



NEUROIMAGING IN STROKE 2025

EVOLVING TOOLS FOR ACUTE CARE

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SIMCON 2025
November 15th 2025, Colombo, Sri Lanka



DISCLOSURE OF RELEVANT FINANCIAL RELATIONSHIP(S) WITH INELIGIBLE COMPANIES

- Nothing to disclose

All relevant financial relationships have been mitigated.

LEARNING OBJECTIVE

- Review acute stroke care pathway and role of neuroimaging.
- Discuss evolving neuroimaging technologies guiding tissue-based stroke therapy.
- Identify stroke mechanisms through neurovascular imaging and case-based discussion.

AUDIENCE

- Internal medicine/ Internist
- Neuroradiologist or radiologist
- Neuro Interventional or Neurosurgery
- Vascular neurologist or neurologist

SIMCON
2025
Colombo

NEUROIMAGING IN ACUTE STROKE CARE 2025

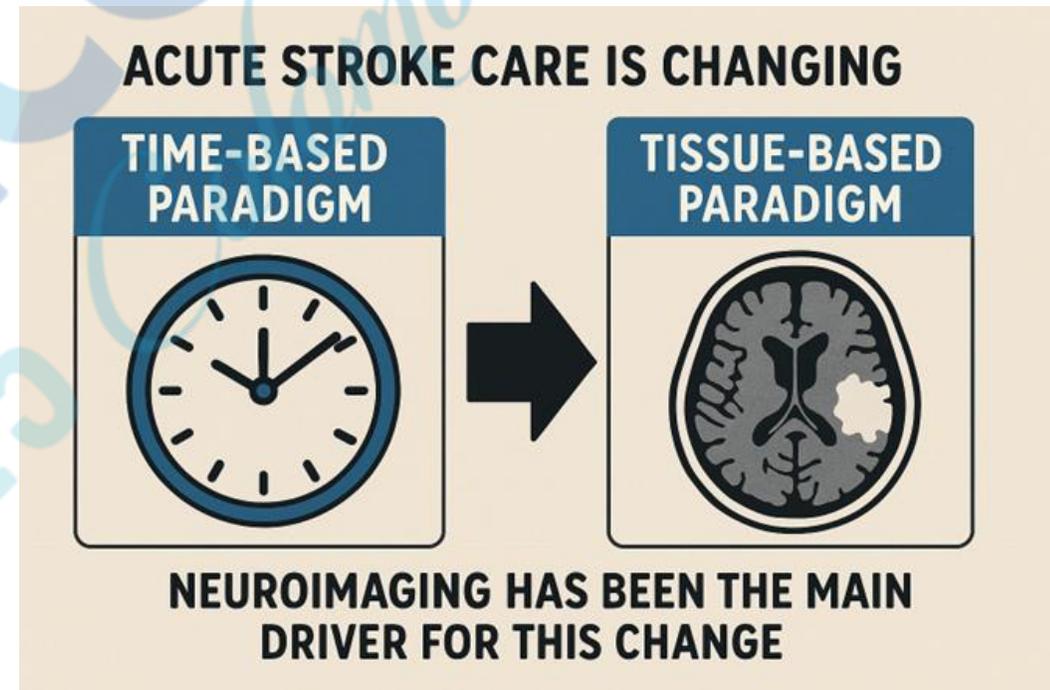
- CT head
- CTA head and Neck
- CT Venogram
- CT perfusion

- MRI brain
- MRA Head and Neck
- MR Venogram
- MR perfusion
- MRA vessel wall imaging

- Carotid ultrasound
- Transcranial dopplers
- Conventional angiogram

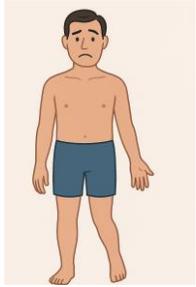
INTEGRATING NEUROIMAGING TO STROKE CARE

- Rapid diagnosis:
 - Ischemic stroke vs hemorrhagic stroke vs +/- mimic
- Treatment eligibility
- Stroke Mechanism/Etiology
- Prognostic insight



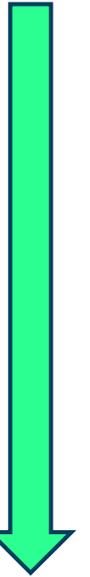
Illustrations created by author

ACUTE STROKE CARE PATHWAY



- ❑ ED Team : nurses, ED consultant & support staff
- ❑ Stroke Team
- ❑ Pharmacist

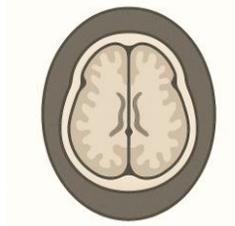
Door



20 min



CT scanner



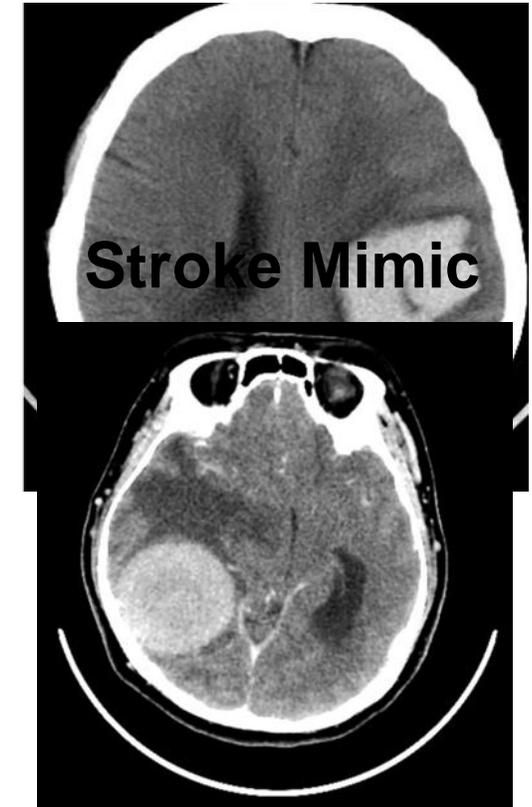
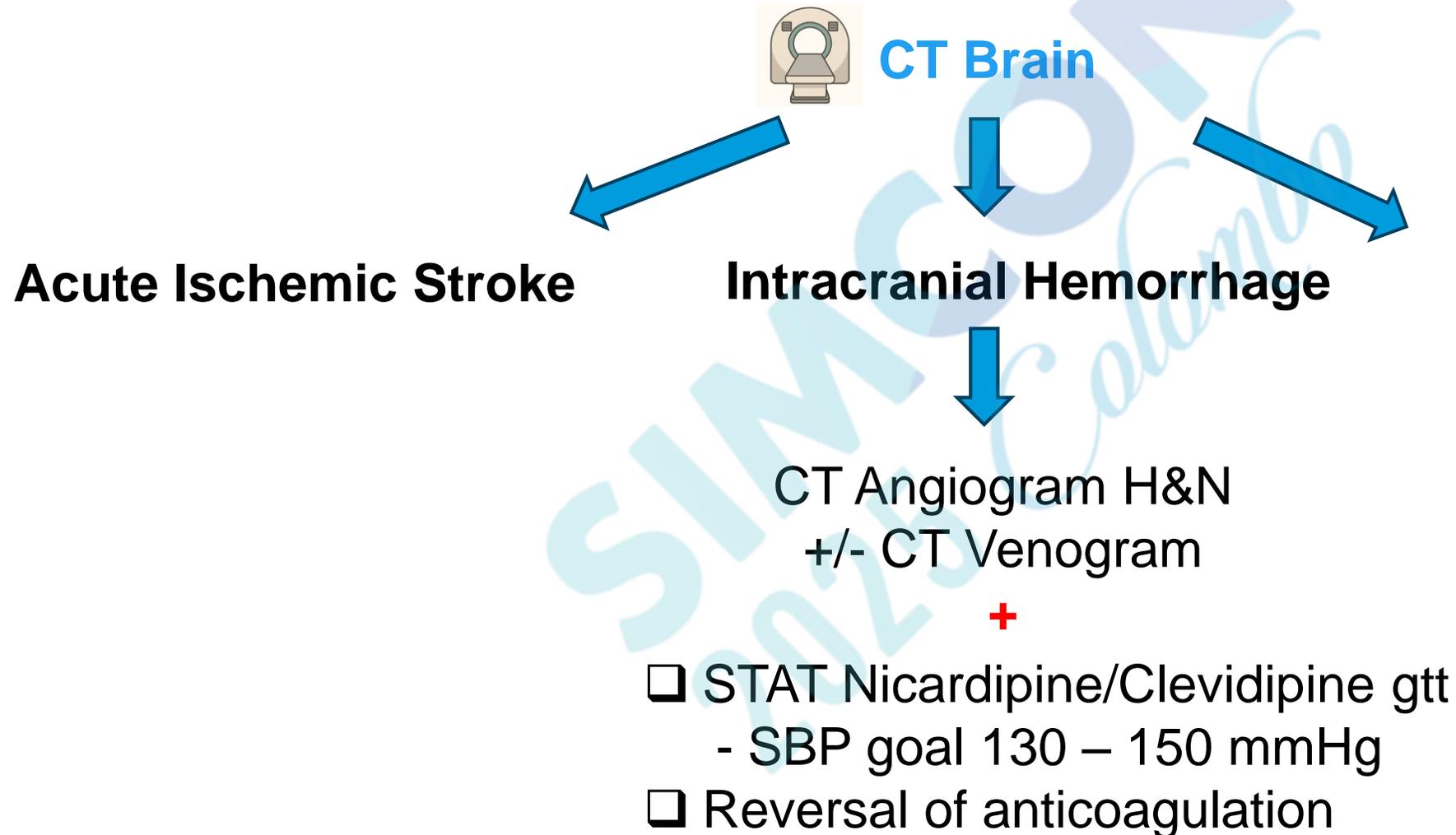
Patient with focal neurological deficits



- ❑ Stroke Team: Neurology residents, fellows, Vascular Neurology consultant
- ❑ Pharmacist
- ❑ CT technologist

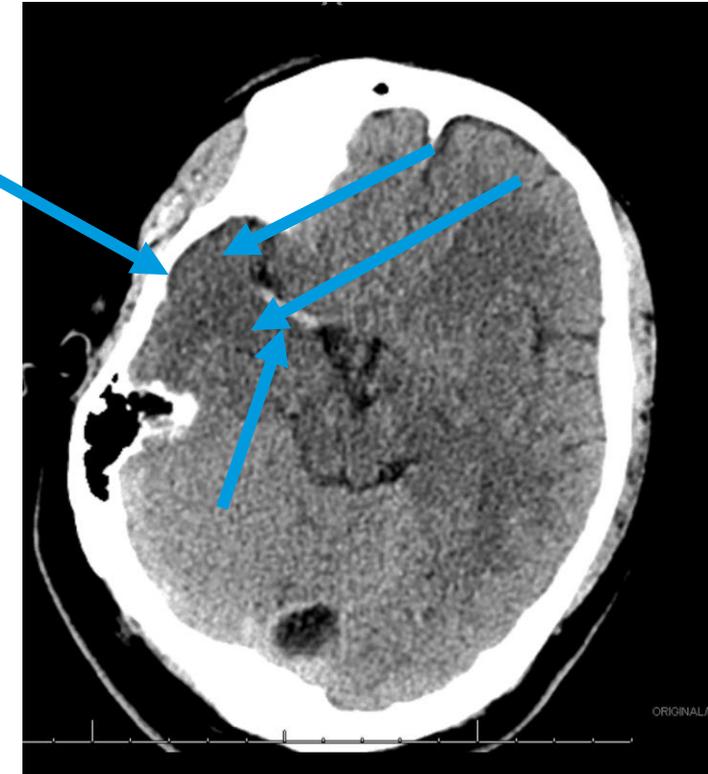
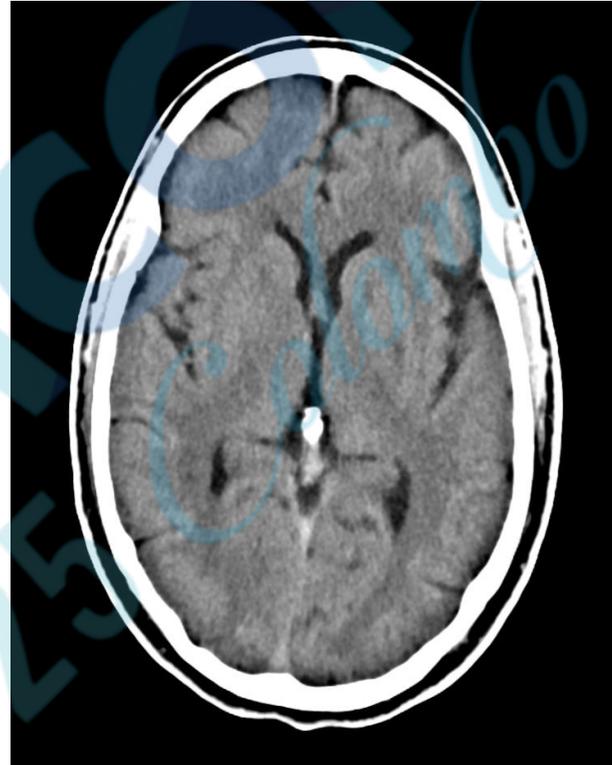
Figure and Illustrations created by author

NEUROIMAGING DRIVEN STROKE CARE PATHWAY

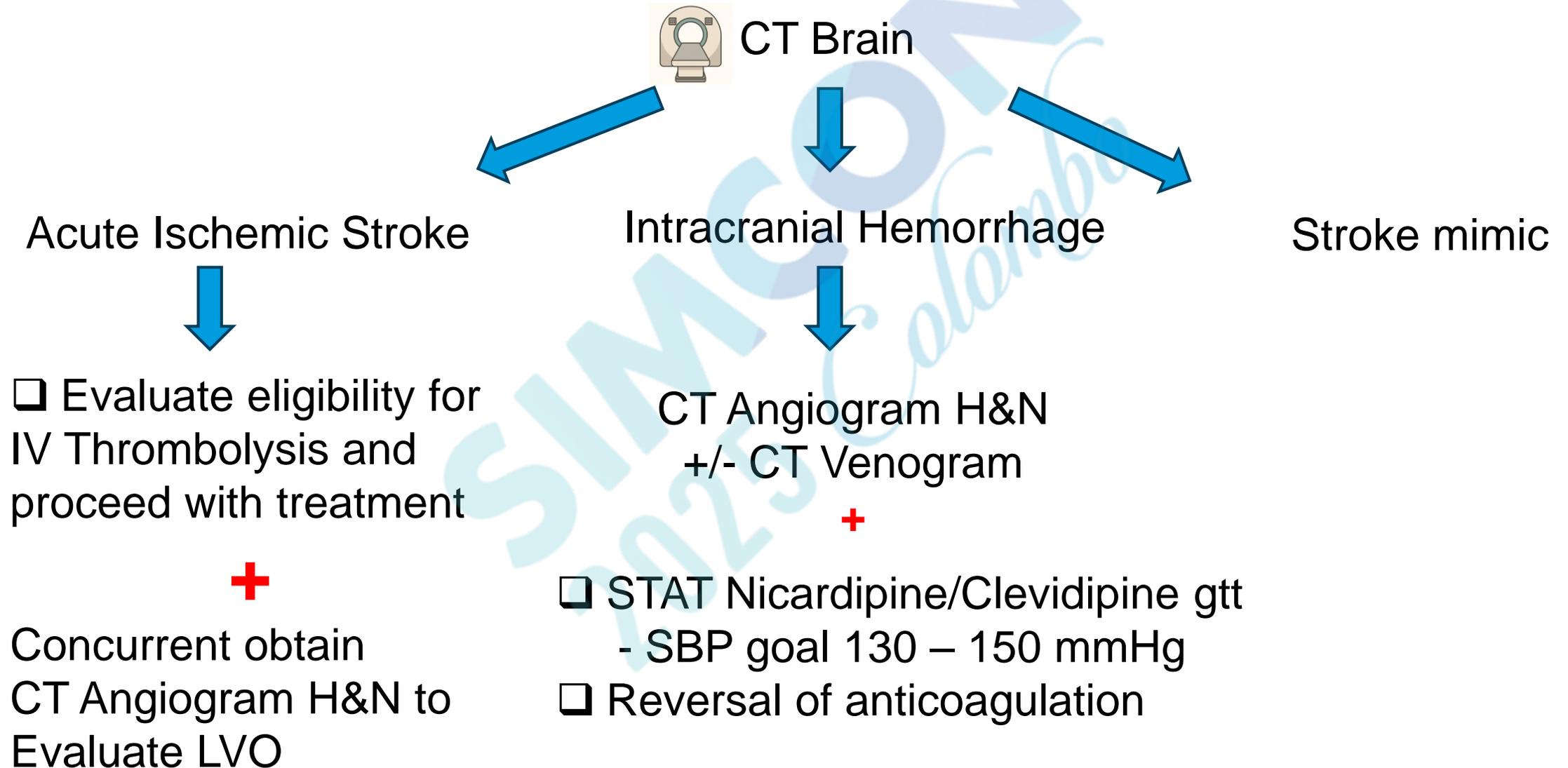


ACUTE ISCHEMIC STROKE – CT BRAIN

- Unremarkable
- Subtle changes
 - Loss of gray-white differentiation
 - Sulcal effacement
 - Slight hypoattenuation in the affected cortex
 - Hyperdense vessel sign (e.g. hyperdense MCA)



