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Outcomes After Endovascular Treatment for Anterior Circulation Stroke Presenting as Wake-up Strokes are Not Different Than Those with Witnessed Onset Beyond 8 hours

Amin Aghaebrahim, Carlos Leiva-Salinas, Syed Zaidi, Mouhammad Jumaa, Xabi Urra, Edilberto Amorim, Guangming Zhu, Ashutosh P. Jadhav, Brian Jankowitz, Max Wintermark, Tudor Jovin

Objective: Patients with wake-up stroke are thought to have different outcomes after recanalization compared to patients with witnessed late time of onset. We sought to verify this hypothesis by determining clinical outcomes, mortality, infarct volume, and rate of parenchymal hematoma (PH) in patients with anterior circulation large vessel occlusion stroke (ACLVOS) treated with endovascular therapy at our center.

Methods: Retrospective review of a prospectively acquired database from consecutive patients meeting the following criteria: (1) ACLVOS, (2) endovascular treatment initiated beyond 8hrs from time last seen well (TLSW) or wake up stroke (WUS). Treatment selection was based on the presence of a small infarct core/large penumbra assessed through visual inspection on MRI or CTP by the treating physician. In addition, imaging characteristics including pre-procedure infarct volumes and final infarct volumes were calculated through automated volumetric analysis.

Results: We identified 192 patients. Patients were divided into two groups. Group 1: patients with WUS (39%, n=75). Group 2: patients with witnessed onset beyond 8hrs (54%, n=104) and patients without witnessed onset but TLSW greater than 8hrs (7%, n=13) who were not WUS. The groups were comparable for median age (68 vs. 65, P=0.25), baseline median NIHSS (15 vs. 13, P=0.14), pre infarct volume (14mL vs. 13mL, P=0.57) and rate of successful recanalization (68% vs. 68%, P=0.96). The proportions of patients with modified Rankin Scale 0 to 2 (43% vs. 50%, P=0.31), any symptomatic intracerebral hemorrhage (18% vs. 12%, P=0.29) and final infarct volume (47mL vs. 46mL, P=0.93) were also comparable. Further, successful recanalization (TICI 2b or 3) was associated with better outcome (P <0.001) and significantly smaller infarct growth (P <0.001). Multivariate logistic regression model identified only age (OR = 0.94, 95% CI 0.91-0.97, P <0.001) successful recanalization (OR 2.9, 95% CI 1.2-7.2, P = 0.018) and final infarct volume (OR 0.98, 95% CI 0.98-0.99, P < 0.001) but not mode of presentation as predictors of favorable outcomes.

Conclusion: In patients with ACLVOS presenting beyond 8 hours from TLSW who are selected based on similar imaging characteristics, clinical outcomes following endovascular treatment do not seem to differ according to mode of presentation relative to TLSW.

Use of Standardized Protocols and Order Sets at a Comprehensive Stroke Center Decreases the Average Hospital Length of Stay for Patients with Non-traumatic Intracerebral Hemorrhage (ICH)

Parita Bhuva, MD; Kyloni D. Phillips, ACNP, CNRN; Alexander Venizelos, MD; Debbie Roper, RN MS; Jeff Coulson, RN; Lauren Carlson, MD MPH; Scott Robbins, MD; Mark Whitely, MBA; Abhi Pandhi, MBBS; Vallabh Janardhan, MD

Background: Establishing and implementing standardized protocols and order sets can be a time-consuming and resource-intensive process. There is limited information on the impact of such standardized protocols and order sets on the hospital length of stay in patients with non-traumatic ICH.

Methods: Standardized protocols and order sets were implemented in 2010 as part of the development of a Comprehensive Stroke Center and regional stroke network of 11 hospitals. Patients with non-traumatic ICH were identified based on in-patient hospital discharge ICD-9 codes from 2008 to 2011 and hospital length of stay data was collected.

Results: A total of 339 patients were hospitalized with non-traumatic ICH over the 4-year period. The average hospital length of stay for patients with non-traumatic ICH decreased from 8.7 days in 2008 to 7.0 days in 2011, a 19.5% reduction.

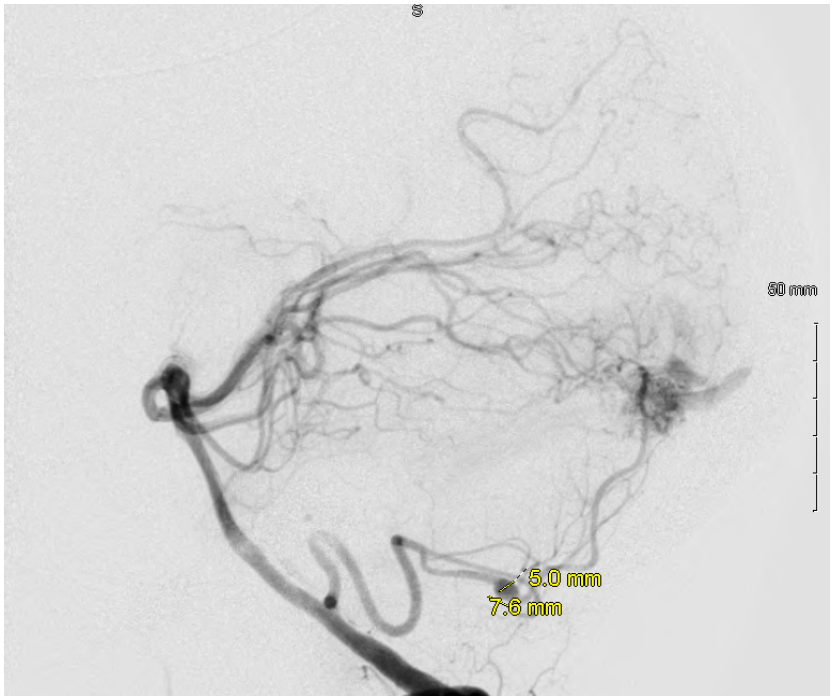
Conclusion: Use of Standardized Protocols and Order Sets at a Comprehensive Stroke Center is associated with a significant decrease in the average hospital length of stay for patients with non-traumatic ICH.

Endovascular Treatment of Distal PICA Aneurysms Associated with AVMs

David Case MD, Taka Higashimori MD, Joshua Seinfeld MD

The association of posterior fossa arteriovenous malformation(AVM) and posterior inferior cerebellar artery(PICA) aneurysms has been previously documented in the literature. We report three cases of distal PICA aneurysms associated with posterior fossa AVMs between June 2009 and July 2013 at our institution. Three patients presented with Fischer grade 4 subarachnoid hemorrhage (SAH). Two patients presented as Hunt and Hess 4 and one as Hunt and Hess 5. CTA was used in the initial evaluation. In each case, distal fusiform aneurysms of the posterior inferior cerebellar artery located along the roof of the fourth ventricle were identified. While the aneurysms were easily visualized on non-invasive imaging, all associated AVMs were obscured by adjacent dural sinuses, bone artifact and not noted on the official radiologic interpretations. Angiography was required for visualization of the AVMs. Four aneurysms were treated by endovascular techniques in 3 patients within 24 hours of presentation utilizing liquid embolic agents (onyx 2, NBCA 1) for parent vessel sacrifice. In two patients the AVM was also embolized at the time of aneurysm treatment using onyx (1 partial and 1 complete).

Conclusions: Non-invasive imaging did not reveal associated small midline superior cerebellar AVMs with radiographically identified PICA aneurysm suggesting invasive imaging studies are needed. In addition, endovascular treatment with parent vessel sacrifice and AVM embolization is a potential approach to these patients.



Distal R PICA aneurysm and superior cerebellar AVM

Texas Stroke Intervention Pre-hospital Stroke Severity Scale (aka LEGS score): A novel Triaging Tool for Interventional Stroke therapy

Sherman Chen, MD; Alexander Venizelos, MD; Abhi Pandhi, MBBS; Ryan Gianatasio, MD; Stewart R. Coffman, MD MBA; Mark Gamber, DO; W. Tim Hartman, DO; John H. Myers, MD; Vallabh Janardhan, MD

Background: A pre-hospital stroke severity scale that correlates well with an NIHSS of 10 or greater (NIHSS $\geq$10 correlates well with large vessel occlusions) but is easier and faster to perform would be very useful triaging tool to emergency medical services (EMS).

Methods: The LEGS score is a shortened NIHSS-5. LEGS score stands for Leg strength, Eyes/visual fields, Gaze, Speech/language. LEGS score (0-16) as well as the full NIHSS (0-42) were performed in the emergency department over a 6-month period.

Results: A total of 182 consecutive ischemic stroke patients were evaluated. LEGS score 4 or greater was a good predictor of an NIHSS of 10 or greater (59/182; positive predictive value 92%; and specificity 95%) and false positives noted was 5/182. LEGS score of less than 4 was a good predictor of an NIHSS of less than 10 (108/182; negative predictive value 91%; and sensitivity 95%) and false negatives noted was 10/182.

Conclusion: LEGS score of 4 or greater is useful to triage moderate-severe stroke patients (NIHSS of 10 or greater) to a comprehensive stroke center for consideration for Interventional Stroke therapy.

Current Risk-adjusted Clinical Outcomes from the INterventional Stroke Therapy Outcomes Registry

John Connors, MD

Introduction: The INterventional Stroke Therapy Outcomes Registry (**INSTOR**®) is a complete process improvement tool combined with the ability to perform complex analyses of clinical outcomes for all forms of acute stroke therapy, including intravenous (IV) as well as endovascular (IA).

Methods: A custom software development company was employed to create a dedicated on-line national registry for tracking hospital processes and performance trends, and that could perform instant complex single and multifactorial analyses of clinical outcomes (90-day modified Rankin Score (mRS) based upon numerous patient-specific characteristics as well as clinical and performance-based characteristics.

Results: Some of the results to be presented include dramatically varying outcomes for all forms of treatment based upon initial NIHSS. Concerning IV TPA, for NIHSS 0-5, mRS 0-1 was 67%; 6-9, 38%; 10-14, 20%; 15-19, 10%, and for NIHSS 20 or over, mRS 0-1 was zero %. For IV+IA treatment, there was a similar pattern – outcomes now listed as mRS 0-2. For NIHSS 0-5, mRS 0-2 was 50%; 6-9, 80%%; 10-14, 72%; 15-19, 42%, 20-24, 33%, over 24, 60%. For IA alone – numbers again listed as mRS 0-2, for NIHSS 0-5, mRS 0-2 was 42%; 6-9, 42%; 10-14, 60%; 15-19, 18%; 20-24, 20%, over 24, 18%.

Conclusion: **INSTOR** is capable of calculating both single and multifactorial risk-adjusted analyses of clinical outcomes for all forms of emergency stroke treatment and these will be presented.

Complexity of Treatment for PICA Aneurysm: A Case Series and Review of Literature

Vladimir Cortez, MD, Muhammed Taqi, MD, Javed Siddiqi, MD, PhD

The frequency of posterior circulation aneurysms is 15% with 3% arising from the PICA. Our institution is presenting a 3-case series of such aneurysms.

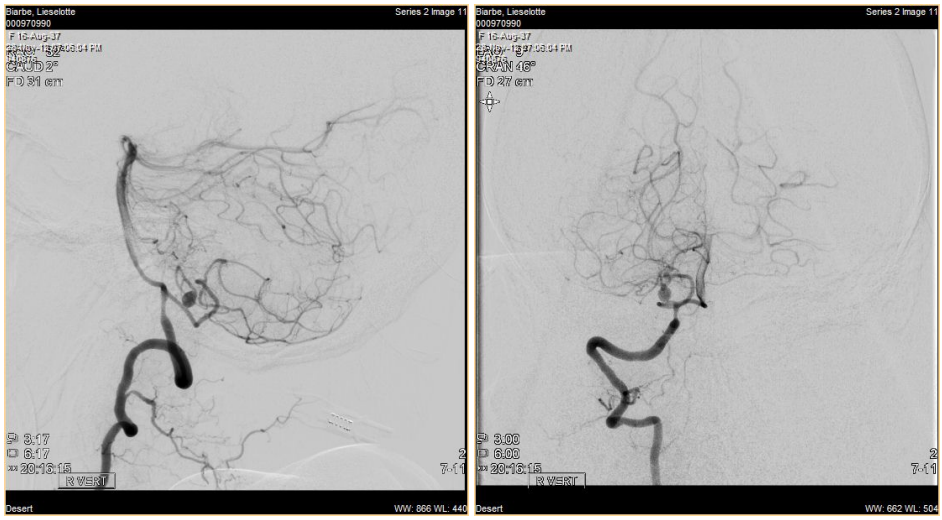
1st: 75 year-old Caucasian female with acute SAH from a ruptured right distal PICA aneurysm. Patient presented with GCS of 11T with diffuse intraventricular SAH. Initial angiogram showed a distal saccular right PICA aneurysm that was deemed not appropriate for coiling. The patient underwent a right suboccipital craniotomy for clipping of aneurysm. Post-operative, the patient recovered and was eventually discharge to rehab.

2nd: 80 year-old Caucasian female with ruptured left proximal PICA aneurysm. The patient presented with GCS of 10T. Initial angiogram showed a possible re-bleed. The patient was then taken for a left suboccipital craniotomy for clipping of aneurysm. The patient's post-operative course showed dependency of the vent. The family withdrew treatment and concentrated on comfort care.

3rd: 57 year-old Hispanic male presented with a 5-day history of headache and subacute SAH. On angiogram, a PICA aneurysm was identified at the VA junction. The patient underwent coiling of aneurysm but with intraprocedural rupture. The aneurysm was able to be coil with control of the hemorrhage. Post-operatively the patient recovered, but develop hydrocephalus, which was treated with shunting. The patient was discharge to home.

By far, aneurysms of the PICA region are the most difficult to treat. Surgery for these aneurysms are challenging due to the location and intimate relation to the brainstem. On the other hand, endovascular results of PICA aneurysms are not well established.

Case 1:



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Case 2

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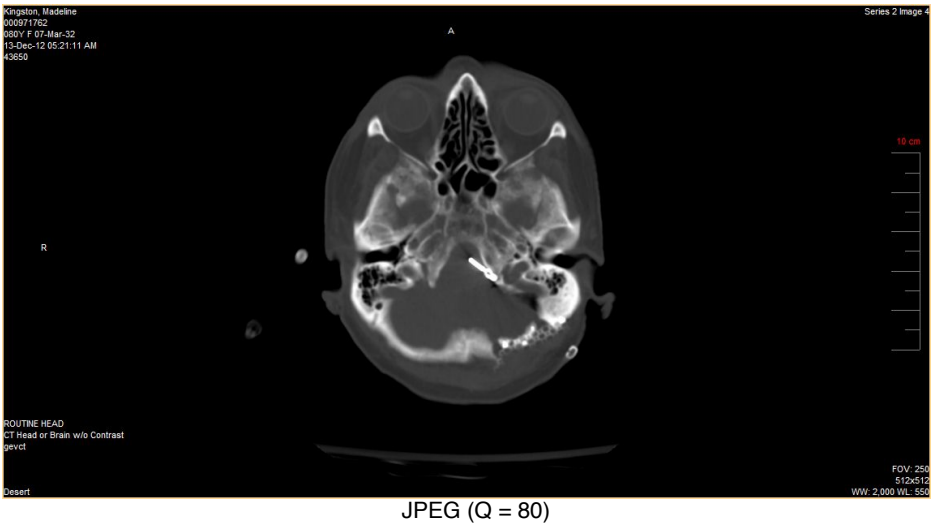

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Case 3

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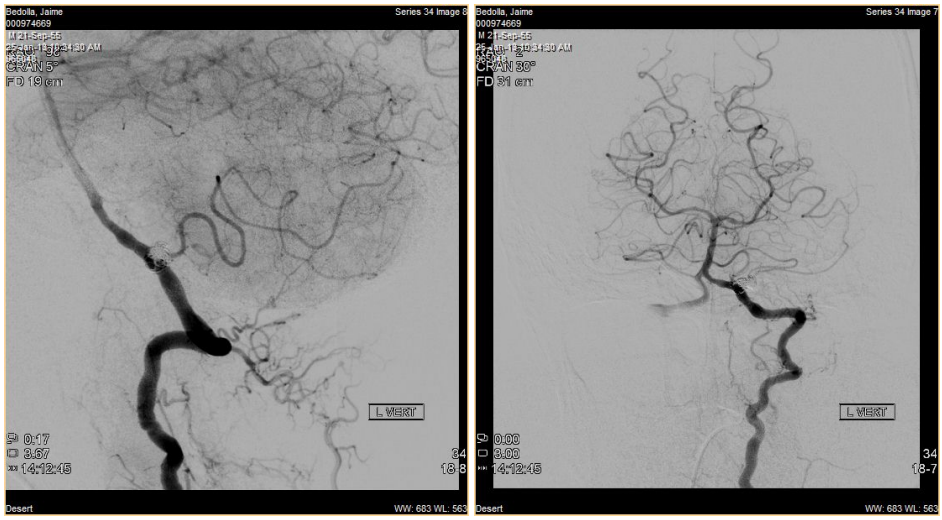

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Increase Incidence of Aneurysmal Rupture Less Than 5 mm

Vladimir Cortez, MD, Ajeet Sodhi, MD, Vivek Ramakrishnan, DO, Muhammed Taqi, MD, Thomas Wolfe, MD

Subarachnoid hemorrhage (SAH) from rupture aneurysms is a common presentation to the ED in the US and abroad with an estimated aneurysmal hemorrhage in most western populations of 6-8 per 100,000. Also, SAH are commonly associated with high morbidity and mortality. However, unruptured aneurysms merit treatment since their outcome is also poor even under the best circumstances. About 65% of patients will die from their first hemorrhage, and even in patients with no neurologic deficits after rupture of aneurysm, only 46% will recover fully and 44% will return to their jobs. There are numerous recommendations for treating unruptured aneurysms. Most guidelines suggest that unruptured aneurysms of >10mm should be treated; 7-9mm aneurysms in young and middle-aged patients need treatment as well. Aneurysms less than 5 mm in size usually can be observed with serial angiography based on recent guidelines.

Our institution will present a case series of 5 patients with aneurysmal rupture of aneurysms < 5mm in size. Locations of these aneurysms were in the anterior and posterior circulation. From this series, 2 patients presented SAH with aneurysms less than 2 mm in size. The patients were of young age and with normal health. The overall degree of outcome was marginal. The increase rate of SAH from aneurysms less than 5 mm suggest an increase trend and shift in the normal pathophysiology of small and micro aneurysms, as initially thought. In all, rupture of small and micro aneurysm should prompt to re-examine their overall rupture rate on a national scale.

Solitaire FR Thrombectomy for Acute Revascularization (STAR) Study In Patients with Acute Ischemic Anterior Circulation Stroke: Subgroup Analyses

Antoni Dávalos for the STAR Study Group

Background:
The STAR study showed that treatment with the Solitaire™ FR device in intracranial anterior circulation occlusions results in high rates of revascularization, low risk of clinically relevant procedural complications, and good clinical outcomes in combination with low mortality at 90 days. We present the results of subgroup analyses.

Methods:
In a prospective, observational, single-arm study, 202 patients (median age 72; 60% female; median NIHSS 17; median time to groin puncture (TGP), 238 min) undergoing mechanical thrombectomy for acute ischemic stroke in the anterior circulation were enrolled in 14 selected dedicated comprehensive stroke centers in Europe, Canada and Australia. Subgroup analyses were based on revascularization (TICI 2b-3) and functional independence (mRS 0–2) at day 90.

Findings:
Analyzed subgroups were intracranial MCA (82%) vs ICA occlusion, general anesthesia (72%) vs sedation, IV tPA (59%) vs no tPA, MRI use (26%) vs CT for patients' selection, collateral status 3-4 (36/128, 28%) vs 0-2 (ASITN/SIR Collateral Flow Grading System), and TGP <4.5h (64%) vs >4.5h. Revascularization rate was similar among the different subgroups. Good functional outcome was significantly higher in patients with good collaterals (72% vs 55%, p=0.034) and treated within 4.5h (65% vs 42%, p=0.002). Functional recovery (mRS, 0-1) was higher in MCA occlusions (47% vs 25%, p=0.016). No significant differences were found in the other subgroups.

Interpretation:
Thrombectomy with the Solitaire FR device results in better clinical outcomes in patients with good collaterals. The present findings reinforce the need to shorten the time to groin puncture as a way to achieve favorable outcomes.

Features of Capillary Malformation-Arteriovenous Malformation Syndrome Associated Cerebral Vascular Anomalies

Johanna Fifi, MD

Background: Capillary malformation-arteriovenous malformation (CM-AVM) syndrome is an autosomal dominant disorder caused by mutations in the RASA1 gene. The hallmark is cutaneous capillary malformations. High flow AVMs occur in about 1/3 of patients, with cerebral malformations in about 10%. We evaluate the clinical and radiographic features of cerebral malformations in CM-AVM patients.

Methods: Since 2006, pediatric patients presenting to our center with head and neck high flow vascular malformations have been screened for capillary malformations. Our database of pediatric head and neck vascular malformations was reviewed for patients with capillary malformations. Patients with only facial arteriovenous malformations were excluded. Clinical and radiographic features were reviewed.

Results: 9 patients were found to have high flow head and neck malformations and CM. 1 patient with an ear AVM was excluded. Of the remaining, 4 patients had confirmed positive genetic mutation in the RASA1 gene. All four of these patients had complex pial arteriovenous fistulas – One was supratentorial and three were in the posterior fossa. One premature infant with a complex posterior fossa lesion and heart failure died shortly after birth. One infant with mild heart failure is on medication and awaiting treatment. The other two were asymptomatic and treated with embolization. These patients are neurologically intact and reaching developmental milestone. 3/4 patients had first degree relative with CM with or without AVM. One patient with vein of Galen malformation and CM has tested negative for RASA1 mutation. The other three patients have not yet been tested. Of these, two have pial arteriovenous fistula which have been treated. One 2 year old had a multifocal dural arteriovenous fistula.

Conclusion: Cerebral vascular anomalies in CM-AVM syndrome are often complex lesions. Thus far, all confirmed RASA1 mutation patients at our center have pial arteriovenous fistulas. Vein of Galen malformation and dural AVM may also be associated. Pediatric patients with these diagnoses should be screened for CM. The diagnosis of CM-AVM with RASA1 mutation plays a role in family planning and screening of other family members.

Establishing a Comprehensive Stroke System of Care Increases the Acute Ischemic Stroke Volume and Intravenous Recombinant Tissue Plasminogen Activator (IV r-tPA) Usage

Ryan Gianatasio, MD; Alexander Venizelos, MD; Debbie Roper, RN MSN; Abhi Pandhi, MBBS; Scott Robbins, MD; Anita Guthmann, RN BS; Jeff Coulson, RN; Mark Whitley, MBA; Vallabh Janardhan, MD

Background: Comprehensive Stroke Systems of Care are needed across the country. However, there is limited information on the growth of acute ischemic stroke volumes within hospitals in a regional stroke network and the associated IV r-tPA rates.

Methods: A Comprehensive Stroke System of Care was developed in 2010 and included 5 hospitals that were certified primary stroke centers. Acute ischemic stroke volume was identified based on in-patient hospital discharges (ICD-9 codes) from 2008 to 2012. IV r-tPA usage was identified based on procedure codes for intravenous thrombolytic administration and data collected by hospital stroke coordinators.

Results: A total of 6,311 patients were hospitalized with acute ischemic stroke over a 5-year period. Acute ischemic stroke volumes grew from 902 in 2008 to 1493 in 2012 with a growth rate of 65.5%. The IV r-tPA usage rates increased from 7.10 % in 2008 to 13.13 % in 2012 with a growth of 6.03%.

Conclusion: Comprehensive Stroke System of Care positively impacts stroke volumes in all the hospitals within the regional stroke network and is associated with increased IV r-tPA rates.

Comparison of Surgical and Endovascular Approach in Management of Spinal Dural Arteriovenous Fistulas (SDAVF): A Single Center Experience of 27 Patients

Sankalp Gokhale, Gavin Britz, Shariq Khan, David McDonagh

Background: Spinal Dural Arteriovenous Fistula (SDAVF) is a rare spinal vascular malformation with an annual incidence of 5-10 cases per million. The data on efficacy, recurrence rates and complications of endovascular versus surgical treatment of SDAVF is limited.

Methods: We conducted a retrospective chart review of 27 adult patients with a diagnosis of SDAVF and who underwent treatment at Duke University Hospital between 1/1/1993 and 1/1/2012. We compared the outcome measures by Aminoff-Logue score (ALS) in patients who underwent treatment with endovascular embolization versus surgical ligation of fistula. We compared complication rates; recurrence rates as well as data on long term follow up in these patients.

