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PATTERNS OF GROWTH AND DEVELOPMENT OF THE HEART OF RATS IN EARLY POSTNATAL ONTOGENESIS

Ziyodullaev Maksud Makhmudovich
Bukhara State Medical Institute.

Ilyasov Aziz Saidmuradovich
Bukhara State Medical Institute.

Ziyodullaev Maksud Makhmudovich

Ilyasov Aziz Saidmuradovich

Annotation

Study of the patterns of growth and development of the heart of rats in early postnatal ontogenesis. Structural transformation of the heart in age dynamics, adaptive rearrangements of the body in the early stages of postnatal ontogenesis require a detailed study. It should be noted that due to species and age variability, the external and internal structure of the mammalian heart is characterized by pronounced age variability. An analysis of the literature shows that to date, the anatomical and topographic features of the heart in rats, the dynamics of its macrometric parameters, micrometric components of the internal relief, as well as correlative relationships at different levels of structural organization, continue to be insufficiently clarified.

By the 21st day of life, the study found that in the early postnatal period, the heart of rats changes from an elliptical to a spherical shape. In our opinion, in connection with the transition of the definitive nutrition of rats, the growth of the heart develops at different rates. The mass and volume of the heart of rats in this period develops up to 90.0%, and morphometric parameters increase to 42.0%.

Keywords: heart, rat, morphometry, ontogeny.

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The Relevance of the Work

The study [1,2,3,4] is devoted to the determination of the features of the morphology of the mammalian heart. The literature provides information on the structure of the heart mainly in adult animals or during their intrauterine development in laboratory, domestic animals and humans, less in newborn domestic animals [5,6]. They found that depending on the species, age, sex of an animal and a person, the structure of the heart has its own characteristics. Linear parameters and heart mass vary with age.

An analysis of literature sources shows that in the postnatal period, namely from birth to nine months of age, due to the fact that the heart grows unevenly (in length and width), its shape changes and due to which the third type passes into the second, and the second into the first . This indicator is due to the intensity of growth of the ventricles in height and a decrease in growth in width. In animals, the second type of heart is more common after 12 months of age [7,8].

Objective

Determine the morphological features of the growth and development of the heart in rats in early postnatal ontogenesis.

An analysis of literature sources shows that in the postnatal period, namely from birth to nine months of age, due to the fact that the heart grows unevenly (in length and width), its shape changes and due to which the third type passes into the second, and the second into the first. This indicator is due to the intensity of growth of the ventricles in height and a decrease in growth in width. In animals, the second type of heart is more common after 12 months of age [7,8].

Objective. Determine the morphological features of the growth and development of the heart in rats in early postnatal ontogenesis. After weighing, the hearts were fixed at room temperature in 5% formalin aqueous solution for 3–5 days, and then in 10% formalin aqueous solution, in which they were stored for further studies.

Morphometric measurements of the heart were carried out using a measuring anatomical ruler and a caliper. The thickness (the largest anteroposterior dimension at the level of the base of the ventricles), length (from the exit of the aorta to the apex of the heart), and width of the heart (between the lateral surfaces of the heart, at the level of the base of the ventricles) were determined.

The shape of the heart was determined by calculating the index, according to the formula: (Width/Length of the organ)×100%. The shape of the heart is considered cone-shaped - with an index of up to 65%; elliptical - up to 75%; spherical - over 75% [10].

Results and discussion. We have studied the early postnatal period of ontogeny, dividing it into two semesters. In the first semester, newborn and 6-day-old rats were studied, in the second semester, 11, 16, and 21-day-old rats.

In rats, the heart is located in the chest cavity in the anterior mediastinum, in the pericardium, between the sheets of the mediastinal pleura. The study of the morphology of the heart, changes in the shape of the organ as a whole, and the structural components of its wall in early postnatal ontogenesis is important for making diagnoses in domestic animals of certain species [11].

The heart of rats subdivides the following surfaces - the anterior (sternocostal), adjacent to the sternum, ribs and intercostal muscles; lower (diaphragmatic) and lateral (pulmonary), adjacent to the roots of the lungs and surrounded by the mediastinal pleura. In the first semester, the diaphragmatic surface is not developed.

In a comparative analysis of the heart structures of large and small ruminants, it was concluded that, despite some differences, the heart of these animals has similar morphological structural features [12].

I. A. Filonova (2021) was the first to determine the patterns of morphometric incompleteness of myocardial tissue structures in day-old lambs and their changes with age. According to the author, outwardly the heart resembles a pyramid, the top of which is directed downwards, and the upper part is the base of the organ.

