RUSH UNIVERSITY MEDICAL CENTER

Treatment of vertebrobasilar fusiform aneurysms
Chicago Approach

Rush Center for
Neuroendovascular surgery

VertebroBasilar Fusiform Aneurysms

Rare… but…

one of the most formidable vascular lesions encountered

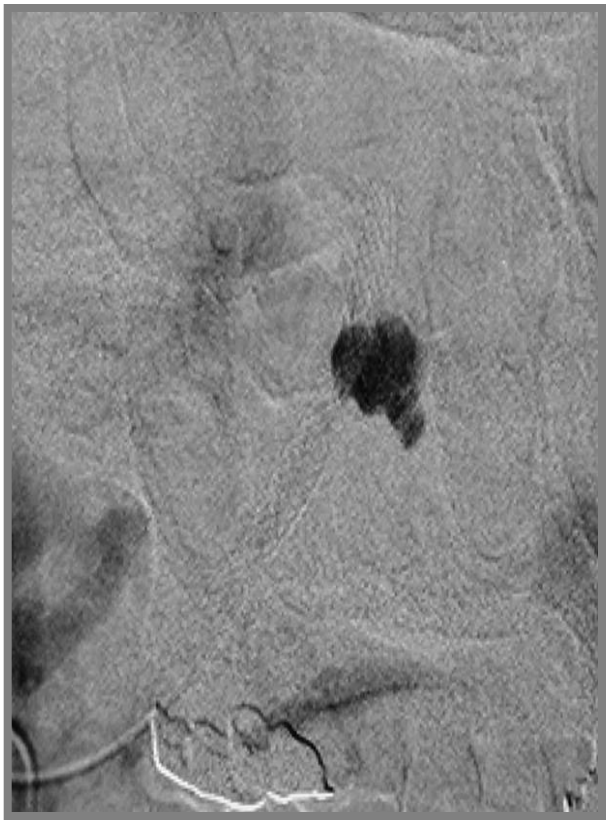
VB Fusiform Aneurysms

- < 2% of all intracranial aneurysms
- Strong association with hypertension
- Presentation:
  - ✓Ischemic stroke
  - ✓Hemorrhagic stroke
  - ✓Compression (Mass effect)

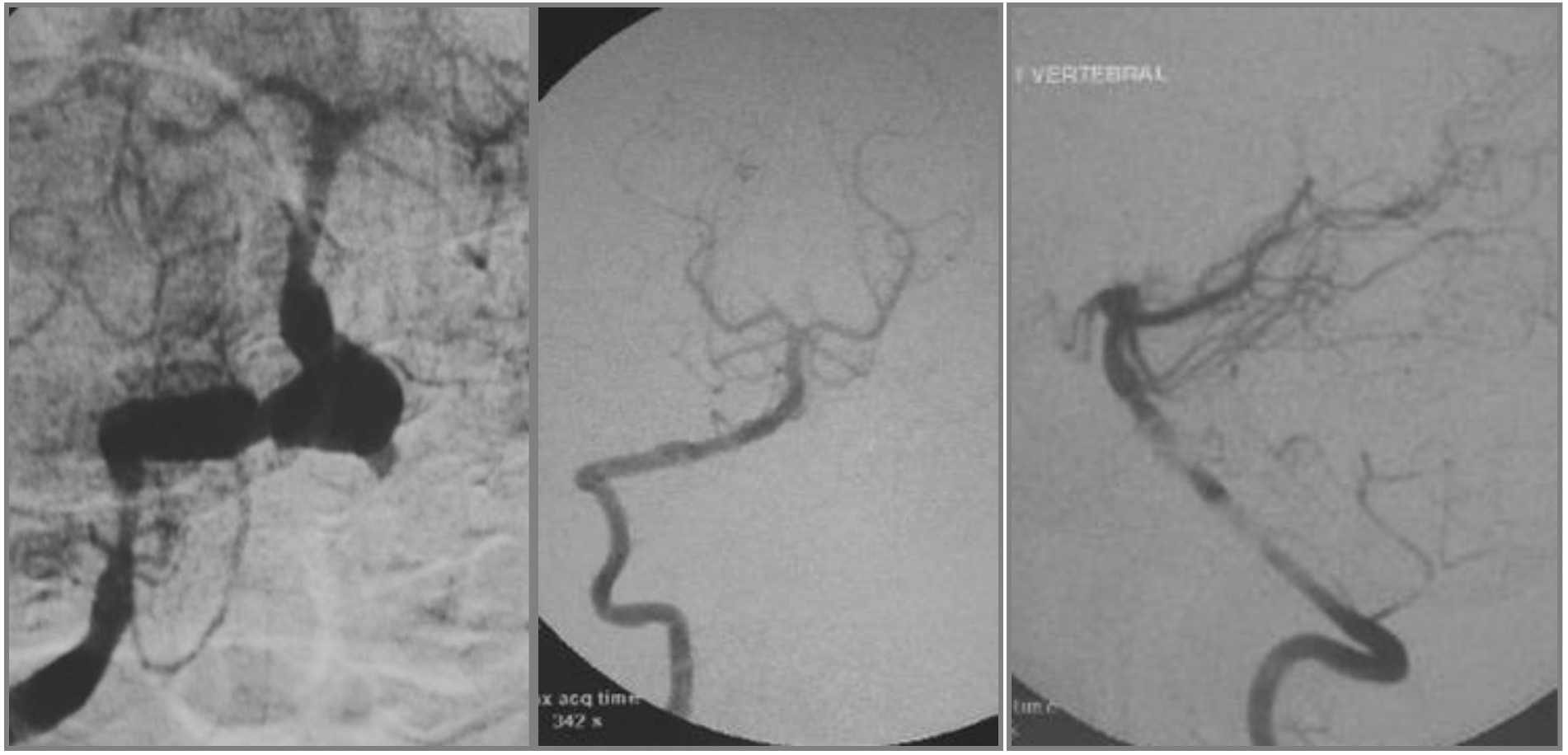
    Brainstem, CN palsies, Hydrocephalus
- Poor natural history
  - Increased risk of stroke
  - Median survival 7.8 years

1990's – Magic wall self expanding stent

From bench research to clinical application of flow diversion



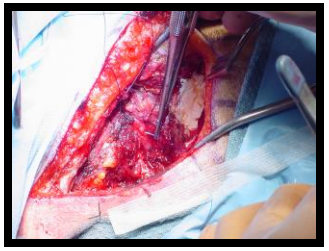
Incredible case and wonderful clinical outcome

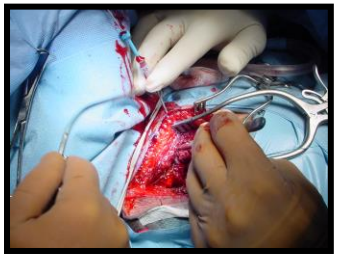


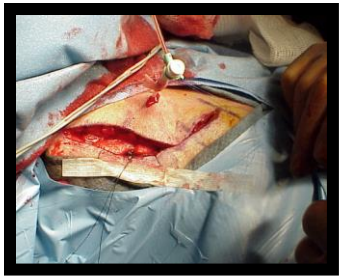
Pre- stent

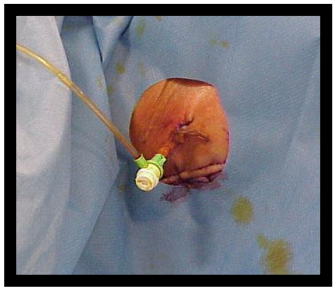
3 months follow-up post stent

1990's other cases not so successful



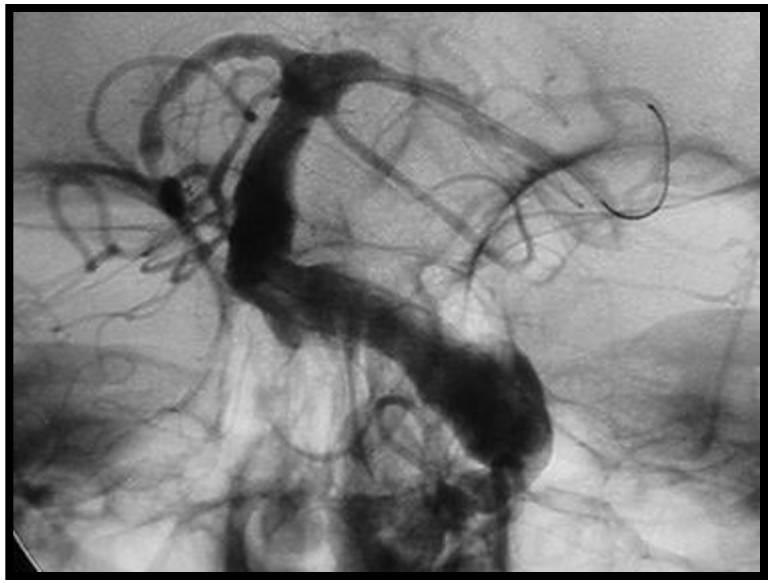






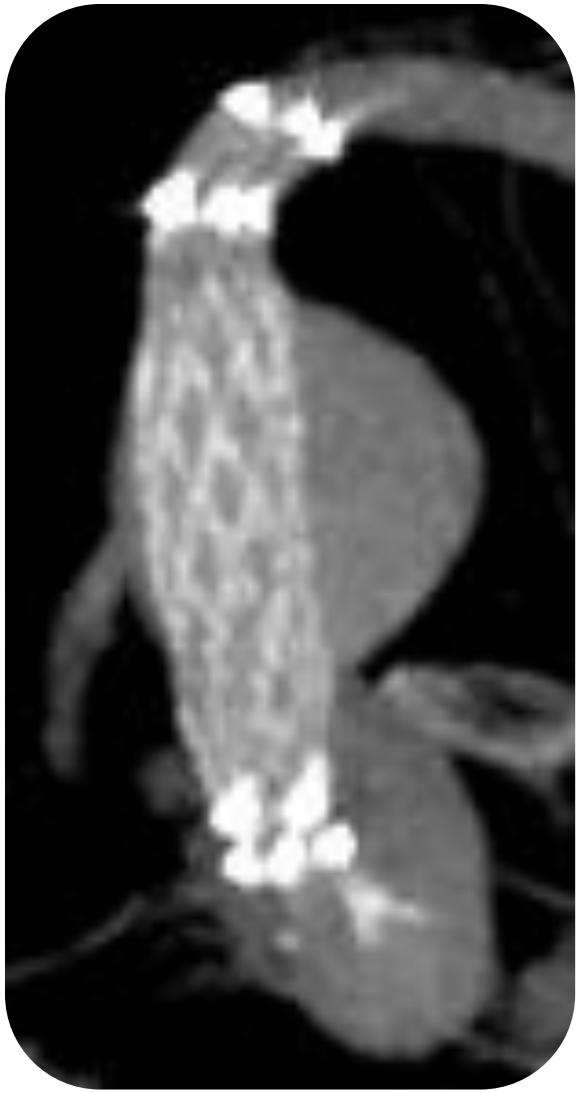
Problems:

1. Access
2. Lack of neuro devices
3. Timing of surgery
4. Best antiplatelet and anticoagulation
5. No intravascular imaging

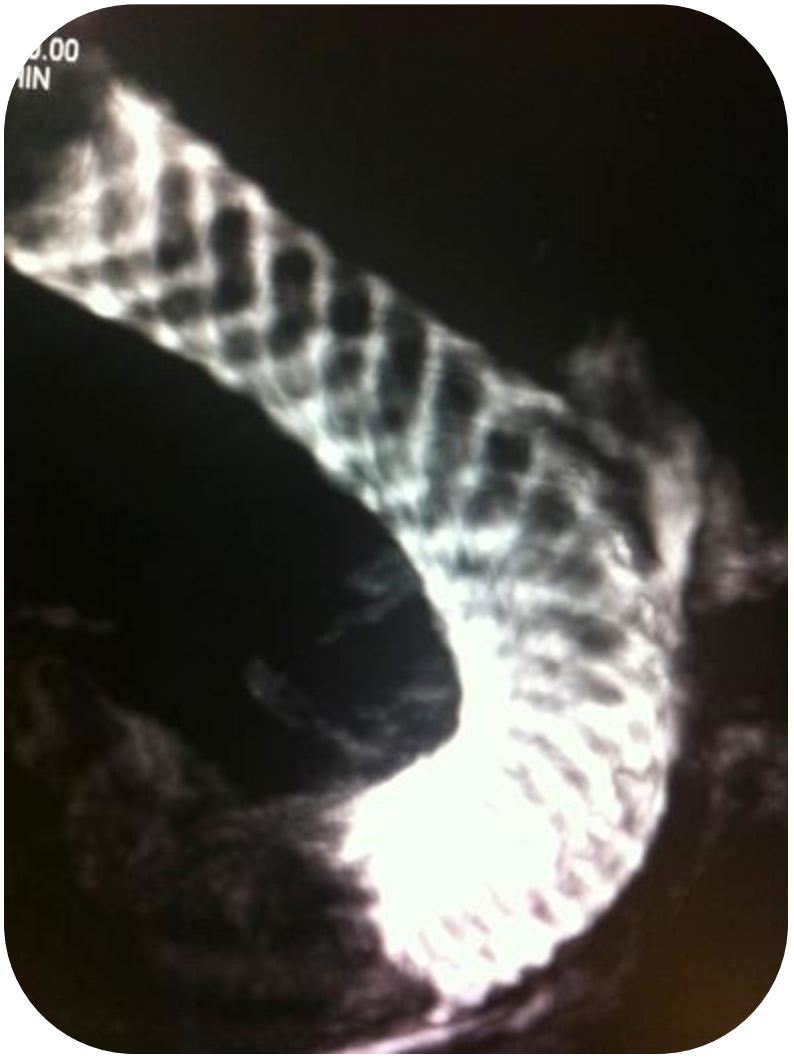


How about Flow Diverters?

"Home made"



The real "thing"



FD in posterior circulation

Bad outcomes reported!

Case	Pre op mRS score	Post op stroke	Post op mRS score
1	1	no	1
2	4	no	6
3	1	yes	0
4	2	yes	6
5	2	yes	6
6	3	yes	5
7	4	yes	6

Siddiqui et al. JNS 116: 1258-1266, 2012

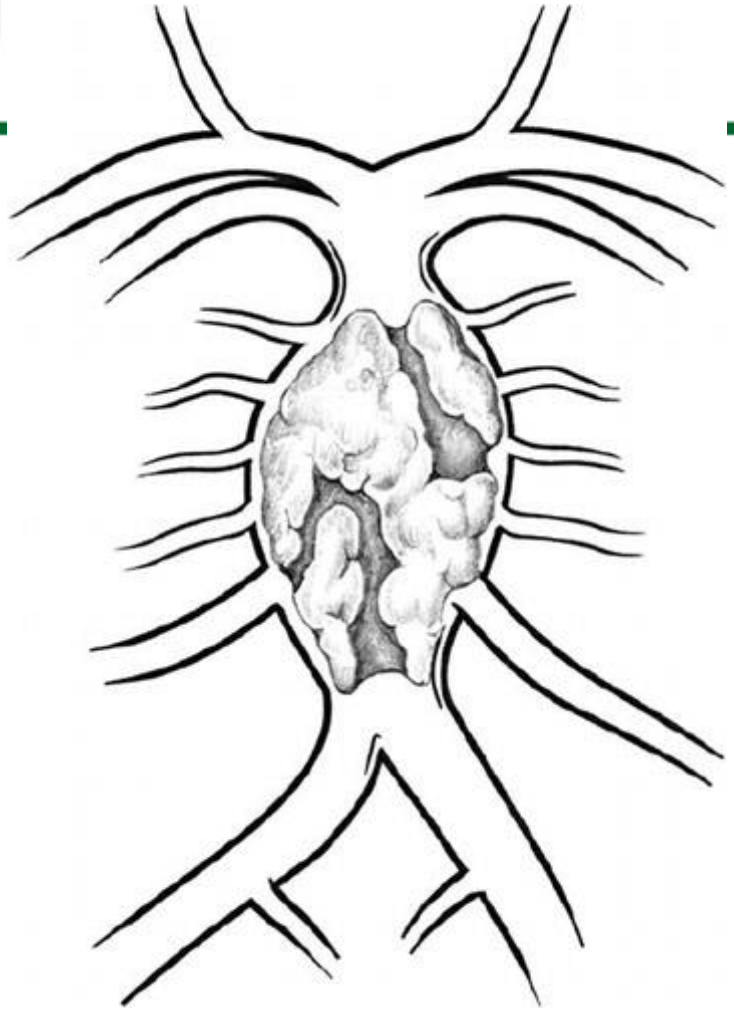
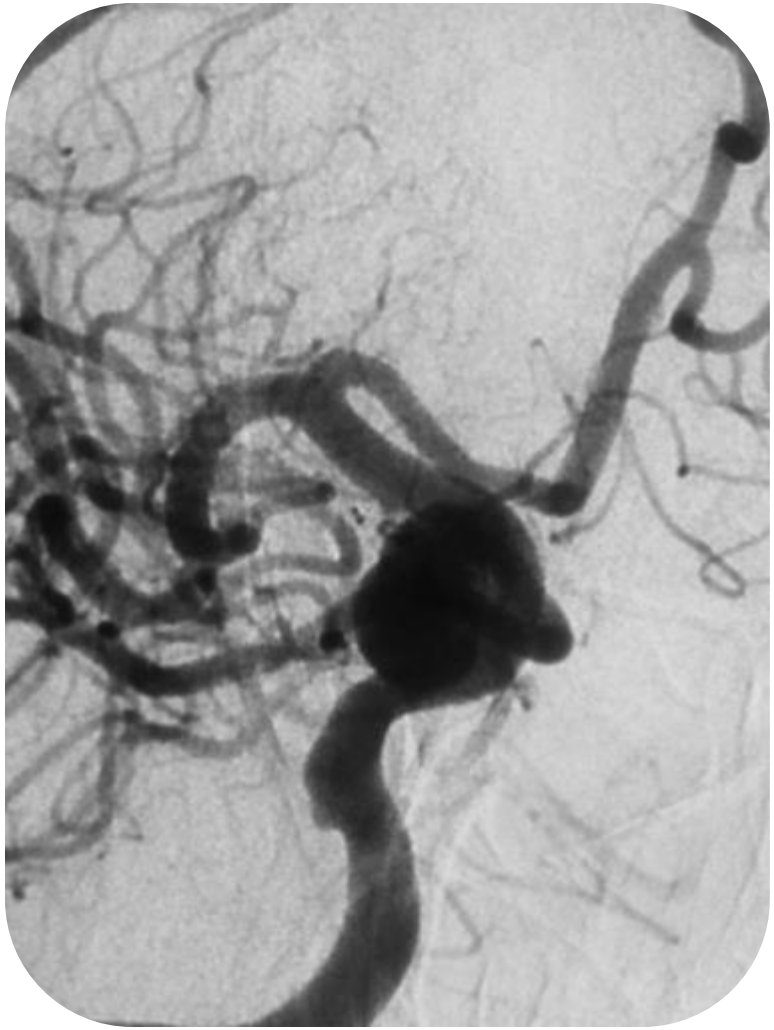


Illustration showing a **fusiform thrombosed holobasilar aneurysm** with multiple patent branches on the walls of the aneurysm with preserved flow in them through the thrombus

These aneurysms are not good candidates for flow diversion and carry a high risk of brainstem stroke

Can you use flow diverters for both?

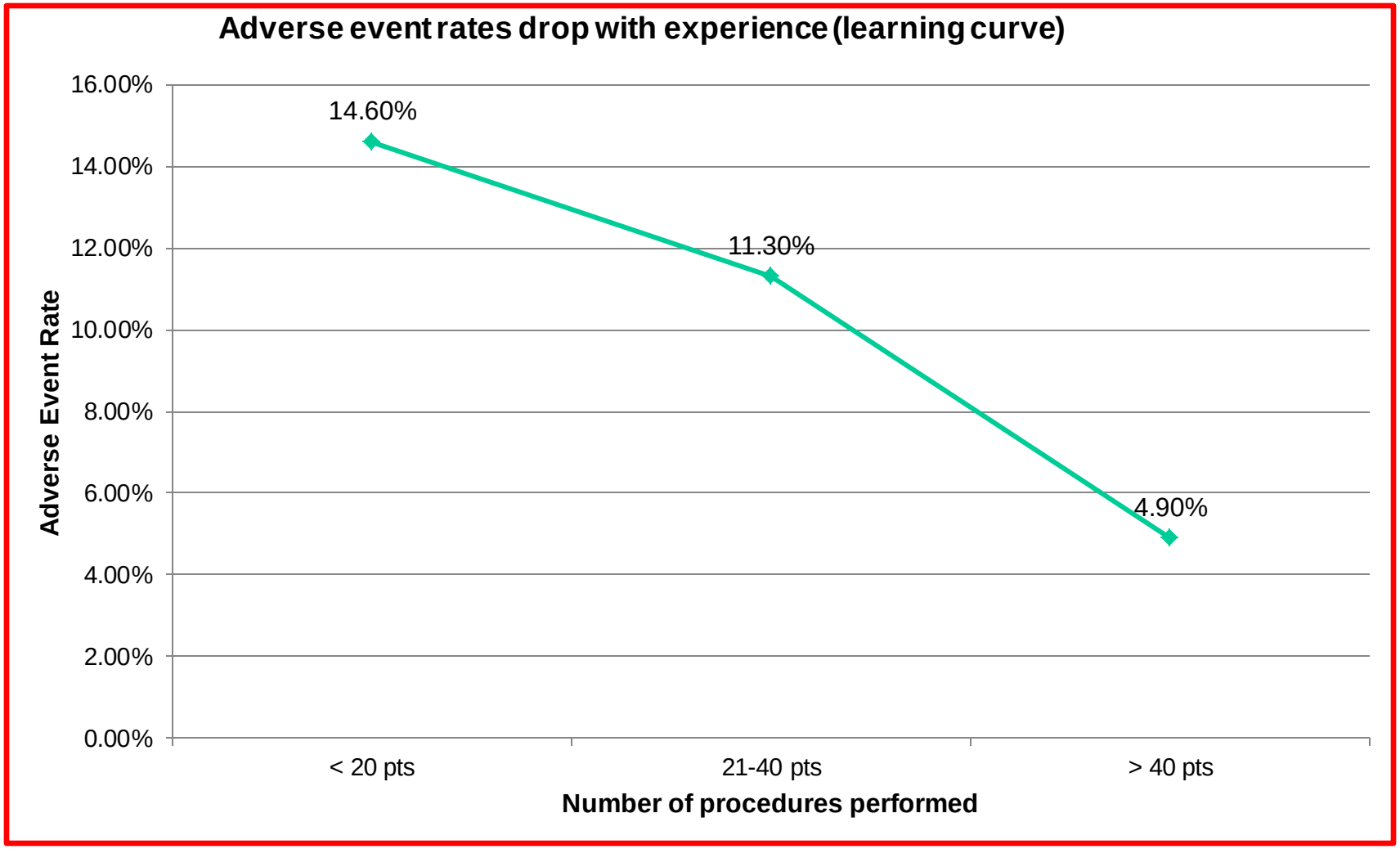


Carotid

Basilar

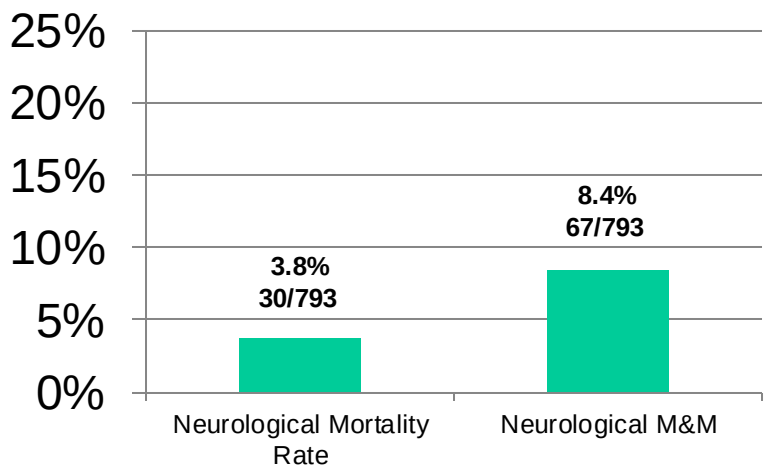
Learning Curve of FD

Data from intrePED registry



IntrePED (International Retrospective Study of the Pipeline Embolization Device: A Multi-center Aneurysm Treatment Study)

Design	Multi-center, retrospective, post-market registry
Objective	Determine the incidence of important safety outcomes in patients who have undergone Pipeline™ embolization for intracranial aneurysms in a true clinical setting
Primary Endpoint	Rate of neurologic adverse events after treatment with Pipeline™
Population & Sample Size	906 Aneurysms in 793 patients treated with the Pipeline™ since approval
Sites	17 centers worldwide



IntrePED posterior circulation

Patient Characteristics	Posterior Circulation
Number of Aneurysms	95
Number of Patients	91
Follow-up duration (median)	22.4 +/- 10.5
Procedure time (min)	
Mean +/- SD (N)	98.3+/- 51.4 (85)
Median, range (min, max)	88.0 (34 – 294)

IntrePED posterior circulation

Location	Saccular	Fusiform	Dissecting	Others	Total
PCA	2 (13.3)	5 (33.4)	6 (40.0)	2 (13.3)	15
BA	22 (50.0)	12 (27.3)	7 (15.9)	3 (6.8)	44
VA	7 (21.2)	11 (33.4)	14 (42.4)	1 (3.0)	33
PICA	3 (100.0)	0	0	0	3
Total	34	28	27	6	95

