



Lecture (7)

Common Brian Diseases Part 1

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Resources:

- Lecture by dr. Tajuddin Malabarey
- Diagnostic imaging book

Radiology of Common Brain Diseases Tumor, Inflammation, Infection

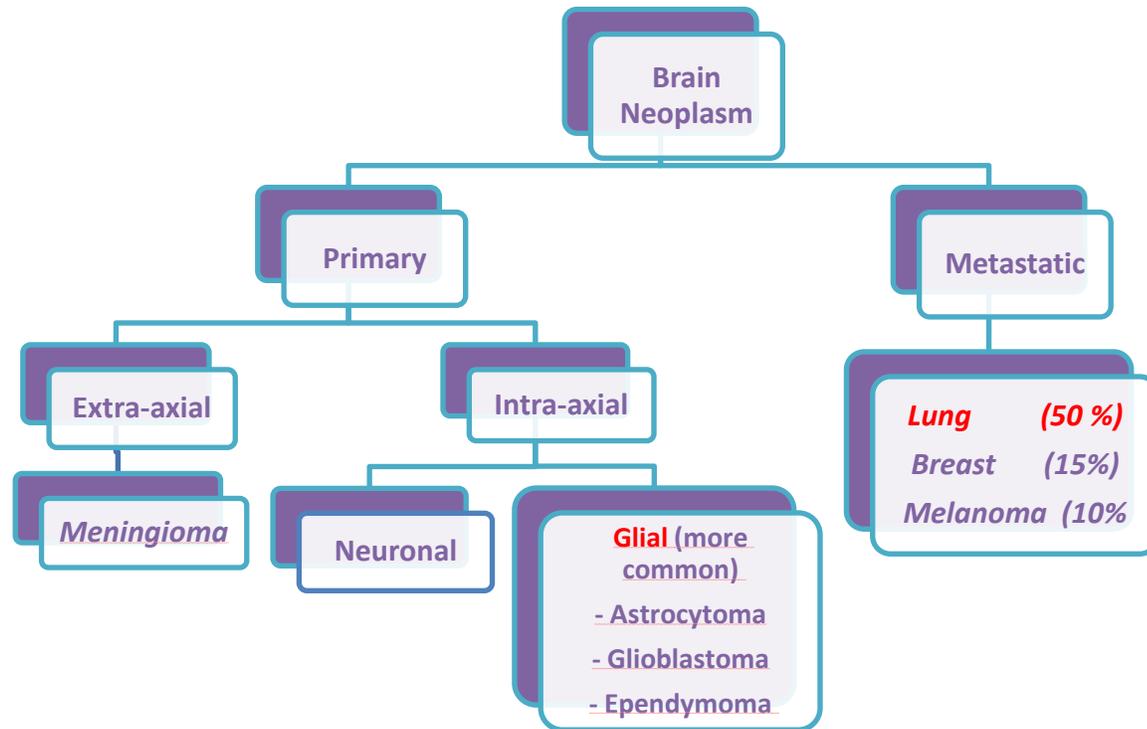
❖ Some Common Brain diseases:

- **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:

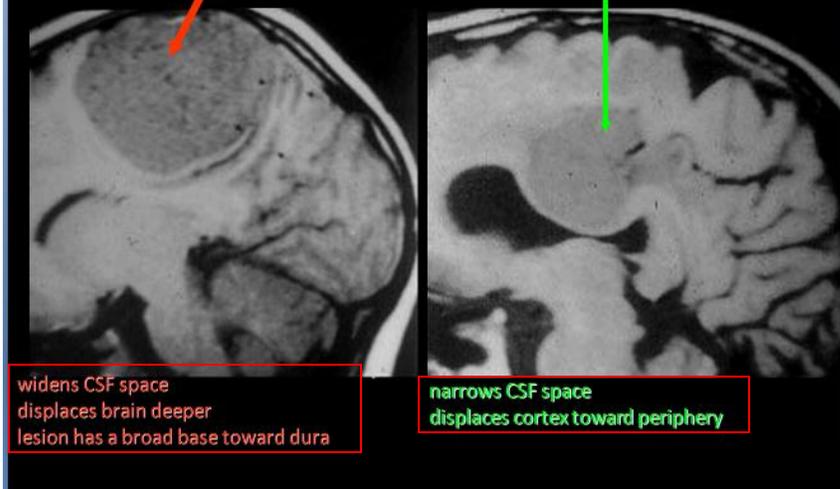
- Medulloblastomas --> Always located in the cerebellum, these fast-growing high-grade tumors represent about 15 - 20% of pediatric brain tumors and 20% of adult brain tumors.
- Meningiomas --> Grow from the meninges
- Schwannomas --> Are benign tumors that begin in Schwann cells, which produce the myelin 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

