



# NEUROVASCULAR NEWS

## The Brain Aneurysm Institute

Multidisciplinary Care of Patients with Hemorrhagic and Ischemic Stroke



Christopher S. Ogilvy, MD  
DIRECTOR  
Brain Aneurysm Institute



Ajith J. Thomas, MD  
CO-DIRECTOR  
Brain Aneurysm Institute

### Flow-Diversion Technology for the Treatment of a Ruptured Intracranial Dissecting Pseudo-Aneurysm of the Vertebral Artery

Abdulrahman Alturki, MD, Ajith J. Thomas, MD, and Christopher S. Ogilvy, MD

Extracranial artery dissection represents a potential source of stroke, especially in younger adults. Traditionally oral anticoagulation or antiplatelet therapy have been the mainstay of treatment to prevent further strokes and promote recanalization. Although medical management remains the mainstay of treatment in cases of arterial dissection, there are some instances of failure of anticoagulation therapy, and patients may progress or become symptomatic with transient ischemic attacks (TIAs) or even stroke.

Subarachnoid hemorrhage can occur secondary to rupture of an intracranial dissecting aneurysm. The blood forces its way between the layers of the artery wall causing a "pseudo-aneurysm" to form. There is only a partial wall covering the aneurysm dome and this can lead to vessel rupture (Figure 1A).

Treatment of these lesions has been difficult in the past (1). Vessel sacrifice,

with surgical or endovascular occlusion, can provide definitive treatment yet in certain cases is not possible due to lack of collateral supply. In such cases, endovascular placement of coils in the pseudo-aneurysm with stent placement in the artery has been used. However, the requirement for dual antiplatelet therapy in the setting of subarachnoid hemorrhage continues to raise concern (2). Direct surgery on the lesion can be difficult due to the fragile nature of the tissue and potential for intraoperative rupture.

The treatment of ruptured dissecting aneurysms of the intracranial vertebral artery (VA) with parent vessel preservation is a challenge for neurovascular neurosurgeons. Flow diversion with the Pipeline embolization device has been used successfully to treat intracranial aneurysms with difficult morphologies (3,4,5). However, the need for dual antiplatelet therapy has limited its use after subarachnoid hemorrhage. Short-acting antiplatelet medications are gaining

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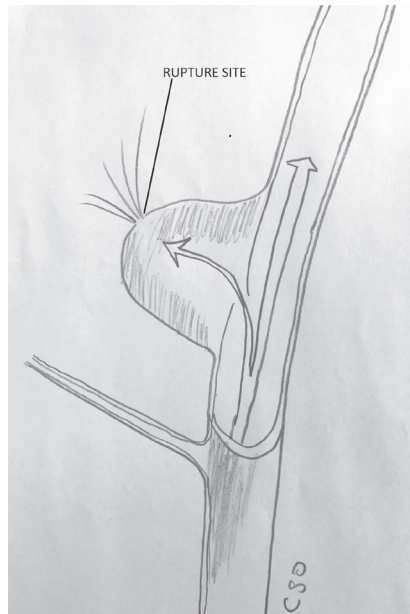
in popularity and are being used in cases of emergent need for flow diverter placement. At the Beth Israel Deaconess Medical Center Brain Aneurysm Institute, we have been pioneering the use of flow diverter technology in the setting of subarachnoid hemorrhage. This produces vessel healing and resolution of the pseudo-aneurysm (Figure 1B).

