Basilar Tip Aneurysms

Laligam N. Sekhar, MD, FACS
Professor and Vice Chairman
Director of Cerebrovascular and Skull Base Surgery
University of Washington

Co Authors

- Farzana Tariq, MD
- Ryan Morton, MD
- Jason Barber, Ph. D
- Basavaraj Ghodke, MD
- Danial Hallam, MD
- Louis Kim, MD

The Current Issues

- BA Tip Aneurysms were considered the most difficult to treat by Microsurgery
- In many centers, Endovascular Therapy has replaced Microsurgery as the Primary Treatment Modality
- Is there a Role for Microsurgery of Some of these Aneurysms? If so, which ones?
- Are the results of Treatment of these aneurysms Different from that of Aneurysms in other locations, in a large Aneurysm Center?

Additional Questions

- What Are some of the Current Techniques for Sophisticated Microsurgical Treatment?
- What are Current Endovascular Treatments?
- How to treat some Very Challenging Cases?

Incidence

- Posterior Circulation Aneurysms Comprise 8 to 10% of Aneurysms in Most Series
- In our Series at HMC 2005 to Jul 2012 1298
  - Total Ruptured Ans. Treated 834 (64.2%)
    - Posterior Circulation 228 (27%)
    - Basilar Tip 72 (8.6%)
  - Total Unruptured Ans. Treated 464 (35.7%)
    - Posterior Circulation 118 (25.4%)
    - Basilar Tip 44 (9.4%)

Natural History

- Natural History of Unruptured Saccular Aneurysms (ISUIA Study LANCET 2003, 12 : 103 -10)
- Anterior Circulation except PCom — Annual Rate of Bleeding
  - 7- 12 mm — 0.5%
  - 13- 24 mm — 2.9%
  - ≥ 25 mm — 8.0%

Posterior Circulation + ICA- PCom

  - 7 -12 mm — 2.9%
  - 13 – 24 mm — 3.7%
  - ≥ 25mm — 10.0%

- Mortality of Ruptured large/ Giant Aneurysms Higher than Small /Medium sized aneurysms
- Incidentally Discovered Unruptured Giant Aneurysms Should be Treated
- Age, and Treatment Morbidity Important Considerations
- Treatment Should be Performed in Centers with a Large Volume (≥100/year) of Aneurysm Patients, which have both Endovascular and Microsurgical (esp. Bypasses) Expertise

Japanese Unruptured Aneurysm Study

- 5720 patients, 6697 aneurysms, age >20years
- Follow up 11,660aneurysm-years, 111 patients had aneurysm rupture
- Annual Rate of Rupture 0.95% (95% CI 0.79 to 1.15)
- With size 3-4mm as reference, rupture rate increased with size:5-6 mm1.13; 7-9mm 3.35;10-24 mm 9.09; ≥25 mm 76.26 (Hazard ratios)
- Compared to MCA aneurysms, Increased rupture risk in ACOM 2.02, PCOM 1.90, and Basilar Tip 1.49
- Daughter Sac 1.63 (95% CI 1.08- 2.48)
- Multiple Aneurysms Increased the risk cumulatively, according to the number of aneurysms

Annual Rate of Rupture for Basilar Tip Aneurysms

3-4mm	0.23 (0.03-1.61)
5-6mm	0.46 (0.06-3.27)
7-9mm	0.97 (0.24-3.89)
10-24mm	6.94 (3.74-12.90)
≥ 25mm	117.8 (16.60-836.43)

The UCAS Japan Investigators, The natural course of Unruptured aneurysms in a Japanese Cohort, NEJM 366;26: 2474 - 2482

Special Anatomical Considerations

- Almost Straight Orientation of VA, and BA relative to the Foramen Magnum
- From its origin, The VA takes many turns before entering the Cranium
- The angulation, and height of the BA tip relative to the skull base (posterior Clinoid process) are variable
- The angle of the PCAs leaving the BA tip varies according to the height of the bifurcation
- The size of the PCA - P1 segment is variable, and has an inverse relationship to the size of the PCOM artery
- The SCAs are usually single, but can be duplicated

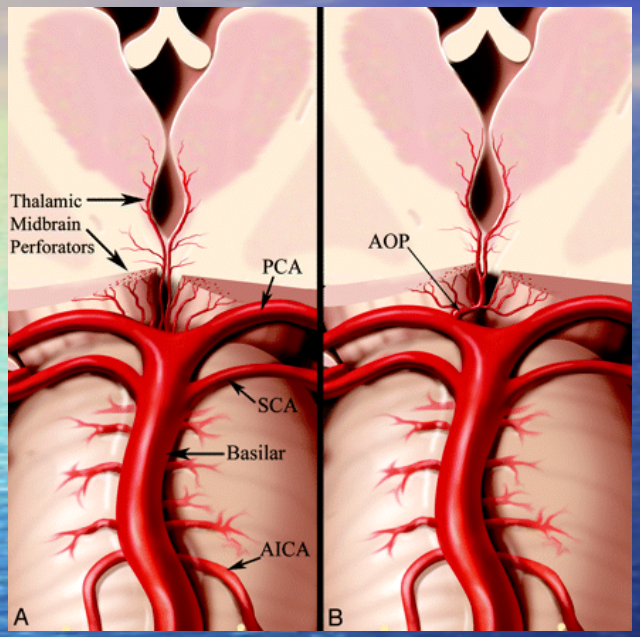
Collateral Circulation

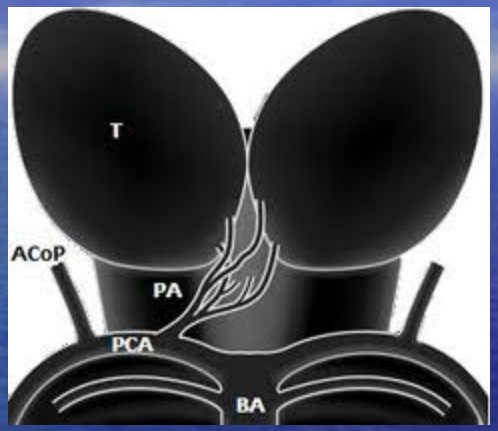
- At the level of the BA Tip, the collaterals are derived from the ICA, thro the PCOMs
- One PCOM ≥1mm. Is considered to be a fair Collateral Circulation
- Two PCOMs ≥1mm. Is considered to be a good Collateral Circulation
- An absent PCOM (s), and a totally fetal PCOM-PCA with a tiny P1 connection creates a poor collateral circulation
- Some collateral flow can also derive from the SCAs, thro their pial connections with the PICA, and the SCA of the opposite side

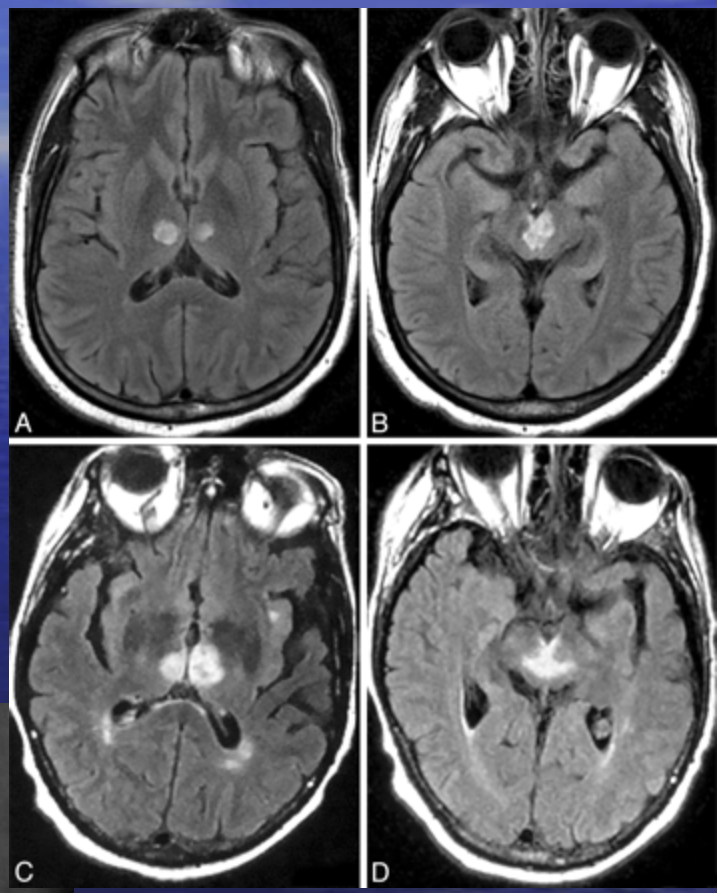
Perforators

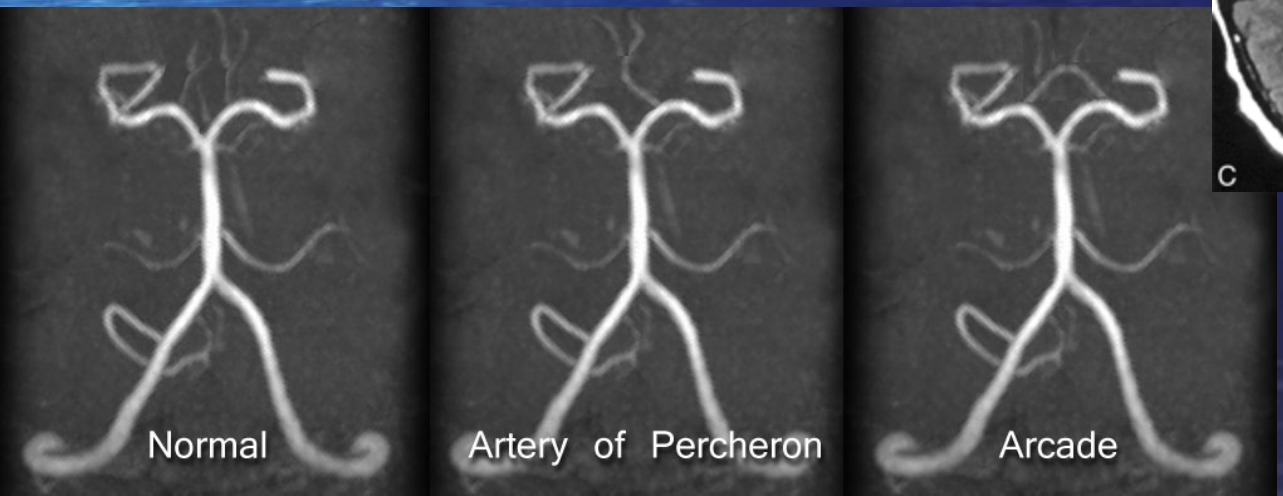
- Most Important ones are the Thalamogeniculate peforators derived from the P1 – PCAs – they are usually assymmetric, sometimes single, with distal branching
- Occlusion of one or more of these perforators results in Thalamic/ Midbrain Infarction, with coma
- Other Important perforators may be derived from the PCom, P2, or the Pre terminal Basilar artery

Variants of Thalamo Geniculate Arteries









Clinical Presentation

- Ruptured Aneurysms: No Symptoms specific to the location; CT may show more blood in the perimesencephalic, prepontine cisterns, and the 3rd ventricle
- Unruptured Aneurysms:

  Incidental Discovery

  Large/ Giant Aneurysms : Midbrain Compression – Hemi paresis, Ataxia, Dementia, CN 3 Palsy

Treatment Decisions

- Patient Factors: General Medical Condition, Age, H&H Status after Rupture
- Surgeon Factors:

  Experience and Expertise of Treating Physician

  Availability of Endovascular Treatment

  ICU and Nursing Team

  Management Protocols for Vasospasm, especially 2H therapy, and Endovascular Angioplasty/ Nicardipine

Aneurysm Factors

- Size of the Aneurysm (measured as the height, and width of the sac)

  0 -6mm, 7- 12 mm, 13 – 24 mm, ≥ 25mm
- Neck Dimension: ≤4mm, > 4mm
- Dome to Neck Ratio: Width / Neck
- Aspect ratio: Height / Neck diameter
- Sac Angle at BA Tip : Superior, Anterior, or Posterior
- Neck Height in Relations to Posterior Clinoid

Additional Aneurysm Factors

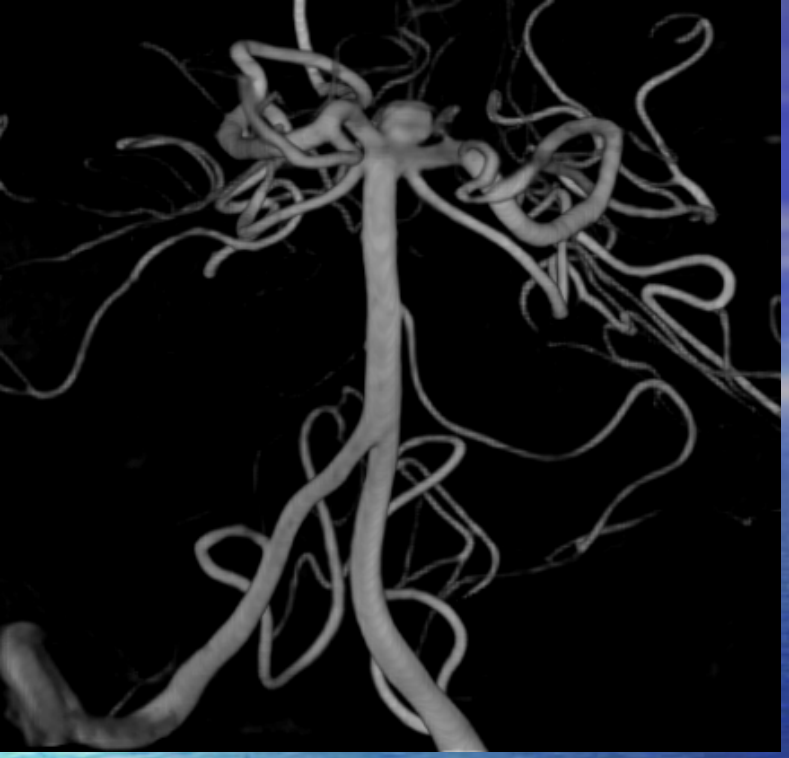
- Entire BA Tip Abnormal (dysplastic BA)
- Origin of PCAs / SCAs from the Neck or the Sac of the Aneurysm

Endovascular Treatment

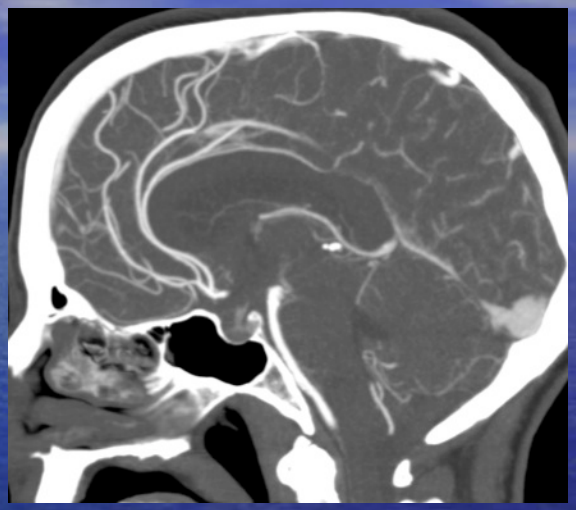
- Endovascular Coiling
- Endovascular Coiling with Balloon Assistance
- Endovascular Coiling with a Single Stent
- Endovascular Coiling with Y – stent (two stents)
- Terminal BA Occlusion

Endovascular Coiling

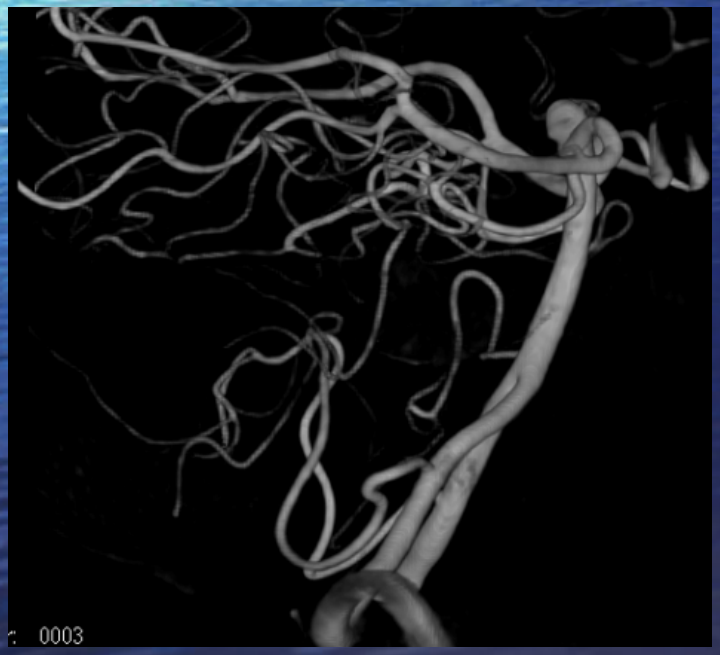
- Balloon Assistance is Used in Many cases, based on Neck Dimension
- Recurrence is Common, especially after treatment for Ruptured Aneurysms

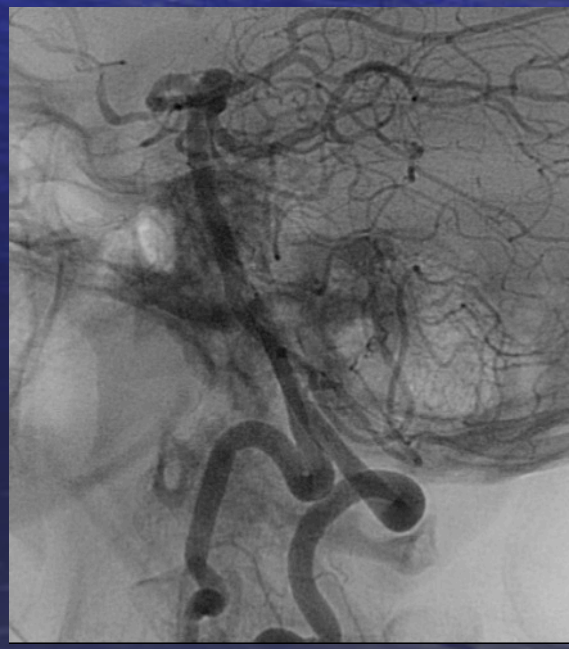


45/F, HH 3, Fisher 3, Ruptured BA Tip Aneurysm, Balloon assisted coiling.

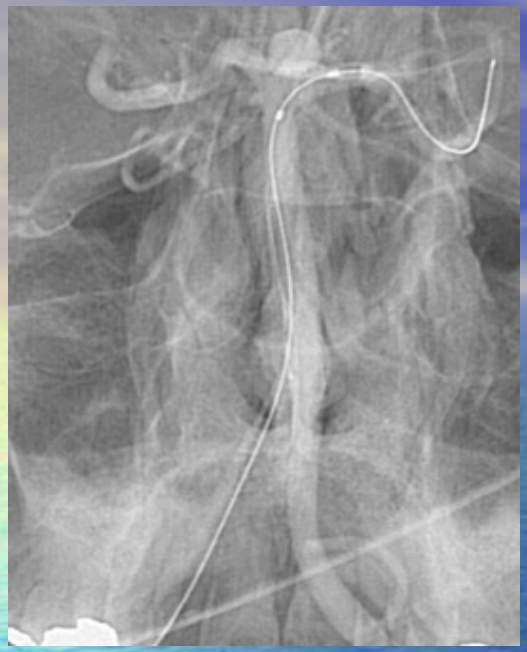


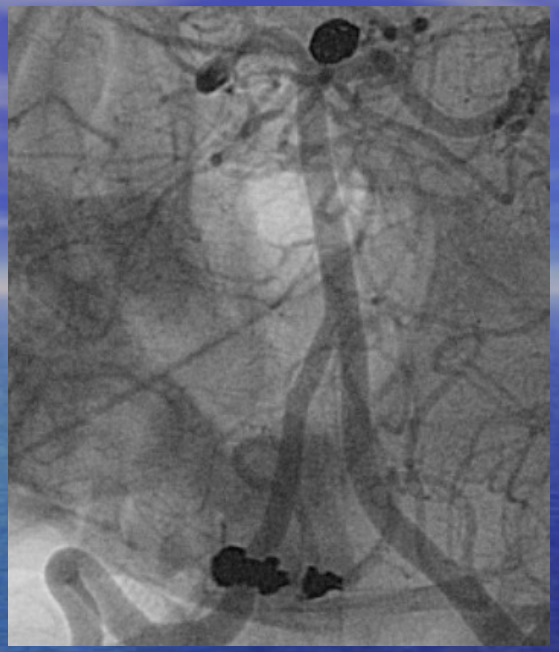
Size	5mm
Neck dimension	2.5
Aspect Ratio	2
Dome to neck ratio	2

