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Comparative characteristics of morphological changes in the pancreas under different types of irradiation in the experiment

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Abstract---The aim of the study was to conduct a comparative characteristic of the morphological changes in the pancreas with different types of irradiation in the experiment. It has been established that a comparative description of the data of the first (acute irradiation) and the second group (chronic irradiation) of white outbred rats revealed 11 morphological signs indicating pathological changes in the pancreatic parenchyma, in terms of the intensity of occurrence of which differences were found that related to such morphological changes as atrophic changes in the interlobular excretory duct, stromal fatty degeneration, which were visualized only in animals of the first group. Plasma impregnation of vessel walls, atrophic changes in the parenchyma, atrophy of the islets of Langerhans were not found in all animals of the second group, while in the first group they were visualized in all rats. Comparative analysis shows that pathological changes in the pancreatic parenchyma of animals treated with acute irradiation were more intense, and more pathological signs were seen compared to chronic irradiation.

Keywords---acute exposure, chronic exposure, pancreas, experimental animals.

Introduction

Ionizing types of radiation include electromagnetic oscillations with a short wavelength, X-rays and γ -radiation, fluxes of α - and β -particles (electrons), protons, positrons, neutrons and other charged particles. It should be emphasized that α -radiation and X-rays are characterized by a high penetrating power, while β -radiation has a lower penetrating power [5, 6].

Radioactive substances can enter the body through intact skin, the gastrointestinal tract, and the respiratory system. It has been proven that the body's hematopoietic system is most susceptible to the effects of radiation, especially bone marrow cells. Under the influence of radiation, aplasia of the bone marrow develops, inhibition of mitotic processes in the hematopoietic organs, and total death of poorly differentiated bone marrow cells [7, 12].

Acute radiation sickness is a group of clinical syndromes that occur after a short (from a few seconds to 3 days) exposure to penetrating radiation in doses that exceed the average allowable for the body of 1 Gy (100 rad). Depending on the total level of doses, power and distribution on the body area, it can occur with a predominant lesion of the hematopoietic organs (1-10 Gy), intestines (10-20 Gy), hemodynamic and toxic manifestations (20-100 Gy) and brain disorders (100 Gr) [7].

Chronic radiation sickness is a complex clinical syndrome that develops in the case of prolonged exposure to ionizing radiation in doses that exceed the permissible. Characteristic manifestations are the duration and undulation of the flow; the presence in the clinical symptoms of both signs of damage to the body from the action of irradiation, and manifestations of restorative and adaptive reactions. Periods of development of chronic radiation sickness: period of formation; recovery period; period of consequences [6].

The place of the pancreas (Latin - pancreas) in the body is important, as it is a gland of mixed secretion. This organ, as an endocrine gland, synthesizes hormones and takes part in the regulation of carbohydrate, fat and protein metabolism, as an external secretion gland produces pancreatic juice and is actively involved in the digestion process. In this regard, it has two parts: exocrine and endocrine [1, 2]. The length of the gland of an adult is 14–22 cm, the width is 3–9 cm (in the region of the head), and the thickness is 2–3 cm. The mass of the organ is about 70–80 g [10, 11].

In preclinical studies, various types of laboratory animals are used, the pancreas of which is similar in structure and function to the human pancreas. However, there are also differences that can affect the result of the experiment [3]. To date, the degree of influence of acute and chronic irradiation on the pancreas in a comparative aspect in the experiment has not been finally elucidated. The aim of the study was to conduct a comparative characteristic of the morphological changes in the pancreas with different types of irradiation in the experiment in a comparative aspect.

Materials and Research Methods

To carry out the research work, 30 white outbred rats weighing 150-180 g, male, kept under standard vivarium conditions (t - 21-22°C, relative humidity - 50-60%, light regime for 12 hours of darkness and light) were involved. The maintenance of laboratory animals, feeding and care for them, selection of animals, cleaning and disinfection of the premises of the vivarium were carried out according to the methodological manual Nuralieva N.A. et al. [nine].

When working with experimental animals, all ethical principles of working with laboratory animals and the rules of biological safety were strictly observed [4, 9]. All laboratory animals were divided into the following groups:

- The first group - white outbred rats (n=12) who received acute irradiation once at a dose of 5 Gray;
- The second group - white outbred rats (n=12) who received chronic exposure for 20 days at 0.2 Gray daily;
- The third group - intact white outbred rats (n=6) that did not receive acute and chronic exposure.

