

RADY 401 Case Presentation

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Ed. John Lilly, MD

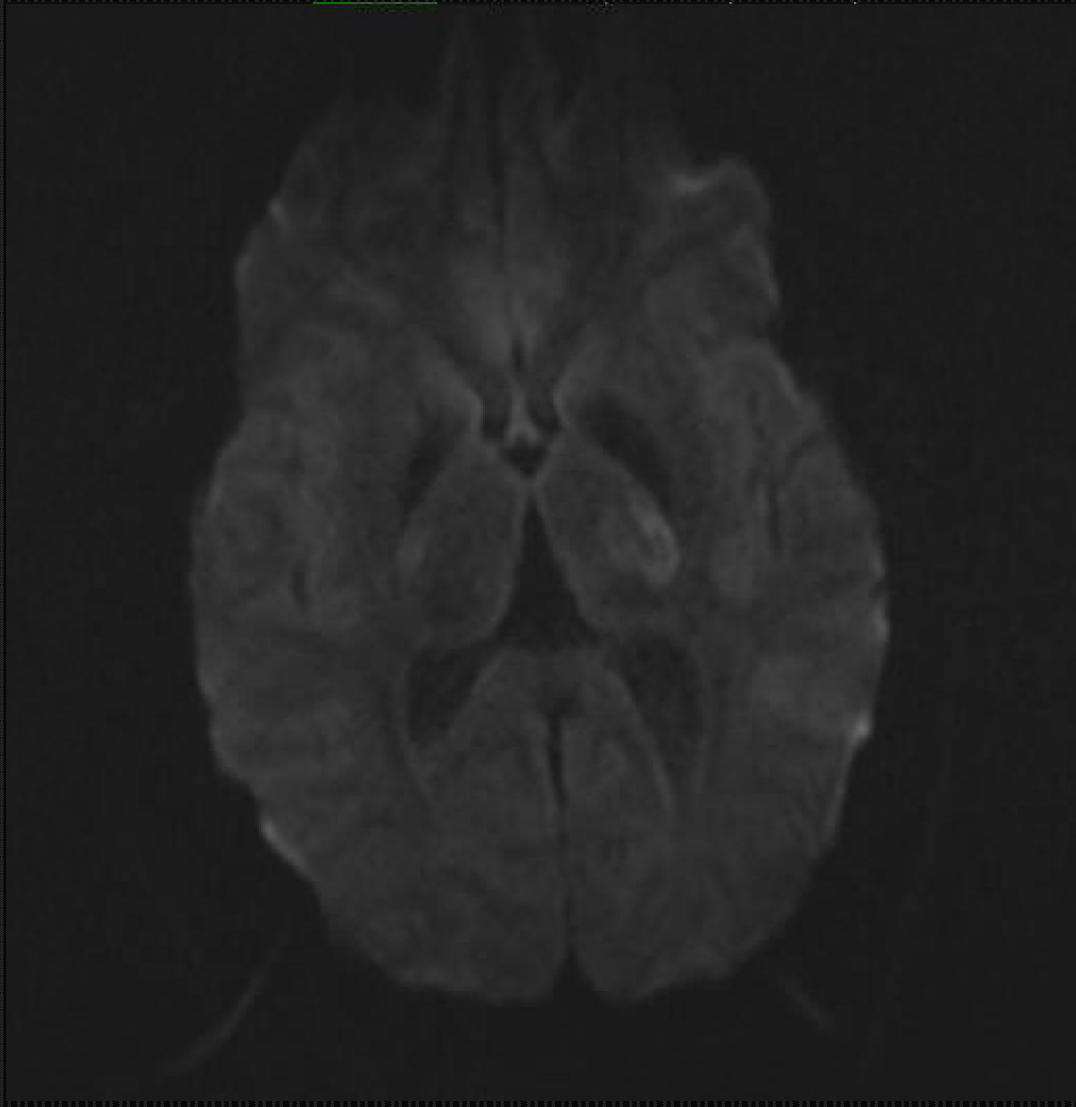
Focused patient history, physical exam, & work-up

- Ms. NT is a 16 yo female with a hx of sickle cell trait who presents to the ED with 2 weeks of headache with acute worsening over the past 2 hours associated with right-sided numbness and weakness
- Symptoms began while swimming. Denies LOC, trauma, seizures, OCP use, blood clots. Family Hx of stroke at age 50+.
- Vitals unremarkable (Except RR 25)
- Neuro Exam: A&O x 3, EOMs intact, R facial numbness V1-3, R facial droop, tongue midline. RUE 2, LUE 5, RLE 1, LLE 5; Sensation diminished in right hemibody
- ED Labs: Negative CBC/BMP/coags, Utox, tylenol/ethanol

List of imaging studies

- MRI Brain with and without contrast
- MRA Head
- MRA Neck (Unremarkable)
- MRI C-Spine with and without contrast (Unremarkable)
- IR Cerebral Arteriogram

DWI (Diffusion Weighted Image), Axial (3:60)

