

Neurovascular News

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Who Should Be Screened for Unruptured Intracranial Aneurysms?

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Large autopsy studies in the 1960s and 70s demonstrated that the prevalence of intracranial aneurysms is on the order of 2 to 3% of the population,¹⁻³ which equates to an estimated 6.5 million people harboring an unruptured intracranial aneurysm in the United States. There are certainly patient specific factors that can influence the incidence of intracranial aneurysms.⁴ As imaging techniques improved in the 1980s and 90s, there has been an increase in the number of unruptured intracranial aneurysms being diagnosed.⁵ In addition, it is known that somewhere on the order of 20 to 25% of patients with intracranial aneurysms have a familial component.³ With this information in the background, the question arises as to who should be screened for an intracranial aneurysm?

The concept of screening for any disease is predicated on the idea that identifying the disease and treating it carries a lower risk than the natural history of the disease. For instance, in the case of colon cancer, it is certainly advantageous to screen individuals at the age of 50 in order to identify and remove potentially malignant lesions.⁶ For intracranial aneurysms, the greatest fear is that of a subarachnoid hemorrhage. The statistics are fairly grim with an overall mortality of 45 to 50% of patients who have a subarachnoid hemorrhage.⁷ This number has not changed significantly even with the advent of lower risk treatment modalities. Of the survivors, a third of the patients generally make a good recovery while a third are left with significant deficits and require the assistance of others and a final third have some degree of disability but can function on their own.⁸

There are several risk factors which predispose patients to the formation of intracranial aneurysms.⁹ These are shown in Table 1. Other factors that may relate to the formation of intracranial aneurysms but are more difficult to prove statistically include female sex, cigarette smoking and hypertension. From a survey performed at our institution, 80% of patients with intracranial aneurysms were previous smokers at the time of diagnosis. Taking all of these factors into consideration, the

Table 1: Risk Factor

Family History
Autosomal Dominant PCKD
Ehlers-Danlos Syndrome Type IV
Coarctation of the Aorta
Bicuspid Aortic Valve
Smoking
Hypertension
Female sex

current American Heart Association recommendations for screening patients for intracranial aneurysms are as follows:

- 1. **Patients with 2 or more family members with intracranial aneurysms or subarachnoid hemorrhage** should be offered aneurysmal screening by CT angiography or MR angiography. Risk factors that predict a high risk for aneurysmal recurrence in such families include female sex, history of smoking and hypertension.
- 2. **Patients with a history of autosomal dominant polycystic kidney disease**, particularly those with a family history of intracranial aneurysm should be offered screening by CT angiography or MR angiography. It is also reasonable to offer CTA or MRA to patients with coarctation of the aorta.
- 3. **Women who smoke cigarettes** (NEW CONSIDERATION: VIDE INFRA)

At the BIDMC Brain Aneurysm Institute, we sought to look further into the question of who should be screened for intracranial aneurysms. We performed a case-control analysis of women between the ages of 30 and 60 (Fig. 1). The cases were patients with an incidental diagnosis of an intracranial aneurysm, and the controls were females in the same demographic group that had an imaging study for unrelated reasons. From a total of 194 patients, we compared their history of cigarette smoking and hypertension (Fig. 2). We found a significant association between a positive smoking history, hypertension, and both factors combined with a diagnosis of an incidental unruptured intracranial aneurysms. For middle-aged females that have a positive smoking history, we found that the risk for developing an intracranial aneurysm was 6 times higher than that of the appropriate matched control patients that underwent a magnetic resonance imaging scan. Furthermore, for women who smoked and also had hypertension, we encountered that these individuals had an 12 times higher likelihood of having an incidental intracranial aneurysm. From all the aneurysm patients, 21% were treated due to high risk characteristics of the aneurysm, such as daughter sacs or lobulations (Fig. 3). In order to validate our findings, we are performing a multicenter study.

