MINISTRY OF HEALTH OF THE REPUBLIC OF UZBEKISTAN
CENTER FOR THE DEVELOPMENT OF MEDICAL EDUCATION
SAMARKAND STATE MEDICAL INSTITUTE
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MODERN DIAGNOSIS AND TREATMENT OF THE BRAIN ARTERIAL ANEURYSMS

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Educational and methodological manual for students of the V, VI courses of the pediatric, medical and medical-pedagogical faculties, residents of the magistracy and clinical residents of medical higher educational institutions

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Annotation. *The main theoretical and practical issues related to cerebral aneurysms are reflected. The anatomy of cerebral vessels, etiology, pathogenesis, clinic, diagnostics, differential diagnostics of cerebral aneurysms are covered in detail. Modern methods of diagnostics and surgical treatment are presented. At the end there are test questions, situational tasks and practical skills on this topic.*

Educational and methodological recommendations are intended for residents of the magistracy, clinical residents and senior students of medical universities.

The teaching Educational and methodological manual was reviewed and approved by the Academic Council of Samarkand State Medical University.
Protocol No. 9 "27" 04 2022 year.

Secretary of the Academic Council: Ochilov U.U.

Timetable of classes

No.	Stages of learning	Location	Time
1.	Participation in the morning conference	Course conference room	40 minutes
2.	Organizational activity	Audience	30 minutes
3.	Checking students' knowledge on a topic	Audience	60 minutes
4.	Discussion of supervised patients	Ward of patients	40 minutes
5.	Discussion of the topic of the lesson	Audience	30 minutes
6.	Checking students' knowledge	Audience	60 minutes
7.	Control of assimilation of material	Audience	30 minutes
8.	Checking students' knowledge	Audience	20 minutes
9.	Room for studying situational tasks and practical skills	Audience	40 minutes
10.	Introducing the next lesson	Audience	10 minutes

The purpose of the lesson: In this lesson, students, residents of the magistracy and clinical residents will study the features of etiopathogenesis, clinical manifestations, modern methods of diagnosis, treatment of arterial aneurisms of the brain.

How to do it

Algorithm for communication between students and patients related to the topic under consideration and any other topic (communication skills):

1. Greet patients and introduce yourself.
2. A sincere smile on the faces of students ensures reliable communication with patients.
3. The student should treat the patient well, explain why he came and how long the conversation will last, and also get the patient's consent to the conversation.
4. If the patient is now hospitalized, he should have a brief conversation with his relatives and, together with the attending physician, inform the patient of the initial diagnosis, the purpose of hospitalization, and the methods of future examinations.
5. Prior to conducting a physical examination for the diagnosis of this disease, the patient must be informed about the method of examination, adverse events that may be observed during the examination, and the consent of the patient to conduct this examination..
6. It is necessary to warn the patient before transporting the patient to another place for examination (X-ray room, MRI or MSCT study).
7. Preparation for examination (for clinical and neurological examination of this pathology) - wash hands with warm water and soap, put on gloves.
8. Carry out scheduled examinations and medical manipulations.
9. The results of examinations necessary for the patient should be briefly explained to the attending physician.
10. Relatives of patients should also be interviewed and the results of the screening method should be explained in a form convenient for them (if they have previously been tested, compared with previous results) and at the end of the interview it is desirable to make sure that the patient's condition is clear.
11. Substantiate and prove the expediency of surgical treatment of the supervised patient in the presence of the attending physician (mandatory!).
12. After surgical treatment, the patient and his relatives should be informed only in the presence of the attending physician about the outcome of the operation and possible early postoperative complications.

13. When examining patients in the postoperative period, the patient should be explained the procedure for the correct implementation of hygiene measures.

14. The patient should be treated in a pleading tone and consented to participate in the process of dressing the surgical wound.

15. Together with the attending physician, the patient should be informed about the ongoing and planned manipulations and further treatment tactics for the next of kin of the patient, if necessary.

16. It is always desirable to end the conversation with a wish to the patient for a speedy recovery.

The student must know:

1. Anatomical and topographic features of the cerebral circulation.
2. Etiology, pathogenesis, development of arterial aneurisms of the brain.
3. Clinical characteristics and modern diagnostics of arterial aneurisms of the brain.
4. Indications for surgical treatment of arterial aneurisms of the brain.
5. Methods of surgical interventions for arterial aneurisms of the brain.
6. Main features of surgical treatment of arterial aneurisms of the brain.
7. Complications of the pre- and postoperative period, methods of their prevention and treatment, features of the postoperative period.
8. Principles of examination of disability and rehabilitation of patients who underwent surgery for arterial aneurisms of the brain.

The student must be able to:

1. Collect anamnesis in patients with pathology of cerebral vessels.
2. Conduct a general clinical examination, detect the main clinical symptoms of arterial aneurisms of the brain.
3. Draw up a plan for laboratory and instrumental examinations, interpret the results of examinations, determine a preliminary diagnosis and management of the patient, conduct a comprehensive examination together with related specialist doctors.
4. Argue and formulate a clinical diagnosis, prepare patients for emergency and planned surgical interventions.
5. To determine the indications and contraindications for surgical intervention, to choose the right preoperative preparation, type of anesthesia, surgical access and volume of surgical intervention, depending

on the clinical form and the presence of complications in patients with arterial aneurisms of the brain.

6. Maintain medical documentation for the curation of patients.
7. Use educational and scientific literature to solve professional tasks, improve the level of professional training.

Aneurysms of the arteries of the brain

Arterial aneurysms of the brain are a local protrusion of the thinned wall of the artery or a limited (possibly over a considerable extent) expansion of the lumen of the artery due to thinning or damage to its wall (Fig. 1.). There is no muscle layer in the wall of the aneurysm, and there is also no internal elastic membrane, or its underdevelopment is noted. In the area of the aneurysm, the normal three-layer structure of the vessel wall is absent, and the aneurysm wall is presented in the form of a plate of varying thickness, consisting of scarred connective tissue growing intima and adventitia.

Fig. 1. Arterial aneurysm of cerebral vessels

According to the configuration (shape) of the aneurysmal sac, there are:

a) saccular (in the form of a small bag) - have a neck, body and bottom. The aneurysm neck usually retains a three-layer structure and is the most durable part of the aneurysm.

The bottom of the aneurysm is represented by one layer of intima, so it is thinned, and the rupture of the aneurysm occurs precisely in the area of the bottom or in the area of the body of the aneurysm, but never occurs in the neck.

This structural feature of the aneurysm must always be taken into account during the operation.

b) spherical - characterized by the presence of a uniform or eccentric expansion of the artery.

c) fusiform (fusiform) - expansion of the lumen of the artery over a considerable extent (Fig. 2.).

Fig. 2. Types of aneurysm according to the configuration (shape) of the aneurysmal sac

Saccular aneurysms are common, while spherical and fusiform aneurysms are much less common.

According to the size of the aneurysmal sac, there are:

a) miliary aneurysms (linear size less than 3 mm);
b) ordinary (4-15 mm);
c) large (16-25 mm);
d) giant (more than 25 mm).

According to etiology, arterial aneurysms of the brain are divided into:

I. Congenital - develop due to improper formation of the arterial wall in the embryonic period. This is manifested by the presence of a defect in the muscular membrane of the arteries at the site of separation and anastomosis of the arteries. Along with this, other malformations are very often found - anomalies in the development of the arterial circle of the cerebrum (circle of Willis), hypoplasia of the renal artery, coarctation of the aorta, etc.

II. Acquired - arising from various reasons.

1) atherosclerotic lesions of the artery wall.

2) hypertension, when there is a direct effect of the shock blood wave on the walls of the artery;

3) a defect in the middle lining of the artery, elastic and collagen fibers of the vessel;

4) the presence of arteriovenous malformations, leading to hemodynamic disturbances in the vascular system of the brain and contributing to the emergence and increase in the size of the aneurysm.

