EFFECT OF WHOLE-BODY γ-RAY IRRADIATION ON TISSUE PROTEIN SYNTHESIS

I. I. Ivanov* and V. V. Rudakov

UDC 612.015.348.015.36.014.482.4

Synthesis of water-soluble mammary gland tissue of lactating rats is undisturbed during the first hours after whole-body γ-ray irradiation even when large doses of irradiation are given (5000 R). In later periods of radiation sickness synthesis is sharply depressed despite the use of smaller doses of irradiation (600-900 R).

* * *

There are conflicting reports in the literature on disturbances of tissue protein synthesis after exposure to ionizing radiation. This applies both to data obtained in the first few hours after irradiation [1, 5, 6] and to data obtained at the time of marked manifestations of radiation sickness [3, 4].

The dynamics of incorporation of glycine-C^{14} into water-soluble tissue proteins of the lactating mammary gland (an organ with the highest intensity of protein synthesis) was studied at various times after whole-body γ-ray irradiation in doses of 600-5000 R.

EXPERIMENTAL METHOD

Experiments were carried out on 45 lactating rats. Altogether there were 5 series of experiments, with 9 rats in each series.

Series I consisted of control (not irradiated) animals.

In the experiments of series II the rats received whole-body γ-ray irradiation in a dose of 5000 R and incorporation of glycine-C^{14} was studied 4-5 h after irradiation.

In series III the experimental animals were irradiated in a dose of 600 R and incorporation of glycine-C^{14} into the tissue proteins of the mammary gland was investigated on the 7th day after irradiation.

In series IV and V the dose of irradiation was 900 and 1200 R respectively, and incorporation of the radioactive amino acid was studied 72 h after irradiation. The source of irradiation was a type ÉGO-2 apparatus (dose rate 2.75 R/sec). Glycine-C^{14} was injected intraperitoneally into all the animals in a dose of 0.1 μCi/g. The animals were sacrificed 20, 90, and 150 min after injection of the radioactive label. The mammary gland was homogenized in the cold, and to obtain water-soluble proteins the homogenate was extracted with 4 volumes of phosphate buffer (pH 7.4, ionic strength 0.03), at first for 3 h and later with a fresh portion of the same solution for 30 min at 3-4°. Proteins of the extract were precipitated with trichloroacetic acid (final concentration 10%), and the residue was repeatedly washed with trichloroacetic acid and water until nonradioactive filtrates were obtained. Lipids were removed with a mixture of alcohol and ether, followed by pure ether, and the residues were then dried. Radioactivity of the protein was determined in a thick layer on a type B-2 apparatus with a BFL-25 counter.

EXPERIMENTAL RESULTS

The experiments carried out can be divided into two principal groups: experiments to study the incorporation of glycine-C^{14} into water-soluble proteins of the mammary gland several hours after irradiation in a dose of 5000 R and experiments to study the incorporation of glycine-C^{14} into water-soluble pro-

*Corresponding Member, Academy of Medical Sciences of the USSR.

Department of Biochemistry, S. M. Kirov Military Medical Academy Leningrad. Translated from Byulleten' Éksperimental'noi Biologii i Meditsiny, Vol. 66, No. 12, pp. 47-49, December, 1968. Original article submitted December 29, 1967.

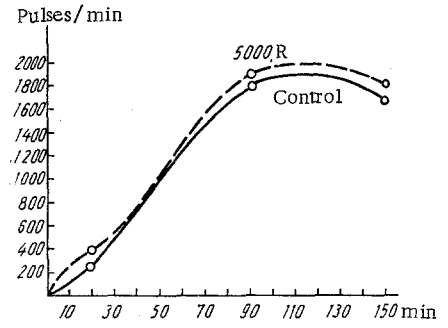

Fig. 1

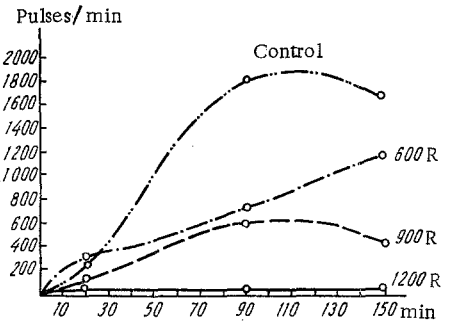

Fig. 2

Fig. 1. Incorporation of glycine-C^{14} into water-soluble tissue proteins of the mammary gland 5 h after γ-ray irradiation in a dose of 5000 R. Abscissa, time after injection of glycine-C^{14} (in min), ordinate, pulses/min (mean results of 3 experiments).