If these findings are validated, our data would suggest that a definite change is needed in screening policy for unruptured intracranial aneurysms, to include middle-aged women with a positive smoking history. Our group has previously published data demonstrating the current management of unruptured intracranial aneurysms using both endovascular and surgical strategies in combination can be performed with risks in the low single digits.¹⁰ Given this, screening can strongly be recommended to subsequently prevent subarachnoid hemorrhage and its associated morbidity. While consideration is certainly given to the cost effectiveness of screening protocols, this must

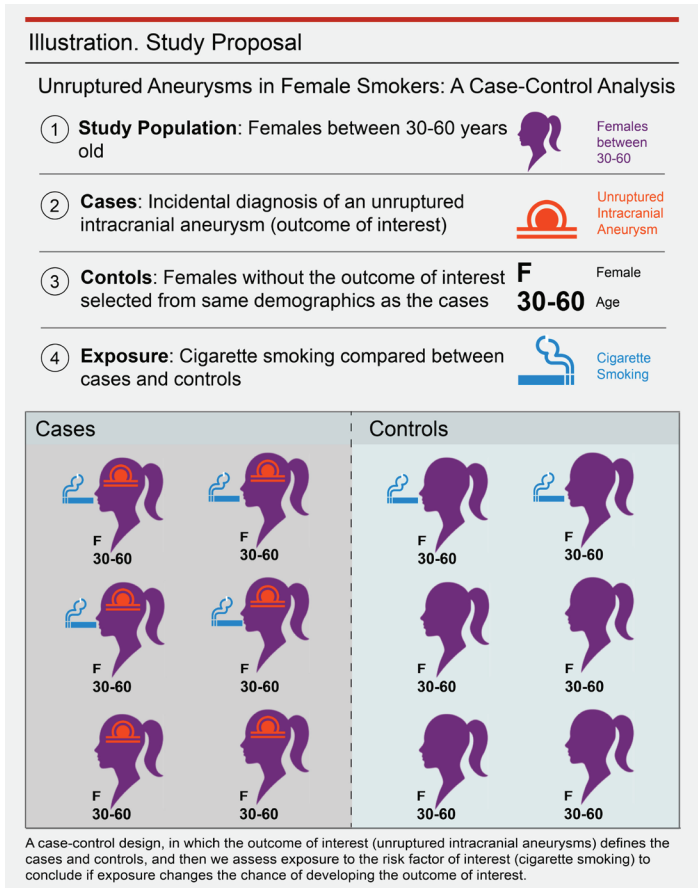


Figure 1. A case-control design, in which the outcome of interest (unruptured intracranial aneurysms) defines the cases and controls, and then we assess exposure to the risk factor of interest (cigarette smoking) to conclude if exposure changes the chance of developing the outcome of interest.

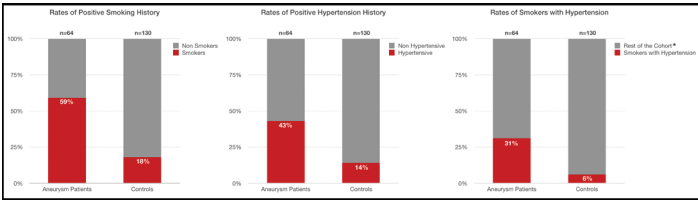


Figure 2. Comparison of key baseline characteristics between aneurysm patients and their respective control group.

**Includes the following: nonsmokers without hypertension, patients that have hypertension only and/or patients with a positive smoking history.*

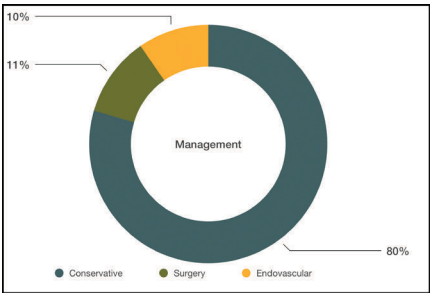


Figure 3. Management strategies in aneurysm patients.

be balanced against the cost to society of patients who suffer a subarachnoid hemorrhage and as importantly, the devastating effects of these hemorrhages on patients and their families.