Extra-axial vs Intra-axial



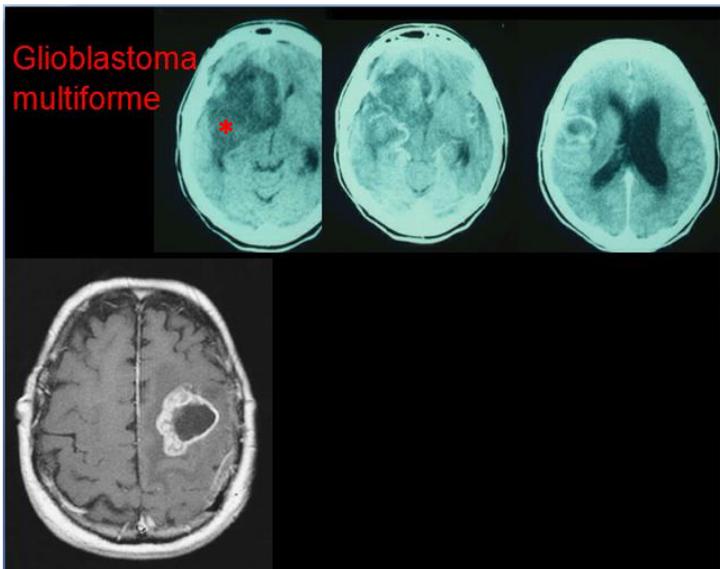
widens CSF space
displaces brain deeper
lesion has a broad base toward dura

narrows CSF space
displaces cortex toward periphery

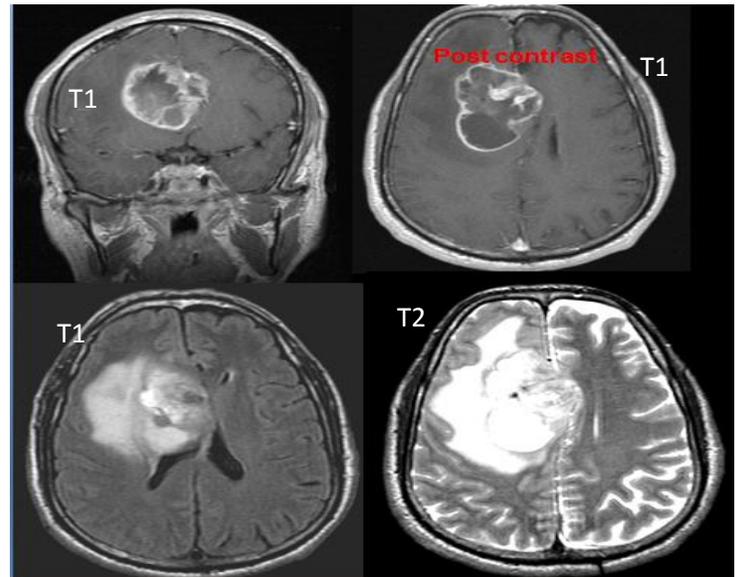
- Intra-axial -- > the tumor inside
- Extra-axial -- > the tumor pouch the brain

❖ 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**.



