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CONTENT

THE EFFECT OF LONG-TERM IONIZING RADIATION ON ORGANS AND SYSTEMS OF THE HUMAN BODY

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Summary. The biological effects of ionizing radiation on the human body can be both genetic and somatic. One of the characteristic features of an organism that has withstood radiation damage is a state of long-term compensatory voltage, which requires constant mobilization and additional costs of the body's reserves and can lead to disruption of compensatory reactions. **The aim of the study**. To establish the clinical and morphological features of the development of pathological processes in the human body that occur over a long period of time after exposure to high doses of radiation and to establish their relationship with the development of periodontal disease. People who permanently live in radiation-contaminated areas develop enzymopathy, metabolic processes are disrupted, toxic metabolic products, radionuclides accumulate, slag excretion is complicated, lipid peroxidation and cell membranes are significantly increased, and antioxidant deficiency develops due to antioxidant deficiency. which causes an imbalance in the nervous, cardiovascular, digestive, immune systems, which in combination leads to changes in periodontal tissues. The action of ionizing radiation can have an initiating, accelerating and modifying effect on the manifestations and course of general somatic diseases. That is why generalized periodontal diseases are polyetiological (comorbid) diseases with an autoimmune component. **Conclusions:** Based on previous clinical and laboratory and experimental morphological studies, as well as literature data, we can clearly state that the variability of kinetic characteristics of bone tissue can be due to both hereditary (family) and non-hereditary (modification) components. Under the action of ionizing radiation, patients develop not only general somatic pathology, but also dental, in particular, from the periodontal tissues. That is why generalized periodontal disease (periodontitis) is a polyetiological (comorbid) disease with an autoimmune component, in which distinct individual correlations in the kinetics of radionuclides in individuals of the same age and sex are clearly traced.

Key words: ionizing radiation, radionuclides, bone tissue, periodontitis.

The study of remote radiation pathology is an urgent task of clinical practice and the need for deep explanation of adaptive-compensatory mechanisms, as a manifestation of the body's response to ionizing radiation.

The action of ionizing radiation can have an initiating, accelerating and modifying effect on the manifestations and course of general somatic diseases.

One of the characteristic features of an organism that has withstood radiation damage is a state of prolonged compensatory tension, which requires constant mobilization and additional costs of the body's reserves and can lead to disruption of compensatory

reactions, which is why the remote effects of radiation damage take different forms and require constant attention from both science and practical medicine.

The relevance of this issue is determined by two aspects – general biological and medical.

The theoretical significance of the problem of individual variability of metabolic processes follows from the fundamental position, which states that the discreteness of life is represented by individuals with morpho-physiological features present to them, which play an important role in life activity.

In medicine, the importance of individual characteristics of the human body has long been recognized as the principle of an individual approach to each patient, which requires a comprehensive examination.

One of the characteristic features of an organism that has withstood radiation damage is a state of prolonged compensatory tension, which requires constant mobilization and additional costs of the body's reserves and can lead to disruption of compensatory reactions, which is why the remote consequences of radiation damage are diverse, and their study remains a topical issue of our time.

That is why special attention in the problem of this issue is paid to individual features of the kinetics of osteotropic substances.

The aim of the study. To establish clinical and morphological features of the development of pathological processes in the human body that occur after a long period of time after exposure to high doses of radiation and to establish their relationship with the development of periodontal tissue diseases.

Main content. The biological effect of ionizing radiation on the human body can be both genetic and somatic.

The genetic consequences of radiation exposure are manifested in the descendant of a person who has been exposed to radiation. These include birth defects and deformities that occur as a result of mutations in germ cells.

Somatic consequences of radiation exposure are manifested in a person who was directly exposed to radiation.

The early somatic effect of ionizing radiation occurs in the period from a few minutes to 60 days. It is characterized by such changes as redness and peeling of the skin, clouding of the lens, damage to hematopoietic organs, radiation sickness, and deaths.

The remote effect of somatic impact manifests itself several months or years after exposure. It consists in persistent skin changes, the appearance of malignant neoplasms, a decrease in immunity, and a reduction in life expectancy.

If we take morphological changes as a criterion of sensitivity to ionizing radiation, then the cells and tissues of the human body can be distributed according to the degree of sensitivity decrease as follows:

1) lymphoid tissue and bone marrow; 2) sex glands; 3) mucous membranes; 4) cutaneous integument; 5) lungs; 6) thyroid; 7) GI internal secretion glands; 8) connective tissue; 9) muscle tissue; 10) cartilage and bone tissue; 11) nerve tissue.

