Endonasal approach viable option in dural arterio-venous fistula care

by Paul A. Gardner, MD

A dural arterio-venous fistula (DAVF) is an abnormal communication between an artery and a vein contained within the two layers of the dura. The etiology is still debated but is likely thrombosis within a dural sinus. The high venous pressure produced by the fistula is responsible for the presenting symptoms which vary according to its location: fistulas in the transverse/sigmoid sinus junction may present with pulsatile tinnitus while DAVF in the cavernous sinus might manifest with eye symptoms like chemosis, proptosis or decreased vision. Independently from their location, DAVFs can also present with headache, seizures or intracranial hemorrhage. They need to be treated urgently if there is radiological evidence of cortical venous retrograde flow, signifying an arterial type of pressure within weak walled cortical veins and therefore higher risk of hemorrhage.

There are three ways of treating a DAVF: surgery, endovascular embolization or radiosurgery. From published series of DAVFs in the anterior cranial fossa, surgical ligation or excision of the fistula through a craniotomy is considered the preferred treatment option. Endovascular embolization is possible by catheterizing directly the ophthalmic artery, however this needs to be sufficiently dilated and the risk of visual compromise from embolic occlusion of the central retinal artery needs to be taken into consideration.

We report the first case of an unruptured dural arteriovenous fistula (DAVF) treated via a fully endoscopic endonasal approach. The patient, a 58-year-old man, presented with sudden onset of retro-orbital pain and had an MRI scan raising the possibility of an aneurysm. For this reason he underwent a cerebral angiogram which showed instead a DAVF next to the crista galli, (figure 1) The fistula was fed on the left by the anterior ethmoidal artery, a branch of the ophthalmic artery and on the right by ethmoidal branches of the internal maxillary artery. The venous drainage was to the superior sagittal sinus predominantly via an asymmetrically prominent superficial cortical vein.

The endonasal approach we used to treat this DAVF is similar to what we employ for pathologies of the anterior cranial fossa such as meningiomas, esthesioneuroblastomas or nasopharyngeal carcinomas and avoids a craniotomy. The procedure was performed under general anesthesia, utilizing image guidance and neurophysiological monitoring and required a team composed of an ENT and a neurosurgeon working side by side through both nostrils of the patient. The approach involved resecting the superior part of the nasal septum to provide wide exposure of the anterior skull base followed by removal of the most anterior portion of the cribiform plates and crista galli. The anterior ethmoidal arteries were ligated in order to “cut off” the arterial supply to the fistula. After a wide exposure of the DAVF and surrounding healthy dura, the major draining vein was finally coagulated (figure 2) allowing for complete excision of the area of dura containing the fistula. The patient tolerated the procedure well and the retro-orbital pain improved immediately following the operation, which was completed without complication. He was able to be discharged the next day after surgery.

The main advantages of this approach when compared to an open one through a craniotomy are the use of a safe anatomical corridor leading directly to the arterial feeders of the fistula, the absence of brain retraction and a better cosmetic result without visible external scars, not to mention shorter hospital stay.

We would like to stress the fact that this type of approach requires the surgeons to be familiar with the endoscopic anatomy of this region, ideally having developed the necessary skills after performing a certain number of procedures within multidisciplinary team composed of an ENT and a neurosurgeon.

We conclude that this is a safe and feasible new option in the armamentarium of treatments available for DAVFs in the anterior cranial fossa.
The dilemma of the unruptured aneurysm

The management of an unruptured aneurysm often poses a significant dilemma. On the one hand, their natural history is most commonly benign. On the other hand—for the ones that do rupture—the consequences are often catastrophic. Therefore, the key question is what to do with unruptured aneurysms once they are found.

Expert clinicians must provide information to the patient in order to proceed in a manner where, if an intervention is recommended, the risk of the intervention must be lower than the natural history of the unruptured aneurysm. The decision to intervene or not to intervene is often the most challenging question.

Unruptured aneurysms are most commonly found incidentally. The individual has an imaging study of the brain and an aneurysm is found. The study could be done due to an unrelated symptom including headaches, cognitive dysfunction or a variety of other neurologic symptoms. Given that aneurysms are sometimes multiple, they may also be identified during the workup of a patient with another ruptured aneurysm. Furthermore, aneurysms can run in families, and specific screening paradigms can be recommended as appropriate.

