

# Techniques for Treating Chronic Carotid Occlusion

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STROKE &  
VASCULAR  
RESEARCH CENTER**



# Disclosures

**Research Grants:** Co-investigator: NINDS 1R01NS064592-01A1, Co-investigator: NIBIB 5 R01 EB002873-07, Co-investigator: NIH/NINDS 1R01NS091075, Co-investigator: NIH-NICHHD R01 HD-04483101

**Financial Interest:** StimSox, Valor Medical, Neuro Technology Investors, Cardinal, Medina Medical, Buffalo Technology Partners, Inc., International Medical Distribution Partners

**Consultant:** Codman & Shurtleff, Inc., Medtronic, GuidePoint Global Consulting, Penumbra, Stryker, MicroVention, W.L. Gore & Associates, Three Rivers Medical, Inc., Corindus, Inc., Amnis Therapeutics, Ltd., CereVasc, LLC, Pulsar Vascular, The Stroke Project, Cerebrotech Medical Systems, Inc., Rapid Medical, Neuroavi, Silk Road Medical, Rebound Medical, Lazarus (acquired by Medtronic), Medina Medical (acquired by Medtronic), Reverse Medical (acquired by Medtronic), Covidien (acquired by Medtronic),

**Advisory Board:** Intersocietal Accreditation Committee

**National Steering Committees/PI:** Penumbra: 3D Separator Trial, COMPASS Trial, INVEST Trial; Covidien (Now Medtronic): SWIFT PRIME and SWIFT DIRECT Trial; MicroVention: FRED Trial, CONFIDENCE Study; LARGE Trial, POSITIVE Trial,

No consulting salary arrangements. All consulting is per project and/or per hour.

# History of revascularization

Author (year)	Event
Kredel , 1942	EDAMS
Woringer & Kunlin, 1963	CCA-ICA bypass with saphenous vein graft
Donaghy & Yasargil, 1968	STA – MCA bypass
Loughheed 1971	CCA- IC ICA bypass
Kikuchini & Karasawa1973	EC-IC bypass for moyamoya
Karasawa, 1977	Encephalomyosynangiosis for moyamoya
Story , 1978	ICA-MCA bypass, saphenous vein graft
Sundt , 1982	Saphenous vein graft for posterior circulation
EC/IC bypass study group, 1985	No benefit of STA-MCA bypass in reducing ischemic events compared to best medical therapy
COSS ,2010	Study stopped for futility

# Cerebral ischemia

(occlusive cerebrovascular disease not amenable to carotid endarterectomy)

- EC – IC bypass study 1985
- Not effective preventing ischemia
- Reduction in bypass
- Criticism
  - Only half of the patients received antiplatelet agents at entry into study
  - No evaluation preop for **cerebrovascular hemodynamic status..**
  - Both the patient and the therapist were **not blinded**
  - **Randomization-to-treatment bias** could have occurred
  - **No angiographic determinants for entry.**
  - A large percentage of patients had **no symptoms between the angiographic demonstration of ICA occlusion and randomization.**
  - large number of patients underwent **surgery outside the study.**
  - A high percentage of patients had **tandem lesions**

# Chronic Carotid Occlusion

- 5-7 % risk of Stroke
- Can be as high as 28 %
  - Pts with increased Oxygen extraction

# Chronic Carotid Occlusion: Considerations

- **Assessment of Cerebrovascular Reserve**
- **Site of Occlusion**
- **Collateral flow**
- **Length of the occluded segment**
- **Extracranial vs Extra and Intracranial occlusion**
- **Protection From Distal Emboli**
- **BP control to prevent reperfusion syndrome**

# Chronic Carotid Occlusion: Techniques

## Long-term Angiographic and Clinical Outcome Following Stenting by Flow Reversal Technique for Chronic Occlusions Older Than 3 Months of the Cervical Carotid or Vertebral Artery

NEUROSURGERY

VOLUME 70 | NUMBER 1 | JANUARY 2012 |

**6 cases: no complications or restenosis at 1 year**

# Chronic Carotid Occlusion: Techniques

- 3 sheath system
- 10F Right Femoral arterial, 8F Right Femoral Venous, 5F Left Femoral Arterial
- Balloon Guide catheter on the side of the occlusion connected to Venous sheath via Filter for Flow Reversal
- Diagnostic catheter on the contralateral sided to visualize retrograde flow
- Balloon catheter (Percusurge Guard Wire) placed in ECA to stop ECA flow
- Lesion crossed with GT (016) or SuperHard (014) exchange length wire and balloon (Gateway) catheter under flow reversal
- Balloon inflated from distal to proximal
- Filter type catheter (MintCatch) placed in the Guide to aspirate the debris

NEUROSURGERY VOLUME 70 | NUMBER 1 | JANUARY 2012 | Stent deployed



# Chronic Carotid Occlusion: Techniques

## Long-term Angiographic and Clinical Outcome Following Stenting by Flow Reversal Technique for Chronic Occlusions Older Than 3 Months of the Cervical Carotid or Vertebral Artery

**CONCLUSION:** COs of the cervical carotid or vertebral arteries older than 3 months can be opened safely with FRT, and 1-year angiographic and long-term clinical outcome is favorable.

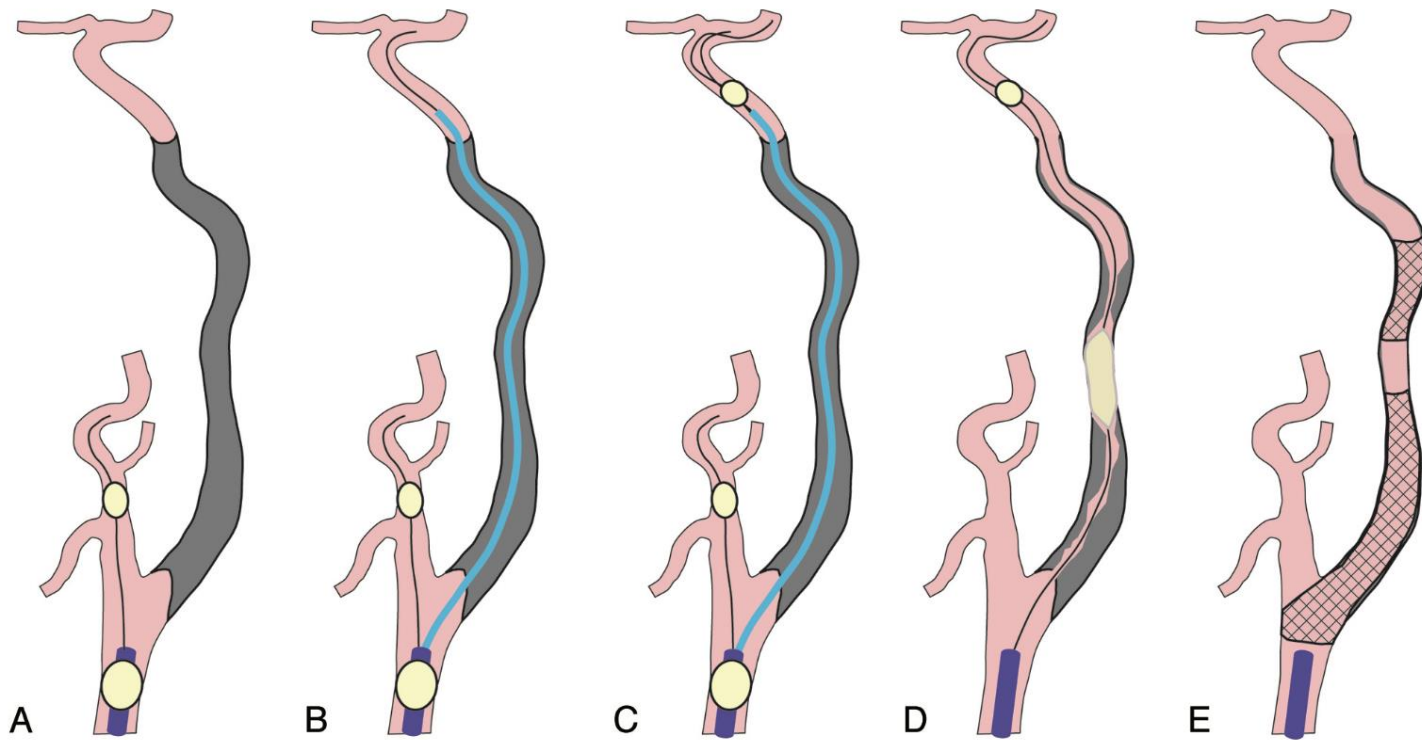
# Chronic Carotid Occlusion: Techniques

## Protected Endovascular Revascularization of Subacute and Chronic Total Occlusion of the Internal Carotid Artery

AJNR Am J Neuroradiol 31:481–86 | Mar 2010 | [www.ajnr.org](http://www.ajnr.org)

**Revascularized 7 of 8 cases**  
**No clinical complications**  
**75% with asymptomatic DWI hits**

# Chronic Carotid Occlusion: Techniques



**Fig 1.** Recanalization procedure schematic. *A*, The procedure is initiated with proximal protection with the occlusion balloon at the CCA and the ECA. *B*, The aspiration catheter is navigated along the guidewire, which is passed successfully across the occluded segment under proximal protection. *C*, The distal protection balloon is navigated beyond the occluded segment through the extraction port of the aspiration catheter. *D*, The occluded segment is dilated with the balloon under distal protection. *E*, The ICA is recanalized after the stents are deployed and the thrombi are aspirated.

# Chronic Carotid Occlusion

## Predictors for Successful Endovascular Intervention in Chronic Carotid Artery Total Occlusion



Ying-Hsien Chen, MD,<sup>a</sup> Weng-San Leong, MD,<sup>b</sup> Mao-Shin Lin, MD,<sup>a,c</sup> Ching-Chang Huang, MD,<sup>a</sup>  
Chi-Sheng Hung, MD,<sup>a</sup> Hung-Yuan Li, MD,<sup>a</sup> Kok-Kheng Chan, MD,<sup>d</sup> Chih-Fan Yeh, MD,<sup>a</sup> Ming-Jang Chiu, MD, PhD,<sup>e</sup>  
Hsien-Li Kao, MD<sup>a</sup>

JACC: CARDIOVASCULAR INTERVENTIONS VOL. 9, NO. 17, 2016

SEPTEMBER 12, 2016:1825-32

# Chronic Carotid Occlusion

**TABLE 5** CAO Score of Carotid CTO Intervention

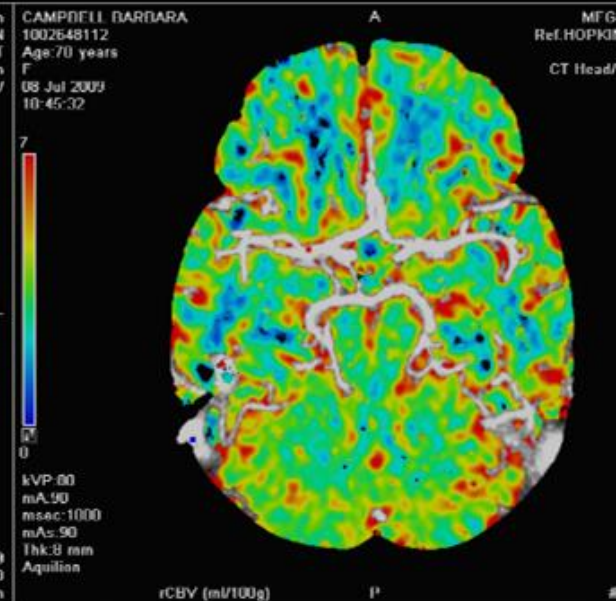
	Status	Coefficient	Score Point
Neurologic event	History of neurologic event	-1.31	0
	No neurologic event		1
Stump morphology	Tapered stump	-1.69	0
	Blunt stump or no stump		2
Distal carotid artery reconstitution	Via ipsilateral injection	-1.66	0
	Via contralateral injection		2
Level of distal carotid artery reconstitution	At or before clinoid segment	-2.16	0
	At communicating or ophthalmic segments		2
<b>Total CAO Score Points</b>		<b>Success Rate (%)</b>	
0		92	
1		80	
2		65	
3,4		31	
≥5		20	
CAO = carotid artery occlusion; CTO = chronic total occlusion.			

