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EFFECT OF X-RAYS ON LIVER METABOLISM

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The experiment was carried out on 20 heads of white rats divided into 3 groups of 5 heads each. The 1st group included intact rats. Experimental animals of the 2nd group were irradiated with X-rays. In white rats belonging to group 3, liver enzymes were detected in the blood 10 days after the cessation of X-ray irradiation. Experimental animals were irradiated with X-rays using the RUM-17 apparatus. The results of our studies showed that the concentrations of liver enzymes in the blood of white rats exposed to X-ray irradiation were elevated and differed from the norm. Thus, the concentration of aspartate aminotransferase in the blood was 27 % compared to the intact state ($P<0.05$), alanine aminotransferase –30 % ($P<0.05$), glutamine transferase increased by 17 %, lactate dehydrogenase – by 31 % ($P<0.05$). The concentration of creatine phosphokinase in the blood, which is the main index of the reparative process, was increased by 52 % above the level in the intact state ($P<0.001$). The synthesis of liver enzymes in the blood of experimental animals irradiated with X-rays was disrupted and led to changes corresponding to hepatitis. Free lipid peroxidation also increased in the liver tissues of experimental animals. The content of hydrogen peroxide, diene conjugate and malondialdehyde in the blood increased by 87.5 %, 61.5 % and 158 % compared to the intact state, respectively. In the homogenate, the average concentrations of surface – located SH-groups, internal protein SH-groups, peroxidase, catalase and total antioxidant activity decreased compared to the intact state.

Key words: X-rays, lipid peroxidation, oxidative stress, liver enzymes.

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ВПЛИВ РЕНТГЕНІВСЬКИХ ПРОМЕНІВ НА МЕТАБОЛІЗМ ПЕЧІНКИ

Експеримент був проведений на 20 головах білих щурів, розділених на 3 групи по 5 голів у кожній. До 1 групи увійшли інтактні щури. Піддослідних тварин по 2 групи опромінювали рентгенівськими променями. У білих щурів, що входять до 3-ї групи, через 10 днів після припинення рентгенівського опромінення у крові визначали ферменти печінки. Експериментальні тварини опромінювалися рентгенівськими променями за допомогою апарату RUM 17. Результати наших досліджень показали, що концентрації печінкових ферментів у крові білих щурів, підданих рентгенівському опроміненню, були підвищені і відрізнялися від норми. Так, концентрація аспартатамінотрансферази в крові склала 27 % порівняно з інтактним станом ($P<0,05$), аланінамінотрансферази – 30 % ($P<0,05$), глутамінтрансферази збільшилася на 17 %, лактатдегідрогенази – на 31 % ($P<0,05$). Концентрація креатинфосфокінази в крові, що є основним показником репаративного процесу, була підвищена на 52 % вище за рівень в інтактному стані ($P<0,001$). Синтез печінкових ферментів у крові експериментальних тварин, опромінених рентгенівськими променями, порушувався та призводив до змін, що відповідають гепатиту. У тканинах печінки експериментальних тварин посилювалося і вільне перекисне окиснення ліпідів. Вміст у крові перекису водню, дієнового кон'югату та малонового діальдегіду збільшився на 87,5 %, 61,5 % та 158 % порівняно з інтактним станом, відповідно. У гомогенаті середні значення концентрації поверхнево-розташованих білків SH груп, внутрішніх білків SH груп, пероксидази, каталази та загальної антиоксидантної активності порівняно з інтактним станом зменшилися.

Ключові слова: рентгенівські промені, перекисне окислення ліпідів, окислювальний стрес, печінкові ферменти.

One of the important problems of the modern world is the intensive pollution of the environment, which is the result of a multifactorial process. Among these factors, ionizing rays occupy a special place [2, 5, 15]. The sources of ionizing rays are considered to be the construction of new power plants, increased use of nuclear reactors, testing of various weapons, etc. [1, 3, 8] It has been proven that due to these sources, atmospheric air is regularly exposed to radioactive rays.

Like any other factor, radioactive rays affect a living organism along with vegetation and reduce the quality of life of people, cause exacerbation of chronic diseases or play an important role in the development of chronic diseases [3, 13].