IntrePED posterior circulation

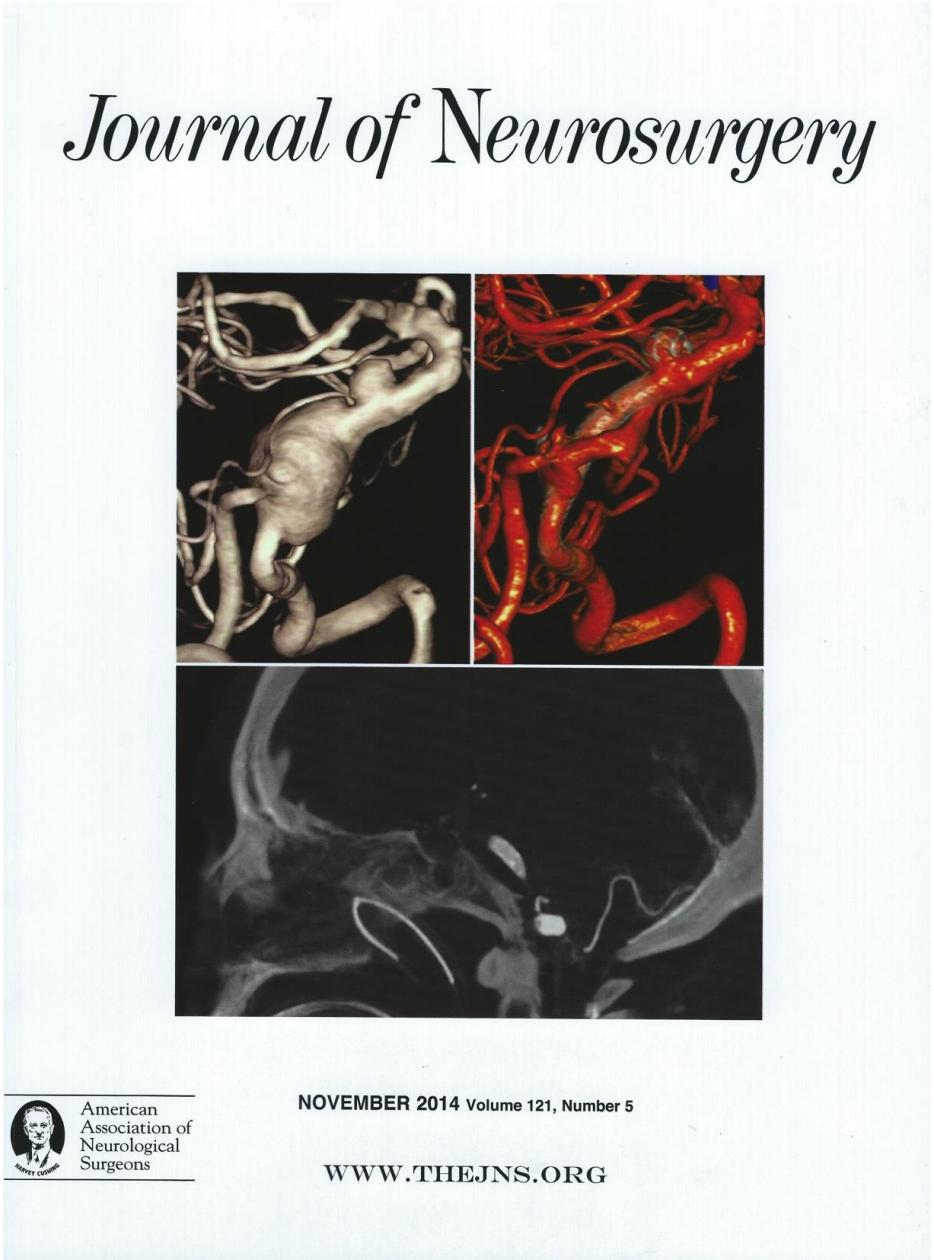
Major Complications	Fusiform	Dissecting	Saccular	Other
Neurological morbidity	5/26 (19.2%)	1/26 (3.9%)	2/35 (5.7%)	0/4 (0%)
Neurological mortality	3/26 (11.5%)	1/26 (3.9%)	3/35 (8.6%)	0/4 (0%)
Neurological morbidity & mortality	7/26 (26.9%)	1/26 (3.9%)	4/35 (11.4%)	0/4 (0%)

Summary and Conclusion

- Major complications after PEDs treatment in posterior circulation aneurysms were ischemic stroke in 6, hemorrhage in 2, spontaneous aneurysm rupture in 1, and death in 7 patients among 91 patients with 95 posterior circulation aneurysms treated.
- Use of PEDs ≥ 3 was a strong predictor for morbidity and mortality after placement of Pipeline Flow Diverter in patients with posterior circulation aneurysms
- Fusiform aneurysms were also a predictor for morbidity and mortality after placement of PEDs in posterior circulation.

Reports of flow diversion for posterior circulation aneurysms

Authors & Year	No. of Patients	No. of Fusiform Aneurysms	No. of Ischemic Complications (%)	No. of Hemorrhagic Complications (%)	No. of Disabilities Related to PEDs (%)	No. of Deaths Related to PEDs (%)	Mean FU (mos)
Phillips et al., 2012 (3 centers)	32	20	3 (9.4)	2 (6.3)	3 (9.4)	0	21
Siddiqui et al., 2012	7	3	5 (71.4)	2 (28.6)	1 (14.3)	2 (28.6)	4.5
Chalouhi et al., 2013	7	2	0	0	0	0	5
Toth et al., 2015	6 (7 aneurysms)	2	3 (50)	0	2 (33)	1 (16.6)	14.5
Munich et al., 2014	12	12	4 (33)	0	3 (25)	1 (8.3)	11
Buffalo series, 2014	12	12	1 (8.3)	0	1 (8.3)	0	22



Chicago experience on endovascular treatment of vertebrobasilar aneurysms

Nov 2014

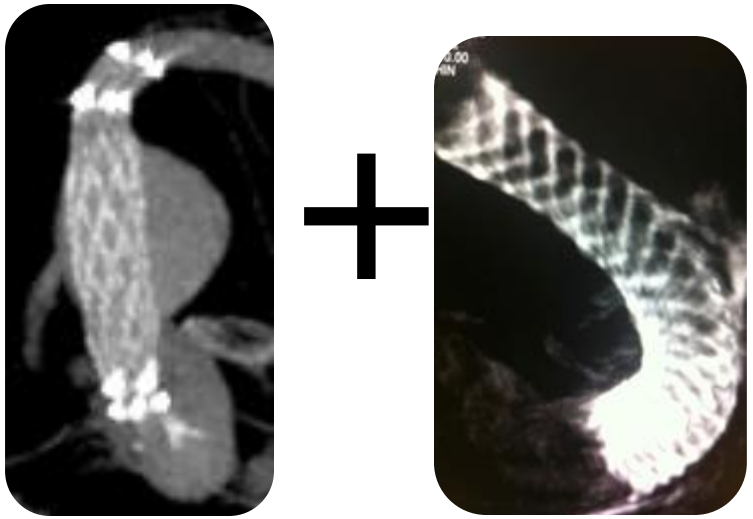
VB fusiform aneurysm: What to do?

Approach:

Hybrid stent/FD overlapping construct staged contralateral VA sacrifice and or coiling of aneurysm

Goals:

1) **Variable Arterial Coverage**
2) **Gradual aneurysm thrombosis**



+

=

Increased Safety?

Technical Considerations

1) Protection of perforating arteries:

- rostral basilar artery may contain a higher density of perforating arteries
- these arteries may be more sensitive to changes in flow dynamics and acute aneurysm thrombosis
- territories served by these arteries may have more severe clinical manifestations when perforators are occluded

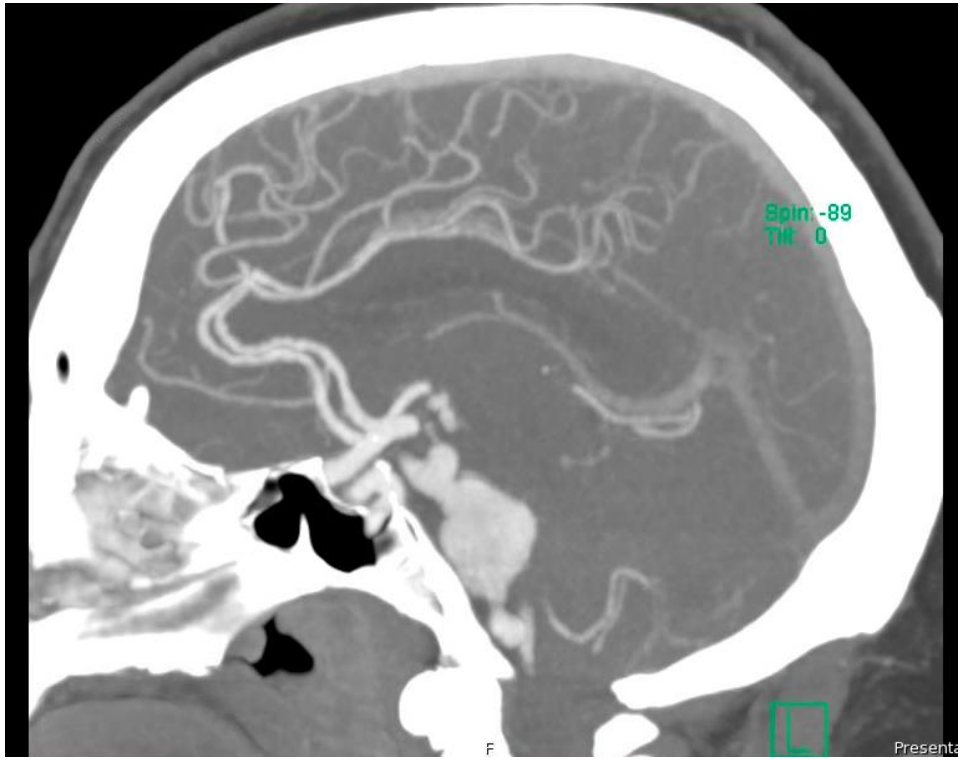
2) Staged contralateral vertebral artery occlusion

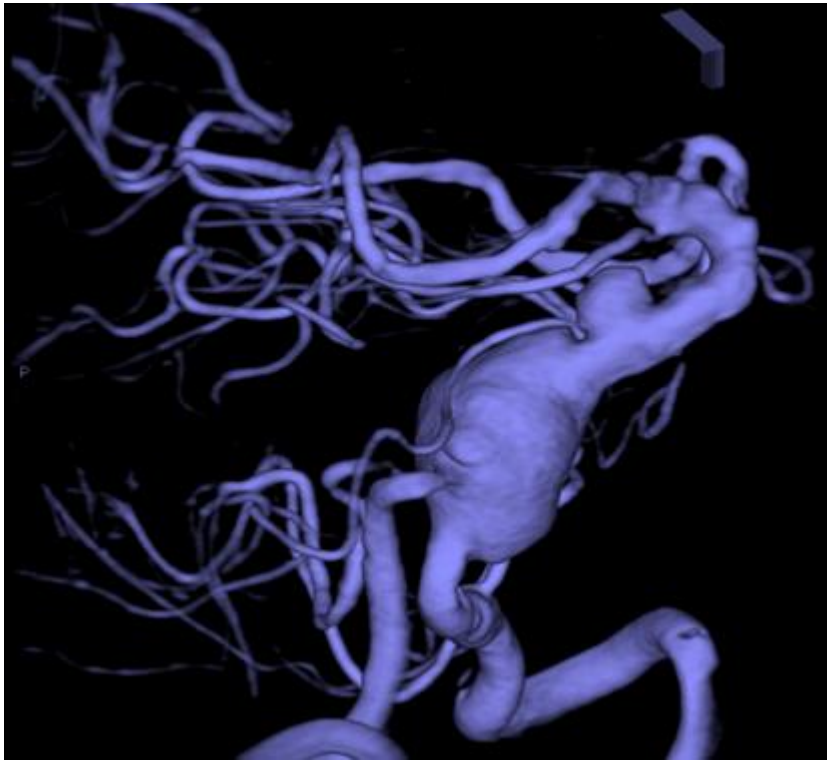
3) Anti-platelet therapy:

- confirmation of platelet inhibition
- strict adherence to dual agent anti-platelet therapy

63 year old female presented with right facial droop, dysarthria, and right tinnitus

Medical history: Hypertension & Obesity






7.37mm
4.73mm
3.59cm
4.00mm

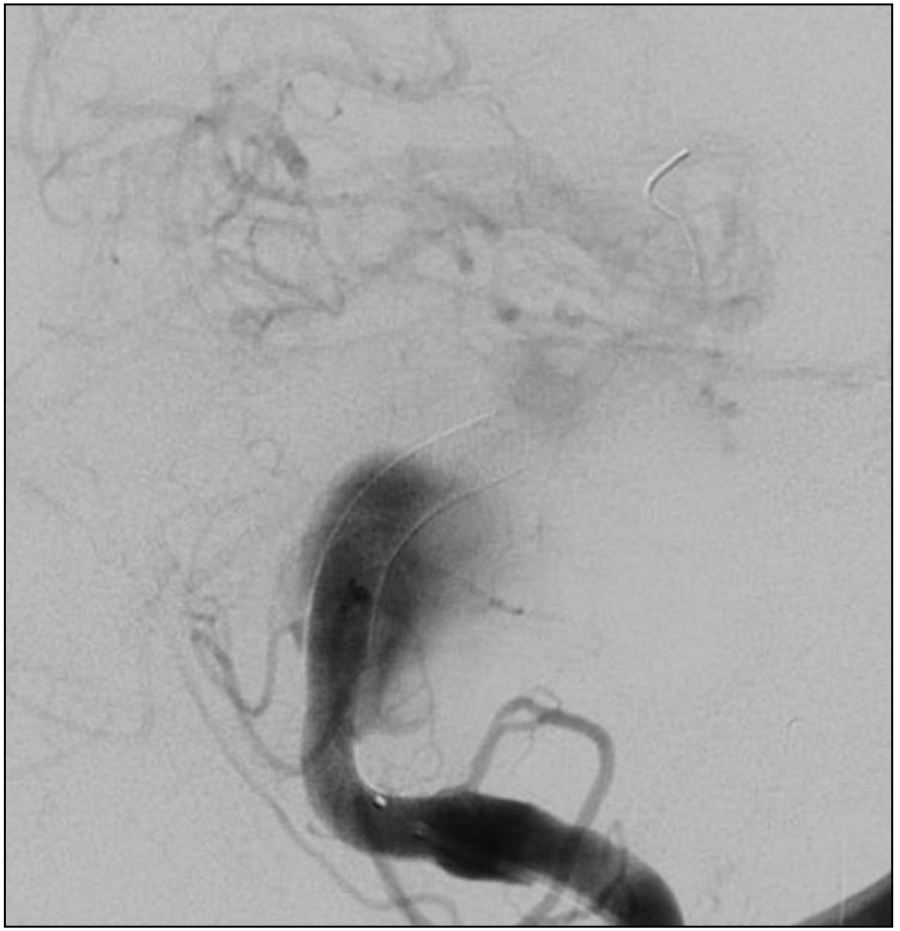
Strategy

- 1st Stage
  - Build a hybrid construct with Enterprise and Pipeline across both aneurysms
- 2nd Stage
  - Coiling of sidewall aneurysm and possible sacrifice of right vertebral artery

1st Stage 4/19/2013

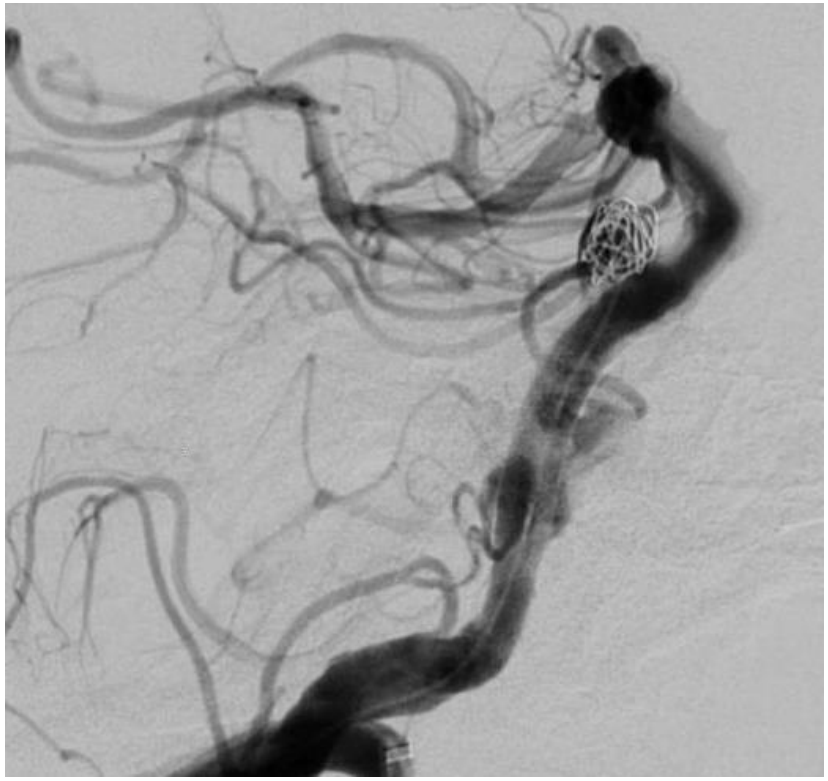
1st Stage

4/19/2013 Placement of PED and enterprise (Hybrid construct)



2nd Stage

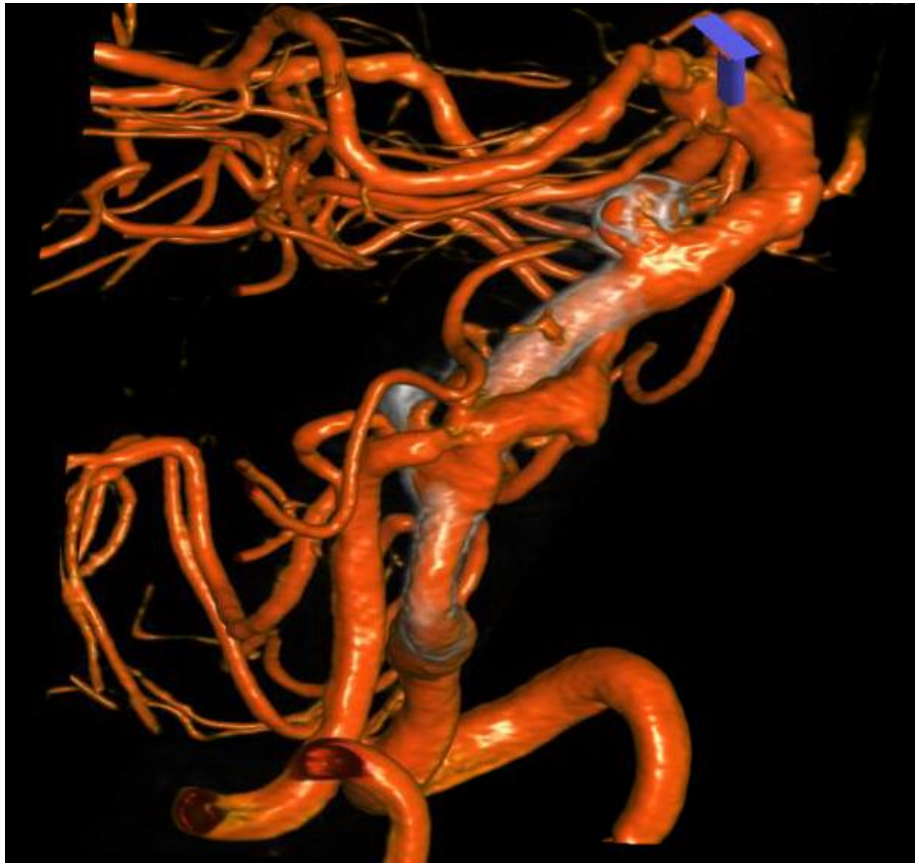
6/7/2013

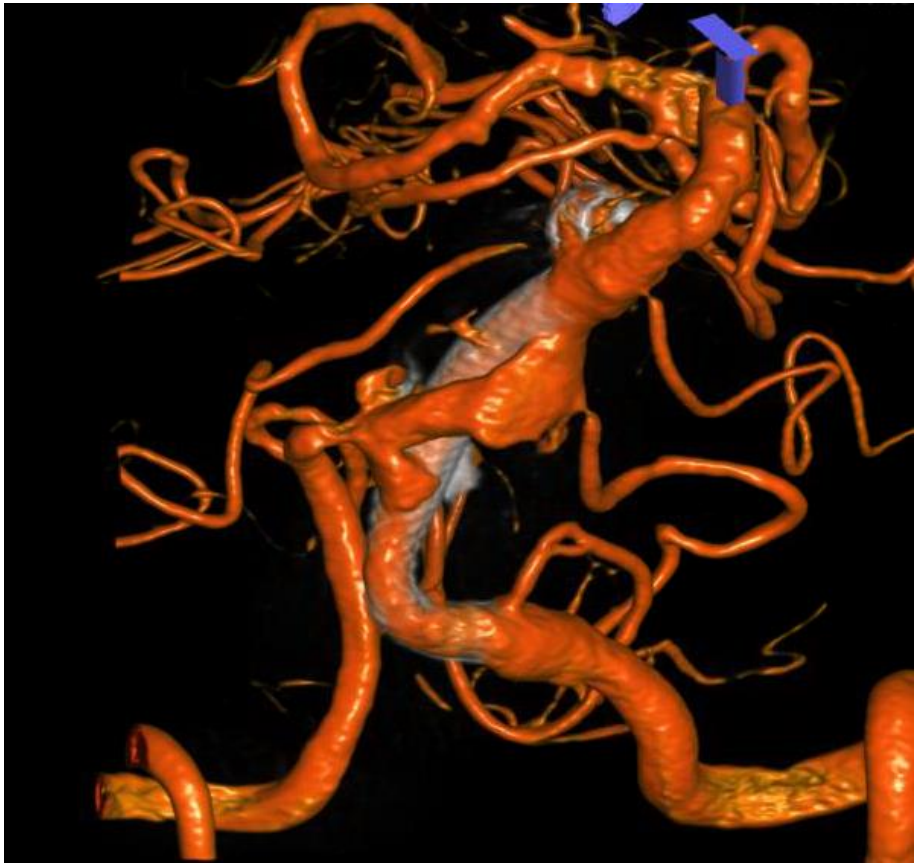


Light coiling of AICA aneurysm

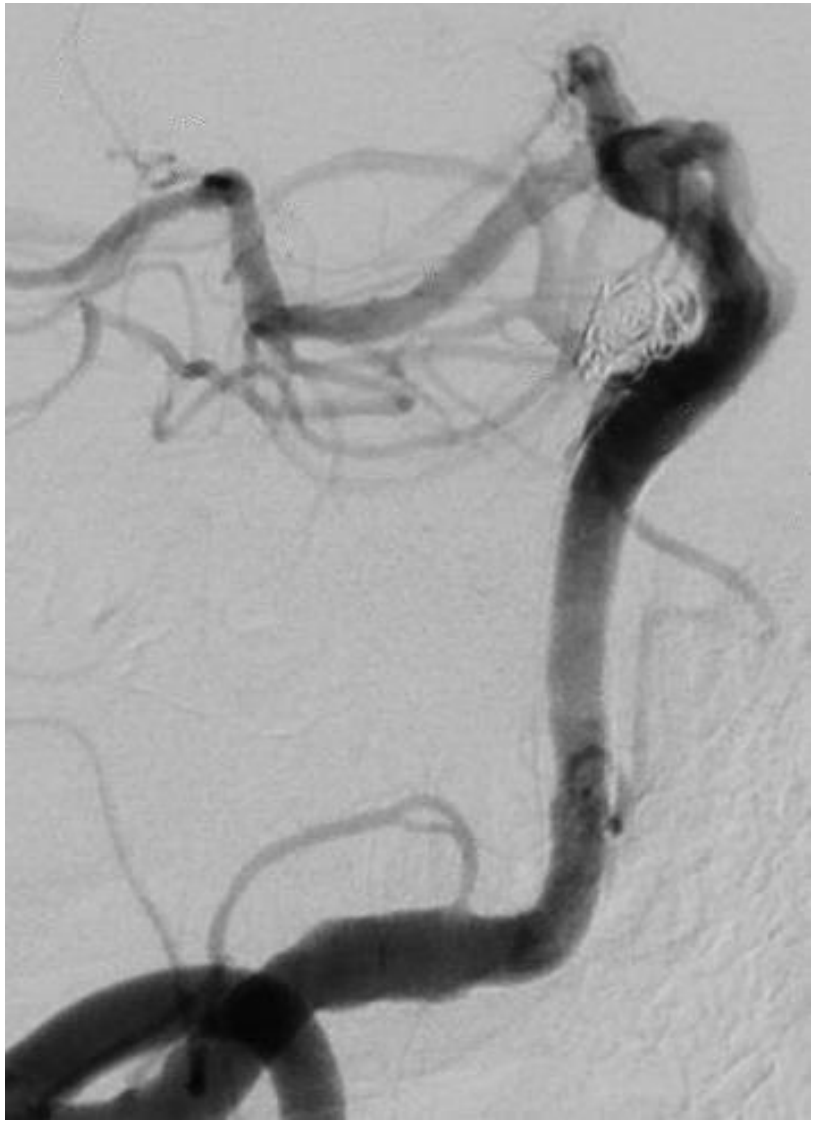
Decided not to occlude contralateral vertebral artery

