REACTION OF THE HEMATOPOIETIC SYSTEM TO BLOOD LOSS IN THE LATE PERIOD AFTER RECOVERY FROM ACUTE RADIATION SICKNESS

N. I. Shmeleva

UDC 616-001.28-036.11-036.82-06:616-005.1]-07:616.155.1-07

The initial quantitative relationship between cell groups in the erythroid population is restored more rapidly after blood loss in irradiated rats than in controls.

* * *

The object of this investigation was to study reactivity of the hematopoietic system of the irradiated animal in the late periods after recovery from radiation sickness.

EXPERIMENTAL METHOD

Experiments were carried out on 68 female rats receiving a single dose of whole-body irradiation of 500 rad on a type RUM-3 apparatus. Twelve months after irradiation, 25% of the total blood volume was withdrawn from the heart of the irradiated and control rats. Before and after blood loss the rate of recovery of the erythroid population of the blood was studied by a cytometric method using the "Celloscope" apparatus. In addition, at various times (from 1 to 30 days) after blood loss the erythrocyte count and hemoglobin concentration were investigated and reticulocytes were differentiated and counted. All differences given in the text are statistically significant ($P < 0.05$).

EXPERIMENTAL RESULTS

The reticulocyte response to blood loss 12 months after irradiation was less marked and shorter than in the control. Restoration of the erythrocyte count and hemoglobin concentration took place either at the same time as the controls or slightly faster than in the unirradiated animals. These results are in agreement with others described in the literature [1].

The cell population as a whole was divided into nine groups based on differences in diameter—from 10.3 to 4.7μ and below. According to the literature [4, 12], the youngest cells are large. The population as a whole can therefore naturally be regarded as a gradual transition from relatively young cells to relatively mature, in which each successive group of cells of smaller diameter is older than its predecessor. In control animals before blood loss the largest number of erythrocytes had a diameter of 5.4 μ. On the 3rd day after blood loss a definite redistribution of the cells in the population was found. The percentage of erythrocytes with diameters between 10.3 and 6.1 μ was increased. The number of cells with the smallest diameter was sharply reduced from 27 to 13%. This suggests rejuvenation of the cell composition. On the 5th, 7th, 12th, and 15th days after blood loss similar changes were observed. Rejuvenation of the blood composition was particularly conspicous on the 12th day. The largest number of erythrocytes had a diameter of 6.1 μ, and the number of cells with the smallest diameter was 9.6%. However, the total number of erythrocytes at this period was below normal.

Blood loss 12 months after irradiation also caused sharp changes in the relative proportions of cell groups. On the 3rd day after blood loss the largest number of erythrocytes was 6.1 μ in diameter instead of 5.4 μ, and the percentage of microcytes fell from 20.2 to 9. This pattern was observed on the 7th day. On the 12th day, when the erythrocyte count had reached normal, the initial ratio between number of cells

---

Laboratory of Radiation Genetics and Late Radiation Pathology, Central Roentgeno-Radiological Research Institute, Ministry of Health of the USSR, Leningrad (Presented by Active Member of the Academy of Medical Sciences of the USSR D. A. Biryukov). Translated from Byulleten' Éksperimental'noi Biologii i Meditsiny, Vol. 66, No. 10, pp. 21-23, October, 1968. Original article submitted November 11, 1966.

of different diameters was restored. Hence, in rats irradiated in the past, the rate of recovery of the initial quantitative relationship between cells of different diameters was much greater than in the control animals.

The smallest cells (microcytes) are known to be the most mature and they are affected by degenerative processes as a result of aging and death. Blood loss causes a sharp decrease in the number of microcytes, presumably by accelerating the processes of cell destruction. According to Ya. G. Uzhanskii [5-9], restoration of erythropoiesis after blood loss is accompanied by increased erythrodieresis, and the products of destruction of erythrocytes stimulate hematopoiesis. Our own findings completely agree with this view and confirm it. They also explain the prolonged hyperregeneration after blood loss in the control animals. According to published data [7], erythrocytes are damaged at the time of blood loss because of hypoxia. It may be postulated that these cells will be less viable, and that their destruction will stimulate hematopoiesis at a time when the body has no need of this stimulation. In our experiments a sudden decline in the number of microcytes, indicating intensive destruction, was observed on the 12th-15th day after blood loss, when the total number of erythrocytes was normal. An abnormally rapid destruction of erythrocytes at this period was combined with an increased number of reticulocytes in the peripheral blood. The reticulocytosis was observed until the 30th day after blood loss.

Blood loss 12 months after irradiation led to more rapid destruction of erythrocytes than in the control. By 24 h after blood loss the number of microcytes was only 45% of the original number compared with 66% in the control. Recovery of the disturbed equilibrium in the cell groups also took place faster than in the control. Whereas on the 12th-15th day after blood loss the number of cells with the smallest diameter in the unirradiated rats was only 35-37%, in the irradiated animals at these times after blood loss their number was 89-94%. The more intensive death of the microcytes, followed by their more rapid restoration were evidently connected with the diminished viability of the cells in the irradiated animal.

LITERATURE CITED

1. L. V. Bogatov, Investigation of the Functional State of the Blood System in Late Periods After Chronic Exposure to γ-Rays [in Russian], Candidate dissertation, Moscow (1965).
2. E. A. Dikovenko, in: Action of Ionizing Radiation on the Animal Organism [in Russian], Kiev (1958), p. 38.
3. E. A. Dikovenko and A. S. Petrova, Abstracts of Proceedings of an Extended Session of the Central Research Institute of Medical Radiology [in Russian], Leningrad (1961), p. 89.
4. A. D. Strzhizhovskii, Byul. Éksperm. Biol. i Med., No. 11, 102 (1962).
5. Ya. G. Uzhanskii, Role of Destruction of Erythrocytes in the Mechanism of Blood Regeneration [in Russian, Leningrad (1949).
6. Ya. G. Uzhanskii, Arkh. Pat., No. 6, 29 (1956).
7. Ya. G. Uzhanskii, Arkh. Pat., No. 6, 6 (1959).
8. Ya. G. Uzhanskii, Pat. Fiziol., No. 4, 52 (1960).
9. Ya. G. Uzhanskii, in: The Pathophysiology of Erythropoiesis [in Russian], Sverdlovsk (1965), p. 17.
10. N. I. Shmeleva, in: Problems in Radiobiology and Clinical Roentgeno-Radiology [in Russian], Leningrad (1966), p. 92.
11. L. A. Yakovleva, Comparative Investigation of Radiation Sickness and Its Sequelae [in Russian], Leningrad (1966).
12. M. Bessis, Cytology of the Blood and Blood-Forming Organs, New York (1956).
13. H. Kusano, Atombombenschläden, Berlin (1954).
14. R. D. Lange et al., Blood, 10, 312 (1955).
15. Fumio Hirose, in: Sequelae of the Atomic Bomb Explosion in Hiroshima [in Russian], Moscow (1960), p. 56.