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Is There Treatment for Carotid Occlusion?

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Is There Treatment for Carotid Occlusion?

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Epidemiology and Clinical Presentation of Atherosclerotic ICA Occlusion

- Incidence 6/100,000
- Accounts for ~15-20,000 strokes/year
- Symptoms
 - Hemodynamic TIAs
 - Furlan-Whisnant Sign
 - Increased facial and angular artery pulses
 - Occasionally Horner's
 - Acute Occlusion
 - Crescendo TIAs followed by stroke
 - Severe deficit- NIHSS ≥ 22

Natural History of Chronic Carotid Total Occlusion (CTO)

- Waltimo O, et al. Stroke 1976;7(5):480-2
 - N=155 w angiographic ICA occlusion
 - Median F/U 53m
 - 45% Independent for ADLs
 - 22% deceased by year 5
- Furlan AJ, et al. Neurology 1980;30(9):986-8
 - N=138 w angiographic ICA occlusion
 - Mean F/U 5yrs
 - Stroke rate 3%/yr, 8X expected rate
- Rautenberg W et al. J Neurol Sci 1990;98(2-3):213-20
 - N=94 w asymptomatic ICA occlusion
 - FU mean 44m
 - Annual Stroke 4.4%
 - Annual mortality 11.3%

Diagnosis

Non-invasive Imaging

- Ultrasound
 - Specificity 95-99%
 - Sensitivity 86-96%
 - Pitfalls: Dense calcification, “Near Occlusion”
- MRA
 - Sensitivity 95-99%
 - Specificity 60-98%
 - Limitations- Movement, Distal Occlusion
 - Hammond CJ, et al. *European J of Vasc & Endovasc Surg* 2008;35(4):405-12
- CTA
 - Sensitivity 95-99%
 - Specificity 90-98%
 - Limitations- Ca²⁺, Distal Occlusion, Poor timing of Bolus

Diagnosis

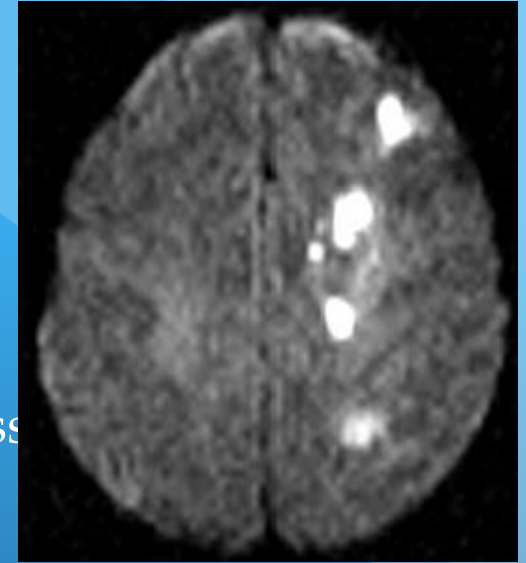
Luminal Imaging

- DSA- Gold standard
 - Differentiate “string sign” from occlusion
 - (1) delayed cranial arrival of ICA contrast compared with ECA; (2) intracranial collaterals seen as cross-filling of contralateral vessels or ipsilateral contrast dilution; (3) obvious diameter reduction of ICA compared with opposite ICA; or (4) ICA diameter reduction compared with ipsilateral ECA.
 - Assessment of ECA-ICA collaterals and intracranial collaterals
 - Pre-surgical assessment

Fox A, et al. AJNR 2005;26(8):2086-94

Ischemia Mechanisms

- Thrombotic occlusion
 - Acute plaque rupture → Thrombosis → Vessel Occlusion → Ischemia
- Artery-to-artery embolism
 - Acute plaque rupture/Turbulence/Sheer Stress → Thrombosis → Embolism → Ischemia
 - Stump embolism??
- Hypoperfusion
 - Flow-limiting stenosis → Autoregulation Failure → Hypoperfusion → Ischemia
- Combination- Impaired “Washout of Emboli”