### Case presentation

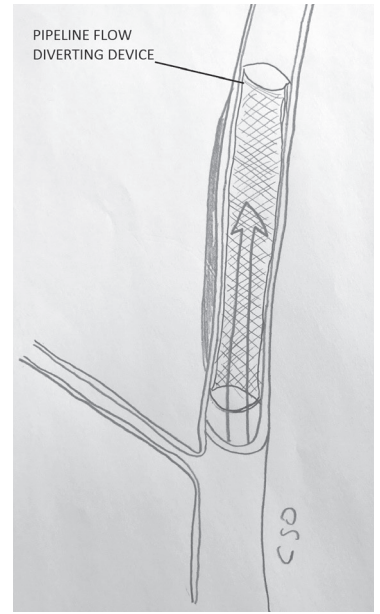
A 53-year-old male developed acute headache while doing push-ups. His headache waxed and waned for several days and acutely intensified to a level of 10/10 while driving. He developed nausea and pulled his car to the side of the road and passed out. Bystanders called EMS. The man was brought to the Beth Israel Deaconess Hospital-Milton Emergency Department, where a plain head CT showed diffuse subarachnoid hemorrhage in the basal cisterns and CT angiography revealed a fusiform pseudo-aneurysm distal to the posterior inferior cerebellar artery (PICA) origin (Figure 2A). He was then transported to the Beth Israel Deaconess Medical Center Brain Aneurysm Institute for neurosurgical evaluation and treatment.

He required ventriculostomy placement for hydrocephalus and was taken to the angiography suite for confirmation of the diagnosis (Figure 2B, Figure 3A) and Pipeline endovascular flow diverter placement in the left vertebral artery across the segment that had the dissection and pseudo-aneurysm. He was started on aspirin and ticagrelor.

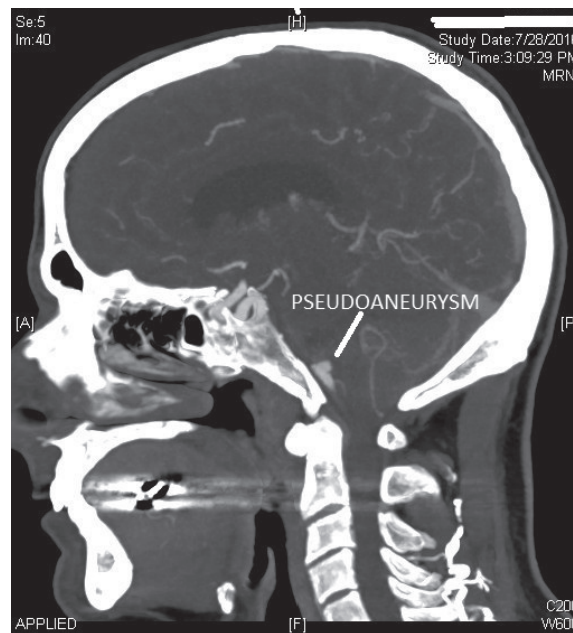
The patient made an excellent recovery after a ventriculoperitoneal shunt was placed for hydrocephalus. Follow-up angiography at three months demonstrated complete healing of the dissection and pseudo-aneurysm (Figure 3B). •



**Figure 1A:** Diagrammatic representation of a vertebral intracranial arterial dissection and pseudo-aneurysm with resultant rupture and subarachnoid hemorrhage. Blood flow (arrow) is forced into a tear in the vessel wall forcing the wall to dissect and the pseudo-aneurysm to form.



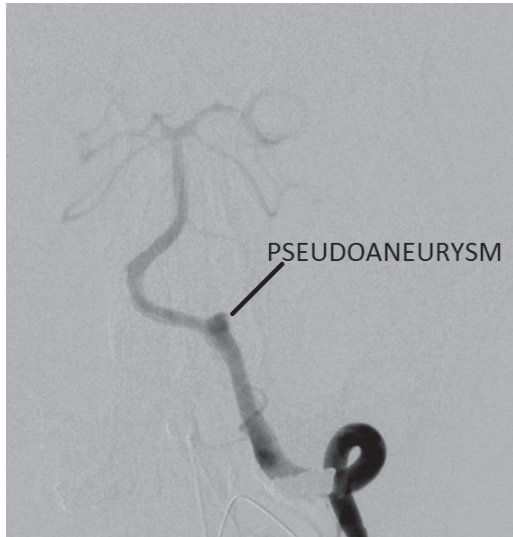
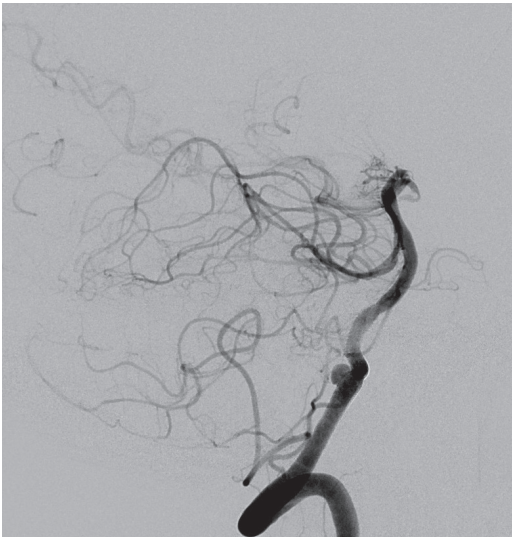
**Figure 1B:** Resolution of the dissection and pseudo-aneurysm in the vessel wall after placement of a flow diverting device. The wall of the vessel heals as flow is reduced into the pseudo-aneurysm.



