

Lecture 9:

# Radiology of common brain diseases



Radiology Team  
Med433

● Slides

● Explanation

● Notes

● Additions

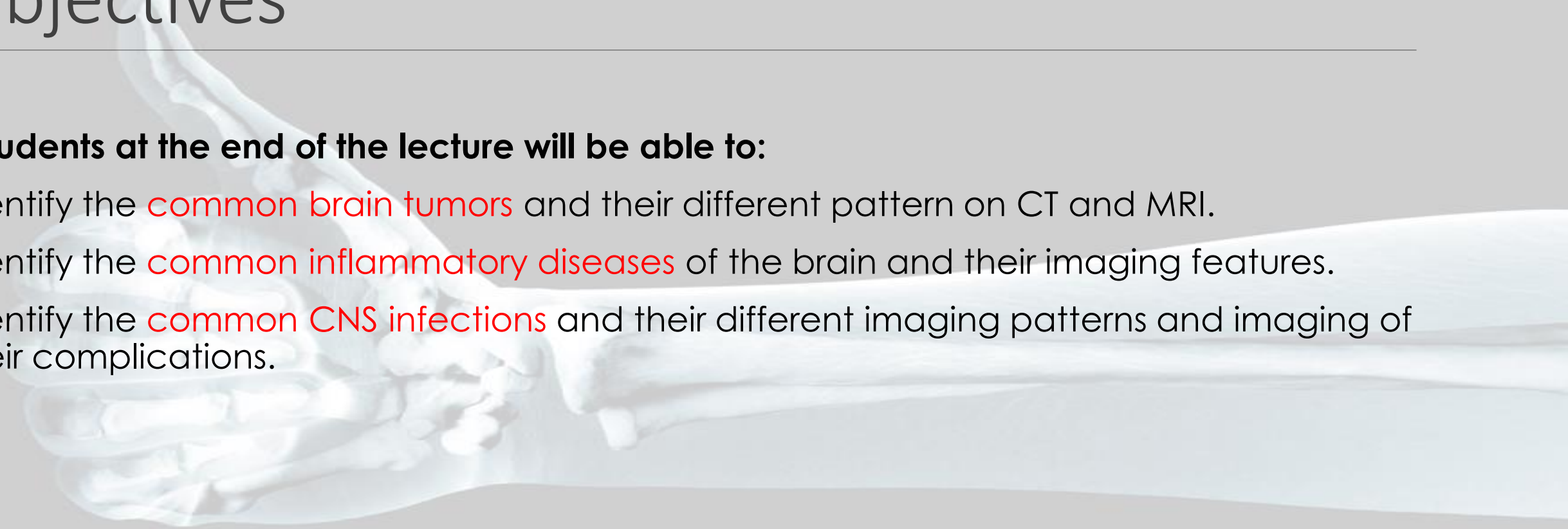
● Important

# Objectives

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**Students at the end of the lecture will be able to:**

- Identify the **common brain tumors** and their different pattern on CT and MRI.
- Identify the **common inflammatory diseases** of the brain and their imaging features.
- Identify the **common CNS infections** and their different imaging patterns and imaging of their complications.



# 1. Brain Tumors

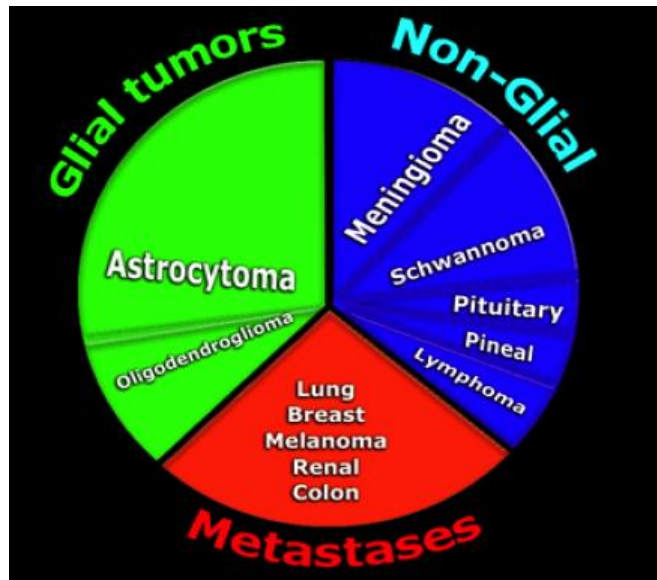
Radiological approach of brain tumor (look first is it solitary or multiple)

Solitary <small>wide DDx &gt;Localize the site first</small>	Multiple <small>narrow DDx</small>
Supratentorial/infratentorial	Metastases
Intra axial / extra axial	Lymphoma or Leukemia
Specific anatomic area	Multicentric GBM
CT/MRI texture, pattern of enhancement	Gliomatosis cerebri
Explained in next slide	Tumor with seeding "primary brain tumor that seeds to other parts of the brain"
	Multiple tumors in phacomatoses "as neurofibromatosis type2"

+ **Age Child/Adult**

The age of the patient is an important factor for the differential diagnosis.

Pathological classification



## Common Intra-Axila (inside the brain parenchyma) Tumors in Pediatric

Supratentorial	Infratentorial
Astrocytoma	Juvenile pilocytic astrocytoma
Pleomorphic xanthoastro (PXA)	Medulloblastoma
Ganglioglioma	Ependymoma
PNET (Primitive neuroectodermal tumor)	Brainstem astrocytoma
DNET (Dysembryoplastic neuroepithelial tumour)	Atypical teratoid/rhabdoid tumor

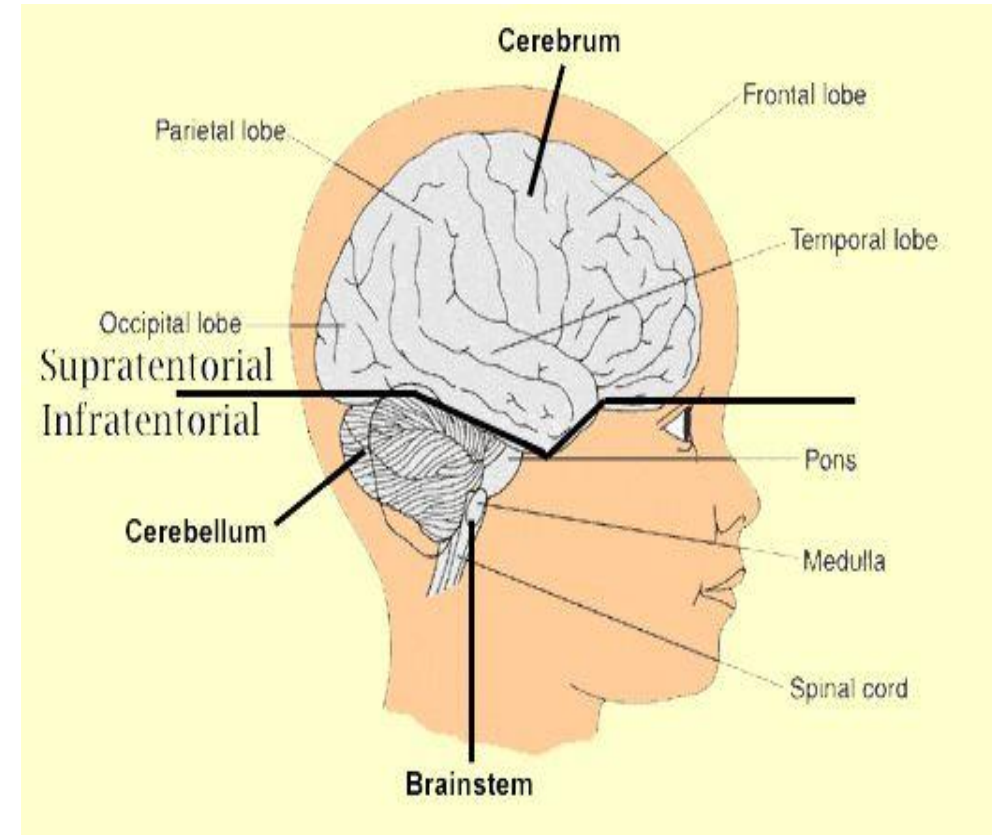
## Common Intra-Axila Tumors in Adult

Supratentorial Metastases	Infratentorial Metastases
Gliomas: <ul style="list-style-type: none"> <li>• Diffuse astrocytoma</li> <li>• Anaplastic</li> <li>• <b>Glioblastoma Multiforme</b></li> <li>• oligodendroglioma</li> </ul>	Hemangioblastoma

