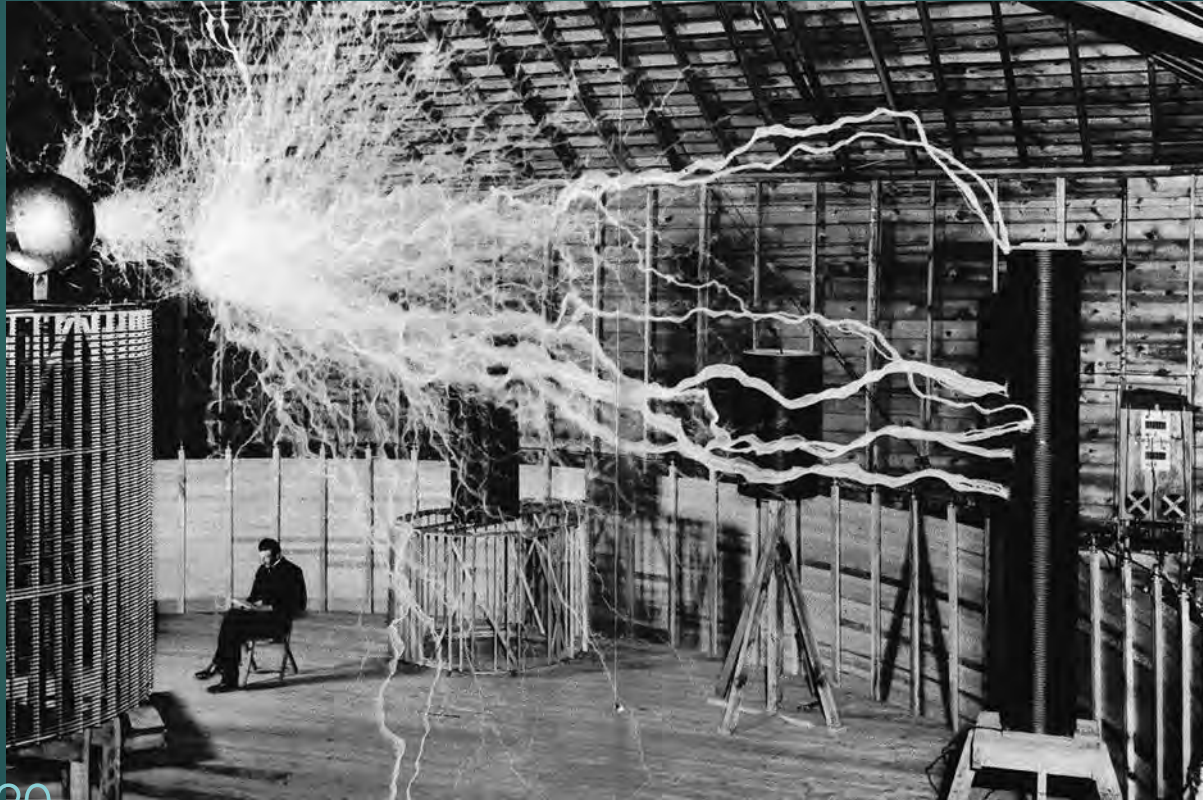


# Neuroimaging in Dementia



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Patient Centered Imaging & Technology Solutions

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# Disclosures

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- ▶ None: I have no conflict of interest related to the material in this presentation.

# Goals for session

- ▶ Review characteristic MRI appearances of the most common causes of dementia

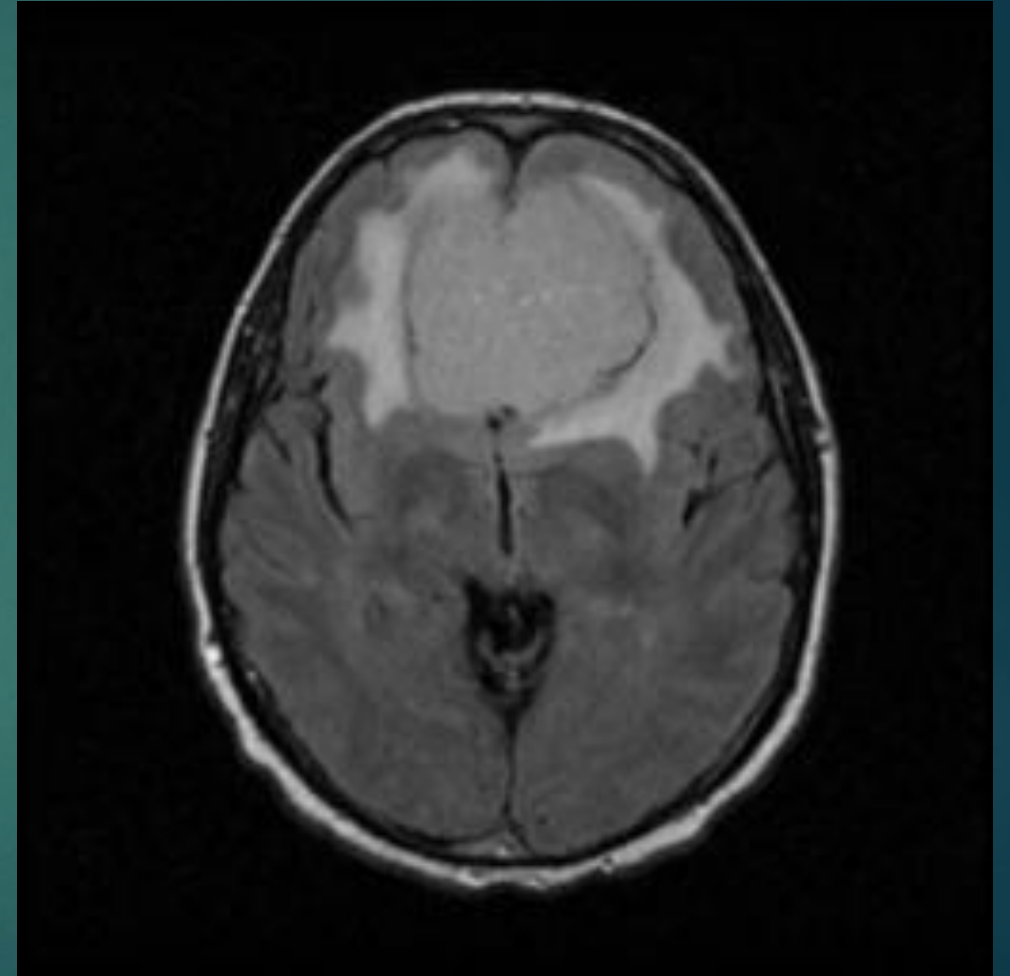
# Dementia Differential considerations

- ▶ Structural: Tumor, chronic subdural hematoma, hydrocephalus (NPH)
- ▶ Vascular
  - ▶ Multi-infarct dementia or Microvascular white matter disease
- ▶ Creutzfeldt-Jakob disease
- ▶ Neurodegenerative
  - ▶ AD, FTLD, Dementia with Lewy Bodies
- ▶ Mixed dementia: >10% patient with dementia have this, usually combination of AD and vascular disease



# Dementia ddx: Tumor

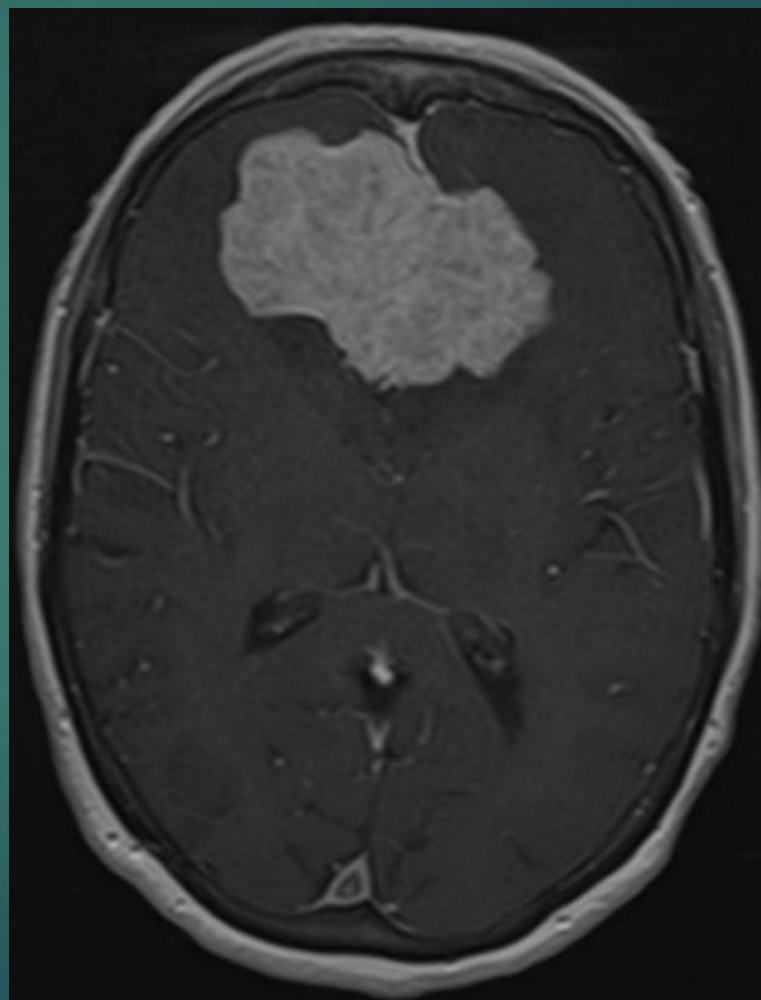
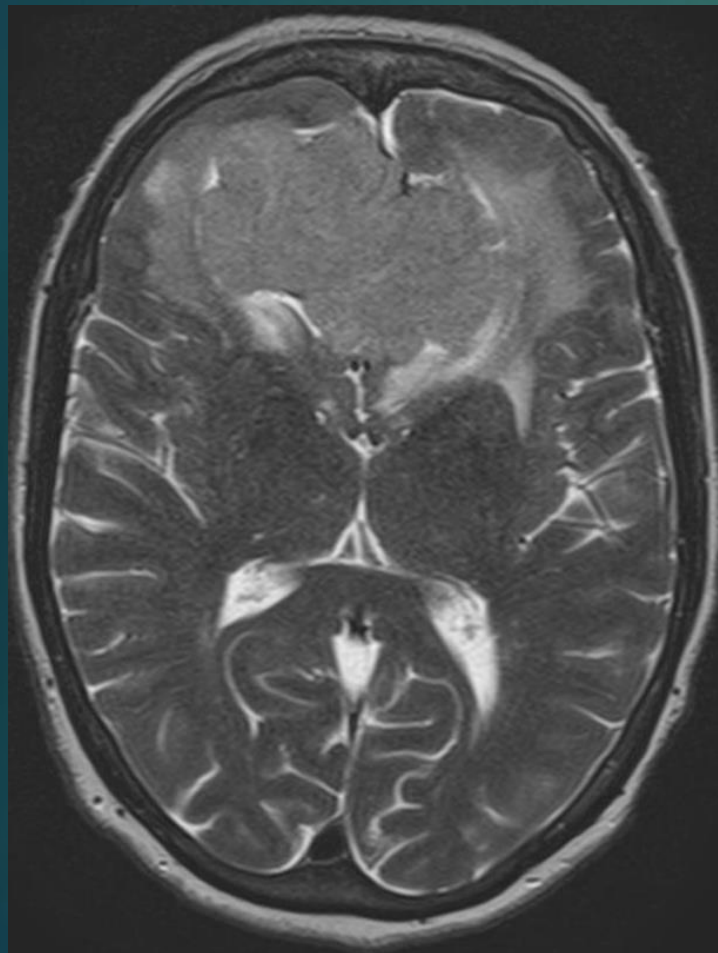
- ▶ Masses may present with cognitive changes
- ▶ Frontal meningiomas in particular may be slow growing with corresponding slow development of intellect and personality changes



