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ELECTROMAGNETIC RADIATION IMPACT ON THE CELLULAR PROTTECTIVE MECHANISMS IN EXPERIMENT

Abstract. *The work examines the changes of activity of antioxidant system of the adrenal glands and thyroid gland of rats in different ages against the ground of influence of EMR in the range 895-905 MHz. The dependence between the increase of its activity and the age of the animals was determined. A possible pathogenic mechanism of the influence of EMR on the cell membrane is described.*
Key words: *EMR, endocrine glands, antioxidant system.*

Introduction. In recent decades due to quick introduction and spread of devices generating electromagnetic radiation (EMR) on many territories of European countries voltage of magnetic fields has increased promoting the origin of such a notion as electromagnetic environmental pollution. Therefore today EMR is considered as a pathogenic exogenous factor which mechanisms of influence on biological objects are not studied completely.

The analysis of literary evidences demonstrates that EMR of different intensity induces rather wide spectrum of biological effects. First, it is thermal action, which signs depend on structural and functional properties of the tissue itself. Second, the mechanisms of EMR resonance action on the cells are determined [1, 2]. Against the ground of chronic influence of EMR on biological membranes the activation of lipid peroxide oxidation (LPO) is known to occur, when a number of free radicals are formed [3]. These compounds act as aggressive oxidants provoking damage of the vital body structures, stimulating development of oxidative stress and provoking development of inflammatory processes. These damages on the cellular level are the bases for further destabilization of general homeostasis affecting disorders of the regulating functional links of the whole integrate body systems – nervous, endocrine, immune etc.

Antioxidant system (AOS) insures one of the first lines of protection of cells against an aggressive effect of free radicals. The list of the most informative indices of AOS having practical clinical-biochemical value includes superoxide dismutase (SOD), catalase, glutathione-dependent peroxidase etc. [4]. Determination of their content can be a sign of an aggressive factor degree affecting a living organism.

Objective: to determine changes of AOS functional activity of the adrenal glands and thyroid gland in the body of rats aged 3-5 months against the ground of EMR effect in the range of 895-905 MHz.

Materials and methods. The study was performed on 24 Wistar male rats with the body weight of 100-140 g. The animals were distributed into groups (6 in each) according to the series of the experiment due to the tasks of the study. The age of animals was chosen according to the table of age periodization of animal age to the human age [5] and corresponds: 3-month rats – human teen age (14-15years), 5-month rats – young people (19-21 years).

EMR effect on the body was simulated by means of the apparatus «ЕМІБІО-1.1» (Ukraine), certified by a certificate for a patent [6]. EMR range in the experiment was 895-905 MHz. The total period of radiation of animals was 2 hours a day.

The activity of catalase, SOD and Schiff base in the homogenate of the adrenal glands and thyroid gland was investigated by means of spectrophotometric method.

The results of the study were statistically processed by means of Student t-criterion with variation statistics methods ("BIOSTAT" program). The probability of the obtained results was assessed on the level of significance no less than 95% ($p \leq 0,05$).

Results and discussion. In the course of the experiment the AOS system activity was found to have a tendency to increase in experimental animals of both age groups against the ground of EMR action. It is evidenced by increased values of the indices of the quantitative content of antioxidant enzymes as compared to the control groups of animals. Thus, catalase content in the homogenate of the adrenal glands in 3-month rats was found to be 2,8 times up, in 5-month rats - 1,2 times up. While examining the indices of the level of SOD and Schiff base in the homogenate of the adrenal glands increased quantitative content of both kinds of molecules in both experimental groups of animals was found. The increase is reliable $p<0,01$ (Table 1).

These signs can be a stimulating factor of the enzymatic systems of the adrenal cells occurring against the ground of an indirect pathogenic EMR effect on the cells. Chronization of over-exertion of the antioxidant system activation can be a cause of further failure of adaptation-adjacent reactions directed to preservation of homeostasis of the whole organism.

While comparing the indices of AOS activity of the adrenal glands against the ground of EMR action between the two age groups it was found that catalase content in the homogenate of 3-month rats was 1,2 times higher as compared to the 5th-month rats. SOD indices of the 3-month rats were 1,1 times up as compared to the5-month rats, Schiff base – practically twice as much (Table 2).