Fig. 2. Incorporation of glycine-C^{14} into water-soluble tissue proteins of the mammary gland 3-6 days after γ-ray irradiation in doses of 600, 900, and 1200 R. Abscissa, time after injection of glycine-C^{14} (in min), ordinate, pulses/min (mean results of 3 experiments).

teins of the mammary gland at a time of marked manifestations of radiation sickness. In addition, the intensity of incorporation of glycine-C^{14} into water-soluble proteins of the mammary gland of animals which were not irradiated was also determined. Comparable data for incorporation of glycine-C^{14} into mammary gland proteins of the control animals and 5 h after whole-body irradiation in a dose of 5000 R are given in Fig. 1. They show that the intensity of incorporation of radioactive label into water-soluble mammary gland proteins during the first few hours after irradiation in a dose of 5000 R was indistinguishable from the intensity of its incorporation in the group of unirradiated animals. The results of this series of experiments confirm data in the literature [5, 6] indicating that incorporation of radioactive amino acids into tissue proteins is undisturbed during the first few hours after irradiation. In our experiments, however, the animals received much larger doses of radiation (5000 R) than in the investigations cited above (1000-2000 R). These results are also in good agreement with those of our previous investigations [2] carried out on the isolated lactating mammary gland of goats, removed a few hours after local x-ray irradiation in a dose of 5000 R. These experiments showed that the synthesis of specific milk proteins from the tissue proteins of the mammary gland is undisturbed in the first few hours after irradiation.

The object of the next series of experiments was to study the intensity of incorporation of glycine-C^{14} into the tissue proteins of the lactating mammary gland in the period of marked manifestation of radiation sickness. Incorporation of glycine-C^{14} was investigated at the following times: 1) on the 7th day after irradiation in a dose of 600 R, 2) 72 h after irradiation in a dose of 900 R (in this series at the time of injection of glycine-C^{14} the mortality rate was 10%), and 3) in the terminal period of radiation sickness, 72 h after irradiation in a dose of 1200 R (in this series about 60% of the experimental animals had died at the time of injection of glycine-C^{14}). It will be clear from Fig. 2 that the intensity of incorporation of radioactive label into water-soluble proteins of the mammary gland tissue in the period of radiation sickness was much lower than the intensity of its incorporation into the same proteins of unirradiated animals. The decrease in incorporation of glycine-C^{14} into proteins depended on the dose given and the severity of the radiation damage. In the terminal period of radiation sickness incorporation of glycine-C^{14} into mammary gland proteins practically ceased.

Hence, comparison of the results of the first and second groups of experiments shows that the direct effect even of such large doses of whole-body irradiation as 5000 R does not disturb protein synthesis in the mammary gland tissue. Meanwhile, irradiation with much smaller doses leads to a sharp decrease in the intensity of incorporation of radioactive amino acid at later periods into the water-soluble proteins of the mammary gland tissue. This is evidence of the secondary character of the action of irradiation on protein synthesis, presumably associated principally with death and disintegration of the cells and subcellular structures of the gland in the period of manifest radiation sickness.

LITERATURE CITED

1. G. I. Zhurbin, Ukr. Biokhim. Zh., No. 3, 235 (1966).
2. I. I. Ivanov and V. V. Rudakov, Radiobiologiya, 7, No. 3, 319 (1967).
3. O. V. Molotkob, Probl. Éndokrinol., No. 5, 109 (1966).
4. A. Notario, G. Slaviero, G. Doneda, et al., Experientia (Basel), 21, 264 (1965).
5. J. E. Richmond, M. G. Ord, and L. A. Stocken, Biochem. J., 66, 123 (1957).
6. N. K. Sarkar, A. Devi, and L. H. Hempelman, Nature, 192, 179 (1961).