Cerebral Aneurysms

U.S. DEPARTMENT OF HEALTH
AND HUMAN SERVICES
National Institutes of Health

Cerebral Aneurysms

What is a cerebral aneurysm?

A cerebral aneurysm (also known as a brain aneurysm) is a weak or thin spot on an artery in the brain that balloons or bulges out and fills with blood. The bulging aneurysm can put pressure on the nerves or brain tissue. It may also burst or rupture, spilling blood into the surrounding tissue (called a hemorrhage). A ruptured aneurysm can cause serious health problems such as hemorrhagic stroke, brain damage, coma, and even death.

Some cerebral aneurysms, particularly those that are very small, do not bleed or cause other problems. These types of aneurysms are usually detected during imaging tests for other medical conditions. Cerebral aneurysms can occur anywhere in the brain, but most form in the major arteries along the base of the skull.

Brain aneurysms can occur in anyone and at any age. They are most common in adults between the ages of 30 and 60 and are 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 or surrounding area. Approximately 30,000 Americans per year suffer a brain aneurysm rupture. Much less is known about how many people have cerebral aneurysms, since they don't always cause symptoms.

What are the symptoms?

Unruptured aneurysm

Most cerebral aneurysms do not show symptoms until they either become very large or rupture. Small unchanging aneurysms generally will not produce symptoms.

A larger aneurysm that is steadily growing may press on tissues and nerves causing:

- pain above and behind the eye
- numbness
- weakness
- paralysis on one side of the face
- a dilated pupil in the eye
- vision changes or double vision.

Ruptured aneurysm

When an aneurysm ruptures (bursts), one always experiences a sudden and extremely severe headache (e.g., the worst headache of one's life) and may also develop:

- double vision
- nausea
- vomiting

- stiff neck
- sensitivity to light
- seizures
- loss of consciousness (this may happen briefly or may be prolonged)
- cardiac arrest.

Leaking aneurysm

Sometimes an aneurysm may leak a small amount of blood into the brain (called a sentinel bleed). Sentinel or warning headaches may result from an aneurysm that suffers a tiny leak, days or weeks prior to a significant rupture. However, only a minority of individuals have a sentinel headache prior to rupture.

If you experience a sudden, severe headache, especially when it is combined with any other symptoms, you should seek immediate medical attention.

How are aneurysms classified?

Type

There are three types of cerebral aneurysms:

- **Saccular aneurysm**. A saccular aneurysm is a rounded sac containing blood, that is attached to a main artery or one of its branches. Also known as a berry aneurysm (because it resembles a berry hanging from a vine), this is the most common form of cerebral aneurysm. It is typically found on arteries at the base of the brain. Saccular aneurysms occur most often in adults, and are found in about 2 to 3 percent of the population.

- **Fusiform aneurysm**. A fusiform aneurysm balloons or bulges out on all sides of the artery.
- **Mycotic aneurysm**. A mycotic aneurysm occurs as the result of an infection that can sometimes affect the arteries in the brain. The infection weakens the artery wall, causing a bulging aneurysm to form.

Size

Aneurysms are also classified by size: small, large, and giant.

- Small aneurysms are less than 11 millimeters in diameter (about the size of a large pencil eraser).
- Large aneurysms are 11 to 25 millimeters (about the width of a dime).
- Giant aneurysms are greater than 25 millimeters in diameter (more than the width of a quarter).

What causes a cerebral aneurysm?

Cerebral aneurysms form when the walls of the arteries in the brain become thin and weaken. Aneurysms typically form at branch points in arteries because these sections are the weakest. Occasionally, cerebral aneurysms may be present from birth, usually resulting from an abnormality in an artery wall.

Risk factors for developing an aneurysm

Sometimes cerebral aneurysms are the result of inherited risk factors, including:

- genetic connective tissue disorders that weaken artery walls
- polycystic kidney disease (in which numerous cysts form in the kidneys)
- arteriovenous malformations (snarled tangles of arteries and veins in the brain that disrupt blood flow. Some AVMs develop sporadically, or on their own.)
- history of aneurysm in a first-degree family member (child, sibling, or parent).

Other risk factors develop over time and include:

- untreated high blood pressure
- cigarette smoking
- drug abuse, especially cocaine or amphetamines, which raise blood pressure to dangerous levels. Intravenous drug abuse is a cause of infectious mycotic aneurysms.
- age over 40.

