INFLUENCE OF LONG-TERM EXPOSURE TO STATIC, HIGH VOLTAGE ELECTRIC FIELD ON ANTIOXIDANT ACTIVITY IN RATS

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ABSTRACT

In this study the influence of long-term, whole-body exposure to strong, static electric field generated usually near direct current high voltage transmission lines on activity of some antioxidant enzymes in liver homogenats of rats was investigated. Experimental material consisted of 96 male Wistar albino rats aged 8 weeks, weighting 180-200 g. During the whole experiment all animals were placed in identical environmental conditions under a 12 h light-dark cycle with free access to standard laboratory pellet food and tap water. All animals were randomly divided into 3 groups (32 animals each). The rats from two experimental groups were exposed for 56 consecutive days (8 hours daily) to static electric field with electric field intensity values of 16 kV/m and 35 kV/m respectively, in a specially designed experimental system. The control animals were subjected to a sham-exposure in the same experimental system, during which no electric field was generated between electrodes. At 14^{th}, 28^{th} and 56^{th} day of exposure cycle and then in 28^{th} day after the end of exposure cycle a part of animals from all groups (8 rats at a same time) was exsanguinated in Morbital narcosis. Then in liver homogenats prepared from obtained liver samples the activity of some antioxidant enzymes as catalase, glutathione peroxidase and superoxide dismutase was determined with use of spectrophotometric methods as well as the concentration of malone dialdehyde (marker of intensity of oxidative processes in tissues) was estimated. As a result of repeated exposures a trascient statistically significant decrease in activity of catalase in second experimental group at 28^{th} day of exposure cycle, a significant increase in activity of glutathione peroxidase in first experimental group at 56^{th} day of exposure cycle and in second experimental group at 14^{th} and 28^{th} day of exposure cycle, a significant decrease in superoxide dysmutase activity in first experimental group at 14^{th} day of exposure cycle and in second experimental group at 28^{th} day of exposure cycle as well as a significant decrease in malone dialdehyde concentration in homogentas of liver tissue in second experimental group at 28^{th} day of exposure cycle and in both groups of electric field-exposed rats at 28^{th} day after the end of exposure cycle as compared to control rats was observed. On the basis of obtained results it was concluded that strong static electric fields with parameters generated usually nearby high voltage direct current transmission lines does not cause any persistent effect on antioxidant reactions in living organism. These data indicate that proper construction of high voltage direct current transmission lines enables to avoid serious health hazards for human population related to disturbances of antioxidant processes in living organisms.

INTRODUCTION

In available literature there are data suggesting that strong electromagnetic fields occurring in the neighbourhood of electric field transmission lines can produce an increased amount of reactive oxygen species in tissues, resulting in stimulation of peroxidation of membrane lipids leading to apoptosis and death of cells [1,2]. As in our previous experiment [3] we found that strong, static electric field with parameters higher than these allowed by actual legislative regulations in construction of high voltage direct current transmission lines causes transcient inhibition of antioxidant enzymes activity in erythrocytes with subsequent adaptative stimulation of this activity after the end of exposure cycle, the aim of the present study was to estimate the influence of long-term, whole-body exposure to static electric field with parameters usually generated by such transmission lines on activity of some antioxidant enzymes and concentration of malondialdehyde (a marker of intensity of oxidative processes in living organism) in liver homogenats of rats.

MATERIAL AND METHODS

Experimental material consisted of 96 male Wistar albino rats aged 8 weeks, weighting 180-200 g. During the whole experiment all animals were placed in identical environmental conditions (constant temperature 22 ± 1°C and humidity of air) under a 12 h light-dark cycle with free access to standard laboratory pellet food and tap water. All animals were randomly divided into 3 groups (32 animals each) with no significant differences in body weight.
The animals from 2 experimental groups were exposed for 56 consecutive days (8 hours daily) to static electric field with different electric field intensity values in a specially designed experimental system consisting of autotransformer, high voltage transformer 220V/60000V, cascade rectifier, water rheostat, 2 electrodes with round shape and specially profiled edges placed in a distance of 50 cm from each other, plastic cage placed between both electrodes containing 8 animals at a same time and magnetostatic kilo-voltmeter C196 type (fig. 1. and fig.2.).