# CTP with and without Diamox

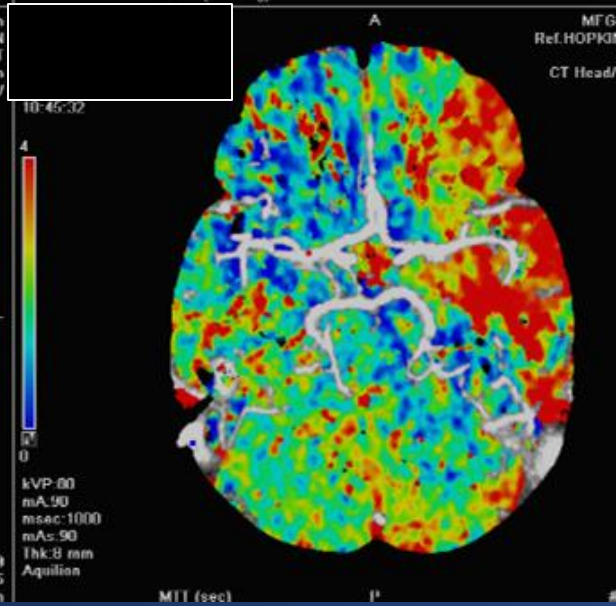
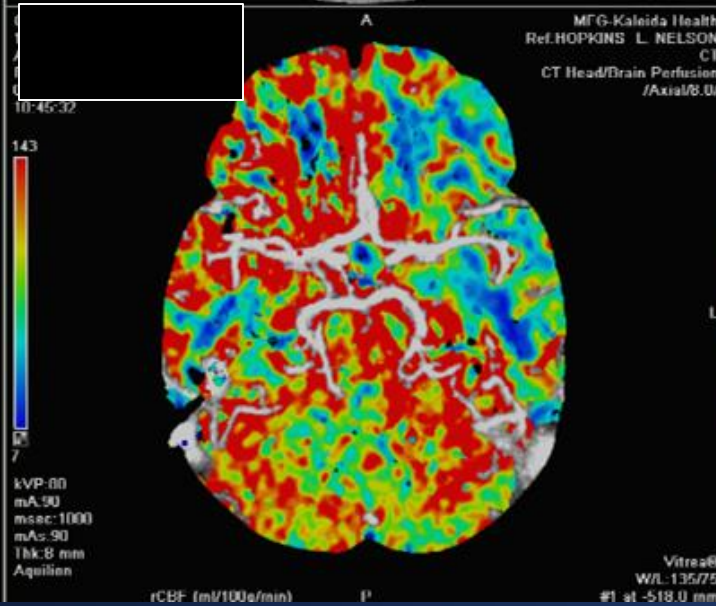
- **Stress test for the brain**

**CBV**

**Without  
diamox**



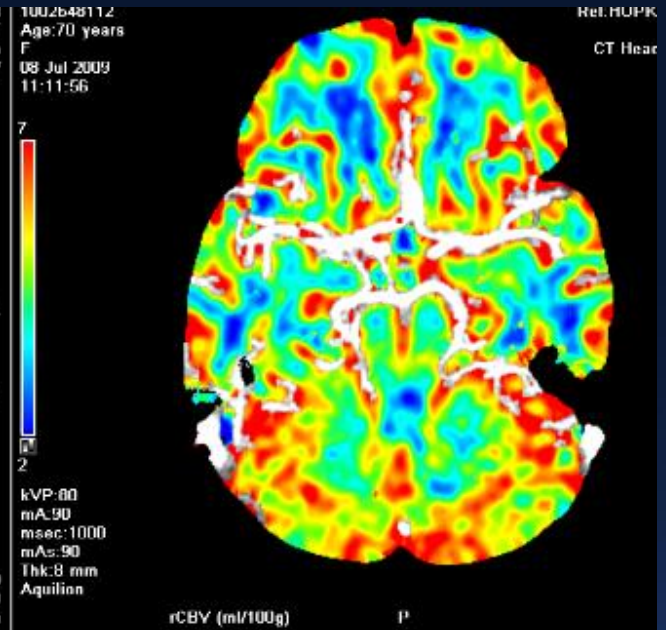
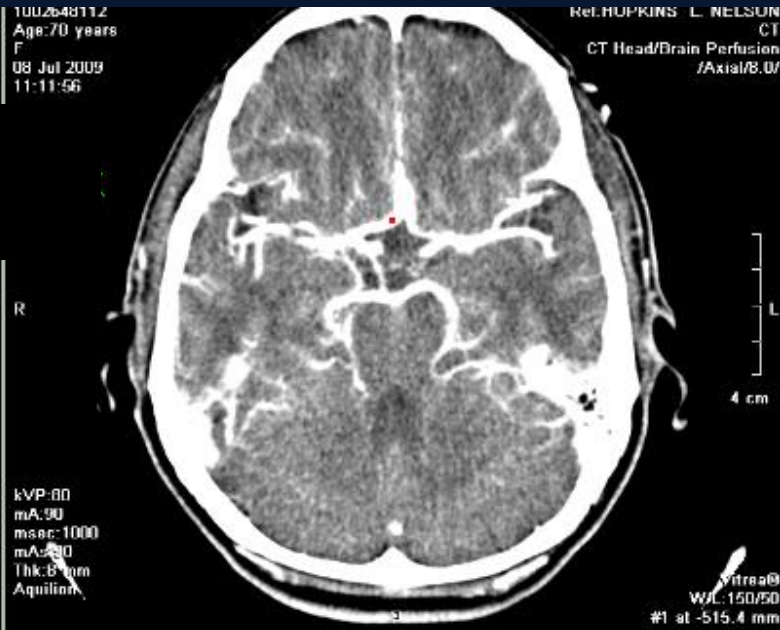
**CBF**



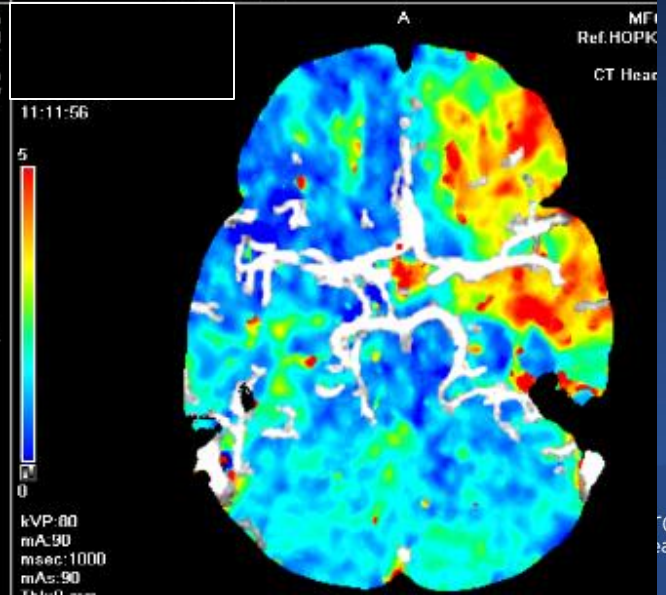
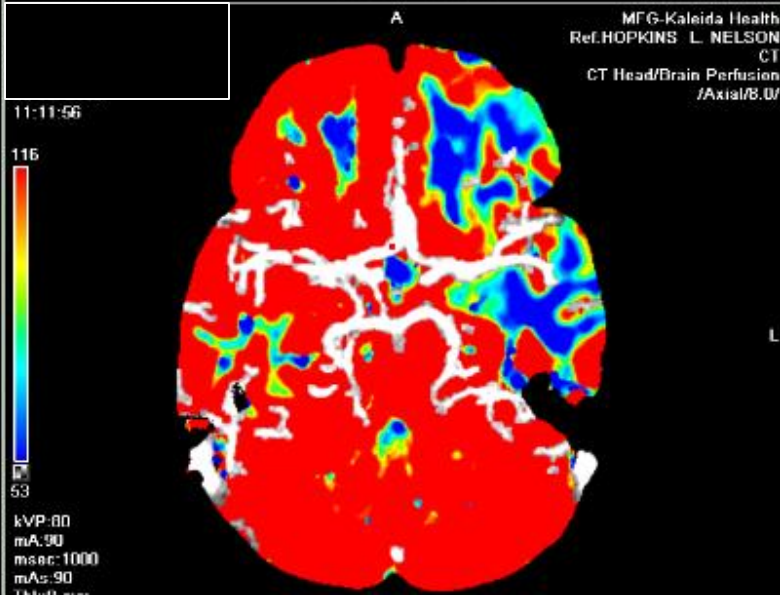
**TTP**

