IOSR Journal of Applied Physics (IOSR-JAP)
e-ISSN: 2278-4861.Volume 8, Issue 5 Ver. III (Sep - Oct. 2016), PP 59-63
www.iosrjournals.org

The Measurement of Changes in the Biophysical Properties of RBC, WBC and PLT after Radiation Exposure

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Abstract:*The present research aim is to investigate the radiation hazard through measurements of changes in the biophysical properties of red blood cell, white blood cell, hemoglobin and the palatate of the human. The biophysical structural functions of blood play the major role to present the injury to the occurred system. Blood sample of 80 healthy students of Al Muthanna University that examined after and before irradiation by X-ray and Gamma-ray. Each sample was equally divided into7blood collection tubes for irradiation. One of the samples remained as control. The x-ray energy rate from 40-120 kV and the time of the exposure of gamma-ray was differing from 3-9 min. In RBC the mean values of blood count in female groups were almost less than males, except in 120 KV, 5.08 and 7.01(106/µL), for male and female, respectively. But in PLT the mean value of blood count in females were more than males. The blood components measured two times pre and post exposure by hematology analyzer machine.Differences between control group and Gamma-ray exposure times for WBC, RBC, HGB, and PLT. But the mean values of blood count were significantly different among males and females in RBC (for all groups) and control group of PLT, which in RBC the mean values in females were less than males, but in PLT, the mean value of females was more than males.*

Keywords:*Co-60 source, Gamma source, Radiation dose, RBC,WBC,PLT, Radiation exposure,X-ray source and Al-Muthanna University*

I. Introduction

Blood is an essential of human life due to its function as a system to immune the entire body, consists of several different compounds that are existed into the plasma (55%); five types of White Blood Cells (WBCs) and Platelets (PLT) (1%) together with Red Blood Cells (RBCs) (44%), while blood is circulating within the body through circulatory system [1]. Blood is dividing into two distinguished layers. Yellowish plasma is definitely the liquid protein of the blood[2]. Moreover, about 90 percentage of the plasma is the water and dissolved protein. RBCs or erythrocytes are the most numerous blood components, for delivering the oxygen to body[3]. In addition to RBC has biconcave disk shape without having any nucleus. Each one of RBC, consists of approximately 280 million molecules of an iron (hemoglobin). Therefore, the color of blood is reddish as a result of red pigment. Depending on gender, age range, overall health, and also altitude the average count of RBCs for female and male are about 4.8 and 5.4 × 10^6 million cells per micro-litter, respectively[4]. The ionization is definitely more effectual in blood compare with the some other tissues. RBCs can live around 120 days. Phagocytic cells in the liver together with spleen are digested them. Up to three million RBCs die each second and the liver is collecting the dead RBCs. The ratio of the WBCs or just leukocytes compare to RBCs cells are 700 to 1 so they are the compact elements of the body's immune system. B lymphocytes which are known as B cells are the most common types of WBCs. Hemoglobin is contained within red blood cells also it responsible to transfer large quantities of oxygen and helps carbon dioxide returning to the lung. The oxygen is chemically absorbed by lungs to hemoglobin consequently; it released in the availability of body the cells that require it. The components of blood are essential for assisting the circulatory system. Small fragments are in bone marrow, known as Platelets. Platelets consist of various type of chemical for blood clothing. Due to the significance of the blood in the life of each person, the blood often tests for disease. Explained right here, analyzed for disease due to the of it. If the quantity or volume of RBCs decreases below normal, the hemoglobin oxygen-carrying capacity reduces. This medical circumstance is called anemia. Nevertheless, whenever the number or volume of RBCs increases above normal, the hemoglobin as well as oxygen-carrying capacity increases.

Radiation exposure which is often known as poisoning influenced by does and does rate, susceptibility of the individual to the radiation and other variables, is a sort of damage to organ. This kind of damages caused due to exposure to ionizing radiation. Radiation alone is an energy configured to transfer like a waveor possibly high speed particles[5]. By becoming exposed to small amount of radiation, DNA together with indications of radiation might have engendered. Acute radiation syndrome [6] is as a result of short exposure. Although, chronic radiation syndrome requires lengthen high exposure. Linear energy transfer (LET) is the energy transferred to the matter per unit pathway. It differs with the form of radiation. X-rays and gamma rays are types of low Let radiation where the ionization is dense. Alpha particles and neutrons are forms of high LET radiation where ionization is dense. Several cellular systems possess various sensitivies as a result of their rate of reproduction. Since WBC together with cells which produce blood, are regularly regenerating, hence, they aredefinitely the major sensitive living cells. Commonly, high linear energy transfer has revealed that involved more biological damage comparing to low LET[6-8]. The aim of this study is to determine the radiation hazard which causes the changes in the biophysical properties of red blood cell, white blood cell, hemoglobin and the palatate of the human.

