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Haematological Profile of Healthy Workers Exposed to Low Dose Radiation

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Abstract
Background: Long-term exposure to low doses of ionizing radiation may affect cells and tissues and result to various adverse health effects. **Objective:** To compare the haematological profile such as (red blood cell count, haemoglobin or hematocrit levels, white blood cell count and platelet count) of medical imaging and therapeutic technologists and controls selected from medical hospitals in Kumanovo and Skopje. **Method:** The study was performed on 140 subjects including 70 persons working with X-ray machines as the case group and 70 unexposed individual as the control. Complete blood cell count was performed with a haematology cell counter (Hem count 50L, Deutschland).Data was analyzed using SPSS version 20. **Results:** Mean values of hematocrit - HCT, mean cell haemoglobin - MCH, red cell distribution width - RDW, white blood cell –WBC, platelets – PLT, plateletcrit – PCT and platelet distribution width - PDW have shown significant difference from the control group. The mean MCH, PLT, PCT and PDW were higher, while HCT, RDW, WBC, granulocytes and neutrophils were lower in the exposed group. **Conclusion:** The haematopoietic system is highly sensitive to radiation and the peripheral blood count may well serve a biological indication. The rapid recovery of this tissue limits its application as a diagnostic tool to accidental cases of irradiation.
Keywords: ionizing radiation, haematological parameters, side effects, occupational health services.

Introduction

There is a worldwide concern about of ionization radiation in the medical field as x-rays, gamma rays and particles: alpha particles, beta particles, protons and neutrons. Radiations are being extensively used in diagnosis as well as in therapeutic use for cancer patients. Therefore, the frequent use of machines by health workers such as x-ray diagnostic units as well as therapy units, CT-scans, PET (positron emission tomography), SPECT (single photon emission computed tomography) gamma cameras, dose calibrators, radiopharmaceutical pose, have been found to be risk for their health condition (Jabeen, Munir & Khalid, 2010; Rehan., Diane., Lisa., Brian & Lewis, 2012).

X-rays have dangerous biological effects as they can impose ionizing effect when penetrating the living tissue, destroy living cells, cause chromosomal aberrations and impose carcinogenic impacts (Adhikari, 2012).

Damage can be caused to living cells, especially to deoxyribonucleic acid (DNA) in the cell nucleus when there is exposure to ionization radiation where the degree of this cellular damage depends on the amount of radiation administered (Dainiak,2002). Ionization radiation exposure is sensitive for those issues (i.e. bone marrow, the gastrointestinal tract and skin) which turnover rapidly as well as these tissues (i.e. central nervous system, lung, heart, liver, kidney and gonads) which turnover slowly (Godekmerdsn, Ozden & Nelson, 2004). Hematopoietic system is one of most radiosensitive systems, because its functional cells transport oxygen in blood which prevent immune system against viruses, bacteria, etc. This system also provides blood coagulation to safe intact blood vessels (Smirnova, 2011). It is known that bone marrow system is highly radiosensitive and analysis of hematopoietic system for such workers is highly emphasizing. Blood forming cells are located in bone-marrow and such cells highly susceptible to radiation damage.

Ionization radiation damage stem cells of hematopoietic system which is radiosensitive and as a result alteration in the production of bone marrow cells is observed which are important to regulate this system. An exposure to ionization radiation can reduce bone marrow production where blood forming cells both immature and rapidly dividing cells locate. Dividing cells of the hematopoietic system are highly radiosensitive which divide rapidly and may show effects at ever and low doses of long term ionization radiations such as x-rays or gamma rays (Edwards, 2012). Several studies suggest that chronic exposure of low-dose radiation has a genomic effect on somatic DNA of professionally exposed workers as well (Wall, Kendall & Mare, 2014)

Nowadays, there has been a rapid increase in the use of medical diagnostic and therapeutic tools like imaging tests of CT scan, X-ray, nuclear medicine tests and radiotherapy which may concern about the long-term consequences of exposure to those ionization radiations. There is much uncertainty about the risks of

haematological abnormalities or aberration and leukaemia after repeated or protracted low dose radiation exposure typical of occupational, environmental and diagnostic medical settings (Fielder., Nothdur & Steinbach, 1988; Meo, 2004). As the insurance of good health of workers and prevention of diseases is a main and first concern in any organization, specifically medical institutions, there needs to be a way to assess occupational risks. According to these findings, the main aim of this study was to assess the effect of low dose radiation on the hematological parameters of healthy workers of radiology department at hospitals in Kumanovo and Skopje.

