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CT SCAN

Patient preparation:

Fasting 4-6 hours in case of:

- Contrast material (Urographin, Telebrex, Isovest) 1-2 ml/kg
- Anesthesia in case of: children – uncooperative patient.

Scanogram:

- Scan starts in the CT from the base line in the scanogram, called orbital-meatal line which extends from the external canthus to the external auditory meatus.
- Scan every 1 cm in adults and 7 mm in children.

Contrast:

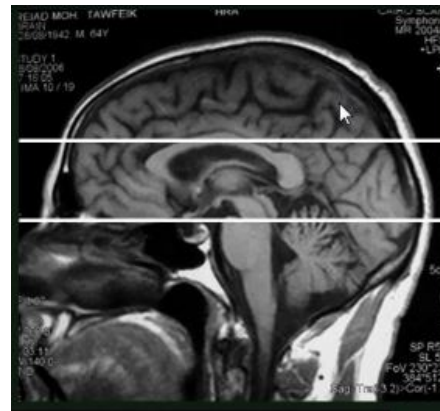
- No contrast administration in: Trauma – CVS
- Contrast in: all cold cases as; epilepsy, increased ICT, headache
- But nowadays due to ease of CT, we do all without contrast and administer contrast only if needed



Reading CT brain:

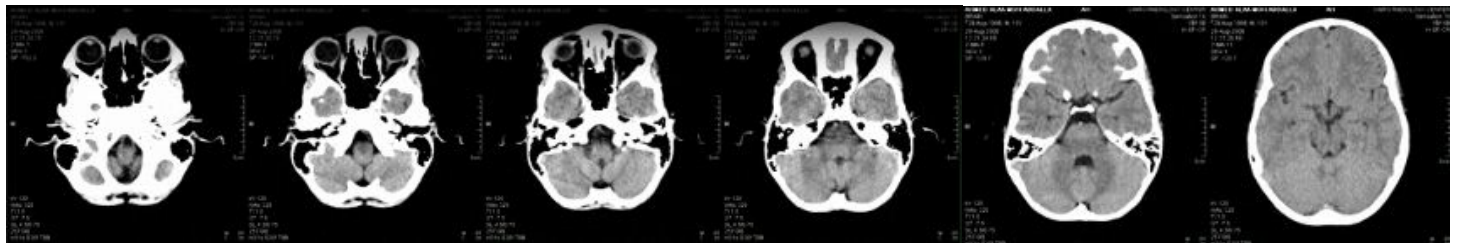
We divide cuts into 3 groups:

- *Before* the appearance of lateral ventricle
- In which the *lateral ventricle* appear
- *After* the appearance of lateral ventricle



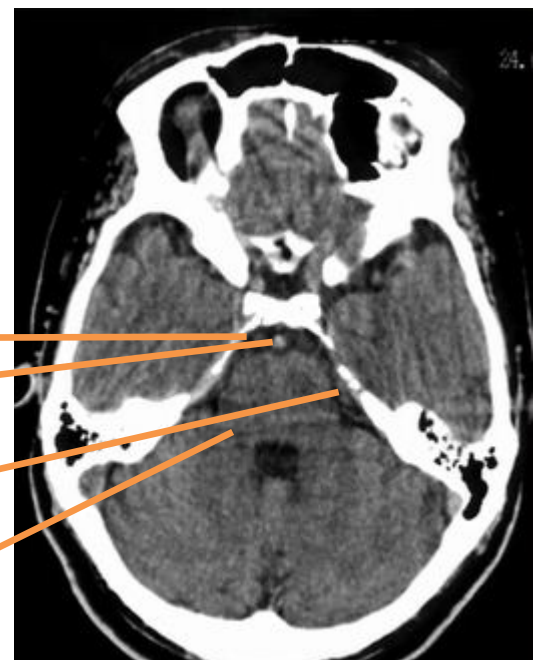
1) Before the appearance of lateral ventricle:

- These cuts are called **posterior fossa sections**
- The main landmark here is the **fourth ventricle**
- The 4th ventricle appears from below upwards; **narrow** then **widen** then return **narrow** again



1- When the fourth ventricle appears wide:

- . In front of the 4th ventricle is the **Pons**
- . Behind the 4th vent is the **Vermis**
- . In front of the pons is the **prepontine cistern**
- . In the prepontine cistern is the **basilar artery**
- . The prepontine cistern extend laterally forming the **cerebellopontine angle cistern** or **ambient cistern**
- . Between pons and cerebellum is the **Middle Cerebellar Peduncle**



2- When the 4th vent is narrow below:

- . In front of 4th ventricle is the **Medulla**
- . Behind 4th vent is a small CSF space connecting cisterna magna to 4th ventricle called the **Vallecula**
- . Behind the vallecula is the **Cisterna Magna**



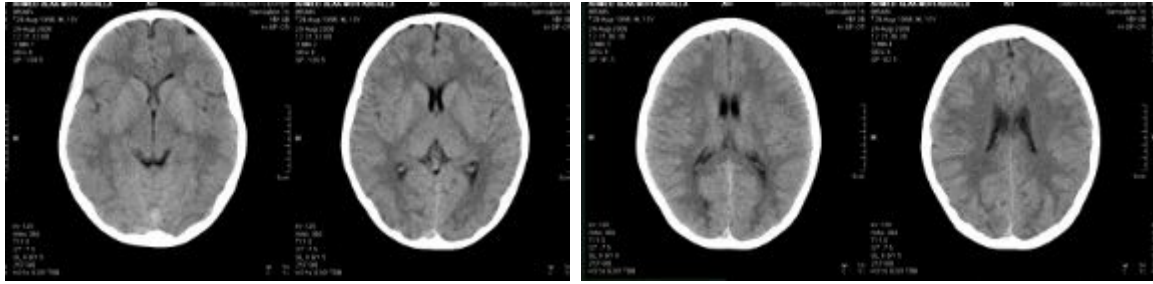
3- When the 4th vent is narrow above:

- . The 4th ventricle is contained in the **Quadrangular Cistern**
- . In the concavity of it is the **Midbrain**
- . The small depression in the midbrain is the end of **Aqueduct of Sylvius**

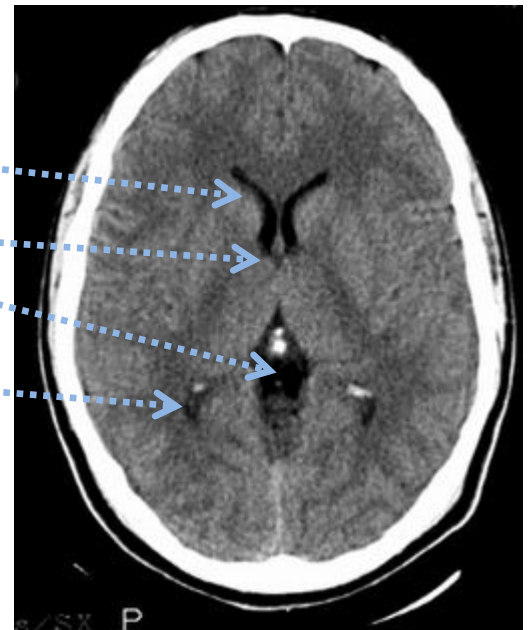


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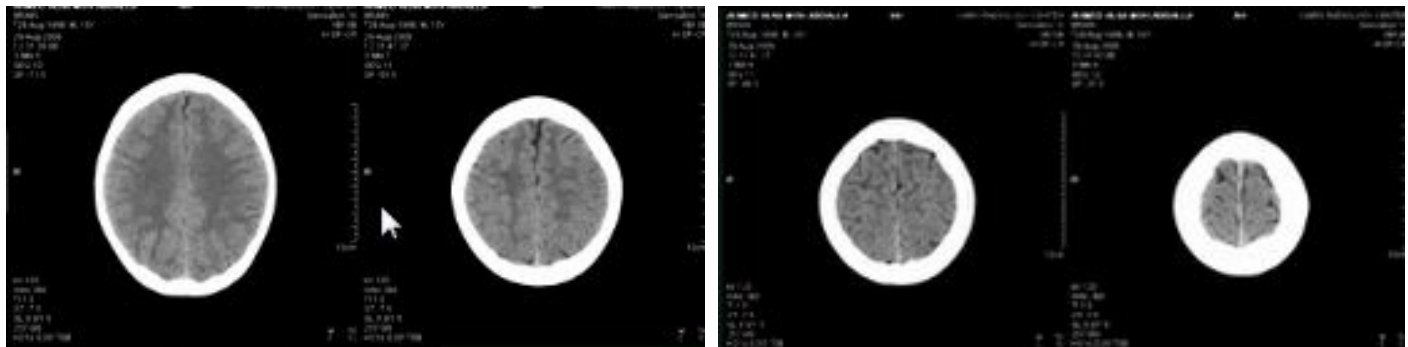
2) Cuts in which the lateral ventricle appear:



- . The frontal horn of lateral ventricle
- . The 3rd ventricle
- . The **Quadrigenial cistern** change its shape into diamond
- . The occipital horn



3) Cuts after the appearance of lateral ventricle:



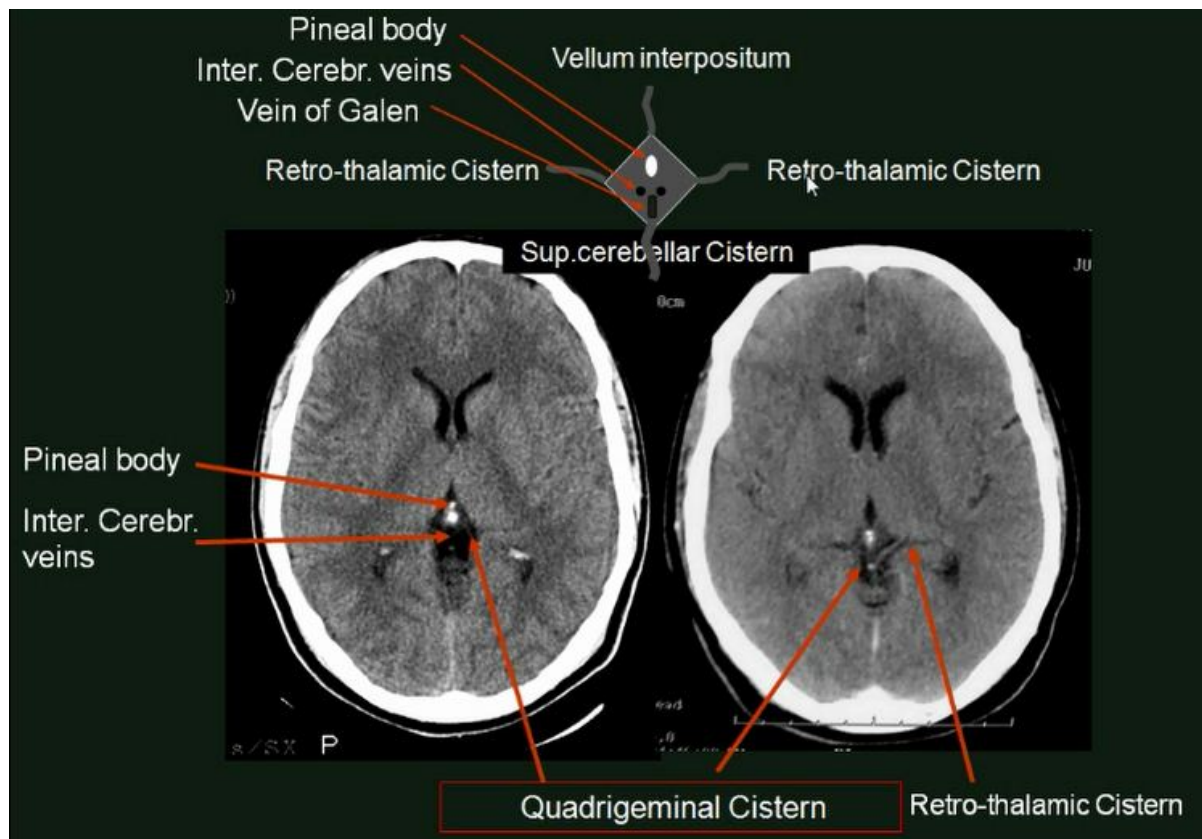
The Quadrigeminal Cistern:

When it is **diamond** shaped, it contains 3 structures:

- **Pineal body**
- **2 internal cerebral veins** seen mainly when contrast injected
- **Vein of Galen**

4 cisterns branching form quadrigeminal cistern:

- **Retro-thalamic cistern**
- **Supra-cerebellar cistern**
- **Vellum Interpositum** anteriorly
above the 3rd ventricle

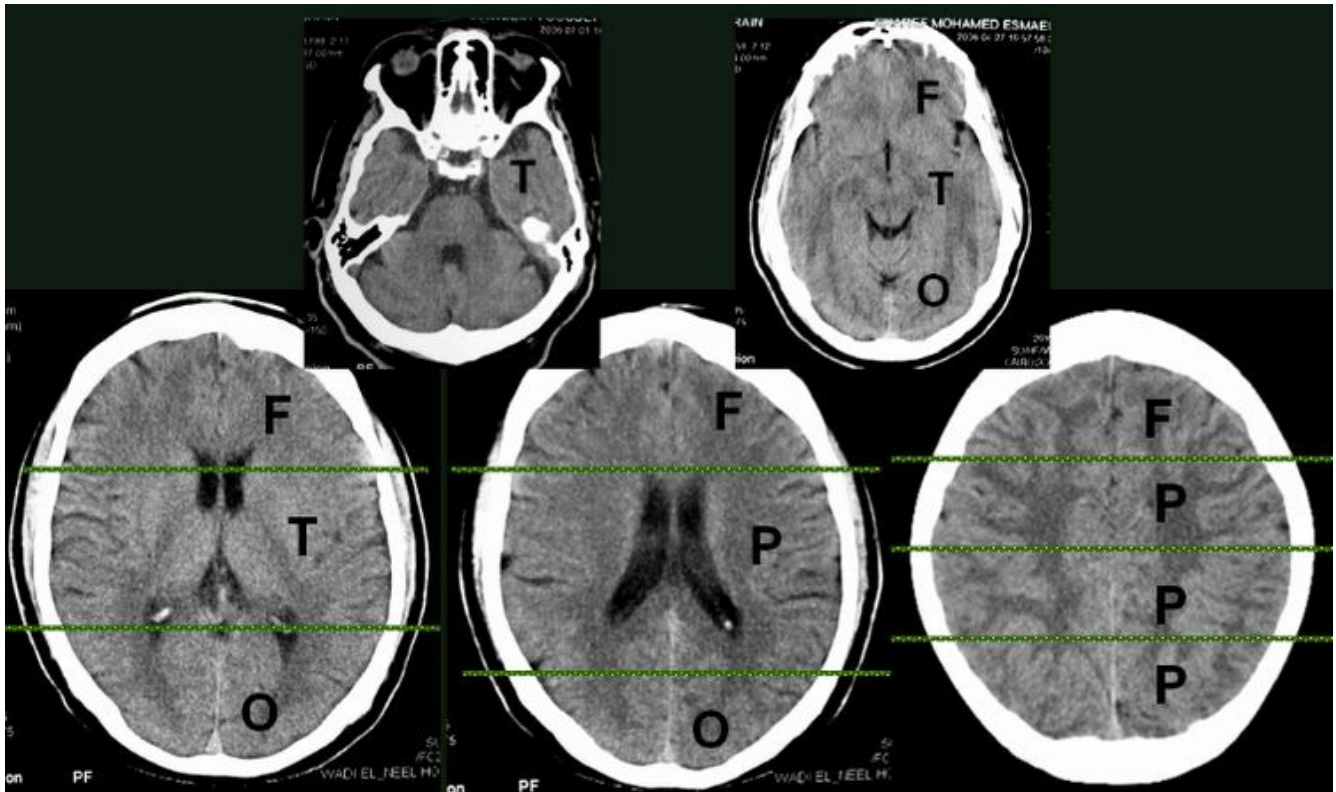


Above the quadrigeminal cistern level:

- . Body of lateral ventricle
- . Head of Caudate
- . Septum pellucidum

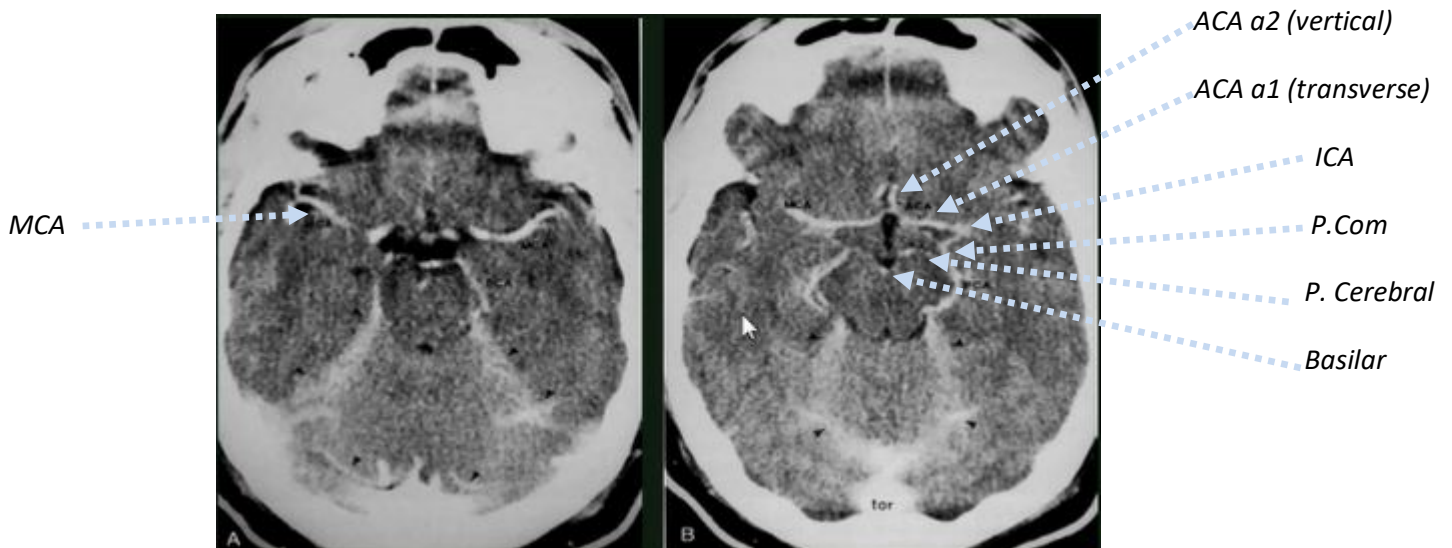


Defining lobes of the brain:



- When the **lateral ventricle** appears, we draw line in front and line behind it, in front it is the frontal lobe and behind it is the occipital lobe.
- To differentiate between parietal and temporal, it is according to presence or absence of the **3rd ventricle**, if present then it is temporal lobe, if absent then it is parietal lobe.
- Occipital lobe disappear once the lateral ventricle disappear

CT Vascular anatomy of the brain:



Brain MRI

Types of weighted images:

- T1 WIs (TR<800 msec TE 20 msec)
- T2 WIs (TR >1000 msec TE >80 msec)
- PD WIs (TR>1000 msec TE 20 msec)

- **T1** CSF appears **Black**
- **T2** CSF appears **White**
- **FLAIR** CSF appears **Black** (Fluid attenuation and inversion)
FLAIR is just like T2 so lesions appear bright white but fluids and CSF are attenuated so appear black

T1 low signal & T2 low signal: “Non mobile protons”

5

- Cortical **bone**
- **Fibrous tissue**
- **Calcifications**
- Flowing blood in the **vessels** (fast moving protons)
- **Air** in sinuses and lungs (minimal hydrogen protons)

T1 high signal T2 high signal:

1

- **Subacute blood** (metHb)

T1 high signal T2 low signal:

1

- **Fat** (subcutaneous, orbital)

T1 low signal T2 high signal: any structure not listed before

4

- **CSF**, Urine, Pleural effusion, Ascites
- **Edema** and **infarctions**
- Most of **tumors**

Use of contrast in MRI:

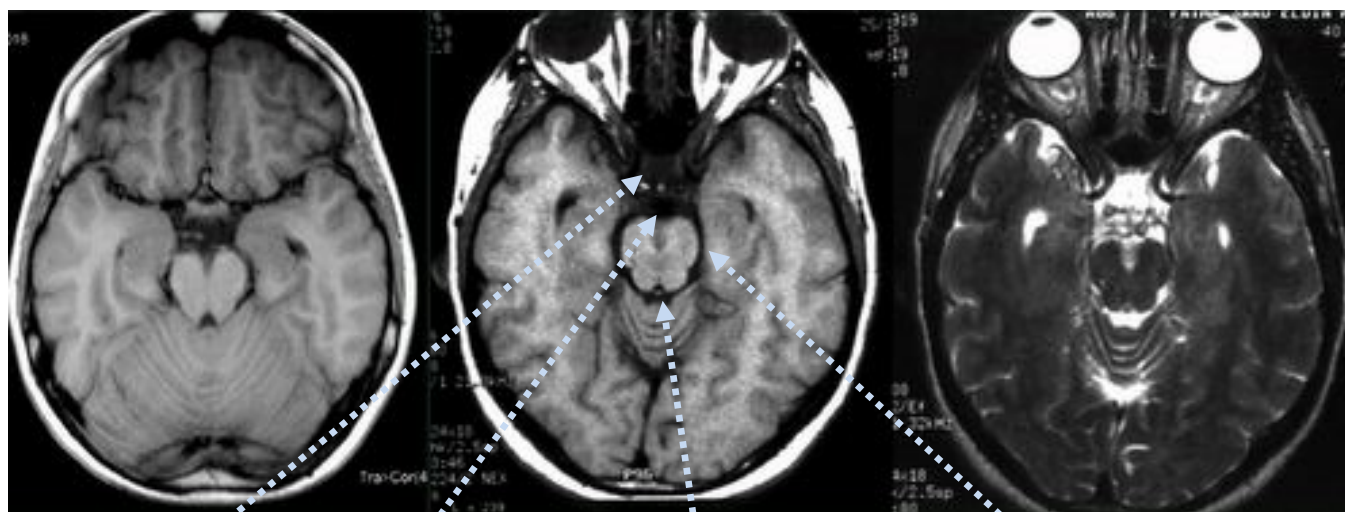
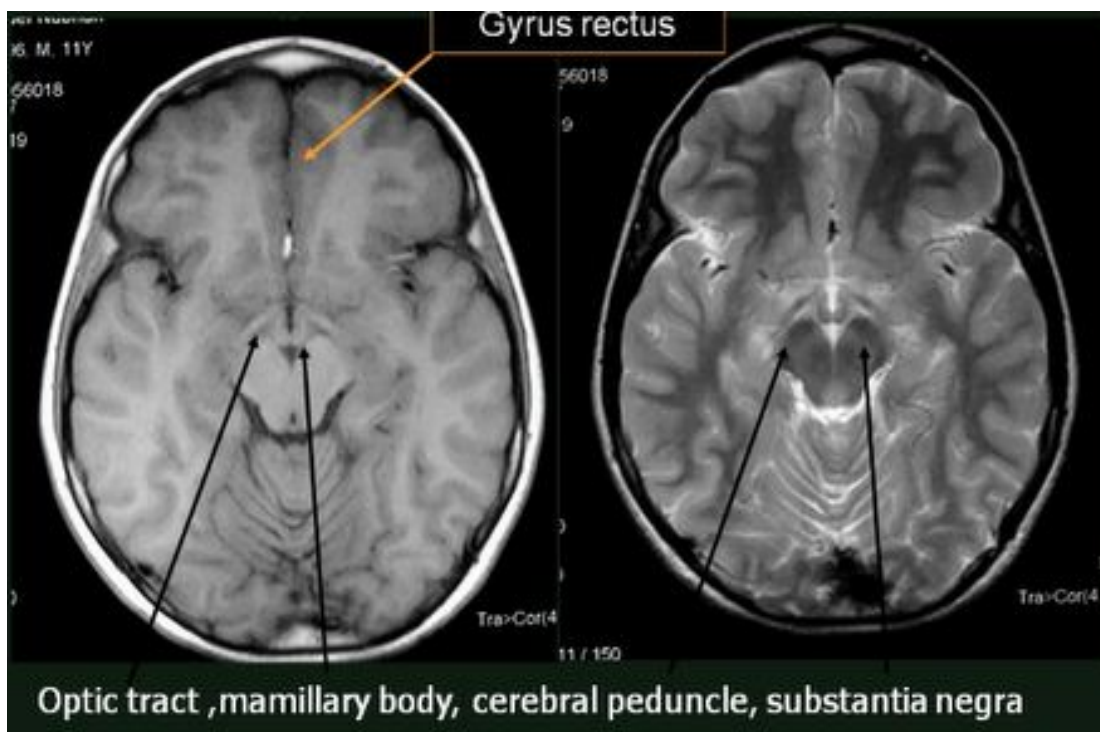
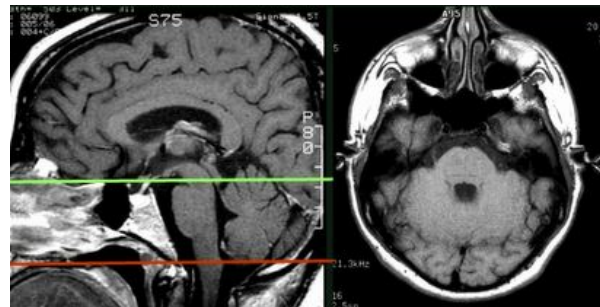
- Gadolinium-DTPA, 0.1 : 0.2 ml/kg body weight
- Gadolinium attached to DTPA because gadolinium alone is toxic
- Used to:
 - 1- Differentiate SOL**
 - 2- Assess activity of MS plaques**
 - 3- Assess post-operative tumor recurrence**

The usual MRI Protocol includes:

- Axial T1, T2, FLAIR
- Sagittal T1

Soma important anatomical differences between MRI and CT:

- **The scan line in scanogram is horizontal** so in post fossa cuts part of occipital lobe appears with the cerebellum
- **Some fine details around the midbrain:**
 - Inter-peduncular cistern
 - Mamillary body in the inter-peduncular cistern
 - Optic tract above the mamillary body
 - Cerebral peduncles and substantia nigra

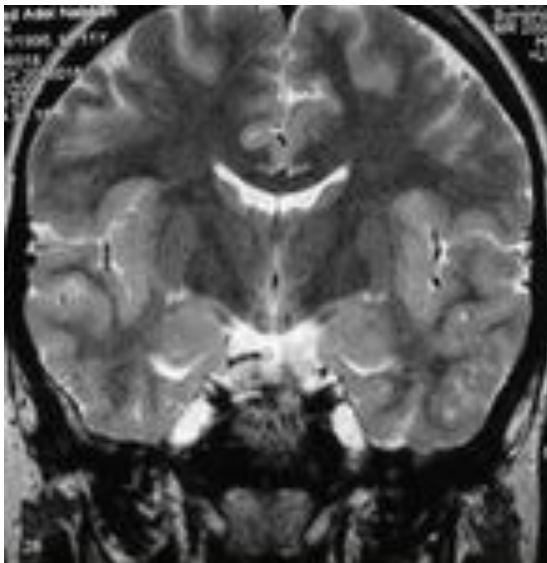


Suprasellar cistern - Interpeduncular cistern - Quadrigeminal cistern - Circum-mesencephalic cistern

- ***The Trigeminal nerve*** appears well in MRI in the ambient cistern in T1 Weighted image.