**With  
diamox**

**CBV**



**CBF**



**TTP**

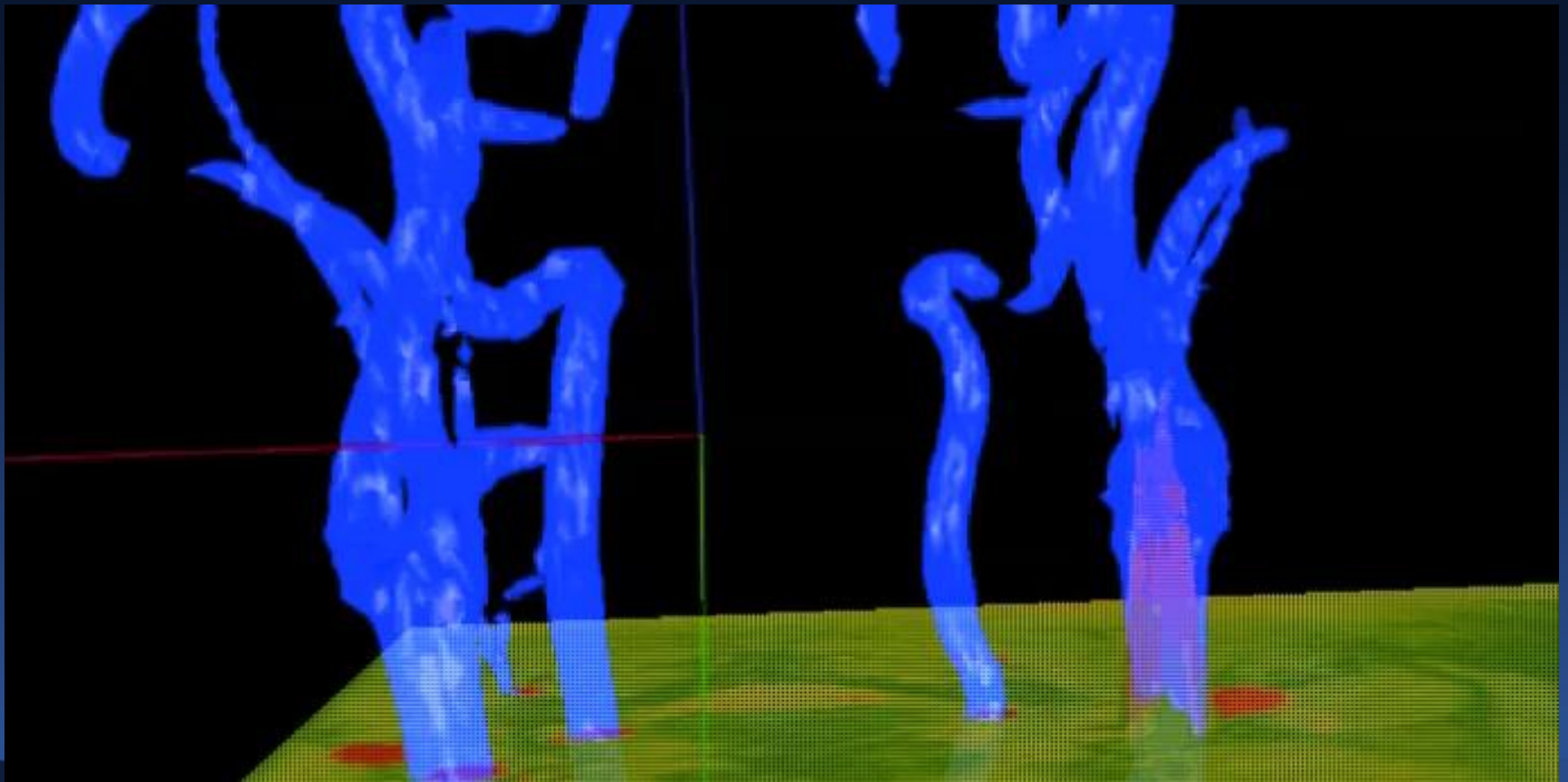


# NOVA qMRA

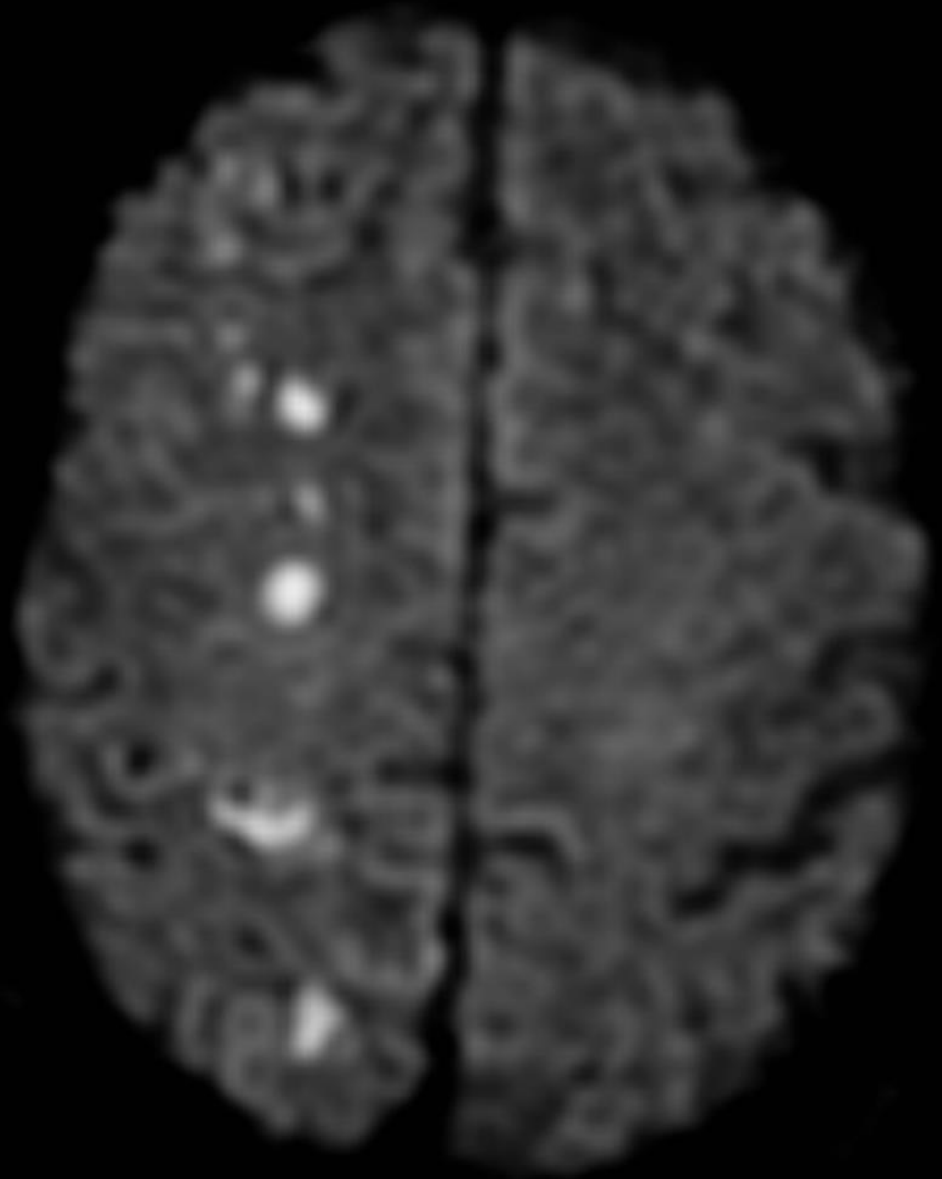
- **Non-invasive Optimal Vessel Analysis**
- **Uses PC MRI technique**
  - **Proportionality of flow velocity and phase shift in the signal of flowing blood**
  - **Calculates flow rate**
  - **Indicates the direction of flow**
- **US Food and Drug Administration 510(k) clearance in 2002**

$$\text{Flow resistance} = \sim 1/r^4$$

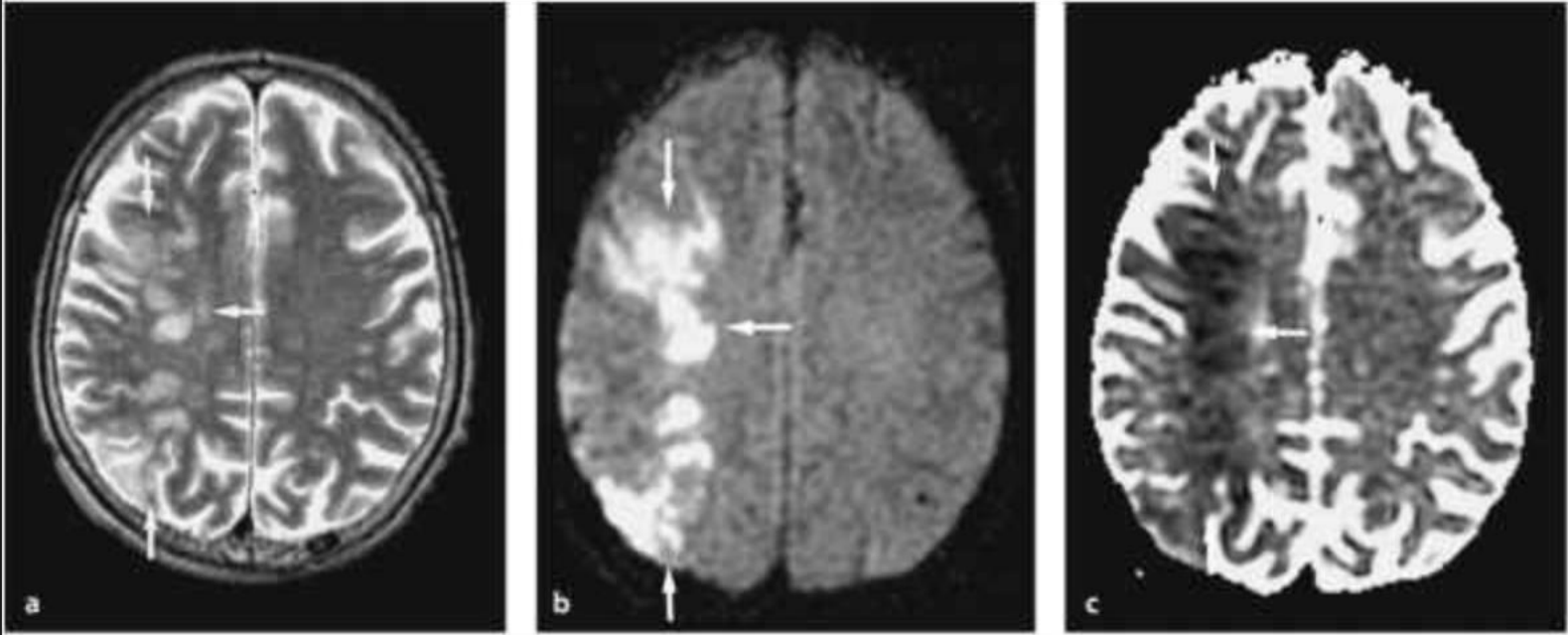
# NOVA MRA 4D Visualization



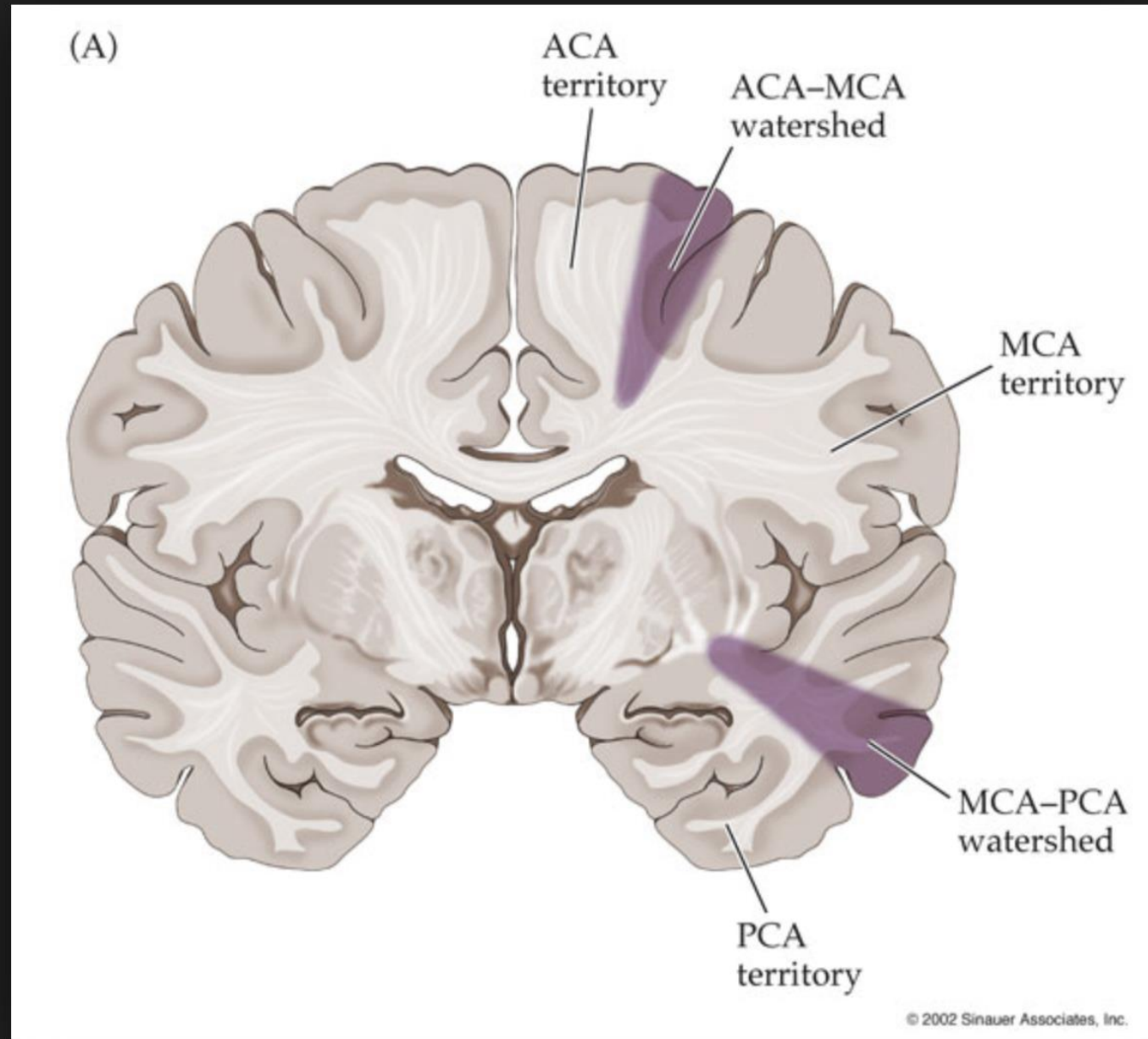
## *Watershed infarcts*



*Watershed infarcts*



## Watershed infarcts



# Chronic Carotid Occlusion: Buffalo Protocol

Neurosurgery. 2010 Oct;67(4):E1152-9; discussion E1159. doi: 10.1227/NEU.0b013e3181edaf99.

**Direct endovascular recanalization of chronic carotid occlusion: should we do it? Case report.**

Hauck EF<sup>1</sup>, Ogilvy CS, Siddiqui AH, Hopkins LN, Levy EI.