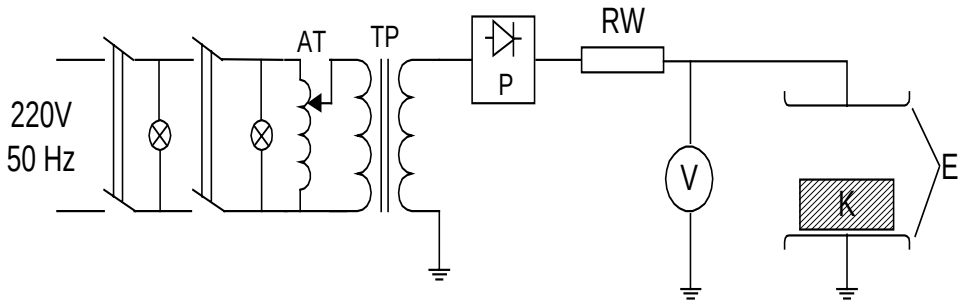

Fig. 1. Scheme of experimental system. AT– autotransformer, TP– high voltage transformer 220V/60000V, P - cascade rectifier, RW - water rheostat, E – round electrodes, K – plastic cage, V – magnetostatic kilo-voltmeter C196 type.

Rats from first experimental group were exposed to static electric field with intensity of 16 kV/m. Rats from second experimental group were exposed to static electric field with intensity of 35 kV/m. The control animals were subjected to sham-exposure in the same experimental system, during which no electric field was generated between electrodes.

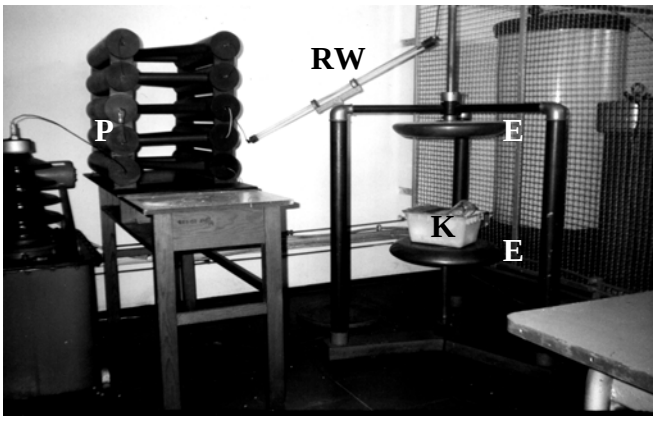

Fig. 2. Picture of experimental system during exposure of animals placed in cage to static electric field generated between round electrodes. P - cascade rectifier, RW - water rheostat, E – round electrodes, K – plastic cage with rats inside

At 14th, 28th and 56th day of exposure cycle and then at 28th day after the end of exposure cycle a part of animals from all groups (8 rats at a same time) was exsanguinated in Morbital narcosis. Then in liver homogenats prepared from obtained liver samples the activity of some antioxidant enzymes as catalase, glutathione peroxidase and superoxide dismutase was determined with use of spectrophotometric methods [4,5,6], as well as the concentration of malondialdehyde (marker of intensity of oxidative processes in tissues) was estimated [7].

RESULTS

.As a result of repeated exposures a trascient statistically significant decrease in activity of catalase in rats exposed to electric field with intensity of 35 kV/m at 28th day of exposure cycle (fig. 3.), a significant increase in activity of glutathione peroxidase (fig. 4.) in rats exposed to electric field with intensity of 16 kV/m at 56th day of exposure cycle and in rats exposed to electric field with intensity of 35 kV/m at 14th and 28th day of exposure cycle as well as a significant decrease in superoxide dysmutase activity (fig. 5.) in rats exposed to electric field with intensity of 16 kV/m at 14th day of exposure cycle and in rats exposed to electric field with intensity of 35 kV/m at 28th day of exposure cycle comparing with control was observed. Besides a significant decrease in malone dialdehyde concentration (fig. 6.) in homogentas of liver tissue in group of rats exposed to electric field with intensity of 35 kV/m at 28th day of exposure cycle and in both groups of electric field-exposed rats at 28th day after the end of exposure cycle as compared to control rats was found.

