

MRI brain - Interactive teaching of basics

sona pungavkar

SDRC

GLOBAL HOSPITALS

SL RAHEJA-FORTIS HOSP

Evolution of MRI

MRI has come a long way

Improved performance of hardware and software

Milestones

- ❖ Routine imaging of brain and spine
- ❖ Advanced imaging of brain and spine
- ❖ Vascular system
- ❖ Mapping of functional areas and metabolites

Advantages of MRI

- Multiplanar capabilities
- Better intrinsic soft tissue contrast - matrix delineation
- No radiation
- No iodinated contrast
- Can provide physiologic / metabolic/functional info



Coils

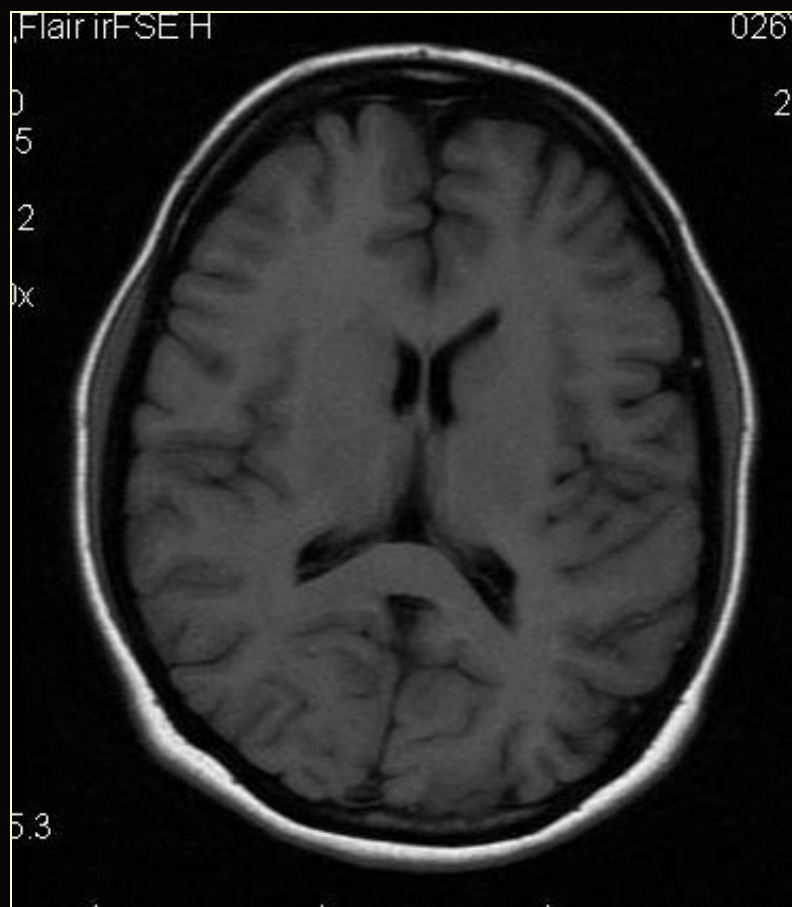
Magnet



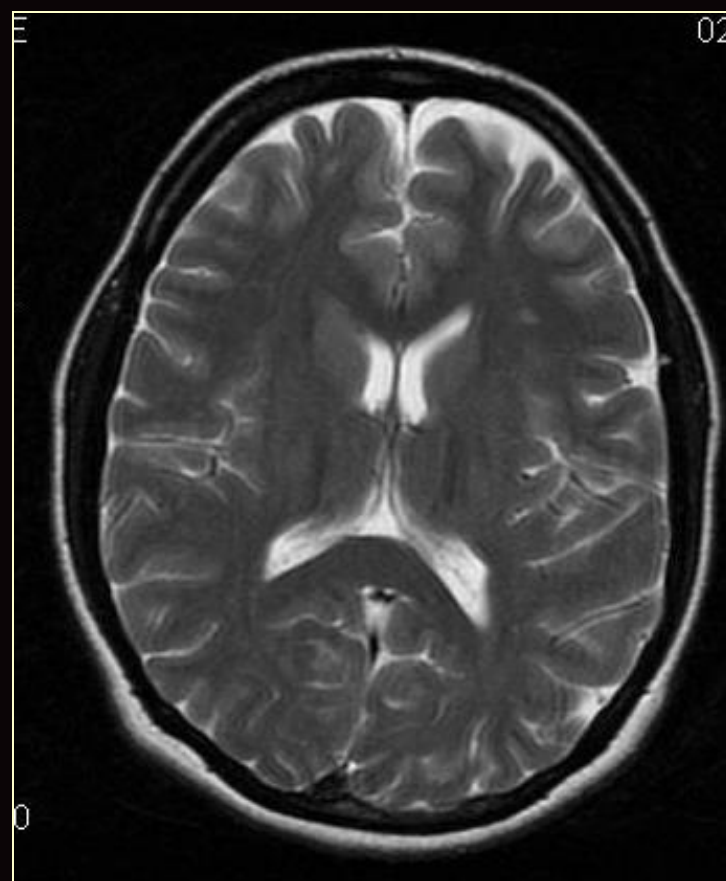
COILS

Wrist
Knee
Shoulder
Elbow
Hip
Ankle
Foot



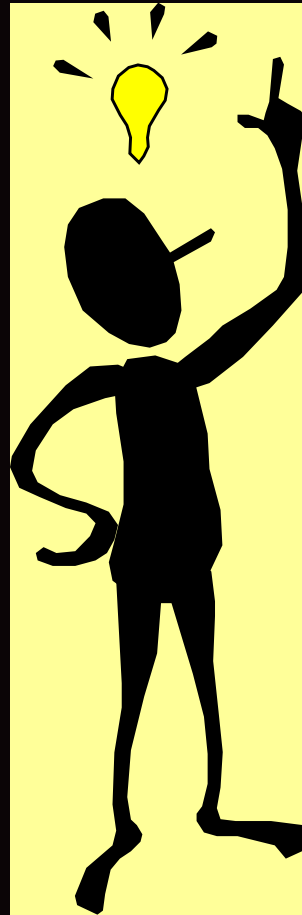
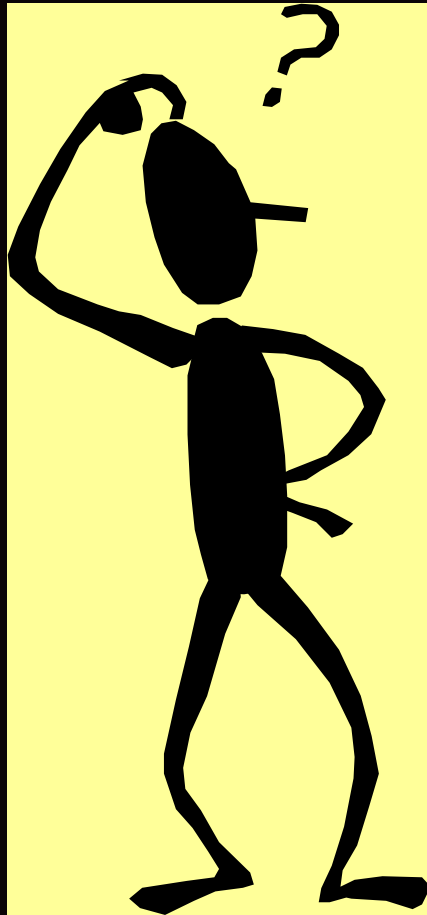


anatomy



pathology

SEQUENCES

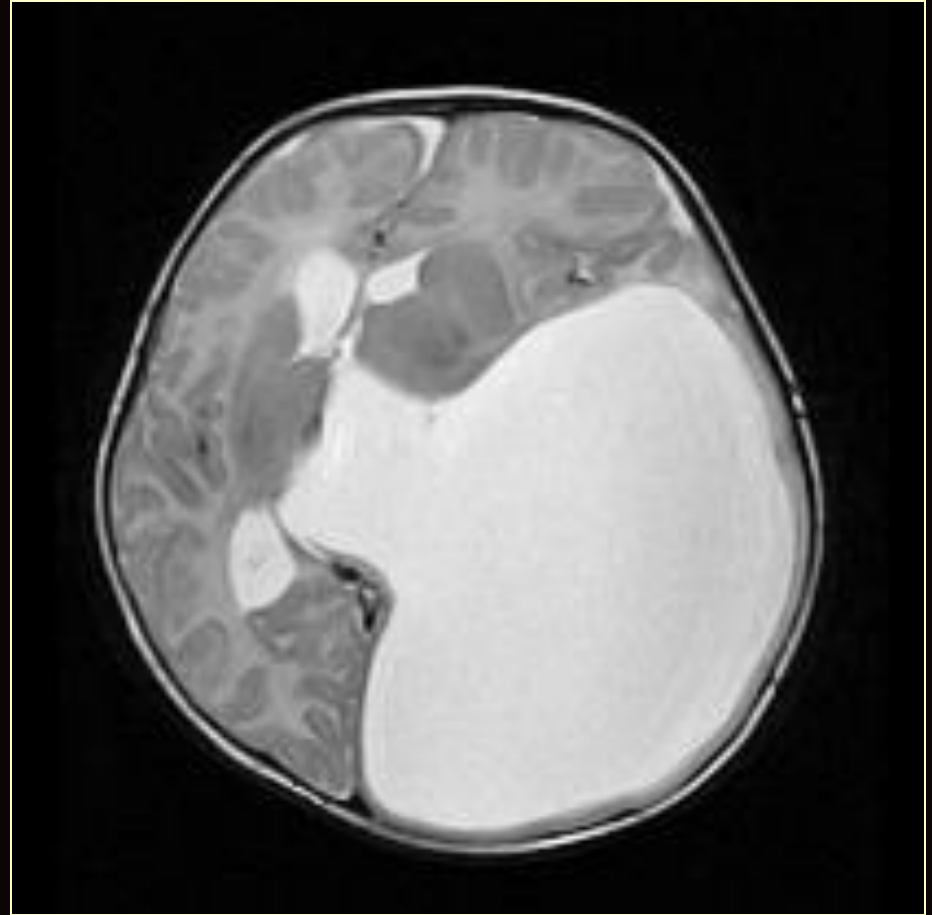
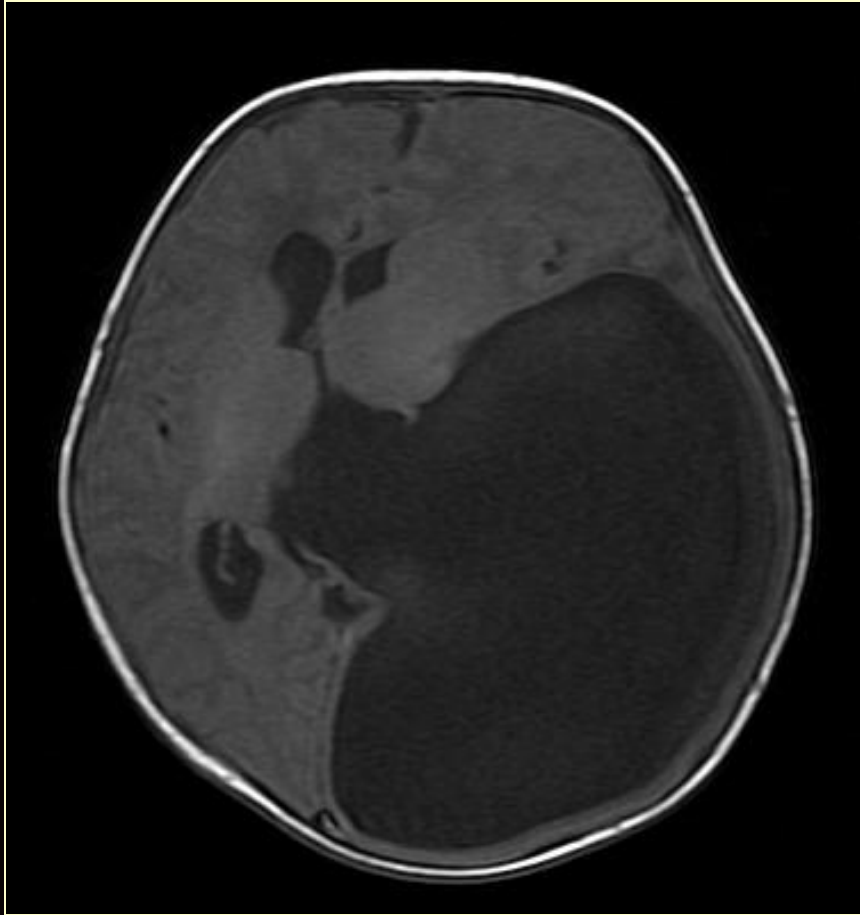


Which?

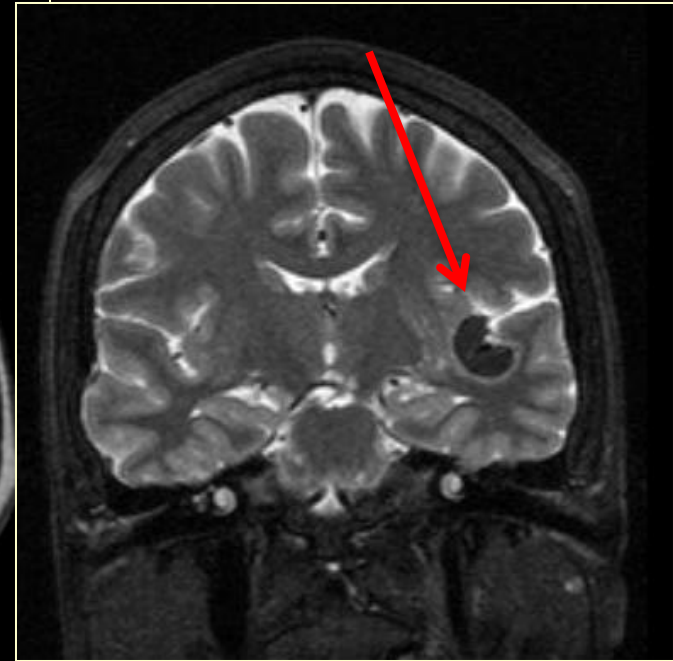
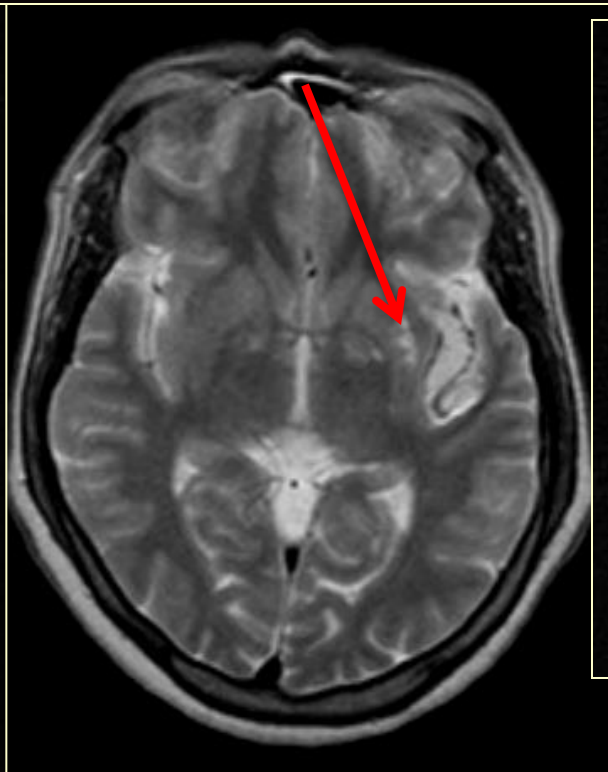
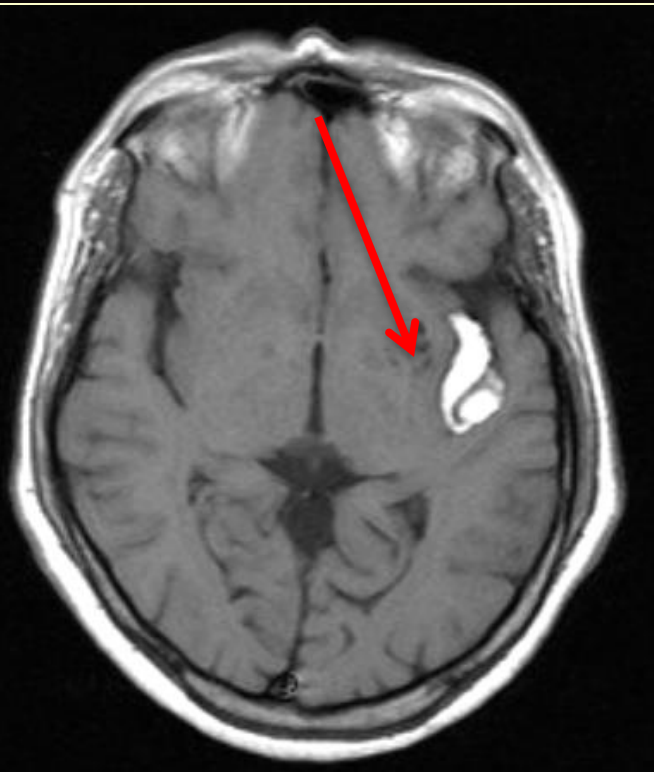
When?

Why?

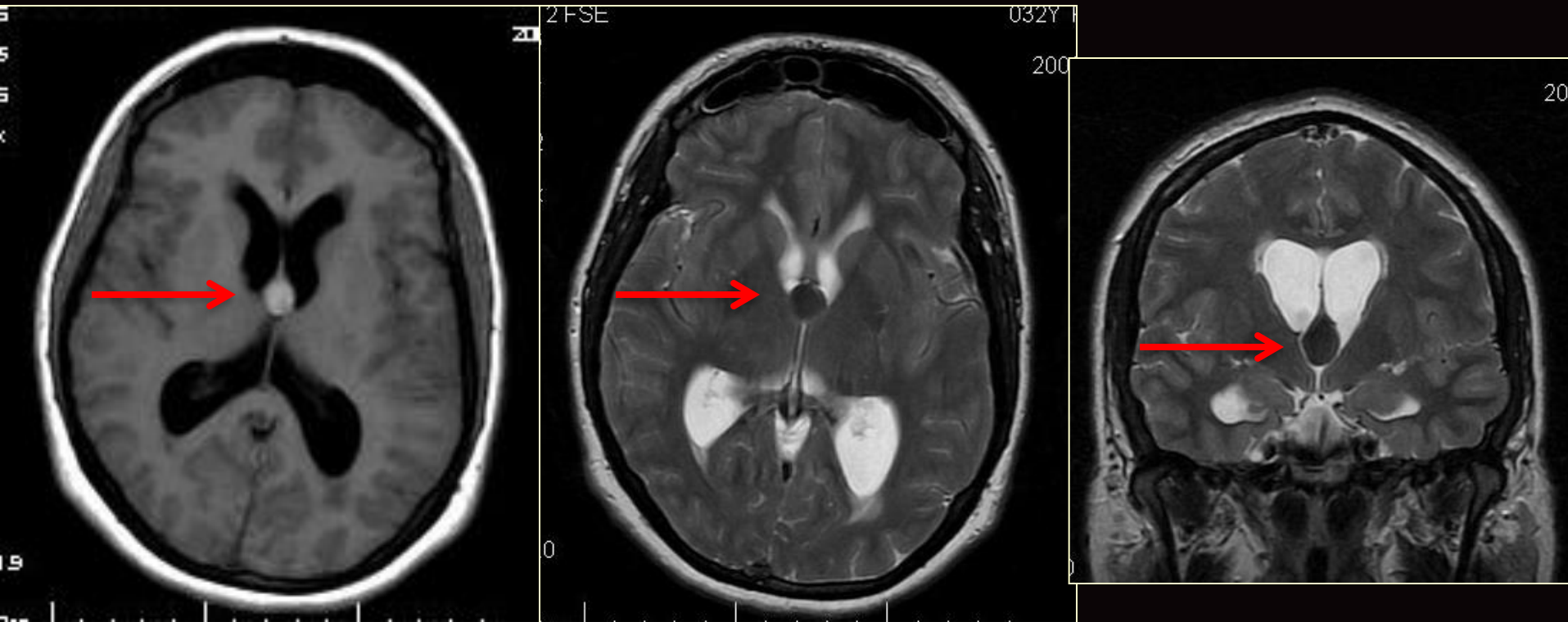
Fluid



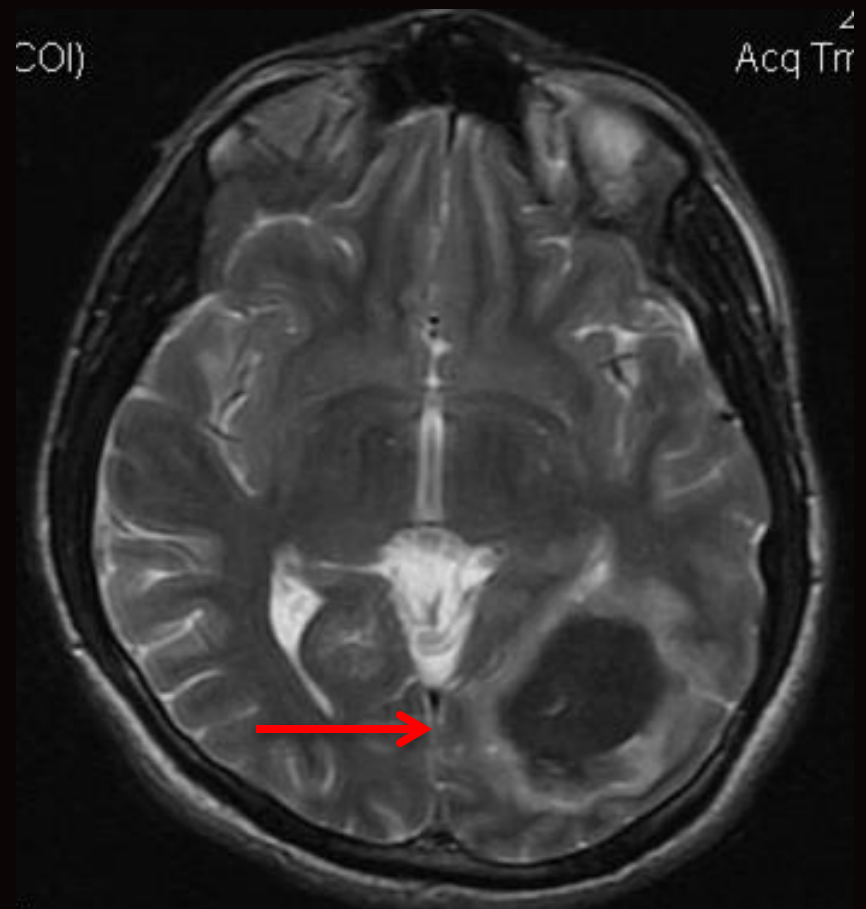
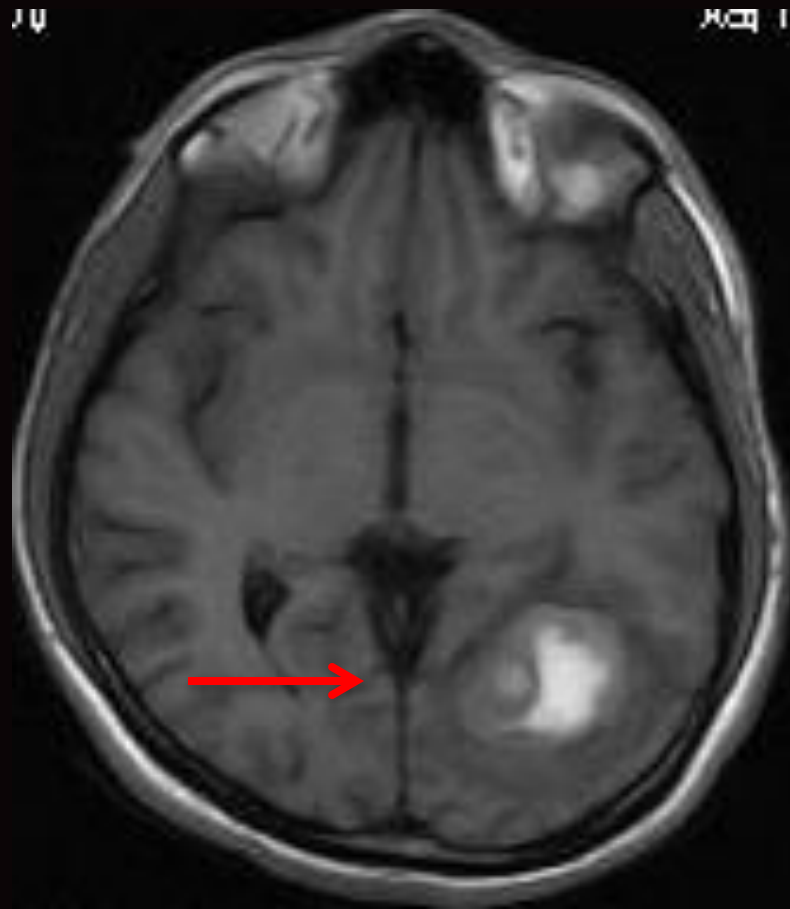
fat



High protein content

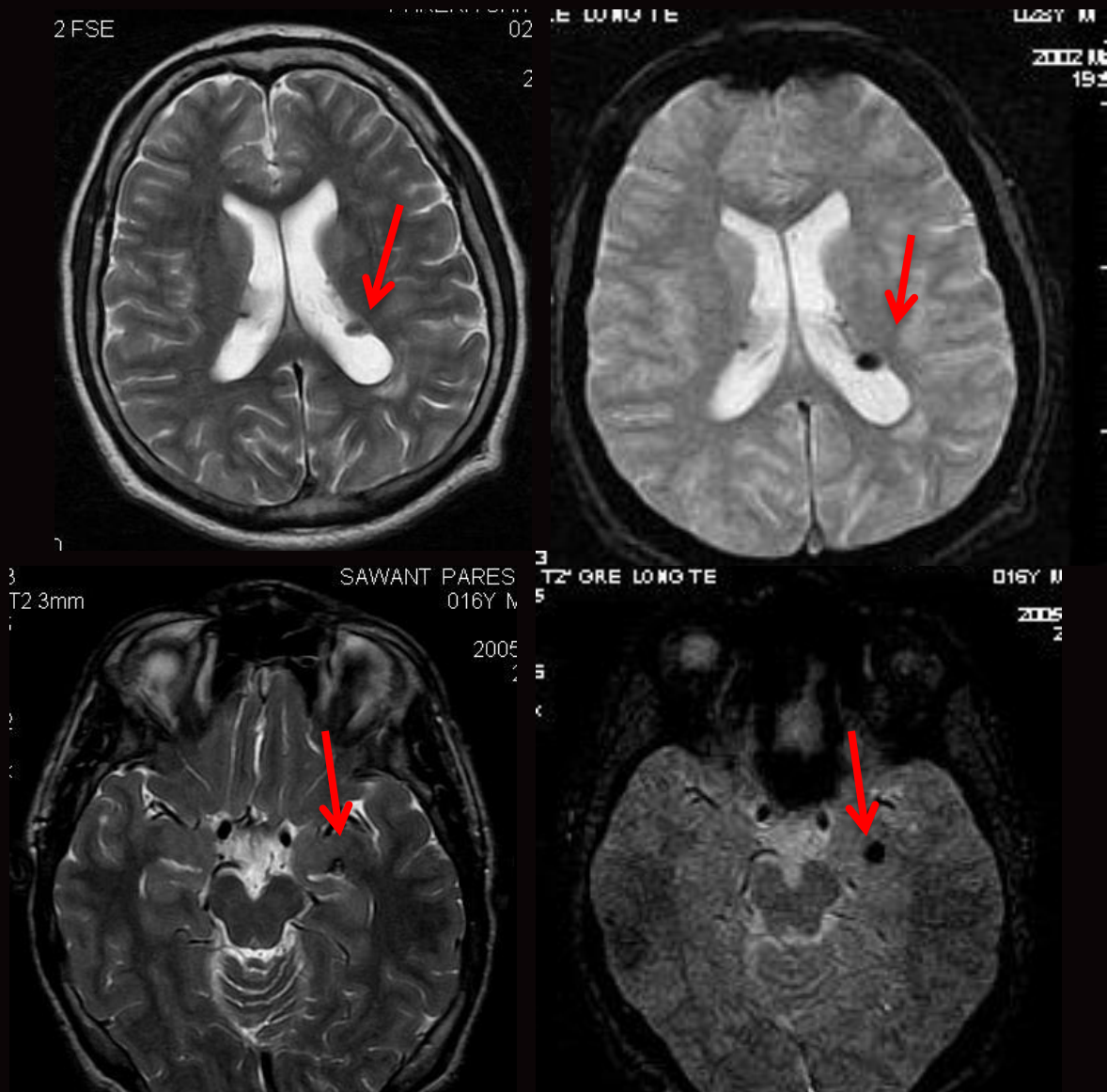


Blood



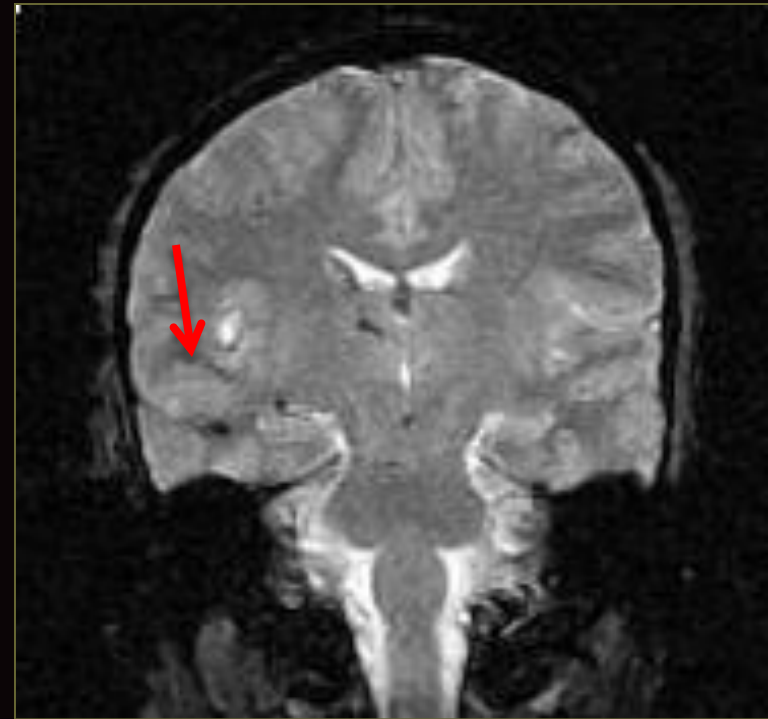
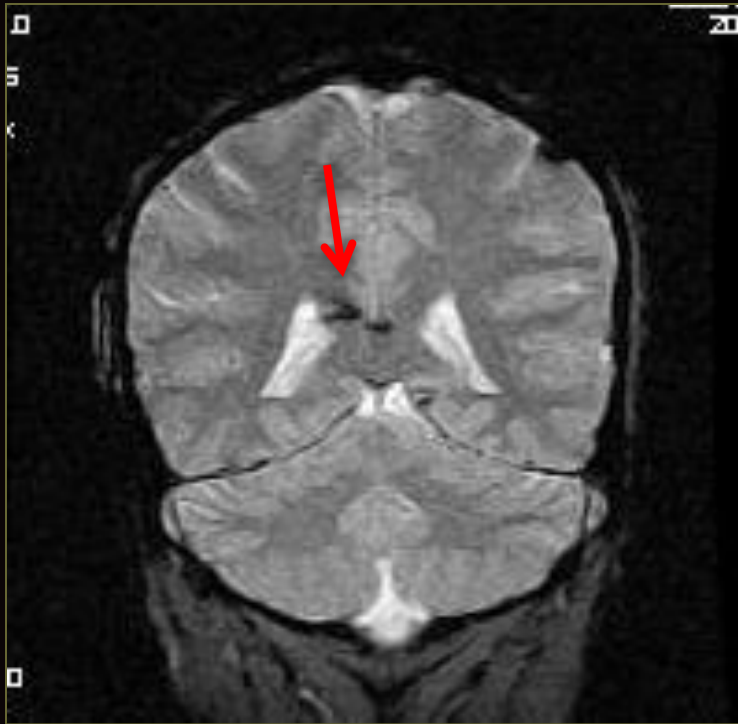
Gradient echo / SWAN

Calcification



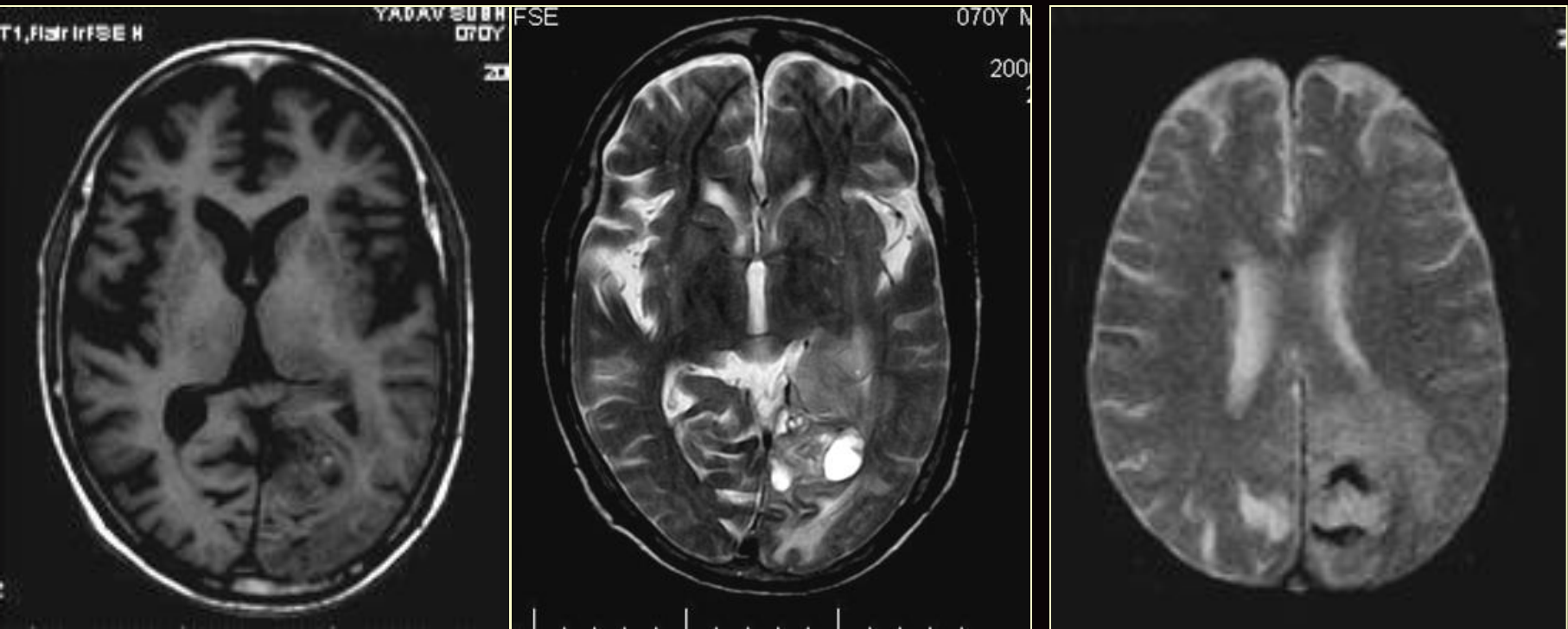
Where is it used ?

