



## Lecture (7)

# Common Brain Diseases Part 1

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### Resources:

- Lecture by dr. Tajuddin Malabarey
- Diagnostic imaging book

## Radiology of Common Brain Diseases

### Tumor, Inflammation, Infection

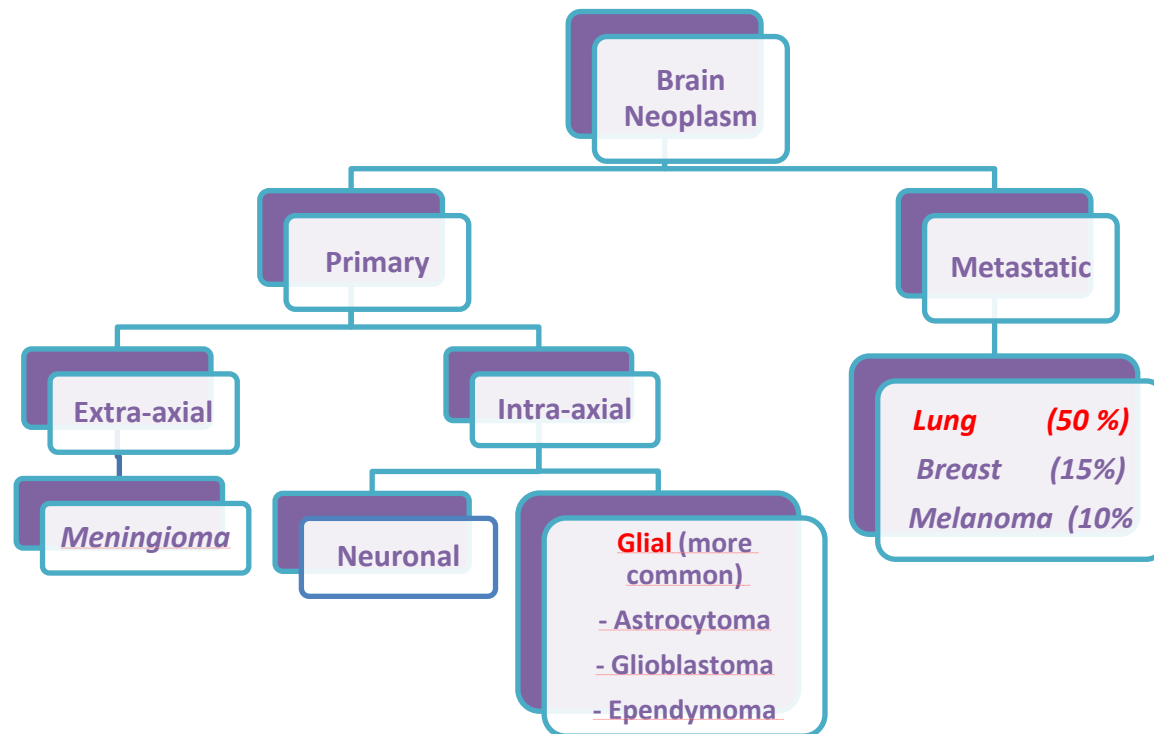
#### ❖ Some Common Brain diseases:

- Brain Tumor -- > is defined as an *abnormal growth of cells* within the brain or the central spinal canal
  - Inflammation is a protective attempt by the organism to remove the injurious stimuli and to initiate the healing process.
  - Infection is the invasion of body tissues by disease-causing microorganisms.
- Inflammation is not synonymous with infection.
  - Without inflammation, wounds and infections would never heal.

#### ❖ Brain tumor:

- The most common primary brain tumors are:
  - Gliomas (50.3%).
  - Meningiomas (20.9%).
  - Pituitary adenomas (15%).
  - Nerve sheath tumors (8%).

- Intracranial Tumors Classification a framework:



- Benign vs. Malignant distinction less clinically relevant for intracranial tumors
- (Mass effect, infiltration preventing removal, critical location).
- Any **lesion** in the **brain**, consider it **malignant**.

### ❖ Primary Brain Tumors:

- Classified by the type of tissue in which they begin.
- The most common brain tumors are **Gliomas**, which begin in the glial (supportive) tissue.
- **MRI is more sensitive than CT for detecting brain tumors.**
- **CT is superior for detecting calcifications** within the lesion.
- There are several types of Gliomas:
  - Astrocytomas -- > Arise from small, star-shaped cells called astrocytes.
  - Brain stem Gliomas
  - Ependymomas -- > Usually develop in the lining of the ventricles.
  - Oligodendrogliomas -- > Arise in the cells that produce myelin, the fatty covering that protects nerves
  - Glioblastoma Multiforme (GBM) -- > Accounts for about 50% of all Astrocytomas -- > **most common and most malignant.**