# Anterior parafalcine meningioma: T2, T1 post-gad

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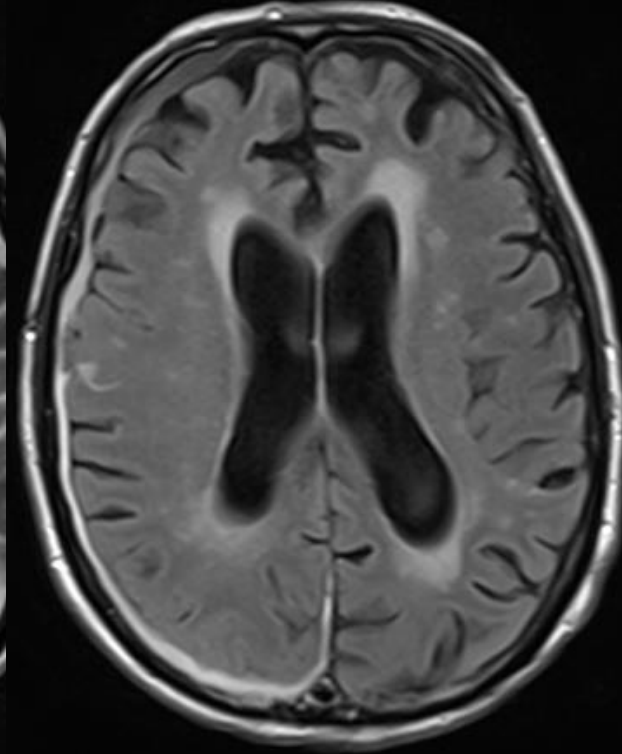
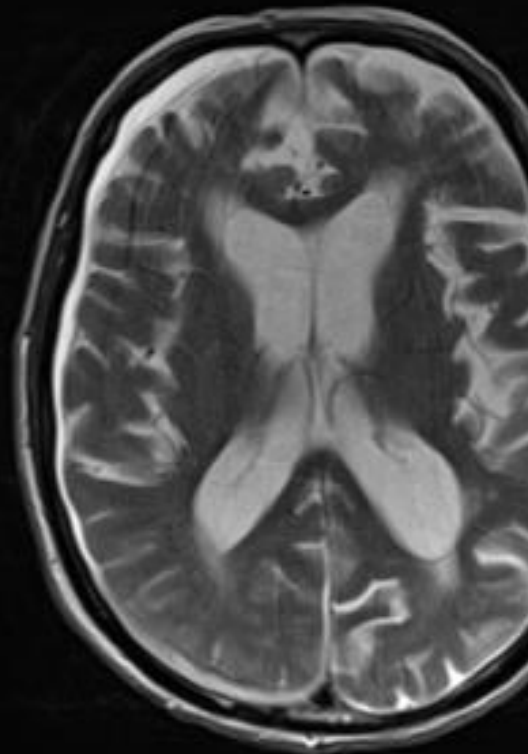
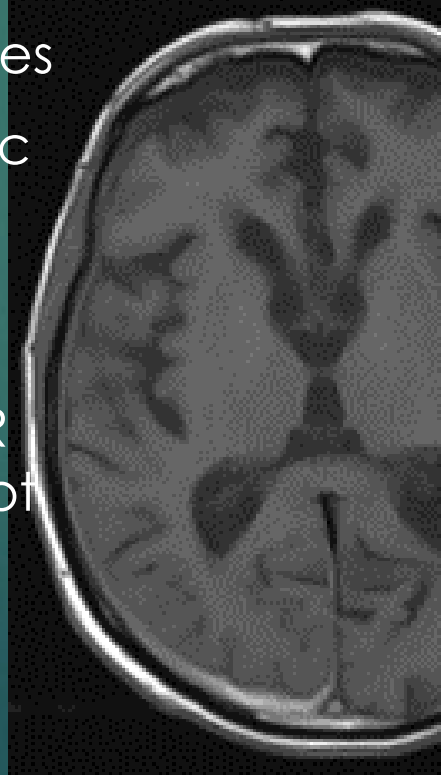
Most common adult intracranial neoplasm



MR appearance:  
Dural based extra-  
axial mass with  
variable adjacent  
edema and avid  
uniform enhancement

# Chronic subdural hematoma

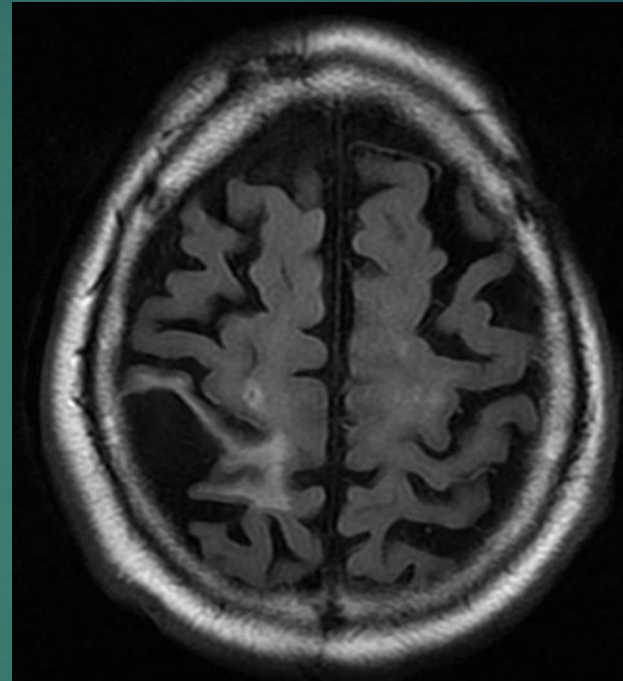
- ▶ Symptoms may include cognitive dysfunction or personality change
- ▶ Crescent-shaped extraaxial collection – most commonly overlies supratentorial convexities
- ▶ CT: Low density suggests chronic SDH (> 3 weeks old)
- ▶ MRI: low T1 (higher signal indicates ongoing more recent bleeding), high T2, high T2 FLAIR (as proteinaceous fluid, does not suppress like standard CSF)



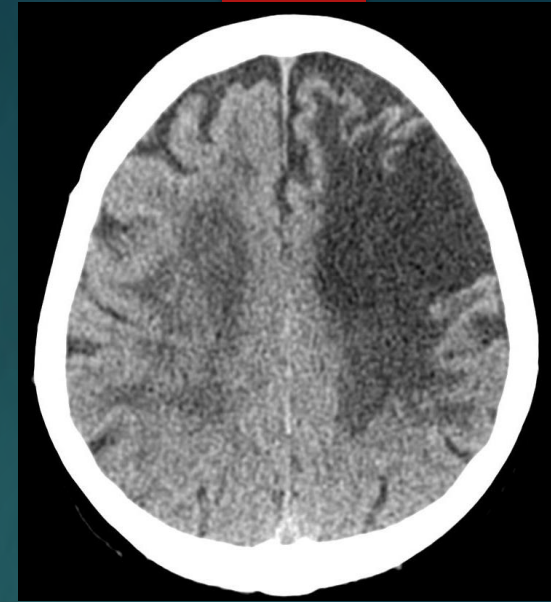


# Vascular dementia

- ▶ 2nd most common dementia (after AD), 10 % of dementias
- ▶ Stepwise progressive ↓ in cognitive function
- ▶ Heterogeneous group of disorders with varying etiologies, pathologic subtypes
  - ▶ Most common: multiinfarct dementia or small vessel disease (leukoaraiosis)
  - ▶ Can occur alone or in association with AD (mixed dementia)
  - ▶ Number of microbleeds independent predictor of cognitive impairment