- H,rrhage in brain



Where is it used ?

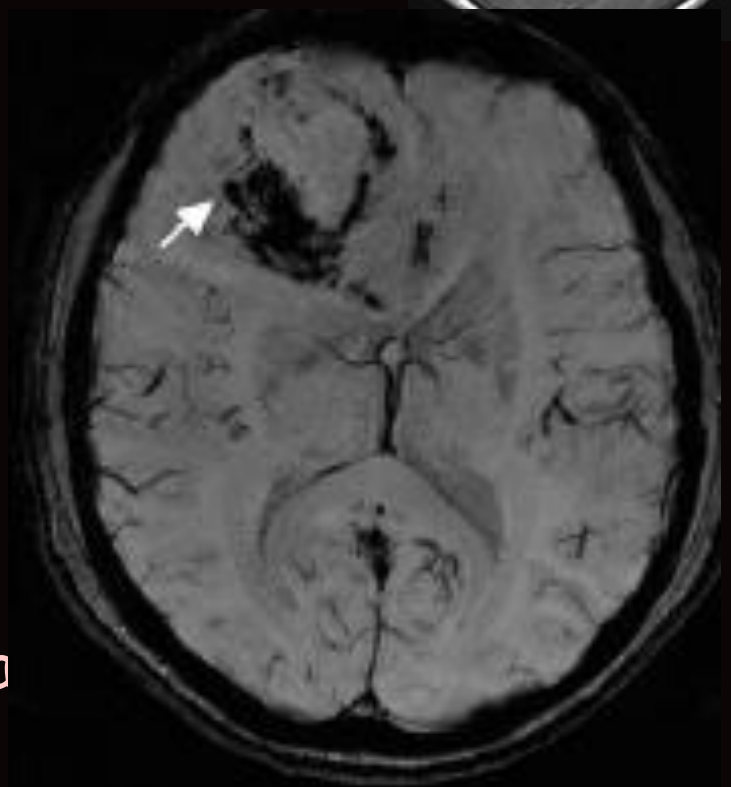
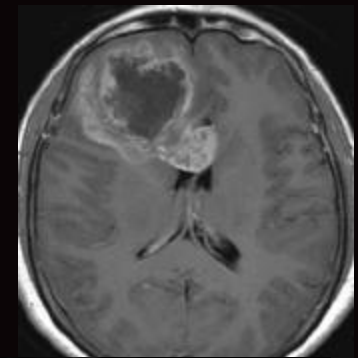
- H,rrhage in brain



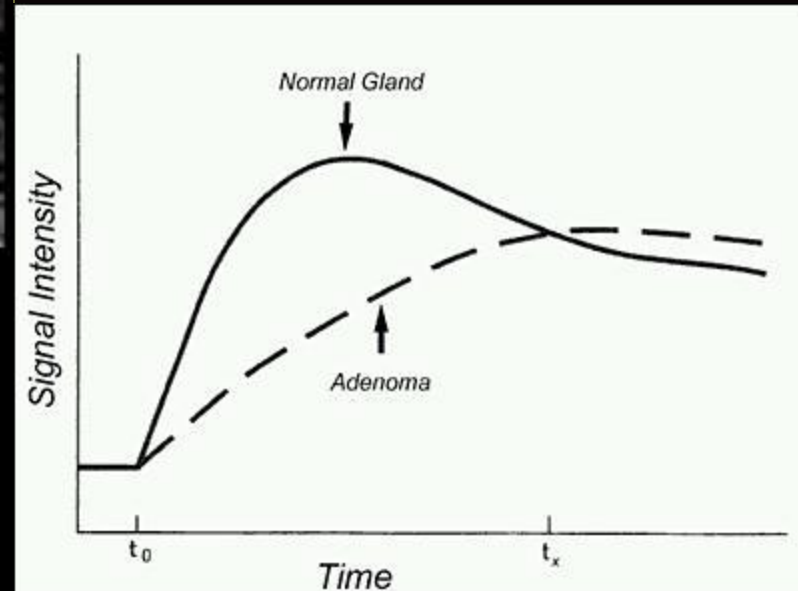
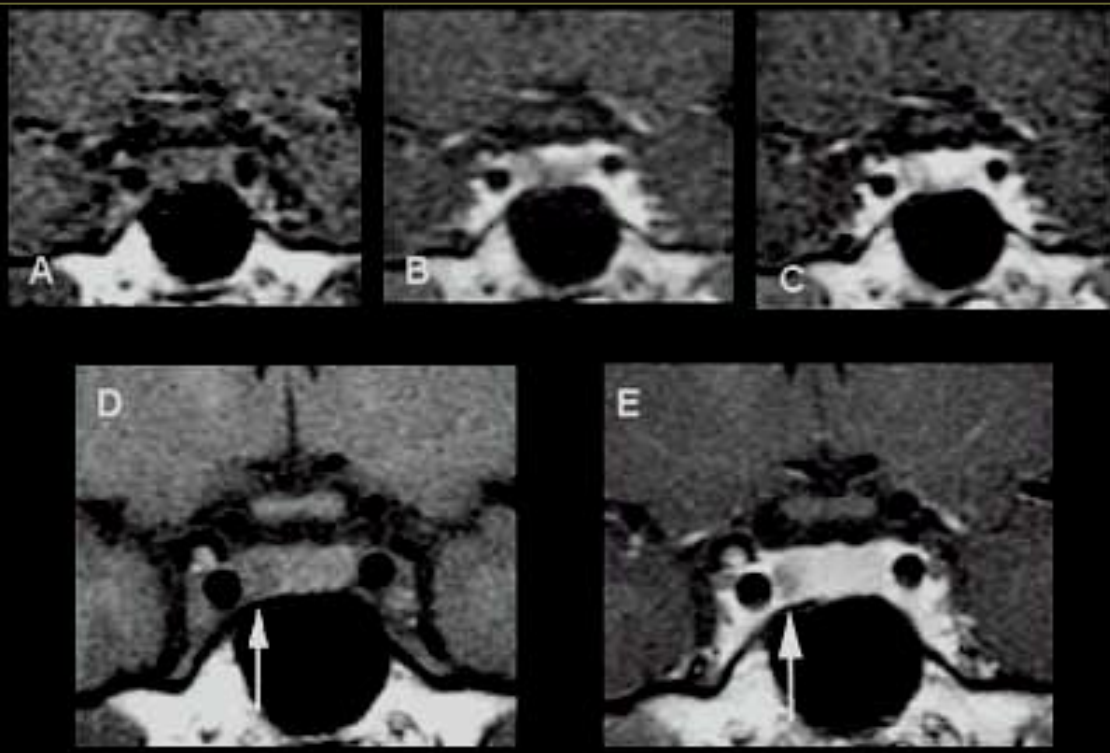
Susceptibility weighted imaging-SWI

- Maximises susceptibility difference among various tissues
- Microhemorrhages, vascular proliferation, neovascularity
- High field MRI

High grade glioma



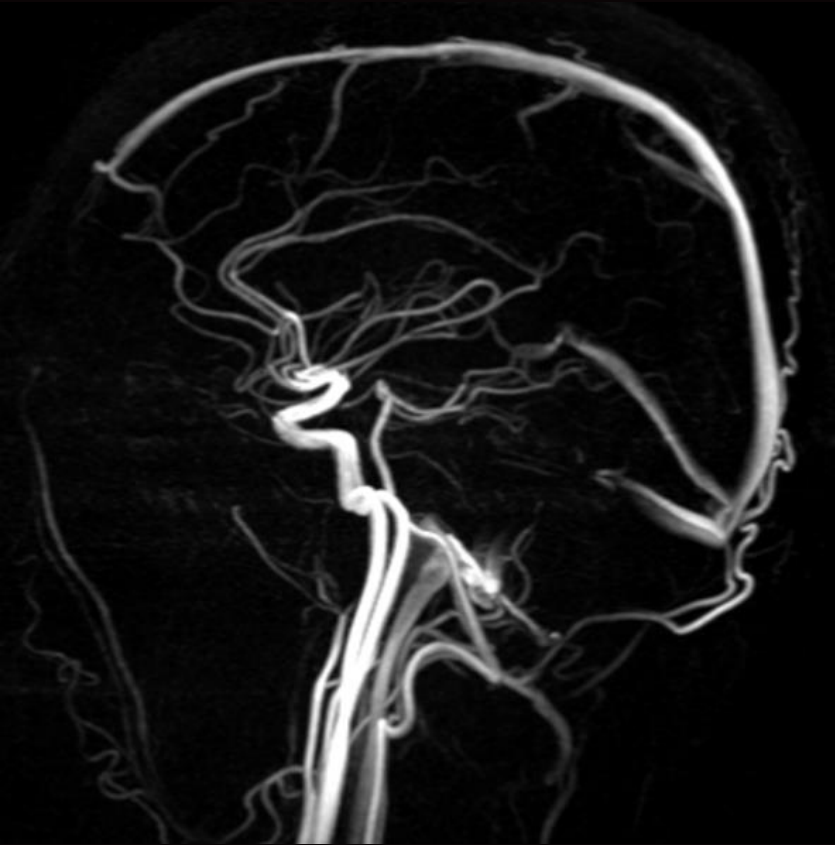
Dynamic scan for pituitary



MR ANGIOGRAPHY

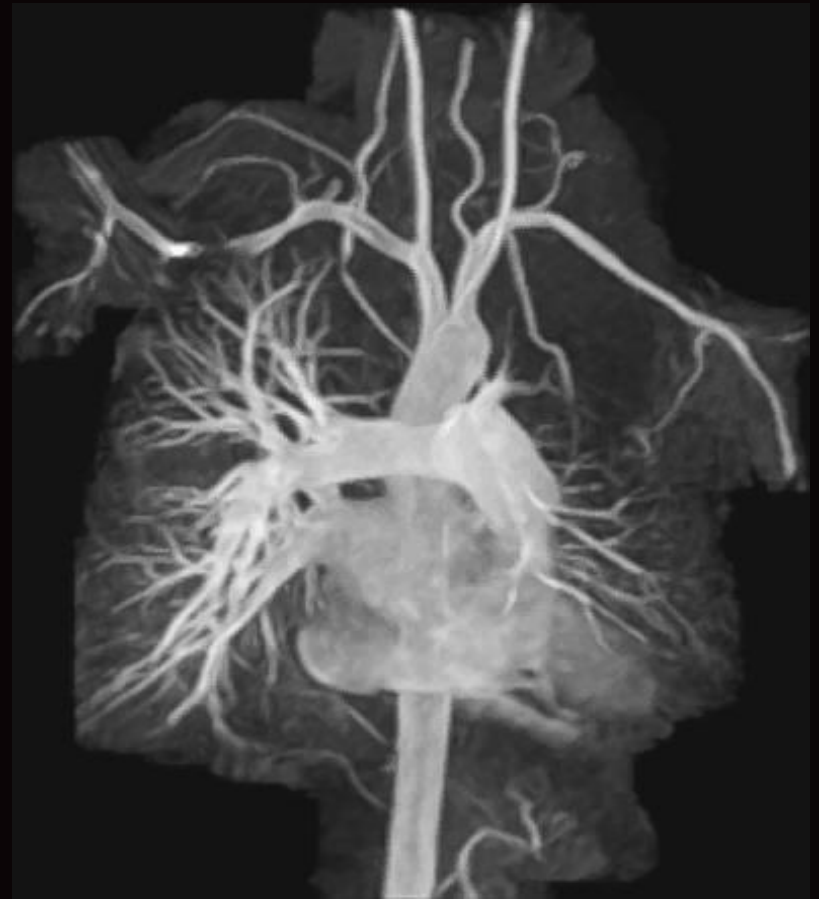


NON-CONTRAST ANGIO- VENO INHANCE



Contrast Enhanced MRA

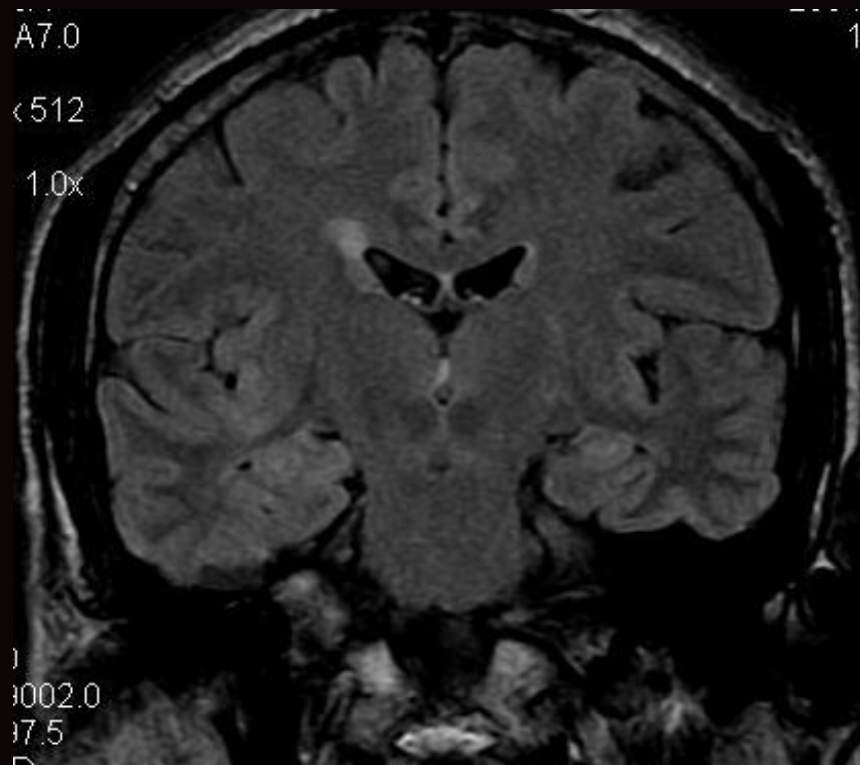
- NON-INVASIVE
- SAFE CONTRAST
- LESS CONTRAST
- MULTIPHASIC



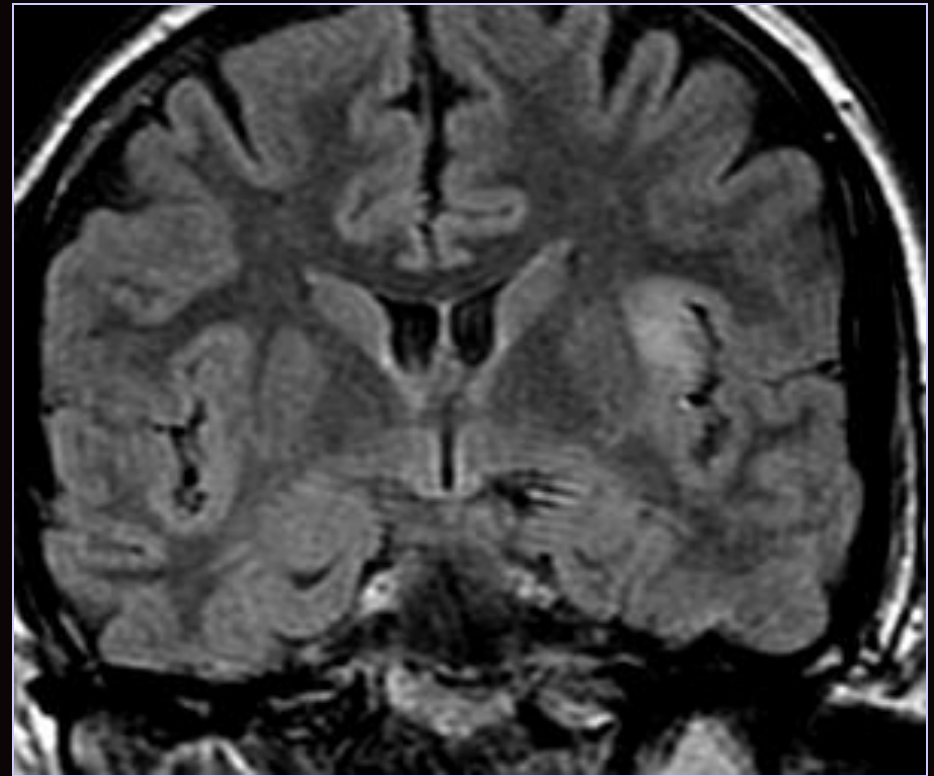
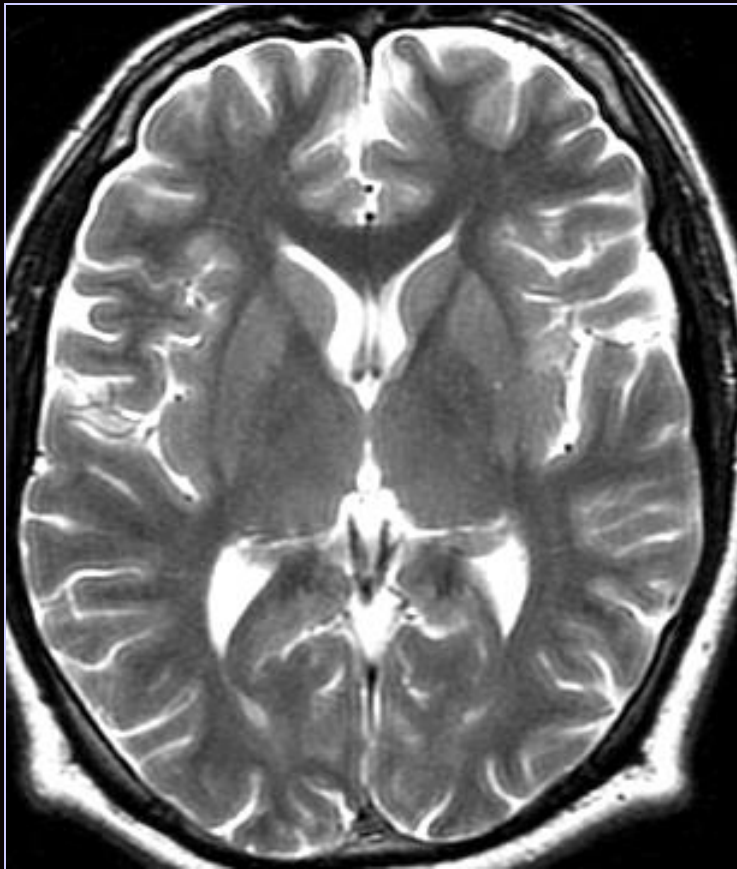
Inversion recovery - FLAIR

FLAIR

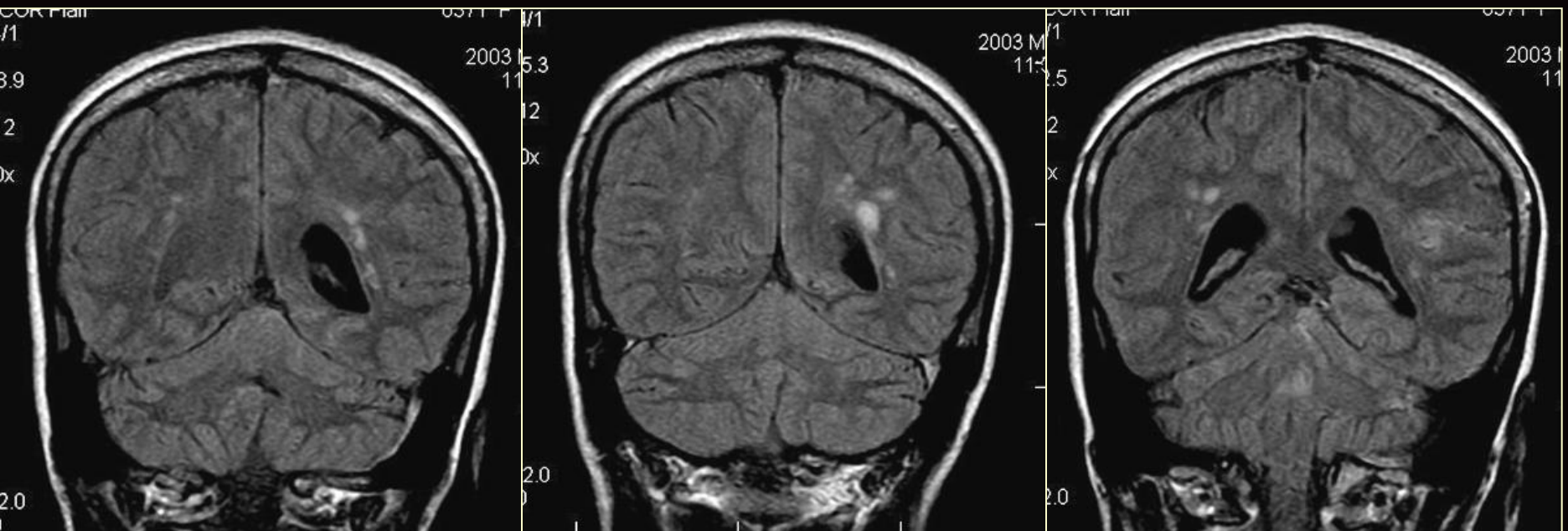
- Similar to T2 WI but no signal from CSF



