CHANGES IN THE GLYCOGEN CONTENT IN INDIVIDUAL NUCLEI OF THE HYPOTHALAMUS WITH NERVE DEGENERATION

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UDC 616.831.41-003.99-008.934.54

In previous investigations to study the changes in the hypothalamic region during the development of nerve degeneration caused by trauma to the sciatic nerve [2] a series of marked morphological disturbances was found in the anterior and posterior nuclei of the hypothalamus. In this connection the question arose of the role of the disturbance of metabolic processes (carbohydrate and nuclear metabolism) in the genesis of these changes.

It is now established that carbohydrates form the main source of energy for nerve cells. A. L. Shabadash analyzed the carbohydrate metabolism in the normal nervous sytem [3] and distinguished two types of neurons: some utilize the blood glucose, may accumulate glycogen reserves and, if need be, mobilize these reserves; the others do not accumulate glycogen and are dependent on a continuous supply of glucose from the blood. Among the first group of neurons Shabadash included the neurons of the various autonomic nuclei of the diencephalon, together with the motor neurons of the ventral roots, the spinal afferent cells, and certain cells of the extrapyramidal and vestibular systems.

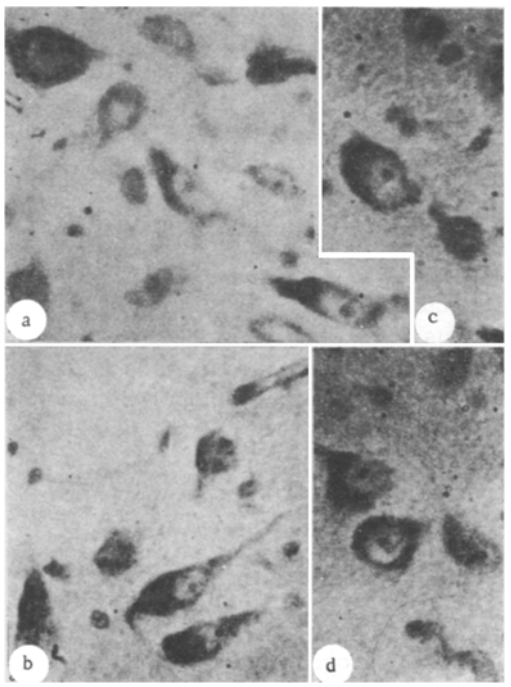

Fig. 1. Glycogen in neurons of the paraventricular (a), supraoptic (b), posterior (c), and lateral mammillary (d) nuclei of the hypothalamus of a normal cat. The presence of polysaccharide in the Nissl granules is clearly seen. Shabadash. 800×.

The object of the present study was to investigate the glycogen content in the nuclei of the hypothalamic region in normal animals and in animals at different stages of development of degeneration of nerves.

EXPERIMENTAL METHOD

Experiments were carried out on cats in which the sciatic nerve was divided below the point of injection of 0.1 ml of 2% formalin solution. The material for the investigation consisted of series of frontal sections through the diencephalon of intact (control) animals and cats sacrificed 7, 21, 45, and 90 days after the procedure. Altogether 12 experimental and 4 control cats were used.

The sections were stained for glycogen by Shabadash's method. The presence of glycogen was verified by treatment with diastase.

EXPERIMENTAL RESULTS

Examination of the series of frontal sections through the diencephalon of the control cats showed that only certain nuclear structures in the hypothalamic region possessed glycogen-containing neurons. Comparison of these preparations with serial sections stained by Nissl's method [1] showed that these were in fact definite groups of neurons forming part of the paraventricular, supraoptic, ventromodial, posterior, and lateral mammillary nuclei (Fig. 1).

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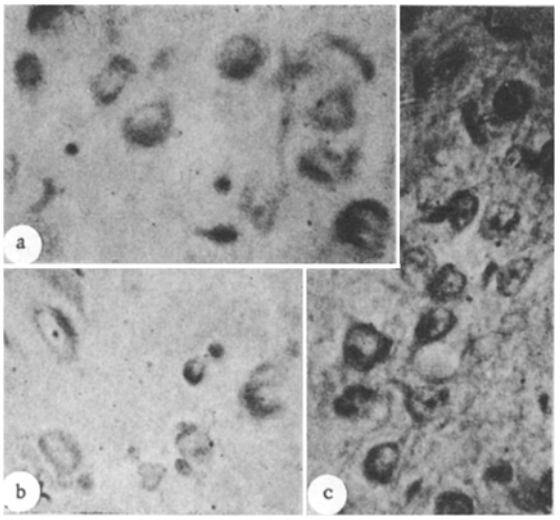

Fig. 2. Exhaustion of glycogen in the neurons of the paraventricular (a), supraoptic (b), and lateral mammillary (c) nuclei of the hypothalamus in experimental cats. 45 days after injury to the sciatic nerve. Shabadash. 600×.

In these neurons the glycogen granules occupied the same positions as the tigroid granules. According to Shabadash, these relationships are characteristics of neurons in a physiological state.

On the 7th day after injury to the sciatic nerve no essential changes had taken place in the glycogen content in the nerve cells of the hypothalamic nuclei.

A similar picture was seen on the 21st day after the operation, although at this time isolated nerve cells were observed in the supraoptic and posterior nuclei whose cytoplasm contained rather fewer glycogen granules than in the control animals.

On the 45th day after the operation essential differences from the normal morphological picture were seen. A marked decrease in the number of glycogen granules was observed in most neurons of the paraventricular, ventromedial, and lateral mammillary nuclei, and none were present in the neurons of the supraoptic and posterior nuclei (Fig. 2).

On the 90th day after the operation no glycogen was found in the nerve cells of the hypothalamic nuclei. At this time, however, a positive reaction for glycogen more intensive than normal was found in the glial cells and in the vessel walls.

The results described demonstrate that in the various stages of development of nerve degeneration caused by trauma to the sciatic nerve considerable changes take place in the glycogen content in the nerve cells of individual hypothalamic nuclei, amounting in some cases to its total disappearance. If these results are compared with those obtained by the author when studying preparations stained by Nissl's method, it may be concluded that the breakdown and lysis of the chromatophilic substance leading, in the late stages of development of degeneration, to death of the nerve cells are to some extent associated also with profound changes in the carbohydrate metabolism.

It must be remembered that disturbances of carbohydrate metabolism may affect not only the energy-producing, but also the plastic processes in cells. A special analysis of these problems is required, for they are very important for the clarification of some aspects of the degenerative disturbances arising in the nerve cells of the hypothalamic nuclei. Evidently, the state of the carbohydrate metabolism must be compared in this context with changes in other types of metabolism and, in particular, with nucleic acid metabolism and with protein synthesis.

LITERATURE CITED

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