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PREVENTATIVE TREATMENT OF CEREBRAL ANEURISMS AS A PRECURSORS OF THE HEMORRHAGIC STROKE

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Abstract
Cerebral aneurysms represent a significant challenge in modern neurosurgery, being a primary cause of non-traumatic subarachnoid hemorrhage (SAH) and stroke, accounting for approximately 85% of intracranial hemorrhage cases. Despite ranking second among cardiovascular diseases, following myocardial infarction, the mortality associated with these conditions is alarming, with cardiovascular diseases overall contributing to 60% of global fatalities. The World Health Organization reports an annual incidence of 100-300 strokes per 100,000 population, with Uzbekistan witnessing over 60,000 new cases annually, translating to 25-30 daily incidents in Tashkent alone. These rising statistics highlight an urgent need for preventive strategies in managing cerebral aneurysms, shifting the focus from reactive surgical interventions post-detection or post-rupture to proactive measures aimed at reducing incidence rates. This article explores the implications of these trends for public health strategies, emphasizing the critical importance of early intervention in preventing the devastating outcomes associated with aneurysm rupture.

Keywords: Cerebral aneurisms, preventative treatment, Early Intervention, Willis circle, classification, pathogenesis, Subarachnoid hemorrhage (SAH), stroke, Neurosurgery, Public Health.

Introduction

An aneurysm is a local expansion of the lumen of an artery due to changes or damage to its wall. Cerebral aneurisms are the main cause of non-traumatic subarachnoid hemorrhage (SAH) and stroke, causing up to 85% of all cases of intracranial hemorrhage and represent one of the most difficult problems of modern neurosurgery, which is associated with high mortality and frequent disability.

Cerebral aneurisms take second place among the cardiovascular diseases, after myocardial infarction, however cardiovascular diseases themselves stays in the first place on the list of diseases leading to death, accounting for 60% of the total lethal diseases. Two main complications of cerebral aneurisms, which develops after its rupture, is the Subarachnoid hemorrhage and stroke. According to the World Health Organization (WHO), 100-300 cases of stroke are registered annually for every 100 thousand population. Statistics from Uzbekistan show that more

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than 60 thousand new cases of stroke occur annually. At the same time, more than 160 new cases occur in the country every day, ranking Uzbekistan No. 67 in the world. In Tashkent alone, 25-30 cases of stroke are observed daily.

And all over the world these indicators are growing every day, and Uzbekistan is no exception. This, in turn, forces doctors and surgeons to think more about preventive treatment of aneurysms as the most optimal option for public health, thereby preventing their occurrence in advance rather than treating them surgically after their detection or, which is more common and is a worse scenario, after a rupture of aneurysms.

It is these data, that became the main reason for writing this review article on the topic of preventive treatment of cerebral aneurysms.

Material and Methods:

Physiology and Etiology:

Aneurysm - a pathological process of expansion of the lumen of a blood vessel as a result of changes or damage to its wall.

As an example, in the United States, stroke is the leading cause of disability and in the early 2010s. ranked fourth among the leading causes of death. The incidence of stroke increases significantly with age, starting at age 30. Older age is the most significant risk factor for stroke. 95% of strokes occur at the age of 45 years or more, 2/3 at the age of over 65 years.

Aneurysms occur predominantly in areas of branching (bifurcations) and bends of arteries. This is due to the increased hemodynamic effect of direct blood flow on these vascular areas. As they say, “it breaks where it’s thin.” But the starting point for the development of cerebral aneurysms is the inadequacy of the arterial wall structure. It may also be associated with congenital connective tissue abnormalities. Pathological anomalies can be either independent or associated with various pathologies:

- Hereditary syndromes: Osler-Rendu syndrome (congenital deficiency of the inner wall of blood vessels), Marfan syndrome (impaired formation of connective tissue), Ehlers-Danlos syndrome (impaired collagen synthesis).
- Infectious damage to the vascular wall.
- Mechanical damage to the artery with dissection of its walls as a result of traumatic brain injury.

In the cases of artery wall defects presence, the causes of an aneurysm can be:

- Hypertension.
- Atherosclerosis.
- Smoking, alcohol abuse.
- Chronic intoxication (drug addiction, hazardous working conditions).
- Excessive and prolonged physical activity (physical body overwhelming).
- Chronic stress.

Classification and development stages:

Based on the shape of the protrusion of the vessel wall, cerebral aneurisms are subdivided into:

- Saccular.
- Fusiform.
- Vesicular.

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Based on the size, cerebral aneurisms are subdivided into:

- Miliary (less than 2-3 mm).
- Medium size. (4-15 mm).
- Large (16-25 mm).
- Giant (more than 26 mm).