5) Proliferation of the inner membrane with loss of elastic properties and fragmentation of brain vascular tissue.

6) Stretching of the fibrous-elastic articulation of the segments of the muscular layer of the artery wall due to hemodynamic disorders.

7) Brain injury with subsequent hemodynamic shock and increased pressure in the arteries of the brain.

8) Infections, mycoses are extremely rare causes of a true aneurysm.

Typical localization of arterial aneurysms is the place of division (dichotomy) and anastomosis of the artery.

Most often, brain aneurysms are located (Fig. 3.) in the carotid basin (85-95%). At the same time, aneurysms of the anterior cerebral artery were detected in 40-45%, in the area of the bifurcation of the internal carotid artery - in 31%, and in the middle cerebral artery - in 19%. Aneurysms localized in the vertebrobasilar basin account for 5-15%.

At the same time, in the area of bifurcation of the main artery, the superior cerebellar artery, the fusion of the vertebral arteries, they make up 10%, and the vertebral artery - 5%. Multiple aneurysms occur in 13% of patients.

Mostly aneurysms are found at the age of 31 to 50 years (54%).

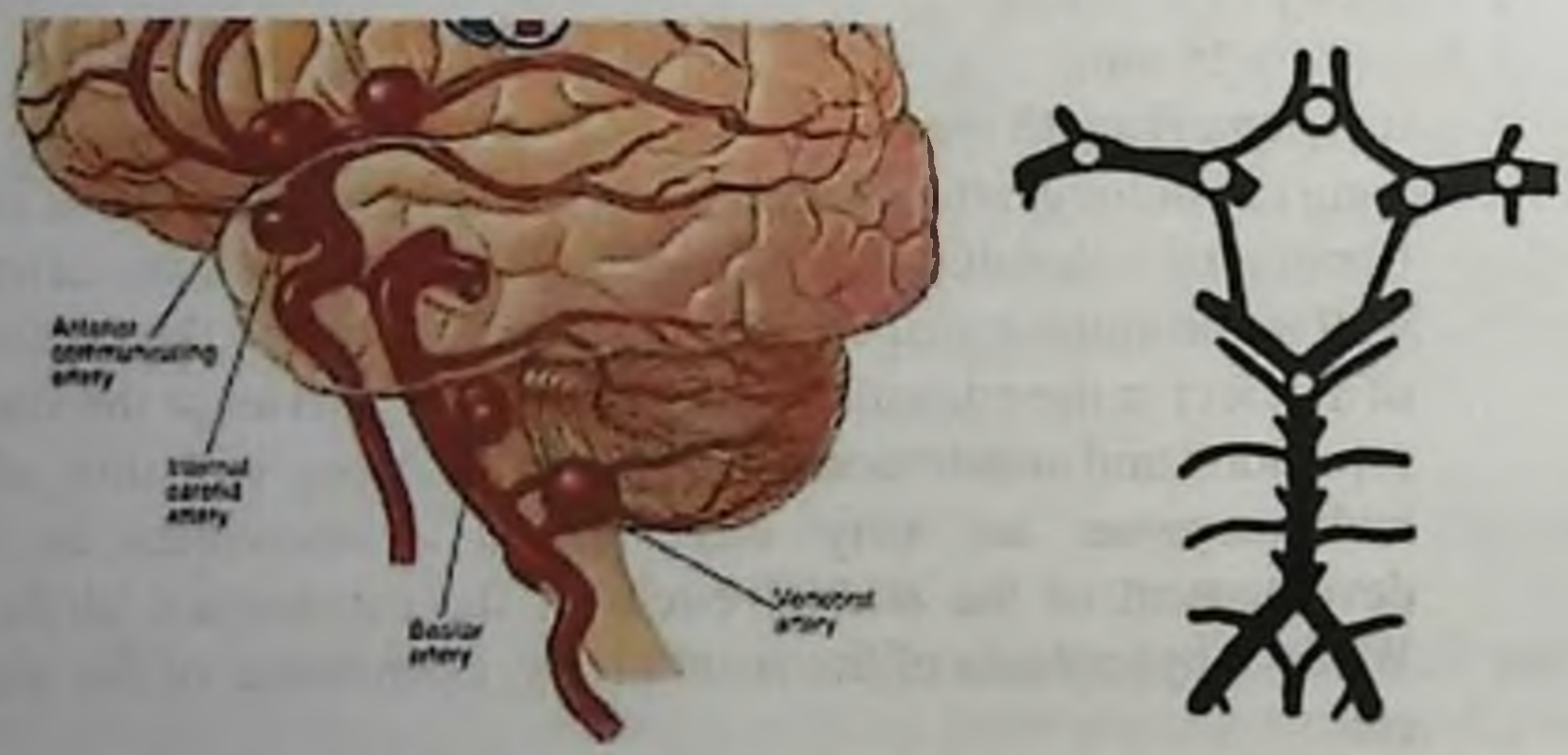

***Fig. 3.** The most common localization of arterial aneurysms of the brain*

Clinical course of arterial aneurysms.

Depending on the clinical manifestation of cerebral aneurysm, there are three main groups:

1) ruptured (apoplectic form), accompanied by subarachnoid or other type of hemorrhage (up to 99.4% of aneurysms).

2) unruptured (paralytic form), manifested by damage to the brain and cranial nerves (up to 9.6% of the total number of aneurysms).

3) accidentally detected (asymptomatic) at autopsy or angiography.

Risk factors for the formation and rupture of aneurysms are smoking, arterial hypertension, diabetes mellitus, etc.

In the clinical course of ruptured brain aneurysms, it is advisable to single out certain periods:

1) Prehemorrhagic - usually asymptomatic, and the first manifestation of the disease are periodic sudden headaches, dizziness, fainting, sometimes nosebleeds. These symptoms are usually interpreted as a manifestation of hypertension, cerebral atherosclerosis, etc. In a small number of cases (up to 10%), the development of ophthalmoplegia makes it possible to suspect the presence of an arterial aneurysm of the cerebral vessels.

2) Acute hemorrhagic - due to a sudden rupture of the bottom or wall of the aneurysm. Its duration from the moment of rupture of the aneurysm and the onset of bleeding is up to 3 days. At the same time, among full health, an acute headache ("like a blow to the head"), nausea, vomiting (sometimes multiple), general weakness, bradycardia, and a violation of cardiovascular activity suddenly appear.

Often there is a loss of consciousness, general convulsive seizures, psychomotor agitation develop. Focal symptoms develop (in 50% of cases) in the form of anisocoria, damage to the oculomotor nerves, hemiparesis, hemiplegia, severe meningeal symptoms.

The development of various focal symptoms and disturbances of consciousness (coma) in this period largely depends on the location of the hemorrhage focus in relation to the diencephalic and stem structures of the brain, the basal parts of the brain, as well as on the degree of occlusion of the ventricular system by blood clots (hemotamponade). In this period, there is no pronounced vascular spasm, which must be taken into account when determining indications for surgical treatment.

3) Acute hemorrhagic - develops from 4 days to 2-3 weeks, repeated bleeding is possible, there is an increase in the severity of focal symptoms, stem disorders due to the development of edema, dislocation and infringement of the brain stem, gross vital disorders.

In the pathogenesis of the formation of these symptoms, a significant role belongs to the presence of a pronounced ischemic spasm of cerebral vessels, followed by the development of ischemia or infarction of certain

parts of the brain, as well as in the region of stem structures. The presence of severe hemotamponade of the ventricular system also contributes to the development of edema and dislocation of the brain stem. The appearance of disorders of cardiovascular activity and respiration often leads to death.

4) Posthemorrhagic:

a) recovery - this period begins 2-3 weeks after SAH and lasts up to 5-6 months. There comes the restoration of speech and motor functions, but only partial. Lethal outcomes occur due to severe somatic disorders (abscess pneumonia, sepsis, etc.). After one month or several months (2-3), repeated SAH may occur.

b) long-term effects - begins 6 months after SAH and lasts up to 5-10 years. Basically, patients have a partial recovery of impaired brain functions.