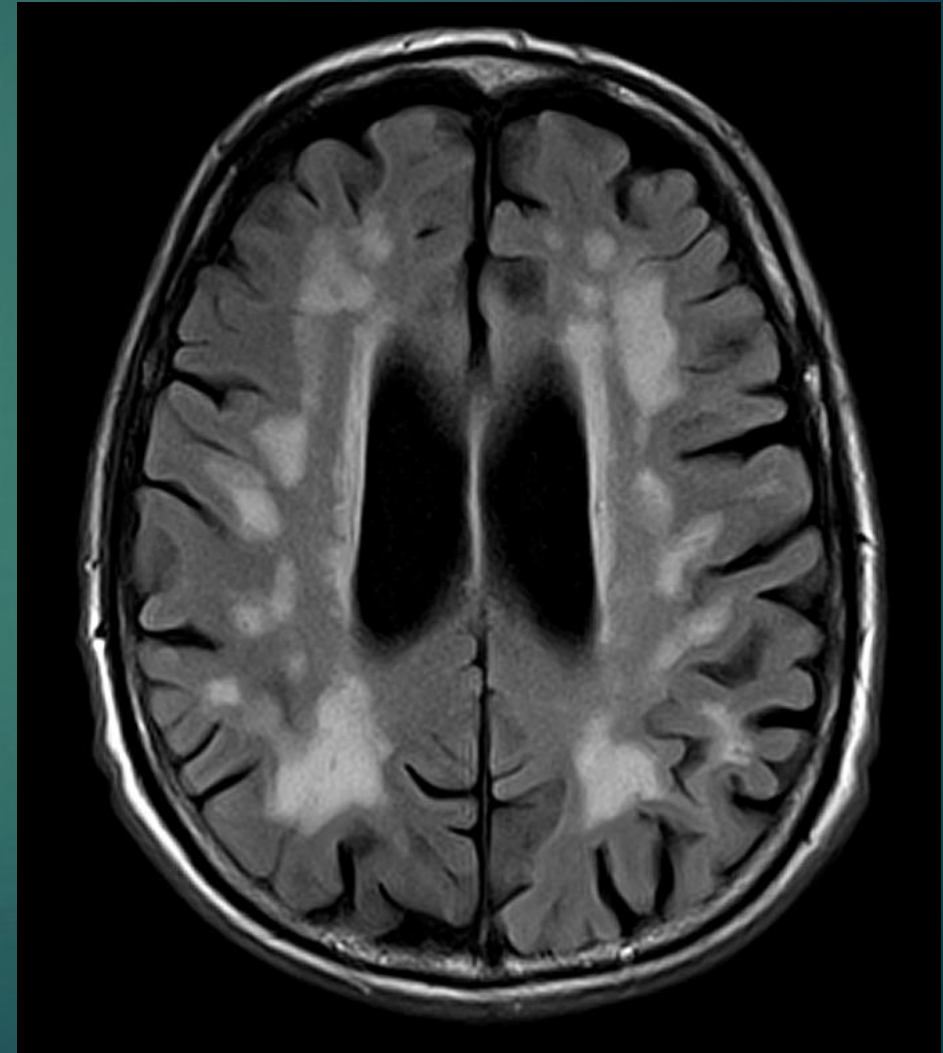
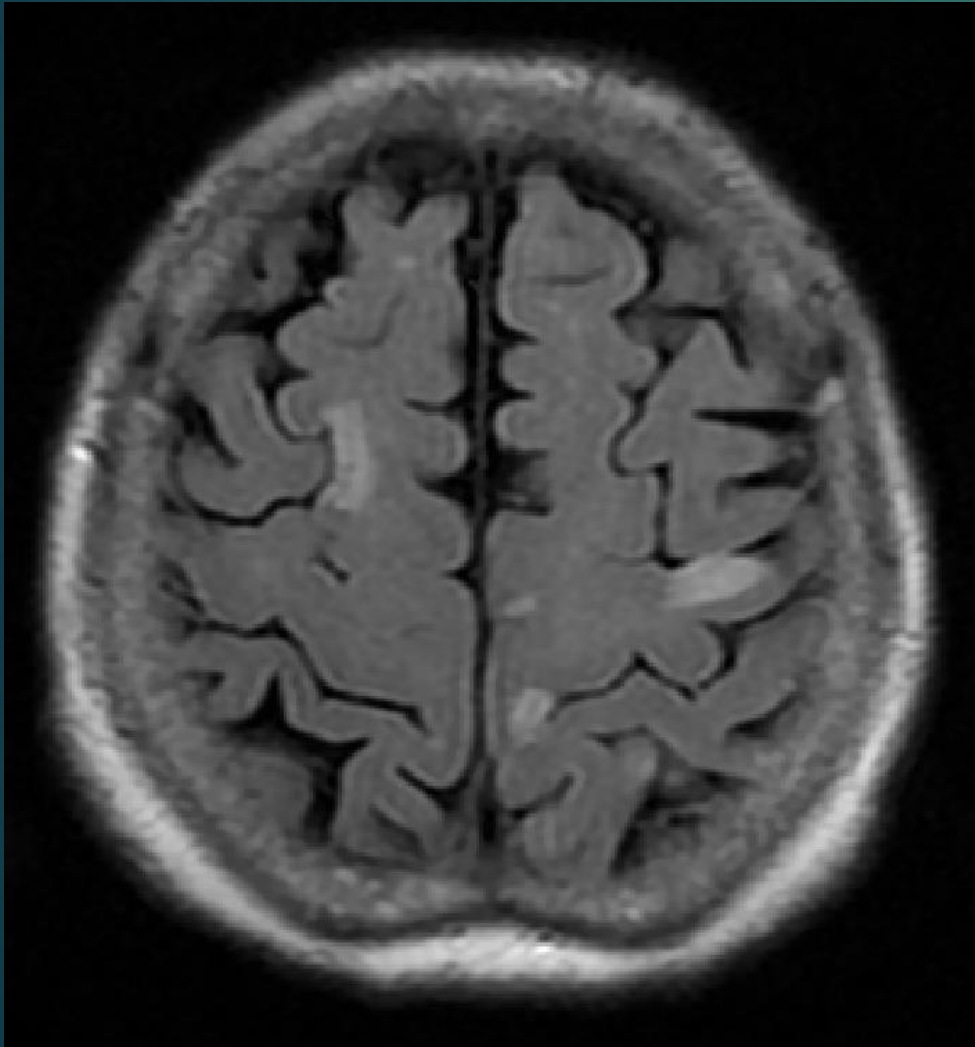


Combined infarcts and small vessel white matter disease





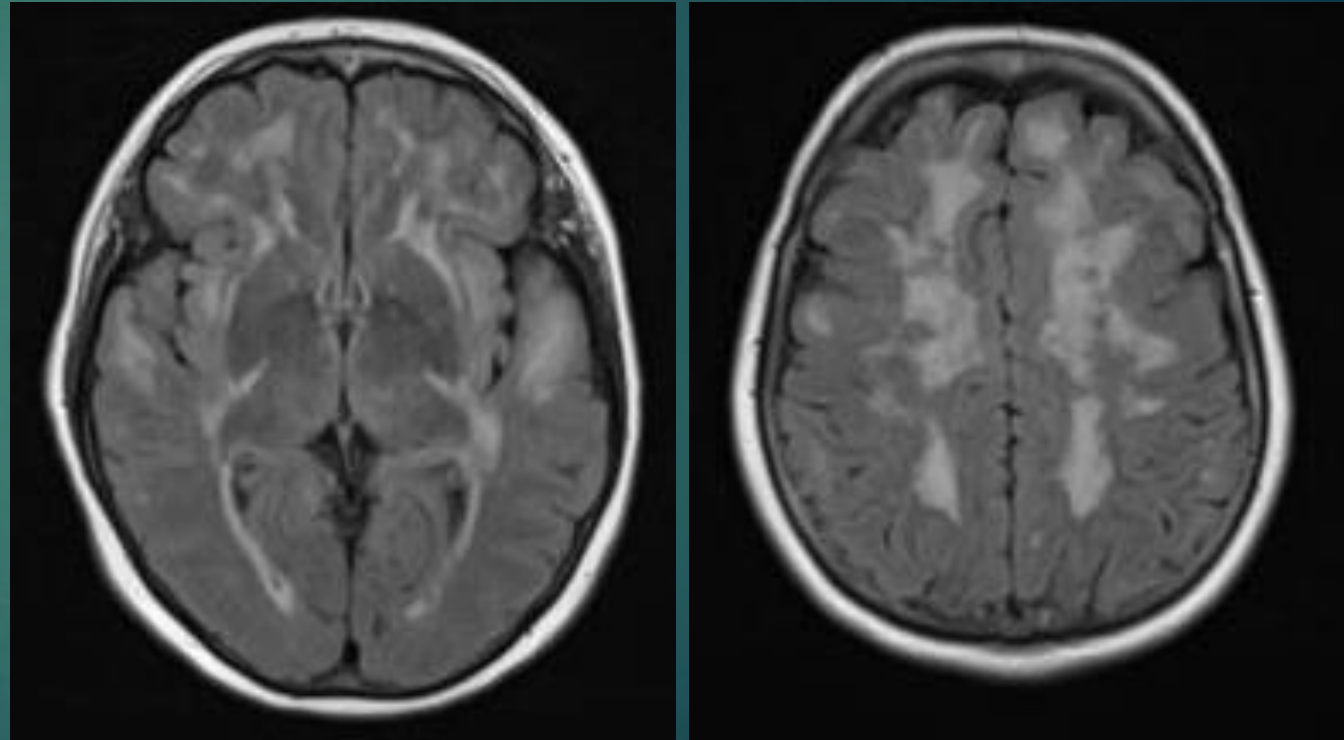
# Multiinfarct versus small vessel white matter disease



# CADASIL Cerebral autosomal dominant arteriopathy

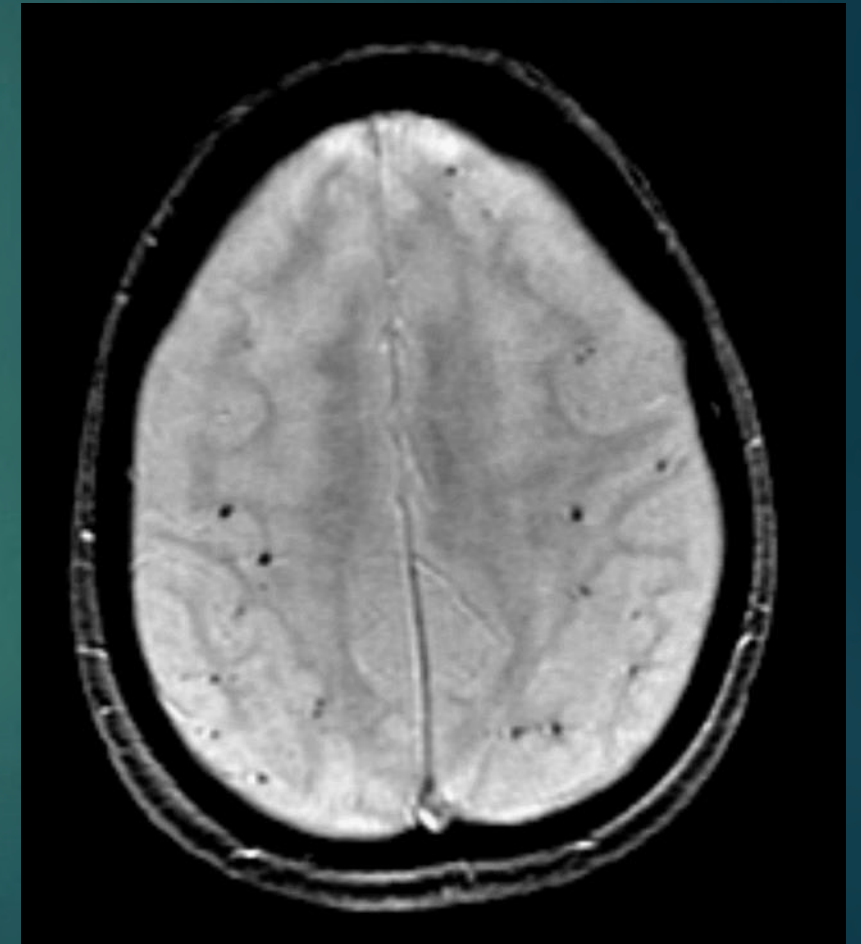
with subcortical infarcts and leukoencephalopathy

