Short Communication

Evaluation of Hematological Parameter Changes on Worker Staff Exposed to Emitted Radiation from Medical Apparatus in Al-Najaf Province

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Abstract

Background: Radiographers have been known to have significant and long-term exposure to ionic radiation. **Objectives:** We aimed to investigate the effects of ionizing radiation (IRs) on medical workers' hematological parameters (HPs) in the Al Hakeem and Al Zahara teaching hospitals in Najaf Province. **Materials and Methods:** The current study included a total of 60 healthy medical radiographers (MRs) who were comparable to a group of 20 healthy controls. **Results:** The results showed a significant decrease in the mean packed cell volume (P.C.V) of the hospital staff compared with the control group, and there was a significant increase in mean corpuscular hemoglobin (MCH), MCHC, platelet count, and lymphocytes of the hospital staff compared with the control group, and there was no significant difference in mean Hb, WBC, and neutrophils, but there was also a significant increase in the mean Hb and PCV of male workers compared with female workers, but no significant difference in the other HPs between male and female workers in the hospital. The results reveal a significant increase in the mean Hb, platelet count, and WBC among Al Zahara staff compared to Al Hakeem staff. The results also revealed that there was no significant difference in the other HPs between the two hospital staff members. **Conclusion:** It is strongly recommended that auditing of personal protective equipment for IR be conducted. In addition, protection and safety should be enforced, and medical monitoring, including that of hematological indices, should be performed on a regular basis. These measures would aid in reducing the effects of workplace radiation hazards and detecting disorders at an early stage.

Keywords: Exposure, hematological parameters, medical apparatus, radiation, workers

Introduction

In the recent decades, the medical use of ionizing radiation (IR) has rapidly evolved all over the world, and it became a key tool with its wide range of applications in diagnosis and treatment of various diseases.[1] IRs such as X-rays are generated by targeting a beam of electrons to a metal object. Ionizing rays pass through living tissues and have the potential to destroy them or cause functional abnormalities in living cells.[2] MRs exposed to reduced IR doses on the workplace are more likely to become affected with diseases that are life-threatening, specifically those involving the hematopoietic system. The hematological system is extremely sensitive to radiation, and therefore complete blood count can be used as a biological indicator. After 0.5–1.0 g-ray of radiation, responses can be seen.[3]

IR contains enough energy to cause physical symptoms within minutes of exposure, which may result in acute radiation syndrome (ARS). Nausea, vomiting, and fatigue are all symptoms of the prodromal phase of ARS. The different symptoms of ARS were influenced by the radiation's type, the dosage, and the dose rate. A dramatic decrease in PBC counts can follow these prodromal symptoms as hematopoietic cells compose a renewal system made up of cells that have high division

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rates and are well known for their susceptibility to IR.[4] The use of hematological, biochemical, and cytogenetic parameters to investigate the biological effects of radiation has become common in recent decades.[5] Peripheral blood analysis may be used to screen for a variety of hematological and non-hematological diseases. Complete blood cell count (CBC) is particularly useful as a health assessment tool used in the sub-clinical stage of many disorders because it is a low-cost, quick point-of-care test. Furthermore, examination of blood cells enables clinicians to create wide impressions of differential diagnosis.[6]

The object of the current study is to determine the effects of IR on the hematological parameters (HPs) of working staff in the Al Hakeem and Al Zahara teaching hospitals in Najaf Province.

Materials and Methods

Subjects and study design

The current research was carried out in two of the largest and most important government hospitals in Najaf Province. A total of 60 people (40 men and 20 women) aged 28 to 55 years old from thesehospitals, were exposed to low doses of IRas part of their job for at least 5 years and had at least 5 years of experience in radiology. As a control group, the cases were compared with a group of 20 healthy controls from outside the hospital (14 males and six females) who had never been exposed to radiation. MRs worked with various imaging modalities and tools, such as X-rays and magnetic resonance imaging (MRI). They also worked 8 hours a day in different shifts, 5 days a week. Participants with diseases previously, such as gross anemia, diabetes mellitus with a documented history, acute or chronic infection, cardiopulmonary disease, malignancy, or autoimmune disease, were not included in the research.

Hematological analysis

Blood samples were taken from all participants (2 mL per participant). Blood was drawn from a vein with a disposable syringe and placed in a tube containing 1.5 mg/mL ethylene diamine tetraacetic acid (EDTA). HPs were measured at a regular laboratory using an ABX Micros 60 analyzer. This research estimated the levels of red blood cells (RBCs), white blood cells (WBCs), platelet count (PLT), hematocrit (HCT), hemoglobin (Hb), MCH, MCHC, mean corpuscular volume (MCV), and typical lymphocytes.

