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Influence of long-lasting exposure to weak variable magnetic field on activity of antioxidant enzymes in rats

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Abstract

The aim of study was to estimate the influence of long-lasting exposure to weak variable magnetic field used in magnetostimulation on activity of some antioxidant enzymes in rats. Experimental material consisted of 96 male Wistar rats. Weak variable magnetic field of saw-like shape of impulse, at a frequency of basic impulse 180-195 Hz and induction 120μT generated basing on ion cyclotron resonance phenomenon was used. All animals were randomly divided into 2 groups (48 animals each). In the first group whole body exposure to magnetic field lasting 36 minutes daily for 14 consecutive days was made. In second – control group – sham-exposure without generating magnetic field inside of cuboid applicator lasting 36 minutes daily for 14 consecutive days was made. In both groups before a cycle of exposures or sham-exposure, 24 hours after first exposure, then at 7th and 14th day of repeated exposures and at 7th and 14th day after the end of a cycle of exposures every time a part of animals (8 rats from each group) was exsanguinated in ether narcosis. In obtained blood samples contents of some antioxidant activity indicators: activity of catalase (CAT), glutathione peroxidase (POX) and superoxide dysmutase (SOD) in erythrocytes, activity of superoxide dysmutase in serum and concentration of malondialdehyde (MDA) both in erythrocytes and serum was determined. In magnetic field-exposed group a significant increase in activity of most of analyzed antioxidant enzymes during succeeding days of exposure, persisting also after the end of exposure cycle was observed as compared to control group. Besides in this group a transient significant increase in malondialdehyde concentration in first phase of exposure with subsequent decrease after the end of exposure cycle was obtained. These data indicate stimulating e ect of weak variable magnetic fields on antioxidant activity of living organisms.

KEYWORDS: weak variable magnetic field, magnetostimulation, antioxidant enzymes activity, oxygen free radicals

1. INTRODUCTION

It has been observed that oxygen free radicals and reactive oxygen species produced in many enzymatic reactions a ect indirectly transformations of nuclear proteins by oxidation of membrane amino-acid radicals, which results in inactivation of enzymes and increase in the susceptibility to proteolysis. The increase in tissue content of oxygen free radicals usually leads to an unfavorable biological process ending in cell apoptosis [1, 2].

Glutathione peroxidase, glutathione transferase, catalase and superoxide dismutase are antioxidant enzymes which collaborating with each other to protect the organism against toxic oxygen free or radicals action [1-3]. The increase in antioxidant enzymes activity indicates the induction of their synthesis as a result of adaptative reaction to increased production of free radicals or direct stimulation of this process under influence of other external factors. The decrease in tissue content of these enzymes is caused by either lower requirement or inhibition of their synthesis. Malondialdehyde is a product of long lasting free radicals action on cellular lipids, and increase in its tissue content indicates high activity of free oxygen radicals in cells.

Many experimental data suggest [4-9] that variable magnetic fields a ect the activity of enzymatic reactions, stimulate protein synthesis and intensity of oxidative-reductive processes in living organisms, which may result in potential influence of the variable magnetic field on activity of antioxidant enzymes decomposing oxygen free radicals with subsequent changes in tissue content of these radicals and products of their biological action.

Since activity of antioxidant enzymes is considered as specific and very sensitive marker of free oxygen radicals contents and oxidative reactions intensity in organism the aim of this study was to estimate the influence of long-lasting exposure to weak variable magnetic field used in magnetostimulation – a new method of physiotherapy – on activity of antioxidant enzymes and concentration of malondialdehyde in serum and erythrocytes in experimental model of adult male rats.

2. MATERIAL AND METHODS

Experimental material consisted of 96 adult Wistar albino male rats weighting 180-200 g.

Weak variable magnetic field of saw-like shape of impulse, at a frequency of basic impulse 180-195 Hz and induction of 120μT generated by device for magnetostimulation Viofor JPS (Poland) basing on ion cyclotron resonance phenomenon was used. All animals were randomly divided into 2 groups (48 animals each). In first group whole body exposure to magnetic field lasting 36 minutes daily for 14 consecutive days was made. In second – control group – sham-exposure without generating magnetic field inside of cuboid applicator lasting also 36 minutes a day for 14 consecutive days was made.