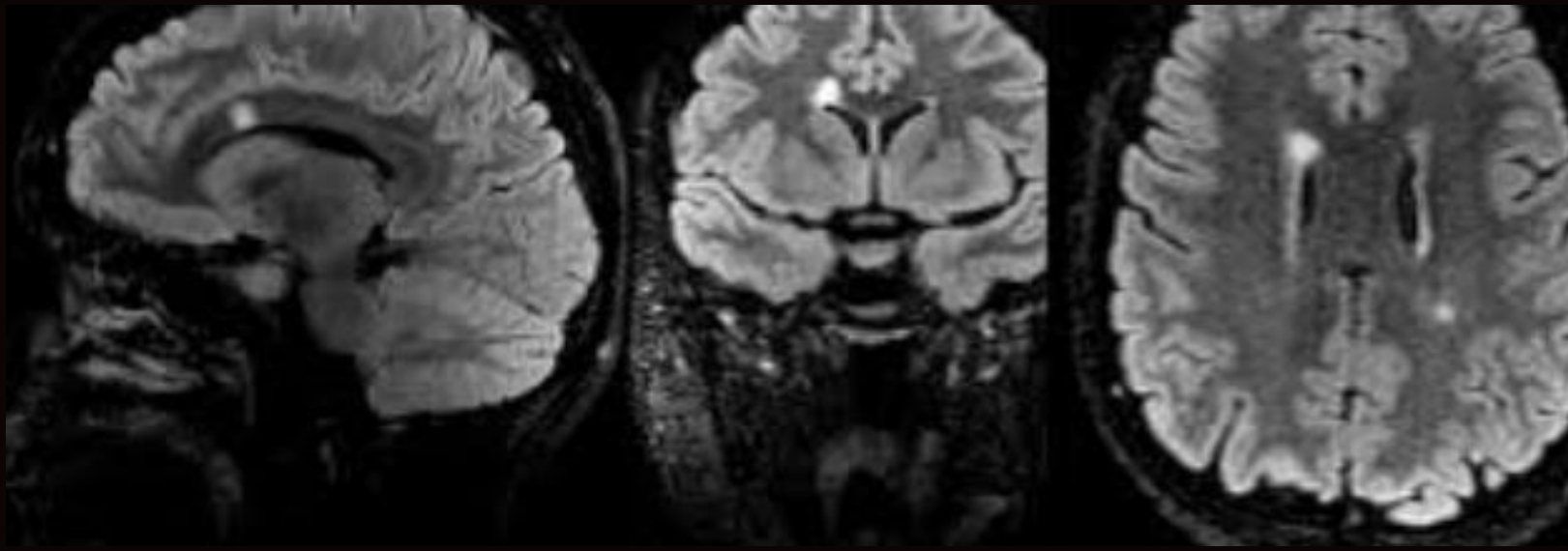
FLAIR



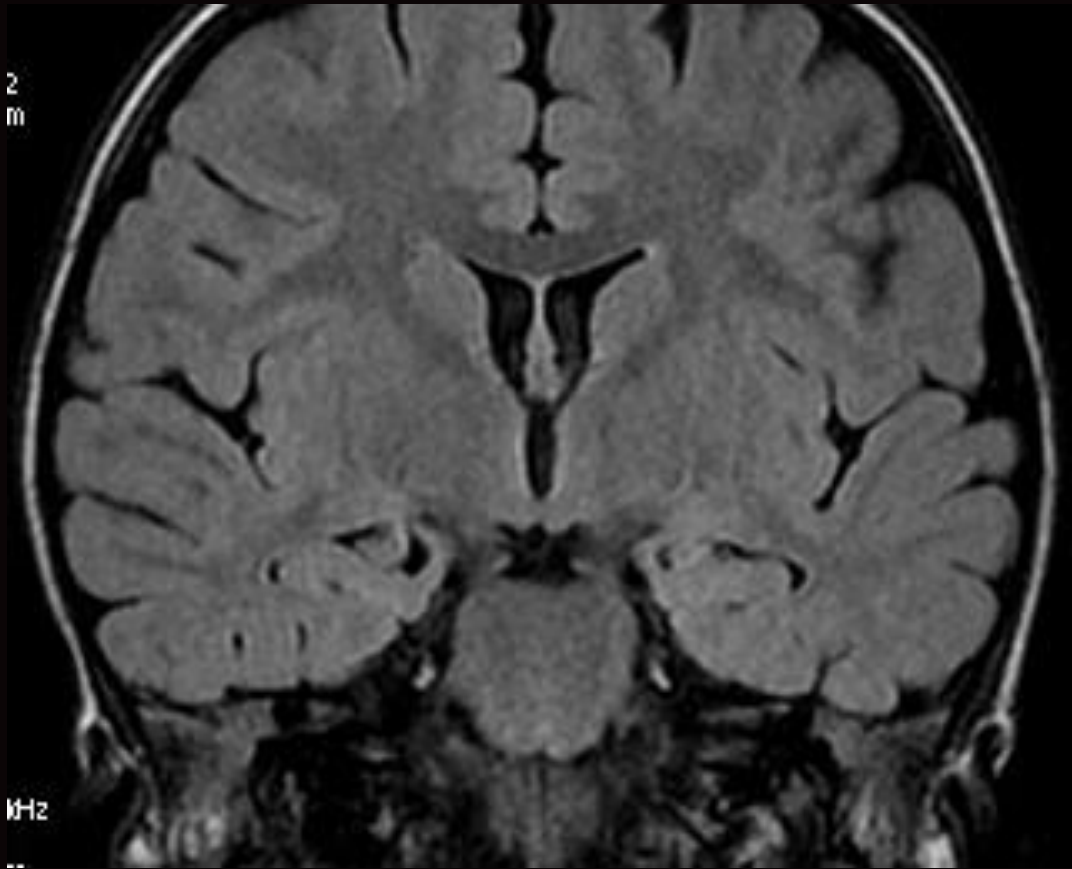
FLAIR - multiple sclerosis



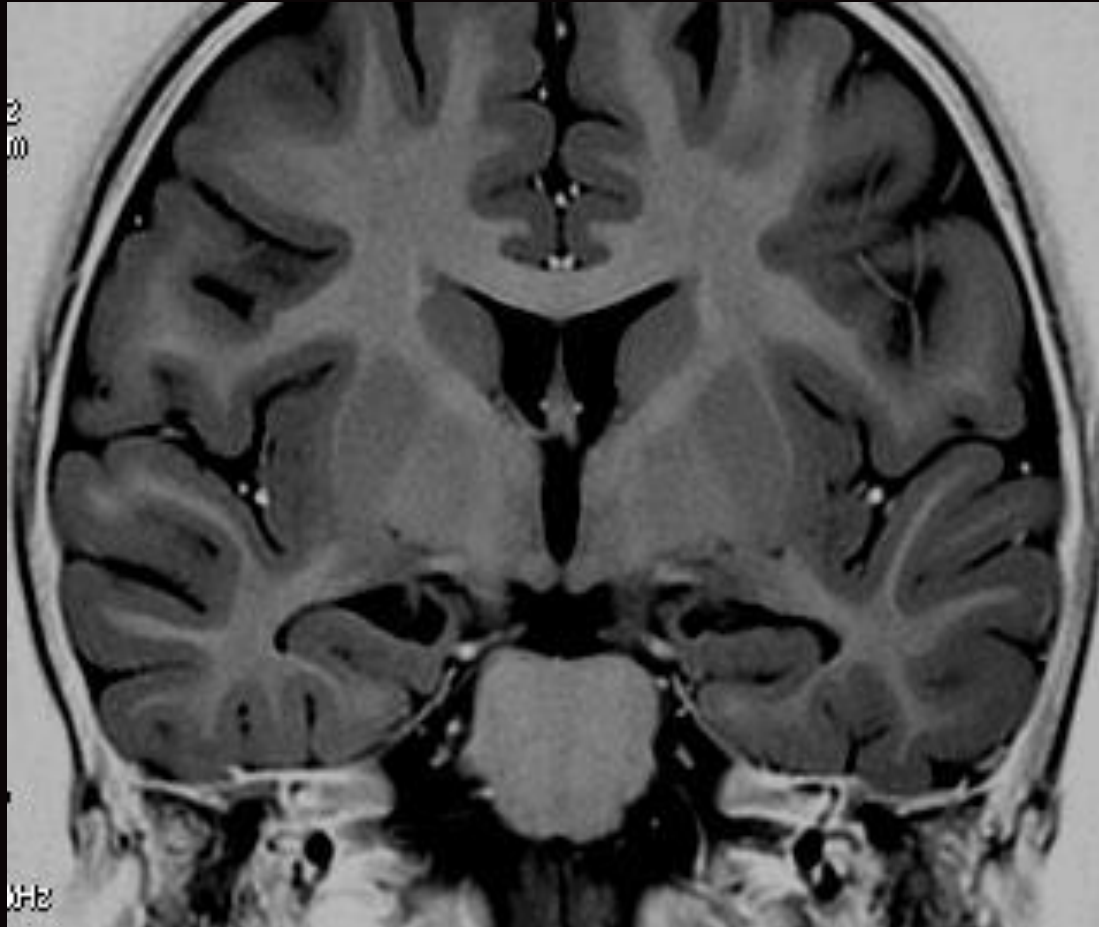
3 D FLAIR CUBE



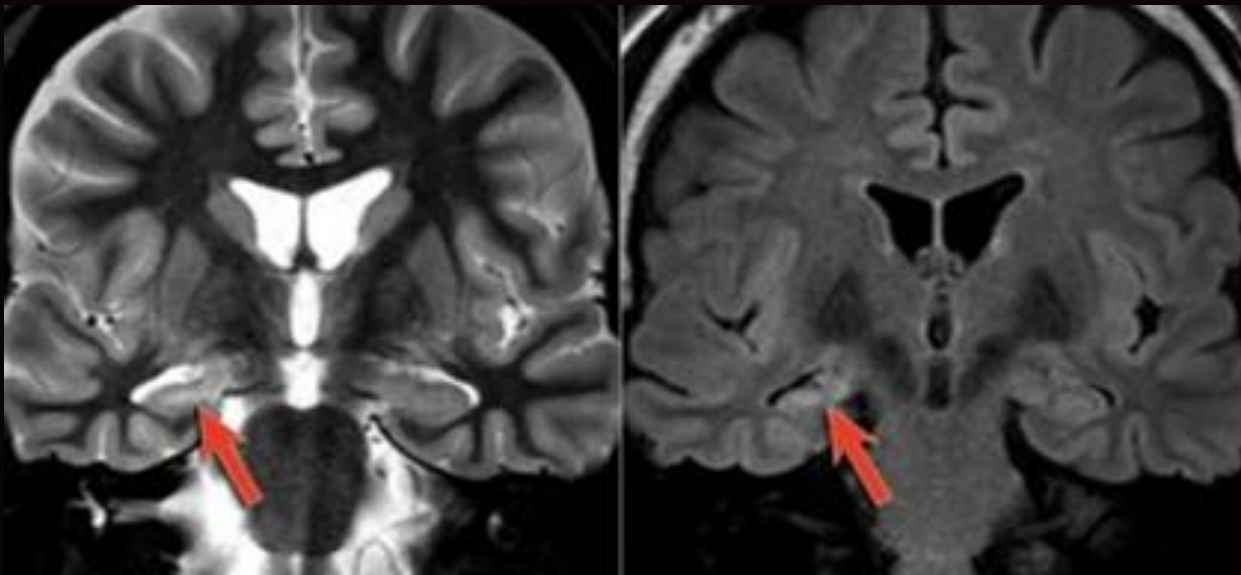
EPILEPSY IMAGING



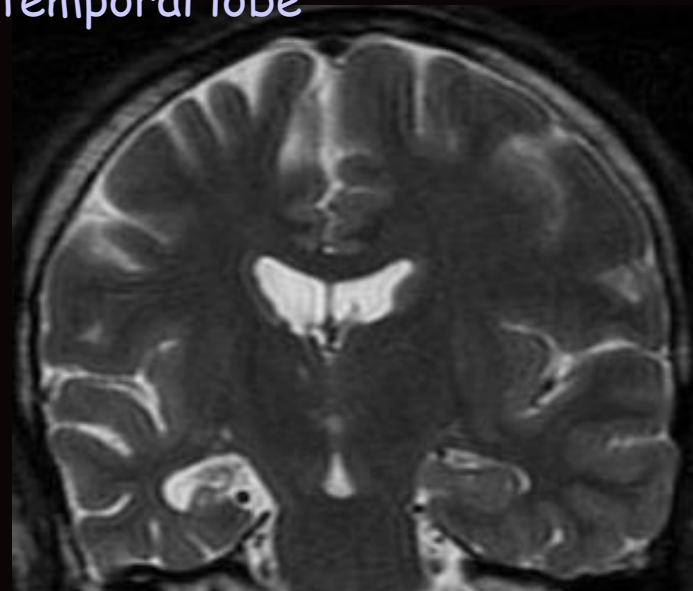
SPGR



FLAIR - Temporal lobe epilepsy

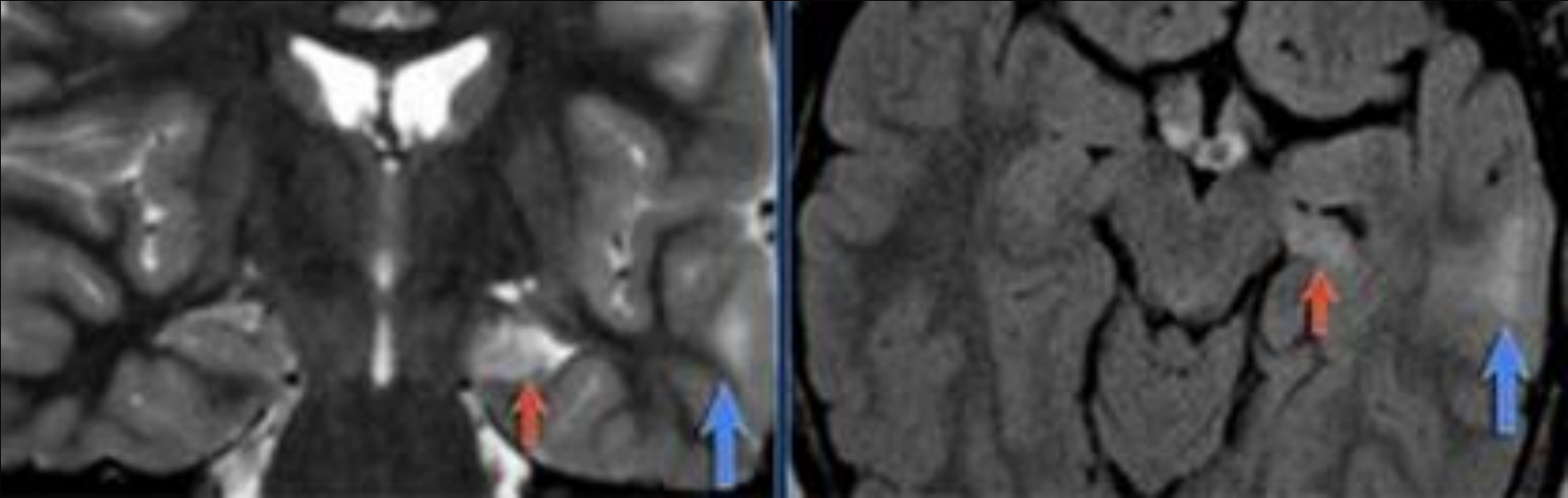


- High T2 signal and atrophy of temporal lobe



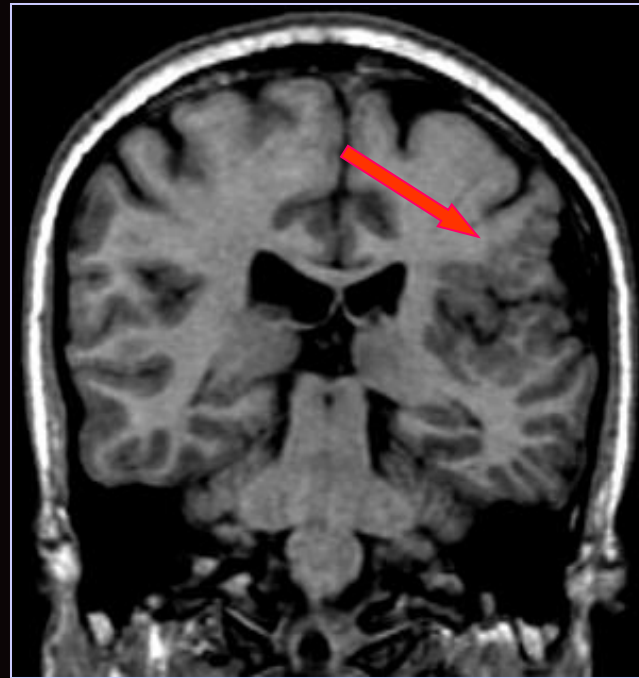
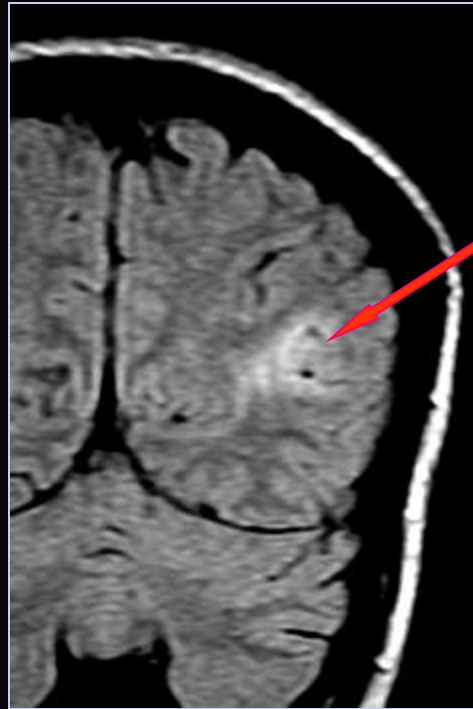
- Hemiatrophy

DUAL PATHOLOGY

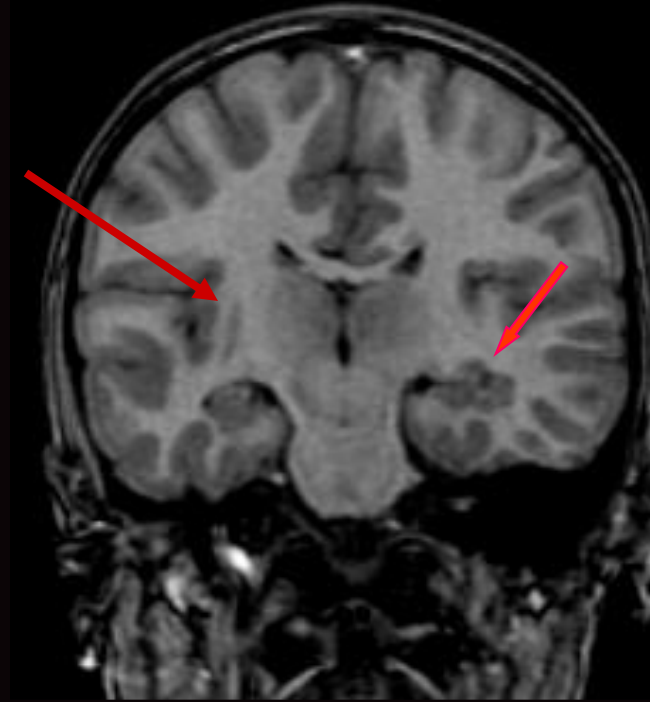


- HS with cortical dysplasia

Focal cortical dysplasia

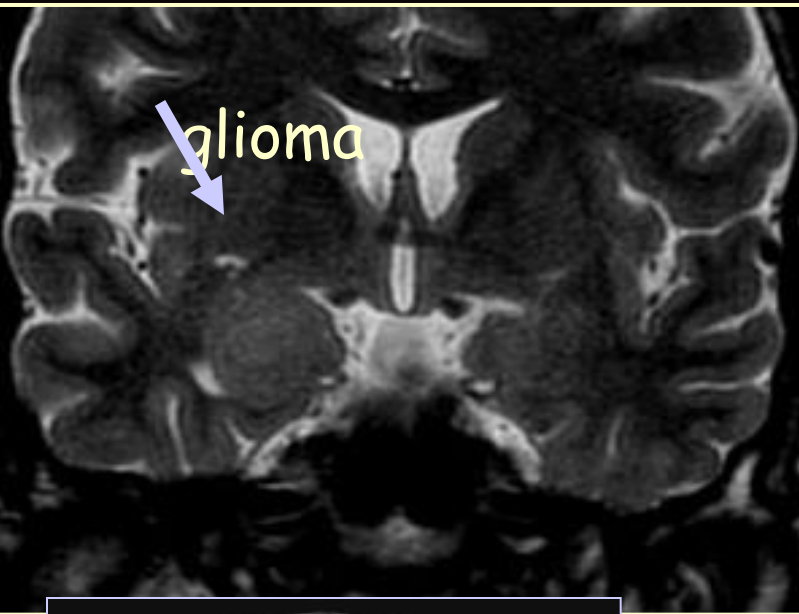


Heterotopia

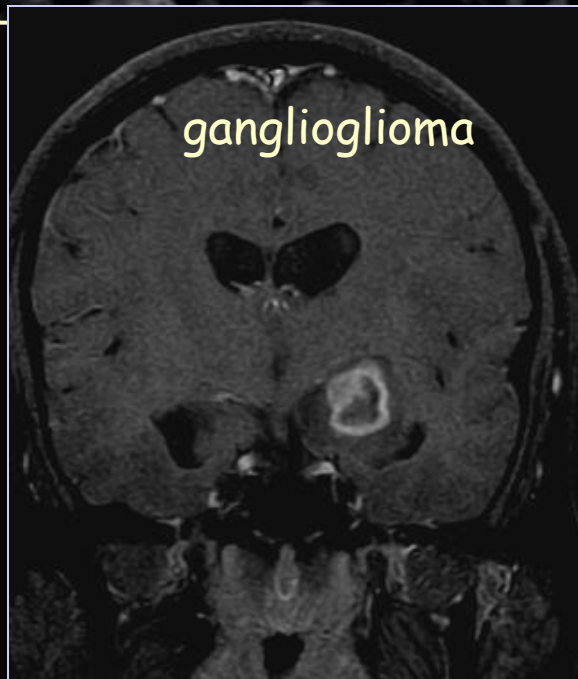
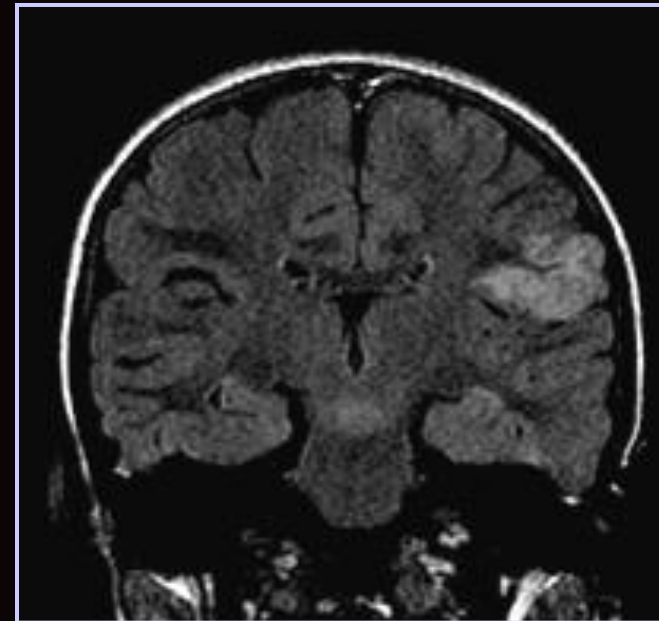


Polymicrogyria

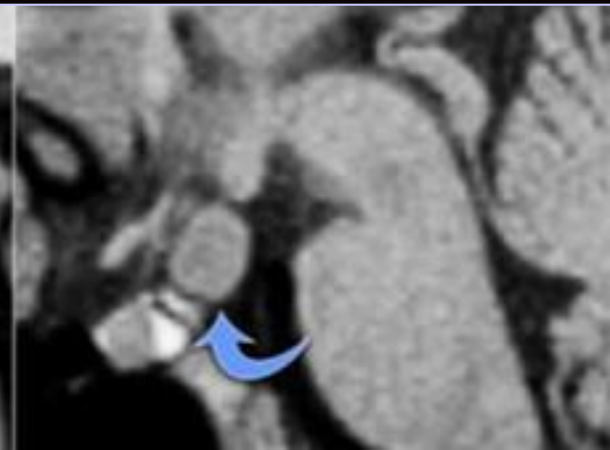
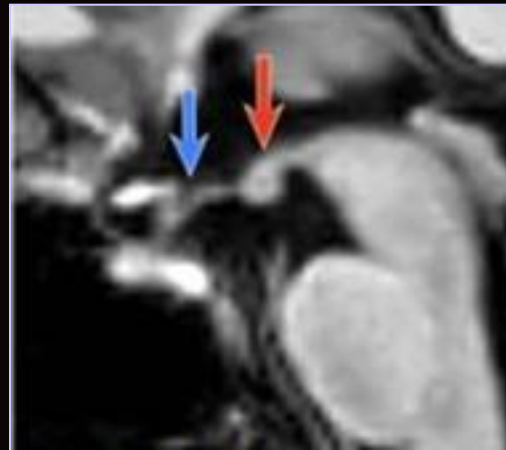
EPILEPSY ASSOCIATED NEOPLASMS



DNET

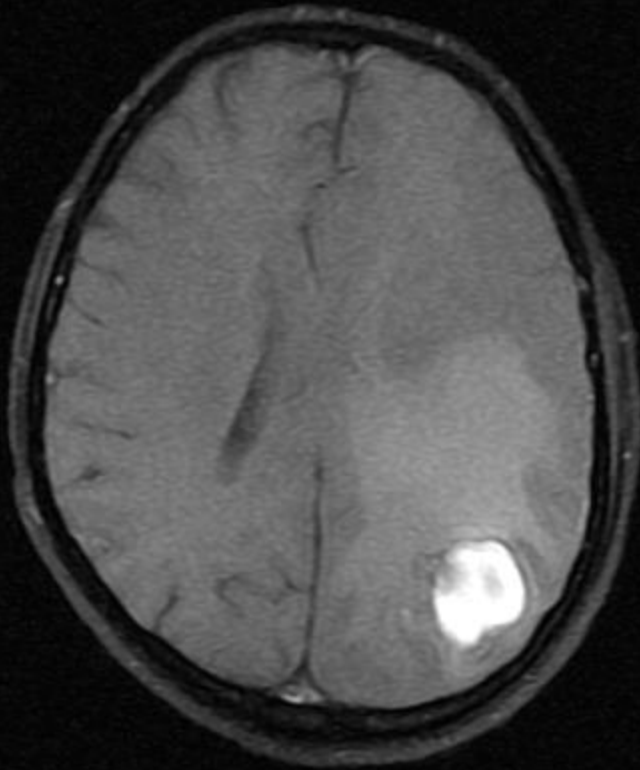


hamartoma



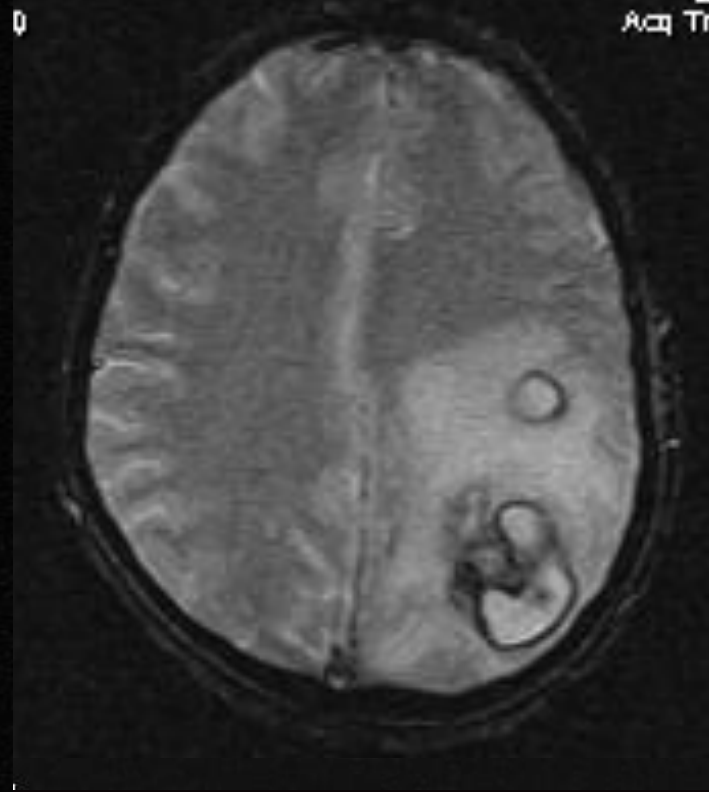
Case

T1+C
2
L
(201)



FSE
0

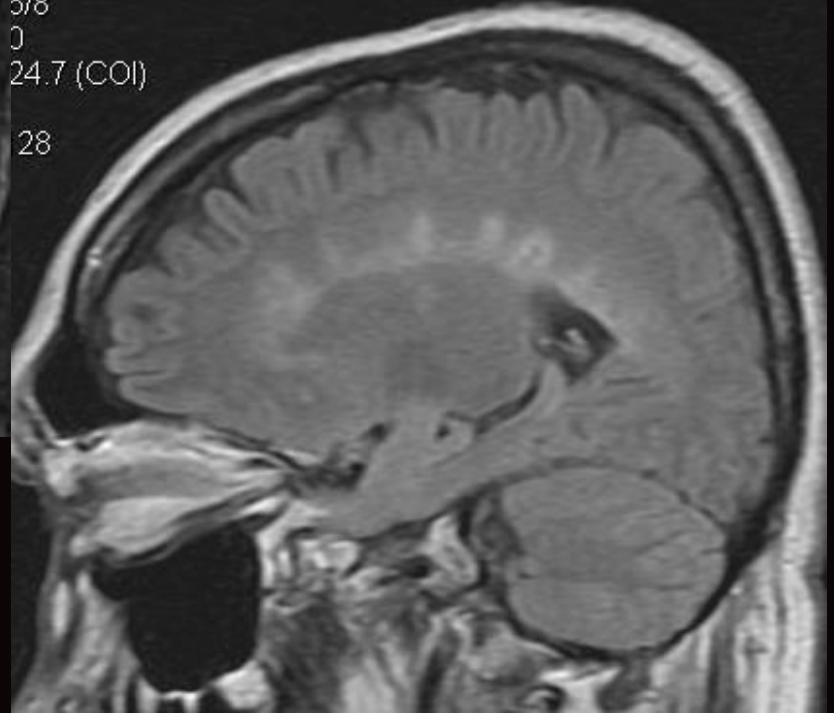
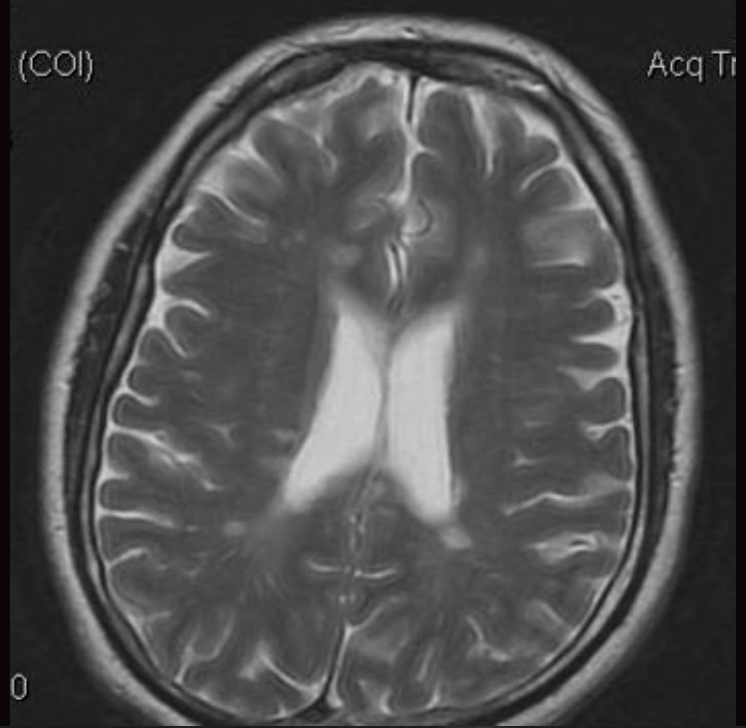
2
Acq Tr

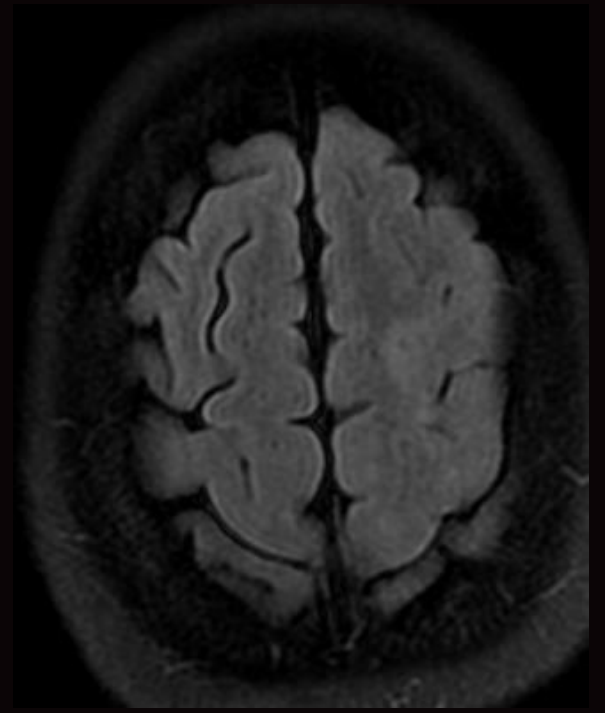
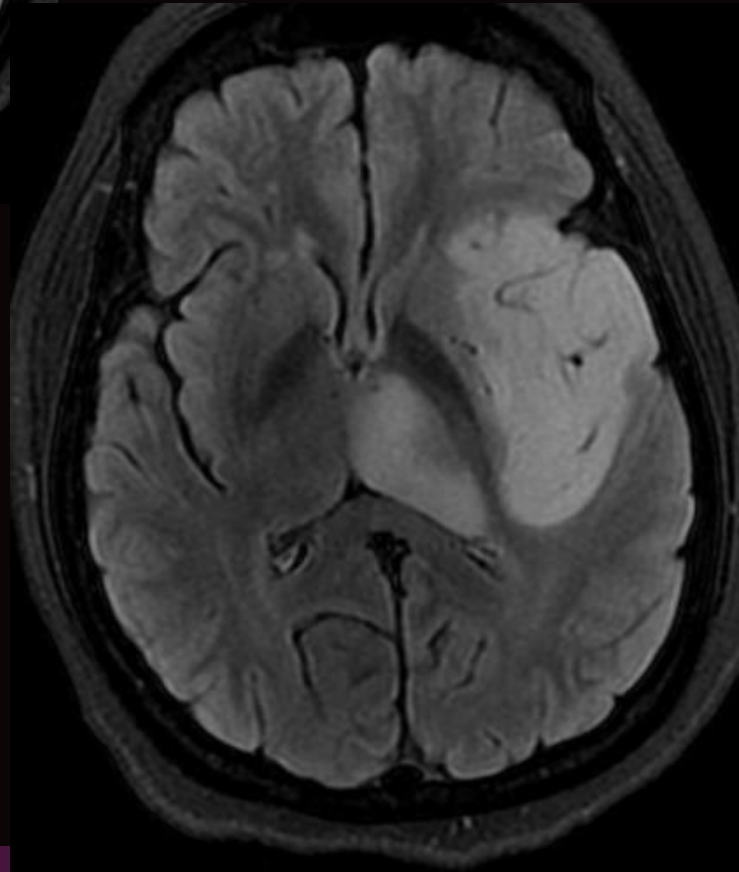
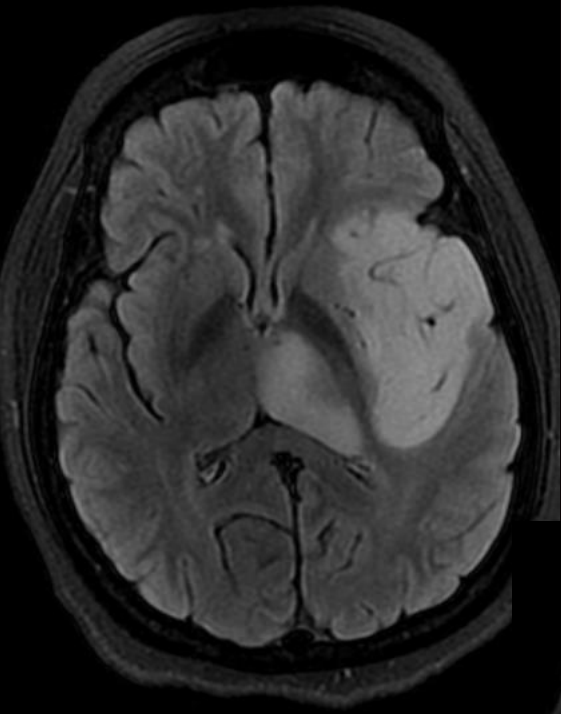


