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# About Some Morphological Changes in the Pancreas in Experimental Hypothyroidism

**Niyozov Norbek Kurbonovich[1], Akhmedova Sayyora Mukhamadovna[2], Nisanbaeva Aziza Urinbekovna[1], Tolmasov Ruzibek Tolmasovich[1]**

[1]Assistant, Tashkent Medical Academy, Uzbekistan
[2]Doctor of Medical Sciences, Professor, Tashkent Medical Academy, Uzbekistan

**Abstract** Research has scientifically substantiated with the results of inspections conducted on 56 white laboratory rats during early postnatal ontogenesis. Complex morphological studies include general histological, histochemical methods of organometry, morphometry. For the study, we used the offspring of rats born from control and experimental white laboratory rats –mothers under conditions of hypothyroidism. The results of the study showed that the introduction of Mercazolil into the pancreatic lobules of experimental rats led to changes associated with the normalization of the structural organization of the pancreatic cranium, interlobular connective tissue with the formation of fibrous tissue components, as well as the disappearance of choroidal edema observed in the interlobular connective tissue.

**Keywords** Mercazolyl, Pancreas, Morphological changes, Pieces of pancreas, Hypothyroidism

## 1. Introduction

Hypothyroidism is a clinical syndrome resulting from a long–term, permanent deficiency of thyroid hormones in the body or a decrease in their biological effect at the tissue level. According to the WHO, the prevalence of open primary hypothyroidism in the population is 0.2–1%, and hidden primary hypothyroidism is 7–10% in women and 2–3% in men. 5% of cases of latent hypothyroidism become apparent within one year [1,5,6,12]. Lack of thyroid hormones leads to systemic changes in the body. Thyroid hormones produced by the thyroid gland regulate the process of metabolism, the consumption of proteins, fats, and carbohydrates, participate in the immunogenic system and thermoregulatory processes, stimulate the work of hematopoietic organs, increase oxygen consumption by cells and tissues, increase glucose consumption in gluconeogenic processes, regulates physical adaptation, adaptive reactions [2,3,4,10]. Hypothyroidism causes several disorders in all organs and systems due to various effects of thyroid hormones [7,8]. First of all, it affects the circulatory system, the digestive system (function of the liver and pancreas), the central nervous system, the organs of vision, and the reproductive system [9,11,13]. The above–mentioned points show that the problem we have chosen is dedicated to the actual problem.

The purpose of the study: to determine the nature of morphological and morphometric changes in the pancreas in experimental hypothyroidism.

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## 2. Material and Research Methods

To achieve the goal of the study, the pancreas of 56 sexually mature white laboratory rats was studied. White laboratory rats were divided into 2 groups. Group 1 was a control group of 20 healthy rats. The rats in the experimental group were divided into 2 groups. In the experimental group, 36 female white laboratory rats were given mercazolil in the amount of 0.5 mg per 100 g of body weight for 14 days to induce experimental hypothyroidism. Later, 0.25 mg of mercazolil per 100 g of body weight was given to rats for 1 month. Mercazolil was administered at 0.25 mg per 100 g of body weight during the nursing period after the rats became pregnant and after the birth of their offspring. Blood was taken from the tail vein of mother and baby rats, and the amount of thyroid hormones was studied. Baby rats were killed by decapitation on the 3rd, 7th, 14th, 21st, and 30th days after birth. For histological examinations, tissues were taken from the head, body, and tail of the pancreas. Pancreas tissue was fixed in 10% formalin solution, dehydrated in alcohol, and paraffin blocks were prepared. 8–12 μm histological preparations were prepared from the prepared paraffin blocks and stained by the hematoxylin–eosin method. Experiments and decapitation of animals were performed by the European Convention for the Protection of Vertebrate Animals Used for Experimental and Other Scientific Purposes (Strasbourg, 1985). Histological sections prepared on a rotor microtome with a thickness of 8–10 microns were stained with hematoxylin–eosin in a standard way [Volkova O.V.V., Yeletsky Yu.K., 1982].

