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CARCINOGENIC EFFECTS OF THE ACTION OF IONIZING RADIATION IN SMALL DOSES

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Abstract. This article deals with the carcinogenic effects of low dose ionizing radiation. From the point of view of molecular events in the genetic material, exposure to any low dose increases the likelihood of future malignancies, which argues in favor of the no-threshold concept.

Keywords: dose-response curve, ionizing radiation, carcinogenic effects, epidemiological data, radiation carcinogenesis.

Аннотация. В этой статье рассматриваются канцерогенные эффекты малых доз ионизирующего излучения. С точки зрения молекулярных событий в генетическом материале воздействие любой низкой дозы увеличивает вероятность возникновения злокачественных новообразований в будущем, что говорит в пользу беспороговой концепции.

Ключевые слова: кривая доза-эффект, ионизирующее излучение, канцерогенные эффекты, эпидемиологические данные, радиационный канцерогенез.

The most important issue in the problem of medical consequences of the action of ionizing radiation in small doses is the question of whether the number of cases of malignant neoplasms increases after irradiation in such doses. There are two opposite points of view on this problem, which are associated with two currently existing concepts of induction of radiogenic tumors: non-threshold and threshold. When accepting a non-threshold concept, the question arises - what is the shape of the dose-effect curve in the region of low doses: linear or not, and if it is linear, then does it coincide with the one obtained by extrapolation (continuation of the curve) obtained with irradiation at high doses. If the induction of malignant neoplasms has a threshold, then the question also arises:

starting from what dose does the threshold in tumor induction end? At present, there is very little reliable evidence to support either view, but the biological effects of low-dose irradiation cited above make it possible to choose the more preferable of them. An increase in the risk of developing malignant neoplasms is associated with disturbances in oncogenes and antioncogenes. At the same time, the former increase their activity (expression), while the latter, on the contrary, reduce the expression or “give out” the information spoiled by the mutation, which leads to the synthesis of an inactive product - a protein. Molecular changes leading to dysfunctions of anti- and oncogenes can in principle also be caused as a result of a single track of an ionizing particle passing through the nucleus of a somatic cell.

Therefore, from the point of view of molecular events in the genetic material, irradiation at any low dose increases the probability of the occurrence of malignant neoplasms in the future, which testifies in favor of the no-threshold concept. However, it is clear that this statement is only circumstantial evidence. The main sources of information about the real carcinogenic effects of low-dose irradiation are epidemiological data and studies of radiation carcinogenesis in experimental animals. The reliability of the results obtained in studies is determined by the sample size and homogeneity of the irradiated and control populations of animals and humans, and in epidemiological observations and its duration. Long-term observations of persons irradiated in small doses as a result of the Chernobyl accident showed that liquidators (average absorbed dose of about 100 mGy) have a statistically significant increase in the occurrence of leukemia, and children living in contaminated areas, including those in whom the thyroid gland is irradiated in a small dose, an increase in the development of thyroid cancer. Therefore, these "Chernobyl effects" can be considered as evidence in favor of the no-threshold concept, although the presence of a threshold in the lower range of low doses cannot be ruled out. With regard to the minimum dose at which a carcinogenic effect can be observed in animal

experiments, according to UNSCEAR experts, it is also unlikely to detect a statistically significant increase in the number of malignant neoplasms at total absorbed doses below 100 mGy (for rare ionizing radiation). Therefore, up to the present time, based on the results of studies, a variety of conclusions have been made about the nature of the dose-effect curves for the induction of malignant neoplasms when irradiated at low doses: development of tumors in comparison with the control level;

• the induction of tumor development increases with dose, and the yield of malignant neoplasms per dose unit is much higher than with high doses of irradiation;

•there is an excess of the occurrence of tumors compared to the control level at any low dose, however, the dependence of the yield on the dose in a small dose range is non-monotonic, and has one or possibly more maxima. Thus, from the information about the biological effects of exposure to low doses, it follows that the manifestation of most effects is associated with an influence on the frequency of mutagenesis in somatic cells, which is directly related to carcinogenesis - the more mutant cells in the body, the more often and earlier malignant neoplasms occur. Two well-known observations testify in favor of this conclusion:

• the vast majority of mutagens are carcinogens;

• in humans and animals with hereditary diseases that manifest themselves in the development of genome instability (leading to an increase in the number of mutant somatic cells in the body), a variety of malignant tumors appear very early and in a large number of cases. The occurrence of mutations in certain genes is a key initiating event in the transformation of a normal cell into a malignant one. However, it is now generally accepted that one mutation is usually not enough to induce a tumor, and the occurrence of most neoplasms requires the occurrence of several more mutations in the cell genome. Thus, in a malignant cell, two, three, and, probably, for the induction of some malignant tumors, and more mutations in certain genes must be present at once. Consequently, by changing the frequency

of occurrence of new mutations in the genome of the descendants of irradiated individuals, the probability of the emergence of cells with the required number of mutated genes that control the process of “malignancy” of somatic cells can either increase or decrease. Irradiation in small doses leads to the induction of a number of processes, both contributing to the emergence of new mutant cells - genome instability, the bystander effect, and preventing their appearance - an adaptive response. Which process is predominant is currently unknown. Since the development of effects does not depend much on the dose in a wide range of doses, not all irradiated cells respond to irradiation at low doses and their number is different in different groups of people and animals examined. It is hardly possible to expect the establishment of strict numerical values of the risks of developing tumors from the radiation dose, as was done for cases of exposure to radiation at high doses, and the absence or presence of a dependence of the incidence of tumors on the radiation dose in the range of low doses, probably, cannot serve as a criterion for conclusions about the radiogenic origin of malignant tumors. The greatest influence on the number of induced tumors in one or another group of exposed people is likely to be exerted by the development of genome instability. It is obvious that the number of mutant cells in the body is an integral indicator of the manifestation of all the effects described above in each given person in response to exposure to a low dose, and the assessment of the frequency of mutant cells will probably allow predicting the carcinogenic effect of radiation in the future. Direct evidence of the induction of malignant diseases was obtained with irradiation at doses of about 100 mGy. When irradiated at lower doses, obtaining direct evidence of the development of an additional number of malignant tumors is hardly possible due to the limited number of individuals in the cohorts of exposed people and experimental animals. Indirect evidence suggests that the carcinogenic effect of irradiation does not have a threshold at low doses. Dependence of the development of tumors on the radiation dose in different exposed groups may differ, and the absence or presence of such a

dependence, apparently, cannot serve as a criterion for the radiogenic origin of tumors. For any kind of dependence of the incidence of tumors on the radiation dose, the number of radiogenic tumors that occur when exposed to low doses of radiation is much less than the number of malignant neoplasms induced by high doses of radiation. Among those exposed to low doses, individuals with a high frequency of mutant somatic cells are likely to constitute a risk group for the development of malignant neoplasms.

References:

1. Radiation hygiene. Workshop. Textbook / Arkhangelsky V.I., Kirillov V.F., Korenkov I.P. - M.: "GEOTAR-Media", 2015.

2. Physical foundations of radiation technologies. Textbook / Obodovsky I.M. – M.: ID Intellect, 2014.

. Radiation hygiene. Textbook for universities / Ilyin L.A., Kirillov V.F., Korenkov I.P. - M.: "GEOTAR-Media", 2010.