

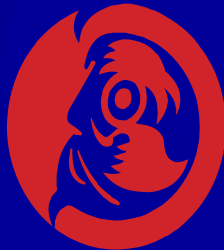
Complex Carotid Stenosis:

Treatment Options

LN Hopkins, MD

Elad Levy, MD

Adnan Siddiqui, MD, PhD



**TOSHIBA
STROKE
RESEARCH
CENTER**



KALEIDA
H E A L T H



University at Buffalo
State University of New York

LN Hopkins, MD

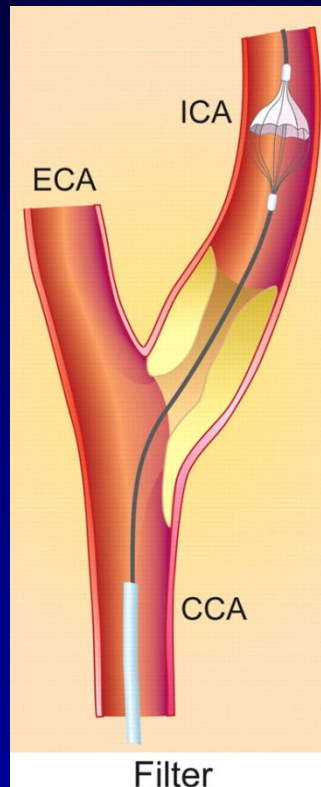
Personal Experience

- CEA > 2000
- CAS > 2000
- PI or Co PI or steering committee
- CREST, CARESS, ARCHeR, CAPTURE, BEACH, CABANNA, CABERNET, SAPPHIRE, VIVA, Act 1, EMPIRE, ARMOUR

Many Choices

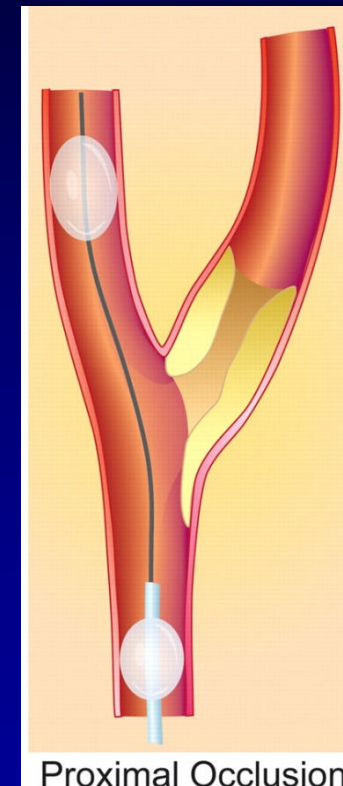
- CEA or CAS
- EP: filters, balloons, mesh, Prox/Distal
- Stents: Open or closed cell, pore size, radial force, laser cut nitenol, woven mesh
- Approach: femoral, radial/brachial, direct
- Pharmacology: Anticoag, Platelet, IIB IIIA
- Access site: suture, plug(intra/extra vascular)

Distal vs Proximal protection



No occlusion of
CBF

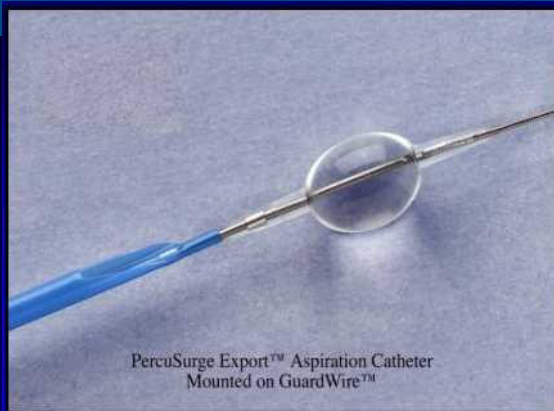
larger crossing profiles
affect trackability



stopping or
reversing flow

Embolic Protection

Occlusion devices for embolic protection



Perfusion filtration EPD

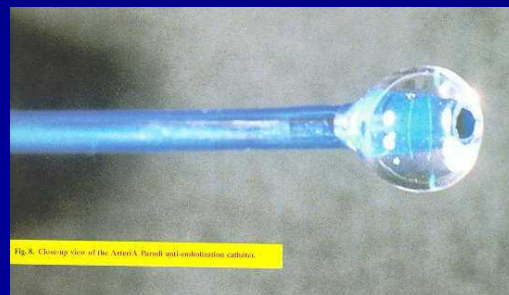
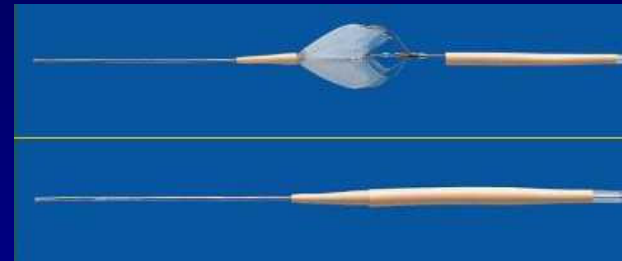
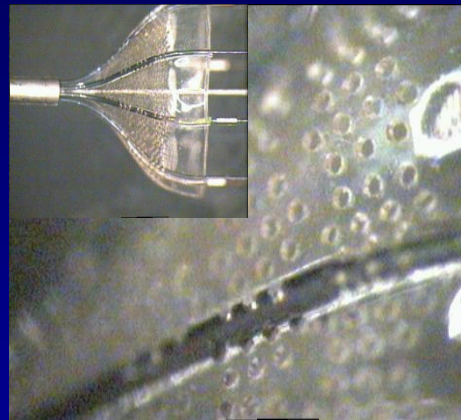
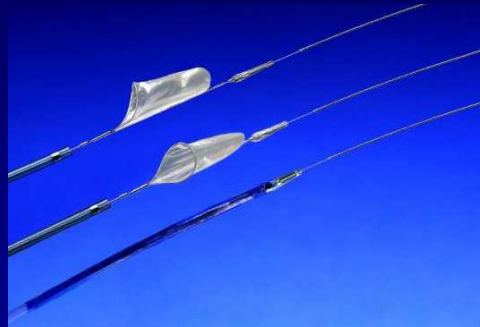
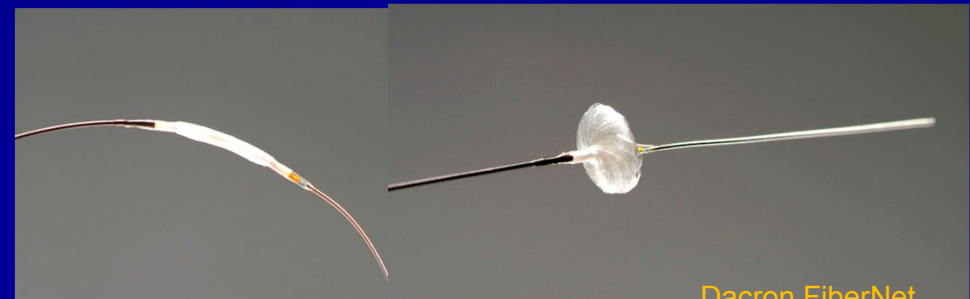


Fig. 8. Close-up view of the Arrow® Perflink and embolization catheter.

Flow Reversal




Dacron FiberNet

CAROTID ARTERY STENTING

Expert Stent Carotid Dissection



Accunet
Embolic Protection System



Xact
Carotid Stent System



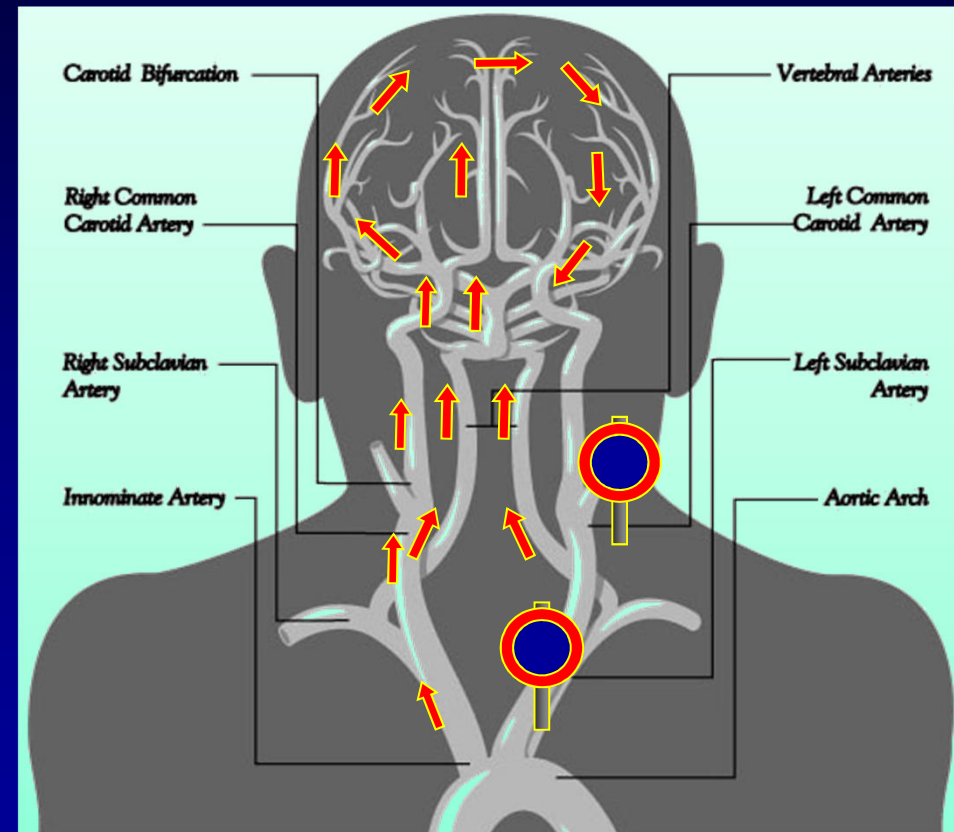
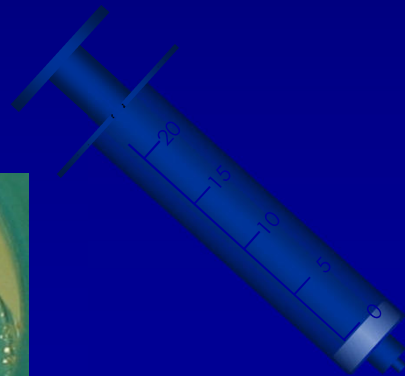
Acculink
Carotid Stent System



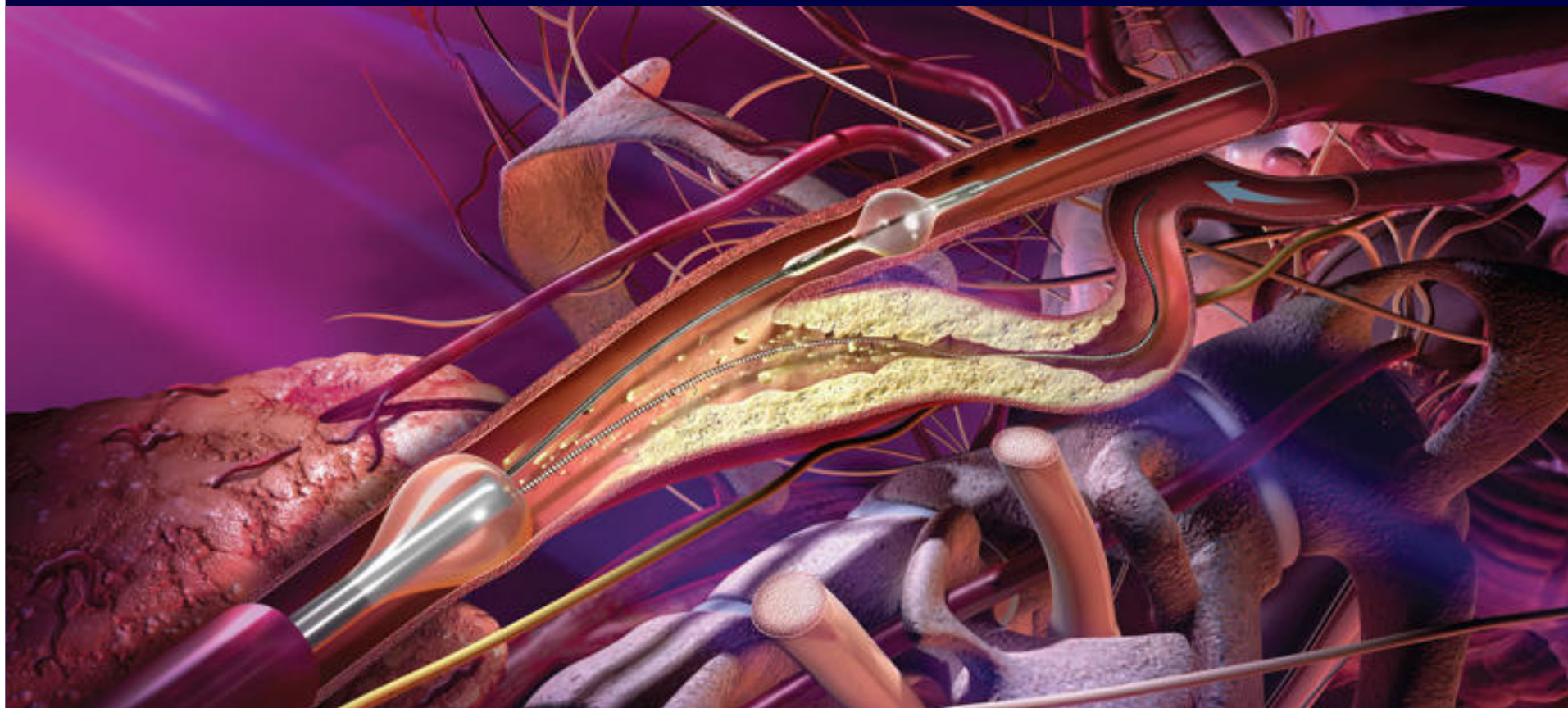
Emboshield NAV⁶
Embolic Protection System

MOMA Proximal Flow Blockage Cerebral Protection Device

- CCA clamping: blockage of antegrade blood flow
- ECA clamping: blockage of retrograde blood flow
- Debris removal: syringe blood aspiration

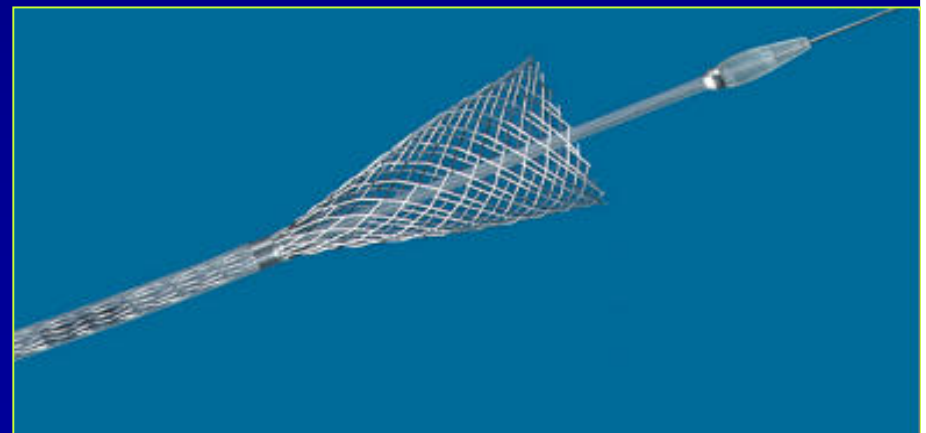
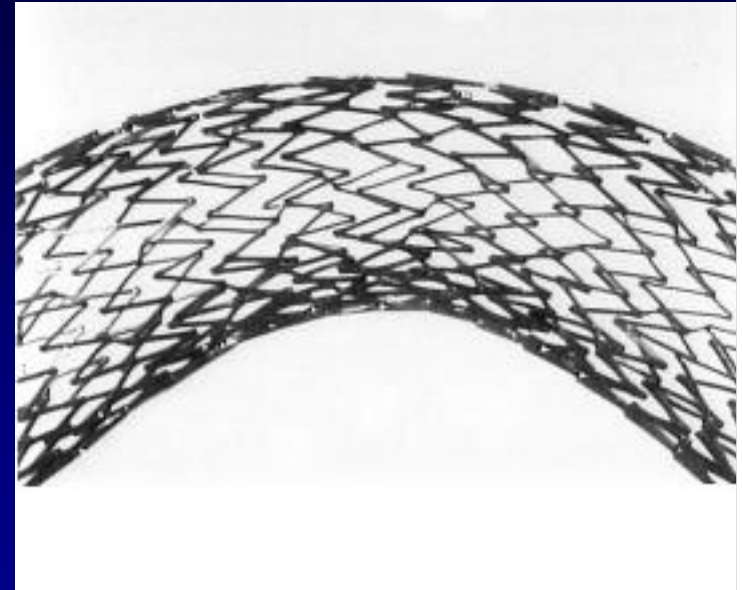


Gore Flow Reversal System



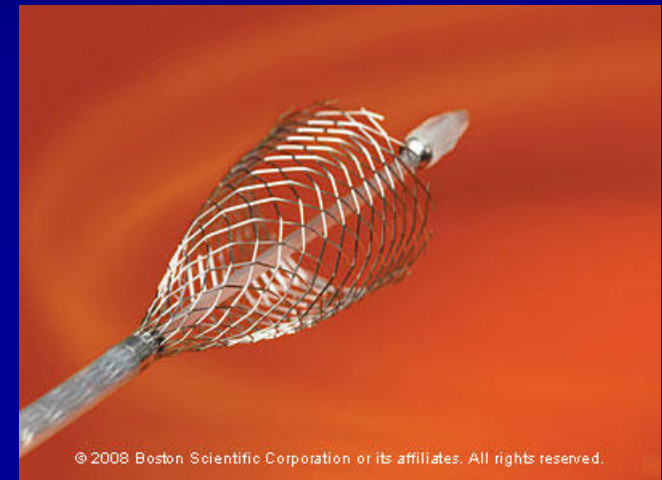
Stent Selection

- Numerous stent available each with their own particular niche
- General Design characteristics:
 - Open Cell - Flexible
 - Take curves better and better wall apposition
 - Distal protection devices, stent deliver catheter, or balloons can hang on tines herniating into artery
 - Closed Cell - Non flexible in artery
 - Tend to kink artery at distal end of stent if involving a curve
 - Allow access for devices better and can be partially resheathed



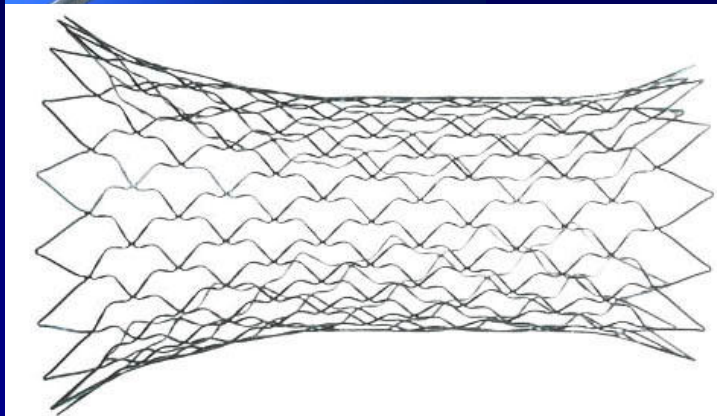
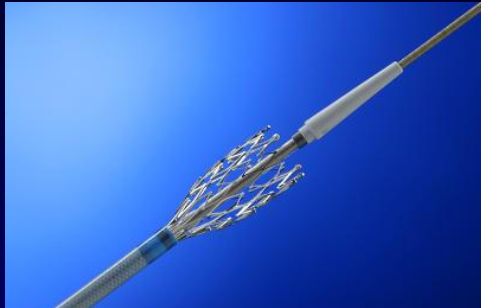
Wallstent

- Woven mesh cobalt chromium stent
- Low Profile
- Highly flexible in delivery system - forshortening
- Good for difficult access (radial;small guides)
- Smallest pore size ie.high metal/artery ratio
- Symptomatic patients..."wallpaper" the lesion
- Trap debris against artery wall
- Dissection, Acute stroke
- Straight anatomy best

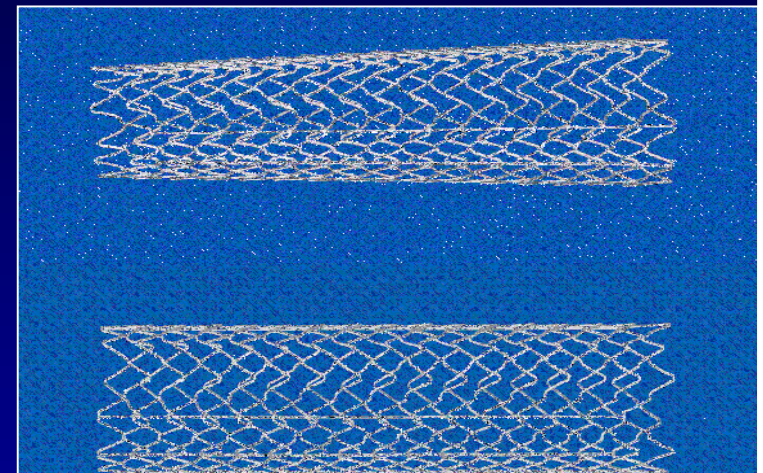
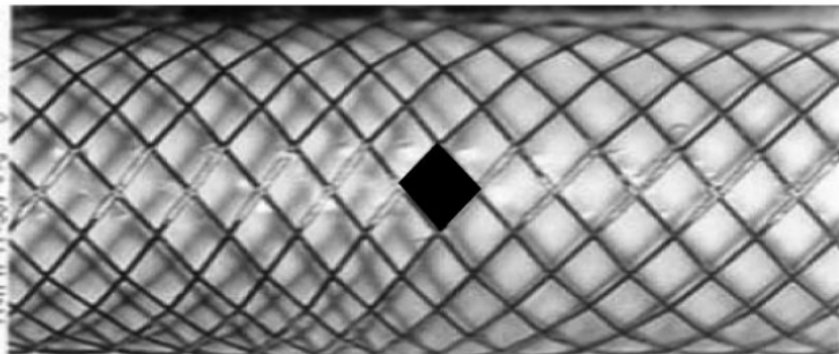


Stent Designs

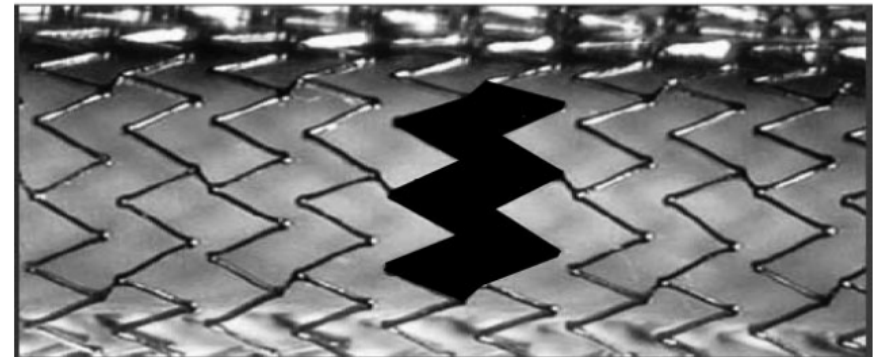
Open or closed cell design
Nitinol or Stainless Steel construction

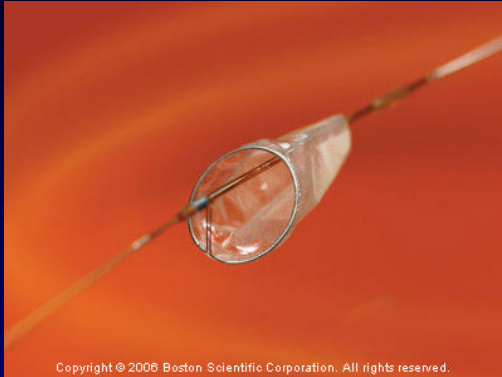


Example of a "closed cell design stent": free cell area is marked black



Example of an "open cell design stent": free cell area is marked black





When to Filter?

- Routine CAS procedures
- Anatomy ok for passing & landing filter
- Moderate non hge plaque burden
- Poor collateral
- “Belt and suspenders” with prox EP

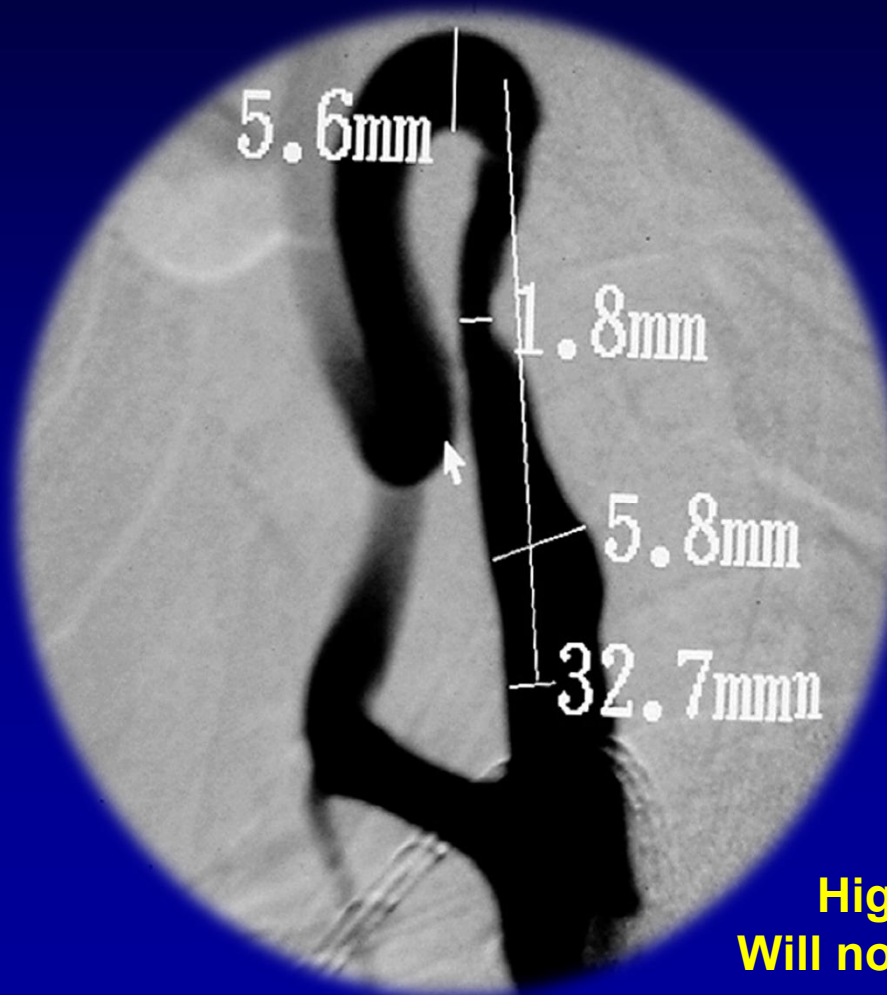
Proximal Embolic Protection

- Great Trial results ... esp elderly and sx patients
- Procedure of choice for:
 - Recent sx ie “Hot Lesion”
 - Hemorrhagic plaque
 - Low GSM, long ulcerative lesions
 - Large plaque burden
 - String sign
 - Acute carotid occlusion/ stroke
 - Luminal thrombus
 - Perilesional kinks/calcification
 - No landing zone for filter

“Endovascular Endarterectomy”

Stent?

EP??