**Figure 2A:** Sagittal CT angiogram demonstrating pseudo-aneurysm of vertebral artery.



**Figure 2B:** Three-dimensional angiogram showing the dissection and pseudo-aneurysm distal to the PICA origin.



**Figure 3A:**

AP and lateral angiograms demonstrating the dissection and pseudo-aneurysm of the vertebral artery.



**Figure 3B:**

AP and lateral angiogram showing complete resolution of the vertebral artery dissection and pseudo-aneurysm three months after placement of the Pipeline endovascular flow diverting device.

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# Endovascular Obliteration of Traumatic Carotid-Cavernous Fistulas with Lesion Obliteration and Endoluminal Reconstruction: A New Treatment Paradigm

Rouzbeh Motiei-Langroudi, MD, Ajith J. Thomas, MD, Christopher S. Ogilvy, MD

Direct carotid-cavernous sinus fistula (dCCF)s are high-flow lesions that are typically the result of a severe blunt or penetrating head injury or ruptured intracavernous aneurysm. The treatment of these lesions has evolved dramatically over the last 30 years with improved endovascular devices and techniques.

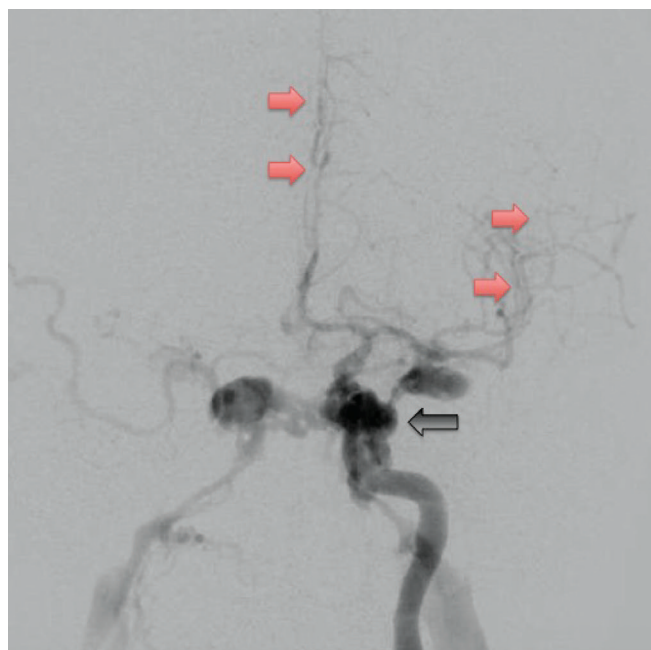
Transvenous and transarterial access has been described with use of detachable balloons, coils, liquid embolic agents, and covered stents (1). Detachable balloons were used to treat high-flow CCFs until the device was withdrawn in the United States (2). More recently, detachable coils have become the mainstay of treatment for high-flow CCFs. Typically a transarterial or transvenous axis is used to reach the site of fistula in the cavernous sinus and it is filled with detachable coils to eliminate the shunt between the carotid artery and the cavernous sinus. Where allowed, detachable balloons can also be used for the same purpose.

