Diagnostic value of computed tomography and magnetic resonance in selected disease states

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Abstract

The aim of this study is to assess the diagnostic value of computed tomography and magnetic resonance imaging (on the example of the diagnosis of such diseases as stroke, ischemic heart disease, pancreatic cancer, Crohn's disease). Computed tomography and magnetic resonance imaging are imaging methods that are developing dynamically. These methods are widely used in medical diagnostics, they enable the examination of organs and systems such as: brain, heart, vascular system and abdominal organs, movement organ, retroperitoneal space, pelvis, mediastinum. Modern imaging methods can be successfully used in conditions such as stroke, in which magnetic resonance diffusion may be the most important diagnostic. MRI and CT are important in diagnosing and assessing the progress of coronary heart disease. MRI sensitivity with a load in diagnosing this disease is estimated at 79–88%, while CT for coronary arteries is 95–99%. These studies are also used, among others in the diagnosis of pancreatic cancer (MRI sensitivity 96%, CT 93.5%), Crohn's disease (CT and MRI sensitivity> 90%). In all the conditions discussed, computed tomography and magnetic resonance imaging have a high diagnostic value.

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Introduction

Imaging tests are one of the basic departments of medical diagnostics. Over the past few decades there has been very great progress in the development and dissemination of diagnostic methods such as MRI or CT. Wide access to achievements in the field of automation and computer science has caused a change in the supply and organization of the work of radiology facilities. Today, radiology uses not only ionizing radiation, but also the phenomenon of magnetic resonance imaging and ultrasound. It focuse primarily on assessing human body structure, tracking the course of treatments and observing physiological phenomena [1]. Currently, the universality of specific imaging methods is affected by the amount of assessment of

their effectiveness. In the assessment of effectiveness, criteria such as recognition efficiency, i.e. sensitivity (ability to detect the disease) and specificity (ability to confirm the absence of the disease), quality of the result, diagnostic and therapeutic significance, examination costs, cost-effectiveness ratio are used [2].

The use of computed tomography in radiological diagnostics

The initiation of computed tomography (TK) led to a breakthrough in radiological diagnostics. Particularly the introduction of spiral computed tomography and the use of a multi-row detector system increased its clinical significance. Spiral computed tomography with a multi-row array of detectors has a greater potential for tissue differentiation than other radiological tests. During the test, as a result of the rotation of the X-ray tube along the examined person, the reading is collected from many sides (obtaining a picture of many layers). Using computed tomography, it is possible to visualize: calcifications in the walls of vessels, organs surrounded by adipose tissue, tumors, fluid reservoirs, organs in the arterial, parenchymal, venous phase [3]. Nowadays, the use of multi-row tomography makes it possible to obtain an image of body cross-sections in all anatomical planes [4]. Thanks to the properties of computed tomography, the subject of research can be: the brain, organs located in the abdomen (also the vascular and digestive system), chest, bone structures [5].

Magnetic resonance imaging in radiological diagnostics

The phenomenon of nuclear magnetic resonance imaging was discovered in 1946 by research teams led by Bloch and Purcell. In 1972 the first imaging technique (FONAR) was developed and five years later the first cross-section of the human wrist was obtained. Magnetic quantum properties of atomic nuclei are used in this diagnostic method [6]. Magnetic resonance imaging has found wide application (biological sciences, medicine, pharmacy). Currently, in medical practice, it is used for anatomical assessment of soft tissues, helps to determine the intensity of metabolic processes and indicates the occurrence of organ dysfunction. The first indications for MRI are: developmental defects, tumors, degenerative changes, inflammatory processes, ischemic foci. Most frequently, organs and systems are examined: central nervous system, heart and vascular system, abdominal organs, retroperitoneal space and pelvis, locomotor system, mammary gland and mediastinum. Magnetic resonance imaging studies are considered safe. The use of this diagnostic method for 30 years has not confirmed its harmfulness [7].

Diagnostic value of magnetic resonance imaging and computed tomography in the diagnosis and differentiation of strokes

Despite the development of various modern imaging methods in the diagnosis and differentiation of strokes, computed tomography (CT) is still the most popular method . The arguments for the wide use of this method are: low costs, speed, accuracy and satisfactory results compared to other imaging methods. In some situations, the test may be negative, despite the appearance of symptoms that indicate a stroke [8]. Complementing CT is a dynamic test after intravenous contrast agent administration (CT perfusion). In this method it is possible to assess the distribution of the contrast agent, which allows to determine the location of acute ischemic foci. The changes are visible just a few minutes after the ischemic incident. In the diagnosis of stroke, MRI and magnetic resonance imaging methods such as magnetic resonance angiography (MRA) and magnetic resonance diffusion (DWI) imaging are also useful. MRI helps to get a picture of diffusion and perfusion, which is why it is useful in differentiating stroke types. MRA is most

commonly used to assess the condition of the carotid and intracranial arteries. DWI is a useful method in diagnosing stroke in the first hours of its duration [9]. It is a very sensitive method that allows detection of small ischemic foci in the initial period of their occurrence. According to a meta-analysis from 2019, CT perfusion is the most accurate in diagnosing stroke using computed tomography. Among the MRI imaging methods, DWI has the highest diagnostic value, which also has the highest diagnostic value among all the imaging methods discussed above [8].

