angiotensin mechanism during chronic overloading of the organ and systemic blocking of the peripheral sympathetic neurotransmitter system, and may be aimed at maintaining homeostasis of sodium by the remaining kidney during its adaptation to chronic hypotension and to the tissue mediator deficiency.

Chronic pharmacological blockade of neurotransmitter influences can thus have a significant influence on the intrarenal hemodynamic shifts in CHK. It is logical to sugggest that reduction of cortical perfusion and redistribution of the blood flow in the medullary zone at different stages of the experiment are stereotyped mechanisms of adaptation in response to the blocking of mediator influences of the autonomic nerves on the residual kidney, which are probably based on tubulomedullary feedback, resulting from neurogenic injury to the tubular transport systems and the switching of the single kidney, under these conditions, to a phylogenetically older humoral-glomerular type of regulation of its many diverse functions.

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HYPERBARIC OXYGENATION IN THE TREATMENT OF EXPERIMENTAL HYPOTHYROIDISM

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UDC 616.441-008.64-092.
9-085.835.3-036.8-07

KEY WORDS: lipid peroxidation; microcirculation; hypothyroidism.

Rehabilitation of patients after resection of the thyroid gland remains an urgent problem. One of the factors aggravating the state of such patients is the development of postoperative hypothyroidism. Besides specific correction of the pathological syndromes arising under these circumstances, nonspecific treatment of hypothyroidism also is possible. Our clinical observations have shown that hyperbaric oxygenation (HBO) is very effective in such patients [2]. However, the nature of the therapeutic effect of HBO on manifestations of hypothyroidism has not been explained.

The aim of this investigation was to study the effect of HBO on the functional state of the heart, on the microcirculation in skeletal muscle and the thyroid gland, and on some parameters of lipid peroxidation (LPO) in the myocardium of hypothyroid rabbits.

EXPERIMENTAL METHOD

Experiments were carried out on male chinchilla rabbits weighing 2.5-3 kg. A model of hypothyroidism was created by giving a single intravenous injection of ^{131}I in the composition

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Translated from Byulleten' Éksperimental'noi Biologii i Meditsiny, Vol. 107, No. 3, pp. 285-288, March, 1989. Original article submitted March 15, 1988.

TABLE 1. Effect of HBO on Level of Iron-Induced LPO in Heart Tissues and on Level of Local Tissue Blood Flows in Thyroid Gland and Skeletal Muscle

Group of animals	LPO level induced by Fe	Local tissue blood flow (min·100 g)	
		skeletal muscle	thyroid gland
Healthy	0,69±0,08	7,90±0,62	16,2±1,9
With hypothyroidism (control)	0,47±0,05*	5,30±0,52*	11,2±1,1*
With hypothyroidism and receiving HBO	0,73±0,09**	8,94±1,09**	15,7±1,7**

Legend. *$p < 0.05$ compared with normal animals; **$p < 0.05$ compared with values for control animals.

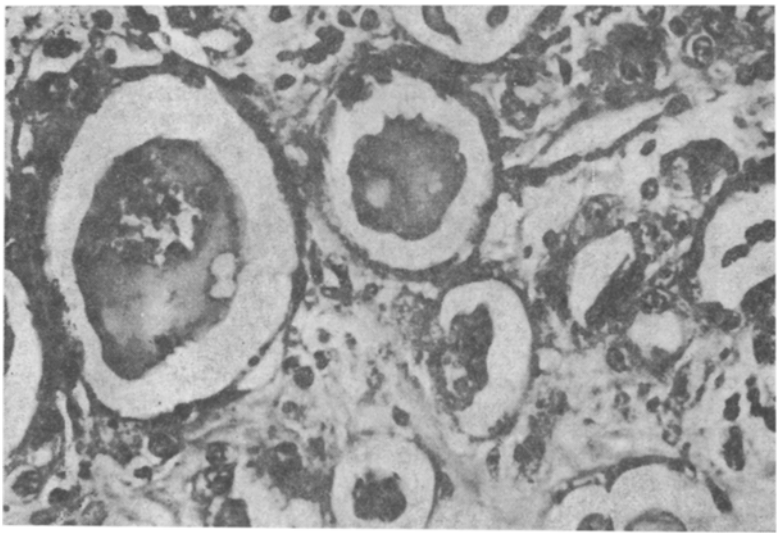

Fig. 1. Hypothyroidism, thyroid gland tissue. Hematoxylin and eosin, 400 ×.

