

# MANAGEMENT OF ACUTE ISCHEMIC STROKE

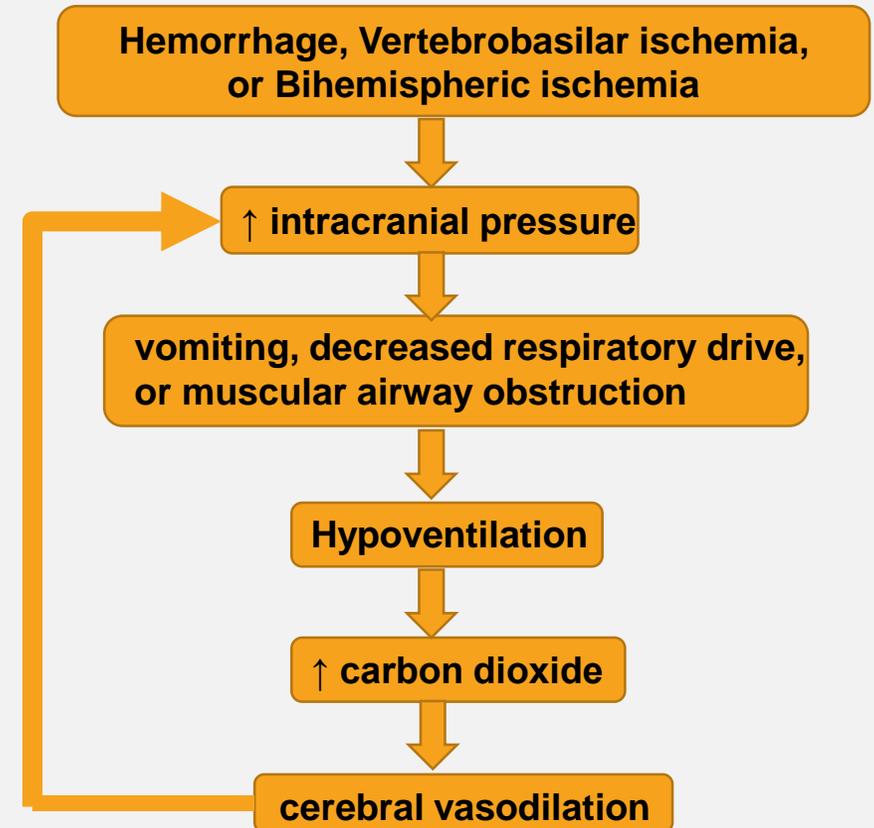
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## CASE

A 54-year-old woman with a history of hypertension presented with left upper extremity weakness and facial droop. She was last seen normal 28 minutes before presenting to the hospital. She had been found by her daughter on the floor and was unable to communicate due to dysarthria and confusion.

# FIRST THING TO DO : AIRWAY, BREATHING, AND OXYGENATION

- Who have...
  - ✓ **Decreased consciousness**
  - ✓ **Bulbar dysfunction(CN9,10,11,12)**
    - dysphagia, dysarthria, choking on liquids, nasal regurg
    - **risk of aspiration pneumonia!!**
- Supplemental oxygen should be provided to maintain **oxygen saturation >94%**.





**BRAIN IMAGING  
TIME COURSE OF ISCHEMIC STROKE ON  
NON-ENHANCED CT**

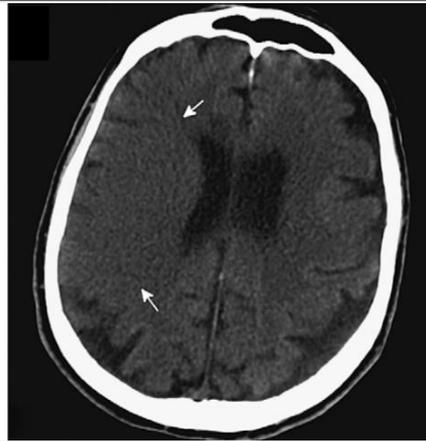
Patient's **Non-contrast head CT was normal**

Perform **within 20 minutes !**



Hyperacute < 24h

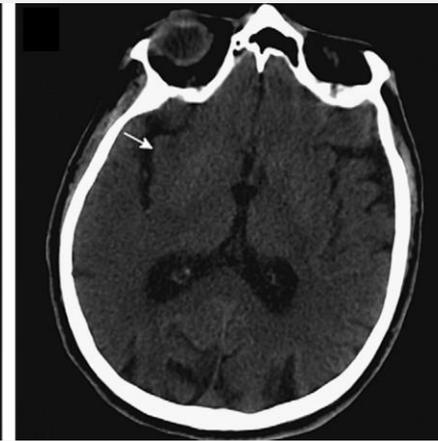
Loss of gray-white matter differentiation



Diffuse cerebral swelling



Hyperdense MCA sign



Insular ribbon sign



Acute < 24h~1wk

## IMMEDIATE WORKUP

- **Vitals**
- **EKG**
- **CBC** including platelets
- Finger stick blood **glucose**
- **Troponin**
- **PT(INR)/aPTT**
- Ecarin clotting time, thrombin time, or appropriate direct factor Xa activity assay if known or suspected that the patient is taking direct thrombin inhibitor or direct factor Xa inhibitor

