Original Article

SEXUAL DIFFERENCES IN ANTHROPOMETRIC FEATURES OF THE PROXIMAL END OF HUMAN HUMERUS

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Summary

The aim of this study is to make basic anthropometric characteristics of the proximal end of humerus and to assess in comparative plan sexual differences in the investigated features. The anthropological investigation was done on osteological material from archaeological excavations of mediaeval necropoleis. A total of 381 humeri (88 right and 82 left in male skeletons, 105 right and 106 left in female skeletons) were investigated. All investigated humeri belong to adult individuals. Five metric features were measured and three indices were calculated. The quantitative assessment of sexual differences was made by Wolanski's index for inter-group comparisons. The established sexual differences were assessed by the Student's t-test at $P < 0,001$. The results about the anthropometric features show that male humeri have more massive proximal end with relatively greater and higher *caput humeri*, in comparison with female ones.

Key words: humerus, proximal end, anthropometric features, sexual differences

Introduction

One of the main tasks in the osteological investigations is the assessment of sexual differences in size and form of the respective bones. Human humerus is from the bones which allow to be obtained objective data to establish these differences. Generally, the male humerus has greater anthropometric measurements and they are more massive than the female one. Based on the osteological investigation of sexual dimorphism in the human humerus, France [1] establishes that the best distinguishing features for sex determination are the metric ones, and best of them are located in the proximal humeral end.

The aim of this study is to make basic anthropometric characteristics of the proximal end of humerus and to assess in comparative plan the established sexual differences.

Materials and Methods

The anthropological investigation was done on osteological material from archaeological excavations of mediaeval necropolis. A total of 381 humeri (88 right and 82 left in male skeletons, 105 right and 106 left in female skeletons) were investigated. All investigated humeri belong to adult individuals. The sex and age were determined previously by metric and scopic features of cranium and postcranial bones after the methods described by R. Martin and K. Saller [2], V.P. Alekseev [3], ect.

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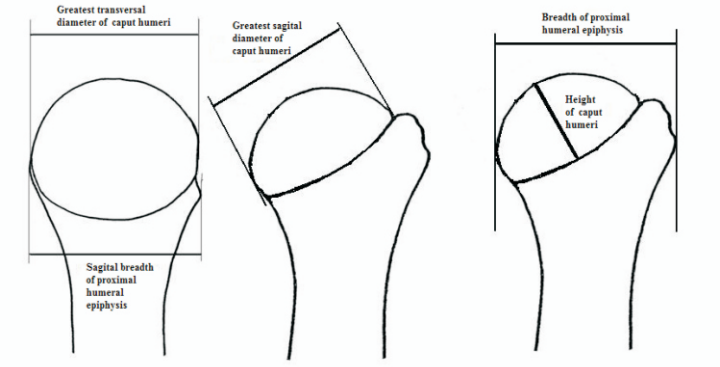
Five metric features were measured and three indices were calculated (Figure 1). The anthropometric investigation of breadth of proximal humeral epiphysis, greatest transversal diameter of caput humeri, greatest sagital diameter of *caput humeri* and index of transversal section of caput humeri, was done after the classical methods of R. Martin and K. Saller [2] and V.P. Alekseev [3]. Two of the features - height of *caput humeri* and sagital breadth of proximal humeral epiphysis, and two of the indices - height index of *caput humeri* and index of proximal humeral epiphysis, are introduced by us. The height of *caput humeri* is the projection distance from the most prominent point on *caput humeri* to the straight line formed by the sagital diameter. The sagital breadth of proximal humeral epiphysis is the direct distance between the most prominent point on *tuberculum minus* and the outermost point on the opposite surface of the bone in the sagital plane.

The metrical data were statistically estimated using SPSS version 13.0. The established sexual differences were assessed by the Student's t-test at $P < 0.001$. The quantitative comparative assessment of sexual differences was made by Wolanski's index for inter-group comparisons [4]. The index in this study is used for assessment of the differences between both sexes and is called Index for Sexual Differences (ISD): $ISD = 2.(x_1 - x_2).100 / (x_1 + x_2)$;

x_1 - mean value of the feature in male humerus, x_2 - mean value of the feature in female humerus.

The positive values of ISD show sexual differences in favour of the male humeri and the negative ones - sexual differences in favour of the female humeri.



Results and Discussion

The main biostatistical results of the study are given in Table 1.

