# Hematological findings in male x-ray technicians

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## ABSTRACT

**Objective:** In view of the known health hazards of x-ray radiation, this study focuses on the basic hematological parameters: red blood cells (RBCs), white blood cells (WBCs) and platelets count in x-ray technicians. The aim was to identify the affect of x-ray radiation on blood cell counts in x-ray technicians.

**Methods:** The present study was conducted in the Department of Physiology, College of Medicine, King Saud University, Riyadh, Kingdom of Saudi Arabia during the year 2002. In this study, a group of 40 apparently healthy male x-ray technicians with age ranging from 25-50-years were recruited. They were matched with another group of 40 apparently healthy control subjects in terms of age, sex and ethnic origin. Both groups met with exclusion criteria as per standard. Red blood cells, WBC and platelets count were performed by using a blood cell auto analyser (Beckman coulter counter).

**Results:** The mean value of platelet count was significantly decreased ($p<0.01$) in x-ray technicians when compared to controls. However, no significant difference was observed in RBC and WBC count between the groups.

**Conclusion:** The present study suggests that exposure to x-ray radiation causes decreased platelet count. Further, studies are needed to study the long-term effects of x-ray radiation on blood cell count in x-ray technicians.

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X rays are part of the electromagnetic energy traveling waves, which includes radio waves, microwaves, and visible light. X-rays are a form of ionizing radiations produced by firing electrons at a heavy metal target. These ionizing radiations penetrate the living tissues and can destroy living cells or make them functionally abnormal.[1] Ionizing radiations including alpha, beta and gamma rays and neutrons with sufficient energy to generate ion pairs such as electrons, which can generate chemically active free radicals these in turn can damage the molecular structure resulting in cell dysfunction (somatic effect) or mutations (genetic damage).[2] Recently National Cancer Institute (NCI) of the United States of America (USA) is considering adding medical x-rays to human carcinogenic list.[3] Workers over exposed to x-ray radiations are prone to develop life-threatening diseases often related with hematopoietic system. In view of the fact that, the hematopoietic system is highly sensitive to radiation and the peripheral blood, count may well serve as a biological indicator of such damage.[4] Blood cell count has maintained a time-honored position in hematological analysis as a screening test for various hematological as well as non-hematological disease states. Being a simple, inexpensive, side room test; the blood cell count is especially valuable for diagnostic and prognostic purposes in silent illnesses including chronic diseases. In addition, blood cells examination allows

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the clinicians to achieve broad differential diagnostic impressions.[5] The blood cell count remains fairly constant in healthy persons and is affected by many factors including occupational hazards.[6] High or low blood cell count even in healthy looking subjects leads to suspicion of disease. Though, the importance of blood cell count was discussed in numerous studies that have addressed the effects of partial or total body irradiation on peripheral blood cell count and most of the studies were focused on high dose radiation received accidentally or therapeutically.[7-9] While many studies dwelled on the high dose radiation hazards these scanty information on the radiation hazards produced in the personal working in the Clinical Radiology Departments especially the probable change in the basic hematological parameters; such as red blood cells, (RBCs), white blood cells (WBCs) and platelets count that can be used in the evaluation of the harmful effects of x-ray radiations. Thus, the present study aims at recording hematological findings in workers exposed to x-ray radiations and comparing them with matched healthy non exposed controls.

**Methods.** The present study was conducted in the Department of Physiology, College of Medicine, King Saud University Riyadh, Kingdom of Saudi Arabia during the year of 2002. In this study all the participants were recruited through personal visit and 2 groups were formed 40 subjects each. In the first group, 40 apparently healthy male volunteer x-ray technicians with age range 25-50-years were randomly selected through personal visit by the author from the Radiology Departments in different hospitals in Riyadh. These x-ray technicians worked in different shifts for 8 hours a day for 5 days per week. The mean duration of exposure in these x-ray technicians was 6.30 ± 0.41 years (mean ± S.E.M) ranging 2-14-years. They were age matched with a second group of 40 apparently healthy control (un-exposed) subjects. The control group was selected with a similar manner to that of the x-ray technicians; they were composed primarily of secretarial staff, shopkeepers and salesmen. All subjects completed a questionnaire, which included anthropometric data and a consent form. Both groups met with exclusion criteria as per standard.

***Exclusion criteria.*** Subjects with gross anemia, known history of diabetes mellitus, cardiopulmonary disease, acute or chronic infection, or both, autoimmune disease, malignancy, subjects with current or previous history or tobacco (smoked or chewed) addictions or who chewed betel nut were excluded from the study. In addition, subjects who had working experience in any industry such as cotton, welding, cement were also excluded.

Two ml of blood was collected from each subject by venipuncture with a disposable syringe. Blood was transferred to a bottle containing ethylene di-amine tetra acetic acid (EDTA) in a concentration of 1.5 mg/ml and this was used for blood cell count. Each specimen bottle was labeled with the subject identification code number. Blood cell count was performed on an electronic cell counter (Beckman coulter counter) USA.

