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DETECTION THE RISK EFFECTS OF X-RAYS ON THE BLOOD FOR WOMEN WITH CANCER BREAST PROBLEMS AFFECTED BY X-RAYS IN DIFFERENT DOSES

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ABSTRACT
The aim of this study was to investigate the effects of low dose of X-ray on blood cells for women with cancer breast problems to study the radiation effects on the red blood cell, white blood cell, and platelet count for women with cancer breast problems, by used the hematology automatic CBC machine to determine the effect of X- ray on the blood cell in the three different times potential range among 40 kV, 80 kV, and 120 kV before and after irradiation with X-ray machine and to derive useful parameters for the evaluation of radiation effects. The results showed decrease in WBC, PLT and showed statistical significance differences in WBC and PLT. The values of WBC and PLT which decreased after irradiation with increasing the value of voltage of irradiation. Therefore, high significant differences ($p = 0.001$) were found in the platelet and WBC. However, no significant ($p > 0.05$) change in red blood count RBC was found in the range of 40 kV, 80 kV, and 120 kV.

Keywords: X-ray Radiation Cancer breast Blood Radiological WBC

Introduction

X-ray and nuclear medicine practitioners together contribute approximately one third of the doses received in the medical area [1]. Persons exposed to X-ray radiations are tending to improve life- intimidating diseases often related with hematopoietic system. Due to this reason the hematopoietic system is highly sensitive to radiation and the blood, count may well serve as a biological indicator of such damage. The type of damage is different for blood component after irradiation. X-rays can pass uninterrupted through low-density substances such as tissue, whereas higher-density targets reflect or absorb the X-rays because there is less space between the atoms for the short waves to pass through [2]. This research has been done in vitro and on fresh human blood. This type of radiation can generate chemically active free radicals in fact could be damage the molecular structure resulting in cell somatic effect or genetic damage and the main target of radiation is Deoxyribonucleic acid (DNA). To know how much radiation exposure is being received in a specified period of time a flat ionization chamber is used to measure the rate of radiation exposure [3, 4]. Because of this reason, X or gamma rays are more effective and they are forms of radiant energy [2, 5]. Blood cell count has maintained a position in hematological analysis test for various hematological as well as non-hematological disease states. It is generally believed that radiation in any amount will only damage cells and that the mutated cells could become cancers [4]. Ever since humans began to exploit nuclear technology weapons tests, nuclear fuel cycles, accidents and other sources have released radioactive elements into the environment. These anthropogenic radionuclides, together with cosmic, cosmogenic and terrestrial radionuclides, make up the back ground radiation in the world today. X-rays are categorized as a short wave electromagnetic radiation (less than 10 nm) that usually functions as a diagnostic and therapeutic tool. X-rays are physically similar to gamma rays though of lower energy. They are produced from the absorption of high-speed charged particles.

Comparatively lower doses of X-ray caused temporary sterility in men or a permanently reduced fertility in women [6]. Red blood cell is not a very radiosensitive cell, thus choosing it is not a reflection of cellular radiation damage in vivo. However, it is a suitable candidate for monitoring the radiation effect for many reasons. First of all, it is a representative sample for the whole body exposure, since it circulates all over the body, second its accessibility and ease in its separation to obtain cells with intact membrane. Also, being enucleated, it represents a useful model for measuring the membrane properties without the interference of intracellular membranes[7].

Radiation and blood

An active cell is affected negatively by the direct interaction with radiation source leading to the death or mutation of the cell. These outcomes are as a result of the cell's relative sensitivity to radiation [8, 9]. The lymphocyte is a distinct kind of mature white blood cell that is very radiosensitive for unknown reasons. Lymphocytes are more susceptible to the effects ionizing radiation compared other mature blood cells. White blood cell population reduces a few days after exposure, often accompanied by slow decrease in red blood cells. Red cells have longer life spans than white blood cells, so they are substituted more gradually [6]. The red blood cell is widely undergoing an indirect damage, caused by water radiolysis that generates reactive oxygen species (ROS) [5]. X-rays have lower energies than gamma rays; it can penetrate into the body [2].