Results: Out of total 27 patients in the study, 10 patients underwent endovascular embolization (Onyx was used in 5 patients and NBCA in 5 patients) as the first line therapy. 17 patients underwent surgical ligation as initial therapeutic modality. Patients in both groups showed significant equivalent improvement in clinical status (ALS) after treatment. 1 patient in endovascular group developed spinal infarction due to accidental embolization of medullary artery. 3 patients in embolization group (onyx) had recurrence of fistula during the course of follow up requiring surgical ligation. 2 patients in surgical group developed local wound infection.

Conclusions: Endovascular embolization and surgical ligation are both effective treatment strategies for SDAVF. Endovascular approach with onyx is associated with higher incidence of recurrence, as compared to NBCA. In our cohort, surgical ligation was associated with higher incidence of post-operative infection rate as compared to endovascular approach.

Community Hospitals within a Regional Stroke Network can Safely Administer Intravenous Recombinant Tissue Plasminogen Activator (IV r-tPA) in Acute Ischemic Stroke

Paul A. Hansen, MD; Alexander Venizelos, MD; Abhi Pandhi, MBBS: Ryan Gianatasio, MD; Debbie Roper, RN MSN; Alex Roland, RN; Jeff Coulson, RN; Scott Robbins, MD; Vallabh Janardhan, MD

Background: Despite FDA approval in 1996, the use of IV r-tPA in acute ischemic stroke remains relatively low (3-4%) partly because of the concerns for symptomatic intra-cerebral hemorrhage (6-12%).

Methods: A Comprehensive Stroke System of Care was developed in 2010 and included 5 certified stroke centers. Standardized emergency department-based (ED) algorithms were implemented and stroke coordinators tracked protocol violations. ED physicians administered IV r-tPA with vascular neurology expertise via Tele-phone or via Camera. IV r-tPA usage was identified based on procedure codes for intravenous thrombolytic administration on in-patient hospital discharges from 2008 to 2012. Symptomatic intra-cerebral hemorrhage was defined based on the ECASS criteria.

Results: A total of 6,311 patients were hospitalized with acute ischemic stroke over 5-year period. The IV r-tPA usage rates increased from 7.10 % in 2008 to 13.13 % in 2012 and the associated symptomatic intra-cerebral hemorrhage rate dropped from 4% in 2008 to 1% in 2012.

Conclusion: Community hospitals within a regional stroke network can safely administer IV r-tPA with low rates of symptomatic intra-cerebral hemorrhages comparable to the results of controlled clinical trials.

Carotid Siphon Calcification Impact on Reperfusion and Outcome in Stroke Intervention

Diogo Haussen, MD, Brandon Gaynor, MD, Jeremiah Johnson, MD, Eric Peterson, MD, Mohamed Elhammady, MD, Mohammad Aziz-Sultan, MD, Dileep Yavagal, MD

Departments of Neurology and Neurosurgery
University of Miami Miller School of Medicine /Jackson Memorial Hospital – Miami, FL - USA

Purpose: The degree of coronary artery calcification has been shown to predict outcomes in coronary artery disease. The impact of intracranial carotid artery calcification on the prognosis of acute ischemic stroke (AIS) is unknown. We sought to examine if the degree of intracranial carotid artery calcification influences reperfusion or outcomes in AIS intervention.

Materials-and-Methods: We retrospectively reviewed all anterior circulation large vessel occlusion AIS cases that underwent intra-arterial therapy from January 2009 to July 2012. Clinical and radiographic data was collected. Non-contrast brain CT scans were assigned a Calcium Extent Score (degree of calcification of the carotid wall circumference), Calcium Thickness Score (thickness of the calcified plaque), and total Carotid Siphon Calcium (CSC) Score (8-point scale).

Results: One hundred eighteen patients met inclusion criteria. The mean age was 65.4±15.6 years and 36% were female. Calcification was present in the intracranial carotid artery of 84 patients (71%). Inter-rater agreement for total CSC score was strong (Spearman's rho=0.883, $p<0.001$). The mean Calcium Extent Score was 1.5±1.3, Calcium Thickness Score 1.3±1.0 and total CSC Score 2.8±2.2. Reperfusion and mRS were not associated with CSC. Multivariate linear regression analysis revealed that older age, history of coronary disease and cervical internal carotid occlusion/near-occlusion were independently associated with higher total CSC scores.

Conclusion: Extensive calcification on the intracranial carotid artery does not have impact on reperfusion or clinical outcomes in AIS patients undergoing endovascular therapy. Higher CSC scores are associated with coronary artery disease, increasing age and cervical internal carotid artery occlusion/near-occlusion.

Medical and Endovascular Treatment of Posttraumatic Bilateral Carotid and Right Vertebral Artery Injury: Case Report with 4-year Follow up and Review of Literature

Takamasa Higashimori, David Kumpe

Choice of appropriate medical and endovascular treatment of traumatic cervical vascular injury is still controversial. CADISS trial is still ongoing to compare anticoagulation and antiplatelet agents for prevention of stroke after carotid and vertebral artery dissection. We present this case of blunt cervical vascular injury complicated with embolic stroke, with 4 year follow up to assess effective treatment and outcome of the patient.

48 year-old healthy female presented with blunt cervical injury after being involved in a T-bone motor vehicle crash while sitting in a passenger seat. Exam revealed transient tongue numbness with dysarthria, which resolved in ED. While initial CTA neck showed only mild R ICA dissection, repeat CTA revealed significant increase in the size of pseudoaneurysm (PA) of R ICA dissection, as well as new small dissections/PAs of the L ICA and R vertebral artery (RVA). The PA in the L ICA extended proximally from its neck, resulting in prolonged contrast stasis in the proximal end of the PA. R ICA stent was placed due to continued worsening of dissection, and coumadin was replaced by plavix post-stent placement.

12 days post-stent placement, she presented with acute onset of nonfluent aphasia, and CTA/MRI revealed L MCA stroke with distal L M1 occlusion, which was treated with IA ReoPro. Thrombus was now present in the region of contrast stasis in the PA. L ICA stent was placed 9 days later after confirming autolysis of thrombus with heparin gtt. Nine weeks later, RVA was stented without complications. No restenosis, PA or thrombus formation was noted on four followup arteriograms over the next 4 years with excellent clinical outcome (mRS=1).

This case suggests the use of anticoagulation over antiplatelet agents may be beneficial in a subset of patients with cervical PA with an angiographic evidence of contrast stasis, which can increase the risk of thrombus formation. In addition, endovascular stent placement is a safe and effective long-term option for treating posttraumatic cervical artery dissection and PA.

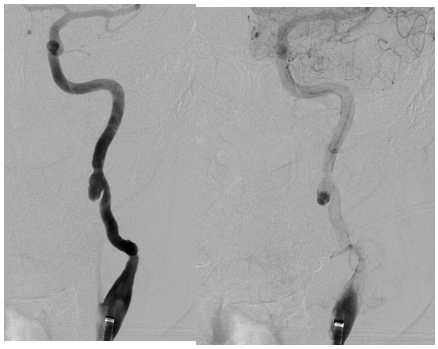


Figure 1

Figure 3

Figure 1

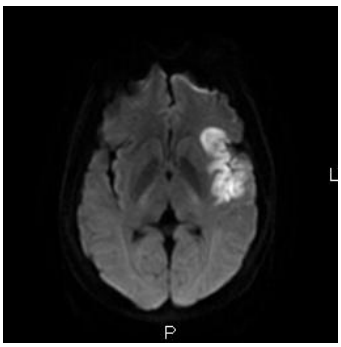


Figure 2

Figure 1: L ICA angiography. Prolonged contrast stasis in pseudoaneurysm

Figure 2: L ICA angiography at the time of stroke. Thick arrow indicates a small thrombus in pseudoaneurysm, and embolic occlusion at anterior temporal artery (thin arrow).

Figure 3: Bilateral cervical aneurysm and pseudoaneurysm in 3D reconstruction of CT angiography

Figure 4: Diffusion-Weighted image at the time of stroke

Are Flow-Diverters the Current Best Treatment Option for Ruptured Blister Like Aneurysms?

Steven Hoover, Sam Safavi-Abbasi, Ankur Garg, Scott Saucedo

Introduction: The term "blister aneurysm" or "blood blister aneurysms" (BBAs) has been used to describe broad-based aneurysms arising from non-branching sites of the supraclinoid internal carotid artery. Histologically, these lesions have been shown to represent focal wall defects covered with thin, fibrous tissue and adventitia, lacking the usual collagen layer. These lesions are often extremely challenging to treat and their optimum treatment modality is still not known. Compared with saccular aneurysms in similar locations, these lesions tend to have a more precipitous course as they are reported to rapidly enlarge and rebleed, sometimes even after treatment. The objective of this study was to analyze the past and current therapeutic modalities for the treatment of these lesions.

Methods: A PubMed search using following search terms: blister aneurysm, blood blister aneurysms, and dorsal internal carotid artery wall aneurysms. These studies were then extensively reviewed for the treatment utilized.

Results: Following microsurgical techniques have been described in the literature: clipping with or without wrapping and extracranial-intracranial bypass with trapping of the internal carotid artery. Following endovascular techniques have been described: coiling, stent-assisted coiling, telescoping stents with our without coiling, endovascular parent vessel sacrifice, and most recently the use of flow diverters (Pipeline embolization device and SILK). Combination microsurgical and endovascular treatments are also reported.

Discussion: Given the recent success with stent-in-stent techniques and the hazardous histology of blister aneurysms, endovascular treatment with flow-diverters may be the current best endovascular treatment of these lesions. However, long term outcome data especially in the setting of acute subarachnoid hemorrhage and/or intraventricular drains, is warranted.

Labeled and Off-labeled Indications and Locations for the Placement of Flow Diverters Across the World: A Review of Literature

Steven Hoover, Sam Safavi-Abbasi, Ankur Garg, Scott Saucedo, Islam Tafish

Introduction: Flow diverters are new-generation endoluminal devices designed to treat aneurysms by diverting the blood flow away from the aneurysm thus creating an environment conducive for intra-aneurysmal thrombosis and eventual exclusion of the aneurysm. Two flow-diverters are currently available for commercial use: Pipeline embolization device (PED; ev3, Irvine, California) and SILK (Balt Extrusion, Montmorency, France). As per the Instructions for Use (IFU) flow diverters are indicated for the endovascular treatment of adults (22 years of age or older) with large or giant wide-necked intracranial aneurysms in the internal carotid artery from the petrous to the superior hypophyseal segments. However, since introduction these devices have been extensively used for treatment of posterior cerebral circulation lesions, as well as distally located lesions in the anterior intracranial circulation. The objective of this literature review was to analyze the labeled as well as off-labeled uses of flow-diverters in terms of placement locations and indications across the world.

Methods: PubMed search was performed using following search words: Pipeline embolization device (97 results), Pipeline stent (81 results), silk stent (56 results), silk flow diverter (20 results), and flow diverter (103 results). These studies were then reviewed for indication and location of the flow diverter placement.

Results: Flow diverters were found to have been placed in following anatomical locations: internal carotid cervical segment, internal carotid petrous segment, internal carotid cavernous segment, internal carotid supraclinoid segment, posterior communicating artery, anterior cerebral artery A1 segment, anterior cerebral artery A1/A2 segments, anterior communicating artery, middle cerebral artery M1 segment, middle cerebral artery bifurcation, middle cerebral artery proximal M2 segment, intracranial vertebral artery, posterior inferior cerebellar artery, basilar artery, superior cerebellar artery, posterior cerebral artery P1 segment, and posterior cerebral artery P2/P3 segments. Analysis of indications for use revealed use of flow diverters for treatment of unruptured and ruptured aneurysms, especially aneurysms with fusiform or blister configuration, giant aneurysms, recurrent aneurysms, aneurysm that have failed other treatments, and dissecting and traumatic intracranial aneurysms. Other indications included direct carotid-cavernous fistulas, spontaneous dissections with pseudoaneurysms, a case of middle cerebral artery compromise following surgical clipping of internal carotid terminus aneurysm, a case of flow diverter use as rescue therapy to treat dissection and vessel perforation following angioplasty

of the basilar artery, and a case of telescoped flow diverters in the management of symptomatic chronic carotid occlusion.

Conclusion: Flow diverters continue to have wide-spread use as per their original intended indication. However a review of literature revealed their wide-spread evolving use for additional indications and locations. Further studies and reviews will be needed to determine the efficacy and safety of these devices in these extended indications.

ADAPT Technique Clinical Experience in Stroke Thrombectomy at Lutheran Medical Center

Nazli Janjua MD[1], Jeffrey Farkas MD[1,2,3], Karthikeyan M. Arcot MD[1], Daniel E. Walzman MD[2,3] Rajesh Kumar MD[1], Jean Delbrune MD[1], Nikolaos Papamitsakis MD[1], Yevgeny Margulis MD[1,] Subasini Dash MD [2],Kenneth A. Levin MD[3,] Salman Azhar MD[1]

[1]Lutheran Medical Center, Brooklyn, NY, [2]Hackensack University Medical Center, Hackensack, NJ, [3]The Valley Hospital, Ridgewood, NJ

Purpose: The new material composition and larger, tapered lumen of the Penumbra MAX microcatheters are designed to improve navigation and enhance aspiration, permitting the 'ADAPT' technique (aspiration thrombectomy without the use of a separator). We sought to report our outcomes using this technique with the prior (5 MAX) and newer (5 MAX ACE) generation Penumbra devices.

Methods: Demographic, clinical, and radiographic data from 21 consecutive acute stroke cases treated with 5MAX ACE (n=7) and 5MAX (n=14) from September 2012 through July 2013 were collected.

Results: Mean age was 74 ± 12 years; median admission National Institutes of Health Stroke scale score (NIHSSS) was 18 (8- 29). Occlusions were in the middle cerebral artery (MCA) M1/M2 (n=13), internal carotid artery (ICA) or ICA/MCA (n=5), and vertebrobasilar arteries (n=3). All patients presented with thrombolysis in cerebral ischemia (TICI) 0 or 1. No adjuvant devices were used. Median discharge NIHSSS was 6 (0- 29). No complications occurred. One death due to cardiac arrest occurred 15 days post-procedure.

All 5MAX ACE patients achieved TICI 2b/3, while 86% of 5MAX patients did. Puncture to revascularization time was 38 min with the 5MAX ACE and 88 min with the 5MAX. First diagnostic angiogram to revascularization time was 22 min with the 5MAX ACE and 46 min with the 5MAX.

Conclusions: The ADAPT technique yields high rates of revascularization with minimal vessel trauma and resultant hemorrhage. Newer devices further improve on efficiency of revascularization. As ongoing experience accrues, larger studies should be performed to verify these findings.

A Novel Approach to Diagnose Reversible Cerebral Vasoconstriction Syndrome (RCVS): A Case Series

Kass-Hout T, Kass-Hout O, Sun CH, Kass-Hout T, Nahab F, Nogueira R, Gupta R

Background and purpose: Reversible cerebral vasoconstriction syndrome (RCVS) is classically a clinical diagnosis with vascular imaging showing vasoconstriction of the cerebral vasculature. We present a diagnostic test that may assist in the clinical diagnosis and facilitate treatment.

Methods: From October 1, 2010 to July 1, 2013 we identified consecutive patients who presented with a presumptive diagnosis of RCVS and underwent cerebral diagnostic angiogram with intra-arterial vasodilator therapy. Medical records including clinical presentation, radiographic and angiographic images were all reviewed.

Results: We identified a total of 6 patients (Four females, age range 37-56; mean 49 years) who met our inclusion criteria. Four patients received a combination of Milrinone and Nicardipine infusion either in the internal carotid arteries (ICA) or in the left vertebral artery (VA); the remaining of the patients received IA therapy solely with Nicardipine. Four patients had a positive angiographic response, defined as significant improvement or resolution of the blood vessels irregularities. All four patients had a definite discharge diagnosis of RCVS. The remaining two patients had a negative angiographic response, based on their clinical and radiographic course both had a final diagnosis of intracranial atherosclerotic disease (ICAD).

Conclusion: Our small case series suggest that Intra-arterial (IA) administration of vasodilators is safe and may aid in distinguishing vasodilator responsive syndromes from other pathologies. Further study is required with long term clinical outcome to determine the utility of this diagnostic test.

Clinical, Angiographic, and Radiographic Outcomes Differences Amongst Mechanical Thrombectomy Devices: Initial Experience of a Large-Volume Center

Kass-Hout T, Kass-Hout O, Sun CH, Kass-Hout T, Belagaje SR, Anderson AM, Frankel MR, Gupta R, Nogueira RG.

Short title: Effectiveness of New Generation Mechanical Thrombectomy in Stroke Therapy.

Background and Purpose: Time dependent reperfusion has been established with endovascular treatment of acute ischemic stroke (AIS). There are limited data on the comparative performance of FDA cleared devices for mechanical thrombectomy. Here, we compare the angiographic, radiographic, and clinical outcomes amongst the three device categories currently available in the U.S.

Methods: Retrospective review of endovascularly treated large vessel AIS in a large academic center. Data from all consecutive patients who underwent clot retrieval using Merci, Penumbra, or Stent-Retrievers (SR) from September 2010 to November 2012 was collected. Baseline characteristics, rates of successful recanalization (TICI 2b-3), symptomatic intracebral hemorrhage (sICH), final infarct volume, 90-day mortality, and independent functional outcomes at 90 days were compared across the 3 groups.

Results: The entire cohort included 287 patients. There were no statistically significant differences in the rate of sICH (7% vs. 7% vs. 6%, P=0.921) and infarct volume (66.9 vs. 69.5 vs. 59.8, P=0.621) between the SR, Merci and Penumbra respectively. Better functional outcomes were found with Penumbra and SR vs. Merci (41% vs. 36% vs. 25% respectively, P=0.079). Complete or near complete (TICI2b/3) reperfusion was higher in the SR and penumbra groups compared to the merci (86% vs. 78% vs. 70% respectively, P=0.027). A binary logistic regression showed that SR was an independent predictor of good functional outcome (OR, 2.27; 95% CI, 1.018 to 5.048; P=0.045).

Conclusion: Although our initial data confirms the superiority of SR technology over the Merci device, there was no significant difference in near complete/complete reperfusion, final infarct volumes, or clinical outcomes between SR and Penumbra thrombo-aspiration.

Simultaneous Endovenous Hypothermia and Intra-Arterial Thrombectomy is Feasible in Patients with Acute Ischemic Stroke

Cynthia Kenmuir, MD, PhD, Kees Polderman, MD, Edilberto Amorim, MD, Ashutosh Jadhav, MD, PhD, Ramesh Grandhi, MD, Brian Jankowitz, MD, Lawrence Wechsler, MD, Tudor Jovin, MD and Guillermo Linares, MD

Background: Hypothermia is a promising neuroprotectant and may ameliorate reperfusion injury. Easy access to the femoral vein allows it to be combined with intra-arterial therapy.

Methods: Consecutive patients with acute ischemic stroke receiving intra-arterial therapy were studied. A femoral arterial sheath and femoral venous catheter were placed for hypothermia induction with cold saline infusion. Goal temperature prior to reperfusion was 35°, followed by 32° for a total of 24 hours. Patients were rewarmed at 0.2°/hour.

Results: Twenty-two patients were studied, five were women. Median age was 62 (range 47 – 80), NIHSS was 15 (13 – 32), time from last known well was 4 hours (1 – 10), and ASPECTS was 8 (7 – 10). There were no groin complications. There were four intubations unrelated to the procedure. Five patients developed pneumonia. One patient was diagnosed with a DVT and one with a PE. Symptomatic hemorrhage occurred in two patients (7.6%). Six patients died (27%), four after withdrawal of care. Eleven patients were discharged to rehabilitation (50%) and five to skilled nursing facilities (22.7%).

Conclusions: Combined endovenous hypothermia and intra-arterial therapy for acute ischemic stroke is feasible. There is no increase in symptomatic hemorrhage rates. This data supports the planning of a phase 2 trial to optimize temperature goals and length of the intervention.

Individuals Aged ≥70 years with Aneurysmal Subarachnoid Hemorrhage: Functional Outcome and 10-years' Survival

Karl-Fredrik Lindegaard,, Søren Jacob Bakke Wilhelm Sorteberg

We assessed outcome and long-term survival after aneurysmal SAH in individuals aged ≥ 70 years.

Patients and Methods: 122 individuals aged ≥70 years (median 74.3, range from 70 to 85 years, (70 % females) were admitted with proven aneurysmal SAH between 1996 and 2004. 96 patie3nts had aneurysm repair (surgical management - microsurgical: 30, endovascular: 66), whereas 26 patients had no repair (non-surgical): 15 of whom were denied on grounds of age alone. There was no significant difference (p>0,3) as to Clinical grade, GCS, CT score (Fisher).and aneurysm size (p>0,11) between surgical and non-surgical patients.

Results: The 90-days mortality in surgical patients was 21/96 (22%; CI95: 14-32 %), and in non-surgical ones 22/26 (86%; CI95: 65% to 96%)- 27 patients were alive on June 30, 2013, at median 120 months after SAH.

The 15 non-surgical patients denied aneurysm repair due to age were on the average 2 years older than the 96 surgical ones, with correspondingly fewer expected remaining life years (p=0,04)- Nevertheless, their loss of expected life years from SAH exceeded the age difference: 2,6 years (p=0,29).

At median 30 months after SAH, all 67 survivors (fluent in the Norwegian) were invited to participate in the study, and received self-assessment health status questionnaires by mail. The return rate was 91 %. Of survivors, 73% considered their health as "good", "very good" or "excellent"; mars scores of 0, 1 and 2 were reported by 70%; 77% had ADEL-score ≥90; 77% reported living at home; whereas 78% used public transportation with or without aid.

Conclusion: Unless ruptured aneurysms are not repaired, the outlook is grim for individuals aged ≥ 70 years. Following repair, the outcome seems acceptable. We posit that individuals aged ≥ 70 years should not be denied aneurysm repair on grounds of chronological age alone.

Endovascular Repair of the Ruptured Anterior Communication Artery Complex and Wide Neck Aneurysm

Lodi YM, Reddy VV, Devasenapathy A, Swrankar A, Sethi K, Gaylon D and Bajwa S

Introduction: Due to the presence a complex anatomical and a hemodynamic profile at the anterior communication artery (AComA), especially when both A2 segments originate from a single A1 segment of the anterior cerebral artery (ACA), a successful surgical or endovascular repair of AComA aneurysm does not always guarantee good outcome. Surgical clipping not only poses difficulties but also may induce spasm to the ACA leading to stroke despite a successful procedure. Therefore, more aneurysms in AComA are being treated with endovascular technique including complex and wide neck aneurysms.

Objective: Objective of our study is to report our experiences of endovascular repair of ruptured AComA aneurysms including wide neck and complex aneurysms.

Methods: From prospectively maintained aneurysm data base consecutive patients with the diagnosis of ruptured AComA aneurysms who underwent with endovascular coiling from July 2007 to July 2009 were enrolled. Patients' demographics including Hunt and Hess (H&H) grade, fisher scale, procedure related complication and outcome were collected.

Results: 54 patients with mean age of 52 ± 14 years old were diagnosed with AComA ruptured aneurysm underwent successful endovascular repair of their aneurysm 21/54 (49% wide neck and complex) in nature. History of hypertension was present in 30, smoking in 40, family history of stroke in 9 and prior stroke 1 patient. H&H V was present in 3 (5%), IV in 12 (22%), III in 16 (30%), II in 15 (28%) and I in 7 (13%). Fisher 4 was present in 25 (46%), 3 in 15 (28%), 2 in 6 (11%) and 1 in 9 (17%) of patients
28/51 (55%) required ventriculostomy catheter 18 (35.3%) before and 10 (19.6%) after the coiling procedure. Procedure related morbidity was observed in 3/54 (5.5%) without mortality or permanent disability. Intraoperative rupture of aneurysm as manifested by the extravasations on the angiogram without any clinical manifestations (dilated pupils or increased blood pressure) was observed in two wide neck cases which resolved with subsequent coils placement . First case was a 74 years old woman who presented with H&H II and Fisher 3 and achieved GOS 5. The second case was a 46 years old woman with H&H II and Fisher 4 who achieved GOS 4. Right middle cerebral artery occlusion was observed in a 56 years old woman during coiling who presented with H&H II and Fisher 4. The MCA was completely revascularized using 2 mg TPA and MERCI retrieval device. Post procedure examination was non-focal and achieved GOS 5 in 30 days. Complete obliteration of aneurysms was observed in 31 (57%) and near complete in 21 (39%) and subtotal in 2 cases (4%). 30 days good outcome was observed in 72% of cases (GOS 5 in 27 (50%), GOS 4 in 12 (22%), GOS 3 in 8 (15%) and poor outcome GOS 1 (dead) in 7 (13%). Poor outcome and disabilities was associated with high H&H grade.