- ***Hippocampal formation:*** (Best seen in the coronal section)

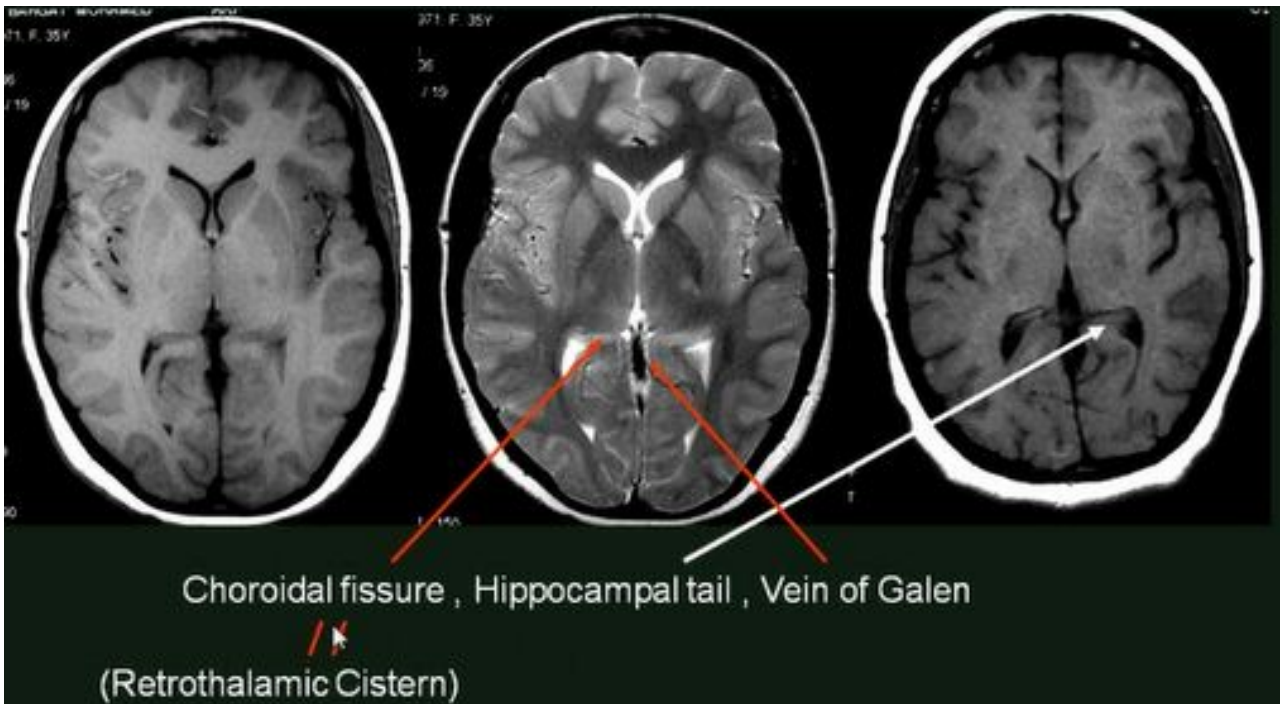


Normal Hippocampus

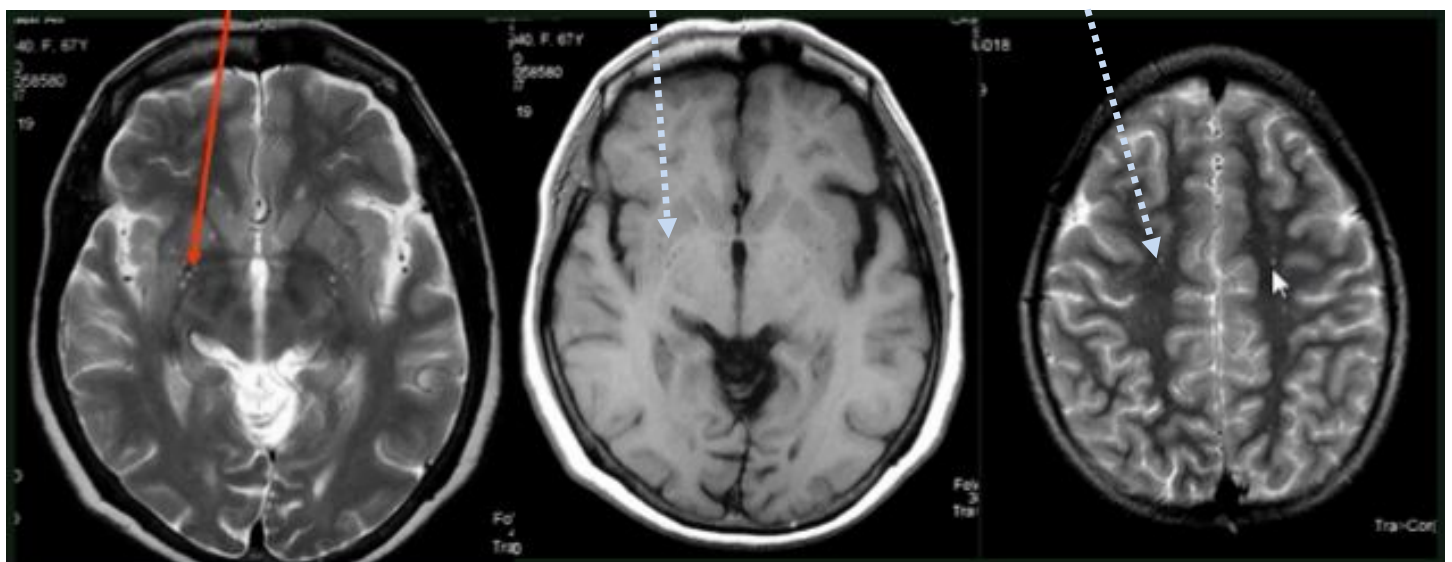


Mesial temporal sclerosis with high SI
In the Hippocampus

- **Some details in the quadrigeminal cistern:**
 - Vein of Galen
 - Choroidal fissure
 - Pineal body don't appear in MRI due to calcifications

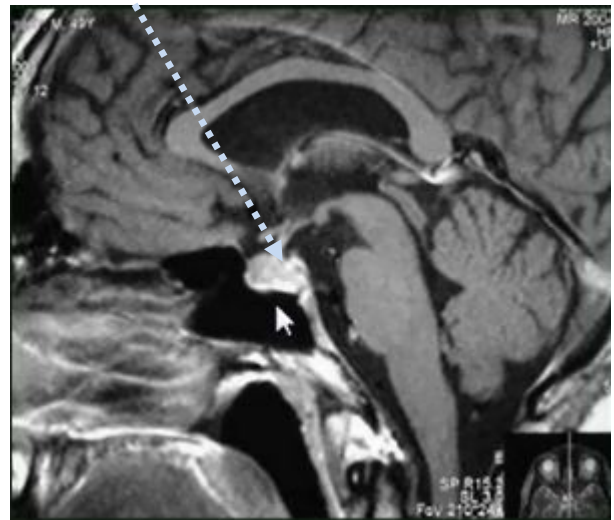


- **Virchow-Robben's spaces** "dilated perivascular spaces"
 - They are CSF around the course of the vessels
 - Usually misinterpreted as lacunar infarcts or MS plaques
 - Seen mainly in basal ganglia and high parietal
 - To differentiate: - they can be seen in T1 WIs, not seen in FLAIR, in anatomical sites, with no clinical correlation



Value of sagittal MRI images:

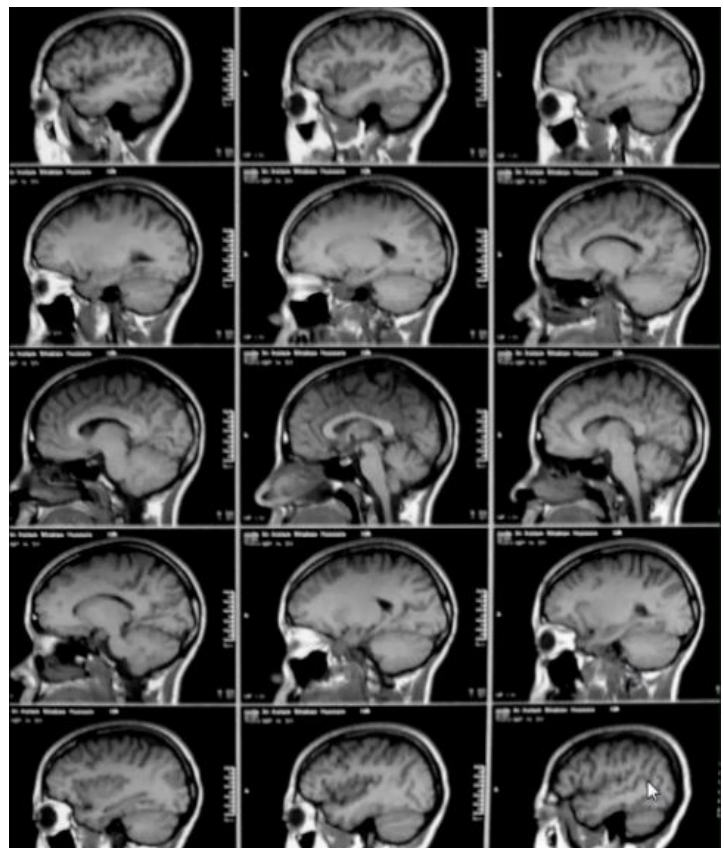
- Anatomical localization (lobes)
- **Corpus callosum** delineation (rostrum, genu, body, splenium)
- Evaluation of **venous sinuses**
- **Craniocervical junction**
- **Pituitary gland** (but coronal cuts are much better), and differentiate ant. from post. Pituitary (post. Pituitary is posterior and contain more fat so appear more bright)



How to know left from right in sagittal sections:

- MRI cuts the body from left to right, so:

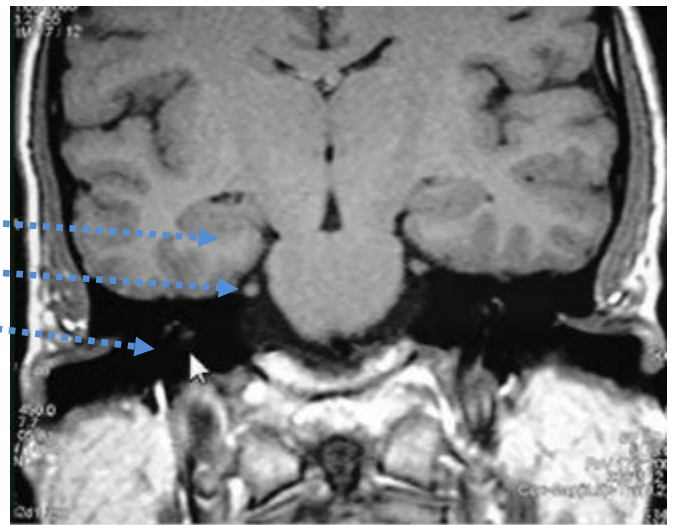
Left



Right

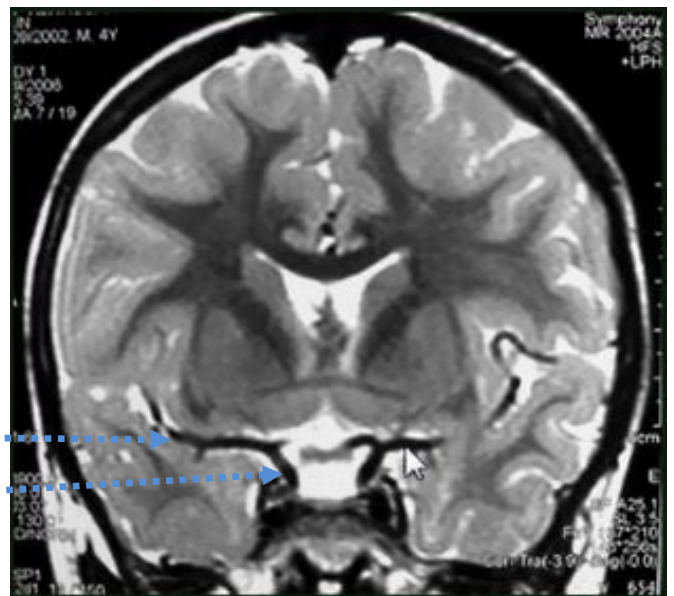
Value of coronal section in MRI:

- Pituitary gland , Chiasma and hypothalamus
- Hippocampal region
- Trigeminal nerve
- Post. Fossa and Skull base
- Vascular anatomy



Middle Cerebral

Internal Carotid



Cerebro-Vascular lesions

CT density:

Normal brain parenchyma: 30:40 HU

Hypodense lesions:

- CSF 0:15
- Edema 20
- Infarction 25
- Fat -10 : -150
- Air -200

Hyperdense lesions:

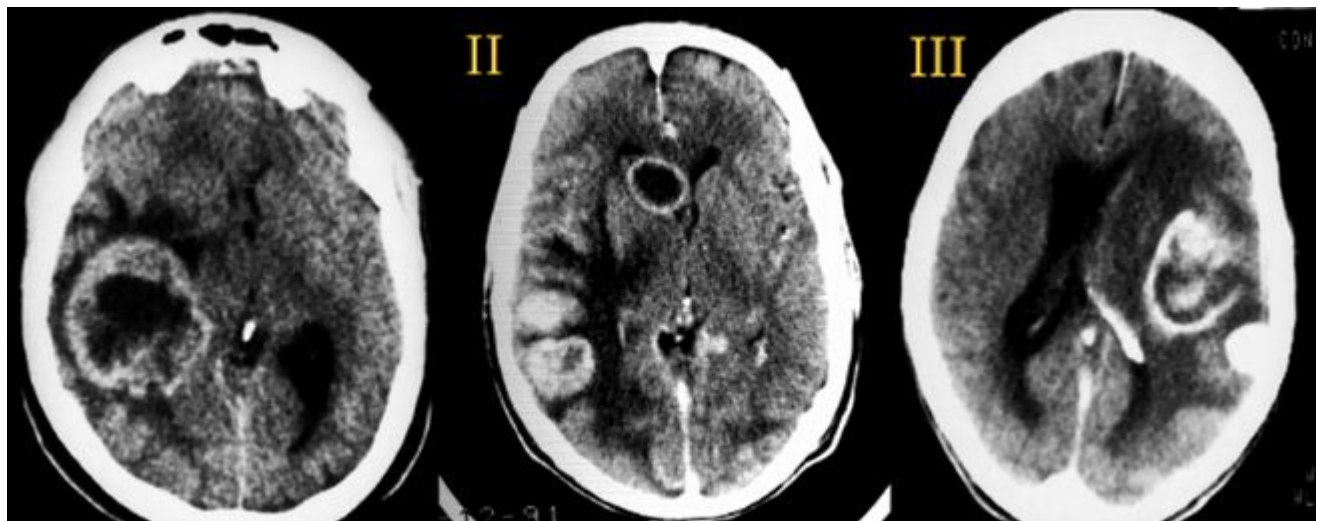
- Hemorrhage 60:90
- Calcification > 100
- Some tumors
- Fluids with high protein contents

Types of brain edema:

- **Cytotoxic edema:** caused by infarction or hemorrhage as a rim around the lesion
- **Vasogenic edema:** caused by SOL as a finger like edema
- **Periventricular "Hydrostatic" edema:** caused by obst. Hydrocephalus as a retrograde transependymal permeation

Grades of vasogenic edema:

- **Grade I:** < 2 cm around the lesion
- **Grade II:** > 2 cm but less than half the cerebral hemisphere
- **Grade III:** more than half the cerebral hemisphere



Contrast Enhancement:

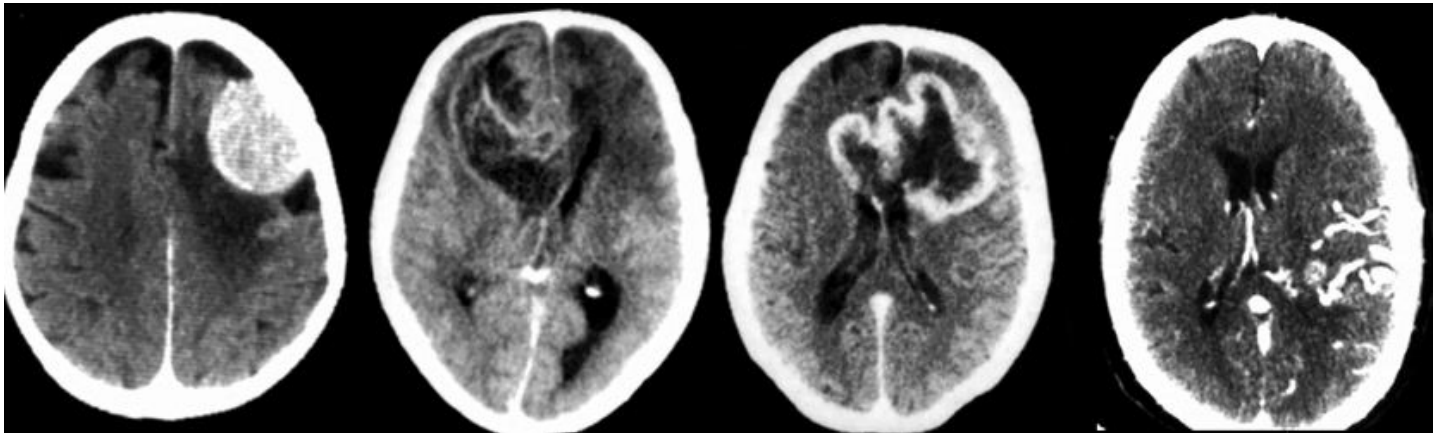
Lesions after contrast enhancement are either:

Non Enhanced Lesions

Enhanced lesions: show contrast uptake (appear whiter)

Pattern of enhancement either:

- **Homogenous**
- **Heterogenous**
- **Ring**
- **Serpiginous**



Homogenous

Heterogenous

Ring

Serpiginous

Mass effect of intracranial lesions:

- Effacement of cortical sulci (earliest sign)
- compression of the ventricle
- Shift of midline structures to contralateral side

Intracranial hemorrhage

Appearance in CT:

- Acute hematoma → hyperdense
- Subacute hematoma → isodense
- Chronic hematoma → hypodense

Anatomical localization:

Extra-axial:

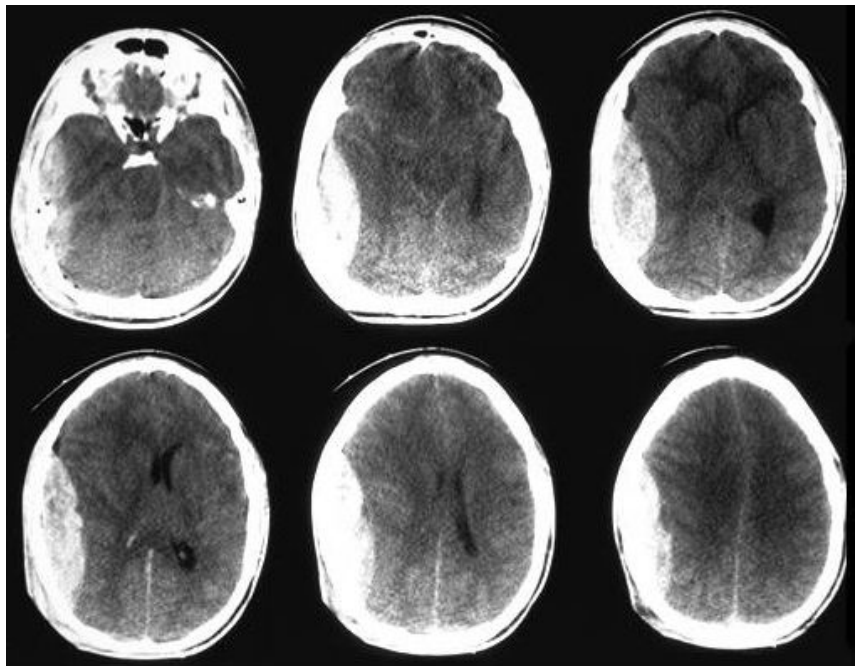
- Epidural
- Subdural
- Subarachnoid

Intra-axial:

- Intracerebral
- Intraventricular

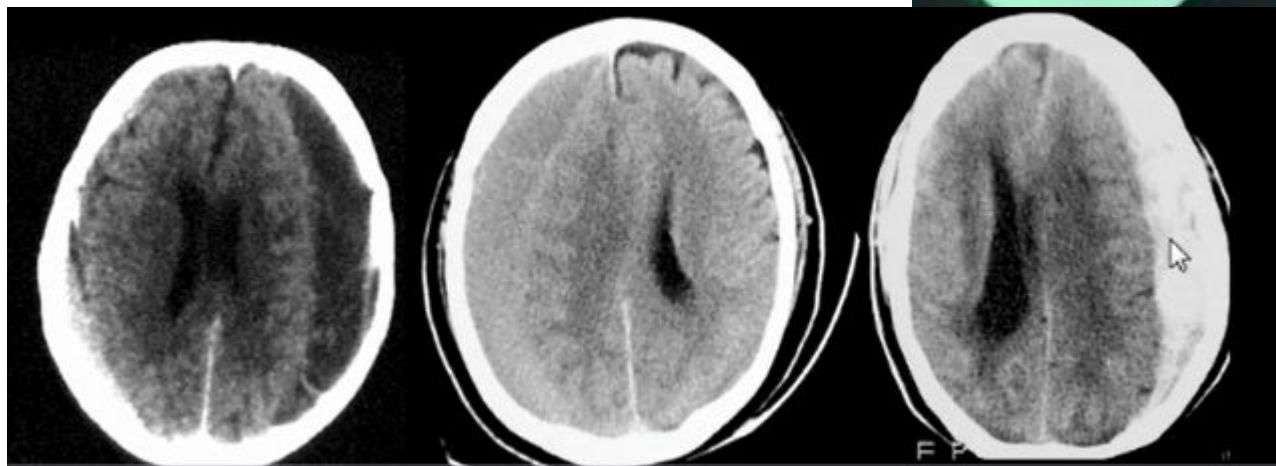
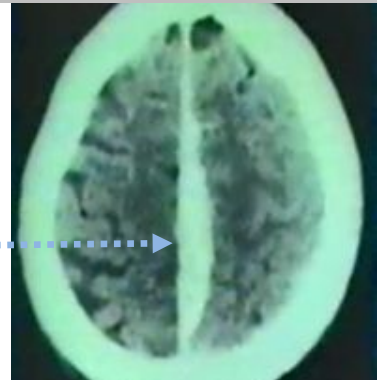
1) Epidural hematoma:

- ✓ Convex inner margin
- ✓ Can cross midline
- ✓ Almost always acute
- ✓ Post traumatic



2) Subdural hematoma:

- ✓ Concave inner margin
- ✓ Can't cross midline
- ✓ History of minor trauma
- ✓ Acute, subacute or chronic
- ✓ Can occur in interhemispheric fissure

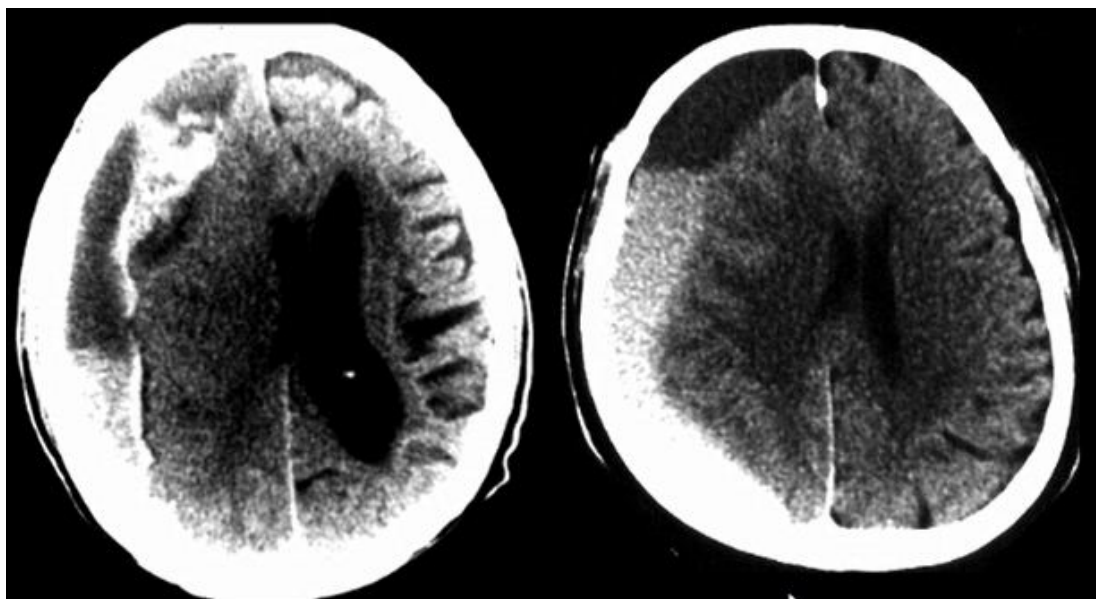


Chronic SDH

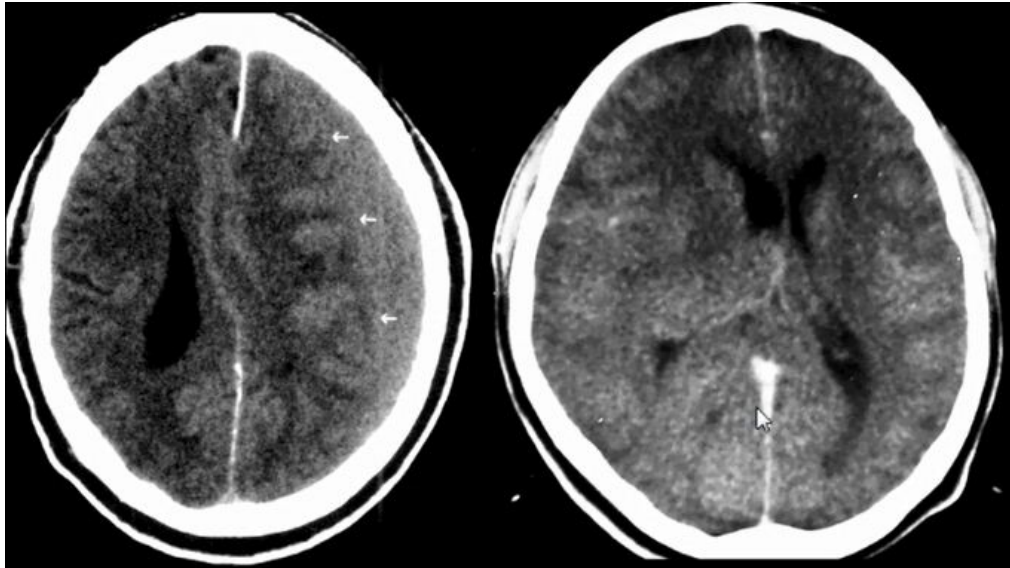
Subacute SDH

Acute SDH

- When Subdural hematoma show **sedimentation** it's called **Subacute**
- When subdural hematoma show **rebleeding** it's called **Subacute**



How to differentiate between subacute subdural hematoma and infiltrating glioma



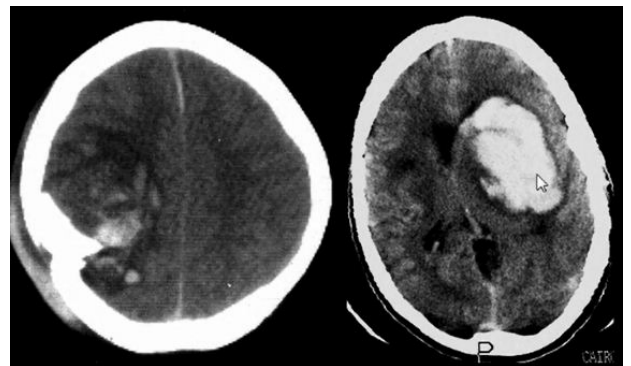
Subacute subdural hematoma compressing the ventricle with **preserved grey-white matter interface**

Infiltrating glioma with **destroyed grey-white matter interface**

3) Intracerebral Hematoma

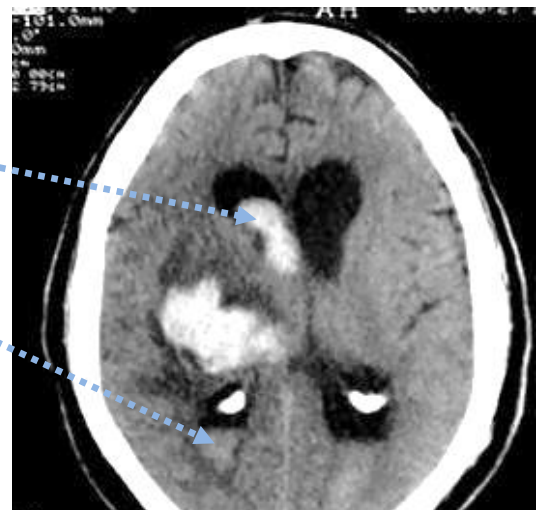
Types of intracerebral hematoma:

- ✓ Hemorrhagic contusion: if 2ry to trauma
- ✓ Spontaneous ICH



ICH may show intraventricular extension which may be:

- ✓ **Subependymal blood** in the vent. wall
- ✓ **Free intraventricular blood**

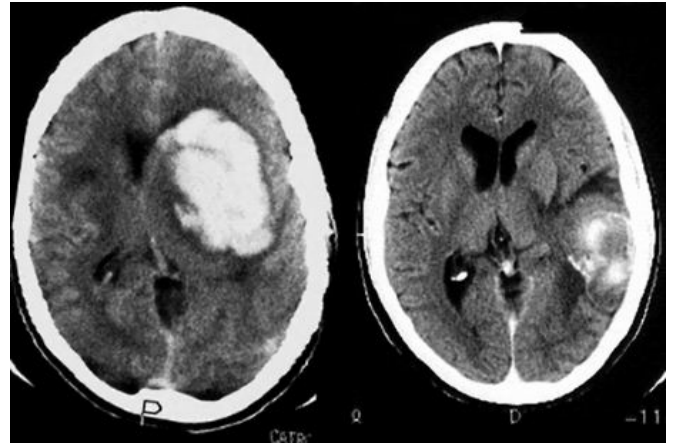


Hemorrhagic tumors:

- ✓ **Metastasis** **38%**
- ✓ **Gliomas** **35%**
- ✓ Meningiomas 14%
- ✓ Adenomas 9%
- ✓ Neuromas 2%

How to differentiate between spontaneous ICH and hemorrhagic tumor:

- ✓ ICH associated with thin rim of edema
- ✓ Tumor associated with vasogenic fingerlike edema