***Statistical analysis.*** The results were computed on computer in Excel program. The statistical analysis was conducted using a paired t test (2-tailed) and the level of significance was taken as $p$ value less than 0.05.

**Results.** The mean values for anthropometric data (age) and hematological parameters RBCs, WBCs and platelets count for x-ray technicians and controls are presented in **Table 1**. X-ray technicians showed a statistically significant decrease in the mean values of platelets count ($p<0.01$). However, no significant difference was observed in age, RBCs and WBCs count between the groups. The mean duration of exposure in x-ray technicians was 6.30 ± 0.41 years (mean ± S.E.M. range 2-14-years).

***Duration of exposure less than 5-years.*** **Table 2** summarizes the comparison of RBCs, WBCs and platelet count in x-ray technicians on the basis of duration of exposure <5-years compared with their matched control. There were no significant difference between the means values of age, RBCs, WBCs and platelet count in both groups. The mean duration of exposure in x-ray technicians was 3.83 ± 0.34 years (mean ± S.E.M.), range 1-4-years.

***Duration of exposure 5-8-years.*** **Table 3** shows the comparison of RBCs; WBCs and platelet count in x-ray technicians on the basis of duration of exposure 5-8-years compared with their matched control. There were no significant differences observed in the mean values of age, RBCs, WBCs and platelet count between the groups. The mean duration of exposure in x-ray technicians was 6.29 ± 0.30-years (mean ± S.E.M.), range 5-8-years.

***Duration of exposure greater than 8-years.*** **Table 4** demonstrates the comparison of RBCs, WBCs and platelet count in x-ray technicians on the basis of duration of exposure >8-years compared with their matched control. There were no significant difference between the mean values of age, RBCs, WBCs and platelet count in both groups. Though, the platelet count was decreased in x-ray technicians with increased duration of exposure, but this decline did not achieve the significance level. The mean duration of exposure in x-ray technicians was 9.0 ± 0.84 years (mean ± S.E.M.), range 8.5-14 years.

**Discussions.** Long-term exposure to low doses of ionizing radiation may affect cells and result in various adverse health effects. Keeping in

view the effects of exposure to x-ray radiation, the present study incorporated basic hematological parameters RBCs, WBCs and platelets count. The aim was to determine the affect of x-ray radiation on blood cell counts in x-ray technicians. Estimation of the blood cell count in clinical practice is useful screening test in routine medical checkup. A normal blood cell count is reassuring but a high or low blood cells count, or both, even in a healthy-looking subject leads to the suspicion of disease, and it should require further investigations. Although it is a non-specific phenomenon, the fact remains that the vast majority of acute or chronic inflammation/infection and most neoplastic and degenerative diseases are associated with acceleration or deceleration of blood cell count.[10]

In this study, we observed a significant reduction in the mean values of platelets count ($p<0.01$) in x-ray technicians with compared to un-exposed healthy controls. However, the RBC and WBC count did not show any significant difference between the 2 groups. There was also no significant effect of duration of exposure to x-ray radiation. The results of the present study shows that x-ray radiation causes a reduction in platelets count. Inadequate production of blood cell occurs in different conditions including inflammatory disorders, fibrosis, drugs, endocrine disorders, decreased formation of erythropoietin, invasion of bone marrow, leukemia, secondary carcinoma and in aplastic anemia.[11] Peripheral blood leukocyte count is a cellular marker of inflammation.[12] Changes in the number of circulating leukocytes can represent a primary disorder of leukocyte production or may reflect a secondary response to some disease process or toxin.[13] Raised leukocyte count also suggests the presence of infection.[14] Similarly, platelet count may be affected in different conditions including generalized bone marrow failure, leukemia, aplastic anemia and in viral infections.[11] Zachariah et al[15] assessed a weekly complete blood cells count to identify the pattern of changes in blood cell count during conventional radiotherapy and showed statistically significant decline in all blood cell counts. However, in the present study only the platelets count was decreased but no change was observed in RBC and WBC count. The probable reason for this difference was that Zachariah et al[15] observed the blood cell count in patients exposed to radiotherapy but not in x-ray technicians. Hrycek et al[16] reported that workers handling x-ray equipment have disturbances of peripheral blood neutrophil metabolism. In addition, they also observed that neutrophil phagocytic activity was weakened in subjects working over 5-years with x-ray equipment. Rozgaj et al[4] reported that long-term exposure to low doses of ionizing radiation may affect the cells and tissues and result in various adverse health effects. They reported that

