

Computed tomography - indications and the course of the examination

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Abstract

Admission

Computed tomography, abbreviated CT or CK (computed tomography) is an imaging diagnostic method that uses the action of X-rays. The test allows you to obtain sections of the examined organs, as well as their 3D visualization, which greatly improves the diagnostic process. A tomography is used to perform a CT scan, and the image obtained with it is called a tomogram. Computed tomography was first performed for diagnostic purposes in the early 1970s in the United States.

The computer tomography consists of three basic elements: the table, the operator's console and the scanner. During the examination, the scanner performs rotations around the patient's body, making a series of x-rays. Then the obtained image is transferred to a computer equipped with specialized software. The image is visible in 2D or 3D technology.

Aim

The aim of the study is to analyze the indications and the course of computed tomography examination.

Material and method

Review of the available literature on the subject.

Results

Computed tomography is always performed based on a medical referral. It is the specialist who determines whether computed tomography will be more suitable than other imaging tests.

Usually, computed tomography of the head and sinuses, chest and abdominal cavity are performed. The most common indications for head tomography are recurring headaches and dizziness, previous craniocerebral and sinus injuries, cerebral ischemia and strokes, as well as suspected neoplastic changes in the head. CT is also performed on people who struggle with neurodegenerative diseases, such as Alzheimer's disease. We can receive a referral for this examination from a neurologist, oncologist, ophthalmologist, whether ENT specialist.

Chest tomography shows the structure of the heart, coronary vessels and the entire respiratory system. Usually it is recommended in the diagnosis of cancers of the respiratory and cardiovascular systems and in the assessment of the stage of coronary artery disease. He can refer us to this research cardiologist, pulmonologist or internal medicine doctor. Abdominal tomography is performed in order to detect possible inflammations (pancreas, large intestine, appendix, kidneys), gastrointestinal obstruction or bleeding, as well as kidney stones or thrombosis of the liver veins. In this case, a referral can be obtained from a gastroenterologist, urologist, whether gynecologist.

Conclusions

Computed tomography examination is completely painless and completely non-invasive for patients. It does not last long and allows you to quickly detect changes taking place inside the body. If the test was performed with a contrast agent, the patient may or may not experience some side effects, such as dizziness, a metallic taste in the mouth, nausea and vomiting, and palpitations.

Key words: Computed tomography

Article

Computed tomography (abbreviated to KT, CT or CT from English) is a radiological examination that uses electromagnetic (X-ray) rays, the machine carrying it out is a computer tomography. This examination enables the mapping of sections - layers of the organ. It is worth finding out what computed tomography is, in what diseases it is ordered and whether it is safe [1,2].

Computed tomography is a commonly used diagnostic method. Its usefulness is determined by high availability, speed of execution and accuracy. This makes it an essential test for serious injuries where immediate damage assessment is essential. It is also used on a large scale, among others in oncology or surgery. Safety is also a big advantage, which is extremely important, there are no absolute contraindications tomography [3].

The tomography consists of a table on which the patient is lying and a gantry, i.e. the actual device. The device contains one or more X-ray tubes, so the principle of imaging is identical to that in the X-ray image. The lamps rotate at high speed around the patient and at the same time move along the body to cover the entire area being examined, during their movement they take many X-ray pictures in different planes and at different angles, so many sections and layered images are created. Different tissues strongly weaken radiation, e.g. bones - very much, but only minimal air [3,4,5].

On the basis of the measurements of this weakening, the computer creates images of cross sections of the patient's body, showing with high accuracy the body's tissues and organ structures. Then, an advanced computer program compares these photos with each other, sums them up, and thanks to the fact that it has many sections, it is possible to create an accurate picture of each layer of the examined person. Tomography enables the assessment of anatomical structures and possible their abnormalities in the human body, currently the best devices have a resolving power of up to 1 mm [5,6].

The examination is facilitated by a special tomography console, which takes over control of the machine. After entering information about the examined anatomical area, it processes it in such a way as to obtain the most accurate images possible. Of course, it is necessary to supervise the operation of the machine. As in any digital technique, in computed tomography it is possible to enlarge and divide the image as well as to perform its secondary reconstruction. The latest software also enables image reconstruction in other planes, and even in three-dimensional images [6,7,8].

Thanks to the most advanced devices, it is possible to study the inside of cavities and the lumen of organs as it happens in a virtual one bronchoscopy or virtual colonoscopy. The resulting images are assessed by a doctor radiologist and the result is in the form of a description. During one CT examination, the radiation dose to which the patient is exposed is many times higher than in the case of a traditional X-ray image. For example, during a chest X-ray the dose is about 0.02 mSv, and during KT it is from 2 to 8 mSv, so the radiation dose is even four hundred times higher. For comparison, during the lifetime we consume a dose of 170 mSv, it comes from cosmic rays and everyday devices [9, 10].

Computed tomography is always performed at the request of a doctor who knows whether the examination will be more beneficial in a given disease than ultrasound, whether magnetic resonance imaging. In emergency mode, indications are primarily serious injuries: head, chest, abdominal cavity and pelvis. Depending on the extent of the injury and indications, each area may be examined individually. In the most severe injuries, a simultaneous examination of the head, chest, abdomen and pelvis is used - it is the so-called "trauma scan", thanks to which it is possible to quickly assess all the injuries suffered by the patient and implement appropriate treatment [11, 12].