Large blood vessels are located at the base of the heart of rats: aorta, pulmonary trunk, pulmonary veins, superior and inferior vena cava. In the first semester of ontogeny in rats, the medial-upper part of the heart touches the thymus in front, which is located at the smaller part of the sternum handle, the parietal pleura limits it behind and to the side, the lower part of the heart is separated by the left diaphragmatic tendon, more precisely, the heart is located in the anterior part of the aortic opening of the diaphragm. Also, the heart is slightly deployed by the left ventricle to the anterior wall of the chest.

In the first semester of ontogenesis in rats, the right atrium has the shape of a cube, but the edges are indistinct, anteriorly it continues with a hollow process - an ear. The walls of the right atrium are noticeably thinner than those of the left.

The left atrium is cylindrical in shape, also has a blind protrusion - the left ear. The inner surface is smooth, only in the ear there are irregularities due to the comb muscles.

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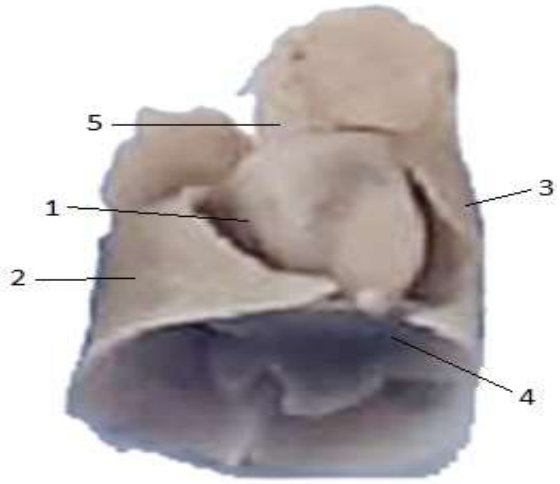

Figure 2. Topographic and anatomical location of the heart in 6 day old rats. 1-heart, 2-right lung, 3-left lung, 4-diaphragm, 5-aorta.

The pulmonary veins enter the atrium. In rats, the veins merge together and enter the right atrium in one common trunk.

The right ventricle is crescent-shaped, crescent-shaped in cross-section due to a powerful interventricular septum. The walls of the ventricle are noticeably thinner than those of the left. In the ventricle, 2 regions are distinguished - the ventricle itself and the arterial cone, which continues with the pulmonary trunk. The left ventricle is conical in shape and covered with thick walls, the inner surface is uneven due to the many trabeculae (Fig. 3), an arterial cone is located next to the aortic opening.

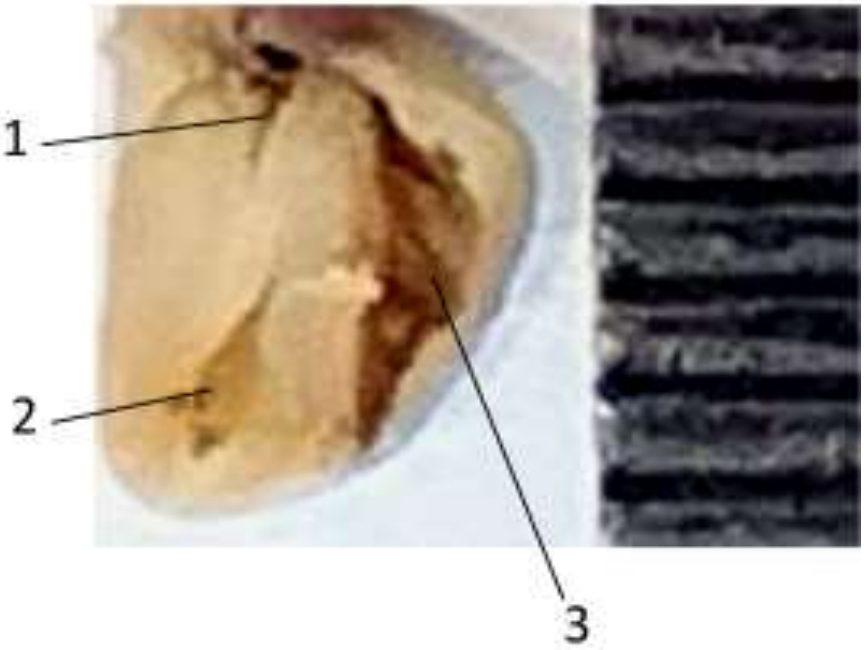

Figure 3. Shape and structure of the heart chamber in 6 day old rats.
1-left atrium, 2-left ventricle, 3-right ventricle

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Studies have established that the weight of 11 day old rats ranged from 8.2 to 12.1 mg, on average - 10.0 ± 0.34 mg. The volume of the chest ranges from 1.7 to 2.5 cm3, on average - 2.2 ± 0.1 cm3, and the volume of the organ varied from 0.5 to 0.9 cm3, on average 0.6 ± 0.035 cm3. In 11 day old rats, the mass of the heart weighs from 0.13 to 0.16 mg, on average - 0.14 ± 0.003 mg. At this age, the length of the heart is from 7 to 9 mm, on average - 8 ± 0.174 mm. And the width of the organ varied from 4.0 to 6.0 mm, on average - 4.6±0.174 mm.