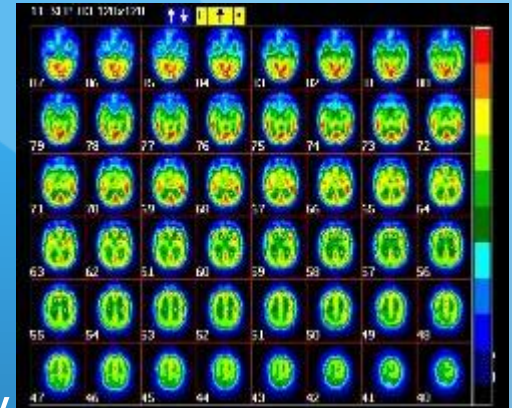


Hemodynamic Ischemia

- Higher risk of recurrence
 - Impaired Cerebrovascular Reserve: Annual Stroke ~25%
Eskey & Sanelli *Neuroimaging Clin N Am* 2005;15
- Especially if
 - Orthostatic symptoms
 - Exercise
 - Low blood pressure
 - Retinal claudication: HR 3.8, 95% CI 1.5 to 9.5
 - Leptomeningeal collaterals (vs. direct, e.g. ACom, etc.)
 - HR 4.1, 95% CI 1.3 to 13.1
Klijn CJ et al. *Neurology* 2000;55:1806-12
- Ischemic tolerance improves over time: ↑ O₂ Extraction Fraction
Derdeyn C et al. *Stroke* 1999;30:1019-24

Assessment of Cerebrovascular Reserve

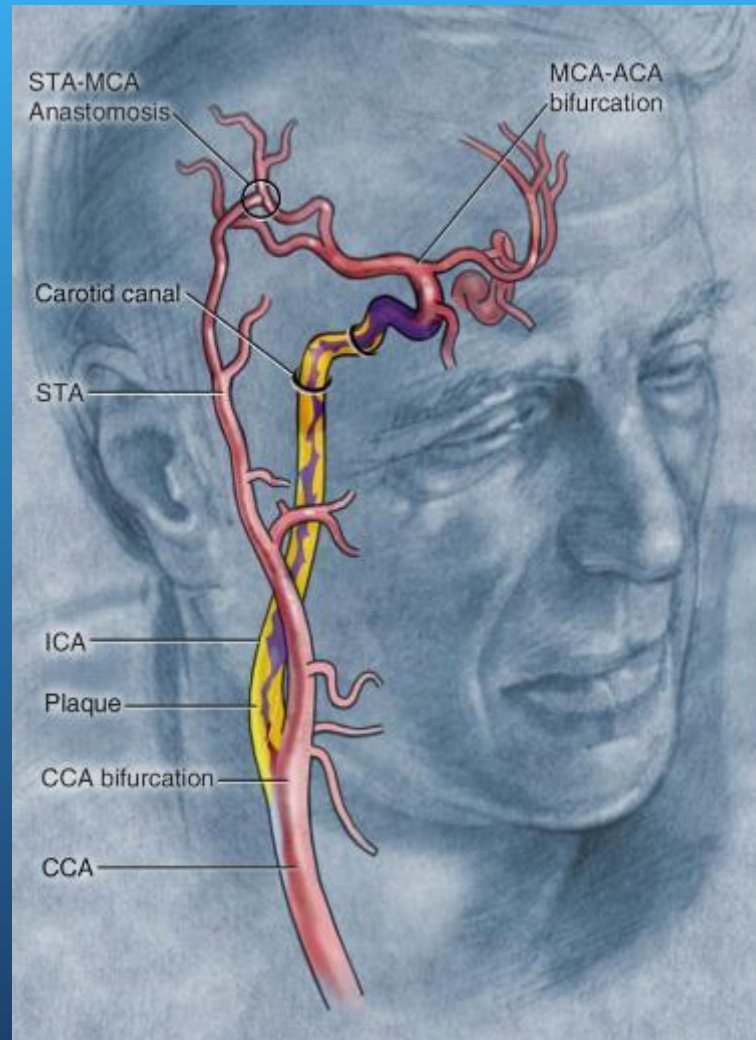
- OEF PET is Gold standard
- Acetazolamide SPECT
 - Useful in combination with an anatomical study
 - Annual Stroke Rates as high 25%
 - RR of ipsilateral stroke 8 (95% CI[1.9-34.4], $p=0.0001$)
- Perfusion CT +/- acetazolamide
 - Good correlation w SPECT
 - Miyazawa N et al. Clin Neurol Neurosurg 2005;108(1):11-17
- Transcranial Doppler U/S with breath holding or acetazolamide
- Xenon CT



Medical Treatment

- Antithrombotics
 - Anticoagulants- stump emboli
 - Aspirin
 - Clopidogrel
- Blood Pressure
 - Augmentation?
 - Days, weeks?, months????
- Statins, etc.
- Avoid dehydration

Surgical Treatment: Indirect High-flow Surgical Bypass



Indirect Recanalization External Carotid-Internal Carotid Bypass (STA-MCA Bypass)

Rates of fatal or non-fatal stroke

	<u>Medical</u>	<u>Surgical</u>	
MCA \geq 70%	14/59 (24%)	22/50*(44%)	p<.05
ICA \geq 70%	26/72 (36%)	29/77 (38%)	NS

* 14% convert from stenosis to occlusion on post op angiogram

(Furlan et al 1980, Awad et al 1984)

