Endovascular Coil Embolization of Brain Aneurysms

**BACKGROUND**

Brain (cerebral) aneurysms are outpouchings of weakened blood vessel walls in the arteries supplying blood to the brain (Figure-1). The exact cause of the vessel weakening is uncertain, but has been correlated with smoking, cocaine, high blood pressure, and genetic syndromes such as kidney cysts (polycystic kidney disease) and disorders of the supportive collagen substance of bone and cartilage (Ehlers Danlos and Marfans Syndromes).

**SIGNS AND SYMPTOMS OF BRAIN ANEURYSMS**

Brain aneurysms often are found on routine MRI’s of the brain as part of a routine headache evaluation by a primary care physician or neurologist. However, most aneurysms are not discovered until after they rupture and release blood over the surface of the brain (subarachnoid hemorrhage or SAH). Patients with ruptured aneurysms may present with “the worst headache of my life” unlike any other headache they have had before. In more moderate cases, neck stiffness, double vision, arm or leg weakness in addition to the headache may be the initial presenting symptoms. In the most severe cases of SAH, patients will present in a coma or die before they reach medical attention. If any of these symptoms are present one should seek immediate attention at the nearest emergency room.

**TREATMENT OPTIONS**

Brain aneurysms can be treated by two different techniques:

- surgically by opening the skull (craniotomy) and putting a small metal clip across the neck of the aneurysm (aneurysm clip ligation).
- a minimally invasive technique whereby the aneurysm is shut off (occluded) with coils (coil embolization) from within the blood vessels (endovascular).

**DIAGNOSTIC IMAGING**

- Angiography remains the most sensitive test for detecting brain aneurysms. An angiogram is performed by passing a catheter from the femoral artery into the blood vessels that feed the brain. An x-ray is then obtained while contrast (dye) is injected through the catheter.

- A CT-angiogram (CTA) is a form of CT scan that is performed very rapidly and is less invasive than an angiogram. This test only requires an intravenous injection of contrast. The sensitivity is close to that of an angiogram and may be a good first screening method. However, it does not show the blood flowing through the vessels in real-time as does an angiogram.

- Magnetic Resonance Angiogram (MRA) is a type of MRI that takes longer than a CTA but is shorter and less invasive than an angiogram. Additionally, this is the only test that does not require contrast. Therefore, it is preferred over an angiogram and CTA as a first test for those patients who have iodine or shellfish allergies, diabetes, or kidney disease.
**ENDOVASCULAR TECHNIQUE**

Aneurysm coiling consists of filling the aneurysm with soft platinum coils resembling the child’s toy “slinky” (Figure-2). The goal of coiling aneurysms is similar to that of aneurysm clipping, namely to stop blood flow into the aneurysm so that it does not rupture.

Aneurysm coiling is performed through a small needle stick in the femoral artery similar to an angiogram. The procedure is performed in an angiography suite which looks similar to an operating room, but has the capabilities for fluoroscopy (continuous x-ray). Fluoroscopy provides a real-time map of the vessels and aneurysm so that the endovascular neurosurgeon can guide the catheters and coils into the correct positions. Sometimes mild sedation with intravenous medications alone can be used to keep the patient still during the procedure. However, the slightest movement during the aneurysm coiling can be dangerous so often the safest method is heavy sedation under general anesthesia with a breathing tube in place, similar to that of surgery.

In order to coil the aneurysm, a tiny catheter (microcatheter) is guided into the aneurysm (Figure-3) under fluoroscopy by way of the arteries in the neck (carotid and vertebral arteries). The soft platinum coils are positioned in the aneurysm (Figure-4) until the aneurysm is filled with coils (Figure-5a,b) and then the catheters are removed. The coils stay in the aneurysm forever.

**SURGICAL RISKS**

The risks of aneurysm coiling are relatively low (5-10%) and include:

- Injury to the femoral artery at the needle puncture site (pseudoaneurysm or dissection), possibly requiring surgical repair by a vascular surgeon.
- Stroke from release of blood clot or cholesterol plaque as the catheters are guided through the arteries into the aneurysm.
- Iodine reaction in those with history of iodine or shellfish allergies.
- Microcatheter perforation of the aneurysm causing it to rupture and cause a SAH, large blood clot in the brain tissue (intraparenchymal hemorrhage), and sometimes death or stroke from the hemorrhages.
- Incomplete coiling of the aneurysm sometimes is necessary in order to avoid aneurysm rupture or a coil from falling into the main artery which would cause a stroke.

**EXPECTED OUTCOME**

After coil embolization, there is up to a 25% risk of the aneurysm recurring within two years after treatment. However, this recurrence rate is lower for smaller aneurysms and those that are completely treated. In larger aneurysms, the coils may compress together much like a slinky does, and the procedure may need to be repeated during the next 6-24 months. Therefore, close follow-up for the first few years after coiling is necessary. Recent advancements in coil technology have allowed for coatings on the surface of the platinum coils in order to stabilize the coil mesh better and reduce the risk of aneurysm recurrence perhaps below the 25% quoted above.
RELEVANT TERMS
1. Angiogram.
2. Catheter.
3. Coil embolization.
5. Craniotomy.
6. CTA.
7. Dissection.
8. Endovascular.
10. Intraparenchymal hemorrhage.
11. Microcatheter.
12. MRA.
13. Pseudoaneurysm.
15. Subarachnoid hemorrhage or SAH.
16. Surgical clip ligation.

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FIGURES

Figure 1. Angiogram demonstrating a brain aneurysm (big arrow). The small arrow shows an otherwise normal brain blood vessel.
Figure 2. Brain Aneurysm Coil resembling a child’s toy “slinky”.
Figure 3. Small catheter in the aneurysm. (Large arrow)
Figure 4. Coils being delivered into the aneurysm.
Figure 5a. Aneurysm before coiling.
Figure 5b. Same aneurysm after coiling.