Brigham and Women's Hospital
Founding Member, Mass General Brigham

HARVARD MEDICAL SCHOOL
TEACHING HOSPITAL

Neuroimaging in Clinical Neuropsychiatry

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Disclosures

Neither I nor my spouse has a relevant financial relationship with a commercial interest to disclose.

Objectives

Imaging tools to assess patients with neuropsychiatric illness

Structural imaging

Metabolic imaging

Objectives

Imaging tools to assess patients with neuropsychiatric illness

Structural imaging (CT, MRI)

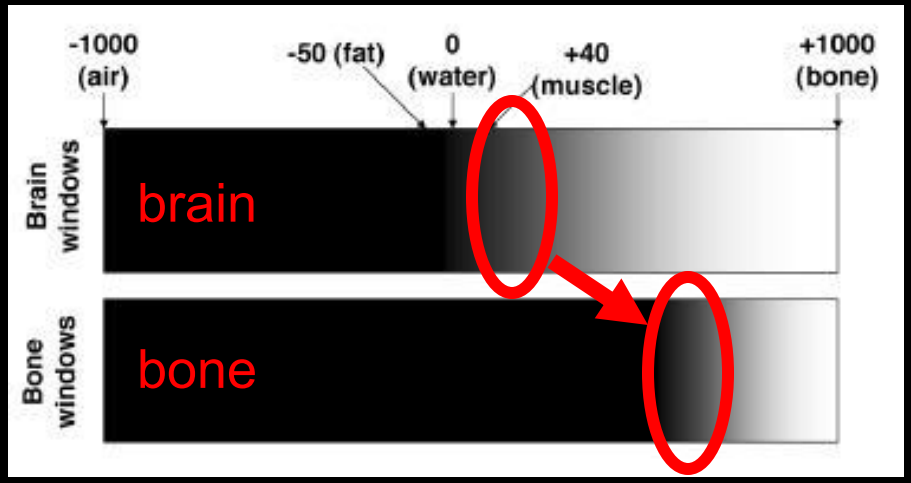
Metabolic imaging (PET, MRS)

General structural imaging principles

1. *Clinical correlation is key*
2. *Assess brain volume, increased or decreased?*
3. *Increased = mass or edema, Decreased = atrophy*
4. *Is atrophy focal, regional, diffuse?*
5. *Interval changes*

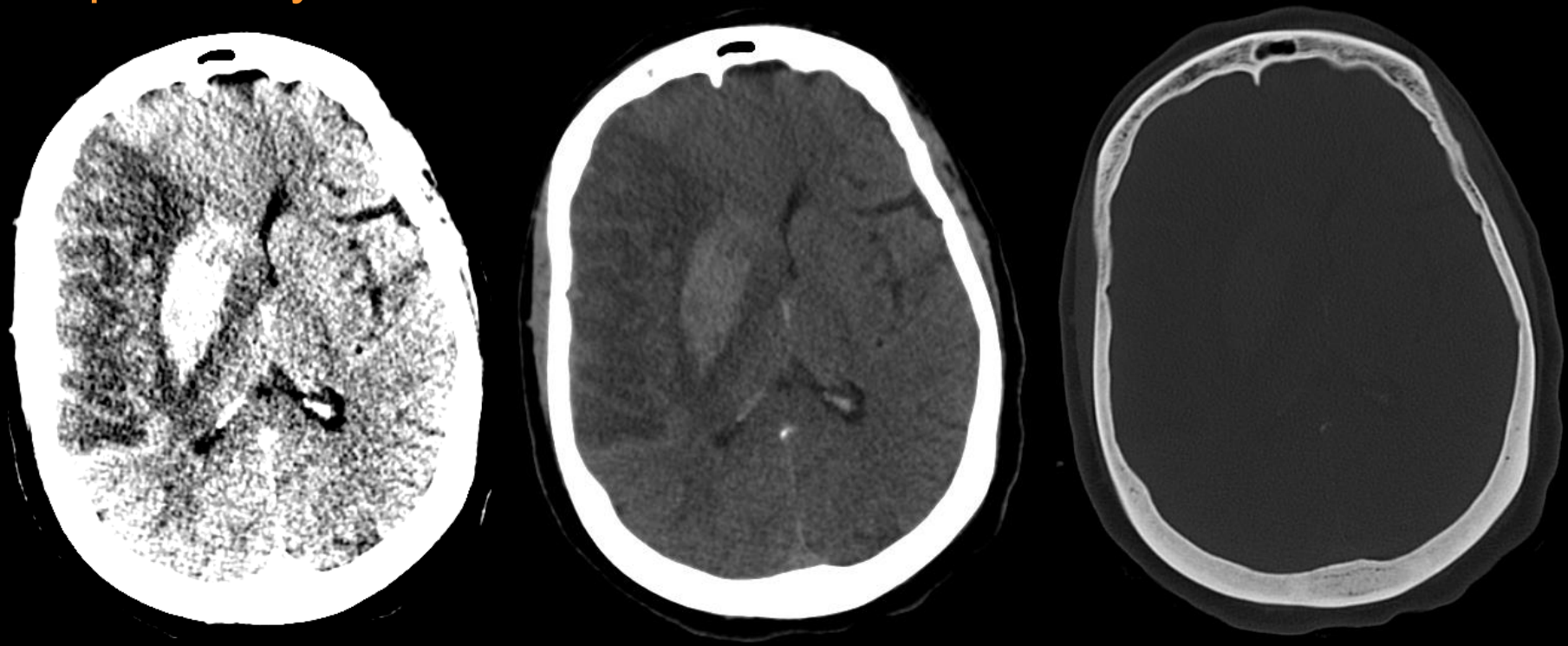
CT: *Hounsfield units*

Cerebrospinal fluid	15
White matter	20 to 30
Gray matter	35 to 45
Acute hemorrhage/thrombus	60 to 100

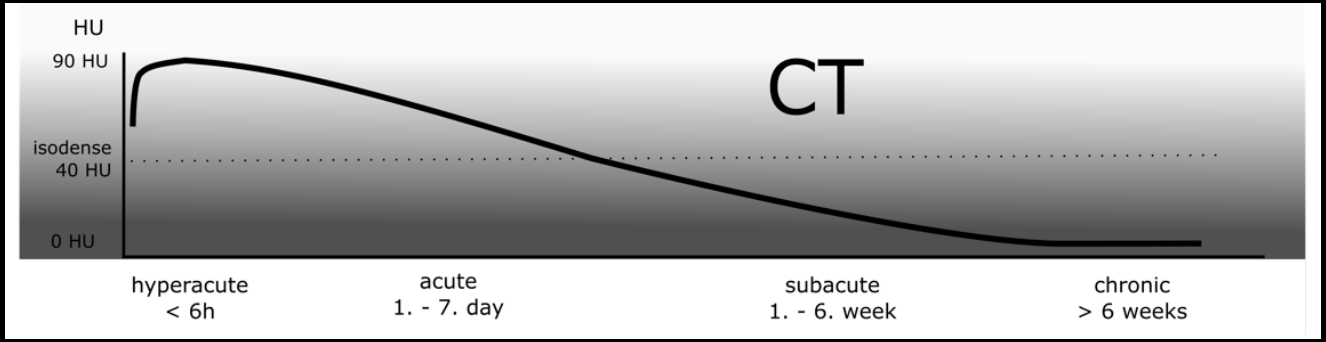


parenchyma

bone

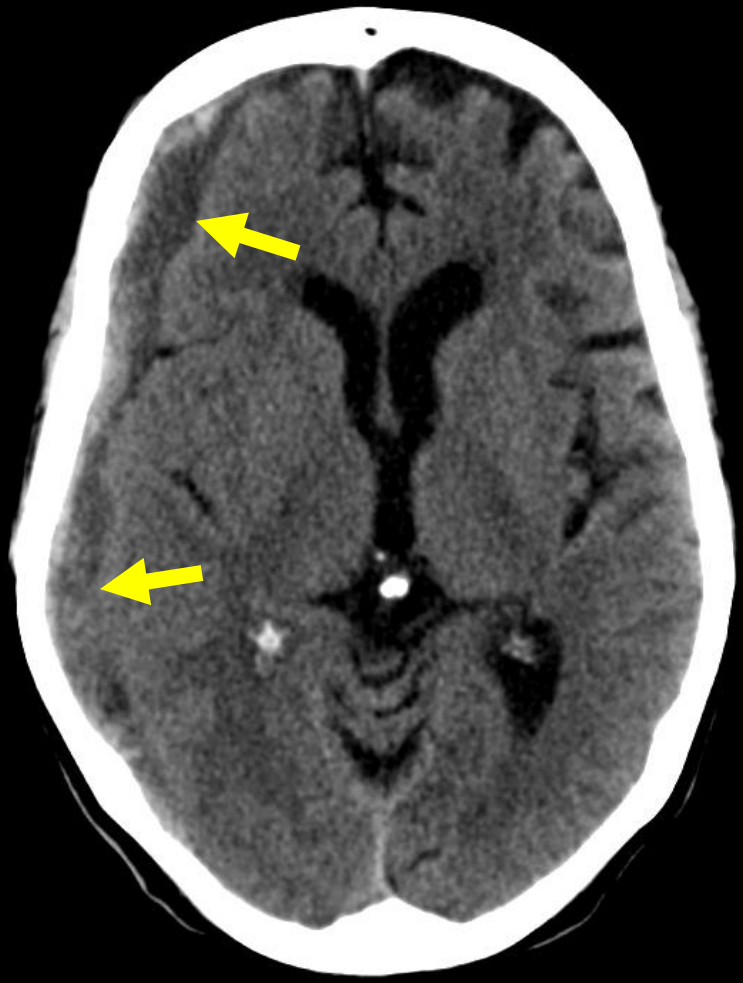


Imaging hemorrhage on CT



Voss YL. Radiopaedia, rID:55643

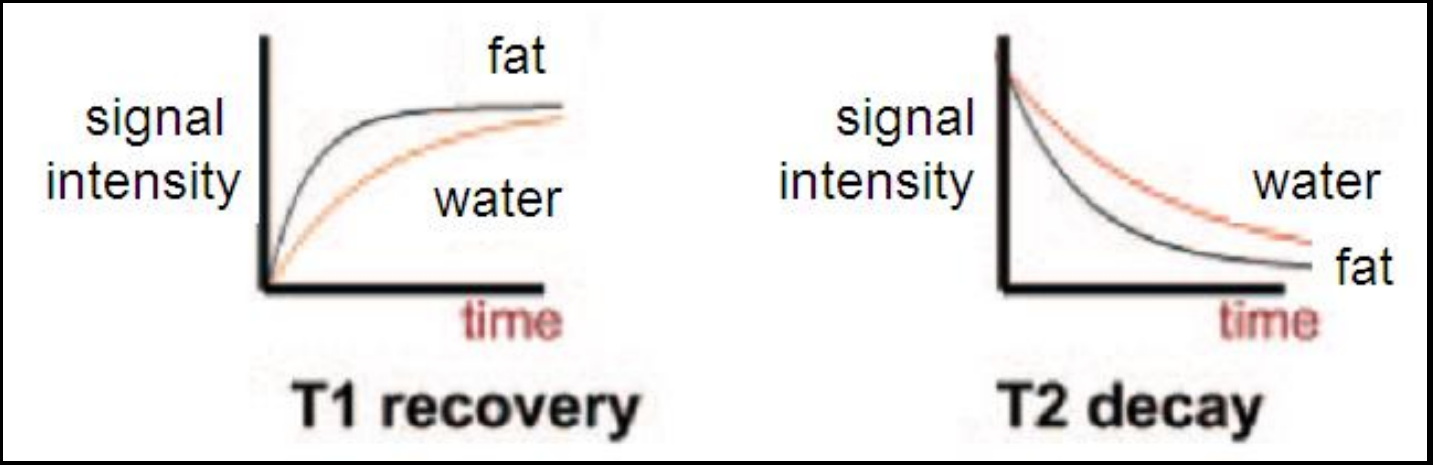
Intracranial hemorrhage, subdural



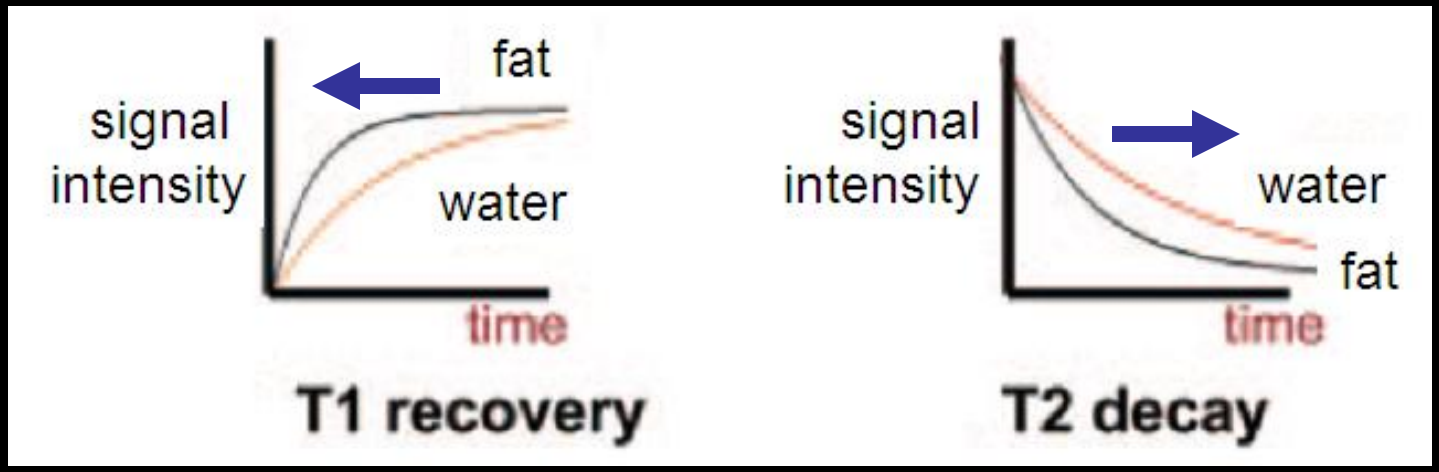
MRI

T1: fat appears brighter than water, so white matter is brighter than gray matter. Edema and CSF are darker than normal brain.