Material and methods

Participants

A total of 140 subjects involving of 70 persons (24 females and 46 males) as the case group and 7o unexposed individuals (28 females and 42 males) as the control group in the period October 2016 to July 2017 were recruited for the study. The ages of the subjects ranged 20 to 60 years with a work experience higher than 3 years. The case group comprised of the healthy radiology staffs who work at medical hospital in Kumanovo and Skopje. The control group consists of 70 healthy subjects with no past history of exposure to ionizing radiation at workplace.

Ethnical Permission Guiding for Study

Ethnical approval was obtained and informed consent obtained from all the participants prior to this study.

Blood sampling

After an overnight fasting period 5 ml. Of peripheral blood samples were taken from the brachial vein of the case and control subjects. Blood samples for evaluation of haematological parameters were collected into sterile tubes with anticoagulant (EDTA).

Determination of the haematological parameters

Complete blood cell (CBC) count was performed with a haematology cell counter (Hem count 50L, Deutschland).Routine haematological parameters including red blood cell (RBC) count, haemoglobin content (HGB), hematocrit (HCT), white blood cell (WBC) count and platelet (PLT) count were determined on a Hem count 50L Automated Haematology Analyzer. Other indices such as MCH (Mean corpuscular haemoglobin), MPV (Mean platelet volume) RDW (RBC distribution width), PDW (Platelet distribution width) and PCT (Plateletcrit) were also reported.

Statistical Analysis

Data were statistically analyzed using one-way ANOVA test to determine significant difference in the data of two groups. Statistical tests were conducted using SPSS version 20. P - Values less than .01 or .05 was considered to be significant.

Results

Background information for all individuals included in this study has been presented in Table 1. Among all radiation workers (N=70) most of them were male (65.71%) and mostly (77.99%) were from the age group between 21-40 years. Also in the category radiation unexposed workers (N=70) most of the individuals were male (60.00%) and mostly (72.85%) were from the age group between 20-40 years.

Table1. Age and sex distribution of exposed and non-exposed participants

Parameter	Occupational Radiation Exposed Workers (N=70) No (%)	Occupational Radiation Unexposed Workers (N=70) No (%)
Sex		
Female	24 (34.29)	28 (40.00)
Male	46 (65.71)	42 (60.00)
Age Group		
21-30	24 (32.28)	20 (28.57)
31-40	32 (45.71)	31 (44.28)
41-50	10 (16.30)	11 (15.71)
51-60	4 (5.71)	8 (11.44)
Total	70 (100.00)	70 (100.00)

The results of blood cell counts are summarized in Table 2. There are the differences between the case and control group among their haematological status. All of the radiation exposed (N=70) workers had low hematocrit - HCT (36.21%), low RBC distribution width – RDW (10.24%), low white blood cell – WBC ($5.32x10^9$/L), low granulocytes – GRANU (47.23%), low neutrophils – NEUT (1.72%), but high Mean

corpuscular haemoglobin – MCH (35.21 pg), platelet – PLT (365.23x10^9g/L), Plateletcrit - PCT (1.76%) and Platelet distribution width - PDW (44.20%) as compared to controls. Overall, five CBC parameters: HCT, RDW, WBC, GRANU and NEUT were in the lower range of radiation exposed workers and four CBC parameters MCH, PLT, PCT and PDW are in high range as compared with the mean values complete blood cell of non-radiation exposes workers. It is observed of course, that majority of radiation exposed workers had their CBC parameters affected, because of the long term use of radiation in the hospitals.

Comparisons based on the one-way ANOVA test (Table 2) were conducted to find out those complete blood cell parameters which show the significance of difference between radiation exposed personnel and radiation unexposed personnel. The results of this test indicated that the difference between those exposed to radiation workers and those not exposed to radiation for HCT is ($F=75.235$, $p<0.05$), for MCH is ($F=112.546$, $p<0.05$), for RDW is ($F=87.357$, $p<0.05$), for WBC is ($F=87.357$, $p<0.05$). Also from the Table 2 we should see that the correlation is significance for following CBC parameters: PLT ($F=145.56$, $p<0.01$), PCT ($F=23.467$, $p<0<01$) and PDW ($F=134.357$, $p<0.01$).