- ▶ Characterized by recurrent lacunar and subcortical white matter ischemic strokes and dementia in young and middle age patients
  - ▶ MRI: widespread confluent white matter hyperintensities, involvement of the anterior temporal white matter and external capsule are characteristic
  - ▶ Diagnosis: genetic testing for NOTCH3 gene mutation



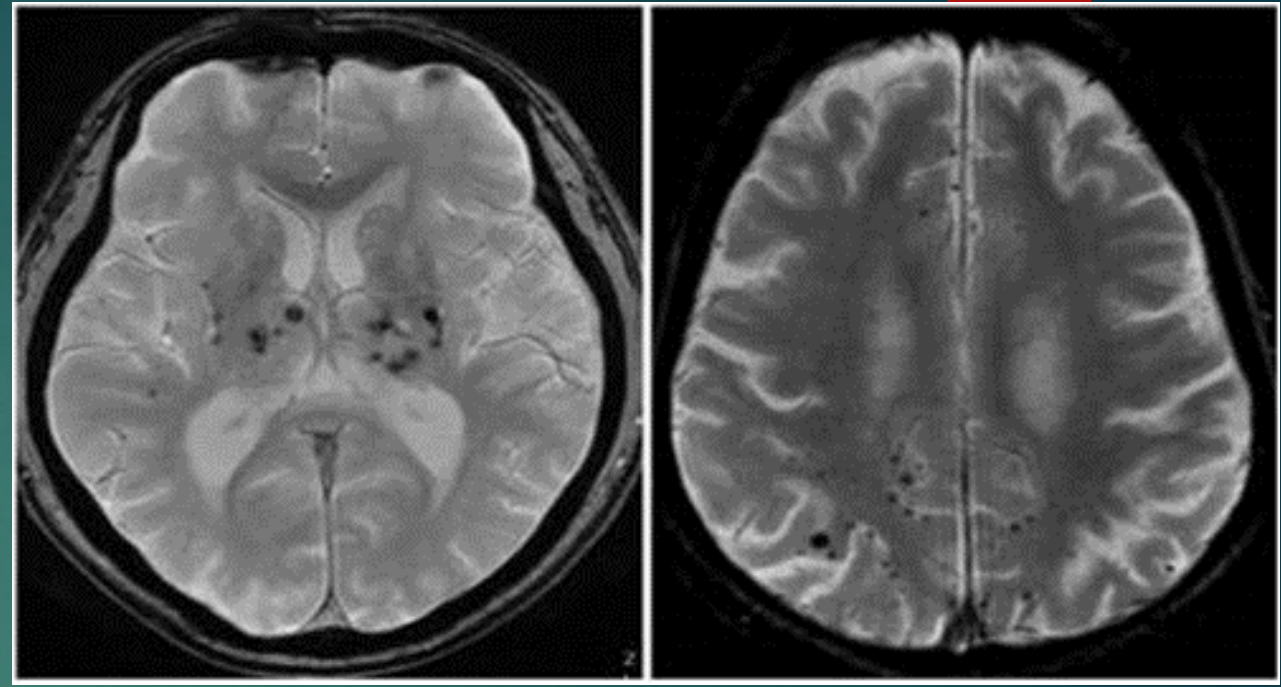
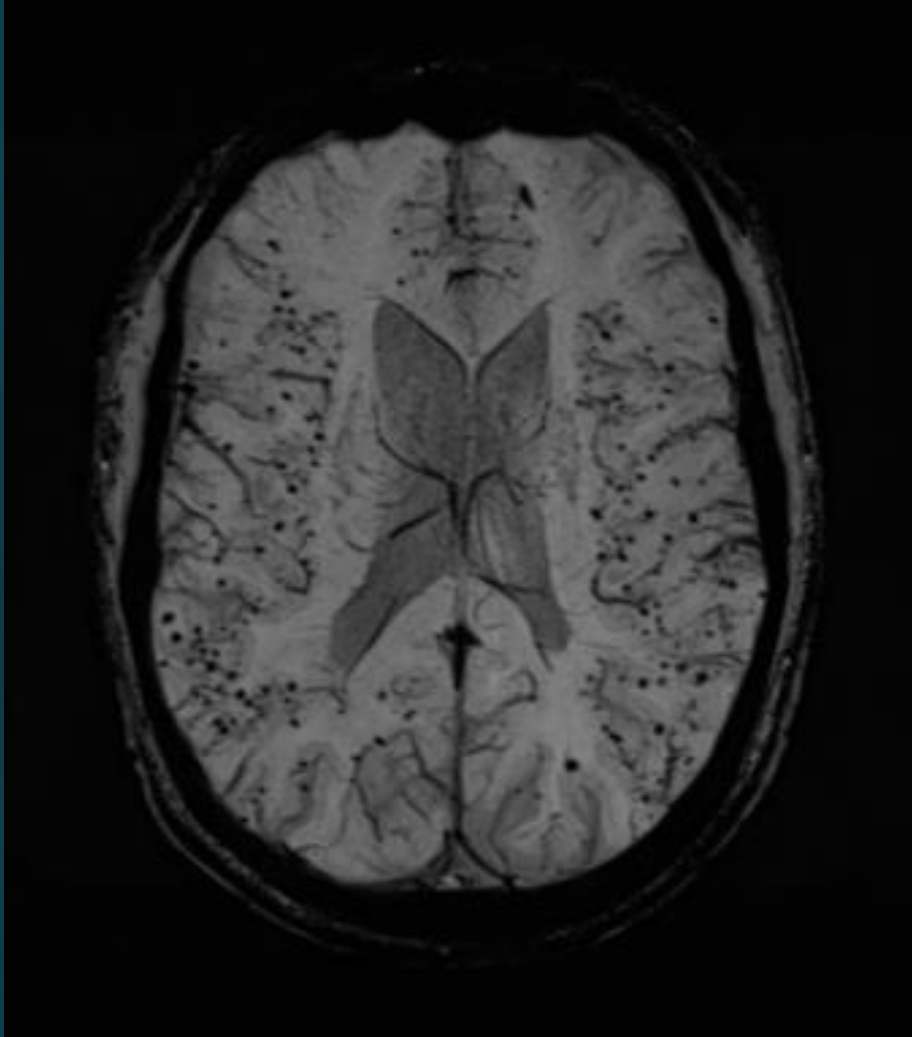
# CAA: Cerebral amyloid angiopathy

- ▶ 15-20% of primary intracranial hemorrhages in patients > 60 years old
  - ▶ Amyloid deposition weakens the cerebral vessel walls leading to hemorrhages
  - ▶ Characteristic MR appearance of multiple remote peripheral micro-hemorrhages on gradient or susceptibility weighted imaging
- ▶ Association with dementia:
  - ▶ Advanced CAA is associated with cognitive impairment
  - ▶ CAA found in 26% AD pts (autopsy series)





# CAA

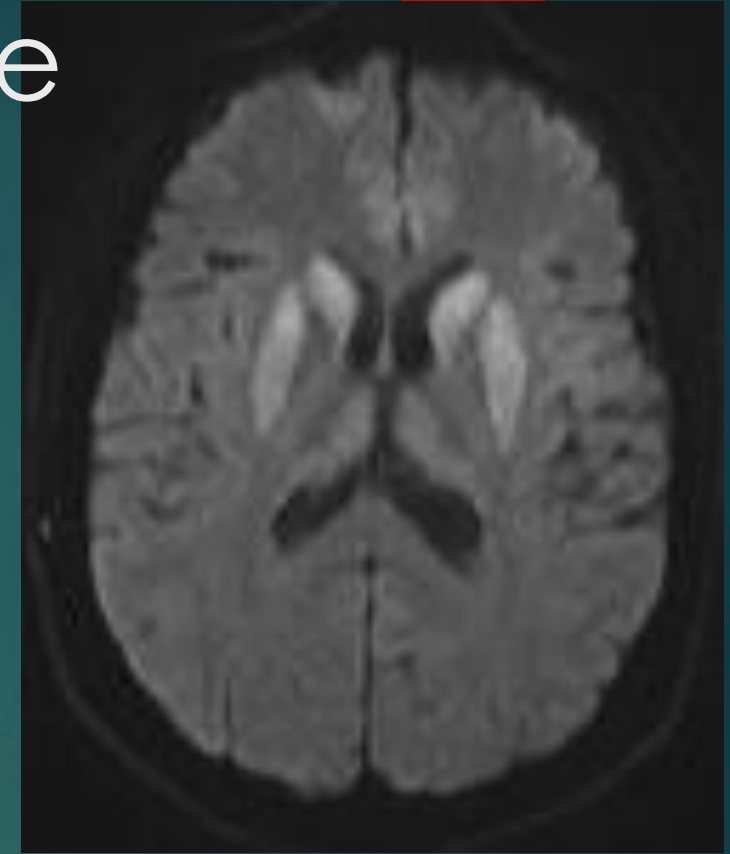
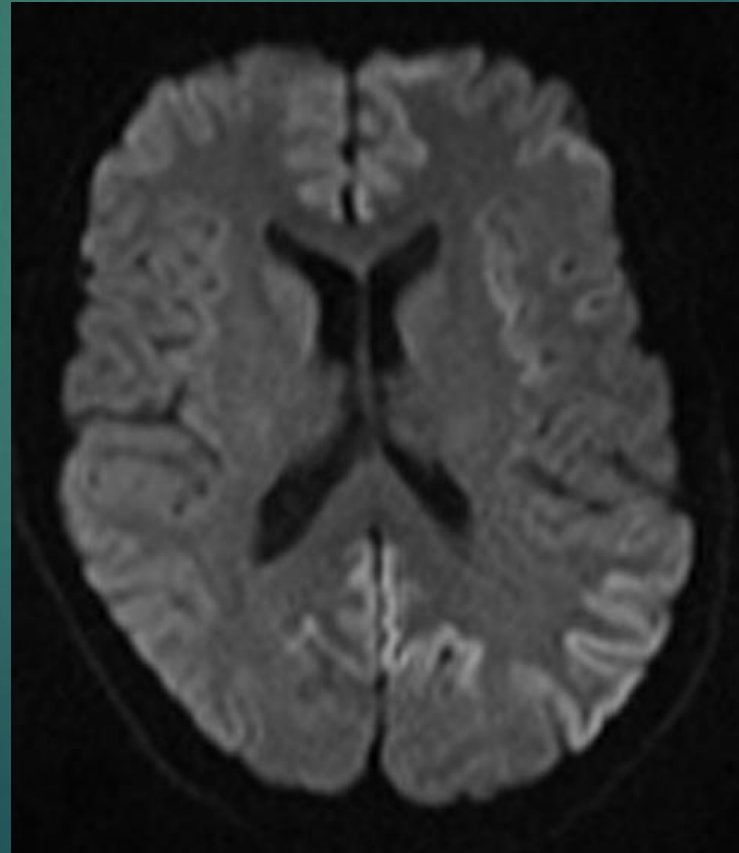