# TEMPERATURE

- Hyperthermia (temperature  $>38^{\circ}\text{C}$ ,  $100.5^{\circ}\text{F}$ )
  - ✓ identify source
  - ✓ antipyretic medications ( $\because$  hyperthermia worsens cerebral ischemia)



## Mechanisms

- $\uparrow$  release of neurotransmitters
- $\uparrow$  oxygen radical production
- blood-brain barrier breakdown
- $\uparrow$  numbers of potentially damaging ischemic depolarizations in the focal ischemic penumbra
- Impaired recovery of energy metabolism and  $\uparrow$  inhibition of protein kinases
- Worsening of cytoskeletal proteolysis

# BLOOD PRESSURE

- **Hypertension (Common in ischemic stroke)**
  - ✓ BP > 220/120 mm Hg → BP < 185/110 mm Hg (Lowering BP initially by 15% is probably safe.) → IV alteplase
  - ✓ BP < 220/120 mm Hg w/o comorbid condition → no hypertension treatment
  - ✓ BP > 140/90 mm Hg + neurologically stable Starting or restarting antihypertensive therapy → improve long-term BP control unless contraindicated.
- **Hypotension and hypovolemia** should be corrected to maintain systemic perfusion levels necessary to support organ function



- stroke-mediated mechanisms
  - ✓ ischemic stroke → impaired cerebral autoregulation → ↓ perfusion pressure distal to the obstructed vessel, and the distal vessels are dilated → ↑ systemic blood pressure to maintain brain perfusion in borderline ischemic areas
  - ✓ falls by as much as 20/10 mmHg within 10 days.
- chronic hypertension
- acute sympathetic response

## CARDIAC EVALUATION

- **EKG** : screen for atrial fibrillation / serious cardiac arrhythmias

Performed for at least the first 24 hours.

- Routine use of **echocardiography** → **not recommended**

# GLUCOSE

- Only **blood glucose** must precede the initiation of IV alteplase in all patients
- **hyperglycemia** → **worse outcomes** than normoglycemia
- Target glucose level : **140-180 mg/dL**
- Treat hypoglycemia (blood glucose <60 mg/dL)
- Screen DM : fasting plasma glucose, **hemoglobin A1c** (more accurate in the immediate post-event period)

Hyperglycemia may augment brain injury by

- ↑ tissue acidosis from anaerobic metabolism,
- free radical generation,
- ↑ blood brain barrier permeability.

## IV ALTEPLASE

### Benefits

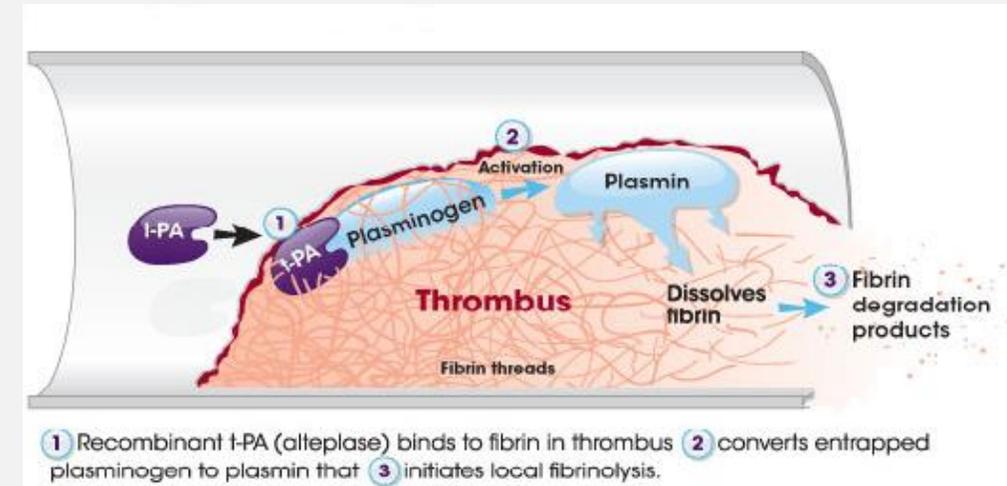


### Potential risks

- bleeding complications
- angioedema
- partial airway obstruction.