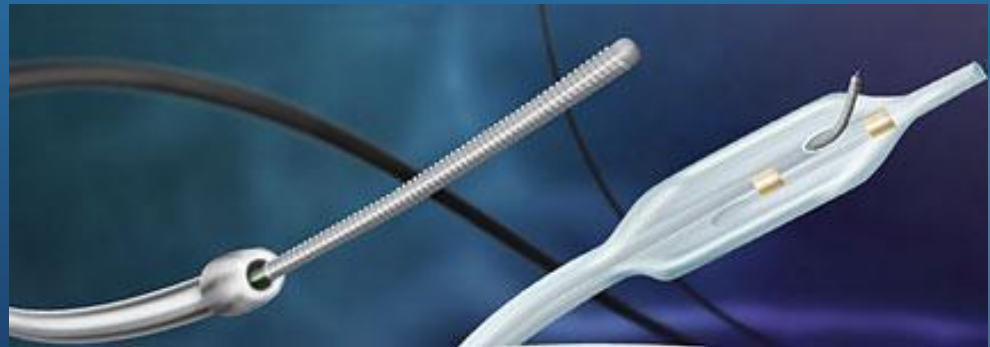
Carotid Occlusion Surgery Study COSS

- EC-IC Bypass for ICA occlusion
- PET documented increased OEF
- Planned N=700 stopped after 195- Futility analysis
- 98 Medical Rx and 97 EC-IC bypass
- Perioperative Stroke 15%
- 2year stroke 21% vs 23%

Powers W et al. JAMA 2011;306:1983-92

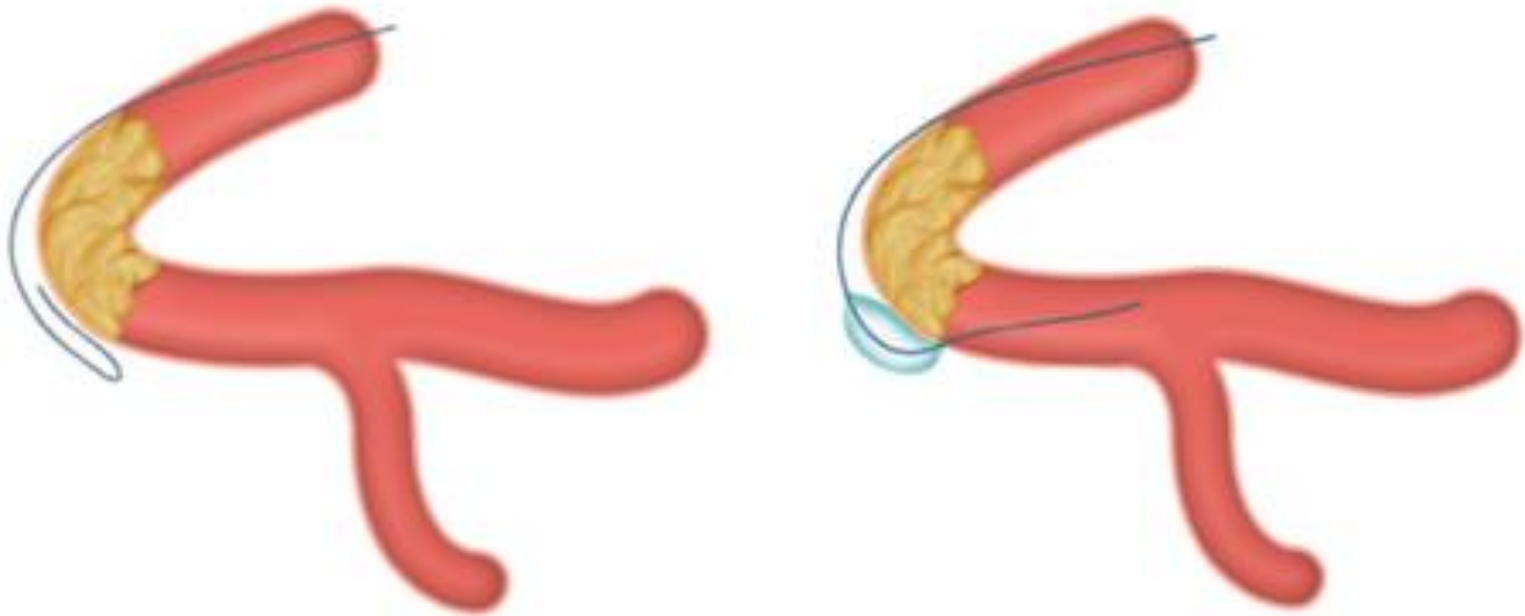
Why Might An Endovascular Approach Be Appropriate