Based on localization, cerebral aneurysms are subdivided depending on the carrier artery (main arterial trunk):

1) carotid basin (85~95%):

- Anterior communicating artery. (ACoA)
- Anterior cerebral artery. (ACeA)
- Internal carotid artery itself. (ICA)
- Middle cerebral artery. (MCA)
- Posterior communicating artery. (PCoA)

2) vertebrobasilar basin (5-15%):

- Posterior cerebral arteries. (PCeA)
- Bifurcation of the basilar artery.
- Superior cerebellar artery. (SCA)
- Basilar artery itself. (BA)
- Anterior inferior cerebral artery. (AICA)
- Fusion of vertebral arteries.
- Vertebral artery. (VA)

Also aneurisms might have only one main sac or multiple protrusions (diverticula).

Many scales have been proposed to classify the severity of the condition of patients with SAH and assess the volume of hemorrhage. The main ones are the Glasgow Coma Scale, the Hunt&Hess Scale, the Fisher Scale.

Physiology and Complications:

In the subarachnoid space (between the arachnoid and pia mater of the brain), clear, colorless cerebrospinal fluid (CSF) normally circulates. The appearance of blood in this space leads to an increase in the volume of cerebrospinal fluid, as a result of which intracranial pressure increases. Mechanical irritation of the receptors and nerve trunks of the arteries of the brain also occurs, which entails the development of short-term narrowing (spasm) of the cerebral arteries. This explains the decrease in blood supply to the brain in the first hours after the onset of aneurysm rupture. As a rule, this does not lead to ischemia (death) of parts of the brain.

The blood, leaked into the subarachnoid spaces, begins to form clots, then lyse (destroy) releasing a whole cascade of vasoactive substances that cause narrowing of the cerebral arteries. This condition is called cerebral vasospasm and is detected in 100% of patients with SAH, usually 3-4 days after aneurysm rupture. Vasospasm usually lasts 1-2 weeks (depending on the amount of bleeding). At this stage, delayed (secondary) ischemic damage to brain tissue may develop in conditions of a previous “vascular accident”, increased intracranial pressure and decreased blood supply to intracranial tissues.

If the patient survives, then he subsequently develops an immunoreactive inflammatory process affecting the walls of the arteries, forms arachnoid adhesions (adhesions), cysts, and areas of

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gliosis (scars in place of dead brain tissue). All these processes disrupt the normal functioning of the brain and lead to loss of functions of the damaged areas. Persistent neurological deficit develops:

- Gross speech disorders in the form of inability to understand and/or produce speech .
- Motor disorders due to developed paresis, paralysis (weakness) in the muscles of the limbs, facial muscles.
- Disturbances of sensitivity up to the loss of the ability to feel pain, touch, cold, heat in a limited area of the body or even half of the body.
- Coordination disorders, up to the inability to maintain balance while standing and even sitting, the inability to perform purposeful movements.
- Cognitive impairment – deterioration of memory, attention, cognitive abilities.
- In some cases, epilepsy and/or hydrocephalus (excessive accumulation of cerebrospinal fluid in the cerebrospinal fluid system of the brain).

Subsequently, these disorders become the cause of severe disability in patients who have suffered massive subarachnoid hemorrhage.

When, in addition to SAH, intracerebral and/or intraventricular hemorrhages occur, the severity of the listed pathological processes is aggravated and accelerated due to even higher intracranial pressure and direct destruction of brain structures from within.

Risks of appearance and development:

Cerebral aneurysm has 3 phases of its development - pre-hemorrhagic, hemorrhagic and post-hemorrhagic (Irger, 1986). The main problem is that the vast majority of aneurysms do not have significant clinical manifestations before their rupture and, as a rule, are detected only during the hemorrhagic period, when they manifest as subarachnoid hemorrhage syndrome (SAH).

With large aneurysms, the risk of hemorrhage increases. With an aneurysm less than 5 mm, the risk of hemorrhage is 2.5% throughout life, an aneurysm measuring 6-10 mm ruptures in 41% of cases, and with an aneurysm measuring 11-15 mm, hemorrhage occurs in 87%. If the aneurysm is larger than 15 mm in diameter, then the risk of hemorrhage is reduced due to the formation of clots in its cavity.

The risk of death in case of secondary rupture of an aneurysm during the first week after hemorrhage is 32%, in the second week - 43%, and during the first year after hemorrhage reaches 63%.

At the same time, the vast majority of aneurysms are diagnosed after their rupture. Patients are taken to the hospital with a diagnosis of acute cerebrovascular accident. At the same time, 87% of patients die within 1 to 6 months after the first rupture of an aneurysm. In 2009, Tremmel with co-authors used numerical modeling to show that the ratio of aneurysm size to it's vessel size is associated with the risk of rupture, and high values of this parameter determine aneurysms with blood flows characteristic of ruptured aneurysms. This conclusion confirms the fact that hemodynamics is one of the reasons for aneurysm rupture. Numerical calculations have shown that it is not the size of the aneurysm, but rather the ratio of its size to the diameter of the vessel that determines the hemodynamics inside the aneurysm.

