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MORPHOFUNCTIONAL CHARACTERISTICS OF HEMOMICROCIRCULATORY BED'S VESSELS OF THE PANCREAS IN RATS AND AT CENTRAL DEPRIVATION OF TESTOSTERONE SYNTHESIS

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In an experimental study of vessels of the hemomicrocirculatory bed of the exocrine pancreas in rats, it was found that the microvessels responded to the introduction of diferelein by persistent dilatation of arterioles during the first month of the experiment by 4.12% compared to the intact group of animals. The exchange component responded by increasing its average diameters, increasing its lumen by 1.93% compared to the intact animal group. The vessel capacity of the pancreas' hemomicrocirculatory bed during the first month of the study responded with enlargement, increasing its lumens by 2.46% compared to the intact group of animals. The numbers recovery of the average diameters of microvessels with the introduction of tryptorelin embonate was not observed until the end of the experiment.

Key words: vessels of the hemomicrocirculatory bed, pancreas, testosterone, rats.

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МОРФОФУНКЦІОНАЛЬНА ХАРАКТЕРИСТИКА СУДИН ГЕМОМІКРОЦИРКУЛЯТОРНОГО РУСЛА ПІДШЛУНКОВОЇ ЗАЛОЗИ ЩУРІВ У НОРМІ ТА ПРИ ЦЕНТРАЛЬНІЙ ДЕПРИВАЦІЇ СИНТЕЗУ ТЕСТОСТЕРОНУ

В експериментальному дослідженні судин гемомікроциркуляторного русла екзокринної частини підшлункової залози щурів виявлено, що мікросудини реагують на введення дифереліну стійкою дилатацією артеріол впродовж першого місяця експерименту на 4,12% порівняно з інтактною групою тварин. Обмінна ланка реагувала збільшенням своїх середніх діаметрів, збільшуючи свій просвіт на 1,93% порівняно з інтактною групою тварин. Ємнісна ланка судин гемомікроциркуляторного русла підшлункової залози впродовж першого місяця дослідження реагувала розширенням, збільшуючи свої просвіти на 2,46% порівняно з інтактною групою тварин. Відновлення показників середніх діаметрів мікросудин при введенні триптореліну ембонату до кінця експерименту не спостерігалось.

Ключові слова: судини гемомікроциркуляторного русла, підшлункова залоза, тестостерон, щури.

The work is a fragment of the research project "Experimental-morphological study of the influence of cryopreserved preparations of cord blood and embryofetoplacental complex (EFPC), diferelein, ethanol and 1% ester of methacrylic acid on the morphofunctional state of certain internals", state registration No. 0119U102925.

In modern biological and medical science it is important to study in detail the features of pancreatic blood supply, which will help to solve a number of issues in the search for modern methods of correction of gastroenterological diseases [4].

Pancreas is the second largest (after liver) gland of the digestive tract that has a high vulnerability to the action of various factors that lead to gland dysfunction, which is an integral part of the digestive system, combines exocrine and endocrine parts, is involved in digestion, in regulation of extremely important for the body carbohydrate metabolism, as well as in the regulation of other processes and activities of organs [7, 11].

Structurally modified vessels of the pancreas lead to a violation of its blood supply, the development of dystrophic and degenerative processes in it, which will affect the disruption of homeostasis of the body as a whole [8].

The "Diferelein" drug is used in the treatment of prostate cancer by chemical castration, which has an indirect effect on the structural components of the pancreas. It has quite rapid and effective influence on the hypothalamic-pituitary-gonadal axis at the highest level of its regulation. In addition, the two-phase mechanism of action allows the use of two opposite therapeutic effects on the reproductive system: stimulating with short-term mode of administration and inhibiting with prolonged use [9]. Therefore, we decided to investigate the mediate effect of the preparation on the vessels of the pancreas' hemomicrocirculatory bed.

The purpose of the study was to establish vascular changes in the hemomicrocirculatory bed of the exocrine pancreas in intact rats and under the conditions of experimental modeling of chemical castration in the first month of the study.

