EFFECT OF SHF ELECTROMAGNETIC FIELDS ON CONTENT OF IRON, COPPER, AND SOME METALLOPROTEINS IN BLOOD AND TISSUES

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Experiments on 55 rats have shown that prolonged whole-body exposure to shf electromagnetic fields causes changes in the concentration and form of iron and copper in the blood, organs, and tissues of the irradiated animals and also changes in metalloproteins: ceruloplasmin and transferrin.

Some important biophysical phenomena associated with absorption of electromagnetic energy by the tissues have been described in the literature. It has been reported that these phenomena arise mainly through different manifestations of the "specific" action of shf radiation and its influences on some processes of regulation and interaction within the organism [5, 10].

Investigations have shown that changes take place in the various functions of the body under the influence of an shf field: changes occur in the serum protein fractions [7-9], in the concentration of potassium and sodium in the blood and urine in man [11], and in the concentration of nucleic acids [9] and histamine [4] and the number of cells in animals' blood [6].

This paper describes the results of an investigation of the dynamics of the concentrations of iron, copper, and some metalloproteins in the blood and organs of albino rats under the influence of an shf field.

Interest in the study of trace elements and metalloproteins during exposure to shf is associated with the fact that ions of these metals, which are components of many enzyme systems, participate in oxidation-reduction processes and in tissue metabolism, and also, because of these properties, they play an important role in hematopoiesis.

EXPERIMENTAL METHOD AND RESULTS

Long-term experiments were carried out on 55 rats exposed daily for 28 successive days to the long-distance action of electromagnetic fields for periods of 10 min at a distance of 9 cm, with intensities of 160 mW/cm^2, using the Soviet "Luch-58" apparatus (λ = 12.6 cm).

The concentrations of iron and copper, the ceruloplasmin activity, and the plasma saturation with transferrin iron were determined colorimetrically [1-3]. These indices were determined at intervals: on the seventh, 14th, 21st, and 28th days of exposure to shf electromagnetic fields. The results were expressed as percentages of the intial values.

As Table 1 shows, ceruloplasmin activity on the seventh day after irradiation by the shf field was reduced, while on the 14th and, in particular, on the 21st day of irradiation the activity of this enzyme was considerably increased, and on the 28th day of irradiation the ceruloplasmin activity again showed a significant decrease.

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TABLE 1. Effect of shf Electromagnetic Fields on Concentration of Iron, Copper, and Metalloproteins in Blood, Organs, and Tissues of Rats

Index studied	Tissue investigated	Normal	Duration of irradiation, days							
			7		14		21		28	
			M±m	P	M±m	P	M±m	P	M±m	P
Iron, mg%/100 g fresh substance	blood	60,86± 3,4	53,37± 1,21	<0,001	50,26± 2,19	<0,02	40,54± 3,39	<0,001	42,82± 2,06	<0,001
	liver	13,88± 0,46	20,50± 0,91	<0,001	17,82± 0,81	<0,001	14,42± 0,59	<0,5	15,86± 1,49	>0,1
	muscles	1,85± 0,09	1,16± 0,02	<0,001	1,12± 0,05	<0,001	1,06± 0,04	<0,001	0,66± 0,06	<0,001
Copper, mg%/100 g fresh substance	blood	0,18± 0,01	0,42± 0,03	<0,001	0,33± 0,03	<0,001	0,48± 0,02	<0,001	0,41± 0,03	<0,001
	liver	0,42± 0,06	0,65± 0,03	<0,02	0,55± 0,03	>0,2	0,32± 0,01	<0,2	0,49± 0,01	>0,1
	muscles	0,20± 0,01	0,26± 0,01	<0,01	0,24± 0,01	<0,05	0,11± 0,01	<0,001	0,33± 0,04	<0,02
Ceruloplasmin, conventional units	blood plasma	54,16± 1,48	48,06± 1,85	<0,02	62,10± 1,79	<0,01	64,94± 1,96	<0,001	35,85± 1,99	<0,001
Transferrin, conven. units	»	0,22± 0,01	0,20± 0,01	<0,001	0,19± 0,02	<0,01	0,23± 0,02	<0,2	0,31± 0,03	<0,05
Erythrocytes, millions/mm³	blood	4,16± 0,09	3,58± 0,02	<0,01	3,66± 0,07	<0,01	3,72± 0,08	<0,01	3,51± 0,04	<0,001

The concentration of copper in the blood was increased throughout the experiment, although it fluctuated (Table 1). By the end of the experiment a slight decrease in the copper concentration in the blood and a further increase in the copper concentration in the liver and muscles were observed compared with the previous time of investigation (21st day of irradiation). These changes are evidence of a redistribution of copper in the blood and organs of rats under the influence of shf electromagnetic fields.

Considerable changes also were found in the iron concentration in the blood and tissues when determined in the animals during exposure to shf fields (Table 1). In the blood and also in the muscles, the iron concentration at all times of investigation showed a statistically significant decrease. In the liver, on the other hand, the iron concentration on the seventh and 14th days showed a significant increase, which was evidently connected with the decrease in iron concentration in the blood and also with the decrease in the degree of saturation of the blood serum with transferrin iron.

A statistically significant and progressive decrease in the erythrocyte count in the circulating blood and a decrease in the hemoglobin concentration to 78.2% by the end of the experiment also were observed in the irradiated animals.

These results show that whole-body irradiation of animals with an shf electromagnetic field produces, besides its other known effects, profound changes in the concentration and form of iron and copper in the blood and tissues. It can be postulated that these changes play an important role in disturbances of metabolism and hematopoietic processes during exposure to shf fields.

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