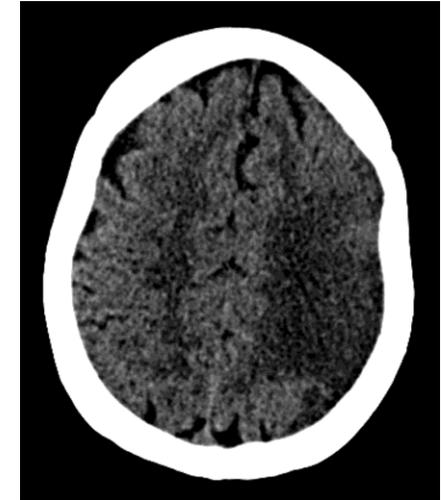
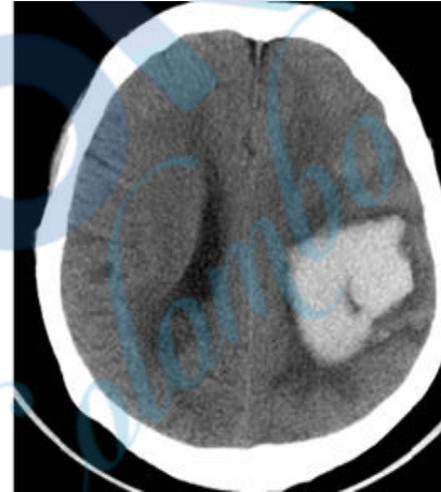
ACUTE ISCHEMIC STROKE CARE PATHWAY AND ROLE OF NEUROIMAGING



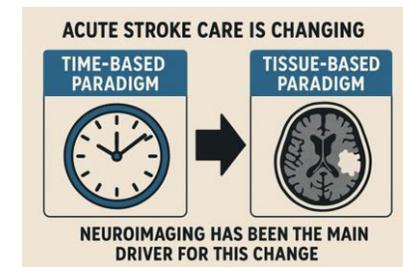
TREATMENT – IV THROMBOLYSIS <4.5HRS

Imaging Exclusion Criteria

- Intracranial hemorrhage on CTH (including SAH)
- Extensive hypo-attenuation (> 1/3 MCA territory on CTH)



If patient is >4.5hrs and no large vessel occlusion → IV thrombolysis ?



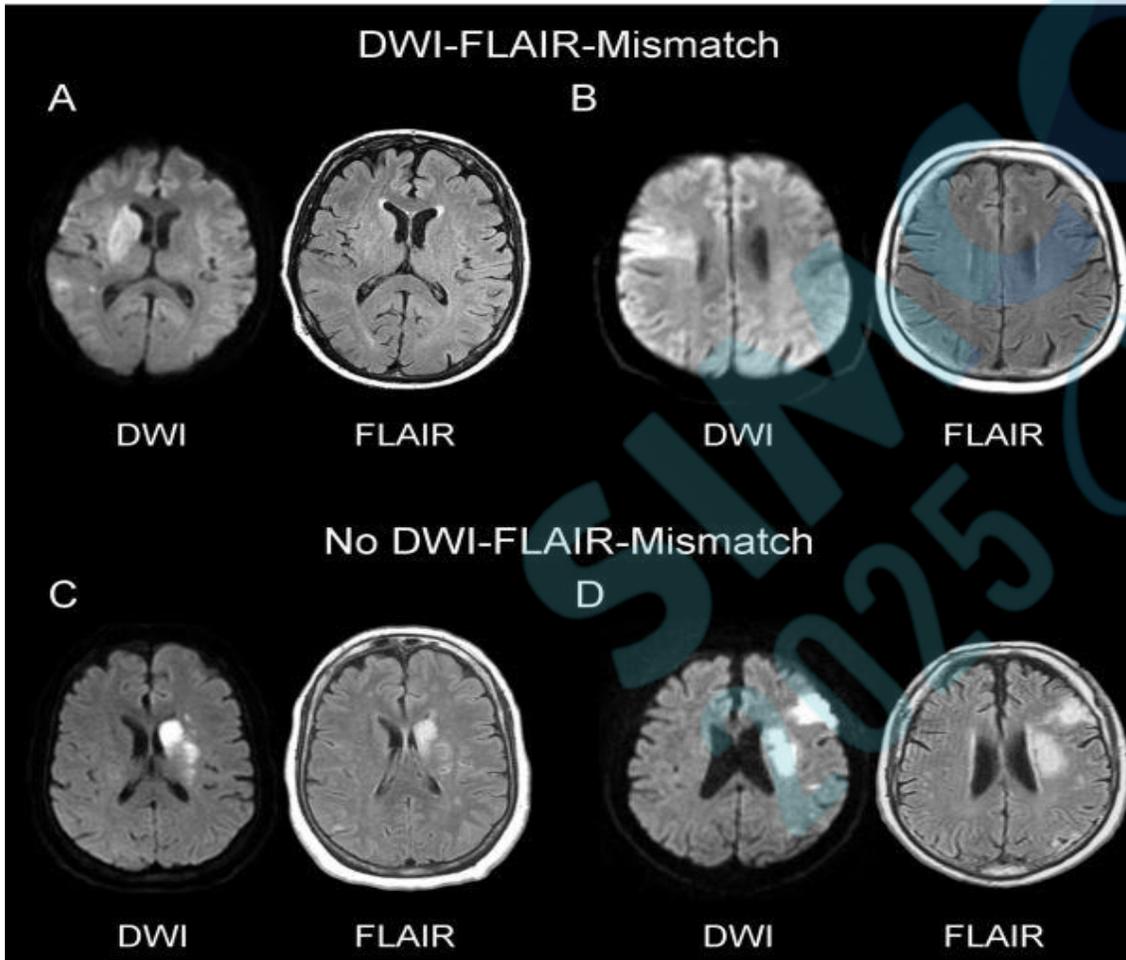
**WAKE UP STROKE
OR UNKNOWN LAST
KNOWN NORMAL
<24HRS**

TISSUE WINDOW



WAKE UP TRIAL (2018)

- MRI brain: DWI visible stroke without T2 FLAIR hyperintensity



The **NEW ENGLAND**
JOURNAL of *MEDICINE*

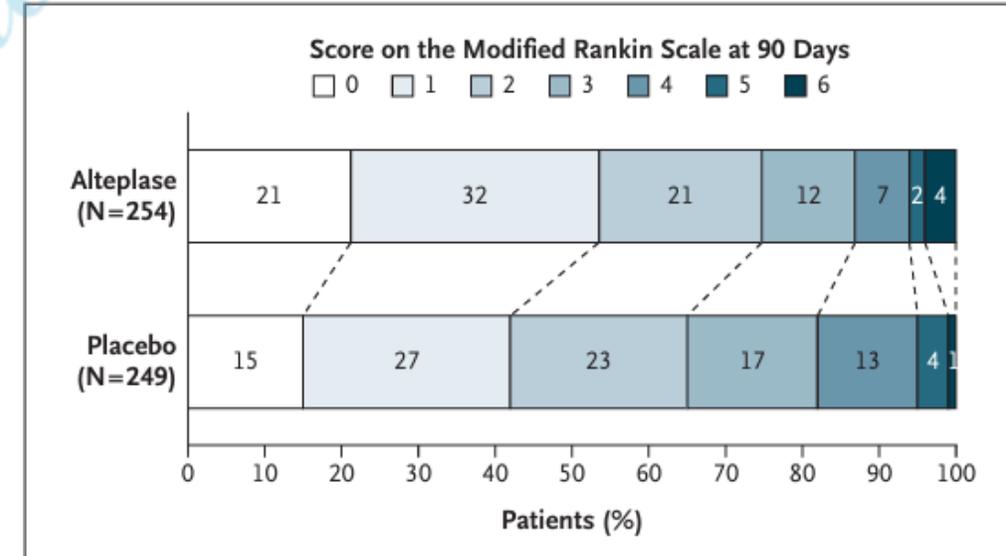
ESTABLISHED IN 1812

AUGUST 16, 2018

VOL. 379 NO. 7

MRI-Guided Thrombolysis for Stroke with Unknown Time of Onset

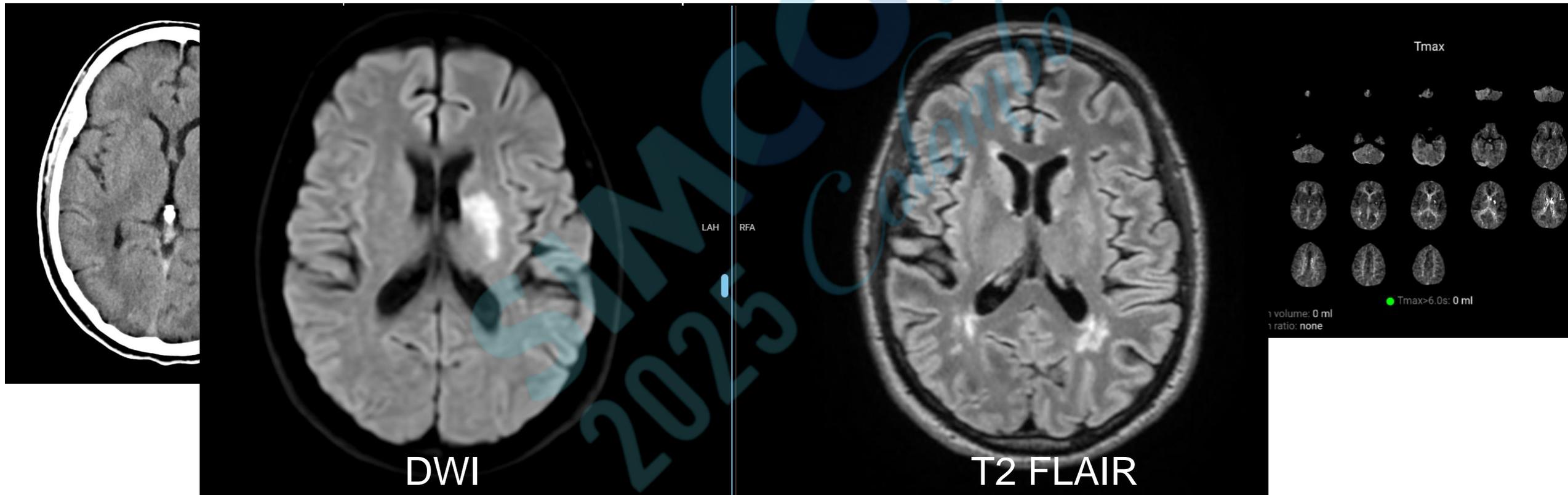
G. Thomalla, C.Z. Simonsen, F. Boutitie, G. Andersen, Y. Berthezene, B. Cheng, B. Cheripelli, T.-H. Cho, F. Fazekas, J. Fiehler, I. Ford, I. Galinovic, S. Gellissen, A. Golsari, J. Gregori, M. Günther, J. Guibernau, K.G. Häusler, M. Hennerici, A. Kemmling, J. Marstrand, B. Modrau, L. Neeb, N. Perez de la Ossa, J. Puig, P. Ringleb, P. Roy, E. Scheel, W. Schonewille, J. Serena, S. Sunaert, K. Villringer, A. Wouters, V. Thijs, M. Ebinger, M. Endres, J.B. Fiebach, R. Lemmens, K.W. Muir, N. Nighoghossian, S. Pedraza, and C. Gerloff, for the WAKE-UP Investigators*



N Engl J Med 2018;379:611-622

CASE #1

- 52 M was found by co-works in a hotel room with slurred speech, aphasia and left hemi-body weakness. LSN 9pm night prior.



