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Comparative Evaluation of Haematological Parameters Among Medical Radiographers and Non-Radiographers

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Abstract
The present cross-sectional comparative analytical study was to assess the comparative evaluation of haematological 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. Independent sample t-test was used to compare the haematological parameters of the medical and non-radiographers and logistic regression was used to evaluate the association of duration of radiation exposures with certain haematological parameters. Mean radiation exposure duration range was 3-40 years (19.00±12.20 years). The demographic details i.e. age, weight, height and BMI the mean of all the parameters was statistically insignificant on comparing between the groups ($p>0.05$). In a Pearson correlation of haematological parameters with duration of radiation exposure it was found that platelet count, hemoglobin, mean capsular volume, mean corpuscular hemoglobin and mean corpuscular hemoglobin concentration were negatively associated with duration of exposure while total RBC count, total WBC count and packed cell volume were associated positively with duration of exposure but none of the parameters were associated significantly ($p>0.05$). Occupational exposure of ionizing radiation significantly affect the levels of haematological parameters in Medical Radiographers, but the effects of duration of work have not been significantly associated with haematological parameters.
Keywords: Medical radiographers, X-ray, Ionizing radiation, Haematological parameters.

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Introduction

Over the past thirty years, there have been fast paced advances in medical imaging technologies like X-ray and computed tomography (CT), the use of which has become common practice in hospitals. The key benefit of such technologies is that they afford structural detail of the human body, which improves disease diagnosis, examination of internal body tissue, monitoring and therapeutic interventions.[1] The importance and benefits of medical radiology are evident, but if proper protective measures are not adopted, it can have adverse effects on people who are directly or indirectly exposed to radiation.[2] The harmful effects of ionizing radiation are divided into two categories of acute and chronic. Acute effects occur in a short while after irradiation and are usually the result of exposing a large part of the body to high intensity radiation whereas the chronic effects are caused by exposure to relatively low intensity of radiation over an extended period of time.[3]

Due to the duration and level of radiation and the appropriate use of protective equipment, the occurrence of acute effects in diagnostic radiation exposure is rare. Therefore, the long term effects associated with occupational exposure radiation are the main risk factors for diagnostic radiation.[3,4] Radiation practitioners and professionals in these centers are always exposed to the potential damage caused by such radiation. Several studies have suggested that the risk of chromosomal damage in occupationally exposed workers was higher than that of their non exposed peers.[4-7]

Exposures to ionizing radiations have been implicated in the pathogenesis of diseases such as haematological cancers, sarcomas, ocular defects/malignancies, embryological/foetal defects affecting progeny of exposed persons, etc. Myriad studies have emphasized on the importance of complete blood count (CBC) in the evaluation of radiation effects on the body, especially among radiographers, which can play an important role in the prognosis and diagnosis of complications such as chronic radiation injury.[8] A study reported the significantly lower counts for WBCs, Neutrophils and Lymphocytes, and higher ranges of abnormal blood cell morphologies, were observed in the radiation exposed (radiographers) with respect to unexposed study subjects.[9] Another similar study reported the basic haematological parameters including the mean value of red blood cells, white blood cells, and platelets level did not show any statistical significant differences between the compared groups. Low and high disturbance in the mean values of hematocrit and corpuscular hemoglobin in some medical radiographers, but their means did not reach the statistical significant levels.[10] In this regard, other some studies have reported decreased numbers of

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white blood cells, lymphocytes, and monocytes in radiology technologists compared to controls while other studies have not shown any significant differences between these two groups.[7]
Considering the necessity of evaluating the health status of radiology staff exposed to protracted low dose radiation and the contradictory results of previous studies, we aimed to assess the comparative evaluation of haematological parameters among medical radiographers and non-radiographers in Department of Physiology, Gajra Raja Medical College and J A group of Hospitals, Gwalior, Madhya Pradesh.

