CEREBRAL ANEURYSMS

A PATIENT’S GUIDE

AN EDUCATIONAL BROCHURE FROM THE AMERICAN ASSOCIATION OF NEUROLOGICAL SURGEONS
WHAT IS CEREBRAL ANEURYSM?

A cerebral (brain or intracranial) aneurysm is an area where a blood vessel in the brain weakens, resulting in a bulging or ballooning out of part of the vessel wall, usually at the point where a blood vessel branches, because the “fork” is structurally more vulnerable. The disorder may result from congenital defects of from other conditions such as high blood pressure, atherosclerosis (the build-up of fatty deposits in the arteries), infection, or head trauma. Aneurysms can range in size from a few millimetres (about one-eighth of an inch) to more than two centimetres (about eight-tenths of an inch). They are usually found at the base of the brain just inside the skull, in an area called the “subarachnoid space.” This space is filled with cerebrospinal fluid (CSF) that bathes the brain. Aneurysms can cause bleeding in this space (see “Risks and Complications”).

TYPES OF CEREBRAL ANEURYSMS

Saccular Aneurysms (Figure 1) are the most common type of aneurysms and occur at the branching points of the large blood vessels at the base of the brain. At these branching points, the walls of the blood vessels are exposed to increased stress as the blood flow is forced to change directions. This constant stress can gradually damage the vessels and cause the vessel wall to balloon. Saccular aneurysms develop gradually over a period of years, so the risk of rupture increases with age.
While the exact cause of aneurysms is unknown, a number of factors believed to contribute to their formation. These include 1) Hypertension (high blood pressure); 2) Cigarette smoking/nicotine use; 3) Diabetes; 4) Excessive alcohol consumption; 5) Congenital (genetic) predisposition; 6) Traumatic aneurysms occur when an accident or trauma injures a cerebral blood vessel. The damage blood vessel weakens at the site of injury which may cause it to rupture.

Fusiform aneurysms are aneurysms that are not saccular in shape but rather are diffuse outpouchings or bulges of the vessel wall involving most of the entire circumference of the blood vessel itself. These types of aneurysms may rupture or may cause symptoms similar to stroke by compressing the surrounding brain or by embolizing debris that blocks the blood vessels away from the aneurysm.

Mycotic aneurysms are rare and result from an infection. The infection damages and weakens the blood vessel, thereby increasing the associated risk of rupture. The infection is most commonly a complication of subacute bacterial endocarditis (a type of infection involving the heart).

Traumatic aneurysms occur when an accident or trauma injures a cerebral blood vessel. The damage blood vessel weakens at the site of injury which may cause it to rupture.

Every year, an estimated 30,000 people in the United States experience a ruptured aneurysm. Aneurysms occur in all age groups, but the incidence increases steadily for individuals age 25 and older, is most prevalent in people ages 50 to 60, and about three times more prevalent in women. Rupture aneurysms are fatal about 30 to 40 percent of the time. The presence of multiple aneurysms or a family history of aneurysms increases risk.

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6) Injury or trauma to blood vessels; and 7) Complication from some types of blood infections.

**WARNING SIGNS / SYMPTOMS**

People who suffer a ruptures aneurysm may have warning signs, including:

- Localized headache
- Nausea and vomiting
- Stiff neck
- Blurred or double vision
- Sensitivity to light (photophobia)
- Loss of sensation

Many people with unruptured aneurysms have no symptoms. Others might experience some or all of the following symptoms:

- Cranial nerve palsy
- Dilated pupils
- Double vision
- Pain above and behind the eye
- Localized headache
- Progressive weakness or numbness

**RISKS AND COMPLICATIONS**

When aneurysms rupture, they often result in a subarachnoid haemorrhage (SAH) (Figure 2, next page). SAH occurs when a blood vessel just outside the brain ruptures. If an aneurysm bleed into the subarachnoid space, it releases high pressure blood from the artery into the low pressure spinal fluid space, stretching and distending the spinal fluid space and the brain. It fills the spinal fluid space with blood. If the point of leakage in the aneurysm is capped by a small bit of clot t its dome and the bleeding stops, the person may survive the haemorrhage. With each additional haemorrhage, however, survival becomes less likely. Most cases of spontaneous SAH are caused by aneurysms. Identifying the exact location, size and configuration of the aneurysms is critical to prevent re-hemorrhage, which occurs in about 20 percent of cases within the first 14 days after the initial rupture.
Figure 2 – CT Scan demonstrating the subarachnoid hemorrhage and the hydrocephalus from acute rupture of a cerebral aneurysm. The hemorrhage, or blood, is the white material designated by the white arrows (pointing the enlarged black fluid-filled spaces, called the ventricles, of the brain).

