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АНАЛИЗ РАСПРЕДЕЛЕНИЯ КОСТЕЙ ПО ЧАСТЯМ ТЕЛА У ВЗРОСЛОГО ЧЕЛОВЕКА

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Аннотация

Введение. Актуальность анализа распределения органов функциональных систем по частям тела обусловлена поиском математических закономерностей для перехода от эмпирического к теоретическому этапу развития анатомии человека. **Цель исследования** – выявить закономерности распределения костей по частям тела человека. **Материал и методы.** Материалом исследования являлись костные скелеты из коллекции кафедры анатомии человека, а также сведения учебной литературы. Были использованы методы количественной оценки костей скелета. **Результаты.** Выявлены соотношения: 1/2:1/2 между парными левыми и правыми костями относительно срединной сагиттальной плоскости; 1/2:1/2 между передними и задними костями туловища относительно фронтальной плоскости перед позвоночником; 2/3:1/3 между количеством костей выше и ниже горизонтальной плоскости через центр тяжести тела; 1/3:1/3:1/3 между осевым скелетом и скелетами верхних и нижних конечностей. **Выводы.** Выявленные соотношения распределения костей в частях тела относительно трех плоскостей 3–х мерного пространства являются проявлением одного из основных естественнонаучных принципов баланса (гармонии, симметрии). Практически это связано с обеспечением равновесия тела в покое и при движениях. Их следует рассматривать как адаптации эволюционного развития, связанные с прямохождением человека.

Ключевые слова: части тела человека, распределение костей, баланс, симметрия, сегментарность.

ANALYSIS OF THE DISTRIBUTION OF BONES IN PARTS OF THE BODY IN AN ADULT

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Abstract

Introduction. The relevance of the analysis of the distribution of organs of functional systems by body parts is due to the search for mathematical patterns for the transition from the empirical to the theoretical stage of development of human anatomy. **The purpose of the study** – to identify patterns of distribution of bones in parts of the human body. **Material and methods.** The material of the study was bone skeletons from the collection of the Department of Human Anatomy, as well as information from educational literature. Methods were used to quantify the number of bones in the skeleton. **Results.** The following ratios were revealed: 1/2:1/2 between paired left and right bones relative to the median sagittal plane; 1/2:1/2 between the anterior and posterior bones of the body relative to the frontal plane in front of the spine; 2/3:1/3 between the number of bones above and below the horizontal plane through the center of gravity of the body; 1/3:1/3:1/3 between the axial skeleton and the skeletons of the upper and lower extremities. **Conclusions.** The revealed ratios of the distribution of bones in body parts relative to three planes of 3-dimensional space are a manifestation of one of the basic natural science principles of balance (harmony, symmetry). In practice, this is connected with ensuring the balance of the body at rest and during movements. They should be considered as adaptations of evolutionary development associated with human bipedalism.

Keywords: parts of the human body, distribution of bones, balance, symmetry, segmentation.

INTRODUCTION

The main subject of study and teaching of human anatomy are organs located in parts of the body and included in functional systems. The human body is a complex structure made up of its parts with organs, tissues and cells inside. In teaching of Human Anatomy much attention is paid to a qualitative anatomical description of the external and internal structure of organs. The quantitative relationships of organs and body parts are selectively mentioned as examples of individual variability. The relevance of the analysis of the number of body parts and the number of organs in these parts is also due to the search for mathematical patterns for the transition from the empirical to the theoretical stage in the development of the science of human anatomy.

The skeletal system, which consists of bones, serves as the framework of the body and supports its weight. In this report, we discuss the number of bones in different parts of the body and their ratios. The goal was to study and identify patterns of distribution of bones in parts of the human body for to understand better the balance and symmetry of the human body.

The discussion highlights the proportion of bones in different parts such as the head, neck, trunk, arms, and legs, and their symmetrical and asymmetrical characteristics. The authors also suggest that these ratios may be related to natural science principles and adaptations of evolutionary and individual development.

