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HEMATOLOGICAL CHANGES IN DESCENDANTS OF ANIMALS IRRADIATED IN DIFFERENT DOSES

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Abstract

An urgent problem today is not only the study of changes in the stability of the genome of somatic cells, the clarification of the mechanisms of its destabilization under the influence of a complex of environmental factors, including radiation, but also the study of the possibility of hereditary transmission of these changes. In the modern experimental and clinical medicine, the most important problem is the harmful effect of ionizing radiation on the descendants of irradiated parents and the specifics of the effect of radiation on the developing organism. An important aspect of the problem of long-term post-radiation effects is the state of reproductive function and health of the descendants of the irradiated population, due to the physiological characteristics inherent to the mother and child - high sensitivity to the action of ionizing radiation, the consequences of which may manifest after a long period of imaginary well-being. The purpose of the work is to investigate the dynamics of body weight and hematological indiexes in the descendants of intact sexually mature animals and descendants born to animals irradiated at different doses, which were exposed to radiation at a dose of 1.0 Gy. The authors revealed that in descendants born to animals irradiated at different doses,

which were exposed to radiation at a dose of 1.0 Gy, it was established that by the 30th day after irradiation at a dose of 1.0 Gy, the general condition of pup rats born from animals irradiated at a dose of 0.5 Gy and exposed to irradiation at a dose of 1.0 Gy is satisfactory against the background of an insignificant decrease in the body weight. This also applies to pup rats born to animals irradiated at a dose of 1.0 Gy, whose general condition slightly improves compared to the previous period of the study. The data obtained showed in the peripheral blood after 1 day in the descendants born to animals irradiated at a dose of 0.5 Gy, after irradiation at a dose of 1.0 Gy, a reduced content of hemoglobin and erythrocytes against the background of an increase in the content of platelets, leukocytes, lymphocytes and reticulocytes in comparison with non-irradiated animals, which was maintained throughout the experiment. Pronounced changes in hematological parameters were observed in the descendants born to animals irradiated at a dose of 1.0 Gy, which were exposed to total γ-irradiation at a dose of 1.0 Gy. The authors suppose their data are in favour of the pronounced adaptationof organisms' regulatiory systems to ionizing irradiation effect that, firstly, outline the adaptative physiologcal mechanisms and, secondly, show the main launches of pathophysiologcial mechamisns in case of irradiation-induced hematological changes.

Key words: ionizing irradiation; irradiated animals; decendants; body weight; hematological indexes; adaptation; pathophysiological mechanisms

An urgent problem today is not only the study of changes in the stability of the genome of somatic cells, the clarification of the mechanisms of its destabilization under the influence of a complex of environmental factors, including radiation, but also the study of the possibility of hereditary transmission of these changes. Until now, a number of experimental and epidemiological data have been accumulated, which indicate the possibility of increased instability of the genome in the descendants of irradiated parents [4, 9, 15-17].

In the modern experimental and clinical medicine, the most important problem is the harmful effect of ionizing radiation on the descendants of irradiated parents and the specifics of the effect of radiation on the developing organism [5, 7].

An important aspect of the problem of long-term post-radiation effects is the state of reproductive function and health of the descendants of the irradiated population, due to the physiological characteristics inherent to the mother and child - high sensitivity to the action of ionizing radiation, the consequences of which may manifest after a long period of imaginary well-being. Not only the dose, but also the radiosensitivity of cells plays its role in the development of this or that pathology. The greatest radiosensitivity is characteristic of cells

that are capable of intense division. Since it is known that the greatest proliferative activity is characteristic of the fetus, it is quite obvious how dangerous the exposure to radiation of a mother who is carrying a child occurs to be. Irradiation at various periods after fertilization causes the greatest damage to those groups of cells which at the time of radiation ensured the formation of one or another organ [3]. Studying the effects of radiation on the physiological integrity of the offspring requires special attention.

