Original Article

Access this article online

Quick Response Code:

Website: https://journals.lww.com/ijhm

DOI: 10.4103/ijh.ijh_1_24

Effects of radiotherapy on blood parameters in patients with different types of cancer; single center experience in Iraq

Salah Qadir Mahmood, Bakhtyar Kamal Talabany[1], Najmaddin S.H. Khoshnaw[2,3], Taib Hamasoor[4,5], Zahir Salih Hussein[6], Mohammad Hassan[7]

Department of X-ray, Sulaimani Technical Institute, Sulaimani Polytechnic University, Departments of [1]Anesthesia and [4]Medical Laboratory, College of Health and Medical Technology, Sulaimani Polytechnic University, [2]Department of Clinical Science, College of Medicine, University of Sulaimani, [5]Department of Medical Laboratory Analysis, Cihan University, [7]Department of Hematology, Hiwa Cancer Hospital, Ministry of Health, [3]Department of Medical Laboratory Science, College of Science, Komar University of Science and Technology, Sulaimani, [6]Department of Medicine, College of Medicine, Hawler Medical University, Erbil, KRG, Iraq

Address for correspondence:
Dr. Najmaddin S.H. Khoshnaw, Department of Clinical Science, College of Medicine, University of Sulaimani, Sulaymaniyah 0046, Iraq.
E-mail: najmaddin.husen@univsul.edu.iq

Submission: 04-01-2024
Revised: 31-01-2024
Accepted: 11-02-2024
Published: 26-03-2024

Abstract:

BACKGROUND: Radiotherapy is important for the treatment of cancer but it is not without side effects on the human body like lethal effects on blood cells. This study aimed to estimate the effect of radiotherapy on blood parameters in cancer patients.

PATIENTS AND METHODS: One hundred and two patients from Zhianawa Hospital in Sulaymaniyah Province, Iraq, were included in this study from July 2022 to October 2022. The blood samples were collected for blood analysis and the information of participants was taken through a detailed questionnaire.

RESULTS: Out of the 102 patients, 61 (59.8%) females and 41 (40.2%) males, the median age was 50.1 years ± 17.02 years. Forty-nine (48%) of studied patients were in Stage 4 and the most common cancer was breast cancer accounting for 43 (42.2%). We found a statistically significant ($P < 0.05$) reduction in total white blood cell (WBC) count, red blood cell (RBC) count, hemoglobin, and platelet counts, but regarding neutrophils, the reduction was statistically not significant ($P = 0.343$). Doses of radiotherapy and more advanced stages of cancer affect the degree of the reduction of blood counts and it can be seen in different ages. The cell drop was significantly lower in younger patients, aged <60 years as related to the curative intent in those age groups.

CONCLUSION: The results suggest that radiotherapy has a potential effect on circulating WBCs, RBC counts, and platelets, but not neutrophils and it is related to the stage of cancer and age of the patients.

Keywords:

Cancer, hemoglobin, leukocyte, platelet, radiotherapy

Introduction

Ionizing radiation (IR) has an important role in both the diagnosis and treatment of different diseases.[1] Radiation as a source of energy emissions such as gamma rays, X-rays, and charged particles is useful for the treatment of cancer.[2]

X-ray imaging is the most common IR used for that purpose in the form of nuclear medicine and computed tomography (scans).[1]

Radiotherapy through using IR becomes one of the most important ways to fight cancer by killing cancer cells.[3,4] The radiation dose is depending on the type of cancer and the tissue around the cancer area because of the differences in their tolerance.[5] The adverse effect of radiation on noncancer cells promotes cell damage at the molecular level.[6] The cell can repair most of the damage, but the problem occurs in misrepaired DNA damage because it causes genomic instability and thus may induce cancer after many years. Due to existing faster proliferation in tumor

How to cite this article: Mahmood SQ, Talabany BK, Khoshnaw NS, Hamasoor T, Hussein ZS, Hassan M. Effects of radiotherapy on blood parameters in patients with different types of cancer; single center experience in Iraq. Iraqi J Hematol 2024;13:90-4.

