

Approach to Normal MRI Brain

Vaishali Phalke MBBS, DNB

Oregon Health & Science University

MRI Sequences

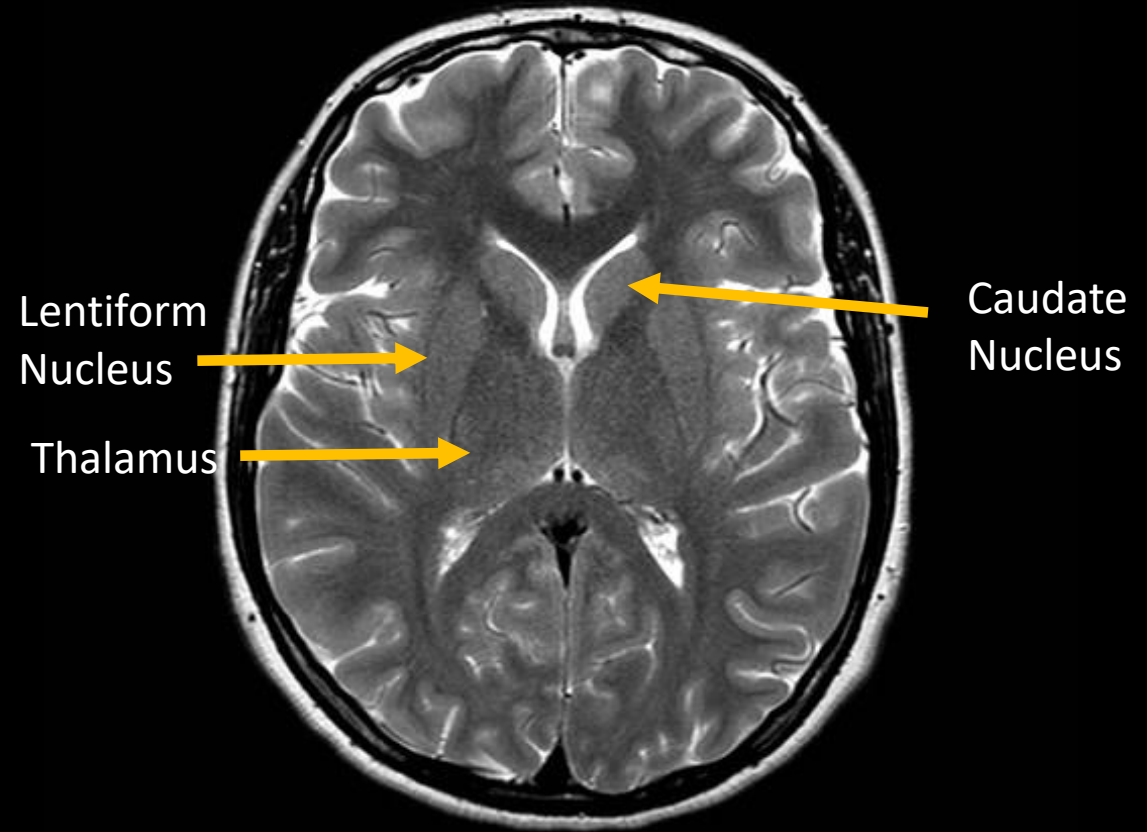
- T1 and T2 weighted sequences:
- On T1: white matter appears white & grey matter appears grey & CSF is black
- On T2: It is the opposite. CSF is hyperintense, thalamus is darker than the corpus striatum (putamen & caudate) which are darker than cortical grey

Examples of T1 and T2 images



Foramen
of
Monro

T 1 weighted



Lentiform
Nucleus

Thalamus

Caudate
Nucleus

T2 weighted

T1 hyperintense (bright) lesions i.e. short T1 lesions

- High protein: e.g. Rathke cleft cyst
- Mineralization
- Fat & cholesterol
- Subacute hemorrhage (Meth Hb)
- Subacute thrombus
- Manganese (e.g. in striatum in liver disease)
- Melanin

T1 hypointense (dark) lesions i.e. lesions with T1 prolongation:

