MAGNETIC RESONANCE IMAGING IN NEUROLOGICAL DISORDERS

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Resume. Cerebral glial tumors remain a significant issue in contemporary medicine, despite considerable breakthroughs in oncology and neurosurgery. Cerebral gliomas make up approximately 40-45% of all glial tumors. These tumors are typically diagnosed in individuals aged 30-60, affecting the most able-bodied segment of the population. Glial tumors typically originate from astrocytic or oligodendrocytes cell populations and are characterized by a high growth rate, invasiveness, early metastatic ability, high rate of recurrence and an unfavourable prognosis. Invasive growth with no distinct macroscopic border between the tumor and normal brain tissue is a characteristic feature of glial brain tumors. This type of growth is typical of fast-growing, highly malignant gliomas such as anaplastic astrocytomas and glioblastomas. An unfavorable outcome is typical of anaplastic gliomas. Highly informative methods of radiation research can be used to image the brain, estimate the size, shape, and structure of neoplasms, determine their position in the brain, identify the presence and prevalence of edema, and assess the areas and degree of brain tissue damage

Keywords: cerebral tumors; brain tumors; neurooncology; neurosurgery, neurovisualization.

МАГНИТНО-РЕЗОНАНСНОЕ ЗОНДИРОВАНИЕ ПРИ НЕВРОЛОГИЧЕСКИХ ЗАБОЛЕВАНИЯХ

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Резюме. Глиальные опухоли головного мозга остаются актуальной проблемой современной медицины, несмотря на значительные достижения в онкологии и нейрохирургии. Глиомы головного мозга составляют примерно 40-45% всех глиальных опухолей. Эти опухоли обычно диагностируются у людей в возрасте 30-60 лет, поражая наиболее трудоспособную часть населения. Глиальные опухоли обычно образуются из популяций астроцитов или олигодендроцитов и характеризуются высокой скоростью роста, инвазивностью, способностью к раннему метастазированию, высокой частотой рецидивов и неблагоприятным прогнозом. Инвазивный рост без четкой макроскопической границы между опухолью и нормальной тканью головного мозга является характерной чертой глиальных опухолей головного мозга. Этот тип роста характерен для быстрорастущих, высокозлокачественных глиом, таких как анапластические астроцитомы и глиобластомы. Неблагоприятный исход характерен для анапластических глиом. Высокоинформативные методы лучевого исследования могут быть использованы для получения изображения головного мозга, оценки размера, формы и структуры новообразований, определения их расположения в головном мозге, выявления наличия и распространенности отека, а также оценки областей и степени повреждения мозговой ткани

Ключевые слова: опухоли головного мозга; нейроонкология; нейрохирургия; нейровизуализация.

Intraduction. Gliomas are the most common type of central nervous system neoplasm, accounting for approximately 40 45% of all intracranial tumors. To ensure consistent treatment and accurate prognosis, clinical classification of glial neoplasms is based on tumor localization, histogenesis, and activity. The principle of localization involves categorising tumors into groups based on their origin within specific brain structures and their spread throughout the brain[1,3]. Epidemiologic studies tentatively report that gliomas affect different parts of the brain (GM) in

