Beth Israel Deaconess Medical Center
HARVARD MEDICAL SCHOOL TEACHING HOSPITAL

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NEUROVASCULAR NEWS

The Brain Aneurysm Institute

Multidisciplinary Care of Patients with Hemorrhagic and Ischemic Stroke

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We are available to accept referrals of patients on an emergent or non-urgent basis.

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Management of Acute and Chronic Carotid Occlusion with Angioplasty and Stenting

Philip G. R. Schmalz, MD, Ajith J. Thomas, MD, Christopher S. Ogilvy, MD

Stenosis and occlusion of the carotid arteries in the neck is an important risk factor for the development of ischemic stroke. As the artery narrows due to the buildup of atherosclerotic plaque, the plaque can become unstable and rupture, causing thrombosis and embolism and thereby producing an acute stroke. When this condition is identified prior to a stroke, or after a small stroke, it can be treated with either carotid endarterectomy or carotid angioplasty and stenting on an elective basis to remove or stabilize the plaque. However, when plaque rupture causes an acute carotid occlusion with an ischemic stroke, a neuroendovascular approach is required to both open the blocked artery in the neck and retrieve the clot from the intracranial circulation in an emergent fashion.

Like carotid stenosis, chronic occlusion of the internal carotid artery is also a risk factor for the development of stroke. Chronic carotid occlusion results from progressive atherosclerosis and thrombosis, radiation-induced endothelial injury and fibrosis in patients with head and neck cancers, or can be idiopathic as in the case below. Patients with chronic carotid occlusion may be symptomatic with focal ischemic symptoms, for example when blood flow is transiently reduced as in rising from a recumbent position or when dehydrated. Nonfocal symptoms such as cognitive impairment can also be a feature of the condition. In many patients, no overt clinical symptom is present despite complete occlusion of the carotid artery as collateral circulation continues to supply the affected hemisphere.

We present two cases of carotid occlusion, one acute and one chronic. We compare and contrast the management of these similar conditions, and discuss the role of carotid angioplasty and stenting for treating both acute and chronic carotid occlusion.

Acute Carotid Occlusion with Ischemic Stroke

Acute ischemic stroke with occlusion of a large artery, such as the internal carotid or middle cerebral arteries, is the newest neurosurgical emergency. Advances in imaging and the development of health systems to identify and treat patients with stroke syndromes amenable to neurointerventional techniques have revolutionized stroke care and have been shown in major trials to improve outcomes.[1] Extracranial carotid stenosis is an important cause of stroke. In this case, an atherosclerotic plaque at the carotid bifurcation in the neck becomes unstable and ruptures, promoting thrombosis at the site of the plaque, and causing distal embolism. This is a common presentation for large-vessel acute ischemic stroke, and is termed a "tandem occlusion" to describe blockage both at the carotid bifurcation in the neck, as well as blockage of the intracranial arteries. This poses a challenge for the neurointerventionalist, as two problems must be addressed at once. The cervical carotid artery must be opened first to allow the passage of catheters to then retrieve the blood clot from the blocked brain arteries and restore blood flow.

Case Presentation

A 65-year-old man with a past medical history of hypertension awoke from sleep and found he was off-balance. He returned to sleep, without addressing his symptoms. When he had not awoken at his usual hour, his family checked on him and noticed left sided weakness and a left facial droop. EMS was notified and he was transferred to BIDMC and a Code Stroke was called. In the emergency room, CT angiography demonstrated occlusion of the internal carotid artery in the neck. He was evaluated by both the Vascular Neurology and Neuroendovascular surgical teams and deemed a candidate for emergent endovascular intervention.

He was taken immediately for diagnostic angiography which demonstrated a complete occlusion of the right carotid artery in the neck (Fig.1). Using a microcatheter, the blockage was passed and a larger balloon was opened in the region of the occlusion to open this artery via angioplasty. After angioplasty, a tapered stent was placed at the site of occlusion, thereby restoring flow and stabilizing the plaque.

After opening cervical carotid occlusion, the intracranial circulation was checked for tandem occlusion, as is common in this type of stroke. An angiogram through the newly opened carotid artery showed further occlusion at the carotid terminus and into the middle cerebral artery. Using a microcatheter a stent-retriever was passed into the middle cerebral artery across the region of the clot (Fig. 2). While using continuous suction-aspiration on the guiding catheter, the stent-retriever was pulled through the clot, successfully opening the blocked artery (Fig. 3).