The common tumors in adult are usually metastasis

## Cont...Brain Tumors

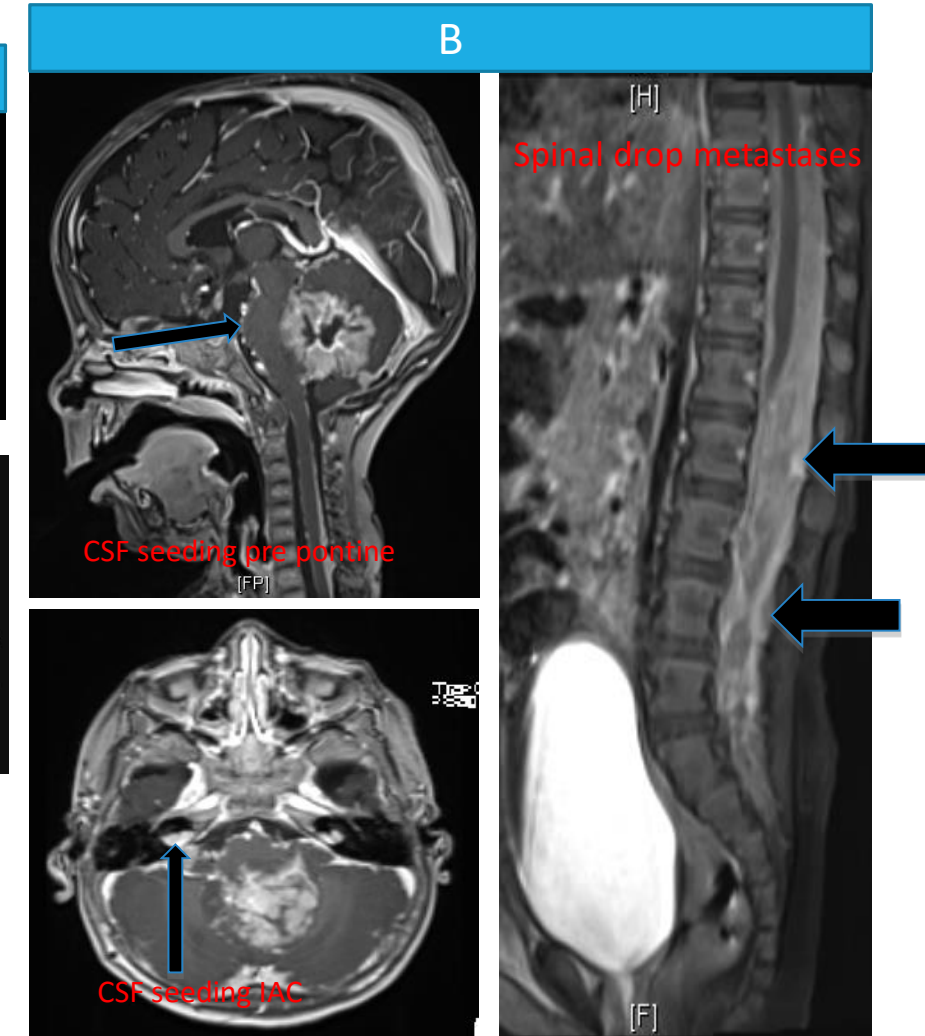
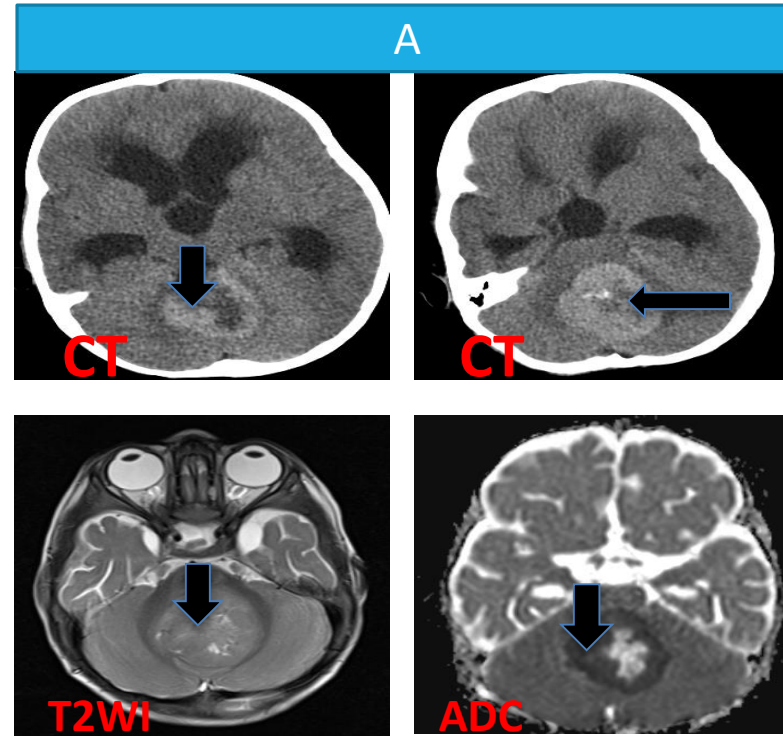
- ❖ **Supratentorial region of the brain** is the area located above the tentorium cerebelli which contains cerebrum.
- ❖ **Infratentorial region of the brain** is the area located below the tentorium cerebelli which contains cerebellum and brainstem .
- ❖ **Intra axial** :inside brain Parenchyma.
- ❖ **Extra axial** :outside brain parenchyma usually meninges.
- ❖ **Specific anatomic area** : sellar and parasellar, perneal gland ,cerebellopontine angle since they have certain types of tumors .



# Common Intra-Axila Infra tentorial Tumor in Pediatric

## 1-Medulloblastoma

- PNET
- WHO **IV**
- Midline >85% 4<sup>th</sup> V
- Age incidence < 10 y, second peak 20-40y.
- Cysts 40%
- Ca++(calcification) 20-25%



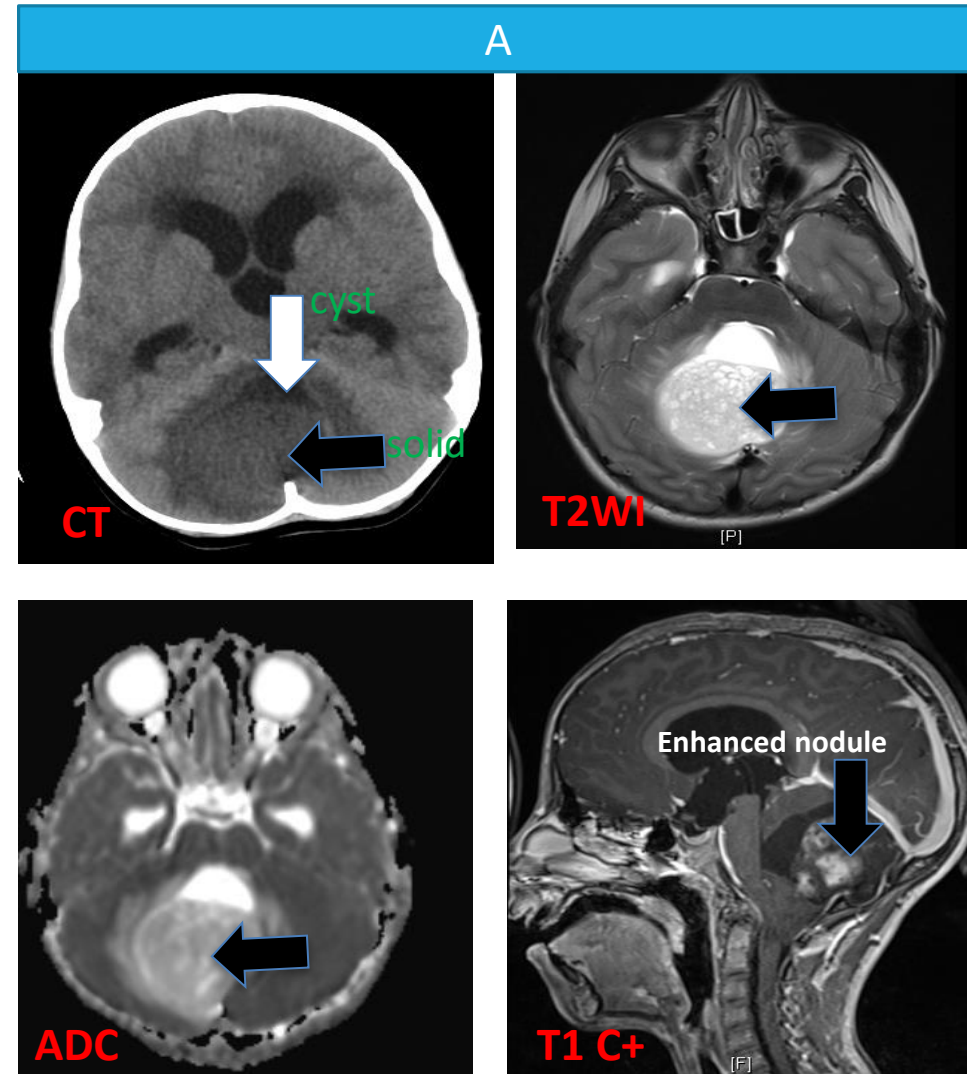
Picture	
A	Hyperdense on CT (white)
	Low / intermediate signal on T2WI (bright)
	Diffusion restriction on ADC (dark)
B	Enhances post contrast injection (heterogeneous strong enhancement)
	CSF seeding and drop metastases are common

# Common Intra-Axila Infra tentorial Tumor in Pediatric

## 2-Juvenile pilocytic astrocytoma

- Low grade I
- Age incidence 5-15 years
- Cyst with enhancing nodule (Most are cyst with solid mural nodule)

Picture	
A	Low density on <u>CT</u>
	High signal on <u>T2WI</u>
	<u>No</u> diffusion restriction on <u>ADC</u> (Bright)
	Enhanced solid mural nodule while the cyst is not



# Common Intra-Axila Supra tentorial Tumor in Adult

## 1-Glioblastoma Multiforme (GBM)

- WHO grade **IV (high grade)**
- Most common 1ry brain tumor and most malignant
- **60-75% of astrocytoma**
- Peak age **45-75 years**
- Can occur at any age even neonates and infants
- **Cerebral hemisphere (subcortical, periventricular and across compact tract), Basal ganglia and thalamus.**

Picture

Heterogeneous complex mass (**solid with necrotic core**)