The clinical course of SAH in some patients is characterized by the absence of loss of consciousness at the time of aneurysm rupture. Therefore, the existing idea that the SAH syndrome resulting from an aneurysm rupture is necessarily accompanied by severe impairment of consciousness (from stunning to coma) is not always reliable. The phenomenon of the absence of loss of consciousness often masks the SAH syndrome, which can lead to delayed or late diagnosis of SAH.

In the acute period, SAH is often complicated by various disorders of cardiovascular activity, and also contributes to aggravating the course of hypertension. This often leads to decompensation of the patient's condition and may be a contraindication to surgical intervention.

In some patients (40%), working capacity is restored. Repeated hemorrhages are characteristic, which can occur after a few months or 5-10 years.

R.Leblanc (1987), M.Yu.Myatchin (1992), V.V.Lebedev et al. (2000), depending on the clinical picture of SAH and its morphological manifestations, the following forms of SAH are distinguished:

I. Uncomplicated subarachnoid hemorrhage.

II. Subarachnoid -parenchymal hemorrhage.

II. Subarachnoid-ventricular hemorrhage.

IV. Subarachnoid-parenchymal-ventricular (mixed) hemorrhage.

V. Subarachnoid hemorrhage with sheath (isolated or combined with intracerebral or ventricular) hematomas.

At SAH in the acute period, the severity of the patient's condition may be different, and depending on the degree of its severity, the method of diagnosis and treatment is determined.

To assess the severity of the patient 's condition, W. Hunt and R. Hess (1968) proposed a classification.

Classification of the severity of the condition of patients with the presence of subarachnoid hemorrhage in the acute period (according to Hunt and Hess)

Degree gravity states	Criteria for determining the severity of the condition
I	Asymptomatic course, mild headache or stiff neck is possible.
II	Headache moderate or mild. The meningeal syndrome is expressed. Focal neurological symptoms are absent, with the exception of possible damage to the oculomotor nerves.
III	The meningeal syndrome is expressed. Consciousness is upset to the point of deafening. Focal symptoms are moderately expressed.
IV	The meningeal syndrome is expressed. Sopor. Focal symptoms are pronounced. Violation of vital functions.
V	Coma of various depths. Akinetic mutism.

The proposed classification makes it possible to assess the severity of the patient's condition in points, to analyze the outcomes of SAH in homogeneous groups of patients in the acute period, and this is very important because cerebral arterial aneurysms are diagnosed in this period in 90% of cases. One of the reasons that aggravate the course of SAH in case of rupture of an arterial aneurysm is vascular spasm. According to a comprehensive study of 68 neurosurgical centers of the world (16 countries), in 34446 patients (33.5% of those examined), vascular spasm was the main cause of deterioration in the condition of patients or death. To determine the severity of spasm of the cerebral arteries, angiography is used, which, according to T.Gabrielsen and T.Greitz (1970), makes it possible to detect the presence of vascular spasm in 63% of the studied patients.

Krylov V.V. (1988), depending on the prevalence and degree of narrowing of the arteries, distinguishes four types of vascular spasm:

I - unexpressed and uncommon - with a degree of narrowing of the arteries less than 50% of the normal diameter of the artery and with a prevalence of no more than one or two segments of the artery (28%).

II - pronounced and not common - with a degree of narrowing of the arteries by 50% or more and with a prevalence of one or two segments (27%).

III - unexpressed and widespread - with a degree of narrowing of the artery less than 50% and with a prevalence of three or more segments (21%).

IV - pronounced and widespread - with a degree of narrowing of the artery by 50% or more and with a prevalence of three or more segments (24%).

These data were obtained on the basis of angiographic studies. It was noted that on the first day after SAH, mainly type I vascular spasm (unexpressed) is detected, and on days 4-7 and especially on the 2nd week, type III and IV (common and pronounced) angiospasm is detected.

The resulting assessment of the severity of vascular spasm makes it possible to take these data into account when choosing a method of surgical treatment.

Currently, a comprehensive study of patients with SAH is used to determine the severity of angiospasm by using non-invasive techniques - transcranial Doppler, transcranial ultrasonography, duplex scanning, MRI tomography, which allow visualization of cerebral vessels, determine hemodynamic disorders, record the speed of linear blood flow, the degree of narrowing of the arteries (severity of spasm). The optimal increase in spasm, according to a comprehensive study (TC -ultrasonography, TKDG, MR-angiography, etc.), is observed on days 6-12 after aneurysm rupture. These data should be taken into account when choosing a method of treatment for SAH.

Diagnosis of an arterial aneurysm of the brain

The main task of diagnosing an arterial aneurysm of the brain is:

1) detection of an aneurysm;

2) determination of the carrier vessel and the exact location of the aneurysm neck discharge;

3) determination of the localization, size and direction of the bottom and neck of the aneurysm;

4) determination of the localization of the aneurysm in relation to the bones of the skull;

5) visualize the brain, cerebral vessels and CSF -containing spaces;

6) depending on the location and size of the arterial aneurysm, determine acceptable methods of treatment;

7) planning and modeling of surgical intervention.

Ultrasound, SCT, MTR and MR angiography can be used for diagnosis.

Ultrasonic Methods

transcranial ultrasonography is one of the informative ultrasound methods (Fig. 4.). This non-invasive technique allows diagnosing aneurysmal disease of the brain in 75-90% of cases of intracranial aneurysms, and the use of echo -enhancing drugs and three-dimensional scanning - up to 97% of aneurysms. At the same time, a pulsating blind - ending section of the vessel is revealed. An aneurysm smaller than 6 mm is not detected in US, and partially thrombosed aneurysms are not always visualized.

