THE PROBLEM OF THE INTERACTION OF THE CEREBELLUM AND THYROID GLAND

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There is widespread evidence of the occurrence of cerebellar damage in many general infections, in diseases of the central nervous system, and in endocrine disturbances. E. Kononova [5] found in myxedema that cerebellar symptoms disappeared when the myxedema was treated. Confirmation of a possible functional connection between the cerebellum and thyroid gland has also been provided by G. V. Tutaev and by M. A. Isichenko [9] who showed that after extirpation of the cerebellum from rabbits there was a reduced thyroid activity. Histologically the thyroid gland could be seen to be in a resting condition [8]. E. S. Karagedova and A. A. Loginov [4] found that in dogs killed 15-20 days after cerebellar extirpation that there were changes in many organs, and that in the thyroid the condition of the colloid corresponded to one of rest.

In the present work we have set out to study the influence of thyroidectomy on the histological structure of the cerebellum, and in particular on the condition of the Purkinje cells.

EXPERIMENTAL METHOD

The work was carried out on 8 rabbits: in four, at operation the thyroid gland was removed completely, and four others were used as controls. The rabbits were killed after $3\frac{1}{2}$ months and the cerebellum removed. The material was fixed in Susa, and then embedded in paraffin. Sections of the cerebellum were stained with chrome hematoxylin by Gomori's method; other sections were stained with paraldehyde fuchsin and counterstained with methylene blue or Nissl's toluidine blue.

In studying cerebellar sections microscopically we found no general pathological changes in the experimental group (Fig. 1). In both the control and the experimental groups the Purkinje cells showed a wide range of structures

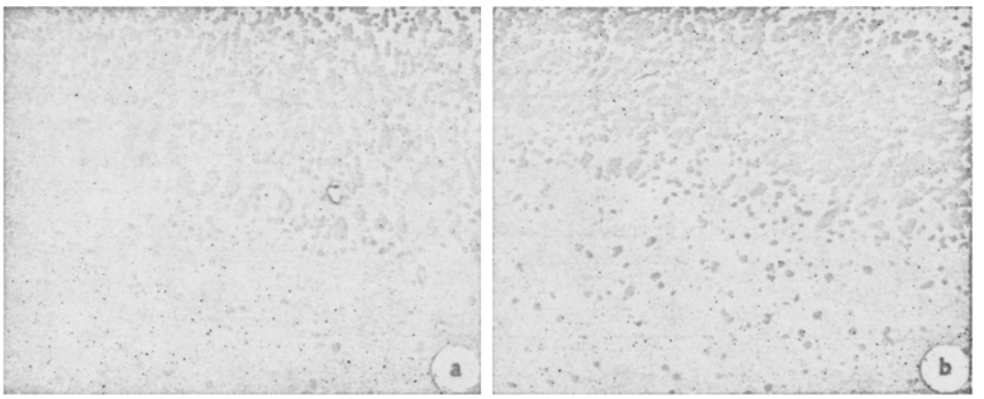

Fig. 1. General appearance of a folium of the rabbit cerebellum. a) Control, b) experiment. Micrograph. Stained with chrome hematoxylin. Low magnification.

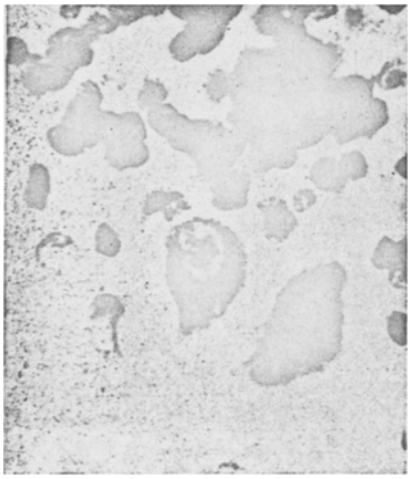

Fig. 2. Purkinje cells of the cerebellum of an experimental rabbit. Micrograph. Stain chrome hematoxylin. Magnification 280 times.

(Fig. 2). It is known that in healthy animals, besides the Purkinje cells, as described classically, there are a certain number of crenated, pyknomorphic cells.

