



431

Radiology Team

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Lecture 12: Radiology of Common Brain Diseases (2)



Done By: Lama AlShwairikh

◆ Important

◆ Doctor's notes

◆ Team's notes



The doctor put this in some of the slides	All the images are from the slides
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Lecture outline:

- Some Common Brain diseases.
- **A brain tumor:** 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.**

1) Tumors

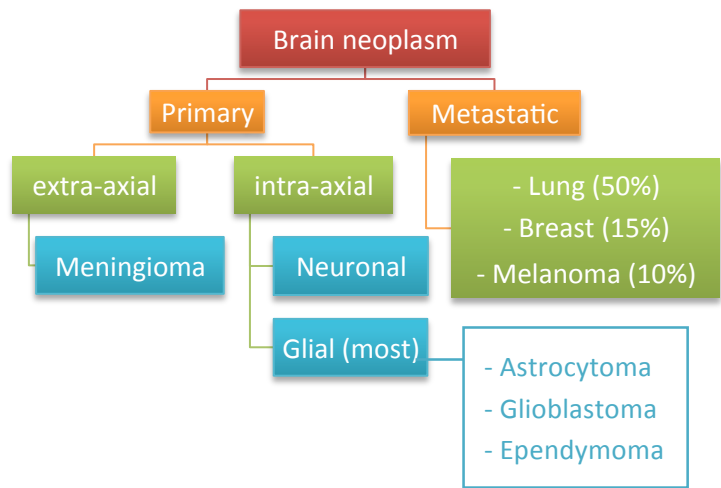
5 tumors will be discussed: glioblastoma multiforme, meningioma, pituitary adenoma, craniopharyngioma and medulloblastoma.

Intracranial Tumors Classification a framework



The most common primary brain tumors are:

- Gliomas (50.3%)
- Meningiomas (20.9%)
- Pituitary adenomas (15%)
- Nerve sheath tumors (8%)



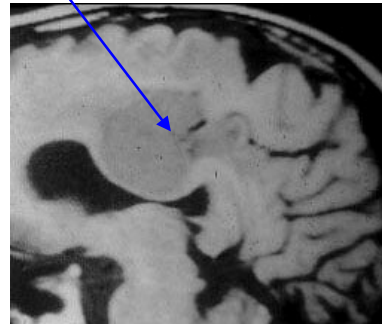
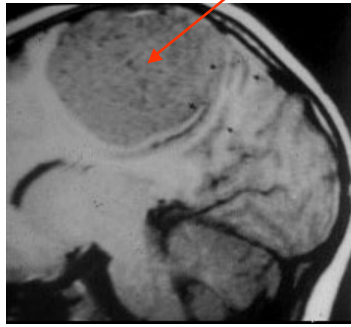
*Benign vs. malignant distinction less clinically relevant for intracranial tumors (Mass effect, infiltration preventing removal, critical location)

Primary Brain Tumors (PBT):

- ❖ They are classified by the type of tissue in which they begin.
- ❖ **The most common brain tumors are gliomas**, which begin in the glial (supportive) tissue. **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.
- ❖ **Primary Non-Glioma 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. **Acousticneuromas**
 - *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.

Extra-axial vs Intra-axial

- Widens CSF space
- Displaces **brain** deeper
- Lesion has a broad base toward dura



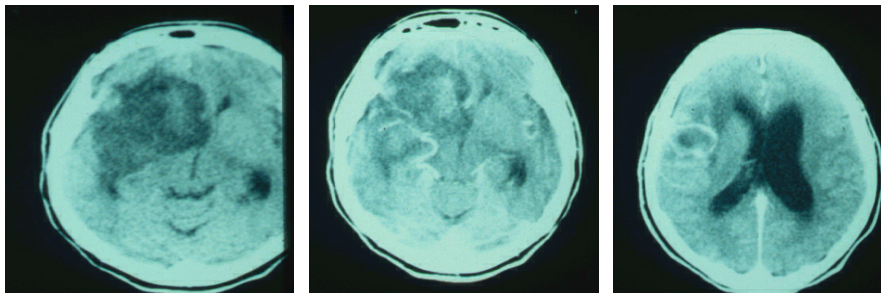
- Narrows CSF space
- Displaces **cortex** toward periphery

- ❖ MRI is more sensitive than CT for detecting brain tumors.
- ❖ CT is superior for detecting calcifications within the lesion.