The purpose of the study – to identify patterns of distribution of bones in parts of the human body.

MATERIAL AND METHODS

When performing this work, methods of quantitative assessment, comparison and analysis were used. The material for the study was preparations of the bone skeleton system from the collection of the Department of Human Anatomy, as well as information from educational literature and Internet resources describing the number of bones in various parts of the body [1,2]. To identify the distribution of bones in parts of the body in an adult, tables and diagrams were compiled. The ratios between the number of bones located in the axial and accessory skeletons, as well as paired and unpaired bones, anterior and posterior bones of the axial skeleton relative to the three main planes of the body were also determined. We were also interested in the change in the number of bones along the length in the axial and accessory skeletons.

RESULTS

The number 7 has significant importance in the division of the human body into different parts. The human body may be divided into 7 parts: head, neck, trunk, right arm, left arm, right leg, and left leg. The arm is subdivided into 7 parts, and so is the leg. In the upper limb they are upper girdle, shoulder, elbow, forearm, carpus, metacarpus and fingers. In the lower limb they are pelvic girdle, thigh, knee, lower leg, tarsus, metatarsus and toes. The hand and foot are also divided into 7 parts each one. So for the convenience of study, the authors propose to distinguish seven parts of the body as a whole, as well as seven parts for the upper and lower extremities, and seven parts for the hands and feet.

It is well known that the total number of bones in an adult is 206.

The axial skeleton has 73–80 bones, which is approximately 35% of the total number of bones in the body. The bones in the arms and legs represent approximately 31% and 34%, respectively. So the ratio of the number of bones of the axial skeleton and the additional skeleton is approximately 1/3:2/3; and the ratio of the number of bones of the axial skeleton, upper and lower extremities is approximately 1/3:1/3:1/3; relative to the horizontal plane through the center of gravity of the body 2/3:1/3.

We can call the paired bones to be symmetrical and the unpaired bones as asymmetrical. In the axial skeleton, there are 16 symmetrical and 7 asymmetrical bones in the head; all 8 bones in the neck are asymmetrical, while 24 bones in the trunk are symmetrical and 19-26 are asymmetrical. In the limb skeleton, all 64 bones in the arm and all 62-66 bones in the leg are symmetrical. The ratio of the number of paired (right and left) bones in both the axial and limb skeletons is 1/2:1/2; the ratio of paired and unpaired bones in the axial skeleton is also approximately 1/2:1/2.

The ratio of the number of anterior and the number of posterior bones in the axial skeleton approaches 1/2:1/2.

Along the vertical of the axial skeleton, a wave-like (sinusoid curve) change in the number of bones in parts of the body was revealed with maxima in the head and chest, minima for the neck and abdomen with the pelvis.

For the additional skeleton, a sharp increase in the number of bones in the distal sections (hand, foot) was revealed, compared with the proximal ones (exponent curve).

DISCUSSION

From the results of the study, a convenient classification is proposed for studying body parts. It is also proposed to introduce the concept of complex bones consisting of simple bones into the teaching of anatomy.

Identified symmetrical ratios of the number of bones relative to the median sagittal plane 1/2:1/2 and relative to the frontal plane 1/2:1/2, as well as 2/3:1/3 relative to the horizontal plane through the center of gravity (second sacral vertebra), – due to the provision of balance of the body under the action of gravity on the surface of the Earth, as well as an example of the manifestation of the general principle of symmetry (balance) in nature.

CONCLUSIONS

1. For the study of human anatomy, a convenient division of body parts is proposed; and also to distinguish complex bones, which consist of several simple bones; there is a difference in the number of bones and their names due to repetitive terms.

2. The distribution of bones in parts of the body and their ratio in the axial and accessory skeletons have been studied. The results showed that the human body is an example of balance and symmetry, as well as a segmental structure. The revealed quantitative ratios of bones in different parts of the human body are a manifestation of the basic natural science principles of balance. They can be associated with the types of symmetry (central and bilateral) and segmentation of the body, the balance for bipedalism in human evolution.

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