In both groups before a cycle of exposures or

sham-exposures, 24 hours after first exposure, then at 7th and 14th day of repeated exposures and at 7th and 14th day after the end of an exposure cycle every time a part of animals (8 rats from each group) were famished for 20 hours after last exposure and then exsanguinated in ether narcosis, at the same time in the morning. The blood (4-5 ml in average) was obtained from the right ventricle of heart and then decanted and centrifuged.

In obtained serum and hemolysate of erythrocytes samples activity of antioxidant enzymes: catalase (E. C. 1.11.1.6), glutathione peroxidase (E. C. 1.11.1.9) and superoxide dismutase (E. C. 1.15.1.1) as well as concentration of malondialdehyde were determined by means of spectrophotometric and kinetic methods according to [10, 11, 12, 13].

The results from each group presented as mean value and SD were statistically analyzed using the Kruskal-Wallis rang ANOVA test and the post-hoc U Mann-Whitney test.

3. Results

In magnetic field-exposed group a significant increase in activity of glutathione peroxidase and peroxide dysmutase both in erythrocytes and serum during succeeding days of exposure, persisting also after the end of exposure cycle, as compared to control, initial values was observed (Fig. 1-3).

No significant changes in catalase serum activity were observed. Besides in this group a transient significant increase in malondialdehyde concentration both in erythrocytes and serum in the initial phase of exposure with subsequent decrease after the end of exposure cycle was obtained (Fig. 4). In control sham-exposed group of rats no significant changes in antioxidant enzymes activity and concentration of malondialdehyde were observed.

4. Discussion

The results of this study, in which significant increase in activity of most analyzed antioxidant enzymes in the last phase of exposure and immediately after the end of exposure cycle was obtained, confirm the stimulating influence of weak variable magnetic field on antioxidant activity in experimental animals. The increased activity of antioxidant enzymes (catalase, glutathione peroxidase and superoxide dysmutase) in serum of rats exposed to variable magnetic field with similar frequency and lower induction of 70 μT, 8 minutes daily for 7-14 days was observed also by other authors [9].

Simultaneously obtained significant decrease in previously increased malondialdehyde tissue content also points to favourable influence of a variable magnetic field on oxygen free radicals activity in experimental animals. On the basis of these results we may conclude that weak variable magnetic field used in magnetostimulation basing on ion cyclotron resonance phenomenon indirectly inhibits the action of oxygen free radicals in living organisms.

5. Conclusion

Weak magnetic field with low value of induction used in magnetostimulation has beneficial stimulating e ect on antioxidant activity in experimental animals.

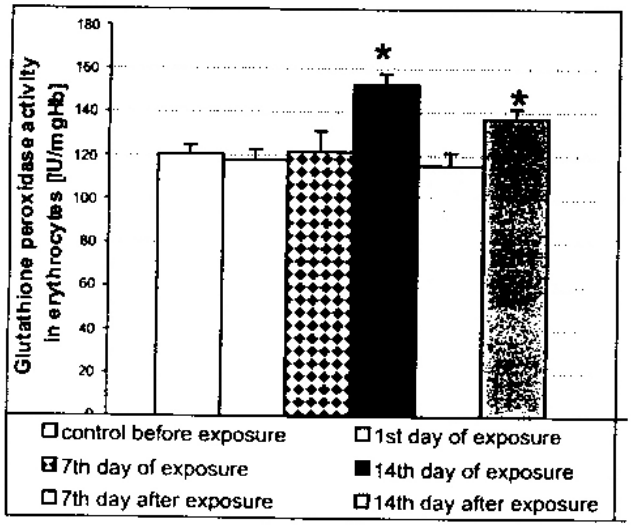

Fig. 1 Glutathione peroxidase activity in erythrocytes of rats exposed to variable magnetic field with induction of 120 μT in succeeding days of exposure cycle as compared to control values before exposure (mean values and SD) with statistical evaluation (*p < 0,05 vs. control)

