Endovascular Recanalization of Symptomatic Chronic Total Occlusion of Cervical Carotid Artery

Paul Hsien-Li Kao, MD

Assistant Professor, Cardiology

National Taiwan University Hospital

ICA stenting

- Proven to be an alternative to CEA in ICA stenosis, especially in patients with high surgical risk profiles
- But the application of endovascular intervention in cervical ICA occlusion has never been explored, which comprise 15% of patients with ipsilateral TIA or infarction
- The Great Myth
  - ICA stenosis causes symptoms through artery-to-artery embolism
  - The risk of stroke is minimal with ICA occlusion, because there is no flow to carry the emboli
  - Is it true?

ICA CTO

- Annual risk of stroke were 5.5% in patients with ICA CTO
- Compromised CBF indicates an even higher annual risk of all and ipsilateral stroke (12.5% and 9.5%)

Stroke. 1997;28:2084–2093

- Pathophysiology of ICA CTO causing symptoms
  - Emboli arising from ECA/CCA and carried via collaterals to the brain
  - Emboli arising from the ICA stump and carried via collaterals (Stump syndrome)
  - Emboli arising from the distal end of the occlusion (trailing thrombi)
  - Hypo-perfusion (hemodynamic insufficiency)

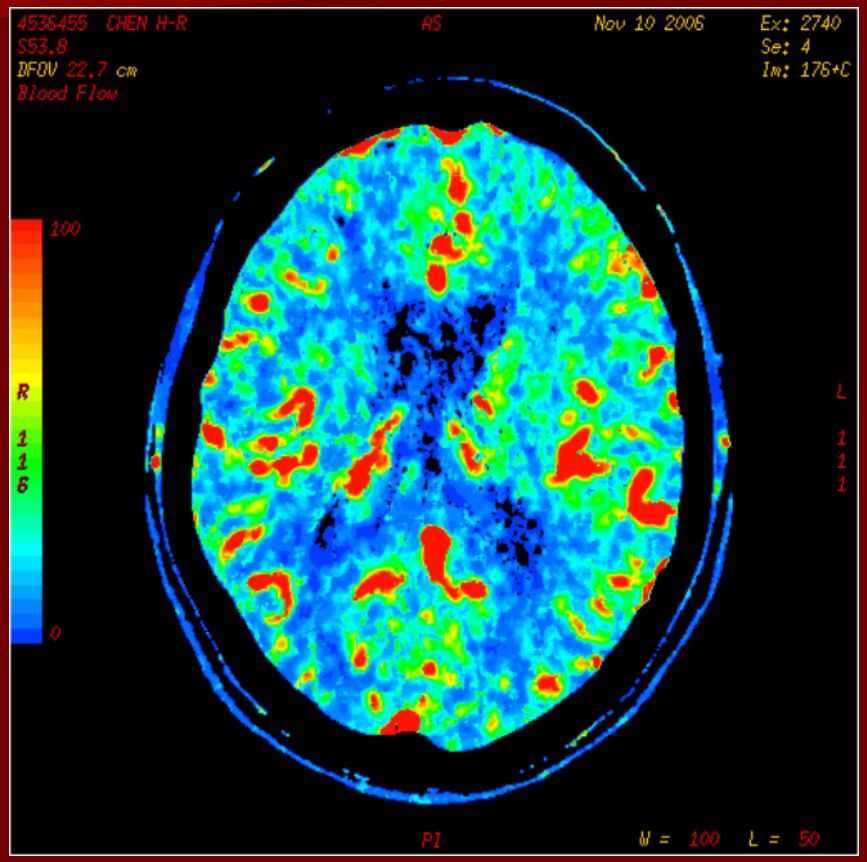
Treatment options for ICA CTO

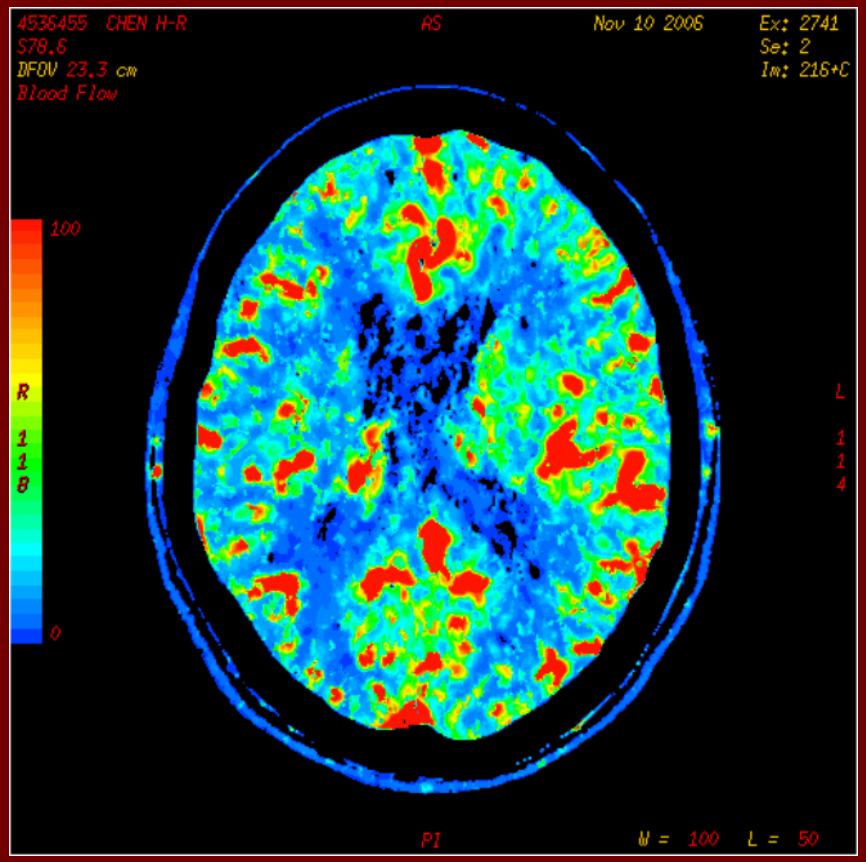
- Medical
  - The recommended treatment at present, but may be insufficient for certain patients
- Surgery
  - CEA
  - Stump ligation/exclusion
  - EC/IC bypass
  - Can be very technically demanding with high periprocedural complications
  - All failed to reduce ipsilateral stroke and are not recommended to ICA CTO in general

Patient selection

- Endovascular recanalization was attempted in 30 patients with ICA CTO from Oct 02 to Dec 06, out of 255 (11.8%) ICA stentings in the same period
- ICA occlusion was first documented by ultrasound, CTA, or MRA, and patients were followed by an independent neurologist
- Enrollment criteria
  - Progression or recurrence of ipsilateral neurological deficit, or
  - Objective ipsilateral hemispheric ischemia by perfusion CT

