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SOME RESULTS OF EXPERIMENTAL RESEARCHES DEVOTED TO THE STUDY OF ALTERNATING MAGNETIC FIELD EXPOSURE EFFECTS ON TUMOR MODELS

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SUMMARY

The aim of the study. There was a presentation of the results of the work done on the study of the effects of exposure to an alternating magnetic field generated by the therapeutic apparatus "TOR" on the hematological parameters of experimental animals with an induced tumor model. **Material and Methods.** Used 200 experimental animals (100 outbred rats and 100 outbred mice). The research was carried out thanks to the use of a portable device "TOR", which is a biostimulator that generates electromagnetic radiation. To accomplish the tasks, outbred rats were divided into 4 groups, of which the tumor strain "Walker's sarcoma" was transplanted into the animals. The first group is presented - rats with a developed tumor process against the background of exposure to the waves of the "TOR" apparatus for 5 days, which we called the experimental group; the second group consisted of rats with a developed tumor process without exposure to the waves of the TOR device; the third group consisted of intact rats against the background of exposure to the waves of the apparatus "TOR" for 5 days and the fourth group consisted of intact rats. Conducted hematological studies. **Results.** The analysis showed that radio waves do not cause massive cell death, but apoptosis of transformed cells and proliferation of immunocompetent cells are induced. Inhibition of tumor growth by volume was 45.2%, by weight - 31.7% when comparing the experimental and intact (without exposure to TOR) groups of rats with an implanted Walker tumor. Shown in the experimental group basophilia, eosinophilia, neutropenia and lymphopenia. After exposure to an alternating magnetic field, slight monocytosis, neutrophilia and lymphocytes are normal. The number of immunocompetent cells increased and there was a 2-fold increase in neutrophil activity compared to the data before and without exposure to an alternating magnetic field, as well as an increase in the phagocytic potential and functional heterogeneity of granulocytes. Effector leukocytes were also increased 2.1 times. **Conclusion.** The possibility of exposure to electromagnetic radio waves for the purposes of clinical oncology remains one of the urgent tasks of medicine. The versatility of the effect of electromagnetic fields on an organism with a tumor is realized due to various mechanisms of interaction with biological structures at all levels of organization and is largely due to their influence on molecular processes and other functions in the tumor cell.

KEYWORDS: medium frequency radio wave, hematology, tumor, immunity, cancer process, magnetic field.

Topicality. The problem of increasing the effectiveness of cancer treatment is one of the most important and topical issues in modern medicine. We all know that disturbances in various regulatory systems of the body and disruption of homeostasis mechanisms associated with the tumor process can be aggravated during intensive courses of chemotherapy and radiation therapy, and at the same time, the principle of a "vicious circle" can develop, which can cause an even greater decrease in antitumor resistance.[1,5,19,20] In this regard, in recent years in oncology more and more attention is paid to areas that are focused on the need to mobilize the body's natural defense mechanisms. Therefore, the relevance of developing effective approaches to electromagnetic therapy as a component of complex antitumor treatment is due to the fundamental role of electromagnetic interactions in the functioning of living systems.[1,2,4,8,10,12]

Studies of the influence of electromagnetic fields on living organisms have been conducted for more than a decade. Thus, it is known that electromagnetic fields are an ecologically significant factor of the external environment, since all living organisms on the planet are under the influence of the natural geomagnetic field and man-made fields. Significant progress in understanding the processes underlying the mechanisms of the biological action of electromagnetic fields, as well as in approaches to the study of their biological effectiveness, occurred in the middle of the last century.[3,4,5,9,11,21] Thus, this information served as an impetus for the development of magnetotherapy. In their monograph, the authors provide data on the benefits of magnetic therapy

in rehabilitation treatment, including cancer patients, for normalizing blood counts, eliminating postoperative complications, accelerating reparative processes, and relieving severe pain.[5,7] Therefore, despite the widespread use of electromagnetic fields in various fields of clinical medicine, including for the needs of oncology, information about the mechanisms of action of this physical factor on the course of pathological processes, as well as the effect on the tumor, is being actively studied.[3,4,8,9, 14.17] When studying the antitumor effect of electromagnetic fields, the objects of influence can be both cell cultures and the body as a whole. It was established that the criteria for the effectiveness of such an impact can be cell vital activity indicators, dynamic characteristics of the tumor, and clinical data on the state of the organism.[7,9,11,15,22]