Statistical analysis

Statistical analysis was carried out using Statistical Package for the Social Sciences (SPSS) version 23.0 (SPSS, IBM Company, Chicago, IL 60606, USA). The independent-sample *t* test and one-way ANOVA were utilized. It is considered significant if the *P* value is less than 0.05.

Results

The results in Table 1 indicated a significant decrease ($P > 0.05$) in the mean P.C.V of hospital staff compared with the control group, and there was a significant increase ($P > 0.05$) in the mean MCH, MCHC, platelets count, and lymphocytes of the hospital staff compared with the control group, and there was no significant difference ($P < 0.05$) in the mean Hb, WBC, and neutrophils.

The result in Table 2 indicated a significant increase ($P > 0.05$) in mean Hb and P.C.V of male workers compared with female workers, and there was no significant difference ($P < 0.05$) in the other HPs between male and female workers in hospital.

The result in Table 3 indicated a significant increase in mean Hb, platelet count, and WBC of Al Zahara staff compared with Al Hakeem staff, and there was no significant difference ($P < 0.05$) in the other HPs between the staff members of the two hospitals.

Table 1: Hematological parameters (HPs) of hospital workers compared with the control group

Groups	Hospital worker	Control	
	$n = 60$	$n = 20$	
HPs	Mean ± SE	Mean ± SE	Sig.
Hb	13.30 ± 0.39	13.29 ± 0.3	0.97
p.c.v.	39.33 ± 1.12	43.35 ± 0.73	0.004*
MCV	87.10 ± 1.39	89.08 ± 1.76	0.38
MCH	29.50 ± 0.55	27.25 ± 0.68	0.014*
MCHC	33.80 ± 0.23	30.57 ± 0.30	0.001*
Platelet count	300.94 ± 18.30	207.96 ± 13.33	0.001*
WBC	7.16 ± 0.29	6.97 ± 0.43	0.71
Neutrophils	5.65 ± 1.69	59.96 ± 2.33	0.42
Lymphocytes	34.89 ± 1.57	29.80 ± 2.59	0.03*

*significant at ($P < 0.05$)

Table 2: Comparison of HPs between male and female hospital workers

Groups	Hospital workers		
HPs	Female	Male	
	Mean ± SE	Mean ± SE	Sig.
Hb	11.90 ± 0.50	14.34 ± 0.45	0.001*
P.C.V	35.52 ± 1.57	42.13 ± 1.26	0.003*
MCV	85.98 ± 1.78	87.93 ± 2.05	0.47
MCH	28.85 ± 0.63	29.99 ± 0.84	0.26
MCHC	33.49 ± 0.32	34.03 ± 0.31	0.24
Platelet count	281.21 ± 17.13	315.47 ± 29.17	0.32
WBC	6.61 ± 0.54	7.56 ± 0.30	0.14
Neutrophils	60.10 ± 2.44	55.84 ± 2.29	0.21
Lymphocytes	32.22 ± 2.13	36.86 ± 2.16	0.13

*significant at ($P < 0.05$)

Table 3: Comparison of HPs of hospital workers between Al Hakeem and Al Zahara hospitals

HPs	Hospital	Mean ± SE	Sig.
Hb	Al Hakeem	12.60 ± 0.50	0.047*
	Al Zahara	14.16 ± 0.55	0.047*
p.c.v	Al Hakeem	37.58 ± 1.54	0.092
	Al Zahara	41.42 ± 1.54	0.089
MCV	Al Hakeem	86.80 ± 1.42	0.816
	Al Zahara	87.47 ± 2.61	0.824
MCH	Al Hakeem	29.13 ± 0.5177	0.470
	Al Zahara	29.96 ± 1.07	0.496
MCHC	Al Hakeem	33.51 ± 0.26	0.179
	Al Zahara	34.14 ± 0.38	0.192
Platelet count	Al Hakeem	268.00 ± 14.53	0.047*
	Al Zahara	340.47 ± 34.24	0.04*
WBC	Al Hakeem	6.63 ± 0.43	0.05*
	Al Zahara	7.79 ± 0.34	0.04*
Neutrophils	Al Hakeem	57.95 ± 2.14	0.85
	Al Zahara	57.30 ± 2.77	0.85
Lymphocytes	Al Hakeem	34.57 ± 2.013	0.25
	Al Zahara	35.28 ± 2.55	0.82

*significant at ($P < 0.05$)

