UDK: 616.155.1-001.2-073:613.6

FEATURES OF LIPID PEROXIDATION AND ANTIOXIDANT PROTECTION IN RED BLOOD CELLS IN INDIVIDUALS OCCUPATIONAL RISK OF EXPOSURE TO RADIOFREQUENCY ELECTROMAGNETIC RADIATION



Ibadova Gulnara Alievna[1], Khamidova Khumayra Alisher kizi[2], Khamidova Gulozod Mahsutovna[3]
1 - Center for the Development of Professional Qualifications of Medical Workers, Tashkent, Uzbekistan,
2 - Amos Alonzo Stagg High School, Illinois, USA
3 - United RX, Illinois, USA

РАДИОЧАСТОТАЛИ ДИАПАЗОНЛИ ЭЛЕКТРОМАГНИТ НУРЛАНИШ ТАЪСИРИНИНГ КАСБИЙ ХАВФИ БЎЛГАН ШАХСЛАРДА ЛИПИДЛАРНИНГ ПЕРОКСИДЛАНИШЛИ ТИЗИМИНИНГ ХУСУСИЯТЛАРИ ВА ҚОНДАГИ ЭРИТРОЦИТЛАРНИ АНТИОКСДАНТЛИ ҲИМОЯСИ

Ибадова Гулнара Алиевна[1], Хамидова Хумайра Алишер кизи[2], Хамидова Гулозод Махсутовна[3]
1 - Тиббиёт ходимларининг касбий малакасини ривожлангтириш маркази,
Ўзбекистон Республикаси, Тошкент ш.;
2 - Амос Алонзо Стагг мактаби, Иллиноис, АҚШ;
3 - Юнайтед RX Иллиноис, АҚШ;

ОСОБЕННОСТИ СИСТЕМЫ ПЕРЕКИСНОГО ОКИСЛЕНИЯ ЛИПИДОВ И АНТИОКСИДАНТНОЙ ЗАЩИТЫ В ЭРИТРОЦИТАХ КРОВИ У ЛИЦ С ПРОФЕССИОНАЛЬНЫМ РИСКОМ ВОЗДЕЙСТВИЯ ЭЛЕКТРОМАГНИТНОГО ИЗЛУЧЕНИЯ РАДИОЧАСТОТНОГО ДИАПАЗОНА

Ибадова Гульнара Алиевна[1], Хамидова Хумайра Алишер кизи[2], Хамидова Гулозод Махсутовна[3]
1 - Центр развития профессиональной квалификации медицинских работников
Республика Узбекистан, г. Ташкент;
2 - Амос Алонзо Стагг старшая школа, Иллиноис, США;
3 - Юнайтед RX Иллиноис, США

e-mail: prof.ibadova@mail.ru

Резюме. *Радиочастота диапазонли электромагнит нурланиш таъсирининг касбий хавфи бўлган шахсларнинг эритроцитларида липидларнинг пероксидланиш ҳолатини (ЛПО), антиоксидант ҳимоя (АОҲ) ва Ar фосфолипаза фаоллиги ҳолатини ўрганиш учун 18 ёшдан 65 ёшгача бўлган 74 нафар киши текширувдан ўтказилган. РЧЭМН (радиочастотали электромагнит нурланиш) шароитида ишлайдиган шахсларда АОҲ тизими фаоллигининг пасайиши, мембраналарнинг бузилиши ва эритроцитлар деформациясининг бузилиши фонида липолитик фермент ЛПО нинг фаоллашиши патологик жараённи ва унинг асоратларини сурункали ҳолатини маълум даражада прогнозлаш имконини бериши аниқланган.*

Калит сўзлар*: липидларнинг пероксидланиши, антиоксидантли ҳимоя, электромагнитли нурланиш, эритроцитларнинг деформацияси.*

Abstract. *To study the state of lipid peroxidation (LPO) and antioxidant protection (AOP) and activity of phospholipase Ar in erythrocytes in persons with occupational risk of exposure to radiofrequency electromagnetic radiation (RFEMR), it was examined 74 people aged 18 to 65 years. It was found that the LPO activation, the lipolytic enzyme activity due to lower AOP system, destruction of membranes, and erythrocyte deformability violation of persons working under RF EMR offers a degree synchronization predict pathological process and its complications.*

Keywords*: lipid peroxidation, antioxidant protection, electromagnetic radiation, erythrocyte deformability.*

Introduction. At present, large-scale projects in the field of telecommunications are being implemented in Uzbekistan. As a result of the implementation of such projects, existing radio-television stations

(RTS) have been modernized, and new radio-television stations (RTS) have been put into operation in all regions of the country. Increasing the number and capacity of radio engineering facilities equipping them with new, modern equipment, increases the importance of electromagnetic safety for the operating personnel of these stations.