The effect of small doses is a fundamentally new way of radiation effect on living systems, new mechanisms for changing cellular metabolism. One of the objective signs of the action of ionizing radiation is the determination of body weight and biochemical indicators of blood.

The aim of the work is to investigate the dynamics of body weight and hematological indicators in the descendants of intact sexually mature animals and descendants born to animals irradiated at different doses, which were exposed to radiation at a dose of 1.0 Gy.

Material and Methods

The studies were conducted on 1-month-old pup rats weighing 38-42 g, born intact and irradiated at doses of 0.5 and 1.0 Gy to animals kept on a standard vivarium diet. Keeping, processing of the animals and manipulations with them were carried out in accordance with the "General Ethical Principles of Animal Experiments" adopted by the Fifth National Congress on Bioethics (Kyiv, 2013), guided by the recommendations of the European Convention on the Protection of Vertebrate Animals for Experimental and Other Scientific Purposes (Strasbourg, 1985), the methodological recommendations of the State Expert Center of the Ministry of Health Ukraine "Preclinical studies of drugs" (2001) and the rules of humane treatment of experimental animals and conditions approved by the Bioethics Commission of the Odesa National Medical University (protocol No. 32D dated 03/17/2016). To conduct the experiment, sexually mature animals were exposed to a single total gamma irradiation of ^{60}Co in the morning on an empty stomach using «Agat» telegammatherapy unit, distance to the absorption source was 75 cm, the dose rate was 0.54 Gy/min, absorbed dose was 0.5 Gy; 1.0 Gy. For irradiation, the animals were placed in a special chamber made of organic glass with dimensions of 20 x 20 x 6 см, separated by partitions according to the size of the animals.

The biostatus of the animals was assessed by changes in mobility, attitude to food, cleanliness reflex, state of fur, mucous membranes, and gastrointestinal tract. Animals were mated within 10 days after irradiation. Keeping pregnant females in exchange cages allowed constant monitoring. To obtain offspring from irradiated animals in vivarium conditions, up to

2 irradiated males at the age of 4-5 months were placed with 10 females of the same age, irradiated at the same dose. Pregnant females were selected every morning based on the analysis of vaginal smears and placed in individual cages for parturition [2]. On the day of delivery, the number of pup rats born to each female was counted, a month later the number of pup rats that reached 1 month of age was counted again, general developmental abnormalities were determined. Pup rats were taken to the experiment at the age of 1 month.

The animals were divided into groups as follows:

1. 1-month-old pup rats obtained from intact animals.

2. 1-month-old pup rats obtained from animals irradiated at a dose of 0.5 Gy, which were exposed to irradiation at a dose of 1.0 Gy.

3. 1-month-old pup rats obtained from animals irradiated at a dose of 1.0 Gy, which were exposed to irradiation at the same dose.

There were 6-10 animals in each group.

Animals were removed from the experiment by euthanasia under propofol (IV, 60 mg/kg) anesthesia. After the animals were dissected, blood was collected, the heart and the anterior group of thigh muscles were removed. Blood was centrifuged at 3000 g for 10 minutes to obtain serum. Blood serum was used for biochemical studies.

We focused our attention on the determination of body weight dynamics and hematological indicators in the descendants of intact sexually mature animals and descendants born to animals irradiated at different doses, exposed to radiation at a dose of 1.0 Gy.

To determine the content of formed blood elements in blood serum, blood was taken from the tail vein of animals, which allowed to observe the dynamics of changes in the same animals during 30 days of observation [6]. The proposed method of determining the blood protein content has the advantage in requiring micro-quantities of blood that can be obtained from the tail vein of animals and does not require to kill the animals. This allows to objectively record the biostatus (formed elements) of the same animals throughout the entire period of the experiment, which is very important in the study of a pathological process.

The obtained data were subjected to statistical processing by the method of estimating the average with the help of "T-tables" using the χ^2 criterion and computer programs. The minimum statistical probability was determined at $p<0.05$.