HOPE TRIAL (2025)

- AIS and salvageable brain tissue identified by perfusion imaging. Symptom onset 4.5-24hrs.
- Functional independence **40% tPA vs 26%**

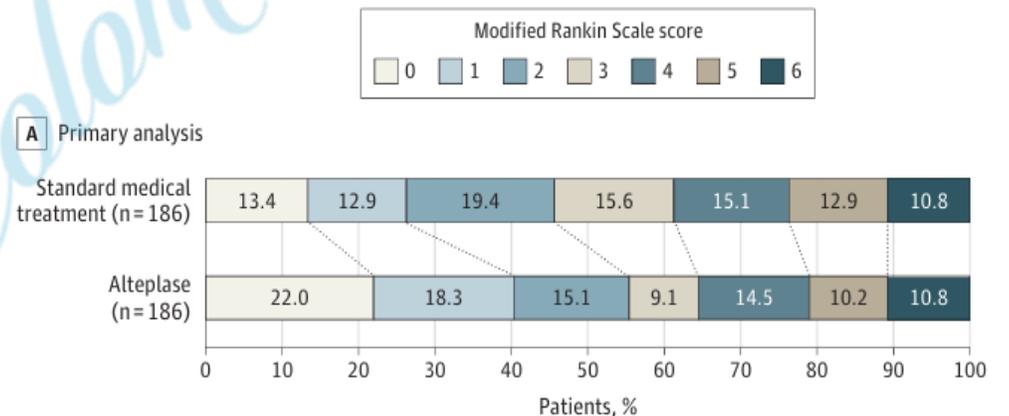
JAMA | Original Investigation

Alteplase for Acute Ischemic Stroke at 4.5 to 24 Hours The HOPE Randomized Clinical Trial

Ying Zhou, PhD; Yaode He, MD; Bruce C. V. Campbell, PhD; David S. Liebeskind, MD; Changzheng Yuan, ScD; Hui Chen, MSc; Yanxing Zhang, MD; Tingyu Yi, MD; Zhongyu Luo, PhD; Zuowen Zhang, MD; Changcai Meng, MD; Jianhua Cheng, MD; Hezhong Ouyang, MD; Jin Hu, MD; Fei Wang, MD; Sheng Zhang, PhD; Qi Fang, MD; Haitao Hu, MD; Xuting Zhang, MD; Yi Chen, MD; Wansi Zhong, MD; Maarten G. Lansberg, MD, PhD; Shenqiang Yan, MD; Min Lou, MD, PhD; for the HOPE investigators

CT perfusion criteria:

- ✓ Ischemic core volume ≤ 70 mL
- ✓ Penumbra >10 mL
- ✓ Ratio of the volume of hypo-perfused tissue to the core volume ≥ 1.2



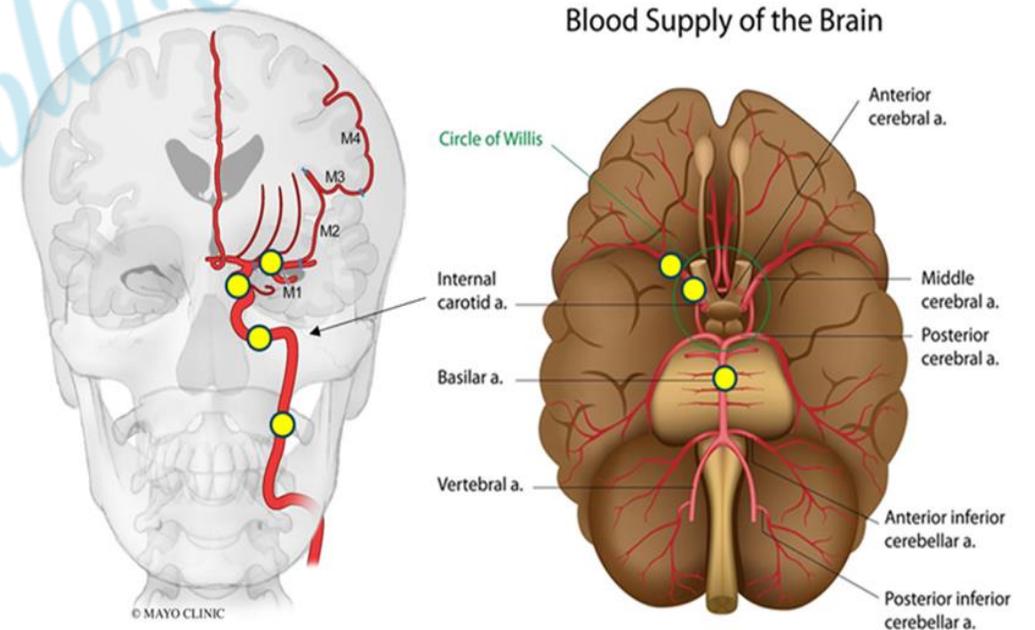
CT ANGIOGRAM HEAD AND NECK – POSITIVE LVO

- Evaluate for Large Vessel Occlusion
 - Internal carotid artery : cervical and intracranial
 - Middle cerebral artery : M1 segment, M2*
 - Basilar artery

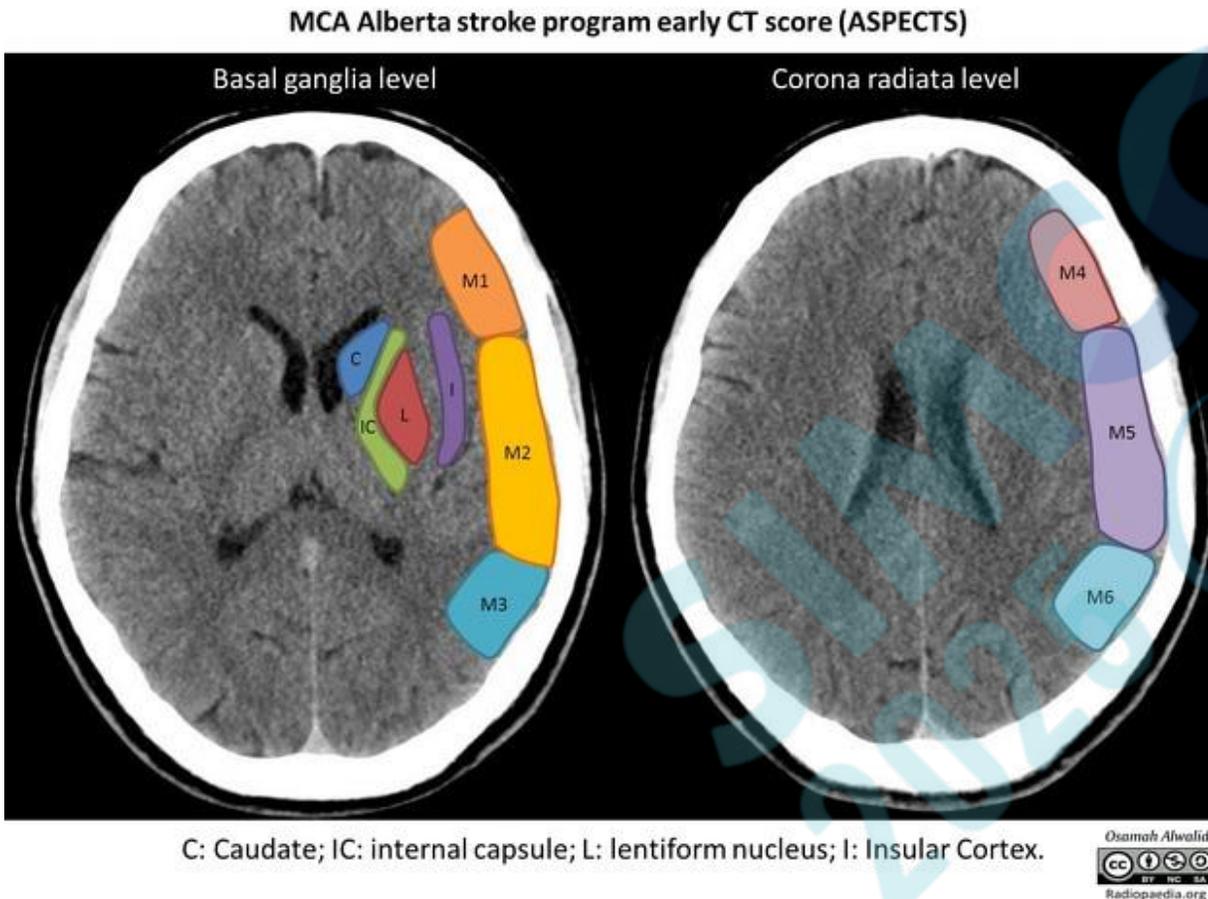
Assess for EVT treatment ? Core? Penumbra?

- CT head → ASPECT score
- CT perfusion studies

Large vessel occlusion (LVO) : ICA, M1 & Basilar artery thrombus



ALBERTA STROKE PROGRAM EARLY CT SCORE (ASPECTS)



Scored from 1 to 10

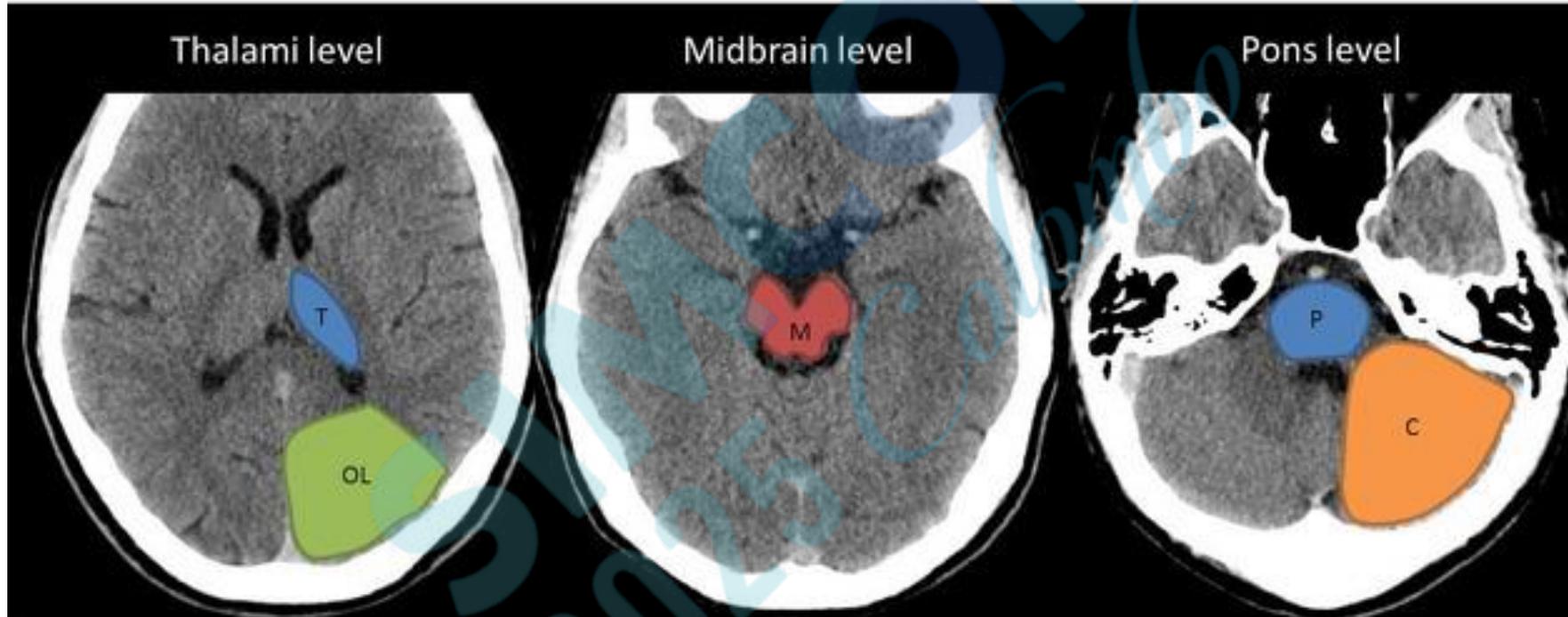
To compute the ASPECTS, 1 point is subtracted from 10 for any evidence of early ischemic change for each of the defined regions.

1. Caudate
2. Putamen
3. Internal capsule
4. Insular cortex
5. M1: Frontal operculum
6. M2: Anterior temporal lobe
7. M3: Posterior temporal lobe
8. M4: Anterior MCA territory immediately superior to M1
9. M5: Lateral MCA territory immediately superior to M2
10. M6: Posterior MCA territory immediately superior to M3

<https://radiopaedia.org/articles/alberta-stroke-programme-early-ct-score-aspects>

PC – ASPECTS

Posterior circulation Acute stroke prognosis early CT score (pc-ASPECTS)

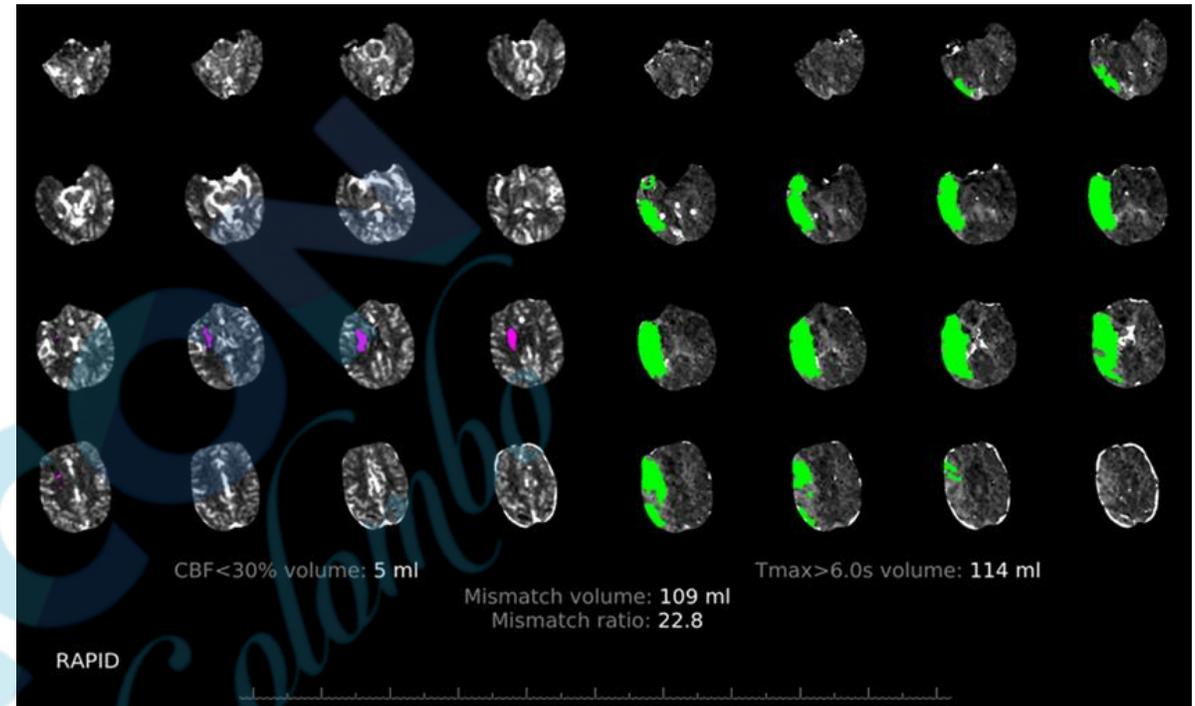
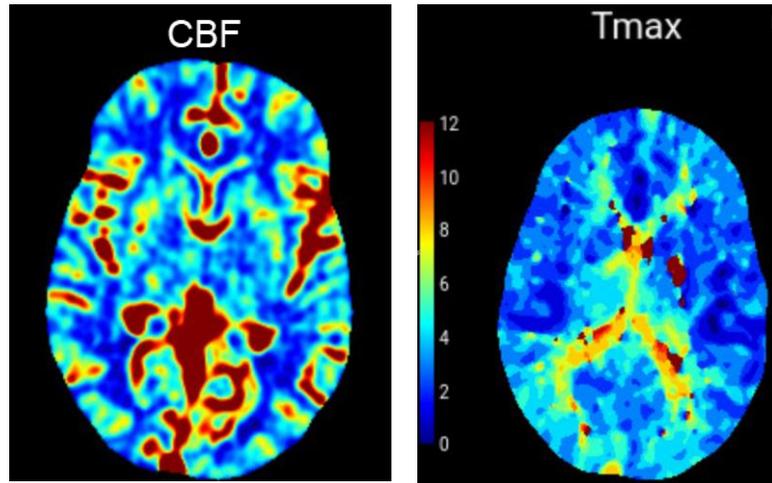


T: thalamus; OL: occipital lobe; M: any part of the midbrain; P: any part of the pons;
C: cerebellar hemisphere.