Target organs of radioactive substances in the body: $_{40}$Ca, $_{90}$Sr, $_{226}$Ra are accumulated in the skeleton; $_{244}$Pu, $_{139}$La are concentrated in the liver; $_{137}$Cs are concentrated in muscle tissue; $_{222}$Rn - in the lungs; $_{209}$Po, $_{3}$H are distributed evenly throughout the body; radioactive $_{127}$L is accumulated in the thyroid gland.

Osteotropic chemical elements, including radionuclides, occupy an important place among man-made pollutants. These include stable elements such as lead, fluorine, zinc, beryllium, alkaline earth metals, radionuclides such as $_{90}$Sr, $_{224}$, $_{226}$, $_{228}$Ra, $_{238}$, $_{239}$Pu,

$_{24}$Am and others. Most of them are toxic. For example, man-made fluoride and lead cause fluorosis and lead intoxication, which in the oral cavity is manifested by «lead stomatitis», beryllium leads to «beryllium rickets», stable strontium causes a violation of mineral metabolism (Knizhnikov V. A., Tseitlin O. Y.) [17, p. 451, 19, p.328].

A number of publications of domestic and foreign scientists have described that radionuclides are sources of internal radiation of the body, with a detailed effect and patterns of accumulation and elimination from the body (Akleev A.V., Balabukha V. S., Buldakov L. O., Ilyin B. M., Lyubashevsky M. M., Moskalev Y.I., Newman M., Newman U., Sokolov Y.O., Fradkin G. E., Shvedov V. L., Comar C.L., Degteva M.O., Kozheurov V.P., Lloyd R.D., Stover B.J., Tolstykh E.I. Wasserman R.H.) [11, p. 84, 12, p. 79, 13, p. 10, 14, p. 6].

Gradually «integrating» into bone tissue, osteotropic substances are slowly removed from the human body (Zakutinsky D. I., Durbin P.W., Vaughan J.M.). In addition, a number of radionuclides have a long half-life (for example, 90Sr – 30 years, 226Ra – 1622 years, 239Pu – 24400 years, 235U-7.1 x 108 years). The effect of their action depends on the sensitivity (for example, radiosensitivity) of the body and the kinetics of substances (the level of deposition, localization, time spent in the body) [17, p. 451, 19, p. 328].

There are significant correlations in the differences in the kinetics of radionuclides in the body of people of the same age and gender.

Variability in the kinetic characteristics of bone tissue can be caused by both hereditary (familial) and non-hereditary (modification) components.

Forecasting individual tolerance to osteotropic toxins, based on the mechanisms of their metabolism, is especially relevant in the conditions of a man-made accident, since then a large number of organisms and animals receive osteotropic toxic substances from the external environment.

To interpret the behavior of osteotropic substances in the human body, the concept of limiting morpho-physiological metabolic factors was used previously, which interpreted the mechanisms of metabolism of stable elements and radionuclides in bone tissue from the same positions. It involved the separation of 10 endogenous factors, which are physiological processes, physicochemical reactions and structural components, which together determine the final results of deposition in bone tissue, tissue redistribution and excretion of osteotropic substances from the body. This concept mediated the influence of other processes of vital activity and the external environment (type, gender, age, physiological state, exogenous influence) and allowed us to formulate the significance and direction of shifts in radionuclide exchange in bone tissue [18, p. 168].

In unfavorable environmental conditions after the Chernobyl accident, along with the occurrence of an increased radiation background, the incorporation of radionuclides that enter the body by biological food chain and inhalation is also essential.

The effect of 90Sr on the body is reflected in bone remodeling. The constant inclusion of radioactive strontium in the mineral bone matrix leads to the development of a number of pathological and compensatory-adaptive reactions in bone tissue at the cellular and tissue levels.

Radiobiological effects of osteotropic radionuclides in bone tissue:

- preosteoblastic failure;
- destruction;
- dysplastic fibrosis;
- accumulation in hydroxyapatite crystals;
- preosteoblastic failure;
- changes in energy metabolism.

The incorporation of 90Sr depends on the intensity of growth and metabolic processes. Incorporated radionuclides interact with the electrons of neighboring atoms, osteotropic ions, and cause ionization. Ionized atoms are actively involved in complex chain reactions, resulting in the formation of active "free radicals". The latter react with each other, causing chemical and biological changes in cellular elements.