According to literary evidence EMR has the biggest effect on the organism of children. The data obtained in the experiment demonstrate that EMR effect has similar influence on the organism of teenagers. AOS activity against the ground of EMR effect is found to have a tendency to increase in rats of a younger age. It can be explained by instability of the protective systems of the cellular membranes caused by the action of free radicals. The authors suggest that it is these disorders to cause a number of pathogenic mechanisms resulting in imbalance of LPO system and promote coordination disorders of general immune-metabolic processes.

Changes of AOS activity in homogenate of the thyroid gland was examined against the ground of EMR effect. The following was found: the content of catalase in 3-month and 5-month rats was reliably higher as compared to the control - 1,6 and 2,1 times up respectively; SOD indices in 3-month rats were 1,3 times, and in 5-month rats - 2,4 times up than those of the control indices. Schiff base content in homogenate of the thyroid gland was characterized by increase in both age groups of animals (Table 3).

Table 1

Activity of the antioxidant system in the adrenal gland homogenate against the ground of EMR effect

3 months	Schiff base			Catalase			SOD		
	Cp.	±	P	Cp.	±	P	Cp.	±	P
contr	1,49	0,06	0,074	0,50	0,021	0,26	29,48	0,01	0,012
exp	1,67	0,05		0,514	0,011		32,53	0,38	
5 months	Schiff base			Catalase			SOD		
	Cp.	±	P	Cp.	±	P	Cp.	±	P
contr	2,01	0,07	0,000	0,405	0,012	0,000	21,91	3,84	0,052
exp	2,69	0,09		0,49	0,005		30,42	0,43	

Notes: (*)-p<0,05; (**)-p<0,01; (***) – p<0,001.

Table 2

Age correlation of antioxidant system enzymatic activity in the adrenal homogenate of rats against the ground of EMR effect

	Schiff base			Catalase			SOD		
	mean	±	P	mean	±	P	mean	±	P
3-month	1,67	0,05	0,000	0,514	0,004	0,002	32,53	0,37	0,002
5-month	2,69	0,09		0,49	0,005		30,32	0,37	

Notes: (*)-p<0,05; (**)-p<0,01; (***) – p<0,001.

The results of the study are indicative of the formation and accumulation of oxidative forms in the tissues of the thyroid gland is more pronounced among 5-month rats as compared to the animals of the younger group indicating the development of oxidative stress in the thyroid cells due to increased activation of AOS (Table 4).

Table 3

Antioxidant system activity in homogenate of the thyroid gland against the ground of EMR effect

3-month	Schiff base			Catalase			SOD		
	mean	±	P	mean	±	P	mean	±	P
contr	0,29	0,01	0,002	0,19	0,005	0,000***	10,22	0,48	0,004
exp	0,36	0,01		0,27	0,005		13,65	0,79	
5-month	Schiff base			Catalase			SOD		
	mean	±	P	mean	±	P	mean	±	P
contr	0,41	0,004	0,000***	0,18	0,004	0,000***	11,53	0,27	0,000***
exp	0,48	0,009		0,3	0,004		20,56	0,55	

Notes: (*)-p<0,05; (**)-p<0,01; (***) – p<0,001.

Table 4

Age correlation of the antioxidant system enzymatic activity in the thyroid homogenate against the ground of EMR effect

	Schiff base			Catalase			SOD		
	mean	±	P	mean	±	P	mean	±	P
3-month	0,36	0,01	0,000	0,19	0,008	0,000	10,22	0,48	0,000
5-month	0,48	0,009		0,30	0,004		20,56	0,55	

Notes: (*)-p<0,05; (**)-p<0,01; (***) – p<0,001.

Conclusions. The data obtained are indicative of general negative effect of EMR on biological objects. Damaging mechanism of EMR effect on the endocrine glands is indirect in 3-month and 5-month rats. Primary thermal effect provokes the development of the secondary membrane-toxic effect. Accumulation of AOS enzymes in the endocrine glands occurs as a result of damage of the membrane and internal cellular structures by free radicals [7], and it results in the failure of mechanisms of free radical oxidation and development of oxidative stress. Such disorders can stimulate chronic disadaptation of the compensatory-adjacent intracellular and intercellular ways of the cell protection. The authors suggest that biochemical investigation of AOS parameters, such as determination of catalase, SOD and Schiff base levels can be one of the prognostic indices to assess the degree of a harmful EMR action.

Prospects of further studies. The topicality of the issue and the necessity of more detailed approaches to its investigation are evidenced by a great difference of indices concerning EMR effect on the human organism, absence of clearly described, common scientific mechanisms describing the sense of a pathogenic action of EMR on biological objects.

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