### • Inclusion Criteria

- 😊 ✓ **Within 4.5 hours** of ischemic stroke symptom onset or patient last known well
- 😊 ✓ Age  $\geq 18$  years
- 😊 ✓ Initial glucose levels  $>50$  mg/dL (recommended)



## **IV ALTEPLASE EXCLUSION CRITERIA**

- **Hematologic**

- ✓ Platelet count  $<100,000/\text{mm}^3$
- ✓ Current anticoagulant use with an INR  $>1.7$  or PT  $>15$  seconds or aPTT  $>40$  seconds or PT  $>15$  seconds
- ✓ Therapeutic doses of low molecular weight heparin received within 24 hours
- ✓ Current use of a direct thrombin inhibitor or direct factor Xa inhibitor

- **Head CT**

- ✓ Evidence of hemorrhage
- ✓ Extensive regions of obvious hypodensity consistent with irreversible injury

- **Patient history**

- ✓ Ischemic stroke or severe head trauma  $<3\text{mo}$
- ✓ Previous intracranial hemorrhage
- ✓ Intracranial neoplasm
- ✓ GI malignancy or hemorrhage  $<21$  days
- ✓ Neurosurgery  $<3\text{mo}$

- **Clinical**

- ✓ subarachnoid hemorrhage
- ✓ BP  $>185/110\text{mmHg}$
- ✓ Active internal bleeding
- ✓ infective endocarditis
- ✓ associated with aortic arch dissection
- ✓ Acute bleeding diathesis

## ALTERNATIVE : TENECTEPLASE

- Tenecteplase has not been proven to be superior or noninferior to alteplase
- But....
- might be considered as an **alternative to alteplase in patients with minor neurological impairment and no major intracranial occlusion.**
- **Tenecteplase before thrombectomy** was associated with a **higher incidence of reperfusion and better functional outcome** than alteplase among patients with ischemic stroke treated within 4.5 hours after symptom onset [N Engl J Med 2018; 378:1573-1582]

## ADDITIONAL BRAIN IMAGING

### Modified Rankin Scale (MRS)

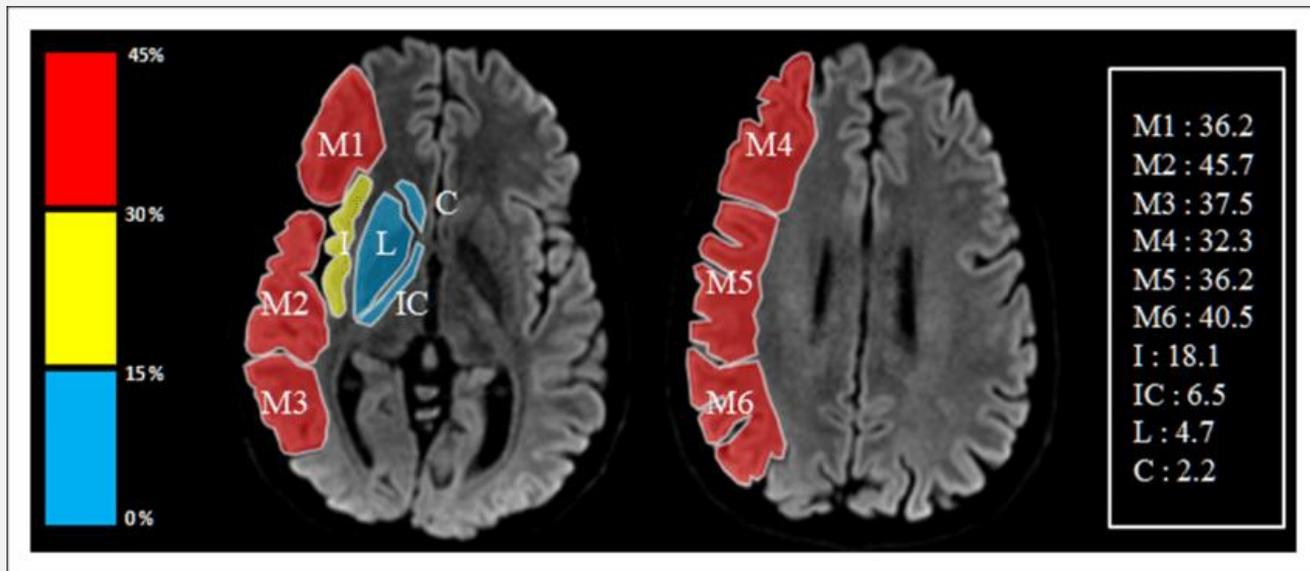
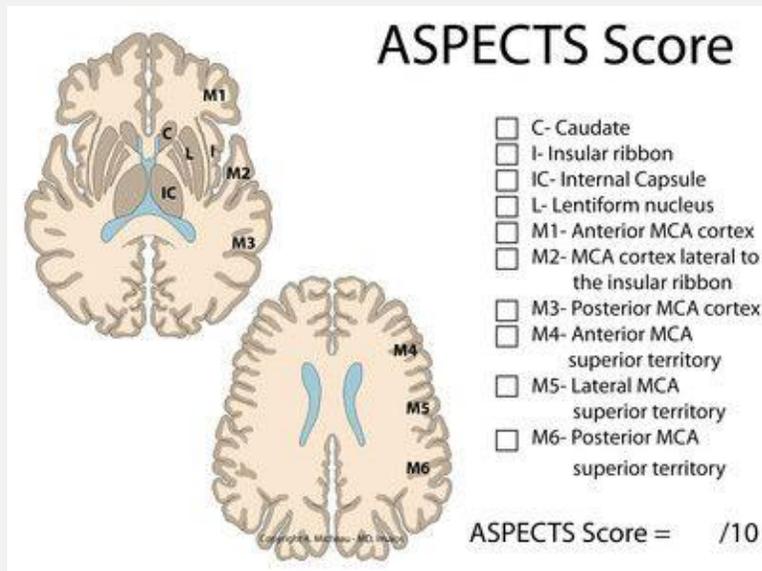
- 0 No symptoms
- 1 No significant disability, despite symptoms; able to perform all usual duties and activities
- 2 Slight disability; unable to perform all previous activities but
- 3- Usually f/u for post stroke
- 4 Moderately severe disability; unable to walk without assistance and unable to attend to own bodily needs without assistance
- 5 Severe disability; bedridden, incontinent, and requires constant nursing care and attention
- 6 Death

receive endovascular therapy with a :hey meet all the following criteria **Evidence A**). (New recommendation):