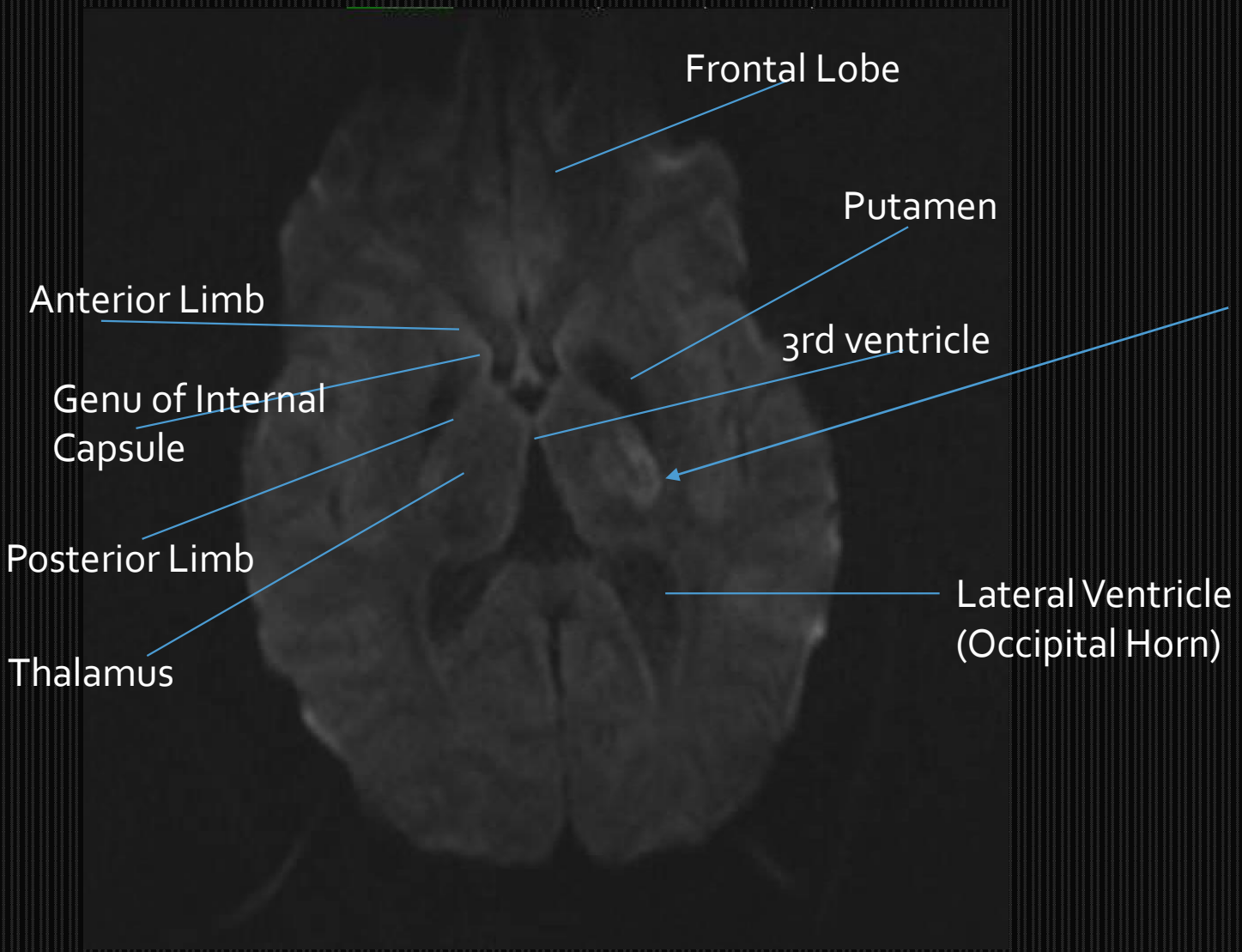


Findings?

Hint:

1. DWI is based upon fast MRI to detect a signal related to the movement of water molecules
2. DWI is bright where there is restricted water diffusion
3. Hard to distinguish vasogenic and cytotoxic edema¹

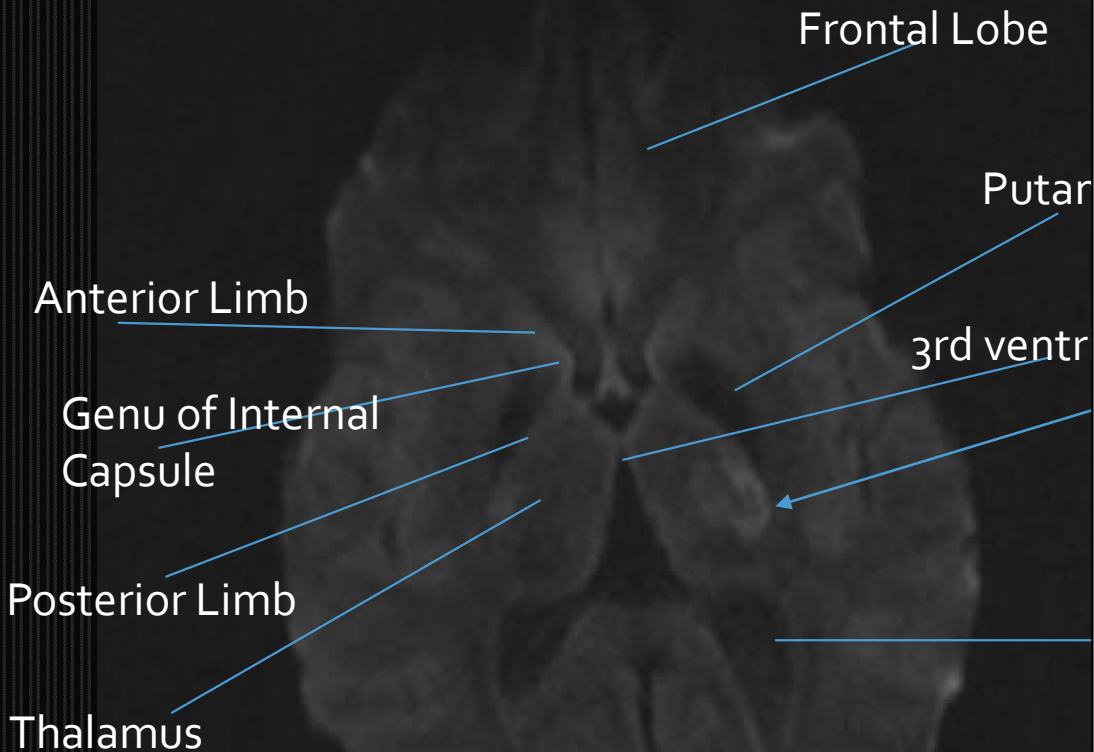
DWI (Diffusion Weighted Image), Axial (3:60)



Findings?

