Lethal dose of mice irradiated through a sieve of twenty percent shielding

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「20%篩照射によるマウスの致死線量」

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骨髄移植の実験に於てマウスでは10%の骨髄細胞が生残すると造血機能の再生が起ると云はれている．そこでどの程度小さな遮蔽率の篩まで保護効果が認められるかを知るために20%遮蔽の篩を用いてマウスの致死線量の増減を調べた．篩照射は1,000R，1,200R，1,400R，1,600Rの4群について行い，対照群として篩を使用せずに，600R，700R，800Rの3群について夫々全身照射を行つて4週生存を観察した．その結果，篩照射群に於て致死線量の増加が著明であつた．

Introduction

It is well known that partial shielding of the bone marrow during irradiation or bone marrow transplantation after whole-body irradiation of mice increases survival of animals and that about ten percent of bone marrow cells survived is effective for hematopoietic recovery of irradiated animals. In the present experiment, protective effect of a sieve was tested. Groups of animals were irradiated through a lead sieve which shielded twenty percent of incident X-rays. Another groups of animals were irradiated without sieve. Integral dose was calculated by Murai's method and dose-survival relations was compared between two groups.

Materials and Methods

Litter-mated dd colony female albino mice purchased from market, weighing 21±1.0 g, were used throughout the experiment. Each animals was placed in a lucite cylinder, 3.0 cm in diameter, 7.0 cm long and 0.3 cm in wall thickness. Ten animals were irradiated at a time in a field of 15×15 cm. A sieve was placed to cover the field keeping in contact with cylinders. Irradiation was performed under

following conditions : 200 kVp, 0.2 mm Cu filter added, TSD 50 cm, exposure rate 112 R/min. Experiments were composed of four groups of sieve irradiation (1,000, 1,200, 1,400 and 1,600 R of single exposure) and three groups of conventional irradiation (600, 700 and 800 R of single exposure). Exposure was measured immediately above a cylinder without a sieve by a Toshiba depth dose meter.

Construction of a sieve is worth while to describe, namely it consists of a series of lead strips of thickness 1.0 mm and of height 3.0 mm separated by spacers of lucite material of width 9.0 mm and this lead lattice is held between two pieces of square lucite plate of 2.0 mm in thickness. Composite thickness of a sieve is 7.0 mm. A lucite plate of this thicknes may reduce an incident radiation by five percent. This grid is so designed and constructed that it is used at focal distance of 50 cm with the least penumbra.

The integral dose was measured by a plastic scintillator developed by Prof. Murai and colleagues[1),2)] and the ratio of sieve to convenotinal irradiation was used as a conversion factor from one irradiation to another. The integral dose of animals exposed through the sieve with 20% shielding was reduced by 25% of conventional one for the same incident exposure on the proximal surface of the sieve. Therefore in this experiment the integral dose of animals irradiated with a single surface exposure of 1,000 R,1, 200 R, 1,400 R and 1,600 R through the sieve corresponded to the integral dose of 750 R, 900 R, 1,050 R and 1,200 R respectively, without the sieve.

Results

The relationship between the dose and the survival rate in the four weeks after irradiation was shown inTable I. As it was clear from Table I, the four week survival rate decreased as the increase of dose in both groups. The $LD_{50(28)}$ with conventional irradiation was 700 to 800 R in the surface dose and that with the sieve was 1,200 to 1,400 R.

Table I Four week survival in each group

	Exposure (R)	Ratio of integral dose (%)	Number of mice irradiated	4 week survival	4 week survival rate (%)	95 percent confidence limits
Conventional irradiation group(Control)	600	100.0	40	34	85.0	71.7—91.8
	700	116.7	40	23	56.0	44.0—69.6
	800	133.3	39	12	30.8	20.4—44.4
Sieve irradiation group	1000	125.0	51	38	74.5	62.5—82.9
	1200	150.0	56	32	57.2	47.3—67.8
	1400	175.0	55	20	36.4	26.3—47.6
	1600	200.0	56	10	17.9	11.2—28.4

Ratio of integral dose represents relative values for each group taking conventional 600R as 100%

The values in the Table I were plotted on the probability paper taking the 25 percent adjustment in sieve irradiation into consideration (Figl I). The four week survival rate at any given dose showed a statistically recognizable significance between two groups.