Discussion

Long-term exposure to IR at low doses can damage cells and tissues. Experiments with IR have long been linked to changes in hematopoietic tissue and, in some cases, death.[6] A few years after X-rays were originally employed for radiologic imaging, physicians and other medical radiation technologists developed skin carcinomas, leukemia, dermatitis, cataracts, and other serious health effects.[7] Our study results in Table 1 indicated a significant decrease in the mean P.C.V of hospital staff compared with the control group, and there was a significant increase in the mean MCH, MCHC, platelet count, and lymphocytes of hospital staff compared with the control group. Mammalian erythrocytes have been used to study the IR effects since 1900s.[8] Radiation has been shown to cause electrolyte imbalance.[9] A different approach to explain radiation-induced hemolysis emphasizes the formation of free radicals. Lipid peroxidation, phospholipid head group hydrolysis, lipid–lipid crosslinks, disulfide bridge formation and amino acid residue damage in membrane proteins, and lipid–protein crosslinks are all examples of lipid peroxidation and membrane changes caused by free radicals produced during radiolysis of water.[10] The cytoskeleton may be affected by changes in membrane structures.[11] The combined effects of free radicals on the erythrocyte membrane and cytoskeleton can lead to hemoglobin leakage from the cells. The free radical hypothesis is backed up by strong evidence. In rats, the production of lipid peroxides in the erythrocyte membrane seems to be linked to hemolysis.[12] Mammalian proliferating cell systems are affected by chronic exposure of IR with a low dose-rate as a result of both dose-rate and cumulative dose received. For a deterministic effect, that is, tissue reaction to occur, the total dose should be greater than the dosing rate. Furthermore, previously reported representative data suggested low dose-rate-mediated responses in the hemopoietic system in rats and dogs. Damage has been found to be accumulating, especially in cell renewal systems that turn over quickly, such as hemopoietic tissue, that establish the link between low-dose exposures and clinical signs and disorders in exposed organisms on a regular basis. This shows that both the overall absorbed dose and the dose-rate or frequency of repeated exposures have a role to play in the tissue effect of hemopoietic failure.[13]

The results in Table 2 indicate a significant increase in mean Hb and P.C.V of male workers compared to female workers, and there was no significant difference in the other HPs between male and female workers in the hospital.

Many studies have discovered that gender has an effect on various serious illnesses. The same can be said of the dangers of being exposed to IR or X-rays from radioactive chemicals.[14]

There are references to differences in the radiation sensitivity in tissues among males and females in clinical research that analyze the early or late side-effects of radiotherapy and combined radio/chemotherapy by sex. However, only a few studies have extensively examined potential sex-specific variations owing to IR exposure. Several epidemiological studies, on the other hand, have investigated sex-related differences in the incidence and mortality of radiation-induced cancer.[15]

The results in Table 3 indicate a significant increase in mean Hb, platelet count, and WBC of Al Zahara staff compared to Al Hakeem staff, and there was no significant difference ($P < 0.05$) in the other HPs between these two hospital staff.

Even at low doses, in therapeutically or diagnostically exposed groups, the effects of radiation-related circulatory disorders have been reported. Similarly, populations with substantial exposure owing to their occupation or the environment, as well as the Japanese atomic bomb survivors in the Life Span Study (LSS) and associated Adult Health Study (AHS), display an elevated risk of developing circulatory system disease. Atherosclerosis is the main cause of ischemic heart disease and cerebrovascular disease, which may result in stroke and acute myocardial infarction.[16]

Among cell types tested, WBCs tended to be the most vulnerable to gamma-ray irradiation.[17] In a dose-dependent manner, IR disruption produces a significant decline in the amount of blood cells. It could be regarded as a potential public health risk upon exposure. The most essential factor in the radiation-induced cell loss reported was, as expected, the radiation dose. WBC counts in the peripheral blood have decreased after whole-body gamma irradiation, which is dose-dependent, consistent with recent findings in a mouse model following whole-body gamma irradiation.[18]

Following systemic radiation exposure, IR causes biological impacts on human health, including HPs that change sooner or later and hematopoietic syndrome in animals and people, according to studies. Platelet elevation causes myelodysplastic disease, as well as chronic myelogenous leukemia. The induction of the most prominent cause of hematopoietic syndrome is the induction of apoptosis in hematopoietic stem cells, and hematopoietic progenitor cells are primarily responsible for IR, causing acute bone marrow damage. The results clearly indicate that changes in HPs are as a result of exposure to the radiation. Moreover, the evaluation of risk owing to low-dose IR based on animal models is also available.[19-22]

Conclusion

Based on the current findings, it is strongly recommended that auditing of personal protective equipment for IR be conducted. In addition, prottection and safety should be enforced, and medical monitoring, including hematological indices, should be performed on a regular basis. These measures would aid in reducing the effects of workplace radiation hazards and detecting disorder at an early stage.

Ethical policy and Institutional Review Board statement

Not applicable.

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Not applicable.

Author contributions

Not applicable.

Ethical approval

The ethics committee (IRB), the College of Science, Kufa University, Iraq, approved this work (6756/2022).