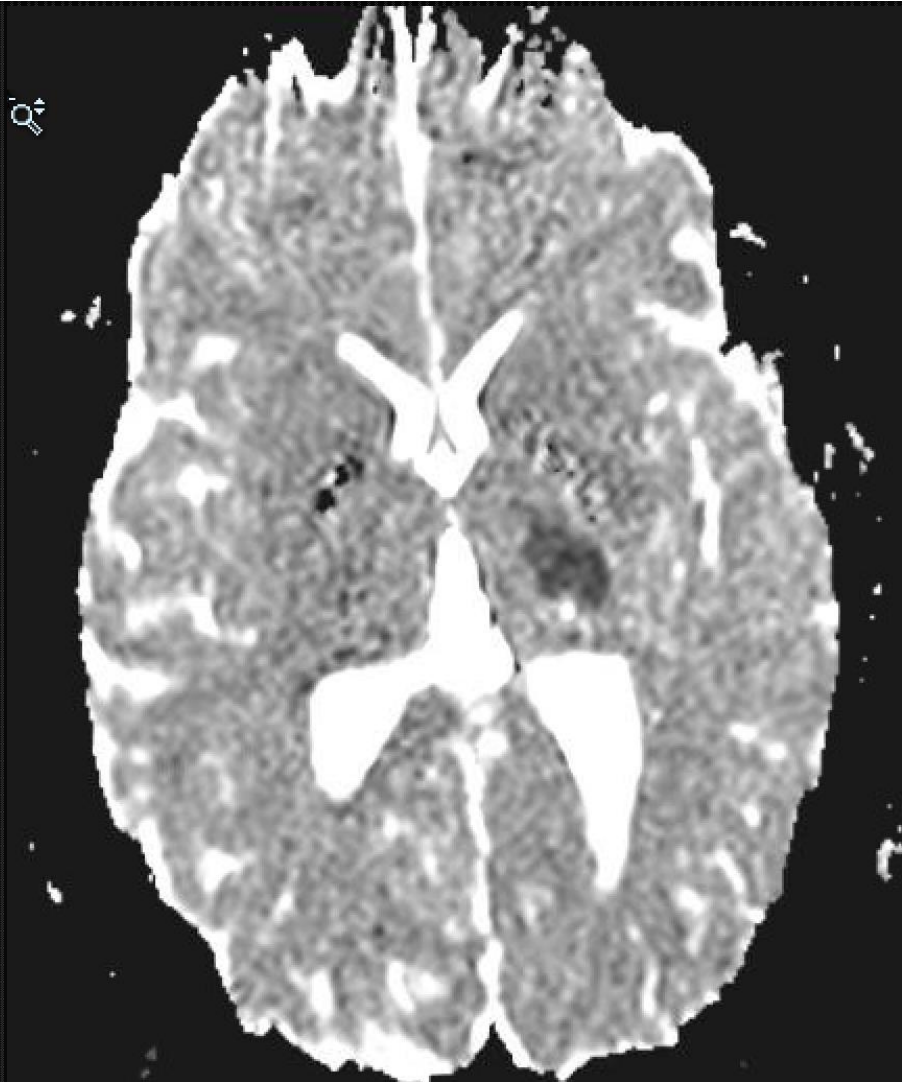
DWI signal bright at left thalamus and posterior limb internal capsule showing restricted diffusion

DWI (Diffusion Weighted



DWI is based upon the capacity of fast MRI to detect a signal related to the movement of water molecules between two closely spaced radiofrequency pulses. This technique can detect abnormalities due to ischemia within 3 to 30 minutes of onset, when conventional MRI and CT images would still appear normal. In acute stroke, swelling of the ischemic brain parenchymal cells follows failure of the energy-dependent Na-K-ATPase pumps and is believed to increase the ratio of intracellular to extracellular volume fractions. DWI contains an additional component of T2 effect, and increased T2 signal due to vasogenic edema can "shine through" on DWI images, making it difficult to distinguish vasogenic from cytotoxic edema on these images. This problem can be overcome by use of the apparent diffusion coefficient (ADC). The ADC provides a quantitative measure of the water diffusion. In acute ischemic stroke with cytotoxic edema, decreased water diffusion in infarcted tissue causes increased (hyperintense) DWI signal and a decreased ADC, visualized as hypointense signal on ADC maps of the brain. In contrast, vasogenic edema may cause increased DWI signal may occur due to T2 shine through, but water diffusion is increased, and increased ADC is seen as hyperintense signal on ADC maps.

ADC (Apparent Diffusion Coefficient), Axial (4:12)

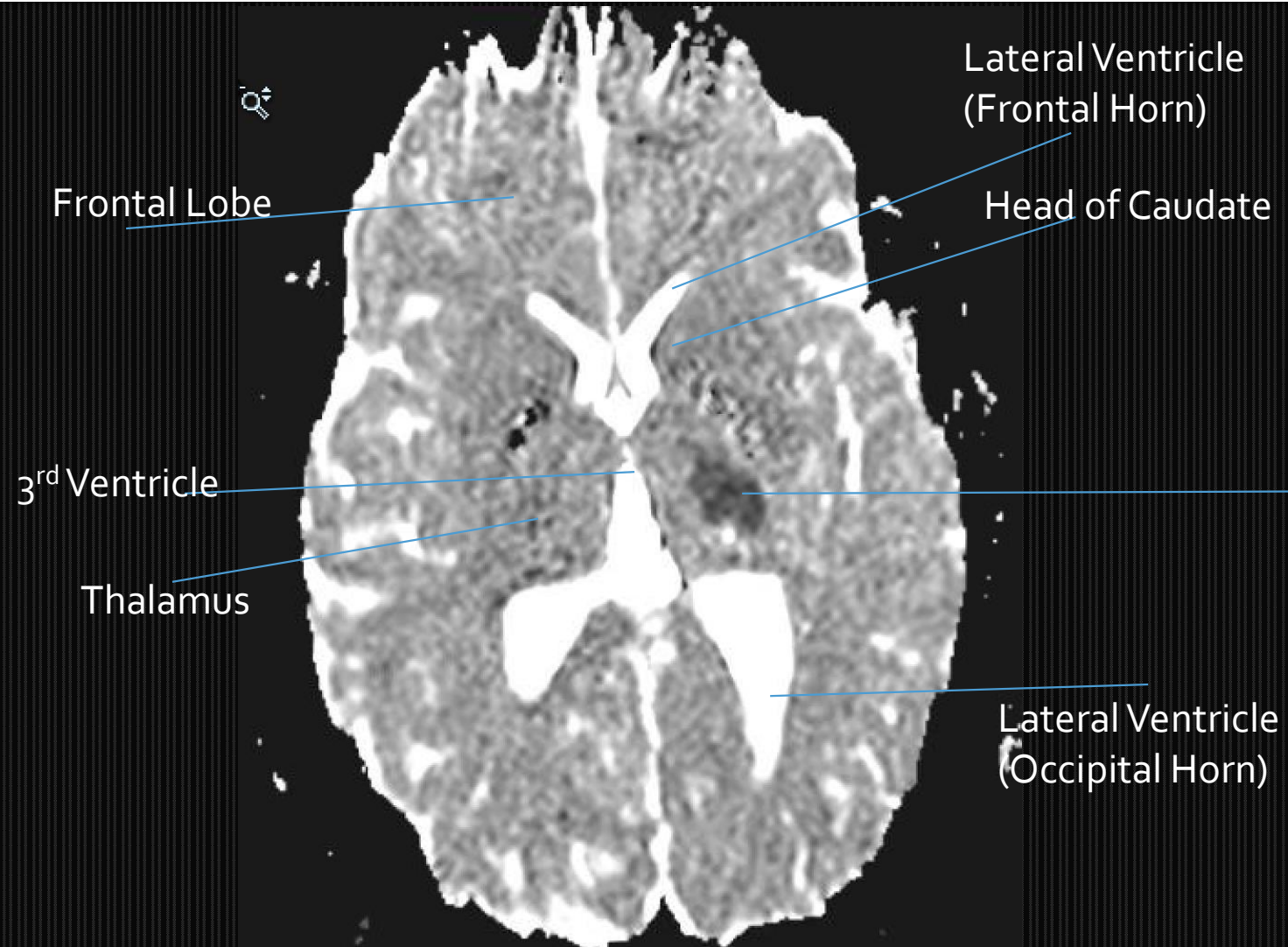


Findings?