Table 1. Biostatistical characteristic of male and female humeri

	Features	Side	Male						Female						Sexual differences	
			n	mean	SD	SEM	min	max	n	mean	SD	SEM	min	max	t-test	ISD
1	Greatest transversal diameter of *c.humeri*	right	77	45.1	2.4	0.3	37.0	53.0	87	39.3	2.2	0.2	34.5	45.0	P <0.001	13.7
		left	68	44.0	2.8	0.3	36.0	51.5	88	39.3	3.0	0.3	35.0	55.5	P <0.001	11.3
2	Greatest sagital diameter of *c.humeri*	right	86	48.1	2.8	0.3	40.0	54.5	103	41.8	2.4	0.2	35.0	47.5	P <0.001	14.0
		left	76	47.7	3.0	0.3	37.5	54.5	104	41.5	2.4	0.2	36.0	48.0	P <0.001	13.9
3	Height of *c.humeri*	right	75	17.9	1.5	0.2	13.0	21.5	96	15.6	1.4	0.1	11.5	19.5	P <0.001	13.7
		left	67	17.8	1.7	0.2	14.0	22.5	98	15.6	1.2	0.1	12.5	19.0	P <0.001	13.2
4	Breadth of proximal humeral epiphysis	right	73	51.0	2.7	0.3	42.0	59.0	91	44.9	2.7	0.3	39.0	56.0	P <0.001	12.7
		left	62	51.1	2.9	0.4	43.0	58.0	83	45.6	3.1	0.3	38.0	58.0	P <0.001	11.4
5	Sagital breadth of proximal humeral epiphysis	right	70	48.0	3.0	0.4	40.0	55.0	83	42.3	2.8	0.3	35.0	53.0	P <0.001	12.6
		left	56	47.1	3.2	0.4	39.0	55.0	81	41.8	2.7	0.3	36.0	53.0	P <0.001	11.9
6	Index of transversal section of *c.humeri*	right	76	94.0	3.7	0.4	84.2	102.4	85	94.1	3.8	0.4	85.7	106.7	P =0.881	-0.1
		left	67	92.2	4.1	0.5	82.9	110.1	87	94.6	7.2	0.8	86.1	146.1	P =0.014	-2.6
7	Height index of *c.humeri*	right	75	37.4	2.3	0.3	31.7	42.3	96	37.4	2.6	0.3	30.3	44.3	P =0.922	0.0
		left	66	37.5	2.9	0.4	32.0	45.5	97	37.6	2.3	0.2	30.9	45.8	P =0.940	-0.3
8	Index of proximal humeral epiphysis	right	68	94.5	4.6	0.6	78.9	102.2	78	94.5	3.8	0.4	87.5	104.4	P =0.915	-0.1
		left	55	92.4	4.5	0.6	83.3	102.2	75	91.9	3.4	0.4	74.1	97.8	P =0.471	0.5

The data about **greatest transversal diameter of *caput humeri*** show that male humeri have greater transversal diameter of *caput humeri*, compared to the female ones. The male-female differences are respectively 5.8 mm in the right humeri and 4.7 mm in the left ones and they are statistically significant at $P < 0.001$. The transversal diameter of caput humeri in male skeletons is greater for the right humeri, but *caput humeri* in female skeletons has equally large transversal diameter in both right and left humeri.

The **greatest sagital diameter of *caput humeri*** is greater in the male skeletons. The mean values on the right and on the left side are respectively by 6.3 mm and by 6.2 mm greater than these in the female humeri. The sexual differences are statistically significant ($P < 0.001$). The right humeri in both sexes have a slightly greater sagital diameter of *caput humeri* in comparison with the left humeri.

The mean values of the **height of *caput humeri*** in male skeletons are 17.9±0.2 mm in the right and 17.8±0.2 mm in the left humeri. This feature in female skeletons has smaller mean values. The male-female differences are respectively 2.3 mm on the right side and 2.2 mm on the left side. They are statistically significant at $P < 0.001$. The right humeri of male skeletons have a slightly higher *caput humeri* than the left ones, and *caput humeri* in the female skeletons again is equally high in both right and left humeri.