Aging of intracerebral hematoma in MRI

Acute blood: Hypointense in both T1 & T2	Grey – Black	(deoxy Hb)
Subacute blood: Hyperintense in both T1 & T2	White – White	(Met-Hb)
Chronic blood: Hypointense in both T1 & T2	Black – Black	(Hemosiderin)

- ✓ When you see hyperintense lesion in T1 suspect Blood
- ✓ Perifocal edema appear as Hyperintense in T2, but don't appear in T1
- ✓ Blood start aging from periphery to inside (subacute blood start appearing in the outer part)
- ✓ More detailing in blood aging includes:

Subdivision of subacute blood into:

Early Subacute: Hyperintense in T1 & Hypointense in T2 White – Black

Late Subacute: Hyperintense in both T1 & T2 White – White

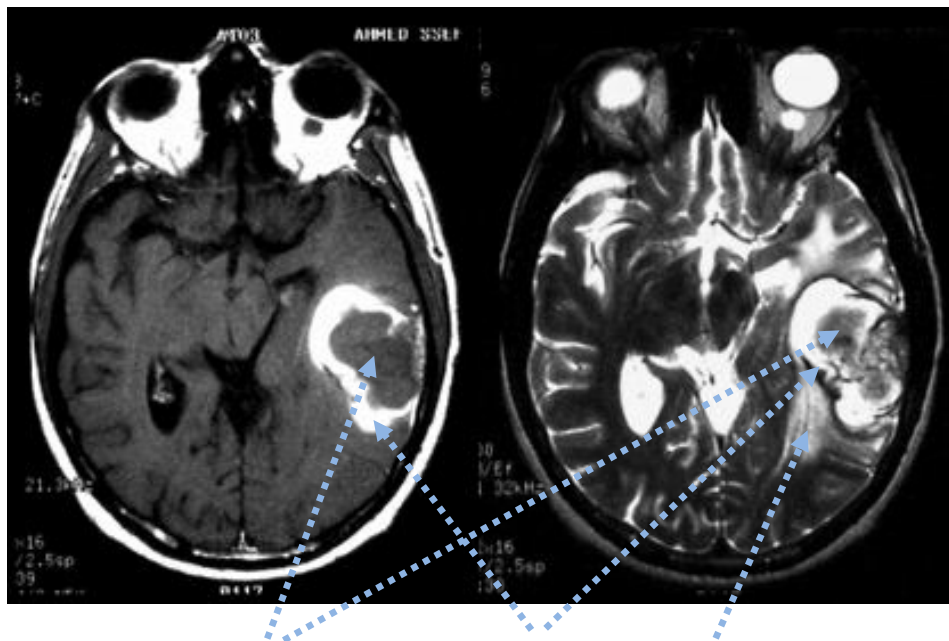
(Remember that Blood colors grade from acute to subacute in MRI, so the Grey color of acute blood in T1 becomes white first in Early subacute stage while T2 still black, then blood in T2 also become whitish in late subacute stage, so Both T1 & T2 are white in late subacute)

Another two stages where blood looks like CSF in T1 & T2:

Hyperacute: Hypointense in T1 & Hyperintense in T2 Black - White

Long standing: Hypointense in T1 & Hyperintense in T2 Black - White

الدم عمره ما يبقى فيه الا في الاتنين دول, الجديد أوي و القديم أوي



Acute blood – Subacute blood – Edema

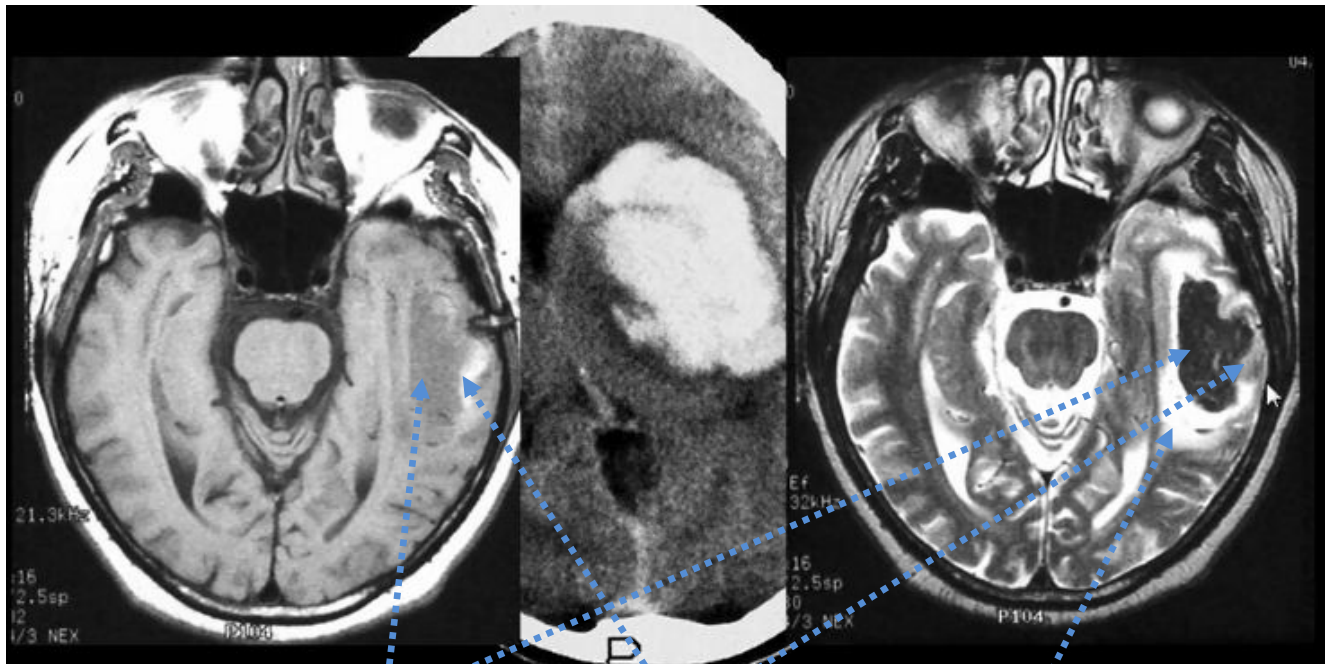
Aging of Cerebral Hematoma

Blood age	T1	T2
Hyperacute (<24 hours)		
Acute (0:3 days)		
Early Subacute (3:7 days)		
Late Subacute (7:14 days)		
Chronic (> 14 days)		
Very old (> 1 year)		

Phase	Time	Hemoglobin, Location	Appearance	
			T1-Weighted MRI	T2-Weighted MRI
Hyperacute	<24 h	Oxyhemoglobin, intracellular	Hypointense	Hyperintense
Acute	1-3 d	Deoxyhemoglobin, intracellular	Hypointense	Hypointense
Early subacute	>3 d	Methemoglobin, intracellular	Hyperintense	Hypointense
Late subacute	>7 d	Methemoglobin, extracellular	Hyperintense	Hyperintense
Chronic	>14 d	Ferritin and hemosiderin, extracellular	Hypointense	Hypointense

1) Acute Hematoma:

Low signal in T1, more low signal in T2



Acute blood – Early small Subacute blood - Edema

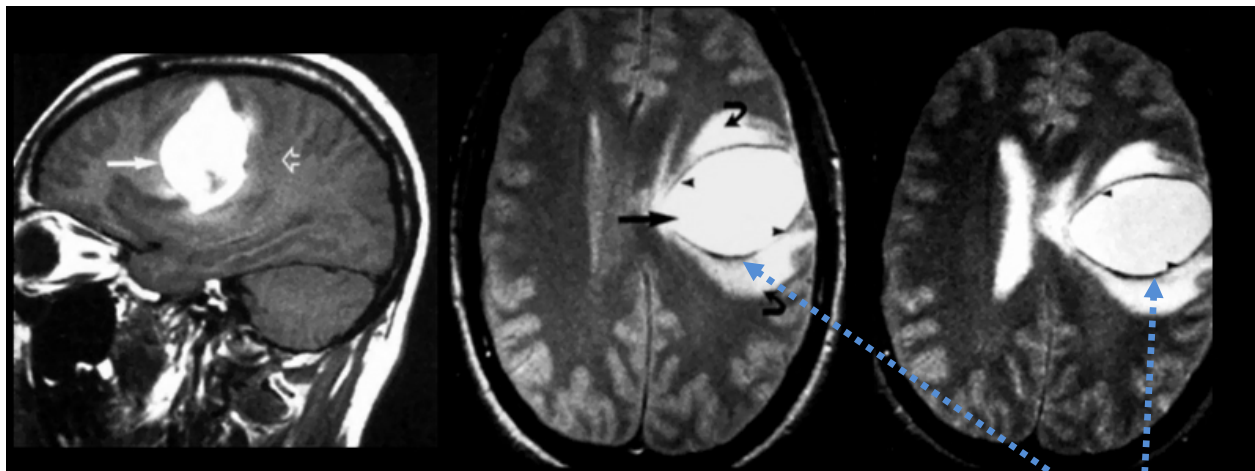
Acute blood has low signal in T1 (grey), more low signal in T2 (black)

Early subacute blood has High signal I T1 (white), but still low signal in T2 (grey)

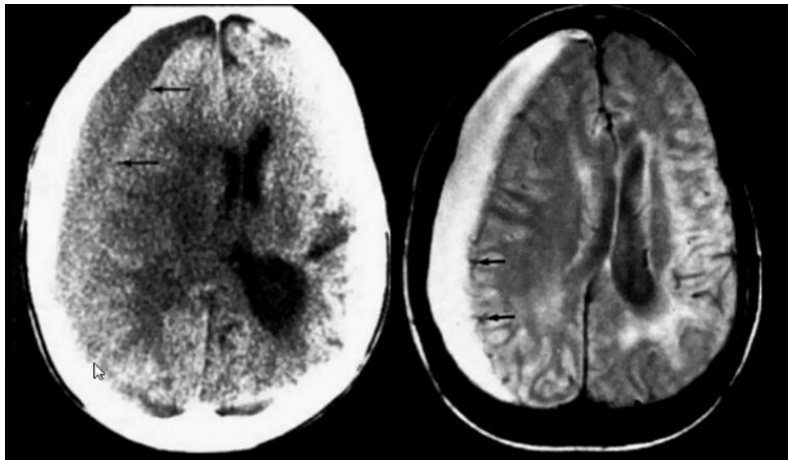
Edema appears only on T2 as hyperintense (white)

2) Subacute Hematoma:

High signal in T1 – High signal in T2

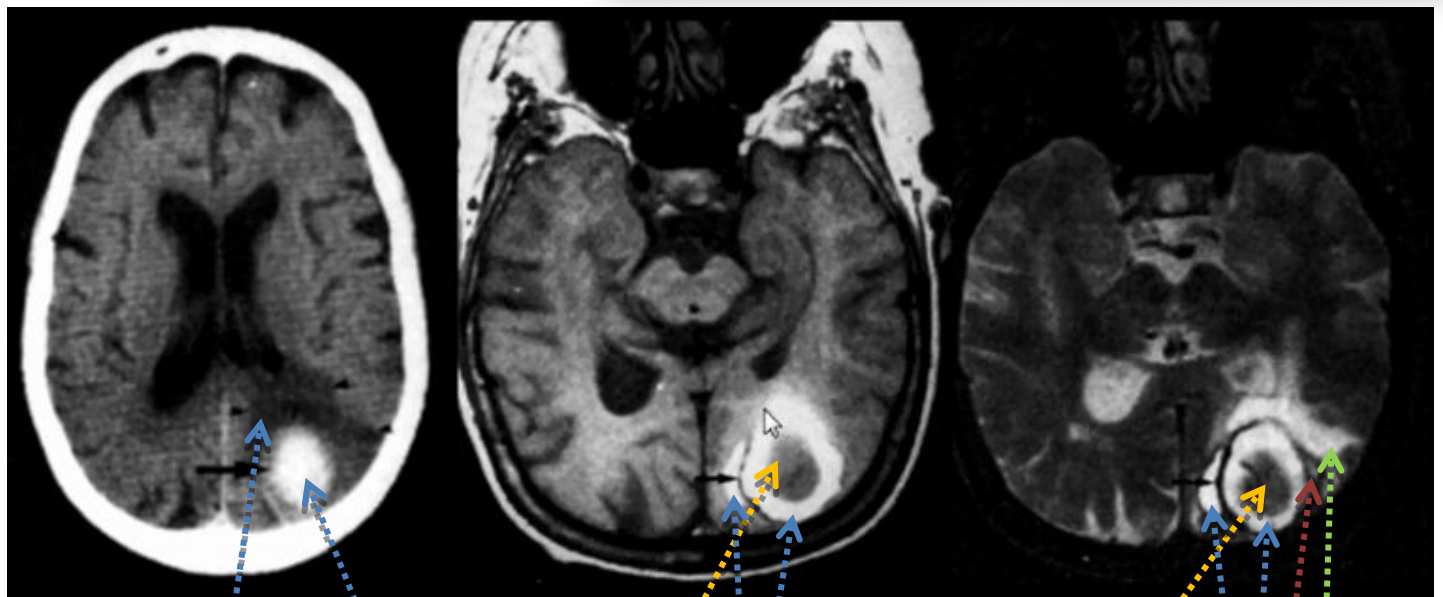
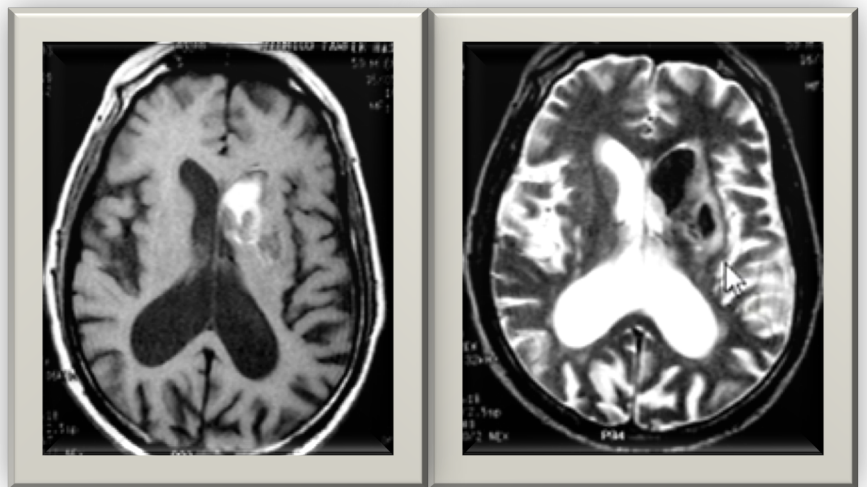


Subacute blood appears as white in sagittal T1, Proton density and in T2, surrounded by hemosiderin rim



Subacute subdural hematoma appear with sedimentation in CT, while appears totally white in MRI

Early subacute intracerebral hematoma appears **white** in T1 and **Black** in T2



CT brain showing:
Perifocal Edema
Acute intracerebral hematoma

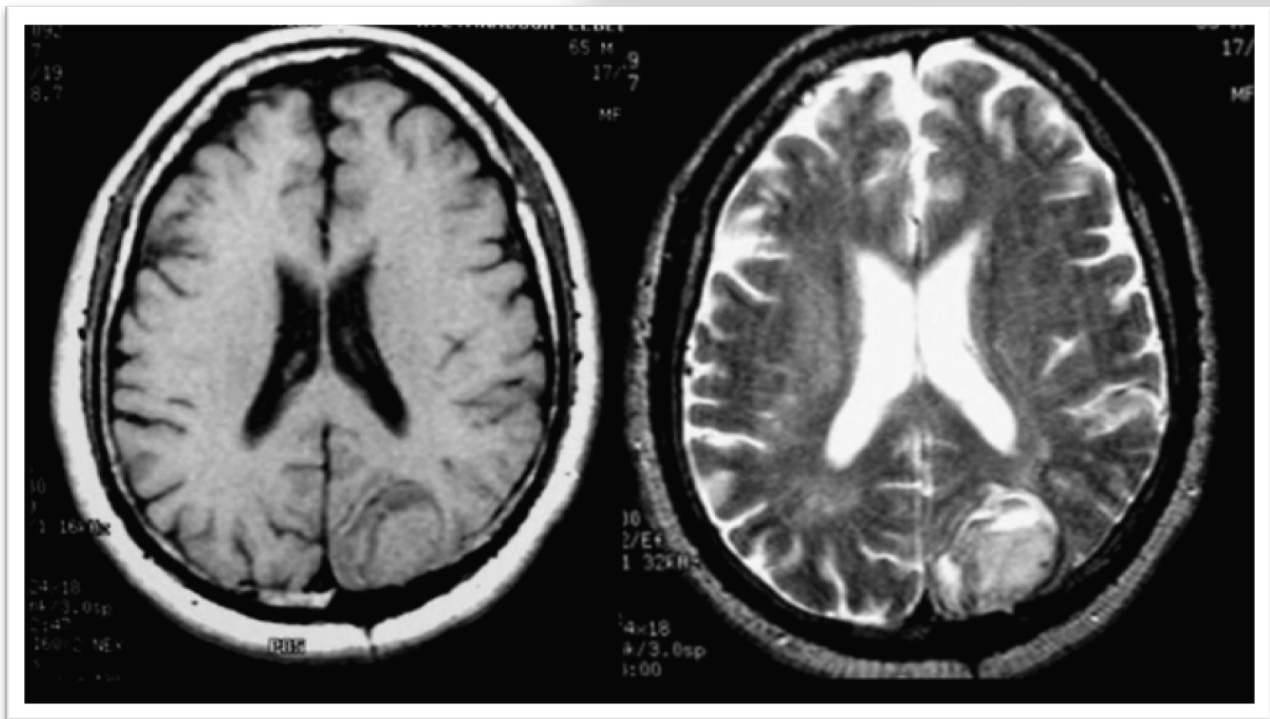
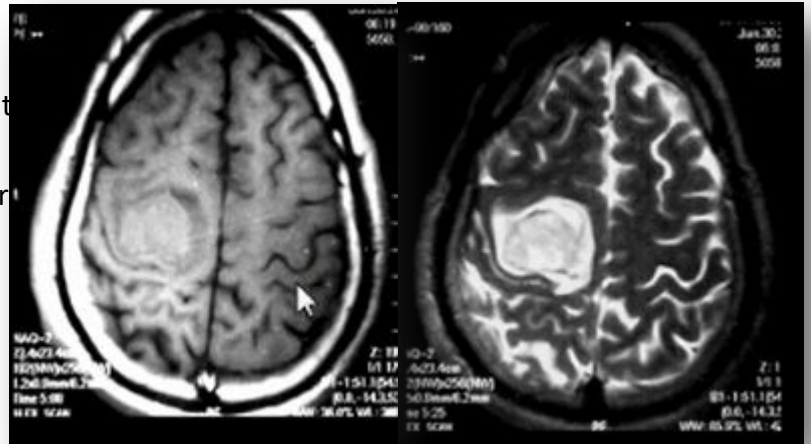
Axial T1 MRI showing:
Acute blood
Subacute blood

Axial T2 MRI showing:
Acute blood
Subacute blood
Hemosiderin

3) Hyperacute and Long standing Hematoma:

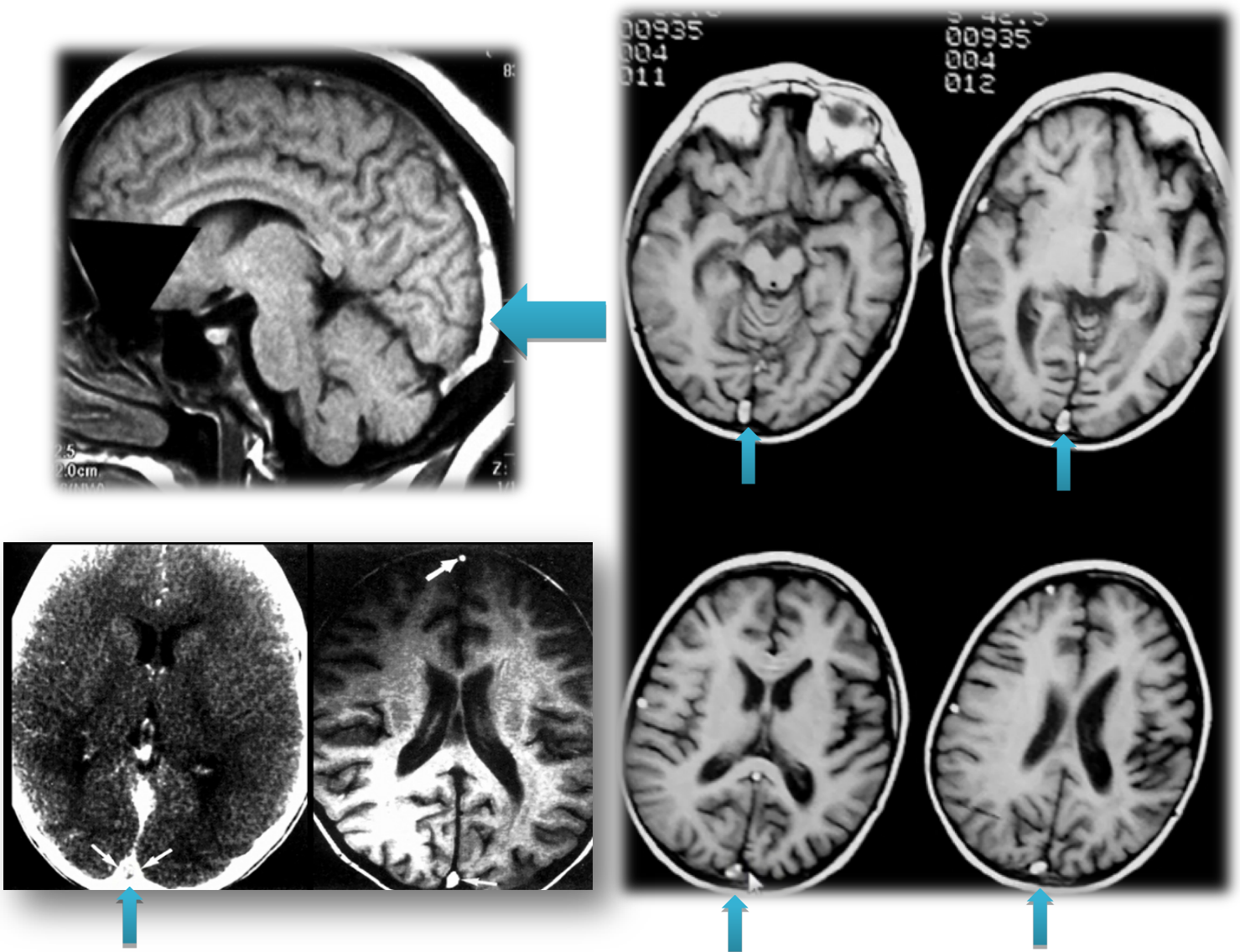
Low signal in T1 - High signal in T2

Hematoma appears in the very early and very late stage as hypointense (grey or black) in T1 and hyperintense (white) in T2, resembling most tumors making it difficult to differentiate hematoma in this stage from tumor except after contrast injection, so MRI is not the first choice in acute insults.

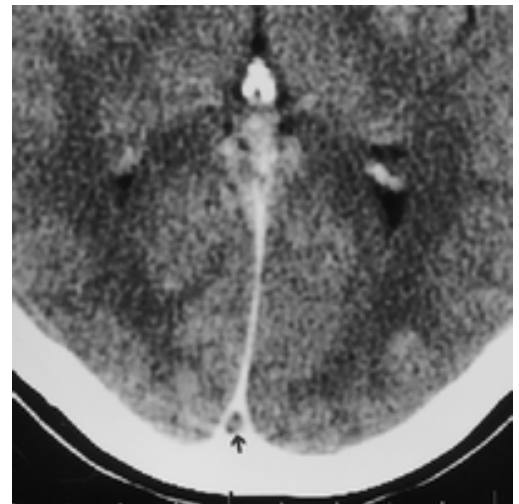
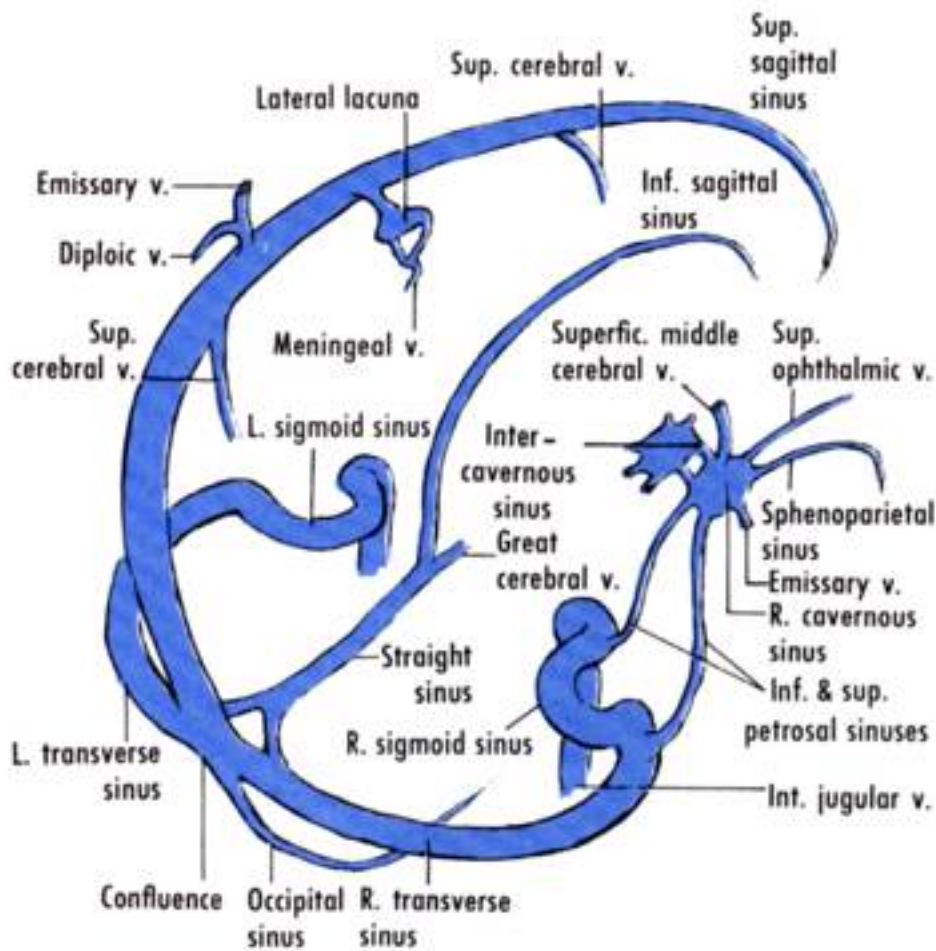


Dural Sinus thrombosis:

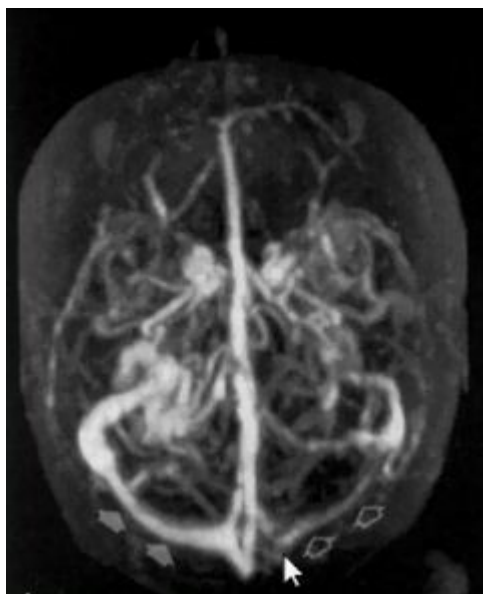
- ✓ Normally blood vessels and sinuses appear hypointense due to signal void (rapidly moving protons)
- ✓ Sometimes, normal sinus appears hyperintense in T1 only due to slow flow in sinuses, but never normal sinus appears white in T2.
- ✓ In usual MRI brain (not MRV) thrombus do not appear except in the **subacute stage**, where it appears white in both T1 & T2, while if acute or chronic it will appear of low signal (black) as normal sinuses.
- ✓ **To diagnose Sinus thrombosis, the sinus must appear hyperintense (white) in T1 and T2 and recurrent in different sections of the same sinus.**



Empty Delta sign: when the thrombus inside the sinus appear in CT.



Empty Delta sign: a thrombus appears hypodense in the superior sagittal sinus.



