ATROPHY OF SOME ORGANS OF YOUNG MICE FOLLOWING 14.1 MEV FAST NEUTRON AND X-RAY IRRADIATIONS

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14.1 MeV 速中性子及びX線照射による幼若マウスの臓器萎縮について

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幼若マウスにたいする180kVp X線と14.1MeV中性子線の照射後30日目における生存マウスを屠殺し，その臓器——脾，胸腺，腸，心臓，脳，肝，腎，睾丸および貯精嚢——の重量が測定された．生殖器官としての睾丸および貯精嚢のみが照射線量とともに，規則的かつ著るしい差を示した．重量における50%および (e−1)/e の成育抑制を与える 180kVp X線にたいする14.1MeV中性子のRBEとして，睾丸について2.66および2.21，貯精嚢について1.89および1.84がそれぞれえられた．睾丸のアルコール抽出物がまた分光学的に照射と非照射の間で吸光度に異なりを示した．

Introduction

In the determination of radiation biological effectiveness many workers have studied the atrophy of organs in small animals. This author studied the atrophy of some organs of young 4 weeks old male mice which were used in the growth delay experiment reported in a previous paper. The atrophy of organs was made on the 30th day after X-ray and neutron irradiations. The condition of the irradiations was, therefore, identical to that described in the section regarding experiment in the previous paper[1]. The difference between the irradiated animals and their controls on the extinction value of organ extracts will be discussed in this paper.

Results and Discussion

Young 4 weeks old mice were exposed to 180 kVp X-ray and 14.1 MeV fast neutron. A total of 20-25 mice was irradiated to each dose. The range of irradiation dose is shown

Table 1. Organ weight percent to that of controls, (%).

Organ	Irradiation dose (rads)								Analysis of variance or linear regression	
	100	200	300	400	500	600	700	SE	F.	P.
For X-ray										
Spleen	—	89.0	100.1	73.7	97.2	96.3	101.6	<±33.6	0.2	>0.20
Thymus	—	88.3	82.8	72.9	98.8	62.5	46.3	<±25.0	4.0	<0.20
Intestine	—	92.9	78.5	84.7	91.8	89.3	70.3	<±10.3	0.2	>0.20
Heart	—	92.7	86.4	74.4	79.4	74.9	60.6	<±11.4	12.1	<0.05
Brain	—	97.3	90.8	93.8	94.2	91.0	87.1	<± 2.5	3.0	<0.20
Liver	—	97.2	85.2	71.5	84.7	77.4	66.8	<± 7.4	6.1	<0.20
Kidney	—	90.6	79.6	76.4	74.1	67.2	53.1	<±10.5	33.2	<0.01
Testicle	—	77.9	64.3	52.1	40.7	36.7	31.1	<± 4.9	579.3	<0.001
Seminal vesicle	—	94.5	74.2	60.2	48.6	51.1	36.8	<± 6.8	98.4	<0.001
Body weight	—	97.1	93.6	79.9	82.6	73.6	60.8	<± 7.3	24.7	<0.01
For neutron										
Spleen	91.8	103.3	88.2	81.5	49.4	—	—	<±26.0	1.5	>0.20
Thymus	86.4	115.0	121.2	58.3	—	—	—	<±15.9	(0.01)	—
Intestine	98.5	92.2	64.1	83.2	75.8	—	—	<±11.4	2.9	<0.20
Heart	85.5	85.3	63.7	72.5	70.9	—	—	<±12.5	3.7	<0.20
Brain	93.1	91.7	86.8	87.5	86.2	—	—	<± 3.4	24.6	<0.05
Liver	104.5	82.7	74.8	71.1	68.4	—	—	<± 8.2	72.8	<0.01
Kidney	84.6	79.1	64.3	61.8	63.0	—	—	<±10.8	25.8	<0.05
Testicle	60.5	45.8	32.4	25.8	23.9	—	—	<± 4.9	237.2	<0.001
Seminal vesicle	93.1	61.3	41.8	42.0	27.9	—	—	<± 8.6	75.4	<0.01
Body weight	90.8	85.7	77.0	68.5	68.5	—	—	<± 3.1	33.3	<0.05

in Table 1. Mice surviving on the 30th day after irradiation were sacrificed and their various organs were weighed. Nine surviving mice of each irradiated group were used and 3 mice were processed at the same time. Only three mice of the group exposed to the highest dose were processed, since most of them in this group died. The atrophy of spleen, thymus, intestine and testicle was reviewed for the study of RBE, because these organs are highly radio-sensitive. The RBE of mouse organ atrophy for the fast neutrons was studied by Carter and Storer et al. Carter[2] used the mean 9 MeV neutrons produced by cyclotron and studied the atrophy of spleen, thymus and intestine on the 5th day, 5th day and 2nd day, respectively after irradiation. Storer et al.[3] who used neutron from U^{235} fission observed the atrophy of spleen and thymus on the 5th day after irradiation. In addition, since Eschenbrenner's study[4], the RBE of the atrophy of testicle was studied by Kohn et al.[5][6] and Storer et al.[3][7] for X-rays, gamma-rays, protons, alpha-particles and thermal neutrons.