# Chronic Carotid Occlusion: Buffalo Protocol

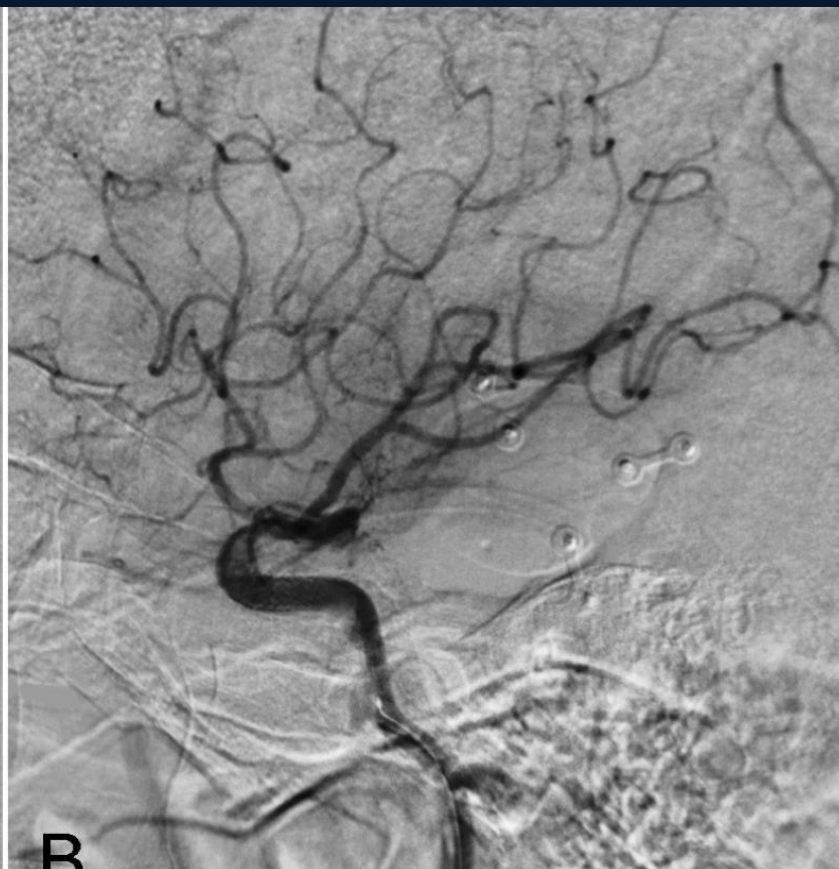
- **9F sheath**
- **MoMA (Proximal Protection System)**
- **5F MPA catheter for support to cross the lesion or Quick cross**
- **May also use Pilot 0.14 wire if there is a taper**
- **Angled 035 exchange length Glidewire to cross the lesion under flow arrest then exchange for 014 spartacore wire**
- **IVUS to confirm the wire in true lumen can be used**
- **Wall stent in the cervical ICA**
- **Rigid Cavernous segment occlusion can be crossed with Gold tip microwire and Nautica (rigid microcatheter)**
- **Balloon mounted Coronary stents for Petro Cavernous ICA or Self expanding Wingspan stent**

# Chronic Carotid Occlusion: Case Example

- **54M presented with dysarthria and mild right hemiparesis, NIH 2**
- **CTSS demonstrated Lt ICA occlusion, chronic for 3 years based on prior CTA**
- **Hypoperfusion in the Lt ICA territory on CTP**
- **Patchy hypodensities in Lt MCA territory on CT head w/o**

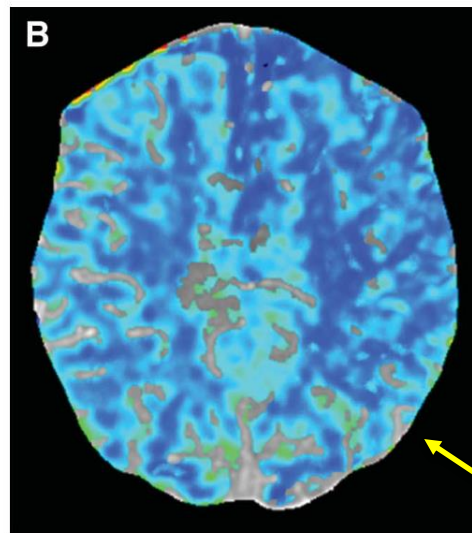
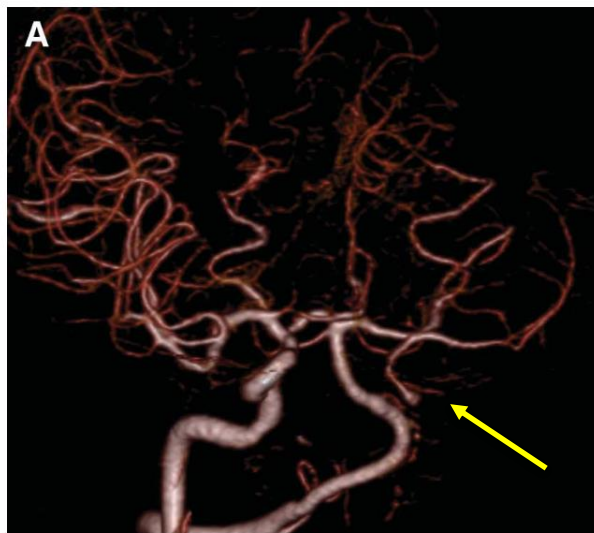






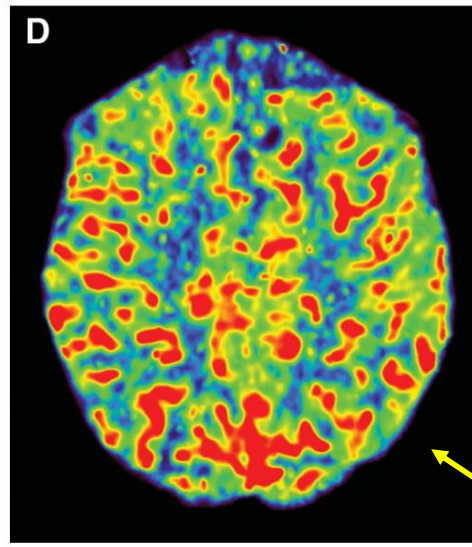
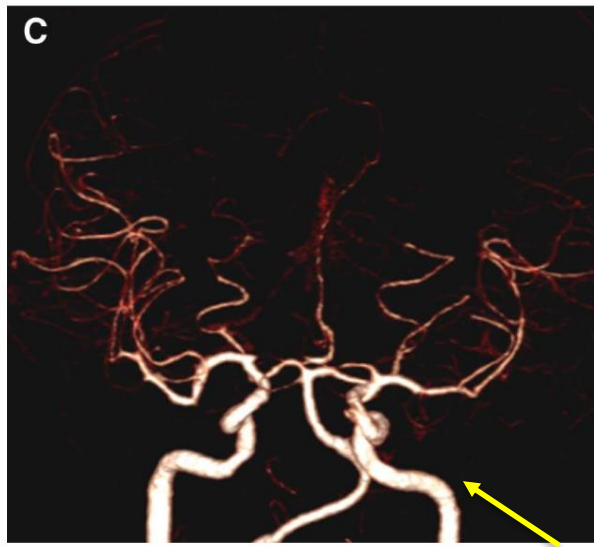
# Chronic Carotid Occlusion: Case Example

*Pre Op*

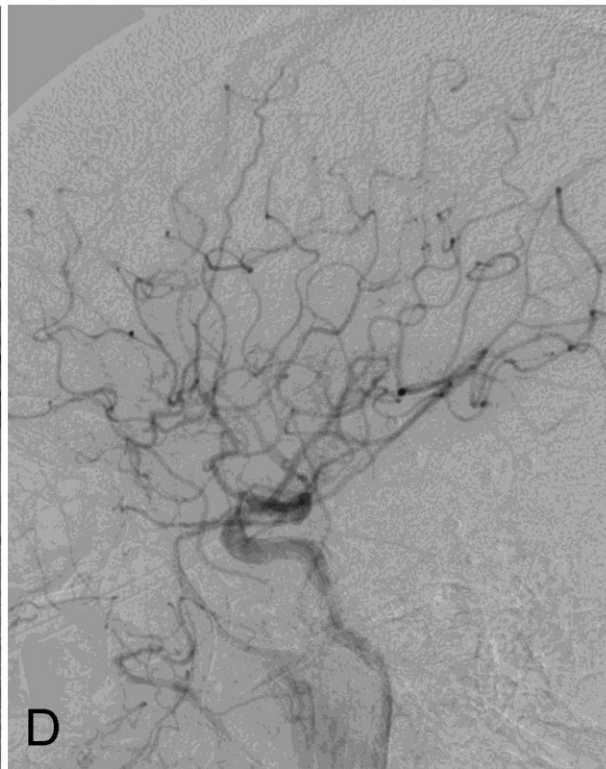
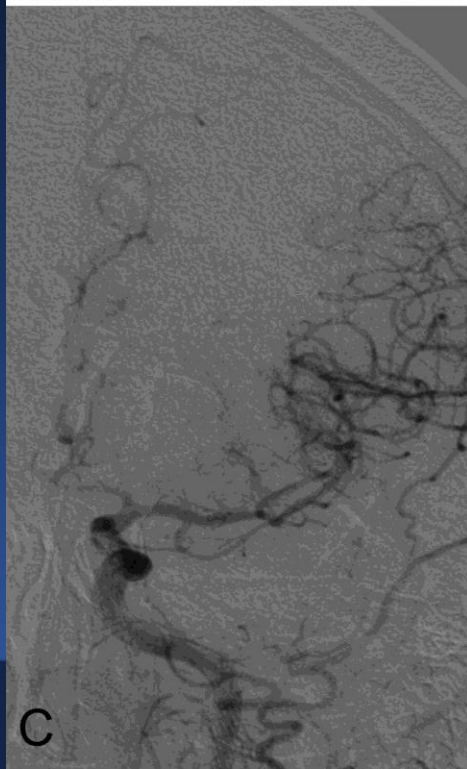
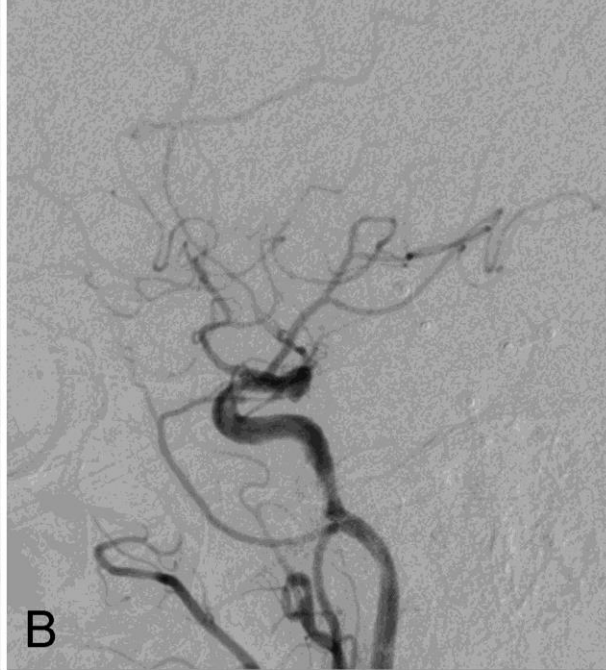