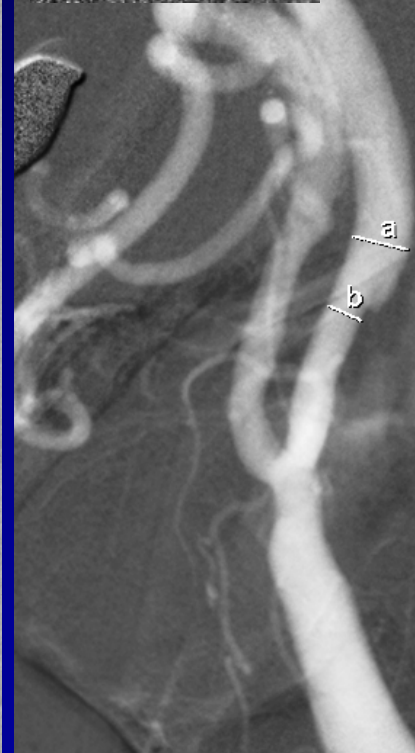
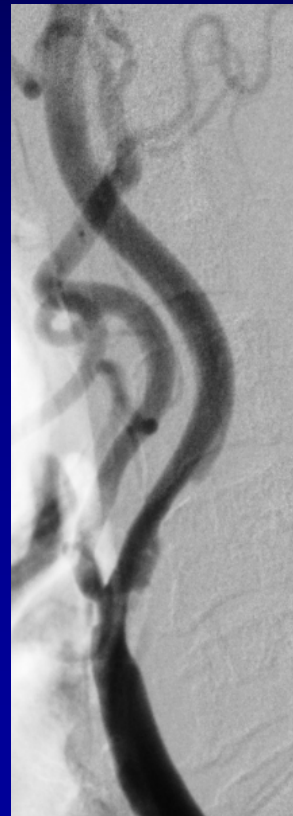
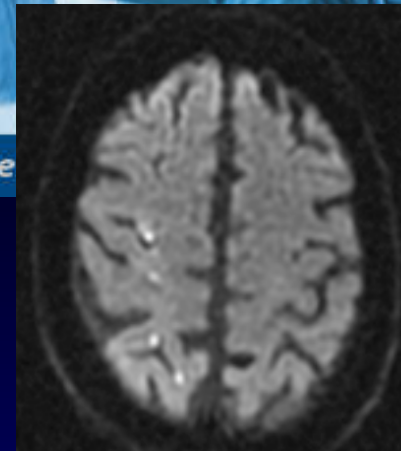
**High lesion
Will not straighten**

74 yo M

- To ER with LUE weakness, LLE heaviness.
- Hx of previous similar Sx
- CTA/Doppler ulcerated plaque RICA <40% stenosis
- PMHx-coronary stents 4/10
- Meds-ASA/Plavix

Treatment ??

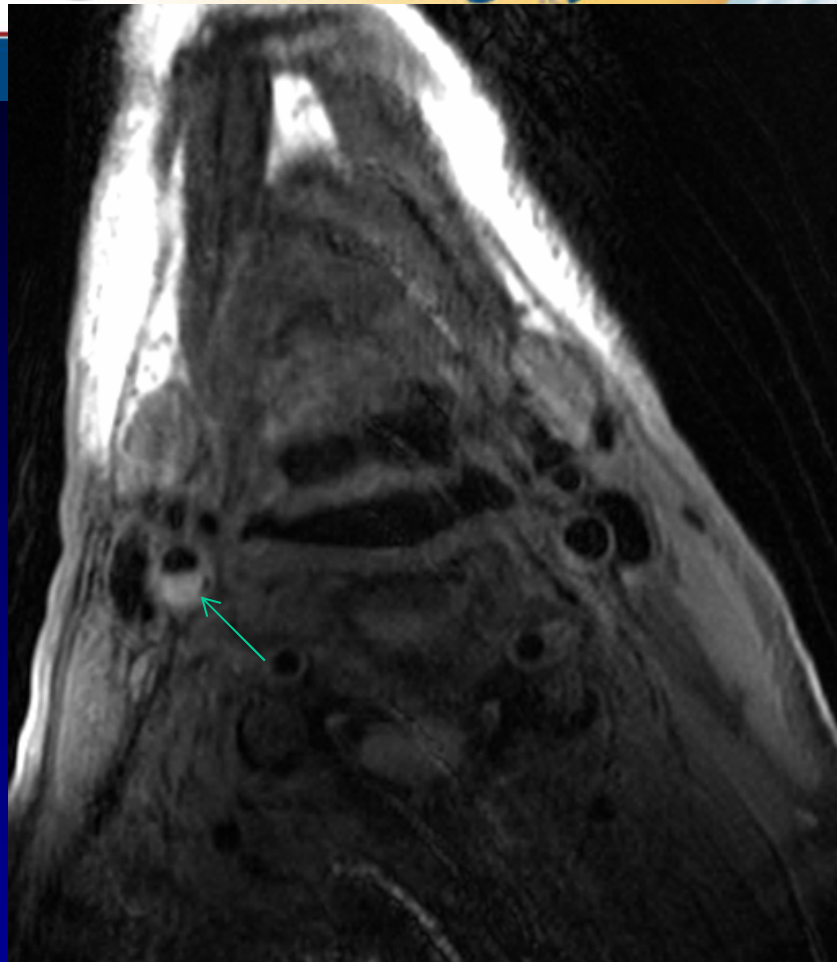
- Med, CEA, CAS??
- Recurrent strokes
- <40% stenosis
- Type III arch
- Dangerous lesion



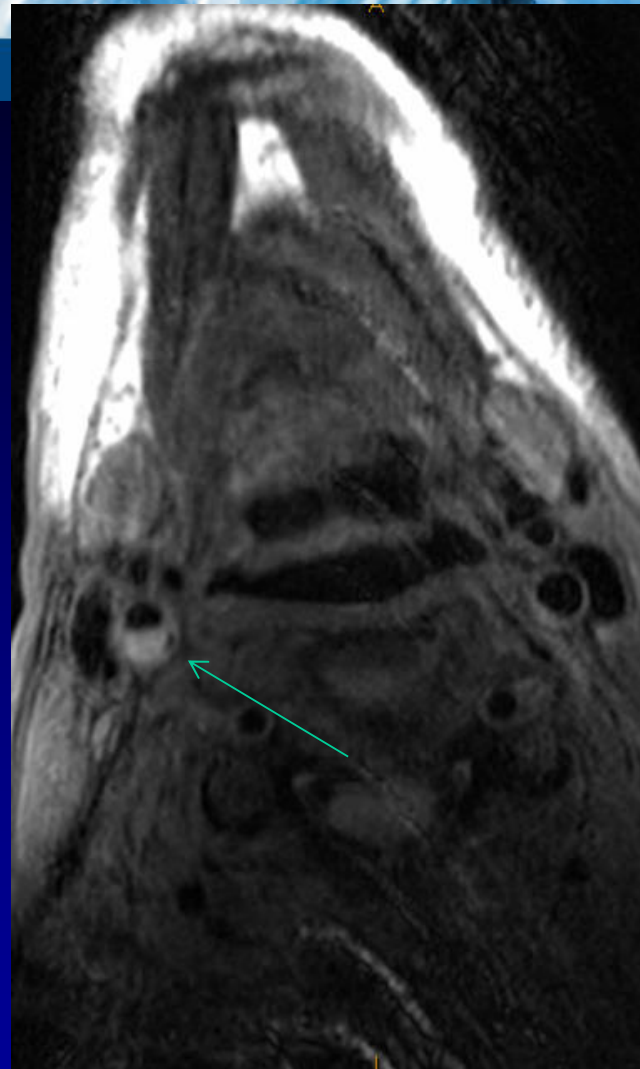
ICA 4.8 mm

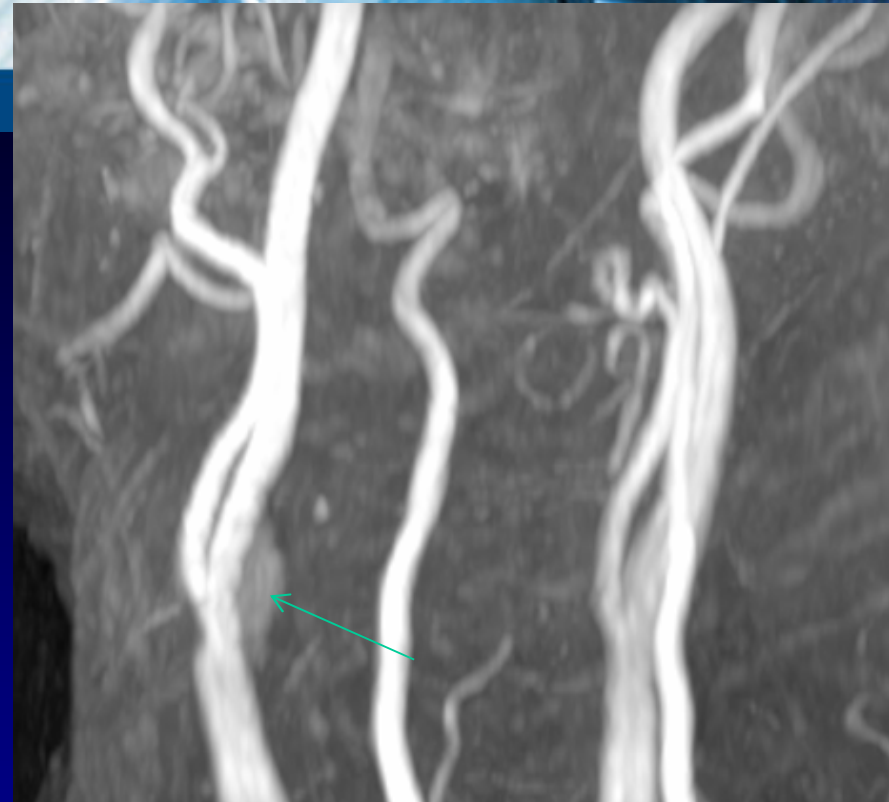
CCA 6.0 mm

Length 33 mm



**T1 Dark Blood with
hemorrhagic plaque**



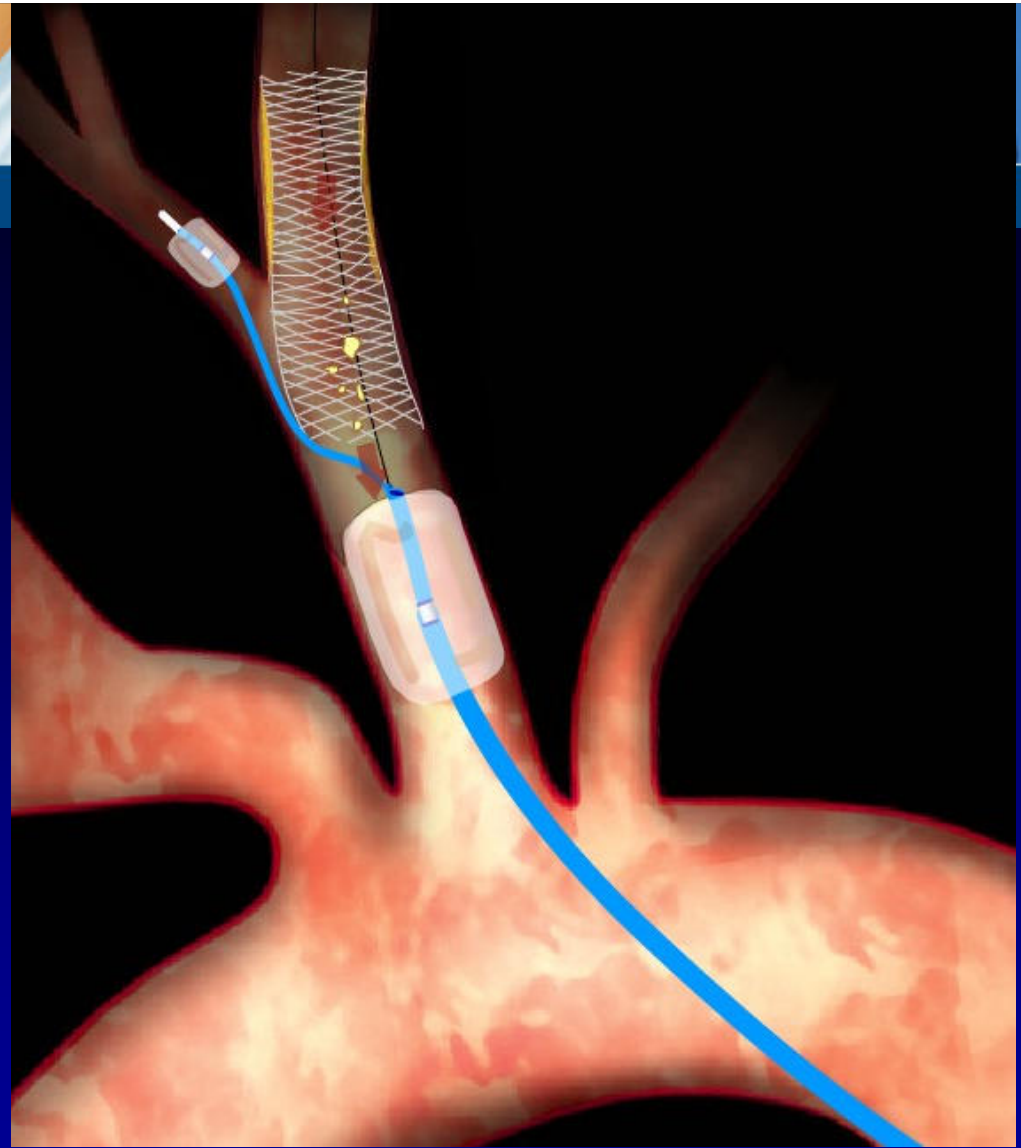


**T2 bright blood and
reconstruction**

**33mm plaque
19mm hemorrhage**



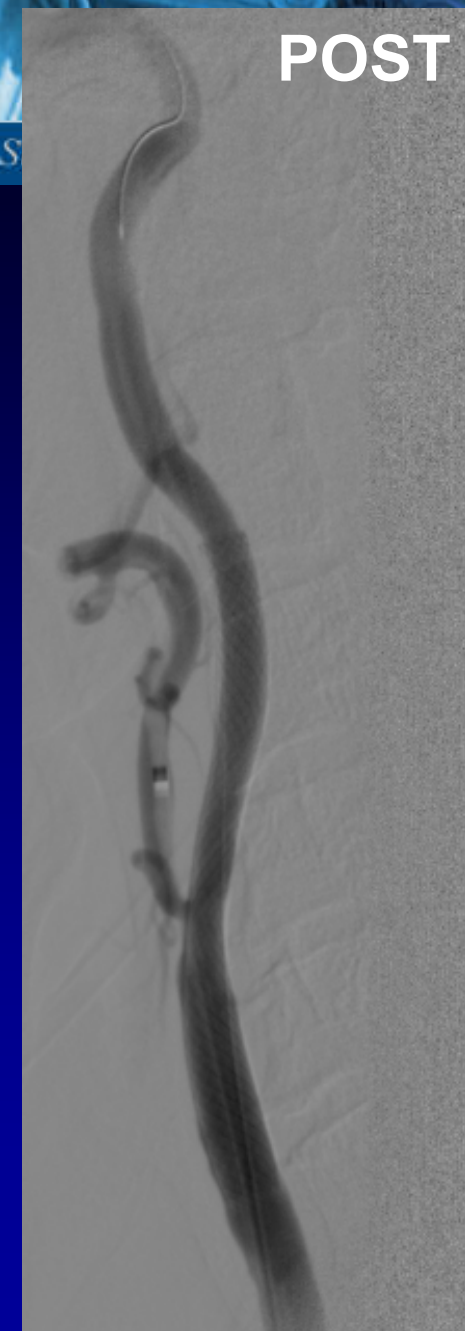
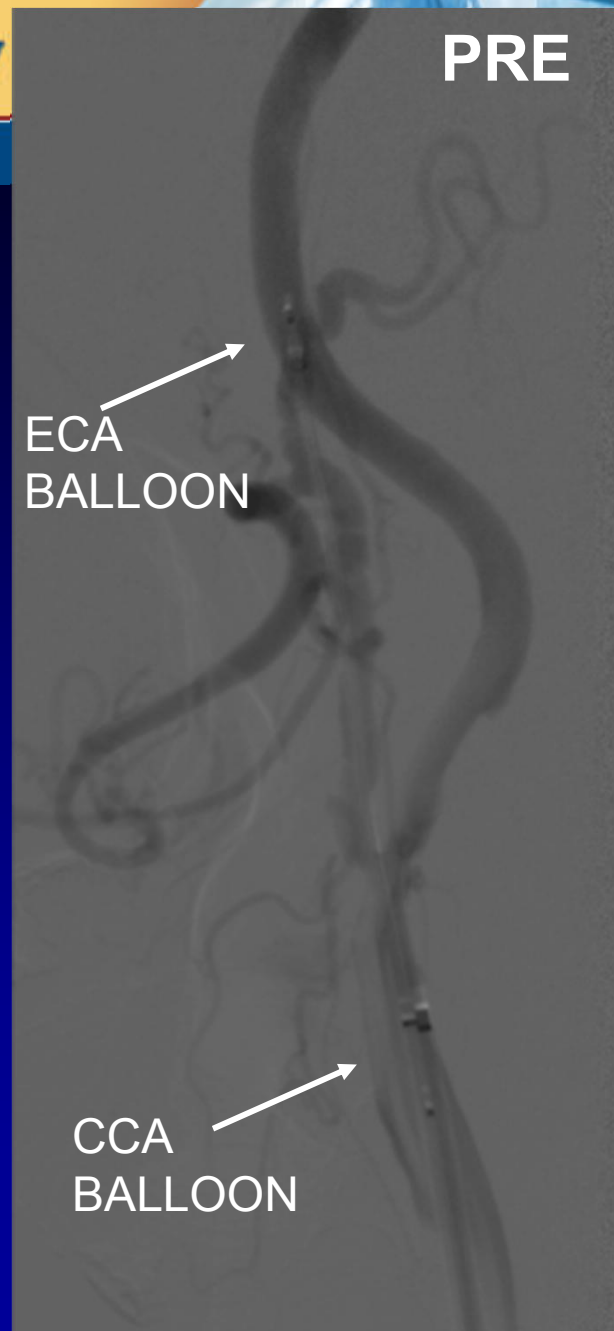
Type III
Arch



MOMA + Wallstent
No post dilatation

At Stenting

- Devices used:
 - 9F Sheath
 - VTK/0.038
 - MoMa
 - BMW Exch
 - Wallstent
8mm x 36mm

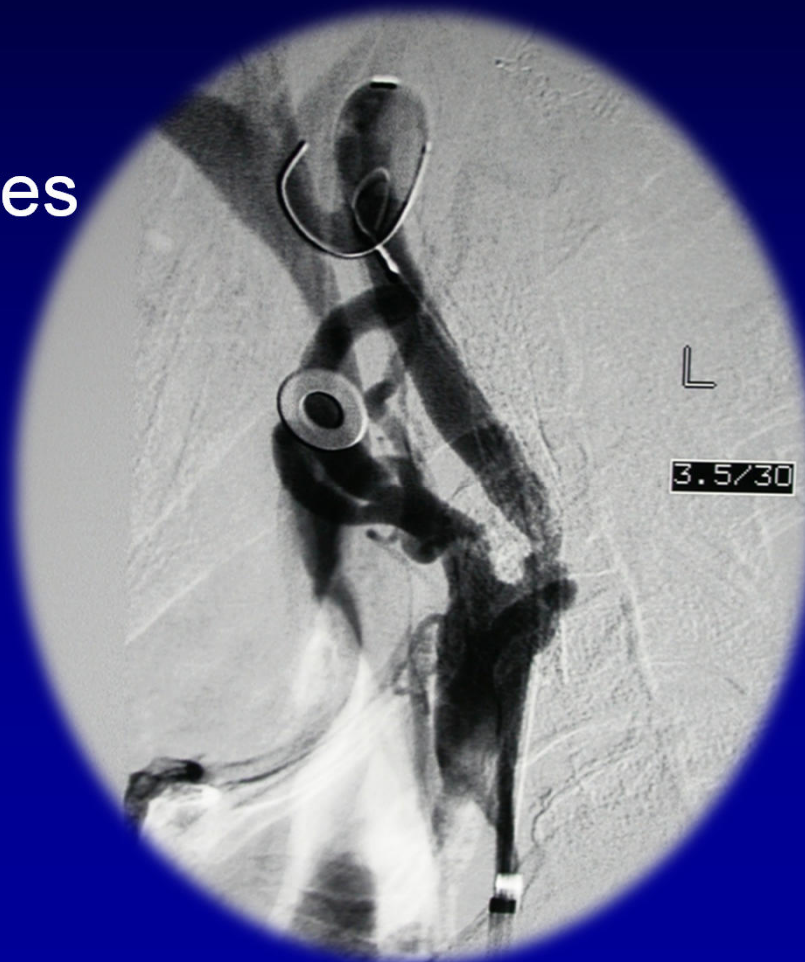


Follow-Up

- CAS uneventful
- 4 hrs post-procedure was found to have dysphasia, otherwise non-focal on exam
- CT Stroke Study: unremarkable
- Eptafibitide drip administered overnight
- By morning of POD#1 (6 hr later)
 - Patient returned to neurologic baseline
 - Subsequently discharged home on ASA/clopidogrel

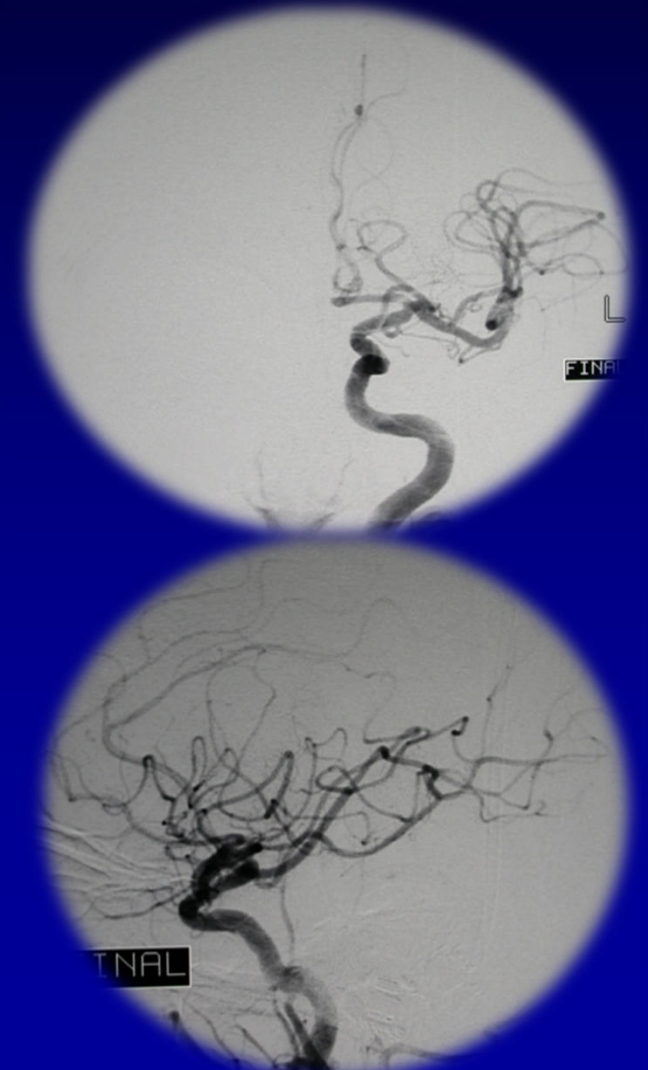
Filter? Where??

- Not in curves



Distal Protection Retrieval

- Evaluate angio for cervical dissection prior to removal of protective device
- Passing retrieval sheath if difficult
 - Post dilate with 035 balloon/retrieve filter
 - Advance guide catheter to unbiased wire
 - Consider angled retrieval (MPA catheter or diagnostic catheter)
 - Neck turning/manipulation
- Obtain final cervical and intracranial angiographic runs and compare to pre-op



Filter?? Proximal EP? Stent?

- Proximal Embolic Protection
- Use open cell design stent to take curve and avoid kinking



Consideration to select stents

Soft/thrombus-containing plaque or a severe string-sign lesion in a symptomatic patient



Use a closed-cell stent

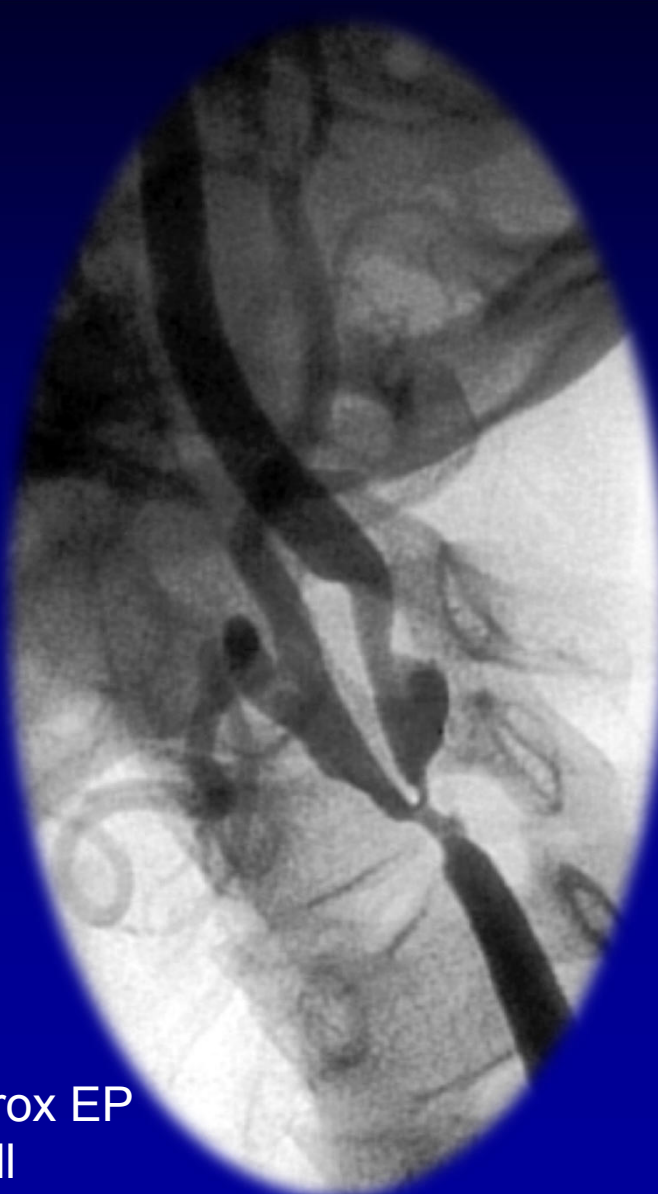


tortuous segment



nitinol open cell





Filter or Prox EP
Closed cell



Prox EP
Open cell



Negative Results of CAS Trials Have Taught Us Much

Mistakes: the “Portals of Discovery”

- Experience is Key to success
 - EVA 3S, SPACE, ICSS, CREST Lead In
- Case Selection is Critical... Anatomy
- Understanding Risk Factors of CAS
- 2/3 of strokes occur post procedure
- 18 % of strokes contralateral

Complications In Intervention

- More common than we realize
- Potential to cause great harm
- 70% judgement or technical errors
- 20-30% device related
- **Can we reduce them ??**

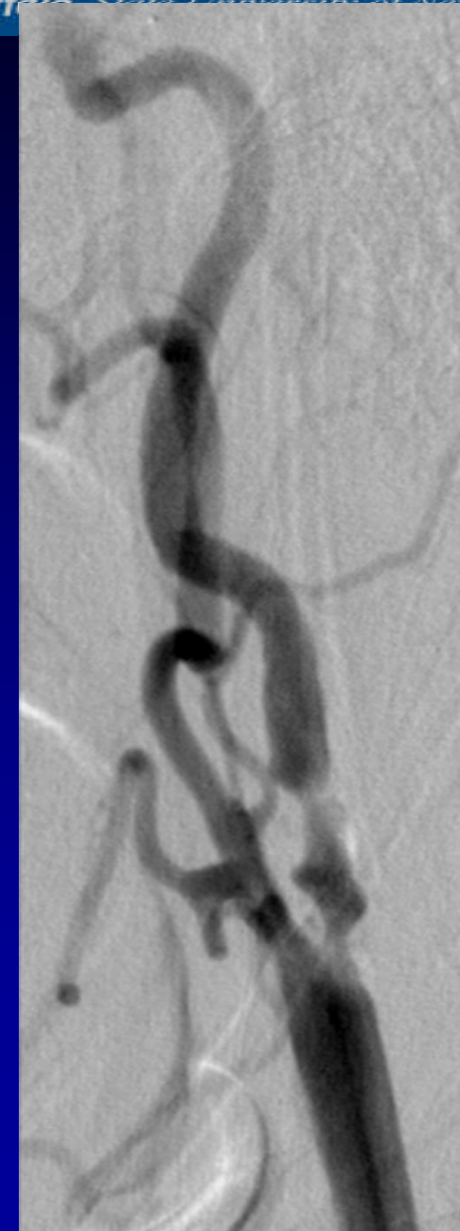
What Do We Need To Face Complications ??