According to numerous researchers, with chronic exposure to electromagnetic radiation (EMR) in unprotected people, multiple organ pathology develops [4]. Under the influence of electromagnetic fields of non-thermal action, suspended particles (erythrocytes and blood leukocytes) line up in chains stretched parallel to the electric field lines of force and, at the same time, the structure of the cell changes due to rupture of intra- and intermolecular bonds. Prolonged exposure to electromagnetic radiation leads to an overstrain of adaptive-compensatory mechanisms, significant deviations in the function of cells and systems, metabolic disorders and enzymatic activity, hypoxia, etc. Since electromagnetic radiation in a production environment usually acts in combination with other factors, its effect on the body person is enhanced. [2,4,5,7]

At present, it has become apparent that one of the necessary conditions for optimal hemomicrocirculation in the body is the presence of normal blood rheological properties, which are determined by many factors, such as its viscosity, fluidity, and the degree of erythrocyte aggregation [10].

One of the most significant factors in maintaining rheological homeostasis is the functional activity of erythrocytes, which is necessary for delivering oxygen to cells and removing metabolites from them. Implementing the full function of erythrocytes is facilitated by their specific shape and size. The normal functioning of erythrocytes also implies a good ability of its membrane to deform.

Disorders of the function of erythrocytes in the form of a decrease in their fluidity can be associated with dyslipidemia, which causes a structural rearrangement of erythrocyte membranes, aggravating microcirculation disorders. With the structural rearrangement of erythrocyte membranes and their increased destruction, a large amount of free hemoglobin enters the vascular bed; the plasma becomes more osmophilic. Hemoglobin and iron ions, which are formed in excess during the hemolytic breakdown of erythrocytes, are potent activators of lipid peroxidation (LPO), the products of which exacerbate the detrimental effect on cell membranes. The question of the features of the lipid peroxidation system and antioxidant protection (AOP) of blood cells under the influence of electromagnetic radiation has yet to be considered in the literature. The demand for this study is explained by the chronic form of the negative impact of Radiofrequency electromagnetic radiation (RFEMR) on organs and cells, which has yet to be studied, especially in people working for a long time under electromagnetic radiation [4,9]. At the same time, the study of the effect of RFEMR on the state of the rheological properties of blood erythrocytes makes it possible, to a certain extent, to predict the chronicity of cardiovascular diseases and the development of complications.

This work aimed to study the state of lipid peroxidation, AOP, and the activity of Ar phospholipase in erythrocytes in persons at occupational risk of exposure to RFEMR.

Table 1. Comparative characteristics of the biochemical parameters of blood erythrocytes in the examined persons under the influence of RFEMR

Groups	Activity of phospholipase -Ar c.u	MDA mol/мg Hb	SOD un/mgHb	Catalaza mmol/мgHb	Deformation index-whiteness	Lactat Mu/g Hb
Control n=9	0,56±0,01	1,64±0,09	2,41±0,33	3,47±0,41	2,63±0,03	3,51±0,12
I group n=12	0,58±0,06	1,69±0,12	2,55±0,18	4,06±0,24	2,44±0,17	3,54±0,23
II group n=10	0,64±0,07	1,74±0,11	2,33±0,14	3,94±0,21	2,01±0,18*	3,96±0,23
III group n=12	0,67±0,06*	2,36±0,14*	2,01±0,12	3,03±0,21	1,98±0,14*	4,54±0,33*
IV group n=10	0,69±0,07*	2,94±0,24*	1,73±0,14*	3,41±0,34	1,76±0,15*	4,93±0,33*
V group n=11	0,73±0,04*	4,51±0,31*	1,66±0,12*	3,76±0,24	1,49±0,13*	5,27±0,41*
VI group n=10	0,74±0,02*	4,93±0,27*	1,61±0,14*	3,98±0,31	1,51±0,04*	5,84±0,23*

Note: * - reliability of differences in indicators compared to control

Materials and methods. Seventy-four people aged 18 to 65 were examined. Depending on the duration of RFEMR exposure, the challenged persons were divided into six main groups:

- Group I (12 people) with work experience up to 5 years.
- Group II (10 people) with work experience of 6-10 years.
- Group III (12 people) with work experience of 11-15 years.
- Group IV (10 people) with work experience of 16-20 years.
- Group V (11 people) with work experience of 21-25 years.
- Group VI (10 people) with more than 25 years of experience.