- CSF
- Edema
- Chronic hemorrhage
- Air
- flow in blood vessels
- Low protein

T2 hyperintense (bright) lesions i.e. long T2

- Sensitive for many pathologies, edema or gliosis
- Edema
- Gliosis
- CSF

T2 hypointense (dark) lesions i.e. short T2

- Calcification
- Air
- Fibrous tissue
- Acute hemorrhage
- Very chronic hemorrhage (hemosiderin)
- High protein
- Calcium
- flow in blood vessels
- Metal

FLAIR (fluid-attenuated inversion recovery)

- Sensitive but not specific
- a type of T2 but CSF is black.
- FLAIR: Helps identify pathologies. shows areas next to CSF (periventricular) very well. Also good for juxtacortical areas.
- Inferior quality to other sequences in posterior fossa and spinal cord.

FLAIR

- Helps differentiate VR space from Lacunar infarct
- Causes of FLAIR hyperintensity in sulci

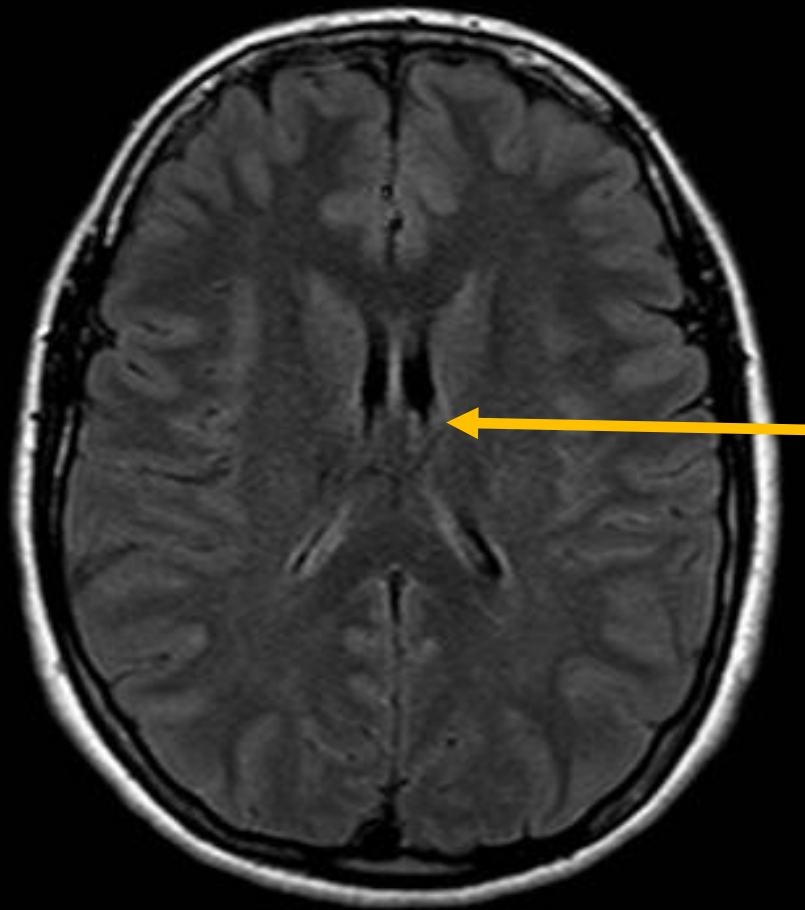
SAH

High protein (meningitis, neoplastic)