The modern era is characterized by the widespread use of radioactive rays in everyday life, medicine, etc. Wars on the planet, tests of modern weapons, an increase in the number of nuclear power plants lead to an increase in the concentration of radioactive rays in the environment. For this reason, the exacerbation of various chronic diseases and the occurrence of other pathological processes in the body have become priority areas of biomedical sciences. Liver diseases occupy an important place among the pathological processes occurring in the body. Therefore, the study of the state of antioxidant protection, lipid peroxidation will provide additional information about the peculiarities of the effect of radioactive rays on hepatic metabolism as a result of a violation of redox homeostasis. Therefore, in the experiment, we set ourselves the goal of studying the changes caused by X-rays in liver tissue.

The purpose of the study was to assess changes in the liver metabolism of white rats exposed to X-rays and to clarify their pathophysiological mechanism.

Materials and methods. The experiments were carried out on 20 heads of white rats raised in vivarium conditions. The experimental animals were divided into 3 groups of 5 heads each.

Group 1 included intact rats. Group 2 white rats were irradiated with X-rays. In experimental animals belonging to group 3, 10 days after the cessation of X-ray irradiation, concentrations of liver enzymes were determined in the blood.

Experimental animals were exposed to X-rays using the "RUM-17" apparatus with the following parameters:

– Voltage – 180 kV;
– Amperage – 15 A;
– Filters – 0,5 mm Cu+1,0 mm Al;
– Focal length ratio – 3.
– Dose strength without tube – 0,86 Gr/sec

Taking into account the recommendation of A.U.Eminov (2014), irradiation was taken in a single dose of 4 g and continued for 5 days.

The experiments were carried out in accordance with the recommendations of the European Commission on Bioethics (Strasbourg, 1986).

In the vivarium, groups of experimental animals were placed in cages at 20 ° C and fed according to the required diet.

Immediately after the end of irradiation and 10 days after the end of the experiments, the animals were decapitated under anesthesia by injecting 0.5 ml of calypsol solution into the abdominal cavity. For the tests, blood was taken and liver homogenate was prepared.

To assess changes in liver metabolism in the blood, the level of activity of aspartate aminotransferase (AST) was determined, alanine aminotransferase (ALT), glutamintransferases (γ-GT), creatine phosphokinase (CPK), lactate dehydrogenase (LDH) and alkaline phosphatase (ALP). The concentrations of these enzymes were determined on the Bio Ssgeep MS-2000 analyzer (USA), operating in semi-automatic mode, using reagent kits manufactured by "Human".

To assess the intensity of free lipid peroxidation, concentrations of hydrogen peroxide (H_2o_2) were determined by the Askawat method.,Matusushita S., diene conjugates (DC) according to the method of I.D.Stalnaya, malondialdehyde (MDA) by method Uchiyama, Michara. The following markers of the body's antioxidant defense system have been identified.

1. SH-protein group located on the surface and inside the structure by the Ellman method;
2. Catalase or reduced glutathione (peroxidase) by the Burgmeyer method;
3. Total antioxidant activity (TAA) according to the method proposed by E.B.Spectr;

The statistical significance of the differences obtained as a result of experiments was calculated on a personal computer using Microsoft Office Excel software applications, using the Student's t-test and the nonparametric Wilcoxon-Mann-Whitney U-test based on modern recommendations [10]. The statistical difference was considered significant at a value of P<0.05. The correlation analysis was carried out using the Broys-Pearson method, and the correlation dependence was confirmed at P>0.07.

Results of the study and their discussion. The results of a group of intact experimental animals were accepted as normal. Quantitative indexs obtained in further experiments were compared with intact ones. It was determined that the activity of liver enzymes in the blood of white rats exposed to X-rays differed from the norm. The activity of the AST enzyme in the blood was 27 % compared to the intact state (P<0.05), ALT activity 30 % (P<0,05), activity γ-GT and LDH increased by 17 % and 31 % (P<0.05), respectively.

Based on the analysis of the results obtained from individual experimental animals, it was found that the concentration of the AST enzyme in the blood of white rats exposed to X-ray irradiation ranged from 28–50 u/ l, and the average activity value was 37.4±3.78 u/l. ALT activity varied in the range of 33–57 u/l, and the average value of activity increased significantly compared to the intact state and reached 45.8±4.53 u/l.

