BIOLOGICAL EFFECTS OF X-RAY RADIATION AND METHODS OF PROTECTION

Student of the Fergana Medical Institute of Public Health

Ahmadjonova Markhabo Azamjon kizi

Abstract

This article analyzes the biological effects of X-ray radiation, the mechanisms of ionizing radiation on cells and tissues, and the biophysical changes occurring in the body. Additionally, methods of protection against X-rays, radiation safety rules, and their significance in modern medicine were scientifically highlighted.

Keywords

X-rays, ionizing radiation, radiation, biophysics, cell, DNA, mutation, biological action, radiation safety, protection, dosimetry, ionization, electromagnetic wave, radiology, medicine, radiation dose, genetic change, radiation background, cancer, diagnosis, protective agents, lead, radiotherapy, organism, energy, bioelectrical process, mutagenic action, physical protection, radiation source, X-ray machine.

Introduction

X-ray radiation is one of the physical phenomena that holds an important place in the development of modern medicine and science. These rays were discovered in 1895 by the German scientist Wilhelm Konrad Rentgen and are electromagnetic rays with short wavelengths. X-rays are widely used in medicine because they allow for the visualization of internal organs and the identification of diseases within the human body.

In biophysics, the biological effect of X-ray radiation is of particular importance. X-rays possess ionizing properties and act on atoms and molecules in living cells. As a

result, physical and chemical changes occur in the cells. Damage to DNA molecules, in particular, can cause serious changes in the body's activity.

The effect of X-rays on the body depends on the radiation dose, the duration of exposure, and the body's sensitivity. While low doses of radiation are useful for diagnostic purposes, high doses lead to cell death and the development of various diseases.

Therefore, when using X-rays, it is important to comply with radiation safety rules and apply protection methods.

Body

X-rays are high-energy electromagnetic waves that have the ability to penetrate substances. When these rays reach the human body, they ionize the atoms of the cell. Free radicals are formed as a result of ionization, damaging biological molecules.

The biological effects of X-ray radiation are primarily associated with the damage of DNA molecules within the cell nucleus. The breaking of the DNA chain leads to the disruption of cellular activity. In some cases, mutations may occur, leading to the development of cancer.

$D=m|E$

This formula represents the radiation dose. Here, D is the dose, E is the absorbed energy, and m is the mass of the substance. The dose determines the degree of effect on the body.

The effect of X-ray radiation on the body is of two types: somatic and genetic. Somatic influence manifests in the human body itself. Genetic influence causes changes that are passed down from generation to generation.

Table 1. Biological effects of X-ray radiation

Type of impact	Description	Consequences
Somatic effect	Damage to body cells	Burn, cancer

Genetic influence	DNA mutation occurs	Hereditary diseases
Acute effect	Short-term effect at high dose	Cell death
Chronic exposure	Long-term effect at low dose	Organ dysfunction

The biological effect of X-rays also depends on the sensitivity of the body's tissues. Rapidly dividing cells are sensitive to radiation. For example, bone marrow, reproductive glands, and blood-forming tissues are more susceptible to X-rays.

In medicine, X-rays are used for diagnostic and treatment purposes. Radiography, computed tomography, and fluorography are widely used in the diagnosis of diseases. Radiotherapy is used in the treatment of cancer.

The main methods of protection against X-rays are based on reducing time, increasing distance, and using protective screens. Lead-based protective equipment significantly reduces radiation exposure.

Analysis results

Analyses indicate that X-ray radiation is considered an ionizing factor that exerts a powerful influence on biological systems. Radiation energy causes the ionization of atoms and molecules within the cell. As a result, chemical reactions in cells change, and biological functions are disrupted.

Analyses revealed that DNA molecule damage is one of the most dangerous consequences of X-ray radiation. Breaks in the DNA chain disrupt cell division and cause mutations. If damaged cells do not regenerate, cancer can develop.

The influence of X-rays on the body depending on the dose was also analyzed. Low-dose irradiation does not pose a significant risk in short-term diagnostic studies. However, high doses or prolonged effects are dangerous to the body. Radiology specialists must use protective equipment, as they work under constant radiation exposure.

Table 2. Methods of protection against X-rays

Protection method	Description	Efficiency

Decrease time	Radiation exposure shortening	Upper
Increase distance	Stay away from the source	Upper
Lead screen	Absorbs rays	Very high
Dosimeter control	Radiation measurement	Critical control method

The data in the table show that protection methods are of great importance in ensuring radiation safety. Lead screens, in particular, absorb a large portion of X-rays and protect the body. Therefore, special lead-lined walls and clothing are used in X-ray rooms.

During the analysis, the sensitivity of biological tissues to radiation was also studied. Young organisms and children are more sensitive to X-rays than adults. Because their cells are in the process of actively dividing. Therefore, X-ray examinations in children are conducted only when necessary.

In radiotherapy, the beneficial properties of X-rays are utilized. High-energy rays are used to destroy cancer cells. However, a precise calculation of the radiation dose is required to protect healthy tissues.

The long-term effects of X-ray radiation are also an important biophysical problem. Chronic radiation weakens the body's immune system and reduces the ability of cells to regenerate. In some cases, cataracts may develop as a result of damage to the lens.

The significance of dosimetric control was also analyzed. The radiation dose received by employees is regularly monitored using specialized dosimeters. This will help ensure radiation safety.

In general, the biological effect of X-ray radiation is based on complex biophysical processes and has both beneficial and harmful aspects for the body. The safe use of these rays is one of the important requirements of modern medicine.

Conclusion

X-ray radiation is an ionizing electromagnetic radiation that exerts a strong biological effect on the body's cells. Radiation can damage DNA molecules and cause various diseases. At the same time, X-rays are of great practical importance in diagnosis and treatment. Compliance with radiation safety regulations, the use of lead-based protective equipment, and the implementation of dosimetric control play an important role in protecting the body from harmful effects.

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