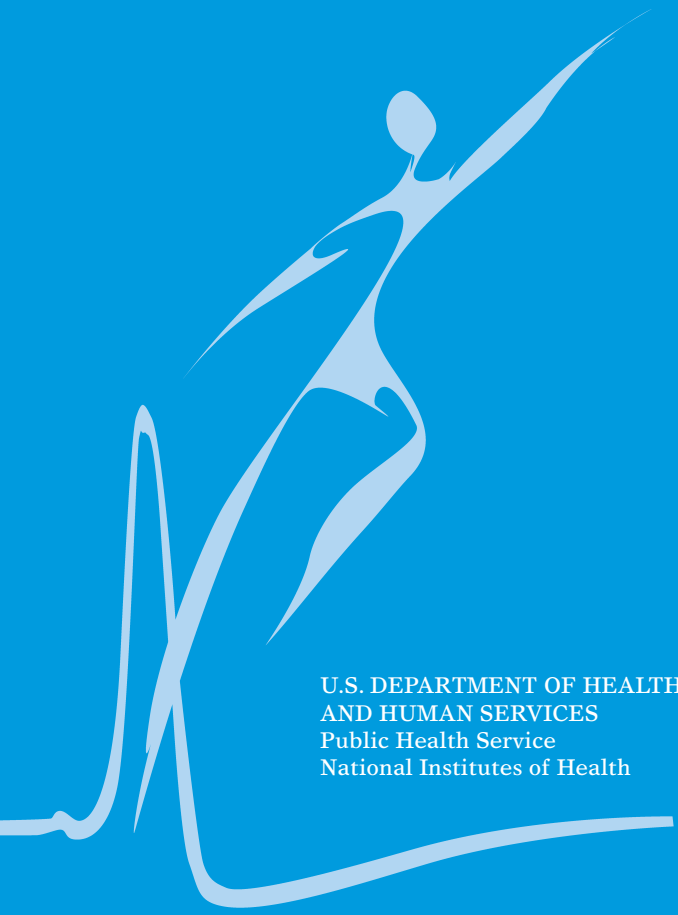
Cerebral Aneurysms



U.S. DEPARTMENT OF HEALTH
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Cerebral Aneurysms

What is a cerebral aneurysm?

A cerebral aneurysm (also known as an intracranial or intracerebral aneurysm) is a weak or thin spot on a blood vessel in the brain that balloons out and fills with blood. The bulging aneurysm can put pressure on a nerve or surrounding brain tissue. It may also leak or rupture, spilling blood into the surrounding tissue (called a hemorrhage). Some cerebral aneurysms, particularly those that are very small, do not bleed or cause other problems. Cerebral aneurysms can occur anywhere in the brain, but most are located along a loop of arteries that run between the underside of the brain and the base of the skull.

What causes a cerebral aneurysm?

Cerebral aneurysms can be congenital, resulting from an inborn abnormality in an artery wall. Cerebral aneurysms are also more common in people with certain genetic diseases, such as connective tissue disorders and polycystic kidney disease, and certain circulatory disorders, such as arteriovenous malformations (snarled tangles of arteries and veins in the brain that disrupt blood flow).

Other causes include trauma or injury to the head, high blood pressure, infection, tumors, atherosclerosis (a blood vessel disease in which fats build up on the inside of artery walls) and other diseases of the vascular system, cigarette smoking, and drug abuse. Some investigators have speculated that oral contraceptives may increase the risk of developing aneurysms.

Aneurysms that result from an infection in the arterial wall are called mycotic aneurysms. Cancer-related aneurysms are often associated with tumors of the head and neck. Drug abuse, particularly the habitual use of cocaine, can inflame blood vessels and lead to the development of brain aneurysms.

How are aneurysms classified?

There are three types of cerebral aneurysm. A *saccular* aneurysm is a rounded or pouch-like sac of blood that is attached by a neck or stem to an artery or a branch of a blood vessel. Also known as a berry aneurysm (because it resembles a berry hanging from a vine), this most common form of cerebral aneurysm is typically found on arteries at the base of the brain. Saccular aneurysms occur most often in adults. A *lateral* aneurysm appears as a bulge on one wall of the blood vessel, while a *fusiform* aneurysm is formed by the widening along all walls of the vessel.

Aneurysms are also classified by size. Small aneurysms are less than 11 millimeters in diameter (about the size of a large pencil eraser), larger aneurysms are 11-25 millimeters

(about the width of a dime), and giant aneurysms are greater than 25 millimeters in diameter (more than the width of a quarter).