## 3. Results

To justify the development of experimental hypothyroidism in rats, the amount of triiodothyronine (T3), unbound thyroxine (T4), and thyrotropin hormone (TTG) in the blood of rats were determined on different days of the experiment. The obtained data showed that on the 7th day of the experiment, the T3 and T4 hormones of the experimentally induced hypothyroidism and control group rats did not differ from each other. On the 14th day of the experiment, there was a decrease in T4 and a smaller decrease in T3. On the 21st day of the experiment, it was found that the indicator of T4 hormone decreased by 2 times, and T3 decreased by 1 time. Thyroid hormones in the blood of 30–day–old rats changed by 4 times according to the T4 index, and T3 decreased by one and a half times. Thus, the analysis of the hormone indicator showed a reliable decrease in the indicator of the hormone thyroxine (T4) in the blood of rats in the state of experimental hypothyroidism. The reduction of the T4 hormone was reflected from the 14th day, and in the last 30 days of the experiment, the reliability decreased to 4 times. The amount of thyroid hormones in the blood is controlled by thyrotropin. A decrease in the amount of T3 and T4 hormones in the blood led to an increase in the TTG hormone. On days 3 and 7, the amount of TTG was not significantly different from the control group. By the 14th day of the experiment, a gradual increase in TTG was noted, and by the 21st day, it was twice as high as in the control group (Table 1).

Histological basis of the structure of the thyroid gland of the control group of rats. The thyroid gland of rats in the control group was covered with connective tissue from the outside. A capsule made of connective tissue forms thin layers and penetrates deep into the gland. Trabeculae divide the gland into separate parts. Follicles are composed of small follicular complexes consisting of several groups of follicles. It can be seen that the thyroid glands of rats in the control group consist of follicles of different shapes, round, oval, and in some cases angular (Fig. 1). The cavity of each follicle is filled with colloid, thyrocytes are visible in their basal membrane. In small follicles, the shape of thyrocytes is prismatic, and in mature follicles, it is cuboidal.

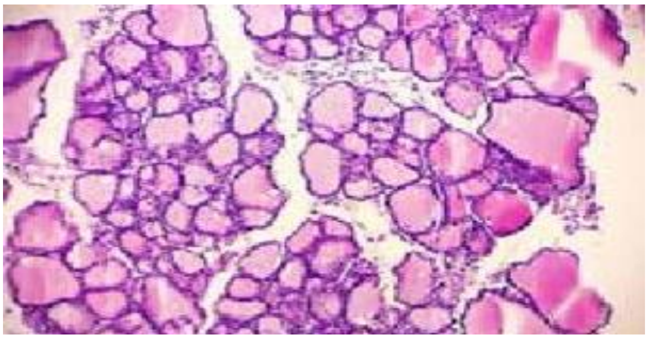

**Figure 1.** Different types of follicles. Thyroid gland of a control rat. Staining: hematoxylin–eosin. X:10x40

The nucleus of thyrocytes has a round shape, chromatin is evenly distributed, basophil staining, and cytoplasm is oxyphil staining. The colloid detected in the cavity of the follicles is also stained with oxyphil color. Each follicle is surrounded by connective tissue and blood vessels. It can be seen that the follicles are surrounded by blood vessels. It was found that lymphoid cells were collected between the follicles. The average height of thyrocytes in the thyroid gland of rats in the control group was 7.5±0.4 μm on average at 3 days, and by 30 days this value was 7.8±0.6 μm, and the diameter of the nucleus was 4.5± 0.5 μm in 3–day–old rat pups and 4.8±0.01 μm at 30 days.

The Pancreas of white laboratory rats with an average body weight of 195.5±6.1 g is pink or pinkish–yellow in color. It is located on the lesser curvature of the stomach and along the proximal part of the duodenum. The shape of the organ is three–part, its left part–lobus sinister or stomach–splenic part or tail part–cauda pancreatitis, middle part–lobus medius, head–caput pancreatitis and ng part–lobe dexter (Fig. 2).