II. Methodology And Experimental Procedure

2.1 Blood Draws

Blood samples collected from healthy volunteers were drawn via periphery venipuncture into heparinized vacutainer tubes from venipuncture site to the antecubital region of the arm of each patient. Tubes contained Ethylene di-amine tetra acetic acid (EDTA) in a concentration of 1.5 mg/ml. Take from each person 5 cc(40 men + 40 wemen=80 samples) and divided to 7 tubes and each tube has 0.5cc. Three tubes for x-ray radiation and three tubes to irradiate by gamma andOne tube remained as a control. Before any further processing, a 100 µl whole blood sample was used for a complete blood count via haematology analyzer machine (Sysmex KX-21N)atHussein Hospital education in Samawah –Al Muthanna /Iraq.

2.2 Irradiation of X-ray with blood cells

Irradiation took place 1 minute after preparing the samples. Samples were prepared at room temperature and irradiated at 16 °C using X-ray machine.Each sample was divided equally into four tubes (0.5 ml/ tube). Samples were irradiateby three different energy rate of the X-ray machine (40 kv, 0.14 sec, 63 mA), (80 kv, 0.32 sec, 63 mA) and (120 kv, 0.40 sec, 63mA). These voltages are producing medium penetrating power of X -rays radiation. The field was projected on a table-top structure. The blood collection tubes placed vertically to the collimator of the x-ray machine. The sampleswereplaced at the center of field size and the flat ionization chamber also placed between two perspexes. Thickness of each perspex was 1.5 cm. The blood component is usually left stationary when the entire x-ray does is being delivered. Source to surface distance (SSD) was fixed to 50 centimeters. field sizewaschosen(10×10) cubic centimeters . Before irradiation each tube was shacked manually to get mix the red blood cells and other blood cells which mightseparate after a few minutes. The time of exposure was1mAs for all the energies. Cable of ionizing chamber was connected to the Radalert 100X Digital. Radalert 100X Digital automatically detects the start and stop of radiation exposure by measuring the current crossing predetermined limit thresholds. The absorption does were measured as followed:

D absorption = D real *t(hr)

D(40 kv) = 3.645 µSv

$=3.645 * 10^{-6}$ Sv

$=3.645 * 10^{-6}$ Gy

D(80 kv) = 39.128 µSv

$=39.128 * 10^{-6}$ Sv

$=39.128 * 10^{-6}$ Gy

D(120 kv) = 103.866 µSv

$=103.866 * 10^{-6}$ Sv

$=103.866 * 10^{-6}$ Gy

2.3 Irradiation of Gamma- ray with blood cells

All blood samples took from the 80 volunteer students (40 female and 40 male) of the basic education college at Al Muthanna University. Blood collection tubes were placed 5 cm near the co-60, 1 µ Ci at three different time of exposure (3, 6, and 9 minutes) in Nuclear Laboratory(Science College-Al Muthanna University) at 25ºC. Immediately after exposing the samples the samples were taken to the Hussein Hospital education in Samawah–Al Muthanna /Iraq for counting the blood component by the heamocytometer.

2.4 Statistical Analysis

The data were entered into the statistical software package, SPSS (ver.21 Inc, Chicago, IL), and the following descriptive statistics were obtained: mean, standard deviation [6], and the frequency of the total individuals. Comparing mean values between independent groups were analyzed statistically by student's t-Test. The comparison between more than two independent groups was performed by one-way analysis of variance (ANOVA). A *P-value* of less than 5% was taken as significant.

III. Result And Discussion

A total of 80 individual (50% male) participated in this study. Totally 32 mean and SD values of complete blood count (WBC, RBC, HGB, PLT) were given in table 1. They were computed among control group and three level of X-ray electromagnetic radiation (40, 80, 120 KV), separately for male and female. The results showed that there was no statistically significant difference between levels of X-ray and control group for both (males and female), except in 120 kV and female group (*P-value*< 0.001). Also the mean values were compared through the gender factor. The results showed that the mean values of males and females were statistically difference in RBC for all levels such as, control, 40 KV, 80 KV, 120 KV, (*P-value*< 0.001). Also they are different in PLT for control, 80 KV, 120 KV. In RBC the mean values of blood count in female groups were almost less than males, except in 120 KV, 5.08 and 7.01(106/μL), for male and female, respectively. But in PLT the mean value of blood count in females were more than males (see Table 1).