However, treatment failures have been known to occur and recanalization of the fistula or intracranial hemorrhage have been described. To minimize the chance of this occurrence, endoluminal reconstruction can be added to the treatment construct by placement of a flow-diverting device in the carotid artery as an adjunct to coil placement in the cavernous sinus (3).

At the Beth Israel Deaconess Medical Center Brain Aneurysm Institute we have successfully shifted our paradigm to deploy a Pipeline flow-diverting device for endoluminal reconstruction after obstructing the fistula itself by coil placement. To date, the results have been promising.

## Case presentation

One of our patients was an 85-year-old woman with a history of hypertension, hypothyroidism, and treated breast cancer. In July 2016, she suffered a generalized tonic-clonic seizure followed by a decreased level of consciousness. She developed proptosis in the left eye.

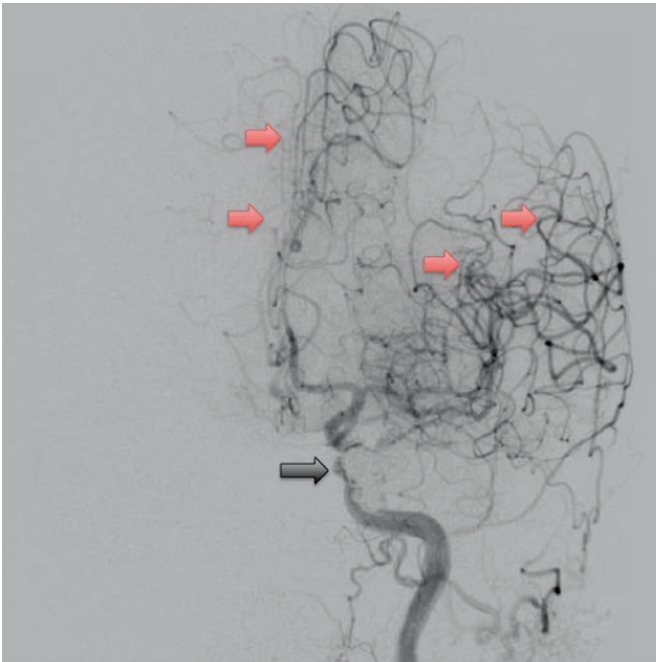


**Figure 1:**

Left ICA angiography before intervention. Red arrows show faint filling of distal anterior cerebral and middle cerebral arteries. Black arrows show site of fistula.

Her initial brain CT scan demonstrated a 2x2 cm left frontal intracerebral hemorrhage. Four-vessel brain angiography confirmed a direct high-flow fistula between the cavernous segment of left ICA and left cavernous sinus (CS) (Figure 1, black arrow), subsequently filling right CS and bilateral sigmoid sinuses and internal jugular veins. There was also retrograde flow and dilation in both superior ophthalmic veins (Figure 1). Because of the high flow nature of the CCF, the distal middle cerebral (MCA) and anterior cerebral (ACA) branches are barely filled (Figure 1, red arrows).

To treat the lesion, coils were placed via an arterial approach through the fistula and two Pipeline flow-diverting devices were used to cover the fistula. Post-intervention angiography showed complete occlusion of the fistula (Figure 2, black arrow) and complete



**Figure 2:**

Left ICA angiography after intervention. Black arrows show point of previous fistula. Red arrows show robust filling of distal anterior cerebral and middle cerebral arteries.

filling of distal MCA and ACA branches (Figure 2, red arrows). There was no direct filling to the CS. The patient tolerated the procedure well and left the hospital without complications. She made a gradual recovery with resolution of her proptosis and cranial neuropathy.