Material and Methods

The current cross-sectional comparative analytical study was conducted in the Department of Physiology, Gajra Raja Medical College and J A group of Hospitals, Gwalior, Madhya Pradesh between April and November 2019. A total of 30 MRs (26 males and 4 females) with age between 30-60 years were occupationally exposed to ionizing radiation in radiology. They were compared with another group of 30 (24 males and 6 females) participants who were non-radiographers. Both the groups were matched in age and sex. MRs were worked on different types of imaging modalities and equipment including conventional and computed radiography, X-rays and computed tomography (CT). Participants who had any previous diseases such as gross anemia, known history of diabetes mellitus, cardiopulmonary disease, acute or chronic infection, autoimmune disease, and malignancy were excluded from the study.
Blood samples of all participants were collected (2 ml of blood from each participant) by vein-puncture in a disposable syringe and blood was transferred to a tube containing ethylene diamine tetra acetic acid (EDTA) in a concentration of 1.5mg/ml. Haematological parameters (HPs) were measured by using s ABX Micros 60 analyzer at a private and standard laboratory. Eight of the HPs were examined in this study including red blood cells (RBC), white blood cells (WBC), platelet count (PLT), hematocrit (HCT), hemoglobin (Hb), mean corpuscular hemoglobin (MCH), mean corpuscular hemoglobin concentration (MCHC) and mean corpuscular volume (MCV). Blood samples were collected from all participants after obtaining an ethical approval from Gajra Raja Medical College and J A group of Hospitals, Gwalior, Madhya Pradesh.
Data was recorded on a predesigned Performa and managed in a Microsoft Excel spreadsheet. All the entries were double-checked for any possible keyboard error. The data obtained were analyzed using SPSS software version 20.0 for Windows (SPSS, Chicago, IL). Categorical data are presented as the percent frequency occurrence. To test the association / difference in proportions between the variables, Chi-square test / Fisher exact test was used. The means of quantitative variables were compared using both independent sample t-test. Logistic regression was used to evaluate the association of duration of radiation exposures with certain variables like 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). P value <0.05 was considered as statistically significant.

Results

In the present study we have divided the participants in two groups (30 in each group) that are medical radiographers and non-radiographers and the majority of the radiographers were male in both the groups. [Table 1] Mean radiation exposure was 19.00±12.20 range from 3-40 years in which X RAYS (n=24) mean radiation exposure was 21.00±12.1 range from 3-40 years and CT (n=6) mean radiation exposure was 8.00±3.56 range from 5-14 years.
In the demographic details i.e. age, weight, height and BMI the mean of all the parameters was statistically insignificant on comparing between the groups (p>0.05) [Table 2].
On comparing the haematological parameters of the MRs and non-radiographers it was found that Packed Cell Volume (PCV) was significantly higher in non-radiographers group (p=0.003), Mean Corpuscular Hemoglobin (MCH) and Mean Corpuscular Hemoglobin Concentration (MCHC) were significantly lower in non-radiographers group (<0.05) rest other haematological parameters like Total RBC Count (TRC), Platelet Count (PC) and Total WBC Count (TWC) were show insignificant lower (p>0.05). [Table 3].
In a Pearson correlation of haematological parameters with duration of radiation exposure it was found that Platelet Count (PC), Hemoglobin (Hb), Mean capsular volume (MCV), Mean Corpuscular Hemoglobin (MCH) and Mean Corpuscular Hemoglobin Concentration (MCHC) were negatively associated with duration of exposure while Total RBC Count (TRC), Total WBC Count (TWC) and Packed Cell Volume (PCV) were associated positively with duration of exposure but none of the parameters were associated significantly (p>0.05) [Table 4].