Hint:

1. ADC is based upon MRI to measure magnitude of water diffusion within tissue
2. ADC is hypointense where there is no water diffusion
3. Vasogenic is hyperintense whereas cytotoxic edema is hypointense¹

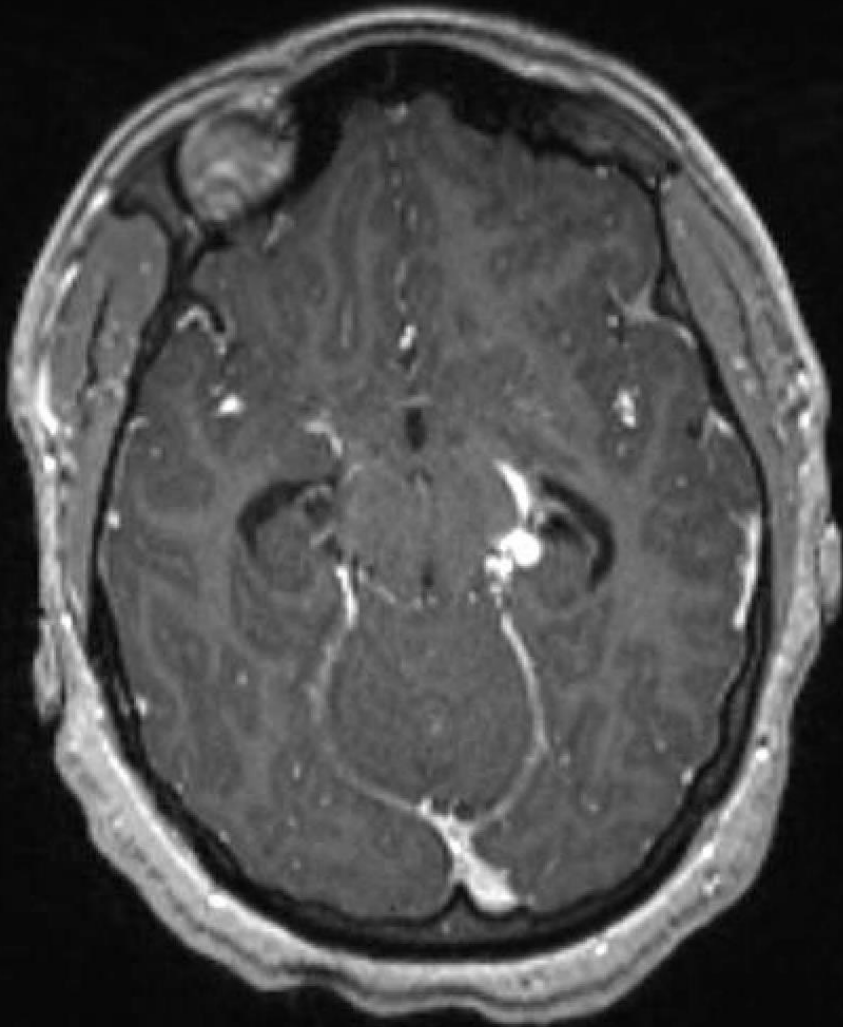
ADC (Apparent Diffusion Coefficient), Axial (4:12)



Findings?

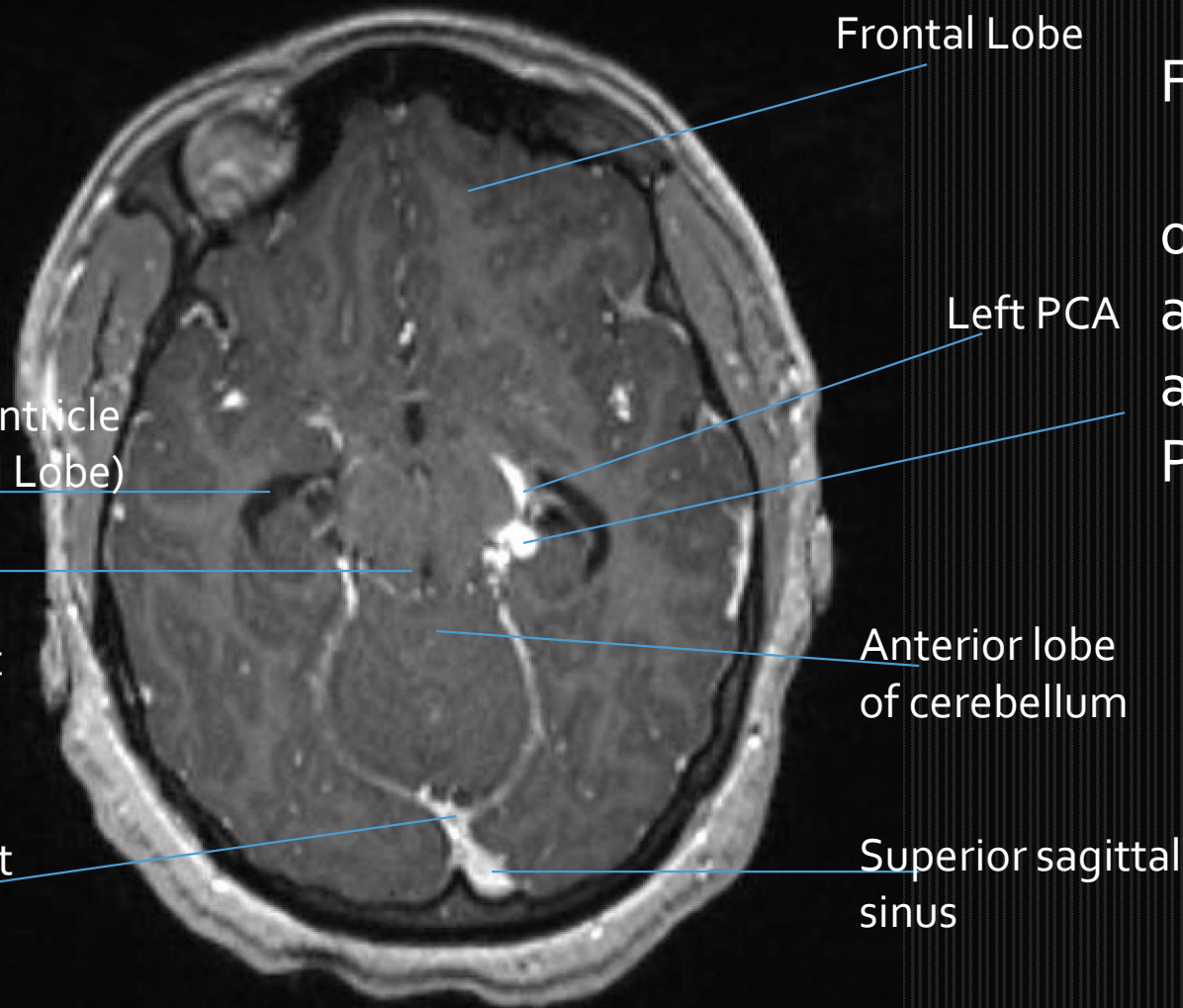
Hypointense signal at left thalamus and posterior limb of internal capsule

