Effect of Cobalt-60 irradiation on the tissue damage and cell deformation in albino mice

Abstract
Radiation is used extensively in the fields of oncology, tissue engineering and therapeutics. Although radiation therapy is highly successful in the latter stages of benign and malignant tumour for its treatment, the side effects associated with the radiation are profound. The study was aimed at studying the impact of cobalt-60 irradiation on the tissue damage and cell deformation using albino mice model. Albino mice were grouped and irradiated with a cobalt-60 source. The grouping done was on the basis of radiation being passed. Test group of mice was irradiated with cobalt-60 source originating radiation. Control group of mice was not irradiated at all. The relationship between the tissue damage and amount of radiation passed was found to be directly proportional and in the case of cell deformation, it became constant after a point of time. Further studies can explain the differences arising between the tissue damage and cell deformation when radiation is passed through a cobalt-60 source.

Introduction
Radiation describes a process in which energetic particles or waves travel through a medium or space. There are two distinct types of radiation, ionizing and non-ionizing. The word radiation is commonly used in reference to ionizing radiation only (i.e., having sufficient energy to ionize an atom), but it may also refer to non-ionizing radiation (e.g., radio waves or visible light). The energy radiates (i.e., travels outward in straight lines in all directions) from its source. This geometry naturally leads to a system of measurements and physical units that are equally applicable to all types of radiation. Both ionizing and non-ionizing radiation can be harmful to organisms and the natural environment. Radiation therapy uses high-energy radiation to shrink tumors and kill cancer cells. X-rays, gamma rays, and charged particles are types of radiation used for cancer treatment. The radiation may be delivered by a machine outside the body (external-beam radiation therapy), or it may come from radioactive material placed in the body near cancer cells (internal radiation therapy, also called brachytherapy). Systemic radiation therapy uses radioactive substances, such as radioactive iodine, that travel in the blood to kill cancer cells. About half of all cancer patients receive some type of radiation therapy sometime during the course of their treatment.

Radiation therapy kills cancer cells by damaging their DNA (the molecules inside cells that carry genetic information and pass it from one generation to the next). Radiation therapy can either damage DNA directly or create charged particles (free radicals) within the cells that can in turn damage the DNA. Cancer cells whose DNA is damaged beyond repair stop dividing or die. When the damaged cells die, they are broken down and eliminated by the body's natural processes. The type of radiation therapy prescribed by a radiation oncologist depends on many factors, including the type of cancer, the size of the cancer, the cancer's location in the body, how close the cancer is to normal tissues that are sensitive to radiation, how far into the body the radiation needs to travel, the patient's general health and medical history, whether the patient will have other types of cancer treatment, other factors such as the patient's age and other medical conditions.

External-beam radiation therapy is most often delivered in the form of photon beams (either x-rays or gamma rays). A photon is the basic unit of light and other forms of electromagnetic radiation. It can be thought of as a bundle of energy. The amount of energy in a photon can vary. For example, the photons in gamma rays have the highest energy, followed by the photons in x-rays. Patients usually receive external-beam radiation therapy in daily treatment sessions over the course of several weeks. The number of treatment sessions depends on many factors, including the total radiation dose that will be given. One of the most common types of external-beam radiation therapy is called 3-dimensional conformal radiation therapy (3D-CRT). 3D-CRT uses very sophisticated computer software and advanced treatment machines to deliver radiation to very precisely shaped target areas.

Cobalt (chemical symbol Co) is a metal that can be stable (non radioactive, as found in nature), or unstable (radioactive, man-made). The most common radioactive isotope of cobalt is cobalt-60. Cobalt-60 is used in many common industrial applications, such as in leveling devices and thickness gauges, and in radiotherapy in hospitals. Large sources of cobalt-60 are increasingly used for sterilization of spices and certain foods.

The powerful gamma rays kill bacteria and other pathogens, without damaging the product. After the radiation ceases, the product is not left radioactive. This process is sometimes called "cold pasteurization." Cobalt-60 is also used for industrial
radiography, a process similar to an x-ray, to detect structural flaws in metal parts. One of its uses is in a medical device for the precise treatment of otherwise inoperable deformities of blood vessels and brain tumors. Radionuclides such as cobalt-60, that are used in industry or medical treatment are encased in shielded metal containers or housings, and are referred to as radiation ‘sources.’ The shielding keeps operators from being exposed to the strong radiation.

The radiation therapy produces various types of cell deformation and tissue damage which are irreversible in nature. Literally all the classes of cells are affected by radiation therapy and the objective of this study is to assess the effect of cobalt-60 irradiation on the tissue damage and cell deformation using albino mice as the animal model.

Materials and Methods

Pre Clinical Standardization

12 male albino mice were obtained from TANUVAS (Tamil Nadu Veterinary and Animal Sciences University), Madhavaram, Chennai. They were 6 weeks old and weighed around 25-30 grams. The mice were placed in 2 cages labeled as Control (C) and Test (T). They were left for 15 days acclimatization period in their respective cages. The mice were fed once a day with standard rodent chow and provided with distilled water. All experiments were performed under controlled conditions (temperature [21 ± 2°C], humidity, and a 12-h light-dark cycle).

Irradiation

The mice were grouped into 6 each (control group – 6 and test group – 6). The test group mice was irradiated with cobalt-60 source irradiation at Department of Oncology, Government Medical College, Patna, Bihar, India. The radiation session lasted for 15 minutes with 2 mice being irradiated at a time in a specially made fibre plastic case. The dose of radiation was fixed at 5 grays for the entire session and was not varied. The physical activity of the mice pre and post radiation session was recorded and tabulated. The control mice group was not radiated.

Results and Discussion

In the case of test mice, the effect of tissue damage and cell deformation were clearly visible. The tissues were broken, bruised and looked quite pale. The cell deformation was on an extreme scale with highly irregular shapes obtained by the cells. (Figure 1). Cells which were originally spherical in shape never hinted any spherical shape after the radiation session. The cells were also found to have been considerably shrunken in size due to the aftermath of radiation. The aggregates of cells were found scattered throughout unlike pre-radiation period where the cells were arranged in an organized fashion.

Fig. 1: Tissue damage and cell deformation in the test mice.
As far as control batch of mice is concerned, the cells and tissues were found to be intact without any signs of deformation or damage. The shape of the cells was found as in the case of pre-radiation therapy status. The cells were also found in the aggregates which is the inborn nature of it.

Radiation seems to be a necessary evil which contains both beneficial and harmful effects. The main setback in using or employing a radiation therapy is the presence of side effects which are unavoidable in any form. The qualitative and quantitative analysis of the radiation effect on the living tissues can provide us with some mechanism or method by which can reduce the impact of damage caused. Future studies can be channeled in that direction for fruitful consequences.

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References


Fig. 2: Absence of tissue damage and cell deformation in the control mice.