Who is at risk?

Brain aneurysms can occur in anyone, at any age. They are more common in adults than in children and slightly more common in women than in men. People with certain inherited disorders are also at higher risk.

All cerebral aneurysms have the potential to rupture and cause bleeding within the brain. The incidence of reported ruptured aneurysm is about 10 in every 100,000 persons per year (about 30,000 individuals per year in the U.S.), most commonly in people between ages 30 and 60 years. Possible risk factors for rupture include hypertension, alcohol abuse, drug abuse (particularly cocaine), and smoking. In addition, the condition and size of the aneurysm affects the risk of rupture.

What are the dangers?

Aneurysms may burst and bleed into the brain, causing serious complications, including hemorrhagic stroke, permanent nerve damage, or death. Once it has burst, the aneurysm may burst again and bleed into the brain, and additional aneurysms may also occur. More commonly, rupture may cause a subarachnoid hemorrhage—bleeding into the space between the skull bone and the brain. A delayed but serious complication of subarachnoid hemorrhage is hydrocephalus, in which the excessive

buildup of cerebrospinal fluid in the skull dilates fluid pathways called ventricles that can swell and press on the brain tissue. Another delayed postrupture complication is vasospasm, in which other blood vessels in the brain contract and limit blood flow to vital areas of the brain. This reduced blood flow can cause stroke or tissue damage.

What are the symptoms?

Most cerebral aneurysms do not show symptoms until they either become very large or burst. Small, unchanging aneurysms generally will not produce symptoms, whereas a larger aneurysm that is steadily growing may press on tissues and nerves. Symptoms may include pain above and behind the eye; numbness, weakness, or paralysis on one side of the face; dilated pupils; and vision changes. When an aneurysm hemorrhages, an individual may experience a sudden and extremely severe headache, double vision, nausea, vomiting, stiff neck, and/or loss of consciousness. Individuals usually describe the headache as "the worst headache of my life" and it is generally different in severity and intensity from other headaches people may experience. "Sentinel" or warning headaches may result from an aneurysm that leaks for days to weeks prior to rupture. Only a minority of individuals have a sentinel headache prior to aneurysm rupture.

Other signs that a cerebral aneurysm has burst include nausea and vomiting associated with a severe headache, a drooping eyelid, sensitivity to light, and change in mental status or level of awareness. Some individuals may have seizures. Individuals may lose consciousness briefly or go into prolonged coma. People experiencing this "worst headache," especially when it is combined with any other symptoms, should seek immediate medical attention.

How are cerebral aneurysms diagnosed?

Most cerebral aneurysms go unnoticed until they rupture or are detected by brain imaging that may have been obtained for another condition. Several diagnostic methods are available to provide information about the aneurysm and the best form of treatment. The tests are usually obtained after a subarachnoid hemorrhage, to confirm the diagnosis of an aneurysm.

Angiography is a dye test used to analyze the arteries or veins. An *intracerebral angiogram* can detect the degree of narrowing or obstruction of an artery or blood vessel in the brain, head, or neck, and can identify changes in an artery or vein such as a weak spot like an aneurysm. It is used to diagnose stroke and to precisely determine the location, size, and shape of a brain tumor, aneurysm, or blood vessel that has bled. This test is usually performed in a hospital angiography suite. Following the injection of a local anesthetic, a flexible

catheter is inserted into an artery and threaded through the body to the affected artery. A small amount of contrast dye (one that is highlighted on x-rays) is released into the bloodstream and allowed to travel into the head and neck. A series of x-rays is taken and changes, if present, are noted.

Computed tomography (CT) of the head is a fast, painless, noninvasive diagnostic tool that can reveal the presence of a cerebral aneurysm and determine, for those aneurysms that have burst, if blood has leaked into the brain. This is often the first diagnostic procedure ordered by a physician following suspected rupture. X-rays of the head are processed by a computer as two-dimensional cross-sectional images, or "slices," of the brain and skull. Occasionally a contrast dye is injected into the bloodstream prior to scanning. This process, called *CT angiography*, produces sharper, more detailed images of blood flow in the brain arteries. CT is usually conducted at a testing facility or hospital outpatient setting.