According to our research on the rat pancreas, it can be divided into three parts: Duodenum–located at the mesentery of the duodenum. The gallbladder is located along the common bile duct, the stomach is located to the right of the spleen (Fig. 3).

**Table 1.** Hormone levels in the blood of rats in the control and experimental groups

| Days | Hormone levels in the blood (M±m) | | | | | |
|---|---|---|---|---|---|---|
| | Control group | | | Experimental group | | |
| | TTG (mkME/ml) | Triiodothy ronine (T3) | Thyroxine (UnboundT4) (pmol/l) | TTG (mkME/ml) | Triiodothyr onine (T3) | Thyroxine (UnboundT4) (pmol/l) |
| 3 day | 0,11±0,05 | 7,5±0,08 | 12,00±0,5 | 0,9±0,6 | 6,3±0,07 | 8,5±0,07 |
| 7 day | 0,17±0,4 | 7,3±0,04 | 12,00±1,7 | 0,15±0,8 | 6,5±0,5 | 9,7±0,3 |
| 14 day | 0,5±0,03 | 8,6±1,13 | 11,00±1,14 | 0,2±0,08 | 4,06±0,7 | 5,09±0,6 |
| 21 day | 0,25±0,06 | 8,9±±0,5 | 11,00±0,65 | 0,25±0,11 | 3,9±0,3 | 3,6±0,5 |
| 30 day | 0,19±0,16 | 9,5±0,6 | 12,00±1,34 | 0,23±0,09 | 3,3±0,4 | 2,7±0,5 |
| 60 day | 0,23±0,09 | 10,04±0,02 | 12,00±1,43 | 0,29±0,8 | 3,01±0,3 | 1,9±0,07 |

**Figure 2.** View of the rat pancreas

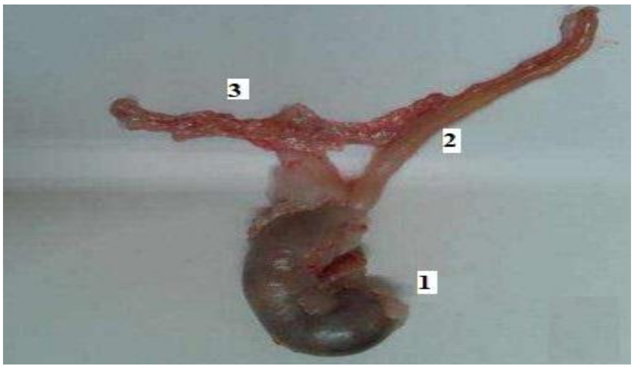


**Figure 3.** 1–stomach, 2–duodenum, 3–location of pancreas in rats

In the white laboratory rats of the control group, the pancreas was covered with a capsule from the outside. The capsule consists of dense fibers of connective tissue, the connective tissue fibers pass from the capsule to the parenchyma, and with their help, the parenchyma is divided into pieces of different sizes. The connective tissue fibers that divide the pancreas into pieces have a thin fibrous component, the pieces of the pancreas are thin and swollen in some places, as a result, the process of dividing into pieces is poorly expressed in such places. Blood vessels, nerve fibers, and excretory ducts can be seen in these connective tissue. The walls of the blood vessels are saturated with plasma fluid, and the space of the venous vessels seems to be filled with the same elements of the blood, and in some vessels, full blood is clearly expressed, and we can also see the expansion of the pancreatic ducts possible (Fig. 4, 5). In some rats, the same elements of blood were not detected or observed in small amounts in the pancreas slices of the arteries and veins passing to the interstitial connective tissue. The interlobular outflow tube is formed from a single–layered prismatic epithelium and a plate of connective tissue. There is a small amount of secretion in the cavity of the discharge tube.