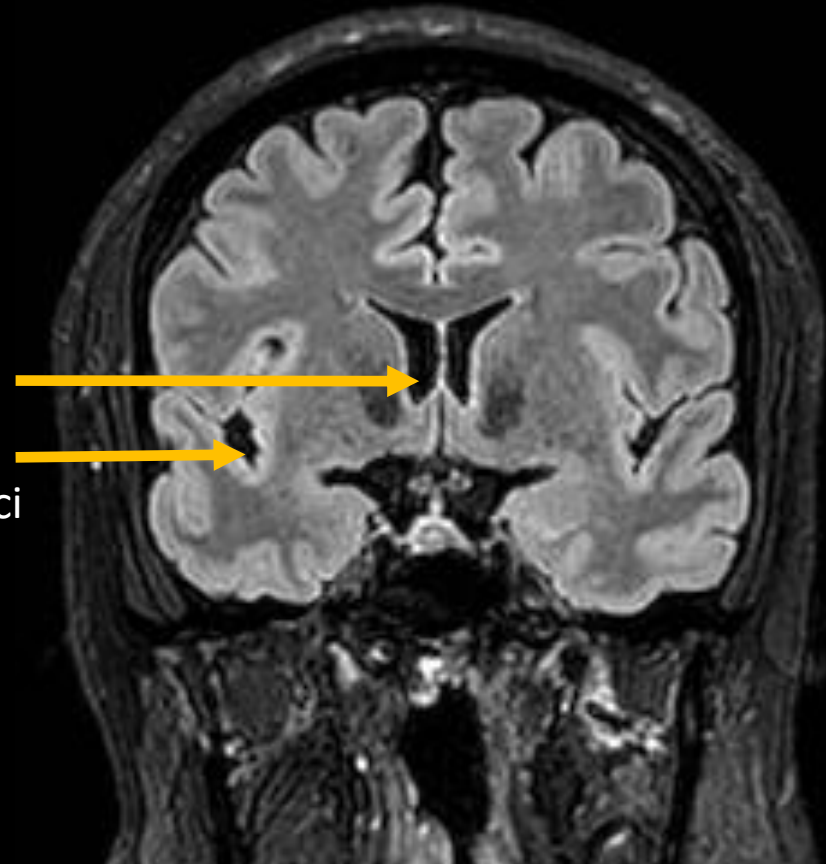
High oxygen tension (intubation & ventilation)

Artifact.

