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Studies on the effects of X-ray irradiation  
upon the blood pressure of rats

by

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ラットの血圧に対するX線照射の影響

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抄 録

LD<sub>50</sub> が約 650r であるラットに250 KVp のX線を70r/min の線量率で1,000r, 800r, 700r, 600r 及び 400r の全身照射を行った。下肢の足首部の収縮期血圧を照射後1時間, 8時間その後毎日50日間にわたって測定した。何れの照射群においても, 1時間以内に急激な血圧降下が認められた。その後血圧は一時やや上昇するが, 600r 以上の照射群では2日乃至4日後に再び二度目の血圧降下を示した。この二度の降下は最初のそれとは異つた原因によると考えられる。

1. Experimental Methods and Material

1.1. Radiation procedure

X-ray irradiation generated at 250 k.v.p. at 15 m. (HVL 1.5 mm Cu; Added Filter 0.5 mm Cu plus 1 mmAl), by General Electric Maxmar 250 II A X-ray Machine. Dose measurements were made prior to and following the exposure of each group of animals with a Victoreen r meter. Dose rate was 70.0r per minute in the phantome at 50 cm target-chamber distance. Cone is open type with square diaphragm of about 140×140 mm at the top producing a field of about 20×20 cm. The calibration is probably 5%.

Animals were irradiated in a square lucite cage which contained three compartments (center one was not used) with perforations on the side for ventilation.

1.2. Experimental animals

Mature hooded female rats of Syracuse strain weighing 200-250 grams were used in all experiments. Animals were selected on a basis of growth curves in order to obtain healthy and infection-free ones. A total of 36 rats were used, which were housed in individual rat cages with six animals-in each.

1.3. Blood pressure measurement

Blood pressure determination was taken with a Metro photo-cell tensometer. This one is an instrument designed for the direct determination in the rat. The procedure does not require the anethetization of the rats. The principle of its functioning is based on measuring the volume change in the foot by use of a photo-electric cell, before and after application of procedure by means of sphygmo-manometer rubber cuff applied to the

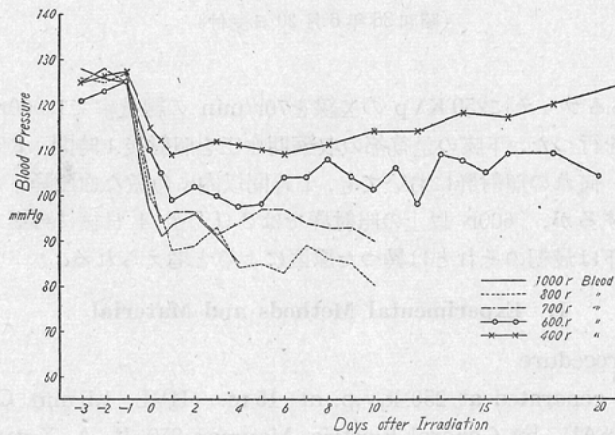
ankle of the foot.

Thus, systolic pressure was taken 3,2,1 days pre-exposure; and 1,8 hours and every day post-exposure for a period of 50 days on six series of rats that had received 400r, 600r, 700r, 800r, and 1,000r.

## 2. Results

In order to obtain the range of a diurnal variation of the blood pressure in the normal rat, measuring was carried out over three days before X-ray irradiation and these also are available as control.

The lines in Figure show the average of six rats, but they can not be always equal weight owing to the reduction in number because of deaths of the animals.



1,000r :

Blood pressure went down abruptly to approximately 90 mmHg from the normal pressure within one hour after irradiation. 4 of 6 animals died on the 4th day after exposure and 2 animals on the 6th day showing low blood pressure.

800r :

Blood pressure decreased rapidly in one hour after irradiation and a further decrease has been observed in one day after irradiation. 5 animals died within 7 day: 2 animals recovered gradually to a level somewhat below normal in a month.

700r :

A fall in the blood pressure has been detected similar to 800r animals. 4 animals died between the 10th day and 12th days: the blood pressure of the other 2 animals did not go as low as the former on that period and are still alive.

600r :

After a fall in blood pressure had occurred during the period of the 5th day post-irradiation, it seems to have increased slowly thereafter to a level a little below normal. 2 animals were found dead between the 10th and 12th days, but 2 of living animals seems to be apparently different from the others as to their trends toward

recovery.

Initial prolonged depression was seen in all 6 animals which are living now; 4 animals of them progressively approached normal levels from about the 4th days, and 2 of them from the 20th day after irradiation.

### 3. Discussion

As already noted in Result rapidly falling blood pressure has been detected for an hour after irradiation of 1,000 to 400r, respectively. The second fall in blood pressure has been seen among some rats of 1000, 800, 600 and 400r irradiation, after depressions were progressively less marked until the 10th day.

Several papers have been published on a rapid falling blood pressure after X-ray irradiation. Painter and et al<sup>1)</sup> have shown that a rapid falling blood pressure during the first hour post irradiation was not accompanied by any significant change in blood volume. Painte<sup>2)</sup> has also emphasized that there is a reason to believe that part of the early hypotention is reflex since vagotomy and atrppinization can reduce the blood pressure response. Montgomery and Warren<sup>3)</sup> have shown that the immediate hypotention is neural in origin, which is suggested further by its absence the spinal animals.

On the other hand W. Feldbelg's classic investigation have shown that any physical stimulus of sufficient strength (e.g. exposure to X-ray) liberates histamine. Bigelow and et al<sup>4)</sup> have pointed out that there is an increase in the blood histamine of irradiated rats.

Accordingly, a fall in blood pressure for the first hour after 1,000 to 400r irradiation seems to be a result either of depression of the central nervous system or liberation of histamine, or of both.

The second fall in blood pressure accord with the second period of the radiation sickness, which is due to haemorrhages, incipient anemia, infection and malnutrition. However, it would be rather hard to connect directly this result with either one of these symptoms, in the present stages of this experiment.

### References

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