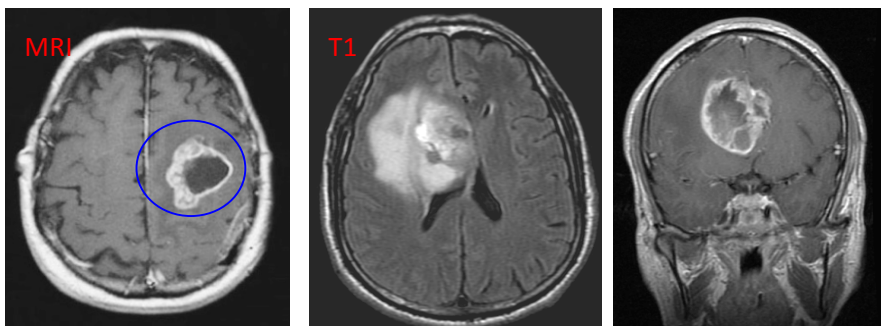


1) Glioblastoma multiforme:

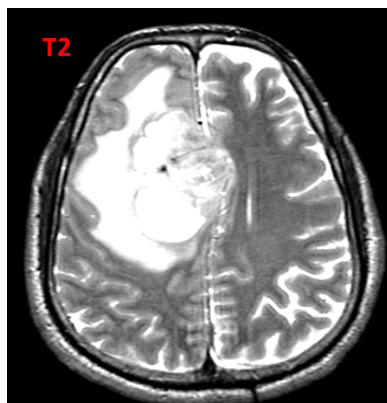
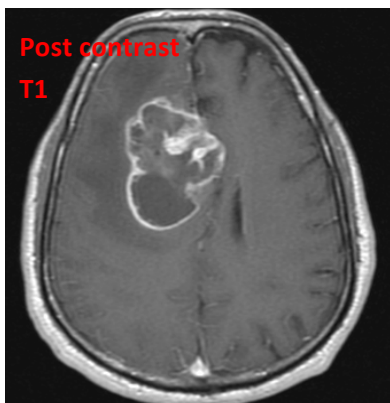
- ❖ The most common and most aggressive primary brain malignancy in adults and accounts for 20% of all primary brain tumors, and 52% of all functional tissue brain tumor cases.
- ❖ MRI is the imaging modality of choice for diagnosis (definitive diagnosis by pathology).
- ❖ The classic presentation is: a heterogeneous mass in the supratentorial white matter with hemorrhage, necrosis, and mass effect (shifting the midline, compressing the ipsilateral ventricle)



- Irregular, dense contrast enhancement
- Ring enhancement is common
- Irregular and nodular, often around necrosis
- Infiltrative, can involve white matter and cross midline
- The tumor is surrounded by edema