FLAIR image



Suppression
Of normal
fluid in
Ventricles & sulci



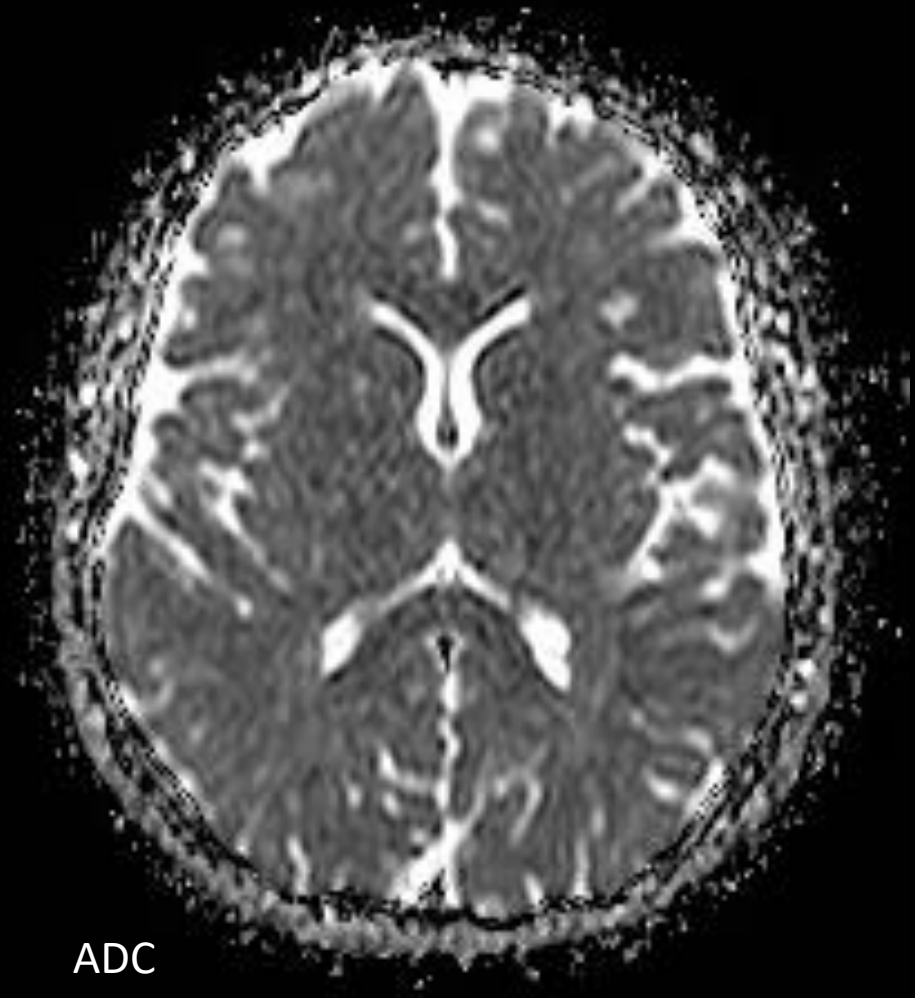
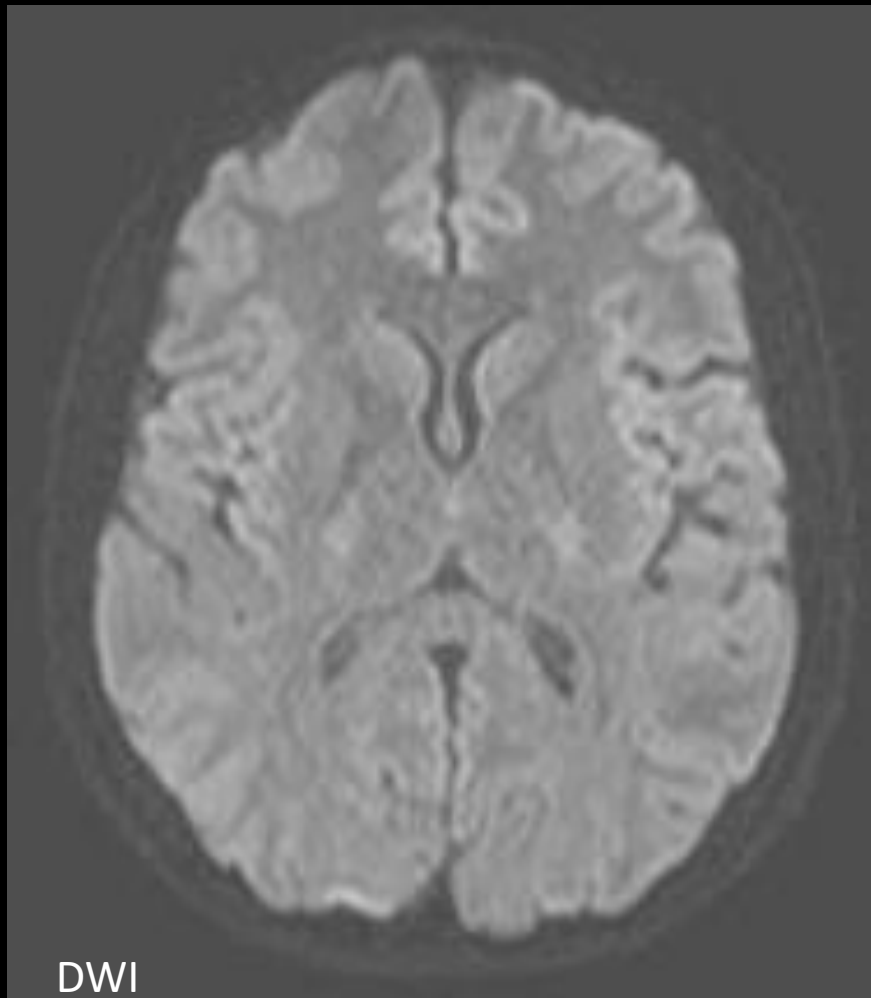
Diffusion weighted imaging

- **Diffusion** imaging uses diffusion of water molecules. Calculates apparent diffusion coefficient ADC that can be displayed on a separate scan.
- Detects changes in local deoxy- and oxy-hemoglobin ratios, helps localize cognitive (including language) & other functions

Apparent diffusion coefficient, **ADC**:

- Decreased in cytotoxic edema i.e. opposite to diffusion i.e. true DW restriction i.e. infarct or abscess.
- Increased from a T2 effect 'T2 shine-through' i.e. same as diffusion.
- **Restricted diffusion= high signal on DWI & low signal on ADC**

