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ORIGINAL ARTICLE

Canine hypothyroidism under the conditions of prolonged exposure to low doses of ionizing radiation

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The results of thyroid gland damage features studies in clinically healthy dogs in the zone of prolonged exposure to low doses of ionizing radiation (zone III of radioactive contamination) are presented. It is established that the studied zone belongs to the biogeochemical province of iodine deficiency. The power of the exposure dose in the zone is 3 times higher than that in a relatively clean zone and is 3.1-3.8 nCl/kg/h (41-41.4 mcR/h). The specific density of the dogs' diet according to Cesium-137 in animals of the III zone exceeded by 5 times that in animals of the pure zone, and the specific activity of thyroid tissue exceeded by 6 times. The results of the clinical study determined the underdevelopment of dogs in the III zone of radioactive contamination, which was manifested in a lag in growth and weight gain, insufficient blood supply to the distal parts of the body, skin pathologies, cardiovascular insufficiency, gastroenterocolitis. The enlargement of the thyroid gland was manifested only by palpation and was determined as an increase of the I degree. Laboratory studies have established a violation of hematopoiesis (hypochromic anemia, regenerative shift of the nucleus to the left, a tendency to lymphopenia, monocytosis), liver failure in the form of damage to hepatocytes (hyperfermentation of aspartate aminotransferase and gammaglutamyltranspeptidase), renal failure in the form of a violation of the filtration and resorption function of the organ (a tendency to creatininemia), as well as a violation of lipid metabolism (cholisterinemia). A significant decrease in the level of thyroid hormones triiodothyronine and thyroxine occurs against the background of a decrease in the level of thyroid-stimulating hormone. Thus, hypothyroidism has a secondary origin, due to the depressing effect of radionuclides on the thyretropic hormone. The results of morphometric and histological studies indicate hyperplasia of the organ due to the proliferation of interfollicular tissue. The specific area of the follicles is reduced, the follicles themselves are devoid of colloid. Thyrocytes have a flattened shape and are desquamated. Hemorrhages were found in the interfollicular tissue. Such changes determine the impossibility of normal synthesis of thyroid hormones necessary for normal metabolism. The pathomorphological picture is equivalent to secondary hypothyroidism, and laboratory data determine the consequences of exposure to low doses of ionizing radiation.

Keywords: Thyroid gland, hypothyroidism, triiodothyronine, thyroxine, thyroid-stimulating hormone, follicles, thyrocytes, colloid, interfollicular tissue, ionizing radiation, cesium-137.

Introduction

It has already been 35 years since the most large-scale man-made disaster of our time-the accident at the Chernobyl nuclear power plant, which led to significant pollution of the environment by products of the nuclear cycle. Such substances are Caesium-137, Strontium-90, isotopes of Cerium, Ruthenium, and also, under conditions of ongoing radioactive decay, isotopes of Iodine-131 and 131I (Burgherr & Hirschberg, 2008).

The northern region of the Central Polissya of Ukraine is located in a forest-swamp biogeochemical zone with a predominance of sod-podzolic soils. This zone is characterized by biogeochemical endemia/enzootia-endemic/enzootic goiter (E01. 0). Sod-podzolic soils are impoverished by the content of active iodine, so its amount is limited in animal feed and even in some cases is absent altogether (Kotwal et al., 2007; Zimmermann, 2009; Vanderpas, 2006; Vanderpump 2011).

Endemic goiter refers to a multifactorial pathology. In addition to insufficient intake of iodine from feed, the development of the disease is also promoted, in particular, by factors of load on the territory with other macro-and microelements that increase iodine deficiency. Among such elements, researchers also distinguish radionuclides-products of the nuclear cycle, for example, Caesium-137, Strontium-90, isotopes of Ruthenium and Cerium, and others (Burgherr & Hirschberg, 2008; Harada et al., 2012; Kotwal et al., 2007).

When animals live in the III zone of radioactive contamination (the zone of guaranteed voluntary resettlement), taking into account the load of nuclear cycle products, the problem of thyroid pathology becomes more and more acute (Burgherr & Hirschberg, 2008; Harada et al., 2012).

