Effects of Radiation on the Hematological Parameters in X-Ray Technicians: A Case-Control Study

Mazin R. Mohammed 1, Shaymaa M. Abdulateef 2, Najm A. Dawood 3, Mustafa G. Taher 4, Shatha A. Jabur 5, Abdulkareem H. Alwain 6

1 F.I.C.M.S. Pathology, Baqubah teaching hospital, Diyala, Iraq
2 M. Sc. Pathology, Baqubah teaching hospital, Diyala, Iraq
3 Assistant Lecturer, M.Sc. Organic chemistry, College of Basic Education, Soran University, Erbil, Iraq
4 Assistant Lecturer, M.Sc. Oral Pathology, Department of Pathology, College of Medicine, Diyala University, Diyala, Iraq
5 Assistant Lecturer, M.Sc. Oral Pathology, Foundation of Technical Education, Baghdad, Iraq
6 Assistant Lecturer, M.Sc. Periodontic, School of Dentistry, University of Sulaimani, Kurdistan region, Iraq

ABSTRACT

BACKGROUND: X-ray technicians are at risk of varying degrees of radiation exposure during their work. One consequence of radiation exposure is changes in hematological parameters. The aim of this study was to identify the effect of X-ray radiation on hematological parameters in X-ray technicians.

METHODS: The study was conducted in the Department of Hematology, Baqubah teaching hospital, Diyala, Iraq during the year 2011. In this study a group of 47 apparently healthy X-ray technicians (34 males; 13 females) with age ranging from 25-50 years were recruited. Technicians were compared with another group of 20 apparently healthy control subjects in the same range of age, gender, ethnic origin. Hematological parameters and blood cell morphology were observed using a blood cell auto-analyser (Sysmex Coulter Counter) and blood films respectively.

RESULTS: The percentage of atypical lymphocytes was significantly higher (p<0.01) in X-ray technicians when compared to control group. Positive correlation was found between percentage of atypical lymphocytes and duration of exposure to X-ray (correlation = 0.67; p=0.005). However, no significant difference (p>0.05) was observed in the rest of hematological parameters between the two groups.

CONCLUSION: The study suggests that exposure to X-ray radiation causes atypical changes in the lymphocyte morphology. Further studies are needed to study the long term effects of X-ray radiation on hematological parameters and immunophenotyping of atypical lymphocyte population in X-ray technicians.

KEYWORDS: hematological parameters; X-ray radiation; X-ray technicians

INTRODUCTION

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]. Radiation includes alpha, beta, and gamma rays and neutrons with sufficient energy to generate ion pairs (electrons), which can generate chemically active free radicals. These radicals in turn can damage the molecular structure resulting in cell dysfunction (somatic effect) or mutations (genetic damage) [2]. Workers over-exposed to x-ray radiations (a type of gamma rays) are prone to develop life-threatening diseases especially related to hematopoietic system [3]. The hematopoietic system is highly sensitive to radiation and the peripheral blood examination may serve as a biological indicator of such damage [3]. Peripheral blood examination may serve as a screening test for various hematological as well as non-hematological disease states. Being a simple, inexpensive, point-of-care test, the blood cell count is especially valuable for diagnostic purposes in the subclinical stage of many diseases.
In addition, blood cell examination allows the clinicians to achieve broad differential diagnostic impressions [4]. The aim of this study was to identify the effect of X-ray radiation on hematological parameters in X-ray technicians.

METHODS AND MATERIALS

Selection of the participants: The present study was conducted in the Department of Hematology, Baqubah teaching hospital, Diyala, Iraq during 2011. The exposure group for this study consisted of 47 apparently healthy X-ray technicians (34 males and 13 females) with age range of 25-50 years, who were randomly selected from the radiology departments of different hospitals in Diyala. These X-ray technicians worked for 8 hours a day for five days per week. The duration of exposure to radiation was based on years of exposure that ranged between 1and 37 years. They were compared with a second group of 20 apparently healthy control (un-exposed) subjects. All subjects completed a questionnaire, which included anthropometric data and a consent form.

Exclusion criteria: Subjects with gross anemia, known history of diabetes mellitus, cardiopulmonary disease, acute or chronic infection, autoimmune disease, malignancy were all excluded.

Hematological Methods: Two milliliters of blood was collected from each subject by venipuncture in a disposable syringe and blood was transferred to a tube containing ethylene diamine tetra acetic acid (EDTA) in a concentration of 1.5 mg/ml. Preparation of blood film slides and staining were conducted according to standard procedures [5]. Blood cell count was performed on an electronic cell counter (Sysmex coulter counter, USA).