The indications for the CT also include:

- suspicion of cranial bleeding,
- before execution lumbar puncture,
- suspicion brain tumor,
- birth defects central nervous system and assessment of the anatomy of the central nervous system structures,
- degenerative disease of the spine,
- diseases of the bones of the skull, sinuses, nasal cavities, pharynx and larynx,
- lung diseases: e.g. lung cancer, lung abscess, sarcoidosis, lung infarction,
- pulmonary vascular disease, e.g. pulmonary embolism; when this disease is suspected, the so-called "angio-KT" is performed - tomography of the pulmonary arteries with contrast,
- heart diseases, pericardium and large vessels: cardiomyopathy heart defects heart tumors aortic aneurysms,

- tumors in the abdominal cavity: liver cancer, pancreatic cancer, gallbladder cancer, kidney cancer or cancer spleen. Thanks to this test, it is possible to assess the advancement of the tumor - is it limited to the primary organ only, whether there are metastases in the lymph nodes or other organs,
- inflammation of the pancreas and its complications,
- kidney diseases: inflammation, tumors, hydronephrosis narrowing of the kidney arteries
- tumors of the reproductive organs and bladder cancer [1,3,13].

This test is also used quite often before surgery in order to plan it - verify the extent and assess anatomical structures. The computed tomography technique also allows its use in the so-called interventional studies, e.g. in biopsy under the control of CT (puncture and removal of a small part of a specific organ for histopathological examination), puncture or abscess drainage [3,8,14].

There is no need to undress for the tomography, but it is necessary to remove all metal objects (earrings, buckles, watches), including getting rid of the phone and wallet, as they significantly distort the image [5,8,12].

During the tomography, the subject lies motionless on a narrow, sliding table and gradually moves into the tunnel. The person conducting the test instructs on how to behave, e.g. about breathing, and at key moments it is recommended to hold the breath. Following the recommendations shortens the examination, and the images obtained then are of much better quality. For this purpose, most of the devices are equipped with an intercom, i.e. a simple method of voice communication between the patient and the examiner, or with LEDs that light up when the patient should hold his breath [1,6,14].

During the examination, the subject can also be in constant contact with the examiner, it is necessary in the event of disturbing symptoms. Anything you are concerned about should be reported immediately: sudden discomfort (e.g. feeling claustrophobic), any symptoms following intravenous contrast (dyspnoea, nausea swelling of the face). Tomography usually lasts from several to several dozen minutes, depending on the extent of the area under examination. However, it is worth booking more time, because, depending on the area and the type of research, the stay in the laboratory may last from half to over 3 hours [8,9,11].

There are no contraindications for driving a car after the tomography, unless sedatives or general anesthesia were used during it. The result of the outpatient examination is issued after a few days, if it is an examination as part of a hospital stay, much faster. The description should be shown to the referring physician and he or she will interpret it properly. It should be remembered that after the examination with the use of contrast, one should spend several dozen minutes under the supervision of the personnel to make sure that it did not cause any serious side effects [5,7,9].

The tomography itself is painless, safe and carries no risks associated with the examination. Concerns about exposure to radiation usually relate to concerns about carcinogenicity. As mentioned earlier, KT is not the only source of radiation, and the dose delivered by the tomography is small compared to the radiation we absorb from other sources. Therefore, it is believed that the dose adsorbed during the test is not harmful, all the more so that modern devices modify it so that the radiation is as low as possible [9, 10].

In addition, when conducting a study, it is necessary to follow the ALARA principle (as low as reasonably achievable), which says that the lowest dose that gives an appropriate image is used. Sometimes it is also possible to carry out HRCT (high-resolution tomography) or low-dose KT, which additionally reduce radiation exposure. Discomforts very rarely appear when a contrast test is performed and it may be the cause of complications. A common symptom that occurs after administration of a contrast agent is a feeling of warmth, which is normal and is not a cause for concern [8, 13].

However, the side effects include:

- edema,
- skin redness,
- rash,
- vomiting,
- weakness,
- dyspnea [2,5,14].

Each of them should be reported immediately, exceptionally, a drop in pressure or even an anaphylactic reaction may occur. Tomography can be performed at any age, but it should not be done in pregnant women as it may cause birth defects in the baby. Performing the test in women in the second half should be avoided monthly with the possibility of becoming pregnant [3, 6].

Contrast tomography is based on exactly the same methods already described, with the difference that a contrast agent (commonly called contrast). Contrast is a substance based on compounds iodine(ionic or non-ionic), relatively neutral to the organism. Contrast very strongly, practically completely weakens X-rays, thanks to which the structures filled with contrast are bright and a very precise analysis of the area is possible. The contrast agent can be administered intravenously, orally, and rectally, depending on the structures to be assessed. In the case of the gastrointestinal tract, it is administered orally or rectally, and in the assessment of the vascular system - intravenously [8, 12].

