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Changes in Thiols Indicators in the Lens of the Eye of White Rats under the Exposure of Radiation during Operation of a Cellular Mobile Phone

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Research Article

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Abstract

The results of previous work carried out at the Laboratory of Biophysics of Cellular Metabolism of the Institute of Physiology named after A.I. Karaev, which concerned the study of the effect of EMR on LPO processes and the antioxidant system in visual structures, pointed to the oxidative nature of the implementation of EMR exposure. Since thiol compounds in living tissues primarily interact with peroxide products, it was assumed that the effect of EMR should be reflected in the thiol content of the lens. For this purpose, a group of white outbred rats (40 species, half of which were identified as the control group) were studied, which were daily irradiated with EMR from a working cell phone. On the 7th, 14th, 21st and 28th day of the experiment, 5 animals from the experimental group and 5 animals from the control group were slaughtered. The lens of the eye was removed from the animals, in which the level of thiols was determined according to the modified Lindsey-Sedlak method based on the Ellman method. The results of the study showed that common and readily available (cytoplasmic) thiols in the nucleus of the lens of the eyes of rats irradiated with mobile phone EMR, in general, have similar dynamics of quantitative changes depending on the duration of exposure. Hidden thiols behave similarly. In the lens cortex, the nature of changes in thiols is not so pronounced, but generally similar to the results in the nucleus. The authors believe that these results may indicate the antioxidant properties of thiols in LPO reactions.

Keywords: Eye lens; EMR; Thiols; LPO reactions

Introduction

Studies on various animal species show that microwave radiation of varying intensity causes significant physiological changes in their visual systems [1,2]. In our previous studies conducted at the Laboratory of Biophysics of Cellular Metabolism of the Institute of Physiology named after A.I. Karaeva, data were obtained indicating that exposure of white rats to high-intensity electromagnetic radiation (EMR) slows down the processes of lipid peroxidation (LPO) in the lens [3,4]. In the format of expanding research on this topic, we conducted a series of experiments to study the effect of mobile phone radiation on the content of thiols in the substructures of the lens of the eye in albino rats.

The Aim of the Study

The purpose of this work was to study the indicators of thiols in the cortex and the nucleus of the lens of albino rats, depending on the duration and power of exposure of animals to EMR, which is formed during the operation of a mobile phone.

Materials and Research Methods

We studied outbred white rats 3 months old (males). The study generation (40 individuals) was divided into a control group (20 individuals) and 4 experimental groups (5 individuals in each group). Animals on each experiments which were carried out were irradiated using a standard mobile phone daily for 20 minutes. To do this, a call was made to a mobile phone located directly next to the animals from another phone and a connection was established for 20 minutes (i.e., the phone was in active mode for 20 minutes). Then after 20 minutes the telephone connection was interrupted. With the indicated daily exposure, the experimental groups were irradiated for 7, 14, 21 and 28 days.

The control group was kept in similar conditions except for the phone, which was not turned on. After the radiation exposure necessary for the experiments, the selected (irradiated) group of animals and 5 individuals from the control group were slaughtered on the seventh day of the experiments. The remaining part of the animals continued to be irradiated in accordance with the intended number of days (they were killed in the above order on the 14th, 21st and 28th day from the start of the experiments).

In slaughtered rats, the lens of the eye was removed by preparation for research. The content of sulfhydryl groups (thiols) was determined by the modified Lindsey-Sedlak method based on the Ellman method [5]. The principle of this method is to reduce 5,5'-dithiobis-(2-nitrobenzoic) acid with sulfhydryl groups to form a yellow colored compound having an absorption maximum at 412 nm. Calculations of the content of sulfhydryl groups were carried out according to the difference in optical densities at the first and 15th minutes (for easily accessible ones), at the first and 30th minutes (for masked ones).

In both cases, when measuring SH-groups in the lens, 20 µl of Ellman's reagent was added due to the saturation of the lens with SH-groups. The content of hidden (masked) SH-groups was determined from the difference between the amount of total and easily accessible sulfhydryl groups. The content of SH groups in the studied lens substructures was expressed in nmol/mg protein. The numerical indicators obtained during the experiments were analyzed using simple methods of variation statistics [6].