Gradient imaging showing hypertensive central microhemorrhages versus peripheral CAA hemorrhages

CAA example with susceptibility weighted imaging

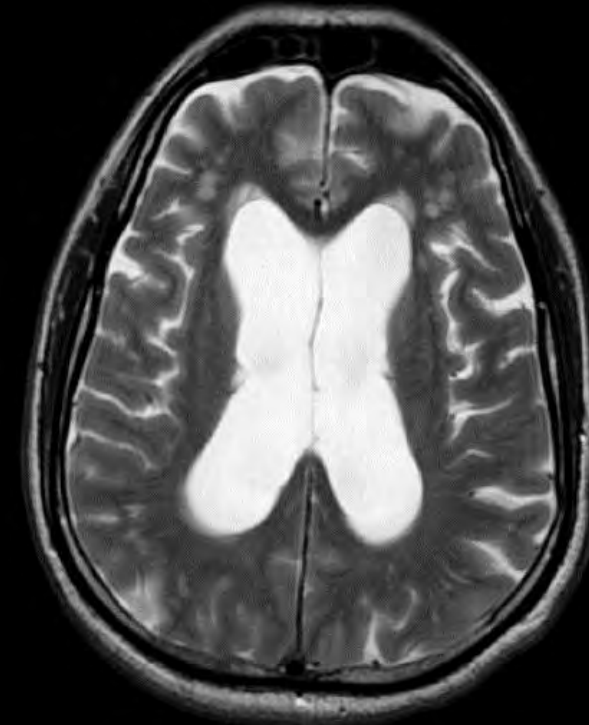
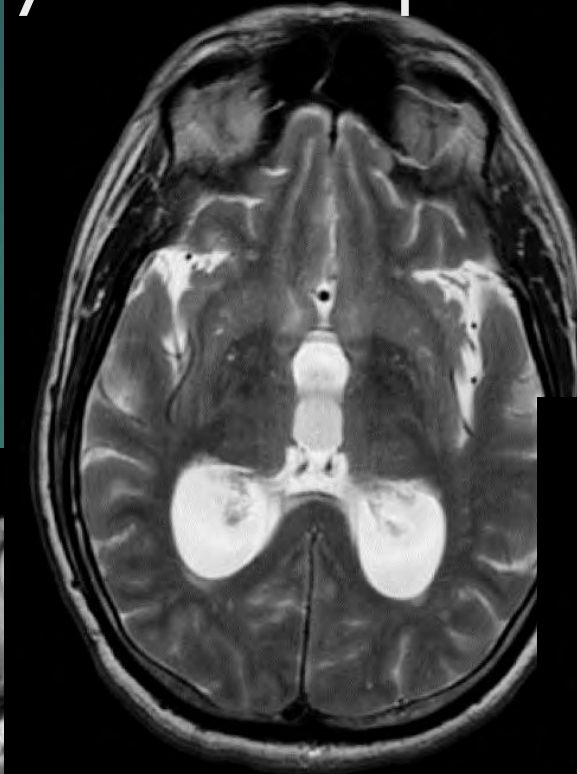
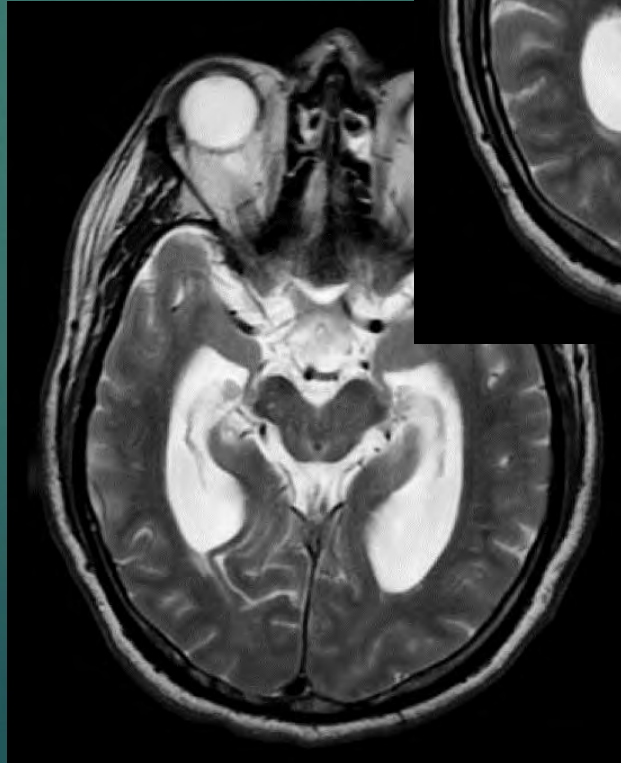
# CJD: Creutzfeldt-Jakob disease

- ▶ Diffusion: Gyriform hyperintense areas in cerebral cortex ("cortical ribbon" sign) and basal ganglia
- ▶ T2: hyperintense in BG, thalami and cortex
- ▶ Diagnosis: MRI and CSF protein biomarkers



# NPH: Normal pressure hydrocephalus

- ▶ MRI findings:
  - ▶ Disproportionately enlarged lateral & 3rd ventricles
- ▶ Evaluation for shunting:
  - ▶ High volume LP or lumbar drain placement
  - ▶ Clinical assessment pre and post CSF removal

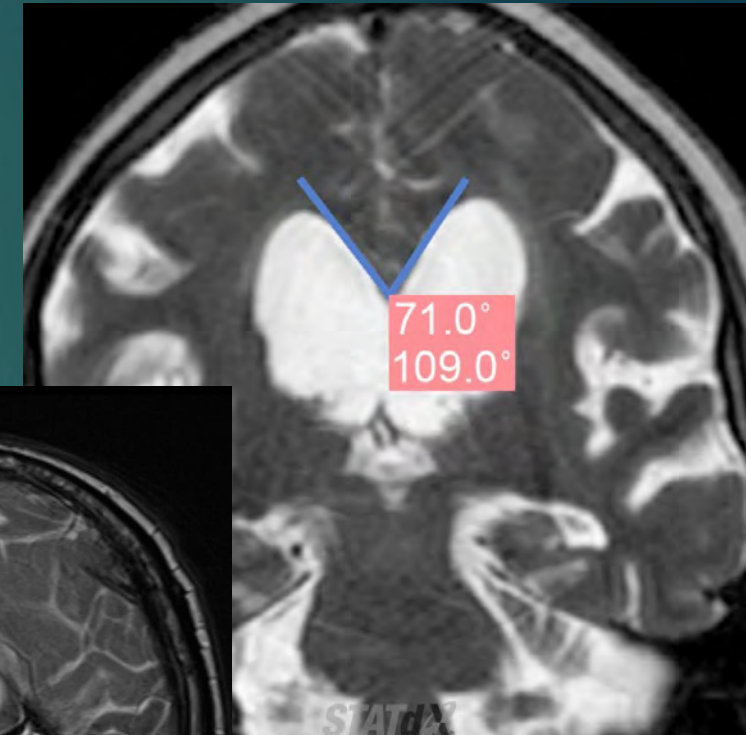
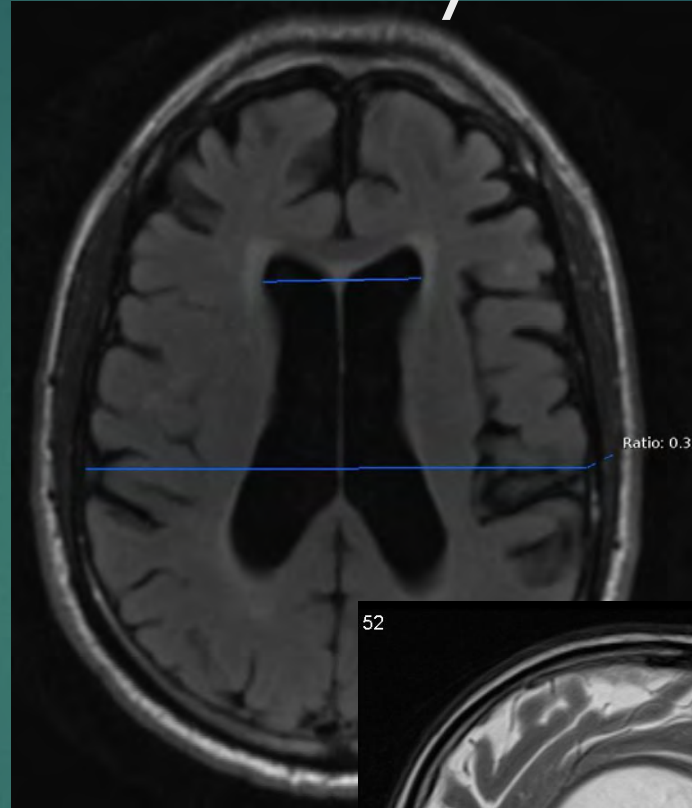