SAH results in fatality 20 to 40 percent of the time, and carries devastating consequences of neurological dysfunction an additional 25 percent of the time.

Blood entering the cerebrospinal fluid (CSF) in the subarachnoid space or areas surrounding the brain can irritate, damage, or destroy nearby brain cells. This may cause problems with bodily functions or mental skills. In more serious cases, the bleeding may cause significant brain damage, paralysis or coma.

If the aneurysm is large, it may cause additional problems just by virtue of its size, with its growth compressing the normal brain and causing the brain to malfunction due to local pressure. Additionally, a hematoma (blood clot) may fill the inside of the aneurysm, and some of this blood lot may be swept upstream out of the aneurysm and cause multiple small strokes.

Blood leaking around the brain (SAH) can cause vasospasm, a narrowing of the blood vessels, which decreases the amount of blood supplied to the brain, and may result in a stroke. Vasospasm usually develops 5-8 days after the initial hemorrhage. To treat vasospasm, blood pressure is often
Rupture of an aneurysm can cause brain edema (collection of fluid in the tissue) or swelling. This can produce severe problems with brain function by increasing pressure in the skull and damaging brain cells. Ischemia (or lack of blood flow to certain parts of the brain) caused by blockage of one or more blood vessels, from a complication of the bleed itself or as a complication of treatment, can also cause brain swelling, increase pressure in the head and cause damage to brain cells.

Cerebral angiography: This test is currently the gold standard for aneurysm identification, by which all other evaluations are judged. This test is done in the radiology department of the hospital, and the patient is usually awake, although mild sedation may be given. The patient lies down.

Blood from a ruptured aneurysm can block CSF circulation, leading to hydrocephalus (figure 2), a condition in which excess CSF builds up within the ventricles (fluid-containing cavities) of the brain. This may increase pressure within the head. To stop fluid from building up, a drain (shunt) may be placed in ventricles, to remove excess CSF and blood that has leaked.

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**DIAGNOSTIC TESTING**

Because your neurosurgeon critically needs accurate information regarding the presence of the aneurysm, small blood vessels that may arise near the aneurysm, or additional aneurysms, each of the following test can play an important role. He or she will evaluate what additional information is needed and which test is the most appropriate for your specific case.

**Cerebral angiography:** This test is currently the gold standard for aneurysm identification, by which all other evaluations are judged. This test is done in the radiology department of the hospital, and the patient is usually awake, although mild sedation may be given. The patient lies down.
Computed Tomographic Angiography (CTA): This is a newer technology in which an injection of a volume of contrast agent is administered, similar to that used in the conventional angiogram, usually through a vein in the patient’s arm. The risk of this procedure, similar to that with conventional angiography, is an allergic reaction to the dye and potential damage to the kidneys caused by the dye. The benefits are that there is no need to transfer patients to an angiographic suite; no additional personnel is required; the imaging is completed within one minute; and the is no risk of ischemic stroke.

Magnetic Resonance Imaging (MRI): A diagnostic test that produces three-dimensional images of body structures using magnetic fields and computer technology. It can clearly show various types of nerve tissue and clear pictures of brain anatomy. MRI of the brain can help determine whether there are signs of prior mini-strokes.
This test is non-invasive, although some patients may experience claustrophobia in the imager.

**Magnetic Resonance Angiogram (MRA):** This is a non-invasive study which is conducted in a Magnetic Resonance Imager. The magnetic images are assembled by a computer to provide an image of the arteries in the head and neck. The MRA shows the actual blood vessels and can help detect blockage and aneurysms.

**TREATMENT OPTIONS**

There are currently three treatment options for people with the diagnosis of an aneurysm:

1. Observation and/or nonsurgical therapy;
2. Surgical therapy/clipping; and
3. Endovascular therapy/coiling.

The treatment of choice for an aneurysm, like all medical decisions, should be agreed upon by both the physician and the patient. If the case is a medical emergency, in which the ruptured aneurysm has caused the patient to lose consciousness, this discussion may take place with the patient's nearest relative or medical decision maker. The treating physician will discuss the risks of benefits of each available treatment option. He or she will usually recommend one treatment over another, based on the patient's individual circumstances.

