EFFECT OF IONIZING RADIATION ON NEUROSECRETION OF HYPOTHALAMIC NUCLEI

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The action of radiation on the nervous system produces certain definite changes in systems responsible for reflex, including conditioned reflex, reactions of all degrees of complexity [1, 4, 5]. As the main disturbances produced by radiation develop in autonomic organs, it is not unnatural that attention should be directed primarily to the autonomic nervous system and, more particularly perhaps, to the central formations controlling the state of the autonomic system itself. Changes in the functional state of the hypothalamic region and cerebellum have been the particular subject of research in this laboratory [9, 10].

One form of functional activity of neurons in hypothalamic nuclei is the production of neurosecretion. Published reports testify to disturbances of the incretory activity of quite a number of formations [2, 11, 13].

Any complete appraisal of the changes developing in the functional state of the hypothalamic region in the irradiated animal must include an examination of the neurosecretory function of its nuclei. So far, there have been but a few isolated reports on this aspect of the problem [7, 12, 14]. In this investigation an attempt was also made to determine the mechanisms responsible for radiation-induced changes in the neurosecretory activity of hypothalamic nuclei.

METHOD

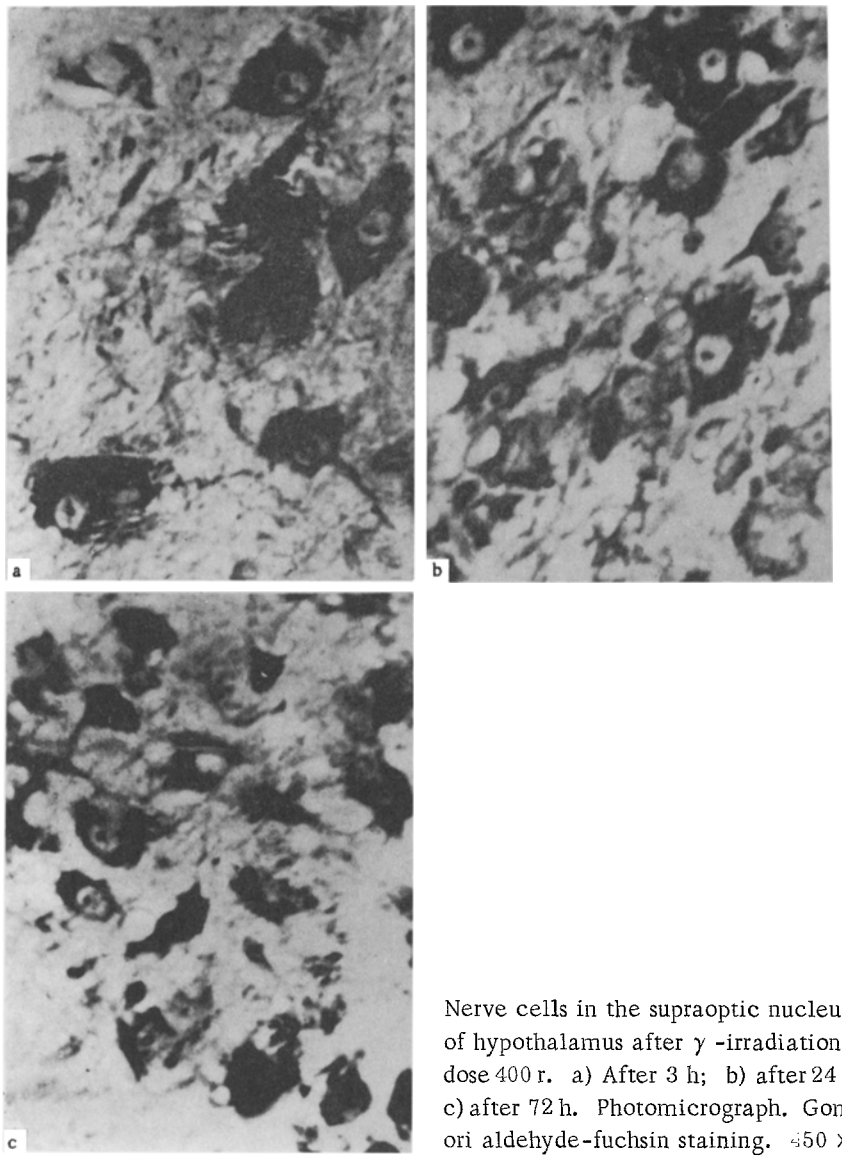
The investigations were carried out on 52 male rabbits weighing between 2.7 and 3.3 kg. The animals were all kept under the same conditions and given the same food. Irradiation was with γ -rays of Co^{60}. Dose strength was 248 r/min and total dose 400 r. Both control and experimental animals were examined 3, 24 and 72 h after irradiation. Brains were extracted and fixed in 10% formalin. Sections (5 μ) were stained with Gomori's acetaldehyde in Maiorova's modification [6] and by Polenov's modification [8] of Gomori's chromalum hematoxylin and fuchsin method.

