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## BIOLOGICAL EFFECT OF MILLIMETER RADIOWAVES

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[Text] Morphological, functional and biochemical studies conducted in humans and animals revealed that millimeter waves caused changes in the body manifested in structural alterations in the skin and internal organs, qualitative and quantitative changes of the blood and bone marrow composition and changes of the conditioned reflex activity, tissue respiration, activity of enzymes participating in the processes of tissue respiration and nucleic metabolism. The degree of unfavorable effect of millimeter waves depended on the duration of the radiation and individual characteristics of the organism.

The ubiquitous propagation of radiowaves, radio broadcasting and television is contributing to the appearance of a new physical factor -- electromagnetic waves of the radio-frequency range. In recent years it has been established that radiowaves of different ranges have an unfavorable influence on the organism. The literature data (A. G. Subbota, 1970; N. V. Tyagin, 1971; B. A. Chukhlovin, 1973; M. I. Yakovleva, 1973; Yu. D. Dumanskiy et al, 1975) testify that long stay in conditions of the effect of radiowaves (the dm and cm ranges) leads to change of the functions of the nervous, cardiovascular and other systems of the organism, with the development of a characteristic complex of symptoms which permit speaking of a special nosological form of disease -- radiowave disease (M. N. Sadchikova, 1973). However, in the literature there is almost no information about the biological effect of radio frequencies of the millimeter range, although that range is widely used in technology and the question of its biological activity has acquired special urgency.

The goal of the present investigations consisted in study of the physiological and biochemical processes lying at the basis of the changes which occur in animals as a result of the effect of radiowaves in the range of 5-8 mm, at a density of the flow of power of 1 milliwatt/cm<sup>2</sup>. The investigations were conducted on rats of the Wistar line and mice of the CBA line, irradiated for 15 minutes daily in the course of 60 days in the volume resonator of an experimental installation working on the basis of a type OV-12 generator.

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Study of the morphological, functional and biochemical indicators, which play an essential role in the formation of reactions of the organism, disclosed various disorders in the experimental animals.

As is known, the energy of millimeter waves, because of its weak penetrating ability, is absorbed primarily and mainly by the skin. Our investigations have shown that in the skin of irradiated animals deformation of the receptor apparatus and well-expressed changes of a reactive character were observed. In the skin layer properly speaking appeared bunches of nerve fibers with hypertrophy of a portion of the fiber and sections with demyelination. In the dermis, among the collagen fibers were small trunks of various thickness, the neural conductors of which were fragmented in separate cases, and phenomena of demyelination were observed in the surface layers.

As the results of histomorphological analysis showed, in the functionally active structures of tissue of the myocardium, liver, kidneys and spleen disorders of the hemodynamics were established, with disruption of the permeability of the vesicular membranes, the appearance of micronecroses and subsequent tissue dystrophy. Moreover, qualitative and quantitative shifts were revealed in the erythrocytic and leukocytic composition of the blood of irradiated animals, indicating suppression of the hemopoietic function of the bone marrow and lymphatic system. Noted in the composition of the red blood was eosinophilia, neutrophilia and lymphopenia, and lowering of the hemoglobin level and reduction of the number of erythrocytes were observed, which was determined to a considerable degree by the retention of erythrocytes in the bone marrow. In the latter occurred an increase of the number of erythroblastic cells and decrease of cells of the leukoblastic series.

Under the effect of millimeter waves of low intensity the degree of affection depends on the general condition of the organism and evidently is not so great, as the observed disorders are in the main reversible.

A characteristic feature of the biological effect of radiowaves was changes of the state of various sections of the central and vegetative nervous systems which involve directly or indirectly disorders of the principal functions of the organisms (M. I. Yakovlev, 1973).

As a result of investigations conducted by us on animals irradiated with millimeter waves, disorders of conditioned reflex activity have been established: weakening of the stimulatory process, reduction of the size of the latent period in response to different conditioned stimuli (light, noise or pain) and disinhibition of differentiation reactions. Disorders of the stimulatory and inhibitory processes displayed in animals during the repeated effects of millimeter radiowaves can be considered suppression of the function of the central nervous system, although the developed inhibition can be linked with protective-compensatory reaction of the organism in response to irradiation.

In the blood plasma of irradiated animals the content of 17-oxycorticosteroids increased ( $22.64 \pm 2.18$  mkg per 100 ml of plasma of the irradiated and  $14.98 \pm 2.01$  mkg of the unirradiated. Along with that, in the adrenal cortex of

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rats irradiated by millimeter waves the ascorbic acid level dropped 3%. The functional changes established in the content of 17-ocs in the blood plasma and of ascorbic acid in the adrenal cortex of irradiated animals indicate the influence of millimeter radiowaves on the central components of the hypothalamus-hypophysis system -- the adrenal glands with involvement of a number of humoral components.