The greatest risk of radiation damage in young bone cells: preosteoblasts and osteoblasts (preodontoblastic failure is the result of a specific action of 90Sr). Osteoblasts secrete polymers of collagen fibrils into the intercellular space, on the surface of which mineralization processes occur. Impaired osteoblast function leads to delayed formation of hydroxyapatite crystals.

Incorporated radioactive 90Sr causes an imbalance in the osteoblast – osteoblast ratio, which disrupts bone remodeling and serves as a trigger for bone destruction.

Immune mediators – cytokines and growth factors-play a significant role in the pathogenesis of osteoporosis.

Lesions of the immune system and gastrointestinal tract should be considered dominant in the progressive development of an autoimmune condition in generalized periodontal diseases.

People who permanently live in radiation-contaminated areas develop fermentopathies, metabolic processes are disrupted, toxic metabolic products and radionuclides are accumulated, the removal of toxins is complicated, lipid peroxidation and cell membranes significantly increases, antioxidant insufficiency develops, the work of the neuro-hormonal system is disorganized, followed by an imbalance of the nervous, cardiovascular, digestive, immune and other systems [1, p. 87, 2, p. 24, 3, p. 304, 7, p. 5].

For most patients in modern conditions the "enteral syndrome" is characterized. The enzymatic activity of the small intestine is disrupted, which leads to morphological changes in the structure of the epithelium and weak adsorption of enzymes on the surface of the mucous membranes. A decrease in the hydrolysis of carbohydrates in the small intestine leads to their ingestion in large quantities in undigested form into the large intestine. Dysbacteriosis of a large intestine, a syndrome of insufficiency of absorption develops (fermentation processes).

There is a correlation between functional disorders in the insular apparatus of the pancreas and periodontal disease.

Most individuals have changes in the neuro-endocrine system, impaired metabolism of endocrine hormones, and hypothalamic dysfunction. At the same time, the intensity of lipid peroxidation increases, immune insufficiency develops, the protection of the antioxidant system decreases against the background of a significant deficiency of vitamins of group A, B, C, K, E, macro - and microelements, etc.

The causes of impaired neuro-endocrine regulation are numerous: hereditary predisposition, mental factors, insufficient endometrial receptor response to the effects of ovarian hormones, ovarian damage, severe endocrinopathies, toxic-infectious damage to diencephalic areas, etc. [6, p. 633, 15, p. 24].

Individuals with thyroid and parathyroid diseases have a high frequency and severe course of generalized periodontal diseases.

In Itsenko-Cushing's disease, characterized by an excessive content of corticosteroids in the blood, along with damage to the long tubular bones and spine, the phenomena of resorption of the alveolar bone of the jaws are noted.

Individuals with hypercorticism have developed a dystrophic process in the periodontium.

The biosynthesis of sex hormones largely depends on a sufficient intake of vitamins, especially vitamin E.

The effect of vitamin E may be mediated through the anterior pituitary gland on the sex glands. At the same time, the effect of vitamin E is not limited to changes only in the gonadotropic function of the pituitary gland, but also in its adrenotropic and thyroid-stimulating functions. Which in turn affects the functional state of the adrenal glands and thyroid gland, as well as on those metabolic processes in the body for which they are responsible. Vitamin E can directly affect redox reactions and metabolic processes [4, p. 30, 16, p. 120].

Due to a violation of the metabolism of sex hormones, shifts in the hypothalamus-pituitary-gonad system, and diencephalic changes, most patients develop generalized periodontal diseases [5, p. 60, 6, p. 633, 8, p. 124].

With reduced estrogen secretion, spastic-atonic state of gum capillaries, anemia and their atrophy, pronounced phenomena of osteoporosis, destructive and resorption processes are detected [9, p. 13, 10, p. 23, 15, p. 24].

An increased content of estrogen in the body causes desquamative phenomena in the gum epithelium, connective tissue proliferation, and increased vascular permeability.

Conclusion. Based on previous clinical, laboratory and experimental morphological studies, as well as literature data, we can clearly state that the variability of the kinetic characteristics of bone tissue can be caused by both hereditary (familial) and non-hereditary (modification) components. Under the influence of ionizing radiation, patients develop not only general somatic pathology, but also dental, in particular, from periodontal tissues. That is why generalized periodontal diseases (periodontitis) are polyethological (comorbid) diseases with an autoimmune component, in which excellent individual correlations in the kinetics of radionuclides in the organisms of individuals of the same age and gender are clearly traced.

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