The thyroid gland plays an important role in the functioning of the body as a whole system. Its main and most important function is the regulation of metabolism and energy due to the synthesis of the hormones calcitonin, triiodothyronine and thyroxine. These hormones regulate the work of various organs and systems, in particular, sexual, cardiovascular, nervous, as well as basic and general metabolism. The activity of the gland is controlled by the thyroid-stimulating hormone of the pituitary gland according to the feedback principle (Bin Saeedan et al., 2016; Chahal & Drake, 2007; Gesing et al., 2012; Mazzoccoli et al., 2010; Vanderpas, 2006).

So, if hypothyroidism is primary, that is, it has an enzootic nature, then changes in the hormonal profile are specific. The addition of the influence of radionuclides leads to the development of secondary hypothyroidism (Albi et al., 2017; Baloch & Livolsi, 2016; Denisova et al., 2019; Hamada & Fujimichi, 2014; Zimmermann, 2009).

The purpose of the work is to study the features of thyroid damage in mongrel dogs that live in the territory of the III zone of radioactive contamination and are considered clinically healthy. To achieve the goal, the following tasks are set: assessment of the clinical status of animals, laboratory blood parameters, pathomorphological changes in the thyroid gland under the influence of abiotic environmental factors (radioactive contamination of the territory with nuclear cycle products).

Materials and Methods

The research was carried out for the period 2017-2020 on the basis of the veterinary clinic and the educational and scientific clinical laboratory of the Polissya National University, Zhytomyr, Ukraine.

Formation of experimental animal groups

Clinically healthy dogs aged 1 year were studied. The selection of this particular age category is due to the onset of physiological maturity of dogs.

The experimental group consisted of dogs living in the Narodichi, Zhytomyr region, Ukraine, (III zone of radioactive contamination) in the amount of 20 animals.

The control group-dogs on the principle of pairs-analogues, living in Zhytomyr, Ukraine (a relatively clean zone for radioactive contamination)-20 animals.

Radiological researching

The degree of contamination of feed, water, and gamma background with radionuclides was assessed using a dosimeter-radiometer MKC-AT1117M with an external detection unit and alarm system (manufactured by scientific and production enterprise «Doza», Russian Federation).

The specific activity of the thyroid gland by gamma radiation was determined using a gamma-beta radiation spectrometer MKC-AT1315 (Atomtech production, Republic Belarus).

Clinical researching

The clinical study was carried out by general methods: Examination, thermometry, palpation, auscultation.

Determination of animals as clinically healthy was carried out on the basis of the absence of pronounced clinical signs of damage to various organs and systems, finding the main hematological parameters within the reference values, the absence of registered pathogens of infectious diseases.

Hematological and biochemical techniques of blood study

Blood sampling for the study was carried out from the lateral subcutaneous vein of the pelvic limb (vena saphena lateralis). To prepare the blood for the study, EximLab plastic vacuum tubes were used with the anticoagulant K2 EDTA, as well as with a dry coagulation activator-silicon dioxide.

The hemoglobin content and cytological composition of the blood were determined using a MicroCC-20Plus hematological analyzer (manufactured by HTI, USA).

The content of total protein, albumins, total bilirubin, creatinine and urea, the activity of the enzymes Gamma Glutamyl Transpeptidase (GGT) and aspartate aminotransferase (AST), the level of cholesterol in the blood serum were studied using an automatic biochemical analyzer VP10 Vet (manufactured by Genrui, China).

The study of the hormones Thyroxine (T4), Triiodothyronine (T3) and Thyroid-Stimulating (TSH) was carried out by immunosorbent analysis using fixed enzymes on a multifunctional microplate photometer Immunochem-2100 (High TechnologyInc., USA) (Devaraj & Garnett, 2021).

Pathomorphological researching

A pathomorphological study of the thyroid gland was performed in clinically healthy animals that died in accidents (mass injuries incompatible with life). The experimental group-dogs of the III zone of radioactive contamination in the amount of 5 animals. The control group consisted of dogs of a relatively clean zone with radioactive contamination according to the principle of pairs of analogues in the amount of 5 animals.

The linear dimensions of the organ were measured, the absolute and relative mass were determined. Paraffin sections were made on a sledge microtome MS-2. The sections were stained with Ehrlich hematoxylin and eosin according to the Van Gieson method (Mecham, 2018).