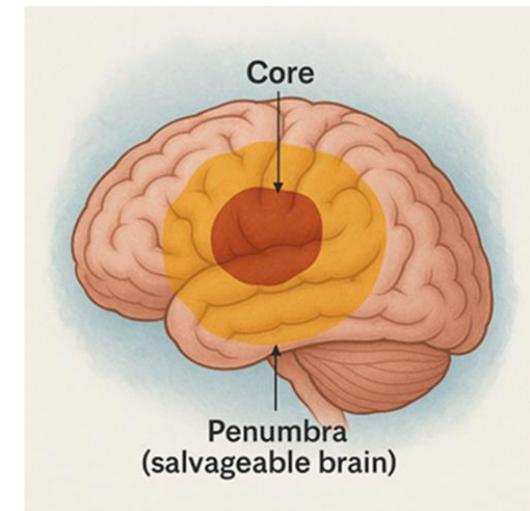
<https://radiopaedia.org/articles/alberta-stroke-programme-early-ct-score-aspects>



CT PERFUSION

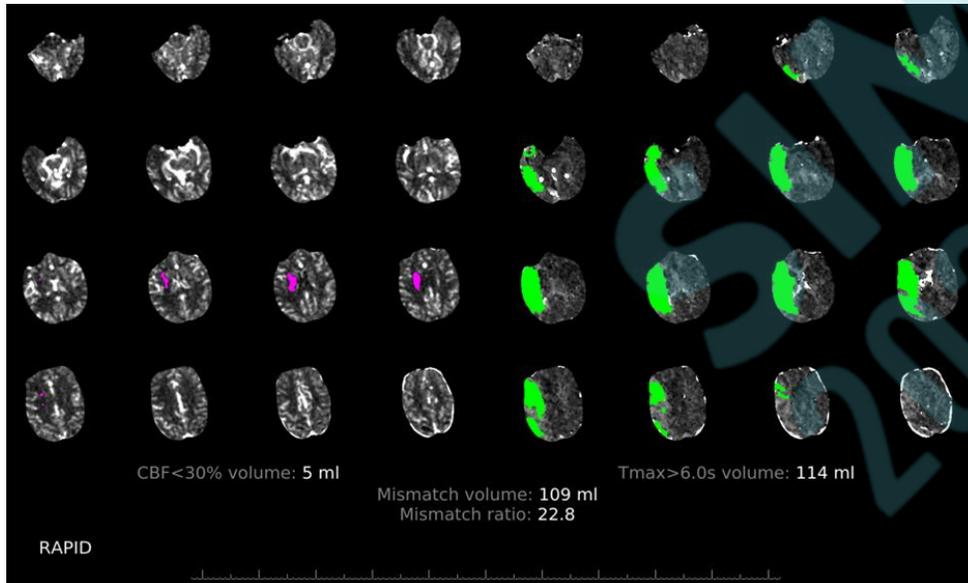


- Quantifies salvageable tissue
- Key parameters: $CBF < 30\%$ and $T_{max} > 6$ secs
- **CTP Core** ($CBF < 30\%$) : is the volume of tissue with a relative reduction of cerebral blood flow ($< 30\%$), as compared with contralateral hemisphere.
- **$T_{max} > 6$ sec** : Greater than 6 sec time delay for the contrast to reach brain tissue compared to the contralateral hemisphere.
- Software: RAPID, Viz.ai, Brainomix



CT PERFUSION CRITERIA FOR ENDOVASCULAR THERAPY

1. Disabling symptoms (NIHSS ≥ 6)
2. Large vessel occlusion on imaging
3. Sufficient salvageable brain tissue (penumbra)
 - **Penumbra >15 mL,**
 - **Core infarct volume <70 mL**
 - **Mismatch ratio > 1.8**



The NEW ENGLAND JOURNAL of MEDICINE

ORIGINAL ARTICLE

Thrombectomy for Stroke at 6 to 16 Hours with Selection by Perfusion Imaging

G.W. Albers, M.P. Marks, S. Kemp, S. Christensen, J.P. Tsai, S. Ortega-Gutierrez, R.A. McTaggart, M.T. Torbey, M. Kim-Tenser, T. Leslie-Mazwi, A. Sarraj, S.E. Kasner, S.A. Ansari, S.D. Yeatts, S. Hamilton, M. Mlynash, J.J. Heit, G. Zaharchuk, S. Kim, J. Carrozella, Y.Y. Palesch, A.M. Demchuk, R. Bammer, P.W. Lavori, J.P. Broderick, and M.G. Lansberg, for the DEFUSE 3 Investigators*

The NEW ENGLAND JOURNAL of MEDICINE

ESTABLISHED IN 1812 JANUARY 4, 2018 VOL. 378 NO. 1

Thrombectomy 6 to 24 Hours after Stroke with a Mismatch between Deficit and Infarct

R.G. Nogueira, A.P. Jadhav, D.C. Haussen, A. Bonafe, R.F. Budzik, P. Bhuva, D.R. Yavagal, M. Ribo, C. Cognard, R.A. Hanel, C.A. Sila, A.E. Hassan, M. Millan, E.I. Levy, P. Mitchell, M. Chen, J.D. English, Q.A. Shah, F.L. Silver, V.M. Pereira, B.P. Mehta, B.W. Baxter, M.G. Abraham, P. Cardona, E. Veznedaroglu, F.R. Hellinger, L. Feng, J.F. Kirmani, D.K. Lopes, B.T. Jankowitz, M.R. Frankel, V. Costalat, N.A. Vora, A.J. Yoo, A.M. Malik, A.J. Furlan, M. Rubiera, A. Aghaebrahim, J.-M. Olivrot, W.G. Tekle, R. Shields, T. Graves, R.J. Lewis, W.S. Smith, D.S. Liebeskind, J.L. Saver, and T.G. Jovin, for the DAWN Trial Investigators*

Table 1. Key Imaging-Based Inclusion Criteria for DEFUSE 3 and DAWN

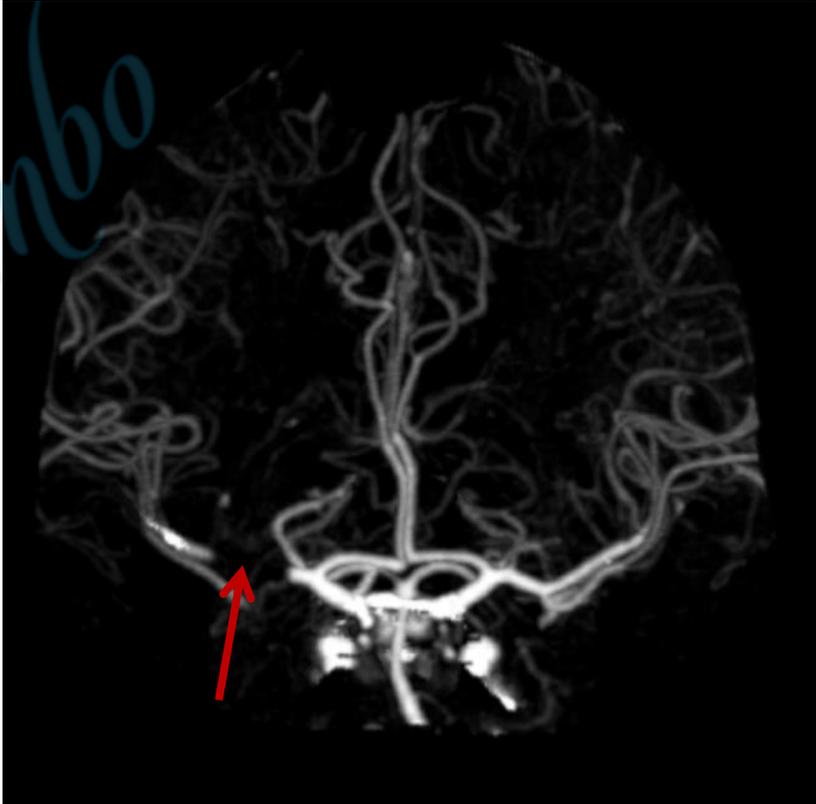
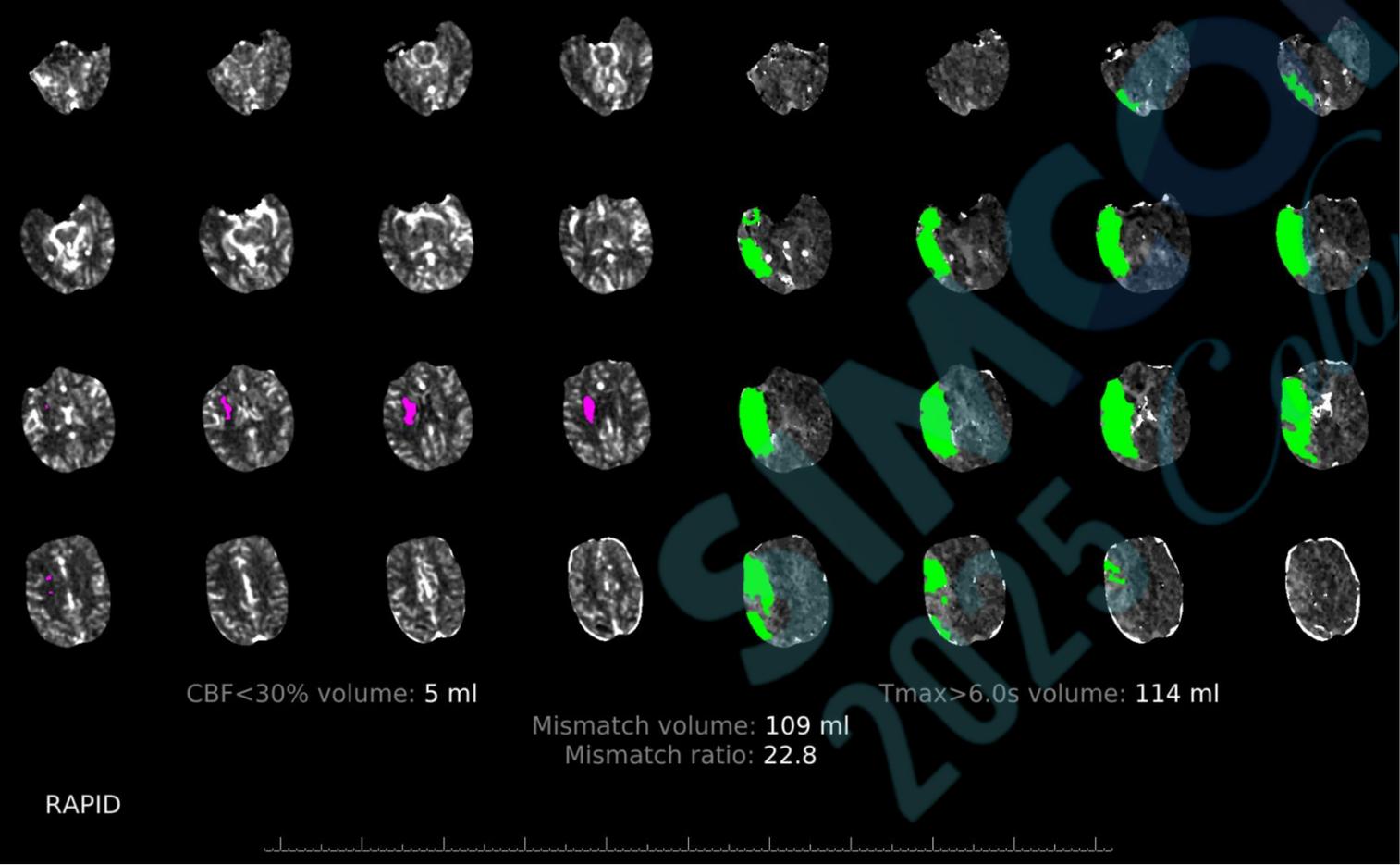
	DEFUSE 3	DAWN
Ischemic core volume	≤ 70 mL	≤ 20 mL if age >80 ≤ 30 mL if age <80 and NIHSS 10–20 ≤ 50 mL if age <80 and NIHSS >20
Mismatch volume	≥ 15 mL and a mismatch ratio of ≥ 1.8	Not required
Vessel occlusion	M1 or ICA (cervical and intracranial)	M1 or ICA (intracranial and cervical if stent not anticipated to be required)

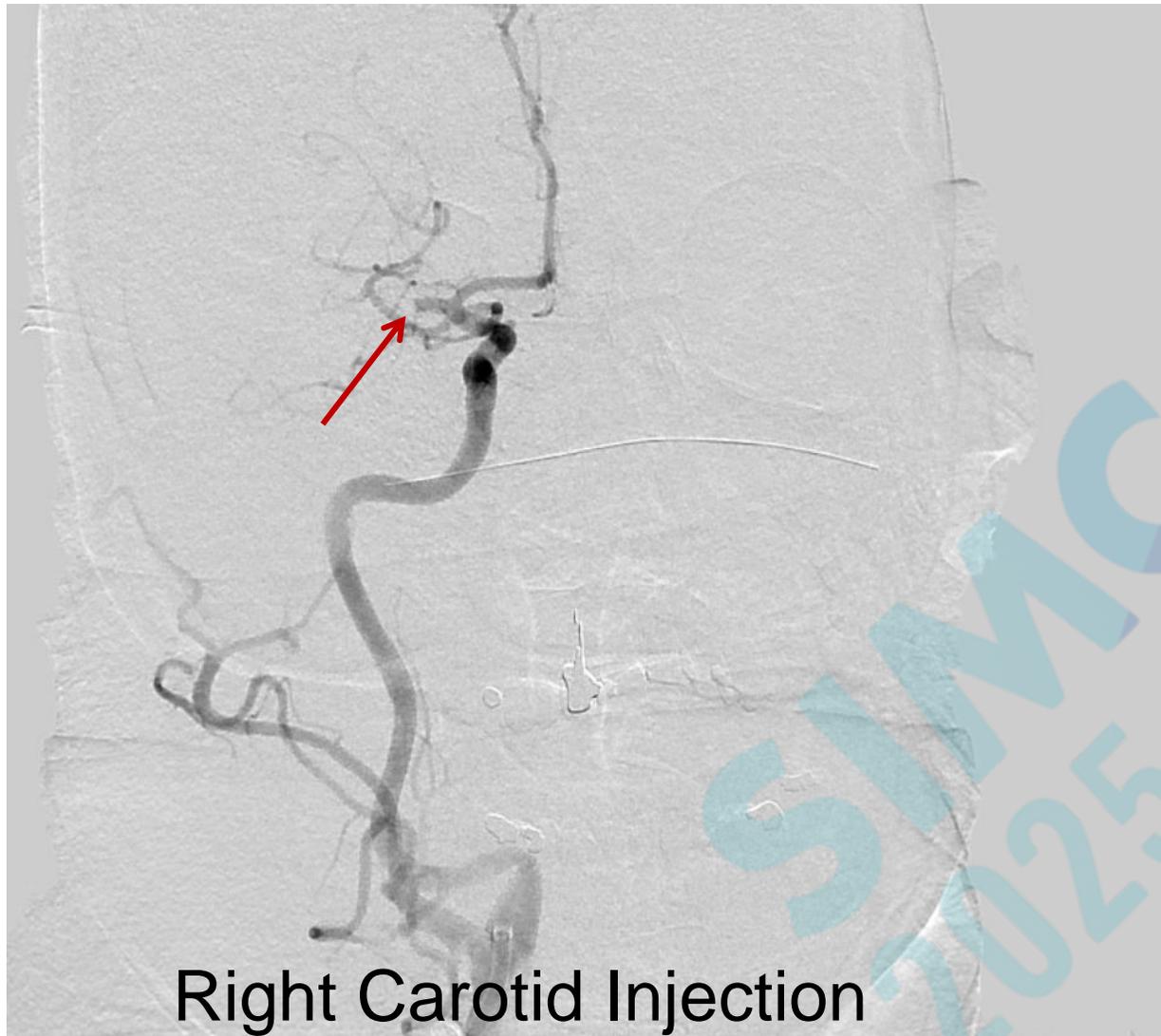
DAWN indicates Triage of Wake-up and Late Presenting Strokes Undergoing Neurointervention With Trevo); DEFUSE 3, Endovascular Therapy Following Imaging Evaluation for Ischemic Stroke 3; ICA, internal carotid artery; M1, the first segment of the middle cerebral artery; and NIHSS, National Institutes of Health Stroke Scale.

