Imaging of acute stroke patients: What is needed to make urgent decisions

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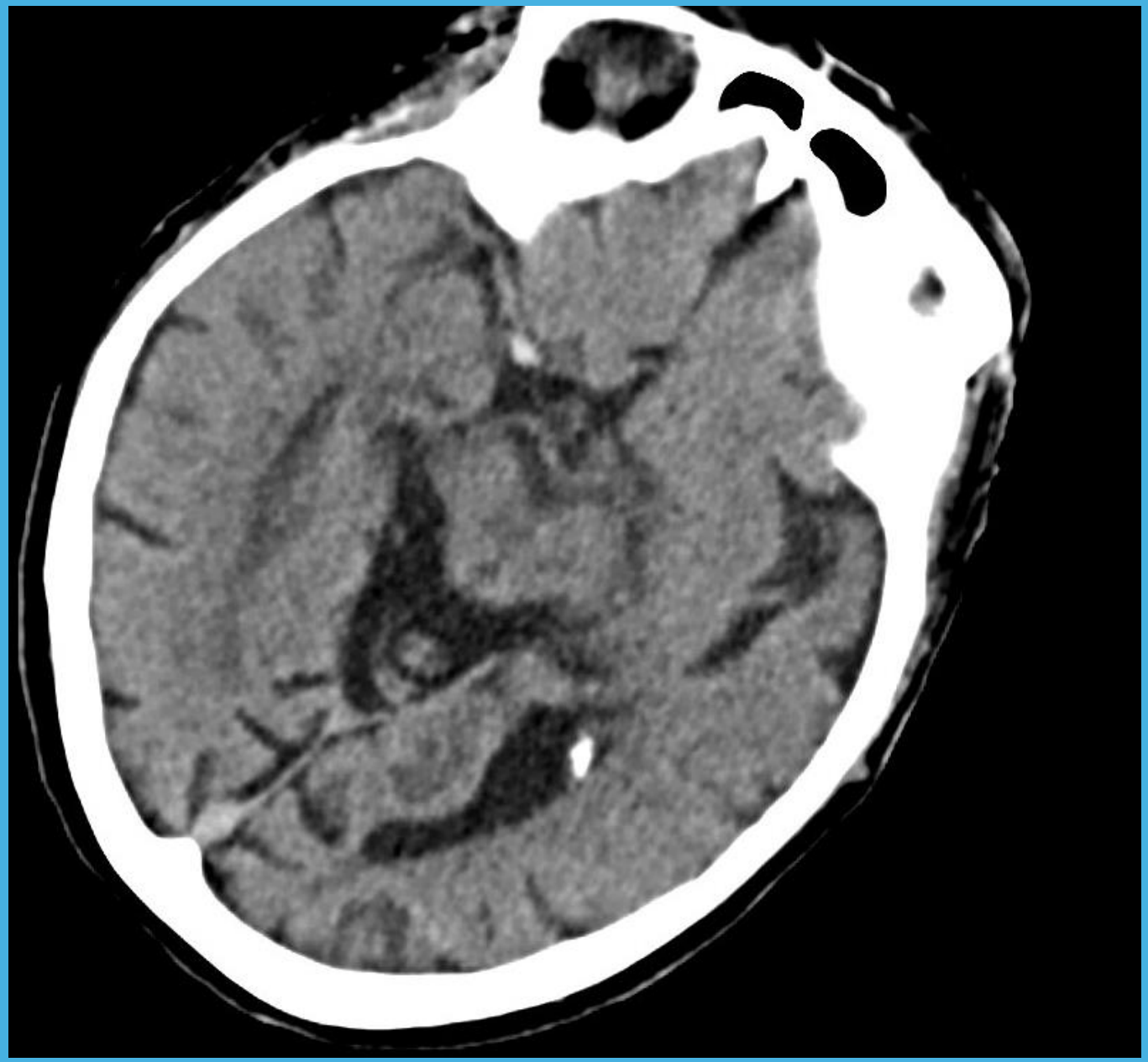
Disclosures

- None

- Early identification of acute stroke is critical for initiating prompt intervention to reduce morbidity and mortality.
- Neuroimaging is an important tool for the detection, characterization, and prognostication of acute strokes, including ischemic and hemorrhagic subtypes.

Goals of imaging

- Identify presence of hemorrhage
- Determine the presence of a Large vessel occlusion-LVO
- Assess proximal anatomy and patency
- Assess collateral flow in the affected territory
- Assess extent/volume of completed infarct
- Identify salvageable penumbra (CT perfusion or MRI DWI/FLAIR)
- Determine pattern of injury

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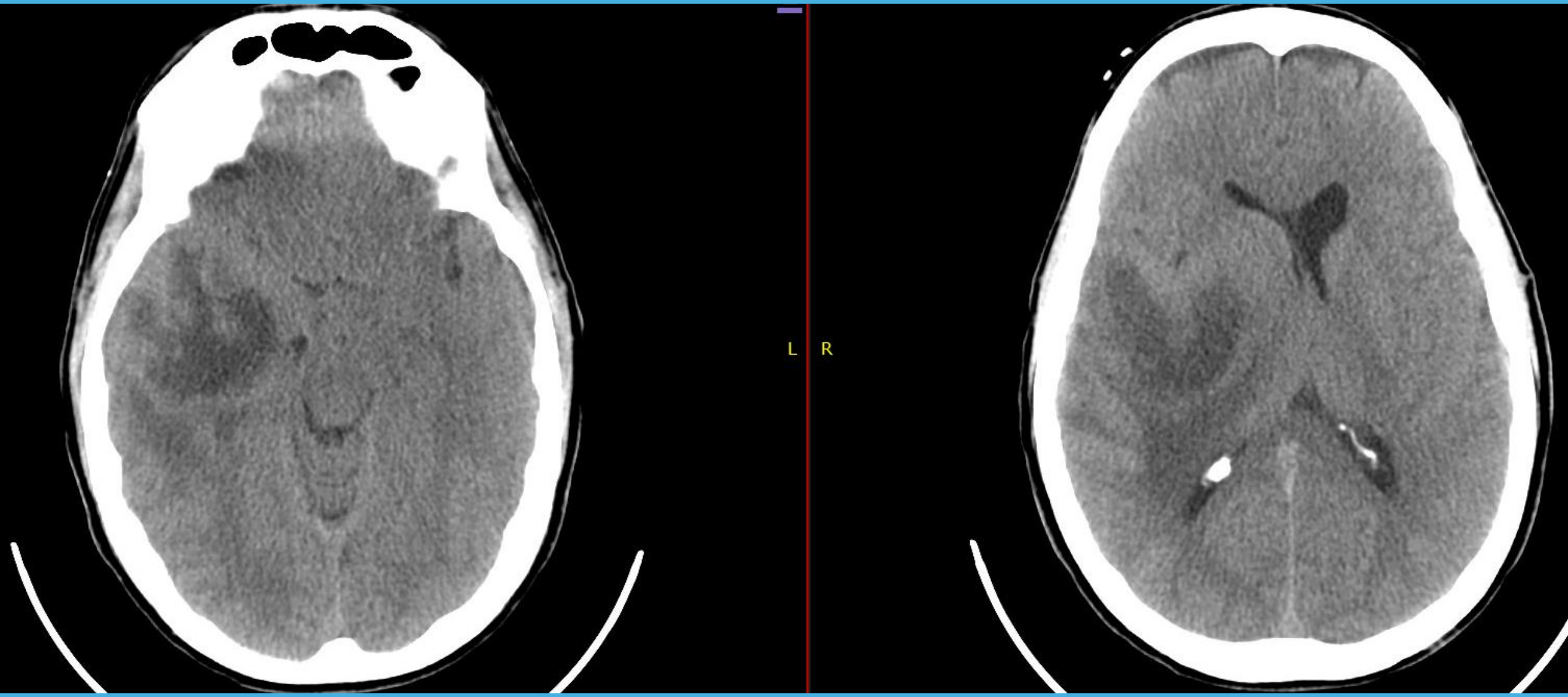
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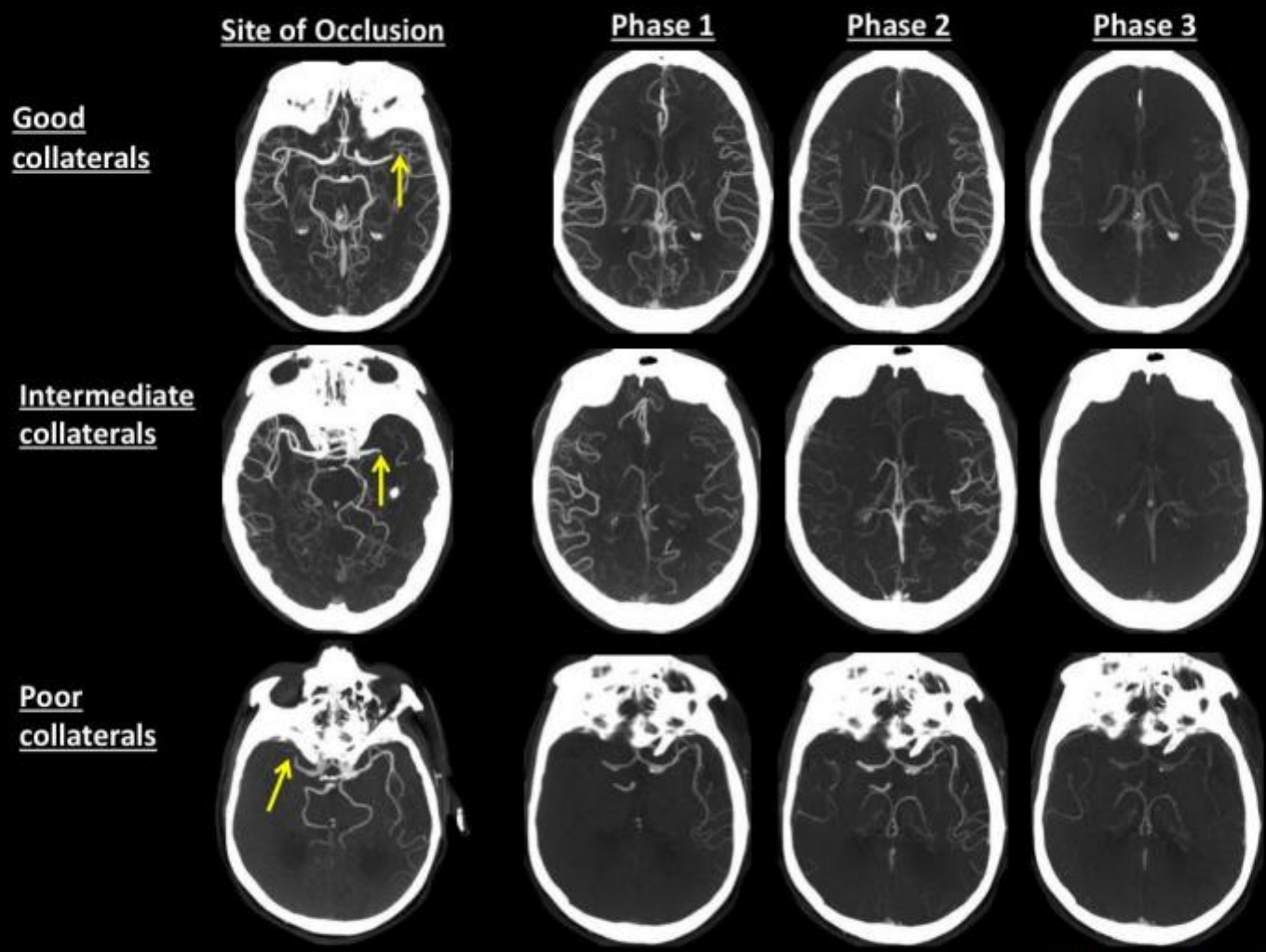
- Imaging algorithm that we follow
- NCCT
- CTA Head and Neck
- CTP if stroke onset >8hrs
- Urgent MRI in selected patients: posterior circulation
- Intraop/ Post Op CT on table
- Post op NCCT
- MRI typically next day

- Alberta Stroke Program Early CT Score (ASPECTS)
- - reproducible grading system to assess early ischemic changes in
- anterior circulation strokes
- - can predict poor functional outcome with increased risk of parenchymal hemorrhage for IV thrombolysis alone or in combination with endovascular therapy (score ≤7)

CTA - Collateral Vessel Scoring

- CT-Angiography is performed concurrently with the non contrast head CT and gives information about:
- - site of occlusion
- - clot length –
- presence of leptomeningeal collaterals
- Regional Leptomeningeal Collateral Score (rLMC)

CTA - Collateral Vessel Scoring



! Leptomeningeal collateral scoring systems based on CT-Angiography have been shown to correlate with and predict clinical outcome

ASPECTS and Collateral Vessel Scoring

Estimation of Infarct Core

	Large	Medium	Small
Non-contrast CT ASPECTS	0-4	5-7	8-10
CT-Angiography Collaterals	Poor	Intermediate	Good
CT Perfusion	>70 mL	20-70 mL	<20 mL
DWI Lesion Volume	>70 mL	20-70 mL	<20 mL

CTP

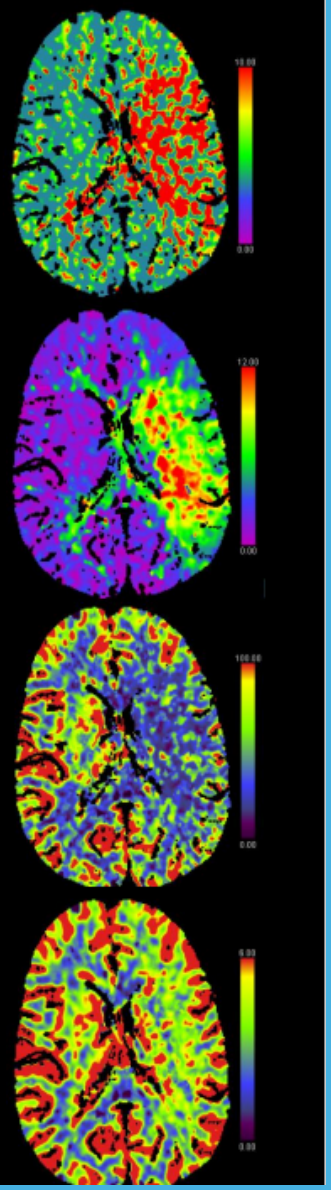
- Perfusion source data are a 4-dimensional data set (3-dimensional volumes captured over time).
- Multiple software products that produce perfusion maps and estimate volumes of ischemic core and tissue at risk are available. Perfusion processing is a nonstandard domain and substantial differences exist between vendors. Frequently, CBF, cerebral blood volume, and Tmax are calculated differently and are, therefore, not comparable between packages.
- A rCBF threshold of <30% has been extensively validated for ischemic core
- The DEFUSE 2 study redefined the mismatch definition for EVT-eligible patients: MMR >1.8, penumbra >15 mL, DWI volume <70 mL, and Tmax >10 seconds

- Units of Measurements
- Cerebral blood vol – ml/100g/min
- Cerebral blood flow-ml/100g/min
- Mean Transit Time-secs
- Time to peak-seconds

Perfusion Slides courtesy Dr Anna Kuhn; Associate Professor of Radiology, UMass Chan Medical School

CT PERFUSION - PARAMETERS

- MTT – MEAN TRANSIT TIME: - AVERAGE AMOUNT OF TIME THAT BLOOD TAKES TO TRANSIT THROUGH THE CAPILLARY VESSELS
  - INCREASED MTT = VASODILATORY RESPONSE TO REDUCED FLOW
- TMAX/TTP – TIME TO PEAK: - RELATIVE TIME TO PEAK ENHANCEMENT FOR BRAIN TISSUE VOXELS
  - IDENTIFIES DELAYED FLOW (STENOSIS OR OCCLUSION)
- CBF – CEREBRAL BLOOD FLOW: - BLOOD FLOW RUNNING THROUGH CAPILLARY BLOOD VESSELS PER UNIT TIME AND BRAIN TISSUE
  - IDENTIFIES LOW BLOOD FLOW
- CBV – CEREBRAL BLOOD VOLUME: - DISTRIBUTION OF BLOOD PER UNIT BRAIN TISSUE
  - EVALUATION OF AUTOREGULATION/COLLATERALIZATION



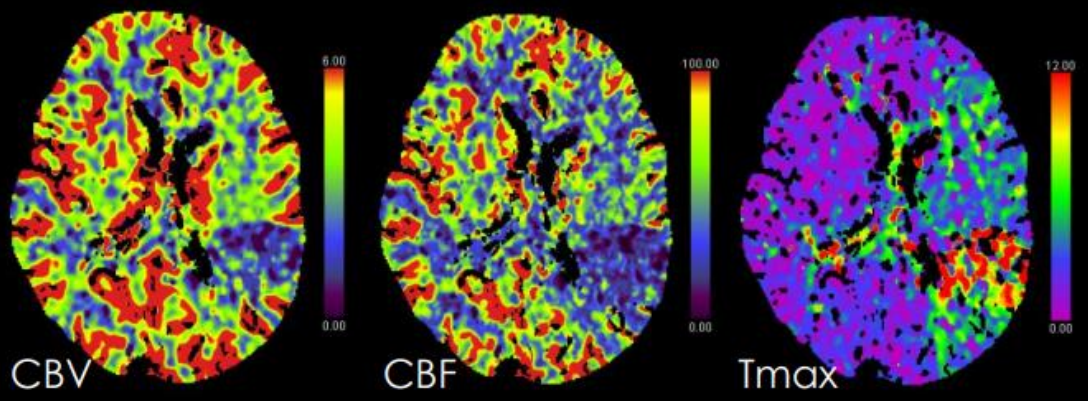
Perfusion Slides courtesy Dr Anna Kuhn; Associate Professor of Radiology, UMass Chan Medical School

DIFFERENT CT PERFUSION SOFTWARES

Calculations not always the same – need to be careful – may overestimate core…

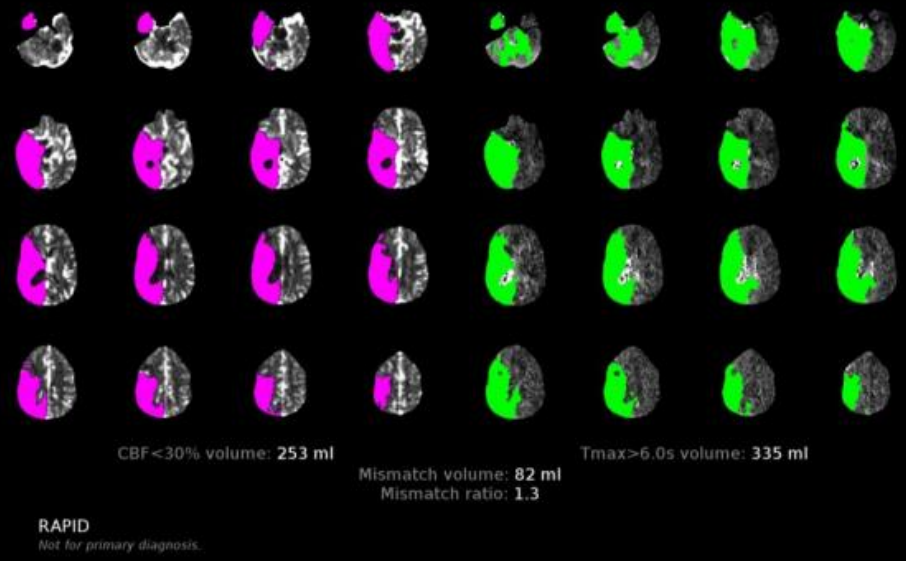
UMASS:

CBV = core
CBF/Tmax=penumbra



RAPID Software:

CBF=core Tmax=penumbra



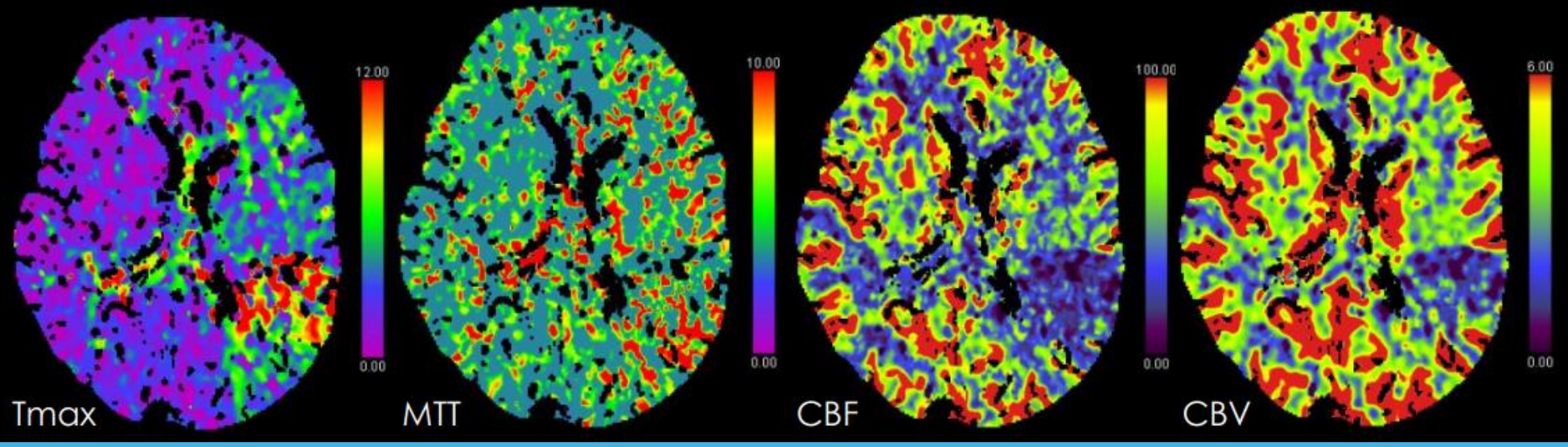
IMAGING APPEARANCE - UMASS

INFARCT CORE

- PROLONGED MTT OR TMAX,
- MARKEDLY DECREASED CBF
- MARKEDLY REDUCED CBV

PENUMBRA

- PROLONGED MTT OR TMAX
- MODERATELY REDUCED CBF
- NEAR-NORMAL OR EVEN INCREASED CBV



CBF

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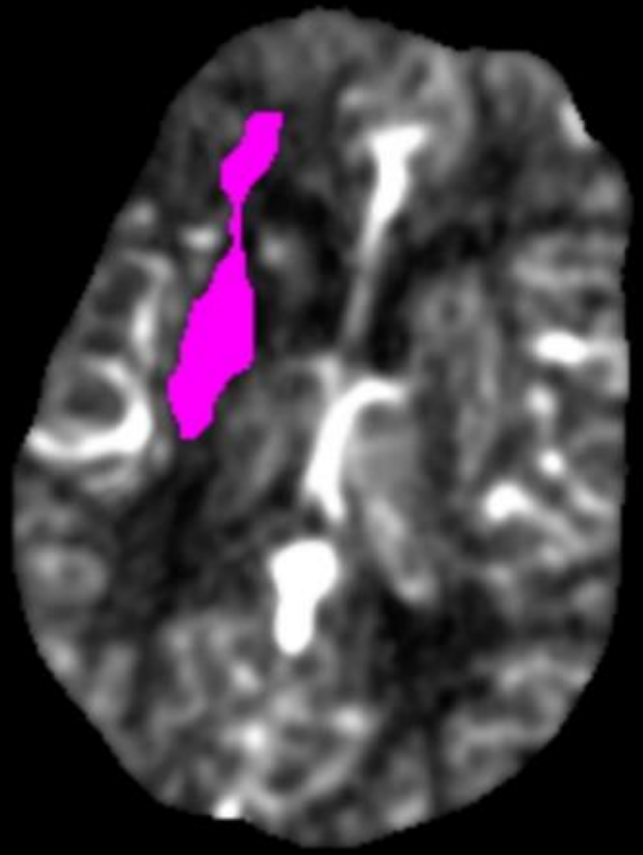
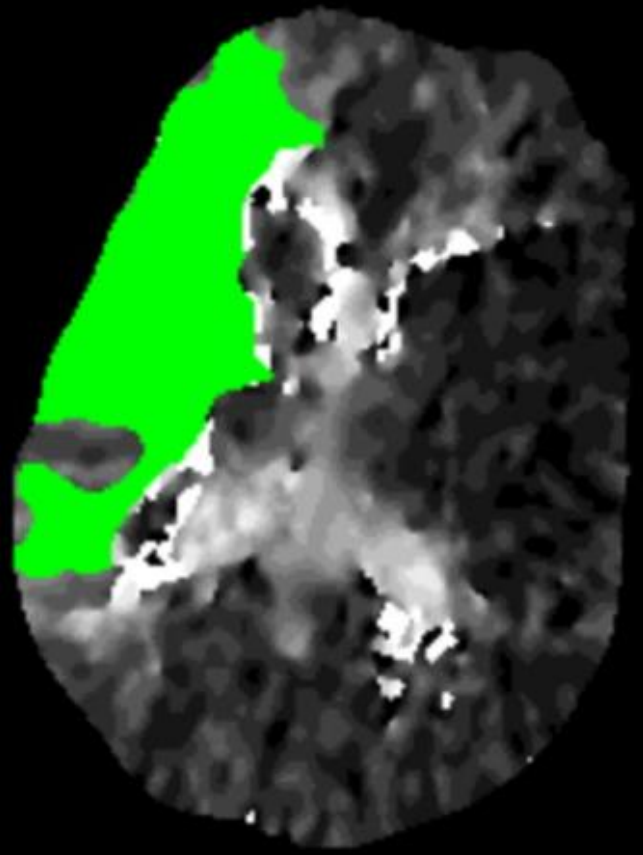
Tmax





● CBF<30%: 23 ml

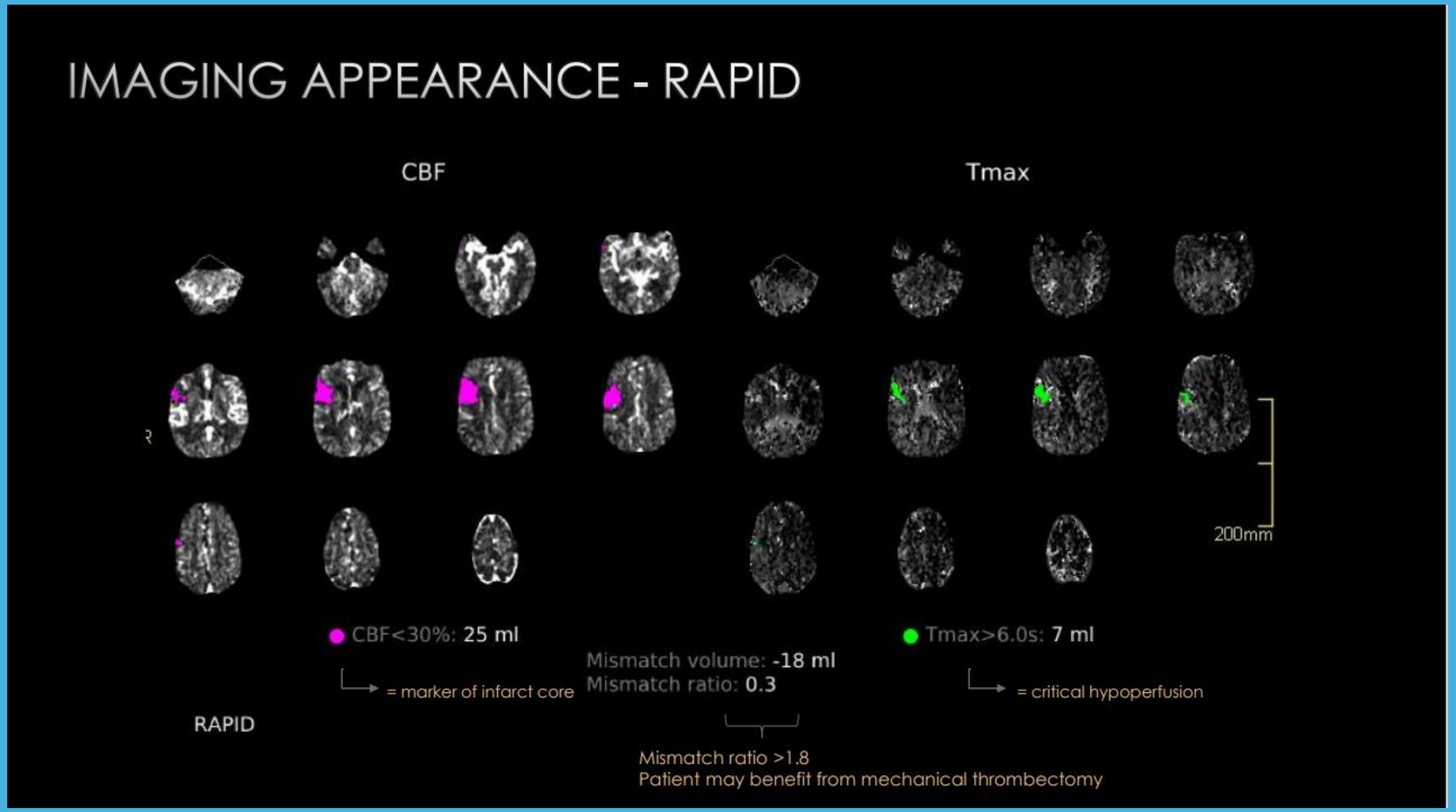
● Hypodensity ≥5 and ≤12 HU

● Tmax>6.0s: 165 ml

Mismatch volume: 142 ml

Mismatch ratio: 7.2

Perfusion Slides courtesy Dr Anna Kuhn; Associate Professor of Radiology, UMass Chan Medical School



CONSIDERATIONS

>> IN PATIENTS WITH UNFAVORABLE PERFUSION IMAGING PROFILE IN EARLY TIME WINDOW, DECISIONS BASED ON CTP ESTIMATIONS SHOULD BE CAREFULLY TAKEN <<

- CT PERFUSION REFLECTS A HEMODYNAMIC STATE AND MEASURES CONTRAST FLOW/TRANSIT!