Based on the result of this patient and others, we have altered our paradigm for the treatment of direct CCF lesions to include endovascular coil or balloon occlusion of the fistula from either transvenous or transarterial approach followed by flow diversion. This produces a biologic situation where there is fistula obliteration complemented by endoluminal reconstruction with flow diversion. This should result in endothelial healing over the area of the fistula in a completely reconstructive process for the artery involved. We acknowledge that in some CCFs, it is difficult to identify the outflow with a micro catheter. These patients may require parent vessel sacrifice with an endovascular technique. •

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# Type 1 Spinal Dural Arteriovenous Fistula: A Rare Cause of Weakness, Numbness, Gait Abnormalities, and Pain

Christoph J. Griessenauer, MD, Ajith J. Thomas, MD, Christopher S. Ogilvy, MD

Spinal vascular lesions include dural arteriovenous fistulas (AVF; Type 1), intramedullary arteriovenous malformations (AVM; Type 2), juvenile AVMs (Type 3), intradural perimedullary AVFs, intramedullary cavernous malformations, and spinal vascular tumors.

Type 1 AVFs are the most common spinal vascular lesion, representing approximately 70% of all such lesions. These lesions consist of an abnormal connection between one or more radicular arteries in the nerve root sleeve and the intradural venous system resulting in venous

hypertension. They are much more common in males, with a mean age at presentation of 60 years. They are most commonly located in the thoracic spine and result in progressive symptomatology such as weakness, sensory changes, gait abnormalities, and pain (2). Physical activity may exacerbate signs and symptoms. The imaging study of choice is MRI showing spinal cord signal changes and flow voids representing a nodular, dilated, and tortuous intradural venous system. Anyone with a compatible clinical picture has to be referred for a spinal angiogram to characterize the lesion.

The natural history is generally poor with 50% of untreated patients becoming severely disabled within three years of onset of lower extremity weakness (1). Both an open surgical approach and endovascular techniques are used as treatment options.

While surgery is more invasive, the medical literature suggests that it is more successful, resulting in fistula obliteration in 98% of patients whereas endovascular embolization only cures 46% of cases (3). The risk of complications is low at approximately 1-3% and slightly higher with endovascular obliteration than with surgery. At the Beth Israel Deaconess Medical Center Brain Aneurysm Institute, we perform both techniques. We usually attempt endovascular embolization as a first-line treatment because it is less invasive. In patients where endovascular embolization is technically not feasible, the patient prefers the more definitive surgical approach as a first-line option, or embolization is only partially occlusive, we perform surgery as shown in the illustrative case. Patients who are successfully treated have an excellent prognosis and usually experience complete resolution of their symptomatology as long as the intervention was performed in a timely manner. •

► **Figure 2:**

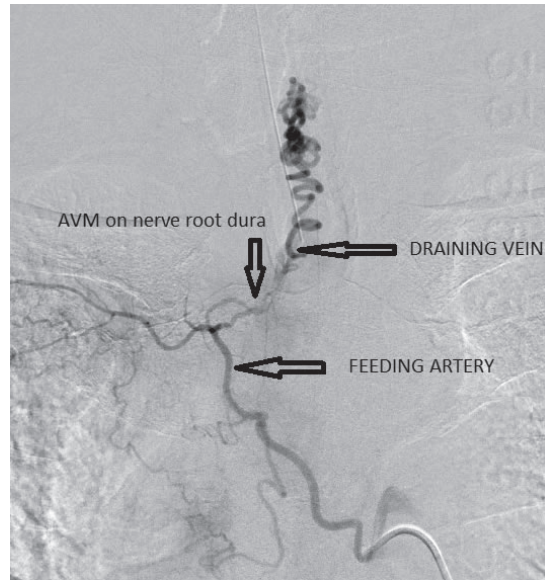
A 62-year-old male started experiencing weakness of the left triceps in the ensuing months after a fall on the ice. He also developed some numbness in a similar distribution. An MRI of the spine showed flow voids of serpiginous vessels centered at the dorsal surface of the spinal cord at C6 and C7.

Electromyography and nerve conduction studies demonstrated a C7 radiculopathy on the left. A subsequent spinal angiogram revealed a Type 1 spinal dAVF fed by the segmental artery of T5 on the left. An attempt to embolize the lesion failed due to the inability to gain access. The patient was taken for surgery.