Exemplary case: 64M with old RMCA infarct



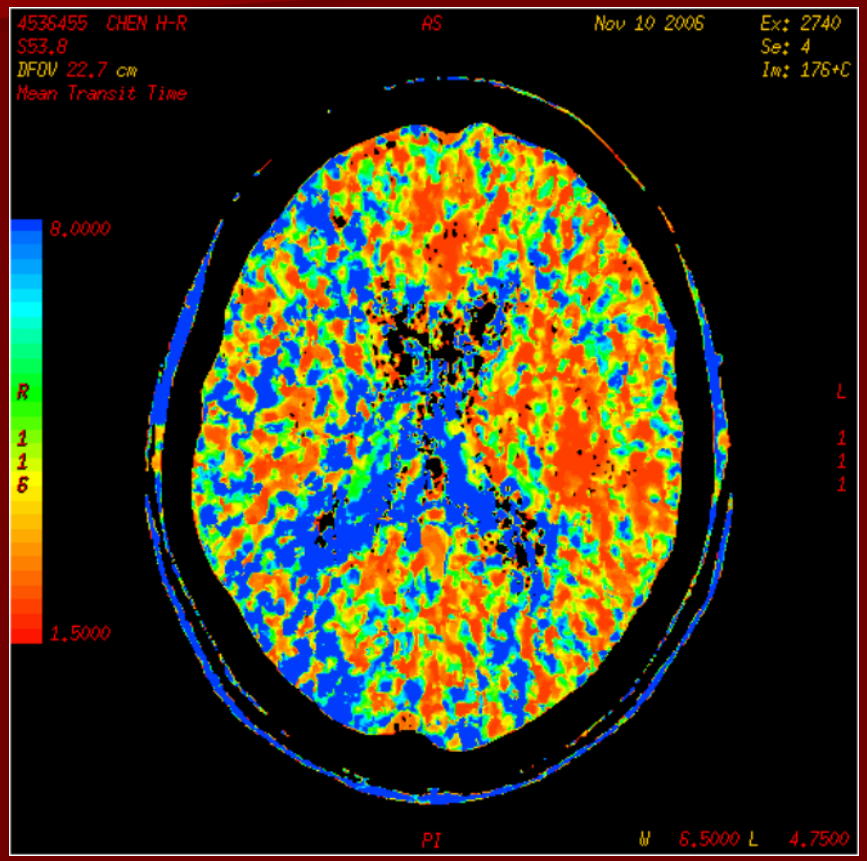


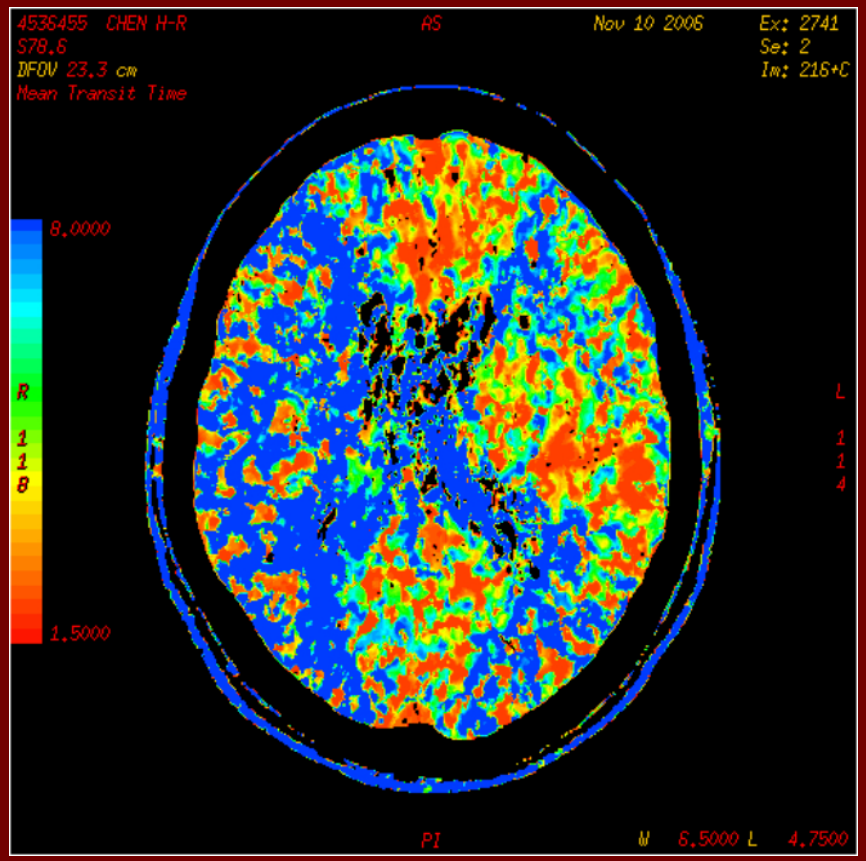
Baseline **Diamox stress**

Flow

Paul HL Kao 07

Perfusion CT imaging for objective ischemia



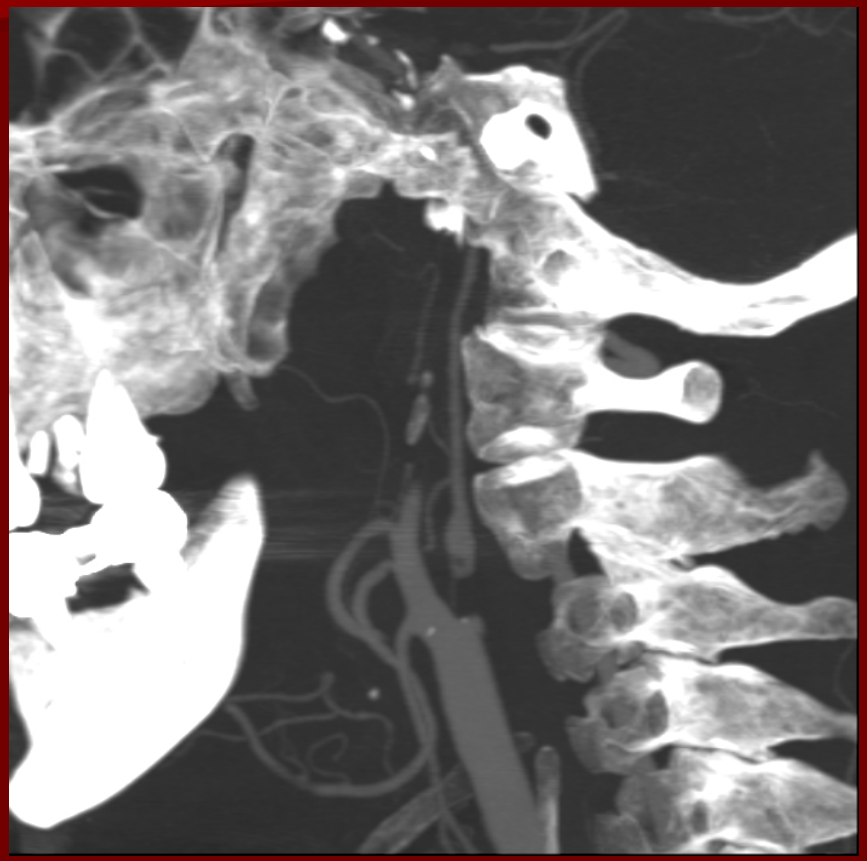


Baseline **Diamox stress**

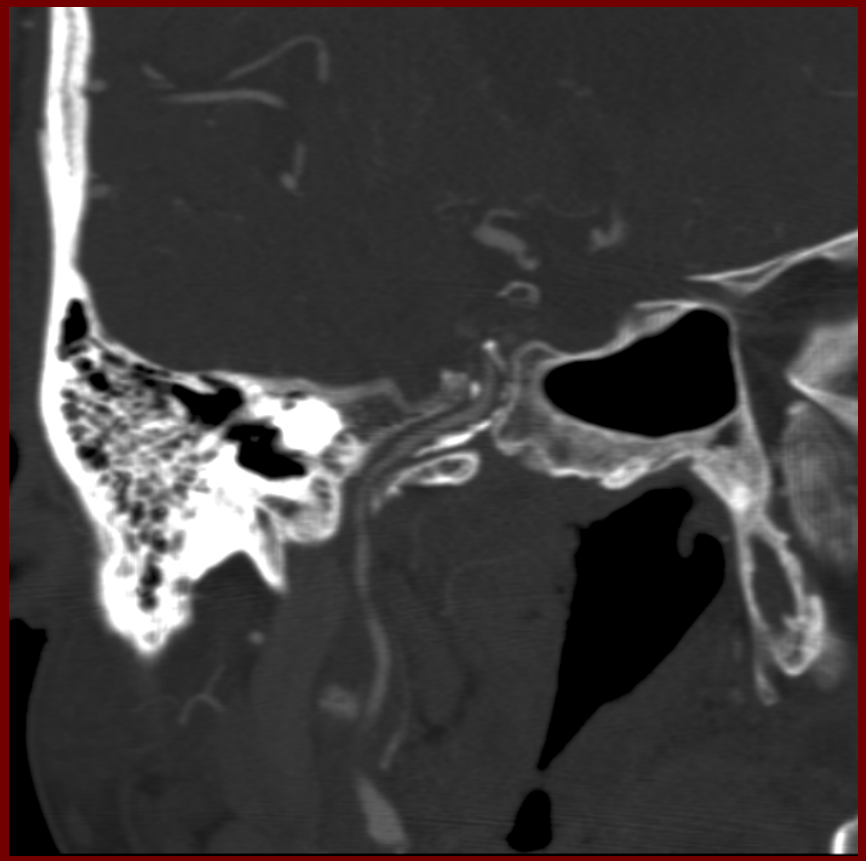
Transit Time

Paul HL Kao 07

CT angiography for path finding



Cervical ICA



Carotid canal

Neurological and ultrasound evaluation

- Complete neurological examination within 24 hours, and at 1, 6, 12 months after procedure
- Neck ultrasound and trans-ocular duplex evaluation of OA flow direction before, and 1, 6, 12 months after procedure
- All done by independent neurologists
- Suspicion of restenosis by ultrasound mandates angiographic follow-up