# NPH: Normal pressure hydrocephalus

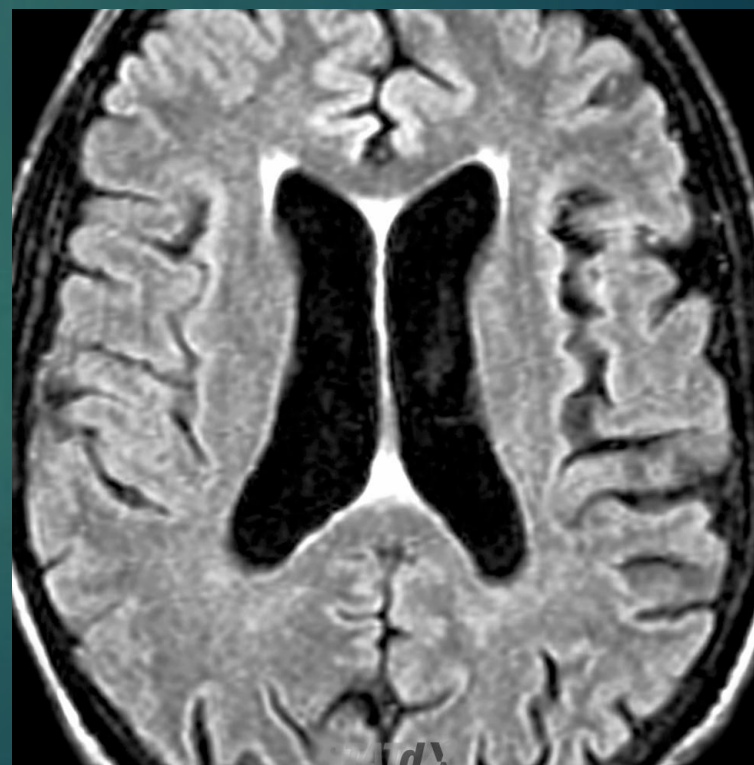
## ► MRI findings:

- **Evans index** (ratio of frontal horn width to widest diameter of brain)  $>0.3$ - $.35$
- **Callosal angle** (angle between lateral ventricles on coronal)  $< 90^\circ$
- Aqueductal flow void or elevated aqueduct stroke volume



# MRI for Neurodegenerative Disease

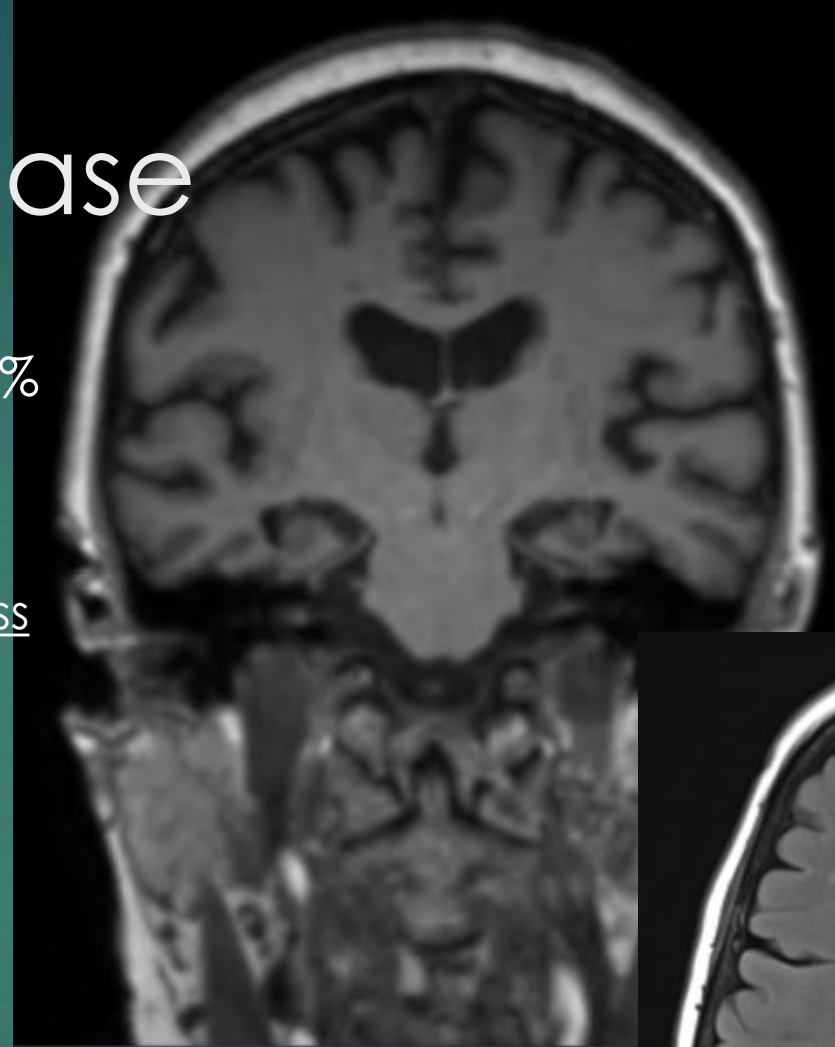
- ▶ Pattern of volume loss may support a particular dementia diagnosis
  - ▶ Imaging characteristics can be difficult to appreciate
  - ▶ There is overlap of findings between diagnoses
  - ▶ Automated volumetric postprocessing can help



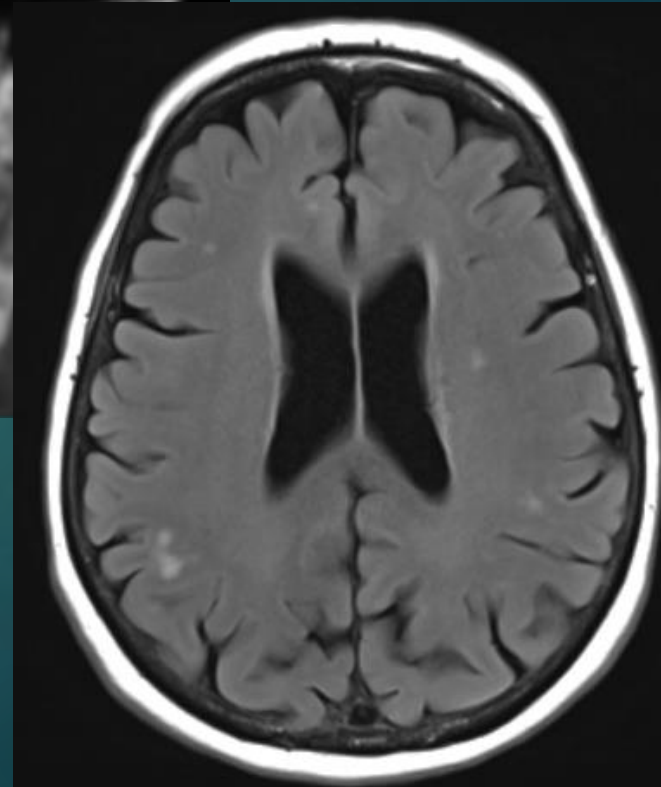
“Normal aging” in elderly patient

# AD: Alzheimer's Disease

- ▶ Most common cause of dementia: 60-80%
- ▶ MRI
  - ▶ Temporal/parietal cortical atrophy with disproportionate hippocampal volume loss



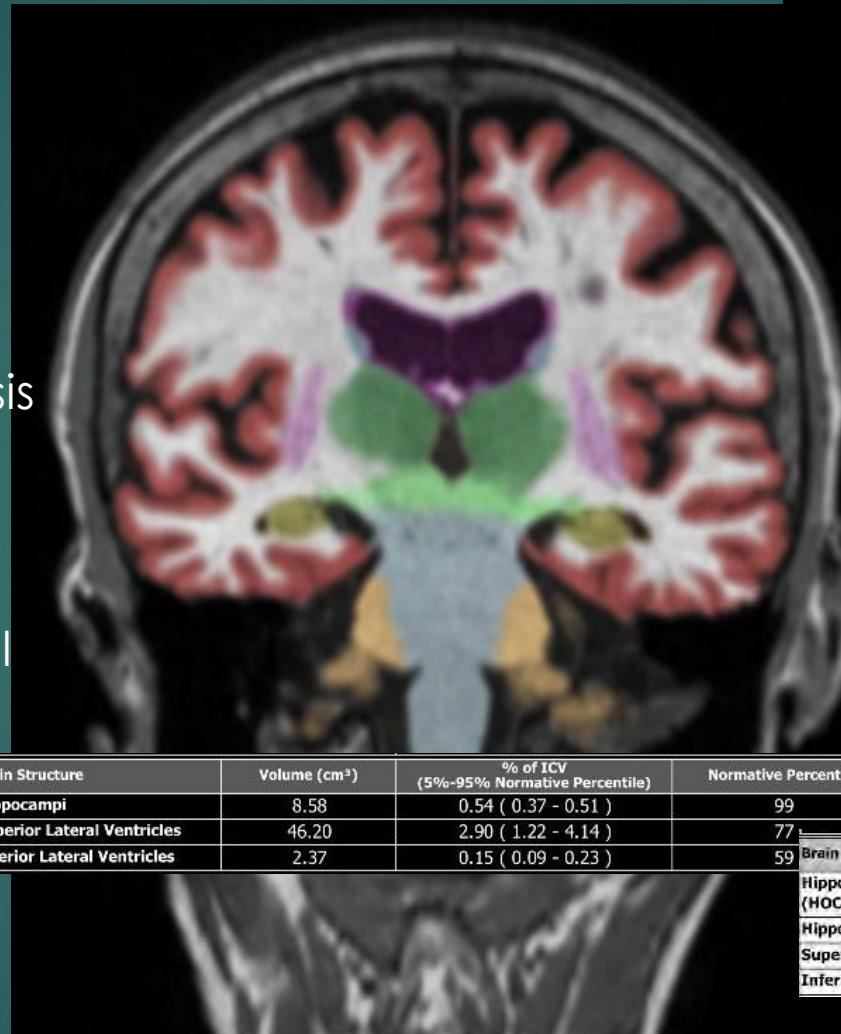
Example showing  
small hippocampi,  
and global volume  
loss