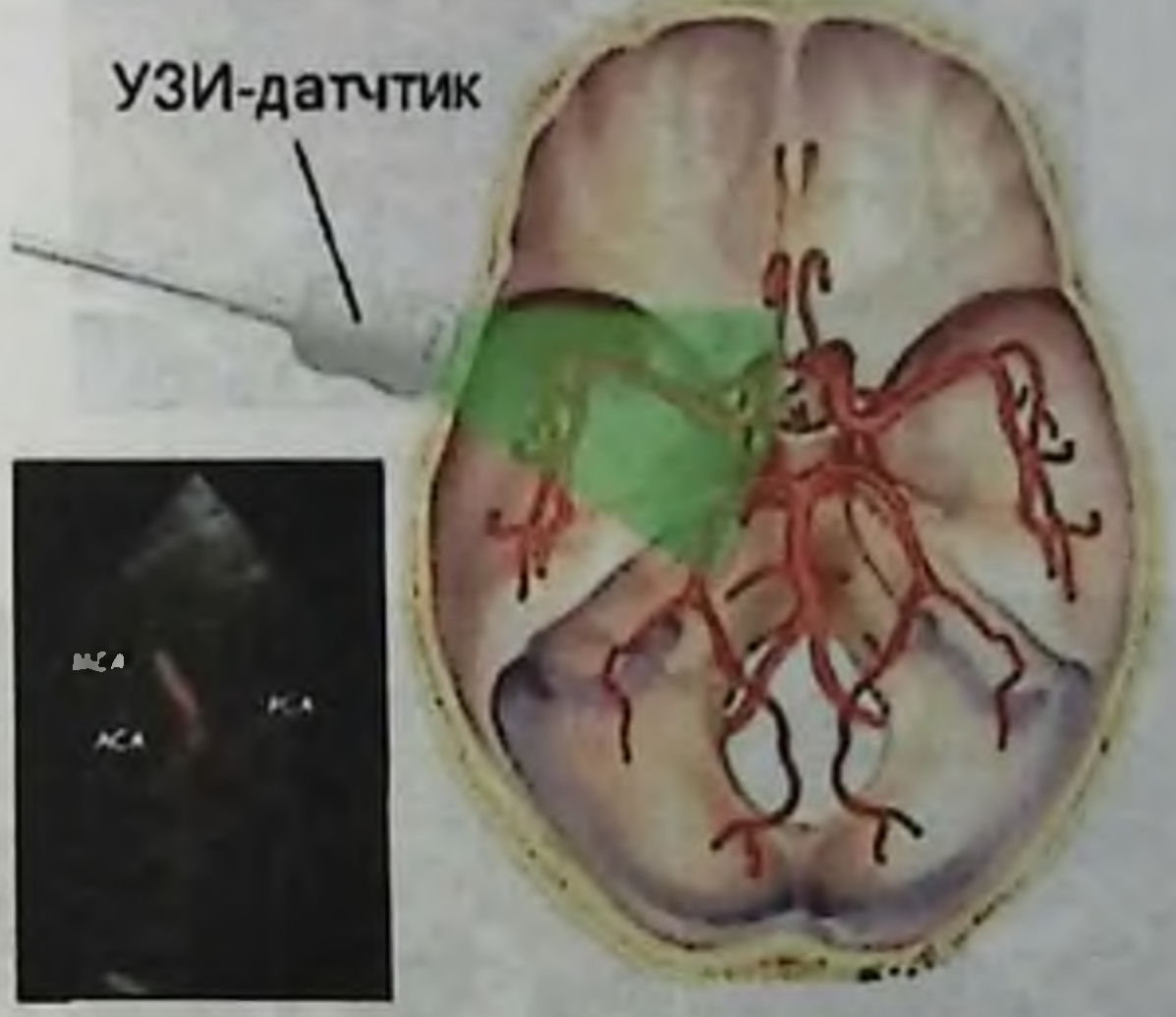

Fig. 4. Transcranial cerebrovascular ultrasonography Spiral computed angiography (SCA)

The use of SCA allows visualizing the non- thrombosed part of the aneurysm, determining its location and size (Fig. 5.). The use of a special SSD program makes it possible to perform a three-dimensional scan, clarify the relationship of the aneurysm to the bone structures of the skull, more clearly determine the anatomical structure of the aneurysm and obtain an image of the cerebral vessels. SCA does not allow diagnosing small aneurysms (less than 2 mm).

Magnetic resonance imaging

The use of MRI allows visualization of arterial aneurysms larger than 3-5 mm. A direct MPT sign of an aneurysm is the absence of an MR signal in the immediate vicinity of the arterial vessels of the base of the brain (Fig. 6.).

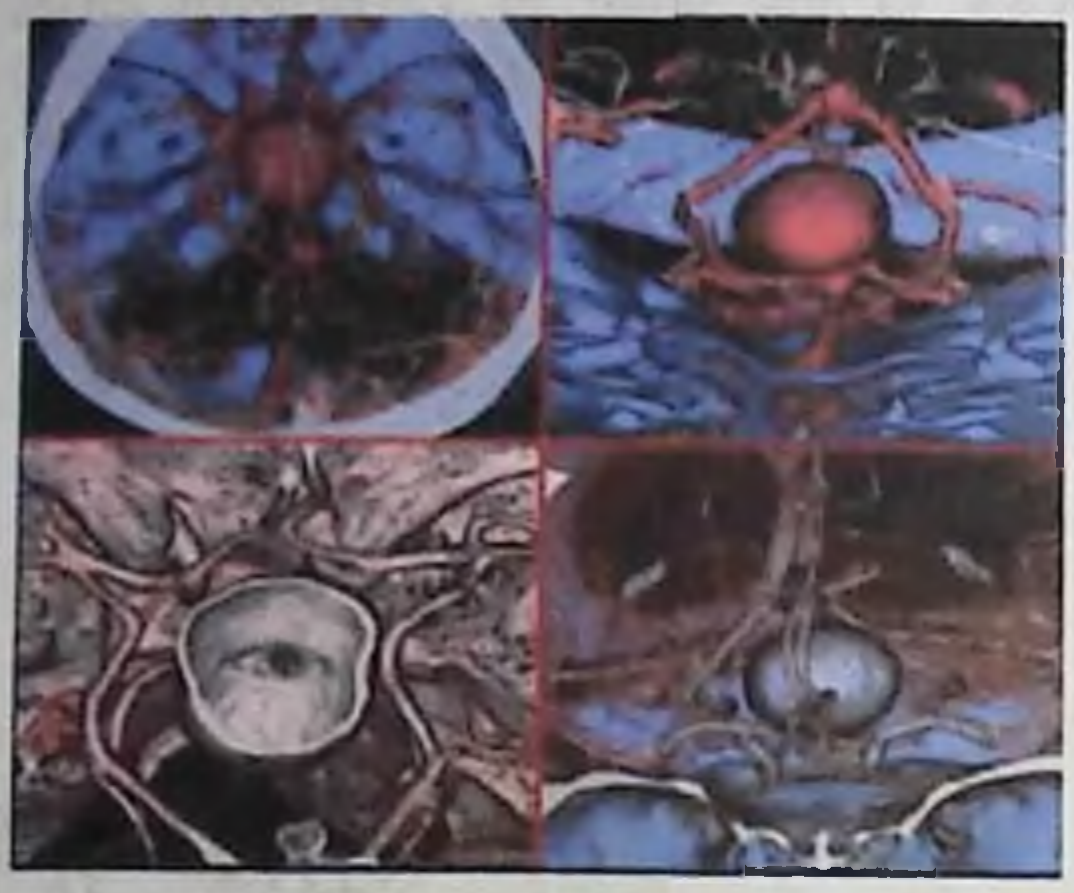

Fig. 5. Spiral computed angiography. Saccular aneurysm of the bifurcation of the basilar artery