T2: fat appears darker than water, so white matter is darker than gray matter. Edema and CSF are brighter than normal brain.



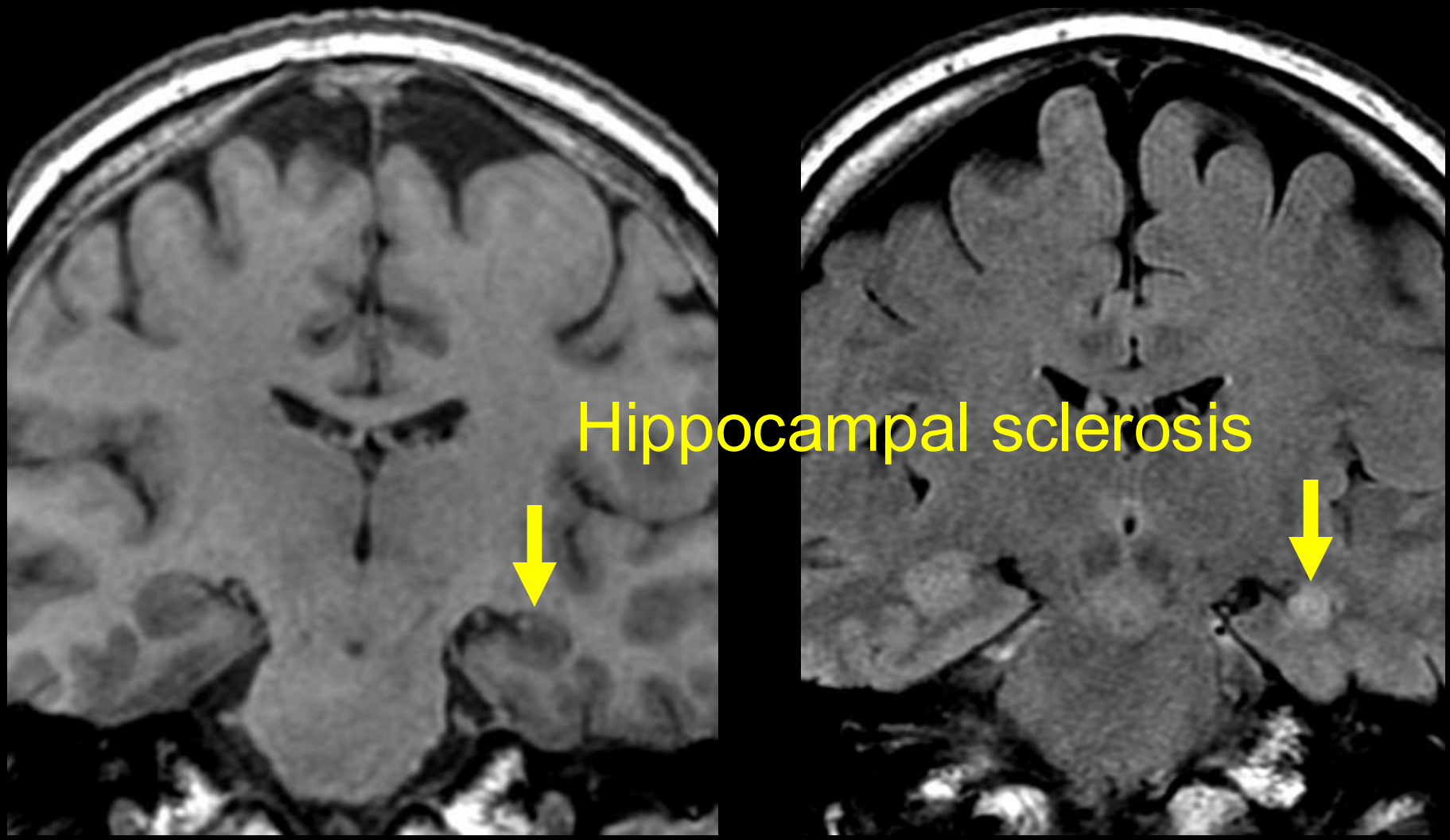
Radiographics 2006;26:513-37



T1 "*shortening*" (hyperintensity): fat, protein, contrast, sub-acute blood, some metals

T2 "*prolongation*" (hyperintensity): edema, gliosis, sub-acute blood

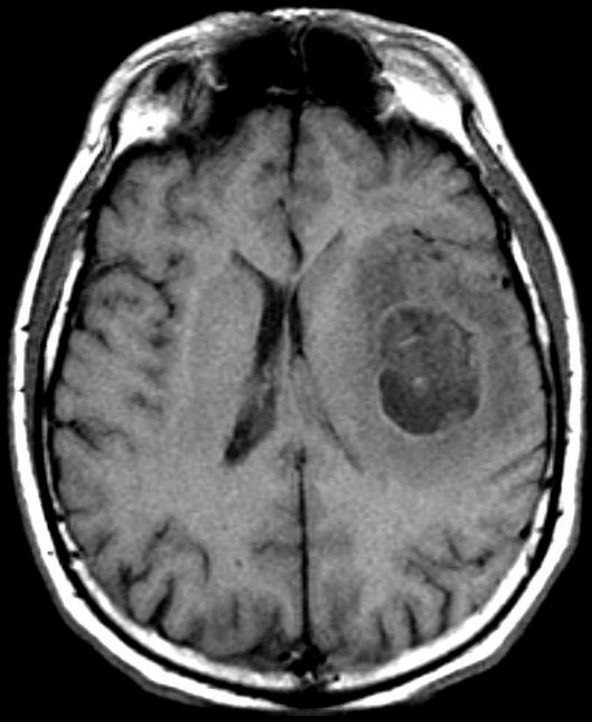
Radiographics 2006;26:513-37



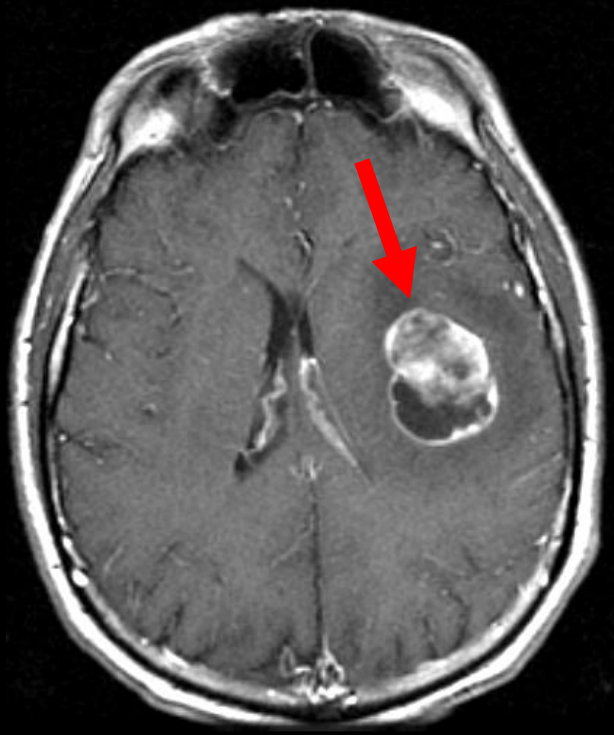
Klein JP, *ACP Medicine*, 2012

MRI

T1

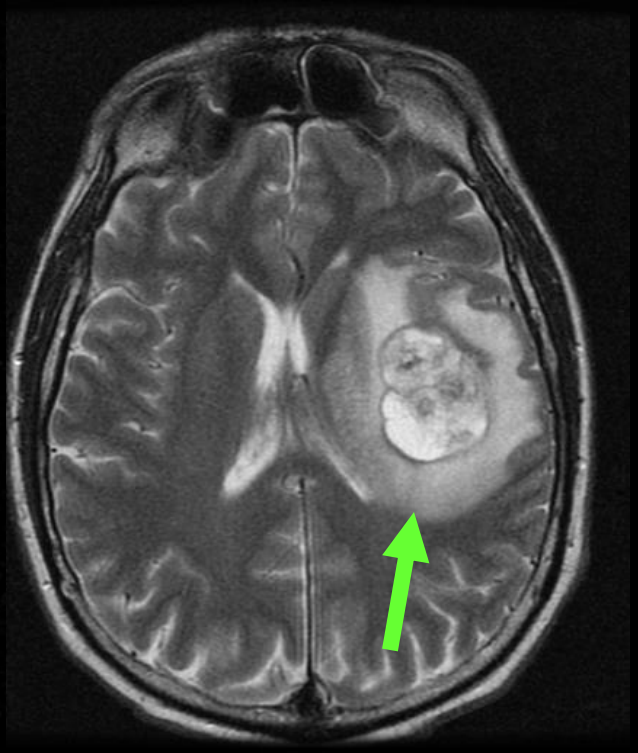


T1 with gadolinium



T1 shortening
(enhancement)

T2

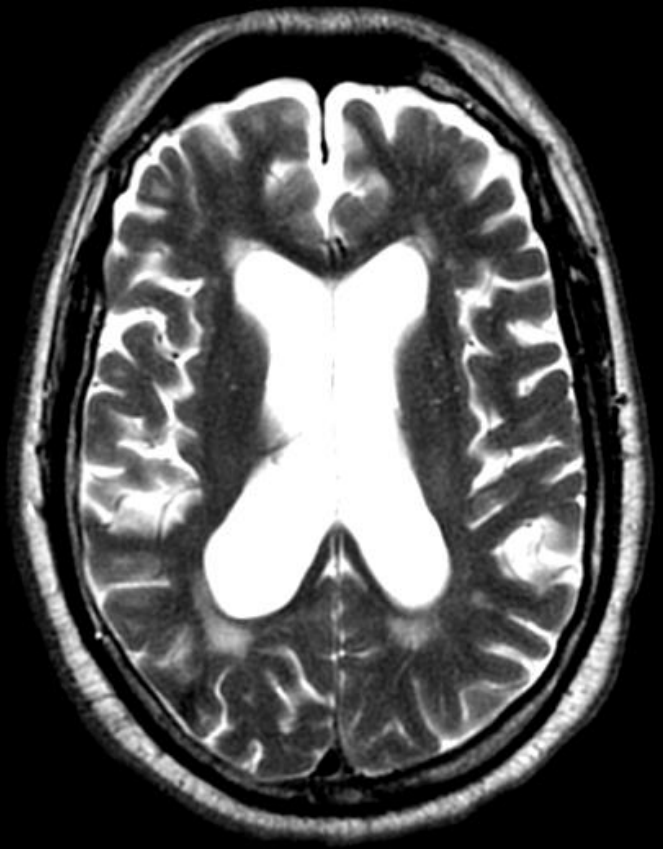


T2 prolongation
(edema)

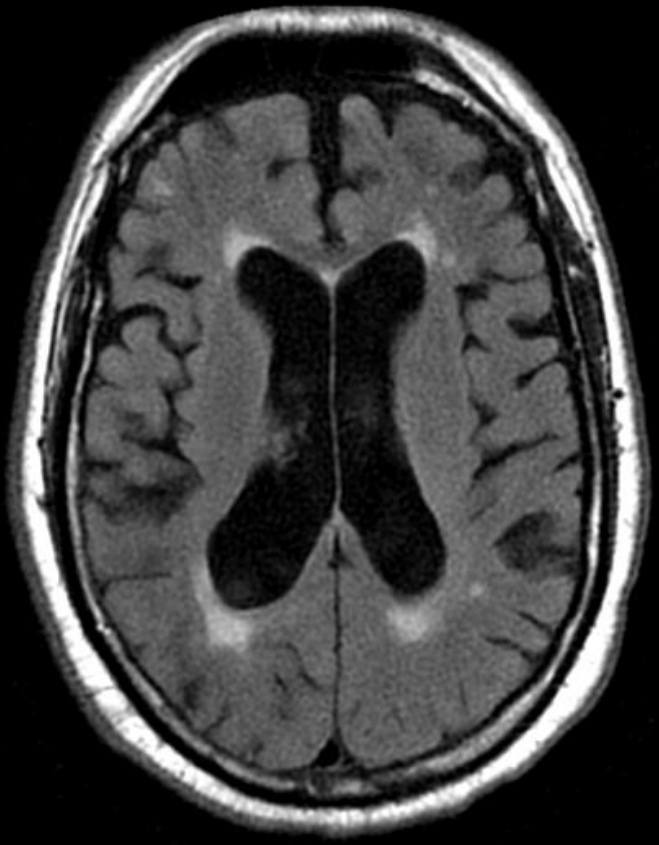
Klein JP, *ACP Medicine*, 2012

Fluid attenuated inversion recovery (FLAIR)

