



Cerebral Aneurysms

- About 27,000 cerebral aneurysms rupture each year in the United States, resulting in subarachnoid hemorrhage
- CT angiography with post processing to create 3-dimensional and maximum intensity projection (MIP) images is an excellent non-invasive method to diagnose aneurysms
- Screening for aneurysms is recommended for patients with 2 or more first degree relatives with aneurysms and for those with autosomal dominant polycystic kidney disease
- Endovascular repair (coiling) offers an alternate treatment to craniotomy and clipping in many cases
- Endovascular repair has resulted in significantly better outcome than traditional craniotomy and clipping in patients with ruptured intracranial aneurysms that were suitable for either treatment option
- After endovascular repair, patients are followed-up with imaging at 6 months, 1 year, 2 years, and 5 years

Data from autopsy studies indicate that 1-5% of adults have cerebral aneurysms. Most are considered to be sporadically acquired lesions although the risk is higher if an individual has a family history of aneurysms or autosomal dominant polycystic kidney disease. About 27,000 cerebral aneurysms rupture each year in the United States, resulting in subarachnoid hemorrhage. The peak incidence is age 55-60 years and there are about double the number of cases in women compared to men. If an aneurysm ruptures, the effect is often devastating, with a 30-day mortality rate of 45% and leaving 30% of survivors with moderate to severe disability.

Diagnosis of Cerebral Aneurysms

At the MGH, CT angiography (CTA) is the method of choice to detect the presence of an aneurysm. This method allows post processing to create 3-dimensional and maximum intensity projection (MIP) images. CTA has a reported sensitivity and specificity of 77-97% and 87-100%, respectively, with lower sensitivity (40-91%) for aneurysms smaller than 3 mm. MRA is an alternate examination that has a somewhat lower sensitivity (69-99%, specificity 100%) and takes longer to perform than CTA. Catheter angiography remains the gold standard but is more invasive and is associated with a risk of neurologic complications, albeit small.

Screening for unruptured aneurysms is recommended for a select group of patients who have two or more first-degree relatives with intracranial aneurysms and/or autosomal dominant polycystic kidney disease.

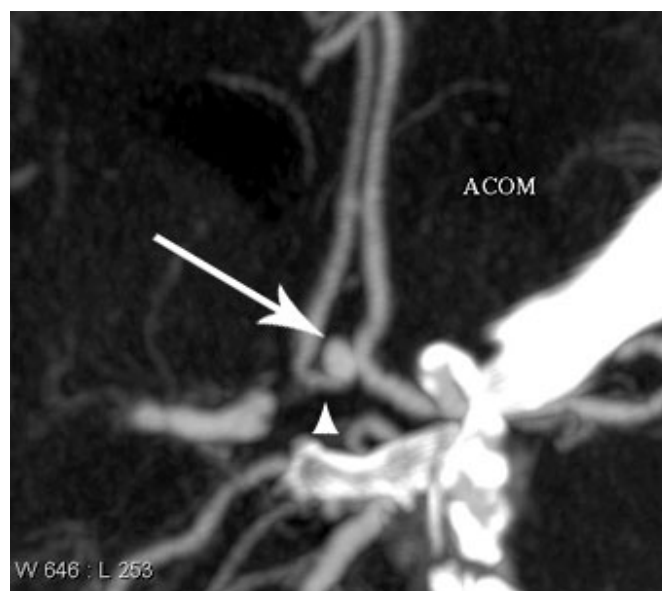


Figure 1. Coronal reformatted MIP images from a CTA demonstrates a 5 mm aneurysm (straight arrow) of the anterior communicating artery (arrowhead) that points anterosuperiorly and has no branch relations. Note the osseous detail adjacent to the aneurysm which has been shown to be helpful for surgical planning.

Most cerebral aneurysms are discovered when they rupture and result in a subarachnoid hemorrhage, which has a 30-day mortality rate of 45%. Patients that survive long enough to reach a hospital present with

symptoms ranging from those described as “the worst headache of my life” to coma. In these cases of suspected aneurysm rupture, it is generally agreed that the best initial diagnostic imaging examination is non-contrast head CT. At the MGH, if hemorrhage is diagnosed, CTA is then performed to detect and characterize the underlying aneurysm, if present. In addition, increasing numbers of unruptured cerebral aneurysms are being diagnosed, most commonly as an incidental findings or in patients who experience symptoms caused by the mass effect of the aneurysm, such as cranial nerve palsies.

Natural History of Cerebral Aneurysms

The risk of rupture of an incidentally found aneurysm depends on the size of the aneurysm, its location, and whether or not there has been a previous bleed from

another aneurysm. The International Study of Unruptured Intracranial Aneurysms (ISUIA), which followed the natural history of aneurysms in 1692 patients whose aneurysms were not repaired, reported that the risk of rupture for small aneurysms (<10 mm) in the anterior circulation during a 5-year observation period was extremely low for patients that had not experienced a previous ruptured aneurysm. In patients who had already experienced the rupture of another cerebral aneurysm, aneurysms of the same size (>10 mm) were about 11 times more likely to rupture.

