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REVIEW ARTICLE

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Determination the Effect of Ionizing Radiation in Blood Cells Parameters among Sudanese Radiology Workers

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ABSTRACT

Background: Radiology work involves risks that affect most blood components, leading to chronic diseases

Design: This analytical study was conducted in Khartoum State from August to December 2020

Objective: The goal is to determine the effect of ionizing radiation on blood values in healthy radiologists using the analysis of complete blood count and blood smear

And to determine the effect of the number of years of work, the number of working hours per day, the years of work: are they continuous or discontinued, the intensity of radiation, wearing a protective shield made of lead on the values of the complete blood count

Materials and Methods: Intravenous blood samples were collected from 50 participants, 27 samples from men and 23 samples from women aged between 25-40 years working in the field of medical radiology and the structural questionnaire was used

Results: The results of this study revealed an indication of a decrease in hemoglobin, red blood cells and white blood cells upon exposure to high dose of radiation intensity for a long time

Conclusion: This study concluded that there is a decrease in hemoglobin, red blood cells and white blood cells among radiologists.

ARTICLE HISTORY

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KEYWORDS

Sudanese, Ionizing Radiation, Blood Cells Parameters

List of Abbreviation

RBCs: Red blood cells

Hb: Hemoglobin

PCV: Packed cell volume

MCV: Mean cell volume

MCH: Mean cell hemoglobin

MCHC: Mean cell hemoglobin concentration

RDW: Red cell distribution width

WBCs: White blood cells

plts: Platelets

PCT: Plateletcrit

MPV: Mean Platelet Volume

PDW: Platelet Distribution Width

Introduction

Ionizing radiation is a type of energy released by atoms that travels in the form of electromagnetic waves (gamma or X-rays) or particles (neutrons, beta or alpha).The use of ionizing radiation in industrial and medical applications is a well established and essential part of the industrial, medical and veterinary world, however, protection is required for the safety of its operators and patients alike.

Hematology is the study of the normal and pathologic aspects of blood and blood elements .hematopoietic system is characterized by turnover and replenishment throughout life. The pluripotent hemopoietic stem cell (HSC) is the progenitor of the cells in blood [1]. The blood volume of an adult correlates with his or her (fat-free) body mass and amounts to ca. 4–4.5 L in women and 4.5–5 L in men of70 kg. The functions of blood include the transport of various molecules (O2, CO2, nutrients, metabolites vitamins, electrolytes, etc.), heat (regulation of body temperature) and transmission of signals (hormones) as well as buffering and immune defense. The blood consists of a fluid (plasma)

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formed elements: Red blood cells (RBCs) transport O2 and play an important role in pH regulation. White blood cells (WBCs) can be divided into neutrophilic, eosinophilic and basophilic granulocytes, monocyte, and lymphocytes. Neutrophils play a role in nonspecific immune defense, whereas monocyte and lymphocytes participate in specific immune responses. Platelets (thrombocytes) are needed for hemostasis. The formation of blood cells occurs in the red bone marrow of flat bone in adults and in the spleen and liver of the fetus. Hematopoietic tissues contain pluripotent stem cells which, with the aid of hematopoietic growth factors develop into myeloid, erythroid and lymphoid precursor cells. Since pluripotent stem cells are auto reproductive, their existence is ensured throughout life [2]. The purpose of this research is to detect the effect of ionizing radiation (essentially gamma and X rays) on whole blood. Ionizing radiation Is a type of energy released by atoms in the form of electromagnetic waves or particles People are exposed to natural sources of ionizing radiation, such as in soil, water, and vegetation, as well as in human-made sources, such as x-rays and medical devices which is effect on RBCs WBC and platelets [3]. Radiology workers Radiologic technologists who perform medical imaging examinations work closely with radiologists and x-rays devises are responsible for accurately positioning patients and ensuring that a quality diagnostic image is produced and they are exposed to radiation along the working time [4].

Materials and Methods

Study population: People who are working in Radiology department.

Inclusion Criteria: Individuals working in Radiology department.

Exclusion Criteria: Individuals who are not working in Radiology department.

