# Computerized Tomography of the Head use in Acute Ischemic Stroke

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# DISCLOSURES

None

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# Objectives

Summarize neuroimaging findings on CT (Computerized tomography) head that allow a clinician to make appropriate clinical decisions regarding management of acute ischemic stroke patients.

# Challenges for the Neurologist

- Often there is a delay in the report of acute neuroimaging
- Lack of hemorrhage is not sufficient to make a decision about treatment

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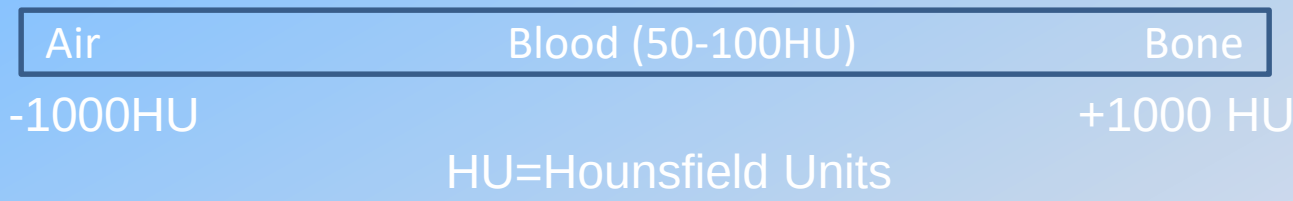
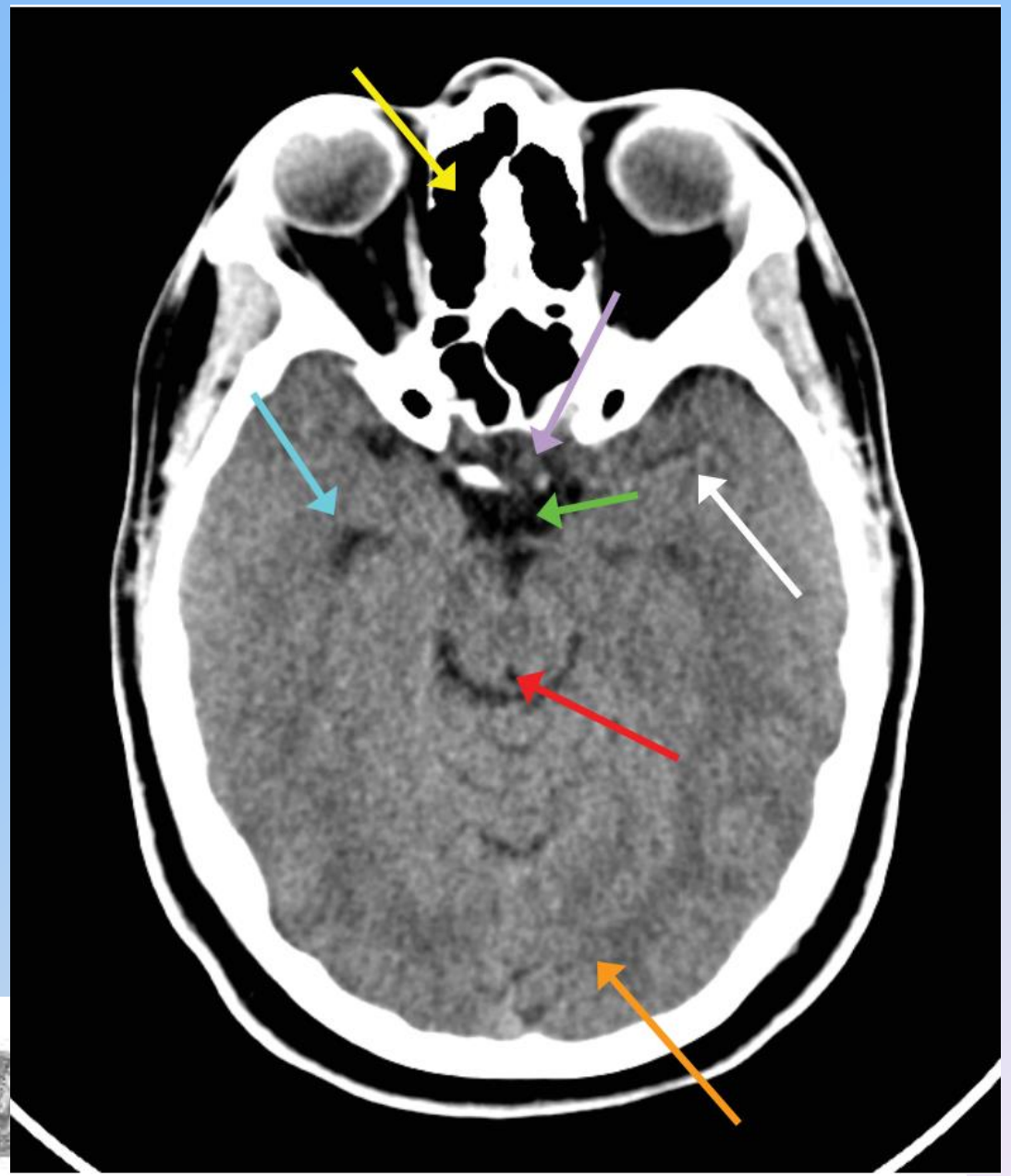
# Basic principles of Computerized Tomography

- Different tissues absorb radiation differently
- Hypodense:
  - Air - White matter
  - Edema - Infarct
- Hyperdense:
  - Blood - Metal
  - Calcium - Grey matter