Although the risk of rupture may be lower than previously reported for small anterior circulation aneurysms, the consequences of a rupture can be devastating. The risk of rupture must, therefore, be weighed against the risk of treatment (Table 1).

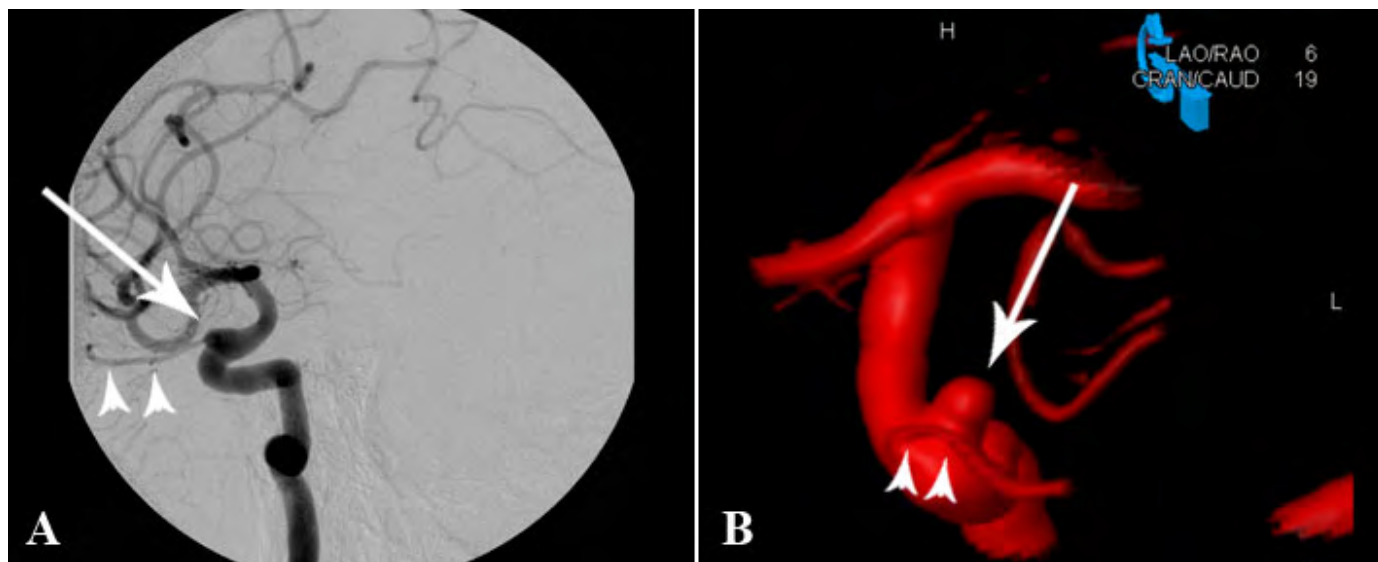


Figure 2. An aneurysm (arrow) of the ophthalmic segment of the left internal carotid artery in a 55 year-old woman. (A) Lateral and (B) Oblique volume rendered views (superior view) of a cerebral angiogram demonstrate an aneurysm of the ophthalmic segment of the left ICA pointing superolaterally with no branch relations. The volume rendered image better details the origin of the ophthalmic artery (arrowheads) in relation to the aneurysm.

The International Subarachnoid Aneurysm Trial

In the International Subarachnoid Aneurysm Trial (ISAT), the risks and benefits of surgical clipping and endovascular repair were compared in a group of patients who had experienced a subarachnoid hemorrhage from a ruptured aneurysm. In this landmark study, patients whose treatment options included endovascular coiling and traditional surgical repair were randomized to either therapy. The study found that, in these circumstances, endovascular coil treatment produced substantially better patient outcomes than surgery in terms of survival free of disability at one year. The relative risk of death or significant disability at one year for patients treated with coils was 22.6% lower than in the surgically treated patients, an absolute risk reduction of 6.9% (p=.0019). Unfortunately, there has been no randomized trial comparing traditional surgery and endovascular treatment performed in the unruptured aneurysm patient. However, it should be noted that the endovascular armamentarium is significantly more

Arterial dissection	0.7%
Parent artery occlusion	2.0%
Thromboembolism	2.4%
Aneurysm rupture	1.4-2.7%
Overall procedural morbidity	3.7-5.3%
Overall procedural mortality	1.1-1.5%

Note that the overall procedural morbidity and mortality reported for surgical clipping is 4-11% and 1-3%, respectively. *Data from Brisman et al., 2006

robust in the scenario of the unruptured aneurysm and one might, therefore, predict that the outcome from endovascular repair is likely to result in fewer complications than traditional neurosurgery.

