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The Effect of the Exposure into a low dose of X-ray on human Hematological Parameters

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***Abstract*— Although low dose of X-rays are widely used in medical radiology, the harmful effects of exposure to low dose of X-rays during diagnostic radiological examination is still a commonly discussed topic. Objective of the current study was to investigate the effects of exposing low dose of X-rays on human parameters, like the white blood cell (WBC), red blood (RBC), hemoglobin (HGB), and platelet counts (PLT) . znn We exposed a human blood into 60kv and 100mA for 80ms of medical diagnostic X-rays. Non-irradiated cells represented as the control group. The results showed there are no changes in the percentage in the RBC , WBC ,PLT , and HGB that were exposed to low dose X-rays, comparing to the corresponding non-irradiated blood cells, control samples, at all the harvest time-points. These finding suggested that there were no harmful effects of the diagnostic low dose X-rays in an in vitro exposure of RBC, WBC , PLT , and HGB.**

***Keywords*— X ray, Hematological Parameters, Ionizing radiation, WBC, RBC , HGB , PLT.**

I. INTRODUCTION

Ionizing radiation, such as gamma and X-ray radiation, affects the human body externally. Ionizing radiation has a high enough energy to ionize the medium's atoms. As a result of interactions, free radicals are produced, chemical bonds are broken, macromolecules are cross-linked, and molecules in human cells that control essential cell functions are destroyed, which may lead to cancer. Thankfully, cells can regenerate and repair themselves to some degrees of damage since most clinical radiation exposures involve modest amounts of 1 Gy, while greater doses can result in cell death [1] . Depending on to the absorbed dose and type of cell, cells respond to ionizing radiation exposure in different ways that vary quantitatively and qualitatively. These responses typically represent damage to specific cellular components and molecular structures.[2-3]

Both direct and indirect impacts of radiation on cells are caused by the interaction of radiation with atoms, which causes all biological actions. This process, known as the direct effect, occurs when radiation interacts directly with the atoms in the DNA molecule or other essential cells. The interaction might affect a cell's ability to divide and, consequently, its ability to live. When enough atoms are damaged, the chromosomes do not rebuild correctly. Since the human body is mainly water, the second form of interaction occurs when radiation interacts with the water in the cell. This is known as indirect impacts. As a result, there is a far higher likelihood that radiation will interact with the water that makes up the majority of the volume of the cell, break the bonds holding the water molecule together, and form fragments like hydrogen (H) and hydroxyls (OH). These fragments have the ability to recombine or interact with other fragments or ions to create compounds, like water, that are safe for cells. As a result, they might combine to create harmful molecules like hydrogen peroxide (H2O2), which could hasten the cell's demise.[4].

II. MATERIAL AND METHODS

A. Patients and Blood Sample

The research was conducted in Al Nasiriyah Teaching Hospital. Blood samples were gathered by venipuncture of 13 healthy adult , then put about 5ml of the blood in EDTA tubes to prevent it from clotting . After that, the samples were sent to the laboratory . The laboratory tests included a Complete Blood Picture (CBP) to examine the quantity of all blood constituents. For all patients, hematological parameters (HPs) or (CBC) are measured by an Automatic hematologic Sysmex device (XB-300) at laboratory of Al Nasiriyah Teaching Hospital (The Sysmex XB-300 device is part of the Sysmex Corporation's range of hematology analyzers. Sysmex is a leading Japanese company in the development and manufacturing of blood analysis systems and diagnostic medical systems. These devices are used for the analysis of blood samples to provide detailed information about various blood parameters, including red blood cell counts, white blood cell counts, platelet counts, hemoglobin levels, and more.). To ensure adherence to the same standard methodology, the same laboratory performed each patient's blood tests twice, once before the x-ray and once in the early post-irradiation period for all patients.

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B. Irradiation of samples

GE HUALUN MEDICAL SYSTEMS Co. Ltd wasused in the radiography process to irradiate blood samples at a time of 80ms and an energy of 60KV. We used an energy of 60 KV and a time of 80 ms because they represent the energy and time that commonly were used in most radiological examinations. The distance between the X-ray source and the sample was approximately 1m.

Fig. (1): Irradiation of samples

Fig. (2): Radiation technique

III. RESULT AND DISCUSSION

A. Result

Hematological parameters for 13 healthy adult (of an average age of 26 years) groups were statistically analyzed, and differences between the groups of samples and the pre-irradiation control groups of samples were examined statistically. Statistical analysis was performed using SPSS 23(Paired Samples Statistics).