- 1. Experience**
- 2. Tips and Tricks**
- 3. Coronary, Peripheral and Neuro tools**
- 4. Pharmacology**
- 5. Collaborative colleagues**
- 6. Judgement**

Filters Can Be Dangerous

- 67 y/o M
- Asymptomatic RICA stenosis
- Pre-CABG
- doppler = LICA occluded, RICA 466

- Severe stenosis
- Concentric calcification
- Pre dil 4x30, 5x30
- Emboshield deployed
- Xact stent would not pass
- Precise 7x30 stent deployed
- **Filter retrieval sheath...no go !**
- Lesion recoiled despite 5x30, 6x30 and 7x30 post-plasty



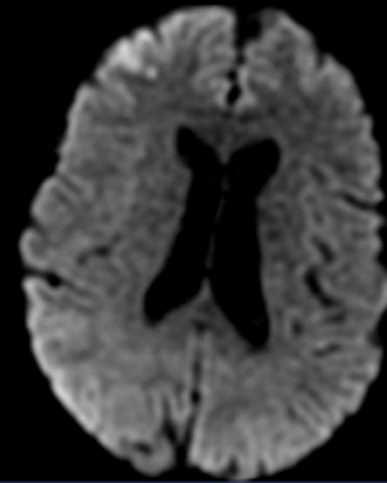
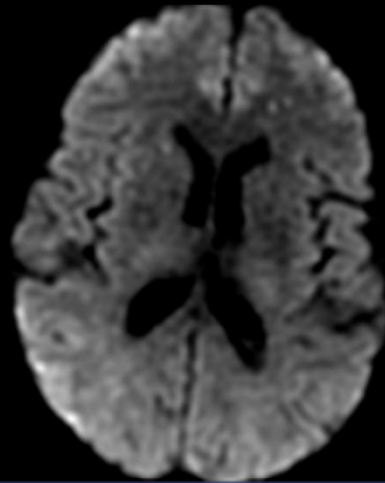
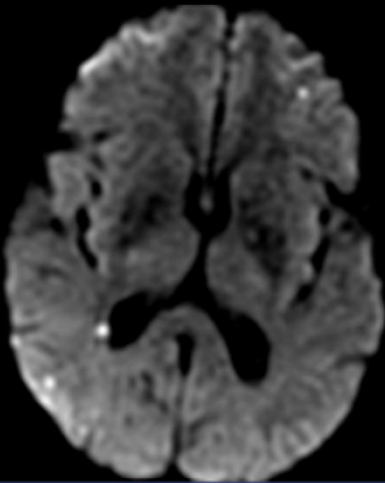
- Could not pass filter capture sheath through tight lesion
- How can we retrieve the filter?
- **Tight heavily calcified lesion**
 - **Cutting balloon**



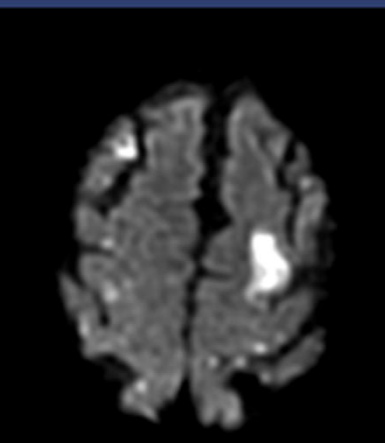
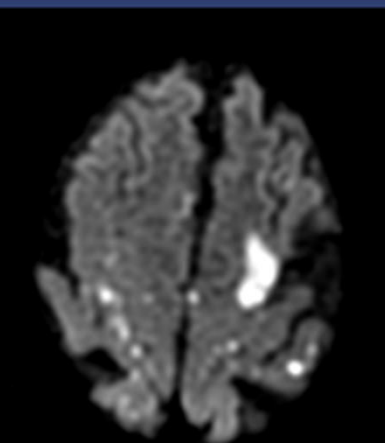
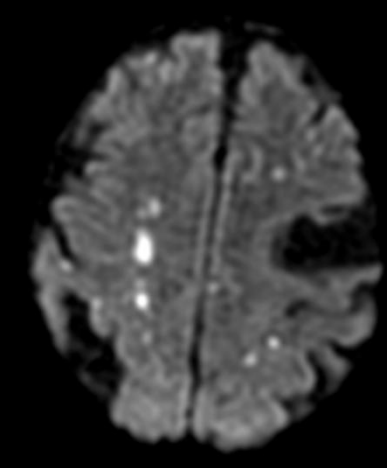
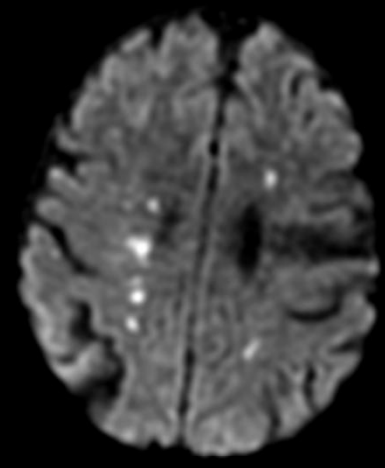
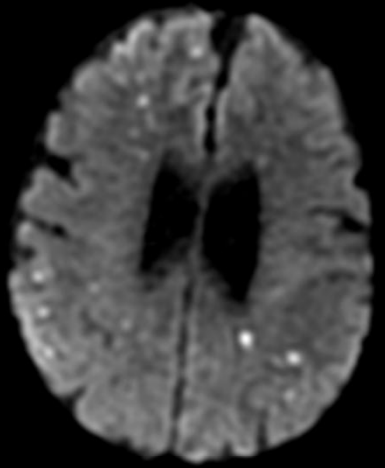
- Multiple techniques:
 - Balloon inflations up to 7mm
 - Shuttle (+balloon) into stent
 - Head turning/message
 - Other tricks???
- Increasing patient agitation
 - → IA Integrilin load
 - Intubation
- Finally recaptured DEP
 - 5F MPA across lesion
 - coronary balloon “nose”



- Observed in ICU
 - Elevated troponin
 - Left hemiparesis- fluctuating; worsening
 - Difficult wean for extubation



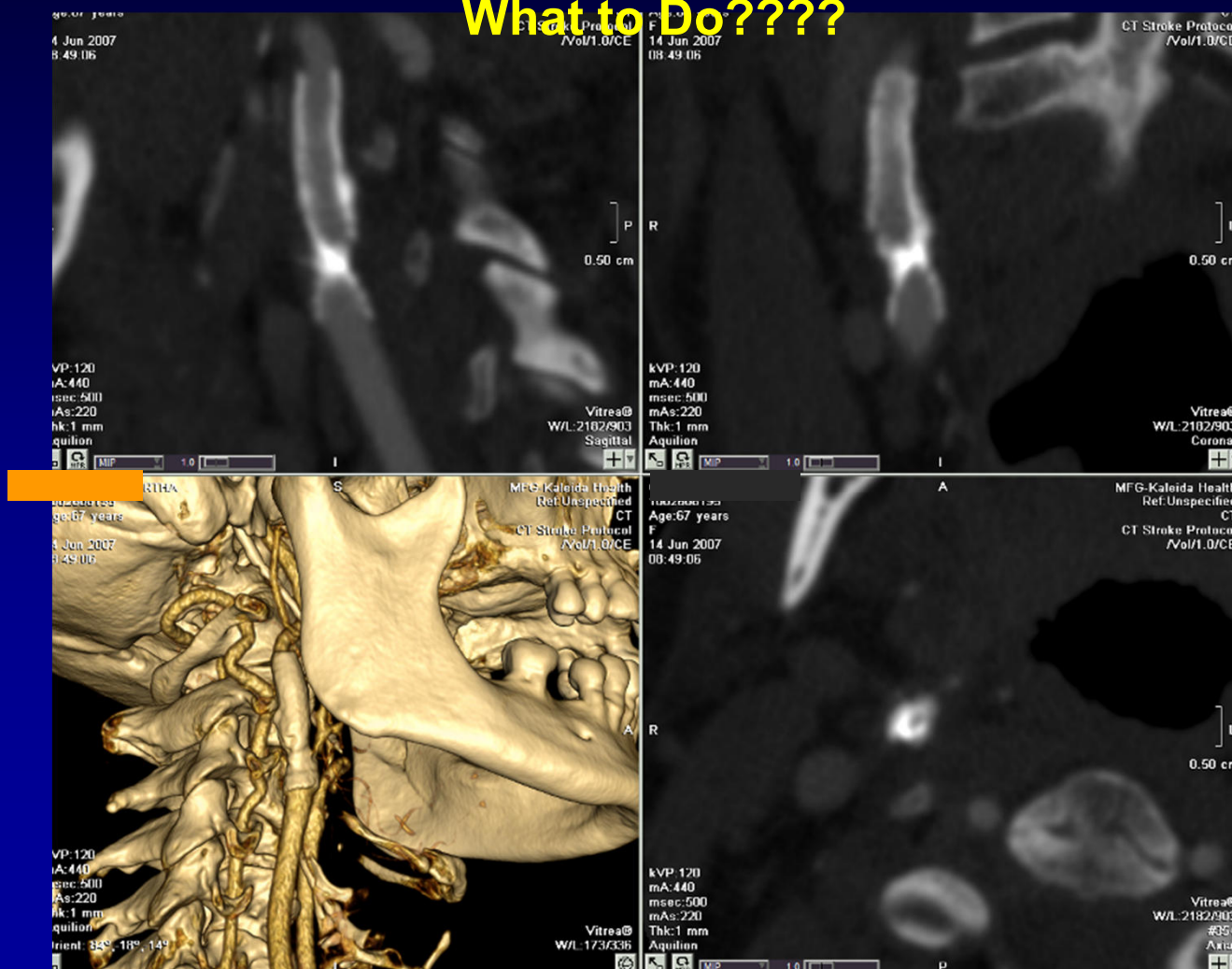
York

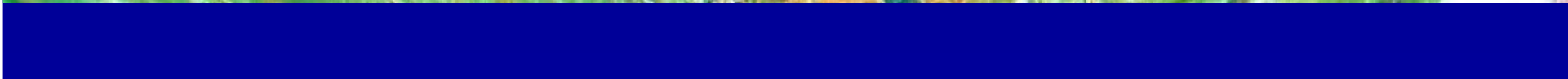


Worsening Deficit...on ASA and Plavix

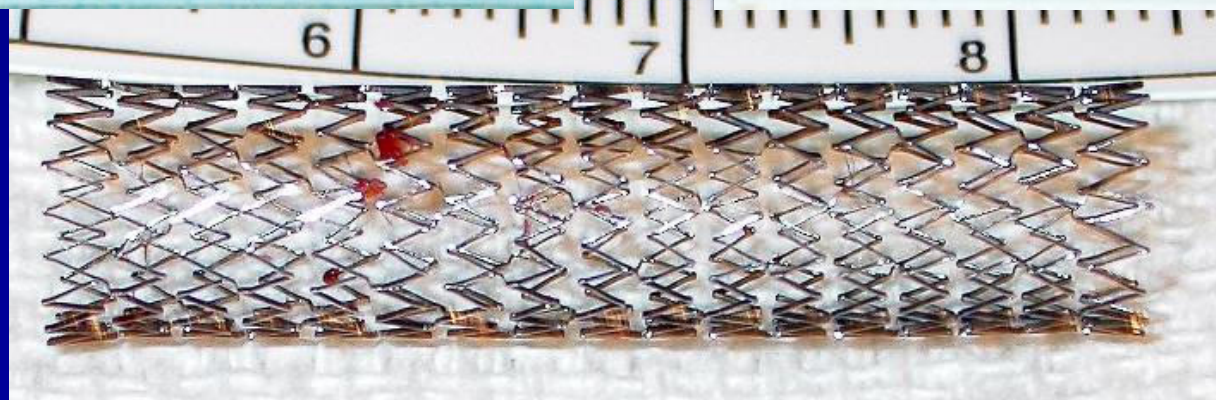
Stent ? Collapsed ? Twisted

What to Do????

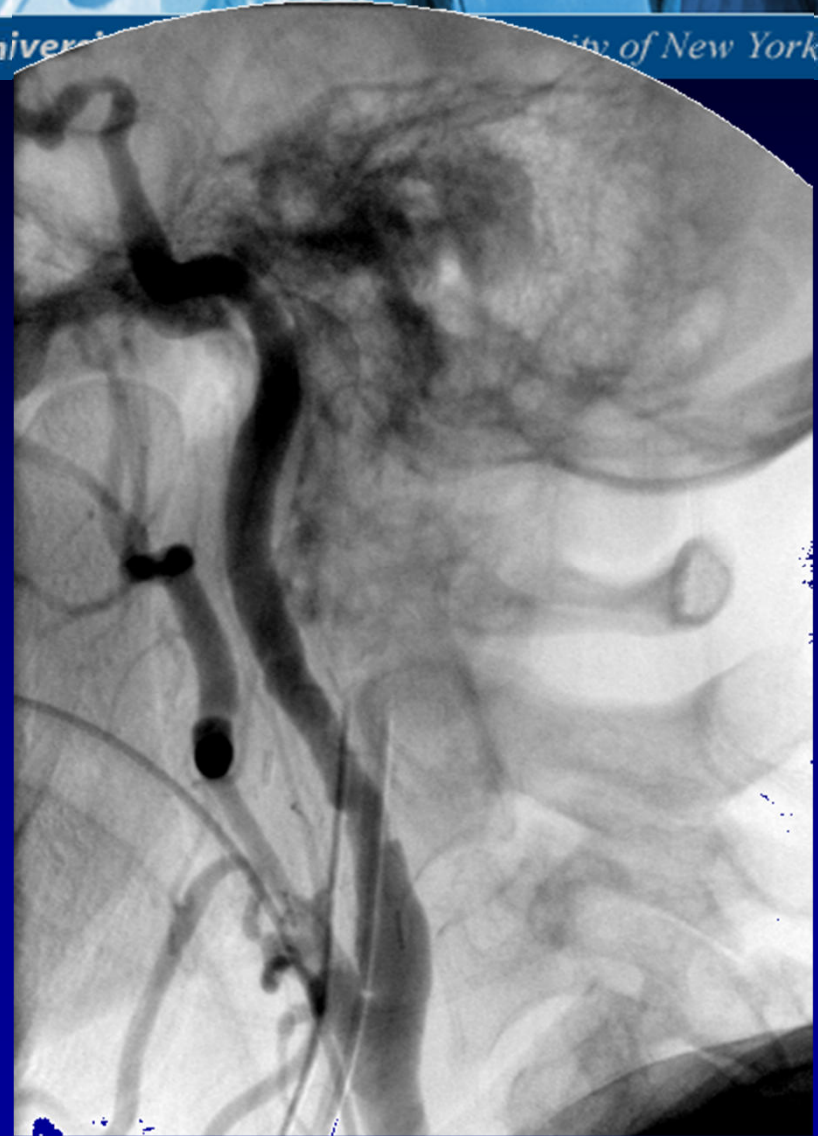




Heavily Calcified Plaque



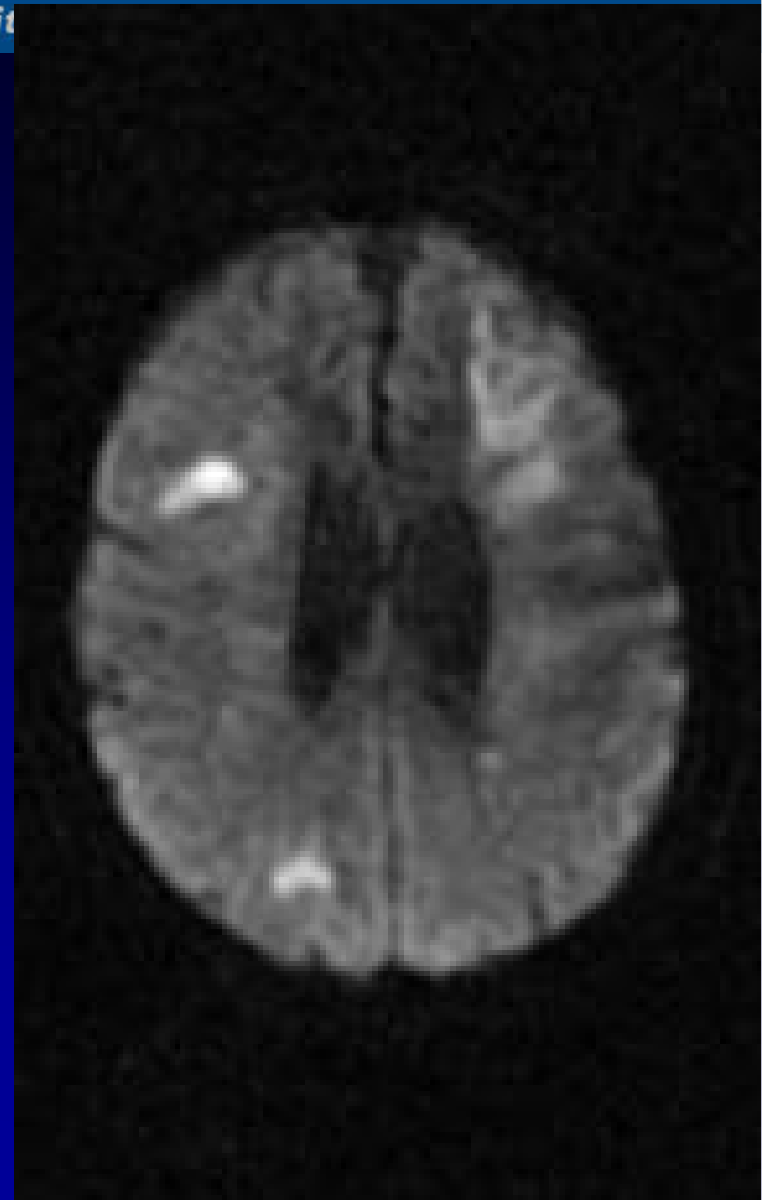
- ~1 month hospital recovery
- Readmitted from rehab with urosepsis and dehydration
- Discharge
 - motor LUE 4+ / 5
 - Improved orientation



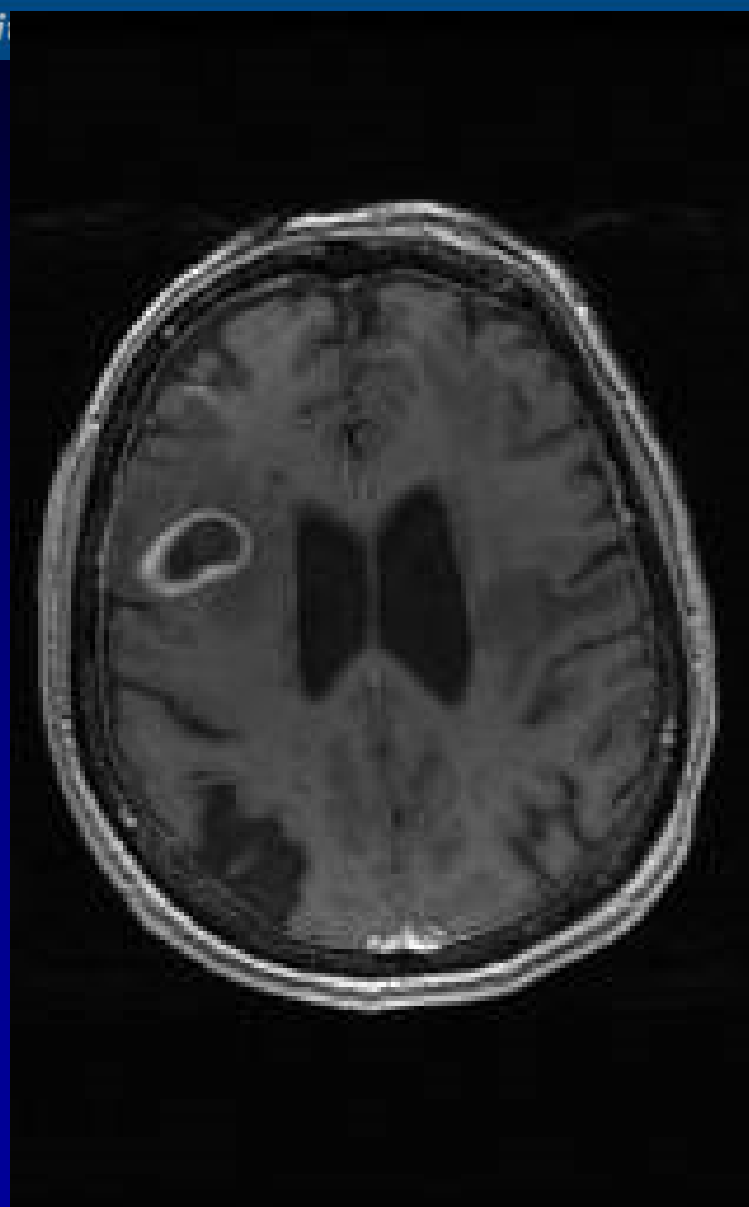
Follow-up Angiogram

- Readmitted from rehab for planned CABG
- Progressive neurologic worsening
 - Confusion
 - Agitation
- MRI showed new DWI lesions ...

However ...



- Contrast MRI showed ...
- Cultures from the craniotomy grew *Nocardia* species
 - 8 weeks IV antibiotics
- Now home with family
 - Ambulatory



What are the Lessons ?

- Case selection... concentric calcification
- Back out before we hurt someone
- Stent choice
- Cutting balloon
- Retrieval of stuck filter
- CEA bail out
- Careful follow up



TOSHIBA STROKE RESEARCH CENTER

University at Buffalo
State University of New York



ork

Carotid Revascularization

It is our choices...that show what we truly are, far more than our abilities

- J.K. Rowling , Harry Potter and The Chamber of Secrets, 1999

Intra-operative Neurologic Deficit

75 YO WM

Previous CVA R; Residual mild L HP

- Known Lt ICA occlusion
- R CEA X 2 with patch graft... remote
 - (>10 years ago)
- Symptomatic Rt ICA restenosis > 80%
- Rt hilar mass... CAS planned prior to lung surgery
- **PMH:** CAD, HTN, Dyslipidemia, DM, GERD, COPD, hx MI, CVA (2001)
- **SH:** smoker **FH:** CAD, HTN

- **Allergies:** Amoxicillin, Trental, shellfish and codeine.
- **Meds:** Plavix, ASA, Paxil, TriCor, Insulin, Nexium.
- **PE: Mild Left HP**

Devices Used

- SAPPHIRE Trial
- 6-French Cook shuttle
- 6 mm ANGIOGUARD distal protection device
- Precise 9 x 40 stent and Precise 10 x 30 stent

Description of Procedure

- Groin access without difficulty
- Groin run with no dye extrav, intimal injury, dissection, or clot.