Images of DWI and ADC



Increased DWI seen in

- acute ischemic stroke

Important to evaluate for diffusion restriction also in

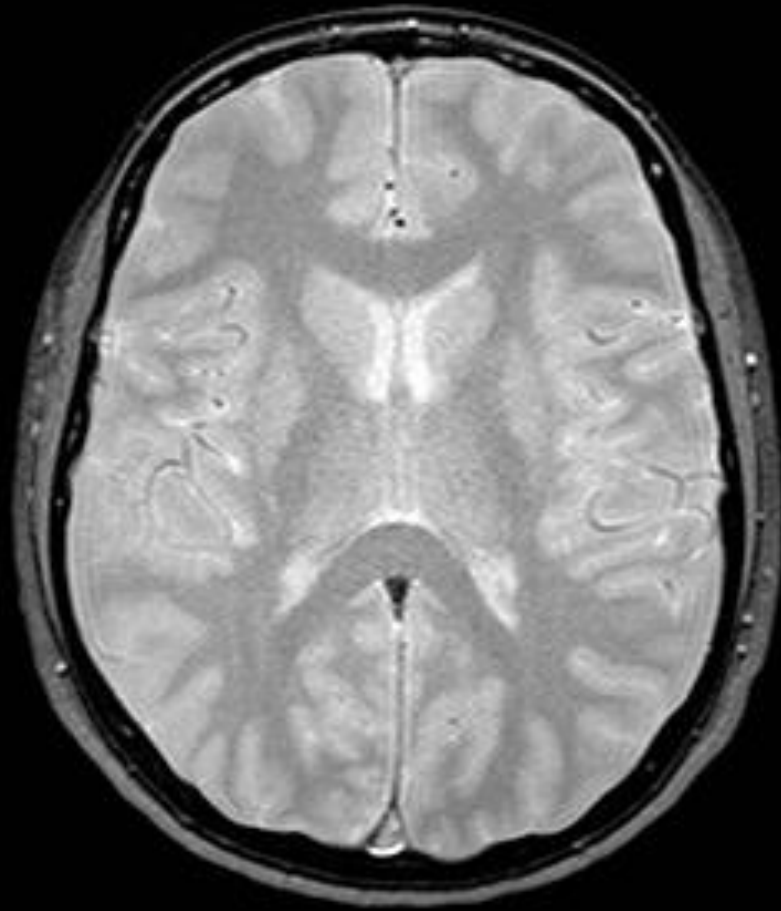
- encephalitis like herpes
- focal seizure
- Infections (like abscess, CJD)
- Tumors and tumor treatment response (egs like medulloblastoma, epidermoid cyst)
- Asses extent of diffuse axonal injury
- Asses active demyelination

GRE & SWI sequences

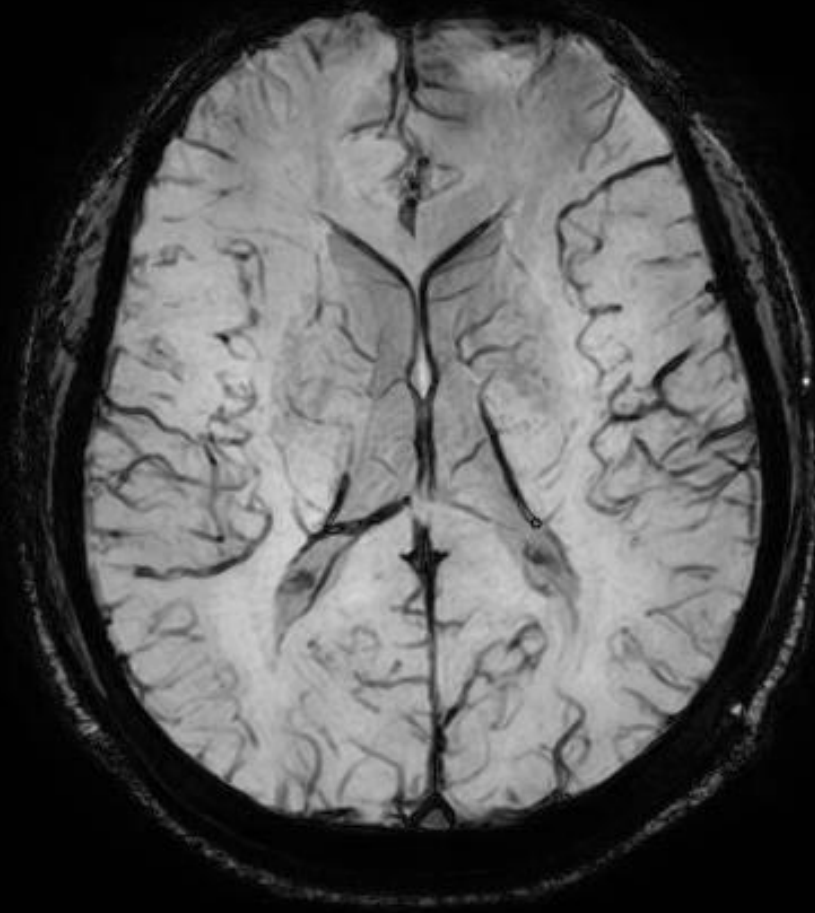
Detects hemorrhage (hemosiderin) well. Low intensity (called susceptibility artifact or T2* effect).