Conclusions: Endovascular coiling to repair ruptured AComA could be offered in most of the cases including those with wide neck and complex in nature. The most common but

challenges are intraoperative rupture of aneurysm and thromboembolic event, which could be successfully treated with good outcome

Single Balloon Microcatheter Technique for Coiling Wide Necked Aneurysms: A Case Series

Sonal Mehta, MD, St Louis University Hospital, Connor J Einertson, St Louis University Hospital, Randall Edgell, MD, St Louis University Hospital

Introduction: Coil embolization of wide necked cerebral aneurysms frequently requires the use of stents and temporary occlusion using non-detachable compliant balloons. The traditional technique of balloon assisted coiling involves the use of two microcatheters, which may be associated with greater thromboembolic complications. We describe a series of coil embolizations performed using a single microcatheter balloon technique to treat wide-necked aneurysms. In this technique the coils were delivered through a balloon microcatheter with a coaxial dual-lumen design with the balloon inflated at the aneurysm neck.

Methods: A retrospective chart review was performed to identify cases in which the Ascent balloon (Codman, Raynham, MA) was used for aneurysm coil embolization as a single balloon microcatheter. Clinical, demographic, angiographic data were obtained.

Results: Five cerebral aneurysms were treated using the single balloon microcatheter technique. Four of these were unruptured whereas one was ruptured. All aneurysms were large (maximum diameter 6 mm or greater), with an average maximum diameter of 7.8 mm, an average neck diameter of 3.5 mm, and average volume of 154.7 mm3. Complete occlusion with coil embolization (RROC I) was achieved in all cases. The average packing density was 42.44%. High PD (>22%) was achieved in 4 cases whereas moderate PD (12-22%) was achieved in one case.

Conclusion: This initial experience demonstrates the feasibility and immediate outcomes of a single balloon microcatheter technique in coil embolization of wide-neck cerebral aneurysms. This technique may be used to achieve high packing density while avoiding permanent stent placement and potentially reducing thromboembolic complications.

Meta-analysis of Reversible Cerebrovascular Vasoconstriction Syndrome WITHOUT Subarachnoid or Intracerebral Hemorrhage

Ghulam Mustafa*, Aman Dabir*, Haris Kamal*, Mufti Owais* , Ping Li*, Mohammed Shafie**, and Han Lee**, Aaron McMurtray**, and Bijal K. Mehta**

* Department of Neurology, SUNY Buffalo, Buffalo, NY 14204
**Department of Neurology, UCLA, Harbor-UCLA Medical Center, Torrance, CA 90509

Background: Reversible vasoconstriction syndrome is a phenomenon where the vasculature of the brain begins to spasm. Although initially thought to be only associated with intracranial and subarachnoid hemorrhage, recently, this has expanded to include non-hemorrhagic states. The etiology and physiology of this type of reversible vasoconstriction syndrome remains to be worked out.

Methods: Our meta-analysis will discuss the demographic, past medical and concurrent medical history, and imaging characteristics, including CT and conventional angiograms of non-hemorrhagic cases in the literature. This includes prior studies and cases/case series where data of non-hemorrhagic cases where vasospasm was noted. A review of treatments, including endovascular approaches, will also be discussed.

Results: Similarities and differences from reversible vasoconstriction syndrome associated with hemorrhage will be noted. A discussion of how patients with non-hemorrhagic reversible vasoconstriction syndrome are managed.

Conclusion: Reversible vasoconstriction syndrome may present differently in patients without associated subarachnoid or intracranial hemorrhage.

Effect of Clot Characteristics on Successful Recanalization with the Solitaire FR Stent Retriever Device in Acute Ischemic Stroke

Maxim Mokin , Simon Morr, Kenneth Snyder, Elad Levy, Adnan Siddiqui

Background: Several studies have addressed the association between thrombus characteristics and efficacy of intravenous and intraarterial revascularization strategies. Current data regarding the value of clot length and Hounsefield unit measurements in predicting successful revascularization with mechanical thrombectomy devices in strokes due to large vessel occlusion are controversial.

Methods: We retrospeci vely reviewed cases of acute ischemic stroke duet o large vessel occlusion (ICA terminus, M1, M2, basilar) treated with Solitair FR stent retriever. We collected data on thrombus location, length, Hounsefield unit values, and clot burden score. Their association with successful revascularization (defined as TICI 2B or 3) was analyzed using Student's T and Wilcoxon tests as appropriate.

Results: We identified a total of 54 patients. No significant difference was found between clot length, location, or average Hounsefield unit values in cases with successful recanalization compared to those without.

Conclusion: Our data do not support the use of clot length and Hounsefield unit values in the acute decision making process in the setting of acute large vessel occlusion strokes.

Stenting and Angioplasty of Small Cerebral Arteries in Symptomatic Intracranial Atherosclerotic Disease

Emad Nourollah-Zadeh, MD, MSc, Alicia Castonguay, PhD, Junaid Kalia, MD, Brian-Fred Fitzsimmons, MD, Marc Lazzaro, MD, John Lynch MD, Osama O. Zaidat, MD, MS

Background: Intracranial atherosclerotic disease (ICAD) is a common cause of stroke with poor natural history despite medical therapy. Symptomatic ICAD in distal intracranial arteries is a poorly studied topic. In medically refractory patients, alternative treatment includes angioplasty with or without stenting; here we characterize feasibility and safety of using these endovascular interventions.

Method: We reviewed personal logs and financial data information to identify patients who were treated for small artery ICAD (stenosis > 50%) using angioplasty ± stenting. Small cerebral artery was defined by diameter ≤ 2 mm or any of branches distal to large intracranial vessels (i.e. distal to ICA, M1, A1, Vertebrobasilar trunk). Patient characteristics, clinical manifestation, treatment, hospital course and follow up data were collected and analyzed.

Results: Ten patients (12 arteries) were treated with either primary balloon angioplasty (58.3%) or angioplasty with stenting (41.6 %) with 100% technical success rate. Mean pre-treatment stenosis was 79.9% while mean post-treatment stenosis was 19.0%. There were no major peri-procedural complications including symptomatic intracranial hemorrhage or mortality; three patients had stable groin hematoma. Patients were followed for mean total of 18.6 months with only one symptomatic restenosis following a primary angioplasty that was re-treated successfully with stenting. All patients had good functional outcome with mRS of either 0 (80%) or 1 (20%) during the follow up.

Conclusion: In our case series, treatment of symptomatic small artery ICAD with angioplasty ± stenting was safe and effective. These interventions should be considered as an alternative in patients refractory to medical therapy.

Figures

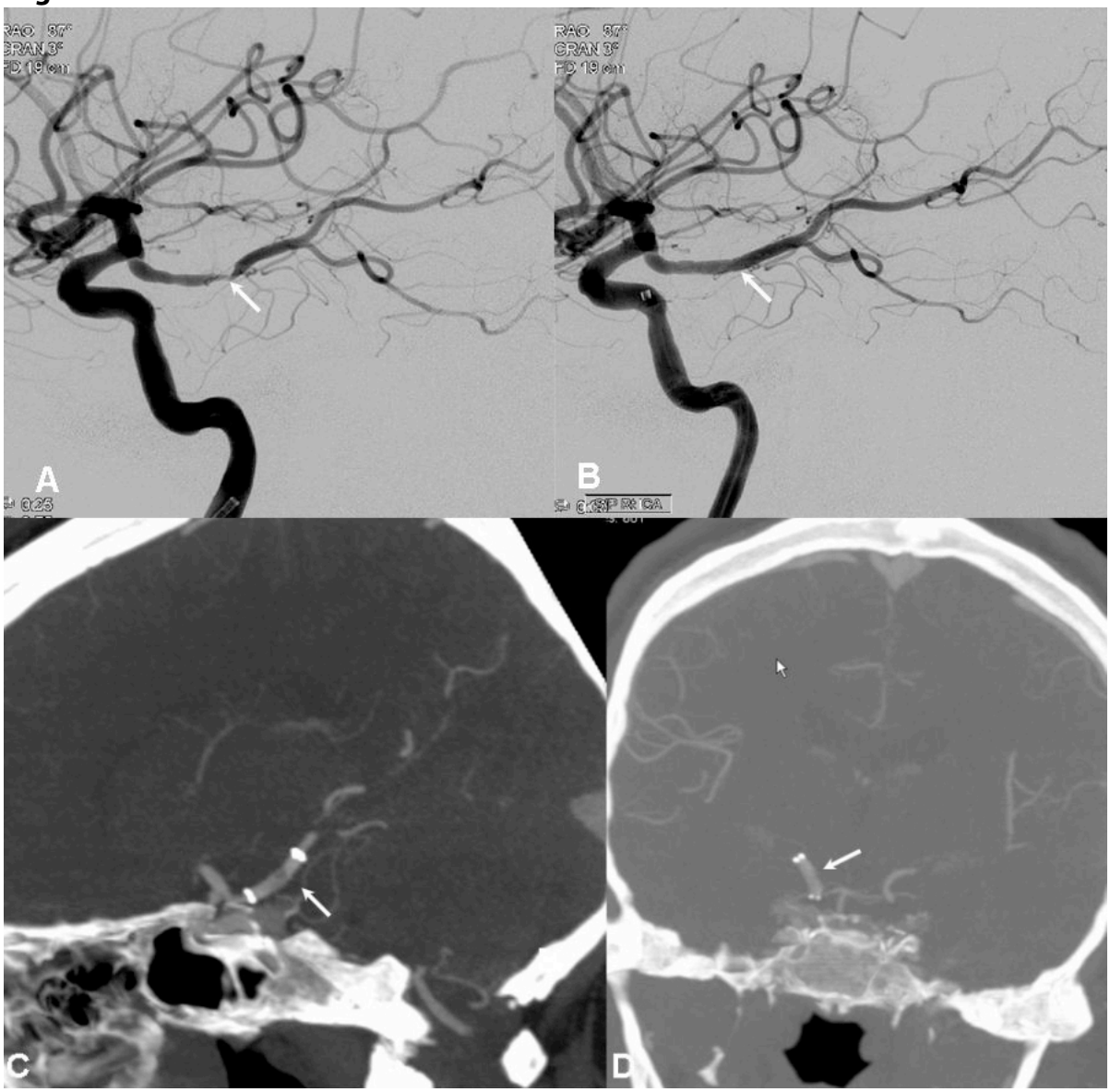


Figure 1: 64-year-old male presenting with visual disturbances and disequilibrium was found to have a ≥ 80% stenosis of right P2 on DSA (*A, arrow*). Patient's symptoms resolved post-PTAS with minimal (~10%) residual stenosis (*B, arrow*). After 11 months, follow-up CT Angiography shows mild intimal hyperplasia on sagittal and coronal views (*C and D, respectively; arrows*).

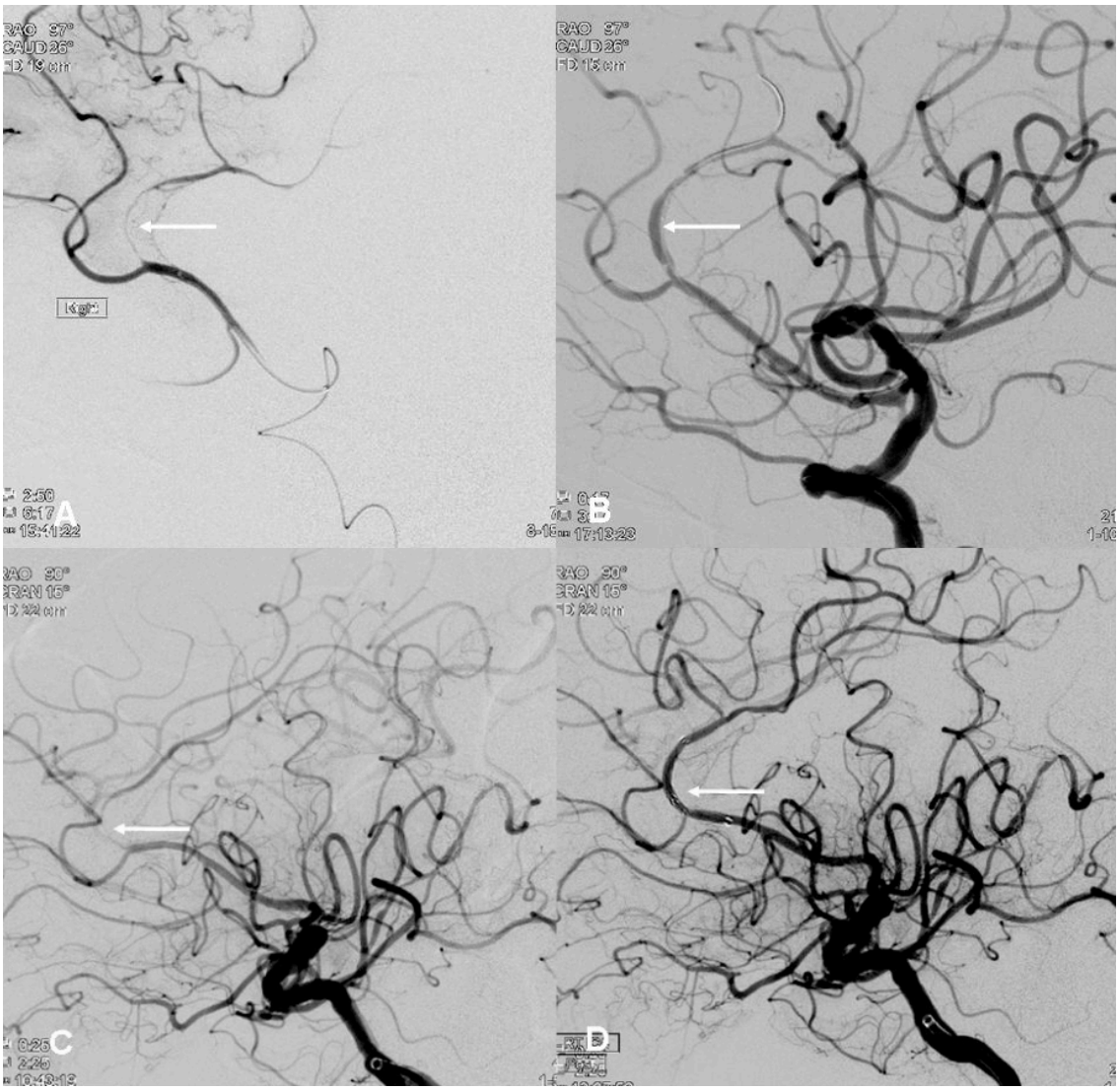


Figure 2: 85-year-old female presenting with left lower extremity shaking was found to have >95% of right A3 portion of anterior cerebral artery (*A, arrow*). Despite aggressive medical management patient continued to have recurrent symptoms and underwent successful primary balloon angioplasty (*B, arrow*). However, patient returned with symptomatic restenosis (> 95%) after 1 month (*C, arrow*) and subsequently underwent PTAS through deployment of two Wingspan stents in a telescoping fashion into the right A3 lesion. Final angiography revealed minimal residual stenosis (*D, arrow*).

Figure 3: A 65-year-old female with right lower extremity weakness was found to have small left thalamic and posterior internal capsule infarcts along with 67% stenosis in left P2 segment of posterior cerebral artery as shown in lateral and frontal views of selective left vertebral DSA (*A and B, respectively; arrows*). Patient underwent successful PTAS with Wingspan system with resultant 14% residual stenosis as seen on frontal and lateral views (*C and D, respectively; arrows*).

Tables

Case #	Age/ Sex	Comorbidity	Site	Stenosis (%) Pre-	Post-	Time of onset to Tx	Balloon (mm)	Stent	Complication	Last Follow Up Imaging	Last Follow Up Clinical	Aspirin + Plavix duration
1	64/ M	HTN, HLD	P2	80	10	3 days	Gateway 2 x 9	WS 3.5 x 15	None	11 months, patent with intimal hyperplasia	11 months, mRS 0	3 days, Plavix & Warfarin
2.1	85/ F	HTN, TIA	A3	99	10	1 month	Gateway 1.5 x 9	None	None	2 months, 95% re-stenosis	2 months, mRS 1 (intermittent Sx)	Indefinite
2.2	85/ F	HTN, TIA	A3	99	10	2 months	Gateway 2.5 x 15	WS 3.5 x 9	None	1 month, patent	12 months, mRS 0	Indefinite
3	65/ F	HTN, HLD, CAD, Stroke	P2	67	14	3 months	Gateway 2.5 x 15	WS 3 x 15	None	68 months, patent	68 months, mRS 0	Indefinite
4	56/ M	HTN, HLD, CAD, TIA	A3	55	20	1 month	Gateway 2 x 9	None	None	1 month, patent	33 months, mRS 1	3 days, Aspirin only
5.1	38/ F	HTN, DM, HLD, CAD, Stroke	P2	95	20	2 weeks	Gateway 2 x 15	None	Groin Hematoma	14 months, <50% restenosis	14 months, mRS 0	Indefinite
5.2	38/ F	HTN, DM, HLD, CAD, Stroke	P2	55	20	2 weeks	Gateway 15 x 15	None	Groin Hematoma	14 months, <50% restenosis	14 months, mRS 0	Indefinite
6	76/ F	HTN, DM, HLD, TIA	A2	80	20	4 months	Maverick 1.5 x 9	None	None	None	2 months, mRS 0	2 months (Plavix daily)

								15		hyperplasia		
8	75/ F	HTN, HLD, TIA	PIC A	75	20	6 months	Gatewa y 2 x 9	None	Groin Hematoma	5 months, patent	5 months, mRS 0	3 months (Aspirin daily)
9	75/ M	HLD	M2/ M3	99	30	3 days	Maveri ck 1.5 x 9	None	None	21 months, <50% re-stenosis	22 months, mRS 0	Indefinite
10	49/ M	HTN, HLD, TIA	P2	80	35	1 month	Gatewa y 1.5 x 15	WS 3 x 15	None	11 months, 45% restenosis	11 months, mRS 0	Indefinite

Table 1. Summary of characteristics, stenosis, treatment and follow up in patients with small artery intracranial atherosclerotic disease. Abbreviations: CAD, Coronary Artery Disease; DM, Diabetes Mellitus; HLD: Hyperlipidemia; HTN, Hypertension; TIA, Transient Ischemic Attack; WS, Wingspan.

Comparison of Large Vessel Stroke Patient Outcomes Before and After Initiation of On-site Endovascular Stroke Treatment Services

Yamin Shwe, Santiago Ortega-Gutierrez, Ahmed Otokiti, Srikar Jonna, David Altschul, Srinivasan Paramasivam, Alejandro Berenstein and Johanna T. Fifi

Rational: Availability of an on-site endovascular program for large vessel stroke decreases the time to acute treatment. Since expanding our program to a Manhattan hospital in July 2009, we have seen a decreased time to treatment. We hypothesize that the expansion was associated with improved discharge outcomes in patients with anterior circulation large vessel strokes.

Methods: A retrospective chart review of consecutive patients before and after the initiation of the program was conducted. Adults presenting to the hospital with an NIHSS greater than 8, within 6 hours from stroke onset, and with carotid terminus or middle cerebral artery occlusion were included. Exclusion criteria were INR or creatinine >3 and premorbid modified Rankin score (MRS) >1. Comparison was made between the groups before and after initiation of the program. MRS, disposition, mortality and MRI stroke volume were selected as discharge outcomes. Logistic regression was performed and $P<0.05$ being statistically significant.

Results: 70 patients were included in the study. 30 were admitted before July 2009 and 40 after. There was no difference between patient demographics. Only 3/30 patient received endovascular treatment prior to July 2009 versus 34/40 after that. Patients admitted after availability of on-site endovascular treatment were less likely to be dependent (OR: 0.14; 95% CI: 0.019-1) or discharged other than home (OR: 0.233; 95% CI: 0.062-0.876) after adjusting for age and admission NIHSS. In addition there was a significant increase in median admission-discharge NIHSS change in patients treated after July 2009 ($p=0.007$).

Discussion: For every 30 minutes until reperfusion, the probability of good recovery after a large vessel stroke is decreased by about 10%. Transfer delays may impede or limit the benefit of endovascular recanalization. In the absence of strategic air transportation systems, rapid deployment of an endovascular team might decrease the time to recanalization and improve patient outcomes.

Single-Center Retrospective Experience with Stentrievers in Acute Ischemic Stroke Treatment

Pankajavalli Ramakrishnan, MD, PhD, Chung-Huan J. Sun, BS, Michael R. Frankel, MD, Aaron M. Anderson, MD, Sameer R. Belagaje, MD, Fadi Nahab, MD, Rishi Gupta, MD, and Raul Nogueira, MD, Marcus Stroke and Neuroscience Center, Grady Memorial Hospital, Atlanta, GA

Introduction: Stentrievers have been approved by the FDA for use in mechanical thrombectomy in the treatment of acute ischemic stroke. High rates of successful reperfusion and improved clinical outcomes using these devices in randomized clinical trials have provided the impetus for supplanting the older generation thrombectomy devices. We present a single-center, retrospective analysis of mechanical thrombectomy with Solitaire FR, and Trevo stentrievers in 202 patients.

Methods: Between June 2011 and August 2013, Solitaire FR or Trevo stentrievers were used in 202 consecutive acute ischemic stroke cases.

Results: Average age of this cohort was 66.7 years with a mean NIHSS of 18.7. 53% received iv tPA before proceeding to IA treatment with stentrievers. ASPECT score was 7 or better in 73%. Solitaire FR or Trevo was the only stentriever used in 54.5%, and 39.1%, respectively, and both were used in 6.4%. The mean duration from last known well to reperfusion was 401.4 minutes. The average time from groin puncture to reperfusion was 76.3 minutes. TICI 2B or better reperfusion rates were achieved in 88.6%. PH1, and PH2 hemorrhagic transformation were noted in 6.5% and 4.5%, respectively. 90 day mRS scores are available for 134 patients as of this submission, and were highly dependent on age, baseline NIHSS, and ASPECT score: mRS of 0-2 in 35.8 % (n=48/134), and mRS of 0-3 in 48.5% (n=65/134).

Conclusion: Stentrievers can be a powerful tool in achieving high rates of successful reperfusion inacute ischemic stroke.

Geographical Location and Transfer Circuits in Acute Stroke Patients Candidates for Endovascular Therapies

Marc Ribo, MD

Introduction: Geographic location may challenge access to endovascular therapies for acute ischemic stroke. Primary transferring potential candidates to centers not offering these therapies may incur in considerable delays. We aimed to study time delays at different points in stroke patients that received endovascular procedures

Methods : Observational, population-based study of consecutive AIS patients treated with any reperfusion modality within 2011 and 2012 in Catalonia (7.5 M inhabitants).

Patients were prospectively included in a health-administration based register with external monitoring of completeness. Inclusion criteria: all patients that received acute endovascular procedures in Comprehensive Stroke Centers (H2), either transferred (TR) from an initial hospital (H1) or primary (PR) admitted to H2.

Results: 571 patients received endovascular treatment, of them 284 received ivTPA before. 208 patients (TR) were initially admitted in H1 and transferred to H2. Mean distance between H1 to H2 was 70 (+/-20) km.

There were no major baseline clinical differences between TR and PR patients. Median time from symptom onset to first admission hospital was (H1: 77min Vs H2: 100 min; p=0.25). TR patients had a significantly longer time from symptom-to- groin puncture (TR 320 Vs PR 240 minutes; p<0.01).

For TR patients, median time from H1-door to H2-door was 185 minutes (IQR 141-217) minutes. Among the 208 TR patients, only 117 (56.3%) received iv-tPA at H1. In the remaining 91 TR patients main predictors of no iv-tPA treatment were: H1 admission> 4.5 hours from symptom onset (89%) and being on anticoagulants (82%).

Conclusion: In acute stroke patients receiving endovascular treatment, inter-hospital transfers may represent a substantial time delay. Clinical algorithms to save time or detect patients who will not benefit from admission in hospitals unable to offer endovascular therapies should be investigated.

Stenting of Symptomatic Extracranial Vertebral Artery Occlusions

Christopher Streib, UPMC, Nima Aghaebrahim, UPMC, Srikant Rangaraju, UPMC, Ashutosh Jadhav, UPMC, Brian Jankowitz, UPMC, Tudor Jovin, UPMC

INTRODUCTION: Bilateral vertebral artery disease can lead to refractory vertebrobasilar insufficiency (VBI). Historically, outcomes in this patient population are poor and optimal treatment remains unclear. The purpose of this study was to assess whether endovascular recanalization of extracranial vertebral artery occlusions (EVAOs) in select patients with VBI led to improved outcomes.

METHODS: In a retrospective analysis of a prospectively collected cohort of patients treated at our center between 2006-2013, we identified patients with VBI secondary to bilateral EVAOs or unilateral EVAO plus contralateral hypoplastic vertebral artery. Six patients who met the aforementioned criteria were treated endovascularly with angioplasty and stenting of an EVAO.

RESULTS: In our series, all six patients were successfully recanalized. Four patients (66%) had a good clinical outcome (mRS 0-2); three had an mRS = 0 at their most recent follow-up (range: 3 months-7 years post-procedure). Two patients (33%) died (brainstem infarct (1), cardiac arrest (1)).