Magnetic resonance imaging (MRI) uses computer-generated radio waves and a powerful magnetic field to produce detailed images of the brain and other body structures. *Magnetic resonance angiography (MRA)* produces more detailed images of blood vessels. The images may be seen as either three-dimensional pictures or two-dimensional cross-slices of the brain and vessels. These painless, noninvasive

procedures can show the size and shape of an unruptured aneurysm and can detect bleeding in the brain.

Cerebrospinal fluid analysis may be ordered if a ruptured aneurysm is suspected. Following application of a local anesthetic, a small amount of this fluid (which protects the brain and spinal cord) is removed from the subarachnoid space—located between the spinal cord and the membranes that surround it—by a spinal needle and tested to detect any bleeding or brain hemorrhage. In individuals with suspected subarachnoid hemorrhage, this procedure is usually done in a hospital.

How are cerebral aneurysms treated?

Not all cerebral aneurysms burst. Some people with very small aneurysms may be monitored to detect any growth or onset of symptoms and to ensure aggressive treatment of coexisting medical problems and risk factors. Each case is unique, and considerations for treating an unruptured aneurysm include the type, size, and location of the aneurysm; risk of rupture; the individual's age, health, and personal and family medical history; and risk of treatment.

Two surgical options are available for treating cerebral aneurysms, both of which carry some risk to the individual (such as possible damage to other blood vessels, the potential for aneurysm recurrence and rebleeding, and the risk of post-operative stroke).

Microvascular clipping involves cutting off the flow of blood to the aneurysm. Under anesthesia, a section of the skull is removed and the aneurysm is located. The neurosurgeon uses a microscope to isolate the blood vessel that feeds the aneurysm and places a small, metal, clothespin-like clip on the aneurysm's neck, halting its blood supply. The clip remains in the person and prevents the risk of future bleeding. The piece of the skull is then replaced and the scalp is closed. Clipping has been shown to be highly effective, depending on the location, shape, and size of the aneurysm. In general, aneurysms that are completely clipped surgically do not return.

A related procedure is an occlusion, in which the surgeon clamps off (occludes) the entire artery that leads to the aneurysm. This procedure is often performed when the aneurysm has damaged the artery. An occlusion is sometimes accompanied by a bypass, in which a small blood vessel is surgically grafted to the brain artery, rerouting the flow of blood away from the section of the damaged artery.

Endovascular embolization is an alternative to surgery. Once the individual has been anesthetized, the doctor inserts a hollow plastic tube (a catheter) into an artery (usually in the groin) and threads it, using angiography, through the body to the site of the aneurysm. Using a guide wire, detachable

coils (spirals of platinum wire) are passed through the catheter and released into the aneurysm. The coils fill the aneurysm, block it from circulation, and cause the blood to clot, which effectively destroys the aneurysm. The procedure may need to be performed more than once during the person's lifetime.

People who receive treatment for an aneurysm must remain in bed until the bleeding stops. Underlying conditions, such as high blood pressure, should be treated. Other treatment for cerebral aneurysm is symptomatic and may include anticonvulsants to prevent seizures and analgesics to treat headache. Vasospasm can be treated with calcium channel-blocking drugs and sedatives may be ordered if the person is restless. A shunt may be surgically inserted into a ventricle several months following rupture if the buildup of cerebrospinal fluid is causing harmful pressure on surrounding tissue. Individuals who have suffered a subarachnoid hemorrhage often need rehabilitative, speech, and occupational therapy to regain lost function and learn to cope with any permanent disability.

Can cerebral aneurysms be prevented?

There are no known ways to prevent a cerebral aneurysm from forming. People with a diagnosed brain aneurysm should carefully control high blood pressure, stop smoking, and avoid cocaine

use or other stimulant drugs. They should also consult with a doctor about the benefits and risks of taking aspirin or other drugs that thin the blood. Women should check with their doctors about the use of oral contraceptives.

What is the prognosis?

An unruptured aneurysm may go unnoticed throughout a person's lifetime. A burst aneurysm, however, may be fatal or could lead to hemorrhagic stroke, vasospasm (the leading cause of disability or death following a burst aneurysm), hydrocephalus, coma, or short-term and/or permanent brain damage.

The prognosis for persons whose aneurysm has burst is largely dependent on the age and general health of the individual, other pre-existing neurological conditions, location of the aneurysm, extent of bleeding (and rebleeding), and time between rupture and medical attention. It is estimated that about 40 percent of individuals whose aneurysm has ruptured do not survive the first 24 hours; up to another 25 percent die from complications within 6 months. People who experience subarachnoid hemorrhage may have permanent neurological damage. Other individuals may recover with little or no neurological deficit. Delayed complications from a burst aneurysm may include hydrocephalus and vasospasm. Early diagnosis and treatment are important.