Data Collection: Collected using self- administrated per coded questionnaire which was specifically designed to obtain information that helped in study.

Blood Sampling: Venous blood was been collected using sterile disposable plastic syringes after cleaning the venous puncture area with 70% ethanol, the blood 2.5 ml was been added to the anticoagulant container EDTA

Methods: The result was calculated by CBC analyzer. Whole blood is passed between two electrodes through an apertures so narrow that only one cell can pass through at a time.

Blood Film: A small drop of blood is placed in the center line of a slide about 1cm from one end. Then using a second slide (spreader), the drop of blood spreaded along the slide and the smear allowed to air dry.

Statistical Analysis: Statistical assessment was carried out with statistical package for social sciences (SPSS) version 17.0 for windows statistical software.

Results

The results of this study revealed that the mean of complete blood count in RBCs profile (Hb, RBCs, HCT, MCV, MCH, MCHC, RDW-CV, RDW-SD) was (10.4g/dl, 4.1*10^9/l, 33.3%, 84.9fl, 31.6pg, 34.8, 13.4fl, 47.8%) respectively. Table(1), WBCs profile WBCs, Lymphocyte count, Mid count, Granulocyte count, Lymphocyte percentage, Mid percentage, Granulocyte percentage) was (4.6*10^9/l, 1.8*10^9/l, 0.37*10^9/l, 3.5*10^9/l, 38.0%, 6.9%, 54.3%) respectively. And Platelet profile, Platelet count, MPV, PDW, PCT) was (251.6*10^9/l, 8.6%, 13.8%, 0.21% respectively. Table (2). Significant negative correlation was observed between working years and Hb level, RBC count, HCT level, WBC count, MPV% . Figure (3). A positive significant correlation between working years and Red blood cell indices MCV, MCH, MCHC levels. Table (3) Figure (4), also significant positive correlation between working Hours per day and MCH, MCHC level, RDW and CV. The present study appear a significant positive correlation between regularity of work and MCH, MCHC, RDW and CV, This current study show the significant positive correlation between radiation high dose intensity and lymphocyte percentage and There is significant negative correlation between dose of radiation intensity and Hb level, granulocyte percentage, MPV% and PCT percentage, Table (6) Figure(7). This study appear the significant positive correlation between protective lead gown usage and PDW%. Table (7).

Table 1: General Characteristics and the Work Details of Participants Working In Radiology Department, Among Study Group

Demographic data	Variables	n	%
Gender	Male	27	54.0
	Female	23	46.0
Residence	Omdurman	19	38.0
	Khartoum	15	30.0
	Bahri	16	32.0
years of work	Less than 5 years	21	42.0
	5 – 10 years	18	36.0
	More than 10 years	11	22.0
Working hours	less than 4 hours	4	8.0
	from 4 - 8 hours	30	60.0
	more than 8 hours	16	32.0
Years of the work, is it regular or disconnected?	Regular	25	50.0
	Disconnected	25	50.0
Do you use protective gown (lead gown)	Yes	40	80.0
	No	10	20.0
The intensity of radiation you are exposed to	Low	3	6.0
	Medium	42	84.0
	High	5	10.0
Are you complaining of any diseases?	Yes	5	10.0
	No	45	90.0
Are you taking any medications?	Yes	5	10.0
	No	45	90.0

Table 2: The Mean of Complete Blood Count of the Study Participants (in Form of Mean and Standard Deviation), among Study Group

Study Variables	Mean	SD
HCB level (g/dl)	10.4	1.8
RBC count (*10^9/l)	4.1	.81
HCT level %	33.3	6.6
MCV level (fl)	84.9	7.1
MCH level (pg)	31.6	4.8
MCHC level (g/dl)	34.8	3.0
RDW_CV (fl)	13.4	1.7
RDW_SD %	47.8	9.1
WBC count (*10^9/l)	4.6	1.6
Lymphocyte count (*10^9/l)	1.8	.39
Mid count (*10^9/l)	.37	.18
Granulocytes count (*10^9/l)	3.5	1.8
Lymphocyte percentage%	38.0	9.7
Mid percentage%	6.9	3.2
Granulocytes percentage %	54.3	10.1
Platelet count (*10^9/l)	251.6	65.6
MPV %	8.6	.92
PDW %	13.8	2.6
PCT %	.21	.05

