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MORPHOLOGICAL CHARACTERISTICS OF THE ARTERIES OF THE SMALL CIRCULATORY CIRCLE AGAINST THE BACKGROUND OF EXPERIMENTAL DIABETES

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Annotation

Diabetes mellitus is a global problem of the whole world. According to WHO, today about 422 million people suffer from diabetes, which is 6.028% of the total population of the planet. Diabetes incidence statistics are growing every year. If the situation develops at the same pace, then by 2025 the number of patients with diabetes will increase by 2 times. By 2030, diabetes mellitus will become the 7th cause of death worldwide. Vascular diseases occupy an important place in the structure of the incidence of diabetes mellitus and are manifested by organ infarction and vascular insufficiency. The severity of angiopathy depends on the degree and duration of hyperglycemia. Timely and correctly selected insulin therapy, maintaining blood glucose levels close to normal values slows down and stops the development of vascular complications.

Keywords

artery, glycoprotein, hyperplasia, diabetes mellitus, membrane, dystrophy, elastic fibers.

The arteries of the 1st and 3rd level belong to the muscular-elastic type, the arteries of the 4th-6th level belong to the arteries of the muscular type. For a more thorough examination, the arteries were divided into three groups: small, medium and large caliber arteries. The results of our research show that a spiral smooth muscle layer develops on the 3rd and 4th degree arteries. This layer in cross sections looks like a separate pillow-like thickening. It is located close to the outer elastic membrane on the adventitia side.

The purpose of the work. Study of morphological changes in the pulmonary arteries against the background of diabetes mellitus.

Material and methods of research. The study is fundamental and was conducted at the Department of Anatomy, Clinical Anatomy of the Tashkent Medical Academy, Vivarium of the Tashkent Medical Academy and the Urgench branch. 163 white laboratory rats of the Vistar line at different stages of postnatal ontogenesis were used as the object of the study.

To achieve the set goals and objectives, scientific work is mainly based on experimental and morphological methods and research materials. Experimental studies were carried out on 163 white Vistar rats. The lungs were selected for morphological examination and the arteries of the small circulatory circle were examined. The rats were divided into 2 groups. The first group is an experimental group. In the experimental group, newborn white laboratory rats from the 3rd day of life were injected with streptozotocin in the amount of 4 mg per 100 g of body weight to create experimental diabetes mellitus intraperitoneal and blood sugar levels were periodically measured by blood sampling from the tail vein. Group 2 was a control group in which 0.9% saline solution was injected into the abdominal cavity of rats. Rats were slaughtered by decapitation at different stages of development: 21 days, 3 months, 12 months and 24 months. Considering that the 21-day period of postnatal ontogenesis corresponds to the period of breastfeeding, 120 days to the period of puberty, 12 months to the period of maturity and 24 months to old age, postnatal ontogenesis was studied during these periods.

To study the morphological structure of the arteries of the small circulatory circle, both lungs were taken together with the mediastinal organs. The resulting lungs were fixed in a 12% formalin solution. After fixation, histological preparations were prepared. Prepared histological preparations were stained with hematoxylin-eosin, Van Gieson and CHIC methods. In the stained ready-made histological preparations, the following parameters were determined: the length of the inner and outer elastic membrane in the wall of the arteries of the small circulatory circle; the cross-sectional area of the cavity bounded by the inner elastic membrane of the blood vessel; the cross-sectional area of the middle layer between the inner and outer elastic membranes. The ratio between the layers of the arterial wall was studied using the Pearson coefficient. A strong correlation relationship was considered in the presence of ratios from +0.7 or -0.7 to 1. The Kernogan index was used to assess the conductivity of the arteries. Transmissive electron microscopy was used to study the ultrastructural structure of lung tissue.

When comparing the thickness of the walls of the right and left pulmonary arteries, the thickness of the middle layer and the inner diameter, it was noted that the size of the right pulmonary artery was 24-28% larger relative to the left pulmonary artery, and the cross-sectional area exceeded 58.7%. When comparing the cross-section of the artery cavity in the pulmonary trunk, this indicator was 26.8% greater than the sum of the cross-sections of the right and left pulmonary arteries, and the inner diameter was 25.4% less than the sum of the inner diameters of both arteries. When comparing the thickness of the walls of the main arteries of the small circulatory circle, in all cases the thickness of the middle layer of the artery exceeded the thickness of the adventitial layer.

According to the results of our research, the ratio of the middle and outer layers of the pulmonary trunk was 1:0.6. This ratio showed that in the right pulmonary artery it is equal to 1:0.62, and in the left pulmonary artery it is greater, that is, it is 1:0.85.