Therefore, unruptured aneurysms can be identified under a spectrum of diverse circumstances. The key is to provide an objective analysis to the patient of the risk and benefits of observation versus intervention. Providing a summary to the patient of the relevant literature regarding likelihood of bleeding of unruptured aneurysms—as well as the consequences of rupture—are important factors for decision making. A challenge is that the available information is not very precise, but certainly provides an important framework for making an informed decision.

If the decision is that the aneurysm or aneurysms need to be treated, the next question is how to treat them, maximizing the likelihood of a long-term cure and minimizing risks. Here at UPMC we will explain and delineate to the patient the pros and cons of the two different techniques for the treatment of these aneurysms. Furthermore, complex cases are presented at our multidisciplinary cerebrovascular conference to obtain different points of view and present the options to the patient.

A key feature of our center is the availability of expertise in endovascular surgery as well as endovascular surgeons. Given the large volume of cases seen and evaluated at UPMC, we have the expertise and experience to manage and treat the broad spectrum of complex aneurysms.

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- CyberKnife ....................... (412) 647-1700
- Donations ....................... (412) 647-7781
- Endovascular .................... (412) 647-7768
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Multi-modal treatment provides successful approach for AVM patient

by Jim Olsen

The best surgical outcomes invariably require the active participation and positive attitude of the patient. Some patients stand out as being especially able and enthusiastic partners in the healing process. Clarel Owarish is one such patient.

Clarel, a single mother of three children, enjoyed a successful and rewarding career as a special education teacher, assisting children with behavioral disorders. On a winter evening in 2005, however, her life was about to change in some dramatic ways.

“On February 5, 2005 I was watching TV and [suddenly] became paralyzed on the left side of my body... I told my daughter to call 911 for help. The ambulance took me to the hospital. This was when the feeding aneurysm was discovered. I was told by one doctor that I was a ‘ticking time bomb and nothing could be done unless it was a case of extreme emergency, such as a bleed.”

Unable to continue work as a special education teacher, Clarel decided to make a career change. She completed a Masters degree in educational technology, and began to develop, refine and support web-based educational software products that assist people with disabilities. This enabled her to work from her home most of the time-a requirement of her treatment regimen.

Meanwhile, however, Clarel’s symptoms did not seem to improve, and in fact may have worsened. Clarel continued to maintain hope that a more effective treatment might be found. Over a period of two years, she and a case worker evaluated her care options. After extensive research, and without the referral of any physician, Clarel directly contacted Michael B. Horowitz, MD—head of Neurosurgery—provided her with Gamma Knife treatment.

“The Gamma Knife represents one of the most advanced means available to manage AVMs,” notes Dr. Lunsford, founder of America’s first Gamma Knife program, which has now treated over 10,000 patients. “Over the years we have successfully treated many patients with deep-seated AVM’s that were once considered inoperable.”

The day after her treatments in Pittsburgh, Clarel was traveling home to New Jersey, filled with renewed optimism.

Although Clarel’s journey to health is ongoing, she feels more confident now that she is receiving the best available treatment, and she is grateful to UPMC, to her team of neurosurgeons, and to all who have assisted in her care. As she anticipates the next stage of her treatment, she pours herself into her new-found passion—providing advice and emotional support to others who suffer from AVM and other debilitating neurologic conditions.

“There are many out there around the globe asking for help, searching for information. I read their stories, I feel their pain. I know their desperation and how depressing it can be. However, in being diligent, by providing support to them and their families and exchanging information, I strongly believe that my message and those of others who are trying to help spread the word will sooner than later resonate to the world out there that having an AVM and/or aneurysm is not necessarily a death sentence, it simply means that our lives are changing. I would have never thought that mine would have changed for the better. Thank you UPMC. I am forever indebted to you all.”
A pproximately one third of stroke patients become severely disabled and many others have other degrees of permanent impairment, leading to a huge societal and economic burden. Of course, rehabilitation therapy is important to maximize functional recovery in the early phase after stroke, but once recovery has plateaued there is no known treatment. Thus, the role of cellular therapy as one approach for repair has been explored. Preclinical studies first established the potential for cultured neuronal cells derived from a teratocarcinoma cell line to be tested for safety and efficacy in the treatment of human stroke. In an animal model of stroke that caused reproducible learning and motor deficits, injection of neuronal cells resulted in a return of learning behavior retention time and motor function. We conducted two clinical trials to test the hypothesis that implantation of neuronal cells would be safe, feasible, and lead to improvement of motor neurologic deficits resulting from basal ganglia cerebral infarction. Currently, we are exploring the use of both a stem cell line, and a neuroprogenitor cell line for stroke repair. Bone marrow derived cells and stem cell sources offer avenues for new research.

