Київський національний університет імені Тараса Шевченка
Навчально-науковий центр радіаційної безпеки Київського національного університету імені Тараса Шевченка
Всеукраїнське об'єднання медичних фізиків та інженерів

Медична фізика – сучасний стан, проблеми, шляхи розвитку. Новітні технології

Матеріали IX Міжнародної конференції
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Medical Physics – the Current Status, Problems, the Way of Development. Innovation Technologies

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Матеріали IX Міжнародної конференції «Медична фізика – сучасний стан, проблеми, шляхи розвитку. Новітні технології» відображають наукові, методичні та практичні результати досліджень, спрямованих на вдосконалення шляхів розвитку медичної фізики, подальшого просування новітніх технологій на ринку медичних послуг.

Конференція проводиться за ініціативою Навчально-наукового центру радіаційної безпеки Київського національного університету імені Тараса Шевченка, Всеукраїнського об’єднання медичних фізиків та інженерів за участю фахівців із провідних закладів вищої освіти, медичних, наукових та регулювальних установ, а також представників МАГАТЕ, Міністерства охорони здоров’я, Академії медичних наук України тощо.

Мета конференції – об’єднати зусилля спільноти в галузі освіти, науки, охорони здоров’я та ядерного регулювання для ефективної підготовки фахівців із медичної фізики.

Proceedings of IX International Conference «Medical physics – the current status, problems, the way of development. Innovation technologies» are reflecting the scientific, methodical and practical results of scientific researches. Results are directed to improve the way of medical physics development in post-Soviet countries and further promotion of innovation technologies in the market of medical services.

The workshop is held by initiative of Taras Shevchenko National University of Kyiv and Ukrainian Association of Medical Physicists and Engineers with the participation of specialists of leading institutions of higher education, medical and scientific organizations, authorities and also representatives of IAEA, Ministry of Public Health of Ukraine, National Academy of Medical Science of Ukraine, etc.

The conference aim is cooperation of community in the area of enlightenment, science, public health and nuclear regulation for effective training of specialists in medical physics.

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3. Організувати проведення верифікації значень дозиметричних величин CTDI і DLP як на етапі інсталяції обладнання, так й у разі заміни програмного забезпечення для КТ.

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DIELECTRIC BIOMARKERS FOR ASSESSING RADIATION DAMAGE TO BLOOD CELLS BEFORE AND AFTER RADIATION THERAPY

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Annotation. The paper deal with the use the parameters of dielectric permittivity of erythrocyte of healthy donors and cancer patients before and after radiation therapy as biomarkers for building a model of a medical test system that allows tracking the dynamics of changes in the state of blood cells of patients during treatment.

Key words: dielectric relaxation, radiation therapy, erythrocytes, model, biomarkers.

Disruption of hydration processes and changes in the water balance in cells and tissues of body after exposure to ionizing radiation is one of the many problems that arise with the use of radiation therapy during treatment and its solution is impossible without an analysis of the adaptive and compensatory mechanisms, the clarification of which in the clinic is difficult. In this regard, experimental studies are of particular interest. Measurement of the dielectric parameters of a cell can become a used test in assessing the functional response of the body to radiation therapy [1, 2]. It can be used to study morph-functional changes in cells that occur in response to changes in the structure and viscosity of membranes, as well as to the metabolism of pathogenic agents (hypoxia, trauma, inflammation, etc.) which as a rule, usually cause the development of one or another type of edema after therapy. The parameters of interest to the doctor, quite often, cannot be measured directly, and the information necessary for the doctor for the correct therapy of oncological disease can be obtained only if the corresponding mathematical models are implemented. The availability of modern personal computers allows at present to implement rather complex mathematical models and methods of medical diagnostics and radiation therapy. Since the content of erythrocytes is a liquid hydrophilic system, which includes water (65%), the structural rearrangements of the membranes cause a change in the ratio of free and bound water and are accompanied by changes in the dielectric parameters of cells. These changes are recorded by microwave dielectrometry in the frequency range corresponding to the dispersion region of water molecules and allow the use of the dielectric permittivity of biological objects as a physical criterion in assessing structural disturbances caused by various factors [3, 4].