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Stroke Prevention from Atrial Fibrillation: Tried Recipes and New Solutions

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Introduction

A few words about Stroke

Stroke is the fourth leading cause of death and the leading cause of disability in the USA. "Stroke" is an all-encompassing term that is used to imply acute brain damage due to problems in the brain vessels. The majority of strokes (~85%) are ischemic, a result of obstruction of blood flow to part of the brain due to a blood clot. A smaller proportion of strokes (~15%) are a result of the exactly opposite problem: rupture of blood vessels and bleeding into the brain, rather than lack of blood flow. These are called hemorrhagic strokes. Despite their radically different mechanisms, both kinds of stroke cause nerve cell death and permanent brain damage. An intriguing aspect of stroke care is that medications used to prevent blood clotting (and therefore decrease the risk for ischemic stroke) naturally lead to increased risk of a hemorrhage. Thus there is a constant and often fragile balance between preventing blood from clotting and thinning it too much which can lead to a bleeding complication.

Ischemic stroke subtypes

To complicate matters more, there are several different mechanisms by which a clot can be formed and cause a stroke. Some patients have atherosclerotic plaques in their large arteries, usually in the neck: little pieces can break off, move downstream and obstruct the flow in a brain vessel. In other patients, the very tiny vessels that feed the deepest parts of the brain get progressively narrower, usually as a result of years of uncontrolled hypertension, diabetes and high cholesterol; over time the narrowing leads to complete occlusion of these vessels. In another group of patients, the problem is neither in the small brain vessels nor in the larger feeding arteries: It lies in the heart. Certain conditions can predispose to clot formation in the heart. These clots can then travel to the brain and obstruct a blood vessel. These strokes are known as "cardioembolic". Although there are several

heart problems that can predispose to clot formation, the most common one is atrial fibrillation also known by its abbreviation "A-fib".

Atrial fibrillation and the need for anticoagulation

Atrial fibrillation is one form arrhythmia, which means irregularity in the heartbeat. The heart of patients with atrial fibrillation is many times structurally normal and usually pumps blood efficiently, therefore most patients have no symptoms or might experience minor symptoms such as palpitations and dizziness. Moreover, atrial fibrillation is often transient: the heart goes in and out of beating regularly and irregularly. This makes atrial fibrillation elusive to diagnose. However, it is a frequent problem: it is estimated that between 3-6 million people in the USA have Afib¹. Its frequency increases with age. Less than 2 % of people younger than 65 years have it, while it is present in ~9% of people older than 65 years. What makes atrial fibrillation peculiar is that prevention of clotting from it requires stronger blood thinning than usual solutions such as aspirin. These blood thinners (also known as anticoagulants) work very well and reduce the risk of stroke substantially but come at the cost of higher bleeding risk. In the last few years we have seen several new blood thinners enter the market, offering more solutions but also creating new challenges. In the following pages we will briefly describe the pros and cons of both tried, traditional approaches and the new solutions.

Anticoagulation solutions: Warfarin

Warfarin (AKA Coumadin) is the longest standing blood thinner in use. Its existence was discovered by accident in the 1920s by a veterinarian investigating cases of cattle hemorrhage in the northern USA and Canada. He determined that the cattle were ingesting spoiled sweet clover which was having a potent anticoagulant effect. The actual agent causing the hemorrhage was not isolated until 1940. As rumors have it, it was indeed initially used as rodenticide. Later it was discovered that it can

be used to prevent clotting in humans. President Dwight Eisenhower was one of the early recipients in 1955 for a heart attack. Contrary to aspirin, which thins the blood mildly by inhibiting the platelets, warfarin has a much more potent anticoagulant action, blocking the production of several agents of the blood clotting mechanism. It does so by interfering with Vitamin K metabolism in the liver.

