EFFECT OF HYPOTHERMIA ON THYROID FUNCTION

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Investigation of thyroid function in rats in deep hypothermia revealed a decrease in activity of dehydrogenases, phosphatases, and cytochrome oxidase, a decrease in the ascorbic acid concentration, and a decrease in the ability of the gland to accumulate radioactive iodine (I^{131}). In experimental hypothyroidism, general hypothermia causes more marked depression of thyroid function, while in hyperthyroidism the depression is intensified.

The effect of hypothermia on thyroid function has received little study. Some workers [2, 7, 8, 13, 15] consider that the development of hypothermic states is accompanied by depression of the hormone-forming activity of the thyroid tissue, but results obtained by different workers are conflicting.

An investigation was therefore undertaken to study the state of thyroid function during the development of deep hypothermia and also during cooling of animals in which the balance of thyroid hormones was disturbed.

EXPERIMENTAL METHOD

Experiments were carried out on albino rats weighing 110-120 g. Artificial hypothermia was produced by cooling the animals in airtight cold chambers [14] down to a rectal temperature of 18-19°. Experimental hypothyroidism was produced by subcutaneous injection of a suspension of 6-methylthiouracil twice daily (total daily dose 20 mg), and hyperthyroidism by daily administration of 0.1 g dry thyroidin to the rats along with the food [3]. The preparations were administered for 8-10 days, resulting in the development of marked hypo- and hyperthyroidism in the experimental rats.

The dehydrogenase, cytochrome oxidase, and phosphatase activity of the thyroid tissue was studied in all the experimental groups of rats (at least 16 rats in each group), and the ascorbic acid content in the

TABLE 1. Changes in Thyroid Function in Albino Rats during Hypothermia (M ± m)

Index	Control	Deep hypothermia
Dehydrogenase activity [extinction/weight of tissue (in g)]	2.12 ± 0.11	1.32 ± 0.13
Cytochrome oxidase (in mg indophenol/g tissue)	4.91 ± 0.17	3.44 ± 0.28
Phosphatase (in mg indophenol/100 mg tissue)		
alkaline	71.41 ± 3.0	32.69 ± 2.4
acid	126.17 ± 6.3	82.59 ± 7.1
Ascorbic acid (in mg%)	31.16 ± 1.4	16.48 ± 1.5
Height of thyroid epithelium (in μ)	8.1 ± 0.10	4.5 ± 0.10
Diameter of follicles (in μ)	42.35 ± 1.90	70.3 ± 1.63
Radiometric index (in %)	15.5 ± 0.74	9.45 ± 0.50

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TABLE 2. Enzyme Activity and Vitamin C Saturation of Thyroid Tissue in Experimental Rats (M ± m)

Group of animals	Dehydrogenase activity	Cytochrome oxidase	Phosphatase		Ascorbic acid
			alkaline	acid	
Control	2,12±0,11	4,91±0,17	71,41±3,0	126,17±6,3	31,16±1,4
Hypothyroidism	1,44±0,10	3,91±0,32	56,79±4,9	92,77±7,4	20,08±1,7
Hypothyroidism + hypothermia	1,03±0,07	3,16±0,18	23,94±2,0	74,42±4,9	13,72±1,0
Hyperthyroidism	2,48±0,13	5,36±0,15	84,21±4,0	148,27±6,2	18,17±1,4
Hyperthyroidism + hypothermia	1,64±0,14	4,07±0,25	41,94±2,2	88,91±4,7	14,07±1,0

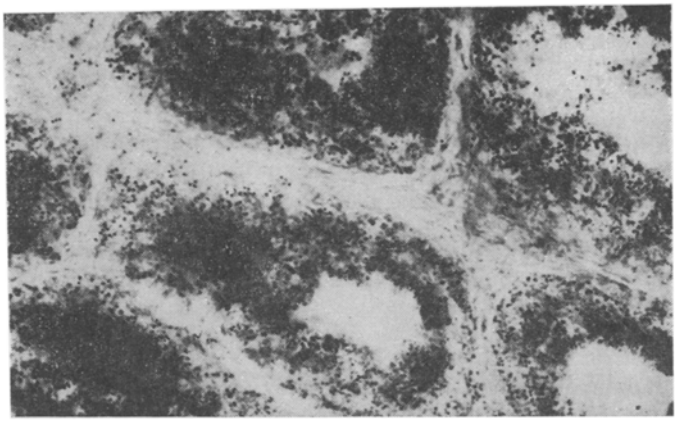

Fig. 1. Cytochrome oxidase activity in cells of thyroid epithelium in intact albino rats (NADI reagent, 400 ×).

gland was determined. Dehydrogenase activity was studied with the use of 2,3,5-triphenyltetrazolium chloride [11, 12], cytochrome oxidase activity colorimetrically with NADI reagent [17, 18], and phosphatase activity by a modified Bodansky's method [4, 10]. The ascorbic acid concentration in the thyroid was determined by the dichlorophenolindophenol method [1].