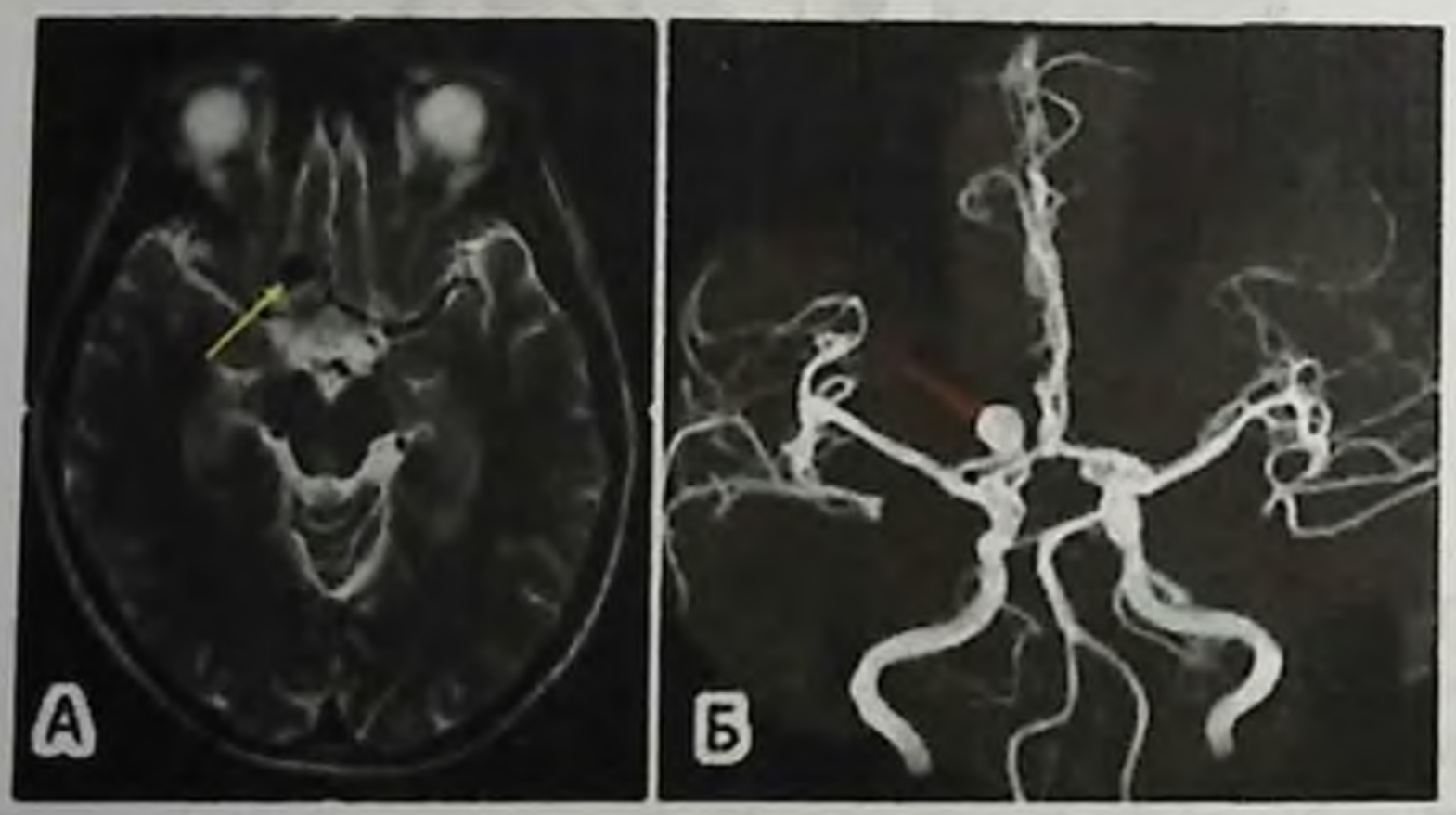

Fig. 6. MRI of the brain. Aneurysm in basin A of the 1st part of the anterior cerebral artery of the brain.

MRI makes it possible, when determining an aneurysm, to identify areas of an aneurysm thrombus, in contrast to cerebral angiography, in which areas of a thrombus are not determined. With a ruptured aneurysm, an intracerebral hematoma is visualized on MRI, and the presence of an aneurysm is determined by the MRI signal. The presence of an MR signal

of high or medium intensity is characteristic of a thrombus site located in the aneurysm cavity or turbulent blood flow.

The use of MR angiography allows determining the size, localization and differential diagnosis between a thrombus and the presence of blood in the aneurysm cavity. This is possible when using MR angiography with the TOF program.

This method is the most informative in detecting intracranial aneurysms (up to 95%).

However, sometimes the presence of a fresh thrombus in the aneurysm cavity can lead to an underestimation of the size of the aneurysm, especially if it is large or gigantic.

Cerebral angiography

The use of cerebral angiography makes it possible to identify the neck and body of the aneurysm by using various non-standard arrangements, especially "oblique" ones. In addition, to determine the presence of dislocation of the main vessels and the severity of spasm of arterial vessels, especially in the area of a ruptured aneurysm, as well as to assess the state of collateral circulation. After the operation for an arterial aneurysm, control cerebral angiography is performed, which makes it possible to identify defects in the operation or postoperative complications. As a result of rupture of cerebral artery aneurysms, SAH occurs in 51% of cases, and conservative treatment is ineffective, and about 60-87% of patients die after the first rupture (S.De la Monte (1985), O.A. Tsimeyko et al.

(2003). During the first two weeks after SAH, 44% of patients have repeated hemorrhages, which ended in death in 85% of patients. In this regard, there was a need for the use of surgical treatment of patients with arterial cerebral aneurysms in the early stages.

Indications for surgical treatment of cerebral arterial aneurysms are:

1) Detected unruptured aneurysm larger than 10 mm.
2) A history of an episode of intracranial hemorrhage caused by an arterial aneurysm.
3) Oculomotor disorders due to the presence of an aneurysm.
4) Progressive increase in arterial aneurysm.

The most radical method of treatment is to exclude the arterial aneurysm from the circulation, which can only be achieved by surgery. Currently, there are two main methods of surgical treatment of arterial cerebral aneurysms:

1) Intracranial intervention:
a) clipping of the aneurysm;

b) clipping of the vessel carrying the aneurysm.

2) Intravascular interventions:

a) occlusion of the aneurysm cavity with a detachable balloon or thrombosis of the aneurysm cavity with a mixture of polymers;

b) occlusion of the aneurysm cavity with microcoils ;

c) occlusion of the vessel carrying the aneurysm.

Intracranial interventions

The main task in performing intracranial operations is to exclude the aneurysm from the bloodstream with the obligatory preservation of the patency of the carrier and surrounding cerebral vessels, including the perforating arteries. In the presence of ruptured aneurysms, it is necessary to remove liquid blood and its clots from the subarachnoid spaces and the brain parenchyma, and in the presence of intraventricular hemorrhage, hemotamponade should be eliminated. For successful operation, a special neuroanesthetic aid is used, aimed at stabilizing perfusion pressure at all stages of anesthesia. Before the operation, medical preparation is carried out, providing the necessary brain relapse.

When accessing aneurysms located in the anterior parts of the cerebral arterial circle (circle of Willis), subfrontal or pterional access is performed.

To approach the aneurysms of the vertebrobasilar basin, a temporal or suboccipital approach is performed.

When performing surgery, it is necessary to ensure a minimum traumatization of the brain by performing optimal approaches, using microsurgical techniques and operating optics. In this case, an operating microscope, special microsurgical instruments and clips are used. After performing the appropriate surgical approach and opening the dura mater, the microsurgical stage of the operation begins. Under conditions of sufficient illumination and an optical magnification of 2-3 times the surgical field, the basal cisterns are opened and the cerebrospinal fluid is aspirated as much as possible, the subarachnoid space around the aneurysm is closed with wet padded jackets. Arachnoid adhesions around the aneurysm are dissected atraumatically and the neck of the aneurysm and its sac are gradually isolated. First, it is advisable to isolate the proximal section of the artery carrying the aneurysm. In this case, it is necessary to isolate the arteries towards the aneurysm using microdiathermy, button microprobes, hooks, dissectors, etc.

In cases where direct access to the neck of the aneurysm is difficult, it is advisable to perform a subpial microresection of the softened medulla around the aneurysm using bipolar coagulation and ultrasonic microaspirator. This

avoids traumatic damage to the walls of the aneurysm and the development of spasm of arterial vessels. One of the important stages of the operation is the preparation of thin perforating arteries soldered to the aneurysm, which should be isolated at maximum magnification (up to 10 times). In order to avoid rupture of the aneurysm bottom, it is advisable to temporarily apply special removable clips to the proximal and distal segment of the aneurysm carrier before the aneurysm is isolated. Along with this, under conditions of arterial hypotension, partial coagulation of the aneurysm wall is carried out using bipolar microdiathermy in order to facilitate the clipping of the aneurysm neck. A special clip is applied to the neck of the aneurysm and the integrity and patency of the vessel carrying the aneurysm and its branches are maintained. Types of clips applied to the neck of saccular aneurysms of the cerebral artery are schematically shown in Fig. 7.