- Allows restoration of antegrade flow
- Endovascular techniques have been developed in the treatment of CTO in coronary artery disease
 - Common practice
 - Antegrade and retrograde approaches
 - Numerous devices and techniques



Endovascular CTO Treatment Antegrade Approach

Antegrade dissection/reentry



Source: R. R. Baliga, Scott M. Lilly, William T. Abraham:
Color Atlas and Synopsis of Interventional Cardiology
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Carotid CTO

Total Endovascular Reconstruction

- Case reports
 - Terada T et al. Journal of Neurosurgery 2005;102:558-64
 - Ishihara H et al. Interv Neuroradiol 2006;12(3):263-8
- Case Series
 - Terada T Journal of Neurosurgery 2010;112(3):563-71
 - Successful in 14/15 patients
 - 10 cervical occlusion
 - 4 petrous
 - Lin M et al. Circ Card Interv 2008;1:119-25
 - Successful in 35/54(65%)
 - Stroke/Death 4%
 - No long term f/u

Personal Experience

- N=20
 - All symptomatic w recurrent ischemia and decreased cerebrovascular reserve
 - Stroke 86%
 - Hemodynamic TIAs 83.3%
 - One patient w progressive focal cognitive decline
 - Mean duration of occlusion 202 ± 316 days (6-1020)
 - Mean Age 64 ± 6.9 yrs
 - 46.7% female
 - 1 African-American

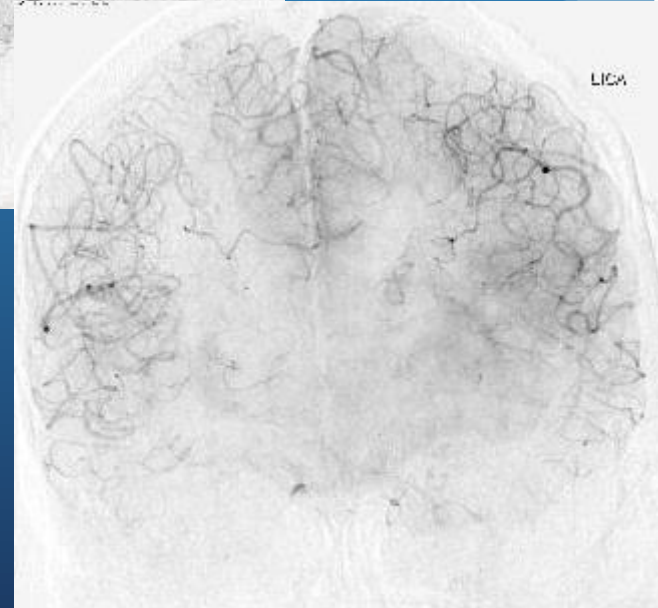
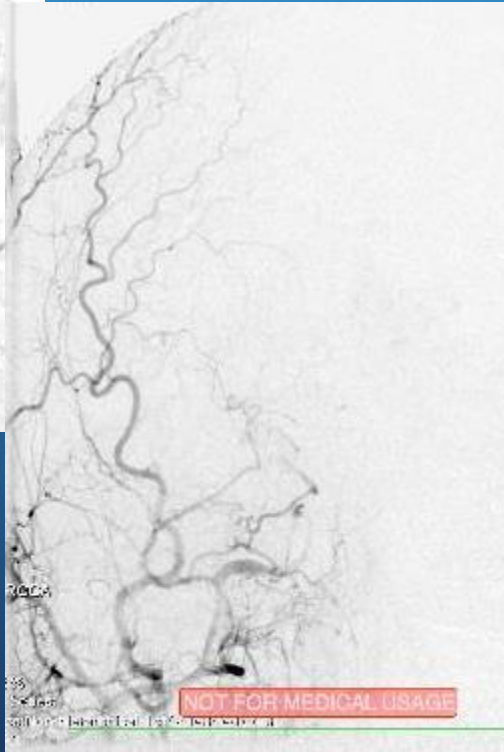
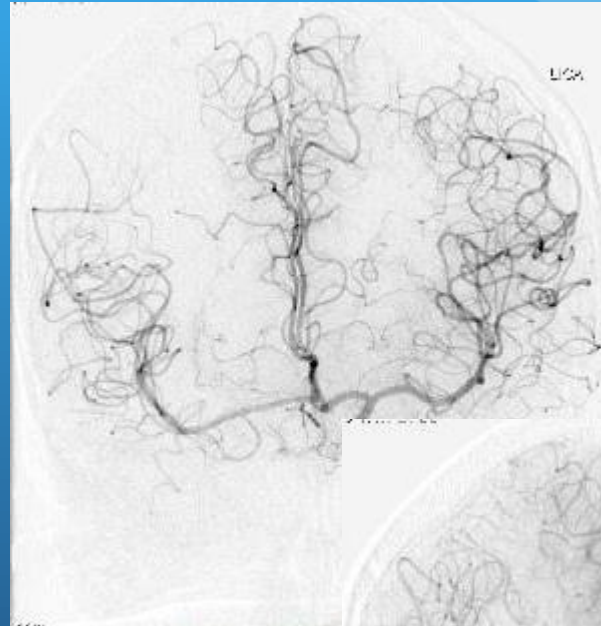
Results

