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OPTIMIZATION OF USING OF COMPUTED TOMOGRAPHY METHODS

Abstract. *Analysis of methods of computed tomography with intravenous contrast and without contrast according to the radiation exposure, diagnostic value, invasiveness and cost was performed. According to three of the four diagnostic criteria method of computed tomography without i/v contrast prevails.*
Key words: *computed tomography, methods.*

Introduction. There are two main methods of computed tomography (CT): CT with intravenous contrast, or CT with contrast image enhancement, and CT without contrast, or CT native. An undeniable advantage of CT with contrast image enhancement has been the dominant view for a long time and it is still so. Meanwhile, with the advent of new diagnostic techniques, including not only radiation, it is important to periodically analyze and rethink pros and cons of these methods of CT, especially taking into account their ionizing effect on the subject.

Objective: To analysis of the advantages and disadvantages of the two main methods of computer tomography.

Materials and methods. 237 computer-tomographic inspections, carried out in 2015 with ambulatory and hospitalized patients of Chernivtsi Oncology Center, among which there was 108 inspections by CT with intravenous contrast, have been studied. Besides of computed tomography other radiation (radiography of the chest cavity, ultrasound diagnostics of organs of the abdomen and pelvis), laboratory and instrumental (fibergastroduodenoskopy, bronchoscopy, colonoscopy) studies, followed by biopsy and histological examination of biopsy material, were performed with patients.

Results and discussion. The comparative analysis of the computed tomography both with and without intravenous contrast has been carried out. When choosing a method of radiation diagnostic the following criteria are commonly used: 1) radiation safety; 2) informativeness; 3) the invasiveness and onerousness for the patient; 4) cost and availability.

Today the concept ALARA (as low as reasonably achievable) is globally applied, which means that for each radiological procedures, including CT, the lowest possible dose must be used [2, 5]. This leads to constant looking for opportunities of reducing radiation exposure to the patient. Thus, resource Eurosafe imaging created by the European Association of Radiologists (ESR) informs patients and radiologists about the risks of radiological procedures and ways to reduce the radiation exposure during the CT.

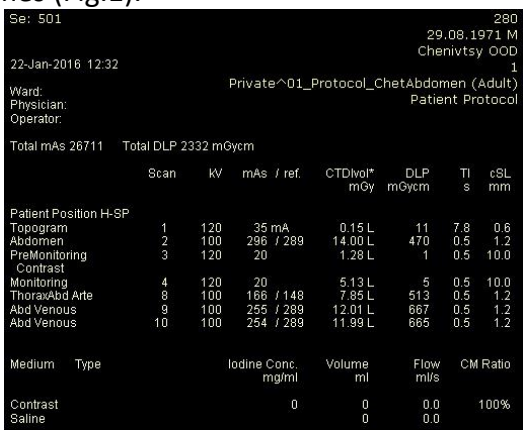
Earlier, at the computed tomography the amount of radiation received by the patient was evaluated by the tables, contained information on approximate amount of absorbed radiation when examining different parts of the body [1]. Nowadays, the amount of radiation received by the patient during the procedure, is mathematically calculated more accurately due to the presence of function Patient Protocol in modern CT scanners.

We compared the parameters of absorbed radiation dose during the whole study of DLP (mGy×cm) in menu Patient Protocol on 20-slice CT device Siemens Somatom Definition AS, which give an indication of the absorbed dose by each patient individually. The effective dose E (mSv) is equivalent to the absorbed dose and is

calculated by the formula $E=DLP \times E_{DLP}$ where E_{DLP} is equal to 0,015 for abdominal and 0,017 for the chest cavity, according to the "European Guidelines on Quality Criteria for Computed Tomography" [3].

During the native study of organs of the chest and abdomen the dose absorbed by most patients is about 300-600 mGy × cm, that corresponds to an effective equivalent dose of 5.10 mSv, depending on the patient's weight and size of the survey area.

At the intravenous contrasting the dose increases significantly to an 800-2000 mHr×cm in average at a summation of all doses at phases of contrasting corresponding to the effective equivalent dose of 14-23 mSv and can be even higher when using postponed phase contrasting. Thus, at CT with i/v contrasting the radiation exposure to the patient increases in 2-3 times (Fig.1).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Private^01_Protocol_ChetAbdomen (Adult)
Ward: Patient Protocol
Physician:
Operator:

Total mAs 26711 Total DLP 2332 mGycm

	Scan	kV	mAs / ref.	CTDIvol* mGy	DLP mGycm	TI s	cSL mm
Patient Position H-SP							
Topogram	1	120	35 mA	0.15 L	11	7.8	0.6
Abdomen	2	100	296 / 289	14.00 L	470	0.5	1.2
PreMonitoring	3	120	20	1.28 L	1	0.5	10.0
Contrast Monitoring	4	120	20	5.13 L	5	0.5	10.0
ThoraxAbd Arte	8	100	166 / 148	7.85 L	513	0.5	1.2
Abd Venous	9	100	255 / 289	12.01 L	667	0.5	1.2
Abd Venous	10	100	254 / 289	11.99 L	665	0.5	1.2

Medium	Type	Iodine Conc. mg/ml	Volume ml	Flow ml/s	CM Ratio
Contrast		0	0	0.0	100%
Saline			0	0.0	

Fig.1. Protocol of patient O., for who the CT of organs of the chest and abdomen with intravenous contrast was performed.