Table2. Mean Complete Blood Count (CBC) values of radiation exposed and non-exposed group

Parameter	Case group N = 70 Mean (SD)	Control group N = 70 Mean (SD	F	P-value
RBC (10^{12}/L)	4.54 (1.22)	4.94 (1.45)	45.651	.231
HGB (g/L)	122.23 (6.54)	137.11 (6.74)	102.453	.437
HCT (%)	36.21 (2.12)	48.36 (2.56)	75.235	.018*
MCV (fL)	81.24 (0.87)	85.68 (0.58)	132.786	.432
MCH (pg)	35.21 (0.76)	29.45 (0.62)	112.546	.016*
MCHC (g/L)	322.42 (6.34)	354.28 (7.14)	64.213	.675
RDW (%)	10.24 (0.78)	14.22 (0.65)	87.357	.017*
WBC (10^9/L)	5.32 (0.43)	7.38 (0.67)	132.687	.003**
LYMPH (%)	19.21 (1.34)	24.45 (1.76)	64.754	.512
GRANU (%)	47.23 (0.69)	54.21 (0.65)	154.325	.016*
NEUT (%)	1.72 (0.11)	4.87 (0.34)	76.987	.014*
PLT (10^9g/L)	365.23 (7.23)	245.26 (5.23)	145.563	.006**
PCT (%)	1.76 (0.11)	0.92 (0.06)	23.467	.009**
MPV (fL)	8.13 (0.92)	7.22 (0.87)	45.236	.987
PDW (%)	44.20 (5.34)	37.21 (4.34)	134.357	.011*

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Discussion

It is well known that dividing cells of the hematopoietic system are highly radiosensitive (Hrycek, Stieber and Baron, 1999). Role of the functional cells of the lymphopoiesis and granulopoiesis is very important for immune protection against infections. Thrombocytopoiesis is one of the most radiosensitive hematopoietic cell lines in humans. Radiation injury or damage of hematological system can lead to hemorrhage and anemia (Davidic, Kelkhaei & Tihmaseb,i 2012; Shahid, Mahmud & Ahmad, 2014; Andreessen, Cioppa, Button & Federica, 2005). However, these alterations are dependent on an effective radiation dose range and exposure time (Ismail and Jaffa, 2011).

Our study revealed that a number of the CBC parameters are affected in the radiation exposed workers as compared to workers who were not exposed to radiation. For example, the mean white blood cell count at radiation workers was significantly lower than controls. Also neutrophil and granulocytes counts were lower as compared to the control group. Lowering in the count of white blood cells might imply the effect of radiation on the disease or infection prevention ability of workers i.e. the immunity of radiation workers might be deteriorating. A study by Caciari et al. (2012) indicating that the mean of total white blood cells was significantly decreased in exposed workers as compared by the controls. At low doses radiation can suppress responses, because of the destruction of cells.

In the present study the mean corpuscular haemoglobin was one of the complete blood count parameters which showed statistically significant differences between the exposed and the unexposed group. Mean corpuscular hemoglobin was higher in the exposed group than the control.

From our findings platelet, platelet distribution width and plateletcrit were also reported. PLT, MCT and PDW are the other higher values in the radiation exposed group in comparison with control. The increase level of platelet cell is associated with thrombocytopenia. PLT has a direct relation with MCT and PDW. In a research

conducted by Mohammed et al (2014) performed on radiation field workers, the platelet count was significantly increased among workers compared to controls. Platelet activity is associated with the initiation of coagulation cascades. When a blood vessel is damaged, the sub-endothelial surface becomes the primary target site of platelet action, where is establishes hemostasis (Babu and Basu, 2004).

Many of the other parameters like red blood cell, mean cellular volume, mean cellular hemoglobin count and lymphocytes have not been significantly different from that of controls. Only the mean value of hematocrit count was significantly lower in the radiation technologists than the controls.

Ionization radiations can damage stem cells of the hematopoietic system and can alter the production of bone marrow stormed elements which are important to maintain this system. Long term damage caused by ionization radiation can induces various hematological disease (Khorrami & Banded, 2015; Waggiallah, 2013; Zykova, 2004).

Conclusions

Hematopoietic system is found to be sensitive for radiation workers, because mostly complete blood cell parameters were observed suppressed. Changes in blood parameters have been noted.

The provision of medical support for radiated field workers has become a standard practice in many countries due to the wide spread use of ionizing radiation and their well recognized adverse affect on health. This should be incorporated into the occupational health service and performed by an occupational health physician with good knowledge of ionizing radiation and its health effects and familiarity with the work processes that involve radiation apparatus and radioisotopes in the workplace.

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