Materials and methods. The work was performed on 20 white male rats divided into 2 groups: group I was 10 intact animals, group II was 10 animals, who were subcutaneously injected with diferelin (tryptorelin embonate) at a dose of 0.3 mg/kg of active substance per animal for 30 days. The study of the pancreas was performed in accordance with the established dates, the material for microscopic examination was taken immediately after euthanasia of animals, sealed in paraffin, according to the conventional method and sections were made on a sledge microtome MC-2 with a thickness of 4–5 μm , which were stained with hematoxylin and eosin [1].

Morphometric study and microphotography were performed using a Biorex-3 BM-500T microscope with a DCM 900 digital photomicrographic attachment with programs adapted for these studies. Quantitative analysis of morphometric study results and statistical processing of morphometric data were performed using conventional statistical methods Student's *t*-test involving Microsoft Excel, 2007 software [6].

The experiment was conducted in accordance with the “Common Ethical Principles of Animal Experimentation” adopted by the First National Congress on Bioethics (Kyiv, 2001) and also the recommendations of the “European Convention for the Protection of Vertebrate Animals for Experimental and Other Scientific Purposes” were kept [3].

Results of the study and their discussion. The study of histological preparations showed that the pancreas is a parenchymal organ. It consists of lobules between which layers of connective tissue lie, which determine the blood vessels, nerves and interlobular excretory ducts. The branches of the abdominal and upper mesenteric arteries participate in the blood supply to the pancreas. The branching of these arteries in the interlobular connective tissue and inside the lobules forms rich capillary nets that intertwine the acini and penetrate the islets.

It is revealed microscopically that the components of the hemomicrocirculatory bed, namely arterioles, that deliver blood to the lobules and distribute it among tissue structures, are localized mainly in the interlobular connective tissue layers with an average diameter of $23.92 \pm 0.27 \mu\text{m}$, whereas venules remove the blood from the lobules, located around the common lobular ducts, the average diameter of which was $35.68 \pm 1.53 \mu\text{m}$. The circulatory vessels (capillaries) of the exocrine part of pancreas had an average diameter of $7.41 \pm 0.18 \mu\text{m}$, and are located in the intercellular space, in contact with the basal lamina of exocrine cells (table 1). All vessels of the exocrine part of pancreas of the rat had a typical three-layered structure (figs. 1, 2).

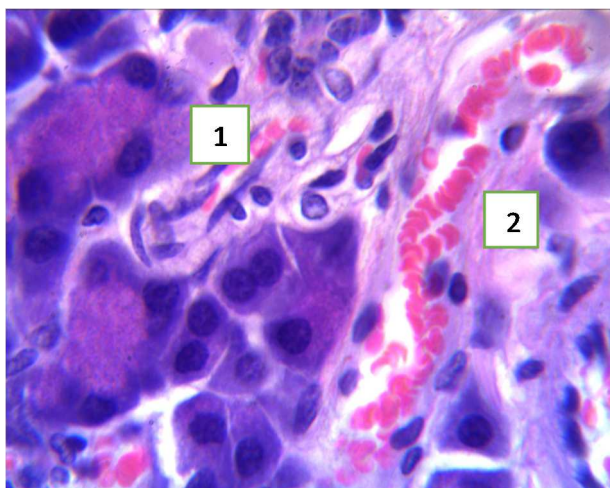


Fig. 1. Arteriole and venule in the pancreas of the rat of the intact group. 1 – arteriole, 2 – venule. Hematoxylin and eosin staining. Magnification: ocular: 10; object 100



Fig. 2. The capillary in the pancreas of the rat of the intact group. Hematoxylin and eosin staining. Magnification: ocular: 10; object 100

Analysis of the morphological changes of the hemomicrocirculatory bed of the exocrine part of pancreas showed that with the introduction of diferelin they have a directional character. The arterioles, already in the first month of the experiment, responded by dilatation, which showed a significant increase in the average diameter of the lumen of the vessels by 4.12%, compared with the intact group of animals ($p < 0.05$) and their average diameters reached $28.01 \pm 0.63 \mu\text{m}$.

It was determined histologically that the arterioles' lumens were enlarged and filled with blood corpuscles, their wall was formed by endotheliocytes, and the inner elastic membrane was visualized as a basophilic strip, which formed numerous high folds and gave the arterioles' lumens a star shape. The restoration of the morphofunctional state of the microvessels by the end of the study was not observed.