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Conflicts of interest

There are no conflicts of interest.

References

1. Gupta P. Problem Solving Questions in Toxicology. Amsterdam: Springer; 2020.
2. Bergstrand JH, Egger PJ. Gravity equations and economic frictions in the world economy. Radiat Phys Chem 2013;13:532-70.
3. Christopher B, Mary YS, Khandaker MU, Bradley D, Chew M, Jojo PJ, *et al*. Effects of mobile phone radiation on certain hematological parameters. Radiat Phys Chem 2020;166:108443.
4. Tong J, Hei TKJ. Aging and age-related health effects of ionizing radiation. Protection 2020;1:15-23.
5. Boice J, Dauer LT, Kase KR, Mettler FA, Vetter RJ. Evolution of radiation protection for medical workers. Br J Radiol 2020;93:20200282.
6. Masoumi H, Hasanzadeh H, Jadidi M, Mirmohammadkhani M, Bitarafan-Rajabi A, Abedelahi A, *et al*. A survey on the radiation protection status among radiology staff. Heliyon 2018;15:176-81.
7. Barman P, Sharma P. Investigation of Amorphous GeTeSeGa Chalcogenides For Physical Structural Optical and Thermal Properties. Solan, HP: Jaypee University of Information Technology; 2022.
8. Prasad KN. Acute Radiation Syndromes. Radiation Biology. Boca Raton, FL: CRC Press; 2020. p. 205-36.
9. Studiengangspezifischer Anhang des Fachbereichs Sprach- und Kulturwissenschaften der Johann Wolfgang Goethe. Universität Frankfurt am Main für den Masterstudiengang Klassische Archäologie vom 19; 2019.
10. Demchenkov E, Nagdalian A, Budkevich R, Oboturova N, Okolelova AJE, Safety E. Usage of atomic force microscopy for detection of the damaging effect of CdCl2 on red blood cells membrane. Ecotoxicol Environ Soc 2021;208:111683.
11. Fliedner TM, Graessle DH, Meineke V, Feinendegen LE. Hemopoietic response to low dose-rates of ionizing radiation shows stem cell tolerance and adaptation. Dose Res 2012;10:12-1040.
12. Wong AP, Wijffels SE, Riser SC, Pouliquen S, Hosoda S, Roemmich D, *et al*. Argo data 1999–2019: Two million temperature-salinity profiles and subsurface velocity observations from a global array of profiling floats. Front Mar Sci 2018;189:700.
13. Boaventura P, Durães C, Mendes A, Costa NR, Chora I, Ferreira S, *et al*. Is low-dose radiation exposure a risk factor for atherosclerotic disease? Radiat Res 2018;189:418-24.
14. Bergstrand JH, Egger PJP. Gravity equations and economic frictions in the world economy. In: Bernhofen D, Falvey R, Greenaway, D, Kreickemeier U, editors. Palgrave Handbook of International Trade. Palgrave Macmillan; 2013. p. 532-70.
15. Maks CJ, Wan XS, Ware JH, Romero-Weaver AL, Sanzari JK, Wilson JM, *et al*. Analysis of white blood cell counts in mice after gamma-or proton-radiation exposure. Radiat Res 2011;176:170-6.
16. Pavlis N, Kenyon S, Factor J, Holmes S. Earth gravitational model 2008. SEG technical program expanded abstracts 2008. Soc Explor Geophys 2008;6:761-3.
17. Gault N, Verbiest T, Badie C, Romeo P-H, Bouffler SJ. Hematopoietic stem and progenitor cell responses to low radiation doses–implications for leukemia risk. Int J Radiat Biol 2019;95:892-9.
18. Hsu W-L, Preston DL, Soda M, Sugiyama H, Funamoto S, Kodama K, *et al*. The incidence of leukemia, lymphoma and multiple myeloma among atomic bomb survivors: 1950–2001. Radiat Res 2013;179:361-82.
19. Wang C, Oshima M, Sashida G, Tomioka T, Hasegawa N, Mochizuki-Kashio M, *et al*. Non-lethal ionizing radiation promotes aging-like phenotypic changes of human hematopoietic stem and progenitor cells in humanized mice. PLoS One 2015;10:e0132041.
20. Sabea DW. Lead precipitation on the gingival tissue of Iraqi workers in some fuel stations in Baghdad. Med J Babylon 2023;20:614-8.
21. Hassan S, Baiee HA, Shaban M, Zaky ME, Mahdi MT. Healthcare providers' knowledge and challenges they face regarding growth charts' utilization in primary healthcare practice. Med J Babylon 2023;20:574-8.
22. Faraj KA. Ionizing radiation-induced non-cancer diseases. Med J Babylon 2023;20:228-35.