As is common in these cases, the patient improved immediately on the table, able to move the left side of his body once again. Over the course of his hospital stay he continued to improve and was walking the following morning. He was discharged home three days later and, at his most recent follow up visit, remains completely neurologically intact.

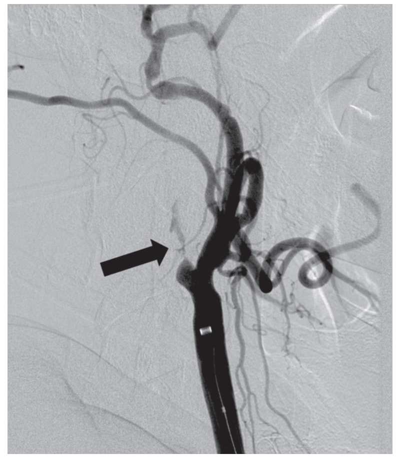

Figure 1: Lateral injection into the right common carotid demonstrating a complete occlusion of the left internal carotid artery just distal to the carotid bifurcation. There is sluggish flow into the proximal right internal carotid artery with atherosclerotic plaque visible (arrow).

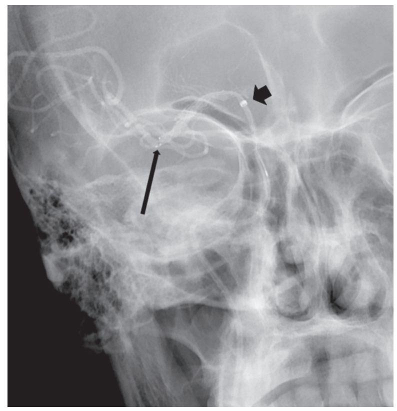

Figure 2: Intermediate catheter angiogram in the terminal internal carotid artery shows the stentriever deployed in the middle cerebral artery, engaging the thrombus. The distal stent markers can be seen at the middle cerebral artery bifurcation (long arrow).

Figure 3: Right common carotid injection after carotid stent placement and right middle cerebral thrombectomy demonstrates a stented and patent right internal carotid artery (large arrow) and complete recanalization of the middle cerebral artery after thrombectomy.

Chronic Carotid Occlusion

Complete occlusion of the carotid artery with an acute stroke is a medical emergency requiring emergent intervention, but when carotid occlusion is identified in asymptomatic patients, a more nuanced approach is necessary. Stroke risk can be predicted by the degree of ischemia present on noninvasive imaging, such as CT perfusion. Patients with late (stage II) hemodynamic failure are at a high risk of stroke, up to 30% over three years in one study.[2] Despite this high risk, open surgical bypass has not been found effective at stroke prevention.[3] Small case series have reported successful revascularization with carotid angioplasty and stenting in selected patients. Additionally, there is evidence that restoration of blood flow improves cognitive outcomes.[4]

Case Presentation

A 42-year-old woman with no past medical history and no history of stroke presented with complains of lightheadedness and vertigo. The patient underwent noninvasive imaging which demonstrated nearly complete occlusion of the left internal carotid artery in the neck and she was referred to the BIDMC Brain Aneurysm Institute. She underwent a diagnostic cerebral angiogram which demonstrated complete occlusion of the internal carotid artery in the neck, at the level of the carotid bifurcation. Interestingly, an extensive collateral circulation to the intracranial carotid artery through branches from the external carotid artery was found. This suggests her occlusion was both gradual and longstanding (Fig. 4, A, B). CT perfusion studies were performed which showed decreased blood flow throughout the left hemisphere consistent with stage II hemodynamic failure, placing her at risk for a stroke.

Prior studies evaluating bypass procedures have found these invasive methods to be ineffective at stroke prevention in cases of chronic carotid occlusion, largely due to the risk of procedural stroke. Less invasive methods including angioplasty and stenting have been performed successfully for chronically occluded carotid arteries.[5]
After a thoughtful discussion with the patient, we planned for endovascular treatment with carotid angioplasty and stenting.

The patient underwent the procedure under conscious sedation in the neurointerventional suite. A catheter was placed in the common carotid artery at the origin of the blocked internal carotid artery. A thin, stiff wire was successfully passed into the internal carotid artery establishing access to the blocked vessel. A balloon was then inflated at the site of blockage, performing angioplasty. This was followed by placement of a tapered stent. Follow-up angiograms demonstrated the artery was opened throughout its course and was supplying the brain once again (Fig. 5, A, B). The patient was discharged home the following day and has had an uneventful recovery with no symptoms of stroke.