A T5 laminectomy was performed and an arterialized vein was visualized intradurally on the left (upper panel). The connection was coagulated (middle panel) and divided (lower panel). The patient did very well and was discharged on the second day after the operation. At four weeks he had fully recovered his strength and was free of any symptoms, returning to his physically active lifestyle.

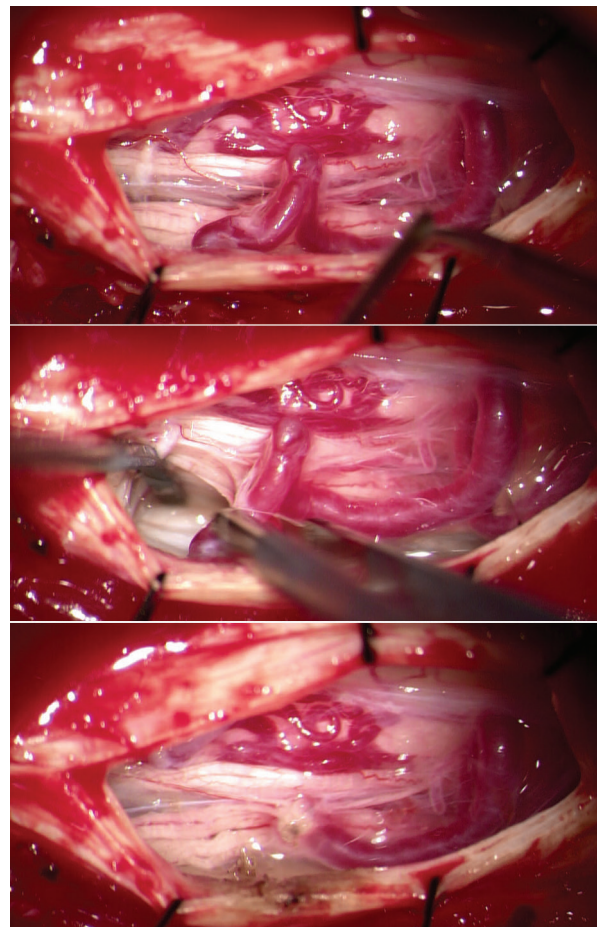
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▲ **Figure 1:**

AP angiogram shows injection of the T5 radicular vessel from the aorta after selective cannulation (feeding artery). The vessel supplies the T3 nerve root sleeve and the dural AVM at this level on the right (dural AVM on root sleeve). The draining vein is inside the spinal canal and is under elevated pressure (arrow, draining vein). Disconnection of the vein from the dural AVM obliterates the lesion (see surgical photo, Figure 2).



# Flow Diversion with the Pipeline Device: One Patient's Experience

Tom Byrne, 68, runs a successful commercial cleaning business, but the native Irishman's true calling is being an entertainer. When Mr. Byrne isn't working his day job, he plays piano and sings Irish tunes at venues throughout the Boston area.

Last fall, Mr. Byrne experienced searing pain across his chest and arms. His wife insisted that he get immediate medical attention. An MRI revealed that Mr. Byrne had two brain aneurysms. His doctor referred him to Ajith J. Thomas, MD, Co-Director of the BIDMC Brain Aneurysm Institute.

"Before the incident that brought me to Dr. Thomas, I'd sometimes feel a pain up the back of my neck when I sang a high note or laughed, but I didn't think much of it," recalls Mr. Byrne.

After additional imaging tests were done at BIDMC, it was discovered that Mr. Byrne had three, not two, aneurysms — two on the right side of his brain on the internal carotid artery, and one on the left. All were about 3.5-4 mm in size. Dr. Thomas, who points out that about 20% of patients have multiple aneurysms, recommended treatment without delay.

Not all aneurysms require immediate — or even any — treatment, but because of their number, location, and the patient's personal and family health history, Dr. Thomas recommended immediate treatment to prevent rupture.