T2



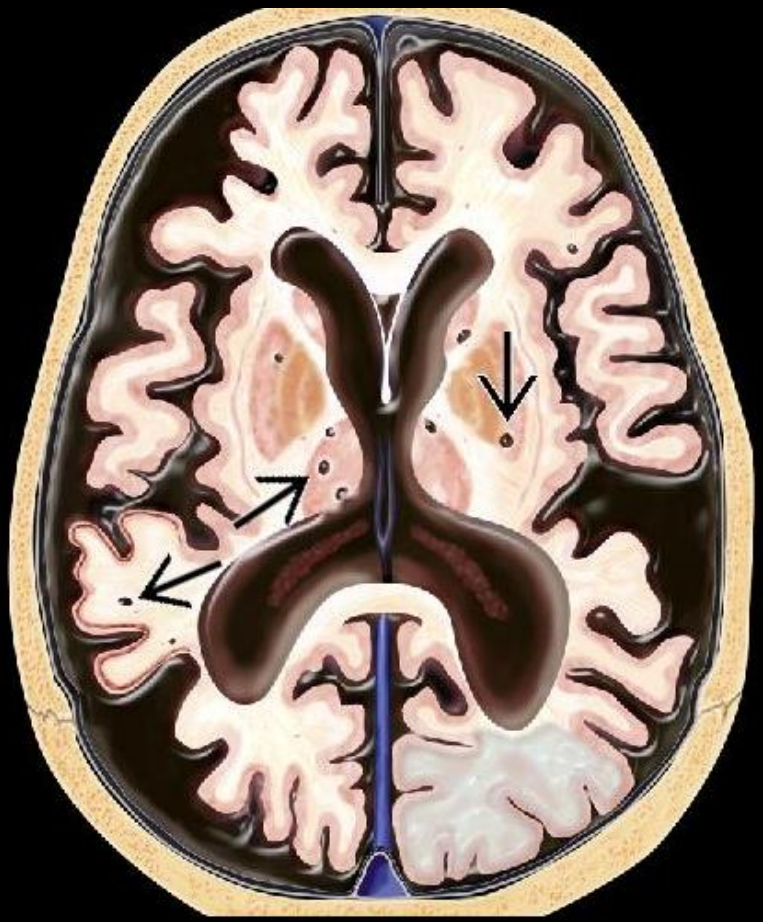
T2-FLAIR

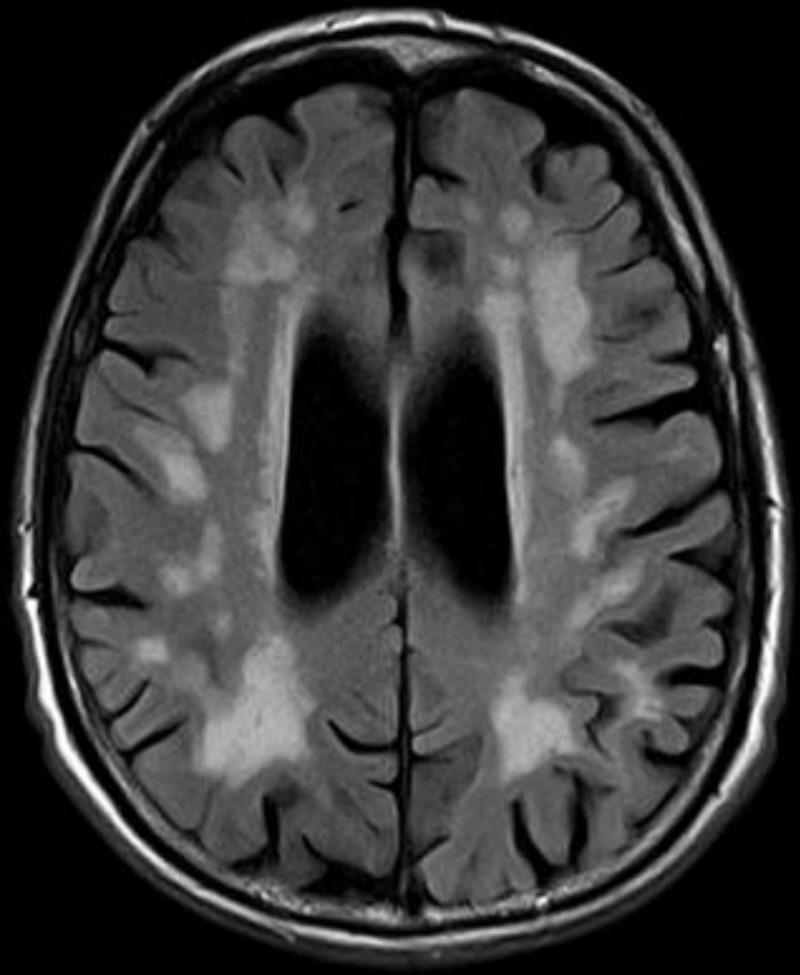


Vascular disease in neuropsychiatry

1. *Microangiopathy*
2. *Intracranial hemorrhage*
3. *Cerebral amyloid angiopathy*
4. *Superficial siderosis*

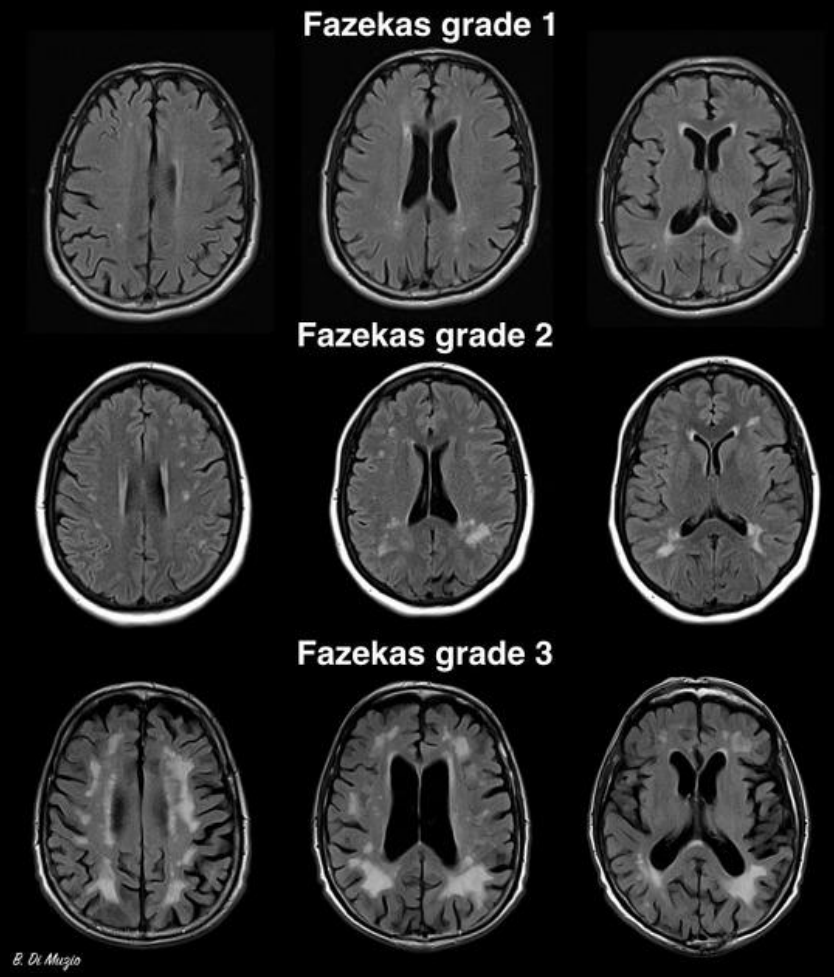
Microangiopathy





StatDx

White matter lesion volume assessment



periventricular white matter (PVWM)

- 0 = absent
- 1 = caps or pencil-thin lining
- 2 = smooth “halo”
- 3 = irregular periventricular signal extending into the deep WM

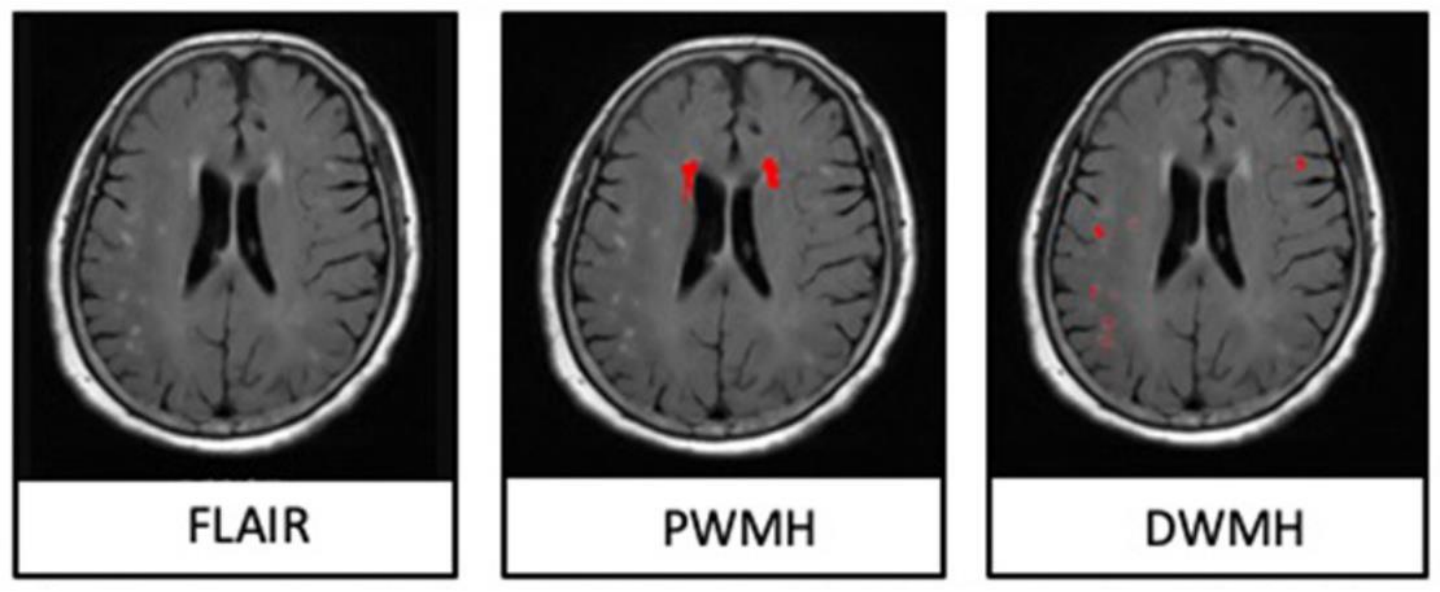
deep white matter (DWM)

- 0 = absent
- 1 = punctate foci
- 2 = beginning confluence
- 3 = large confluent areas

Am J Roentgenol 1987;149(2):351

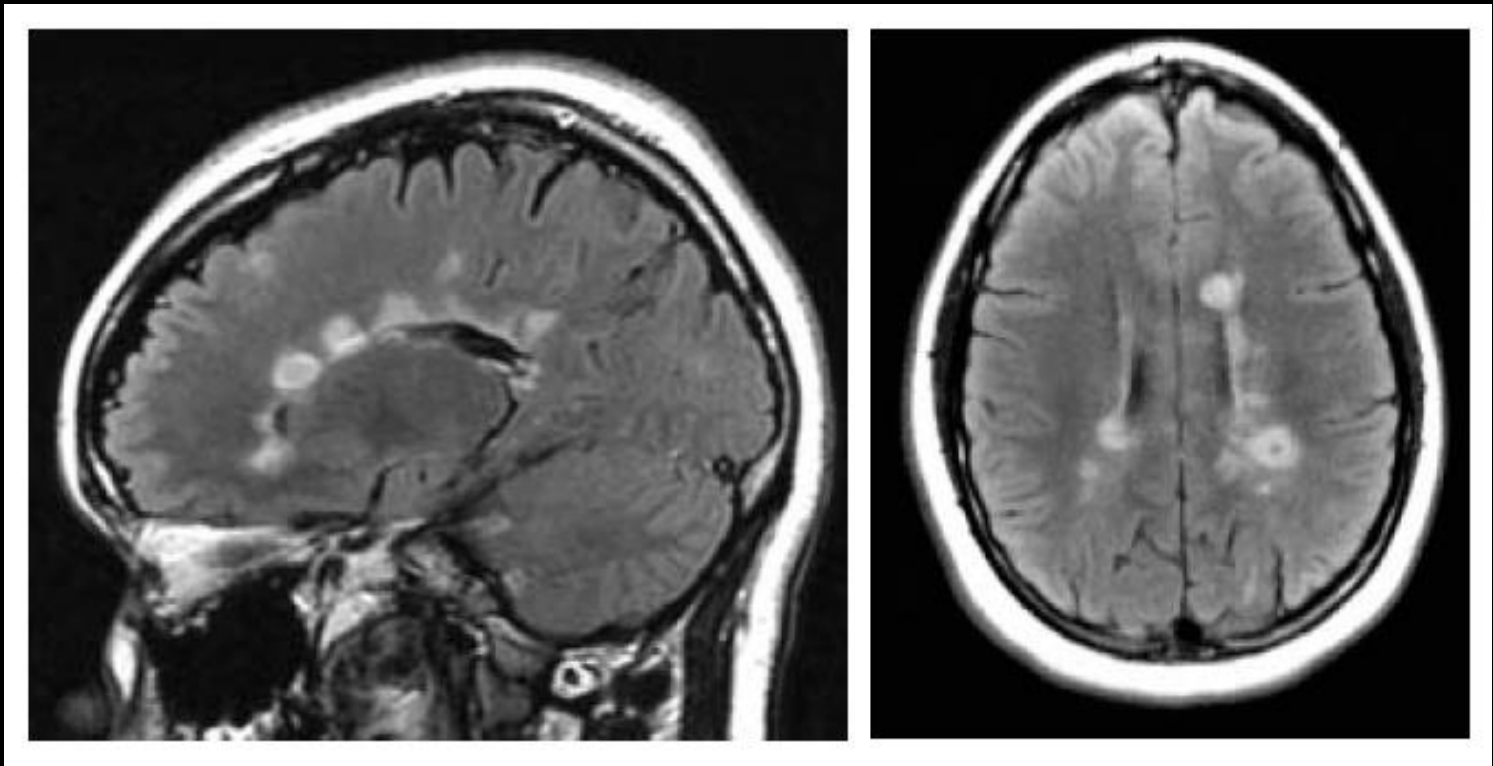
Etiology of periventricular and deep white matter changes

- Periventricular white matter lesions → combination of chronic demyelination, sub-ependymal gliosis, and small vessel ischemia
- Deep white matter lesions → chronic small vessel ischemia (microangiopathy, leukoaraiosis)