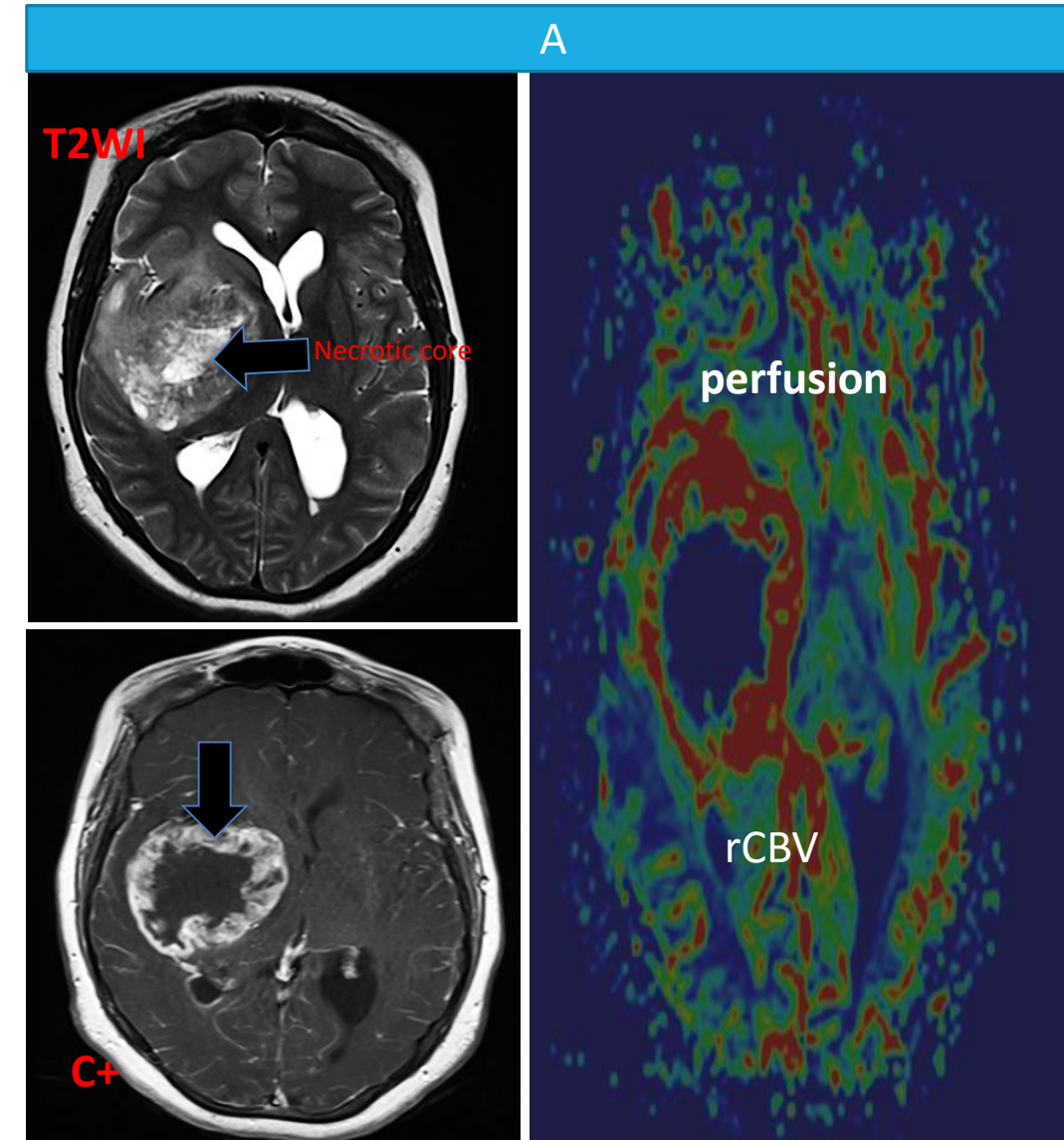
**Thick irregular** nodular **peripheral** enhancement

High perfusion value (more red more perfusion more high grade)

Mass effect

A

If the surgeon need to do biopsy he should do biopsy from periphery of the mass not from the center because the center is will be necrotic core will not get cells , cells are high cellular part of tumor which is in periphery .

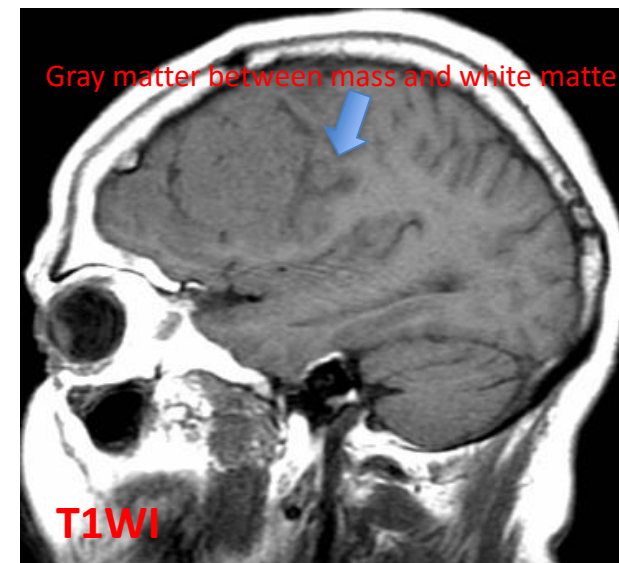


## Extra Axial (outside of the brain parenchyma) tumor

- **Meningioma (most common)**
- **Metastasis** (calvarial, dural and leptomeningeal) **Dural** (breast, lung, prostate, melanoma, neuroblastoma, lymphoma and leukemia) **leptomeningeal** (CSF seeding from GBM, AA, medulloblastoma and ependymoma)
- **Schwannoma (exit from nerve root)**
- **Epidermoid**
- **Dermoid**
- **Arachnoid cyst**

### Signs of Extra-Axial Location :

- ✓ CSF cleft
- ✓ Broad dural base
- ✓ Cortical gray matter between mass and white matter
- ✓ Displaced subarachnoid vessels





# Meningioma

**Meningioma** is the most common type of **extra-axial neoplasm** and accounts for 14 - 20% of intracranial neoplasms. It is a non-glial neoplasm that originates from the arachnoid cap cells of the **meninges**.

## Location

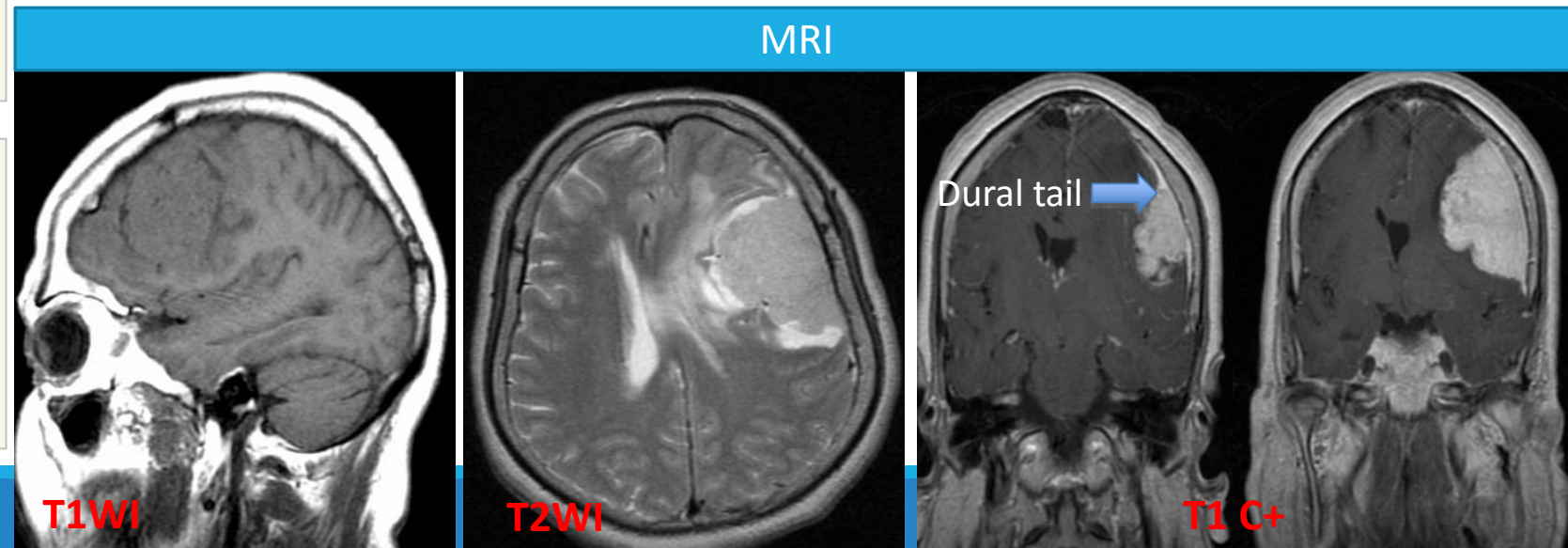
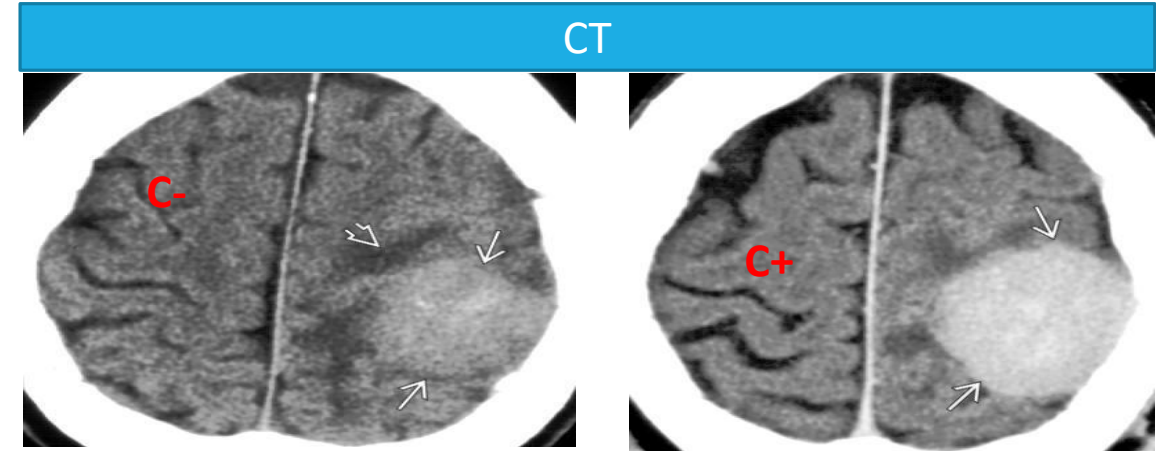
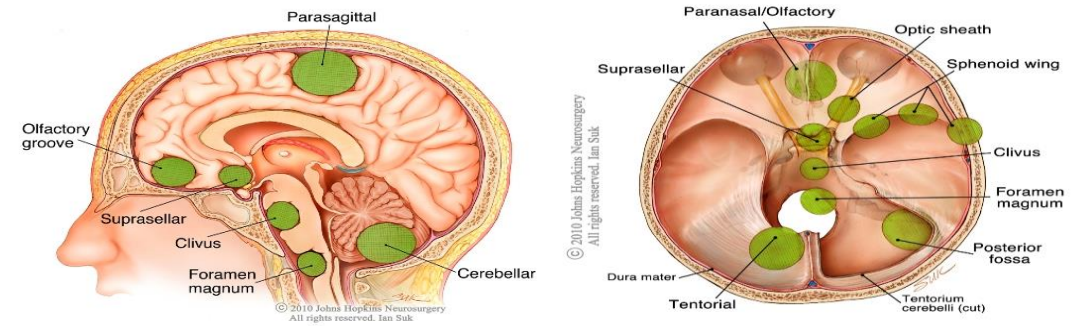
- **85 - 90% supratentorial**
- 45% parasagittal, convexities
- 15 - 20% sphenoid ridge
- 10% olfactory groove / planum sphenoidale
- 5 - 10% juxtaseellar

