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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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Unruptured Intracranial Aneurysms

Kimberly Kicielinski, MD, Christopher S. Ogilvy, MD, Ajith Thomas, MD

An intracranial aneurysm is defined as an outpouching or extension of the normal arterial vessel wall into a saccular abnormality. Due to the advances in the quality and increased utilization of neuro imaging, the identification of unruptured aneurysms continues to rise. Incidental aneurysms can be discovered when scans are obtained for a variety of reasons including neurologic events, head injuries, headaches or as part of a screening process for cancer. Once an aneurysm is detected the question becomes what, if anything, should be done about the lesion.

Many details go into the decision-making process and management of unruptured intracranial aneurysms. Patient factors and aneurysm characteristics are the two broad categories to consider when contemplating treatment. While size of aneurysm is certainly one facet to consider, the age of the patient (number of years at risk for hemorrhage), location and shape of the aneurysm, and other patient comorbidities factor into the decision as to whether an aneurysm warrants treatment. Each of these factors has implications regarding the natural history of aneurysms (i.e. what happens if I leave the aneurysm alone) and the treatment related risks.

Deciding which aneurysms to treat is just the first question. Once a lesion has been deemed a candidate for treatment, the appropriate type of treatment is then based on the risks and efficacy of each modality relative to the lesion of interest. Unruptured aneurysms can be treated with open surgery and direct clipping, or endovascular strategies which include coil embolization of the aneurysm, stent assisted coiling, or flow diversion where a stent is placed inside the artery and the aneurysm slowly obliterates due to reduced flow and ultimate stagnation and occlusion of the aneurysm due to parent vessel remodeling.

There are number of studies designed to examine the natural history of unruptured aneurysms (1,2). Two of the largest studies conducted had similar design and were not randomized. The studies demonstrated that the smaller an aneurysm was (less than 5-7 mm), the less likely it was to hemorrhage. However, when one evaluates patients who present with subarachnoid hemorrhage from intracranial aneurysm, 75% of these patients harbor aneurysms measuring 10 mm or less. This apparent discrepancy is difficult to resolve.

This becomes a somewhat confusing topic for patients as they investigate

information regarding unruptured aneurysms. At the Beth Israel Deaconess Medical Center Brain Aneurysm Institute, we evaluate patients on a case-by-case basis. After meeting each patient and reviewing their images, we present their films at a weekly neurovascular conference attended by multiple cerebrovascular senior faculty, fellows, nurse practitioners, and research fellows, as well as neuroanesthesia and neuroradiology colleagues. Options of continued observation or intervention with either surgery or endovascular therapy are discussed. For younger patients with larger aneurysms, we tend to favor treatment with either endovascular or surgical techniques. In older patients with a shorter lifetime horizon, the overall risk of aneurysm rupture is lower and therefore conservative therapy is sometimes the best option. We present three cases here to highlight different features of unruptured aneurysm management.