Acute and chronic irradiation of laboratory animals was carried out using the AGAT-R1 gamma-therapeutic apparatus (Estonia). Irradiation source Co-60. Studies related to the irradiation of animals were carried out in the Bukhara branch of the Republican Specialized Scientific and Practical Center of Oncology and Radiology of the Ministry of Health of the Republic of Uzbekistan.

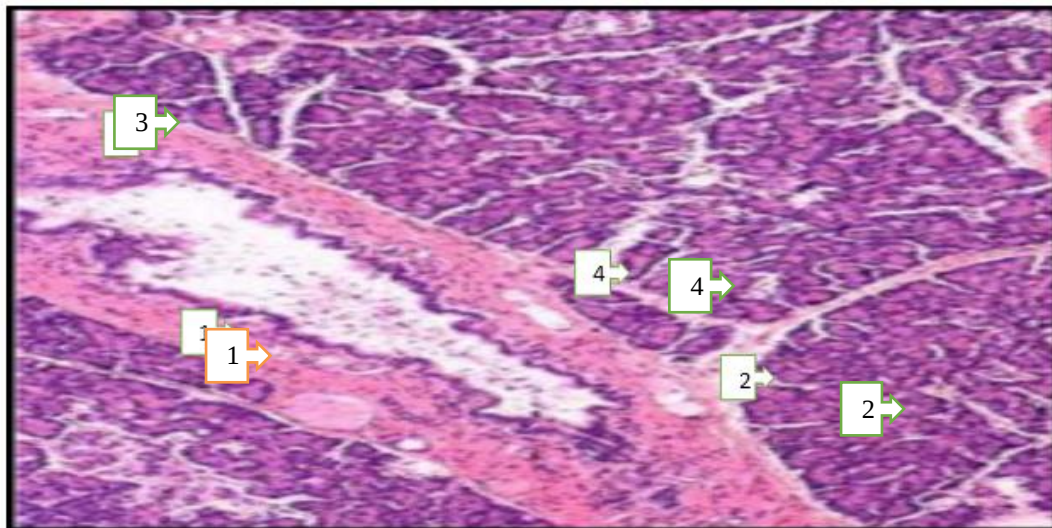
To study the morphological parameters of the organs of laboratory animals, research methods were used that are widely used in experimental studies - anatomical dissection. All biological micro-objects were studied using a trinocular microscope with software on an HL-19 model (China).

The main objects of the study were histological preparations prepared from the organs of white outbred rats. The preparation of histological preparations consisted of 4 stages, which were carried out by traditional methods. To prepare preparations, a YD-315 mechanical rotary microtome (China) was used, and the prepared sections were stained with hematoxylin and eosin.

Statistical processing of the material was carried out using traditional methods of variation statistics. When organizing and conducting research, the principles of evidence-based medicine were used.

Research results and discussion. The results obtained show that, in macroscopic examination, the pancreas of white outbred rats that did not receive irradiation and were included in the control group did not show any visible pathological changes.

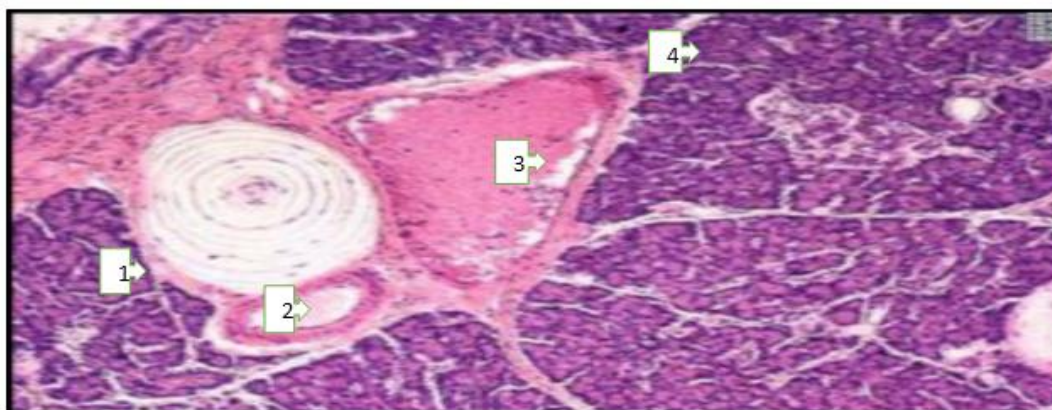
Under the microscope, in the field of view, the interlobular excretory duct, connective tissue septa are visible, which divide it into lobules, pancreatic acini, islets of Langerhans (Fig. 1).