- Technical success 17/20 (85%)
- Mean procedure duration 132 ± 52 min
- Complications
 - 1/20 (5%)- Fatal ICH due to wire perforation in patient with intracranial occlusion (first patient treated)
- 1 (5.2%) restenosis at 6months
- No recurrent events
 - Mean FU 10.5 ± 10.6 months (range 2-48)

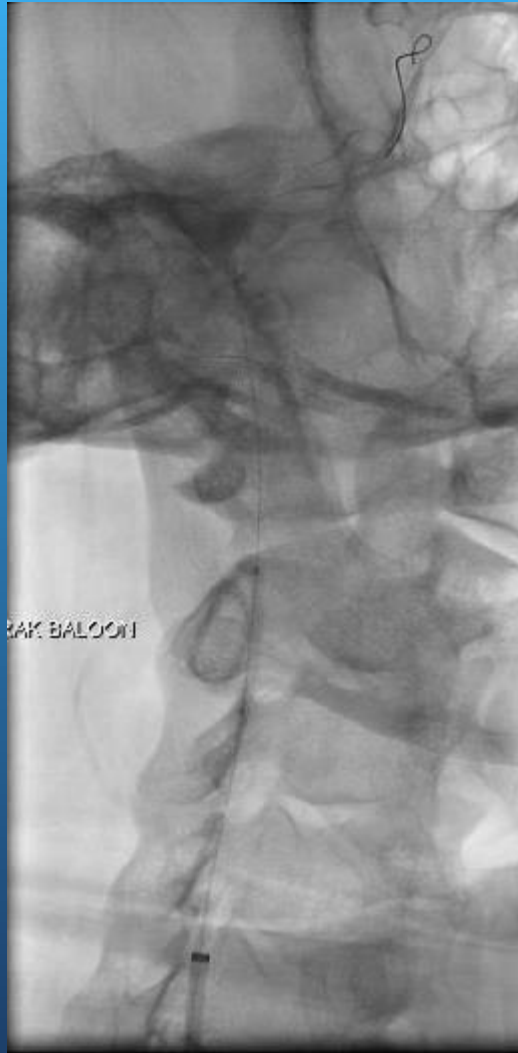
Illustrative Case 1

- 57yo Left H musician w HTN, DM, Obesity, Smoking
 - 2months prior RMCA syndrome s/p IV tPA
 - Dx RICA occlusion
 - Tx with ASA and a NOAC
 - Recovered to mRS 1
 - Presents w frequent, intermittent L hand weakness
 - Started on high-dose statin and clopidogrel and ASA
 - Diamox SPECT- Moderate decreased perfusion inferior R frontal and adjacent fronto-temporal

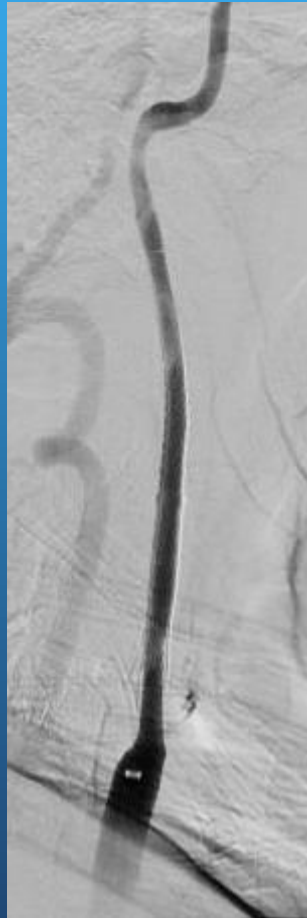
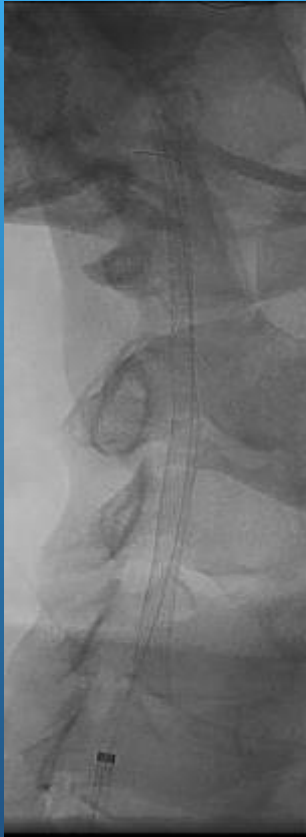
Diagnostic Angiogram