Table 1

Dynamics of changes in the average diameters of vessels of the pancreas' hemocirculatory bed in the experiment (μm)

Diameter	Arterioles	Capillaries	Venules
Norm	23.92±0.27	7.41±0.18	35.68±1.53
1 month	28.04±0.63*	9.31±0.21*	38.14±1.62*

Note * – $p < 0.05$ compared to intact group of animals.

The exchange component of the pancreas responded also by increasing of its average diameters, but not as significantly as the arterioles (fig. 3). During the first month of the experiment, the average diameters of the capillaries were expanded, with an average value of $9.31 \pm 0.21 \mu\text{m}$, increasing by 1.93%, compared to the intact group of animals ($p < 0.05$), in their lumens a small number of erythrocytes was observed. The capillaries' wall was formed by endothelial cells that located on a continuous basal membrane. The recovery of the morphofunctional state of the vessels of the exchange component was not observed by the end of the experiment.

As a result of the morphometric study, it was found that in the pancreatic capacity component, vasodilation was observed, their average diameters were $38.1 \pm 1.62 \mu\text{m}$, increasing by 2.46%, compared with the intact group of animals ($p < 0.05$). Histologically it was found that the venules had a typical thin-walled structure, the endothelial cells were arranged in a row on the basement membrane, which had a smooth contour, and the vessel lumens were tightly filled with erythrocytes. (fig. 4).

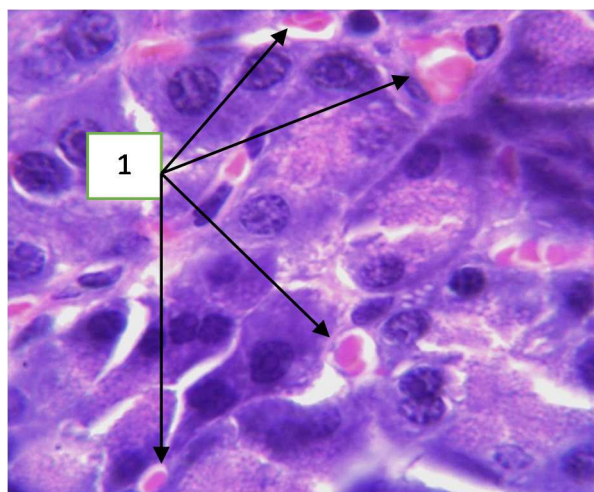


Fig. 3. Capillaries in the pancreas of the rat with the introduction of diferelin for the 1st month of the experiment. Hematoxylin and eosin staining. Magnification: ocular: 10; object 100

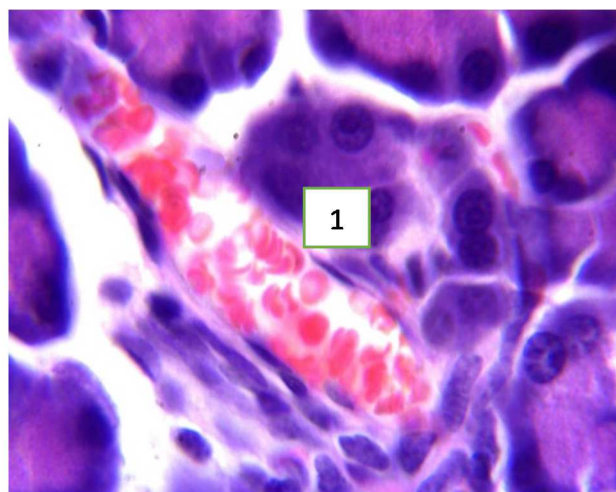


Fig. 4. Venule in the rat's pancreas with the introduction of diferelin for the 1st month of the experiment. 1 – venule. Hematoxylin and eosin staining. Magnification: ocular: 10; object 100