- Diffuse axonal injury
- Hypertension and amyloidosis
- Multiple cavernomas
- Evaluation of Venous sinus/cortical vein thrombosis.
- Infections

GRE and SWI



T2 *



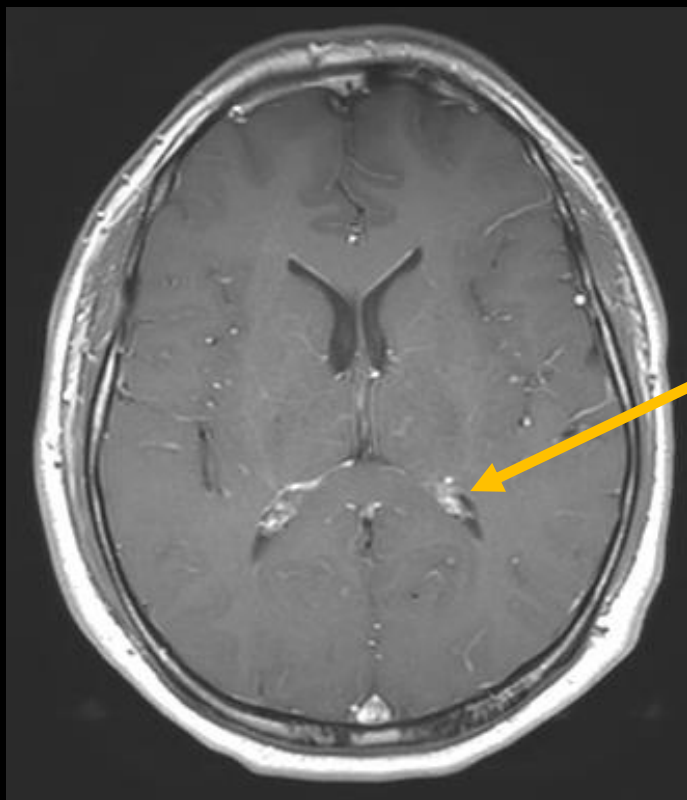
SWI

Normal structures that enhance on MRI

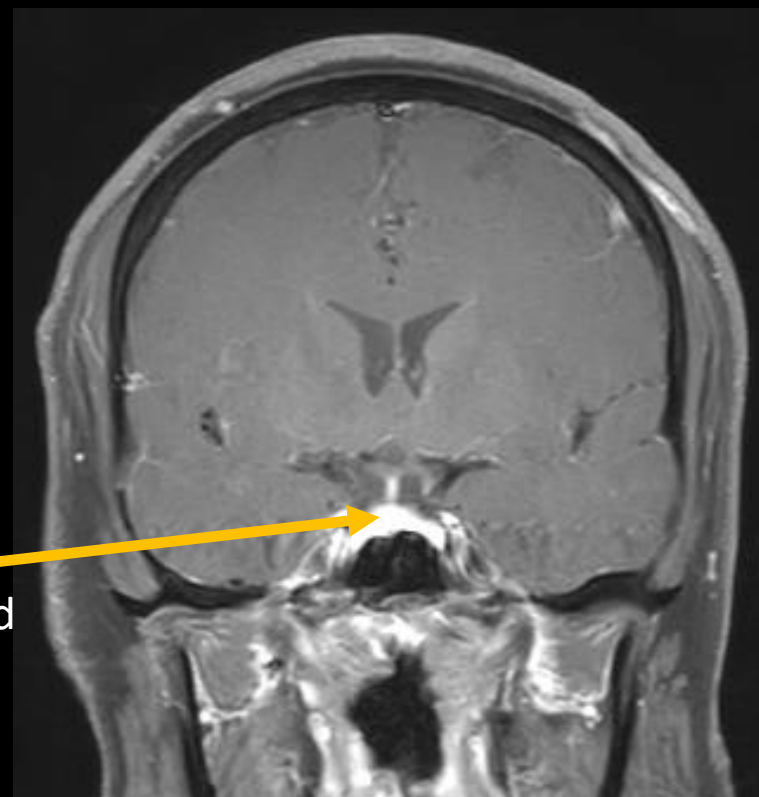
Structures outside the blood-brain barrier like

- Dura
- Adenohypophysis and pituitary stalk
- Pineal gland
- Choroid plexus
- Nasal mucosa
- Tuber cinereum
- Area postrema