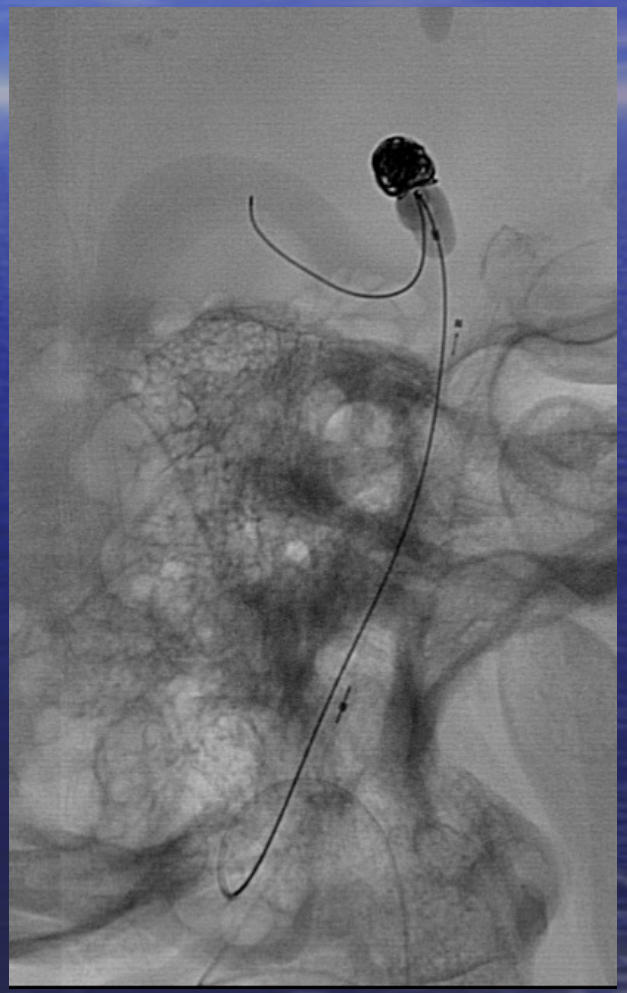


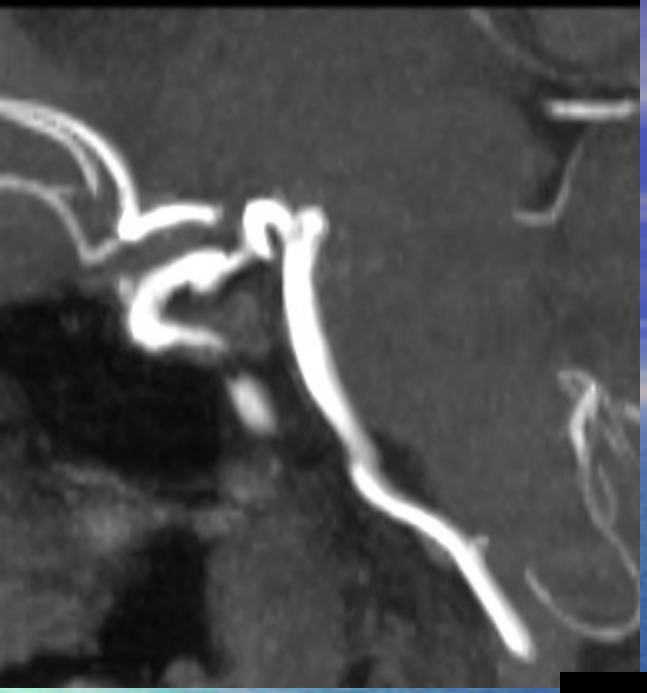


Balloon assisted coiling of the basilar tip aneurysm







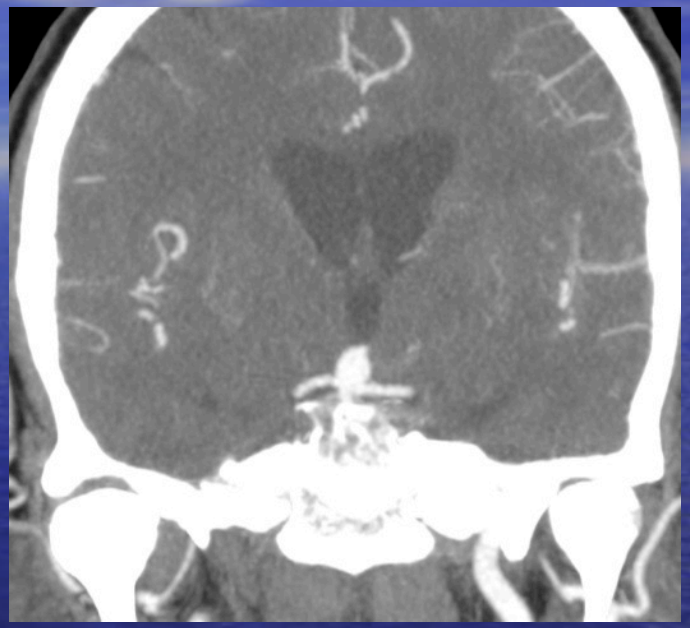


1year follow-up scan showing complete obliteration of the aneurysm

Endovascular Stent / Coil

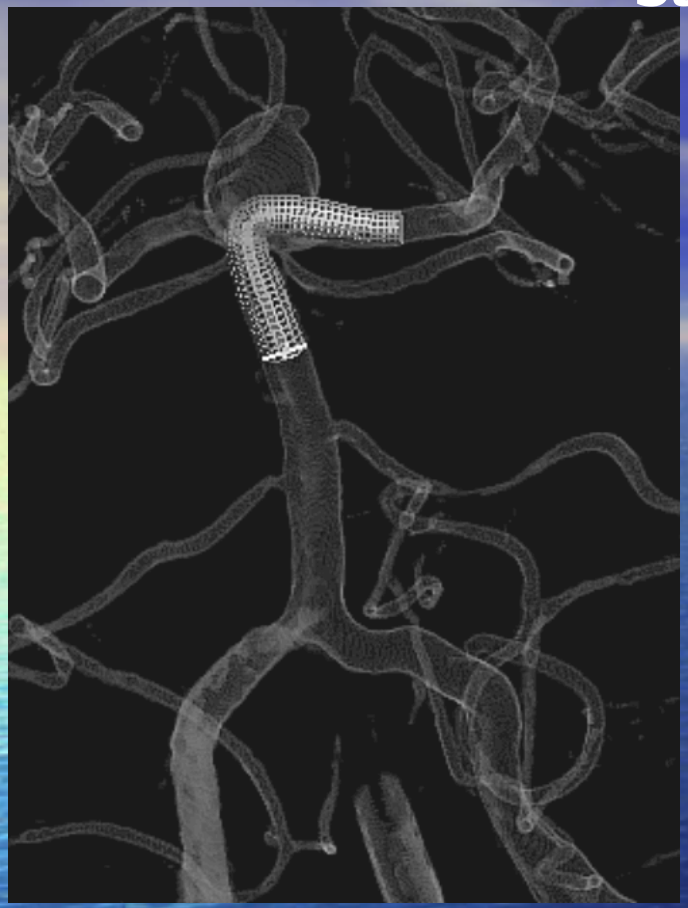
- Mainly in Unruptured Aneurysms, due to the Need for Dual Antiplatelet therapy for at least 3 months
- May be used as a Rescue in Ruptured cases, patient will need Abciximab (Reopro) acutely, and conversion to ASA/ Clopidogrel
- Stent usage in SAH cases makes further management more complicated

53 f, H/H 2, Fisher 3, Ruptured basilar tip aneurysm treated with stent assisted coiling

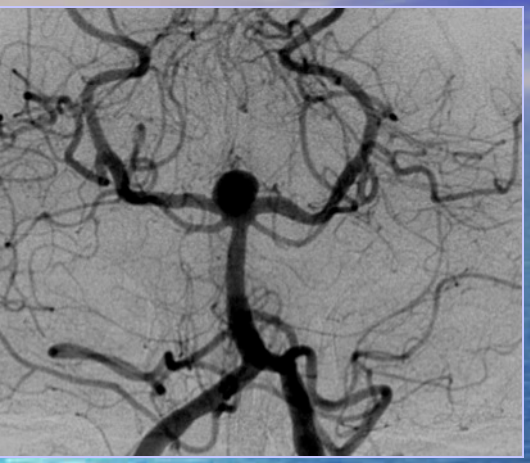


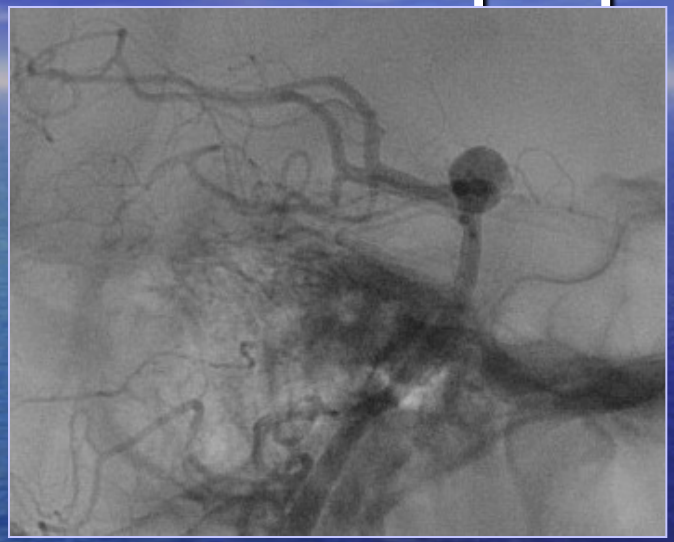
Size	7mm
Neck dimension	5mm
Aspect Ratio	1.4
Dome to neck ratio	1.1

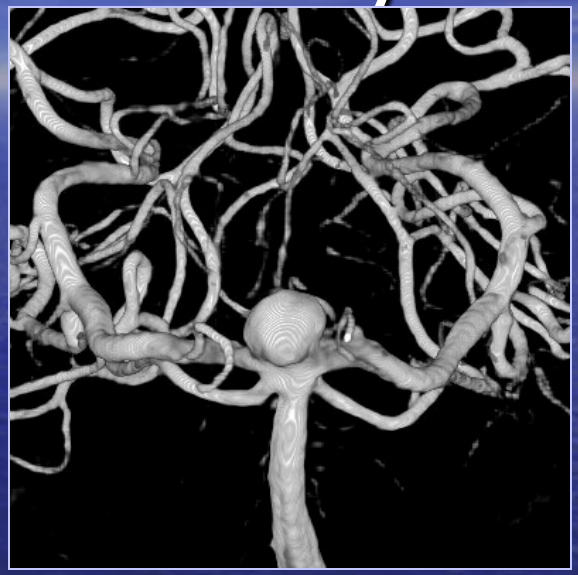
Stent assisted coiling

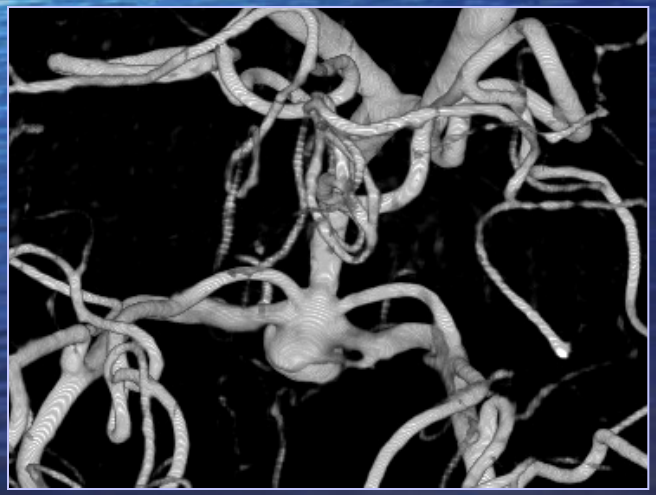


45 year old presented with migraines, blurred vision and Diplopia for 5 days



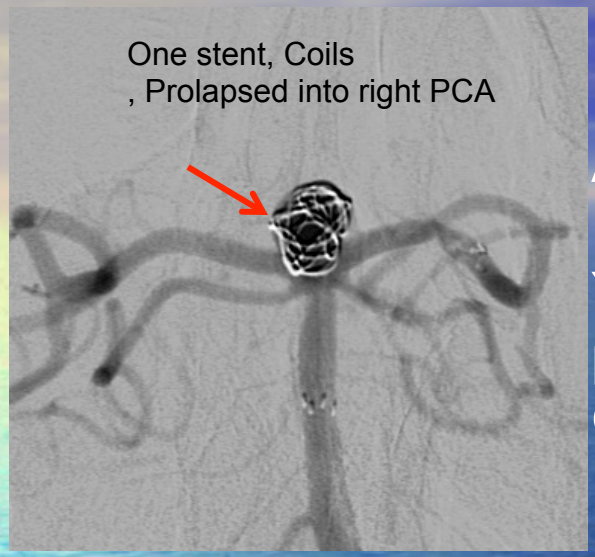




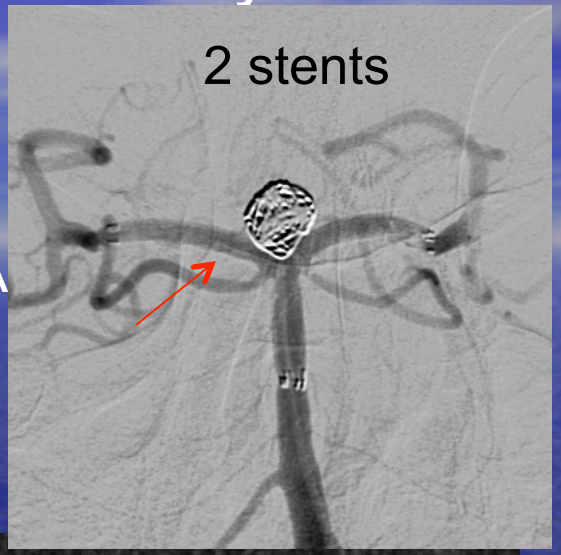


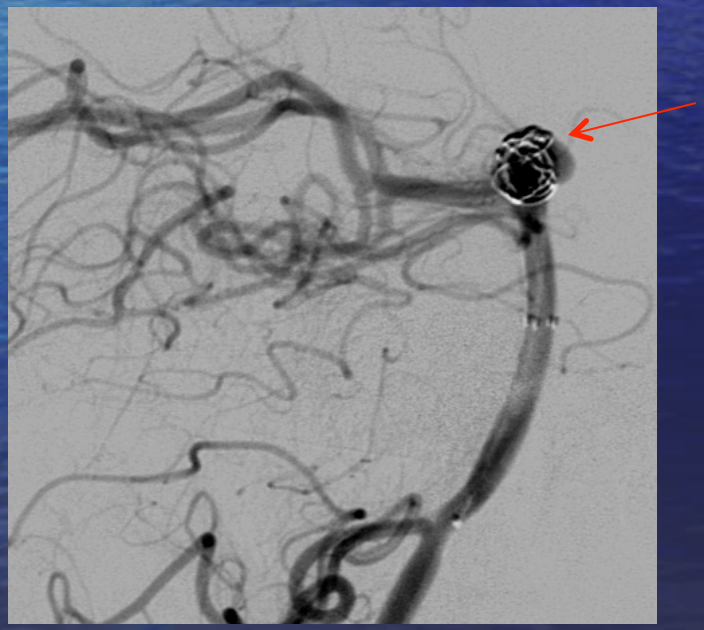
Broad based
Basilar tip aneurysm

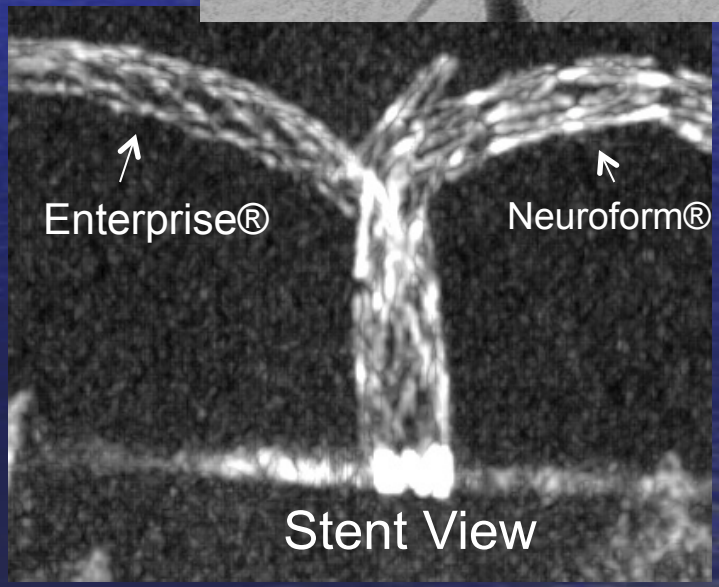
Y stent and Coiling of the basilar tip aneurysm



Aneurysm Coiled with
Neuroform® stent into left PCA
Y Enterprise® stent
placed to keep coils
Out of right PCA







Patient recovered well,
discharged home 5 days later

Microsurgical Clipping

- Drake, Yasargil, and Dolenc were Pioneers
- Skull Base Approaches (Sekhar, Al Mefty, others) Have made a difference, are essential
- Fibrin Glue Injection into the Cavernous Sinus (Sekhar et al, Krisht et al) have made it much easier
- The Sonopet Ultrasonic Bone Curette has made the resection of the Posterior Clinoid Process/ Dorsum Sellae much safer
- Other Important Adjuncts: Rubber Dam Interposition (Sekhar), Adenosine Cardiac Arrest

Surgical Approaches

- Fronto temporal- Orbital, Transcavernous Approach (Most Aneurysms)
- Subtemporal, Transzygomatic, trans cavernous, trans apical Approach (neck below base of Dorsum Sellae)
- Transpetrosal Approach (Some Giant Aneurysms)
- Rarely, Transcallosal Approach (very high BA Bifurcation)

Surgical Accoutrements

- Good Neuro Anesthesia team
- Total Intravenous Anesthesia
- MEP and SSEP Monitoring
- Burst Suppression (and Normotension) with Diprivan (Propofol) during temporary Occlusion
- Transient Adenosine Induced Arrest in helpful in many patients (trans esophageal ECHO, test dose, chest paddles for shock)
- Post Clipping MEP/SEP, micro Doppler, and ICG Angiography

Highly Complex BA Tip Aneurysms

- Very Large (≥19mm), and Giant Aneurysms
- Very Poor Neck, or No neck
- Deep Hypothermic Circulatory Arrest Technique
- Terminal BA Occlusion, when there are 2 good PComs
- Build a Radial Artery/ Saphenous Vein Graft Bypass, and then do a Terminal BA Occlusion

Fronto Temporal – Orbital, Trans cavernous Approach –

Operative Steps

1. Frontotemporal Craniotomy (Ventriculostomy in SAH cases)
2. Full Orbitotomy, Decompress Superior Orbital Fissure
3. Sylvian Fissure Opened Widely
4. Intradural Optic Canal Decompression, and Anterior Clinoidectomy
5. Approach thro' Optico - Carotid ,and Carotid-Tentorial Space

Operative Steps (Contd.)

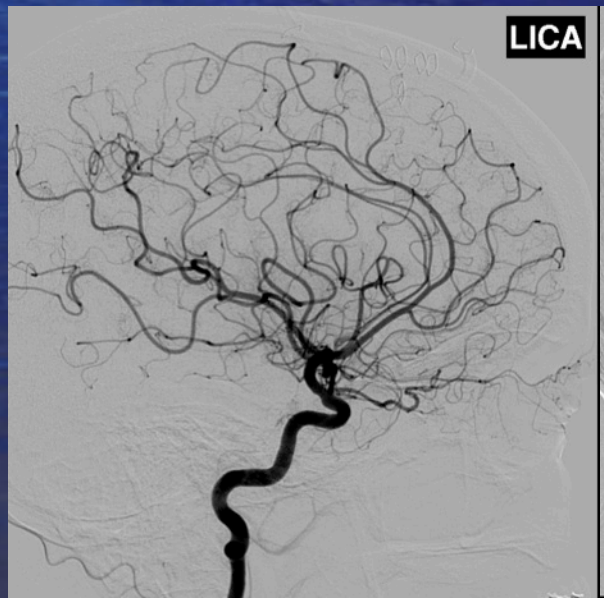
6. Open Cavernous Sinus, Inject Fibrin Glue as needed
7. Posterior Clinoid and Dorsum Sellae resection as needed with Sonopet®, protect Aneurysm with a cotton patty
8. Temporary Clip on Basilar Artery, after Burst Suppression with Propofol
9. Dissect Aneurysm inferior to PCA, and between PCAs
10. Protect perforators with a Rubber Dam

Operative Steps III

11. Adenosine Cardiac Arrest, Apply first clip
12. Puncture and Empty Aneurysm
13. Bipolar Cautery of Sac
14. Further Clips as needed, remove Rubber dam
15. Remove Temporary Clip on BA
16. Adenosine Arrest as needed, for clip adjustment, or intra operative rupture
17. MEP, Doppler, and ICG Control post clipping

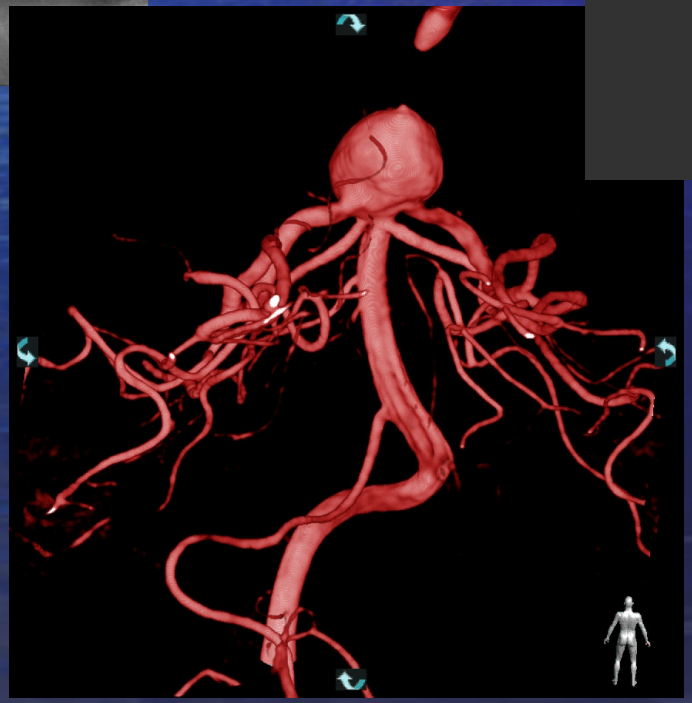
50 year old smoker
SAH, H/H 1, Fisher 3
Ventriculostomy

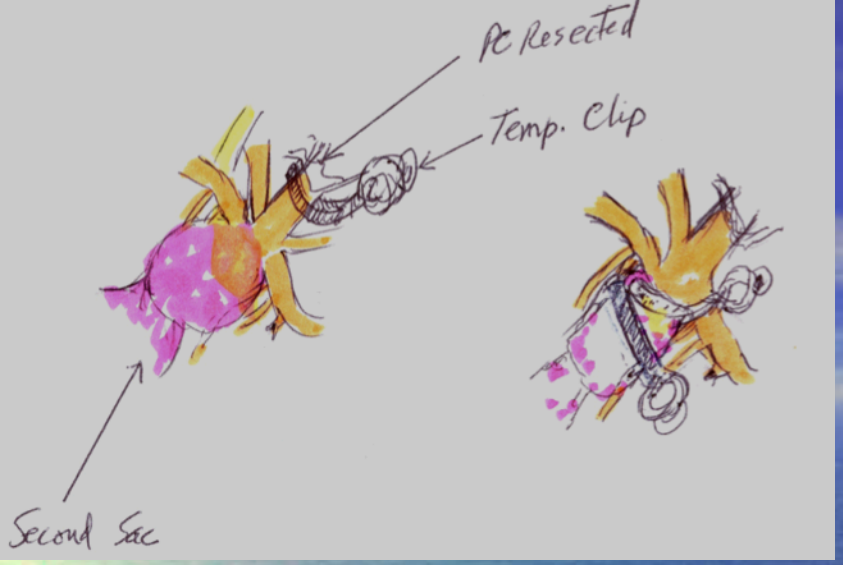
Size	9mm
Neck dimension	7.3
Aspect Ratio	1.2
Dome to neck ratio	1.2