Mr. Byrne was an excellent candidate for the Pipeline embolization device, which was FDA approved in 2011. The device represents a "paradigm shift and is one of the most significant advances in aneurysm treatment in the last 20 years," according to Christopher S. Ogilvy, MD, Director of the BIDMC Brain Aneurysm Institute and Director of Endovascular and Operative Neurosurgery.

Studies to date show that between 75-96% of aneurysms are closed off from the circulation using the Pipeline device, with many remaining aneurysms



Brain aneurysm patient Tom Byrne was successfully treated with two Pipeline devices.

virtually disappearing over a matter of months. In contrast, between 5-25% of patients undergoing coiling require re-treatment at some point. The Pipeline device also expands the number of patients who can undergo endovascular treatment safely or, in some cases, any type of treatment at all.

At first Pipeline was used mostly for the treatment of very large or wide-necked aneurysms, which often could not be effectively treated with coiling. But studies at BIDMC and elsewhere have shown that it can be used safely and effectively for many different types of aneurysms, including tiny ones that formerly were too risky

to treat with an endovascular approach. Pipeline is also useful for treating pseudo-aneurysms (see cover article), which were previously very difficult to treat, as well as for dissecting aneurysms.

Last December, Mr. Byrne underwent treatment with one Pipeline device for the two aneurysms on the right side of his brain; in January 2016, he had the third aneurysm treated with a second device. Each procedure took less than two hours and both times Mr. Byrne stayed in the hospital only one night.

Today, Mr. Byrne is feeling and doing very well. As do all patients, he undergoes regular follow-up evaluations, which thus far have shown that his aneurysms are shrinking in size and are expected to be completely obliterated within the next six months.

Mr. Byrne has no side effects from treatment and, equally important, no nagging fears that a ruptured brain aneurysm could rob him of precious time with his family, which includes six grandchildren.

The Brain Aneurysm Institute has been using the Pipeline device since 2012, and has one of the largest experiences in New England, now performing up to 30% of endovascular procedures with the device. •



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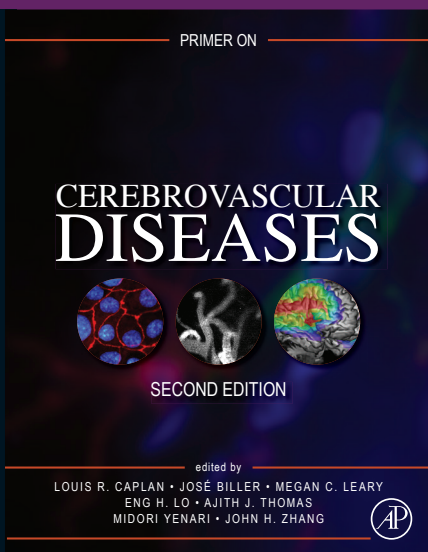
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Brain Aneurysm Institute  
110 Francis Street, Suite 3B  
Boston, MA 02215

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## News and Events

### *Primer on Cerebrovascular Diseases, Second Edition*



(Academic Press) is an important reference for scientists, students, and physicians needing reliable, up-to-date information on basic mechanisms, physiology, pathophysiology, and medical issues related to brain vasculature. The book consists of short, specific chapters written by international experts on cerebral vasculature, and presents the information in a comprehensive and easily accessible manner. The book also contains valuable information on practical applications of basic

research. One of the book's editors is BIDMC Brain Aneurysm Institute Co-Director Ajith J. Thomas, MD.

### Save the Date

#### **Ischemic and Hemorrhagic Update: Current Practices and Future Directions**

FRIDAY, MAY 12, 2017

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**Course Directors:**  
**Christopher S. Ogilvy, MD**  
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This daylong symposium will focus on recent advances in the field of neurovascular disease including current theories on carotid disease, stroke, cerebral hemorrhage, brain aneurysms, cavernous malformations, and AVMs.

For information about registration, contact Deidre Buckley, NP, at: [dabuckle@bidmc.harvard.edu](mailto:dabuckle@bidmc.harvard.edu).