cells, they are more susceptible to DNA damage due to radiation because the cells are growing faster than surrounding normal tissues.[5]

The bone marrow is very sensitive to radiation and radiation therapy causes a significant decline in white blood cells (WBCs) and platelet counts that way it is important to monitor complete blood count to follow the patient's during treatment.[7] Radioprotective compounds for patients and department staff are necessary during clinical radiotherapy.[8]

Radiotherapy despite of it is hematological toxicities, because of its beneficial effect for the treatment of cancers should not be used as an excuse to stop radiotherapy, especially low doses of therapeutic radiation.[9] The extent of side effects of radiotherapy depends on the type of tissues treated, their radiosensitivity, and the dose delivered.[10] Radiation therapy's side effects could be acute or chronic.[11-13] This study aims to evaluate the changes in blood parameters during treatment with radiotherapy with or without chemotherapy in different types of cancers.

Patients and Methods

Study design and sampling

This is a prospective study done on 102 cancer patients treated at Zhianawa Radiotherapy Center at Sulaymaniyah city, who were suffering from different types of cancers (breast cancer, gastrointestinal tract (GIT), metastasis bone cancer, prostate, sarcoma, lung cancer, lymphoma, brain, cervix, head and neck, and skin cancer). All patients were treated with three-dimensional conformal radiation therapy as part of planning radiotherapy. Patients were treated with a total dose of centigrade (cGy), using a radiotherapy machine (model: Elekta Synergy) between July 4, 2021, and October 25, 2021.

For all patients, hematologic tests were performed before the start of the treatment and at the end of radiation treatment. The parameters were measured by a hematological analyzer (Sysmex-XN-350, compact 5-part differential analyzer, Germany).

The inclusion criteria were any cancer patients from Sulaymaniyah city of different ages who attended the Zheanawa Radiotherapy Center.

Statistical analysis

The statistical calculations were performed using the Statistical Package for the Social Sciences (SPSS) version 25 (SPSS 25, IBM Company, Chicago, IL, USA). Descriptive data, frequency, mean, and standard deviation (SD) were used. A paired *t*-test was used for categorical data. $P < 0.05$ was regarded as statistically significant.

Ethical consideration

The study was conducted by the ethical principles that have their origin in the Declaration of Helsinki. The study was approved by the ethical committee of the Technical College of Health and the agreement of the Sulaymaniyah General Directorate of Health. Consent was taken from patients and their parents if the patient was younger than 18 years old. Confidentiality of the information was maintained and the privacy of the patients was kept ethically.

Results

Out of the 102 patients who received radiotherapy at Zhianawa radiotherapy center, 61 (59.8%) were female, and 41 (40.2%) were male, the median age was 50.1 years SD ± 17.02 years. The male-to-female ratio was 0.67/1. About 21 (20.6%) of cases were smokers. About 49 (48%) patients have Stage 4 cancers, 46 (45%) patients have Stage 3, and only 7 (6.9%) patients have Stage 2 diseases [Table 1]. The most common cancer in the studied population was breast cancer, 43 (42.2%). Metastatic bone and prostate cancers were the second-most common cancers accounting for 9 (8.8%) [Table 2].

The WBCs were analyzed to see the difference between their number in pre- and postexposure to radiotherapy. The mean differences were compared using a paired *t*-test. The results showed a positive *P* value in total WBC count, red blood cell (RBC) count, hemoglobin (HB), and platelet counts. The study showed a reduction in former blood counts with a significant *P* value. While there was a reduction in neutrophils after the radiotherapy but its statistically not significant, $P = 0.343$ [Table 3].

Different doses of radiotherapy affect the degree of the reduction of blood counts and it was found to give different means but statistically not significant in those who took < or > doses than 6000 cGy [Table 4].

The effect can be seen in different ages. The result showed that the drop in blood count was significantly lower in

Table 1: The demographic data of the studied group of patients

Variables	Categories	Frequency (%)
Gender	Female	61 (59.8)
	Male	41 (40.2)
Smoking	No	81 (79.4)
	Yes	21 (20.6)
Cancer stage	II	7 (6.9)
	III	46 (45.1)
	I	49 (48.0)

younger ages (<60 years) as related to the curative intent in younger ages in comparison to elderly people in both RBC and WBC levels [Table 5].

