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METHODS OF CONTROLLING RESPIRATORY CYCLE IN RADIATION THERAPY

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Considered aspects of the use of methods of determining the boundaries of the irradiated target during the respiratory cycle of the patient during the treatment with ionizing radiation in order to determine the dose more accurately.

Keywords: radiation therapy, breath control, planned target volume (PTV), 4 DCT.

Currently for accurate dose delivery in radiation therapy, various fixation devices are used, but, unfortunately, none of them takes into account the movement of the irradiated target during the respiratory cycle. It is known that the position of a number of anatomical structures of the body depends on the phase of the respiratory cycle: first, it concerns the organs of the chest and abdomen. Therefore, the control of respiratory movements plays an important role in the treatment of malignant tumors of the lungs, liver, pancreas, kidneys, breast, etc. The ability to take into account changes in the position of these structures during radiation therapy can increase the accuracy of dose delivery and reduce the radiation load on the surrounding healthy organs and tissues.

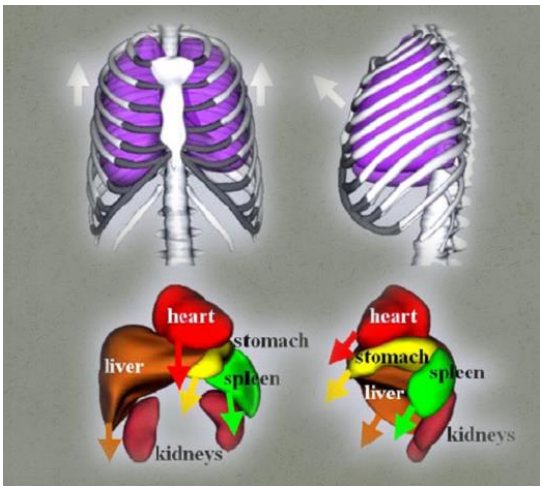

Fig. 1. Direction of movement of organs during the respiratory cycle

Standard methods of radiation therapy do not involve direct control of the target position and critical organs depending on the cycle of respiratory movements. Compensation of variability of the target positions and of its parts depending on the phase of the respiratory cycle during a session of radiation therapy is usually based on the increase of the indentation forming the planning target volume (PTV), which increases the risk of post-radiation complications.

The solution to this problem based on the determination of the volume covering the full range of tumor movement (ITV, Internal Tumor Volume). The main advantage of determining the volume of ITV is the use of individual indentation, taking into account the breathing range of a particular patient.

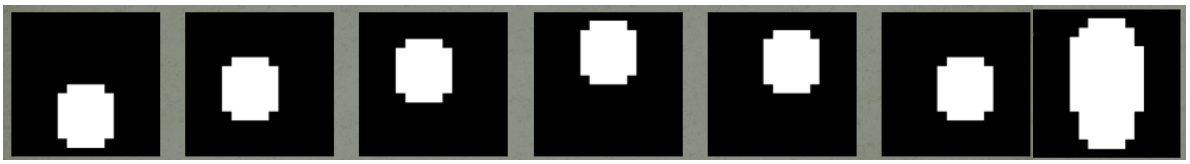

Fig. 2. ITV volume determination

For today, one of the methods of tracking the movement of the target during breathing is the use of 4D computed tomography (4DCT). When taking pictures with 4DCT the sampled images for each region of interest in the patient's body, each image links to the corresponding portion of the sinusoid of respiration. Retrospectively formed images, according to the respiratory signal, forming a set of three-dimensional scans, each of which corresponds to a certain phase of the respiratory cycle. Together they form a 4D scan covering the entire respiratory cycle of the patient. The application of this method assumes the presence of appropriate equipment in the clinic to obtain such types of images. Unfortunately, now not all clinics can purchase such equipment. In this case, the option of obtaining three series of CT images (inhalation, exhalation and free breathing) for each patient can help to determine the boundaries of the target movement during the full respiratory cycle.

The application of these methods of accounting for the respiratory cycle during radiation therapy in the clinic is associated with an increase in the time of pre-radiation preparation of the patient and an increase in dose loads from obtaining x-ray images.

PROBLEMS OF QUALITY CONTROL OF AUTOMATIC DISPENSING SYSTEMS FOR RADIOPHARMACEUTICALS

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Peripheral equipment has an important place in nuclear diagnostic medicine. At the moment, in the Republic of Belarus commissioned three automatic injector (for radiopharmaceutical). This fact confirms the need to create a quality control system for this equipment

*Keywords:*quality control, automatic injector, radiopharmaceutical, nuclear medicine.

Currently, there are no national quality control protocols for automatic injection dosing systems, all verification and testing procedures are carried out only in accordance with the manufacturer's documents. The world market offers a relatively small number of automatic dosing systems. Typically, they all have a similar operating principle and differ in the level of automation (the type of installation and supply of the container), the operating system, the software.

The principle of the automatic injector is to dose a predetermined amount of the radiopharmaceutical into the activity calibrator through the capillary system using peristaltic pumps. Quality control of automatic injectors includes: – testing the activity calibrator (daily, quarterly, annual). The daily, as the rule is conducted with a source of ^{137}Cs, the annual – with a radiopharmaceutical, the quarterly depends on the type of system and the requirements of the manufacturer. The quarterly calibration of MedRaDIntego is carried out with a source of ^{57}Co and takes up to 12 hours, which is not practical in relation to the time frame and the economic costs of acquiring the source, but it is advisable for the radiation safety of personnel. – testing of the capillary system (in automatic mode).

Quality control of automatic dosing system and standard activity calibrators is a fundamentally important component in the general quality control system of multi-channel detectors for nuclear medicine (in particular PET / CT), since The accuracy of measuring activity affects the generation of a cross-calibration factor. In addition, a number of questions are caused by the features of the dosing of the drug, which depend on the following parameters: – specific activity; – the minimum volume of a portion of the drug from the capillary; – Dosing error.

In addition to the lack of national QC standards, automatic injectors are licensed to work with one radiopharmaceutical (18F-FDG). Thus, when creating national protocols for PET / CT QC, it is important to develop protocols for QC to work with various radiopharmaceuticals.