The **breadth of proximal humeral epiphysis** has mean values for male skeletons 51.0±0.3 mm in right humeri and 51.1±0.4 mm in left ones respectively. The mean values of this feature in female skeletons are smaller of these in male skeletons by 6.1 mm on the right side and 5.5 mm on the left side. The established sexual differences are statistically significant at $P < 0.001$. The right humeri of both sexes have wider proximal epiphysis in comparison with the left ones, but the right-left differences in male skeletons are very small.

The **sagital breadth of proximal humeral epiphysis** in the right and in the left humeri of male skeletons has greater mean values in comparison with the female humeri - respectively by 5.7 mm on the right side and by 5.3 mm on the left side. The established differences between both sexes are statistically significant at $P < 0.001$. The right humeri in both sexes have greater sagital breadth of proximal epiphysis, compared to the left ones.

The data about indices of proximal humeral end characterize its form and proportionality.

The **index of transversal section of caput humeri** determines the proportion between the greatest transversal diameter of *caput humeri* and its greatest sagital diameter. The mean index values are greater in the female humeri, as the sexual difference is only 0.1% for the right humeri and it is 2.4% for the left ones. The differences between both sexes are statistically significant only in the left humeri ($P < 0.01$). The greater values in female skeletons show that their *caput humeri* have proportionally greater transversal diameter in relation to the sagital diameter, in comparison with *caput humeri* in male skeletons. The right humeri of male skeletons have relatively greater transversal diameter in relation to the sagital one, but the transversal diameter of *caput humeri* in female skeletons is relatively slightly greater in the left humeri.

The **height index of *caput humeri*** determines the proportion of the height of *caput humeri* towards the greatest sagital diameter. The sexual differences for this index are missing in the right humeri, but the index mean values in the left humeri are slightly greater in the female skeletons in comparison with these of male skeletons, and this male-female difference is not statistically significant. The results obtained for the left humeri show that proportionally *caput humeri* in female skeletons is a bit higher in relation to its sagital diameter, compared to the left *caput humeri* of male skeletons. The left humeri in both sexes have relatively slightly greater height of *caput humeri* in relation to the greatest sagital diameter, in comparison with the right *caput humeri*.

The **index of proximal humeral epiphysis** determines the proportion between the sagital breadth of proximal epiphysis and the breadth of proximal humeral epiphysis. According to the results, this index has equal mean values in the right humeri of both male and female skeletons. But the index in the left humeri has greater values in male skeletons as the difference is only 0.5% and it is not statistically significant. The greater index values for left male humeri show in them a tendency to relatively greater sagital breadth of the proximal epiphysis in relation to the breadth of proximal humeral epiphysis in comparison with the left humeri of female skeletons. The right humeri in both sexes have relatively greater sagital breadth of proximal epiphysis in relation to the breadth of proximal humeral epiphysis, compared to their left humeri.

Comparative assessment of the sexual differences in the anthropometric features of proximal humeral end on the basis of ISD values

According to the results about sexual differences in the direct measured features of proximal humeral end is established the presence of sexual differences in the measurements of all investigated metric features in the right and the left humeri. All investigated metric features have greater values in the male humeri than the female ones. The sexual differences of measured features in the right and in the left humeri are statistically significant at a very high level of significance ($P < 0.001$). According to the ISD results, all metric features in both right and left humeri show average pronounced differences between both sexes.

After the ISD data for the indices of proximal humeral end, sexual differences are established only for a part of them. Among the calculated indices, statistically significant differences between both sexes are established only for the index of transversal section of *caput humeri* in the left humeri ($P < 0.01$).

The sexual differences in the right humeri for the index of transversal section of *caput humeri* and the index of proximal humeral epiphysis are very slightly pronounced. The differences between both sexes for the height index of *caput humeri* are not reported.

The index of transversal section of caput humeri in the left humeri shows stronger pronounced sexual differences in comparison with the rest of indices, which show more weakly pronounced differences.

Conclusions

According to the results about directly measured features, the male humeri have bigger and more massive proximal end in comparison with the female humeri. The comparative assessment of sexual differences by ISD shows that the sexual differences in the right and in the left humeri are most emphasized for the greatest sagital diameter of *caput humeri*.

The right humeri in both sexes have comparatively greater measurements, compared to the left ones.

The results about indices of the right humeri do not show perceptible sexual differences in their proportionality, while the transversal diameter and the height of caput humeri in the left humeri of female skeletons have relatively greater measurements in relation to the sagital diameter, compared to these in the male skeletons.

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