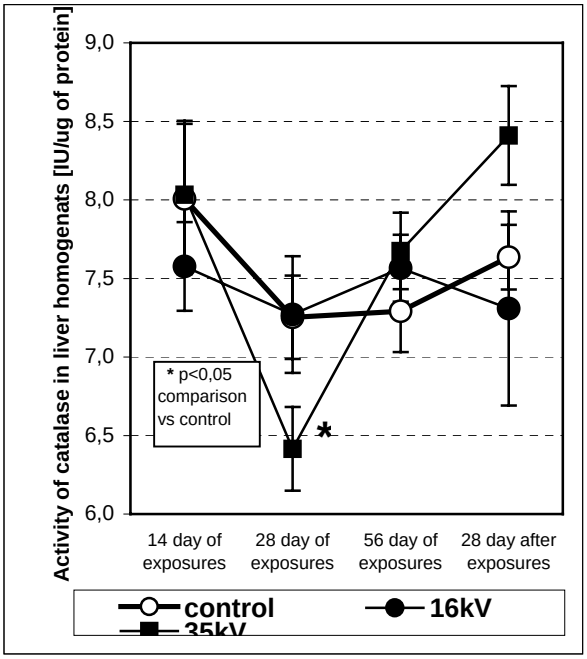

Fig. 3. Activity of catalase in liver homogenats in both groups of electric field-exposed rats in particular days of exposure cycle and in 28 day after the end of exposure cycle with statistical comparison to control group

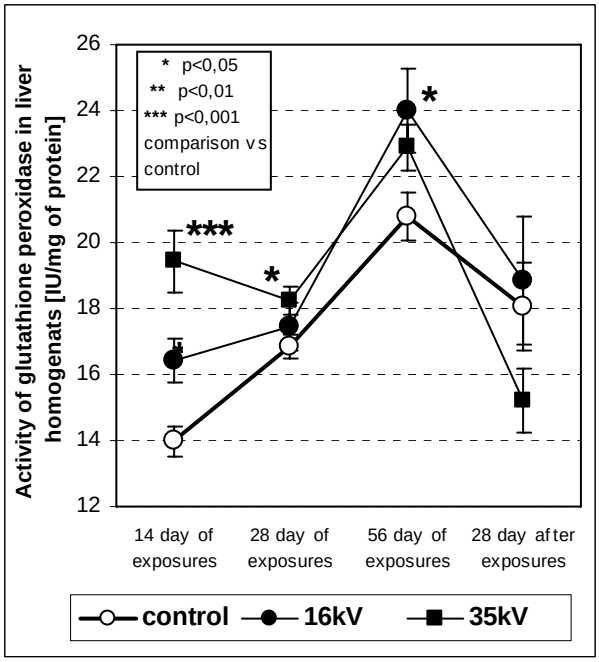

Fig. 4. Activity of glutathione peroxidase in liver homogenats in both groups of electric field- exposed rats in particular days of exposure cycle and in 28 day after the end of exposure cycle with statistical comparison to control group