Results and Discussion

The results of the study showed that in animals slaughtered after 7 days of irradiation, the content of readily available and total thiols, both in the nucleus and in the lens of the eye, changes slightly. The difference between the numerical indicators is not statistically significant, and in this case we can only speak of a slight trend towards an increase in the content of SH-groups in the studied lens substructures.

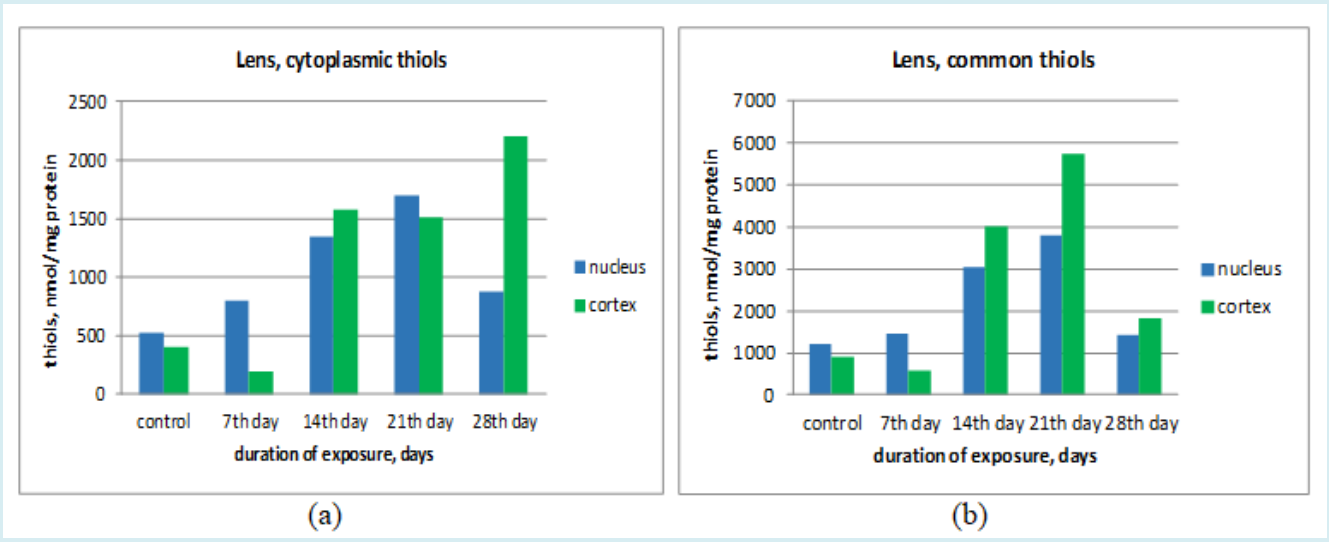

Figure 1: Histograms showing the content of cytoplasmic (a) and total (b) thiols (nmol/mg protein) in the substructures of the lens of the eyes of 3-month-old white rats irradiated with EMR mobile phone for 28 days (daily exposure 20 min.).

The amount of total and cytoplasmic thiols significantly increases in both substructures of the lens (indicators are statistically significant at $p<0.05$). Interesting in the results for this group of animals is a more pronounced change in the thiols of the cortex compared to the SH-groups of the nucleus, while in rats irradiated for 7 days, sulfhydryl groups, as well as in the experimental series, contain more in the nucleus.

The content of sulfhydryl groups in the nucleus and cortex of the lens of animals slaughtered after 21 days of irradiation also significantly exceeds the values of the control group. At the same time, the amount of cytoplasmic thiols exceeds the control values in both substructures by more than 200%, and total thiols in the nucleus increase by more than 350%, and in the cortex by almost 500%. However, the qualitative ratio of the amount of cytoplasmic thiols in the nucleus and lens cortex of the experimental animals again becomes the same as in the control ones (there are more SH-groups in the nucleus).

For common thiols, however, the tendency for a higher content of SH groups in the core than in the core is retained. Note that this trend for total thiols does not change in animals slaughtered after 28 days of exposure. In addition, this duration of irradiation is characterized by a drop in the content of total thiols in the nucleus to figures close to the control ones (the content of total thiols is almost the same as after 7 days of irradiation), while in the cortex the amount of the corresponding SH-groups remains somewhat high (the difference between the control statistically significant, although at $p>0.05$).