Complex or highly irregular aneurysms frequently involve a combination of surgical intervention and endovascular therapy. Neurosurgeons may be experts in both forms of treatment, or may work in close conjunction with an endovascular expert to evaluate cases on an individualized basis, to determine the safest long-term solution for each patient. Individual patient risk factors and resources available in the community may also contribute to determining the best, lowest risk treatment option.
While the best method of securing the aneurysm should be made on an individualized basis, in general, patients with a ruptured aneurysm should be treated as soon as possible. Surgical risks and outcome depend on whether or not the aneurysm has ruptured, the size and the location of the aneurysm, and the patient’s age and overall health.

**OBSERVATION AND/OR NONSURGICAL THERAPY**

Observation is considered a reasonable option if the aneurysm is small or in location which is felt to represent a low risk of growth or rupture. Repeated testing over time is required for observation, and the risks of aneurysmal hemorrhage remain, but are considered to be at the lower end of the risk spectrum and may be lower than the risks associated with treatment.

Medical therapy is an option reserved for the treatment of unruptured aneurysms. Patients can stop smoking or using nicotine, and control their blood pressure. These are important factors that have been shown to have significant effect on aneurysm formation, growth, and/or rupture. If you suffer from high blood pressure, your physician may prescribe an antihypertensive (blood pressure lowering) medication and/or diet and exercise program. Periodic radiographic imaging (MRA, cerebral angiography, or CTA) at regular intervals will likely be advised to monitor the size and/or growth of the aneurysm. The following are factor to consider in the treatment of unruptured aneurysms:

- Risk of hemorrhage – what is the probability of the aneurysm rupturing?
- Size and location
- Age and health of patient
- Family history
- Risks of treatment
TYPES OF CEREBRAL ANEURYSMS

Open surgical intervention has been around for the longest period of time and has generally been considered the gold standard treatment. An operation to “clip” the aneurysm is performed under general anaesthesia through a craniotomy, which is a surgical procedure in which the brain and the blood vessels are accessed by grating an opening in the skull (Figure 3, top). After the aneurysm is identified, it is carefully separated from the surrounding blood vessels and brain tissue. A small metal clip (usually made of titanium) is then applied to the neck (base) of the aneurysm (Figures 3 and 4). The size and shape of the clips is selected based on the size and location of the aneurysm. The clip has a spring mechanism which allows the two “jaws” of the clip to close around either side of the aneurysm, thus separating the aneurysm from its originating blood vessel. Angiography may be used to visualize closure of the aneurysm and preserve normal flow of blood in the brain (Figure 5; page 12. Clips are permanent, remain in place, and generally provide a durable cure for the patient.

Elective aneurysm surgery usually requires hospitalization for three to five days, with a period of three to four weeks off work. Hospitalization for patients with ruptured aneurysms is generally seven or more days. After an aneurysm is clipped surgically, a follow-up angiogram may be recommended at about five years post surgery.
Figure 3
Top- Skin incision and proposed craniotomy bone removal are indicated.
Bottom- Clipping performed to neck of aneurysm, permanently preventing blood flow into the aneurysm.

Figure 4
Left- exposure of ruptured right posterior communicating artery aneurysm. The neck has been dissected but the dome remains covered with clot
Right- following clip placement the aneurysm has been secured.
ADVANTAGES AND DISADVANTAGES OF SURGICAL THERAPY/CLIPPING

The advantages of clipping include: durability, direct visualization of the aneurysm (which can have very complex dimensions), the ability to decompress or deflate the aneurysm after clipping, and the ability to inspect other blood vessels in the area for smaller aneurysms. If there is haemorrhage, surgery has the advantage of enabling evacuation of some of the clotted blood surrounding the aneurysm and the base of the brain. In addition, a craniotomy, a surgical procedure in which part of the skull is removed and left off temporarily, may be done to help relieve raised pressure.

The disadvantages of surgery are its invasive nature, the possible complications of opening the cranium, and the risk of damaging other structures while clipping the aneurysm.
OBSERVATION AND/OR NONSURGICAL THERAPY

Endovascular treatment has been developed over the past 15 years, and has some similarities to procedures done by cardiologists to unblock clogged arteries in the heart and other blood vessels in the body. It has emerged as an acceptable alternative to open surgical clipping, particularly over the past five years. Patients who present a high surgical risk, patients who are in poor neurological condition, and patients which aneurysms in certain locations (such as the basilar artery) may be excellent candidates for endovascular treatment.

