Imaging in Suspected Stroke: Optimizing the Tube of Truth

Debbie Yi Madhok, MD

Associate Professor of Clinical Emergency Medicine & Neurology

University of California, San Francisco

Disclosures

- US Department of Defense (HT9425-24-1-1072): to study outcomes in patients with TBI
- US Department of Defense: to study blood-based biomarkers in TBI
- Abbott Laboratories to advance development of Abbott’s TBI test for diagnosis and determination of severity of brain injury in adults and children

Objectives

- Identifying core vs. penumbra on CT
- Extended window TNK
- Posterior circulation strokes and CT
- HREM MRI Checklist

Case

0944

BIBA “found down”

EMS Report

- Prior to arrival, 68yo pt drove to SF to help son getting bone marrow transplant. Normally speaks clearly and handles all own affairs. Retired doctor.
- Normal bedtime of 2200 last night, this AM was found on group banging on wall for help by son in other room.
- Upon EMS arrival, pt found laying on the ground. No trauma noted.

Case

Vital Signs

Time	AVPU	Side	POS	BP	Pulse	RR	SPO2	ETCO2	CO	BG	Temp	Pain	GCS(E+V+M)/Qualifiers	RASS	RTS	PTS
09:31	Alert	L	Sit	148/84 A	69 R	18 R	95 Rm		1.0	168		0	14= 4 + 4 + 6		12	
09:33				/	71	20	96									
09:38				154/92 A	69	60	97									
09:41	Alert	L	Sit	128/75 A	70 R	23 R	96 Rm					0	14= 4 + 4 + 6		12	

ECG

Time	Type	Rhythm	Notes
09:31	3-Lead	Sinus Rhythm	
09:41	3-Lead	Sinus Rhythm	

Flow Chart

Time	Treatment	Description	Provider
09:33	**12-Lead ECG**	Comments: sinus no STE noted; Patient Response: Unchanged; Successful; Medical Control: Protocol (Standing Order);	MULLANEY, MARK
09:35	**Stroke Alert**	Comments: CVA; Patient Response: Unchanged; Medical Control: Protocol (Standing Order);	MULLANEY, MARK
09:40	**IV Therapy**	18 ga; Antecubital-Left; Normal Saline (.9% NaCl); Total Fluid: 10 ml; Patient Response: Unchanged; Successful; Medical Control: Protocol (Standing Order);	MULLANEY, MARK
09:45	**ALS Assessment**	Patient Response: Unchanged; Successful; Medical Control: Protocol (Standing Order);	MULLANEY, MARK

Case

HPI

Patient is primarily English speaking - no interpreter used.

HPI

68F h/o afib no on AC presenting with code stroke.

- per son, pt was banging against wall, found down in her room unable to communicate this morning
- was not able to speak with son
- normally alert and oriented x3, able to walk by herself
- last known normal was 10 pm last night by son
- FSG in field 168
- she is a prior physician
- no blood thinners

No data recorded NIH Stroke Scale: 13

Case

ED Triage Vitals		
Temp	08/18/23 0948	**36.1 °C (96.9 °F)**
Heart Rate	08/18/23 0948	**67**
Resp	08/18/23 0948	**18**
BP	08/18/23 0949	**140/69**
SpO2	08/18/23 0948	**99 %**
Temp Source	08/18/23 1005	**Oral**
FiO2	--	
BP Palpated	--	

Physical Exam

Vitals and nursing note reviewed.

Constitutional:

Comments: **Ill apearing**

HENT:

Head: Normocephalic and atraumatic.

Right Ear: External ear normal.

Left Ear: External ear normal.

Nose: Nose normal.

Mouth/Throat:

Mouth: Mucous membranes are moist.

Eyes:

Conjunctiva/sclera: Conjunctivae normal.

Cardiovascular:

Rate and Rhythm: Normal rate and regular rhythm.

Heart sounds: No murmur heard.

Case

No friction rub. No gallop.
Pulmonary:
Effort: Pulmonary effort is normal. No respiratory distress.
Breath sounds: No wheezing, rhonchi or rales.
Abdominal:
General: Abdomen is flat. There is no distension.
Tenderness: There is no abdominal tenderness. There is no guarding or rebound.
Musculoskeletal:
General: No deformity.
Cervical back: Normal range of motion.
Right lower leg: No edema.
Left lower leg: No edema.
Skin:
General: Skin is warm and dry.
Capillary Refill: Capillary refill takes less than 2 seconds.
Neurological:
General: No focal deficit present.
Mental Status: She is alert.
Comments: **+right facial droop. Visual fields grossly intact, able to cross midline. + expressive and receptive aphasia, unable to follow commands or speak. +right upper and lower extremity drift, intact strength in LUE, LLE.**
Psychiatric:
Comments: **Unable to assess**

Case

ED Course & Medical Decision Making

Medical Decision Making

68F h/o afib no on AC presenting with code stroke. Vitals reviewed and unremarkable.

Patient presents with sudden-onset, concerning for potential stroke. Last known well at 10 pm. A code stroke was activated. Fingerstick 168. SBP in the ED . Initial NIHSS calculated to 13.

Differential diagnosis includes TIA, post-seizure paralysis, aortic or cervical vessel dissection, peripheral nerve palsy, space occupying CNS lesion, atypical migraine, substance/ingestion, or recrudescence of remote CNS insult in the setting of metabolic/infectious stressor. High c/f LVO at this time, L MCA syndrome.

Plan:
-Non-contrast Head CT
- CTA Head/Neck
- EKG
- CXR
- CBC, BMP, PT/INR
- Neuro consult
- to NEURO IR

Case

ED Course as of 08/19/23 1128

Fri Aug 18, 2023

0952 68F h/o AF not on A/C, HTN, here with aphasia, R facial droop and R sided weakness, found by son at 0915. Son, Christopher, heard her banging on bedroom door at 0915am, then moaning. Found mom lying on side, trying to talk. LSW 9:30 or 10pm last night. On exam: mild HTN, not oriented, intermittent commands, receptive and expressive aphasia, R facial droop, R arm drift, R leg drift, full strength in LUE and LLE.

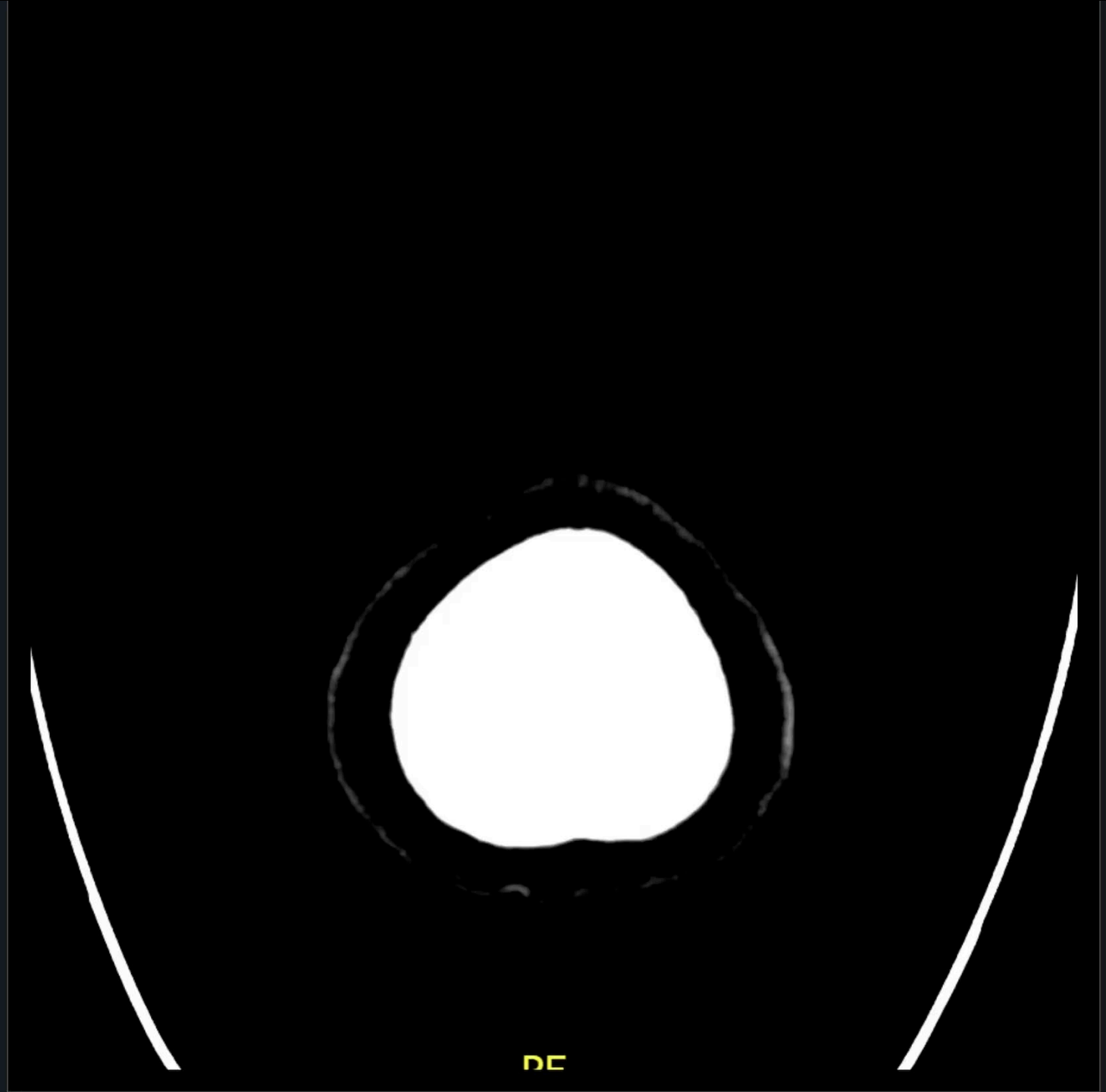
PMHx: AF (5 years ago, brief episode, spontaneously resolved, no A/C), HTN
Meds: clonazepam, flexeril, spironolactone, toprol, ASA 81mg, celexa 80mg, trazadone
Allergies: Sulfa