The transverse sinuses are usually asymmetrical, meaning that one is wide and

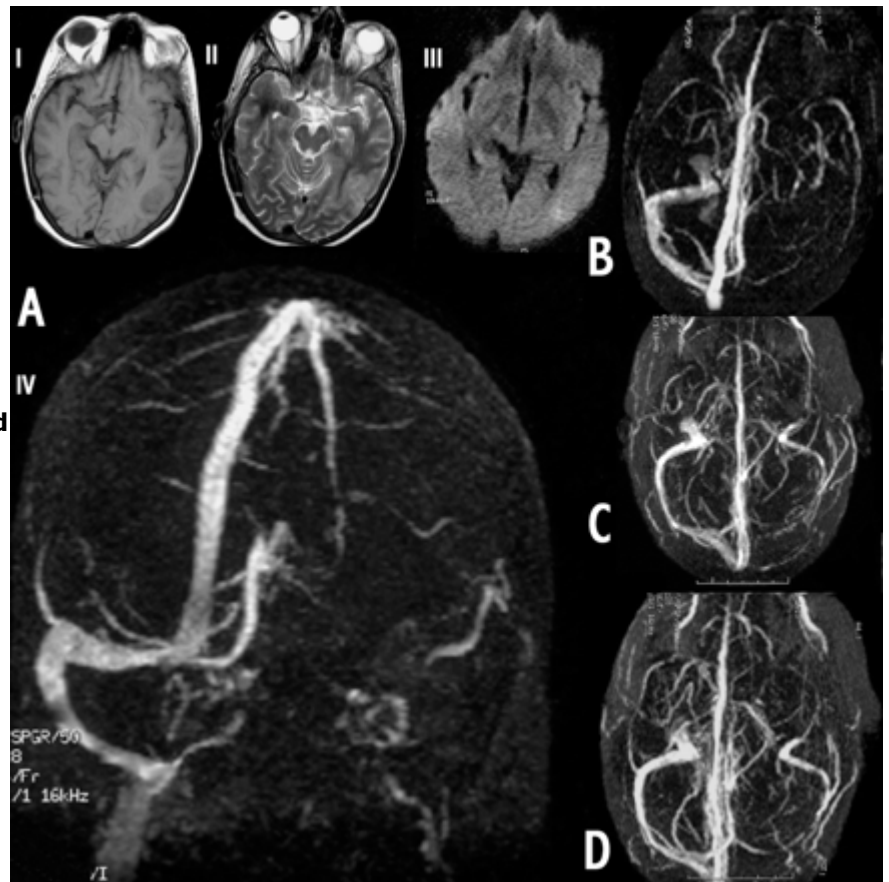


A noncontrast CT image located demonstrates

the other is narrow, which is usually misinterpreted in reports as sinus thrombosis.

thrombus (arrows) extending along the course of the right transverse sinus.

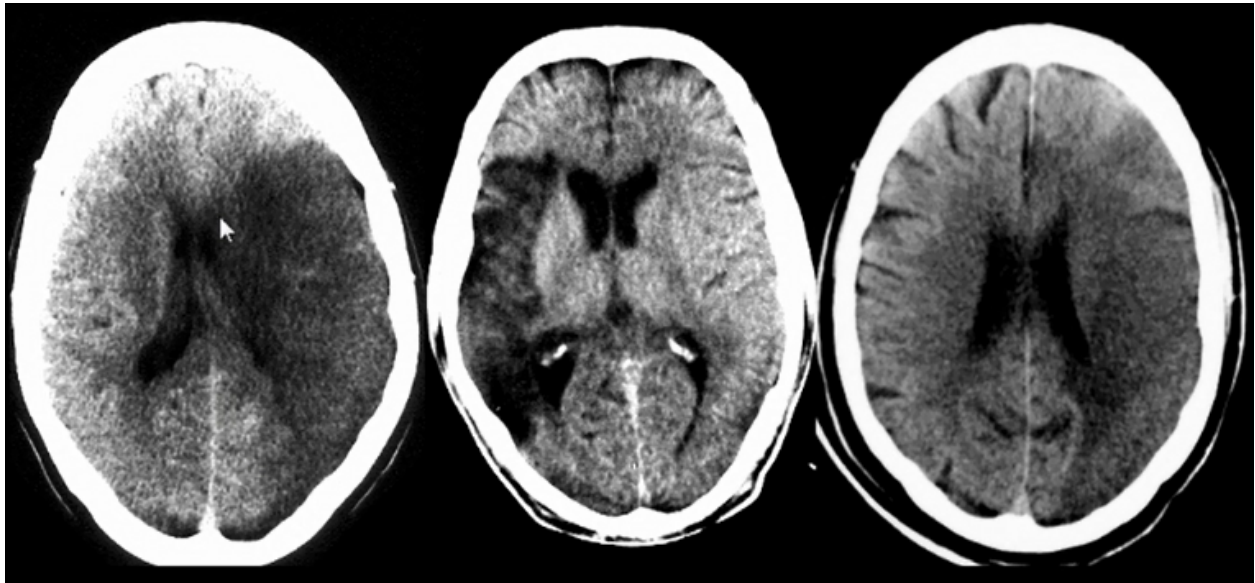
A case of transverse sinus thrombosis without recanalization. A, MRI on admission. I, T1-weighted sequence with left temporal hypointensity. II, Left temporal signal hyperintensity on T2-weighted sequence. III, Slight diffusion abnormality on diffusion-weighted imaging. IV, MR angiography with left-sided transverse sinus thrombosis. MR angiographies on days 20 (B), 150 (C), and 382 (D) without recanalization of the occluded transverse sinus.



Ischemia

- ✓ A hypodense lesion
- ✓ Has vascular territory
- ✓ Has cortical distribution
- ✓ May be Acute, subacute or chronic

How to differentiate between Acute, subacute and chronic Infarction:



Acute Infarction

Associated with brain edema that causes mass effect in the form of effacement of the ventricle or even midline shift.

Chronic Infarction

Undergone liquefaction and necrosis leading to traction and dilatation of the ventricle.

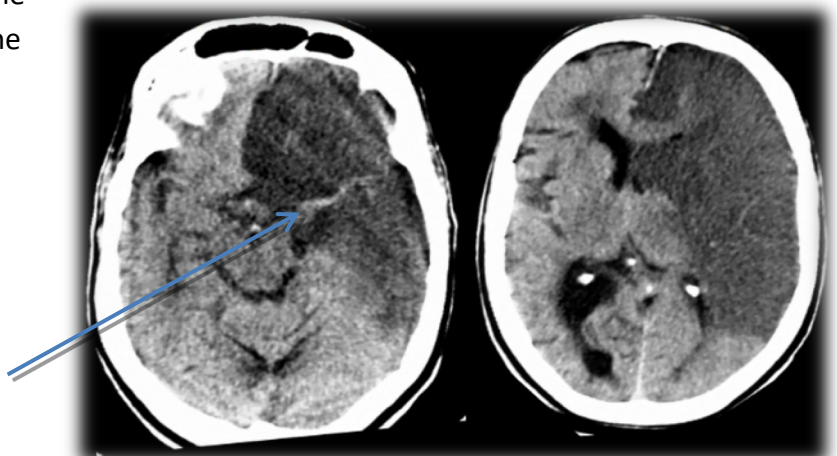
Subacute Infarction

Has no effect on the ventricle.

Hyperdense Vessel Sign

When the vessel appear hyperdense inside the infarction, which means a thrombus inside the artery.

Thrombosed Middle cerebral artery



Ex-vacuo dilatation:

When an old infarction due to gliosis exerts negative mass effect on the ventricle causing it dilatation.

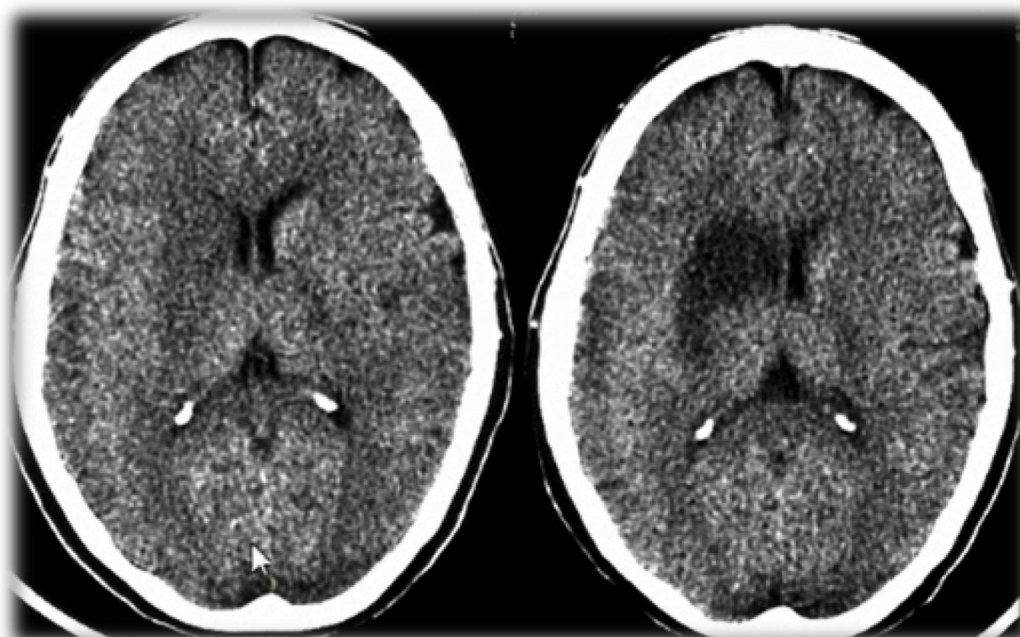
Porencephaly:

Cyst filled with CSF communicating with the ventricular lumen. May be Congenital Primary porencephaly or Secondary due to chronic ischemia, infection, trauma or surgery.



Infarction in Evolution:

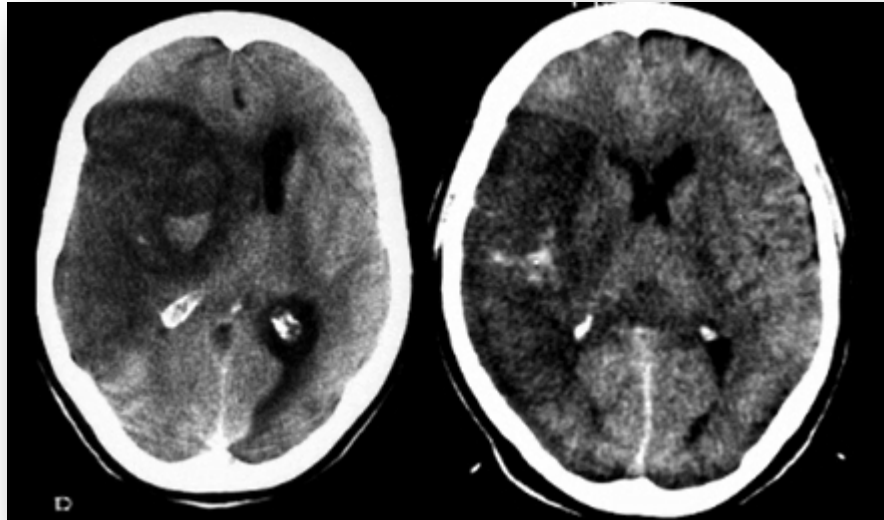
Infarction that has not yet been developed, appear as subtle hypodensity and subtle mass effect. Maximum time an infarction needs to appear in CT is 72 hours, if infarction didn't appear after 72 hours then either there is no infarction or it's a small lacunar infarction.



Infarction in evolution showing subtle effacement on right lateral ventricle and subtle hypodensity

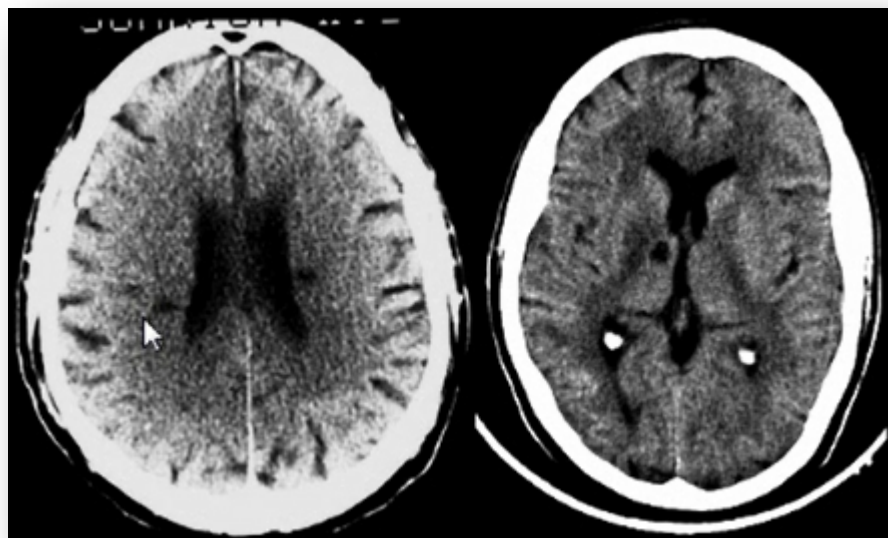
Hemorrhagic Infarction:

- ✓ Infarction with some hemorrhagic foci
- ✓ Main causes include: Venous infarction, Massive infarction and Embolic infarction (due to recanalization of embolus).



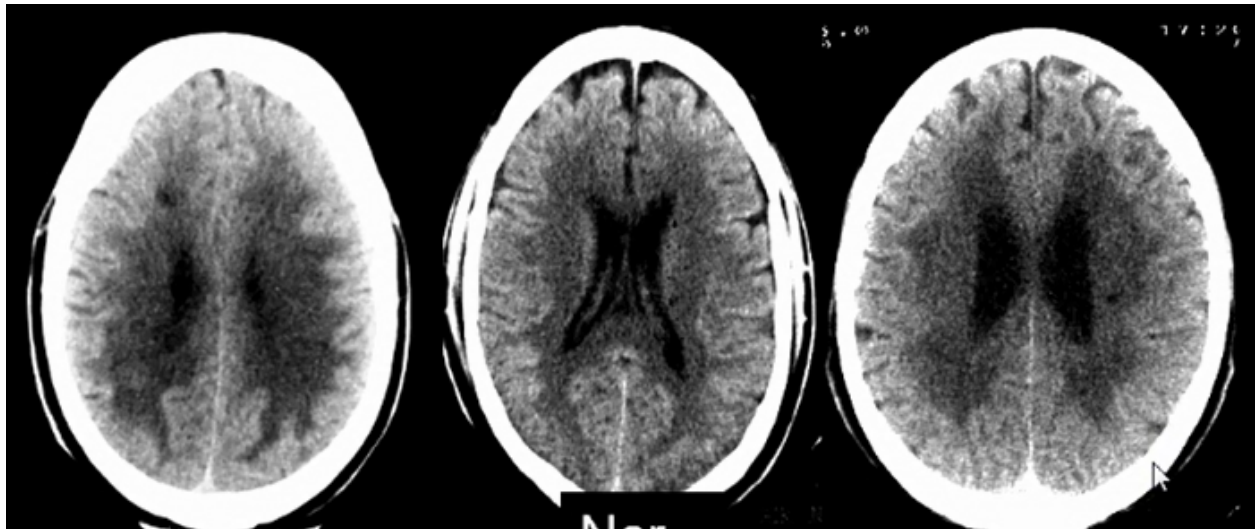
Lacunar Infarction:

- ✓ Infarction less than 1 cm in size
- ✓ It has no mass effect, so we can't differentiate between acute, subacute or chronic with CT, but we can differentiate by using diffusion MRI or FLAIR MRI.



Subcortical Arteriosclerotic Encephalopathy:

- ✓ White matter ischemic changes → diffuse hypodensity
- ✓ In hypertensive and diabetic patients.



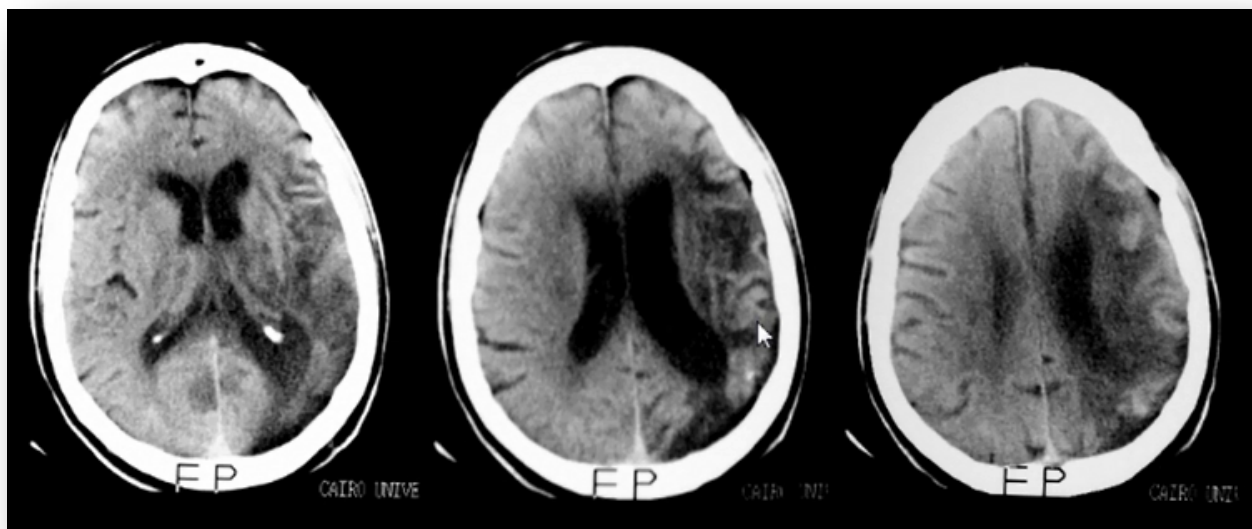
Subcortical Arteriosclerotic Encephalopathy

Normal Brain

Subcortical Arteriosclerotic Encephalopathy

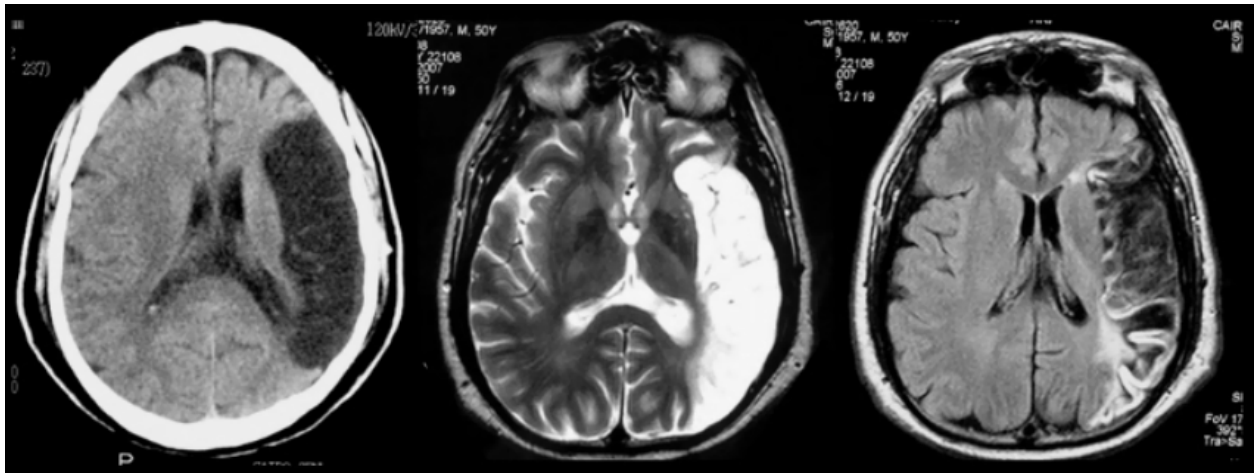
Infarction with Calcification:

- ✓ A very old infarction with hyperdensity inside due to calcium deposition.



Infarction in MRI

Low signal intensity in T1, High signal intensity in T2

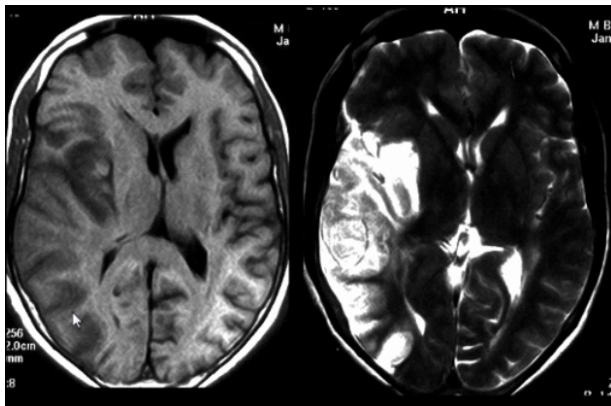


Aging of the infarction in MRI is similar to the CT:

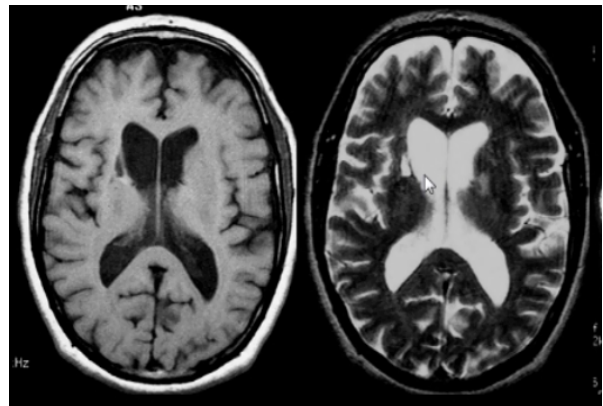
If there is mass effect → Acute infarction

If there is no mass effect → Subacute infarction

If there is traction on ventricle → Chronic infarction



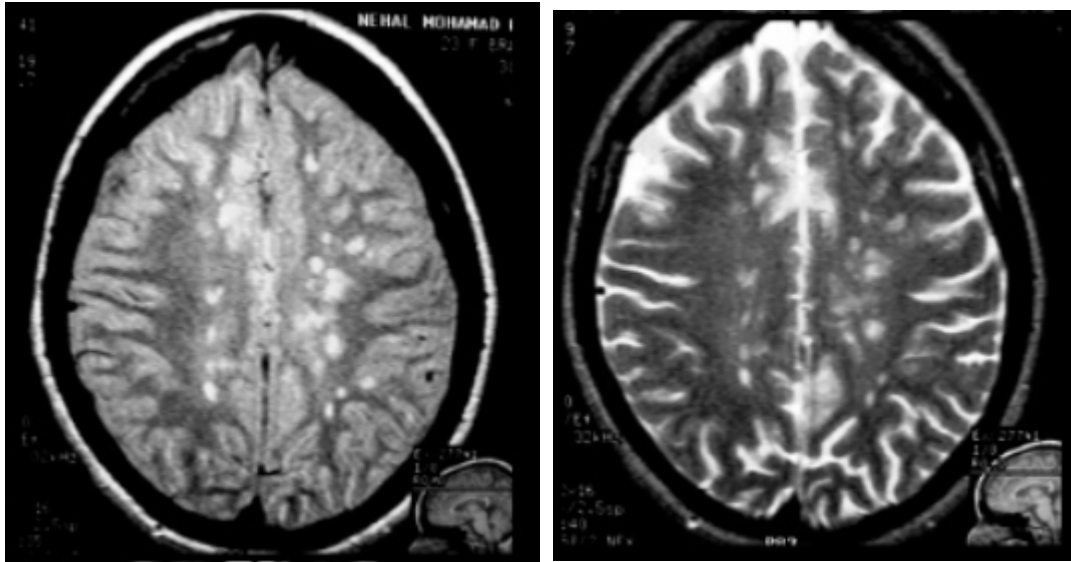
Acute infarction causing a mass effect on the ventricle.



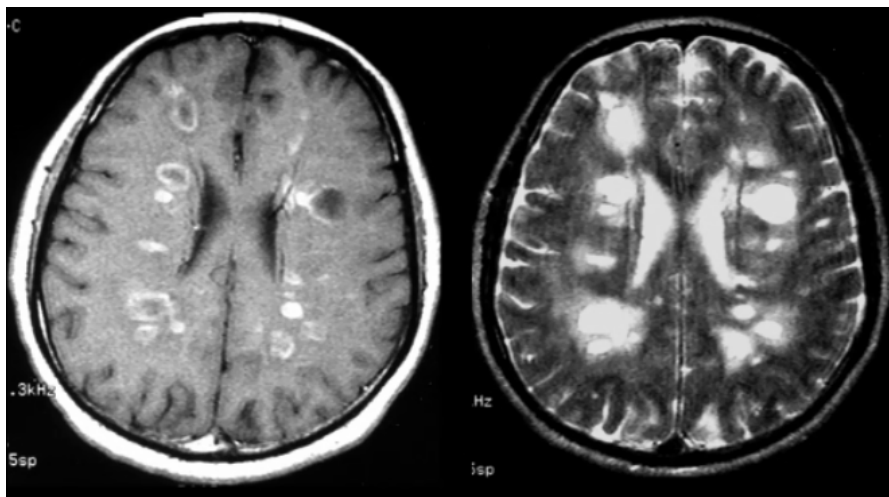
Chronic infarction causing traction on the ventricle.

If there are multiple lacunar infarcts, to differentiate from M.S plaques:

- ✓ MS is a disease of young age
- ✓ Plaques are close to the ventricle
- ✓ Perpendicular to the ventricle
- ✓ High signal intensity in FLAIR
- ✓ Enhancement of active lesions with contrast
- ✓ Clinical picture

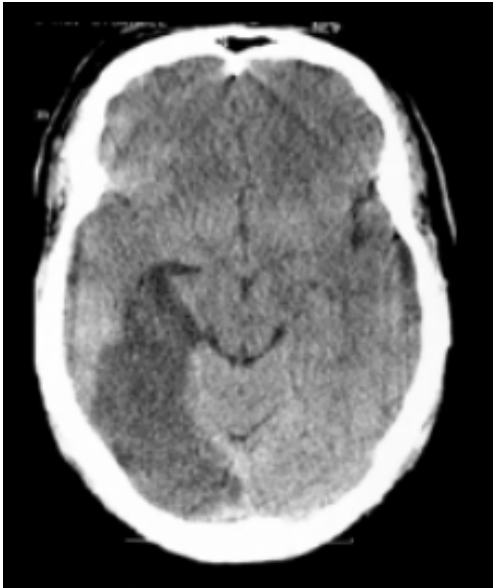


MS plaques before contrast

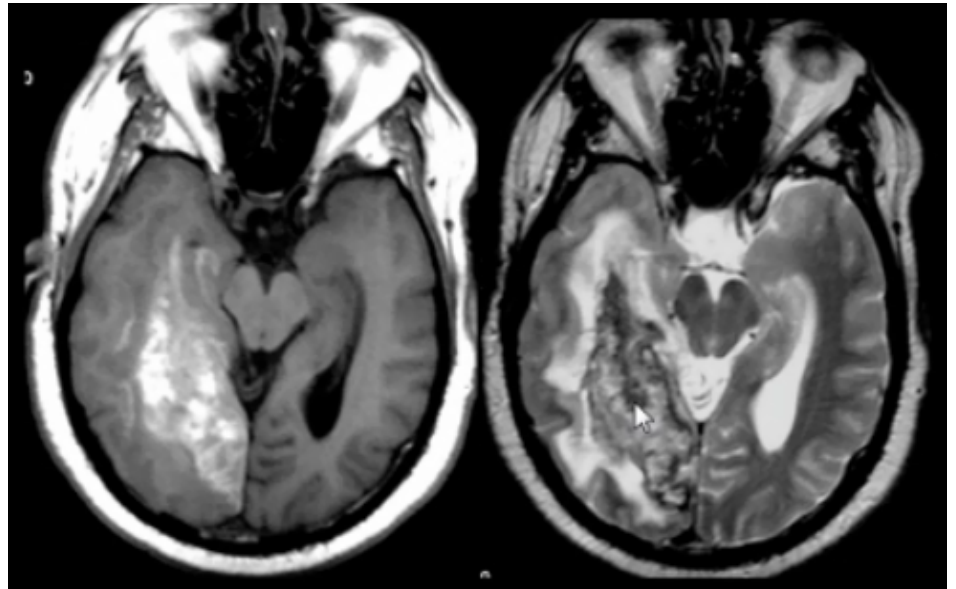


MS plaques after contrast enhancement

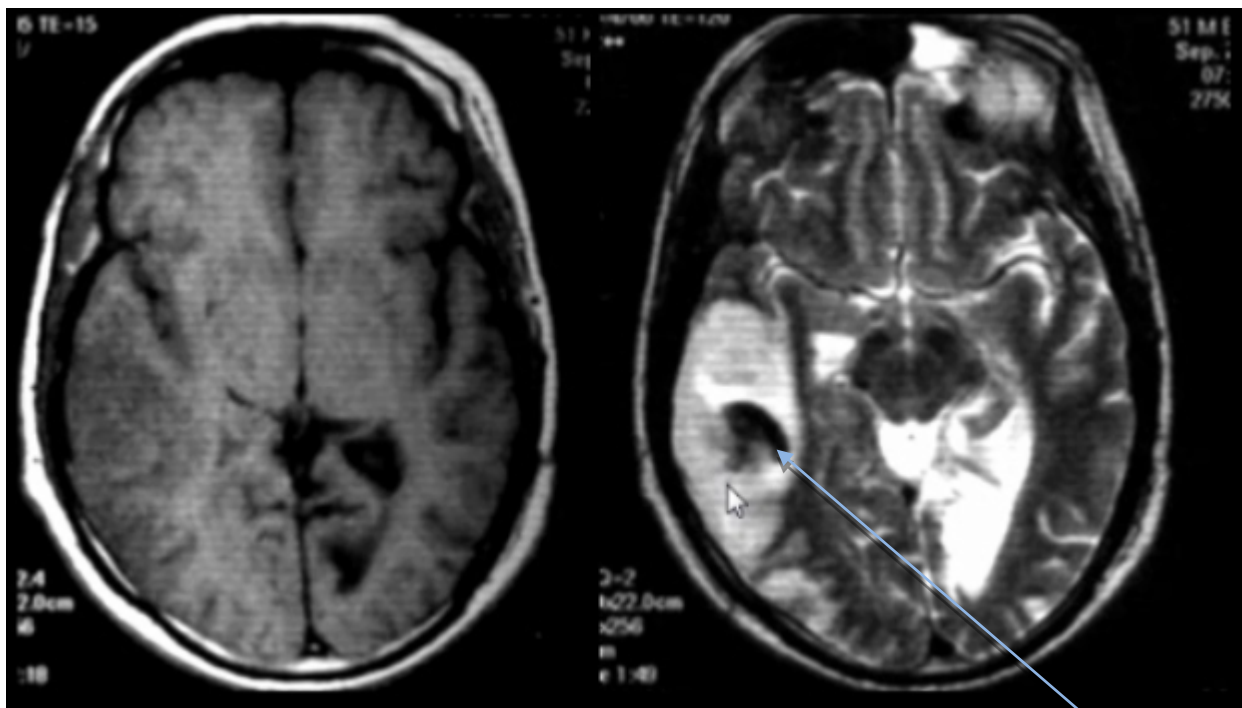
Hemorrhagic infarction:



Same infarction in the CT, but the blood doesn't appear, as blood in the subacute stage is isodense



Infarction with subacute blood (white in T1 & T2), hemorrhagic transformation.