The objective of this study are to develop firstly is physically based model of registration of the changes of parameters the dielectric permittivity for erythrocytes under the influence of radiation therapy; secondly, showing how you can to use our data to evaluate the model; and to establish practical correction factors based on a few simple media parameters for the simple test-system. The calculations were based on the Debye model. The study of the dielectric characteristics of the suspension of erythrocytes and the shadows of erythrocytes of donors and cancer patients before and after radiation therapy in the temperature interval from 1 to 50 °C was performed the method of microwave dielectrometry of the resonator type at a frequency of 9.2 GHz. The study had been involved the group of patients with breast cancer and lung cancer. The group with breast cancer (62 people) received postoperative radiation therapy in the classical fractionation mode - a single focal dose per tumor was 6 Gy, the total focal dose was 45 Gy. A group of patients with lung cancer (36 people), received radiation therapy as an independent course in the classical fractionation mode: a single focal dose per tumor was 1.8-2.2 Gy, the total focal dose was 45-50 Gy.

The linear dependence of the real (ε') and imaginary (ε'') parts of the complex dielectric constant on the erythrocyte concentration indicates that the dielectric properties of the solvent do not depend on the cell concentration. After calculations the dielectric relaxation time of water molecules τ and the change in the free activation energy of the dipole relaxation of water molecules in the studied systems was found using the relation given in [5]. It is shown that the structural transitions of erythrocyte membranes of cancer patients in the temperature range of 8-15°C, 18-21°C, 32-35°C and 42-46°C are accompanied by a change of the water permittivity of the membranes and the ratio of free and bound by erythrocytes water. The obtained values dependence of the dielectric relaxation of water molecules from temperature suggest the existence of an aqueous phase, similar to the phase of a bulk solution, but with a relaxation time that is less than the time of reorientation of water molecules in solution. With the development of the tumor process, there is an increase in the hydration of erythrocyte membranes (increase in the thickness of the hydrate layer), which slows down the diffusion of water through the membrane. After radiation therapy, the degree of hydration of erythrocyte membranes decreases as a result of their structural and molecular rearrangements. The mathematical model is a system of differential equations, which was solved under different initial and boundary conditions [6]. The parameters that were obtained in experiments and published in scientific articles were used as input parameters of the model [7]. The output parameters of the model were also compared with experimental data, for example, the intervals of change of temperature-dependent the dielectric parameters ε_S and f_d (the static dielectric constant and the frequency of the dielectric relaxation of water in the solution) the suspensions and shadows of erythrocytes patients obtained during calculations and experiments were compared.

The obtained results contain and illustrate three main points characteristic of test development:

1. At primary processing of the dielectric data obtained by taking parameters of cells before and after radiation therapy, the approximation of the measured data important.

2. Identification of mathematical models at the theoretical level, that is, the construction of models based on well-known theoretical premises of the "behavior" of the objects under study and adequate only within a fairly narrow class of problems.

3. Identification of the parameters of a mathematical model or the search for the most adequate model for a given criterion by establishing "hidden" parameters of the object or process under study, which are the parameters of the frequency of dielectric relaxation of water molecules in erythrocyte membranes, which the model opens access to. Moreover, as a rule, the model parameters identified on the basis of laboratory measurements have the most essential medical meaning. The data obtained are biomarkers of the model for the integral assessment of structural changes that occur at the erythrocyte-water interface and can be used as a test system that characterizes the dynamics of changes in the state of patients' erythrocytes during treatment.

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ПЭТ/КТ с ^{18}F-ФДГ ПРИ АТИПИЧНОЙ ЗЛОКАЧЕСТВЕННОЙ ХЕМОДЕКТОМЕ ШЕИ

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Аннотация. В данной работе авторами продемонстрировано динамическое наблюдение методом визуализации ПЭТ/КТ с ^{18}F-ФДГ редкого случая злокачественной хемодектомы шеи атипичной локализации.

Ключевые слова: злокачественная хемодектома, ПЭТ/КТ, радиофармпрепарат, метаболизм, ^{18}F-ФДГ, SUV, пациент, опухоль.