Results

The conducted studies showed that one day after irradiation at a dose of 1.0 Gy, the descendants born to animals irradiated at a dose of 0.5 Gy and 1.0 Gy are outwardly no different from intact ones against the background of an insignificant decrease in body weight .

They are mobile, their fur is smooth, their mucous membranes are pink, they eat food well, and no disorders of the gastrointestinal tract and urinary system were detected (Tables 1 and 2).

Table 1

Dynamics of body weight of descendants born to animals irradiated at a dose of 0.5 Gy and exposed to irradiation at a dose of 1.0 Gy

Body weight of animals (M±m), g							
After irradiation at a dose of 1.0 Gy on the					Intact animals on the		
1 day, n=10	3 days, n=10	7 days, n= 9	15 days, n= 8	30 days, n= 8	1 day, n=10	15 days, n=10	30 days, n=10
48.6 ± 1.4	46.8 ± 1.2	47.4 ± 1.6	72.8 ± 2.3*	92.4 ± 1.5*	52.4 ±1.2	74.6 ± 2.2*	96.2 ± 1.8*

Note. * - P<0.05 – probable differences in the studied indicators compared to the corresponding data at the beginning of the observation.

Table 2

Dynamics of body weight of descendants born to animals irradiated at a dose of 1.0 Gy, exposed to irradiation at a dose of 1.0 Gy

Body weight of animals (M±m), g							
After irradiation at a dose of 1.0 Gy on the					Intact animals on the		
1 day, n=10	3 days, n=9	7 days, n=8	15 days, n=7	30 days, n=6	1 day, n=10	15 days, n=10	30 days, n=10
42.2 ± 1.2*	38.4± 2.2**	37.8± 2.3**	65.8± 3.4* ###	82.8± 2.6*** ###	52.4±1.2	74.6 ± 2.2*	96.2 ± 1.8*

Notes:

1. * - P<0.05, ** - P <0.01 and *** - P <0.001 - probable differences in the studied indicators compared to the corresponding data at the beginning of the observation;

2. ### - P <0.001 – probable differences in the studied indicators compared to such indicators in intact animals of the same age .

On the 3rd day, pup rats irradiated at a dose of 1.0 Gy, born to animals irradiated at a dose of 0.5 Gy, outwardly do not differ from intact animals against the background of an

insignificant decrease in body weight, in contrast to pup rats irradiated at a dose of 1.0 Gy, born to animals irradiated at a dose of 1.0 Gy, which are depressed, their fur is disheveled, their appetite deteriorates, there is a significant decrease in the body weight of the animals compared to the initial values, but to a greater extent compared to intact animals of the same age. It should be noted that after the 3rd day out of the total number of rats exposed to radiation at a dose of 1.0 Gy, 1 animal died.

7 days after irradiation, pup rats born to animals irradiated at a dose of 0.5 Gy have a poor appetite, are depressed, and a slight decrease in the body weight is observed. On the 7^{th} day, out of the total number of pup rats born to animals irradiated at a dose of 0.5 Gy and exposed to radiation at a dose of 1.0 Gy, 1 animal died. Rats born to animals irradiated at a dose of 1.0 Gy, 7 days after irradiation at a dose of 1.0 Gy, are lethargic, eat food poorly, there is a steady decrease in weight compared to intact animals of the same age, disorders of the gastrointestinal tract, mucous membranes are pale. It should be noted that on the 7th day out of the total number of pup rats born to animals irradiated at a dose of 1.0 Gy and exposed to radiation at a dose of 1.0 Gy, 2 animals died.

On the 15^{th} day after exposure, the general condition of pup rats born to animals irradiated at a dose of 0.5 Gy remains unchanged, in contrast to rats born to animals irradiated at a dose of 1.0 Gy, whose condition continues to be poor. Animals are depressed, appetite is poor, weight is decreased. During the period from the 7th to the 15^{th} day after irradiation, from the total number of pup rats born to animals irradiated at a dose of 0.5 Gy and 1.0 Gy, one in each group died.