As described in the foregoing reports, the weight of the spleen and the thymus decreases markedly on about the 5th day after irradiation[2][3][8–16], the intestine on about the 2nd day[3][17][18] and the testicle on about the 4th week[3–7]. Table 1 shows the data regarding organ atrophy or growth restraint of young mice on the 30th day after irradia-

tion. Spleen, thymus and intestine which are very radio-sensitive and show remarkable atrophy within a few days after irradiation, have various values and within the same dose group even individual differences are remarkable. This suggests that a complex recovery process takes place in those organs until the 30th day after irradiation. Heart, brain, liver and kidney show a slight decrease in weight with increase in irradiation dose. However, even at $LD_{100/30}$, growth restraint exceeding 50 percent of organ weight in comparison with the control could not be expected in 4 weeks old male mice on the 30th day after exposure. Testicle whose atrophy is known to be most remarkable on the day passed about 4 weeks after irradiation, and seminal vesicle, one of the genital organ, presented an orderly and marked difference with change in irradiation dose. Their linear regressions are sufficiently of statistical significance (Fig. 1 and 2). The linear regressional equations of the genital organs, and RBE of 14.1 MeV neutron to 180 kVp X-ray which gives 50 percent and (e−1)/e growth restraints in weight are as follows:

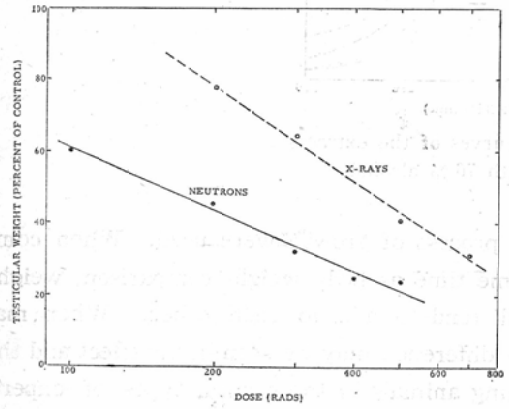

Fig. 1. Testicular weight in mice on the 30th day after irradiation as a function of dose of 14.1 MeV neutrons and X-rays.

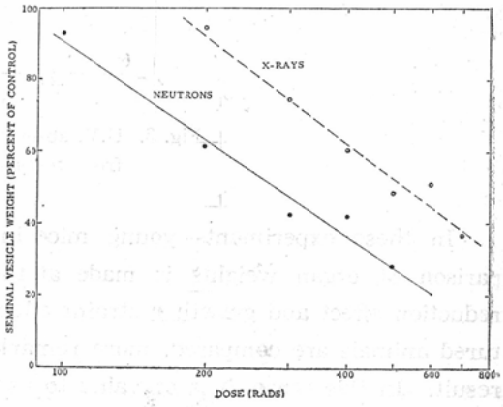

Fig. 2. Seminal vesicle weight in mice on the 30th day after irradiation as a function of dose of 14.1 MeV neutrons and X-rays.

	For testicle	For seminal vesicle
X-rays	Log Y=105.3—89.1X	Log Y=122.4— 99.4X
Neutrons	Log Y=61.0— 56.0X	Log Y=90.7 — 90.4X
RBE of 50% restraint in weight	$\gamma_x^n=2.66$	$\gamma_x^n=1.89$
RBE of (e-1)/1 restraint in weight	$\gamma_x^n=2.21$	$\gamma_x^n=1.84$

In addition to this weight reduction experiment, the testicles removed on the 30th day after irradiation were immersed in 76% alcohol for 24 hours and the extinctions of the extracts were measured by U.V. spectrometer. An increase in absorbance was observed distinctly in the extract solutions of testicles of mice irradiated to X-rays and neutrons (Fig. 3). Though the extracted substance is yet unknown, data of interest should become available.

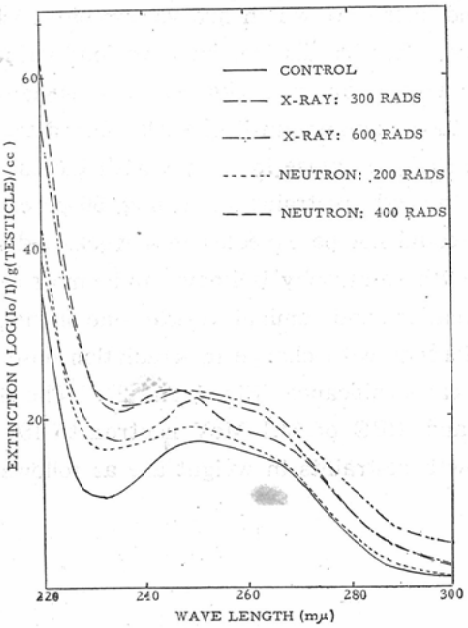

Fig. 3. U.V. absorption curves of the extracts from testicles with 76 % alcohol.

In these experiments young mice in the process of growth were used. When comparison of organ weights is made at the same time as body weight comparison, weight reduction effect and growth restraint effect will tend to add to each other. When matured animals are compared, more remarkable difference may be seen in the effect and the result. In this sense, it is of value to use young animals in the certain types of experiments.

Summary

Young mice were exposed to 180 kVp X-rays and 14.1 MeV fast neutrons and those surviving on the 30th day after irradiation were sacrificed and their organs, that is spleen, thymus, intestine, heart, brain, liver, kidney, testicle and seminal vesicle, were weighed. Only the testicle and the seminal vesicle, the genital organs, showed an orderly and marked difference with irradiation doses. As the RBEs of 14.1 MeV neutron to 180 kVp X-ray which gave 50 percent and (e−1)/e growth restraint in weight, 2.66 and 2.21 for the testicle and 1.89 and 1.84 for the seminal vesicle were obtained, respectively.

The extracts obtained from the testicles immersed in alcohol showed difference in extinction values between the irradiated and the controls. The extinction value of the irradiated was higher than that of the controls.

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