

Bilateral Asymmetry of Human Clavicle (Osteological Investigation)

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The aim of the study is to make a comparative assessment of the manifestations of asymmetry in lengths, diameters, circumference and heights of clavicle and to seek for sexual differences in direction and degree of established asymmetry. A total of 136 clavicles (36 right and 36 left clavicles of male skeletons; 32 right and 32 left clavicles of female skeletons) were investigated. All investigated clavicles belong to adult individuals. Ten metric features were measured. It is established, that the left clavicles in both sexes are longer than the right ones, but the right clavicles are more massive and more curved, compared to the left ones.

Key words: clavicle, anthropometric features, asymmetry.

Introduction

The metrical characterization of pair bones in human skeleton contributes the manifestations of bilateral asymmetry in human body to be established. Scarce data in the specialized literature on asymmetry in the clavicle determine the aim of this study – to make a comparative assessment of the manifestations of asymmetry in lengths, diameters, circumference and heights of clavicle and to seek for sexual differences in the direction and degree of established asymmetry.

Material and Methods

The anthropological investigation was done on osteological material from archaeological excavations. A total of 136 clavicles (36 right and 36 left clavicles of male skeletons; 32 right and 32 left clavicles of female skeletons), belonging to adult individuals, were investigated. The sex and age were determined previously by metric and scopic features of cranium and postcranial bones described by R. Martin – K. Saller [5], V. P. Alekseev [9], etc.

The anthropometric investigation was done mostly after the classical methods of R. Martin and K. Saller [5] and V. P. Alekseev [9]. Ten metric features were measured and, for eight of them, the numbers assigned by Martin are marked in brack-

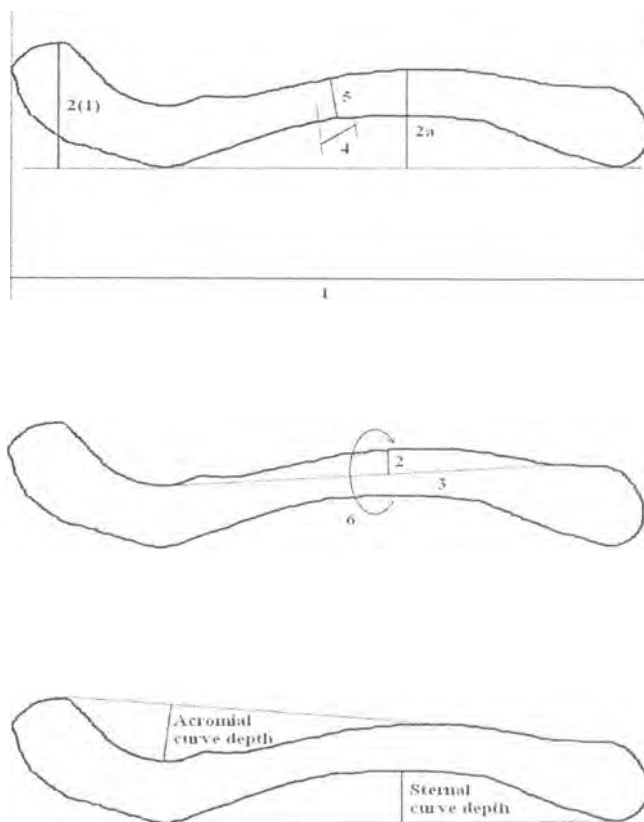


Fig. 1. Measurements of clavicle – greatest clavicle length (1), length of corpus curve basis (2), middle vertical diameter (4), middle sagittal diameter (5), middle circumference (6), height of corpus curve (2), height of corpus curve (2a), acromial end curve (2(1)), sternal curve depth, acromial curve depth

ets (Fig. 1). Both heights of corpus curve were marked conditionally as first height of corpus curve (2) and second height of corpus curve (2a). The sternal curve depth and acromial curve depth are introduced by us.

The metrical data were statistically analyzed using SPSS version 13.0. The reliability of established bilateral asymmetry was verified by the U-test of Mann – Whitney at $P < 0.05$. The quantitative assessment of the bilateral asymmetry was made using the relative index of Wolanski for inter-group comparisons [8]. The index in this study is used for determination of the asymmetry and is called Index for Asymmetry (IA):

$$IA = \frac{2 \cdot (x_1 - x_2) \cdot 100}{x_1 + x_2}$$

x_1 – mean value of the feature in right clavicle; x_2 – mean value of the feature in left clavicle.

The degree of bilateral asymmetry was assessed by percentile analysis according to the data of IA. The border values were set at P_{25} ($P_{25} = 0.62$ IE) and P_{75} ($P_{75} = 2.49$ IE). The bilateral asymmetry is slight at values of IA less than 0.61 IU, the asymmetry

is moderate at values between 0.62 IU and 2.48 IU, and it is strong at values more than 2.49 IU. The positive sign of IA shows right-side asymmetry and the negative one – left-side asymmetry.