By the 30^{th} day after irradiation at a dose of 1.0 Gy, the general condition of pup rats born to animals irradiated at a dose of 0.5 Gy is satisfactory against the background of an insignificant decrease in the body weight. This also applies to pup rats born to animals irradiated at a dose of 1.0 Gy, whose general condition slightly improves compared to the previous period of the study, however, compared to intact animals of the same age, the weight of pup rats to animals irradiated at a dose of 1.0 Gy after exposure is much lower.

In the peripheral blood, one day later, in the descendants born to animals irradiated at a dose of 0.5 Gy, after irradiation at a dose of 1.0 Gy, a slightly reduced content of hemoglobin and erythrocytes was observed against the background of an increase in the content of platelets, leukocytes, lymphocytes, and reticulocytes compared to non-irradiated animals (Table 3).

Table 3.

Hematological indicators of descendants born to animals irradiated at a dose of 0.5 Gy, exposed to irradiation at a dose of 1.0 Gy

The investigated indexes	Intact rats, n=10	Irradiated rats on the				
		1 day, n=10	3 days, n=10	7 days, n=9	15 days, n=9	30 days, n=9
Hemoglobin, g/l	92.34 ± 0.72	90.76 ± 0.71	89.27± 0.69*	87.96± 0.68*	84.28± 0.67*	87.56± 0.68*
Erythrocytes, 10^{12}/l	4.22±0.24	3.98 ± 0.21	3.82 ± 0.13	3.65 ± 0.17	3.57± 0.14*	3.76 ± 0.17
Reticulocytes, %	28.6±1.96	28.9 ± 1.92	27.4 ± 1.88	26.8 ± 1.86	25.3 ± 1.84	27.2 ± 1.91
Platelets, 10^{9}/l	647±30.2	672.4 ± 42.1	646.3 ± 38.4	627.2 ± 34.8	621.4 ± 27.5	656.1 ± 29.3
Leukocytes, 10^{9}/l	11.43 ± 0.74	15.42± 0.92*	14.62 ± 0.90*	12.26 ± 0.54	11.72 ± 0.52	10.45 ± 0.64
Lymphocytes, %	41.6±3.8	43.2± 3.7	46.8± 3.2	44.6± 2.8	55.9± 2.4*	38.6± 1.8

Note. * - P<0.05 – probable differences in the studied indicators compared to the corresponding indicators in intact animals.

On the 3rd day after exposure, the amount of hemoglobin continued to decrease, which was significantly lower compared to non-irradiated animals. Along with this, there was a tendency to decrease erythrocytes, reticulocytes, leukocytes, platelets against the background of an increase in lymphocytes. And, if the content of erythrocytes, reticulocytes, platelets was somewhat lower compared to non-irradiated rats, the content of leukocytes, despite the decrease, remained higher compared to this indicator in non-irradiated animals.

7 days after irradiation, a significant decrease in the hemoglobin content is observed in the blood, against the background of an unreliable decrease in erythrocytes, reticulocytes, and platelets. In addition, there was a tendency to a decrease in leukocytes and lymphocytes, but this indicator still exceeded the similar indicator in intact animals by 2.5% and 11.2%, respectively.

On the 15th day, the absolute content of formed elements in the blood was noticeably reduced, with the exception of leukocytes, the content of which remained somewhat higher, against the background of the increase in the content of lymphocytes, which exceeded the indicator in intact animals by 13.4%.

By the 30th day, the cellular composition of the blood improves slightly, but the content of formed elements is still significantly lower than in intact animals, with the exception of platelets, the content of which is slightly higher than in intact animals.

More profound changes in hematological indicators were observed in descendants born to animals irradiated at a dose of 1.0 Gy, which were exposed to total γ-irradiation at a dose of 1.0 Gy.