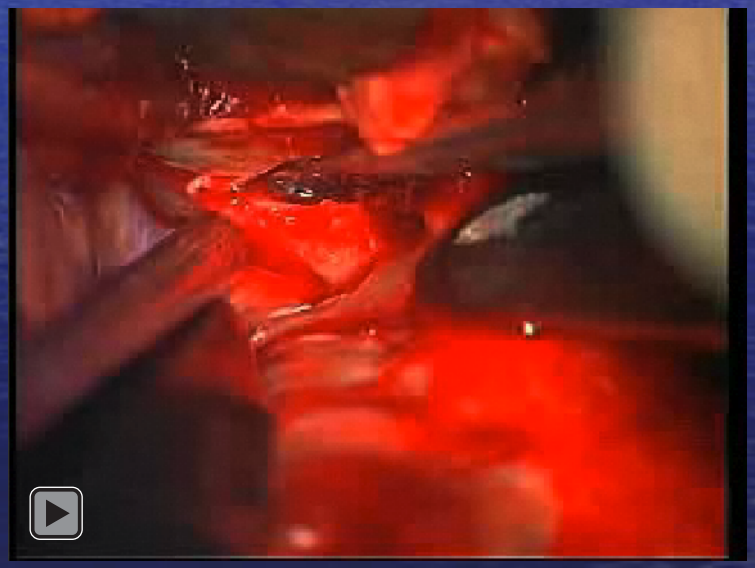

LT VERT

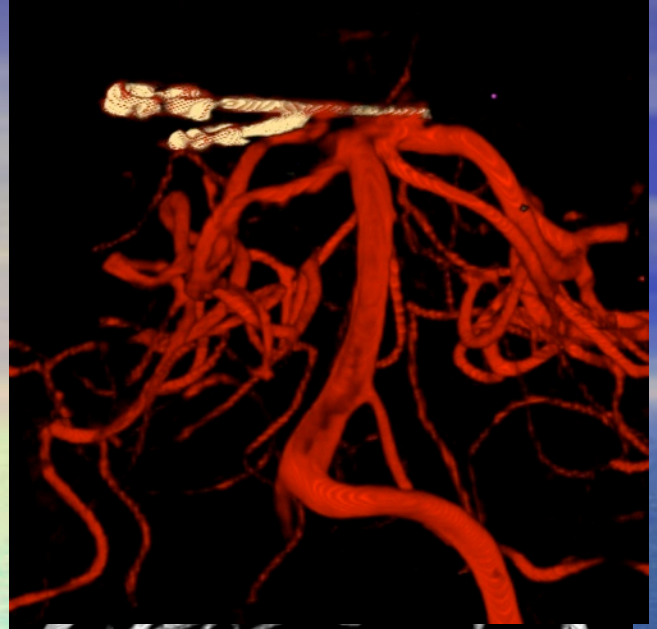

2
1
Quick Measurement 1
12.59 mm
Quick Measurement 2
10.73 mm

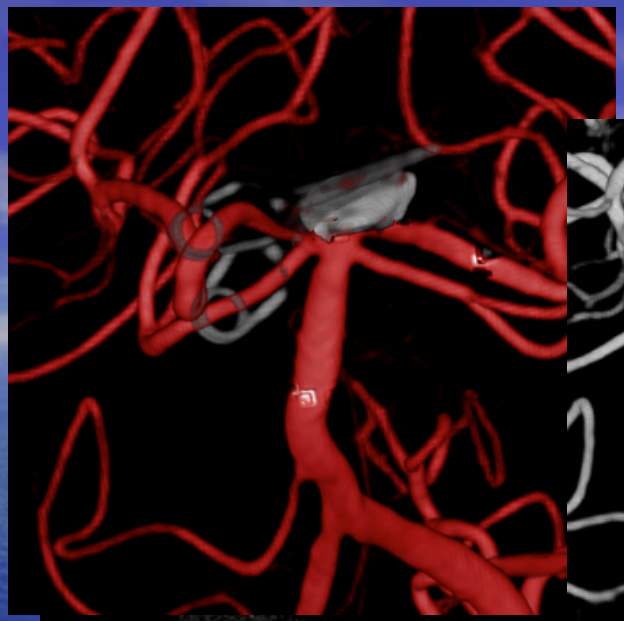


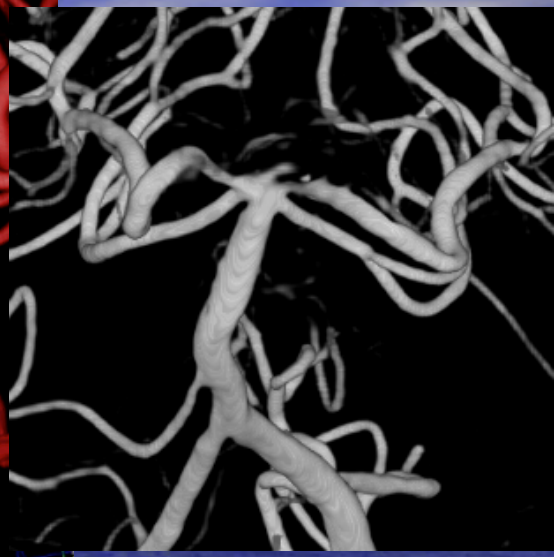


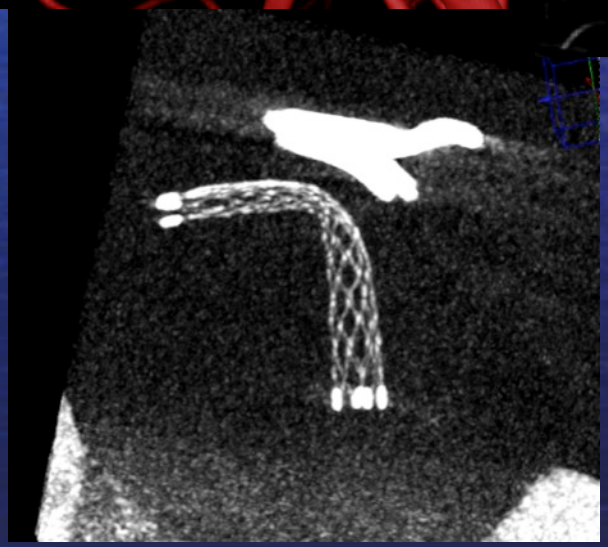
Video 1:









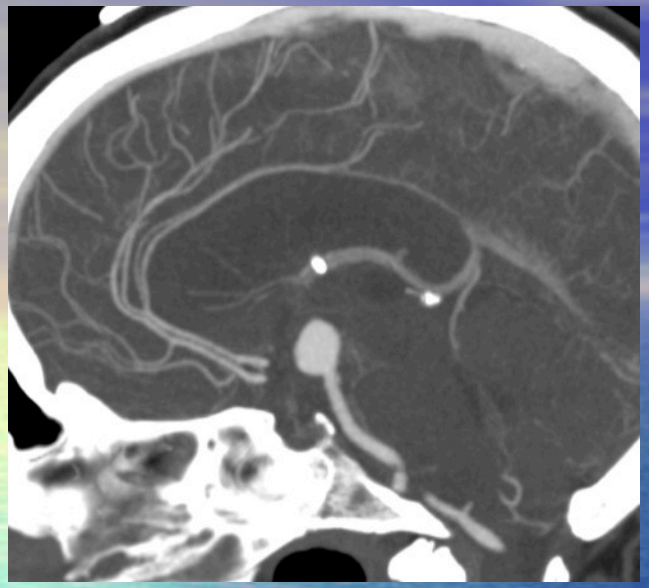


Coiled with
a Single Stent;
NO Recurrence

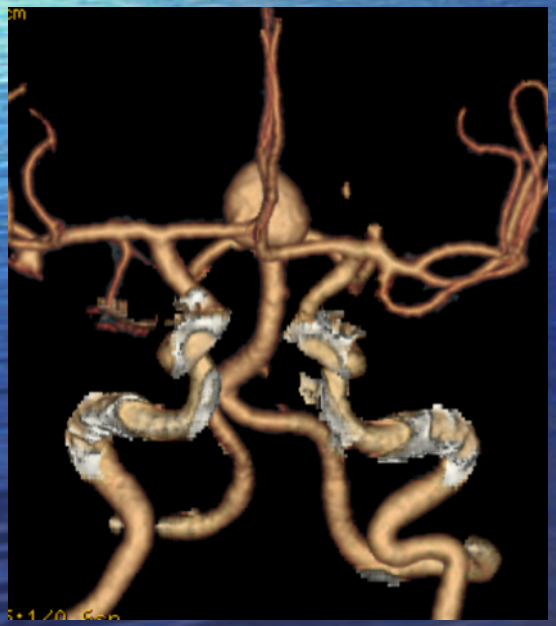
Mild CN 3 Paresis , Recovered
mRS 2;
Residual Aneurysm After Clipping

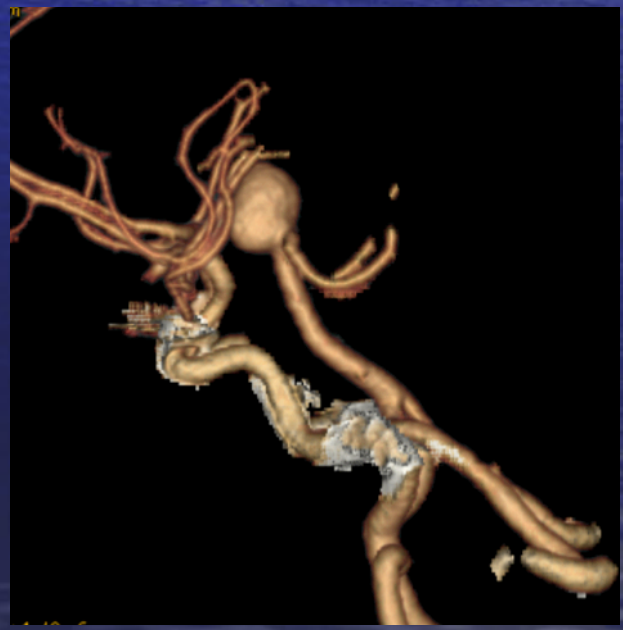
Large, Wide Necked Aneurysm
Both PCAs from the Aneurysm Neck
Above the Clinoid

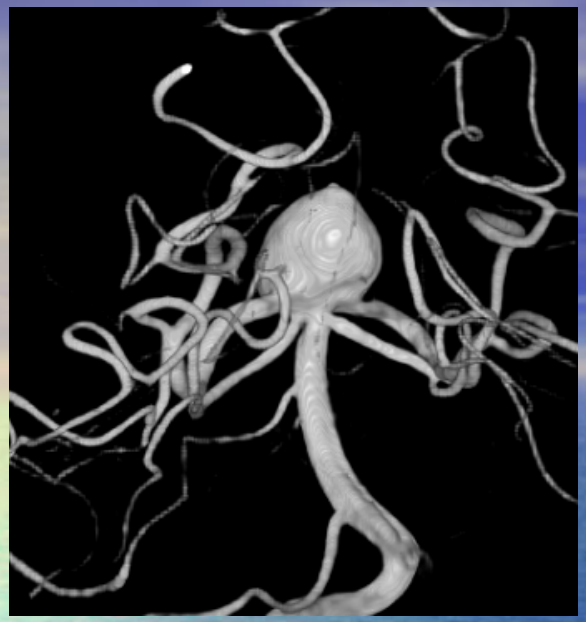
Large BA Tip Aneurysm, Neck Above the Dorsum Sellae



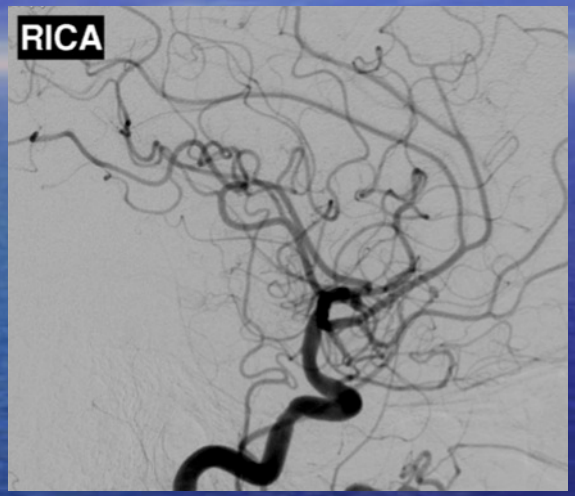
52 / Woman
SAH, H/H 2, Fisher 3
Ventriculostomy placed

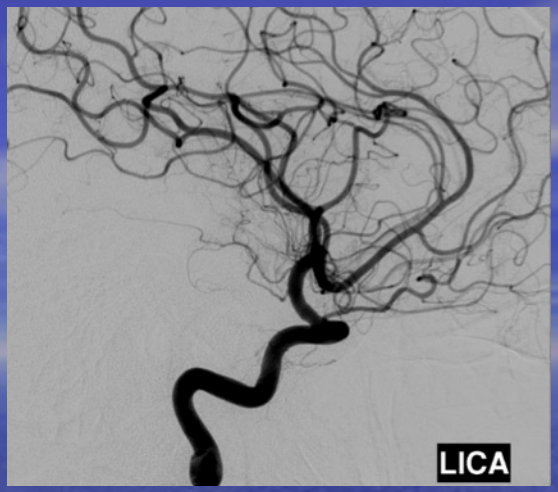




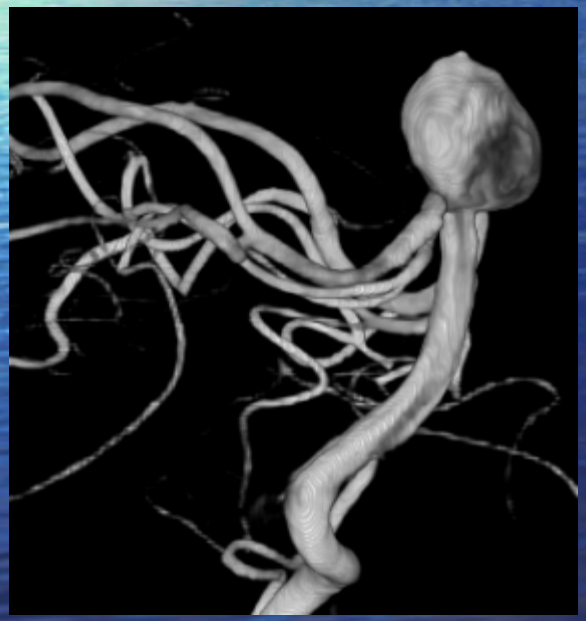


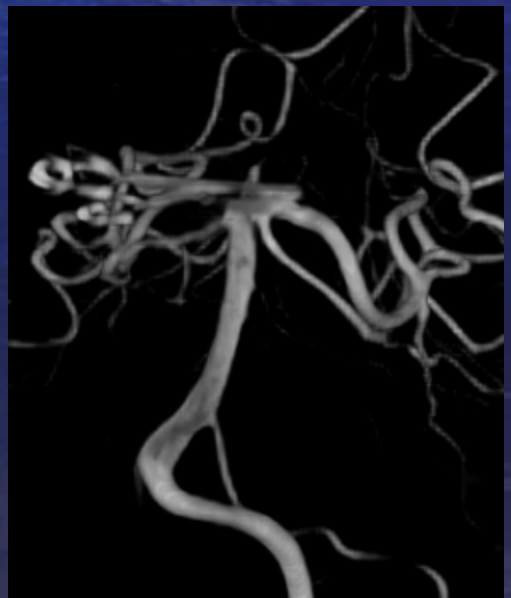
Wide Neck 9mm
Dome/ Neck=11/9
Height/Neck= 13/9
Small PCOMs bilaterally

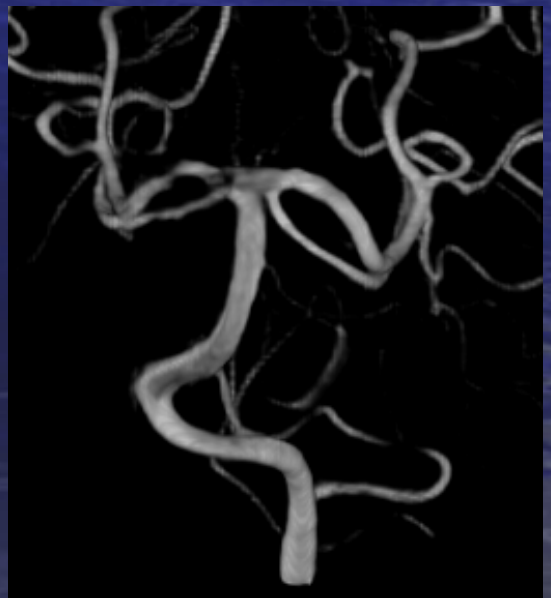




Excellent Recovery
mRS 1 at 3 months,
CN 3 Paresis resolved

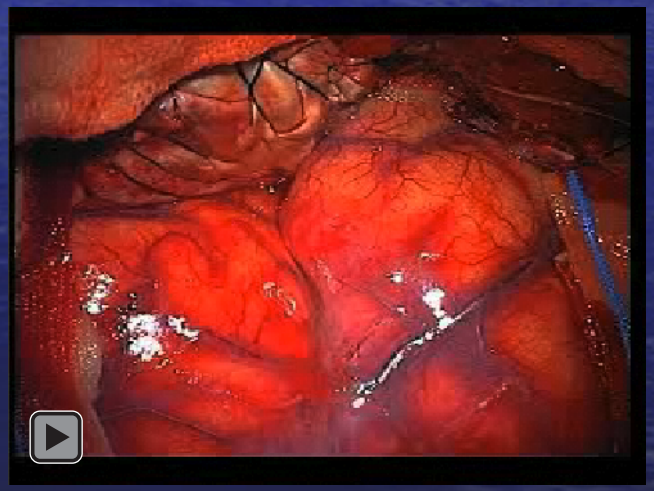


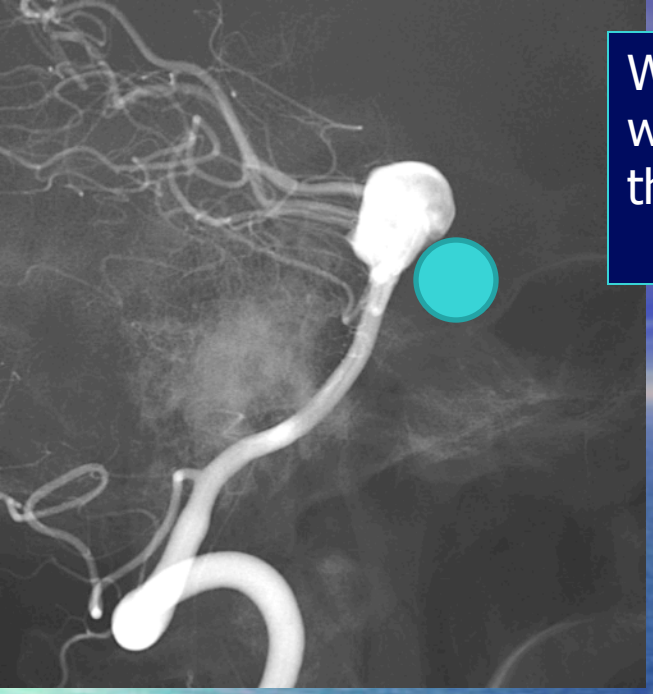




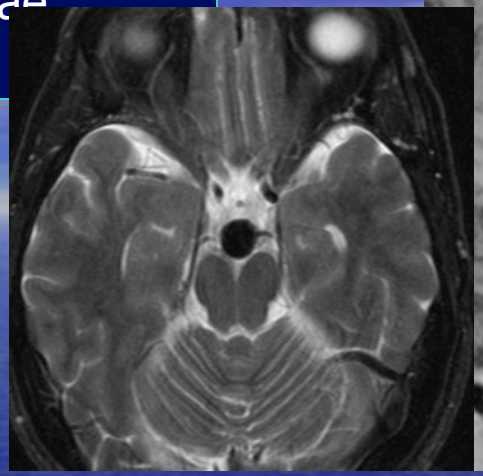
Aneurysm Clipping with Two Clips
Temporary Clipping
after Burst Suppression
Rubber Dam Protection of Perforators
Adenosine Arrest if needed

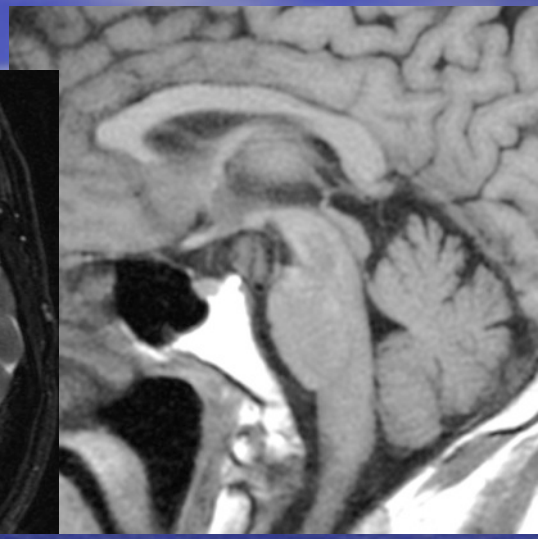
Video 2:



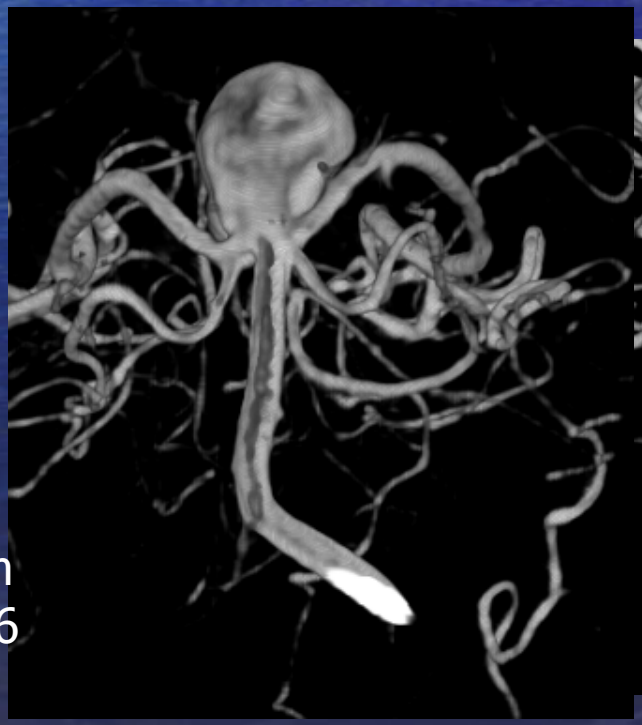


Wide neck aneurysm with neck at the base of the Dorsum Sellae



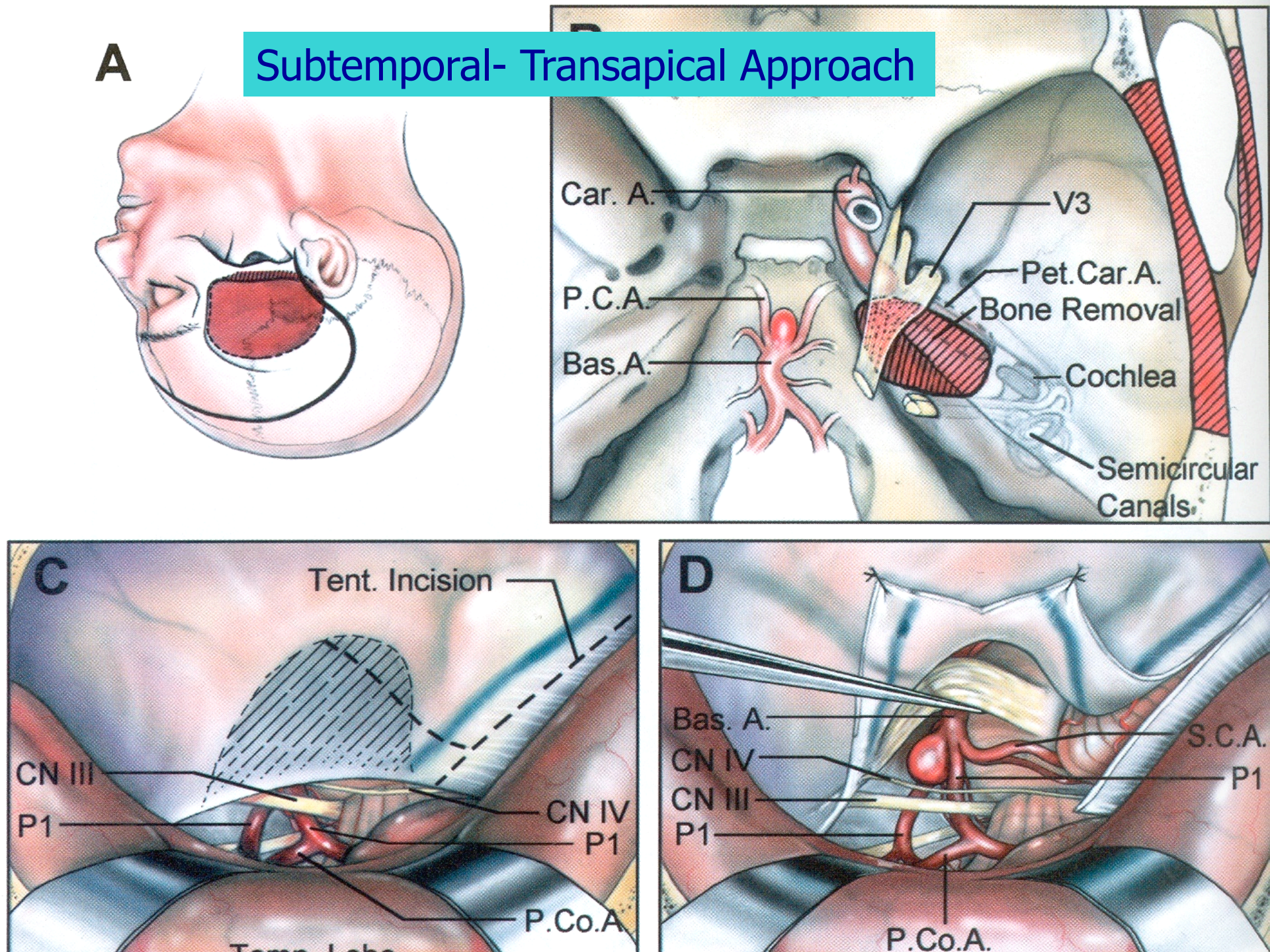


52 Year Old Man with Severe Headaches

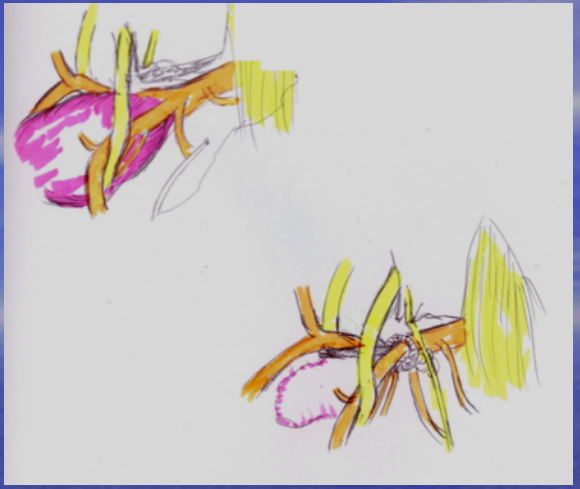


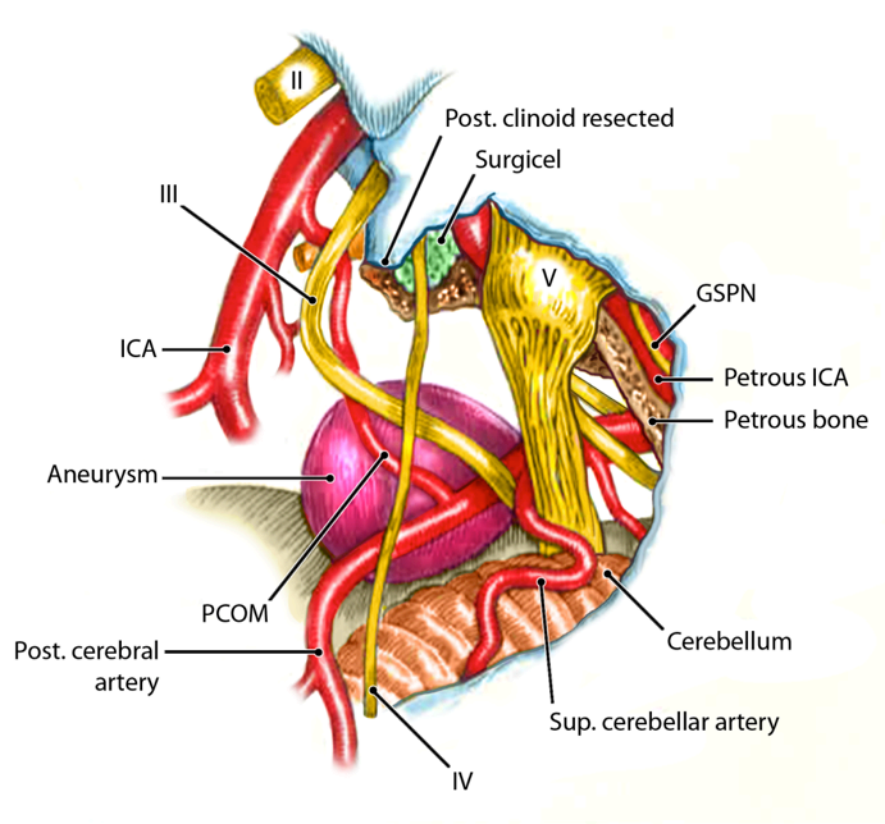
Large basilar tip aneurysm
14.7 x 12.8 mm ; Neck 7.6 mm
Aspect Ratio 1.9; D/N Ratio 1.6
Very Low Neck

Subtemporal- Transapical Approach

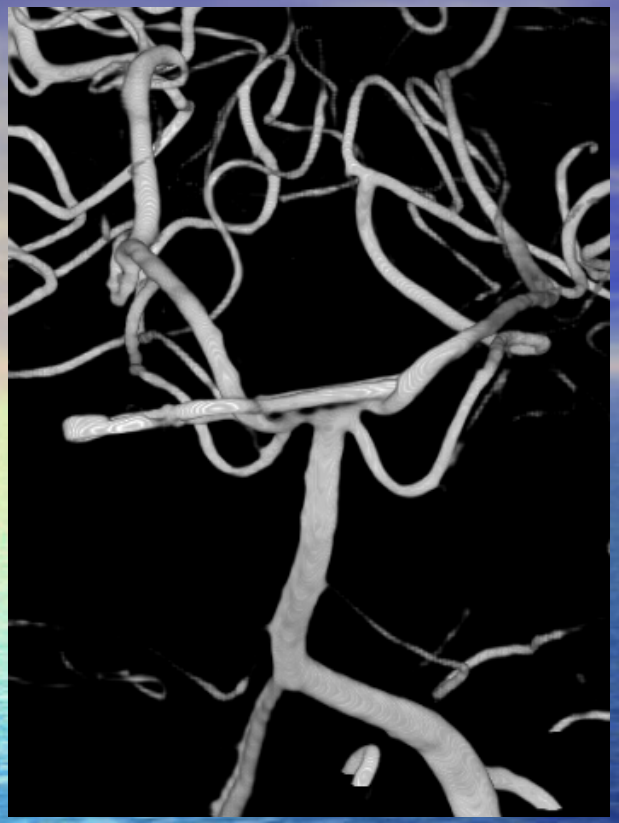


Subtemporal Transzygomatic Transcavernous, Trans apical Approach

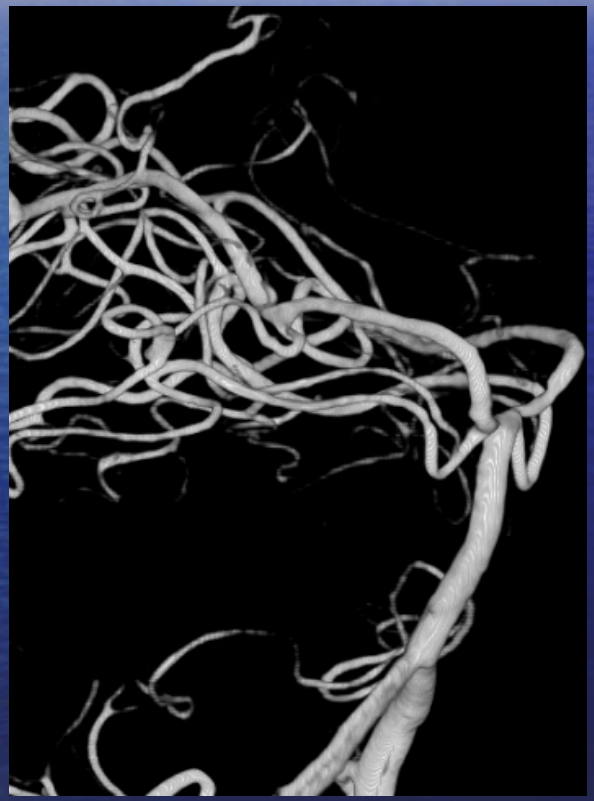


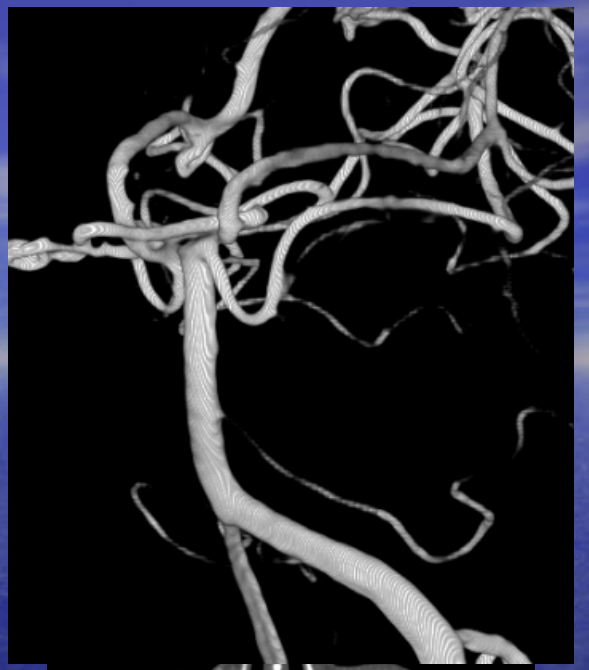


Video 3:



Postoperative Imaging
NO Residue

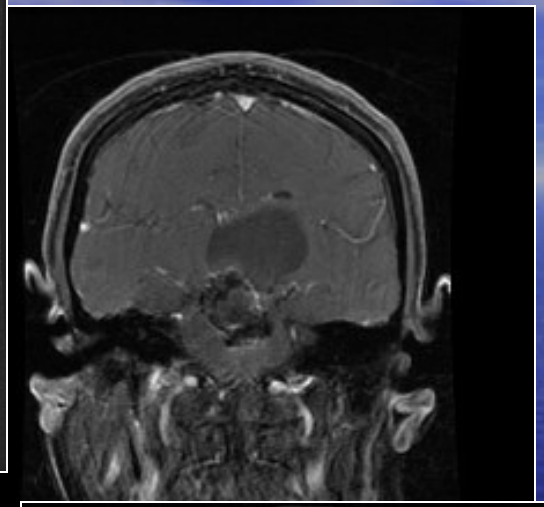


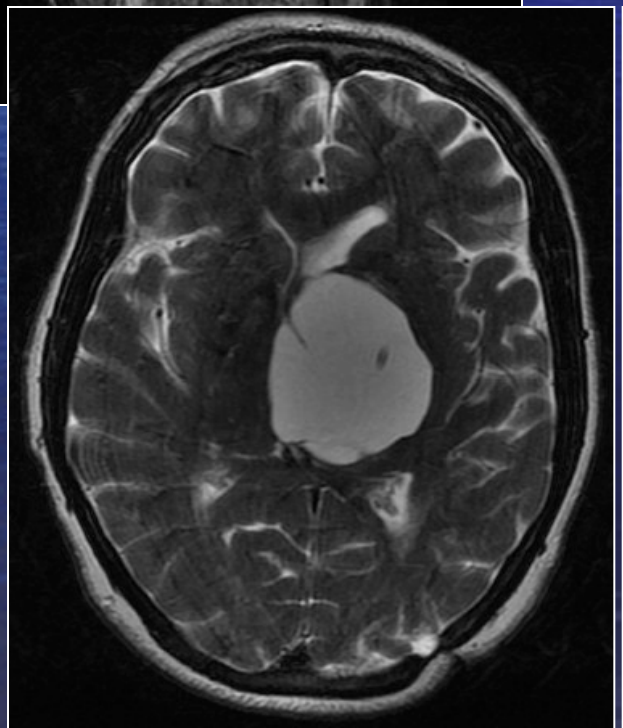


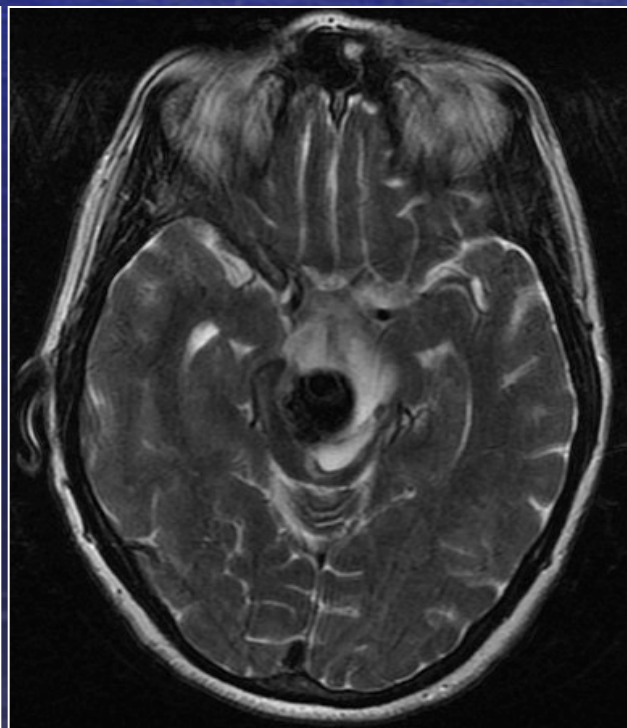
- **Good Recovery**
- **3rd nerve paresis; Resolved**
- **Slight numbness on V1 and V2 distribution**
- **Patient was mRS2 at 6 weeks follow-up**
- **Complete Recovery**

Trans Petrosal Approach: Giant Basilar Tip Aneurysm

- 62 year old woman
- Diagnosis of Giant BA Tip Aneurysm 2002, Coiled
- Further Coilings 2003, 2004, 2005
- Progressive Neurological Deterioration
- Brain Cyst on top of Aneurysm, Ommaya reservoir, then fenestration 2005
- Recent Deterioration
- Exam: Alert, In a wheel chair, Global Cognitive Dysfunction
  Expressive Aphasia, able to understand speech
  Depressed
  Spastic Quadriparesis R>> L, Wheel Chair Bound
  Gastrostomy, can swallow solids, not liquids

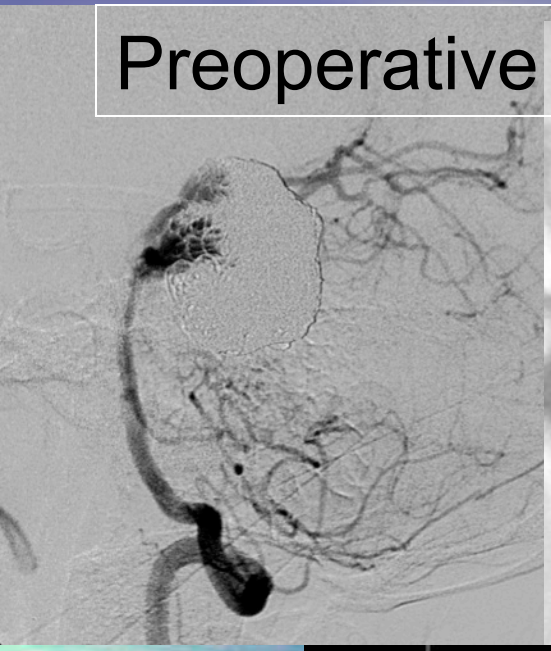


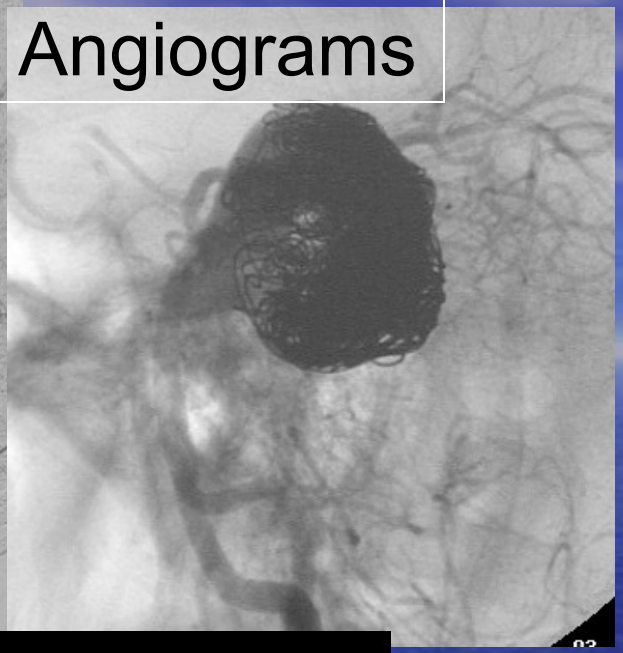


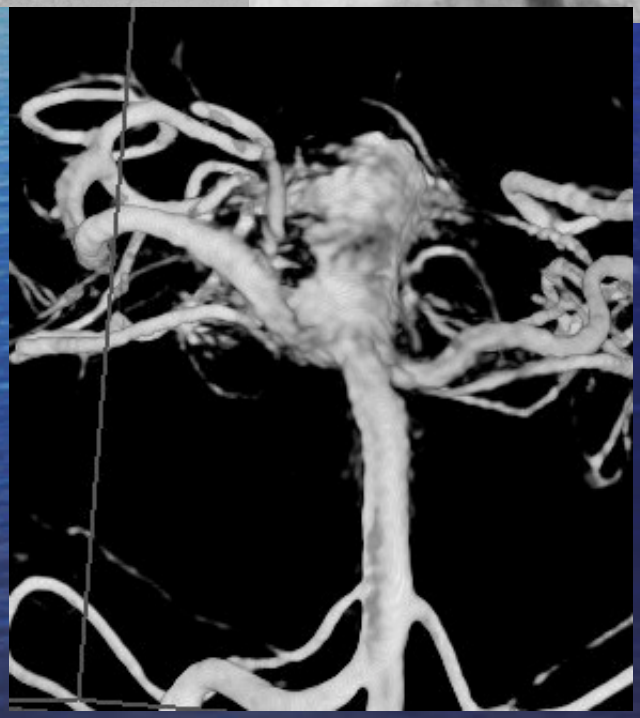


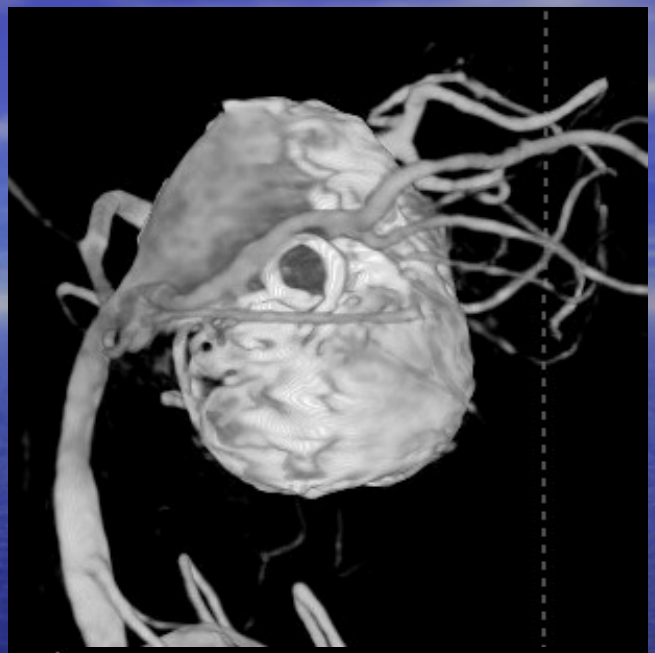
Preoperative
MRI Scans

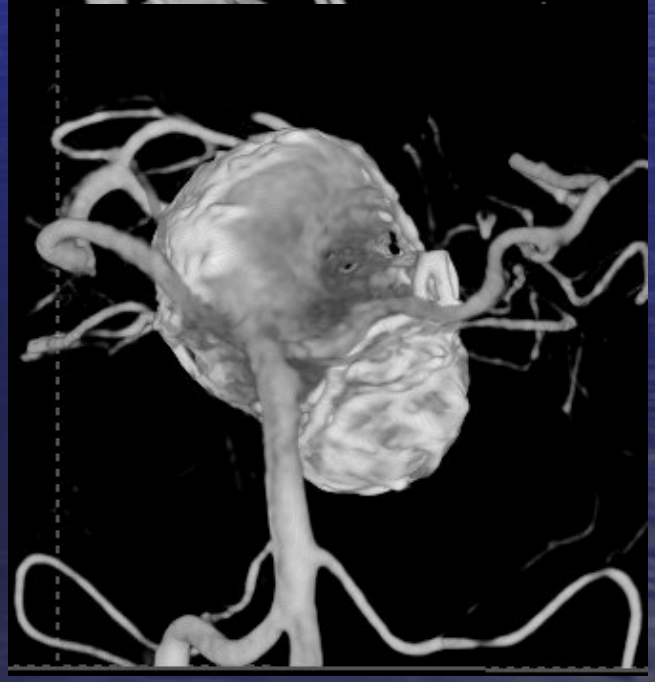
Preoperative Angiograms







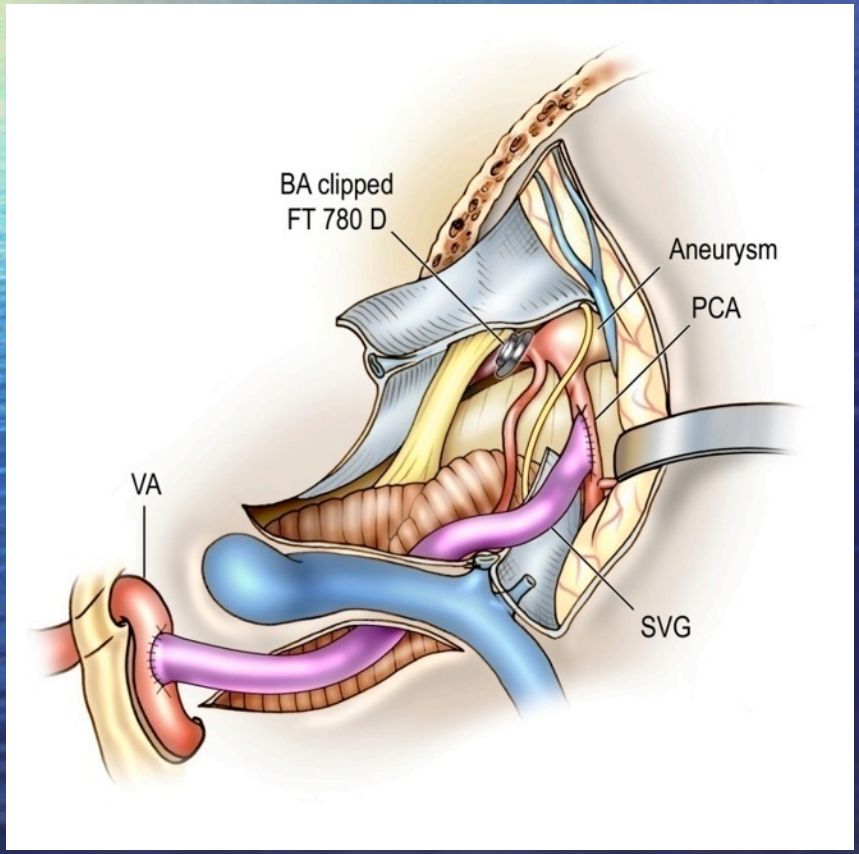




7/2008 First Operation Endoscopic Fenestration of Cyst, and Shunt Insertion (RGE)