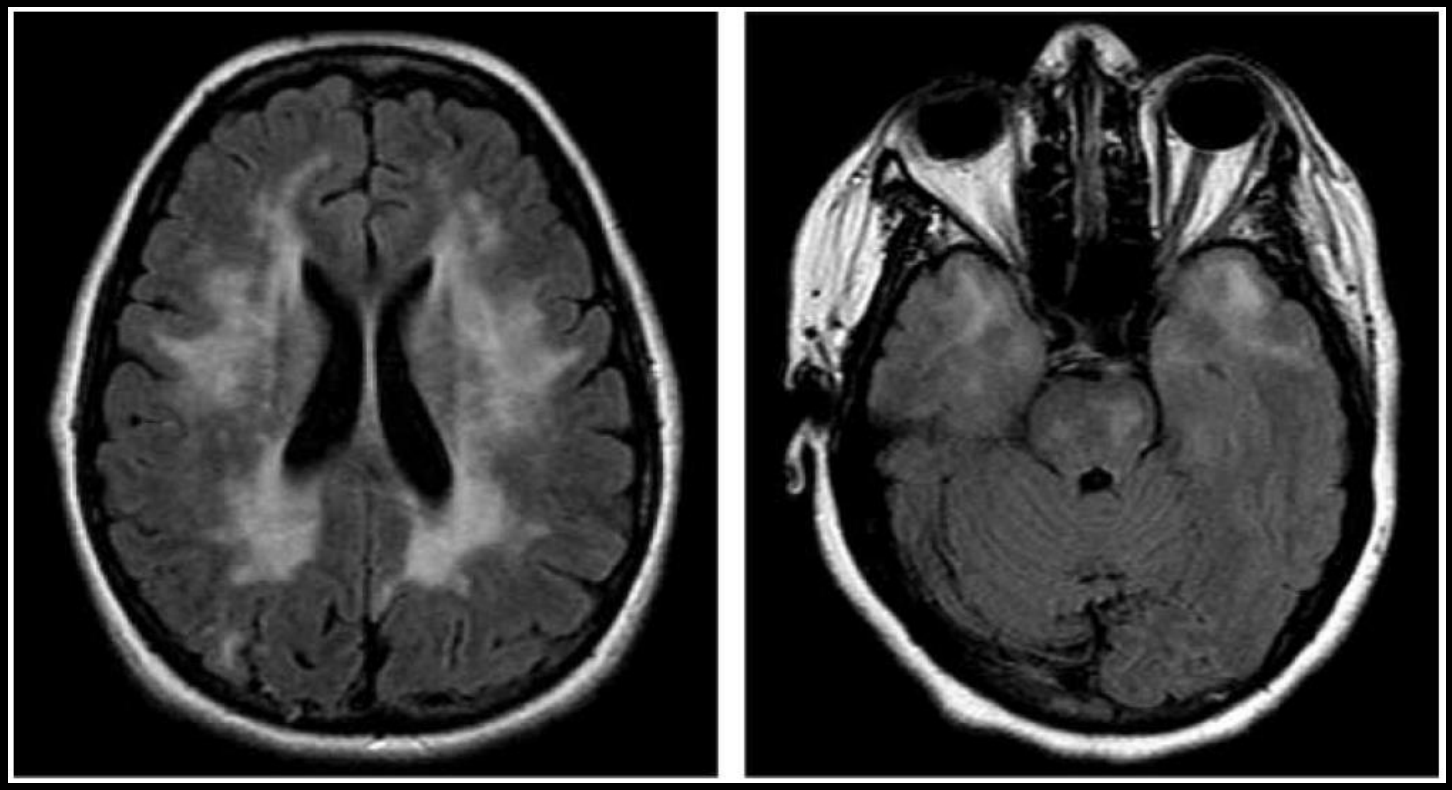
Front Aging Neurosci 2022;14:940538; radiopaedia.org

Multiple sclerosis

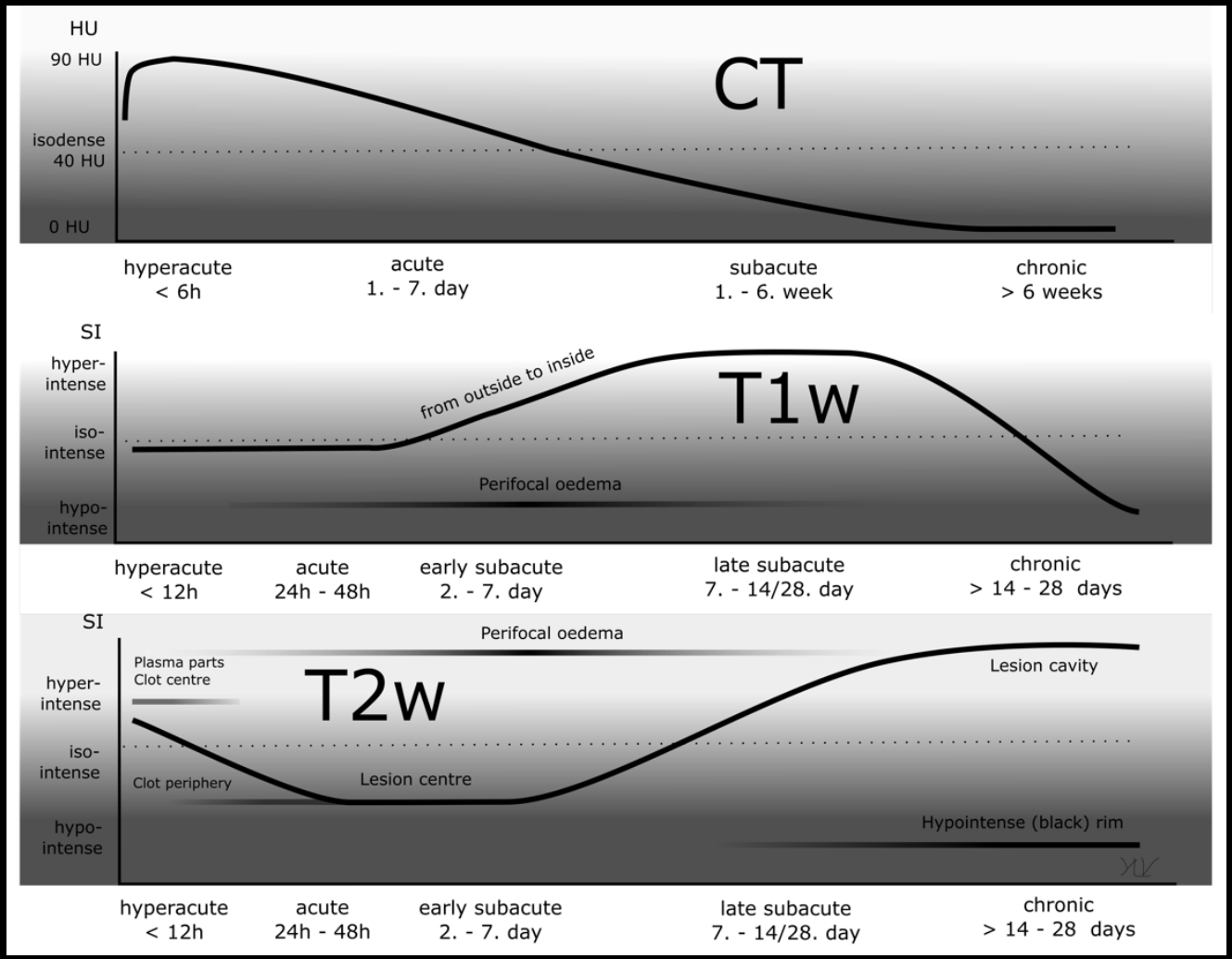


Klein JP, Sci Am Medicine 2012

CADASIL (*cerebral autosomal dominant arteriopathy with subcortical infarctions and leukoencephalopathy*)

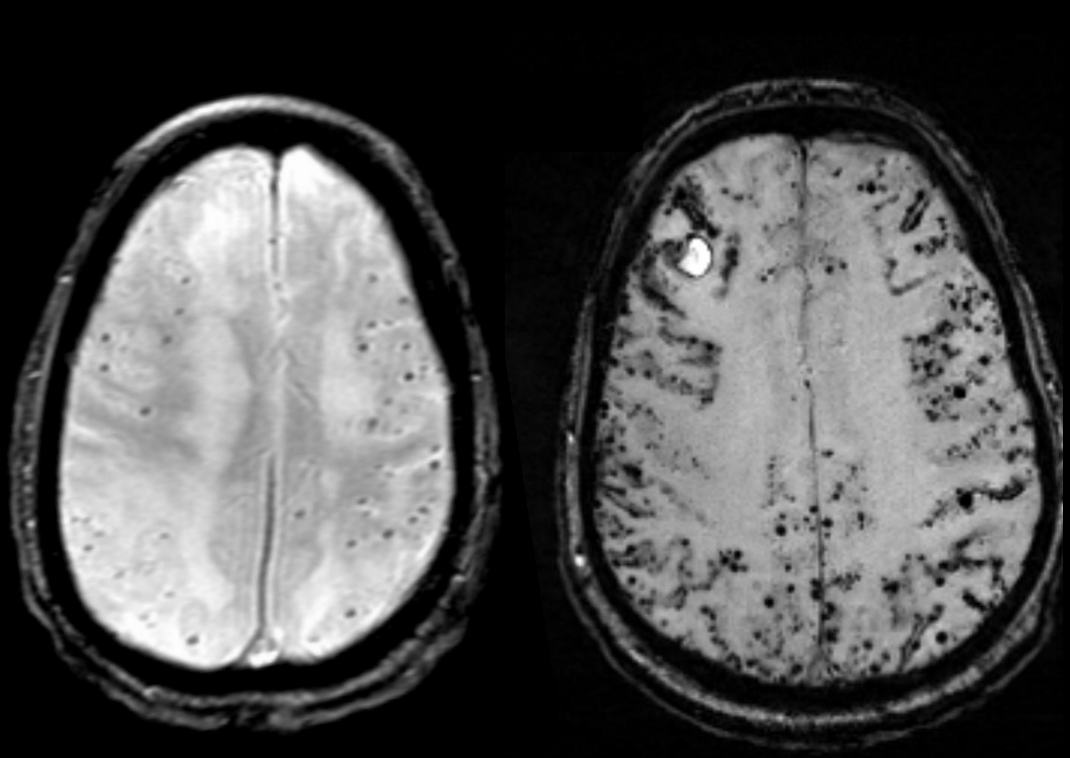


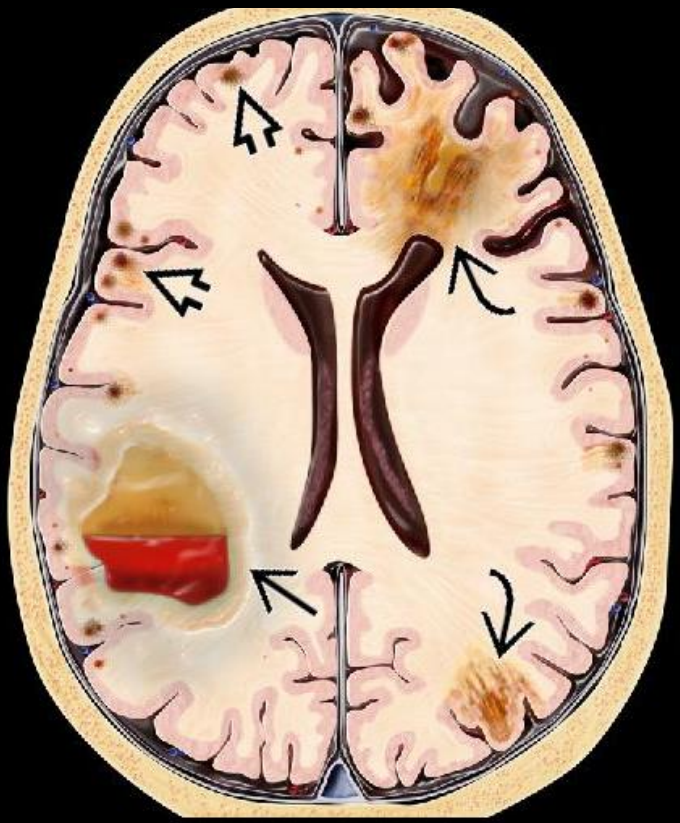
Imaging hemorrhage on CT and MRI



Voss YL. Radiopaedia, rID:55643

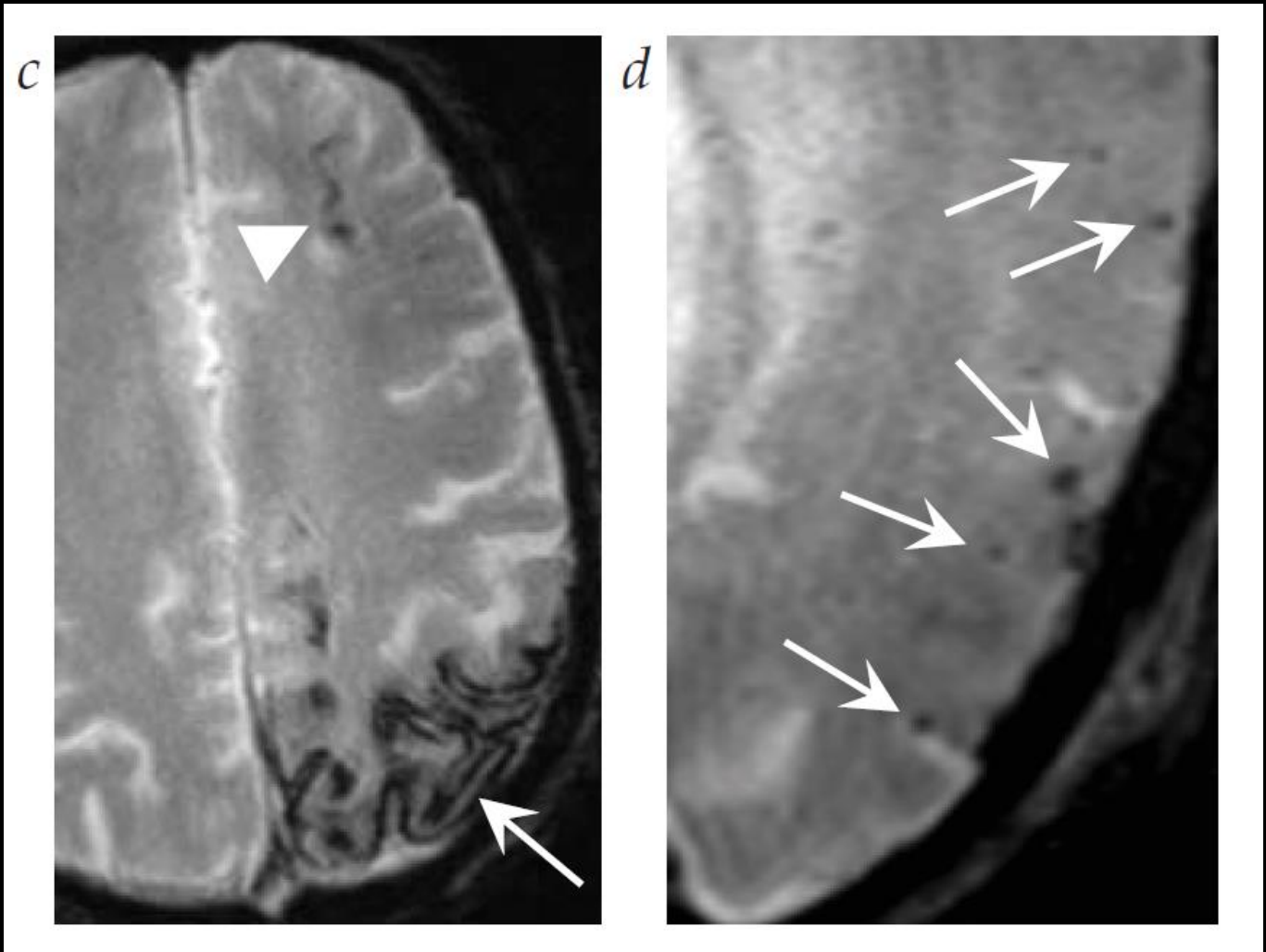
Cerebral amyloid angiopathy (CAA)





