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Effect Of Ionizing Radiation On Complete Blood Count Among Medical Radiographers: A Comparative Study

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ABSTRACT:

Background: Long-term ionizing radiation exposure may harm human cells, particularly the peripheral blood cell count. Changes in a radiation worker's hematological parameters could be a sign of the health impacts of ionizing radiation.

Methodology: The Department of Physiology at G R Medical College and J A Group of Hospitals in Gwalior, Madhya Pradesh, conducted a comparative study on medical radiographer staff. To compare the haematological parameters of medical and non-medical radiographers, an independent sample t-test was employed, and logistic regression was utilized to discover associations.

Results: The average radiation exposure ranged from 3 to 40 years. When comparing the groups, the demographic details were statistically unimportant ($p>0.05$). In a Pearson correlation of haematological parameters with duration of radiation exposure, it was discovered that platelet count, Hb, MCV, and MCHC concentration were negatively associated with duration of exposure, whereas RBC, WBC count, and PCV were positively associated with duration of exposure, but none of the parameters were significantly associated ($p>0.05$).

Conclusion: It is advised that radiology professionals to be monitored more accurately at shorter intervals and that individualized dosimeters be more exact and up to date.

Keywords: Medical radiographers; Ionizing radiation; complete Blood count.

Introduction:

Over the last thirty years, there have been rapid improvements in medical imaging technologies such as X-ray, computed tomography (CT), and magnetic resonance imaging (MRI), the usage of which has become standard practice in hospitals. The main advantage of such technologies is that they provide structural detail of the human body, which improves disease diagnosis, study of internal body tissue, monitoring, and therapeutic interventions[1]. The necessity and benefits of medical radiology are obvious, but if suitable protective measures are not implemented, it can have negative effects on those who are directly or indirectly exposed to radiation[2]. Ionizing radiation's damaging effects are classified as acute or chronic. Acute effects occur shortly after irradiation and are frequently the result of exposing a significant portion of the body to high intensity radiation, whereas chronic effects are induced by prolonged exposure to relatively low doses of radiation[3]. The incidence of acute effects in diagnostic radiation exposure is uncommon due to the duration and quantity of radiation, as well as the proper use of protective equipment. As a result, the longterm consequences of low dose radiation are the primary risk factors for diagnostic radiation[1,3]. Radiation practitioners and professionals in these facilities are always at risk of being harmed by such radiation. Several studies have revealed that workers exposed to radiation doses lower than the limit were at a higher risk of chromosomal damage than their nonexposed colleagues [2,3,4]. Ionizing radiation exposure has been linked to the development of diseases such as haematological cancers, sarcomas, ocular defects/malignancies, embryological/fetal defects in exposed people's offspring, and so on. A plethora of studies have stressed the importance of complete blood count (CBC) in the evaluation of radiation effects on the body, particularly among radiographers, as it can play a significant role in the prognosis and diagnosis of consequences such as chronic radiation injury [1,5].
A study found that radiation exposed (radiographers) had considerably lower counts of WBCs, Neutrophils, and Lymphocytes, as well as larger ranges of aberrant blood cell morphologies, than unexposed study individuals[1]. Another similar study found no statistically significant changes between the examined groups in basic hematological

characteristics such as the mean value of red blood cells, white blood cells, and platelets levels. Some medical radiographers had low and high disturbances in their mean hematocrit and corpuscular hemoglobin readings, although their means did not approach statistically significant levels [2,6]. A number of studies have found lower levels of white blood cells, lymphocytes, and monocytes in radiology technologists as compared to controls, while others have found no significant changes between these two groups[7]. So, we have planned to assess the comparative evaluation of hematological parameters among medical radiographers and non-radiographers in the Department of Physiology, Gajra Raja Medical College and J A group of Hospitals, Gwalior, Madhya Pradesh, in light of the need to evaluate the health status of radiology staff exposed to prolonged low dose radiation and the contradictory results of previous studies.

