Victoria Neurosurgery

Mr Jeremy Russell
BSc/BE (Hons) MBBS (Hons) FRACS
Cranial and Spinal Specialist

Level 1, 435 Malvern Rd
South Yarra VIC 3141
P: 03 9981 9588
www.drjeremyrussell.com.au

CEREBRAL (BRAIN) ANEURYSMS

What is an Aneurysm?

A brain aneurysm (also known as a "cerebral", "berry" or "saccular" aneurysm) is a bulge or dilatation of an artery within the brain. These arteries are high pressure vessels surrounded by cerebrospinal fluid (CSF), which bathes your brain and is known as the subarachnoid space. There are four main arteries that supply blood to the brain, and aneurysms typically form at weak areas of one of these arteries, typically where the artery splits into two or 'bifurcates'. Aneurysms usually develop around the age of 45 to 65 due to various risk factors (see below). They occur in approximately 2-3% of the population, and the vast majority of them are unrecognised and never cause a problem. Of those people that have an aneurysm, approximately 20 % will have more than one aneurysm.

What are the Symptoms of an Unruptured Aneurysm ?

Typically, aneurysms do not cause any symptoms until they become very large or rupture. When they are large they can press on nearby structures causing symptoms such as double vision, an enlarged pupil or weakness. When they rupture into the CSF, this is known as a subarachnoid haemorrhage (SAH). This is a very dangerous condition that requires urgent hospital treatment and repair of the aneurysm.

What are the symptoms of a Ruptured Aneurysm (Subarachnoid Haemorrhage) ?

When an aneurysm ruptures, high pressure arterial blood is released into the CSF space, known as a subarachnoid haemorrhage, or sometimes the brain tissue itself, known as an intracerebral haemorrhage (ICH). As the blood is released, the pressure within the head suddenly increases and eventually stops as a delicate clot seals the rupture point. This sudden increase in pressure causes the symptoms typically seen where patients may transiently lose consciousness, report "the worst headache of my life", nausea, vomiting, stiff neck and reduced consciousness state.

Aneurysm Risk Factors

Certain conditions are associated with known increased risk of aneurysm formation. The most important factors are mentioned below. The more of these a patient has, the higher the likelihood of treatment being offered.

- Age – increased age, especially > 50 years old
- Gender – females are at increased risk (women twice that of men)
- Smoking – significant increase of both formation and rupture
- Hypertension – untreated high blood pressure
- Family History – two or more direct family members 2 or more direct family members
- Collagen disorders – Ehlers Danlos, adult polycystic kidney disease, Marfan's syndrome
- Excessive alcohol – excessive daily alcohol intake
- Drug use – especially cocaine and amphetamines

Should an Aneurysm be Treated ?

All ruptured aneurysms are urgently treated to prevent re-bleeding and worsened outcomes.

However as most incidental aneurysms never rupture, treatment is not necessarily required. Ultimately the person's life time risk of rupture (and subsequent related problems) must be balanced against the risk of treatment. The short-term

Victoria Neurosurgery

Mr Jeremy Russell
BSc/BE (Hons) MBBS (Hons) FRACS
Cranial and Spinal Specialist

Level 1, 435 Malvern Rd
South Yarra VIC 3141
P: 03 9981 9588
www.drjeremyrussell.com.au

risk of an aneurysm rupturing is typically low (< 1% per annum for most aneurysms < 10mm in size). Many factors are taken into consideration when deciding upon this:

- Patient age – younger patients are more likely to be treated
- Aneurysm size – often smaller aneurysms (< 5mm) are simply monitored
- Aneurysm location – different aneurysm locations are more dangerous
- Aneurysm shape – irregular aneurysm shape is more dangerous
- Prior aneurysm rupture – prior aneurysm rupture heralds increased risk for subsequent aneurysms
- Risk of aneurysm treatment – not all aneurysms have the same treatment risk
- Patient wishes – patient anxiety and quality of life are treatment factors

All patients should be discussed in a multidisciplinary meeting with a neurosurgeon, interventional neuroradiologist (INR) and often a neurologist, to ensure a consensus opinion on both treatment requirement and best treatment modality. When treatment risk is deemed less than the lifetime risk of the aneurysm itself, treatment is typically offered.