Table 3: Correlation between Years of Work and CBC Results among Study Group

StudyVariables	Mean			P-value	Correlation co-efficient
	Less than 5 years	From 5 to 10 years	More than 10 years		
HCB level (g/dl)	11.7	10.3	8.4	0.000	-0.702 *
RBC count (*10^9/l)	4.6	3.9	3.5	0.000	-0. 536 *
HCT level %	37.7	31.9	27.2	0.000	-0.629*
MCV level (fl)	83.2	83.8	90.5	0.010	0.362**
MCH level (pg)	30.2	30.6	36.2	0.001	0.439**
MCHC level (g/dl)	33.5	34.5	38.1	0.000	0.480**
RDW_CV (fl)	13.4	13.3	13.9	0.480	0.102
RDW_SD %	48.1	44.6	52.5	0.373	0.129
WBC count (*10^9/l)	5.5	3.7	4.5	0.017	-0.336*
Lymphocyte count (*10^9/l)	1.9	1.6	1.9	0.567	-0.083
Mid count (*10^9/l)	.42	.34	.34	0.154	-0.205
Granulocytes count (*10^9/l)	4.0	2.7	3.6	0.291	-0.152
Lymphocyte %	36.4	38.4	40.5	0.253	0.165
Mid %	6.8	7.8	5.8	0.630	-0.070
Granulocytes %	56.3	52.3	53.4	0.347	-0.136
Platelet count (*10^9/l)	235.9	279.6	235.8	0.667	0.062
MPV %	9.1	8.5	7.9	0.000	-0.498*
PDW %	13.4	14.8	13.3	0.744	0.049
PCT %	.22	.22	.19	0.344	-0.141

Table 4: Correlation between Working Hours per Day and CBC Results among Study Group

StudyVariables	Mean± SD			P-value	Correlation co-efficient
	Less than 4 hours	From 4 – 8 hours	More than 8 hours		
HCB level (g/dl)	13.1	10.9	8.8	0.000	-0.547*
RBC count (*10^9/l)	4.8	4.3	3.7	0.000	-0.693**
HCT level %	39.3	34.0	30.5	0.003	-0.416**
MCV level (fl)	76.9	84.5	87.9	0.010	-0.359**
MCH level (pg)	27.3	30.9	34.1	0.006	0.380*
MCHC level (g/dl)	33.3	34.1	36.7	0.004	0.404*
RDW_CV (fl)	13.7	13.3	13.7	0.003	0.409*
RDW_SD %	45.8	47.4	49.1	0.719	0.052
WBC count (*10^9/l)	6.4	4.6	4.3	0.062	-0.266
Lymphocyte count (*10^9/l)	2.1	1.7	1.8	0.363	-0.131
Mid count (*10^9/l)	.40	.38	.36	0.686	-0.059
Granulocytes count (*10^9/l)	4.3	3.2	3.63	0.957	-0.008
Lymphocyte %	29.2	38.0	40.2	0.083	0.248
Mid %	6.9	7.2	6.5	0.628	-0.070
Granulocytes %	64.6	54.0	52.2	0.085	-0.246
Platelet count (*10^9/l)	219.4	258.0	247.5	0.816	0.034
MPV %	8.8	8.8	8.2	0.032	-0.309**
PDW %	14.9	13.8	13.7	0.574	-0.084
PCT %	.18	.23	.19	0.407	-0.124

Table 5: Correlation between Years of the Work, is it Regular or Disconnected? and cbc Results, among Study Group