Available evidence suggests both the value of humoral mechanisms from the graft, as well as a direct action of surviving implanted neuronal cells. The neuronal cells could improve neurologic function through a number of different mechanisms. These include provision of neurotrophic support (acting as local pumps to support cell function), provision of neurotransmitters, reestablishment of local interneuronal connections, cell differentiation and integration, and improvement of regional oxygen tension. In our first human trial, fluorodeoxyglucose-18 positron emission tomography showed increased uptake at the target site that correlated with the clinical response, and an autopsy evaluation of one graft 27 months after surgery showed surviving donor cells.

The second two-center study was an open-label trial with observer-blinded neurologic evaluation of patients with stroke who received stereotactic implants of human neuronal cells. The first nine patients were randomized to either surgery plus rehabilitation (n=7) or rehabilitation alone (n=2) (surgery consisted of 5 million cells divided into 25 implants along five trajectories; 10 microlitres per implant). The next nine patients were randomized to receive either surgery with 10 million cells plus rehabilitation (n=7) or rehabilitation alone (n=2). Cyclosporine-A was administered one week prior to surgery and continued for six months.

Safety and Feasibility in Stroke Patients

These studies were intended to provide data on safety and feasibility of cellular repair in this setting. We concluded that safety and feasibility was achieved. Measurable improvements were noted in both motor and behavioral function. Study limitations included the lack of information known regarding optimum patient criteria (age, stroke age, size, type or location), adequate cell number, location and number of the brain implantation sites, use of immunosuppression, lack of larger control or study groups, and best way to evaluate the patient response. Any indications of efficacy must be tempered by the fact that signs of improvement were not consistent. In our first trial, an equal number of patients had no improvement or worsening in stroke or disability scales as had improvement. In that trial, clinical improvement correlated with change on fluorodeoxyglucose PET imaging at both the implant site and in the contralateral cerebellum (remote diaschisis effect).

After completion of two clinical trials in cellular transplantation for motor stroke, we believe that further research should focus on the development of new cell lines as well as refining clinical inclusion criteria. Because of the wide variety of patients and clinical factors evaluated in the first two studies (age, degree of deficit, spectrum of neurologic symptoms, stroke size, stroke type (hemorrhagic or ischemic), length of immunosuppression) it is difficult to make firm comments regarding inclusion and exclusion criteria. We believe that patients with younger strokes may have more potential to improve since their motor deficits are less likely to be fixed at the level of the distal musculature. On the other hand, both motor and cognitive improvements were measured in patients who were several years out from their stroke. It is likely that future trials will evaluate patients with an earlier stroke age (three months to 12 months). Eventually, the concept of a placebo effect would need to be tested, if a reasonable and consistent level of clinical improvement was identified.

What about stem cells? Human embryonic stem cells represent the most fundamental source of cells, but their clinical usage is currently limited by a need to restrict the cells to neural stem cell fate and prevent the development of tumors prior to implantation. Thus, an alternative source of cells for therapeutic use is somatic, or lineage-restricted stem cells derived from human fetal tissue. This approach is limited by tissue availability and variable purity and/or quality of the resulting cell product. The ethics related to procurement of embryonic versus adult stem cells are well known.

ReNeuron, Inc has developed a human neural stem cell line (ReN001) for the treatment of stable ischemic stroke. This cell line is currently being tested in a clinical trial within the United Kingdom. With the ReNeuron cell line, cells were generated by genetic modification of neural stem cells isolated from first trimester fetal brain tissue. The technology (c-mycERTAM) employed to achieve conditional growth control is a fusion protein expressed by a growth promoting gene, c-myc, and a hormone receptor that is controlled.
Stroke is still the 3rd leading cause of death in the Unites States, and the number one cause of adult disability. There are currently ~800,000 strokes occurring every year in the U.S., equating to one every 40 seconds.

UPMC Presbyterian is leading the way in attempting to treat these events the moment they happen in an effort to halt or reverse brain damage from a blood vessel occlusion. As one of the most prolific medical systems for the treatment of acute stroke in the United States, UPMC’s Presbyterian is the only site in Pittsburgh to begin enrolling in the SWIFT trial (Solitaire with Intention for Thrombectomy).