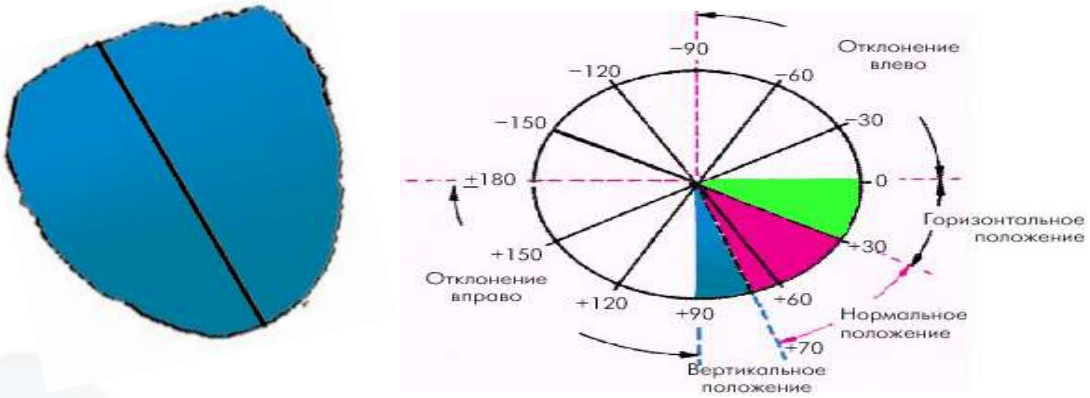

Figure 4. Location of the heart of a 21-day old rat in relation to the chest.

At the base of the heart, large blood vessels begin to develop faster and the aorta, pulmonary trunk, pulmonary veins, superior and inferior vena cava become visible. In the second semester of ontogeny in rats, the medial-upper part of the heart comes into contact with the thymus in front, which is located at the greater part of the manubrium of the sternum, the parietal pleura limits the back and side, the lower part of the heart is separated by the left diaphragmatic tendon. In connection with the transition to mixed feeding, the diaphragm rises, bringing the top of the heart closer to the sternum. В этом периоде сердце заметно развернётся левым желудочком к передней стенке грудной клетки, и соединительные ткани диафрагмы начнут покрывать нижнею часть сердца.

During this period, the heart will noticeably turn with the left ventricle towards the anterior chest wall, and the connective tissues of the diaphragm will begin to cover the lower part of the heart.

In this semester of rats, the transversely located coronal sulcus and the longitudinal anterior interventricular sulcus are well visualized on the surface of the heart (Fig. 5).

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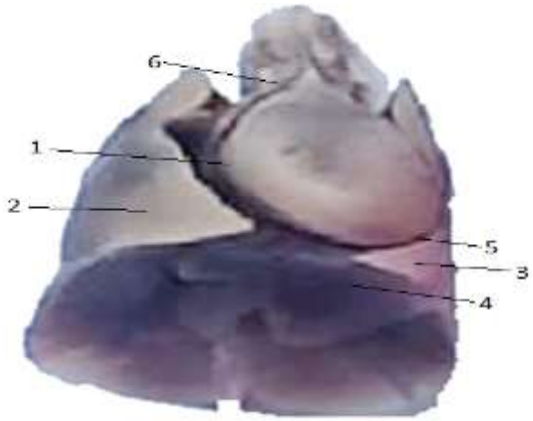

Figure 5. Topographic and anatomical location of the heart in 21 day old rats. 1-heart, 2-right lung, 3-left lung, 4-diaphragm, 5-apex of the heart, 6-aorta.

The walls of the ventricle are noticeably thinner than those of the left. In the ventricle, two regions are distinguished: the ventricle itself and the arterial cone, which continues with the pulmonary trunk.

The left ventricle is conical in shape and covered with thick walls, the inner surface is uneven due to the many trabeculae (Fig. 6), an arterial cone is located next to the aortic opening.

Figure 6. The shape and structure of the heart chambers of 21 day old rats.1-left atrium, 2-right atrium, 3-left ventricle, 4-right ventricle

Conclusions

Thus, the study showed that by the age of 11 days in rats in early postnatal ontogenesis, the growth rate of morphometric parameters was as follows: rat weight by 85%, heart weight by 42%, heart length by 31%, heart volume by 90% increases relative to 6 days old. The growth rate of the chest volume is 34% and the width of the heart increases by 39% by 16 days of age in relation to the previous age.

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