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RADIOPROTECTION BY MPG OF MICE OVARIES EXPOSED TO SUBLETHAL GAMMA RADIATION DOSES AT DIFFERENT POSTNATAL AGES

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Abstract

Female Swiss albino mice were exposed at 1, 3 or 6 weeks of age respectively to sublethal doses (0.6, 1.2 and 2.4 Gy) of gamma radiation in the presence or absence of 2-mercaptopropionylglycine (MPG). Ovaries were histologically examined at different intervals after irradiation and the follicles were counted. Most follicular depletion had occurrred already at postirradiation day 1 and the depletion then gradually continued. At day 35 after irradiation a few follicles could still be found in mice exposed at 1 week of age while all follicles were eliminated in mice exposed at 3 and 6 weeks of age. In MPG-treated animals the depletion of follicles was significantly less pronounced and obviously MPG to some degree protected the ovaries from radiation damage.

Key words: Ovary, mice, gamma radiation, follicles, MPG, radioprotection.

Radioprotective sulphydryl compound 2-mercaptopropionylglycine (MPG) is reported to have maximum radioprotective efficacy at a non-toxic dose (20 mg/kg body weight). Its presence at the time of exposure has been found to decrease radiation-induced lipid peroxidation and enzyme release (1). Uma Devi (2) in 1983 observed that MPG is a better protector of mammalian tissues against sublethal exposures than against lethal exposures.

In adult mice, irradiation of female gonads results in the destruction of surviving follicles and MPG protects different types of follicles after lethal and sublethal exposure (3, 4). The present experiment was designed to study the radioprotective effect of MPG on the ovaries of mice exposed to sublethal doses of gamma radiation at different postnatal ages (1, 3 and 6 weeks).

Material and Methods

Healthy Swiss albino female mice one, three and six weeks of age were selected from an inbred colony. The mice were housed in an animal house at optimum temperature and were given standard mouse food and water ad libitum. The animals were divided into two groups.

Group I (irradiation): The animals in this group were injected with double distilled water intraperitoneally (i.p.) 15 min before irradiation with the same volume as that of injections in group II.

Group II (irradiation + MPG): The animals in this group received an aqueous solution of MPG i.p. at a dose of 20 mg/kg body weight (2 mg/ml, pH 6.4) 15 min before irradiation.

The age of the animals was 1, 3 and 6 weeks respectively and they were exposed to 0.6, 1.2 and 2.4 Gy gamma rays from a ^{60}Co-source (dose rate 0.24 Gy/min). Six animals from each dose level, age and group were sacrified at 6 h and 1, 3, 5, 7, 14 and 35 days post-irradiation respectively and the ovaries removed. Serial sections of 5 μm thickness were cut and stained with haematoxylene and eosin. Parallel studies were also made on the ovaries of sham-treated animals.

The follicles were counted in every 5th section from the serially sectioned ovaries. The follicles were identified by Pedersen and Peters' classification (5) using the nucleolus as a marker. The survival percentage of follicles was obtained by comparison with sham-treated mice. The significance of the difference between group I and group II was calculated by Student's t-test.

Results and Discussion

The quantitative estimation showed a dose-dependent reduction of the follicular fecundity in mice exposed at

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Table 1

Percentage surviving follicles in the ovaries of Swiss albino mice exposed at the age of 1, 3 and 6 weeks of age to different sublethal doses (0.6, 1.2 and 2.4 Gy) of gamma radiation in the absence (group I) and presence (group II) of MPG. Each value represents the mean (± SD) of 6 animals