T1 +Gadolinium



Enhancing
Choroid
Plexus

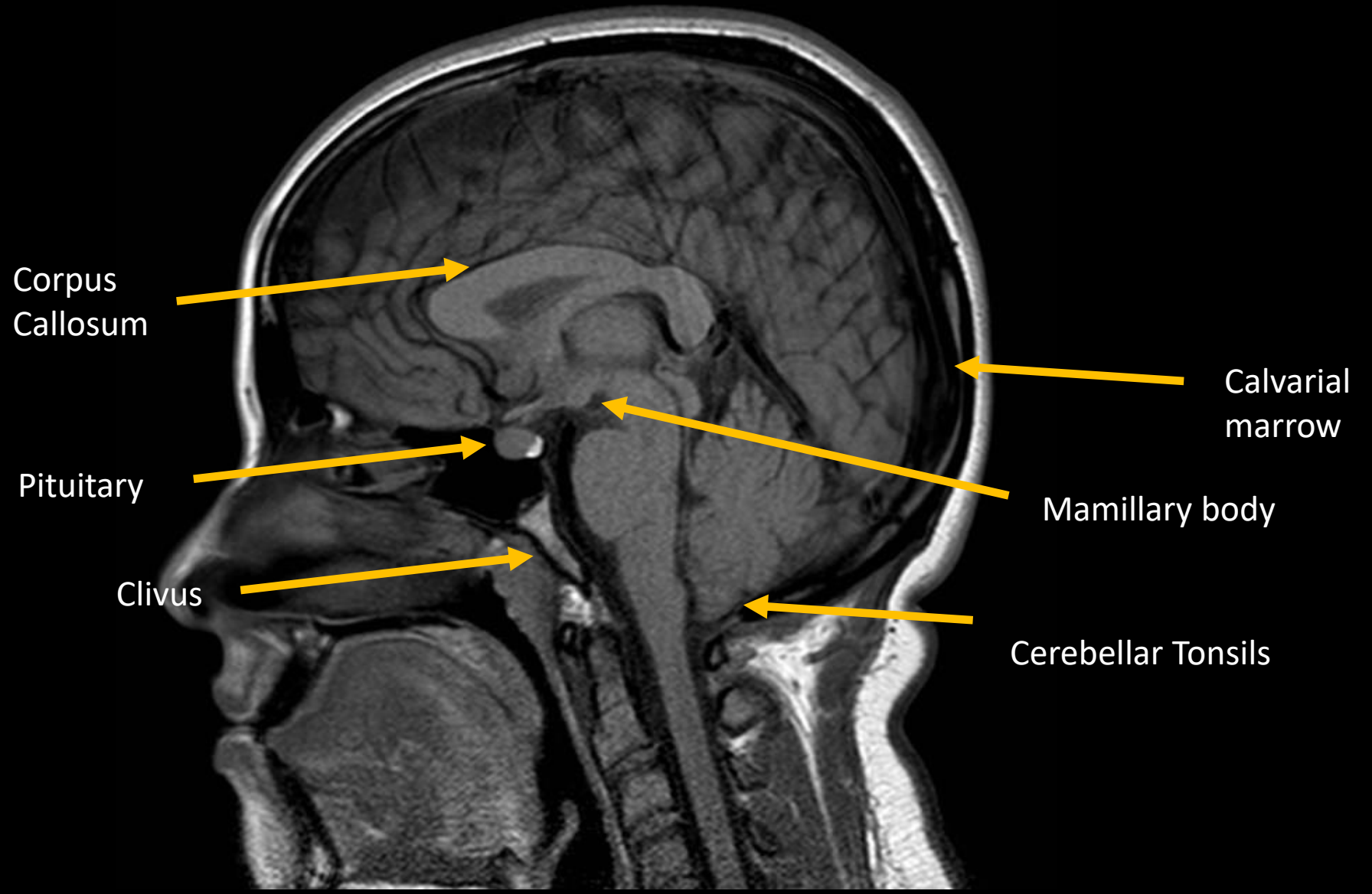


Enhancing
Pituitary gland
& stalk

- Disruption of normal blood brain barrier causes enhancement of different lesions on MRI.
- Enhancement may be seen in :
 - ❖ Tumors
 - ❖ Infections
 - ❖ Inflammatory conditions such as active demyelinating lesions
 - ❖ Subacute areas of ischemia

Sagittal images

- Scroll and look at midline image (in the mid-sagittal plane) from bottom to top. Then look laterally at the parasagittal planes. Observe the normal and abnormal structures.
- Foramen magnum & base of skull including cerebellar tonsils
- Clivus and nasopharynx
- Fourth ventricle and Cerebellar vermis
- Sella, pituitary & optic chiasm
- Corpus callosum
- Superior sagittal sinus
- Visualized cervical spine



Corpus
Callosum

Pituitary

Clivus

Calvarial
marrow

Mamillary body

Cerebellar Tonsils

- When interpreting the axial images follow a systematic approach. Scroll through the MRI from bottom to top interpreting each of these systems or areas at a time. The CSF system (ventricles, cisterns and sulci), the brain matter (grey matter structures and white matter structures), the vessels and venous sinuses, the meninges and skull and adjacent tissues. And finally the extended search i.e. review areas (paranasal sinuses, orbits, nasal cavity, visualized tongue and face).

Ventricles, cisterns & sulci