- **Meet criteria for EVT**, → **noninvasive intracranial vascular study**  
**But** should **not delay IV alteplase**
- AIS within 6-24 hours of last known normal who have large vessel occlusion in the anterior circulation → **CTP, DW-MRI, or MRI perfusion** for selection of **mechanical thrombectomy**
- nondisabling (mRS score 0–2) AIS in the carotid territory who are candidates for CEA or stenting → **noninvasive imaging of the cervical vessels** (routinely **within 24 hours** of admission)

-  a. Prestroke mRS score 0 to 1,
-  b. Acute ischemic stroke receiving intravenous r-tPA within 4.5 hours of onset according to guidelines from professional medical societies,
-  c. Causative occlusion of the ICA or proximal MCA (M1),
-  d. Age ≥18 years,
-  e. NIHSS score of ≥6,
- f. ASPECTS of ≥6, and
-  g. Treatment can be initiated (groin puncture) within 6 hours of symptom onset

# ADDITIONAL BRAIN IMAGING



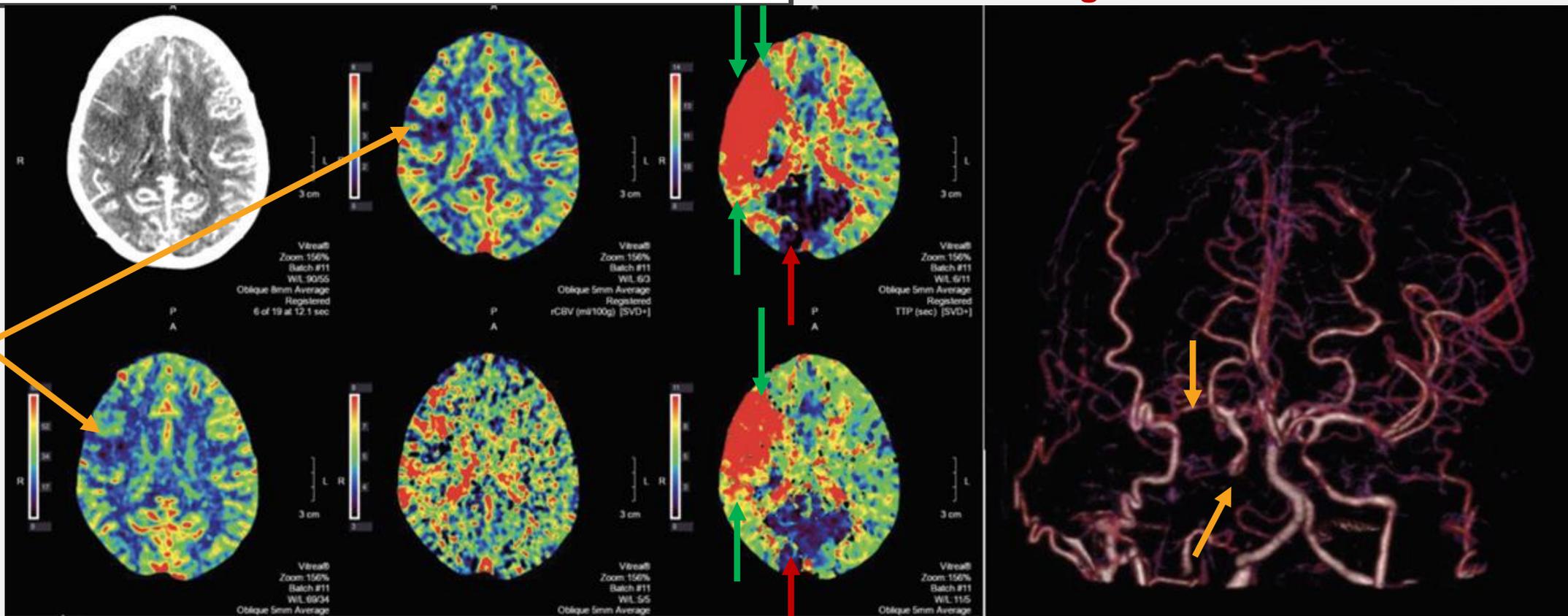
Frequency of Alberta Stroke Program Early CT Score (ASPECTS) mismatch (ie, presence of hypoperfusion but normal diffusion-weighted imaging)

Conclusion : inconsistency of Alberta Stroke Program Early CT Score (ASPECTS) scoring and the HERMES data showing that patients with large infarct **burden (ASPECTS < 5) still potentially benefit from revascularization** and are not injured from the procedure.