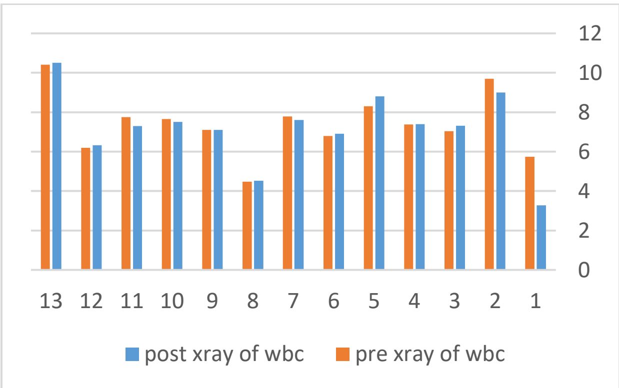

Fig. (3): WBC values before exposure to X-rays and after exposure to X-rays

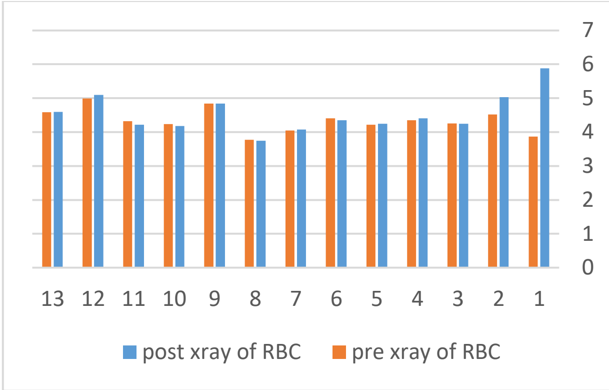

Fig. (4): RBC values before exposure to X-rays and after exposure to X-rays

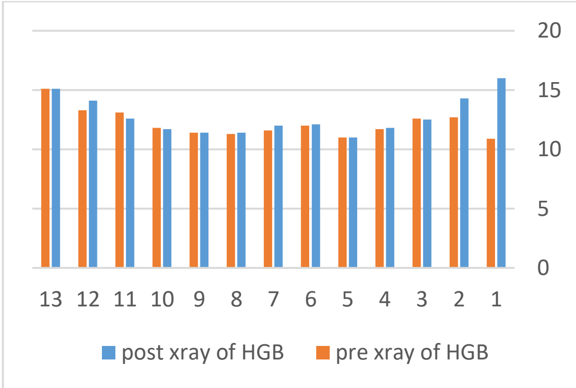

Fig (5): HGB values before exposure to X-rays and after exposure to X-rays

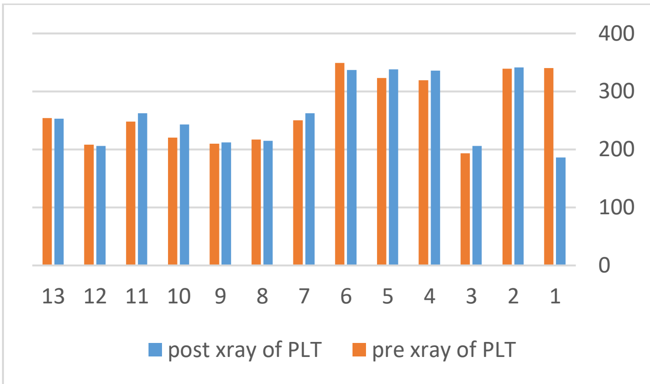

Fig. (6): PLT values before exposure to X-rays and after exposure to X-ray

Table (1) shows Statistical analysis for each samples

Paired Samples Statistics				
		Mean	Std. Deviation	Std. Error Mean
Pair 1	Pre Radiation WBC 103/ml	7.4077	1.54845	.42946
	Post Radiation WBC 103/ml	7.1931	1.83710	.50952
Pair 2	Pre Radiation RBC 106/ml	4.3408	.34563	.09586
	Post Radiation RBC 106/ml	4.5338	.55762	.15466
Pair 3	Pre Radiation HGB g/DL	12.1923	1.16294	.32254
	Post Radiation HGB g/DL	12.7692	1.58345	.43917
Pair 4	Pre Radiation PLT 103/ml	266.9231	58.31732	16.17432
	Post Radiation PLT 103/ml	261.3077	57.95887	16.07490

Table (2) shows Statistical analysis of blood samples before and after radiation

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Pre Radiation WBC 103/ml - Post Radiation WBC 103/ml	.21462	.74168	.20571	-.23358-	.66281	1.043	12	.317
Pair 2	Pre Radiation RBC 106/ml - Post Radiation RBC 106/ml	-.19308-	.56649	.15711	-.53540-	.14925	-1.229-	12	.243
Pair 3	Pre Radiation HGB g/DL - Post Radiation HGB g/DL	-.57692-	1.45325	.40306	-1.45511-	.30126	-1.431-	12	.178
Pair 4	Pre Radiation PLT 103/ml - Post Radiation PLT 103/ml	5.61538	45.66096	12.66407	-21.97726-	33.20803	.443	12	.665