All patients were male between ages 49-63. Two patients had bilateral EVAOs, four patients had an EVAO and a contralateral hypoplastic vertebral artery. Locations of treated vertebral artery occlusions included V1 (3), V2 (1), V3 (2). Indications for treatment included: progressive posterior circulation strokes (4), recurrent TIAs (1), and radiographic evidence of poor collateralization (1).

CONCLUSION: The dichotomy of our results likely reflects both the severity of the disease process as well as the potential for good outcomes. Recanalization of extracranial vertebral artery occlusions should be considered for carefully selected patients presenting with VBI secondary to bilateral vertebral artery disease.

Implementation of an ED-Based Rapid Brain-Attack Triage Algorithm in a Regional Tele-Stroke Network Positively Impacts Treatment Rates for Acute Ischemic Stroke

Alexander Venizelos, MD; Abhi Pandhi, MBBS; Ryan Gianatasio, MD; Sherman H. Chen; Paul A. Hansen, MD; Parita Bhuva, MD; Mark M. Murray, MD; Anita Guthmann, RN BS; Debbie Roper, RN MSN; Mark Whitley, MBA; Vallabh Janardhan, MD

Background: A simplified algorithm for evaluating and triaging brain-attack patients in the emergency department (ED) similar to heart-attack patients can potentially improve treatment rates.

Methods: A simplified 2-step ED-based Rapid Brain-Attack Triage Algorithm was developed as part of our stroke network. The first step includes a non-contrast head CT to distinguish a hemorrhagic stroke from an ischemic stroke. The second step includes identifying the "last known normal (LKN)". The Texas Stroke Institute Rapid Brain-Attack Triage Algorithm was implemented for all Tele-stroke consultations within the regional stroke network. Data was prospectively collected from January 2012 August 2013.

Results: A total of 1,763 Tele-stroke consultations were performed either via the Telephone or via the Camera. The majority of them were stroke patients (1,279/1,763; 73%) and 21% were hemorrhagic stroke patients (370/1763). Among the ischemic stroke patients, 56% (711/1279) presented within 12 hours from LKN and 41% (294/711) received either intravenous r-tPA and/or catheter based mechanical thrombectomy.

Conclusion: A simplified ED-based Rapid Brain-Attack Triage Algorithm as part of a regional Tele-stroke Network is feasible and increases treatments rates in patients with acute ischemic stroke.

Cost Efficiency and Follow-Up Data Using the Penumbra Coil 400 for Treatment of Aneurysms in the Cerebrovascular System

G. Vidal[1], J. Milburn[2], A. Pansara[2], R. Martinez[3]

[1]Neurology, Ochsner Medical Center, New Orleans, LA, [2]Radiology, Ochsner Medical Center, New Orleans, LA, [3]Neurology, Louisiana State University, New Orleans, LA

Purpose: This study was designed to compare the cost effectiveness and treatment stability of the larger diameter Penumbra Coil 400 with the commonly used smaller diameter Orbit/Galaxy coil.

Methods: In a retrospective single center study, 18 consecutive aneurysms treated using the Penumbra coil were compared to 40 treated with Orbit or Galaxy coils from 2010 to February 2012. Aneurysm occlusions based on the Raymond Scale at the time of initial treatment were compared with follow-up studies to evaluate coil stability.

Results: Number of coils per aneurysm volume was 0.026 coil/mm^3 for Penumbra. This was significantly less than 0.114 coil/mm^3 for Orbit/Galaxy. Average packing density of 33.7% for Penumbra was significantly greater than 24.4% for Orbit/Galaxy. Aneurysm occlusion rates at the time of treatment were similar in the 2 groups. Cost analysis estimated a 67% reduced cost for Penumbra coils per volume of aneurysm. Follow-up was available on 14 of the 18 Penumbra aneurysms with an average time of 9.6 months, and stability or improved obliteration was noted in 13. There was one coil migration into mural thrombus which was retreated with additional coiling. Follow-up studies on 25 of the 40 aneurysms treated with Orbit/Galaxy averaging 11.4 months showed stability or improvement in 21. There were 4 that had a worse Raymond class, and one was retreated with stent-coiling.

Conclusions: Aneurysm treatment using the Penumbra Coil 400 results in higher packing density compared to Orbit/Galaxy. The Penumbra coil is more cost effective, and follow-up studies suggest durable occlusions.

Cost Effectiveness for Intra-arterial Stroke Therapy Achieved with Image-based Selection and not with Type of Device

Brenda Reese, MSN[1], Scott Young, RT[1], Kevin Stands, RT[1], Rishi Gupta[2], MD, Jenn Mejilla, DO[1], BJ Hicks, MD[1], Tom Davis, MD[1,3], Peter Pema, MD[1,3], Ron Budzik, MD[1,3], Nirav Vora, MD[1,3]

[1]OhioHealth Neuroscience Institute, Riverside Methodist Hospital, Columbus, OH
[2]Wellstar Neurosurgery, Marietta, GA
[3]Riverside Radiology and Interventional Associates, Columbus, OH

Background: Our aim was to determine if stentriever treatment results in cost effectiveness over Merci thrombectomy and to identify a cost-effective imaging threshold for intra-arterial treatment selection.

Methods: With institutional approval, we retrospectively reviewed patients undergoing intra-arterial stroke therapy from March 2011 to March 2013 at our center. We collected the following data: stroke score, occlusion site, baseline Alberta Stroke Program Early CT Score (ASPECTS), device used, reperfusion, hemorrhage, 90-day modified Rankin Score (mRS), and procedure cost. Using published criteria, a quality-adjusted life year (QUALY) value of 0.74 and 0.4 was ascribed to a mRS outcome ≤ 2 and > 2 respectively. Using the procedural mean cost, we calculated an incremental cost efficiency ratio (ICER) for stentriever versus Merci embolectomy and for interventions done for a baseline ASPECTS above and below the following thresholds: > 6, > 7, > 8, and > 9. Using established criteria, we identified a cost effective patient selection if the ICER was positive and less than $50,000/QUALY.

Results: Our cohort included 122 patients, 45 treated with Merci in the first year and 78 with stentrievers in year two. Reperfusion occurred in 79% (87% in the stentriever and 64% with Merci groups, p=0.002). The good outcome rate for the entire cohort was 40% (43% good outcomes in the stentriever and 33% in the Merci groups, p=0.21) respectively. Stentriever interventions were not cost effective compared to Merci embolectomy (ICER > $500,000/QUALY). Using baseline ASPECTS > 6 and > 7 as a selection criteria for intervention, the good outcome rate was 42% and 44% respectively but with a negative ICER due to higher costs in treating those with lower scores. For those with an ASPECTS > 8 and > 9, the good outcome rate was 44% and 54% with an ICER of $40,000/QUALY and $24,000/QUALY respectively.

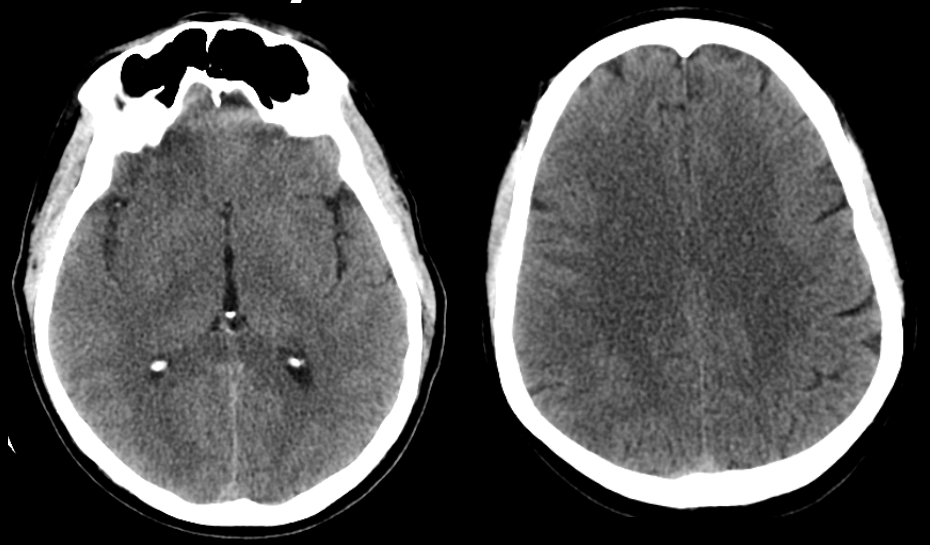
Conclusions: At our institution, despite better outcome and reperfusion rates, stentriever interventions are yet to show a cost benefit. Optimizing patient selection by using the ASPECTS scoring system has led to improved clinical outcomes and cost effectiveness. Further prospective study may validate this technique for greater value to the individual patient and the health system at large.

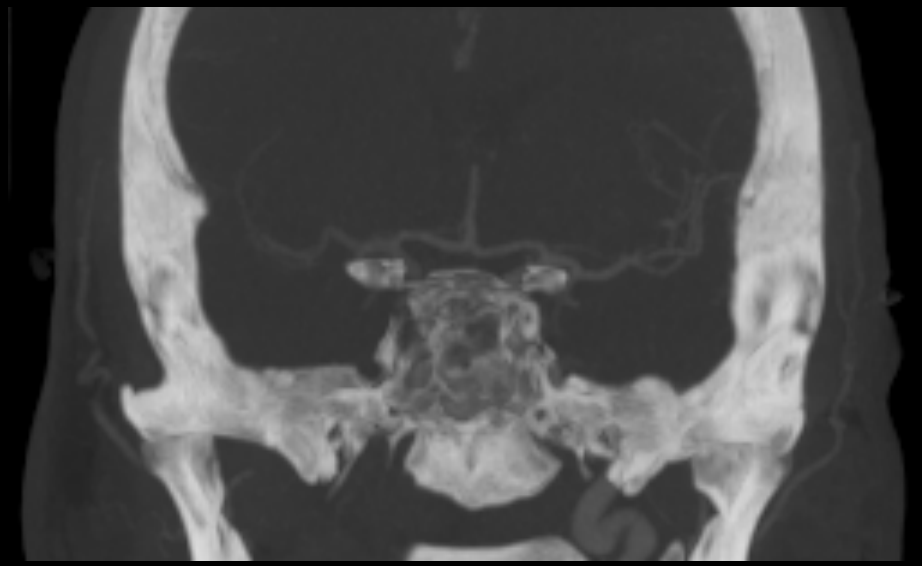
Acute intervention for R MCA infarct complicated by persistent dissection pseudoaneurysm, and stent thrombosis.

Dan-Victor Giurgiutiu
Neurovascular Fellow
UPMC
Pittsburgh, PA

Clinical History

- 44M, who on 7/25/2013 at 22:30 developed confusion, dysarthria, and L sided neglect, progressing to hemiparesis. He was transferred to our facility at 4:30 AM on 7/26/2013 after infarct was identified as a possible cause.
- He presented with a R MCA syndrome, NIHSS 7.
- He had been suffering from occipital headaches for a week prior to presentation, but no focal symptoms.





Baseline Angiographic Findings

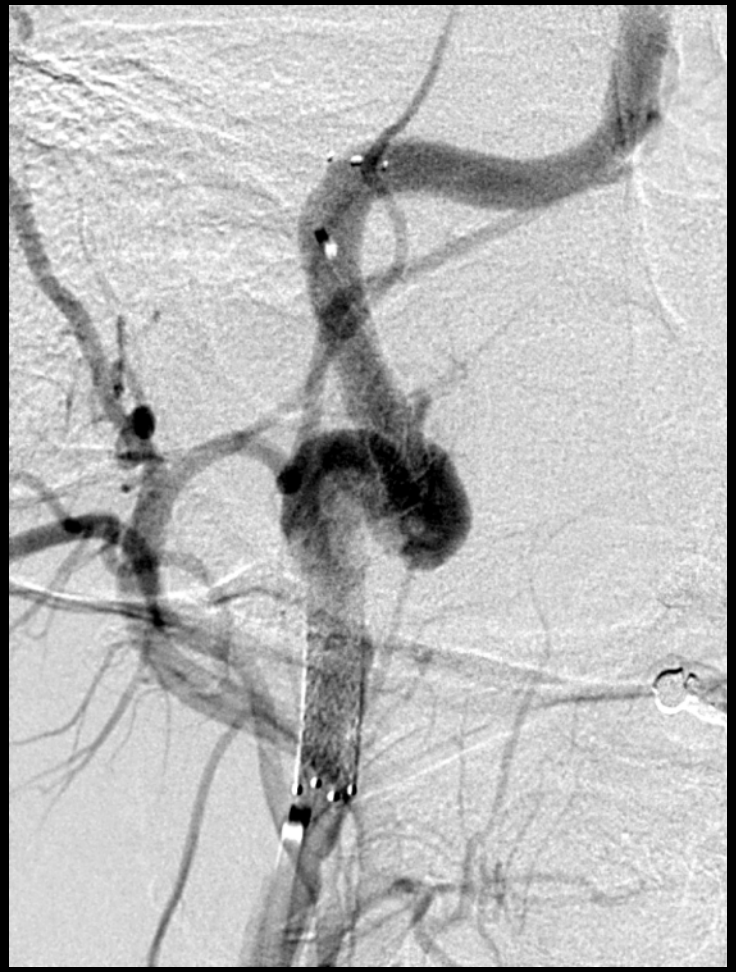
Planned Endovascular Approach

- Right petrous ICA thrombectomy
- Right MCA thrombectomy
- Stent if necessary to maintain a patnet Right ICA

Devices and Intra-Operative Pharmacological Treatment

- 6 French shuttle into R CCA.
- Triaxial system consisting of the 072 Navien, Marksman microcatheter, and Synchro 014
- TREVO
- Zilver 5 x 60 mm stent

Angiographic Images Showing Complication

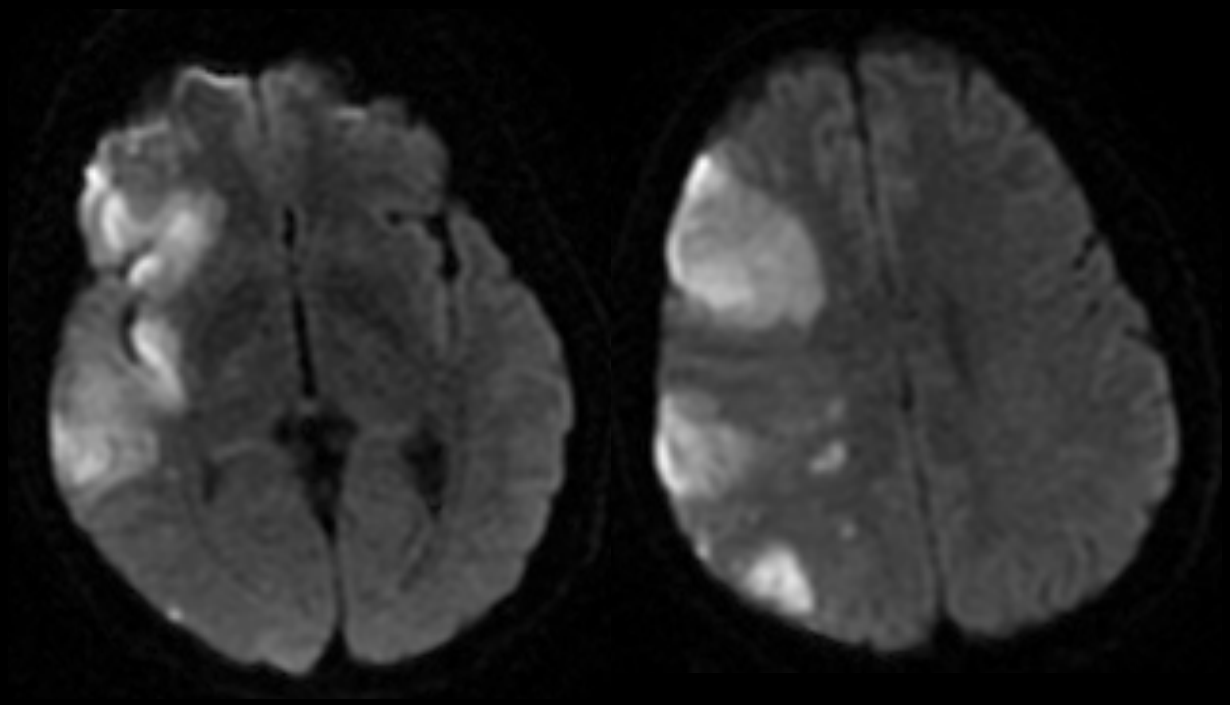


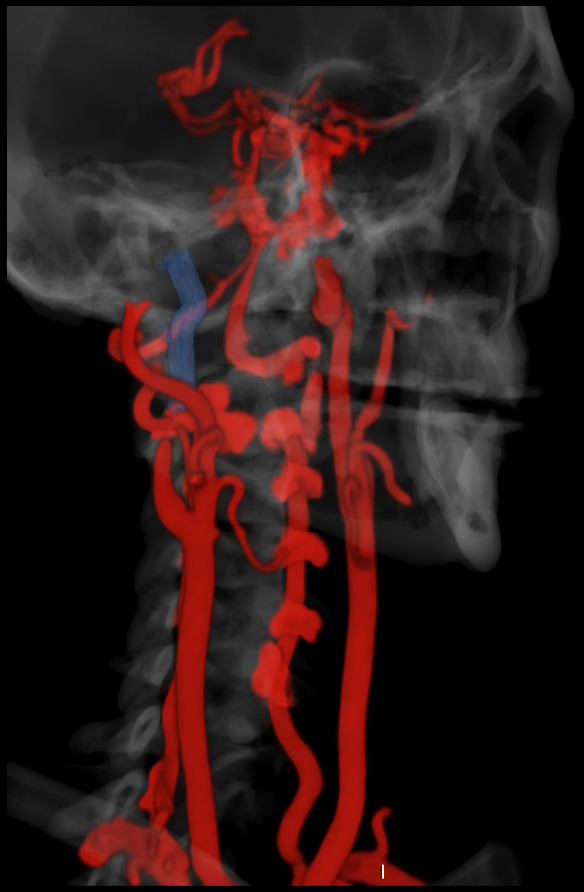
Description of Bailout

- Pipeline 5 x 30 mm stent deployment within Zilver stent
- TREK 4 x 20 mm balloon
- Maverick 5 X 20 mm balloon

Clinical Outcome

- While on aspirin and clopidogrel, Pipeline stent occluded on 7/26 overnight
- NIHSS maximum 13





Discussion

- Natural history of dissections after initial thrombectomy
- Was any stenting necessary?
- Was resolution of the false lumen necessary?
- Intensity of antiplatelet and anticoaguation in the peri-infarct period?
- When to reintervene (should we use the same criteria as for a fresh acute infarct)?

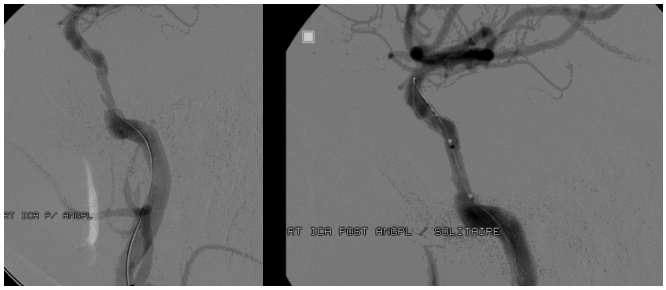
Permanent Deployment of a Stent Retriever

Becske, T, Shapiro, M, Raz, E, Zumofen, D, Favate, A, Jackson, R, DeSousa, K, Bowry, R.

Background: While stent retrievers are mainly used in a temporary deployment fashion to facilitate removal of thromboembolism, The Solitaire I devices may be electrolytically detached for permanent implantation. There are scarce reports of permanent deployment in setting of acute stroke. Here we describe a case of this occurrence.

Case History: A 62 year old male presented with RMCA symptoms and NIHSS=13. He received IV-tPA with improvement to NIHSS=3. Nine days later he worsened to NIHSS=25. An angiogram was performed, demonstrating complete occlusion of the intracranial right ICA. A Navien 058 catheter, coaxially introduced through a 6F Shuttle Sheath, was used to directly aspirate the occlusive thrombus, revealing a pre-existing critical stenosis involving the ascending segment of the petrous carotid artery. Angioplasty was attempted using Hyperglide 4x10 and Maverick 3x15 balloons, without improvement in degree of stenosis and a suggestion of further narrowing, implying resistance to angioplasty and instability. A Solitaire 6x20 device was opened across the stenosis, leading to modest increase in vessel caliber. A Maverick balloon was then re-inflated within the Solitaire for stent-supported angioplasty, with meaningful improvement in flow and reduction of stenosis. The device was then electrolytically detached. Post-detachment imaging demonstrated stable morphology without distal embolization. The patient was discharged from the hospital with NIHSS=1 and MRS of 1.

Discussion: We present a case of a patient in whom permanent deployment of a Solitaire device was clinically required for treatment of intracranial carotid stenosis in setting of recurrent stroke, unresponsive to medical management and balloon angioplasty.


RT ICA P/ AMBPL
RT ICA POST AMBPL / SOLITAIRE

Onyx Embolization Through Offending Microcatheter to Seal Vessel Perforation during AVM Embolization

Keith G. DeSousa M.D., Eric C. Peterson M.D., Dileep R. Yavagal M.D.

UNIVERSITY OF MIAMI

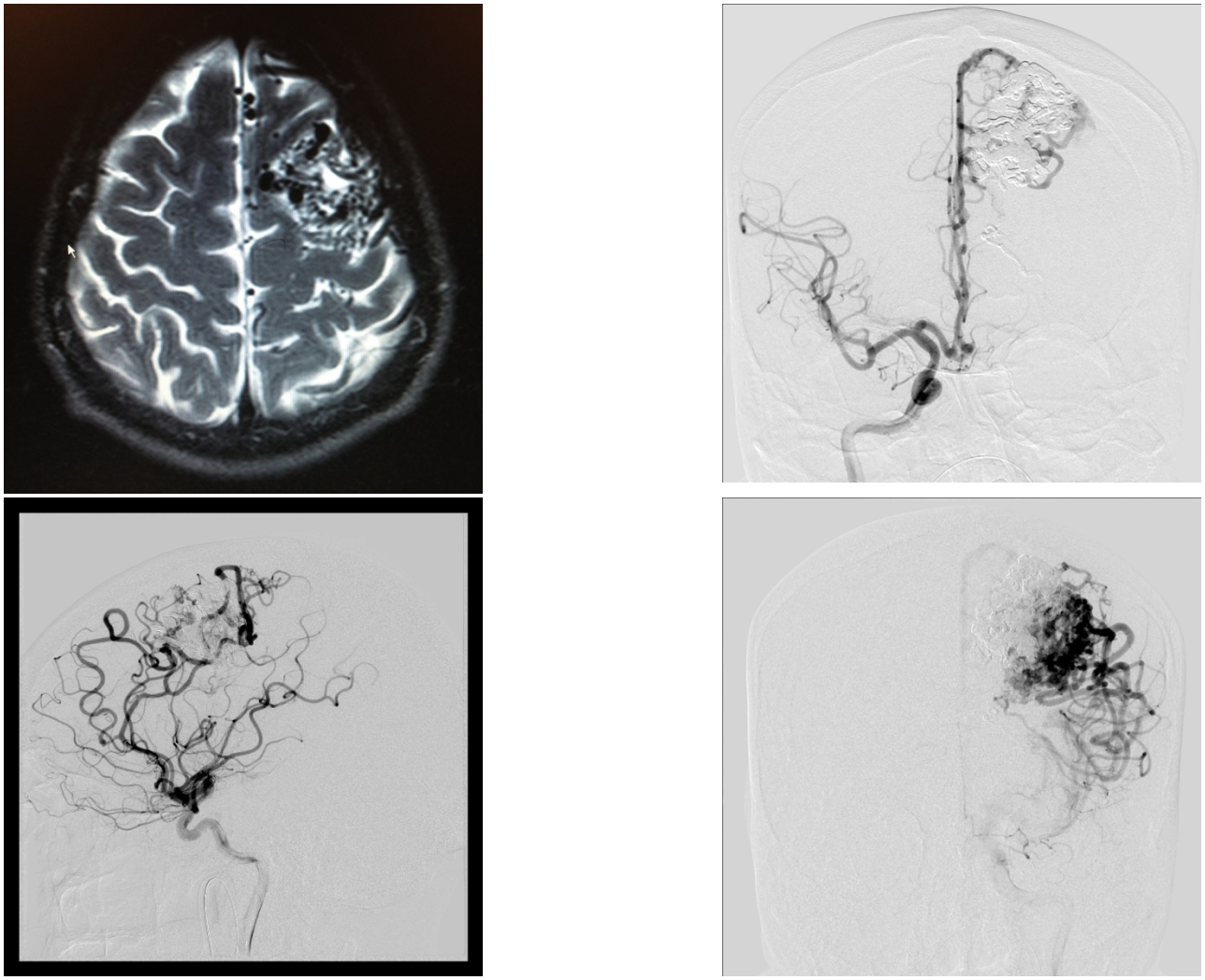
Clinical History:

- 34M with intractable seizures presents for 2nd embolization of large left frontal AVM (Grade 3)

- The patient was found to have a large left frontal AVM fed by multiple feeders from the MCA and ACA with superficial drainage into the superior saggital sinus

- Neurological examination was normal, cranial nerves were intact. Strength was full in all extremities. Sensation was intact throughout.