Warfarin: very effective

The safety and efficacy of warfarin in preventing stroke in patients with atrial fibrillation was tested in several large randomized clinical trials in the early 1990s². In these studies, warfarin was tested against aspirin. These studies showed beyond doubt that warfarin performed much better: it reduced stroke risk by ~65-70% compared to 15-20% by aspirin. Thus warfarin was endorsed as the mainstay of stroke prevention in this population of people with atrial fibrillation³.

Warfarin: the challenges

The exceptional efficacy of warfarin in reducing clotting risk comes at a higher risk of bleeding. It was discovered that unless the warfarin levels are kept within a certain tight range, it loses its advantage. Physicians monitor warfarin levels with a blood test that measures the coagulation function. This test is known as INR (International Normalized Ratio) and the target level is 2.0-3.0. Too low and it does not thin the blood enough and warfarin loses its edge. Too high and the risk of bleeding is unacceptably high. The process of regulating the warfarin dose and keeping the INR within target range can be quite complex and onerous. Because the metabolism of warfarin occurs in the liver, it can be affected by many things such as different foods (especially leafy green vegetables) and medications. One has to keep a stable diet and pay close attention to any new medications or changes in the doses of existing medications. It also entails frequent blood checks and dose adjustments especially early on and until a steady dose has been found.

Bleeding from warfarin: antidotes

Hemorrhage is the most serious complication of treatment with warfarin and brain hemorrhage is the most feared kind of bleeding. Fortunately, warfarin has well-established and widely available antidotes that can reverse its action very rapidly. The first identified antidote was vitamin K, which is effective but does not restore anticoagulation before 24-48 hours. In emergency situations a ready-made mix of blood coagulation factors can be administered which restores the coagulation function very rapidly (within 1-2 hours). This antidote is readily available in most emergency rooms.

New solutions: Direct oral anticoagulants

As already described, despite its efficacy, the onerous monitoring process, frequent blood testing and strict dietary adjustments related to warfarin treatment triggered an intense quest for simpler and safer solutions.

This led to the discovery of new class of drugs which are known as "Direct oral anticoagulants" (DOACs) or "New oral anticoagulants" (NOACs). Instead of an all-encompassing inhibition of the coagulation mechanism, these medications selectively targeted specific steps of the pathway. The aim was to achieve the same blood clotting reduction as warfarin but at a lower bleeding complication cost and do so without need for frequent blood checks. Four new medications were introduced: Dabigatran⁴ (Brand name: Pradaxa), Rivaroxaban⁵ (Brand name: Xarelto), Apixaban⁶ (Brand name: Eliquis) and Edoxaban (Brand name: Savaysa).

NOACs vs warfarin: head to head comparison

Given that there was a well-established treatment to prevent stroke related to Afib (warfarin) these new medications had to show that they are at least as good as warfarin, with equal or lower risk of hemorrhage. Therefore, all of these medications were tested in large clinical trials against warfarin. All trials showed that each of the NOACs was as good as warfarin and most importantly, had a lower bleeding risk⁴⁻⁶. Therefore, all of the NOACs are now well-established choices for stroke prevention from atrial fibrillation.

NOACs advantages and disadvantages: convenience and ease of use, difficult to monitor

NOACs have a significant advantage: they do not require monitoring of their levels and frequent adjustment of their dose, although certain details merit attention. Older, thinner patients and those with kidney problems might need adjustment of their dose. They do not require any special dietary adjustments. This makes them much more convenient than warfarin. On the other hand, one has to be precise and compliant: missed doses mean increased clotting risk. No need for regular monitoring can be a double edge cutting knife. Although there are laboratory tests that can confirm whether NOAC blood thinning is in effect, these tests are not readily available in all hospitals and cannot always be processed rapidly. On the contrary warfarin-related blood thinning can be rapidly confirmed: INR can be obtained within minutes. This can cause a significant management dilemma, e.g. in instances when a patient taking a NOAC needs an urgent surgical procedure with bleeding risk but ingestion of the blood thinner cannot be confirmed. This leaves the physicians at loss as to whether it is safe to operate.