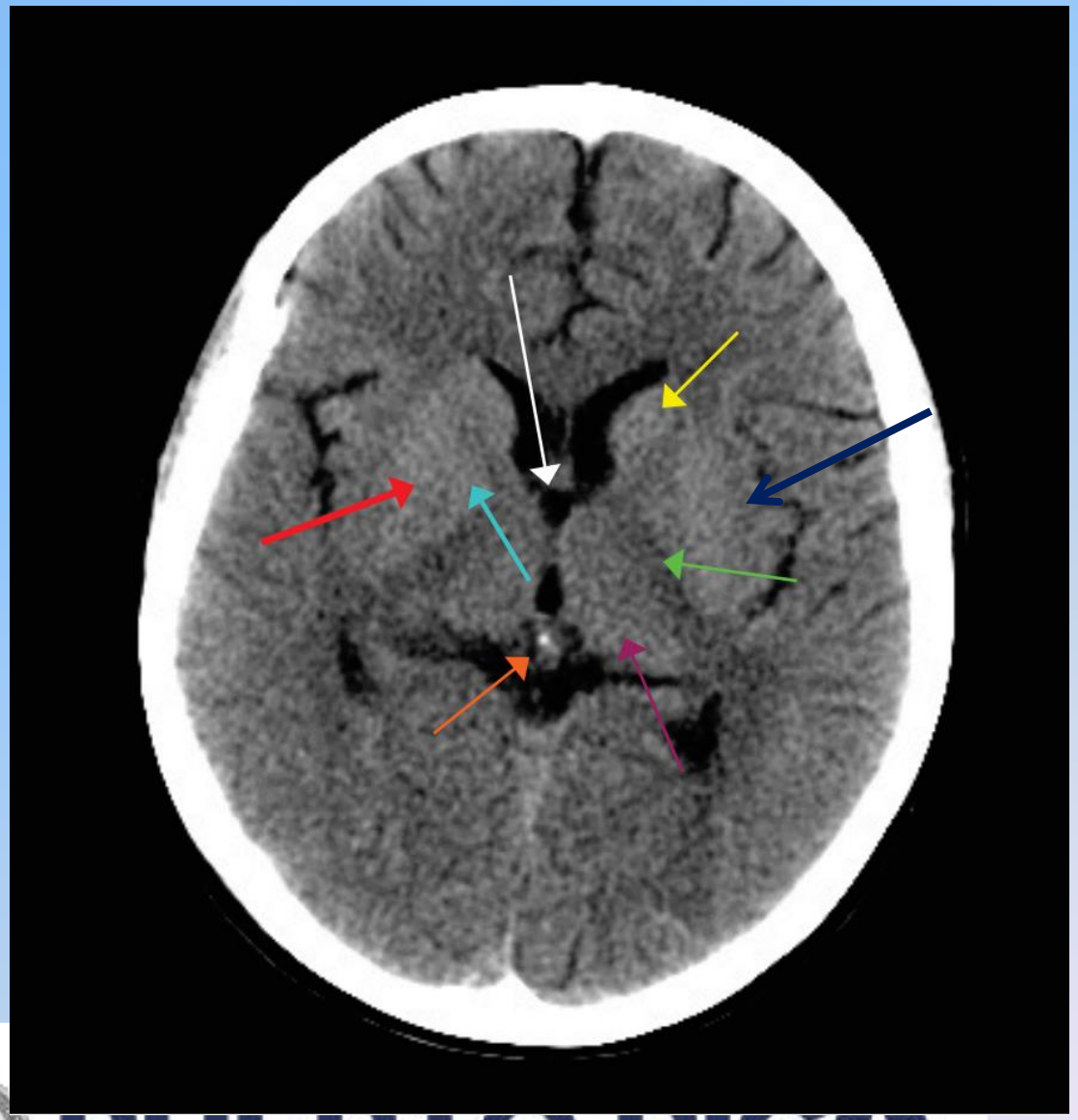
# Basic Anatomy-CT head

- Etmoid sinus
- Sellar fossa
- Suprasellar cistern
- Lateral ventricle
- MCA
- Cerebral aqueduct
- Occipital lobe



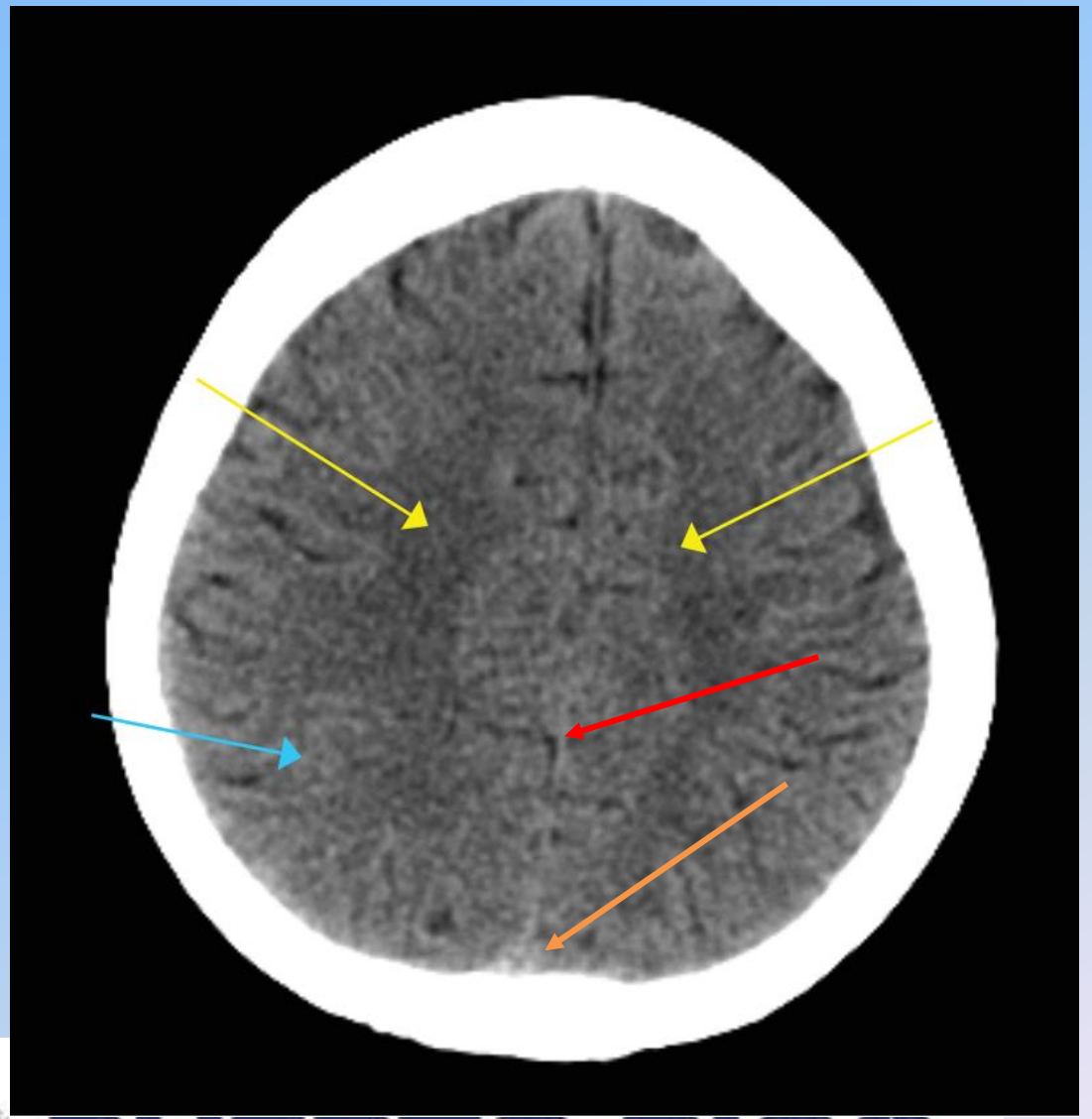
# Basic Anatomy-CT head

- Caudate (head)
- Foramen of Monroe
- Lentiform nucleus
  - Putamen
  - Globus pallidus
- Internal capsule (posterior limb)
- Thalamus
- Pineal gland (calcified)
- Insula



# Basic Anatomy-CT head

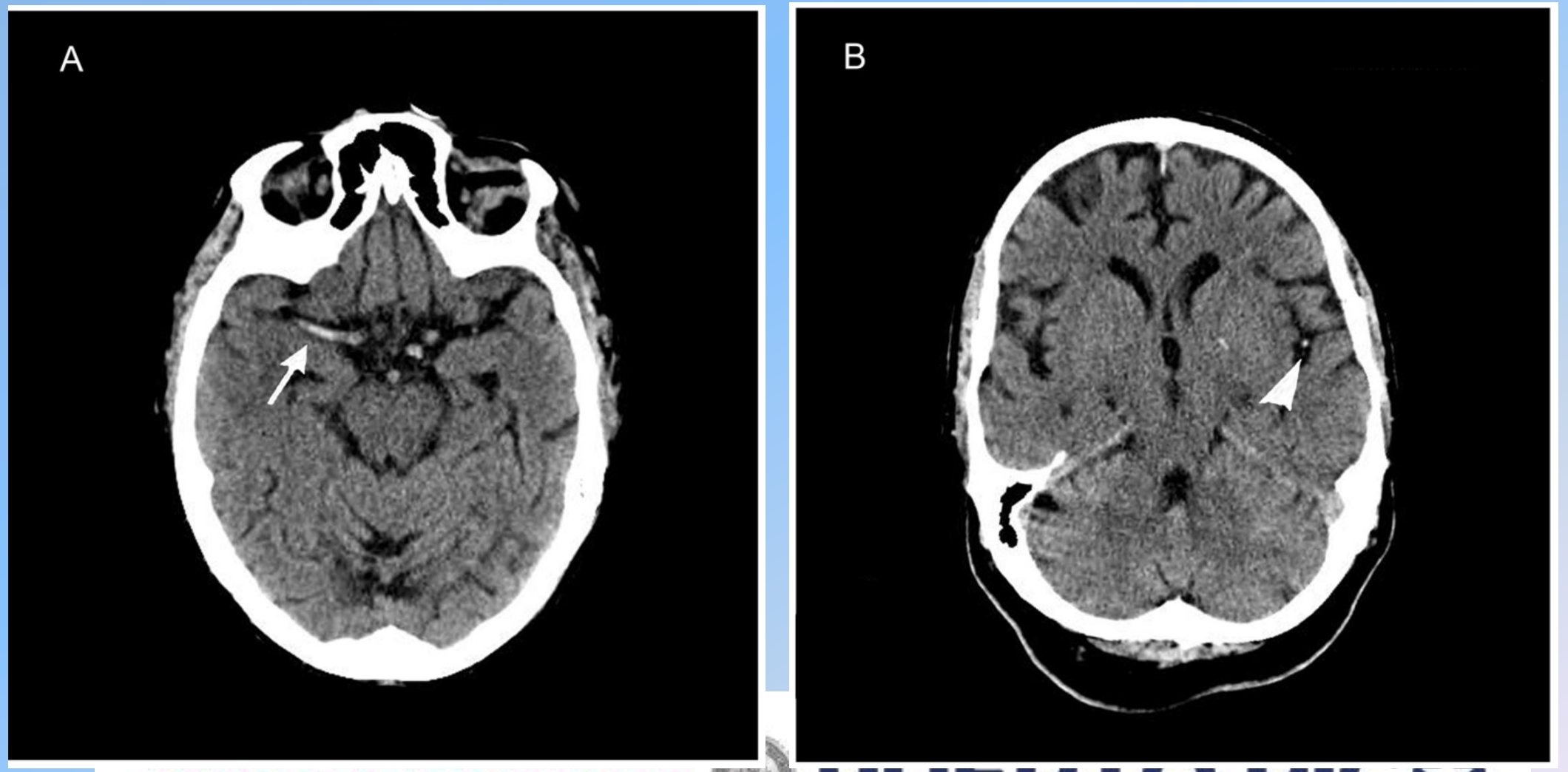
- Centrum semiovale (white matter)
- Cortex (gray matter)
- Superior sagittal sinus
- Falx