In the peripheral blood 1 day after irradiation at a dose of 1.0 Gy, a slightly reduced content of hemoglobin, erythrocytes and reticulocytes was observed in comparison with non-irradiated animals with a slight increase in platelets and a significant increase in leukocytes (Table 4).

Table 4.

Hematological indicators of the descendants born to animals irradiated at a dose of 1.0 Gy, exposed to irradiation at a dose of 1.0 Gy

The investigated indexes	Intact rats, n=10	Irradiated rats on the				
		1 day, n=10	3 days, n=10	7 days, n=9	15 days, n= 7	30 days, n= 8
Hemoglobin, g/l	92.34 ± 0.72	90.28 ± 0.69	82.73± 0.67*	79.96± 0.62*	62.49± 0.56*	76.16± 0.58*
Erythrocytes, 10^{12}/l	4.22±0.24	3.82 ± 0.19	3.69 ± 0.17	3.47± 0.16*	2.26± 0.12*	3.25± 0.14*
Reticulocytes, %	28.6±1.96	27.9 ± 1.94	25.7 ± 1.84	23.2 ± 1.82	18.4 ± 1.76*	29.1 ± 1.96
Platelets, 10^{9}/l	647.0 ± 30.2 _	653.2 ± 43.4	598.5 ± 39.2	497.6 ± 35.3*	461.7 ± 27.8*	439.7± 21.8*
Leukocytes, 10^{9}/l	11.43± 0.74	15.22± 0.91*	12.36 ± 0.94	10.24 ± 0.58	8.31± 0.36*	9.88 ± 0.54
Lymphocytes, %	41.6±3.8	37.8± 3.6	44.7± 3.1	43.9± 3.0	32.6± 1.8	40.2± 2.1

Note. * - P<0.05 – probable differences in the studied indicators compared to the corresponding indicators in intact animals.

The content of lymphocytes on the 1st day after irradiation decreased in contrast to this indicator in descendants born to animals irradiated at a dose of 0.5 Gy, which were exposed to

irradiation at a dose of 1.0 Gy, where the content of lymphocytes, on the contrary, increased compared to this indicator in intact animals.

On the 3rd day after irradiation, the amount of hemoglobin, reticulocytes, and platelets reliably decreased with an unreliable decrease in erythrocytes. In addition, there was a tendency to a decrease in the content of leukocytes, although this indicator remained higher compared to the one in non-irradiated animals. Against the background of a decrease in most hematological indicators, an increase in lymphocytes by 10.7% was observed.

7 days after irradiation, a significant decrease in hemoglobin, reticulocytes and platelets is observed in the blood, with an unreliable decrease in erythrocytes and leukocytes compared to the corresponding indicators of non-irradiated animals. In addition, a decrease in lymphocytes was also observed, although this indicator still remained somewhat higher than the indicator in non-irradiated pup rats.

On the 15th day, the lowest indicators of hemoglobin and formed elements in the blood are observed.

By the 30th day, the cellular composition of blood improves slightly, but the content of formed elements is still significantly lower than in intact animals, with the exception of reticulocytes, the content of which is slightly higher than in intact ones.

Discussion

An important aspect of the problem of long-term post-radiation effects is the state of reproductive function and health of the descendants of the irradiated population, due to the physiological characteristics inherent to the mother and child - high sensitivity to the action of ionizing radiation, the consequences of which may manifest after a long period of imaginary well-being [13]. We want to atress that these experiomental trials are the sequence of the preliminary which showed muscle tissue metablism depress after ionizing irradiaton [14]. Hence, the analogous diection of the results we heve receiedalso in these trials. Therefore, studying the effects of radiation on the physiological well-being of descendants requires special attention.