Finding: Coils had migrated into Previous Ventricular Catheter; New VP Shunt Inserted…

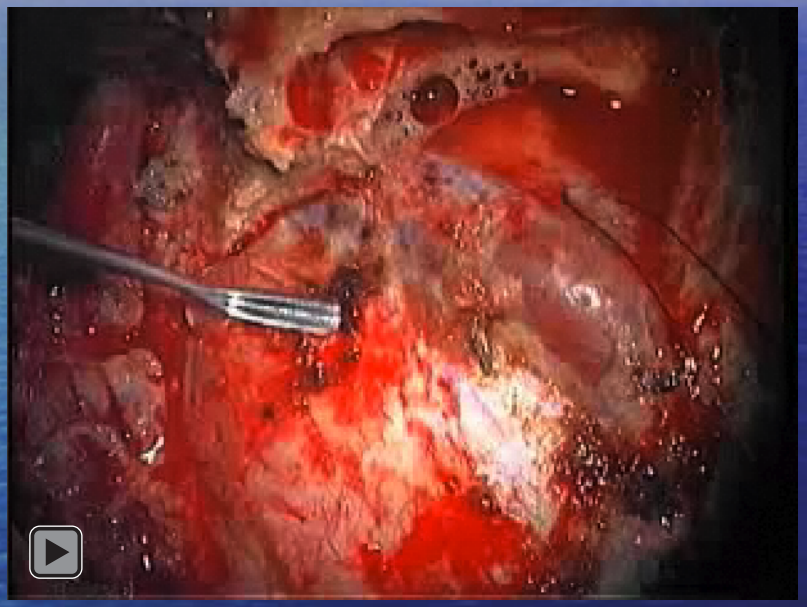
Video 4:



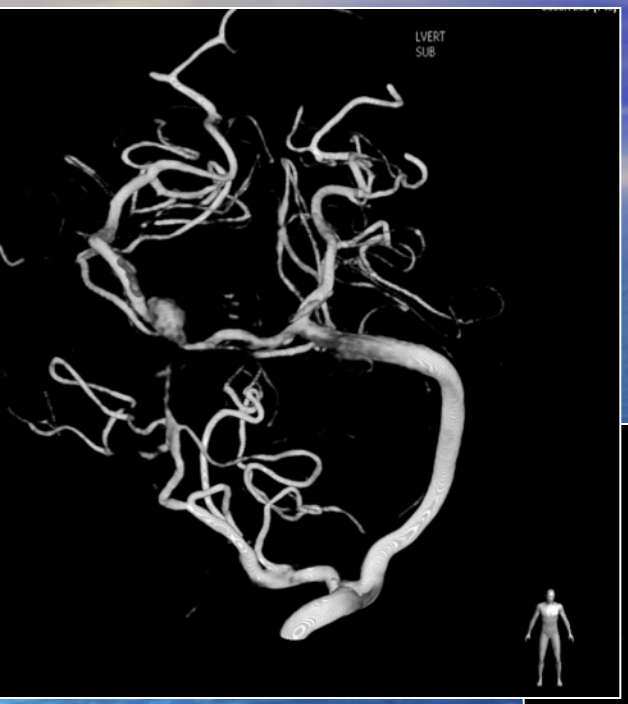
7/2008 Second Operation

- Transpetrosal and Extreme Lateral Approach
- SVG Bypass from Left VA (V3) to left PCA ; Occlusion of BA just below the SCA
- Postoperative Course: Transient Deterioration days 2-4, Gradual Improvement over 1 week

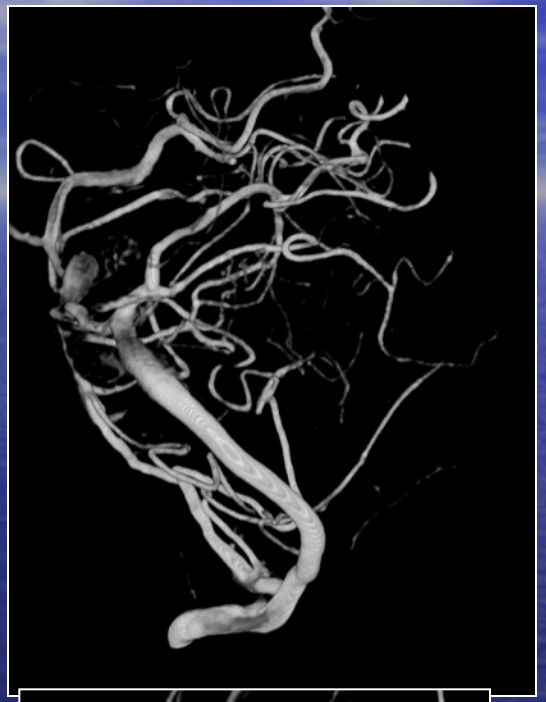
Video 5:



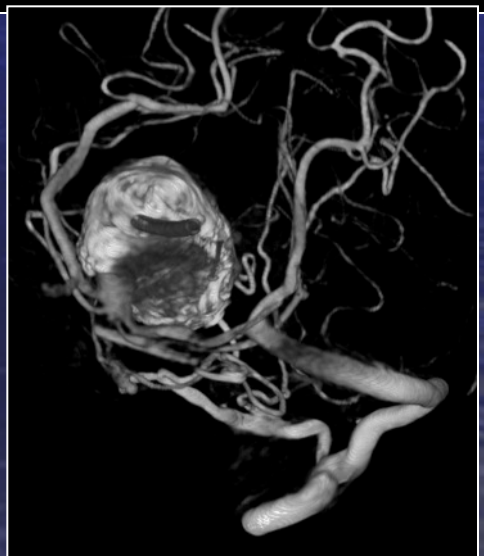
At 18 month follow up



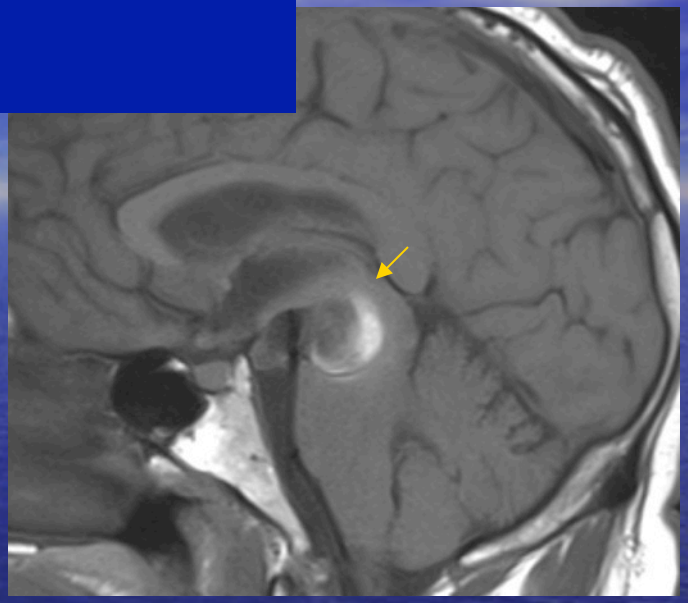
Graft patent with a small
Stable aneurysm remnant.
Both PCAs filling well, one by
RAG and other by PCOM

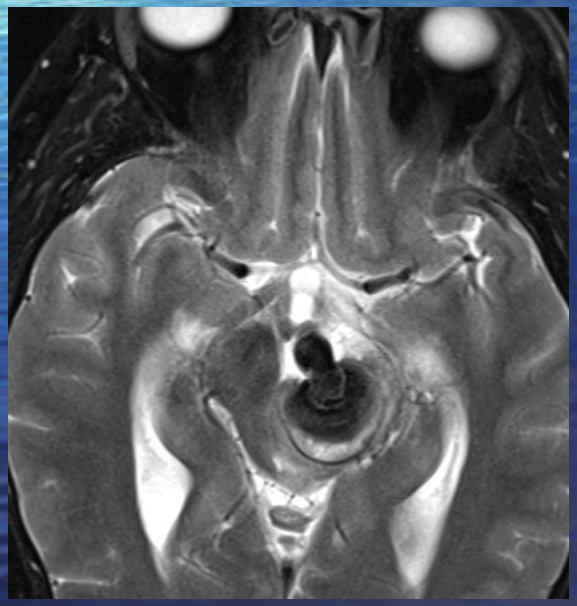


Patient much improved,
Speaking a few words, eating
By herself, hemiparesis
improved
And able to walk with help
mRS 3

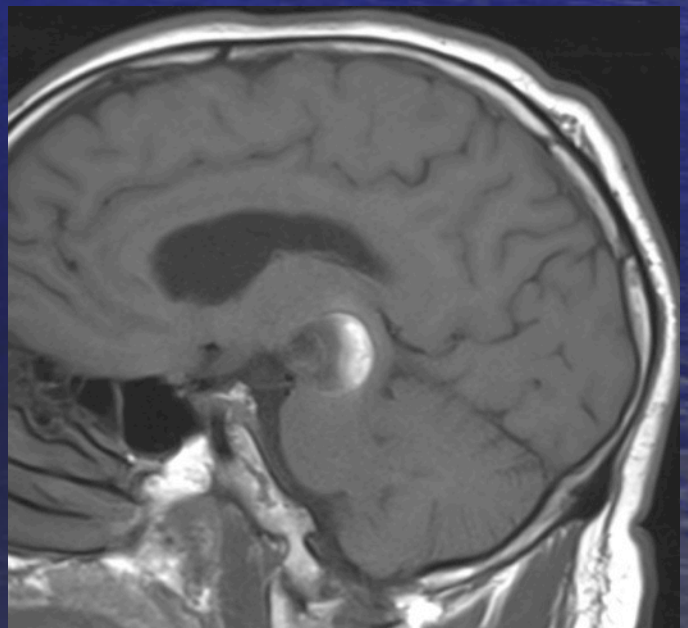


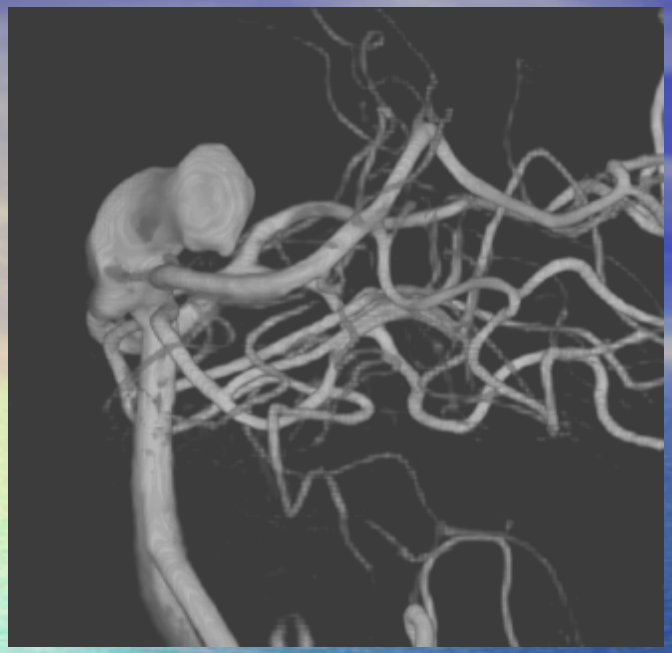
47 years, Male
1 mo progressive R Hemiparesis, R Pronator drift
Intermittent R facial numbness
2 mo dizziness

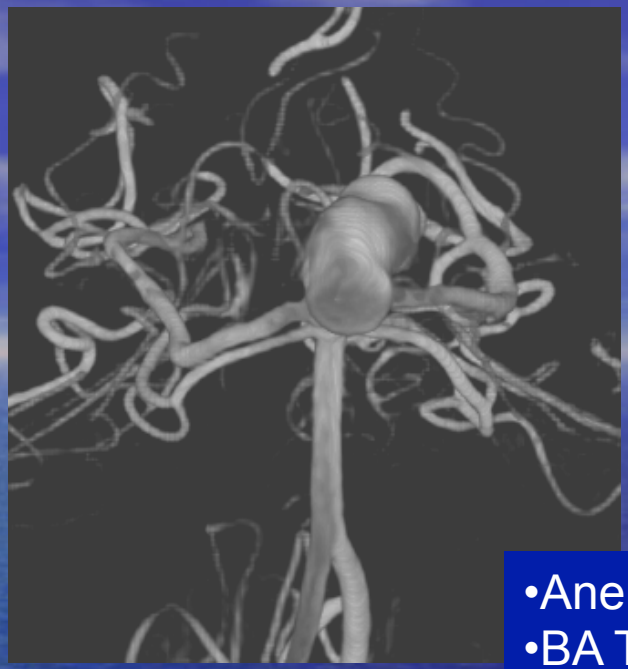


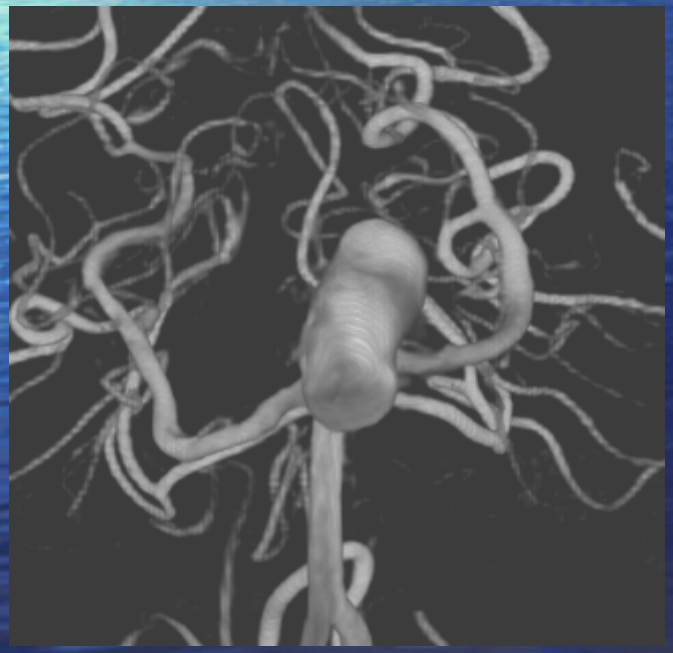


BA Tip Aneurysm
32 x 25 x 23 mm
Unruptured



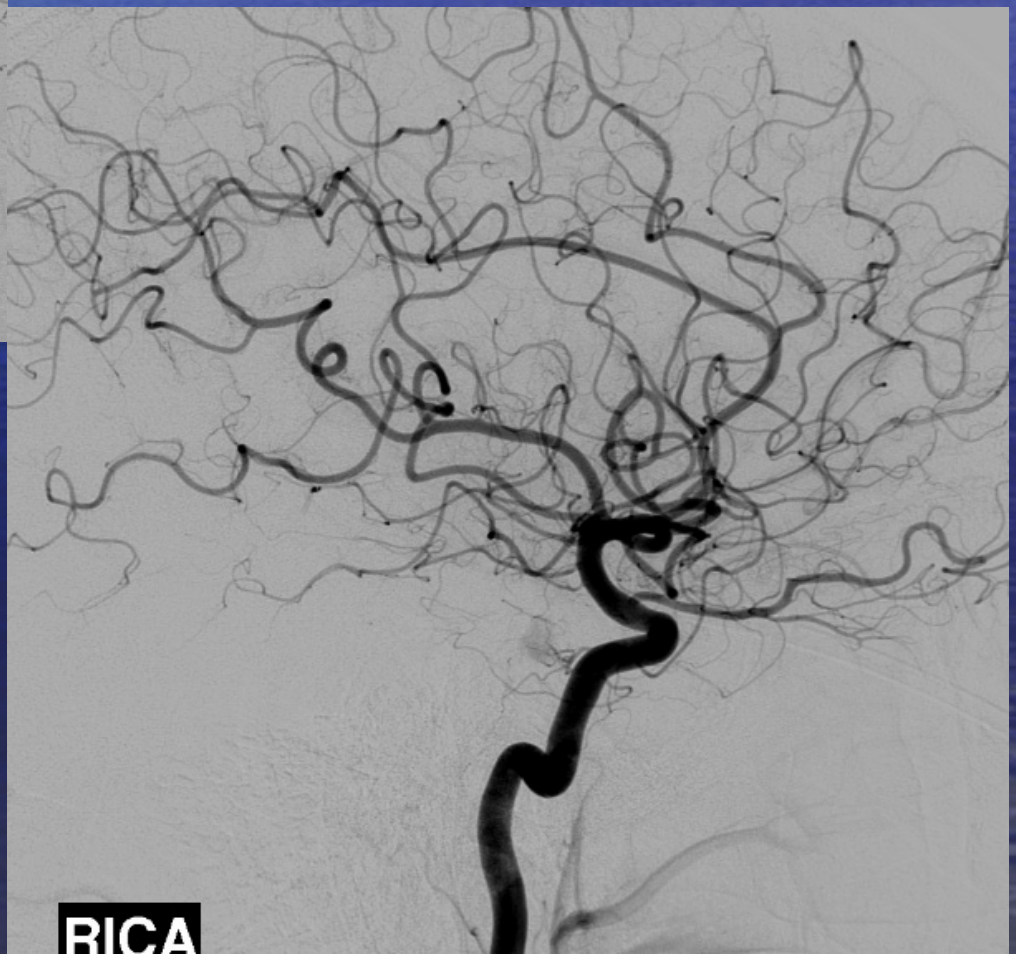






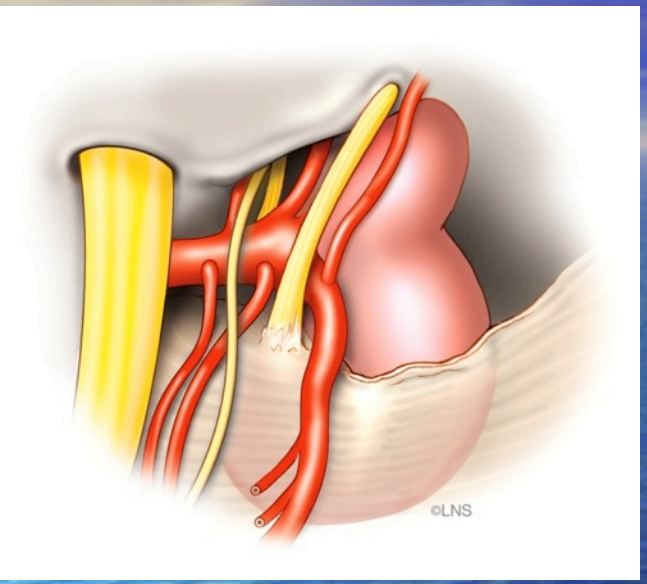
- Aneurysm Fills Partially
- BA Tip is 270°Involved by the Neck

NO PCOM Collaterals



Surgical Plan: Creation of New PCOM, then Proximal BA Occlusion

Initial View



Stage I: Approach

Left Presigmoid, Transpetrosal, Subtemporal

Aneurysm Had Ruptured Between stages 1 and 2

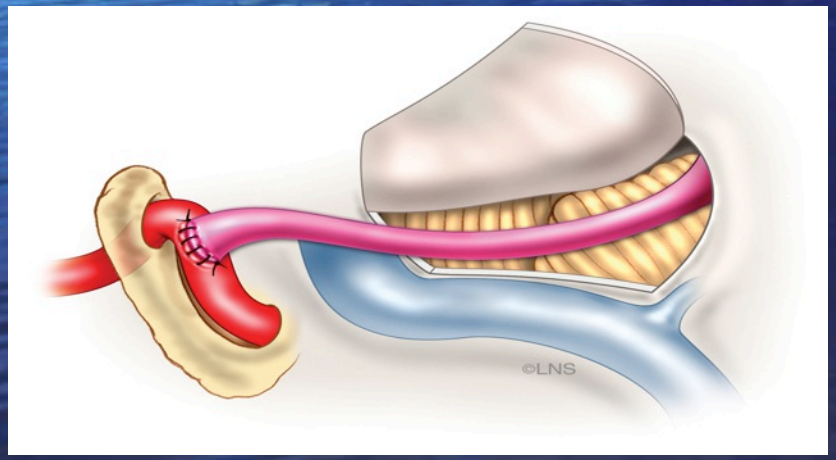
Stage II: Bypass, and Proximal Occlusion (next day)