Patient Evaluation and Care

When an aneurysm is diagnosed or when a patient with an aneurysm arrives at MGH, physicians from traditional neurosurgery as well as the Interventional Neuroradiology/Endovascular Neurosurgery team evaluate each patient to decide the best possible care; observation, endovascular coiling, or neurosurgical clipping to close the aneurysm. If a decision is made to repair the aneurysm neurosurgically, the anatomical information obtained from CTA is often considered sufficient for surgical planning.

For the patients whose cerebral aneurysms are approached endovascularly, a series of detachable platinum coils are inserted into the aneurysm in order to occlude it. The procedure is carried out under general anesthesia in a specialized neurointerventional radiology suite, equipped with a bi-plane X-ray machine with flat panel fluoroscopes, allowing for high-speed rotational angiograms and 3-D reconstructions of cerebrovascular anatomy. A catheter is placed into an artery in the neck and, under image-guidance, a smaller microcatheter is passed through the artery to the aneurysm. This microcatheter is used to deposit coils, one at a time, into the aneurysm until it is occluded. Depending on the anatomy of the aneurysm, adjunctive techniques such as balloon-assisted or stent-assisted coiling may be employed.

After the procedure, patients are given heparin to minimize the risk of thromboembolism and transferred to Neuro Intensive care for close monitoring. After a routine elective procedure, patients remain in hospital for 36-60 hours.

Follow-up Imaging

A repeat procedure has been reported to be necessary more frequently following endovascular repair compared to surgical clipping. In the ISAT study, 17.4% of patients required retreatment. About half of these were within the first 30 days and were due to either failure to deploy the coils or incomplete occlusion. The remainder were retreated 3-80 months after the original procedure. Follow-up imaging surveillance is, therefore, important to monitor the status of the repaired aneurysm. At this time, a CTA, MRA, angiography, or radiography is recommended after 6 months, 1 year, 5 years, and 10 years following endovascular repair.

Scheduling

Elective endovascular repair can be scheduled after consultation with physicians in the Interventional Neuroradiology/Endovascular Neurosurgery Unit, who may be reached at 617-726-1767. Each case is typically reviewed at a multidisciplinary cerebrovascular conference where input is obtained from all elements of the vascular neurosciences including neurointerventional radiologists, traditional neurosurgeons, stroke neurologists and diagnostic neuroradiologists and appropriate referrals made. Both elective and emergency endovascular repairs are carried out in the interventional neuroradiology suite on the main campus at MGH.

Further Information

For further questions, please contact [Joshua A. Hirsch, M.D.](#), interventional neuroradiologist, MGH Department of Radiology at 617-726-1767.

We would like to thank Joshua A. Hirsch, M.D., and Rivka R. Colen, M.D., Department of Radiology, and Ferdinando S. Buonanno, M.D., Department of Neurology, for their assistance and advice for this issue.

References

- Brisman, JL, Song, JK and Newell, DW. (2006) *Cerebral aneurysms*. N Engl J Med **355**: 928-39
- Campi, A, Ramzi, N, Molyneux, AJ, Summers, PE, Kerr, RS, Sneade, M, Yarnold, JA, Rischmiller, J and Byrne, JV. (2007) *Retreatment of ruptured cerebral aneurysms in patients randomized by coiling or clipping in the International Subarachnoid Aneurysm Trial (ISAT)*. Stroke **38**: 1538-44
- Hoh, BL, Cheung, AC, Rabinov, JD, Pryor, JC, Carter, BS and Ogilvy, CS. (2004) *Results of a prospective protocol of computed tomographic angiography in place of catheter angiography as the only diagnostic and pretreatment planning study for cerebral aneurysms by a combined neurovascular team*. Neurosurgery **54**: 1329-40; discussion 1340-2
- International Study of Unruptured Intracranial Aneurysms Investigators. (1998) *Unruptured intracranial aneurysms--risk of rupture and risks of surgical intervention*. N Engl J Med **339**: 1725-33
- Molyneux, A, Kerr, R, Stratton, I, Sandercock, P, Clarke, M, Shrimpton, J and Holman, R. (2002) *International Subarachnoid Aneurysm Trial (ISAT) of neurosurgical clipping versus endovascular coiling in 2143 patients with ruptured intracranial aneurysms: a randomised trial*. Lancet **360**: 1267-74
- Ogilvy CS. (2003) *Neurosurgical clipping versus endovascular coiling of patients with ruptured intracranial aneurysms*. Stroke. **34**:2540-2
- Wiebers, DO, Whisnant, JP, Huston, J, 3rd, Meissner, I, Brown, RD, Jr., Piepgras, DG, Forbes, GS, Thielen, K, Nichols, D, O'Fallon, WM, Peacock, J, Jaeger, L, Kassell, NF, Kongable-Beckman, GL and Torner, JC. (2003) *Unruptured intracranial aneurysms: natural history, clinical outcome, and risks of surgical and endovascular treatment*. Lancet **362**: 103-10

©2008 MGH Department of Radiology

Janet Cochrane Miller, D. Phil., Author
Raul N. Uppot, M.D., Editor