Of course, the diagnostic value of CT with contrast image enhancement is higher than the one of native CT. The tumors and metastases, the structure of the organs and vessels are visualized better. That is why for wider implementation of CT with i/v contrasting at early years of this method the directive requirement of leading radiologists to perform only CT with i/v contrasting appeared. This requirement exists today. But even as at CT with i/v contrasting all the morphological and pathological structures are more visible, most of these structures, including the ones of blood vessels, can be seen based on the sufficiently fundamental anatomical knowledge. Often CT with intravenous contrast bears no additional information necessary to form the correct diagnosis (Fig. 2).

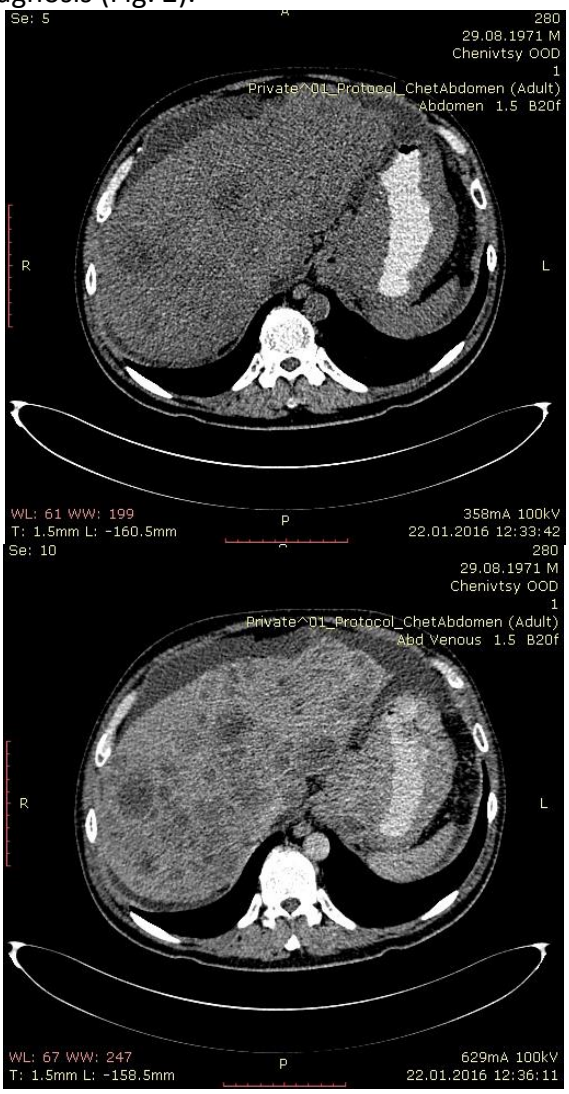

Fig. 2. CT scan of the patient O. with cancer of cardia of stomach with metastases to the liver and retroperitoneal lymph nodes.

Often, even when detecting pathological focus using CT with contrast image enhancement, is difficult to the specialist to distinguish malignant tumor from a chronic disease process with absolute certainty. This forces to apply additional instrumental, laboratory and radiation methods, including methods of interventional radiology, particularly puncture biopsy.

The pathomorphologic conclusion in oncology practice is a prerequisite for further successful patient treatment, including radiotherapy and chemotherapy. Therefore, if further histological study of a pathological focus with defined localization, it is needed just to

detect the presence of pathological focus, that can be easily performed by modern CT without contrast enhancement in most cases.

With the advent of modern multislice CT scanners, allowing to analyze slices of 1mm thick, highly qualified and experienced specialist in most cases can identify pathology based on direct and indirect signs even without contrast enhancement, and in doubtful cases, can perform further histological study of the material by patient biopsy of pathological focus. It must be remembered that radiologist needs for a comprehensive approach in his conclusions about the nature of the disease, including data of such non-radiation modern diagnostic methods as endoscopy and determination of tumor markers. These methods often help to detect malignant tumors much earlier, not only by CT with the contrast image enhancement, but by other radiation methods of diagnosis, even positron emission tomography, which reduces the role of CT in defining the nature of the process. It should be added that in many cases in the oncology practice the patients are performed CT for the first time in so late stages that diagnosis and prevalence of the process can be carried out without problems even without i/v contrasting.