Bleeding from NOACs: Antidotes

Initially there were no antidotes or reversal agents for NOACs. However, this has changed in the last few years. First an antidote to Dabigatran was approved (Idarucizumab, brandname Praxbind): an antibody that removes the drug from the blood circulation rapidly and restores blood coagulation. Apixaban and Rivaroxaban share the same mechanism of action and therefore share the same reversal agent, which appeared a few years later: It is known as andexanet alpha (brand name:

Andexxa) and laboratory tests have shown that it restores blood coagulation rapidly. Contrary to warfarin antidotes, these reversal agents are available in most but not all hospitals yet and their cost can be considerably high.

NOACs head to head: Is one better than the others?

This is a frequent question. It needs to be emphasized that no trial compared NOACs against one another. Although they were all tested against warfarin, one cannot extrapolate results from these trials to conduct direct comparisons as the studied populations were quite different. There are certain characteristics that can make them more appealing: For example, Rivaroxaban requires once daily dosing, while Apixaban and Dabigatran must be taken twice/day. Therefore, Rivaroxaban might be more desirable for someone with medication compliance issues. Dabigatran is more sensitive to fluctuations in renal function while Rivaroxaban is more sensitive to liver issues. It is best to approach such decisions on an individual basis, taking into account specific factors and preferences.

The elephant in the room: cost

Medication cost is not always discussed when making medication decisions but it is relevant when considering a NOAC vs warfarin and should be brought up. The convenience and safety profile of NOACs make them a desirable and reasonable choice for many patients. Most insurance plans provide coverage for FDA-approved indications for NOACs but sometimes the out-of-pocket costs can be prohibitive. Thus, it is prudent to consult with one's insurance plan and inquire about out-of-pocket cost before committing to a medication.

Conclusion

Atrial fibrillation is a frequent but treatable cause of embolic stroke, especially in older adults. Warfarin and NOACs are effective treatments that reduce stroke risk by ~65–70%. Warfarin is well-trying and affordable but inconvenient solution with a complex monitoring and adjustment process. NOACs are more convenient and with lower bleeding risk. Primary care physicians, Neurologists and Cardiologists should ideally be involved with a complex monitoring and adjustment process.

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Treatment of Complex Dural Arteriovenous Fistulas

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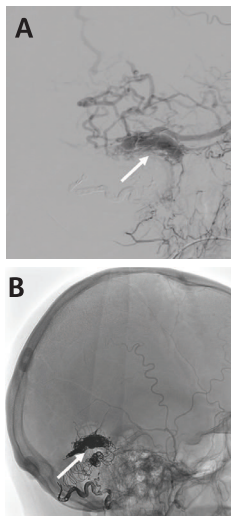
Introduction

Dural arteriovenous fistulas (dAVFs) are rare vascular malformations, which consist of abnormal arteriovenous shunts that occur in the confines of the dural leaflets.¹ They arise from pachymeningeal arteries (usually dural branches of the external carotid artery) that communicate with dural veins or dural venous sinuses.^{1–3} These lesions account for approximately 10–15% of all intracranial arteriovenous malformations.² The diagnosis is more prevalent in males and is usually made between the fifth and seventh decade of life. Carotid cavernous fistulas (CCFs), a subset of dAVFs, are more common in women.¹ Most of dAVFs are acquired.^{1,2} The natural history of dAVFs and their clinical presentation depend on their location and angiographic characteristics.^{1–3} Some patients may remain asymptomatic, while others may suffer intracranial hemorrhages, non-hemorrhagic neurological deficits, tinnitus, eye symptoms, seizures, dementia or even parkinsonism, usually secondary to the presence of venous hypertension.¹ The risk of bleeding is higher in lesions that present with drainage to cortical veins.^{1,3}