The conducted investigations showed that in animals subjected to the effect of millimeter radiowaves there was a variation of the content and ratio of catecholamines: in the blood the concentration increased, in the hypothalamus the adrenaline content increased and the noradrenaline level dropped, in the cerebral cortex there was a slight redistribution of catecholamines, in the adrenal glands the adrenaline content doubled and the noradrenaline level dropped by 11% in comparison with that in unirradiated animals. The adrenaline concentration in the adrenal glands remained elevated by 60% 10 days after the irradiation ceased. The obtained results indicate well-expressed changes of metabolism of catecholamines under the influence of millimeter waves both in the hormonal and in the sympathetic components of the sympathetic-adrenal system and also reflect changes of the functional activity of its hormonal and mediator components.

The main mass of the energy in tissues and organs of animal organisms, as is known, is released during the biological oxidation of organic substances, in which case the greater part of it is accumulated in the form of macroergs. The processes of bioenergetics, occurring mainly in the mitochondria with the direct participation of respiratory enzymes which accomplish the terminal stage of biological oxidation, are of universal importance and assure the functional activity of organs and tissues, the synthesis of proteins and nucleic acids, the formation of some intermediate products of exchange, etc.

The conducted investigations showed that the irradiation of animals by millimeter waves caused changes of the processes of oxidative phosphorylation in the liver, kidneys, heart and brain of the animals. The irradiation inhibited the oxygen consumption rate by the mitochondria of those organs in the active phosphorylating state and slowed down the rate of respiration upon exhaustion of the ATP. In the liver and kidneys of irradiated animals the intensity of phosphorylation decreased by 64%, the values of the respiratory controls decreased by 26 and 28% respectively and the changes were less expressed in the heart and brain.

The established disorders of the process of conjugate oxidative phosphorylation in the mitochondria of irradiated animals testify to suppression of energy exchange and can be a result of changes occurring in the electron transport chain. The expressed hypothesis was confirmed by the results of investigations of the activity of enzymes participating in the processes of tissue respiration. In the mitochondria of the livers of irradiated animals the succinate dehydrogenase activity increased by 34% and the cytochromoxidase activity decreased by 37%. Those data testify to destruction of the cytochrome chain.

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Very essential in the system of enzymes of cell energy supply is the role of the ATPases regulating the processes of formation and use of the energy of macroergs (V. P. Skulachev, 1969). The conducted investigations revealed in the mitochondria of the livers of irradiated animals an increase of ATPase activity by 63% as compared with similar indicators for the unirradiated. In that case in the liver and spleen of animals irradiated many times by millimeter waves there was a decrease of the content of adenyl nucleotides by 61 and 68% respectively.

Investigation of the influence of millimeter waves on the state of nucleic exchange showed that in the liver, spleen, kidneys, lungs and heart there was a reduction of the content of nucleic acids and suppression of the rate of  $^{14}\text{C}$ -thymidine in DNA and  $^{14}\text{C}$ -uridine in RNA. In a comparison of the results of quantitative determination of nucleic acids it was established that the rate of inclusion of the predecessor in RNA and its content in the organs changes less than the DNA. The change of the nucleic acids concentration was more expressed in the liver, spleen and kidneys than in the heart and lungs. Together with reduction of the nucleic acids content, the quantity of acid-soluble products in the liver and spleen of irradiated animals increased by 35 and 43% and the activity of ribonuclease and DNAase increased 50%.

Under the influence of radiowaves the protein spectrum of the blood serum changed (the albumin content decreased and the number of globulins increased, which led to decrease of the value of the albumin-globulin coefficient) and the number of free amino acids decreased by 22%. An indicator of the reduced level of protein synthesis in the irradiated animals also was the established reduction of the rate of inclusion of  $^{14}\text{C}$ -methionine in proteins of the liver, spleen, lymph nodes and thymus. The presented data testify to substantial changes in the protein metabolism which occur under the influence of multiple irradiation of animals by millimeter radiowaves. Evidently the reduction of the general energy level occurring in the organism under the influence of millimeter radiowaves had an effect on the formation of macroergs and caused a suppression of all functions of the organism, including suppression of synthetic processes but especially of nucleoprotein metabolism, which is very energy-consuming.

The conducted experimental investigations were compared with observations of the state of health of 97 persons working with generators of the millimeter range on the basis of systematic conducting of biochemical analyses. The obtained data confirmed the existence of an influence of radiowaves on the state of metabolic processes in the organism, in particular, changes of the indicators of protein and carbohydrate metabolism were revealed and disturbances of the indicators of immuno-biological reactivity and of the blood system were established.

Thus the conducted investigations indicate high biological activity and an unfavorable influence of millimeter radiowaves on the organism. The expressness of the biological reactions increased with increase of the period of irradiation and depended on individual characteristics of the organism.

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