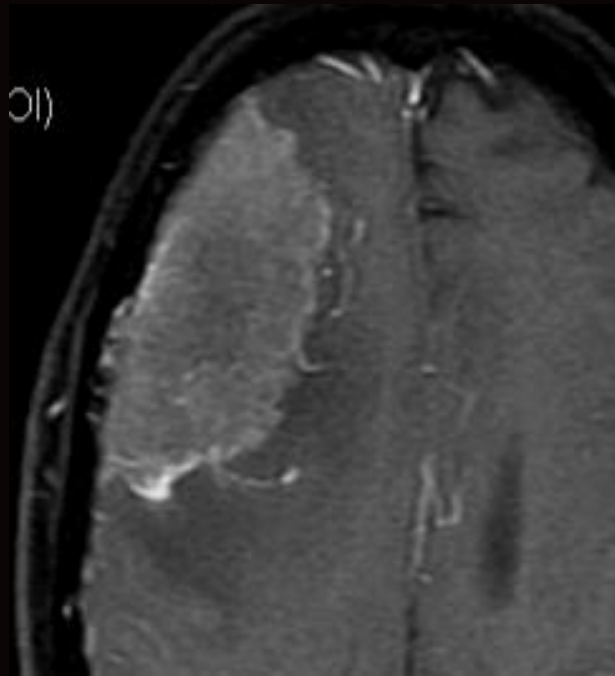
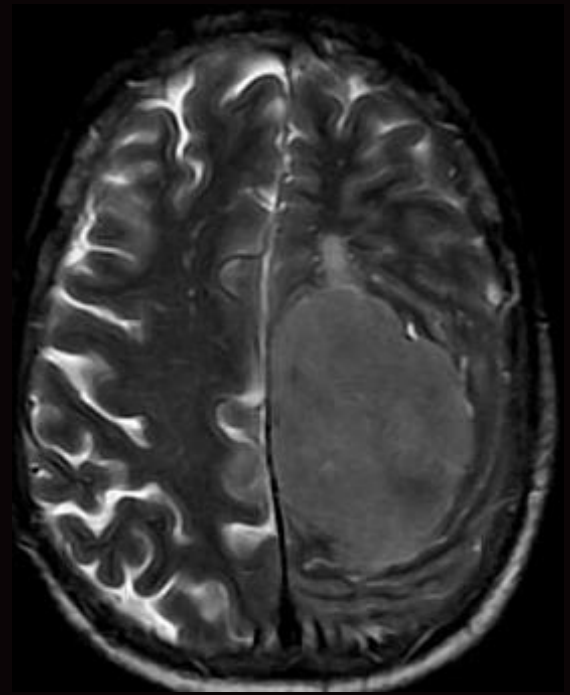
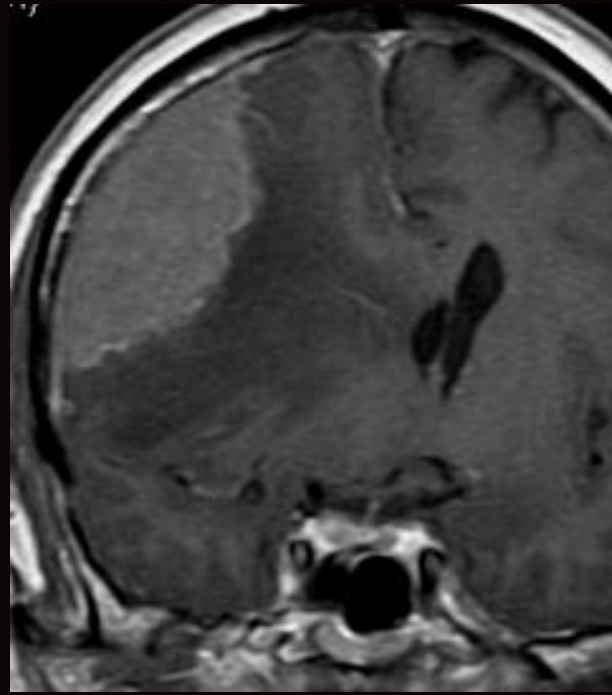
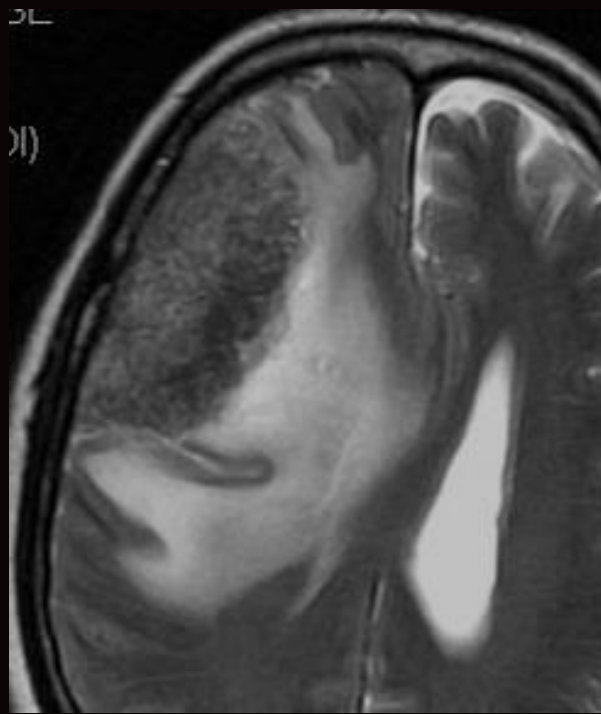
Case



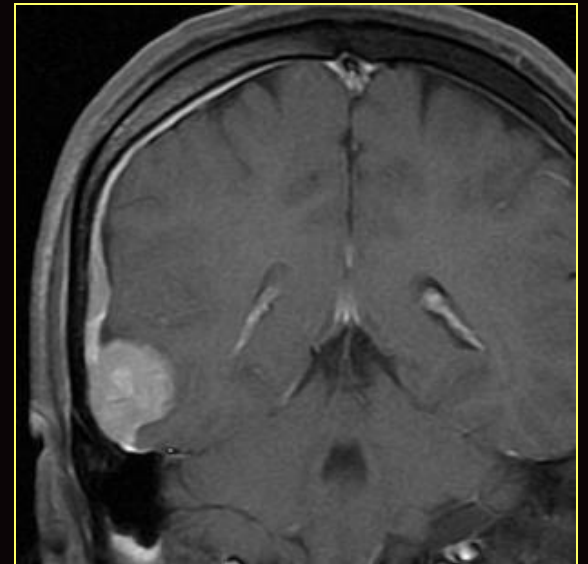
Case



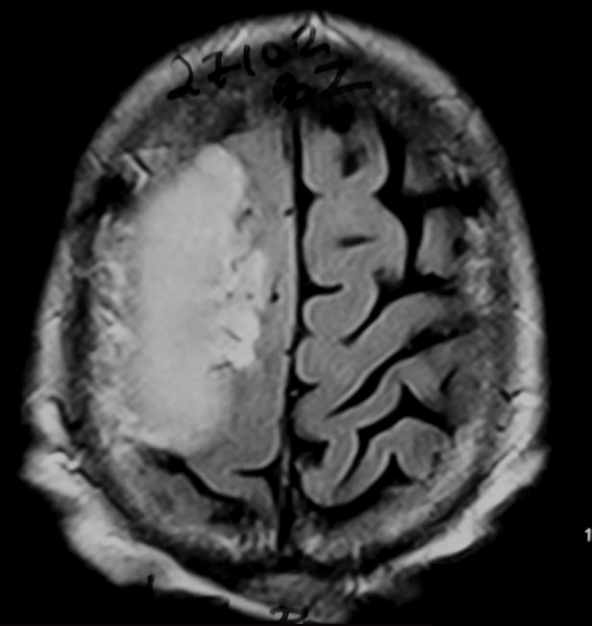




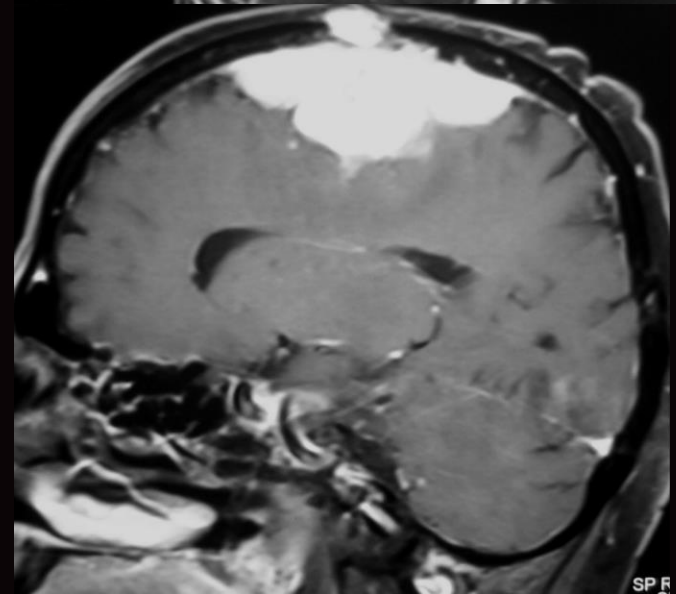
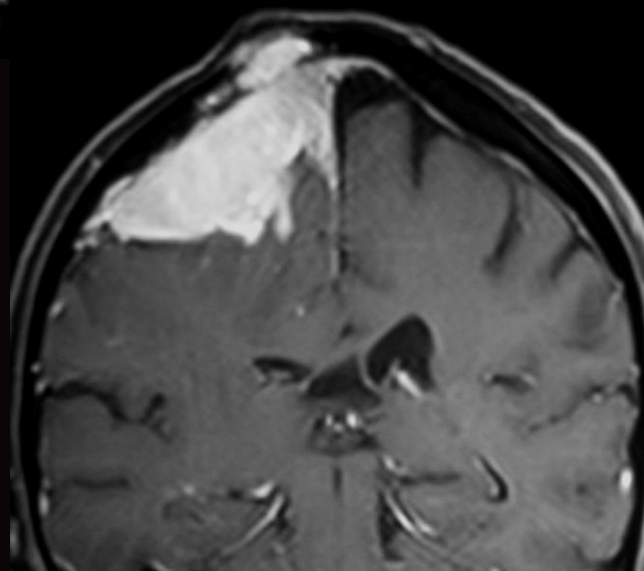
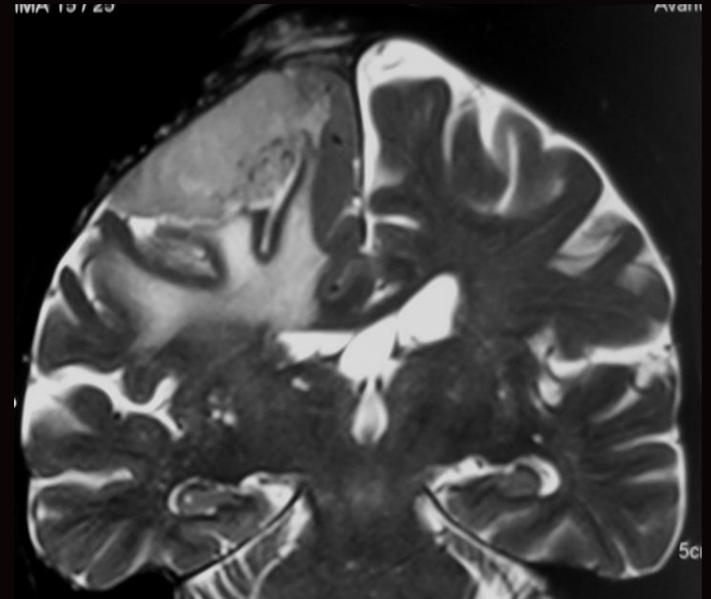
Meningioma



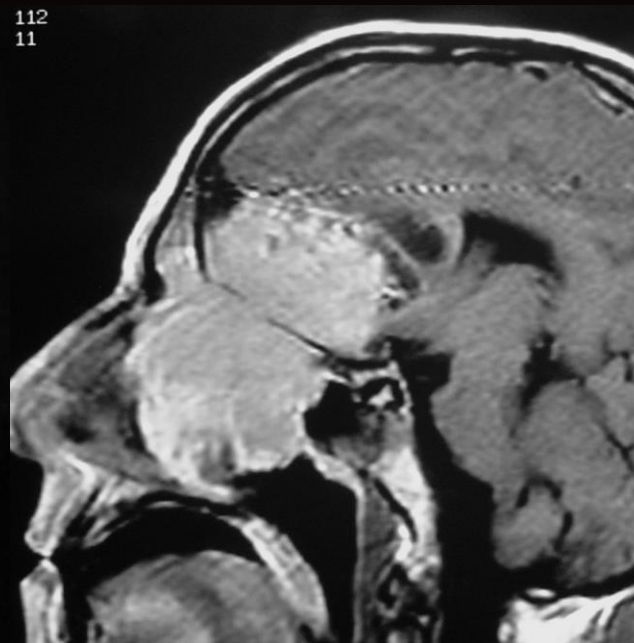
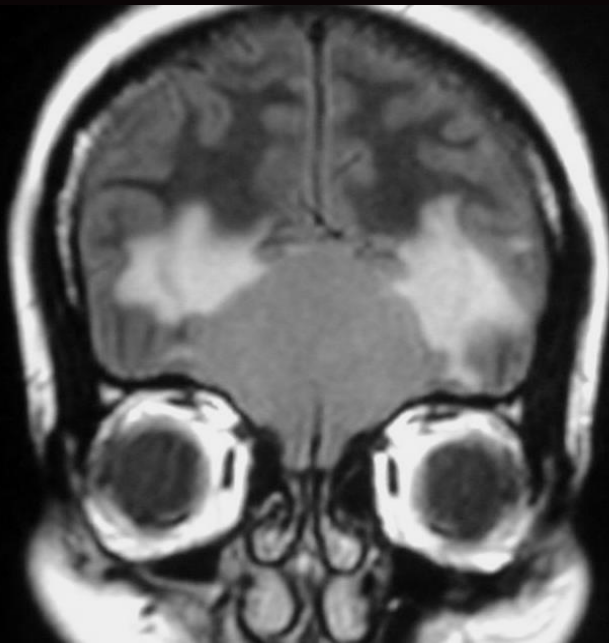
Bone destruction



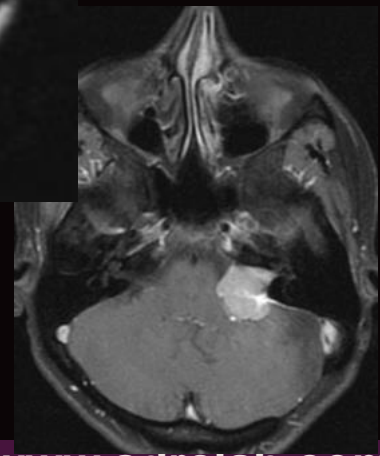
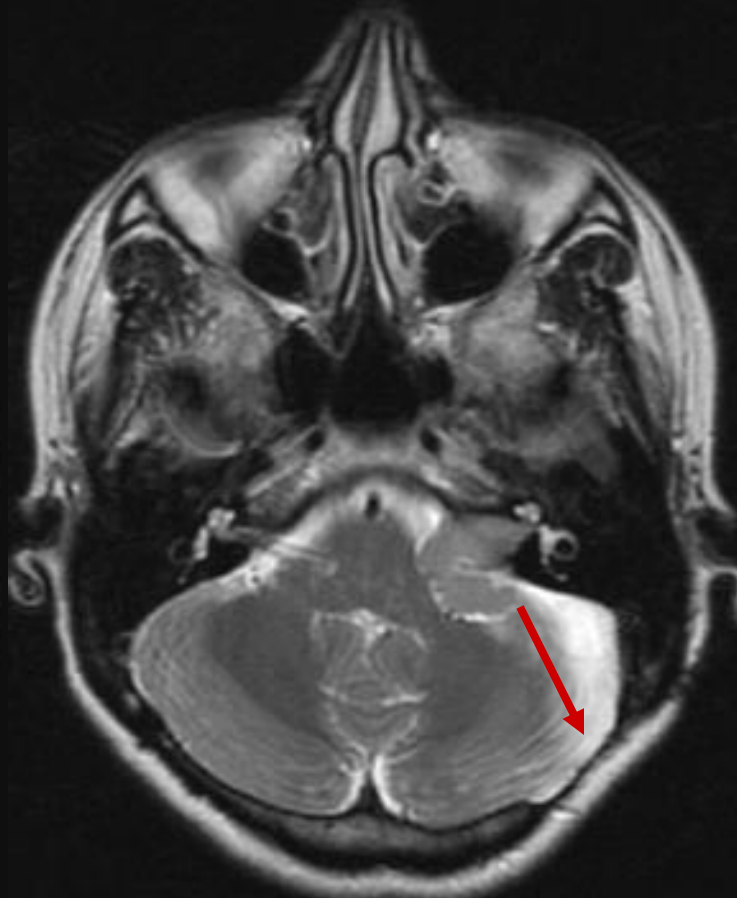
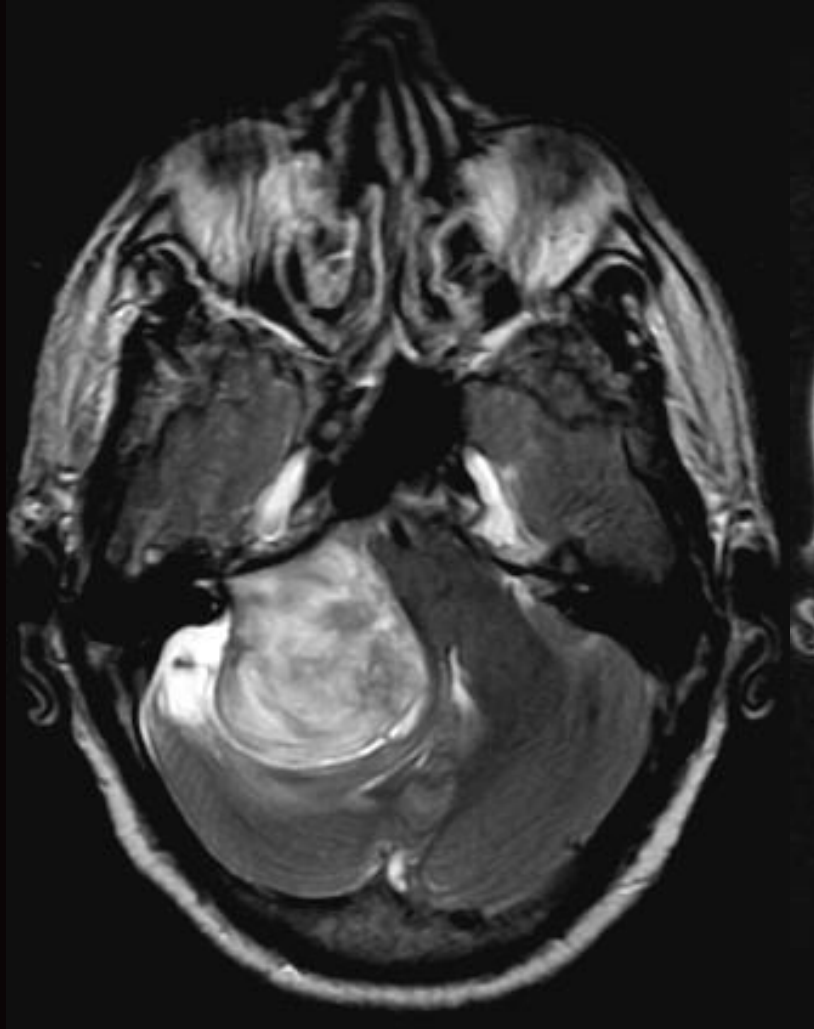
10



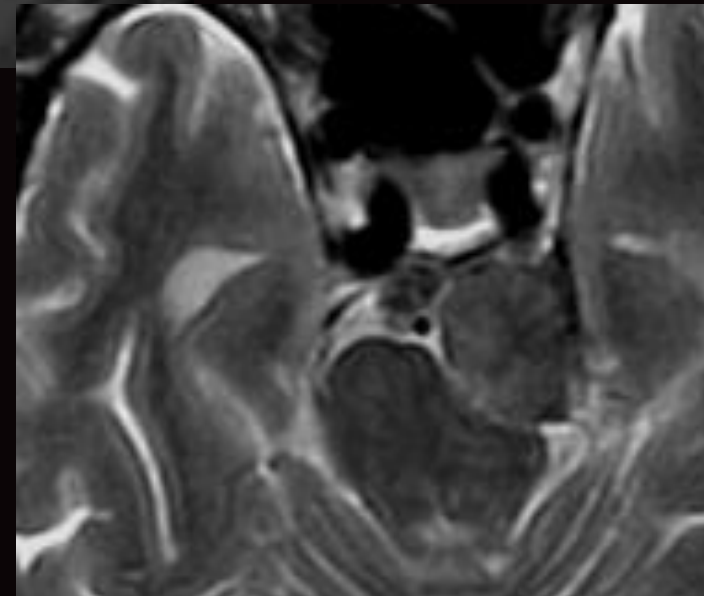
Olfactory groove meningioma vs esthesioneuroblastoma



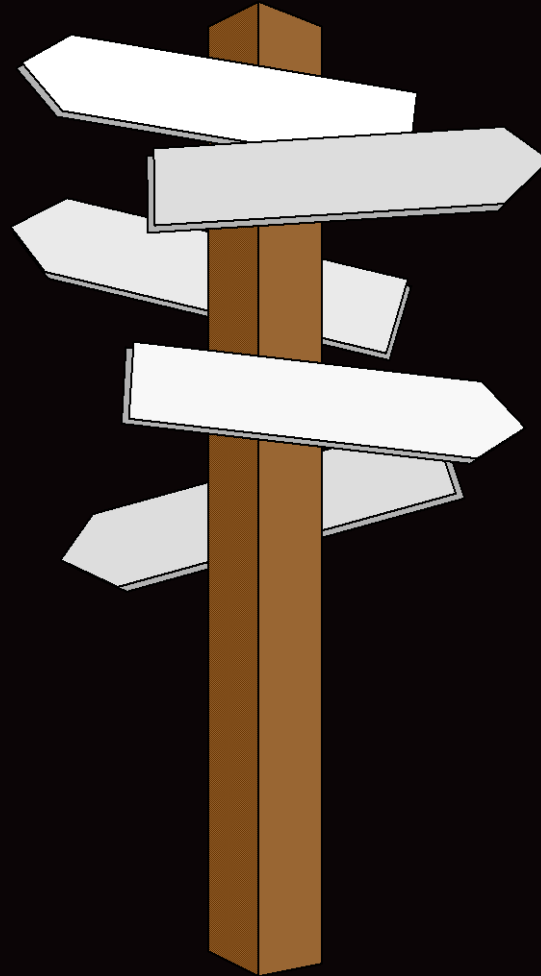
Schwannoma



Schwannoma



Newer sequences



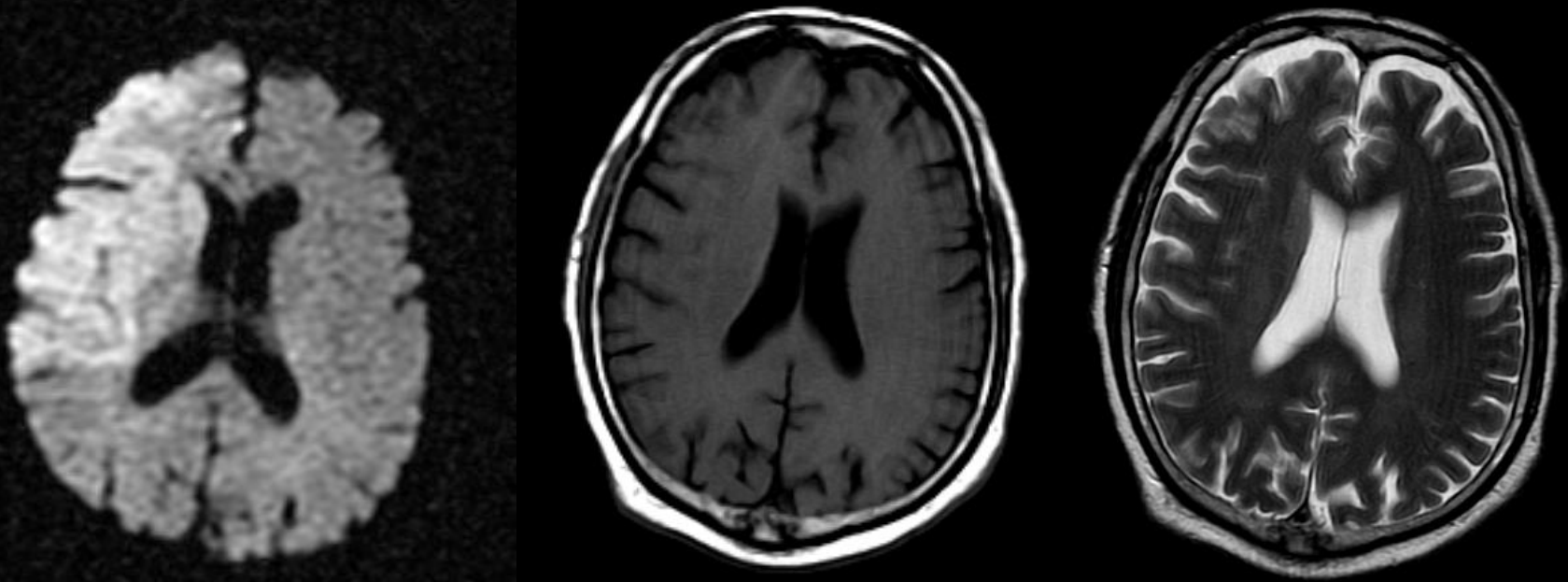
Commonest EPI applications

- Diffusion
- DTI
- MRS
- Perfusion
- ASL
- Functional mri

Modalities

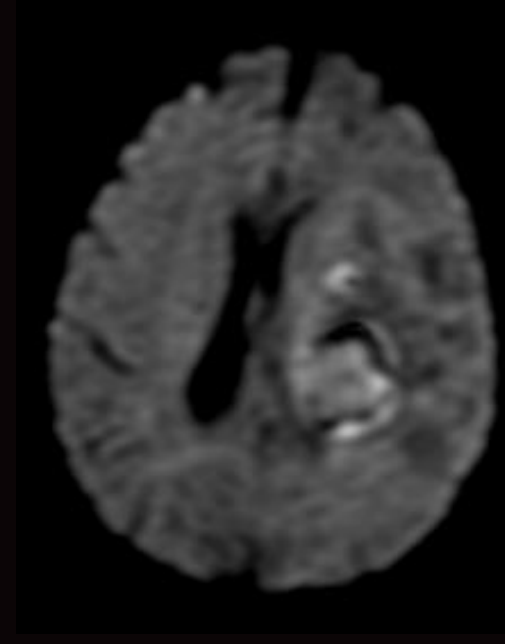
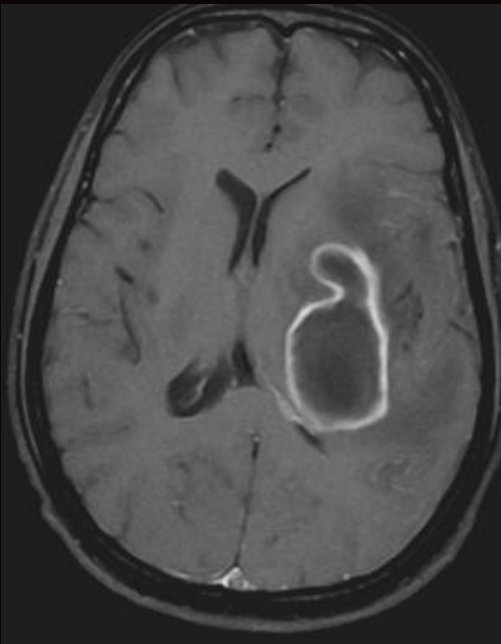
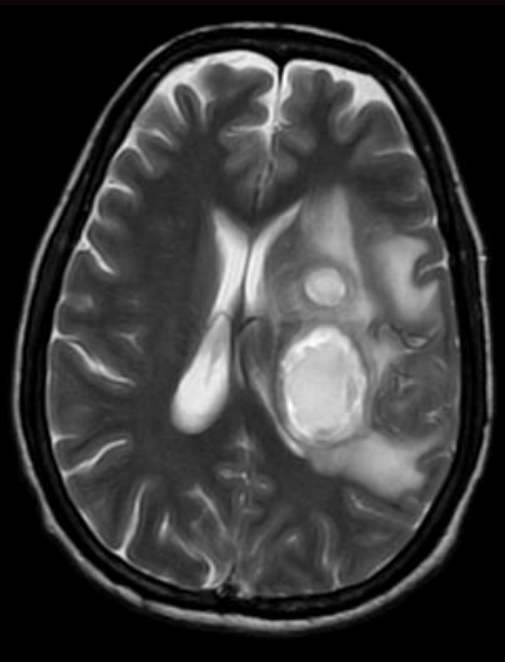
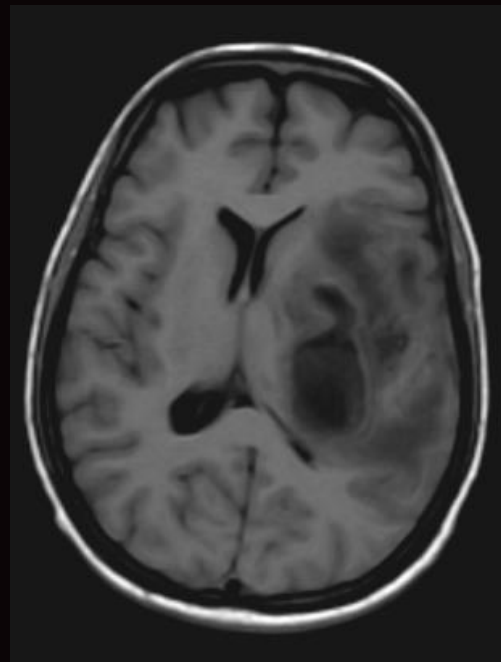
- MRI - better detection & characterisation
- MRS - biochemistry, metabolic milieu
- MRP - angiogenesis, BBB disruption

- DWI - cellularity, matrix
- DTI - white matter integrity
- SWI - calcification, microhemorrhages, vasculature
- fMRI - physiology