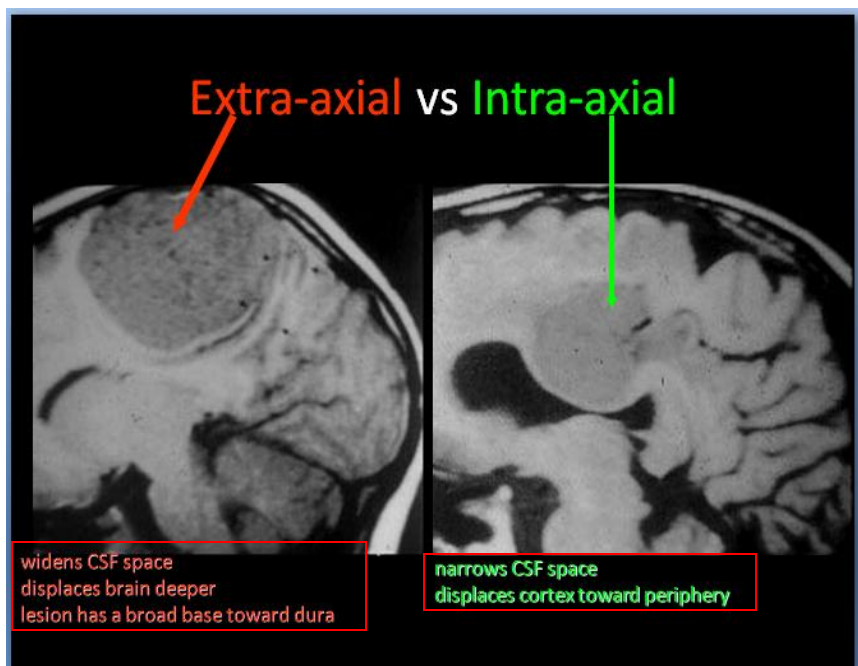
### - Primary Non-Gliomas Brain Tumors:

- Medulloblastomas --> Always located in the cerebellum, these fast-growing high-grade tumors represent about 15 - 20% of pediatric brain tumors and 20% of adult brain tumors.
- Meningiomas -- > Grow from the meninges
- Schwannomas -- > Are benign tumors that begin in Schwann cells, which produce the myelin that protects the acoustic nerve (the nerve of hearing) -- > e.g. Acoustic neuromas
- Craniopharyngiomas -- > Develop in the region of the pituitary gland near the hypothalamus.
- Pituitary Adenomas -- > Pituitary tumors comprise about 10% of PBT and are often benign, slow-growing masses in the pituitary gland.

### ❖ Secondary Brain Tumors (Brain Metastases):

- A metastatic, or secondary, brain tumor
- Begins as cancer in another part of the body.
- Some of the cancer cells may be carried to the brain by the blood or lymphatic fluid, or may spread from adjacent tissue.
- The site where the cancerous cells originated is referred to as the primary cancer.
- **Metastatic brain tumors are the most common brain tumors.**
- Characteristics:
  - 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**, but can **also develop in the cerebellum or brain stem.**
  - More than half of people with metastatic tumors have multiple lesions (tumors).

- Primary tumors -- > single
- Secondary tumors -- > multiple



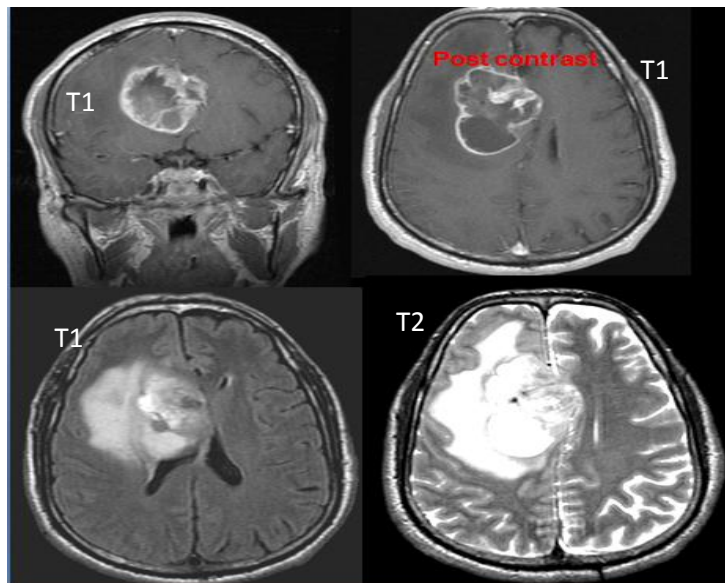
- Intra-axial -- > the tumor inside
- Extra-axial -- > the tumor pouch the brain

#### ❖ Glioblastoma multiforme:

- It is the **most common primary brain malignancy in adults** and accounts for 20% of all primary brain tumors and it is the **most aggressive**.
- **MRI** is the **imaging** modality of **choice** for diagnosis (**definitive diagnosis by pathology**).
- If the patient came with **acute presentation** -- > **use CT**.
- The classic presentation is **a heterogeneous mass in the supratentorial white matter** with **hemorrhage, necrosis, and mass effect**.



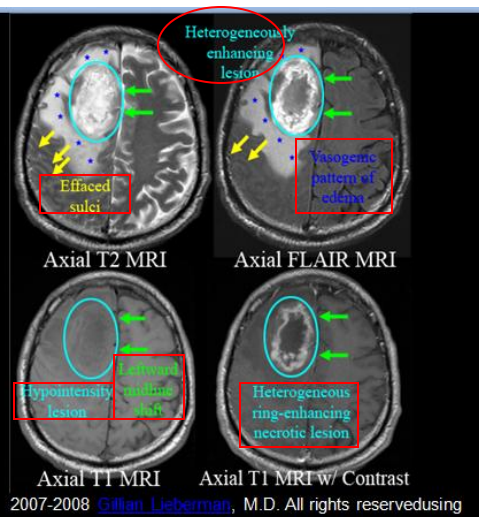
- **Tumor\*** -- > left cerebral hemisphere.
- Irregular, dense contrast enhancement
- Ring enhancement common.
- irregular and nodular, often around necrosis
- Infiltrative, can involve WM and cross midline



- MRI we have what we called it T1 and T2 :
- T1 -- > Dark CSF (Black).
- T2 -- > White CSF.
- The whitish area is the edema -- > note that it is not appreciable in T1 because it is fluid and fluids appear black in T1.