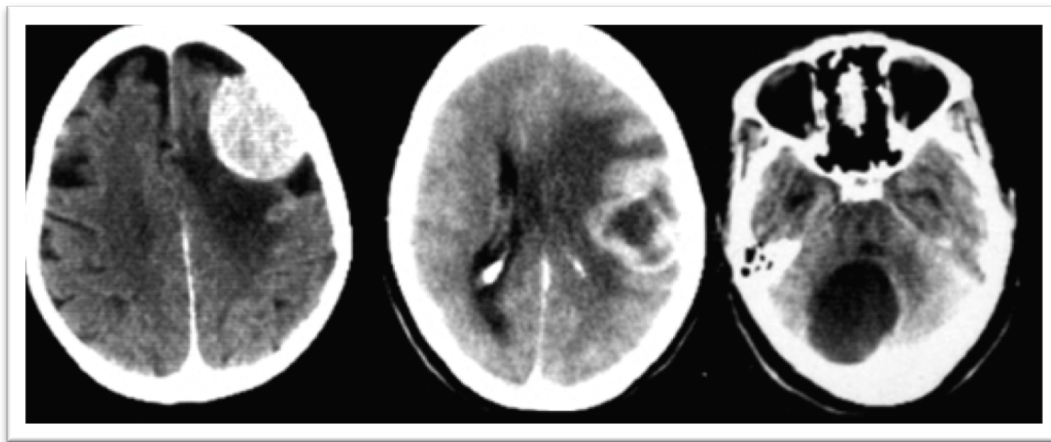
Acute infarction (due to mass effect on the ventricle) with an area of ACUTE BLOOD (grey in T1 & black in T2)

Brain Tumors

Introduction:

Tumors according to contrast enhancement are either:

- 1- Non-Enhancing
- 2- Enhancing:
 - Homogenous
 - Heterogenous
 - Serpiginous
 - Ring (marginal)



Homogenous

Heterogenous

Non-Enhancing

Tumors are differentiated according to:

- ✓ Definition of edges
- ✓ Shape
- ✓ Site
- ✓ Size
- ✓ Enhancement
- ✓ Edema
- ✓ Mass effect

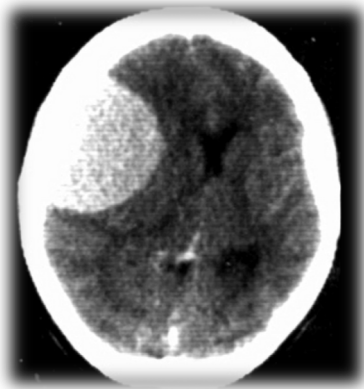
We will classify tumors while talking, into 3 main categories according to contrast enhancement.

I. Homogenous enhancement:

- | | |
|---------------------------|------|
| 1- Meningioma | 14% |
| 2- Giant cell astrocytoma | 0.3% |
| 3- Lymphoma | 1% |

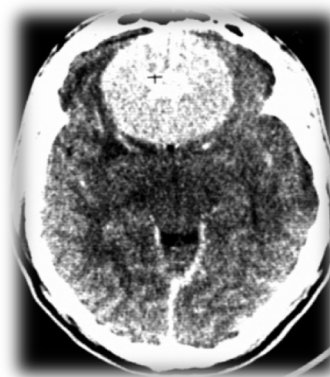
1) Meningioma:

- Show homogenous enhancement
- Has a dural base (resting on a meningeal surface)
- May show (calcification – bone sclerosis – brain edema in 40%)
- Are named according to the base it arise from



Convexity meningioma

When it is related to the convex surface of the brain.

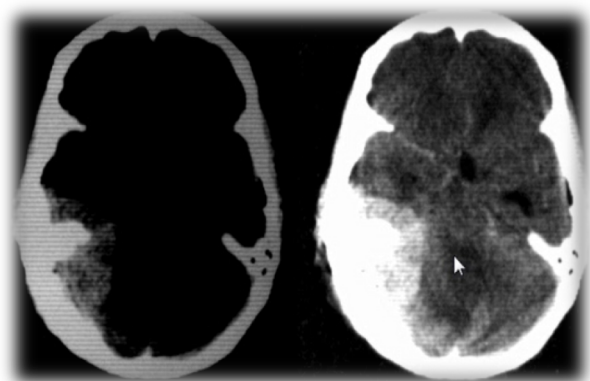


Subfrontal meningioma

In the anterior cranial fossa, from the dura below frontal lobe.



Tentorial meningioma



Meningioma with bone sclerosis

Meningioma may cause irritation & sclerosis of underlying bone

as appearing in bone window.

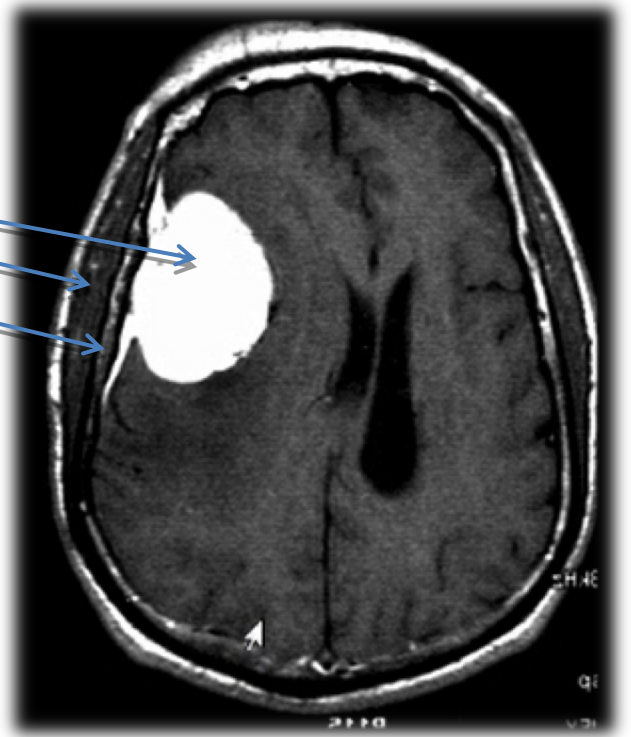
Meningioma in MRI:

- Varies according to water content
- May show either:
 - Isointense signal in T1 & T2
 - Low signal in T1 & high signal in T2
- Dural tail appears in MRI because bone appears black while meningioma white after contrast.

Meningioma

Bone Sclerosis

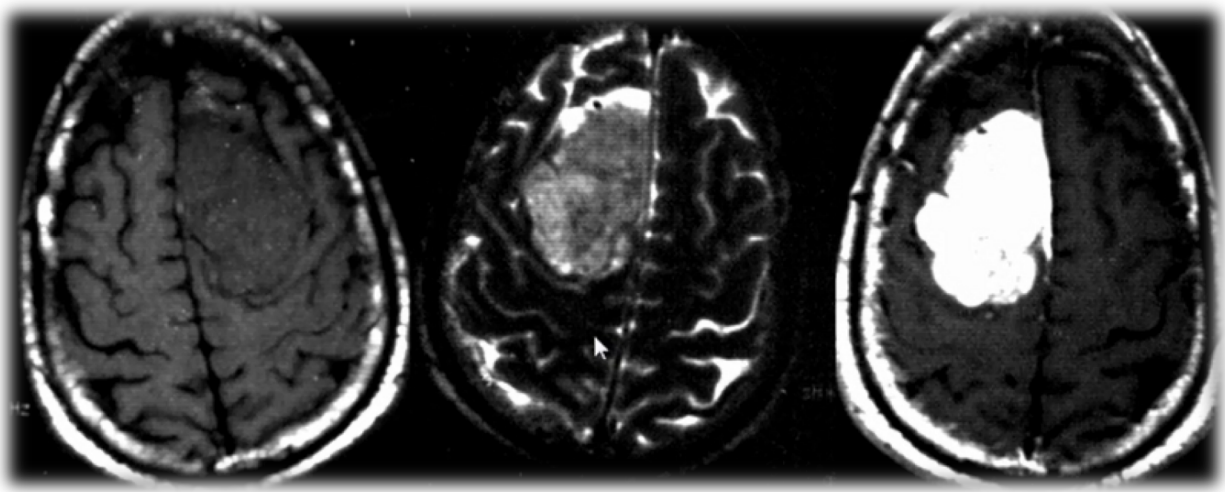
Dural tail



A well-defined hypointense mass lying on the parietal bone with underlying bone sclerosis, and show mass effect.

The mass appears hyperintense in T2 with perifocal edema.

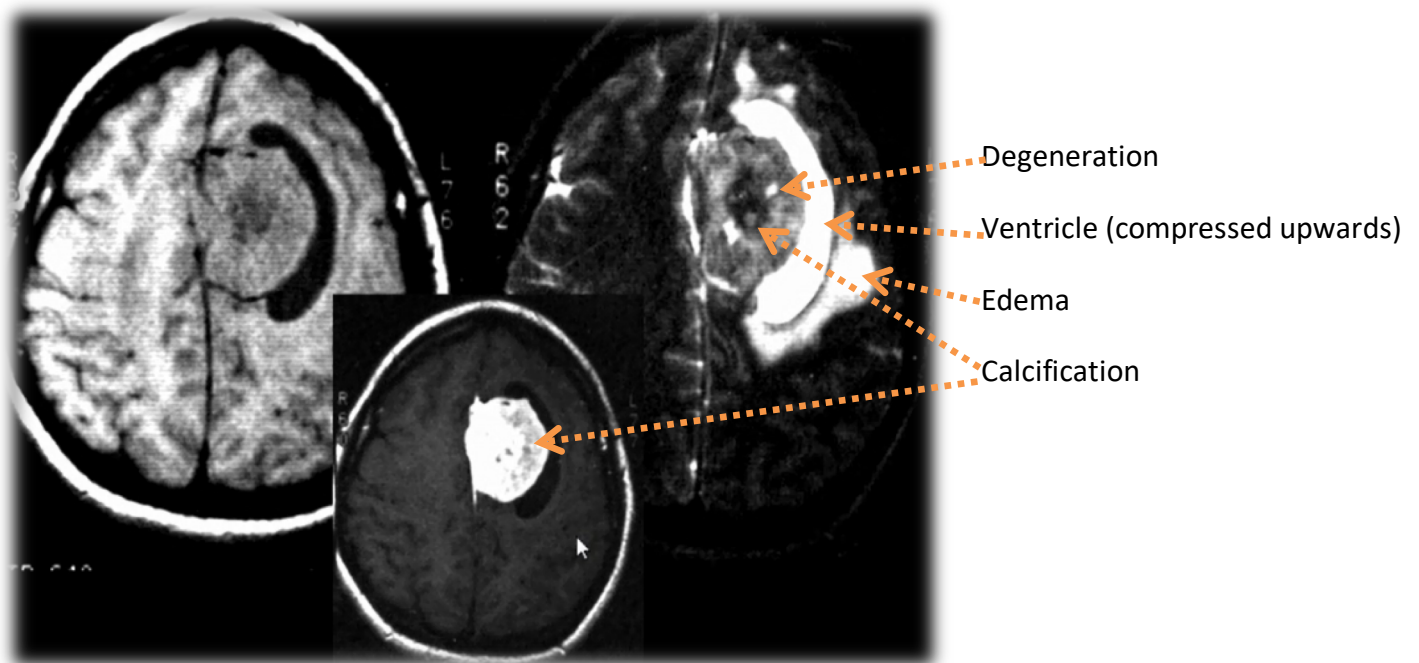
The mass shows homogenous contrast enhancement, with dural tail and underlying bone sclerosis.



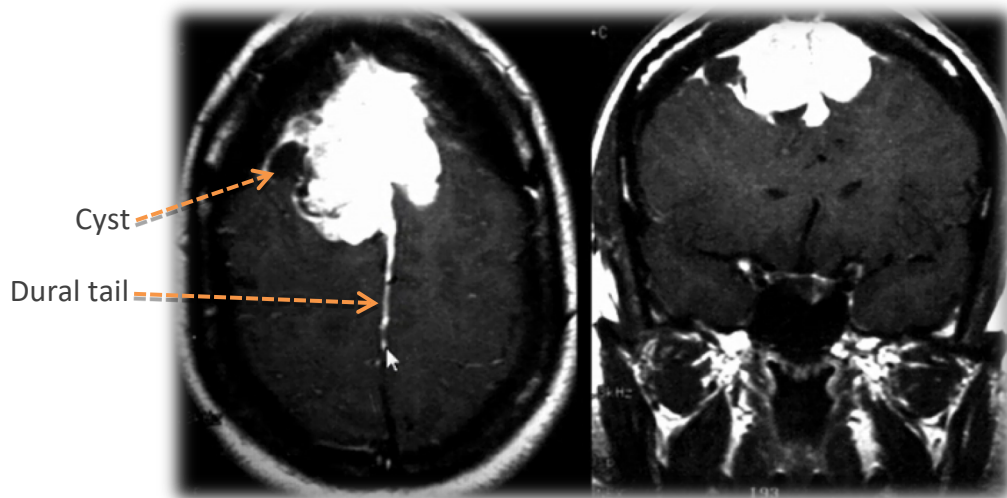
Falcine Meningioma

Meningioma may show areas of low signal in contrast enhancement:

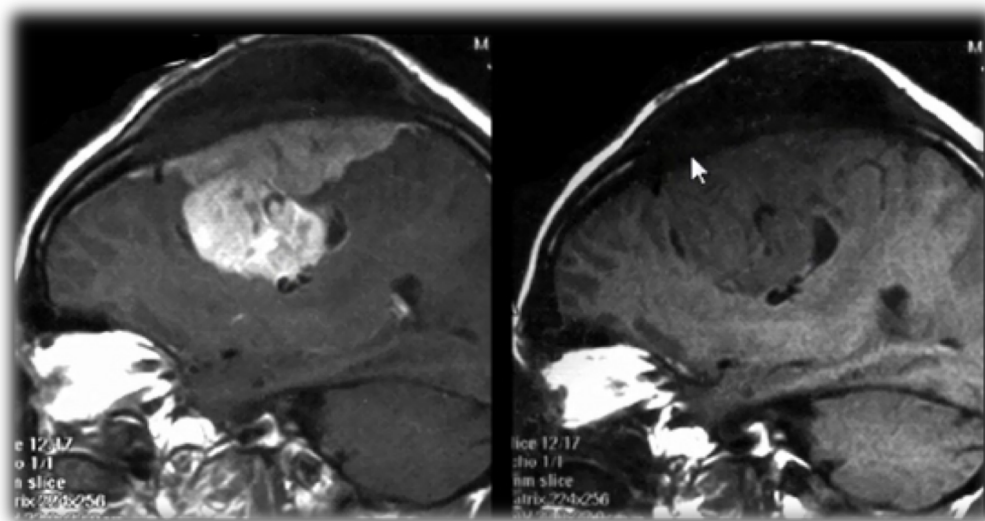
- Calcifications (low signal in T1 & T2)
- Blood vessels (low signal in T1 & T2)
- Area of breakdown (low signal in T1, high signal in T2)



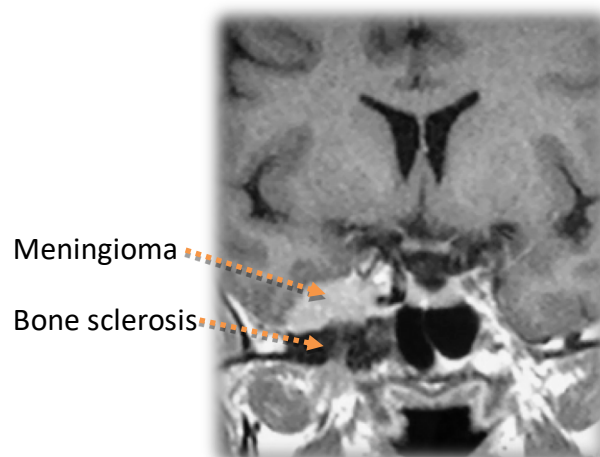
In the contrast T1 image, meningioma with calcification will show some areas without contrast due to calcification, but it is still named homogenous enhancement.



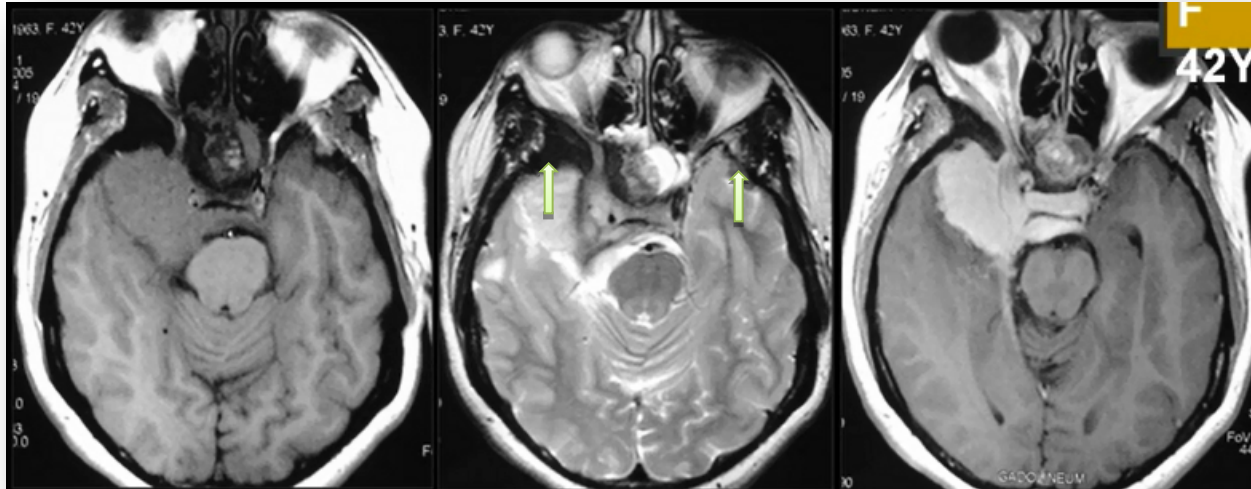
Convexity and falcine meningioma with cystic component and dural tail



Convexity meningioma with bone sclerosis (remember that bone is black in T1 & T2)



Parasellar meningioma with bone sclerosis

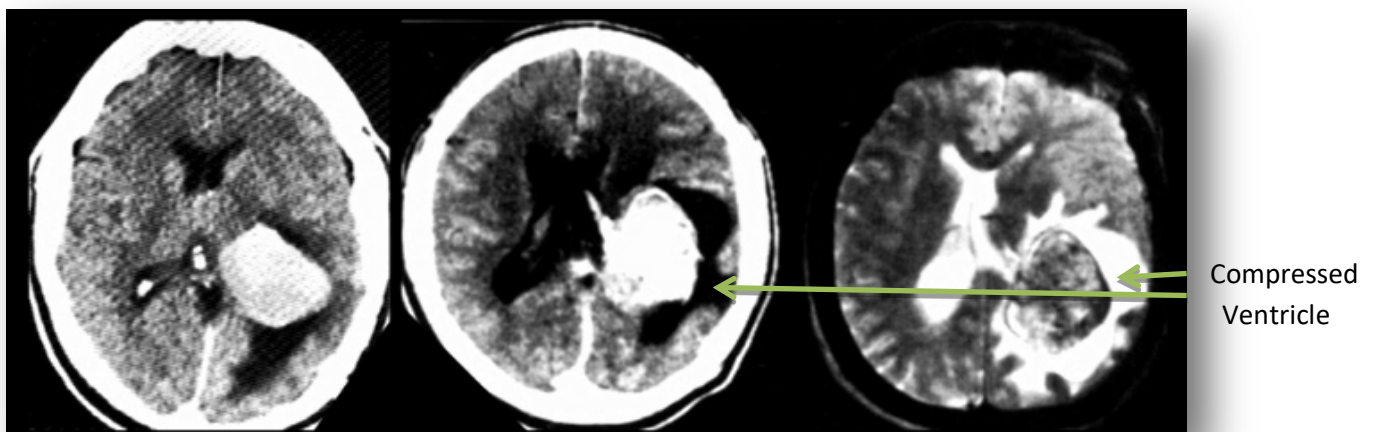


Hypointense tumor in the middle Rt cranial fossa, resting on the greater wing of sphenoid and sella turcica

The tumor is slightly hyperintense with small perifocal edema (white), and there is marked sclerosis of the greater wing of sphenoid.

The tumor is homogenously enhanced

- Intraventricular meningioma:



Intraventricular meningioma arising from aberrant subependymal cells, almost always arise in the atrium of left lateral ventricle

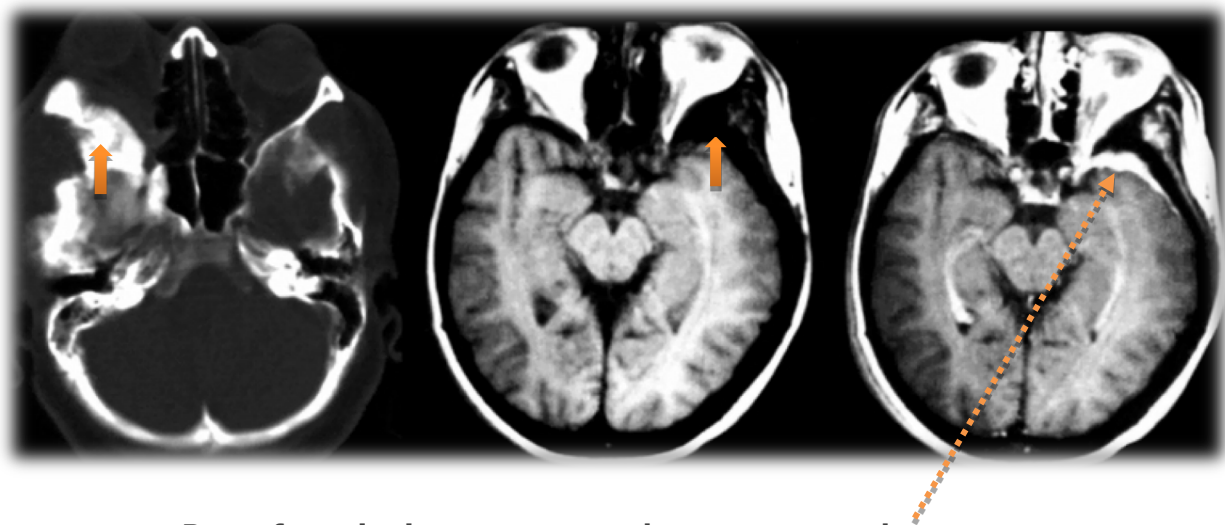
Intraventricular meningioma must be differentiated from:

- Choroid plexus papilloma
- Ependymoma

Meningioma is common in young female, homogenous contrast, always in lt. occipital horn of lat. Ventricle

- Meningioma en plaque (intraosseous meningioma)

A young female present with proptosis, CT & MRI showing thickened lateral orbital wall



Part of meningioma appear as homogenous enhancement

Meningioma en plaque must be differentiated from fibrous dysplasia:

- Meningioma en plaque is limited to lateral orbital wall
- Fibrous dysplasia starts in orbital wall then spread in all directions

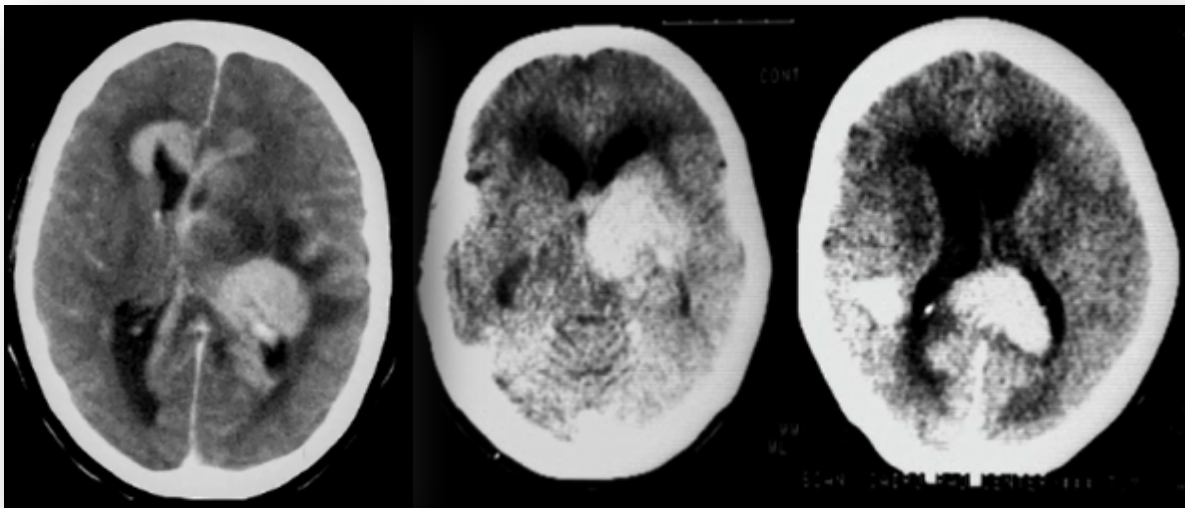
2- Lymphoma

Primary CNS lymphoma:

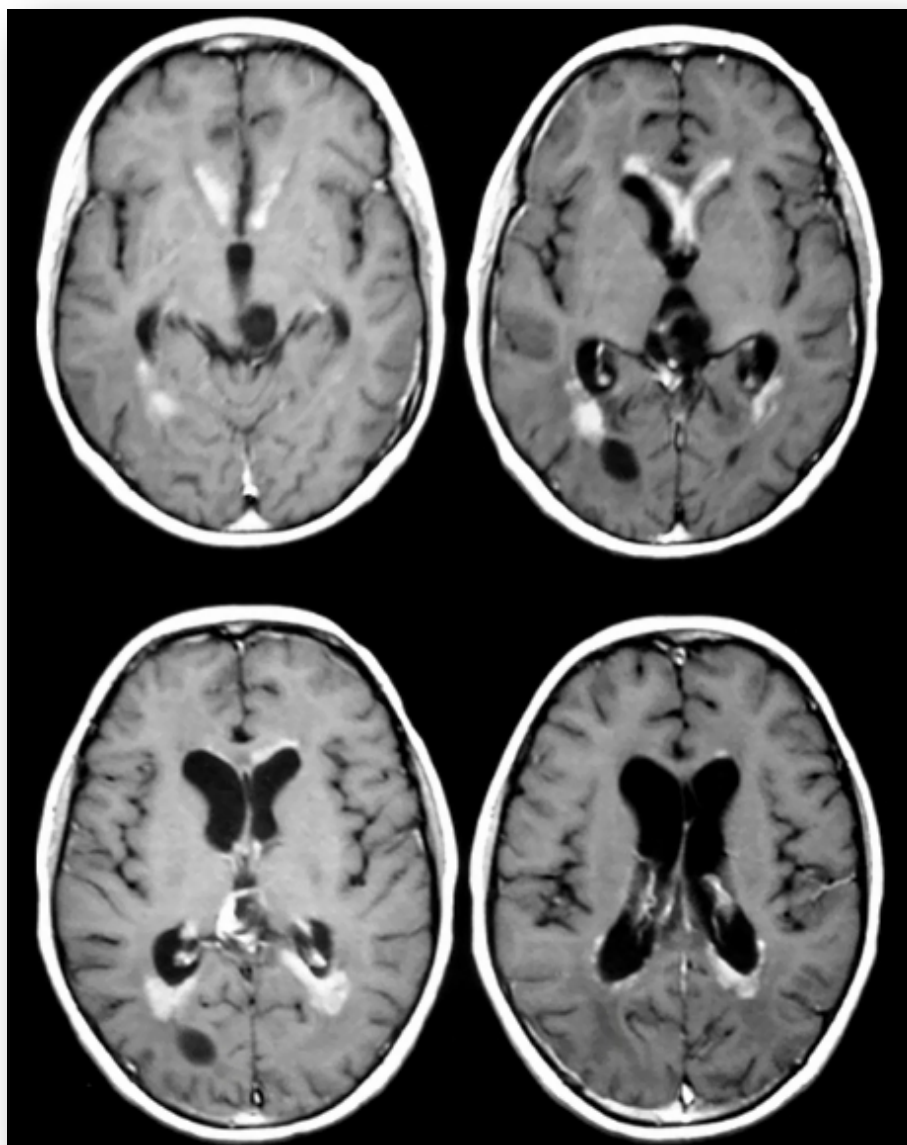
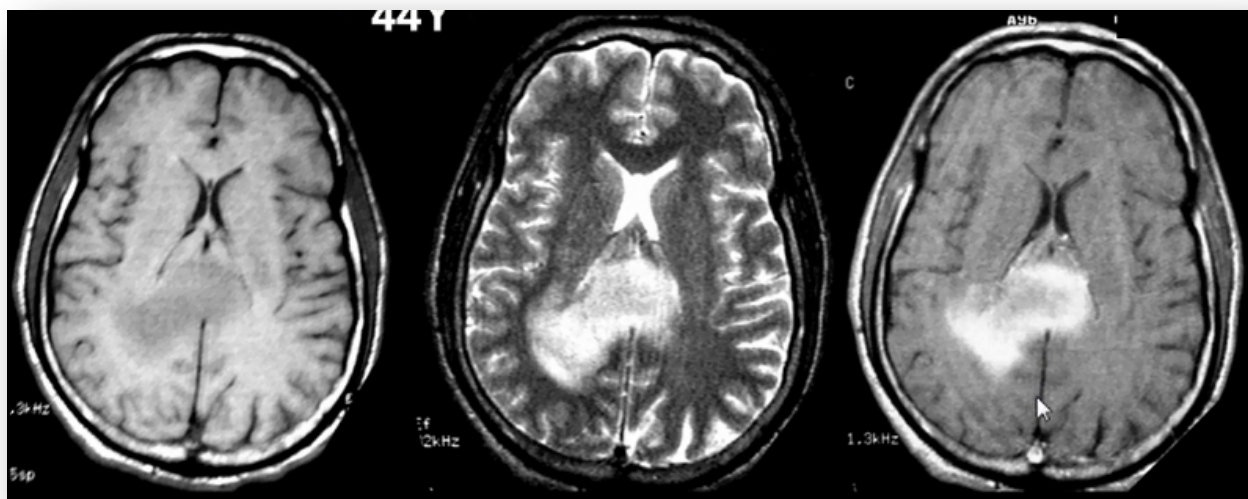
- Usually above 50 years
- Usually single lesion except in young patients and immunocompromised
- Response to steroids is diagnostic

Characteristics of lymphoma:

- Homogenous enhancement
- No dural base (dural base means a **large** part of tumor surface resting on meninges)
- Periventricular location
- Little edema and mass effect
- No calcifications
- Can infiltrate corpus callosum and cross the midline



Multiple lymphomas must be differentiated from metastasis: Metastases usually show heterogenous enhancement.