A significant relation was found between the stage of cancer and lower level of blood counts including total WBC, neutrophil count, basophils count, RBC, HB, hematocrit, mean corpuscular hemoglobin (MCH), and red cell distribution width (RDW), especially in Stage 4 disease as shown in Table 6.

Discussion

Radiation is a physical form of treatment that damages any tissue in its path, its selectivity for cancer cells may be due to defects in a cancer cell's ability to repair sublethal DNA and other damage.[14]

IR is sometimes the single best treatment for cancer stopping it from spreading as it can provide a cure or control of the disease.[15] However, while having a central role in cancer therapeutics; it injures as well normal cells by damaging their genetic material as DNA which is the principal target for the biological effects of IR.[16]

The indirect interaction of IR leads to hydrolysis of water molecules resulting in hydrogen and a hydroxyl free radical molecule.[17]

In the present study, there is a statistically significant association between radiotherapy and the reduction in blood parameters such as total WBC count, RBC count, HB, and platelet counts, the results are similar another study reported by Wersal, *et al*., whereas in a study done by Yang *et al*. blood parameters decreased except HB.[18,19]

It has been shown in many studies that changes occur in blood parameters when blood is exposed to high doses of X-rays such as those of RBCs, WBCs, and platelets.[20] In a recent study, we demonstrated that the relationship between the dose of radiotherapy and the degree of the reduction of blood counts was found to give different means but statistically not significant in those who took less or higher doses than 6000 cGy.

Furthermore, the study showed a statistically significant lower blood count in those younger ages <60 years as related to the curative intent in younger ages in comparison to elderly people in both RBC and WBC levels. Hence, the effect is higher at younger ages.

The stage of cancer has a critical role in the change. We find a significant relationship between the stage of cancer and lower level of blood counts including total WBC, neutrophil count, basophils count, RBC, HB, hematocrit,

Table 2: The frequency and percentage of the different types of cancer in the studied group of patients who underwent radiotherapy

Type of cancer	*n* (%)
Breast cancer	43 (42.2)
GIT	17 (15.6)
Bone metastasis	9 (8.8)
Prostate	9 (8.8)
Sarcoma	6 (5.9)
Lung cancer	5 (4.9)
Lymphoma	4 (3.9)
Brain (whole brain)	3 (2.9)
Cervix	2 (2)
Head and neck	5 (4.9)
Skin cancer	2 (2)

GIT: Gastrointestinal tract

Table 3: Pre- and post-exposure mean differences were analyzed using paired *t*-test

Categories	Mean difference±SD	95% CI	*P*
WBC	1.36±2.06	0.95–1.76	≤0.001
NEU	8.62±79.26	−26.60–9.37	0.343
RBC	0.10±0.39	0.02–0.18	0.011
HB	0.45±1.08	0.23–0.66	≤0.001
PLT	18.7±93.8	0.18–37.2	0.048

WBC=White blood cell, RBC=Red blood cell, NEU=Neutrophil, PLT=Platelet, HB=Hemoglobin, CI=Confidence interval, SD=Standard deviation

Table 4: Relationship between the doses of radiotherapy and blood counts

Categories	TDE <6000	*P*	TDE ≥6000	*P*
WBC-pre	6.9	≤0.001	6.9	0.012
WBC-post	5.6		5.3	
NEU-pre	4.5	0.047	4.1	0.861
NEU-post	4.1		4	
RBC-pre	4.4	0.7	4.4	0.033
RBC-post	4.3		4.1	
HB-pre	12.1	≤0.001	12.4	0.024
HB-post	11.7		11.8	
PLT-pre	270.9	0.76	246.7	0.351
PLT-post	252.4		228.4	

TDE=Total radiotherapy dose exposure, WBC=White blood cell, RBC=Red blood cell, NEU=Neutrophil, PLT=Platelet, HB=Hemoglobin