Albers G. Stroke. 2018

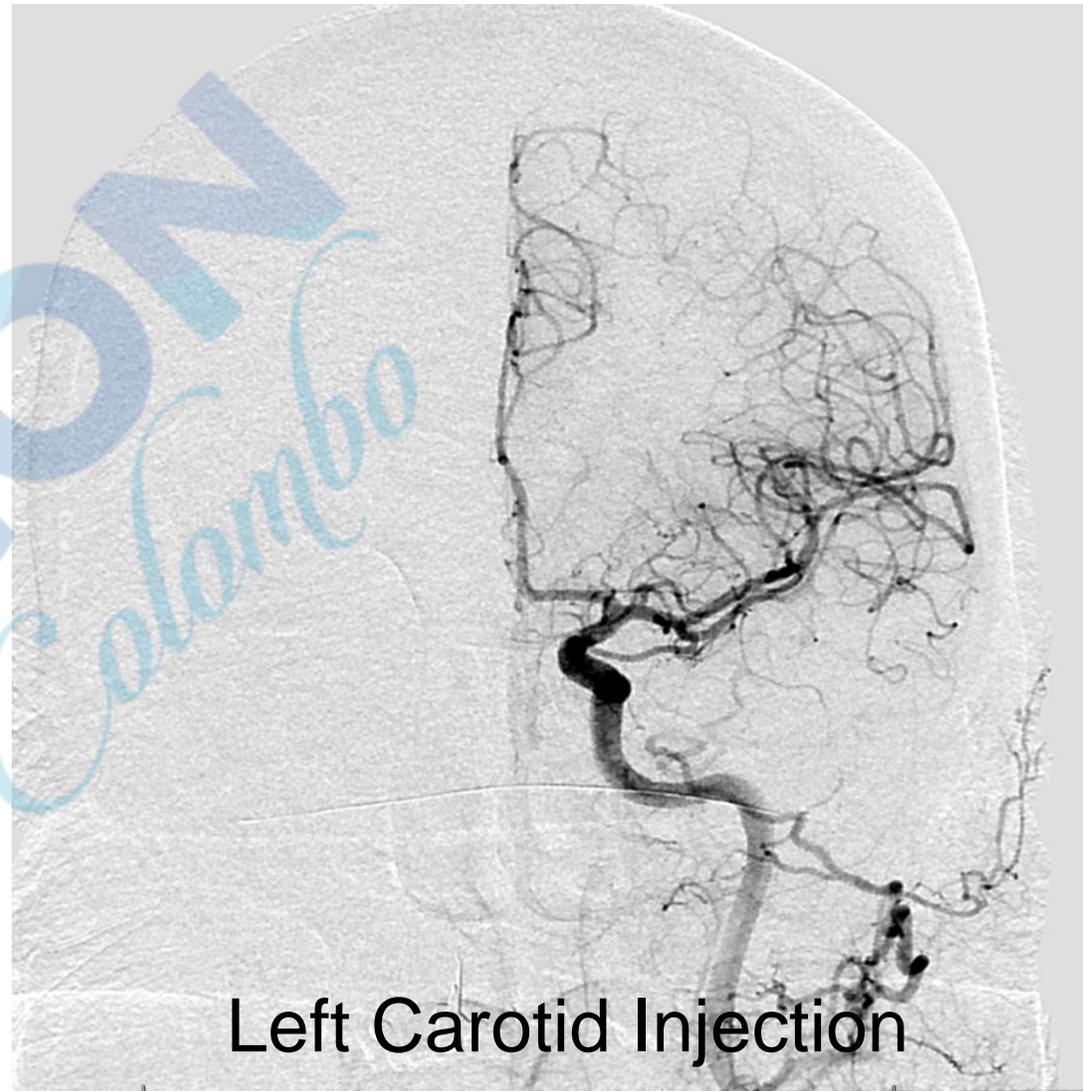
CASE #2

67 F presented with right gaze preference and left sided weakness. LKN 4hrs. NIHSS 16





Right Carotid Injection



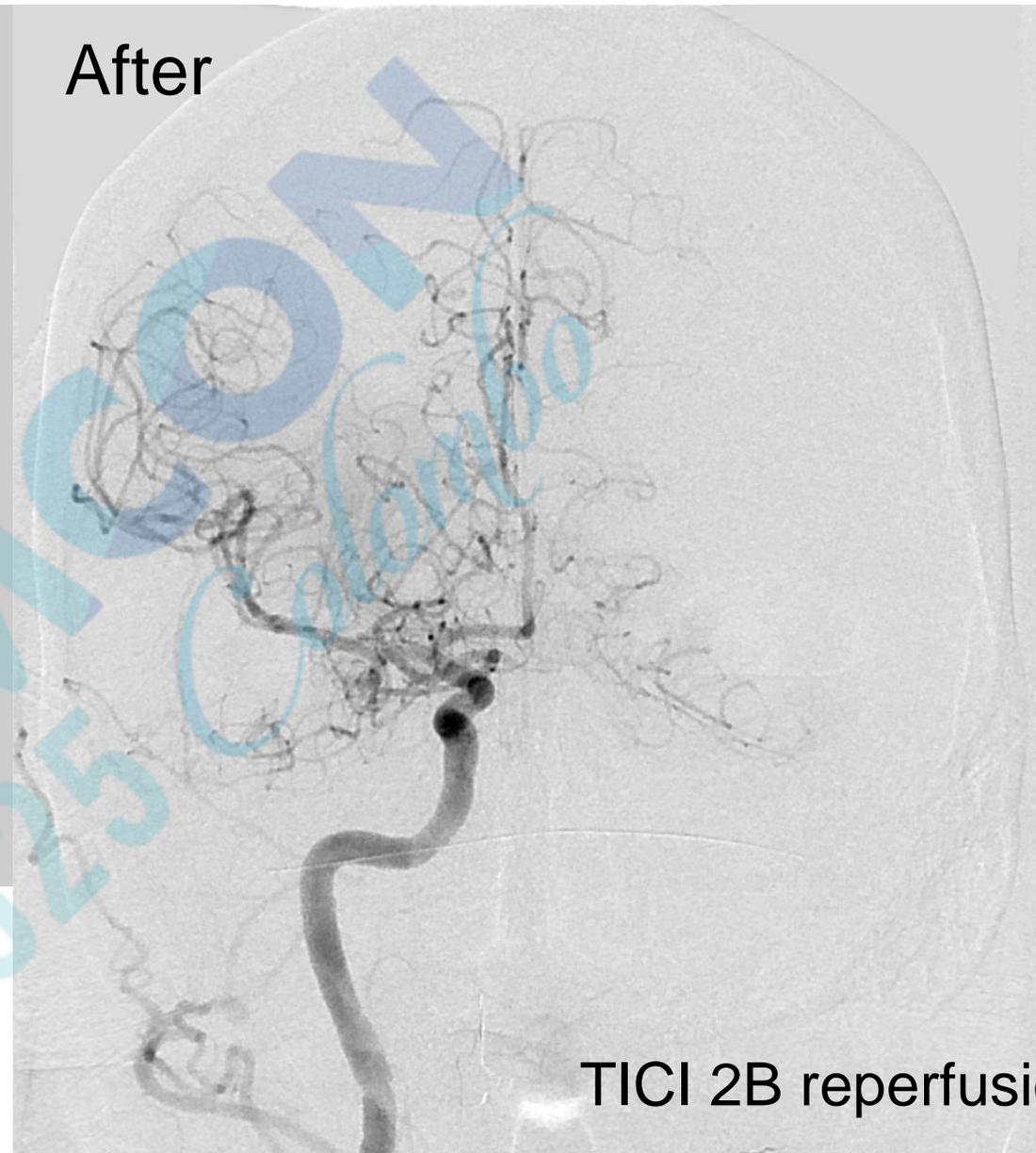
Left Carotid Injection

Conventional Cerebral Angiogram

Before



After

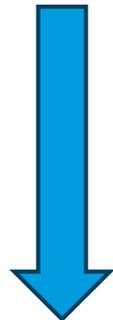


TICI 2B reperfusion

THROMBOLYSIS IN CEREBRAL INFARCTION SCORE (TICI)

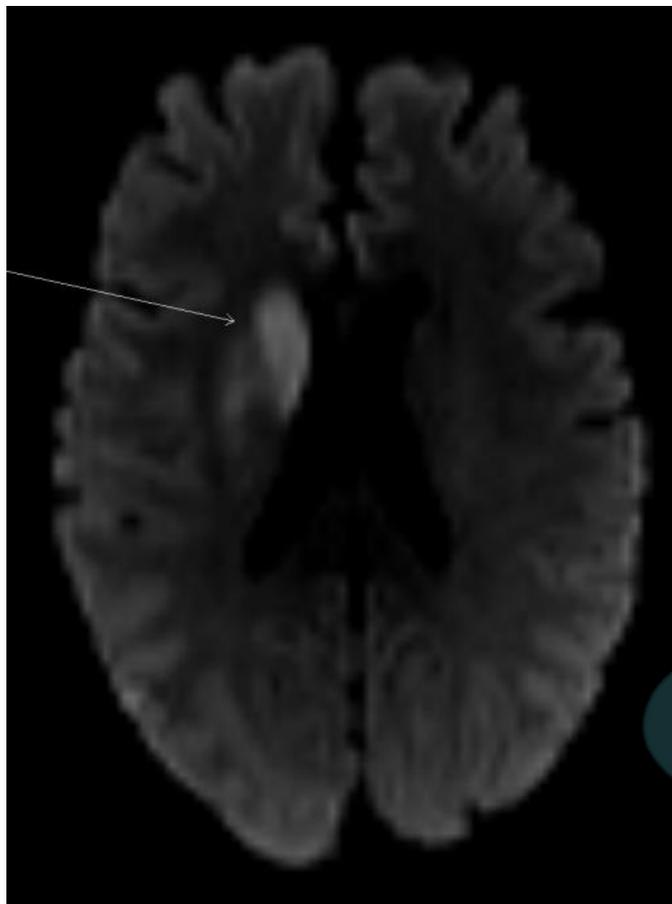
Angiographic Revascularization Grading for AIS following EVT

2b or not to be

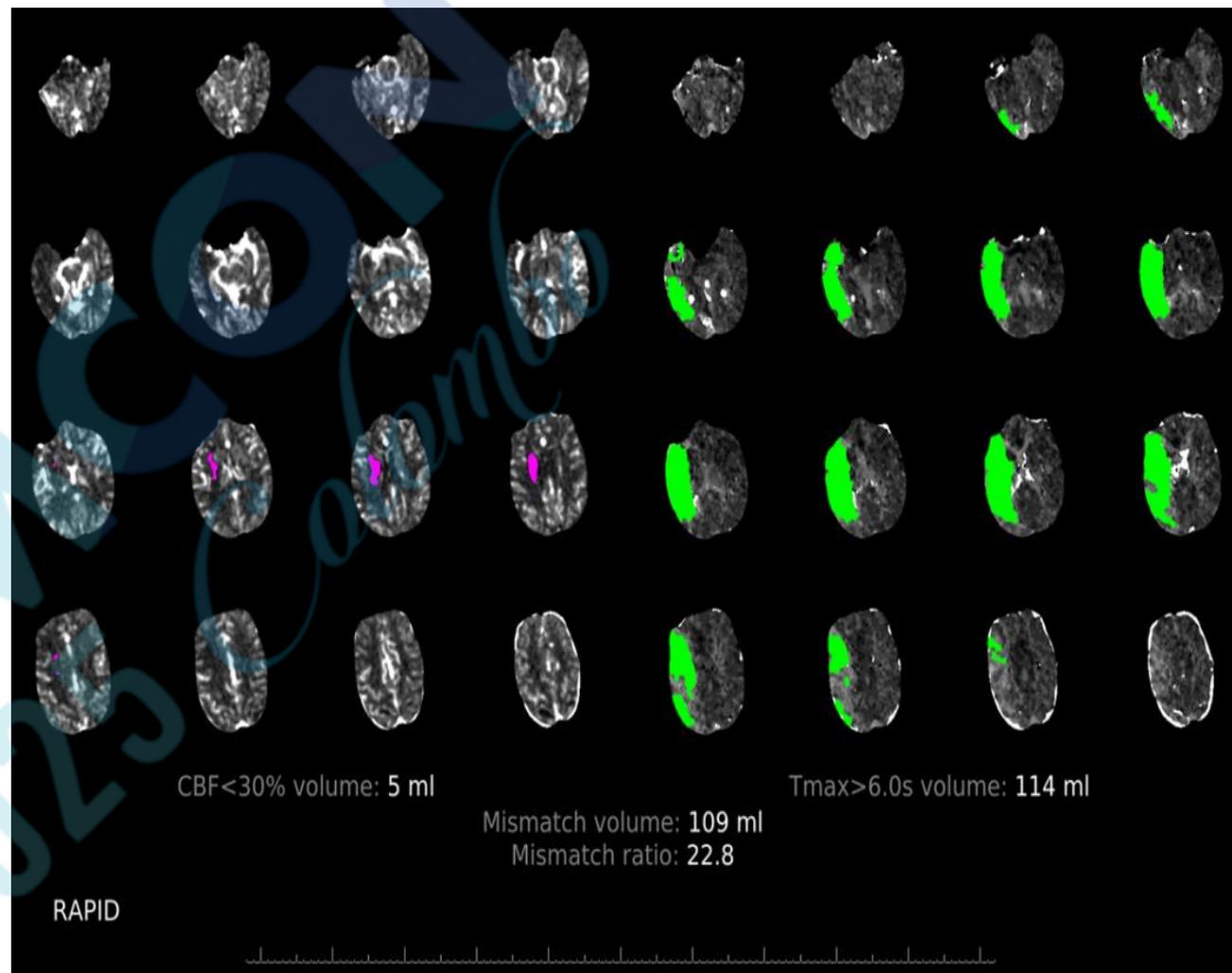


Grade	Description	Definition (Angiographic Reperfusion)	Clinical Meaning
0	No perfusion	No antegrade flow beyond the occlusion	Complete failure of recanalization
1	Minimal perfusion	Contrast passes the occlusion but no distal branch filling	Negligible tissue reperfusion
2a	Partial reperfusion <50%	Perfusion of <50% of the vascular territory distal to occlusion	Limited benefit
2b	Substantial reperfusion ≥50%	Perfusion of ≥50% of the affected territory	Considered successful reperfusion in early trials (e.g., MR CLEAN, ESCAPE)
2c (expanded TICI / eTICI)	Near-complete reperfusion except for slow flow or small distal emboli	Nearly full perfusion with only minor distal deficits	Now considered optimal/superior to 2b
3	Complete reperfusion	Full antegrade flow with normal filling of all distal branches	Ideal outcome, best clinical prognosis