## Glioblastoma multiforme

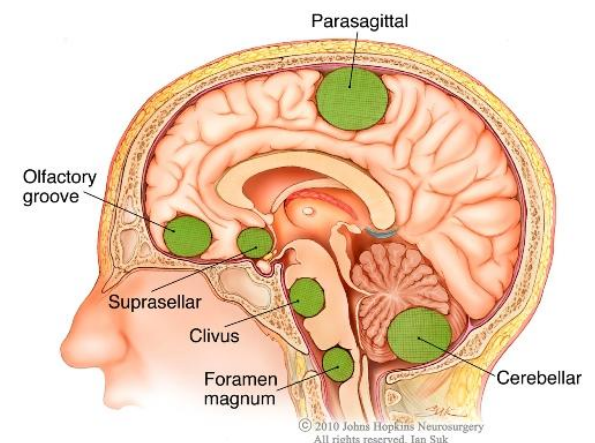
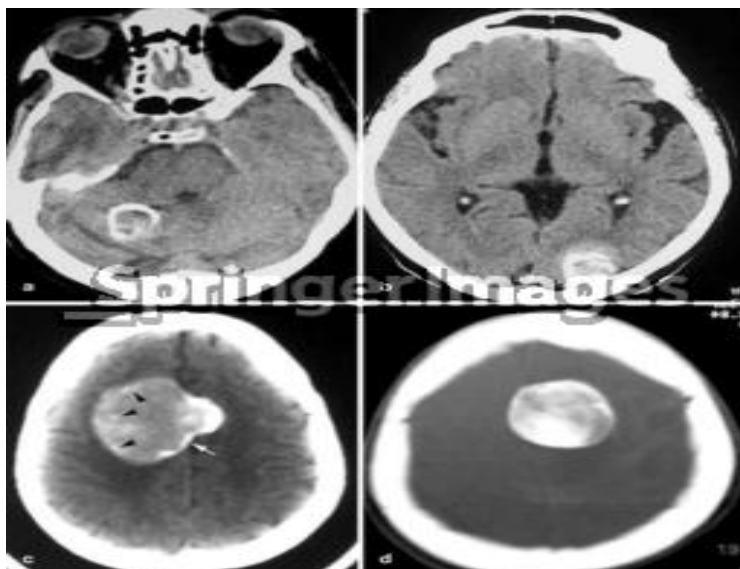
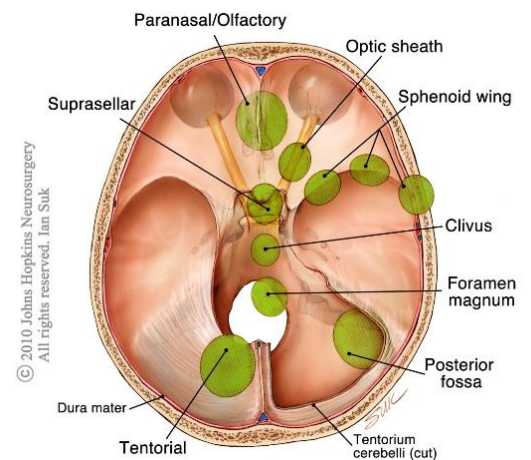


### ❖ The Differential Diagnosis For Ring-Enhancing Lesion On MRI & CT:

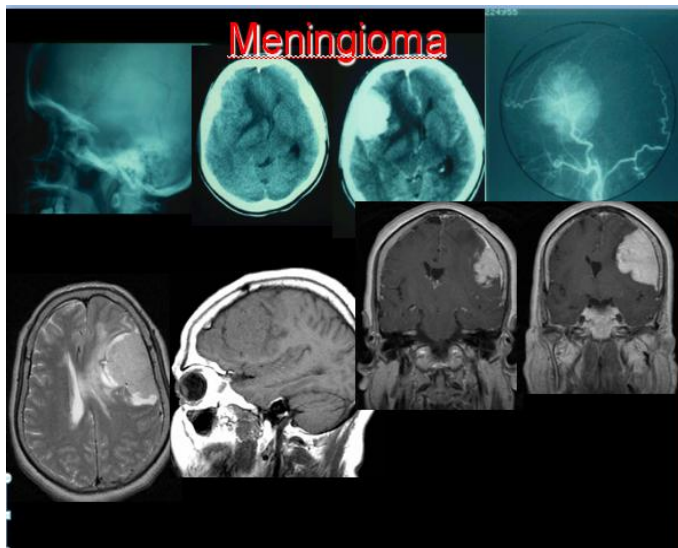
- Includes --> Brain Tumors, Metastasis, Abscess, Gliomas, Granuloma, Demyelinating disease, and Resolving hematoma.