Thus, some works have shown that, depending on the modes of electromagnetic action, it is possible to obtain stimulation or suppression of the rate of synthesis and doubling time of human lymphoma cells in the experiment.[8,9] Thus, the inhibition or stimulation of the observed effects was of a non-linear nature, which allowed the authors to suggest the existence, among other things, of the resonance mechanism of the response of tumor cells to electromagnetic fields applied in various modes. As for immunity, the study of the state of the immune system of patients with stage II-III breast cancer during complex treatment with the use of magnetotherapy showed that its action leads to the activation of the T-cell link of the immune system and helps to reduce the damaging effect of radiation on immunocompetent cells. Thus, the ratio of helper-suppressor fractions of T-lymphocytes increased in favor of T-helpers, which is a positive moment before surgery during systemic chemotherapy.[15,17] However, despite all of the above, there is still no evidence base for the results of the influence of electromagnetic fields on the body. In this regard, we have set the task to study in the experiment the changes occurring in the body of experimental animals.

The aim of the study is to present the results of the work done on the study of the effects of exposure to an alternating magnetic field generated by the therapeutic apparatus "TOR" on the hematological parameters of experimental animals with an induced tumor model.

MATERIAL AND METHODS

To achieve the set goal and task, 200 experimental animals (100 outbred white rats and 100 outbred white mice) were used for experimental studies. The animals were kept in plastic cages (6 per cage) under standard conditions under the same conditions.

The research was carried out thanks to the use of a portable device "TOR", which is a biostimulator that generates electromagnetic radiation. We have set a goal to investigate the hematological changes that we can observe during exposure to electromagnetic fields. So, below will be presented the results of hematological studies against the background of the effects of waves on experimental animals, the so-called electromagnetic radio wave therapy. To accomplish the tasks, outbred rats were divided into 4 groups, of which the tumor strain "Walker's sarcoma" was transplanted into the animals. The first group is presented - rats with a developed tumor process against the background of exposure to the waves of the "TOR" apparatus for 5 days, which we called the experimental group; the second group consisted of rats with a developed tumor process without exposure to the waves of the TOR device; the third group consisted of intact rats against the background of exposure to the waves of the apparatus "TOR" for 5 days and the fourth group consisted of intact rats. To determine the antitumor activity, a blood sample was taken before and after exposure to waves during the experiment after exposure to "TOR" for 5 days. The percentage of inhibition of tumor growth was determined by the formula below. Determination of antitumor activity was carried out at the end of the experiment after exposure to the apparatus "TOR" for 5 days.

The percentage of inhibition of tumor growth was determined by the formula:

$$T\% = \frac{[Vc-Vo] \times 100;}{Vc}$$

Vc is the average mass of the tumor in the control,
Vo is the average mass of the tumor in the experiment;
- Determination of the apoptotic index:

$$AI\% = \frac{\text{number of cells in apoptosis} \times 100}{P}$$

P– the total number of cells

A general blood test and counting of the cellular element of peripheral blood was carried out in the clinical laboratory and the laboratory of tumor biology of the Institute of Oncology of the Ministry of Health of the Republic of Uzbekistan.