Conclusions

These cases highlight the expanding role for neuroendovascular techniques in the management of both acute and chronic extracranial occlusive cerebrovascular disease. As techniques and technology continue to improve at a rapid pace, we can offer treatment for patients with conditions that have been previously found unamenable to open surgical techniques.

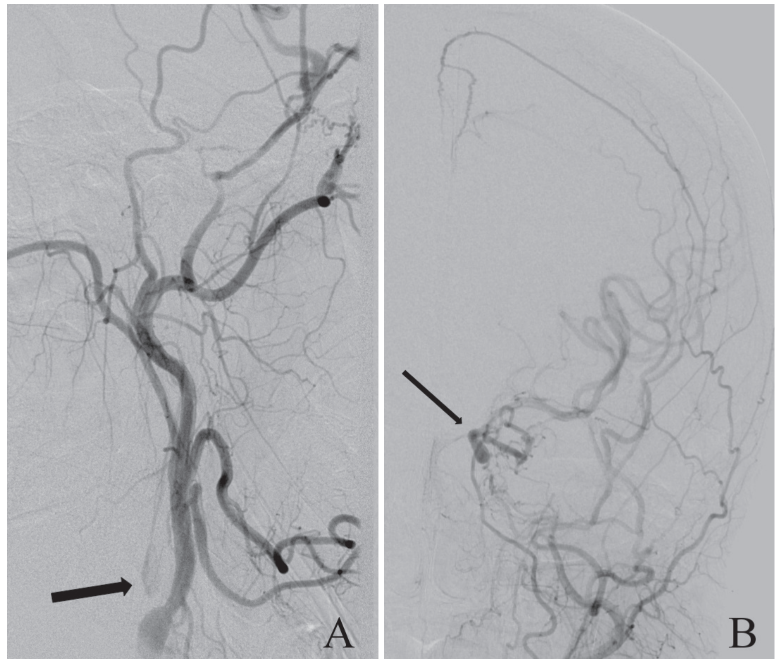

Figure 4:
A Chronic occlusion of the right internal carotid artery. Proximally, the internal carotid artery can be seen with a faint "string sign" just prior to complete occlusion (thick arrow)
B Partial reconstitution of the intracranial portion of the internal carotid artery through collaterals from the external carotid artery. The left carotid siphon can be seen partially filling through external carotid collaterals (thin arrow).

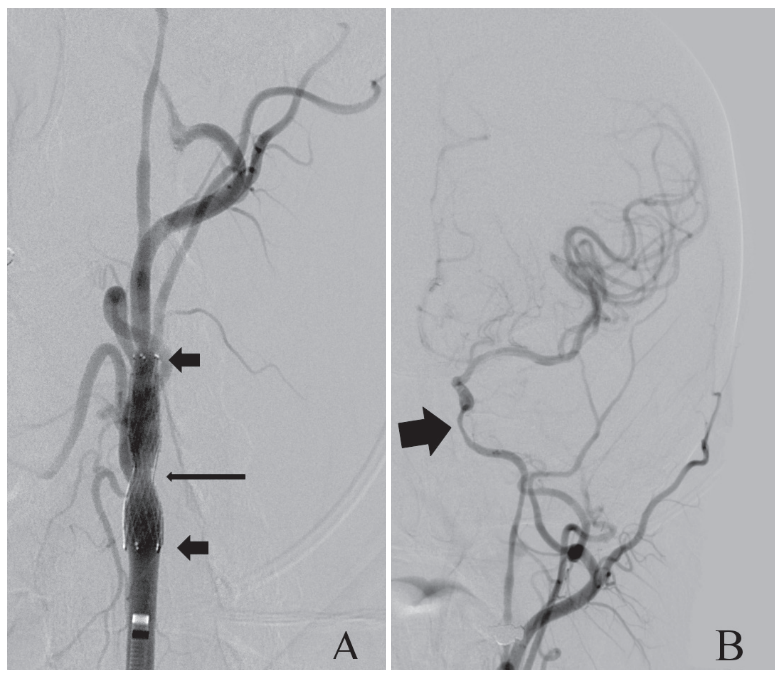

Figure 5:
A Injection into the left common carotid artery after angioplasty and stent placement. The proximal and distal ends of the stent can be seen spanning the carotid bifurcation (short arrows) and the region of stenosis can be seen in the middle of the stent (long arrow).
B After angioplasty and stenting, the internal carotid artery is now patent, though hypoplastic due to prolonged absence of flow (large arrow). With time, this vessel will enlarge as it resumes its role supplying the left hemisphere.