Head MRA w/ contrast, axial (32:116)



Findings?

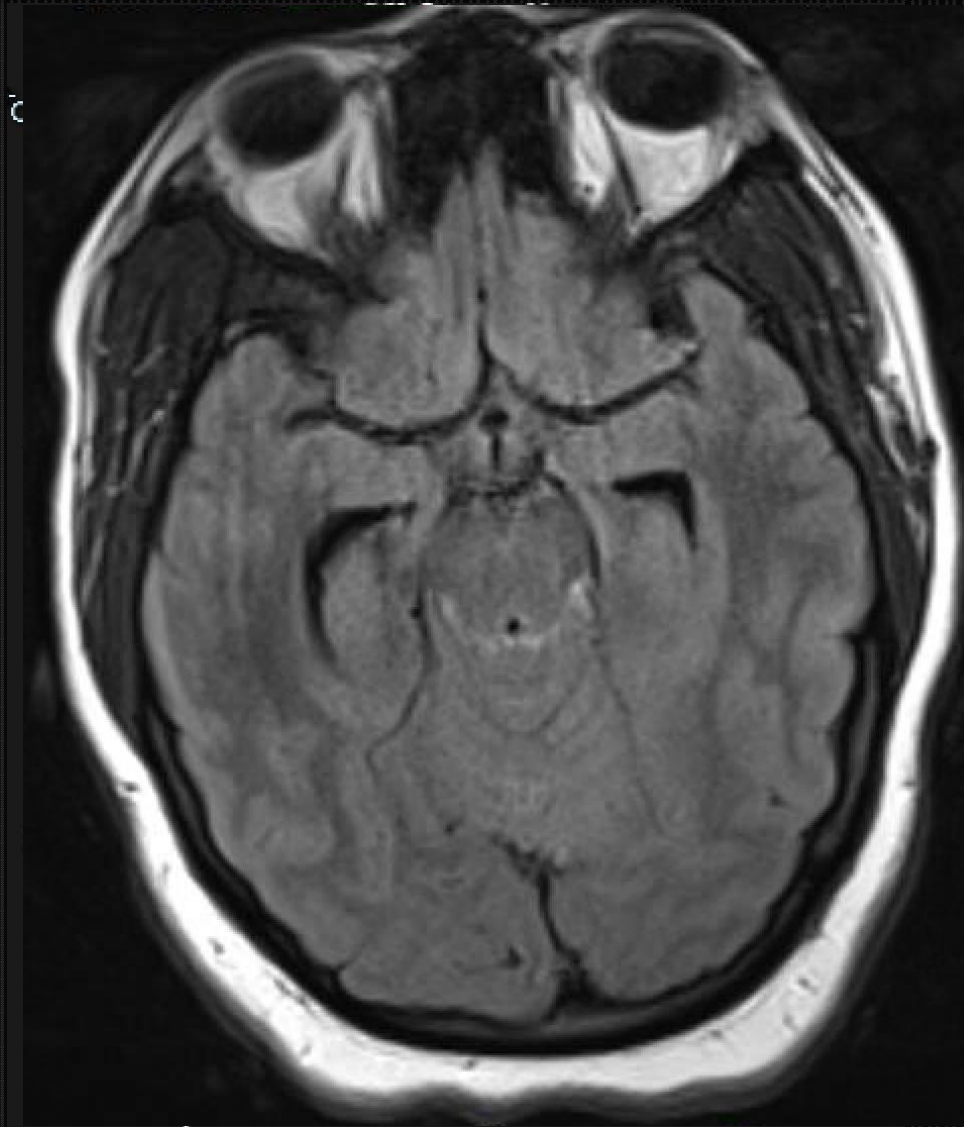
Head MRA w/ contrast, axial (32:116)



Findings?

0.7cm, possibly bilobular aneurysm arising from the left posterior cerebral artery, likely at the junction of P₂ and P₃

FLAIR (Fluid-attenuated Inversion Recovery), Axial (5:27)