Also, it should be noted, that having learnt to analyze high quality images of CT with contrast image enhancement the CT specialists do not improve their skills in analyzing the morphological and indirect signs of the disease, forgetting that previously radiologists were able to make correct conclusions by the analysis of naught information of X-ray images only due to the high level of professionalism, synthesis and analysis of clinical and laboratory data, even in the absence of modern methods of diagnosis. Radiation native CT images of organs of chest and abdomen are barely analyzed in textbooks and scientific journals on radiology.

Regarding the invasiveness and onerousness for the patient, the possibility of allergic reactions and even anaphylactic shock during intravenous administration of iodinated drugs, long list of contraindications, including renal failure, severe diabetes, pregnancy, severe general condition of the patient, thyroid disease, allergy to iodine compounds, etc., this criterion indicates the disadvantage of the use of CT with i/v contrasting compared to the native CT. Moreover, according to the latest data, during the use of iodinated contrast agents at CT enhances radiation DNA damage [4].

Accessibility for people of native CT is higher than the one of CT with contrast image enhancement, because not all CT scanners are equipped with intravenous injectors. Besides, in order to save the disposable catheters for injectors, CT with intravenous contrast is often performed in treatment and diagnostic institutions only on selected days of the week.

The cost of the CT with contrast image enhancement is higher than the one of native CT. The medical management requires taking into account the cost of not only the contrast, but other consumables (disposable syringes, tubes for pumps and patients), not forgetting that the increasing number of CT scans reduces the resource of X-ray tube, which in this case uses its resource faster, because at CT with i/v contrasting the same area of the body is scanned for several times.

Regarding the current situation in medical institutions of Ukraine, such service as CT of different parts of the body without contrasting is available in all the private diagnostic institutions, and its price is lower than the one of CT with contrast image enhancement in several times, and these data are available Internet for everyone. Native CT is widely used in the practice of public health institutions of Ukraine, including ChRCOC. In the early stages of the CT the requirement to implement it in the study of internal organs only with i/v contrasting was probably justified from the standpoint of the broader implementation of this method in practice. However, the existence and widespread use of native CT in medical practice force us to take into account the needs of practical medicine by wide informing general practice doctors about the advantages and disadvantages of different methods of radiation diagnosis, such as native CT and CT with contrast image enhancement. For example, PET-CT has even greater diagnostic value in detecting tumors than CT with i/v contrasting, but it does

not give us the right to object to the latest diagnostic methods in oncology practice. For example, PET-CT has even greater diagnostic value in detecting tumors than CT with i/v contrasting, but it does not mean it needs to object to the latest diagnostic methods in oncology practice.

Thus, a comparative analysis of native CT and CT with i/v contrasting indicates the advantage of native CT in three of the four major diagnostic criteria. The task of radiologist is to more fully and fairly inform other doctors about the pros and cons of each method of radiation diagnosis, including computed tomography, thus expanding their choices. Often radiologists narrow the choices of patients and other doctors who appoint CT to these patients by their categorical necessity in CT with contrast image enhancement in order to analyze images with better quality with more diagnostic information.

Due to the fact that a good doctor should choose the method and amount of diagnostic procedures taking into account the views of the patient, explaining to him all the advantages and disadvantages of the method, there is no assurance that after bringing relevant information to the patient and inviting him to make a choice, he chooses CT with i/v contrasting, especially because of its radiation exposure, which in several times higher than the one of native CT. Moreover, in the absence of a system of health insurance and a decrease in living standards in Ukraine, the patient often chooses a cheaper method of diagnosis.

In addition, in terms of oncology clinic where a significant number of patients receive radiation therapy the radiation dose excess may cause to radiation reactions in some patients such as leukopenia, anemia, etc. In many cases, the advantages of the diagnostic capabilities of CT with contrast image enhancement are offset by the possibility of using the whole range of other non-ionizing research methods, including laboratory and instrumental ones, most of which should be appointed to the patient by the doctor according to the diagnostic protocol of making the pathomorphologic diagnosis. Also, we should not forget that in doubtful cases it is always possible to conduct CT with contrast image enhancement even after native CT, as the fold difference in radiation exposure of these methods leads to the radiation exposure of CT with contrast enhancement is not significantly different from the one of complex of both CT methods.

Conclusions. 1. CT with intravenous contrast compared to CT without contrast has greater diagnostic value, but is more onerous procedure, has a higher cost, lower availability and has more radiation exposure for the patient. 2. In each case the complex approach to choose the method of computed tomography is necessary, taking into account the current trends in modern methods of diagnosis and the mentioned above selection criteria. 3. CT without i/v contrast is widely used in clinical practice in Ukrainian medical institutions, which leads to the need of developing of radiation semiotics of this radiation diagnosis method for training specialists in computed tomography.

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