How are cerebral aneurysms diagnosed ?

Most cerebral aneurysms go unnoticed until they rupture or are found during medical imaging tests for an unrelated condition.

Where a patient presents to hospital with suspicion of a subarachnoid haemorrhage, the first step is to perform imaging to confirm the diagnosis. Several tests are available for this :

- Computed tomography (CT)
  Rapid and non-invasive test using X-rays to determine if blood has leaked into the CSF space. This is then combined with a separate contrast dye scan called CT angiography (CTA) to show the blood vessels within the brain, and location, size and shape of the aneurysm. Treatment decisions are typically made from this imaging alone.

- Magnetic Resonance Imaging (MRI)
  An MRI uses radio waves and a magnetic field to create brain images without radiation. This process can show the brain blood vessels as well using MR angiography (MRA), however it is much slower than a CTA, and thus typically only used for elective and screening cases.

- Cerebral Angiography
  A minimally invasive imaging technique that involves a small puncture within the groin, passing a thin tube up the arteries to the brain and injecting contrast to obtain very high quality images of the brain blood vessels and aneurysm. Now typically reserved for patients who are to undergo coiling treatment only, as well as patients who have vasospasm as a complication of their SAH (See below).

- Cerebrospinal fluid (CSF) analysis
  When the initial CT does not show any evidence of a brain bleed, but the doctor remains very concerned the patient has had a SAH, then a lumbar puncture is performed. This involves passing a small needle into the fluid cavity of your lower spine, and removing a small amount of CSF for analysis.

What are the complications of SAH ?

- Rebleeding. As the small clot stopping the aneurysm from continuing to bleed is extremely delicate, there is a very high chance of an aneurysm re-rupturing. This may be as high as 13.6% within the first 24 hours[1] and 50% within the first 6 months if left untreated. The likelihood of a patient dying doubles if they rebleed.

Victoria Neurosurgery

Mr Jeremy Russell
BSc/BE (Hons) MBBS (Hons) FRACS
Cranial and Spinal Specialist

Level 1, 435 Malvern Rd
South Yarra VIC 3141
P: 03 9981 9588
www.drjeremyrussell.com.au

- Hydrocephalus. Initial brain pressure increase from the SAH is often compounded by a build-up of CSF within the fluid spaces (ventricles) known as hydrocephalus. This is treated by placing a small rubber catheter known as an external ventricular drain (EVD) into the ventricle and diverting the fluid into an attached bag. This remains in place until the brain self regulates the fluid once more, or sometimes a permanent version of an EVD is required where the catheter is tunneled from the brain into the abdomen, known as a ventriculo-peritoneal shunt (VPS).

- Vasospasm. Blood within the subarachnoid space released during the rupture often causes the blood vessels supplying the brain to narrow and limit the blood supply to vital brain areas. Despite optimal management, if severe enough, this may lead to stroke and permanent disability.

- Altered sodium level. Subarachnoid haemorrhage can disrupt the sodium balance within the blood, potentially causing your brain to swell and increase brain pressure.

- Seizures. Subarachnoid hemorrhage may cause seizures (convulsions), either at the time of the initial bleed, or in a delayed fashion. Often these seizures are obvious, though sometimes they are clinically silent and require special brain monitoring called an EEG to find them. If allowed to continue uncontrolled, they may cause permanent brain damage.

How are cerebral aneurysms treated ?

Once the decision has been made to treat the aneurysm, there are 2 primary methods use to exclude the aneurysm from the brain circulation and thus prevent rebleeding. Your neurosurgeon and interventional neuroradiologist (INR) will discuss between them which is preferable for each patient, as there are relative pros and cons to each method. It is important the patient understands the reasons why a particular treatment option has been recommended, as well as relative risks and benefits of each for their particular situation.

Both methods require a general anaesthetic and after care in either an intensive care unit (ICU) or neurosurgical high dependency unit (HDU), depending on how sick the patient is. General treatment risks include deep venous thrombosis (DVT) / pulmonary embolus (PE) (1-2%), pneumonia (<1%), heart attack (<1%), adverse drug reaction (<0.1%) and death (<0.1%).

