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Cerebral Aneurysms

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

DIAGNOSIS OF CEREBRAL ANEURYSMS

CT angiography (CTA) with postprocessing to create 3-D and maximum-intensity projection images is the noninvasive method of choice to detect an aneurysm (Figure 1). CTA has reported sensitivity and specificity of 77% to 97% and 87% to 100%, respectively, with lower sensitivity (40%–91%) for aneurysms <3 mm in size [1]. MR angiography (MRA) demonstrates comparable performance (sensitivity, 69%–99%; specificity, 100%) but requires longer table times than CTA [1]. Catheter angiography remains the gold standard but is more invasive and is associated with a small risk for neurologic complications [2].

Most cerebral aneurysms are discovered when they rupture and result in subarachnoid hemorrhages [3]. Patients who survive long enough to reach hospitals present with symptoms ranging from “the worst headache of my life” to coma [1]. In cases of suspected aneurysm rupture, the best initial diagnostic imaging examination is noncontrast head CT [1]. If hemorrhage is diagnosed, CTA is then performed to detect and characterize the underlying aneurysm. Unruptured cerebral aneurysms are diagnosed most commonly as incidental findings or in patients who experience symptoms caused by the mass effect of the aneurysms, such as cranial nerve palsies [4].

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NATURAL HISTORY OF CEREBRAL ANEURYSMS

The risk for rupture of an incidentally found aneurysm depends on its size, its location, and whether there has been a previous bleed from another aneurysm [5]. The International Study of Unruptured Intracranial Aneurysms, which followed the natural history of aneurysms in 1,692 patients whose aneurysms were not repaired, reported that the risk for rupture of small aneurysms (<10 mm) in the anterior circulation during a 5-year observation period was extremely low for patients who had not experienced previous ruptured aneurysms. In patients who had experienced the rupture of other cerebral aneurysms, those of the same size (>10 mm) were about 11 times more likely to rupture [5].

TREATMENT OPTIONS

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 subarachnoid hemorrhages from ruptured aneurysms [6,7]. Patients whose treatment options included endovascular coiling and traditional surgical repair were randomized to either therapy. In these circumstances, endovascular coil treatment produced substantially better patient outcomes than surgery in terms of survival free of disability at 1 year, and the survival benefit continued for ≥7 years [7]. The relative risk for death or significant disability at 1 year for patients treated with coils was 22.6% lower than for surgically treated patients, an absolute risk reduction of 6.9% ($P = .0019$) [6,7]. The intraprocedural risks are also low (Table 1) [1]. Although traditional surgery and endovascular treatment have not been similarly compared in patients with unruptured aneurysms, endovascular repair is likely to convey less morbidity in this scenario as well.

ENDOVASCULAR COILING

At our institution, if a decision is made to repair an aneurysm neurosurgically, the anatomic information obtained from CTA is often considered sufficient for surgical planning [8]. If endovascular repair is selected (Figures 2 and 3), the procedure is carried out in a specialized neurointerventional radiology suite, equipped with a biplane x-ray machine with flat-panel fluoroscopes, allowing for high-speed rotational angiography and 3-D reconstructions of cerebrovascular anatomy. Under general anesthesia, a catheter is placed into an artery in the neck, through which a smaller microcatheter is passed intracranially into the aneurysm. This micro-catheter 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 used.

Depending on the acuity and specifics of the situation, patients may be treated with antiplatelet agents such as clopidogrel and aspirin. Additionally, both during and after the procedure, patients are typically given heparin to minimize the risk for thromboembolism and are transferred to the intensive care unit for close monitoring. After a routine elective procedure, patients remain in the hospital for 36 to 60 hours and are then seen in follow-up as outpatients.

FOLLOW-UP IMAGING

A repeat procedure has been reported to be necessary more frequently after endovascular repair than surgical clipping. The risk from additional coil embolization does not negate the advantage of the initial embolization [9]. In ISAT, 17.4% of patients required retreatment, about half within the first 30 days because of either failure to deploy the coils or incomplete occlusion. The remainder were retreated 3 to 80 months after the original procedures [10]. Follow-up imaging surveillance is therefore important to monitor the status of a repaired aneurysm. At this time, CTA, MRA, angiography, or radiography is recommended 6 months, 1 year, 5 years, and in some instances 10 years after endovascular repair.

UTILIZATION LESSONS

Endovascular repair (coiling) offers an alternate treatment to craniotomy and clipping in many cases. A multi-center randomized prospective clinical trial has demonstrated that endovascular repair results in significantly better outcomes in terms of morbidity and overall survival than conventional surgery in patients with ruptured intracranial aneurysms that were suitable for either treatment option. Compared with craniotomy and clipping, a higher proportion of patients treated with coiling will require repeat treatment.