Materials and Methods

Sample collection and preparation

In this study, the blood samples were collected from women with cancer breast problems in Sulaymania city to investigate the effects of X -Ray on blood for women with cancer breast problems via the analysis of major blood components (WBC, RBC, and PLT). The blood samples were collected by using a syringe in the Health Center from patients aged between 25 and 46 years with the volume of the samples before division was 3ml. A special blood tube contain Ethylene Di-amine Tetra Acid (EDTA) was used, and transferred into a tube. Then, the blood samples were irradiated by X ray at 3 different voltages and fixed the distance between the source and the samples at (50 cm) [10]. In this study the Automated hematology analyzer machine (CBC) machine was used to test the blood parameters (WBC, RBC, and PLT) of women blood before and after irradiation (in vitro irradiation of X-ray) to investigate the impact of X-ray on blood at a room temperature of 23^{o}C. The irradiation was repeated for 3 energy values of X-ray machine: 40 kV, 80 kV and kV [10].

Statistical Analysis

All statistical calculations were performed using SPSS for Windows, Standard version 21.0. The data of the research were analyzed by using Wilcoxon Signed Rank test and Kruskal Wallis test to explain the nonparametric (non normality) distribution and paired t-test was with One Way ANOVA were usid to give details on the paramiters- normality distribution. The SPSS was performed to compare between the control and the irradiated samples. Results were always represented as mean± standard error of the mean of the results. Values of $p < 0.05$ were considered significant, and those of $p < 0.001$ reflect high significance [11].

Results and Discussion

The purpose of this study was to investigate the effect of different doses of X-ray on the blood for women with cancer breast problems were determined by conducting haematology blood tests before and after irradiation by exposure to X-ray. The statistical SPSS was used to examine the presence of any relation between the effect of X-ray on the blood samples and the 3 major blood parameters (WBC, RBC, and PLT) of the samples. The values showed statistical significance based on the mean of their differences before and after irradiation. The result of the blood test for WBC parameter before irradiation and after irradiation showed in (Tables 1, 2), the number of all the WBC has decreased after irradiation that is agreement with [10]. The maximum level of X-ray radiation based on the field strength of the voltage. The mean count of WBC parameter was normality and significant statistically ($p = 0.009$) because the mean of White Cell Count for the exposed to X- ray irradiation were observed to be decreased, respectively when compared to the mean White Cell Count for control, as shown in (Fig 4a) and (Tables 1, 7).

Table 1 The effective of X-Ray on blood parameter (WBC) for women under study, by irradiation method used X-Ray irradiation with (40, 80,120) kV

No.	WBC× 10^3 μL (Control)	X-Ray		
		WBC × 10^3 μL irradiation with (40 kV)	WBC ×10^3 μL irradiation with (80 kV)	WBC ×10^3 μL irradiation with (120 kV)
1	3.5	3.4	3.0	2.4
2	3.1	3.3	3.1	2.7
3	3.9	3.6	3.4	3.0
4	3.7	3.7	3.3	3.1
5	4.0	4.1	3.6	3.2
6	3.9	3.8	3.4	3.0
7	4.1	4.0	3.7	3.3
8	4.1	3.9	3.5	3.2
9	4.7	4.5	3.9	3.2
10	3.9	3.6	3.2	2.7
11	4.3	4.3	3.7	3.2
**	3.927	3.836	3.436	3.0

**=Mean

The effective changes of X-Ray on blood parameter (ΔWBC) for women with cancer breast problims under study, by irradiation method used X-Ray irradiation with (40, 80, 120) kV were showed in the (Table 2) and Fig. 1) when the poteintional affects on the blood increase the changed of WBC count also increase (0.93 > 0.49 > 0.09) respectively.