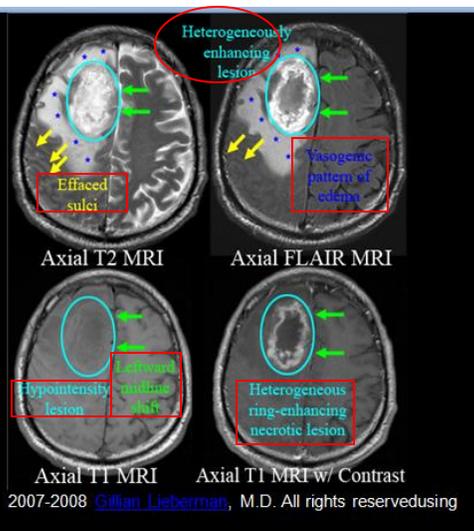
Glioblastoma multiforme



- **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

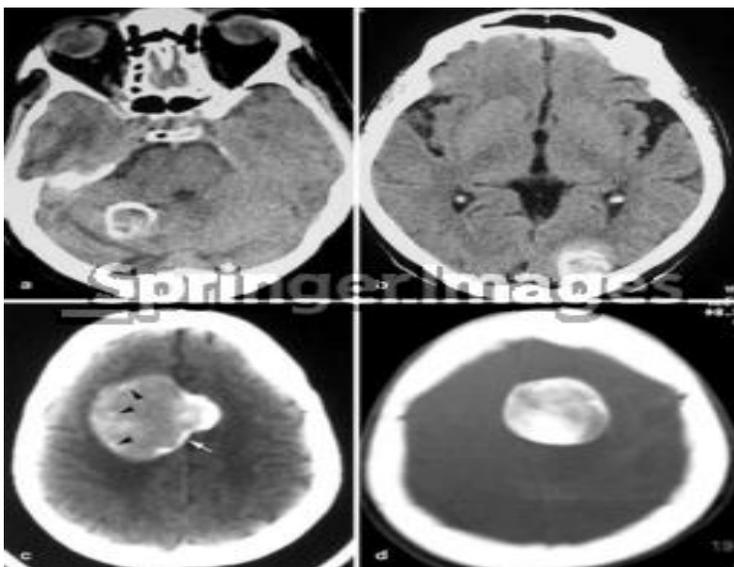
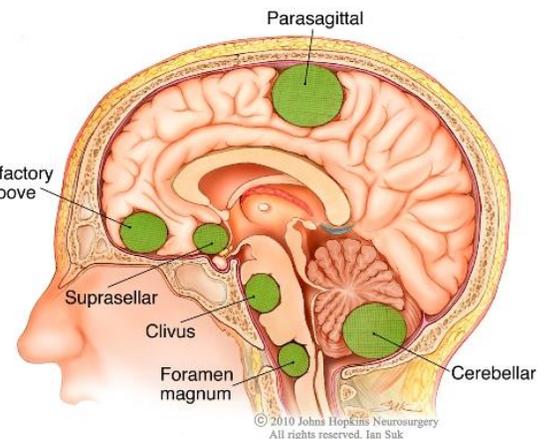
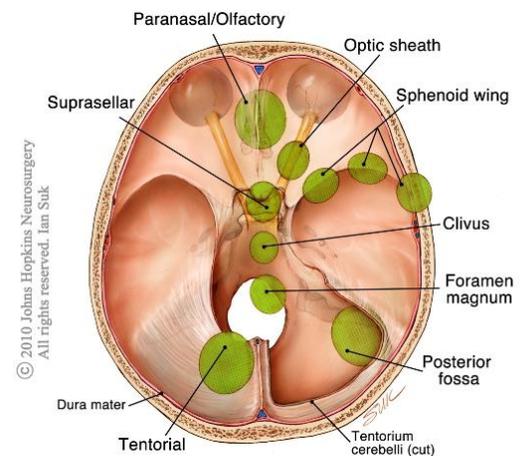


❖ The Differential Diagnosis For Ring-Enhancing Lesion On MRI & CT:

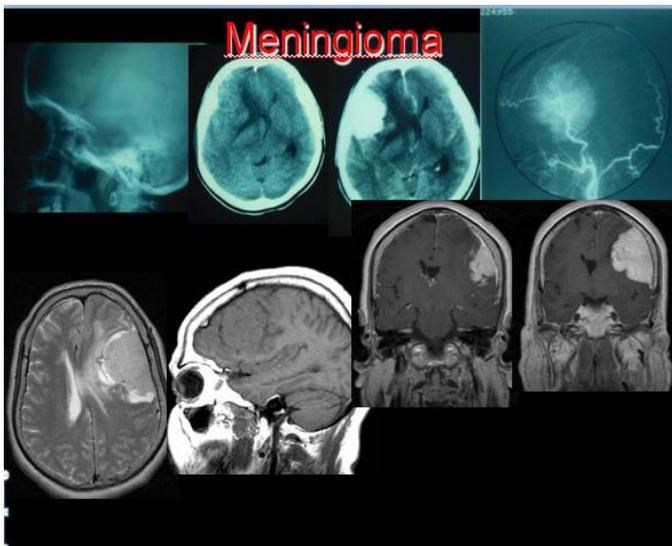
- Includes --> Brain Tumors, Metastasis, Abscess, Gliomas, Granuloma, Demyelinating disease, and Resolving hematoma.

❖ Meningiomas:

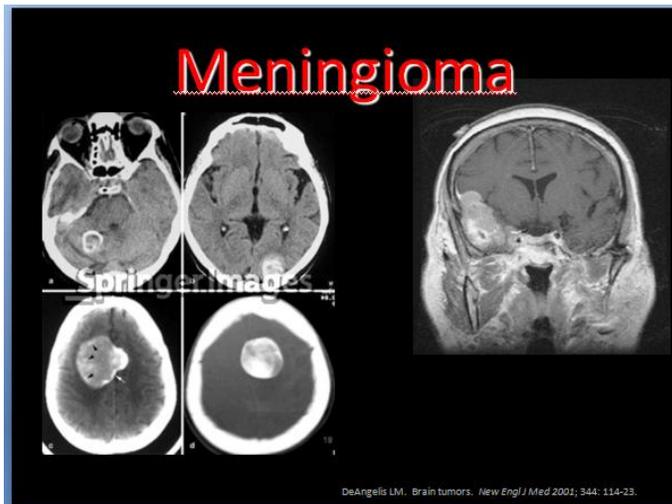
- It is the **most common type of extra-axial neoplasm** and accounts for 14 - 20% of intracranial neoplasm. It is a non-gliar neoplasm that originates from the arachnoid cap cells of the meninges.
- It is **more benign lesion**.
- Location:
 - **85 - 90% supratentorial.**
 - 45% parasagittal, convexities.
 - 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.



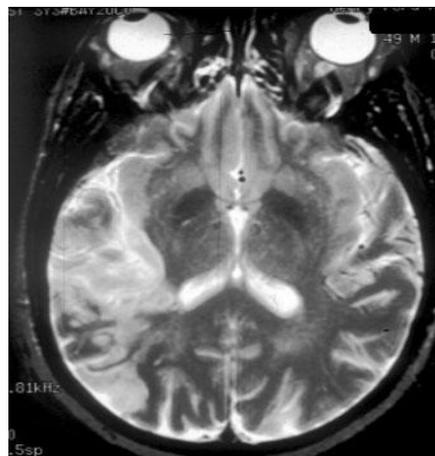
- Plan film --> you will see sclerosis of the bone due to long standing of the bone and enlarged middle menigeal artery.
- CT without contrast --> demonstrating iso-tens or hyper-tens to normal brain and have some calcification.
- CT with contrast --> the lesion will be **markedly enhanced** --> called 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