# VASCULAR IMAGING WITH CTA AND CT PERFUSION

Penumbra

Right ICA and MCA occlusion

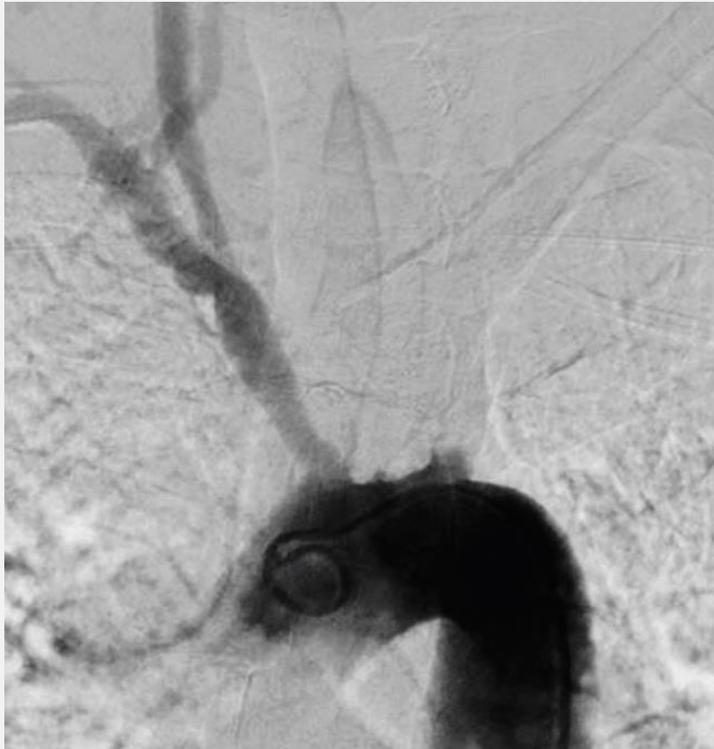


Ischemic core

- Mostly preserved CBV & CBF but ↓CBV & CBF at ischemic core
- ↑MTT in Rt MCA territory
- ↓TTP in the posterior circulation → bilateral carotid occlusion (:: maybe vasodil. Or collateral ??)

## VASCULAR IMAGING WITH CTA AND CT PERFUSION

- Given the concern for bilateral occlusions, an angiographic run of the aortic arch was performed



- An aortic arch run showing a left CCA occlusion, as well as a left subclavian artery occlusion.
- **Right ICA was the symptomatic vessel and recently occluded**, potentially requiring acute carotid angioplasty and stenting.

## ENDOVASCULAR THERAPY CAROTID

- Tandem occlusions Rx : **angioplasty and stenting** of the proximal cervical ICA occlusion first. → aspiration **thrombectomy** of any distal occlusions
- Rx Plan : stent the carotid artery open, followed by an MCA thrombectomy