Table 2 The effective of X-Ray on blood parameter (ΔWBC) for women under study, by irradiation method used X-Ray irradiation with (40, 80,120) kV

No.	Age/year	X-Ray		
		ΔWBC× 10^3 μL irradiation with (40 kV)	ΔWBC×10^3 μL irradiation with (80 kV)	ΔWBC×10^3 μL irradiation with (80 kV)
1	46	0.1	0.5	1.1

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2	32	-0.2	0	0.4
3	31	0.3	0.5	0.9
4	40	0	0.4	0.6
5	29	-0.1	0.4	0.8
6	25	0.1	0.5	0.9
7	42	0.1	0.4	0.8
8	30	0.2	0.6	0.9
9	28	0.2	0.8	1.5
10	26	0.3	0.7	1.2
11	25	0	0.6	1.1
**		0.09	0.49	0.93

**=Mean

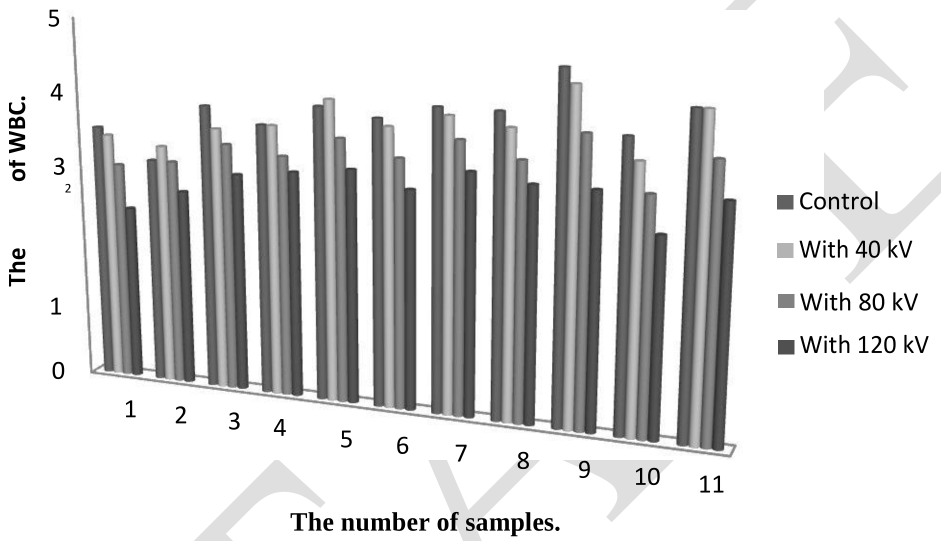


Fig. 1 The relation between the control blood (WBC) and blood (WBC) samples after irradiation with (40, 80, 120) kV.

The result of the blood test for RBC parameter before irradiation and after irradiation showed in (Tables 3, 4). The number of RBC not changed after irradiation that is agreement with [12]. The mean count of RBC parameter not significant statistically ($p = 0.330$). The mean value of Red Cell Count for the exposed to alpha radiation were observed to be not changed, respectively when compared mean Red Cell Count to control, (Fig. 4b) and (Tables 3, 7), the results agreement with [13, 14].

Table 3 The effective of X-Ray on blood parameter (RBC) for women under study, by irradiation method used X-Ray irradiation with (40, 80,120) kV

No.	RBC× 10^6 µL (Control)	X-Ray RBC × 10^6 µL irradiation with (40 kV)	RBC ×10^6µL irradiation with (80 kV)	RBC ×10^6µL irradiation with (120 kV)
1	4.96	4.97	4.97	4.98
2	4.65	4.65	4.66	4.67
3	5.48	5.46	5.46	5.47
4	4.89	4.89	4.90	4.90

5	4.34	4.34	4.33	4.34
6	4.06	4.05	4.05	4.05
7	5.32	5.32	5.33	5.34
8	4.85	4.85	4.86	4.87
9	4.77	4.77	4.78	4.79
10	4.76	4.76	4.76	4.76
11	5.84	5.84	5.84	5.85
**	4.901	4.900	4.903	4.911

