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Effects of External Radiation Exposure on some Hematological Parameters of Hospitals Workers Staff

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Abstract: The current study was conducted on a number of workers in a hospital for cancer treatment in Baghdad. The studied subjects included 11 workers and nine controls. The study focued on basic hematological parameters including the mean value of red blood cells (RBCs), white blood cells (WBCs), hemoglobin (Hgb), hematocrit (Hct), neutrophils (Neu), lymphocytes (Lymph), monocytes (Mono), mean cell volume (MCV), mean corpuscular hemoglobin (MCH), mean corpuscular hemoglobin concentration (MCHC) and red cell distribution width (RDW) in blood samples of hospital workers matched with a control group. The results showed the occurrence of significant differences between age of workers and healthy control group and high frequences were recorded at age 41-60 years (55.6%). No significant difference was noted between gender of workers and control. Significant differences were noted in hematological parameters in RBCs. Highly significant differences were noted in Neu, Lymph, Mono and MCHC, while no significant differences were noted in WBC, Hgb, Hct, MCV, MCH and RDW between workers and control group. The present study concluded that in addition to the safety and protective measures that have been adopted in the hospital, appropriate personal protective measures for workers in external radiation therapy field (i.e., periodic medical surveillance including the hematological parameters) must be applied.

Keywords: Ionizing radiation, Workers staff, Blood cells, Exposure, Hematological parameters.

Introduction

As ionizing radiation is often used in medicine for diagnostic and therapeutic purposes, radiation workers exposed to ionizing radiation have to follow all the safety measures and precautions at their work. Should all safety procedures not be followed, human health may be seriously endangered by ionizing radiation. Nuclear medicine workers are occupationally exposed to low doses of ionizing radiation. For those who are occupationally exposed, effective doses range from 6 to 20 mSv (Djokovic-Davidovic et al., 2016). Ionizing radiation displaces electrons in the atoms of material through which it passes and creates charged particles. Ionizing radiation can induce cellular

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damage through direct interaction with tissue or by indirect damage by generating free radicals and inducing inflammation. Deterministic effects, including acute radiation sickness and cutaneous burns, occur predictably after exposure depending on the type and total dose of radiation received, the rate at which that dose is delivered, and the relative sensitivity of the exposed tissues (Deas et al., 2017).

Not only the high ionizing radiation is harmful, but also low chronic doses are known as mutagenic and carcinogenic agents in mammals, including humans. The medical staff, using radiation for diagnostic and therapeutic purposes, is potentially at risk of overexposure. Fortunately, due to an application of principles of radiological protection, the levels of exposure of medical staff to ionizing radiation have decreased, and they are usually below the limit of 20 mSv/ year. However, several studies have shown an increased frequency of micronuclei, chromosomal aberrations and DNA strand breaks in workers exposed to low doses of ionizing radiation (Dobrzynska et al., 2014). The harmful effects of ionizing radiation are divided into two categories: acute and chronic. Acute effects occur in a short time after irradiation and are usually the result of exposing a large part of the body to high intensity radiation, whereas the chronic effects are caused by exposure to relatively low doses of radiation over an extended period of times (Talab et al., 2018).

Therefore, the concern and unawareness of Medical Radiographers (Mrs) are related to the stochastic effects of long-term exposure to low-dose radiation. The risk of stochastic effects such as cancer increases by dose without threshold (Alnahhal et al., 2017). Cells with rapid turnover are most susceptible to the adverse effects of ionizing radiation, e.g., gastrointestinal cells, hematopoietic cells and reproductive cells. Hematopoietic cells are of interest because decreased blood cell counts leave irradiated individuals susceptible to infection and decreased immunity (Sanzari et al., 2014). The hematopoietic system is highly sensitive to radiation and the peripheral blood examination may serve as a biological indicator of such damage (Mohammed et al., 2014).

Blood consists of two parts: plasma and cells. The cellular part consists of the red blood cell cells (R.B.Cs) and the white blood cells (W.B.Cs). Red blood cells are disc-shaped which lost their nucleus quickly after configuration producing in the bone marrow. About 71% of these cells is water and 28% is hemoglobin (Hb). Hemoglobin transports oxygen and food to all cells of the body, white blood cells contain different combinations (acid, base, neutral) and they are made in the bone marrow.

The lymphocytes are responsible to protect the body from diseases (Kadhim, 2013). High or low blood cell counts, even in healthy apparent subjects, lead to suspicion of the disease since blood forming cells are most sensitive to be use as an indicator to determine the effect of ionizing radiation and its severity (Nureddin & Alatta, 2016). Actually, the blood cell count is commonly used as a bio dosimeter for occupational exposure (Shafiee et al., 2016).