### ❖ Meningiomas:

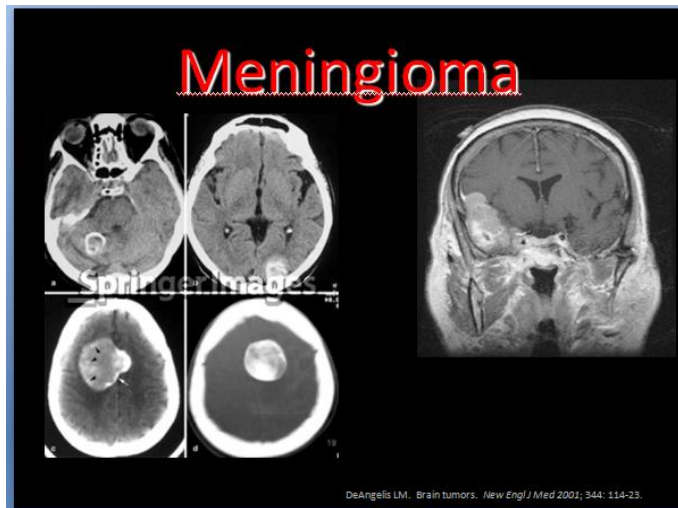
- It is the **most common type of extra-axial neoplasm** and accounts for 14 - 20% of intracranial neoplasm. It is a non-glial neoplasm that originates from the arachnoid cap cells of the meninges.
- It is **more benign lesion**.
- Location:
  - **85 - 90% supratentorial.**
  - 45% parasagittal, convexities.
  - 15 - 20% sphenoid ridge.
  - 10% olfactory groove / planum sphenoidale.
  - 5 - 10% juxtaseellar.
- Plain film:
  - Enlarged menigeal artery grooves.
  - Hyperostosis or lytic regions.
  - Calcification.



- CT scan demonstrates calcify tumor.
- If the patient young (< 30 - 35) --> use plane film.
- Above 30 -35 --> use CT or MRI.



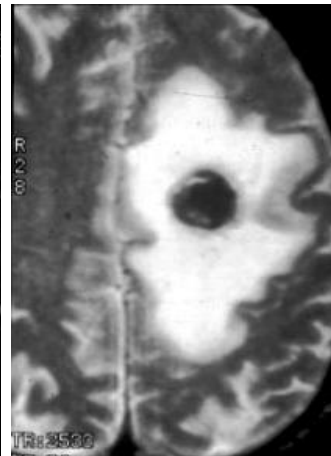
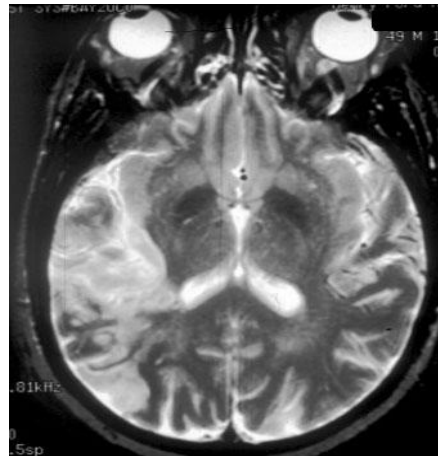
- Plan film -- > you will see sclerosis of the bone due to long standing of the bone and enlarged middle menigeal artery.
- CT without contrast -- > demonstrating iso-tens or hyper-tens to normal brain and have some calcification.
- CT with contrast -- > the lesion will be **markedly enhanced** -- > called light bulb enhancement.
- Cerebral angiogram
- MRI (T1 and T2) -- > iso-tens or hyper tens and you will see CSF Cleft sign (**Dural tail**) (**not specific sign**).



- Base of skull (parasellar), cerebral convexities
- Adjacent to bone, 'Dural tail'
- Characteristic diffuse pattern of enhancement
- Slow growing, little edema, histological benign

#### ❖ **Patterns of edema:**

- There is 2 types of edema:
  - Vasogenic edema -- > interstitial edema --> usually involve only white matter -- > usually seen in cases of neoplasm.
  - Cytogenic edema -- > intercellular edema -- > both gray and white matter -- > seen usually in cases of hemorrhage

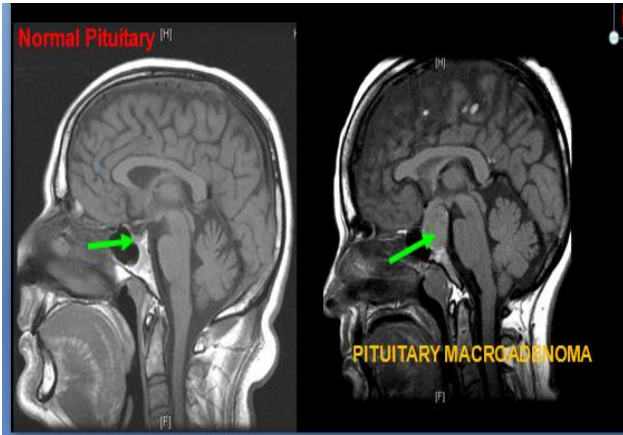


- In CT -- > edema appears black

- MRI -- > T2 -- > edema -- > appears white.

### ❖ Pituitary adenoma

- Comprise 10% of intracranial tumors.
- The majority are hormonally active.
- The homogenous iso-intensity of the enlargement suggests pituitary macro adenoma as opposed to cystic, vascular, or inflammatory lesions/enlargements.
- **Clinical correlation is important.**



- The MRI scan demonstrates an iso-intense enlargement in the region of the pituitary characteristic of a pituitary adenoma.
- The **radiological image of choice** is **MRI**.
- A **biopsy** or **angiogram** or **conventional studies** has to be done **before surgery** because it might be not tumor. It could be aneurysm.

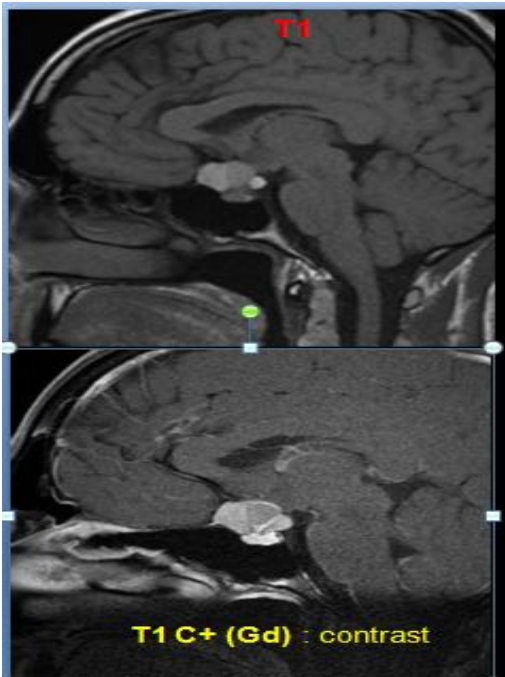
### ❖ Craniopharyngiomas:

- 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 tumors.
- 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).