The activity of γ-GT in the blood of experimental animals was in the range of 33–60 u/l, the average activity index was 50.6±5.18 u/l, the values of LDH activity varied in the range of 320–390 u/l, and its average activity was 482±45.54 u/l.

It was found that irradiation at this dose significantly increased the concentration of enzymes in the blood, disrupting the physiological process of metabolism in the liver of white rats. Among these enzymes, the greatest increase in activity was observed in the indexs of CPK, which is the main index of the reparative process. Thus, its activity in the blood was 52 % higher than the level in the intact state (P<0.001) and varied between 315–463 u/l, and the average was 394.8 ±24.25 u/l.

Thus, the enzyme-synthesizing function of the liver of experimental animals irradiated with X-rays was disrupted and led to changes corresponding to hepatitis (Fig.1).

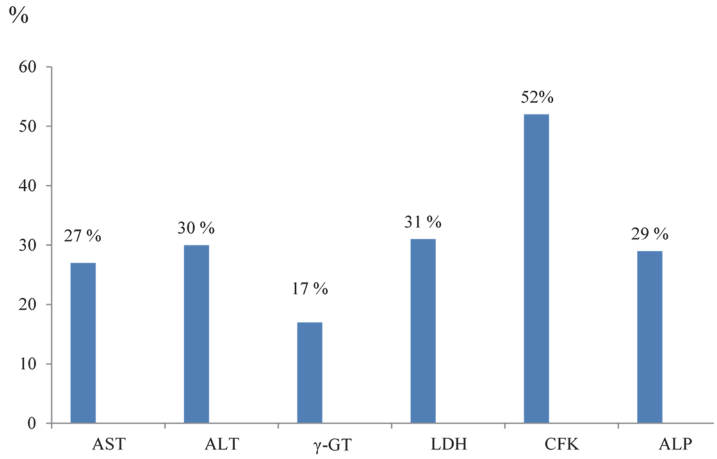

Fig. 1. Percentages of increased activity of liver enzymes in the blood of white rats exposed to X-rays, compared with the norm

The results of our studies have shown that due to exposure to X-rays, the concentration of enzymes in the blood not only increased, but also increased the free peroxidation of lipids in liver tissue. Thus, the concentration of the primary product of lipid peroxidation H_2o_2 varied in the range of 23.25–4.25 cu and its average value was 3.75–0.18 cu, which was 87.5 % higher compared to the intact state (P<0,001), such an increase in concentration was recorded in 100 % of experimental animals.

The concentration of the intermediate product of free lipid peroxidation DC varied in the range of 1.9–2.8 D_{232}/ml. Its average value was 2.3±0.16 D $_{232}$/ml and was 61.5 % higher than the level in the intact state (P<0.01). A sharp increase in the concentration of DC was observed in 100 % of the experimental animals.

The concentration of MDA sharply increased by 158 % compared to the intact state (P<0,001) and was recorded in experimental animals in the range of 2.5–3.4 nmol/mg. Its average value was 2.94±0.16 nmol/mg.

Corresponding changes were also found in the concentration of markers of the antioxidant defense system. Thus, the concentration of surface-located SH-group proteins (SP-SH) in liver homogenate was 12–25 nmol/ml. Its average value decreased by 45 % (<0.001) compared to the intact state. This pattern was observed in 100 % of experimental animals.

Approximately the same orientation was found when determining the content of internal proteins of SH-groups (IP-SH). Its concentration was in the range of 9–18.5 nmol/mg, and its average concentration was 12.24±1.63 nmol/mg. Compared with the intact state, this limit of the concentration of IP-SH was fixed in 100 % of white rats.

The concentration of peroxidase in liver homogenate was recorded in the range of 4.1–10.7 nmol/mg. Based on the quantitative parameters of the serum of experimental animals, it was found that the average concentration of peroxidase in liver tissue is 7.94±1.12 nmol/mg. It was determined that as a result of exposure to X-rays, the concentration of peroxidase in the blood decreased by 29 % (P<0.05) compared to the level in the intact state. This decrease was observed in 80 % of experimental animals.

