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The Impact of Alpha Particles on Physiology of Human Body

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ABSTRACT

The aim of this review is to provide an overview on the effect of alpha particles on human blood considering three axes. The first one considers defining alpha particles and source of alpha particles and types of alpha, the second axes consider the physiology of human body while the third one clarify health effects of the alpha particles with different doses on human body.

Keywords: Alpha particles, Physiology, Cancer

INTRODUCTION

The pollution by radiation is a serious problem that threatens the human health. Humans have a known the destructive that effects of radiation pollution by the atomic bombing of Hiroshima and Nagasaki on 6th and 9th August 1945 during the final stage of World War II. The nuclear explosions lead to the death and wounding; a large number of residents in Hiroshima and Nagasaki have burns and other injuries and died after a few years later [1,2]. Environmental pollution means the presence of materials in the air in such concentration, which are harmful to man. The various environment sources of pollution, such as radioactive substances, which released by nuclear explosions and explosives are extremely harmful for health [3]. The sources of radioactivity in environment permanently include natural or made man sources. The natural sources include cosmic rays (from the sun, planets and stars are starting to pour down on the earth at all times reach the earth and interacts with the earth's atmosphere and produce different isotopes), environment (terrestrial sources rocks, air and water) and living organisms (internal) [4]. Made man sources which produced by the bombing of the nuclei of stable isotopes of different types of nuclear particles [5].

ALPHA PARTICLES AND SOURCES

There are many unstable nuclei which undergo transformations accompanied by emission of energetic that called parent atom, alpha particle (α), can be emitted from parent atom and product nucleus which contains less than parent in two protons and two neutrons [6,7]. Alpha particles are a one type of ionizing radiation, which is the least penetrating of the radiations emitted from unstable heavy metal [8]. These particles are harmful to living tissues than other types of ionizing radiation because of the more massive and highly charged for these particles [9]. In air, even the most energetic alpha from radioactive substances travel only several centimeters, while in the body tissue, the range of alpha particles is very short approximately 0.03 mm [10] and is measured in microns ($1\ \mu=10^{-4}$ cm). Alpha particles are emitted from radioactive sources. There are three natural radioactive series called uranium, Th and Ac series. All three series contain alpha emitters. The first series begins with the decay of ^{238}U (half-life 4.49×10^9 y) and is called the “Uranium-series”. The second begins with ^{232}Th (half-life 1.39×10^{10} y), which is called the “Thorium series”. The third begins with ^{235}U (half-life 7.10×10^8 y) and is called “Actinium series” [11,12]. The three series that contain alpha emitters [13]. There is a very strong correlation between the energy of alpha particle and half-life for the parent isotope during alpha particles emitted from radioactive sources [14]. Uranium is a naturally radioactive element and heavy-metal toxicity, symbolized by the letter U. It consists of a group of radioactive isotopes such as ^{238}U,

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^{236}U and ^{235}U. Most of these isotopes emitted particles and nuclear radiation [10]. The most prominent qualities are: heavy, silvery white, the poisoning and melting temperature (1132°C) and density at a temperature (25°C) are (18.9 g/cm^3) [10]. Uranium enters bodies from the water, food and air intake distributed on to the following proportions: (66% in the skeleton 16% in the liver, 8% in the kidneys and 10% in other tissues) [6,15]. The DU is produced from the uranium enrichment process. It typically contains about 99.8% of ^{238}U, 0.2% of ^{235}U and 0.0006% of ^{234}U [12]. Both natural uranium and DU are emitters of alpha particles of most of the isotopes contained in each of them. They richly vary from isotope to another [12]. Excessive intake of hazardous uranium materials into the body could pose long-term health risks from both chemical toxicity and its radioactivity [16]. Such risks to health will depend on the pathway and extent of uranium exposure [17]. The small particles of uranium are inhaled down to the lower part of lung if they do not dissolve. They stay in lung and cause most of the radiation dose there; may be they gradually dissolve and go into blood [18].