PRACTICE RECOMMENDATIONS

- Head CT without contrast is recommended as the initial imaging study in patients with suspected ruptures of cerebral aneurysms.
- CTA with 3-D and maximum--intensity projection images and MRA are the noninvasive methods for aneurysm detection and characterization. Although invasive catheter angiography remains the gold standard, CTA images are often sufficient for treatment planning with endovascular or conventional open surgical repair.
- After endovascular repair, follow-up imaging is indicated because retreatment will be required in a proportion of these patients.

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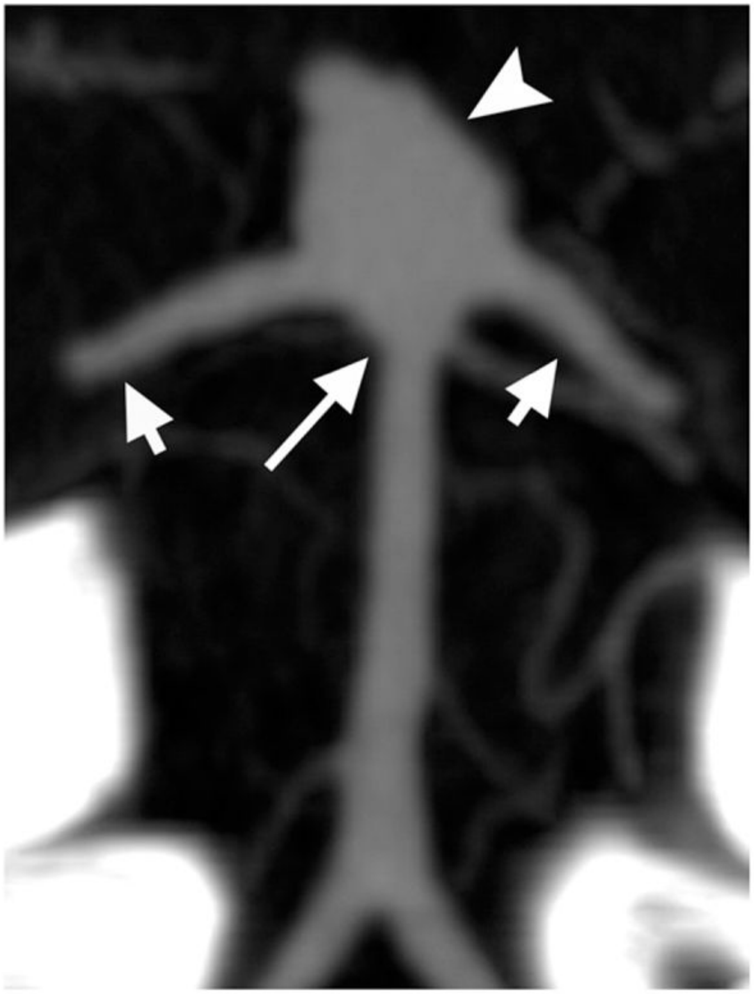

Fig. 1.
Coronal reformatted maximum-intensity projection image from CTA demonstrates a 1.1-cm bilobulated, saccular aneurysm (arrowhead) at the tip of the basilar artery (long arrow) with a 2-mm bleb in the superior aspect of the aneurysm. Bilateral posterior cerebral arteries (short arrows) originate from the wide-necked aneurysm at depressed angles.