The concentration of catalase in the liver of white rats exposed to X-rays decreased by 80 % compared to the norm. In samples taken from individual experimental animals, the minimum limit of catalase concentration was 160 mcat/l, and the maximum was 270 mcat/l. The average catalase concentration in this range was 199±19 mcat/l and was 12 % (P <0.05) less than the level in the intact state.

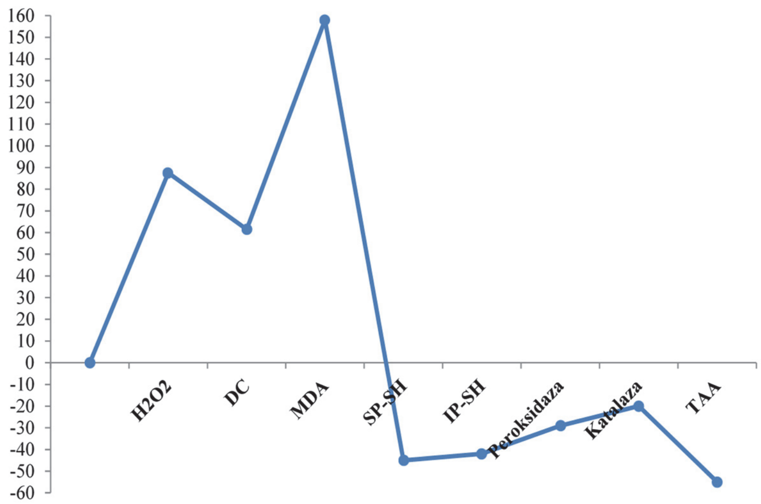

Fig. 2. Dynamics of changes in markers of oxidative stress in the liver under the influence of X-rays compared with the intact state

The most informative marker of the body's antioxidant defense system TAA ranged from 12–28 %, and its average value equated to 18.4±2.7 %. Unlike other antioxidant markers, the TAA index in liver tissue decreased by 55 %. This decrease was observed in 100 % of experimental animals.

Thus, the X-ray beam significantly weakens the general system of antioxidant protection of the liver of white rats, contributing to the occurrence of oxidative stress. Among the markers of the body's general defense system, the most noticeable was a decrease in TAA and catalase (Fig. 2).

Recently, diseases of the hepatobiliary system account for most of the total number of diseases. Liver diseases are on the eighth place among the causes of mortality of women of reproductive age in different countries. Exposure to hepatotoxic agents is one of the most common causes of these diseases. Medicines, production toxins, alcohol and environmental pollutants are examples of xenobiotics that can damage the liver of humans and animals [8]. Some other factors that can negatively affect the liver, in addition to toxic lesions, include ionizing radiation. Although the liver has historically been considered a radioresistant organ, many studies using various types of ionizing radiation in a wide range of doses have shown that the liver is not only sensitive to radiation exposure, but also experiences significant violations of regeneration processes. Liver tissue is exposed to radiation both in malignant neoplasms of the hepatobiliary system and in cancers of the gastrointestinal tract due to its large size and close location [8]. During preparation for allogeneic bone marrow transplantation or hematopoietic stem cell transplantation, the liver may also be exposed to radiation [14]. The ability to hepatocellular regeneration worsens, as well as irreversible liver failure are associated with radiation-induced damage to liver tissues [5]. Despite the fact that the pathophysiological features of radiation-induced liver damage in humans have been described in sufficient detail, the exact mechanisms of the development of the disease are still poorly understood. As a result, there are no effective methods of preventing and treating this pathology.

A large number of studies of the effects of ionizing radiation on living organisms have been conducted in the literature [8, 15]. In previous studies, the effect of microwave radiation was shown, which was accompanied by a change in the level of reactive oxygen species, in particular hydrogen peroxide, a change in the volume of mitochondria, a change in cellular respiration and the degree of dissociation of oxidation and phosphorylation in these organelles. In radiation therapy of cancer, liver fibrosis is reported as a form of acute radiation damage after exposure to high doses of radiation [12]. The effect of ionizing radiation on DNA methylation at the molecular level has been studied [14]. However, in these studies, the pathogenetic mechanism of liver metabolism disorders has not been fully elucidated. A distinctive feature of our work was the study of the activity of antioxidant enzymes, liver enzymes and the content of lipid peroxidation products in the blood and liver homogenate under prolonged exposure to radioactive radiation.