Table created by author

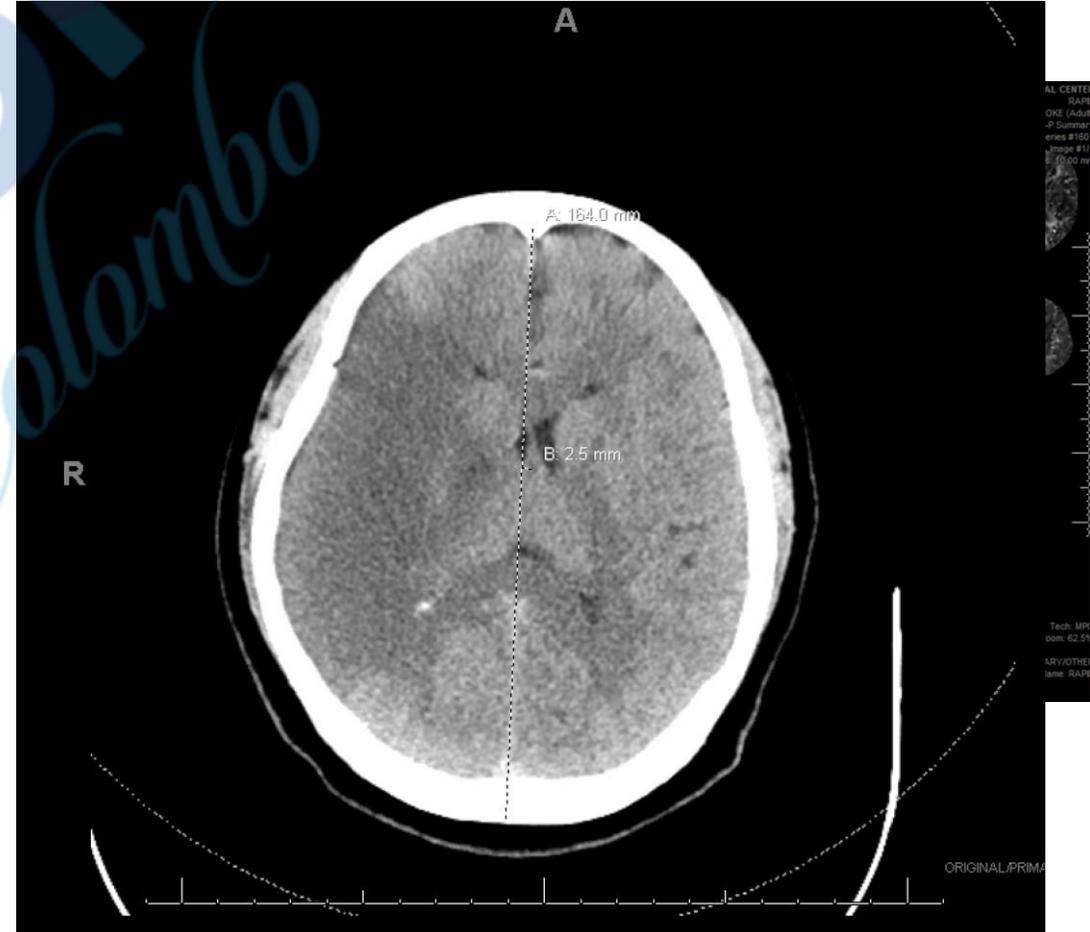
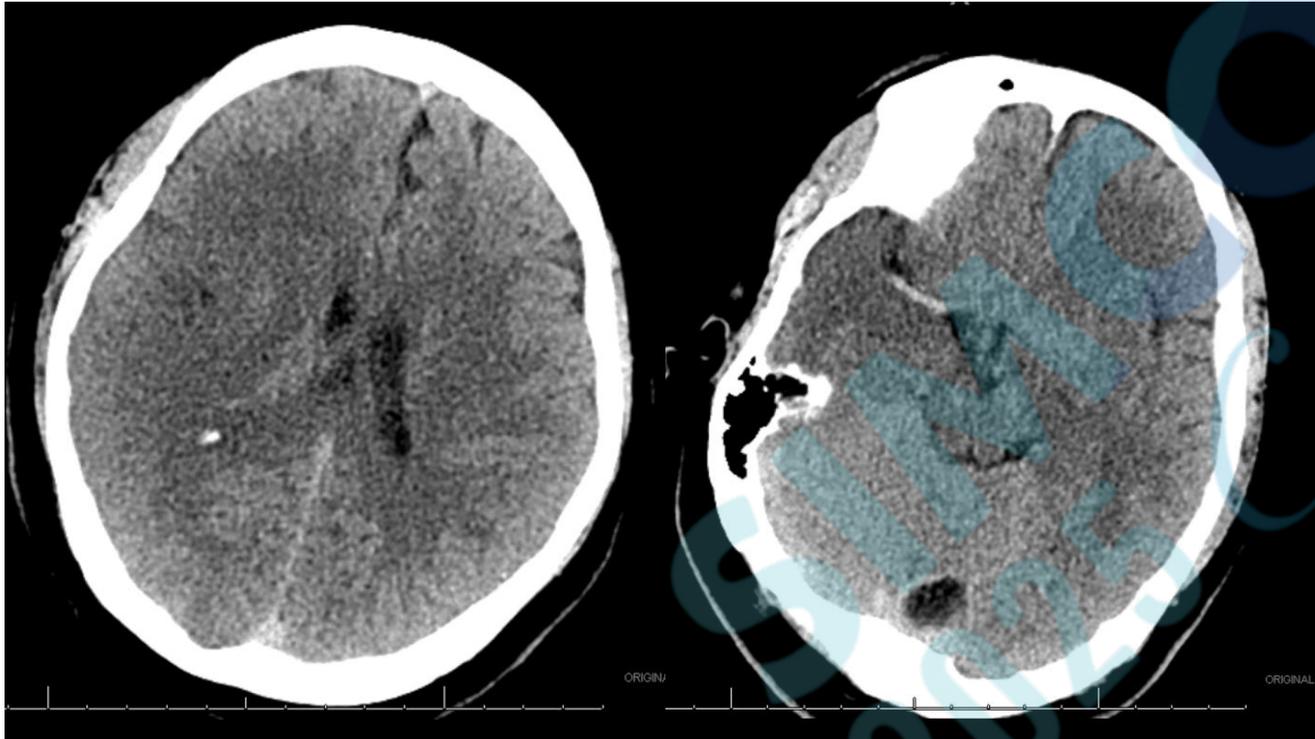


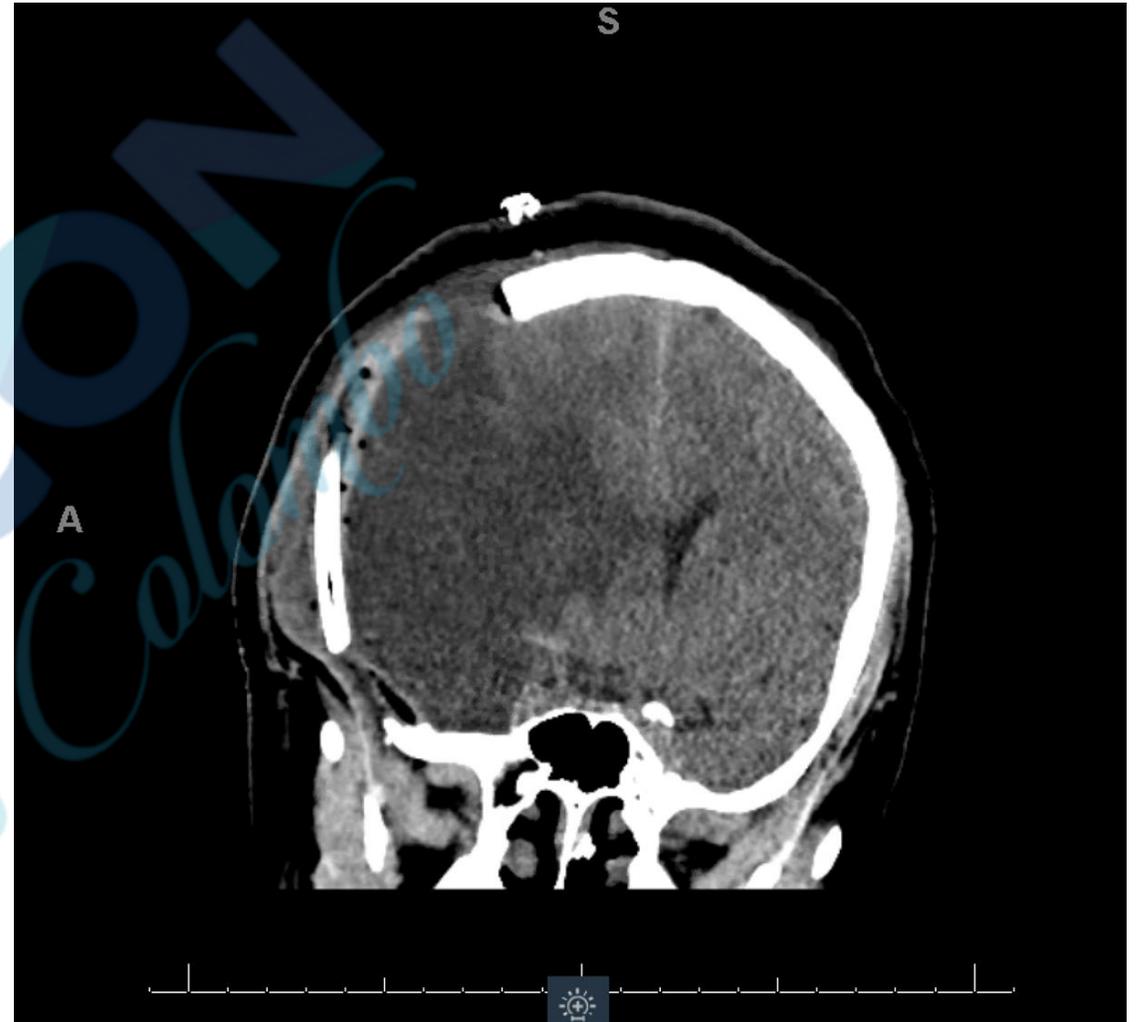
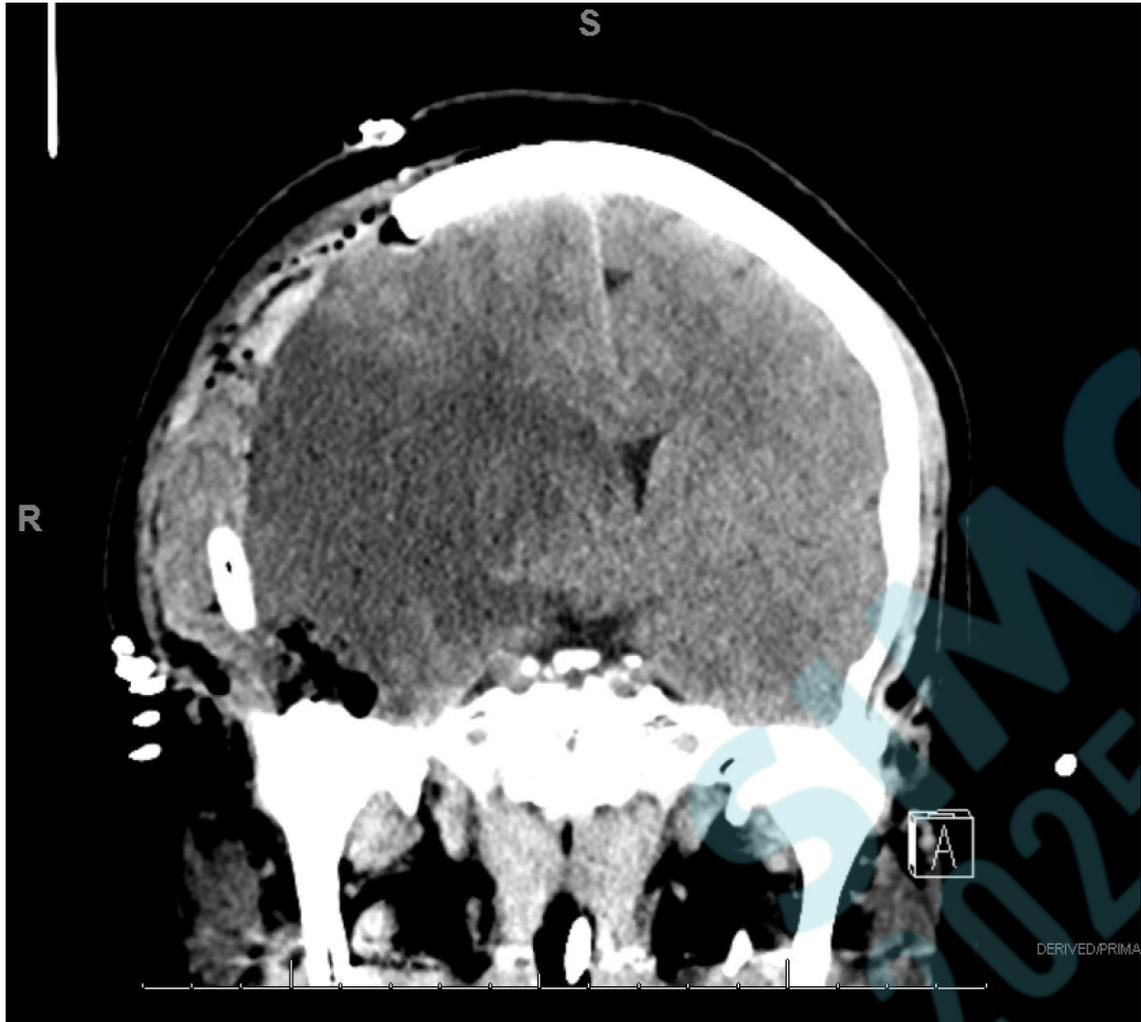
MRI brain Imaging



CASE #3

40M H/o recent femur fracture presented with AMS, dysarthria and left hemi-body weakness. NIHSS 15. LSN 5hrs.