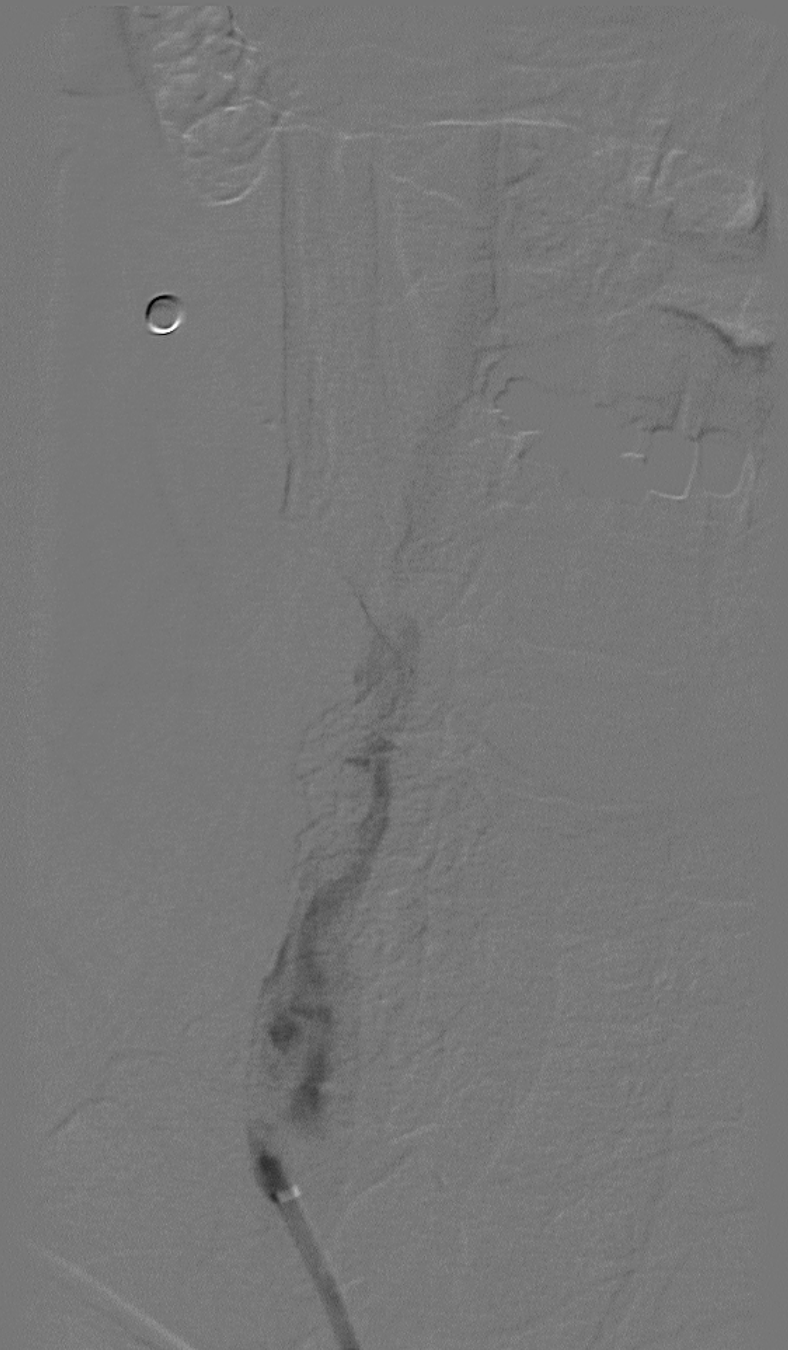
Lesion

long segment (65 mm)
irregular, 81% ulcerative stenosis
Patch graft- old

Access uncomplicated

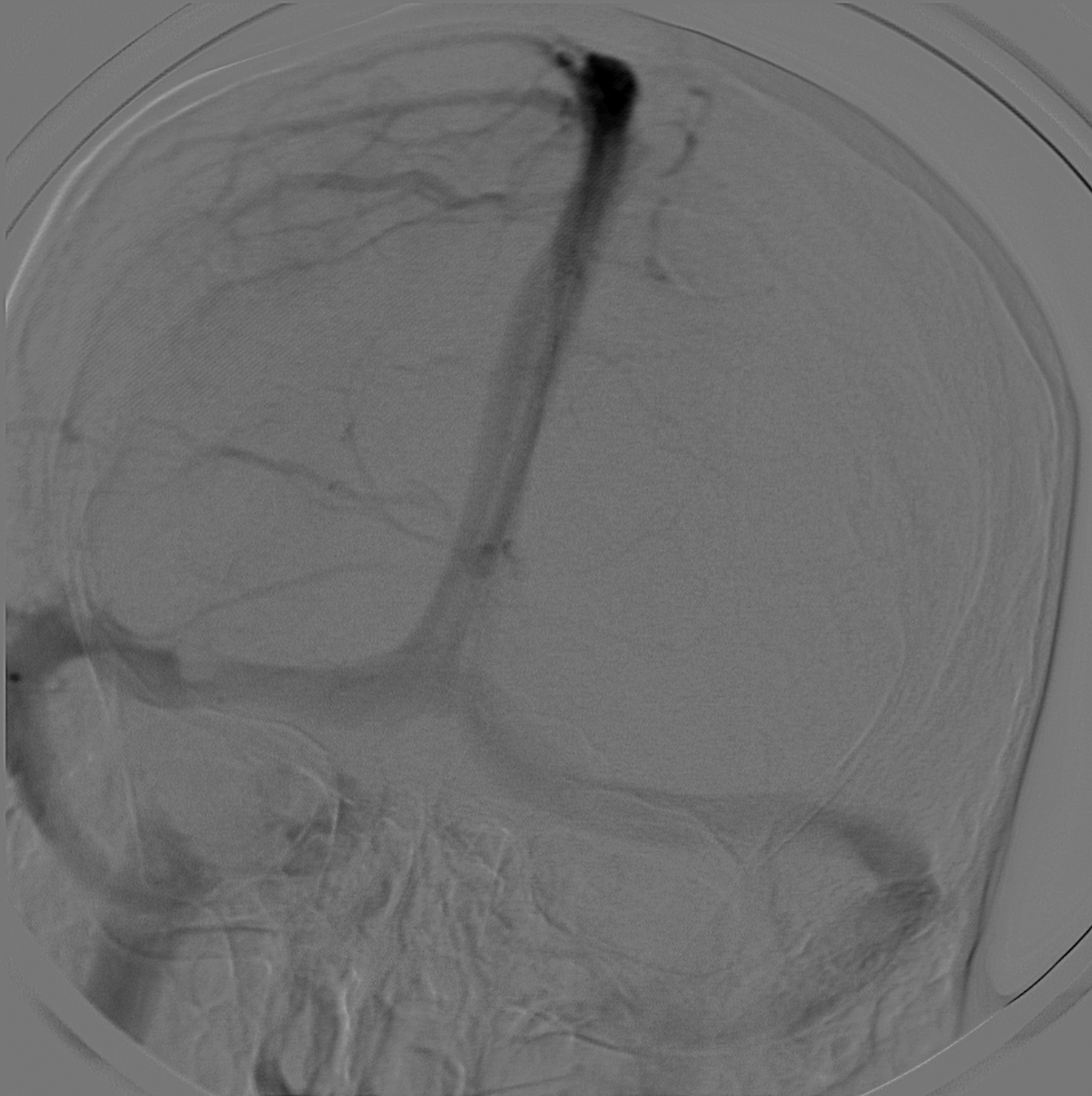


of New York



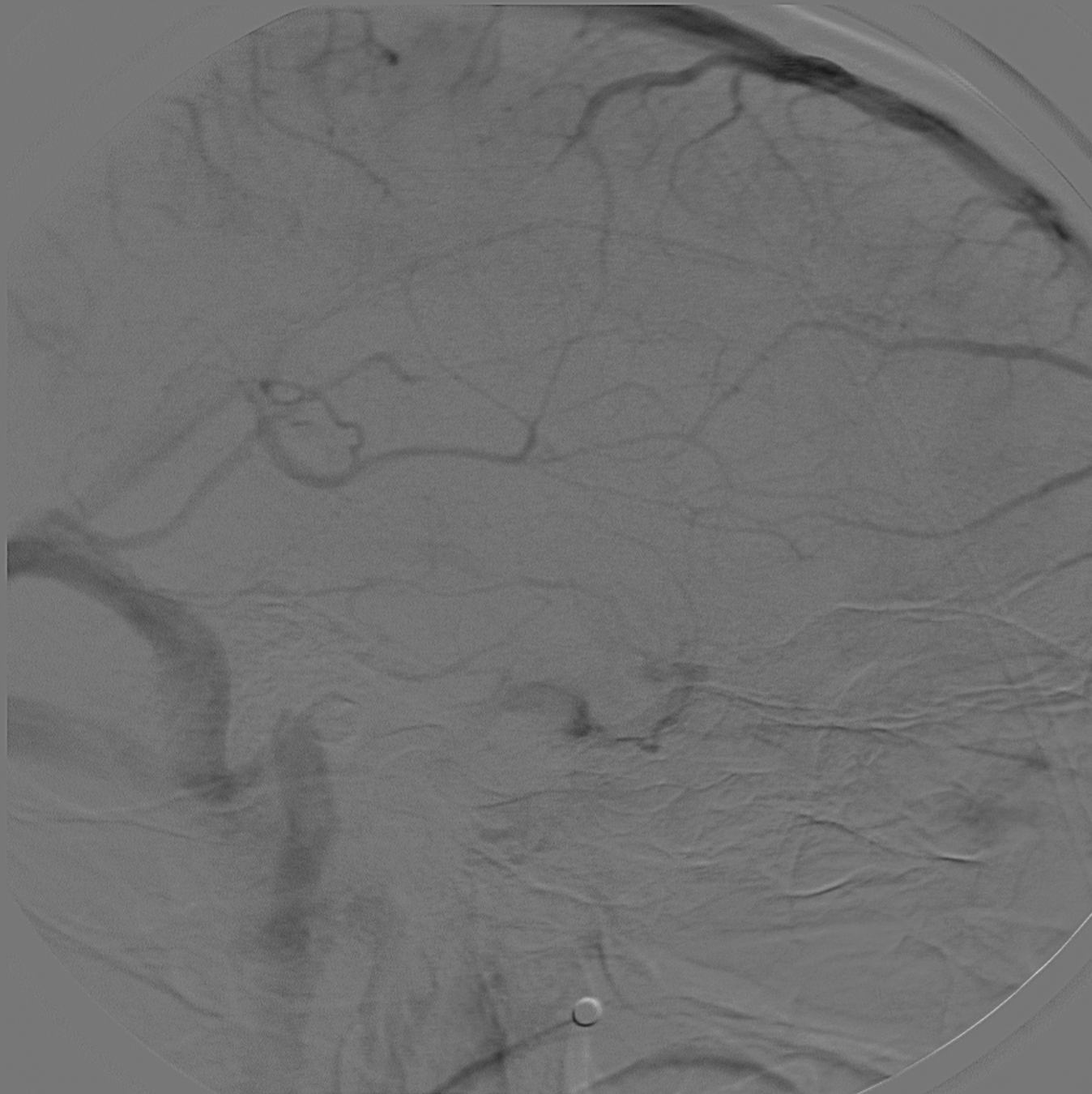


of New York





of New York

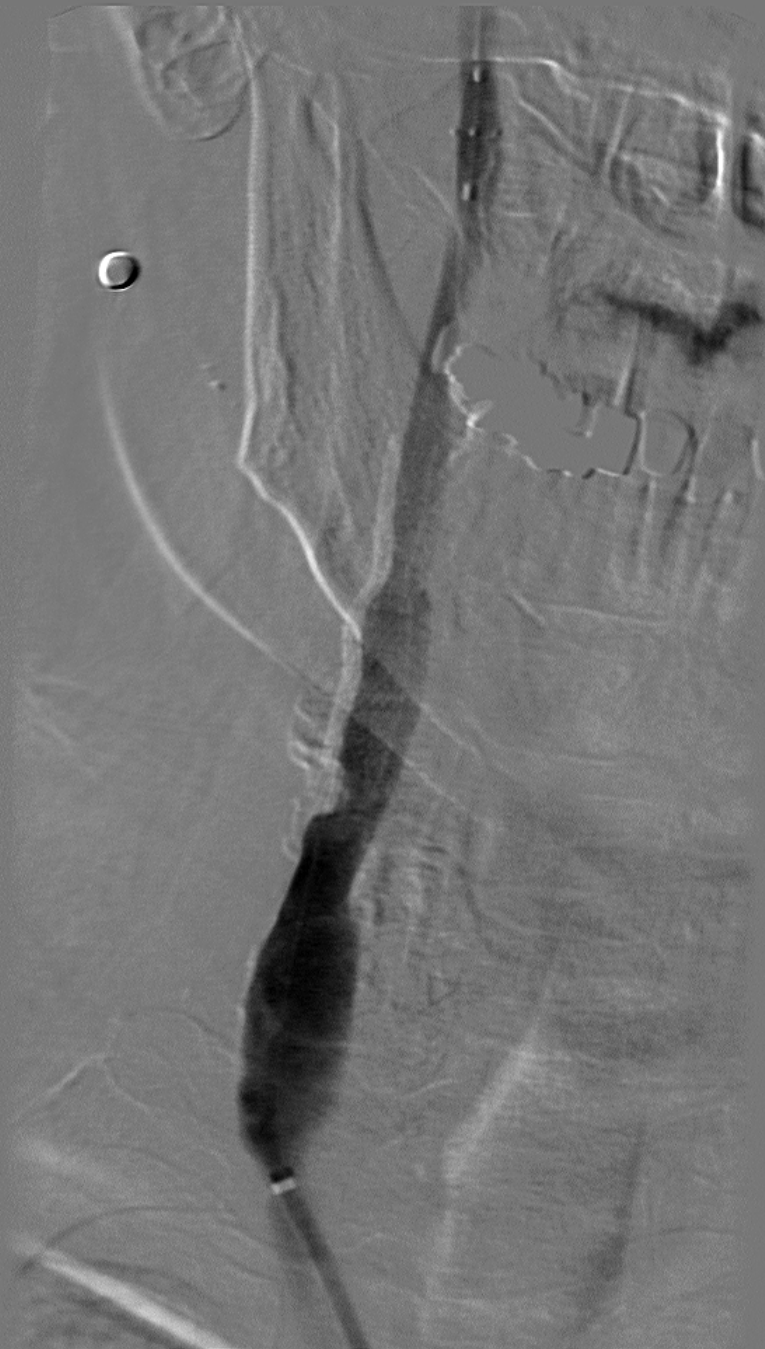


Description of Procedure

- VTK cath R CCA
- 0.038 glide to prox CCA, Cook Shuttle
- hep 5000 U, act 230s, additional 1000 U
- 6 mm Angioguard distal ICA.
- Precise stent deployed.



of New York

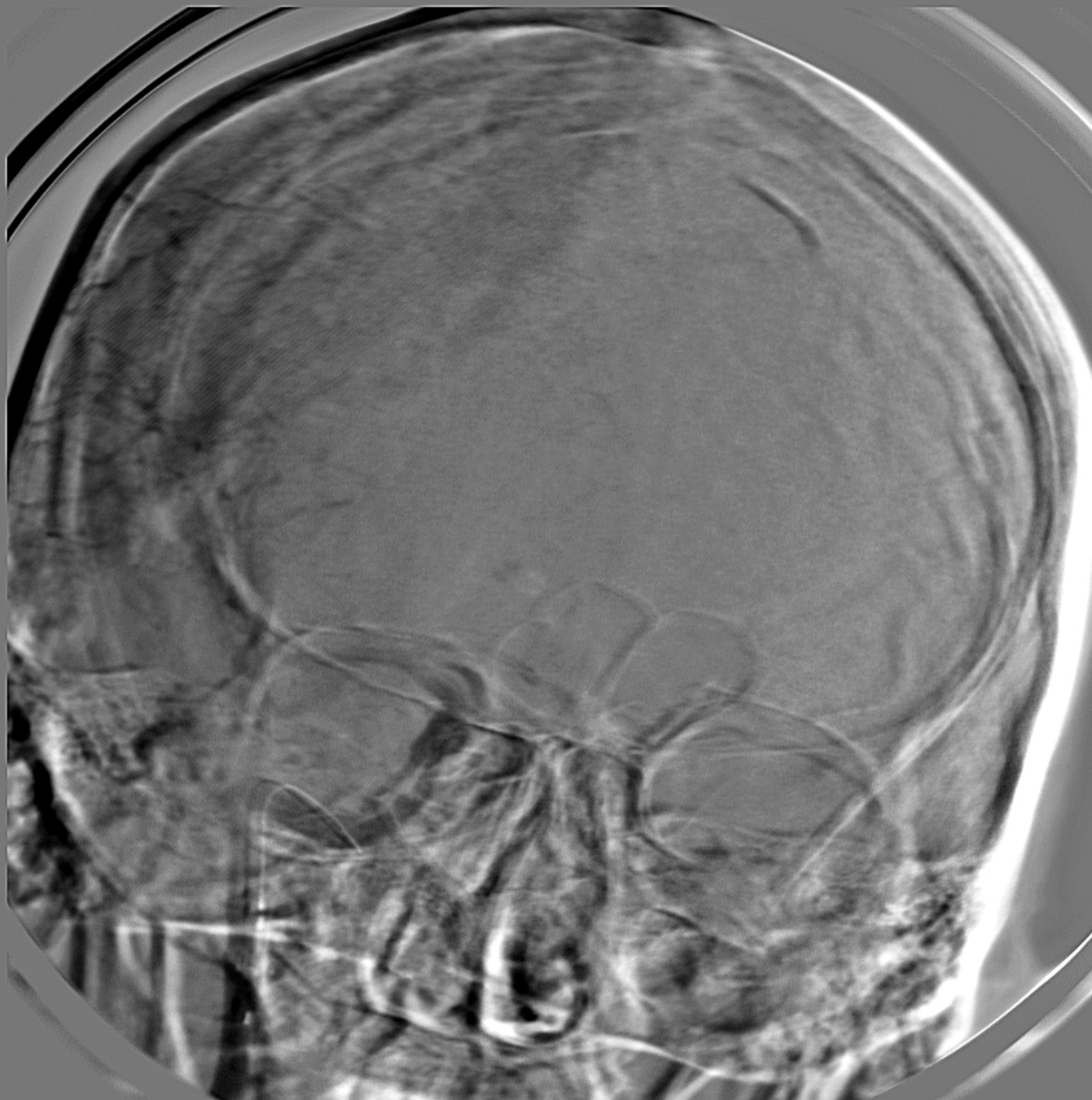


Description of Procedure

- Neuro changes after stent #1 deployed
- MS decline, aphasia, restless,
- **RIGHT (ipsilateral) HP... NIHSS 21**
- **What is going on ??**
- Lets look at intracranial angio...



University of New York



Immediate Angio Right ICA

- Slow flow...
- Ipsilateral ACA only- flash filling
- Sx are **ipsilateral** to the stent
- Assumption: **L hemisphere ischemia**
 - ie poor collateral

Description of Procedure

- Second stent quickly deployed to complete lesion coverage as planned
- Second dx run...no changes.
- Pt's new neuro deficits unchanged.
- Capture device quickly brought up and filter recaptured.
- Correct diagnosis?
- Correct maneuver?

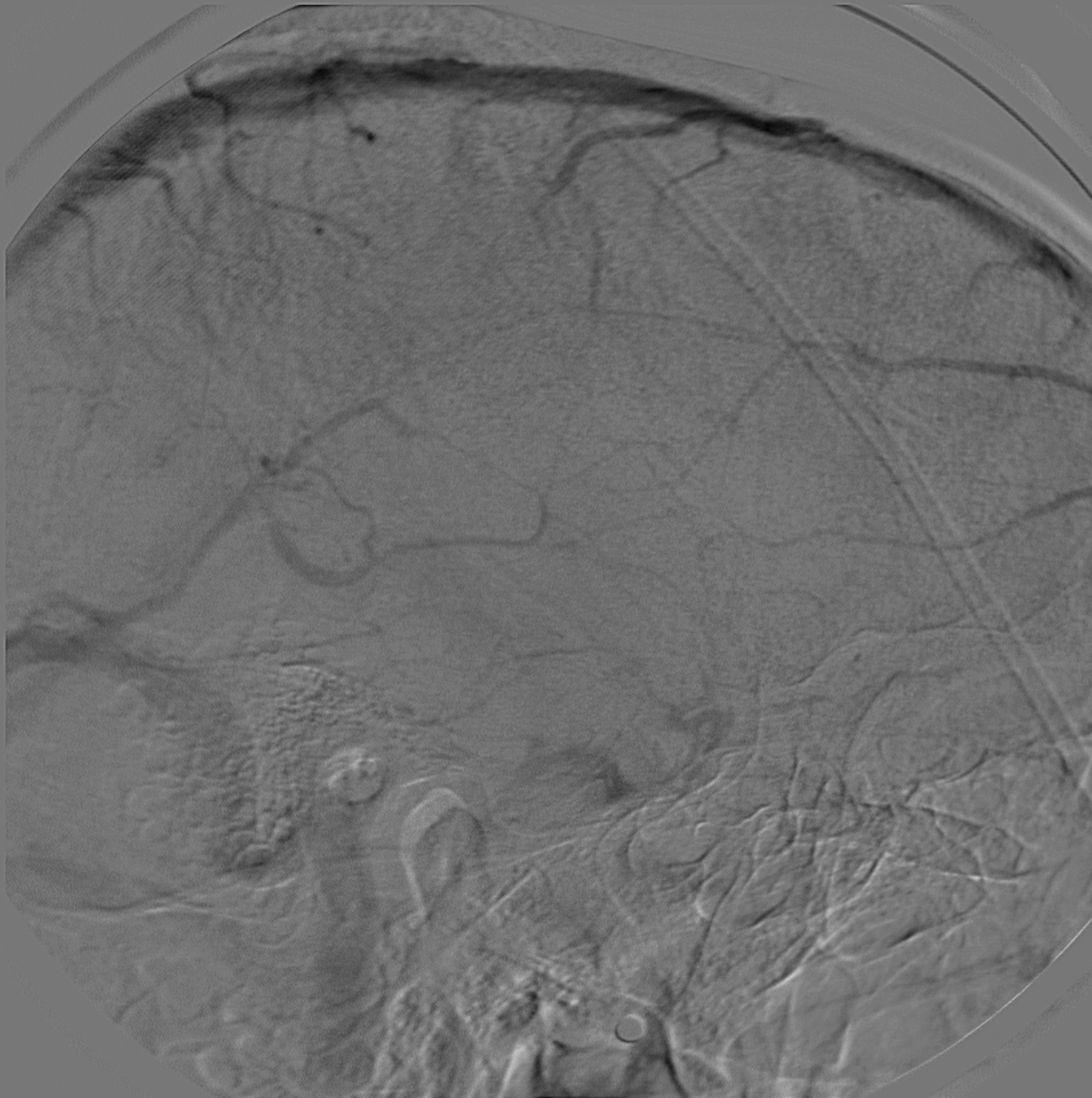


of New York

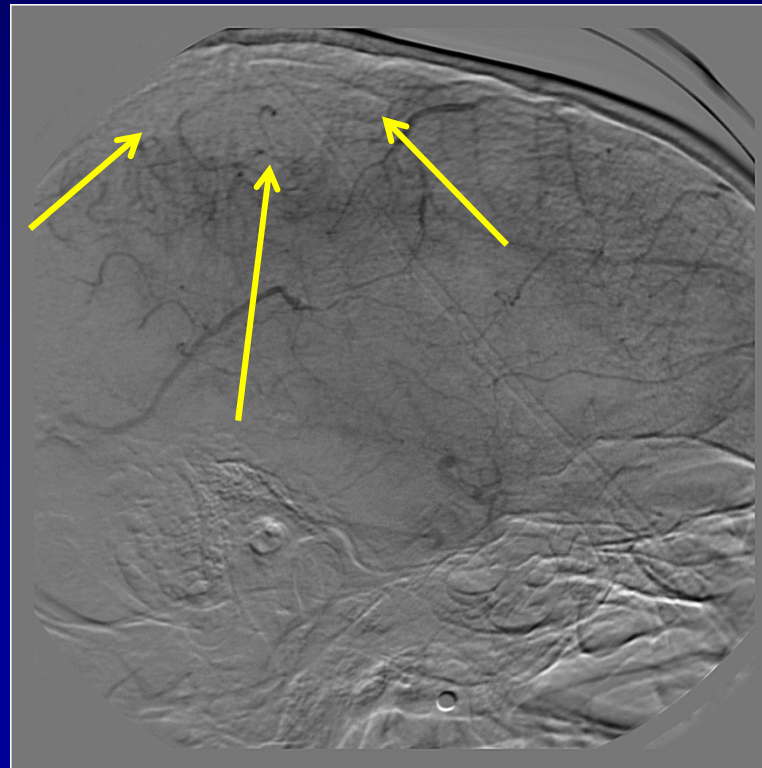




of New York



- Repeat angio showed resolution of slow flow and return of b/l ACA filling...
- BUT decreased capillary phase in high right parietal region.



Filter Full !!

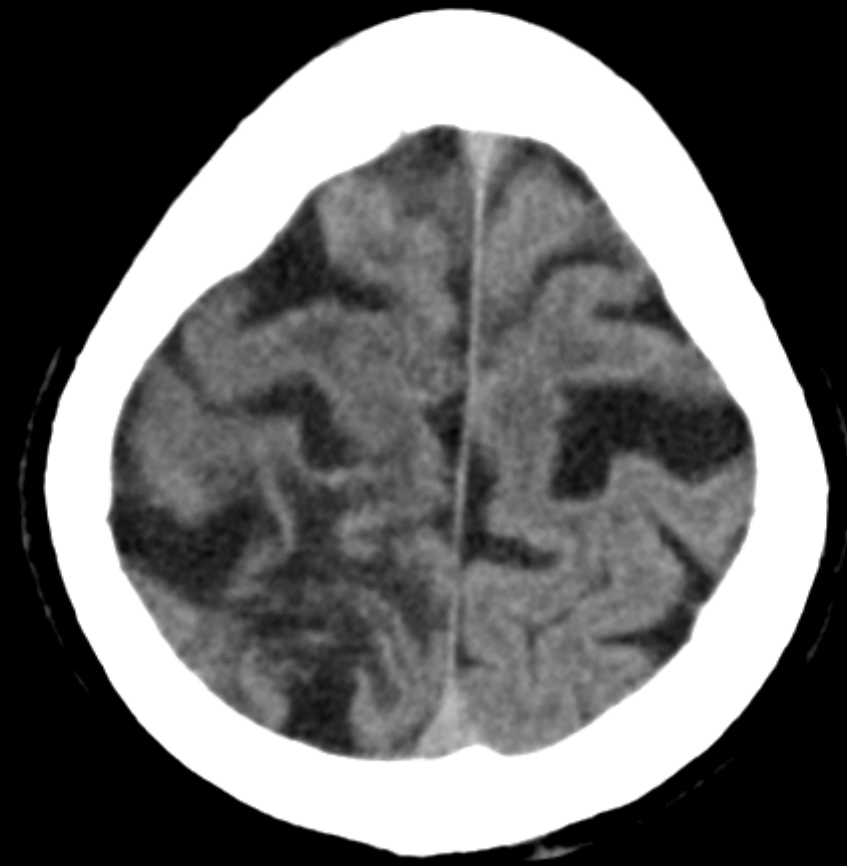
AG-08 X16

- Large amt of debris and plaque within filter on inspection
- Intra arterial Integrilin given
- Dx angio with small improvement in capillary phase delay
- On way to CT, right side near baseline, BUT NOW worsened LEFT HP with decreased spontaneous movement, pt following simple commands.
- NOW WHAT??

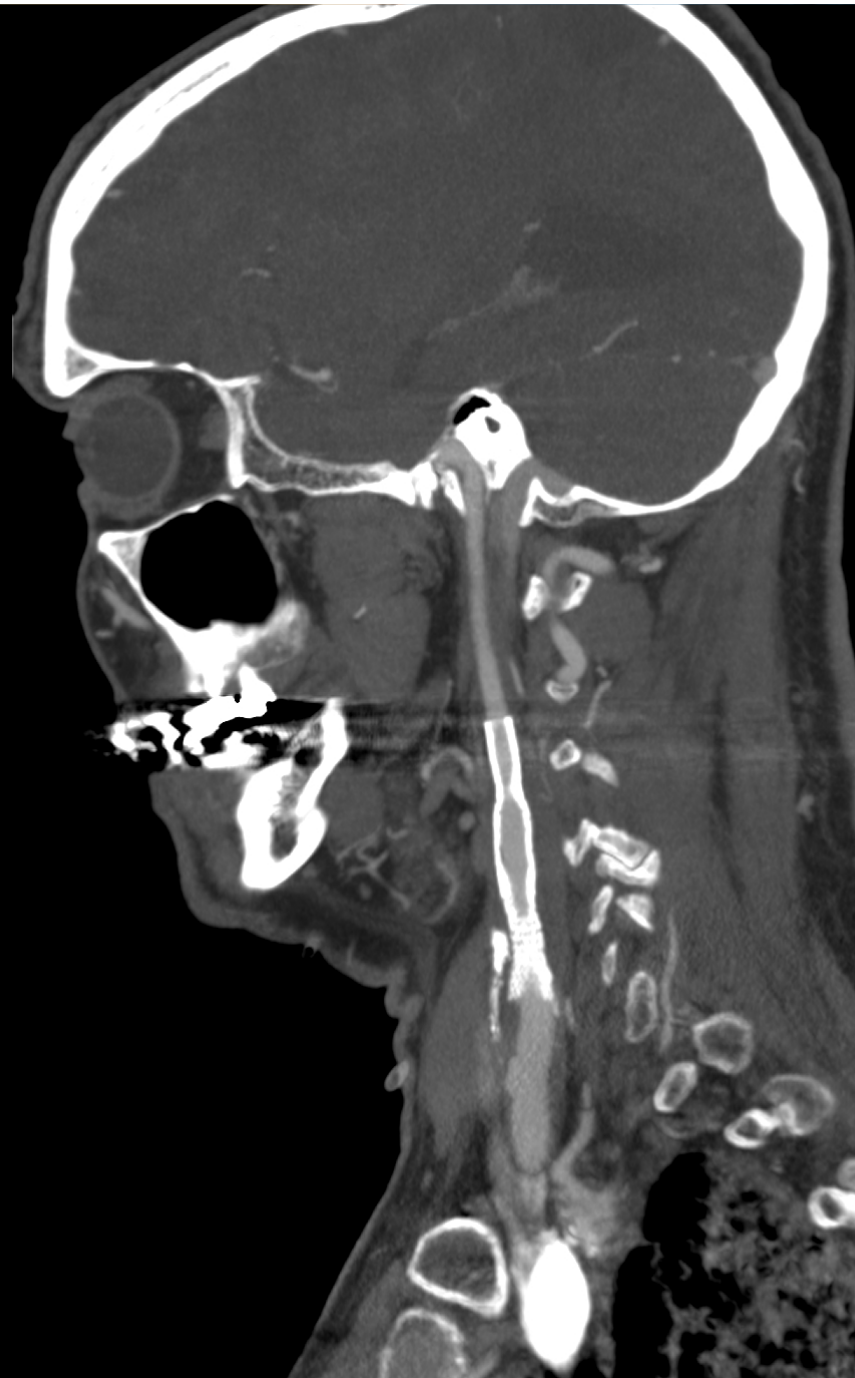
[A]



of New York



[P]



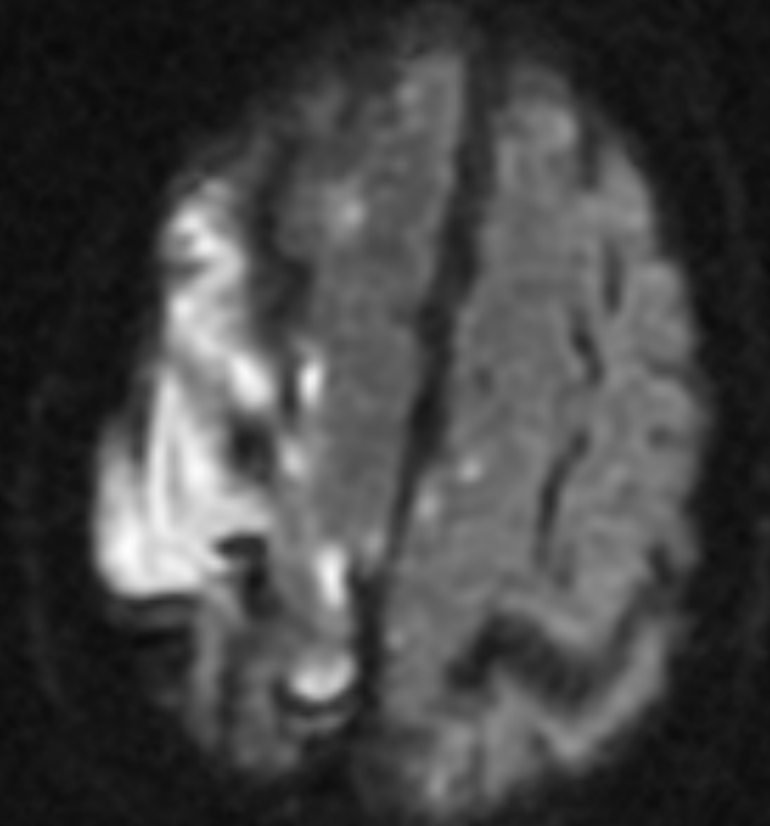
- Post op imaging?
- Pt stable in ICU overnight on integrillin drip.
- MRI in AM.