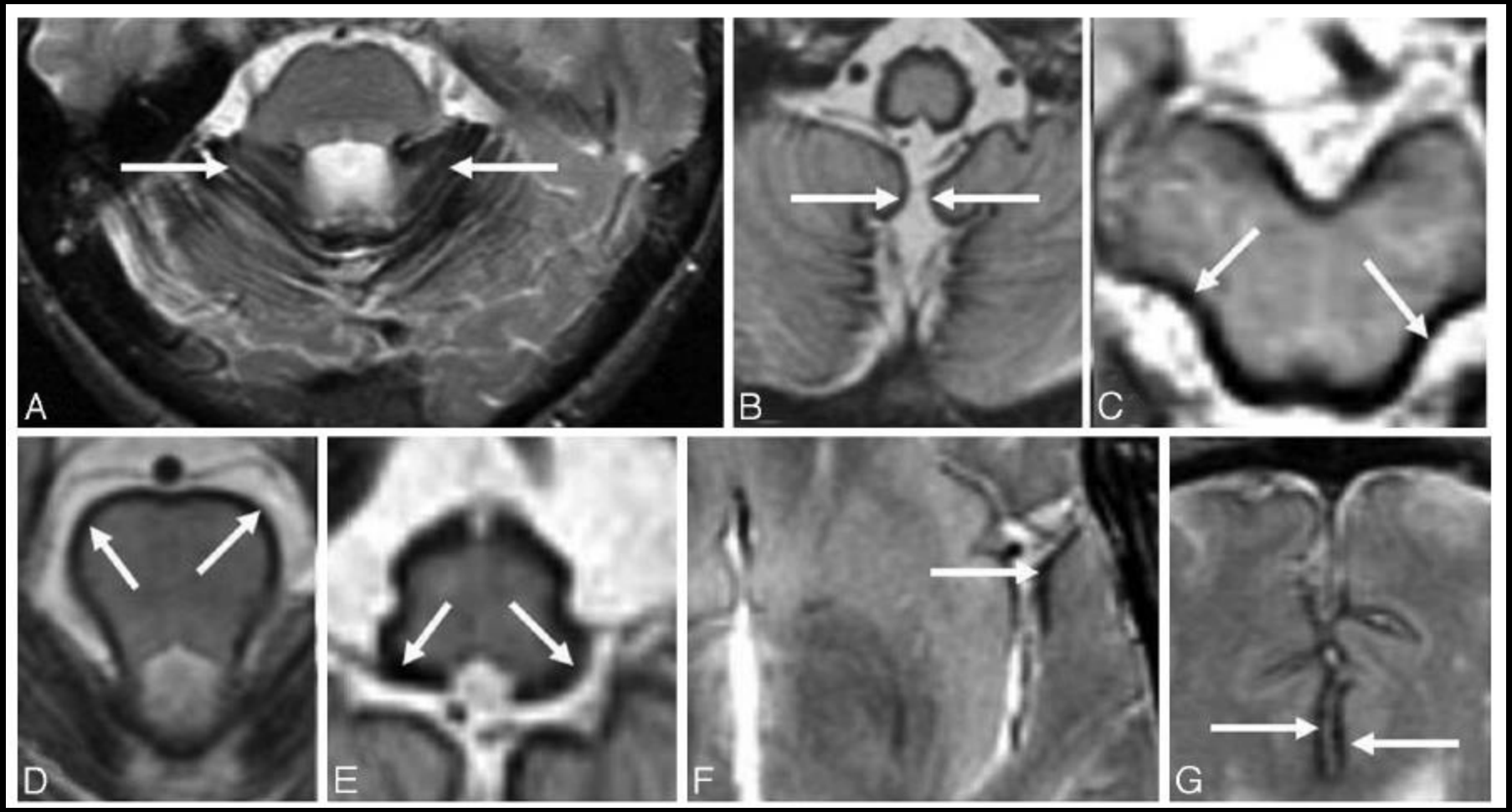
StatDx

Superficial siderosis in CAA



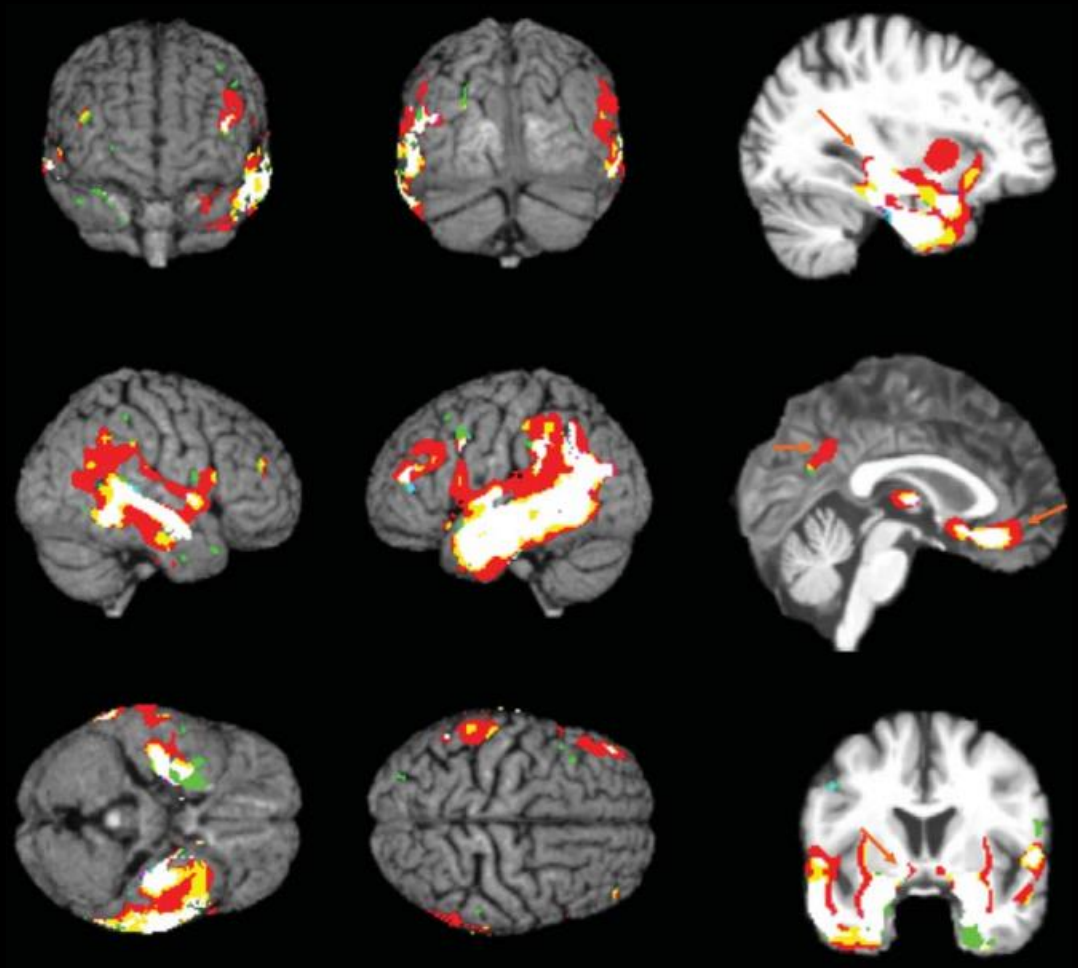
Klein JP. ACP Medicine, 2012

Superficial siderosis



AJNR 2010;31:5

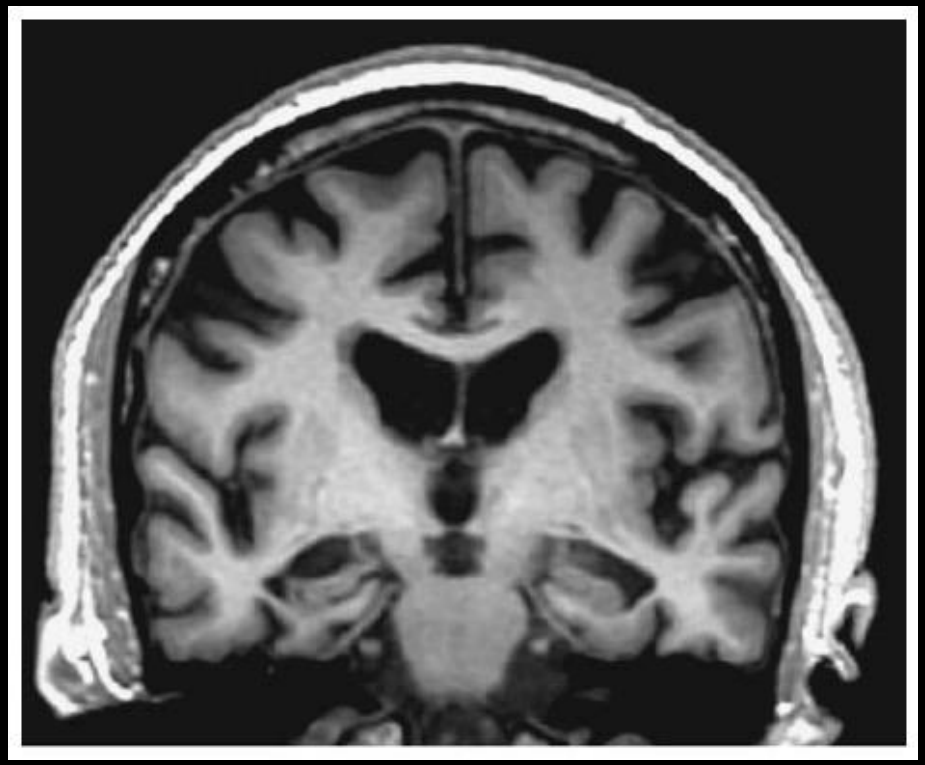
Cortical atrophy in AD, *volumetry*



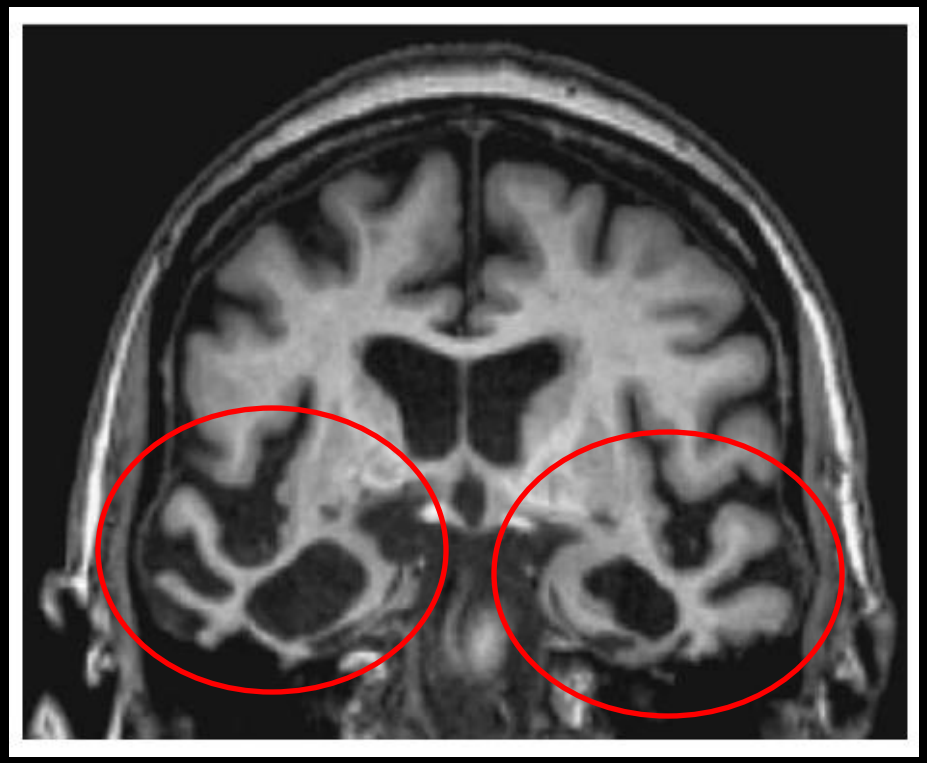
- *Hippocampus*
- *Entorhinal cortex*
- *Posterior cingulate*
- *Precuneus*
- *Basal forebrain*