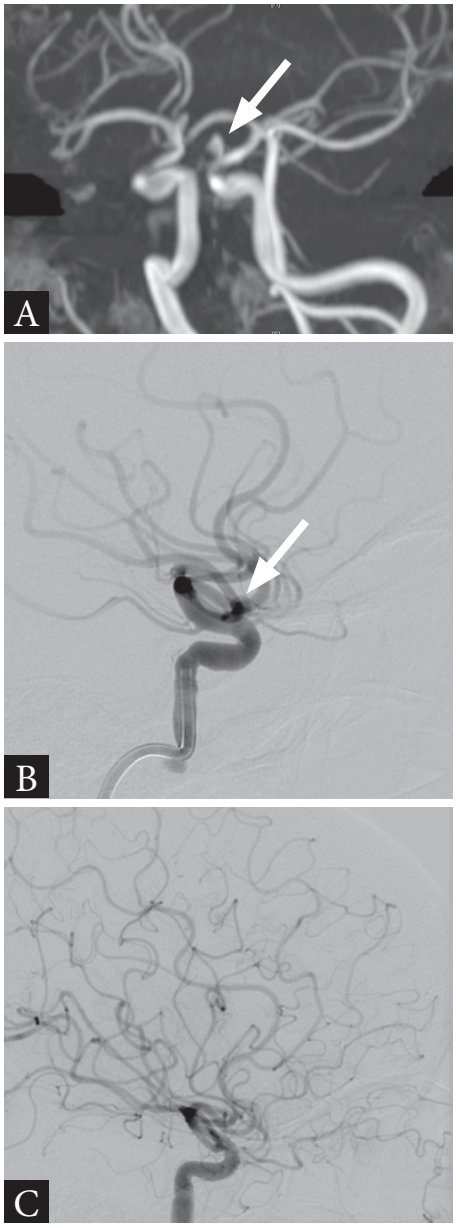
PATIENT 1: This 33 year old, otherwise healthy female, 9 weeks post-partum presented to an urgent care with several weeks of chronic, dull headaches. She also complained of several pre-syncopal events, auras, and intermittent right-eye visual changes. An MRI/MRA was ordered to evaluate the above symptoms, and a 4mm left internal carotid artery (ICA) aneurysm was identified, and felt to be unrelated to her presenting symptoms. She had a grandfather with a possible history of subarachnoid hemorrhage. She was referred to the BIDMC Brain Aneurysm Institute where the decision was made to treat the patient with placement of a flow diversion device due to her young age and lifetime risk of rupture. After an uncomplicated procedure, she was discharged from the hospital the following morning. There was evidence of complete occlusion/resolution of the aneurysm at recent six month follow up angiogram . The patient remains neurologically intact at most recent follow up.

PATIENT 2: This 77 year old female with a history of hypertension presented to her primary care physician with complaints of persistent headache and vertigo. An MRI was ordered and followed up with a CTA that confirmed a 5mm right middle cerebral artery (MCA) aneurysm. She lives independently, and was referred to the BIDMC Brain Aneurysm Institute Clinic for evaluation. Based on the accessibility of the lesion and her excellent functional status, she was selected for open surgical clipping of the aneurysm. After an uncomplicated surgical clipping, she was discharged on the morning of hospital day 2. She remains neurologically intact and continues to live independently as of last follow up.

PATIENT 3: This is a 53 year old female who initially presented with symptoms of acute onset of headache, vertigo, nausea, vomiting, and falling to the left. She was found to have a left cerebellar stroke related to a posterior inferior cerebellar artery dissection. She was also found to have an internal carotid artery dissection that was asymptomatic. Cerebrovascular imaging also identified an incidental 4mm middle cerebral artery aneurysm. The patient is also a non-smoker with no family history of aneurysms.

She was evaluated in clinic at the BIDMC Brain Aneurysm Institute, and aneurysm treatment was deferred until her higher priority dissections had resolved. Follow up imaging at 6 and 12 months was stable. After discussion at vascular conference, serial observation was recommended since the complexity of this aneurysm with branches arising from the dome and intimately at the neck make any form of treatment higher risk combined with the fragility of the patient's vessels and multiple dissections. She continues to remain asymptomatic.

Nuances of aneurysm treatment and awareness of the latest devices requires complete dedication to