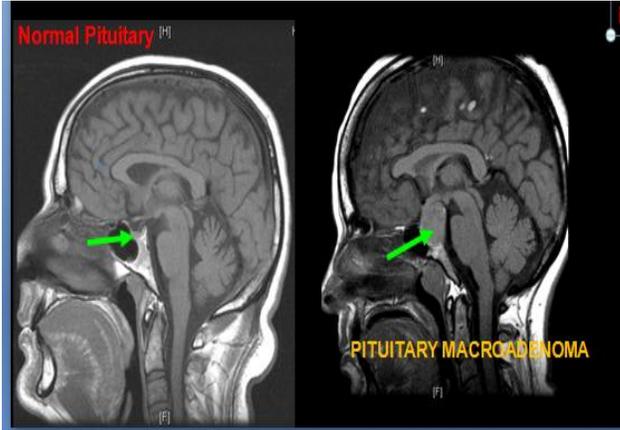


- In CT --> edema appears black

- 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.**



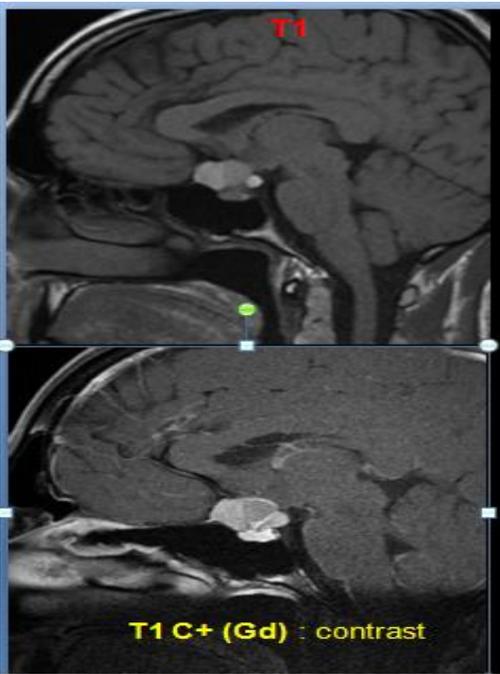
- The MRI scan demonstrates an iso-intense enlargement in the region of the pituitary characteristic of a pituitary adenoma.
- The **radiological image of choice** is MRI.
- A **biopsy** or **angiogram** or **conventional studies** has to be done **before surgery** because it might be not tumor. It could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

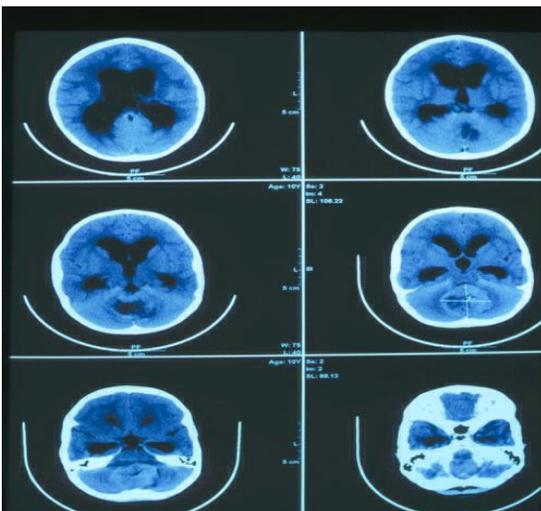
- MR features can significantly vary depending on the histological subtype⁴ and on the size and content of the cysts.
- **T1** : signal intensity varies depending on cyst contents, and can appear hyper intense due to protein, blood products, and / or cholesterol
- **T1 C+ (Gd)**: contrast enhancement 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:

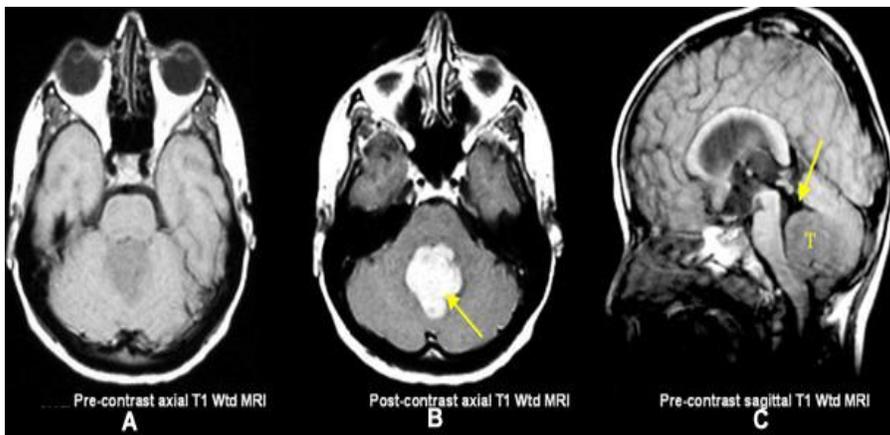
- **A Medulloblastomas** is **the most common pediatric posterior fossa tumor** and accounts for 30 - 40% of such entities.
- They are a type of **CNS primitive neuroectodermal tumor**.