PHYSIOLOGY OF HUMAN BODY

The knowledge of the physiology of the human body is important for how radioactive materials are transmitted within the human body. In general, the human body consists of several organs and systems. Each of which has a specific function. The most important equipment needed to understand how the radioactive material being distributed in the human body are: the circulatory system responsible for pumping and distributing blood to the body, the respiratory system responsible for oxygen supply and the digestive system responsible for digestion and absorption of food [19]. The Circulatory System is a closed circle of tubes which is responsible for moving the blood from the heart to all parts of the body and then returns to the heart to be distributed to all organs of the body [20]. The Respiratory System; breathing occurs in the lungs when blood passes through the capillaries near the alveoli where oxygen obtained to burn food and feed the cells [19]. During the breathing process, the person inhales many substances that are either in the gas or in the form of dust stuck in the air. If these substances are in the case of gas, they pass with the air to the blood at varying rates depending on the speed of melting in the blood [21]. If these substances are in the form of dust, part of them would be deposited in the lungs and the other part will be exhaled [19,20]. The behavior of precipitants in the lungs depends on the speed of their melting. If they are fast soluble, they are absorbed during limited hours and move with blood. If they are slow to melt, they attached to the lungs for as long as several months. It is clear that the respiratory system is one of the main entrances to the entry of radioactive materials in the body and then transmission of blood to different organs of the body [21]. The Digestive System; the food in this system is transformed by digestive enzymes into a simple and a suitable image to be absorbed by the blood then from it into the cells of the body [20]. When the radioactive material is ingested with food, it passes through the gastrointestinal tract [19]. If these substances are the kind that dissolves in water or the different enzymes, they are absorbed with the food and can reach the blood that is distributed to all parts of the body [20]. Radioactive substances can be concentrated in certain organs of the body. For example, radioactive ^{137}Cs is concentrated in soft tissue while ^{90}Sr is concentrated in the bone. The substances that are insoluble in water or enzymes pass through the digestive system and expose it to radiation as they pass through [21].

HEALTH EFFECTS OF ALPHA RADIATION

Alpha particles enter the bodies through the digestive and respiratory system by the nourishment that we eat or the water we drink or the air we inhale and furthermore by ingestion [19,20]. When we inhale the tidy of the α-radiation emitters, these radioisotopes chemically and physiologically behave like calcium [22], some of it is breathed out and some stay in our lungs and then to the bone marrow through the blood [21]. If these minutes are taken through the mouth and digested food into the blood stream and move to the organs of the body then concentrate mostly in the kidney and bones and liver. These minutes are deposited inside the human body, remain radiated by a low level of radiation for a very long time causing the stimulation of the cells of the bone marrow [23] and causing cancerous illnesses. Many studies have discovered a direct correlation between cancerous diseases and the exposure to radiation [24,25]. Some of these studied the associated cancers like lung cancer - uranium miners and bone cancer - radium dial painters [26]. The way alpha particles are exposed determines their health risks. In general, the external exposure has less effect than internal exposure, because alpha particles lack the penetration power of the outer dead layer of skin [10]. If the radionuclides emitting alpha particles are taken by ingestion or inhalation, they are very toxic because they release a large amount of energy in a short distance within living tissue [7]. Mainly, the elements which are emitting alpha particles such as uranium, radon and plutonium due to their size are slow and interact with atoms, causing ionization and excitation. Alpha particles lose energy rapidly when passing through a material during numerous collisions with the electrons that make up the atoms and molecules, because the collisions produce ionizations. The initial energy of alpha particles is reasonably high (3 to 8 MeV) [14]. If α-particle source is outside the body, there is less danger than if the source is inside the body where all the energy deposits in the body. When alpha are inhaled and swallowed, they are absorbed into the blood stream; in this case alpha radiation may cause lung cancer [10].

CANCER

The period between radiation exposure and an increased risk for cancer is generally quite long [27]. In adults, the median latency period may be about 8 years for leukemia and two- to three-times longer for solid cancers [28]. Generally, the additional cancer risk for low dose exposure is assumed to be proportional to the radiation dose. It is difficult to detect an increased cancer risk due to radiation at doses lower than 100 mSv because the excess risk at low doses is small in comparison to spontaneous rates of cancers of the same type. Therefore, no direct experimental or epidemiological evidence can be obtained. In the absence of any direct evidence UNSCEAR [28] has estimated the increase of cancer risk due to low radiation doses by linear extrapolation from highly exposed human populations, such as the survivors of Hiroshima and Nagasaki. These calculations show that the additional risk of a lethal cancer associated with a dose of 1 mSv is about 1 in 20,000. This represents only an insignificant increase in comparison with the normal cancer risk in Europe of about one in five or 20%. These theoretical considerations also form the base of the assessment recently published by the World Health Organization [29] which also excluded any link between exposure to depleted uranium and the onset of congenital abnormalities or serious toxic chemical effects on organs. Mass screening of the population and the creation of an immediate, cleanup programmer at the sites where depleted uranium was used in ammunition in the Balkans was therefore not recommended. Well documented lung cancer risks in many cohorts of uranium miners [30], should not be used for the assessment of DU risks. The increased risk of lung cancer in uranium miners can be attributed to another group of radionuclides-radon and its short-lived decay products in a synergistic interaction with tobacco smoke. Radiation exposures in miners from uranium proper are only a tiny fraction of those from radon and its short-lived decay products and are still smaller than those from longer-lived members of the uranium decay chains such as radium, polonium and lead.

CONCLUSION

Substances that produce alpha particles are among the most dangerous sources of internal hazards, for the following reasons: The extent of alpha particles in the human body is small, where it does not exceed several parts of a millimeter. Alpha particles have a high ability to ionize. They increase the relative biological effect of this ionization. The half-life of all radioactive sources for alpha is span. And, extracting the isotopes from the human body is difficult. Finally, alpha particles are not used for *in vivo* diagnostic studies, because they are damaging biologically.

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