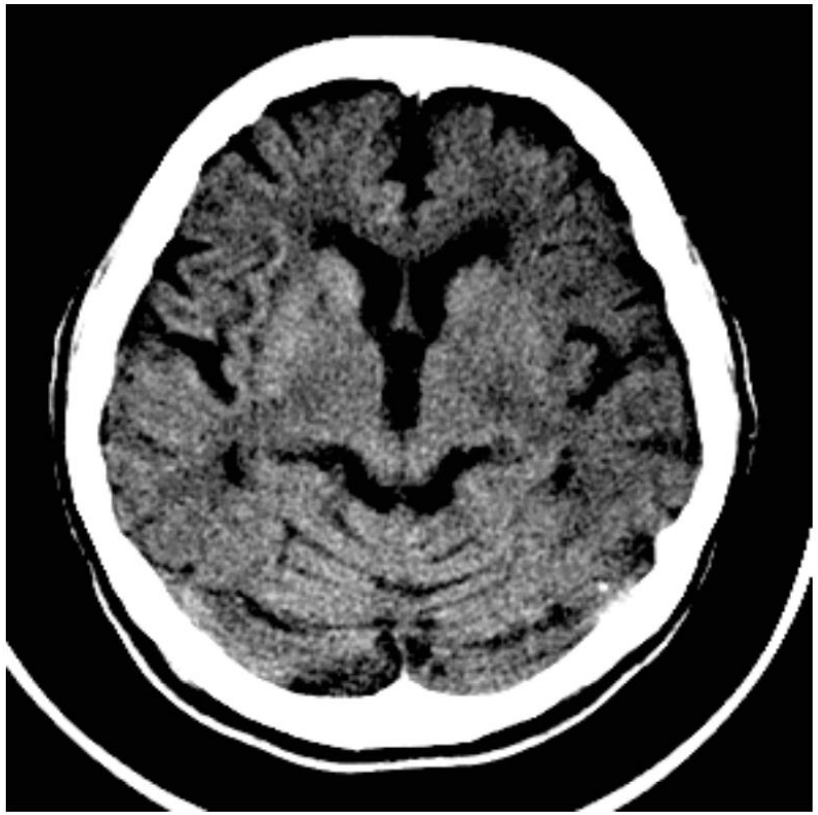
# Early ischemic changes (EIC) in ishemic stroke “Classic”

- Hyperdense Middle Cerebral artery sign
- “Insular Ribbon” sign
- Loss of Gray-White matter differentiation
- Loss of sulcal effacement
- Hypodensities,
- Mass effect

# EIC “Hyperdense MCA”



# EIC “loss G-W matter”



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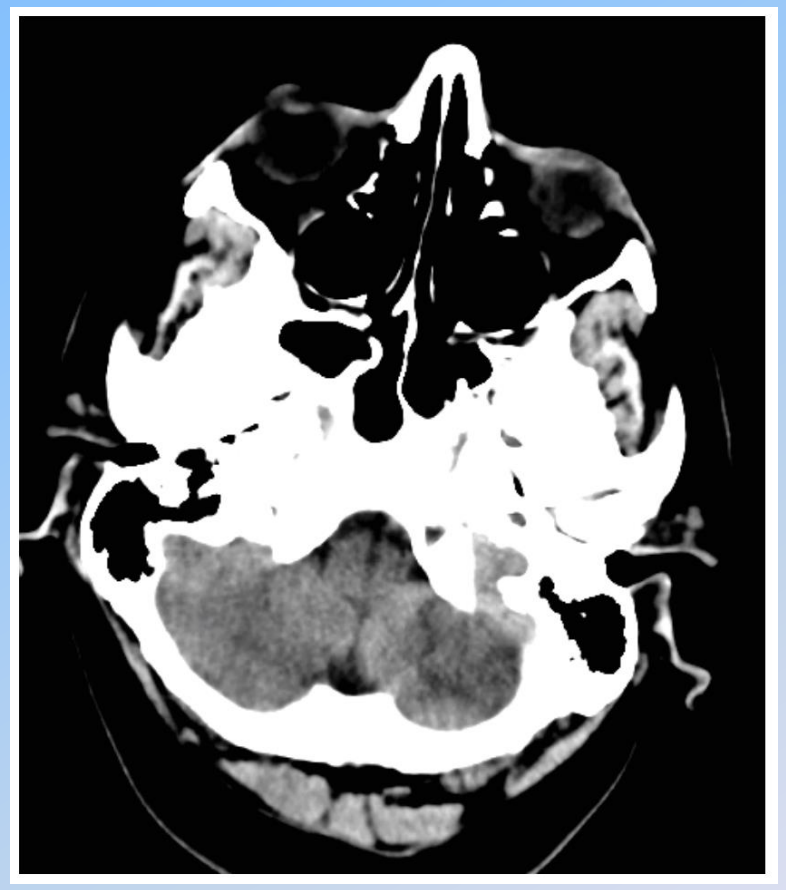
# EIC “Hypodensities”



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# EIC “Mass effect”