Less common risk factors include:

- head trauma
- brain tumor
- infection in the arterial wall (mycotic aneurysm).

Additionally, high blood pressure, cigarette smoking, diabetes, and high cholesterol puts one at risk of atherosclerosis (a blood vessel disease in which fats build up on the inside of artery walls), which can increase the risk of developing a fusiform aneurysm.

Risk factors for an aneurysm to rupture

Not all aneurysms will rupture. Aneurysm characteristics such as size, location, and growth during follow-up evaluation may affect the risk that an aneurysm will rupture. In addition, medical conditions may influence aneurysm rupture.

Risk factors include:

- **Smoking**. Smoking is linked to both the development and rupture of cerebral aneurysms. Smoking may even cause multiple aneurysms to form in the brain.
- **High blood pressure**. High blood pressure damages and weakens arteries, making them more likely to form and to rupture.
- **Size**. The largest aneurysms are the ones most likely to rupture in a person who previously did not show symptoms.
- **Location**. Aneurysms located on the posterior communicating arteries (a pair of arteries in the back part of the brain) and possibly those on the anterior communicating artery (a single artery in the front of the brain) have a higher risk of rupturing than those at other locations in the brain.

- **Growth**. Aneurysms that grow, even if they are small, are at increased risk of rupture.
- **Family history**. A family history of aneurysm rupture suggests a higher risk of rupture for aneurysms detected in family members.
- The greatest risk occurs in individuals with multiple aneurysms who have already suffered a previous rupture or sentinel bleed.

How are cerebral aneurysms diagnosed?

Most cerebral aneurysms go unnoticed until they rupture or are detected during medical imaging tests for another condition.

If you have experienced a severe headache or have any other symptoms related to a ruptured aneurysm, your doctor will order tests to determine if blood has leaked into the space between the skull bone and brain.

Several tests are available to diagnose brain aneurysms and determine the best treatment. These include:

- **Computed tomography** (CT)**.** This fast and painless scan is often the first test a physician will order to determine if blood has leaked into the brain. CT uses x-rays to create two-dimensional images, or "slices," of the brain and skull. Occasionally a contrast dye is injected into the bloodstream prior to scanning to assess the arteries, and look

for a possible aneurysm. This process, called CT angiography (CTA), produces sharper, more detailed images of blood flow in the brain arteries. CTA can show the size, location, and shape of an unruptured or a ruptured aneurysm.

- **Magnetic resonance imaging** (MRI)**.** An MRI uses computer-generated radio waves and a magnetic field to create two- and three-dimensional detailed images of the brain and can determine if there has been bleeding into the brain. Magnetic resonance angiography (MRA) produces detailed images of the brain arteries and can show the size, location, and shape of an aneurysm.
- **Cerebral angiography.** This imaging technique can find blockages in arteries in the brain or neck. It also can identify weak spots in an artery, like an aneurysm. The test is used to determine the cause of the bleeding in the brain and the exact location, size, and shape of an aneurysm. Your doctor will pass a catheter (long, flexible tube) typically from the groin arteries to inject a small amount of contrast dye into your neck and brain arteries. The contrast dye helps the X-ray create a detailed picture of the appearance of an aneurysm and a clear picture of any blockage in the arteries.
- **Cerebrospinal fluid** (CSF) **analysis.** This test measures the chemicals in the fluid that cushions and protects the brain and spinal cord (cerebrospinal fluid).

Most often a doctor will collect the CSF by performing a spinal tap (lumbar puncture), in which a thin needle is inserted into the lower back (lumbar spine) and a small amount of fluid is removed and tested. The results will help detect any bleeding around the brain. If bleeding is detected, additional tests would be needed to identify the exact cause of the bleeding.

What are the complications of a ruptured cerebral aneurysm?

Aneurysms may rupture and bleed into the space between the skull and the brain (subarachnoid hemorrhage) and sometimes into the brain tissue (intracerebral hemorrhage). These are forms of stroke called hemorrhagic stroke. The bleeding into the brain can cause a wide spectrum of symptoms, from a mild headache to permanent damage to the brain, or even death.