↓

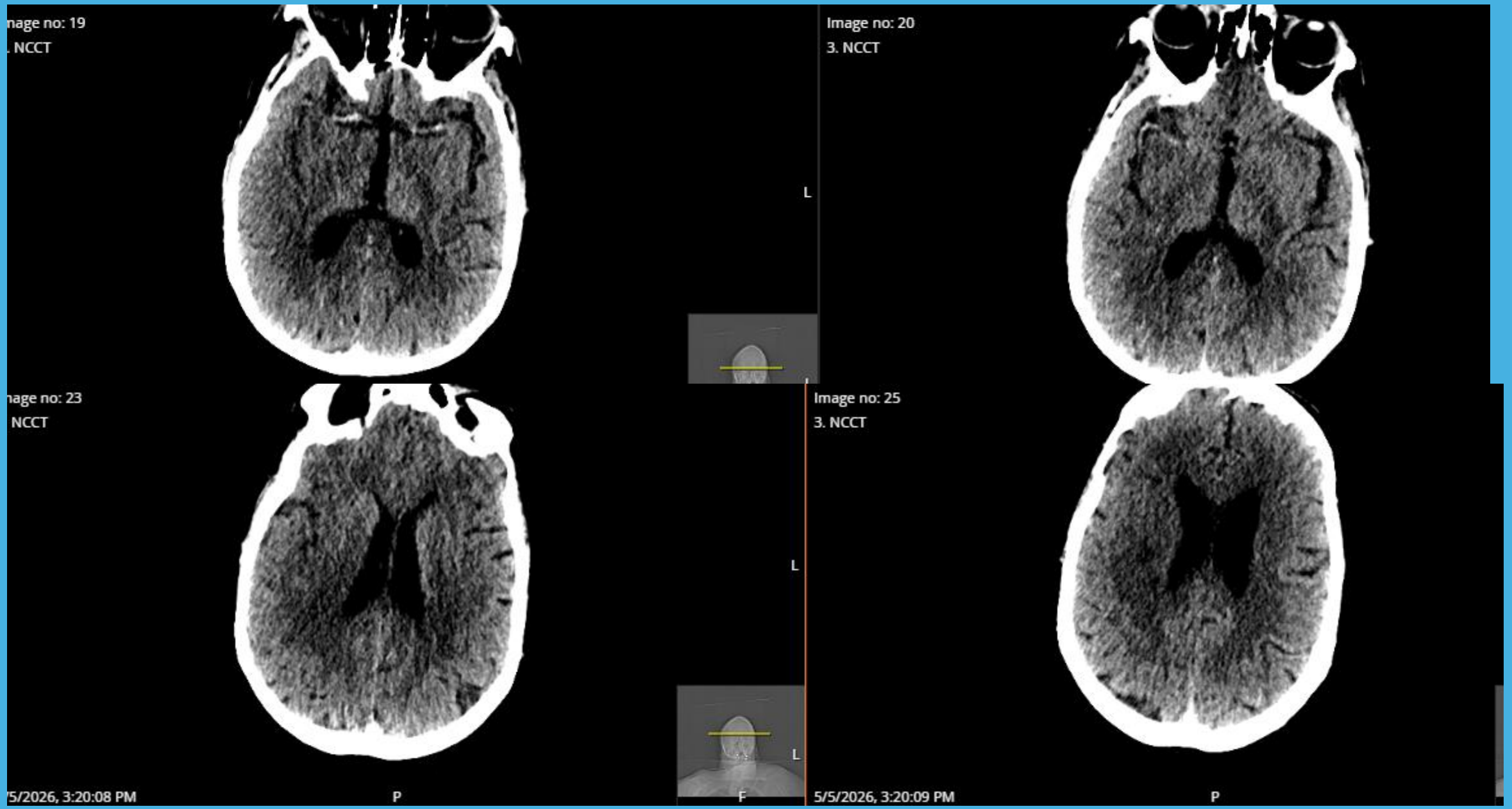
POOR COLLATERAL STATUS = LOW BRAIN PERFUSION AND LOW CONTRAST FLOW/TRANSIT

↓

SYMPTOM ONSET TO IMAGING TIME <8HRS = OVERESTIMATION OF CORE INFARCT

SYMPTOM ONSET TO IMAGING TIME >8HRS = MORE APPROPRIATE ESTIMATION OF CORE INFARCT

51 y.o. male with limited PMH, recent stroke ~2 weeks ago with left sided symptoms, who was d/c home on aspirin/plavix, reported to have 100% occluded right ICA from recent admission who presents from home to ED via LifeFlight directly from field for Right MCA syndrome.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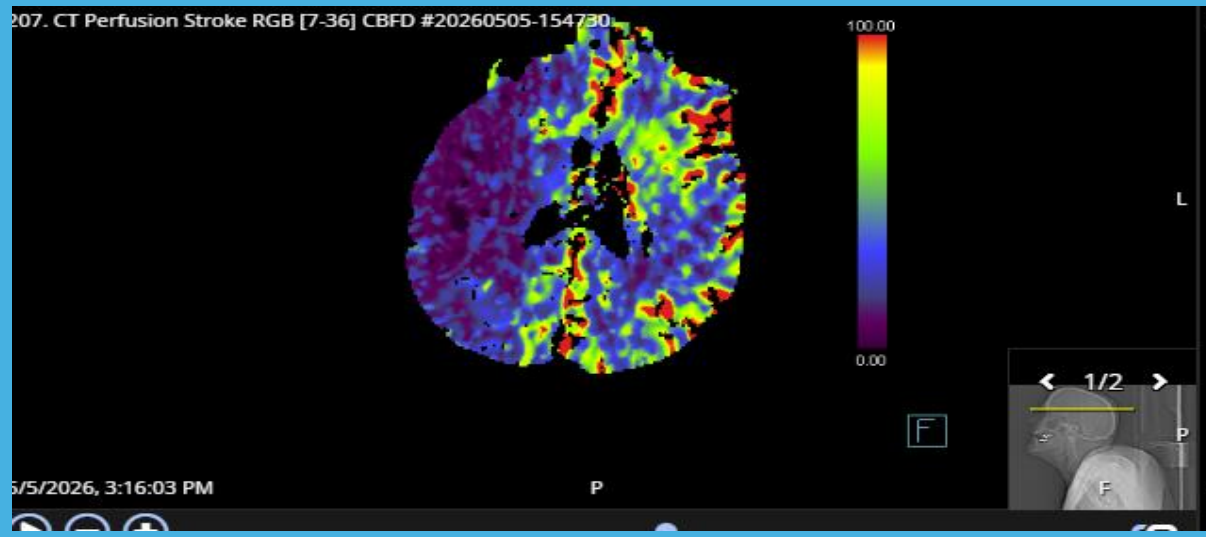
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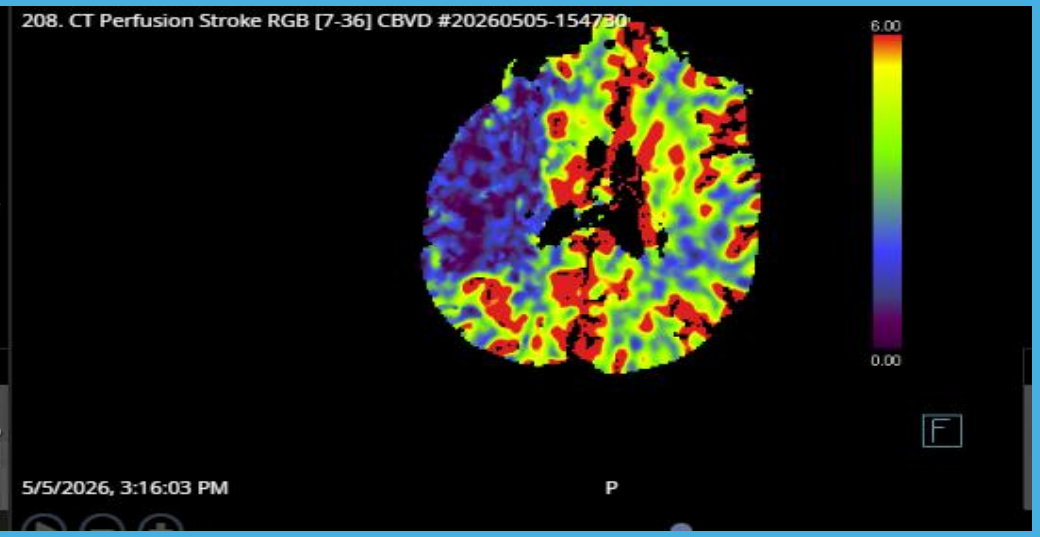
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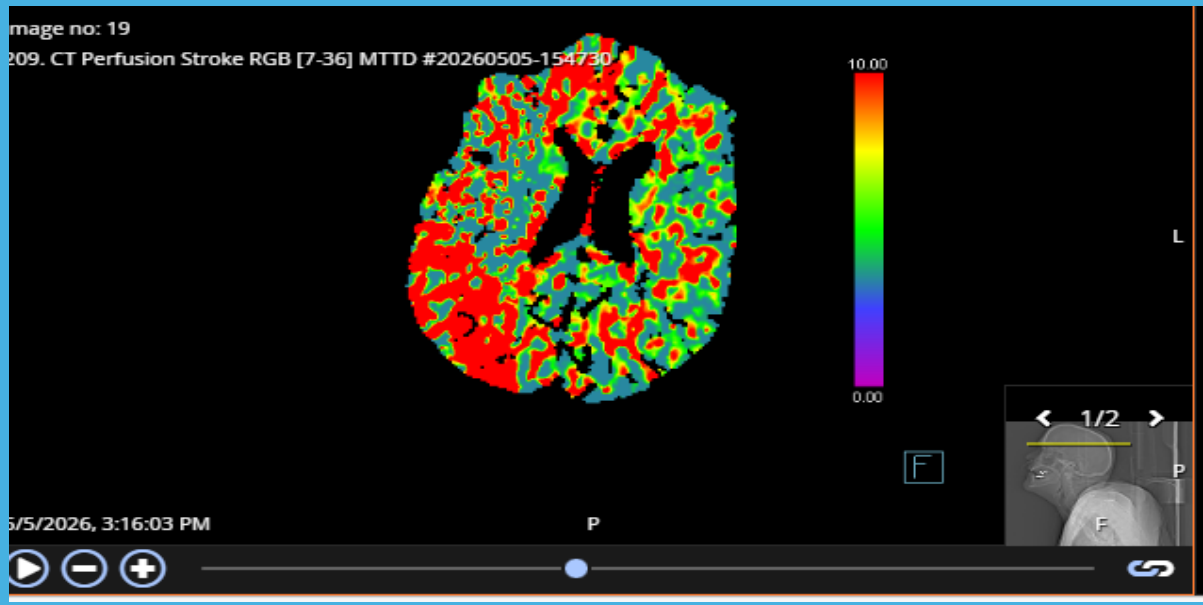
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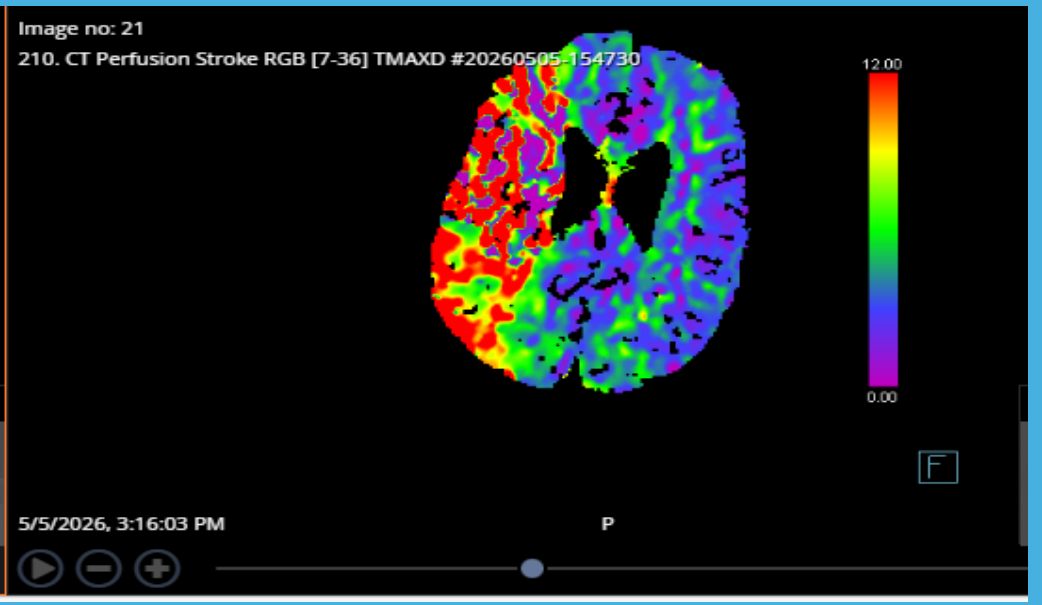
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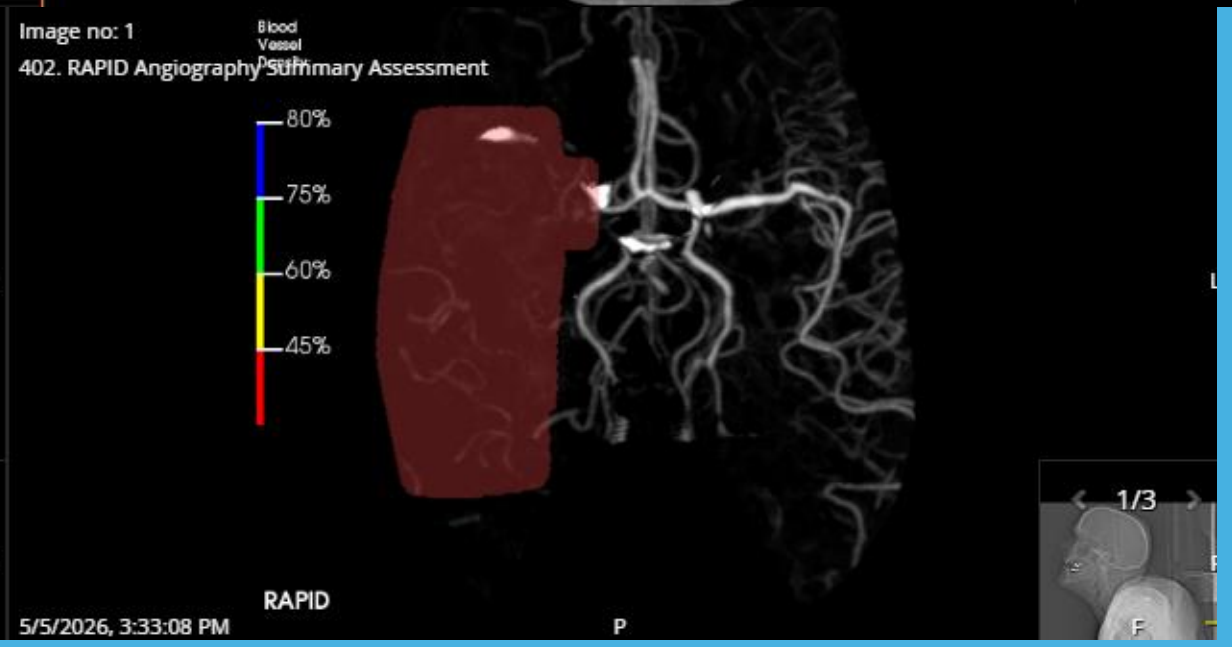
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402. RAPID Angiography Summary Assessment
Blood Vessel Density
80%
75%
60%
45%
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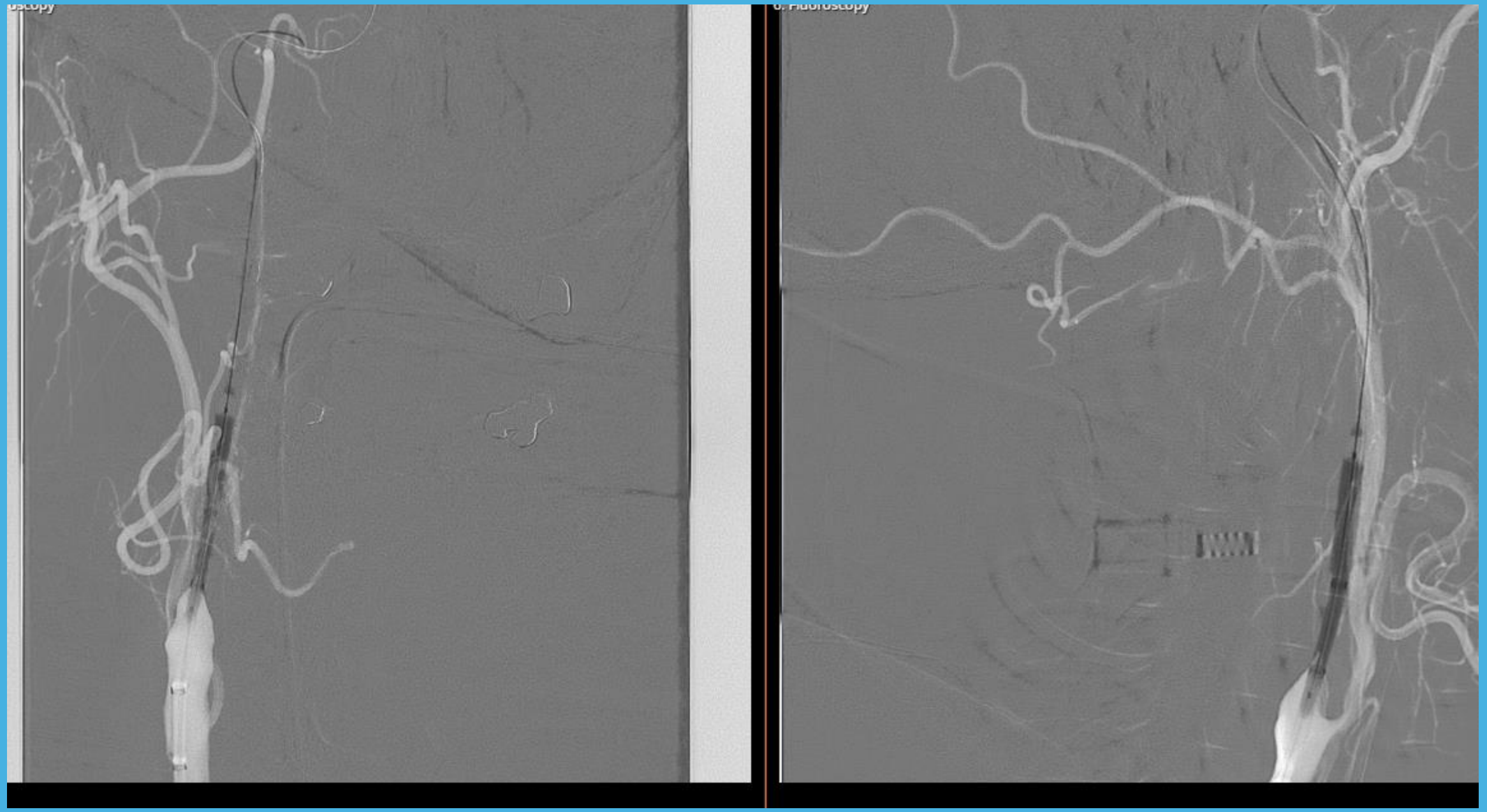
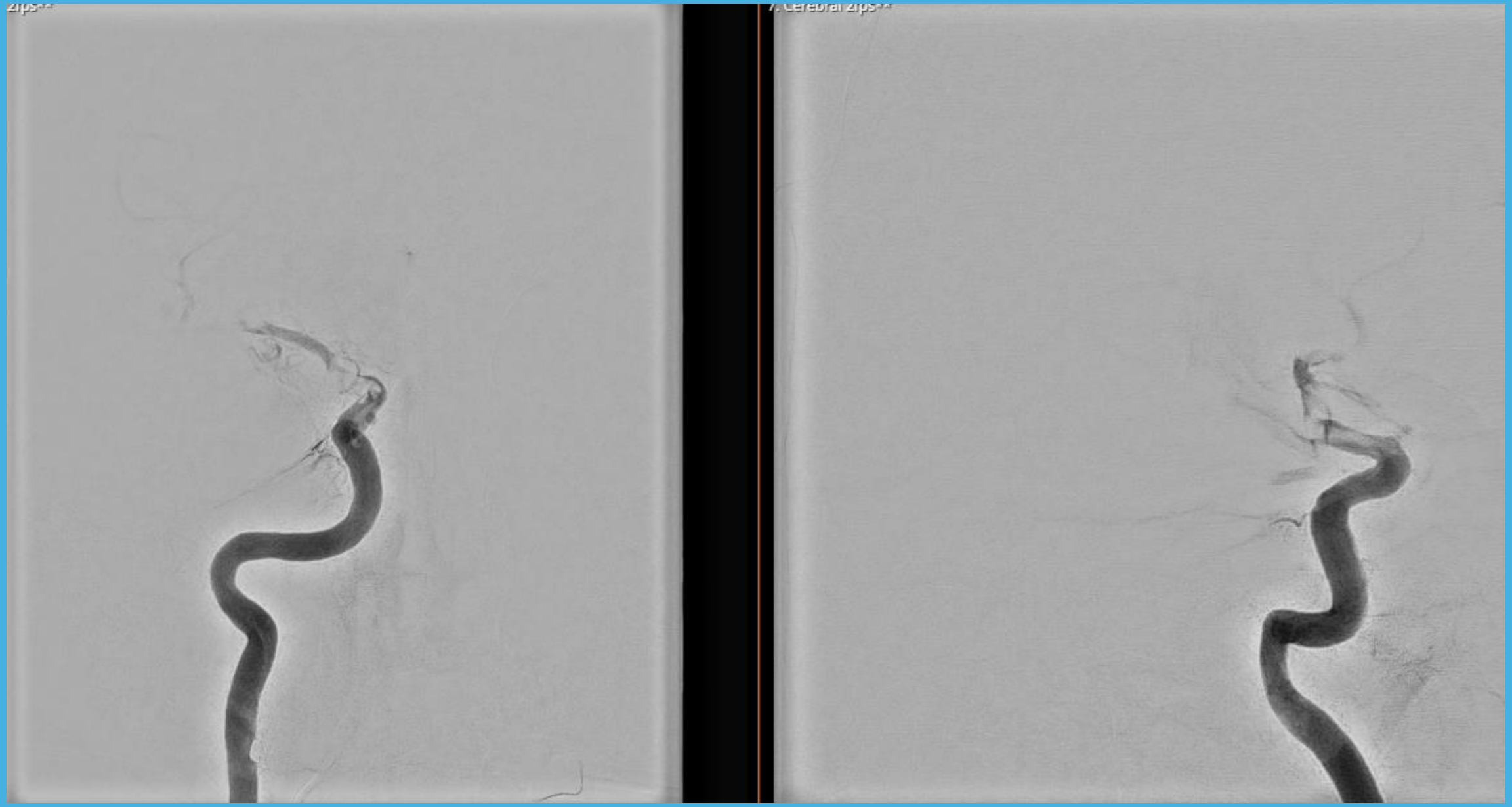
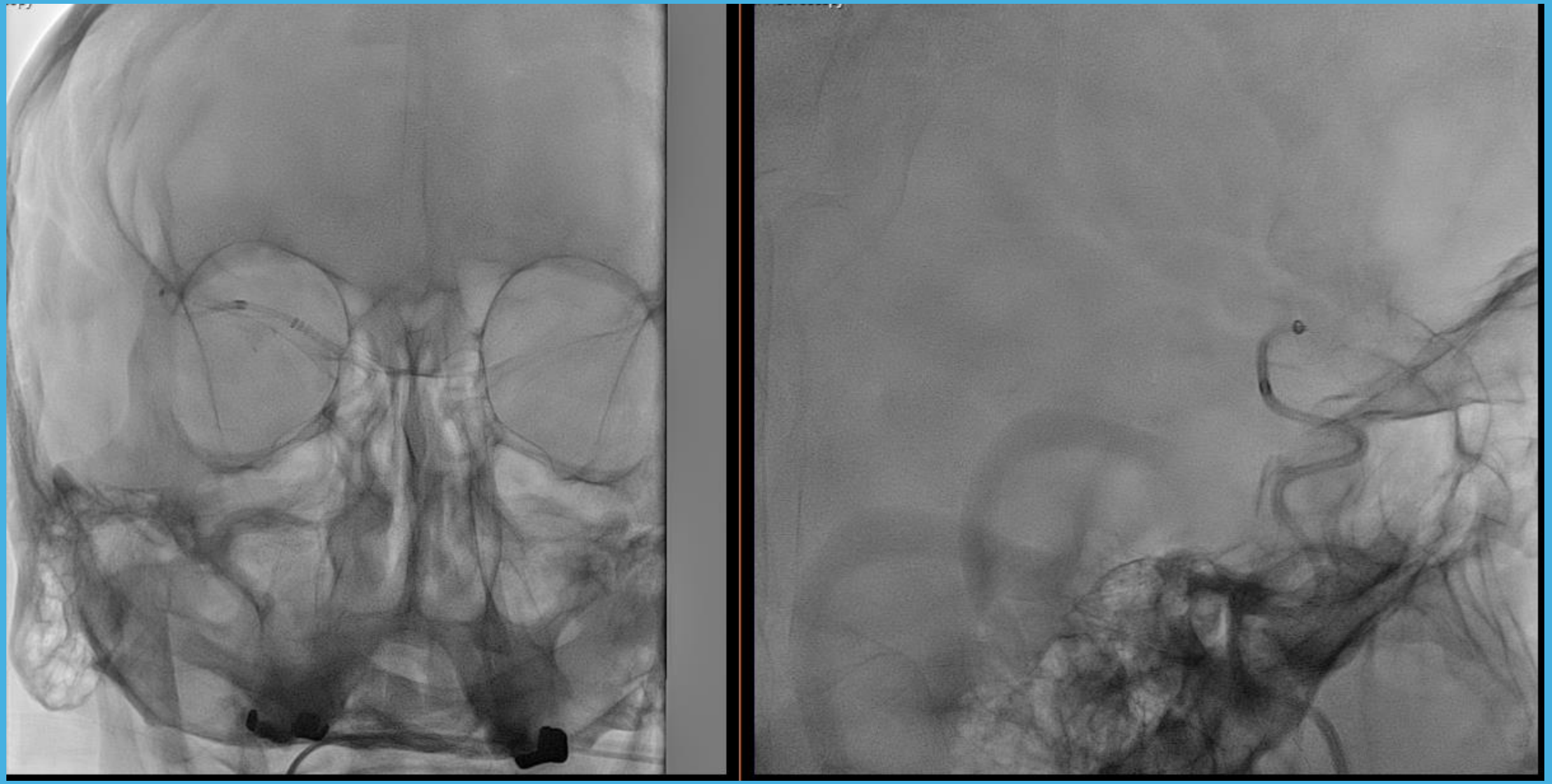
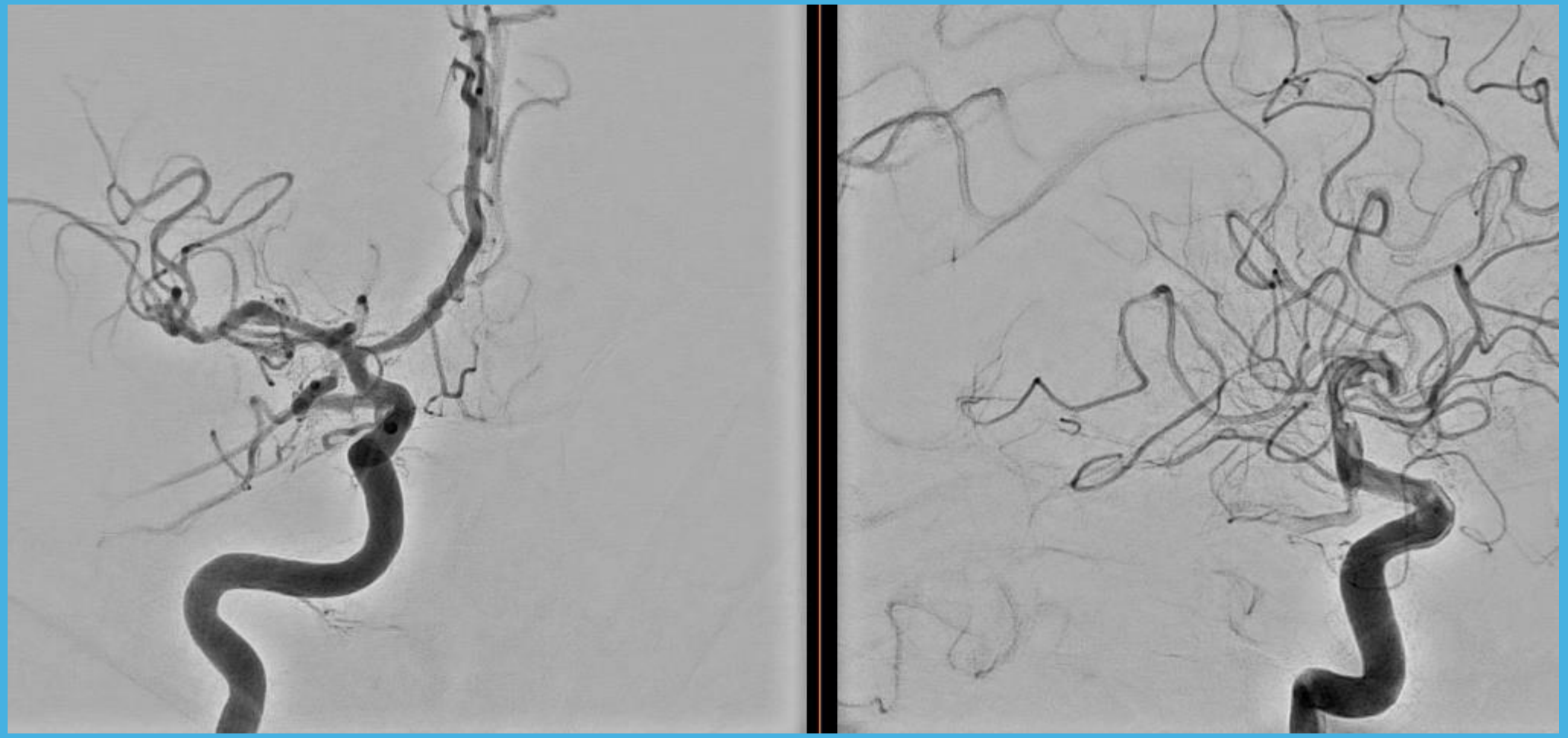
2. Cerebral 2fps**