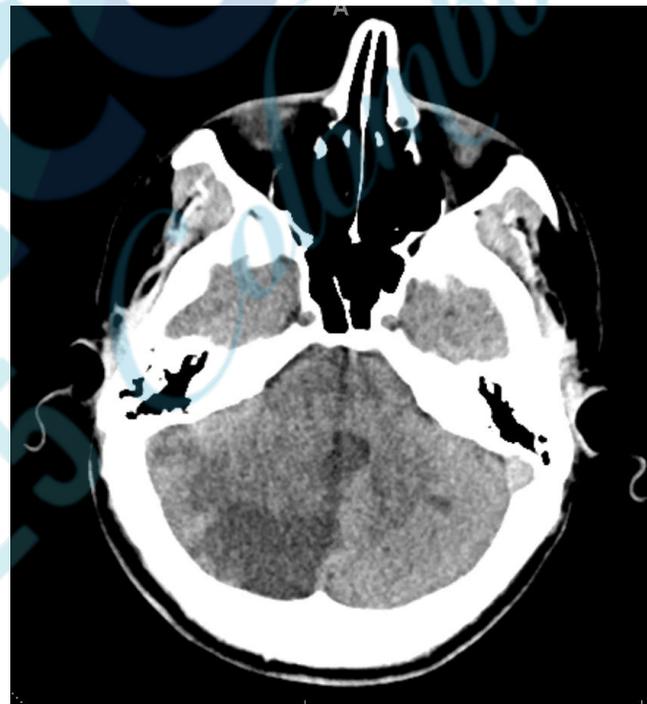
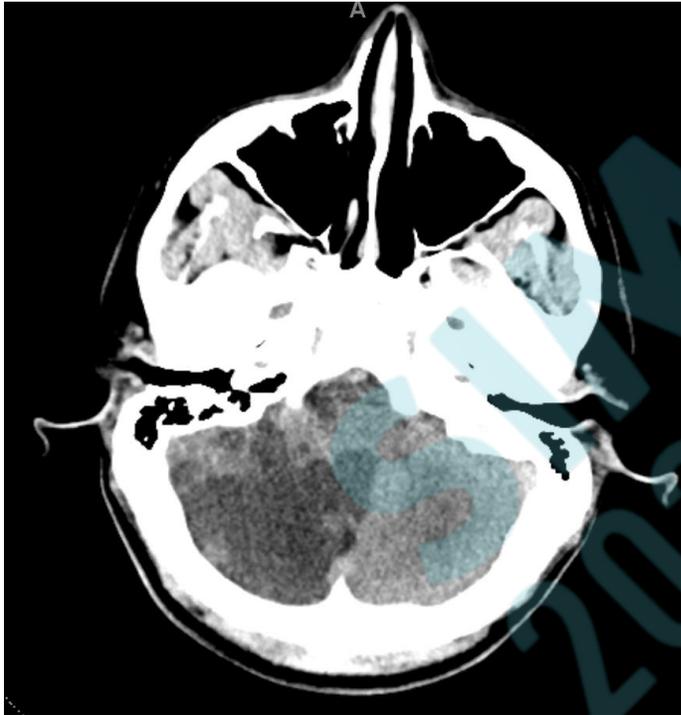


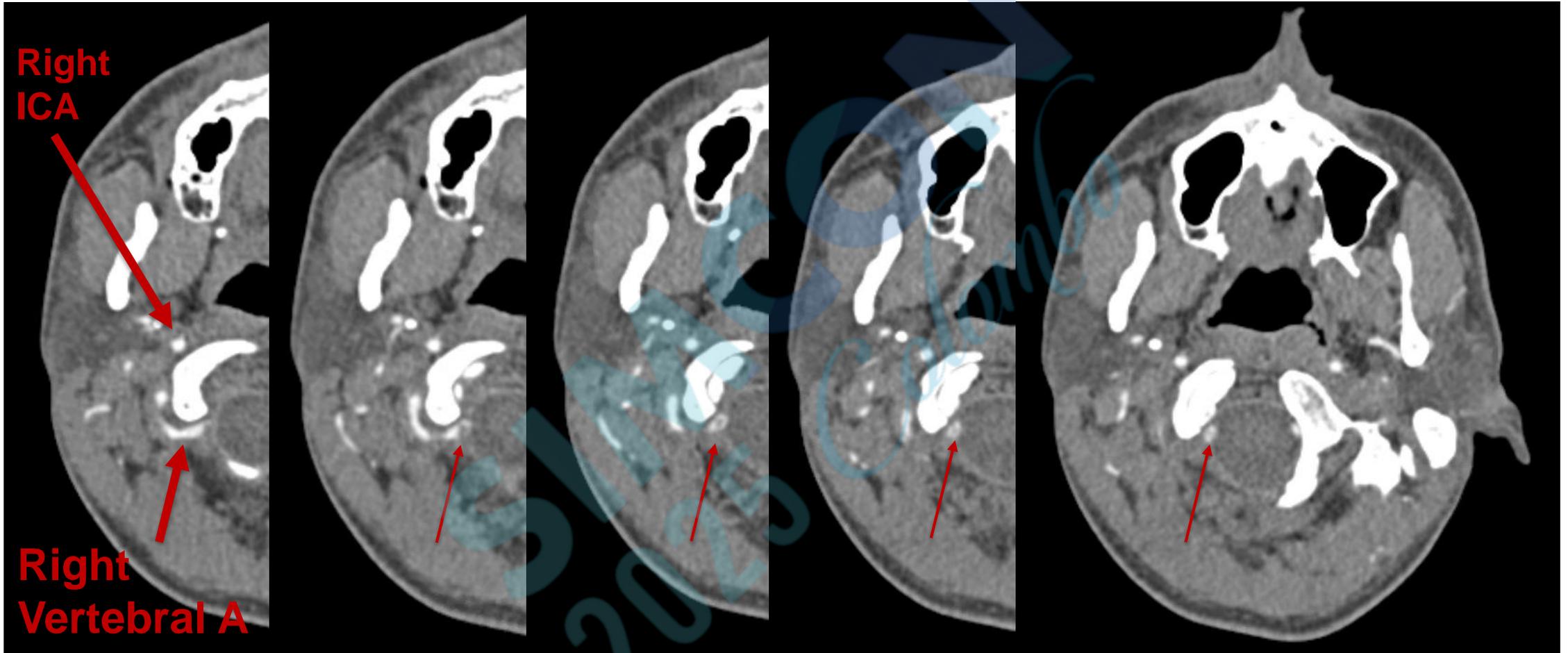
NEURO-VASCULAR IMAGING BASED STROKE ETIOLOGY

- Extracranial carotid stenosis
- Intracranial stenosis
- Intraluminal thrombus
- Dissections: carotid or vertebral artery
- Carotid web
- Reversible Cerebral Vasoconstrictive Syndrome (RCVS)
- Arteriopathies (vasculitis, moyamoya, etc)
- Aneurysms, AV fistulas

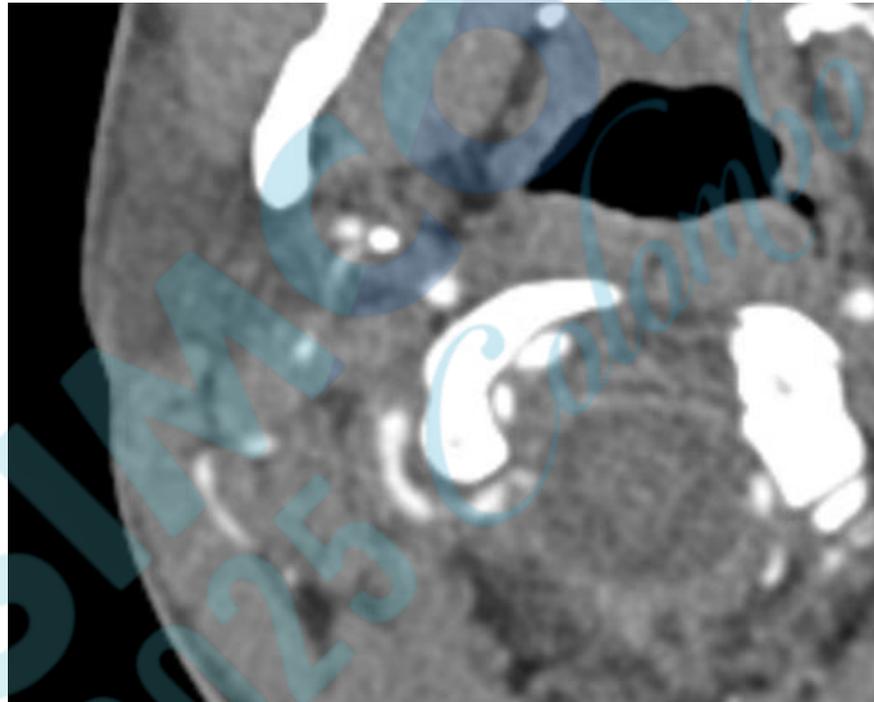
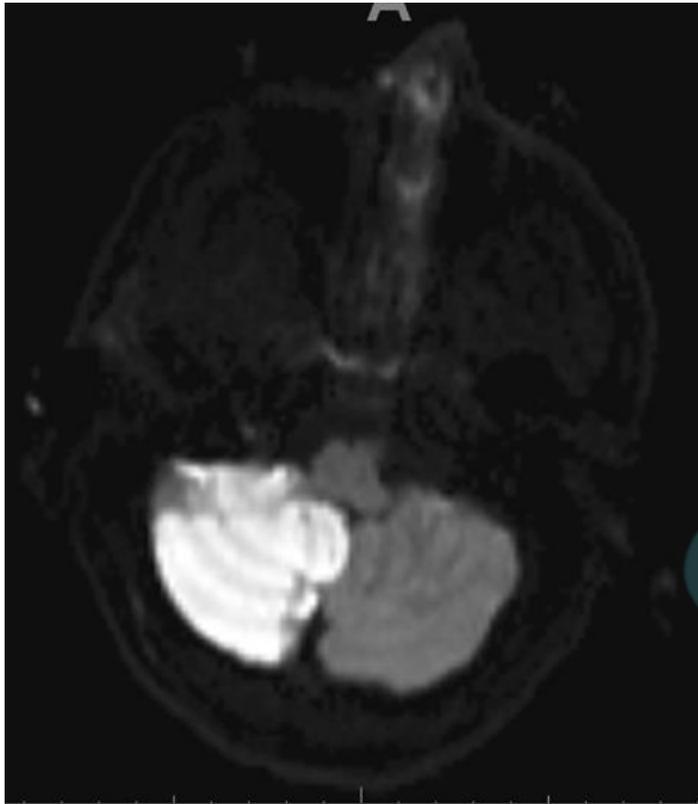
CASE #4

28 M, presented with dizziness, nausea, incoordination, right neck pain, headache. H/o chiropractor neck manipulation 1 day prior. On exam nystagmus, ataxic on the right.

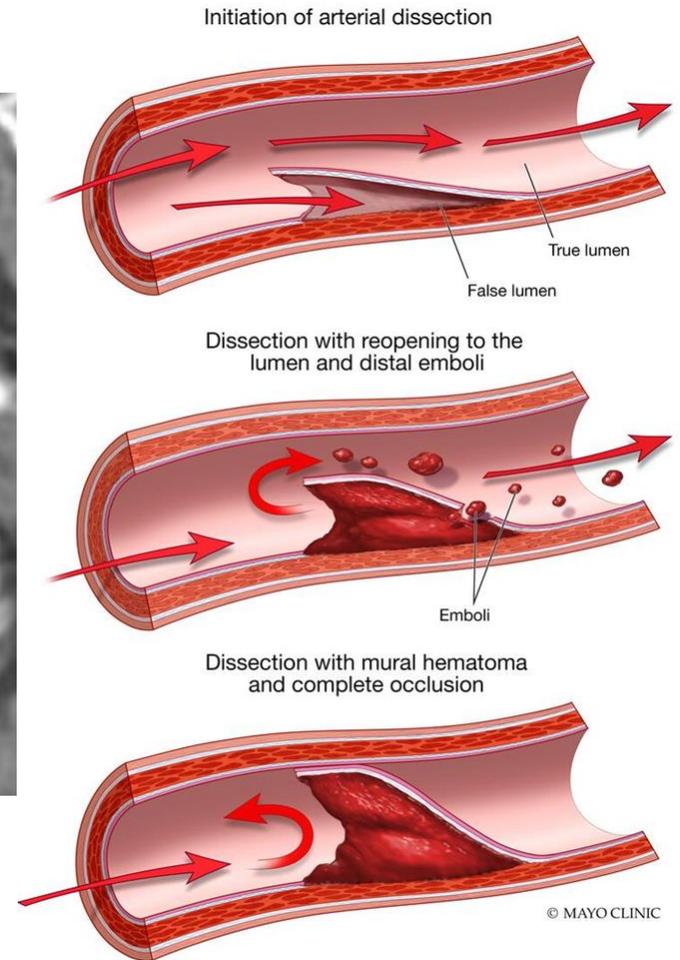




VERTEBRAL ARTERY DISSECTION



Right vertebral artery dissection with an intraluminal thrombus.



CASE #5

Wiley
Case Reports in Neurological Medicine
Volume 2024, Article ID 2503963, 8 pages
<https://doi.org/10.1155/crmm/2503963>

WILEY

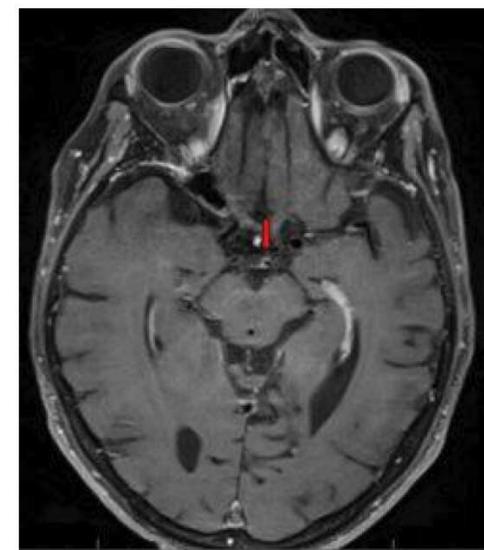
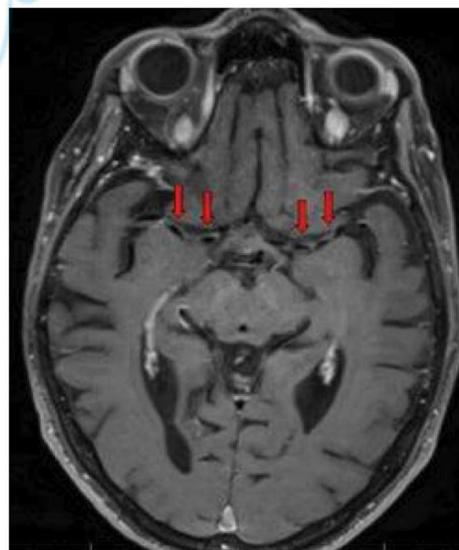
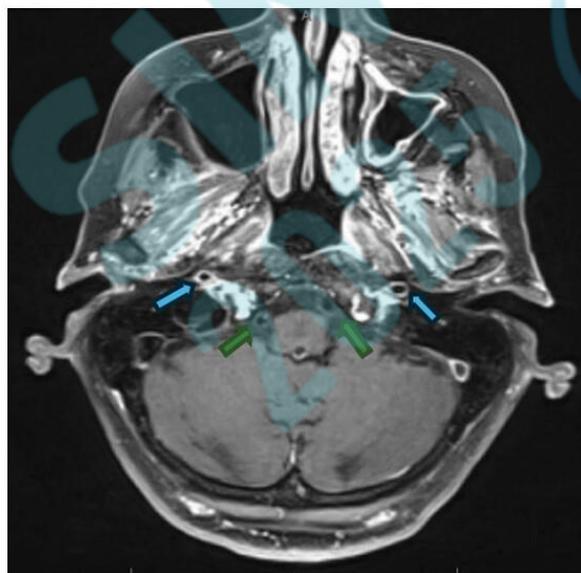
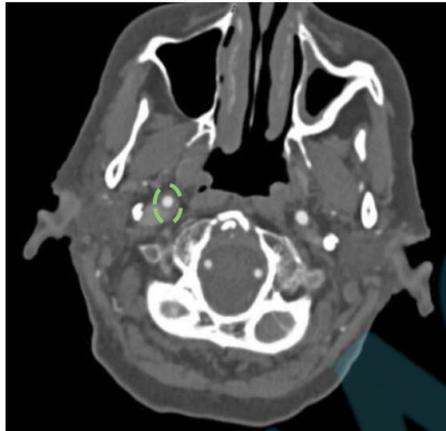
82F right partial Horner's Syndrome, +ESR/CRP

Case Report

Unveiling the Uncommon: A Case Report of Horner's Syndrome as a Rare Glimpse Into Giant Cell Arteritis