The stereometric analysis was performed by the method of point volumetry using an ocular morphometric grid (Draganski & Accolla, 2013).

Microphotography of histological preparations was performed using a CAM V200 video camera mounted in a Micros MC-50 microscope.

Statistical analysis

Statistical processing of the results was carried out using StatSoft Statistica Analyst 14 spreadsheets. ANOVA analysis of variance was used to evaluate the data. The reliability of the obtained results was evaluated by the Fisher F-criterion at a 5% confidence level.

Results

A radiological assessment of the dog study areas was carried out. The degree of air ionization is determined by a source or group of radiation sources within a certain area of space and a certain period of time. The physical measure of the radiation energy is the exposure dose (Table 1).

Table 1. The power of the exposure dose of radioactive radiation of places where dogs are kept, nKl/kg/h (mkR/h),M ± m.

Places Where Dogs Are Kept	Exposure Dose	
	III Zone Of Radioactive Contamination	The Zone Is Relatively Clean In Terms Of Radioactive Contamination
Cages	10.6 ± 1.2*** (41.4 ± 3.8)	3,8 ± 0,2 (14 ± 1.7)
Walking grounds	10.2 ± 0.9*** (41.0 ± 3.4)	3.1 ± 0.01 (13.6 ± 1.3)

***p <0.001.

The power of the exposure dose of radioactive radiation was three times higher in the III zone of radioactive contamination. Radionuclides-products of the nuclear cycle enter the body of dogs with feed (Harada et al., 2012; Koizumi et al., 2012; Meli et al., 2013; Steinhauser & Saey, 2016).

The specific activity of the dogs ' diet for Cesium-137 in the animals of the experimental group was 5 times higher than that in the animals of the control group (Table 2).

Table 2. Specific activity of the diet and thyroid tissues by Caesium-137, Bc/kg, M ± m.

Measurement Object	Experimental Group	Control Group
Diet	318 ± 7.4 ***	67 ± 4.2
Thyroid gland	197.2 ± 8.3 ***	38.6 ± 2.3

***p <0.001.

The specific activity for Cesium-137 of the thyroid gland in the experimental group dogs is 6 times higher than the indicator of the control group. The absorbed energy of ionizing radiation by the biological tissue was recalculated by the equivalent dose. So, in the control group, it was 0.092 ± 0.02 mSv/h, which averaged 3.24 mSv per day, and 1.2 mSv per year. In animals of the experimental group, respectively, 0.37 ± 0.012 mSv/h (9.35 mSv per day and 3.5 mSv per year). Thus, 1 kg of biological substance of experimental dogs absorbs three times more ionizing gamma radiation than in control animals. The rate of accumulation in the tissues of Caesium-137 is greater than the rate of excretion, so there is an accumulation effect (Harada et al., 2012; Koizumi et al., 2012; Meli et al., 2013; Steinhauser & Saey, 2016). According to the results of a clinical study, it was found that the dogs of the experimental group had lower fatness, underdevelopment of subcutaneous tissue (up to 68% of dogs). Pale conjunctiva was observed in 25% of animals. Up to 20% of dogs had signs of dermatoses-the skin is dry, hyperemic, covered with wet or dry scales. The hair is tousled, dry, brittle. Changes in the activity of the cardiovascular system were found in 34% of the examined animals-weakened heart tones, tachycardia. In 30% of animals, the development of gastroenterocolitis was established, which was manifested by soreness in the duodenal plane, stomach and intestines. The thyroid gland was enlarged in 18% of the examined patients. Palpated enlargement of the gland particles, the presence of pathological pulsation. In 20% of the animals, enophthalmos was detected-the sinking of the eye deep into the orbit. For a deeper characterization of the general condition of clinically healthy animals, a laboratory blood test was performed (Table 3, 4).

Table 3. Hematological parameters of clinically healthy dogs from different zones of radioactive contamination, M ± m.