Image no: 2 (10 of 19)
2. Cerebral 2fps**







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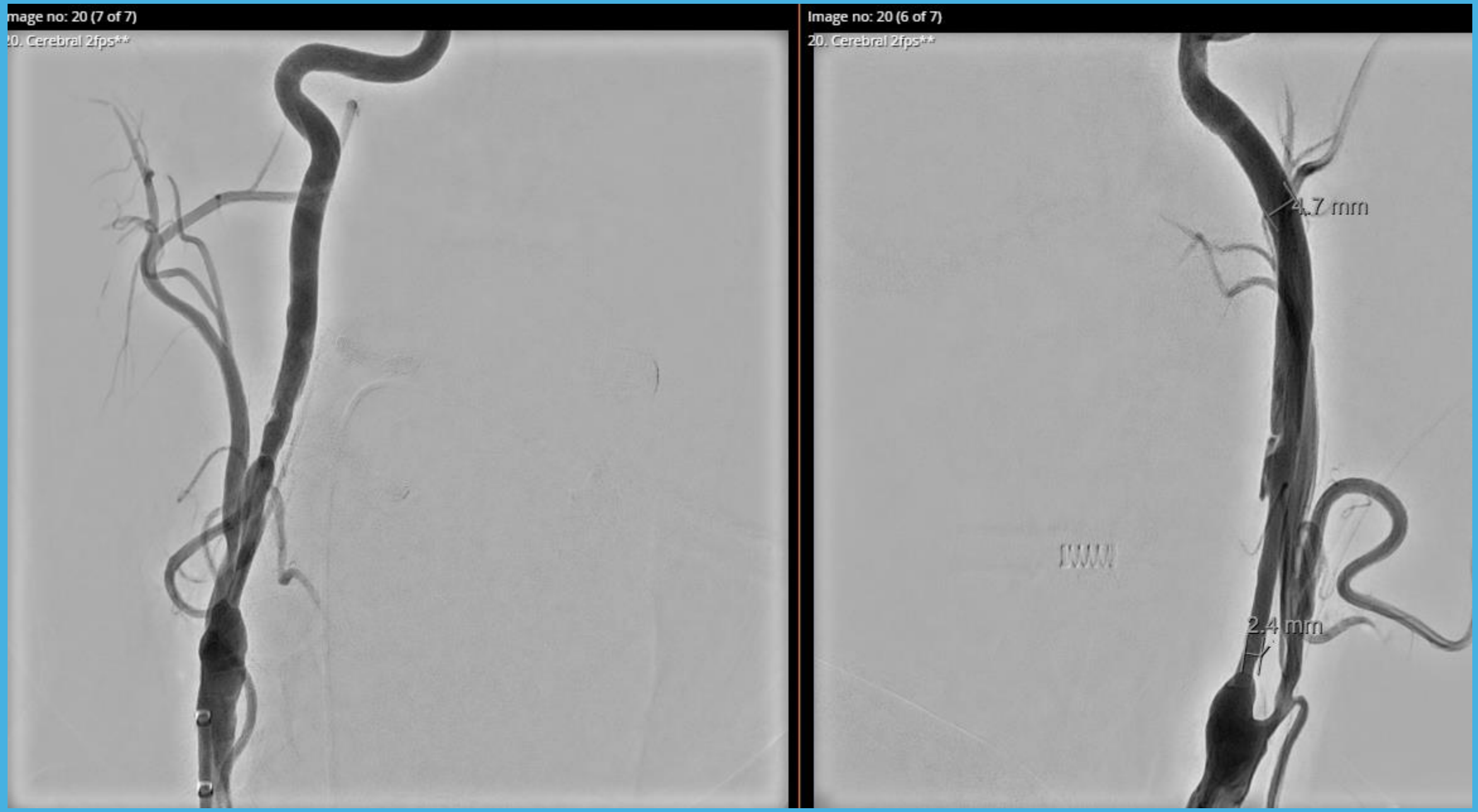
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20. Cerebral 2fps**
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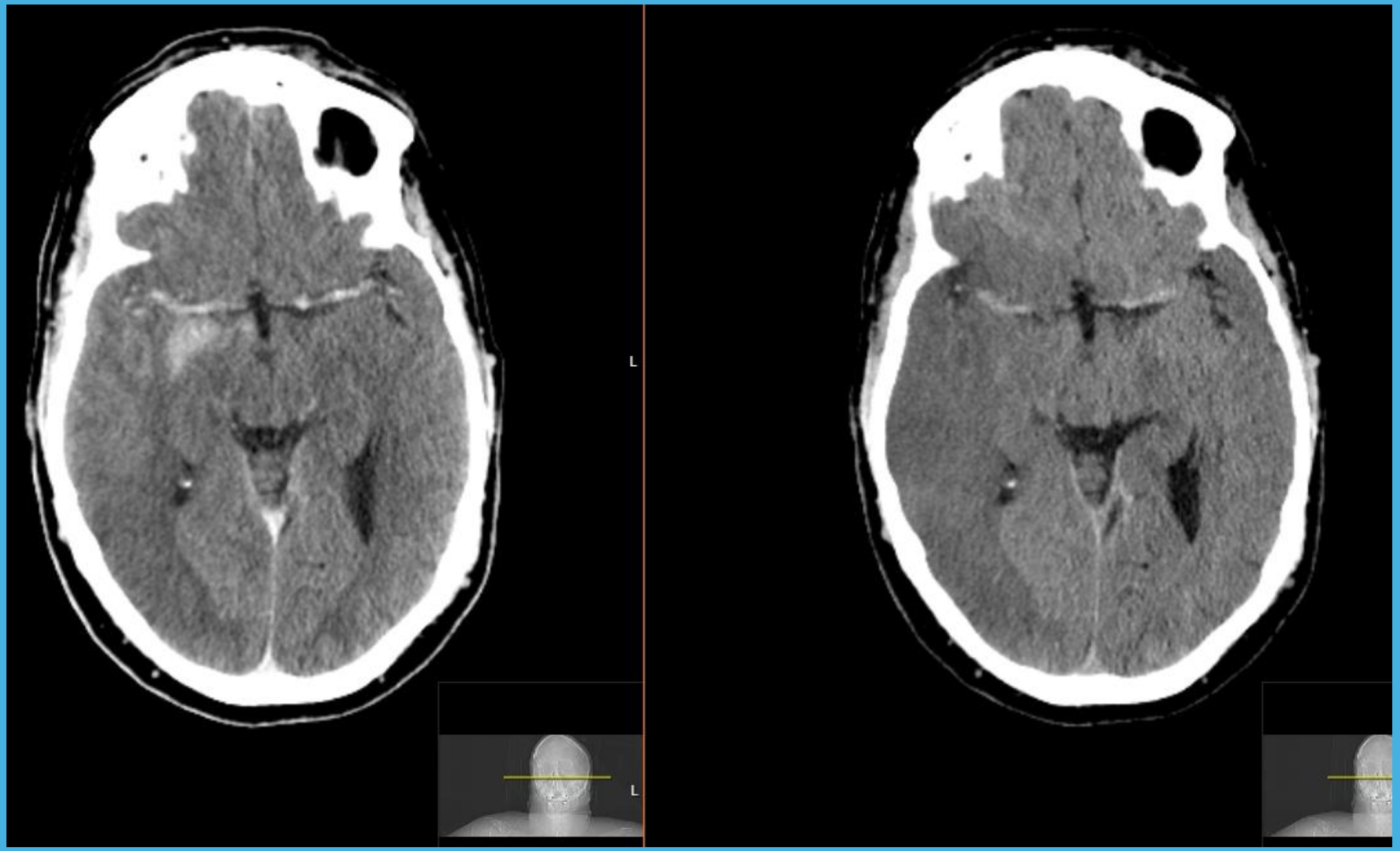
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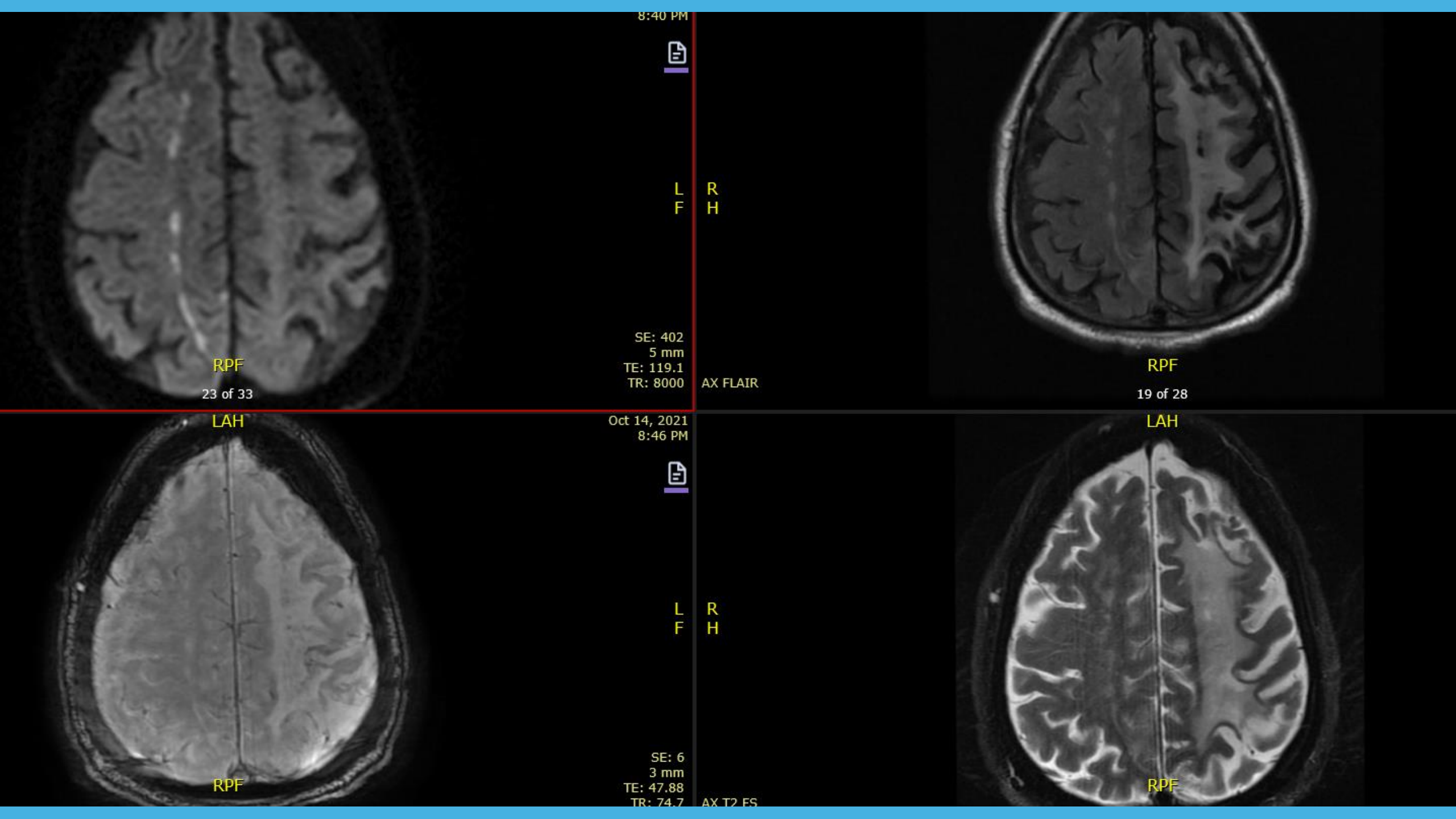
Large Artery Atherosclerosis

- Infarctions larger than 15 to 20 mm, involving the cortex, cerebellum, brainstem, and subcortical regions, are usually caused by large vessel disease arising from atherosclerosis of cervical or proximal intracranial vessels
- 30-43% of all strokes
- The mechanism of infarction secondary to atherosclerosis of the extracranial vasculature is a combination of low-flow states and artery-to-artery emboli, with the latter thought to be the greater contributing factor

