

EFFECT OF X-RAY IRRADIATION OF RATS ON THE NINTH DAY OF PREGNANCY ON DEVELOPMENT OF THE EMBRYOS AND PLACENTAS

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UDC 612.64.014.481.1

In recent investigations considerable attention has been paid to the study of the action of ionizing radiation on the embryonic development of animals and man.

The author's own observations and reports in the literature [2, 5, 7, 9, 10-12, 15-19] have shown that during the action of ionizing radiation the degree of the changes produced in the embryo and placenta is determined not only by the dose, but also to a considerable extent by the period of pregnancy at the time of irradiation.

Previous investigations have shown that following irradiation of a cow in a dose of 200 R at different periods of pregnancy, mild clinical manifestation of radiation sickness develops. Meanwhile, more marked disturbances of development of the fetus were observed during the embryonic period, especially in rats irradiated on the 4th and 9th days of pregnancy, a finding confirmed by the results of other investigations [1, 3, 13, 14, 20].

To continue the study of the effect of irradiating rats on the 9th day of pregnancy, in the present investigation the development of the embryo and placenta was studied over a period of time.

EXPERIMENTAL METHOD

Irradiation was given by a type RUM-11 apparatus with the following conditions: voltage 180 kV, current 18 mA, skin-focus distance 40 cm, filters 0.5 mm Cu and 1 mm Al, dose rate 42 R/min.

Experiments were carried out on 132 rats, receiving a single dose of irradiation of 200 R on the 9th day of pregnancy, and sacrificed at various times thereafter: on the 10th, 11th, 12th, 13th, 14th, 15th, 16th, 17th, 18th, 19th, and 21st days of pregnancy.

To investigate the action of x-rays on the pregnant rat and development of the fetus the following indices were studied: the general state of the irradiated animals, their body weight, the number of leukocytes in the peripheral blood, the number of fetal sacs, the dimensions of the fetal sacs, the fetuses, and the placentas, and the mean weight of the fetal sac. The results obtained were analyzed by statistical methods. At the same time, for control purposes, the same indices were studied at the corresponding times in unirradiated pregnant rats.

EXPERIMENTAL RESULTS

From the 1st and 2nd days after irradiation the experimental animals appeared lethargic, their hair was untidy, their appetite poor and their thirst increased. Starting with the 3rd day, the external clinical manifestations of the action of irradiation became much less marked and the rats were almost indistinguishable from the control.

The results of daily weighing of the irradiated pregnant rats showed that the mean daily increase in their weight fell by 1.2 g from its value in the control (unirradiated) animals.

The number of leukocytes in the peripheral blood of the rats fell by 55.8% on the first day after irradiation and by 62.8% on the second day compared with its initial level, but after the 3rd day it began to rise, although by the 21st day of pregnancy it had not regained its former value.

Department of Histology, Grodno Medical Institute (Presented by Active Member of the Academy of Medical Sciences of the USSR, N. N. Zhukov-Verezhnikov). Translated from *Byulleten' Éksperimèntal' Biologii i Meditsiny*, Vol. 63, No. 1, pp. 85-88, January, 1967. Original article submitted May 13, 1965.

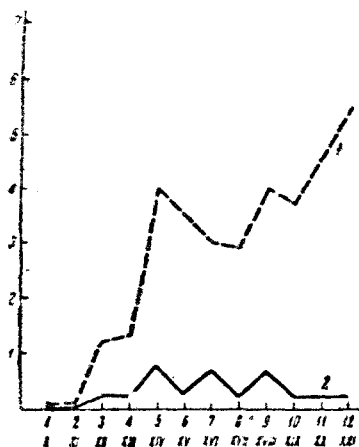


Fig. 1. Number of pathological fetal sacs in rats irradiated on the 9th day of pregnancy in a dose of 200 R (1) and in unirradiated control rats (2). Along the axis of ordinates—number of fetal sacs; along the axis of abscissas—here and in Figs. 2 and 3—days after irradiation (Arabic numbers) and days of pregnancy (Roman numbers).

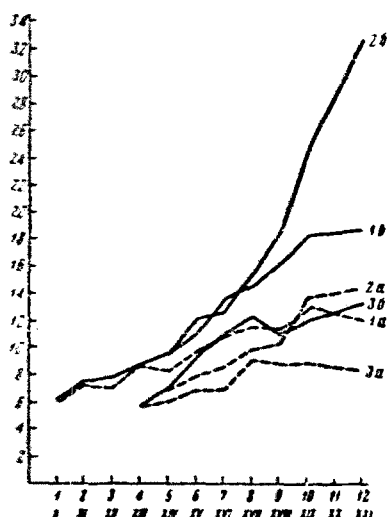


Fig. 2. Dimensions of fetal sacs, fetuses, and placentas (in mm) in rats irradiated on the 9th day of pregnancy in a dose of 200 R (1a-3a) and in unirradiated controls (1b-3b).