Index	Experimental Group	Control Group
Hemoglobin, g/l	94.3 ± 3.7***	143.6 ± 2.2
Red blood cells, T/l	6.0 ± 0.2***	7.9 ± 0.25
White blood cells, G/l	6.1 ± 0.2**	8.7 ± 0.4
Leukogram:		
- Basophils, %	0	0
- Eosinophils, %	4.2 ± 0.02**	3.0 ± 0.01
- Neutrophils:		
-- Young, %	0	0
-- Stick-Nuclear, %	6.7 ± 0.7*	4.2 ± 0.4
-- Segment-Nuclear, %	47.2 ± 4.6	49.6 ± 3.7
- Lymphocytes, %	36.3 ± 4.2	42 ± 1.2
- Monocytes, %	4.6 ± 0.7*	2.8 ± 0.04

***p <0.001, **p <0.01, *p <0.05.

Table 4. Biochemical parameters of blood of dogs from different zones of radioactive contamination, M ± m.

Index	Experimental Group	Control Group
Total protein, g/l	59.3 ± 2.6	68.2 ± 1.3
Albumins, g/l	24.6 ± 1.8	35.2 ± 1.6
Total bilirubin, mmol/l	5.7 ± 1.8	4.4 ± 0.07
Creatinine, μmol/l	117.1 ± 6.2	107.2 ± 4.8
Urea, mmol/l	6.2 ± 0.6	5.9 ± 0.2
AsAT, units/l	56.8 ± 4.1***	21.6 ± 3.2
GGT, units/l	1.2 ± 0.01***	4.6 ± 1.1
Cholesterol, mmol/l	9.9 ± 1.7	3.8 ± 0.8

***p <0.001.

The animals of the experimental groups have hypochromic anemia (p <0.001), a tendency to lymphopenia and monocytosis (p <0.05). According to the biochemical parameters, the tendency to hypoproteinemia, hypoalbuminemia, creatininemia, hyperfermentation of AST (p <0.001), GGT insufficiency (p <0.001), a pronounced tendency to cholesterol were determined. Despite the revealed changes, the biochemical parameters were within the reference limits. The indicators of the hormones level in the blood serum that characterize the functional activity of the thyroid gland of dogs are presented in Table 5.

Table 5. The level of thyroid hormones in the blood of dogs from different zones of radioactive contamination, M ± m.

Index	Experimental group	Control group
Thyroid-stimulating hormone, mU/l	1.9 ± 0.04***	4.33 ±0.06
Free thyroxine, nmol/l	11.2 ± 1.9***	23.8 ± 2.8
General triiodothyronine, nmol/l	0.18 ± 0.02***	1.7 ± 0.03

***p <0.001.

There is a significant decrease in the level of Thyroid-Stimulating Hormone (TSH), free Thyroxine (T4) and general Triiodothyronine (T3), and the levels of TSH and T4 go beyond the established reference indicators. Histomorphological studies allowed us to determine changes in the histoarchitectonics and structure of the thyroid gland in dogs aged 1 year, raised in the conditions of the III zone of radioactive contamination. The thyroid gland consists of the parenchyma and stroma, which is formed by connective tissue, where the vessels of the microcirculatory bed are located. In animals of the control group, the consistency of the organ is dense, the color is dark red. The gland is located on both sides of the ventral surface of the first rings of the trachea. The shape of the particles is oval, flattened on both sides, the surface is smooth. The walls of the follicles are formed by thyrocytes, which have a cubic shape with a spherical core. The space of the follicles is filled with a colloid, inside which there are resorption vacuoles (Fig. 1). Oblong forms of the follicles dominate.

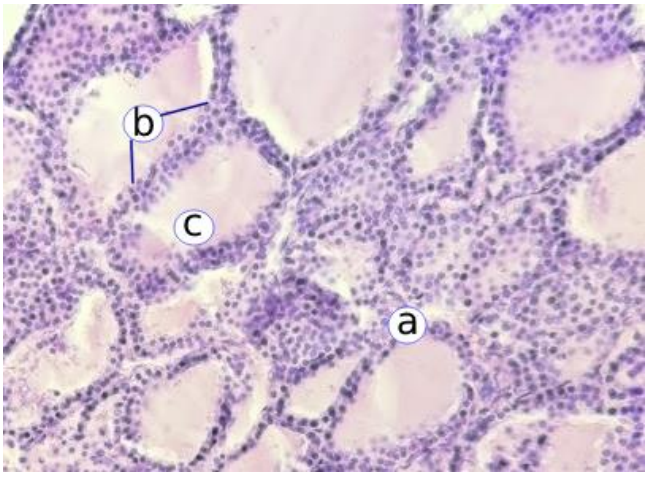

Fig. 1. Histological structure of the thyroid gland of the control group dog: **a**-follicle, **b**-thyrocytes, **c**-colloid. Hematoxylin-eosin × 300.