J Alzheimer Disease 2012;31:S33

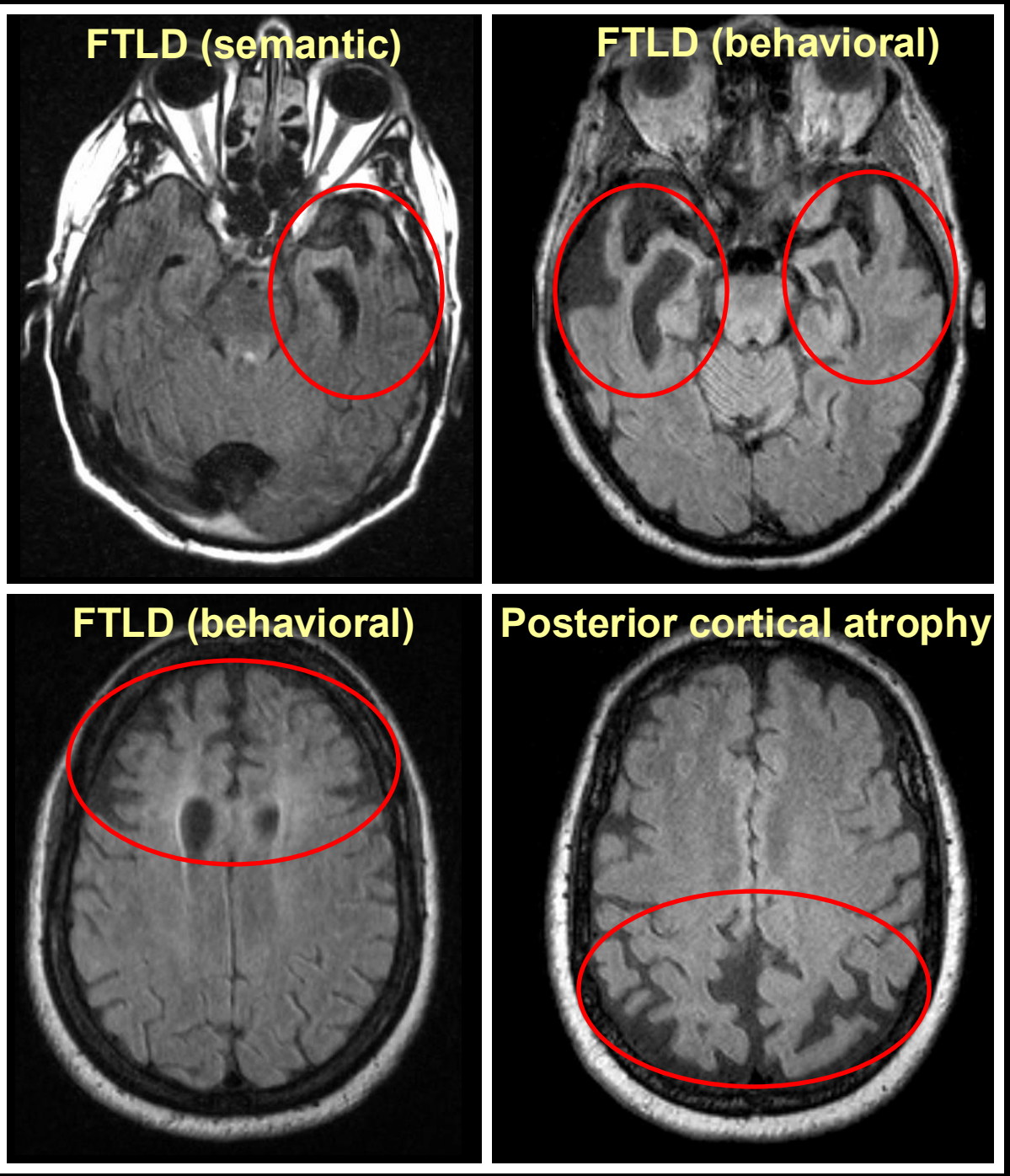
AD



FTLD



Principles of Neurology, 12th Ed., 2023

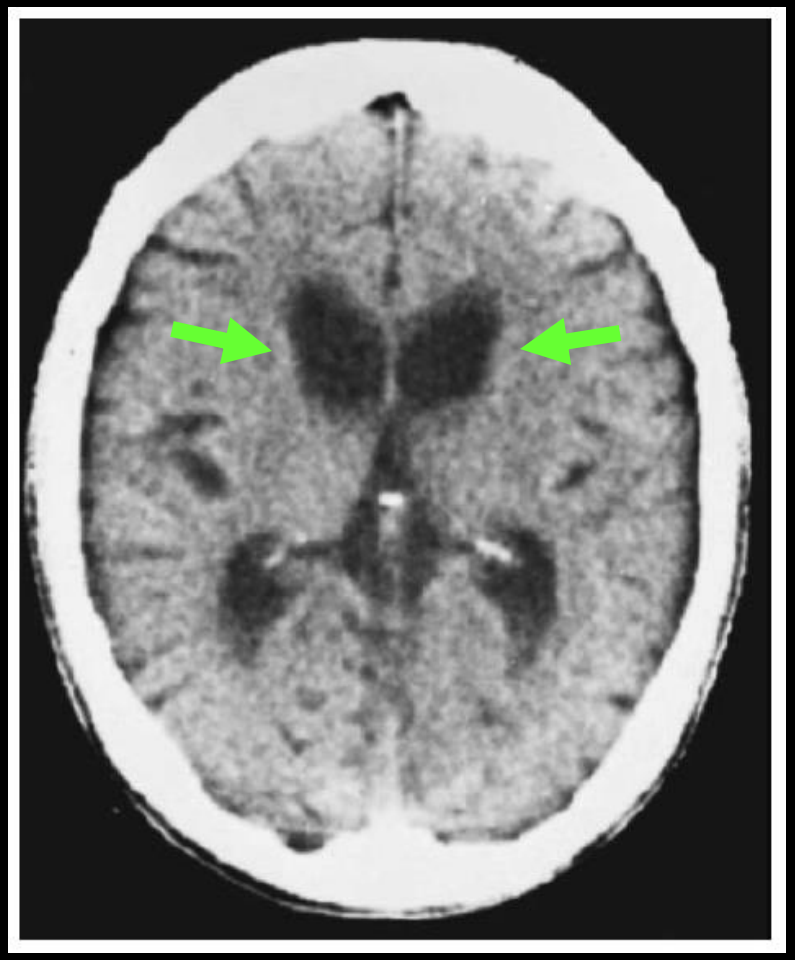


Focal lobar atrophy

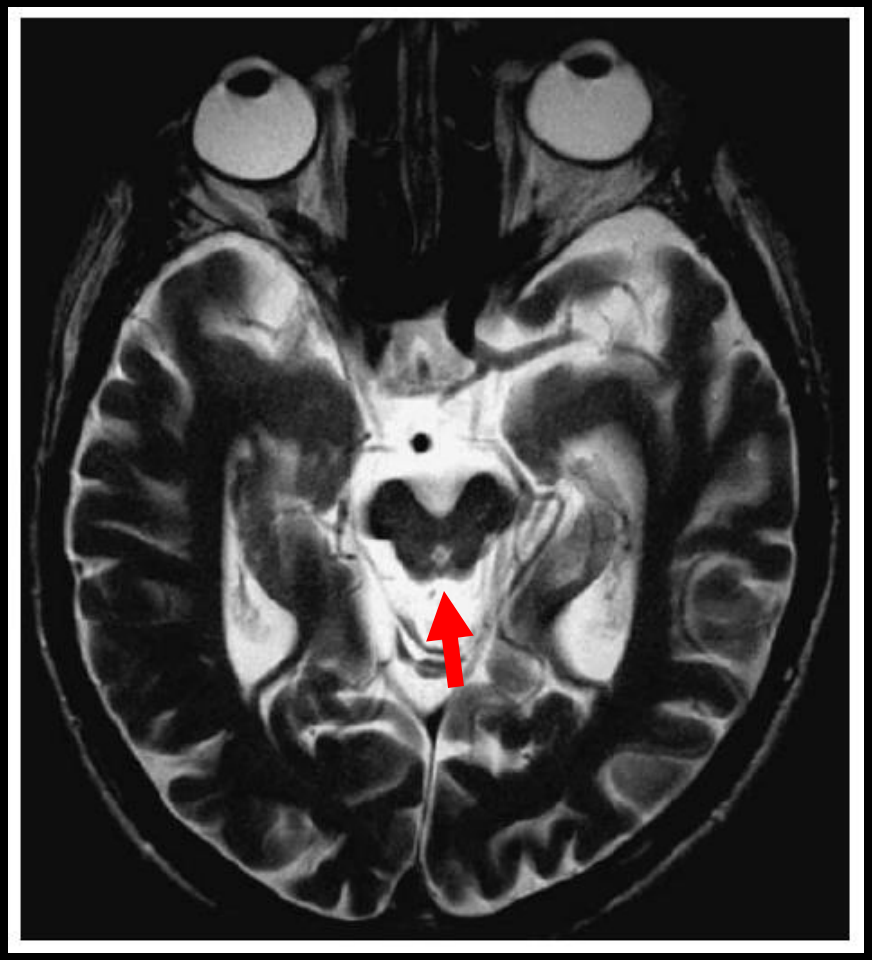
Klein JP, ACP Medicine, 2012

Other focal atrophy

HD



PSP



Principles of Neurology, 12th Ed., 2023

The New England
Journal of Medicine

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Volume 273 JULY 15, 1965 Number 3

SYMPTOMATIC OCCULT HYDROCEPHALUS WITH "NORMAL" CEREBROSPINAL-FLUID PRESSURE*

A Treatable Syndrome

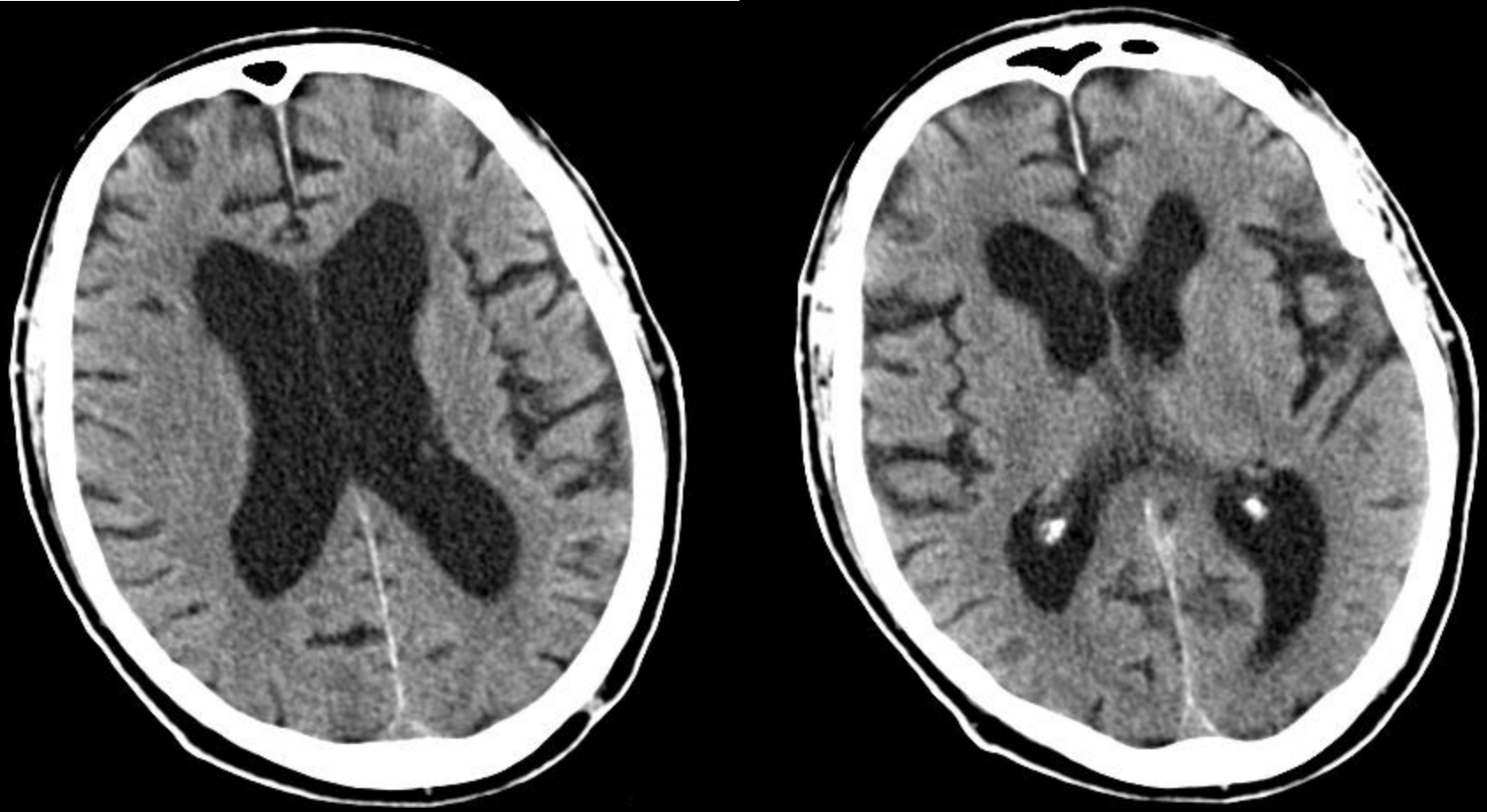
R. D. Adams, M.D.,† C. M. Fisher, M.D.,‡ S. Hakim, M.D.,§ R. G. Ojemann, M.D.,¶ and W. H. Sweet, M.D.‖

BOSTON, MASSACHUSETTS, AND BOGOTÁ, COLOMBIA

The diagnosis and treatment of idiopathic normal pressure hydrocephalus

Gary L Gallia, Daniele Rigamonti and Michael A Williams*

NATURE CLINICAL PRACTICE NEUROLOGY JULY 2006 VOL 2 NO 7



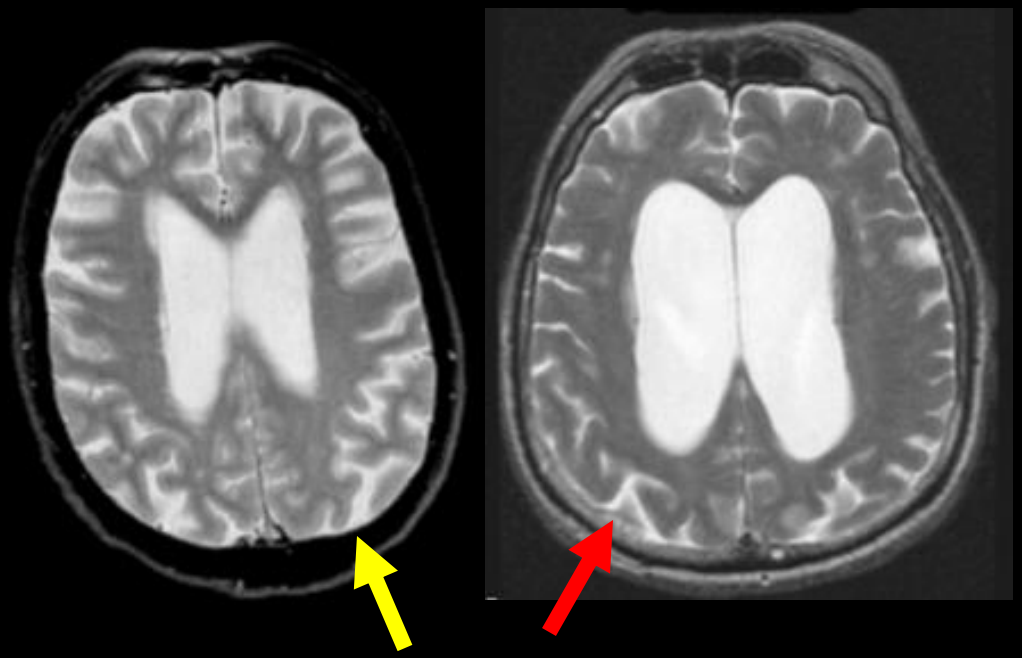
Imaging abnormalities in NPH

1. No macroscopic obstruction of CSF flow
2. Ventriculo-sulcal disproportion
3. Upward bowing of the corpus callosum
4. Empty sella

