ORIGINAL ARTICLE Open Access

ISSN 2278-1404

International Journal of Fundamental & Applied Sciences

Occupational Ionizing Radiation Effects on Blood Cell Counts among workers engaged in a few Radio-Diagnostic Centers

Vanishree R[1], Krishnamurthy V[1*], Uma M V[1]

[1]Department of Biotechnology, PES University, Banashankari III Stage, Bangalore – 560085, Karnataka India.

Manuscript: received 1 Jan, 2018 revised 11 Feb, 2018 accepted 12 Feb, 2018

Abstract

Background: Ionizing radiation is being used widely for diagnostic and therapeutic purposes. Continuous and intermittent exposure of technicians to low doses of ionizing radiation can exert measurable changes at the level of cell and chromosomes. **Aim:** In this study, the ionizing radiation prevalent in the work environment at diagnostic labs and the background radiation in general environment of Bengaluru, India was measured using hand held dosimeter. **Methodology:** The blood samples from the normal population and the occupants were also collected and investigated for cellular changes induced by exposure to ionizing radiation. The number of lymphocytes was measured and the $CD4^+/CD8^+$ ratio was checked to find any difference between the two groups (control group and the occupants group) of blood samples collected. **Results:** It was seen that there was no significant difference between the change in the lymphocyte number and also the $CD4^+/CD8^+$ ratio among these groups. **Conclusion:** The study indicates that the prevalent ionizing radiation was at a quite low degree to induce changes at cellular levels; also the exposure was intermittent and not continuous which is also a reason for not noticing cellular changes.

Keywords: Ionizing Radiation, $CD4^+/CD8^+$ ratio, lymphocytes

1. Introduction

Ionizing radiation has been a subject of interest from a long time. Its practical applications in the field of medicine and nuclear energy are immense and its scope is increasing with the technological applications in various fields. However, exposure to ionizing radiation is not always considered to be beneficial (Agency for Toxic Substances and Disease Registry 1999). IR has been, since long, considered as a mutagen and also as an agent that induces cellular stress. Induction of cellular stress makes the cell vulnerable to undergo lots of changes at cellular and molecular levels (Ward JF 1995, Little JB 2006; Rodemann HP & Blaese MA, 2007). One of the major changes observed in the cells due to exposure to Ionizing radiation is death of the cell by apoptosis. This leads to a change in the cell population, causing abnormal cell populations thus leading to an observable change in the body (Helen Barcellos-Hoff M 2005; Little JB 2000). Each tissue in the body has different effects caused when the energy of ionizing radiation is incident upon it. This effect, measured as effective dose, thus is different from one tissue to the other and the effect seen is also variable. Amongst all the types of blood cells, lymphocytes are considered to be highly radiosensitive and prone to cellular stress induced by ionizing radiation (Brent RL 1980). In the present study, the blood samples collected from individuals exposed to ionizing radiation was checked for changes in the cell populations, specifically the lymphocytes, and compared with the control group for any observable change.

2. Materials and methods

The ionizing radiation was measured using the personal dosimeter AT6130. Background ionizing radiation at various locations in Bengaluru city was measured and the average background radiation was calculated. Ionizing radiation was also measured at few diagnostic centres where X-rays were used for diagnosis, as shown in previous studies (Vanishree et al., 2014).

Nine blood samples were collected from individuals exposed only to background radiation (Considered as control population in the current study) and thirty samples from technicians/clinicians working in the laboratories (Considered as occupants in the current study).

The blood samples were collected using vacutainers using venepuncture tubes and stored at -200 C in vacutainers having EDTA, a blood anticoagulant.

***Corresponding author**
Full Address :
Department of Biotechnology, PES University, 100ft Ring Road, BSK III Stage, Bangalore – 560085, Karnataka, India
E-mail: ***v.krishnamurthy@pes.edu***

Differential blood count was performed on the blood samples of the control group and the occupants using Giemsa stain. A thin smear of blood was made on the slide and flooded with Giemsa stain, and allowed to stay for 2 minutes. The slide was washed with distilled water, air dried and observed under a microscope at 45X and 100X magnifications. A minimum of 100 cells were counted and the percentages of different types WBC was found out (Brown 1993).

The samples were also checked for the number/amount/ concentrations of the subpopulations of T-lymphocytes – specifically the $CD4^+$ and $CD8^+$ cells. 50 µl of whole blood collected from individuals was mixed with 20 µl monoclonal antibodies mixture [Anti CD4PE, Anti CD3 FITC, Anti CD45, Per CP, Anti CD8 APC] conjugated with fluorochrome. The mixture was vortexed for a minute and was run on the FACS flow cytometer that was equipped with 635 nm and 488 nm lasers. The results were further analysed to find out $CD4^+/CD8^+$ ratio (Sciences 1993).

