Abstract. The article presents an analysis on the modern aspects of diagnosis and surgical treatment of cavernous malformations of the brain. The modern approaches to surgical treatment depending on the type of clinical course of cavernous angiomas you can see in this paper.

Keywords: cavernous malformations, neurological symptoms, surgical treatment.

Relevance. Cavernous malformations occupy a special place among CNS vascular malformations, and at present, some aspects of this problem are poorly
understood. Taking into account the fact that cavernomas are benign by nature, determining the indications for surgery is a rather difficult task [1]. Many aspects of CM remain controversial. Depending on the localization of the pathological focus, there are different points of view on the pathogenesis (their blood supply, growth and clinical course), the information content of various diagnostic methods, as well as the tactics of surgical treatment. Surgical removal of the cavernoma has proven to be an effective treatment for eliminating the risk of hemorrhage and, in many cases, significantly alleviating the course of epilepsy. However, the experience of various clinics has shown that surgery, especially for cavernomas located in functionally important areas, can be associated with the development of severe complications [5]. At the moment, there are no clear indications for surgical treatment of the cerebral cavernous. The attitude towards the necessity and possibility of surgical treatment of cavities is largely determined by the experience of a particular clinic. In this regard, the analysis of the results of surgical treatment of the cerebral cavities and the assessment of the role of various factors affecting treatment outcomes are a prerequisite for improving the quality of treatment of patients and determining the objectives of further research.

According to current data, cavernous malformations (CM) account for 5-13% of vascular malformations in the brain [8,10] and occur in approximately 0.5% of the population [11]. The main clinical manifestations of symptomatic cerebral supratentorial cavernous angiomas (CAs) are epileptic seizures (79%) and hemorrhages (16%), with symptoms most often developing in patients aged 30-50 years [13]. Cavernomas can cause rare seizures that respond well to antiepileptic conservative therapy and cause severe drug-resistant epilepsy [3]. Pharmacoresistant epilepsy due to supratentorial CA accounts for approximately 4% of all pharmacoresistant partial epilepsies [3].

In cases of symptomatic CM, their clinical manifestations are extremely diverse: epileptic seizures, intracerebral or subarachnoid hemorrhages, with focal neurological symptoms, occlusive hydrocephalus [6]. Currently, there is no final opinion on the causes of the varied course of cerebral coronary artery disease.
Despite modern research methods, the diagnosis of cerebral coronary artery presents certain difficulties. Focal changes detected by CT or MRI studies are often assessed as an intracerebral tumor-glioma, and in cases of a deep location of a mass with a projection onto subcortical nodes, the "tumor" is recognized as inoperable. Therefore, the issue of the possibility of improving the diagnosis of coronary artery disease, revealing the pathognomonic signs of this defect is widely discussed.

**Purpose of the work:** on the basis of a comprehensive study of the clinical course of CM of the brain, determining the value of various diagnostic methods, to give recommendations for improving their detection, solving the issue of surgical tactics and managing patients with this pathology.

To propose a differentiated treatment strategy for patients with cavernous malformations based on clinical features.

**Work tasks:**
1. To improve the methodology of a comprehensive examination of patients with suspected CM.
2. To determine the tactics and technique of angiographic, CT and MRI examination of patients with CA.
3. Clarify the specifics of the CM clinic and determine the informative significance of individual research methods in the structure of a modern neurosurgical diagnostic complex.
4. On the basis of an integrated approach and the results of surgical treatment of patients with CM of the brain, develop recommendations on the tactics of surgical intervention.
5. To highlight the main types of clinical course of BM and to offer differentiated tactics of their surgical treatment.

**Materials and methods.** The work is based on the analysis of 176 patients with CM of the brain who underwent a comprehensive examination and operated at the Republican Scientific and Practical Center for Neurology and Neurosurgery from 2011 to 2018, inclusive. In all cases, the diagnosis of BM was verified histologically. Among the patients there were 105 men (59.7%) and 71 women.
(40.3%) aged 18 to 65 years. Of these, 122 patients (69.3%) had the lesion size from 10 to 20 mm, in 54 (30.7%) - more than 20 mm.