Material & Methods:

Between April 2019 and November 2019, a cross-sectional, comparative, and analytical study was undertaken at the Department of Physiology, Gajra Raja Medical College, and J A group of Hospitals in Gwalior, Madhya Pradesh. A total of 30 MRs (26 males and 4 females) aged 30-60 years old were occupationally exposed to low doses of ionizing radiation in radiology. The selected were compared to a group of controls of 30 healthy individuals (24 men and 6 females) who hadn't previously been exposed to radiation. The exposed group was age and gender-matched to controls. MRs have been performed using various imaging modalities and equipment, which includes conventional and computed radiography, X-rays, computed tomography (CT), and magnetic resonance imaging (MRI). They also worked in different shifts for 7 hours a day, five days a week. Participants with a history of disorders such as gross anemia, diabetes mellitus, cardiac disease, acute or chronic infection, autoimmune disease, or cancer were excluded from the study. Blood samples were taken from all participants by vein-puncture in a disposable syringe and transferred to a tube containing ethylene diamine tetra acetic acid (EDTA) at a concentration of 1.5mg/ml.
In a private and conventional laboratory, hematological parameters (HPs) were tested using an ABX Micros 60 analyzer. Red blood cells (RBC), white blood cells (WBC), platelet count (PLT), hematocrit (HCT), hemoglobin (Hb), and mean corpuscular hemoglobin (MCH), mean corpuscular hemoglobin concentration (MCHC), mean corpuscular volume (MCV), and atypical lymphocytes were all examined in this study. After getting ethical approval from Gajra Raja Medical College and J A group of Hospitals in Gwalior, Madhya Pradesh, blood samples were taken from all participants.
Data was collected on a pre-programmed Performa and handled in a Microsoft Excel spreadsheet. All of the entries were double-checked for potential keyboard errors. SPSS software version 20.0 for Windows (SPSS, Chicago, IL) was used to analyze the collected data. Categorical data is provided as a percentage of occurrence. The Chi-square test / Fisher exact test was performed to evaluate the change in proportions between the variables. The independent sample t-test was used to compare the means of quantitative variables. The duration of radiation exposure was linked to variables such as total RBC count (TRC), total WBC count (TWC), platelet count (PC), hemoglobin (Hb), packed cell volume (PCV), mean capsular volume (MCV), mean corpuscular hemoglobin (MCH), and mean corpuscular hemoglobin concentration (MCHC) using logistic regression. Statistical significance was defined as a P value of <0.05.

Observation & Result:

In the current study, we categorized radiographers into two groups (30 in each), medical and non-medical radiographers, and the majority of the radiographers were male in both groups, 93.3% and 86.0% in the medical and non-medical groups, respectively(table-1). Mean radiation exposure was 19.00±12.20 range from 3-40 years, with X RAYS (n=24) exposing to 21.00±12.1 range from 3-40 years and CT (n=6) exposing to 8.00±3.56 range from 5-14 years. In terms of demographic information, such as age, weight, height, and BMI, the mean of all parameters was statistically insignificant when compared between groups ($p>0.05$) (Table-2). When the hematological parameters of medical and non-medical radiographers were compared, it was discovered that Packed Cell Volume (PCV) was significantly higher in the non-medical group ($p<0.003$), Mean Corpuscular Hemoglobin (MCH) and Mean Corpuscular Hemoglobin Concentration (MCHC) were significantly lower in the non-medical group ($P<0.05$), and the rest of the hematological parameters such as Total RBC Count (TRC), (Table-3). Platelet Count (PC), Hemoglobin (Hb), Mean capsular volume (MCV), Mean Corpuscular Hemoglobin (MCH), and Mean Corpuscular Hemoglobin Concentration (MCHC) were found to be negatively associated with duration of exposure in a Pearson correlation, whereas Total RBC Count (TRC), Total WBC Count (TWC), and Packed Cell Volume (PCV) were positively associated ($p>0.05$) (Table-4).