*CBF showing hypoperfusion*

*Post Op*



*CBF nearly symmetric*



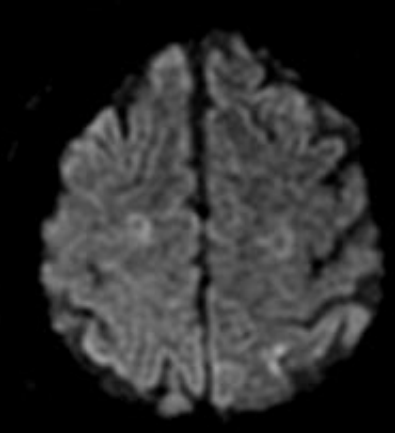
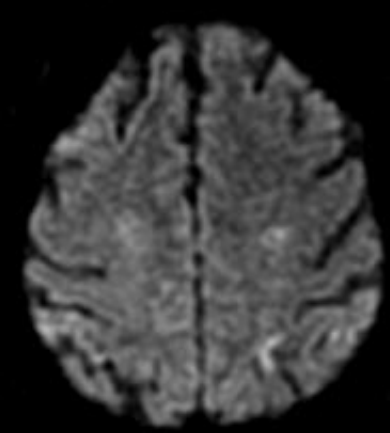
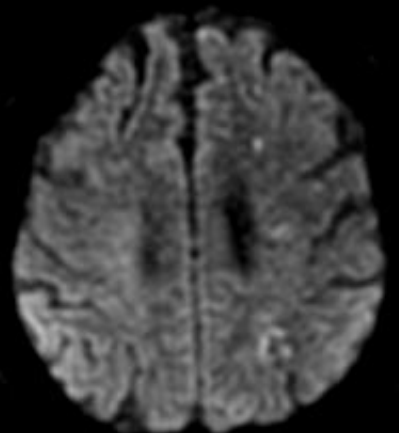
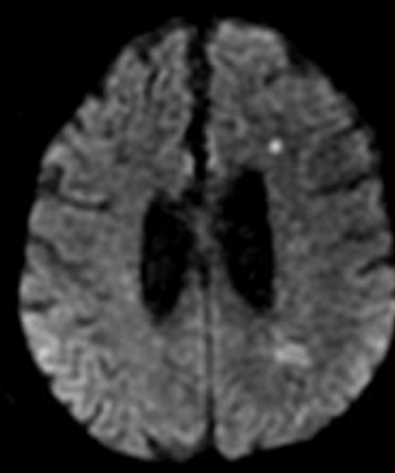
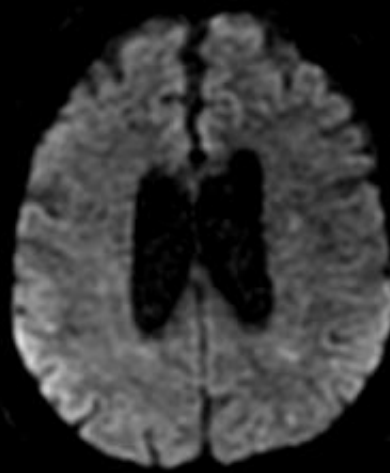
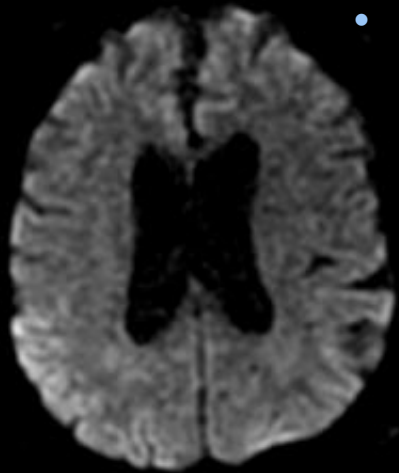
# Chronic Carotid Occlusion: Case Example

- **Did well post op**
- **NIH 0**
- **Monitored in ICU for several days until BP controlled with oral anti hypertensive's**
- **Discharged home**

# Chronic Carotid Occlusion: Case Example

# Presentation MRI/DWI with L ICA occlusion

• 8/20/09



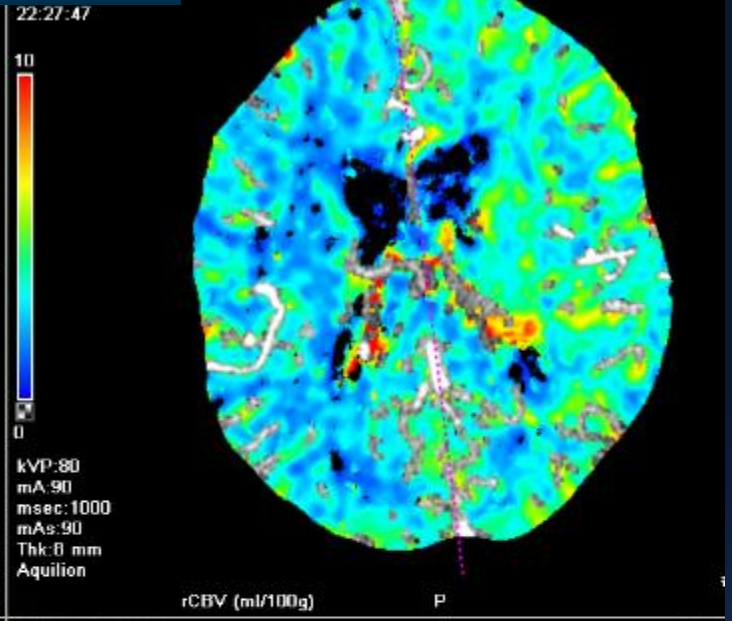
# CTP @ Presentation

MFC  
Ref: BOR  
CT Str

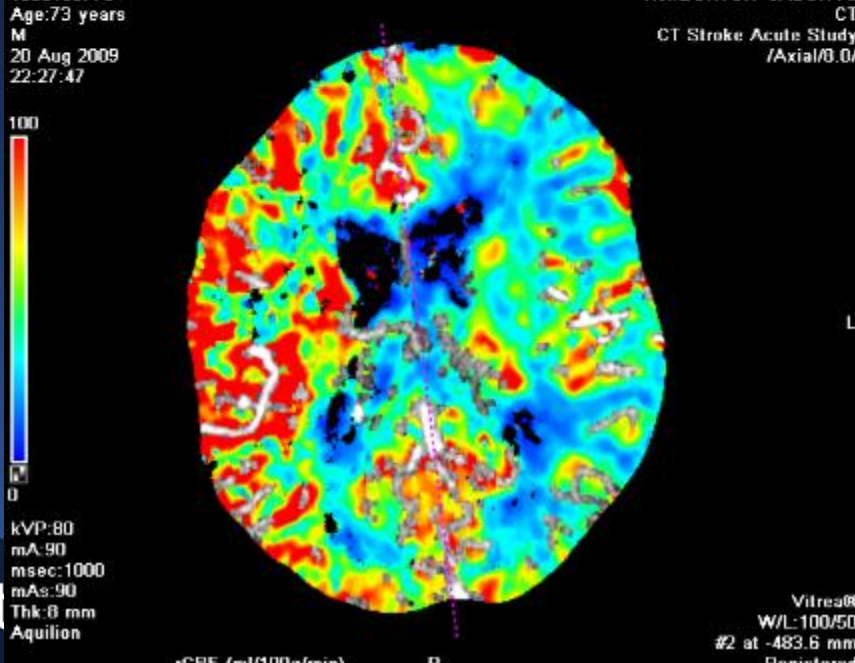
22:27:47



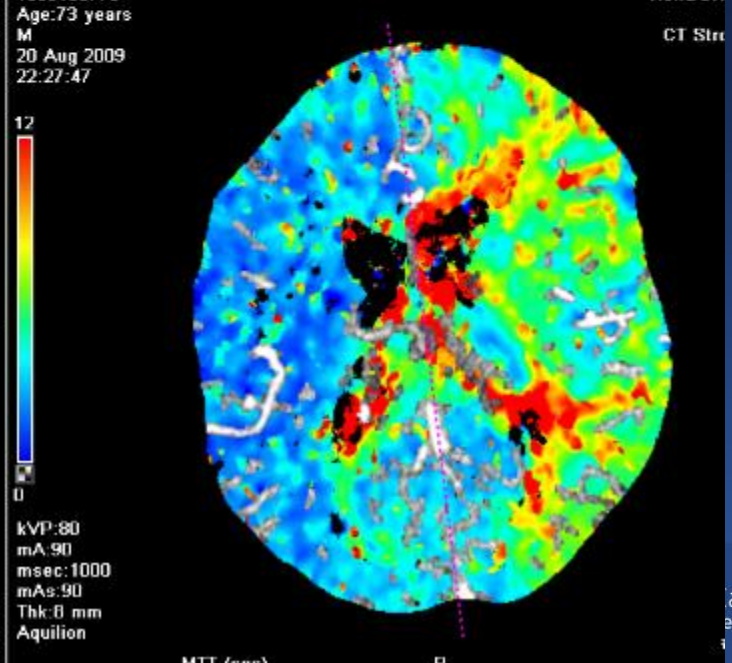
22:27:47



Age:73 years  
M  
20 Aug 2009  
22:27:47



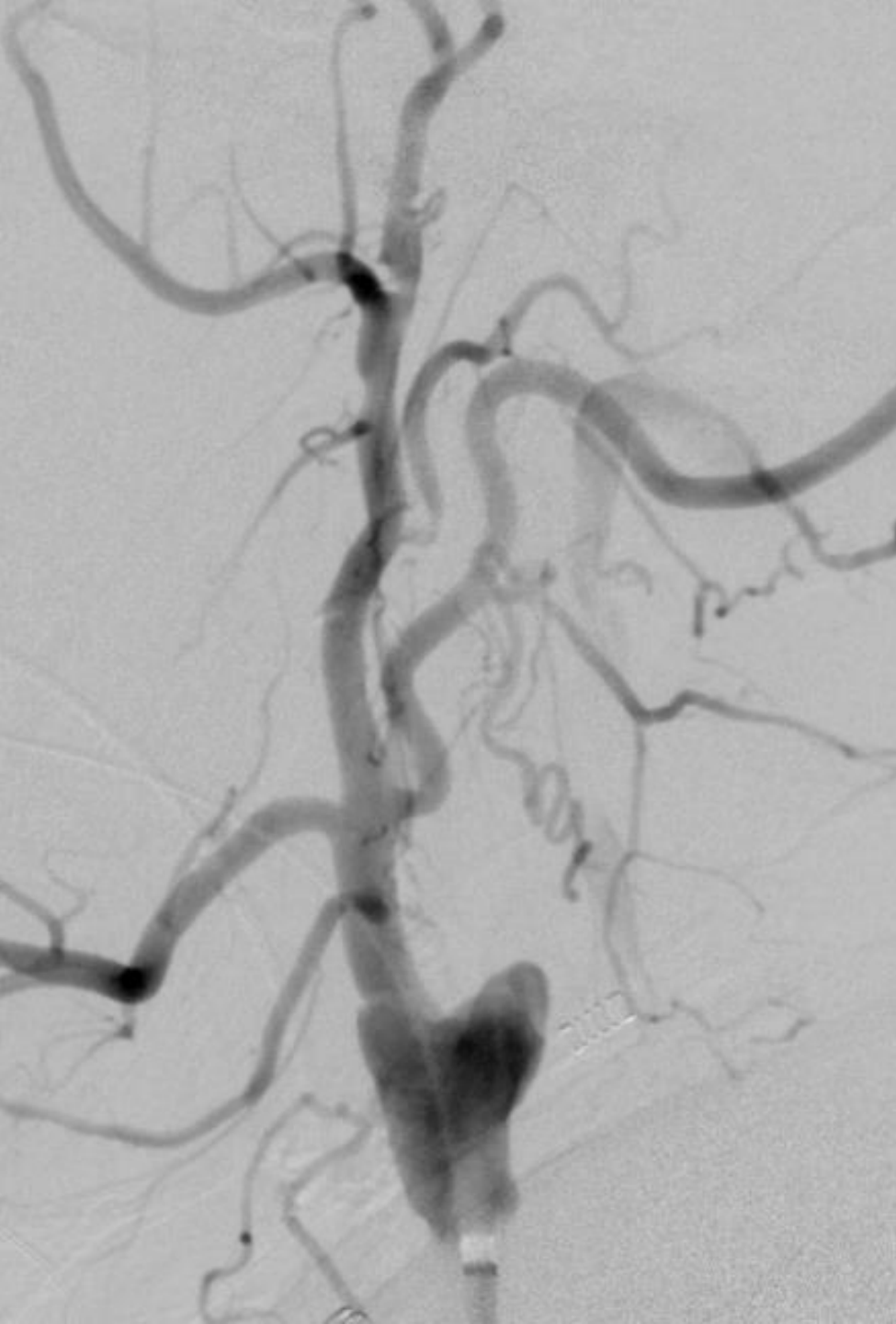
Age:73 years  
M  
20 Aug 2009  
22:27:47