In comparison with other indicators, in previous studies, there was a multidirectional reaction of blood vessels of hemocirculatory bed under the action of 1% ester of methacrylic acid on the elements of the capacity component. Thus, during the experiment on the fourteenth day at the action of 1% methacrylic acid solution, the average values of the outer diameter of the venules significantly increased from the parameters in the control group by 25.50%. The lumen diameter increased by 36.30%, the mean values of the thickness of the vascular wall were $1.51 \mu\text{m}$, which was 13.22% significantly less than the parameters of the rats control group. Venules' lumens were enlarged, and endothelial cells became flattened. On the thirtieth day of the study, the average parameters of the outer diameter were 1.80% higher than its values on the fourteenth day, and 27.76% significantly higher than the parameters in the control group of animals. The diameter of the venules' lumen of the lobules in the submandibular glands of rats increased by 4.70%, compared to the results of the previous period of the study, which was also significantly higher than that of the control group of animals by 42.71%. The thickness of the vascular wall was less than the values on the fourteenth day of the observation by 14.57% and 25.86% less than its values in the control group, its indicators were $1.29 \mu\text{m}$ [5, 10]. The effect of acute aseptic inflammation on the vessels of the hemocirculatory bed of the red bone

marrow, previously studied, also confirmed the multidirectional response of microvessels. In a comparative analysis of the diameter morphometric parameters of the elements in the hemomicrocirculatory bed proved that λ -carrageenan caused the reaction of all links of the hemomicrocirculatory bed by increasing their average diameter with a maximum parameters on the 3rd–5th days at $p < 0,05$. It was found that changes in the structural components of the red bone marrow depend on the duration of acute aseptic inflammation and the synthetic activity of the organ itself, which is aimed at compensating for the inflammatory response [2].

Conclusions

1. The morphometric analysis of vessels of the hemomicrocirculatory bed in the pancreas allows us to evaluate its morphofunctional features in the normal state and in experimental conditions. The identified arterioles and capillaries of an intact group of animals, which deliver blood to the lobules and distribute it among tissue structures, were localized mainly in the interlobular connective tissue sections. Venules that drain blood from the lobule were visualized around the common lobular ducts. All pancreatic vessels had a typical three-layered structure.

2. The hypersensitivity of vessels in a pancreas' hemomicrocirculatory bed to action of a diferelin was found. It was revealed by dilatation of arterioles, increase of average diameters of capillaries and expansion of vessels of a capacitive link. Recovery of the morphometric parameters of the vessels during the first month of the experiment was not observed.

References

1. Bagri MM, Dibrova VA, Popadinets OG. Methods of morphological studies: Monograph. Vinnitsa. 2016:328.
2. Boruta NV. Morphological changes in the structural elements of the rat bone marrow in acute aseptic inflammation of the peritoneum. Bulletin of problems of biology and medicine. 2017; 1(135):273–77.
3. European convention for the protection of vertebrate animals used for experimental and other scientific purposes. Strasbourg: Council of Europe; 1986. 53 p.
4. Kim D. Topographic-anatomical relationships of the liver, spleen and pancreas in normal state and in chronic pancreatitis. Morphologia. 2012;6(3): 26–31.
5. Kramarenko DR, Yeroshenko HA. Structural adjustment of the capacitive unit of the hemomicrocirculatory bed after the action of 1% ester of methacrylic acid. World of Medicine and Biology. 2019; 3(69):194–97.
6. Lapach SN, Chubenko AV, Babich PN. Statisticheskiye metody v mediko-biologicheskikh issledovaniyakh s ispolzovaniyem Exel. Kiev: Morion; 2000. 320 s. [in Russian]
7. Miskiv VA. Features of the structure of the hemomicrocirculatory bed of pancreatic islets in rats of different age groups. World of Medicine and Biology. 2013; 3:64–66.
8. Popyk PM. Morphometric characteristics of changes in the links of the hemomicrocirculatory bed of the pancreas under the influence of Nalbufin. Current issues of modern medicine. 2013; 4 (44): 158–61.
9. Stetsuk YeV, Kostenko VO, Shepitko VI, Goltsev AN. Influence of the 30-days central deprivation of testosterone synthesis on the morphological and functional features of rat testicular interstitial endocrinocytes and sustentocytes. World of Medicine and Biology. 2019; 4(70): 228-233
10. Yeroshenko GA, Shevchenko KV, Yakushko OS. Morphometric characteristics of rat salivary glands hemomicrovasculature capacity component under normal conditions and in ethanol chronic intoxication. World of Medicine and Biology. 2018;3(65):149–52.
11. Zabudskaya LR. Normal MRI anatomy of the pancreas. Radiation diagnostics. Radiation therapy. 2017;3:36–41.

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