64 y.o. male with PMH of LICA (MCA/ACA territories) CVA, recent right SAH, right posterior cingulate gyrus and L cerebellar subacute infarction, significant intracranial stenoses, IDDM, HTN, HLD, Hypothyroid, Psoriasis/psoriatic arthritis on Humira who presented from rehab for AMS/inability to follow commands after an episode of hypotension. CODE STROKE activated. Initial NIHSS 18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AX FLAIR
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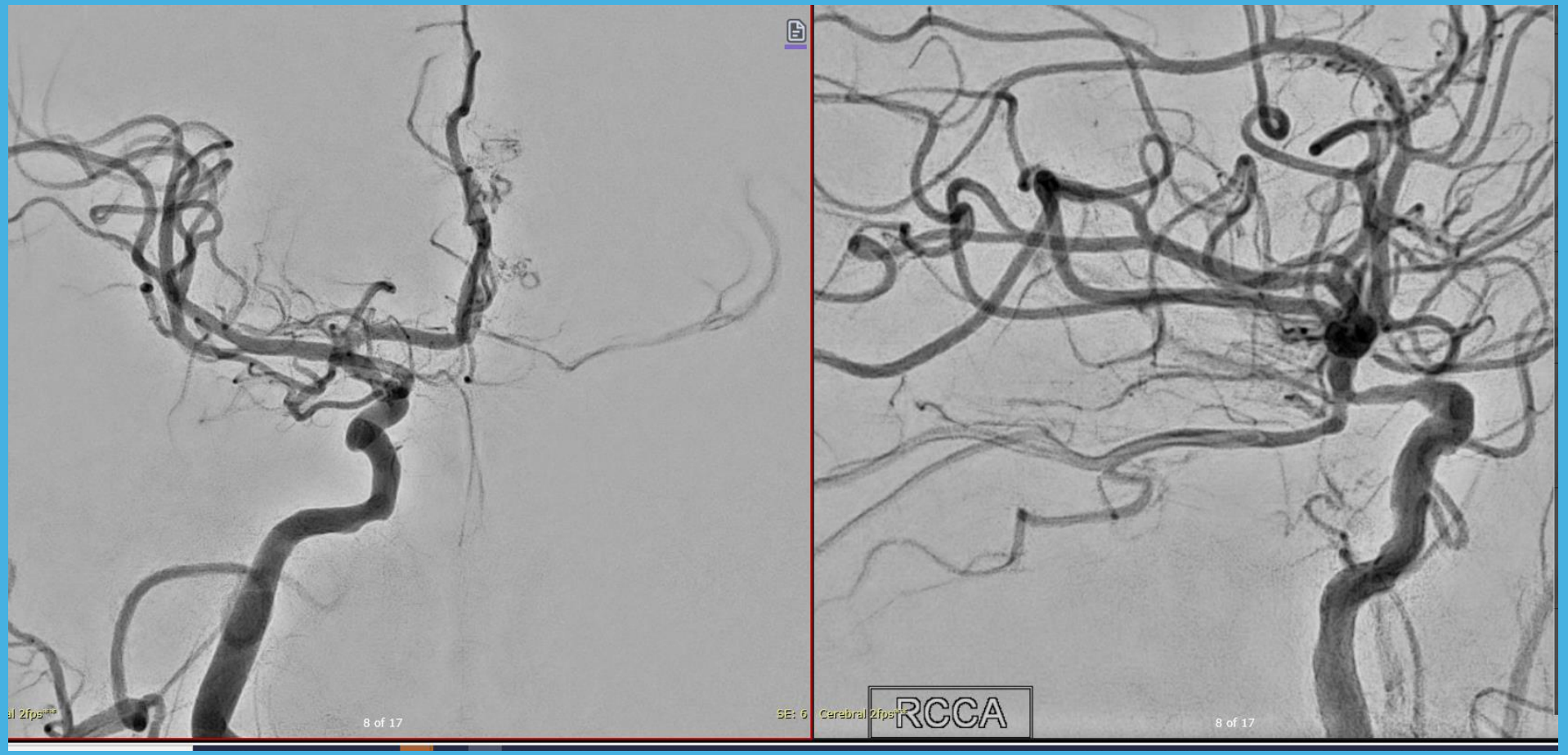
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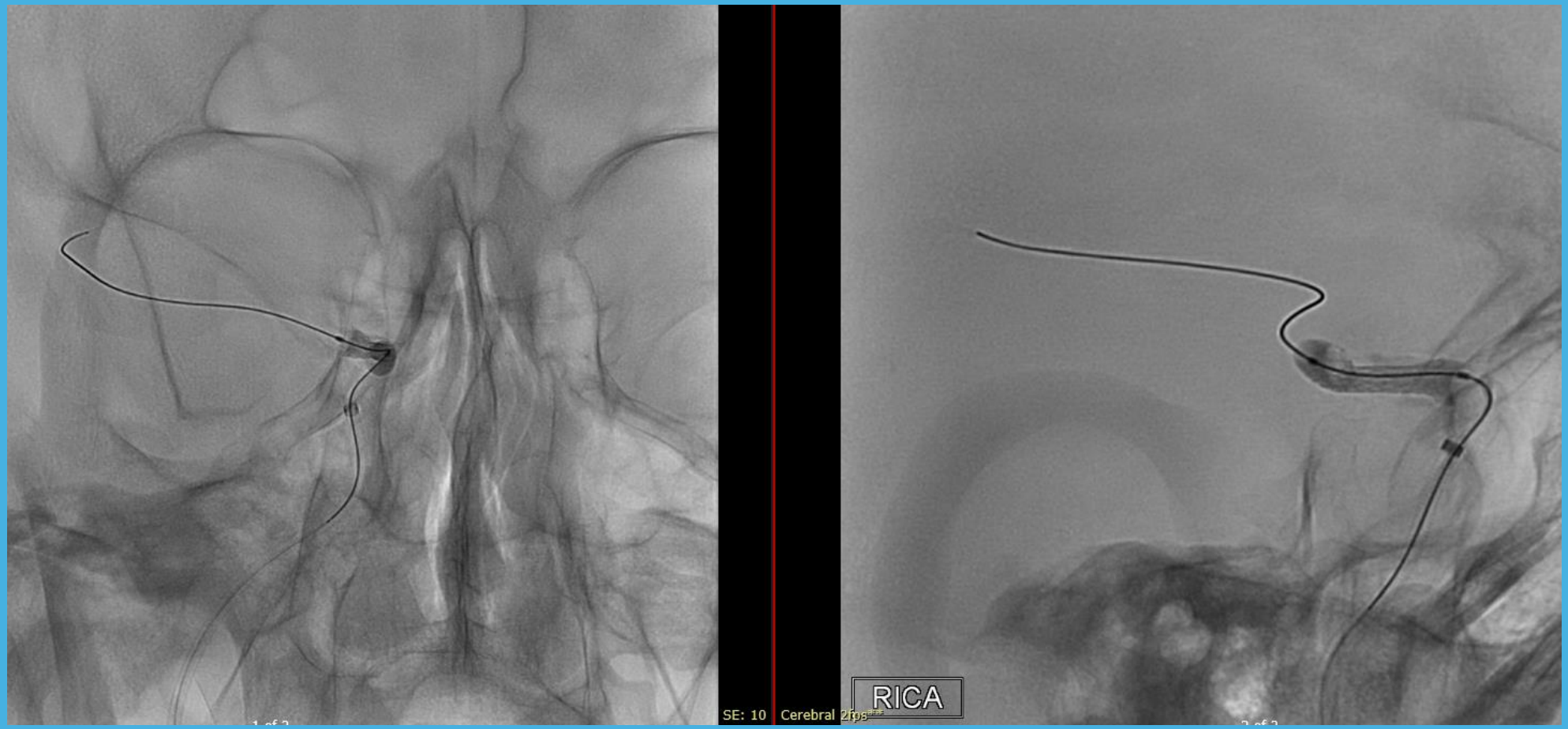
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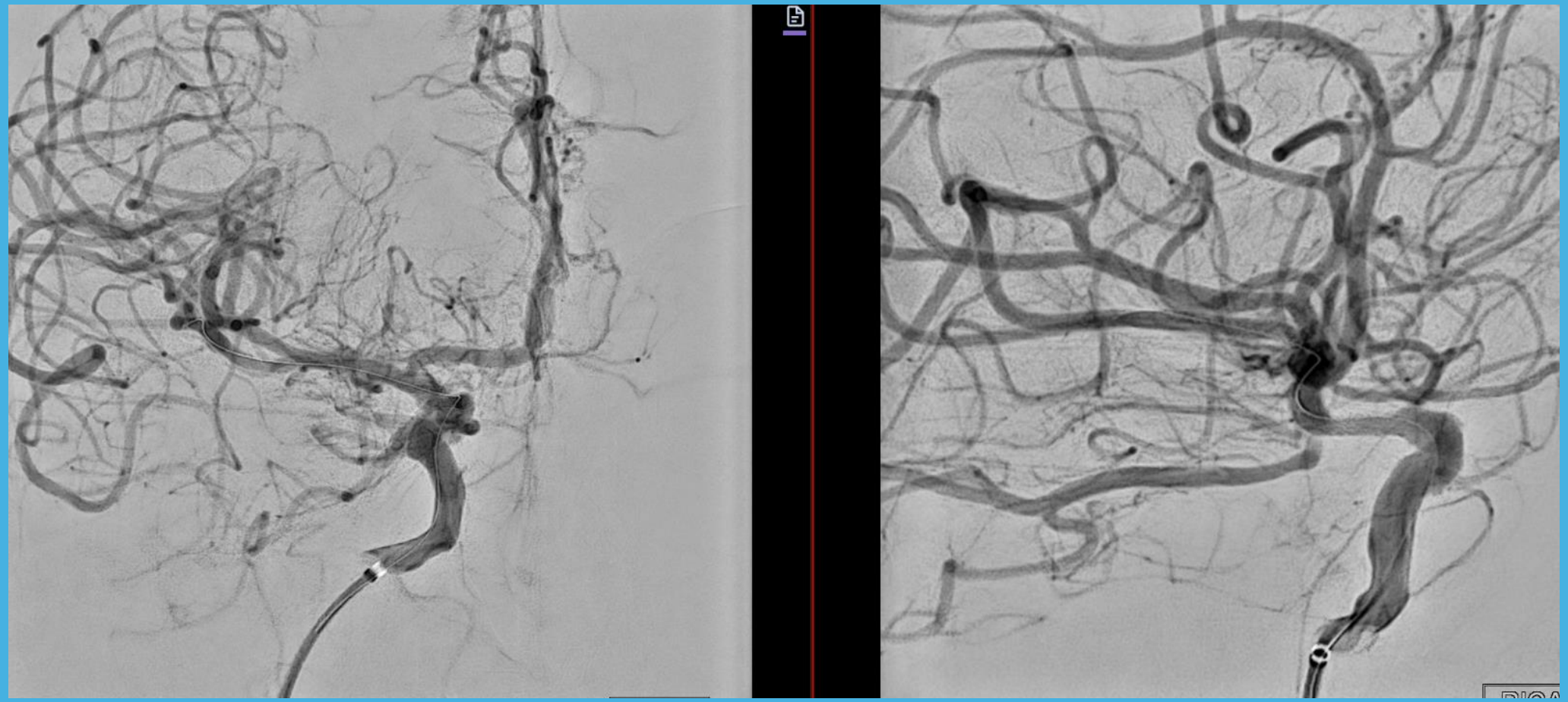
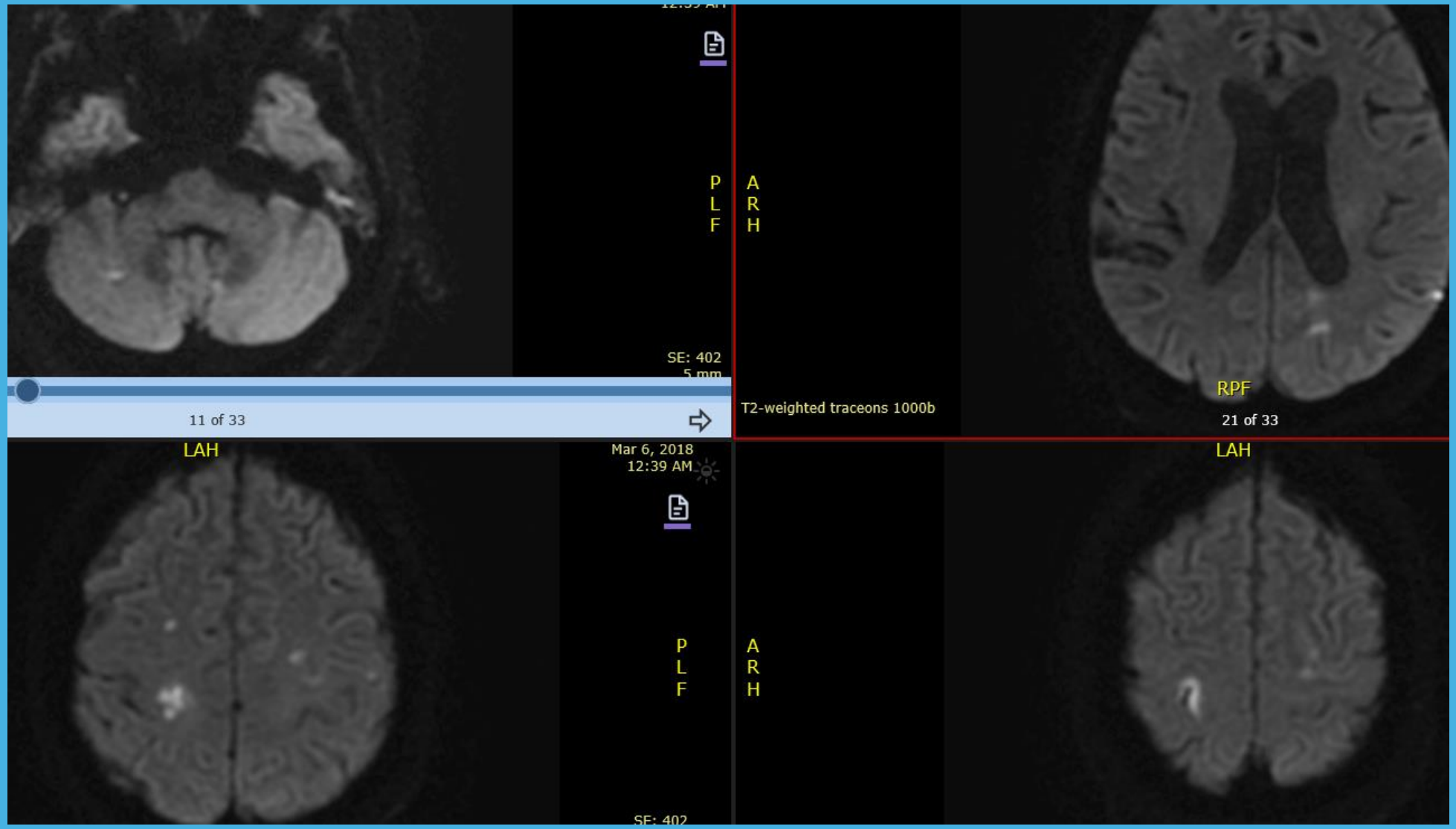
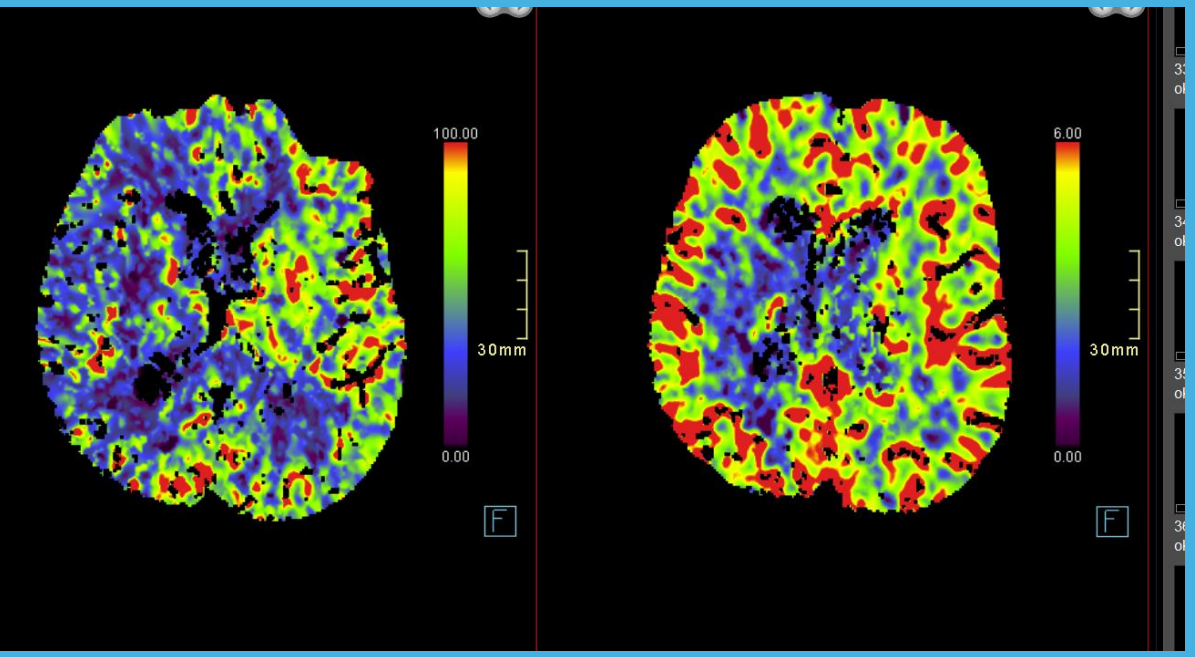


Cardioembolic infarcts



- Found to have endocarditis with vegetations

- 67 y.o.female with past medical history HTN, HLD, Obesity, OSA, DMII, and a prior right subclavian to carotid graft who presented outside hospital with new onset with L sided weakness and speech difficulties. Her NIH on arrival to outside hospital was 8.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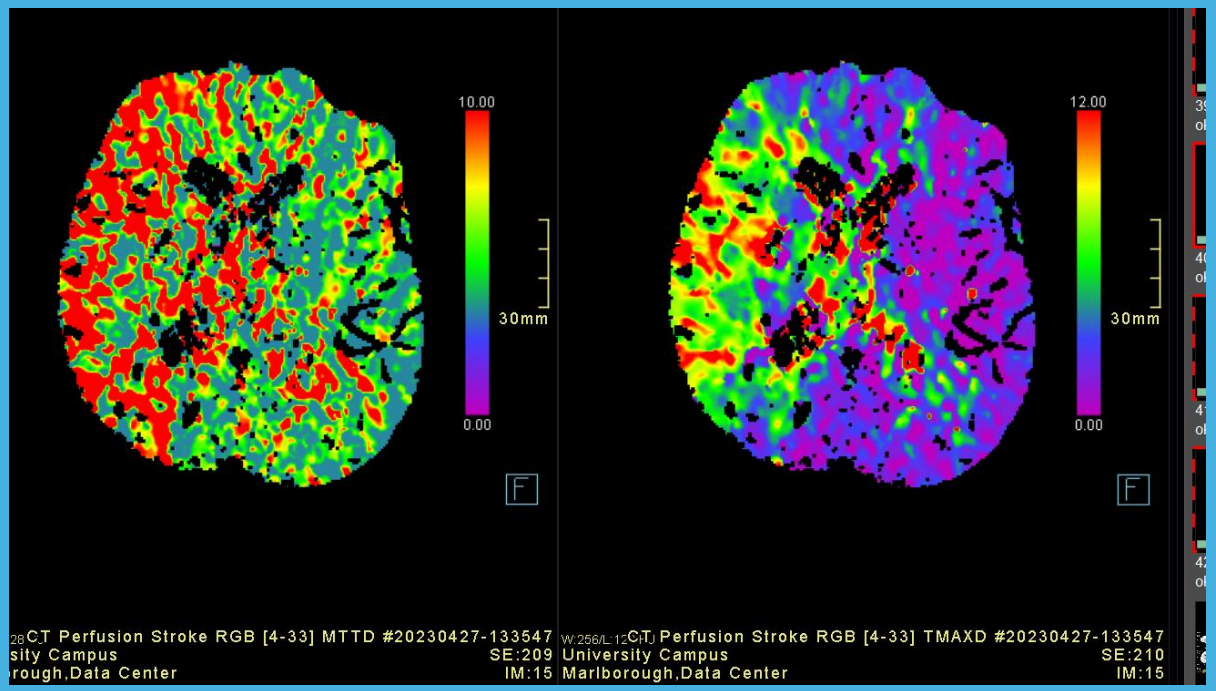
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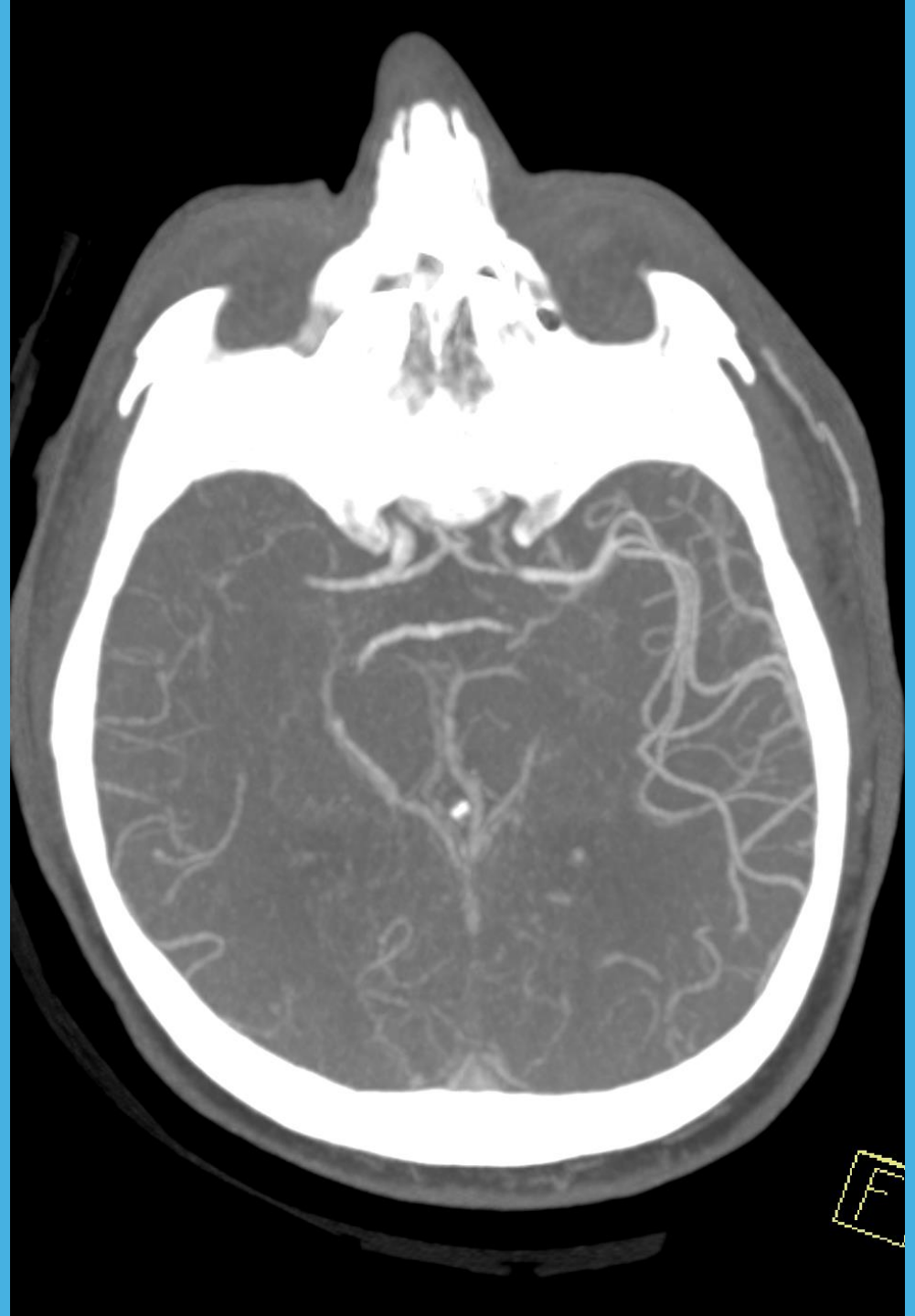

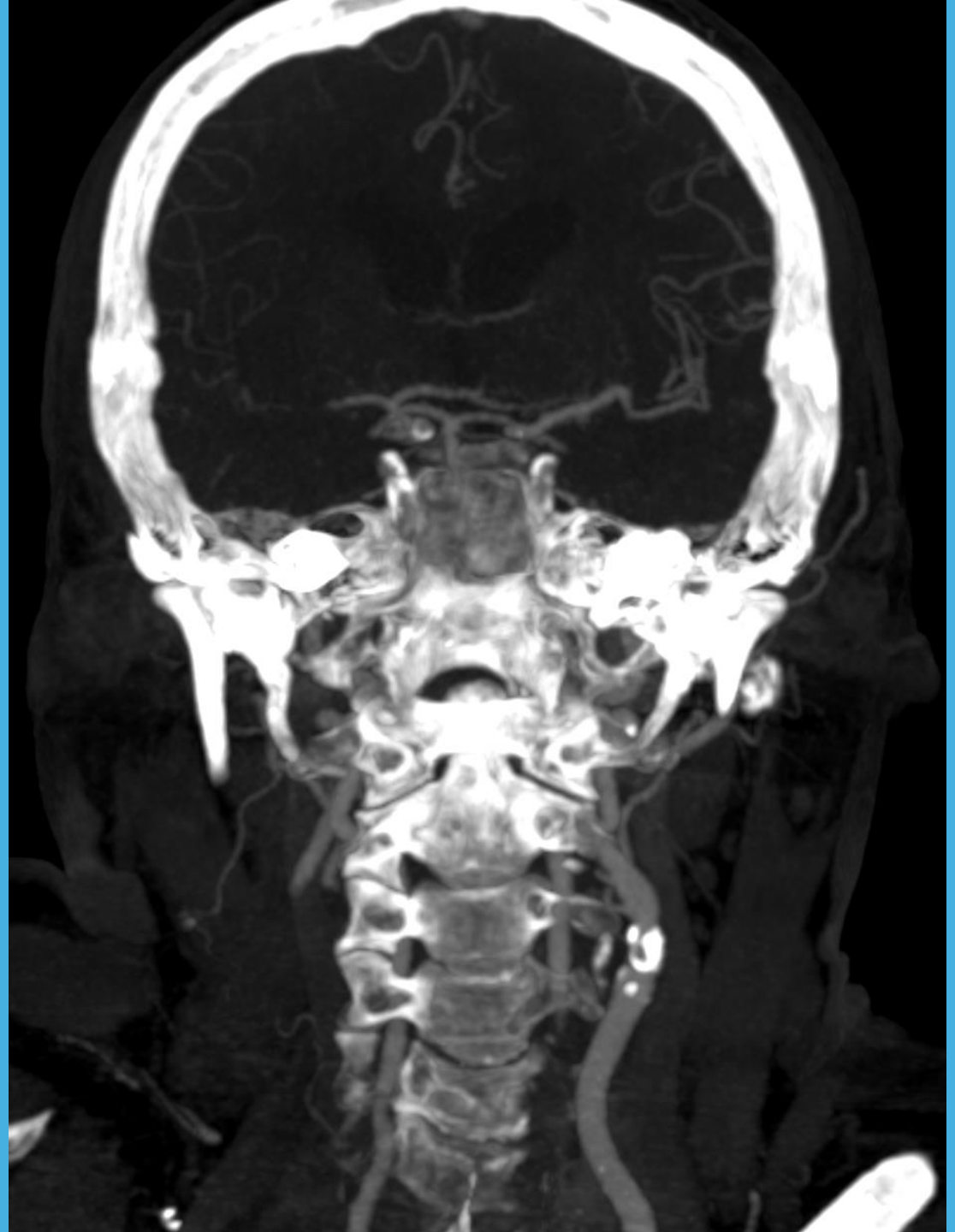

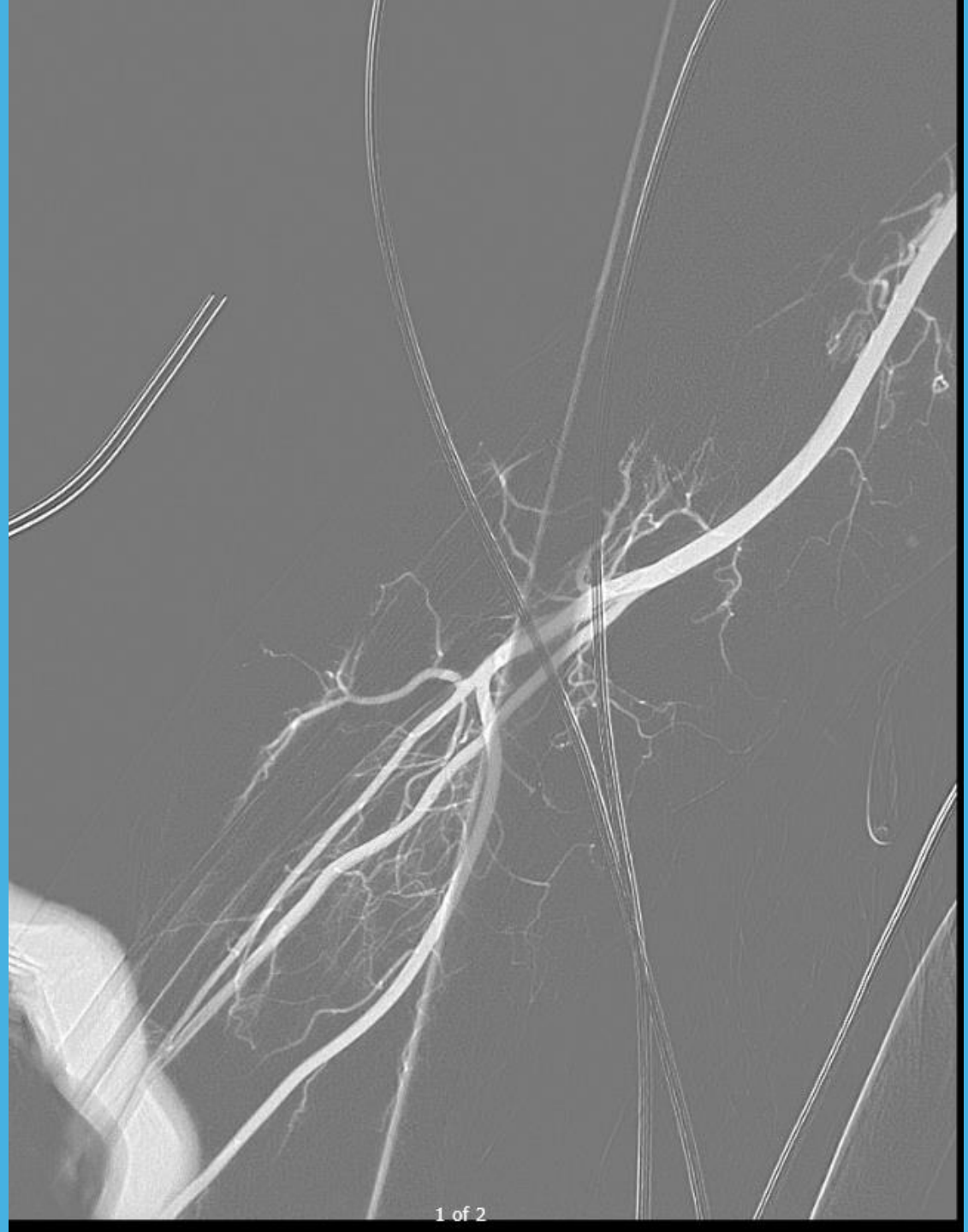
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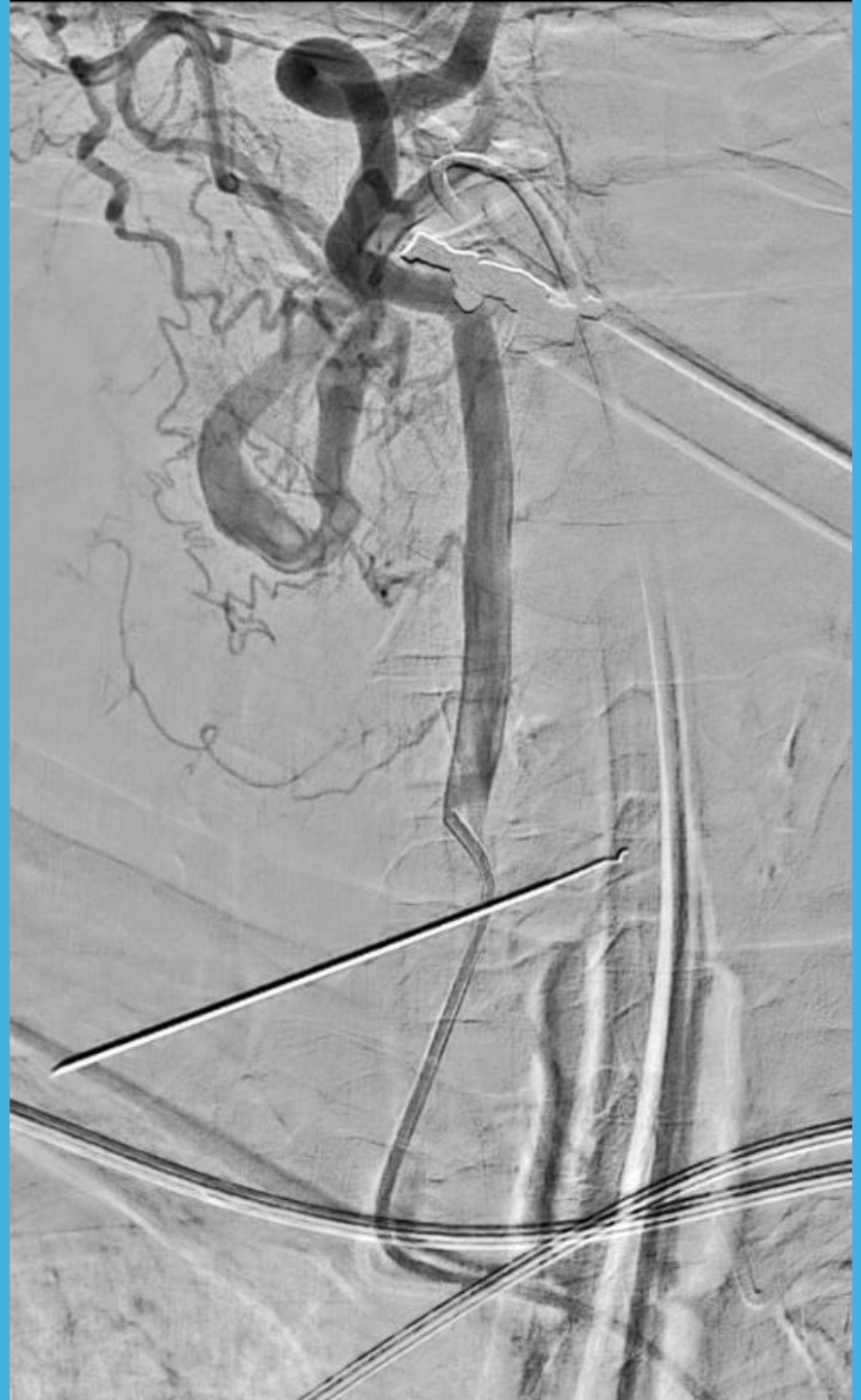