The control group consisted of 9 people of the same age, conditionally healthy volunteers without any pathology and not having contact with RFEMR. The leading group consisted of persons with direct and constant exposure to RFEMR at work who were in the same working conditions and under dynamic observation for three years. When selecting individuals for laboratory tests, such indicators as initial visitability, the results of their periodic examinations in the form of a confirmed diagnosis, and data on the body's functional state were considered.

The study used venous blood taken in a ratio of 9:1 with a 3.8% sodium citrate solution. To obtain an erythrocyte suspension, erythrocytes were washed thrice with saline, followed by centrifugation for 15 min. at 2000 rpm. Hemolysis of erythrocytes was done by adding an equal amount of distilled water. 0.2 ml of 2M sodium chloride solution was added to 0.4 ml of hemolysate and stirred for 10 minutes. At 37°C for complete extraction of phospholipase. An enzyme solution was prepared by mixing different volumes of the resulting extract and three HCl buffers. Phospholipase activity was assessed by the degree of clearing of the lecithin emulsion (10% solution of lecithin in a solvent consisting of 95% ether and methanol). The optical density of the control sample against the experimental one at 500 ml and the specific activity of phospholipase A in blood erythrocytes were calculated at about 1 mg of hemoglobin. To assess the morphology of erythrocytes, the erythrocyte deformability index was determined according to the modified method of C. Jannert et al. [12], cited in the works of Fedorov Z.D. et al. [11].

To determine the content of the end product of the LPO process - malondialdehyde (MDA), the method of L.I. Andreeva et al. was used. [1]. During the study, the optical density of the prototype was measured and compared with the density of the standard solvent (butanol) at a wavelength of 535 nm. The study's results were calculated using the molar extinction coefficient of MDA and expressed in μmol/l or nmol/ml.

The catalase activity was studied according to the method of M.A. Korolyuk et al. [8]. The color intensity during the study was measured on a spectrophotometer at a wavelength of 410 nm. Catalase activity in erythrocytes was expressed in mol/min/mg hemoglobin.

Studies of the activity of superoxide dismutase (SOD) in blood erythrocytes were carried out according to the method of E.E. Dubinina et al. [6]. The optical density of the test sample was measured at a wavelength of 540 nm. SOD activity was expressed in arbitrary units relative to mg of hemoglobin.

The study results were processed by the method of variation statistics, using the Excel program and the student's test for parametric values; the differences were considered significant at $p<0.05$.

Results and its discussion. Analysis of the results of the study presented in Table 1. indicates a significant increase in the content of malonic aldehyde in the erythrocytes of the blood of persons working in the conditions of RFEMR. A significant increase in lipid peroxidation products was noted in people working for 15 years or more, where the level of malonic aldehyde in erythrocytes exceeded the control group by 15 times ($p<0.05$). With an increase in the length of service in the conditions of RFEMR, the level of malonic aldehyde tended to increase, and the highest values were noted in persons with an experience of more than 25 years, where the content of the end product of lipid peroxidation exceeded the initial level by three times ($p<0.05$). It is known that the activation of free-radical oxidation and the formation of intermediate lipid peroxidation products cause damage to the structural components of cell membranes, in particular, erythrocytes, and lead to loss of deformability of blood cells, changes in the lipid composition of membranes due to an increase in hydroxyeicotetraenoic acid responsible for the adhesive properties of erythrocytes.

The activation of lipid peroxidation processes is accompanied by the activation of the lipolytic enzyme - phospholipase Ar, which promotes the deacetylation of phospholipid molecules and the formation of lysophospholipids in the erythrocyte membrane and the subsequent hemolytic breakdown of blood cells. It is known that LPO and phospholipase Ar, influencing the same substrate, i.e., on unsaturated fatty acids of phospholipids, are in interaction. This condition may be one of the reasons for the development of anemia in the examined persons working in the conditions of RFEMR for a long time. It should be noted that the severity of anemia in all cases remained within the range of mild or moderate severity. In no case did we find severe forms of anemia.

The enhancement of LPO processes is probably associated with inhibiting the activity of antioxidant enzymes in blood erythrocytes. As can be seen from the obtained data, SOD activity significantly

decreases in persons with more than 20 years of work experience. The adaptive capabilities of intracellular enzymes and natural antioxidants compensate for the lack of an antioxidant defense system for many years and are gradually depleted. Activation of lipid peroxidation and phospholipase Ar also affect the magnitude of the cell potential, i.e., violate the deformability of erythrocytes, which determines their shape and size, as well as the ability of its membrane to deform.