adult patients as follows: hemispheres of the large brain - 70% (including frontal lobe - up to 19%, temporal lobe - up to 13%, parietal lobe - up to 9%, occipital lobe - up to 2%, combination of lesions of different lobes - about 28%); corpus callosum - 5%; subcortical ganglia - 6%; brain ventricles - 7%; optic nerves and chiasma - 1-1. 5%; brainstem - 6%; cerebellum - 4-4.5%. Gliomas are a type of tumor that can affect individuals of all ages, but are more commonly found in patients between the ages of 30 and 60. Men are at a higher risk of developing gliomas than women, with a ratio of 1.5:1. Additionally, the elderly are at a higher risk compared to the young, with a ratio of 3.2:1 [2,4]. A pathomorphological classification of gliomas has been created based on the initial histological type of the precursor cell of the tumor clone. This classification involves several categories, including astrocytic tumors, oligodendroglial tumors, oligoastrocytic tumors, ependymal tumors, chorioid plexus tumors, other neuroepithelial tumors, neuronal and mixed neuronal-glial tumors, pineal gland tumors, and embryonal tumors. Unlike the classification of glial neoplasms based on their localization, which is mainly intended to optimize surgical treatment tactics, the pathomorphological classification is of primary importance for selecting chemotherapy, determining the prognosis of the disease, and conducting basic research in neuro oncology [6,7]. Approximately 70% of primary brain tumors are gliomas, with over half being highly malignant (G grade III-IV according to the WHO classification) at the time of diagnosis. The degree of malignancy is determined by histologic examination methods. According to the World Health Organization (WHO), glial tumors are classified based on the activity of the tumor process, specifically the degree of malignancy. This classification system involves four degrees, with the fourth degree being the most active and consisting of fast growing, low-differentiated or undifferentiated, malignant tumors (e.g.,). The text describes different types of gliomas, including grade II and III gliomas, which are characterized by rapid growth and invasion, and grade I gliomas, which grow slowly and have a high degree of tumor cell differentiation. Nodular type of growth with more or less clearly delineated border and insignificant infiltration occurs much less frequently, most often in conditionally benign gliomas (I-II degree according to WHO classification), which have a more favorable prognosis of treatment. Clinical manifestations of glial brain tumors are represented by a variety of general cerebral and focal organic symptoms of varying severity according to the localization and volume of the neoplasm, syndromes of intracranial hypertension, hydrocephalus (in case of occlusion of liquor passages) and, in advanced cases, dislocation syndrome. Pathognomonic symptoms are usually absent[8,9]. At early stages of development, the tumor may manifest with single signs (dizziness, epileptic seizures, sensory disturbances, etc.), which often does not allow to establish either a topical diagnosis or to determine the hyperplastic nature of the pathological process. In a number of cases, the diagnosis of brain tumor is an incidental finding on CT or MRI when the patient is examined by a neurologist in connection with certain complaints. High invasive activity and metastatic potential of gliomas have been most clearly demonstrated in a number of clinical studies [11,15], which revealed an unusual increase in the incidence of distant foci of neoplasm growth with improved treatment results of the primary tumor node area (maximal complete cytoreduction, aggressive radiation and chemotherapy). Magnetic resonance angiography, magnetic resonance spectroscopy, functional magnetic resonance imaging, single photon emission computed tomography, multispiral computed tomography, multispiral computed tomography angiography, positron emission computed tomography can provide the necessary additional information in complex diagnostics [20,22]. For a long time computed tomography (CT) remained the only method of diagnostics of intramedullary volumetric brain masses, and detection of glial brain tumors according to CT data is performed by indirect signs, which, first of all, include structural disorders: deformation, tissue displacement, edema. MSCT method allows convincingly distinguishing neuroepithelial tumors among volumetric intramedullary brain formations. X ray contrast preparations provide additional information about the structure and features of the pathological focus, relationships with surrounding tissues, character of vascularization. The use of contrast agents in the diagnosis and localization of