**=Mean

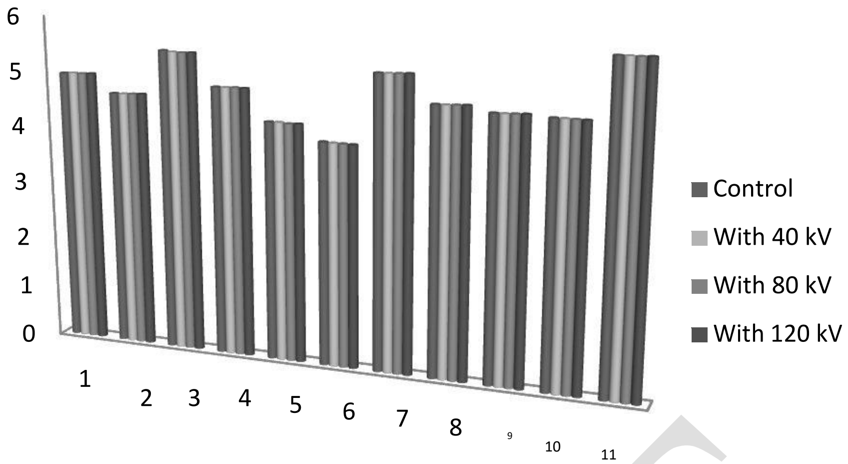
The effective changes of X-Ray on blood parameter (ΔRBC) for women with cancer breast problims under study, by irradiation method used X-Ray irradiation with (40, 80, 120) kV were showed in the (Table 4) and (Fig. 2) when the poteintional on the blood increase the changed of RBC count not increase just so so little.

Table 4 The effective of X-Ray on blood parameter (ΔRBC) for women under study, by irradiation method used X-Ray irradiation with (40, 80,120) kV

No.	Age/year	X-Ray		
		ΔRBC× 10^6μL irradiation with (40 kV)	ΔRBC×10^6 μL irradiation with (80kV)	ΔRBC×10^6 μL irradiation with (120kV)
1	46	-0.01	-0.01	-0.02
2	32	0	-0.01	-0.02
3	31	0.02	0.02	0.01
4	40	0	-0.01	-0.01
5	29	0	0.01	0
6	25	0.01	0.01	0.01
7	42	0	-0.01	-0.02
8	30	0	-0.01	-0.02
9	28	0	-0.01	-0.02
10	26	0	0	0
11	25	0	0	-0.01
**		0.001	-0.002	-0.009

**=Mean

No difference was seen between pre and post-X-irradiation because irradiation not causes damage to the RBC therefore; there was no significant difference in hematological analaysis in X-ray in the RBC, as shown in (Fig. 2).



The number of samples.

Fig. 2 The relation between the control blood (RBC) and blood (RBC) samples after irradiation with (40, 80, 120) kV.

The result of the blood test for PLT parameter before irradiation and after irradiation showed in Tables 5, 6, the number of PLT count has decreased after irradiation. The mean count of PLT parameter was highly significant statistically ($p = 0.001$) because the mean of PLT Count for the exposed to X ray irradiation were observed to be decreased, respectively when compared to the mean PLT Count for control, as shown in (Fig. 4c) and (Tables 5, 7).

Table 5 The effective of X-Ray on blood parameter (PLT) for women under study, by irradiation method used X-Ray irradiation with (40, 80,120) kV

No.	PLT× 10^3 µL (Control)		X-Ray	
		PLT × 10^3 µL irradiation with (40 kV)	PLT ×10^3 µL irradiation with (80 kV)	PLT ×10^3 µL irradiation with (120 kV)
1	149	136	130	122
2	140	134	127	119
3	139	134	122	117
4	146	140	135	128
5	152	146	139	132
6	143	137	132	127
7	113	109	103	97
8	135	129	128	119
9	150	139	132	127
10	119	116	105	99
11	145	132	128	120
**	139.181	132.000	125.545	118.818

**=Mean

The effective changes of X-Ray on blood parameter (ΔPLT) for women with cancer breast problims under study, by irradiation method used X-Ray irradiation with (40, 80, 120) kV were showed in the (Table 6) and (Fig. 3) when the poteintional increase the changed of PLT count was increase (20.363 > 13.636 > 7.181) respectively.