- **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 4th 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 cases⁷.
- Enhancement is present in over 90% of cases and is usually prominent.



- Note the location of the tumor.

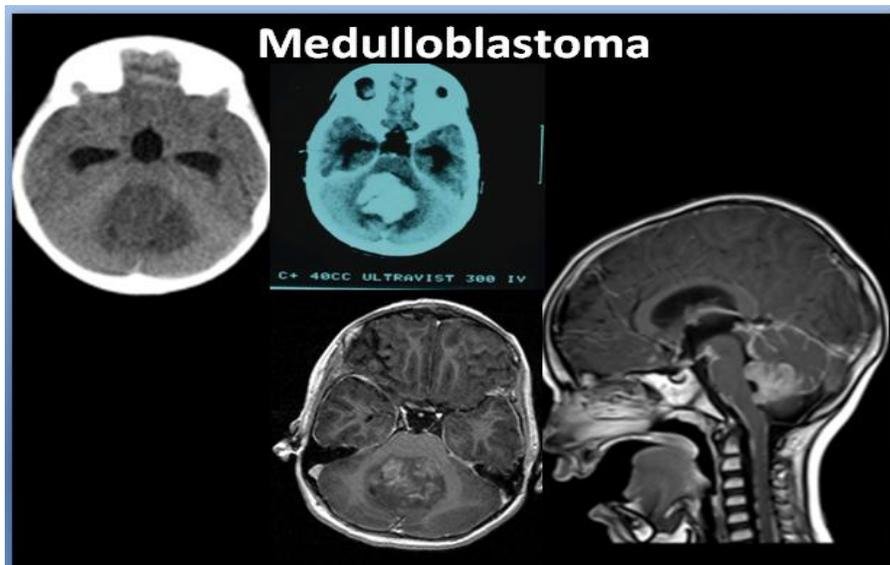
Findings:

An enhancing tumor (yellow arrow in B) seen posterior to the IV ventricle. Pre-contrast sagittal T1-weighted MR image (figure c) shows tumor (T) and its location posterior inferior to the IV ventricle (yellow arrow).

Diagnosis:

MEDULLOBLASTOMA

- Common pediatric brain tumor
- Common location is posterior to the IV ventricle, involving the vermis.
- Tumor enhances with contrast.

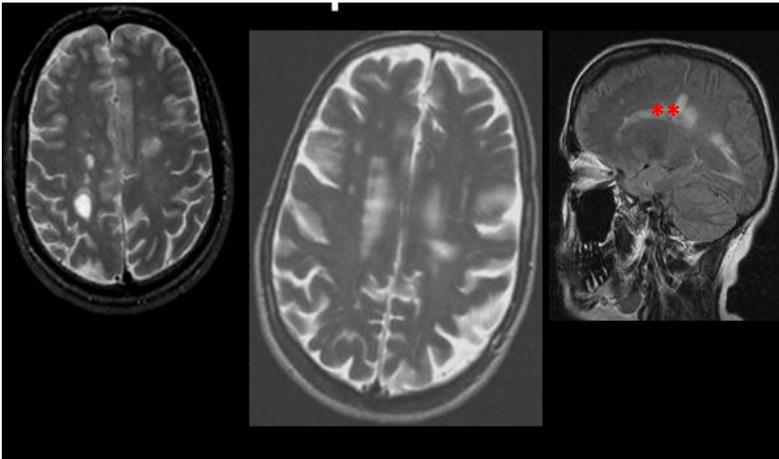


❖ Inflammation In The Brain:

- 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.