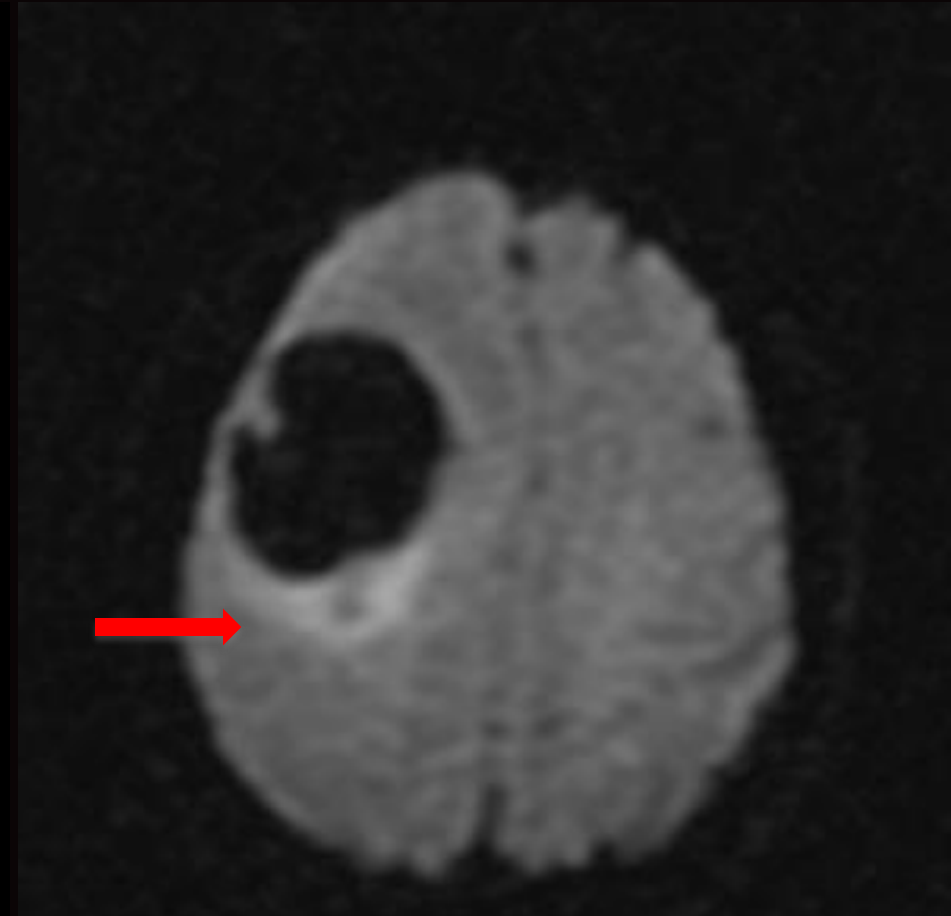
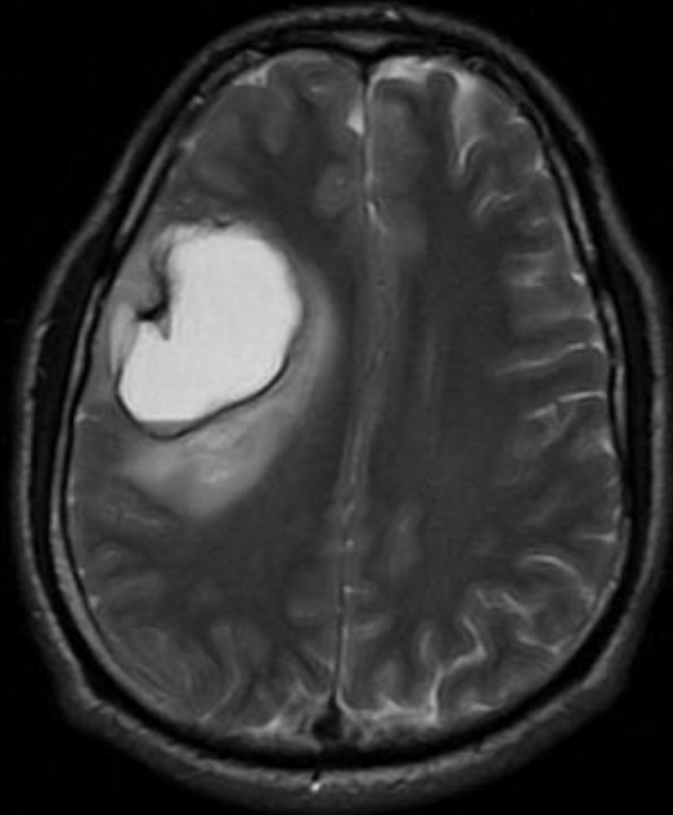


< 6hrs - 97% infarcts detected on Diffusion images
58% on plain MRI
40% on NECT

abcess

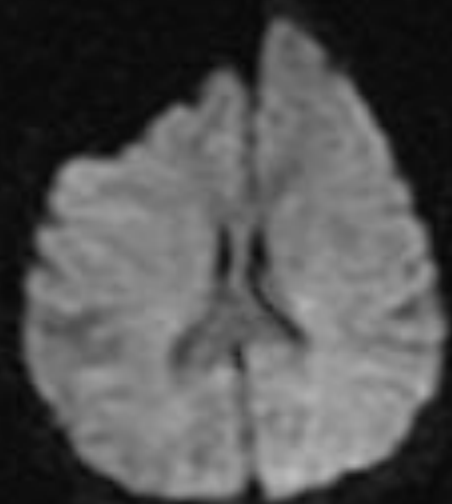
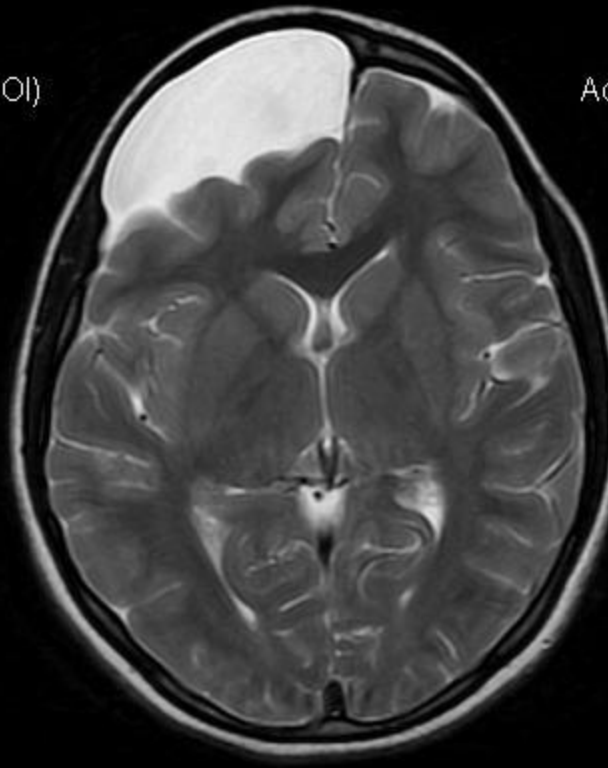
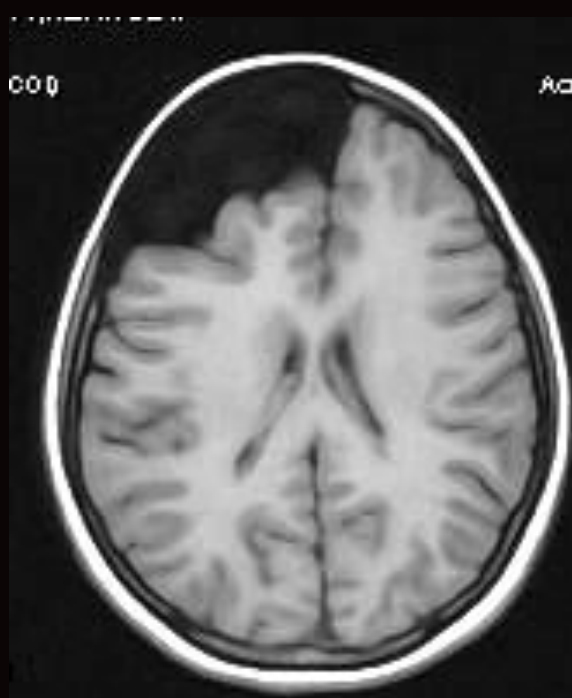
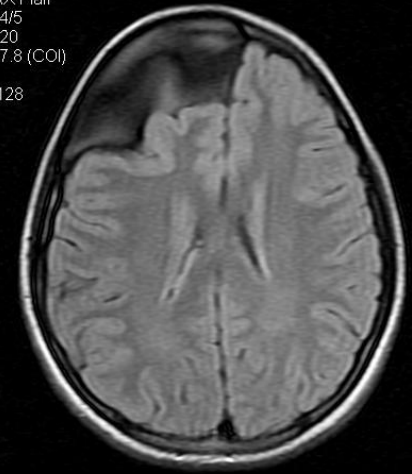


GBM showing no restriction of diffusion in the necrotic center

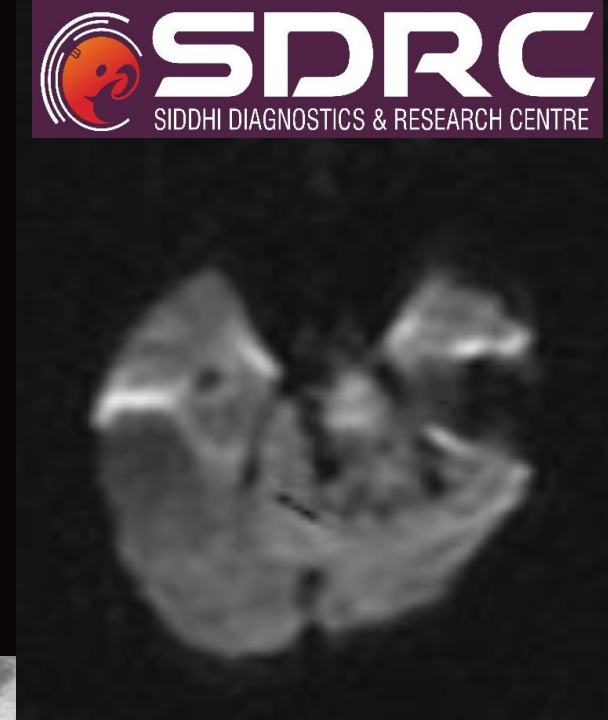
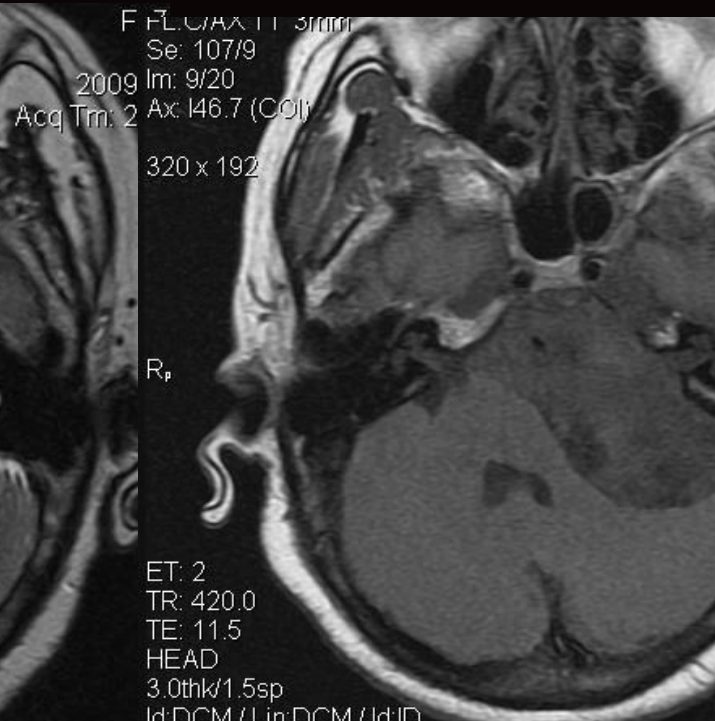
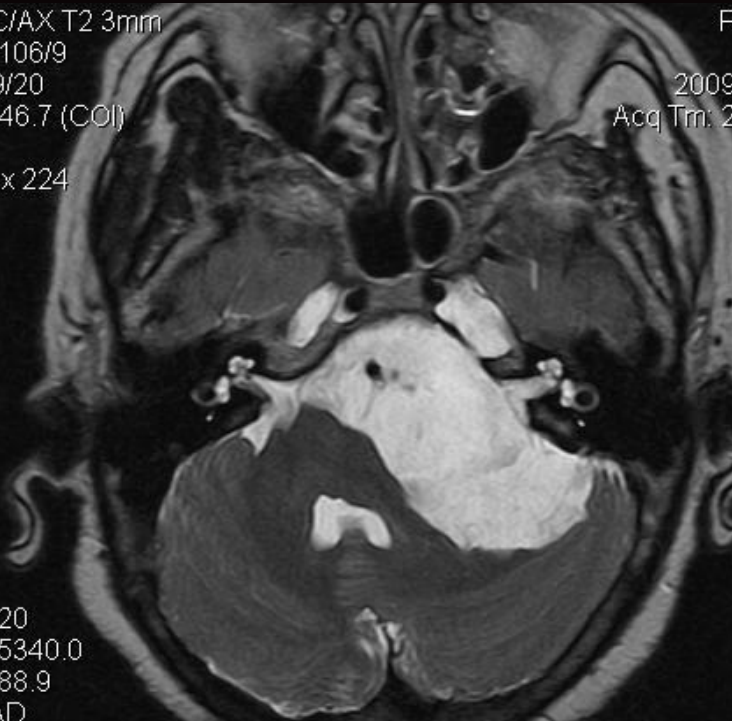


Arachnoid cyst

SEMSOW
164
AX Flair
14/5
120
17.8 (COI)
128

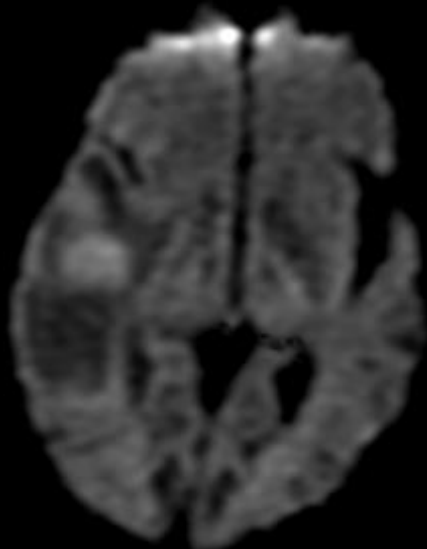
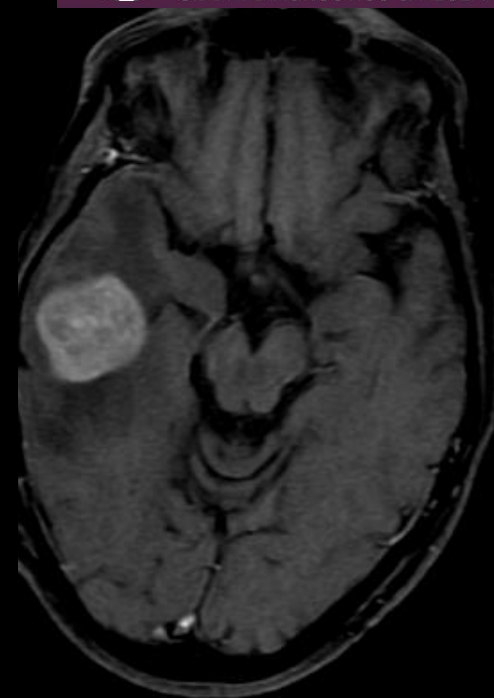
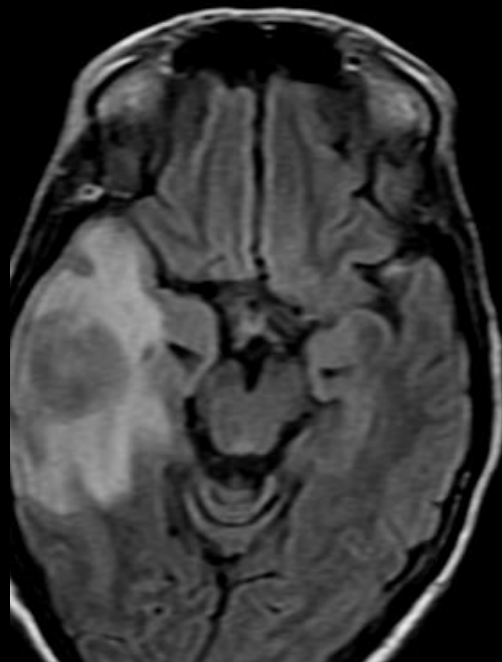
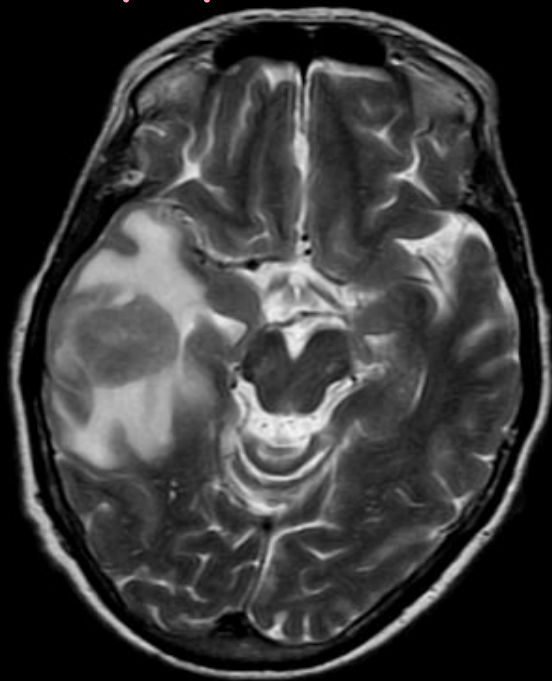


Epidermoid



Acq Tm: 22:16:2

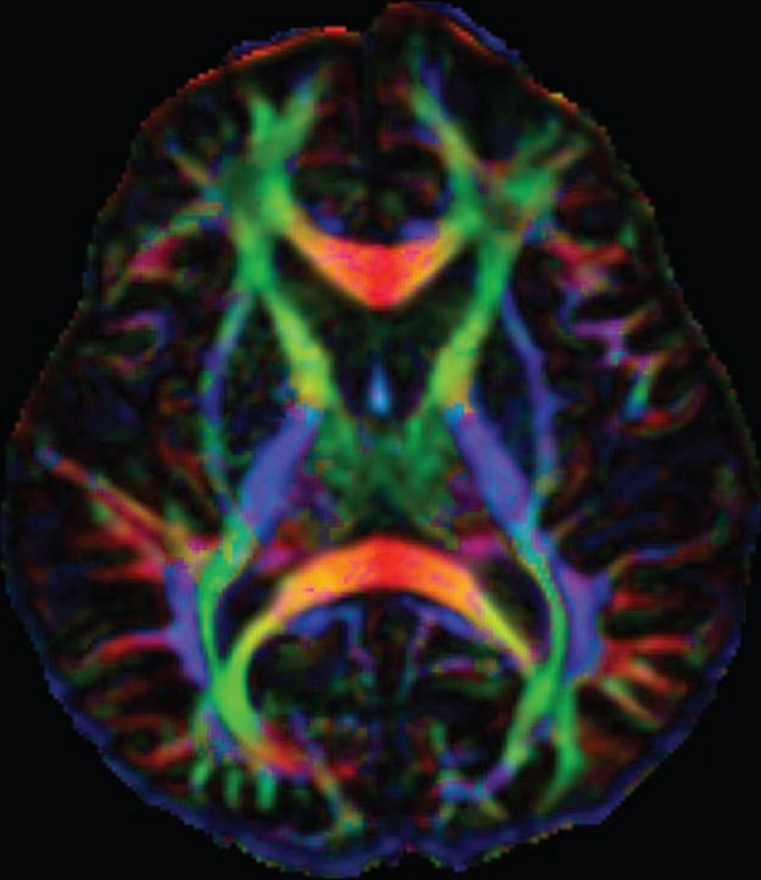
Lymphoma



Diffusion Tensor Imaging -DTI

- Motion of water molecules + **direction**
- Localization of tumors in relation to the white matter tracts (infiltration vs deflection).
- Neurosurgical planning - ELOQUENT CORTEX

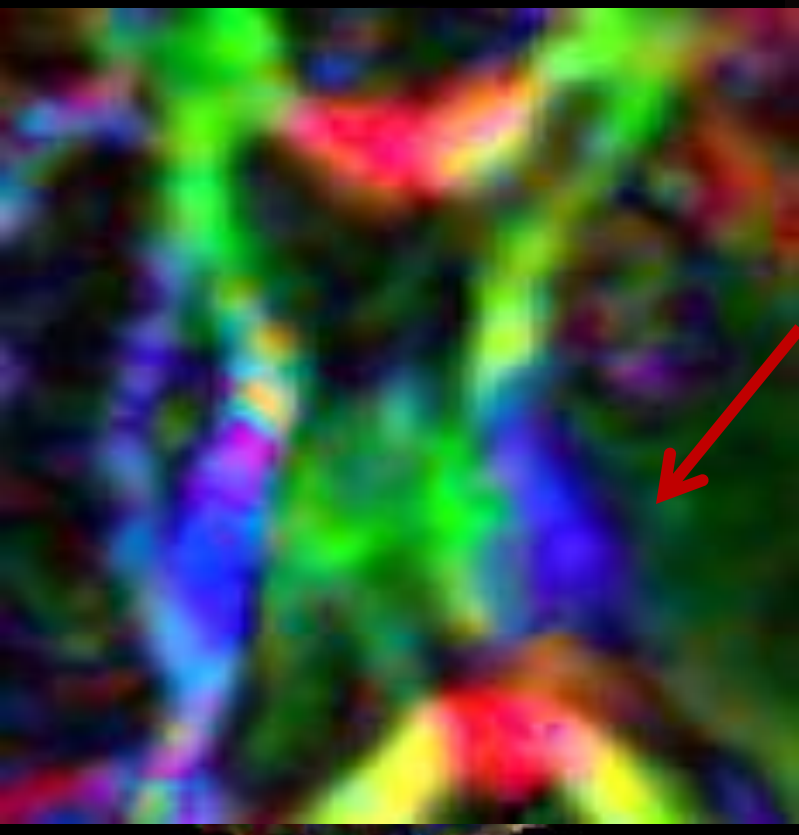
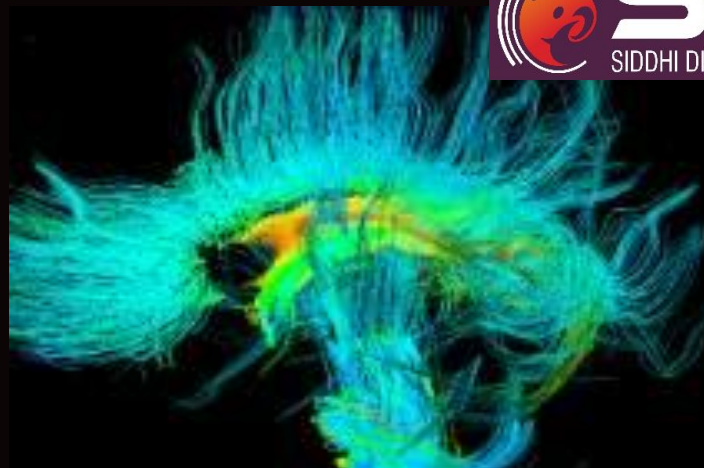
Diffusion Tensor Imaging -DTI



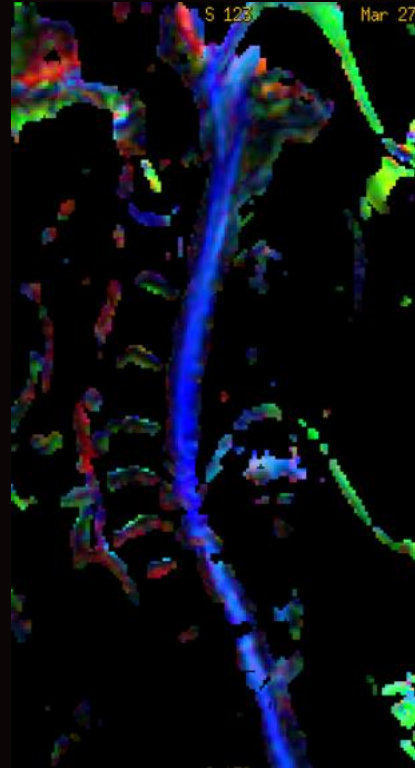
- Colour Pixels - direction of tensor
- Green = Ant to Post (fasciculi)
- Red = Rt to Lt (corpus callosum)
- Blue = Sup to Inf (pyramidal tracts)



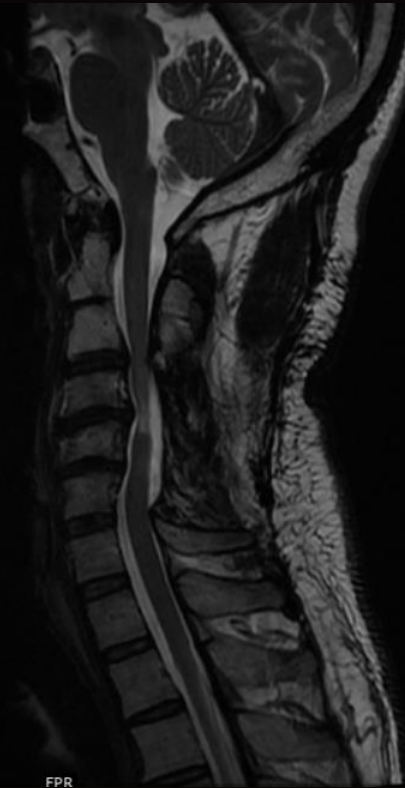
GBM



CORD DTI



Edema

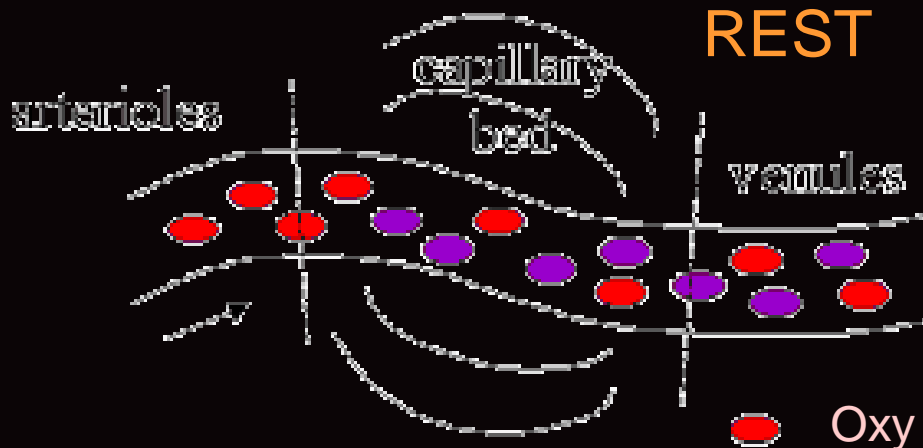


Myelomalacia

*f*unctional MRI

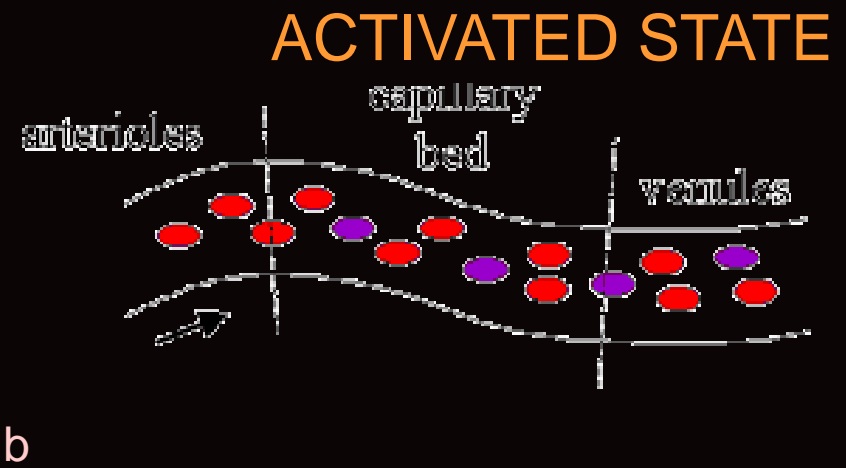
- Eloquent areas
- Select patients for intraoperative cortical stimulation

BASAL STATE



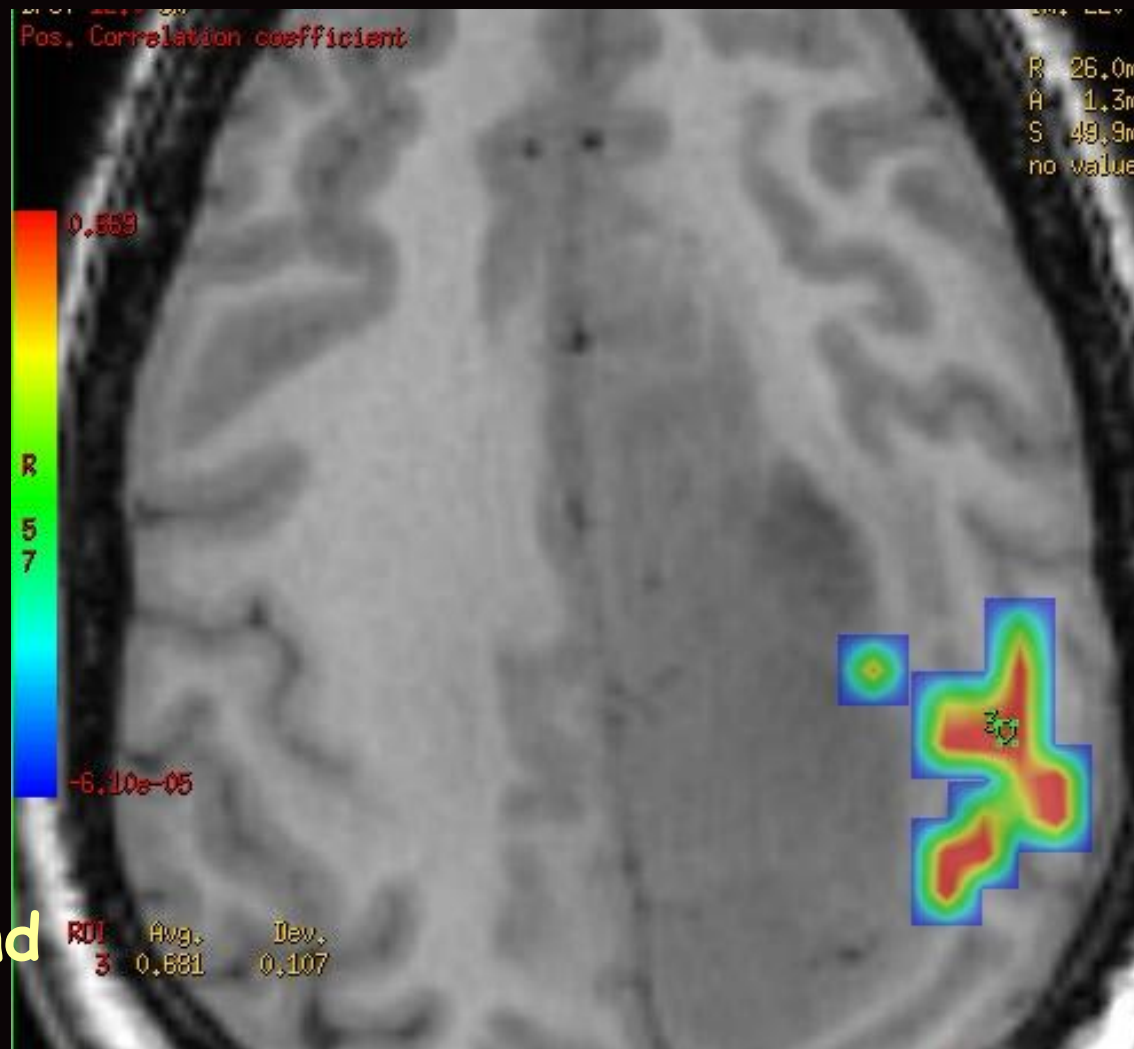
- Normal flow
- Basal level [Hbr]
- Basal CBV
- Normal MRI signal

REST



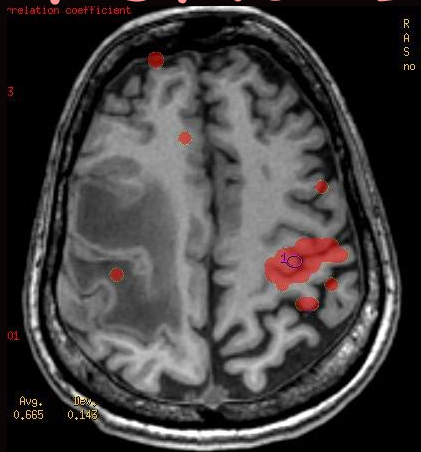
- Increased flow
- Decreased deoxy Hb
- Increased CBV
- Increased MRI signal

FUNCTIONAL MRI - Motor

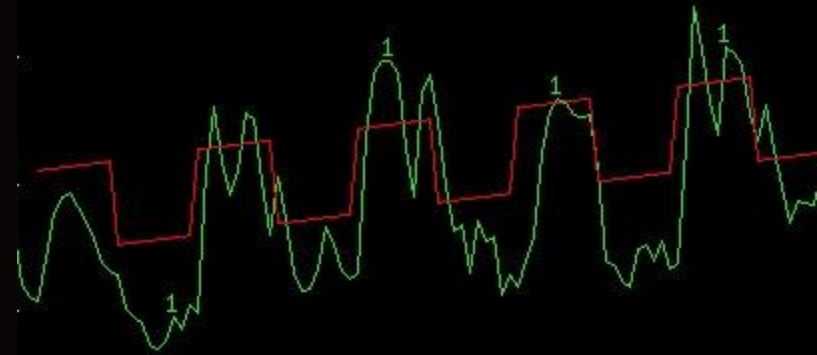


Right hand

FUNCTIONAL MRI - Motor

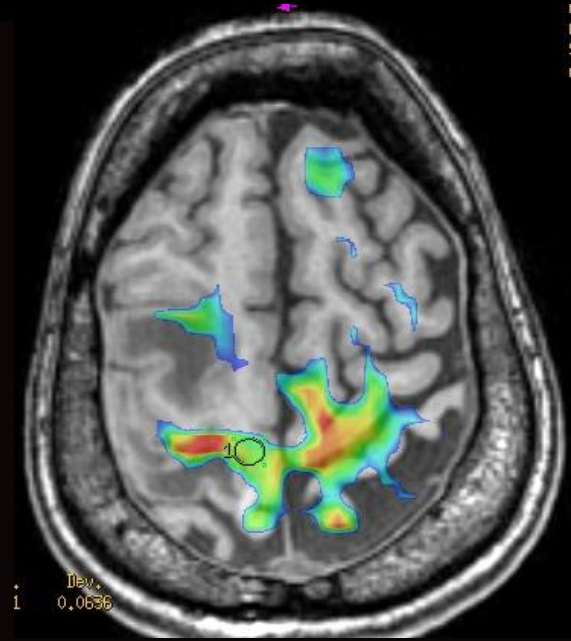
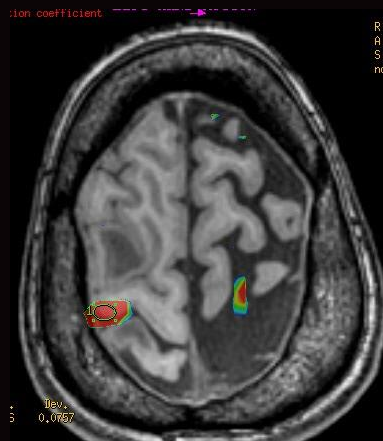
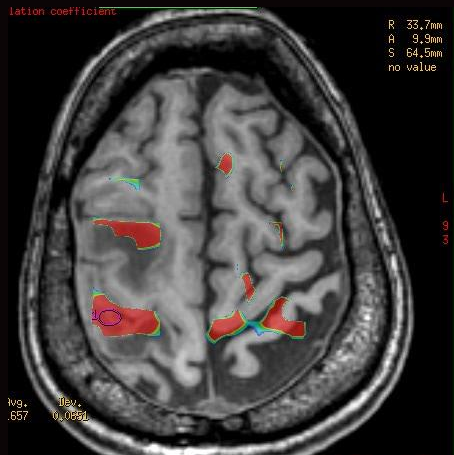


Right hand



Left hand

Left foot



Angiogenesis

Sprouting of new capillaries

Induction of new vessels

Increased density

Imperfect walls - increases permeability

MALIGNANT TUMOR - fast and strong enhancement

VEGF, EGFR etc.