3. Results and discussion

Background ionizing radiation was measured in Bengaluru city at nineteen locations within 25 kilometres from PES university as centre. At each location, ionizing radiation was measured from 8 AM to 8 PM on an hourly basis. To get more accurate readings, the radiation was measured in an interval of 7 days for 5 days. With all the data collected, background radiation was found to be 1.53 mSv/year. Studies carried out by Ramachandran et al., also shows similar results (Ramachandran 2011).

Ionizing radiation was measured in radio diagnostic labs as well. There was a lot of fluctuations in the radiations in the labs. When the instrument was being used, there was a sudden increase in the ionizing radiation which gradually subsided. The usage of the instrument was directly related to the patient turn over. Higher the patient turn-over, higher was the usage of the instrument and thus, higher was the background radiations. Technicians working in labs with higher patient turnover were exposed to a higher background radiation in general and episodic peaks when the instrument was used.

Since, there was inconstancy in the radiation levels at labs, radiation was measured every minute in the labs for eight hours for 2 to 5 consecutive days. The data was used to find out the average radiation, mode and episodic maximum (in mSv/year). Of the six labs chosen to study the background radiation in the labs, centre 5 showed the maximum ionizing radiation of episodic maximum of 12.27 mSv/year with an average ionizing radiation of 1.04 mSv/year. Centre 4 showed the least radiation with episodic maximum of 3.35 mSv/year and an average ionizing radiation of 0.61 mSv/year. The maximum radiation a technician exposed to was expected to be the episodic maxima in the centre he/she works (Vanishree et al., 2014).

This clearly showed that the ionizing radiation in a diagnostic lab depends on various factors, patient turn-over being a prime factor. Other factors like size of the room, type of the instrument used for diagnosis, protective measures taken in the lab and so on.

The values obtained in the study was lesser than the radiation limits prescribed by ICRP and UNSCEAR. They have prescribed a maximum occupational exposure limits to 20 mSv/year (UNSCEAR 2000). In our study, however, the radiation exposure ranged from 3.35 mSv/year to 12.27 mSv/year. These readings are lower than the prescribed limits by ICRP. Also, the effective dose for different individuals will vary due to different tissue weighted sum of equivalent doses.

Thus, the blood samples from the control group and the technicians were collected to look for any cellular changes in the blood sample.

A thin smear of the blood collected was made and was stained with Giemsa. Observation of the stained slide under the microscope led us to find out the percentages of various types of cells in the blood. All the samples (from the control group and the occupants) showed a normal percentage ranges for neutrophils, eosinophils, monocytes and lymphocytes. There was no significant difference between the control population and occupants.

Since lymphocytes are considered to be highly radiosensitive, their averages were taken to analyse the effects of radiation exposure. The average percentages were 34.0 and 34.93 respectively for the control group and the radiation exposed occupants. As was seen, there was no significant difference in their averages in the lymphocyte population between the two groups. Also, the range of lymphocytes were found to be that of any healthy individual which is 20% to 40% (CDC 2011-2).

Since, lymphocytes show high sensitivity to ionizing radiation, immunophenotyping assay would reflect the effects of acute exposure to radiation on lymphocytes.