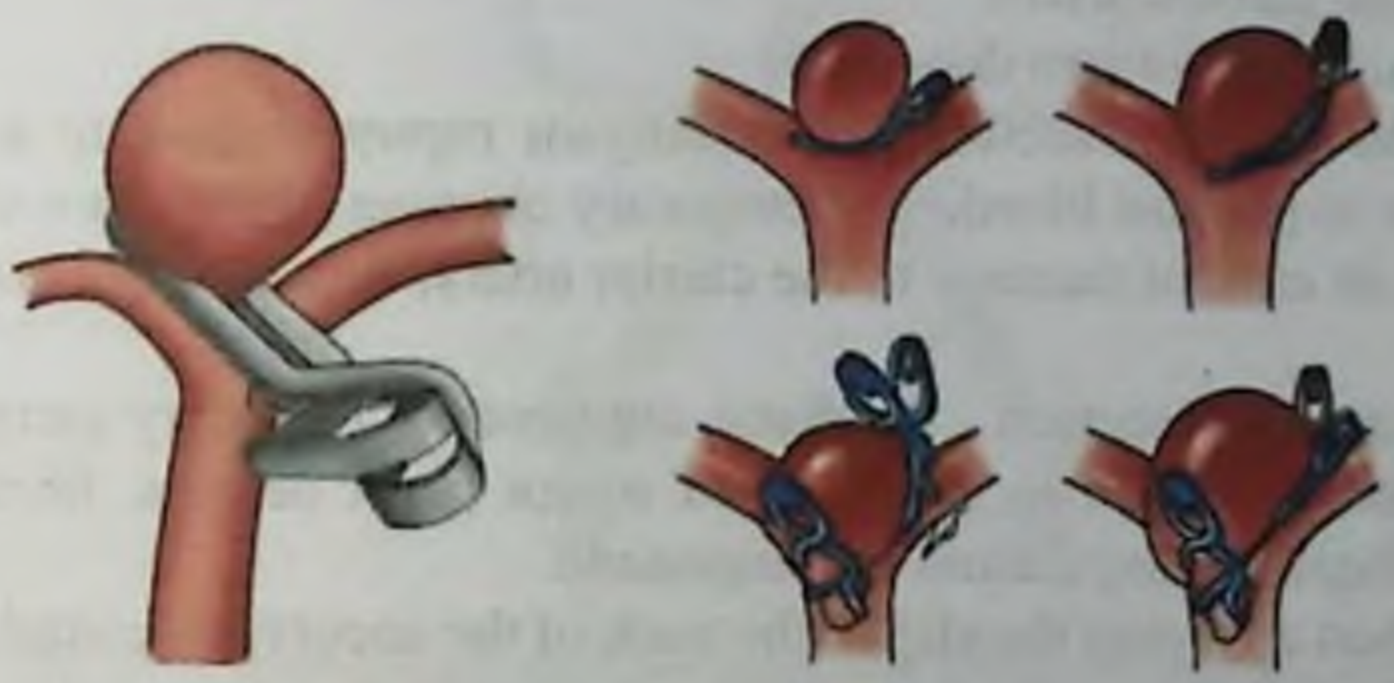

Fig. 7. Types of clip application on the neck of saccular aneurysms of the cerebral artery

Fig. 8. Carotid angiogram. Before (A) and after (B) arterial aneurysm clipping. Saccular aneurysm is turned off by applying a clip

Often, in order to control clipping of the aneurysm neck and check the patency of the vessels carrying the aneurysm and the main arteries of the brain, cerebral angiography is performed (Fig. 8).

To determine the absence of blood flow in the aneurysm and assess the patency of the arterial vessels carrying the aneurysm, intraoperative microvascular Doppler sonography is used.

One of the complications that arise during operations is the rupture of the aneurysmal sac at different stages of the operation:

1) During the surgical approach due to vibration at the stage of trepanation or due to arterial hypertension. In this case, it is necessary to lower blood pressure, temporarily compress the vessels on the neck, or temporarily apply a removable clip in the region of the supraclinoid segment of the internal carotid artery.

2) During aneurysm dissection :

a) with blunt dissection, the aneurysm ruptures close to its neck, which leads to profuse bleeding. Temporary clipping of the main vessel is shown, and in case of damage to the carrier artery, it is necessary to suture the defect.

b) in acute dissection - the distal segments of the artery carrying the aneurysm are dissected in the form of minor point defects. Bleeding is stopped by bipolar coagulation or tamponade.

3) When applying the clip to the neck of the aneurysm, complications are possible:

a) perforation of one of the insufficiently isolated chambers of the aneurysm of the clip jaws. In this case, it is necessary to remove the clip and stop the bleeding temporarily. by clipping the arterial vessel carrying the aneurysm, and then isolating the aneurysm and its neck completely and re-clipping the aneurysm neck.

b) damage to the aneurysm neck due to its incomplete clipping. Bleeding is stopped by applying a second clip parallel to the first or by applying several additional clips.

In order to prevent arterial aneurysm rupture, it is advisable to limit brain retraction by resection of the sphenoid wing, hyperventilation and dehydration of the brain, controlled arterial hypotension, lumbar punctures, and other measures aimed at reducing brain volume. Isolation of the aneurysm should be performed by acute microdissection using temporary preliminary clipping of the aneurysm carrier vessel, ultrasonic aspirator and laser microsurgical technique.

Intravascular (endovascular) interventions for arterial cerebral aneurysms

The main task in the surgery of cerebral arterial aneurysms is the development of minimally invasive methods to reduce the traumatization of hard-to-reach brain regions, which occurs when transcranial approaches are used.

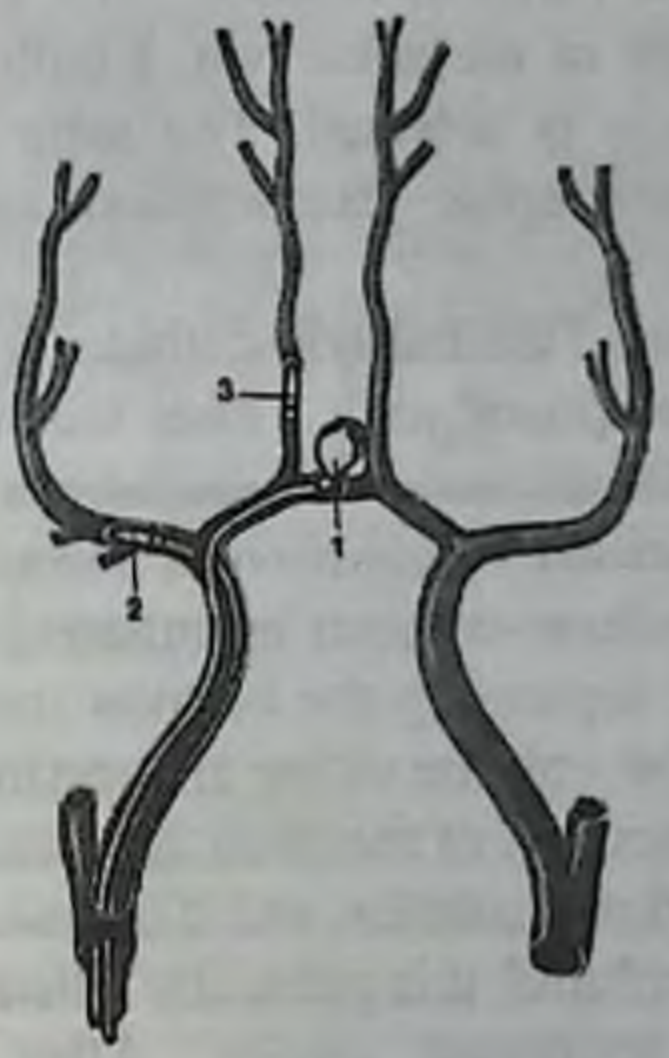

Fig. 8. Scheme of endovascular exclusion using a balloon-catheter for an aneurysm of the anterior communicating artery.
(1). Two auxiliary balloons temporarily turn off the initial section of the middle cerebral artery (2) and the anterior cerebral artery (3) distal to the aneurysm (according to A.P. Romodanov et al.).

One of the minimally invasive methods of surgical treatment of arterial aneurysms is the endovascular insertion of a balloon-catheter into the aneurysm cavity (Fig. 8.).