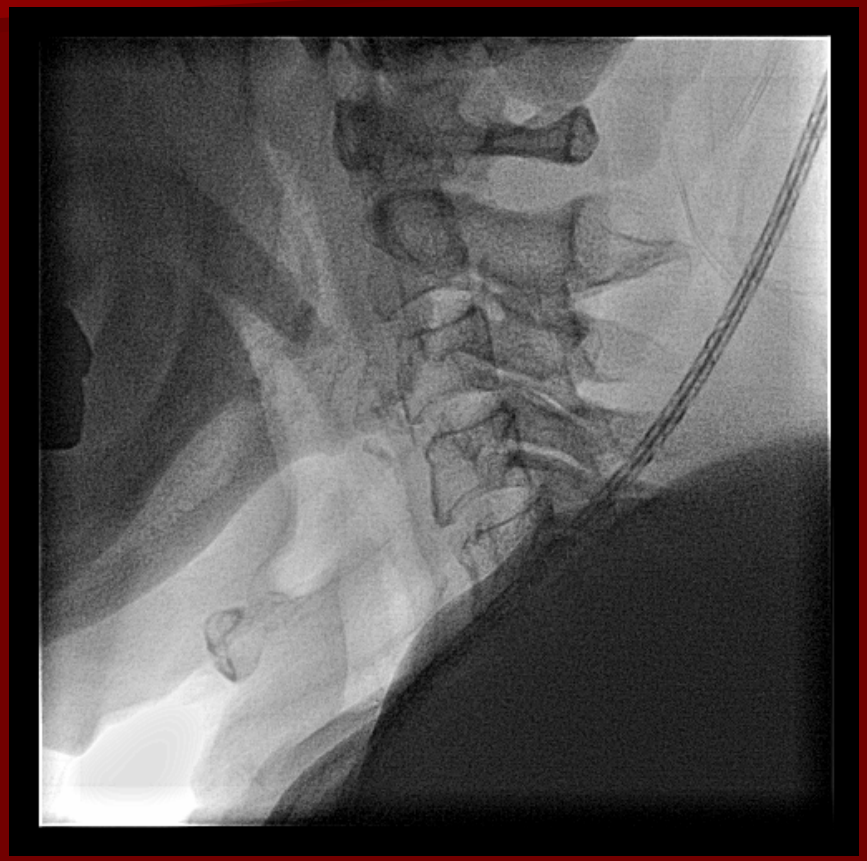
Interventional technique

- 8F JR4 guide transfemoral approach
- 0.014" wire (Rinato) through micro-catheter (Excelsior) to engage the stump
- Exchange wire to tapered-tip stiff 0.014" wire (Conquest Pro or Conquest Pro 12G)
- Penetrating maneuver with bi-plane medium magnified high resolution fluoroscopy all the time (no roadmap or DSA)
- Using CTA or mirror-image of the contralateral carotid artery as reference tract, aiming at distal vessel visualized via collaterals

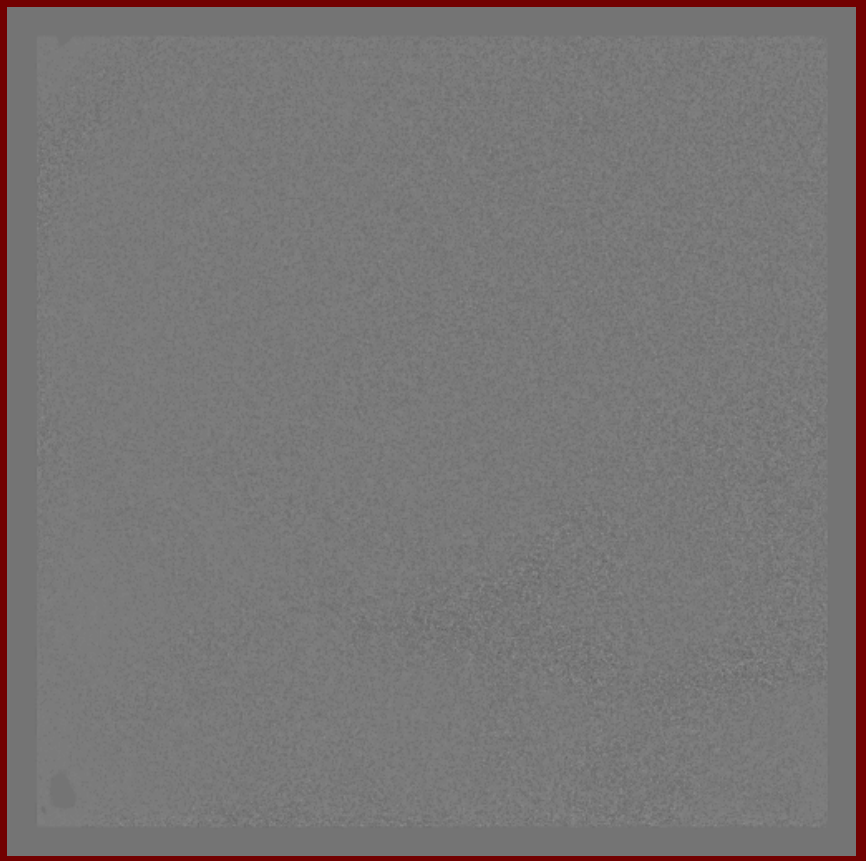
Interventional technique (continued)

- Once the wire reaches distal true lumen, advance micro-catheter across the occluded segment and exchange the stiff wire to soft wire (Rinato or Fielder)
- Pre-dilate with small coronary balloon (Sprinter, Maverick, Ottima)
- Deploy distal protection device (EZ FilterWire or PercuSurge) if the distal landing zone is adequate after pre-dilatation (pre-petrous, distal enough for stent delivery system, diameter >3mm)
- Deploy self-expanding stent (Carotid Wall stent) for the proximal ICA, and conforming balloon-expandable stent (Driver or Tsunami) for distal ICA if necessary