Right radial artery harvest

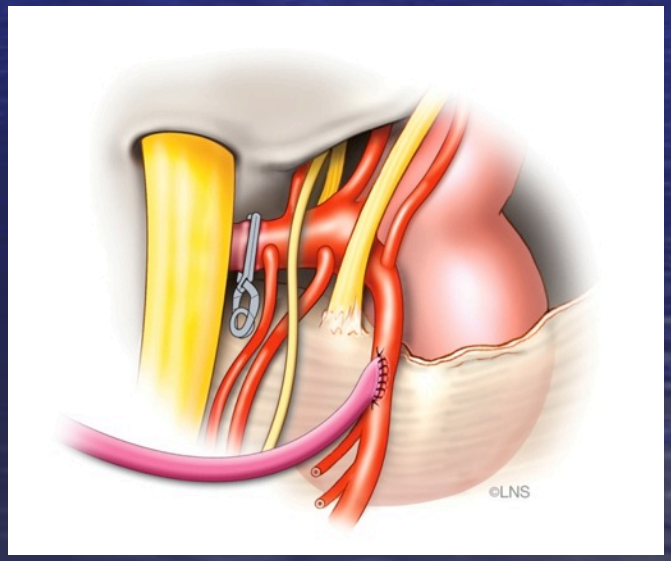
Left V3 to Left PCA Bypass

BA Clip Occlusion Just Below SCA

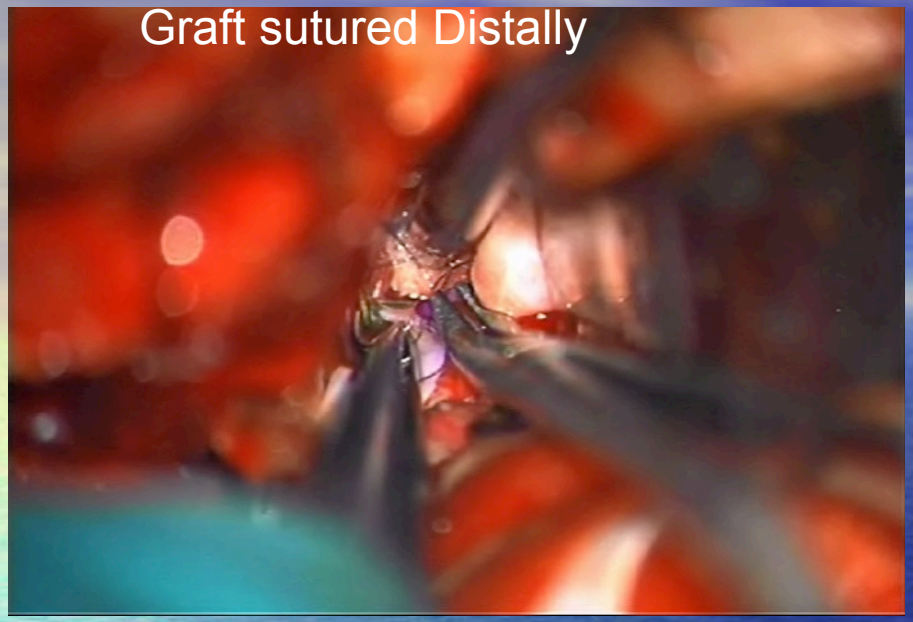
Overview of Graft



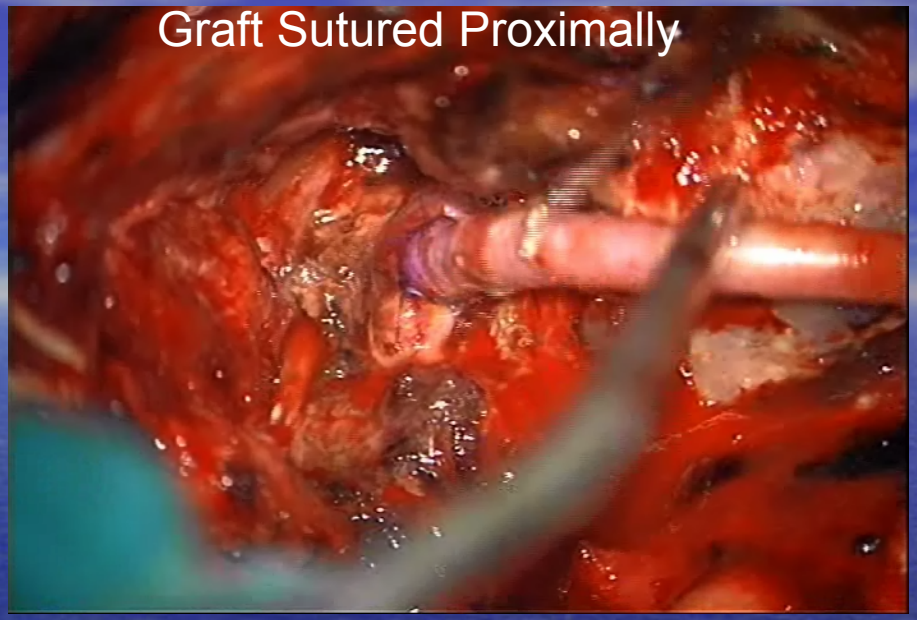
BA Occlusion



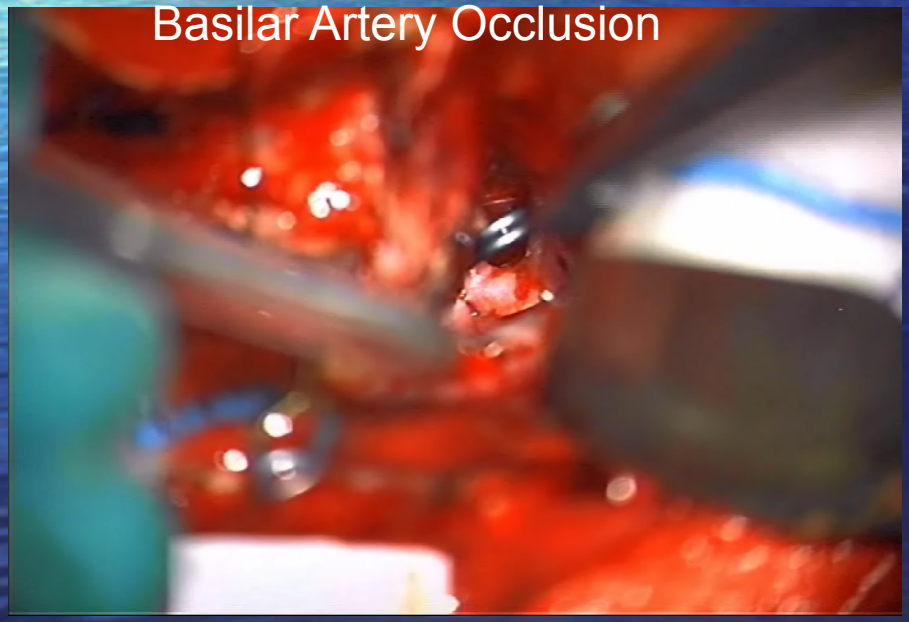
Graft sutured Distally



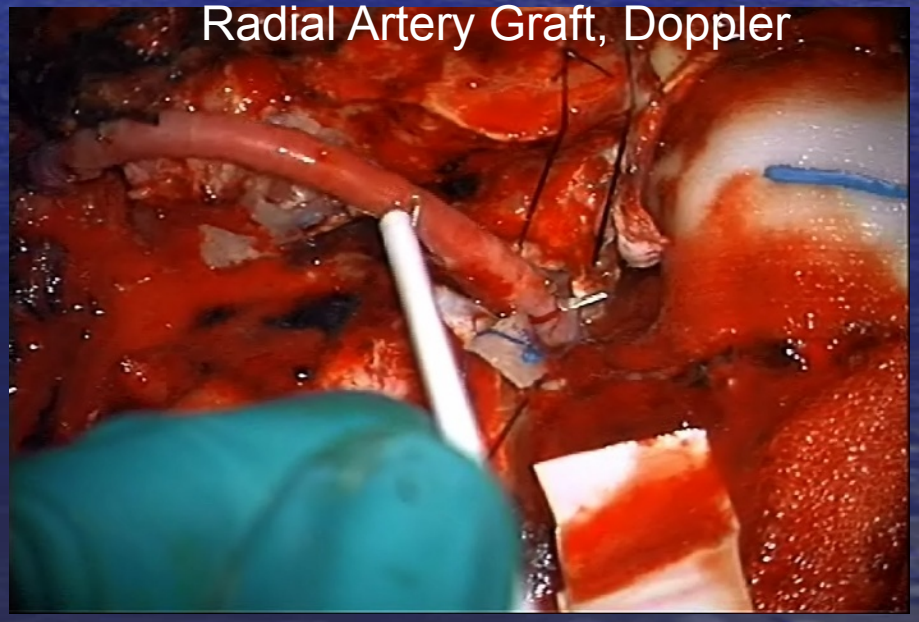
Graft Sutured Proximally

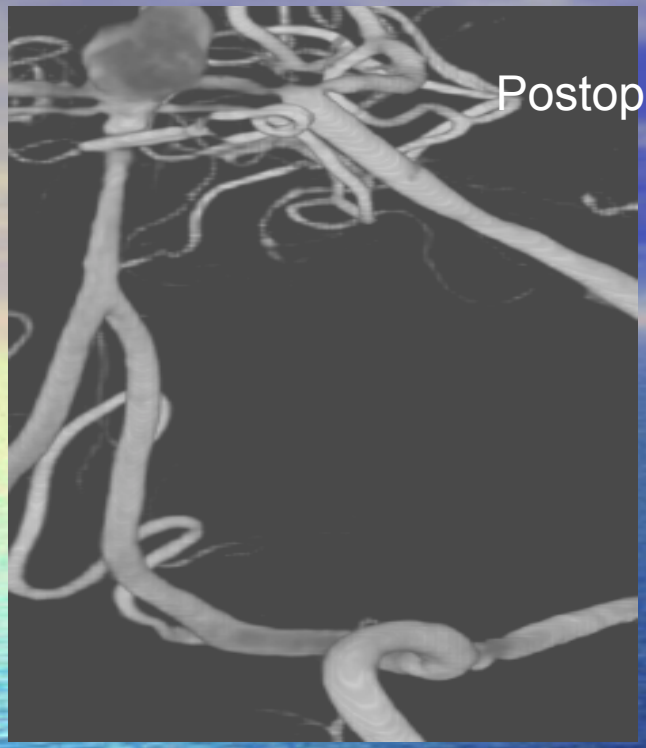


Basilar Artery Occlusion

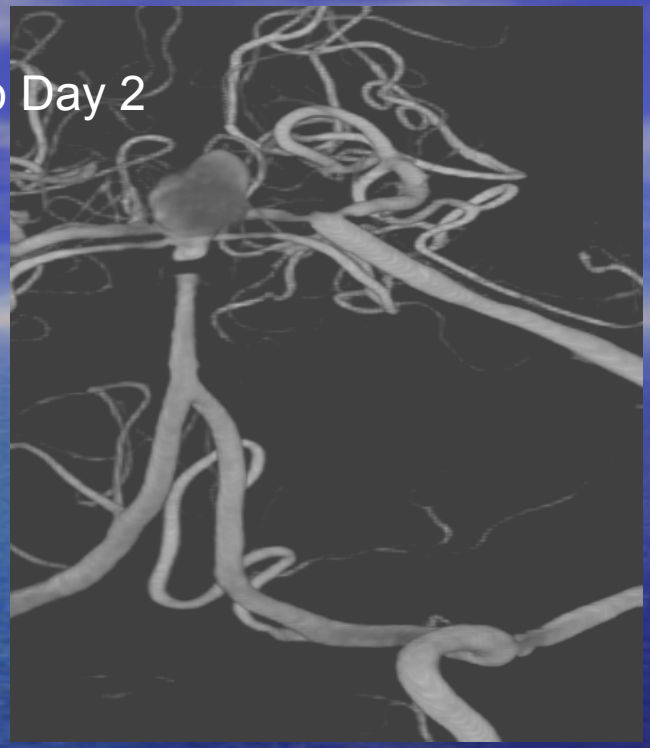


Radial Artery Graft, Doppler



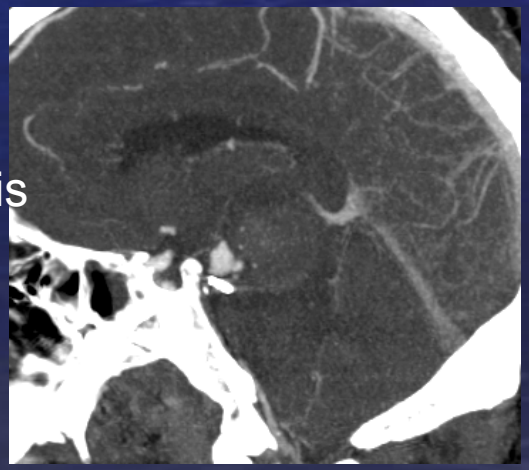


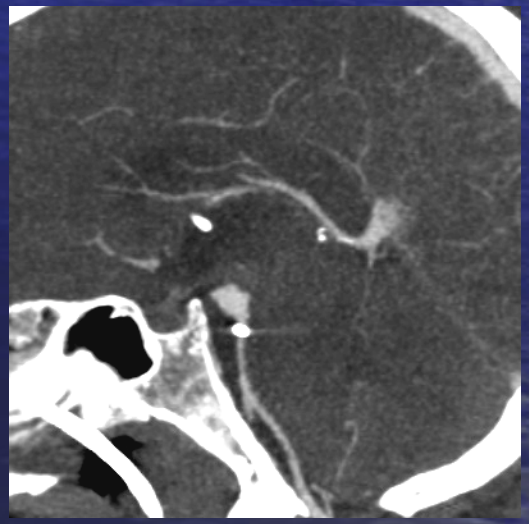
Postop Day 2



Postop Day 23

Postop Day 7





Postoperative Course
Hemiparesis, Obtundation
Recovered after about 10 days
At 2months, mild aphasia, Hemiparesis
mRS 3, Still Improving

6 Month follow up

- Fluent speech, Normal Cognition and memory
- Ambulates unassisted, occasionally uses cane.
- 4 out of 5 strength in his right upper extremity, and shoulder, still improving
- mRS 2
- Aneurysm Status: Small remnant at the base, slowly shrinking, being followed

Results of Large/ Giant BA Tip Aneurysms Treated with Bypass and Clipping/ BA Occlusion

- Patients Treated 4
  - Prior Coiling 2
- Outcomes mRS
  - Preoperative 3,4,3,2
  - 3 Months 1,4,2,2
  - 1 Year 1,3,1,1
- Aneurysm Status
  - Occluded 2
  - Residual Neck 2
  - Stable 1
  - Retreatment 1
- Bypass Status after 1 Year
  - Patent 3
  - Occluded, enlarged PCOM 1

Analysis of 100 Consecutive Basilar tip aneurysms treated at HMC from 2005 to 2011.

- **Total Cases** **100**

- **Ruptured** **63 (63%)**
  - Number of cases Clipped 24/62 (38 %)
  - Number of cases coiled 39/62 (62 %)

- **Unruptured** **37 (37.3%)**
  - Number of cases Clipped 13/37 (35.1%)
  - Number of cases coiled 24/37 (64.8%)

- **Overall Outcomes at 3 months**

Ruptured	mRS 0 – 2	44(70%)
	mRS 3 – 6	19 (30%)
Unruptured	mRS 0 – 2	34(92%)
	mRS 3 – 6	3(8%)

- The outcomes were not significantly different (Non-ruptured group= p =1.0 ; Ruptured group=p=0.7)

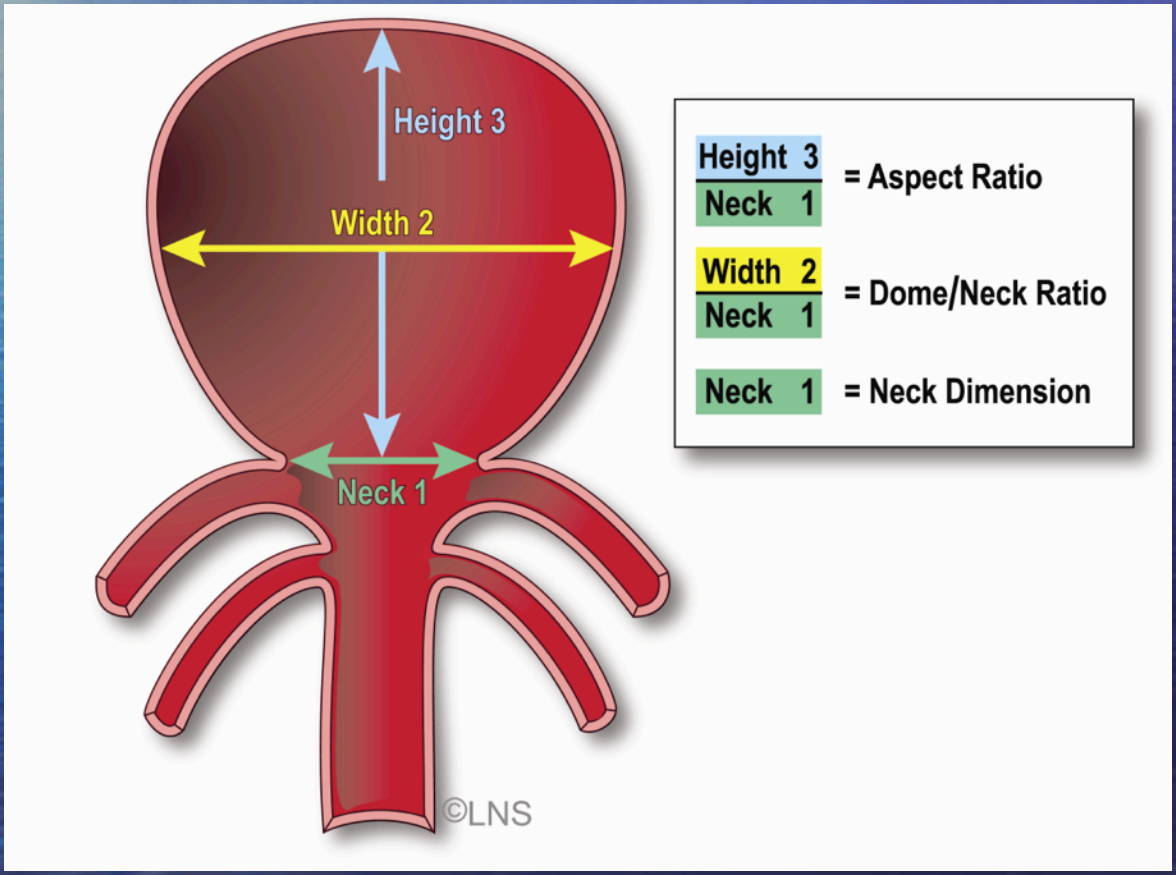
What is the Modified Rankin Scale?

- 0 - No symptoms
- 1 - No significant disability. Able to carry out all usual activities, despite some symptoms
- 2 - Slight disability. Able to look after own affairs without assistance, but unable to carry out all previous activities
- 3 - Moderate disability. Requires some help, but able to walk unassisted
- 4 - Moderately severe disability. Unable to attend to own bodily needs without assistance, and unable to walk unassisted
- 5 - Severe disability. Requires constant nursing care and attention, bedridden, incontinent
- 6 - Dead

1. Rankin J (May 1957). "Cerebral vascular accidents in patients over the age of 60. II. Prognosis". *Scott Med J* **2** (5): 200–15.

2. Farrell B, Godwin J, Richards S, Warlow C, *et al.* (1991). "The United Kingdom transient ischaemic attack (UK-TIA) aspirin trial: final results.". *J Neurol Neurosurg Psychiatry* **54** (12): 1044–1054 (modification)

Dome to Neck Ratio, and Aspect Ratio, Neck Size



Ruptured Aneurysms: Overall Statistical Analysis

Preoperative Features	Ruptured (N=63)		
	Clip (n=24)	Coil (n=39)	Sig.*
Age Mean ± St.Dev. Range	48.8 ± 10.9(28, 66)	57.6 ± 11.9(27, 87)	.006
Comorbidity	9 (38%)	18 (47%)	.603
Size of Aneurysm Mean ± St.Dev. Range	6.5 ± 2.8 (3, 12)	7.3 ± 3.1 (3, 14)	.448
Neck Dimension Mean ± St.Dev. Range	5.8 ± 3.0 (1.5, 11.8)	4.9 ± 2.4 (1.4, 11.6)	.328
Aspect Ratio Mean ± St.Dev. Range	1.2 ± 0.5 (0.5, 3.1)	1.6 ± 0.7 (0.5, 3.5)	.007
Dome to neck Ratio Mean ± St.Dev. Range	1.1 ± 0.2(0.8, 1.8)	1.3 ± 0.4(0.6, 2.3)	.011
Admission H&H Mean ± St.Dev. Range	2.6 ± 1.2(1, 5)	3.0 ± 1.3(1, 5)	.215

Clipped Aneurysms were Younger, and had lower Dome/Neck, and Aspect ratios

Two Variable Logistic Regression

Regression analysis of Clip/ Coil for predicting a good outcome on the 3-month mRS (3-6), after adjusting for each covariate individually	Ruptured (N=63)		
	Coil vs. Clip Odds Ratio†	Coil vs. Clip Sig.*	Covariate Sig.*
Age	0.34	.179	***.001***
Admission H&H	0.55	.497	***.004***
Co morbidity	0.62	.639	***.003***
Size of Aneurysm	0.71	.755	*.066*
Neck Dimension	0.85	.996	*.389*
Aspect Ratio	0.68	.698	*.516*
Dome to neck Ratio	0.94	1.000	*.563*

Only Predictive factors were Age, Admission H&H, and Co morbidity

No Difference In Outcome for Ruptured Aneurysms at 3 Months or 1 Year

Ruptured BA Tip Aneurysms: Outcomes - Clipping vs. Coiling	Ruptured (N=63)		
	Clip (n=24)	Coil (n=39)	Sig.*
Three-Month mRS 0-2 3-6	16 (67%) 8 (33%)	28 (72%) 11 (28%)	.779
One-Year mRS 0-2 3-6	16 (73%) 6 (27%)	30 (77%) 9 (23%)	.763

Unruptured Aneurysms: Two Variable Logistic Regression Model to Predict Good Outcome

Surgery descriptive:	Unruptured (N=37)		
	Clip (n=13)	Coil (n=24)	Sig.*
Age Mean ± St.Dev., Range	57.2 ± 9.0(46, 78)	61.1 ± 12.4(45, 87)	**.499**
Comorbidity	3 (23%)	10 (42%)	**.305**
Size of Aneurysm Mean ± St.Dev, Range	12.6 ± 10.3(4, 35)	8.8 ± 3.6(3, 17)	**.718**
Neck Dimension Mean ± St.Dev, Range	8.3 ± 4.6(2.8, 20.1)	6.2 ± 3.5(2.3, 16.0)	**.095**
Aspect Ratio Mean ± St.Dev, Range	1.5 ± 0.8(0.8, 3.1)	1.6 ± 0.7(0.6, 3.4)	**.441**
Dome to neck Ratio Mean ± St.Dev, Range	**1.2 ± 0.4(0.9, 2.2)**	**1.4 ± 0.5(0.9, 2.6)**	**.169**

No Differences Found Between the Two Groups

Unruptured BA Tip Aneurysm Outcomes: No Difference Found

	Unruptured (N=37)		
	Clip (n=13)	Coil (n=24)	Sig.*
Three-Month mRS **0-2** **3-6**	**12 (92%)** **1 (8%)**	**22 (92%)** **2 (8%)**	**1.000**
One-Year mRS **0-2** **3-6**	**12 (92%)** **1 (8%)**	**21 (91%)** **2 (9%)**	**1.000**

Unruptured Aneurysms- Two Variable Logistic Regression Model

Regression analysis of Clip/Coil for predicting a good outcome on the 3-month mRS (3-6), after adjusting for each covariate individually	Unruptured (N=37)		
	Coil vs. Clip Odds Ratio†	Coil vs. Clip Sig.*	Covariate Sig.*
Age	0.50	1.000	***.006***
Admission H&H	---	---	---
Comorbidity	0.81	1.000	*.560*
Size of Aneurysm	---	---	*.095*
Neck Dimension	2.00	1.000	*.711*
Aspect Ratio	1.00	1.000	*.142*
Dome to neck Ratio	1.00	1.000	*.370*

Age was the Only Predictive Factor

Statistical Analysis

- No Significant Difference in the Outcomes of Clip and Coil groups in the Ruptured (p=0.77) and Unruptured (p=1.0) aneurysms
- Adjusting the Age did not affect the Outcomes in the Unruptured Group (p=0.49)
- Age is a significant predictor of Outcomes in the overall Ruptured group (p=0.006), and adjusting for the age did not affect outcomes between clipping and coiling in the Ruptured group (p=0.17).
- H/H grade is a significant predictor of overall outcome in the Ruptured Group (p=0.004), but adjusting for the H/H grade did not affect the outcomes between clipping and coiling groups (p=0.49).