There are two opposing points of view on what, high or low, tangential stresses on the wall are considered dangerous and determine the rupture of the aneurysm. On the one hand, it is believed that high touch stresses can cause mechanical damage to the endothelium, which can initiate wall

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remodeling and degeneration. This can cause the aneurysm to further increase in size and rupture. On the other hand, low touch stresses affect the stagnation of blood in the dome, causing endothelial dysfunction and adhesion of platelets and leukocytes on the wall surface, which causes intimal damage, inflammation and further degradation of the wall. Kojima, by analogy with his work, showed that blood pressure on the aneurysm wall plays a significant role in the process of aneurysm growth, and larger aneurysms have higher blood pressure in the dome compared to small aneurysms. It should be noted that the most commonly cited artery affected by aneurysms is the anterior communicating artery (ACoA).

Shear stresses on the wall are the most convenient parameter in terms of numerical calculations. But its numerical characteristics are difficult to measure in a patient at the diagnostic stage, so for now its use in medical practice remains practically impossible. However, the development of computational methods and diagnostic methods suggests that it is the mechanical factors, which can be calculated using biomechanics and computer modeling methods, that can become the most effective and reliable parameter for assessing the probability of growth and rupture.

Results:

Main methods of preventative treatment:

Methodology of cerebral aneurisms preventative treatment is generally subdivided into three main categories:

1) look after your health

- Quit smoking. Smoking means not only the risk of developing emphysema and lung cancer, but also an increased likelihood of developing an aneurysm. Can't quit on your own? Contact your doctors, they will help you choose a suitable smoking cessation plan. Also avoid secondhand smoke. If you are at risk for developing an aneurysm, avoid places where smokers gather.
- Avoid alcohol abuse. Excessive alcohol consumption can lead to thinning of the walls of blood vessels. If you have other problems associated with the cardiovascular system, you should stop drinking once and for all.
- Take your medications correctly. Drug abuse is fraught with negative consequences, including inflammatory processes in blood vessels and the formation of aneurysms. Of course, this also applies to narcotic drugs - the use of cocaine and amphetamine in particular increases the risk of developing a cerebral aneurysm.
- Build healthy dietary habits. Your diet should include fruits, vegetables, whole grains, lean meats, and non-meat sources of protein. Fat, cholesterol, sodium (salt) and sugar should be avoided. Eat less, start cooking for yourself to control the size of portions and their composition. Consider eating smaller meals throughout the day instead of two or three large ones.
- Have an active life style. Do cardio and light strength exercises to keep your body healthy and strong. If you exercise for 30 minutes a day, the chances of encountering an aneurysm are sharply reduced. Your doctor can recommend the most appropriate exercises to start with, and you can do them even at home. For example:

1. Light stretching before breakfast. 15-20 minutes of calisthenics every morning helps to cheer up and perfectly warms up the body for other types of activity.
2. Short sets of squats and push-ups. To protect yourself from an aneurysm, you don’t have to lift 300 kg weights and run a marathon. It is enough to start with 20 squats and 10 push-ups a day and gradually increase their number.

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3. Look on the Internet or in the library for manuals on how to properly perform the appropriate exercises, talk to your doctor or physical therapy instructor.

• Monitor your well-being and physiological state. The key factors in the fight against aneurysm are monitoring your weight, cholesterol and blood sugar levels, and blood pressure. Visit your doctor on monthly basis and take care of your body.

2) monitor your stress level and control it

• Know what triggers stress. The less stress in your life, the lower the chances that something will explode in your head - literally. Think about what causes you stress and this will be the first step in dealing with it. You may be experiencing stress due to many different factors, such as:

1. Problems in relationships.
2. Job.
3. Family obligations.
4. Financial difficulties.
5. Other problems.

• Find a calming and rewarding hobby for yourself. Let it be an activity that gives you pleasure and distracts you from the omnipresent bustle and stress. You don't have to build ships in a bottle if you're more inclined to play paintball. Think about what you could do to relax with all your heart and soul? There are many options:

1. Play chess and other board games.
2. Engage in physical activity outdoors, be it hiking, cycling or swimming.
3. Read more.
4. Learn to play a new musical instrument or refresh your skills on an old one.
5. Sign up for lessons or courses of your choice.

• Consider practicing meditation. Research has shown that the oldest inhabitants of the planet have one thing in common: they are all doing something quiet, calm, and absolutely not requiring unnecessary words, day after day. Many ordinary people enjoy the relaxation that meditation brings, and you don't need to become a yoga master to reap its benefits. Even if you just sit somewhere outside in peace and quiet for 20–30 minutes, you can significantly reduce your stress level. Start watching the sunset or sunrise every day to relax and focus on your feelings.