Exemplary case: 64M RICA CTO



Lateral view

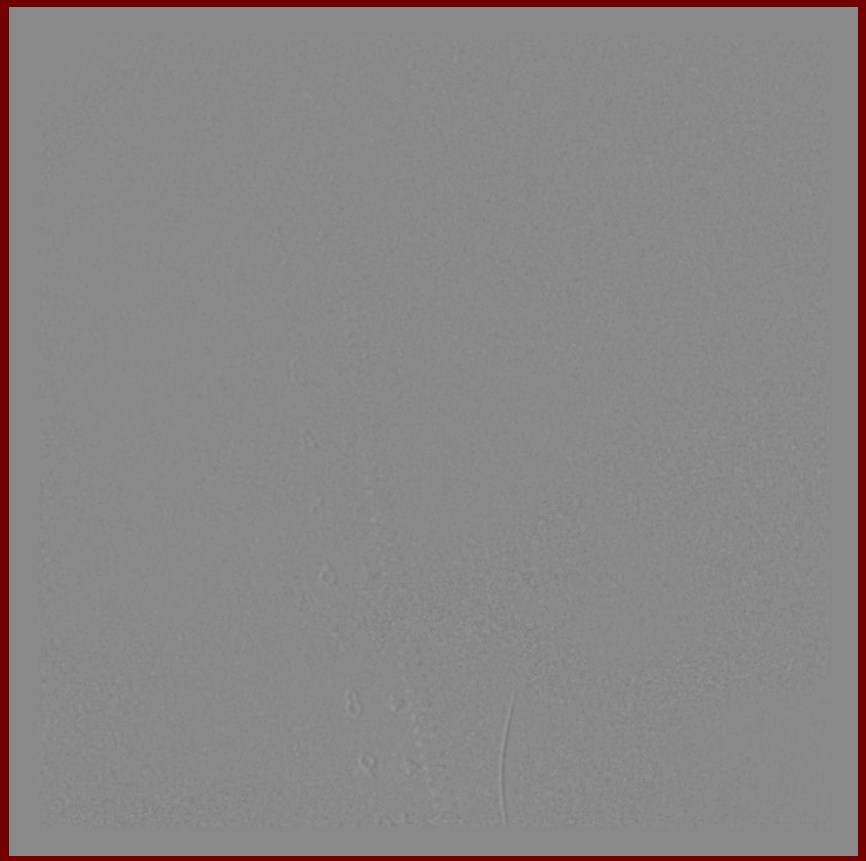


IC lateral view

Paul HL Kao 07

Wire crossed and confirmed

Wire crossed



Position confirmed

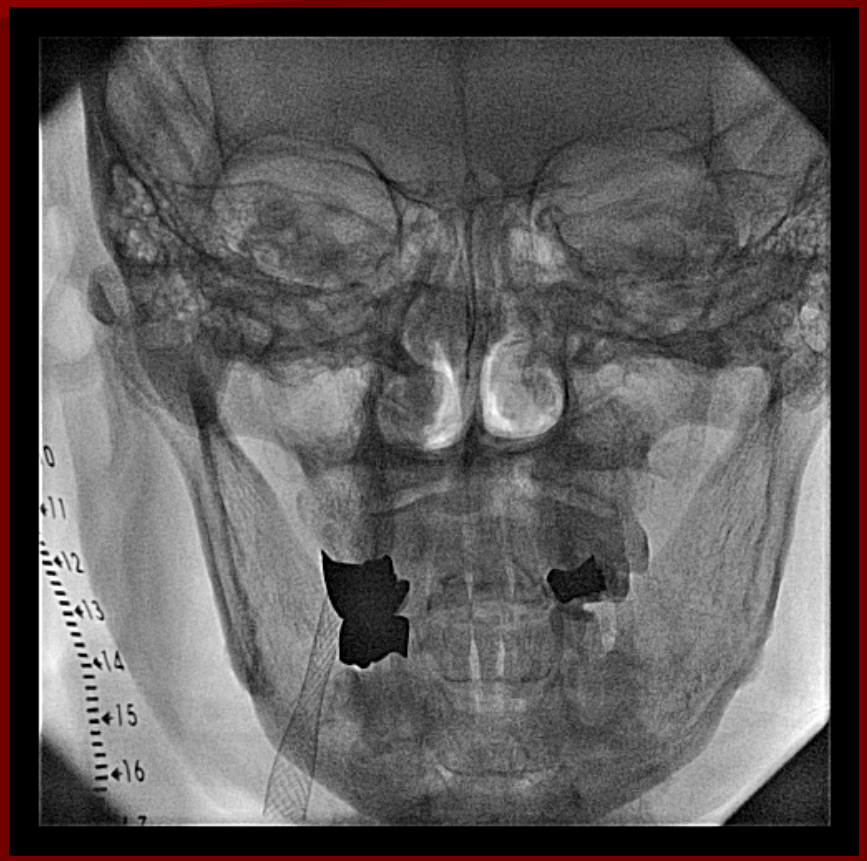
Paul HL Kao 07

Pre-dilatation and PercuSurge

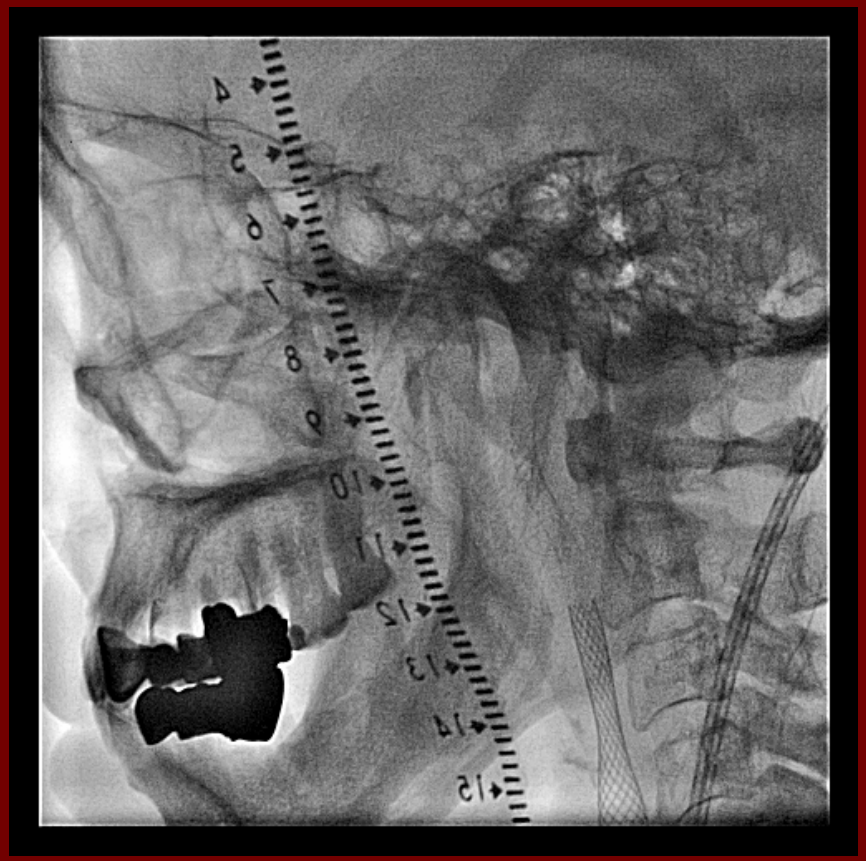
2mm balloon

4mm balloon with PercuSurge

After Carotid Wall and Tsunami



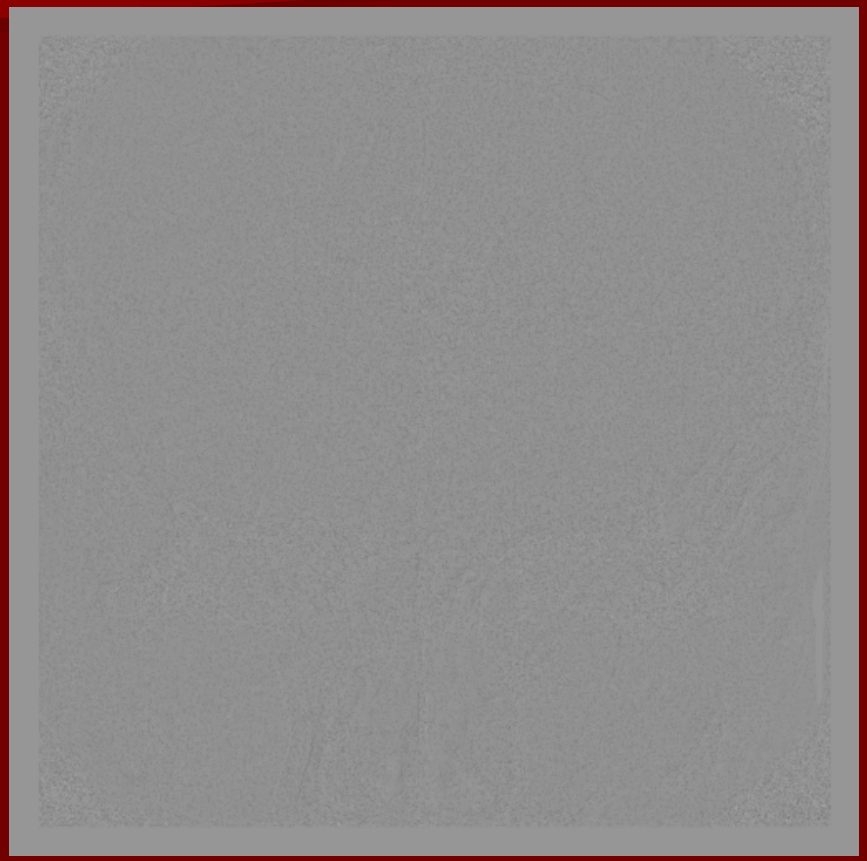
AP view



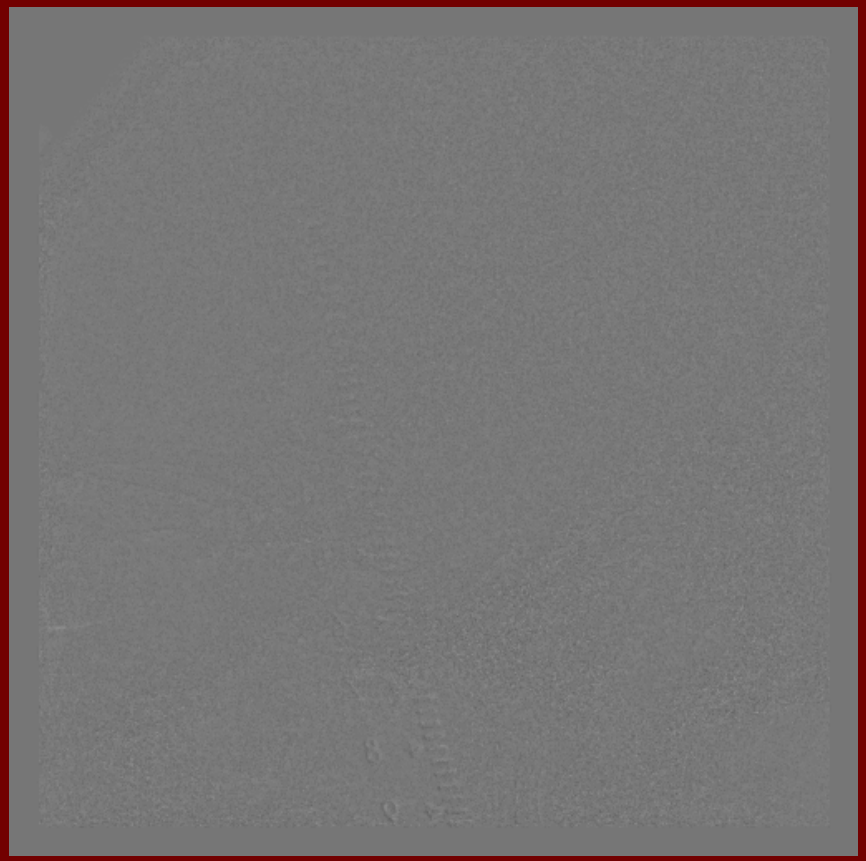
Lateral view

Paul HL Kao 07

3m follow-up



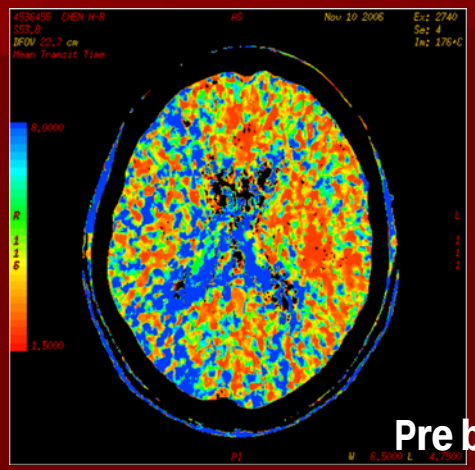
IC AP view



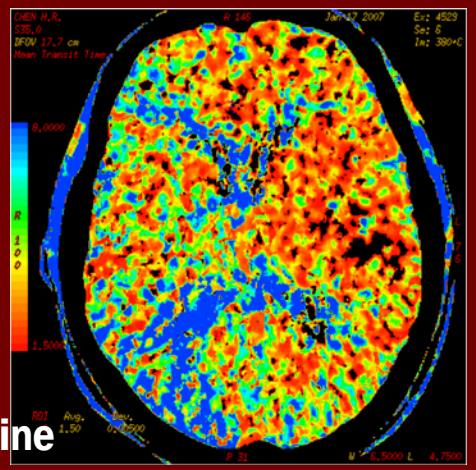
IC lateral vew

Paul HL Kao 07

Partial recovery of perfusion CT at 1 month

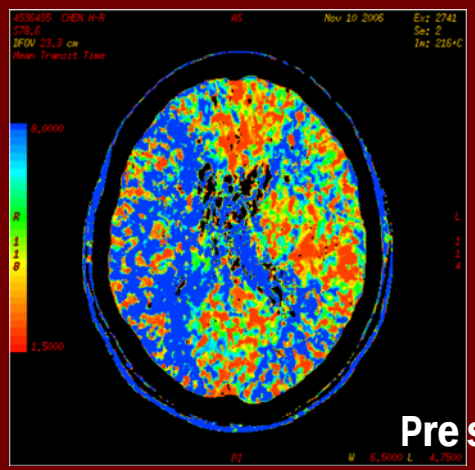


Transit time

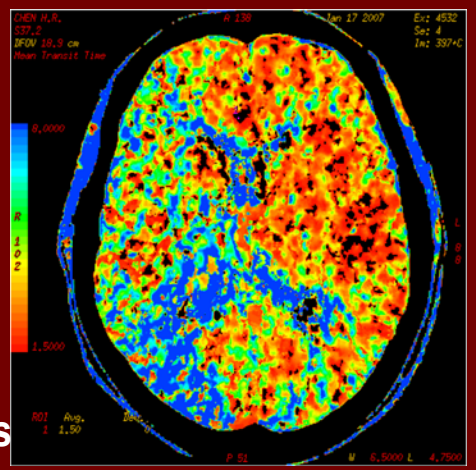


Pre baseline

Post baseline



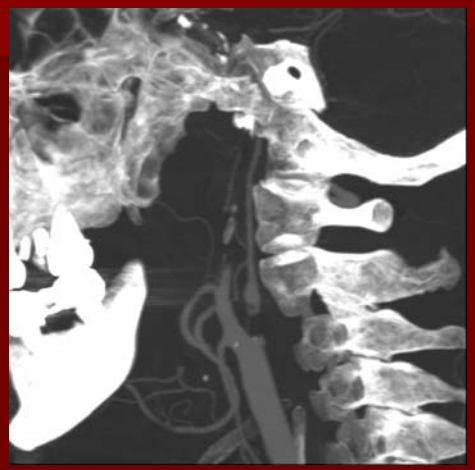
Pre stress

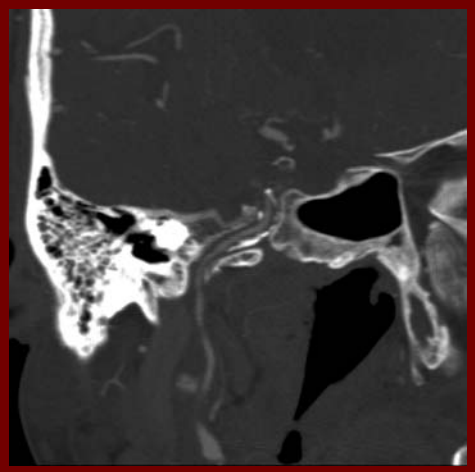


Post stress

Paul HL Kao 07

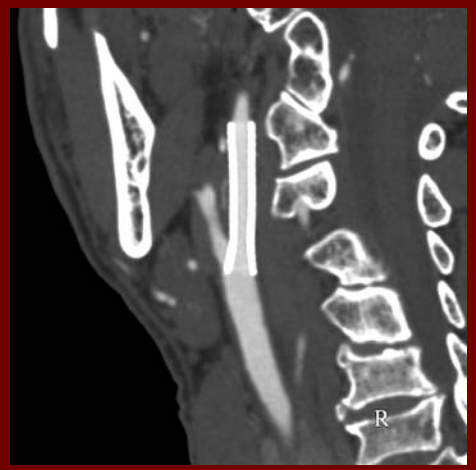
Comparison of CTA at 1 month

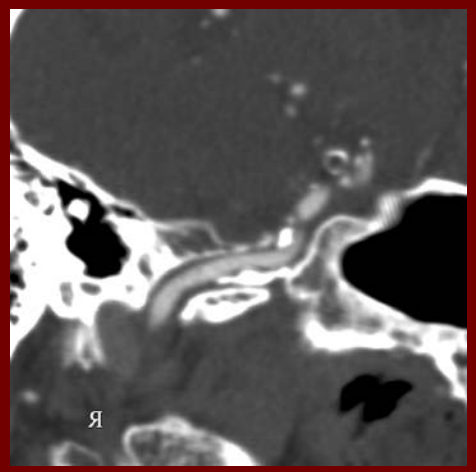




Pre

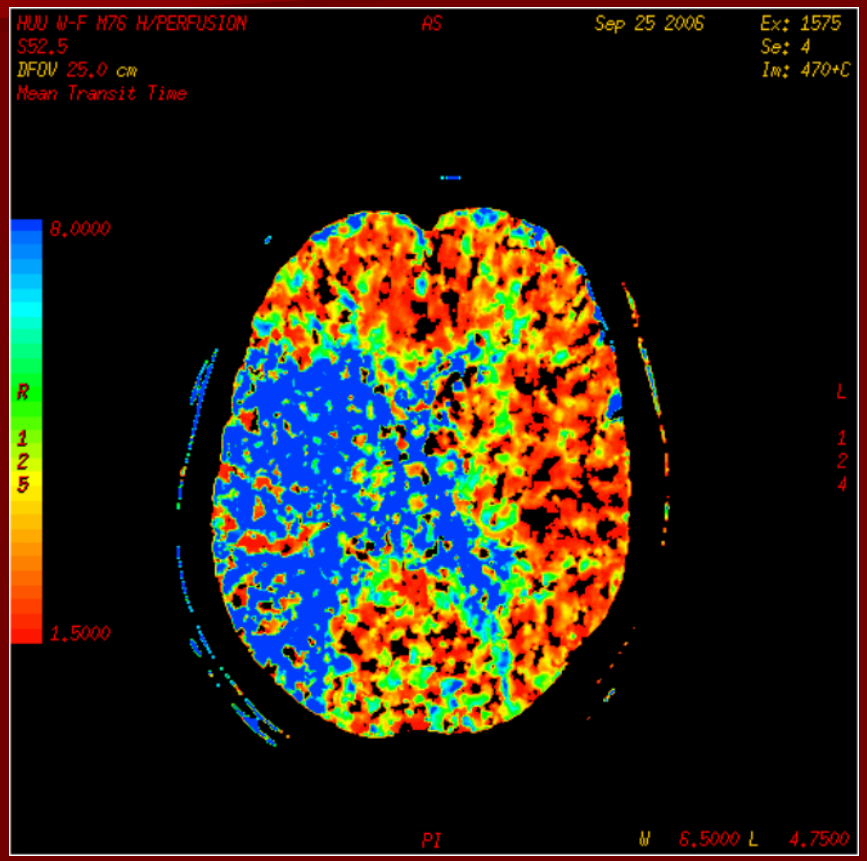
Post



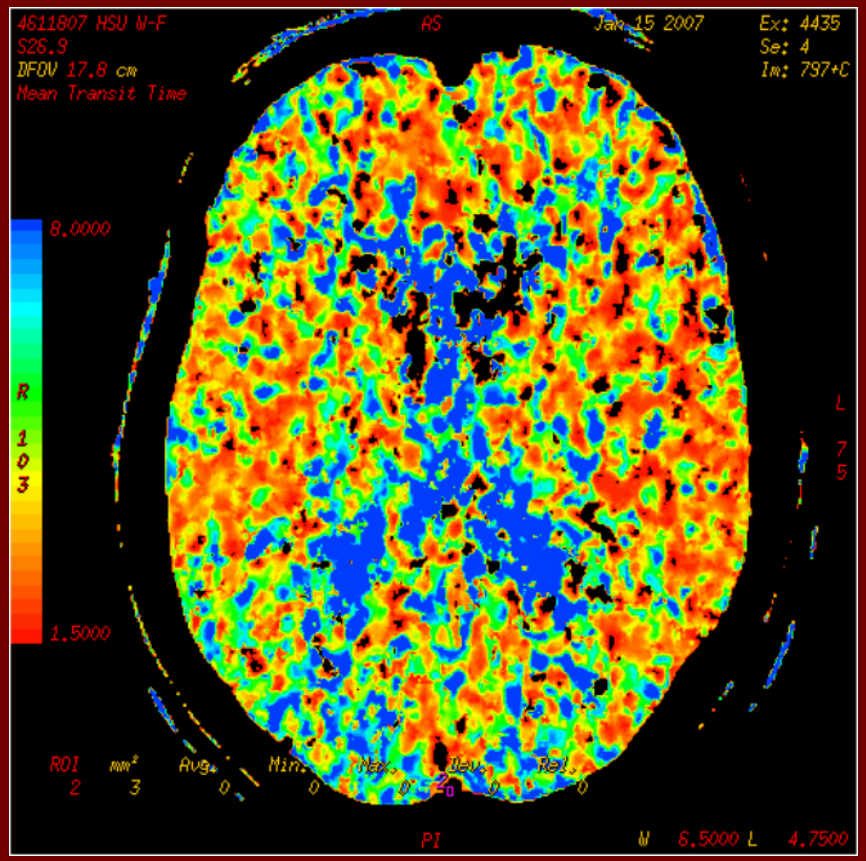


Paul HL Kao 07

Example of complete recovery



Pre stress transit time



Post stress transit time

Paul HL Kao 07

Demographics

Male sex	27	90%
Age (y)	72.1 ± 8.0	
Hypertension	24	80%
Diabetes mellitus	12	40%
Hyperlipidemia	17	57%
Smoking	11	37%
Prior ipsilateral stroke	17	57%
Ipsilateral TIA	10	33%
Amaurosis fugax	3	10%