A precise amount of contrast is injected into the vessel with an automatic syringe when the subject is lying in the gantra, then after a predetermined time, the test is performed so that at the time of the test, the maximum amount of contrast is in the vessel to be imaged [2,9 14].

Contrast is removed from the gastrointestinal tract unchanged, it is not absorbed from the intestines, with blood while they remove it kidneys therefore their function should be checked by measuring the concentration before such a test creatinine in the blood [8, 13].

References

1. Abbara S., Chow BJ, Pena AJ, Cury RC, Hoffman U., Nieman K., Brady TJ: Assessment of left ventricular function with 16- and 64-slice multi-detector computed tomography. *Eur. J. Radiol.* 2008, 67, 3, 481.
2. Agatston AS, Janowitz WR, Hildner FJ, Zusmer NR, Viamonte M. Jr., Detrano R. : Quantification of coronary artery calcium using ultrafast computed tomography. *J. Am. Coll. Cardiol.* 1990, 15, 4, 827.
3. Becker CR, Kleffel T., Crispin A., Knez A., Young J., Schoepf UJ, Haberl R., Reiser MF: Coronary artery calcium measurement: agreement of multirow detector and electron beam CT. *Am. J. Roentgenol.* 2001, 176, 5, 1295.
4. Budoff MJ, Dowe D., Jollis JG, Gitter M., Sutherland J., Halamert E., Scherer M., Bellinger R., Martin A., Benton R., Delago A., Min JK: Diagnostic performance of 64-multidetector row coronary computed tomographic angiography for evaluation of coronary artery stenosis in individuals without known coronary artery disease: results from the prospective multicenter ACCURACY (Assessment by Coronary Computed Tomographic Angiography of Individuals Undergoing Invasive Coronary Angiography) trial. *J. Am. Coll. Cardiol.* 2008, 52, 21, 1724.
5. Budoff MJ, Georgiou D., Brody A., Agatston AS, Kennedy J., Wolfkiel C., Stanford W., Shields P., Lewis RJ, Janowitz WR, Rich S., Brundage BH: Ultrafast computed tomography as a diagnostic modality in the detection of coronary artery disease: a multicenter study. *Circulation* 1996, 93, 5, 898.
6. Callister TQ, Cooil B., Raya SP, Lippolis NJ, Russo DJ, Raggi P. : Coronary artery disease: improved reproducibility of calcium scoring with an electron beam CT volumetric method. *Radiology* 1998, 208, 3, 807.
7. Girard SE, Miller FA Jr., Orszulak TA, Mullany CJ, Montgomery S., Edwards WP, Tazelaar HD, Malaouf JF, Tajik AJ: Reoperation for prosthetic aortic valve obstruction in the era of echocardiography: trends in diagnostic testing and comparison with surgical findings. *J. Am. Coll. Cardiol.* 2001, 37, 2, 579.
8. Min JK, Shaw LJ, Devereux RB, Okin PM, Weinsaft JW, Russo DJ, Lippolis NJ, Berman DS, Callister TQ: Prognostic value of multidetector coronary computed tomographic angiography for prediction of all-cause mortality. *J. Am. Coll. Cardiol.* 2007, 50, 12, 1161.
9. le Polain de Waroux JB, Pouleur AC, Goffinet C., Pasquet A., Vanoverschelde JL, Gerber BL: Combined coronary and late-enhanced multidetector-computed tomography for delineation of the etiology of left ventricular dysfunction: comparison with coronary angiography and contrast-enhanced cardiac magnetic resonance imaging. *Eur Heart J.* 2008, 29, 2, 2544.
10. Sarno G., Decramer I., Vanhoenacker PK, De Bruyne B., Hamilos M., Cuisset T., Wyffels E., Bartunek J., Heyndrickx GR, Wijns W. : On the inappropriateness of noninvasive multidetector computed tomography coronary angiography to trigger coronary revascularization: a comparison with invasive angiography. *J. Am. Coll. Cardiol. Interv.* 2009, 2, 6, 558

11. Sheth T., Dodd JD, Hoffmann U., Abbara S., Finn A., Gold HK, Brady TJ, Cury RC: Coronary stent assessability by 64 slice multi-detector computed tomography. *Catheter Cardiovasc. Interv.* 2007, 69, 7, 933.
12. Stary HC, Chandler AB, Dinsmore RE, Fuster V., Glagov S., Insull W. Jr., Rosenfeld ME, Schwartz CJ, Wagner WD, Wissler RW: A definition of advanced types of atherosclerotic lesions and a histological classification of atherosclerosis. A report from the Committee on Vascular Lesions of the Council on Atherosclerosis, American Heart Association. *Circulation* 1995, 92, 5, 1355.
13. Stein PD, Yaekoub AY, Matta F., Sostmann HD: 64-slice CT for diagnosis of coronary artery disease: a systematic review. *Am. J. Med.* 2008, 121, 8, 715.
14. Wilson PW, D'Agostino RB, Levy D., Belanger AM, Silbershatz H., Kannel WB: Prediction of coronary heart disease using risk factor categories. *Circulation* 1998, 97, 18, 1837.