- **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.





## MRI

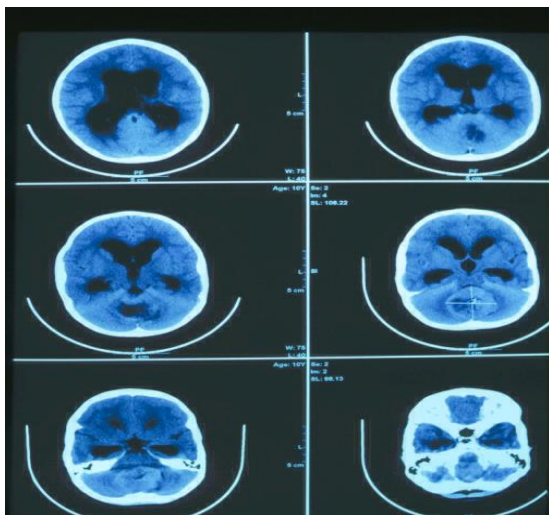
- MR features can significantly vary depending on the histological subtype<sup>4</sup> and on the size and content of the cysts.
- **T1** : signal intensity varies depending on cyst contents, and can appear hyper intense due to protein, blood products, and / or cholesterol
- **T1 C+ (Gd)**: contrast enhancement is typical, with thin enhancement of the cyst wall, or diffuse heterogeneous enhancement of the solid components. (the doctor did not talk about it)
- **T2**: signal is high in both solid and cystic components, but is variable depending on content of fluid.

## ❖ Medulloblastomas:

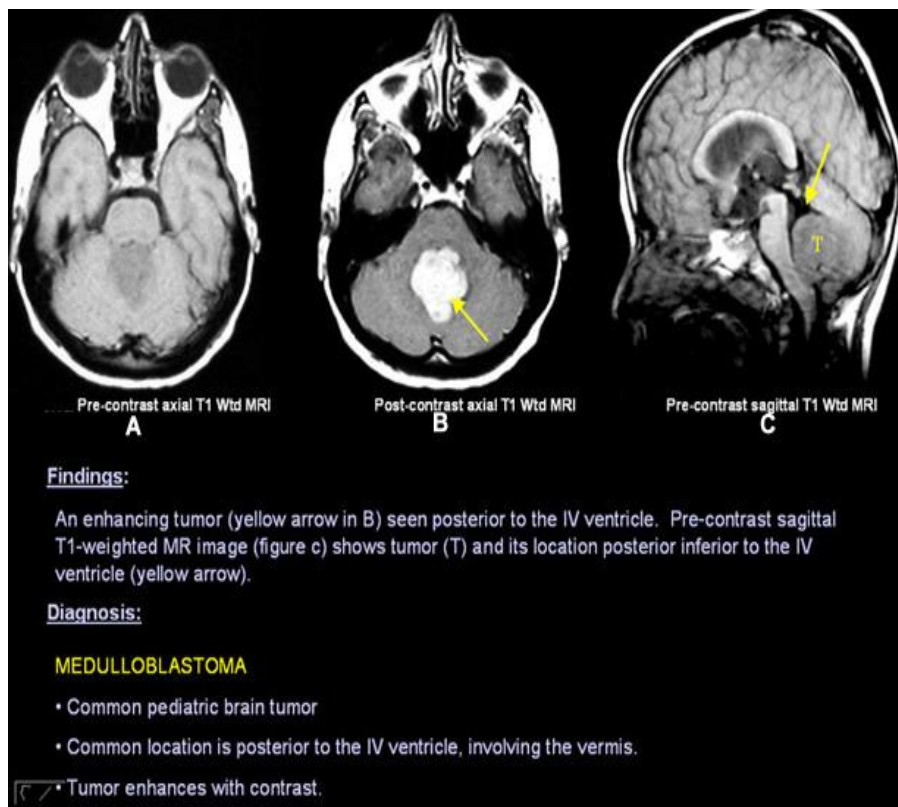
- A Medulloblastoma is the most common pediatric posterior fossa tumor and accounts for 30 - 40% of such entities.
- They are a type of CNS primitive neuroectodermal tumor.