Lymphoma in MRI

II Heterogenous enhancement

1. Gliomas
2. Other

Gliomas (Neuroepithelial Tumors)

- 45% of intracranial tumors
- **Gliomas are Classified into:**
 - 1) Astrocytoma 20%
 - 2) Ependymoma 6%
 - 3) Oligodendroglioma 5%
 - 4) Choroid plexus papilloma 2%
 - 5) Pineal body tumors

1) Astrocytoma:

- **Astrocytoma Classified according to grade into:**

Low grade astrocytoma in young age

- 1) Pilocytic astrocytoma (WHO grade I)
- 2) Subependymal giant cell astrocytoma (WHO grade I)
- 3) Pleomorphic xantho-astrocytoma PXA (WHO grade I)

High grade astrocytoma

Diffuse astrocytoma

Anaplastic Glioma in middle age (WHO grade III)

Glioblastoma in old age (WHO grade IV)

Unclassified

Gliomatosis cerebri

- **Astrocytoma classified according to contrast into:**

Homogenous enhancement: giant cell astrocytoma

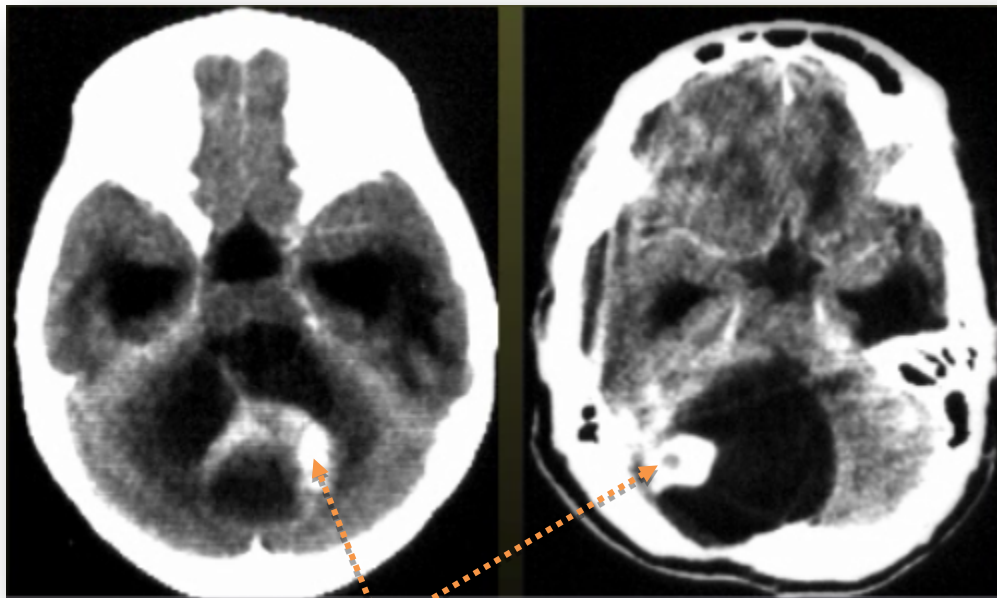
Marginal enhancement: glioblastoma

Cystic lesion with mural nodule: pilocytic astrocytoma & PXA

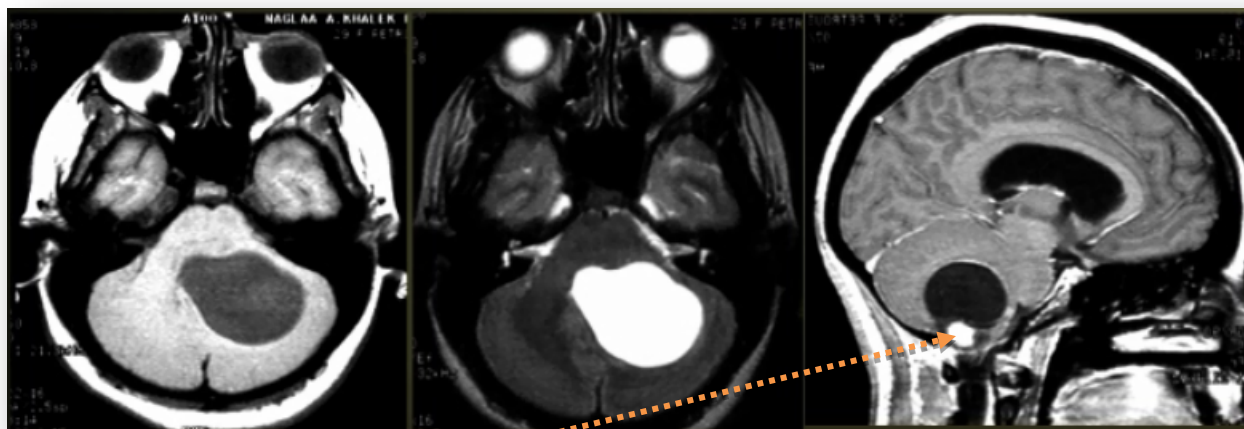
Non-enhancing: diffuse glioma

Pilocytic astrocytoma:

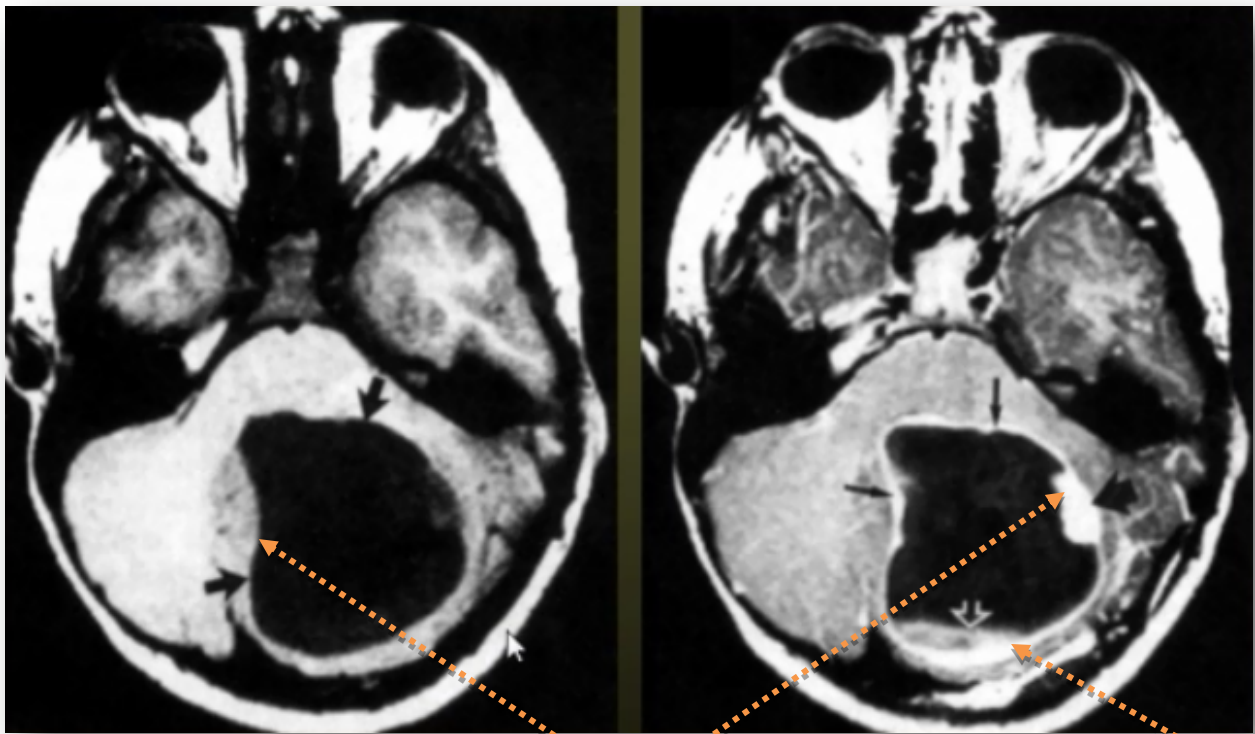
- Low grade astrocytoma
- In young age 5:15 years
- Female > male
- Represents 5% of primary brain tumors
- Cyst with an enhancing mural nodule



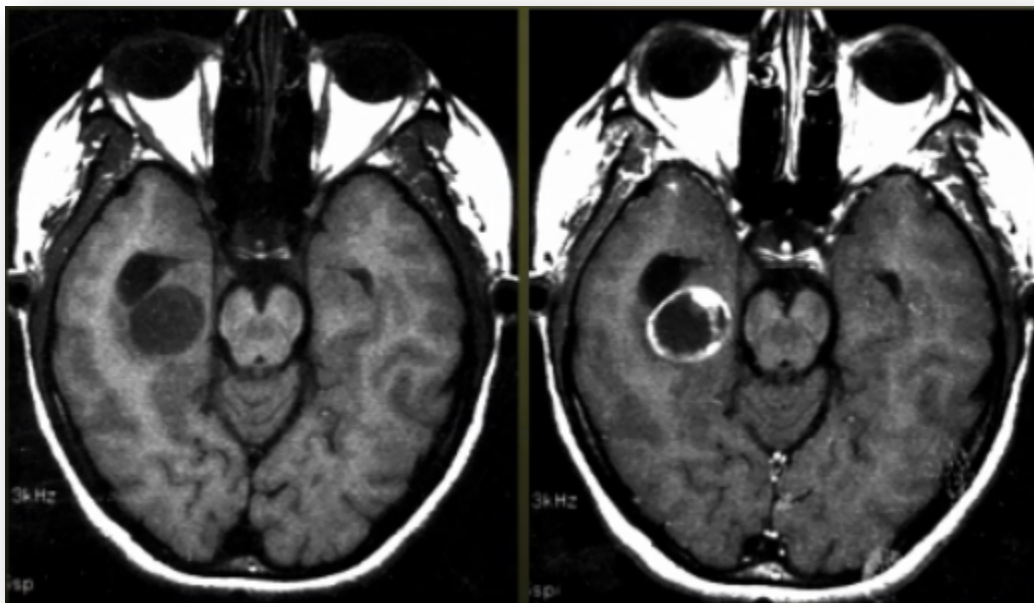
Cyst with an enhancing mural nodule in the 4th ventricle causing hydrocephalus



Cystic lesion in T1, T2 with mural nodule appear with homogenous enhancement in sagittal section



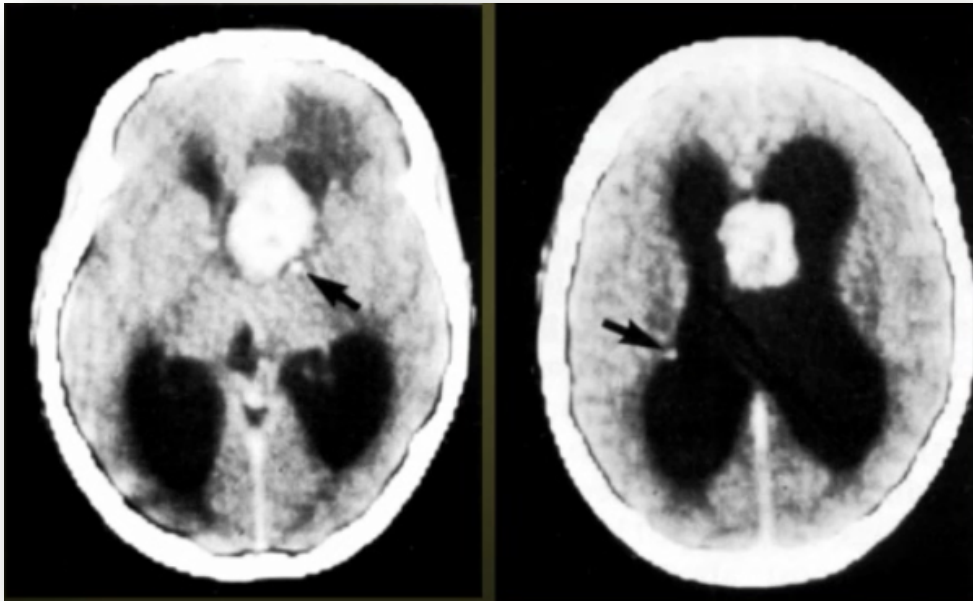
Cystic lesion in posterior fossa with enhancing mural nodule and extravasation of dye causing fluid level



Pilocytic astrocytoma with enhancing mural nodule in the hippocampal region

Subependymal giant cell astrocytoma (SEGA):

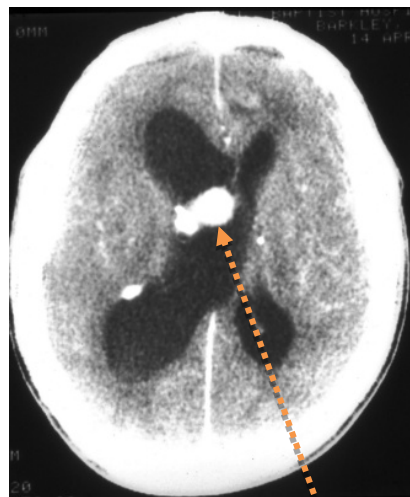
- Very rare 0.3% of brain tumors & 90% occur in **tuberous sclerosis**
- In **young** age 10:20 years
- **Low grade** tumor: no recurrence after operation
- Always arise in the lateral ventricle at the **foramen of monro** in the frontal horn causing hydrocephalus
- Has **homogenous** enhancement
- In CT appear as isodense or slightly hyperdense with **calcification**



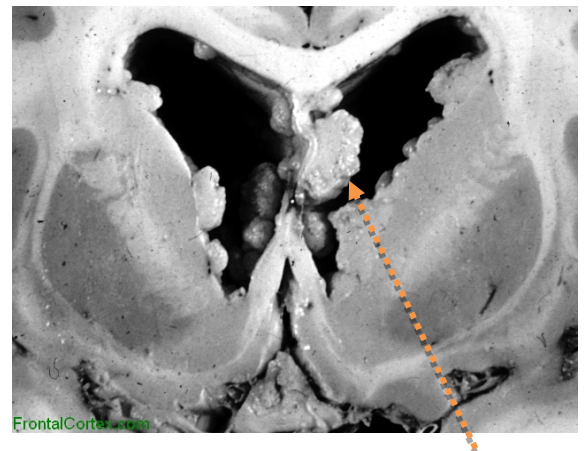
SEGA with periventricular calcifications (arrows) in a patient with tuberous sclerosis



Non-contrast CT showing calcifications (arrow) & SEGA

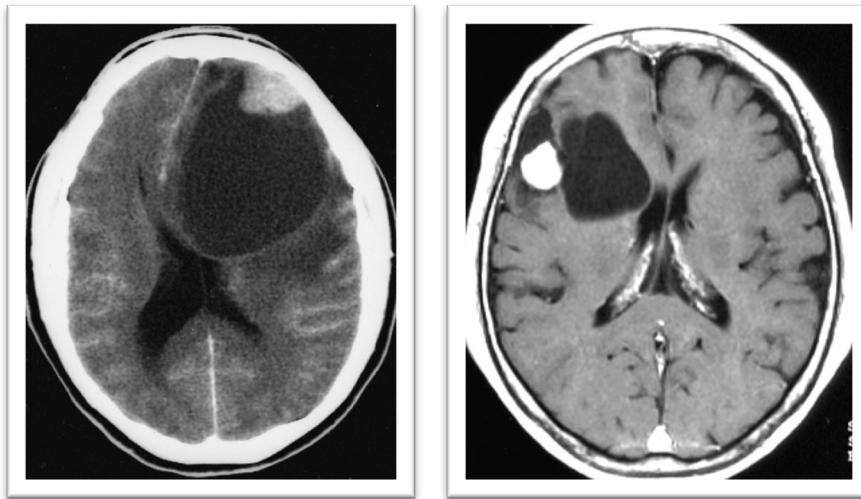


After contrast: homogenous enhancement of SEGA

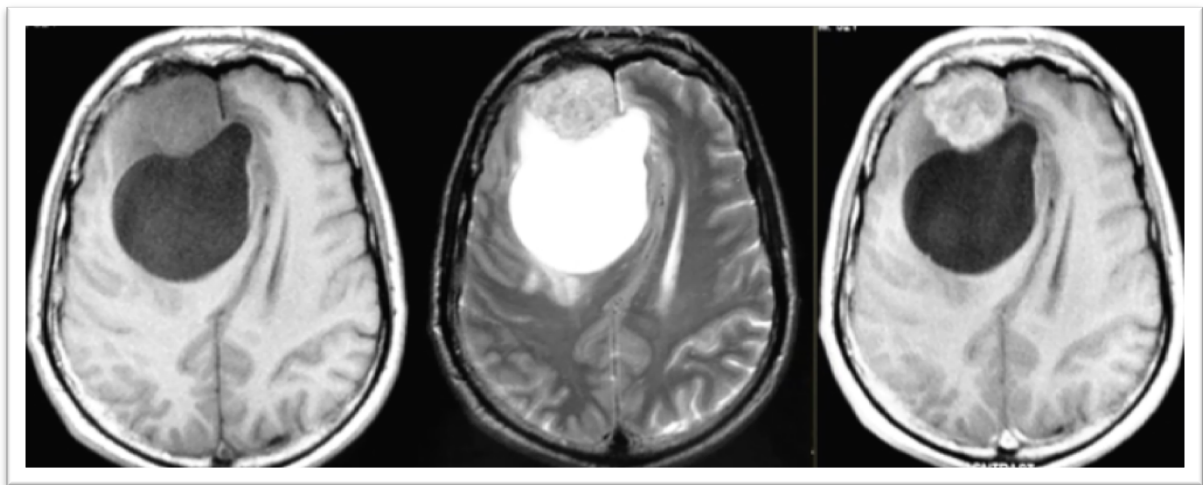


Pleomorphic xantho-astrocytoma (PXA):

- Intermediate grade astrocytoma (WHO grade II)
- In young age around **20 years**
- Usually presented with **seizures**
- **Supratentorial** cystic lesion with enhancing **mural nodule** located in a superficial location.



CT brain and MRI with contrast showing supratentorial cystic lesion with contrast enhancing mural nodule of cortical position.

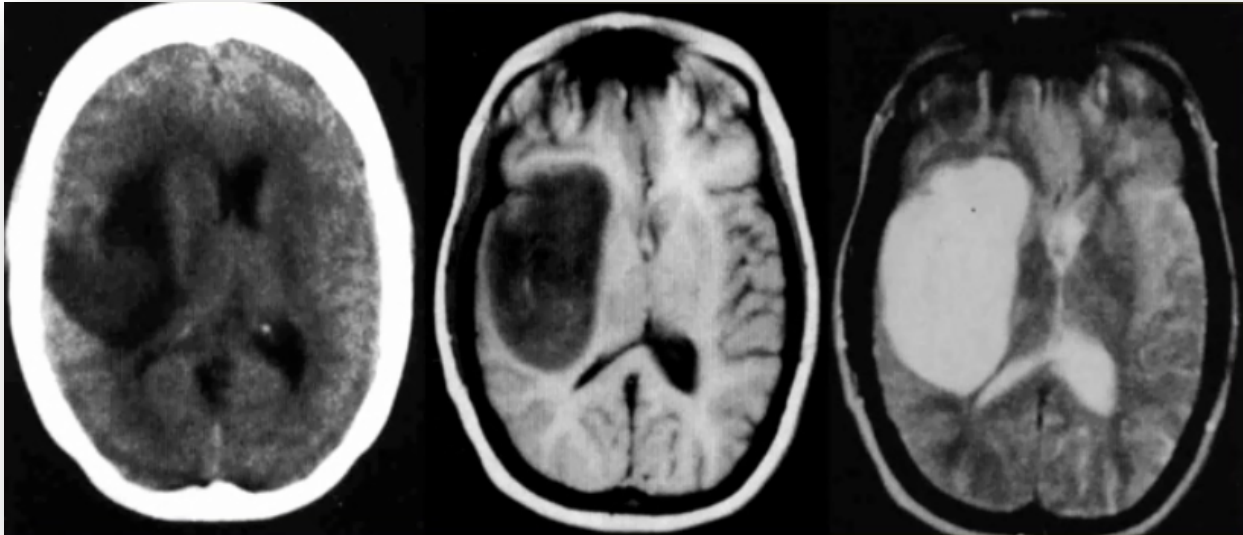


MRI brain showing cystic lesion with mural nodule of cortical position with contrast enhancement.

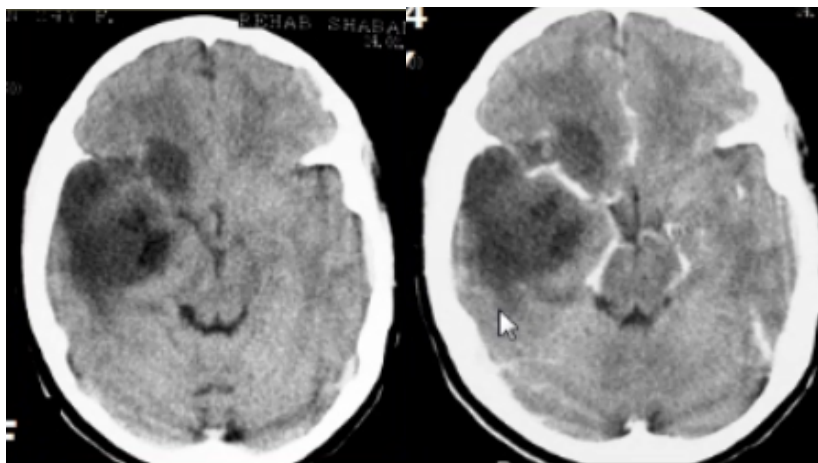
Pilocytic astrocytoma	Pleomorphic xanthoastrocytoma
Low grade astrocytoma	Intermediate grade astrocytoma
10:15 years old	Around 20 years old
Usually infratentorial	Any site
Mural nodule in any site in the cyst	Mural nodule in cortical location
Extravasation is characteristic	No extravasation

Diffuse astrocytoma:

- 10% of primary brain tumors
- In young adults up to 45 years old
- Male > female
- No contrast enhancement (misdiagnosed as infarction)
- Frequent progression to high grade astrocytoma



CT showing hypodense lesion of no vascular territory, causing mass effect and midline shift, MRI showing the lesion actual size larger than CT, with no contrast enhancement.



