EXPERIMENTAL BIOLOGY

Biological Effects Observed in Postnatal Ontogeny of Male Rats Subjected to Acute and Chronic Prenatal γ-Irradiation

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Changes in the number of spermatogenic cells and spermatozoa, RNA and DNA contents, and weights of the thymus, spleen, and testes of 7- and 19-week-old rats subjected to acute and chronic prenatal irradiation in a dose of 1 Gy attest to long-lasting disturbances in the body.

Key Words: *embryogenesis; acute and chronic prenatal γ-irradiation; radiosensitive organs; spermatogenesis; DNA; RNA*

Analysis of immediate and delayed effects of prenatal irradiation is one of the most important problems of radiobiology, especially in light of environment contamination. However, delayed consequences of prenatal low-dose irradiation and chronic irradiation on animal offspring received little attention [3,4,10,12].

Here we studied the effects of acute and chronic γ-irradiation in a dose of 1 Gy on general (weights of the spleen, testes, and thymus), morphological (number of spermatogenic cells, SC, and spermatozoa), and biochemical (testicular DNA and RNA contents) parameters in prenatally irradiated 7- and 19-week-old male rats.

MATERIALS AND METHODS

Experiments were performed on albino outbred rats. Four-month-old female rats (at the stage of proestrus-estrus) weighing 200±20 g were caged with male rats in a ratio of 3:1. Pregnancy was confirmed by the presence of spermatozoa in vaginal smears. Acute γ-irradiation in a single dose of 1 Gy (5.40 cGy/min dose power) was performed at gestational day 15 (late organogenesis) using an IGUR-1 device (^{137}Cs). Chronic γ-irradiation in a total dose of 1 Gy (5.76 cGy/day dose power) was performed for 24 h a day (except for the period of feeding and cleaning) from gestation day 1 through 18 in a special chamber using a 120/192 GAMMARID device (^{137}Cs).

Seven- and 19-week-old male rats were studied. After decapitation, the spleen, thymus, and testes were weighted. In a suspension obtained from testes, the total number of SC and spermatozoa and their amount per 1 g tissue were determined [2], and the content of RNA and DNA was measured in testicular tissue homogenate [5,8]. The offspring of unirradiated females of the same age served as the control. The results were analyzed by Student's *t* test.

RESULTS

Acute γ-irradiation of pregnant rats led to a decrease in the absolute weights of the spleen, testes, and thymus in offspring (Fig. 1). The decrease in the weights of some organs in prenatally irradiated animals of various ages was reported by other investigators [1, 10]. Chronic γ-irradiation of embryos caused different changes in the weight of radiosensitive organs in 7- and 19-week-old rats. Chronic prenatal γ-irradiation decreased the absolute weight of the testes and, to a

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lesser extent, of the spleen in 7-week-old rats (Fig. 1). In 19-week-old animals, the weight of the spleen and testes decreased, while the thymus weight increased.

The amount of SC per 1 g tissue did not differ from the control in 7-week-old rats exposed to acute γ-irradiation at gestational day 15 and tended to decrease in 19-week-old animals of the same group. The number of spermatozoa in the testes of 7-week-old rats considerably surpassed the control level, while in 19-week-old animals this parameter decreased to 84.4% of the control (Table 1). The total number of SC in the testes of rats irradiated during organogenesis decreased, while the number of spermatozoa in 7-week-old rats increased in comparison with the control. Irradiation in a single dose of 1 Gy during organogenesis probably stimulates maturation of gametes in the prepubertal period (week 7) and depresses spermatogenesis in adult rats (week 19).

Effects of chronic prenatal γ-irradiation in a total dose of 1 Gy on the number of SC considerably differ from those observed after acute γ-irradiation. In 7-week-old animals, the content of SC per 1 g tissue slightly increased, while their total number in the testes decreased due to a considerable decrease in the organ weight. Total number of spermatozoa in the testes and

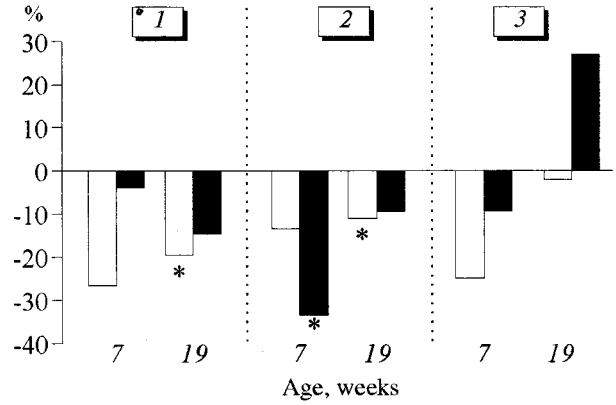

Fig. 1. Effects of acute (light bars) and chronic (dark bars) γ-irradiation in a dose of 1 Gy on the absolute weights of the spleen (*1*), testes (*2*), and thymus (*3*) in rat offspring during postnatal ontogenesis. *$p<0.05$ compared with the control.