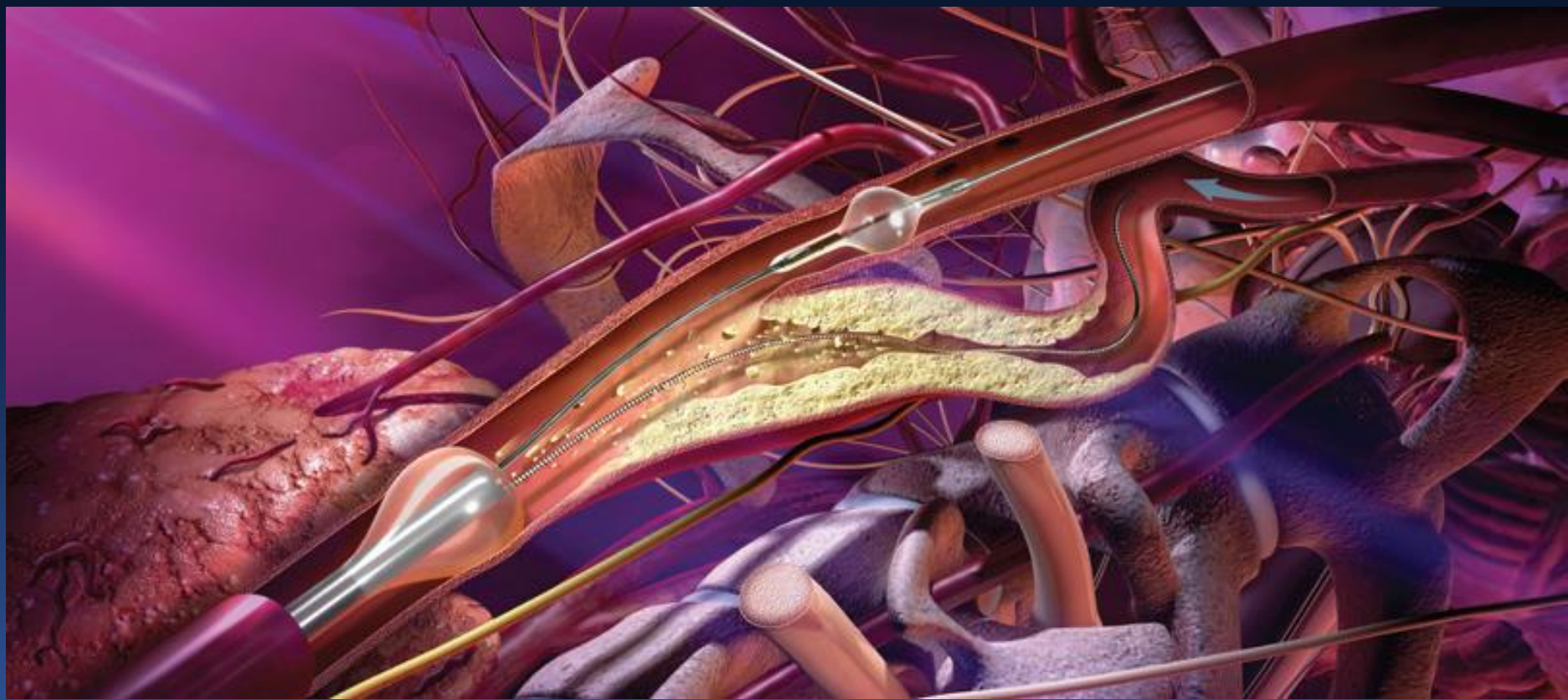
# DEVICES USED

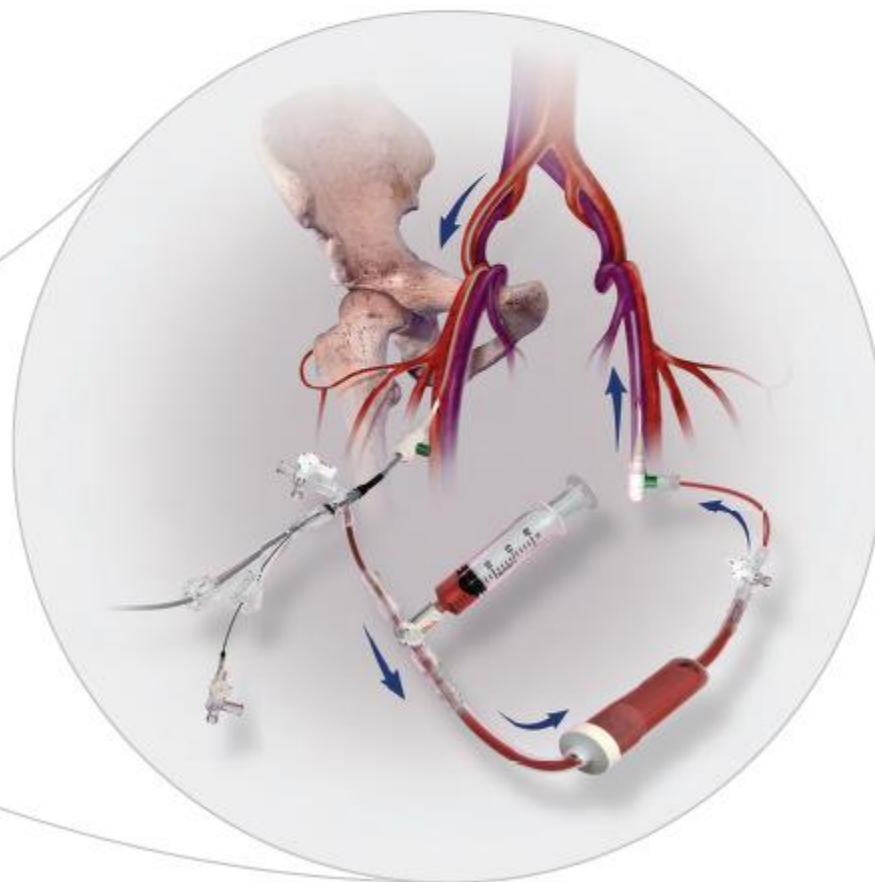
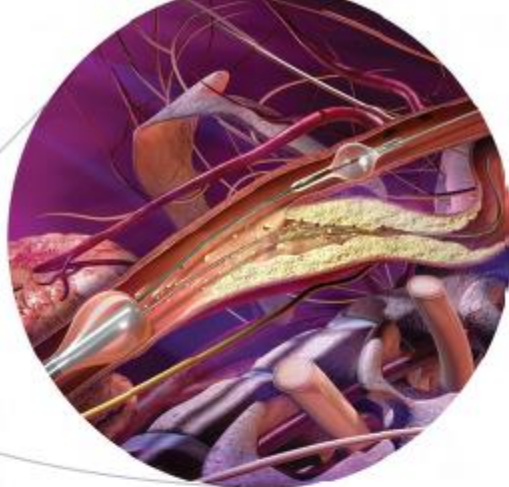
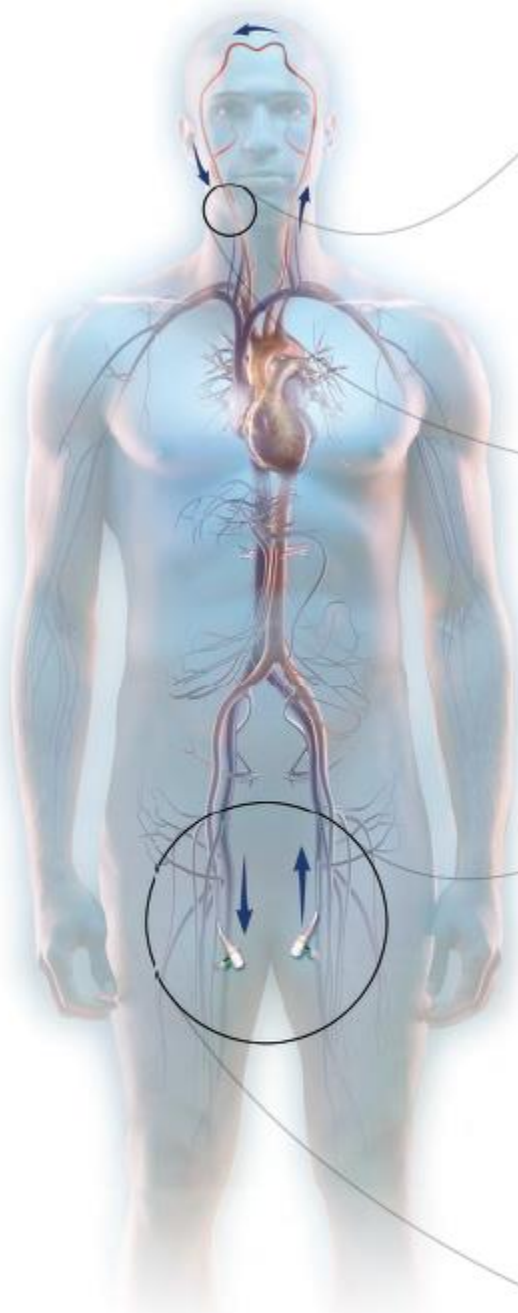
- 1. A 6 Fr sheath.
- 2. 7 and 9 Fr dilators
- 3. Stiff 35 exchange.
- 4. VTK.
- 5. 9F Gore flow reversal system
- 6. Heparin 3500 / ACT 484 + 1600 / ACT 272.
- 7. Excelsior 1018, Gold tip, All Star micro wire.
- 8. IVUS.
- 9. Wallstent 6 x 22 and 6 x 22.
- 10. Aviator Plus balloon 6 x 30.
- 11. All Star micro wire and 8 Fr Angio-Seal.