From the treatment perspective, the clinical and angiographic characteristics are key features that dictate whether the dAVF should be observed or treated.¹ Treatment options include endovascular embolization, open surgery and/or radiosurgery.¹ The primary goal is to obtain direct occlusion of the shunt site.¹ Although most dAVFs nowadays can be treated through endovascular methods, in some cases (usually complex lesions) a combined surgical and endovascular management is required.¹ This management could be done in one stage (hybrid management) or in several stages, determined by lesion characteristics and/or surgeons preference and expertise. At the Brain Aneurysm Institute of the Beth Israel Deaconess Medical Center, we have qualified healthcare professionals trained for the diagnosis, management, and treatment of dAVFs. Furthermore, clinicians at the Institute have extensive experience in complex lesions which require a combined approach. We describe a case below which demanded a hybrid approach utilizing surgical exposure followed by endovascular embolization.



Figure 1. Retromastoid Burr-hole exposing the sigmoid-transverse sinus junction, which was subsequently accessed through an angiocath.



Case illustration

A 56-year-old male presented to another institution with intracranial hemorrhage and was diagnosed with a right sigmoid-transverse sinus junction dAVF with venous hypertension from retrograde cortical venous drainage. He was treated by an endovascular approach with Onyx embolization of the arterial pedicles supplying the fistula. However, there was residual filling of the fistula and drainage into ectatic cortical veins with a high risk for re-hemorrhage. The patient was taken to the operating room. A small right retromastoid craniostomy was performed. The sigmoid-transverse sinus junction was exposed, and a direct puncture of the dural sinus was performed using an angiocath (Fig. 1). Thereafter, under fluoroscopic guidance with a C-arm, detachable coils were deployed within the

sinus until we obtained complete fistula obliteration. This was confirmed with post-operative cerebral angiography at the end of the procedure (Fig. 2). The patient recovered without any associated neurological complications and was discharged home.

Conclusion

Dural arteriovenous fistulas are complex arteriovenous malformations. Depending on the associated clinical symptomatology and angioarchitecture characteristics, these lesions may be observed or treated. Since there are a variety of treatment techniques, it is recommended that an expert cerebrovascular neurosurgeon be consulted to obtain comprehensive management of these malformations.

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Figure 2. Pre and Post-Treatment cerebral angiographies. A: Lateral view of the pretreatment angiogram demonstrating the shunting point in the sigmoid-transverse sinus junction (white arrow). B: Lateral view of the post-treatment angiogram showing the coil nest inside the sigmoid-transverse sinus junction and complete obliteration of the dAVF. There is also Onyx embolization material inside the former arterial feeders from the previous neuro-endovascular intervention.

Intrasaccular Flow Disruption: An Emerging Trend in Aneurysm Management

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Flow modification has permanently changed the management of many intracranial aneurysms. The Pipeline Embolization Device (PED) FDA approved in 2011, has grown to become the modality of choice for many large and wide-necked aneurysms. Flow diverting stents operate from within the parent artery, providing a scaffold for cell growth at the aneurysmal neck and inducing thrombosis. However, a new subset of intrasaccular flow disruptors act from within the aneurysms. Several endosaccular flow disruptors have been developed, including the WovenEndobridge (WEB; Microvention, Aliso Viejo, CA), which was introduced in Europe in 2011, Medina (Medtronic, Minneapolis, MN), and Artisse (formerly LUNA; Medtronic, Minneapolis, MN) as well as the Contour and Cerus devices (Cerus Endovascular, Fremont, CA).