In the control rats, the presence of medium–sized lobes and acinus and tubules of different diameters were significantly predominant in the exocrine part. Acinus varies from 56.2±1.9 microns, the smallest acinus size is 37.3±1.4 microns. The pancreatocytes in the apical part are narrowed and the base is much wider. Secretory granules can be seen in the apical and terminal parts of the secretory tubules. In these cells, you can see the round or oval shape of the nucleus. These pancreatocyte nuclei are closer to the base of the cell. The main part of the chromatin of the pancreatic nucleus is located throughout the nucleus, a small part of the chromatin is adjacent to the sarcolemma. Pancreatocytes located in the walls of acinus have an average size of 9.17±0.52. In the center of the most acinus, no uniform cells can be seen, they are mostly near the center of the cell, but they are rarely found in the secretory compartment.

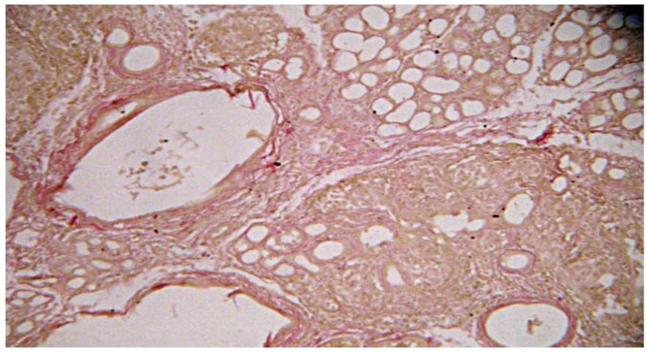

**Figure 4.** Rat pancreas on the 14th day of the experiment. Enlargement of the pancreatic ducts. Color: by Van Gieson

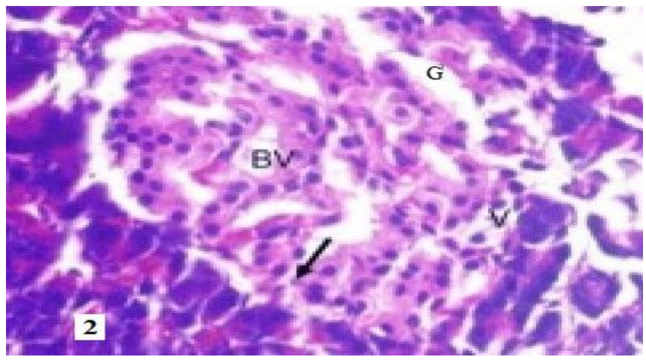


**Figure 5.** BV–dilated capillary blood vessels, V–cytoplasmic vacuolization, G–eosinophilic stained cytoplasm pyknotic nucleus, arrow karyolytic nucleus. Staining: hematoxylin–eosin. X: 10x40

Sometimes it is difficult to determine the boundaries between pancreatic cells and acinus, in some places, it is possible to determine the violation of the structure of the terminal part of the secretory department. These pancreatic cells have an average height of 12.9±1.1 microns. A small hemorrhage was found in the cells of the pancreatic parenchyma and pancreatic islets of Langerhans. In the parts of the exocrine terminal secretory granules of the lobes, as well as smaller exit ducts with walls covered with flat epithelium, exit ducts were observed in larger–interactions lobes with walls covered with cuboidal epithelium. Examination of pancreatic tissue samples from experimental groups of rats showed that the interlobular connective tissue had a clear fibrous appearance, the lobes were slightly enlarged, and fat cells were accumulated, which shows that the structure of the cells of the pancreas has changed.

## 4. Conclusions

The results of the study showed that the introduction of

Mercazolil into the pancreatic lobules of experimental rats led to changes associated with the normalization of the structural organization of the pancreatic cranium, interlobular connective tissue with the formation of fibrous tissue components, as well as the disappearance of choroidal edema observed in the interlobular connective tissue. In addition, the intensity of symptoms of the destruction of the terminal secretory section of the lobules decreased and at the same time, the number and height of the pancreas in the lobules increased. This may be due to the intensification of the process of division of the pancreas and the activation of the secretory process. In the endocrine part of the gland lobules, a thickening of the location of insulocytes in the islets and a decrease in areas filled with a loose connective tissue layer were observed, in addition, the size of the islets increased and became larger than in the control animals. This may indicate a general increase in the number of endocrine cells in the gland, and hence an increase in hormone production.

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