Under a single, and even more so, chronic exposure to small doses of radiation the mechanisms of radiogenic changes formation in the hematopoietic system are more complex than under the influence of sublethal and lethal doses, and still do not have a definitive interpretation. The further accumulation of experimental material under conditions close to natural ones that have developed in radiation-contaminated areas after the accident at the Chernobyl nuclear power plant can contribute to the resolution of this issue [1]. The results of such studies are a necessary basis for creating a new concept of the mechanism for the

implementation of small doses of radiation. In addition, the totality of this information will make it possible to determine the contribution of radiogenic changes in the hematopoietic system to the formation of certain diseases determined by the radiation factor.

The interesting siution with our data discussion is the following that we have found linited amount of the analogous scientific literature abroad. We suppose that this is due to complete absence nuclear disasters throughoutn the world like it was in Chernobyl, Ukraine. The onluy one fact that approaches our investigations to the well-known is the low dose ionizing radiation schemes of chemotherapy in case of cancer [10, 12].

If we take into account that the descendants born to animals irradiated at small doses are exposed to radiation, then we should expect deeper changes in the blood system. As a result of the research, we established interesting points regarding changes in hematological indicators in the descendants of intact sexually mature animals and descendants born to animals irradiated at different doses, which were exposed to radiation at a dose of 1.0 Gy.

In the peripheral blood after 1 day in descendants born to animals irradiated at a dose of 0.5 Gy, after irradiation at a dose of 1.0 Gy a slightly reduced content of hemoglobin and erythrocytes was observed against the background of an increase in the content of platelets, leukocytes, lymphocytes and reticulocytes compared to non-irradiated animals.

On the 3rd day after the exposure to radiation, the amount of hemoglobin continued to decrease, which was significantly lower compared to non-irradiated animals. Along with this, there was a tendency to a decrease in erythrocytes, reticulocytes, leukocytes, platelets against the background of an increase in lymphocytes.

And, if the content of erythrocytes, reticulocytes, platelets was slightly lower compared to the one in non-irradiated rats, the content of leukocytes, despite the decrease, remained higher compared to this indicator in non-irradiated animals. 7 days after irradiation, a significant decrease in the hemoglobin content was observed in the blood, against the background of an unreliable decrease in erythrocytes, reticulocytes, and platelets. In addition, a tendency to a decrease in leukocytes and lymphocytes was observed, but this indicator still exceeded the similar indicator in intact animals by 2.5% and 11.2%, respectively.

On the 15th day, the absolute content of formed elements in the blood was noticeably reduced, with the exception of leukocytes, the content of which remained somewhat higher, against the background of an increase in the content of lymphocytes, which exceeded the indicator in intact animals by 13.4%.

By the 30th day, the cellular composition of the blood slightly improved, but the content of formed elements was still significantly lower than in intact animals, with the exception of platelets, the content of which is slightly higher than in intact animals.

Approximately the same chages were registered in case of blood irradiation which might have harmful effects if transfused [8]

More profound changes in hematological indicators were observed in descendants born to animals irradiated at a dose of 1.0 Gy, which were exposed to total γ-irradiation at a dose of 1.0 Gy.

In the peripheral blood 1 day after irradiation at a dose of 1.0 Gy, a slightly reduced content of hemoglobin, erythrocytes and reticulocytes was observed in comparison with non-irradiated animals with a slight increase in platelets and a significant increase in leukocytes. The content of lymphocytes on the 1st day after irradiation decreased in contrast to this indicator in descendants born to animals irradiated at a dose of 0.5 Gy, which were exposed to irradiation at a dose of 1.0 Gy, where the content of lymphocytes, on the contrary, increased compared to this indicator in intact animals.

On the 3rd day after irradiation, the amount of hemoglobin, reticulocytes, and platelets reliably decreased with an unreliable decrease in erythrocytes. In addition, there was a tendency to decrease the content of leukocytes, although this indicator remained higher compared to non-irradiated animals. Against the background of a decrease in most hematological indicators, an increase in lymphocytes by 10.7% was observed.