Study Variables	Mean± SD		P-value	Correlation co-efficient
	Regular	disconnected		
HCB level (g/dl)	9.2	11.7	0.000	-0.568*
RBC count (*10^9/l)	3.9	4.4	0.000	0.710**
HCT level %	30.9	35.7	0.019	0.330**
MCV level (fl)	86.8	83.2	0.009	0.366**
MCH level (pg)	32.7	30.7	0.066	-0.262*
MCHC level (g/dl)	36.1	33.6	0.135	-0.214
RDW_CV (fl)	13.8	13.1	0.002	-.420*
RDW_SD %	49.2	46.4	0.136	-0.214
WBC count (*10^9/l)	4.2	5.1	0.056	0.272
Lymphocyte count (*10^9/l)	1.8	1.8	0.803	-0.036
Mid count (*10^9/l)	.35	.40	0.361	0.132
Granulocytes count (*10^9/l)	3.3	3.6	0.683	0.056
Lymphocyte percentage%	40.5	35.5	0.067	-0.261
Mid percentage%	7.0	6.8	0.812	-0.034
Granulocytes percentage %	52.0	56.5	0.117	0.224
Platelet count (*10^9/l)	249.7	253.4	0.843	0.029
MPV %	8.4	8.8	0.184	0.195
PDW %	13.6	13.9	0.654	0.067
PCT %	.20	.23	0.098	0.245

Table 6: Correlation Between dose of Radiation intensity and CBC Results, among Study Group

Study Variable	Mean			P-value	Correlation co-efficient
	low	Medium	High		
HCB level (g/dl)	10.2	10.7	8.4	0.044	0.285*
RBC count (*10^9/l)	4.0	4.1	3.9	0.062	-0.266
HCT level %	28.3	34.3	28.0	0.842	-0.029
MCV level (fl)	81.4	84.9	88.2	0.544	-0.088
MCH level (pg)	36.4	31.1	33.3	0.184	0.192
MCHC level (g/dl)	34.9	34.8	35.9	0.662	-0.065
RDW_CV (fl)	13.4	13.6	12.0	0.554	0.086
RDW_SD %	46.2	47.6	49.9	0.041	-0.290**
WBC count (*10^9/l)	6.0	4.6	4.2	0.163	-0.200
Lymphocyte count (*10^9/l)	1.6	1.0	1.9	0.156	0.204
Mid count (*10^9/l)	.40	.38	.30	0.387	-0.125
Granulocytes count (*10^9/l)	3.6	3.5	2.9	0.522	-0.093
Lymphocyte percentage%	30.1	37.5	46.7	0.012	0.351*
Mid percentage%	4.0	7.3	5.2	0.989	0.002
Granulocytes percentage %	64.6	54.4	47.0	0.017	-0.336**
Platelet count (*10^9/l)	241.7	256.7	214.8	0.409	-0.119
MPV %	9.1	8.7	7.7	0.022	-0.329**

PDW %	15.0	13.7	14.2	0.823	-0.033
PCT %	.23	.22	.16	0.024	-0.328**

Table 7: Correlation between Protective Clothes Usage and CBC Results, among Study Group

Study Variable	Mean		P-value	Correlation co-efficient
	using	Not using		
HCB level (g/dl)	10.9	9.8	0.178	0.194
RBC count (*10^9/l)	4.2	3.9	0.241	-0.169
HCT level %	32.9	34.9	0.277	-0.157
MCV level (fl)	84.9	85.2	0.383	0.126
MCH level (pg)	32.0	30.2	0.904	0.017
MCHC level (g/dl)	34.9	34.6	0.285	-0.154
RDW_CV (fl)	13.7	12.5	0.710	-0.054
RDW_SD %	49.4	41.4	0.041	-0.290*
WBC count (*10^9/l)	4.8	4.2	0.288	-0.153
Lymphocyte count (*10^9/l)	1.8	1.6	0.262	-0.162
Mid count (*10^9/l)	.39	.31	0.207	-0.182
Granulocytes count (*10^9/l)	3.8	2.9	0.302	-0.149
Lymphocyte percentage%	38.3	36.8	0.656	-0.065
Mid percentage%	6.9	6.9	0.955	0.008
Granulocytes percentage %	53.9	55.4	0.685	0.059
Platelet count (*10^9/l)	252.7	247.2	0.816	-0.034
MPV %	8.7	8.3	0.278	-0.160
PDW %	13.3	15.9	0.003	0.425**
PCT %	.20	.23	0.291	0.157

