01		

Table 3. Significance, direction and degree of the correlations between anthropometric features of left male scapulae and humeri

Features	LCG	BCG	DCG	GTDCH	GSDCH	HCH
LCG	1	0.69**	0.57**	0.76**	0.72**	0.46*
BCG		1	0.31*	0.62**	0.63**	0.50**
DCG			1	0.44**	0.36	-0.01
GTDCH				1	0.85**	0.47*
GSDCH					1	0.59**
HCH						1
Low degree		High and very high degrees		* P<0.05; ** P<0.01		

Table 4. Significance, direction and degree of the correlations between anthropometric features of right female scapulae and humeri

Features	LCG	BCG	DCG	GTDCH	GSDCH	HCH
LCG	1	0.84**	0.53**	0.76**	0.71**	0.50*
BCG		1	0.56**	0.73**	0.71**	0.50**
DCG			1	0.21**	0.15	0.17
GTDCH				1	0.86**	0.58**
GSDCH					1	0.81**
HCH						1
	Low degree	Moderate degree	High and very high degrees		* P<0.05; ** P<0.01	

Table 5. Significance, direction and degree of the correlations between anthropometric features of left female scapulae and humeri

Features	LCG	BCG	DCG	GTDCH	GSDCH	HCH
LCG	1	0.61**	0.60**	0.36*	0.53**	0.29
BCG		1	0.56**	0.30	0.70**	0.50**
DCG			1	0.14	0.37*	0.44**
GTDCH				1	0.35*	0.24
GSDCH					1	
HCH						1
	Low degree	Moderate degree	High and very high degrees		* P<0.05; ** P<0.01	

The features of *cavitas glenoidalis* in both sexes correlate with each other predominantly of a moderate degree. The relationship between the breadth and depth of *cavitas glenoidalis* in the male *scapulae* is an exception and the degree is “low” on the both sides. A different degree is also found in the relationship between the length and breadth of *cavitas glenoidalis* in the right female *scapulae*, but it is “high”. According to Bukov et al. [1], the length and breadth of *cavitas glenoidalis* correlate of a high degree, and the dependences between these lengthwise features and the height of *cavitas glenoidalis* are of low and moderate degrees, which resembles to our results, although they have not studied male and female *scapulae* separately.

The correlations between the features of *caput humeri* in both right and left male humeri show that both diameters correlate of a high degree, the sagittal diameter and the height correlate of a moderate degree and the transversal diameter and the height – of a low degree. In the right female *humeri*, the sagittal diameter correlates with the other two features of a high degree, and the transversal diameter and the height correlate of a moderate degree. Bukov et al. [2] also established a high correlation between both diameters of *caput humeri*. The correlations in the left female bones are lower, and the transversal diameter depends on the other two features of a low degree; the sagittal diameter and the height correlate of a moderate degree. Similar results for correlations between features of *caput humeri* are reported in our previous study, devoted to the correlations between humeral length and features of the proximal humeral end [10].

The results obtained for the dependences between the features of *cavitas glenoidalis* and these ones of *caput humeri* are the most interesting in order to be studied the metrical relationships between these bone structures. The length and breadth of *cavitas glenoidalis* and both diameters of *caput humeri* in male bones correlate strongly and the degrees are “moderate” and “high”. Such degrees are observed in the right bones of female skeletons. But in the left ones, a moderate degree is found only between the length and breadth of *cavitas glenoidalis* and the sagittal diameter of *caput humeri*; the correlations with the transversal diameter are of a low degree.

The length of *cavitas glenoidalis* and the height of *caput humeri* correlate with each other comparatively poorly. The breadth of *cavitas glenoidalis* and the height show slightly higher correlation coefficients, which are of a moderate degree or on the border between the categories “low” and “moderate”.

The correlations between the depth of *cavitas glenoidalis* and both diameters of *caput humeri* are low or very low, and only the correlation with the transversal diameter in the male bones and this one with the sagittal diameter in the left female bones are statistically significant. The relationship between the depth of *cavitas glenoidalis* and the height of *caput humeri* is unexpectedly slightly, as in male bones it is even negative. Only in the left bones of female skeletons this dependence is a bit higher and statistically significant. A possible reason for this result is that *cavitas glenoidalis* and *caput humeri* do not fit perfectly to each other and there are many other structures (muscles, tendons, ligaments, bursae), which take part in the shoulder joint. *Cavitas glenoidalis* (with labrum glenoidale) covers only one quarter to one third of the surface of *caput humeri* and to keep the humeral head in close contact with the cavity a number of muscles blend with the capsule to form the rotator cuff [5].

The dimensions of *cavitas glenoidalis* and *caput humeri* as well as the relationships between their shapes are of great importance for the understanding of variations in normal anatomy and they could be considered in cases of shoulder arthroplasty.

Conclusions

Cavitas glenoidalis and *caput humeri* are larger in male skeletons. In both sexes the right *scapulae* and right *humeri* has greater *cavitas glenoidalis* and *caput humeri* respectively, than the left ones.

The comparative assessment of the sexual differences shows that *cavitas glenoidalis* of male and female *scapulae* differ most strongly in its depth, and *caput humeri* – in its diameters.

The correlation matrices show well pronounced dependences between the metrical features of *cavitas glenoidalis* and *caput humeri* separately as well as between the features of both bone structures. Nevertheless, the relationship between the depth of *cavitas glenoidalis* and the height of *caput humeri* is the slightest one. Remarkable bilateral differences are observed in the female correlation matrices and the correlations in the left female bones are an exception to the mentioned above.

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