The results obtained and their discussion. According to the results of the experiment, they acted with an alternating field - modulation of the amplitude of the average frequency generated by the portable device "TOR" on tumor cells and tissues of rats with an implanted Walker tumor. After slaughtering the rats and obtaining tumor tissue, the apoptotic index was calculated. Thus, the analysis showed that mass cell death is not caused, but apoptosis of transformed cells and proliferation of immunocompetent cells are induced. Thus, inhibition of tumor growth by volume was 45.2%, by weight - 31.7% when comparing the experimental and intact (without exposure to TOR) groups of rats with an implanted Walker tumor.

Further an analysis of the hematological values of rats before and after exposure to electromagnetic radio waves on the tumor tissues of experimental animals was made. Initially, the hematological spectrum of rats with a grafted tumor was studied before exposure to an

alternating magnetic field. An analysis of hematological values before conducting an alternating magnetic field showed that basophilia, eosinophilia, neutropenia and lymphopenia were observed in the experimental group, all values were significant. After exposure to an alternating magnetic field, slight monocytosis, neutrophilia and lymphocytes are observed within the normal range. If we make a comparison, then in the group without exposure to the TOR device with a tumor process, basophilia, eosinophilia, myelocytosis, neutrophilia and lymphopenia are observed. The data we received were all reliable.

Further the number of immunocompetent cells was studied, so the analysis of immunocompetent cells showed that there was a 2-fold increase in neutrophil activity compared to the data before and without exposure to an alternating magnetic field, as well as an increase in the phagocytic potential and functional heterogeneity of granulocytes. Effector leukocytes were also increased 2.1 times.

Conducting biochemical studies did not reveal reliable results with and without exposure to an alternating magnetic field on tumor tissues.

Therefore, we set a goal to study the antitumor effect of exposure to an alternating magnetic field on the body in an experiment with the study of hematological parameters of animals. It is shown that basophilia, eosinophilia, neutropenia and lymphopenia are observed in the experimental group. After exposure to an alternating magnetic field, slight monocytosis, neutrophilia and lymphocytes are normal. The number of immunocompetent cells increased and there was a 2-fold increase in neutrophil activity compared to the data before and without exposure to an alternating magnetic field, as well as an increase in the phagocytic potential and functional heterogeneity of granulocytes. Effector leukocytes were also increased 2.1 times. After electromagnetic exposure, the indicators characterizing the activity and / or functional potential of leukocytes in peripheral blood become higher than in the experiment without exposure to radio waves ($p<0.05$).

Moreover, we have shown that the antitumor effects of electromagnetic effects are accompanied by a visually more significant infiltration of the tissue and the peripheral zone of transplanted tumors by leukocyte cells compared to tissues without the use of alternating magnetic radio waves.

After the slaughter of animals exposed to electromagnetic radio waves, signs of intercellular interactions are observed in the spleen. An increase in the number of macrophages with activated lymphocytes in the red pulp of the spleen by 1.6 times ($p<0.05$) was noted. Therefore, with the help of elementary hematological studies, we see significant changes that may clarify some understanding of the mechanisms of the antitumor effect after exposure to an alternating magnetic field on tumor tissues. Thus, the possibility of exposure to electromagnetic radio waves for the purposes of clinical oncology remains one of the urgent tasks of medicine. So, from a fairly large number of works devoted to the influence of electromagnetic fields on the development of tumors, an ambiguous, and in some cases contradictory idea is formed about when electromagnetic fields will have an inhibitory or suppressive effect on a tumor, and when it can initiate or stimulate the process of carcinogenesis. The versatility of the effect of electromagnetic fields on an organism with a tumor is realized due to various mechanisms of interaction with biological structures at all levels of organization and is largely due to their influence on molecular processes and other functions in the tumor cell. So, for the practical application of electromagnetic fields in oncology, a scientifically based idea of their biological effect both on the tumor and on the activation of regenerative processes at the level of the whole organism is important. Despite the large number of existing studies, there is no unambiguous information about the mechanisms of the antitumor effect of electromagnetic fields, questions about the mechanisms of physiological effects remain unclear or controversial, and this determines the prospects for their further study.

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