Strong correlation with CE

Suppression reduces CE

Basic concept

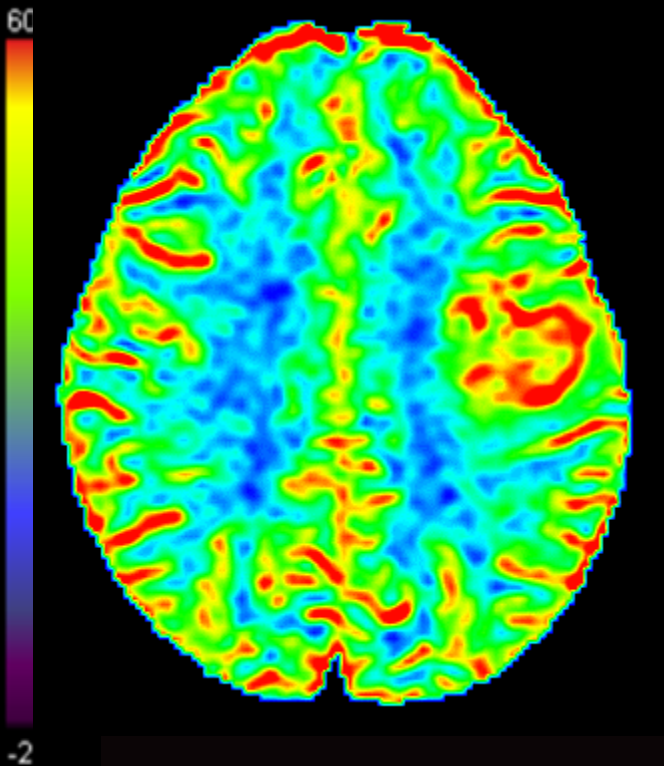
TUMORS - VEGF / EGFR



NEOANGIOGENESIS



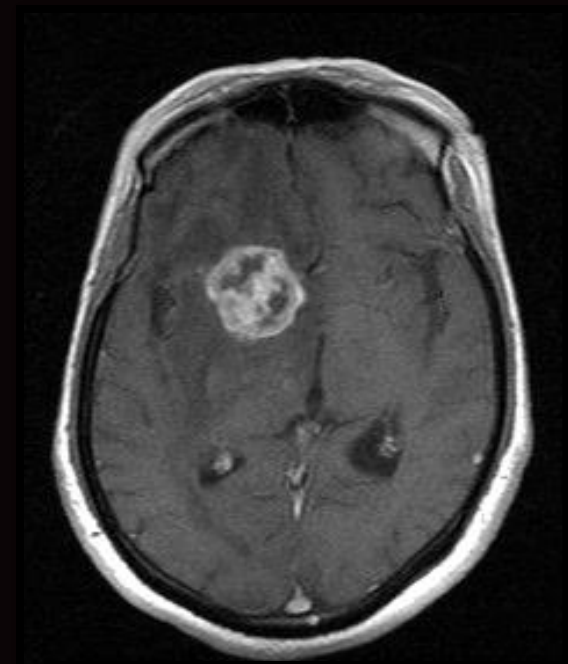
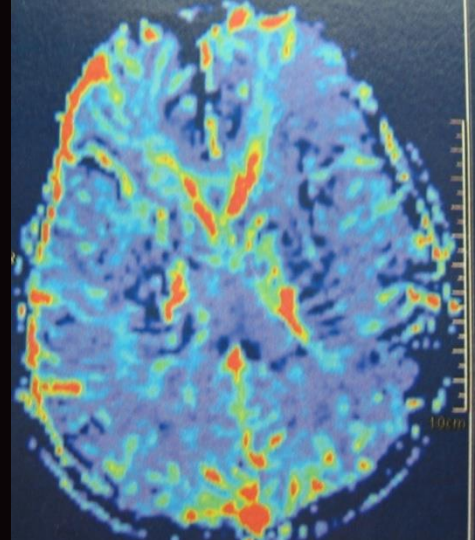
ELEVATED CBV



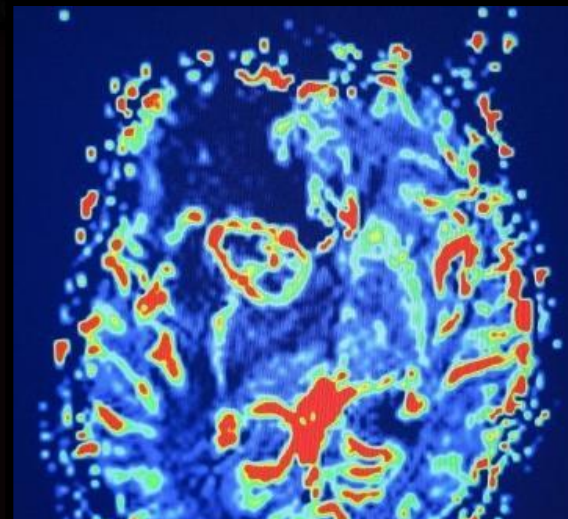
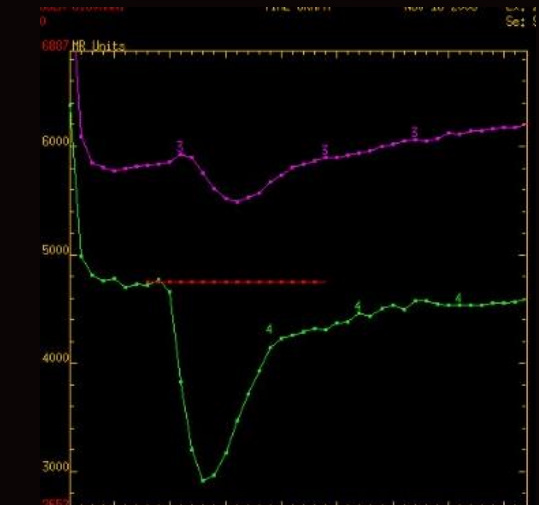
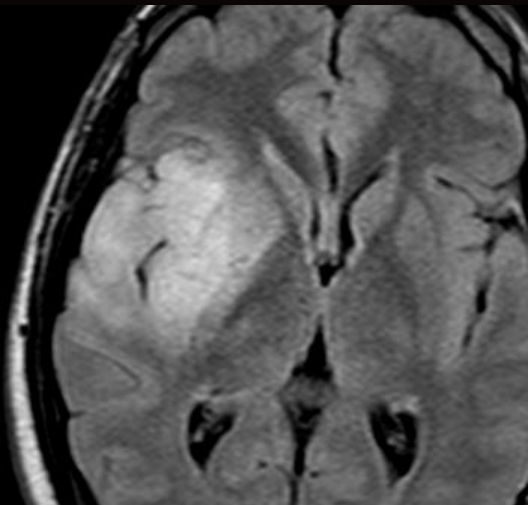


Gliomatosis Cerebri

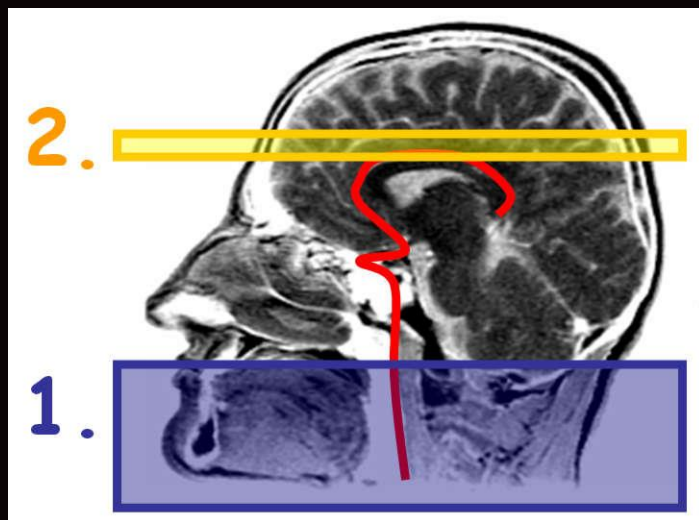
GBM



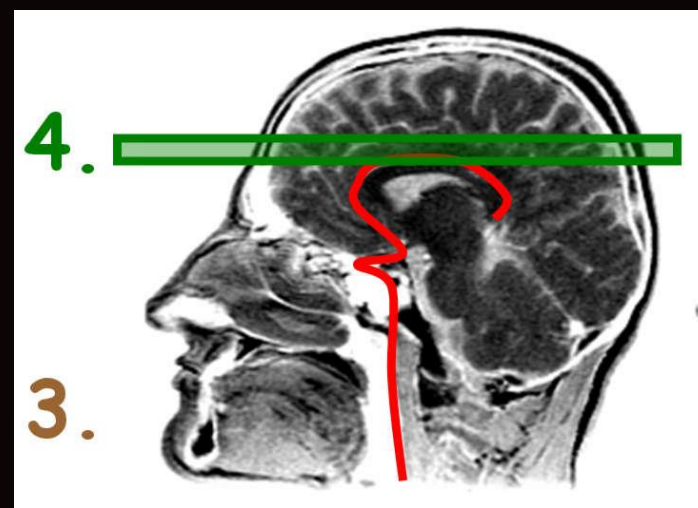
GBM



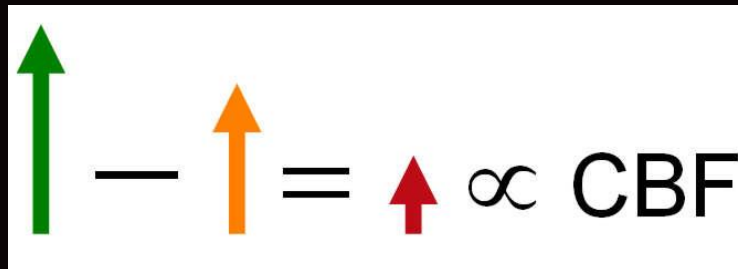
3D Arterial spin labelling



1. **Tag** inflowing arterial blood by magnetic inversion
2. Acquire the **tag image**



3. Repeat experiment without **tag**
4. Acquire the **control image**


$$\uparrow - \uparrow = \uparrow \propto \text{CBF}$$

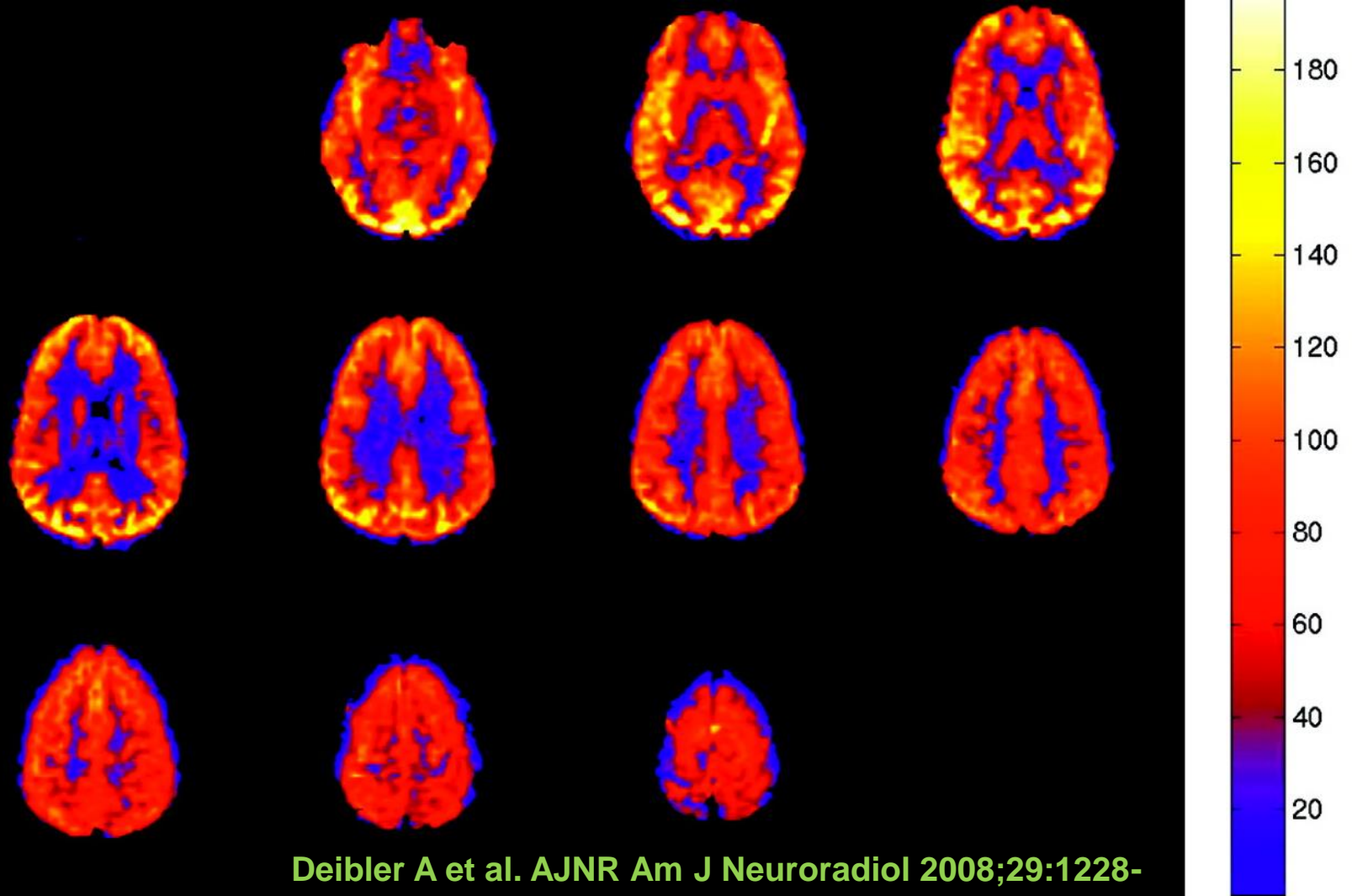
$$M_{\text{control}} - M_{\text{tag}} = \Delta M$$

Advantages

3D ASL Perfusion MRI

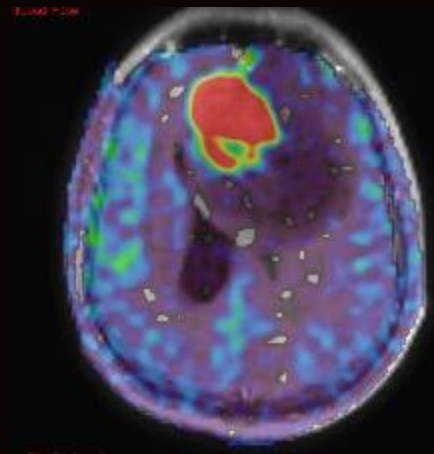
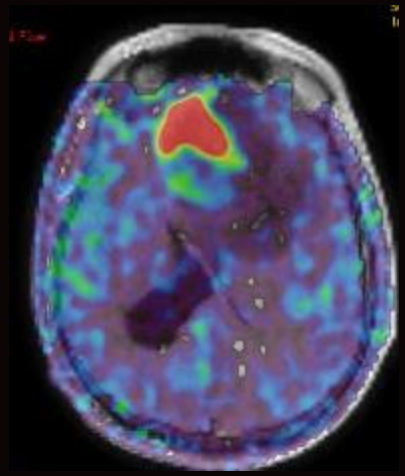
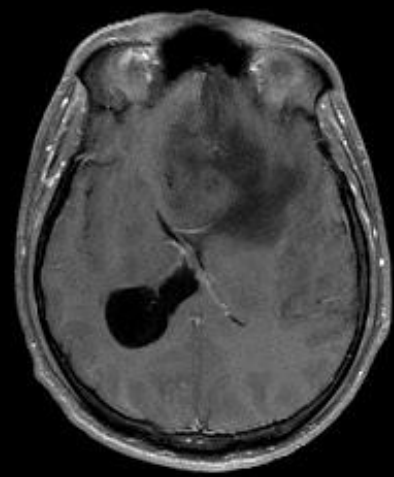
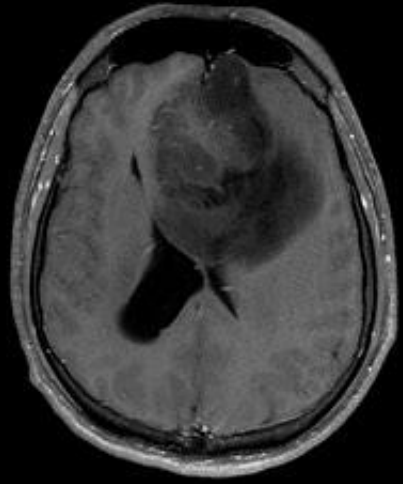
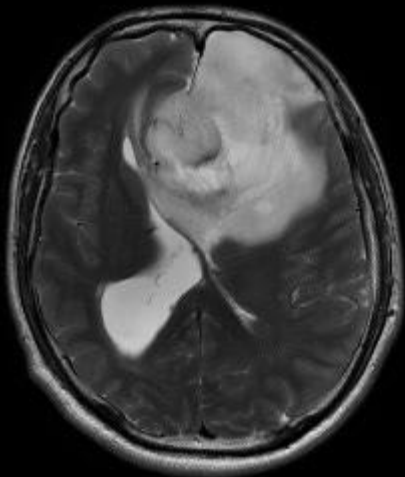
- Non-invasive quantification of blood flow
 - Measures absolute values
 - No contrast
 - Easily reproducible
 - Large bore catheters not required
- Esp pediatric and Chemotherapy patients

Normal ASL CBF map



Deibler A et al. AJNR Am J Neuroradiol 2008;29:1228-1234

Infiltrative tumor - grade 3 astrocytoma

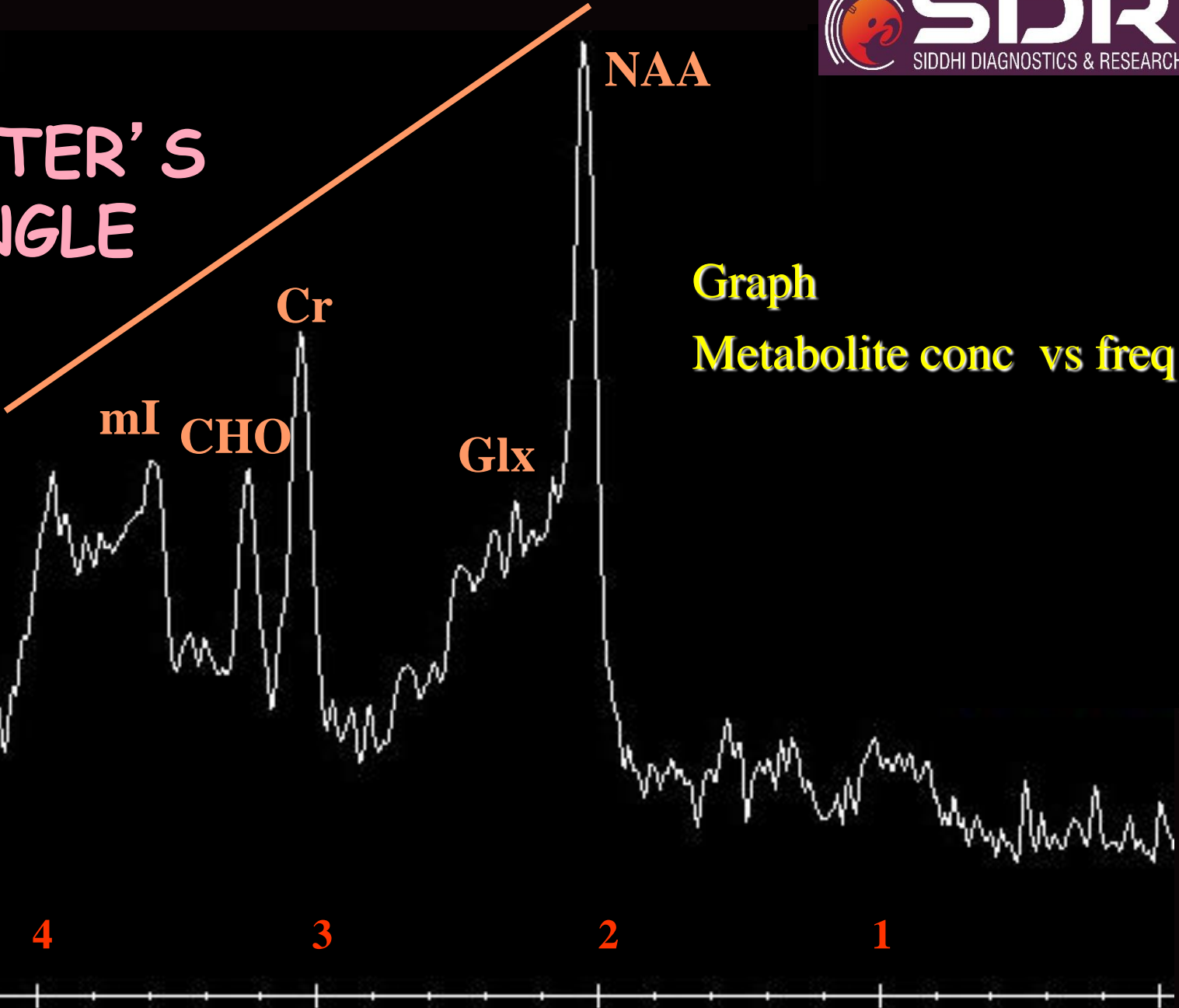


ASL
CBF

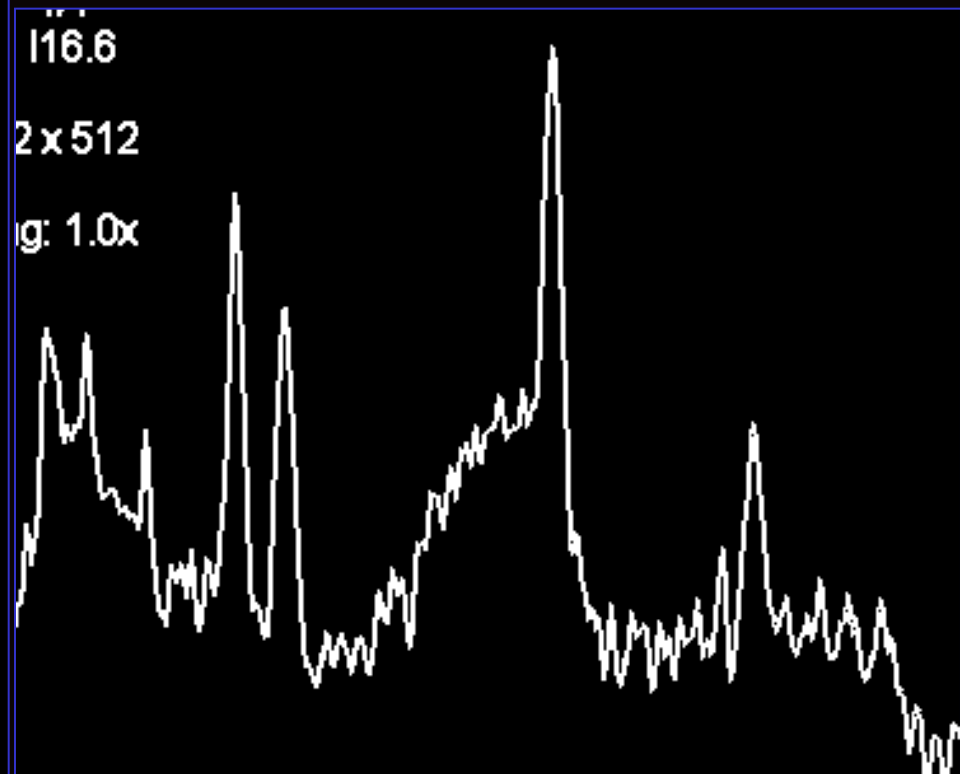
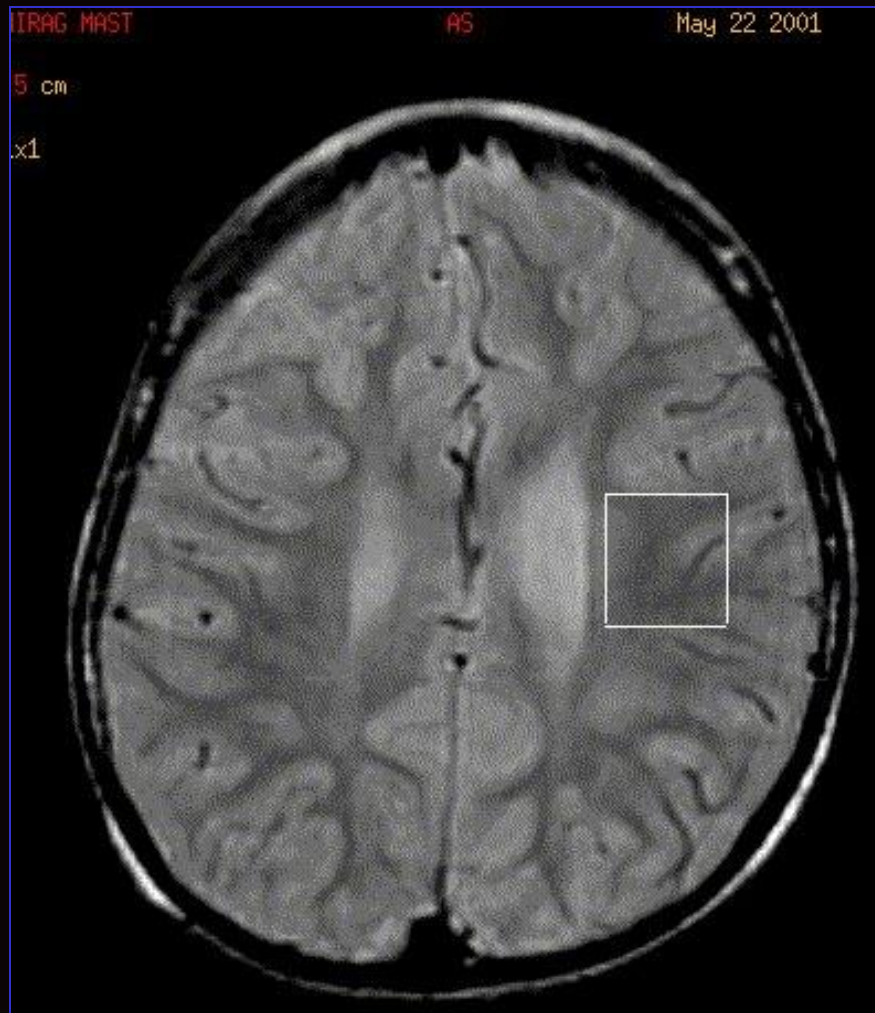
MR Spectroscopy is possible

- Nature & concentration of brain chemicals is remarkably constant
- Their concentrations alter in defined & reproducible way in disease process