The temporal distribution of death was summerized in Figure II. In 700 R conventional, one peak on twelfth day and in 800 R conventional one peak on eighth day was found. But in sieve irradiation, two peaks on twelfth and fifteenth in 1,400 R and two peaks on seventh and thirteenth days in 1,600 R were found respectively.

Figure I Dose-survival relations 4 weeks after sigle irradiation

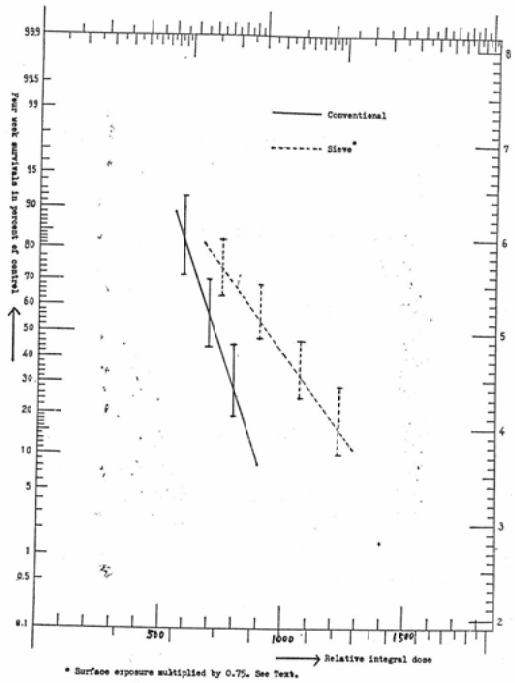
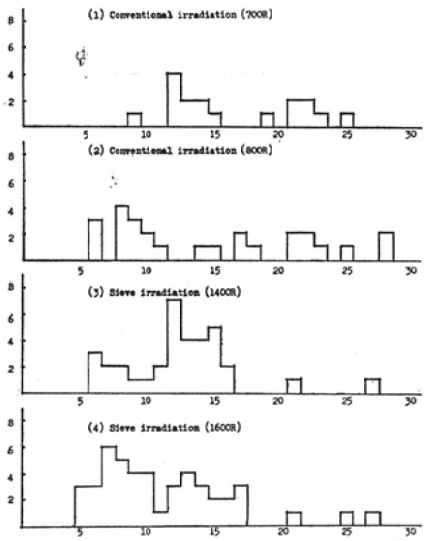


Figure II Temporal distribution of deaths after conventional and sieve whole-body irradiation. Ordinate: mumber of deaths. Abscissa: days after irradiation.



Conclusion and Discussion

The increase of lethal dose was recognized by using twenty percent sieve and the peaks of conventional 700 R and 1,400 R with sieve were probably due to "marrow death". However, eighth day's peak of conventional 800 R and seventh day's peak of 1600 R with sieve was considered neither likely to be "gastr-

ointestinal death" nor to be "marrow death". The integral dose of mice by sieve irradiation of 1400 R corresponds to 1,050 R of conventional irradiation. The dose of 1,050 R is the lowest possible level of gastrointestinal death. But the gastrointestinal syndrome was not clear in our experiments. These results have suggested the protective effect of sieve which shielded partilly the hematopoietic or gastrointestinal tissues at the time of irradiation. The regeneration of survived tissues reduced the radiation-induced lethality of the mice.

Summary

Albino mice were irradiated with X-rays through lead sieve of twenty percent shielding. Conventinally irradiated mice were used as a control.

An increase in lethal dose noted in sieve irradiation and possible mechanism of this protective effect was discussed.

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