Table 1: Sex distribution in both groups

Sex	Group		P value
	Medical Radiographers	Non-Medical Radiographers	
Male	26 (85.7%)	24 (80.0%)	0.488
Female	4 (13.3%)	6 (20.0%)	

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Table 2: Demographic profile distribution in both groups

Demographic profile	Group		P value
	Medical Radiographers	Non-Medical Radiographers	
Age	43.27±10.07	42.17±8.46	0.649
Height	165.23±6.53	162.70±7.85	0.179
Weight	69.96±8.93	65.18±9.73	0.483
BMI	25.67±3.15	24.62±3.19	0.760

Table 3: Haematological Parameters distribution in both groups

Haematological Parameters	Group		P value
	Medical Radiographers	Non-Medical Radiographers	
Total RBC Count (TRC)	4.78±0.45	4.96±0.28	0.059
Total WBC Count (TWC)	6743.33±988.10	7006.67±1080.53	0.329
Platelet Count (PC)	1.99±0.71	2.03±0.46	0.788
Hemoglobin (Hb)	13.79±1.09	13.89±0.98	0.728
Packed Cell Volume (PCV)	41.82±3.82	44.77±3.43	0.003
Mean capsular volume (MCV)	88.03±6.32	90.24±5.43	0.151
Mean Corpuscular Hemoglobin (MCH)	29.05±1.97	28.02±1.96	0.045
Mean Corpuscular Hemoglobin Concentration (MCHC)	33.07±1.97	31.14±2.70	0.003

Table 4: Pearson Correlation of Haematological Parameters with Duration of Radiation Exposure

Haematological Parameters	Duration Of Radiation Exposure	
	Pearson Correlation	Sig. (2-tailed)
Total RBC Count (TRC)	0.078	0.682
Total WBC Count (TWC)	0.283	0.129
Platelet Count (PC)	-0.174	0.357
Hemoglobin (Hb)	-0.038	0.842
Packed Cell Volume (PCV)	0.101	0.596
Mean capsular volume (MCV)	-0.031	0.872
Mean Corpuscular Hemoglobin (MCH)	-0.198	0.295
Mean Corpuscular Hemoglobin Concentration (MCHC)	-0.188	0.319
*. Correlation is significant at the 0.05 level (2-tailed).		

Discussion

Exposures to ionizing radiations have been demonstrated to have various degrees of harmful effects on different parts of the human body which may be acute or chronic. The effects of chronic exposures are usually gradual; therefore periodic examinations of haematological parameters would serve as internal indicators of adverse health conditions because of the high sensitivities to radiation exhibited by hematopoietic cells. The present study was aimed to compare the haematological 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 between April and November 2020. A total of 30 (26 males and 4 females) MRs with age between 30-60 years old were occupationally exposed to long term low occupational exposure of ionizing radiation experience in radiology.

In the present study we have divided the radiographers in two groups (30 in each group) that are medical and non-medical radiographers and the majority of the radiographers were male in both the groups 85.7% and 80.0% in medical and non-medical groups. In the demographic details i.e. age, weight, height and BMI the mean of all the parameters was statistically insignificant on comparing between the groups ($p>0.05$). Talab DA et al,[11] reported the mean ages of the case and control groups were 36.98±8.50 and 36.49±10.90 years, respectively. In general, 57 and 52 of the subjects in the case and control groups were female, respectively. There was no significant difference between the two groups with respect to mean age and gender distribution. Alnahhal M et al,[10] reported the mean age for MRs was 35.39±6.38 years, while it was 37.05±6.85 years for the control group; with age range 28-55 years. They also reported that 74.1% were male patients and 25.9% was female.

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Mean radiation exposure in present study was 19.00±12.20 range from 3-40 years in which X RAYS (n=24) mean radiation exposure was 21.0012.1± range from 3-40 years and CT (n=6) mean radiation exposure was 8.00±3.56 range from 5-14 years. Talab et al,[11] reported the mean work experience was 11.95±6.89 years (range: 1-30 years) in their study.Alnahhal M et al,[10] reported the mean age for the exposed group was 35.39±6.38years, while it was 37.05 ± 6.85 years for the control group.

Blood cell count (CBC) analysis is a useful screening test in routine medical check-up. A high or low blood cell count even in a healthy-looking subject leads to the suspicion of disease and it should prompt further investigations. Some studies have demonstrated the negative effect of low occupational exposure radiation on haematological parameters while others detect the change at genetic analysis level only.