Thus, on the one hand, a violation of the deformability of erythrocytes; on the other hand, microcirculation and, thirdly, an increase in the adhesive properties of blood cells contribute to the formation of "erythrocyte sludge," lining them up in chains elongated parallel to the lines of force of the electromagnetic field. Violation of the membrane structures of erythrocytes, their ability to flow, and the degree of permeability indicate the accumulation in the cell of the end product of glycolysis - lactic acid. The latter, changing the balance of the erythrocyte's buffer and electrolyte systems, adversely affects the functional state of the hemoglobin protein.

Based on the preceding, it can be concluded that the activation of LPO, a lipolytic enzyme, against the background of a decrease in the activity of the AOD system, membrane destruction, and impaired erythrocyte deformability in persons working under RFEMR conditions makes it possible to predict the chronicity of the pathological process and its complications to a certain extent.

Literature:

1. Andreeva L.I. Modification of the method for determining lipid peroxides in the test with thiobarbituric acid / L.I. Andreeva, L.A. Kozhemyakin, A.A. Kishkun // Laboratory business. - 1988. - No. 11. - S. 4143.
2. Barkagan. Z.S. Momat A.P. Diagnosis and controlled therapy of hemostasis disorders-M 2001.
3. Berkovsky A.L. Vasiliev S.A. Zherdova L.V et al. Manual for the study of the adhesive-aggregative function of platelets / Moscow 2009. C30
4. Grigoriev Yu.G. Electromagnetic field and human health / M.: RUDN University, 2002.- 112p.
5. Devyatkov N.D. Millimeter waves and their role in the process of life /M. Radio and communication. 1991-168 C
6. Dubinina E.E., Salnikova L.A., Efimova L.F. Activity and isoenzyme spectrum of superoxide dismutase of erythrocytes and human blood plasma // Lab. case. - 1983. - N10. - S. 30-33.
7. Ivanov A.N. Influence of RFEMRon stress disorders of the functional activity of platelets / Abstract of Candidate of Diss. Saratov 2007. 27C
8. Korolyuk M.A. Method for determining catalase activity / M.A. Korolyuk, L.I. Ivanova, I.G. Mayorova // Lab. case. - 1988. - No. 1. - P. 16–19.
9. Determination of the energy flux density of the electromagnetic field in the locations of radio equipment operating in the frequency range of 300 MHz-300 GHz. Guidelines (MUK 4.3.1167-02 10), - M., Federal Center of the State Sanitary and Epidemiological Surveillance of the Ministry of Health of Russia, 2002.-80 p.
10.Reitman E.V. Clinical hemorology (thrombosis, hemostasis, rheology) 2003-N3-C13-27.
11.Fedorova Z.D., Kotovshchikova M.A., Bessmeltsev S.S., Popova T.I. On the determination of the erythrocyte deformability index. Lab.case.1986.-No.12.-S.732-735.
12.Jannert C., Lux W. Actabiol. med. germ., 1981. (-Vol.40.-P.739-742)

ОСОБЕННОСТИ СИСТЕМЫ ПЕРЕКИСНОГО ОКИСЛЕНИЯ ЛИПИДОВ И АНТИОКСИДАНТНОЙ ЗАЩИТЫ В ЭРИТРОЦИТАХ КРОВИ У ЛИЦ С ПРОФЕССИОНАЛЬНЫМ РИСКОМ ВОЗДЕЙСТВИЯ ЭЛЕКТРОМАГНИТНОГО ИЗЛУЧЕНИЯ РАДИОЧАСТОТНОГО ДИАПАЗОНА

Ибадова Г.А., Хамидова Х.А., Хамидова Г.М.

Резюме. *Для изучения состояния перекисного окисления липидов (ПОЛ), антиоксидантной защиты (АОЗ) и активности фосфолипазы Ar в эритроцитах, у лиц профессионального риска воздействия электромагнитного излучения радиочастотного диапазона, были обследованы 74 человек в возрасте от 18 до 65 лет. Установлено, что активация ПОЛ, липолитического фермента на фоне снижения активности системы АОЗ, деструкция мембран и нарушение деформабельности эритроцита у лиц, работающих в условиях ЭМИРЧ, позволяет в определенной степени прогнозировать хронизацию патологического процесса и его осложнения.*

Ключевые слова*: перекисное окисление липидов, антиоксидантная защита, электромагнитное излучение, деформабельность эритроцитов.*