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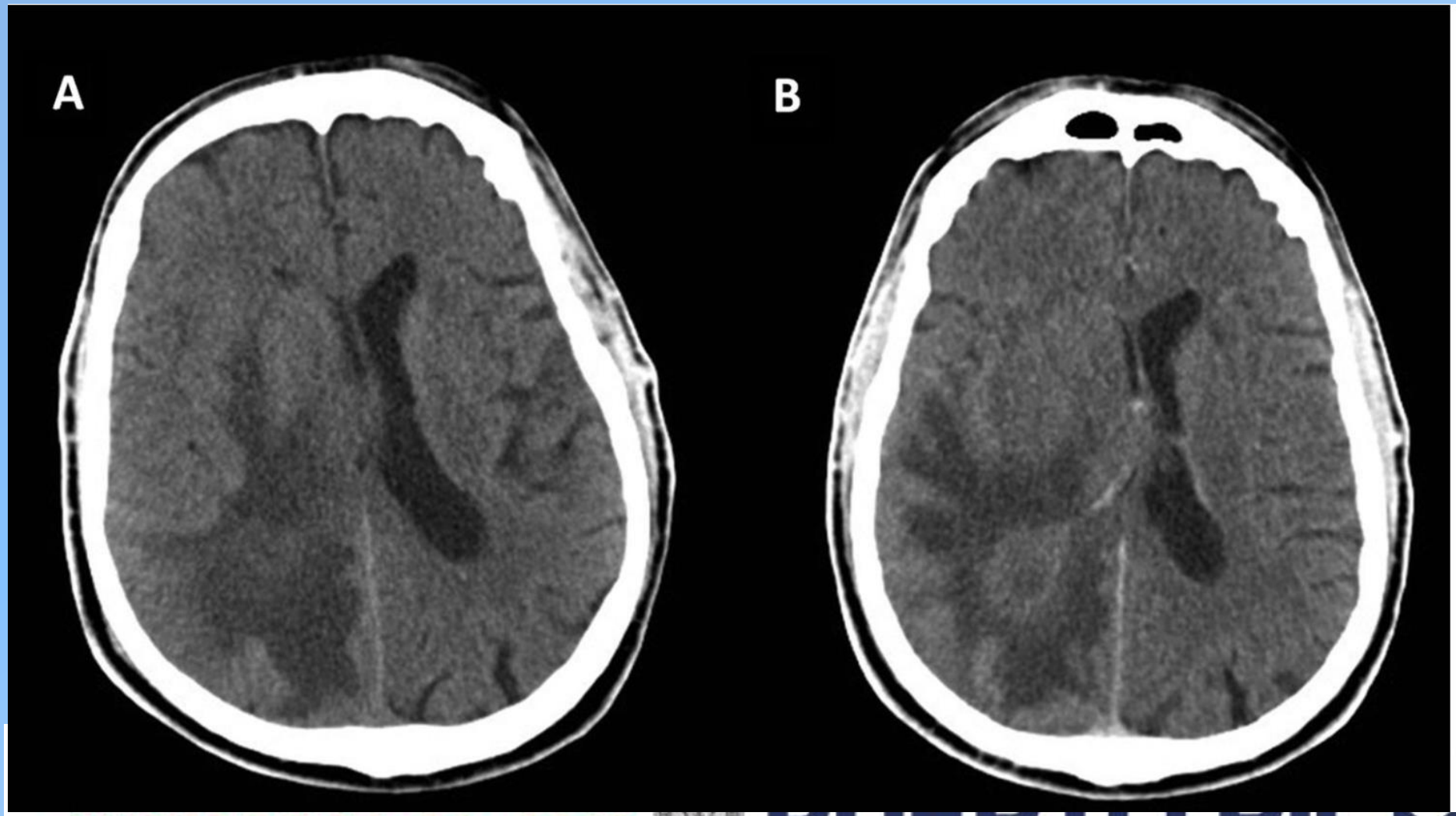
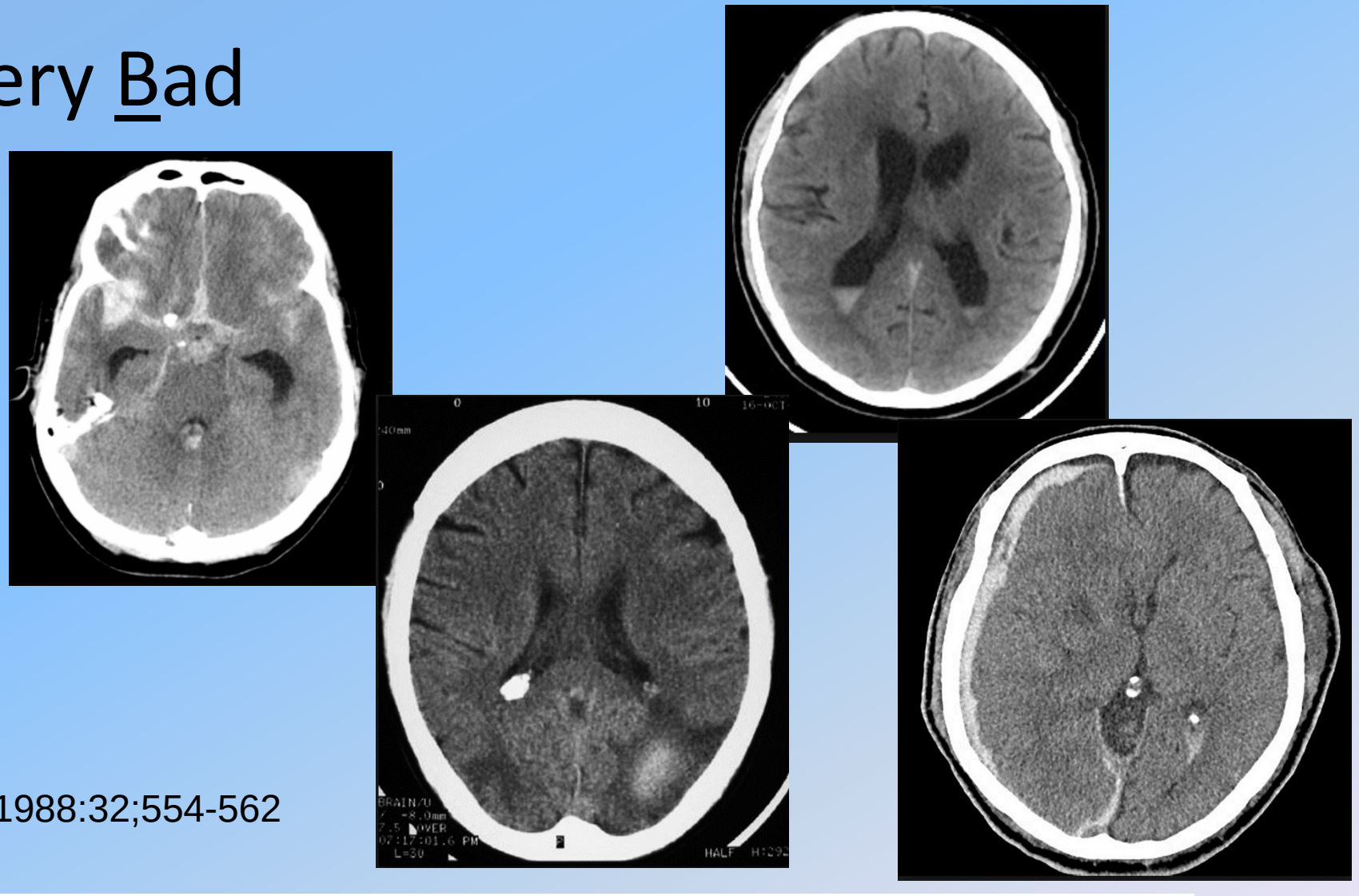
# EIC “Mass effect”