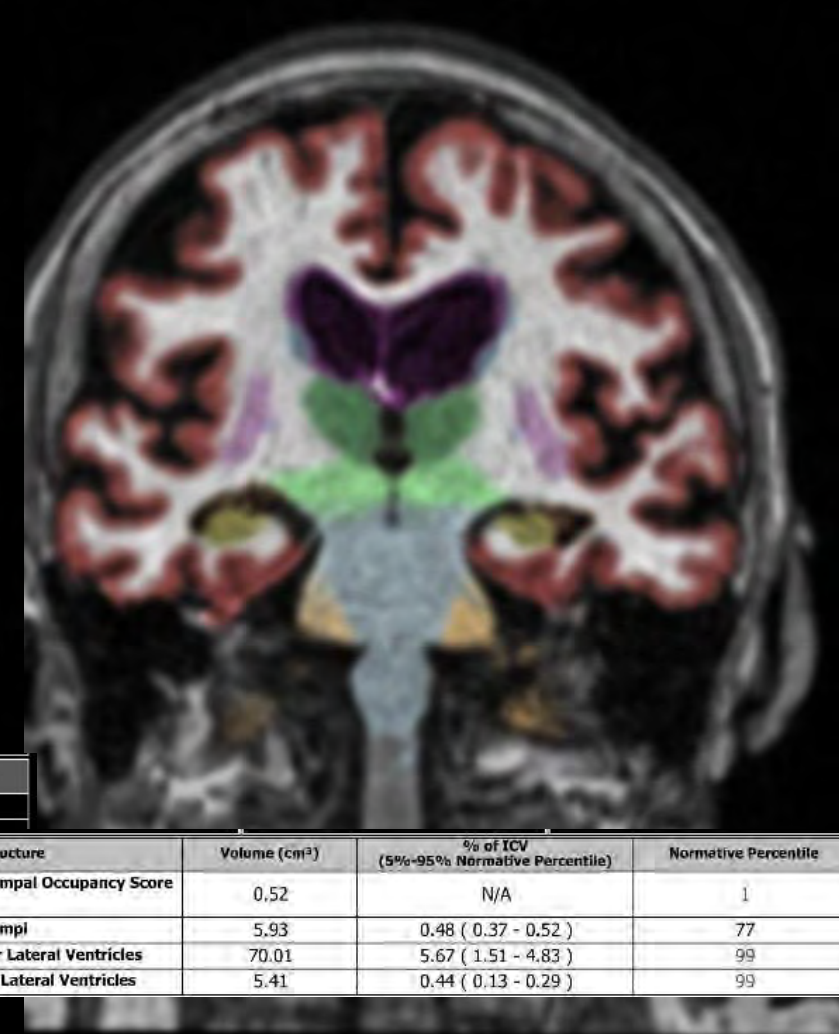


# Structural MRI

- ▶ MR volumetric analysis helps diagnosis and helps predict progression
  - ▶ Worse short term prognosis for patients with severely atrophic hippocampi
  - ▶ Serial MRIs may show progressive hippocampal volume loss which is predictive of clinical progression



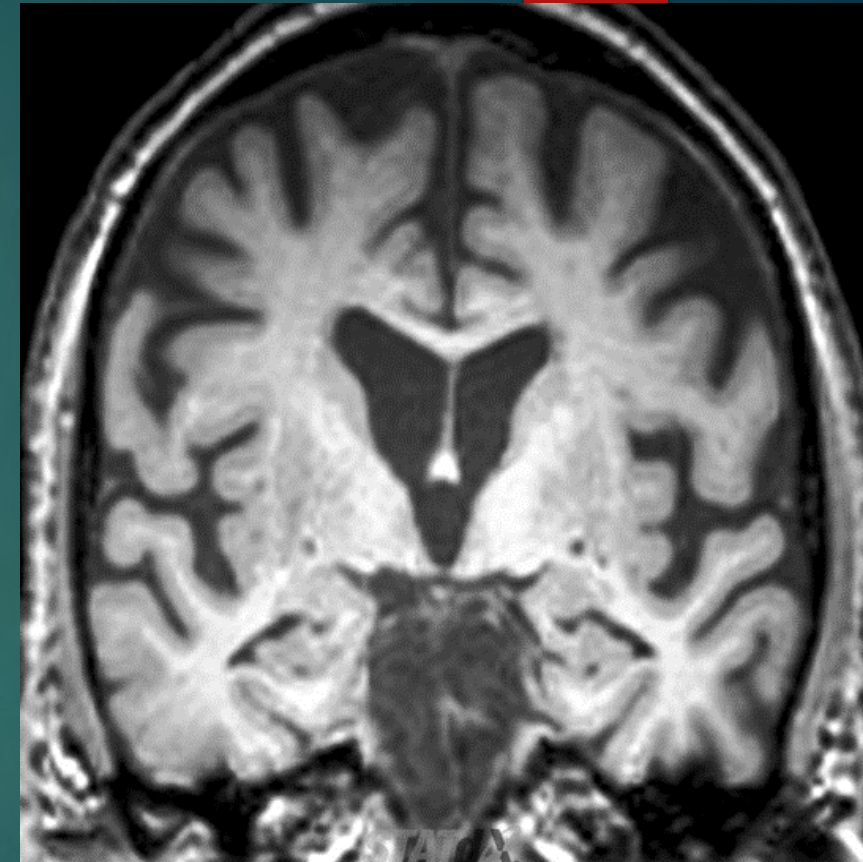
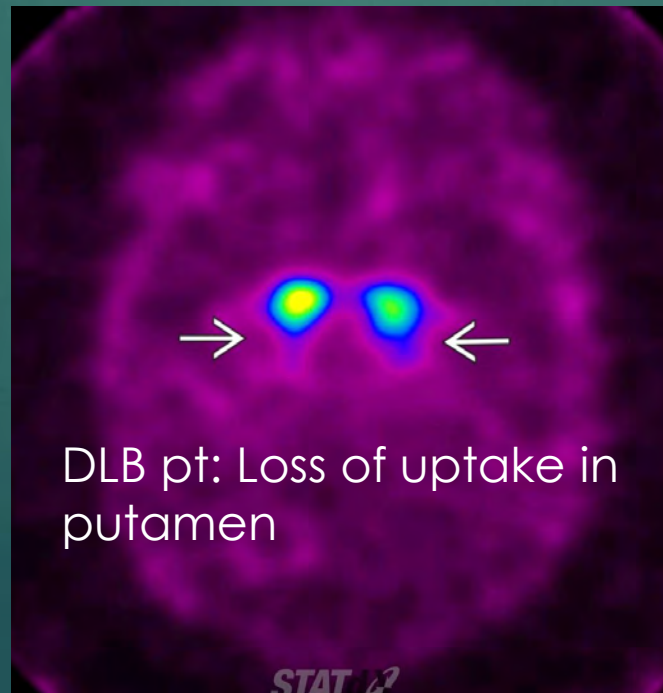
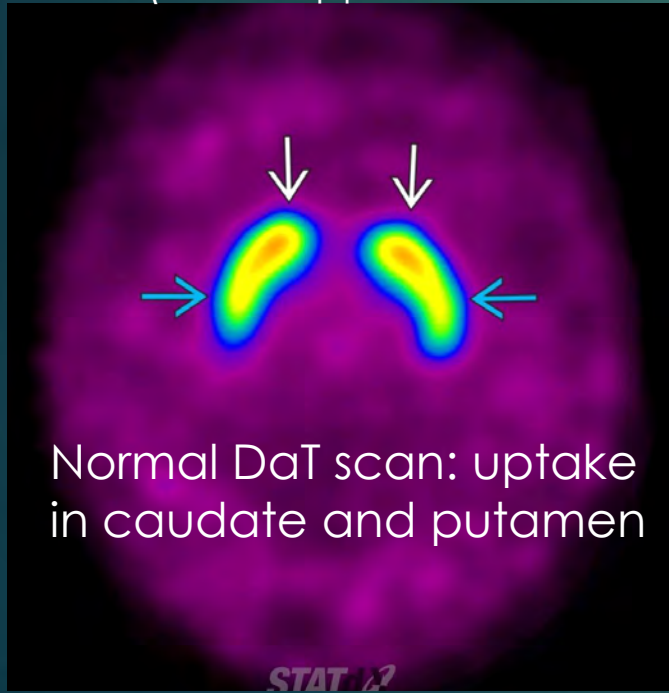
Normal volumes for age



Diffuse volume loss (including hippocampal volume loss)

# Dementia with Lewy Bodies

- ▶ Third most common cause of dementia, 5-10 % of dementia cases
- ▶ MRI
  - ▶ Generalized decrease in cerebral volume with preserved hippocampal/medial temporal lobe volume
- ▶ NM studies useful for DLB diagnosis
  - ▶ Dopamine transporter (DaT) SPECT: decreased uptake in putamen
  - ▶ FDG-PET: ↓ in glucose metabolism in occipital lobe
  - ▶ (similar appearances for both studies in Parkinson disease dementia)

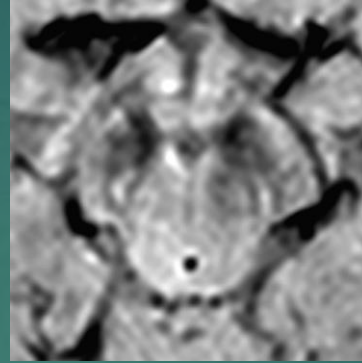


DLB pt: Generalized volume loss with relative sparing of hippocampal volume

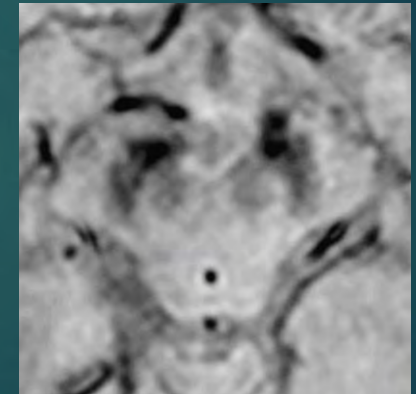
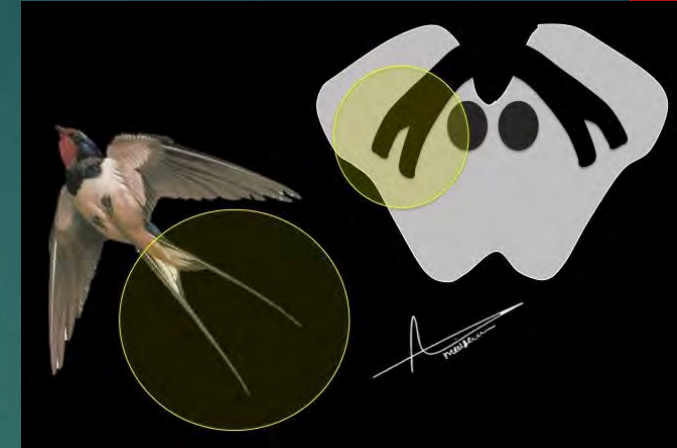