carotid stent  
placement

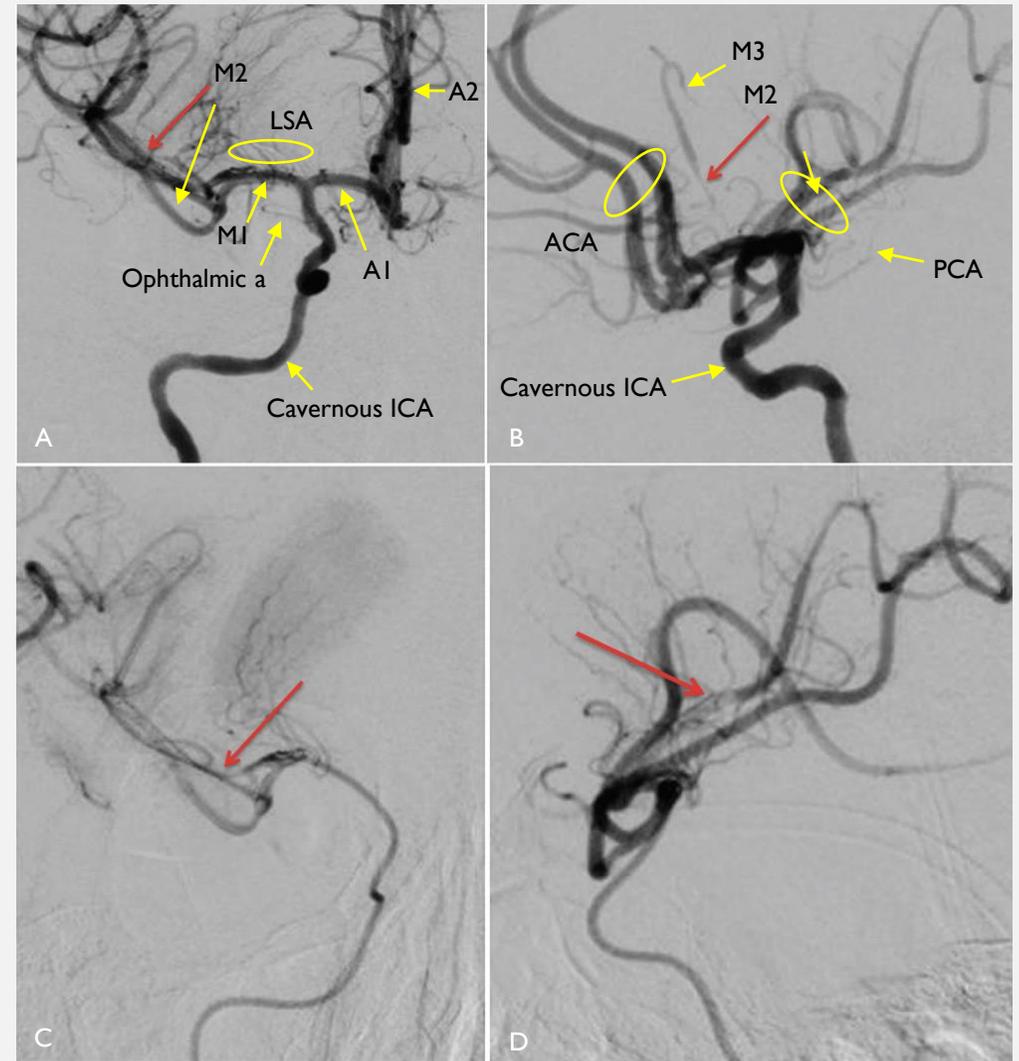


# THROMBOLYSIS MCA

beneficial : <6 hr, occlusions of the MCA.

- A(AP), B(Lat) : subocclusive thrombus in the **superior M2 branch**. There is delayed filling of this vessel.
- C(AP), D(Lat) magnified microcatheter runs: subocclusive thrombus in the superior M2 branch.
- Thrombolysis in cerebral infarction (**TICI**) grade 2b  
→ Determine the response of thrombolytic therapy for ischemic stroke (TICI ≥2 → Thrombolysis)

Grade 0	No perfusion
Grade 1	Penetration with minimal perfusion
Grade 2	Partial perfusion
2a	Only partial filling (2/3) of the entire vascular territory is visualized
<b>2b</b>	Complete filling of all of the expected vascular territory is visualized, but the filling is slower than normal
Grade 3	Complete perfusion



LSA=lenticulostriated a

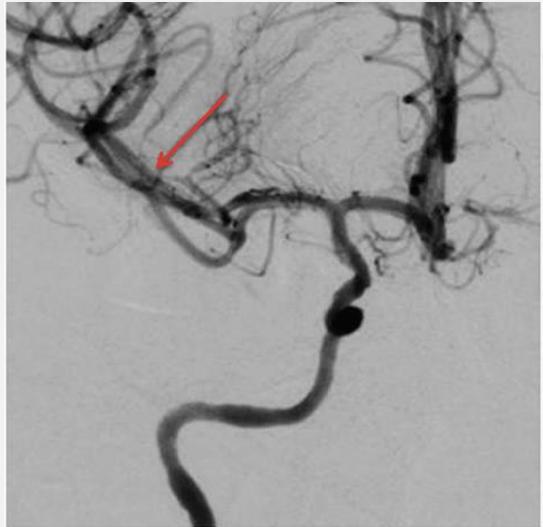
**intra-arterial recombinant tPA** injected into the superior M2 branch

→ No significant changes in the filling of this vessel

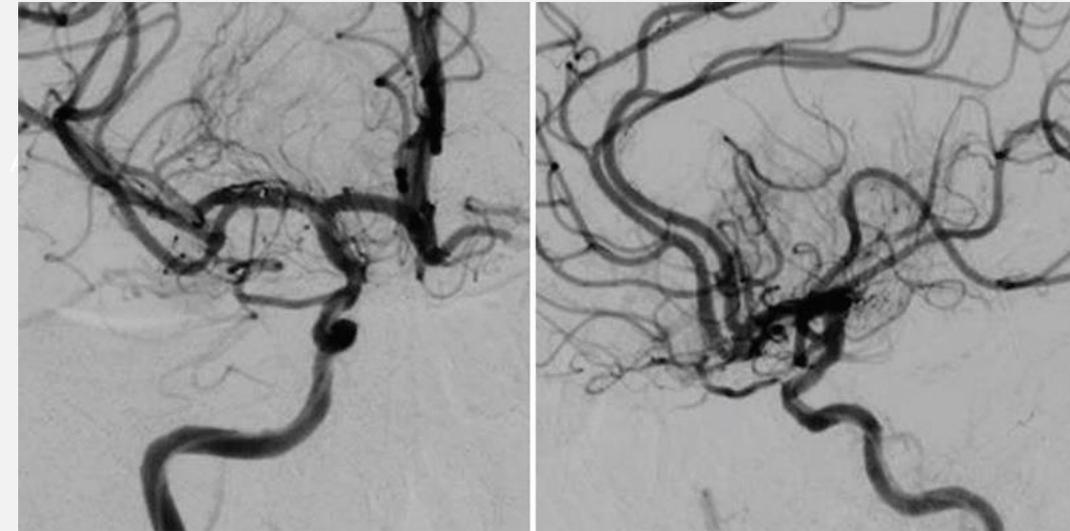
# THRON

Patients should receive endovascular therapy with a stent retriever if they meet all the following criteria (Class I; Level of Evidence A). (New recommendation):