Concern for L MCA stroke. Neurology paged within 1 minute of evaluation. Plan for CT stroke protocol with perfusion. Patient is outside window for IV-tPA but within extended

How do you assess these strokes?

NCHCT

- When to mix TNK or IV-tPA?


PE

NCHCT

- Window 30/30
- Thrombolysis time?

CTA

- Now it’s time for the CTA

8: 2mm True Ax Brain (Series 9)

9: Monitoring 10.0 Br38 (Series 11)

PROTOCOL HEAD AN

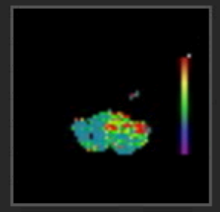
10: 0.6mm Axial CTA head/neck C_AuSn120kV iMAR (Series 12)

11: 1mm COR Brain (Series 13)


R

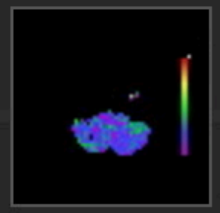
CT Perfusion

- When to get a CT perfusion



30: CT Perfusion
ZSFG Perfusion RGB
[20] MTTD
#20230818-101503
(Series 209)

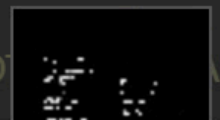
PROTOCOL HEAD AN



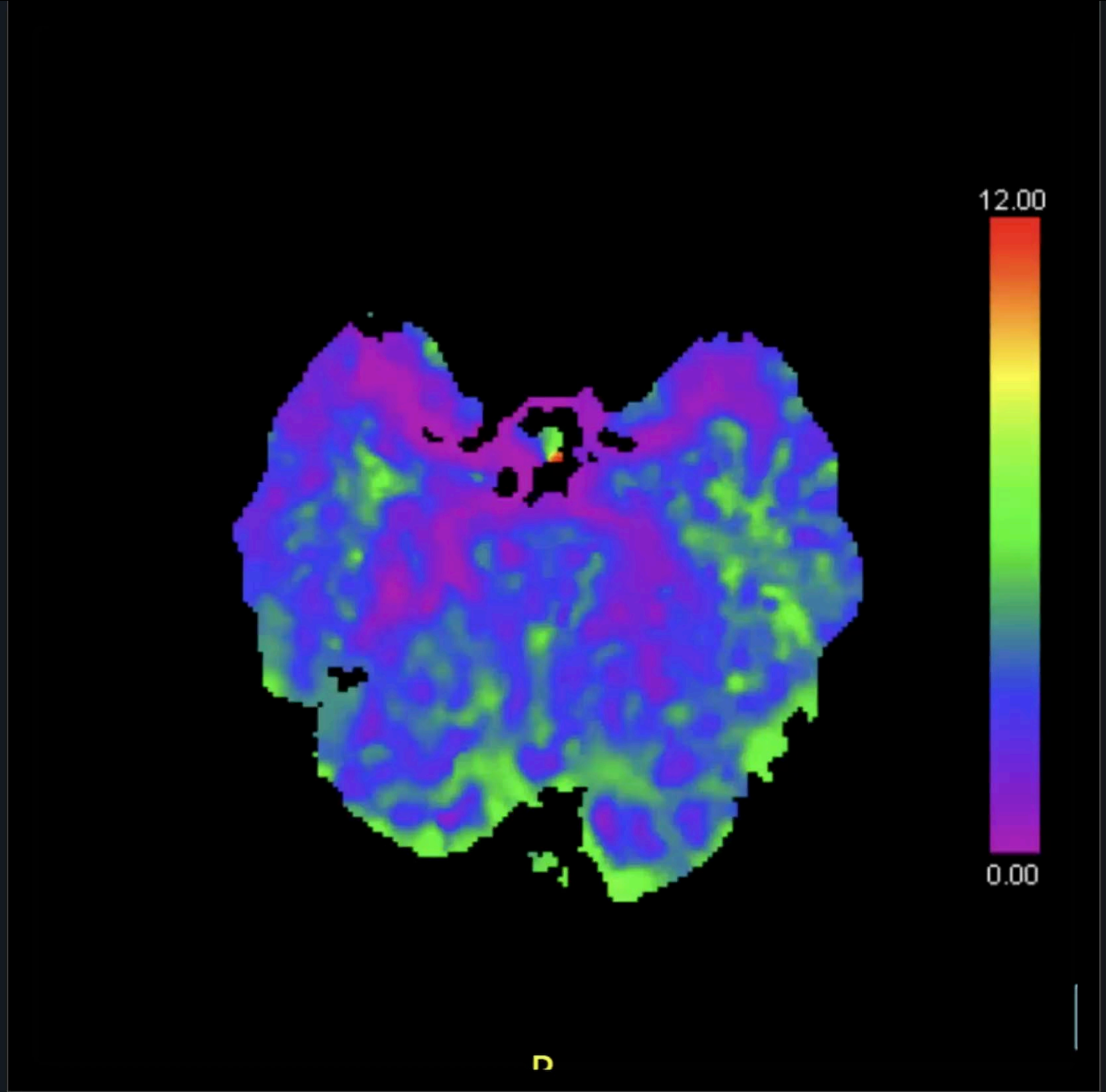
31: CT Perfusion
ZSFG Perfusion RGB
[20] TMAXD
#20230818-101503
(Series 210)

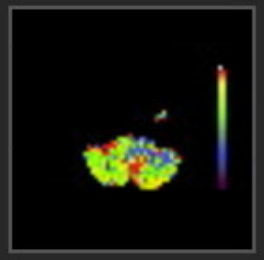
Aug 1

32: Patient Protocol
(Series 502)

