THE EFFECT OF MICROWAVES ON THE HORMONAL ACTIVITY OF THE ADRENAL CORTEX

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Data exist in the literature demonstrating the possibility of stimulating adrenal cortex function by physiotherapeutic factors.

Thus, N. I. Speranskii [12], using small doses of diathermy in the region of the adrenals of individuals suffering from infectious arthritis, noted an increase in 17-ketosteroids in the urine, appearance of the so-called moon-shaped face in the patients, a decrease in the inflammatory symptoms in the joints, and an improvement in the general condition, i.e. the picture which is observed during treatment of these patients with cortisone or adrenocorticotropic hormone.

L. A. Skurikhina and I. I. Sliva [11] confirmed the possibility of stimulating adrenal cortex function with the aid of diathermy, having observed a decrease in the number of eosinophiles in the blood by 25-50% in a series of patients with infectious arthritis.

Desgrez and co-workers [16] observed an eosinopenia in the peripheral blood, and a reduction in the concentration of ascorbic acid in the adrenal cortex, of rabbits, associated with exposure to short waves (wavelength of 18 m) of low intensity, not causing dilatation of the blood vessels.

In the last few years, both in our country and abroad, the new method of treatment with microwaves has gained wide application–the method involves the use of alternating current of ultra-high frequency–from 1000 to 300,000 million cycles per second, which corresponds to wavelengths of from 30 cm to 1 mm. Such an ultra-high frequency wave process generates electromagnetic energy, which is absorbed by the organism, causing various reactions of direct and reflex nature. Some of these reactions have already been studied, for example, the reactions of vascular receptors and of the internal organs [13], of the central nervous system [7, 8], of the cardio-vascular system [10]; changes in the morphological and biochemical composition of the blood and in the metabolic processes [9, 15], lowering of the intraocular pressure [2]; the formation of cataracts with large doses [1], etc.

The influence of microwaves on the functioning of the endocrine system and, in particular, on the functioning of the adrenals, has apparently not yet been studied, or at least we have not encountered similar works in the literature available to us.

In connection with this, we considered it of value to investigate the effect of microwaves on the hormonal activity of the adrenal cortex.

METHOD

The experimental animals (20 white rats, weighing approximately 150 g) were subjected to a single total irradiation with microwaves, over a course of 10 minutes, using a generator output intensity of 50 watts and a distance between the radiator and the animal of 5 cm. We employed the domestic microwave generator, coded LUCh-58, generating waves with a frequency of 2375 Mc (wavelength of 12.62 cm).

Study of the hormonal activity of the adrenal cortex was accomplished by the histochemical method, determining the cortical concentration of sudanophilic lipoids (stained with Sudan III and Sudan black B, as well as by the method of polarization microscopy) and of ascorbic acid (silver impregnation by the method of Giroud and

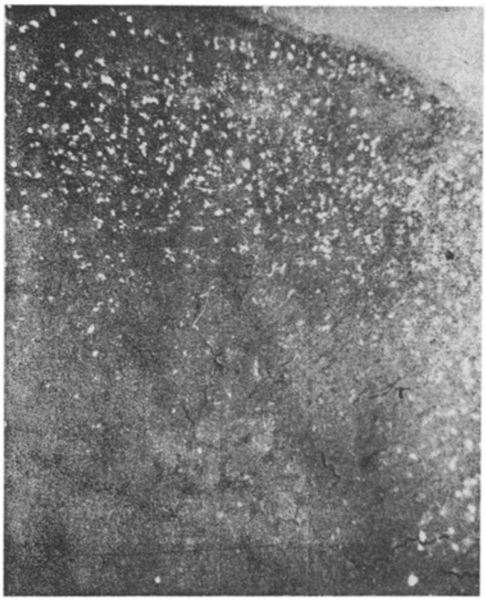

Fig. 1. The concentration of anisotropic lipoids in the adrenal cortex of the control animals. Polarization microscopy. Magnification: ocul. 10 ×, obj. 8 ×.

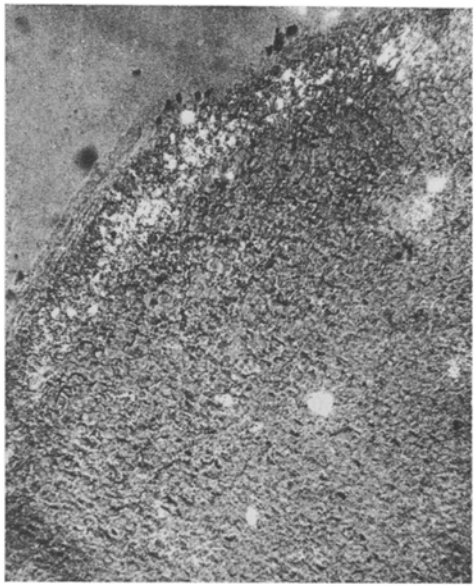

Fig. 2. Depletion of the anisotropic lipoids in the adrenal cortex, with their preservation in the tuberous zone. The fascicular zone is widened. Polarization microscopy. Magnification: ocul. 10 ×, obj. 8 ×.

Leblond) [17]. The amount of these substances in the cortex, according to accepted principles [3, 5, 6, 14, 18, 19, and many others], reflects the level of corticoid secretion. For a quantitative appraisal of the ascorbic acid concentration in the cortical cells of the adrenals, we carried out an actual count of the number of granules entering an individual cell of the tuberous zone in the adrenal cortex (total inspection of 100 cells), with subsequent statistical analysis of the data obtained from the experimental and control subjects.

The experimental animals were sacrificed at 1, 2, 3, and 4 hours, and 1, 2, 3, 4, 5, 7, and 14 days after the irradiation. A group of 20 healthy rats served as the control, and was maintained under the usual conditions of environment and nutrition.