Contralateral ICA stenosis >50%	9	30%
Progression or recurrence of neurologic deficit after known ICA occlusion	25	83%

Procedural results

Technical success	22	73%
Lesion location, right/left	14/16	47%/53%
CCA diameter (mm)	8.0±0.8	
ICA diameter (mm)	4.3±0.5	
Occlusion length (mm)	27.9±16.2	
Wire crossing successful	22	73%
Distal protection device used after crossing	17	77%
PercuSurge/FilterWire	5/12	29%/71%
Post-dilatation balloon diameter (mm)	4.4±1.9	
Post-dilatation pressure (atm)	6.3±3.2	
ECA orifice covered by stent	22	100%
Final residual diameter stenosis (%)	10±7	

Post-procedural care

- All patients stented were monitored in CCU overnight
- No post-procedural anticoagulation, but aspirin and clopidogrel are maintained for 3 months
- Continuous BP monitoring, clamping SBP within 100-140mmHg using NTG/dopamine

Clinical outcome

	In-hopsital (N=30)	Follow-up (N=29)
	Number (%)	Number (%)
Stroke	1 (3.3)	
Death (neurological)	1 (3.3)	
Death (non-neurological)		1 (3.4)
Restenosis (N=22)		3 (13.6)

- No extravasation or bleeding complication
- Follow-up period:16.1±18.5 months

Acknowledged work

Interventional Cardiology

Feasibility of Endovascular Recanalization for Symptomatic Cervical Internal Carotid Artery Occlusion

Hsien-Li Kao, MD,* Mao-Shin Lin, MD,† Chia-Sung Wang, MD,* Yen-Hong Lin, MD,* Lung-Chun Lin, MD,* Chia-Lun Chao, MD,* Jiann-Shing Jeng, MD,‡ Ping-Keung Yip, MD,‡ Shih-Chung Chen, MD§

Taipei and Yun-Lin, Taiwan