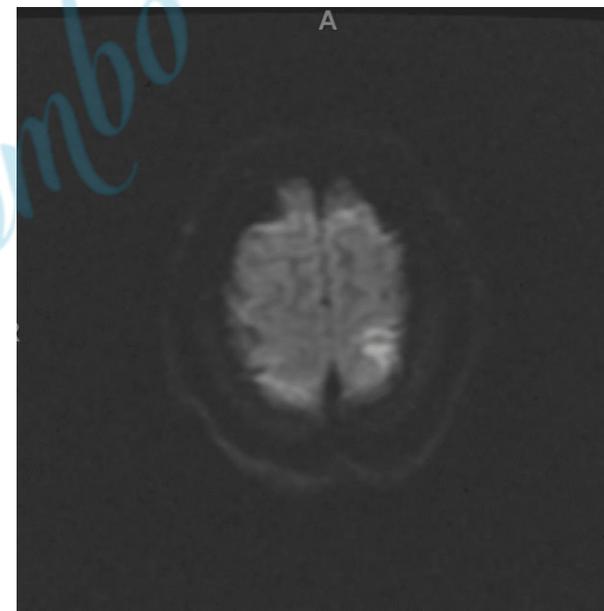
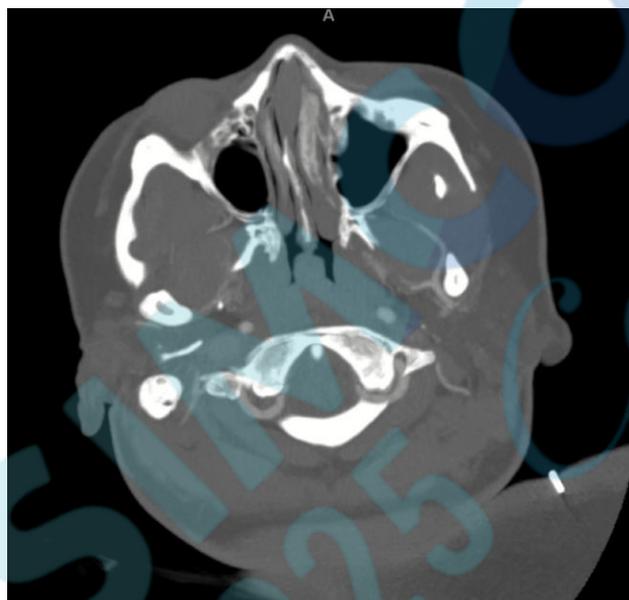
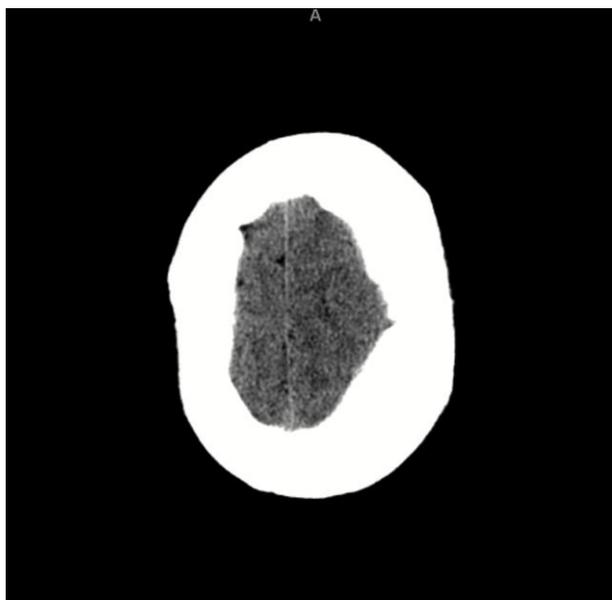
Emily Barr ¹, Justine Levesque,¹ John Badir ¹, Randall Dunston,²
and Tamra Ranasinghe³

MRA VESSEL WALL IMAGING

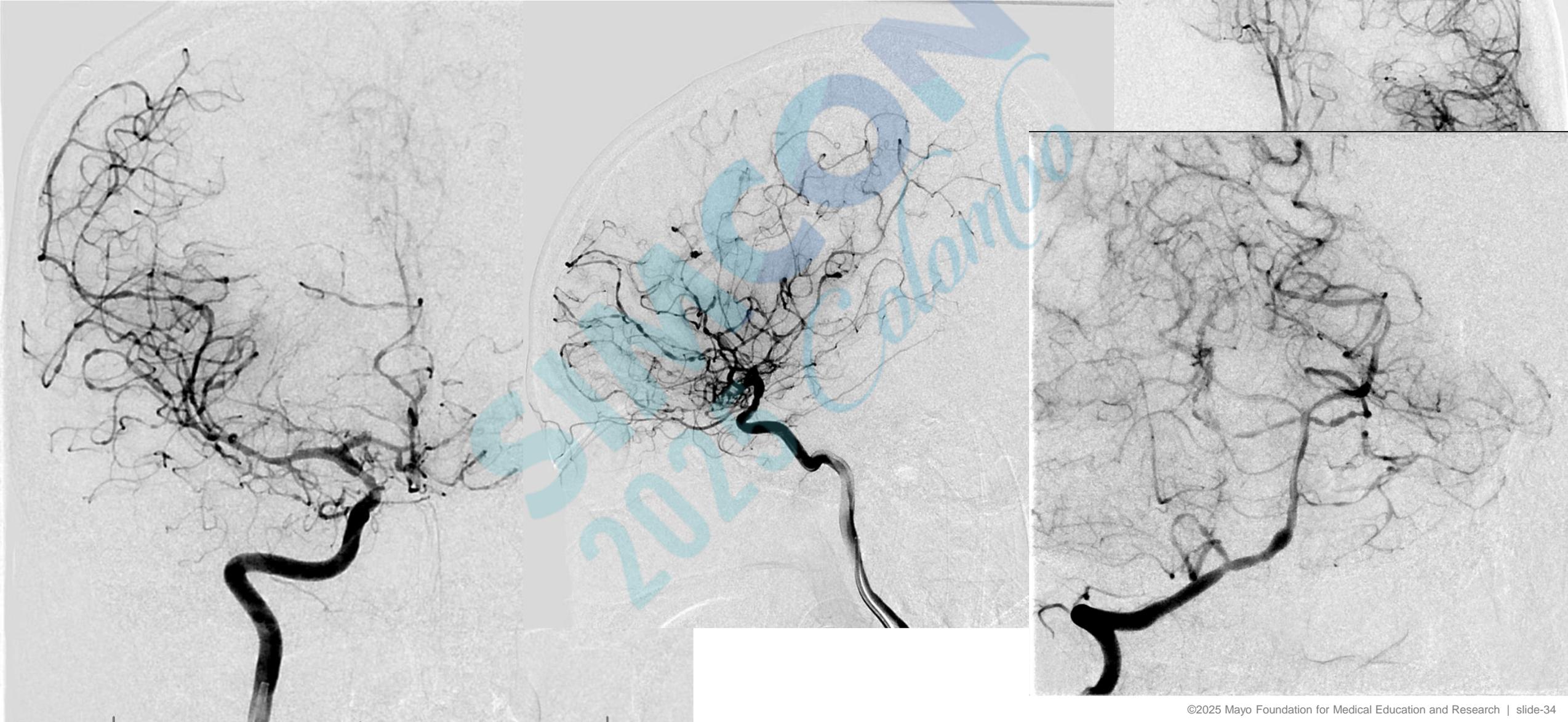


CASE #6

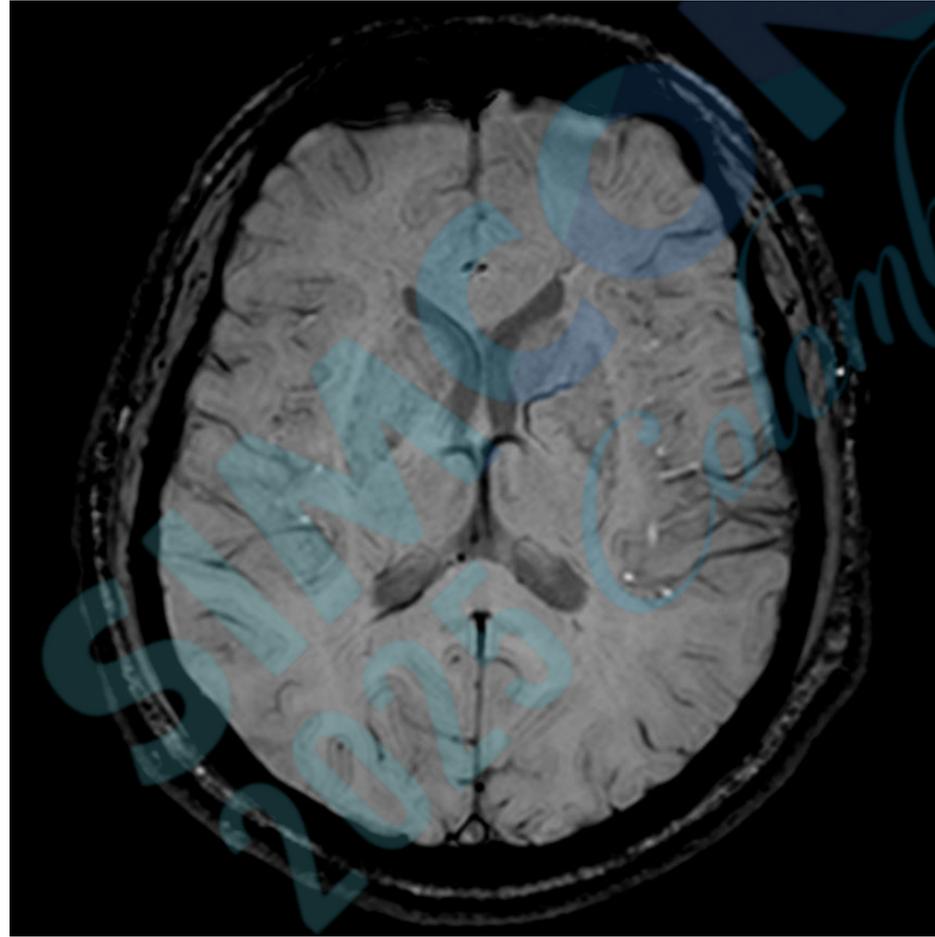
18F severe headaches x 12, confused with incoherent speech. Current marijuana smoker.



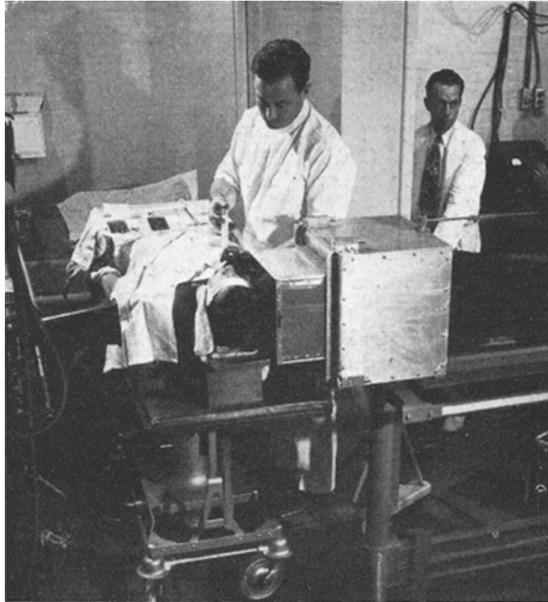
Reversible Cerebral Vasoconstrictive Syndrome (RCVS)



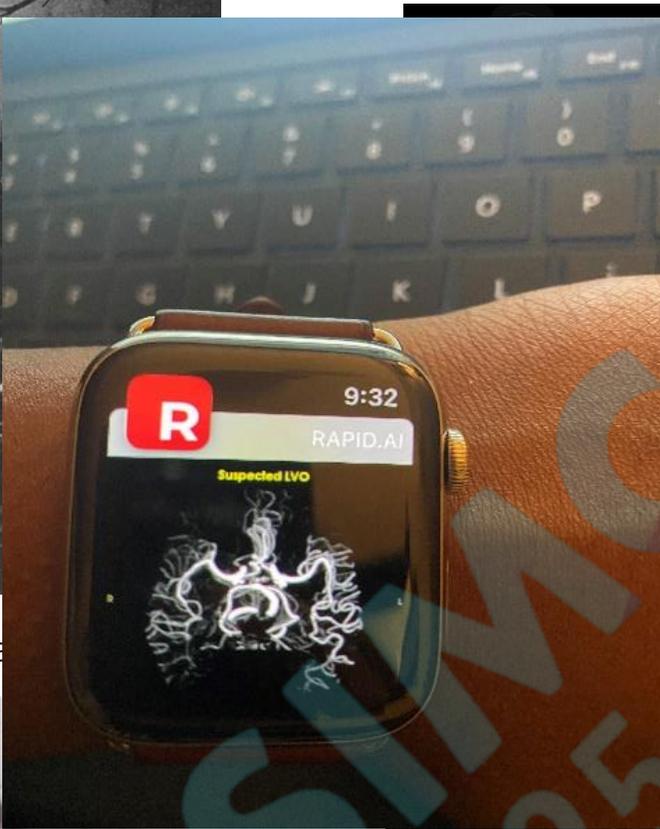
ADVANCE IMAGING



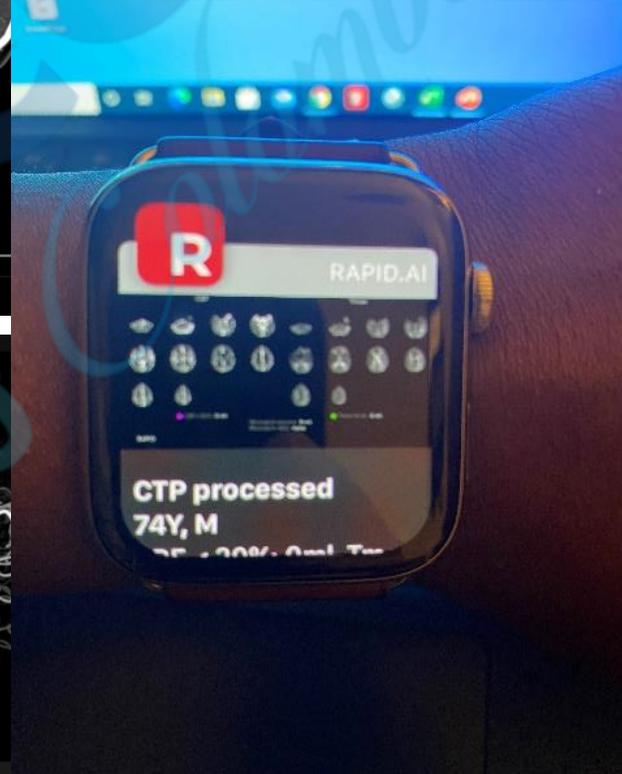
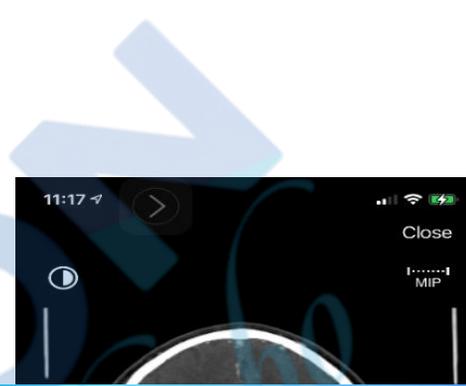
ADVANCES IN STROKE IMAGING



Hounsfield GN. Computerized transverse axial CT. Part 1. Description of system. Br J Radiol. 1973



Dandy WE. Cerebral angiography: introduction of contrast medium by direct injection into the carotid artery. Annals of Surgery. 1927;85(3):387-395.



QUESTIONS & ANSWERS



Thank you!

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NEUROIMAGING BASED TISSUE WINDOW



24 hours

Endovascular Therapy in patients with a large vessel occlusion

- ✓ Anterior circulation LVO → **ASPECT score ≥ 6**
- ✓ Posterior circulation LVO (Basilar artery occlusion) → **PC-ASPECT score ≥ 6**
- ✓ **CTP: Penumbra >15 mL, Core infarct volume <70 mL, Mismatch ratio > 1.8**



❖ Anterior circulation LVO → **ASPECT score 3-5**