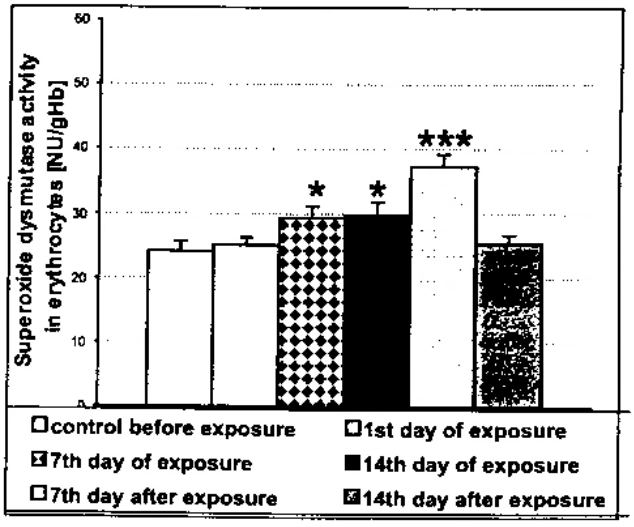

Fig. 2 Superoxide dysmutase activity in erythrocytes of rats exposed to variable magnetic field with induction of 120 μT in succeeding days of exposure cycle as compared to control values before exposure (mean values and SD) with statistical evaluation (*p < 0,05, ***p < 0,001 vs. control)

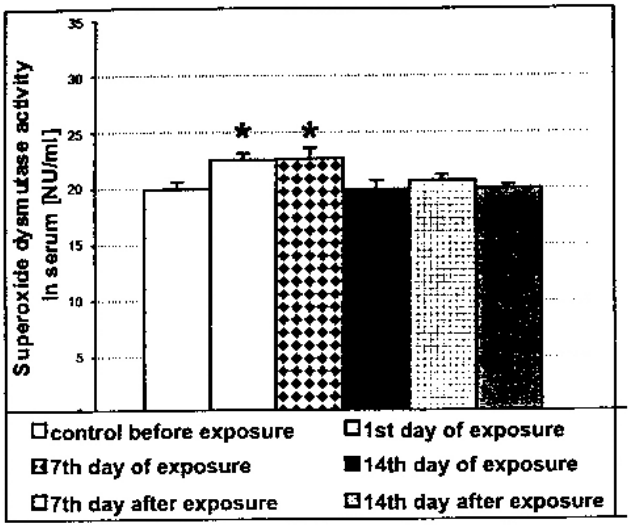

FIG. 3 Superoxide dysmutase activity in serum of rats exposed to variable magnetic field with induction of 120 μT in succeeding days of exposure cycle as compared to control values before exposure (mean values and SD) with statistical evaluation (*p < 0,05 vs. control)

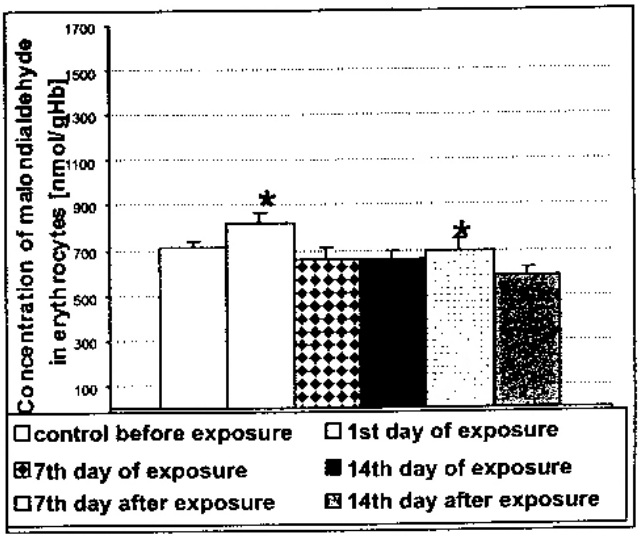

FIG. 4 Concentration of malondialdehyde in erythrocytes of rats exposed to variable magnetic field with induction of 120 iT in succeeding days of exposure cycle as compared to control values before exposure (mean values and SD) with statistical evaluation (*p < 0,05 vs. control)

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