The Solitaire™ FR Revascularization Device is a self-expanding fully retrievable stent designed to be navigated and deployed within the intracranial blood vessels. It is self-expanding thereby avoiding the need to inflate with a balloon. It is retrievable in the sense that if the placement is inadequate, the stent can be recaptured, removed, or adjusted.

The stent comes pre-loaded and attached to the tip of a pusher wire. Once a narrow plastic tube or catheter is positioned across the clot, the collapsed stent is passed through the catheter, which extends from the femoral artery to the intracranial blockage.

Although the stent was initially designed to aid with coiling wide neck aneurysms as a neck remodeling device, it was noted that not only could the stent create a channel within occlusive clots to immediately restore blood flow, but the clots tended to stick to the stent. Thus, if the stent could be deployed within a clot, removal of the stent may also remove the clot, thereby re-establishing blood flow without having to leave the stent in the blood vessel.

The SWIFT trial is currently randomizing patients to treatment with the Solitaire™ FR Revascularization Device or the Concentric® Merci® retriever, making this the first prospective, randomized clinical trial comparing the safety and efficacy of two mechanical thrombectomy devices for large vessel occlusion of intracranial arteries.

The study will attempt to enroll 200 patients. The primary endpoint will be recanalization and the secondary endpoints will be time to recanalization and 30/90 day clinical outcomes as measured by the modified Rankin Scale. Patients can be enrolled if they present within 8 hours of their stroke, are age 22-85, and have an NIHSS ≥8 and <30.

UPMC Presbyterian has thus far enrolled five patients and eagerly awaits the outcome of this trial. Tudor Jovin, MD, director of the UPMC Stroke Institute, and the principal investigator of the trial at the hospital, remarked that “This technology represents another leap forward in the treatment of acute stroke and will very likely become a valuable tool in our armamentarium to open occluded blood vessels.”

Endovascular neurosurgeons are using new techniques and devices to successfully treat vascular disorders. (A), Solitaire™ FR revascularization device; (B) digital subtraction angiography revealing a left M1 occlusive thrombus impeding blood flow to the distal vasculature; (C) imaging after deployment of the solitaire device within the thrombus showing restoration of blood flow.

**Stroke repair**

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by a synthetic drug, 4-hydroxy-tamoxifen (4-OHT). In the presence of 4-OHT, c-Myc is able to translocate to the nucleus and thereby promote stable cell growth. Removal of the 4-OHT in vitro and prior to implantation in vivo switches off the c-Myc protein thereby removing growth promotion and permitting the cells to differentiate into normal neuronal cells.

Human bone marrow appears to be a promising source of cells for restorative medicine.20 Numerous studies on the role of stromal cells for traumatic brain injury have been published by Mahmood, Chopp and colleagues. SB623 cells are human bone marrow-derived neuroprogenitor cells being developed by SanBio Inc. (Mountain View, CA) as an allogeneic cell therapy for chronic, stable stroke and other neurodegenerative conditions. SB623 cells are generated under good manufacturing process (GMP) conditions by the transient transfection of bone marrow stromal cells (MASC) with a plasmid encoding the human Notch-1 intracellular domain (NICD). This transfection is considered transient because the products of the plasmid rapidly disappear with further expansion/passaging of the cells. Thus, the gene is not present in greater than minor levels in the cells and is not expected to be present at all after short time post-implantation. We are planning a clinical trial using SB623 cells for patients with motor stroke in 2011.
Percutaneous revascularization: Catching up to rest of endovascular world

by Tudor G. Jovin, MD; Brian T. Jankowitz, MD

While endovascular revascularization of chronically occluded peripheral arteries and coronaries has been a long accepted paradigm, neurointerventionalists have traditionally been reluctant to apply this technique to the extra/intracranial carotid arteries or verteobasilar system. The understandable respect for this approach is due to the fact that the brain is the most unforgiving target organ. Thus, unforeseen events such as dissection or distal embolization may have minor consequences on the ultimate clinical outcomes in the peripheral or coronary world either because they may not be clinically relevant or because open surgical or other endovascular techniques are available to correct these problems. Such events however can have catastrophic consequences in the brain where small emboli can produce devastating clinical strokes or Intracerebral hemorrhage. Even when procedures are successful from a technical standpoint, the brain’s low tolerance and dramatic manifestations of reperfusion injury remains a significant concern.