of sodium iodide, in amounts creating a mean adsorbed dose by the thyroid gland of about 1000 g. This model ensures the development of hypothyroidism 1.5 months after injection of the isotope. There were three groups of animals: intact (control), rabbits with hypothyrodidsm, and rabbits with hypothyroidism treated with HBO. The course of HBO consisted of daily sessions in a BKI-191 pressure chamber, under a pressure of 1.7 atm for 40 min, for 10 days. The contractile function of the heart was assessed by the pressure in the left ventricle, recorded by an electromanometer on the "Mingograf-82" apparatus under conditions of relative rest and in the course of 5-sec occlusion of the ascending aorta in animals anesthetized with hexobarbital and with artificial ventilation of the lungs. Resistance of the heart tissue to induced LPO was determined by measuring the concentration of malonic dialdehyde, a product of LPO, in tissue homogenates, on a "Gilford-260" spectrometer [1]. The state of the microcirculation in skeletal muscle and thyroid gland tissue was estimated from the level of local tissue blood flows, determined radiographically by the use of ^{133}Xe as the indicator [3]. To assess the state of thyroid gland function, blood levels of tri-iodothyronine, thyroxine, and thyrotrophic hormone were determined by radioimmunoassay. Material for histological study of the thyroid gland was fixed in Carnoy's fluid and embedded in paraffin wax. Sections were stained with hematoxylin and eosin and by Van Gieson's method.

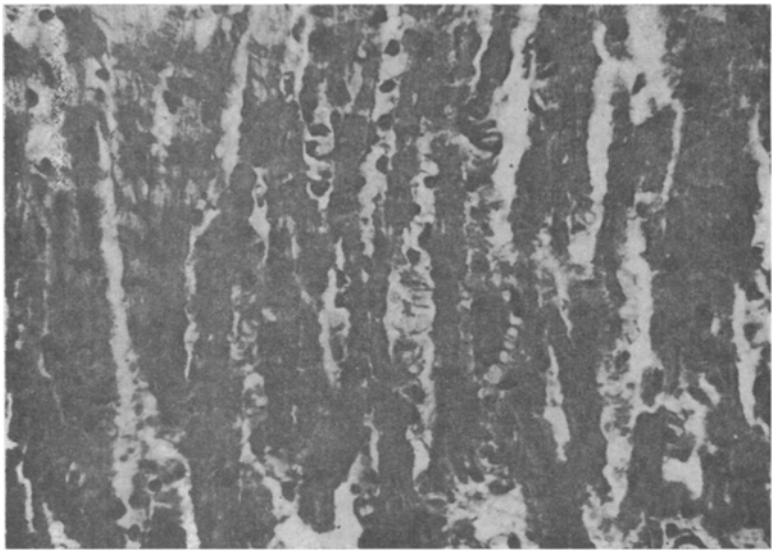

Fig. 2. Hypothyroidism, myocardium. Degenerative changes affecting cardiomyocytes, marked diffuse sclerosis. Hematoxylin and eosin, 252 ×.

EXPERIMENTAL RESULTS

Administration of sodium ^{131}I-iodide to the animals caused death of most follicles of the thyroid gland and their replacement by connective tissue. The structure of the few follicles which remained reflected a state of hypofunction, expressed as considerable flattening of the thyrotrophic epithelium with dense, thick colloid, with no signs of peripheral resorption (Fig. 1). The blood thyroid hormone levels were significantly reduced.

Bradycardia and reduction of the contractile function of the heart were recorded simultaneously, the latter reflected in a reduction of 19% in the developed pressure during the aortic compression test, and also in a fall of the rate of contraction and of relaxation of the left ventricle by 16 and 32%, respectively, compared with the control.

In animals with hypothyroidism, a decrease in the intensity of LPO was observed. The level of the local tissue blood flow in skeletal muscle and thyroid gland tissues of these animals was significantly reduced (Table 1).