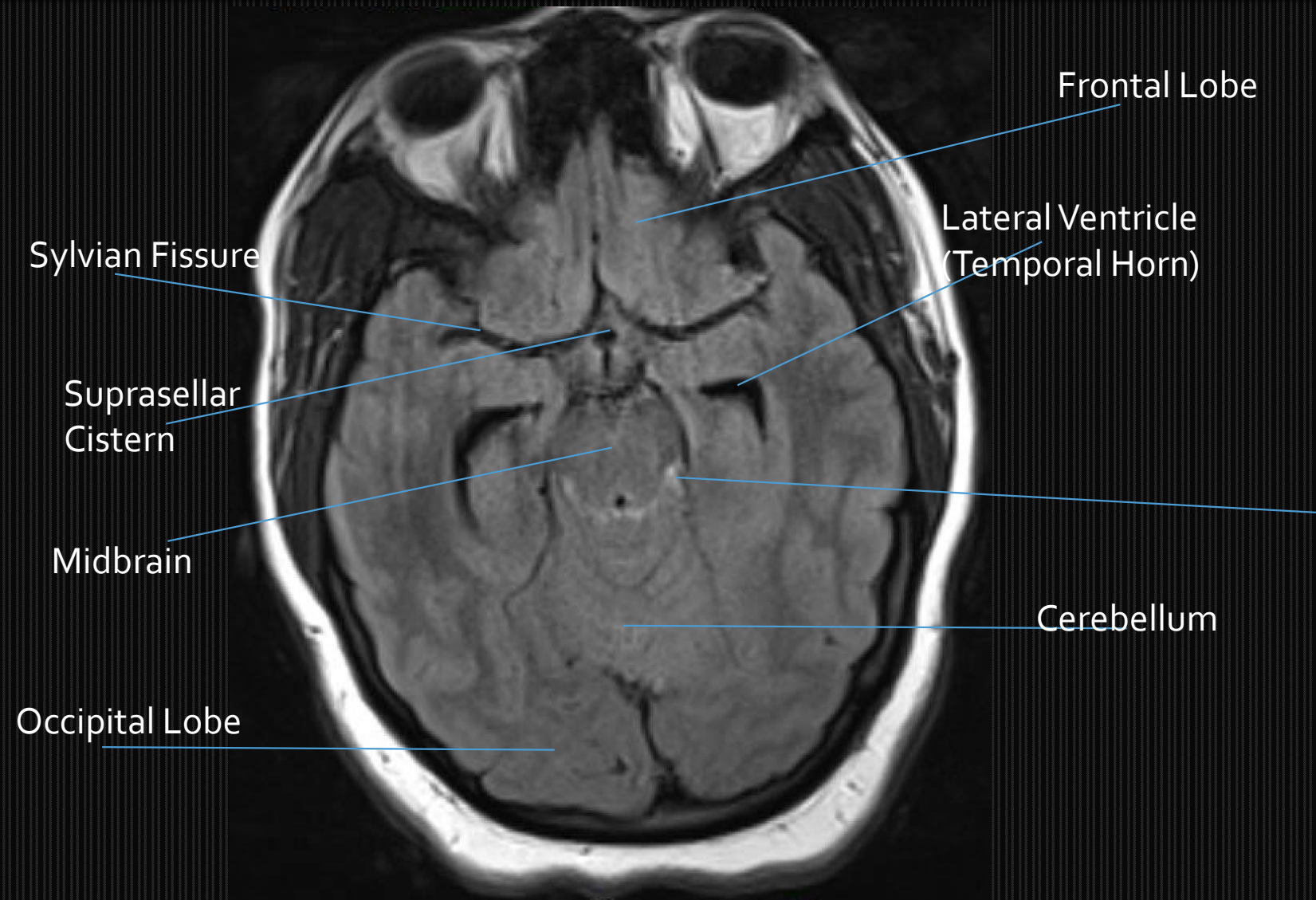


Findings?

Hint:

1. FLAIR is similar to T2 except it suppresses free-moving fluid (CSF).²

FLAIR (Fluid-attenuated Inversion Recovery), Axial (5:27)



Findings?

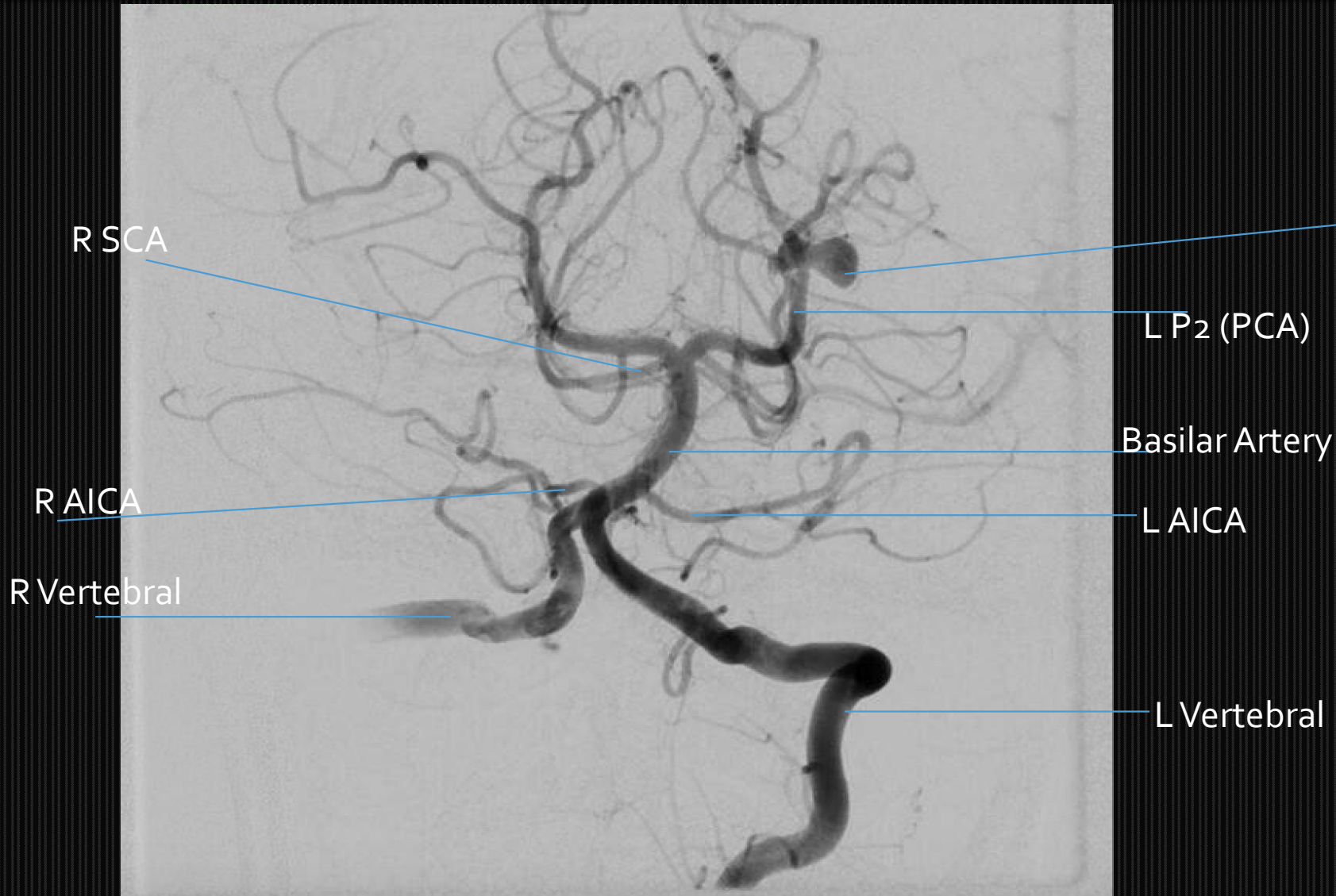
Hyperintense region in quadrigeminal cistern and at the roof of the fourth ventricle (not shown)

IR Cerebral Arteriogram - Left Vertebral



Findings?

IR Cerebral Arteriogram - Left Vertebral



Findings?

Left PCA aneurysm at P₂/P₃ junction. Left vertebral artery shows opacification of the basilar artery and branches. Good retrograde opacification of R vertebral artery.