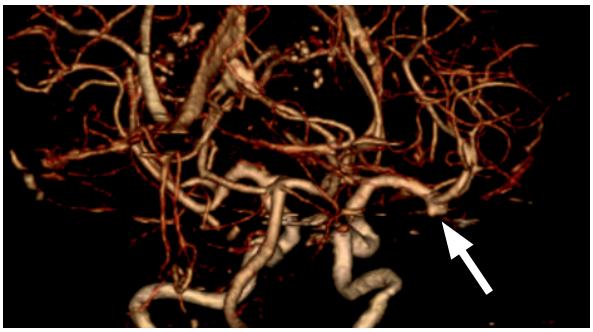


Patient 1

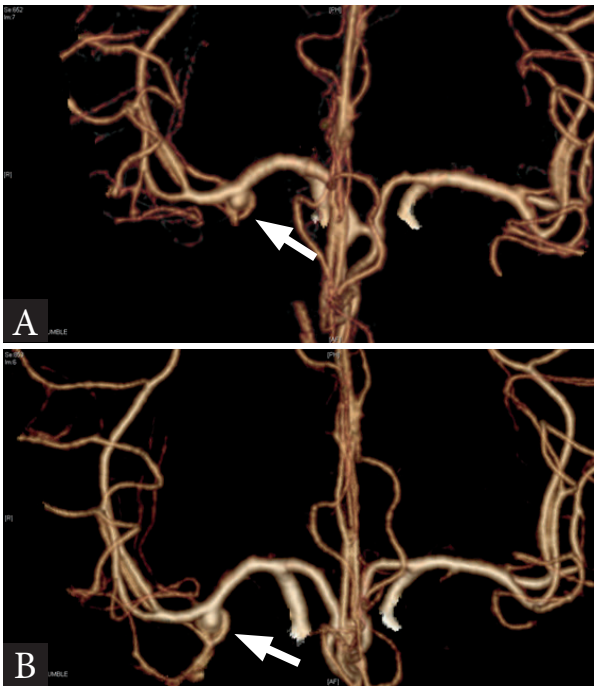
A: MRA showing incidentally-found 4mm left ICA aneurysm

B: Angiogram demonstrating aneurysm during placement of flow diversion device

C: Angiogram demonstrating complete obliteration of aneurysm at six month follow up



Patient 2: CTA reformat demonstrating right MCA aneurysm



cerebrovascular neurosurgical care and a multidisciplinary approach. We treat over 250 aneurysms a year at the BIDMC Brain Aneurysm Institute. By harnessing the technical skills to treat any aneurysm with any modality, the focus shifts to understanding the patient, explaining treatment options, and shepherding the often anxious aneurysm patient through a treatment plan we have customized for them based on the world-class expert opinion of our team at the BIDMC Brain Aneurysm Institute. We aim to provide top-notch, cutting edge, patient-centered aneurysm treatment.

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Patient 3

A: CTA showing 4mm right MCA bifurcation aneurysm with multiple branches intimately involved

B: CTA at 6 months showing stable R MCA aneurysm

Ruptured Distal Anterior Choroidal Artery Aneurysm Treated with Superselective Provocative Testing and Coil Embolization

Philip G. R. Schmalz, MD, Abdulrhaman Alturki, MBBS, MSc, FRCSC, Christopher S. Ogilvy, MD, Ajith J. Thomas, MD

Background and Importance

Aneurysms of the anterior choroidal artery are uncommon, and those located on the distal aspect of this artery are even rarer, with only 28 cases reported in the medical literature. Presentation most commonly is by hemorrhagic stroke (subarachnoid or intraventricular hemorrhage). These lesions have been most commonly reported in association with cerebrovascular disease or arteriovenous malformations. Treatment of distal anterior choroidal artery aneurysms is not well described, with 12 patients treated surgically and only three reported cases of endovascular embolization in the English literature. Most authors report distal lesions where the artery can be safely sacrificed. This aneurysm, however, was in the cisternal segment, a vital portion of the artery. Sacrifice of the anterior choroidal artery in this location can cause paralysis and visual field loss. Many reports on endovascular treatment of these aneurysms favor liquid embolization which would sacrifice the artery. Few cases of coil embolization of these lesions have been reported, occurring entirely in Japan. Here we present a case of a ruptured distal anterior choroidal artery aneurysm treated with coil embolization. Prior to treatment, the patient underwent provocative testing to assess the safety of parent vessel occlusion.