Objectives This study sought to report technical details and clinical results of the first series of endovascular recanalization for cervical internal carotid artery (ICA) occlusion.

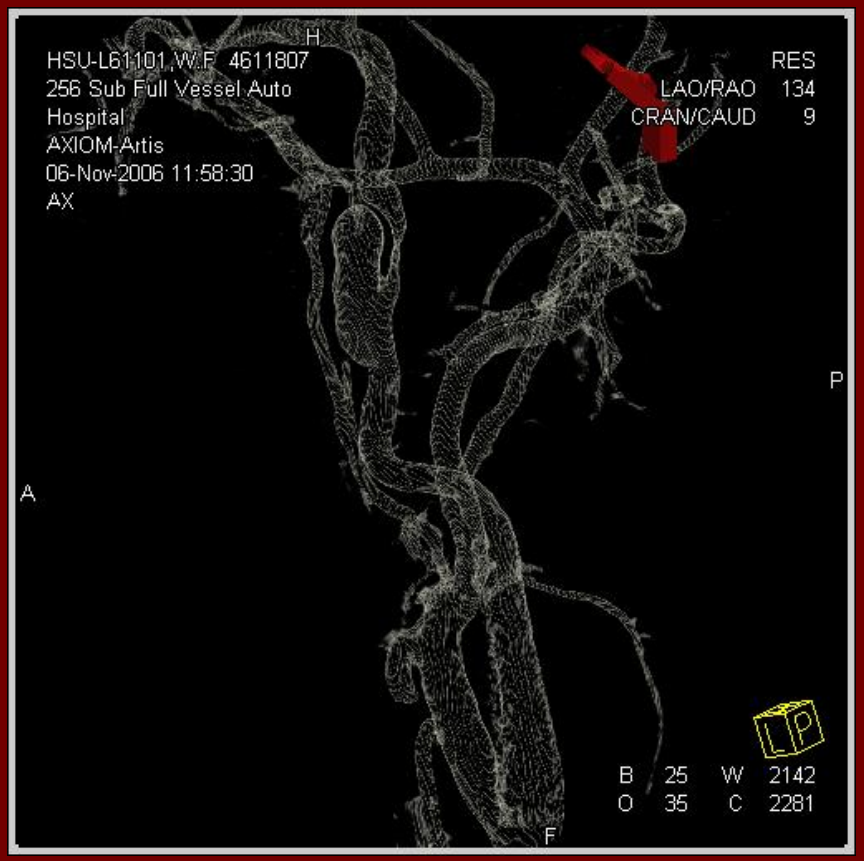
Background Cervical ICA occlusion is associated with impaired cerebral perfusion, which may lead to ischemic cerebral symptoms and hemodynamic infarcts. Neither surgical nor endovascular revascularization has been shown to benefit this population.

Methods Endovascular recanalization was attempted in 30 patients with ICA occlusions (27 men; age 72.1 ± 8.0 years, range 48 to 85 years). Recurrent neurologic deficit or cerebral ischemia by perfusion study, after known ICA occlusion, was noted in all patients. Strategies and devices for coronary occlusion intervention were applied, including microcatheter-supported tapered-tip stiff coronary guidewires. Contralateral ICA stenosis was found in 9 patients (30%). All patients underwent independent neurologic and duplex ultrasound follow-up.

Results The overall technical success rate was 73% (22 of 30). No neck hematoma, intracranial hemorrhage, or hyperperfusion was noted. One (3.3%) fatal brainstem infarction occurred 1 day after a successful ICA procedure, with angiographically proven acute basilar artery occlusion and patent ICA stent. Baseline ophthalmic artery flow was reversed in 15 of the 22 successfully recanalized patients, and was normalized in 12 after the procedure. There was no new cerebral ischemic event or neurologic death for a mean follow-up of 16.1 ± 18.5 months.