HUNTER'S ANGLE

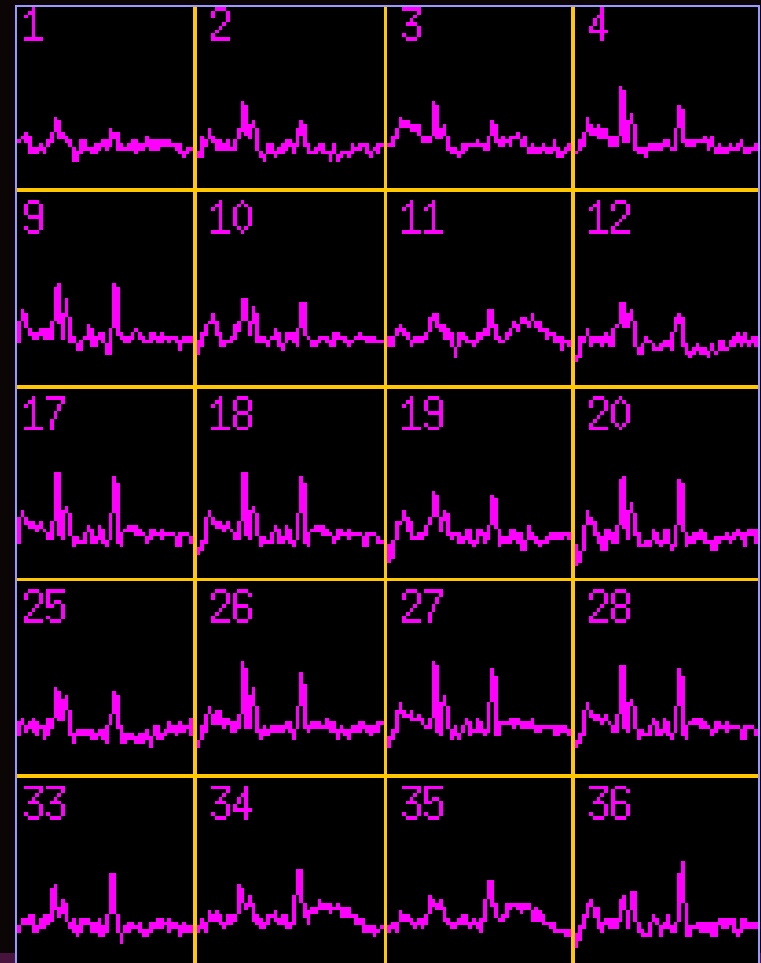
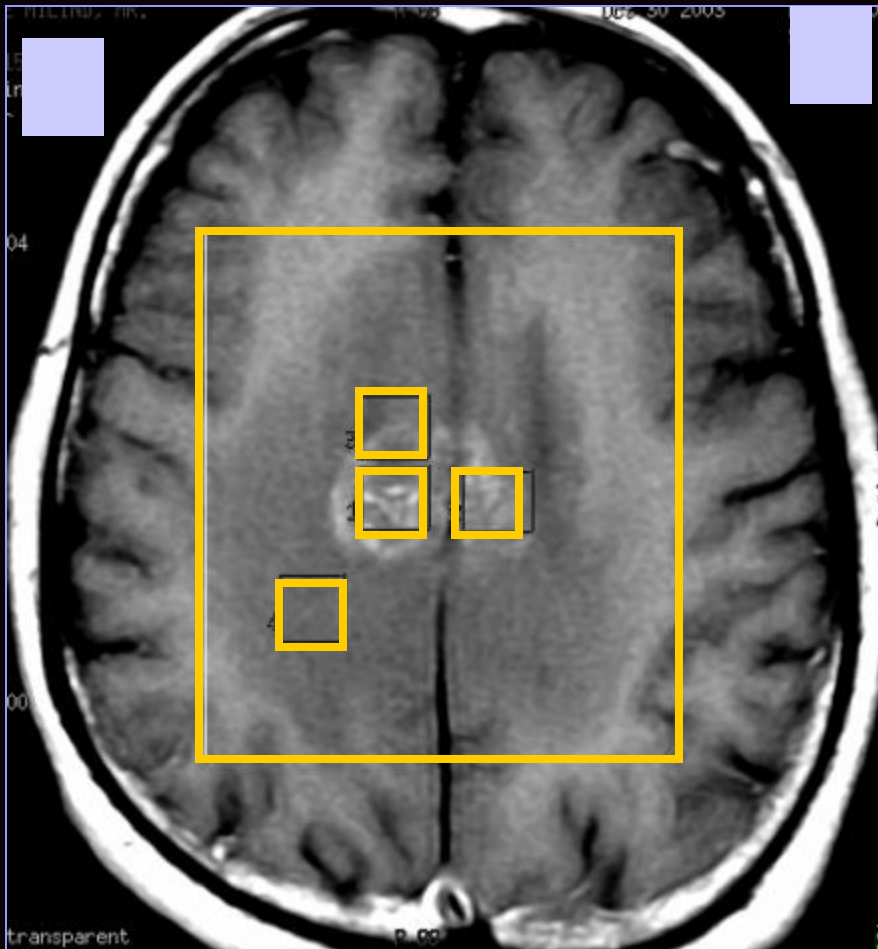


Single voxel spectroscopy



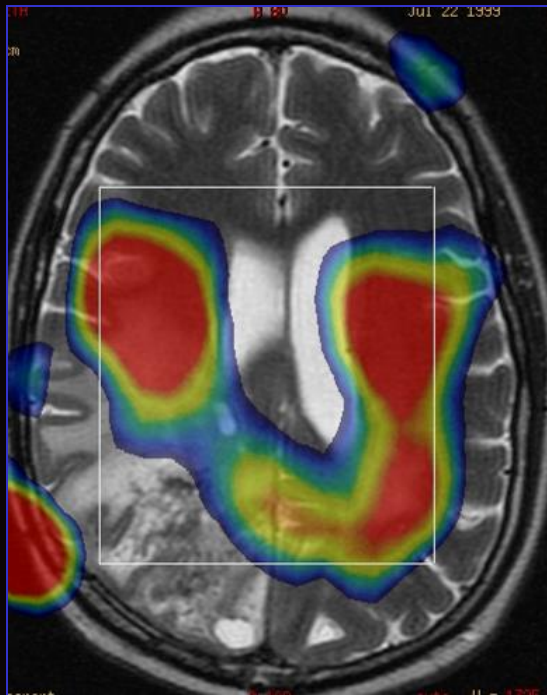
Chemical shift imaging

- ✓ Assessment of several components of the lesion simultaneously

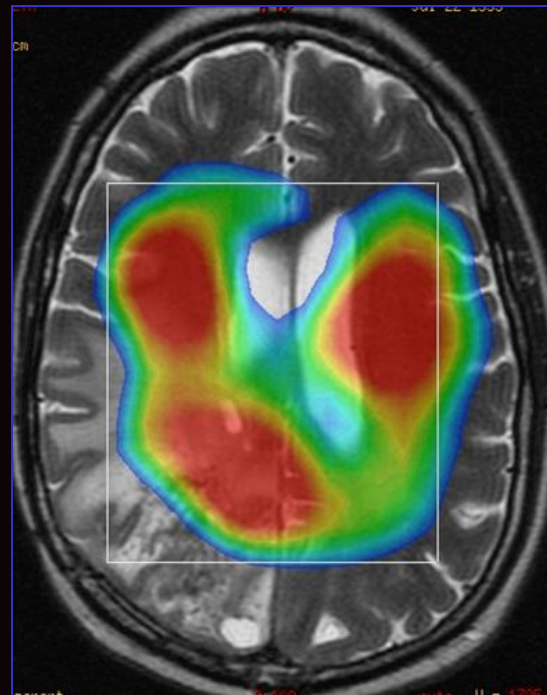


Metabolic maps

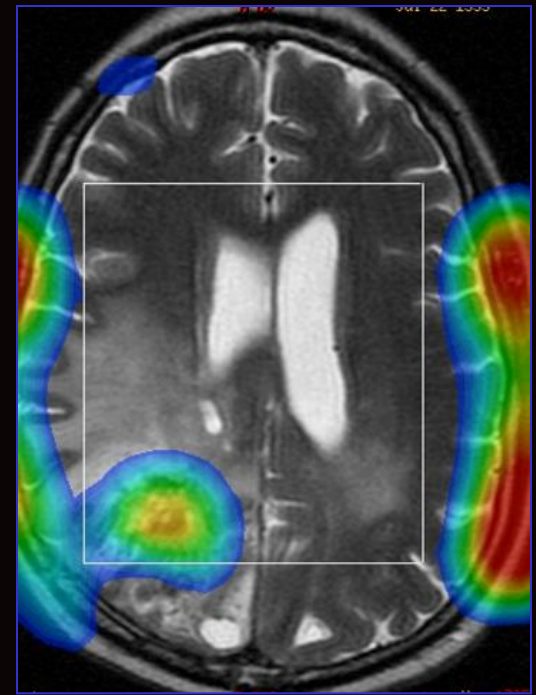
MRI + MRS = metabolic mapping.



NAA



Choline



Lactate - lipid

PROTON MRS IN TUMORS

Dec NAA - neuronal loss

Inc Cho - cellular proliferation

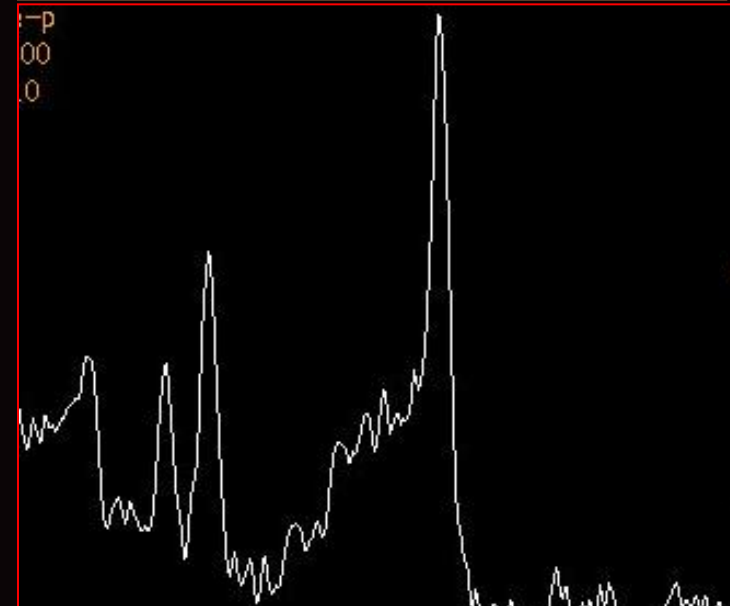
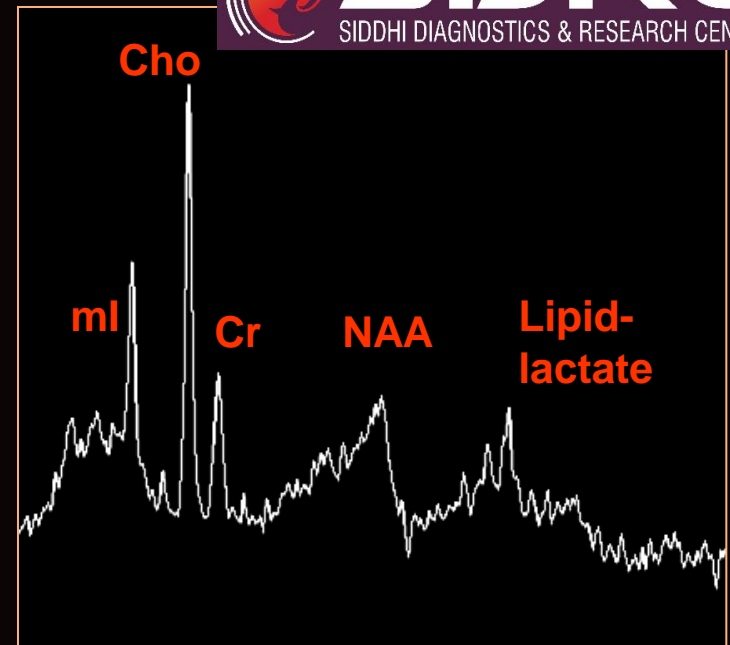
Dec Cr - neuronal loss

Lipid - necrosis

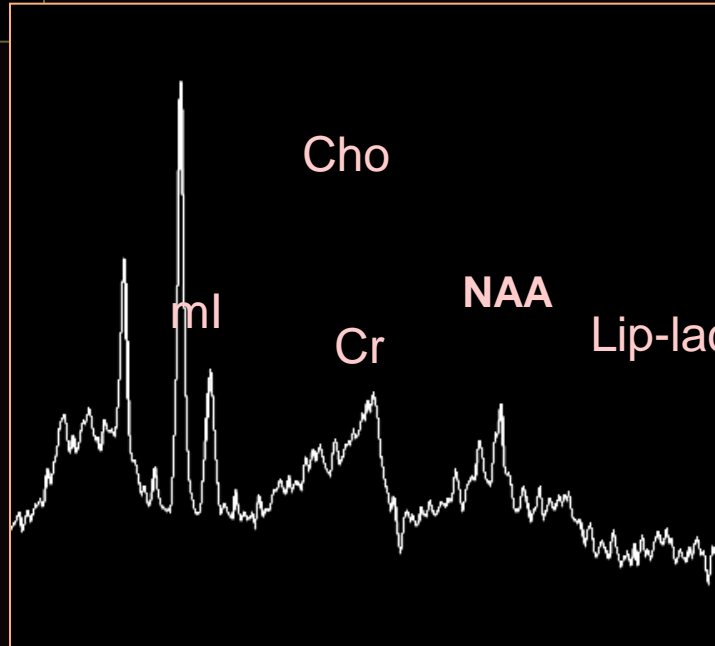
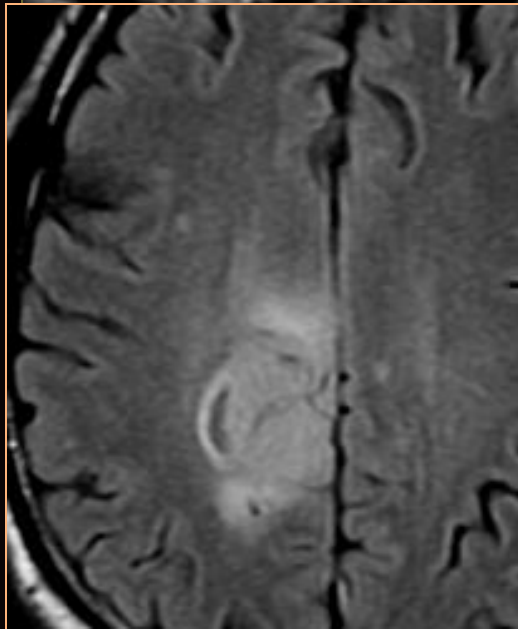
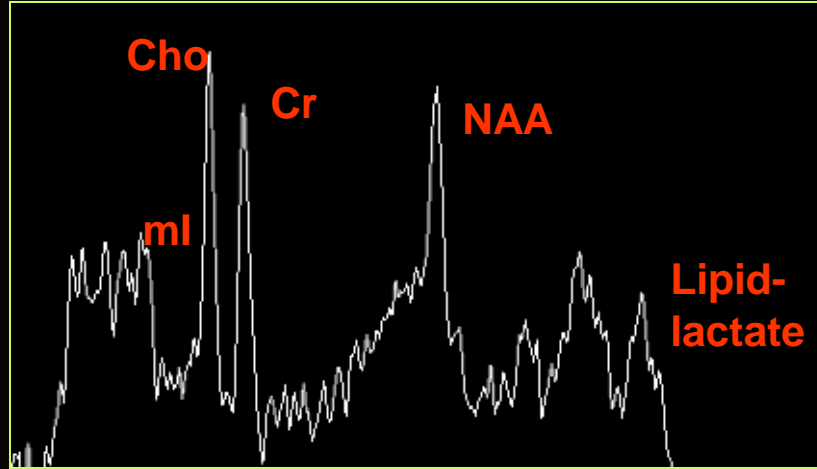
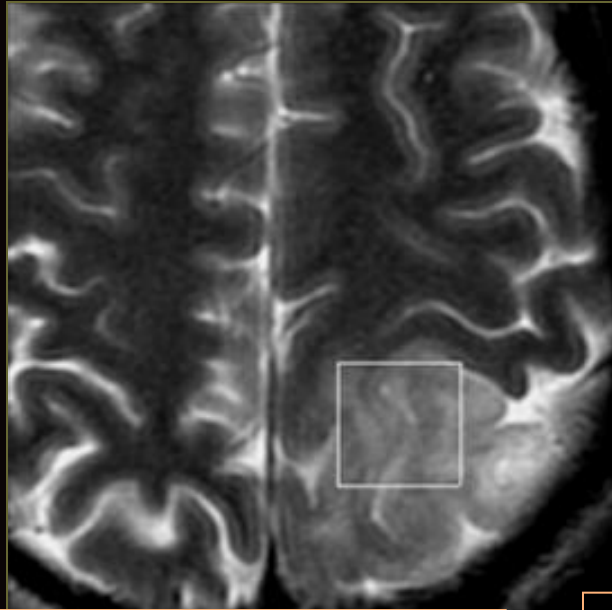
Lactate - anerobic metabolism

Variable mI - osmolytic changes

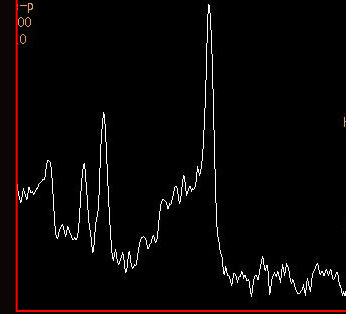
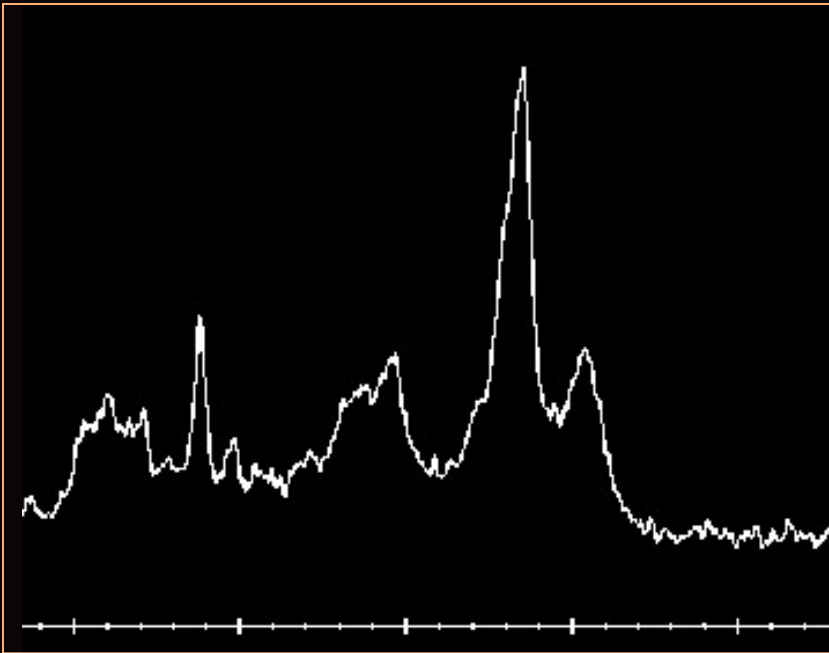
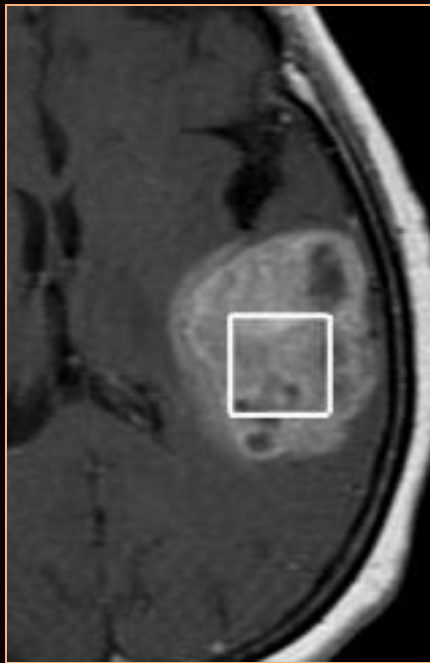
Lipid



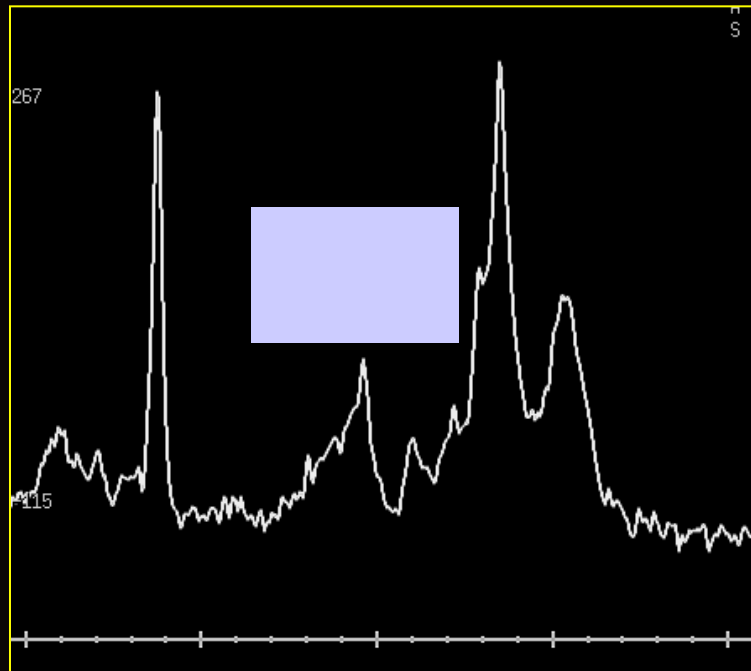
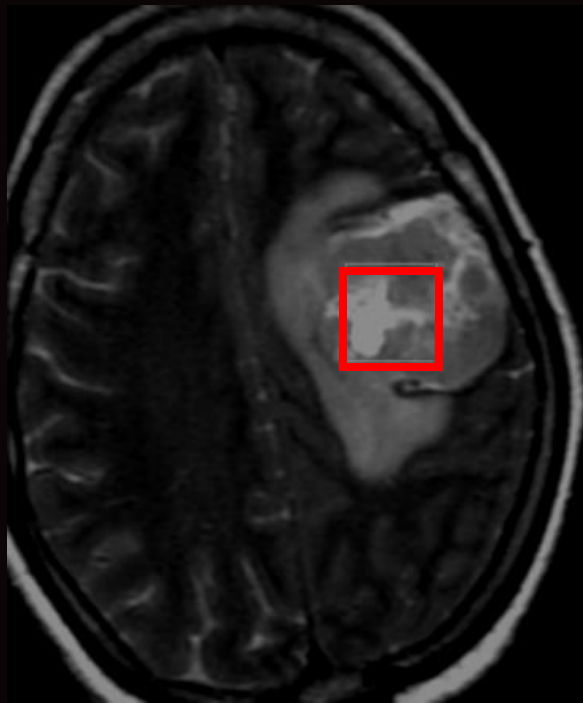
Low grade



Anaplastic

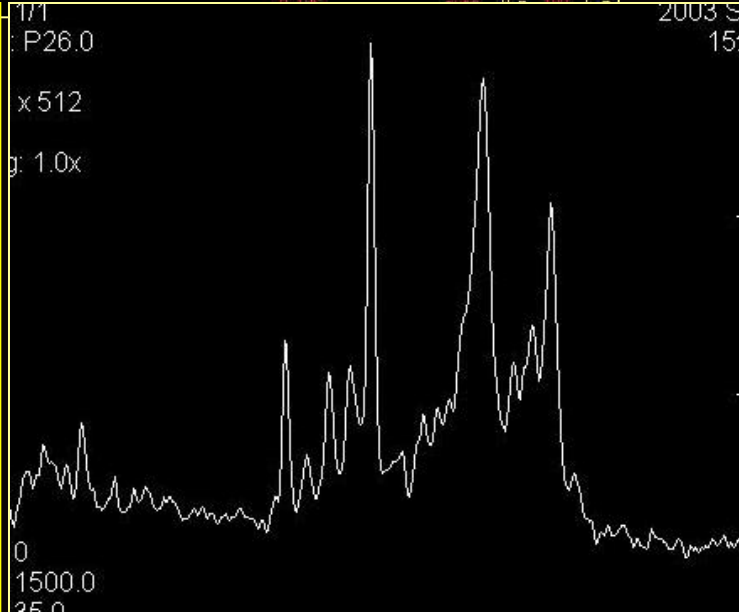
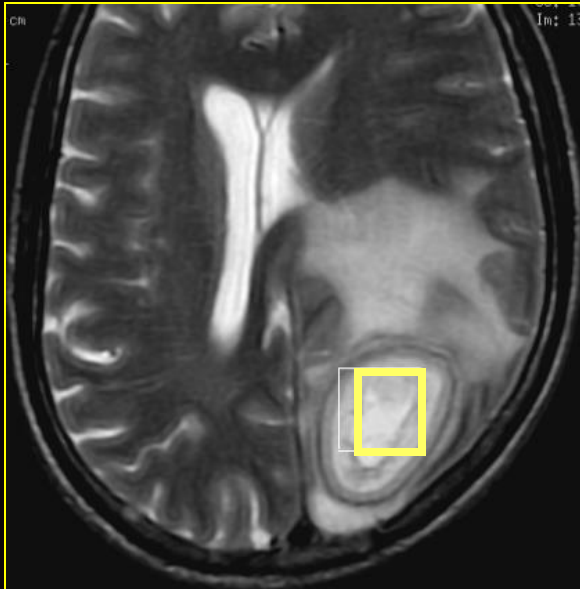
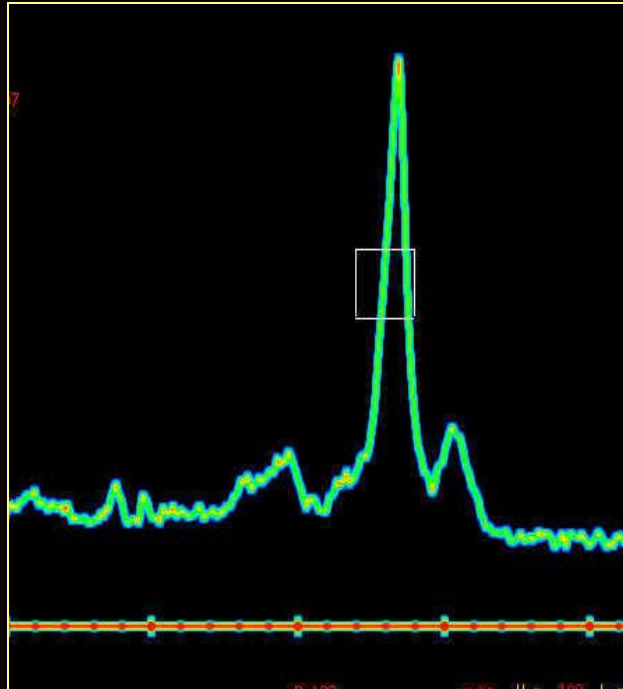


Glioblastoma



Solitary
meningioma

Tuberculoma

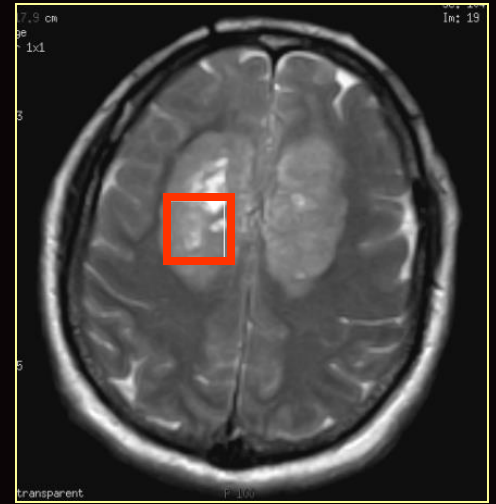


Abscess

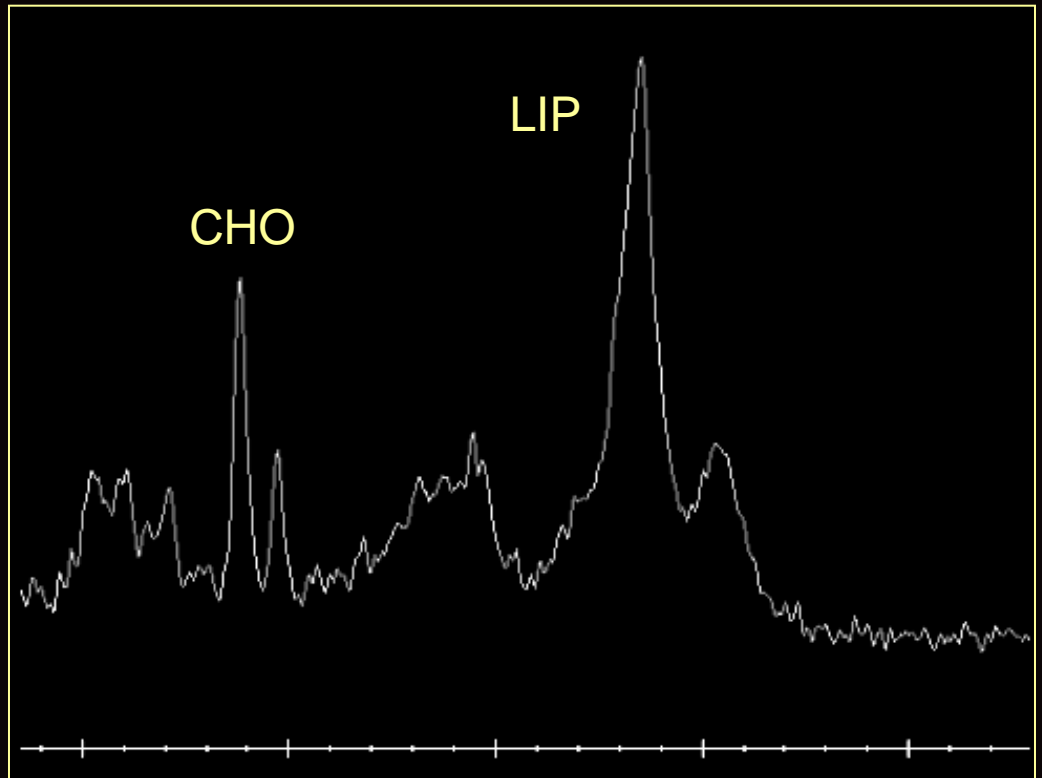
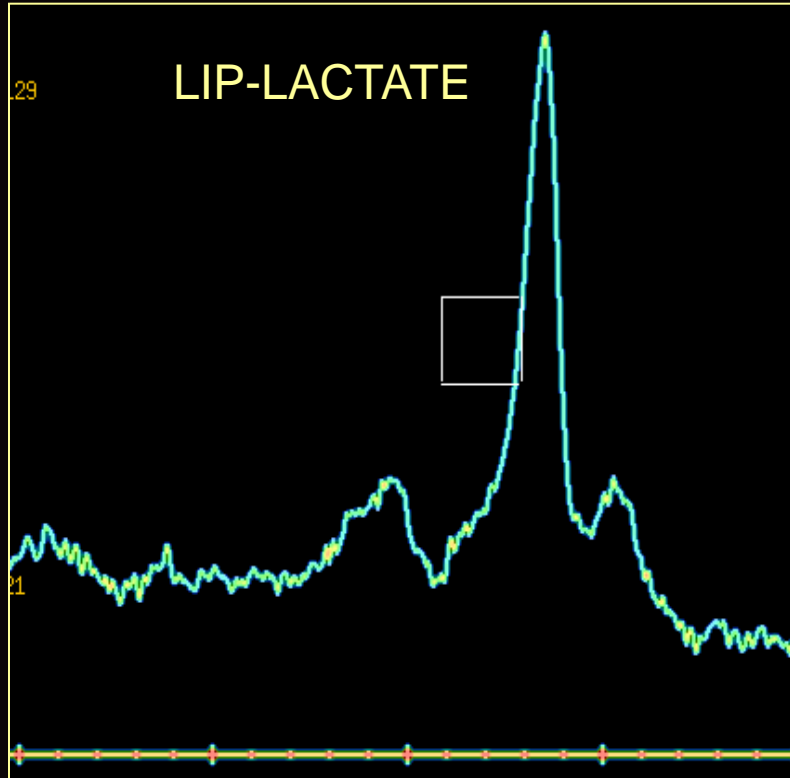
HIV