As for the sulfhydryl groups of the cytoplasm, the dynamics of their number in the nucleus is similar to the changes in total thiols. Their quantitative indicators are similar to those obtained from animals slaughtered after 7 days of exposure. However, unlike total thiols, the difference between the data on cytoplasmic thiols of the lens nucleus of the control group and the corresponding data on the last experimental group was statistically significant ($p>0.05$). Cytoplasmic thiols of the lens cortex behave most predictably: with increasing duration of irradiation, their content continues to grow and is maximum in animals slaughtered after 28 days of irradiation. At the same time, the differences with the control group are statistically significant with high reliability ($p<0.001$).

Thus, the present study shows that total and readily available (cytoplasmic) thiols in the nucleus of the lens of the eyes of rats irradiated with mobile phone EMR have approximately the same graphs characterizing their quantitative change depending on the duration of exposure. Hidden thiols behave in a similar way, the quantitative characteristics of which can be easily obtained from the difference in the indicators of total and cytoplasmic thiols (Figure 2).

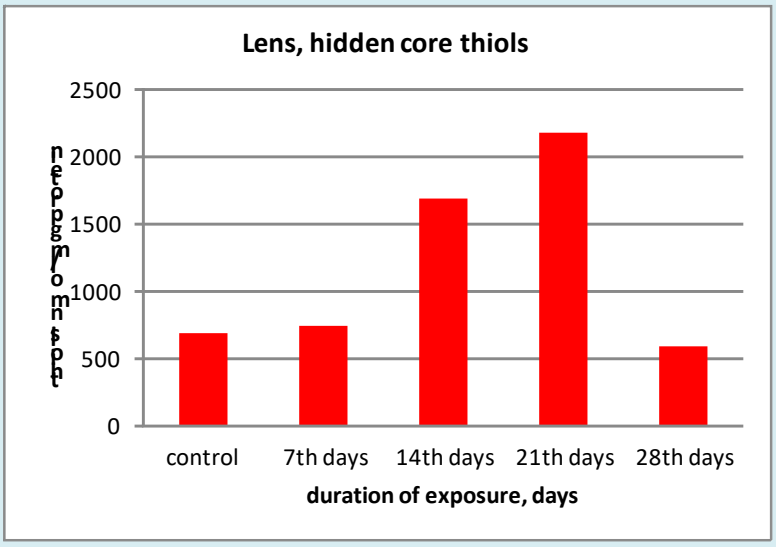

Figure 2: Histogram showing the content of latent thiols (nmol/mg protein) in the substructures of the lens of the eyes of 3-month-old white rats exposed to mobile phone EMR for 28 days (daily exposure 20 min.).

The content of sulfhydryl groups in the lens cortex as a result of irradiation does not show such a pronounced tendency to increase and decrease as in the nucleus. Nevertheless, the nature of the changes is similar, which is especially clearly demonstrated by the indicators in the groups that were irradiated for 14 and 21 days, respectively.

An analysis of the results obtained showed that these data do not contradict the data that were revealed in the work of other researchers. Various authors have data on both strongly negative and possibly protective effects of EMR on the physiological systems of living organisms [7,8]. Of course, much depends on the specific situation (EMP duration, source power, etc.). Regarding our context, there is still more data that testify to the detrimental effect of EMR and the oxidative stress induced by it on the structural elements of the visual analyzer [9,10].

Comparison of the results of this study with previously obtained data [2,3] concerning the study of the effect of EMR on lipid peroxidation (LPO) reactions in the lens substructures also turned out to be very interesting. These data showed changes in the course of lipid peroxidation processes both in the nucleus and in the cortex of the lens of rats of the same age. The vector of these changes showed an increase in the LPO rate in both substructures, however, the nature of the changes turned out to be rather moderate. Thus, we can say that the redox reactions in the lens of the eye undergo a shift towards oxidation under the influence of the corresponding EMR. At the same time, an increase in the amount of reduced thiols may be evidence of the participation of the latter in compensatory reactions in response to an increase in the LPO rate.

Conclusions

Electromagnetic radiation from mobile phones affect the content of thiols in the substructures of the lens of the eye in albino rats. The noted phenomenon is characterized by an increase in the amount of reduced thiols in this tissue. The authors believe that this observation may reflect the antioxidant properties of thiols in LPO reactions.

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