Thus it should come as no surprise that until several years ago any carotid artery whether acutely or chronically occluded was considered untouchable. Even in the setting of acute stroke due to extracranial occlusion with a second, more distal, intracranial occlusion (tandem occlusions) endovascular revascularization techniques would consist of either accessing the distal occlusion through Circle of Willis collaterals (typically anterior communicating artery) or passing a microcatheter over a microwire through the occluded extracranial carotid artery into the distally occlusive thrombus where local infusion of lytic drug would be administered. Prior to or following lytic infusion, no attempts would be made to open the occluded extracranial carotid artery. Besides the reasons mentioned above, this reluctance to revascularize the vessel was also rooted in the still prevailing but largely incorrect belief that the occluded segment extends from the extracranial carotid all the way to the carotid terminus. Thus in view of such presumed extensive clot burden any attempts to revascularize the vessel were considered impossible. In the early part of the past decade however, as endovascular treatment of acute ischemic stroke at UPMC Presbyterian become increasingly more prevalent, neurointerventionalists frustrated by the limited success in dealing with tandem occlusions the way described above decided to tackle the problem in a radically different way. This consisted of passing the microwire/microcatheter through the occlusion, but instead of targeting the distal lesion only, once past the extracranial carotid segment, the microcatheter was used to explore the vessel and determine the length of the occlusive lesion. If the occlusion was focal and no further thrombus was found in the vessel distal to the occlusion, the ICA would be stented under cerebral protection by means of a distal protection device.

Proximal revascularization as the initial step confers some advantages. Increased distal perfusion through collaterals from enhanced proximal flow may increase the likelihood of successful distal recanalization. Another advantage of proximal recanalization is the improved vascular access that can be obtained to treat intracranial lesions. This approach allows for better support when trying to access an intracranial occlusion and presents an improved ability to deploy mechanical devices. An additional advantage is the presumably lower risk of stroke recurrence in patients who make a good recovery since persistent carotid occlusion is associated with a significant risk of subsequent stroke. Carotid occlusion with hemodynamic impairment heralds a poor prognosis and is associated with early clinical deterioration and late stroke recurrence risk. Proximal revascularization as the first step is fraught with theoretical disadvantages. The risk of distal embolization is one major safety concern associated with this approach, however this untoward event can be limited or prevented by using emboli protection devices. Another theoretical shortcoming of this revascularization sequence is the increased time to restoration of flow in the intracranial circulation. An argument can be made that proximal prior to distal interventions may be too time consuming. However, some of the procedural steps, such as groin access and all steps necessary for base catheter placement, are common for both approaches and therefore the extra steps necessary to revascularize the proximal occlusion does not cause a significant delay while offering the advantages described above. Another concern derived from this reperfusion approach is the requirement of dual anti-platelet therapy after proximal stent placement which may precipitate hemorrhagic complications in those patients with a large stroke. A study on 77 patients with tandem occlusions authored by UPMC Stroke Institute and neurosurgery department faculty recently accepted for publication in the journal Stroke has found that this approach is relatively safe with symptomatic intracerebral hemorrhage rates at 10% and is associated with a 41% rate of good clinical outcomes (functioning at least at independent level). The rates of good outcome in this group of patients compare favorably to historical controls.

The high rates of recanalization noted with revascularization of extracranial internal carotid occlusions in the setting of acute stroke due to tandem occlusions have provided the impetus of exploring the feasibility of carotid

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60-year-old male presented in 2005 (fig. 1) with acute left hemispheric stroke and a new diagnosis of an ICA occlusion. He experienced another isolated event in 2007 (fig. 2) and finally multiple, recurrent events in 2010 (fig. 3) with associated evidence of ipsilateral hemispheric hypoperfusion. He underwent successful carotid stenting of a chronic, focal ICA occlusion (fig. 4) resulting in improved intracranial blood flow (fig. 5).
Radiosurgery or Open Surgery for Epilepsy trial

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aims include: To compare the seizure-free outcomes and morbidity of Gamma Knife radiosurgery (GK) for patients with pharmaco-resistant temporal lobe epilepsy with those of open temporal lobectomy.

The primary hypothesis is that radiosurgery will be non-inferior to lobectomy with respect to seizure-free rates at 25-36 months following therapy (one-year of seizure freedom beginning two years after treatment).

A second aim is to compare the neuropsychological outcomes in patients undergoing radiosurgery and temporal lobe surgery, in particular with respect to verbal memory function for language-dominant hemisphere treated patients. The hypothesis of the study is that patients treated for speech-dominant temporal lobe seizures with temporal lobectomy will show greater reduction in verbal memory than patients treated with radiosurgery.