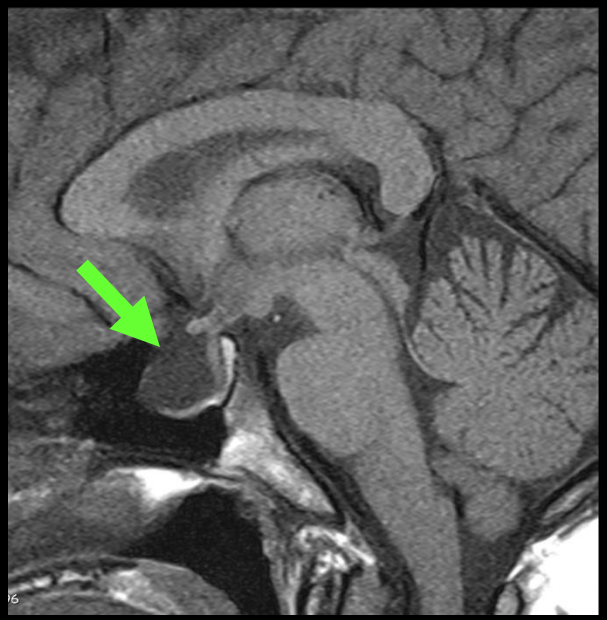
Imaging abnormalities in NPH

Ventriculo-sulcal disproportion

AD *NPH*

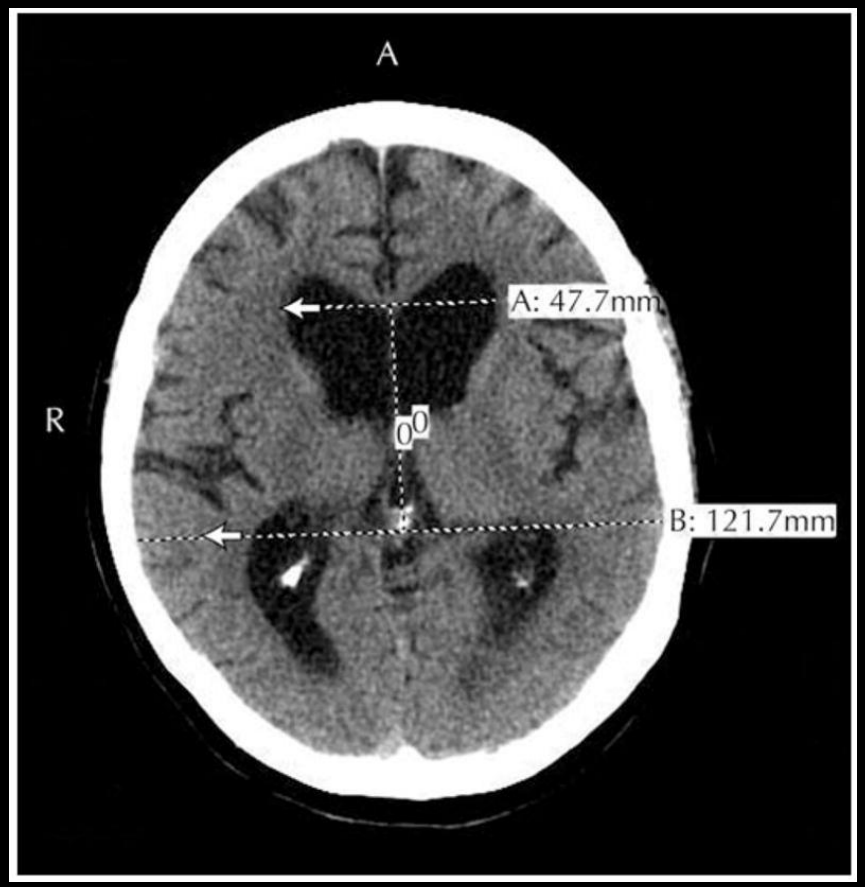


Empty sella

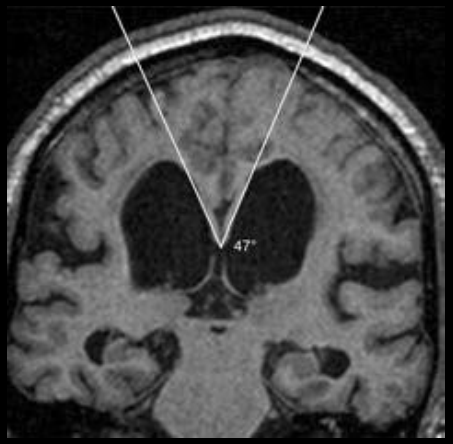


Imaging abnormalities in NPH

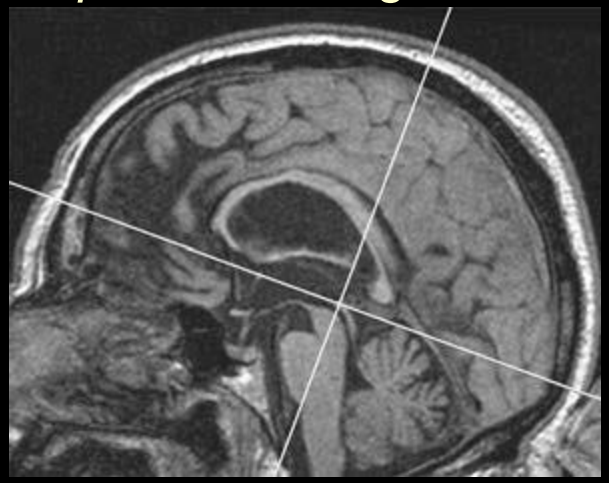
Evans ratio (>0.3)



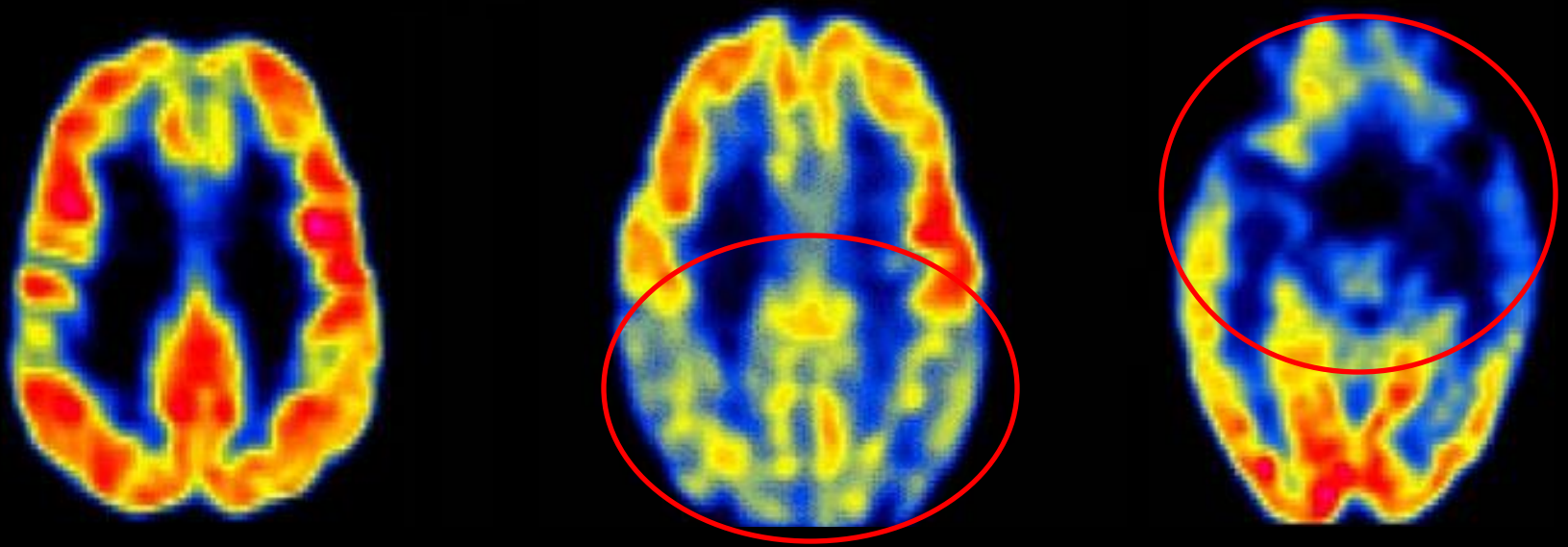
Callosal angle (acute)



Upward bowing of CC



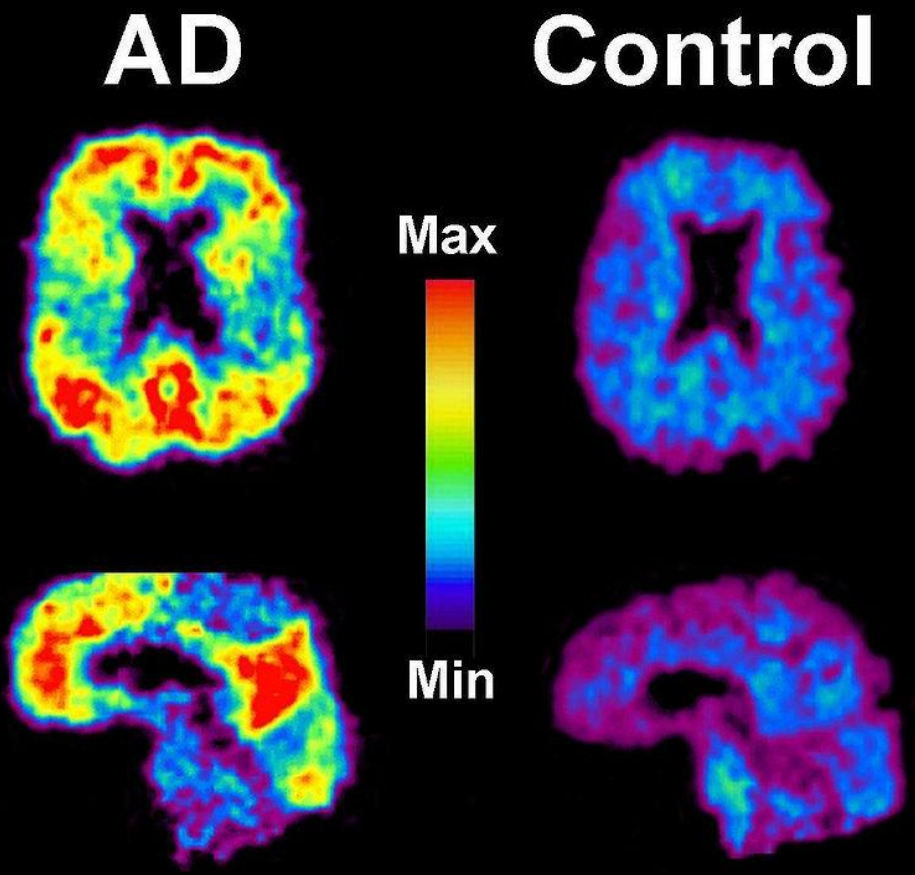
FDG PET in dementia



Control AD FTLD

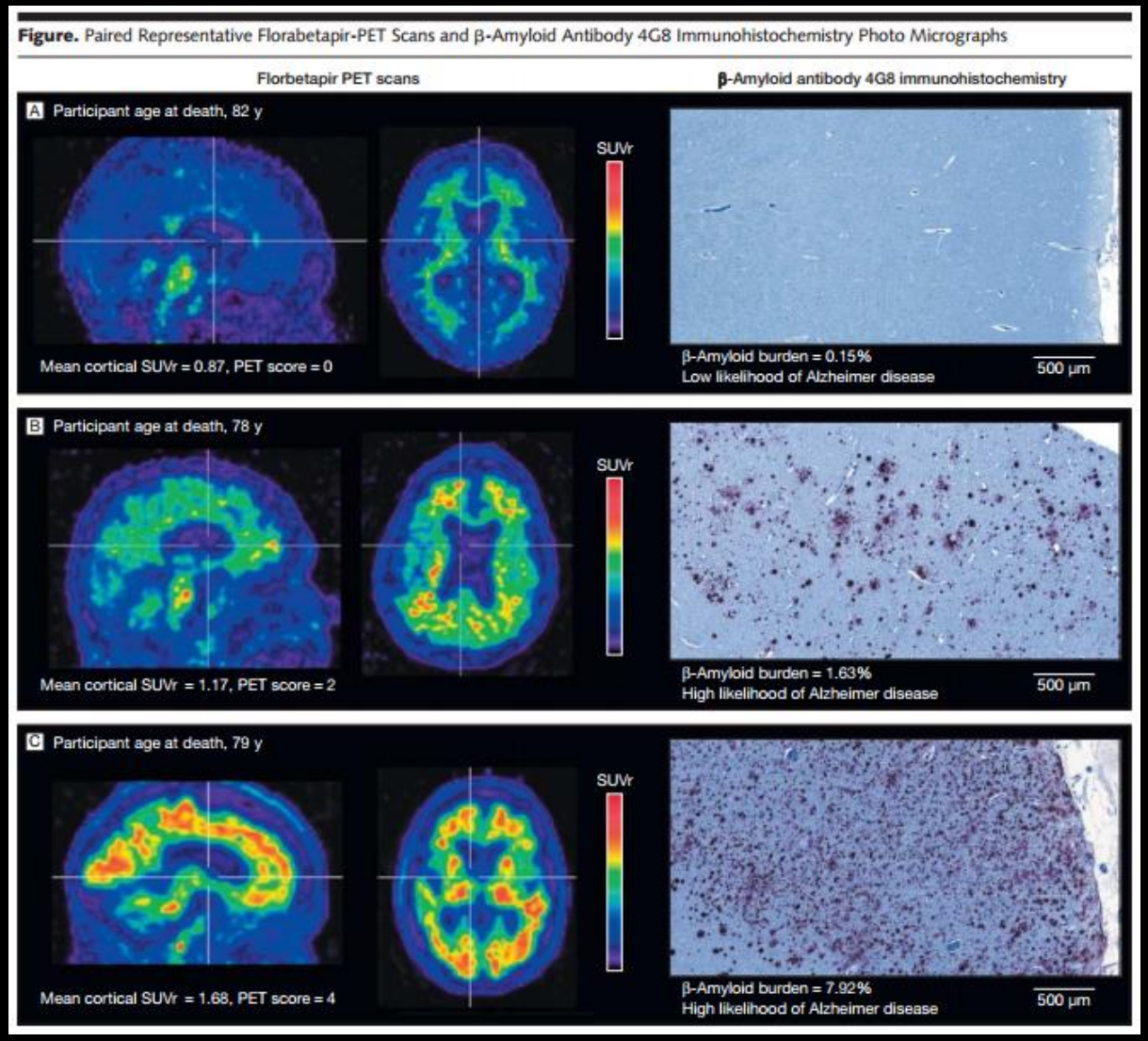
MGH Rad Rounds 2006;4(4)