## CT:

- 60% mild-moderate **hyperdense** to normal brain
- 60% **peri tumoral vasogenic edema**
- 20 - 30% have some calcification <sup>8</sup>
- Vast majority of meningioma **enhance strongly and uniformly**

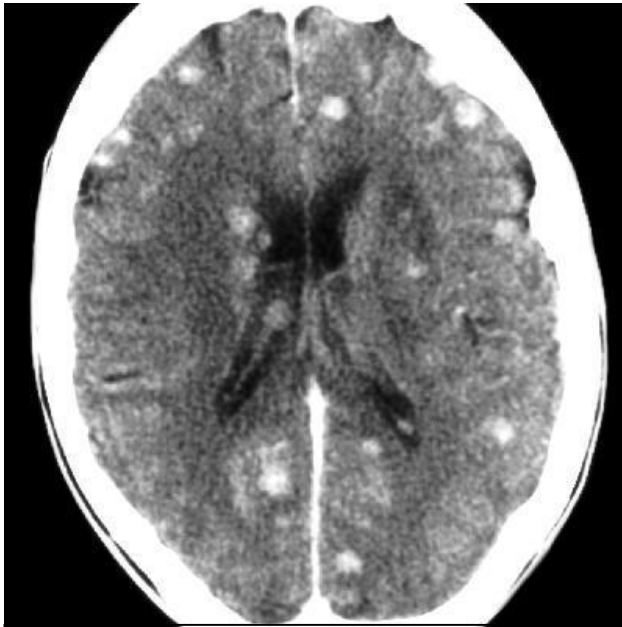
## MRI

- T1** : Isointense ; : ~ 60 - 90%
- T2**: isointense : ~ 50%
- T1 C+ (Gd)** : **usually intense and homogenous enhancement**.
- Dural tail sign** seen in 60-70% (not specific to meningioma, it can be seen in any tumor attached to dura).

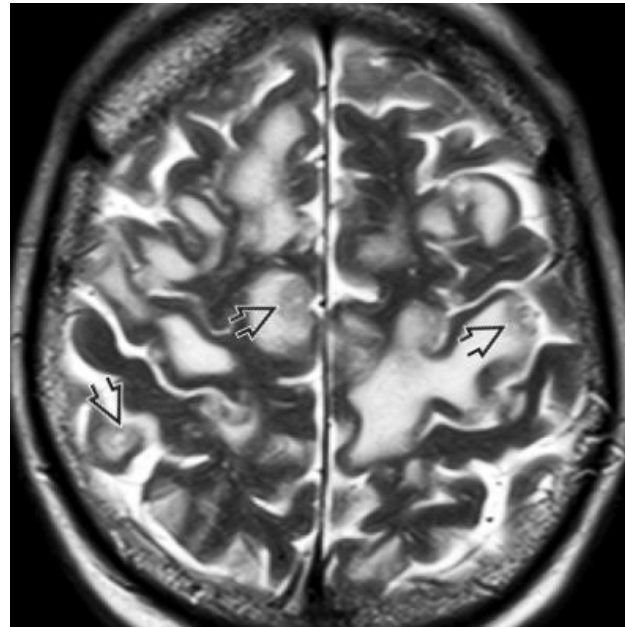


## Secondary Brain Tumors (Brain Metastases)

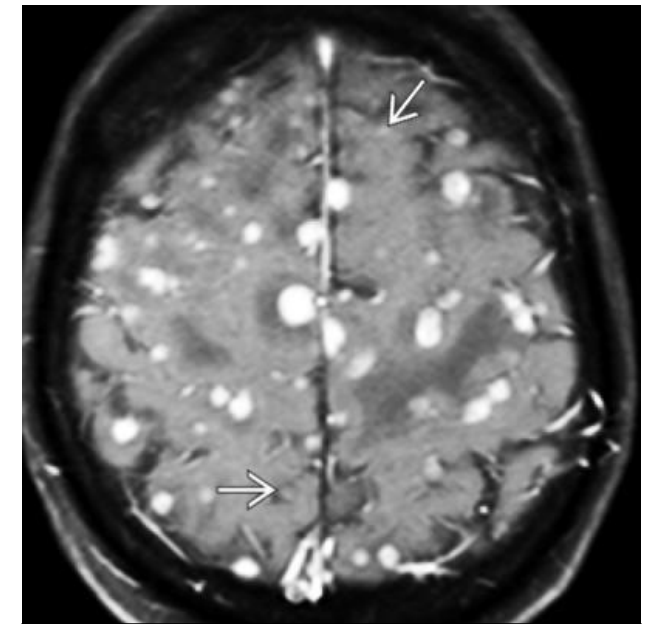
- **Metastatic brain tumors are the most common brain tumors.**
- The primary cancer is usually in the lung, breast, colon, kidney, or skin (melanoma), but can originate in any part of the body.
- Most are located in the cerebrum (supratentorial) , but can also develop in the cerebellum or brain stem(Infratentorial).
- More than half of people with metastatic tumors have **multiple lesions** (tumors)
- **The common thing is all secondary are enhancing post-contrast .**



**CT+(CT post contrast)**  
**Multiple enhanced lesions at**  
**Grey-white matter interface**



**MRI T2WI**  
**Multiple slightly hyperintense**  
**nodules with surrounding edema**



**MRI T1WI C+**  
**The nodules are strongly**  
**enhanced**

## Specific anatomic area

### Sellar and Parasellar masses

Adult	Child	Other less common
<ul style="list-style-type: none"><li>▪ <b>Adenoma</b> (common)</li><li>▪ Meningioma</li><li>▪ Aneurysm</li></ul>	<ul style="list-style-type: none"><li>▪ <b>Craniopharyngioma</b> (common)</li><li>▪ Hypothalamic/optic chiasm pilocytic astrocytoma</li></ul>	<ul style="list-style-type: none"><li>▪ Metastasis</li><li>▪ Lymphoma</li><li>▪ Hypothalamic hamartoma</li><li>▪ Rathke cleft cyst</li><li>▪ Arachnoid cyst</li><li>▪ Epidermoid</li><li>▪ Dermoid</li><li>▪ Germinoma</li></ul>