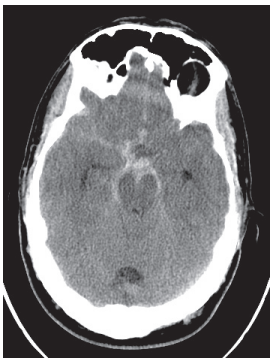

Figure 1: Noncontrast CT scan of the head obtained at admission demonstrating diffuse subarachnoid hemorrhage without intraventricular hemorrhage.

Clinical Presentation

History

A 40-year-old man was transferred to the Beth Israel Deaconess Brain Aneurysm Institute with the acute onset of a thunderclap headache with associated nausea and vomiting. Medical history was notable for asthma and scoliosis, corrected surgically. Social history was notable for occasional alcohol use, but negative for the use of tobacco or other drugs. There was no family history of aneurysms or vascular disease.

Examination

Upon examination mental status and speech were normal. There was no cranial nerve, sensory, or motor deficit. He underwent a computed tomography (CT) scan of the head which demonstrated diffuse subarachnoid hemorrhage (Figure 1). A CT angiogram of the head and neck was performed which failed to disclose the source of hemorrhage.

Operation

The patient underwent a diagnostic cerebral angiogram under conscious sedation on hospital day two. Injection of the right internal carotid artery demonstrated a 3 mm aneurysm of the distal right anterior choroidal artery just proximal to the plexal point (Figure 2, Panels A, B). Coil embolization of this lesion was planned, however given its critical location, a superselective amobarbital test was performed prior to embolization. This test temporarily anesthetizes selective parts of the brain supplied by a particular artery, and can predict the results of occluding that artery. A high-magnification arteriogram was performed to better characterize the lesion (Figure 3). Next, 10 mg of sodium amobarbital was administered into the anterior choroidal artery at the planned site of occlusion. After administration, the patient's motor function, memory, and visual fields were tested. No deficits were observed. The aneurysm was then sealed with a single detachable coil. The coil was allowed to pass into the parent artery to achieve parent vessel occlusion and thoroughly block the aneurysm. A follow-up angiogram demonstrated complete occlusion of the aneurysm and the distal anterior choroidal artery with preservation of the critical cisternal segment more proximally (Figure 4).

Postoperative Course

The patient recovered in the neurointensive care unit and was discharged home on hospital day eight in excellent condition.

Discussion

The anterior choroidal artery arises from the posterior wall of the internal carotid artery and supplies the posterior limb of the internal capsule, optic tracts, lateral thalamus, and the globus pallidus. The cisternal segment of the vessel travels in the subarachnoid space and then enters the lateral ventricle by piercing the choroidal fissure. Prior to entering the choroidal fissure, the anterior choroidal artery gives off multiple perforators to the critical structures listed above. Distal to the plexal point occlusion is usually inconsequential, though large and important perforators to the thalamus and lateral geniculate nucleus have been described. Occlusion proximal to the plexal point has variable clinical consequences ranging from asymptomatic to complete hemiplegia, hemianopsia, and hemianesthesia, depending on the contribution of the posterior communicating and posterior cerebral arteries to the internal capsule, lateral thalamus, and optic tract. In this case, the aneurysm was located proximal to the plexal point, placing the patient at risk for a severe neurologic deficit. For this reason, we used provocative testing to evaluate the results of occlusion prior to permanently sacrificing the vessel.

It has been suggested that distal aneurysms of the anterior choroidal artery are not amenable to coil embolization. Parent vessel occlusion with n-butyl cyanoacrylate (n-BCA, TruFill, Codman Neuro, Raynham, MA, USA) has been advocated. Due to the anatomy in this case, liquid embolization would have put a greater portion of the proximal anterior choroidal artery and associated perforators at risk for occlusion in the event of reflux. Though provocative testing was performed, we favored an approach to preserve as great a portion of the cisternal segment as possible.