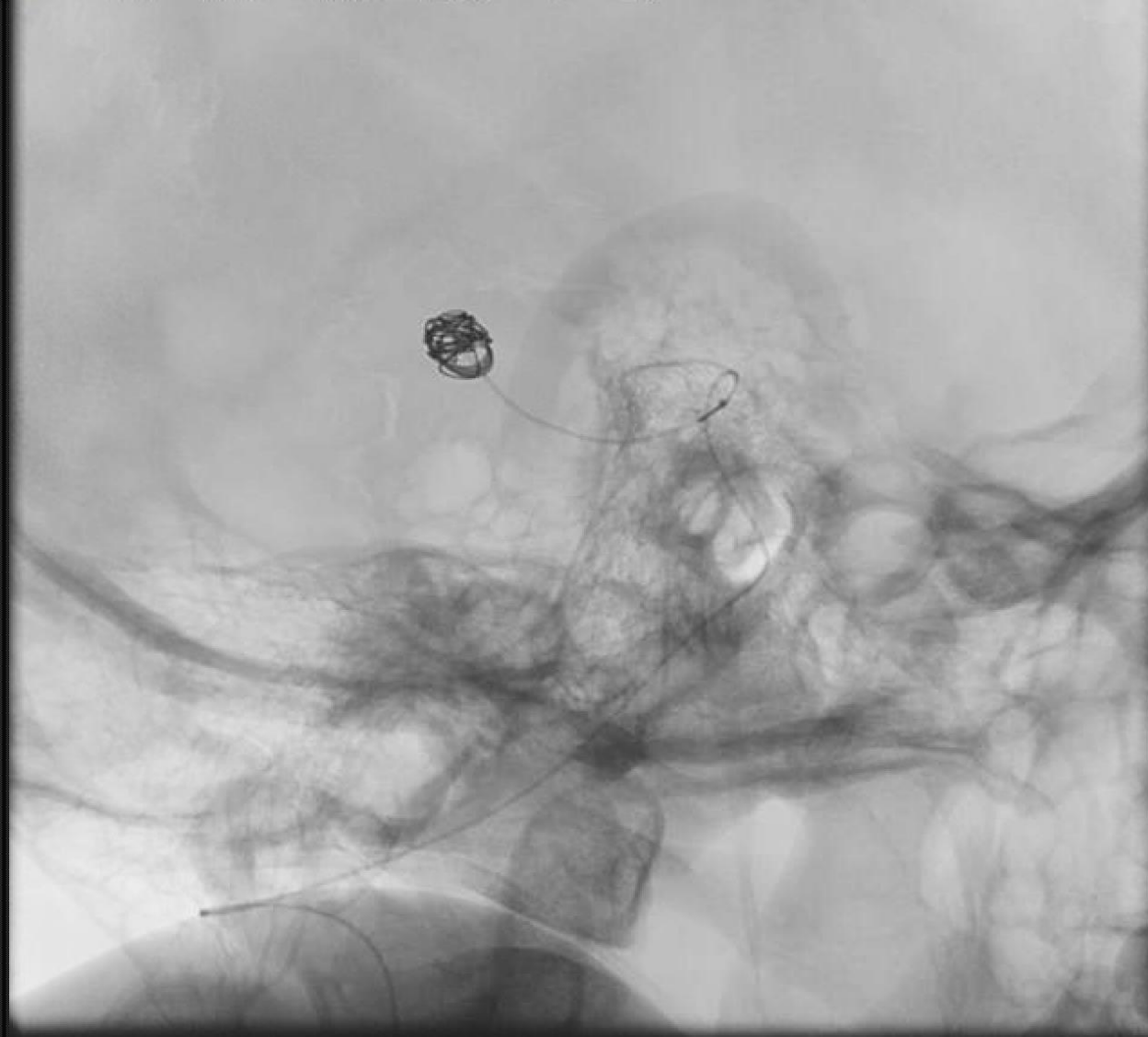
Putting It Together: Outcome and Treatment

- Bright DWI at left thalamus and posterior limb of internal capsule - suggests acute vs subacute infarct, infection/abscess, or tumor. Cannot differentiate vasogenic vs cytotoxic edema.³
- ADC hypointensity at left thalamus and posterior limb of internal capsule. DWI and ADC results suggest *acute ischemic infarct with cytotoxic edema*.
- Head MRA indicates 0.7cm bilobular PCA aneurysm at P₂/P₃ junction.
- FLAIR shows evidence of small SAH in quadrigeminal cistern.

Putting It Together: Outcome and Treatment

- IR Cerebral Arteriogram showed left PCA aneurysm.
- Underwent coil embolization with VIR for treatment
- Leading hypothesis at this point: Small L PCA aneurysm rupture with subsequent vasospasm of L thalamogeniculate branches off PCA. This caused sensory motor stroke – primary sensory symptoms with paresis of same limbs.

VIR Coil Embolization



Correct Imaging Done?

On presentation, the patient had a focal neurologic deficit⁴:

Angiogram was appropriate after discovering aneurysm.

Could argue MRI C-spine w &w/o contrast was unnecessary⁴.



Date of origin: 2006
Last review date: 2012

American College of Radiology ACR Appropriateness Criteria[®]

Clinical Condition: Focal Neurologic Deficit

Variant 1: Single focal neurologic deficit, acute onset, stable or incompletely resolving.

Radiologic Procedure	Rating	Comments	RRL*
MRI head without and with IV contrast	8	Both CT and MRI may be necessary. CT screens for suspected hemorrhage in the acute setting and MRI screens for infarction and masses.	O
CT head without IV contrast	8	Both CT and MRI may be necessary. CT screens for suspected hemorrhage in the acute setting and MRI screens for infarction and masses.	☼☼☼
MRI head without IV contrast	7		O
MRA head and neck without and with IV contrast	7		O
MRA head and neck without IV contrast	7		O
CTA head and neck with IV contrast	7		☼☼☼
CT head perfusion with IV contrast	7		☼☼☼
MRI head perfusion with IV contrast	7		O
CT head without and with IV contrast	5	If MRI is unavailable or contraindicated. Consider CT perfusion.	☼☼☼
CT head with IV contrast	4		☼☼☼
MR spectroscopy head without IV contrast	4		O
MRI functional (fMRI) head without IV contrast	3		O
Tc-99m HMPAO SPECT head	3	For problem solving in HIV/AIDS.	☼☼☼☼
Arteriography cervicocerebral	3	For problem solving.	☼☼☼
FDG-PET/CT head	2		☼☼☼☼
Thallium-201 SPECT head	2	For problem solving in HIV/AIDS.	☼☼☼☼

Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate

*Relative Radiation Level

Pediatric Ischemic Stroke

- Differential is extensive for this patient but includes: subarachnoid hemorrhage with subsequent vasospasm, polycystic kidney disease, cardiac, vasculitis, connective tissue disorder, fibromuscular dysplasia, hypercoagulable state, infectious, drug use
- Only 0.63-6.4 strokes per 100,000 children per year⁵

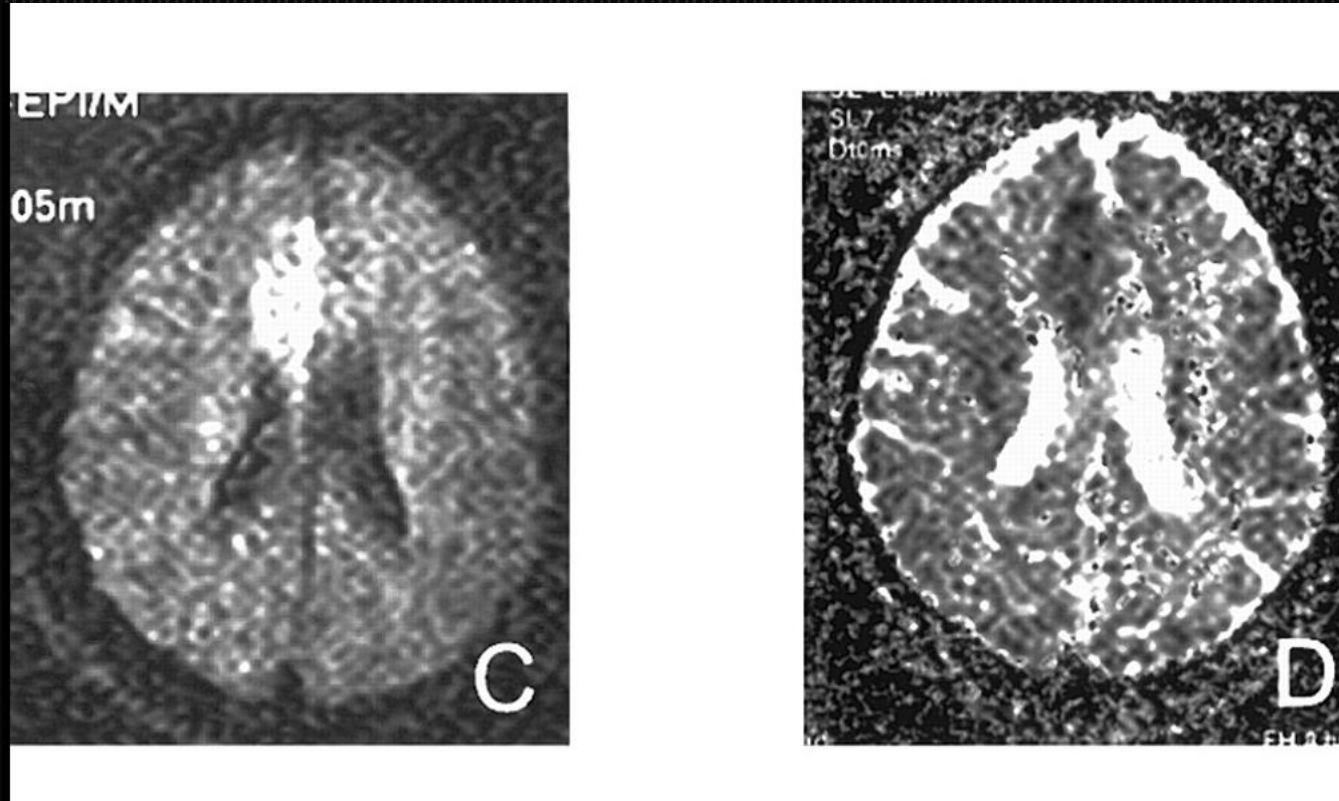
Ischemic Stroke Work-up

- <4.5 hours, can use Alteplase
 - 4.5-24 hours, candidate for only mechanical thrombectomy
 - >24 hours, not a candidate for either⁵
-
- Our patient was not eligible for alteplase from inclusion criteria (<18 years old) and not mechanical thrombectomy from exclusion criteria (aneurysm present, SAH present)⁵

Ischemic Stroke Imaging

- **DWI was a sensitive and specific indicator of ischemic stroke in patients presenting within six hours of symptom onset compared to CT or standard MRI⁶.**
- **CT is still preferred for possible hemorrhagic stroke due to time of scan**
- **MRI should be used rather than CT only if it does not delay treatment with intravenous alteplase in an eligible patient.**

Ischemic Stroke: Classic Findings



C) Early DWI scan shows right-sided hyperintensity in frontal lobe. D) Hypointensity in same area on ADC map⁷.

Sensitivity, Specificity, and Radiation

	DWI (ordered as Brain MRI non-contrast)	CT (non-contrast)
Sensitivity ⁸	91%	61%
Specificity ⁸	95%	65%
Radiation ⁹	0 mSv	2 mSv
Cost ¹⁰	\$675-\$2,975	\$304-\$1,873

WrapUp

- Pediatric ischemic stroke is incredibly rare with a wide differential diagnosis
- DWI is a more sensitive and specific test compared to CT or standard MRI for ischemic stroke
- Ischemic stroke is bright on DWI and hypointense on ADC
- Thus, MRI (DWI) should be used when it does not affect alteplase timing

References

- 1) UpToDate: Neuroimaging of acute ischemic stroke [Accessed 15 June 2018].
- 2) De Coene, B. et al. MR of the brain using fluid-attenuated inversion recovery (FLAIR) pulse sequences. *American Journal of Neuroradiology*. Nov 1992. 13(6) 1555-1564.
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- 4) Acsearch.acr.org. (2018). Appropriateness Criteria. [online] Available at: <https://acsearch.acr.org/list> [Accessed 14 June 2018].
- 5) Demaerschalk, B. et al. Scientific Rationale for the Inclusion and Exclusion Criteria for Intravenous Alteplase in Acute Ischemic Stroke. *Stroke*. 2016;47:581-641, originally published December 22, 2015.
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- 7) Van Everdingen, K.J., et al. Diffusion-Weighted Magnetic Resonance Imaging in Acute Stroke. *Stroke*. 1998. 29:1783-1790.
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- 10) Healthcare Bluebook. (n.d.). Retrieved June 16, 2018, from https://www.healthcarebluebook.com/page_SearchResults.aspx?SearchTerms=MRI+with+contrast&tab=ShopForCare