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Features Of The Application Of Mathematical Modeling To Study The Structure Of The Rabbit Heart In Normal.

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ABSTRACT

The presented results of the studies allow us to confirm the change in the morphology of the rabbit heart during the period of the physiological maturity of the animal. This work allows you to reproduce the features of the heart and the vascular system, the establishment of quantitative and logical dependencies between the various elements of the heart of the rabbit home. The results of the morphometric data of the heart during the period of physiological maturity are presented. To estimate the mass of the myocardium of the left ventricle, the formulas "area-length" and "truncated ellipsoid" were used.
Keywords: Oryctolagus cuniculus, morphometry, heart, mass of myocardium of the left ventricle, mathematical modeling.

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INTRODUCTION

In the postnatal period, as a result of changes in blood circulation, morphological and functional changes in the heart, the growth and development of other organs, changes in the shape of the chest, the shape and size of the heart are constantly changing. Changes in the heart at the macro-and microscopic levels of the organization, revealed by objective morphometric methods of research, reflect the stages of ontogenesis at each stage.

It has long been known that the decisive factor determining the intensity of heart growth in the postnatal period, the magnitude of its relative weight and especially the relative weight of the heart muscle, is the magnitude of the functional load on the heart. In ontogeny the growth of the Atria has consistently lagged behind growth of the ventricles. In the postnatal period, the left ventricle receives intensive development, compared with the right one.

Quantitative assessment of the size of the chambers of the heart, mass and function of the ventricles is one of the most important and popular tasks of modern medicine, biology and veterinary medicine, which is not possible without the methods of mathematical modeling.

However, in the scientific literature to describe changes in the size and mass of the body used mainly descriptive methods using statistics, at the same time mathematical modeling allows you to get more accurate and reliable information about the macroscopic changes at different stages of the formation of structures and the body as a whole. A complete picture of an organ can be created only on the basis of the totality of knowledge about its structure and function. The heart is an exceptional unity of the constituent elements, each of which makes a cumulative contribution to the formation of its functions and properties [2, 9].

In 1895 Lesgaft argued that each organ and system is constructed so that at a minimum cost of building material, they could perform the maximum work, which is especially applicable to the structure of the heart, which has an extremely high potential to perform their functions [3].

There is no doubt that in the development and progression of heart disease the main role belongs to changes in the functions of the left ventricle, which has the most powerful muscle layer, and, accordingly, is able to withstand large hemodynamic loads [10].

From a technical point of view, the heart is a four – chamber pump in which the Atria act as low-pressure pumps (swap), and the ventricles function as high-pressure pumps. These pumps are controlled by an autoregulation system consisting of a sinus node with an average heart rate of 120 beats per minute in rabbits.

So, the pumps will be presented in the form of pistons with suction and discharge valves, the pistons of which are impulses that cause a reduction in the volume of the chambers for certain periods of time.

The purpose of this study is: to build a mathematical model of the rabbit heart, which allows you to reproduce the features of the heart and vascular system, the establishment of quantitative and logical relationships between the various elements, manifestations of the process that are available registration. The model is designed to study the pumping function of the rabbit heart in normal.

To achieve this goal, the following tasks have been developed: to determine the absolute live weight of rabbits, to identify the structure of the heart, to calculate the length, width, thickness of the heart, to build a mathematical model based on the data obtained, to calculate the mass of the left ventricular myocardium (MML).

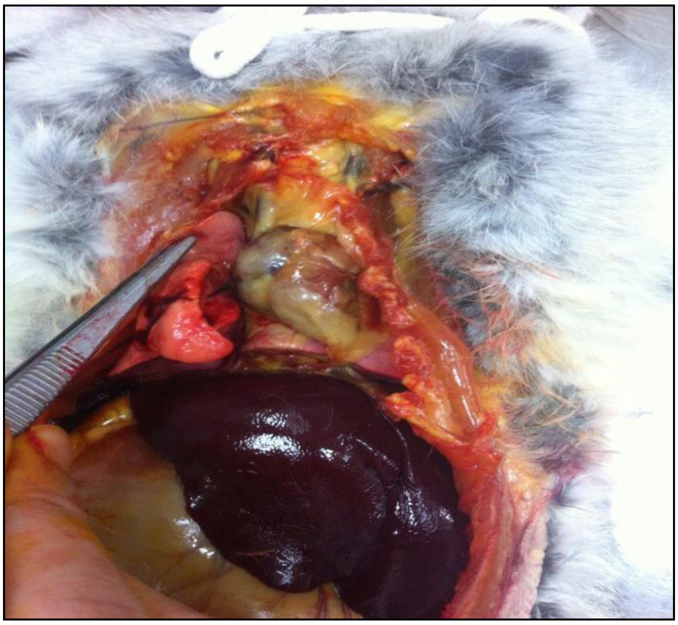
RESULTS

The rabbit's heart is shifted to the left and elongated. It extends from the posterior edge of the second rib to the posterior edge of the fourth rib. Heart of the rabbit is weak, and light. The relative weight of the heart – 0,298%, the relative weight of the lungs of 0.4%. Cardio – pulmonary index (the ratio of the mass of the heart to the lung mass) at a given age is 0,745.