After an aneurysm has ruptured it may cause serious complications such as:

- **Rebleeding**. Once it has ruptured, an aneurysm may rupture again before it is treated, leading to further bleeding into the brain, and causing more damage or death.
- **Change in sodium level.** Bleeding in the brain can disrupt the balance of sodium in the blood supply and cause swelling in brain cells. This can result in permanent brain damage.

- **Hydrocephalus**. Subarachnoid hemorrhage can cause hydrocephalus. Hydrocephalus is a buildup of too much cerebrospinal fluid in the brain, which causes pressure that can lead to permanent brain damage or death. Hydrocephalus occurs frequently after subarachnoid hemorrhage because the blood blocks the normal flow of cerebrospinal fluid. If left untreated, increased pressure inside the head can cause coma or death.
- **Vasospasm**. This occurs frequently after subarachnoid hemorrhage when the bleeding causes the arteries in the brain to contract and limit blood flow to vital areas of the brain. This can cause strokes from lack of adequate blood flow to parts of the brain.
- **Seizures.** Aneurysm bleeding can cause seizures (convulsions), either at the time of bleed or in the immediate aftermath. While most seizures are evident, on occasion they may only be seen by sophisticated brain testing. Untreated seizures or those that do not respond to treatment can cause brain damage.

How are cerebral aneurysms treated?

Not all cerebral aneurysms require treatment. Some very small unruptured aneurysms that are not associated with any factors suggesting a higher risk of rupture may be safely left alone and monitored with MRA or CTA to detect any growth. It is important to aggressively treat any coexisting medical problems and risk factors.

Treatments for unruptured cerebral aneurysms that have not shown symptoms have some potentially serious complications and should be carefully weighed against the predicted rupture risk.

Treatment considerations for unruptured aneurysms

A doctor will consider a variety of factors when determining the best option for treating an unruptured aneurysm, including:

- type, size, and location of the aneurysm
- risk of rupture
- the person's age and health
- personal and family medical history
- risk of treatment.

Individuals should also take the following steps to reduce the risk of aneurysm rupture:

- carefully control blood pressure
- stop smoking
- avoid cocaine use or other stimulant drugs.

Treatments for unruptured and ruptured cerebral aneurysms

Surgery, endovascular treatments, or other therapies are often recommended to manage symptoms and prevent damage from unruptured and ruptured aneurysms.

Surgery

There are a few surgical options available for treating cerebral aneurysms. These procedures carry some risk such as possible damage to other blood vessels, the potential for aneurysm recurrence and rebleeding, and a risk of stroke.

- **Microvascular clipping.** This procedure involves cutting off the flow of blood to the aneurysm and requires open brain surgery. A doctor will locate the blood vessels that feed the aneurysm and place a tiny, metal, clothespin-like clip on the aneurysm's neck to stop its blood supply. Clipping has been shown to be highly effective, depending on the location, size, and shape of the aneurysm. In general, aneurysms that are completely clipped do not recur.

Endovascular treatment

- **Platinum coil embolization.** This procedure is a less invasive procedure than microvascular surgical clipping. A doctor will insert a hollow plastic tube (a catheter) into an artery, usually in the groin, and thread it through the body to the brain aneurysm. Using a wire, the doctor will pass detachable coils (tiny spirals of

platinum wire) through the catheter and release them into the aneurysm. The coils block the aneurysm and reduce the flow of blood into the aneurysm. The procedure may need to be performed more than once during the person's lifetime because aneurysms treated with coiling can sometimes recur.

- **Flow diversion devices.** Other endovascular treatment options include placing a small stent (flexible mesh tube), similar to those placed for heart blockages, in the artery to reduce blood flow into the aneurysm. A doctor will insert a hollow plastic tube (a catheter) into an artery, usually in the groin, and thread it through the body to the artery on which the aneurysm is located. This procedure is used to treat very large aneurysms and those that cannot be treated with surgery or platinum coil embolization.

Other treatments

Other treatments for a ruptured cerebral aneurysm aim to control symptoms and reduce complications. These treatments include:

- **Antiseizure drugs** (anticonvulsants)**.** These drugs may be used to prevent seizures related to a ruptured aneurysm.
- **Calcium channel-blocking drugs**. Risk of stroke by vasospasm can be reduced with calcium channel-blocking drugs.