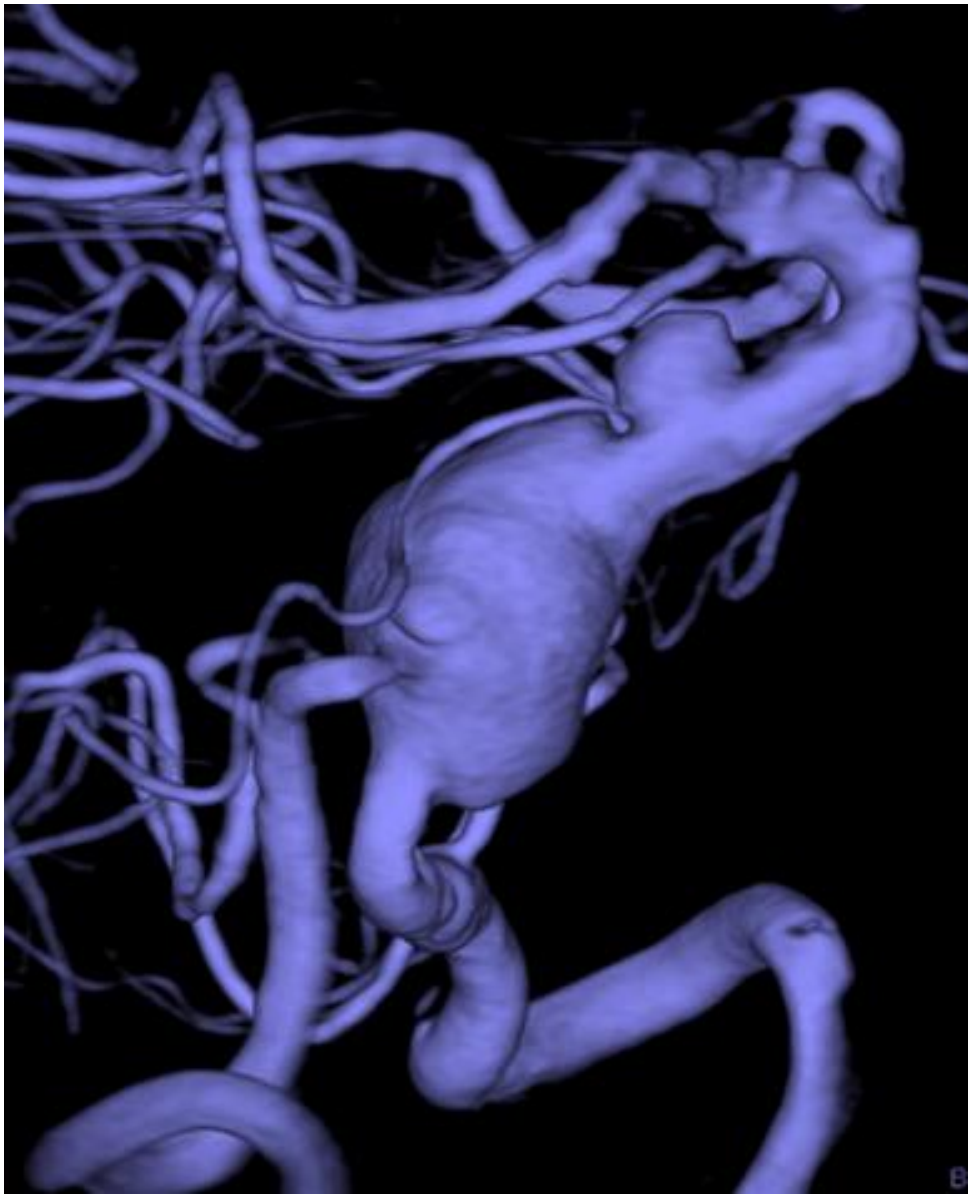
6/7/2013

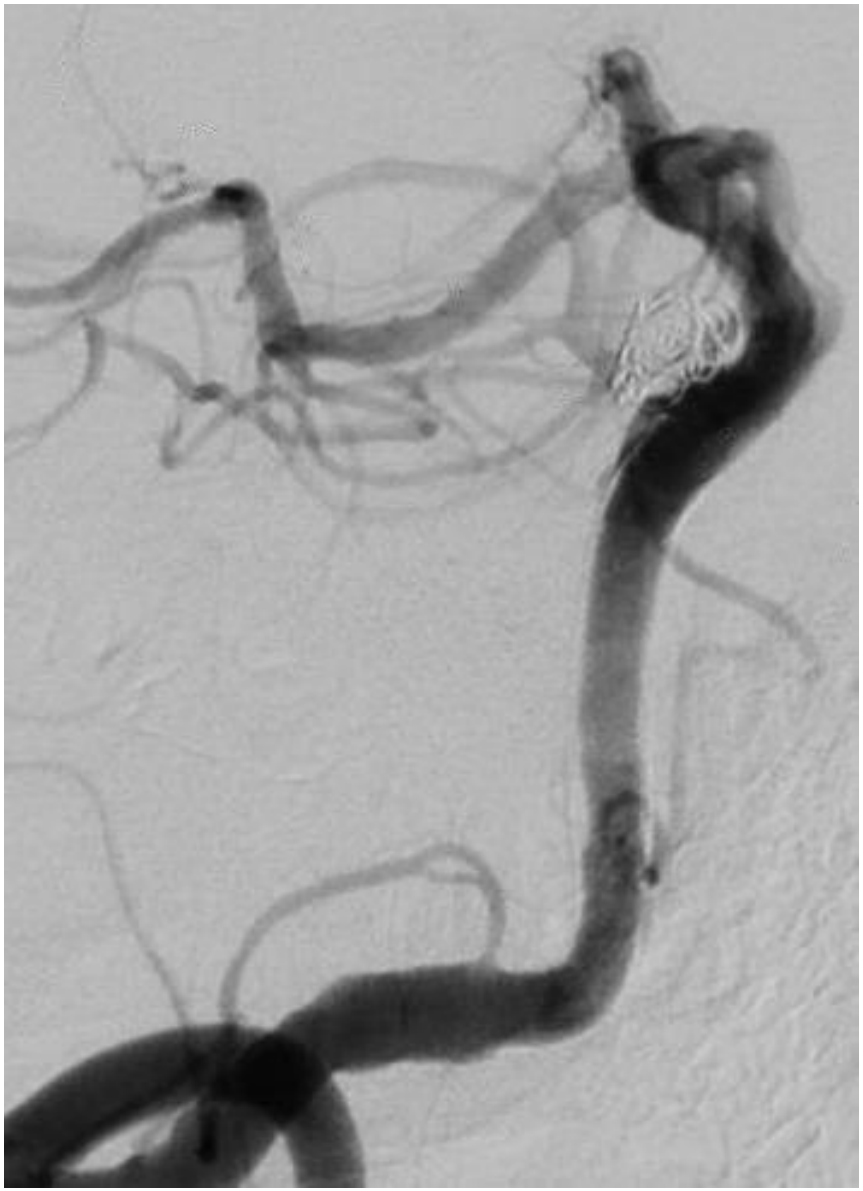




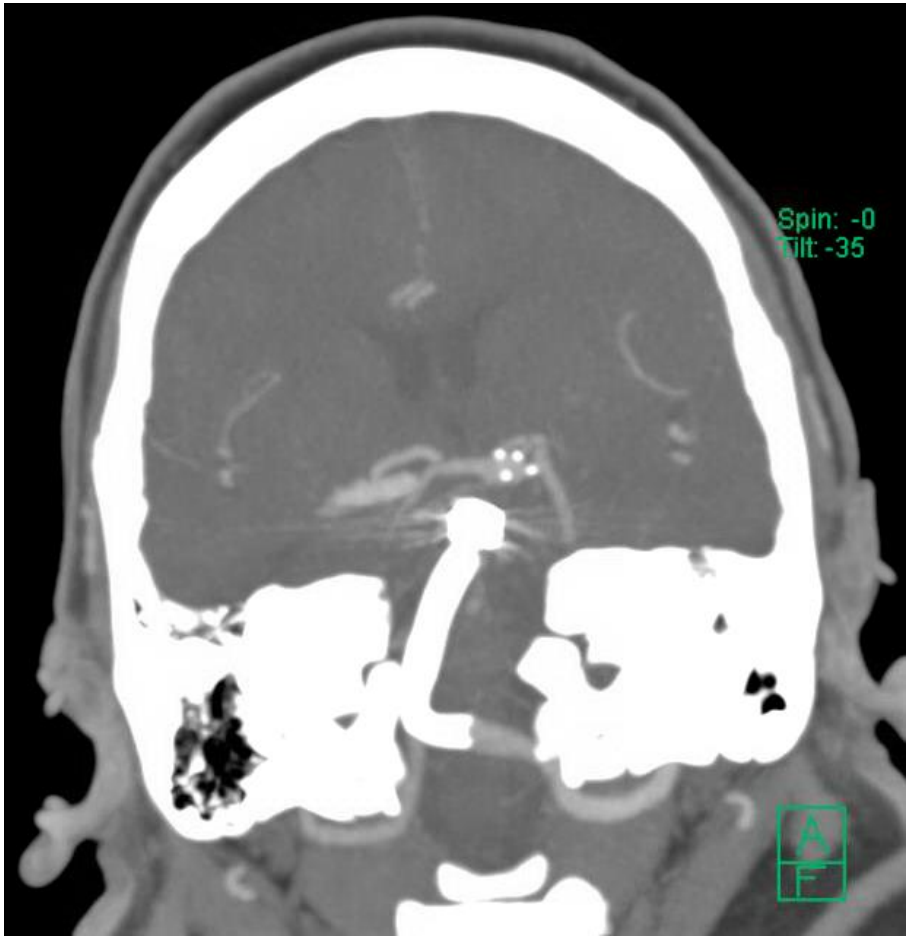
12 months follow up

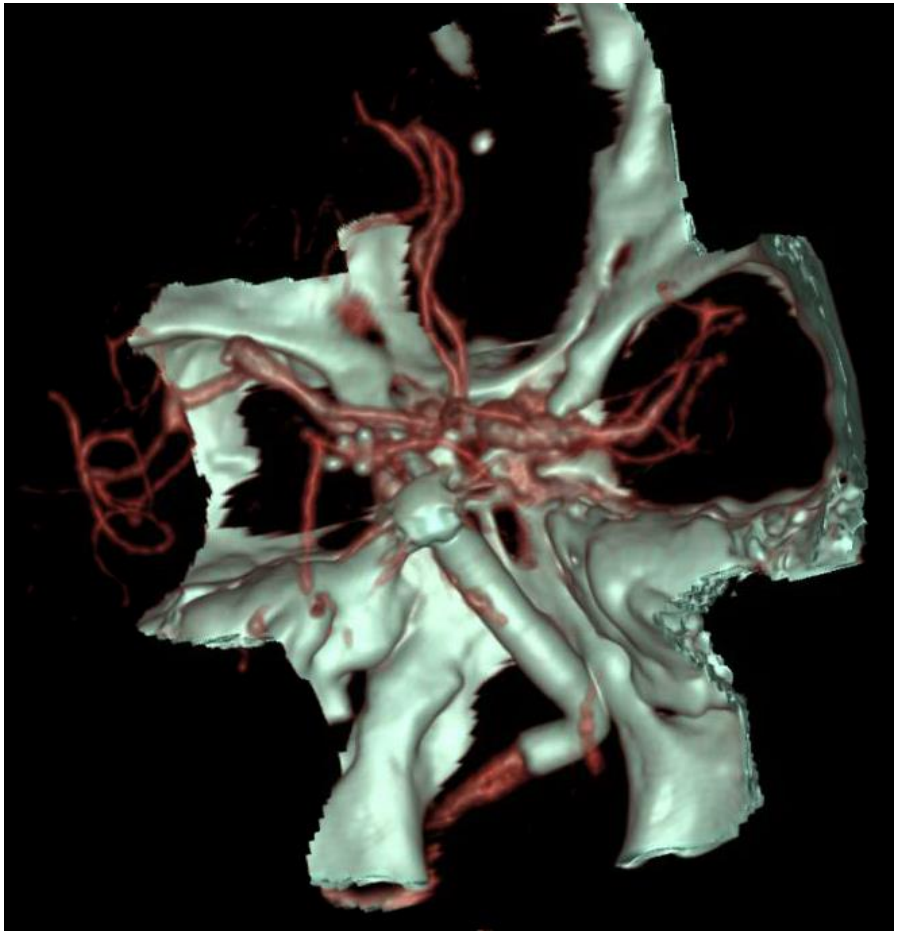






9/20/13 Keep close imaging follow-up!!!!



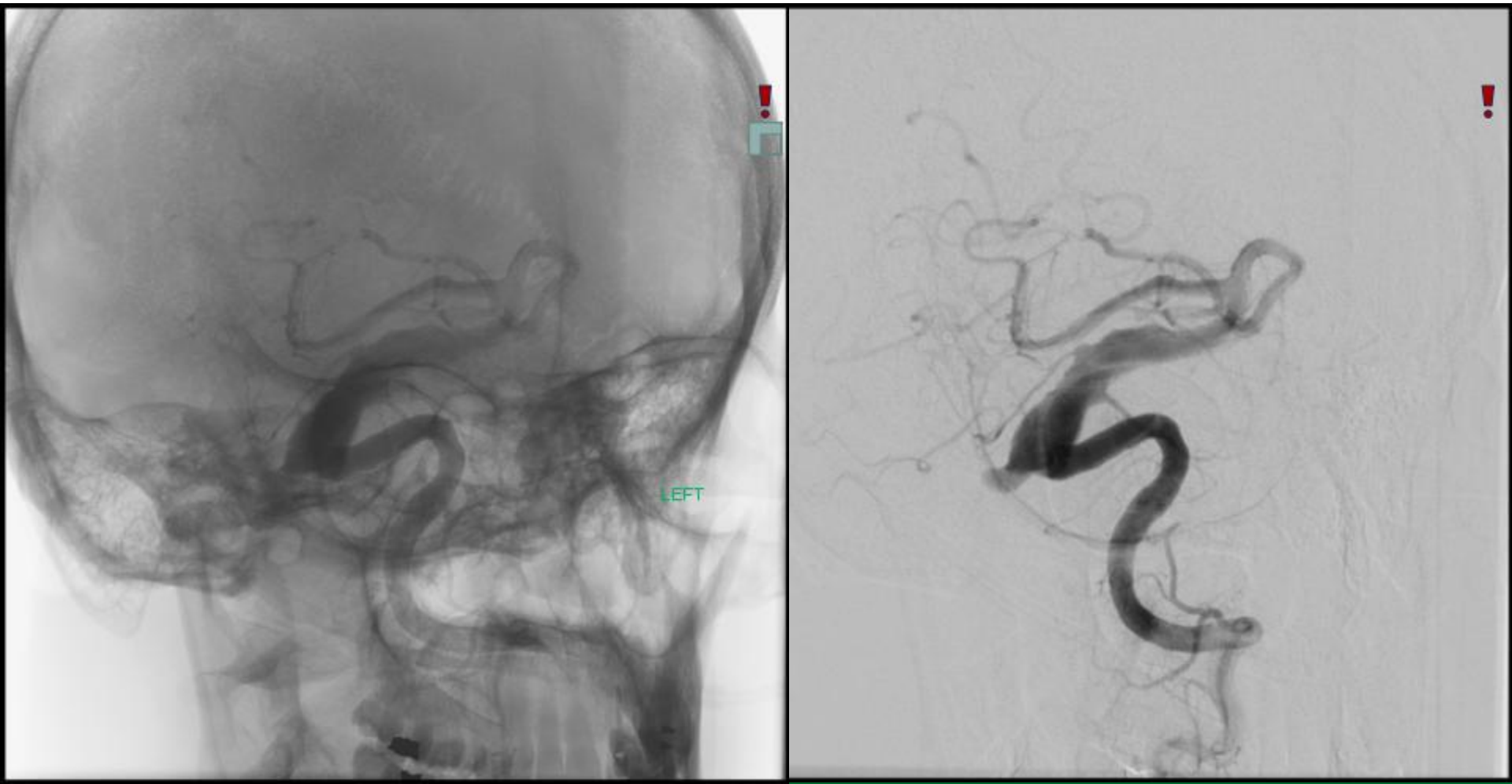


IPJ 6539806

- HPI: Patient 53yo male with history of right side headache in 2013.
- CT showed fusiform basilar aneurysm, no SAH.
- Physical exam: neuro intact
- Several interventional procedures since than.

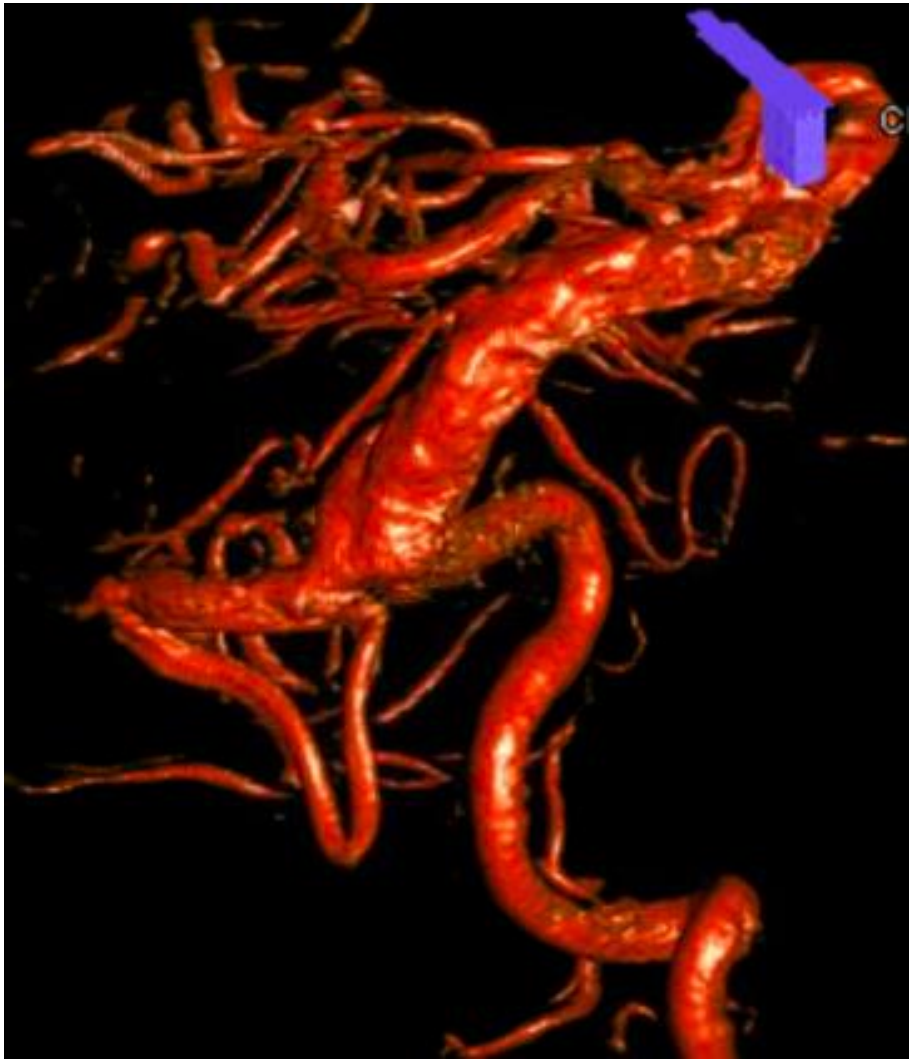
RUSH UNIVERSITY MEDICAL CENTER

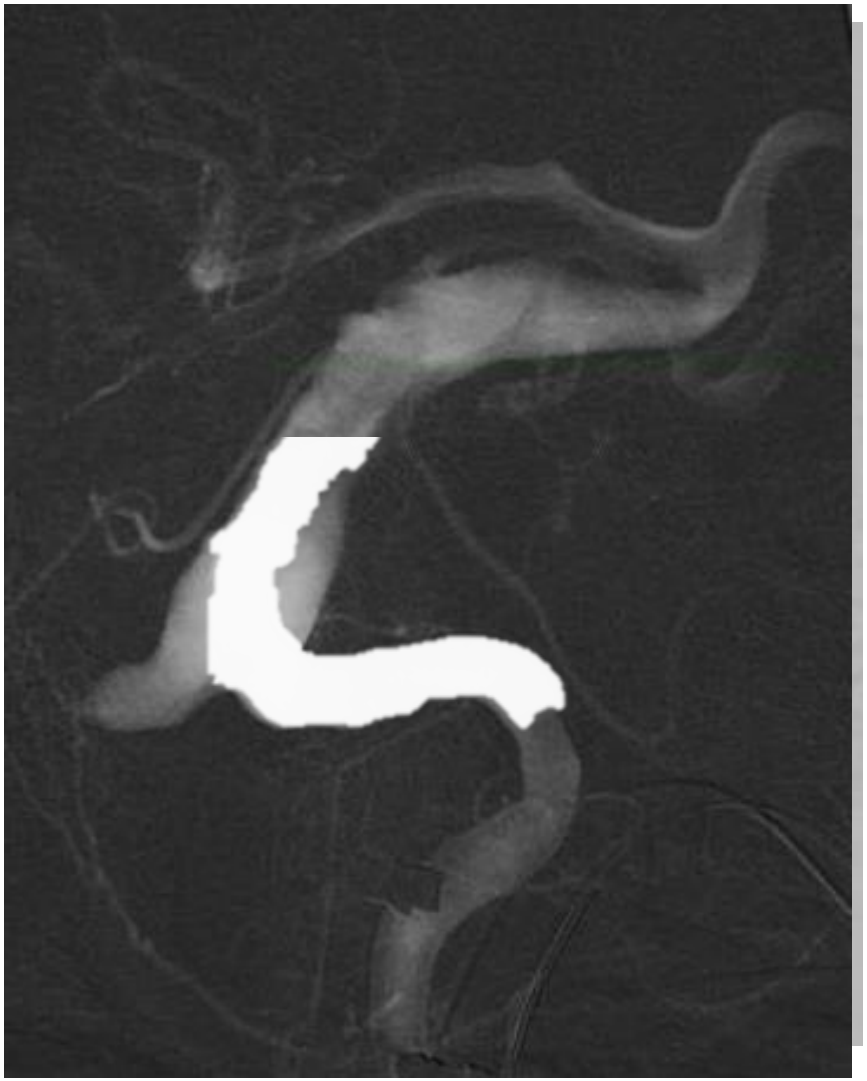
First Angio 02/12/2013



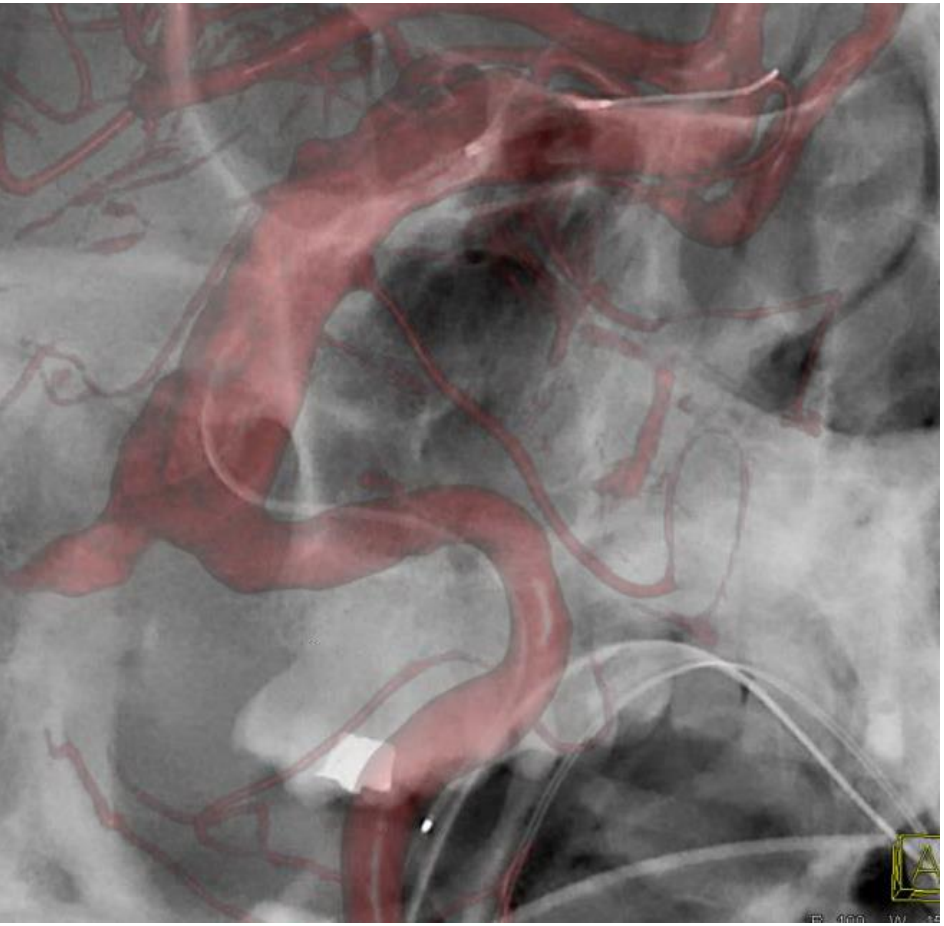
50 y/o man presenting with headaches and diplopia

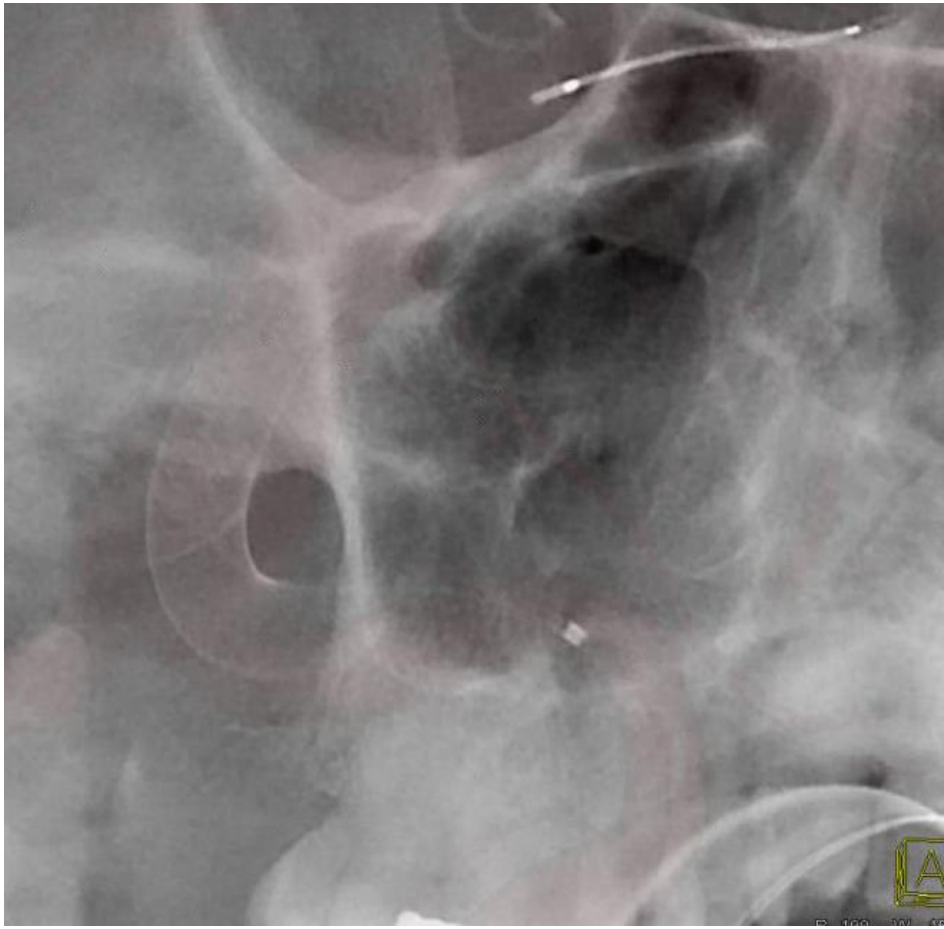
2/13/13 1st Step placement of PED proximal to AICAs