We divided the Purkinje cells arbitrarily into three kinds: 1) cells with a well-marked nucleus and nucleolus having usually only a moderate amount of Nissl substance in the cytoplasm, part of it arranged at one pole of the cell near to the nucleus on the side of the axon (normal cells); 2) cells in which the cell body was highly crenated and which had a strong affinity for dyes, and which were diffusely stained with Nissl; the nuclei of such cells were either pyknotic and masked by the cytoplasm which was diffusely and intensely stained, or else they could not be made out (pyknomorphic cells); 3) cells in which only the outlines of the cell body and the nucleus remained, and which took up scarcely any dye (shadow cells). In the cerebellum of the control animals and still more in the cerebellum of the experimental group we found great irregularity in the distribution of all three types of Purkinje cells.

A comparison of the cerebellar preparations of the control and experimental animals showed a definite difference in the relative numbers of the different kinds of cells. We made a count of the Purkinje cells in serial sections stained with toluidine blue, but for confirmation and more precise estimation we used sections stained with chrome hematoxylin or with paraldehyde fuchsin (objective 90× ocular 10×), Repeated counts were made.

In Table 1 we show average figures obtained in counts of Purkinje cells made on serial sections for each rabbit. The figures have been treated statistically. Because the results obtained from the control rabbits were uniform, Table 1 shows only results for two of the rabbits.

From Table 1 it can be seen that there is a considerable change towards an increase in the number of pyknomorphic cells in the experimental as compared with the control group. The effect is still more clearly apparent from Table 2. The number of pyknomorphic elements in the operated group shows an increase of 1,7-2 times. In the control animals there were many more normal than altered cells, but in the thyroidectomized rabbits the numbers of the two groups were about the same. The number of shadow cells shows very little change in the operated animals. Possibly they represent functionally exhausted cells.

Our results therefore show that after removal of the thyroid gland from rabbits considerable changes in the Purkinje cells of the cerebellum occur.

It is known that changes occurring as a result of damage or removal of the cerebellum lead to profound disturbances which are basically chemical. Following this line of thought T, Senise [14] put forward the hypothesis that the cerebellum has an internal secretory function. When considering the secretory function of certain elements of the central nervous system A. M. Zimkina [2] referred to investigations [1, 3, 6, 7] providing evidence that stimulation of the cerebellum brings about alterations in the functional condition of a whole number of organs and tissues whose nervous connection with the cerebellum had been interrupted. According to A. M. Zimkina this result is in line with the views of T. Senise, who regards the cerebellum as an organ of internal secretion.

TABLE 1. Number of Purkinje Cells of Different Kinds

Rabbits	No. of rabbit	Normal cells	Pyknomorphic cells	Shadow cells	Total cells
Control	1	432±24	176±22	42±16	693±69
	2	514±47	205±13	62±7	781±68
Experimental	1	402±67	369±43	81±4	861±78
	2	548±67	480±65	82±6	1137±[illegible]
	3	326±63	348±9	58±8	734±[illegible]
	4	257±10	382±20	51±1	690±[illegible]

TABLE 2. Percentage of Different Kinds of Purkinje Cells

Rabbits	No. of rabbit	Normal cells	Pyknomorphic cells	Shadow cells
Control	1	69	25	6
	2	65	26	12
Experimental	1	46	42	12
	2	46	41	13
	3	49	43	8
	4	37	55	8

At the present time there is only scanty evidence of cerebellar neurosecretion. Mosinger [10] pointed out that neurosecretion of the Purkinje cells was greatly increased in shock. Next he produced further material indicating a neurosecretion of the cells of the granular layer and of the dentate nucleus of the cerebellum.

Thomas [17], Seite [12, 13], Stahl [16] working on cats, dogs, rabbits, hamsters, and Teleost fish showed that special spherical structures, which according to Seite were lipoprotein complexes representing products of the basal metabolism of the nerve cell might be extruded from the Purkinje cell nuclei.

It is interesting to compare the results of experiments obtained in this investigation with those published elsewhere. The question arises as to whether the changes in the Purkinje cells which we observed after thyroidectomy in rabbits were associated with an impairment of their secretory function. We intend to continue our studies in this direction.

SUMMARY

It was shown that after thyroidectomy rabbits showed regular changes in the cerebellar cortex in which the number of pyknomorphic forms of Purkinje cells increased by 1.7-2 times. In the light of other relevant reports it has been proposed that these changes are related to a humoral connection between the cerebellum and the thyroid gland.

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