The intra-organ artery of the lung is a vessel of muscular-elastic and muscular type. According to a number of scientists, intra-organ arteries of the lungs can be divided into the following groups: arteries of the 1st and 3rd degree belong to the muscular-elastic type, and arteries of the 4th-6th degree - arteries of the muscular type. They, in turn, are divided into 3 groups: arteries of large, medium and small caliber. According to the structure of the intrapulmonary lobular arteries, they belong to the vessels of the muscular-elastic type. In the middle and inner layers of these arteries, fully formed elastic membranes are revealed, and in the outer layer – delicate elastic membranes. Therefore, these arteries belong to the arteries of the muscular-elastic type. The inner layer of these arteries is represented by an endothelial layer consisting of round endothelial cells. Below it is the subendothelial layer. The middle layer consists of smooth muscle fibers with an oblique-longitudinal direction. In this layer, you can see 3 elastic membranes. When stained by Van Gieson, a small amount of collagen fibers can be seen in the middle layer of these arteries. The external and internal elastic membranes of the arteries of the musculoelastic type are equally well developed, the boundaries are clearly separated. As the diameter of the artery decreases, the elastic membrane in the middle layer of the artery becomes smaller, thinner and merges with the outer elastic layer. It was revealed that the adventitial layer consists of connective tissue fibers, mainly collagen and elastic fibers. In the outer adventitial layer of muscle-type arteries, a muscle layer is additionally developed, which spirally surrounds the vascular wall. As a result, the middle muscle layer of such arteries becomes thicker, relative to the middle layer of arteries of a different caliber.

Special patterns were observed in the development of vessels of the small circle of blood circulation. According to the structure, qualitative and quantitative composition of the walls, the pulmonary trunk and pulmonary arteries belong to elastic-type vessels. The inner diameter of these arteries was larger than the outer one. Minor age-related changes in the arteries were observed. Age-related changes were observed in all layers of the arteries. In 21-day-old rats, an increase in elastic fibers in the wall of the pulmonary trunk was revealed. The growth rate of the pulmonary trunk was 30%, and the pulmonary arteries averaged 25%. In 21-day-old rats, the thickness of the adventitial layer of small blood arteries was higher than in the previous period. This indicator in the pulmonary trunk is 30%, in the right pulmonary artery – 32% and in the left arteries – 28%. There is an increase in the size of the inner and outer diameters, thickening of the walls of the pulmonary trunk, right and left pulmonary arteries in 12-month-old rats. In the outer layer of these arteries, an increase in the number of collagen fibers was observed compared to the previous age. The thickness of collagen fibers in the trunk of the lung increased 2.2 times, in the right lung – 1.7 times, in the left – 1.4 times. Thus, there was a decrease in the ratio of the middle and outer layers of these arteries. In the pulmonary trunk, this ratio was 1:0.95; in the right pulmonary artery – 1:0.91, in the left pulmonary artery – 1:0.89. During this period, compared with a young age, in the adventitial layer, you can see a thickening of collagen and elastic fibers by 75.2% and 50%. When comparing the morphometric parameters of the arteries of this age with the previous age period, an increase in the outer diameter was noted. A correlation was established between the external and internal diameters of all arteries, regardless of the size of the arteries. There is a change in the size of the middle layer of the vessel. Significant changes were observed in the arteries of medium and large calibers. Compared to the previous period, there was an increase of 3.5 and 4.9 times. Morphological and morphometric changes were noted in 24-month-old rats in all layers of the vessels of the small circulatory circle. There is an increase in the number of collagen fibers in all layers of the pulmonary trunk and pulmonary arteries. By this time, there is an increase in the internal diameter of the pulmonary trunk and pulmonary arteries by 32%, 25% and 21%, and the external diameter by 34.6%, 22% and 20% (Table 1).

Table 1

Indicators of the main arteries of the small circulatory circle, mm

Arteries	**Indicators**			
	Outer diameter	**Inner diameter**	**Average layer thickness**	**Thickness of the outer layer**

The trunk of the lung	3,5 ± 0,08	3,5± 0,08	1,003± 0,001	0,96 ± 0,0006
Right pulmonary artery	1,94± 0,04	1,83 ± 0,04	0,105 ± 0,001	0,082 ± 0,0002
Left pulmonary artery	1,64 ± 0,03**	2,3± 0,01**	0,098 ± 0,001**	0,078± 0,0003

Note: * – p<0.05 is significant in relation to the control group

The thickness of collagen fibers in Truncus pulmonalis increased 2.2 times, in arteria pulmonalis dextre – 1.7 times, in arteria pulmonalis sinistra – 1.4 times.

Thus, there was a decrease in the ratio of the middle and outer layers of these arteries.

In truncus pulmonalis, this ratio was 1:0.95; in arteria pulmonalis dextre - 1:0.91, in arteria pulmonalis sinistra – 1:0.89. During this period, a thickening of collagen fibers by 75.2% and 50% can be seen in the adventitial layer compared to the previous age.

An increase in the outer diameter was observed in all arteries of the small circulatory circle in rats of this age. In the arteries of the muscular type, these changes are clearly reflected. At this age, an increase in the outer diameter of muscle-type arteries by 56.2%, and muscle-elastic-type arteries by 25% was found. However, the increase in internal diameter was not significant in all arteries. As for arteries of other ages, there is a correlation between changes in the external and internal diameters of the arteries at this age (r=0.96). There is a change in the thickness of the walls of the arteries.