Conclusions Endovascular recanalization for cervical ICA occlusion is feasible with acceptable midterm clinical results.
(J Am Coll Cardiol 2007;49:765–71)

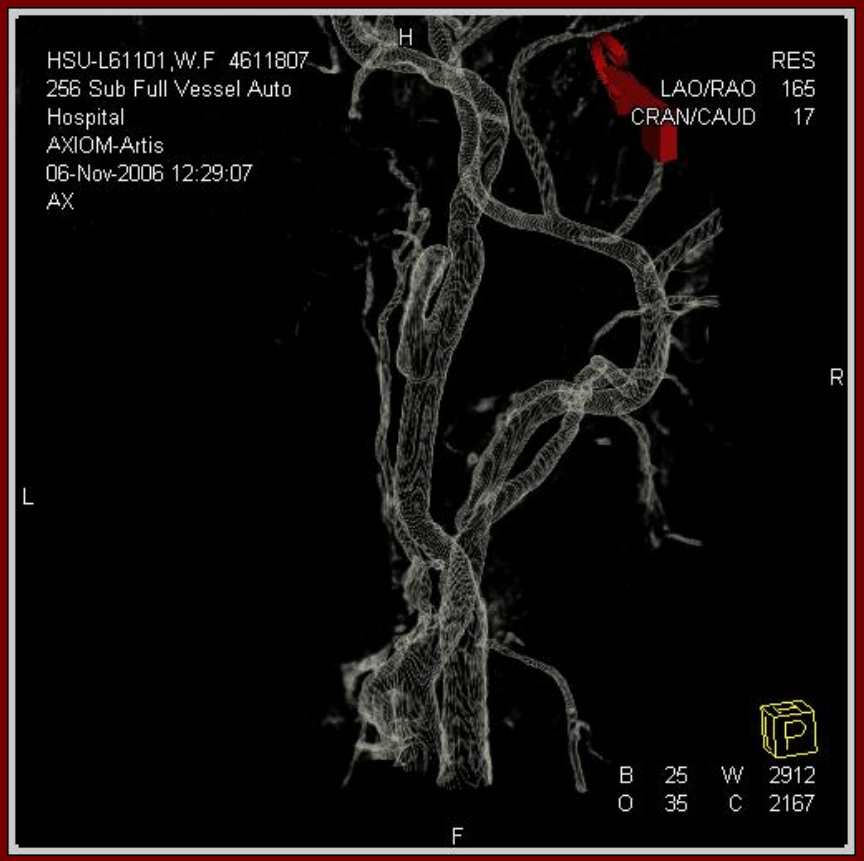
Reversal of normalized OA flow at 6 month



Distal RICA aneurysm and stenosis

Paul HL Kao 07

Stenting of the culprit



Result after deployment of another Carotid Wall stent

Paul HL Kao 07

New endpoints in the future

- In PCI trials, we don't just look at death/MI (hard endpoints), but also angina relief, LV function recovery, and TVR (soft endpoints)
- What are the "soft endpoints" in ICA CTO intervention?
  - Neuro-cognitive evaluation
  - Changes in perfusion imaging, such as perfusion CT, MRI, and PET
- These are the objectives of our on-going study

Conclusions

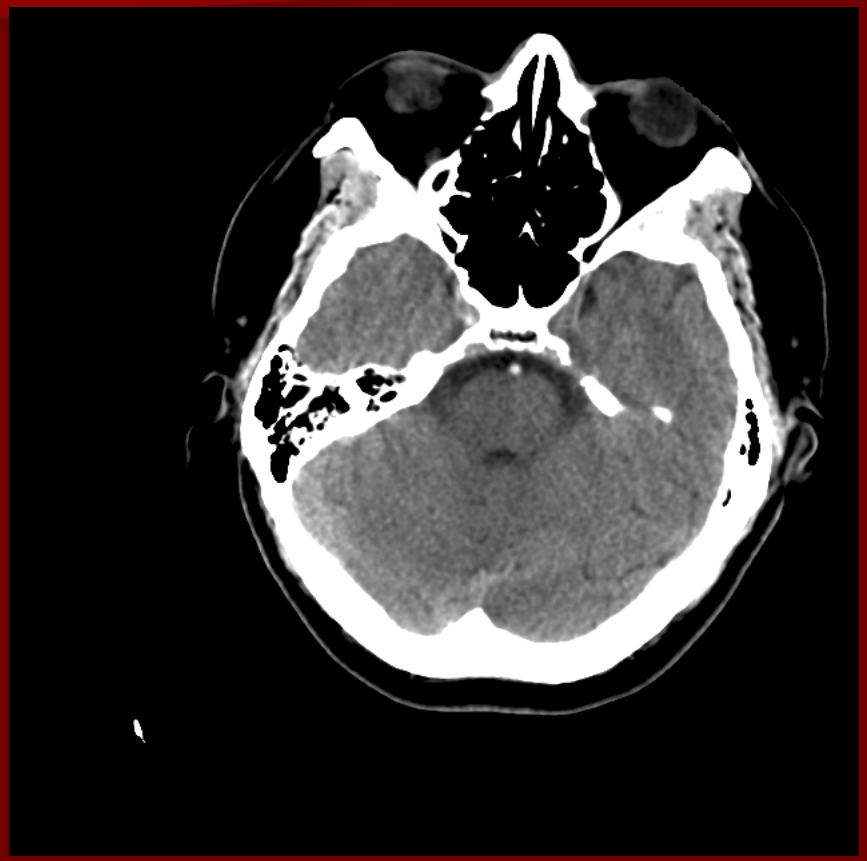
- Our single center experience demonstrated the feasibility and safety of endovascular recanalization of ICA CTO
- Future prospective randomized studies with larger patient numbers and “soft” endpoints are mandatory to establish the benefit and indication of recanalization of ICA CTO

It’s never too late to open a closed door, as the room behind may be full of surprises

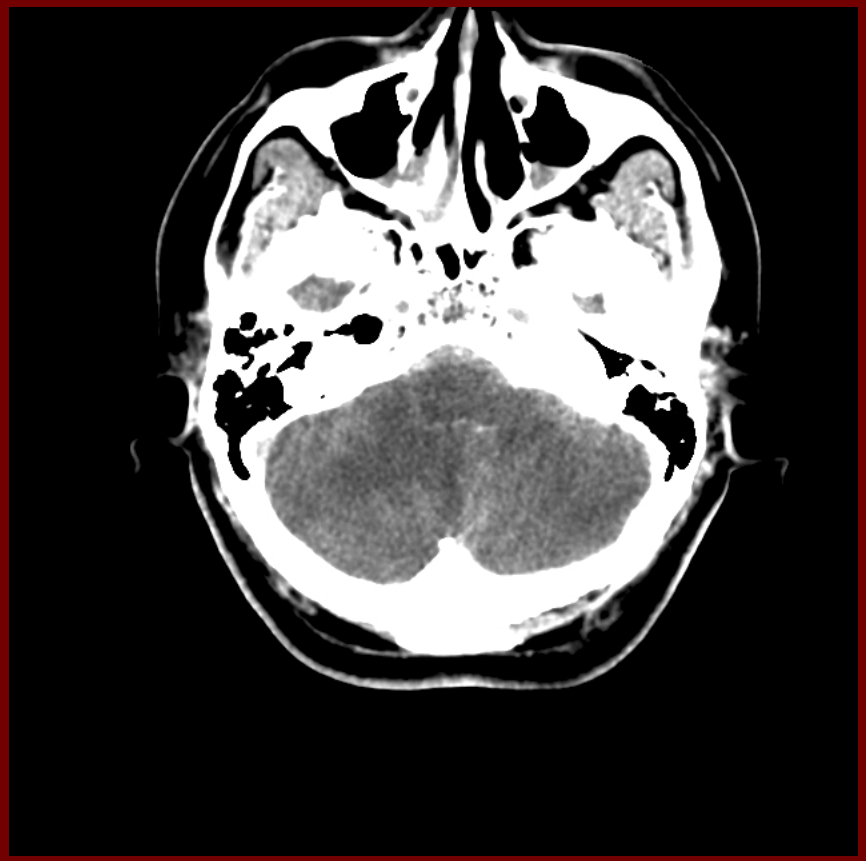
The only mortality

- 49M with LICA occlusion and repeated right limb TIA for 2 years
- Diagnostic EC4V showed LICA CTO and dominant RVA ostial 80% stenosis
- Loss of consciousness 3 hours after successful recanalization of LICA
- Emergent CT revealed posterior fossa infarction
- Emergent angiography showed distal RVA embolic occlusion
- Intra-arterial lytic therapy with 20mg rt-PA failed to open BA
- Patient died 12 hours after the procedure