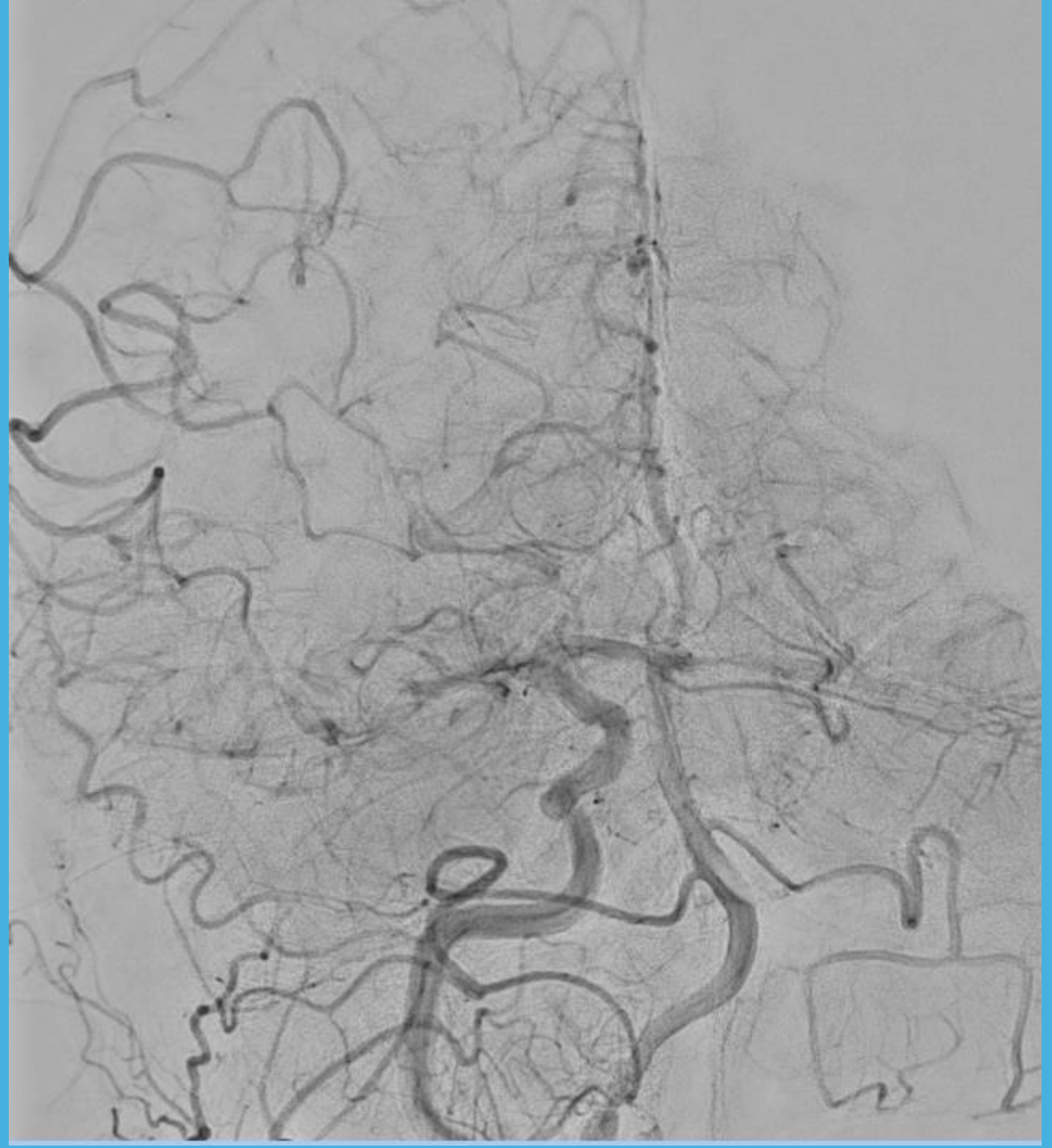

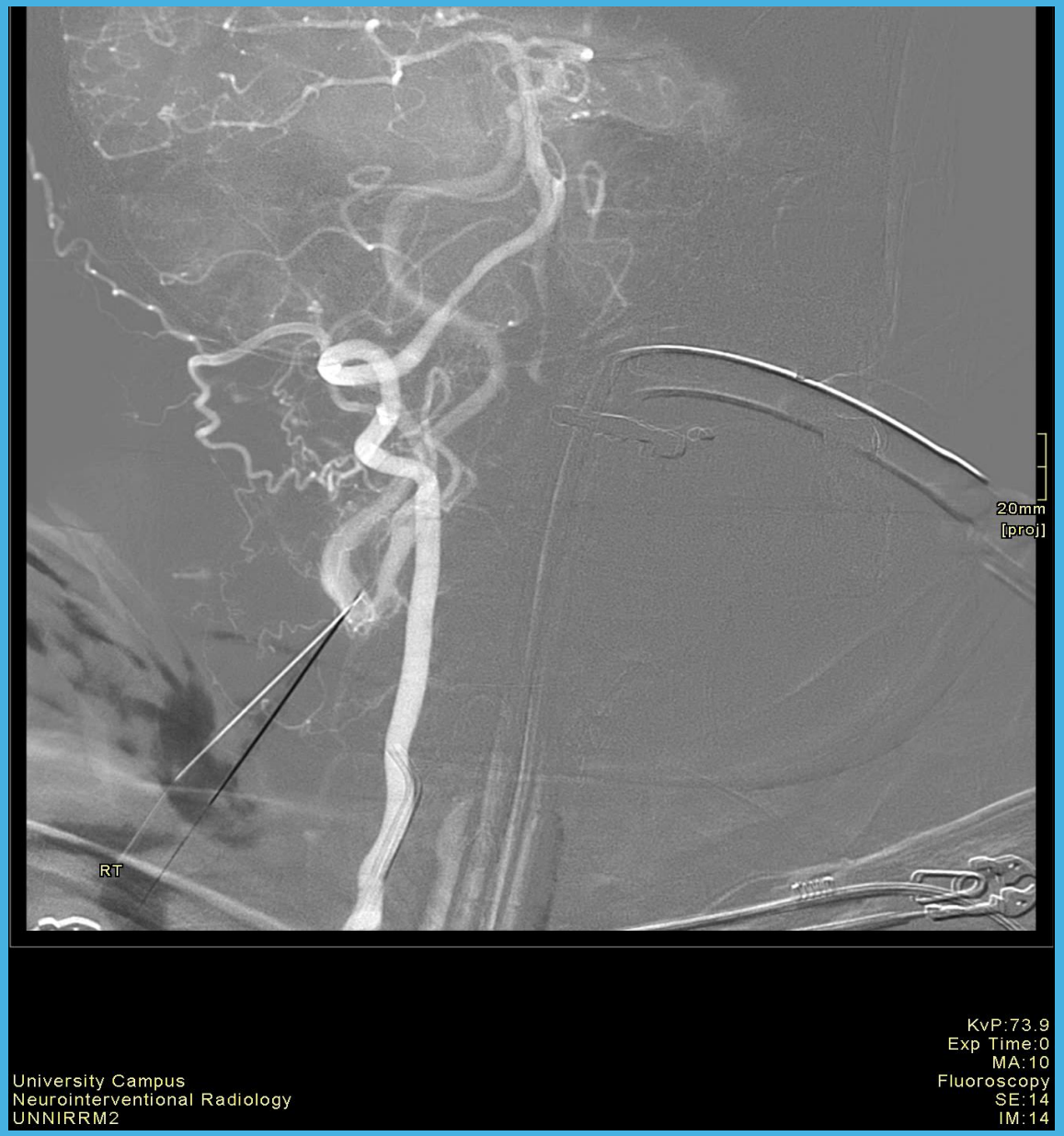
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Neurointerventional Radiology
UNNIRRM2
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Fluoroscopy
SE:14
IM:14


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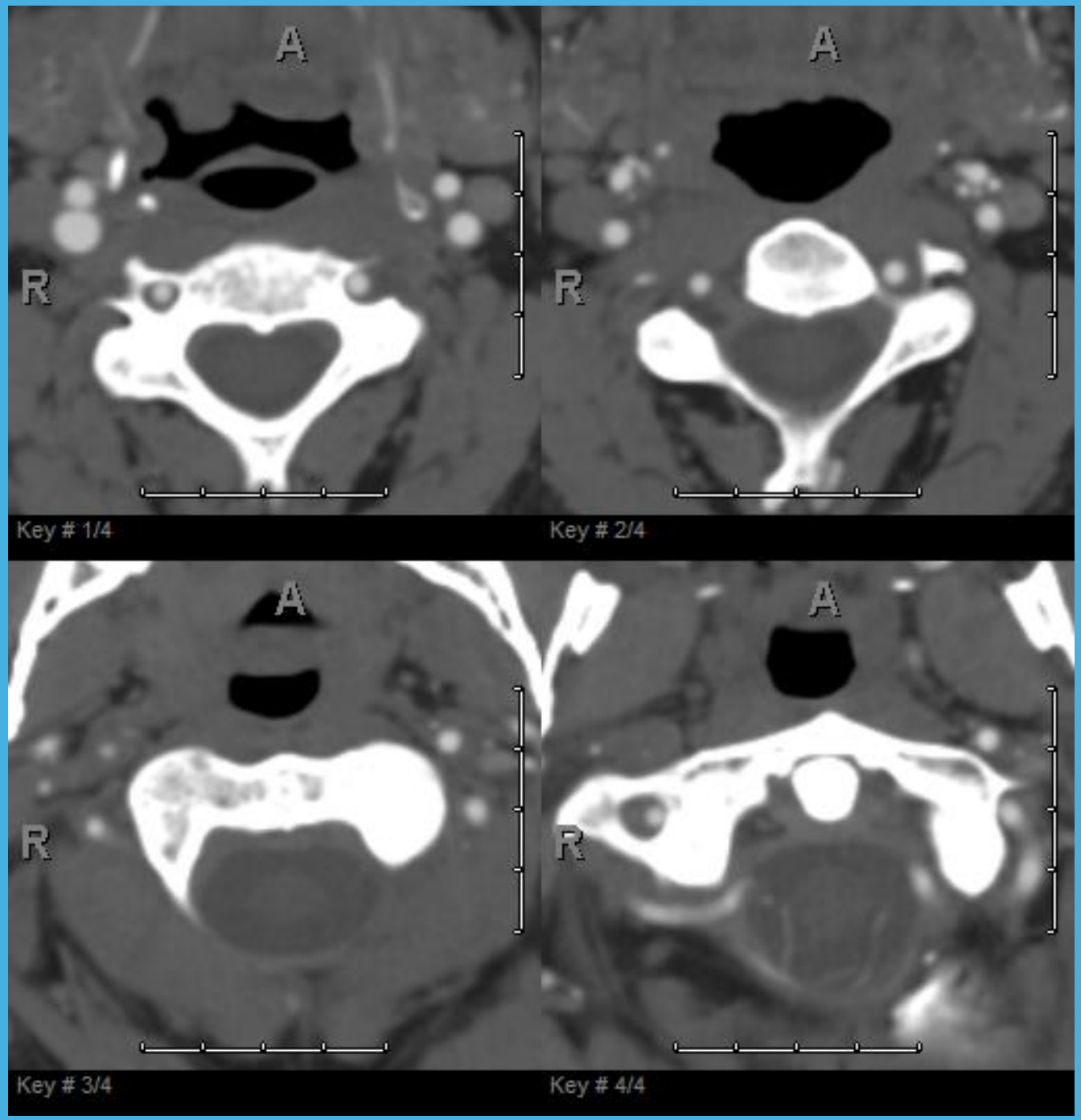
RICA


A
©TANeck Art ©

- 49 y old; right sided headache with radiation to neck for a week.
- Acute onset left hemiplegia
- NIHHS stroke scale 35. Airlifted to Wake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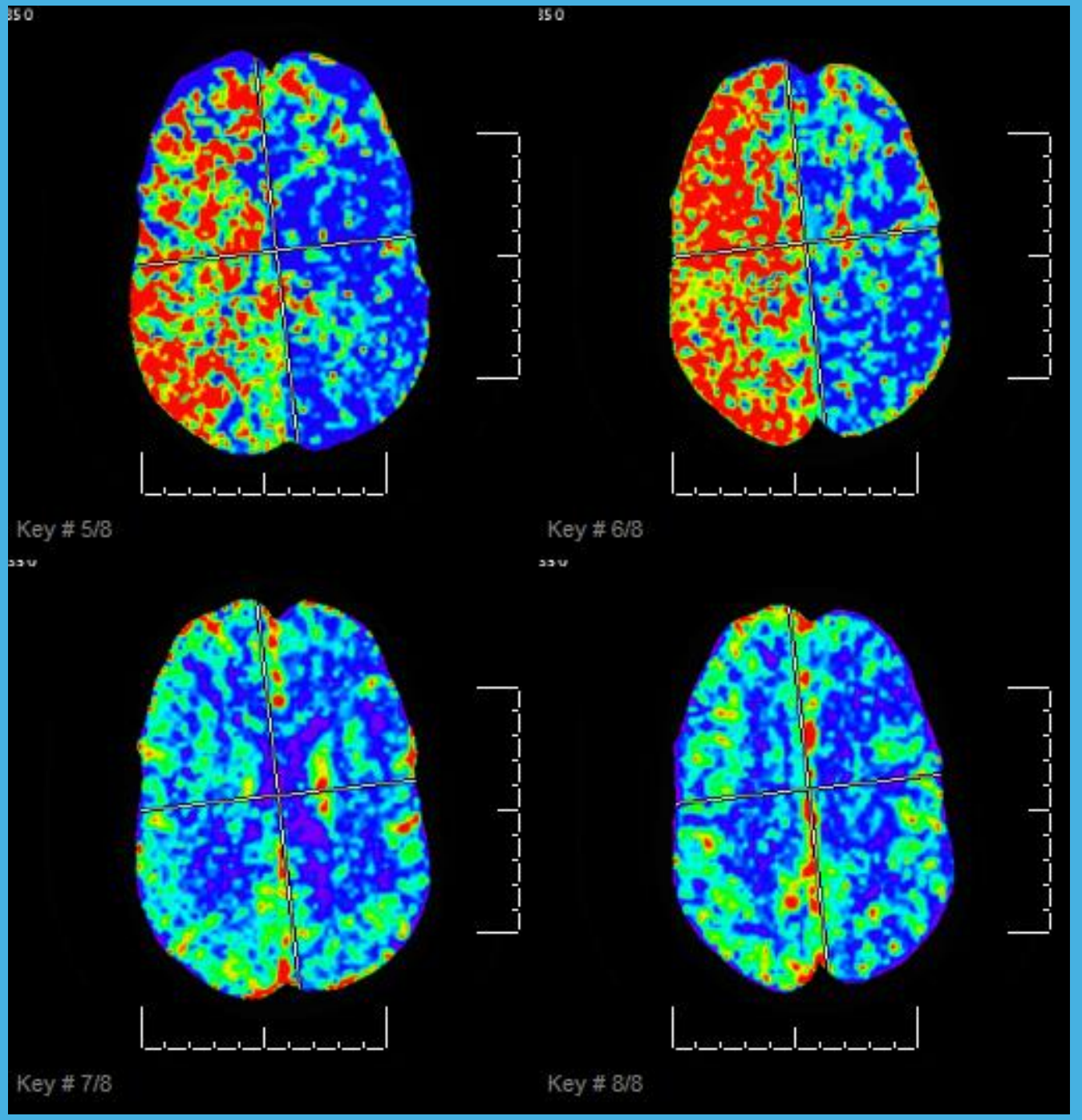
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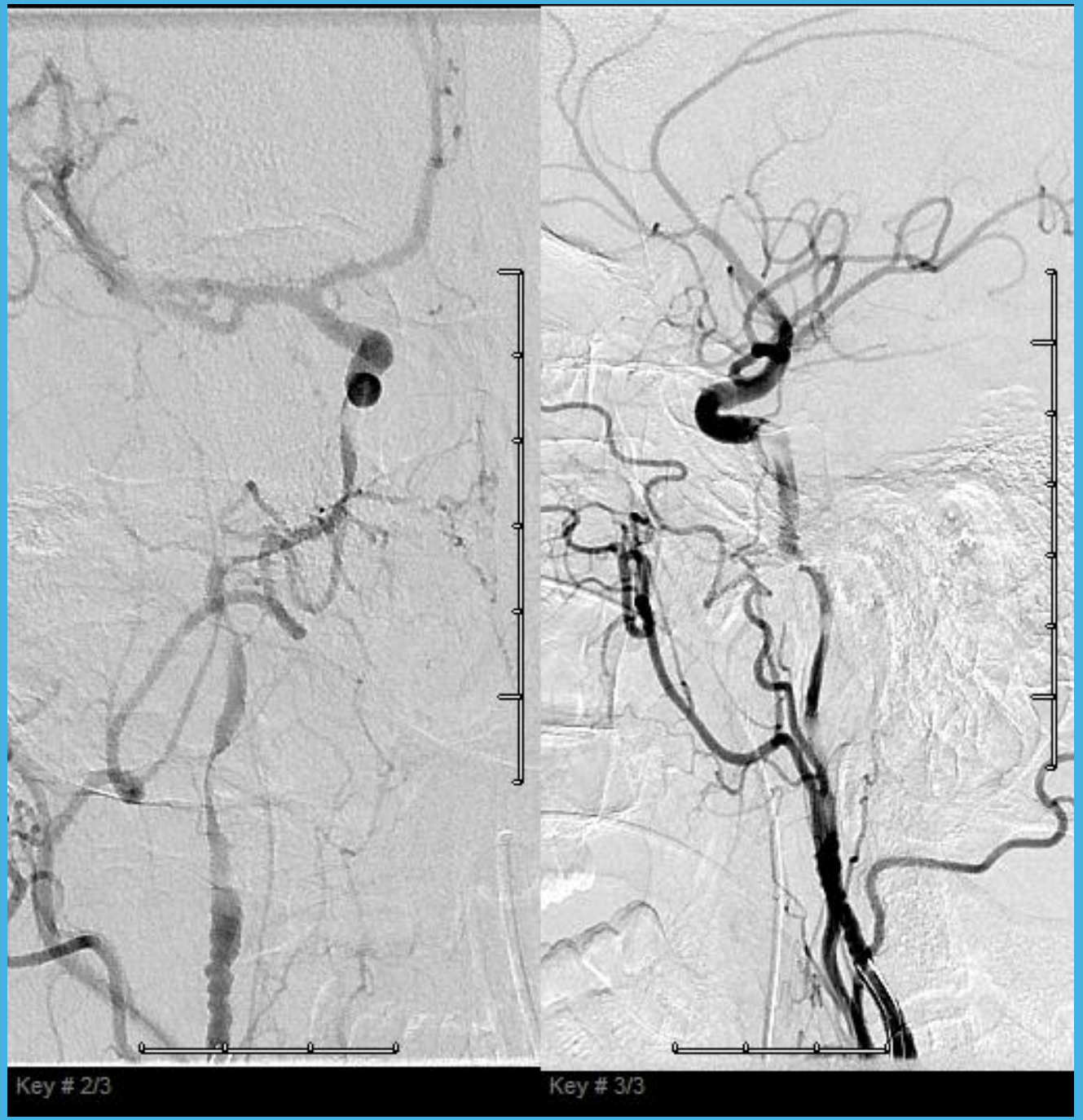
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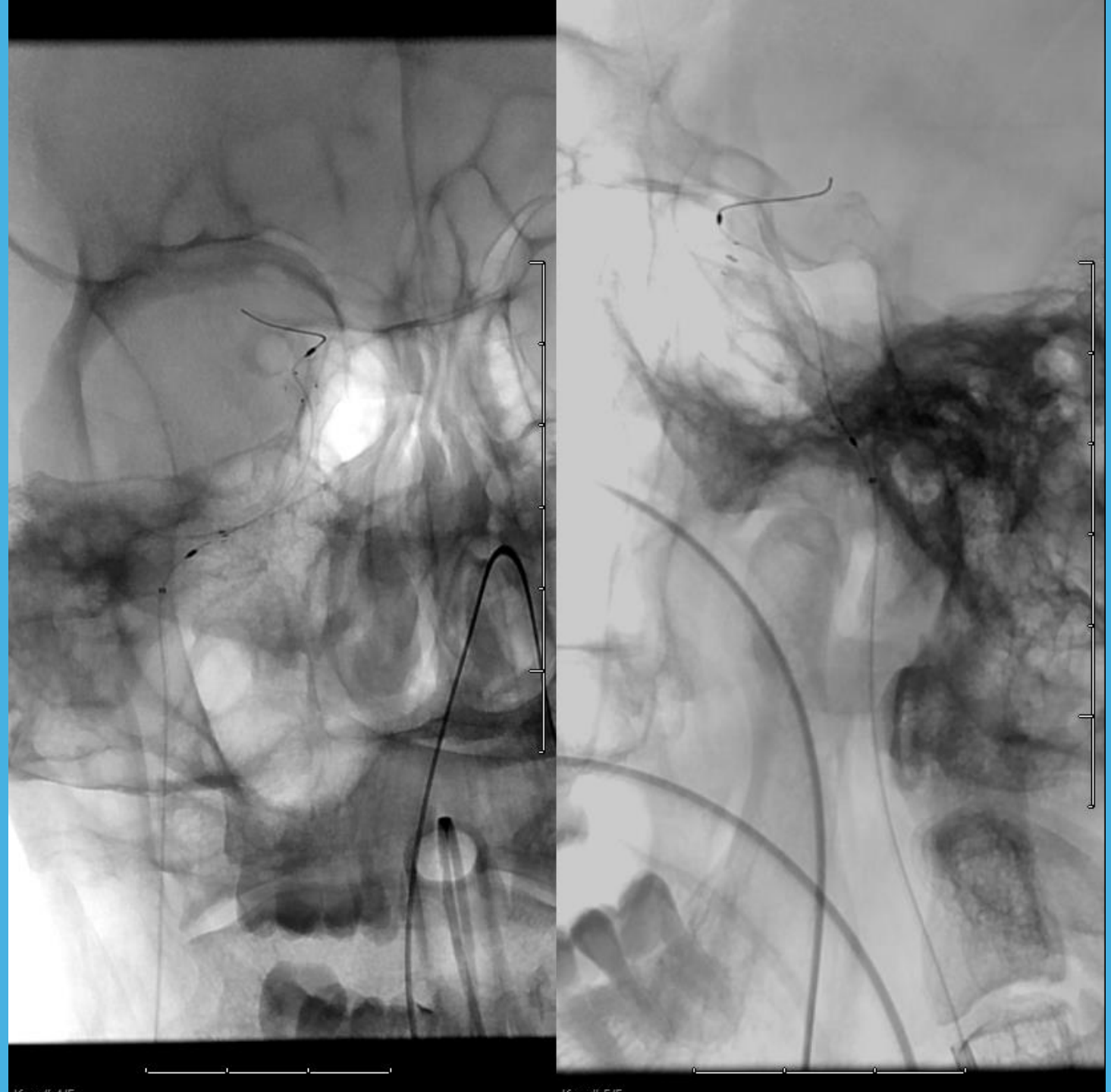