At the height of development of hypothermia, a histochemical study also was made of the character and distribution in the thyroid gland of cytochrome oxidase (NADI reagent), alkaline phosphatase (by Gomori's method), and succinate dehydrogenase (by Nachlas's method using neotetrazolium). Morphological indices (height of the thyroid epithelium and diameter of the follicles) also were determined, and intravital radiometry (using I^{131}) and investigation of β-activity of thyroid homogenates were carried out [5, 6, 11, 16].

All the experimental results were subjected to statistical analysis. Differences were taken as significant when $P < 0.05$.

EXPERIMENTAL RESULTS

Results of biochemical investigation of thyroid function of the experimental rats are given in Table 1. They show that deep hypothermia reduces the dehydrogenase, cytochrome oxidase, and phosphatase activity of the thyroid tissue. The decrease in enzyme activity was accompanied by lowering of the vitamin C concentration in the thyroid.

The data showing inhibition of enzyme activity in the thyroid tissue during deep hypothermia were confirmed by histochemical investigation, which showed that cytochrome oxidase (Figs. 1 and 2), succinate dehydrogenase, and alkaline phosphatase activity are lower during hypothermia than in the gland in intact animals.

Histological examination of the thyroid revéaled congestion of blood vessels, dilatation of the lumen of the capillaries, and small focal hemorrhages. Retention of colloid and changes in its staining properties were observed in the medium and large follicles. Meanwhile the height of the thyroid epithelium was

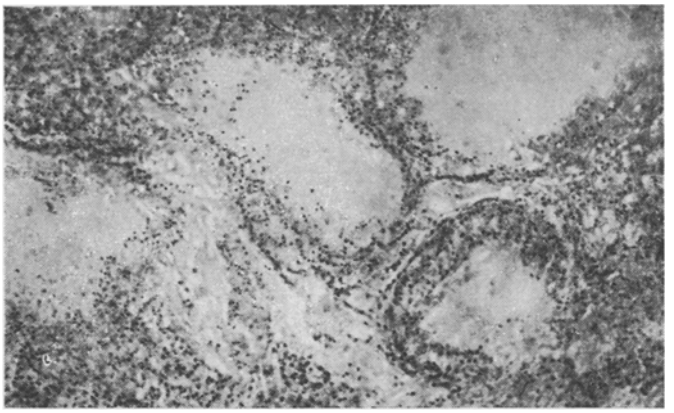

Fig. 2. Inhibition of cytochrome oxidase activity in thyroid epithelium of hypothermic animals (NADI reagent, 400 ×).

reduced, the diameter of the follicles was increased, and the radiometric index fell (Table 1). Intravital radiometry, as well as additional determination of the β-activity of thyroid homogenates showed that the ability of the gland to accumulate radioactive iodine is depressed in experimental hypothermia.

The results of investigation of the biochemical and morpho-functional indices of the state of the thyroid tissue of the experimental rats thus indicate that deep hypothermia inhibits functional activity of thyroid tissue.

Changes in the biochemical indices of thyroid reactivity in hypothermic animals depending on the saturation with thyroid hormones are given in Table 2. Experimental hypothyroidism depresses enzyme activity and lowers the ascorbic acid level in the thyroid. Cooling of animals in a state of hypothyroidism leads to a much more marked decrease in these indices.

When the organism is saturated with thyroid hormone, a marked increase in the activity of the investigated enzymes takes place in the thyroid. Meanwhile the level of the vitamin C saturation is considerably reduced. During hypothermia developing against a background of hyperthyroidism, enzyme activity is reduced and the ascorbic acid content in the thyroid gland falls.

Comparison of data showing changes in the biochemical indices of metabolism in the thyroid tissue of the hypothermic animals against the background of hypo- and hyperthyroidism shows that lowering the body temperature at a time of increased saturation with thyroid hormone causes less marked biochemical disturbances than against the background of action of 6-methylthiouracil.

The results of these investigations thus showed that at the height of development of deep hypothermia, functional activity of the thyroid tissue is depressed, and biochemical disturbances developing in the gland during cooling against the background of hypothyroidism are much more severe.

These results demonstrate the importance of a disturbed hormonal balance in the development of metabolic disturbances in the thyroid during states of hypothermia and reflect the role of thyroid hormones in changes of biochemical reactivity of thyroid tissue arising during exposure to cold.

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