gliomas is of great importance in case of diffuse growth of the formation [3]. However, according to a number of authors, some voluminous glial masses with diffuse growth do not accumulate contrast agent or accumulate it in insufficient quantity for visualization [18,19]. Although increased perfusion is usually associated with the process of neoangiogenesis in the tumor, some authors believe that it may also indicate the appearance of hypervascularized areas - regeneration of microcirculatory vessels, which reduces the severity of hypoxic phenomena and improves drug delivery to tumors. The study of R. Mangla et al. showed that the perfusion status of postoperative cavity walls on MRI after chemoradiation treatment can be a significant predictor of the time of progression in patients with malignant brain tumors. The researchers hypothesized that MR perfusion data may serve as a prognostic biomarker for subsequent chemotherapy and identify individuals who are more likely to respond to its use. An area with increased perfusion possibly indicates increased delivery of chemotherapy, whereas decreased perfusion impedes delivery of therapeutic agents, severely reducing the efficacy of chemotherapy. This view has been supported by recent clinical trials reporting that combination therapy that provides vascular regeneration is associated with favorable outcome in tumor lesions of the head and neck as well as in metastatic colorectal, renal, and lung cancer [13,17]. Another known problem in evaluating the results of therapy of malignant gliomas, which requires additional examination, is pseudoprogression, which is observed in 20 30% of patients who received chemoradiation therapy. The appearance and enlargement of areas of pathologic contrast enhancement in the marginal zone of the postoperative defect after combined treatment are visually noted during 3 months of follow-up [19,22]. The interval of the first 12 weeks after completion of radiation therapy is also recommended by the leading neuro-oncology working group RANO, which also studied this issue. The phenomenone of pseudoprogression is caused by radiation induced endothelial damage, vascular dilatation and fibrinoid necrosis, and inflammatory changes of the GEB. Although its pathophysiology is still unclear, chemical exposure is thought to induce a transient local inflammatory response, edema, and increased vascular permeability, which is manifested by increased signal on postcontrast images [21,23]. Accurate differentiation between pseudoprogression and continued growth is crucial to make informed treatment decisions. When perfusion imaging was used, true progression showed a higher maximum CBV than pseudoprogression, which was confirmed by radiologic and clinical data in several studies (sensitivity and specificity 81.5 and 77.8%, respectively) [20]. A promising direction of studying MR-perfusion technique is it use as predictors of survival after completion of chemoradiation treatment. A number of studies have shown that the increase in maximal cerebral blood flow using such an index as normalized blood flow between initial and follow-up images was a better prognostic factor for a shorter progression-free period ($p=0.01$) than the increase in tumor diameter ($p=0.049$) [20]. At one-month post-radiation therapy, R. Mangla et al. found that increased nBV was predictive of poor one-year overall survival (sensitivity 90% and specificity 69%), while tumor size did not provide this information. Nevertheless, the results of the mentioned works were mixed, as another study showed that perfusion imaging was inferior in predicting survival, whereas tumor size determined by T1- and T2-weighted imaging had prognostic value. Some authors have shown that 25% of patients with recurrent glioblastomas treated with sediranib exhibit increased perfusion, and these patients had higher progression-free and overall survival than patients with stable or decreased perfusion. This was confirmed in patients with newly diagnosed glioblastomas whose treatment consisted of radiation therapy, temozolomide, and sediranib. Patients with increased perfusion had longer median overall survival than patients with decreased perfusion (overall survival 504 days vs. 321 days). In particular, the problem of differential diagnosis of gliomas according to the degree of malignancy by means of MRI with KU remains unsolved. Such a direction of radiation diagnostics as magnetic resonance spectroscopy (MRS), which allows quantitative assessment of a number of biochemical parameters characterizing volumetric formations and the state of GM tissues, continues to develop [3,7]. With the development of MRS, an additional possibility of

metabolic studies with determination of the level of some tissue metabolites, such as choline, N-acetylaspartate, creatinine, etc., appeared. According to some authors, choline concentration is the main indicator that should be relied on in the diagnosis of tumors. Increased choline levels are characteristic of gliomas of II and III degrees of malignancy and, on the contrary, in gliomas of IV degree of malignancy may decrease [5,6]. The experience of using contrast-enhanced MRI has shown that the level of contrast agent accumulation in tumor tissue depends on a number of parameters, such as the state of neoplasm microcirculation, the degree of HEB disruption, the volume of intercellular space in the tumor and therefore does not always accurately reflect the nature of the lesion [22]. Treatment tactics in radiation necrosis and in continued growth of neoplasms differ radically. At the same time, the presence of altered or damaged tissues in the investigated postoperative zone, detected at MRI with KU, can serve as a source of false-positive diagnostics in the identification of continued tumor growth.

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