The gland of dogs raised in the territory of the III zone of radioactive contamination tends to increase organometric indicators. The thyrocytes of the follicles have a flat shape, desquamated. The follicles are most often devoid of colloid or have a small amount of it in a condensed state. The growth of connective tissue was established, as well as the penetration of the vessels of the interfollicular tissue. Multiple hemorrhages in the interfollicular tissue (Fig. 2)

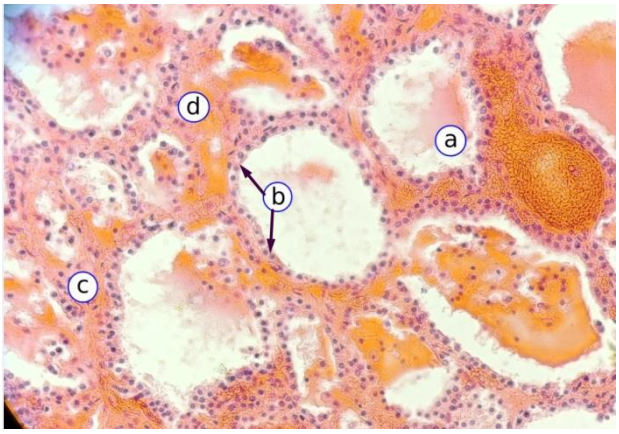

Fig. 2. A fragment of the thyroid gland of a dog of the experimental group: **a**-a follicle with a condensed colloid; **b**-thyrocytes of follicles, flat and desquamated; **c**-interfollicular tissue; **d**-hemorrhages in the interfollicular tissue. Hematoxylin-eosin × 300.

Morphometric parameters of the thyroid gland undergo significant changes in dogs of the experimental group compared with the control ones (Table 6).

Table 6. Morphometric parameters of the thyroid gland of 1-year-old dogs in different zones of radioactive contamination, M ± m.

Index	Units Of Measurement	Animal Group	
		Experimental	Control
Gland relative mass	%	0.008 ± 0.001***	0.012 ± 0.001
Diameter of large follicles	μm	224.2 ± 6.8***	185.3 ± 4.7
Diameter of the average follicles	μm	143 ± 3.7***	106.4 ± 6.2
Diameter of small follicles	μm	63.2 ±3.6**	40.2 ± 3.3
Specific area of follicles per 5 mm^2	mm^2	4.2 ± 0.02***	4.5 ± 0.03
	%	78 ± 1.2***	87.2 ± 0.8
Specific area of the interfollicular part per 5 mm^2	mm^2	1.2 ±0.045***	0.57 ± 0.02
	%	21.8 ± 0.8***	13.8 ± 0.5

**p <0.01, ***p <0.001.

In the dogs of the experimental group, all the studied ones were significantly changed: against the background of an increase in the size of the gland itself, the diameter of the follicles and the specific area of the interfollicular part, there is a significant decrease in the specific area of the follicles, that is, the main functional structure of the thyroid gland. Thus, in the histological structure of the thyroid gland of dogs of the III zone of radioactive contamination, the changes are clearly expressed and indicate degenerative changes in the organ characteristic of hypothyroidism.

Discussion

The effect of small doses of ionizing radiation on the animal body under the conditions of chronization of the process has a rather destructive effect (Ashish & Vinod, 2019). This action did not bypass such an important organ in the regulation of metabolism as the thyroid gland (Albi et al., 2017; Baloch & Livolsi, 2016; Denisova et al., 2019; Hamada & Fujimichi, 2014).

Under the conditions of permanent residence in the III zone of radioactive contamination, radionuclides enter the body of dogs mainly with food (Harada et al., 2012; Koizumi et al., 2012; Meli et al., 2013; Steinhauser & Saey, 2016). Since the dogs of the region are fed mainly with homegrown feeds that constantly accumulate radionuclides for a long time, the content of Caesium-137 accumulates (Steinhauser & Saey, 2016).