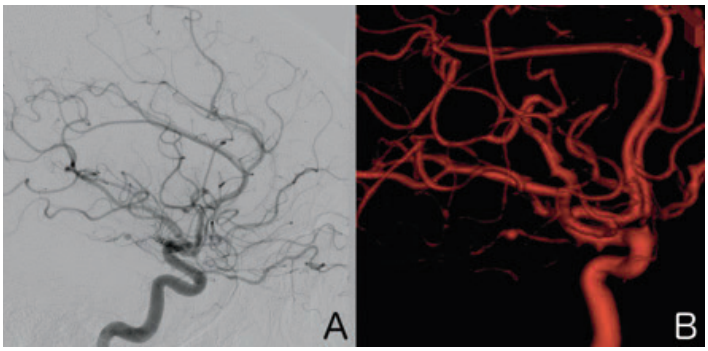

Figure 2

A: Lateral internal carotid injection demonstrates a 3 mm aneurysm of the distal anterior choroidal artery. The vessel entry into the choroidal fissure can be seen just distal to the aneurysm and is indicated by a sharp bend in the vessel. Distal to this bend, the anterior choroidal artery blends into the choroid plexus of the lateral ventricle.

B: Three dimensional reconstruction showing the aneurysm in the cisternal segment of the anterior choroidal artery. The vessel is rendered out distal to the aneurysm as the vessel caliber decreases.

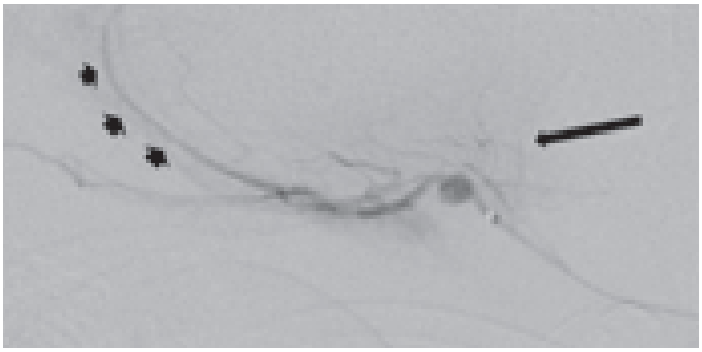

Figure 3: Superselective injection into the anterior choroidal artery just prior to provocative testing. Proximal perforators from the cisternal segment can be seen passing posterolaterally to irrigate deep brain structures (long arrow). The most distal visible perforator, the capsulothalamic artery, can be seen curving around the thalamus (short arrows). This vessel was likely occluded during embolization.

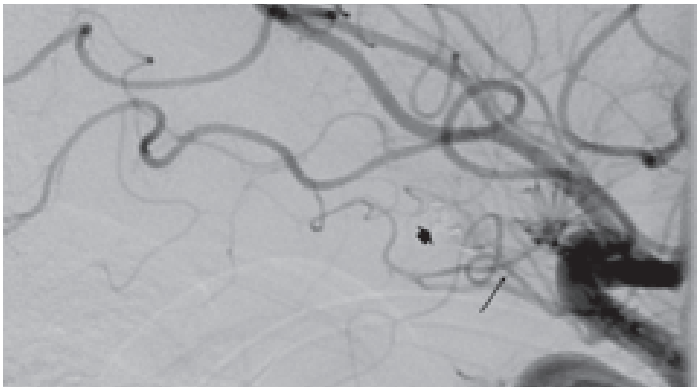

Figure 4: Injection into the right internal carotid artery after coil embolization. The coil mass can be seen filling the aneurysm, with a proximal loop which completed parent artery occlusion (thick arrow). The cisternal segment of the anterior choroidal artery is seen filling proximal to the coil mass (thin arrow).

This case demonstrates the utility of provocative testing for aneurysm treatment, particularly for distal lesions. We performed superselective provocative testing in this case to evaluate the risk of parent vessel occlusion during embolization. Selective amobarbital injection into the posterior cerebral and anterior choroidal arteries has been reported previously for presurgical evaluation in epilepsy and vascular lesions. Superselective provocative testing has also been employed with success for the treatment of infectious aneurysms requiring parent vessel sacrifice. Other strategies such as nonoperative management, clipping, or aneurysm trapping, were considered in the event of provocative test failure. Thus, provocative testing was important for treatment planning. In this particular case, no deficits were observed during testing and embolization was undertaken without complication. Notably, both the testing and embolization phases of the intervention were completed with the patient lightly sedated but cooperative to facilitate continuous neurologic monitoring.