**Table 1** - Anthropometric and blood cell count data between x-ray technicians and controls (n=40)

| Parameters | Control subjects (mean ± SEM) | x-ray technicians (mean ± SEM) | % change | Sig. level |
|---|---|---|---|---|
| Age (year) | 35.35 ± 1.07 | 36.70 ± 1.13 | +3.8 | NS |
| RBCs/μ lit | 5441500 ± 147732 | 5572000 ± 169116 | +2.3 | NS |
| WBCs/μ lit | 7410 ± 365 | 7195 ± 396 | -2.9 | NS |
| Platelets/μ lit | 231875 ± 9513 | 193300 ± 13341 | -16.6 | $P<0.01$ |

RBC - red blood cells, WBC - white blood cells, NS - not significant

**Table 2** - Anthropometric and blood cell count data between x-ray technicians on the basis of duration of exposure <5years compared with their matched controls (n=12).

| Parameters | Control subjects (mean ± SEM) | x-ray technicians (mean ± SEM) | % change | Sig. level |
|---|---|---|---|---|
| Age (year) | 30.16 ± 1.20 | 33.75 ± 1.77 | +11.90 | NS |
| RBCs/μ lit | 5612500 ± 263479 | 5528333 ± 341640 | -1.49 | NS |
| WBCs/μ lit | 7325 ± 687 | 6000 ± 400 | -18.08 | NS |
| Platelets/μ lit | 249666 ± 15493 | 206415 ± 26412 | -17.32 | NS |

RBC - red blood cells, WBC - white blood cells, NS - not significant

**Table 3** - Anthropometric and blood cell count data for x-ray technicians on the basis of duration of exposure 5-8-years compared with their matched controls (n=17).

| Parameters | Control subjects (mean ± SEM) | x-ray technicians (mean ± SEM) | % change | Sig. level |
|---|---|---|---|---|
| Age (year) | 35.11 ± 1.33 | 37.0 ± 1.59 | +5.3 | NS |
| RBCs/μ lit | 5451764 ± 265443 | 5607647 ± 231477 | +2.8 | NS |
| WBCs/μ lit | 7500 ± 578 | 7588.23 ± 782 | +1.1 | NS |
| Platelets/μ lit | 231529 ± 15996 | 204411 ± 17705 | -11.7 | NS |

RBC - red blood cells, WBC - white blood cells, NS - not significant

**Table 4** - Anthropometric and blood cell count data for x-ray technicians on the basis of duration of exposure >8 years compared with their matched controls (n=11).

| Parameters | Control subjects (mean ± SEM) | x-ray technicians (mean ± SEM) | % change | Sig. level |
|---|---|---|---|---|
| Age (year) | 41.36 ± 1.89 | 39.45 ± 2.51 | -4.6 | NS |
| RBCs/μ lit | 5239091 ± 211374 | 5564545 ± 364198 | +6.2 | NS |
| WBCs/μ lit | 7363 ± 701 | 7890 ± 541 | +7.5 | NS |
| Platelets/μ lit | 213000 ± 17108 | 161818 ± 27838 | -24.0 | NS |

RBC - red blood cells, WBC - white blood cells, NS - not significant

the blood count drops soon after irradiation and recovers within several weeks. Our results for the drop of platelets count confirms the results observed by Rozgaj et al.[4] Takeuchi et al[17] Takeuchi[18] suggested that the x-ray irradiation has a destructive action on cells of the immune system and depress their functional activity. In addition, antibody-producing ability, delayed type hypersensitivity reaction and mitogenic activity were also found to be sensitive to x-ray irradiation. Nothdurft et al[19] reported that ionizing radiation is one of the cytotoxic agent that particularly cause damage to cell renewal systems. They also demonstrated that the lymphocytes, thrombocytes and neutrophilic granulocytes uniformly showed early decrease within the first days corresponding to cumulative radiation doses. Nothdurft et al[20] demonstrated that the platelet count was transiently depressed during the course of the treatment with total-body irradiation with a dose of 2.4 Gy. In the present study, a decreased in the mean values of platelets has been demonstrated, but other parameters did not reveal significant difference between the groups. This difference probably reflects the low degree of severity of disease expressed in terms of hematologically changes or it may be due to remarkable regenerative capacity of blood cells, or both, which will recover within a short period of time.[21,22] Therefore, we believe that rapid recovery of these cells limits its application as a diagnostic tool.

Although as per obtained hematological result, the above values of RBCs, WBCs, and platelets cannot be reliably translated into clinical benefit for the x-ray technicians. However, a study involving large size and long term exposure to x-ray radiation might bring out significant hematological findings.

It is worthwhile that the X-rays Department workers, their employers and health officials work together to adopt technical preventive measures such as wearing appropriate protective equipment, like lead apparel, lead goggles, thyroid shield etc. We recommended that x-ray technicians should regularly use appropriate personal protective equipment at their work site. These measures will help to prevent the hazards of x-ray radiations. In addition, x-ray technicians must undergo pre-employment and periodic medical surveillance tests to identify the more susceptible workers. It is also suggested that after every 3 months short term leaves should be granted for x-ray technicians to minimize the exposure affect of x-ray radiation.

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