CT showing a hypodense lesion in the fronto-temporal region, but after contrast, the middle cerebral shows contrast enhancement (patent MCA), this patient needs MRI ?? diffuse astrocytoma

Infarction

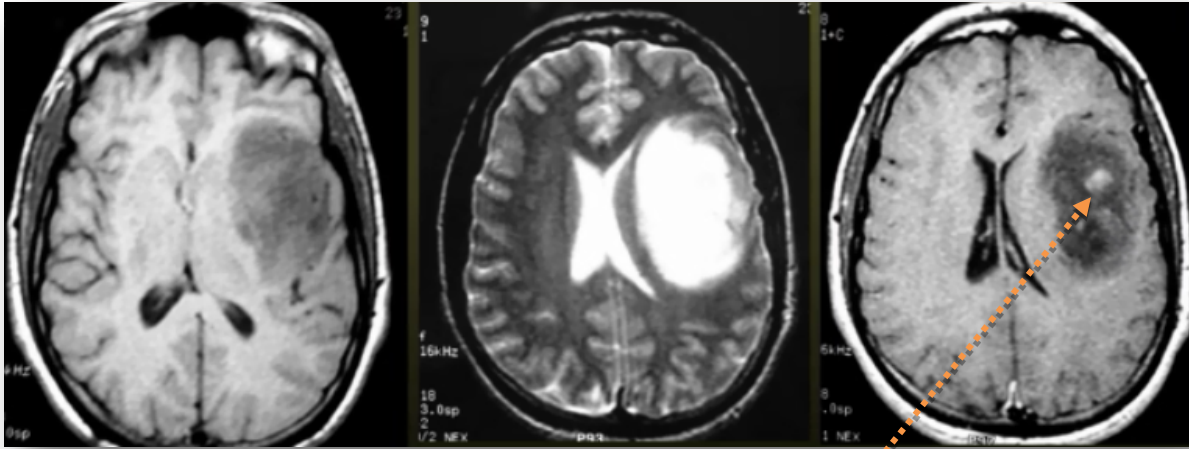
Patient presents with acute deficit
Has a vascular territory
Wedge shaped reaching cortex
No contrast enhancement
Size in MRI = CT

Diffuse astrocytoma

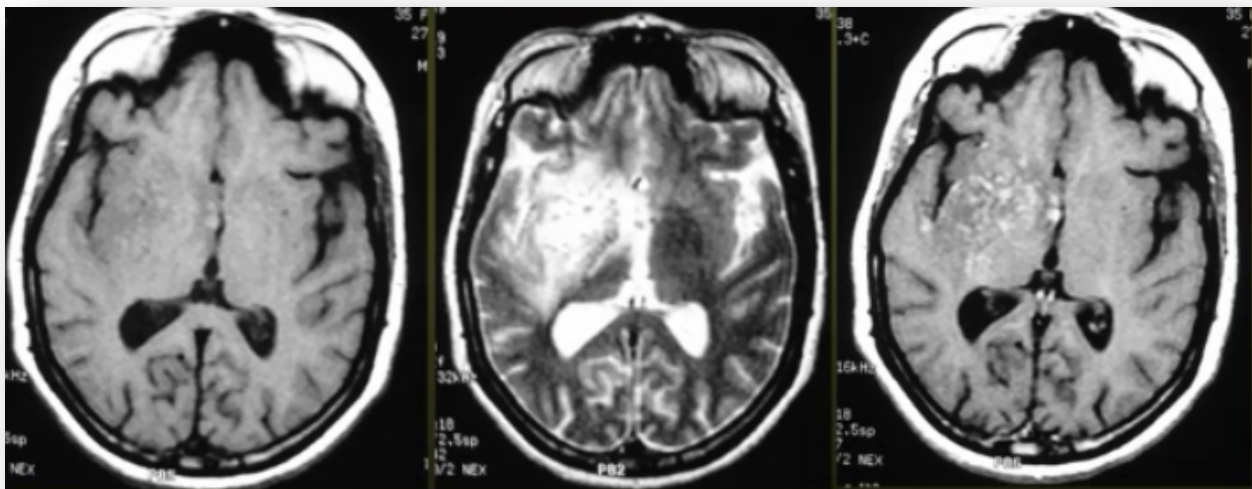
Manifestations of increased ICT
No vascular territory
Not necessarily wedge shaped
No contrast enhancement
Size in MRI > CT (MRI more accurate in detecting diffuse parts of lesion)

Anaplastic astrocytoma:

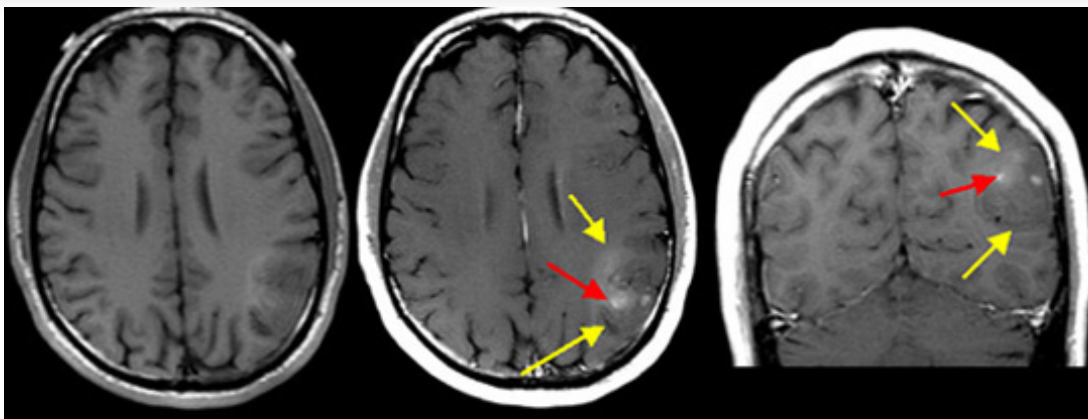
- Similar to diffuse astrocytoma, but differ in contrast enhancement
- Around 40:60 years
- Show patchy (feeble) enhancement
- No ring or heterogenous enhancement



Patches of contrast enhancement

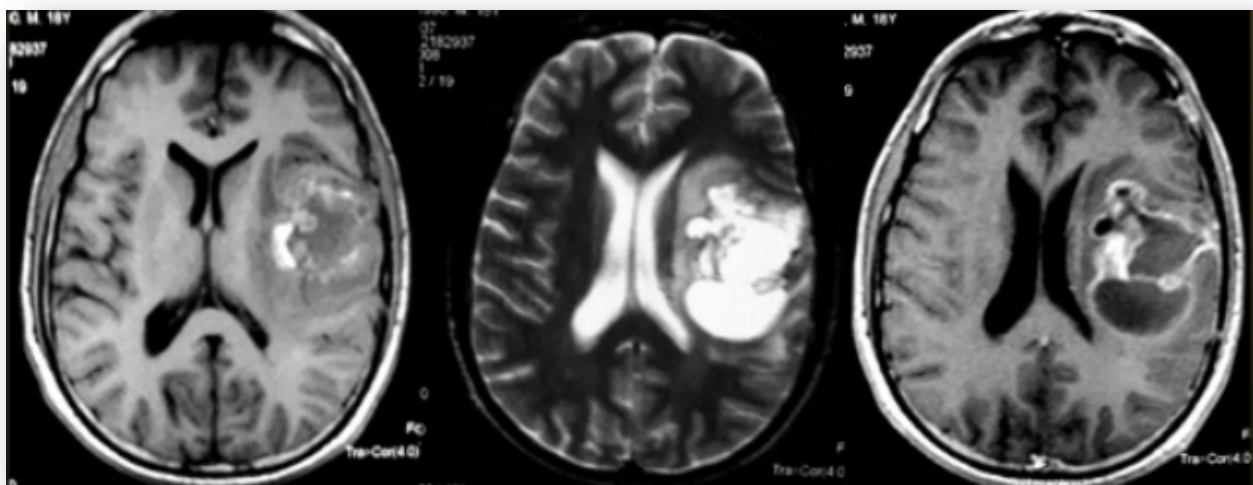
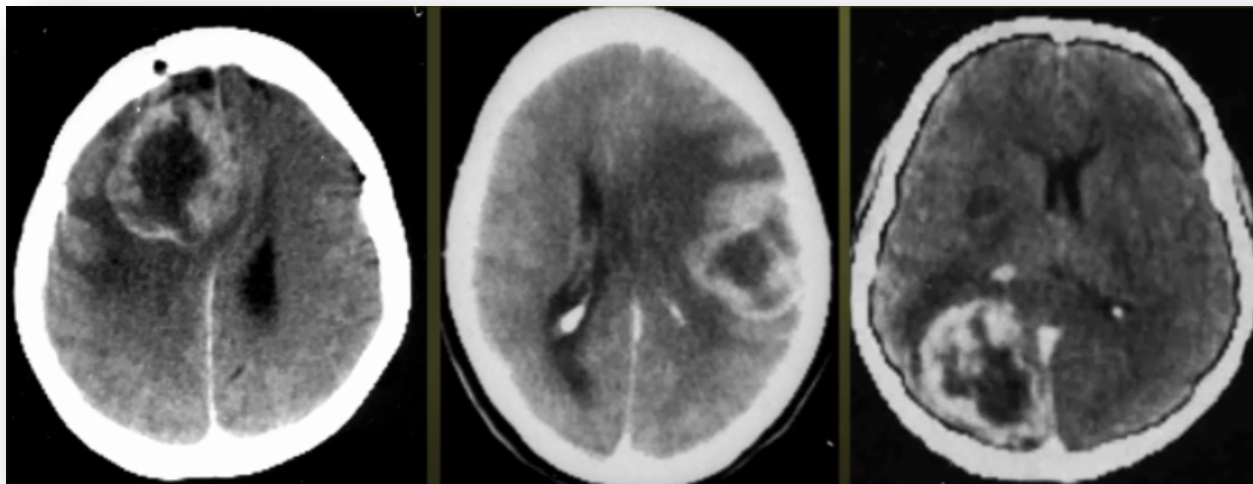


Patches of contrast enhancement

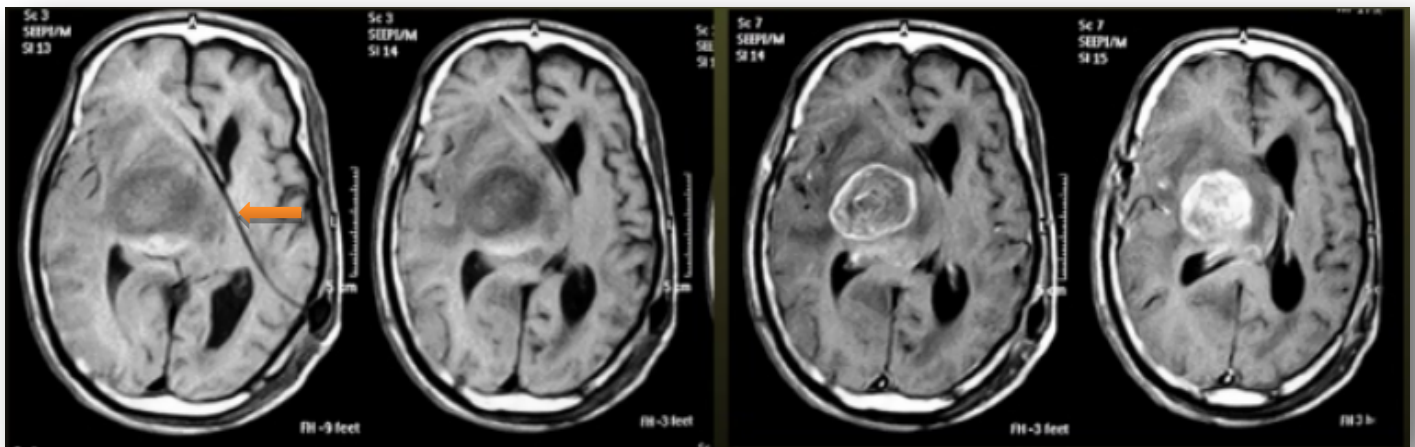


Glioblastoma:

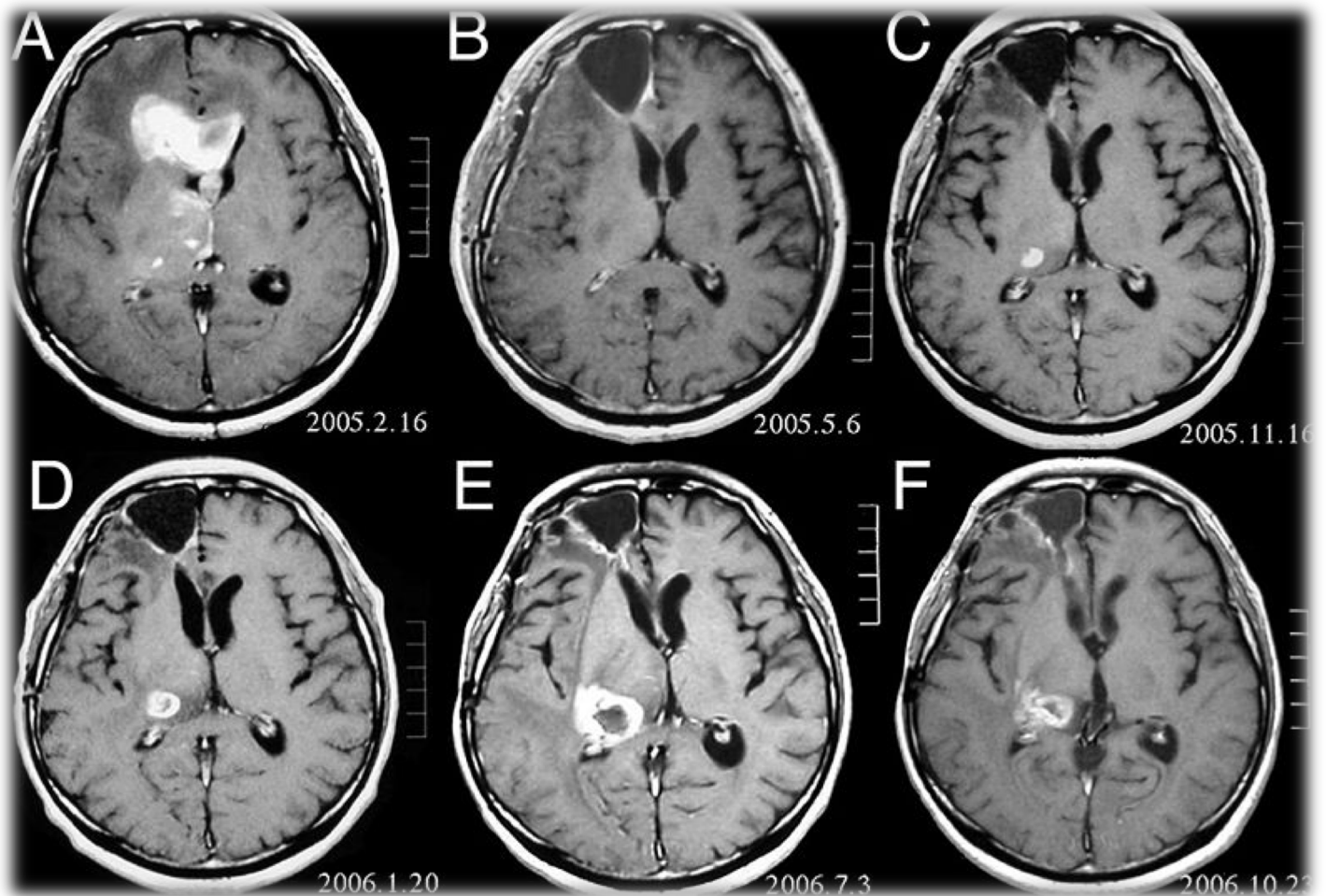
- 20% of intracranial tumors
- 50% of all gliomas
- Favorite sites: **frontal** lobe & **temopro-occipital** site
- **Butterfly** appearance, extending across the midline in 75% of patients
- Associated with brain **edema** in 90% of cases
- **Heterogenous** or **marginal** enhancement but usually of irregular density, if regular then can be confused with brain abscess, but differentiated by MRI diffusion (abcess has restricted diffusion while glioblastoma not)



MRI brain showing SOL with heterogenous enhancement and show areas of high signal intensity in T1 & T2 indicating areas of bleeding (subacute blood).



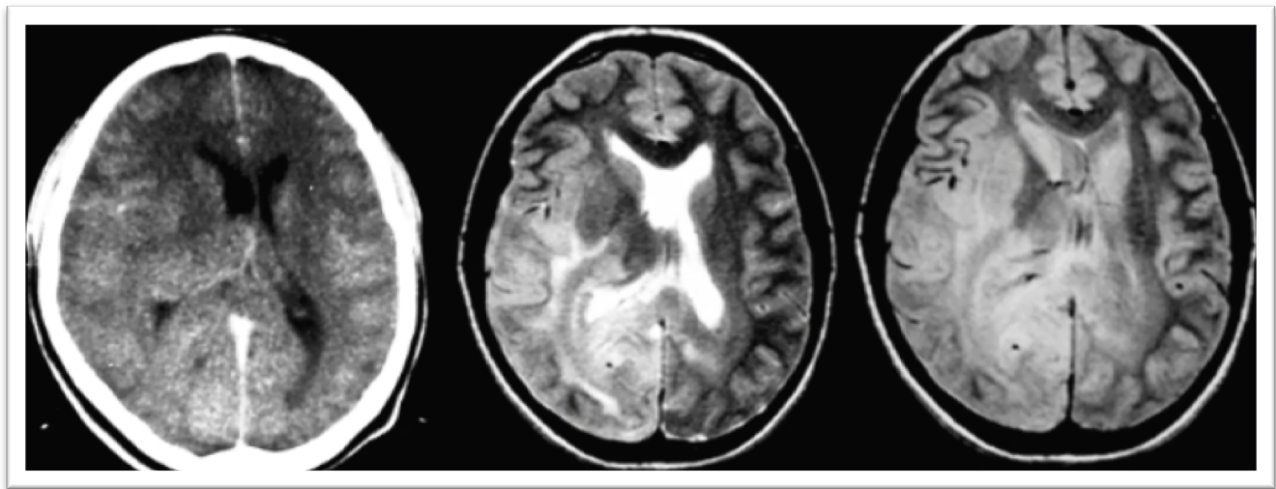
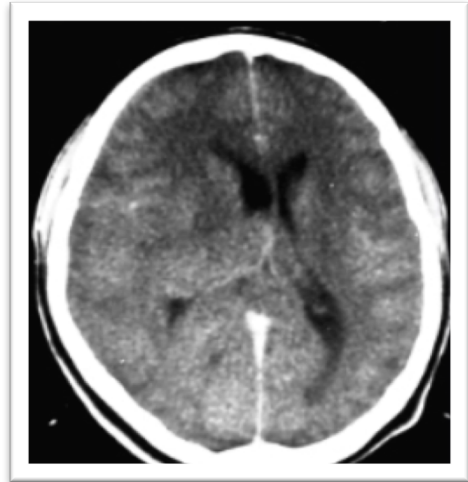
MRI brain showing SOL with heterogenous enhancement and a ventricular shunt



MRI of brain. (A) Initial MRI on February 16, 2005, shows a tumor in the right and left frontal lobe as well as the right thalamus. **(B)** MRI after surgery, radiation and chemotherapy. The tumor has completely disappeared except for slight enhancement adjacent to the surgical margin. **(C)** Recurrence of the thalamic tumor despite maintenance chemotherapy on November 16, 2005. **(D)** Increase in size of the thalamic tumor two months after stereotactic radiotherapy. **(E)** After 6 cycles of TMZ therapy, the thalamic lesion enlarged, and the patient developed dysarthria and hemiparesis. **(F)** After 2 courses of treatment with interferon-beta and TMZ, the tumor shows a partial response.

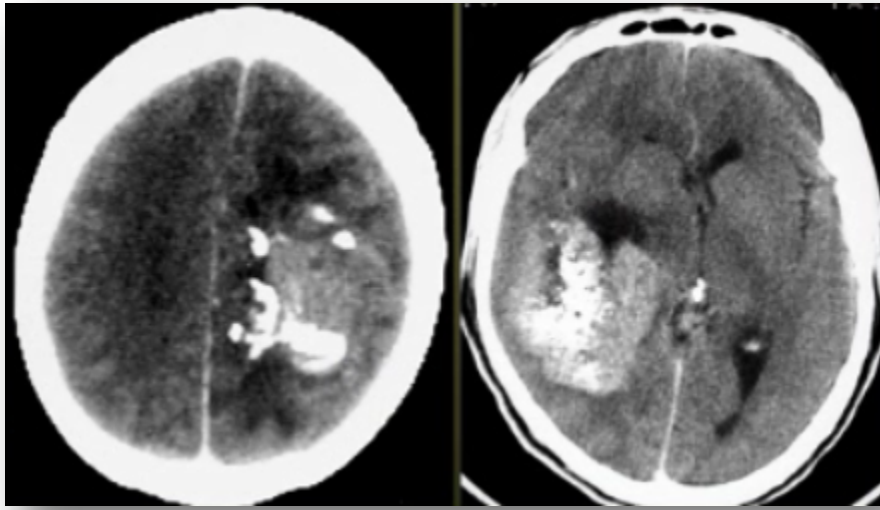
Gliomatosis cerebri (infiltrating glioma)

- A rare tumor
- Age around 20:40 years
- Mass effect is not so evident
- Poor prognosis
- Male = female
- **No contrast enhancement**
- **Loss of grey white matter interface**

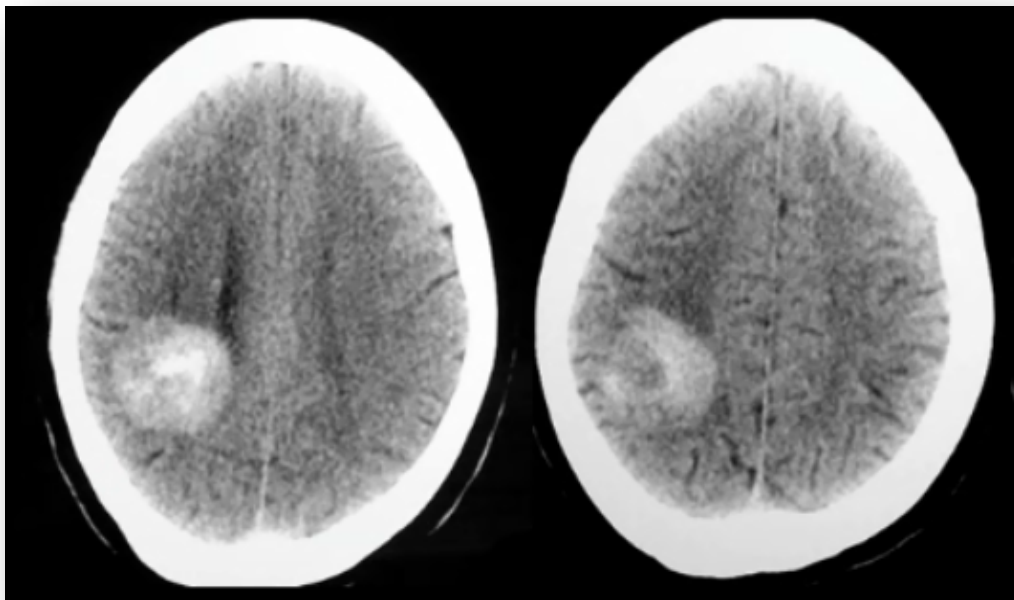


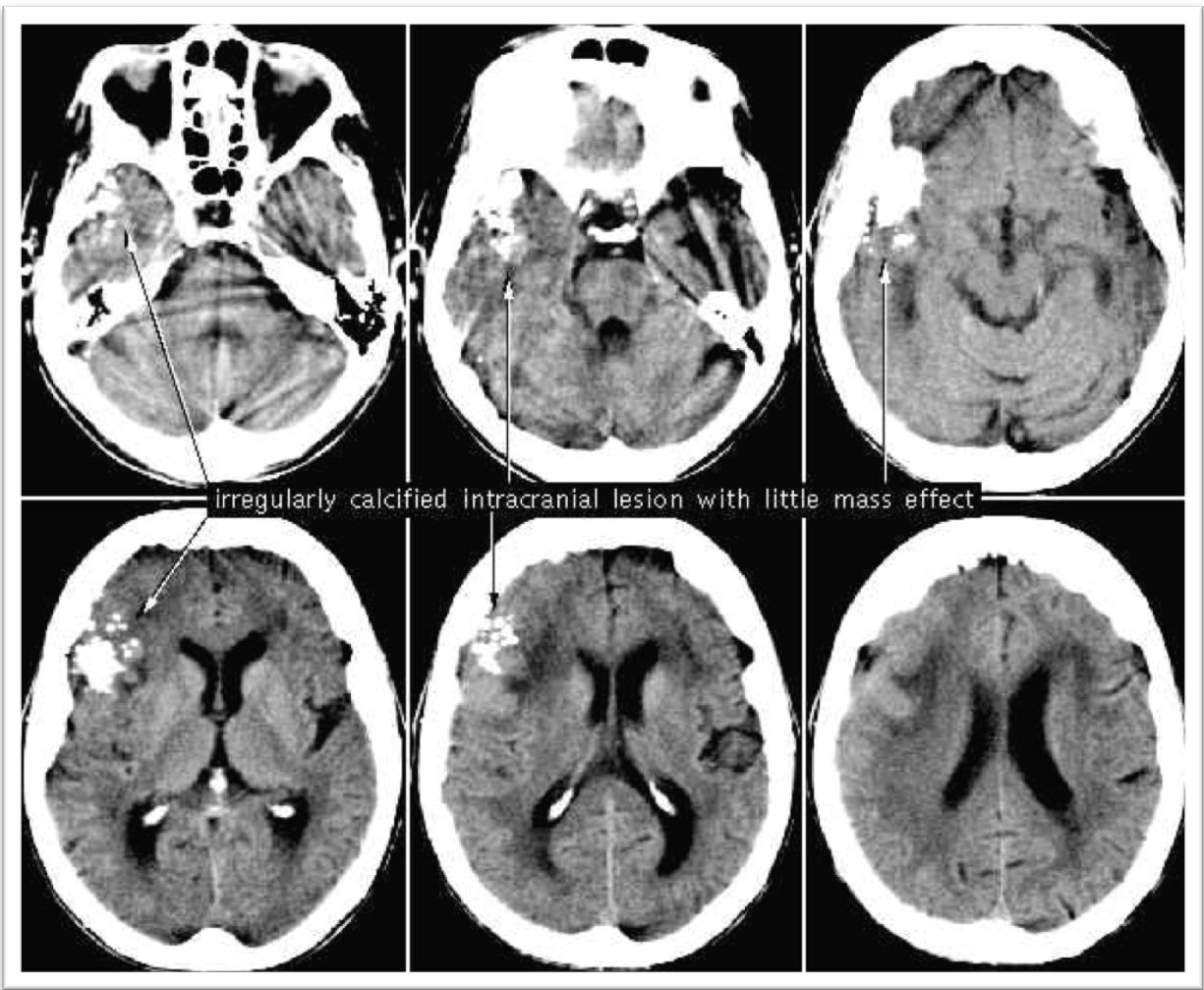
Oligodendroglioma

- 15% of primary brain tumors
- Low grade glioma
- **Calcifications** in 90%
- **No brain edema**
- **Heterogenous** enhancement



SOL with minimal mass effect and minimal edema, shows calcification and heterogenous contrast enhancement, but no meningeal base (not meningioma)

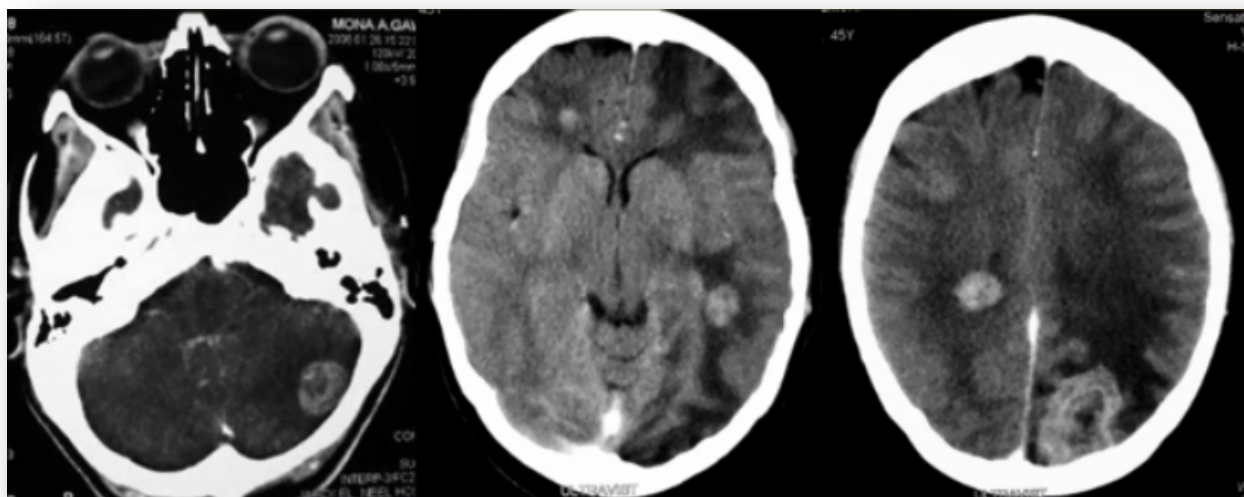
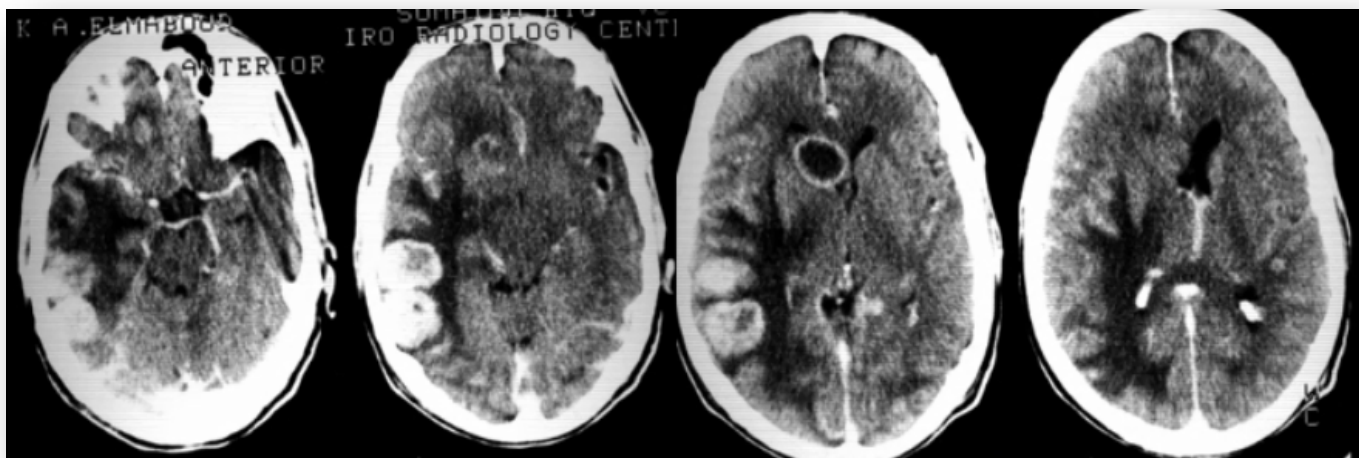




Irregularly calcified intracranial lesion with little mass effect

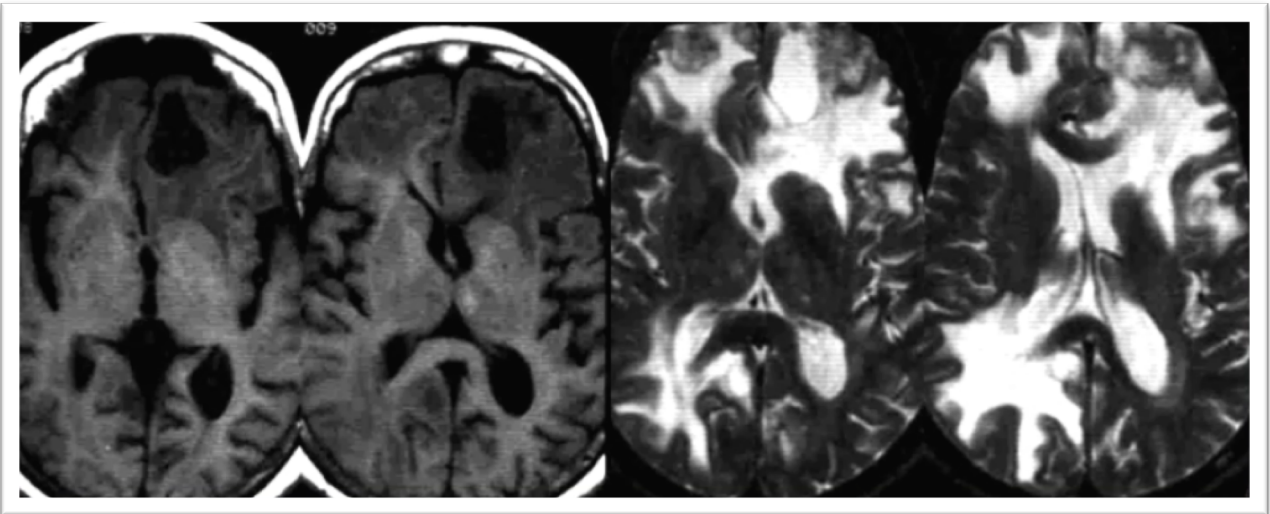
2) Metastasis

- 4:37% of brain tumors
- Usually supratentorial
- Usually multiple, but solitary deposit in 30% of cases
- Associated with edema
- **Usually Heterogenous** enhancement but any pattern can be seen
- Most common sites: Lung (**bronchogenic** carcinoma), breast, GIT, GUT