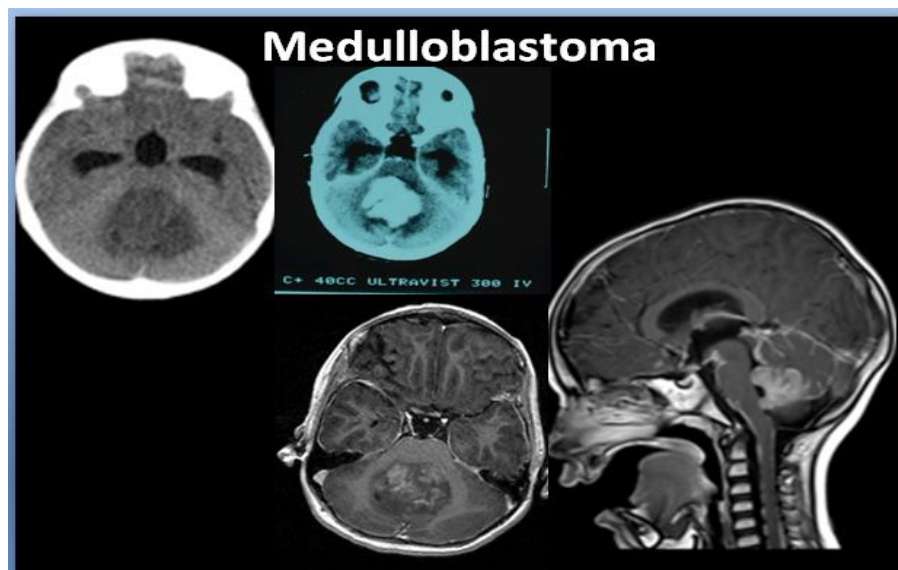
- MRI is able to delineate the fourth ventricle and subarachnoid space to a much greater degree than CT. Although Medulloblastomas project into the fourth ventricle, unlike Ependymomas they do not usually extend into the basal cisterns.
- As CSF seeding\*\* is common at presentation, imaging with contrast of the whole neuraxis is recommended to identify drop metastases / leptomeningeal spread.
- This type of tumor does not arise from 4<sup>th</sup> ventricle but it compresses it --> leading to acute or chronic hydrocephalic --> which is one of the clinical presentations.
- MRI is the best modality here.



- CT ( the doctor just said that the patient will have hydrocephalus)
- On CT, Medulloblastomas appear as a mass arising from the vermis, resulting in effacement of the fourth ventricle / basal cisterns and obstructive hydrocephalus.
- They are usually hyper dense (90%) and cysts formation / necrosis is common (40 - 50%), especially in older patients.
- Calcification is seen in 10 - 20% of cases<sup>7</sup>.
- Enhancement is present in over 90% of cases and is usually prominent.



- Note the location of the tumor.

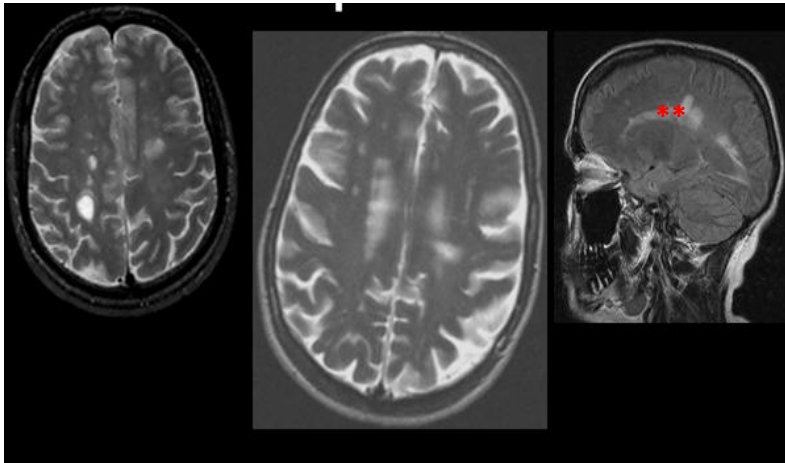


### ❖ Inflammation In The Brain:

- Neuronal damage in classic neuro-inflammation
- “Secondary” neuro-inflammation in neurodegenerative diseases
- Chronic autoimmune disorders of the brain, such as
  - **Multiple sclerosis** (ms).
  - Alzheimer disease (ad).
  - Parkinson disease (Pd).
  - Huntington disease (HD).

### ❖ Multiple sclerosis:

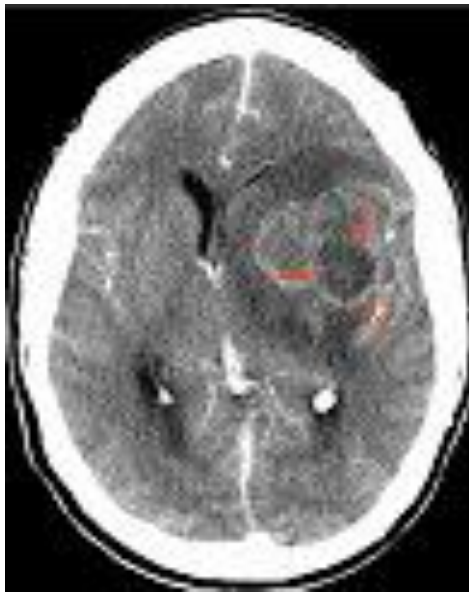
- A relatively common acquired chronic relapsing Demyelinating disease involving the central nervous system.
- It is by definition disseminated not only in space (e.g. multiple lesions), but also in time (e.g. lesions are of different age).
- MRI has revolutionized the diagnosis and surveillance of patients with MS. Not only can an **MRI confirm the diagnosis** (see McDonald MRI criteria for multiple sclerosis) but **follow-up** scans can assess response to treatment and try and determine the disease pattern. (**MRI is best for diagnosis and follows up**).
- **T1** -- > lesions are typically iso to hypo intense (chronic)
- **T2** -- > 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).



- Multiple lesions in periventricular white matter.
- Hypo intense on T1, hyper intense on T2.
- T2 images extremely sensitive for MS plaques.
- T2 weighted images (image 2)
- CSF is bright
- On T2, demyelinated areas are bright
- Periventricular Region (image3)
- **Dawson's fingers\*\*** (the projection) -- > represent lymphocytic infiltration along periventricular modularly veins.