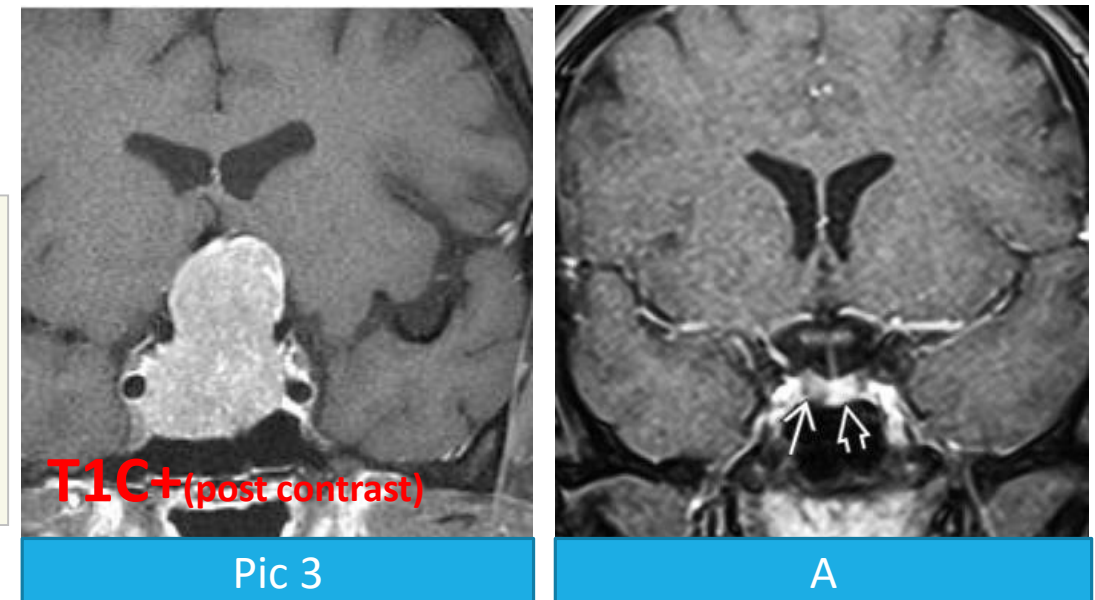
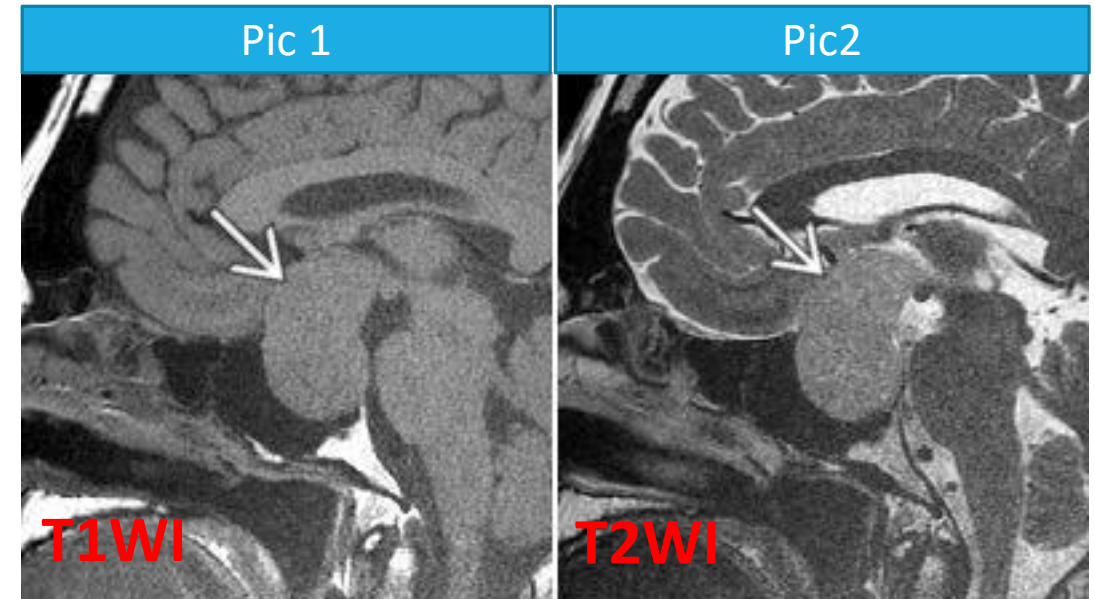
# Pituitary adenoma in adult

- Pituitary adenomas are accounting for 10-15% of primary intracranial neoplasms.
- All are WHO grade I tumors.
- Types of adenoma according to size of tumor : **Macroadenoma and Microadenoma**.

Pics 1,2,3

- **Macroadenomas** are defined as tumors  $\geq 10$  mm in diameter.
- Macroadenomas are usually **isointense** with cortex on T1WI and T2WI.
- **Cysts and hemorrhage** are common.
- Most macroadenomas **enhance strongly**(because there is no blood brain barrier) but heterogeneously on T1 C+.
- Patient usually complains of **pressure symptoms**( visual field defect, headache ).

- **Microadenomas** are defined as tumors  $\leq 10$  mm in diameter.
- Patient usually comes with **high prolactin level**.
- **Dynamic contrast-enhanced study** usually used **for detection of small microadenomas**.
- Picture A :Early coronal image from a dynamic contrast-enhanced sequence shows the intensely, rapidly enhancing normal gland (white open arrow). The mass enhances more slowly and so appears relatively hypointense (white arrow).

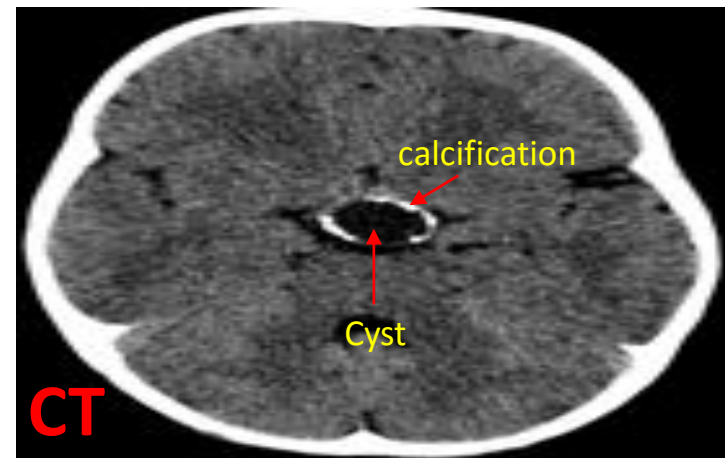


# Craniopharyngioma in children

- **Craniopharyngiomas** are a type of relatively benign (WHO grade I) neoplasm which typically arises in the sellar / suprasellar region.
- They account for ~ 1 - 5 % primary brain tumours.
- They derive from remnants of the **craniopharyngeal duct** (narrowing which separates Rathke's pouch from the primitive oral cavity), and can occur anywhere along the infundibulum (from floor of the third ventricle, to the pituitary gland).
- **Craniopharyngiomas are primarily suprasellar tumors (75%).**
- A small intrasellar component is present in 20-25% of cases.
- Two types of craniopharyngiomas are recognized: Adamantinomatous 90% , Papillary 10%.

## CT :

- Typically seen as a heterogeneous mass in the **suprasellar region**.
- Overall, **calcification is very common**, but this is only true of the adamantinomatous subtype (90% are calcified).
- **The pattern of calcification is typically stippled and often peripheral in location.**
- Cysts are seen in 70 - 75% of cases and are a more dominant feature of the adamantinomatous type.



Q:how to differentiate between pituitary adenoma and craniopharyngioma ?

By presence of calcification in CT which is very likely to be seen in craniopharyngioma.

(CT scan is more sensitive in detecting calcification than MRI)

## Cont...Craniopharyngioma in children

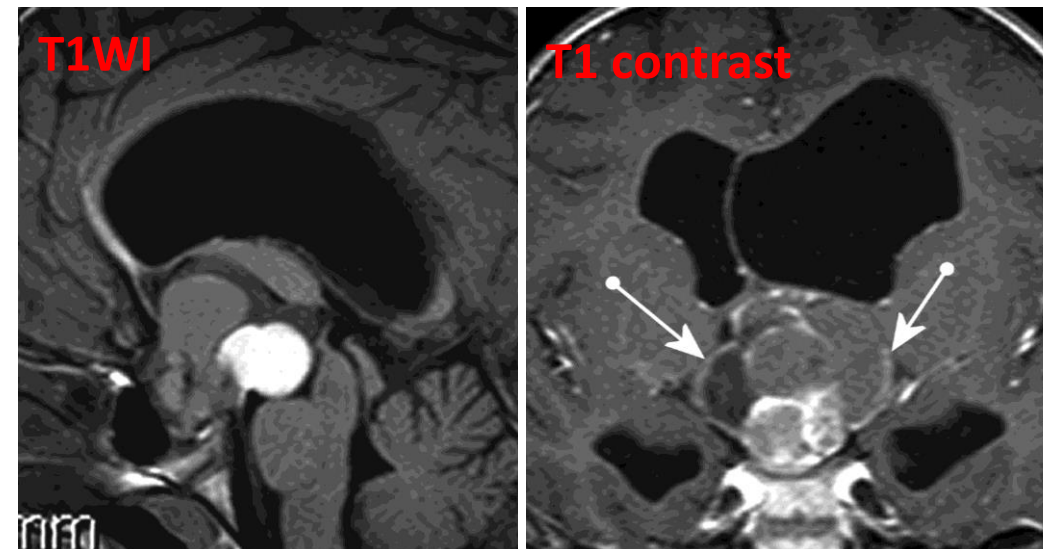
### MRI

MR features can significantly vary depending on the histological subtype and on the size and content of the cysts.

**T1WI** : signal intensity varies [depending on cyst contents](#), and can appear **hyperintense (white)** due to protein, blood products, and / or cholesterol

**T1 C+ (Gd)** : contrast enhancement is typical, with thin enhancement of the cyst wall, or diffuse heterogeneous enhancement of the solid components.