WovenEndobridge (WEB)

The WEB (Microvention, Aliso Viejo, CA) device is designed to be placed within the aneurysm and span the ostium¹. Holding a globular shape (Fig. 1), it is intended to be used as a stand-alone therapy without antiplatelet medication. There are now eight prospective series in patients mostly

harboring bifurcation aneurysms showing occlusion rates of approximately 60% and generally low adverse events.

With flow diverters, the majority of treated aneurysms are unruptured. The potential risk of aneurysmal rebleeding following rupture necessitates a rapid securing of the aneurysm. With dual antiplatelet therapy the potential need for additional invasive procedures over the course of subarachnoid hemorrhage management (e.g. ventriculostomy insertions) could be riskier. With the WEB device, the lack of dual antiplatelet prophylaxis may mitigate concerns surrounding hemorrhagic complication. The largest cohort was reported by van Rooji et. al, of 100 patients, where the authors reported adequate occlusion (complete occlusion or neck remnant) in 96% of patients. However, thromboembolic complication rates appeared to be high (9%) and the study was limited by a short follow-up period (3-months). The CLARYS (CLinical Assessment of WEB Device in Ruptured aneurYSms; NCT02687607) is ongoing in France, with a target follow up of 12 months, evaluating WEB in patients with ruptured aneurysms.

Medina Embolic Device (MED)

The Medina (Medtronic, Minneapolis, MN) is a CE Mark-approved hybrid flow disruptor with complex three-dimensional self-expanding mesh (Fig. 2A–B). The mesh resembles multiple “petals” that provide flow diversion and the device assumes a sphere upon deployment². The smallest Medina currently available is 5mm in diameter, so smaller aneurysms cannot be addressed³. Preliminary clinical results from a small series of 15 patients with wide-neck aneurysms show the Medina system used as the first stage of complex treatments (e.g., endoluminal flow diverters or bifurcation stents), so its performance in isolation is difficult to assess. A small study (N=12) with longer follow-up found 83% complete occlusion rate at 6 months but again 85% of patients had adjunctive treatment and this follow-up is yet short⁴.

Artisse

The Artisse (formerly LUNA) is a braided implant which is self-expanding (Fig. 2C–D)⁵. Similar to the WEB, it obviates dual antiplatelet therapy¹. The current model possesses ovoid and flared configurations; although the manufacturer states that a revision is imminent. The long-term results of the European LUNA AES trial was recently published⁶, which is the the largest data set available regarding the safety, efficacy and procedural outcomes of this device. These are comparable but slightly inferior to WEB.

Contour Neurovascular System

The Contour (Cerus Endovascular, Fremont, CA) is also intrasaccular and is constructed from a dual layer-shape memory mesh. It can transition from a discoid shape to a tulip configuration, conforming to the lower hemisphere of an aneurysm across its neck (Fig. 3). The device is oversized to the aneurysm neck and largest equatorial diameter and the device “blooms” from the catheter tip, and can be repositioned until the natural vessel shape is reconstructed.

Hemodynamic flow and blood pressure at the base is intended to stabilize the system within the aneurysm and resists any further pressure applied. Any electrolytic detacher used for endovascular coils will also detach this device. Preliminary unpublished 6 and 12-month data are promising. However, all lesions were unruptured and graduation to ruptured lesions will likely be assessed in the coming year.

Conclusions

Neuroendovascular therapy has embraced flow diversion and disruption, and the latter may aid in the realm of ruptured aneurysms especially, given that dual antiplatelet therapy is obviated. As the learning curve is surmounted and long-term data emerge, their role will be further defined.

Figure 1. Woven EndoBridge (WEB) device with (A) device markers and VIA Markers, and (B) overhead view showing lowest porosity in highest-flow areas. The device is delivered with the (C) proprietary VIA catheter which possesses internal coils for stability and a PTFE liner. The (D) high density braiding has been conceived for both neck and dome sealing.