Thirdly, investigators will determine what changes occur in the quality of life of patients with temporal lobe epilepsy following radiosurgical treatment as compared with open surgery. Finally, investigators will compare the cost-effectiveness of the two approaches.

Epilepsy surgery is the only potential cure for some people whose seizures cannot be controlled by anticonvulsant medications. To be considered for epilepsy surgery, a presurgical evaluation is necessary and consists of several examinations and diagnostic investigations.

Compensation for transportation, including bus tickets or parking cost, may be provided. The study is funded by the National Institutes of Health, and Elekta, manufacturer of the Gamma Knife. For more information, please call (412) 683-7279.

Percutaneous revascularization

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stenting and angioplasty for symptomatic internal carotid occlusions without accompanying tandem intracranial lesions. Because in this setting the intracranial arteries are patent, the consequences of distal embolization and subsequent occlusion of an intracranial artery can have a stronger impact on the eventual clinical outcome compared to the tandem occlusion where the intracranial vessel is already occluded and therefore appropriate patient selection is the key to a successful approach. Patients considered for this procedure at our center have known subacute or chronic symptoms with an acute unstable clinical course characterized by progressive neurological deficit or fluctuations. All patients must have failed maximal medical therapy and show evidence of severe hemodynamic impairment in the affected hemisphere. At our center, the latter is assessed with CT perfusion or SPECT studies with or without the use of a Diamox challenge.

Using this approach we have been able to revascularize over 50 occluded ICA’s in patients presenting with subacute symptoms and over 10 ICA’s in patients presenting with chronic symptoms and known long-standing (at least weeks) carotid occlusion on non-invasive studies.

In conclusion, revascularization of occluded carotid arteries is feasible in the context of acute, subacute and even chronic presentation. Because of the potential for significant complications, most notably distal embolization and Intracerebral hemorrhage, this approach should only be considered in highly selected patients who have symptoms despite maximal medical therapy and evidence of severe hypoperfusion in the affected hemisphere.
Mesial temporal lobe sclerosis is a common cause of intractable epilepsy. When medication therapy fails, surgical resection of the affected structures (amygdala and hippocampus of the mesial temporal lobe) can be effective.

Another potential approach is stereotactic Gamma Knife radiosurgery, where the target tissue is ablated with precise radiation, rather than resected. This concept is based on research in the laboratory of Douglas Kondziolka, MD—Peter J. Jannetta Professor of Neurological Surgery and Radiation Oncology at the University of Pittsburgh and co-director of UPMC’s Center for Image-Guided Neurosurgery—and on early phase clinical trials performed in Europe. A pilot clinical trial was recently completed and showed favorable outcomes after radiosurgery, similar to what is typically expected after resection.

The Radiosurgery or Open Surgery for Epilepsy (ROSE) trial will prospectively compare these two options in participants 18 years and older with drug-resistant temporal lobe epilepsy.

The ROSE Trial is a six-year-long NIH-funded multicenter, prospective, blinded, randomized controlled trial. The principal investigator is Nicholas M. Barbaro, MD, professor of neurological surgery at the University of California, San Francisco. Coprincipal investigators are Mark Quigg, MD, MSc, associate professor of neurology at the, University of Virginia. The site PI is Anto Bagic, MD, MSc, professor of neurology at the University of Pittsburgh.

The ROSE Trial is being conducted in major epilepsy centers across the U.S., England and Canada. This is an intent-to-treat trial with the recruiting goal of randomization of 234 patients (117 each arm) in ~14 treatment sites in a three-year enrollment window. Each participant will be followed for three years.

“ROSE is a fundamental study that may establish another much needed therapeutic option for many of those 30 percent of epilepsy patients who continue to suffer in spite of our best efforts,” notes Dr. Bagic. “It is our professional obligation to change the current reality in which a patient with uncontrolled epilepsy continues to suffer on average for 15 years or longer on their antiepileptic regimen before established non-pharmacologic therapeutic options are considered. Pitt contributed significantly to the initial pilot study, and we are proud to be a part of this selected group of centers that can offer participation in this advanced clinical trial to our epilepsy patients.”

The purpose of this study is to compare the effectiveness of Gamma Knife radiosurgery with temporal lobectomy in the treatment of patients with pharmacoresistant mesial temporal lobe epilepsy. Study

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