EFFECT OF HYPOXIC HYPOTHERMIA ON PHOSPHOLIPID METABOLISM IN THE ENDOCRINE ORGANS OF RATS IN CHRONIC HYPOXIC HYPOXIA

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Hypoxic hypothermia in chronic hypoxia inhibits phospholipid metabolism in the adrenals but does not affect their metabolism in the thyroid and testicles. Disturbance of heat emission in chronic hypoxic hypoxia leads to a sharp increase in the incorporation of radioactive label (P^{32}) into phospholipids of the endocrine organs.

Interest in the action of the temperature factor on the animal organism has risen sharply in recent years. Optimal temperature conditions for biosynthesis of protein, steroids [14, 16], and lipids [17] in the testicles have been determined. Differences in the rate of synthesis of glucocorticoids and mineralocorticoids in the adrenals have been studied in hypothermia and hyperthermia [18]. Considerable disturbances of the spermatogenic function of the gonads have been found following the local application of heat [19, 20]. Preliminary cooling of animals and natural hypoxic hypothermia increase their resistance to oxygen deficiency [1, 8, 9, 11, 21].

According to the literature [4, 5, 10], depression of the intensity of phospholipid metabolism of the rat brain during transient hypoxia is due, not to the hypoxia, but to the hypothermia which develops under those conditions. There is no information about the role of hypoxic hypothermia in phospholipid metabolism of certain endocrine organs in chronic hypoxia.

The object of this investigation was to examine the role of natural hypothermia in phospholipid metabolism of the thyroid and adrenal glands and testicles of rats in chronic hypoxic hypoxia.

EXPERIMENTAL METHOD

Experiments were carried out on 103 sexually mature male Wistar albino rats. The animals were divided into 3 groups: 1) control (54 rats), 2) animals (34 rats) exposed to chronic hypoxic hypoxia, 3) animals (15 rats) exposed to the combined effect of chronic hypoxia and heat. The temperature was maintained between 35 and 37°C in the pressure chamber throughout the experiment, thus completely preventing the onset of compensatory hypothermia. A state of chronic oxygen deficiency was produced in the pressure chamber [7], in which the animals were kept for 8-10 h daily for 3-4 weeks under an atmospheric pressure of 250 mm Hg. Before and after their stay in the pressure chamber, the rectal temperature of the animals was measured. The rats were killed by decapitation after brief ether anesthesia. The thyroid and adrenal glands and the testicles were removed, freed from blood, weighed, and their lipoid phosphorus content was determined. Total lipids were extracted and purified by the method of Folch et al. [13].

Lipoid phosphorus was determined quantitatively by the method of Fiske and Subbarow [12], with replacement of the eiconogen by ascorbic acid [6]. The rate of metabolism of total phospholipids was judged from the specific activity, expressed in pulses/min/mg phosphorus, determined in 21 ml of washed total

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TABLE 1. Effect of Chronic Hypoxia and Temperature on Content and Metabolism of Phospholipids in Endocrine Organs of Albino Rats

Group of animals	Statistical index	Thyroid			Adrenals			Testicles		
		Weight (in mg %)	PL (in mmoles/100g)	SA (in pulses/min mg P × 10^3)	Weight (in mg %)	PL (in mmoles/100g)	SA (in pulses/min mg P × 10^3)	Weight (in mg %)	PL (in mmoles/100g)	SA (in pulses/min mg P × 10^3)
1 (control)	M	10,8	2,45	4,62	15,1	3,78	3,35	1,2	1,42	2,8
	$\pm m$	0,03	0,17	0,08	0,54	0,25	0,63	0,02	0,06	0,36
2 (chronic hypoxia)	M	9,0	3,02	4,05	17,8	4,25	1,61	0,66	1,13	5,6
	$\pm m$	0,21	0,21	0,68	0,54	0,40	0,26	0,03	0,12	0,44
	P	<0,05	<0,05	>0,05	>0,05	<0,05	<0,05	<0,05	<0,05	<0,05
3 (chronic hypoxia and temperature)	M	9,54	7,0	23,2	19,0	6,32	8,75	0,94	1,80	31,1
	$\pm m$	0,29	0,68	8,55	1,02	0,83	1,0	0,06	0,17	4,95
	P	<0,05	<0,05	<0,05	<0,05	<0,05	<0,05	<0,05	>0,05	<0,05

Note. PL – phospholipids, SA – specific activity (pulses/min/mg P · 10^3).

lipid extract in experiments in vitro. The isotope (P^{32}) was injected as the sodium salt (Na_2HPO_4) in a dose of 2.5 μCi per sample [7]. Pulses were counted on a B-2 apparatus with a type MST-17 counter.

EXPERIMENTAL RESULTS AND DISCUSSION

The results given in Table 1 show that chronic hypoxia leads to a decrease in weight of the thyroid glands and testicles and to an increase in weight of the adrenals.

The total content of phosphatides in the thyroid glands of the animals exposed to hypoxia was increased, in the testicles it was reduced, and in the adrenals it was unchanged. Incorporation of radioactive label into the phosphatides of the thyroid gland was unchanged, in the adrenals it was reduced, and in the testicles it was appreciably increased.

The response of the endocrine organs to the combined effect of chronic hypoxia and temperature differed from their response to hypoxia alone. Under these conditions the weight of the thyroid glands and testicles was reduced, but to a lesser degree than in chronic hypoxia. The weight of the adrenals increased even more than during hypoxia alone. The marked increase in weight of the adrenals during simultaneous exposure to hypoxia and the temperature factor may be the result of the cumulative effect of hypoxia and hyperthermia, which are both stressors [7, 15, 21]. The concentration of total phospholipids in the thyroid and adrenal glands was 2 to 3 times higher than in the control, and 1.5-2 times higher than in the animals exposed to hypoxia alone. The phospholipid content in the testicles was the same as in the control, but it was higher than during exposure to chronic hypoxia alone. The intensity of incorporation of P^{32} into the phospholipids of the thyroid gland and testicles was increased compared with the control by 5 and 10 times, respectively, and compared with the animals exposed to chronic hypoxia alone, by 5-6 times. Metabolism of the phosphate group of the adrenal phospholipids was also increased, but to a lesser degree (2.5 times higher than in the control).

Analysis of the relationship between the intensity of phosphatide metabolism of the endocrine organs in chronic hypoxia and the accompanying hypothermia reveals that hypoxic hypothermia ($\Delta t = 4.5°C$) has an inhibitory action on phospholipid metabolism in the adrenals only, and not in the thyroid gland or testicles. In these organs the specific activity was either unchanged during chronic hypoxia (thyroid gland) or was higher than the control values (testicles). The inhibitory action of natural hypothermia, demonstrated during acute hypoxia in the case of brain tissue [4, 5, 10], was thus characteristic during chronic hypoxia of the adrenals alone, and not of the thyroid gland and testicles.

The work of Vladimirov et al. [2, 3] has shown that hypothermia inhibits brain phospholipid metabolism, while hyperthermia, on the contrary, increases the rate of P^{32} incorporation into the brain phospholipids. The marked increase in intensity of phosphatide metabolism of the endocrine organs observed in the present experiments in animals kept in a state of hypoxia and under conditions in which their heat emission was disturbed could be attributed to the cessation of the action of hypothermia, a factor limiting the unfavorable effects of hypoxia on the enzyme systems of phosphatide metabolism.

However, the result of this investigation, like those obtained by other workers [4, 5, 10], cannot provide an unambiguous interpretation of the effect of hypoxic hypothermia on metabolic changes affecting the phospholipids in various organs in hypoxic states.

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