The exposure dose of ionizing radiation by gamma rays in the III zone of radioactive contamination was three times higher than the indicator of a relatively clean zone. The specific activity of the diet of the experimental group for Cesium-137 exceeds the indicator of the control group by 5 times. Thus, the source of radionuclides entering the animal body is constant.

Since the accumulation of Caesium-137 occurs more intensively than its elimination, the effect of accumulation is pronounced clearly (Koizumi et al., 2012; Steinhauser & Saey, 2016). The specific activity of thyroid tissue for Cesium-137 in animals of the experimental group exceeds that in dogs of the control group by 6 times.

Clinically healthy animals were determined under conditions of preservation of signs of physiological vital activity of the body, the absence of pathogens of infectious diseases. According to the results of clinical studies, the animals of the experimental group had a developmental disorder (about 68% of dogs), insufficient blood supply to the distal parts of the body, which is manifested by the pallor of the mucous membranes, in particular, the conjunctiva (25%). Signs of the inferiority of metabolic processes are also manifestations of pathologies of the skin, which were characterized by dermatoses. In addition, cardiovascular insufficiency and gastroenterocolitis testified to the improper development of animals (Bahn et al., 2011; Delitala et al., 2019; Garber et al., 2012).

Is known (Chahal & Drake, 2007; Gesing et al., 2012; Mazzoccoli et al., 2010), that the thyroid gland plays an important regulatory role in the body's metabolism, which in turn is subordinate to the activity of the hypothalamus. The latter, thanks to the thyroid-stimulating hormone of the pituitary gland, directs the work of the thyroid gland.

A pronounced increase in the thyroid gland, which can be palpated, was found in 18% of the dogs of the experimental group. The presence of enophthalmos in 20% of individuals determines one of the leading symptoms of endemic goiter (Blum et al., 2015; Chaker et al., 2017; Charlton & Skeaff, 2011; LeFevre, 2015; McAninch & Bianco, 2016). Thus, according to the results of a clinical study, there are grounds to suspect a pathology of the thyroid gland, which is displayed by a symptom complex of insufficiency of various organs and systems. Since the increase in the thyroid gland in the dogs of the experimental group was determined only by palpation, but not visually, that such an increase has the I degree (Blum et al., 2015; Chaker et al., 2017; Charlton & Skeaff, 2011).

The dogs of the control group did not have these clinical changes. In more detail, the effect of chronic ionizing radiation on the body of dogs can be assessed on the basis of morphological and biochemical blood tests, as well as the establishment of the hormonal status of animals relative to thyroid hormones in connection with the thyroid-stimulating hormone of the pituitary gland (Chaker et al., 2017; Charlton & Skeaff, 2011; Delitata et al., 2019).

Hypochromic anemia, established in animals of the experimental group, indicates a violation of erythropoiesis (Manjari et al., 2019; Singhal et al., 2011). With hypothyroidism, iron is poorly absorbed by the body of animals in the gastrointestinal tract. Also, folic acid with vitamin B12, which are necessary for erythropoiesis, are not sufficiently absorbed, since the processes of their assimilation are regulated directly by the hormone thyroxine. In dogs of the III zone of radioactive contamination, hypochromic anemia determines chronic hypoxia and, as a result, a high degree of attachment of the body to various diseases (Charlton & Skeaff, 2011; McAninch & Bianco, 2016).

Some problem was also noted in the process of hematopoiesis of the white germ. There was a tendency to lymphocytopenia and monocytosis. Obviously, the influence of ionizing radiation and hypofunction of the thyroid gland are among the factors of inhibition of cellular immunity. At the same time, the activity of tissue protection factors increases, probably as a result of compensatory adaptation of the insufficiency of cellular immune factors (Singhal et al., 2011). According to the biochemical parameters that characterize the main functional capabilities of the organs that provide vital activity, there was a significant hypoalbuminemia, a tendency to creatininemia, hyperfermentation of AsAT and GGT, cholesterolemia.