Age	Time after radiation exposure	Group	Dose		
			0.6 Gy	1.2 Gy	2.4 Gy
1 week	6 h	I	86.9 ± 4.9	79.9 ± 2.9	74.4 ± 3.6
		II	89.9 ± 5.1	83.0 ± 4.3	76.9 ± 3.9
	1 day	I	18.1 ± 0.9	15.4 ± 0.5	11.0 ± 0.6
		II	28.9 ± 1.5*	22.6 ± 0.4*	17.8 ± 1.0*
	3 days	I	13.6 ± 0.9	10.9 ± 0.5	9.5 ± 0.6
		II	27.1 ± 1.5*	17.9 ± 0.8*	16.9 ± 0.9*
	5 days	I	10.9 ± 0.5	10.3 ± 0.5	8.0 ± 0.9
		II	25.9 ± 0.8*	15.8 ± 0.4*	16.8 ± 0.8*
	7 days	I	8.1 ± 0.4	7.2 ± 0.9	6.7 ± 0.3
		II	15.8 ± 0.8*	12.3 ± 0.9*	11.7 ± 0.4*
	14 days	I	6.9 ± 0.9	6.0 ± 0.9	5.9 ± 0.5
		II	12.5 ± 1.5*	10.4 ± 1.2*	10.0 ± 0.6*
	35 days	I	4.5 ± 0.2	3.5 ± 0.2	1.9 ± 0.1
		II	11.9 ± 1.5*	8.1 ± 0.8*	5.7 ± 0.6*
3 weeks	6 h	I	84.1 ± 2.6	79.8 ± 2.8	73.6 ± 4.2
		II	89.5 ± 3.1	84.9 ± 4.0	78.8 ± 2.6
	1 day	I	10.9 ± 0.9	9.2 ± 0.9	6.7 ± 1.3
		II	15.6 ± 1.6*	12.4 ± 1.4	9.3 ± 2.8
	3 days	I	9.8 ± 1.4	7.9 ± 0.5	5.6 ± 0.6
		II	14.9 ± 0.9*	10.8 ± 0.8*	9.2 ± 0.7*
	5 days	I	8.3 ± 0.2	6.3 ± 0.3	4.1 ± 0.2
		II	12.9 ± 0.9*	10.6 ± 1.4*	7.0 ± 0.9*
	7 days	I	5.9 ± 0.3	3.6 ± 0.3	0.4 ± 0.1
		II	9.9 ± 0.7*	6.3 ± 0.5*	1.3 ± 0.4*
	14 days	I	1.5 ± 0.1	0.6 ± 0.1	0
		II	3.8 ± 0.5*	1.7 ± 0.2*	0
	35 days	I	0	0	0
		II	0	0	0
6 weeks	6 h	I	88.0 ± 4.2	81.0 ± 5.0	74.6 ± 5.9
		II	98.7 ± 5.7	86.6 ± 6.6	77.7 ± 5.3
	1 day	I	22.2 ± 2.3	18.2 ± 2.2	13.2 ± 1.8
		II	31.7 ± 3.5*	26.4 ± 2.7*	22.5 ± 3.5*
	3 days	I	18.3 ± 1.7	10.9 ± 1.6	9.4 ± 1.5
		II	27.3 ± 2.6*	22.4 ± 2.3*	16.8 ± 2.7*
	5 days	I	15.8 ± 1.5	9.2 ± 1.7	7.1 ± 0.9
		II	23.8 ± 2.3*	19.7 ± 3.6*	12.2 ± 1.4*
	7 days	I	10.0 ± 1.6	6.9 ± 0.8	4.2 ± 0.9
		II	19.4 ± 0.7*	13.8 ± 0.7*	8.7 ± 0.6*
	14 days	I	7.8 ± 0.9	4.5 ± 0.3	3.5 ± 0.3
		II	14.9 ± 0.9*	9.3 ± 0.9*	6.8 ± 0.8*
	35 days	I	0	0	0
		II	0	0	0

* Statistically significant difference between groups I and II.

different ages (Table). Most of the follicular depletion had occurred already at day 1 and the depletion was seen to gradually continue with later autopsy intervals. In all three exposure group, a few follicles were found at day 35 in the ovaries of mice exposed at 1 week of age. In mice exposed at 3 and 6 weeks of age all the follicles were eliminated at day 35.

A postirradiation follicular depletion was also observed in animals pretreated with MPG, but it was not as pronounced as in the non-MPG-treated animals.

Mammalian ovary represents a non-renewal system. The number of oocytes is constant during late gestation and very early postnatal period. In immature mice oocytes are eliminated continuously from the ovary as a result of atresia, while in adult mice both atresia and ovulation deplete the follicular population.

In the present study the radiation-induced ovarian damage was dose-dependent. Kapoor et al. (6) also reported a dose-dependent reduction in the follicular population in the ovaries of Swiss albino mice exposed to tritiated water.

Mice exposed at three weeks of age showed the maximum radiation effect on the ovaries followed by mice exposed at 1 week and 6 weeks. The high radiosensitivity of ovaries at 3 weeks of age can be attributed to the presence of newly formed highly radiosensitive dictyate oocytes (7). The relative radioresistance of adult mice may be due to greater activity of repair processes in mature females than in young ones (8). The comparatively lower radiosensitivity of ovaries in mice exposed at 1 week of age can be ascribed to the presence of primary oocytes mainly with nuclei in the late diplotene stage, a stage which is considered to be comparatively radioresistant (7).

The present study clearly shows that MPG to some degree is capable of protecting follicles against radiation-induced damage. The radioprotective effect of MPG includes a combination of mechanisms. Presence of MPG at the time of irradiation probably provides protection by decreasing chromosomal aberrations and enhancing the DNA repair capacity. It may also protect tissues from direct and indirect action of radiation by forming mixed disulphide or by competing with target molecules for free radicals. It may also offer protection by releasing endogenous non-protein sulphahydryls or by hydrogen donation (9).

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