- Prestroke mRS score 0 to 1,
- Acute ischemic stroke receiving intravenous r-tPA within 4.5 hours of onset according to guidelines from professional medical societies,
- Causative occlusion of the ICA or proximal MCA (M1),
- Age  $\geq 18$  years,
- NIHSS score of  $\geq 6$ ,
- ASPECTS of  $\geq 6$ , and
- Treatment can be initiated (groin puncture) within 6 hours of symptom onset



In selected patients with AIS **within 6-16 hours** of last known normal who have **LVO in the anterior circulation** and meet other **DAWN or DEFUSE 3 eligibility criteria**, mechanical thrombectomy is recommended.

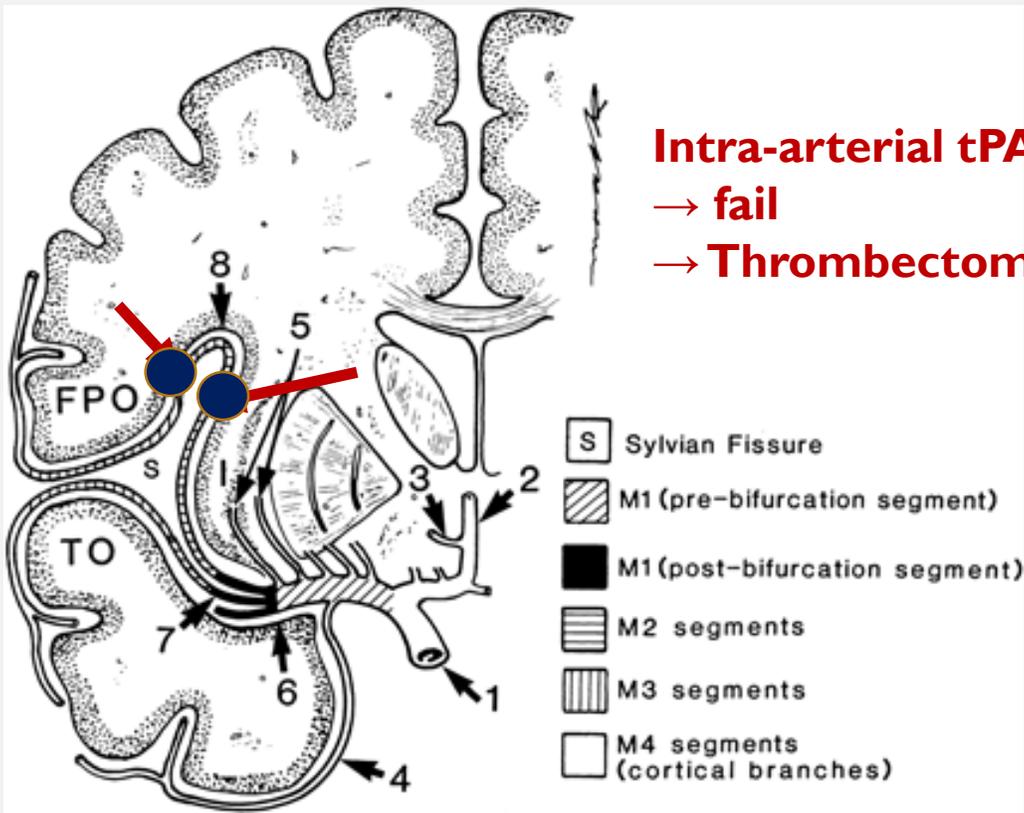
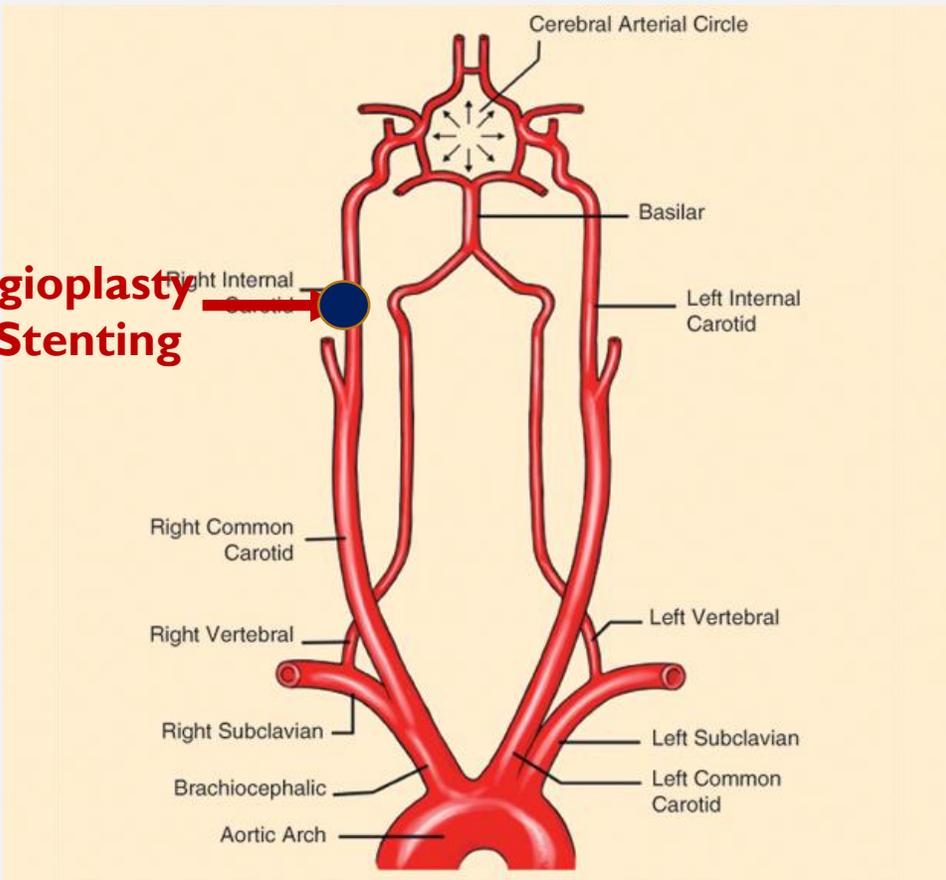