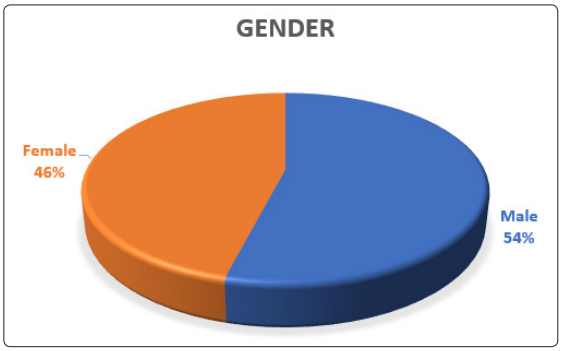

Figure 1: Shows the Distribution of Participants According to Gender in Percentages

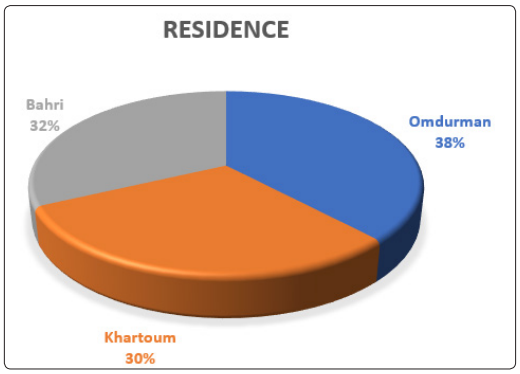

Figure 2: Shows the Distribution of Participants According to Residence Area, in Percentages

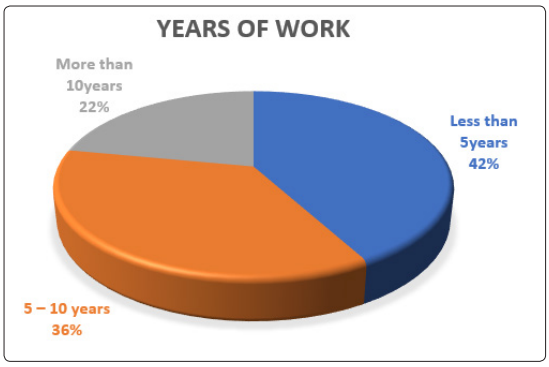

Figure 3: Shows the Distribution of Participants According to Years of Work, in Percentages

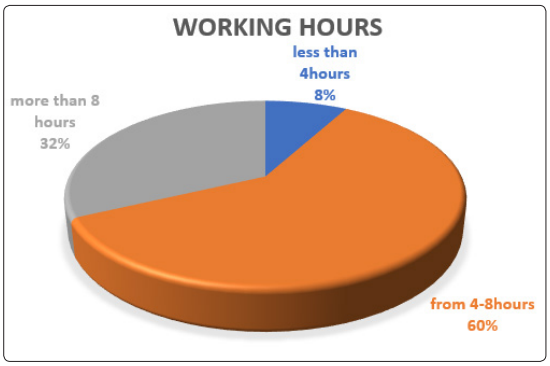

Figure 4: Shows the Distribution of Participants According to Working Hours, in Percentages