Table 6 The effective of X-Ray on blood parameter (ΔPLT) for women under study by irradiation method used X-Ray irradiation with (40, 80,120) kV

No.	Age/year	X-Ray		
		ΔPLT × 10^3 μL irradiation with (40 kV)	ΔPLT×10^3 μL irradiation with (80 kV)	ΔPLT×10^3 μL irradiation with (120 kV)
1	46	13	19	27
2	32	6	13	21
3	31	5	17	22
4	40	6	11	18
5	29	6	13	20
6	25	6	11	16
7	42	4	10	16
8	30	6	7	16
9	28	11	18	23
10	26	3	14	20
11	25	13	17	25
**		7.181	13.636	20.363

**=Mean

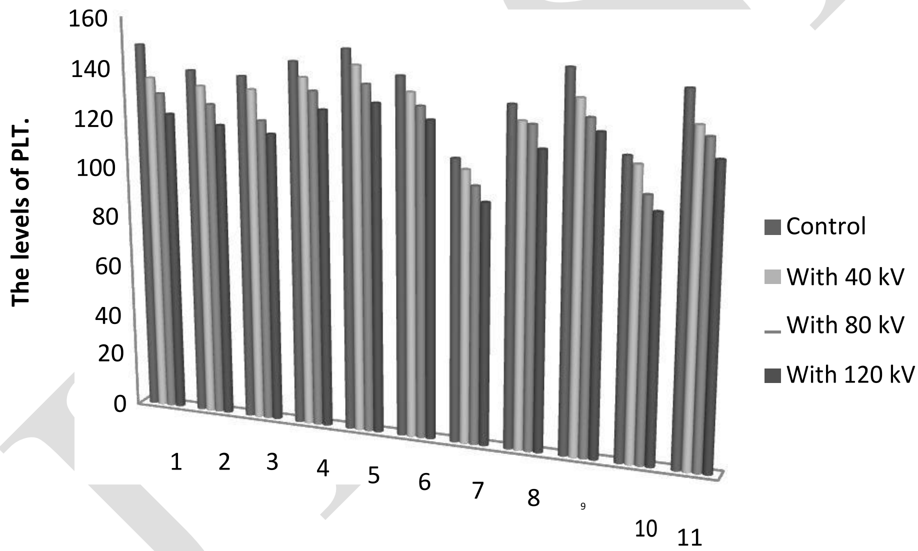


Fig. 3 The relation between the control blood (PLT) and blood (PLT) samples after irradiation with (40, 80, 120) kV

Decrease in the number of platelets in the blood due to a thrombocytopenia, this can result in poor blood clotting. Thrombocytopenia is usually defined as less than 150,000 platelets per cubic millimeter of blood [15]. The stastistical analyzes of blood parameterd (WBC, ABC, and PLT) for normality disterbution and non normality distrbution when used shapero test for normality were found in the (Fig. 4a, 4b, 4c).