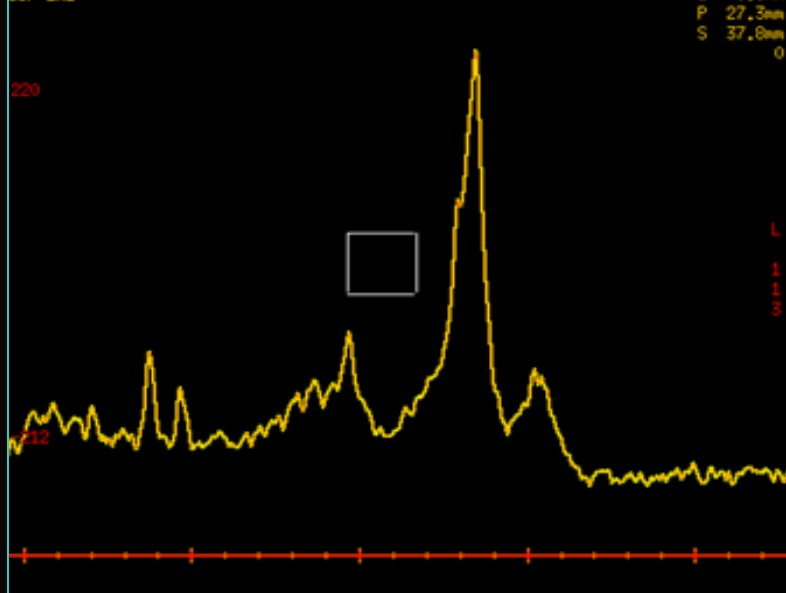


TOXOPLASMOSIS

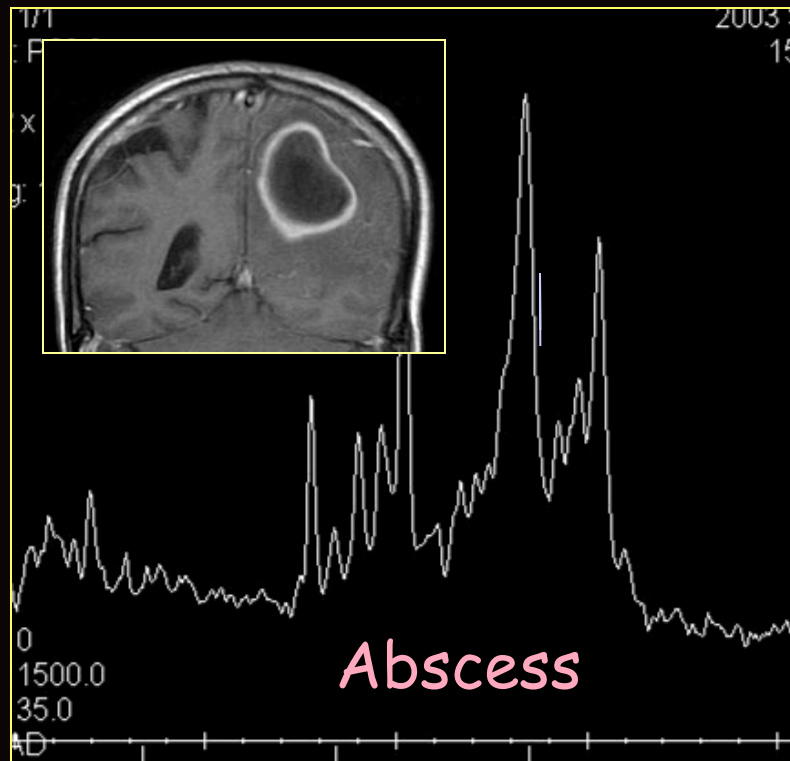
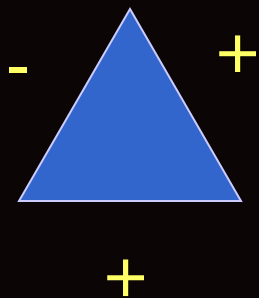
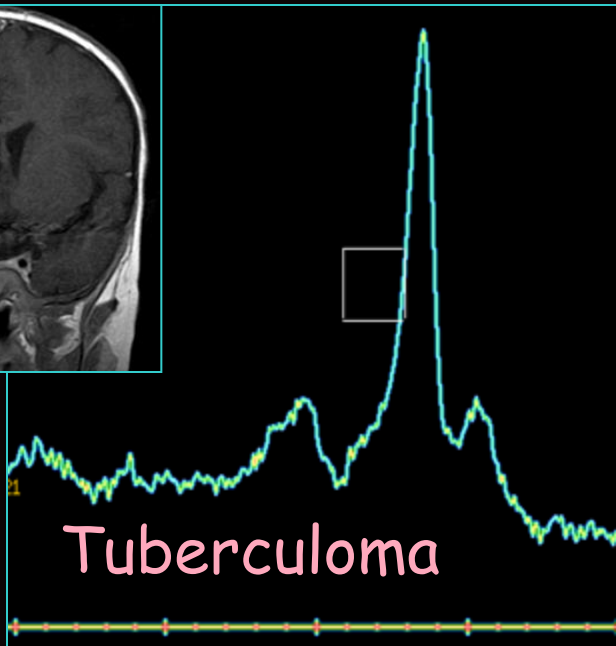


LYMPHOMA





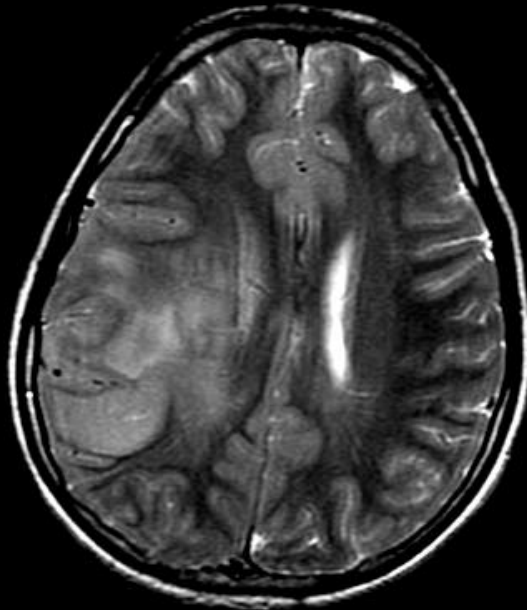
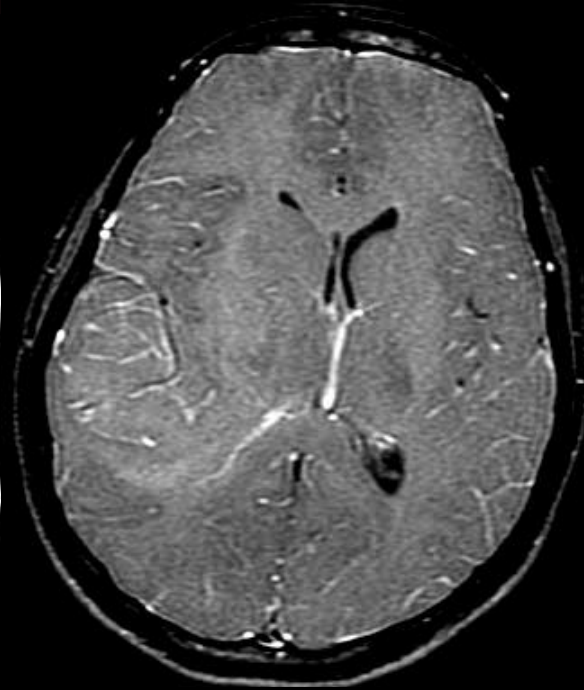
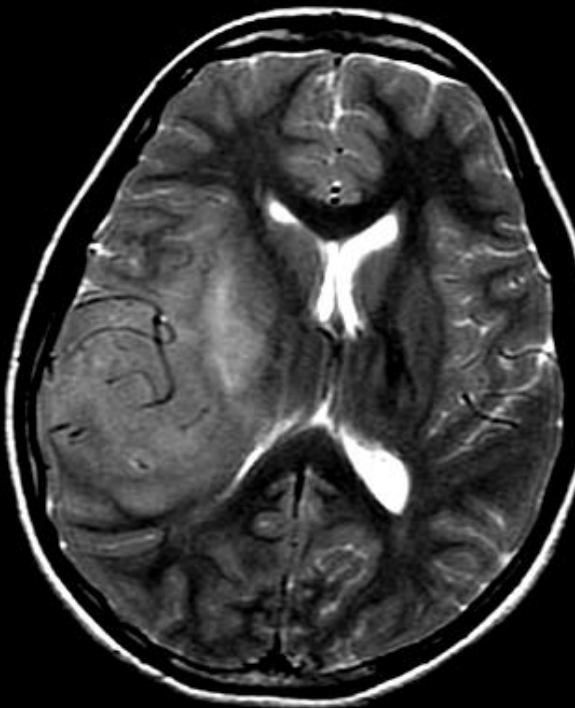
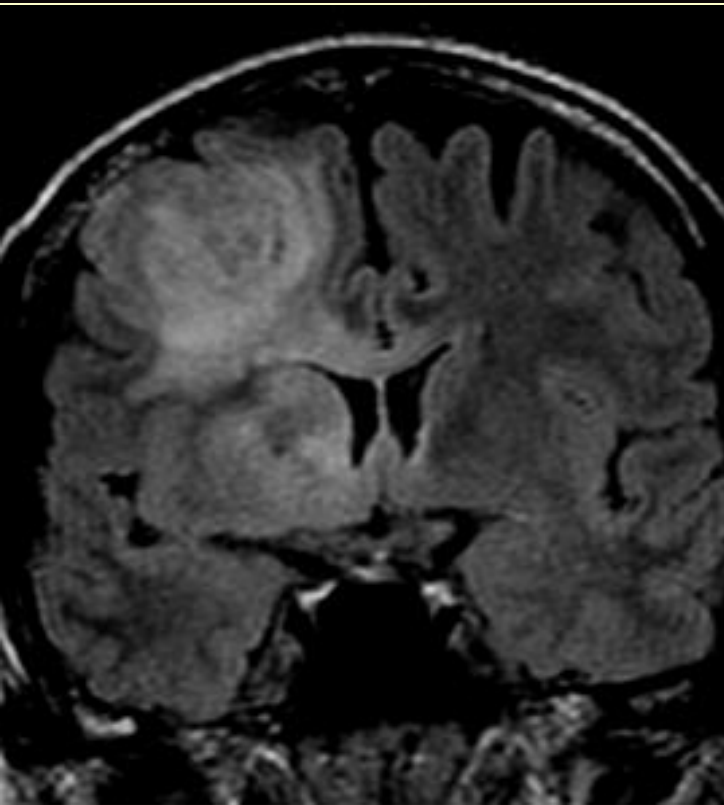
Glioblastoma
Multiforme



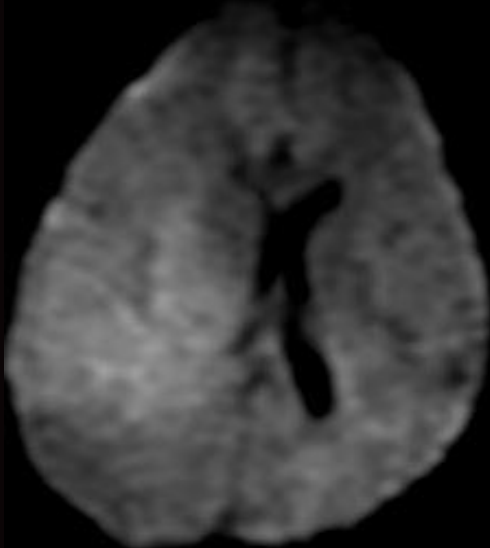
Tumor protocol - OUR CENTRE

- T1, T2, Flair, T2*
- Post contrast T1 fat sat, SOS spine imaging
- Diffusion & ADC
- MRS
- Perfusion
- DTI (in selected cases)
- fMRI (in selected cases)

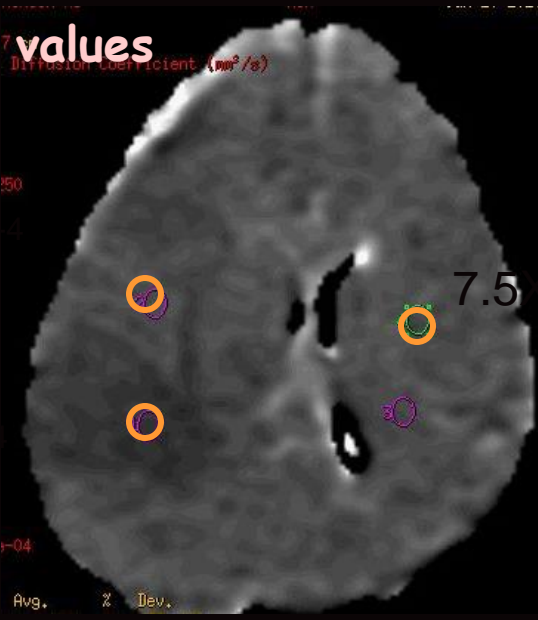
Middle aged lady with seizures since 1 month



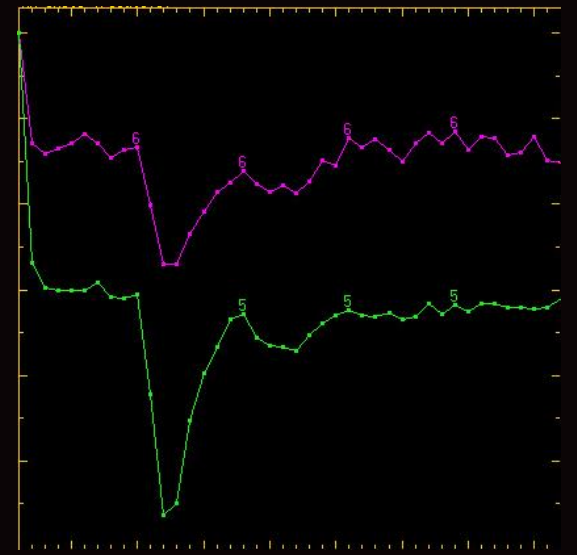
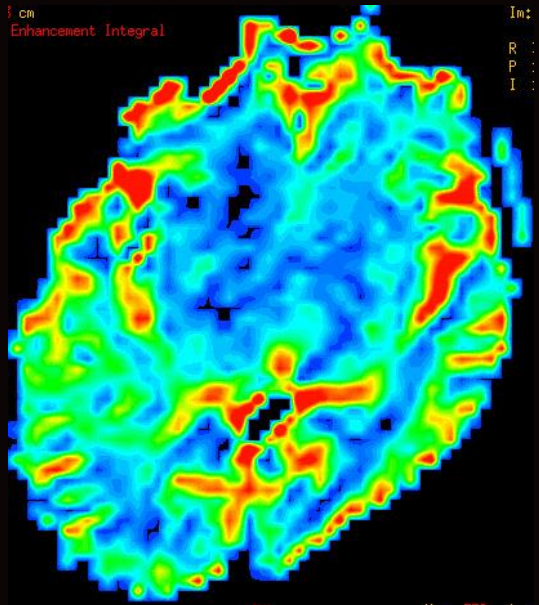
Restricted diffusion



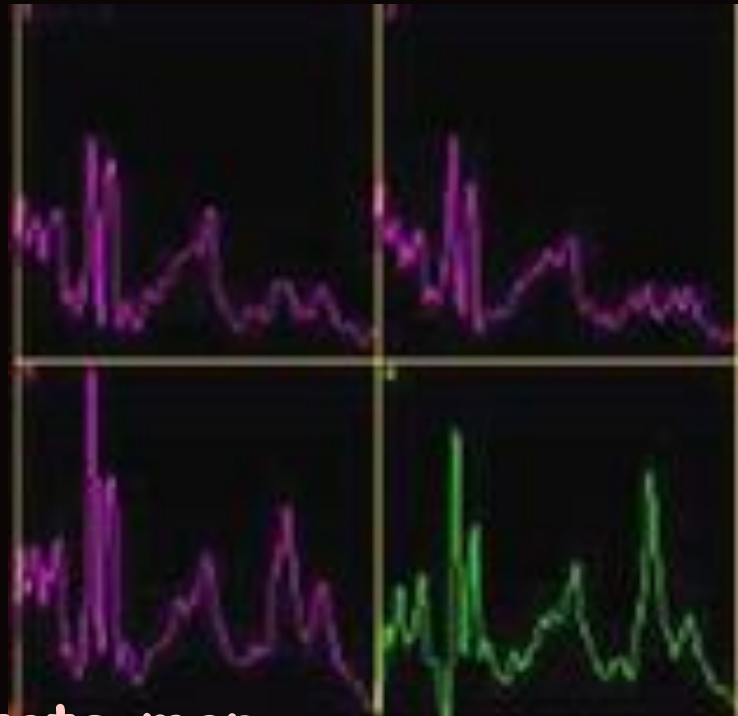
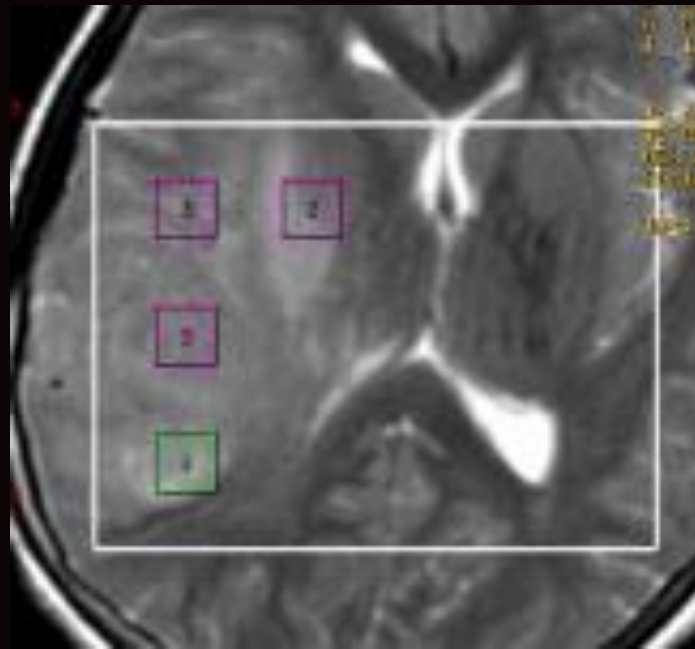
Reduced ADC values



MR perfusion - Increased

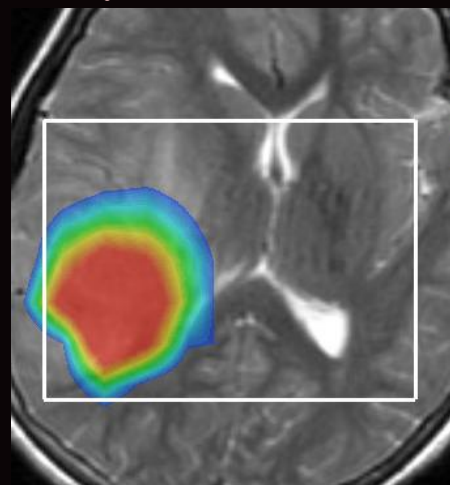
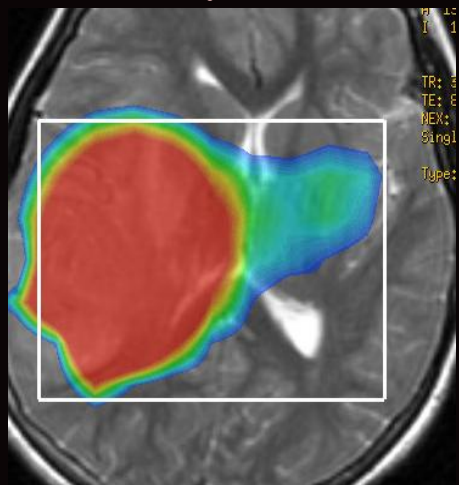


Multivoxel spectroscopy

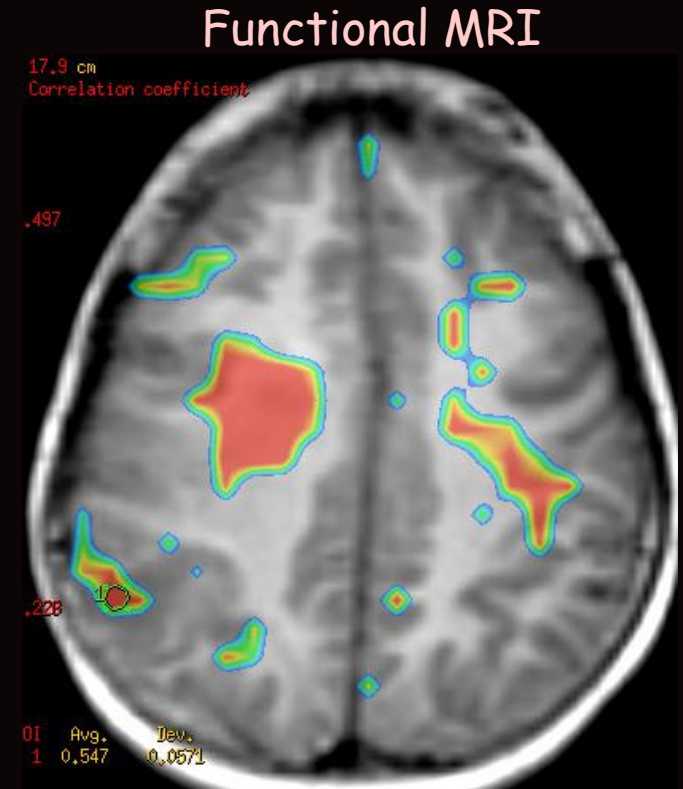
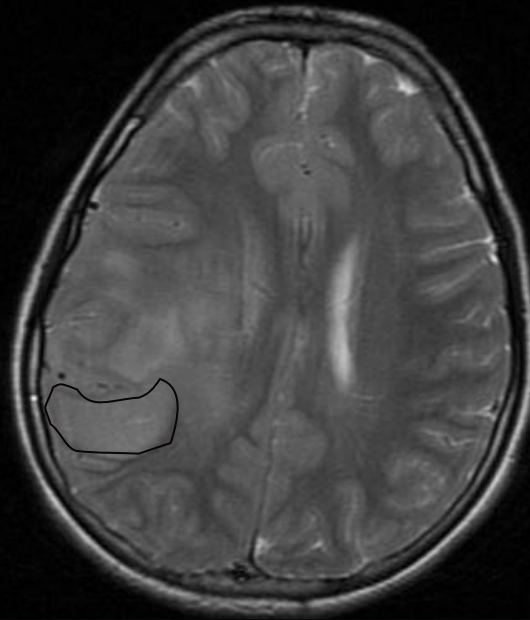
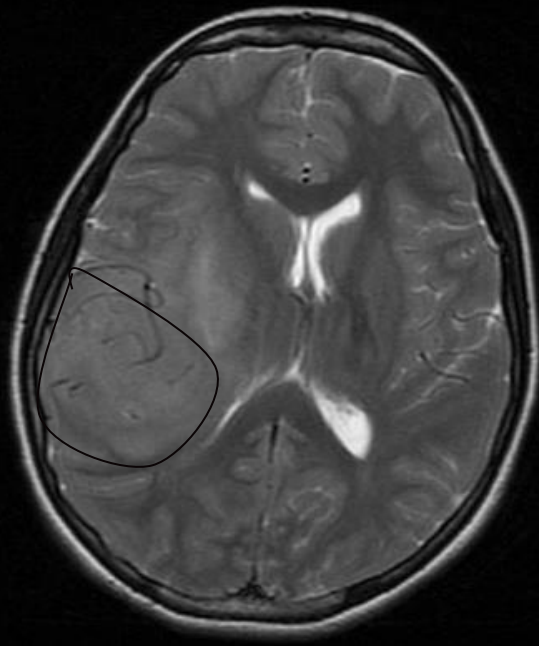


Cho map

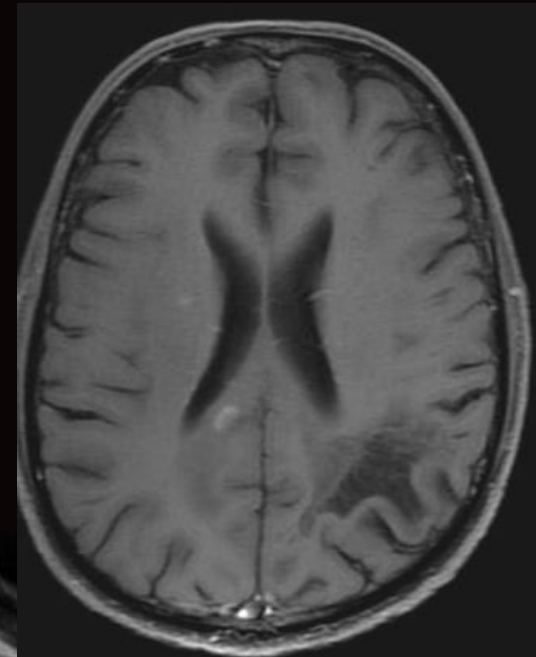
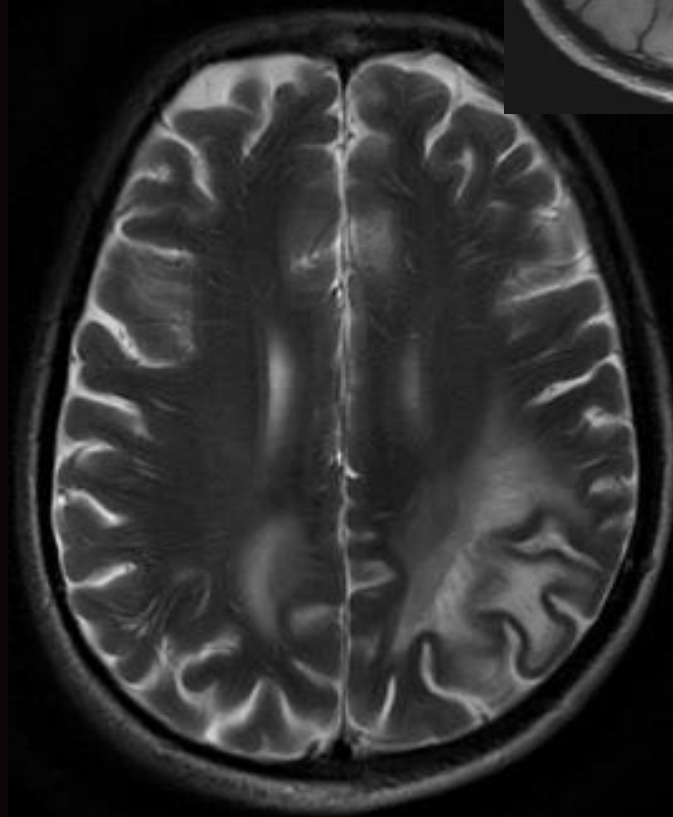
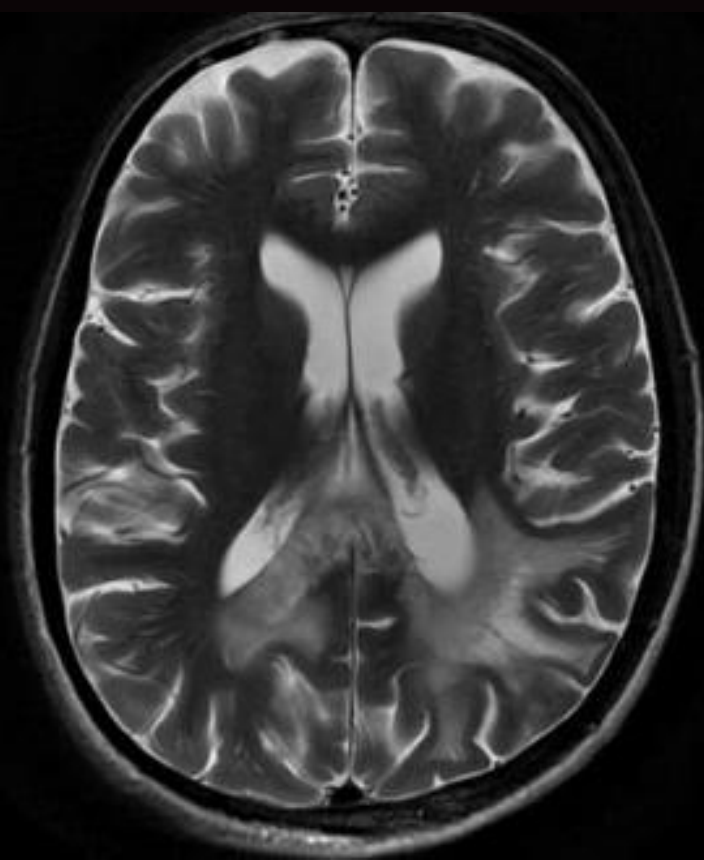
Lipid lactate map



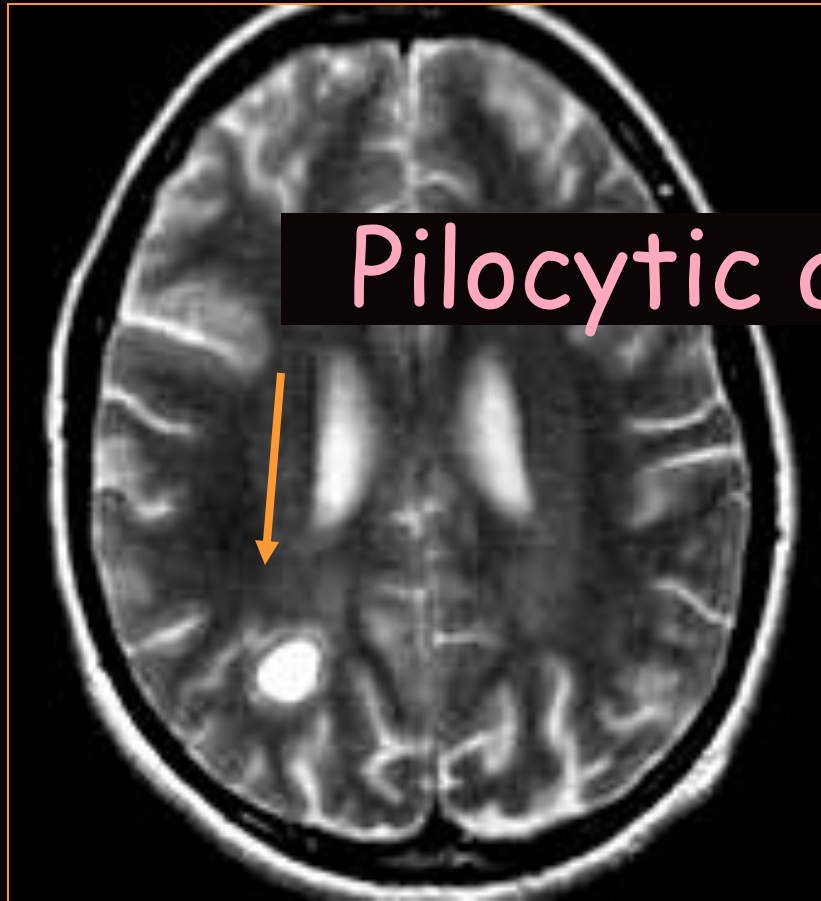
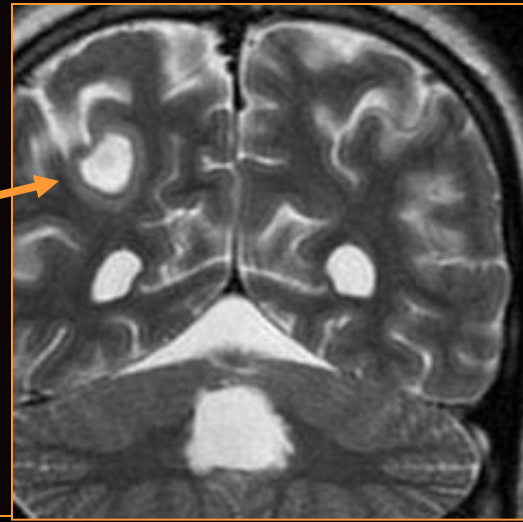
Mapping of biopsy site



Tumefactive demyelination



Ependymoma



Pilocytic astro



thank you