In our study on comparing the haematological parameters of the medical and non-medical radiographers it was found that Packed Cell Volume (PCV) was significantly higher in non-medical group (p=0.003), Mean Corpuscular Hemoglobin (MCH) and Mean Corpuscular Hemoglobin Concentration (MCHC) were significantly lower in non-medical group (<0.05) rest other haematological parameters like Total RBC Count (TRC), Platelet Count (PC) and Total WBC Count (TWC) were show insignificant lower (p>0.05). Dimitar D et al,[12] reported the mean MCH, PLT, PCT and PDW were higher, while HCT, RDW, WBC, granulocytes and neutrophils were lower in the exposed group. The mean corpuscular haemoglobin was one of the complete blood count parameters which showed statistically significant higher in the exposed group. The other parameters like red blood cell, mean cellular volume, mean cellular hemoglobin count and lymphocytes have not been significantly different from that of controls. Talab et al,[11] reported that there was no significant difference in the mean values of blood factors between the case and control groups (P>0.05). Alnahhal M et al,[10] reported that no statistically significant differences between exposed and the control group in haematological parameters. Wejie-Okachi et al,[9] reported the statistically significant differences were noted in the values obtained between the exposed and unexposed subjects in some indices such as Hemoglobin levels and total White blood cell (WBC), which were much lower in the same group of subjects. RBC and Platelet counts and Hematocrit levels were recorded to be marginally higher in the exposed group. The significantly lower values recorded for WBCs and differentials implied that prolonged exposures to minimal x-ray occupational exposure.

Shaffie M et al, Nureddin AS et al, Khorrami MB &Riahi B, Diaband I & Abdallah M, Mohammed M et al, Oskouii M et al and Zakeri F et al conducted their studies in Iran, Iraq, Egypt, and Sudan which reported some variations in the basic haematological parameters (HPs) with no statistically significant effects.[13-19] However, some studies Giragn E, Shahid S et al, Klucinski P et al, and Waggiallah H conducted in Poland and Pakistan,[20-23] Sudan, Sudia Arabia Kingdom found statistically significant difference between exposed and non-exposed subjects regarding lymphocytes count. These results and variations can be attributed to the performing and practices of protection standards and experience years among exposed participants.

In our study the Pearson correlation of haematological parameters with duration of radiation exposure it was found that Platelet Count (PC), Hemoglobin (Hb), Mean capsular volume (MCV), Mean Corpuscular Hemoglobin (MCH) and Mean Corpuscular Hemoglobin Concentration (MCHC) were negatively associated with duration of exposure while Total RBC Count (TRC), Total WBC Count (TWC) and Packed Cell Volume (PCV) were associated positively with duration of exposure but none of the parameters were associated significantly (p>0.05). Talab et al,[11] reported the Pearson correlation coefficient reflected a significant correlation between age and work experience in technologists and reduced white blood cell count while no significant relationship was found among the other blood factors investigated in this study. Alnahhal M et al,[10] reported the HPs did not reach the statistically significant levels when they compared with the duration of work in radiation. Shahid S et al,[21] reported the long term work on radiations at even low occupational exposure (<20 mSv) can impact health and results in an altered immune response or anemia.

Limitation:

One limitation of this study was inaccessibility to the blood tests of all radiation workers. It was a single center study and had a small sample size. In addition, some of the radiation workers employed in other native clinics did not have blood tests. Although the current study investigated the blood tests of only 30 radiation workers which were much lower than other comparative study.

Conclusion

The findings of this study showed that low occupational exposure of ionizing radiation significantly affect the levels of haematological parameters in Medical Radiographers, but the effects of duration of work have not been significantly associated with haematological parameters. Uncontrolled exposures to radiation have deleterious effects on the human body, due to their capacity to penetrate living cells and cause abnormal biochemical changes. The effects of this type of radiation have not been thoroughly identified and further studies are required. Therefore, more accurate monitoring of radiology staff in shorter intervals is recommended.

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