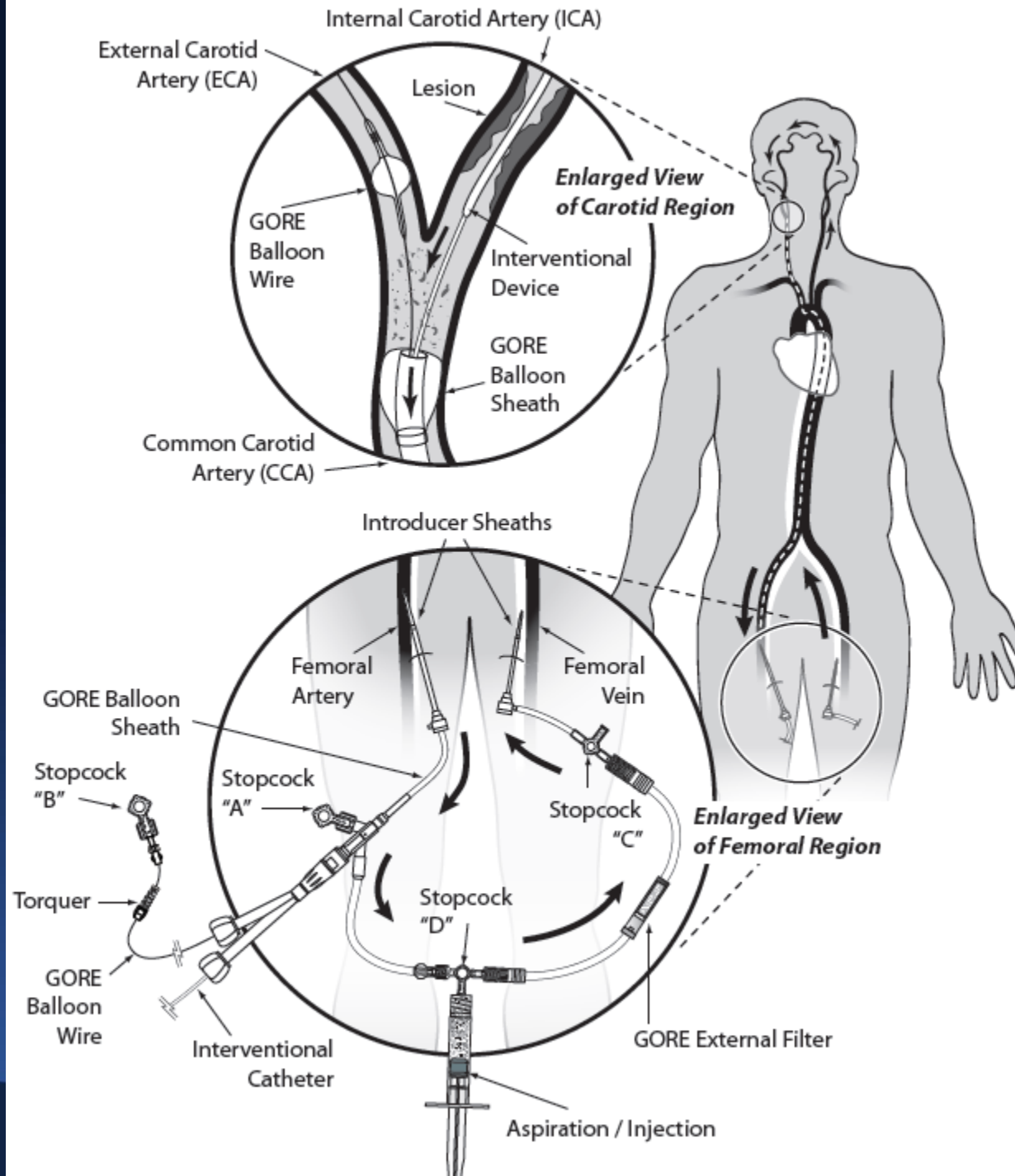


# Plan

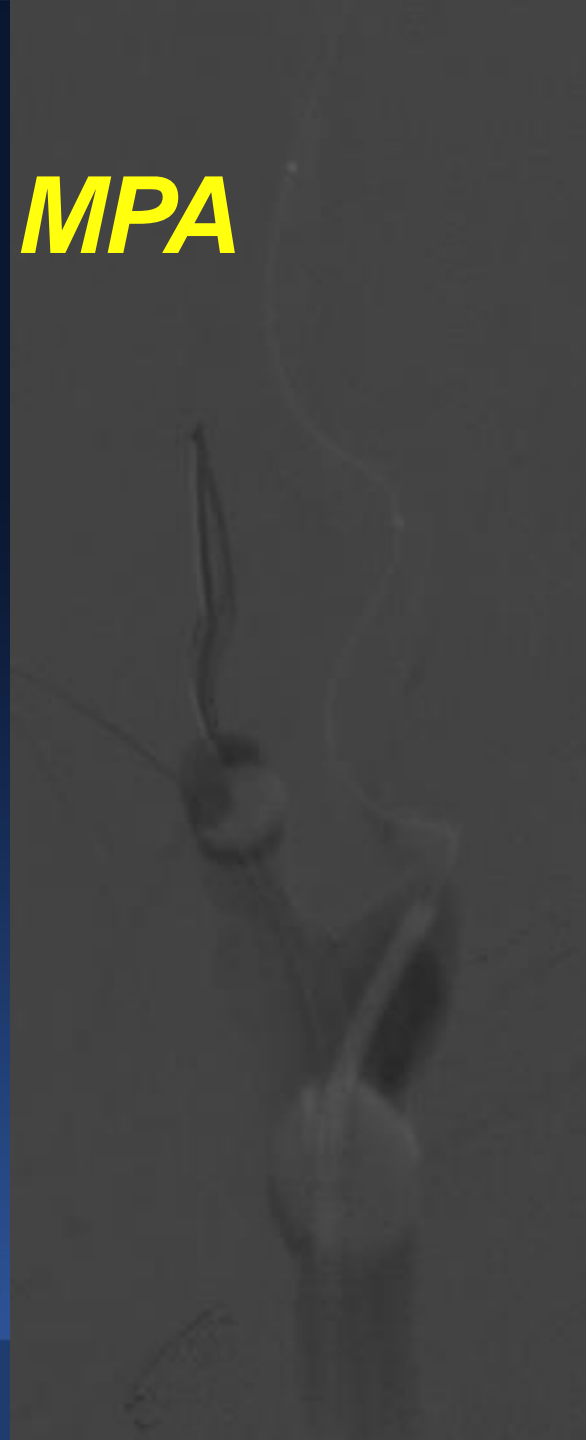
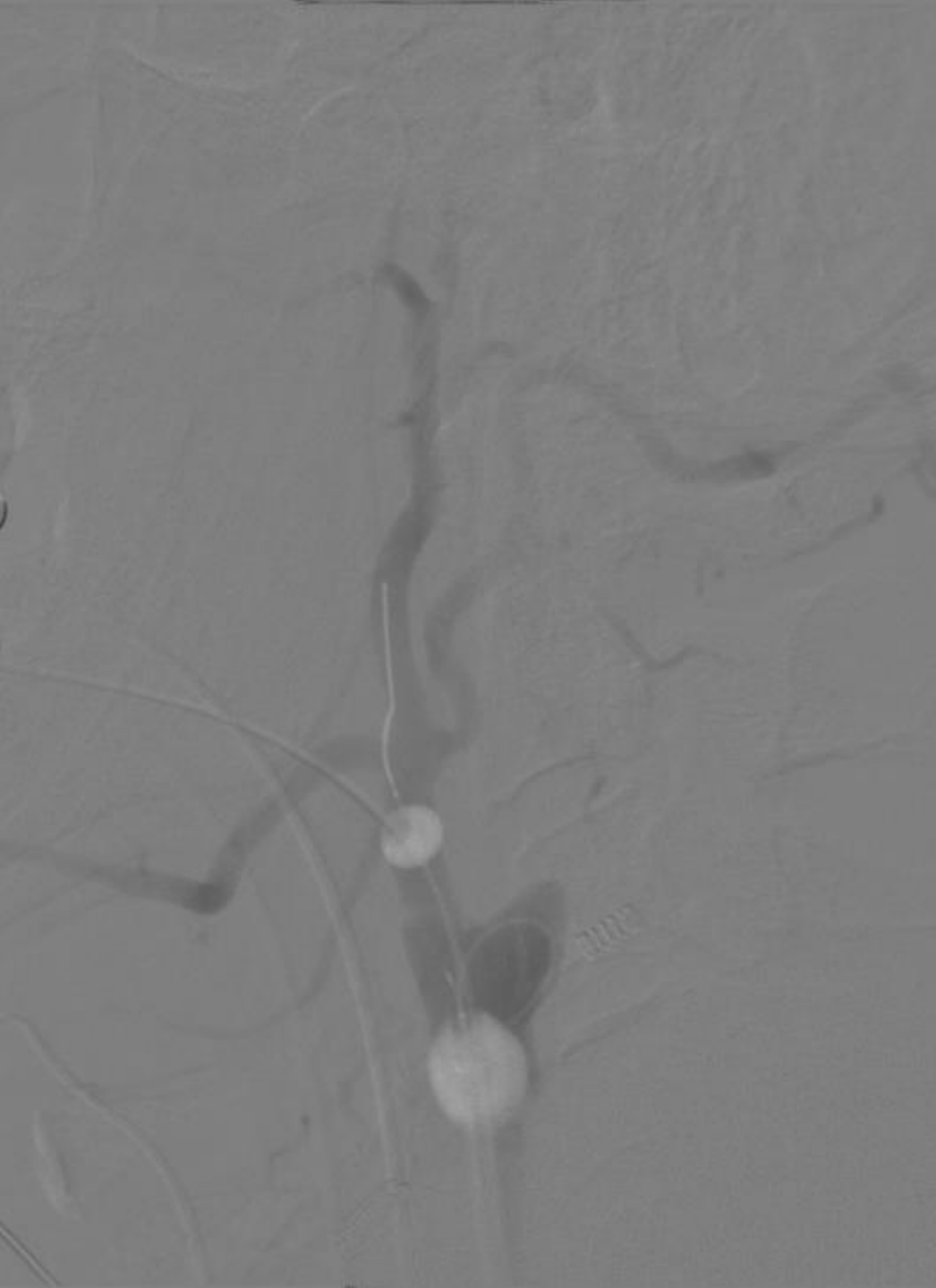
- 1. Do Nothing**
- 2. Medical Management**
- 3. Open surgical repair**
- 4. Percutaneous balloon**
- 5. Endovascular repair**

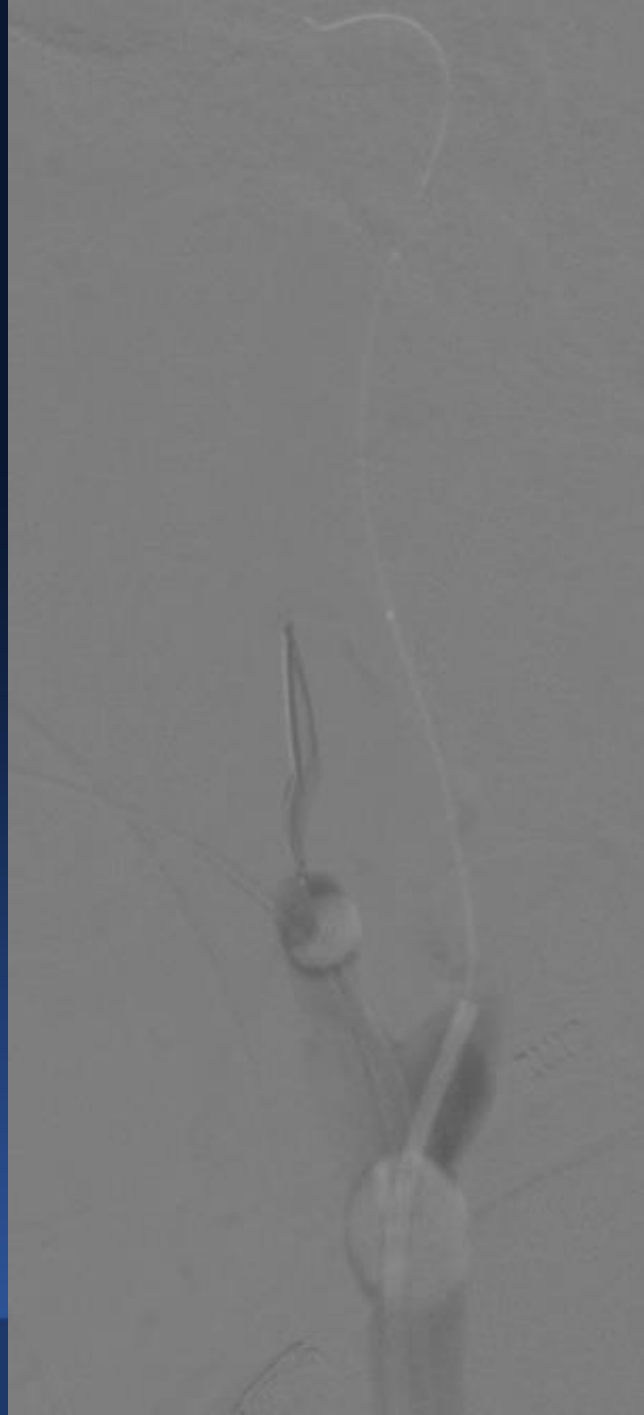
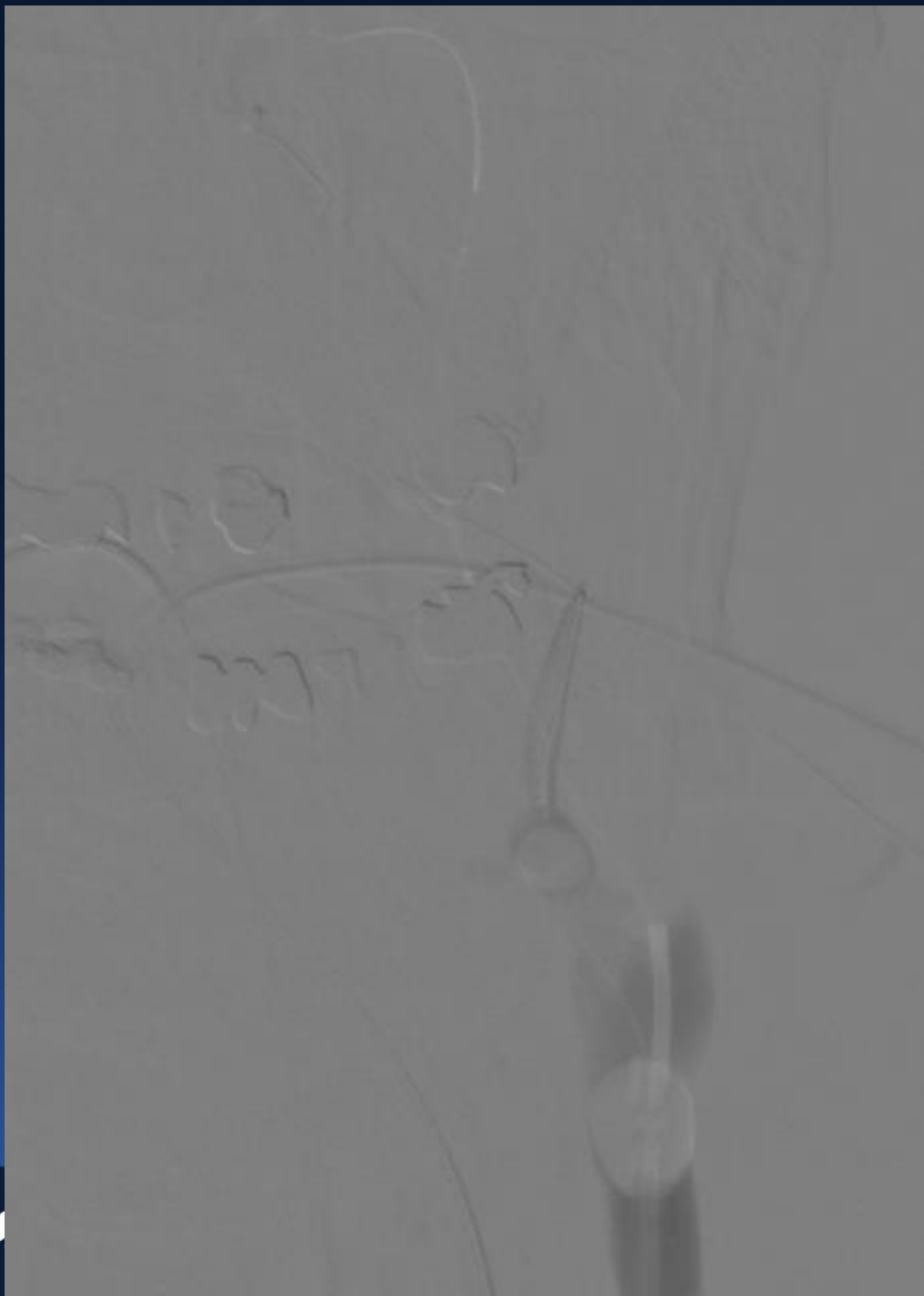