Hypoalbuminemia indicates a violation of the protein-synthesizing function of the liver. Is known (Khanam, 2017; Malik & Hodgson, 2002), that the hormones thyroxine and triiodothyronine are necessary for the normal functioning of basal metabolism, in particular, hepatocytes. The ability of hepatocytes to metabolize these hormones regulates the endocrine effects of the thyroid gland. Insufficiency of the functions of the gland leads to insufficiency of hepatocytes, and the latter, in turn, increases the insufficiency of the thyroid gland. A kind of vicious circle is being formed.

Hyperfermentation of AsAT confirms damage to hepatocytes as a result of constant insufficiency associated with a lack of thyroid hormones (Khanam, 2017). The weak activity of GGT is due to a lack of thyroid hormones, with which it has a direct connection (Khanam, 2017; Malik & Hodgson, 2002). The established tendency to creatinemia may also indicate involvement in the pathological cycle of the kidneys. Is known (Chaudhuri et al., 2013; Thalquotra et al., 2014), that the increase in creatinine level reflects a violation of the filtration and sorption properties of the kidneys. The effect of thyroid hormones on the kidneys ensures the regulation of electrolyte metabolism, vascular tone and determines both the speed of blood flow and the speed of glomerular filtration and diuresis.

Cholesterolemia in animals of the experimental group determines a metabolic disorder associated with a slowdown in the synthesis and breakdown of lipids. With insufficient thyroid hormones, this condition is a consequence of increased reabsorption of cholesterol in the intestine, which is possible due to a decrease in the lipogenic activity of the liver. Cholesterol accumulates in the blood, since tissue receptors are not able to interact with lipoproteins quickly enough (Duntas & Brenta, 2012).

The hormonal profile of the dogs of the experimental group is colorful. A significant decrease in the level of thyroid hormones T3 and T4 occurs against the background of a decrease in TSH levels. This condition indicates that hypothyroidism has not a primary origin due to endemic/epizootic features of the biogeochemical province, but a secondary one, which is due to the depressing effect of radionuclides accumulated in the thyroid gland on the thyroid-stimulating hormone (Chaker et al., 2017; Charlton & Skeaff, 2011). Thus, the main cause of hypothyroidism in dogs of the experimental group was established and the leading role of the influence of small doses of ionizing radiation, which animals receive for a long period, was confirmed. Confirmation of the development of hypothyroidism was a pathomorphological study of the thyroid gland obtained from clinically healthy dogs of the experimental group who died as a result of accidents.

Morphometric parameters of the thyroid gland of the dogs of the experimental group are increased, the follicles are often devoid of colloid. The increase in the organ occurs due to the proliferation of connective tissue stromal interfollicular elements, and parenchymal elements reduce their area. Desquamation of enterocytes determines the impossibility of normal synthesis of the hormones triiodothyronine and thyroxine necessary for normal metabolism (Albasri et al., 2014; Baloch & Livolsi, 2007; Garber et al., 2012). Thus, morphometric and histological changes of the thyroid gland, determined in dogs of the III zone of radioactive contamination, are pathomorphological equivalents of hypothyroidism. The absorption of ionizing radiation energy leads to significantly powerful changes in the morphological structure of the thyroid gland. Further violations of the vital activity of the body are the result of primary organ lesions.

Conclusion

In dogs of the III zone of radioactive contamination, a lesion of the thyroid gland was found in the form of secondary hypothyroidism, the development of which is due not only to the influence of the biogeochemical province for iodine deficiency, but also to chronic exposure to low doses of ionizing radiation. Clinical signs are manifested by underdevelopment, chronic insufficiency of the cardiovascular system, gastrointestinal tract, skin conditions. Characteristic laboratory changes are signs of liver, kidney

failure, lipid metabolism, as well as hematopoiesis (red and white germ). The hormonal profile is characterized by a significant decrease in the level of thyroid hormones T3 and T4 against the background of a significant decrease in TSH levels. This determines the advantage of the secondary nature of hypothyroidism and is associated with the accumulation of radionuclides in the thyroid gland. Pathomorphological signs of organ hyperplasia, degenerative changes characteristic of hypothyroidism have been established: enlargement of the gland due to the proliferation of interfollicular connective tissue, expansion and dystrophy of follicles, desquamation and destruction of thyrocytes, condensation of the colloid or its complete absence.

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