Table 5: The relation of blood counts with age after radiotherapy

Categories	Age <60 years	*P*	Age ≥60 years	*P*
WBC-pre	6.9	≤0.001	7	0.091
WBC-post	5.2		6.5	
NEU-pre	4.4	0.053	4.6	0.7
NEU-post	3.9		4.4	
RBC-pre	4.4	0.042	4.3	0.08
RBC-post	4.3		4.2	
HB-pre	12.1	0.002	12.3	0.003
HB-post	11.6		11.8	
PLT-pre	267.9	0.101	269.3	0.252
PLT-post	248.4		251.8	

WBC=White blood cell, RBC=Red blood cell, NEU=Neutrophil, PLT=Platelet, HB=Hemoglobin

Table 6: The relationship between cancer staging and white blood cell parameters after giving radiotherapy

Categories	Cancer stages					
	Stage 2	*P*	Stage 3	*P*	Stage 4	*P*
WBC parameters						
WBC-pre	6.29	0.798	7.33	0.004	6.59	≤0.001
WBC-post	6.55		6.01		5.20	
NEU-pre	4.25	0.226	4.53	0.999	4.45	0.015
NEU-post	4.54		4.27		3.59	
LYM-pre	1.29	0.241	2.06	≤0.001	1.57	≤0.001
LYM-post	1.43		1.07		0.97	
MON-pre	0.42	0.457	0.44	0.494	0.43	0.452
MON-post	0.40		0.41		0.39	
EOS-pre	0.19	0.182	0.17	0.086	0.15	0.392
EOS-post	0.15		0.14		0.13	
BASO-pre	0.04	0.256	0.04	0.050	0.04	0.008
BASO-post	0.003		0.03		0.03	
RBC parameter						
RBC-pre	4.44	0.886	4.32	0.336	4.42	0.002
RBC-post	4.47		4.18		4.26	
HB-pre	12.61	0.562	11.97	0.230	12.23	0.005
HB-post	12.24		11.50		11.86	
HCT-pre	37.97	0.535	35.83	0.296	36.56	0.020
HCT-post	36.60		34.71		35.46	
MCV-pre	85.63	0.194	83.11	0.907	83.26	0.579
MCV-post	82.01		83.30		84.28	
MCH-pre	28.57	0.120	27.53	0.915	27.72	0.045
MCH-post	27.49		27.60		27.86	
RDW	13.80	0.756	14.02	0.842	14.01	0.090
RDW	14.14		14.40		14.46	
Platelets parameters						
PLT-pre	255.14	0.911	248.12	0.352	255.29	0.205
PLT-post	258.00		279.13		244.38	
MPV-pre	8.63	0.760	8.87	0.319	9.07	0.475
MPV-post	8.79		8.49		8.57	
PDW-pre	10.51	0.264	12.12	0.019	11.90	0.117
PDW-post	12.00		10.70		11.38	

WBC=White blood cell, RBC=Red blood cell, PLT=Platelet, NEU=Neutrophil, LYM=Lymphocytes, MON=Monocytes, EOS=Eosinophils, BASO=Basophils, HB=Hemoglobin, HCT=Hematocrit, MCV=Mean corpuscular volume, MCH=Mean corpuscular hemoglobin, RDW=Red cell distribution width, MPV=Mean platelet volume, PDW=Platelet distribution width

MCH, and RDW, especially in Stage 4 disease, the same results were obtained in other studies.[21]

Conclusion

In summary, the study showed that the radiotherapy treatment has effects on blood counts, and the effects related to the stage of cancer and age of the patient. Curative intent in younger ages has more effects on lowering blood counts in comparison with the elderly with more palliative plans in the latter. Finally, this study is important to check the blood parameters before giving radiotherapy and after radiotherapy to help patients live with a better quality of life.