The aim of the present study was to assess the effects of ionizing radiation on the hematological parameter changes of hospital workers.

Materials and Methods

This study was carried out during the period from February to March 2018 on 20 individuals (11 workers and nine controls). Six males and five females in their age between 24-64 years old in Baghdad province were selected as cases to compared with another group of nine (five males and four females) population as a control group.

The exposed group was matched with controls in age and gender. Basic hematological parameters including the RBCs, WBCs, Hb, Hct, Neu, Lymph, Mono, MCH, MCHC, MCV and RDW in blood samples of hospital workers matched with a control group.

Subjects with gross anemia, known history of diabetes mellitus, cardiopulmonary disease, acute or chronic infection, autoimmune disease and malignancy, subjects with a current or previous history of smoking or alcohol consumption were excluded from this study.

Five milliliters of blood from each participant were collected by vein-puncture in a disposable syringe and blood was transferred to a tube containing ethylene diamine tetra acetic acid (EDTA K3) in a concentration of 3 mg/ml.

Hematological parameters were measured by using Sysmex–Mmindray–Njhoneoden analyzer at a private and standard laboratory. Twenty individuals were examined in this study. Hematological markers included WBC, RBC, Hb, HCT, MCHC, MCH, MCV, RDW, Neutrophils, Lymphocytes and Monocytes.

Data were analyzed by mean, standard deviation, standard error and graphical presentation through using Bar- charts for quantitative variables were compared with the independent sample t-test in software IBM SPSS statistics program Version 21. The P values lower than 0.05 assumed as significant (Lu et al., 2015).

Results

The present investigation revealed the occurrence of significant differences among studied hospital workers in comparison with the control group, especially within age group 41->60 years (Table 1). The mean and stranded error of age in workers compared with the control group are shown in Table (2).

Table 1: Number and percentage of workers and control group distributed according to their age.

Age groups (year)		Studied groups		Chi-Square & P-value
		Control	Workers	
20-40	No.	4	10	χ^2= 5.089 P= 0.024 Significant (P<0.05)
	%	44.4	90.9	
41->60	No.	5	1	
	%	55.6	9.1	
Total	No.	9	11	
	%	100	100	

Table 2: Mean and stranded error of age in workers compared with the control group.

Parameters		No.	Mean	Standard error	T-test (P-value)
Age (year)	Control	9	44.33	7.075	P= 0.109 Non significant (P>0.05)
	Workers	11	31.82	3.424	
Total		20			

Males were more frequently (55.6%) compared to females (44.4 %) and non significant differences were noticed when comparing workers group with the control group at P value > 0.05 (Table 3).

Table 3: Number and percentage of workers and control group distributed according to their sex.

Gender		Studied groups		Pearson Chi-Square (P-value)
		Control	Workers	
Male	No.	5	6	χ^2 = 0.002 P= 0.964 Non significant (P>0.05)
	%	55.6	54.5	
Female	No.	4	5	
	%	44.4	45.5	
Total	No.	9	11	
	%	100	100	

Significant differences in mean and standard error of RBCs in workers group (4.8864±0.10527) were noticed in comparison with the control group

(4.4667±0.10270) at a P value > 0.05, while WBCs, Hg and HCT showed no significant differences as indicated in Table (4).

Table 4: Mean and stranded error of WBCs, RBCs, Hb and HCT in workers group in comparison with the control group.

Parameters		No.	Mean	Standard error	T-test (P-value)
WBCs ($x 10^3$/ µl)	Control	9	7.780	0.6295	P= 0.595 Non significant (P>0.05)
	Workers	11	8.282	0.6597	
RBCs ($x 10^3$/ µl)	Control	9	4.4667	0.10270	P= 0.011 Significant (P<0.05)
	Workers	11	4.8864	0.10527	
Hg (g/ dl)	Control	9	12.878	0.2763	P= 0.251 Non significant (P>0.05)
	Workers	11	13.518	0.4312	
HCT (%)	Control	9	40.222	1.0050	P= 0.073 Non significant (P>0.05)
	Workers	11	43.209	1.1511	
	Total	20			

Highly significant differences in mean and stranded error of neutrophils, lymphocytes and monocytes among hospitals workers (50.164±1.7276, 38.727±1.8799 and 10.518±0.9694, respectively) compared with the control group (62.233±2.8334, 26.556±2.2186 and 5.433±0.3512, respectively) were noticed at P value P<0.01 as indicated in Table (5).