Pittsburgh compound-B PET in dementia



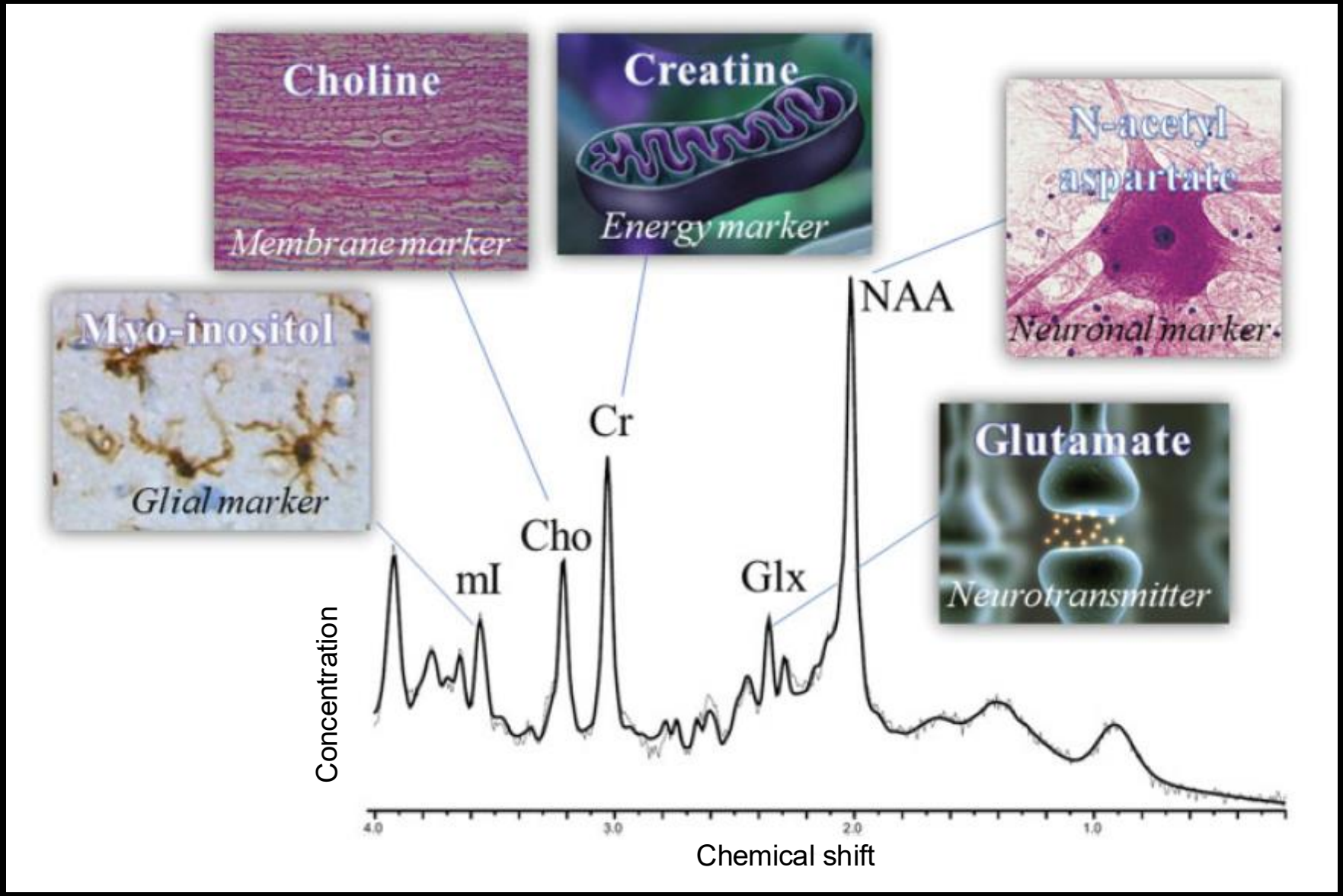
U. Pittsburgh PET Amyloid Imaging Group

Florbetapir-F18 PET in dementia



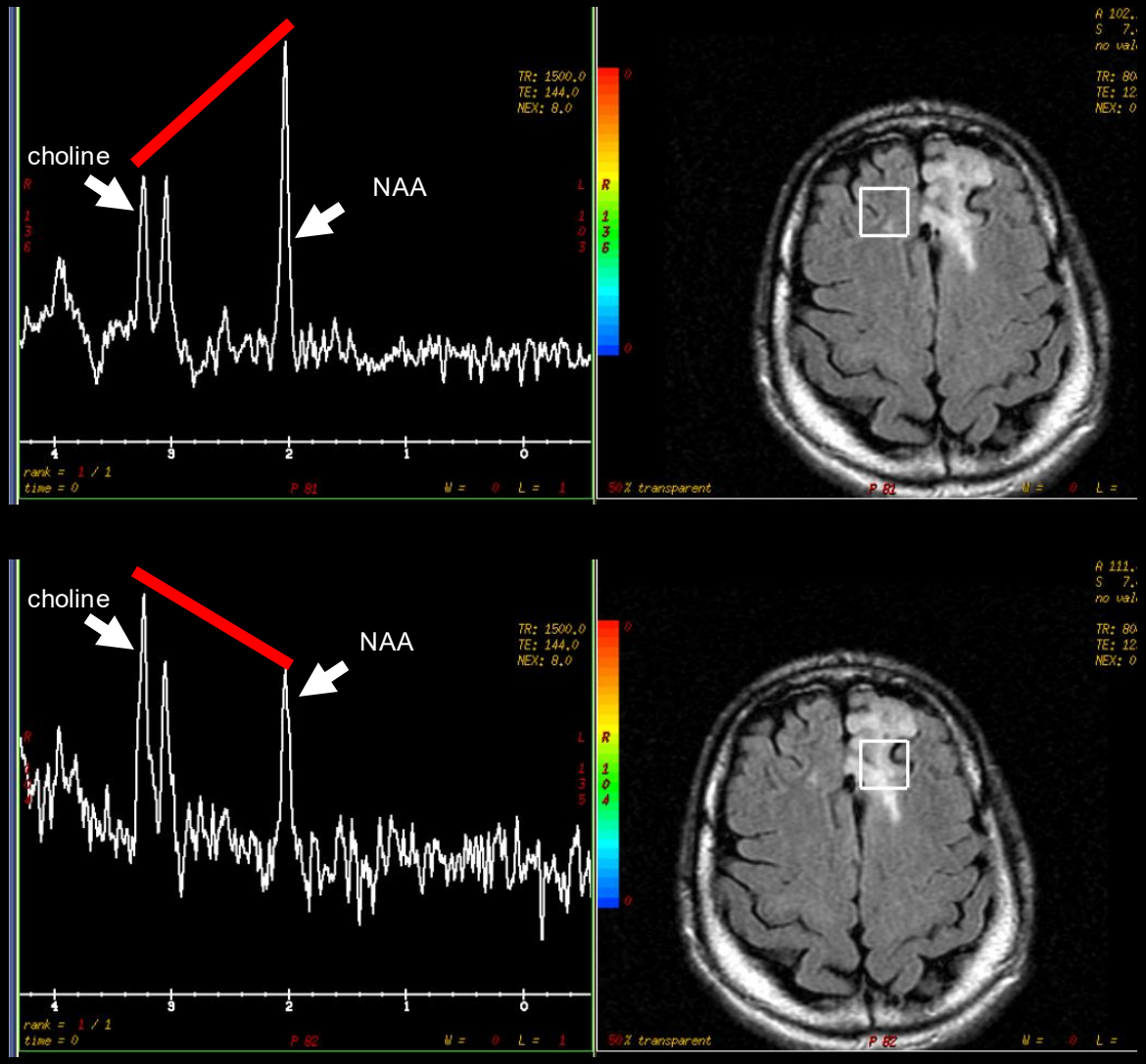
JAMA 2011;305(3):275

Neurospectroscopy, a ‘virtual biopsy’

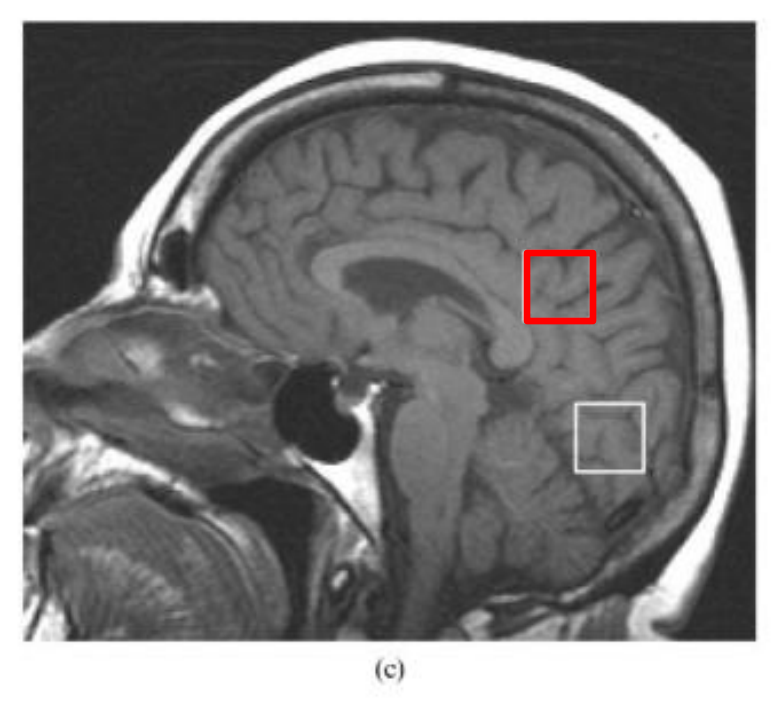


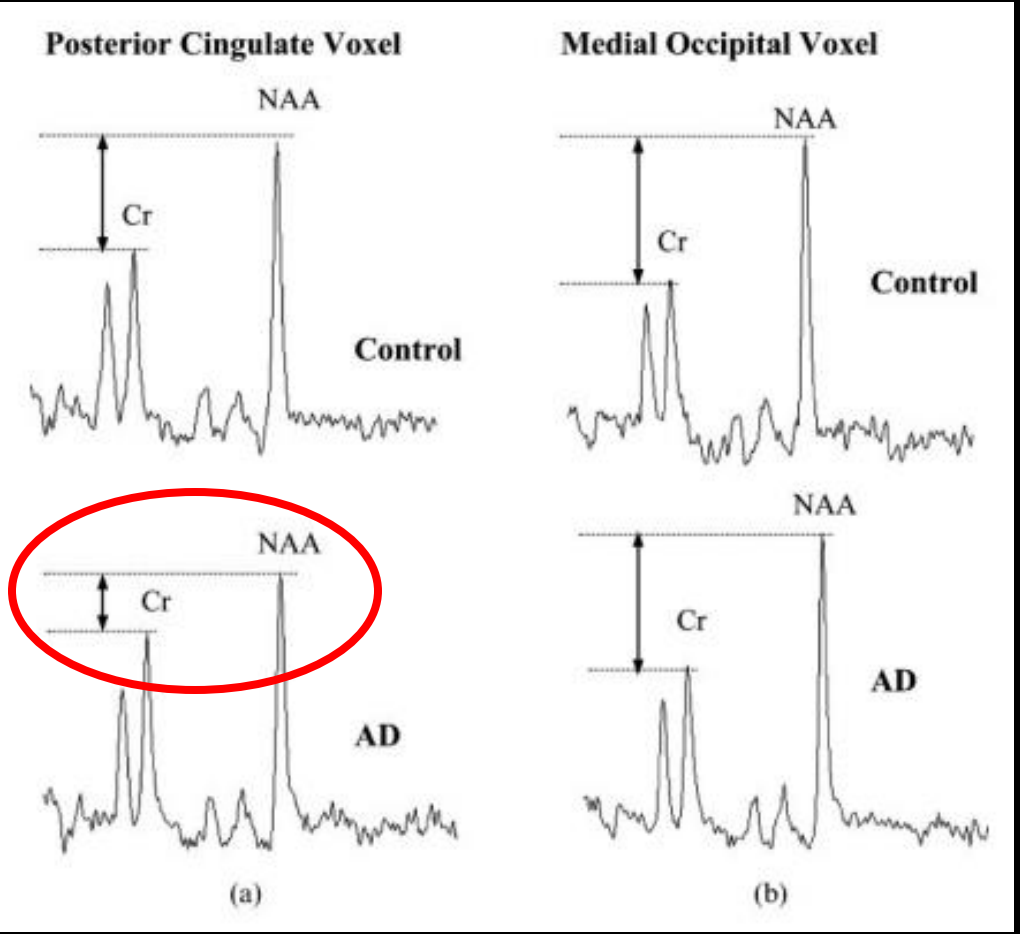
Semin Neurol 2012;32:432

MR spectroscopy



MR spectroscopy in dementia





Br J Radiol 2007;80(2):S146

Conclusion

- **Neuroimaging should be hypothesis-driven.**
- **Localize the problem from the history and physical exam.**
- **Assess carefully for interval changes.**
- **Metabolic changes likely precede structural changes in neurodegenerative diseases.**