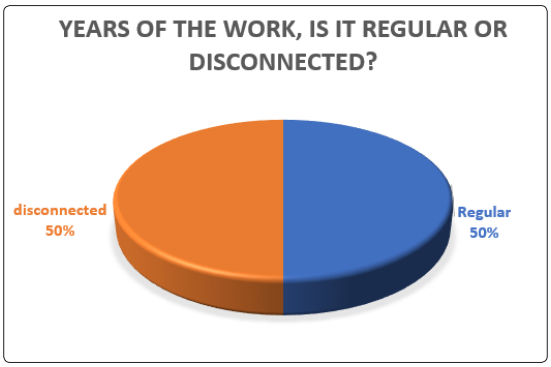

Figure 5: Shows the Distribution of Participants According to Regularity of Work

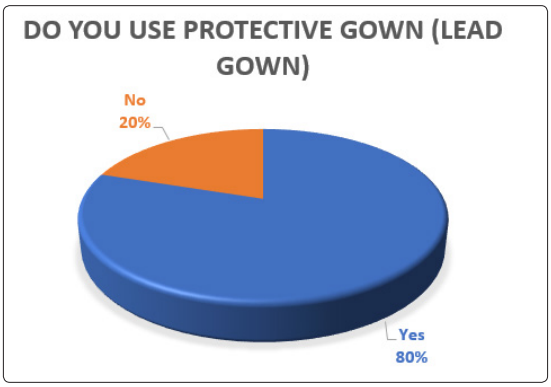

Figure 6: Shows the Distribution of Participants According to their Wearing Of Protective Lead Gown, in Percentages

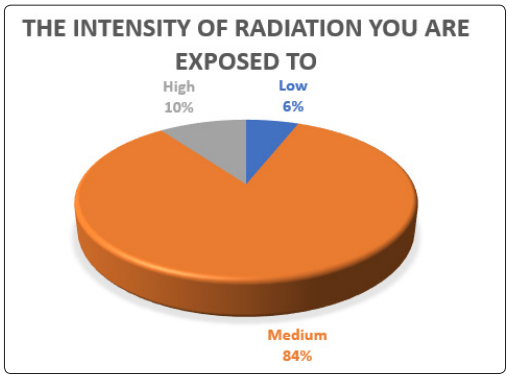

Figure 7: Shows the Distribution of Participants According to Radiation Intensity they are exposed to, in Percentages

Discussion

These result agreed with study done by Taqi et al reported change in RBCs morphology when exposed to high dose of X-ray [5]. This study agreed with study done by Dimitrovski D, Gordana S, and Imran M was attributed to change in red blood cell parameter when exposed to high dose of ionizing radiation [6,7]. This study agreed with study done by Shahid S, was the Mean corpuscular hemoglobin (MCH) hematocrit and red cell distribution width (RDW) values are reported to be lower when exposed to high dose X-ray [8]. This study disagreed with study done by Shafiee M and Hoseinnezhad E, was the hematocrit and red cell distribution width (RDW) values are reported to be higher in X-ray exposure [9]. This study agreed with study done by Joudoh HJ, Al-Kaysi AM and Kadhim NF was the Lymphocyte and granulocyte count tends to be lower in X-ray workers [10]. This study agreed with study done by Meo SA was report the Platelet count was lower in X-ray workers [11]. This study agreed with study done by Mohamed Anwar Abdelhalim in King Saud University [12,13], suggested the effects of different Gamma-radiation doses on haematological are low RBCs, HGB, and HCT might produce anemia and cessation of erythrocytes production in the bone marrow, Moreover, the RBCs size increase might be attributed to changes in the morphology and deformability of RBCs, which was confirmed by a slightly increase in RDW [14,15].

Conclusion: There is significant positive correlation between working years and Hb level, RBC count, HCT level, WBC count, MPV%, that is any increase in working years will lead to a decrease in levels of these parameters. There is significant positive correlation between working hours per day and Hb, RBC count, HCT level, MCV, MPV%. That is any increase in working hours per day will lead to a decrease in levels of these parameters. There is significant positive correlation between radiation intensity and (HGB, granulocyte percentage, MPV%, PCT%), That is any increase in radiation intensity will lead to a decrease in levels of these parameters [16-19].

Declarations

Ethical Approval and Consent to Participant

Approval of This study was obtained from hematology department of medical laboratory science (MLS), Alrazi University,

and ministry of health issued by the local ethical committee, Khartoum State, Sudan. Written consent was taken from each member of the study.

Consent for Publication

Not applicable.

Availability of Data and Materials

The datasets generated during and / or analyzed in this study are not publicly available due to Radiology centers ethical policy in order to protect participant confidentiality .

Competing Interest

The authors declare that they have no competing interests.

Funding

No funding was obtained for this study

Authors contributions

AH, and AA contributed in literature search and manuscript writing. AH had the main idea of the study and contributed in manuscript writing, AA contributed to clinic work, AH contributed in statistical analysis. AA supervised the study and critically reviewed the manuscript. All authors read and approved the final draft of the manuscript.

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