Results

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

Length features of clavicle

Both length features of the clavicle, which are measured, give general information on the clavicle size. After the results obtained for first feature, the left clavicles of male and female skeletons have greater lengths than the right ones. The bilateral differences are statistically significant for female clavicles only. The greater length of left clavicles in both sexes observed in the present study confirms the results of many authors (Terry [7], Singh and Gangrade [6], Jit and Shani [2] and Kaur et al. [4]). However, this is refuted by Bilodi et al. [1], which results show greater length for the right clavicles. The length of corpus curve basis also has greater values in left clavicles of both sexes. The bilateral differences for this feature are not statistically significant. According to the border values of IA for determination of the asymmetry degree, the asymmetry of greatest clavicle length is moderate in both sexes. The length of corpus curve basis shows strong bilateral asymmetry in the clavicles of male and female skeletons.

Diameters and circumference in the middle of the clavicle

The three measured features in the middle of the clavicle characterize the massiveness of the bone. The middle vertical diameter is with greater values in right clavicles of male and female skeletons. The middle sagittal diameter also has greater values in right clavicles of male skeletons. However, the left clavicles of female skeletons have greater sagittal diameter, in comparison with the right ones. The mean values of middle circumference show right-side asymmetry in both sexes. The circumference of right clavicles is greater by 0.78 mm in male skeletons and by 0.28 mm in female skeletons. The bilateral differences are not statistically significant for any of these three features. The greater diameters and circumference in the middle of right clavicles are also observed by Jit and Singh [3] and Bilodi et al. [1]. According to IA data, the right-side asymmetry for these three features in male skeletons is moderate. The middle vertical diameter and the middle circumference in female clavicles show right-side asymmetry as well, but the middle sagittal diameter is with left-side asymmetry. According to the degree of asymmetry, both diameters in female skeletons belong to the slightly asymmetric features and the circumference – to the moderately asymmetric features.

Height features of clavicle

The three height features measured characterize the clavicle curve. The first height of corpus curve is greater in left clavicles of both male and female skeletons. The second height of corpus curve has greater values in right bones of both sexes. The values of acromial end curve are greater in the right bones of male and female skeletons, respectively by 0.71 mm and by 0.81 mm. This shows that acromial end of right clavicles of both sexes is more curved than the acromial end of left ones. The right-left differences for these three features are not statistically significant. According to the values of IA, the strongest left-side asymmetry in both male and female clavicles is found for the first height of corpus curve. (“strong” degree). The second height of corpus curve in both sexes is with positive sign of IA i.e. it is with right-side asymmetry – by “moderate”

Table 1. Asymmetry indicators of male and female clavicles

No	Feature	Male (n = 36)					Female (n = 32)				
		\bar{x} right	\bar{x} left	Asymmetry indicators			\bar{x} right	\bar{x} left	Asymmetry indicators		
				Absolute difference	U-test	IA			Absolute difference	U-test	IA
1	Greatest clavicle length (1)	147.28	149.58	-2.30	0.321	-1.55	132.00	135.19	-3.19	0.038*	-2.39
2	Middle vertical diameter (4)	11.10	10.96	0.14	0.602	1.26	9.48	9.44	0.04	0.842	0.50
3	Middle sagital diameter (5)	12.63	12.38	0.25	0.570	2.00	10.56	10.58	0.02	0.882	-0.15
4	Middle circumference (6)	39.53	38.75	0.78	0.368	1.99	33.69	33.41	0.28	0.745	0.84
5	First height of corpus curve (2)	7.58	7.82	-0.24	0.659	-3.07	7.14	8.09	-0.95	0.182	-12.51
6	Length of corpus curve basis (3)	92.60	95.03	-2.43	0.203	-2.59	85.19	87.67	-2.48	0.121	-2.87
7	Second height of corpus curve (2a)	29.97	29.72	0.25	0.905	0.84	26.09	25.94	0.15	0.665	0.60
8	Acromial end curve (2(1))	32.82	32.11	0.71	0.252	2.18	28.75	27.94	0.81	0.310	2.87
9	Sternal curve depth	18.61	18.93	-0.32	0.498	-1.70	17.31	17.42	-0.11	0.788	-0.63
10	Acromial curve depth	13.53	13.51	0.02	0.959	0.10	11.97	11.91	0.06	0.995	0.52

* statistically significant differences at the $P < 0.05$.

degree in the male skeletons and by “slight” degree in the female ones. IA values of acromial end curve show that this feature is with comparatively strongest right-side asymmetry. In accordance with asymmetry intensity, the acromial end curve in male clavicles belongs to the moderately asymmetric features and this in female clavicles – to the strongly asymmetric ones.