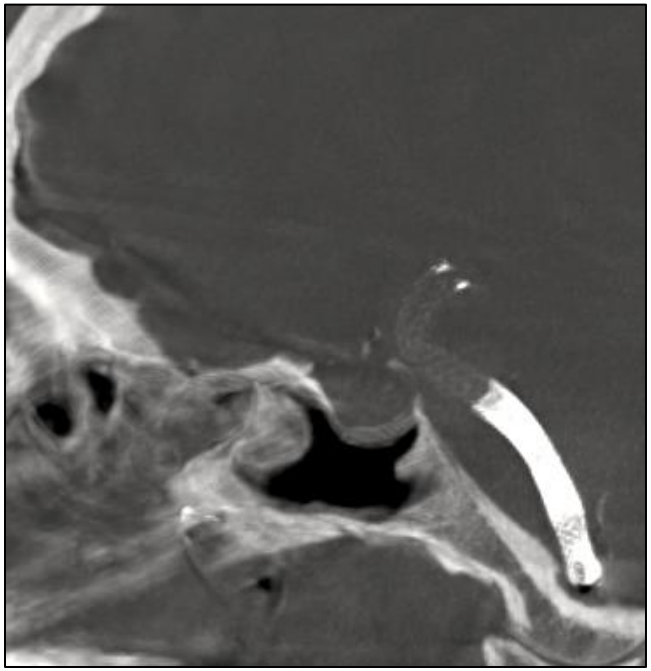
2/13/2013 – Placing enterprise stent distal to PED





Hybrid Construct – Enterprise and PED

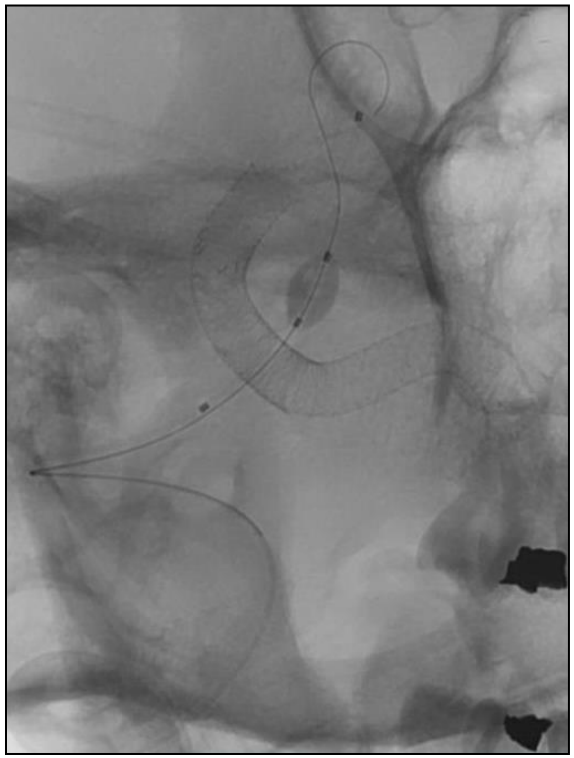
2/13/2013

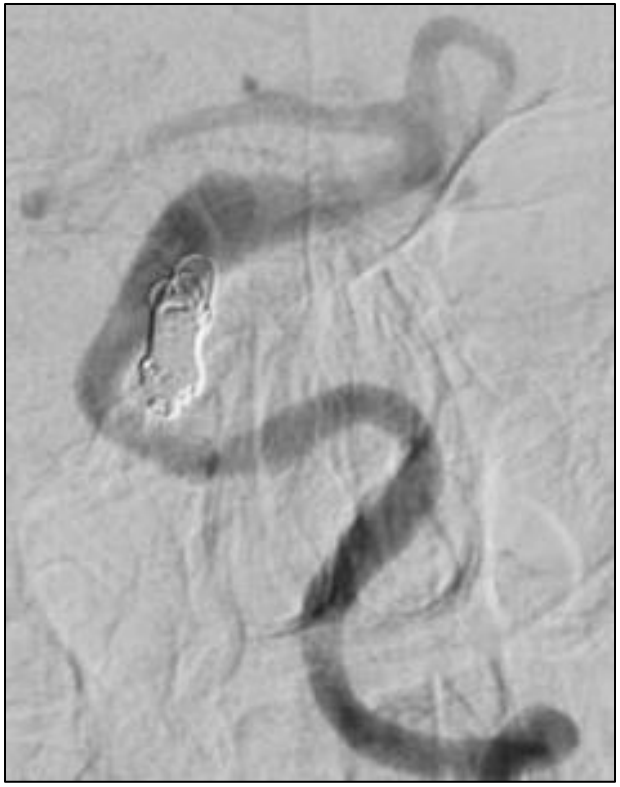


2 months after the initial procedure, the patient presented with recurrence of symptoms

Headaches and worsening in diplopia

Staged occlusion of contralateral vertebral



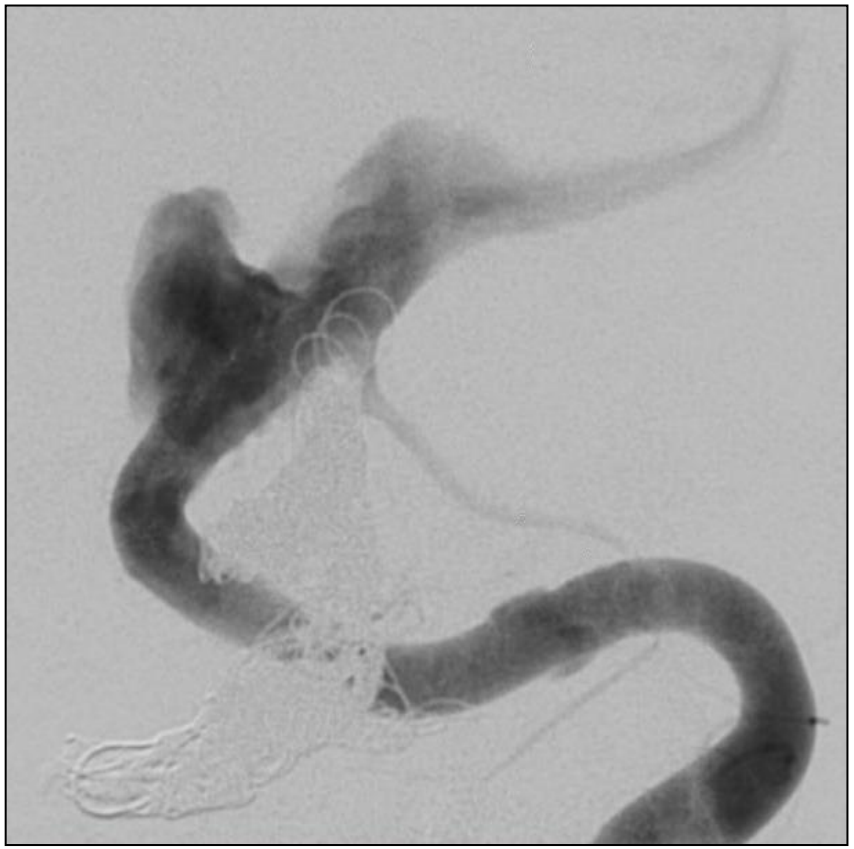


4/4/2013

Right VA occlusion Stage 2

10/17/2013

Stent-assisted coil embolization of “new”aneurysm



10/17/2013

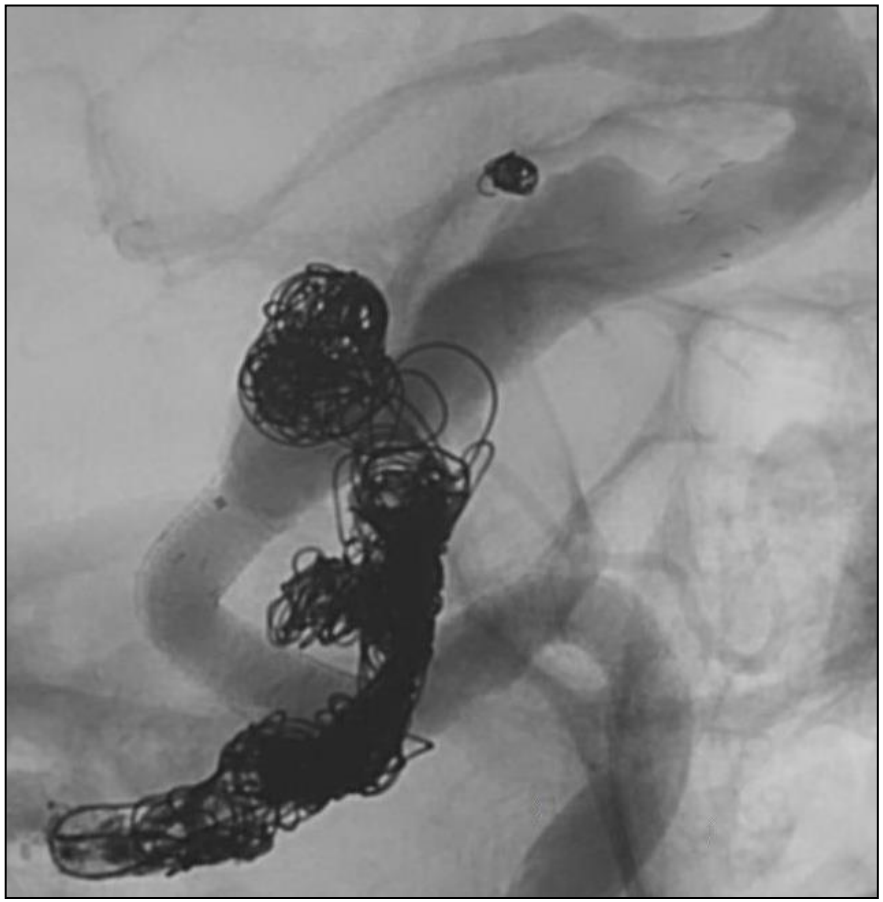
Stent-assisted coil embolization of recurrent aneurysm

Final device count: Two enterprise stents + 1 PED + Coils

10/17/2013

Staged FD + Stent-assisted coil embolization

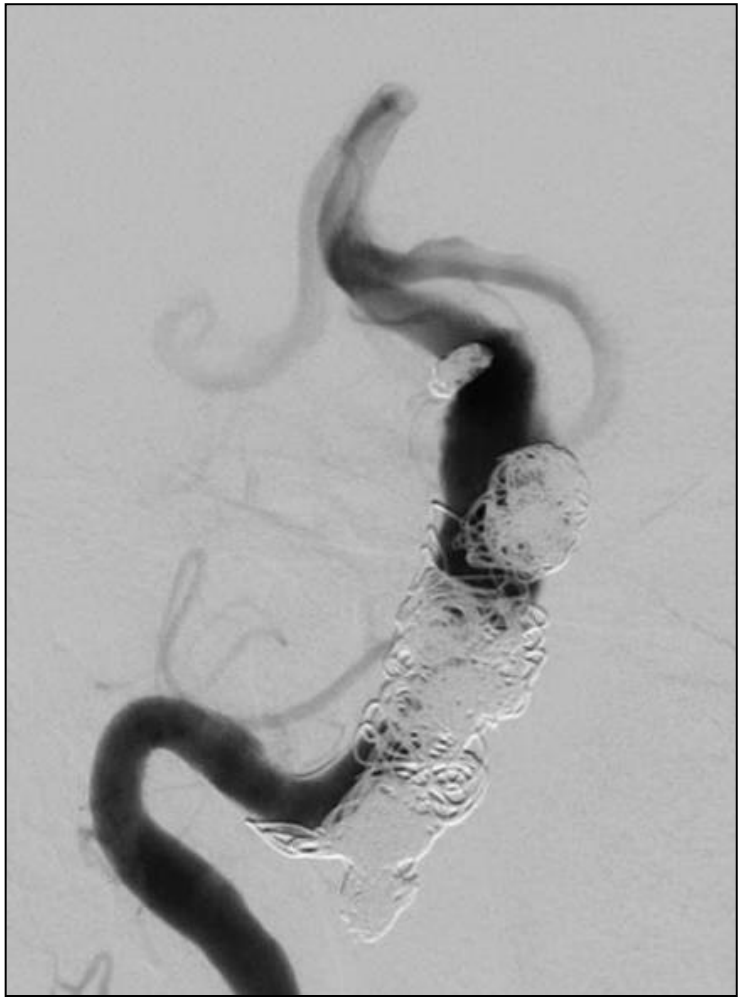
Final device count: Two enterprise stents + 1 PED + Coils



10/17/2013

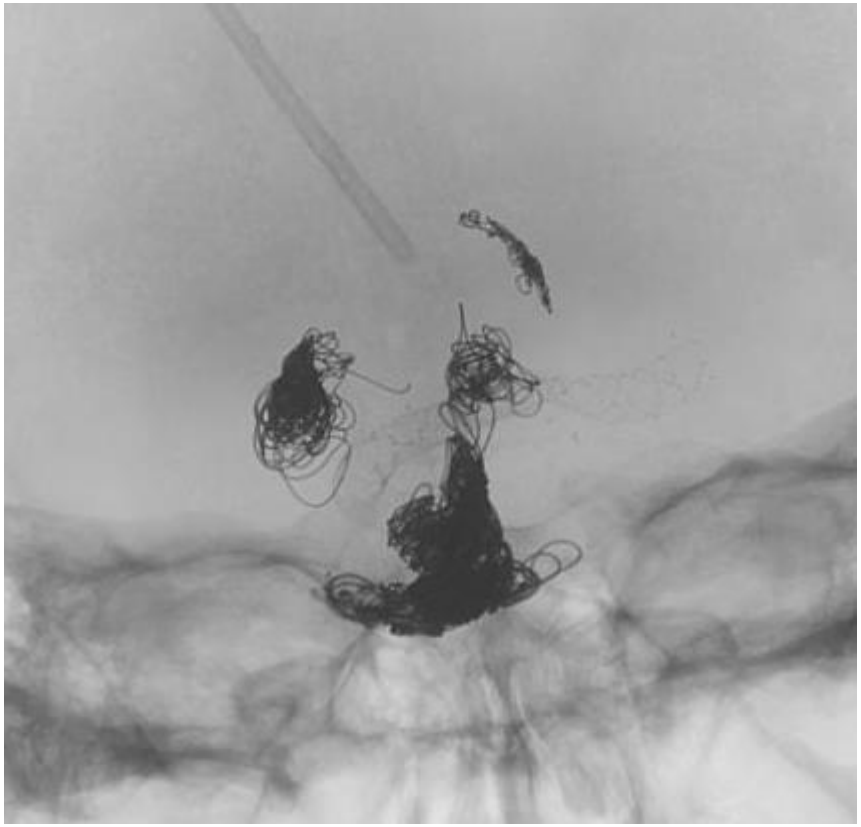
Staged FD + Stent-assisted coil embolization

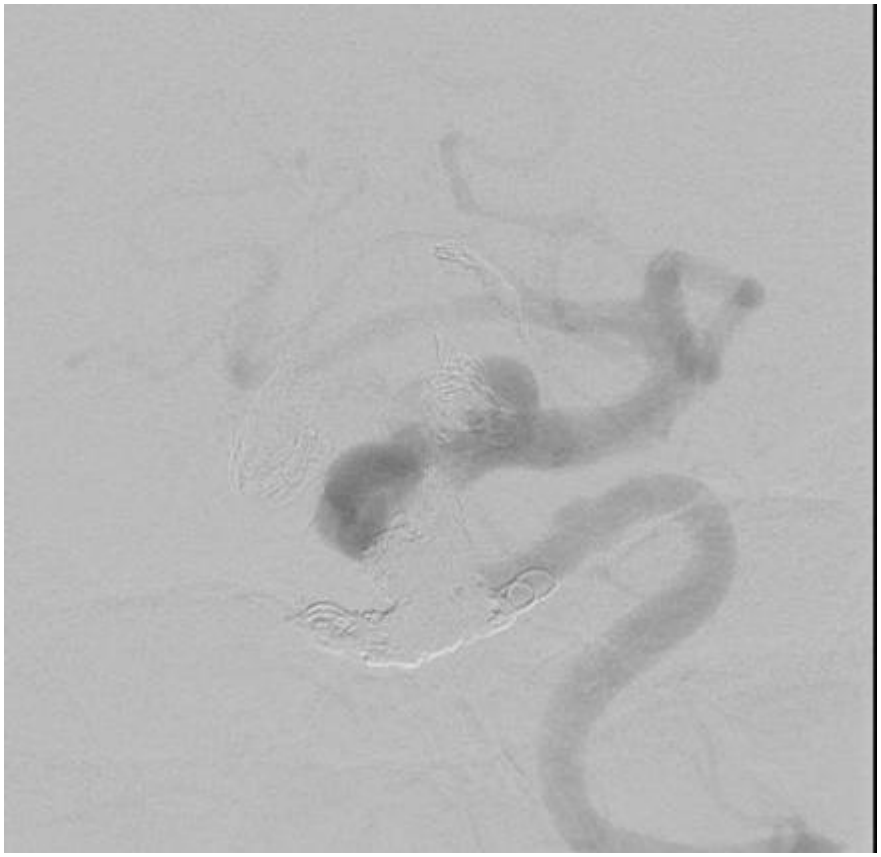
Final device count: Two enterprise stents + 1 PED + Coils

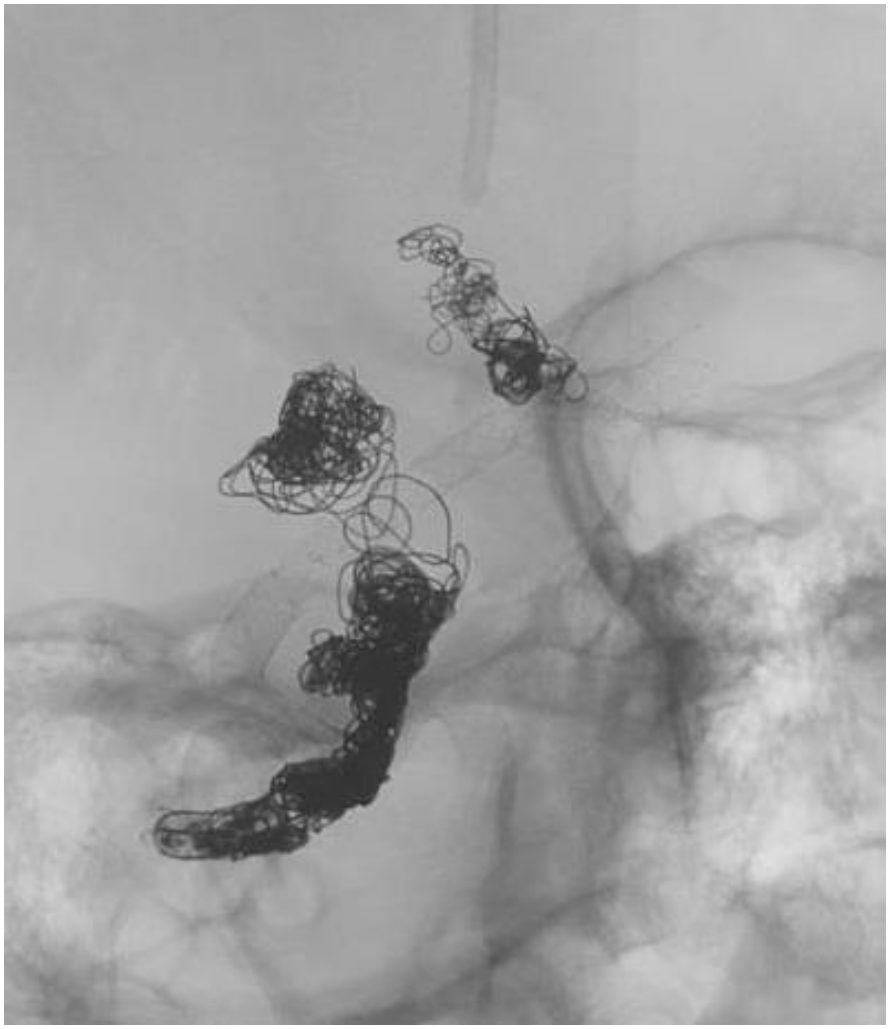


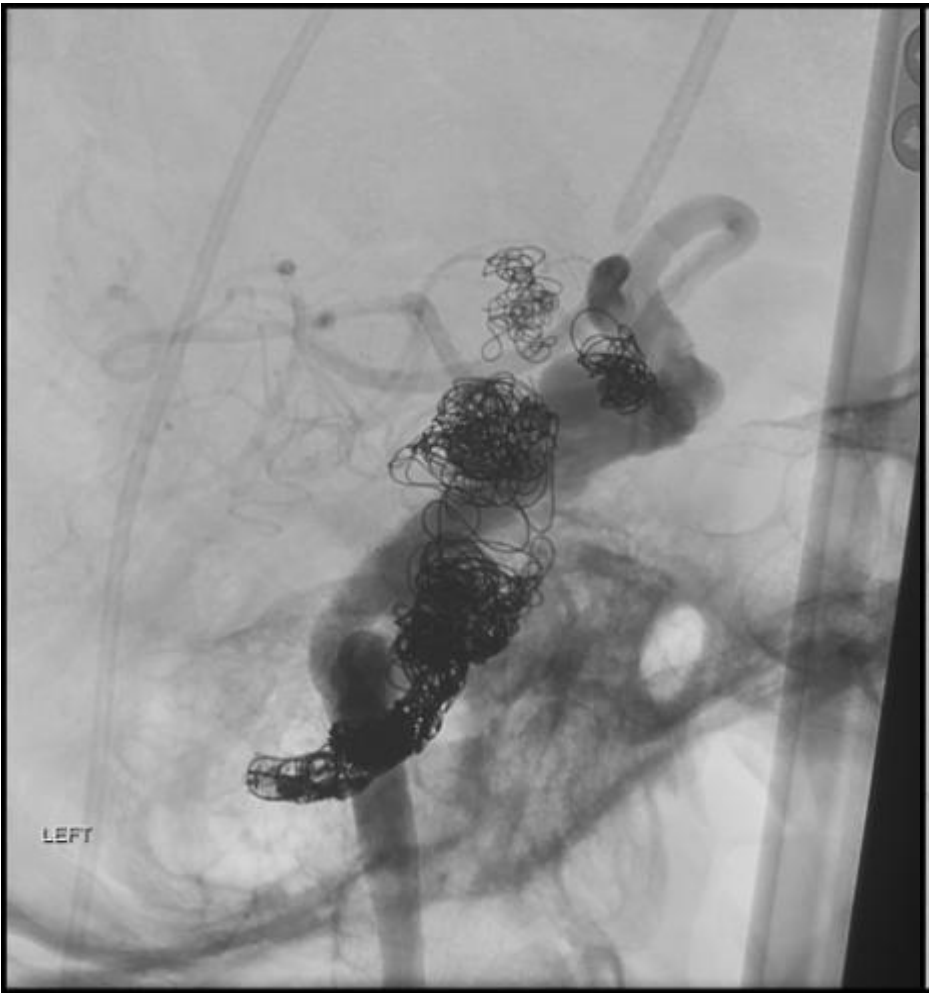
12 months follow up

02/16/2016








LEFT

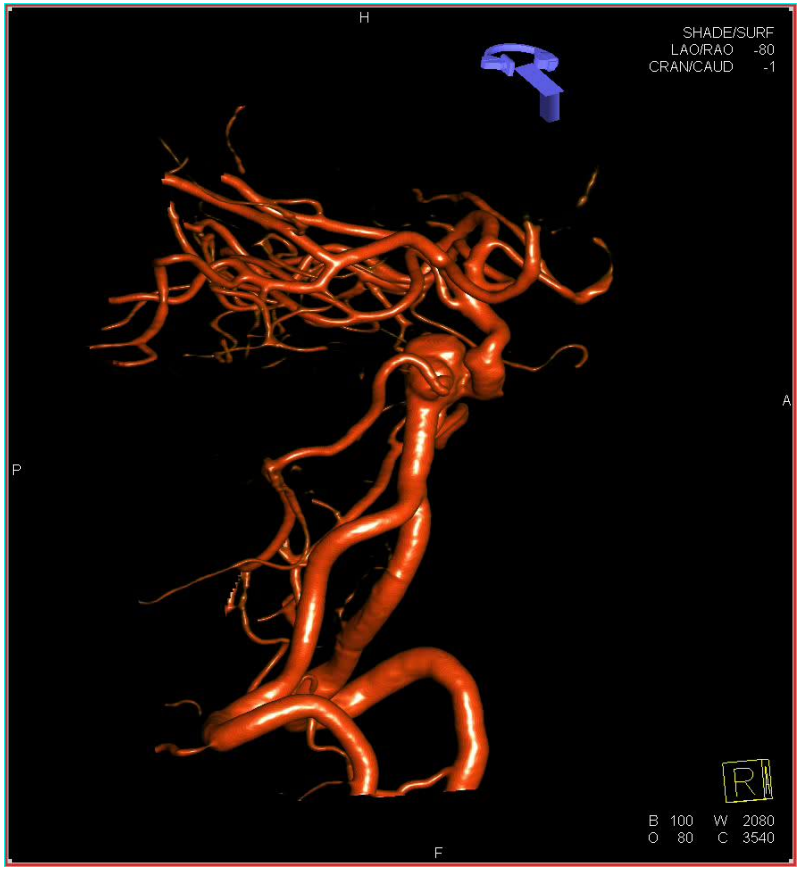

LEFT

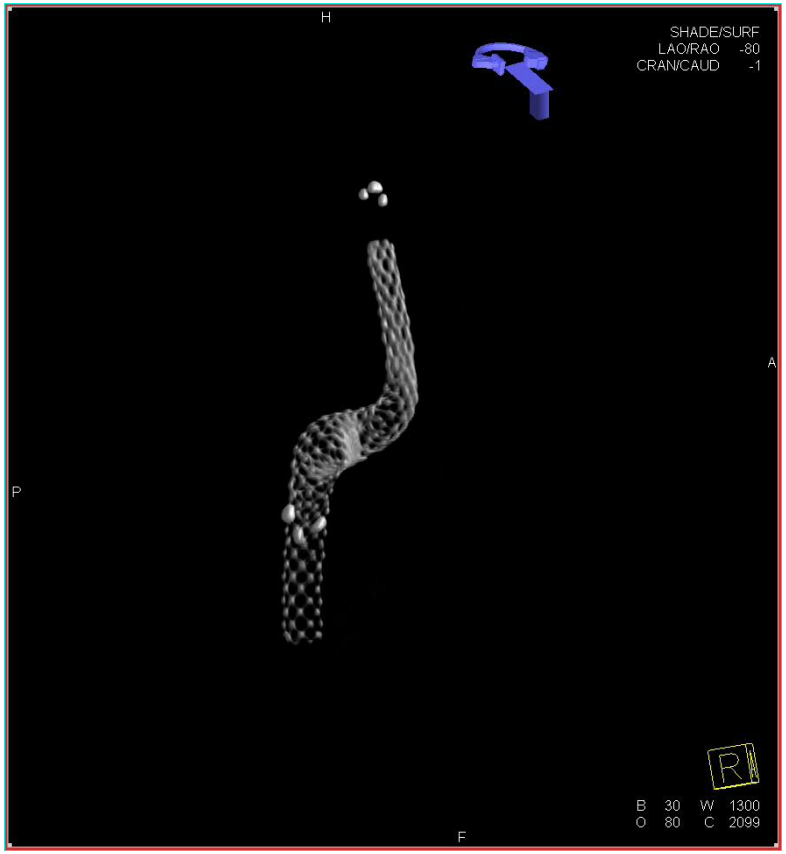
JO 6560727

- HPI: Patient 54yo female with history of headaches for 2 years.
- CT/MRI showed tortuous fusiform aneurysm of the basilar artery.
- Parafalcine and right parietal meningioma.
- Physical exam: decrease sensation of left side of face, left arm and chest.
- Had right parietal craniotomy for tumor resection in 06/03/2013.