A recent, large study has shown that for ruptured aneurysms suitable for both clipping and endovascular coiling, patients who underwent endovascular coiling had better outcomes at least in the short term (chance of death or disability were at one year of 23.5 percent in patients who were coiled versus 30.9 percent in those who underwent clipping). There are notable limitations to this study, and numerous aneurysms remain unsuitable for endovascular treatment. Nonetheless, this study has firmly established endovascular coiling of aneurysms as an acceptable treatment option for select patients with aneurysms.

Endovascular coiling can be performed under general anaesthesia or sedation. The arterial system is entered through a large artery, usually in the groin (the femoral artery in the leg) (Figure 6). A needle is placed into the artery. A small catheter much like an angiogram catheter is advanced under x-ray control through the body to one of the four blood vessels that feed the brain. Through the catheter, a smaller catheter (micro-catheter) is advanced into the aneurysm. When the catheter is properly positioned in the aneurysm, a thin wire filament or “coil” is advanced into the aneurysm. This coil, made of flexible platinum, is designed to form itself into a basket and additional coils are advanced into the aneurysm to fill the aneurysm from the inside, preventing blood flow into the aneurysm. A clot forms within the aneurysm,
A procedure called balloon-assisted coiling uses a tiny balloon catheter to help hold the coil in place. A procedure called stent-assisted coiling utilizes a small flexible cylindrical mesh tube that provides a scaffold for the coiling. Both of these can be utilized as treatment options for complex aneurysms with wide bases.

Figure 6 – Coiling of a posterior communicating artery aneurysm. 
Left – A catheter is inserted in the femoral artery of the right groin. A tiny catheter is ultimately brought into the aneurysm in the head. 
Top Right – A tiny catheter is placed within the aneurysm to allow placement of coils inside it. 
Bottom Right – The aneurysm has been completely treated by packing with coils.

and in the long-term, new tissue may grow across the coils at the base of the aneurysm, resulting in complete healing (Figure 7. Next page).

A procedure called balloon-assisted coiling uses a tiny balloon catheter to help hold the coil in place. A procedure called stent-assisted coiling utilizes a small flexible cylindrical mesh tube that provides a scaffold for the coiling. Both of these can be utilized as treatment options for complex aneurysms with wide bases.
The disadvantages of endovascular treatment (coiling) include a lower chance of immediate complete aneurysm occlusion and a higher possibility of aneurysm recurrence. Another procedure may be needed and longer follow-up necessitated to ensure durable treatment.

The advantages of endovascular treatment are that it is minimally invasive, it does not require opening the cranium, and thus may have fewer early complications. Patients with unruptured aneurysms are frequently able to go home in a matter of one or two days and often can return to work within a week or two.

**ADVANTAGES AND DISADVANTAGES OF ENDOVASCULAR THERAPY/COILING**

Guglielmi Detachable Coils (GDC) were invented in the 1980s and allow the endovascular surgeon to insert a coil into an aneurysm or blood vessel, assess its position, and withdraw it if the result is less than satisfactory.

![Pre-operative(left) and post-operative angiograms demonstrating complete occlusion of a basilar aneurysm with coils. The red arrows indicate the aneurysm before coiling (left) and the complete obliteration of the aneurysm following coiling (right).](image)

Figure 7 – Pre-operative(left) and post-operative angiograms demonstrating complete occlusion of a basilar aneurysm with coils. The red arrows indicate the aneurysm before coiling (left) and the complete obliteration of the aneurysm following coiling (right).
RECOVERY AND FOLLOW UP

Recovery varies from patient to patient, depending on the type of aneurysm, its location, whether its ruptured, and the type of treatment, and the patient’s overall physical condition. For SAH survivors, the deficits are often greater, more noticeable, and require a longer recovery period. While every patient is unique, the following are some of the possible side effects post surgery:

- Headaches
- Drowsiness and fatigue
- Incision pain
- Jaw pain
- A clicking noise in the head
- Visual disturbances
- Partial or complete blindness
- Peripheral vision deficits
- Fine motor control impairments
- Emotional problems
- Depression
- Cognitive difficulties
- Speech problems
- Perceptual problems
- Behavioural changes
- Loss of balance or coordination
- Decreased concentration
- Short-term memory problems

As with stroke, recovery and rehabilitation are important aspects of aneurysm treatment. In some cases, undamaged areas of the brain may be able to perform functions that were lost when the aneurysm ruptured or that occurred during treatment of the aneurysm. Rehabilitation may include physical therapy, speech therapy, and occupational therapy.