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Carotid-Cavernous Fistula Embolization via the Facial Vein

Luis C. Ascanio-Cortez MD, Abdulrahman Alturki MD, Ajith J. Thomas MD, Christopher S. Ogilvy MD

Carotid-Cavernous fistula (CCF) is an abnormal communication between the carotid artery and the cavernous sinus. The fistula may arise from the branches of the Internal Carotid Artery (ICA) or from the External Carotid Artery (ECA).

The pathophysiology varies according to the type of fistula. In direct fistulae, there is a direct connection between the ICA and the cavernous sinus often secondary to trauma. An "indirect" fistulae is usually a dural arteriovenous fistula of some element of the cavernous sinus dura. Symptoms may include chemosis, proptosis, orbital bruit, visual loss, headache, epistaxis and cranial nerve palsies. [1,2]

Diagnosis begins with clinical suspicion after ruling out other medical conditions that can mimic the ocular symptoms (i.e. thyroid ophthalmopathy, eye allergy and conjunctivitis).[3]

Imaging is essential to establish the diagnosis. Head CTA and Brain Three-dimensional, time-resolved MRA are often the first studies obtained and may show a dilated vein in the orbit.[1] Complete cerebral angiography is then used to detail the arterial inflow and venous outflow of the lesion.

Patients with venous drainage to the cerebral hemisphere have an increased risk of intracranial hemorrhage and those with venous drainage through the ophthalmic veins can have elevated orbital pressures and threaten vision.

Currently, endovascular techniques are the most commonly used form of treatment. The approaches can be both arterial or venous with the overall goal of occluding the venous outflow with resultant lesion obliteration.[3–5] Transvenous approaches to the cavernous sinus can be through the inferior petrosal sinus (IPS) and is often the most common route. Other approaches include surgical access through the superior ophthalmic vein (SOV), facial vein, pterygoid plexus and through direct percutaneous puncture.[4] We present a case of a CCF that was treated with endovascular embolization through the right facial vein.

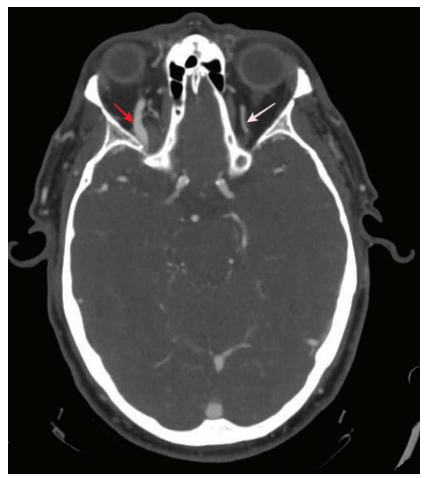

Figure 1: Preoperative CTA that shows a dilated right superior orbital vein (red arrow) compared to the left superior orbital vein (white arrow).

Case presentation

A 60-year-old male was referred to our service presenting with right eye redness and proptosis that had been present for a month. There is negative history for eye surgery, head or eye trauma. His past medical history was significant for mitral valve replacement, paroxysmal atrial fibrillation, hyperthyroidism, and anemia. A head CTA and MRI showed vascular congestion in the right orbit and right eye proptosis (Fig.1). Physical exam revealed right eye conjunctival hyperemia and proptosis. The rest of the physical exam was unremarkable. Neuro-ophthalmologic evaluation revealed an increased intraocular pressure on the right eye, proptosis of 7mm, corkscrew vessels and cup-to-disc ratios of 0.4-0.45 in the right compared to 0.2 on the left. No disc pallor or swelling was found. No visual loss was evident.