Table-1: Gender distribution in both groups

Gender	Group	
	Medical Radiographers (N=30)	**Non-Medical Radiographers (N=30)**
Male	28 (93.3%)	26 (86.0%)
Female	2 (6.6%)	4 (13.3%)

Table -2: Demographic profile distribution in both groups

Demographic profile	Group		P value
	Medical Radiographers	**Non-Medical Radiographers**	
Age	42.37±9.27	41.67±7.65	0.549
Height	166.33±76	161±98.8	0.179
Weight	68.86 ± 8.34	68.98 ± 7.89	0.383
BMI	25.67±3.15	22.76 ± 5.76	0.660

Table-3: Hematological Parameters distribution in both groups

Hematological Parameters	Group		P value
	Medical Radiographers	**Non-Medical Radiographers**	
Total RBC Count (TRC)	4.98 ± 0.68	5.01 ± 0.38	<0.059*
Total WBC Count (TWC)	6698.23 ± 87.23	7106.6 ±1098.23	0.268
Platelet Count (PC)	2.04 ± 0.81	2.89 ±0.56	0.677
Hemoglobin (Hb)	13.59± 0.89	13.89 ±0.89	0.567
Packed Cell Volume (PCV)	40.73 ± 2.98	43.66 ± 2.45	<0.002**
Mean capsular volume (MCV)	87.04± 5.54	91.54 ± 6.27	<0.051*
Mean Corpuscular Hemoglobin (MCH)	30.06 ± 2.97	27.98 ± 0.99	<0.039*
Mean Corpuscular Hemoglobin Concentration (MCHC)	34.76 ± 2.76	30. 65 ± 3.66	<0.002**

Table-4: Pearson Correlation of Hematological Parameters with Duration of Radiation Exposure

Hematological Parameters	Duration of Radiation Exposure	
	Pearson Correlation	**Sig. (2-tailed)**
Total RBC Count (TRC)	0.079	0.582
Total WBC Count (TWC)	0.31	0.029*
Platelet Count (PC)	-0.24	0.357
Hemoglobin (Hb)	-0.086	0.798
Packed Cell Volume (PCV)	0.28	0.596
Mean capsular volume (MCV)	-0.045	0.872
Mean Corpuscular Hemoglobin (MCH)	-0.301	0.154
Mean Corpuscular Hemoglobin Concentration (MCHC)	-0.190	0.289
. Correlation is significant at the 0.05 level (2-tailed).		

Discussion:

Ionizing radiation exposure has been shown to have varying degrees of detrimental effects on various regions of the human body, which can be immediate or chronic. Because hematopoietic cells have significant sensitivities to radiation, periodic assessments of haematological parameters would serve as internal markers of severe health conditions due to the progressive effects of chronic exposures. The purpose of this study was to evaluate the haematological parameters of medical radiographers and non-radiographers at the Department of Physiology, Gajra Raja Medical College and J A group of Hospitals in Gwalior, Madhya Pradesh, between April and November 2020. A total of 30 MRs (28 males and 2 females) aged 30-60 years old were occupationally exposed to low doses of ionizing radiation in radiology.

In this study, we divided radiographers into two groups (30 in each), medical and non-medical radiographers, and the majority of the radiographers were male in both groups, 93.3% and 86.0% in the medical and non-medical groups, respectively. In terms of demographic information, such as age, weight, height, and BMI, the mean of all parameters was statistically insignificant when compared between groups ($p>0.05$). Talab DA et al[8] revealed that the case and control

groups had mean ages of 36.98 ± 8.50 and 36.49 ± 10.90 years, respectively. In the case and control groups, 57 and 52 of the participants were female, respectively. In terms of mean age and gender distribution, there was no significant difference between the two groups.

According to Alnahhal M et al [9], the mean age for MRs was 35.39 ± 6.38 years, while the control group's mean age was 37.05 ± 6.85 years, with a range of 28-55 years. They also stated that 74.1% of the patients were male and 25.9% were female.

The current study's mean radiation exposure was 19.00 ± 12.20 range from 3-40 years, with X RAYS (n=24) mean radiation exposure being 21.00 ± 12.1 range from 3-40 years and CT (n=6) mean radiation exposure being 8.00 ± 3.56 range from 5-14 years. In their study, Talab et al**[11]** found that the average job experience was 11.95± 6.89 years (range: 1-30 years). According to Alnahhal M et al[9], the mean age for the exposed group was 35.39 ± 6.38 years, while the control group was 37.05 ± 6.85 years.

