Endovascular Treatment of Giant Anterior Circulation Intracranial Aneurysms

Randall T. Higashida, M.D., Van V. Halbach, M.D., Christopher F. Dowd, M.D., Tony Smith, M.D., Kenneth Fraser, M.D., Jean K. Higashida, M.D., and Grant B. Hieshima, M.D.

Summary: Endovascular treatment of large and giant intracranial aneurysms of the anterior circulation, are now being treated by detachable silicone balloons, coils, and electrolytic platinum coils in selected cases. From a transfemoral approach, under local anesthesia, a catheter is navigated through the intracranial vessels to the aneurysm. For fusiform, ectatic aneurysms, without a well defined neck, test occlusion followed by parent artery occlusion can be performed with detachable balloons. For aneurysms with a well defined anatomical neck, detachable balloons and/or coils can be placed directly into the aneurysm to exclude it from the circulation. Angiography is performed immediately after the procedure and long term follow-up is obtained at 6-12 months post-treatment, to document exclusion of the aneurysm from the circulation.

Of the 321 cases treated by endovascular techniques by our group, 74 patients were treated for a giant aneurysm (>2.5 cm) involving the anterior circulation. The presenting symptoms were mass effect in 65/74 cases (87.8%), subarachnoid hemorrhage in 6/74 cases (8.1%), and thromboembolic symptoms in 3/74 cases (4.1%). The embolic materials utilized were balloons in 67 cases, electrolytic coils in 6 cases, and balloons and coils in combination in 1 case. In 51 cases (68.9%) parent vessel occlusion was performed and in 23 cases (31.1%) direct aneurysm occlusion was achieved. Complications related to treatment included 9 cases (12.2%) of stroke, 4 cases (5.4%) of transient, reversible, cerebral ischemia, and 5 deaths (6.8%).

Endovascular treatment appears to be a feasible alternative to surgery for giant anterior circulation intracranial aneurysms in selected cases. As improvements in these techniques evolve, the morbidity associated with therapy should improve.

Key words: endovascular neurosurgery, aneurysm therapy, anterior circulation aneurysms, giant aneurysms, interventional neuroradiology

Introduction

Endovascular treatment of intracranial aneurysms was first reported in the early 1970's by Serbinenko. He described the use of latex balloons for treatment of a variety of intracranial aneurysms by two methods: (1) Direct balloon occlusion of the aneurysm utilizing detachable balloons; and (2) Trapping of an aneurysm by parent vessel occlusion.

In the early 1980's, numerous centers including Romodanov and Shcheglov, Debrun, Berenstein, Moret, and Higashida and Hieshima, began reporting results of treatment of large and giant aneurysms utilizing both silicone and latex balloons. In the late 1980's, newer techniques utilizing platinum microcoils and electrolytic detachable coils were reported.

As more experience is gained with endovascular techniques, the treatment results have continued to improve.

Materials and methods

Since 1981, our group has now treated a total of 321 cases of an intracranial aneurysm by interventional neurovascular techniques. In this series, 242 cases, (75.4%) were aneurysms involving the anterior cir-
culation, and 79 cases (24.6%) involved the posterior circulation.

For anterior circulation aneurysms, 74/242 were giant aneurysms measuring greater than 2.5 cm in diameter. There were 56 females and 18 males in this series. The presenting clinical presentation of this group included 65/74 cases (87.8%) with mass effect, 6/74 cases (8.1%) with subarachnoid hemorrhage, and 3/74 cases (4.1%) with symptoms of thromboemboli and/or stroke.

Table 1 lists the location of the giant aneurysms treated in the anterior circulation.

**Technique**

All procedures were performed in the interventional neurovascular radiology suite under light neuroleptic anesthesia. Patients were therefore awake throughout the procedure and continuous neurological assessment could be performed. Preoperatively, a computed tomographic (CT) or magnetic resonance imaging (MRI) brain scan was obtained to evaluate the true size of the aneurysm, the presence of intraluminal thrombus, and for evaluation of stroke or cerebral ischemia.

From a transfemoral approach, a 7.5 French sheath was inserted into the common femoral artery. A 7.3 French catheter was then placed into the internal carotid artery. A rapid sequence, digital subtraction angiogram was performed in multiple views to evaluate the size of the aneurysm and neck, anatomical location, presence of intraluminal thrombus, and for evaluation of stroke or cerebral ischemia.

For aneurysms that were fusiform and ectatic, without a well defined anatomical neck, test occlusion under systemic anticoagulation, was then performed for aneurysms arising from the internal carotid artery. A 7.0 French catheter, with an affixed balloon (MediTech Corp., Watertown, Mass.), was inflated to occlude the proximal cervical internal carotid artery, test occlusion for 30 minutes with continuous neurological monitoring was performed, and arterial back pressures were obtained. In patients that tolerated test occlusion, two silicone detachable balloons were then used to occlude the inflow of the aneurysm and parent artery. (Interventional Therapeutics Corp., South San Francisco, CA) For patients that demonstrated a well defined anatomical neck, a silicone detachable balloon and/or platinum coils (Target Therapeutics Corp., Fremont, CA) were placed directly into the aneurysm for occlusion with preservation of the parent artery.