All patients were examined according to the generally accepted scheme. The diagnostic neurosurgical complex included clinical, laboratory, electroencephalographic, ophthalmological examinations, hypertension or SKT-AG, SKT, MRI. At the same time, hypertension examination of cerebral vessels was performed in 34 patients. The volume of the angiographic study was determined depending on the clinical manifestations. CT examination was performed in 49 patients with cerebral cavernomas. At the same time, in almost all cases, the study was carried out both without amplification, and with the help of contrasting by injecting a contrast agent intravenously. In 163 patients, an MRI study was performed in the T1 and T2 modes.

Analysis of CT, MRI, AH and gamma-topography of the brain showed that none of the above studies, taken separately, is capable of revealing pathognomonic signs of a cavernoma, which would make it possible to diagnose cavernous angioma with confidence. At the same time, their detectability as a volumetric formation is high in cases of using CT or MRI.

According to our data, AH examination in 26% of cases reveals only indirect signs of a mass formation in the form of a displacement of great vessels or venous collectors, in 79% angiography does not reveal either vascular pathology or signs of a volumetric process of the brain, in 9% angiograms either small vascular a network, which is most often interpreted as a tumor network, or a conglomerate of vessels is contrasted by the type of arteriovenous malformations.

SCs on SCT were detected already on native images in the form of areas of inhomogeneous density. After contrast enhancement, the CM density usually did not increase. CMs on SCT had a rounded, somewhat angular shape and heterogeneous density with small spots of low density. In 12% of BM cases, according to the CT scan, calcifications were included.

154 patients were examined using MRI. In the T1 mode, CMs had a pronounced increased signal. In the T2 mode, there was no signal change. At the same time, there were no signs of hemorrhage, which have a special signal
characteristic of vascular malformations. If you suspect CM, you should not limit yourself to MRI research, since with this method CMs look more real due to the receipt of the same signal from both CM itself and from the medulla atrophically altered due to previous hemorrhages.

The analysis of this work allows us to propose performing SCT or MRI of the brain in all cases when the disease manifests itself as a clinic of subarachnoid hemorrhage, and the AH data do not reveal signs of cerebral vascular pathology. When making a differential diagnosis between BM and a tumor, one should pay attention to the fact that BM does not cause either perifocal cerebral edema (except for the acute period of hemorrhage) or displacement of the midline structures, even with large sizes of the pathological focus. The latter is probably due to the innate nature of the process and the adaptation of the medulla to it [6,7].

The surgeon should pay special attention to contrasting vascular conglomerate on angiograms, which indicates a more intense blood flow in the BM and the possibility of manifestations in the form of recurrent hemorrhages and significant bleeding during operations.

The clinical manifestations of CA are extremely diverse. Most often, the clinical picture of the disease was presented by epileptic seizures (64%), headaches of various nature (46%), pyramidal symptoms (29%). However, among such polymorphic symptoms, it is impossible to single out a separate symptom or syndrome that could be considered pathognomonic for a cavernoma. Based on the literature data [2,12] and our work, separate types of clinical course of CM were identified: epileptic, hemorrhagic, pseudotumorous, mixed and latent (asymptomatic).

In 72 (40.9%) patients, BM proceeded according to the epileptic type. In 63 (35.8%) patients, the main manifestation of cavernous angiomas was hemorrhage. The mixed type of cavernomas occurred in 41 (23.3%) patients.

The group with an epileptic type of BM course included patients in whom paroxysmal syndrome prevailed in the clinical picture of the disease, hemorrhages with hemorrhagic type of BM were manifested by hemorrhages, a mixed type of course meant a history of hemorrhages and epileptic seizures. It should be noted that hemorrhages often remain unverified and the diagnosis is established on the basis of
anamnestic data. A separate group consisted of patients with a latent BM course. Such malformations did not appear clinically, but were, as a rule, an accidental finding during MRI. Such patients were not included in the study group, as well as those with pseudotumorous course.

One of the topical issues in BM surgery is the choice of surgical treatment tactics. The tactics were determined by the clinical and radiological manifestations of BM and the localization of the malformation. The size of the formation did not affect the choice of surgical tactics. When choosing the tactics of surgical treatment, we used the classification proposed by R. Spetzler and N. Martii (1986), which distinguished functionally "sounding" areas of the brain. Functionally "sounding" areas of the brain were understood to be the areas in the defeat of which the development of neurological loss is most likely. These include the sensorimotor, speech and visual cortex, hypothalamus and thalamus, inner capsule, brain stem, legs and deep cerebellar nuclei. Areas of the brain that are less likely to develop neurological deficits (such as the pole of the temporal lobe and the cerebellar cortex) are conditionally designated as functionally "non-sound" zones.

