STRUCTURAL CHANGES IN THE THYROID GLAND AFTER REPEATED EXPOSURE TO RADIAL ACCELERATION

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A histochemical and morphometric study of the thyroid in dogs exposed to repeated radial acceleration revealed changes indicating the development of atrophy in the gland.

As a result of the action of radial acceleration, destructive, degenerative, and atrophic changes can develop in a number of organs in experimental animals [2, 5, 6, 14, 19].

However, no information on structural and functional changes in the thyroid gland after exposure to this factor could be found in the literature. Considering the important role of the thyroid in the control of metabolism [4, 11, 17] and the development of adaptive reactions in the body [7, 9, 13], such an investigation must be of great importance.

This problem also deserves special attention in connection with the view that destructive changes in the thyroid gland play a role in the development of autoimmune processes [10, 20]. An important role is ascribed to these processes in the genesis of certain thyroid diseases [8, 12, 15, 16].

EXPERIMENTAL METHOD

The thyroid glands of dogs (males) exposed to acceleration with an intensity of 8 units, produced by rotating the animals on a standard turn-table with radius 4.2 m for periods of 3 min, were investigated. The direction of the overload was from chest to spine.

The animals (four) of group 1 were exposed once to acceleration, while the six animals in group 2 were exposed repeatedly (12-14 times) at intervals of 30 days. Material was taken under superficial ether anesthesia 30 days after the last exposure to acceleration; two dogs from group 1 were sacrificed on the day of the experiment so that acute changes in the gland could be analyzed. Thyroid glands of intact animals (six dogs) acted as the control. Various survey and histochemical staining methods were used: hematoxylin-eosin Van Gieson's method with counterstaining for elastic tissue, Heidenhain's modification of Mallory's method, silver impregnation by the method of Gordon and Sweet, Brachet's method; and the activity of the following enzymes were studied: succinate dehydrogenase, peroxidase, and alkaline and acid phosphatases. The relative percentages of the principal tissue components were determined by Uotila's method [18], and the diameter of the follicles, the volume of the nuclei, and the height of the thyroid epithelial cells were measured.

EXPERIMENTAL RESULTS

After a single exposure to acceleration, morphological evidence of activation was found in the thyroid gland on the day of the experiment. This was evidently a stereotyped response to the stressor character of the procedure [9]. The mean diameter of the follicles was reduced (Table 1), but the height of the cells and volume of the nuclei of the thyroid epithelium were increased. Signs of increased resorption were found in

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TABLE 1. Results of Morphometric Investigation of the Thyroid Gland in Dogs Exposed to Radial Acceleration

Group of animals	Number of animals	Relative weight of thyroid gland (in mg/kg body weight)	Diameter of follicles (in μ)	Thyroid epithelium		Principal tissues components (in %)			
				height of cells (in μ)	volume of nuclei (in μ)	thyroid epithelium	colloid	stroma	parafollicular epithelium
Control	6	103,75±12,76	139,30±5,26	5,69±0,08	76,51±1,12	31,6	55,8	4,2	8,4
1	4	88,15±10,41 $P>0,5$	100,35±5,27 $P<0,05$	7,14±0,18 $P<0,01$	91,80±2,27 $P<0,05$	43,6	36,2	9,4	10,8
2	6	46,80±8,32 $P<0,05$	74,34±4,34 $P<0,05$	4,36±0,14 $P<0,01$	58,19±2,15 $P<0,01$	13,5	22,5	45,1	18,9