# Dementia with Lewy Bodies

- ▶ Absent swallow-tail sign
  - ▶ Normally see “swallow-tail” appearance of substantia nigra on high-resolution SWI
  - ▶ Nigrosome-1, a cluster of dopaminergic cells within the substantia nigra, normally shows linear high signal on axial SWI
  - ▶ Absent swallow tail sign = diffuse low SWI signal of substantia nigra in Parkinson disease and dementia with Lewy bodies
    - ▶ Reported diagnostic accuracy of greater than 90%
    - ▶ 2ary to iron accumulation



Swallow-tail present:  
normal appearance  
of substantia nigra



Absent swallow-tail  
sign (suggestive of  
PD or DLB)



# Frontotemporal Lobar Degeneration (FTLD)

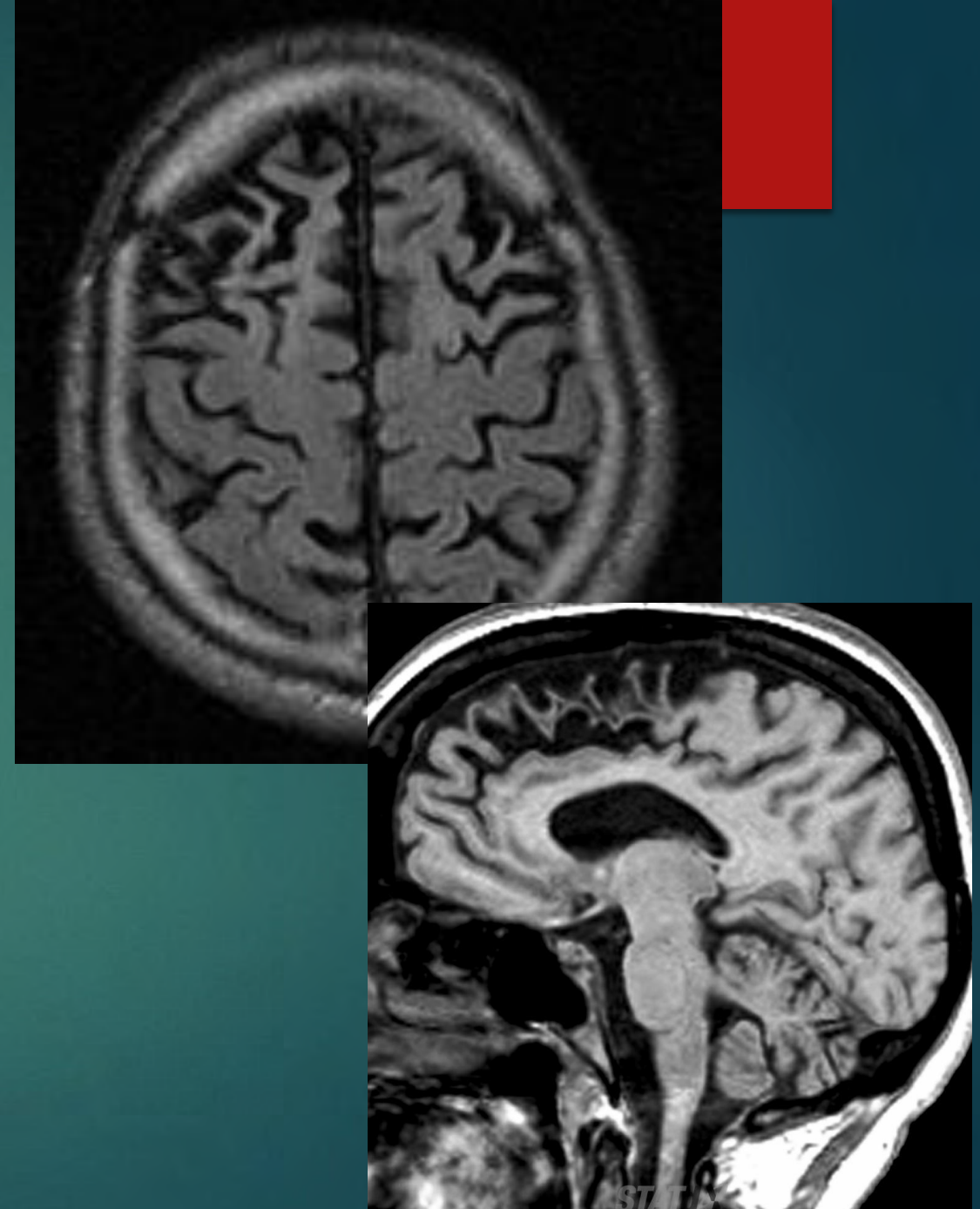
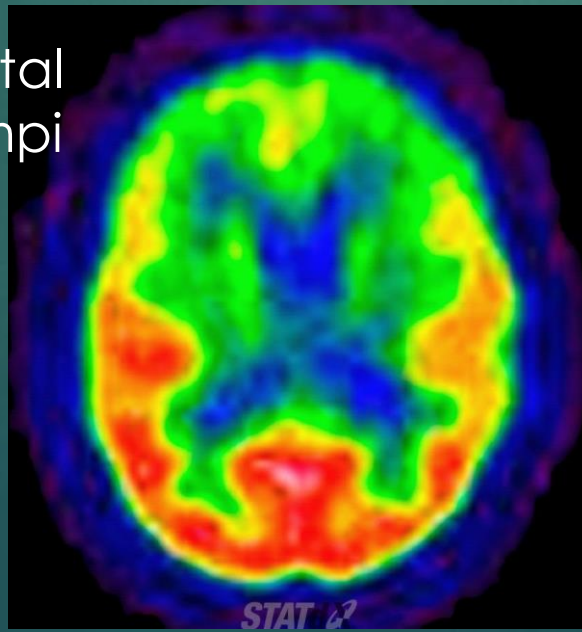
- ▶ Fourth most common cause of progressive dementia
- ▶ Pathologic subtypes (on the basis of the type of proteinaceous inclusions):
  - ▶ FTLD-Tau: misfolded tau protein
  - ▶ FTLD-TDP: transactive response DNA binding protein 43 (TDP-43)
- ▶ Clinical subtypes (depending on primary sites of degeneration)
  - ▶ Behavioral-variant frontotemporal dementia (bvFTD)
  - ▶ Primary progressive aphasia syndromes (PPA)



FTLD: prominent frontal atrophy

# FTLD

- ▶ FDG-PET: frontotemporal ↓ glucose metabolism
- ▶ MRI: Atrophy of frontal & temporal lobes
  - ▶ Knife-like gyri and dilated sulci (late stage)
  - ▶ Relative sparing of parietal lobes, occipital lobes, and hippocampi



# Summary

- ▶ Noncontrast brain MRI is best study for imaging dementia patients
  - ▶ Exclude structural cause of dementia (ie tumor, chronic subdural, hydrocephalus)
  - ▶ Evaluate for vascular dementia (multiple infarct or small vessel disease)
  - ▶ Support clinical diagnosis of neurodegenerative disease
    - ▶ Low hippocampal volumes with AD
    - ▶ Dementia with Lewy Bodies: general volume loss with preserved hippocampi, absent swallow tail sign
    - ▶ Prominent frontal or temporal atrophy with FTLD
- ▶ If MRI not an option (implanted device, anxiety) → noncontrast CT is second choice
- ▶ Functional and Molecular imaging:
  - ▶ FDG-PET: glucose analogue, may help distinguish between AD, DLB, and FTLD
  - ▶ Dopamine transporter (DaT) SPECT: decreased uptake in putamen with dementia with Lewy bodies (and PD)
  - ▶ Amyloid-PET: good for diagnosis of AD, but expensive and not commonly used in clinical practice



# Thank You!



## Contact info:

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# Image credits

- ▶ Nikola Tesla [http://griffithobservatory.org/exhibits/halloftheeye\\_teslacoil.html](http://griffithobservatory.org/exhibits/halloftheeye_teslacoil.html) Purchased from Alamy.com
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- ▶ Callosal index: StatDx, <https://www.statdx.com/>
- ▶ AD: Case courtesy of Assoc Prof Frank Gaillard, Radiopaedia.org, rID: 64586
- ▶ FTLD: Case courtesy of Assoc Prof Frank Gaillard, Radiopaedia.org, rID: 28163
- ▶ FTLD, DLB: StatDx, <https://www.statdx.com/>
- ▶ Dementia with Lewy Bodies: Case courtesy of Assoc Prof Frank Gaillard, Radiopaedia.org, rID: 28774
- ▶ Normal swallow-tail drawing and MRI: Case courtesy of Dr. Reem Alketbi, Radiopaedia.org, rID: 54700
- ▶ Normal swallow-tail MRI: Case courtesy of Dr Andrew Dixon, Radiopaedia.org, rID: 31112
- ▶ Absent Swallow-tail: Case courtesy of Dr Andrew Dixon, Radiopaedia.org, rID: 31115

# Resource suggestion: ACR Appropriateness criteria

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- ▶ Evidence-based guidelines to assist referring providers in ordering the most appropriate imaging for a specific clinical condition.

▶ <https://www.acr.org/Clinical-Resources/ACR-Appropriateness-Criteria>

American College of Radiology ACR Appropriateness Criteria® Dementia		
<b>Variant 1:</b> Cognitive decline. Suspected Alzheimer disease. Initial imaging.		
Procedure	Appropriateness Category	Relative Radiation Level
MRI head without IV contrast	Usually Appropriate	○
CT head without IV contrast	Usually Appropriate	⦿⦿⦿
Amyloid PET/CT brain	May Be Appropriate	⦿⦿⦿
FDG-PET/CT brain	May Be Appropriate	⦿⦿⦿⦿
MRI head without and with IV contrast	Usually Not Appropriate	○
HMPAO SPECT or SPECT/CT brain	Usually Not Appropriate	⦿⦿⦿⦿
MR spectroscopy head without IV contrast	Usually Not Appropriate	○
MRI functional (fMRI) head without IV contrast	Usually Not Appropriate	○
CT head with IV contrast	Usually Not Appropriate	⦿⦿⦿
CT head without and with IV contrast	Usually Not Appropriate	⦿⦿⦿

