EFFECT OF RADIOFREQUENCY ELECTROMAGNETIC WAVES ON HYPOTHALAMIC NEUROSECRETION AND THE ENDOCRINE GLANDS

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Results have been obtained which show that electromagnetic waves with a frequency of 27 Mc/s stimulate neurosecretion formation in the nuclei of the hypothalamus and its flow into the posterior lobe of the pituitary. The trophic function of the anterior lobe of the pituitary is increased and the thyroid and adrenals are activated.

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The object of this investigation was to study the effect of the energy of electromagnetic waves on the neurosecretory nuclei of the hypothalamus.

EXPERIMENTAL METHOD

Experiments were carried out in the fall on 45 albino rats of both sexes weighing 120-230 g.

The electromagnetic waves chosen for study had frequencies of 27 Mc/s, 27 kc, 9.5 Mc/s, and 9.5 kc, and their effect on metabolic processes and other functions of the body have already been established. Daily irradiation was given from a "V-605" generator with a field intensity of 1000 V/m for 10 min, with irradiation concentrated mainly on the animal's head. The irradiation procedures were repeated for 5 or 10 days. The animals were sacrificed 24 h after the last procedure. Histological studies were made of the hypothalamus, pituitary, adrenals, and thyroid glands, fixed in Bouin's fluid and embedded in paraffin wax. Neurosecretion was revealed with paraldehyde-fuchsin by Gomori's method with counterstaining with hematoxylin, and in V. F. Maiorova's modification. The adrenal and thyroid were stained with hematoxylin and eosin. The width of the cortical layer of the adrenal was measured by an ocular micrometer with movable scale.

EXPERIMENTAL RESULTS

Exposure to electromagnetic waves caused significant changes in the weight of the endocrine glands (see Table 1). The irradiated rats showed a smaller gain in weight than the controls, or even lost weight. In the rats of the experimental series a statistically significant increase in weight of the thyroid and adrenal was observed. Exceptions to this were animals irradiated with electromagnetic waves with frequencies of 9.5 and 27 kc. Changes in the weight of the thyroid in these animals were not statistically significant.

The greatest changes in neurosecretion were found in rats exposed to the action of 27 Mc/s waves. After five irradiations, secretion formation in the neurons and its migration along the processes were increased. All cells in the paraventricular nucleus were large and filled with tiny granules of neurosecretion. The numerous processes containing secretion had the appearance of bands or chains (Fig. 1, a). The neurons of the supraoptic nucleus also were light and large, but contained fewer secretory granules. Abundant liberation of neurosecretion took place in the direction of the pia mater. Many small granules and spherical collections of secretion could be seen in the medium eminence along the course of the hypothalamo-hypophysial tract. In the posterior lobe of the pituitary, filled with tiny secretory granules, the number and size of the Herring's bodies were increased. They were surrounded by a dark, compact border, giving the impression that secretory substance was concentrated in them (Fig. 1, b). After ten irradiation pro-

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TABLE 1. Changes in Body Weight of Endocrine Glands after Irradiation

Series	Mean weight of animals	Difference in weight (in %)	Weight of endocrine glands (in mg/100 g)			
			thyroid		adrenal	
			M	P	M	P
control	144.3	+7.6	16.9	–	24.0	–
9.5 Mc/s	161.0	+6.6	21.3	0.001	34.5	0.001
27 Mc/s	155.7	−4.9	19.9	0.001	38.8	0.001
9.5 kc	136.4	+0.7	16	> 0.05	31.7	0.001
27 kc	165	−4.7	18.8	> 0.05	31.4	0.001