Baseline Angiographic Findings



UNIVERSITY OF MIAMI

Figure 1a-d: MRI T2 and bilateral ICA angiograms showing the a left frontal AVM. Angiographic pictures show partial embolization of AVM nidus.

Summary of Endovascular Approach

- Right CFA access with 6-65 cm sheath, therapeutic heparinization followed by guidecatheter insertion in left ICA.
- A flow-directed microcatheter was navigated into the pericallosal a. feeder and a superselective angiogram performed.
- This was followed by intra-nidal embolization of the AVM from this feeder with Onyx 18
- Subsequently the callosal marginal a. was microcatheterized with a flow-directed microcatheter for embolization

Devices and Intra-Operative Pharmacological Treatment

- Procedure
  - 6-65 cm sheath
  - 6F Envoy navigated into the LICA
  - Marathon microcatheter and Mirage wire

Complication

- Initial imaging revealed that the microcatheter was well proximal to the nidus in the callosal marginal a. feeder to AVM. The catheter was then attempted to be navigated further around a tight bend.
- As microwire was advanced with the microcatheter following, it appeared that the wire became extravascular.
- A microrun was performed demonstrating extravascular location of the microcatheter

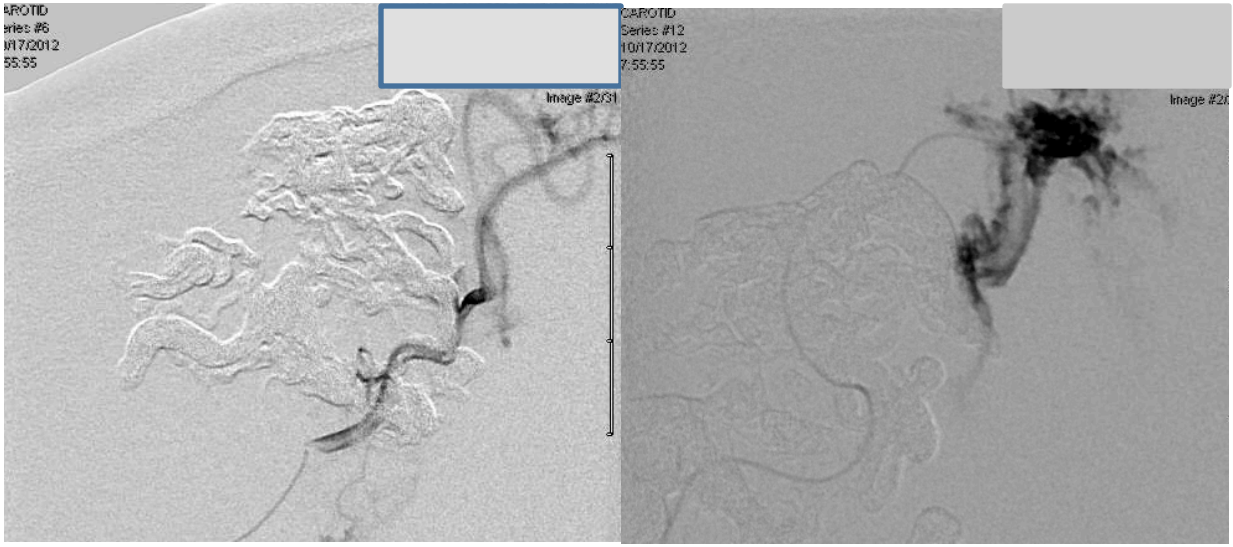


Figure 2a & 2b: Navigation of flow-directed microsystem around tight loop resulted in feeding artery perforation

Description of Bailout

- 50mg of protamine was given.
- Catheter was flushed with DMSO
- Onyx 18 was injected into the extravascular space
- The catheter was drawn back during the injection to seal the leak

Clinical Outcome

- A follow up LICA angiogram was performed which did not show any contrast extravasation
- The procedure was then aborted
- An intraop DynaCT was performed which did not show any hematoma
- The patient was awakened in the angio suite and was noted to have full movement of his extremities. He was then transferred to the ICU in stable condition.

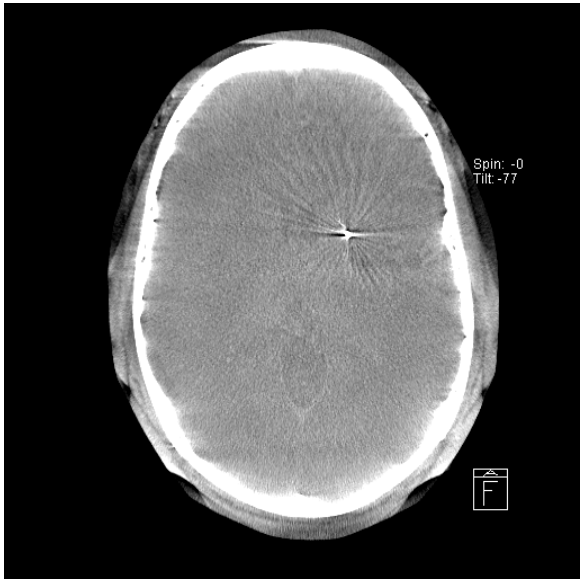


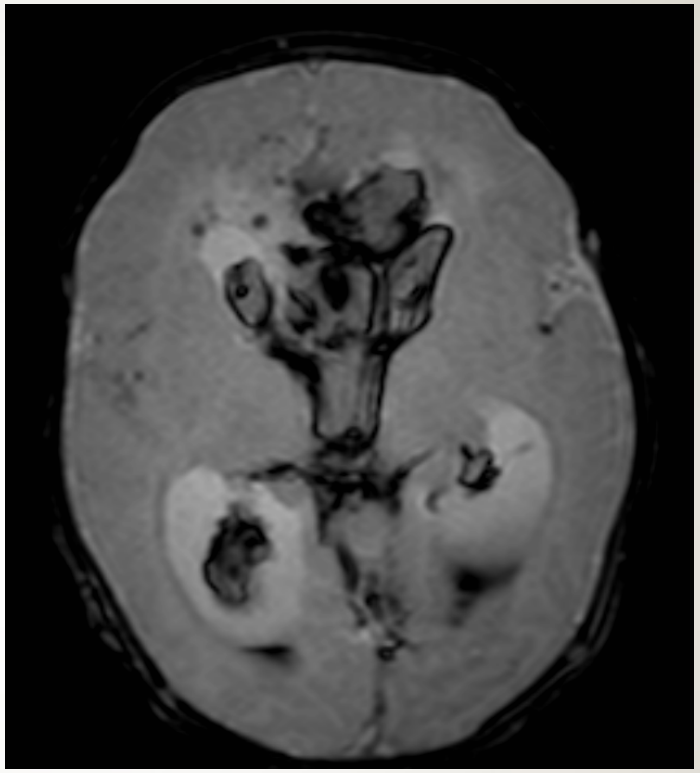
Figure 3: DynaCT post-op without evidence of hematoma

Discussion

- Despite technical advances, vascular perforations with microwire/microcatheter can occur during AVM embolization, especially during navigating around tight loops
- Prompt recognition and sealing with liquid embolic while catheter tip is still in extra-vascular space is an effective “bail-out” strategy with good outcomes

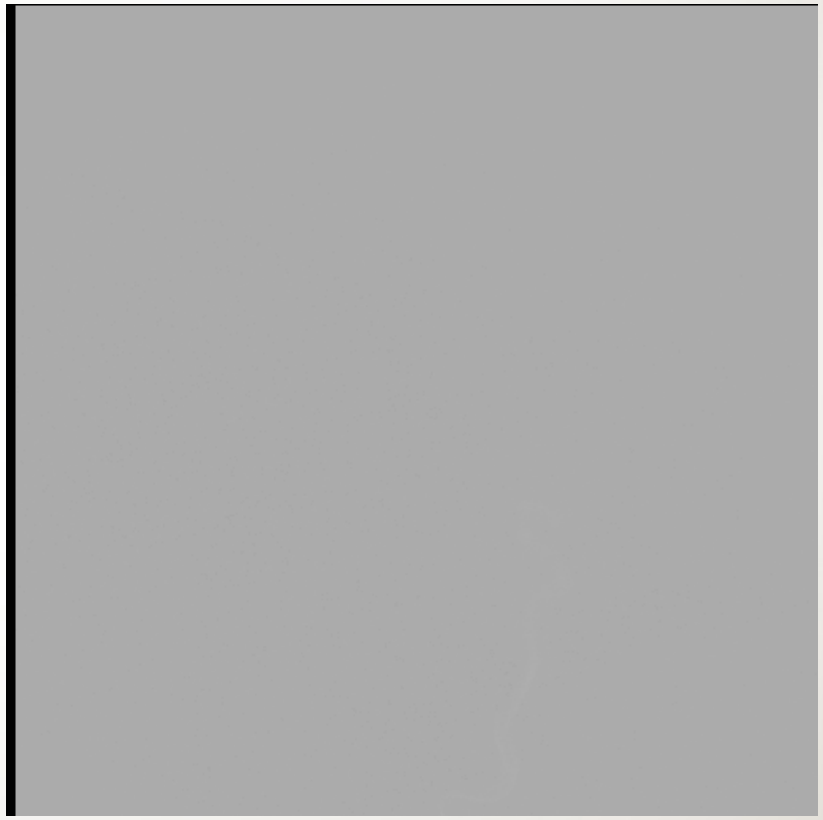
Clinical History

- 7-day-old male who was born at 40 weeks via cesarean section, uncomplicated pregnancy. Patient has no significant medical history, and care has been unremarkable . Today, he was feeding when he had an acute cry out and then became limp. Patient was brought to the emergency department where a head CT was emergently obtained. Head CT demonstrates significant intraventricular hemorrhage with casting of blood throughout the ventricular system. Also hemorrhage in the regions of the genu and anterior body of the corpus callosum. MRA,MRV is obtained, and an external ventricular drain is placed urgently.



Baseline Angiographic findings

- A direct arteriovenous fistula supplied by and aberrant branch of the anterior cerebral artery. The fistula flows directly into a large ectatic venous pouch, which is stagnant with poor outflow.
- This venous pouch measures approximately 16 mm x 18 mm x 13 mm.



Summary of Planned Endovascular Approach

- Diagnostic angiogram
- Positioning of 4F guide catheter
- Super-selective angiogram
- Embolization of lesion with NBCA
- Post embolization angiography

Devices and Intra-Op Pharmacological Treatment

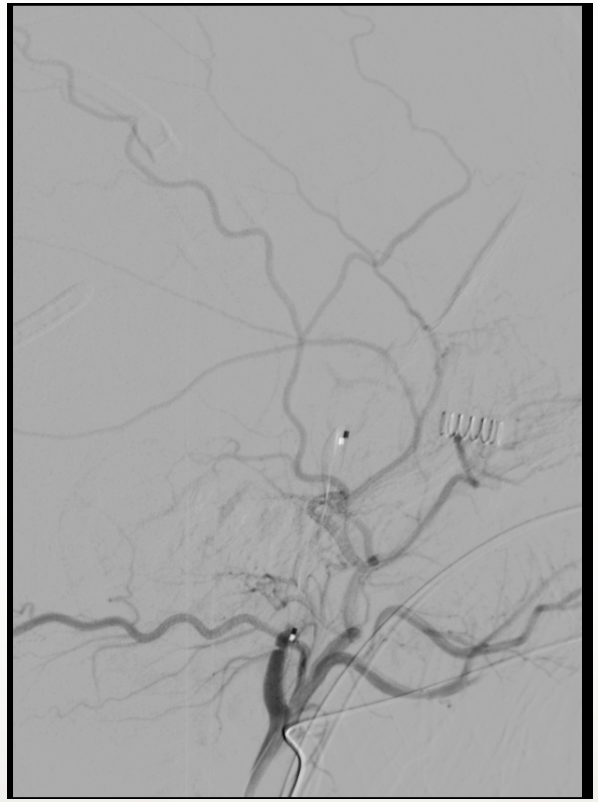
- The right common femoral artery was then entered with a 4 French micropuncture system.
- A 4 French glide catheter was then inserted, over a 0.035 Cook Bentson guidewire, and connected to a pressurized continuous saline drip flush.

- The glide catheter was advanced over the 025 Terumo angled guidewire. The innominate artery was selected, followed by selection of the right common carotid artery. A cervical projection angiogram was performed. Next, the right internal carotid artery was selected, and an angiogram was performed (AP and lateral, and magnified biplane oblique).

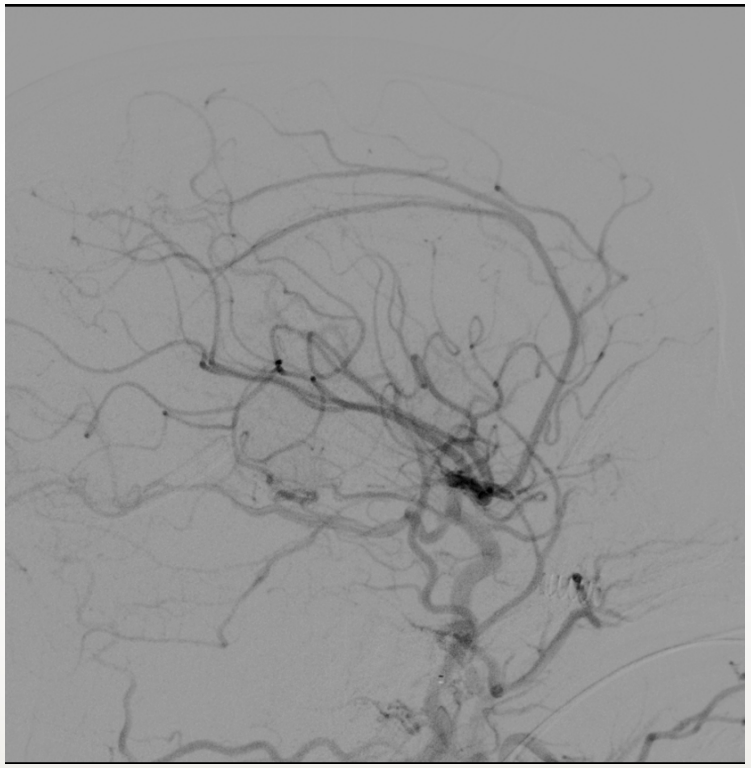
- Next, a Synchro 14 soft microguidewire was advanced into the echelon 10 microcatheter and the entire system was advanced into a rotating hemostatic valve attached to the guide catheter which was also connected to a pressurized saline flush.
- Next, using roadmapping technique, the entire microsystem was advanced to the distal internal carotid artery.
- At this point, slow flow was noted in the internal carotid artery, and therefore a control angiogram was performed in the cervical biplane projection. Significant vasospasm was observed in the proximal cervical internal carotid artery.
- Therefore a total of 150 mcg nitroglycerin was slowly administered intra-arterially, with good resolution of the vasospasm.
- Angiogram was then performed which showed no filling of the lesion.
- After 10 min angiography was repeated and the lesion could again be visualized.

- The microcatheter was then prepared with 5% dextrose solution. Under subtraction fluoroscopy, a 3:1 mixture of n-BCA was carefully infused into the fistulous pouch. The microcatheter was quickly removed, and an angiogram (AP and Lateral) was performed.

Severe ICA vasospasm with occlusion



Resolution of vasospasm
Transient disappearance of lesion



Clinical Outcome

- Resolution of seizure activity
- General: awake and interactive.
  Brainstem: pupils equal and reactive. able to track light.
  Motor: moves all extremities symmetrically
  Fontanelle: full, soft
- EVD in place at + 10. ICP < 20.
- Repeat CT with some interval improvement in IVH
- Patient tolerating PO feeds
- Continued care in pediatric intensive care unit

Discussion

- Endovascular treatment in the Neonate
- Congenital AV fistula
- Risk of re-rupture
- Spontaneous thrombosis with vasospasm
- Risk of embolization
- NBCA embolization of lesion
- Follow up and further treatment

Transvenous Embolization of Bilateral Dural Carotid Cavernous Fistula with Bilateral Cavernous Sinus Embolization Using Transvenous Coils and n-BCA

Gauravjot Sandhu, MD

Introduction: 73 year old female patient with 2month history of diplopia and bilateral 6th nerve palsy, chemosis, proptosis and headaches.

Methods: Cerebral Angiogram showed bilateral indirect Barrow type D, moderate flow carotid cavernous fistulas with early drainage into bilateral cavernous sinus and right angular vein with primary feeders from distal small internal maxillary artery branches. The first procedure involved transvenous coil embolization of both cavernous sinuses. Post procedure angiogram showed partial opacification of bilateral cavernous sinuses and visualization of early veins draining into the facial vein and then into right internal jugular vein. A second endovascular procedure was performed 2 weeks later that involved trans venous coil embolization of right cavernous sinus followed by glue embolization of both cavernous sinuses using n-BCA.

Result: Angiogram showed complete embolization, no opacification of fistula, no early venous filling and no small branch arteries from bilateral internal maxillary artery. At 1 year follow-up, patient has no double vision, no proptosis or chemosis, complete resolution of headache and a subtle 6th cranial nerve palsy.

Conclusion: In some complicated cases of Dural venous fistulas coil deployment alone is not sufficient and in such cases n-BCA can be used as an effective alternative/adjunctive treatment choice to achieve complete embolization.

Curative Onyx Embolization of a Surgically Occult Sacral Dural Arteriovenous Fistula

Pankajavalli Ramakrishnan, M.D., Ph.D. and Jacques Dion, M.D.

Neuro IR Fellow
Emory University Hospital
Atlanta GA

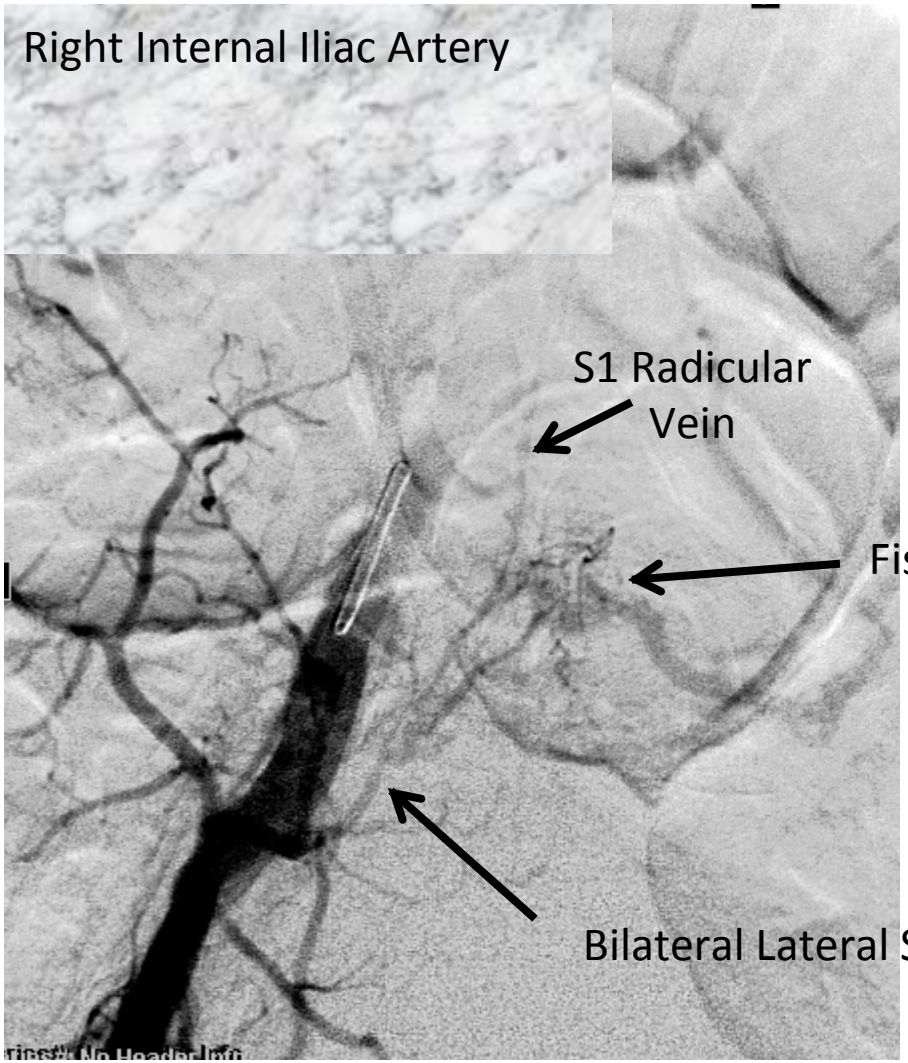
Clinical History

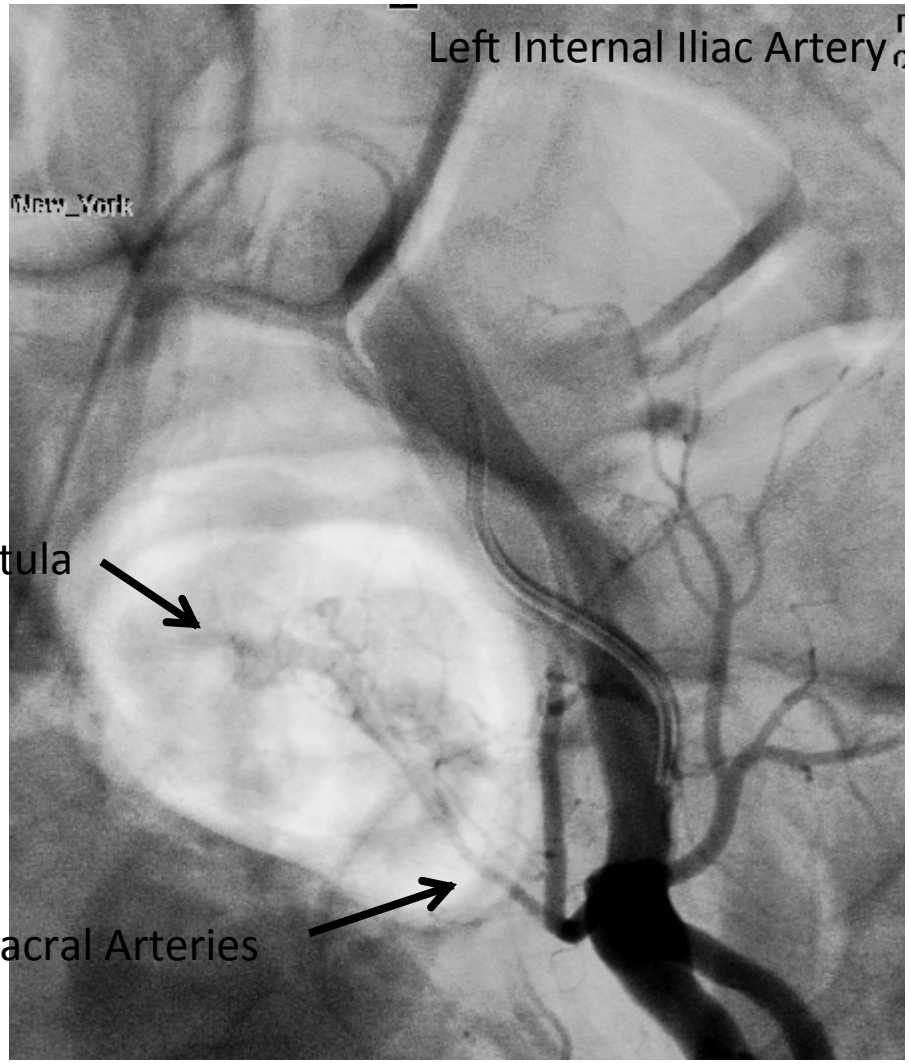
74 year old man with a 9 month progressive history of leg weakness, impaired balance, urinary frequency, urgency, and erectile dysfunction. He had become wheelchair bound.

An MRI of the spine revealed lower thoracic and lumbar spinal cord edema accompanied by engorged appearance of vessels on the ventral and dorsal surface.

A diagnostic spinal angiogram was performed.