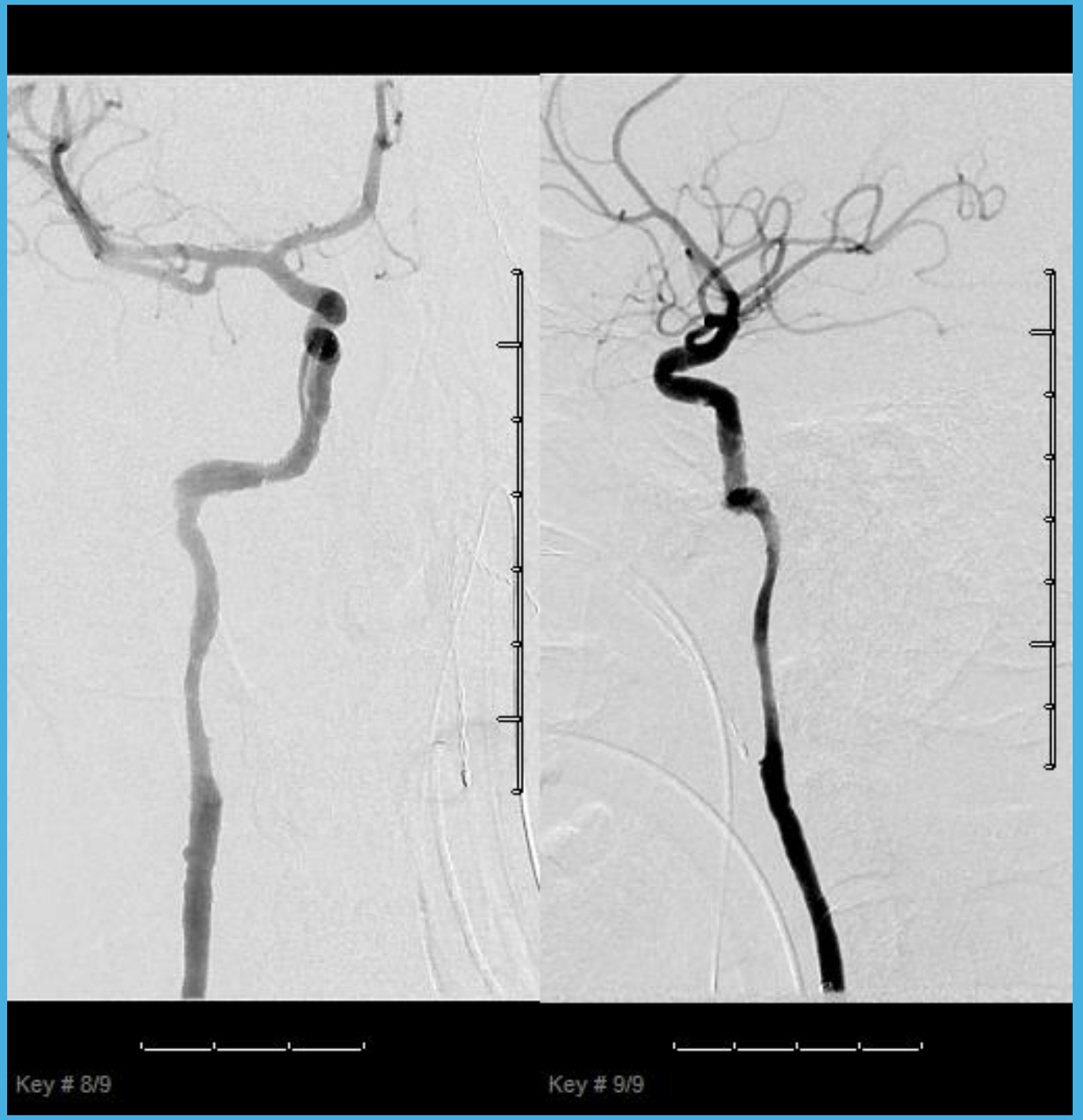
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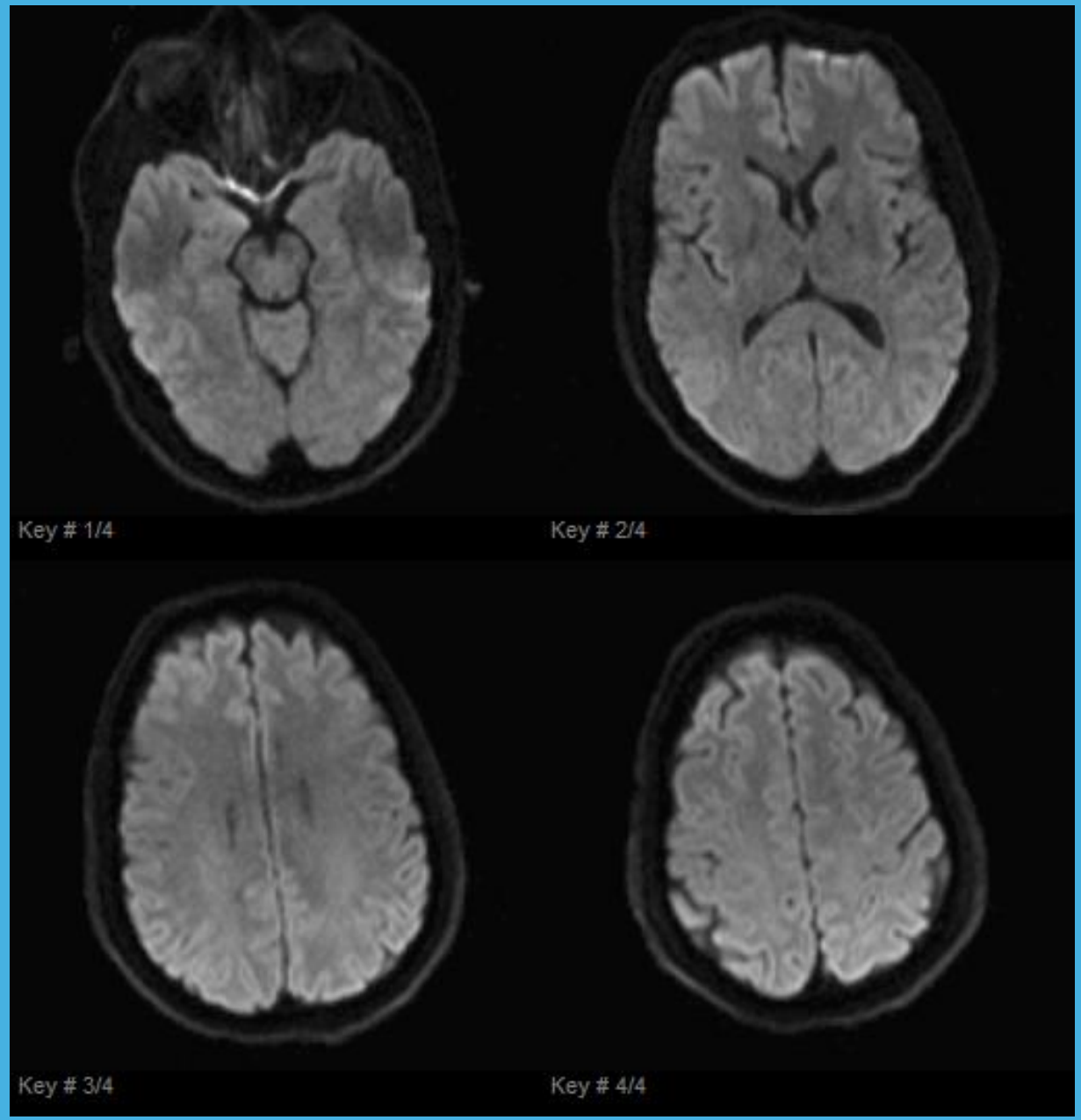
Key # 9/9

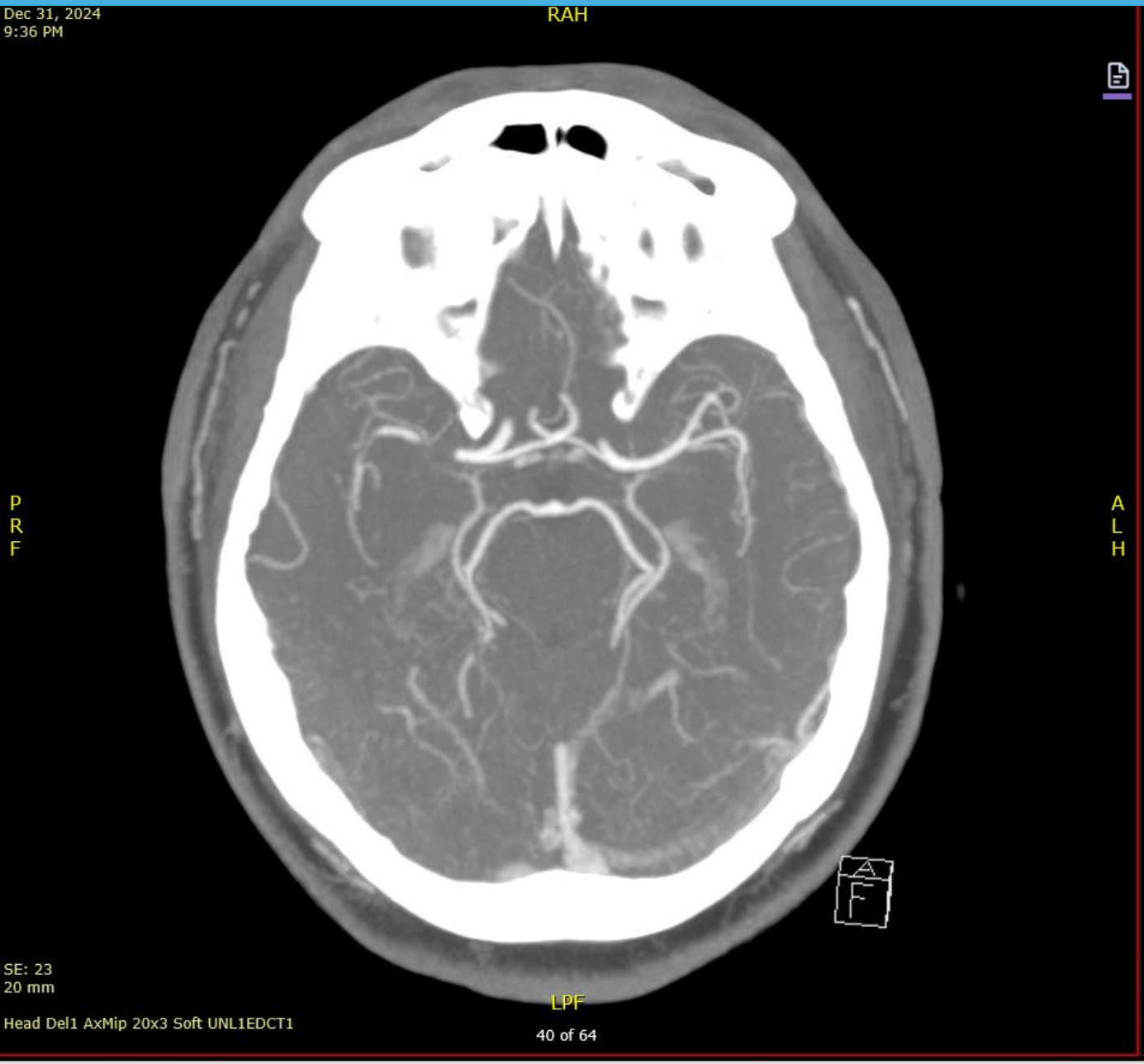

Key # 10/11
Key # 11/11

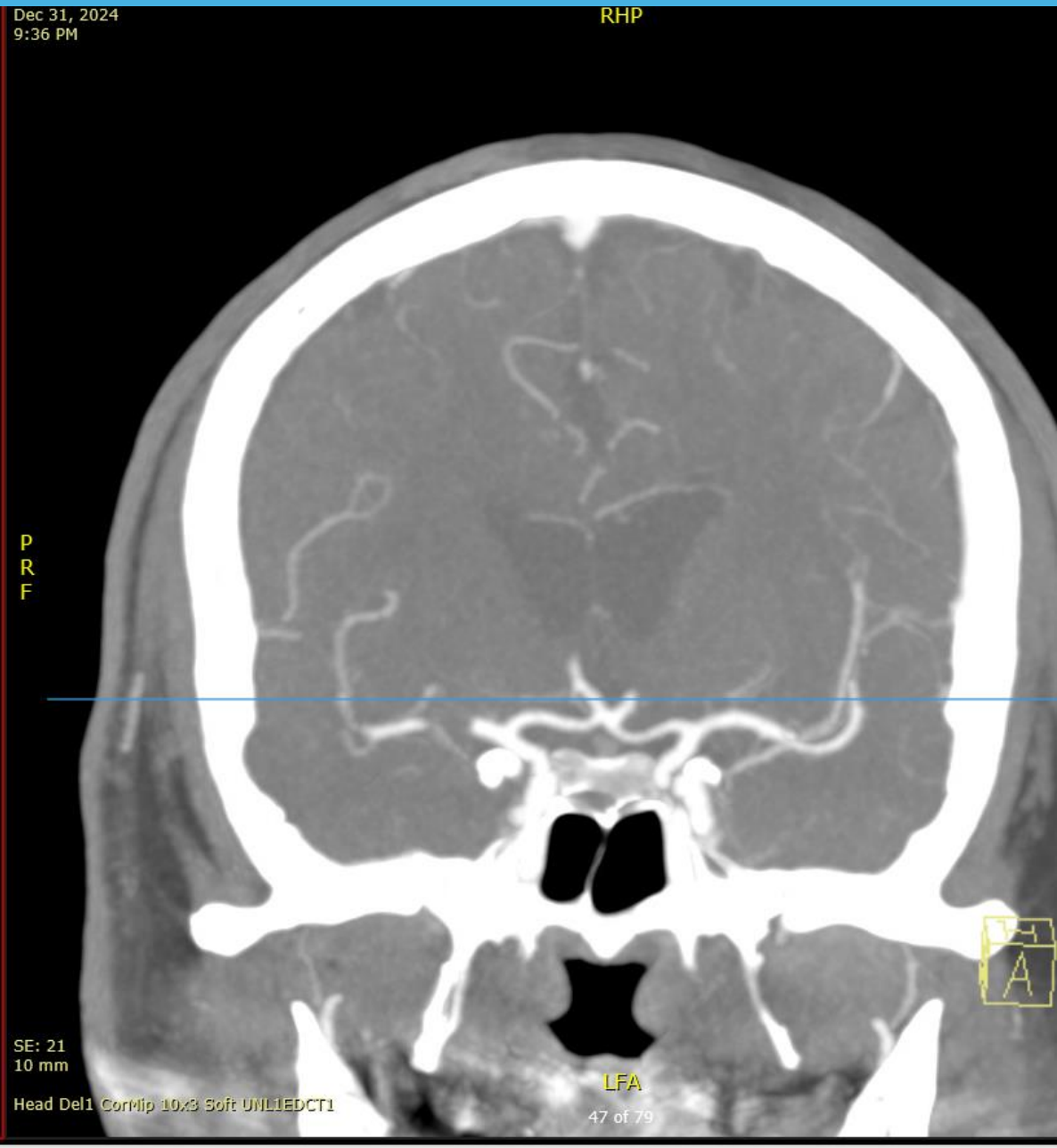

Key # 1/4
Key # 2/4
Key # 3/4
Key # 4/4

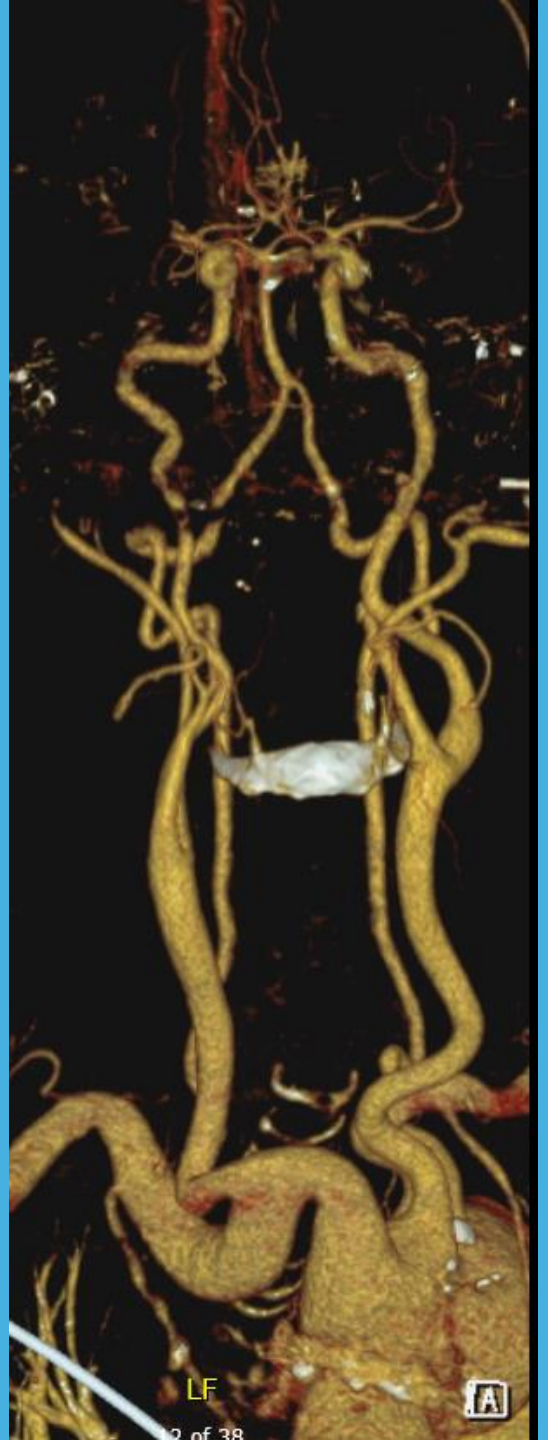
Key # 1/2

Key # 2/2

74 y.o. with a PMH of aortic dissection s/p repair 2008 , A-fib on apixaban, multiple past strokes, seizures (last seizure in 2023 on keppra and lamictal), who presented to the ER 12/31 with left arm weakness, left facial droop, and dysarthria. He reported around 2100 he was getting into the shower and slipped. No HS. Symptoms noted at that time. Not a TNK candidate given apixaban use. NIHSS 11

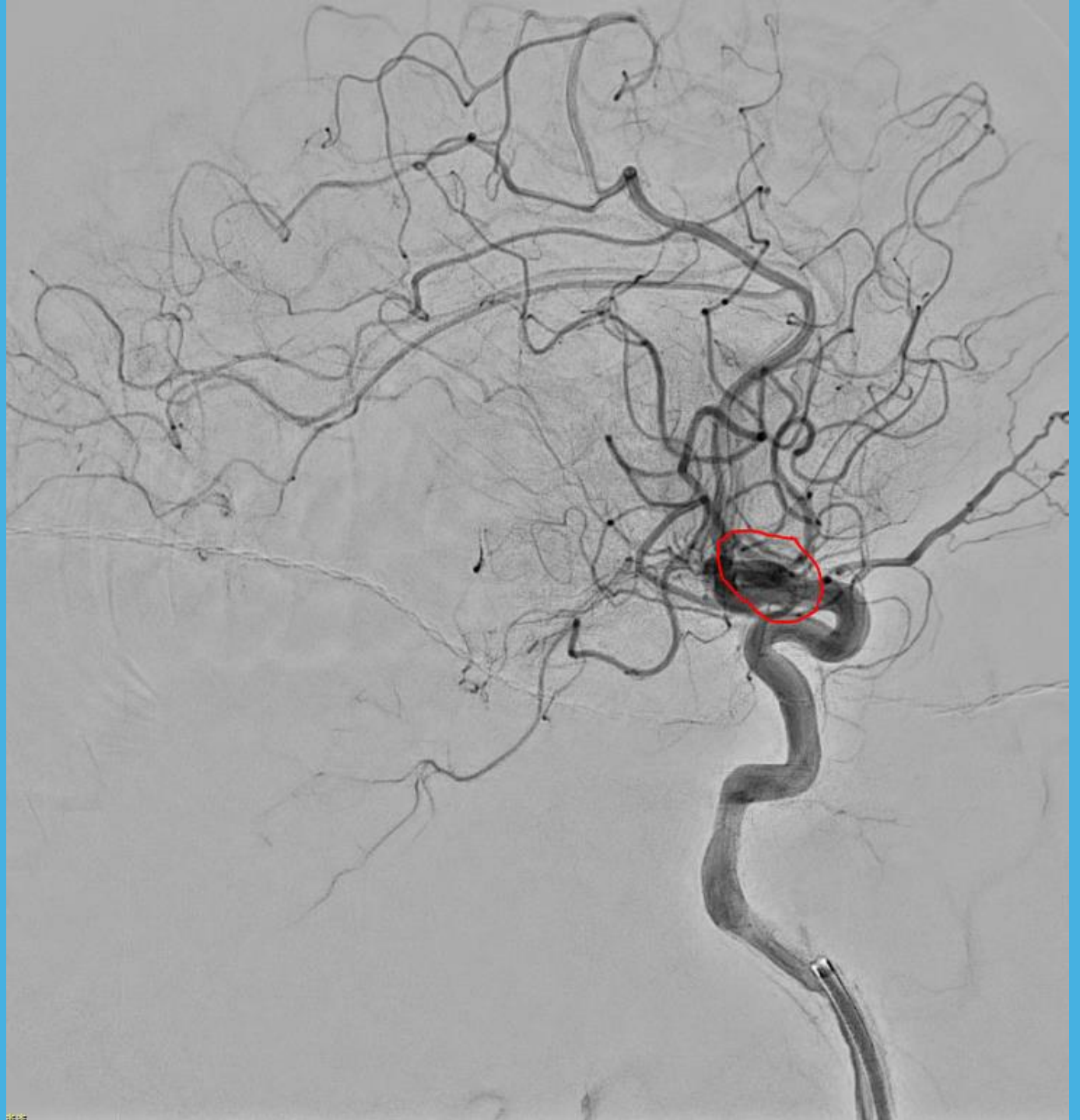

Dec 31, 2024
9:36 PM
RAH
P
R
F
A
L
H
SE: 23
20 mm
Head Del1 AxMip 20x3 Soft UNL1EDCT1
LPF
40 of 64

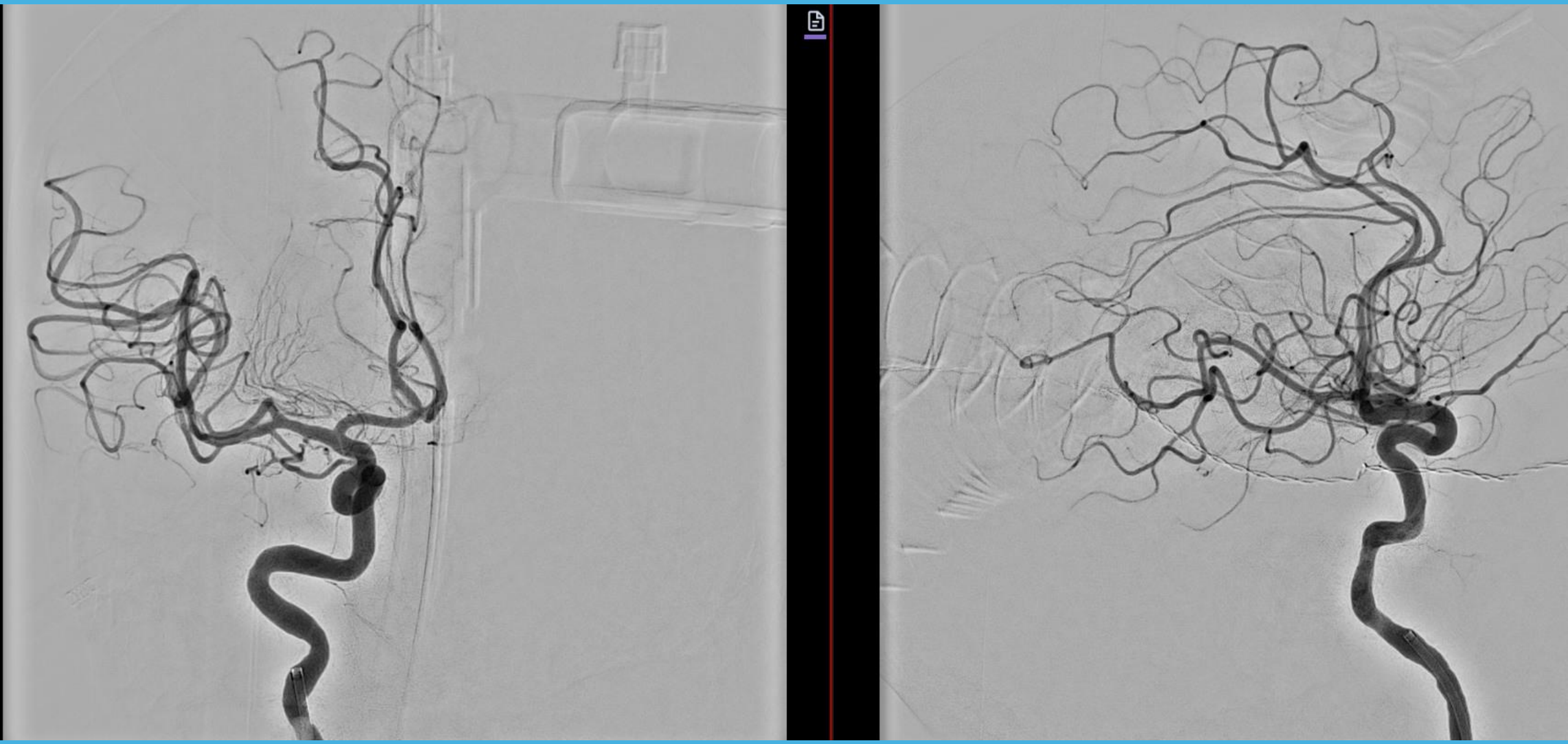

Dec 31, 2024
9:36 PM
RHP
P
R
F
SE: 21
10 mm
Head Del1 CorMip 10x3 Soft UNL1EDCT1
LFA
47 of 79