3) Stay in contact with medical examinations

• Review your family medical history. If at least two other relatives have had aneurysms, either recently or in the distant past, you should also undergo appropriate medical evaluation. Doctors usually advise undergoing such examinations every three to five years.

1. As a rule, aneurysms are diagnosed after the fact, when they begin to threaten the patient's life due to rupture. However, sometimes aneurysms are also detected on MRI of the brain, performed for unrelated reasons. Because of the difficulty in diagnosing, most doctors will refer a patient with a suspected aneurysm for additional testing, unless, of course, the patient complains of symptoms that fit perfectly into the clinical picture of an aneurysm.
2. Typically, screening is recommended for men aged 65–75 years who smoke or have smoked in the past. For non-smoking men in this age group, examination may be prescribed selectively, depending on the state of health and previous infections. Screening is not usually recommended for women in this age group.

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- Know the symptoms of an aneurysm. Pain in the eyes (especially from behind the eyes), blurred vision and facial paralysis are the very symptoms for which you should consult a specialist as soon as possible and undergo appropriate examinations. In the vast majority of cases, before the aneurysm ruptures, there are no specific symptoms. "Silent" (i.e., not-ruptured aneurysms) are detected by chance, for example, when a neurologist refers a patient for examination due to frequent attacks of headaches to exclude intracranial pathology: tumors, developmental anomalies, etc. In patients with "Silent" aneurysms may be accompanied by complaints of episodic dizziness, headache, decreased performance and cognitive function (less frequently).

- Know the clinical, pre-ruptural manifestations of an aneurysm. According to its clinical manifestations, the pathology can have a tumor-like or apoplexy course. In the tumor-like variant, the cerebral aneurysm progressively increases and, reaching a significant size, begins to compress the anatomical structures of the brain located next to it, which leads to the appearance of corresponding clinical symptoms. The tumor-like form is characterized by the clinical picture of an intracranial tumor. It is most often detected in the area of the optic chiasm (chiasm) and in the cavernous sinus. It is most often detected in the area of the optic chiasm (chiasma) and in the cavernous sinus. Anomaly of the vessels of the chiasmal area is accompanied by disturbances in visual acuity and fields; if it persists for a long time, it can lead to optic nerve atrophy. A cerebral aneurysm located in the cavernous sinus may be accompanied by one of three cavernous sinus syndromes, which are a combination of paresis of the III, IV and VI pairs of the cranial nerve with damage to various branches of the trigeminal nerve. Paresis of the III, IV and VI pairs is clinically manifested by oculomotor disorders (weakening or impossibility of convergence, development of strabismus); damage to the trigeminal nerve - symptoms of trigeminal neuralgia. A long-term condition may be accompanied by destruction of the skull bones, revealed by radiography.

- Learn about the different types of diagnostic tests. The doctor can offer you a variety of examination options, so it is better to find out in advance what they are so that you agree to the necessary ones, but not to do unnecessary ones. It will be very useful to know which tests are needed and which are not relevant to diagnosing an aneurysm at all. So, most often in this case they are carried out:

1. Computed tomography (CT) is a special type of x-ray examination commonly used to detect bleeding. The scanner will scan the brain layer by layer, which may require an injection of X-ray contrast fluid.
2. Magnetic resonance imaging (MRI) - this type of examination is based on the use of radio waves that interact with a magnetic field. The result of an MRI will be a two- or three-dimensional image of your brain. An injection of radiopaque contrast fluid may be required.
3. CSF leak – also known as a spinal tap. This test is used when a patient suffers from bleeding that is not detected by other tests. The name, of course, of this test is creepy, but there is no need to worry? Few people feel noticeable discomfort during the puncture.
4. Angiography of cerebral vessels is the most invasive of all the above studies, used when all others do not reveal anything. The idea is this: a catheter is inserted into the patient's body through the femoral artery, then a radiopaque liquid is supplied through the catheter. The liquid fills the vessels, the patient is scanned (at a very gentle level of radiation) with x-rays. This way, blood flow pathologies and areas of bleeding are identified.

- Contact a specialist. Having received a referral from your doctor for tests, if, of course, there is a reason for this, you should also discuss the examinations with the doctor who will conduct them.

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In principle, if the tests show something suspicious, then you will still have to talk to a neurosurgeon or neurologist. In any case, be prepared for the fact that additional tests and medical consultations may be required.

Conclusion:

As a c conclusion should be noted that cerebral aneurisms are getting more relevant in nowadays and spreading out in the modern society among both young and older generations. Taking into account the fact about severity of SAH and cerebral stroke, particularly how high level of emergency situations they may cause and the level of disability, that they may lead to, for medical workers it's better to practice the preventative treatment of cerebral aneurisms and not lead to their occurrence, or, if present, to their rupture.

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