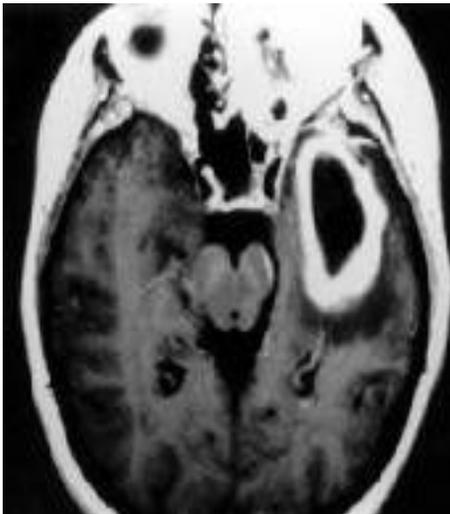
- Two patients with altered mental status and fever.

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

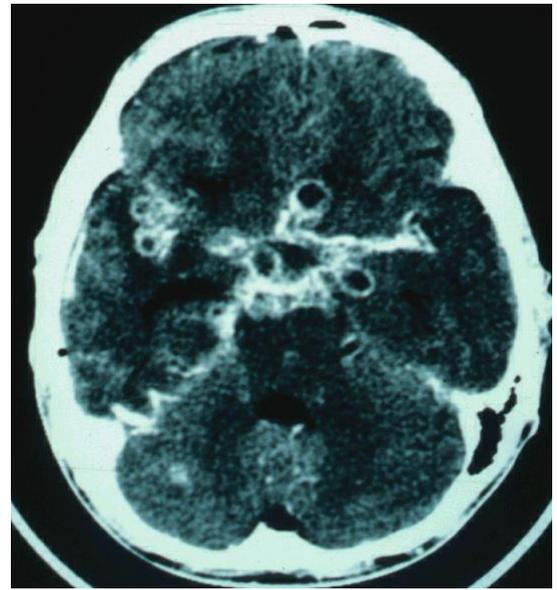
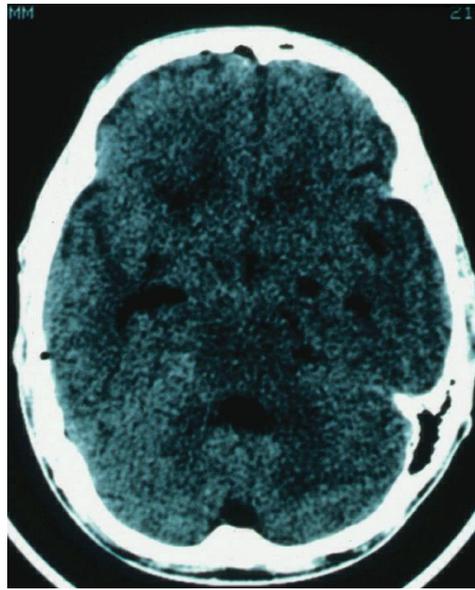
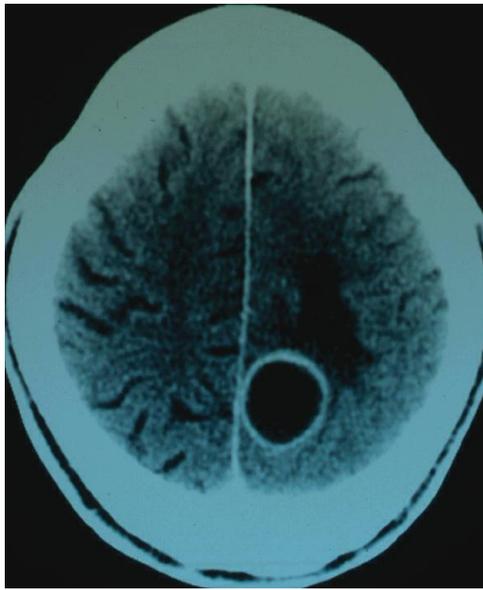
- MRI illustrates an extensive signal abnormality in a typical distribution for herpes encephalitis --> there is edema

❖ 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.