LF
A

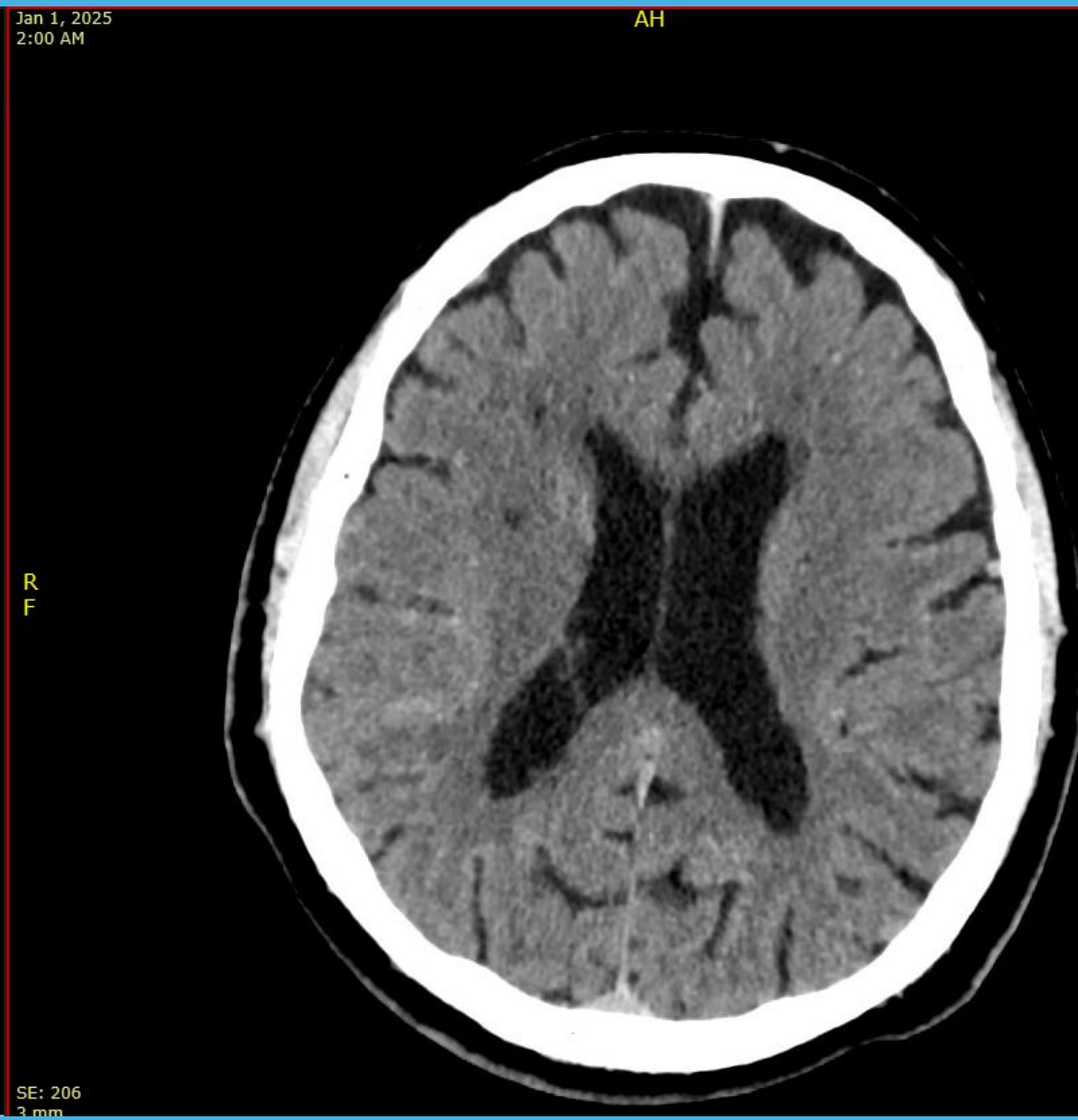

A
50 of 101

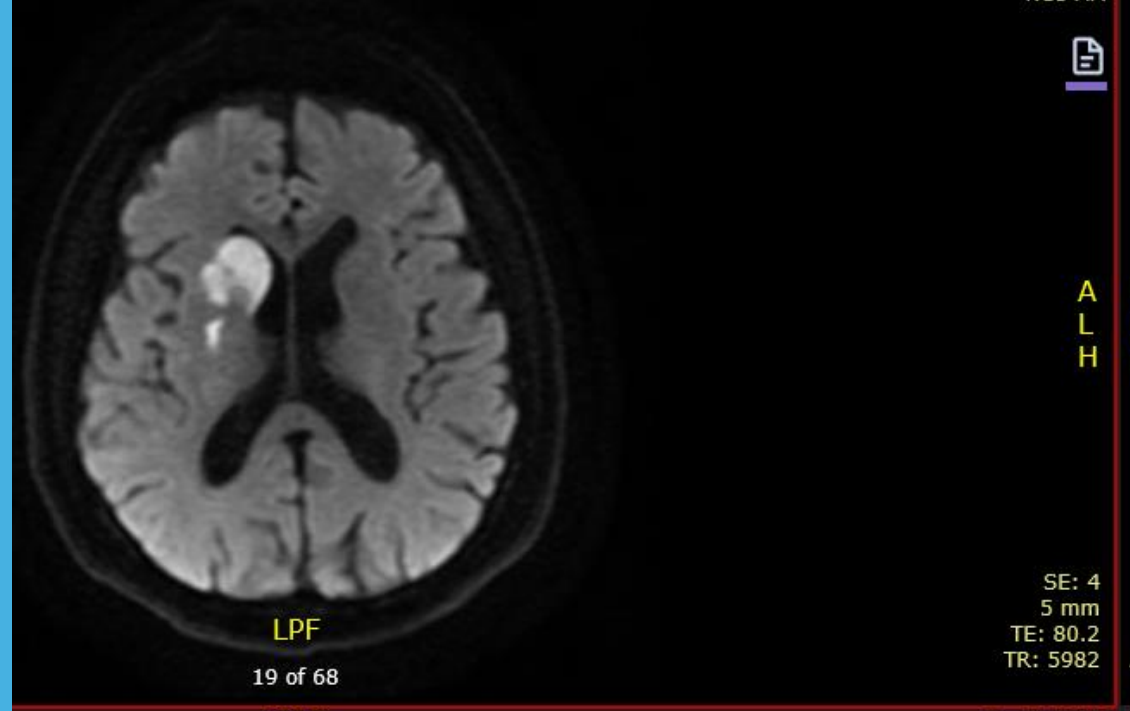

9:36 PM
A
L
R
SE: 14
3 mm
-123
Head Neck Art 3x3 Soft UNL1EDCT1
P
116 of 123

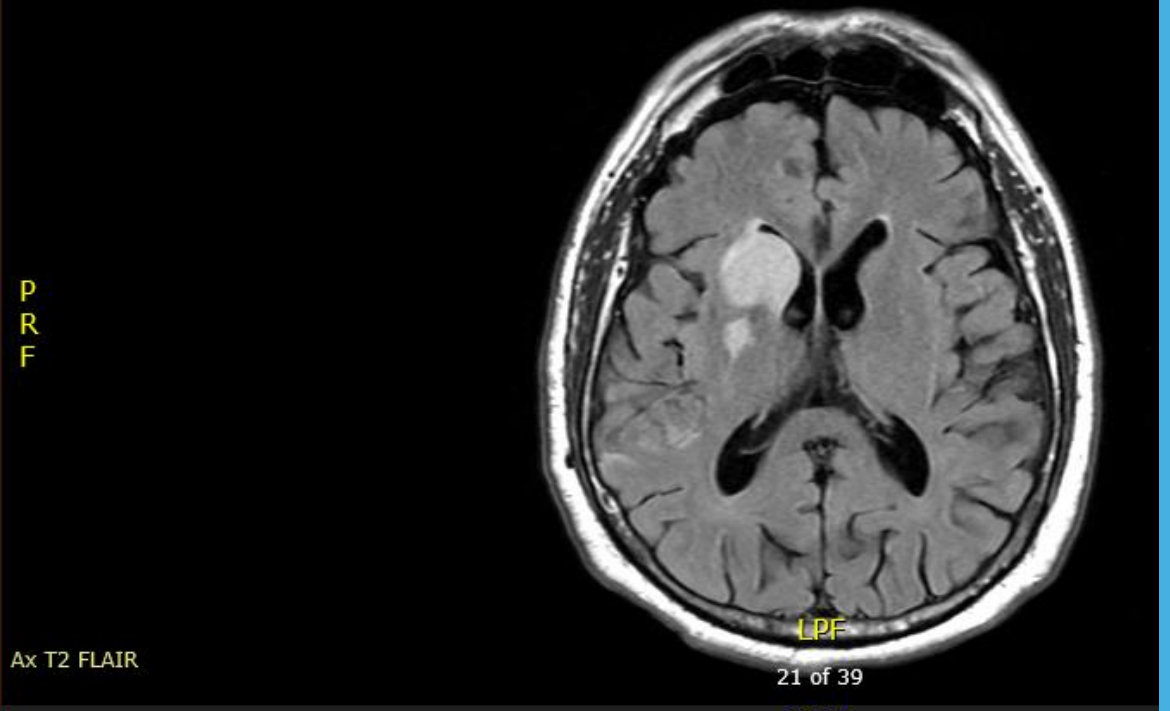


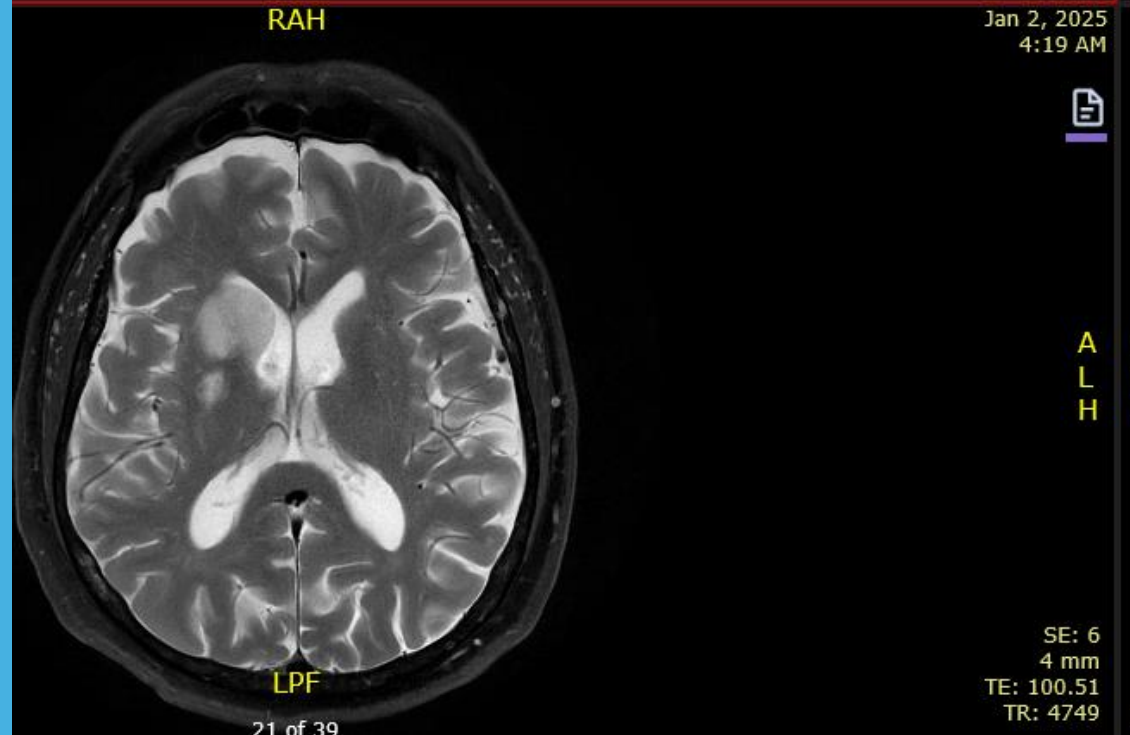


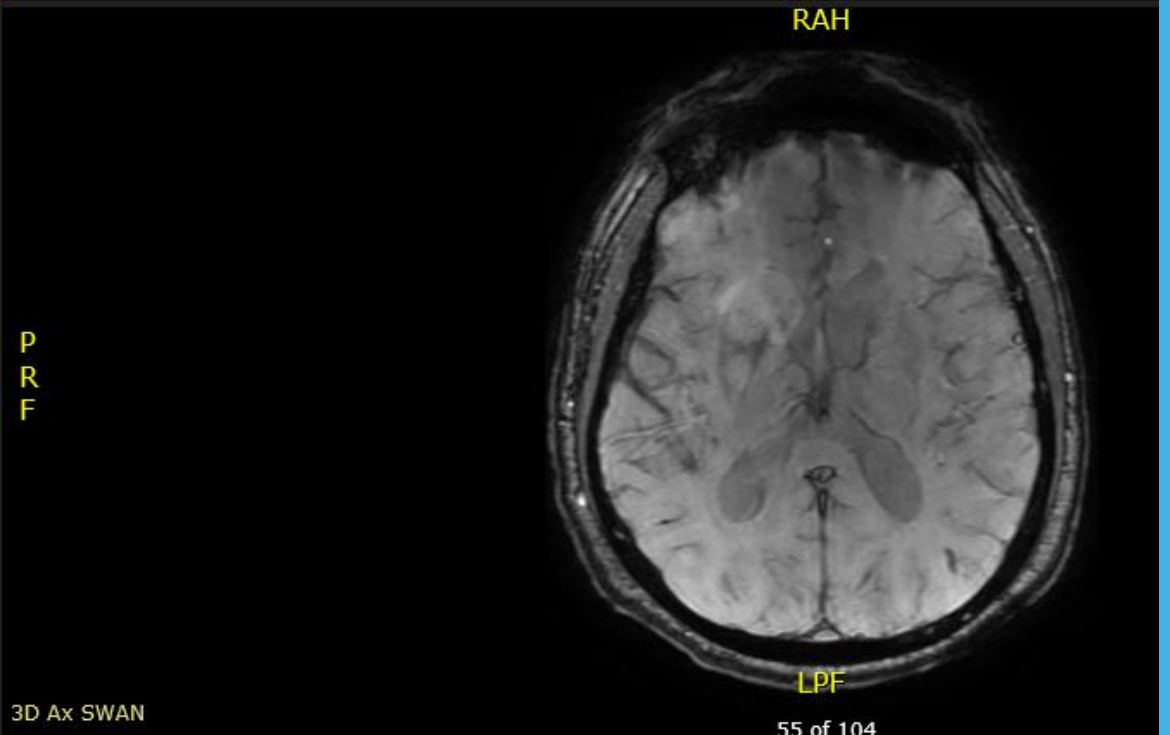

Jan 1, 2025
2:00 AM
AH
R
F
L
H
SE: 201
5 mm


Jan 1, 2025
2:00 AM
AH
R
F
SE: 206
3 mm

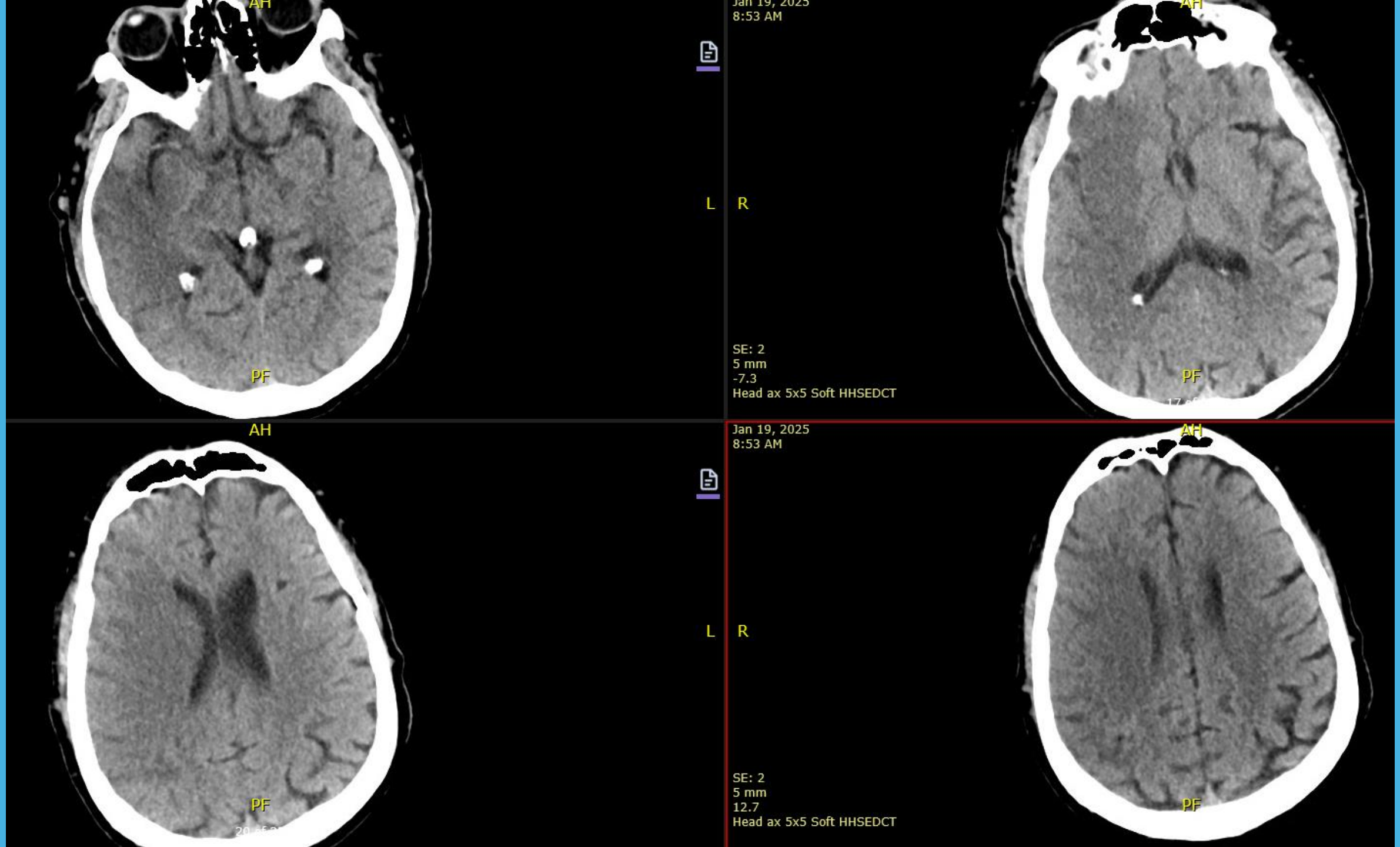

A
L
H
P
R
F
SE: 4
5 mm
TE: 80.2
TR: 5982
LPF
19 of 68
RAH
Jan 2, 2025
4:19 AM

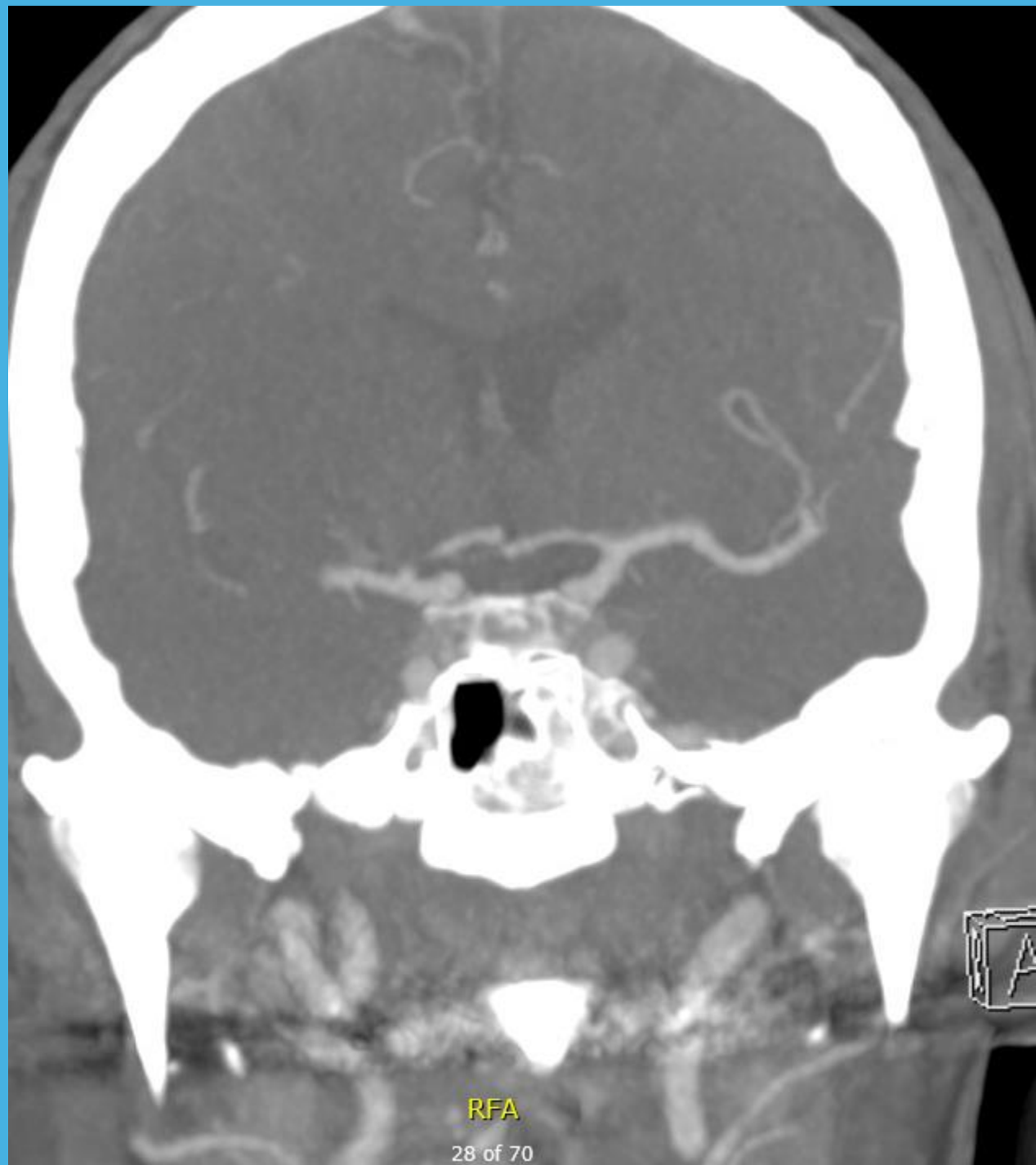

Ax T2 FLAIR
LPF
21 of 39
RAH


A
L
H
P
R
F
SE: 6
4 mm
TE: 100.51
TR: 4749
LPF
21 of 39


3D Ax SWAN
LPF
55 of 104

- 66-year-old man with history of hypertension, hyperlipidemia, prior MI, GERD, recent right inguinal incarcerated hernia repair 2 weeks ago, who last known well was 7 PM last night when he went to bed, woke up around 7:30 AM today try to get out of the bed and he fell due to a left-sided hemiplegia. Patient NIH stroke scale was 18.

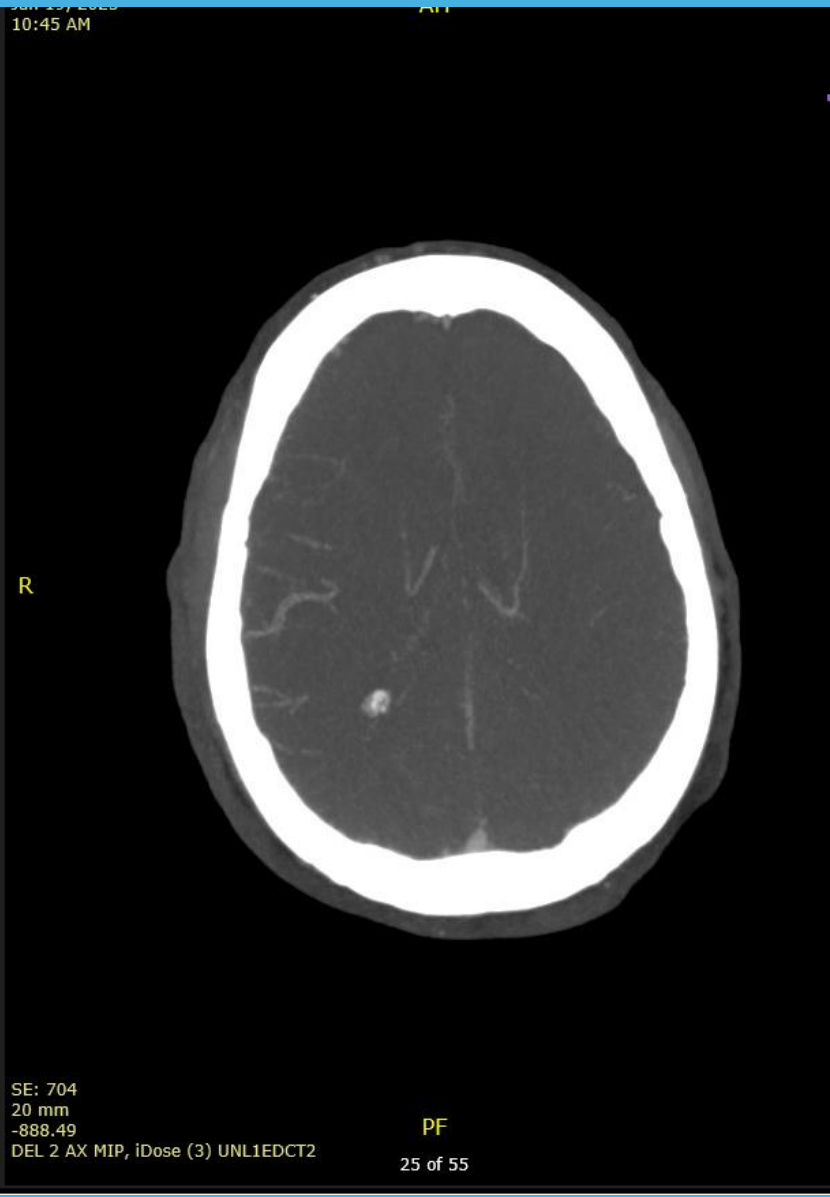

AH
PF
Jan 19, 2025
8:53 AM
L
R
SE: 2
5 mm
-7.3
Head ax 5x5 Soft HHSEDCT
AH
PF
AH
PF
Jan 19, 2025
8:53 AM
L
R
SE: 2
5 mm
12.7
Head ax 5x5 Soft HHSEDCT
AH
PF