Table 5: Mean and stranded error of neutrophils, lymphocytes and monocytes in workers compared with control.

Parameters		No.	Mean	Standard error	T-test (P-value)
Neutrophils ($x 10^3$/ µl)	Control	9	62.233	2.8334	P= 0.001 Highly significant (P<0.01)
	Workers	11	50.164	1.7276	
Lymphocytes ($x 10^3$/ µl)	Control	9	26.556	2.2186	P= 0.001 Highly significant (P<0.01)
	Workers	11	38.727	1.8799	
Monocytes ($x 10^3$/ µl)	Control	9	5.433	0.3512	P= 0.00 Highly significant (P<0.01)
	Workers	11	10.518	0.9694	
	Total	20			

Non significant differences in the mean of MCV, MCH and RDW of workers group compared with control group were noted, but highly significant differences were noted in MCHC among workers (31.200±0.2132) compared with the control group (34.200±0.6958) at P value P<0.01 as indicated in Table (6).

Table 6: Mean and stranded error of MCV, MCH, MCHC and RDW in workers compared with the control group.

Parameters		No.	Mean	Standard error	T-test (P-value)
MCV (fl)	Control	9	85.144	0.9611	P= 0.155 Non significant (P>0.05)
	Workers	11	88.655	1.9836	
MCH (pg)	Control	9	27.778	0.1479	P= 0.855 Non significant (P>0.05)
	Workers	11	27.627	0.7200	
MCHC (g/ dl)	Control	9	34.200	0.6958	P= 0.00 Highly significant (P<0.01)
	Workers	11	31.200	0.2132	
RDW (%)	Control	9	14.444	0.3877	P= 0.178 Non significant (P>0.05)
	Workers	11	13.773	0.2961	
	Total	20			

Discussion

Ionizing radiations can induce different types of biological effects on human cells. Cells and tissues have different radiosensitivity. Some cells and tissues are more radiosensitive than others. The bone marrow is one of the highly radiosensitive system in the human body so analyzing hematopoietic parameters helps to assess the amount of the effects of the radiations (Shahid et al., 2015).

The results of the present work revealed that complete blood count (CBC) parameters had been more altered among hospital workers compared with a non workers control group. This may be due to the exposure of their erythropoietic system during maturation of erythrocytes in the circulation (Shahid et al., 2014). The present results showed that there was slight increase in values of WBCs count among workers compared with the control group (Table 4). Also, the results showed slight increase in values of RBCs count among workers (Table 4). This disagrees with Rozgaj et al. (1999) and Zachariah et al. (2001) who found a significant decrease in the values of

RBCs, as compared with control group. The present results indicated a slightl increase in Hb values among hospital workers compared with control nonworker group (Table 4). HCT also showed slight increase among workers than nonworkers (Table 4) which agrees with Xu et al. (2012). Meo et al. (2006) studied individuals who were exposed to low levels of X-ray and found that the leukocyte number of these individuals showed no significant difference compared to the control group. Hrycek et al. (1995) showed that operating x-ray equipment by radiation workers had a significant reduction in neutrophil adherence and spontaneous migration of leukocytes.

The present results also showed a decrease in neutrophil values among workers compared with nonworkers as well as an elevation of both lymphocytes and monocytes among workers compared with nonworkers control group (Table 5). This result is in agreement with Dainiak (2002) who found that ionizing radiation can significantly reduce the percentage of peripheral blood lymphocytes. Lymphocytes are most sensitive signal of bone-marrow radiation injury. The renewal of stem cells occurs, followed by the generation of functional cells to overcome infections and other adverse conditions (Health Protection Agency, UK, 2009).

As indicated in Table (6), MCV showed slight (but not significant) increase among workers (88.655±1.9836) compared with the control group (85.144±0.9611). MCHC values also showed high significant difference among workers (31.200±0.2132) compared with the control group (34.200±0.6958). Variations of MCV and MCHC parameters may be due to the destruction of RBCs or deformability of RBCs (Yousuf et al., 2015). RDW showed no significant differences among hospital workers (13.773±0.2961) in comparison with the control group (14.444±0.3877). These results and variations can be attributed to the performing and practices of protection standards and experience years among exposed participants. In case of anemia, a patient will have lower levels of both MCH and MCHC as these two parameters help to diagnose the anemia. Too little iron in the body is a microcytic anemia, which specifies a condition when extremely small RBCs are present and then smaller RBCs will contain less amount of hemoglobin (Guyton & Hall, 2006).

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