**T2WI** : signal is high in both solid and cystic components, but is variable depending on content of fluid



## 2.Demyelinating and Inflammatory Diseases

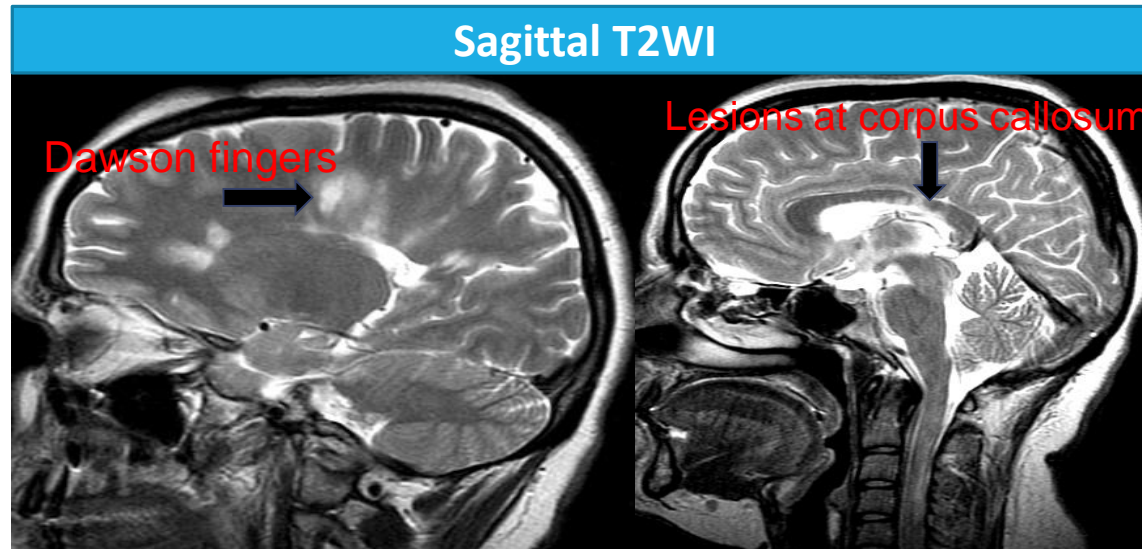
- **Inflammation is not synonymous with infection.**
- Inflammation is the response of tissues to a variety of pathogens (which may or may not be infectious microorganisms). The inflammatory "cascade" is complex and multifactorial.
- It involves the vascular system, immune system, and cellular responses such as microglial activation, the primary component of the brain's innate immune response.
- Inflammation can be acute or chronic, manageable or life-threatening. Imaging plays a central role in the identification and follow-up of neuroinflammatory disorders.

# MULTIPLE SCLEROSIS (MS)

- Is a chronic, persistent inflammatory-demyelinating disease of the central nervous system ,characterized pathologically by areas of inflammation, demyelination, axonal loss and gliosis scattered throughout the CNS.
- **Etiology:** unknown  
autoimmune-mediated demyelination.
- **Age:** 20-40 years  
female preponderance in young
- According to the **McDonald criteria** for MS, the diagnosis requires objective evidence of lesions disseminated in **time and space.** As a consequence there is an important role for MRI in the diagnosis of MS, since MRI can show multiple lesions (dissemination in space), some of which can be clinically occult and MRI can show new lesions on follow up scans (dissemination in time).

## Characteristic location:

- Corpus callosum
- U fibers (juxtacortical)
- Periventricular (Dawson's fingers)
- Temporal lobes
- Brainstem
- Cerebellum
- Spinal cord
- Optic nerve



## Cont...MULTIPLE SCLEROSIS

**T1WI** : lesions are typically **iso to hypo intense** (chronic)

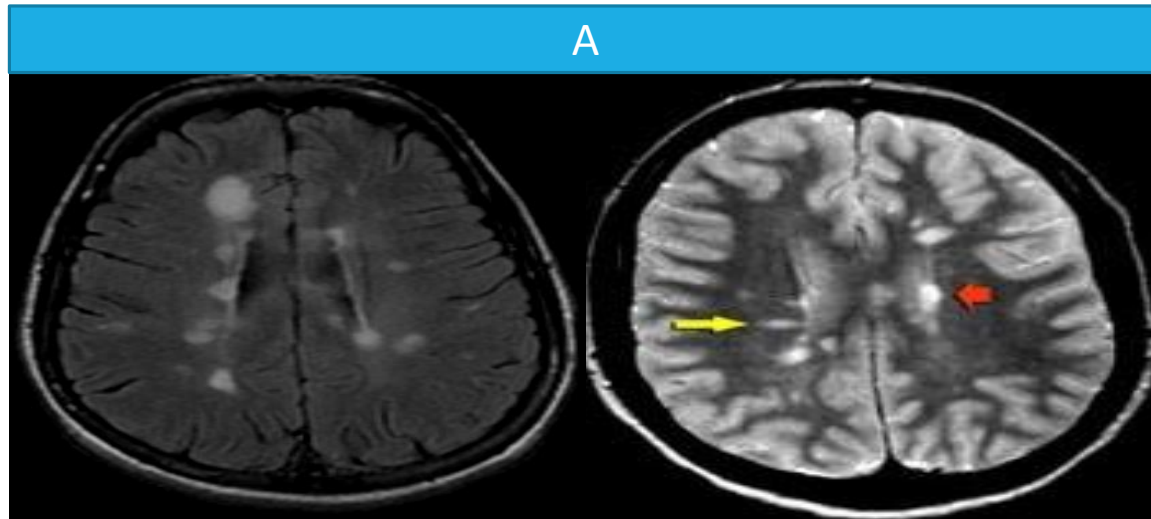
**T2WI** : lesions are typically **hyper intense**

**FLAIR** : lesions are typically **hyper intense**

when arranged perpendicular to lateral ventricles, extending radially outward (best seen on parasagittal images) they are termed **Dawson fingers**.

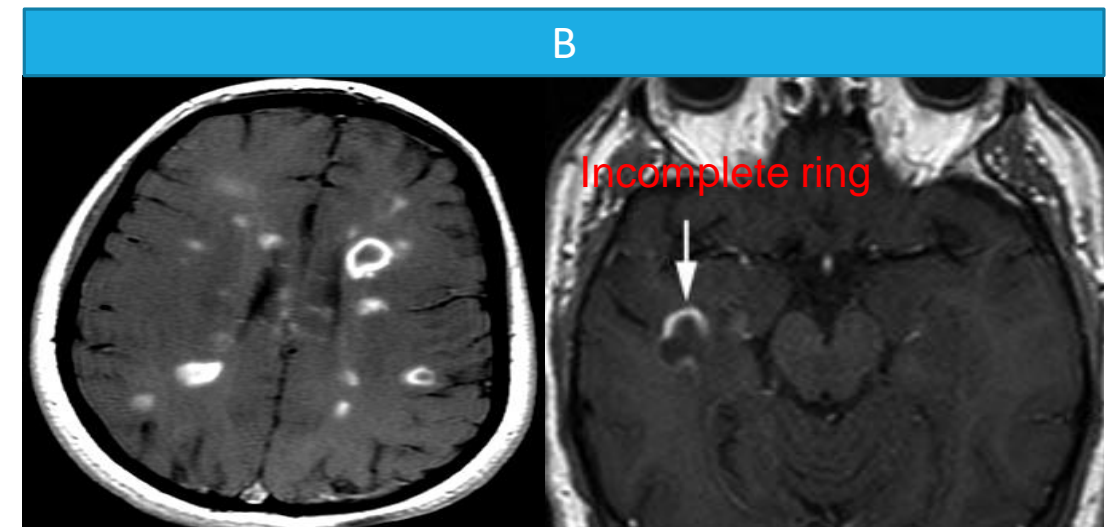
**T1 C+ (Gd)** : **active lesions** show enhancement .

enhancement is often incomplete around the periphery (**open ring sign**).



**The most common lesions are: A**

- Multiple
- **Discrete ovoid/round ± some confluence**
- Bilateral asymmetrical
- Preferentially located along lateral ventricles



**Enhancement pattern: B**

- Nodular solid – 70%
- Thick complete ring – 20%
- **C-shaped or incomplete ring – 10% characteristic for MS**
- Thin irregular marginal



### 3. CNS infections

According to type of organisms				According to pattern of diseases	
Viral infection	Bacterial infection	Fungal infection	Parasitic infection	Congenital / Neonatal	Acquired
<ul style="list-style-type: none"> <li>▪ Herpes virus</li> <li>▪ Varicella</li> <li>▪ HIV</li> <li>▪ SSPE</li> <li>▪ Creutzfeldt-Jakob disease</li> <li>▪ ADEM</li> <li>▪ Rasmussen Encephalitis</li> </ul>	<ul style="list-style-type: none"> <li>▪ Pyogenic</li> <li>▪ Spirochetes</li> <li>▪ TB</li> </ul>	<p>-----</p>	<ul style="list-style-type: none"> <li>▪ Toxoplasma</li> <li>▪ Cysticercosis</li> <li>▪ Amoeba</li> <li>▪ Hydatid</li> </ul>	<ul style="list-style-type: none"> <li>▪ TORCH ( <u>T</u>oxoplasmosis , <u>R</u>ubella , <u>C</u>ytomegalovirus and <u>H</u>erpes )</li> <li>▪ HIV</li> </ul>	<ul style="list-style-type: none"> <li>▪ <b>Meningitis</b></li> <li>▪ Pyogenic parenchymal infection: cerebritis/abscess</li> <li>▪ Encephalitis</li> <li>▪ T.B, fungal</li> <li>▪ Parasitic</li> </ul>

# Meningitis

Most common form of CNS infection.