- Clipping

Microsurgical clipping of a cerebral aneurysm involves shaving a small amount of hair, followed by a skin incision and creating a hole in the skull known as a craniotomy. A microscope is then used to carefully expose the aneurysm and surrounding arteries. One or more alloy clips (current clips are always MRI compatible) are used to pinch off the aneurysm from the brain circulation, ensuring that the arteries leading to and from it are not narrowed or blocked. This is done using a combination of visual inspection, doppler ultrasound and intraoperative angiogram. This is a very technically demanding procedure, and should only be performed by an experienced cerebrovascular neurosurgeon who regularly performs this kind of surgery.

The risks of the procedure are primarily dependant on the aneurysm size and location, as well as the patient's general health and pre-existing medical conditions. For an elective aneurysm clipping, the risk of a serious complication (stroke, major neurological deficit or death) is typically 2 to 4 %. Other less serious complications include a brain bleed requiring repeat surgery (<1%), brain infection (1%), wound healing problems (1%), seizures (1-2%) and incomplete aneurysm clipping (<5%). For ruptured cases, these figures are higher, at least twice that of unruptured cases.

Whilst clipping is initially a more invasive procedure than coiling, if an aneurysm is adequately clipped, it will very rarely recur and requires significantly less frequent imaging follow up.

Link to aneurysm clipping: https://www.youtube.com/watch?v=8WSZUtC9oi0&feature=youtu.be

Victoria Neurosurgery

Mr Jeremy Russell
BSc/BE (Hons) MBBS (Hons) FRACS
Cranial and Spinal Specialist

Level 1, 435 Malvern Rd
South Yarra VIC 3141
P: 03 9981 9588
www.drjeremyrussell.com.au

- Endovascular treatment

Performed by a either an interventional neuroradiologist (INR) or INR trained neurosurgeon, this is a less invasive treatment whereby a small catheter is inserted into the groin and fed up into the brain vessels, taking X-ray photos of the vessels to guide them along the way. Often referred to as "coiling", as this is the most common method where the aneurysm is packed with small platinum coils, other options include placing a small stent or flow diverter (alloy mesh sleeves) across the aneurysm, or a tiny alloy 'basket' into the aneurysm (called a WEB device). These induce clot formation within the aneurysm, which blocks it off from the main arterial circulation. Different techniques are used for different situations, however if an aneurysm can be completely treated, the risk of future rebleed is extremely small.

The major risks of endovascular treatment are very similar to clipping, with the risk of serious complication (stroke, major neurological deficit and death) again typically 2 to 4%. This does vary based upon the complexity of the aneurysm and technique required. Often blood thinning agents such as aspirin and / or clopidogrel are needed to slow this clot formation and reduce stroke risk for a period of 3 to 12 months. Less serious risks include reaction to the dye effecting kidney function and problems with the artery used for access in the groin. This method is significantly less invasive than an open craniotomy, with elective patients often having no side effects from the procedure at all.

Whilst coiling is a minimally invasive procedure that does not require open brain surgery, it must be considered a very serious procedure. The risk largely depends on size and shape of the aneurysm, pre-existing blood vessel disease and the experience of the operator. Aneurysm recurrence, though rarely presenting with a rebled, is more common with this technique and occasionally requires retreatment. Imaging follow up is more frequent as well.

Link to aneurysm coiling: https://www.youtube.com/watch?v=5Ss-IOmFyeA&feature=youtu.be

---

Aneurysm Screening

Typically, patients are recommended for screening when 2 or more first degree family relatives (i.e. child, sibling or parent) are known to have an aneurysm (either incidental or ruptured). If only one such relative exists, screening may also be offered if they had multiple aneurysms, or the patient in question heralds multiple risk factors.

References

1. Ohkuma H, Tsurutani H, Suzuki S. Incidence and significance of early aneurysmal rebleeding before neurosurgical or neurological management. *Stroke*. 2001;32(5):1176-1180.

Helpful Links

1. https://www.ninds.nih.gov/Disorders/Patient-Caregiver-Education/Fact-Sheets/Cerebral-Aneurysms-Fact-Sheet
2. https://journals.sagepub.com/doi/epub/10.1177/1358863X18754693
3. https://strokefoundation.org.au