### ❖ Brain Infection:

- Brain, the spinal cord, and its surrounding structures could become infected by a large spectrum of microorganisms.
- Bacteria and viruses are the most common offenders. Parasites, fungi, and others can infect the central nervous system (CNS), although more rarely.
- Depending on the location of the infection, different names are given to the diseases.
- Meningitis is the inflammation of the meninges.
- Encephalitis is an inflammation of the brain itself.
- Myelitis actually means a spinal cord inflammation.
- Abscess is an accumulation of infectious material and offending microorganisms within the CNS.



- CT shows an abscess in the left frontal lobe (arrows) causing the **brain to shift** to the **right side**

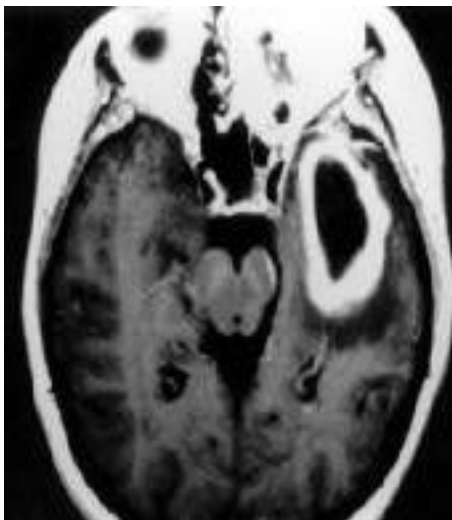


- MRI illustrates an extensive signal abnormality in a typical distribution for herpes encephalitis -- > there is edema

- Two patients with altered mental status and fever.

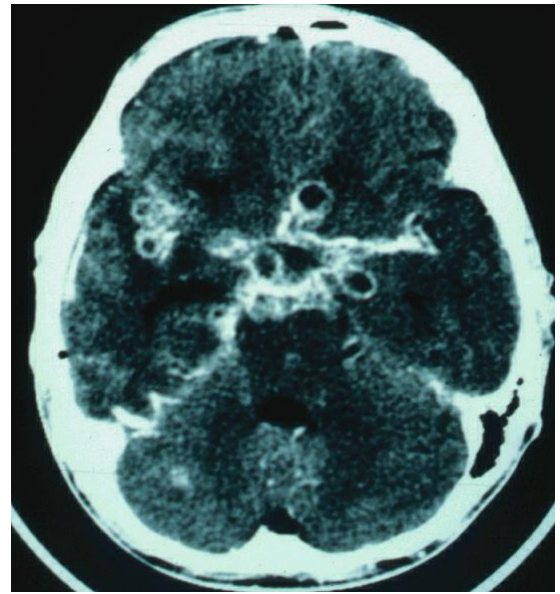
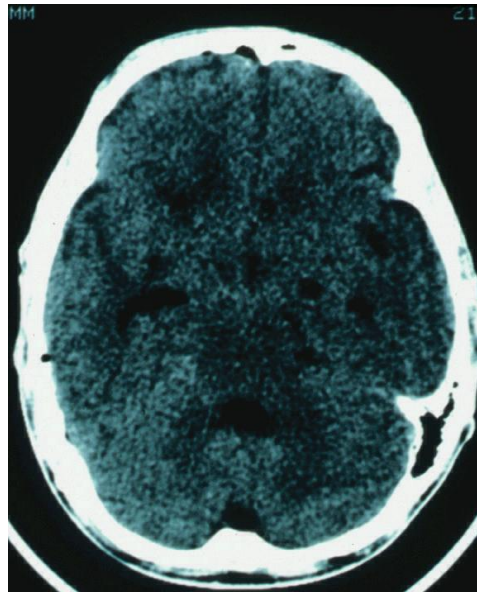
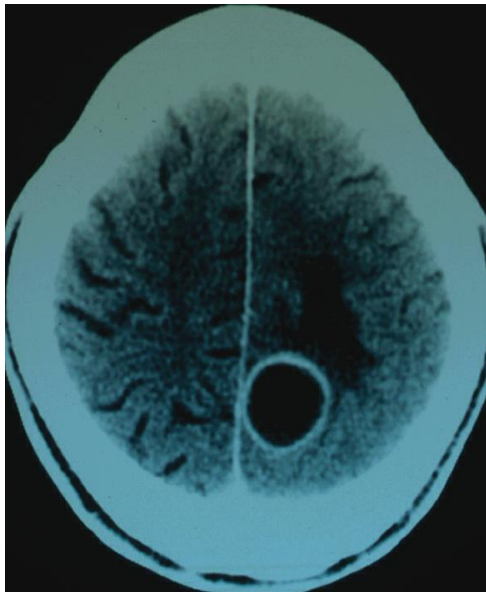
### ❖ Brain abscess

- There is 2 important types of brain abscess:
  - Tuberculous abscess -- > the hole will be irregular
  - Bacterial abscess -- > the hole will be clear and smooth.



- **MRI Brain**
- **T1**
  - Central low intensity (hyper intense to CSF)
  - Peripheral low intensity (Vasogenic edema)
  - **Ring enhancement**
  - Ventriculitis may be present, in which case hydrocephalus will commonly also be seen
- **T2 / FLAIR**
  - Central high intensity (hypo intense to CSF, does not attenuate on FLAIR)
  - Peripheral high intensity (Vasogenic edema)
  - The abscess capsule may be visible as a intermediate to slightly low signal thin rim.