## Types:

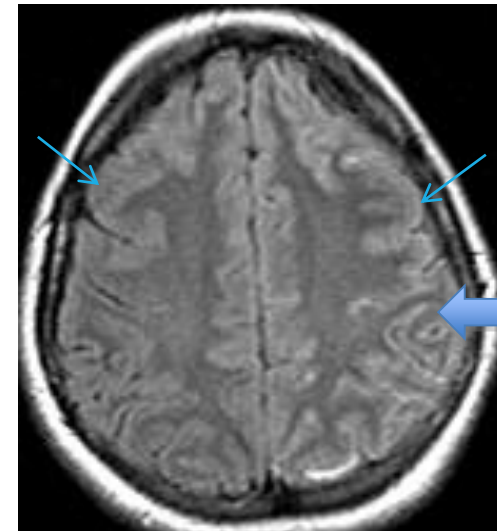
- Acute pyogenic ( bacterial )
- Lymphocytic ( viral )
- Chronic : T.B and coccidiomycosis

**Pathology : Purulent exudates in basal cisterns and subarachnoid spaces.**

## Imaging :

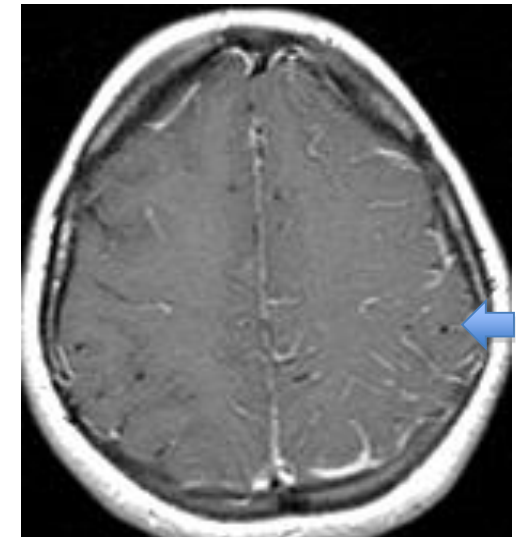
- Most common finding is normal scan in CT & MRI**
- Mild ventriculomegaly (early) > Mild enlargement of the ventricular system
- Effacement of basilar and convexity cisterns
- Enhancing meninges.**
- Increased signal of subarachnoid space on FLAIR.**

- The role of radiological imaging in case of meningitis is monitoring complication of meningitis not for diagnosis.
- Meningitis is diagnosed by lumbar puncher & clinical findings.



**Axial FLAIR**

Increased signal at subarachnoid space (compare right and left )



**Axial T1 C+**

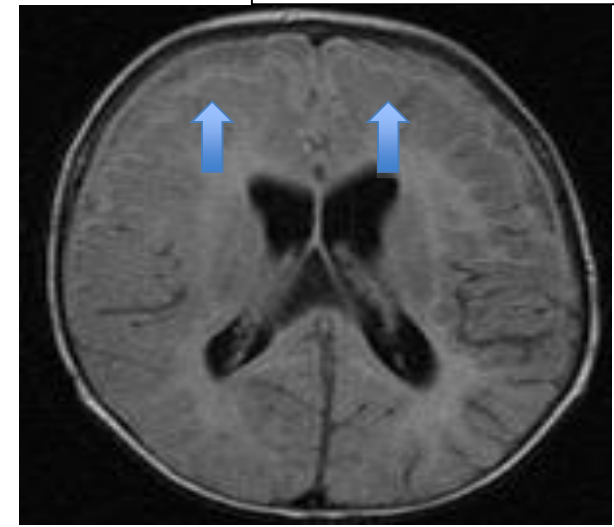
Enhancing meninges

# ACUTE PYOGENIC MENINGITIS

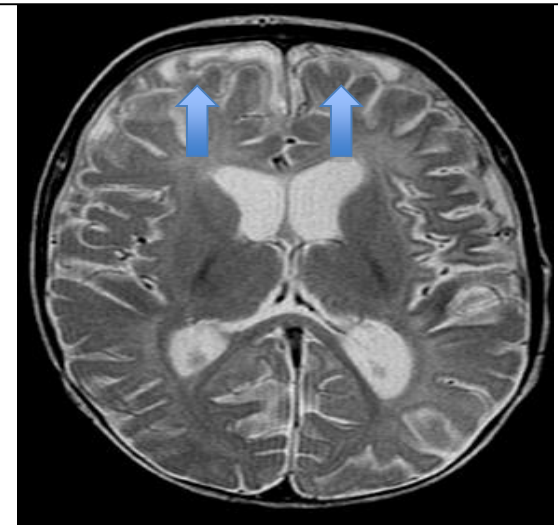
## Complications :

- Hydrocephalus and ventriculitis
- Subdural effusion (clear fluids)
- Empyema (Purulent fluids)
- Cerebritis and abscess
- Cerebrovascular complication

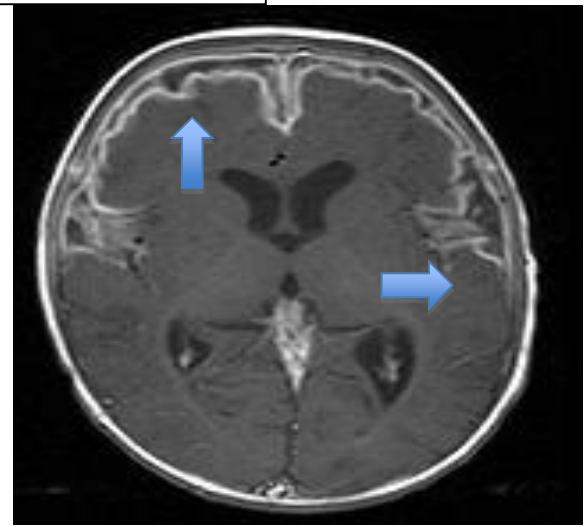
## SUBDURAL EMPYEMA



Axial T1WI



Axial T2WI

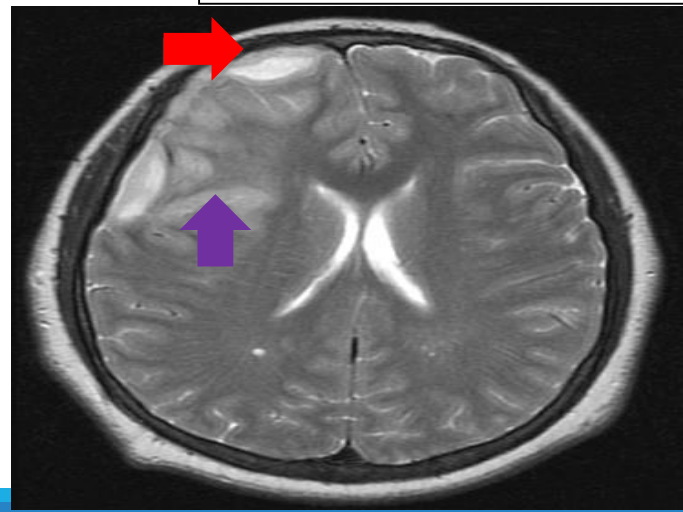


Axial T1 C+  
Thick enhanced meninges

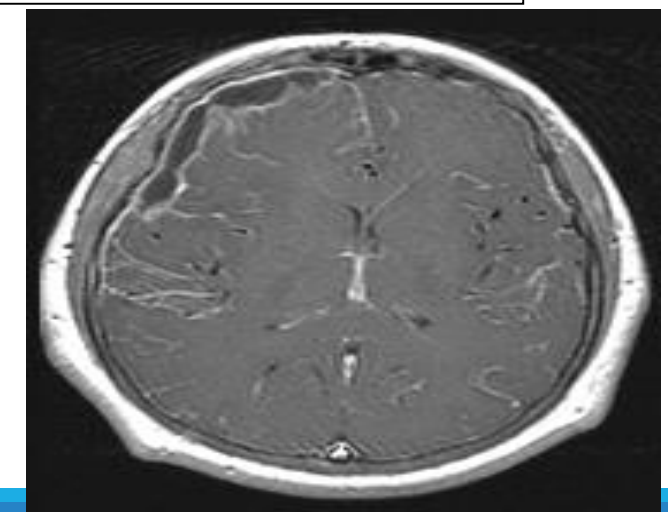
Widening of bi-frontal subdural space

## Subdural collection with underlying cortical cerebritis

Red arrow: Subdural collection  
Purple arrow : Swollen cortex due to cerebritis



Axial T2WI

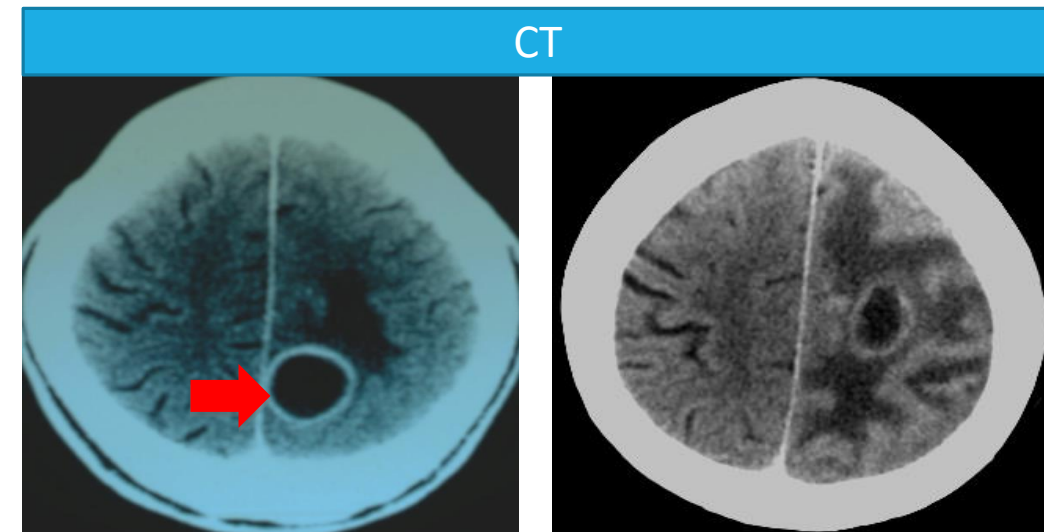


Axial T1 C+

# BRAIN ABSCESS

## CT Brain:

- central **low density**
- iso / hyperdense ring
- peripheral low density (**vasogenic oedema**)
- Peripheral thin smooth regular ring enhancement ( red arrow )**