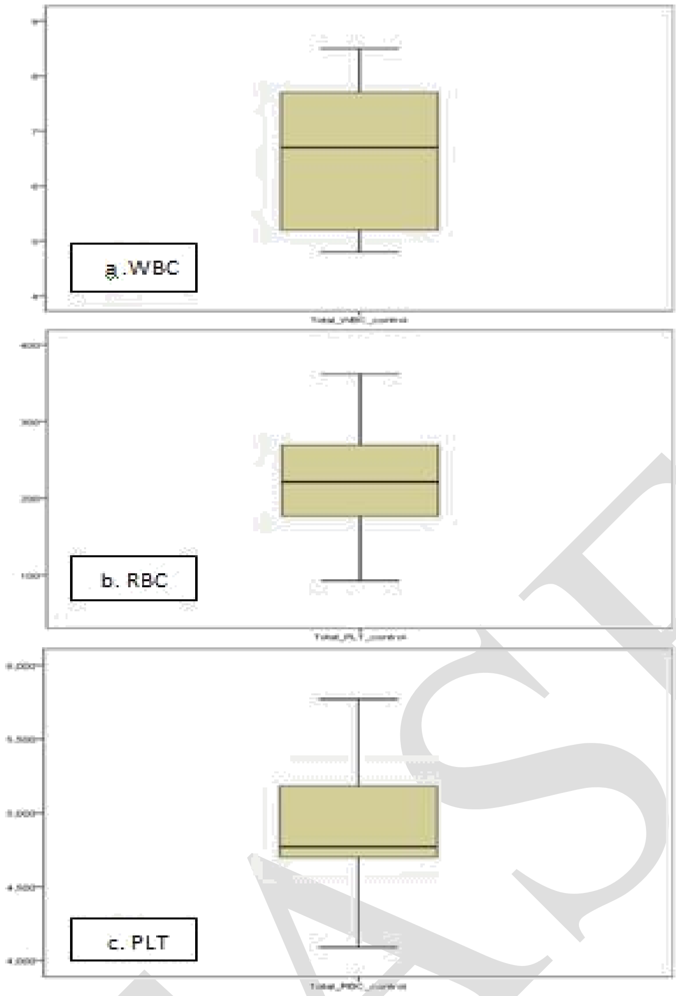


Fig. 4a., b., c. The stastistical analyzes of blood parameterd (WBC, ABC, and PLT) for normality and non normality disterbution

Wilcoxon Signed Rank test used to find the differences of non-parametric results for blood cells before and after radiation with control. Significant differences observed for blood cells before and after radiation with 40 kV because WBC significantly showed reduction after radiation, and PLT showed significantly reduction after radiation with 40 kV. High significant differences observed for all blood cells before and after radiation with 80, 120 kV, as shown in Table 7. Wilcoxon Signed Rank test was used for non-parametric variables to find the difference between WBC and RBC before and after radiation. Significant difference was found only for WBCs ($p < 0.05$), which decreased after irradiated. The amount of difference of WBC parameter after irradiation was $p = 0.009$. Paired t test used for parametric variables to find the difference in PLT before and after radiation. The results showed that PLT have a statistical significant difference ($p < 0.05$), which decreased after irradiated with control values. The amount of difference of PLT parameter was high significant decrease ($p = 0.001$) after irradiation. From the results RBC showed no statistical significant difference ($p > 0.05$) after irradiation with control values. No statistically significant difference was found because the amount of difference of RBC parameter was very low ($p = 0.330$) after irradiation as showed in (Table 7).

Table 7 also showed WBC, and PLT were decreased after irradiation and RBC, so little increased after irradiation (not changed). Hence, statistically there is no change in the value of RBC count.

Table 7 Difference of blood cells between control and after radiation

Laboratory measurements		Mean (± SD)	Mean difference ± SD		p value
WBC	Control Radiation	6.272 ± 2.073 6.077 ± 2.143	0.195 ± 0.408		**0.009***
Laboratory measurements		Ranks	Number	Mean rank	p value
RBC	Radiation - control	Negative ranks Positive ranks Ties Total	11 10 1 22	12.17 10.83	**0.33**0**
PLT	Radiation – control	Negative ranks Positive ranks Ties Total	14 6 2 22	11.84 11.16	**<0.001****

* Paired t test
** Wilcoxon Signed Rank test

Radiation does and blood cells

Kruskal Wallis test used to find the differences among doses of RBC and PLT, while One Way ANOVA used to find differences among doses of WBC. The overall blood cells were statistically not different with radiation dose, as shown in (Table 8).