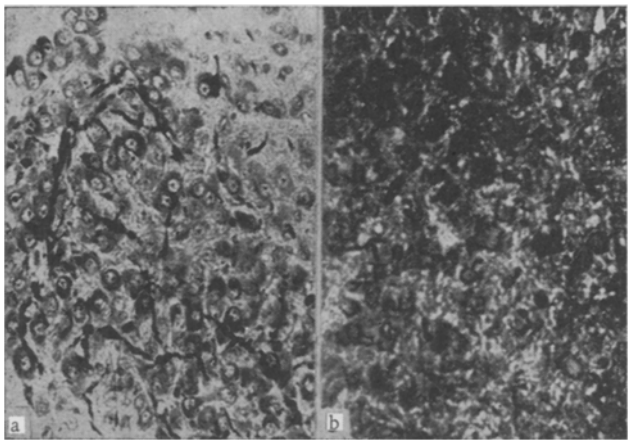

Fig. 1. Abundance of secretion in paraventricular nucleus of a rat exposed to electromagnetic wave with a frequency of 27 Mc/s (a) and numerous massive Herring's bodies in the posterior lobe of the pituitary of the same rat (b). Paraldehyde-fuchsin. 400 ×.

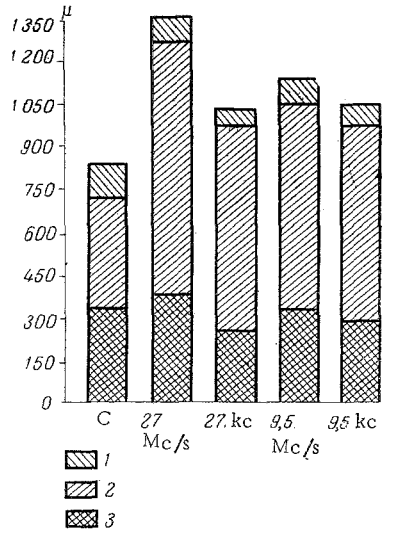

Fig. 2. Thickness of zones of adrenal cortex (in μ) in control (c) and experimental animals. 1) zona glomerulosa; 2) z. fasciculata; 3) z. reticularis.

cedures the intensity of secretion fell, but the changes in the endocrine glands increased; in the anterior lobe of the pituitary there was an increase in the number of basophils, which were irregular and angular in appearance and contained large granules (staining with paraldehyde-fuchsin). The thyroid was in a state of hyperfunction, as shown by an increase in its weight and the small size of the follicles, surrounded by high epithelium and containing pale, vacuolated colloid. The adrenals were also enlarged because of widening of the zona fasciculata and zona reticularis of the cortex (Fig. 2, 2nd column).

In rats irradiated with radiofrequency waves of 27 Mc/s slight stimulation of neurosecretion was observed in the paraventricular nucleus. In the supraoptic nuclei the cells contained more Nissl's substance than secretory granules, demonstrating a low intensity of secretion formation.

After irradiation for 10 days at a frequency of 9.5 Mc/s, the reaction of the neurosecretory system of the rats differed considerably.

The functional changes in the thyroid and adrenal of the animals of these experimental groups were equally varied and were directly dependent on the intensity of neurosecretion. The relative thickness of the zones of the adrenal cortex is illustrated in Fig. 2. In animals irradiated at a frequency of 27 Mc/s the increase in thickness of the adrenal cortical zones was maximal, and more or less equivalent in all members of this particular series. In the rats of the other experimental series the width of the adrenal cortex varied just as sharply as the state of secretion in the hypothalamus. However, calculation of the mean index for the series showed a tendency for the thickness of the cortical layer to increase.

The results indicate that electromagnetic waves of 27 Mc/s stimulate neurosecretion formation in the nuclei and its outflow into the posterior lobe of the pituitary. At the same time the trophic function of the anterior lobe of the pituitary is increased and the thyroid and adrenals are activated. The chief manifestation of irradiation with electromagnetic waves of this frequency is an increase in migration of neurosecretion from the hypothalamic nuclei into the neurohypophysis, reaching a maximum 5 days from the beginning of the experiment. Subsequently (until the 10th day) adaptation begins to take place in the neurosecretory system, while the endocrine glands continue to react progressively. Electromagnetic waves with frequencies of 9.5 Mc/s and 9.5 kc stimulate neurosecretion formation in the paraventricular nucleus of some rats, but prevent migration of the secretion into the posterior lobe of the pituitary. Neurosecretion still penetrates into the blood stream, however, resulting in stimulation of function of the anterior lobe of the pituitary and, indirectly, of the endocrine glands. The same frequencies applied to the other animals inhibit neurosecretion formation or cause it to be held up in the neurons of the hypothalamic nuclei.