RESULTS

In the control animals, the concentration of ascorbic acid was seen to be sufficiently constant. Thus, the number of granules of ascorbic acid entering the individual cell of the tuberous zone (with inspection of 100 cells in each of the 20 animals) constituted 7.92 ± 0.165. The concentration of sudanophilic lipoids was greatest in the fascicular zone, somewhat less in the tuberous zone, and was least in the reticular zone of the adrenal cortex.

The single, total exposure to microwaves caused unique changes in the hormonal activity of the adrenal cortex. Initially, we observed a gradual decrease in the concentration of ascorbic acid and lipoids in the adrenal cortex (Figs. 1 and 2). Thus, 1 hour after the exposure to microwaves, the number of granules of ascorbic acid in the tuberous zone of the cortex was equal to 7.95 ± 0.138, i.e. essentially unchanged from the original. Only after 2 hours did this number drop to 7.49 ± 0.122, and after 3 hours—to 7.30 ± 0.223. At 4 hours after the exposure, the concentration of ascorbic acid granules entering the individual cell of the tuberous zone fell to 6.82 ± 0.135. The maximum reduction in the number of ascorbic acid granules in the cells of the tuberous zone was noted 24 hours after irradiation with the centimeter waves, when their number per individual cell was reduced to 5.77 ± 0.152. At this time, a decrease was noted in the number of granules and clumps of ascorbic acid in the cells of the reticular zone, and also the appearance of these granules in the lumina and the endothelium of the capillaries in the tuberous zone and in the lumina of the sinusoids in the medullary layer of the adrenals. A parallel arrangement of the capillaries in the tuberous zone of the cortex created (with accumulation of ascorbic acid granules in them) the characteristic picture of parallel strata, which is correctly regarded as a sign of intensified endocrine secretion on the part of the cells of the adrenal cortex. At the same time, we observed the maximum reduction in the concentration of lipoids within the adrenal cortex, especially in the tuberous and reticular zones. In the fascicular zone of the cortex, the concentration of sudanophilic lipoids remained unchanged.

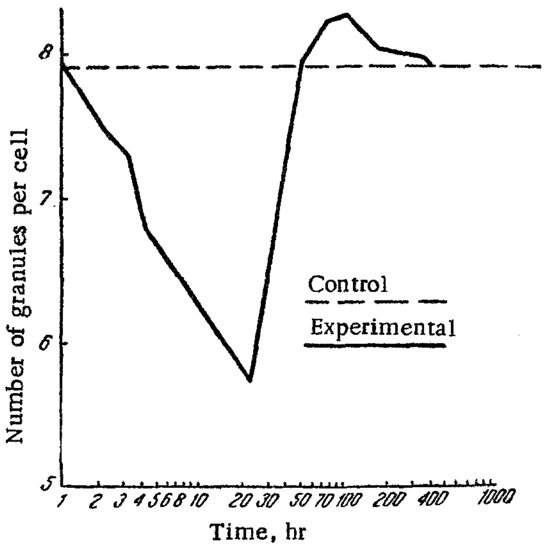

Fig. 3. Dynamics of the concentration of ascorbic acid in the cells of the tuberous zone of the adrenal cortex. Time readings (in hours) are along the abscissa, beginning with the first hour after irradiation of the animals and following a logarithmic scale.

At 2 and 3 days after the single exposure to microwaves, a moderate, progressive accumulation of sudanophilic lipoids and ascorbic acid took place in the cells of the adrenal cortex. The content of ascorbic acid granules per single cell of the tuberous zone rose, in this case, to 7.98± 0.125 (2nd day) and 8.24± 0.132 (3rd day) respectively. In the following days (4th and 5th) the amount of sudanophilic lipoids and ascorbic acid in the adrenal cortex cells essentially corresponded to the data obtained for the 3rd day (8.27± 0.104 and 8.22± 0.201). At one week after irradiation, the amount of ascorbic acid approached the original level (8.05± 0.161), and after two weeks it did not essentially differ from it (7.96± 0.176). The dynamics for the content of sudanophilic lipoids in the adrenal cortex was analogous at those intervals of the experiment.

Thus, with single exposure of animals to microwaves in the doses used by us, a moderate, but statistically significant, change occurs in the content of ascorbic acid within the adrenal cortex (Fig. 3), serving as evidence of an initial intensification in the discharge of hormonally active secretions into the blood stream, and, apparently, a subsequent elevation in its accumulation within the cortical cells (especially in the tuberous zone). The changes in the content of sudanophilic lipoids in the adrenal cortex were analogous as well. The reaction of the adrenals to microwave irradiation developed, judging from our data, beginning on the 2nd-3rd day after the irradiation. Maximum for the first phase of the reaction (the phase involving intensified discharge of hormonally active secretions into the blood stream) occurred 24 hours after the irradiation. In the following days of the first week, the second phase of the adrenal cortex reaction developed—increase in the content of ascorbic acid and lipoids, apparently indicating an elevation in the synthesis of hormonally active substances in the cortex. By the end of the 1st week, reversal of the reactive changes in the adrenal cortex began, with return to the original level during the 2nd week after the single irradiation with microwaves.

SUMMARY

The histochemical method (silver impregnation according to Giroud and Leblond for ascorbic acid, sudan staining of lipoids) and polarization microscopy were used for studying the effect of a single exposure to microwave radiation on the hormonal activity of the adrenal cortex.

A distinct and statistically significant change in hormonal activity was noted in the adrenal cortex; this occurred within the first 1.5-2 weeks after the effect of the microwave radiation manifested itself in an initial intensified discharge of functionally active substances into the blood stream and their subsequent accumulation in the adrenal cortex cells.

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