SCREENING

When only a single aneurysm is found in a family, generally no additional screening of other family members is warranted. However, if more than one aneurysm exists in a sibling group (immediate “blood family”), or one family member has multiple aneurysms, then screening of other family members may be recommended.
THE NEUROSURGEONS´S ROLE IN TREATING ANEURYSMS

Neurosurgeons are medical specialists trained to help patients suffering from cerebrovascular disease, including cerebral aneurysms, stroke, carotid stenosis, and vascular malformations. Surgical clipping of a cerebral aneurysm is performed by a neurosurgeon, often one with expertise in cerebrovascular disease. Endovascular coiling is done either by a neurosurgeon or by an interventional neuro-radiologist. Neurosurgeons provide operative and non-operative care (prevention, diagnosis, evaluation, treatment, critical care, and rehabilitation) of a wide array of neurological disorders affecting the entire nervous system.

Qualifications of a Neurosurgeon:

Neurosurgeons undergo six-to-eight years of specialized training following medical school; one of the longest training periods of any medical specialty. This is due to the extreme complexity of the nervous system and the advanced techniques used in neurosurgical operations.

After successfully completing this training and after at least two years of medical practice, including successfully passing a written and oral examination, the neurosurgeon then becomes Board-certified.

Certification by the American Board of Neurological Surgery (ABNS) is considered the ‘gold standard’ in the field. The ABNS is the only board authorized by the American Board of Medical Specialties to certify physicians in the field of neurosurgery.
**GLOSARY OF TERMS**

**Aneurysm** – an abnormal, balloon-like bulging of the wall of an artery.

**Angiogram** – A study which shows the blood vessels leading to and in the brain by injecting a dye or contrast substance through a catheter placed in the artery of the leg.

**Angiography** – Radiography of blood vessels using the injection of material opaque to x-rays, to better define the vessels.

**Anticoagulant** – Any medicine that keeps blood from clotting; a blood thinner.

**Antihypertensive** – Any medicine or other therapy that lowers blood pressure.

**Arachnoid** – Middle layer of membranes covering the brain and spinal cord.

**Arteriovenous** – Relating to both arteries and veins.

**Artery** – A blood vessel that carries blood away from the heart to the body.

**Cerebral embolism** – A blood clot or debris from one part of the body or the environment that is carried by the bloodstream of the brain, where it blocks an artery.

**Cerebral hemorrhage** – Bleeding within the brain resulting from a ruptured blood vessel, aneurysm, or head injury.

**Cerebral infraction** – A stroke caused by interruption or blockage of blood flow to the brain; also called ischemic stroke.

**Cerebral Thrombosis** – Formation of a blood clot in an artery that supplies blood to part of the brain.

**Cerebrospinal fluid (CSF)** – A clear fluid surrounding the brain and spinal cord; CSF acts as a “Shock absorber,” a means of delivering nutrients to the brain and removing waste, and helping regulate pressure.
Cerebrovascular – Pertaining to the brain and the blood vessels that supply it.
Cerebrovascular occlusion – The blocking or closing up of a blood vessel in the brain.
Cranectomy – Surgical removal of a portion of the skull.
Cranietomy – Surgical opening of the skull to gain access to the intracranial structures.
Edema – Collection of fluid in the tissue causing swelling.
Endovascular – Pertaining to a surgical procedure in which a catheter containing medications or miniature instruments is inserted through the skin into a blood vessel for the treatment of vascular disease.
Hematoma – A localized swelling filled with blood resulting from a break in a blood vessel.
Hydrocephalus – A condition in which excess cerebrospinal fluid builds up within the ventricles (fluid-containing cavities) of the brain and may increase pressure within the head.
Ischemia – Inadequate circulation of blood generally due to a blockage of an artery.
Ischemic stroke – A stroke caused by interruption or blockage of blood flow to the brain.
Subarachnoid Hemorrhage (SAH) – Blood in, or bleeding into, the space under the arachnoid membrane, most commonly from trauma or from rupture of an aneurysm.
Thrombus – A blood clot
Vasospasm – Spasm of blood vessels which decreases their diameter.
This information does not replace physician consultation. A careful examination by a qualified neurosurgeon is the best way to obtain a complete assessment of your problem.