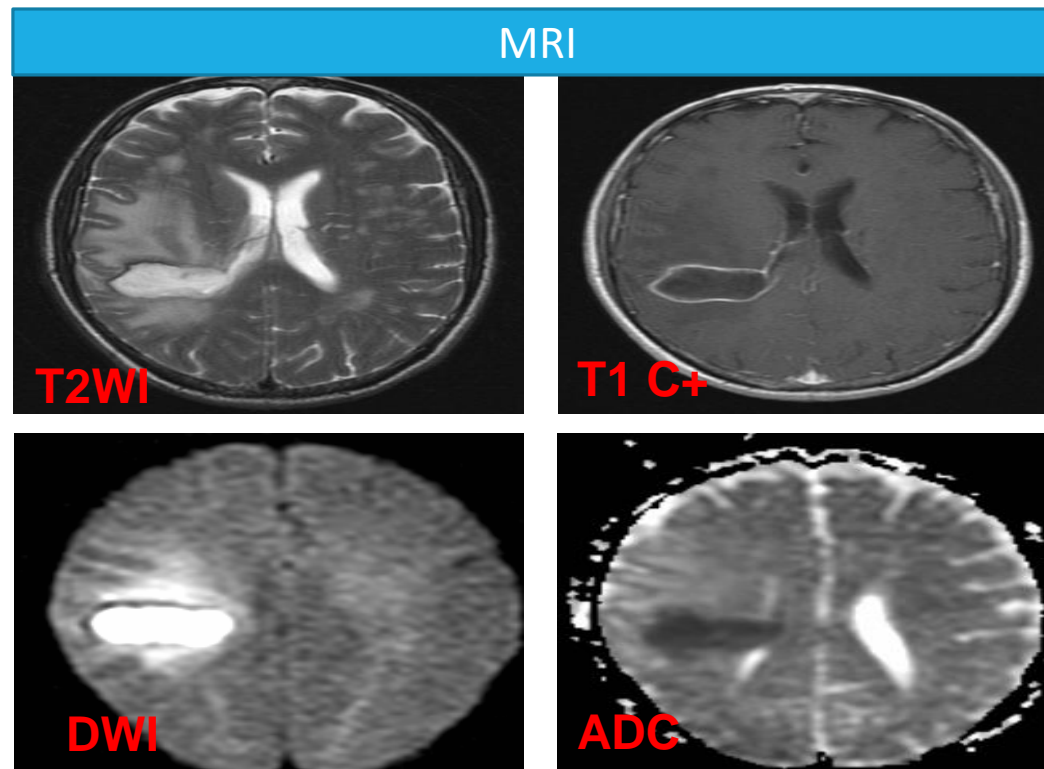


## MRI Brain:

- T1WI:** Low signal intensity.
- T2WI:** **high signal intensity surrounded with vasogenic edema.**
- T1 C+:** **peripheral thin smooth regular ring enhancement.**

We have to describe the pattern of enhancement (is it thick or thin ?/ is it smooth or irregular ?)

- DWI:** **diffusion restriction (Not specific characteristic)**
- Mild mass effect on the right lateral ventricle



# Encephalitis

Diffuse non-focal parenchymal inflammatory disease that can be caused by broad spectrum of agents, the most common are viral.

## HERPES SIMPLEX ENCEPHALITIS :

- Most common viral encephalitis.
- HSV2 in neonates, HSV1 in children & adults.
- Transported along sensory fibers to olfactory nerve or gasserian ganglion

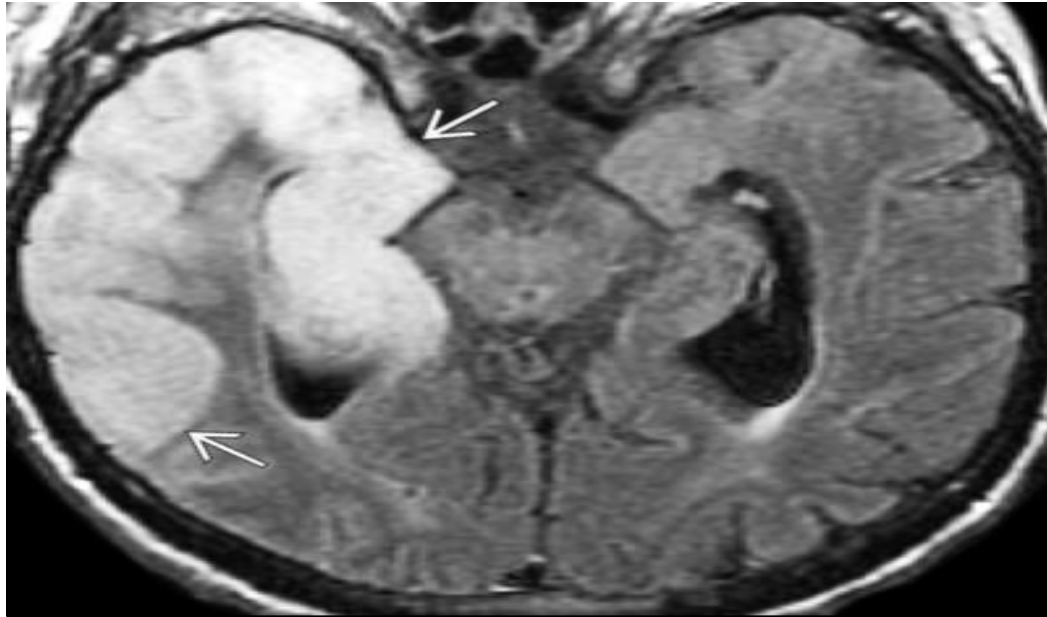
Location :



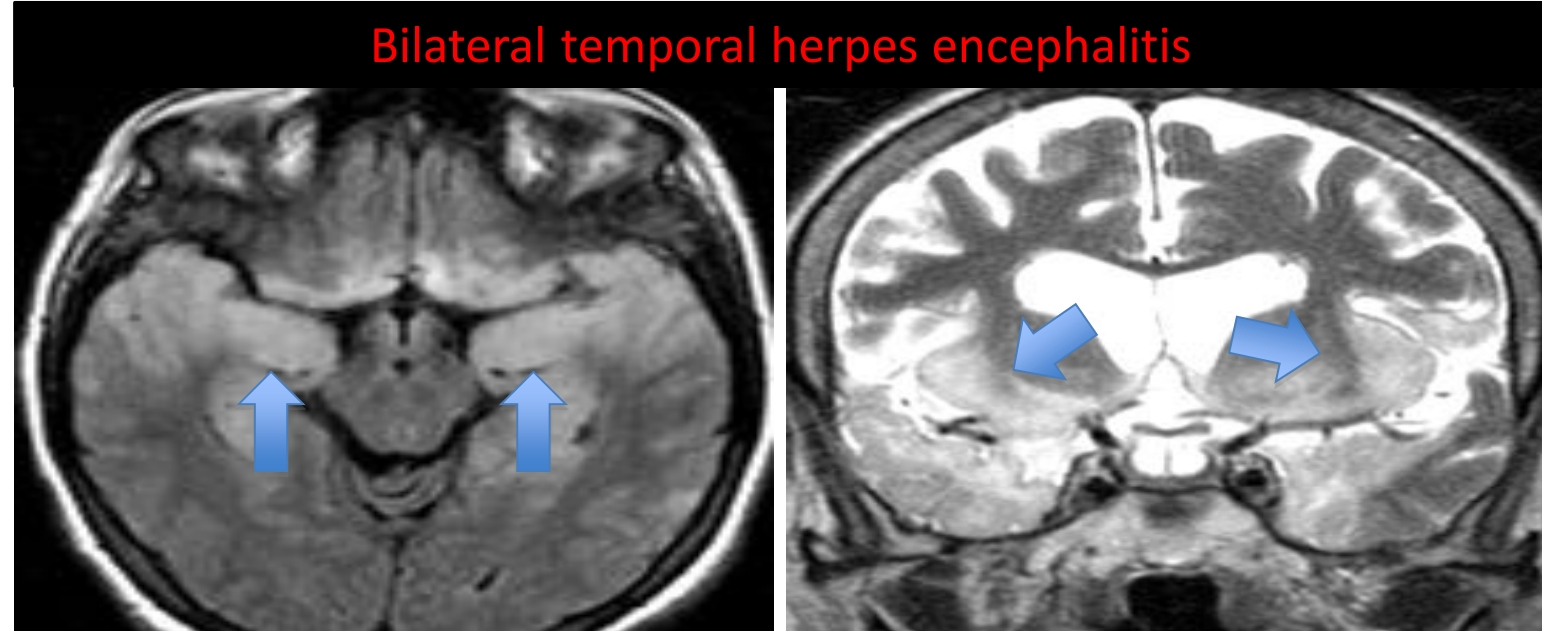
\*\* At early stage it will be unilateral then it will progress to become bilateral.

\*\* It progress gradually until it reaches singulate gyrus.

## Cont...HERPES SIMPLEX ENCEPHALITIS



Axial FLAIR shows: **striking hyperintensity, cortical swelling of the right temporal lobe** (white arrow) due to Herpes simplex encephalitis.



Axial FLAIR

Coronal T2WI

# Thank You!

We hope you found this helpful and informative.

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Done by:

- Rahma Alshehri
- Kholoud Aldosari

Reviewed by:

- Kholoud Aldosari
- Abdullatif Alhassan

You can always contact us at [Radiology433@yahoo.com](mailto:Radiology433@yahoo.com)