Individuals who receive treatment for an unruptured aneurysm generally require less rehabilitative therapy and recover more quickly than persons whose aneurysm has burst. Recovery from treatment or rupture may take weeks to months.

Clinical studies suggest that in the first six months after treatment patients treated with endovascular coiling have less disability than those with surgical clipping, but that beyond six months after treatment the amount of disability is about the same. Long-term results of coiling procedures are uncertain and investigators need to conduct more research on this topic, since some aneurysms can recur after coiling. Individuals may want to consult a specialist in both endovascular and surgical repair of aneurysms, to help provide greater understanding of treatment options.

What research is being done?

The National Institute of Neurological Disorders and Stroke (NINDS), a component of the National Institutes of Health (NIH) within the U.S. Department of Health and Human Services, is the nation's primary supporter of research on the brain and nervous system. As part of its mission, the NINDS conducts research on intracranial aneurysms and other vascular lesions of the nervous system and supports studies through grants to medical institutions across the country.

The NINDS sponsored the International Study of Unruptured Intracranial Aneurysms, which included more than 4,000 people at 61 sites in the United States, Canada, and Europe. The findings suggest that the risk of rupture for most very small aneurysms (less than 7 millimeters in size) is small. The results also provide a more comprehensive look at these vascular defects and offer guidance to individuals and physicians facing the difficult decision about whether or not to treat an aneurysm surgically.

The Familial Intracranial Aneurysm Study is a collaborative research effort of scientists in the United States, Canada, Australia, and New Zealand to identify possible genes that may increase the risk of development of aneurysms in blood vessels of the brain. The study will involve 475 families with multiple affected family members. Researchers also hope to determine the effect of environmental factors such as cigarette smoking and high blood pressure on the expression of these genes.

The relationship between intracranial and aortic aneurysm has long been recognized but poorly quantified. Recent genome-wide association studies (GWAS) provide molecular evidence for shared biological function and activities (pathophysiology) of these aneurysms. A specific site on chromosome

9p21 has been identified as increasing the risk for both intracranial and aortic aneurysms. These GWAS data, along with linkage data to other susceptible locations for genes or DNA sequences, indicate that individuals and families harboring one type of aneurysm may be at especially increased risk of the other.

Other scientists are studying additional chromosomes and chromosomal regions to identify aneurysm-related genes.

Aspirin may lessen inflammation in cerebral aneurysms and reduce their incidence of rupture. Scientists using enhanced MRI to monitor the signal generated by macrophages (a type of white blood cell that travels to the injury site during the inflammatory response) hope to determine if daily aspirin intake for three months will reduce the MRI signal changes generated by macrophages in the aneurysm wall.

The incidence of intracranial aneurysms and subarachnoid hemorrhage is significantly higher in women after menopause than in men. Estrogen replacement therapy reduces the risk for subarachnoid hemorrhage in post-menopausal women. Researchers are investigating the role of estrogen in the pathophysiology of intracranial aneurysms.

Other research projects include studies of the effectiveness of microsurgical clipping and endovascular surgery to treat various types of ruptured and unruptured aneurysms, the use of various types of coils to block the flow of blood into the aneurysm, and the aspects of blood flow (hemodynamics), such as blood flow velocity and blood pressure, in initiating cerebral aneurysms.

Where can I get more information?

For more information on neurological disorders or research programs funded by the National Institute of Neurological Disorders and Stroke, contact the Institute's Brain Resources and Information Network (BRAIN) at:

BRAIN
P.O. Box 5801
Bethesda, MD 20824
800-352-9424
www.ninds.nih.gov

Information also is available from the following organizations:

Brain Aneurysm Foundation
269 Hanover Street
Building 3
Hanover, MA 02339
781-826-5556
888-BRAIN02 (272-4602)
www.bafound.org

American Association of
Neurological Surgeons
5550 Meadowbrook Drive
Rolling Meadows, IL 60008-3852
847-378-0500
888 566-AANS (2267)
www.anns.org

American Stroke Association:
A Division of American Heart Association
7272 Greenville Avenue
Dallas, TX 75231-4596
888-4STROKE (478-7653)
www.strokeassociation.org

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