***MPA***

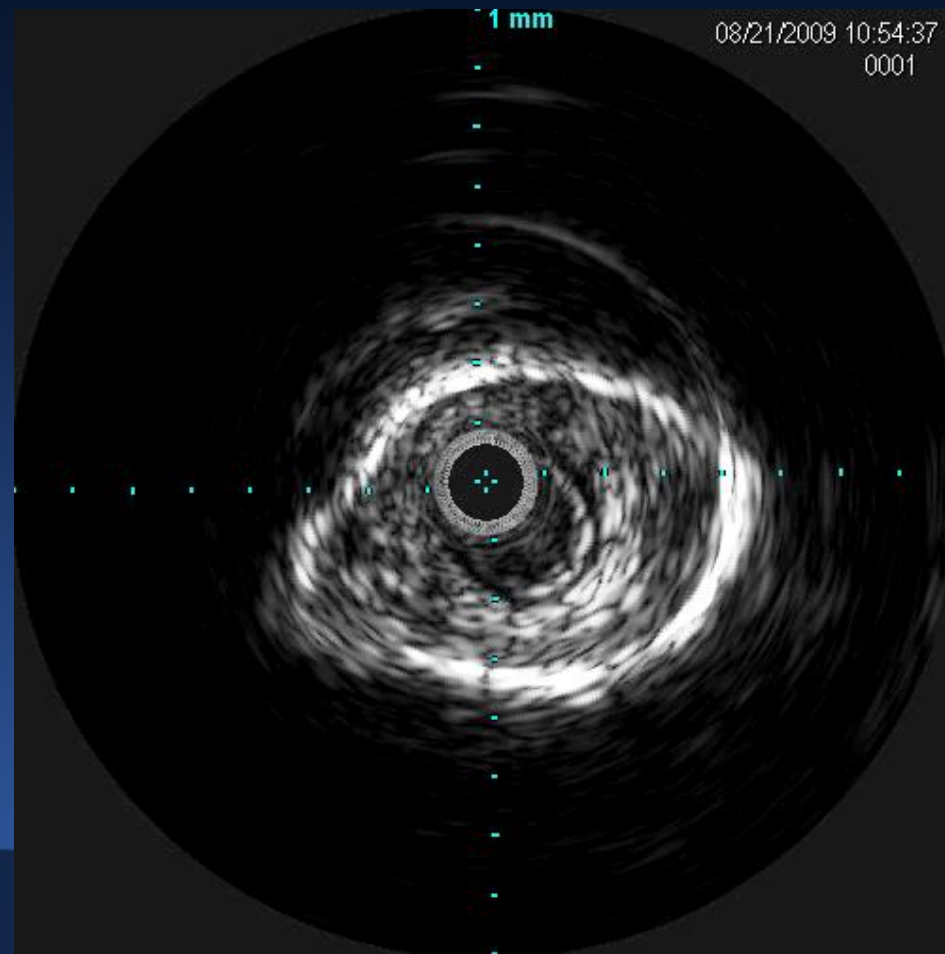




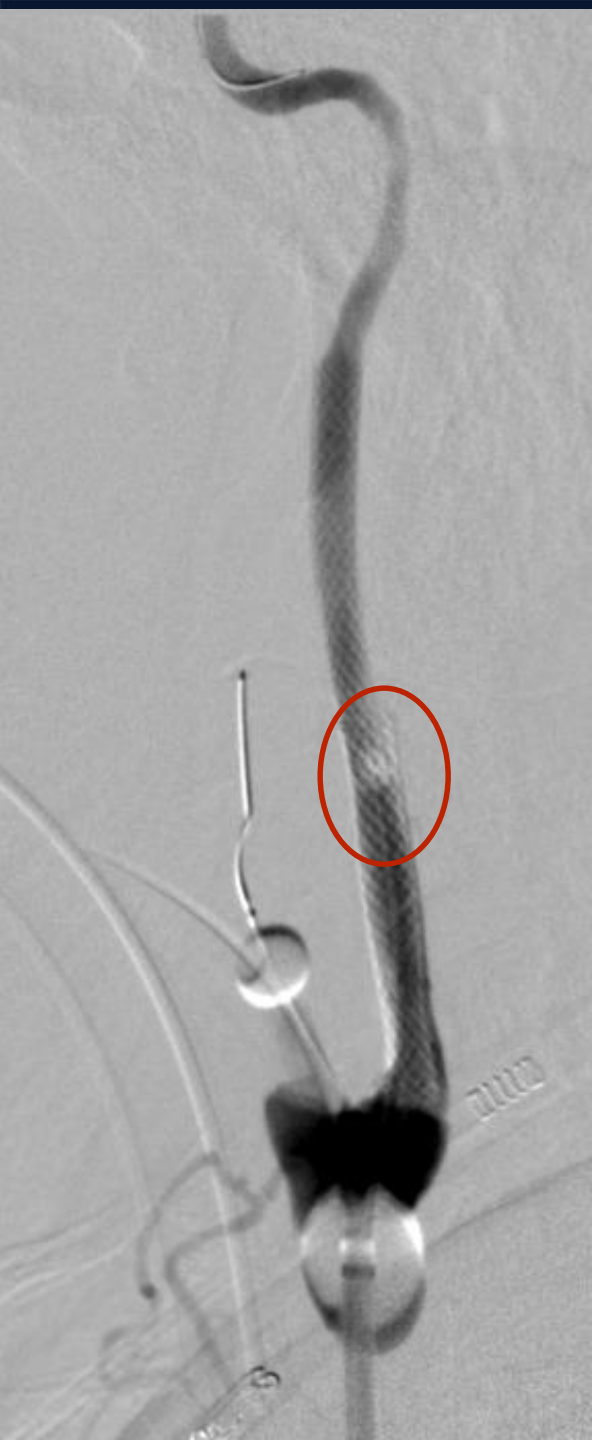




**ECA: Hypoechoogenic**  
**ICA: Hyper (dye stasis) with hypo (intraluminal thrombus)**



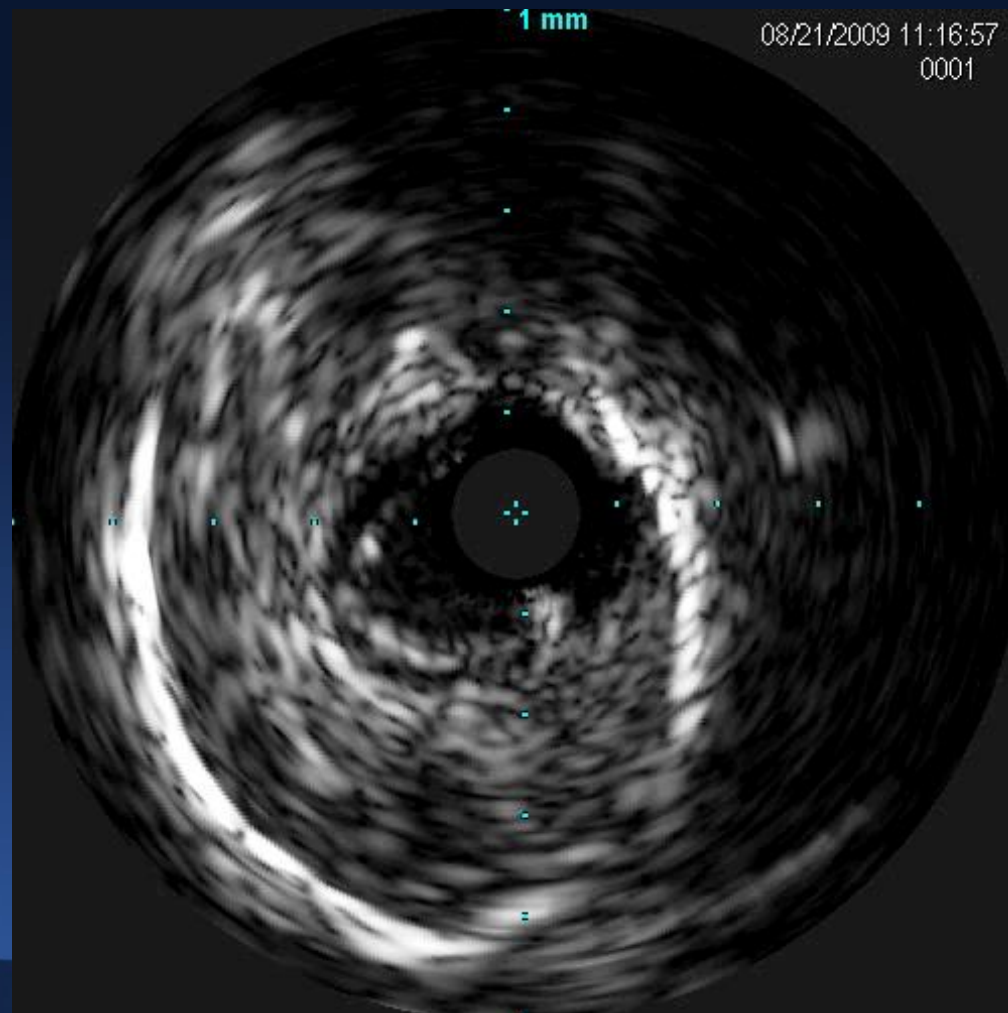




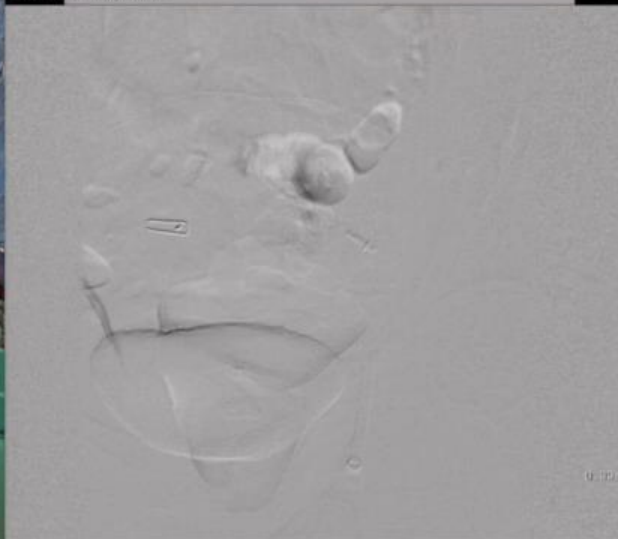
**Filling  
Defect!  
?Thrombus**



# No Intraluminal Thrombus



- **Hosp. Course:**
  - **POD#2 &4: NIHSS = zero**
  - **Patient was D/C home on ASA/Plavix**







# Conclusions

- Rare to see a true chronic occlusion
- Most now present acutely or subacutely
- Ideal patient improves with hypertension
- Establish angiography and collaterals
- Ideal patient refills carotid retrogradely or anterogradely to petrous segment
- Establish infarct volume MRI shows watershed hits
- Establish compromised vascular reserve or steal with Diamox
- Use proximal protection
- IVUS prior to restoring antegrade flow

***Thank you!  
Questions?***