- When ventricles, cisterns, fissures or sulci are “squashed” we use the term effaced. When they are large we just describe them as large or enlarged. The different CSF spaces should be interpreted together for example, effaced sulci tell us that the enlarged ventricles likely represent hydrocephalus. Whereas enlarged sulci and enlarged ventricles likely represent brain volume loss

Ventricles:

- Lateral ventricles (frontal, occipital & temporal horns), Third ventricle, fourth ventricle

Cisterns & fissures:

- Quadrigeminal plate cistern, interpeduncular cistern, ambient cistern, suprasellar cistern

Sulci:

- Appearance: effaced, obscured
- Ventriulo-sulcal proportionality

Brain Grey & white matter

- Midline shift
- Grey white differentiation

Structures:

- Caudate nucleus, Internal capsule, Putamen & globus pallidus, thalamus.
- Other structures: centrum semiovale, midbrain, pons, medulla, cerebellum

Vessels: arteries, veins & venous sinuses

- **Arteries:** basilar, carotid arteries, vertebral artery, middle cerebral arteries
- **Venous:** Superior sagittal sinus, torcula, transverse sinus, sigmoid sinus, internal jugular vein

Meninges

- Dural involvement/enhancement look at (falx, tentorium, CP angle)
- Leptomeningeal enhancement look at (basal cisterns, cerebellar folia, sulcal perivascular spaces)

Extended search

- Sella, pituitary & optic chiasm
- Paranasal sinuses (ethmoidal, sphenoid, frontal, mastoid), temporal bone/ears
- Orbits
- Nasopharynx, Oropharynx