Deaths, complications, results and retreatment of patients who had clipping or BA occlusion with bypass n= (37):

Aneurysm occlusion:	
Complete	34/37(91.8%)
Incomplete	3/37(8.1%)
Retreatment of residual(coiled with stent)	1(2.7%)
Re-growth of fusiform aneurysm	1(2.7%)
Death*	3(one related to treatment)
Stroke*	3(8%)(2 recovered completely)
CN palsy 3rd Transient	10(27%)
Persistent	1(2.7%)
CN5 paresis, persisting	1(2.7%)
Intra-operative rupture*	1(2.7%)
Further treatment of clipped aneurysm:	2/37(5.4%)
Coiling with stent	1(2.7%)
Bypass with BA occlusion for re-growth	1(2.7%)

Cranial nerve Paresis/palsy after microsurgical operation:
*Had a sub-temporal approach.

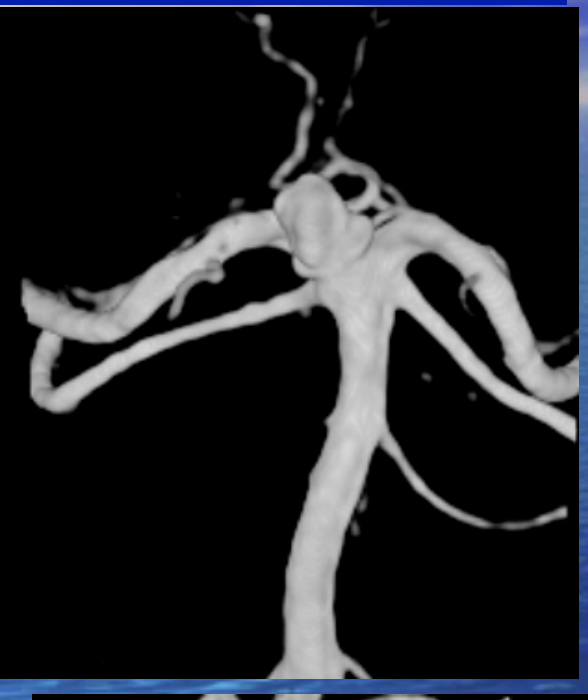
CN Paresis /Palsy	Fibrin glue		No fibrin glue	
	Occurrence	Complete recovery	Occurrence	Complete recovery
CN 3	7	7	4	3
CN 5	-	-	-	1*

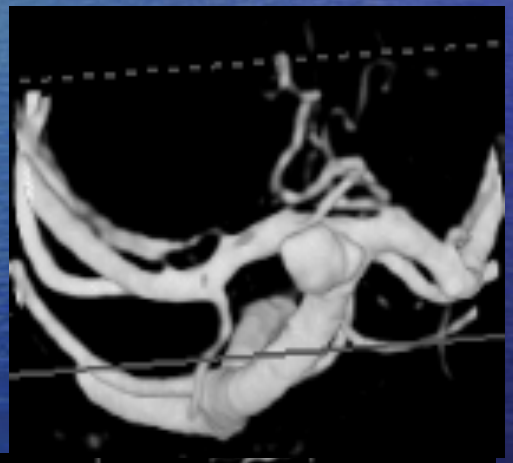
***Had a sub-temporal approach.**

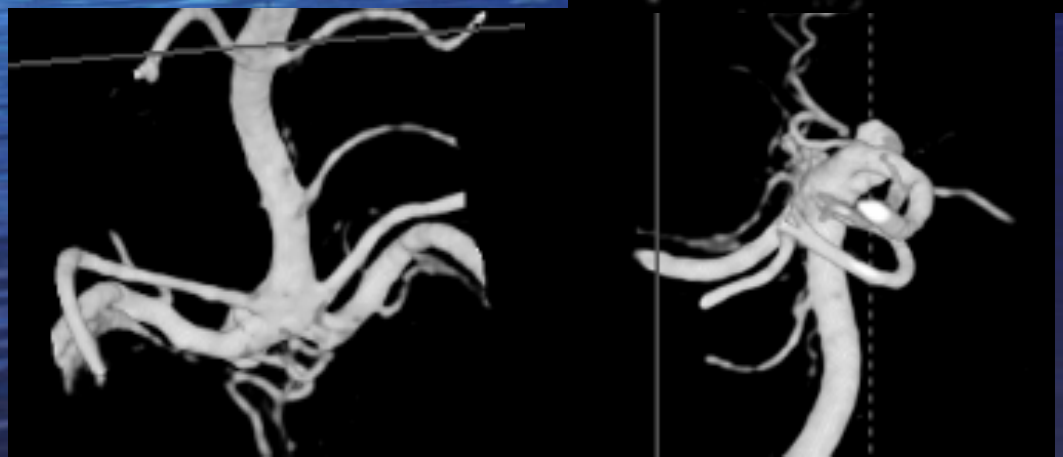
Reformation of New Aneurysm

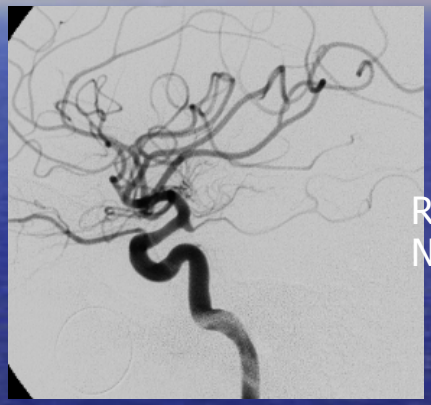
42/M, H/H 1, Fisher 3, Ruptured BA Tip Aneurysm, Clipped with Good Result

Preoperative 11/21/2006



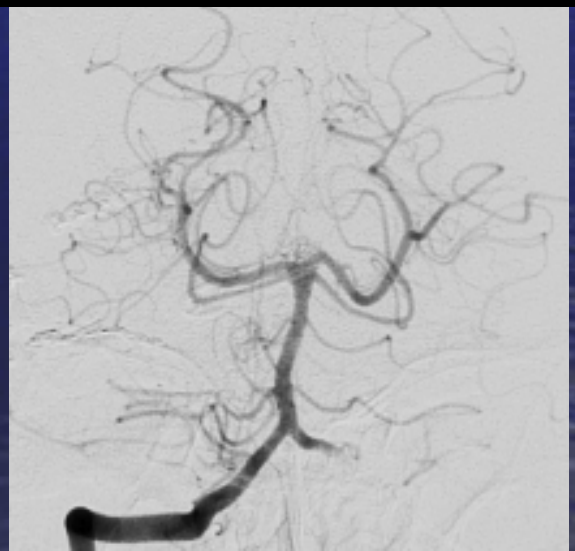






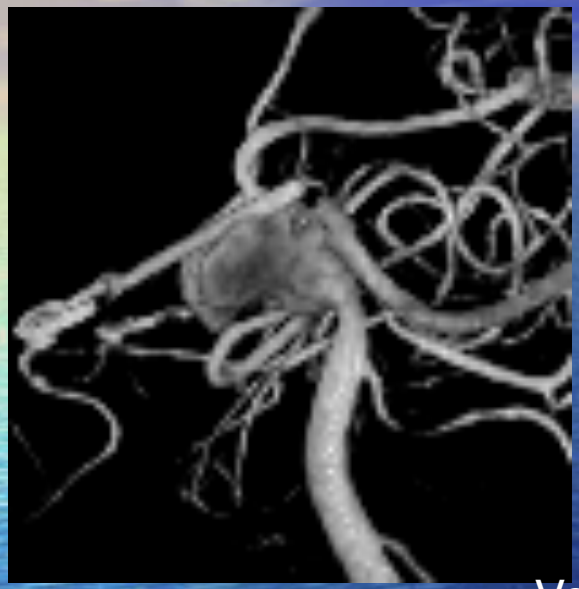
Right ICA
No Aneurysm Noted

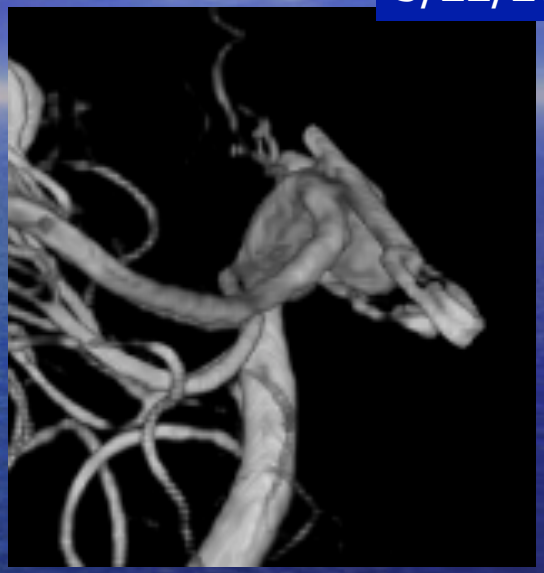
Post Clipping Angiogram 11/22/2006



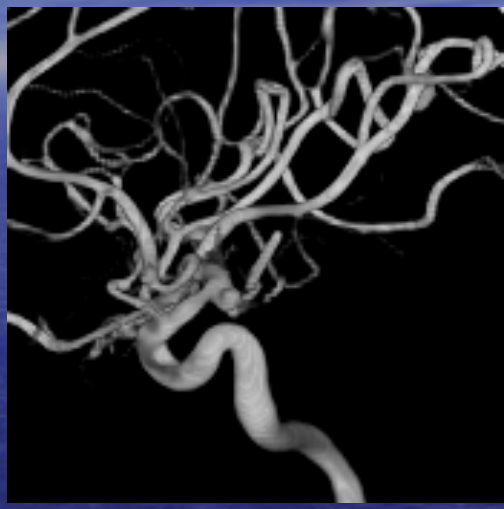
3 Yrs. Later, Recurrent SAH, New Fusiform Aneurysm at BA Tip; New ICA PCOM Aneurysm

3/22/2010

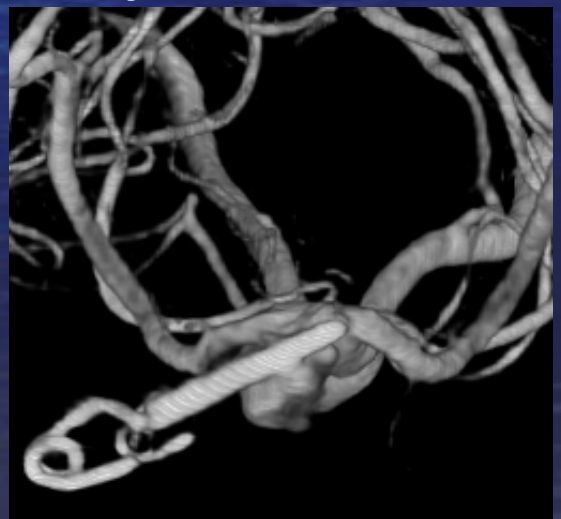




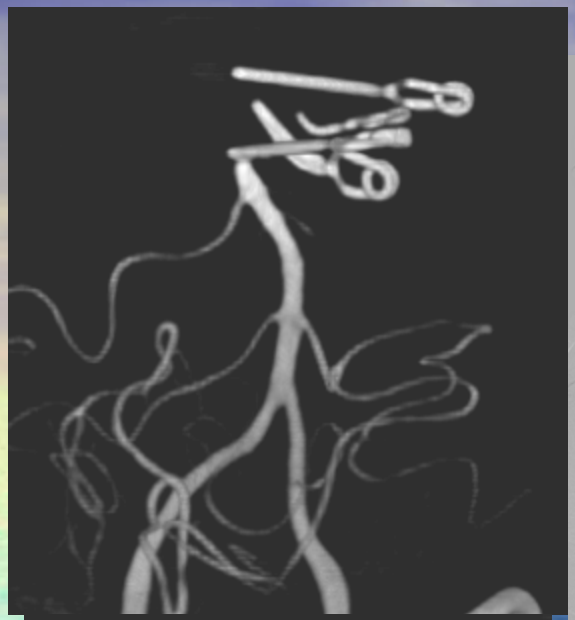
Vertebral Injections

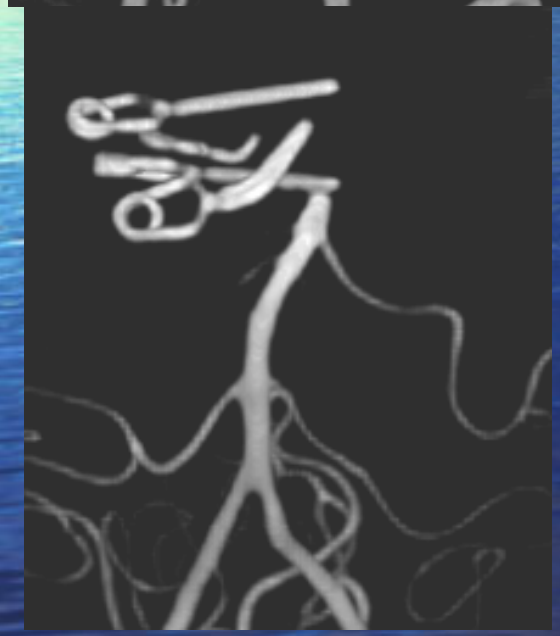


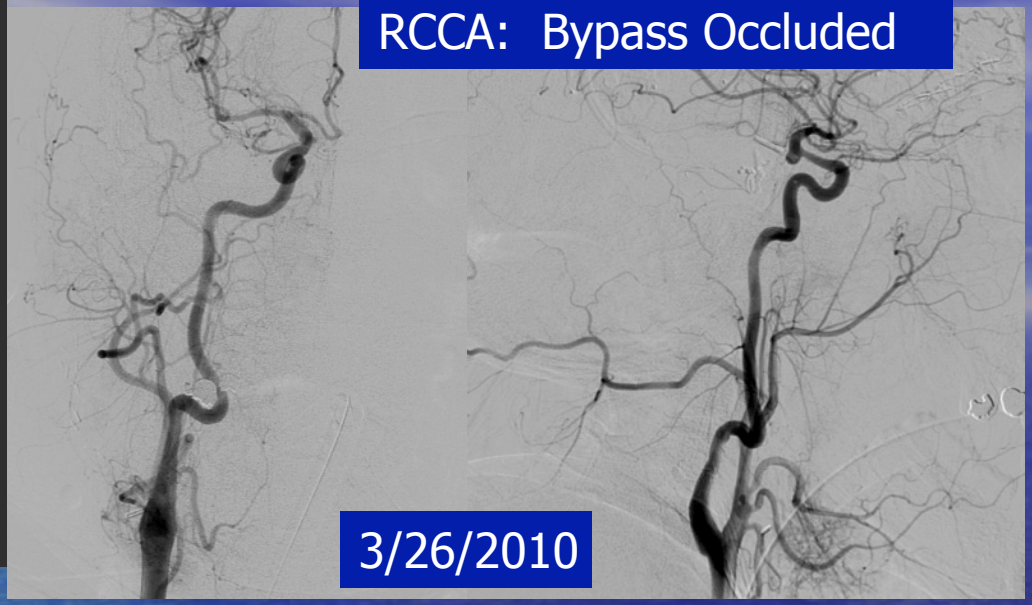
Right ICA
New PCOM Aneurysm

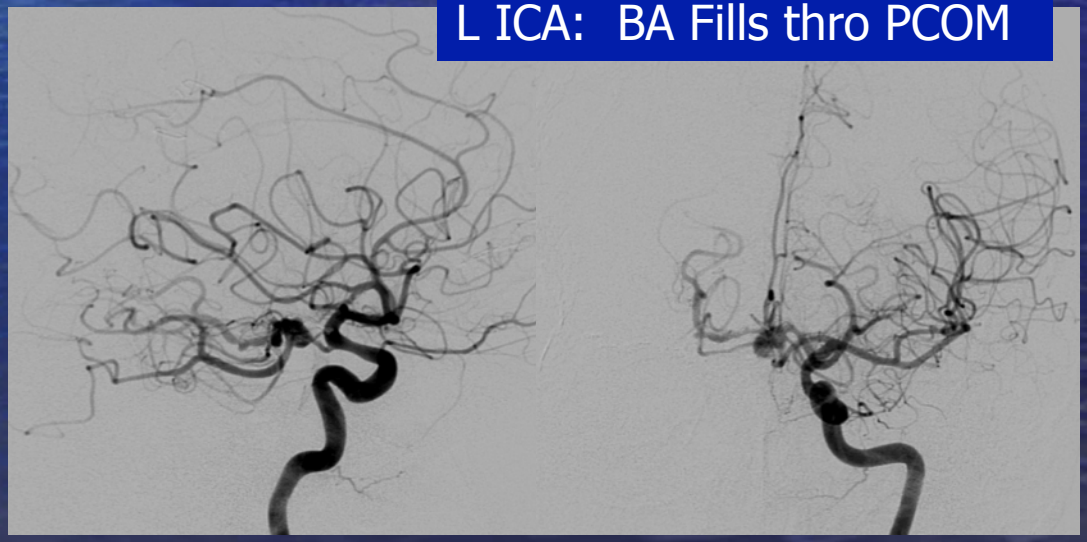


Entire BA terminus Expanded into an Aneurysm, below the Previous Clip





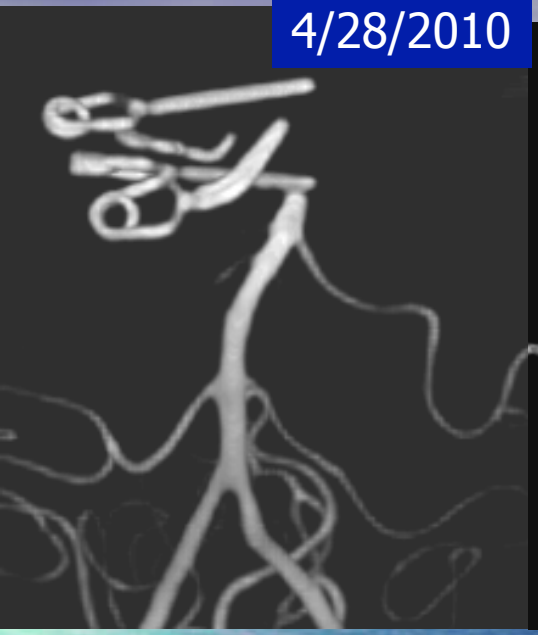


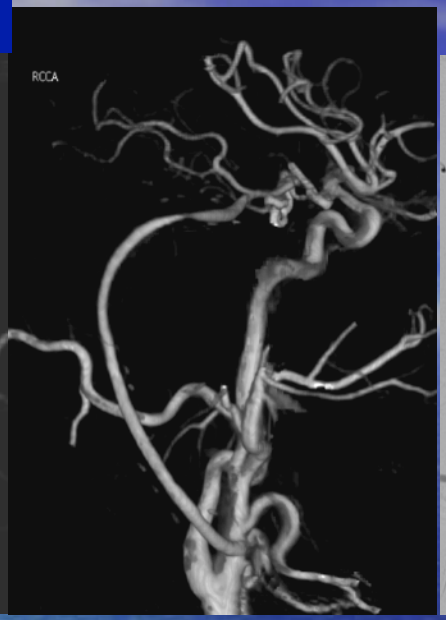


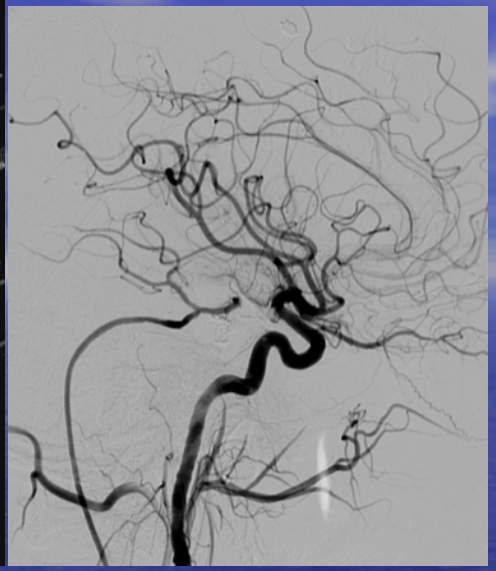
Postoperative Angiogram, Obtunded, No Hemi paresis