Rice. 1. Histological picture of the pancreas of a white outbred rat (without pathological changes, the interlobular excretory duct (1), connective tissue septa (2), pancreatic acini (3), islets of Langerhans (4) are visible. Staining with hematoxylin-eosin).

The pancreatic acinus is a structural and functional unit of the exocrine part of the pancreas. It consists of a terminal section and an intercalary duct, the acini are separated from each other by thin layers of loose connective tissue. The secret of acinocytes enters the intercalary duct, from there into the interacinous duct [1, 2].

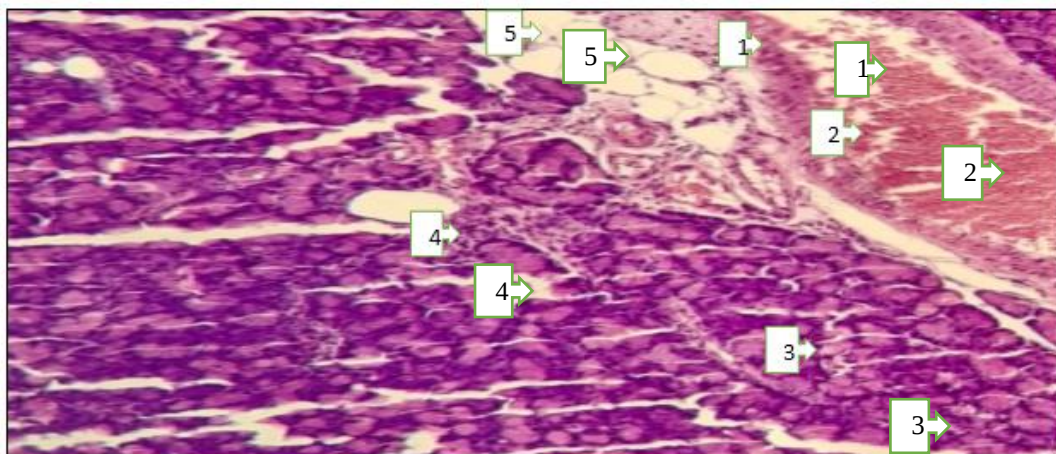
In terms of structure, the described structure of the pancreas of outbred rats practically does not differ from the literature data [3]. Pancreatic islets of Langerhans - the endocrine part of the gland, located inside the lobule among the secretory sections. In the pancreas of an adult healthy person, there are about 1 million islets, with a total weight of 1 g to 1.5 g [1, 2, 11]. On another prepared histological preparation of the pancreas of laboratory animals, Vater-Pacini bodies, blood vessels, pancreatic acini, and islets of Langerhans are visible under a microscope (Fig. 2).



Rice. 2. Histological picture of the pancreas of an intact white outbred rat (without pathological changes, Vater-Pacini bodies, blood vessels, pancreatic acini, islets of Langerhans are visible. Staining with hematoxylin-eosin).

Numerous studies have established that the bodies of Vater-Pacini (lamellar body) - a complex encapsulated nerve receptor, consists of processes of altered cells of the ciliated epithelium with secondary-sensing cilia. Size 0.5-3 mm [13]. In our studies, the descriptions of the Vater-Pacini body coincided with this description. The next stage of our work was the study of the histological structure of the pancreas of white outbred rats that received acute irradiation (the first group).