# EIC “Mass Effect”



# Blood Can Be Very Bad

- Blood
- Cisterns
- Brain
- Ventricles
- Bone



Perron et al: Ann Emerg Med 1988:32;554-562

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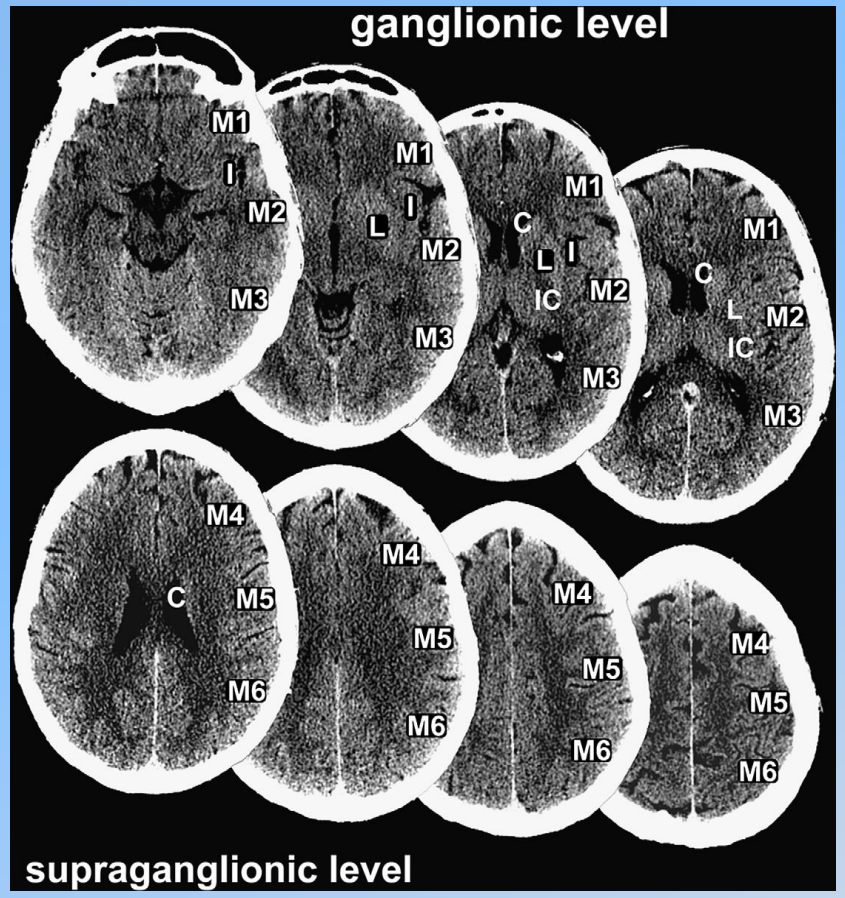
# Alberta stroke program early CT score (ASPECTS)

- Simple, reliable, and systematic approach to assessing EIC on non-contrast computerized tomography (NCCT) of the head .
- EIC on NCCT head were defined as:
- Parenchymal hypoattenuation (gray-white dedifferentiation or decreased density of brain tissue relative to attenuation of other parts of the same structure or of the contralateral hemisphere)
- Focal swelling or mass effect (any focal narrowing of the cerebrospinal fluid spaces as a result of compression by adjacent structures)

# Alberta Stroke Program Early CT Score (ASPECTS)

- MCA territory is divided into 10 regions based on functional importance.
- Caudate head serves as boundary for two levels

(Ganglionic vs Supra ganglionic)




Ganglionic
ASPECTS region (M1–M3), I (insula), C (head of caudate), L (lentiform nucleus), IC (internal capsule)

Supraganglionic
ASPECTS region (M4–M6)

# Alberta Stroke Program Early CT Score (ASPECTS)

- Visualization of all ASPECTS regions in more than one slice, axial cuts with 4- to 5-mm slice thickness should be used.
- Hypodensities should be visible on at least 2 adjacent cuts to ensure is not partial-volume effect.
- Caution when comparing left and right hemispheres.

  Head tilt, motion artifact, and bone artifact are common reasons for false-positives.
- The rule of thumb; if there is doubt about a region, do not call it

# Alberta Stroke Program Early CT Score (ASPECTS)

- ASPECTS study - patients thrombolysed within 3hours, a baseline value ≤7 less likely to achieve an independent functional outcome.
  - ASPECTS predicted functional outcome in a graded fashion, with a linear relationship for ASPECTS scores 6 through 10, about 50% of patients experienced an independent functional outcome.

*Lancet 2000;355(9216):1670–4*

- ASPECTS score of 0 – 3, the chance for an independent functional outcome was very low (~15%).

*Neurology 2006;67(3):516–8*

# Alberta Stroke Program Early CT Score (ASPECTS)

- Secondary analysis of the NINDS-stroke trial, sICH (Symptomatic ICH)
  - ASPECT scores of >7 and 3 -7 carried a similar sICH rate of 5% and 4.5%, respectively.
  - ASPECTS 0–2 showed a trend toward increased sICH risk (20%; 95% CI 1.6–38.3)

| Trial | MR CLEAN | ESCAPE | EXTEND-IA | SWIFT PRIME | REVASCAT | THERAPY | THRACE[‖] |
|---|---|---|---|---|---|---|---|
| Key inclusion criteria | NIHSS ≥ 2, age ≥ 18 | NIHSS > 5, ASPECTS > 5, moderate/good collaterals (CTA) | Eligible for IV-tPA < 4.5 hours from stroke onset, ischemic core < 70 $cm^3$, mismatch[†] | Eligible for IV-tPA < 4.5 hours from stroke onset, age 18-80, NIHSS 8-29, ASPECTS ≥ 6 | [¶]Age 18-80, NIHSS ≥ 6, ASPECTS ≥ 7 | Eligible for IV-tPA < 4.5 hours from stroke onset, age 18-85, NIHSS ≥ 8, Clot length ≥ 8 mm | Eligible for IV-tPA < 4.5 hours from stroke onset, age 18-80, NIHSS 10-25 |
| Interventional arm | Intra-arterial therapy | Intra-arterial therapy | Endovascular thrombectomy with Solitaire FR stentriever | Endovascular thrombectomy with Solitaire FR stentriever | Endovascular thrombectomy with Solitaire FR stentriever | Endovascular thrombectomy with Penumbra aspiration system | Endovascular mechanical thrombectomy |
| Control arm | Best medical management (+/– IV-tPA) | Best medical management (+/- IV-tPA) | IV-tPA only | IV-tPA only | Best medical management (+/- IV-tPA) | IV-tPA only | IV-tPA only |
| Time window for intervention | < 6 hours from onset | < 12 hours from onset | < 6 hours from onset | < 6 hours from onset | < 8 hours from onset | < 4.5 hours from onset | < 5 hours from onset |
| Number of patients | 500 (I: 233, C: 267) | 315 (I: 165, C: 150) | 70 (I: 35, C: 35) | 196 (I: 98, C: 98) | 206 (I: 103, C: 103) | 108 (I: 54, C: 54) | 385 (I: 190, C: 195) |
| Mean/median age (year) | I: 65.8, C: 65.7 | I: 71, C: 70 | I: 68.6, C: 70.2 | I: 66.3, C: 65.0 | I: 65.7, C: 67.2 | NR | I: 62, C: 62 |
| Median NIHSS | I: 17, C: 18 | I: 16, C: 17 | I: 17, C: 13 | I: 17, C: 17 | I: 17, C: 17 | NR | I: 17, C: 17 |
| Median ASPECTS | I: 9, C: 9 | I: 9, C: 9 | NR | I: 9, C: 9 | I: 7, C: 8 | NR | NR |
| Received IV-tPA | I: 87.1%, C: 90.6% | I: 72.7%, C: 78.7% | I: 100%, C: 100% | I: 100%, C: 100% | I: 68.0%, C: 77.7% | I: 100%, C: 100% | I: 100%, C: 100% |
| Median time from stroke onset to groin puncture (minute) | 260 | 241[‡] | 210 | 224 | 269 | 226 | 255[‡] |
| Intervention with stentriever device | 81.5% | 86.1% | 100% | 100% | 100% | 0%[§] | NR |
| Improvement in mRS 0-2 at 90 days | 13.5%* (I: 32.6, C: 19.1%) | 23.7%* (I: 53.0%, C: 29.3%) | 31.4%* (I: 71.4%, C: 40.0%) | 24.7%* (I: 60.2%, C: 35.5%) | 15.5%* (I: 43.7%, C: 28.2%) | 7.6% (I: 38.0%, C: 30.4%) | 12.1%* (I: 54.2%, C: 42.1%) |
| Decrease in mortality at 90 days | 1.1% (I: 21.0%, C: 22.1%) | 8.6* (I: 10.4%, C: 19.0%) | 11.4% (I: 8.6%, C: 20.0%) | 3.2% (I: 9.2%, C: 12.4%) | -2.9% (I: 18.4%, C: 15.5%) | 11.9% (I: 12.0%, C: 23.9%) | 0.6% (I: 12.5%, C: 13.1%) |
| TICI grade 2b/3 recanalization | 58.70% | 72.40% | 86.20% | 88.00% | 65.70% | NR | NR |
| Symptomatic ICH | I: 7.7%, C: 6.4% | I: 3.6%, C: 2.7% | I: 0%, C: 5.7% | I: 0%, C: 3.1% | I: 1.9%, C: 1.9% | I: 10.9%, C: 11.3% | NR |