RAG Bypass to PCA, Aneurysm Clip, BA Occlusion

4/28/2010



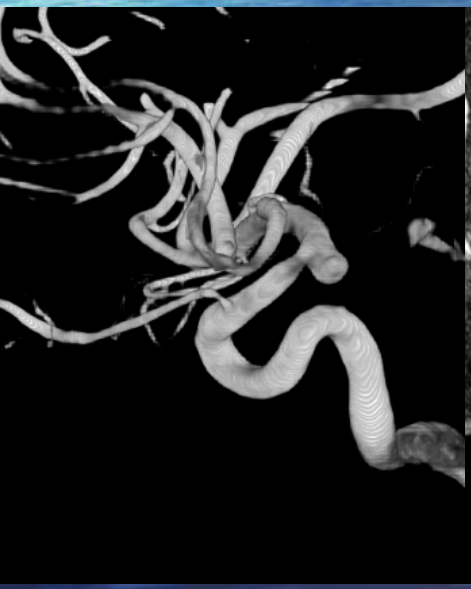


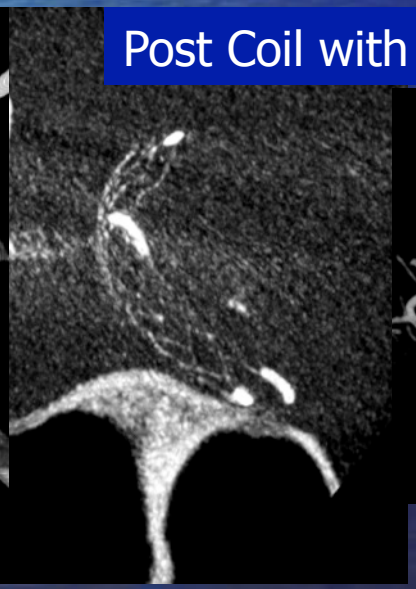


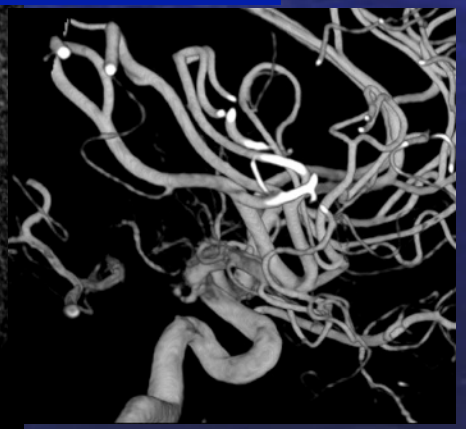
L ICA

PCom Aneurysm Coiled with a stent

Post Coil with 5/18/2010

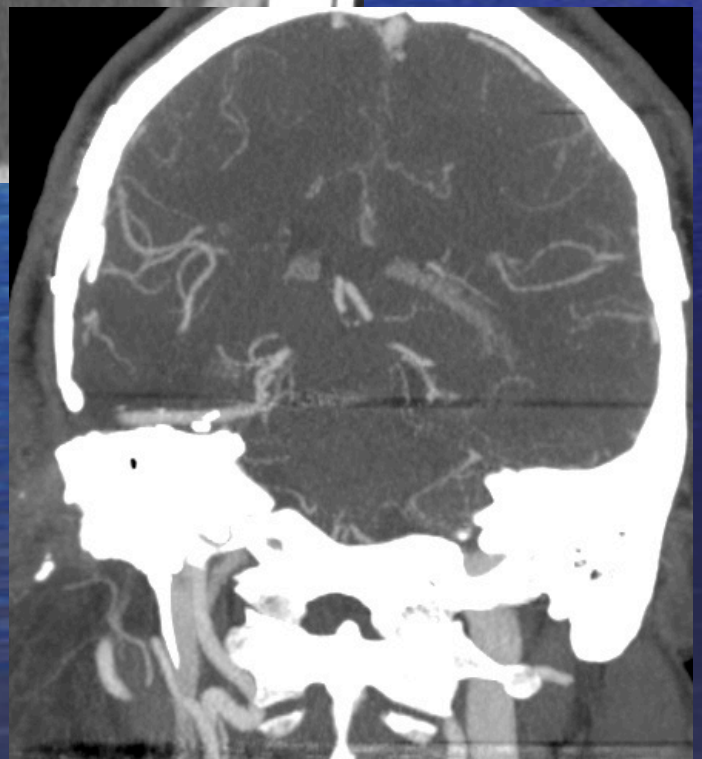






Recovery to mRS 2

L ICA An, Enterprise Stent 4.5x22mm, 5 GDC Coils



After 1 1/2 years, No aneurysm Recurrence
Experiences daily headaches, shooting pain
Started Gabapentin; complete relief
mRS 2

10/11/2011

All Coiled Patients (n=63)

Treatment Type and Efficacy

Coils only	**36(57.1%)**
Coiling with a Balloon	**12(19 %)**
Coiled with stent assistance	**15(23%)**
single stent	**12**
Y- stent	**3**
Patient with both balloon and stent	**1(1.5%)**
Raymond Score:	
	42(66.6%)
Raymond 1 (no residual)	**20(31.7%)**
Raymond 2 (neck residual)	**1(1.5%)**
Raymond 3 (sack residual)	

Deaths and complications in the Endovascular coiling group of patients (n=63):

Death within 1 month	4*(non were directly related to the procedure)
Stroke	2 (3.2%) (Unruptured aneurysms)
Thromboembolic event	5(8.1%)
Groin hematoma	2(5.8%)
Femoral artery pseudo-aneurysm	1(1.6%)
Hemorrhage(1 Intracranial along EVD tract , and 1 pt. had hematuria and malena	1.6%) 2(5.8%)

Endovascular coiling patients Ruptured or Unruptured: Type of treatment, Residual and Recurrence:

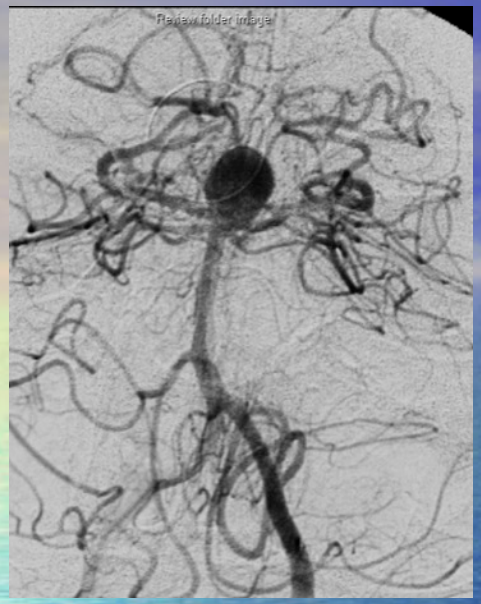
Type of treatment:	
Coiling with microcatheter only	36(57.1%)
Coiling with balloon assistance	12(19%)
Coiling with stent assistance	15(23%)
Single stent	12
Y-stent	3
Balloon and stent	1(1.5%)
Residual aneurysm:	21(33.2%)
Raymond 2(neck residue)	20(31.7%)
Raymond 3(sac residue)	1(1.5%)
Retreatment	11(17.4%)
More than one retreatment	3/11(27.2%)

Multiple BA Tip Recurrences after Coiling, Stent/ Coiling

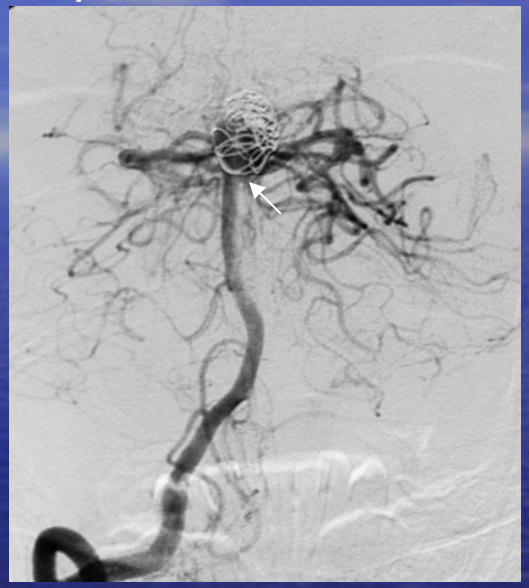
- 43F, Incidental discovery of Unruptured basilar tip aneurysm in 2003
  Patient underwent coiling procedure.
- 1year follow up revealed recurrence in 2004.
  Patient was retreated with coiling.
- Patient had recanalization of the aneurysm after three years in 2007.
  Patient was treated with stent assisted coiling.
- 6month follow up revealed recanalization
  Patient underwent re-coiling through previously placed stent in 2008.
- Post coiling MRA revealed a small residual at the base of the aneurysm.
  1year follow-up angiogram revealed more prominent residual neck.
- Patient is followed annually with an angiogram.

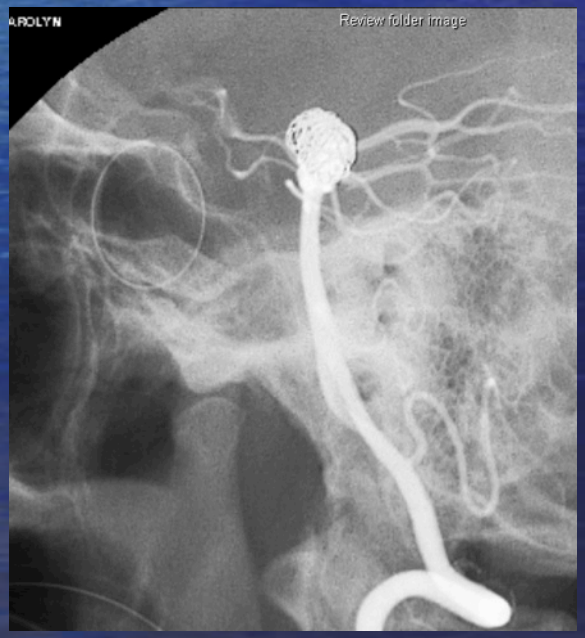
Total of 4 retreatment's, still a residual aneurysm present

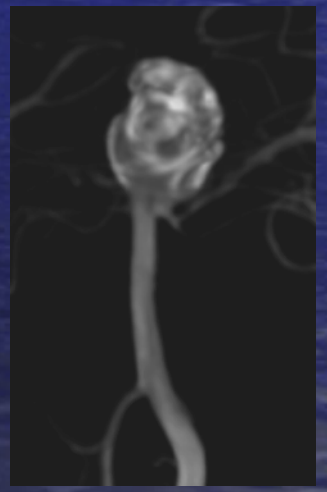
43F, Incidental discovery of unruptured basilar tip aneurysm treated with coiling
Size=10mm, Neck= 6, Aspect ratio=1.6, Dome to neck ratio= 1.6



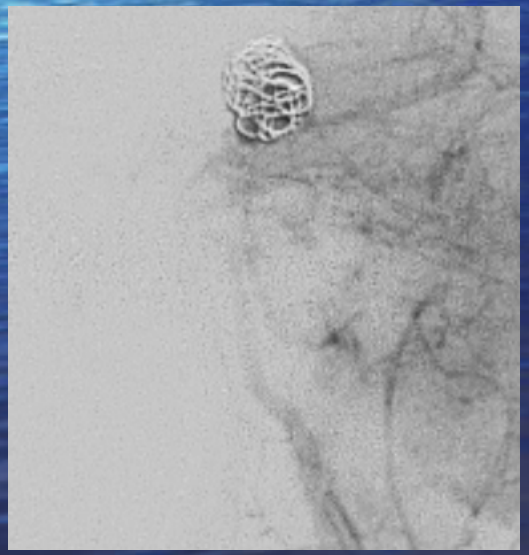
Patient presented with recurrence after 1 year

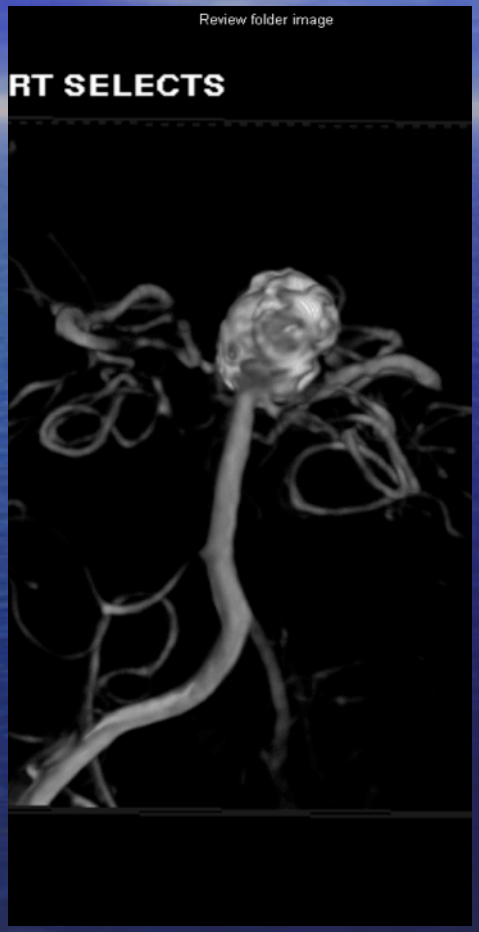






Patient underwent recoiling of the recanalized portion.

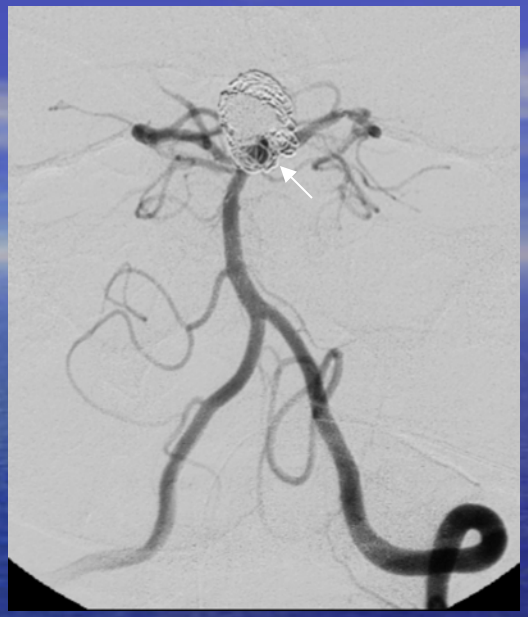


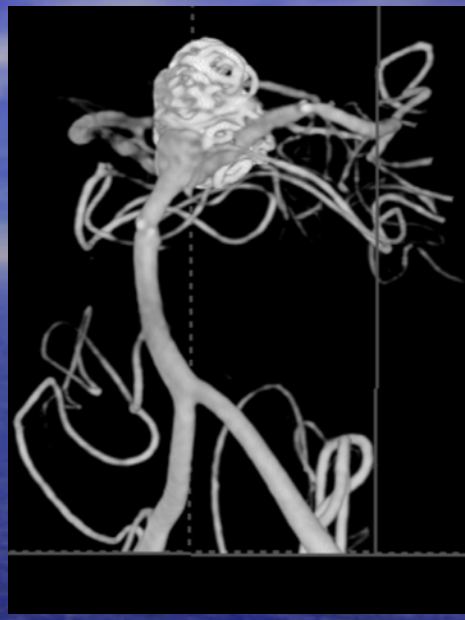


Recanalization of re-coiled aneurys after 3 years

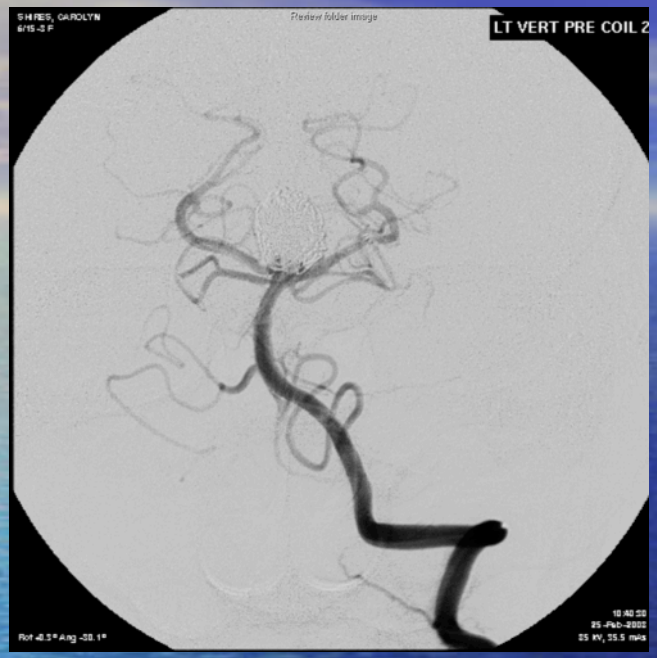
Stent placement in the aneurysm:

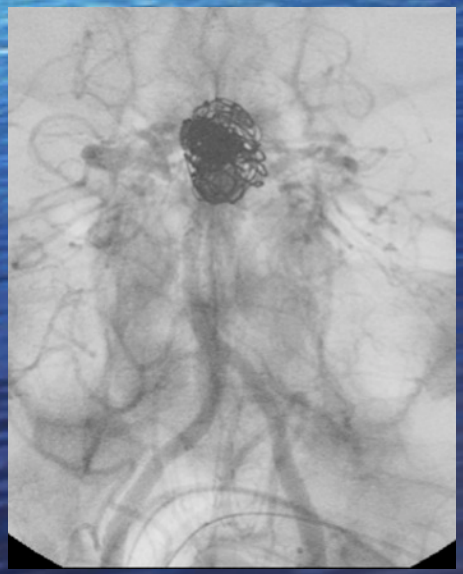
Recanalizationof the prior stent assisted coiling 6months

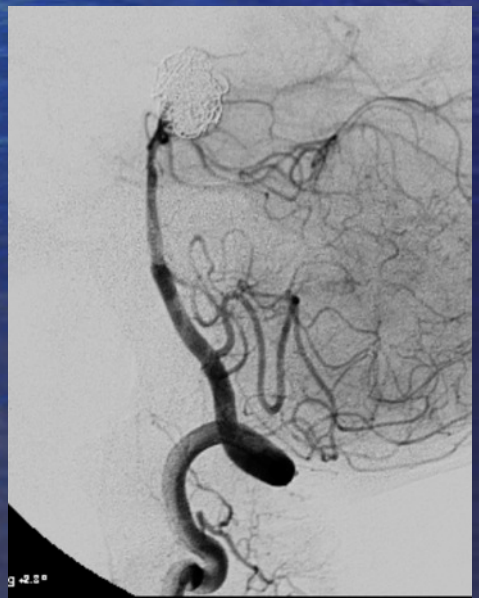




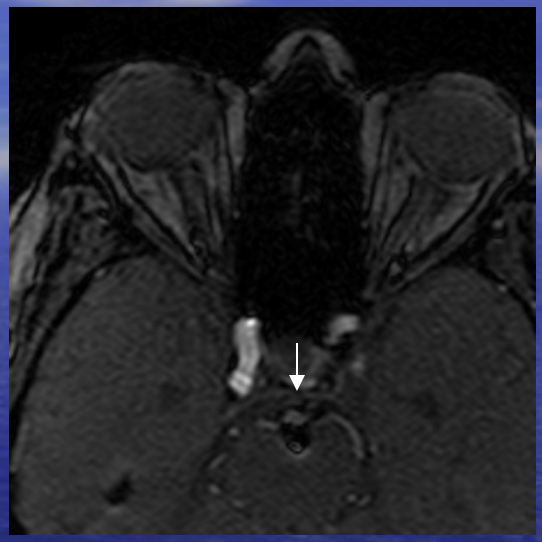
Recoiling of prior stent assisted coiling

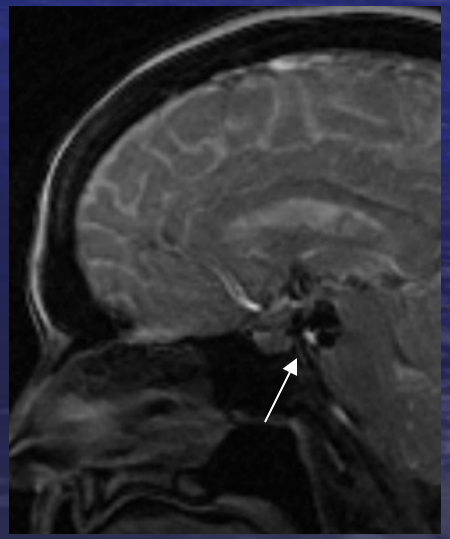




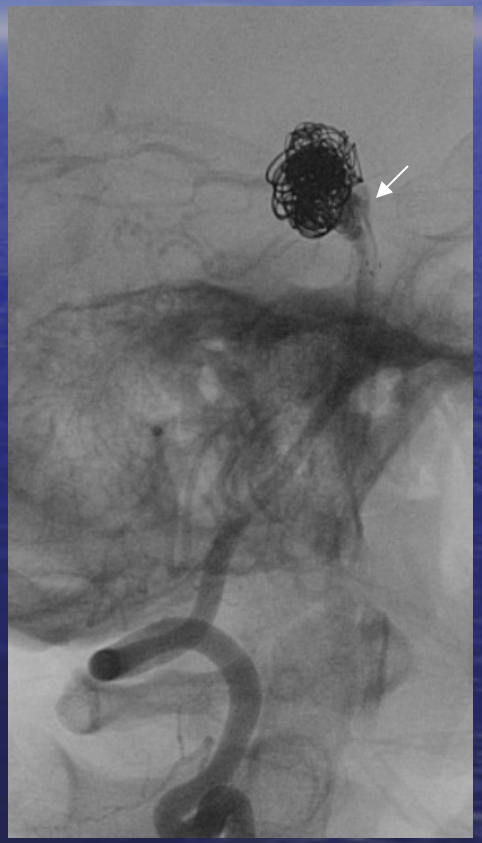


Post retreatment residual followed annually





Post retreatment angiogram at 1 1/2 years shows more prominent residual as compared to MRA done at 6 month post treatment. Residual followed annually.



Conclusions

- BA Tip Aneurysms are well Treated by Endovascular and Microsurgical Methods in a Center with Experience and Expertise in Both
- Both Types of Treatments have evolved, and improved
- Endovascular Technique remains Primary for Ruptured Aneurysms with favorable shape and neck, but Microsurgery should be strongly Considered for Complex Aneurysms (neck > 4mm, aspect ratio >1.6)
- For Unruptured Aneurysms, Microsurgery should be strongly considered in patients < 60 yrs. Of age
- For Very Large, Giant, or Very Complex Aneurysms, terminal BA Occlusion, with or Without RAG Bypass to the PCA, appears to give Good Results
- Deep Hypothermic Circulatory Arrest Technique may be a relic of the past (My apologies to Spetzler, and Solomon)