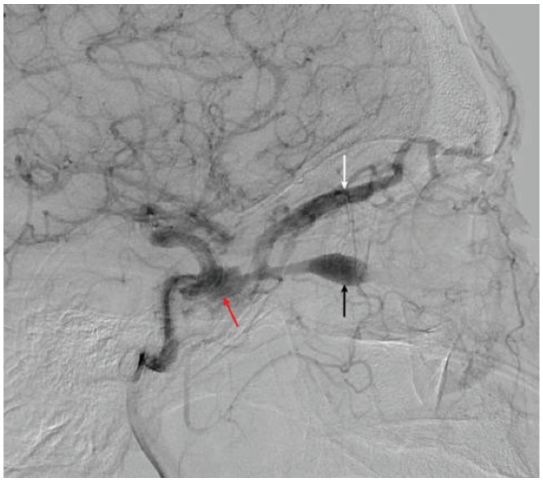

Figure 2: A diagnostic angiogram of the right internal carotid artery run showed a shunt with the cavernous sinus (red arrow) and both dilated superior orbital vein (white arrow) and inferior orbital vein (black arrow).

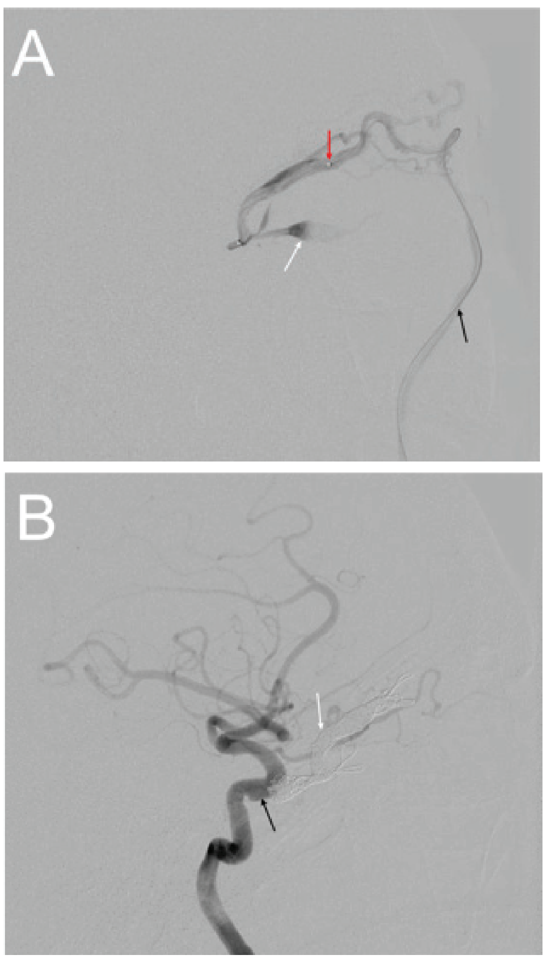

Figure 3:
A Interventional angiogram that shows catheterization of the right superior orbital vein (red arrow) through the right facial vein (black arrow) before coiling. The right inferior orbital vein is also observed (white arrow).
B Post-coiling run through the right internal carotid artery (black arrow) demonstrates complete obliteration of the shunt (white arrow).

Diagnostic angiography with the injection of the right internal carotid artery revealed an indirect right dural Carotid-Cavernous fistula (CCF) that drained into the superior orbital vein (SOV) and the inferior orbital vein (IOV) (Fig. 2). The external artery was found to be occluded.

Intervention: Endovascular access was accomplished via the right femoral vein with microcatheter access via the right facial vein which was enlarged and communicated to the SOV (Figure 3A). Coils were then placed in the venous outflow of the lesion which resulted in complete obliteration (Figure 3B). The patient was neurologically intact and was discharged on postoperative day 1.

This case illustrates the use of endovascular venous treatment cavernous sinus CCF with a catheter in the internal carotid artery for demonstration of complete occlusion. While a bit unique, this makes the point that reaching the venous side of the fistula with an endovascular microcatheter is the key to complete lesion obliteration. Biondi et al. described extensively the indications, usefulness, and challenges of CCF endovascular treatment through the facial vein.[6]

Endovascular treatment of CCFs via the facial vein is an alternative route of treatment for those patients with anterior venous drainage and in which the IPS cannot be easily accessed. Here at BIDMC Brain Aneurysm Institute, our highly skilled team of doctors and nurses can handle successfully such scenarios in which traditional routes of treatment cannot be used.

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Stent-Assisted Coiling

Gabriel Sneh, Abdulrahman Alturki, MD, Ajith J. Thomas, MD, Christopher S. Ogilvy, MD

Prevalence of intracranial aneurysms is estimated to range from two to five percent in the general population (1). While the need for treatment in the setting of a ruptured aneurysm is uncontroversial, the standard for surgical or endovascular treatment of unruptured aneurysms is relatively less settled.