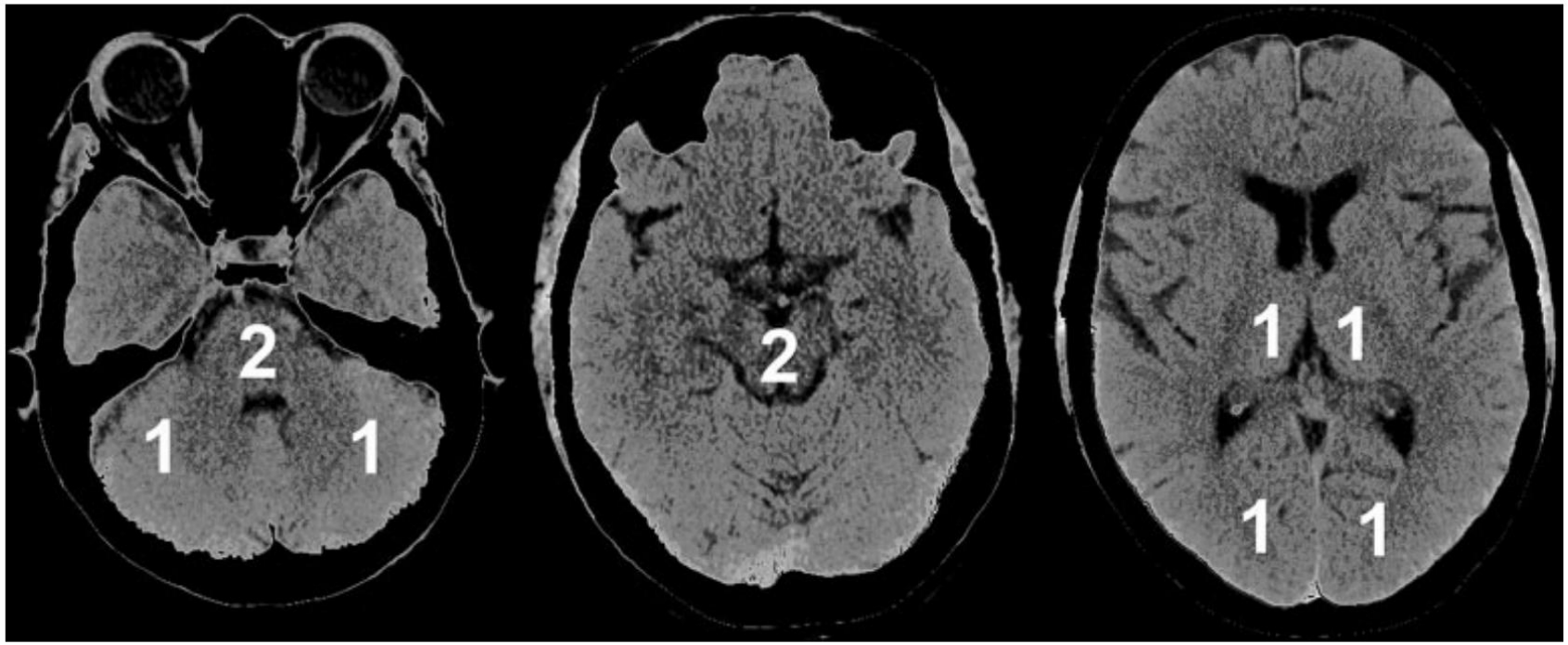


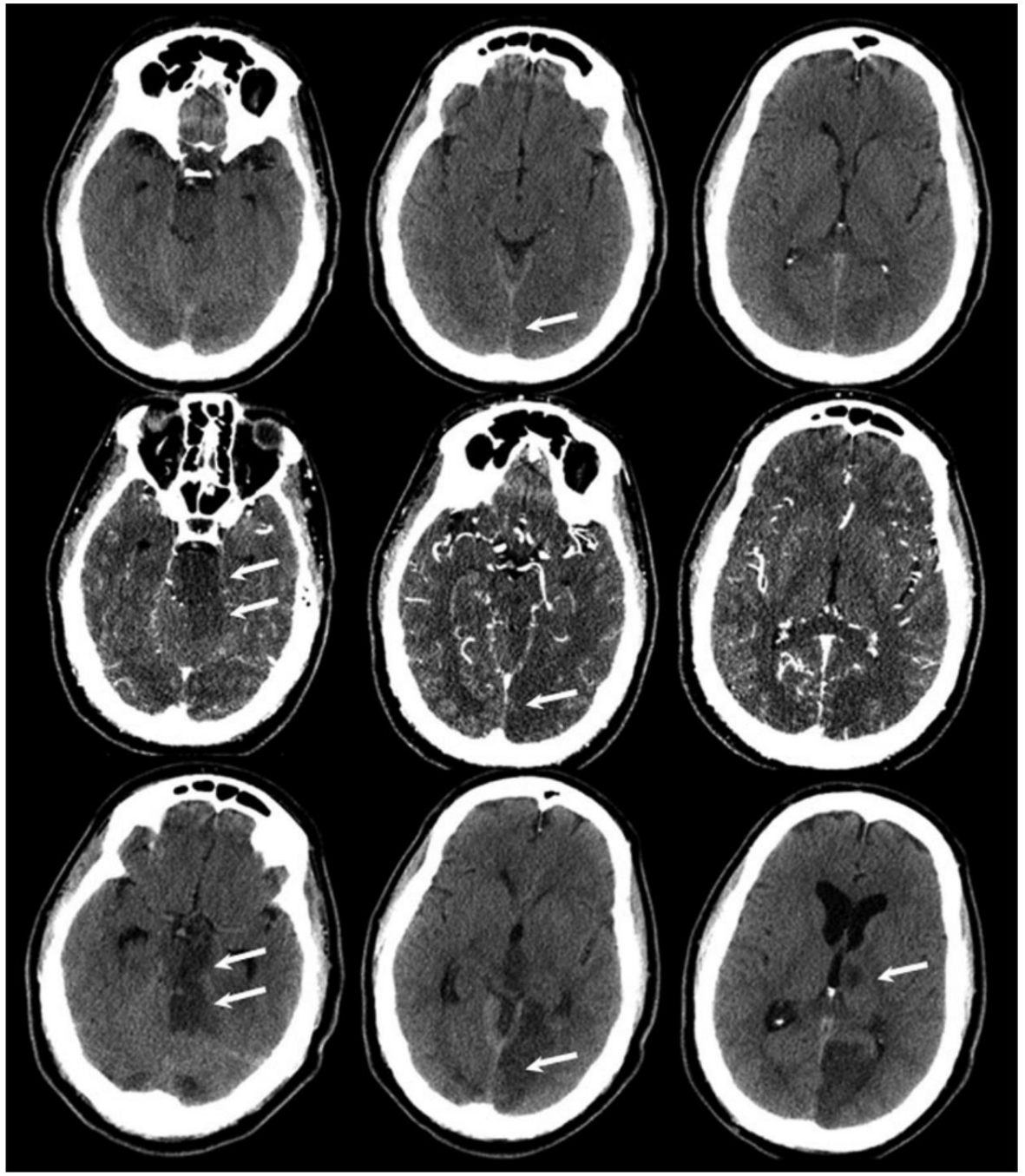

**Figure 1.** The posterior circulation Acute Stroke Prognosis Early CT score (pc-ASPECTS). From 10 points, 1 or 2 points each (as indicated) are subtracted for early ischemic changes (NCCT) or hypoattenuation (CTASI) in: left or right thalamus, cerebellum or PCA-territory, respectively (1 point); any part of midbrain or pons (2 points). Pc-ASPECTS=10 indicates a normal scan, pc-ASPECTS=0 indicates early ischemic changes (NCCT) or hypoattenuation (CTASI) in all above territories.