In the development and development of intravascular surgical interventions, a significant role was played by the studies of Luessephop, Velesques (1964), who for the first time managed to insert a balloon catheter into the supracline for the first time - part of the carotid artery and to prove the feasibility and possibility of occluding the cavity of the supraclinoid aneurysm with an inflating balloon. A new stage in the development of endovascular neurosurgery is associated with the development of a detachable balloon-catheter by F.A. Serbinenko (1971). Yu.N. Zubkov (1973) proposed a new model of a detachable balloon-

catheter for exclusion of saccular aneurysms from the bloodstream. At the Kiev Institute of Neurosurgery of the Academy of Medical Sciences. Academician A.P. Romodanov, changes were made to the design of the balloon catheter F.A. Serbinenko (V.I. Shcheglov et al., 1978, 1983), which was used to turn off saccular aneurysms and other types of vascular pathology. Before endovascular surgery, patients undergo a total angiographic study of cerebral vessels. After clarifying the dimensions of the body and the neck of the aneurysm, a balloon catheter of the required size and configuration is selected. The state of collateral circulation is determined by angiographic examination of the patient and during endovascular surgery.

The introduction of the balloon-catheter is carried out by transfemoral access under neuroleptanalgesia. The technique developed by F.A. Serbinenko (1973) for exclusion of saccular arterial aneurysms from the blood flow is that stationary occlusion of saccular aneurysms is performed using a detachable balloon-catheter by inflating it after inserting it into the aneurysm cavity and separating the balloon from the catheter. To do this, taking into account the volume of the aneurysm, the diameter of the artery and the length of the section of the occluded vessel, 0,1-1,0 cm 3 of silicone is injected into the balloon catheter, and if necessary, its amount is increased. When the balloon is inflated, it is gradually filled with silicone and complete obturation of the aneurysm cavity. After the onset of complete polymerization of the silicone (after 5-20 minutes), the catheter is freely removed from the balloon. It is very important that the catheter is withdrawn only when the balloon becomes immobile in the aneurysm. The location of the balloon and its immobility are determined according to the control cerebral angiography (Fig. 8b).

Depending on the volume of endovascular surgery performed using a detachable balloon catheter, the following are distinguished:

1) Reconstructive operations - occlusion of the saccular aneurysm is performed, and the lumen of the artery carrying the aneurysm is kept intact. This type of operation is performed for aneurysms with a narrow aneurysm neck (small, medium and large).

When performing reconstructive endovascular operations, complications are possible:

a) for technical reasons, the arterial aneurysm is switched off together with the vessel carrying it (13%);

b) only partial occlusion of the aneurysm is performed (14%);

c) ischemic disorders as a result of severe angiospasm (12%);

d) ruptured aneurysms (19%);

e) deaths (21%).

2) Destructive operations - the carrier artery is turned off along with the arterial aneurysm. This type of surgery is mainly performed for giant partially thrombosed aneurysms, which are clinically manifested by compression of the cranial nerves.

One of the important stages in the development of endovascular surgery is the use of microcoils for thrombosis of the aneurysm cavity. G.Gu - glielmi et.al. (1991) first reported the valuable application in clinical endovascular neurosurgery of electrolytic detachable microcoils. In this case, the microcoil is connected to the conductor of light alloys, which allows you to control its location, and under the influence of direct electric current, the coil can be separated (Fig. 9.).

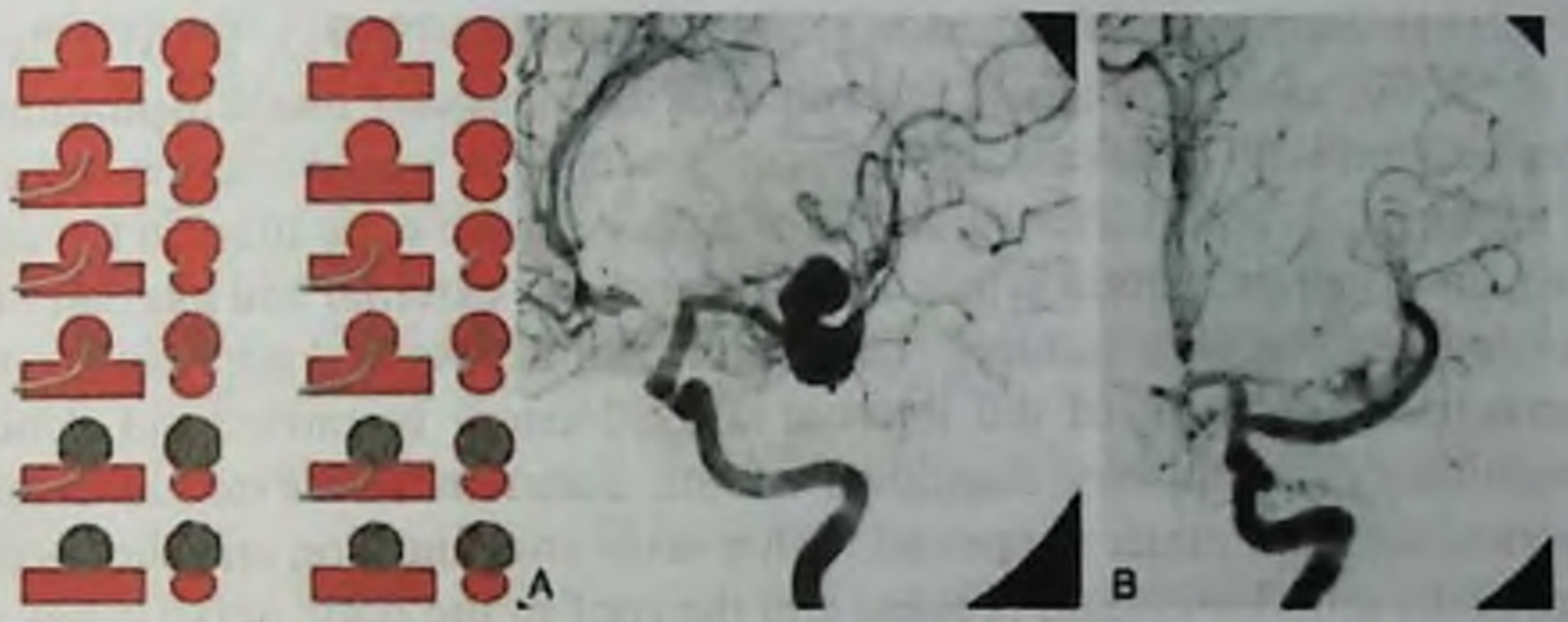

Fig. 9. Endovascular microcoils for thrombosis of the aneurysm cavity

Currently, the world clinical neurosurgery has accumulated a huge positive experience in the use of microcoils. F.A. Serbinenko et al. (2002) performed endovascular occlusion of cerebral arterial aneurysms using microcoils in 42 patients and showed the possibility of complete occlusion of saccular arterial aneurysms.

Based on the analysis of the results of endovascular operations using detachable microcoils performed in 42 patients with arterial cerebral aneurysms, F.A. Serbinenko et al. (2002) concluded that arterial aneurysms that do not have a well-defined neck are not suitable for treatment with this method.

G. Guglielmi (2000) reported that more than 60,000 patients worldwide have been cured by endovascular surgery using electrically detachable platinum microcoils. The greatest effect is observed when using detachable microcoils in the treatment of small aneurysms with a narrow

aneurysm neck in the acute period of hemorrhage. At the same time, the positive result of endovascular operations varies from 65 to 98%, which is due to the topographic and anatomical features of cerebral arterial aneurysms.

Despite the positive results of this technique, it is unacceptable for giant arterial aneurysms. Therefore, a combined technique of endovascular interventions is currently used by using a temporary ballon - occlusion of the vessel carrying the aneurysm and embolization of the aneurysm with platinum detachable microcoils. Despite significant advances in endovascular surgery and direct open surgery for large fusiform and giant aneurysms of the paraclinoid segment of the ICA in a significant number of patients with aneurysms of this localization, it is not possible to perform endovascular or open occlusion.