TABLE 1. Effects of Acute and Chronic Prenatal γ-Irradiation in a Dose of 1 Gy on Some Morphofunctional Parameters of Testes in 7- and 19-Week-Old Rats ($M\pm m$, n=6-7)

Parameters	Age, weeks			
	7		9	
	control	experiment	control	experiment
Acute γ-irradiation				
Content of SC per 1 g tissue, $\times10^8$	4.24±0.14	4.06±0.05 (98.1)	4.01±0.20	3.76±0.28 (93.8)
Content of spermatozoa per 1 g tissue, $\times10^8$	0.24±0.08	0.39±0.11 (162.5)	1.64±0.09	1.39±0.09 (84.8)
Total number of SC in testes, $\times10^8$	2.49±0.24	2.12±0.23 (85.2)	6.08±0.47	4.94±0.51 (81.9)
Total number of spermatozoa in testes, $\times10^8$	0.15±0.06	0.23±0.07 (153.3)	2.48±0.23	1.81±0.15* (73.0)
RNA, mg/ml	2.42±0.09	2.34±0.13 (96.7)	1.86±0.04	1.79±0.06 (96.2)
DNA, mg/ml	2.27±0.21	2.36±0.10 (104)	2.18±0.05	2.15±0.09 (98.6)
RNA, mg/testes	1.42±0.05	1.19±0.06 (83.8)	2.79±0.09	2.33±0.11* (83.5)
DNA, mg/testes	1.33±0.12	1.20±0.10 (90.2)	3.27±0.14	2.80±0.12* (85.6)
Chronic γ-irradiation				
Content of SC per 1 g tissue, $\times10^8$	4.37±0.15	4.80±0.16 (109.8)	4.74±0.24	4.64±0.23 (97.9)
Content of spermatozoa per 1 g tissue, $\times10^8$	0.11±0.05	0.06±0.01 (54.5)	1.76±0.20	1.75±0.11 (99.4)
Total number of SC in testes, $\times10^8$	2.14±0.18	1.55±0.09* (72.4)	7.27±0.41	6.38±0.44 (88.1)
Total number of spermatozoa in testes, $\times10^8$	0.10±0.02	0.02±0.004* (20.8)	2.66±0.28	2.43±0.24 (91.4)
RNA, mg/ml	2.72±0.10	2.70±0.07 (99.3)	2.09±0.08	2.14±0.07 (102.4)
DNA, mg/ml	3.29±0.06	3.41±0.06 (103.6)	2.24±0.10	2.37±0.11 (105.8)
RNA, mg/testes	1.36±0.19	0.90±0.09 (66.2)	3.21±0.18	3.05±0.23 (95.1)
DNA, mg/testes	1.64±0.23	1.12±0.11 (68.3)	3.43±0.21	3.38±0.19 (98.5)

Note. In parentheses: % of control (100%), *$p<0.05$ compared with the control.

their content per 1 g tissue decreased. The amount of SC and spermatozoa per 1 g tissue in 19-week-old rats approached the control levels. A decrease in the number of SC in these animals was less pronounced than in rats subjected to acute irradiation. These changes in the number of SC in rats exposed to acute and chronic prenatal irradiation can be attributed to a decrease in the number of seminal ducts [9,11] and spermatids [7].

The content in RNA and DNA in the testicular tissue of 7- and 19-week-old rats changed insignificantly after acute and chronic prenatal γ-irradiation. The content of nucleic acids decreased in the testes because of a decrease in their weights in prenatally irradiated rats. The absence of differences between RNA and DNA levels in the brain and liver of prenatally irradiated rats examined immediately after birth and later has been reported [6].

Our findings indicate that embryogenesis is highly sensitive to low-dose irradiation. This adversely affects the development of some systems during postnatal ontogenesis.

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