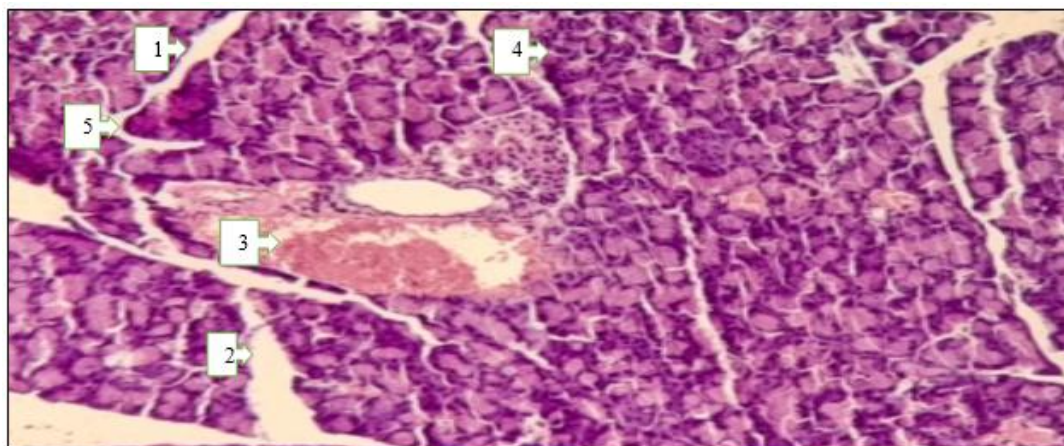
The obtained results on the study of histological preparations prepared from the pancreas of white outbred rats that received acute irradiation showed that, unlike materials obtained from the control group, interstitial edema and plasmatic impregnation (plasmorrhagia) of the walls of blood vessels, stroma rupture, atrophic changes are visible in the field of view interlobular excretory duct, uneven plethora of vessels and dystrophic changes in epithelial cells with venous plethora and sclerotic changes in the vessels of the organ, dystrophic changes in epitheliocytes, atrophic changes in the parenchyma, stromal lymphocytic infiltration, atrophy of the islets of Langerhans, stromal fatty degeneration of the studied organ was also found - accumulation of lipids inside the organ of the organ (Fig. 3).



Rice. Fig. 3. Histological picture of the pancreas of a white outbred rat with acute irradiation (interstitial edema and plasma impregnation of the walls of blood vessels (1), stratification of the stroma, venous plethora (2) and sclerotic changes in blood vessels, degenerative changes in epitheliocytes (3), atrophic changes in the parenchyma, stromal lymphocytic infiltration (4), atrophy of the islets of Langerhans, stromal fatty degeneration (5. Staining with hematoxylin-eosin).

Atrophy of the islets of Langerhans is a condition expressed in the loss of pancreatic mass and atrophy of acinar cells, accompanied by secretory insufficiency [12]. The above conditions are the main morphological signs of pathological changes in the pancreatic stroma of the studied laboratory animals of the first group (acute irradiation). In histological preparations of the pancreas of other laboratory animals that received acute irradiation, the same picture was observed. The next stage of research was the conduct of morphological studies in white outbred rats that received chronic irradiation at a dose of 0.2 Gray for 20 days (4 Gray in total).

Microscopic examination of the material from the pancreatic tissue in the field of view shows interstitial edema, rupture of the stroma of the organ, atrophic changes in the parenchyma are noticeable in some places, vascular plethora, as well as focal lymphocytic infiltration, atrophy of the islets of Langerhans (Fig. 4).



Rice. Fig. 4. Histological picture of the pancreas tissue of a white outbred rat with chronic irradiation (interstitial edema (1), stroma rupture, atrophic changes in the parenchyma in some places (2), vascular congestion (3), focal lymphocytic infiltration (4), atrophy of the islets of Langerhans (5) .Staining with hematoxylin-eosin).

After the evaluation of the results obtained for the detection of morphological changes in the pancreas in intact and received acute and chronic irradiation of laboratory animals, the percentage of detection of these parameters was studied in a comparative aspect. The results obtained showed that all laboratory animals of the control group had morphological features without pathological abnormalities (Table 1).

Table 1
Detectability of morphological signs of the pancreas of intact white outbred rats that did not receive radiation (n=6)

Morphological features of the pancreas	No pathological changes	With pathological changes
interlobularexcretoryduct	6 / 100,0	0
Connectivetissue septa	6 / 100,0	0
Pancreatic acini	6 / 100,0	0
IsletsofLangerhans	6 / 100,0	0
Vater-Pacinibodies	6 / 100,0	0
Bloodvessels	6 / 100,0	0

Note: in the numerator are absolute, in the denominator are relative (%) indicators

Comparative description of the data of the first (acute irradiation) and the second (chronic irradiation) groups of laboratory animals revealed 11 morphological signs indicating pathological changes in the pancreatic parenchyma, the intensity of which slightly differed between the groups (Table 2).