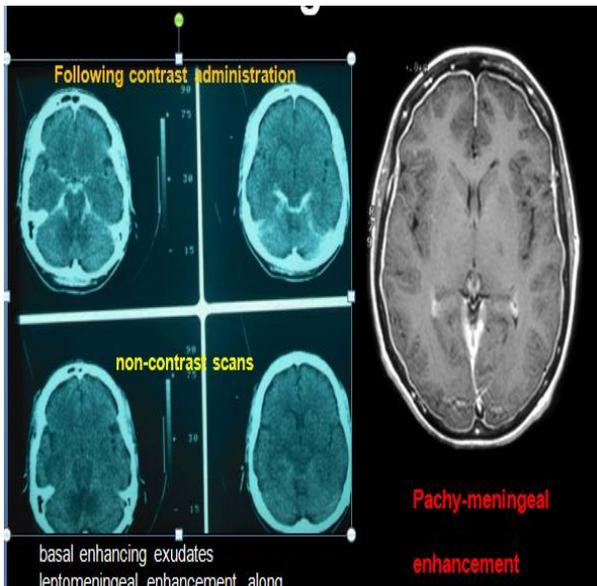


- Bacterial abscess.
- **Regular, smooth hole.**
- Central low density.
- Iso / hyper dense ring.
- Peripheral low density (Vasogenic edema)
- Ring enhancement.
- Ring enhancing lesion, thin rim with uniform enhancement.

- Plane CT --> demonstrating nothing

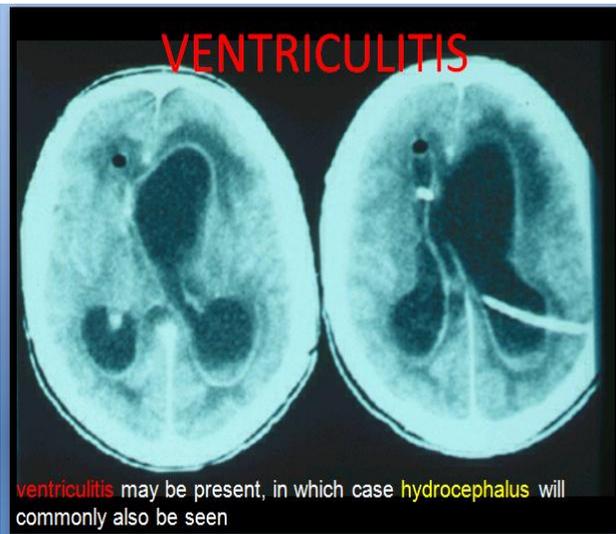
- CT with contrast --> showing nodular formation

❖ Meningitis



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

❖ Ventriculitis:

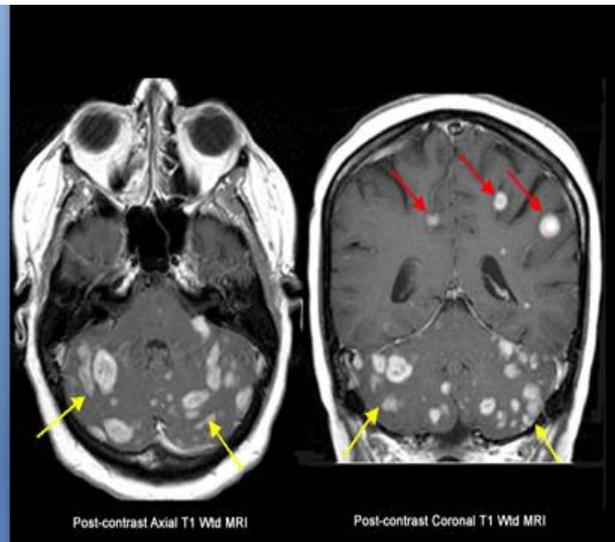


❖ Contrast Enhancement Ring Lesions (summary):

- **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.