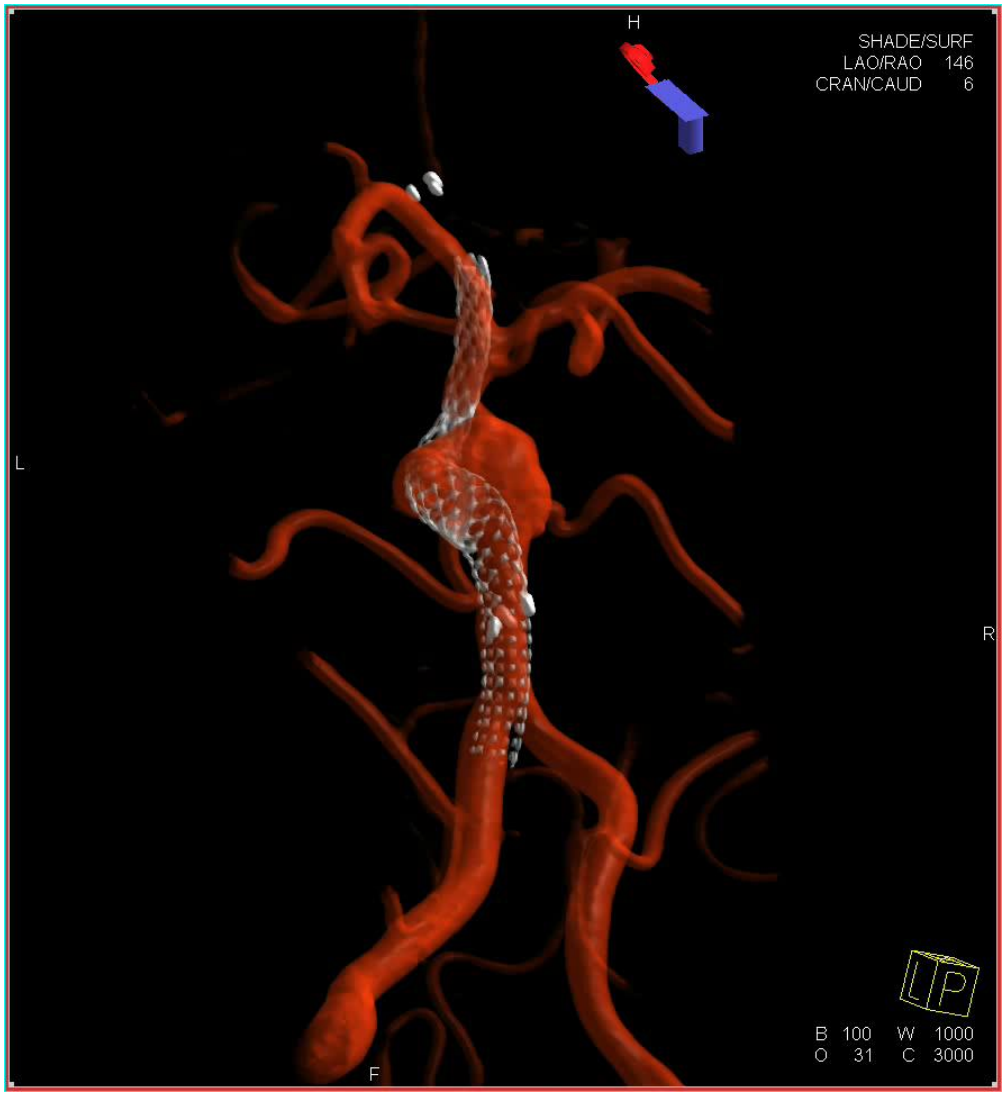
RUSH UNIVERSITY MEDICAL CENTER

Day of Treatment





Day of Treatment



Pre Stent Deployment 3D DSA fused with post-stent deployment DynaCT Micro

Notice vessel deformation from device placement

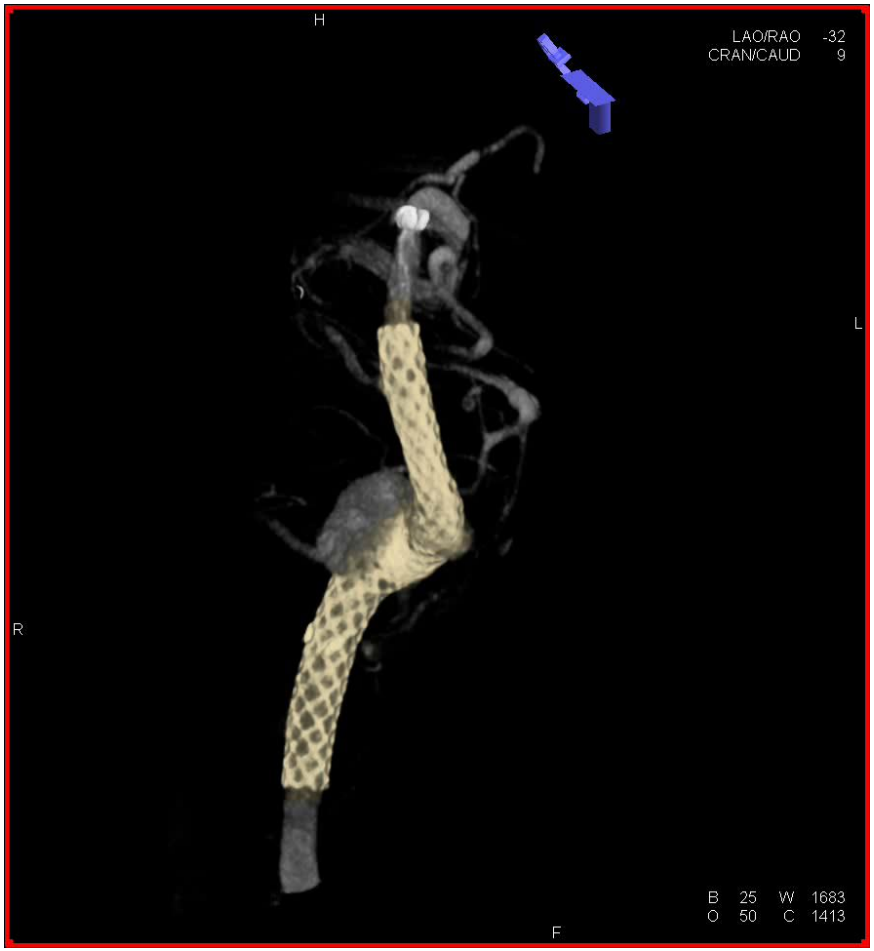
WLNC 2014 Buenos Aires Follow Up Cases

- Basilar artery aneurysm s/p Pipeline-Enterprise hybrid construct
- 6 month angiogram revealed residual filling of aneurysm
- Discontinued dual anti-platelets
- Follow-up DSA demonstrating positive remodeling of aneurysm sac and preservation of branches
- mRS=0

