The Effect of Momentary X-Ray Exposure in Small Dose upon the Peripheral Blood Picture

By

Masaru Wakabayashi, Fumio Kawamura*, Shinbei Nakaya, (若林勝) (河村文夫) (仲屋真兵衛)
Akio Yoshikawa, Yasuo Nakayama, Mitsuo Matsui, (吉川秋雄) (中山泰夫) (松井光夫)
Michiya Tazaka, Minoru Kido, Mitsuo Iizima, (田坂迪哉) (木戸英) (飯島三男)
Toshiya Tahara, Kaoru Motonaga and Kenji Ueda (田原利也) (木永敏) (上田意次)

From the Department of Radiology, School of Medicine, Hokkaido University, Sapporo

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INTRODUCTION

“A permissible weekly dose is a dose of ionizing radiation accumulated in one week of such magnitude that, in the light of present knowledge, exposure at this weekly rate for an indefinite period of time, is not expected to cause appreciable bodily injury to a person at any time during his lifetime.”

This is a well-known recommendation as to the permissible dose from external source of ionizing radiation which is proposed by National Committee on Radiation Protection (1954).1,2)

This weekly dose corresponds 50 mr per day. That is to say it has been believed that there occurs no appreciable bodily injury even if one is continuously exposed to 50 mr during 8 hours (working time for a day).

On the other hand, radiation effects are the more remarkable the shorter the time during which the dose is given.

So, does the range of this dose, if momentarily administered, cause any appreciable change in a human body?

* Present address: Department of Radiology (Director: Prof. F. Kawamura), School of Medicine, Tokushima University, Tokushima.

This paper was read by Dr. M. Tsutuki, Delegate of Japan, before the United Nations Scientific Committee on the Effects of Atomic Radiation, Second Conference, New York, October, 22-November, 2, 1956.
In the clinical service, patients are often exposed to this order of dose in the routine procedure of fluoroscopy or radiography. In such cases, does any change occur in the patient exposed? To research these points, the authors carried out some clinical experiments using the changes of peripheral blood picture as an indicator at the time of the routine radiography of chest.

**EXPERIMENTAL**

Method and Results

The subjects of the investigation were 106 healthy Japanese adults (77 men and 29 women). The majority of them were from 16 to 35 years of age.

The condition of exposure and the dose received on the back of the subjects are presented in Table I. The dose is calculated as dose in air by means of the film method.

### Table I

<table>
<thead>
<tr>
<th>Conditions of Exposure</th>
<th>Chest radiography</th>
<th>Chest fluorography</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voltage</td>
<td>50–58 kVp</td>
<td>70–75 kVp</td>
</tr>
<tr>
<td>Filter</td>
<td>0.5 mm. Al.</td>
<td>0.5 mm. Al.</td>
</tr>
<tr>
<td>Focus-skin distance</td>
<td>150–200 cm.</td>
<td>120 cm.</td>
</tr>
<tr>
<td>Intensity r/min</td>
<td>30–60</td>
<td>30–40</td>
</tr>
<tr>
<td>Exposed time</td>
<td>0.1 sec.</td>
<td>0.3 sec.</td>
</tr>
<tr>
<td>Part of exposure</td>
<td>Upper half body</td>
<td>Whole body</td>
</tr>
<tr>
<td>mA</td>
<td>20–30</td>
<td>15–20</td>
</tr>
<tr>
<td>Received dose in air on the surface of the subject</td>
<td>16–32 mr</td>
<td>50–60 mr</td>
</tr>
</tbody>
</table>

In the control cases, the numbers of leucocytes, neutrophile leucocytes and lymphocytes in 1 cmm. of their peripheral blood were 7,000±1380, 4,160±1060 and 2,220±795 respectively. These numbers correspond nearly to the blood pictures of healthy Japanese people.3)4)

The changes of blood picture in the serial blood examinations were observed. The mean values of the ratio of each cell number in the first examination to those in the second examination in each individual were obtained in the serial examinations.

In the case of high intensity momentary exposure of 60 mr by photofluorography of the chest, the main X-ray fell in the form of a circle (120 cm. in diameter) on (one spot of) the body, i.e., this 120 cm. diameter circle may be considered to be the same as the area of the back of the body.
The blood counts were made in 15, 30, 60 and 120 minutes after the exposure. A comparison of the blood pictures before and after the exposure was made and the results obtained may be stated as follows. After the exposure, the numbers of total leucocytes and neutrophile leucocytes showed no marked change, while the lymphocyte value decreased considerably (Fig. 1). The number of lymphocytes reached the minimum 30 minutes after the exposure and did not begin to recover until 60 minutes.

![Graph showing the change of lymphocyte number in percentage after a single whole body exposure to X-ray (60 mr).](image)

Fig. 1. The change of lymphocyte number in percentage after a single whole body exposure to X-ray (60 mr).

Similarly, in the 56 cases of momentary exposure to X-ray by radiography (16–30 mr) of the chest, the number of lymphocytes decreased during 30 minutes after the exposure when compared to that of pre-exposure number (Table II). Making a t-test for this experiment, the

| Table II |
| The Effect of X-ray Exposure by Chest Radiography on the Peripheral Blood Picture |

<table>
<thead>
<tr>
<th></th>
<th>Leucocytes (%)</th>
<th>Neutrophile leucocytes (%)</th>
<th>Lymphocytes (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control (66 cases non-exposed)</td>
<td>99.5±7.6</td>
<td>100.0±9.4</td>
<td>100.5±8.0</td>
</tr>
<tr>
<td>Exposed after 30 min. (56 cases)</td>
<td>96.3±8.3</td>
<td>101.5±14.3</td>
<td>88.2±12.9</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>t=6.950</td>
</tr>
</tbody>
</table>
calculated value of \( t \) is 6.950, which is larger than the value of \( t \_0.01 \) whereby \( n \_120 \).

Therefore, it is said that the exposed group shows a significant decrease of lymphocytes at the 0.1\% level.

**DISCUSSION AND SUMMARY**

The peripheral blood picture at the time of routine radiography was examined in 106 cases of healthy adult Japanese. In the total leucocyte and the neutrophile leucocyte numbers there was no significant difference between those before and after radiography. But in the number of lymphocytes a significant decrease was observed after radiography.

The mechanism of the decrease may be due to a functional reaction of the human body.

The decrease of the number of lymphocytes in the peripheral blood is a typical change in the case of X-ray irradiation and this fact is regarded as one of the indicators of radiation effects.\(^6\)

According to Mayneord\(^7\), exposure to 10–20 mr per day over a year caused leucopenia, and exposure to 20 mr per day for several weeks caused a tendency toward leucopenia. Further, it has been discussed that exposure over a year to a smaller dose than maximum permissible dose causes anemia, excessive lobulation, decrease of total number of leucocytes and left-shifting of neutrophile leucocytes.

Single exposure to 5 r in mice resulted in the degeneration of lymphocytes of the spleen.\(^8\)

Exposure to such small dose as 15–20 r causes occasionally a continuous radiation hazard in the human being.\(^9\)

The results obtained in the present study should not be taken as the typical radiation hazards, but they show surely the fact that even a single momentary exposure to X-rays in such a small dose as 15–60 mr exerts some effects on the human body.

**References**


Effect of X-Ray Exposure upon Peripheral Blood Picture

8) Langendorff & Saurborn, Strahlenther., 1943, 73, 91.