The examination of blood cell counts (CBC) is a valuable screening test in routine medical check-ups. A high or low blood cell count, even in a seemingly healthy patient, raises the possibility of disease and should urge additional evaluation. Some studies have shown that modest doses of radiation have a deleterious effect on hematological parameters, whereas others only identify the alteration at the genetic analysis level.

In our study comparing the haematological parameters of medical and non-medical radiographers, we discovered that Packed Cell Volume (PCV) was significantly higher in the non-medical group ($p<0.002$), Mean Corpuscular Hemoglobin (MCH) and Mean Corpuscular Hemoglobin Concentration (MCHC) were significantly lower in the non-medical group ($P<0.05$), and the rest of the haematological parameters like Total RBC Count (TRC), Platelet.

Davudiantalab A, and Diaband, I.[10,11] found that in the exposed group, MCH, PLT, PCT, and PDW were greater, whereas HCT, RDW, WBC, granulocytes, and neutrophils were lower. One of the total blood count indicators that was statistically significant higher in the exposed group was mean corpuscular haemoglobin. Other metrics such as red blood cell count, mean cellular volume, mean cellular hemoglobin count, and lymphocytes were not substantially different from controls. Talab et al**[8]** found no significant difference in the mean values of blood factors between the case and control groups ($P>0.05$).

Alnahhal M et al[9] found no statistically significant differences in hematological parameters between the exposed and control groups. Wejie-Okachi et al.[12] reported statistically significant differences in values obtained between exposed and unexposed subjects in some indices such as hemoglobin levels and total white blood cell (WBC), which were significantly lower in the same group of subjects. RBC and platelet counts, as well as hematocrit levels, were found to be slightly higher in the exposed group. The significantly lower values for WBCs and differentials indicated prolonged exposure to low-dose x-rays. Oskouii[13], Nureddin[14] Klucinski[15] have conducted a multicentric study and found some variations in basic hematological parameters (HPs) with no statistically significant effects. However, Eze, C[16], Waggiallah, H[17], Giragn E [18] have conducted a multicentric study and found a statistically significant difference in lymphocyte count between exposed and non-exposed subjects. These findings and variations can be attributed to the performance and practices of protection standards, as well as years of experience among exposed participants. In our study, the Pearson correlation of haematological parameters with the duration of radiation exposure revealed that Platelet Count (PC), Hemoglobin (Hb), Mean capsular volume (MCV), Mean Corpuscular Hemoglobin (MCH), and Mean Corpuscular Hemoglobin Concentration (MCHC) were found to be negatively associated with duration of exposure, while Total RBC Count (TRC), Total WBC Count (TWC), and Packed Cell Volume (PCV) were found to be positively associated with duration of exposure. The Pearson correlation coefficient revealed a significant relationship between age and work experience in technologists and lower white blood cell count, whereas no significant relationship was discovered among the other blood factors investigated in this study. A number of studies have compared with the duration of work in radiation, the HPs did not reach statistically significant levels [19]. Shahid S. et al[20] concluded long-term research on radiations has revealed that even low doses (20 mSv) can have an impact on health, resulting in an altered immune response or anemia.

Conclusion:

The present study highlighted that low doses of ionizing radiation have an important impact on the levels of hematological parameters in Medical Radiographers, but the effects of work duration are not significantly associated with all the hematological parameters. Because of their ability to pass through cellular membranes and cause abnormal biochemical changes, uncontrolled radiation exposures harm the human body.

The thorough study in different discrepancy in the radiation are not studied. So, an accurate monitoring of radiography staff at shorter intervals is advised by using precise and up-to-date personalized dosimeters.

Limitation:

One limitation of this study was the inability to obtain blood tests from all radiation workers. It was a single-center study with a small sample size. A major drawback of present study, has only examined the blood tests of 30 radiation workers, which was significantly less than other comparative studies.

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