RUSH UNIVERSITY MEDICAL CENTER

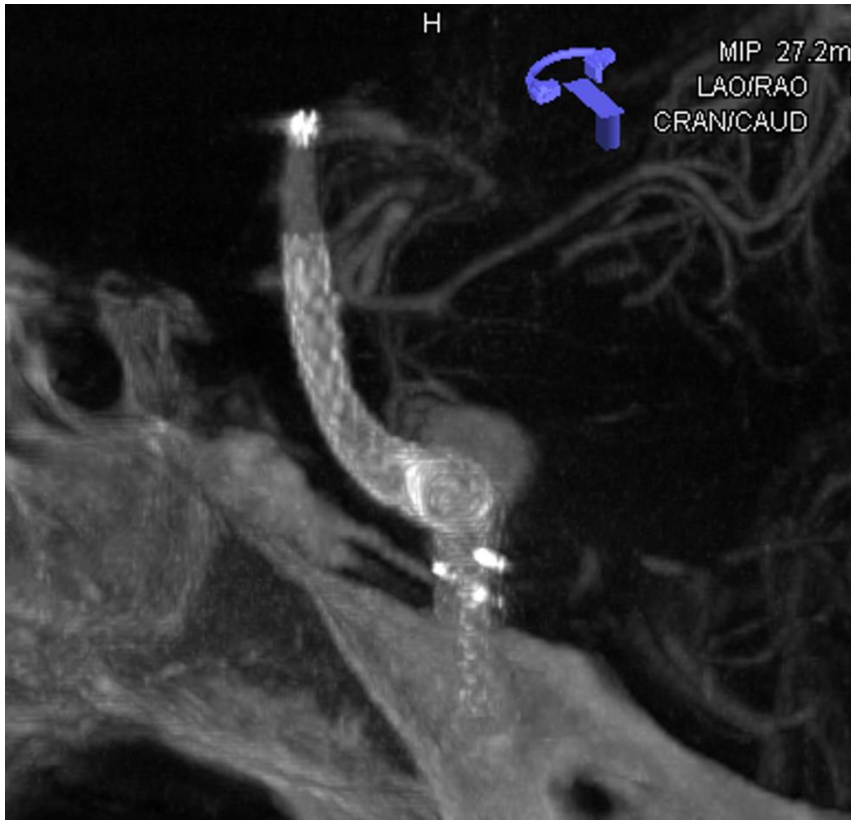
Follow Up

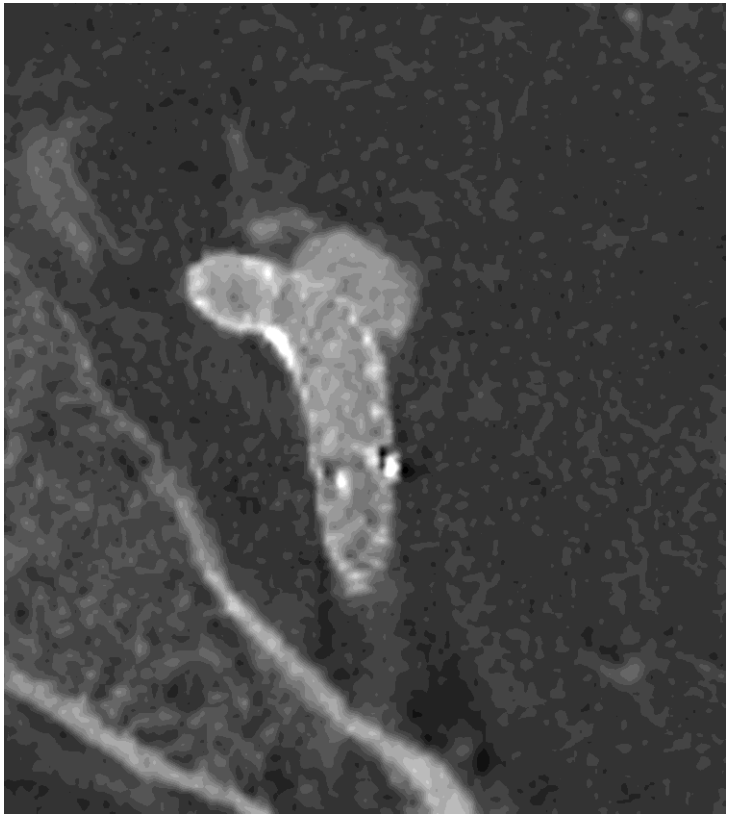
5s 3D DSA Dual-Volume



DynaCT Micro

2nd Follow Up

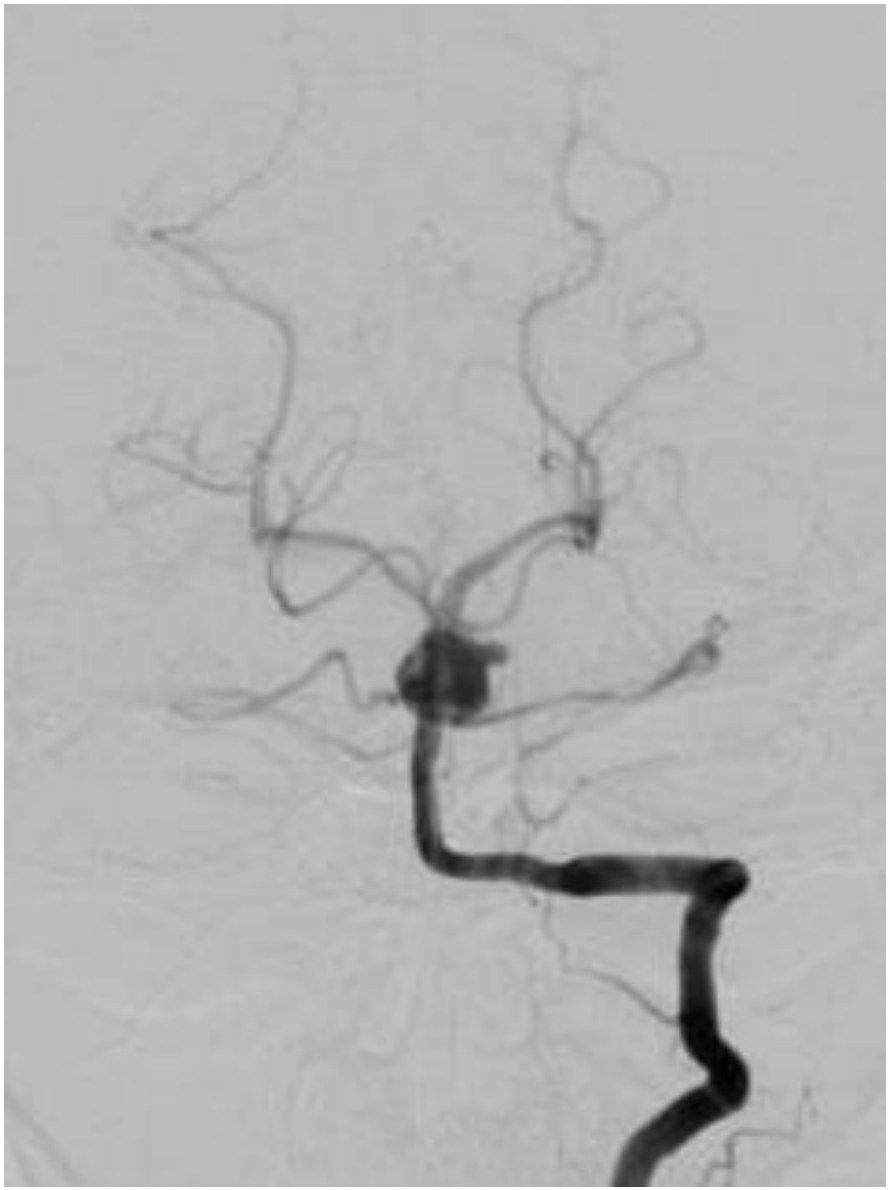


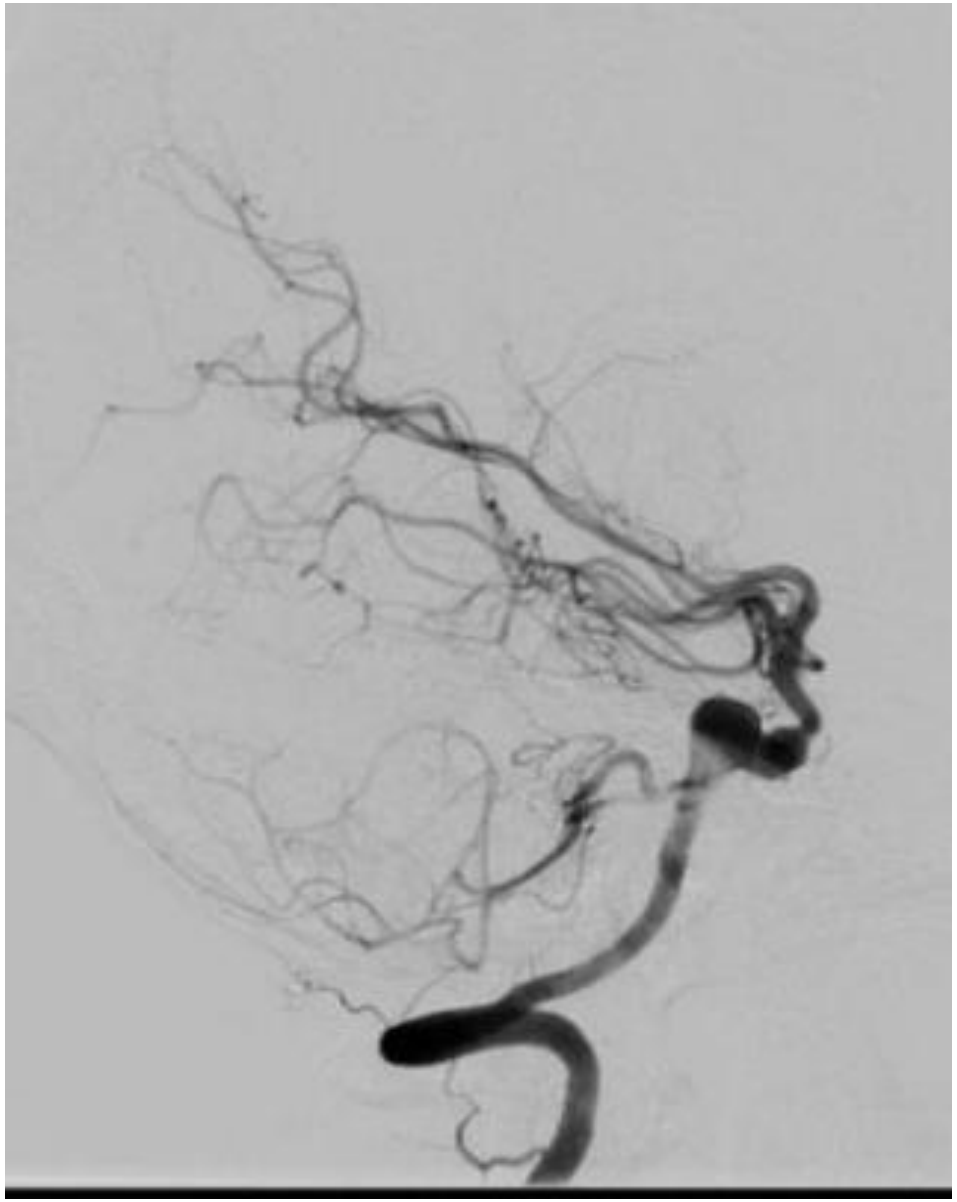


Excellent Neck Coverage and Good Wall Apposition

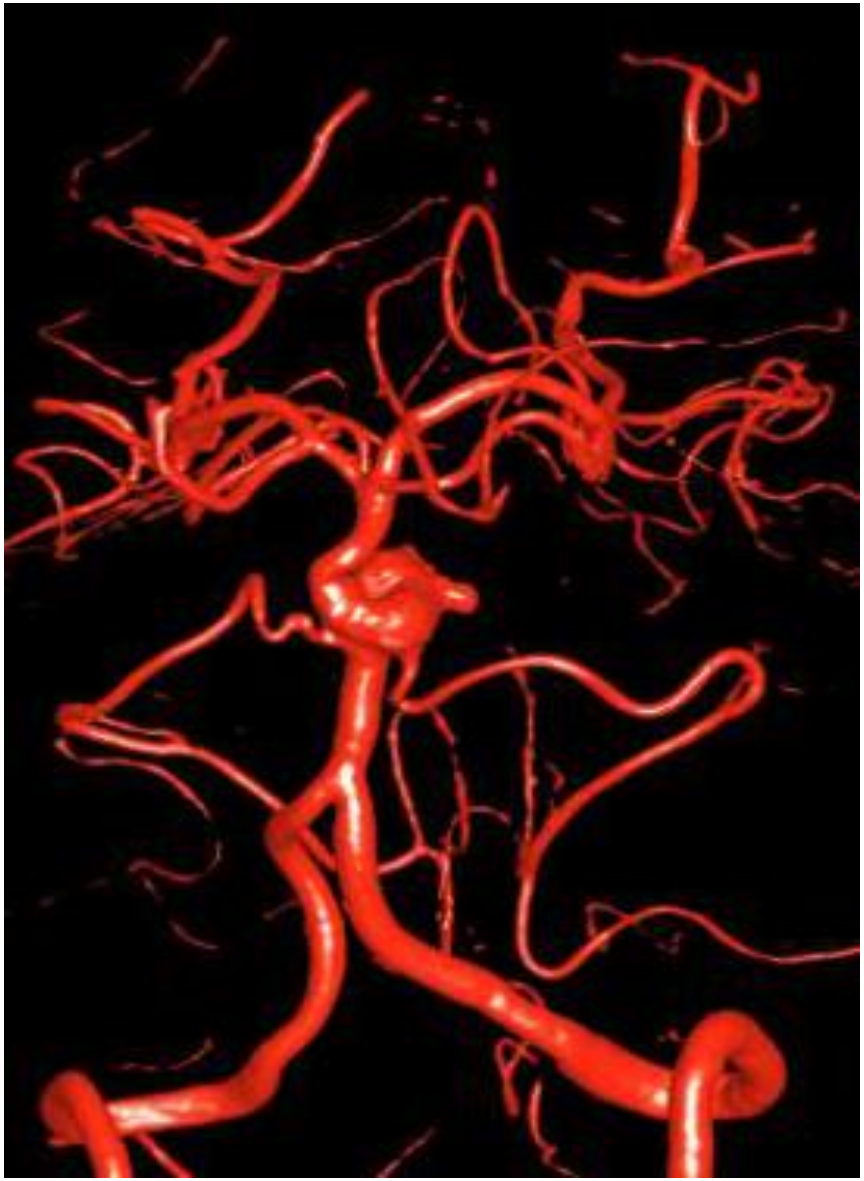
RUSH UNIVERSITY MEDICAL CENTER

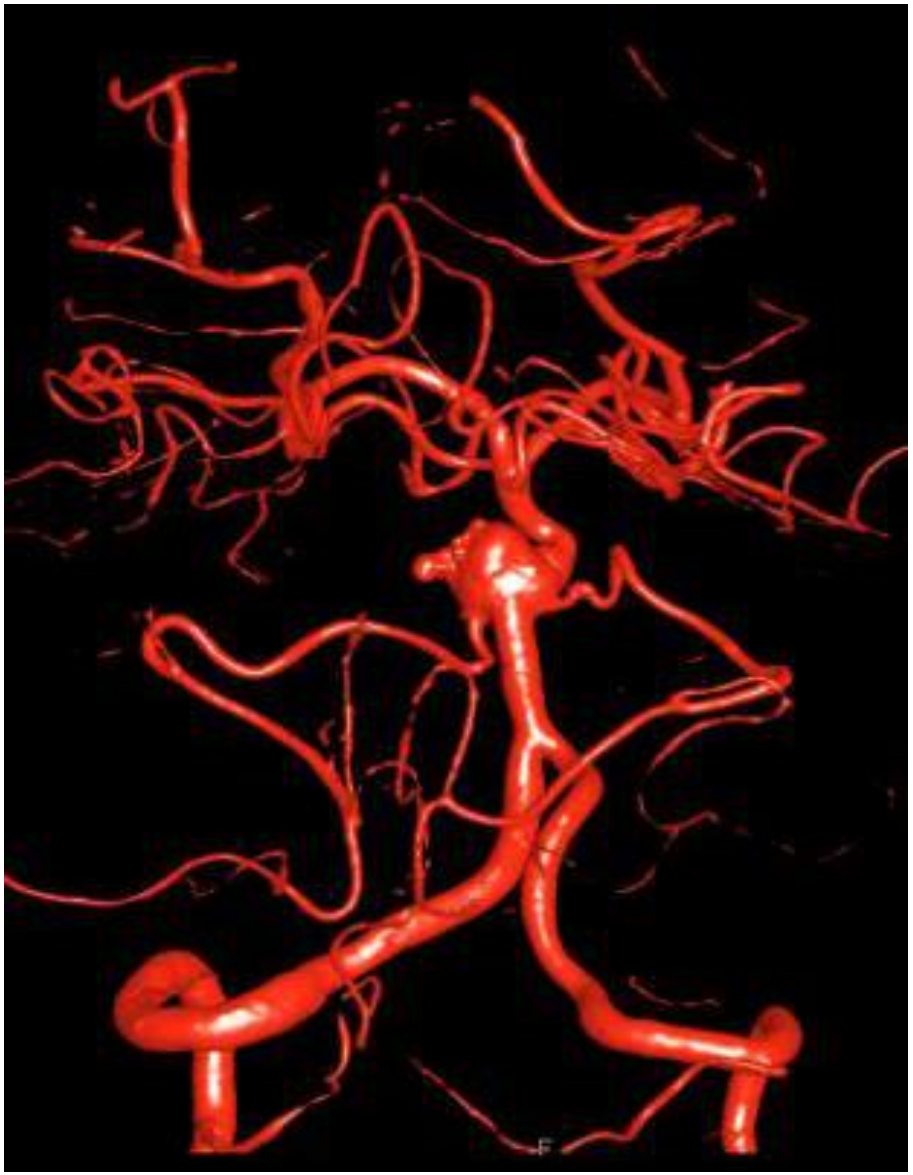
First Angio AP and Lateral View





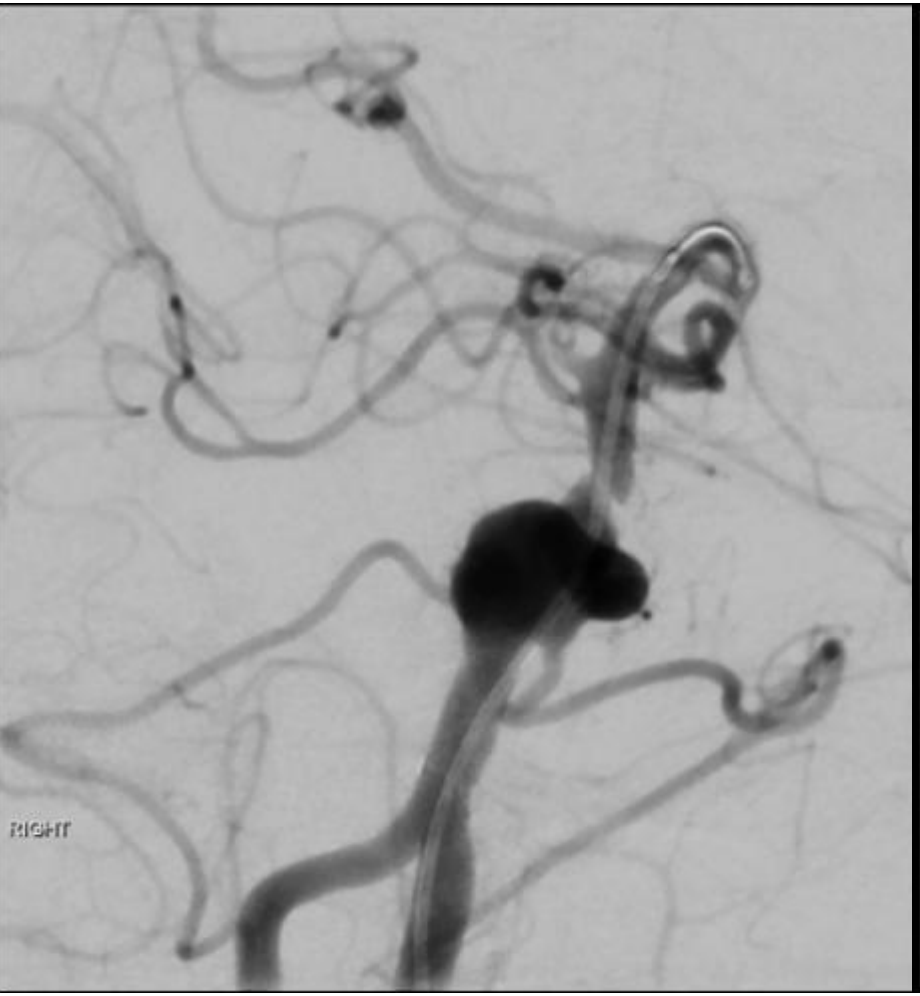
Anterior and Posterior View



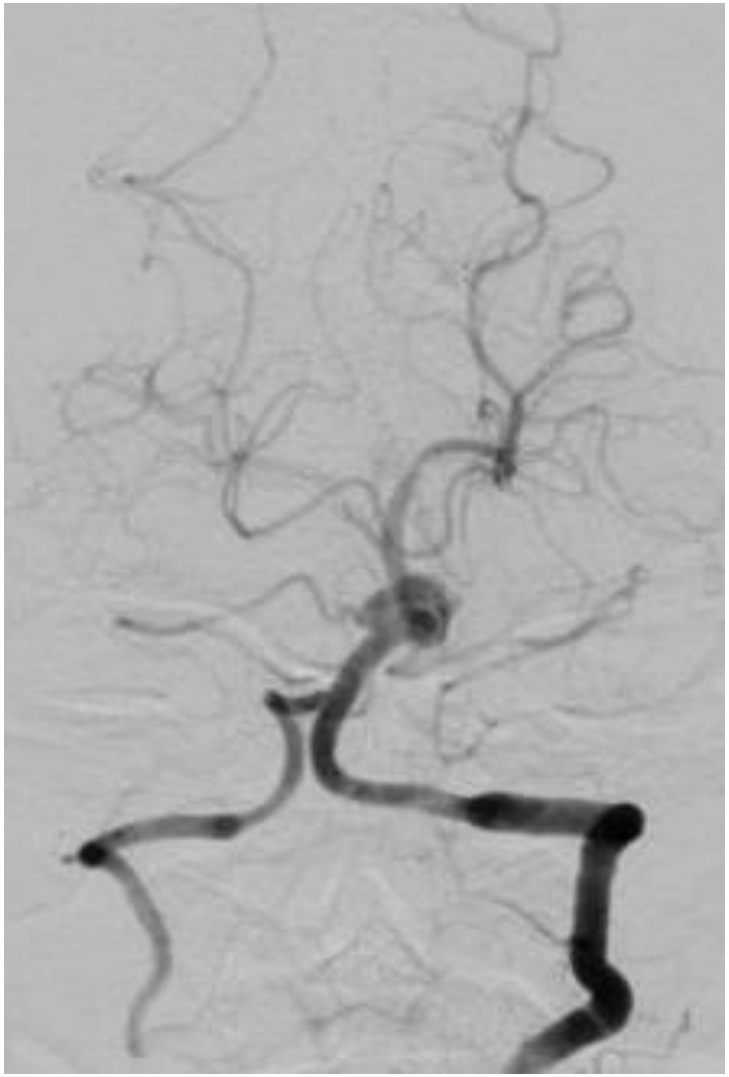


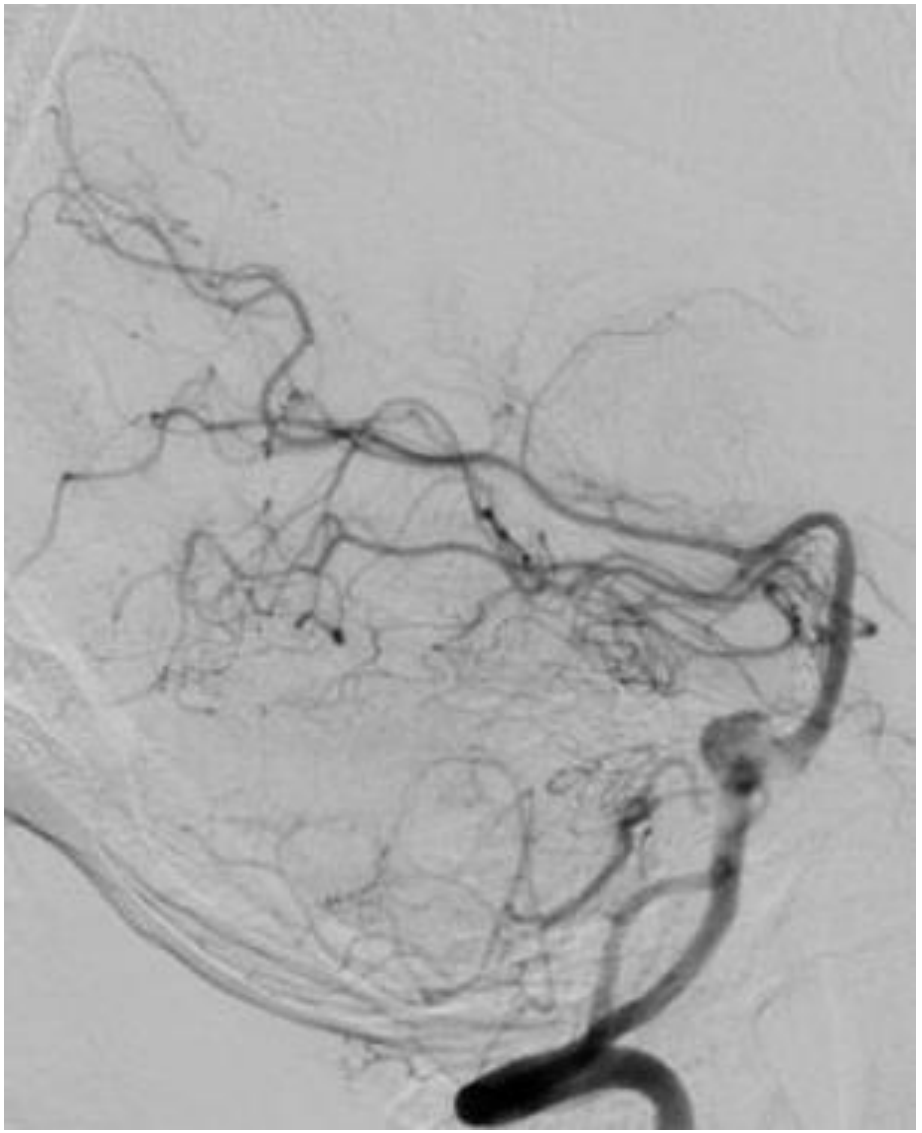
RUSH UNIVERSITY MEDICAL CENTER

Pipeline+Enterprise stent

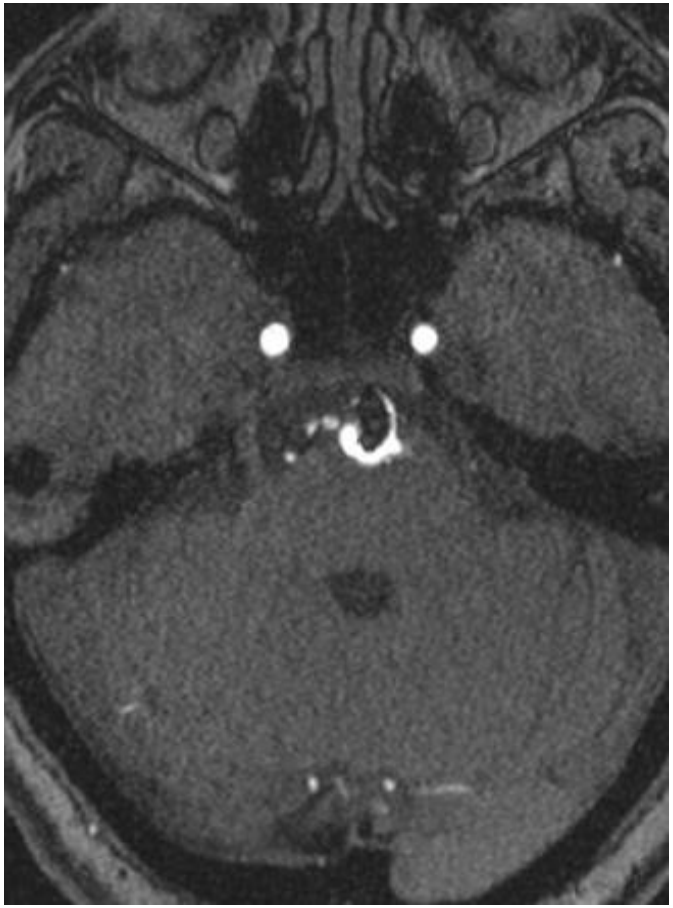


03/17/2015





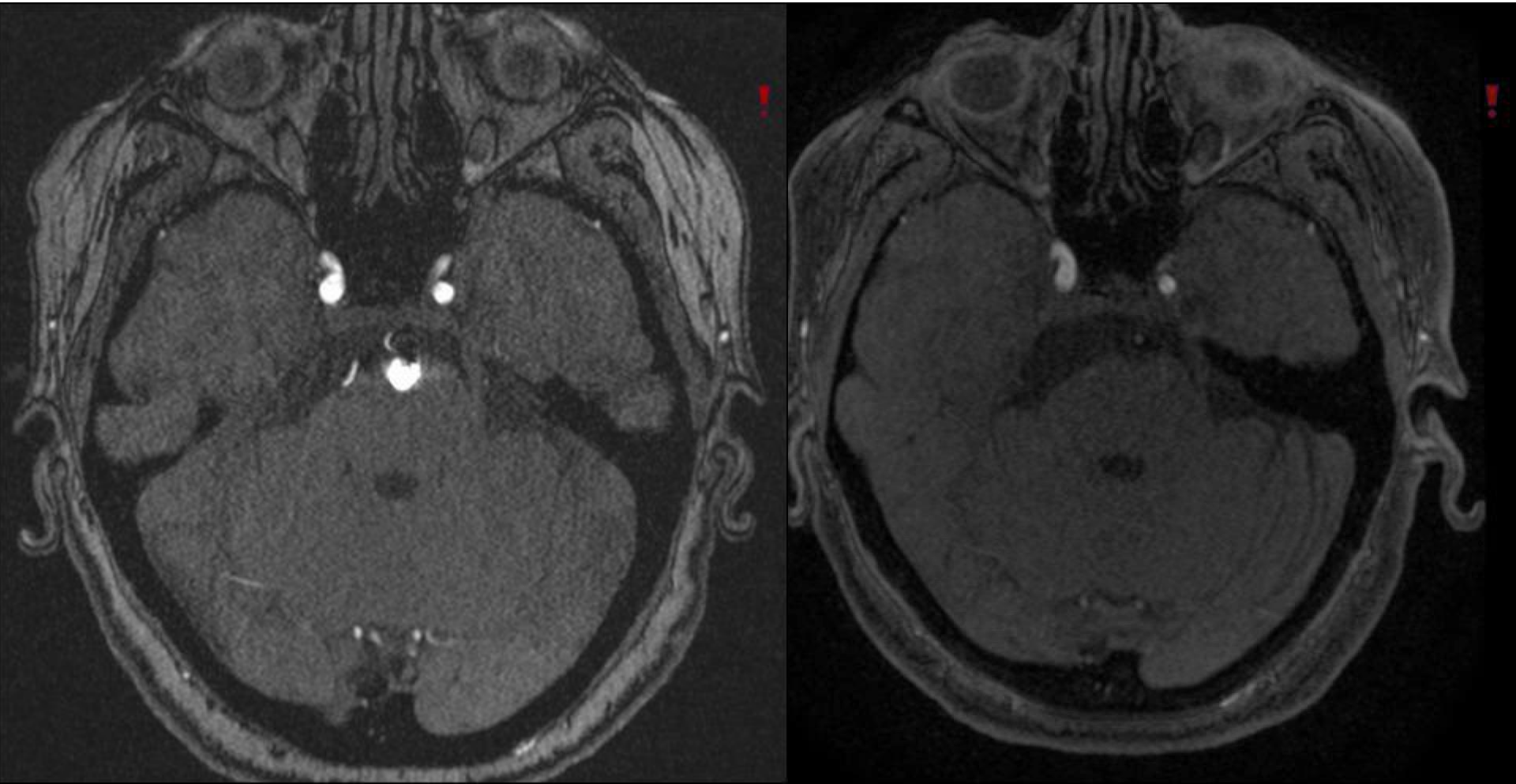
06/10/2014



02/17/2016

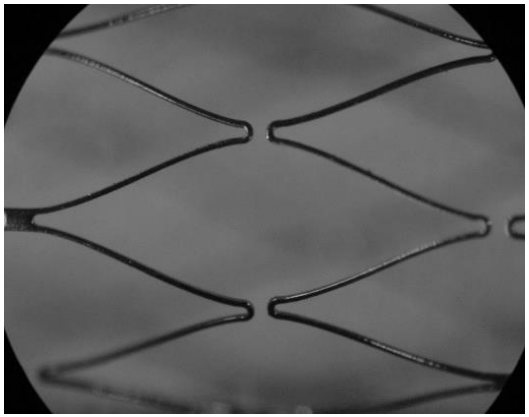
06/10/2014

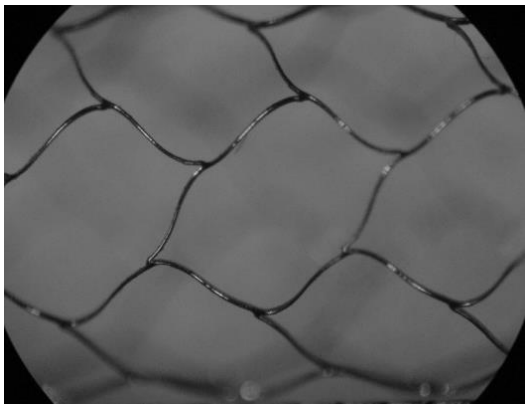
02/17/2016



A few important points for the future…

Variable Arterial Coverage

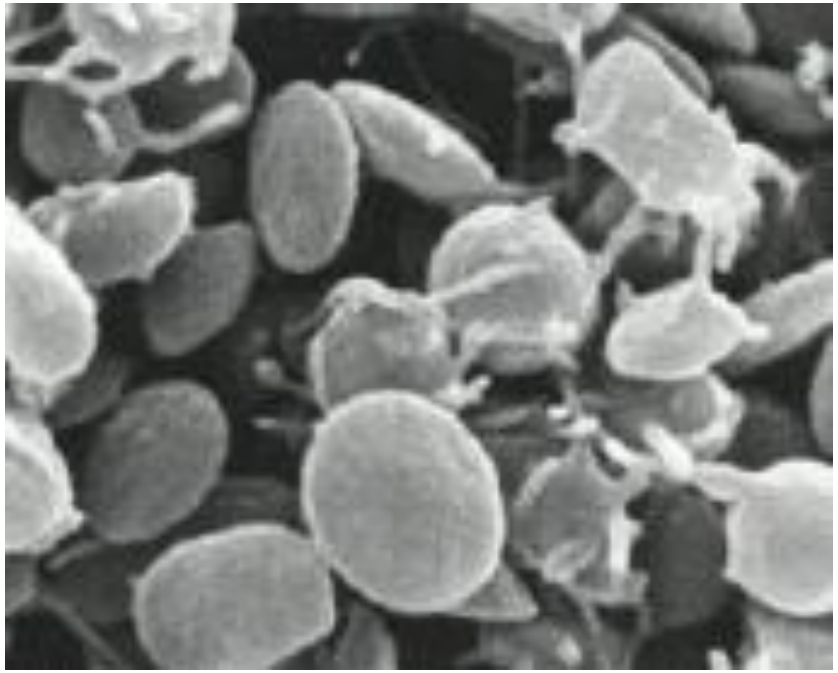




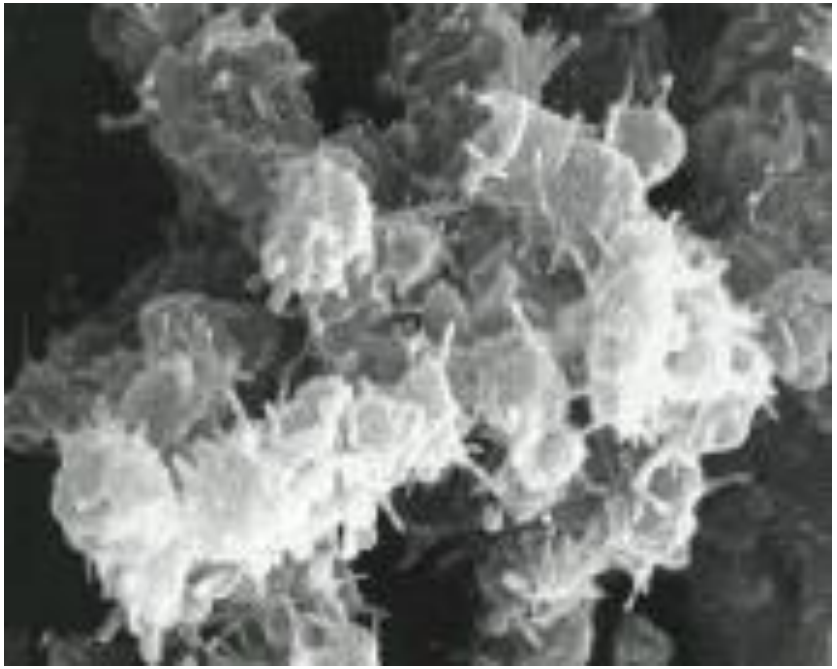
Stent	Approximate Coverage
Neuroform, Enterprise	6%
Liberty, Lvis	15%
PED, Silk,Fred, Surpass, P64	30%