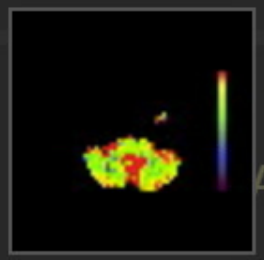


PRO AD AN

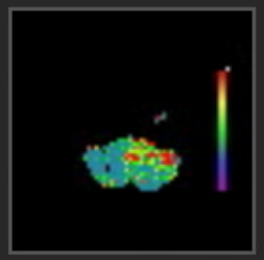

12.00
0.00

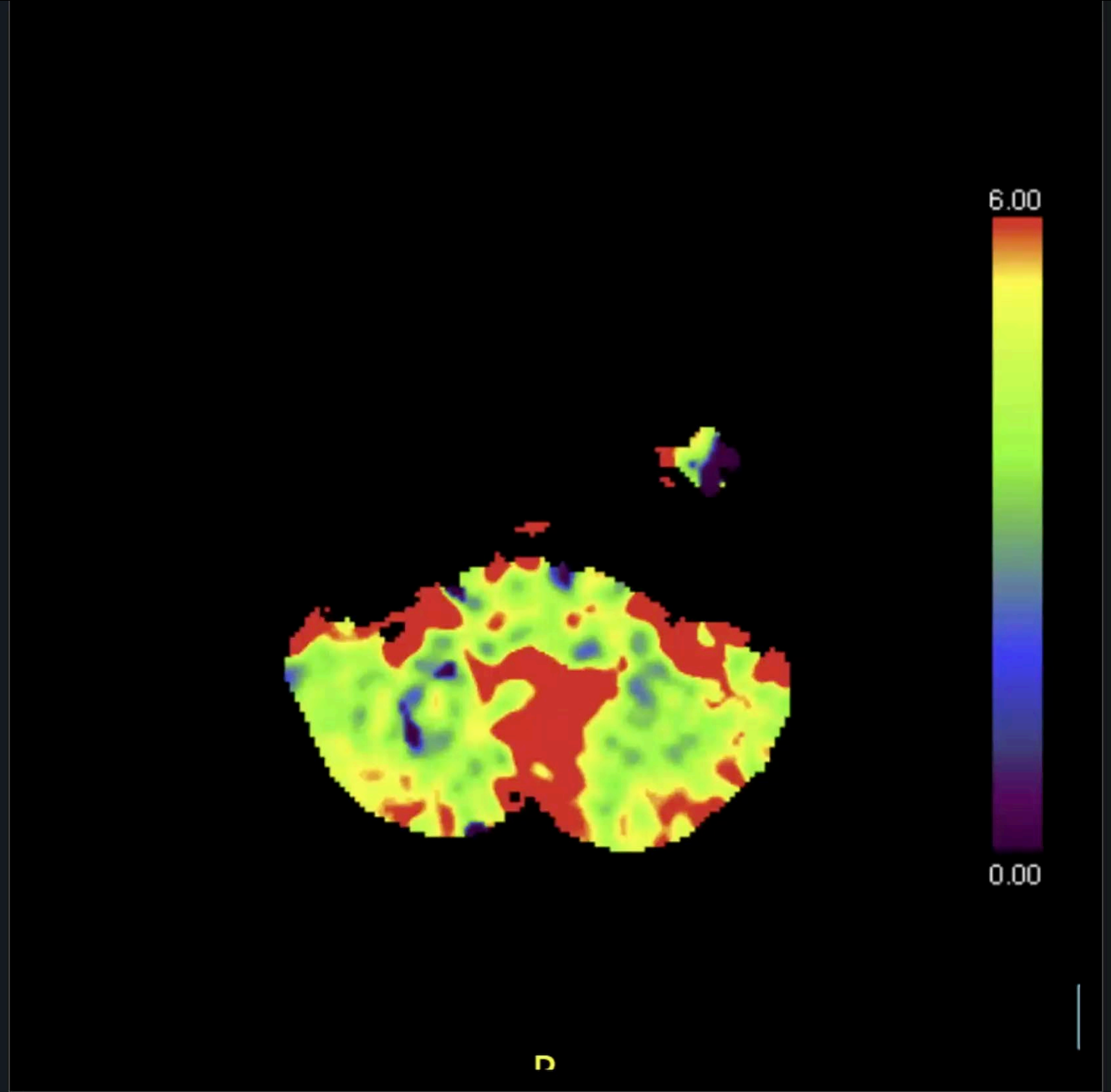


28: CT Perfusion
ZSFG Perfusion RGB
[20] CBFD
#20230818-101503
(Series 207)

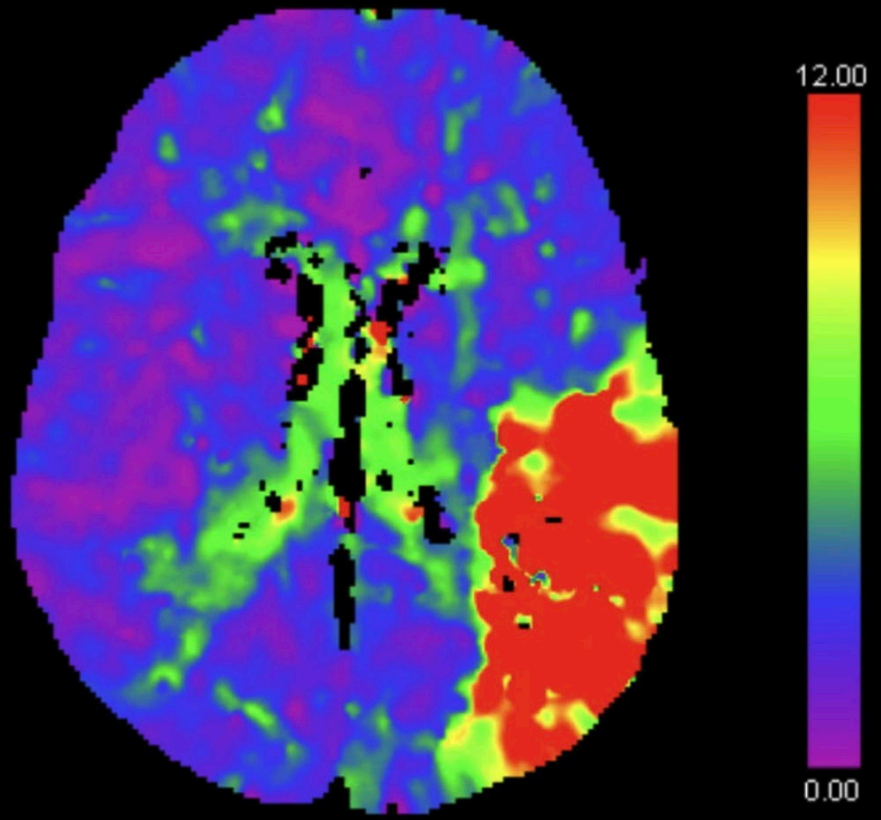


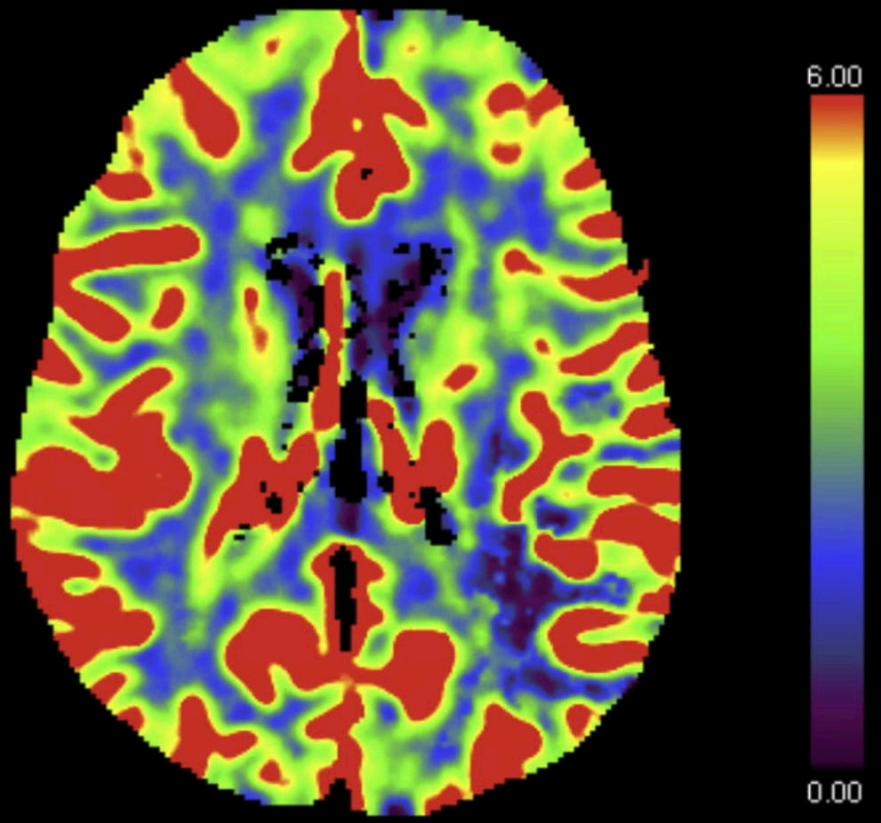
29: CT Perfusion
ZSFG Perfusion RGB
[20] CBVD
#20230818-101503
(Series 208)