Baseline Angiographic Findings

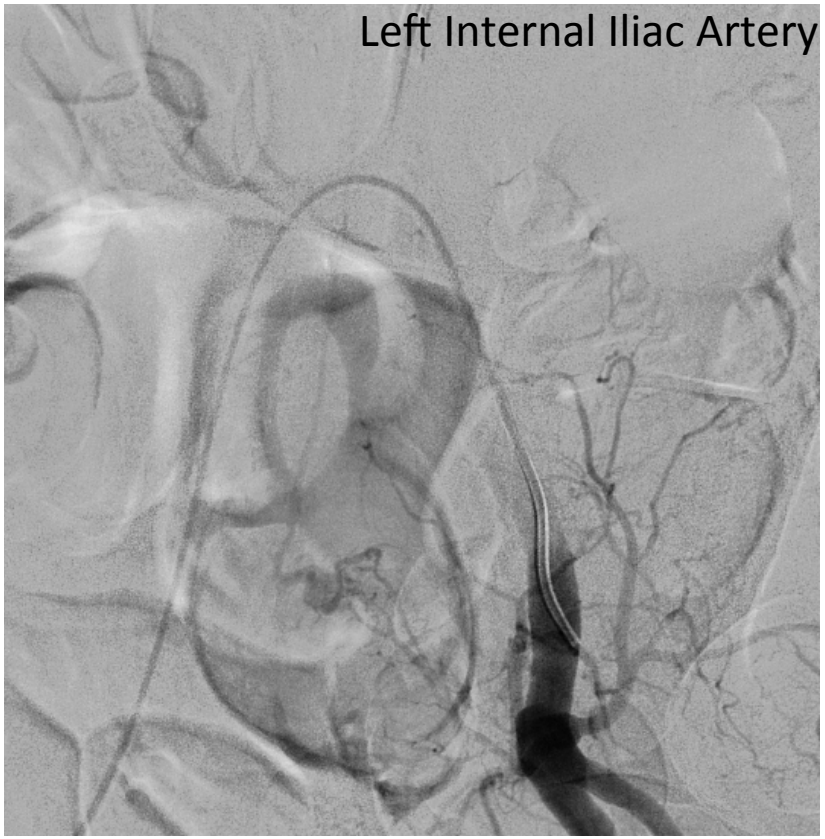




Decision was made to proceed with open surgical disconnection of the fistula.

Complication

Surgical exploration and intra-operative angiography did not reveal the draining vein of the fistula



Repeat spinal angiogram revealed persistence of the fistula

Summary of Planned Endovascular Approach

Goals:

Obtain high quality Images:

Elimination of bowel gas: Glucagon and Abdominal Binder Use

Cure fistula endovascularly:

Balloon Assisted Onyx Embolization of the target draining vein

Demonstration of the Onyx Cast post-embolization using a Cone Beam CT

Devices and Intra-Operative Pharmacologic Treatment

Right Common Femoral Artery Access: 6 Fr Terumo Pinnacle Sheath

Guide Catheter: 6 Fr Envoy guide catheter with Simmons II tip

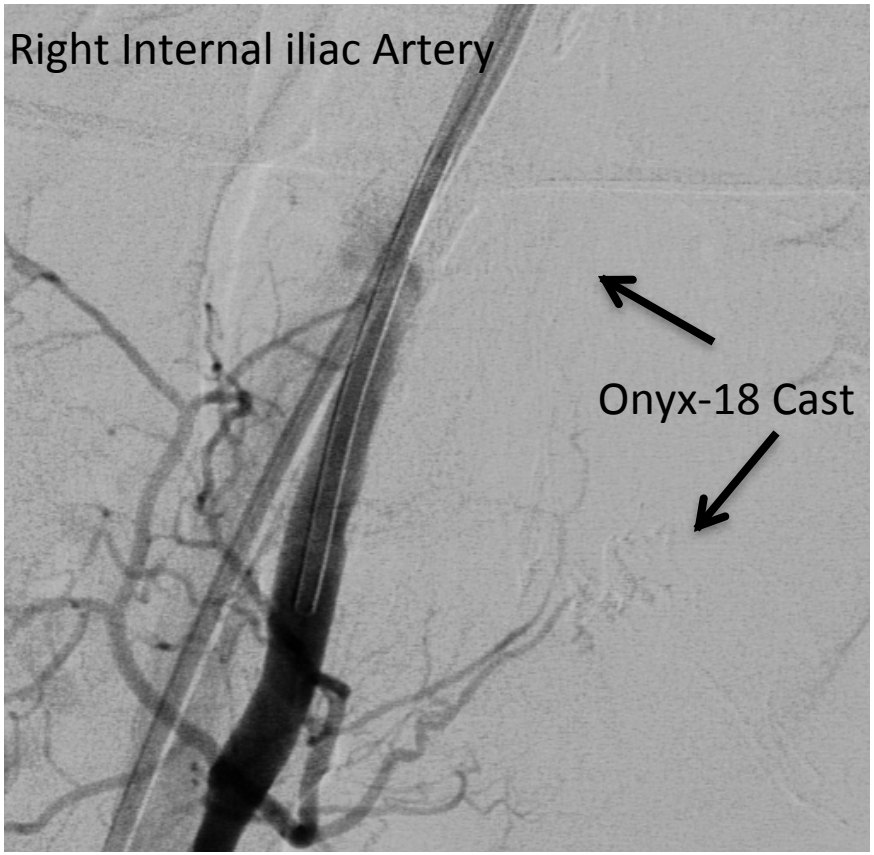
Microcatheter/Balloon: Scepter C 4 x 10 mm coaxial balloon microcatheter

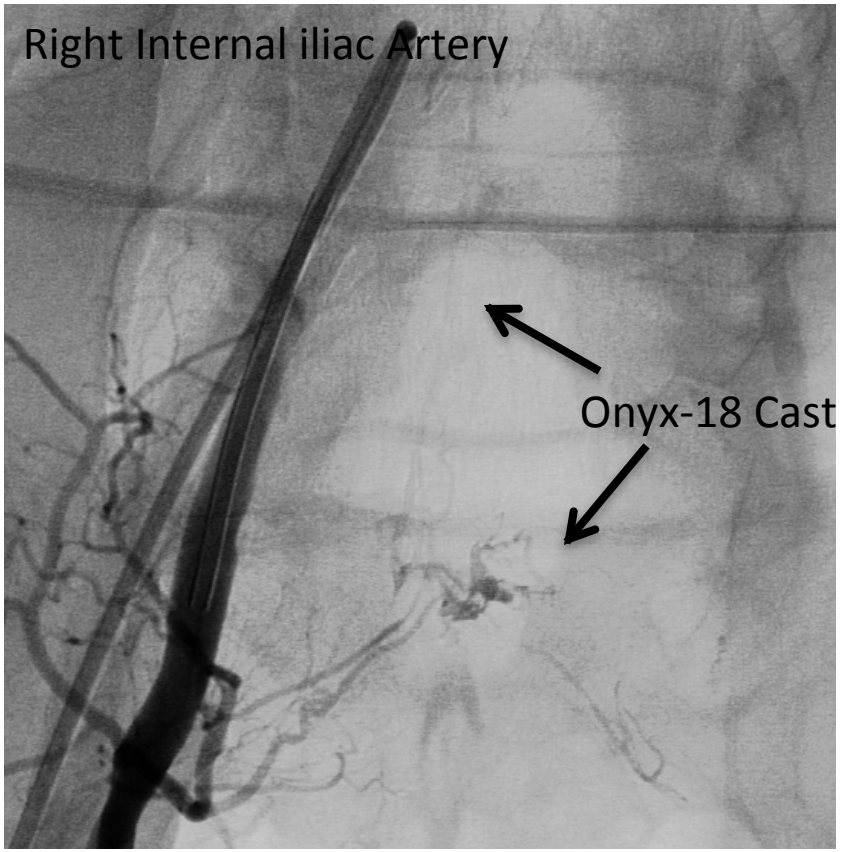
Microguidewire; Transend EX 14 microguidewire

Glucagon 1 mg IV, and abdominal binder

Onyx 18, DMSO

Angiographic Images Showing Cure





Post Trans-arterial Onyx 18 Embolization

Clinical Outcome

Approximately 1 month following the curative Onyx embolization the patient was able to ambulate with a walker and no longer needed a wheelchair.

The number of episodes of bowel and bladder incontinence had diminished greatly, as did the urinary frequency.

Discussion

This case illustrates the need for a thorough angiographic evaluation to ensure that sacral dural AV fistula, a rare but treatable entity is not missed.

A high quality spinal angiogram is essential for making this diagnosis.

Bowel gas can be minimized with judicious use of IV glucagon and the placement of an abdominal binder.

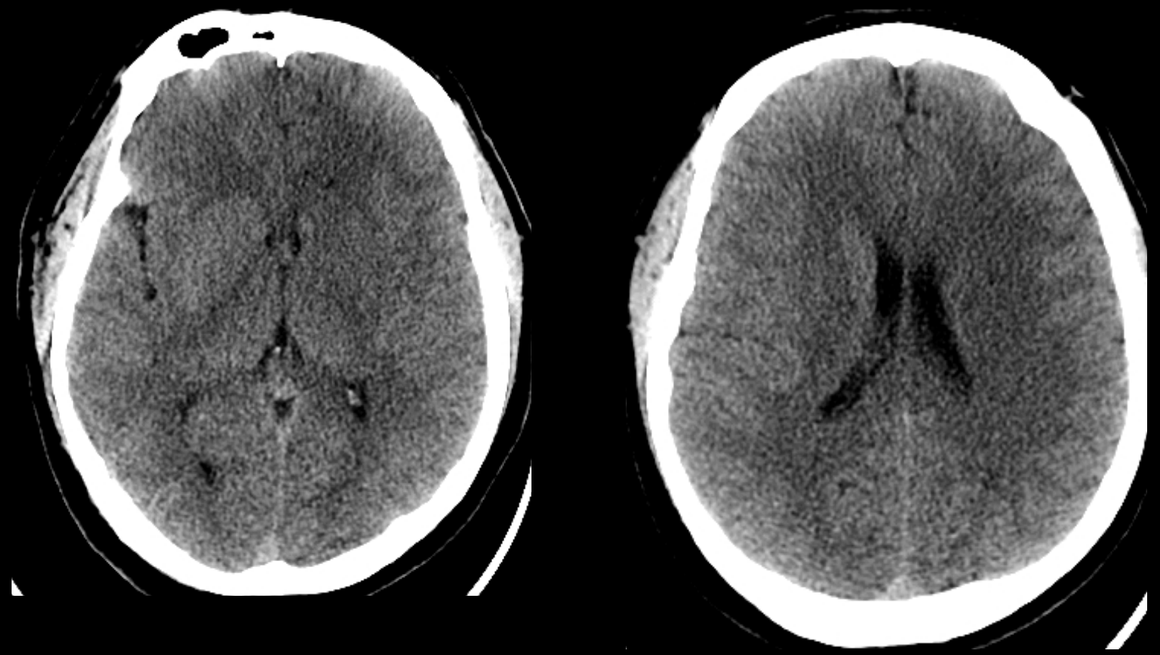
The principles of surgical and endovascular cure are identical: obliterate the draining vein.

Endovascular curative treatment was achieved with balloon assisted Onyx-18 embolization, thus demonstrating its efficacy as an alternative to surgical disconnection.

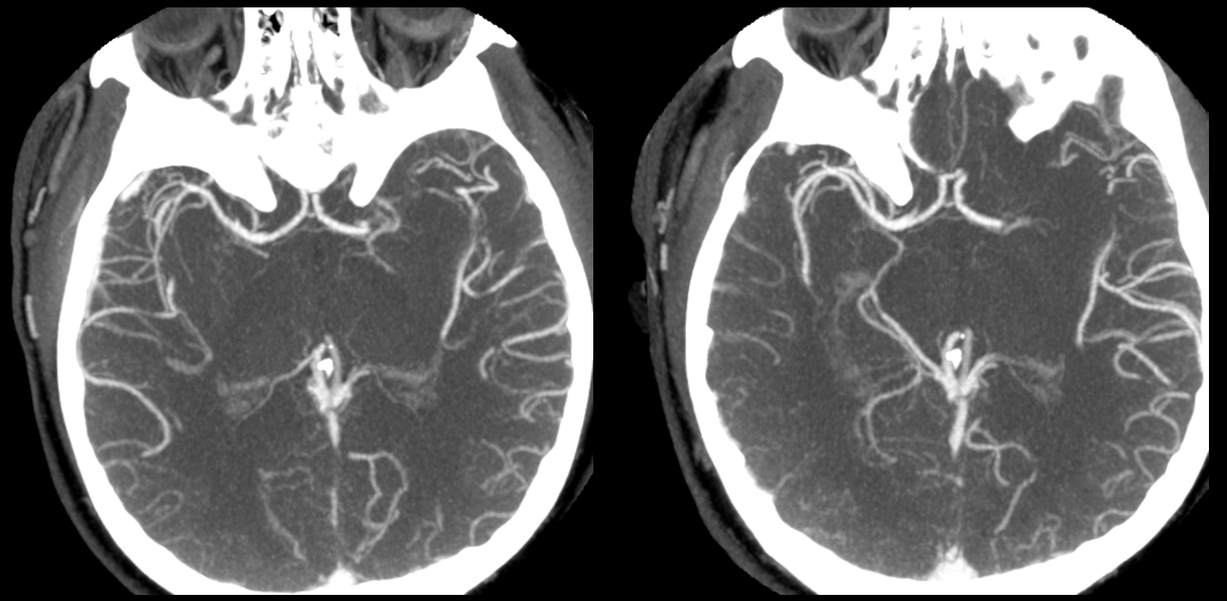
CASE 1

- 44 yo RHD male
- Smoker, HTN (untreated), Dyslipidemia (untreated), Obesity (115 kg)
- Sudden onset right hemiparesis and hemisensory loss, global aphasia and forced left gaze preference.
- Symptom onset to stroke team assessment = 90 min
- **NIHSS = 18,**
- **BP 110/60**, HR 90, ECG NS, Labs = normal

CASE 1 44 yo Male, NIHSS =18 (Sx onset 1.5 hrs)



ASPECTS 7, NIHSS =18
HIAT =0, THIRVE =3



CTA-SI Robust collaterals
(CS = 3)

CASE 1

44 yo Male, ASPECTS 7, NIHSS =18

Stroke etiology: LICA near occlusion

Stroke Treatment:

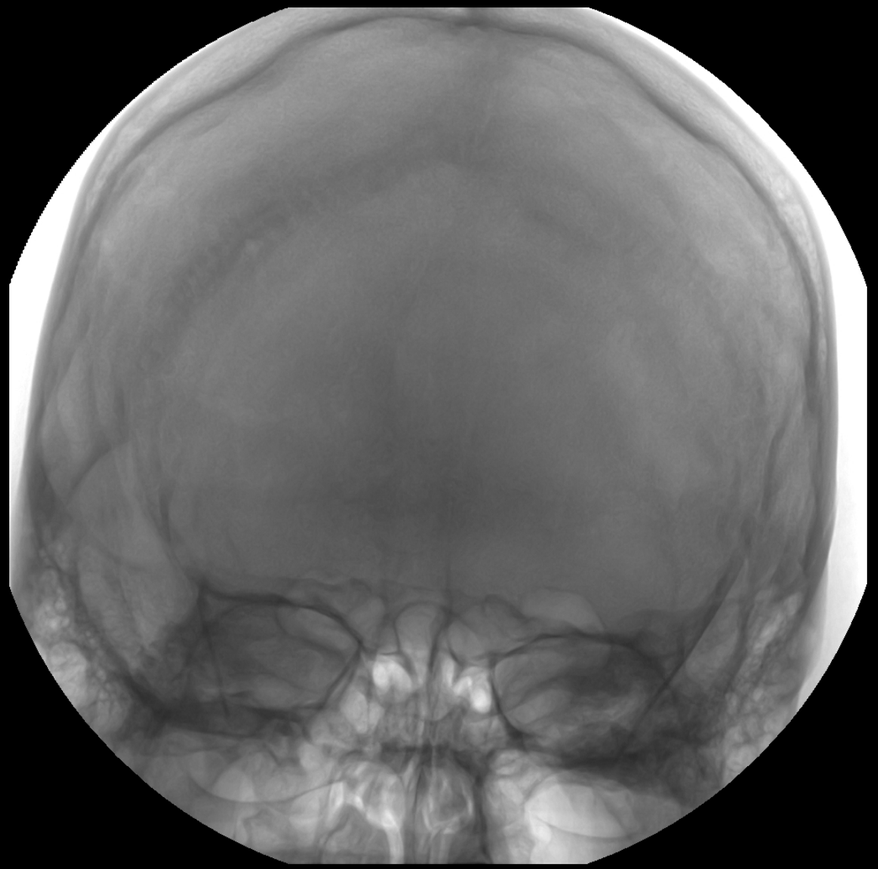
1) IV tPA 90 mg (within 1.5 hrs from LSN)

2) Sent immediately for IA mechanical thrombectomy

CASE 1

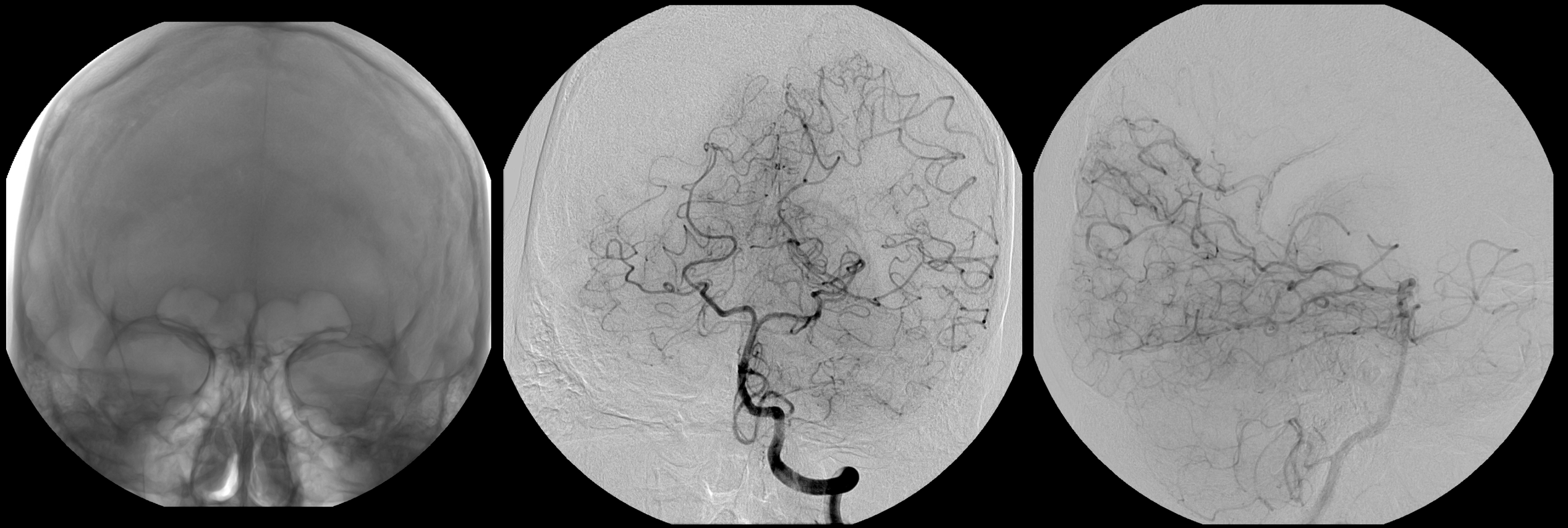
44 yo Male, NIHSS 18

Near occlusion
LICA



occluded left M1 segment

CASE 1

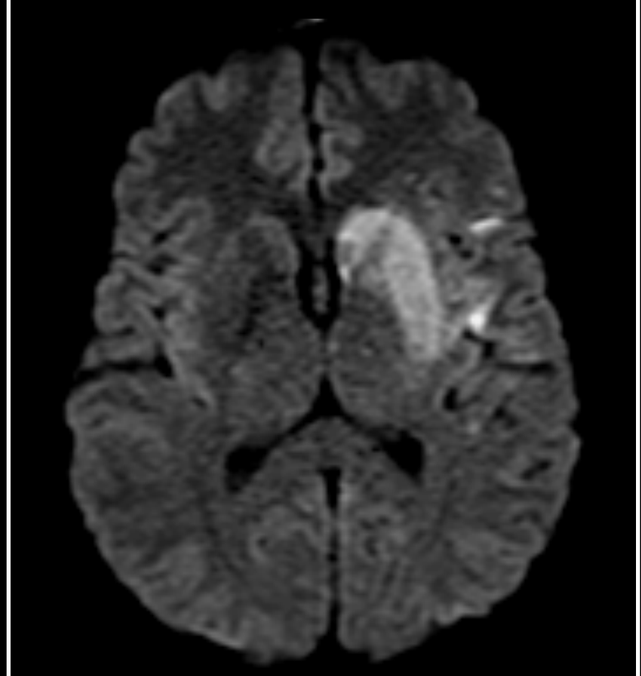


Rapid clinically improvement - NIHSS now 4

CASE 1

44 yo Male, L MCA stroke

NCCT 1.5h post sx onset



MRI 12h post sx onset

NCCT 24h post sx onset

NCCT 2 mths post sx onset

CASE

44 yo Male, L MCA stroke

TREATMENT: CEA at 2.5 mths

Outcome: mRS = 1

Secondary stroke prevention:

Plavix 75mg
Atorvastatin 80 mg,
Perindopril 8 mg,
Indapamide 1.25 mg
quit smoking
10 kg weight loss

DISCUSSION

What is the role of dynamic collateral circulation in AIS?

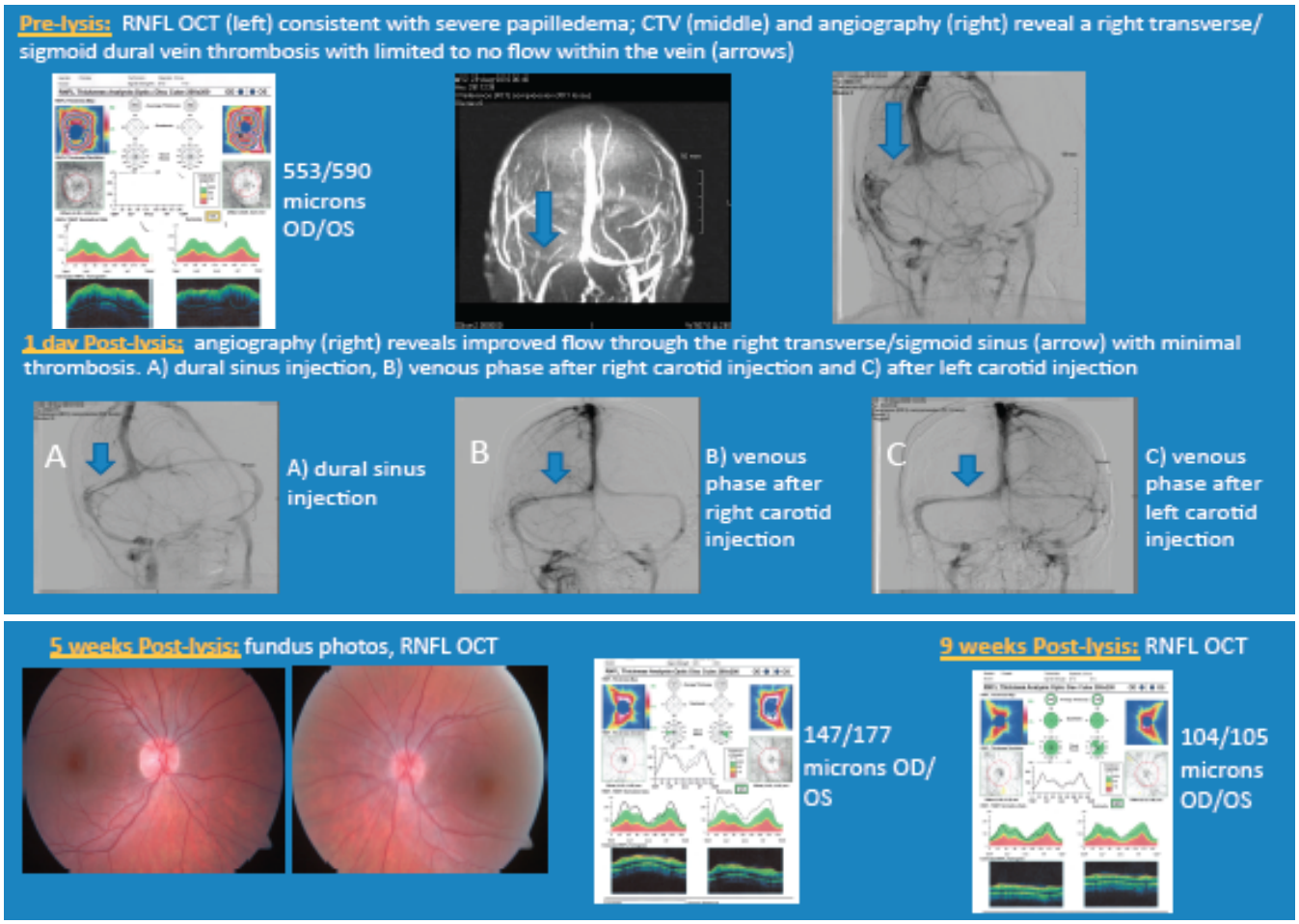
Endovascular Treatment of Cerebral Venous Thrombosis with Combination of Rheolytic Thrombectomy, angioplasty and Thrombolysis: Complete Resolution of Severely Elevated ICP Syndrome

We report successful endovascular treatment of transverse and sigmoid dural vein thrombosis with rapid reversal of elevated intracranial pressure syndrome manifesting as severe papilledema, bilateral sixth nerve palsies, and headache, and prevention of permanent vision loss, morbidity and mortality.