RESULTS

In the case of control animals aldehyde fuchsin staining revealed only a small quantity of neurosecretory substance in the form of granules in the perikaryon.

The quantity of neurosecretory substance was increased in hypothalamic nuclei 3 h after irradiation, the granules filling some cells completely. By the end of 24 h the content was returning to normal. After 72 h the quantity of neurosecretion was reduced and some cells in the supraoptic and paraventricular nuclei now contained none. Such cells were markedly vacuolated (figure).

Chrome-hematoxylin-fuchsin staining revealed basophil (Gomori-positive) and oxyphil (Gomori-negative) substance. Neurosecretory substance is known to be a lipoprotein or lipoglycoprotein complex, with phospholipids the most important constituent [2]. These compounds stain a dark blue with chromalum hematoxylin, and this color is characteristic of Gomori-positive substance. If cells are stained a pink or raspberry color by the fuchsin, the substance is Gomori-negative.



Nerve cells in the supraoptic nucleus of hypothalamus after γ -irradiation, dose 400 r. a) After 3 h; b) after 24 h; c) after 72 h. Photomicrograph. Gomori aldehyde-fuchsin staining. ×450.

In the case of the control animals, Gomori-positive substance was observed in the paraventricular nuclei and both Gomori-positive and Gomori-negative substance in supraoptic nuclei. No definite changes could be observed in either nucleus as a result of the action of γ -rays, although there was some predominance of oxyphil substance in the supraoptic nucleus after 3 h.

A change in excitability [10] and increased electrical activity [5] are regularly observed in hypothalamic centers soon after irradiation; mechanisms controlling autonomic functions must undoubtedly, therefore, be affected. A contributory factor is change in the neurosecretory activity of hypothalamic nuclei, as observed by Maiorova and the author in relation to whole-body irradiation of animals.

Theoretically, the mechanism responsible for this effect may possibly be direct action of ionizing radiation on the neurosecretory mechanism of the neuron together with stimulation of the process from elsewhere in the nervous system, particularly the reticular formation. That the latter is important is the more probable in that there is experimental evidence of reticular formation excitation resulting from whole-body irradiation [3, 5]. This was tested in some experiments in which rabbits were given chlorpromazine (5 mg/kg) intravenously before irradiation. This drug is known to affect adrenergic systems in the reticular formation. In these experiments the quantity of neurosecretory

substance in hypothalamic nuclei was found to be reduced after 3 h. It has already been stated that there was increased secretion in the cells of hypothalamic nuclei of irradiated rabbits which had not been given chlorpromazine.

SUMMARY

The effect of ionizing radiation on the neurosecretion of the nuclei of the subthalamic area was investigated in rabbits subject to gamma-irradiation (sum total dose of 400 r).

An increase of neurosecretory substance was revealed 3 h after irradiation of cells of the supraoptic and paraventricular nuclei. There was a reduction of secretion on the 1st and 3rd days. Aminazine was administered to animals to ascertain the irradiation mechanism on the neurosecretory process. This agent eliminated the effect of increased secretion in the subthalamic nuclei, which was possibly associated with the blocking action of aminazine on the adrenergic systems of the reticular formation.

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