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Haemolytic Assessment of Red Blood Cell on Exposure to X-Ray

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Abstract

This research studied the effect of electromagnetic radiation in forms of X-ray radiation on red blood cell. It is well known that ionizing radiation provokes damage directly by deposition of energy or indirectly by producing oxygen/nitrogen species in DNA double helix in the nucleus. The test was carried out using in-vitro study with five different blood samples collected and divided into four test tubes after which they are exposed at different radiation threshold (50kv, 75kv and 100kv) with the fourth test tube kept s control. Erythrocyte osmotic fragility test was conducted to determine the absorbance, hence the percentage hemolysis. The result was analyzed using a 1-way ANOVA statistical method. Result showed that there is minimal effect of x-rays radiation on human RBC. And the probability of x-ray radiation to cause significant cell damage therefore depends on dose and time. Even at this, protective shields need to be put on by those working in diagnostic imaging centers to prevent the residual damage from the exposure. It is therefore recommended that another result should be carried out to determine the effect of the x-ray radiation on multiple exposures to the radiation, this is to know and correlate between the stochastic and non-stochastic effect of x-ray radiation and thus, to give a clearer picture of the effect of the x-ray radiation.

Keywords*: haemolysis, red blood cell, x-ray*

Introduction

The red blood cells (RBCs) are highly specialized well adapted for their primary function of transporting oxygen from the lungs to all of the body. Red blood cells are approximately 7.8nm in diameter, and have the form of biconcave discs, a shape that provides a large surface-to-volume ratio. When fresh blood is examined with the microscope red cells appeared to be yellow-green discs with pale centers containing no visible internal structures. When blood is centrifuged to cause

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the cells to settle, the volume PCV ranges between 42 and 54 percent of total volume in men and between 37 and 47 percent in women. Values are somewhat lower in children. Normal RBCs are fairly uniform in volume, so that the hematocrit value is determined largely by the number of red cells per unit volume of blood. The normal red blood cell counts ranges between 4million and 6 million per cubic millimeter.[1]

RBC is enclosed in a thin member that is composed of chemically complex lipids, proteins, carbohydrates in a highly organized structure. Extraordinary distortion of red blood cell occurs in its passage through minute blood vessels, many of which have a diameter less than that of the red blood cell. When the deforming stress is removed, the cell springs back to its original shape.[2-3] When red blood cell membranes are damaged, hemoglobin and other dissolved contents may escape from the cells, leaving the membranous structure as "ghosts" this process called Hemolysis is produced not only by the osmotic effects of water, but also by numerous other mechanisms. These include physical damage to red cells, as when blood is heated, is forced under great pressure through a small needle, or is subjected to freezing and thawing; Damage can also be as a result of the ionizing radiation through highly ionizing radiation emitted by the ionizing agent such as X-ray, Gamma ray. When such destruction proceeds at a greater than normal rate, hemolytic anaemia results.[4,5] The study was done to access the degree of hemolysis in RBC against exposure to X-ray. To achieve the aim of this study, the specific objectives are:

Material and Methodology

Collection of Sample

5ml of blood sample was collected from five healthy people who had no history of previous exposure to any clastogens. The blood samples were collected from blood bank of Ahmadu Bello University medical center main campus, Samaru Zaria.

Irradiation

The irradiation process was carried out at the Diagnostic Imaging Centre (DIC) faculty of veterinary medicine Ahmadu Bello University Zaria. The following kilo voltage peaks; 50kv 75kv and 100kv was used during irradiation MDX-25(RMS).

Experimental Design

Red blood cell is divided into (2):

i. Control: This is not exposure to x-ray
ii. Irradiation: Is exposed to x-ray

Experimental Procedure

Five blood samples were shared into 20 EDTA bottles, a control and irradiation one. The irradiated is at 3 different kilovoltages; 50kv, 75kv and 100kv following irradiation. The irradiated sample was labeled according to the level of irradiation across 15 sample bottles. Another 5 samples bottle was used for control. The samples were then taken to the veterinary pharmacology laboratory at ABU, Department of veterinary pharmacology, Faculty of veterinary Medicine, for osmotic fragility test (OFT).

Osmotic Fragility Test

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A 5ml of each of the solutions was placed into a separate test tube; few drops of the normal blood were discharged across all the samples. The samples were shaked properly for homogeneity mixture and allowed to settle for 30 minutes. The sample was then centrifuged using centrifuge machine at 3000rpm for 10 minutes. After centrifuging the sample, a spectrophotometric machine was used to read the absorbance value of each sample. The level of hemolysis was determined from the normal reference value.

Result

Table 1: Absorbance values of blood samples from Osmotic fragility test

Samples sites	0.9%	0.7%	0.5%	0.3%	0.1%	0.0%
Control	2.340±0.2731	5.300±0.9445	6.820±2.601	70.66±11.79	65.25±5.580	87.12±12.88
Irradiated at 50kv	4.160±1.554	7.800±1.115	7.380±1.560	83.64±3.246	87.88±5.954	91.46±3.335
Irradiated at 75kv	3.900±0.9503	7.980±1.573	10.38±4.908	77.56±8.769	85.10±6.903	82.22±8.359
Irradiated at 100kv	3.818±1.126	6.880±1.686	8.520±0.7858	67.20±6.525	80.38±9.145	82.14±11.99

Discussion

Radiobiology has been studying the biological responses of cells or tissues to ionizing radiation. It is well known that ionizing radiation provokes damage directly by deposition energy or indirectly by producing oxygen/nitrogen species in DNA double helix in the nucleus. However, the origin of molecular and mechanical events triggered at the plasma membrane caused by radiation is unclear. In this study, RBCs were used as primary test objects since they are nucleus free and have smooth membrane surfaces maintaining their integrity. In contrast, all white blood cell and platelets have nucleic acids that regulate the cellular activities. Nucleic acids are reported to be adversely affected by radiation.[5] Therefore, the presence of nucleic acids potentially has effects on cell deformability. However, we wanted to evaluate the effect of radiation on cell membrane, and therefore we focused our research on red blood cells only. Since RBCs are nucleus-free and off-target cells circulating throughout the body, they are very suitable for studying the mechanic effects of radiation exposure on the membrane structure. Additionally, many studies have shown that high dose ionizing radiation obtained by accidental exposure or radiation therapy can damage human health such as inducing cancer, invading the hematopoietic system, and causing.[6-11]

Conclusion

There is minimal effect of x-rays radiation on human RBC. And the probability of x-ray radiation to cause significant cell damage therefore depends on dose and time. Even at this, protective

shields need to be put on by those working in diagnostic imaging centers to prevent the residual damage.

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