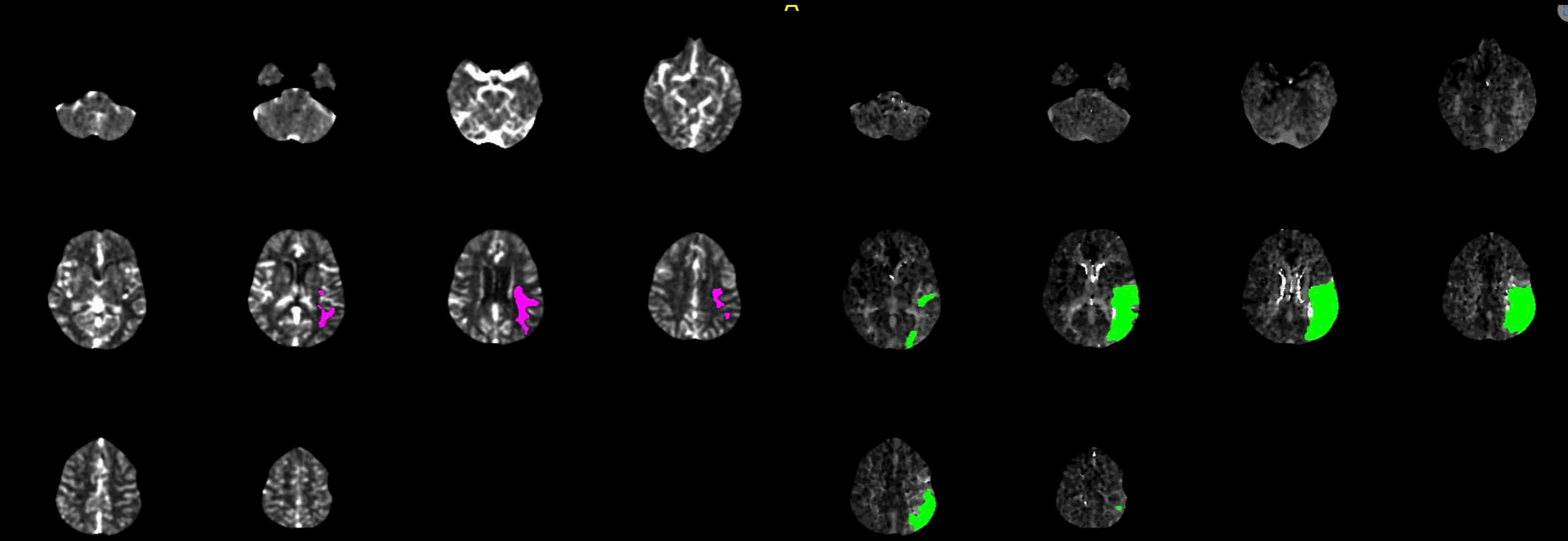



6.00
0.00

Core vs. Penumbra







CBF<30% volume: 13 ml

Tmax>6.0s volume: 72 ml

Mismatch volume: 59 ml
Mismatch ratio: 5.5

RAPID

What Happens If There’s No LVO on CTA?

- Finding the core vs. penumbra

What Happens If It’s Been > 4.5 Hours?

- WAKE UP

WAKE UP, EXTEND, & TRACE-III...

- Stroke symptom onset 2.5 to 24 hours prior
  - For those with 'wake up' stroke, this time was the last time seen normal.
- Pre-stroke modified Rankin score ≤1
- Baseline NIHSS between ranging from 6 to 25
- Salvageable brain tissue on perfusion imaging
- 38% had wake-up strokes
- Tenecteplase vs. usual care
- Outcome: absence of disability (mRS <= 1) at 90 days
  - 33% vs 24% (RR 1.37; 95% CI 1.04 to 1.81; P=0.03; NNT=11)

What If You Are Concerned For a Posterior Circulation Stroke?

- MRI

MRI: answers 3 core questions

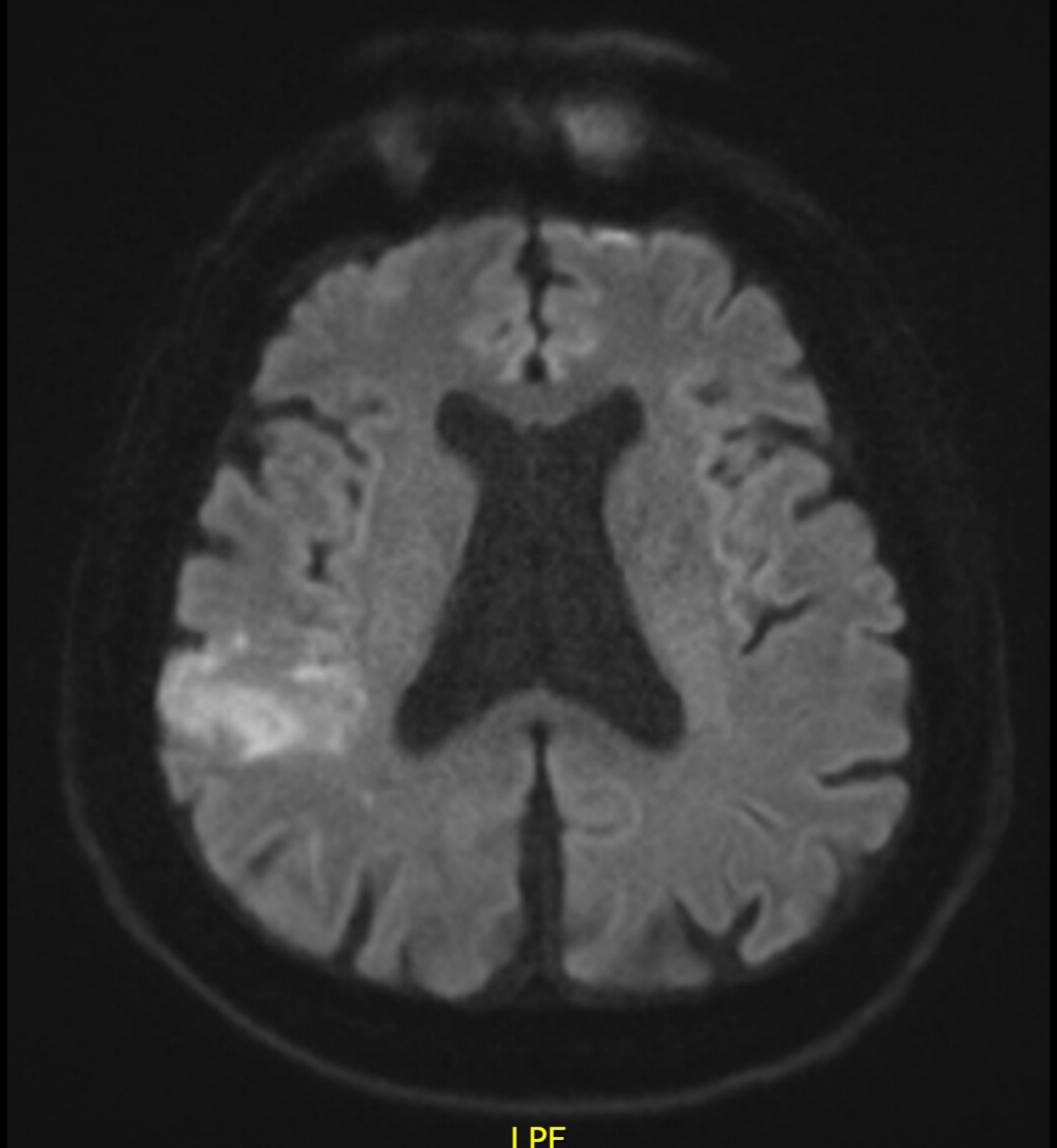
- Is there an acute infarct?
- Is there bleeding?
- Is there tissue we can save?