A total of 176 (100%) patients with BM were operated on. All operations were performed using microinstrumentation and magnifying equipment (binocular optics, Leica operating microscope). In all 100% of observations, radical removal of cavities was performed.

Used conventional approaches to the above-mentioned parts of the brain. Osteoplastic trepanation in all cases was performed according to the standard technique. One of the morphological features of BM is the absence of the medulla in the structure of the malformation; therefore, manipulations on BM did not lead to significant brain injury. Access to the malformation is considered the most traumatic stage of the operation; therefore, sparing approaches with minimal encephalotomy were used. Out-of-projection approaches were widely used, in which encephalotomy was performed outside the functionally "sounding" zones or with minimal trauma. When BM was localized in the deep parts of the temporal lobe, access through the lateral cleft of the brain was used. A prerequisite was the use of microsurgical techniques. Taking into account that BM is supplied from small vessels of the capillary type and is not
connected with large vessels, when isolating them, it is necessary to preserve the arteries and veins that are located near the malformation, and often adjoin its wall.

Intraoperative ultrasound navigation was used in 98 (55.7%) cases to clarify the localization of deeply located BMs and to select the optimal approach, and intraoperative neuronavigation was used in 56 (31.2%) cases. In 84 (47.7%) patients, intraoperative electocorticography was performed to determine the localization of the focus of paroxysmal activity. The data obtained made it possible to clarify the location and type of the dura mater incision, the encephalotomy zone.

The indications for the removal of cavernous malformations in the epileptic type of course were:
1) focal epileptic seizures, reflecting lobar localization;
2) manifestation of an epileptic focus on the EEG, coinciding in localization with the location of the cavernoma;
3) frequent epileptic seizures resistant to anticonvulsant therapy.

Indications for removal of cavernous malformations in hemorrhagic flow were:
1) subarachnoid hemorrhage with the formation of an intracerebral hematoma, accompanied by dislocation symptoms;
2) a history of repeated hemorrhages;
3) deepening of neurological deficit;

Indications for removal of cavities in mixed flow were:
1) a history of repeated hemorrhages;
2) focal epileptic seizures reflecting lobar localization;
3) manifestation of an epileptic focus on the EEG, coinciding in localization with the location of the BM;
4) frequent epileptic seizures resistant to anticonvulsant therapy;
5) deepening of neurological deficit;

Results and its discussion:
1. For the diagnosis of BM, a comprehensive examination of the patient using CT, MRI and AH of the brain is necessary, since none of these studies, carried out separately, fully reveals the pathognomonic signs of cavernous malformations.
2. The absence of perifocal edema and displacement of the midline structures are important diagnostic signs of BM, in contrast to a tumor, during SCT examination. Computed tomography is used to detect calcifications.

3. In the structure of the diagnostic neurosurgical complex, MRI is the most informative method for diagnosing BM, the use of T1 and T2 modes allows to clarify the morphological features of malformations, and magnetic resonance angiography is necessary to exclude the shunting process.

4. Total removal of bone marrow allows to exclude the risk of hemorrhage, and removal of the altered medulla along the periphery of the malformation is necessary to prevent recurrence of epileptic syndrome in the postoperative period. The use of microsurgical techniques, optical magnification and intraoperative neurosonography can reduce trauma to the brain and great vessels, which makes it possible to remove cavernous malformations located in functionally "sounding" areas of the brain.

Conclusions. Surgical tactics for treating patients with cavernous malformations should be decided individually, taking into account the data of the clinical course of the disease, localization and data of X-ray research methods.

A complete diagnosis of cerebral cavernous malformations with a clear localization of the pathological process in combination with microsurgical techniques and auxiliary intraoperative techniques allows them to be removed without the appearance of additional gross neurological symptoms.

The main indications for surgical treatment of patients with various types of clinical course of CM of the brain were frequent epileptic seizures resistant to anticonvulsant therapy; parenchymal-subarachnoid hemorrhages, accompanied by dislocation symptoms; repeated hemorrhages; as well as aggravation of neurological deficits. BM located in functionally important structures of the brain require an individual approach to their removal.

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