Conclusion

The results obtained indicate a change in the activity of biochemical markers of the liver and the activity of antioxidant enzymes in the blood and liver tissues after exposure to X-rays.

In the studied liver and blood serum homogenates of white rats exposed to X-rays for 5 days, the activity of liver enzymes, markers of the antioxidant defense system, as well as the quantitative content of DC and MDA undergo significant changes.

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MEDICAL AND SOCIAL FEATURES OF LASER EYE INJURIES IN MILITARY PERSONNEL OF THE DEFENSE FORCES OF UKRAINE

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For the first time, an analysis of tactical and medico-social features of combat damage to the organ of sight in the Defense Forces of Ukraine servicemen from field tactical lasers was conducted using open-world sources of scientific information. The medical and tactical characteristics of admission of victims to specialized healthcare facilities are given, and complaints, medical history, and clinical features of laser injuries are revealed. It was noted that 2/3 of the lesions were monocular. The direct dependence of the severity of the lesion on the distance to the laser beam source was proved. Macular ruptures, manifested severe retinal lesions, and central or paracentral scotoma were noted. All patients with eye injuries underwent conservative treatment. In 25 % of cases, surgical interventions were performed. After treatment and rehabilitation, the servicemen underwent a military medical examination; 50 % remained fit to perform their military service duties.

Key words: laser lesions, eye, military personnel, retinal lesions, scotomas, field tactical lasers

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МЕДИКО-СОЦІАЛЬНІ ОСОБЛИВОСТІ ЛАЗЕРНИХ УШКОДЖЕНЬ ОРГАНУ ЗОРУ У ВІЙСЬКОВОСЛУЖБОВЦІВ СИЛ ОБОРОНИ УКРАЇНИ

Вперше у відкритих світових джерелах наукової інформації проведено аналіз тактичних та медико-соціальних особливостей бойових ушкоджень органу зору у військовослужбовців Сил оборони України від польових тактичних лазерів. Наведена медико-тактична характеристика надходження постраждалих до спеціалізованих закладів охорони здоров'я, виявлено скарги, анамнез, клінічні особливості лазерних уражень. Відзначено, що 2/3 уражень були монокулярними Доведено пряму залежність тяжкості ураження від відстані до джерела лазерного променя. Тяжкі ураження сітківки очей проявлялись макулярними розривами, відмічались центральні або парацентральні скотоми. Усі пацієнти з ураженнями органу зору проходили консервативне лікування. У 25 % випадків проводились оперативні втручання. Після лікування та реабілітації військовослужбовцям було проведено військово-лікарську експертизу: 50 % військовослужбовців залишились придатними до виконання обов'язків військової служби.

Ключові слова: лазерні ураження, орган зору, військовослужбовці, ураження сітківки, скотоми, польові тактичні лазери

The study is a fragment of the research project: "Scientific substantiation of the standardization of the system of medical support of the Armed Forces of Ukraine in different operating conditions" code "Standard", state registration No. 0116U002816.

Eye injury and its consequences today remain one of the leading causes of blindness and professional disability of military personnel, especially in conditions of military conflict. The overwhelming number of combat ocular trauma of military personnel in the war in Ukraine from 2014 to the present day is caused by factors of conventional types of firearms (bullet and shrapnel wounds). Although the ocular surface area occupies less than 1 % of the total body surface, the frequency of combat injuries to the eyes and related structures reaches more than 8 %, with a clearly increasing trend. According to domestic experts, combat eye injuries in military personnel came out on top in the structure of causes of visual disability and accounted for 22.8 % of cases of primary disability. At the same time, 70.6 % of the visually impaired are young working-age people [2]. The standards and algorithms of the clinic, diagnosis, treatment and prevention of combat ocular trauma are well covered in the publications of scientists from other countries [3, 7, 9]. Modern national innovative methods of treatment are also proposed [1].