Table 2 showed the mean and SD values of complete blood count among control group and three different exposure times of Gamma-ray (3, 6, 9 min), separately for male and female. From the results, it can be concluded that there were no differences between control group and Gamma-ray exposure times for WBC, RBC, HGB, PLT. But the mean values of blood count were significantly different among males and females in RBC (for all groups) and control group of PLT, which in RBC the mean values in females were less than males, but in PLT, the mean value of females was more than males[9, 10].The effects of X-ray and Gamma-ray on complete blood counts were compared in Figure 1.Data revealed that the mean values of complete blood counts in control group and X-ray and Gamma-ray exposure times were almost the same (*P-value*>005), except for RBC. The mean value of 120 kV of X-ray was higher than others *(P-value*< 0.001) (see Figure 1)[11].

Table 1. Mean and standard deviation [6] values of complete blood count [a] among four groups [b] after X-ray electromagnetic radiation.

	Energy	Gender	N	Mean [6]	P-value [c]	P-value [d]
WBC (10^3/μL)	Control	Male	40	6.99 (1.67)	-	0.638
		Female	40	6.75 (1.60)	-	
	40 kV	Male	39	7.07 (1.78)	0.839	0.338
		Female	40	6.71 (1.60)	0.906	
	80 kV	Male	40	7.08 (1.82)	0.823	0.334
		Female	39	6.72 (1.55)	0.934	
	120 kV	Male	40	7.07 (1.83)	0.839	0.889
		Female	38	7.01 (1.92)	0.509	
RBC (10^6/μL)	Control	Male	40	5.15 (0.34)	-	< 0.001 *
		Female	37	4.51 (0.41)	-	
	40 kV	Male	40	5.07 (0.34)	0.324	< 0.001 *
		Female	40	4.44 (0.39)	0.467	
	80 kV	Male	40	5.06 (0.42)	0.302	< 0.001 *
		Female	39	4.48 (0.34)	0.771	
	120 kV	Male	40	5.08 (0.39)	0.421	< 0.001 *
		Female	38	7.01 (1.92)	< 0.001 *	
HGB(S/dL)	Control	Male	40	13.72 (1.65)	-	0.226
		Female	37	13.24 (1.79)	-	
	40 kV	Male	40	13.52 (1.63)	0.587	0.268
		Female	40	13.08 (1.85)	0.701	
	80 kV	Male	39	13.46 (1.66)	0.486	0.416
		Female	39	13.15 (1.69)	0.819	
	120 kV	Male	39	13.51 (1.70)	0.575	0.366
		Female	38	13.16 (1.67)	0.837	
PLT(10^3/μL)	Control	Male	39	239.44 (57.62)	-	0.022 *
		Female	38	276.39 (80.06)	-	
	40 kV	Male	40	250.80 (69.07)	0.430	0.174
		Female	38	272.11 (68.01)	0.777	
	80 kV	Male	40	242.88 (59.20)	0.794	0.023 *
		Female	38	277.03 (70.421)	1.00	
	120 kV	Male	40	243.20 (61.41)	0.780	0.016 *
		Female	37	280.11 (70.23)	0.862	

[a] WBC (103/μL): White blood cells; RBC (106/μL): Red blood cells; HGB(S/dL): Hemoglobin; PLT(103/μL): Platelets.
[b] Four independent groups: Control, 40 kv, 80 kv, 120 kv.
[c] Using independent samples T-test for comparing mean values between three powers of X-ray (40, 80, 120 kv) and control.
[d] Using independent samples T-test for comparing mean values between males and females.
**Significant at 5% level.*

Table 2. Mean and standard deviation [6] values of complete blood count [a] among four groups [b] after Gamma-ray electromagnetic radiation.

	Time	Gender	N	Mean [6]	P-value [c]	P-value [d]
WBC ($10^3/\mu L$)	Control	Male	40	6.99 (1.67)	-	0.505
		Female	40	6.75 (1.60)	-	
	3 min	Male	40	7.12 (1.72)	0.738	0.240
		Female	40	6.68 (1.60)	0.851	
	6 min	Male	40	7.07 (1.65)	0.846	0.291
		Female	39	6.68 (1.54)	0.854	
	9 min	Male	40	7.14 (1.84)	0.704	0.197
		Female	40	6.65 (1.53)	0.782	
RBC ($10^6/\mu L$)	Control	Male	40	5.15 (0.34)	-	< 0.001 *
		Female	37	4.51 (0.41)	-	
	3 min	Male	40	5.02 (0.34)	0.222	< 0.001 *
		Female	40	4.43 (0.37)	0.654	
	6 min	Male	40	5.09 (0.36)	0.446	< 0.001 *
		Female	39	4.46 (0.35)	0.887	
	9 min	Male	40	5.01 (0.39)	0.093	< 0.001 *
		Female	39	4.46 (0.37)	0.929	
HGB(S/dL)	Control	Male	40	13.72 (1.65)	-	0.171
		Female	37	13.24 (1.79)	-	
	3 min	Male	39	13.48 (1.58)	0.519	0.143
		Female	38	13.92 (1.78)	0.508	
	6 min	Male	40	13.56 (1.72)	0.678	0.202
		Female	39	13.06 (1.76)	0.749	
	9 min	Male	40	13.39 (1.72)	0.392	0.361
		Female	40	13.04 (1.75)	0.707	
PLT($10^3/\mu L$)	Control	Male	39	239.44 (57.62)	-	0.023 *
		Female	38	276.39 (80.06)	-	
	3 min	Male	40	243.53 (67.09)	0.772	0.062
		Female	38	273.68 (73.61)	0.878	
	6 min	Male	40	242.95 (60.40)	0.792	0.071
		Female	37	272.54 (80.62)	0.836	
	9 min	Male	40	250.35 (69.34)	0.450	0.175
		Female	37	272.81 (74.59)	0.842	