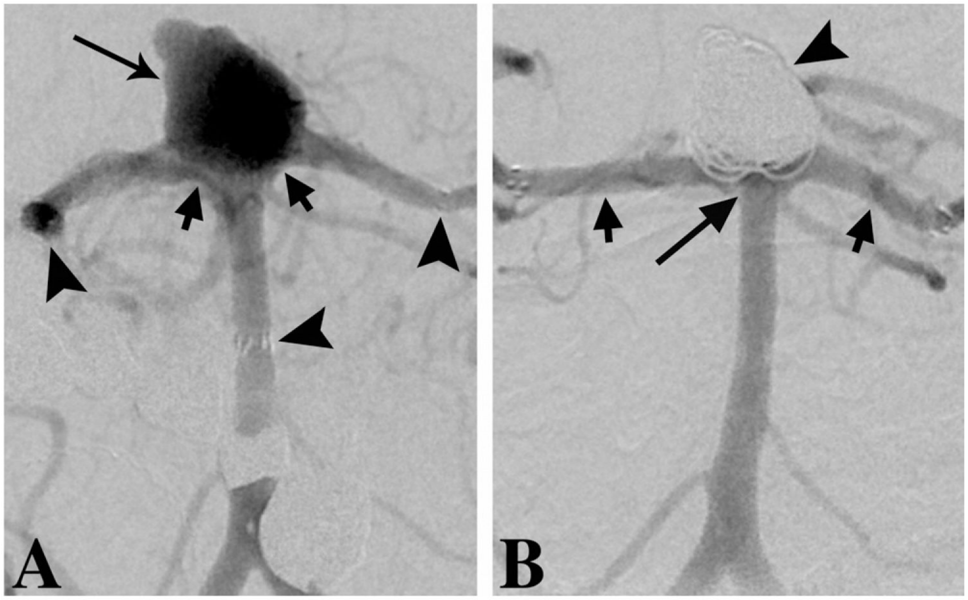

Fig. 2.
Anteroposterior projection of a cerebral angiogram (A) demonstrates normal filling of the basilar and posterior cerebral arteries after deployment of two overlapping Neuroform stents (Boston Scientific Corporation, Natick, Massachusetts) (arrowheads). This resulted in flow diversion from the aneurysm (long arrow) to the bilateral posterior cerebral arteries by altering their takeoff (short arrows) from the basilar artery. Anteroposterior view of a cerebral angiogram shows subsequent coil embolization (B) of the aneurysm (arrowhead) with normal filling of the basilar (long arrow) and posterior cerebral arteries (short arrows). The appearance of the coils lying over the basilar tip is projectional.

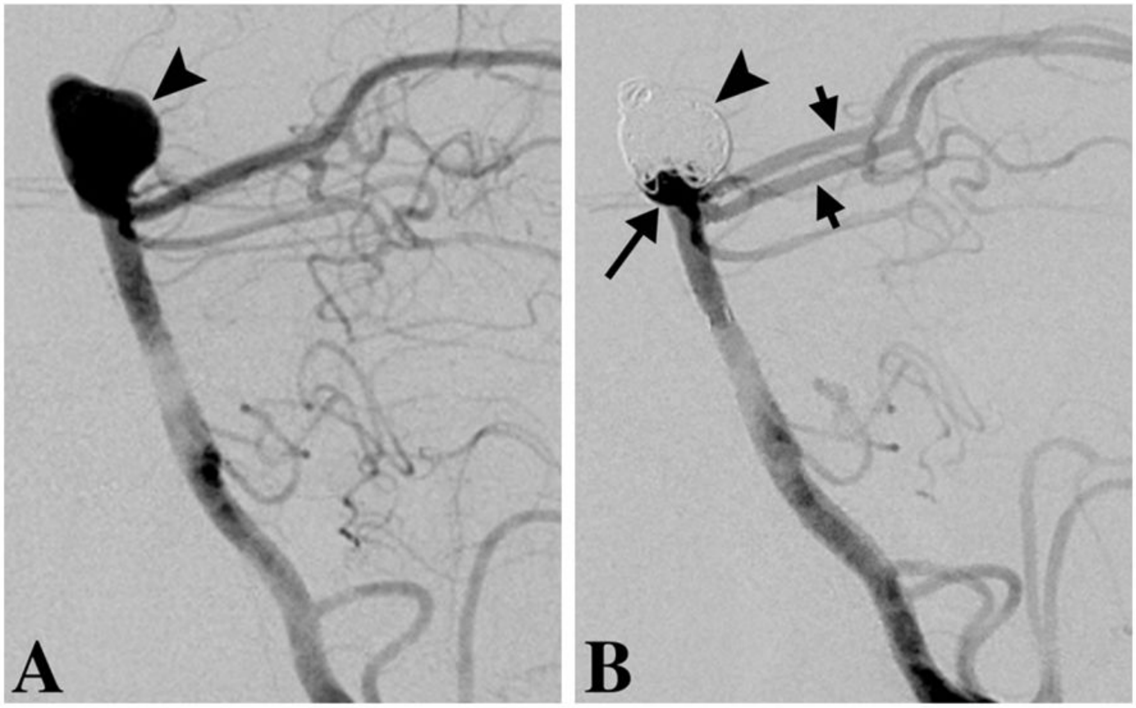

Fig. 3.
Lateral views of a cerebral angiogram (A,B) demonstrate successful coil embolization of the basilar tip aneurysm (long arrows). The coil mass is draped over the contour of the stents, allowing for normal filling of the basilar (arrowhead) and posterior cerebral arteries (short arrows).

Table 1

Reported risk of endovascular coiling

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: The overall procedural morbidity and mortality reported for surgical clipping are 4% to 11% and 1% to 3%, respectively [1].