[AH]



ty of New York



[PF]

- NIHSS 21
- Integrillin to heparin to coumadin
- Hospital course complicated by MI, new onset Afib
- Pt made DNR/DNI
- NIHSS improved to 14 prior to transfer to rehab.
- Pt expired on 6/5/08 from pneumonia/respiratory distress.

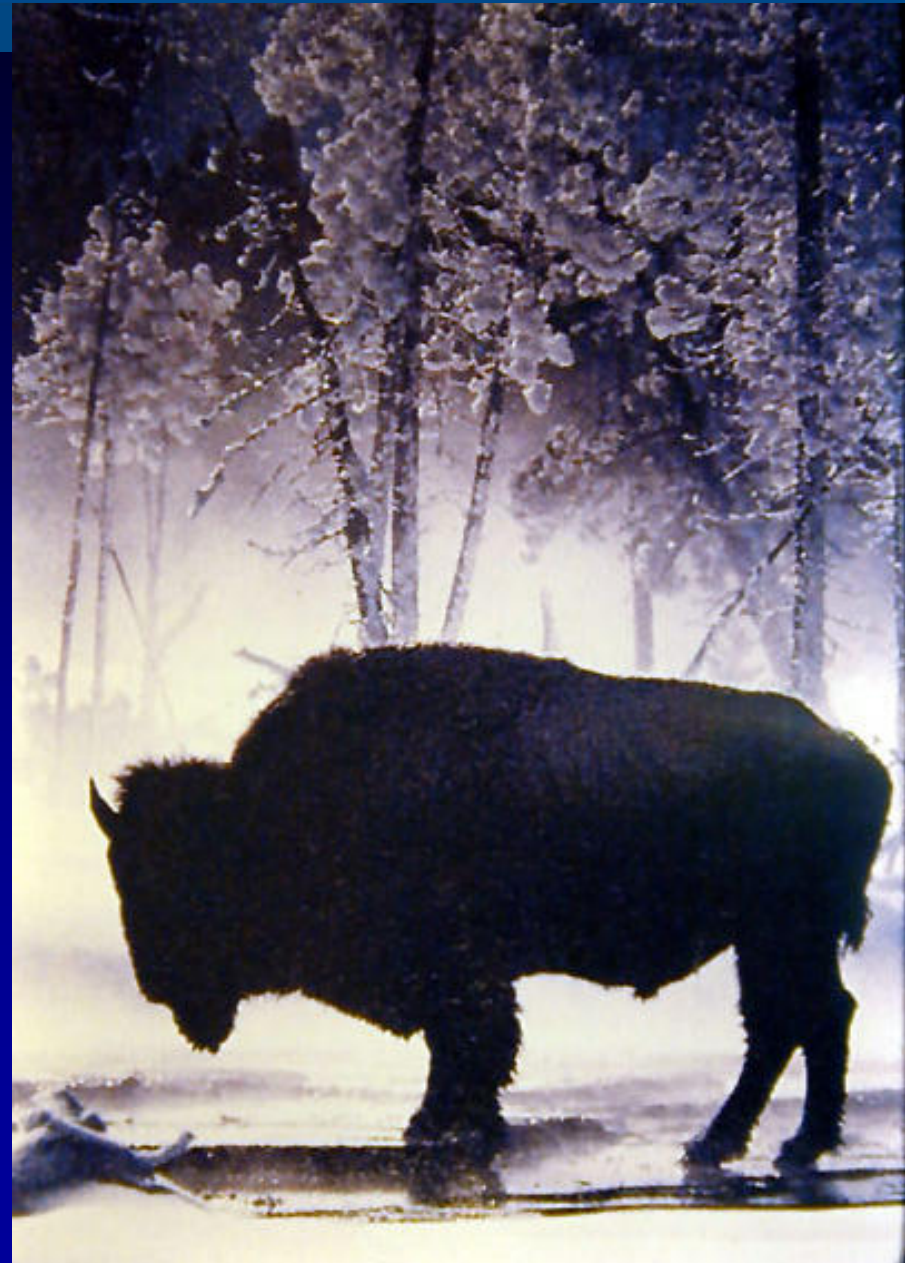
What did we learn ?

- Restenosis
 - 10 yr old- may be atherosclerotic, not fibrotic
- Management of patch grafts
 - Patch grafts may be like vein grafts (ie debris)
- Choice of embolic protection for this lesion
 - Filter not adequate
 - No ECA so proximal EP easy (Gore, Concentric)
 - Dealing with intolerance = preparation(hydration/speed)
- Choice of stent- smallest pore size possible (Wallstent)
- What to do with slow flow?
 - **Don't remove the filter without aspiration**
- Decision to treat with undiagnosed lung lesion



TOSHIBA STROKE RESEARCH CENTER

University at Buffalo
State University of New York

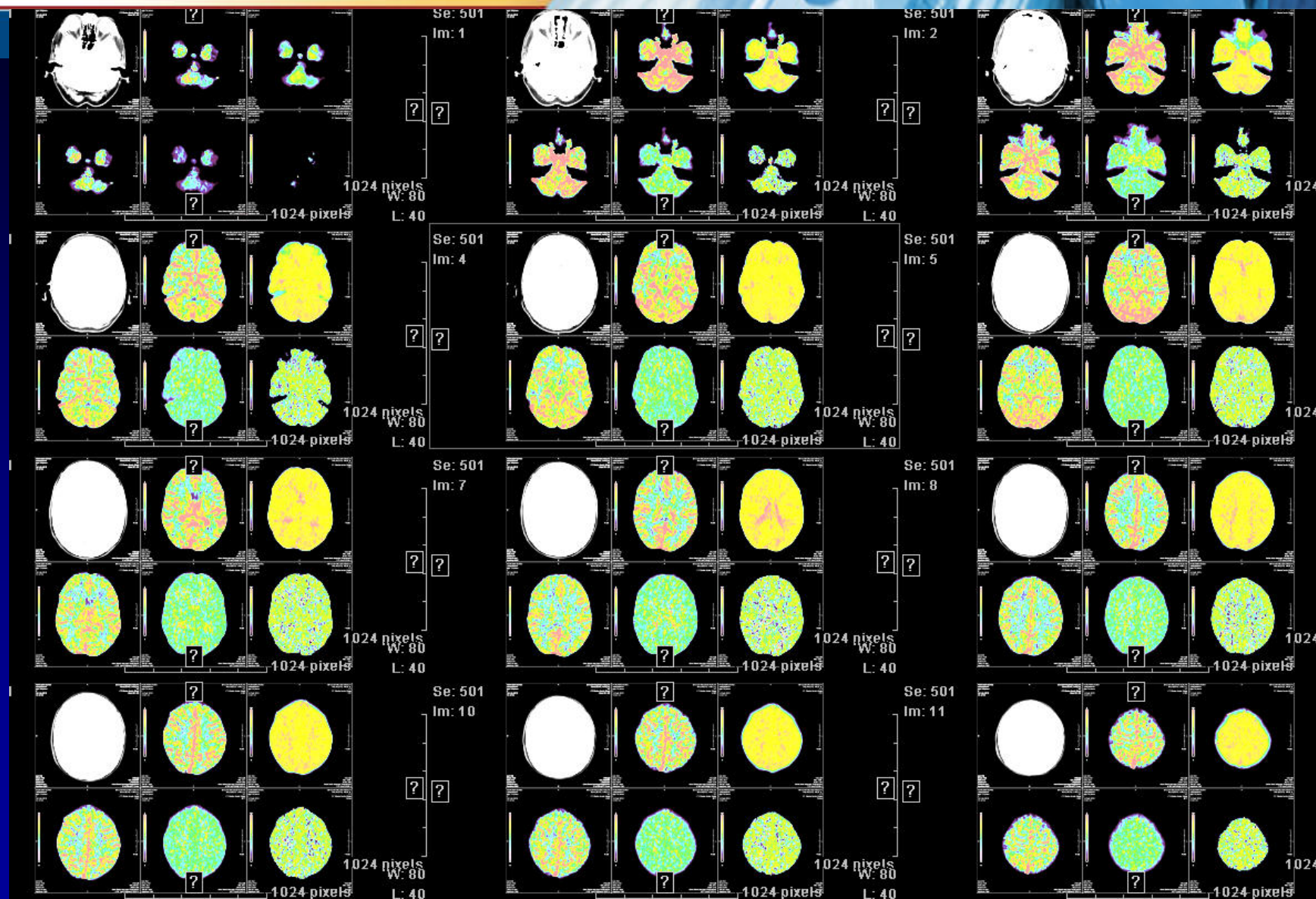


ork

Be Careful and Complete

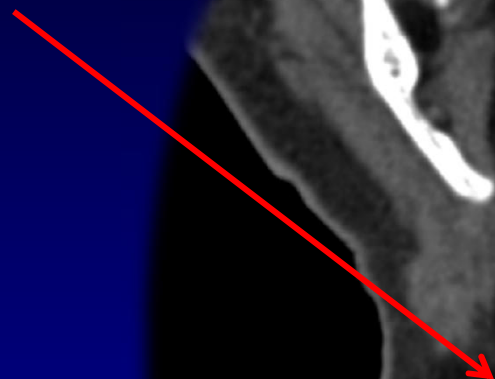
Case Presentation

- 74 year old woman
- 40 pack-year tobacco history
- TIA characterized by aphasia and
R hemiparesis
- Completely resolved on presentation
NIHSS 0



Unremarkable

CTA- Lt ICA



CAROTID

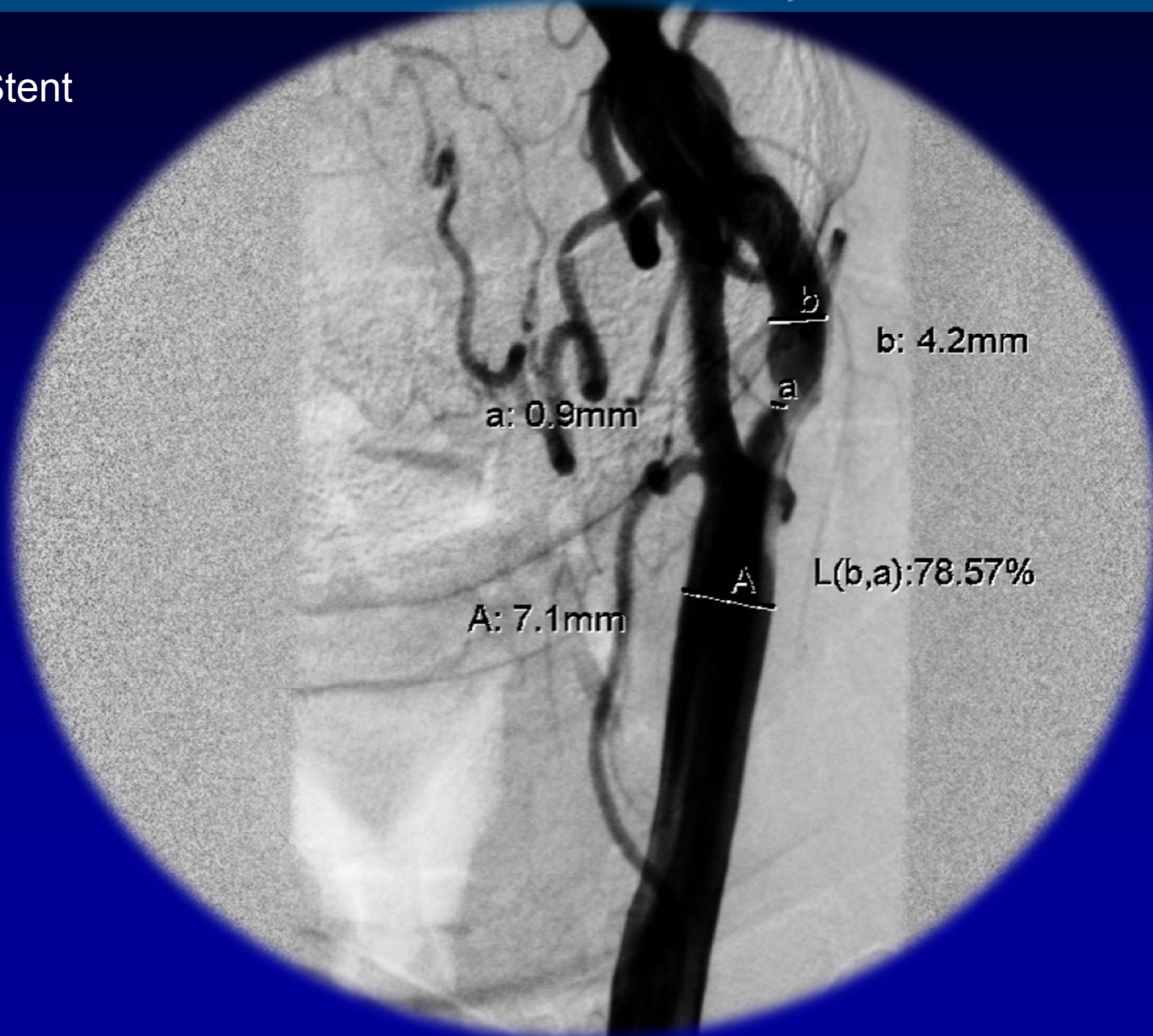
Symptomatic L ICA stenosis

- L CAS
- ASA/Plavix Load
- Cook Shuttle, VTK, 0.038
- EPI Filter device
- Wallstent
- Aviator Post-Dilation Balloon





Pre- Stent





University at Buffalo
Neurosurgery

Post-Stent Angiogram

University at Buffalo State University of New York

Post Stent



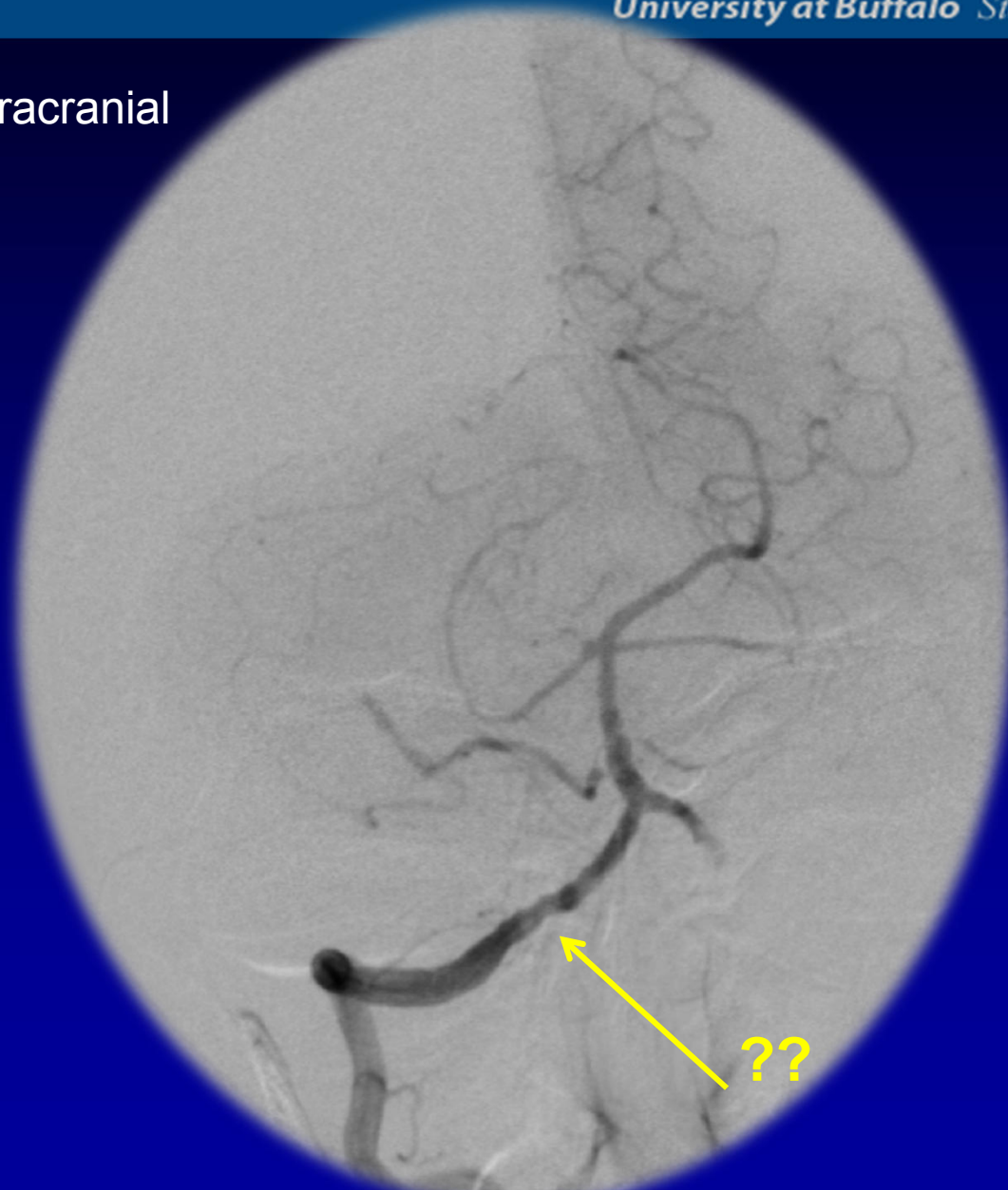
Post-Procedure

- Immediately Dysarthric with L facial and LUE weakness
- Angio L ICA and cranial unremarkable
- Review R ICA... normal
- ?? VBI symptoms

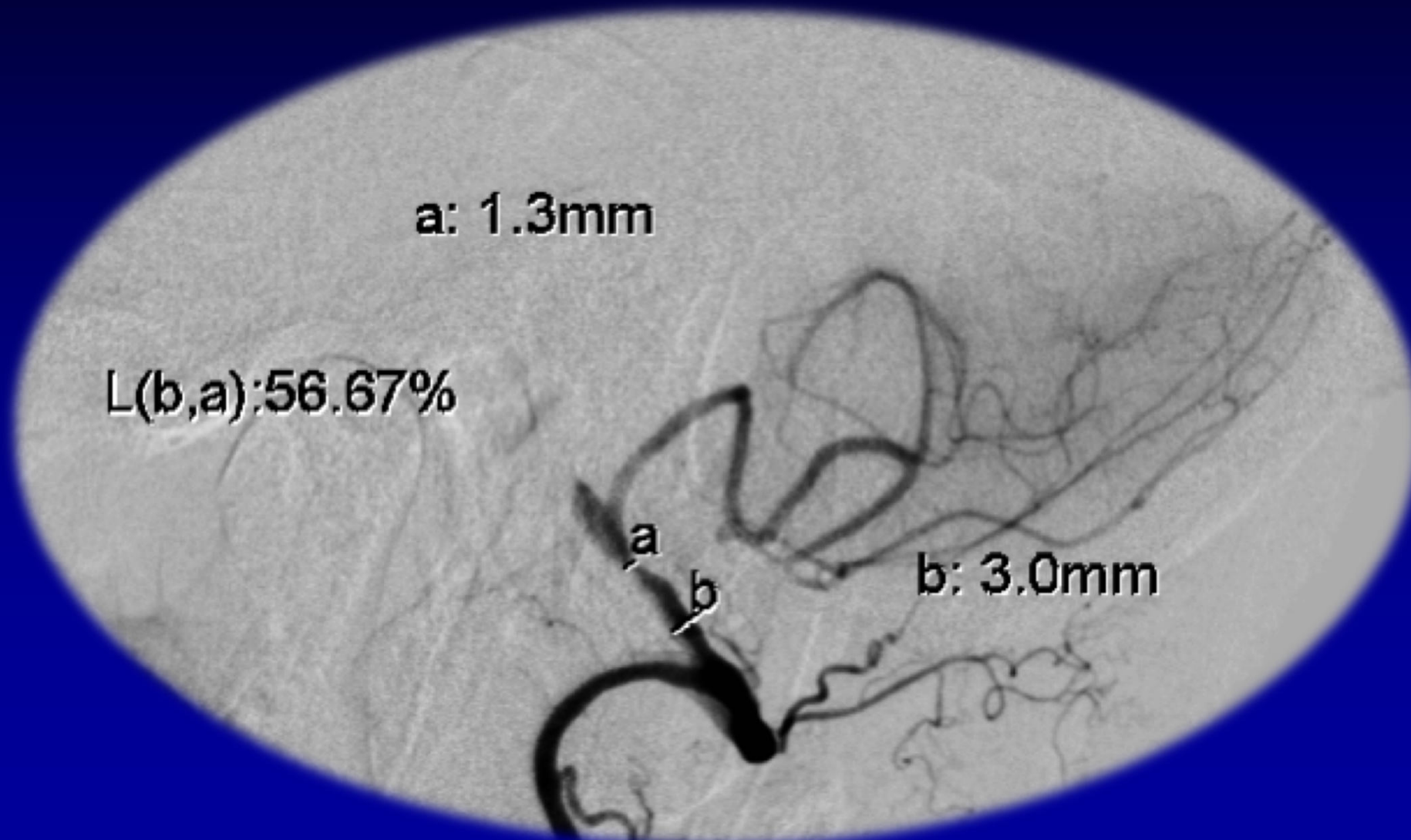
R vert origin Stenosis



Rt Vertebral Intracranial



L Vert Intracranial Stenosis

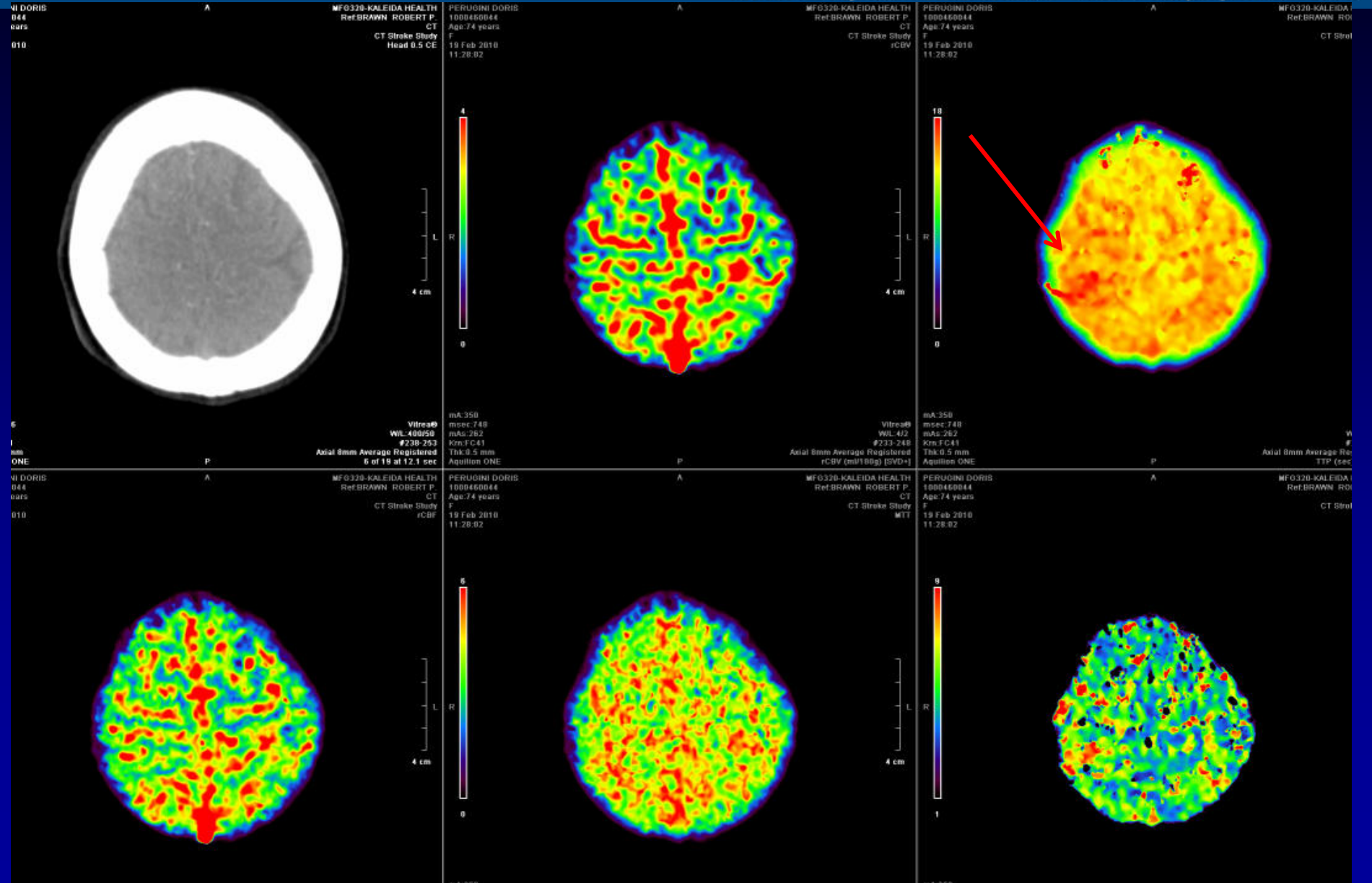


Post-Procedure

- ?? VBI... R VA and L VA stenosis
- Loaded with integrillin and 24 hour gtt instituted
- Immediate CTP and CTA negative.
- Pt improved over several hours

Post-Op Day 4 - A new event

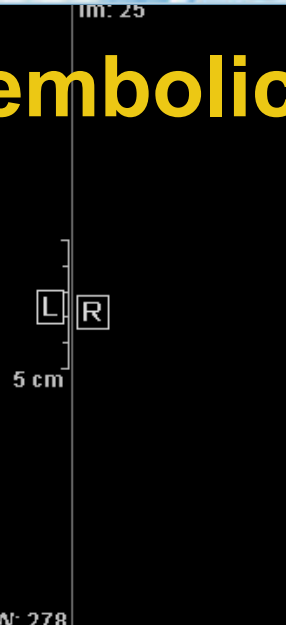
- On ASA/Plavix.
- Sudden L facial and LUE weakness, confusion and slurred speech
- CTP: R posterior frontal increased TTP