The decision of which patients to treat and which treatment approach to take is multifactorial, and depends on both clinical and anatomic factors. These include: aneurysm size, location, and shape, and whether these parameters have changed over time; patient age; family or personal history of previous intracranial aneurysms or associated conditions; whether the aneurysm is symptomatic (for example, compression of a large aneurysm on the cranial nerves can result in impaired eye movement); and whether or not the patient has had a previous subarachnoid hemorrhage (2).

Aneurysms can be categorized into several subgroups based on differences in their anatomy and etiology. The most common of these are saccular aneurysms, which are a localized dilatation of a vessel wall, with a "neck" that connects the aneurysm to the parent vessel and which can vary in size. Wide-necked saccular aneurysms can be difficult to treat by primary endovascular coiling alone, as the coils in these cases are prone to "fall out" of the aneurysm sac.

Stent-assisted coiling (SAC) was introduced to address the treatment needs of these sometimes difficult-to-treat aneurysms. This technique involves placing a stent in the parent vessel adjacent to the aneurysm that bridges the aneurysm's neck. This allows coils to be placed within the lumen of the aneurysm with decreased risk of the coils drifting out of the aneurysm sac into the parent vessel; the stent acts as a scaffold that holds the coils in place (2).

Several studies have shown that stent-assisted coiling results in a statistically significant decrease in the rate of angiographic recurrence of intracranial aneurysms (3, 4). However, this treatment can also be associated with an increased risk of thrombosis, and therefore requires treatment with dual anti-platelet therapy following the procedure. Careful patient selection by the cerebrovascular neurosurgery team is therefore important.

At Beth Israel Deaconess Medical Center, we have successfully used stent-assisted coiling for wide-necked aneurysms with good long-term outcomes.

Case Presentation

A 65-year-old man with a history of aortic valve replacement initially presented to his primary care provider

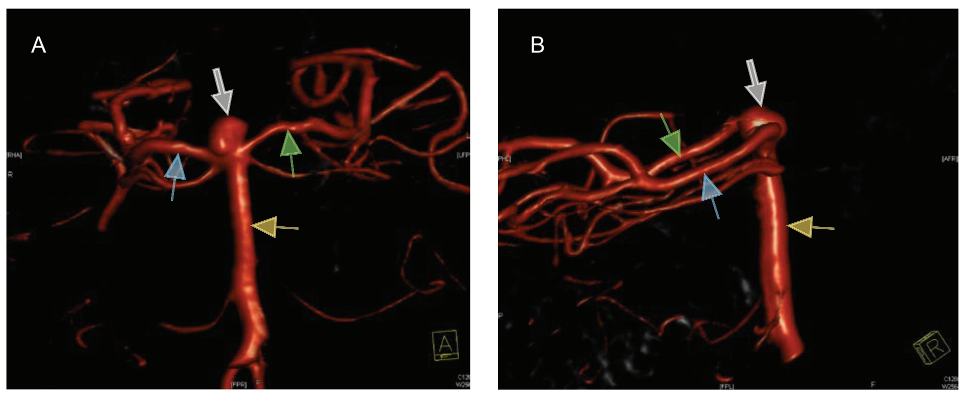

Figure 1: 3D reconstruction shows anterior-posterior (left) and lateral (right) views of the verterbrobasilar tree. The saccular aneurysm of the basilar tip (white arrow) can be seen where the basilar artery (yellow arrow) branches to form the right (blue arrow) and left (green arrow) posterior cerebral arteries.