Endovascular Approach



Outcome



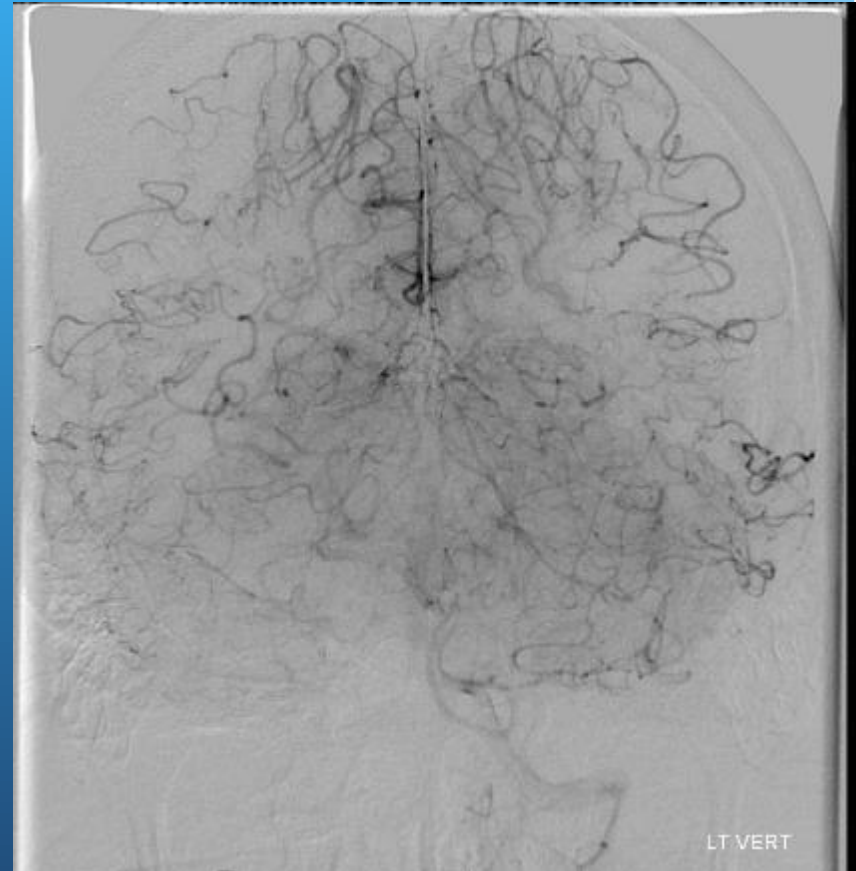
Clinical Course

- Sx resolved
- Restenosis cavernous ICA at 6 months
 - Successful treatment with DES
- TCD and Carotid U/S stable
- F/U angiogram at 6months all stents patent
- Asymptomatic for 2 years