B. Discussion

The purpose of this study was to look at how irradiation affected a group of healthy people' hematological markers. The analysis of the white blood cell (WBC), red blood (RBC), hemoglobin (HGB), and platelet counts (PLT) before and after irradiation was the main focus of our investigation. An understanding of the potential effects of irradiation on blood cell composition and general hematological health can be gained via statistical study of these characteristics. White According to the findings the mean of WBC count was 7.407 prior to radiation and 7.19 following radiation. Although the post-irradiation mean was more than that the pre-irradiation mean, the non-significant p-value (0.317) shows that this change was not statistically significant. The low p-value implies that the observed difference might be the result of chance rather than radiation's effect. Although whole-body ionizing radiation exposure causes leukoneutropenia, the reduction in granulocyte count takes longer than 1-2 days to develop and does not reach a trough until 3–4 weeks later [5].

The mean of RBC count values were 4.34 prior to radiation and 4.53 following radiation. Even though the post-irradiation drop in RBC count is slight, it is nevertheless important to note. Similar to the WBC count analysis, the p-value (0.243) indicates that this difference is not statistically significant. The effects of radiation on RBC levels may be limited. This result was consistent with the study (The Effect of Exposure to X-Rays on Some Blood Factors in Human Compared with Control) which states that there was no significant difference in the number of red blood cells (RBC) due to the time span of radiation exposure [6].

The mean HGB count was 12.19 prior to radiation and 12.76 after radiation. This result implies that irradiation had a little effect on HGB levels in this investigation. The mean difference in hemoglobin level (HGB) is -0.57692. The t-value is -1.431 with a p-value of 0.178. This suggests no statistically significant difference in HGB levels before and after radiation Our study results align with several studies indicating that long-term exposure to low-dose radiation may not have a significant effect on blood parameters [6-9], [10]

According to the findings, the platelet counts significantly increased after irradiation, with a mean of 266.9 before and 261.3 after. p-value of 0.665 again, there is no statistically significant difference in platelet count before and after radiation. After being exposed to a light or moderate ionizing radiation dose, the platelet count normally starts to fall 5–10 days later. Due to non-hematologic effects of ionizing radiation exposure, such as gastrointestinal injury, trauma, etc., the length of thrombocytopenia is strongly correlated with ionizing radiation dose and platelet usage at sites of active bleeding. The ensuing hematologic recovery is not often predicted by reductions in circulating granulocyte and platelet counts, even if they do correlate with ionizing radiation dose [5].

These findings imply that irradiation may not significantly alter hematological markers in healthy persons right away. It is significant to highlight that the sample size was small (n=13) and healthy individuals were included, which may restrict the generalizability of the results. Additionally, the unique features of the irradiation doses used in this investigation should be taken into account. The radiation dosages utilized in this investigation fell within the range commonly used for diagnostic imaging. It is critical to remember that the dose, dose rate, and exposure time all have an impact on how irradiation affects hematological parameters. Blood cell counts and hematological health have been linked to more pronounced effects of higher doses or extended irradiation [10]. The exposure period was 80 ms, with a energy of 60 kv. The effects on blood components are probably modest or nonexistent at such a low dose and brief exposure duration. Our study's findings supported research showing that low-dose radiation exposures (1 Gy) do not have immediate impacts. However, long-term effects of low-dose exposures may exist and should be carefully taken into account.[2].

Moreover, the relatively brief follow-up time may have had an impact on the lack of notable changes in the majority of hematological markers seen in this study. The short-term effects seen in this study may not accurately represent the potential long-term implications of hematological abnormalities brought on by irradiation.

This current finding suggests that fluoroscopic X-rays do not induce any harmful effects to human blood. These results are consistent with the findings that were previously reported by Farman et al [6], [9], [10]

IV. Conclusion

The results suggest that irradiation, especially at a low dose and short exposure time (60kev for 80 ms), may not have an immediate significant impact on hematological markers in healthy individuals. However, the short-term effects observed may not represent potential long-term consequences. These findings align with research indicating that low-dose radiation exposures (1 Gy or less) do not typically lead to immediate hematological abnormalities. Long-term effects of low-dose exposures should be carefully considered.

It's essential to keep in mind the limitations of this study, such as the small sample size, the use of healthy individuals, and the unique characteristics of the radiation doses employed. Future research with larger sample sizes and longer follow-up times may provide further insights into the long-term effects of irradiation on hematological health. These finding suggested that there were no harmful effects following fluoroscopic X-rays combined with iodinated radiographic contrast media when human blood was irradiated in an in vitro condition.

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Conflict of Interest

Authors declare that they have no conflict of interest.

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