A 28-year-old woman presented with acute onset headache, diplopia, and intracranial noises. MRV brain revealed thrombosis of the right transverse and sigmoid sinus. She was referred to tertiary care center after refractory anticoagulation therapy for three weeks. Initial exam revealed VA 20/20 OU, normal VF, bilateral abduction deficits (-3), severe papilledema (RNFL OCT thickness 553/590µ OD/OS), and LP opening pressure 50cmH_20. Cerebral angiography revealed minimal flow within the right transverse and sigmoid sinus with torcula pressure of 35 mmHg and lower right sigmoid sinus pressure of 9 mmHg. Local thrombolysis with tPA, Angiojet thrombectomy and angioplasty were performed, followed by 48-hour tPA infusion. The repeat angiography the following day revealed good flow through the right transverse and sigmoid sinus with torcula pressures of 22-25 mmHg, and Right lower sigmoid pressures of 13-14 mmHg.

The patient's headache improved within a few hours of the procedure. Two weeks post-intervention, LP opening pressure was decreased to 16cmH_20 and papilledema was mild-moderate (247/301µ). In two-month follow-up, papilledema was completely returned to baseline (104/105µ) without any residual visual deficits.

In this case, severely elevated ICP syndrome secondary to cerebral venous thrombosis was successfully treated with early endovascular intervention, which effectively reversed her symptoms, and prevented permanent complications of elevated ICP syndrome. Combined therapies including mechanical rheolytic thrombectomy, angioplasty and/or thrombolysis are a safe and effective technique for refractory case of cerebral venous thrombosis. We expect further development of safe and effective endovascular techniques to treat venous thrombosis in the near future.



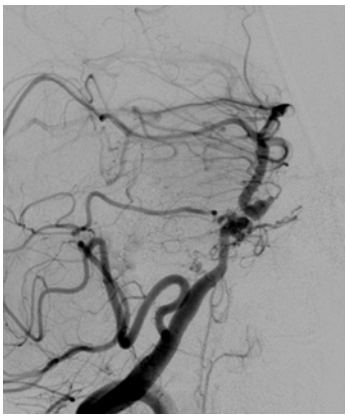
Unique Case of Axial Nonfusion of the Basilar Artery with Basilar Rete Mirabile in a Patient with Multiple Other Intracranial Aneurysms and a Cerebral Arteriovenous Malformation

Steven Hoover, Ankur Garg, Scott Saucedo

Introduction: The embryologic development of the basilar artery involves fusion along the longitudinal as well as axial axis (1). Persistent longitudinal nonfusion can range from small basilar fenestrations to very rare duplicated basilar artery. Persistent axial nonfusion of the basilar artery is an extremely rare entity (1, 2). Rete mirabile (a compensating arterial network) is another rare occurrence that is usually associated with segmental agenesis of a parent artery. This condition has been described in association with a congenital dysplastic internal carotid artery; however, in the posterior circulation there are only rare reported cases of vertebral artery and posterior cerebral artery rete mirabile (4, 5, 6). To the best of our knowledge, basilar artery rete mirabile has never been reported. In addition, there are no prior reports of axial non-fusion of the basilar artery in association with basilar rete-mirabile. Here we report a case of axial non-fusion of the basilar artery with basilar rete mirabile in a patient with multiple intracranial aneurysms and a small cerebral arteriovenous malformation.

Case: A 27 year-old Hispanic man with no significant past medical history presented to our institution with acute onset of severe headache, nausea, and vomiting. A CT brain showed diffuse subarachnoid hemorrhage, more prominent in the left basal cistern. Catheter based cerebral angiography revealed a complex, multilobulated, and partially thrombosed left posterior communicating artery aneurysm. This aneurysm was presumed to be the source of hemorrhage based on the pattern of blood on CT. Additional angiographic findings included: a small saccular left anterior choroidal artery aneurysm, a small saccular left internal carotid artery terminus aneurysm, a small right posterior communicating artery aneurysm, a small, low-flow, left parasylvian cerebral arteriovenous malformation, and axial non-fusion of the basilar artery just distal to the origin of the anterior inferior cerebellar arteries (See Image 1). There was no delay in flow to the distal basilar segment secondary to a rete mirabile. Successful microcoil embolization of the left PCoA aneurysm was performed and patient was later discharged to home with plan for follow-up angiography in three months.

Conclusion: Axial non-fusion of the basilar artery is an extremely rare occurrence, while basilar artery rete mirabile has never been reported before. To our knowledge, this is the first reported case of a basilar axial non-fusion with basilar rete-mirabile. This patient's cerebrovascular anatomy was made more unique by the additional findings of multiple intracranial aneurysms and a cerebral arteriovenous malformation.



A Rare Association between Ulcerative Colitis and Bilateral Thalamic Stroke

Sara Misthal, BA; Nikita Maniar, BS; Haitham Dababneh, MD; Mohammed Hussain, MD; Mohammad Moussavi, MD; Asif Bashir, MD; Jawad F. Kirmani, MD

JFK New Jersey Neuroscience Institute at Seton Hall University

Background: Bilateral thalamic stroke combined with cerebral venous thrombosis is a rare phenomenon. Usual causes include CO poisoning, metabolic toxicity or infarction due to the occlusion of the artery of Percheron. In this case, we present a patient with bilateral thalamic stroke due to a flare-up of ulcerative colitis.

Case Summary: A 35-year-old woman with ulcerative colitis was transferred to our hospital with a two day history of altered mental status and headache. Two weeks prior to the transfer she had episodes of nausea, vomiting and diarrhea. She was non-compliant with her medications for ulcerative colitis. MR venogram and MRI with contrast demonstrated extensive thrombosis of the intracranial venous system. There was thrombosis of internal cerebral veins, the superior sagittal sinus, straight sinus, transverse sinus and sigmoid sinuses with extension into jugular veins. There also was acute ischemia of the thalami bilaterally. Homocysteine and protein C levels were normal. Protein S and thrombin levels were slightly low. Subsequently, anticoagulation was initiated with continuous intravenous infusion of heparin.

Discussion: Ulcerative colitis (UC) is an idiopathic chronic inflammatory bowel disease that affects patients between the ages of 20 and 30 years old with a second peak age between the ages of 70 and 80 years old. CNS manifestations include thrombotic and cerebrovascular disease, myelopathy, cerebral vasculitis, multiple sclerosis and acute disseminated encephalomyelitis. Patients suffering from UC are at risk of developing a hypercoagulable state with the two most common thrombotic complications being deep venous thrombosis and pulmonary thromboembolism. The frequency of cerebral vein and sinus thrombosis (CVST) is rare, ranging from 1.3% to 7.5% of cases yearly.

Conclusion: Cerebral sinus and vein thrombosis is a serious and often fatal complication of idiopathic inflammatory bowel disease if undiagnosed. It should be considered in any patient with little or no known vascular risk factors presenting with a severe headache and other focal or diffuse neurological signs.

Figure 1:
(A) Sagittal MR Venogram showing absence of flow through the superior sagittal sinus (white arrow) and confluence of sinuses (black arrow).
(B) Coronal imaging demonstrates absence of flow in superior sagittal sinus (black arrow) and transverse sinus (white arrow).

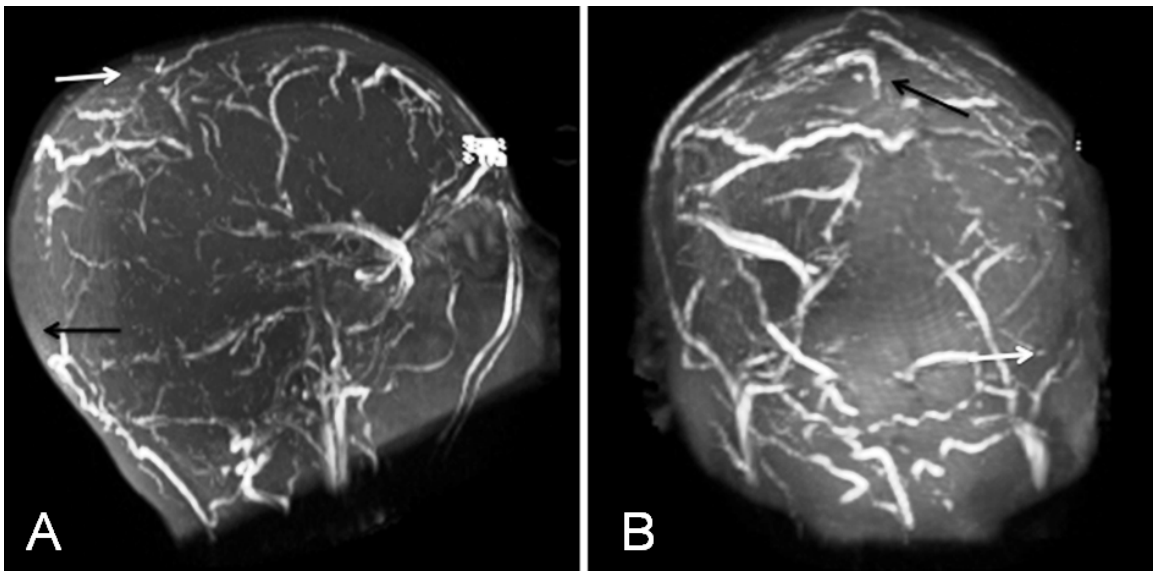
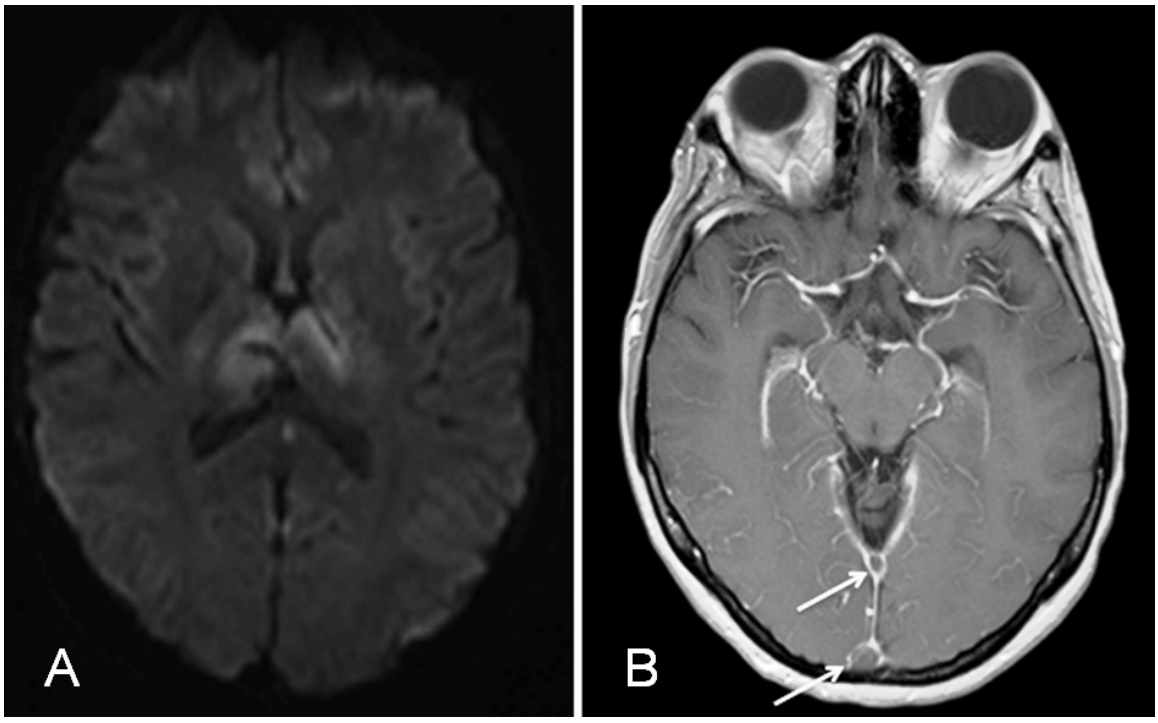


Figure 2:
(A) MR diffusion weighed imaging showing bilateral thalamic infarcts.
(B) T1 MRI with gadolinium demonstrates empty delta sign in the superior and Inferior sagittal sinuses (white arrows).



An Unusual cause of Carotid Artery Dissection

AUTHOR(S): Sumeet S. Multani, MD Aparna M. Prabhu, MD Sridhara Yaddanapudi, MD
Jonathan Dissin, MD George C. Newman, MD PhD Paul S. Brady, MD

INTRODUCTION

Internal carotid artery dissection (ICAD) can be spontaneous or traumatic. Spontaneous ICAD is the cause of cerebral infarction in 22% of otherwise healthy younger stroke patients. Carotid dissection is associated with cystic medial necrosis; syphilitic arteritis; α_1-antitrypsin deficiency; and several heritable collagen disorders, including Marfan syndrome, Ehlers-Danlos syndrome, and type III collagen deficiency. Chronic and recurrent arterial dissections are more likely to occur in patients with fibromuscular dysplasia. Traumatic ICAD may be related to hyperextension injuries of the neck and neck manipulations.

Cocaine induced carotid dissection is rarely described in the literature

CLINICAL COURSE

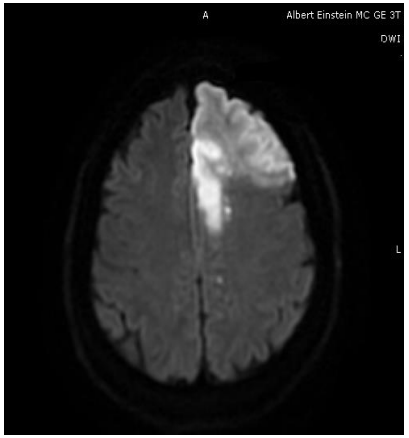
48 year old male with a history of borderline hypertension presented with acute onset of right sided arm and leg weakness with associated speech problems. He had consumed alcohol and smoked cocaine about 15 minutes prior to onset of symptoms. He denied trauma, fall or injury to his head or neck. His systemic pressure was elevated at 148/9 1 mmHg. He was alert and had no language impairment. He had dysarthria and bradyphrenia. He had a subtle right sided facial droop with associated right facial hemi sensory impairment, mildly reduced strength on right upper and lower extremity (MRC grade 4/5) with normal tone and reflexes bilaterally. As symptoms improved during the evaluation he did not receive thrombolytic. CTA demonstrated left ICA occlusion. He underwent 4-vessel conventional angiogram which showed left ICA dissection. He was started on heparin and aspirin. His work up for collagen vascular disease was negative. On day 3, he developed an expressive aphasia with worsening of his right hemi paresis . He underwent magnetic resonance perfusion study which demonstrated a large penumbra on left hemisphere in the MCA territory and a new area of infarct in the left ACA territory. He underwent angiography with stent placement in his ICA re-establishing flow. He rapidly improved.

DISCUSSION

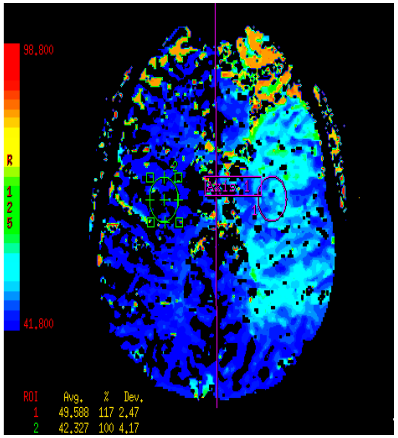
Cocaine induces stroke by multiple mechanism including vasospasm, vasculitis, enhanced platelet aggregation and cardio-embolic phenomenon. Cocaine induced dissection is very rare in the carotid artery territory. Aortic dissection and coronary artery dissection are the more common arterial territories involved.

We conclude that cocaine causes intimal wall thinning and shear effects secondary to hemodynamic changes in cerebral blood flow which can result in dissection of the carotid artery. Although very rare, cocaine induce ICA dissection remains important to be recognized from prognostic as well as therapeutic point of view in patients presenting as stroke secondary to cocaine with no other risk factors.

MAGNETIC RESONANCE AND ANGIOGRAPHY IMAGES

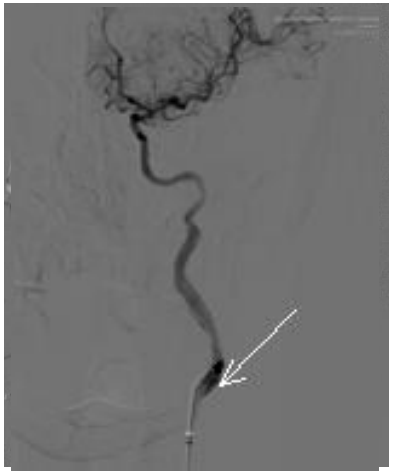


MRI –DWI SHOWING ISCHEMIC STROKE: LEFT FRONTAL LOBE (LEFT ACA TERRITORY)



PERFUSSION MRI SHOWING INCREASE IN MEAN TRANSIT TIME IN THE LEFT MCA TERRITORY

CEREBRAL ANGIOGRAPHY: OCCLUSION OF LEFT ICA SECONDARY TO DISSECTION



CEREBRAL ANGIOGRAPHY- LEFT ICA AFTER STENT

Complete Obliteration of a Palpebral Supraorbital Fistulous Arteriovenous Malformation Using the Combination of Percutaneous and Endovascular Embolization

Santiago Ortega-Gutierrez, David Altschul, Srinivasan Paramasivam, Johanna T. Fifi and Alejandro Berenstein

Introduction: Palpebral and orbital arteriovenous malformations (AVMs) are complex vascular lesions associated with a significant psychological burden due to the magnitude of its cosmetic disfigurement. Commonly, treatment of this disease requires a multidisciplinary approach involving several specialist visits.

Material and methods: A case report of orbital high-flow AVM treated in a single session by combining percutaneous and endovascular embolization is presented.

Results: An 18-year-old woman who was born with a mass in the upper eyelid and superior orbital region that increased in size over the last few years. On exam a significant thrill was found. Regional ultrasound and MRI revealed a high flow palpebral arteriovenous malformation with extension to the forehead. Diagnostic angiogram showed multiple arterial feeders from the left internal maxillary artery, ophthalmic artery and the zygomatic branch of the left superficial temporal artery forming a complex network leading to a main fistula point. The venous drainage occurred primarily into the left facial and superior ophthalmic vein to cavernous sinus. Initial endovascular embolization through zygomatic branch using NBCA filled several arterial feeders. Subsequent ultrasound-guided and X-ray guided percutaneuous NBCA embolization into the fistula was performed demonstrating a complete resolution of the fistula.

Conclusion: A combined percutaneous-endovascular approach might improve therapeutic results of orbital fistulous AVMs. Percutaneous embolization represent an additional skill that incorporated during training might generate comprehensive future neurointerventionalist with an increase ability to treat superficial head and neck AVMs that cannot be easily accessed through traditional endovascular techniques.

EPIDURAL HEMATOMA AFTER A DOUBLE LUMEN BALLOON LIQUID EMBOLIZATION

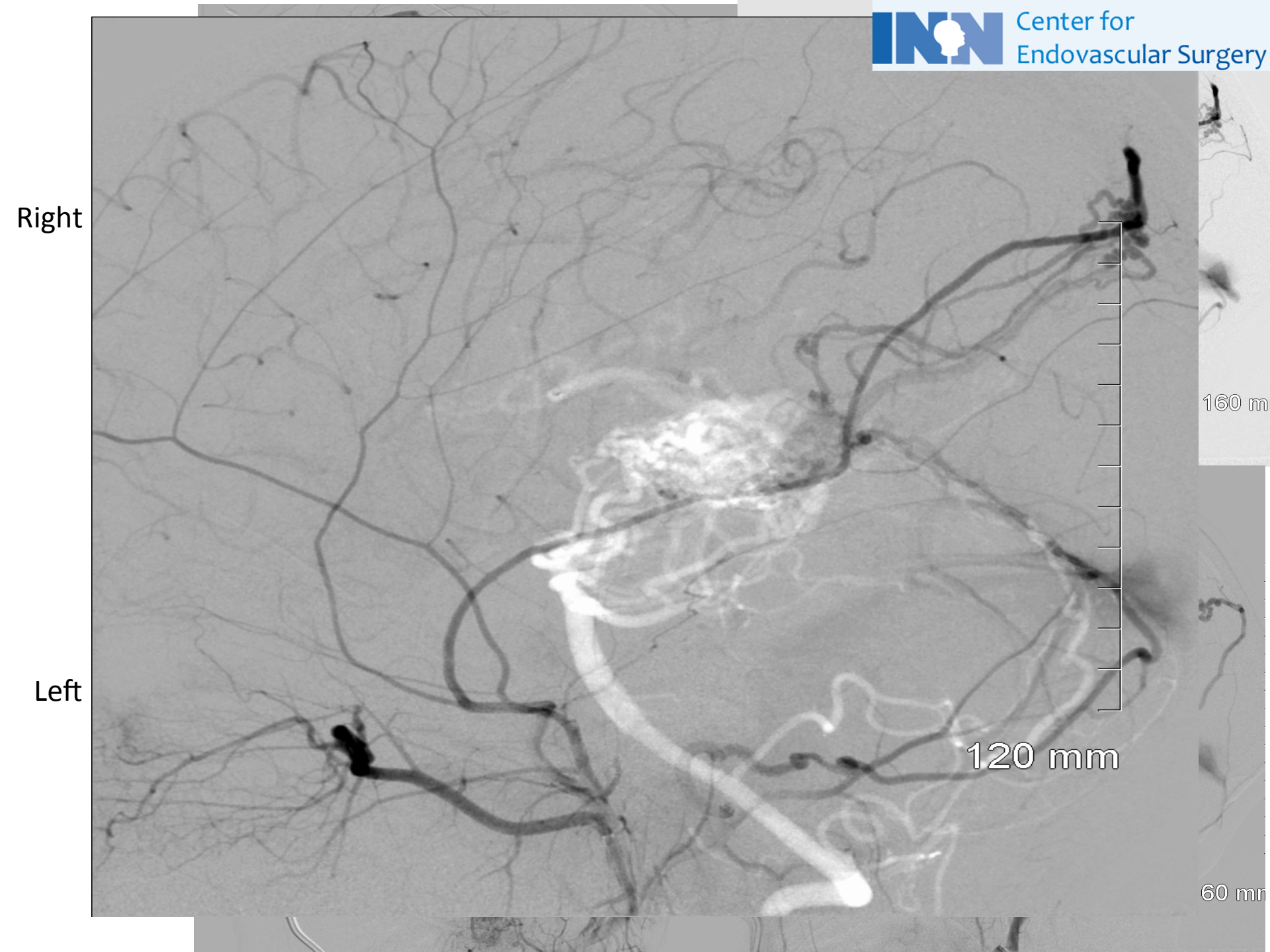
*Santiago Ortega-Gutierrez MD, MSc; David Altschul MD; Srinivasan Paramasivam MD; Johanna T Fifi MD; Alejandro Berenstein MD

Center for Endovascular Surgery

CLINICAL HISTORY

- **7** yo boy with history of a **Vein of Galen** Malformation diagnosed intrautero who underwent **several previous embolizations** in France:
  - 2006 at the new born period due to severe CHF
  - 2008 due to hydrocephalus
- **Follow up** MRI showed a **progression** of the VOG with **neo-angiogenesis** around the fistula