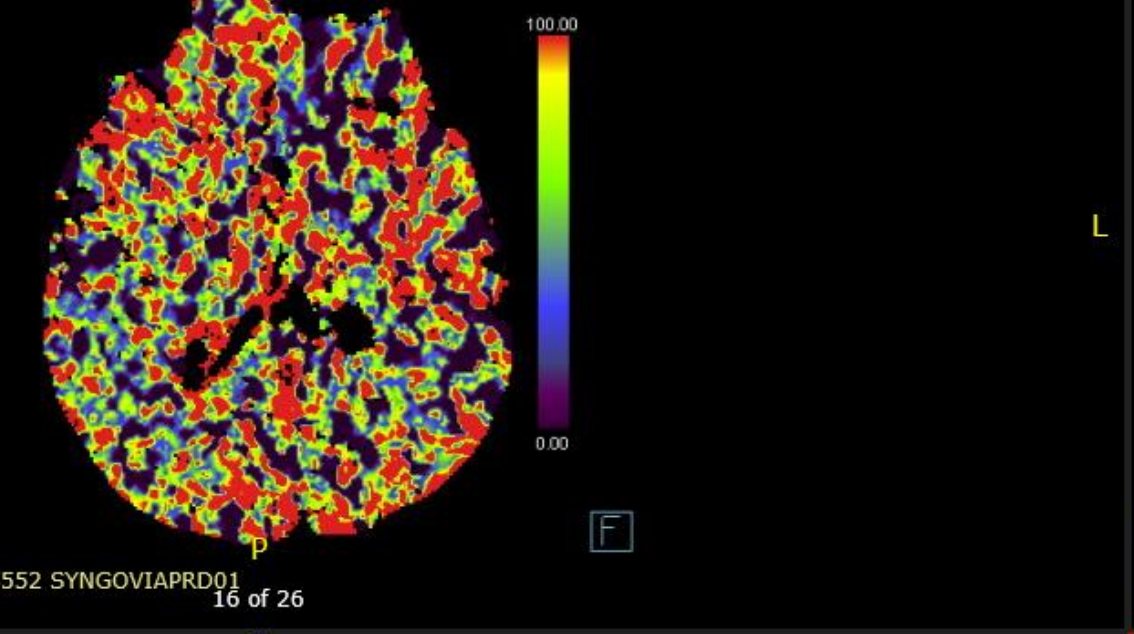

RFA
28 of 70

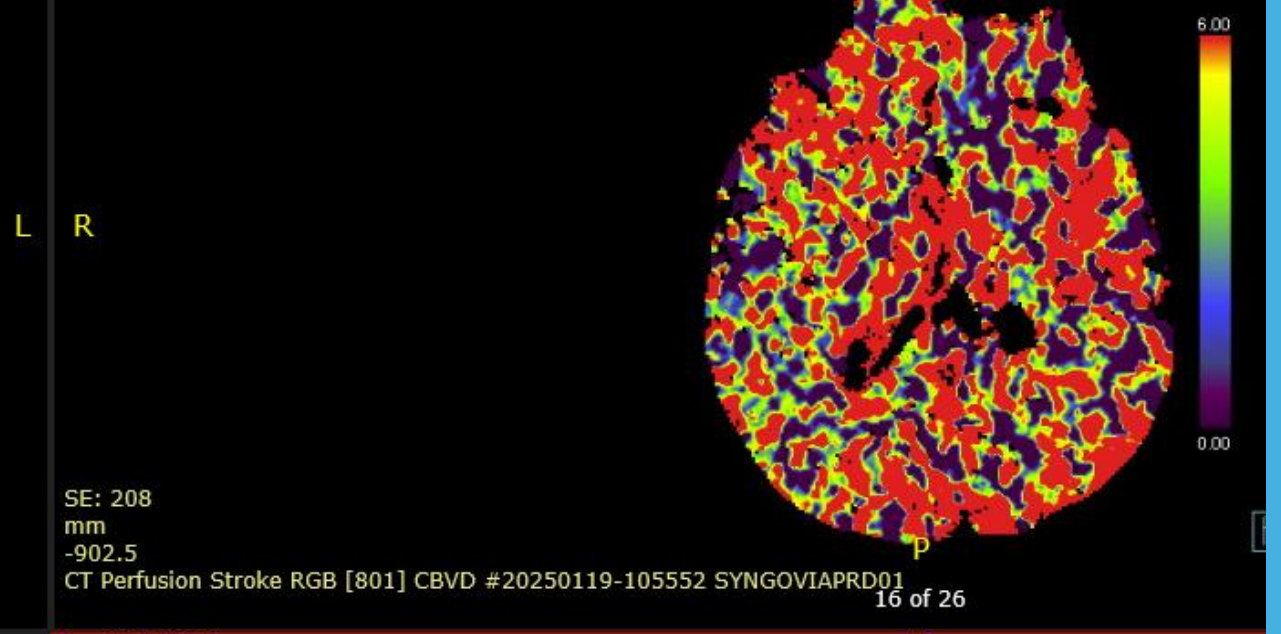

L
R
PF
SE: 604
20 mm
-917.22
DEL 1 AX MIP, iDose (3) UNL1EDCT2
L
R
PF
SE: 704
20 mm
-917.13
DEL 2 AX MIP, iDose (3) UNL1EDCT2

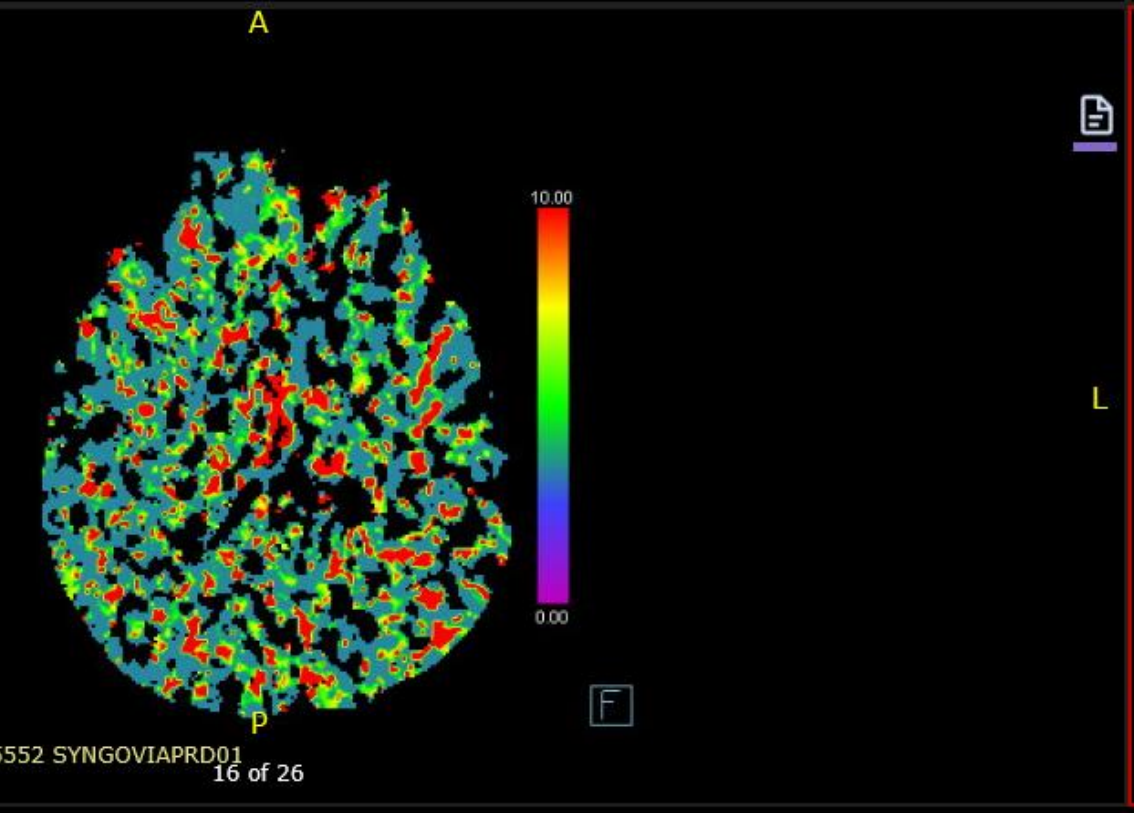

10:44 AM
R
L
SE: 504
20 mm
-888.49
AX HEAD MIP, iDose (3) UNL1EDCT2
PF
26 of 57

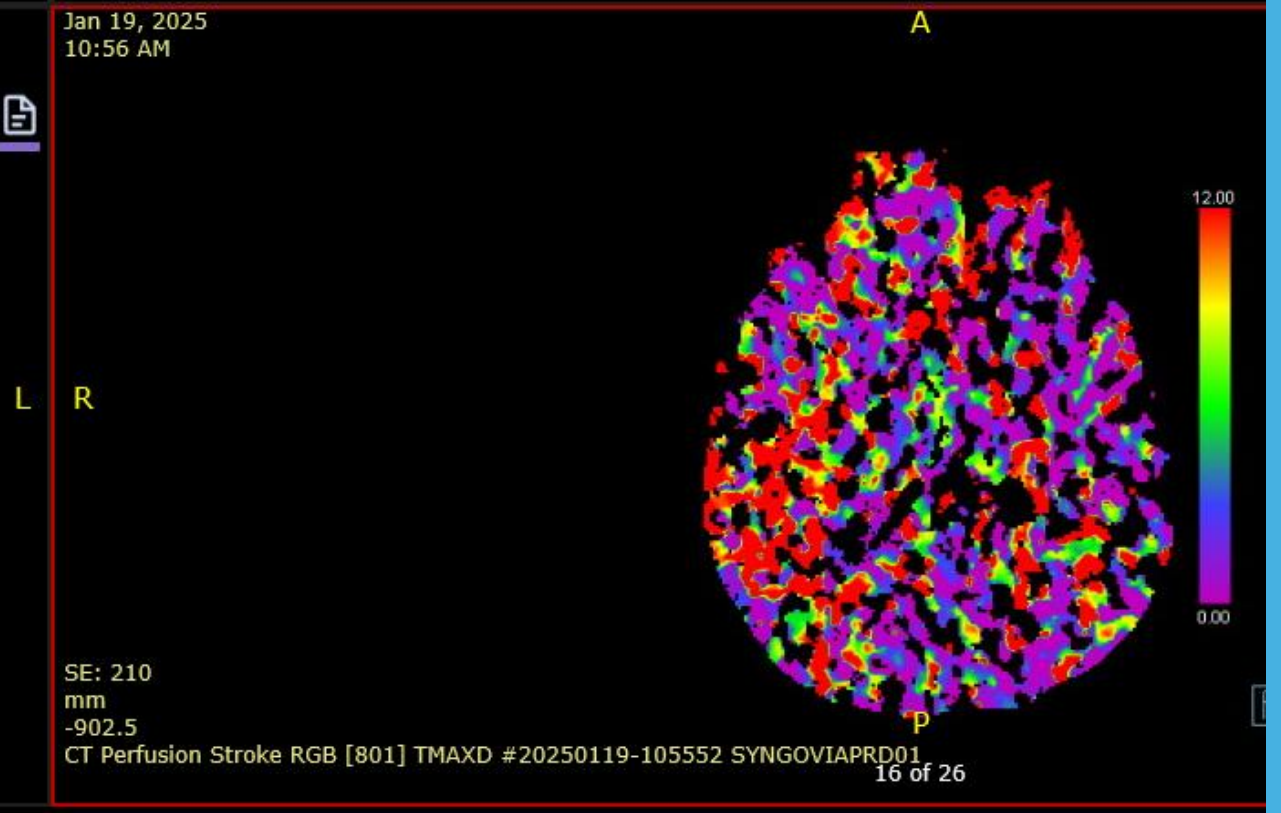

10:44 AM
R
L
SE: 604
20 mm
-888.58
DEL 1 AX MIP, iDose (3) UNL1EDCT2
PF
25 of 55


10:45 AM
R
SE: 704
20 mm
-888.49
DEL 2 AX MIP, iDose (3) UNL1EDCT2
PF
25 of 55


100.00
0.00
P
F
552 SYNGOVIAPRD01
16 of 26


L
R
6.00
0.00
P
SE: 208
mm
-902.5
CT Perfusion Stroke RGB [801] CBVD #20250119-105552 SYNGOVIAPRD01
16 of 26


A
10.00
0.00
P
F
5552 SYNGOVIAPRD01
16 of 26

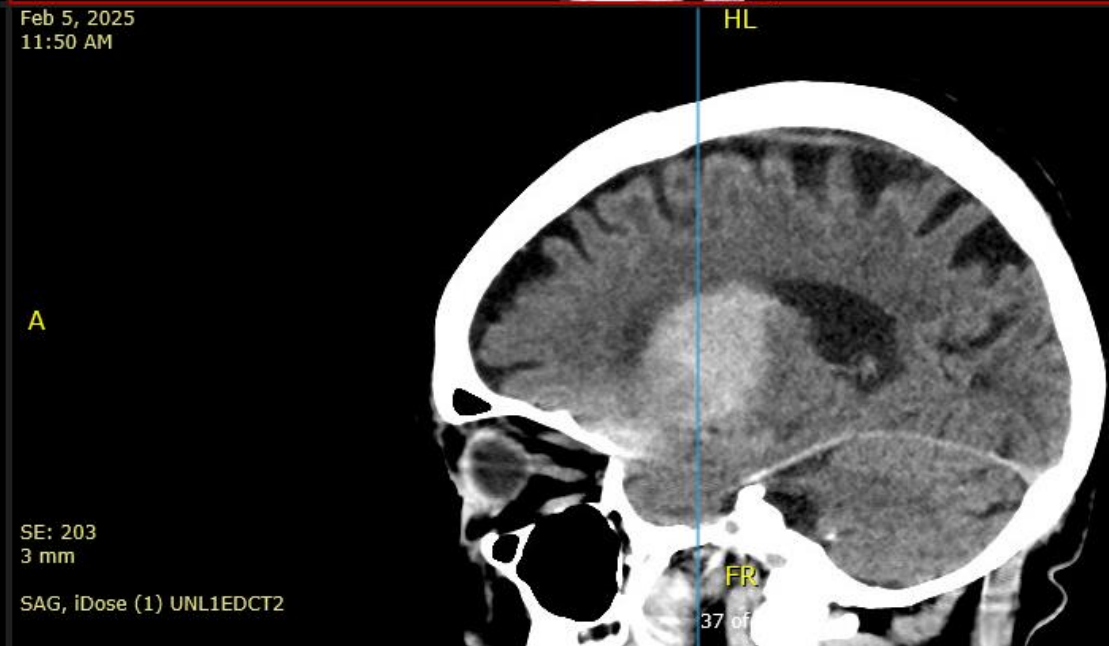

Jan 19, 2025
10:56 AM
A
L
R
12.00
0.00
P
SE: 210
mm
-902.5
CT Perfusion Stroke RGB [801] TMAXD #20250119-105552 SYNGOVIAPRD01
16 of 26

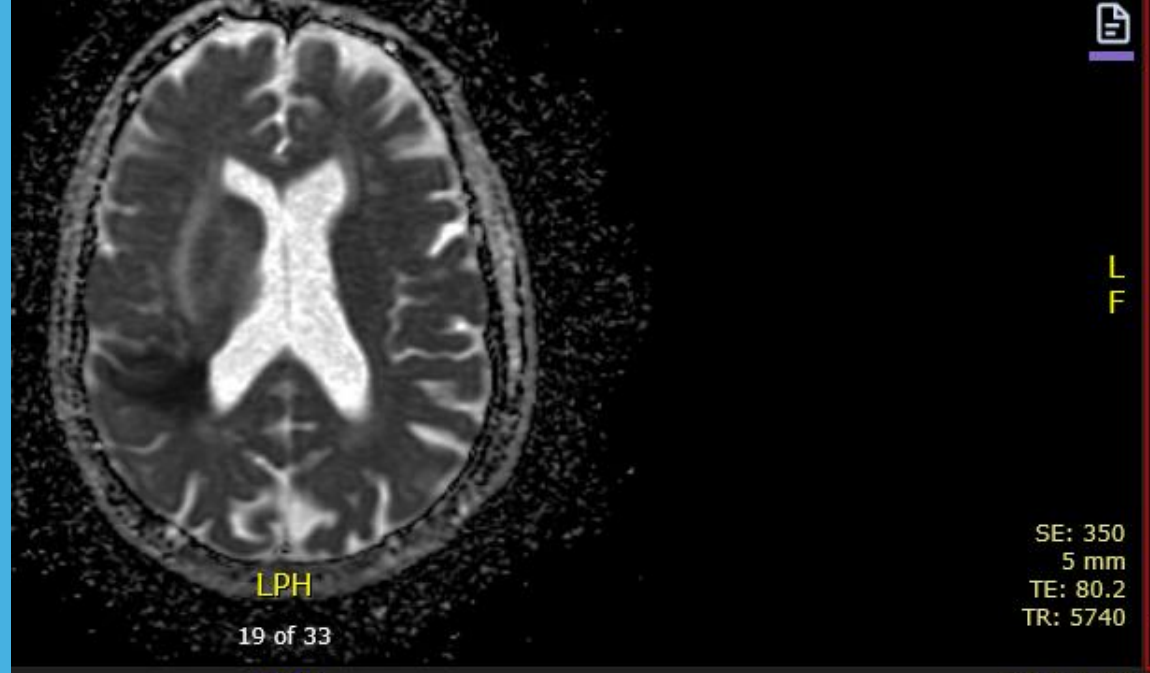
Post OP Imaging/spectral CT

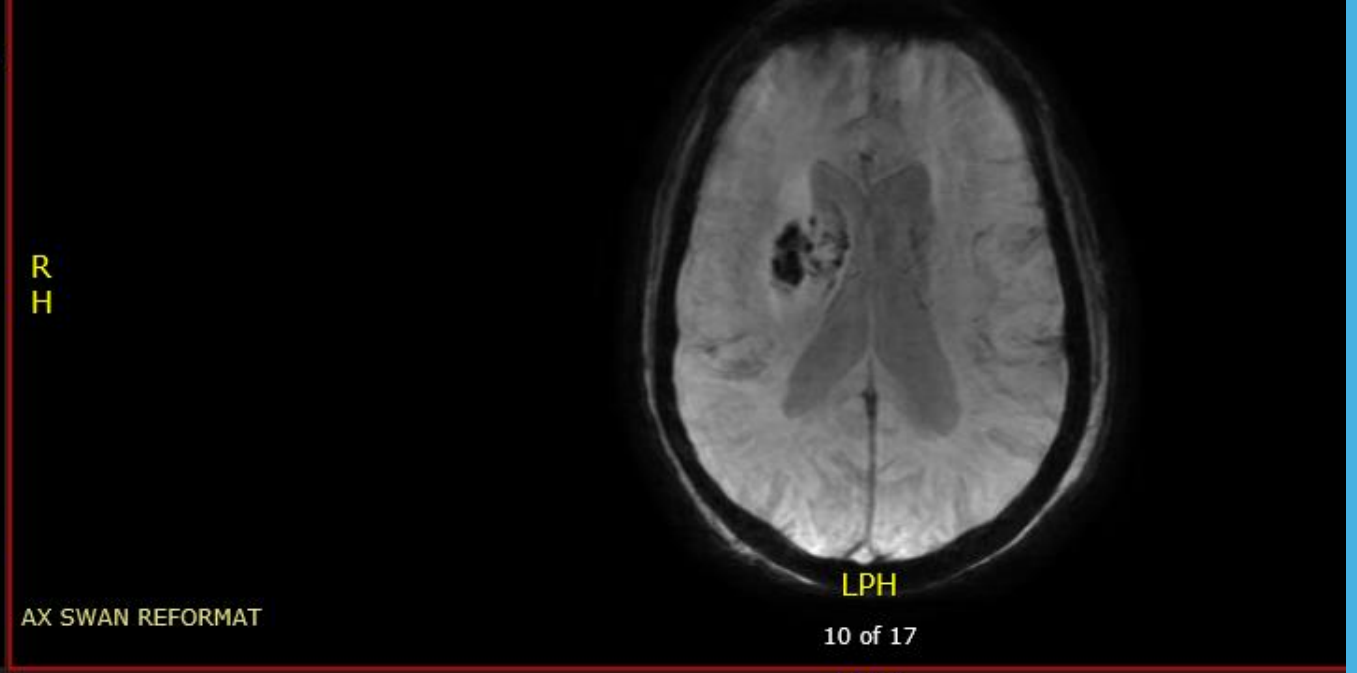

11:50 AM
A
R
H
L
F
SE: 201
5 mm
-83.35
AXIAL ST, iDose (1) UNL1EDCT2
P
15 of 36

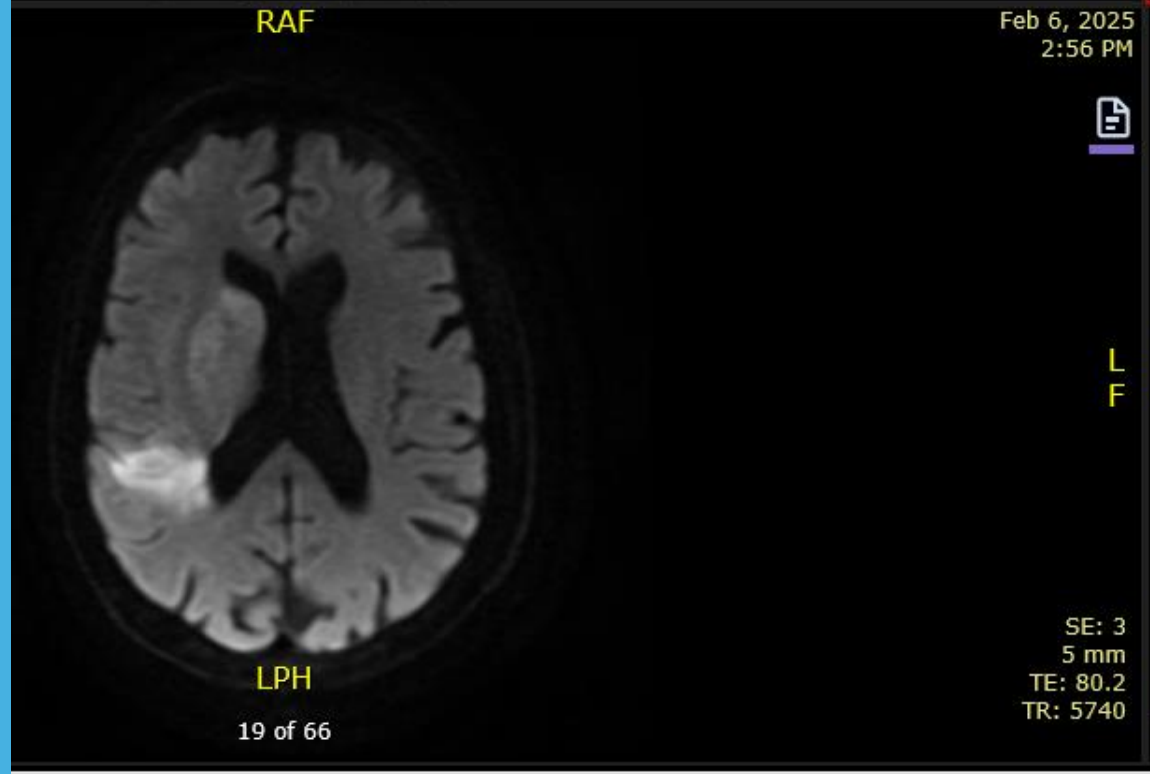

11:50 AM
HL
R
H
SE: 202
3 mm
COR, iDose (1) UNL1EDCT2
FR
33 of 78

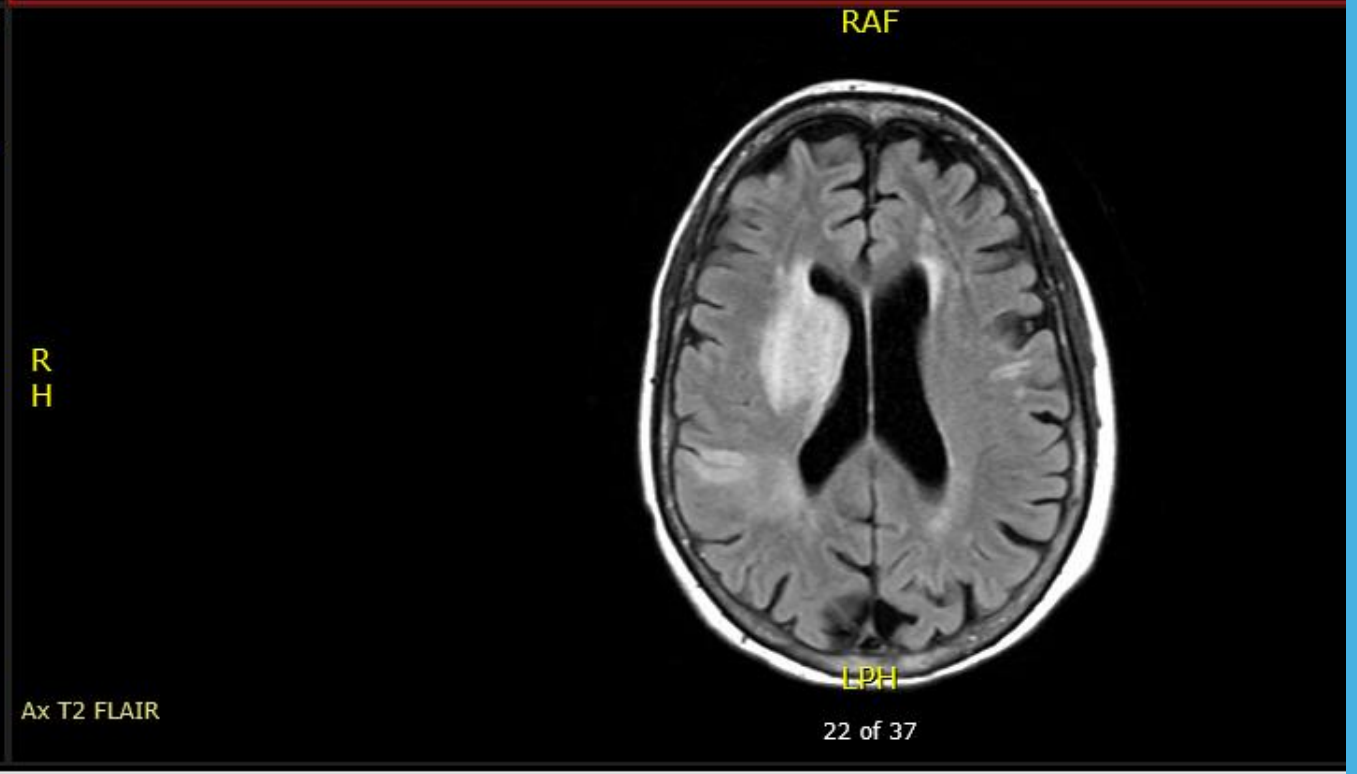

Feb 5, 2025
11:50 AM
A
R
H
L
F
SE: 206
3 mm
-85.35
VNC [HU*] , Spectral (1) UNL1EDCT2
P
24 of 60


Feb 5, 2025
11:50 AM
HL
A
SE: 203
3 mm
SAG, iDose (1) UNL1EDCT2
FR


L
F
SE: 350
5 mm
TE: 80.2
TR: 5740
LPH
19 of 33
RAF


R
H
AX SWAN REFORMAT
LPH
10 of 17
RAF


Feb 6, 2025
2:56 PM
L
F
SE: 3
5 mm
TE: 80.2
TR: 5740
LPH
19 of 66


R
H
Ax T2 FLAIR
LPH
22 of 37

Thanks