- **Shunt**. A shunt, which funnels cerebrospinal fluid from the brain to elsewhere in the body, may be surgically inserted into the brain following rupture if the buildup of cerebrospinal fluid (hydrocephalus) is causing harmful pressure on surrounding brain tissue.
- **Rehabilitative therapy**. Individuals who have suffered a subarachnoid hemorrhage often need physical, speech, and occupational therapy to regain lost function and learn to cope with any permanent disability.

What is the prognosis?

An unruptured aneurysm may go unnoticed throughout a person's lifetime and not cause symptoms.

After an aneurysm bursts, the person's prognosis largely depends on:

- age and general health
- pre-existing neurological conditions
- location of the aneurysm
- extent of bleeding (and rebleeding)
- time between rupture and medical attention
- successful treatment of the aneurysm.

About 25 percent of individuals whose cerebral aneurysm has ruptured do not survive the first 24 hours; another 25 percent die from complications within 6 months. People who experience subarachnoid hemorrhage may have permanent neurological damage. Other individuals recover with little or no disability. Diagnosing and

treating a cerebral aneurysm as soon as possible will help increase the chances of making a full recovery.

Recovery from treatment or rupture may take weeks to months.

What research is being done?

The mission of the National Institute of Neurological Disorders and Stroke (NINDS) is to seek fundamental knowledge about the brain and nervous system and to use that knowledge to reduce the burden of neurological disease. The NINDS is a component of the National Institutes of Health (NIH), the leading federal supporter of biomedical research in the world. As part of its mission, the NINDS conducts research on cerebral aneurysms and supports studies through grants to medical institutions across the country.

The NINDS-funded International Study of Unruptured Intracranial Aneurysms collected natural history data that guides medical decision-making based on size and location of asymptomatic aneurysms.

Genetics

Scientists have long known about the link between cerebral and aortic aneurysms (the aorta is the body's main artery). However, they still do not fully understand the relationship between the two types of aneurysm. 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 cerebral and aortic aneurysms. This 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.

Diagnostic tools

Cerebral aneurysms located at the posterior communicating artery and in the arteries in the back part of the brain (called the vertebral and basilar arteries) are common and have higher risk of rupture than aneurysms at other locations. NINDS-funded scientists are working to identify the features associated with rupture and will use these factors to build a scoring scale to guide and support clinical decisions.

The risk of having an aneurysm burst is difficult to determine and there can be serious complications from surgical treatments. Researchers are developing a new model to diagnose brain aneurysms based on the presence of molecules that can potentially tell whether there is a high chance of an aneurysm burst. This procedure can be done by using brain imaging without the need to open the skull. Not only would this new tool be less invasive, it would also allow for people to be treated before an aneurysm bursts.

Hormones and medication

Studies indicate aspirin lessens inflammation in cerebral aneurysms and reduces the risk of rupture. However, aspirin also inhibits the blood cells (platelets) that are important in stopping bleeding once a rupture occurs. Researchers are using mouse models to examine how inflammation impacts the formation and rupture of cerebral aneurysms, and the molecular mechanisms that contribute to the protective effect of aspirin.

Cerebral aneurysms and subarachnoid hemorrhage are more common in post-menopausal women than in men. Estrogen replacement therapy reduces the risk for subarachnoid hemorrhage in post-menopausal women. Researchers are investigating exactly how estrogen protects women against developing aneurysms. They hypothesize protection primarily occurs through inflammatory cells.

Treatments

Other research projects include studies of the effectiveness of microsurgical clipping and endovascular surgery to treat ruptured and unruptured aneurysms, the use of various types of coils and other materials to block the flow of blood into the aneurysm, and the influence of blood flow speed and pressure on the success or failure of treatment.

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

More information about aneurysm research supported by NINDS and other NIH Institutes and Centers can be found using NIH RePORTER (projectreporter.nih.gov), a searchable database of current and past research projects supported by NIH and other federal agencies. RePORTER also includes links to publications and resources from these projects.

Information also is available from the following organizations:

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

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

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

Joe Niekro Foundation
26780 N. 77th Street
Scottsdale, AZ 85266
877-803-7650
www.joeniekrofoundation.com

National Institute of
Neurological Disorders
and Stroke

NIH . . . Turning Discovery Into Health

Prepared by:
Office of Communications and Public Liaison
National Institute of Neurological
Disorders and Stroke
National Institutes of Health
Department of Health and Human Services
Bethesda, Maryland 20892-2540

NIH Publication No. 18-NS-5505 May 2018