[a] *WBC (103/µL): White blood cells; RBC (106/µL): Red blood cells; HGB(S/dL): Hemoglobin; PLT(103/µL): Platelets.*
[b] *Four independent groups: Control, 40 kV, 80 kV, 120 kV.*
[c] *Using independent samples T-test for comparing mean values between three powers of X-ray (40, 80, 120 kv) and control.*
[d] *Using independent samples T-test for comparing mean values between males and females.*
**Significant at 5% level.*

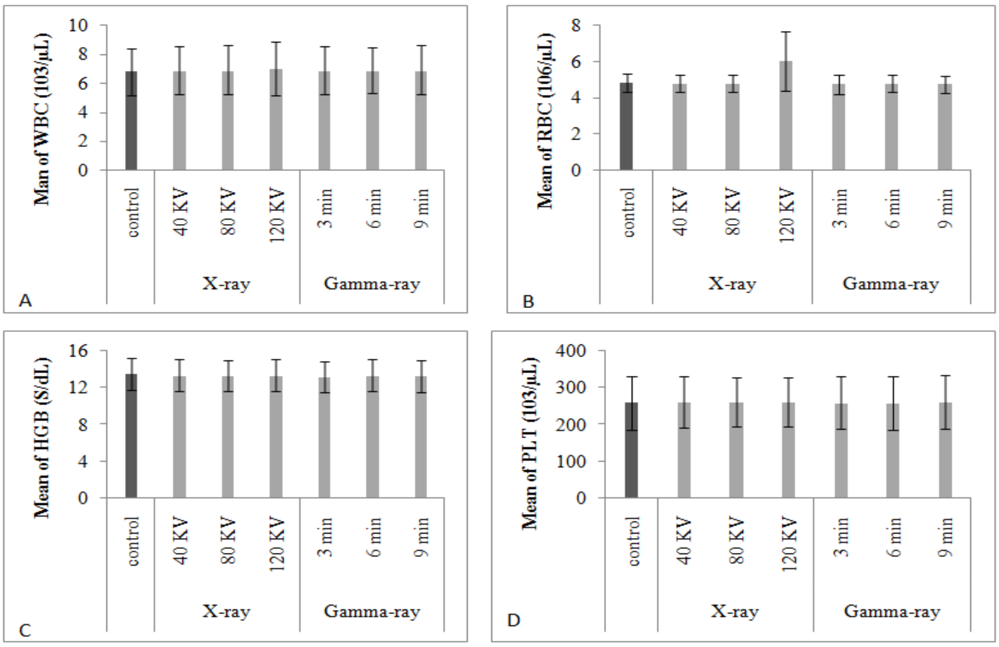

Figure1. Mean values of completed blood count for X-ray and Gamma-ray. A: WBC ($10^3/\mu L$): White blood cells, B: RBC ($10^6/\mu L$): Red blood cells, C: HGB (S/dL): Hemoglobin, D: PLT ($10^3/\mu L$): Platelets.

IV. Conclusion

The (80) samples (40 females and 40 males) randomly selected from healthy students at Al Muthanna University. They came from different areas of middle ,south Iraq .In first part of this research ,the exposure of blood samples to Gamma ray by Co-60 for 3,6 &9 minutes. In second part,the exposure of blood samples to X-ray for 40, 80 &120 Kv. In RBC the mean values of blood count in female groups were almost less than males, except in 120 KV, 5.08 and 7.01(106/µL), for male and female, respectively. But in PLT the mean value of blood count in females were more than males. The blood components measured two times pre and post exposure by hematology analyzer machine. Differences between control group and Gamma-ray exposure times for WBC, RBC, HGB, and PLT. But the mean values of blood count were significantly different among males and females in RBC (for all groups) and control group of PLT, which in RBC the mean values in females were less than males, but in PLT, the mean value of females was more than males.

Acknowledgements

We would like to thanks Physics department in college Science, ALMuthanna University Assis. Lect. Ali NadhimSabbar and Hussein Hospital education in Samawah – Al Muthanna / Iraq.

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