The differences mainly concerned such morphological changes as atrophic changes in the interlobular excretory duct, stromal fatty degeneration, which were visualized only in animals that received acute irradiation. In addition, such morphological changes as plasma impregnation of vessel walls, atrophic changes in the parenchyma, and atrophy of the islets of Langerhans were not found in all animals of the second group, while in rats of the first group they were visualized in all animals. Thus, morphological features without pathological abnormalities were found in all laboratory animals of the control group.

Table 2
Comparative evaluation of the detection of morphological changes in the pancreas of white outbred rats treated with acute and chronic exposure

Morphological changes in the pancreas	White outbred rats	
	with sharp irradiation, n=12	with chronic exposure, n=12
Interstitial edema	12 / 100,0	12 / 100,0
Plasma impregnation of vessel walls	12 / 100,0	11 / 91,67
Stromal disintegration	12 / 100,0	12 / 100,0
Atrophic changes in the interlobular excretory duct	10 / 83,33	0
Uneven venous plethora of blood vessels	12 / 100,0	12 / 100,0
Sclerotic	12 / 100,0	12 / 100,0
vascular changes	12 / 100,0	12 / 100,0
Dystrophic changes in epitheliocytes	12 / 100,0	9 / 75,0
Atrophic changes in the parenchyma	12 / 100,0	12 / 100,0
Stromal lymphocytic infiltration	12 / 100,0	10 / 83,33
Atrophy of the islets of Langerhans	9 / 75,0	0

Note: in the numerator are absolute, in the denominator are relative (%) indicators

A comparative description of the data of the first and second groups of laboratory animals revealed 11 morphological features indicating pathological changes in the pancreatic parenchyma, the intensity of which was found to differ between groups. The differences mainly concerned such morphological changes as atrophic changes in the interlobular excretory duct, stromal fatty degeneration, which were visualized only in the animals of the first group. Plasma impregnation of vessel walls, atrophic changes in the parenchyma, atrophy of the islets of Langerhans were not found in all animals of the second group, while in rats of the first group they were visualized in all experimental white outbred rats.

Comparative analysis shows that pathological changes in the pancreatic parenchyma of white outbred rats that received acute irradiation were more intense, and more pathological signs were seen compared to chronic irradiation. This is due to the greater and simultaneous dose of gamma irradiation of these laboratory animals. It should be emphasized that in both cases (acute and chronic irradiation), morphological changes were noticeable in comparison with histological preparations prepared from the pancreas of intact white outbred rats.

Conclusions

1. The results of the study of histological preparations from the pancreas of white outbred rats that received acute irradiation showed that, in contrast to the control group, various pathological changes of a morphological nature are visible in the field of view.
3. A single irradiation of white outbred rats at a dose of 5 Gray led to the following changes: interstitial edema; plasmatic impregnation of vessel walls (plasmorrhagia), stroma rupture, venous plethora, sclerotic changes in blood vessels, stromal fatty degeneration, dystrophic changes in epitheliocytes, atrophic changes in the parenchyma, stromal lymphocytic infiltration, atrophy of the islets of Langerhans.
3. Chronic irradiation of white outbred rats at 0.2 Gray for 20 days daily, once a day, led to morphological changes in the pancreas, which were expressed in the following changes: macular edema and plasma impregnation of vessel walls, stromal disintegration, atrophic changes in the parenchyma of the organ, vascular plethora and sclerotic vascular changes, focal lymphocytic infiltration, as well as atrophy of the islets of Langerhans.
4. Comparative description of the data of the first (acute irradiation) and the second group (chronic irradiation) of laboratory animals revealed 11 morphological signs indicating pathological changes in the pancreatic parenchyma, the intensity of which was found to differ between the groups. The differences mainly concerned such morphological changes as atrophic changes in the interlobular excretory duct, stromal fatty degeneration, which were visualized only in the animals of the first group. Plasma impregnation of vessel walls, atrophic changes in the parenchyma, atrophy of the islets of Langerhans were not found in all animals of the second group, while in rats of the first group they were visualized in all experimental white outbred rats.
5. Comparative analysis shows that pathological changes in the pancreatic parenchyma of white outbred rats that received acute irradiation were more intense, and more pathological signs were seen compared to chronic irradiation. This is due to the greater and simultaneous dose of gamma irradiation of these laboratory animals.

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