Table 8 Differences among doses of blood cells WBC, RBC and PLT parameters

Variable		Number	Mean rank	Chi-square	*p* value
Total RBC after radiation	40 kv 80 kv 120 kv	11 11 11	15.73 16.73 18.55	0.480	0.786*
Total PLT after radiation	40 kv 80 kv 120 kv	11 11 11	13.86 18.09 19.05	1.790	0.409*
Variable		Number	Mean (± SD)	F	*p* value
Total WBC after radiation	40 kv 80 kv 120 kv	11 11 11	5.918 ± 2.437 6.432 ± 1.919 5.779 ± 1.907	0.295	0.747*

* Kruskal Wallis test
** One Way ANOVA

Difference of blood cells between control and after radiation with dose

Not significant differences found for RBC on dose 120 kV, where PLT showed significantly reduction after radiation with dose 120 kV. WBC significantly showed reduction after radiation with 120 kV doses, as shown in Table 9. Therefore, not significant differences found for RBC, where PLT and WBC showed significantly reduction after irradiation with dose 120 kV, as shown in (Table 9).

Table 9 Differences of blood cells in control and after radiation with different doses

Variable	Difference	Ranks	Number	Mean rank	Z value	*p* value
RBC 40 kv	Radiation – control	Negative ranks Positive ranks Ties	8 3 0	6.56 4.50	-1.740	**0.082***
WBC 80 kv	Radiation – control	Negative ranks Positive ranks Ties	5 3 3	5.10 3.5	-1.054	**0.292***
RBC 80 kv	Radiation – control	Negative ranks Positive ranks Ties	4 6 1	5.50 5.50	-0.564	**0.573***
RBC 120 kv	Radiation – control	Negative ranks Positive ranks Ties	10 1 0	6.20 4.00	-2.587	**0.110***
PLT 120 kv	Radiation – control	Negative ranks Positive ranks Ties	11 7 3	5.00 6.67	-0.766	**0.044***

Variable	Difference	Mean (± SD)	Mean difference	*p* value
WBC 40 kv	Control - radiation	6.189 ± 2.375 5.918 ± 2.437	0.271	**0.084****
PLT 40 kv	Control - radiation	184.273 ± 61.090 166.546 ± 54.831	17.727	**0.001****
PLT 80 kv	Control - radiation	206.546 ± 82.427 192.636 ± 82.070	13.909	**0.018****
WBC 120 kv	Control - radiation	5.900 ± 1.886 5.779 ± 1.907	0.121	**0.037****

* Wilcoxon Signed Rank test
** Paired t test

WBC and PLT decreases after irradiation while RBC showed no considerable changes, which is in agreement with the result of [12]. No significant decrease in red blood count was found after irradiation by radium that is concert with [16]. After irradiation the blood, the WBC reduced and susceptibility to infection increases, because of insufficient white blood cells to fight bacteria, viruses, and other microbes that damage DNA [17]. Also decreased PLT after irradiation inhibits blood clotting.

To know the effect of X-ray on blood, most of the researches had done many researches in vivo and they had done them on rats, muses, monkeys and the other animals [5].

Thomas et al., in 1919, were presented the study on X-ray effect to simulative action on the lymphocytes. They summarized their study consists of blood count on nine rabbits. Most of these animals there resulted an increase of circulating lymphocytes but two of them had not change before and after exposure [18].

Kohn in 1951, carried out the serial dose on X-rays sufficient to cause a leucopenia markedly reduce the amount of hemolysin when given prior to the injection of red cells [19].

Craddock et al., 1948, had irradiate pigs with X-rays, he found out after intraperitoneal inoculation of infected material, white blood cells (WBC) were discouraged by one half [20].

Conclusion

The purpose of this study was to investigate the effect of different doses of X-ray on the blood for women with cancer breast problems. The results showed significant differences in the WBC and PLT before and after radiation with 40 kV because WBC / PLT significantly ($p<0.05$) showed reduction after irradiation. Also high significant differences ($p<0.001$) observed in the WBC / PLT before and after radiation with 80, 120 kV. From the results of RBC showed no statistical significant difference ($p > 0.05$) after irradiation with control values. This research has been done in vitro. It is generally believed that radiation in any amount will only damage cells and that the mutated cells could become cancers [2]

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