The differential count in X-ray technicians was quantified manually by cell counter (Karl Kolb, Germany) and was compared to normal control group. Cell morphology was viewed at high power magnification (X400) for the entire blood film slides. Lymphocytes of large size, abundant, basophilic cytoplasm were regarded as atypical lymphocytes [5].

RESULTS

Forty seven healthy X-ray technicians; 34 males and 13 females were included in this study. The mean age for x-ray technicians was 37.10 ±1.17 years (range 25 to 50 years) while that for controls was 35.81±1.06 years (range 23 to 51 years).

We found significantly higher percentage of atypical lymphocytes in X-ray technicians than the control group (7.5% vs. 2.7%, P= 0.01) (Table1). However, no significant difference was observed in RBCs, WBCs or platelets counts between the groups (Table 1). The mean duration of exposure in X-ray technicians was 6.80 +/- 0.31 years. Positive correlation was found between atypical lymphocyte percentage in the exposed group and duration of exposure to radiation in years (correlation = 0.67, p=0.005).

No significant correlations were found between other hematological parameters in the exposed group and duration of exposure to radiation (Table 2).

Table 1: Blood cell count data between X-ray technicians and control group

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Control Subjects (N=20) (Mean +/- S.E.M.)</th>
<th>X-ray technicians (N=47) (Mean +/- S.E.M.)</th>
<th>Significance level</th>
</tr>
</thead>
<tbody>
<tr>
<td>RBC</td>
<td>4.83+/-.09</td>
<td>5.10+/-.07</td>
<td>0.055 NS</td>
</tr>
<tr>
<td>WBC</td>
<td>6.73+/-.34</td>
<td>7.65+/-.25</td>
<td>0.052 NS</td>
</tr>
<tr>
<td>Platelets</td>
<td>262.85+/-.13.30</td>
<td>258.31+/-.9.45</td>
<td>0.70 NS</td>
</tr>
<tr>
<td>Percentage of atypical lymphocytes</td>
<td>2.7+/-.0.5</td>
<td>7.5+/-.0.4</td>
<td>P=0.01</td>
</tr>
</tbody>
</table>

NS= Non significant; RBC = red blood cells; WBC = white blood cells

DISCUSSION

Long term exposure to low doses of ionizing radiation may affect cells and tissues and may result in various adverse health effects [6]. The present study confirmed a significant increase in atypical lymphocyte percentage in X-ray technicians compared with control subjects (Table 1) (figure 2). We also found that X-ray technicians with longer exposure time were more likely to have atypical lymphocytosis. Takeuchi, et al. (1992) and Minoru et al. (1997) [7,8] suggested that the X-rays had a destructive effect on immune cells with functional impairment. In addition, antibody production and mitogenic activity were also sensitive to X-ray irradiation. Many researchers did not compare atypical lymphocytes...
Table 2: Correlation (r(p-value)) between exposure time to radiation and laboratory findings of X-ray technicians group

<table>
<thead>
<tr>
<th>Time exposure</th>
<th>Hb</th>
<th>HCT</th>
<th>RBC</th>
<th>MCV</th>
<th>MCH</th>
<th>MCHC</th>
<th>WBC</th>
<th>NEUTROPHIL%</th>
<th>LYMPHOCYTE %</th>
<th>PLATELET</th>
<th>Atypical lymphocyte %</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.09 (0.50)</td>
<td>-0.12 (0.41)</td>
<td>-0.01 (0.93)</td>
<td>-0.20 (0.17)</td>
<td>-0.20 (0.17)</td>
<td>-0.22 (0.12)</td>
<td>0.28 (0.053)</td>
<td>0.07 (0.63)</td>
<td>-0.03 (0.83)</td>
<td>0.05 (0.73)</td>
<td>0.67 (0.005)</td>
</tr>
</tbody>
</table>

This finding cannot be elucidated in our study. Secondly, the sample size is small and hence the results might be underpowered. Thirdly, the temporality cannot be assessed given the case control study design although it is likely that it is radiation that caused changes in lymphocytes. Future studies with a prospective design and larger sample size should be able to ascertain the clinical relevance of our findings.

Figure 1: Blood film of an x-ray technician shows atypical lymphocytes, high power field X400.

REFERENCES

7. Takeuchi M, Shibata H, Nasu T. Effect of soft x-ray