Baseline angiographic Findings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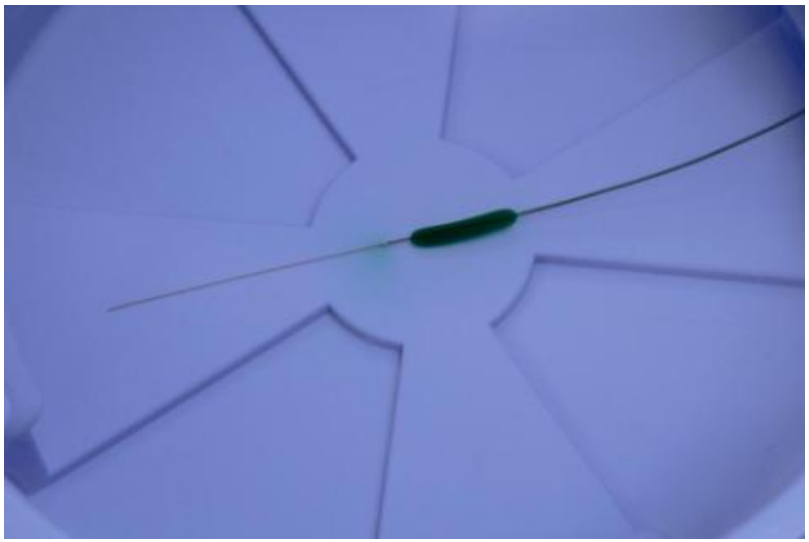
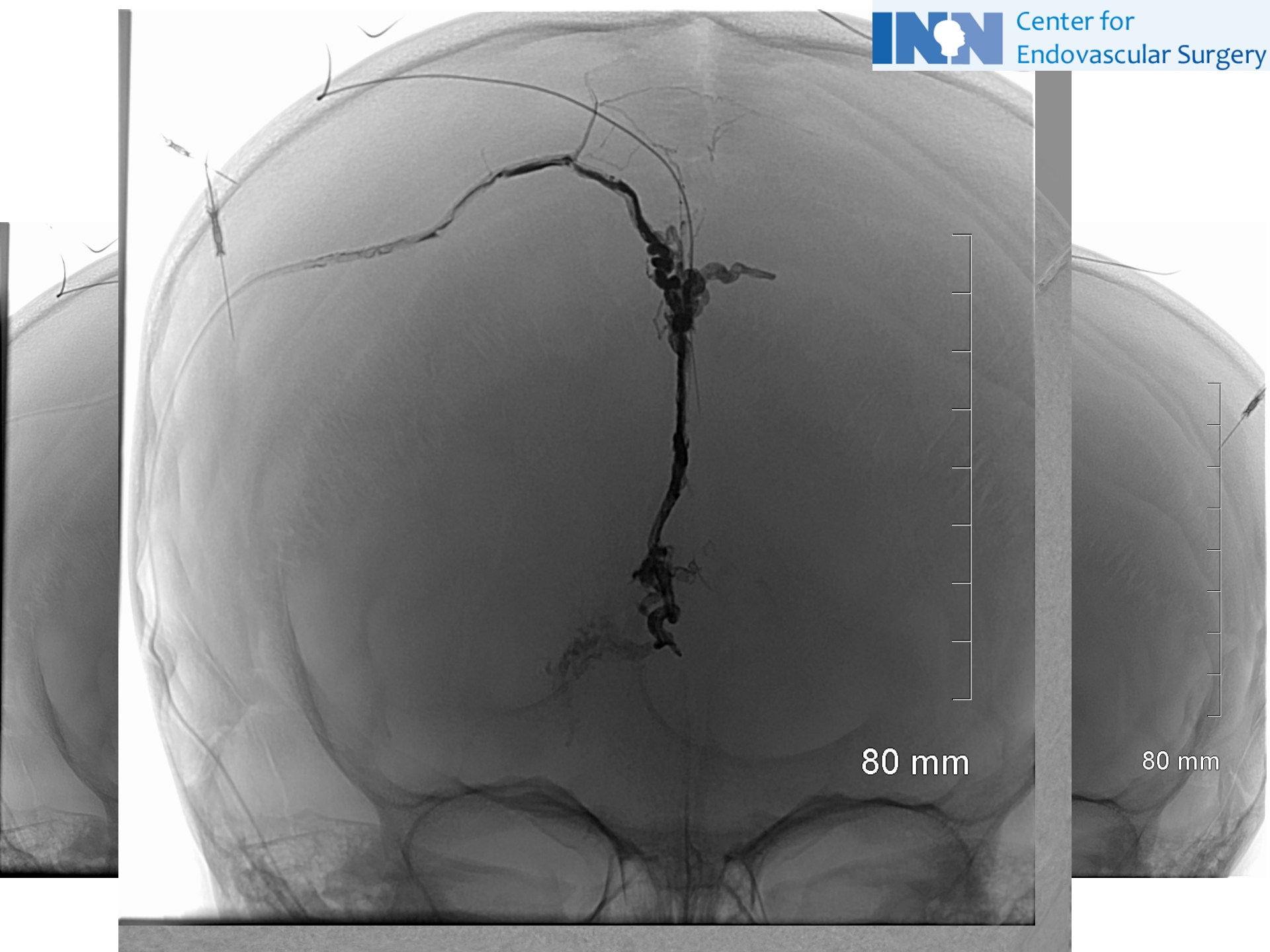
Right
Left
120 mm
160 m
60 mm

Summary of planned Endovascular Approach and materials

- Right Groin:4-Fr Angiodynamic catheter Lvert
- Left groin: 5-Fr Envoy catheter RECA
- Traxcess-14 microguidewire
- **Scepter XC balloon microcatheter**
- **ONYX 18** from right middle meningeal

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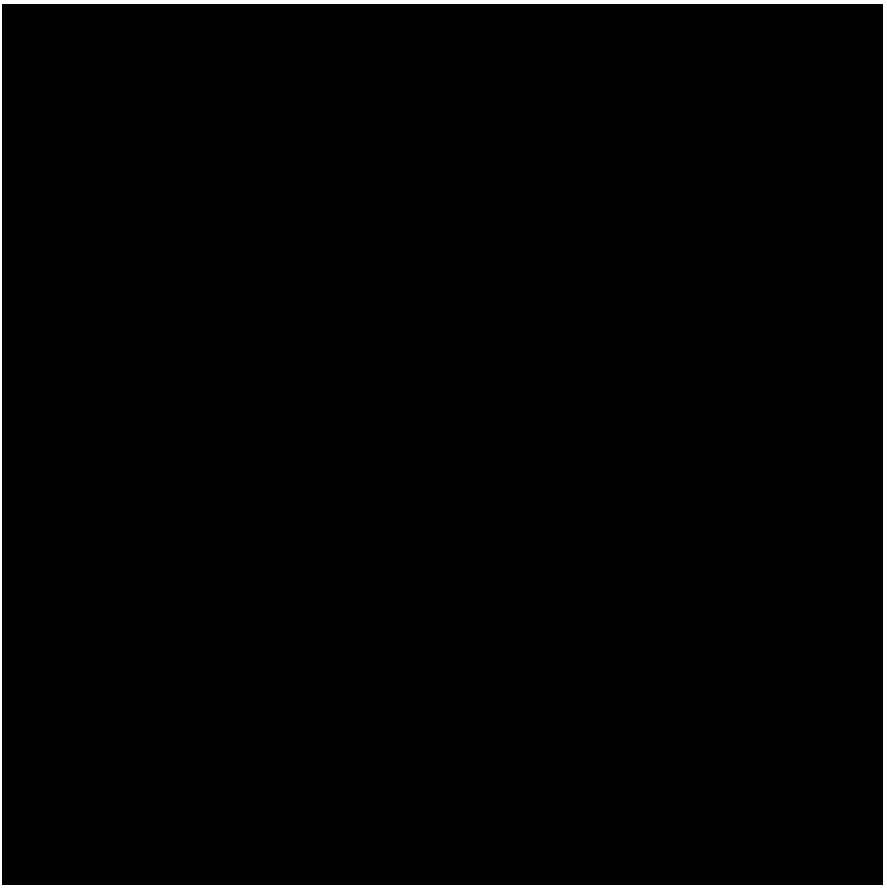
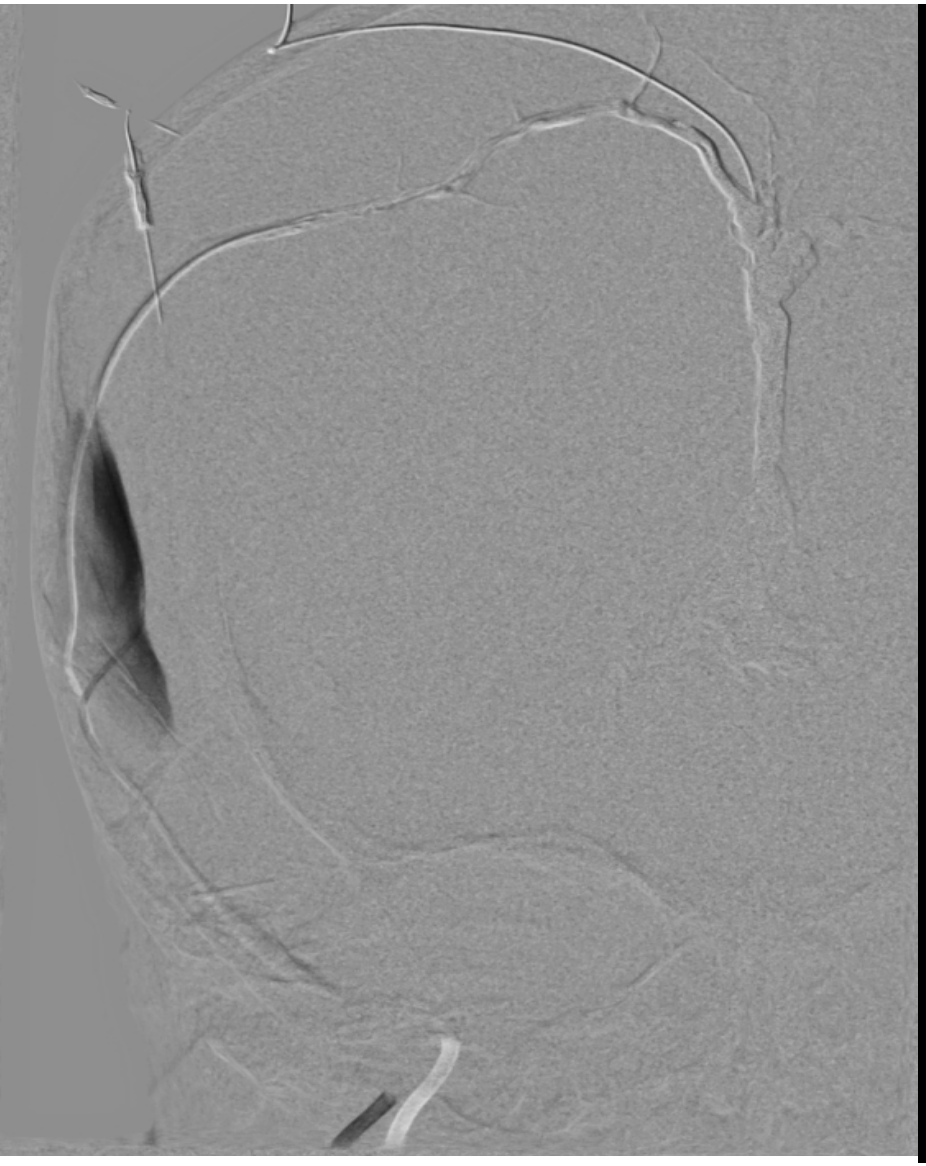
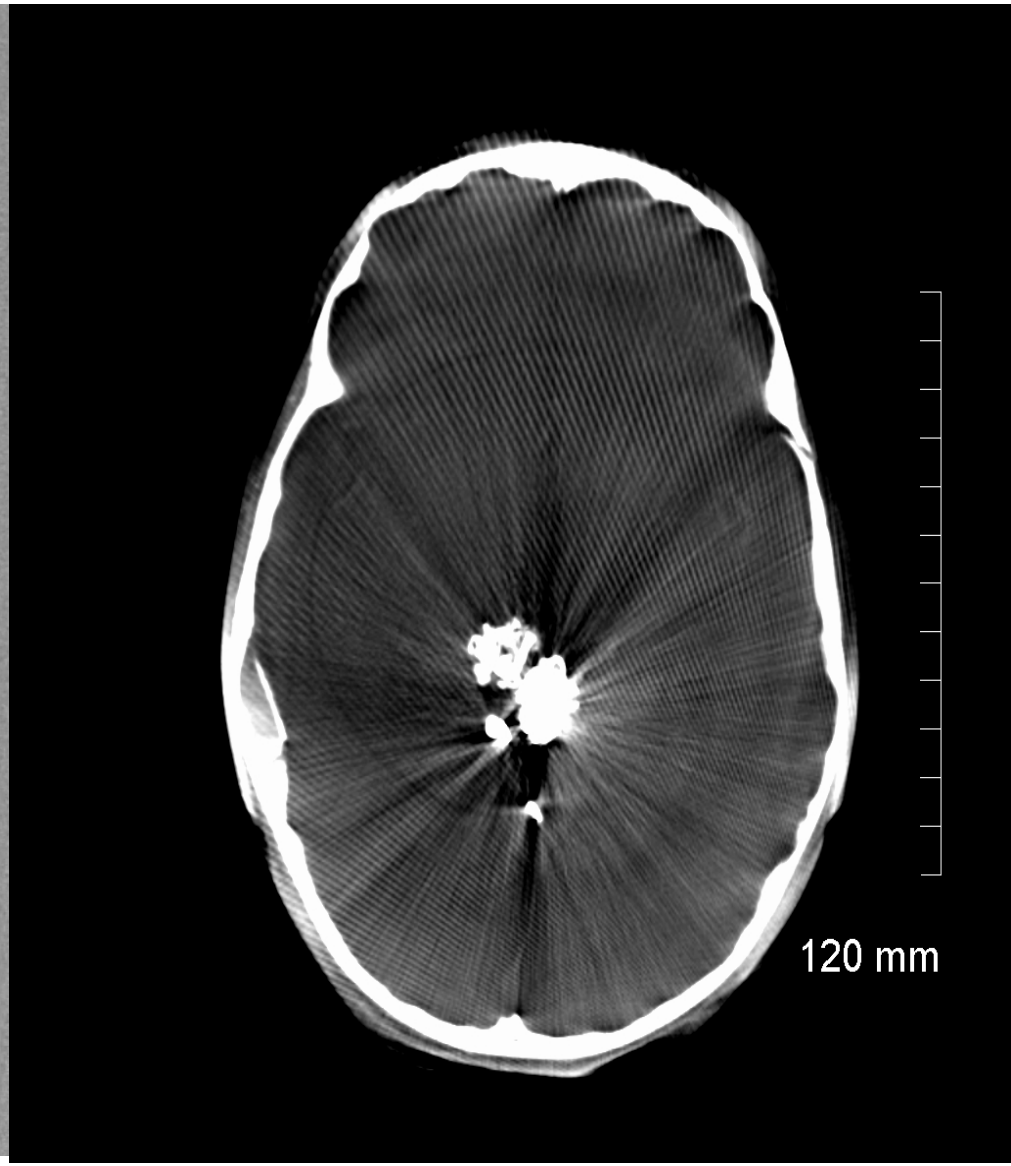
80 mm
80 mm

Pots-embolization angiogram



Angiographic approach and

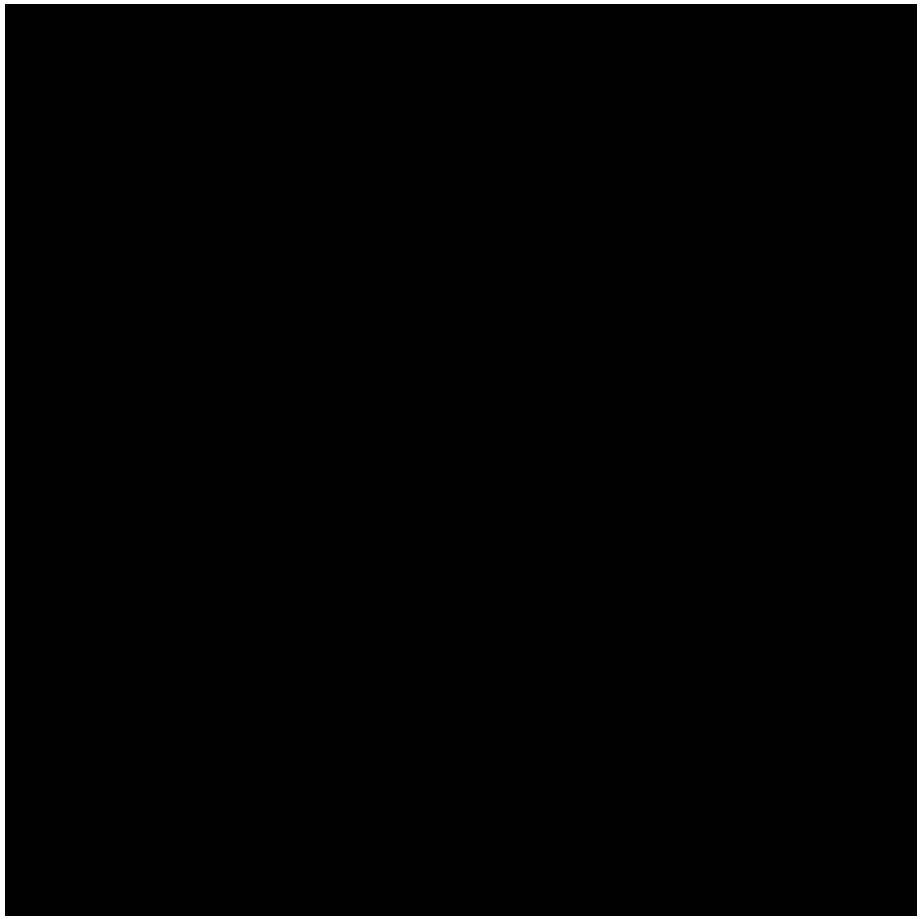




Complication bailout

Center for Endovascular Surgery

- Neurosurgery was call stat and OR was prepared
- A Magic 1.2 FM and glue set was open
- Catheterization through the left MMA was attempted.

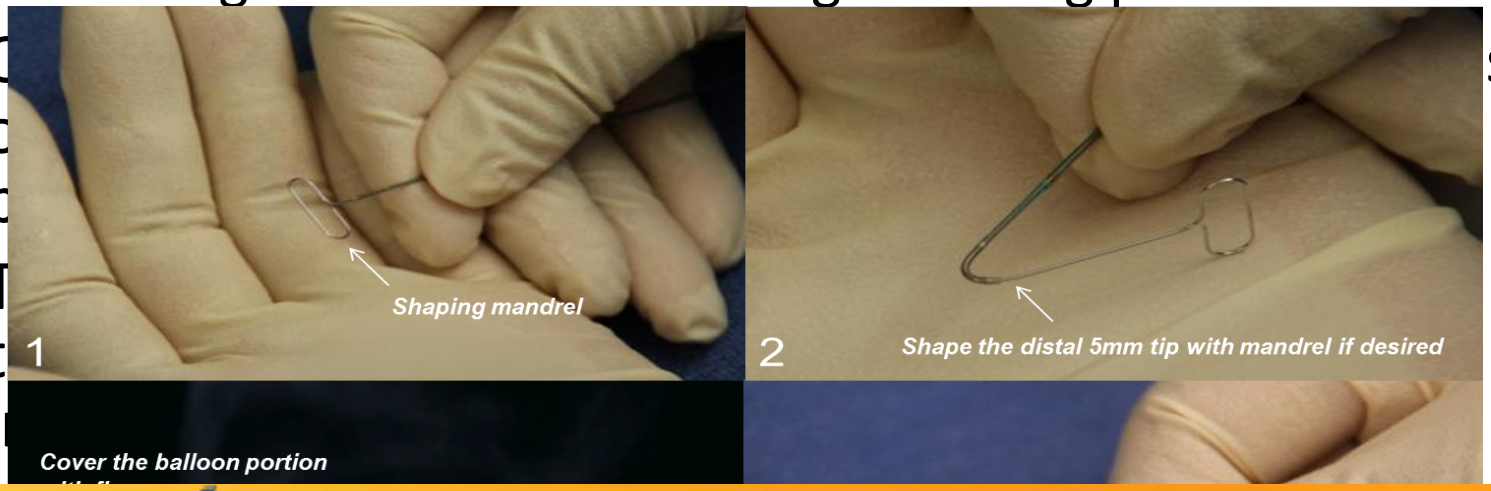


Outcome

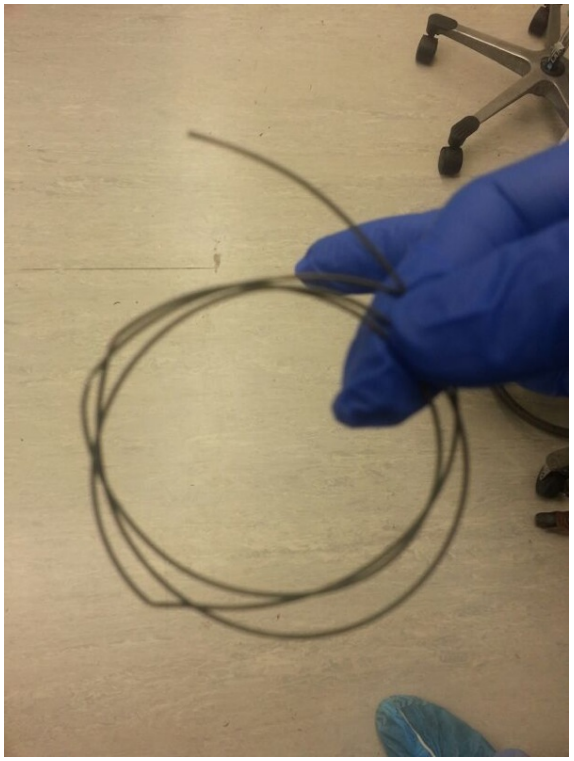
- Patient remained hospitalized for 7 days with no further complications
- At discharge patient had only mild impairment in the fast alternating movements in UE
- He had a full recovery of gross motor function in the upper and lower extremity
- Plan: return for further embolization in 6 month

Lessons learnt

- Appropriate functioning and location of balloon microcatheters should impede any Onyx reflux
- Reflux could indicate manufacture malfunction or suboptimal preparation or influence:
  - Under steamed tip with leakage of contrast
  - Damage of the balloon during steaming process
- C… s a c… p…
- T… t… i…
- …



Be careful with the External carotid!



Thank you for your attention

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Treatment of a Large, Extradural Internal Carotid Aneurysm with Flow Diversion using a Covered Stent (JOSTENT)

Tom C Pitts MD, Jacob Kitchener MD, Brian Ludwig, MD, John Terry MD, William Protzer MD

Introduction: The authors describe off-label use of **JOSTENT** (Abbott Vascular) for treatment of an internal carotid artery aneurysm, with multi-year follow-up.

Case: An 18 year old with headaches and diplopia was found to have an unruptured internal carotid aneurysm. CTA demonstrated a 2.5 cm right internal carotid aneurysm in the skull base at the foramen lacerum, with erosion of the surrounding structures including the clivus.

Technique: IRB approval was sought for the off-label use of the device prior to procedure. An aspirin and Plavix load was given previously. Via transfemoral access, a 7F shuttle sheath was placed in the right internal carotid artery and a 4.5mm x 26mm Jostent was placed across the aneurysm. Arteriography showed a significant endoleak from the proximal portion of the stent/aneurysm. A second 4mm x 19mm Jostent was deployed resulting in reduction of the endoleak. A 5mm x 2mm balloon was used for angioplasty proximal and distal to the remaining endoleak, resulting in complete obliteration. There were no complications. The patient remained on aspirin and Plavix for 6 months, followed by just aspirin. Imaging from 2007 to 2011 confirmed circulatory exclusion of the aneurysm.

Discussion: In light of recent interest in flow diversion for large carotid artery aneurysms, this case shows that the JOSTENT may be a safe option. Published examples similar to this case remain sparse, and most lack multi-year follow-up.

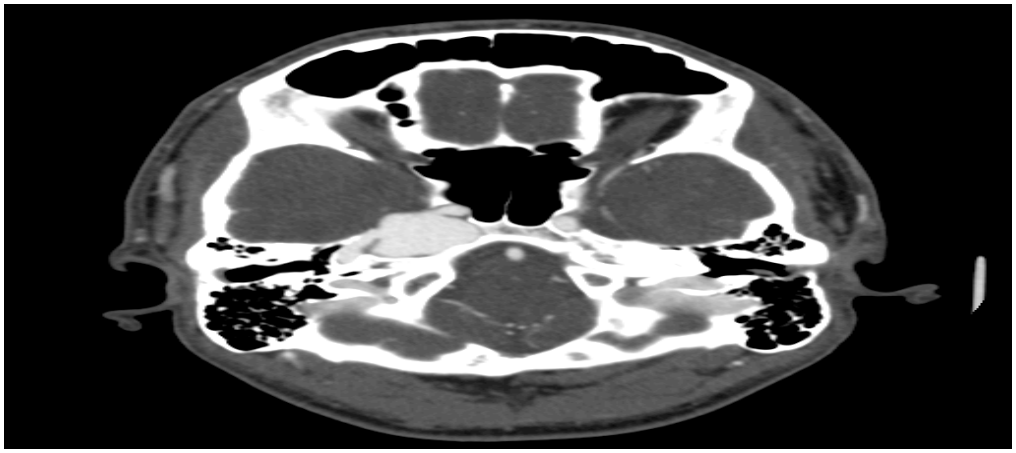

Image 1 CTA head, pre-procedure

Image 2 CTA head, 2 years post-procedure
Miami Valley Hospital Wright State University, Dayton, Ohio