The retrogression of the embryos is characteristic of the multiparous animals in normal conditions. The control unirradiated rats began to show signs of resorption of the embryos on the 12th day of pregnancy. In the animals with radiation sickness resorption of the fetal sacs was observed at the same time, although it was more marked in degree than in the unirradiated rats (Fig. 1). It is clear from Fig. 1 that in the irradiated pregnant rats the number of pathological fetal sacs increased, but the difference compared with the number in the control animals became significant only on the 5th day after irradiation (the 14th day of pregnancy, $P < 0.01$). They were particularly numerous on the 5th day after irradiation (amounting to 50%). Toward the end of pregnancy (on the 21st day, 12 days after irradiation) the number of pathological fetal sacs became maximal (on the average 5.5 to each female). In the control rats at the same period of pregnancy the number of pathological fetal sacs per rat was only 0.2.

During the course of pregnancy in the irradiated rats the development of the fetal sacs was slower than in the unirradiated control animals, as the measurements showed. The difference in the size of the fetal sacs was significant on the 5th day after irradiation (Fig. 2), when their mean size in the control animals was 9.6 mm compared with 8.3 mm in the irradiated rats at the same period ($P < 0.001$). Later this difference became still more marked, and on the 21st day of pregnancy (12 days after irradiation) the fetal sacs in the control animals measured 18.5 mm compared with 12 mm in the irradiated animals.

The weight of the irradiated females was less than that of the control animals (Fig. 3). On the 6th day after irradiation the fetal sacs in the control rats had a mean weight of 800 mg compared with 517 mg in the irradiated females. This lag in the development of the fetal sac in the irradiated animals was also obvious in the later periods. Toward the end of pregnancy the weight of the fetal sacs showed a particularly marked decrease by comparison with their weight in the controls. On the 21st day of pregnancy (12 days after irradiation) their mean weight was 1817 mg compared with 5137 mg in the control rats—i.e., a decrease of 64% ($P < 0.001$).

The developing fetuses had some influence on the inhibition of development of the fetal sacs in the rats with radiation sickness. A marked delay in the growth of the irradiated rats in length was observed on the 5th day after irradiation. The length of the fetuses of the irradiated rats was 6.9 mm, compared with 9.2 mm in the control, unirradiated rats, i.e., 40% greater ($P < 0.001$). In the later periods of pregnancy the fetuses of the irradiated rats were still more retarded in development, as is clear from Fig. 3. On the 21st day the fetuses of the control unirradiated females had a mean length of 32.6 mm compared with 14.4 mm for the fetuses of the irradiated females ($P < 0.001$).

The effect of x-rays on the placenta of the rats was also studied. In control animals on the 14th day of pregnancy the placenta measured 7 mm in diameter, compared with 6 mm in the experimental rats on the 5th day after irradiation, i.e., it was 1 mm smaller ($P < 0.001$). By the 21st day of pregnancy (12 days after irradiation) the diameter of the placenta in the control animals averaged 13.2 mm, compared with 8.2 mm in the experimental animals, i.e., it was 23% smaller ($P < 0.001$). It may be concluded from these measurements that the harmful measurement of x-rays was also manifested in delay in the development of the placenta, leading to disturbance of the blood supply to the developing fetus and to a higher incidence of death of the fetus with subsequent resorption.

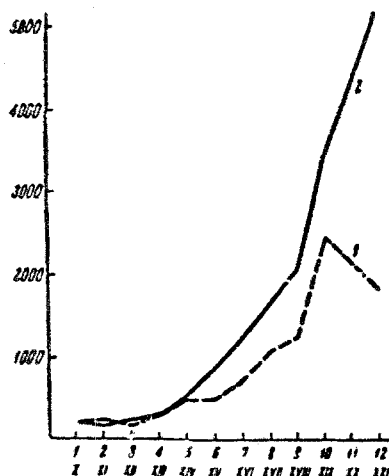


Fig. 3. Weight of fetal sacs (in mg) in rats irradiated on the 9th day of pregnancy in a dose of 200 R (1) and unirradiated control rats (2).

A characteristic feature of radiation sickness is the development of hemorrhages in various tissue structures. In these experiments hemorrhages appeared in the wall of the uterus and of the yolk sac on the 3rd day after irradiation. The number of fetal sacs with hemorrhages increased considerably on the 5th and 6th days after irradiation. From the 7th days the hemorrhages became almost invisible, and they were detected in the fetal sacs by the presence of a brown or brownish-green fluid.

The differences between all these indices were seen most clearly from the 6th day after irradiation, demonstrating the existence of a latent period in the development of pathological changes in the fetus and placenta following irradiation on the 9th day of embryogenesis in a dose of 200 R.

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