3-ish Sequences

- DWI
- ADC
- FLAIR
- +/- GRE/SWI

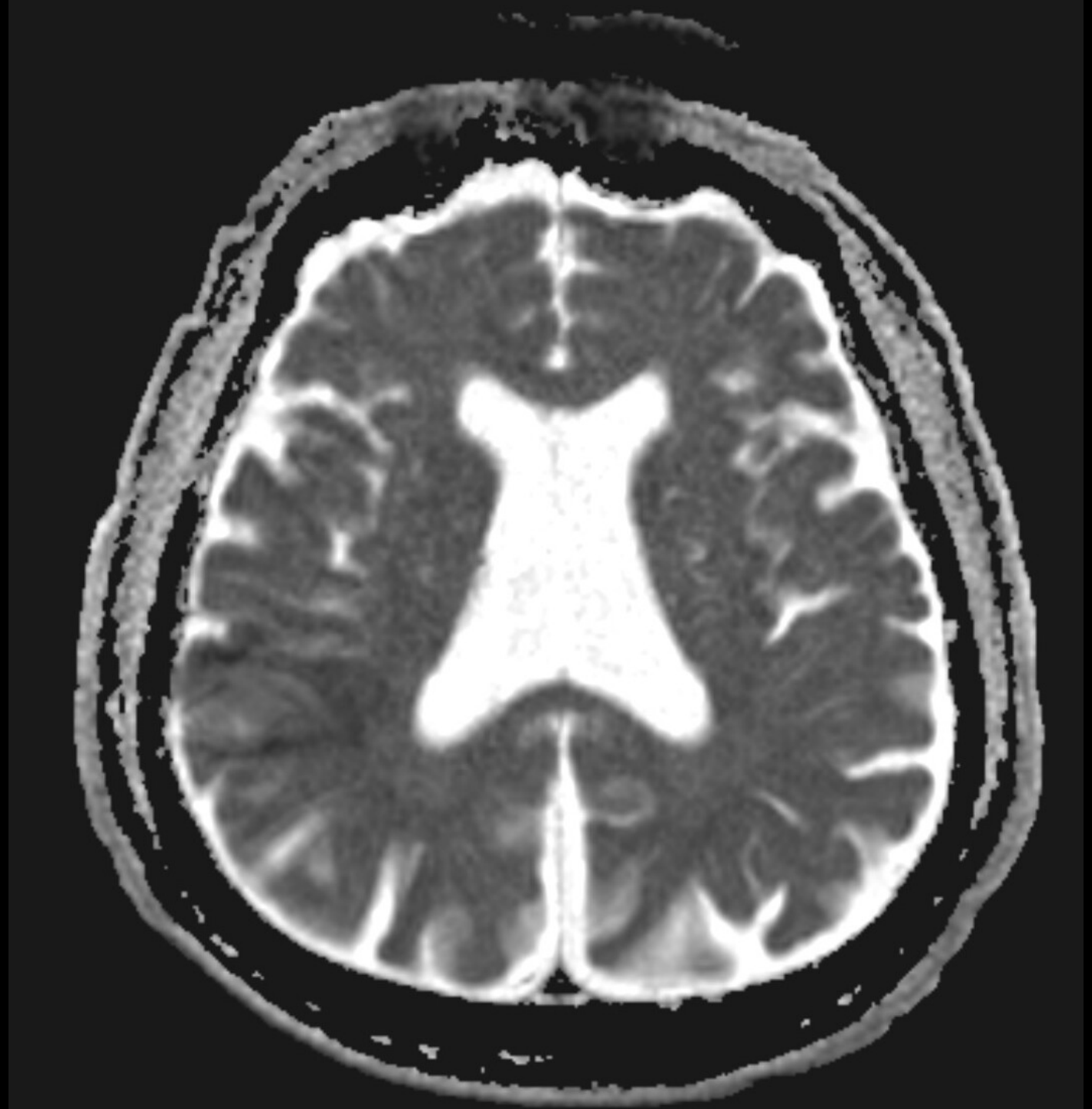
DWI

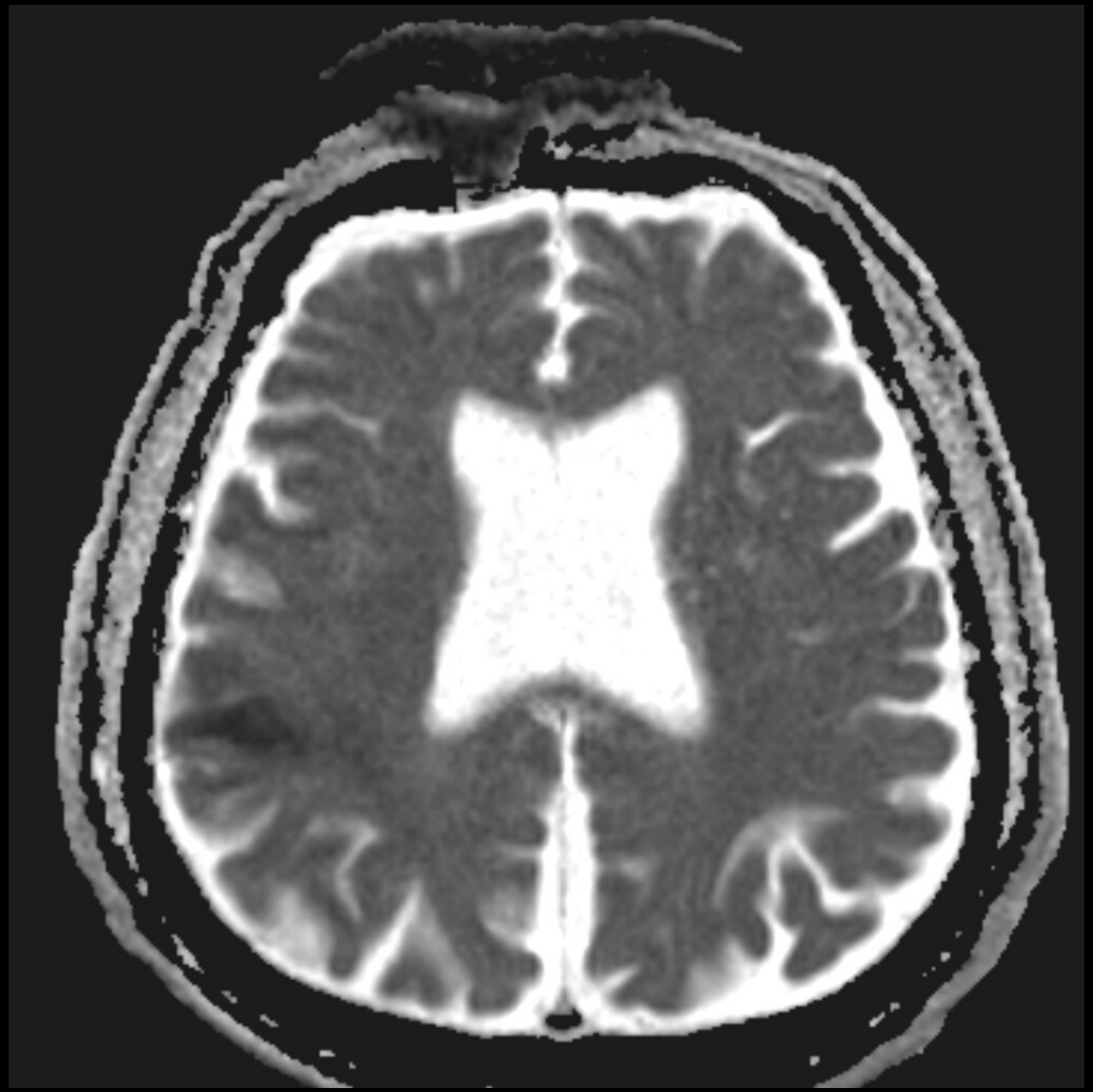
- Where is the stroke happening right now?
- Bright on DWI = ischemic stroke until proven otherwise
- This is the CORE infarct = DEAD TISSUE


L PF

ADC

- Is this truly acute?
- Bright on DWI + Dark on ADC = REAL acute infarct





FLAIR

- How old is it?
- FLAIR tells us whether the stroke has been there long enough to show tissue change
- Bright on DWI + normal FLAIR = EARLY stroke (<4.5-6 hours)

FLAIR

- But… Bright on DWI + Bright on FLAIR = established stroke
- What we use in WAKE UP strokes