Clavicle curve depths

Both clavicle curve depths, which are measured in this study, show that the sternal curve depth is greater in the left clavicles of both sexes. However, the acromial curve depth has greater values in the right bones of male and female skeletons. This result shows that the sternal curve is deeper in the left clavicles and the acromial curve – in the right ones. The right-left differences for both depths are not statistically significant. IA values of sternal curve depth show right-side asymmetry of “moderate” degree in both sexes. According to the border values for determination of asymmetry intensity, the asymmetry of acromial curve depth is slight right-side one in female skeletons, while in male skeletons can be assumed that the asymmetry of this feature is missing, i.e. there is symmetry.

Comparative assessment for asymmetry profiles of both sexes (Fig. 2)

A summary idea of asymmetry in size and form of the human clavicle is given by the graphically presented asymmetry profiles based on IA data from all ten investigated features.

Six of all clavicle features in the male skeletons are with right-side asymmetry and four – with left-side one. A right-side asymmetry is accounted in five metric features of the female clavicles and a left-side asymmetry – in the other five.

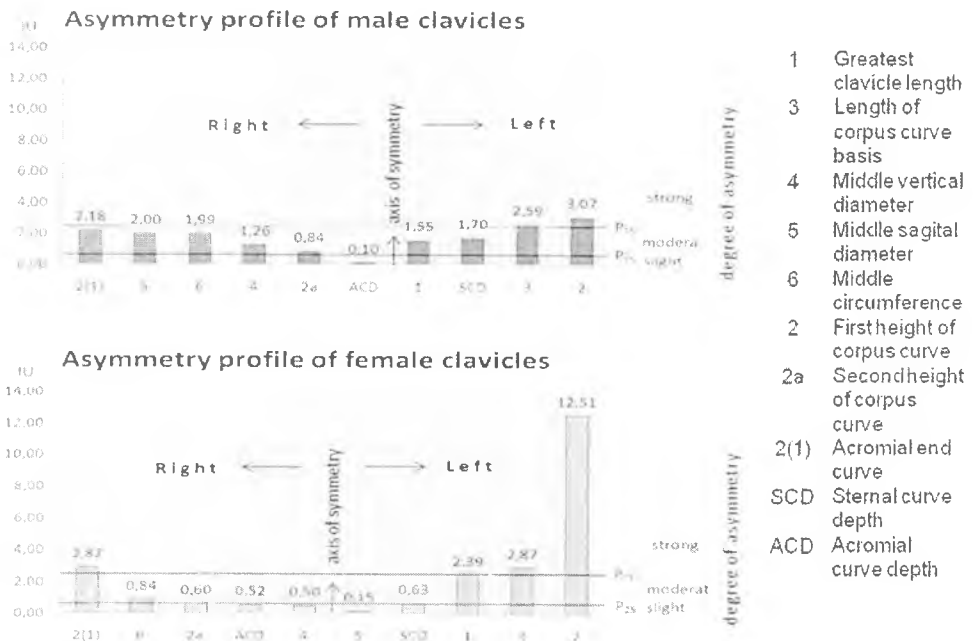


Fig. 2. Asymmetry profiles of male and female clavicles. The features with right-side asymmetry are ranked in descending line and those with left-side asymmetry – in ascending one

The features with moderate asymmetry predominate in the male clavicles and this degree of asymmetry is accounted for 7 features – 5 with right-side and 2 with left-side asymmetry. More features in the female clavicles have slight asymmetry (4 features), 3 of the features are with moderate asymmetry and 3 – with strong one.

According to the direction of asymmetry, the sexual differences are found for one feature only and it is the middle sagittal diameter. It is with right-side asymmetry in the male clavicles and with left-side one – in the female clavicles. According to the degree of asymmetry, it is found that right-side asymmetry in male clavicles is mostly of “moderate” degree, while in female bones – of “slight” one. Among the features with left-side asymmetry, the asymmetry is “moderate” and “strong” in the clavicles of both sexes.

The comparative assessment of the asymmetry profiles of both sexes shows that the strongest right-side asymmetry in male and female clavicles is established for the acromial curve depth, and the strongest left-side one – for the first height of corpus curve. The asymmetry for these two features is stronger in the female clavicles in comparison with the male ones.

Conclusions

The left clavicles in both sexes are longer than the right ones, but the right clavicles are more massive and more curved, compared to the left ones.

According to the direction of asymmetry, the sexual differences are found for the middle sagittal diameter only, as in male skeletons it is greater in the right clavicles and in female ones – in the left clavicles.

According to the degree of asymmetry, the strongest asymmetry in male clavicles is the left-side asymmetry of first height of corpus curve and length of corpus curve basis. The strongest asymmetry in female clavicles is the left-side asymmetry of first height of corpus curve and length of corpus curve basis also and the right-side asymmetry of acromial end curve.

The general assessment of the asymmetry manifestations shows that clavicles of male skeletons as a whole are more asymmetric than those of female ones.

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