Conclusions

Distal anterior choroidal aneurysms are uncommon lesions that can be challenging to treat. They often occur in association with high-flow conditions, such as moyamoya disease and arteriovenous malformations, but can occur in isolation. Endovascular treatment with coil embolization is feasible and offers favorable outcomes.

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The Use of Single Stent-Assisted Coiling in Treatment of Bifurcation Aneurysms: A Multicenter Cohort Study With Proposal of a Scoring System to Predict Complete Occlusion

Alejandro Enriquez-Marulanda, MD, Nimer Adeeb, MD, Christopher S. Ogilvy, MD, Ajith J. Thomas, MD

Treatment of brain aneurysms was made easier by the development of endovascular procedures such as coiling or stenting. Despite this, some aneurysms were still challenging to manage, particularly wide-necked aneurysms at the bifurcation of intracranial arteries, in which a parent vessel divides into two branches (Figure 1). In this type of aneurysms coil protrusion into the parent artery and high rates of recanalization are problematic. To mitigate this, stent-assisted coiling technique has been described in which the stent is used to buttress the coil mass at the aneurysm neck (Figure 2). However, placing a stent often covers only one-half of the aneurysm neck. Several newer techniques were developed to deal with bifurcation wide-necked aneurysms including using two stents in a Y-configuration, the WEB device, the PCONus device, among others, which have also shown advantages including decreasing the risk of recanalization.

The decision of which treatment approach is most beneficial is influenced by multiple factors, including clinical and anatomical characteristics. An improved understanding of the factors associated with aneurysm occlusion at time of treatment or recanalization in wide-necked aneurysms at the bifurcation of intracranial arteries, treated with these newer techniques, may influence the choice of the appropriate approach and device.

Investigators at the BIDMC Brain Institute have done a retrospective analysis of the cases of bifurcation aneurysms treated with single stent-assisted coiling technique performed between 2007 and 2015, at 3 academic institutions, (including University of Alabama at Birmingham, Birmingham, USA, the Hospital Israelita Albert Einstein in Sao Paulo, Brazil and at Beth Israel Deaconess Medical Center, Boston, USA).

In this study, they have shown that the single stent-assisted coiling technique is effective in 91% of the cases, decreasing the need for complex reconstruction of the aneurysm neck. Analysis of the characteristics that predicted occlusion of the aneurysms treated with this technique was undertaken, identifying the subgroup of patients who would most benefit from the procedure.

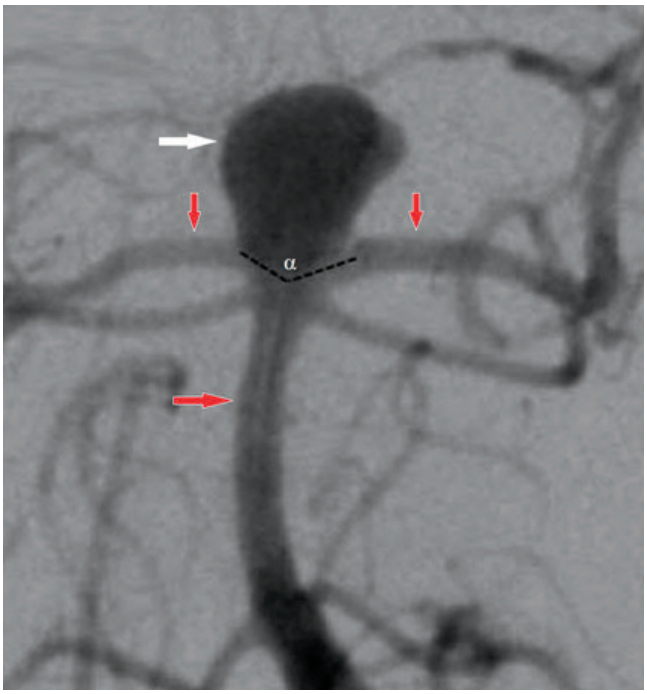

Figure 1: Diagnostic angiogram showing a basilar tip artery aneurysm (white arrow) and the posterior cerebral arteries (Vertical red arrows) which are the terminal branches of the basilar artery (Horizontal red arrow).