Thus, 1.5 months after injection of radioactive iodine into rabbits, signs of hypothyroidism were observed, accompanied by weakening of contractility of the heart and a decrease in activity of free-radical processes in heart muscle and slowing of the blood flow along the microvascular system in the skeletal muscle and thyroid gland. During morphological investigation of the hearts of animals in a state of hypothyroidism, a combination of vascular changes was observed, in the form of congestion, focal hemorrhage, increased permeability of the vessel walls, and the consequent development of perivascular and interstitial edema. Signs of edema were clearer under the epicardium. Because of edema, the interstitial tissue was loose in texture and abundantly infiltrated with leukocytes, whereas in the heart muscle fibers there were signs of cloudy-swelling degeneration and, in some places, foci of coagulation necrosis. The micronecroses which formed were replaced by connective tissue, as a result of which foci of cardiosclerosis appeared (Fig. 2). Meanwhile proliferation of connective tissue elements of the interstitial tissue led to the development of marked diffuse cardiosclerosis.

The morphological investigations showed that after a course of HBO the structure of the myocardium of the myxedematous rabbits was disturbed to a much lesser degree. Virtually no signs of focal cardiosclersis could be seen. Meanwhile proliferation of fibroblasts of the interstitial tissue was considerably inhibited, and as a result of this, the signs of diffuse cardiosclerosis were much weaker than in the animals of the control group (Fig. 3). Treatment with HBO led to preservation of the structure of the heart muscle fibers, as a result of which the cloudy swelling degeneration was weaker and virtually no foci of coagulation necrosis of the myofibrils could be detected.

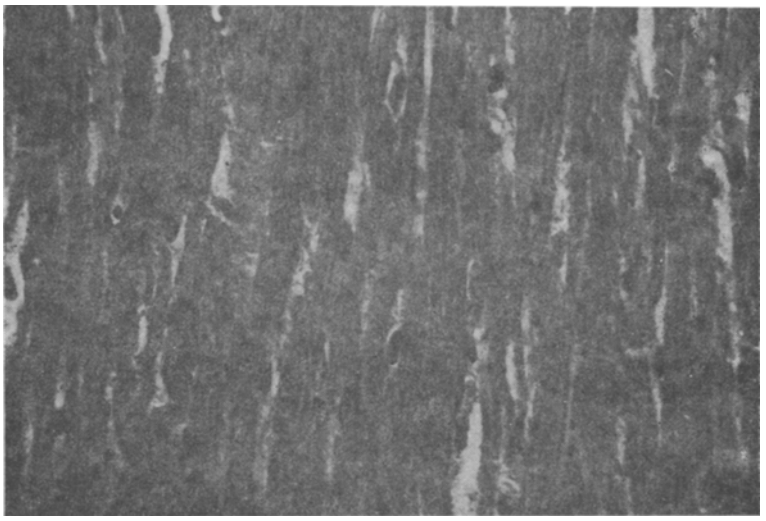

Fig. 3. Hypothyroidism, exposure to HBO, myocardial tissue. Mild diffuse sclerosis. Hematoxylin and eoxin, 252 ×.

The facts described above confirm that exposure to hyperbaric oxygen of animals with marked thyroid hypofunction helps to preserve the structure of the myocardium.

Investigation of the thyroid hormones showed that HBO has no effect on the levels of the thyroid gland hormones or of thyrotrophic hormone.

In rabbits with hypothyroidism, a course of HBO was accompanied by favorable changes in the contractile function of the heart, consisting of positive changes in the developed pressure and rate of contraction and relaxation of the left ventricle. At the same time, the malonic dialdehyde concentration in the heart tissue was restored to normal.

After animals with thyroid hypofunction had been treated by a course of HBO, the tissue blood flow in the thyroid gland and skeletal muscle was restored to the level observed in intact animals.

Thus HBO has a beneficial effect on cardiac function and also on the microcirculation in skeletal muscle and the thyroid gland, without causing any change in blood thyroid hormone levels. It can be tentatively suggested that in the presence of a stable level of thyroid hormones, HBO realizes its positive action through mechanisms unconnected with changes in hormone production. One such mechanism is the direct action of HBO on the velocity of metabolic processes, as shown by normalization of activity of free-radical LPO in the myocardium. Another possible mechanism may be strengthening of the microcirculation in various organs and tissues under the influence of HBO and, as a result of this, improvement of their functional state. Finally, the possibility cannot be ruled out that the effect of HBO may be realized through enhancement of receptor sensitivity of the body cells to thyroid hormones.

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