DISCUSSION

Catalase, glutathione peroxidase, and superoxide dismutase are antioxidant enzymes which collaborating with each other protect the organism against toxic action of reactive oxygen species [8,9,10]. Lower activity of catalase and superoxide dysmutase in early phase of exposure cycle with simultaneous decrease in concentration of malondialdehyde in liver tissue observed in present study suggest the reduction of intensity of oxidative processes in this organ under the influence of static electric field resulting in favourable effect on antioxidant status in living organism. On the other hand increase in peroxidase activity in initial phase of exposure cycle is probably related to proper balance of antioxidant status. Lack of significant changes in antioxidant enzymes activity in liver tissue in both groups of rats exposed to electric field at 28th day after the end of exposure cycle confirm that long-term exposure to strong static electric field with parameters usually existing nearby high voltage direct current transmission lines does not have any persistent effect on antioxidant activity of living organisms. Moreover significant decrease in malondialdehyde contents in liver tissue after the end of exposure cycle seems to support a thesis that such exposure does not cause pathological processes of peroxidation of lipids in biological membranes.

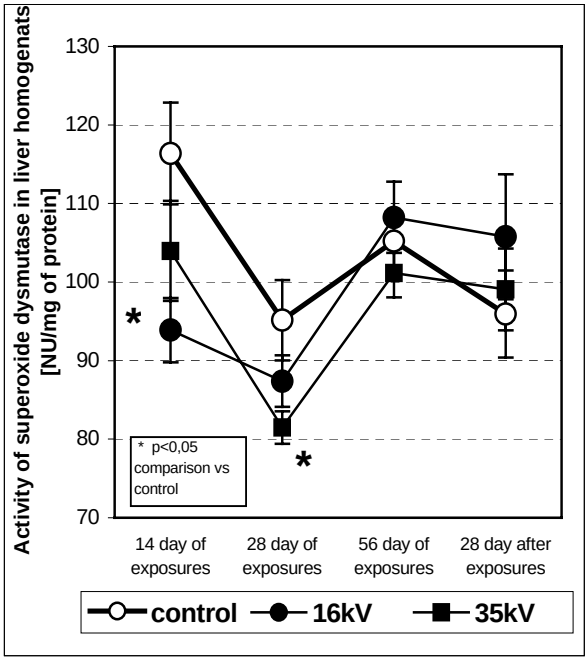

Fig. 5. Activity of superoxide dysmutase in liver homogenats in both groups of electric field -exposed rats in particular days of exposure cycle and in 28 day after the end of exposure cycle with statistical comparison to control group

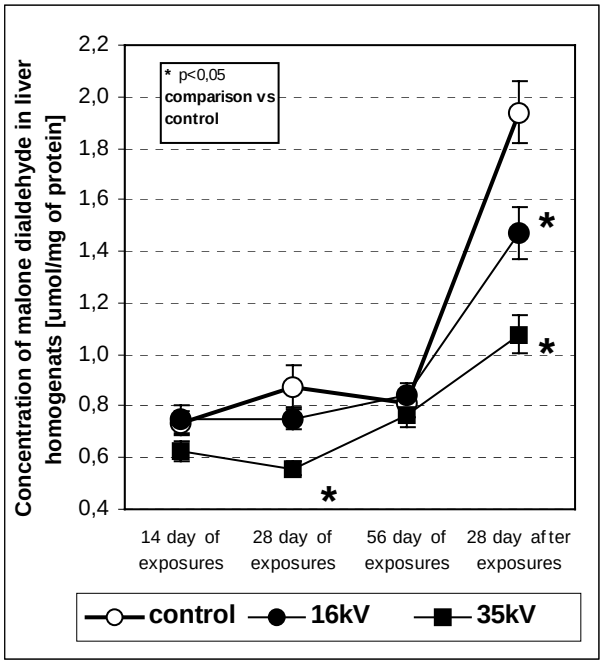

Fig. 6. Concentration of malone dialdehyde in liver homogenats in both groups of electric field-exposed rats in particular days of exposure cycle and in 28 day after the end of exposure cycle with statistical comparison to control group

CONCLUSIONS

Strong static electric fields with parameters generated usually nearby high voltage constant current transmission lines does not cause any persistent effect on antioxidant reactions in liver of experimental animals. These data indicate that proper construction of high voltage constant current transmission lines enables to avoid serious health hazards for human population related to disturbances of antioxidant processes in living organisms.

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