MRI: Acute embolic ischemia

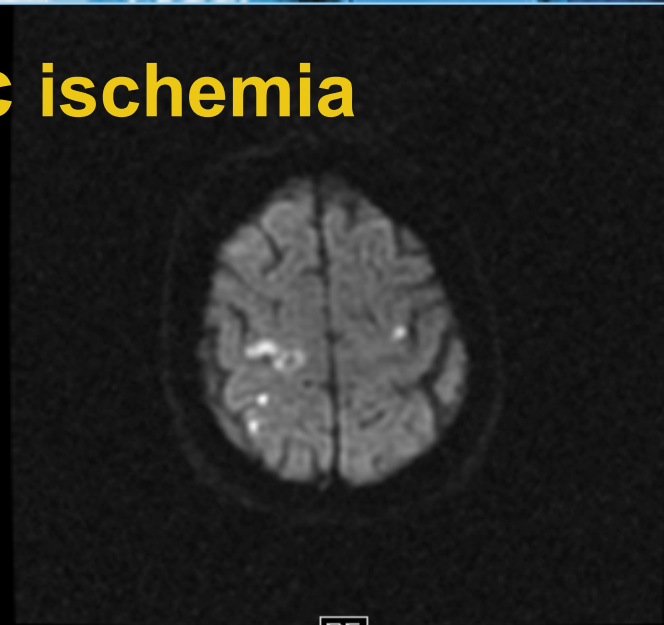


PF
AH

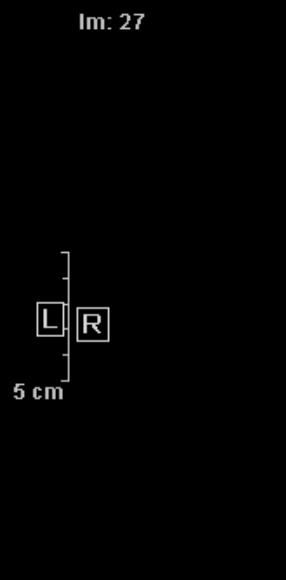
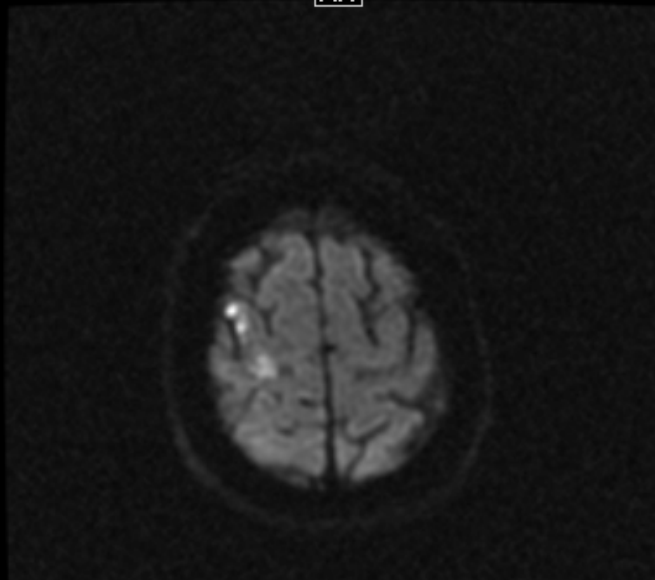


W: 278
L: 139

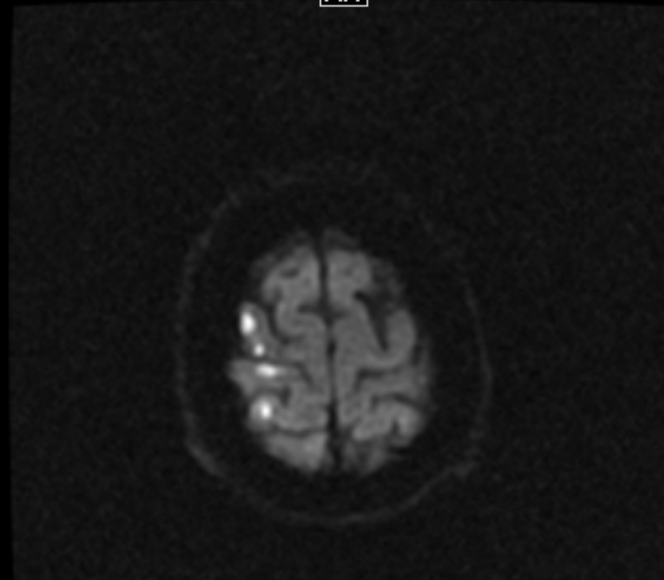
Se: 2
Im: 27



PF
AH



L R
5 cm



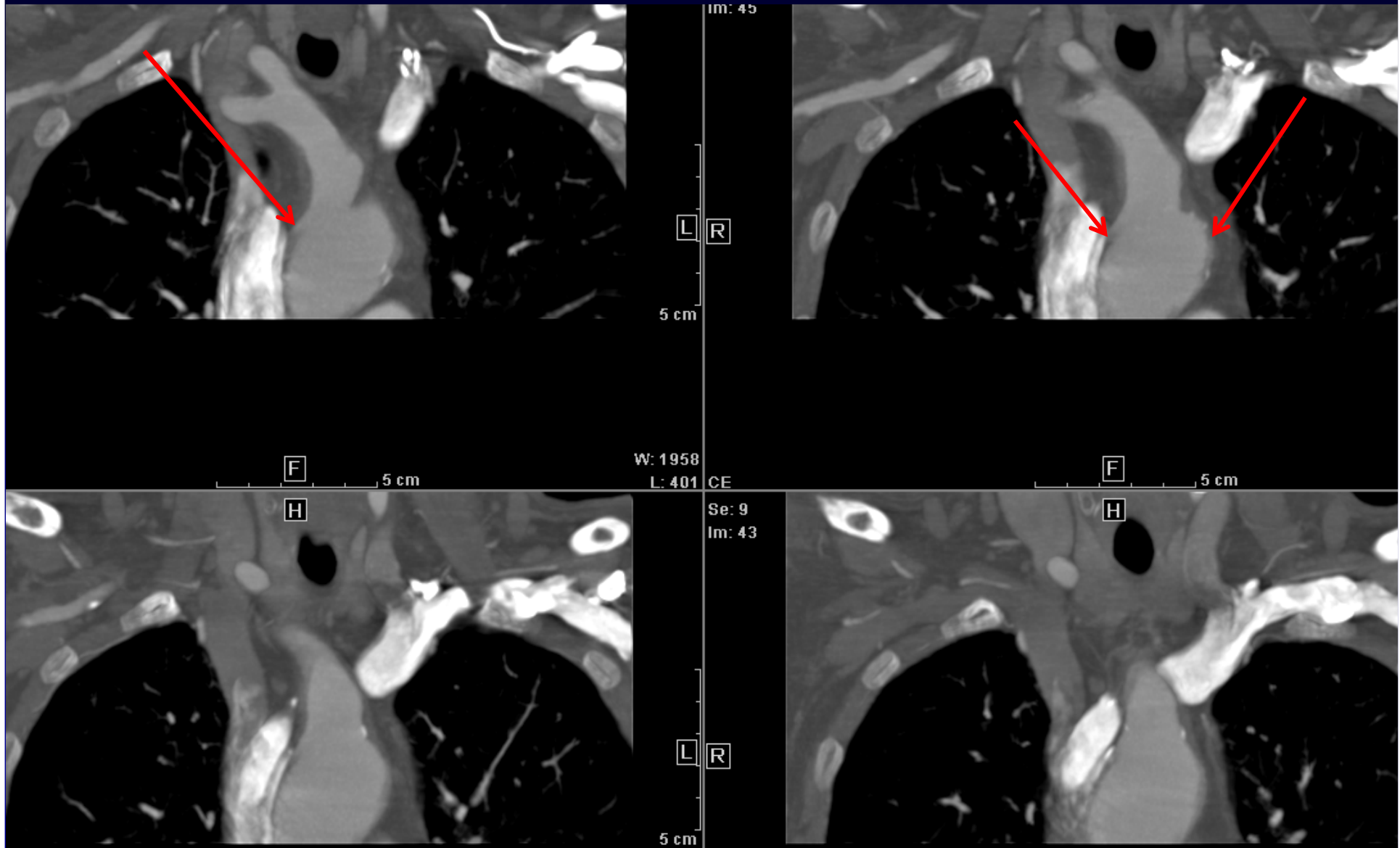
**Symptoms not due to posterior
circulation disease, but in R
ICA distribution.**

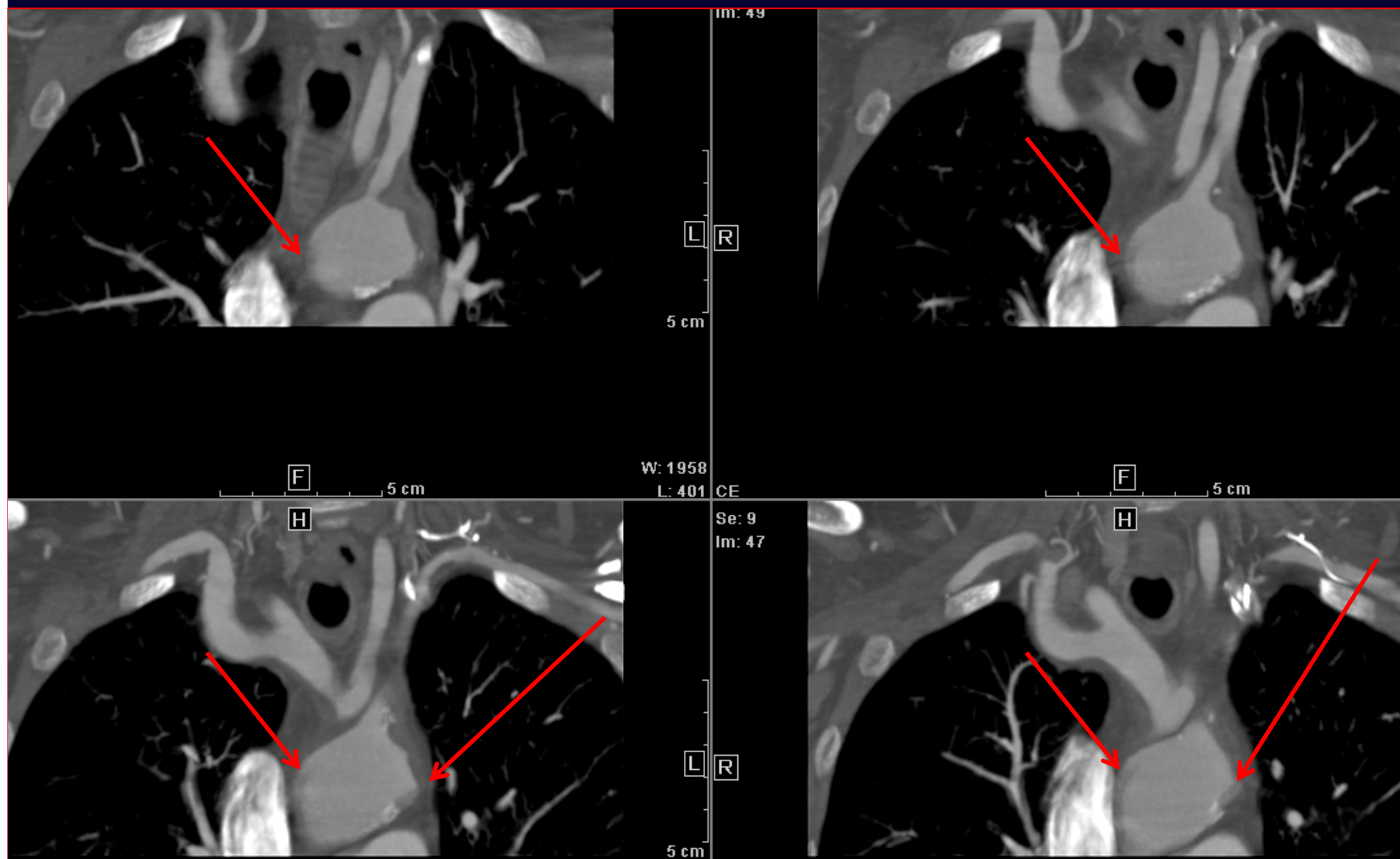
Her only non-diseased vessel!

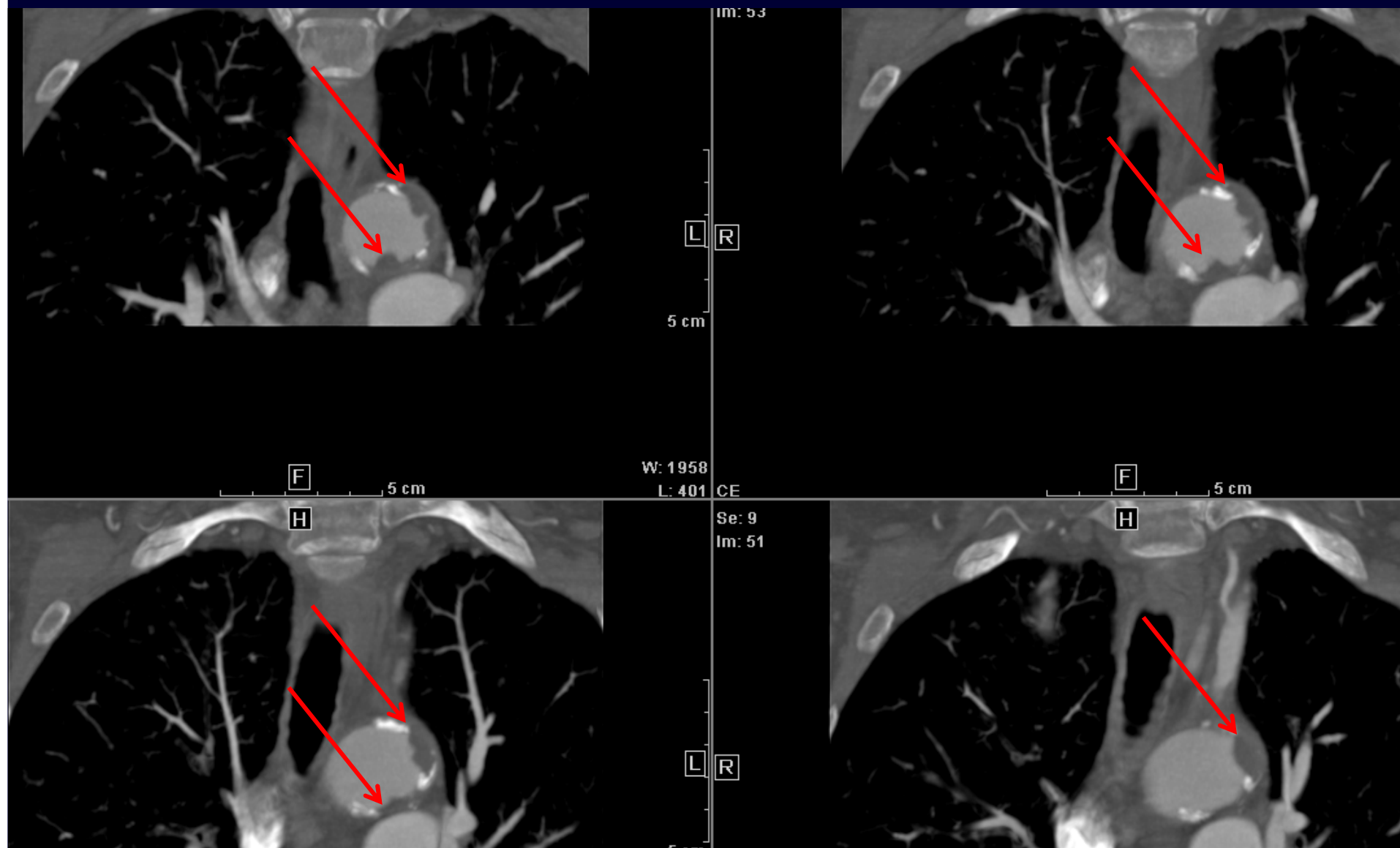
What's going on??

Lets get a CTA of the Arch

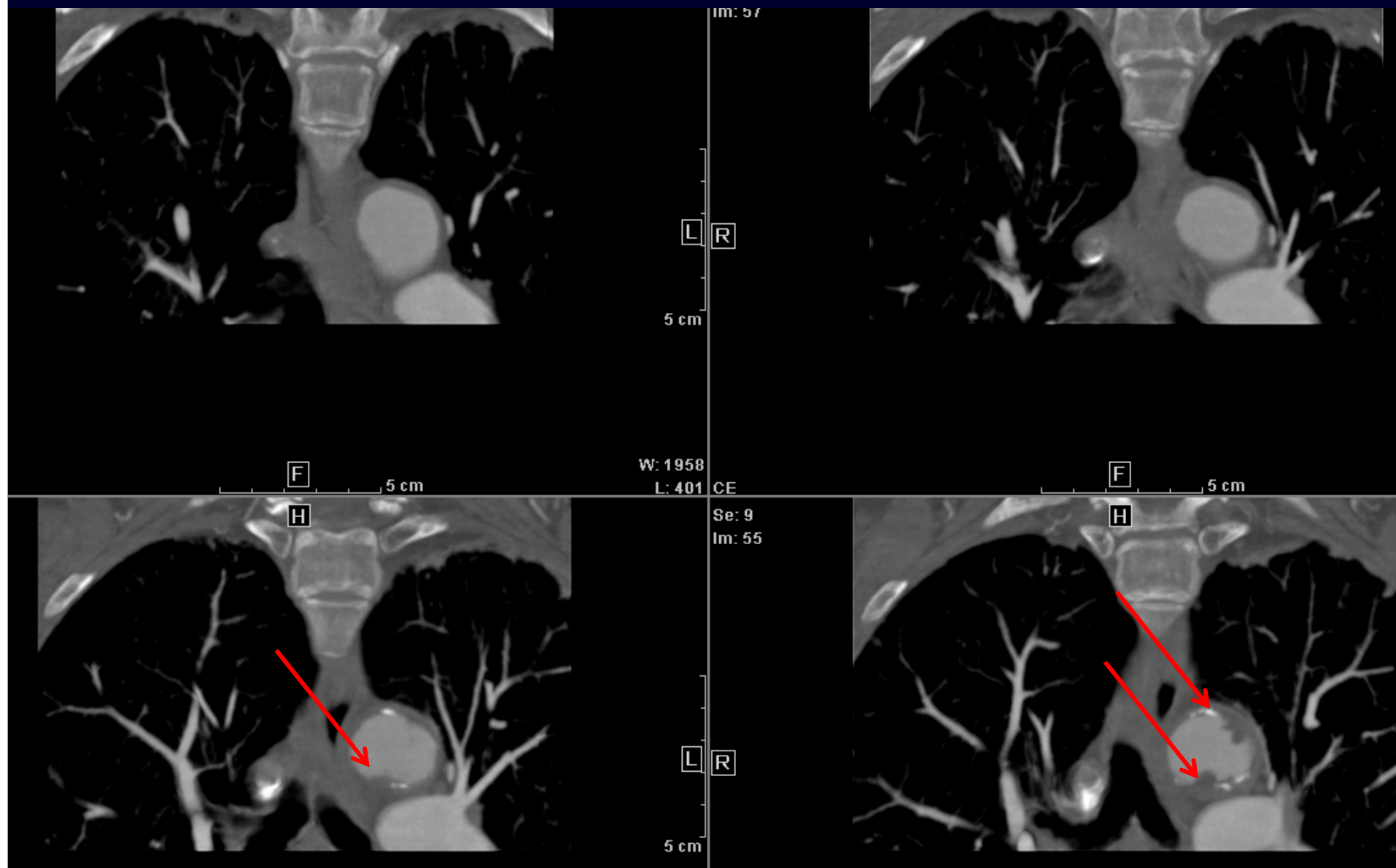
Reviewing CTA - Arch







The Culprit: Previously unrecognized aorto-embolic disease



Embolic events in multiple vascular distributions

Was the L CAS the right procedure?

Discharge

- Somewhat improved on discharge.
- Mild facial and LUE weakness/apraxia/confusion.
- D/C Home with OP rehab.

Lessons

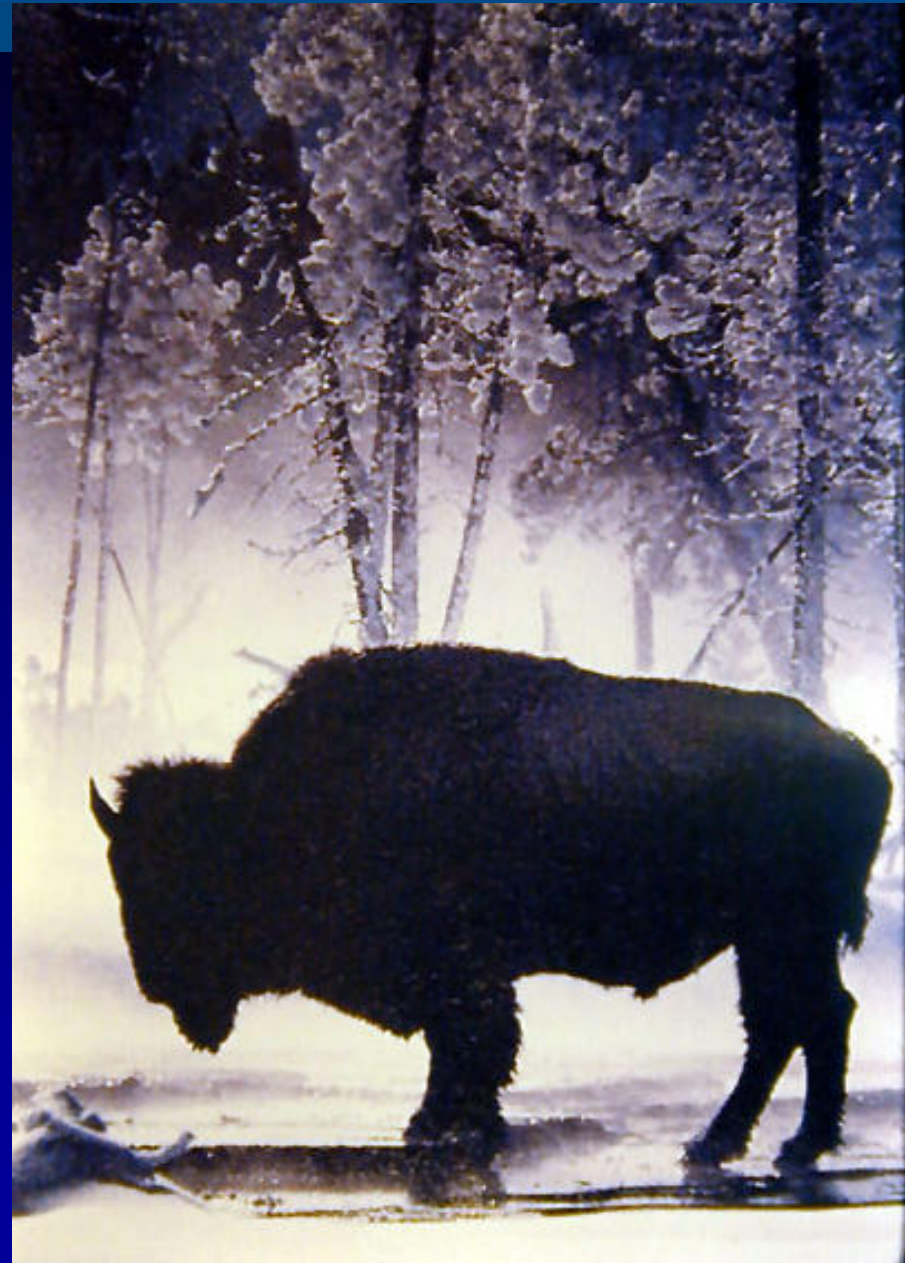
ARCH-ARCH-ARCH

**Do not do a CAS procedure
without looking at the Aortic Arch**



TOSHIBA STROKE RESEARCH CENTER

University at Buffalo
State University of New York



ork

Case

Closed Cell Stent

Flow Reversal Embolic Protection

History of Present Illness

- 46 year old male
- Medical history –heavy smoker 1.5 packs per day
- Usual state of health at midnight 1/06/10
- Awoke with Left upper extremity subjective weakness / apraxia while attempting to light a cigarette

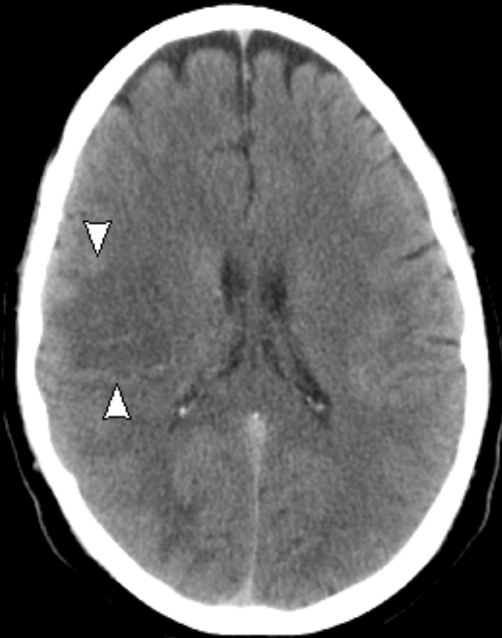
Past Medical History

- New Diagnosis of Diabetes by Hg A1c
- New Diagnosis of Dyslipidemia with Cholesterol 222, LDL 177, HDL 26.
- Family history of Antiphospholipid Syndrome in sister (patient never tested)

Physical Exam

- In ER symptoms progressed to: NIHSS 14
 - Left face and Upper Extremity Weakness
 - R gaze preference
 - L homonymous hemianopsia
 - Dense L sensory deficit and neglect
 - L ataxia