- TICl grade 3 recanalization after ADAPT of the subocclusive thrombus from the superior M2 branch and superior M3 branch

**Goal of the thrombectomy** : modified Thrombolysis in Cerebral Infarction (**mTICI**) **2b/3**

# OVERVIEW OF TREATMENT

**Angioplasty**  
→ **Stenting**



## ENDOVASCULAR THERAPY AND ANTIPLATELET THERAPY

- **No tPA given** → administer dual antiplatelet therapy.
- **tPA given** → **ASA and ticagrelor** , check P2Y12 reaction units immediately after the procedure to titrate the antiplatelet therapy are crucial steps.
- Administration of aspirin : AIS within 24 - 48 hours after onset.
- **Treated with IV alteplase, aspirin administration is generally delayed until 24 hours later but** might be considered in the presence of concomitant conditions for which such treatment given in the absence of IV alteplase is known to provide substantial benefit or withholding such treatment is known to cause substantial risk.
- Ticagrelor is not recommended (over aspirin) in the acute treatment of patients with minor stroke.

## CASE

The patient was seen in the neurointensive care unit on postprocedure day 1, and her NIHSS score was 0. She was maintained on dual antiplatelet therapy and discharged to home.

## ANTITHROMBOTIC TREATMENT

- **Non-cardioembolic AIS** : antiplatelet agents rather than oral anticoagulation  
→ reduce the risk of recurrent stroke and other cardiovascular events.
- **AIS in the setting of atrial fibrillation**: oral anticoagulation within 4 to 14 days after the onset of neurological symptoms

## DEEP VEIN THROMBOSIS PROPHYLAXIS

- In immobile stroke patients : intermittent pneumatic compression (IPC) in + routine care (aspirin and hydration) to reduce the risk of deep vein thrombosis (DVT)
- No elastic compression stockings

## DEPRESSION SCREENING

- Administration of a structured depression inventory is recommended to routinely screen for poststroke depression, but the optimal timing of screening is uncertain.
- Patients diagnosed with poststroke depression should be treated with **antidepressants** in the absence of contraindications and closely monitored to verify effectiveness.

# CEREBRAL EDEMA

- Age ≤ 60 years, unilateral MCA infarctions, < 48 hours, medication nonresponsive : **decompressive craniectomy with dural expansion**
- Medications : **osmotic therapy, hyperventilation** (Pco<sub>2</sub> target 30–34mm Hg)
- Corticosteroids (in conventional or large doses) should **not** be administered for the treatment of cerebral edema and increased intracranial pressure complicating ischemic stroke.

## CEREBELLAR EDEMA

- **Obstructive hydrocephalus** : Ventriculostomy
- **Brainstem compression** despite maximal medical therapy : Decompressive suboccipital craniectomy with dural expansion

# SEIZURES

- Recurrent seizures after stroke : treated in a manner similar to when they occur with other acute neurological conditions, and anti-seizure drugs should be selected based upon specific patient characteristics.
- No prophylactic use of anti-seizure drugs

# STATINS

- Among patients already taking statins at the time of onset of ischemic stroke continue statin
- **High-intensity statin therapy** : age  $\leq 75$  years + clinical ASCVD(Atherosclerotic cardiovascular disease) unless contraindicated.
- Clinical ASCVD : acute coronary syndromes, history of MI, stable or unstable angina, coronary or other arterial revascularization, stroke, TIA, or peripheral arterial disease presumed to be of atherosclerotic origin

# SMOKING CESSATION INTERVENTION

- Healthcare providers should strongly advise every patient with AIS who has smoked in the past year to quit.

THANK YOU