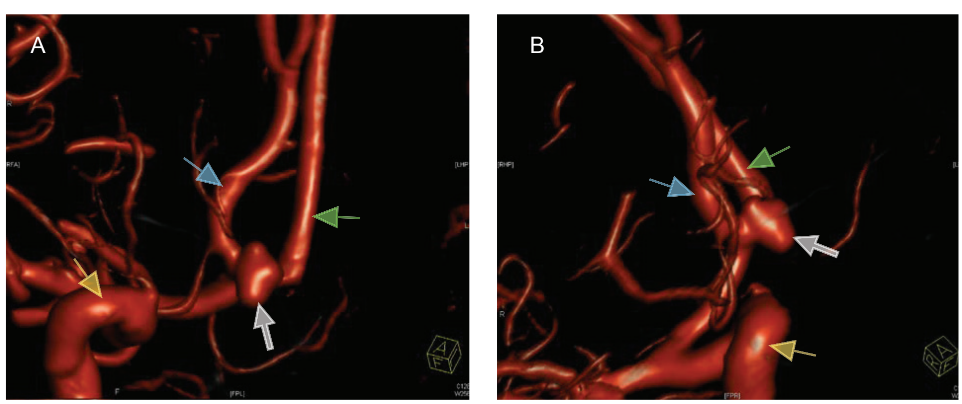

Figure 2: 3D reconstruction shows anterior-posterior (left) and lateral (right) views of anterior communicating artery aneurysm (white arrow). The right internal carotid artery (yellow arrow) and bilateral anterior cerebral arteries (blue and green arrows) can be seen.

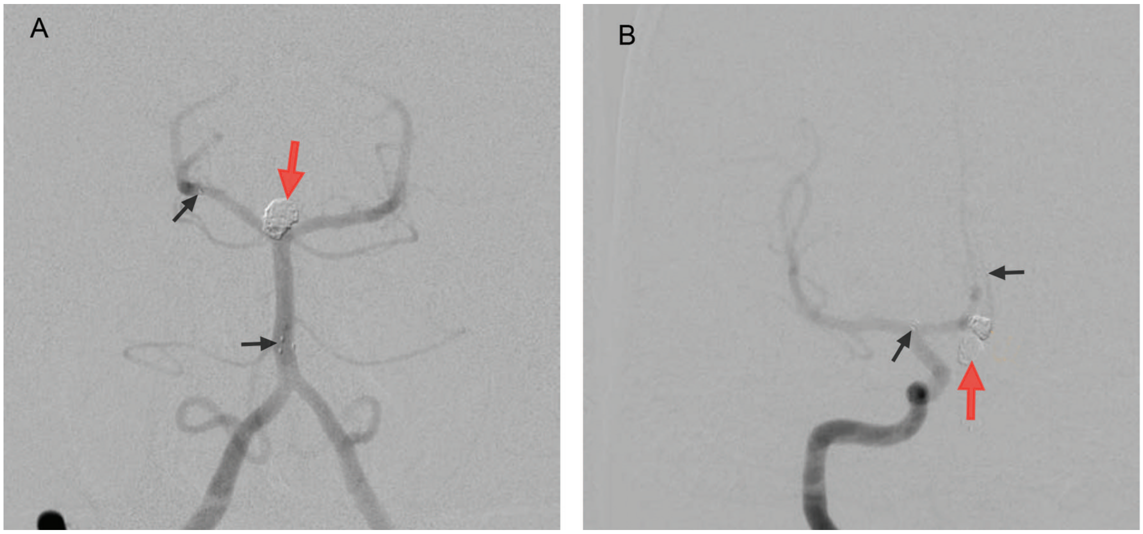

Figure 3: Cerebral angiogram showing the anterior-posterior (left) and lateral (right) views of the basilar tip aneurysm after stent-assisted coiling. The red arrows demonstrate the coil-filled aneurysm; the black arrows demonstrate the ends of the underlying stent, which extends from the P1 segment of the the posterior cerebral artery at its distal end to the proximal part of the basilar artery at its proximal end.