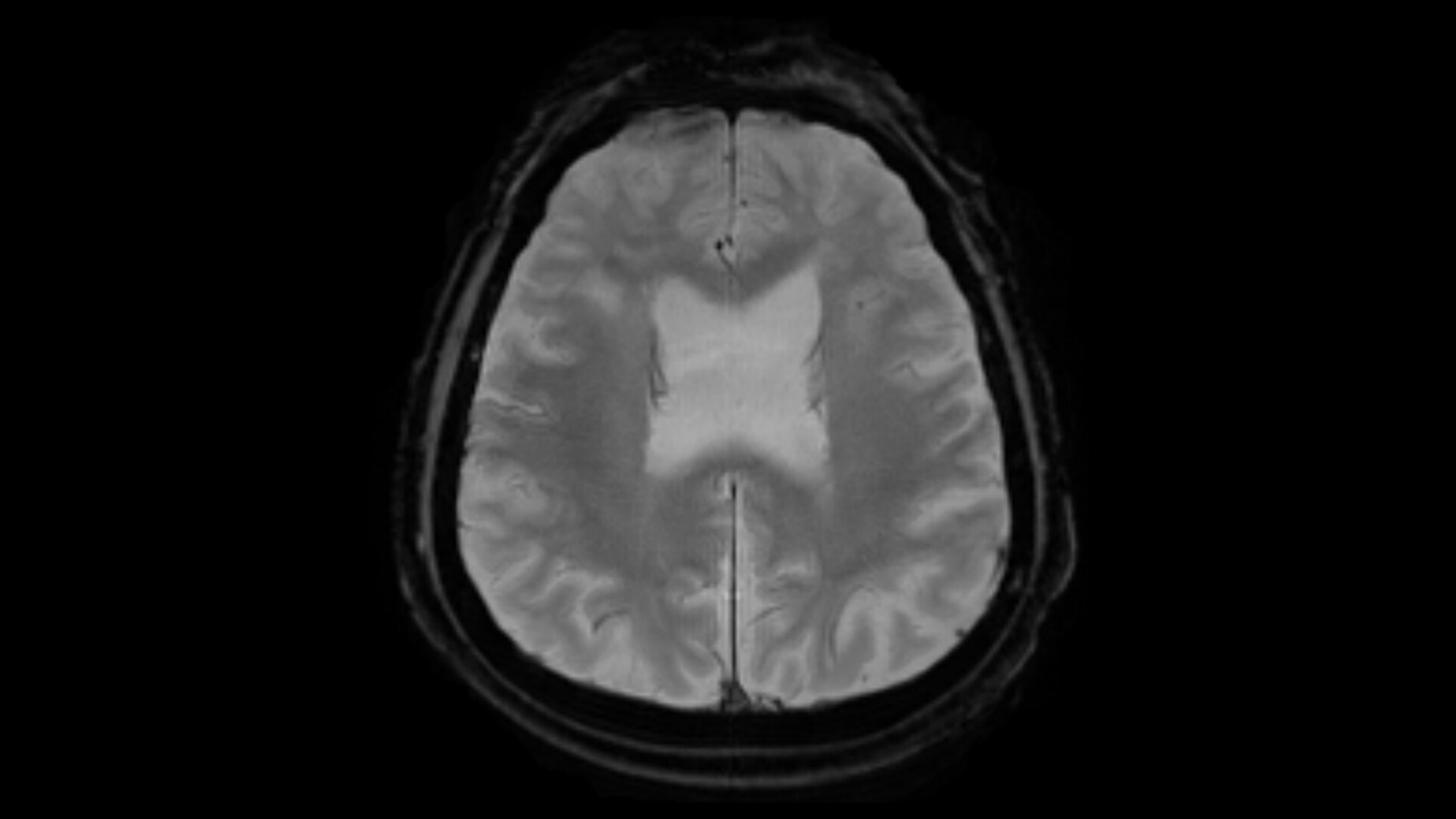

LPF

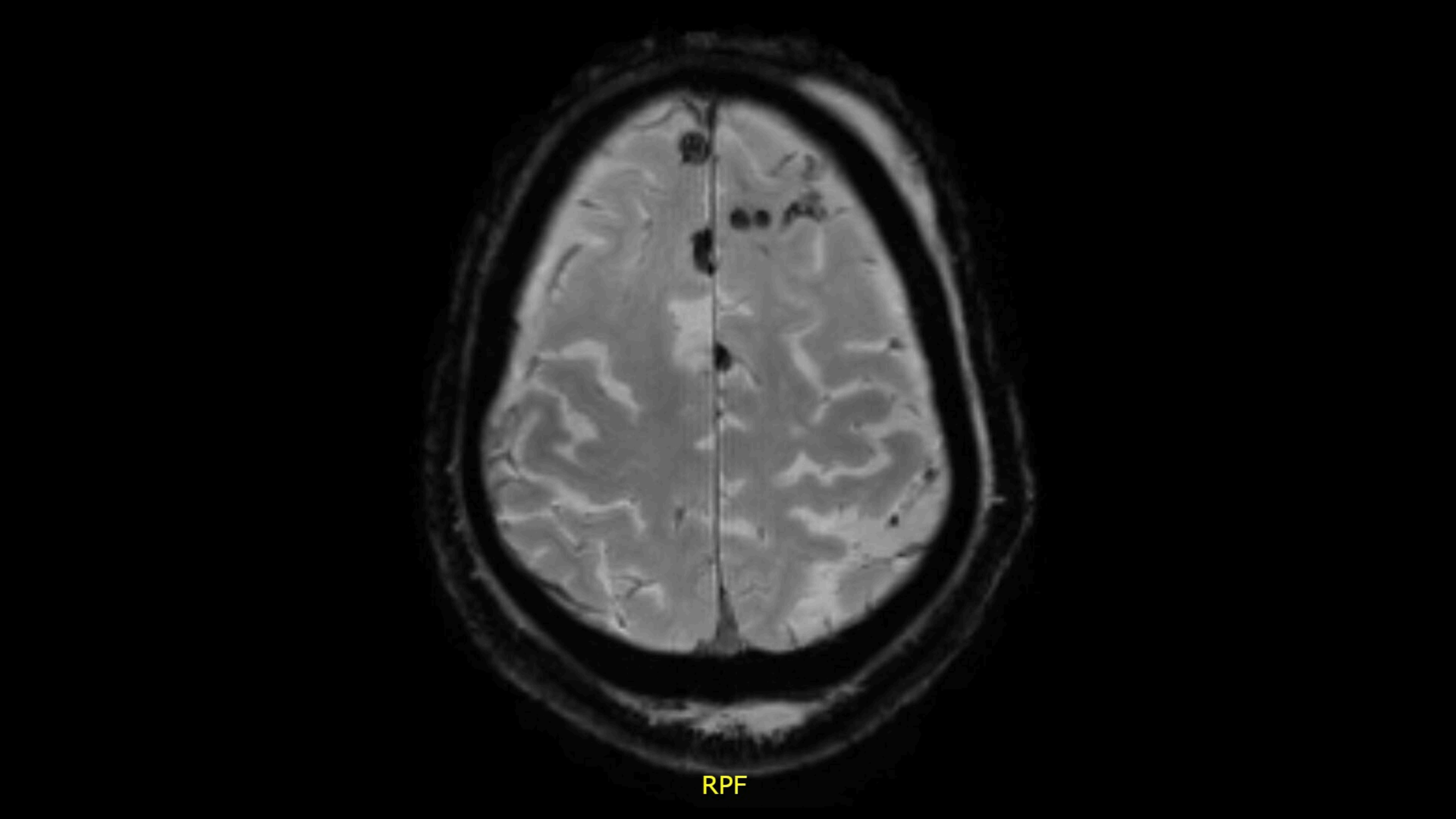
FLAIR

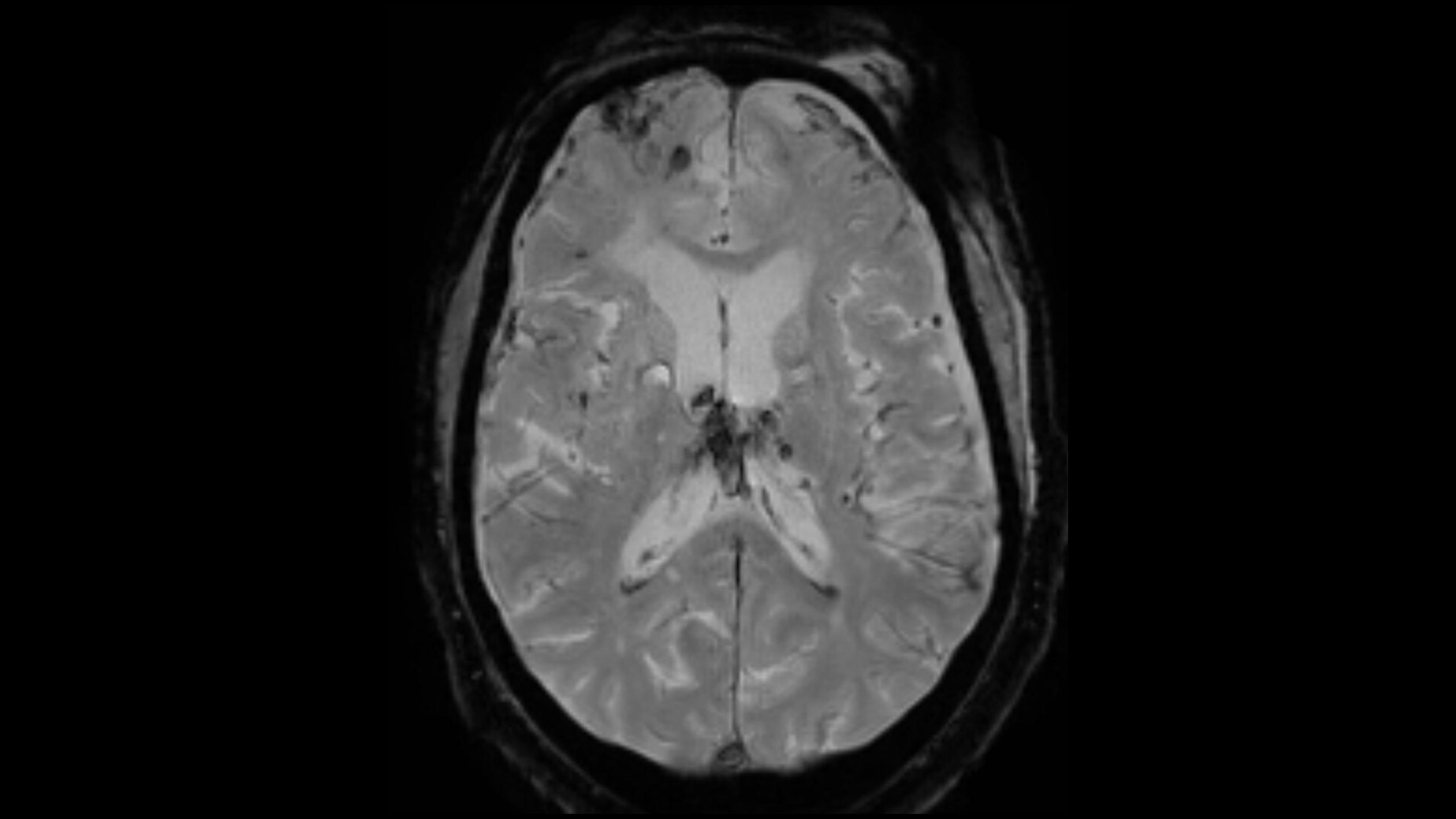
- WAKE UP: no flare change → thrombolysis
- Rapid stroke protocol

GRE/SWI

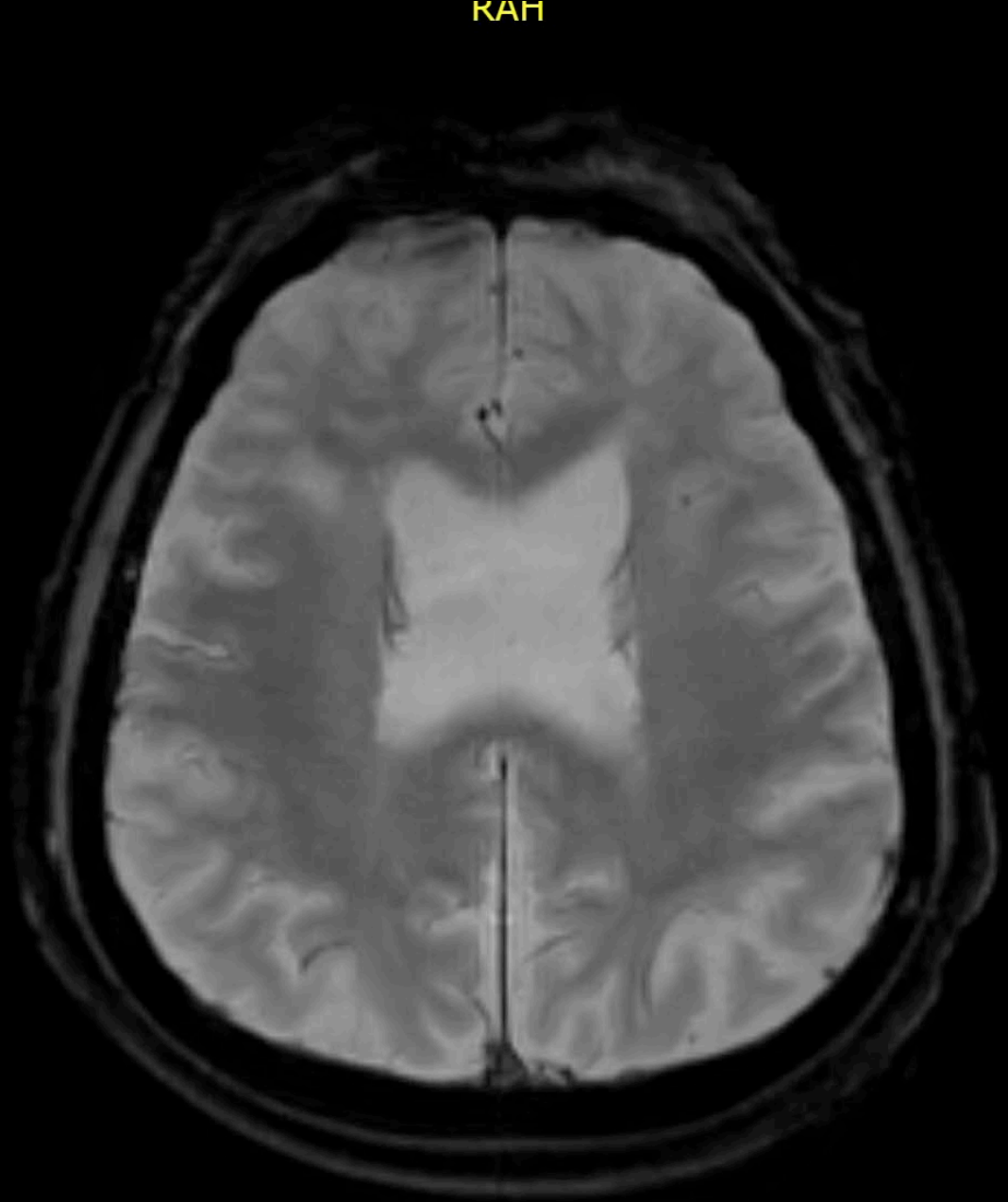
- GRE/SWI show blood as black, blooming areas
- Helpful for hemorrhage stroke, hemorrhagic conversion, microhemorrhages



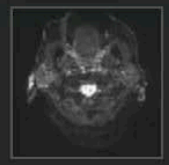

RPF



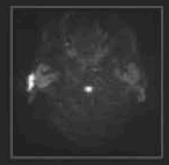
Let’s Do One Together!



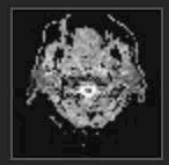
20 of 32



1: resolve_4scan_trace_tra_s2_224_TRACEW (Series 5)



