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RESEARCH ARTICLE

THE EFFECT OF THE LONG-TERM EXPOSURE TO X-RAY ON THE PERIPHERAL BLOOD CELLS COUNTS: A PREDICTIVE TOOL FOR THE RISK OF A LOW DEGREE OF THE DISEASE SEVERITY AMONG X-RAY WORKERS

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ABSTRACT

X-ray is one of the ionizing radiation that penetrates living tissues and generate chemically active free radicals these in turn potentially causes DNA damage. This study aimed to determine hematological changes, in particular total white blood cells count (TWBC), red blood cells count (RBC) and platelets count in X-ray workers in Sudan. Following informed consent, one hundred and twenty individuals; sixty apparently healthy volunteer X-ray technicians worked 8 hours a day for six days per week, and age and sex matched sixty unexposed healthy control were enrolled. TWBC, RBC and platelets count were determined for all participants. A significant correlation between a reduction in the TWBC count and the duration of the exposure to X-ray radiation was determined, however, no significant differences were observed in the mean values of RBC, TWBC and Platelets count between the X-ray technicians and the un-exposed healthy controls. We concluded that long-term exposure to X-ray may cause a low degree of severity of disease which is expressed in terms of haematological changes

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INTRODUCTION

X-rays are forms of electromagnetic radiation that carry enough energy to ionize atoms and disrupt molecular bonds. This makes it a type of ionizing radiation been capable to penetrate living tissues and generate chemically active free radicals these in turn potentially causes DNA damage (Masumura *et al.*, 2002). X-rays have been used widely in medical practice to create images of the human body using different technologies and techniques including computed tomography (CT scan), fluoroscopy, and radiography ("conventional X-ray" including mammography). As in many aspects of medicine, there are risks associated with the use of X-ray imaging. The most common adverse impact is the induction of cancer with a latent period of years or decades after exposure (Hall and Brenner 2008; Brenner 2010; De Santis *et al.*, 2007). World Health Organization's International Agency for Research on Cancer has classified X-ray as carcinogen (Roobottom *et al.*, 2010). It is estimated that 0.4% of current cancers in the United States are due to CT scans (Brenner and Hall 2007). Experimental and epidemiological data do not support the proposition that there is a threshold dose of radiation below which there is no increased risk of cancer. However, this is under increasing doubt (Calabrese

and Baldwin 2003). It is estimated that the additional radiation will increase a person's cumulative risk of getting cancer by age 75 by 0.6–1.8% (Berrington and Darby 2004).

The blood cell count remains fairly constant in healthy persons and is affected by many factors including occupational hazards (Ward *et al.*, 1996) High or low blood cell count even in healthy apparent subjects leads to suspicion of disease. Since the blood forming cells are one of the most sensitive cells to ionizing radiation due to their rapid regeneration rate, it can be used as an indicator to determine the effect of ionizing radiation and its severity (Theodoret *et al.*, 2007). Numerous studies have addressed the effects of partial or total body irradiation on peripheral blood cell count, most of them were focused on high dose radiation received accidentally or therapeutically (Littlefield *et al.*, 1991; Yang *et al.*, 1995). Workers over exposed to X-ray radiations are prone to develop life-threatening diseases often related with haematopoietic system. While many studies addressing the high dose radiation hazards there is scanty information on the radiation hazards produced in the individuals working in the clinical radiology departments specially the probable change in the basic hematological parameters e.g., RBCs, WBCs and Platelets counts that can be used in the evaluation of the harmful effects of X-ray radiations. Thus, this study aimed to determine hematological changes, in particular RBC, WBC and platelets count in X-ray workers in Sudan.

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MATERIALS AND METHODS

Following informed consent, one hundred and twenty individuals were enrolled; sixty apparently healthy volunteer X-ray technicians worked 8 hours a day for six days per week were randomly selected from the Radiology Departments in different hospitals in Khartoum state; and age and sex matched sixty unexposed control. Subjects with gross anemia, known history of diabetes mellitus, cardiopulmonary disease, acute or chronic infection, autoimmune disease, malignancy and subjects with current or previous history of tobacco addictions were excluded from the study. Two ml of EDTA anticoagulated blood was collected from each subject. Blood cell count was performed by automated cell counter (Sysmex KX-21N) at the Department of haematology, faculty of medical laboratory sciences, Alneelain University, Sudan. Statistical analysis was performed using statistical package for social science (SPSS) software. Evaluation of patient's data was performed using the t-test and Pearson correlation test. Results with p value < 0.05 were considered statistically significant.

RESULTS

The male: female ratio was 1.4 and the mean age of the X-ray technician was 33±8.6 years. The mean work duration was 5.6±2.9 years. All patients were tested for the blood cell count. The results of the correlation between the duration of the exposure to X-ray (work duration) and the blood cells counts were as follows: negative association with TWBC (P value = 0.020); no correlation with RBC count (p value = 0.70) and platelets count (p value = 0.87). The results of the blood cells count were as follows: RBC count mean 4.5±0.48 X10¹²/L; TWBC count mean 5.2 ±1.6 X10⁹/L; platelets count mean 256 ±51X10⁹/L. The mean of the blood cells counts showed no significant differences between the X-ray technician and control group (Table 1).

Table 1. Blood cell count data between X-ray technicians and Controls

Parameter	X-ray technician	Control	P value
RBC mean (X10 ¹² /L)	4.5	4.3	0.053
TWBC mean (X10 ⁹ /L)	5.2	5.1	0.66
Platelets mean (X10 ⁹ /L)	256	258	0.84

DISCUSSION

Long-term exposure to low doses of ionizing radiation may affect cells and tissues and result in various adverse health effects. The present study incorporated basic hematological parameters RBCs, WBCs and platelets count. The aim was to determine the effect of X-ray radiation on blood cell counts in X-ray technicians. In this study we observed a significant correlation between a reduction in the TWBC count and the duration of the exposure to X-ray radiation, however, no significant differences were observed in the mean values of RBC, TWBC and Platelets count between the X-ray technicians and the un-exposed healthy controls. Peripheral blood leukocyte count is a cellular marker of inflammation. 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. Inadequate production of leukocyte occurs in different conditions including inflammatory disorders, fibrosis, endocrine disorders, leukemia, secondary carcinoma and in aplastic anemia. Many studies (Zachariah *et al.*, 2001; Nothdurft *et al.*, 1995) reported that exposure to low doses of ionizing radiation may affect the cells and tissues and result in various adverse health effects. They reported that the blood count drops soon after irradiation, however, their observations concerned patients exposed to radiotherapy but not X-ray workers. Hrycek *et al.* (1995) 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 persons working over five years with X-ray equipment. Our findings probably reflect a low degree of severity of disease with long term exposure to X-ray which is expressed in terms of haematological changes.

Conclusion

Long-term exposure to X-ray may cause a low degree of severity of disease which is expressed in terms of haematological changes

Recommendation

We recommended that, in addition to the safety and protective measures that have been adopted in the different radiology departments, X-ray technicians must undergo periodic medical surveillance check including blood cells count that can help detecting the low degree of severity of disease with long term exposure to X-ray.

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Authors contributions

I.E. Diab and M.H.A. Abdalla conceived the idea of the study, collected and analyzed samples and data and wrote the manuscript.

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