Author contribution

SQM primary investigator, BKT designed the study, NSHK wrote most parts of the manuscript, THS shared in writing, and ZSH did the statistical analysis and reviewed the manuscript. MH shared in statistical analysis.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

References

1. Vaiserman A, Koliada A, Zabuga O, Socol Y. Health impacts of low-dose ionizing radiation: Current scientific debates and regulatory issues. Dose Response 2018;16:1-19.
2. Brundha M, Pathmashri V, Sundari S. Quantitative changes of red blood cells in cancer patients under palliative radiotherapy – A retrospective study. Res J Pharm Technol 2019;12:687-92.
3. Chen HH, Kuo MT. Improving radiotherapy in cancer treatment: Promises and challenges. Oncotarget 2017;8:62742-58.
4. De Ruysscher D, Niedermann G, Burnet NG, Siva S, Lee AW, Hegi-Johnson F. Radiotherapy toxicity. Nat Rev Dis Primers 2019;5:13-5.
5. West CM, Barnett GC. Genetics and genomics of radiotherapy toxicity: Towards prediction. Genome Med 2011;3:52.
6. Georgakilas AG. Processing of DNA damage clusters in human cells: Current status of knowledge. Mol Biosyst 2008;4:30-5.
7. El-Dessouky YM, El-Dessouky MM, El-Batrawy OA. Penicillamine as radiation protector against gamma radiation effect on complete blood count parameters of guinea pigs. Al Azhar Assiut Med J 2019;17:145.
8. Zachariah B, Jacob SS, Gwede C, Cantor A, Patil J, Casey L, *et al.* Effect of fractionated regional external beam radiotherapy on peripheral blood cell count. Int J Radiat Oncol Biol Phys 2001;50:465-72.
9. Jameus A, Kennedy AE, Thome C. Hematological changes following low dose radiation therapy and comparison to current standard of care cancer treatments. Dose Response 2021;19:1-19.
10. Kasper D, Fauci A, Hauser S, Longo D, Jameson J, Loscalzo J. Harrison's Principles of Internal Medicine. 19th ed., Vol. 1. New York, NY, USA: Mcgraw-Hill; 2015.
11. Shahid S. Review of hematological indices of cancer patients receiving combined chemotherapy & radiotherapy or receiving radiotherapy alone. Crit Rev Oncol Hematol 2016;105:145-55.
12. Coussens LM, Werb Z. Inflammation and cancer. Nature 2002;420:860-7.
13. Gao J, Hu JY, Xia YF, Yi W, Tao YL, Li G. Continuous fall in hemoglobin level is a poor prognostic factor in patients with nasopharyngeal carcinoma treated with radiotherapy. Chin J Cancer 2010;29:561-6.
14. Colledge NR, Walker BR, Ralston SH. Principles and Practice of Medicine. Edinburgh; New York: Churchill Livingstone/Elsevier; 2011. p. 258-74.
15. Srinivasan M, Sudheer AR, Pillai KR, Kumar PR, Sudhakaran PR, Menon VP. Modulatory effects of curcumin on γ-radiation-induced cellular damage in primary culture of isolated rat hepatocytes. Environ Toxicol Pharmacol 2007;24:98-105.
16. Govindan R. The washington manual of oncology 2e. Lippincott Williams & Wilkins; 2008.
17. Ridnour LA, Thomas DD, Mancardi D, Espey MG, Miranda KM,

Paolocci N, *et al.* The chemistry of nitrosative stress induced by nitric oxide and reactive nitrogen oxide species. Putting perspective on stressful biological situations. Biol Chem 2004;385:1-10.

18. Wersal C, Keller A, Weiss C, Giordano FA, Abo-Madyan Y, Tuschy B, *et al*. Long-term changes in blood counts after intraoperative radiotherapy for breast cancer-single center experience and review of the literature. Transl Cancer Res 2019;8:1882-903.
19. Yang FE, Vaida F, Ignacio L, Houghton A, Nauityal J, Halpern H, *et al.* Analysis of weekly complete blood counts in patients receiving standard fractionated partial body radiation therapy. Int J Radiat Oncol Biol Phys 1995;33:617-17.
20. Faraj K, Mohammed S. Effects of chronic exposure of X-ray on hematological parameters in human blood. Comp Clin Pathol 2018;27:31-6.
21. Koma Y, Onishi A, Matsuoka H, Oda N, Yokota N, Matsumoto Y, *et al.* Increased red blood cell distribution width associates with cancer stage and prognosis in patients with lung cancer. PLoS One 2013;8:e80240.