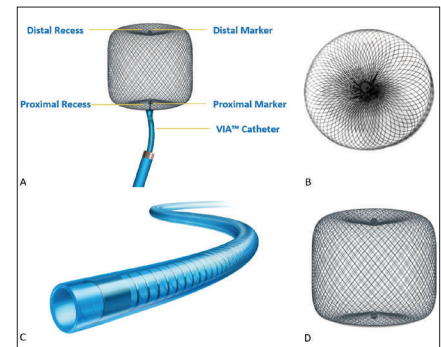


Figure 2. The Medina device forms a (A) mesh scaffold of nitinol-platinum petals at the aneurysm neck by (B) self-orienting along the axis of the core wire, whereas Artisse deploys as a semi-fixed construct which may be (C) flared or (D) spheroid in nature.

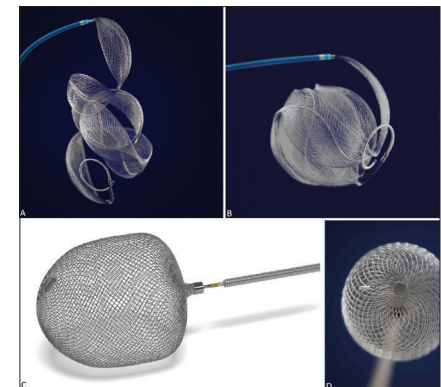
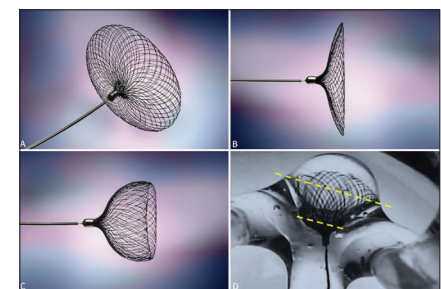


Figure 3. Contour (A–C) acts as both a neck and intrasaccular flow disruptor, the former of which is designed to promote neointimal growth without an intraluminal stabilizing component and which (D) aligns to the equatorial plane of the aneurysm.



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News & Events



Santiago Gomez-Paz, MD

Recipient of \$30,000 Grant funded by the
Brain Aneurysm Foundation Grant Program

Santiago Gomez-Paz, MD, was one of 14 recipients at the Brain Aneurysm Foundations' 13th Annual Research Grant Symposium on Sept. 12, 2019 in Pasadena, CA.

The Brain Aneurysm Foundation is the largest private funder of brain aneurysm research. Each year the Foundation awards research grants for basic scientific research directed at early detection, improved treatment modalities, and technological advances that will ultimately improve outcomes for patients with brain aneurysms.

His project: **Intracranial Aneurysms in Female Smokers Between 30-60 Years of Age**
The funding of his \$30,000 grant is from **The Boston Marathon Chair of Research (\$25,000)** and **The Fight Like Frank Chair of Research (\$5,000)**

Dr. Gomez-Paz was born and raised in Panama and studied medicine at Universidad Latina de Panama, where he earned his medical degree. He did two years of internship in Panama focused on Neurosurgical care. After his internship years, and before applying for a residency program, Dr. Gomez-Paz pursued further postdoctoral training through the International Research Initiative in Boston. Under this program's curriculum, he acquired extensive research knowledge and analytical techniques and was recognized with the Distinguished Alumni Community recognition for 2019. Currently, Dr. Gomez-Paz works at the BIDMC Brain Aneurysm Institute where he dedicates his work on evaluating cerebrovascular pathologies, mainly brain aneurysms. This research grant award involves a multi-center study design that includes six major academic institutions from the US and Canada. The study is focused on the assessment of risk factors that might act as a trigger for the development of brain aneurysms in females, ultimately with the aim of defining a screening protocol as an early detection strategy for a demographic group with a potential higher-than-average risk for both having an aneurysm or developing a rupture.

SAVE THE DATE **Ischemic and Hemorrhagic Update: Current Practices and Future Directions**

May 4, 2020

Omni Parker House Hotel
Boston, Massachusetts

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.