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The Dominance of the Left Hemisphere is the Cause of the Bilateral Asymmetry of Shoulder Girdle Bones

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In this article there are presented the results of studying the bilateral asymmetry of the shoulder girdle bones of 13 skeletons. The measurements were taken without detaching the latter. The highest number of linear sizes that are consistently different from the Wilcoxon criterion was discovered on the humerus, less-on the radius, no consistent differences-on ulna and the scapula. The data received allows to suggest that the reason for the morphologic asymmetry is the functional asymmetry of the brain hemispheres. This leads to one hand being dominant over another and being exposed to more exercise, which leads to the prevalent formation of the bone microrelief on the dominant side.

Key words: bilateral asymmetry, upper limb skeleton.

Introduction

In the past years the attention of the researchers is more and more drawn to the study of the morphofunctional status of the organism, which is formed under the influences of the gender, age, ethnicity, ecology, alimentary habits etc. The study of the specifics of the osteometric measures of the human body give the possibility to look at the patterns of the morphofunctional status formation from a new point of view. The interest for the osteometric research is still very much alive, even due to its 200-year-old history. The anthropometric measures are applied in the production of clothes and furniture, the designing of the ergonomic machines and mechanisms, which has a crucial importance not only for the civilian life but also for the production of the military equipment, aircrafts, submarines and the piloted space satellites. A lot of attention is paid nowadays to the study of the human skeleton asymmetry [1, 3]. At the same time the question about the origin of the morphological asymmetry is still relevant. In our opinion the reason why such an asymmetry takes place is that the number of right-handed people prevails in the human population. Currently, the ratio of the right-handed and left-handed people is estimated at about 86/14 [2], which indirectly shows the benefits of using the right hand in the manual labor.

The goal of our work is to study the scapula, humerus and the forearm bones on whole skeletons. Theoretically, the basis for such a research is the reasonable sugges-

tion that each of the skeletons is composed of the bones from one particular human, which is proven through historical data and the witness testimony.

In the course of study we were also working on proven true the hypothesis, that different functional exercise of the right (dominant) and the left (usually supporting) hand would affect the osteometric measures differently. In particular, we suggested that several right hand sizes would be substantially bigger than those sizes in the left hand.

Materials and Methods

There were examined 26 scapulas (13 left and right ones), 26 humeri, 26 ulnar and 26 radial bones of the whole skeletons from the collection of the Chair of Normal Anatomy, and also those of the Chair of the Operative Surgery and Topographic Anatomy of Kuban State Medical University. Common linear sizes available for the measurements without disassembling the skeleton were being determined, using the guidelines proposed by V. P. Alekseev (1966). The sizes were being measured by a caliper and a measuring tape. 1 mm was used as a unit of measurement. All the calculations were performed in the Excel application. The statistical processing included determining the median line, upper and lower quartiles in the spreadsheet application of Excel. The data is presented in the form of Me (p25, p75), where Me is the median line of the selection, p25 and p75 – lower and upper quartiles, respectively. Determining of the bilateral differences was performed by the methods of the non-parametric statistics with the help of the Wilcoxon criterion in the Statistica 6.15 application (StatSoft, USA).

Results and Discussion

While comparing the linear sizes of the scapula we did not receive any substantial bilateral differences among any of the studied parameters. The only feature that had a tendency to be different from right to left side ($p = 0.11$) – "the width of the glenoid cavity" – on the right it equaled 31 (30; 33) mm, and on the left – 30 (30; 32) mm. While comparing the right and the left humeri there were received the differences in such parameters as the greatest length of the humerus ($p = 0.021$), which equals 33.10 (32.22; 34.38) cm on the right, 32.95 (31.38; 33.75) cm on the left, the total length of the humerus ($p = 0.024$) is on the right 32.30 (31.90; 33.65) cm, and on the left – 32.25 (31.71; 33.25) cm, the width of the humerus at the level of the anatomical neck ($p = 0.007$), which is on the right – 3.48 (3.23; 3.82) cm, and on the left – 3.28 (3.01; 3.71) cm. Also, the substantial bilateral differences were found for the size of the circumference of the midpart of humerus diaphysis ($p = 0.015$): on the right – 7.15 (6.60; 7.53) cm, on the left – 7.10 (6.26; 7.35) cm.

While determining the extent of the bilateral asymmetry of the radius the following results have been received: the distance between the head and the radial tuberosity was substantially different ($p = 0.049$) on the right – 3.70 (3.25; 4.09) cm, and on the left – 3.50 (3.18; 3.78) cm, and the width of the diaphysis midpart as well ($p = 0.050$) on the right – 1.70 (1.58; 2.13) cm, and on the left – 1.93 (1.71; 2.20) cm. Also at the level of a tendency ($p = 0.060$) there was noted the bilateral asymmetry of the physiological radius length 23.55 (21.68; 23.85) cm, and 22.95 (21.75; 23.55) cm, and the circumference of the diaphysis midpart ($p = 0.093$) 4.65 (4.52; 5.30) cm, 4.60 (4.50; 5.20) cm, on the right and the left respectively.

While determining the extent of the bilateral asymmetry of the ulna there were received the differences only at the level of a tendency: the smallest circumference of the

diaphysis differed (p = 0.066) on the right – 3.98 (3.81; 4.43) cm, and on the left – 3.85 (3.63; 4.26) cm, also there was noted a tendency for a different (p = 0.069) extent of the ulnar diaphysis deviation from back to front – 20.48 (20.04; 21.04) cm on the right, and 19.90 (19.61; 20.93) cm on the left.

As it can be seen from the data presented, in all the cases except one – the width of the radial diaphysis midpart – the greater linear sizes were noted on the right, which allows to consider the above-mentioned hypothesis true. The lack of the substantial bilateral differences in the linear sizes of the scapula allows to suggest that the position close to the axial skeleton causes the bone to be less mobile and, consequently, lessens the differences in how the dominant and the codominant hands affect it. At the same time it is important to note that even though the forearm is much more mobile compared to the shoulder, the motor skills of the bones and the muscles in it are finer and the strain is much less. This is why the differences between the ulnar and the radial bones from different limbs are less prominent, the level of importance is much higher and the substantiality of the differences is lower than that in the study of the humerus bilateral asymmetry. Probably it is related to a higher level of physical exercise performed by the muscles attached to a humerus and, thus, more prominent bilateral differentiation of those bones.

Conclusion

Thus, the data received allows to reasonably suggest that the bilateral asymmetry of the upper limb skeleton may be related to the functional asymmetry of the brain hemispheres, which leads to one hand being dominant and also, taking into account the shift of the binomial distribution towards the right-handed individuals, to an increase of some linear sizes of the right hand in the population as a whole. Although the absolute value of the asymmetry is small, it is necessary to take it into account in the medical field, in designing of the clothing, creating the ergonomic systems etc.

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