In large- and medium-caliber muscle-type arteries, the thickness of the middle layer varies from 3.1 to 4.3. However, no correlation was found between changes in the external and internal diameters of the arteries and the thickness of the middle layer. The change in the thickness of the adventitial layer in all layers was 43-47%. The thickness of the adventitial layer of large arteries of the musculoelastic type prevails over the thickness of the muscular layer, the ratio is 1:1.17. In arteries of other sizes, the thickness of the middle layer of the arteries prevailed mainly, and in medium–caliber muscle-type arteries, the ratio of adventitial and medial layers is 1:0.36, in small muscle-type arteries - 1:0.6.

During the study, it was determined that the Kernogan index in muscle-type arteries and in small-caliber arteries was higher, and in muscle-elastic type arteries due to the large internal diameter, the Kernogan index had small indicators. In our studies, a correlation was revealed between the internal and external diameters of the arteries and the Kernogan index. Also, a strong correlation was found between the mean and outer diameters of the pulmonary arteries (r=0.89). In smaller diameter muscle-type arteries, the correlation between the thickness of the adventitial layer and the diameter of the arteries was confirmed (r=0.98). There is also a positive correlation between the areas of the adventitious and middle layers (r=0.94).

When comparing the weight of rats of the control and experimental groups, the body weight of the rats of the control group in the early stages of the experiment was increased relative to the rats of the experimental group.

In order to verify diabetes mellitus in rats, the amount of sugar in the blood was determined at different times of the experiment. In dynamics, in the first days of the experiment, the blood sugar level in the rats of the experimental group increased from 7.9 to 15.9 mmol/l and remained above 15 mmol/l. Against the background of diabetes mellitus, changes in the walls of the arteries of the small circulatory circle were observed.

On the 120th day of the experiment, some changes were detected in the walls of the pulmonary trunk and pulmonary arteries relative to the control group. Mucoid and fibrinoid swellings of the inner layer are determined. Atherosclerotic plaques of circular or segmental shape of various degrees of development have been identified, these plaques are constructed of collagen and elastic fibers, thickened areas in the inner layer of the pulmonary arteries are noted.

No dystrophic changes were detected in the thickened areas, but connective tissue compaction was observed. During these experimental periods, a decrease in the cross-sectional area of elastic-type arteries relative to the control group was noted.

During this period of research, a decrease in the inner diameter is noted due to hyperplasia of the inner layer of the pulmonary arteries. The surface layer of plaques visible on the inner layer of the pulmonary arteries consists of dense connective tissue, and the part adjacent to the elastic membrane is represented by tender connective tissue.

In this part, cholesterol crystals are determined. In rats 12-24 months old, you can see obvious changes in the wall of the arteries of the small circulatory circle. In the inner layer of the pulmonary arteries in the area of hyperplasia, connective tissue fibers were located on the surface of the plaques, compacted and sprouted deep into the atherosclerotic plaque.

Neutral mucopolysaccharides were determined in all layers of the pulmonary arteries. There is a loosening, thickening of the elastic membrane fibers along the wall of the blood vessel.

There is swelling of the subendothelial layer and the appearance of macrophages in these areas. Due to desquamation and proliferation of endothelial cells, the appearance of a parietal thrombus was noted. In the period of 24 months, you can notice the beginning of the process of sclerosis in the walls of elastic-type arteries.

In the initial periods of the experiment, changes were observed in small-caliber muscle-type arteries. These changes were manifested by hyperplasia of the inner wall of the arteries, followed by thickening of the elastic membrane, the development of plaques. The presence of such changes in the main arteries has been scientifically substantiated. The appearance of the above signs is manifested by narrowing of the artery cavity. This in turn causes the appearance of blood clots.

Visualization under a transmissive electron microscope of the arteries of the small circulatory circle in the experimental group. The space of the pulmonary capillaries in the experimental group is empty, but in some capillaries red blood cells are visible, and they seem to be layered on top of each other in the form of coins. This indicates the process of stasis in the capillaries. Endotheliocytes in most capillaries are dystrophically altered in a dark type.

It is established that pericytes belong to the light type. In some pericytes, the formation of lipids and lipofuscin may occur. You can see capillaries whose normal structure of the basement membrane has changed. It can be seen that the capillary space is filled with collagen fibers. In some capillaries, the integrity of the capillary basement membrane was violated, different levels of lipofuscin accumulation and fibrous astrocytes were observed at the border with the pericapillary space.

Conclusion. As a result of the conducted research, the following conclusions are presented:

At different stages of the period of postnatal ontogenesis in the walls of the arteries of the small circulatory circle, there is an age-related increase in collagen fibers in the middle and outer layer of the vessel wall, thickening of the artery wall and an increase in the Kernogan index.

The presence of a strong correlation (r=0.89) between the middle layer and the outer diameter of the main and intra-pulmonary arteries of the lung was established. Also, there is a high correlation between the thickness of the adventitial layer and the diameter of the artery (r=0.98) and a positive correlation (r=0.94) between the area of the adventitial layer and the middle layer of the artery.

Against the background of diabetes mellitus, atherosclerotic changes, hyperplasia of the connective tissue of the inner wall and narrowing of the vessel cavity are detected in the walls of the arteries. Changes in muscle-type arteries at the early stages of the experiment were scientifically substantiated, and at later stages of the experiment, changes were found in all types of arteries.

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