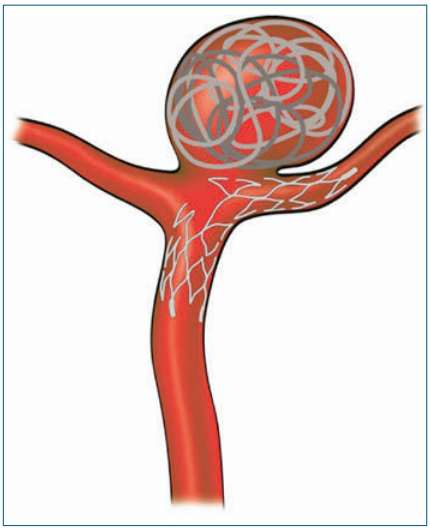

Figure 2: Single stent-assisted coil procedure in a bifurcation aneurysm.

Factor	Score	
	0	1
Location	ICA and Basilar	MCA and Acom
Aneurysm maximal diameter	>9.0 mm	≤9.0 mm
Aneurysm neck size	>7.0 mm	≤7.0 mm
Alpha	>165°	≤165°

ICA = internal carotid artery terminus, Basilar = basilar artery apex,
MCA = middle cerebral artery, Acom = anterior communicating artery.

Table 1: Scoring system

Class	Score	Complete occlusion
I	0	14%
II	1-2	55%
III	3-4	92%

Table 2: Prediction of complete bifurcation aneurysm occlusion based on the scoring system classification

Also, they proposed a scoring system classification (scores ranging from 0 to 4) in which higher scores (3 and 4) predict complete occlusion for bifurcation aneurysms treated with Single stent-assisted technique (Table 1 & 2). This scoring system is calculated based on anatomical variables of the aneurysm such as the location, the maximal diameter, neck size and the α angle (which is defined as the angle between two branches at the site of the aneurysm; Figure 1.

The development of this score aids in the decision making because patients with high scores can be safely and effectively treated with a single stent-assisted coil technique. In addition, they defined patients with lower scores as those who would require complex reconstruction techniques by different treatment options, such as a Y-stent technique.

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News and Events

September declared Brain Aneurysm Awareness Month in Massachusetts

FROM LEFT TO RIGHT:
Christopher S. Ogilvy, MD, Director, BIDMC Brain Aneurysm Institute, Bob Halloran, Survivor, Channel 5 Sports Anchorman, Tom Tinlin, Survivor, Retired Massachusetts Highway Commissioner, Christine Buckley, Executive Director, The Brain Aneurysm Foundation, Representative Paul Donato, Charles Baker, Governor of Massachusetts, presenting the Proclamation

FROM LEFT TO RIGHT:
Christopher S. Ogilvy, MD, Director, BIDMC Brain Aneurysm Institute Christine Buckley, Executive Director of the Brain Aneurysm Foundation, Charlie Baker, Governor of Massachusetts, presenting the Proclamation

Save the Date

Ischemic and Hemorrhagic Update: Current Practices and Future Directions

FRIDAY, MAY 7, 2018

Omni Parker House
60 School Street, Boston, MA 02108

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

This is a unique course focused on recent advances in the field of neurovascular disease including up-to-date theories of carotid disease, cerebral hemorrhage, and brain aneurysms. Topics covered will include assessment, management, and specific issues of carotid disease, cerebral hemorrhage, and brain aneurysms.

CME credit awarded.

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