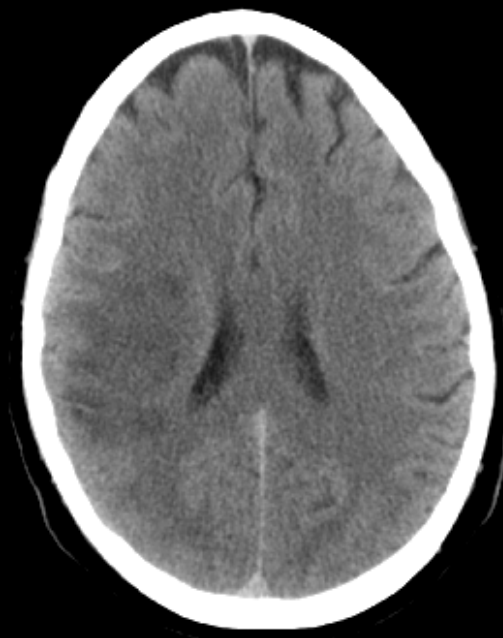
Admission CT



PF
AH
5 cm

L R
5 cm

W: 90
L: 40
Se: 3
Im: 20



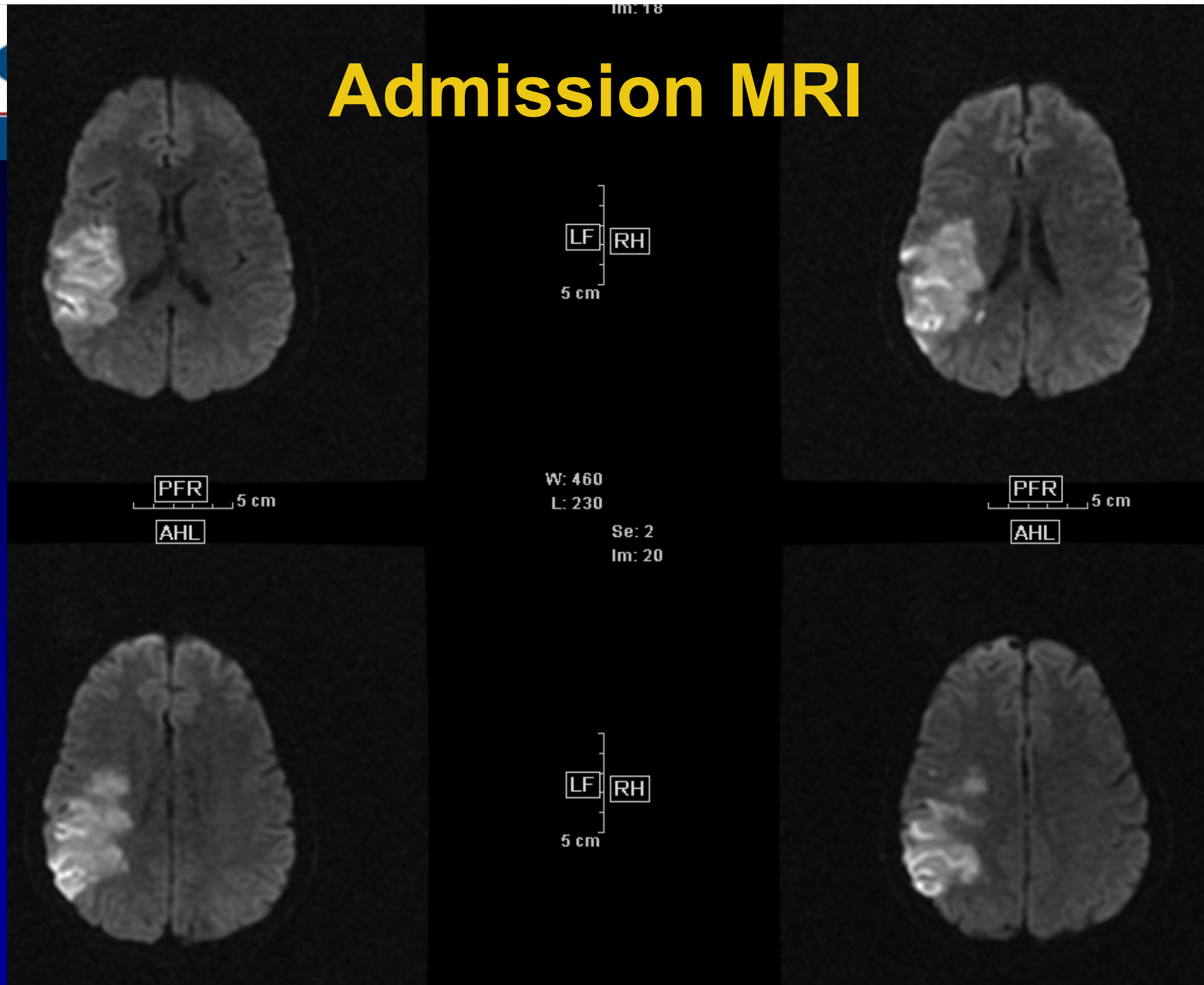
PF
AH
5 cm



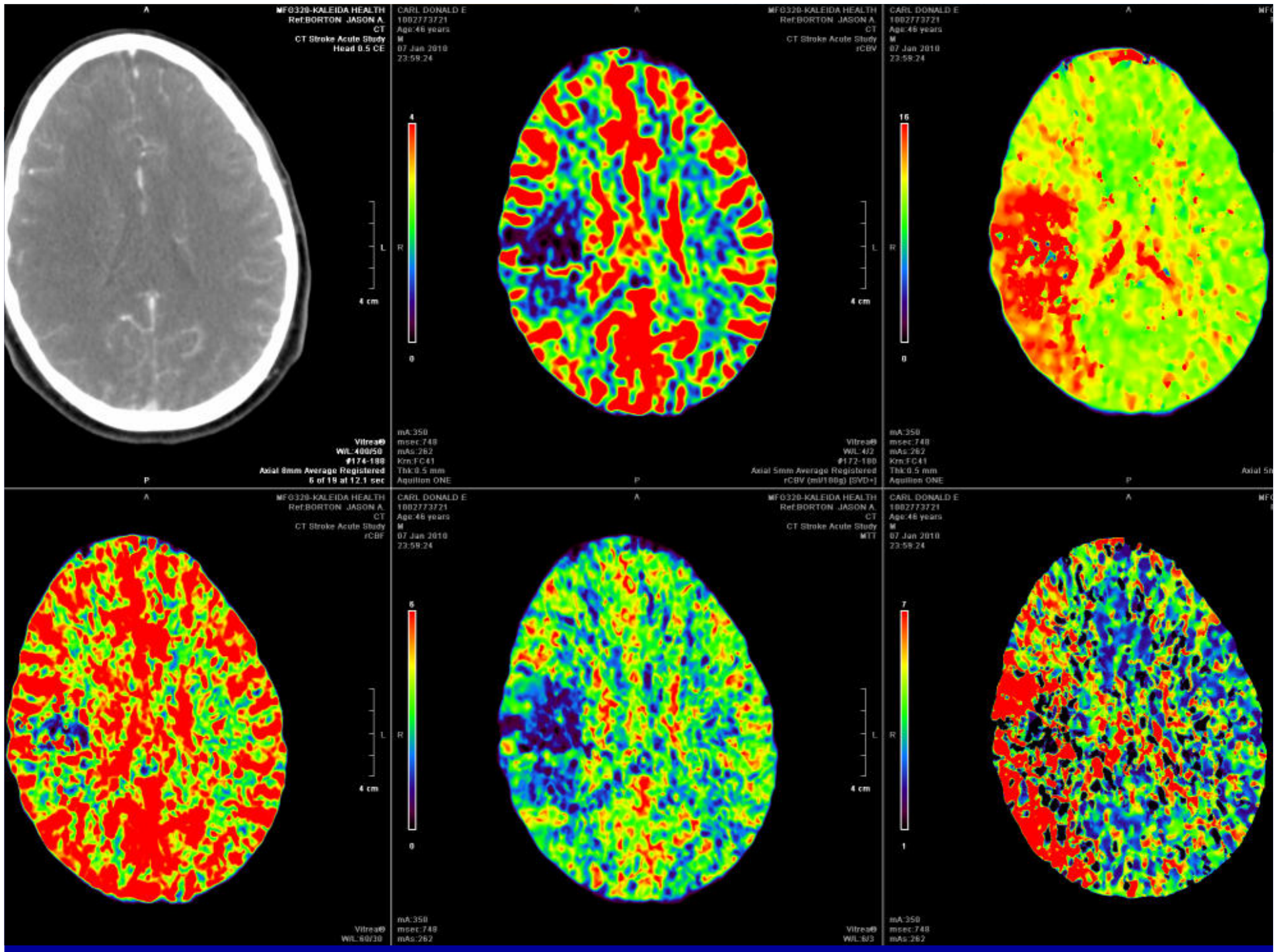
L R
5 cm



Admission MRI



Admission CT Perfusion



Admission CTA



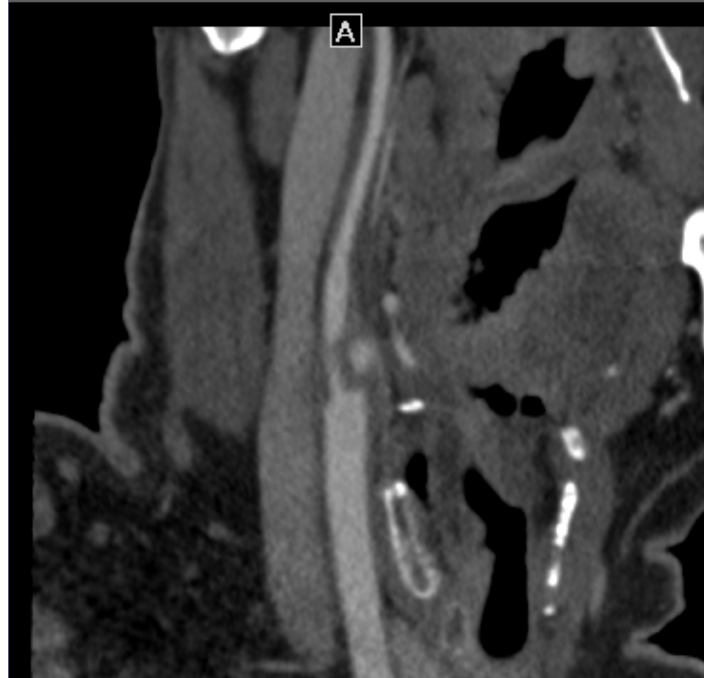
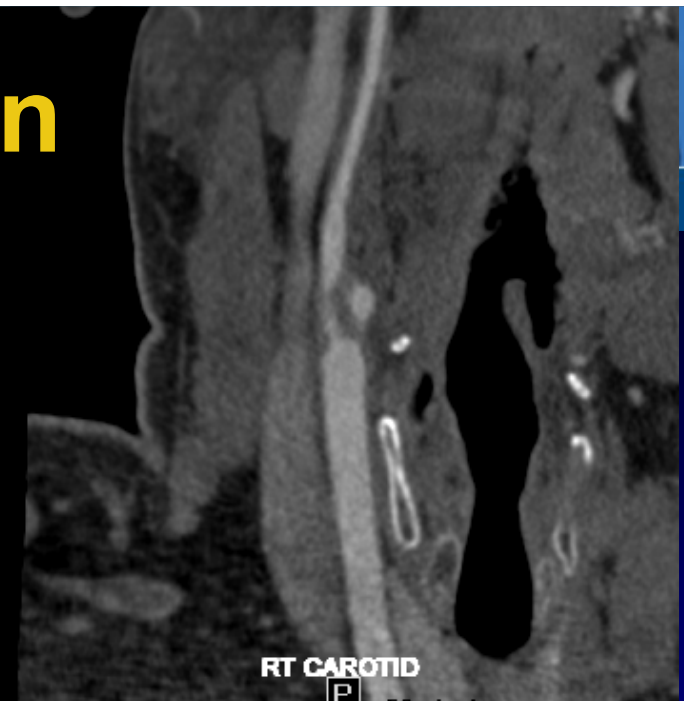
Im: 2

L R

50 pixels

W: 861

L: 260



Se: 249

Im: 4

L R

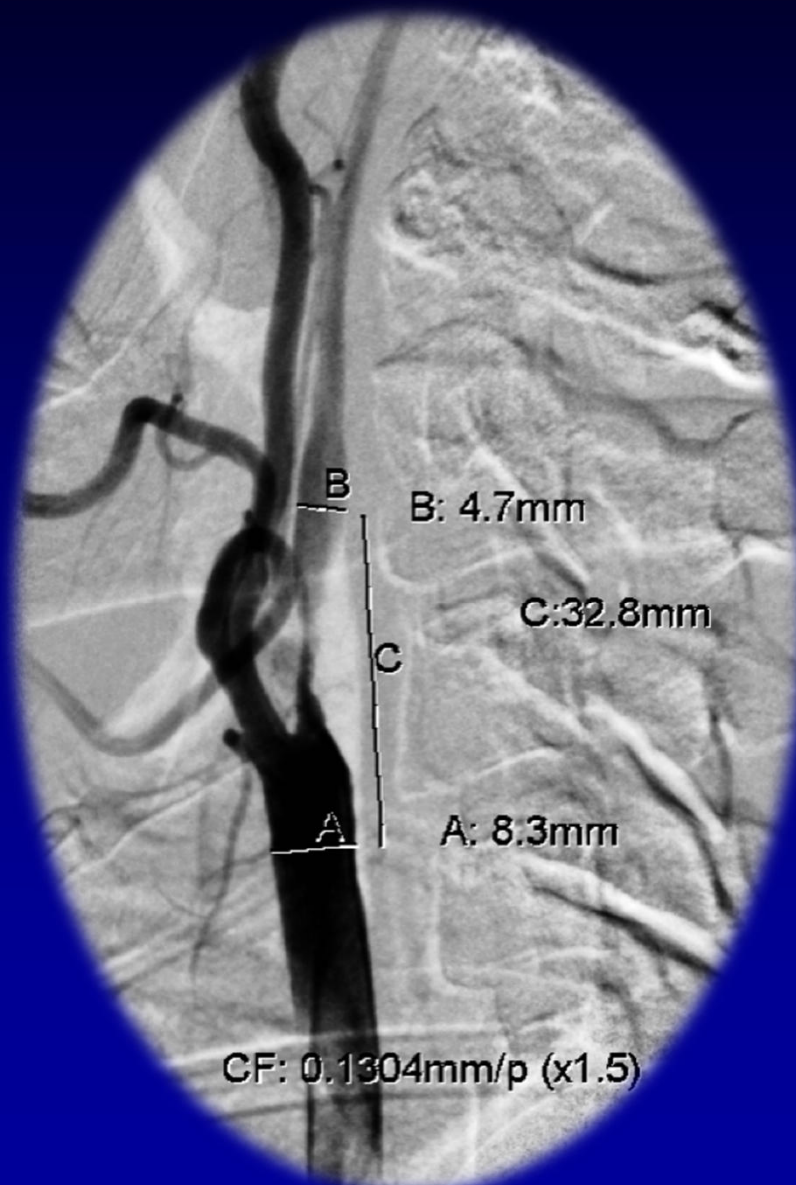
50 pixels



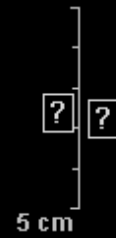
Medical Therapy

- ASA 325 mg
- Plavix Load 600 mg
- Lipitor 20mg po Qdaily
- Goal SBP 110-150

Admission Angiogram

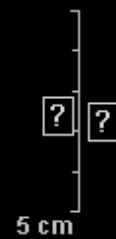


Im: 520,000 F: 8/26
Comments: RCCA



W: 4096
L: 2048

Se: ALL (5)
Im: 520,000 F: 8/26
Comments: RCCA



York



Comments: RCCA

?

?

5 cm

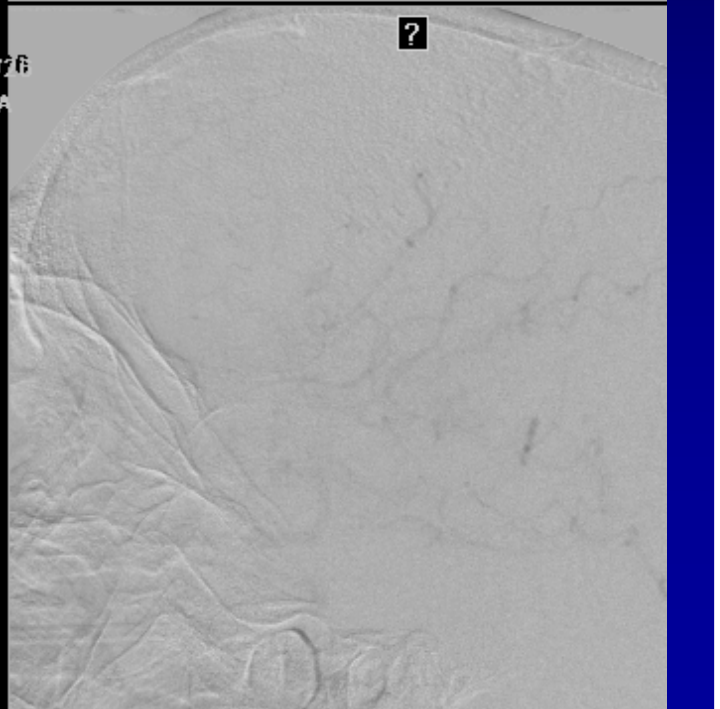
W: 4096
L: 2048

Se: ALL (5)
Im: 520,000 F:12/26
Comments: RCCA

?

?

5 cm



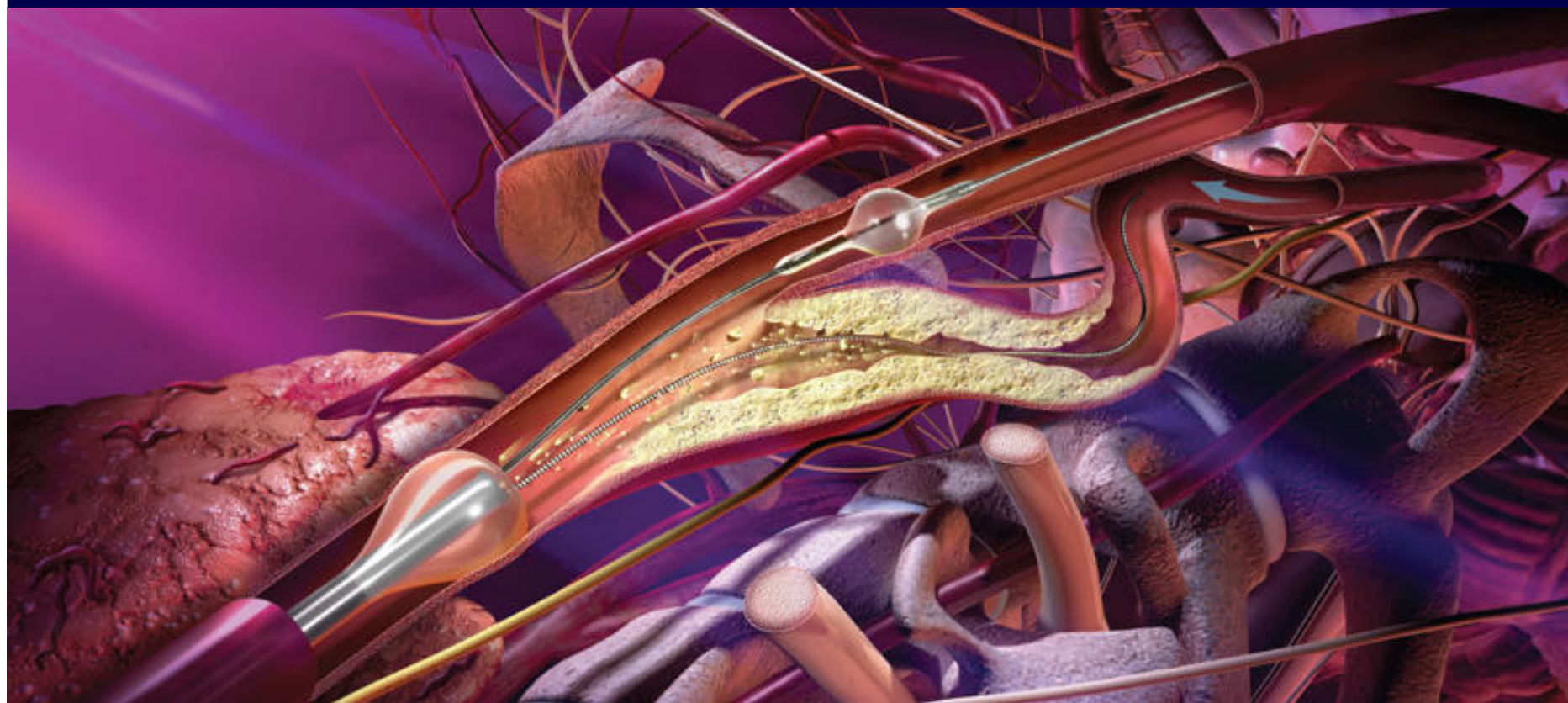
symptomatic high grade stenosis/ thrombus -
flow limiting, straight segment



Proximal protection
closed cell braided mesh stent

Treatment Plan-

- Right Carotid **WallStent** 8 x 29
- **Gore Device**: Proximal Flow Reversal
 - 9 Fr R femoral arterial sheath
 - 6 Fr L femoral venous sheath
 - External Wire Mounted Balloon to occlude ECA
 - 9 Fr Balloon tipped guide to occlude CCA
 - Flow Reversal: Back Bleed into Filter with reintroduction of blood volume into venous sheath



Treatment Plan

- Intravascular Ultrasound (IVUS)
 - Angiographic runs during proximal flow reversal risk distal embolic shower
 - IVUS allows examination of vessel lumen for a priori or in-stent debris to assess embolic risk prior to restoration of physiologic flow
 - Wallstent

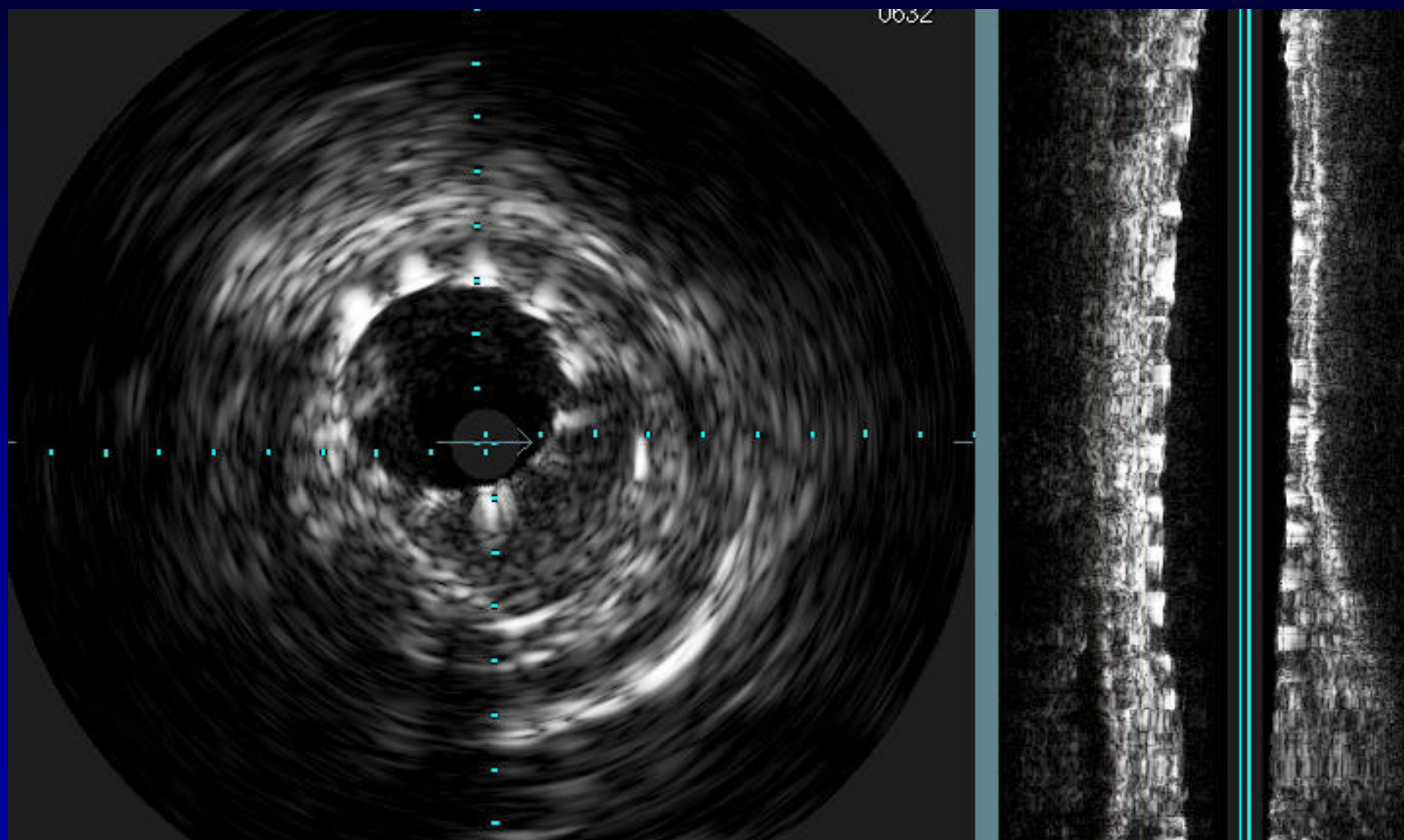


York



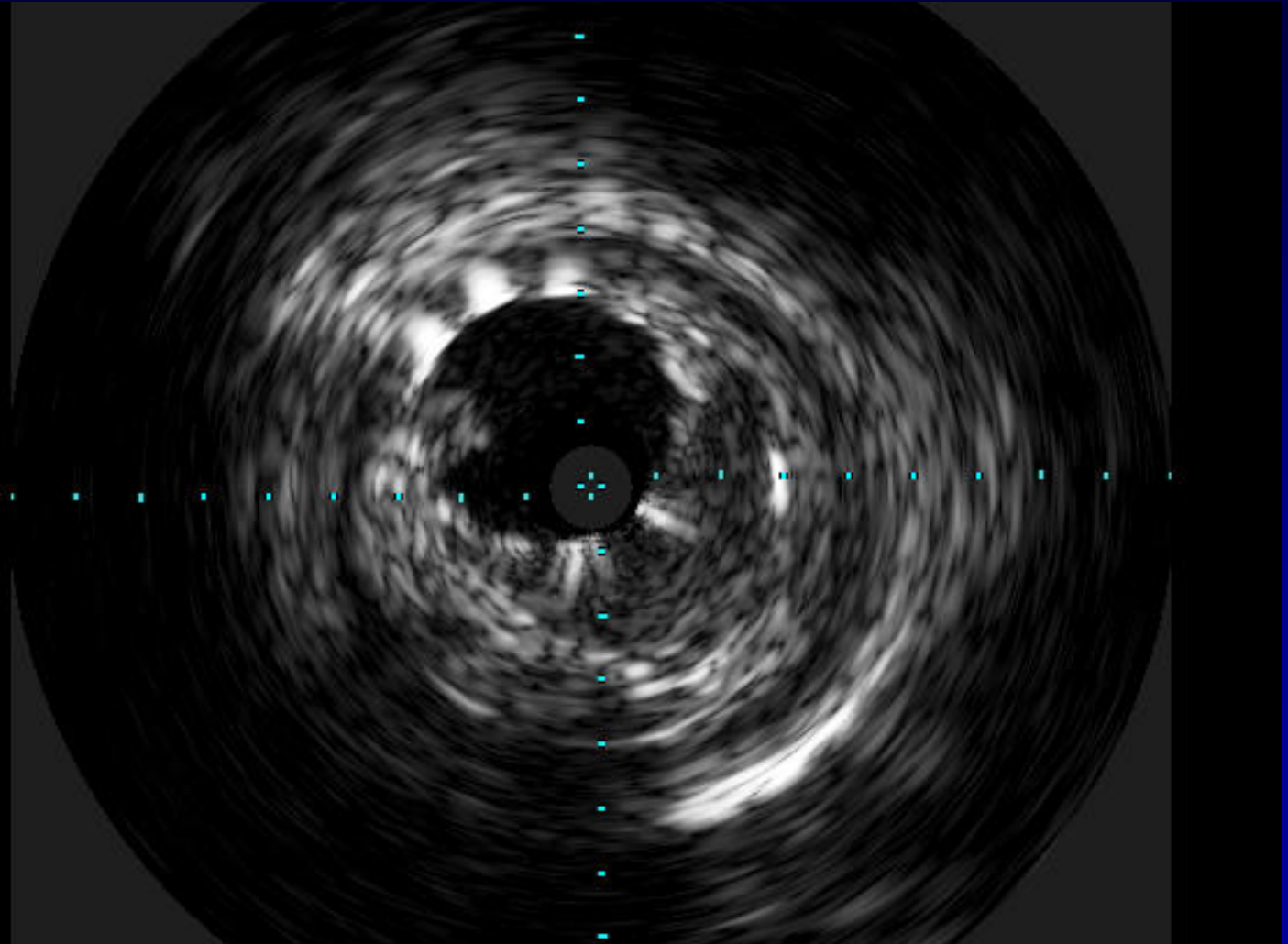
Under flow reversal IVUS reveals. .

Intraluminal Thrombus!