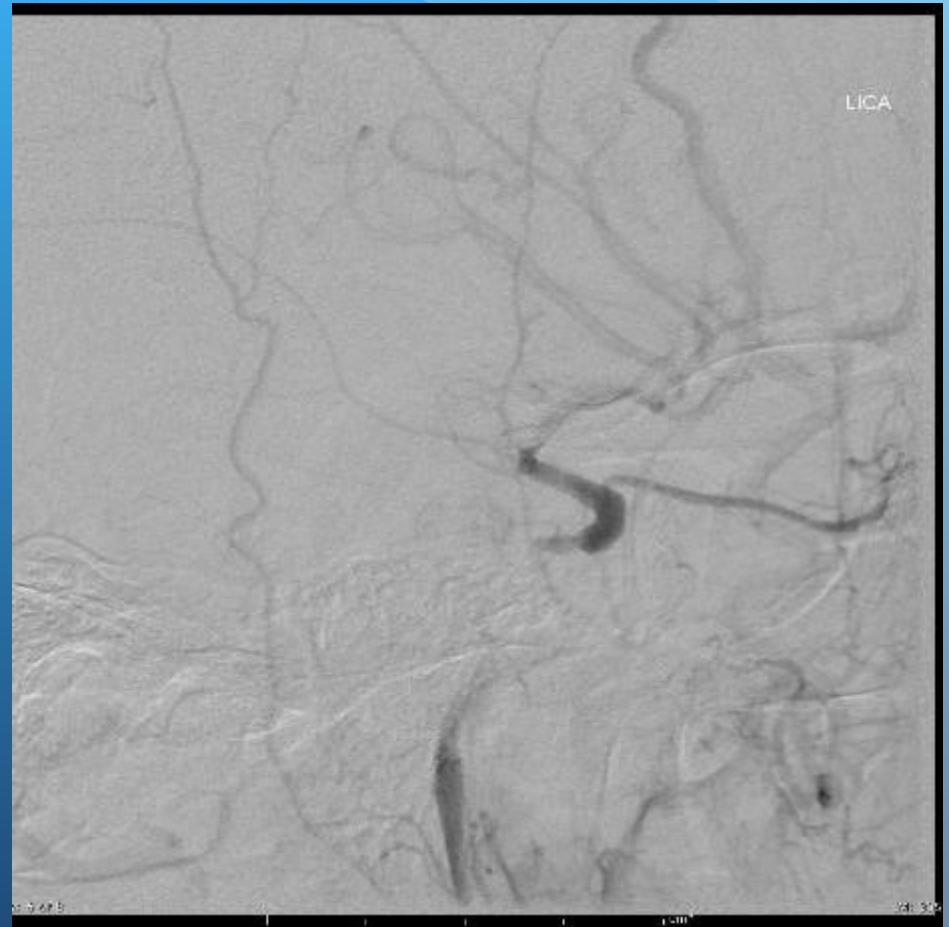
Illustrative Case 2

- 62 yo WM with HTN, HLD, Cigs, Hepatitis C
- Recurrent left retinal TIAs X6months
- Left Hemispheric TIAs Tx with aspirin 2months prior
 - Dx Carotid Occlusion by U/S
- Hemsipheric stroke, full recovery 1month prior
 - CTA- carotid occlusion
 - Plavix added
 - Recurrent and slowly progressive left hemispheric ischemia
 - Orthostatic Sx

