INFLUENCE OF THE AUTONOMIC NERVES ON PROTEIN SYNTHESIS IN THYROID TISSUE

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Conclusive evidence has now been obtained to show that the thyroid gland possesses no specific secretory nerve supply [5-10]. Other evidence of this is given by the results of the authors' previous investigations [1-3], which demonstrated the role of the hormonal mechanism as the main factor in the transmission of trigger influences of the central nervous system to the thyroid.

Having shown that the nerves to the thyroid gland are not secretory, investigators began to consider that these nerves mainly fulfill a vasomotor function. However, it has not yet been determined whether or not they also perform a trophic function like other autonomic nerves such as the sympathetic nerves supplying the muscles. The basis for this hypothesis was the results of previous investigations showing that the denervated thyroid gland is still able to react to trigger influences of the central nervous system but has lost its power of adaptive regulation. These observations suggested that the nerves to the thyroid gland, by influencing the metabolism of the innervated structures, created the most favorable background for the functioning of this organ. Their removal disturbs the optimal conditions of metabolism ensuring the fine and precise adaptation of the activity of the gland to external environmental influences.

However, to verify this hypothesis experimentally, it was necessary to investigate the biochemical processes taking place in the thyroid tissue after denervation. The state of the protein metabolism is an important index of metabolic processes in an organ. Accordingly, the intensity of protein synthesis was investigated in the tissue of the intact and denervated thyroid gland.

EXPERIMENTAL METHOD

The intensity of protein synthesis in the thyroid was estimated from the incorporation of S^{35}-methionine into protein in vivo. Methionine was injected intraperitoneally into dogs in a dose of 30,000-35,000 pulses/min/g body weight. The animals received no food for the 24 h before injection of radiomethionine. To obtain some idea of the dynamics of methionine incorporation, the animals were sacrificed at various times (1, 4, and 24 h) after injection of the radiomethionine. The radioactivity of the proteins of the thyroid tissue and the blood plasma was investigated. The thyroid tissue was washed to remove blood, ground in a mortar to a homogeneous state, and the proteins of the homogenate were precipitated with 10% trichloroacetic acid (TCA) solution. The precipitate was washed several times with 5% TCA, with alcohol, with a 1:1 mixture of alcohol and ether, and with ether by the usual method [4]. The blood plasma was treated in the same way as the thyroid tissue to obtain dry protein. The radioactivity in a weighed sample (5 mg) of dry protein isolated from the thyroid tissue and plasma was determined with an end-type counter.

The investigation was carried out on 14 dogs. The thyroid gland was denervated as follows: all the visible nerve fibers approaching the thyroid gland were divided and the blood vessels were treated with 5% phenol solution.

To eliminate any effect of topography on the incorporation of radiomethionine into the thyroid proteins in some animals, the gland was denervated on the right side, and in others on the left. The intact gland on the opposite side served as control.

Protein synthesis was investigated at various times after the operation: 8-12 days, in the period of maximal degeneration of the nerve fibers, and 40-60 days, when the innervation of the gland as a rule was restored [1-3].

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Table 1. Incorporation of Radiomethionine into Tissue Proteins of Intact and Denervated Thyroid Glands in Dogs at Various Times After Operation (results expressed in pulses/min/5 mg protein, 24 h after injection of radiomethionine)

Expt. No.	Time after operation	Radioactivity of intact gland	Radioactivity of denervated gland	Changes (%)	Remarks
1	12 days	260	320	+23	Denervation on left
2	12 »	590	682	+16	» on right
3	11 »	932	1 060	+14	» »
4	11 »	780	930	+19	» »
5	9 »	585	650	+34	» on left
6	8 »	645	812	+26	» »
7	9 »	390	655	+59	» »
				$P<0,001$	
8	40 »	360	350	—3	
9	40 »	600	620	+3	» »
10	40 »	1 300	1 055	—11	» on right
11	40 »	810	864	+6	» on left
12	60 »	1 200	1 300	+8	» »
				$P>0,5$	

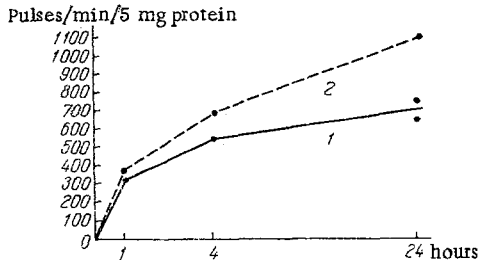

Fig. 1. Dynamics of incorporation of radiomethionine into proteins of intact and denervated thyroid gland. 1) Intact gland; 2) denervated gland.

EXPERIMENTAL RESULTS

The results of the investigations of the intensity of protein synthesis in the tissue of the intact and denervated thyroid gland are shown in the table. As these results show, the intensity of incorporation of radiomethionine into the proteins of the denervated thyroid was higher than into the proteins of the intact gland. This result was clearly seen in seven dogs investigated on the 8th-12th day after the operation, i.e., at a time when degeneration of the nerve fibers was active and the direct nerve connection between the thyroid gland and the central nervous system was broken. The incorporation of radiomethionine into the thyroid proteins 40-60 days after denervation (see table) as a rule remained on the same level as in the intact thyroid; this may be attributed to regeneration of the nerve fibers and, consequently, to restoration of the direct nervous connection between the thyroid gland and the central nervous system. Analysis of the dynamics of radiomethionine incorporation into the proteins of the intact and denervated thyroid showed that the relationship observed persisted throughout the period of investigation. It is clear from the figure that 1 h after injection of radiomethionine, the animals investigated on the 8th-12th day after denervation showed differences in the intensity of methionine incorporation into the proteins of the intact and denervated gland. This difference increased steadily after 4 h, to reach a maximum after 24 h.

It is clear from the results given in the table that an increase in the intensity of incorporation of the amino acid was always observed in the denervated thyroid regardless of the side on which the operation was performed. It was stated above that, besides determining the radioactivity of the tissue proteins of the thyroid gland, the radioactivity of the serum proteins also was investigated. The intensity of incorporation of methionine into the serum proteins was higher than that into the tissue proteins both of the intact and of the denervated thyroid gland, and varied between 858 and 1710 pulses/min/mg protein.

The results of these investigations thus confirmed the authors' view that the autonomic nerves of the thyroid gland have a trophic function. They showed that the rate of incorporation of radiomethionine into the tissue proteins of the thyroid gland is directly dependent on the state of innervation of the gland. After denervation, with rupture of the nervous connection between the gland and the central nervous system, protein synthesis in the thyroid gland took place more intensively; during regeneration of the nerve fibers and, consequently, restoration of the disturbed connection between the thyroid gland and the central nervous system, protein synthesis in the gland returned to its initial level.

The results of these investigations show that innervation of the thyroid gland determines the intensity of protein synthesis in the gland. In the absence of innervation this intensity rises and during recovery of the innervation it returns to normal.

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