H.H. Batjer and DS Samson (1991), N. Tamaki (1991), Yu.M. Filatov et al. (2000) used a combined technique of intravascular blood aspiration in combination with endovascular temporary occlusion with a balloon catheter of the internal carotid artery and microsurgery. At the same time, in the neck area, the common carotid artery and its branches - external and internal - are isolated and taken on holders. Then, pterional access and approach to the supraclinoid segment of the internal carotid artery is carried out. Under conditions of temporary shutdown of the common and external carotid arteries, the dura mater is opened with a semi-oval incision and the medial part of the anterior clinoid process and the roof of the optic nerve canal are resected, and then the proximal segment of the supraclinoid part of the internal carotid artery and the aneurysm sac are visualized.

Transfemoral access according to the Seldinger method under X-ray control using an X-ray television installation, a double- lumen is inserted and installed into the lumen of the internal carotid artery in the neck occlusive -aspiration catheter. Under conditions of temporary occlusion with a balloon of the internal carotid artery and temporary clipping supraclinoid segment of the internal carotid artery, blood is aspirated, and after the onset of the effect of aneurysm relaxation, the aneurysm neck is dissected and clipped.

Combined surgical treatment of ruptured arterial aneurysms of the brain with the presence of intracranial hematoma is carried out by preliminary endovascular occlusion of the aneurysm using a detachable balloon catheter, followed by removal of the intracranial hematoma.

The accumulated significant experience in the use of endovascular surgical interventions for cerebral aneurysms (F.A. Serbinenko 1971, 2002;

V.A. Khilko, Yu.N. Zubkov, 1982; V.I. Shcheglov 1983; G. Guglielmi, 1997 and etc.) led to the conclusion that there are significant advantages of the method of endovascular surgical interventions:

1) The method of endovascular operations makes it possible to perform minimally invasive occlusion of aneurysms or cerebral vessels in hard-to-reach areas without the use of craniotomy.

2) The use of a detachable balloon-catheter allows temporary and permanent occlusion of the artery carrying the aneurysm, as well as any arterial vessel of the brain.

3) Detachable balloon-catheter in the presence of an appropriate topographic and anatomical structure of the aneurysm allows stationary and complete occlusion of the arterial aneurysm.

4) The stage of approaching and performing aneurysm occlusion with a balloon-catheter is controlled, visually controlled using an X-ray television installation.

5) All stages of endovascular surgery do not require the use of endotracheal anesthesia, but are performed under local anesthesia or neuroleptanalgesia.

6) At any stage of endovascular surgery, the balloon catheter can be removed from the arterial vessel.

7) The use of a balloon catheter allows for balloon angioplasty of cerebral arteries in cerebral vasospasm.

8) After an endovascular minimally invasive operation - occlusion of an arterial aneurysm, the length of the patient's stay in the hospital is reduced.

9) Endovascular embolization microcoils is the method of choice in the treatment of multiple cerebral aneurysms.

10) Endovascular method using balloon-occlusion of an aneurysm or cerebral arteries can be successfully used in combined techniques - installation of a microcoil in the aneurysm cavity, flexible intra-arterial prostheses (stents) or in combination with intracranial microsurgical operations.

Test questions

1. What is the most common location of cerebral aneurysms?

A) anterior cerebral artery;
B) internal carotid artery
C) main artery;
D) middle cerebral artery.

2. What methods make it possible to make a diagnosis of an aneurysm of cerebral vessels?

A) MRI-AG;
B) SKT-AG;
C) digital cerebral angiography;
D) MRI.

3. What is an arterial aneurysm of cerebral vessels?

A) narrowing of the vessel lumen;
B) limited or diffuse expansion of the lumen of the artery or protrusion of the artery wall;
C) segmental expansion of the vessel;
D) spherical protrusion on the vessel wall.

4. What phenomenon most often underlies the clinical manifestation of an aneurysm?

A) intracranial hemorrhage from an aneurysm;
B) compression of nearby formations by the aneurysm;
C) aneurysm thrombosis;
D) thromboembolism from the aneurysm cavity.

5. At what age does hemorrhage from an aneurysm most often occur?

A) in the young;
B) in the nursery;
C) at the age of 50–60 years;
D) in people older than 70 years.

6. What aneurysms are considered asymptomatic?

A) aneurysms, manifested by headache;
B) aneurysms with clear signs of thrombosis;
C) aneurysms, not manifested by hemorrhage;
D) aneurysms without any clinical manifestations typical for this pathology.

7. What methods are used to confirm the clinical diagnosis of subarachnoid hemorrhage?

A) MRI of the head;
B) CT of the head;
C) lumbar puncture;
D) CT of the head, MRI of the head, lumbar puncture.

8. What shape is most typical for aneurysms?

A) saccular;
B) blister;
C) infundibular;
D) round.

9. What size aneurysms are most common?

A) more than 2cm;
B) from a few mm to 1.5 cm;
C) more than 1cm;
D) less than 1 mm.

10. What is the main goal of surgical treatment of a patient with a cerebral aneurysm?

A) exclusion of the aneurysm from the bloodstream;
B) improvement of the patient's condition;
C) removal of intracerebral hematomas;
D) sanitation of liquor spaces.

11. What methods allow you to objectively detect angiospasm?

A) digital angiography;
B) dopplerography of intracranial arteries;
C) duplex scanning of intracranial arteries;
D) MRI;
E) SKT-AG.

12. What size aneurysms are classified as medium?

A) 6-15mm;
B) from 1.5 to 2 cm;
C) less than 1cm;
D) less than 2 cm.

13. What is the reason for the delayed development of neurological symptoms in angiospasm?

A) with the degree of narrowing of the arteries;
B) with temporary features of the formation of angiospasm;

C) with fluctuations in blood pressure;
D) with the prevalence of angiospasm.

14. What variant of intracranial hemorrhage is most typical for ruptured arterial aneurysm?
A) mixed hemorrhage;
B) hemorrhage in the ventricles of the brain;
C) intracerebral hematoma;
D) subarachnoid hemorrhage.

15. What types of operations are used to remove aneurysms from the bloodstream?
A) direct microsurgical interventions;
B) endovascular operations;
C) radiosurgery;
D) laparoscopy.

16. What is the main factor when choosing a method of surgical treatment of an aneurysm?
A) the number of aneurysms;
B) the size of the aneurysm;
C) anatomical and topographic features of the aneurysm;
D) the stage of the disease.

17. What scale should be used to select the tactics of treating a patient in the acute period of SAH?
A) NISS scale;
B) modified Renin scale;
C) Hunt-Hess scale;
D) WFNS scale.

18. What method is currently considered the main one in the diagnosis of aneurysms?
A) MRI-AG;
B) radiography;
C) SKT-AG;
D) digital cerebral angiography.

19. Multiple aneurysms occur with frequency
A) very rarely;
B) 50%;
C) 20%;
D) do not meet.

20. In what parts of the cerebrovascular system are aneurysms more common?

A) mainly on the arteries of the posterior parts of the circle of Willis;
B) mainly on the arteries of the anterior circle of Willis;
C) mainly on peripheral arteries;
D) equally often in all departments.

21 Sizes of aneurysms can be

A) no more than 2 cm in diameter;
B) 1-1.5 cm in diameter;
C) more than 10 cm in diameter;
D) from 1 mm to several cm in diameter.

22. Multiple aneurysms are characterized

A) the same size;
B) there are no multiple aneurysms;
C) a variety of combinations of vascular pools and aneurysms of different sizes;
D) location in one vascular pool.

23 What complication of aneurysmal subarachnoid hemorrhage leads to the development of a delayed neurological deficit?

A) angiospasm;
B) intracerebral hematoma;
C) cerebral edema;
D) lowering blood pressure.

24. In what cases should a lumbar puncture be performed with the clinical picture of subarachnoid hemorrhage?

A) in the absence of blood on CT or MRI;
B) when blood is detected on CT or MRI;
C) always;
D) never.

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