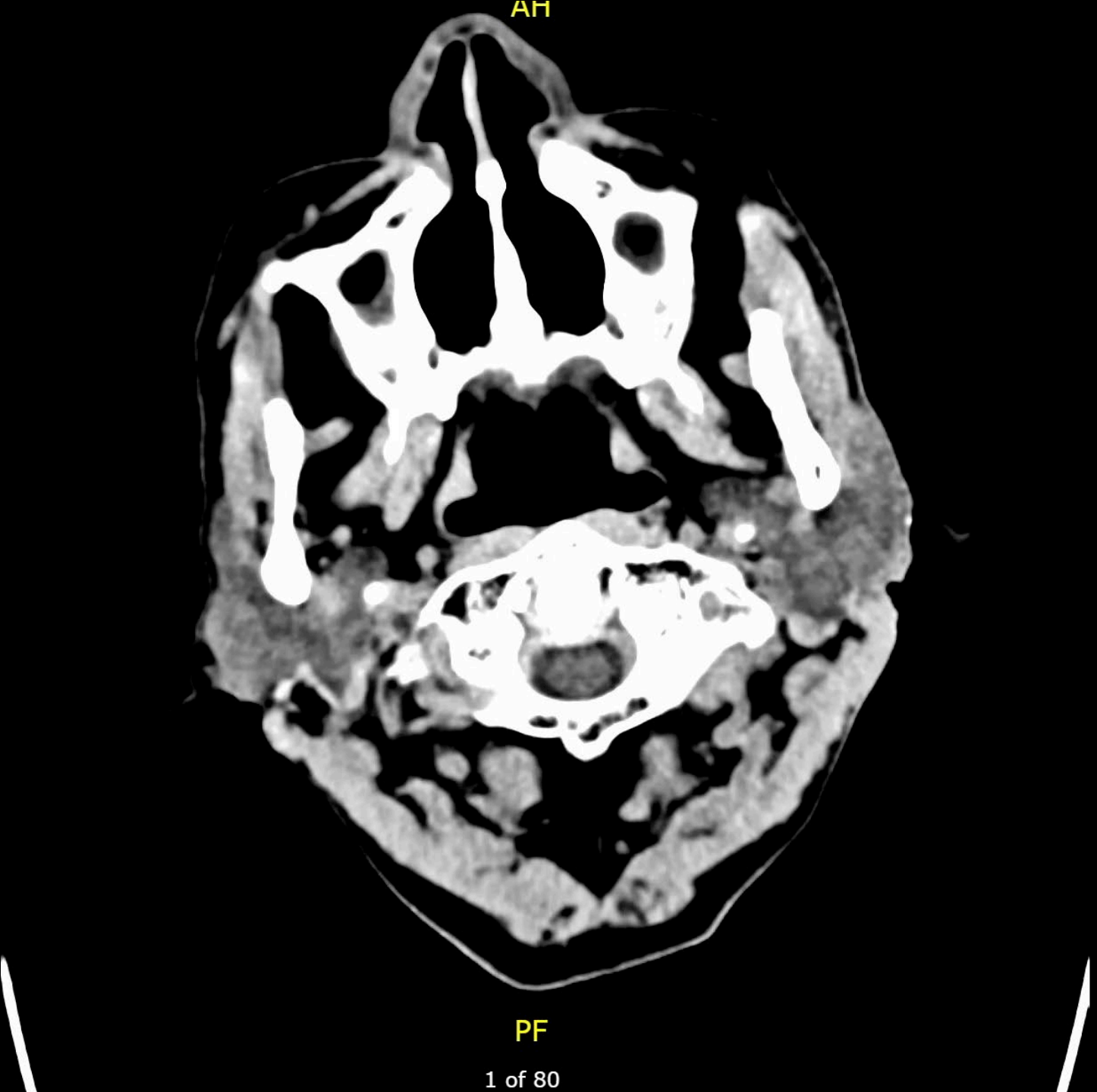
2: resolve_4scan_trace_tra_s2_224_TRACEW (Series 5)



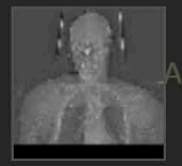
3: resolve_4scan_trace_tra_s2_224_ADC (Series 6)

4: t2_space_flair_fs_dark-fluid_sag_caipi4 (Series 7)

Let’s Do One From CT to MRI!



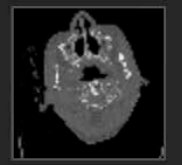
1 of 80



1: PA Topogram

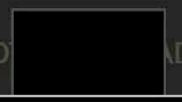
2: LAT Topogram

3: 2mm Axial non con Brain

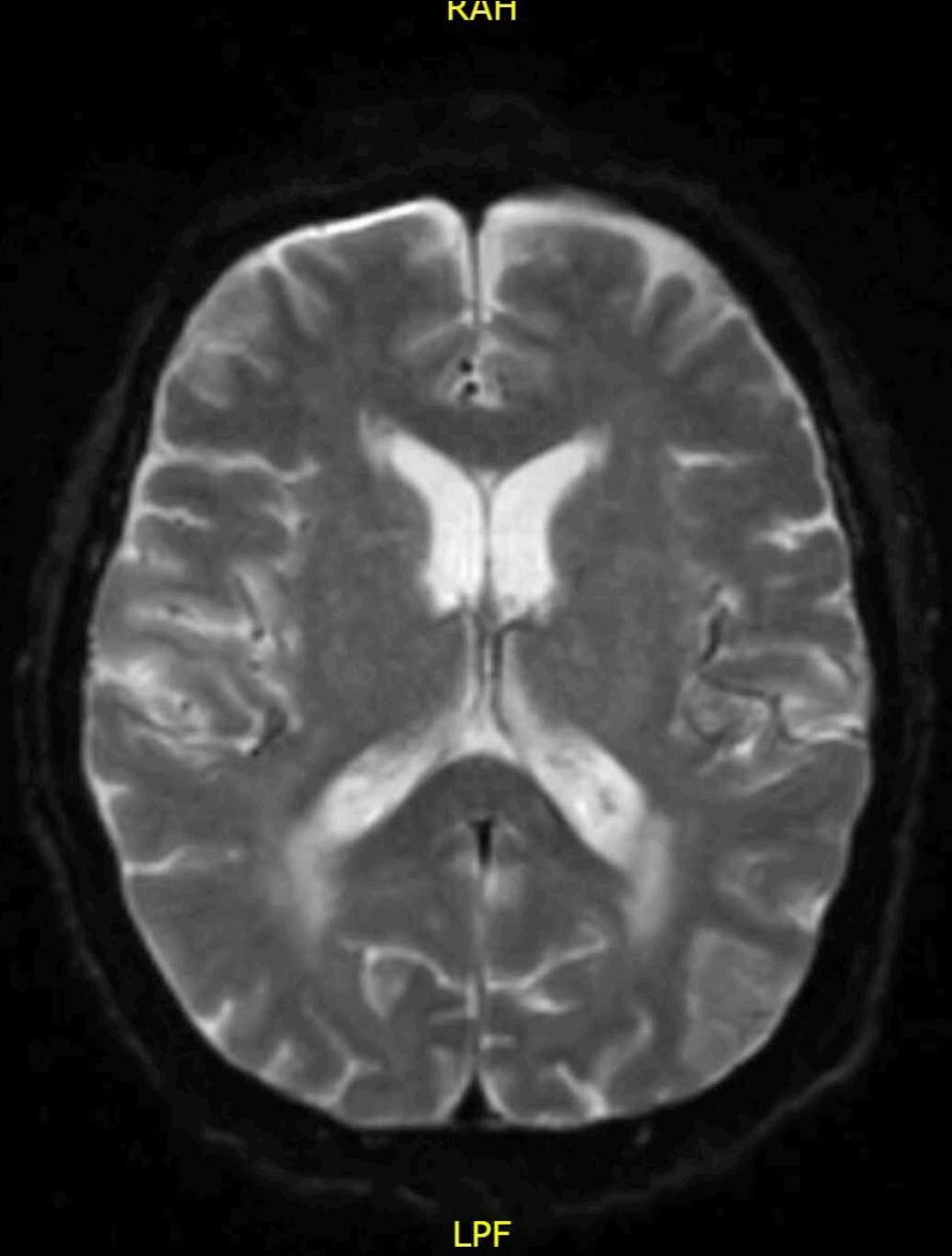


4: 0.6mm Axial Bone Alg. (Series 5)

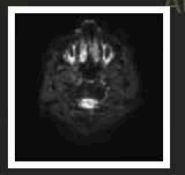
5: 5mm Axial non con Brain (Series 7)



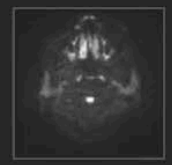
CT STROKE



16 of 28

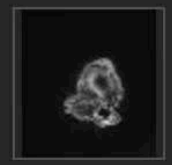


1: resolve_4scan_trace_tra_s2_224_TRACEW (Series 5)

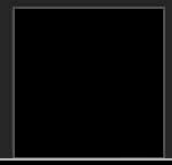


2: resolve_4scan_trace_tra_s2_224_TRACEW (Series 5)

3: resolve_4scan_trace_tra_s2_224_ADC (Series 6)



4: t2_space_flair_fs_dark-fluid_sag_caipi4 (Series 7)



HREM MRI Checklist

- Look at DWI: is there a bright area? = ischemic stroke until proven otherwise
- Confirm on ADC: is it dark? = ACUTE infarct
- Look at FLAIR: is it bright yet? → BRIGHT + BRIGHT = established stroke
- +/- Look at GRE/SWI: is there bleeding?

1 Slide for Localization

- MCA = face/arm > leg weakness
- ACA = leg weakness
- PCA = visual deficit
- Brainstem = crossed findings

Questions?

Debbie.Madhok@ucsf.edu