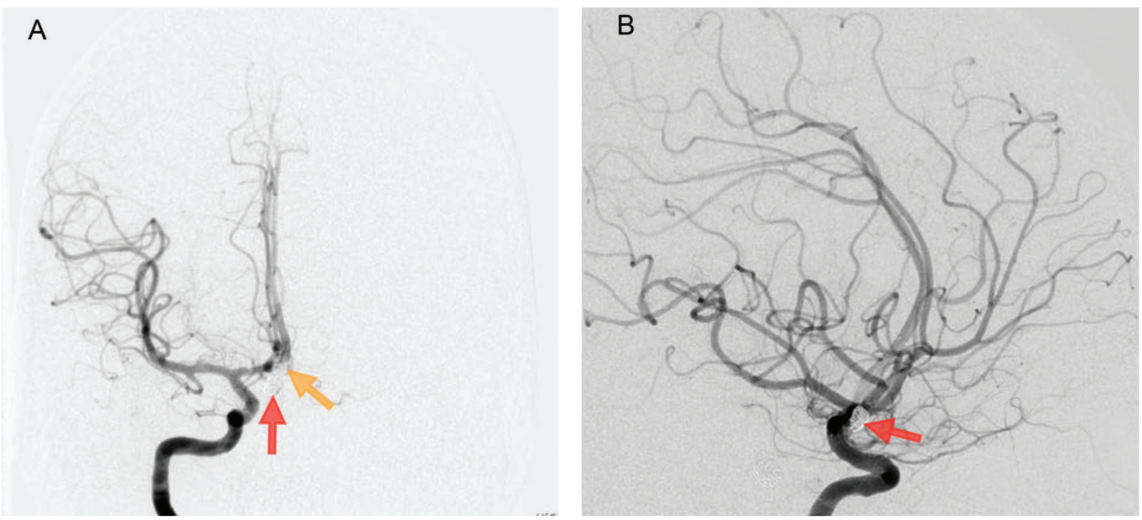

Figure 4: Cerebral angiogram showing the anterior-posterior views of the anterior communicating artery aneurysm after stent-assisted coiling (orange arrow). The black arrows mark the ends of the stent, which extends from the proximal part of the A1 segment of the anterior cerebral artery to the A2 segment of the anterior cerebral artery. The coiled basilar tip aneurysm can also be visualized in this view (red arrow).

following 7-8 months of dizziness, for which he first underwent cardiac evaluation. Because his cardiac angiogram showed only insignificant regurgitation, and MRI/MRA was performed to explore an intracranial cause for his symptoms, which demonstrated the possibility of three separate aneurysms: a basilar tip aneurysm, aneurysm of the anterior communicating artery, and one of the left middle cerebral artery. The patient was subsequently referred to the Beth Israel Deaconess Brain Aneurysm Institute for evaluation and treatment.

Following CTA confirmation of the basilar tip and anterior communicating artery aneurysms, his case was discussed at the weekly cerebrovascular conference at BIDMC. The patient subsequently underwent stent-assisted coiling of the basilar tip aneurysm first, (as posterior cerebral circulation aneurysms have a greater risk of rupture than those located in the anterior circulation), followed by stent-assisted coiling of the anterior communicating aneurysm three months later.

Now, 6 months following his first stent-assisted coiling, and one month following his second, the patient is doing well with resumption of his usual daily activities. Follow-up imaging shows persistent obliteration of both aneurysms (Fig. 3, 4).

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News and Events

Deidre A. Buckley, NP, *wins prestigious Joseph M. Koufman Award*

The BIDMC Brain Aneurysm Institute is proud to announce that Deidre Buckley, NP is the recipient of the 2017 Joseph M. Koufman and Department of Surgery Annual Award for Excellence in Surgical Nursing.

This award acknowledges exceptional service and dedication to surgical patients. Deidre Buckley has over 33 years of experience as a nurse in the field of neuroscience. She holds a Master's Degree in the Science of Nursing and has been a certified Nurse Practitioner since 1999.

She has written various cerebrovascular book chapters, participated in a multiplicity of clinical research projects, and has lectured on the topic of neurovascular disease and patients. She dedicates herself to patient advocacy and started the first Brain Aneurysm Support group in the United States, which has since inspired the growth of other support groups around the country.

Deidre is also a co-founder of the Brain Aneurysm Foundation (BAF), which is the nation's premier nonprofit organization solely dedicated to providing critical awareness, education, support and research funding to reduce the incidence of brain aneurysm ruptures. She is past President of the BAF Board of Directors, and currently serves as a Board member.

She has furthered the goals of the institution, department and division in a magnificent way.

Save the Date

Ischemic and Hemorrhagic Update: Current Practices and Future Directions

FRIDAY, MAY 12, 2017

Omni Parker House
60 School Street, Boston, MA 02108

Course Directors:
Christopher S. Ogilvy, MD, Magdy Selim, MD, PhD, *and* **Ajith J. Thomas, MD**

The symposium will focus on recent advances in the field of neurovascular disease including current theories on carotid disease, stroke, cerebral hemorrhage, and brain aneurysms and AVMs. We will also cover stroke issues and an overview of hemorrhagic stroke and intraparenchymal hemorrhage. This course will provide a learning experience for neurovascular medical and surgical clinicians in innovative management of patients with complex cerebrovascular disease through interactive didactic lectures, panel presentations and Q&A sessions.

For information about registration, contact Deidre Buckley, NP, at *dabuckle@bidmc.harvard.edu.*