The mass of the heart in six months of 8.95±0.03 g. shape Index of on – 58.9 per cent (conical). At the index up to 65% the heart shape was considered to be cone-shaped, from 65% to 75% - ellipsoid and more than 75% - spherical (Babich I. I., 1988). Heart length 4.5 cm, width -2.8 cm.

Main part part of the mass falls on the left half. Then the mass of the left half will take equal to 4.75, right-4.2 g.

Mass of the Atria is 1/3от mass of the respective halves. Therefore, in this mathematical model of the heart, we take: for the right ventricle m1=2/3×0.0042=0.0028 kg; the mass of the piston of the pulmonary artery is five times the mass of the piston of the right ventricle: m2=0.0028×5=0.014 kg;



Rice 1: The location of the heart in the chest during the period of physiological maturity.

for the left atrium m4=1/3×0,00475=0,001583 kg; the mass of the piston of the pulmonary veins is five times the mass of the piston of the left atrium m3=0,001583×5=0,007916 kg;

for the left ventricle m5= 2/3×0,00475=0,00316 kg; mass of the piston of the aorta five times the mass of the piston of the left ventricle m6=0,00316×5=0,01583 kg;

for the right atrium, m8=1/3×0.0042=0.0014 kg; the mass of the piston of the genital vein is five times the mass of the piston of the right atrium; m7= 0.0014×5=0.007 kg.

In clinical practice, linear parameters of the left ventricle are used to assess systolic function. The most commonly used two-dimensional methods for estimating mmlg are based on the area-length and truncated ellipsoid formulas.

Both methods are based on the measurement of myocardial area at the level of papillary muscles. To obtain the total area (A1), the epicardium is circled, and to obtain the area of the cavity (A2), the endocardium is circled.

Rice 2: Cardiopulmonary organocomplex rabbit in the period of physiological maturity.

Myocardial area (Am) is calculated as the diffeence (Am) =A1-A2 (1) . Assuming that the area has the shape of a circle, the radius b=A2π and the average wall thickness t=A1P – b (2) can be calculated .

The mass of the left ventricle can be calculated by the formula area-length (AL) and truncated ellipsoid (TE):

MLW (AL)= 1,0556 A1 (a+d+t) - 56A2(a+d) (3);
MLW (TE)= 1.05 Pb+t223 a+t+d-d33a+t2-b223a+d-d33a2 (4); where
A1 - total area of the left ventricle
A2 - the area of the left ventricular cavity
Am-area of the myocardium
a - semi-major axis from the minor radius to the top
b-radius on the short axis (calculated from the area of LV on the short axis)
d - truncated semi-major axis from the minor radius to the plane of the mitral annulus
The radius (b) and average wall thickness (t) are calculated from the LV areas along the short axis.

For the area of the left ventricle of the heart of rabbits at the age of six months are characterized by the following parameters:

A1=3.6 cm2 A2=1.89 cm2 Am= 1, 71 cm2
a=1.35 cm a=0.5 cm d=2 cm
b=0.85 cm b=1.2 cm
b= A2π = 0.6 cm
t= A1P-b=0.47 cm
ILW (AL)=1,0556 3,6(2+0,7+0,47)-561,89(2+0,7) = 5,523 d.

SUMMARY

1. The wall thickness of the left ventricle at the age of six months is 0.47 cm.
2. The mass of the myocardium of the left ventricle is 5, 523 g, which is 61.7% of the mass of the whole heart, which, apparently, indicates the maximum degree of development of the organ associated with the most intense increase in heart mass during the period of physiological maturity.
3. The wall of the right ventricle due to hemodynamic load is much thinner than the wall of the left ventricle, the lumen of the sickle-shaped cavity. The right ventricle is located almost on a par with the left ventricle and is slightly shorter than it, the apex of the heart protrudes less sharply. The right ear of the heart is much larger than the left. This type of heart is widely represented in rabbits of meat breeds.
4. The rabbit heart structure has a number of features, some of which are primitive features, while others are highly adaptive features.

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