Stroke. 2008;39:2485-2490

CT head

CTA head

24 hours
CT head



Stroke. 2008;39:2485-2490

CASE SERIES

# Favorable revascularization therapy in patients with ASPECTS ≤ 5 on DWI in anterior circulation stroke

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## ABSTRACT

**Background** A low baseline Alberta Stroke Programme Early CT Score (ASPECTS) is strongly associated with low rates of favorable outcome in patients with acute stroke.

**Objective** To evaluate the efficacy and safety of revascularization therapy in patient with ASPECTS ≤5 in anterior circulation infarct.

**Methods** We retrospectively analyzed 108 consecutive patients presenting low ASPECTS on diffusion-weighted imaging. Sixty patients were treated by mechanical thrombectomy, including 34 patients who received simultaneously intravenous thrombolysis. A control group of 48 patients not eligible for reperfusion therapy gave us a perspective on the natural history. Clinical outcome was evaluated at 90 days using the modified Rankin Scale (mRS) score. Hemicraniectomy after malignant infarction, mortality, and symptomatic intracranial haemorrhage (sICH) were also reported.

**Results** Thrombolysis in Cerebral Infarction 2b–3 was assessed in 75% of treated patients. Reperfusion therapy led to significantly reduced disability (mRS score 0–2) at 90 days compared with the control group (30% vs 2.1%, p<0.001), hemicraniectomy (3.3% vs 22.9%, p=0.002), and death at 90 days (25% vs 47.9%, p=0.01). The sICH level was similar in treated patients and in the control group (p=0.78). Patients aged ≤70 years in the thrombectomy group had a significantly better clinical outcome than older patients (37.5% vs 10%, p=0.02), regardless of baseline characteristics or recanalization rate.

**Conclusions** In patients with acute stroke in the anterior circulation and ASPECTS ≤5 revascularization therapy contributes to a favorable clinical outcome at 90 days, especially in patients younger than 70 years.

Mourand I, et al. J NeuroIntervent Surg 2018;10:5–9. doi:10.1136/neurintsurg-2017-013358

# The TELSA Trial: Thrombectomy for Emergent Salvage of Large Anterior Circulation Ischemic Stroke (TESLA)

**Inclusion Criteria:**

1.18 to 85 years of age
2.Presenting with symptoms consistent with an acute ischemic stroke
3.Imaging evidence of an anterior circulation occlusion of the Internal Carotid Artery (ICA) terminus and/or Middle Cerebral Artery Main Stem (MCA M1) segment
4.NIHSS score >6 at the time of randomization
5.Ability to randomize within 24 hours of stroke onset
6.Pre-stroke mRS score 0-1
7.Ability to obtain signed informed consent

Imaging evidence of moderate-large infarct defined as: **NCCT ASPECTS 2-5**

NIH U.S. National Library of Medicine
ClinicalTrials.gov

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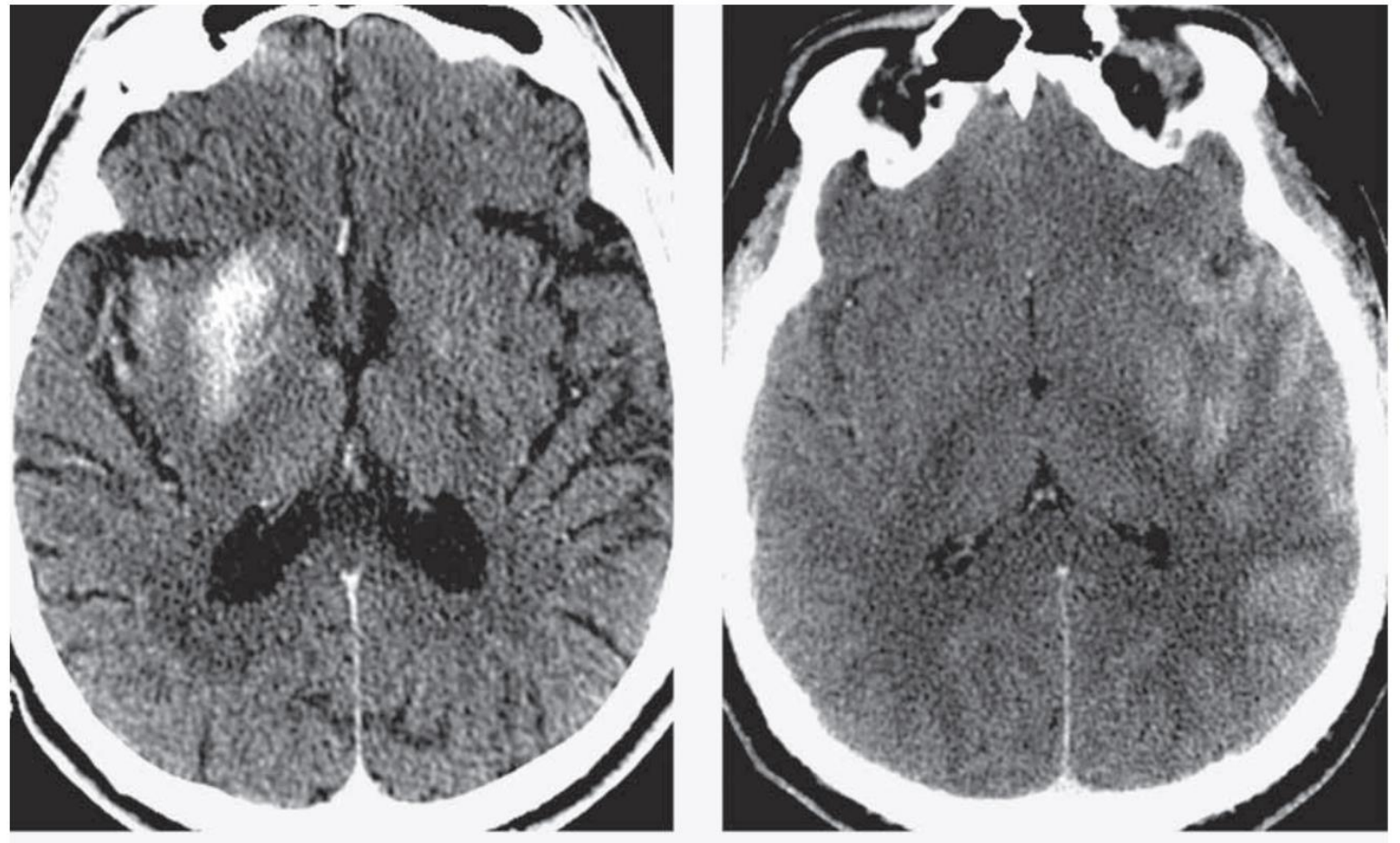
# Contrast staining vs Hemorrhage after endovascular treatment