7 days after irradiation, a significant decrease in hemoglobin, reticulocytes, and platelets was observed in the blood, with an unreliable decrease in erythrocytes and leukocytes compared to the corresponding values of non-irradiated animals. In addition, a decrease in lymphocytes was also observed, although this indicator still remained somewhat higher than the indicator in non-irradiated pup rats.

On the 15th day, the lowest indicators of hemoglobin and formed elements in the blood were observed. By the 30th day, the cellular composition of the blood slightly improves, but the content of formed elements is still significantly lower than in intact animals, with the exception of reticulocytes, the index of which is slightly higher than in intact animals.

To compare our results we choose the work outlined widespread changes in blood counts, with the most severe effects related to leukopenia after high dose radiation during the chemotherapy [11].

Conclusions

The obtained data highlighted interesting points regarding changes in the dynamics of body weight and hematological indicators in the descendants of intact sexually mature animals and descendants born to animals irradiated at different doses, which were exposed to radiation at a dose of 1.0 Gy.

When studying the effects of radiation on the physiological health of descendants born to animals irradiated at different doses, which were exposed to radiation at a dose of 1.0 Gy, it was established that by the 30th day after irradiation at a dose of 1.0 Gy, the general condition of pup rats born from animals irradiated at a dose of 0.5 Gy and exposed to irradiation at a dose of 1.0 Gy is satisfactory against the background of an insignificant decrease in the body weight. This also applies to pup rats born to animals irradiated at a dose of 1.0 Gy, whose general condition slightly improves compared to the previous period of the study, however, compared to intact animals of the same age, the weight of pup rats born to animals irradiated at a dose of 1.0 Gy after exposure is much lower.

Under a single, and even more so, chronic exposure to small doses of radiation the mechanisms of radiogenic changes formation in the hematopoietic system are more complex than under the influence of sublethal and lethal doses, and still do not have a definitive interpretation. If we take into account that the descendants born to animals irradiated at small doses are exposed to radiation, then we should expect deeper changes in the blood system.

In the peripheral blood after 1 day in the descendants born to animals irradiated at a dose of 0.5 Gy, after irradiation at a dose of 1.0 Gy, a reduced content of hemoglobin and erythrocytes was observed against the background of an increase in the content of platelets, leukocytes, lymphocytes and reticulocytes in comparison with non-irradiated animals, which was maintained throughout the experiment, however, by the 30^{th} day of the trial, we registered a marked reduction in the hemoglobin content.

Pronounced changes in hematological parameters were observed in the descendants born to animals irradiated at a dose of 1.0 Gy, which were exposed to total γ-irradiation at a dose of 1.0 Gy. During the entire observation period, the hemoglobin content was less than the corresponding control indicators, the number of erythrocytes and platelets was also significantly less than normal indicators.We suppose our data are in favour of the pronounced adaptationof organisms' regulatiory systems to ionizing irradiation effect that, firstly, outline the adaptative physiologcal mechanisms and, secondly, show the main launches of pathophysiologcial mechamisns in case of irradiation-induced hematological changes.

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Conceptualization, (Stepanov G.F. & Vastyanov R.S.); methodology, (Stepanov G.F. & Mokriienko E.M.); formal analysis, (Kostina A.A.); data curation, (Lazor N.V.); writing—original draft preparation, (Lazor N.V.); writing—review and editing, (Kostina A.A. & Mokriienko E.M.); supervision (Stepanov G.F. & Vastyanov R.S.).

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Institutional Review Board Statement

The experimental studies were carried out in the conditions of a chronic experiment in accordance with international standards of humane treatment of vertebrate animals and approved by the Ethics Committee of Odesa National Medical University (N7/21, 11 October 2021)

Informed Consent Statement

The data of experimental studies are given. Written informed consent from the patients was not necessary to publish this paper.

Data Availability Statement

The data presented in this study are available on request from the corresponding author.

Conflicts of Interest

The authors declare no conflict of interest.