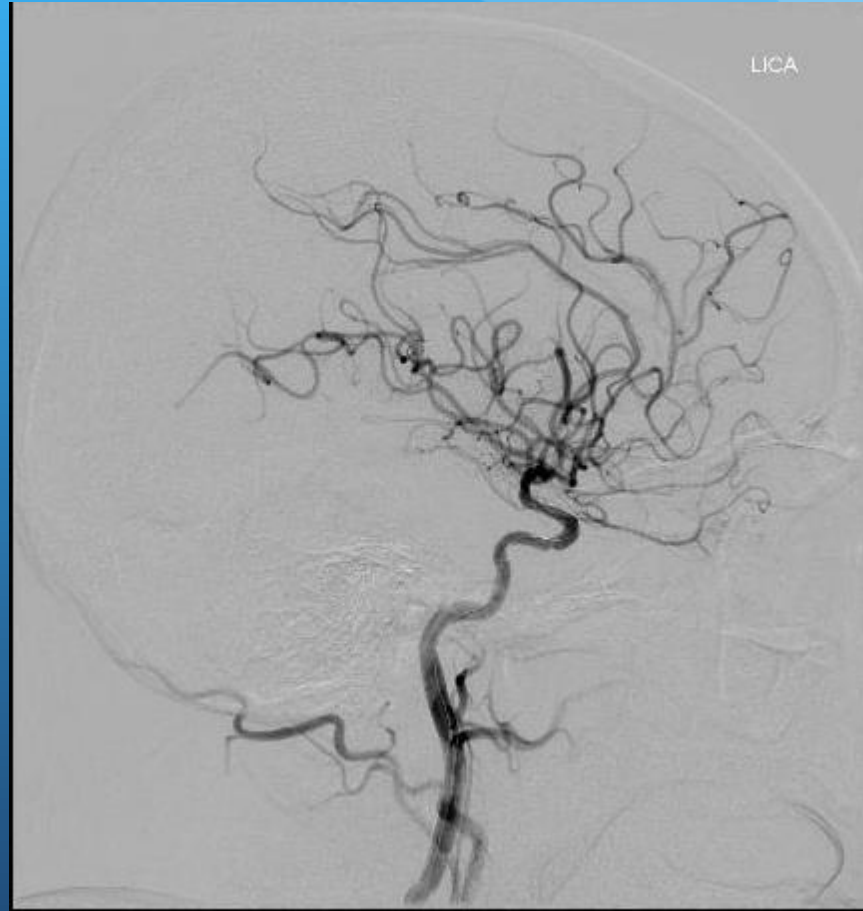
Angiographic findings



Angiographic findings



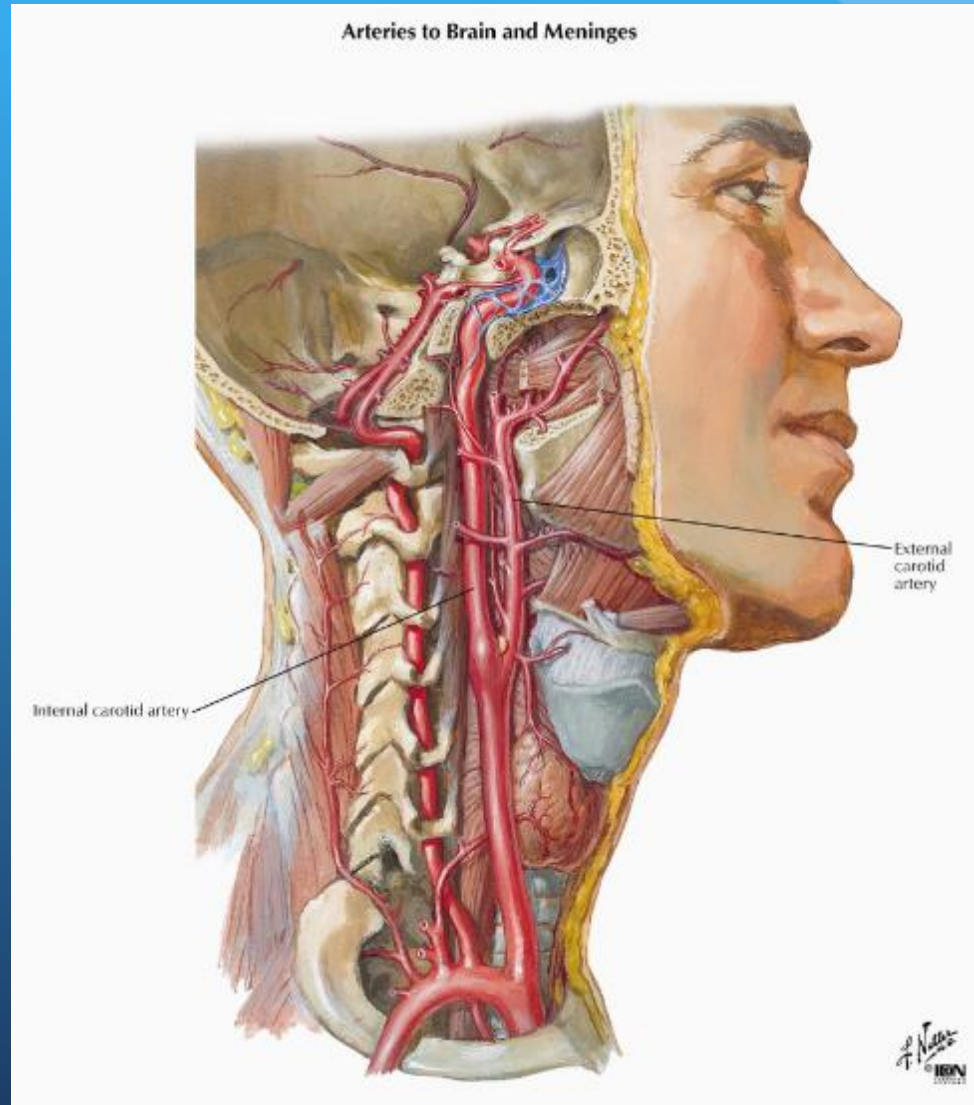
Angiographic outcome



Outcome

- All events resolved
- At 30days mRankin=1

Anatomical Considerations



Improvement in Cognition Following Endovascular Reconstruction

- N=40 w symptomatic ICA CTO assigned Endov. Tx (A, N=18) or Med Tx (B, N=22)
- Successful recanalization (TICI 2-3) achieved in 16 of 18 (88.9%) of patients
- No peri-procedural ischemic events
- Improvement in perfusion observed in 12 of 18 (75%) patients on SPECT
- Improvement in cognition-increase of ≥ 8 on the Montreal Cognitive Assessment (MoCA) in group A
 - Baseline 14.67 ± 3.56 vs. 3m 24.17 ± 3.55 and 6m 24.72 ± 2.85 , $p < 0.01$
- Sig. difference in MoCA scores between group A and B at 1, 3, and 6m ($p = 0.05$)

Conclusions

- Carotid CTO can be associated with high-risk of recurrent stroke
 - Hemodynamic insufficiency
- Medical therapy first line treatment in symptomatic and asymptomatic patients
- Surgical bypass ineffective in 2 randomized trials but is still a reasonable option in selected patients Tx at experienced centers
- Endovascular reconstruction may be considered in selected individuals who have:
 - Recurrent hemispheric ischemia and decreased cerebrovascular reserve
 - If performed by experienced operators
 - A randomized trial is needed
- No indication in asymptomatic patients
- No current indication for cognitive impairment