**Second WallStent deployed
within the initial stent in an
attempt to sandwich in-stent
embolic material**

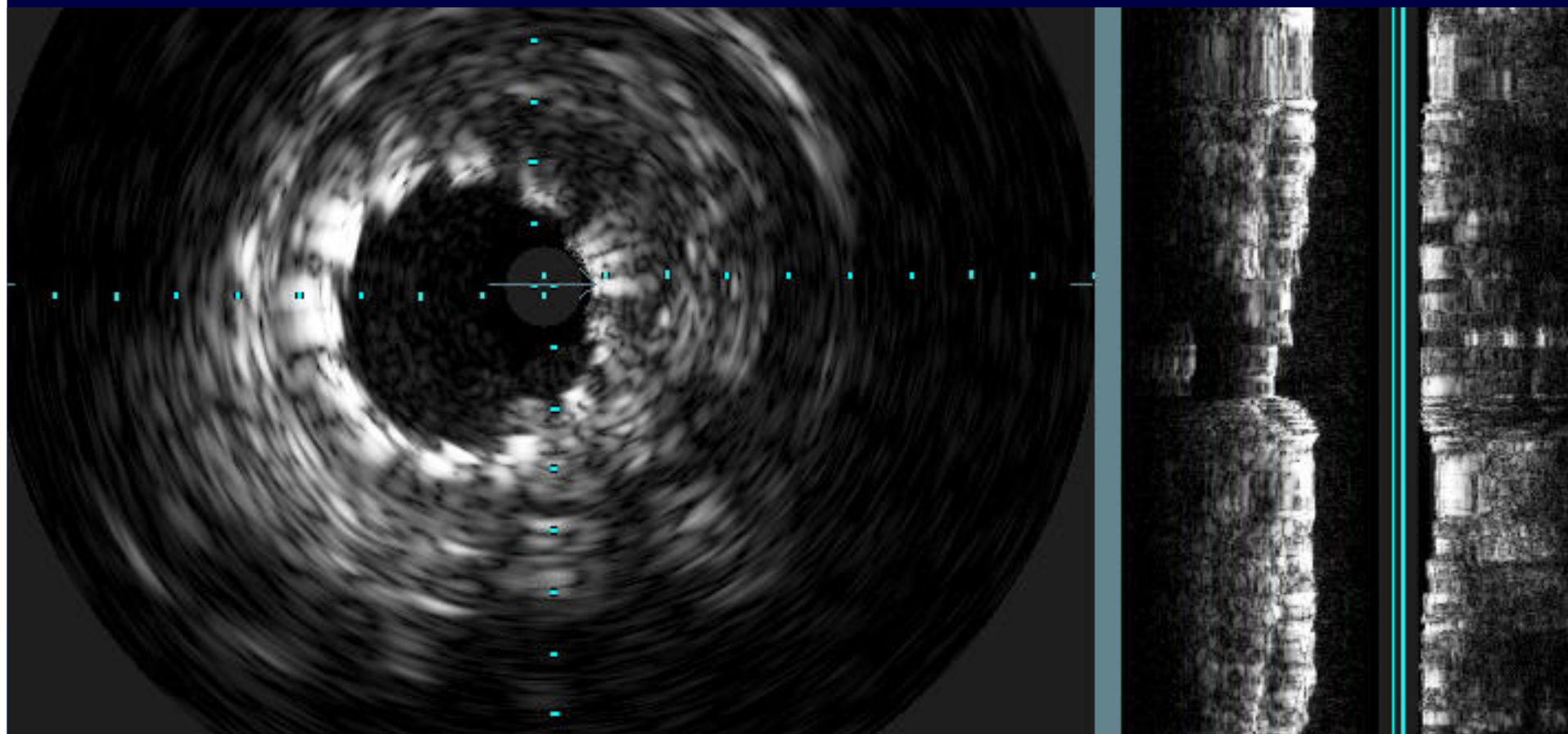
Follow-up IVUS: Thrombus Persists!



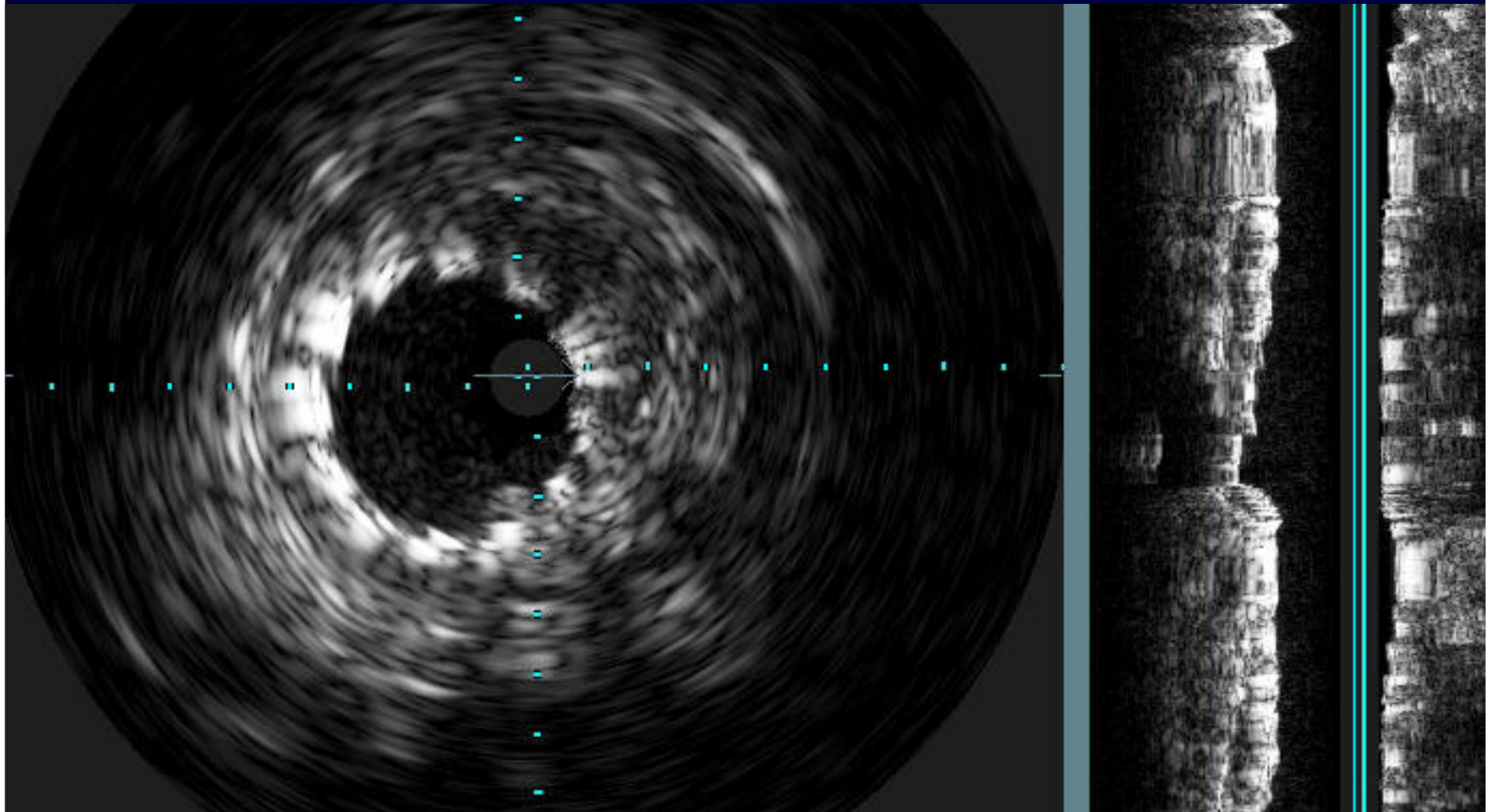
**5 French MPA used to scrape
within stent and recover in-
stent embolic material under
proximal flow reversal**



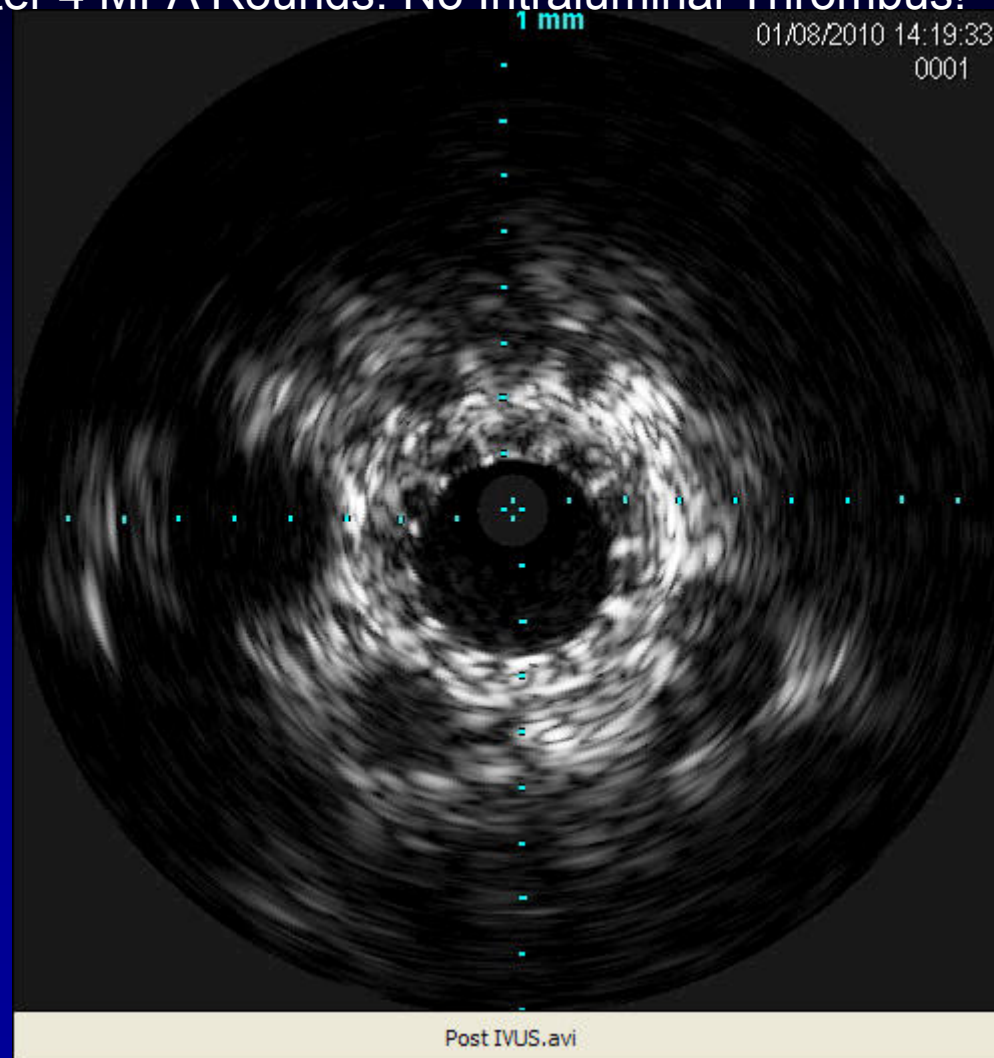
MPA Round 1: 11 o'clock debris gone but new lesion at 5 o'clock!



Post MPA Round 3: Lesion Persists!



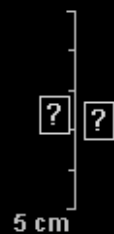
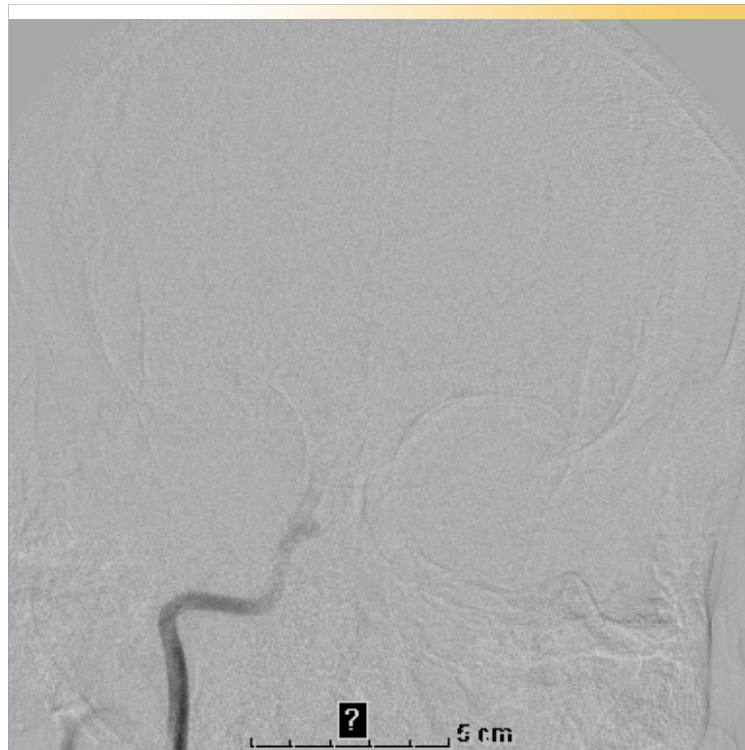
Final IVUS Video after 4 MPA Rounds: No Intraluminal Thrombus!



Final Angiogram
No Filling Defect or Distal
Embolus / Branch Occlusion

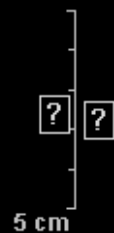




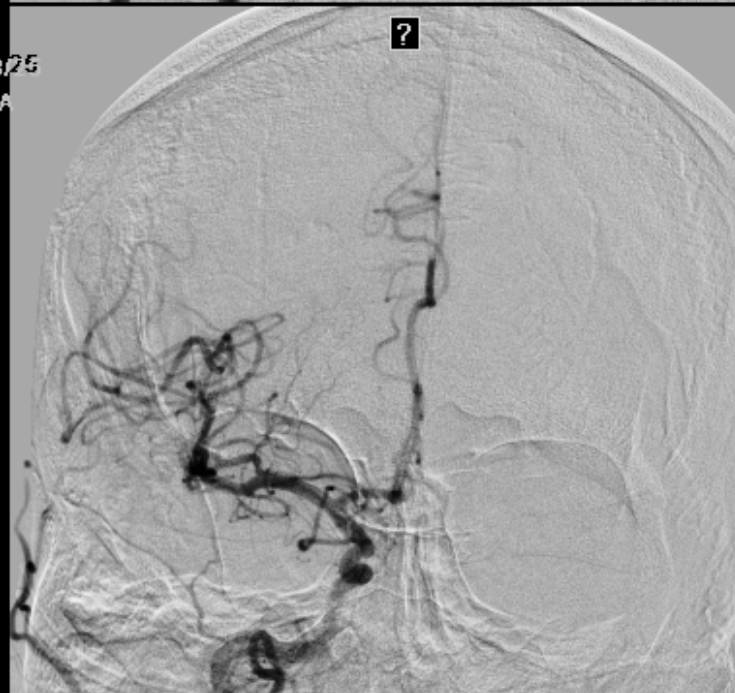


W: 4096
L: 2048

Im: 1,210,000 F: 6/25
Comments: RCCA



Se: ALL (12)
Im: 1,210,000 F: 8/25
Comments: RCCA



Post-Operative Course

- Dramatic Improvement in R hemisphere CBF
- Tremendous Clinical Progress over 48
- NIHSS 3 at 48 hours
- Persistent mild gaze deviation, L facial droop and LUE ataxia
- Currently participating well with Occupational and Speech Therapy



TOSHIBA STROKE RESEARCH CENTER

University at Buffalo
State University of New York

Open cell stent case Symptomatic Carotid Stenosis- Filter Distal Embolic Protection

History

- 68yo WM with multiple episodes of left amaurosis fugax.
-
- Pretreated on ASA and Plavix

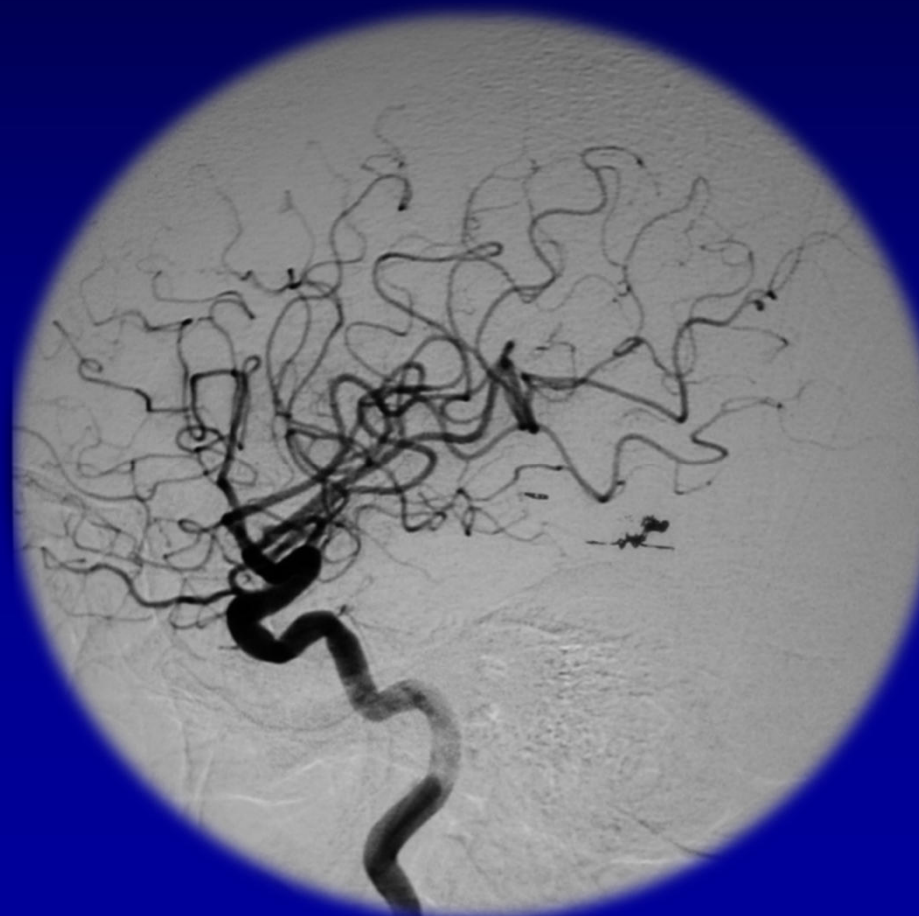
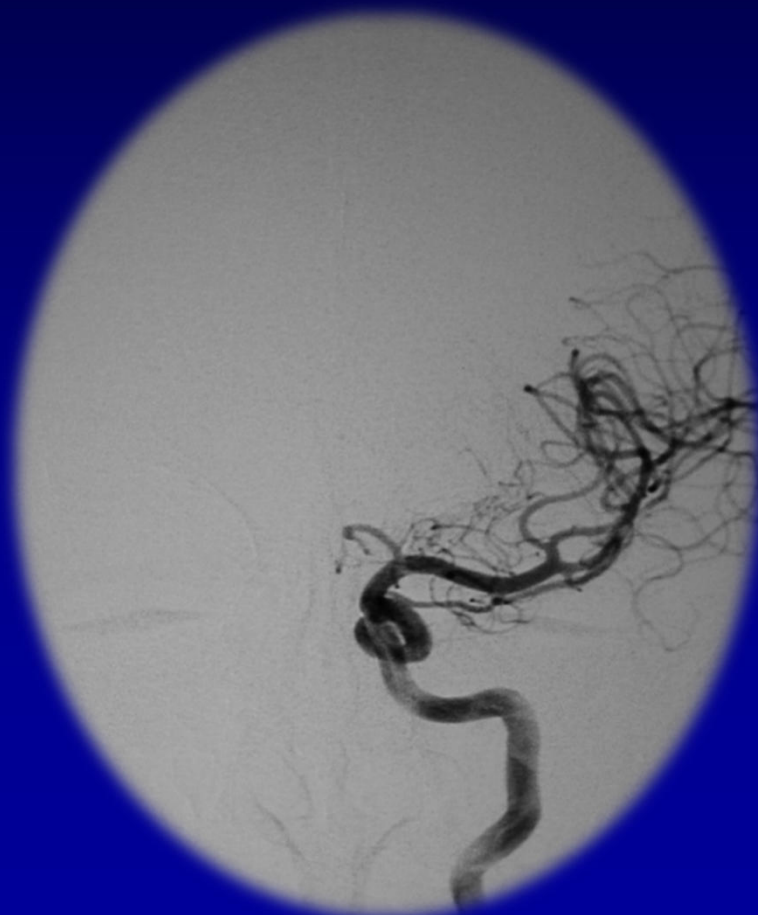
Carotid Stenosis: Pre-treatment Lesion



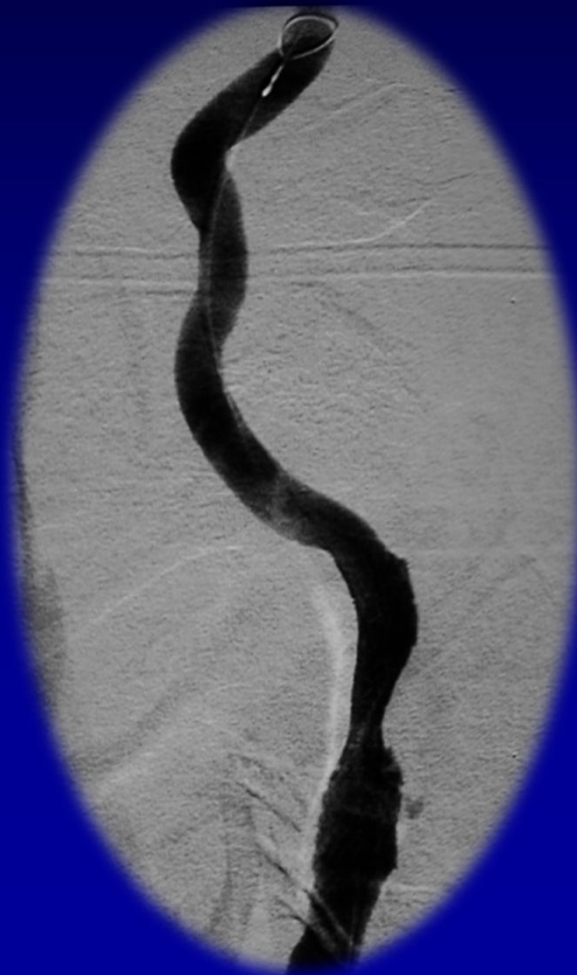
72% Left ICA symptomatic stenosis

Left ECA Occlusion-

Pre-treatment Intracranial Runs



Carotid Stenosis: Stent Placement



EPI Filterwire 190cm placed

Precise Rx 9mmx30 chosen-
open cell nitinol

- 4.5mm x 20 Aviator balloon
inflated to 10 atm

Post-Stent Angioplasty

While Filterwire was removed, was caught on the stent tines

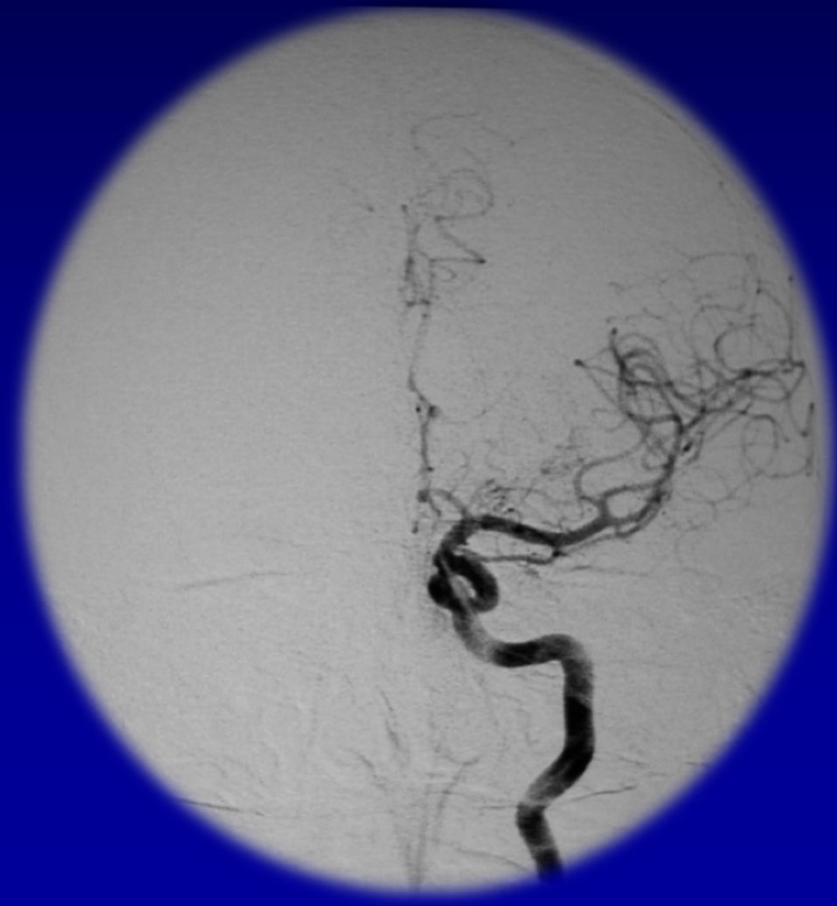
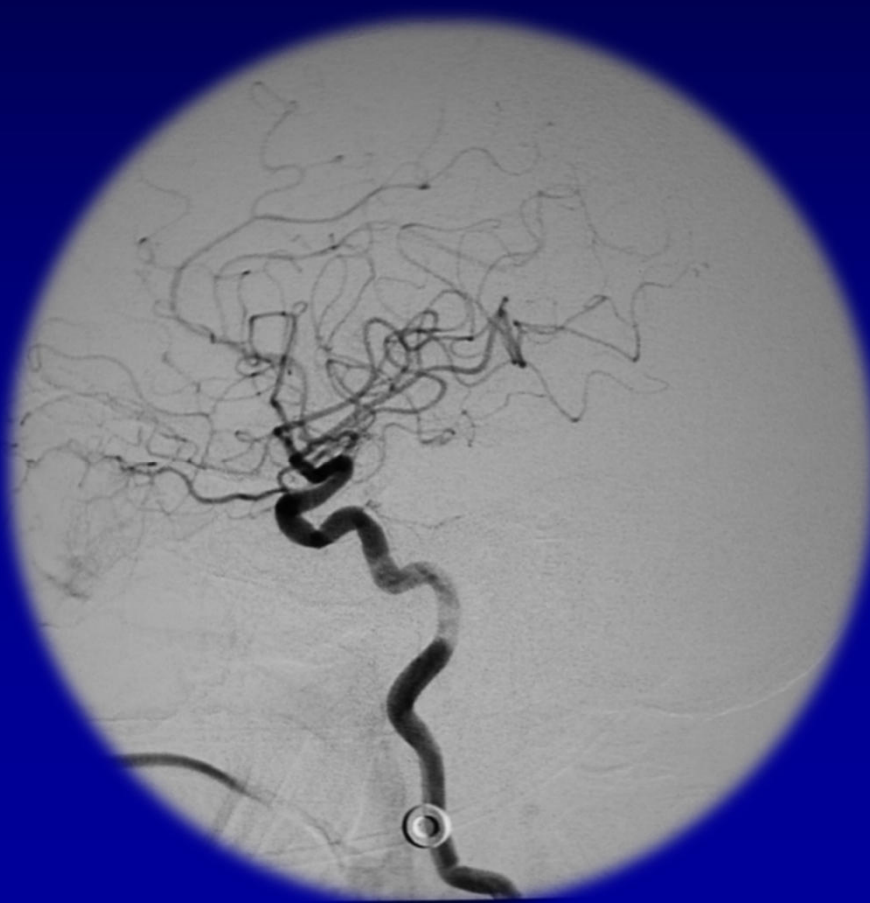
MPA catheter
was used to
capture the filter
from the stent

Pt developed Left amaurosis -but this
resolved in under 5 minutes

Closed cell was a better choice



Carotid Stenosis: Final Intracranial Runs



Carotid Stenosis: Post-Op

- Pt with hypotension treated with IV fluids and minimal Dopamine which was weaned off on POD 1
- No Further Neurologic Events
- Pt discharged POD 2

Thank You!





TOSHIBA STROKE RESEARCH CENTER

University at Buffalo
State University of New York



Thank you!