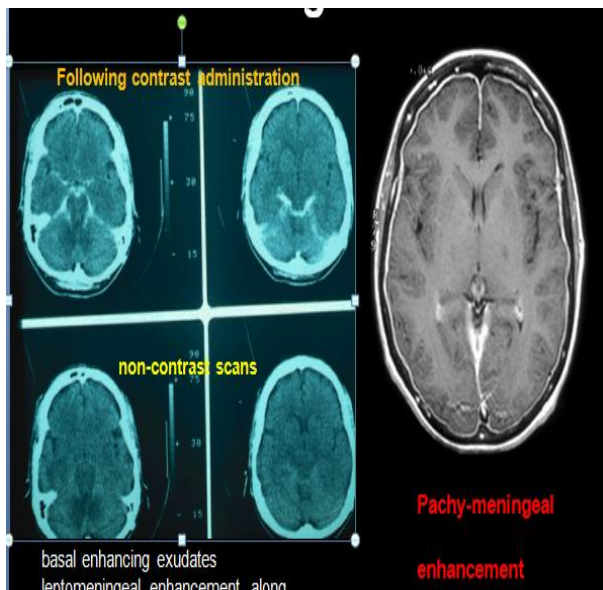


- Bacterial abscess.
- **Regular, smooth hole.**
- Central low density.
- Iso / hyper dense ring.
- Peripheral low density (Vasogenic edema)
- Ring enhancement.
- Ring enhancing lesion, thin rim with uniform enhancement.

- Plane CT --> demonstrating nothing

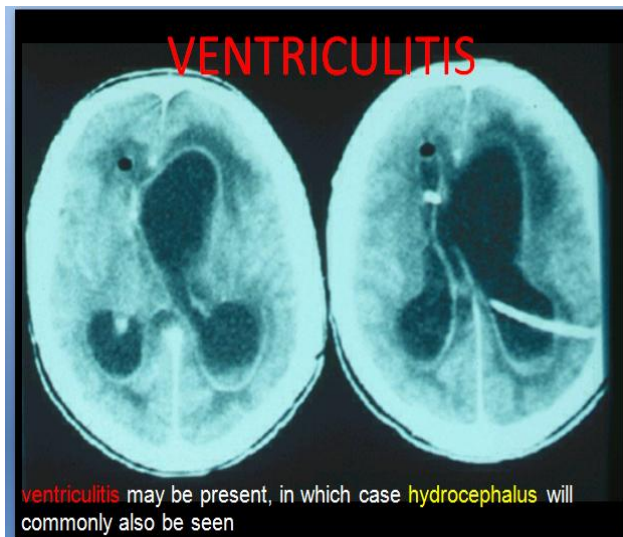
- CT with contrast --> showing nodular formation

## ❖ Meningitis



- Basal enhancing exudates
- Leptomeningeal enhancement, along sylvian fissures, tantrum.
- MRI --> **pachy menigeal enhancement** --> classical appearance of **meningitis**.

#### ❖ Ventriculitis:

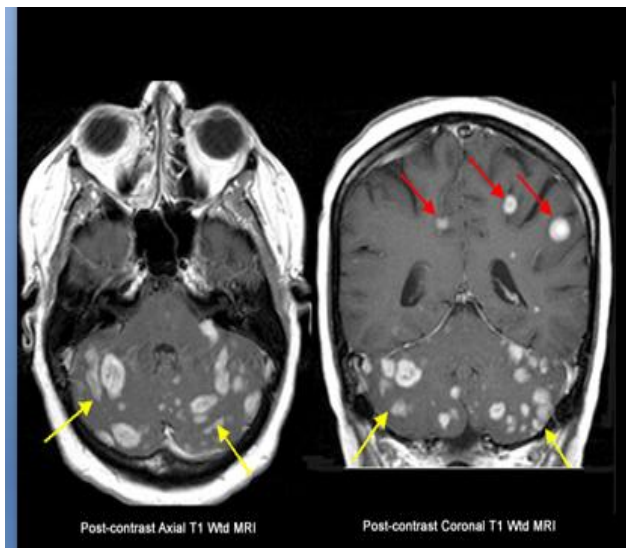


#### ❖ Contrast Enhancement Ring Lesions ( summary ):

- **M** --> Metastasis, MS.
- **A** --> Abscess/cerebritis.
- **G** --> Gliomas/Granuloma.
- **I** --> Infarct.
- **C** --> Contusion.
- **D** --> Demyelination.
- **R** --> Resolving Hematoma.

#### ❖ Secondary Brain Tumors (Brain Metastases):

- A metastatic, or secondary, brain tumor
- It is one that begins as cancer in another part of the body.
- Some of the cancer cells may be carried to the brain by the blood or lymphatic fluid, or may spread from adjacent tissue.
- The site where the cancerous cells originated is referred to as the primary cancer.
- Metastatic brain tumors are the most common brain tumors.
- **Characteristics:**
  - 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, but can also develop in the cerebellum or brain stem
  - More than half of people with metastatic tumors have multiple lesions (tumors)



- **Multiple Metastasis To The Brain From Breast Primary**
- 40-year old lady with a history of breast carcinoma diagnosed 6 years ago, presented with headache and ataxia.
- **Findings:** Shower of at least 30 metastatic enhancing lesions are seen closely packed together within both cerebellar hemispheres (yellow arrows), and few lesions also seen within both posterior fronto-parietal lobes (red arrows).

### ❖ Intracranial Tumors:

- Role of imaging in neuro-oncology:
  - Diagnosis.
  - Differential Diagnosis: tumor vs. infection vs. vascular.
  - Clinical complications: parenchyma compromise, mass effects.
  - Treatment.
  - Treatment planning.
  - Localization for therapeutic modalities: RT, stereotaxic surgery.
  - Evaluation.
  - Post-treatment surveillance.
  - Tumor recurrence.