Following treatment, cerebral angiography was performed to evaluate exclusion of the aneurysm from the circulation. Patients were then monitored in the neurosurgical observation unit for 24-48 hours, and if stable discharged home. Follow-up was performed by clinical examination at 1, 3, 6, and 12 months post procedure. Radiological follow-up was performed by CT, MRI, plain skull X-rays, and/or angiography, at 1, 3, and 6-12 months post procedure.

**Representative case report**

A 57 year old, right-handed, white male presented with symptoms of severe headaches, memory difficulty, personality changes, and generalized seizures. Due to his severe symptoms, the patient was unable to function as a school teacher.

An MRI scan demonstrated a giant (> 3.0 cm) aneurysm involving the anterior cerebral artery, that was partially thrombosed, and associated with marked cerebral edema. (Fig. 1) Cerebral angiography confirmed the presence of a giant anterior cerebral aneurysm, arising from the anterior communicating artery segment. The residual portion of the aneurysm measured 8.0 × 8.0 × 10.0 mm. (Fig. 2)

Under local anesthesia from a transfemoral approach, a single 1.5 mm silicone detachable balloon, was flow directed through the internal carotid artery, through the anterior cerebral artery, and directed into the residual lumen of the aneurysm. After placement of the balloon into the aneurysm, the balloon was filled with 2 hydroxyethyl-methacrylate, allowed to solidify, and then detached. The post-embolization angiogram demonstrated occlusion of the aneurysm by the balloon, and preservation of the distal anterior cerebral artery. (Fig. 3) The patient was observed several days post procedure and discharged home in stable neurological condition.
His follow-up MRI scan at 1 year demonstrated continued thrombosis of the entire aneurysm with complete resolution of his cerebral edema. (Fig. 4) Clinically at two years of follow-up the patient continues to do well. He has regained more than 80% of neurological function, has returned to part time work, and has resolution of his headaches and improvement of his seizures.

Results

Of the 74 cases of giant anterior circulation aneurysms treated by endovascular techniques, 67 patients (90.5%) were treated by using detachable silicone balloons, 6 patients (8.1%) by electrolytic detachable platinum coils, and 1 patient (1.4%) by a combination of balloons and coils. In 51 cases (68.9%), the aneurysm did not have a well defined anatomical neck. Therefore test occlusion, followed by permanent occlusion of the aneurysm and parent internal carotid artery were performed for treatment. In 23 cases (31.1%), direct occlusion of the aneurysm with preservation of the parent artery, was performed by balloons and/or coils.

Complications associated with treatment included 9 cases (12.2%) of stroke and 4 cases (5.4%) of transient, reversible cerebral ischemia. There were 5
deaths (6.8%) in this group of patients. Two deaths were due to anterior circulation strokes with resultant cerebral edema and herniation, two deaths were due to subtotal occlusion of the aneurysm with subsequent hemorrhage, and one death was due to perioperative myocardial infarction.

Discussion

The largest reported series of endovascular treatment for intracranial aneurysms is by Romodanov and Shcheglov from the Kiev Research Institute of Neurosurgery. In 1982, they reported on 119 patients treated by detachable latex balloons, and in 1989, updated their series to 617 cases.\textsuperscript{16,18} In their larger series, they reported occlusion of the aneurysm with preservation of the parent artery in 91%. Their mortality rate was 1.7% for patient’s in “fair” condition and 22% for patient’s in “poor” condition. They did not break down their series based on size of the aneurysm.

Giant aneurysms present the greatest difficulty to the neurosurgeon and endovascular therapist for treatment due to the broad based neck or no well defined anatomical neck. Often there will be intraluminal thrombus present within the aneurysm and since these tend to be present for years, there may be associated calcification of the walls, making surgical clipping difficult. Technically it is now possible to treat these aneurysms by endovascular therapy with a combination of balloons and/or coils. The advantages of endovascular therapy are that since it is performed under local anesthesia it is possible to monitor the clinical status of the patient throughout the procedure. Especially for fusiform, ectatic aneurysms without a well defined neck, test occlusion prior to permanent occlusion is desirable. Patient’s can undergo test occlusion of the parent artery for 30 minutes or longer. If the arterial back pressures are low or if the patient cannot tolerate temporary blockage, then an extracranial to intracranial bypass graft can be performed to increase cerebral perfusion prior to parent vessel occlusion.\textsuperscript{7} Several recent articles by Fox, Higashida, and Merland have validated this procedure of parent vessel occlusion for large and giant aneurysms of the anterior and posterior circulation using detachable balloons.\textsuperscript{1,10,12}

Direct occlusion of an aneurysm by balloons and/or coils is still developmental. Long term follow-up has demonstrated in a certain percentage of cases that both balloons and coils may migrate into thrombus, there may be “compacting” of coils, and aneurysm regrowth with subtotal occlusion of an aneurysm may occur. Therefore long term follow-up for these patients, as has been demonstrated for surgical patient’s with incomplete aneurysm clipping, is still mandatory.\textsuperscript{4,9,10,13,14}

The disadvantages to this technique include the need for systemic anticoagulation during the procedure to avoid thrombus formation on the microcatheters and embolic devices during delivery, the risk of dislodging intraluminal thrombus within an aneurysm during placement of the embolic device, shifting of balloons and/or coils after detachment, delayed thrombus formation within the aneurysm after reversal of the anticoagulation, and the long term results of primary aneurysm therapy.

Certainly as more experience is gained in this field, the long term results of endovascular therapy will be better assessed and with continued improvements in these techniques the morbidity and mortality from treatment should continue to improve.

References