Diagnostic value of CT and MRI in the diagnosis of ischemic heart disease

Standard coronary angiography is currently the test of choice for the diagnosis of coronary artery disease [10]. Coronarography is an invasive test that carries the risk of complications such as heart attack, kidney damage as a result of contrast, vascular injury, bleeding, and death [11]. In the diagnosis of coronary artery disease, modern non-invasive tests with high diagnostic value and fewer complications are also used. Such diagnostic methods include, e.g. magnetic resonance imaging of the heart with load (dobutamine or vasoconstrictor drug) and multi-row computed tomography of coronary arteries. MRI with load induced dobutamine is an imaging method used to assess abnormalities in myocardial contractions due to ischemia. MRI sensitivity in dobutamine load is 79–88%, and specificity 81–91%. Adenosine is the more commonly used pharmacological load agent. Adenosine loading test is used to assess myocardial blood supply. Magnetic resonance imaging of the heart is a test useful in assessing myocardial viability. MRI scans identify areas of myocardial necrosis. No-load imaging method is coronary artery multi-row computed tomography [12]. In the diagnosis of myocardial ischemia, the degree of coronary artery calcification is assessed. This study is associated with a low radiation dose of 1–2 mSv. The absence of calcifications in the study indicates a low probability of significant stenoses in the coronary arteries [10]. Patients who do not have coronary artery calcifications have a low risk of dying from cardiac diseases, which is estimated at 0.3% annually [13]. In patients with moderate or high levels of calcification, the test allows determining the level of risk and taking action to modify the risk factors for coronary heart disease. A very high degree of coronary artery calcification suggests severe coronary artery disease [14]. CT scan of coronary arteries is highly sensitive (95–99%) with slightly lower specificity (64–83%) [8].

Diagnostic value of computed tomography and magnetic resonance imaging in diagnosing pancreatic cancer

Imaging tests are very important in the diagnosis of oncological diseases. They help detect cancer, differentiate tumors between benign and malignant, and help determine the stage of cancer. The use of imaging tests in screening allows the detection of neoplastic changes at early stages. Computed tomography is not only used to assess the tumor, but can also be a review (metastasis detection, monitoring response to therapies) [15]. CT scan is the test of choice for diagnosing pancreatic cancers. The second method of choice is magnetic resonance cholangiopancreatography, which is used in the case of ambiguous CT results. Both studies are highly sensitive, up to 96% and 93.5%, respectively. CT scan is more accurate in assessing tumor resection compared to MR, it is 86.8% to 78.9%, respectively. New MRI methods such as DWI may be useful in detecting pathological changes within the pancreas. It is possible to use them in the diagnosis of not only small tumor lesions, but also extensive pancreatitis [16].

Diagnostic value of computed tomography and magnetic resonance imaging in diagnosing Crohn's disease

In the treatment of a patient with Crohn's disease (CD), it is necessary to evaluate inflammatory

changes using imaging techniques. It is necessary to determine the extent and location of lesions in order to plan further treatment. Radiological imaging methods can also be useful in detecting disease complications such as fistulas, abscesses, and stenoses. In recent years attention has been paid to the inaccuracy of normal clinical evaluation. Some patients with symptoms of exacerbation of the disease based on endoscopic, radiological and laboratory tests have no evidence of active Crohn's disease. It was shown that 18% of patients did not have ulcerative lesions at endoscopic examination.

In recent years, CT and MRI examinations have been used more and more often in the assessment of changes in the course of CD [17]. In the MRI at the initial stage of the disease, such changes as increased thickness, flattening and deformation of mucosal folds, ulceration over Peyer's patches, mucosal tuberosity are visible. Computed tomography may show changes in the intestines: thickening of the intestinal wall, fibrous-fatty hyperplasia, abscesses and fistulas, enlarged lymph nodes, narrowing of the intestinal lumen, wall congestion [18]. Research techniques like colonoscopy cannot show characteristic changes for CD like transmural inflammation. The specificity of cross-sectional tests allows to assess the condition of the intestinal wall, adjacent organs, mesentery and retroperitoneal space, which is why these tests are very important to determine the occurrence of disease complications. Techniques like MRI or CT in the diagnosis and assessment of the course of Crohn's disease have high diagnostic value. MRI is highly accurate (93% sensitivity, 90% specificity), computed tomography has a similar value. In diagnosing stenoses, fistulas and abscesses, their diagnostic ability is also high and amounts to >80%. The preferred test for safety should be magnetic resonance imaging (especially in young patients) due to lack of radiation [17].

Summary

Computed tomography and magnetic resonance imaging are diagnostic methods with a high diagnostic value and sensitivity of up to 95% in the diagnosis of certain disease entities. High efficiency in relation to price is noticeable especially in the case of computed tomography, which is the gold standard in the diagnosis of many disorders. The dynamic development of CT and MRI in recent decades has had an impact on ensuring the significant position of these tests in medical diagnostics [1].

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