Interventional Neuroradiology 20: 106-115, 2014

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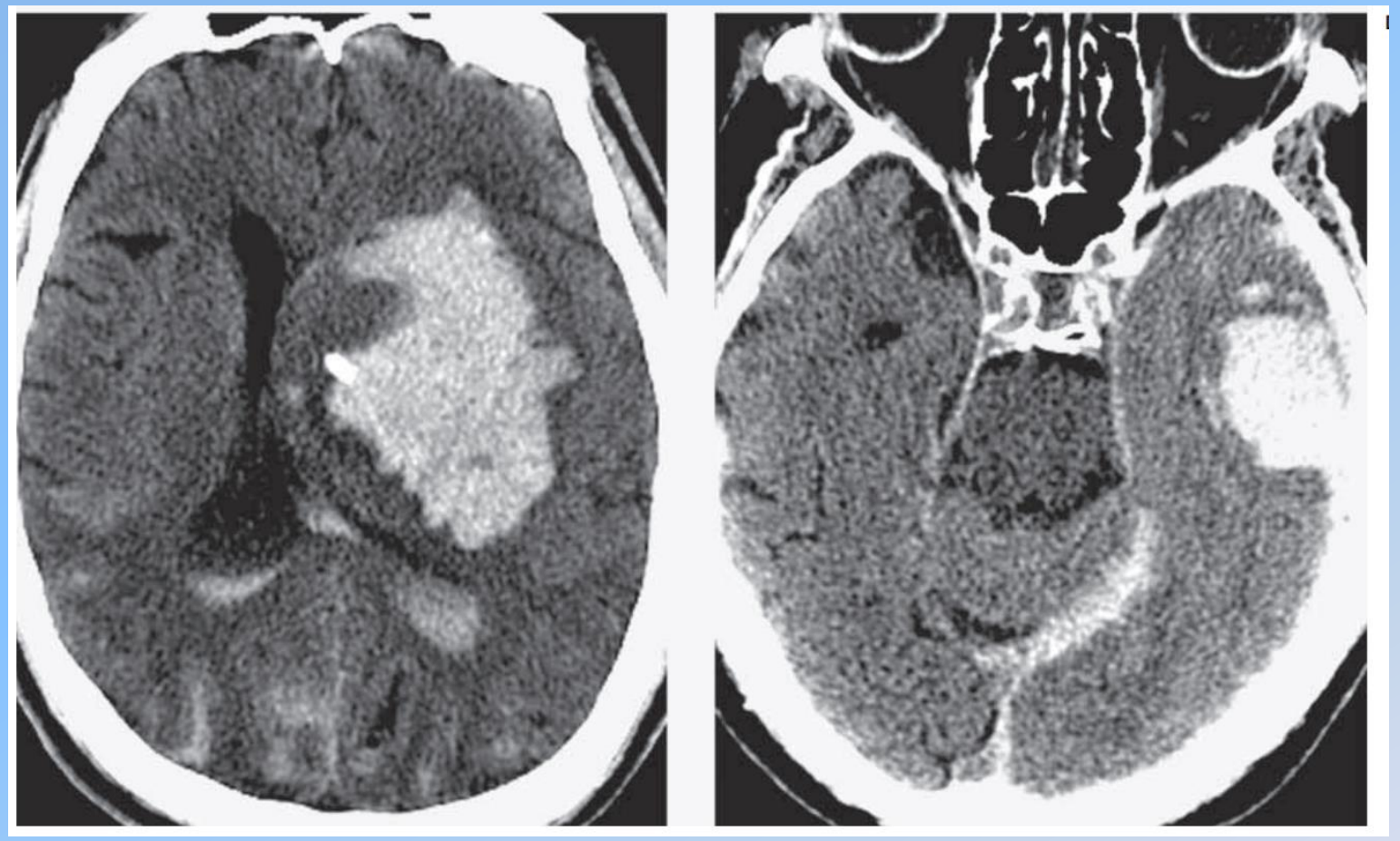
# Contrast staining vs Hemorrhage after endovascular treatment



Interventional Neuroradiology 20: 106-115, 2014

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## Contrast staining vs Hemorrhage after endovascular treatment

- Contrast staining may occur in 30-60% of patients undergoing endovascular treatment
- Resolution may be a good prognosis indicator, leading to normal brain
- Occasionally may lead to hemorrhagic transformation
- Contrast staining more commonly indicates ischemia and not hemorrhagic transformation

Interventional Neuroradiology 20: 106-115, 2014

# European Cooperative Acute Stroke Study (ECASS) classification of ICH following thrombolysis

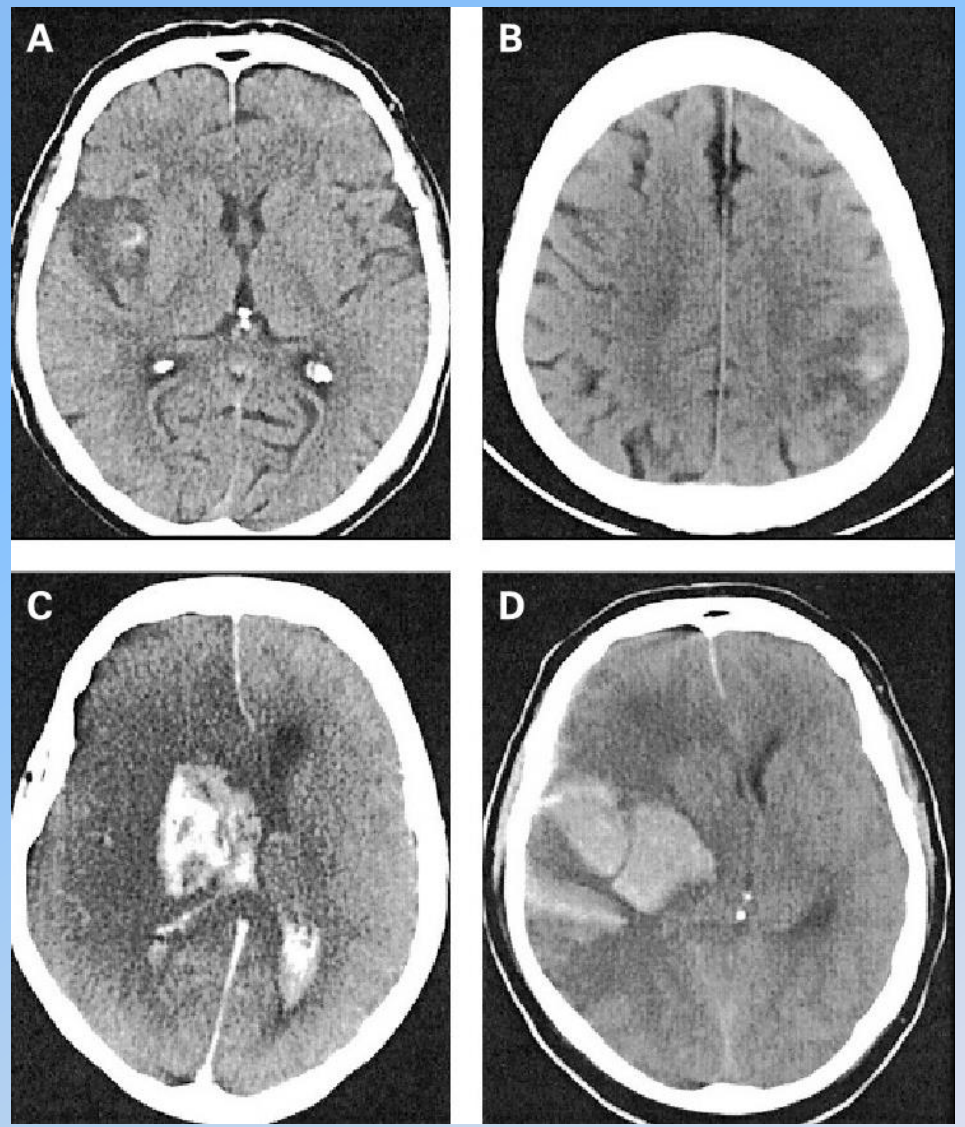
**Table. Radiologic Classification Schemes for Postthrombolysis Intracranial Hemorrhage**

| Hemorrhage Classification | Definition |
|---|---|
| HI 1 | Small petechial hemorrhage without space-occupying effect |
| HI 2 | More confluent petechial hemorrhage without space-occupying effect |
| PH 1 | Hemorrhage in <30% of the infarcted area with mild space-occupying effect |
| PH 2 | Hemorrhage in >30% of the infarcted area with significant space-occupying effect |

Abbreviations: HI, hemorrhagic infarction; PH, parenchymal hematoma.

*JAMA Neurol.* 2014;71(9):1181-1185.

European Cooperative Acute Stroke Study (ECASS) classification of ICH following thrombolysis




Journal of neurology, neurosurgery, and psychiatry 79(10):1093-9

# Conclusions:

- Knowledge of NCCT is important in the management of acute ischemic stroke
- ASPECTS is a commonly used method to assess eligibility for recanalization therapies and prognosis
- It is important to recognize that contrast staining can occur after recanalization therapies

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