Comparison of baseline and emergent CT



Baseline



Emergent

Paul HL Kao 07

Emergent angiography at 4 hours

RVA ostial stenosis

Acute embolic occlusion
at distal RVA

Paul HL Kao 07

Emergent angiography at 4 hours

LVA connects to PICA only

RICA IC view

Paul HL Kao 07

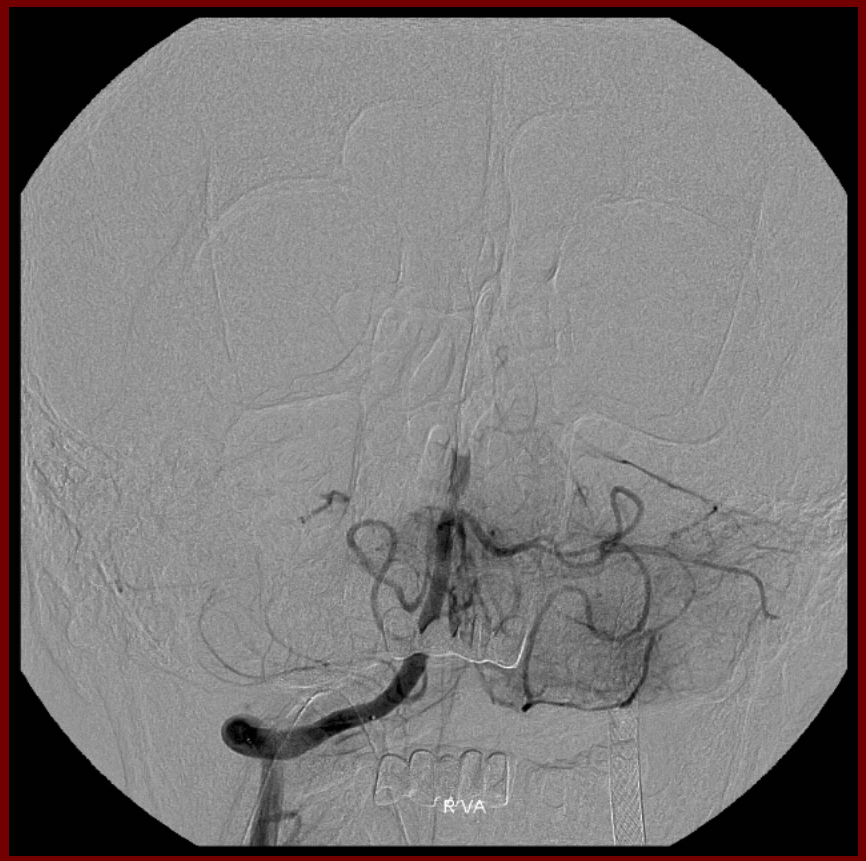
Emergent intra-arteial lytic therapy

LICA stent and IC view

RVA IA rt-PA

Result after lytic therapy

RVA ostial stenosis



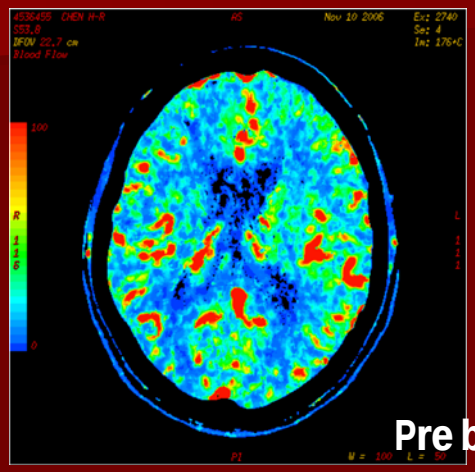
Partial lysis but still poor BA flow

Paul HL Kao 07

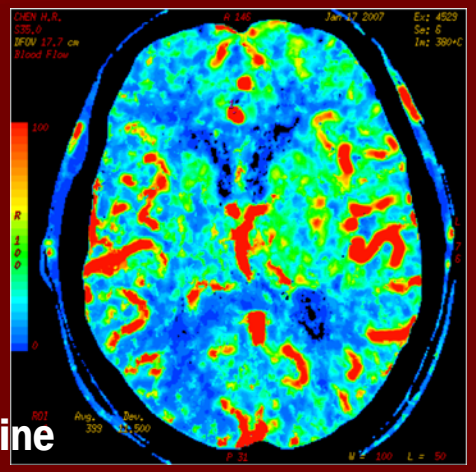
Definitions

- Atheromatous pseudo-occlusion (APO)
  - String-like residual filling of ICA behind the "occlusion"
  - Retrograde filling of the proximal so-called "occluded" ICA reaching the skull base
- Chronic total occulsion (CTO)
  - The occlusion must be documented for at least 1 month
  - TIMI 0 flow behind the occlusion with discontinuation of ICA lumen at least 5mm in length
  - Established filling to the ipsilateral intracranial ICA via A-Com, P-Com, OA, meningeal, or other collaterals

Partial recovery of perfusion CT at 1 month

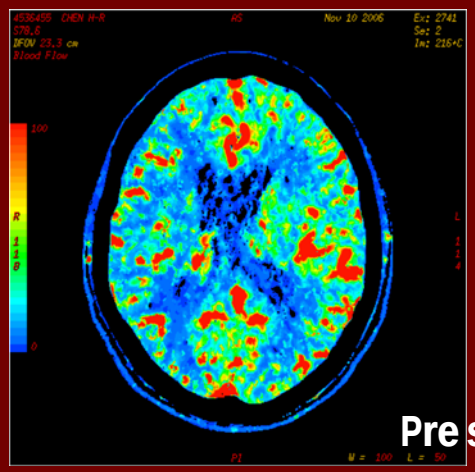


Flow

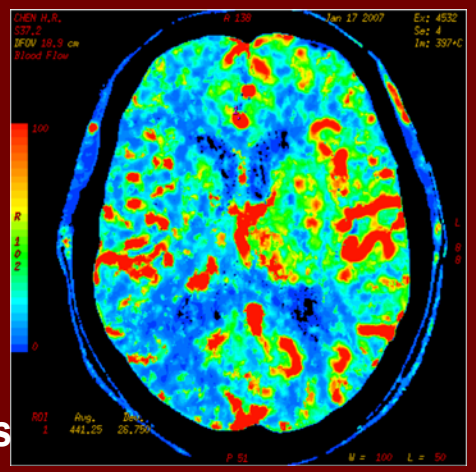


Pre baseline

Post baseline



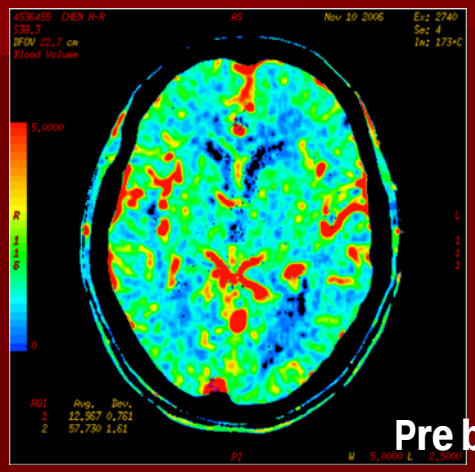
Pre stress



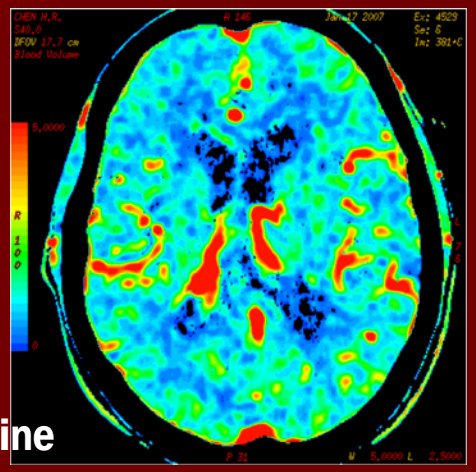
Post stress

Paul HL Kao 07

Partial recovery of perfusion CT at 1 month

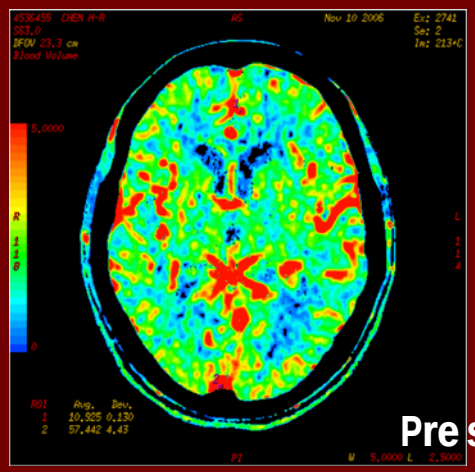


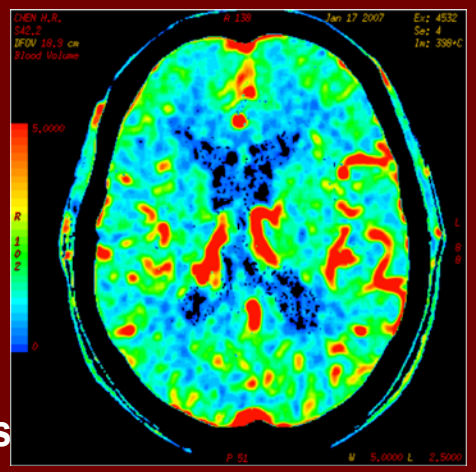
Volume



Pre baseline

Post baseline





Pre stress

Post stress

Paul HL Kao 07