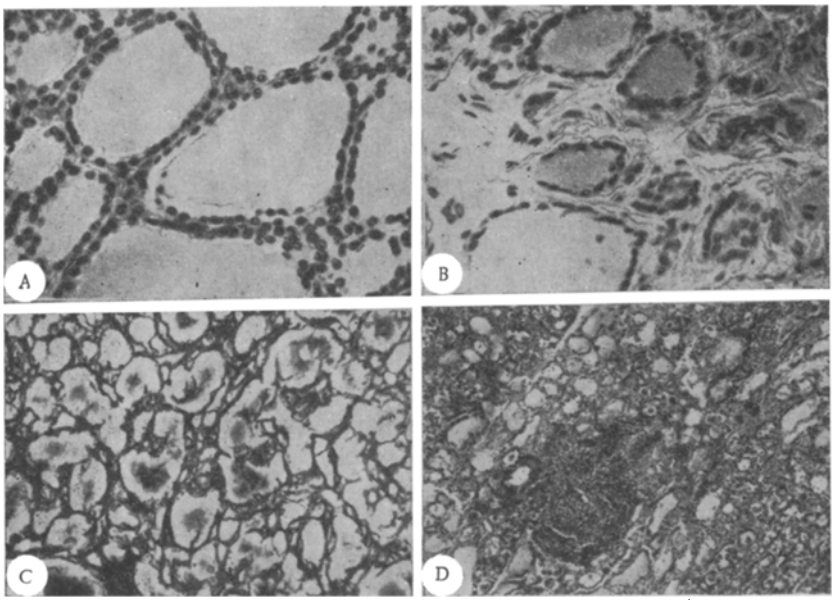

Fig. 1. Structure of the thyroid gland in dogs after repeated exposure to radial acceleration: A) structure of normal thyroid gland (Van Gieson, 280 ×); B) diffuse interstitial sclerosis; reduction of follicles (Van Gieson, 280 ×); C) changes in basement membranes (Gordon–Sweet, 280 ×); D) infiltration with lymphocytes and plasma cells; lymphoid follicles in thyroid gland tissue (hematoxylin-eosin, 70 ×).

the colloid; peroxidase and acid phosphatase activity in the cytoplasm of the thyroid cells was increased; and the pyroninophilia was slightly intensified. The capillary network was dilated and a marked reaction for alkaline phosphatase was present in the endothelium. Focal changes, consisting of destruction of the follicle walls and discharge of colloid masses and signs of focal lymphocolloid edema, also were observed. Enzymes were found in these areas in the form of large granules, possible evidence of injury to the structural elements of the cell [1, 3]. Diapedesis and perivascular edema were present.

After 30 days and near the time for the second session of acceleration, evidence of thyroid activation was accompanied by the appearance of numerous islets of parafollicular cells with signs of microfollicle formation. Signs of perivascular sclerosis were present.

Repeated exposure to radial acceleration led to a decrease in the absolute and relative weight of the thyroid glands (Table 1). Three types of changes were found histologically in the glands of this group of animals.

The first type was characterized by the appearance of atrophic changes at the cell and tissue levels. Fatty degeneration was observed in the thyroid epithelial cells, the height of the cells and volume of their nuclei were considerably reduced, and enzyme activity and the intensity of pyroninophilia in the cytoplasm of the cells were reduced. The relative area occupied by the epithelium was reduced while that of the stroma was increased, indicating the development of sclerosis in the gland. Two types of sclerosis were found: diffuse interstitial sclerosis developing against the background of lymphostasis and manifested as thickening of the capsule and of interlobular and interfollicular connective-tissue septa (Fig. 1B), and focal replacement sclerosis in areas of destruction and death of the follicles. In some cases the appearance of replacement lipomatosis, a rare phenomenon in the thyroid gland, was found. With the development of the atrophic changes in the gland, signs of reduction of the circulation became increasingly evident.

The second type of changes was characterized by infiltration with lymphocytes and plasma cells, either diffuse in character of as solitary lymphoid follicles (Fig. 1D). Changes in the basement membranes (Fig. 1C) and the appearance of multinuclear cells must evidently be regarded as similar in type. The changes in this type are, of course, a morphological reflection of autoimmune processes in the gland [8, 12, 15, 16].

Changes of the third type combine the features of regeneration in the gland (formation of microfollicles, appearance of Aleshin's buds and of Sanderson's cushions).

Analysis of the changes thus discovered in the thyroid gland of dogs exposed to repeated acceleration thus revealed the development of atrophy in the gland. It is possible that autoimmune reactions played an important role in the genesis of this process. A factor predisposing to the development of these reactions could be the disturbance of physiological isolation of the thyroid antigen through cumulation of destructive changes in the gland as a result of exposure to acceleration.

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