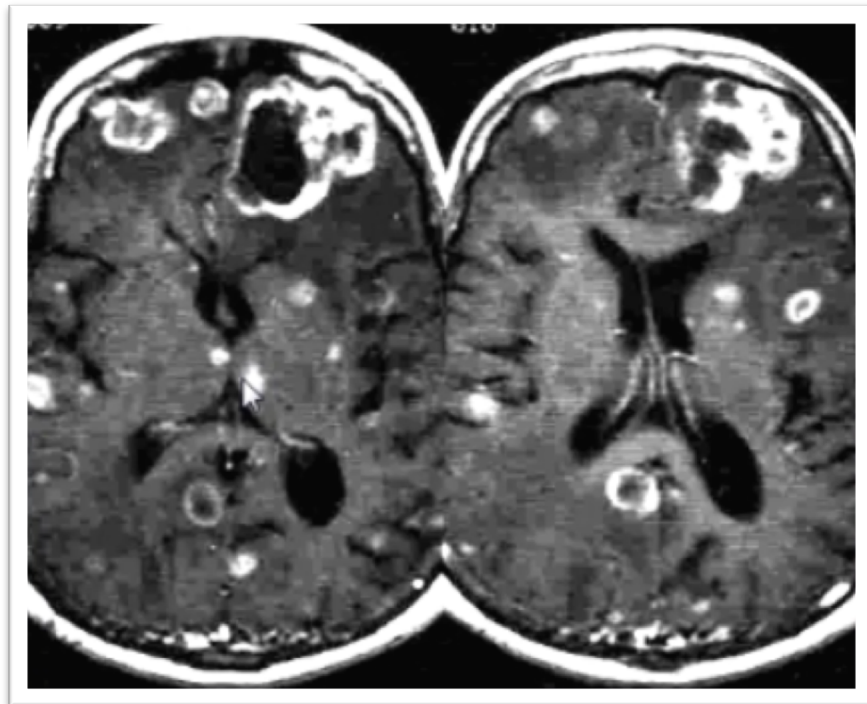


Metastasis in MRI:

- Usually low SI in T1 and high SI in T2 as any tumor
- But may show high SI in both T1 & T2 due to hemorrhage
- Small lesions may show isointensity so difficult to see without contrast



MRI before contrast showing multiple SOL surrounded by edema

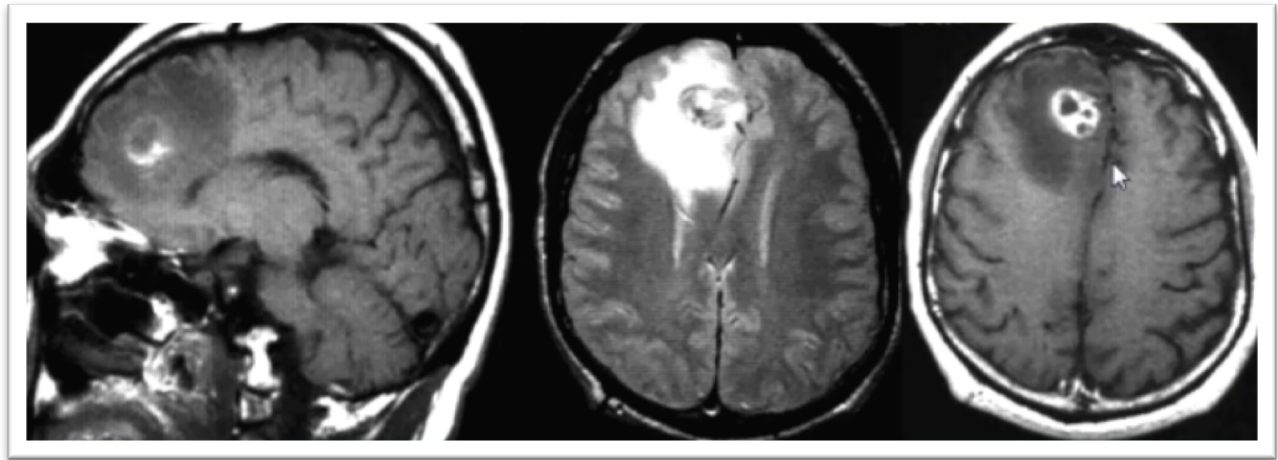
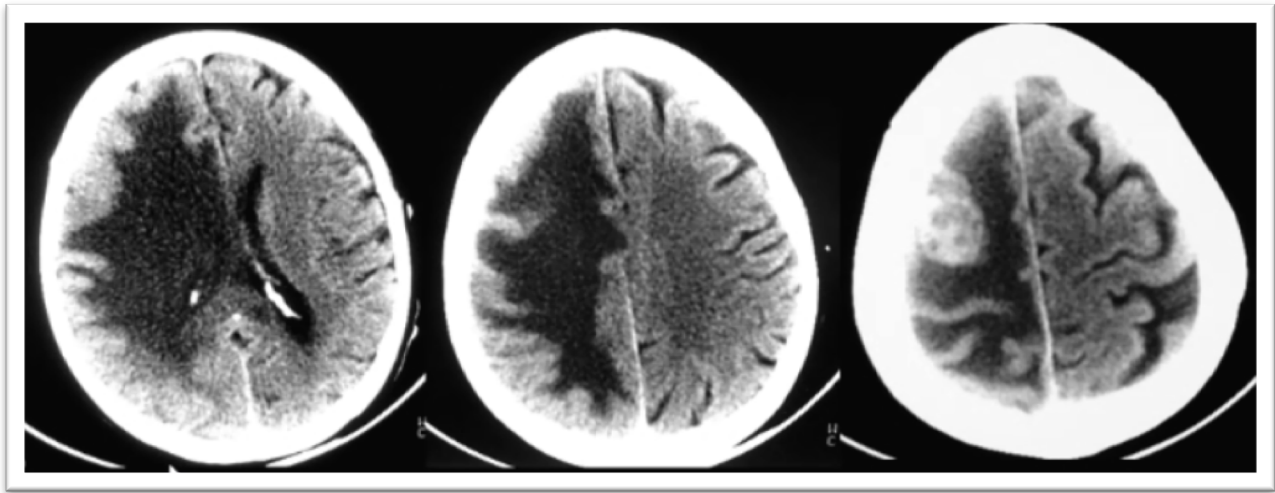


MRI after contrast showing many lesions that were missed by the initial non-contrast MRI

Solitary metastasis:

To diagnose solitary SOL as metastasis, it must be:

- Show heterogenous enhancement
- Marked brain edema



The MRI shows SOL with heterogenous enhancement, and show areas of hemorrhage (high SI in T1 & T2), and marked edema, the diagnosis should be either glioblastoma multiformis or metastasis.

Intracranial cysts

Extra-axial cysts:

- Arachnoid cyst
- Epidermoid cyst
- Dermoid cyst

Intra-axial cysts:

- Astrocytomas (cystic types)
- Hydatid cyst
- Porencephaly

Intra-axial midline:

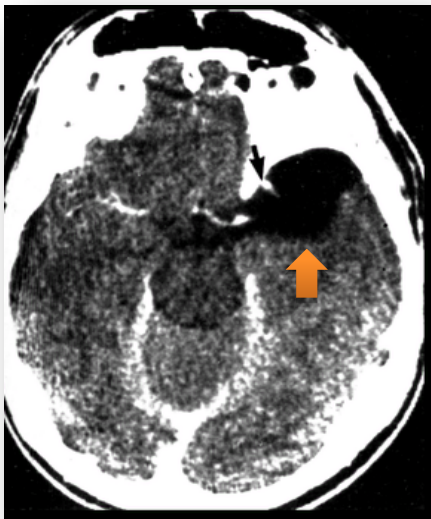
- Colloid cyst

Others

- Abscesses
- Cysticercosis
- Leptomeningeal cysts
- Cystic metastasis
- Meningioma with cystic parts

1) Arachnoid cyst:

- 1% of intracranial masses
- Sites: Sylvian fissure (against greater wing of sphenoid), CP angle, retro-cerebellar, suprasellar, intraventricular
- No contrast enhancement
- No calcifications
- Has CSF density in both CT and MRI



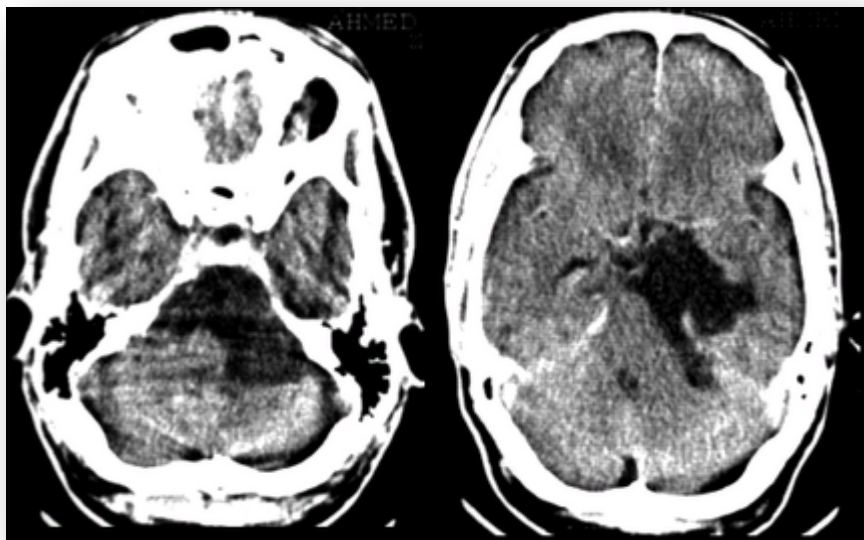
The most common site of arachnoid cyst is against the greater wing of sphenoid bone



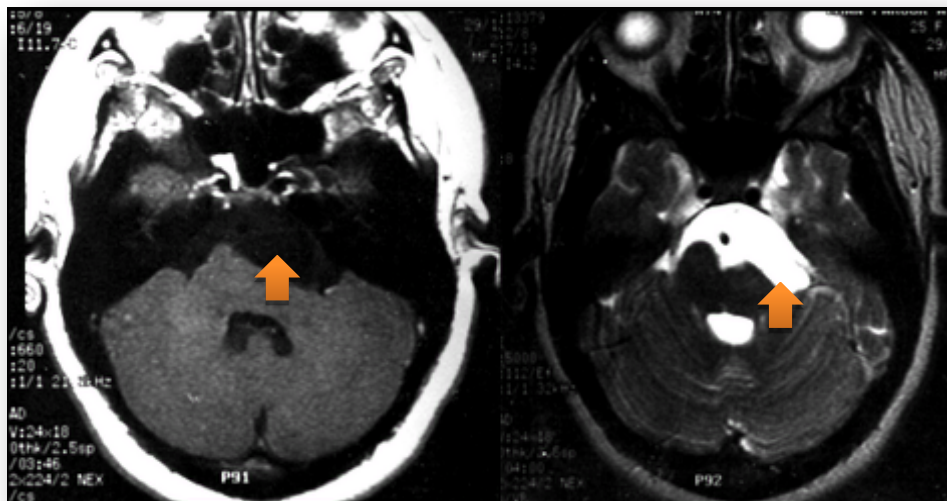
Arachnoid at the greater wing of sphenoid is usually bilateral

2) Epidermoid cyst:

- 1% of brain masses
- Sites: CP angle, suprasellar, parasellar, middle fossa & cisterna magna
- In CT it may resemble arachnoid cyst but:
 - Surface is lobulated
 - May show calcifications
- In MRI:
 - Hypointense in T1 between CSF & brain
 - Hyperintense in T2 > CSF
 - Never isointense in PD



A hypodense cystic lesion in the CP angle and creeping into the middle cranial fossa, surface is lobulated

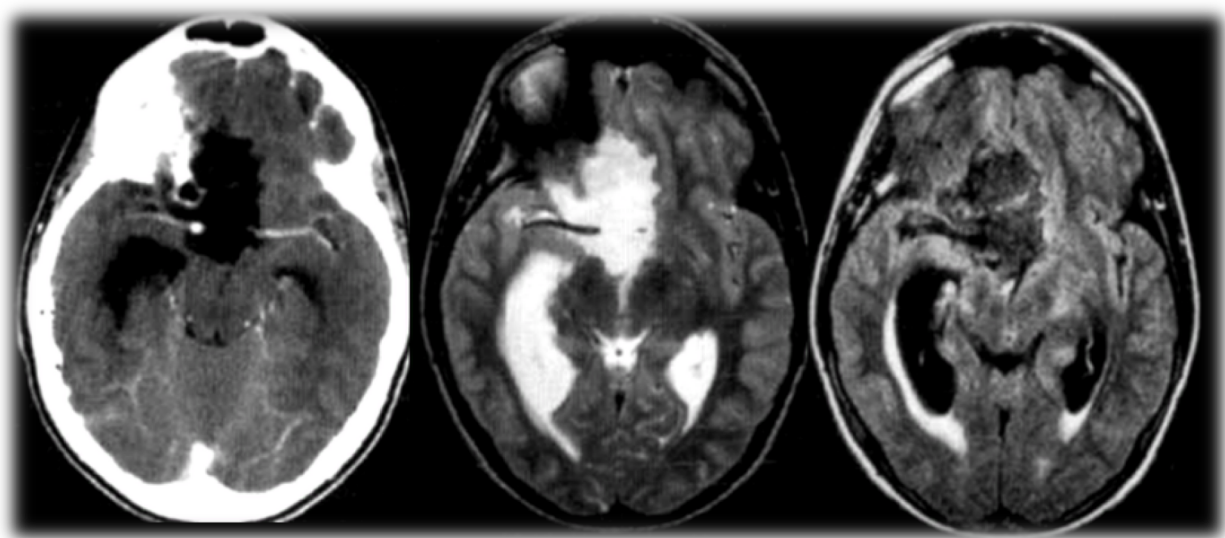


The cystic lesion at the CP angle is moderately hypointense (less than CSF) in T1 & markedly hyperintense in T2 more than CSF

	Arachnoid cyst	Epidermoid cyst
Most common site	Against <u>greater wing</u> of sphenoid, but can arise anywhere	In <u>CP angle</u> but can arise anywhere
Lobulation	Surface is <u>not</u> lobulated	Surface is <u>lobulated</u>
Calcifications	Uncommon	No calcifications
T1 MRI	Hypointense midway between CSF & brain	Hypointense like CSF (black)
T2 MRI	Hyperintense more than CSF	Hyperintense like CSF (white)
FLAIR	Hypointense but never like CSF (grey)	Hypointense like CSF (black)
Diffusion	Restricted diffusion	Free diffusion

How to differentiate arachnoid cyst from epidermoid cyst:

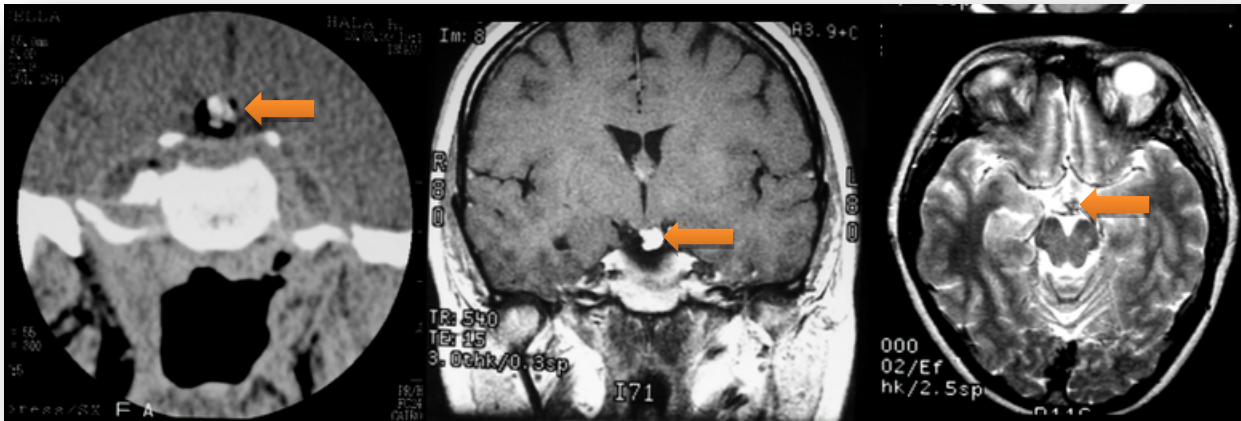
- If both a cyst is difficult to differentiate from appearance, then FLAIR & Diffusion will differentiate.



Epidermoid cyst showing lobulated surface, hypointensity in FLAIR

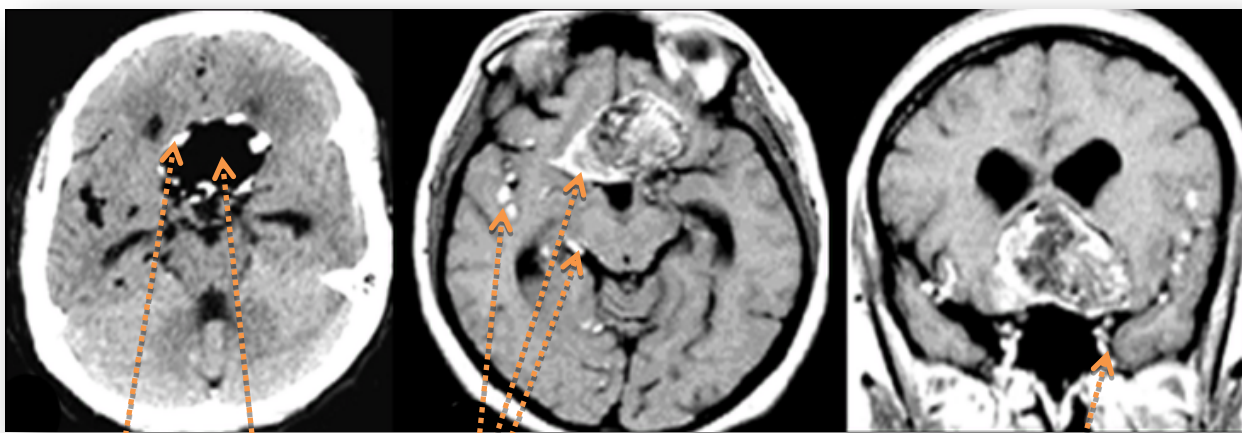
3) Dermoid cyst:

- Rare
- Site: **Midline**
- CT: fat density (marked hypodensity -10:-150 HU)
- MRI: fat intensity (hyperintense in T1, hypointense in T2)
- May rupture intraventricular causing fat fluid level
- May show calcifications



CT showing cystic lesion with marked hypodensity (fat)

T1 showing hyperintense lesion so it is either fat or blood, but it is hypointense in T2 and hypodense in CT, so the cyst contains fat.

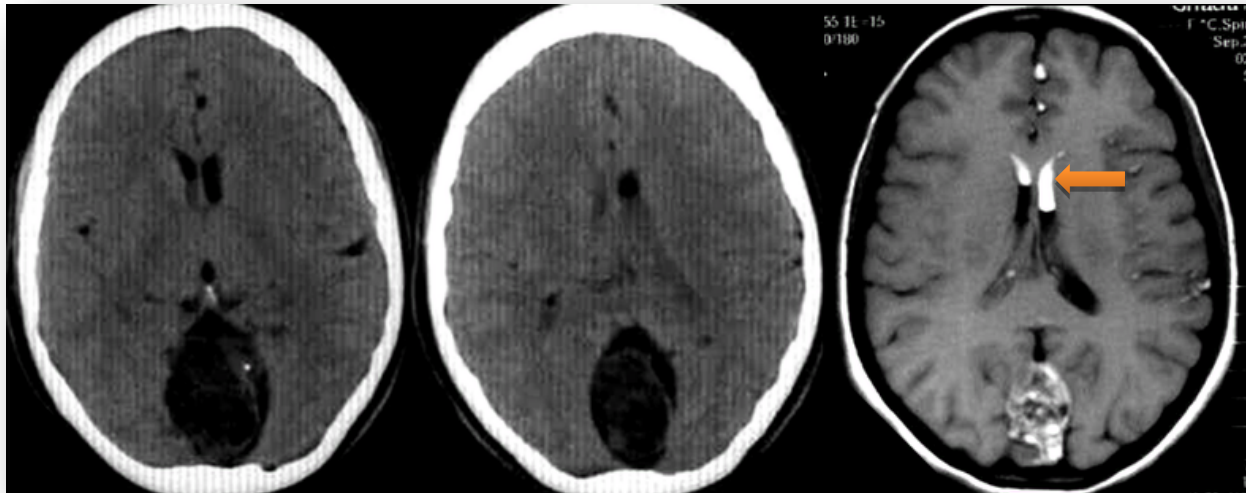


Calcium Fat

Fat hyperintense in T1

Intraventricular Fat

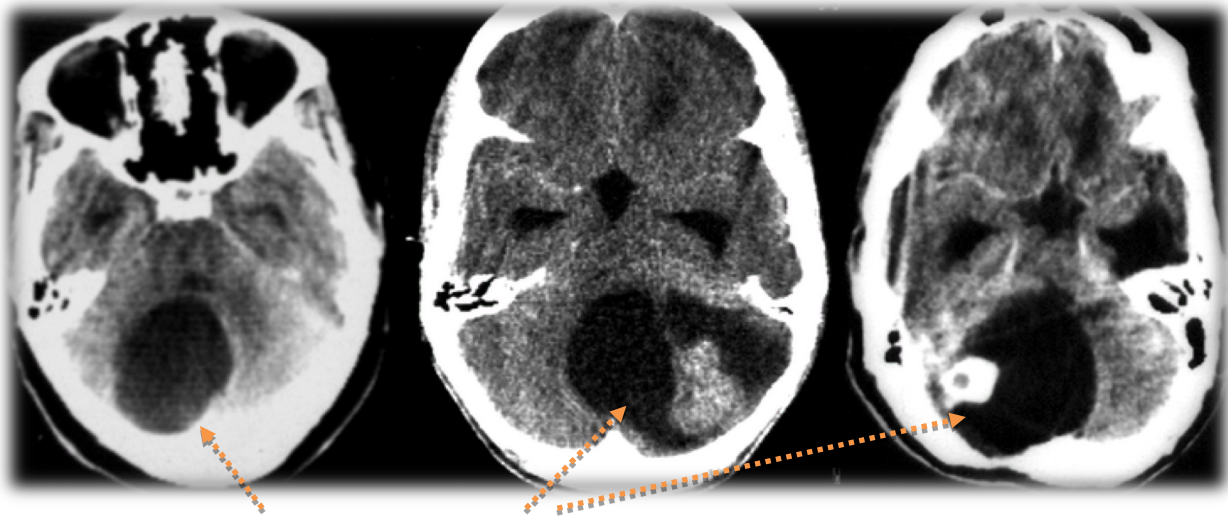
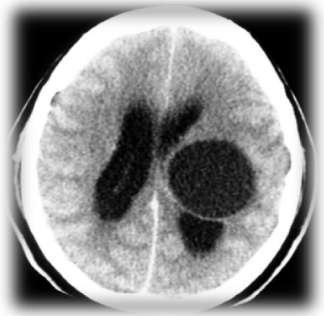
Dermoid cyst may rupture inside the ventricle: CT showing dermoid cyst with calcifications, MRI showing the dermoid cyst ruptured with intraventricular fat



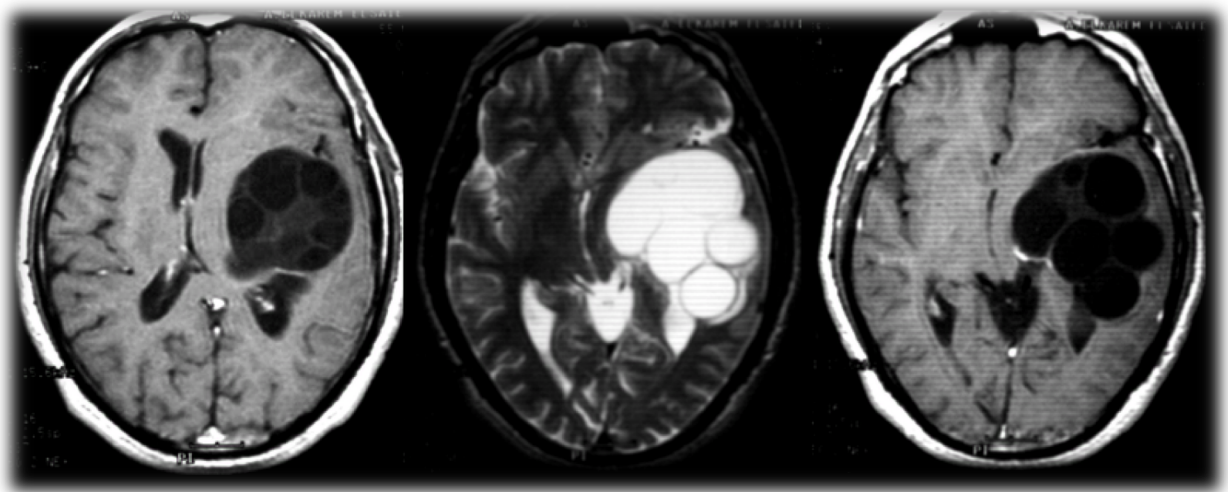
Dermoid cyst black in CT, heterogeneously white in T1, ruptured in the ventricle causing fat floating over CSF

4) Hydatid cyst:

- 2% of intracranial SOL
- The only cyst present inside the brain parenchyma
- CT: unilocular cyst of CSF density with no edema
- MRI: low SI in T1, high SI in T2
- May show calcifications



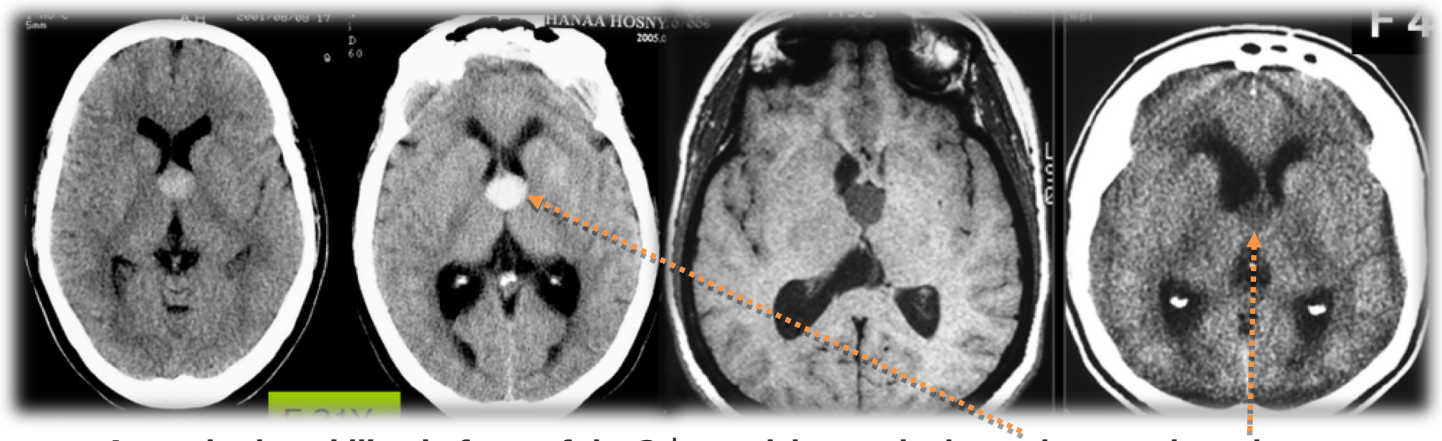
Compare between hydatid cyst and pilocytic astrocytoma in posterior fossa (mural nodule)



Hydatid cysts in MRI

5) Colloid cyst:

- Considered a glioma and represents 2% of all glial neoplasms
- Site: **Anterior to 3rd ventricle only**
- Contains dense viscid mucoid substance
- CT: **Midline** lesion with no contrast enhancement, density depend on the contents
- MRI: variable signals depending on the contents



A cyst in the midline in front of the 3rd ventricle may be hyperdense or hypodense