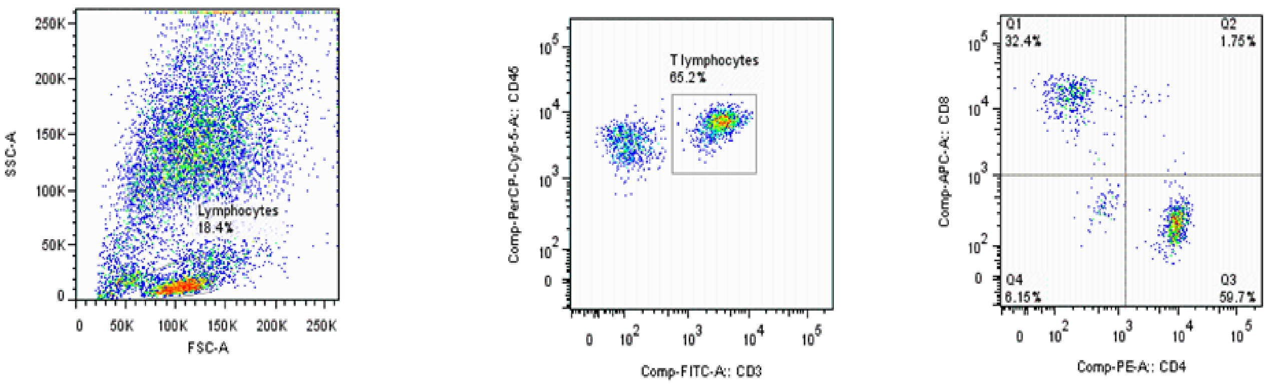

Figure 1: Sample Graphical Representation of Immunophenotyping of MA3

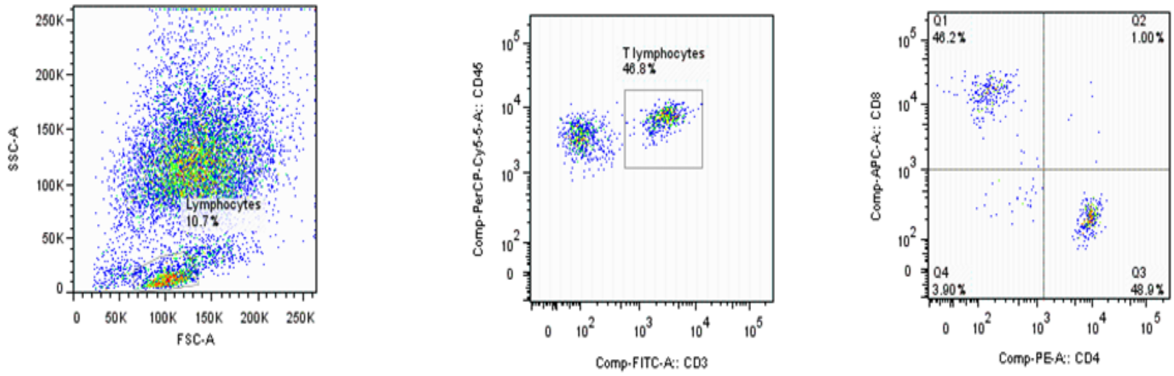

Figure 2: Sample Graphical Representation of Immunophenotyping of MA15

An immunophenotyping assay was carried out to find out the number of $CD4^+$ and $CD8^+$ lymphocytes. Since the ratio of $CD4^+$ to $CD8^+$ cells indicate the overall immune health of an individual, the ratio was calculated from the data obtained. The following figure shows the sample graphical representation of immunophenotyping assay.

Conflict of interest

The author's declares none.

References

1. Agency for Toxic Substances and Disease Registry (1999) Toxicological Profile for Ionizing Radiation," *Toxicol. profiles*, no. September, pp. 1 –438, 1999.

2. Morgan WF (2003) Non-targeted and delayed effects of exposure to ionizing radiation: I. Radiation-induced genomic instability and bystander effects in vitro. *Radiation Research*, 159(5) 567–80.

3. Rodemann HP & Blaese MA (2007) Responses of Normal Cells to Ionizing Radiation. *Semin Radiation Oncology,* 17(2) 81–88.

4. Ward JF (1995) Radiation Mutagenesis: The Initial DNA Lesions Responsible. *Radiation Research,*142(3) 362-368.

5. Little JB (2006) Cellular radiation effects and the bystander response. *Mutation Research Molecular Mechanism Mutagen*, 597(1–2)113–118.

6. Helen Barcellos-Hoff M (2005) Integrative radiation carcinogenesis: interactions between cell and tissue responses to DNA damage. *Seminar Cancer Biology*, 15(2)138–148.

7. Little JB (2000) Radiation carcinogenesis," *Carcinogenesis*, 21(3)397–404.

8. Brent RL (1980) Radiation teratogenesis *Teratology*, 21(3), 281–298.

9. Vanishree R, KrishnaMurthy V, Uma M & Harish M (2014) Work environmental levels of Ionizing radiation at various radio diagnostic laboratories in Bangalore. *Intional Reveiw Applied Biotechnology Biochemistry*, 2 (1)27–36.

10. Brown BA (1993) *Hematology : principles and procedures*. Lea & Febiger.

11. Sciences B (1993) Direct Immunofluorescence Staining of Whole Blood Using a Lyse / No-Wash Procedure. 349(202)1–3.

12. Ramachandran TV (2011) Background radiation , people and the environment. 9(2) 63–76.

13. UNSCEAR (2000) *Sources and Effects of Ionizing Radiation, United Nations Scientific Committee on the Effects of Atomic Radiation UNSCEAR 2000 Report to the General Assembly, with Scientific Annexes*, vol. I. 2000.

14. https://wwwn.cdc.gov/nchs/data/nhanes/2011-2012/labmethods/cbc_g_met_he.pdf