PRU range >50 < 210

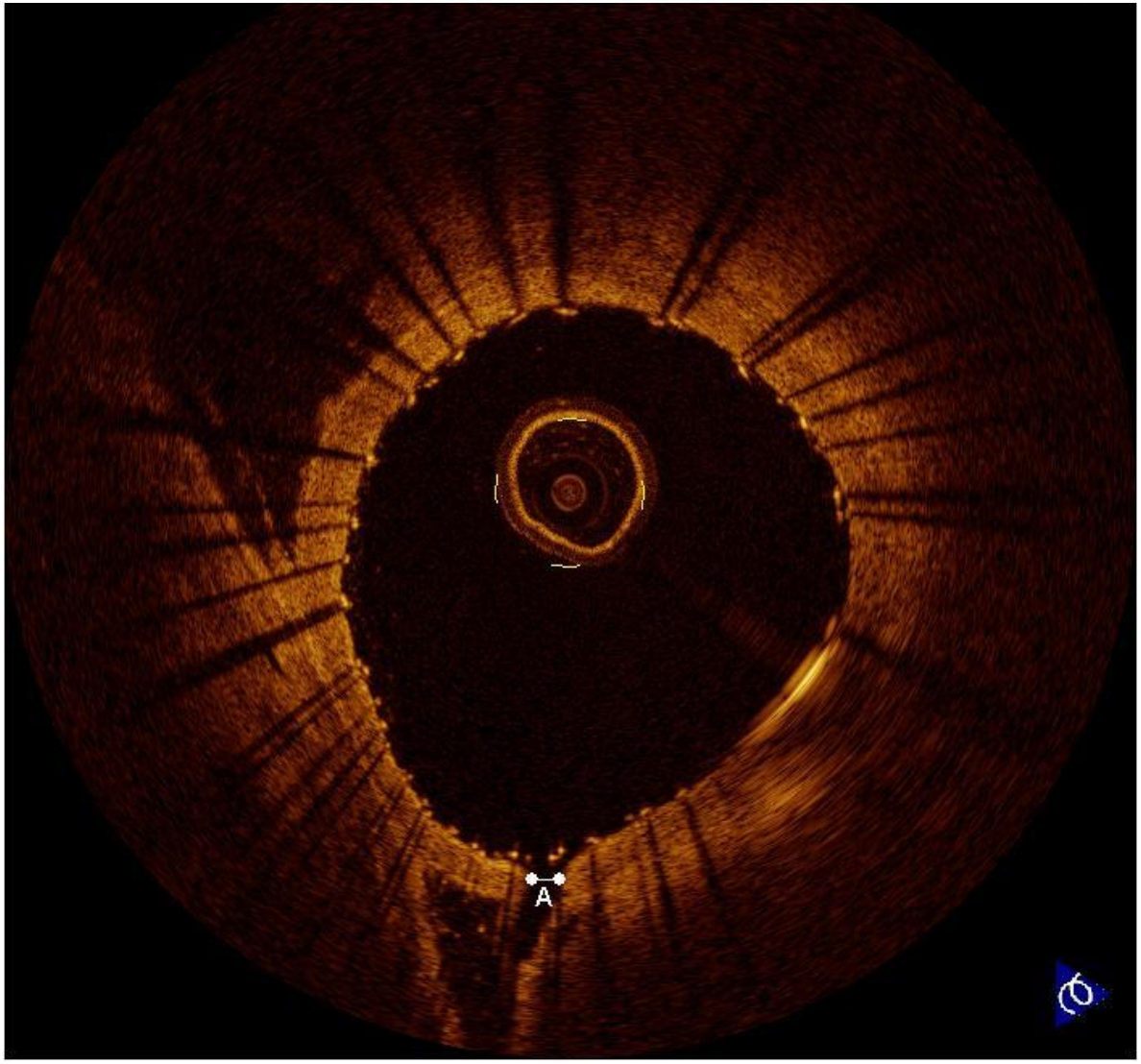
Dormant Platelets



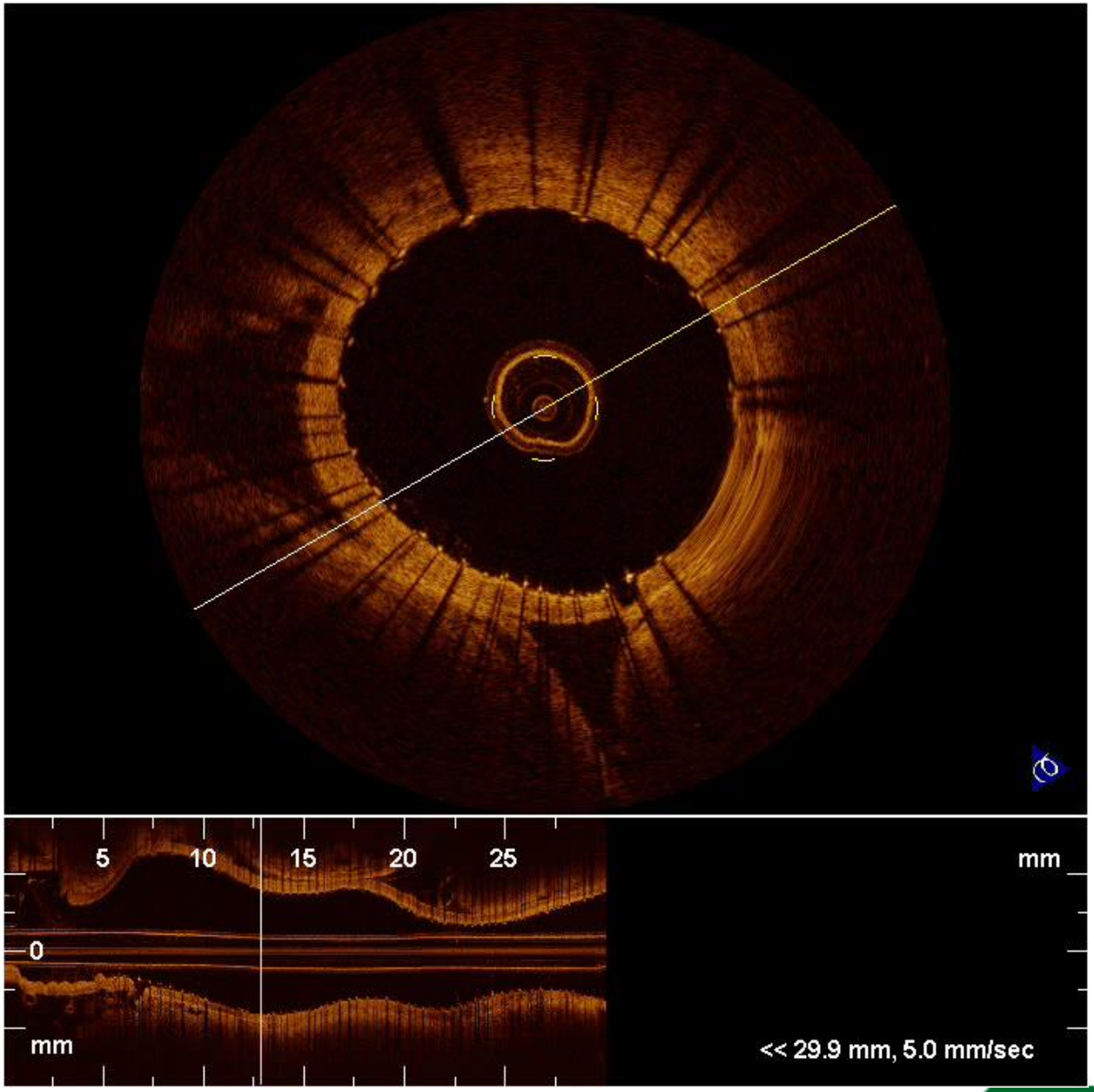
Activated Platelets



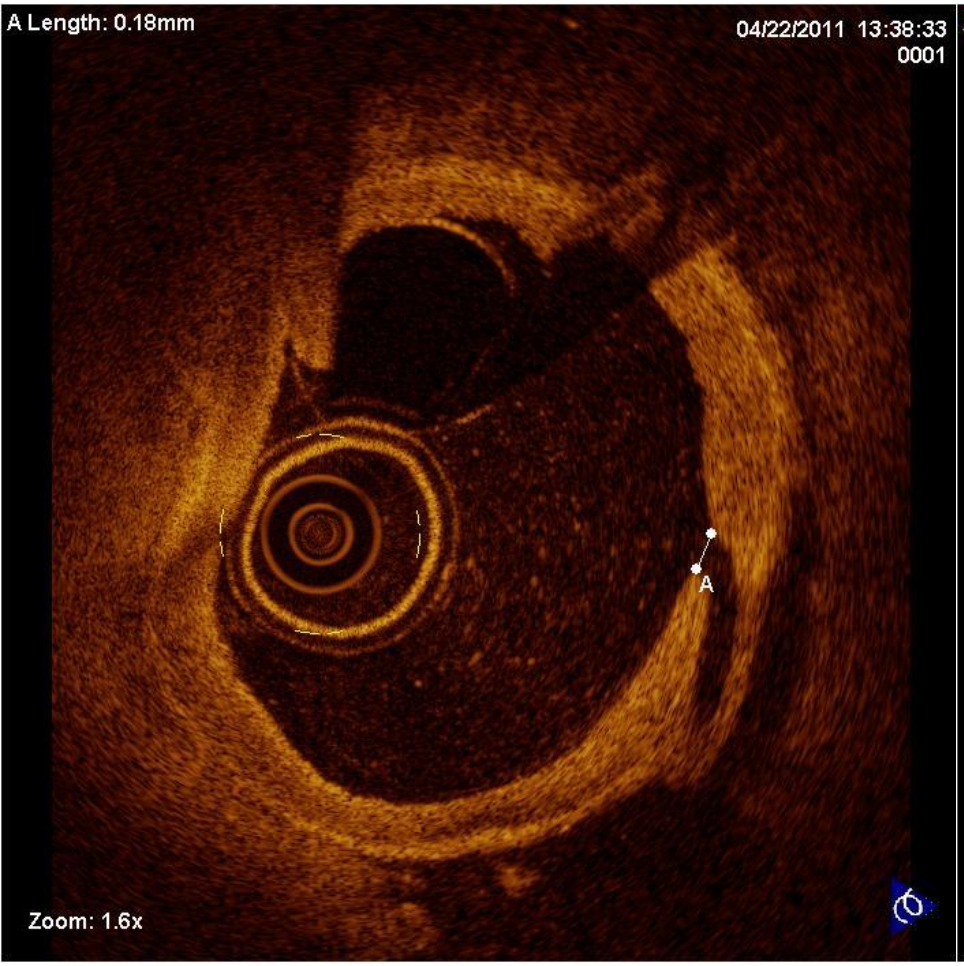
Relationship pipeline - perforator

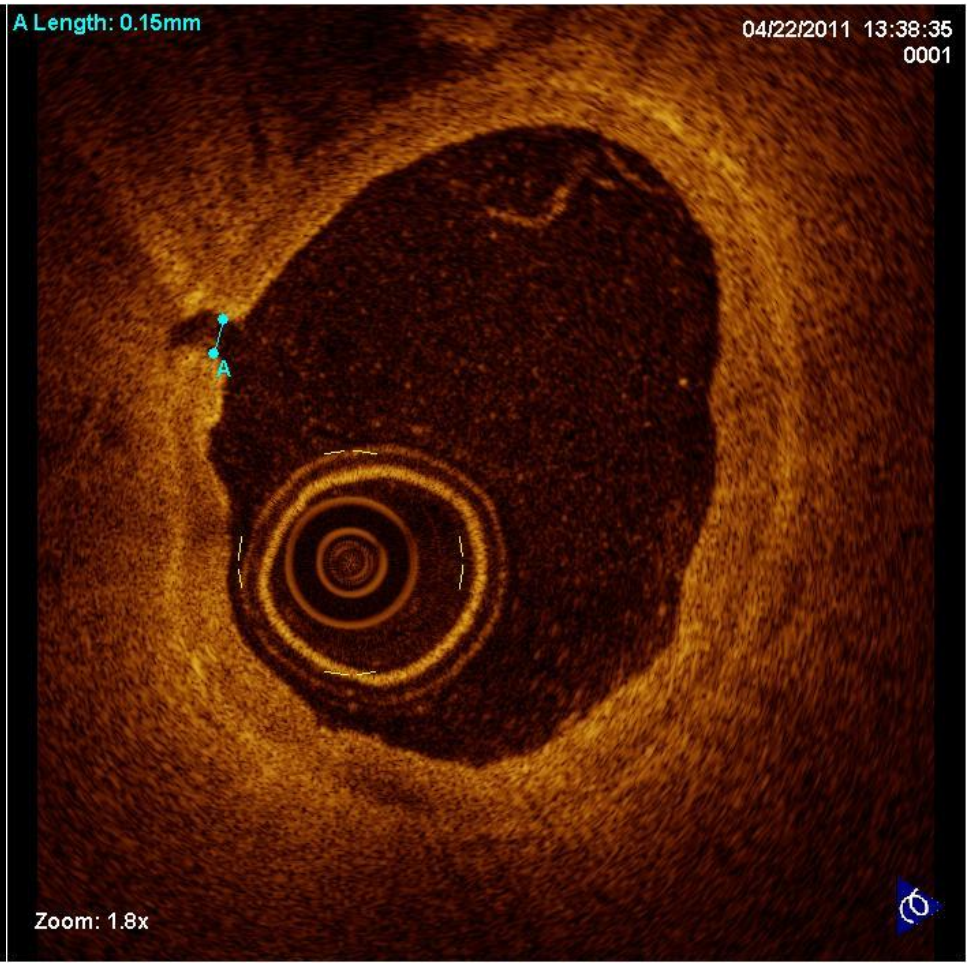


Developing intravascular imaging with OCT for brain vessels

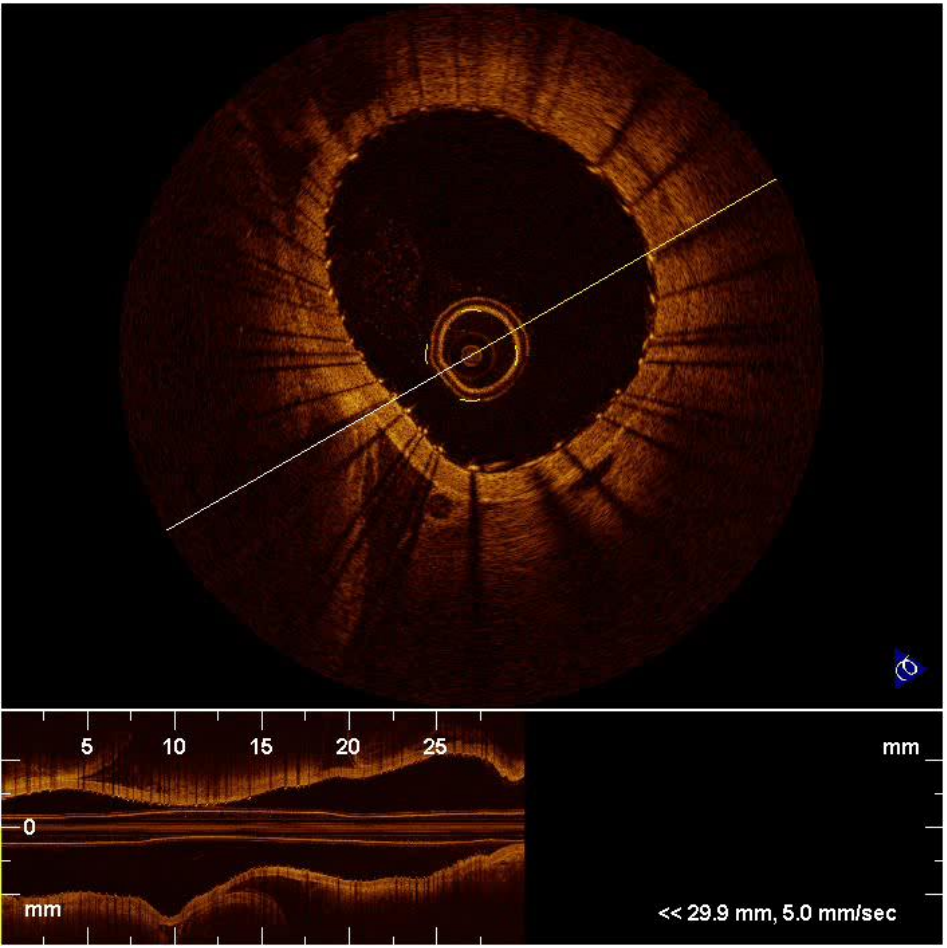

5
10
15
20
25
0
mm
mm
<< 29.9 mm, 5.0 mm/sec

MCA – Lenticulostriate perforators

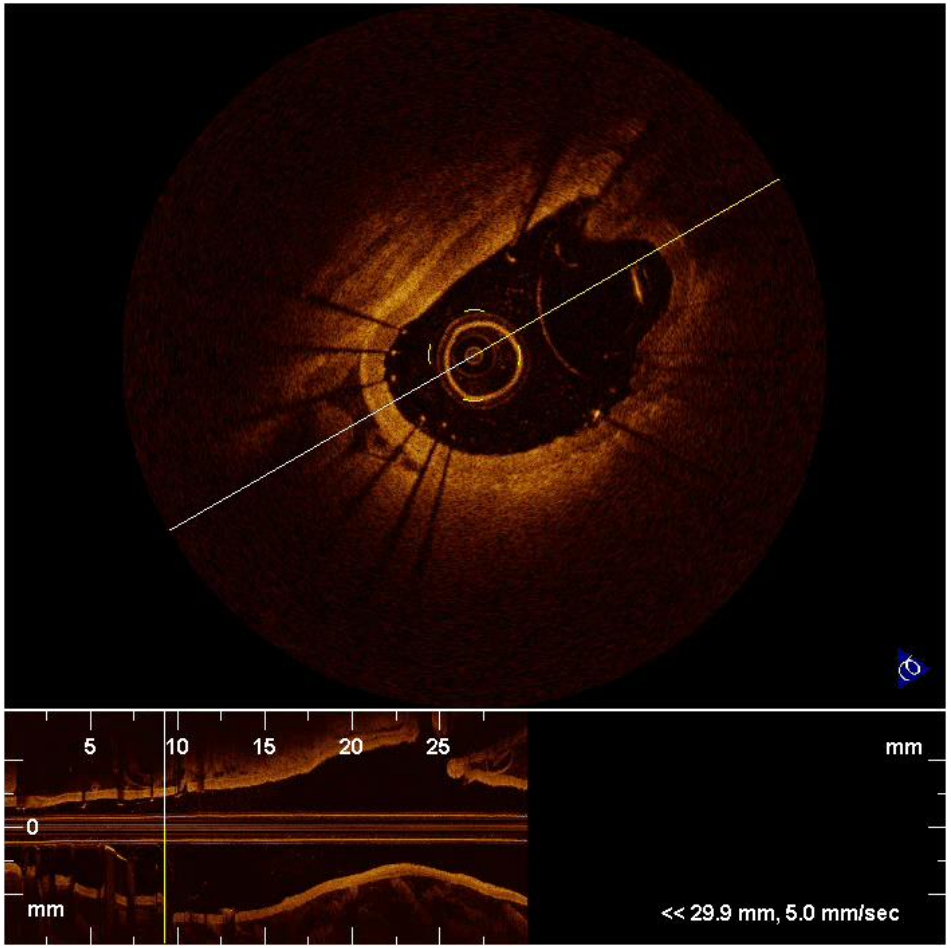




Flow - Diverter



Self-expanding Stent



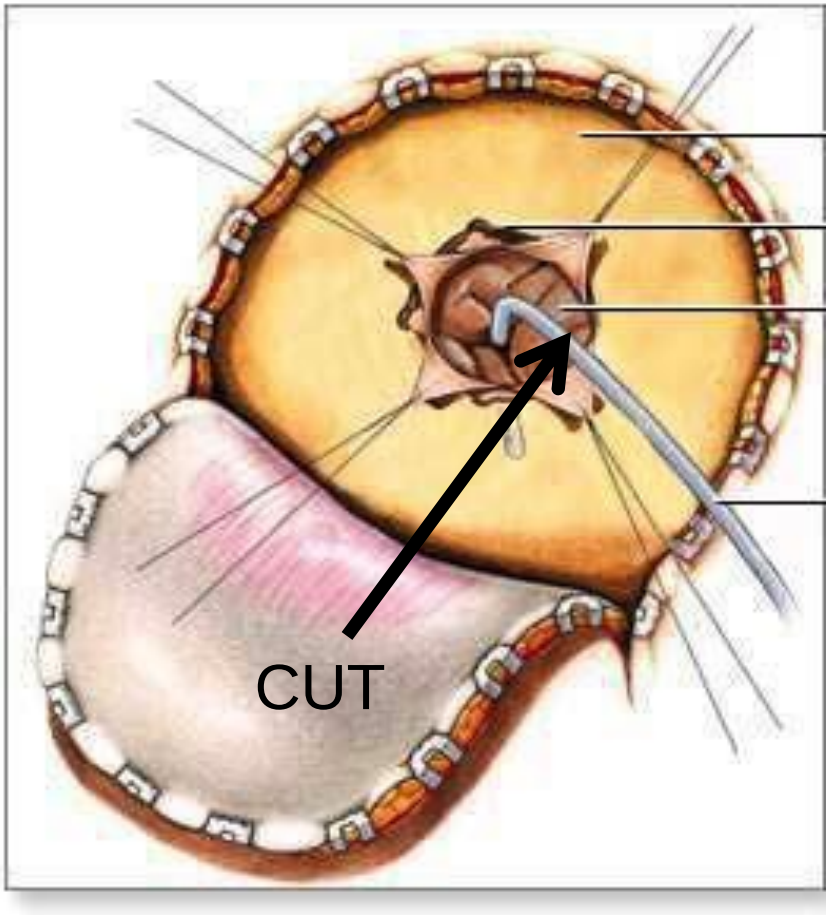
Thromboembolic Risk

- PRU>208 + procedure >116 min – high risk
- PRU<208 + procedure > 116 min – moderate risk
- PRU>208 + procedure < 116 min – moderate risk
- PRU<208 + procedure < 116 min – low risk

J Neurointerv Surg. 2015 Mar;7(3):217-21. doi: 10.1136/neurintsurg-2014-011111. Epub 2014 Feb 19.

Thromboembolic complications with Pipeline Embolization Device placement: impact of procedure time, number of stents and pre-procedure P2Y12 reaction unit (PRU) value

What about patients with ventriculostomy?



- Technique for shunt
  - Expose ventriculostomy burr hole
  - Cut venticulostomy catheter and discard proximal section
  - Attach shunt valve directly to original ventriculostomy catheter
- No movement of ventriculostomy catheter

RUSH UNIVERSITY MEDICAL CENTER

Intraoperative Monitoring

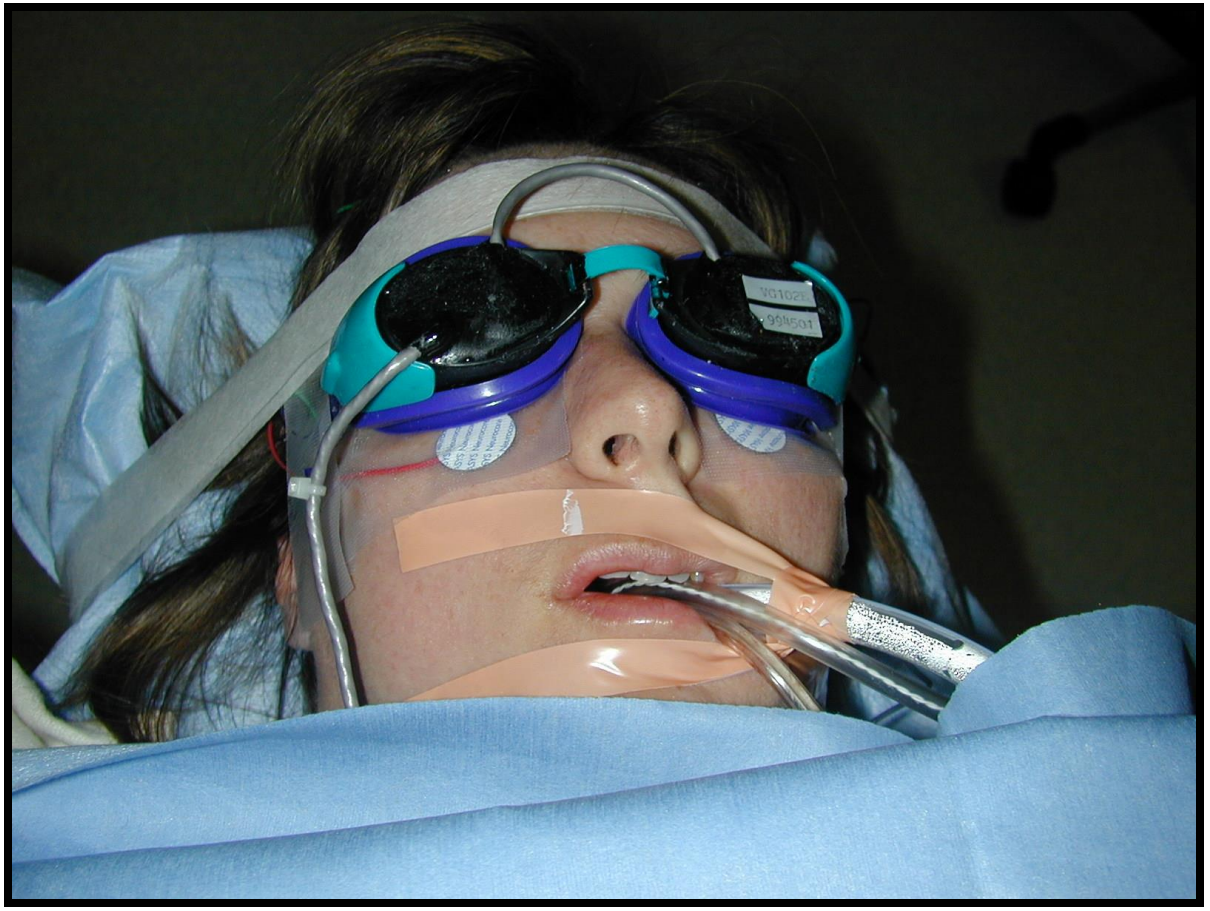
Have all the "amenities" that we have for clipping