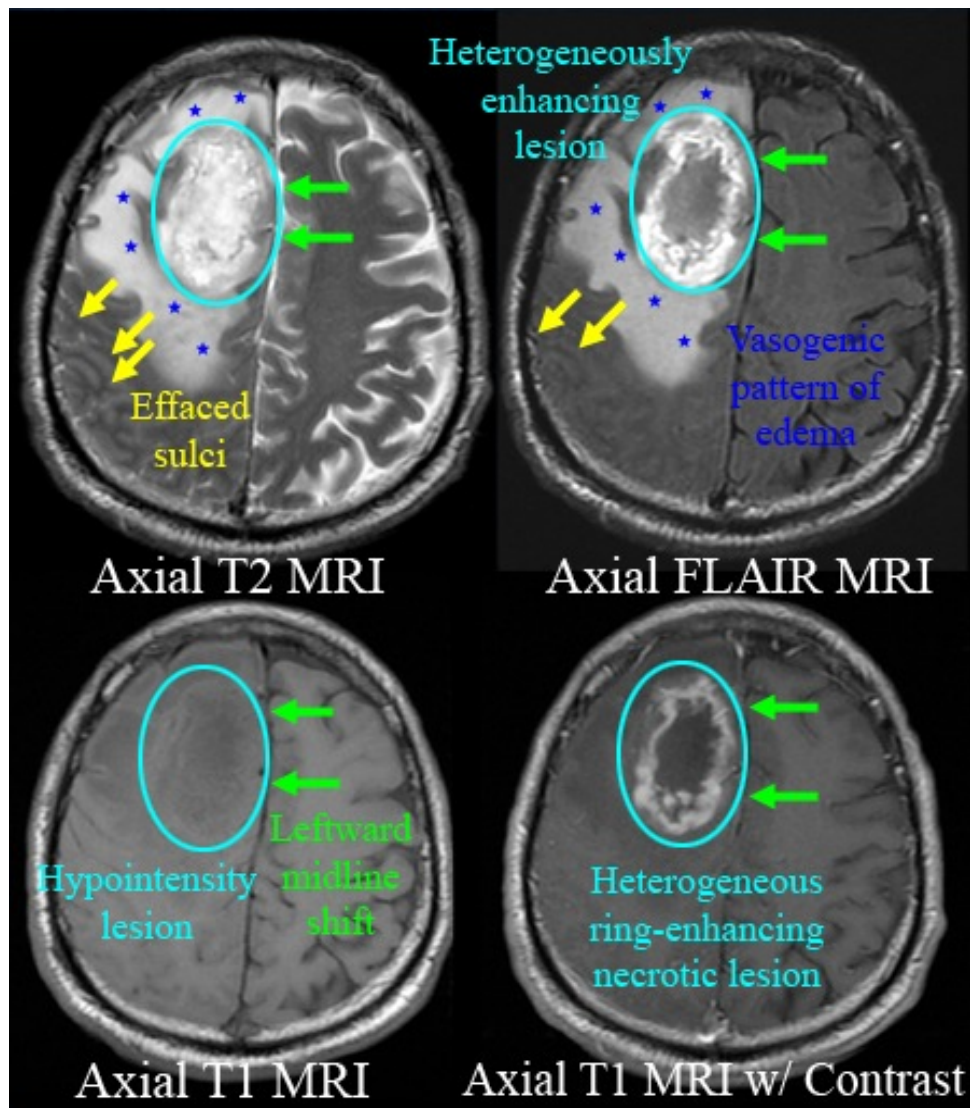


- The contrast media used in CT is iodine (IV). It's safe and has a high atomic number (absorbs more x-ray).
- Gadolinium is used in MRI
- Barium is only used in GI imaging
- The bone appears white in CT because the atomic number is high (absorbs more x-ray). While the lung appears black because the air has a low atomic number.



- MRI two type of common sequences: T1 and T2
- In T1:
CSF (and any other fluid): black
- In T2:
CSF (and any other fluid): white

CSF in the sulci of the brain



The differential for ring-enhancing lesion on MRI & CT: **[MAGIC DR T]**

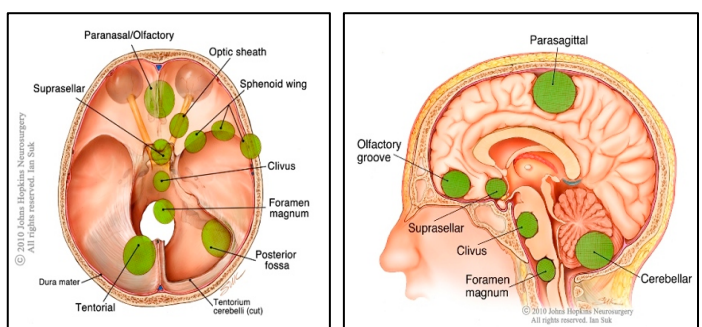
- ❖ **M** Metastasis, MS
- ❖ **A** Abscess/cerebritis
- ❖ **G** Glioma/Granuloma
- ❖ **I** Infarct
- ❖ **C** Contusion
- ❖ **D** Demyelination
- ❖ **R** Resolving Hematoma
- ❖ **T** Tumors

2) Meningioma

A meningioma is the most common type of extra-axial neoplasm and accounts for 14 - 20% of intracranial neoplasms. It is a non-gliar 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% juxtassellar



Plain film:

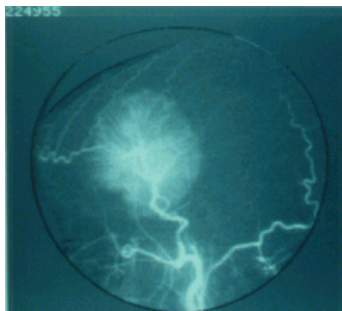
- ❖ Enlarged menigeal artery grooves.
- ❖ Hyperostosis or lytic regions.
- ❖ Calcification.