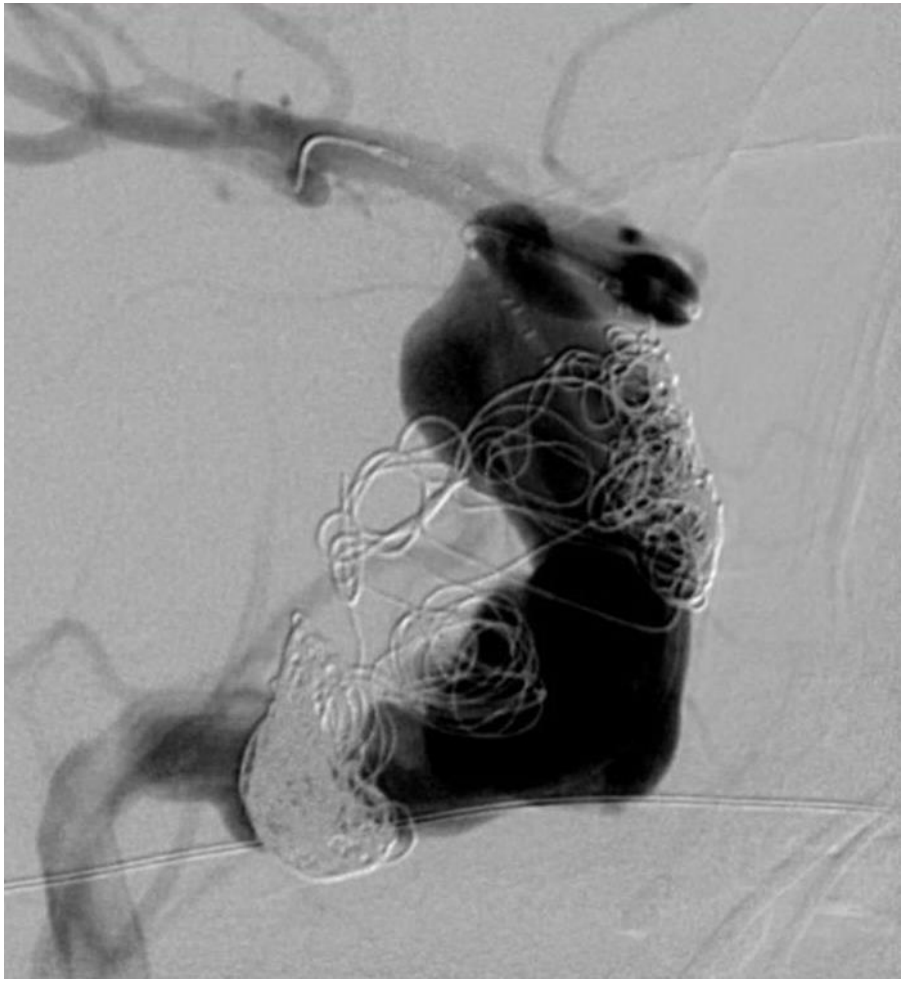
Motor

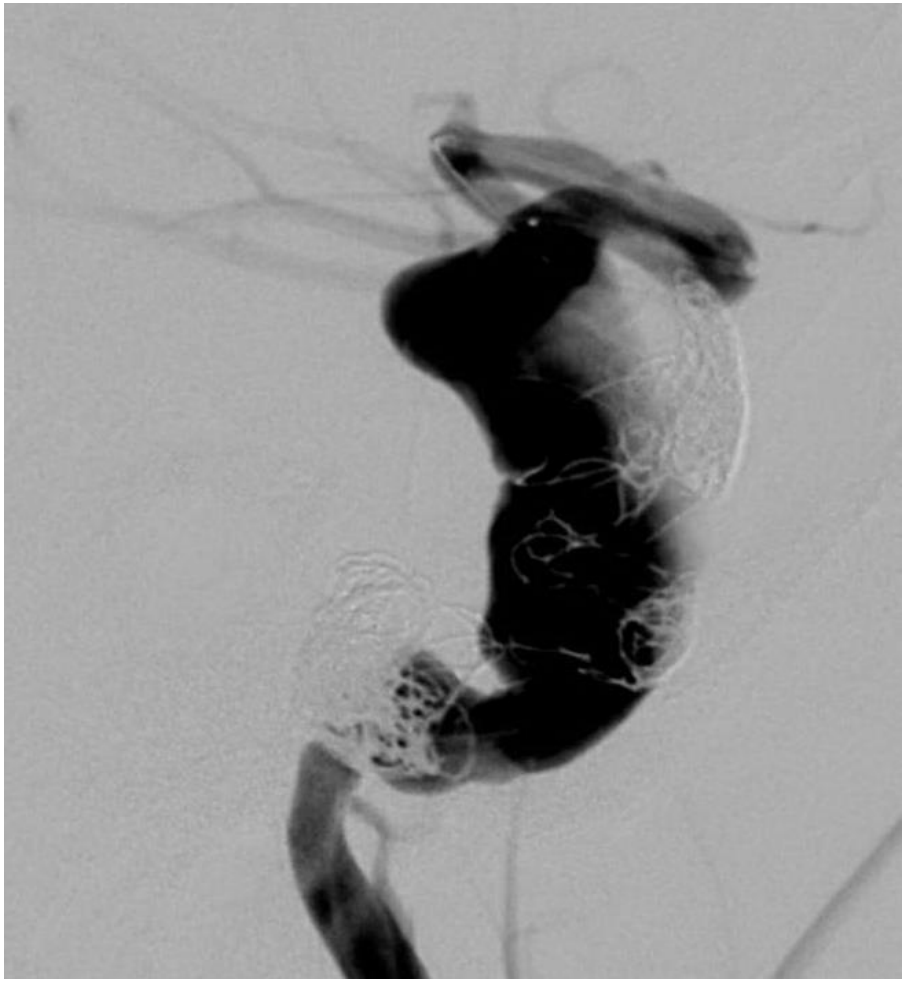
VER

SSEP

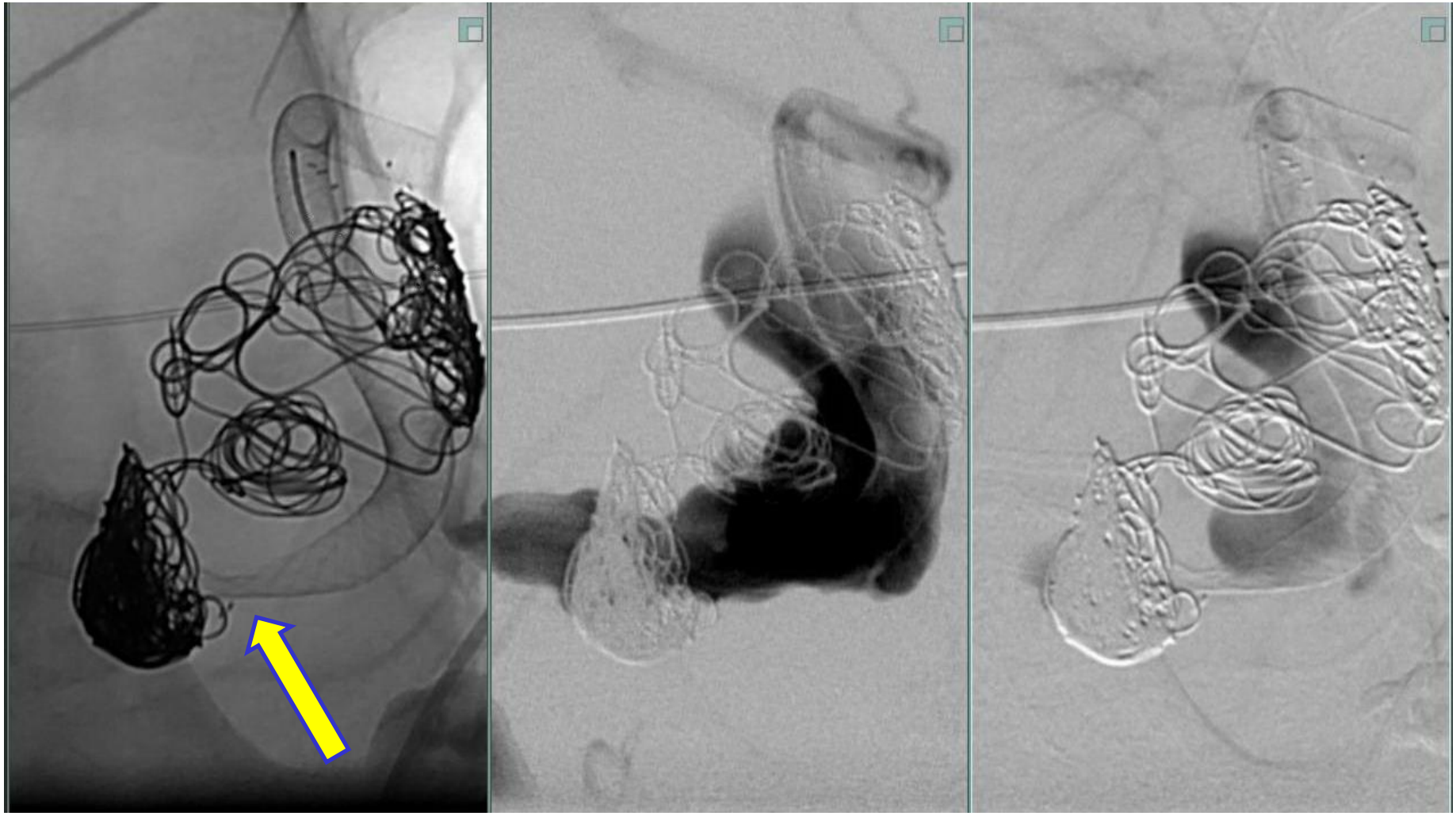
EEG



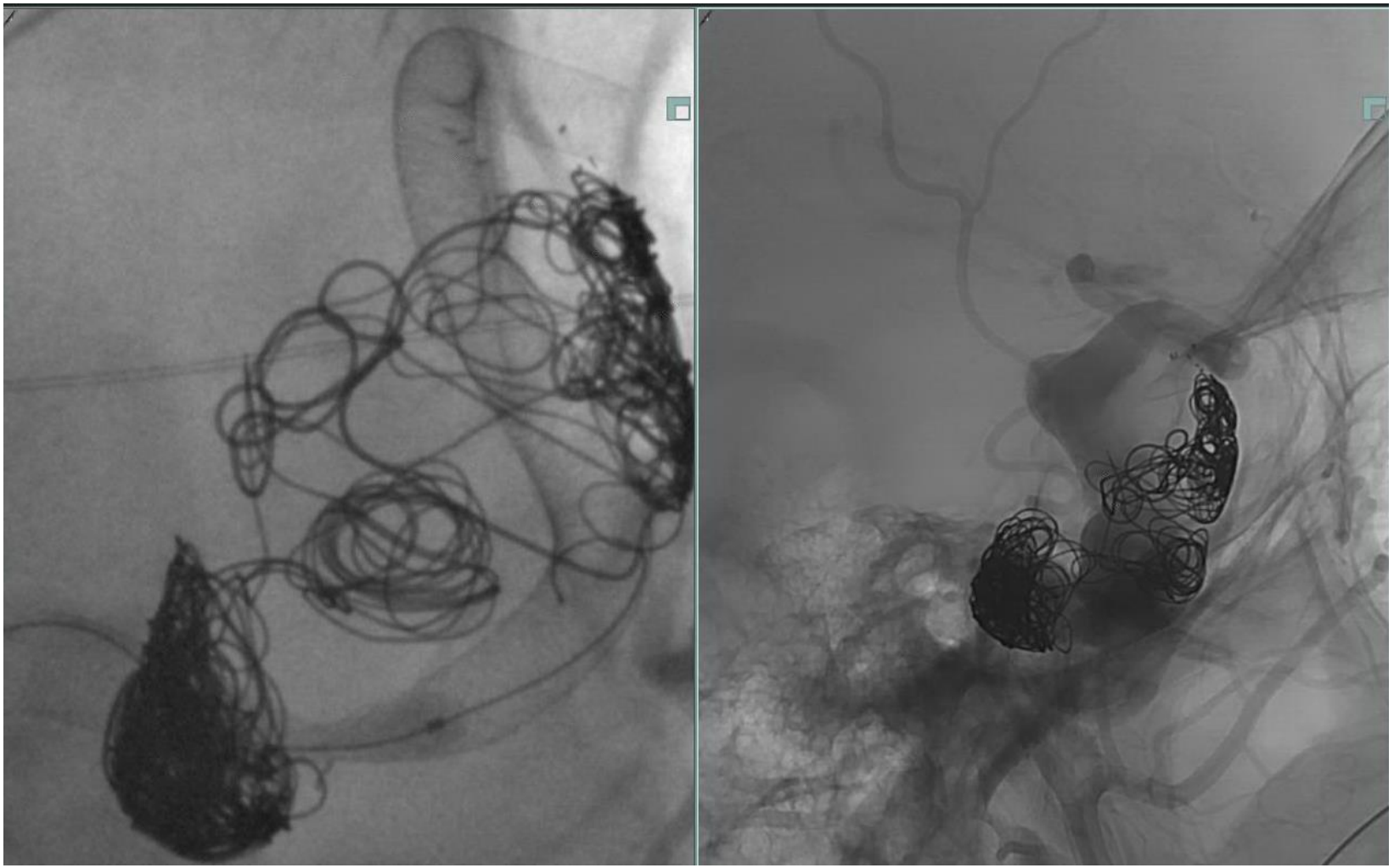




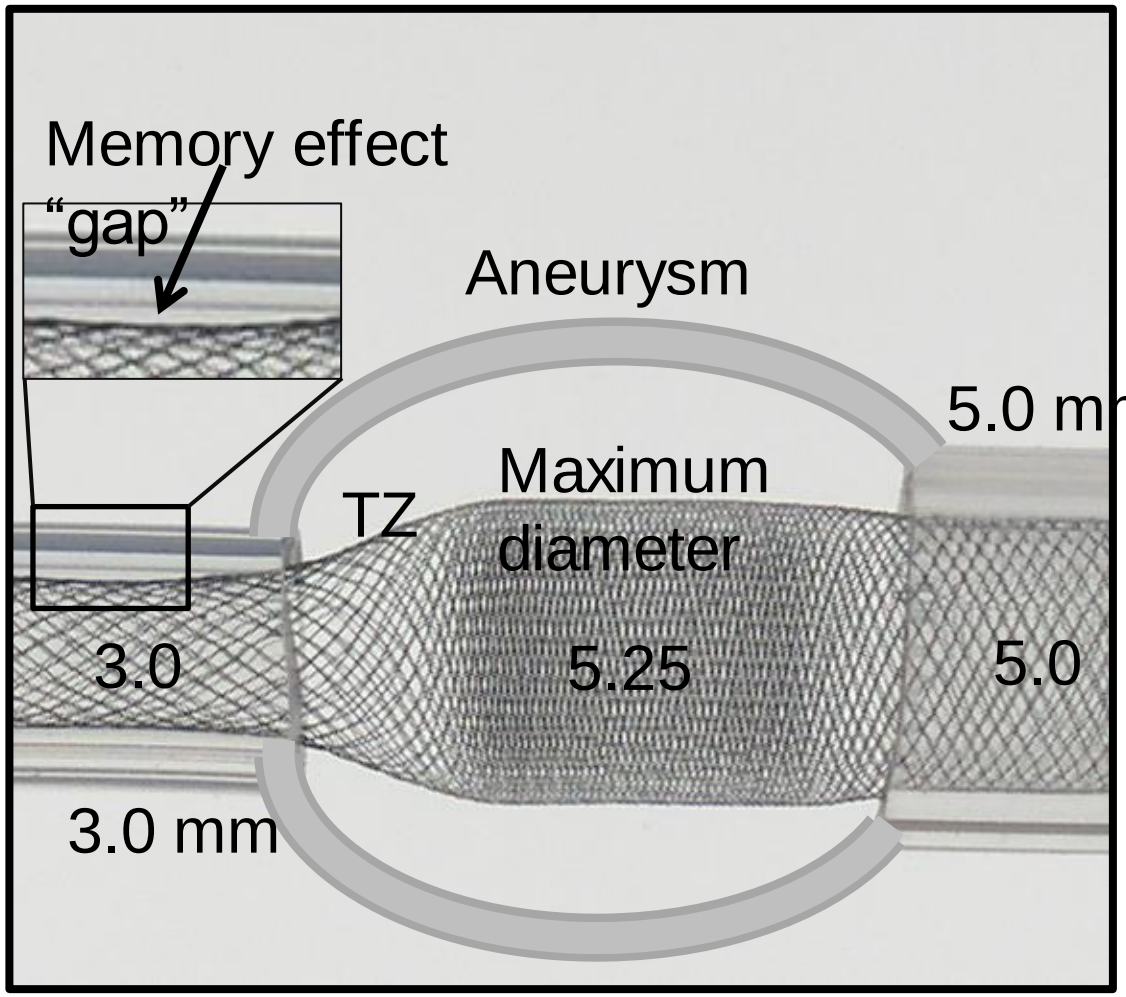
8 Overlapping Pipeline stents



Angioplasty within Pipeline

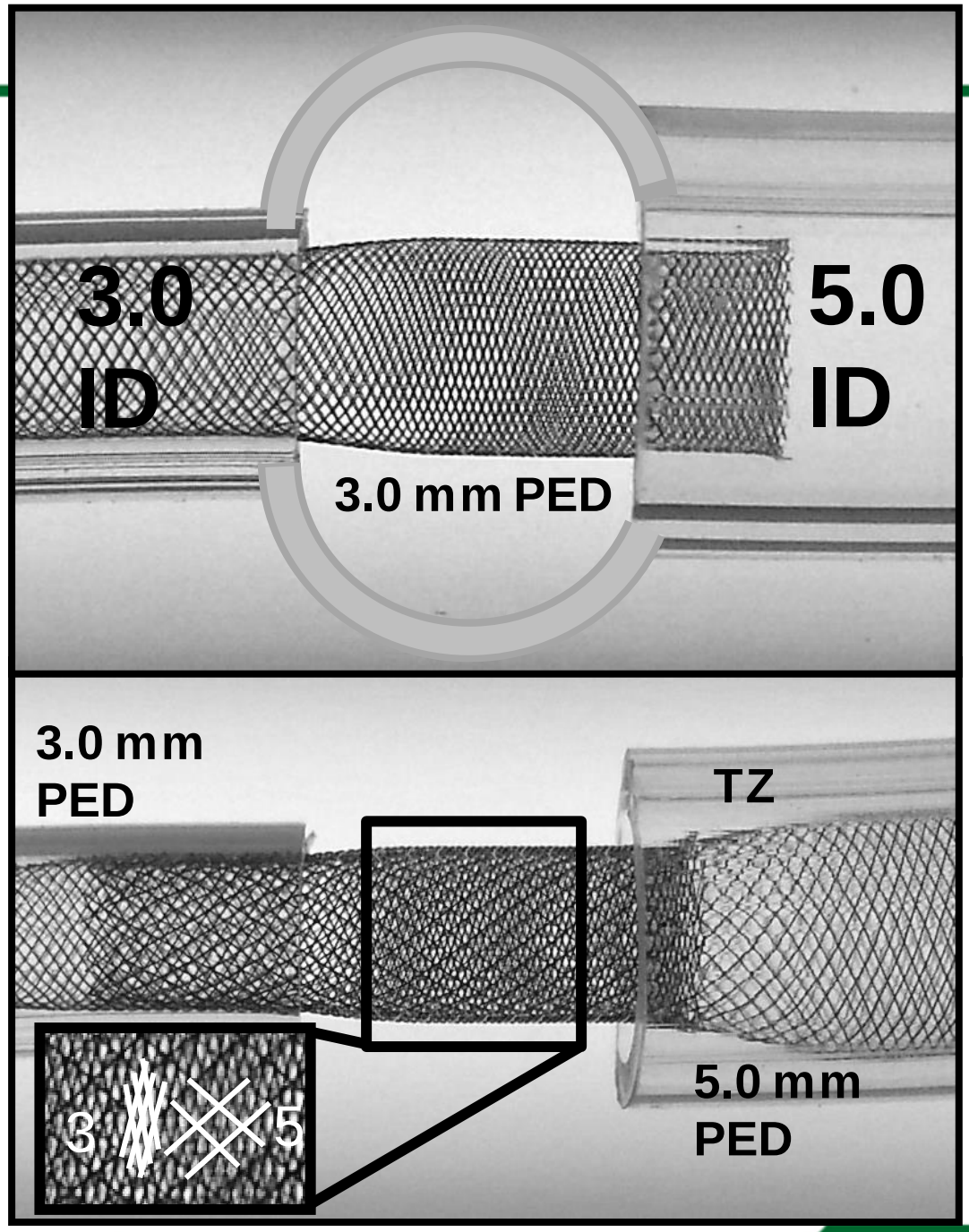


Device/Vessel Mismatch Behavior

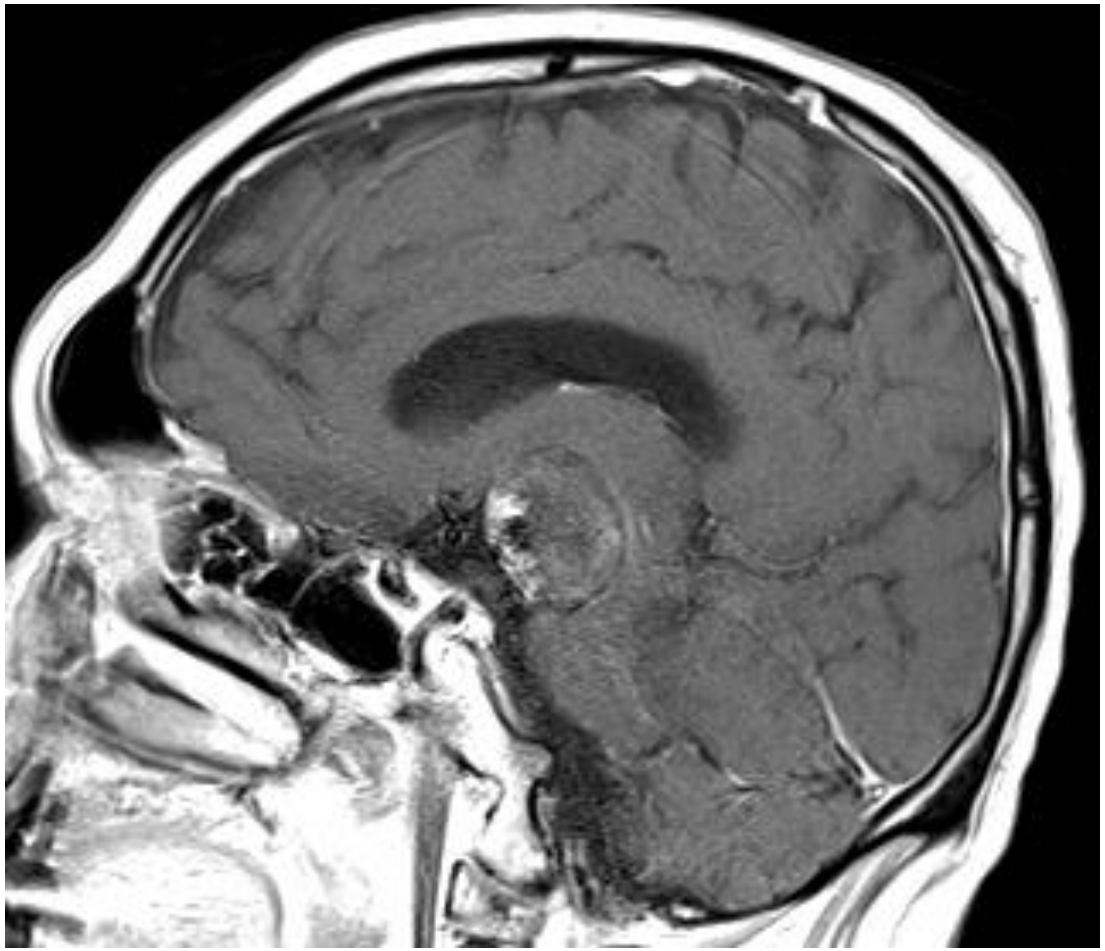


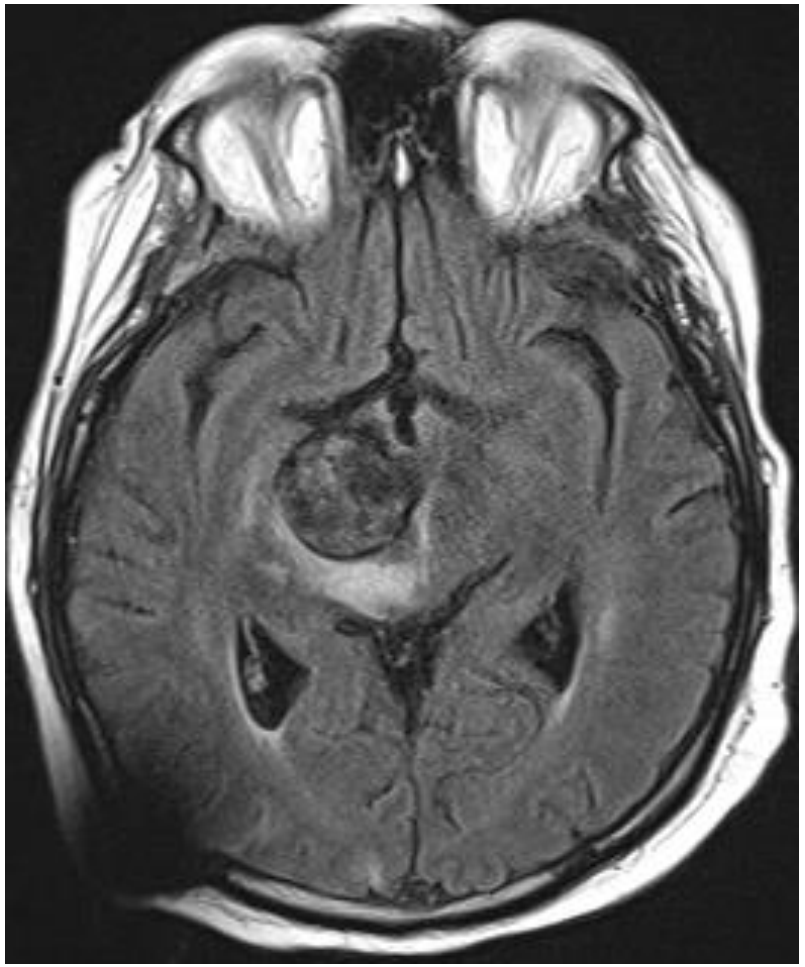
5 x 20 mm PED Nominal diameter

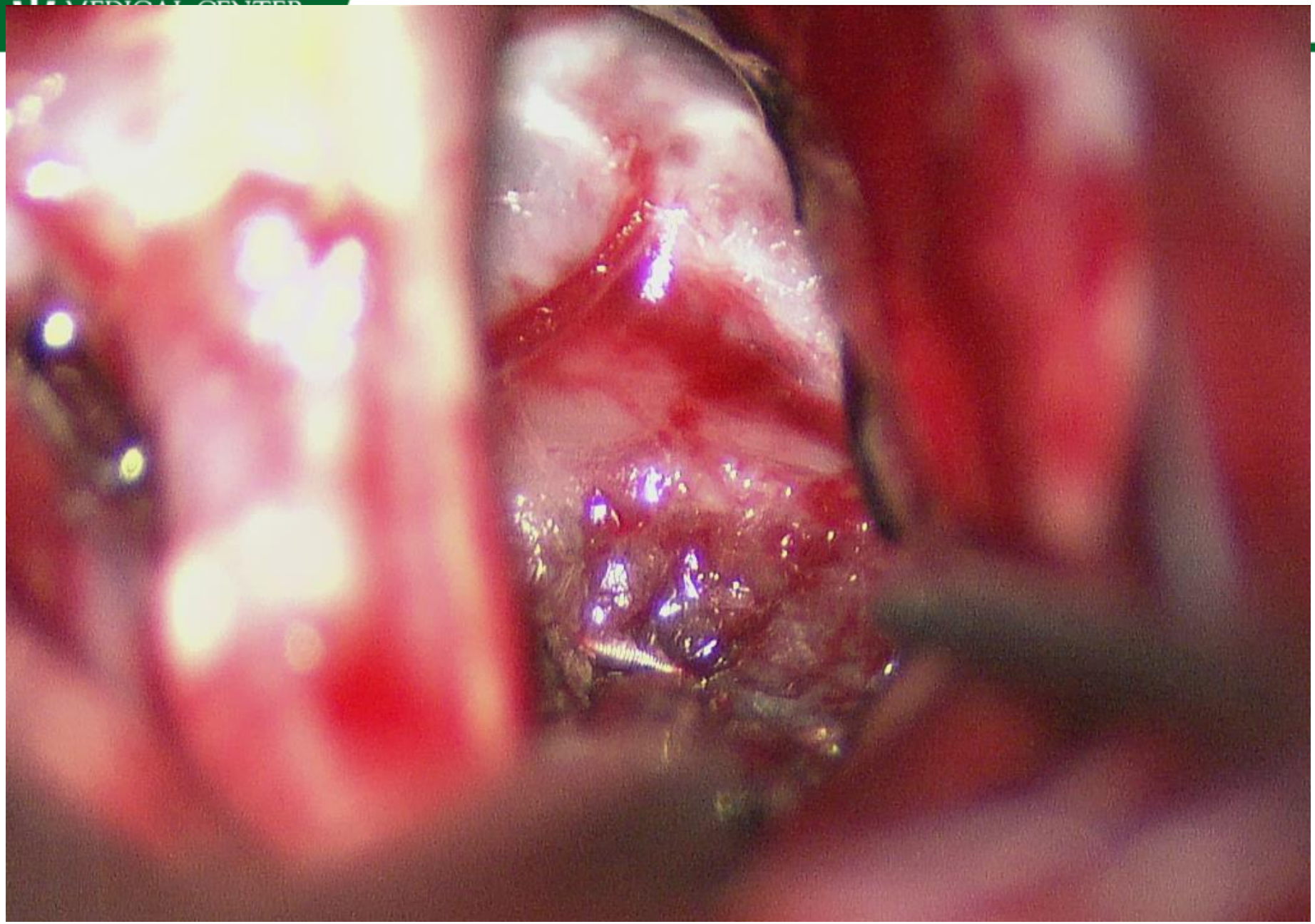
Addressing mismatch



Symptomatic occluded aneurysm







Conclusions:

- Vertebrobasilar fusiform and recurrent large and giant aneurysms remain formidable lesions associated with high morbidity and mortality when left untreated
- Safer treatments may allow early intervention prior to quality of life permanently affected
- Treatment with a variable coverage may be an alternative to invasive and extensive open vascular reconstruction and unpredictable impact of FD coverage
- Progressive thrombosis of the aneurysm is a fine balance of controlling blood coagulation and flow remodeling
- OCT imaging could be helpful mapping perforators for tailored coverage

RUSH UNIVERSITY MEDICAL CENTER

Hope to see you there!!!

www.wlnc.net

RUSH UNIVERSITY MEDICAL CENTER

Rush Center for Neuroendovascular surgery

brainaneurysm@me.com