CT:

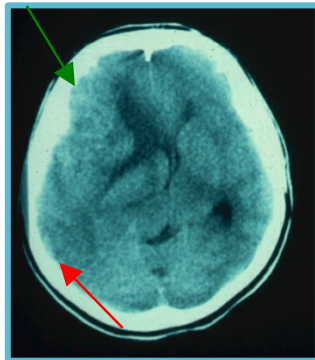
- 60% slightly hyperdense to normal brain
- 20 - 30% have some calcification
- 72% brightly and homogenously contrast enhance



The zigzag line: the enlarged middle meningeal artery

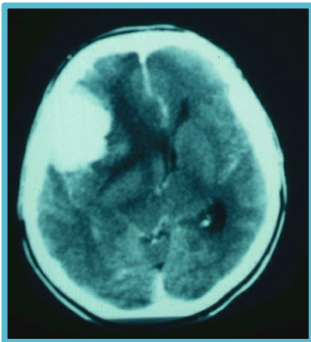


Angiogram showing the middle meningeal artery.



- Bone is highly reactive
- Bone is smooth

- Without contrast.
- More hyperdense than normal tissue
- The meningies is attached to the dura matter



- Extensive enhancement after contrast media
- Light bulb appearance
- Mass effect (the midline is shifted)
- If the tumor is very aggressive, we'll get associated edema around it

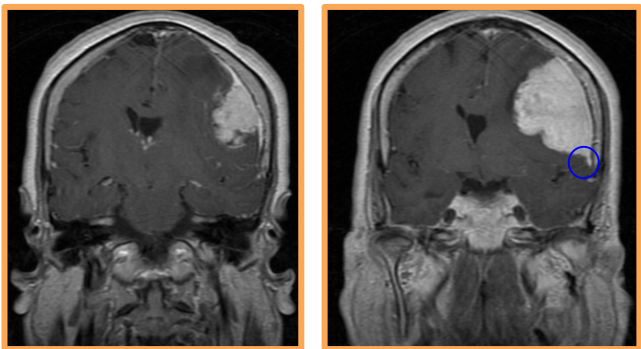
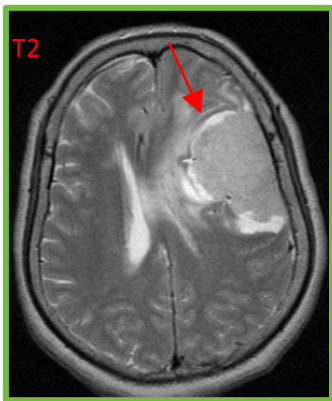
MRI

T1 : Isointense: ~ 60 - 90% isointe

T1 C+ (Gd) : usually intense and homogenous enhancement

T2: isointense: ~ 50%. Associated edema

Hyperintense: ~ 35 - 40%

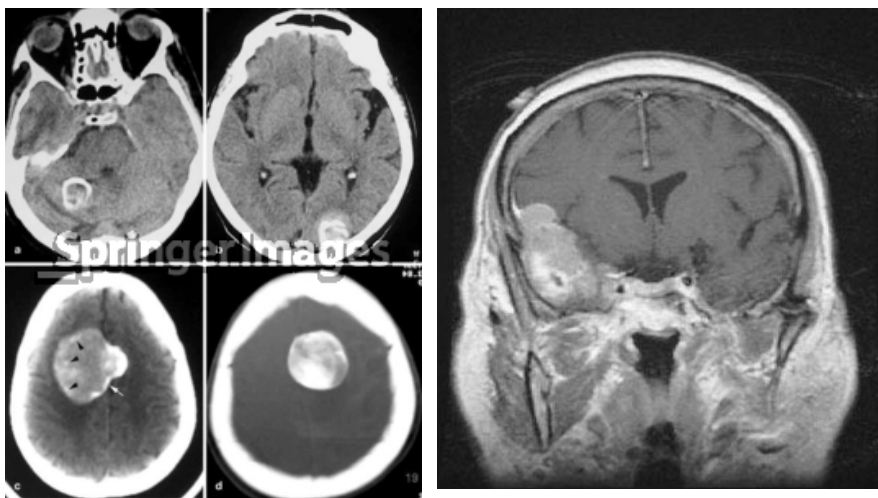


Specific signs:

- **CSF Cleft sign**
- **Dural tail** seen in 60 - 72% (blue circle)

(Note that a dural tail is also seen in other processes)

- The dural tail sign occurs as a result of thickening of the dura.



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

Patterns of edema:

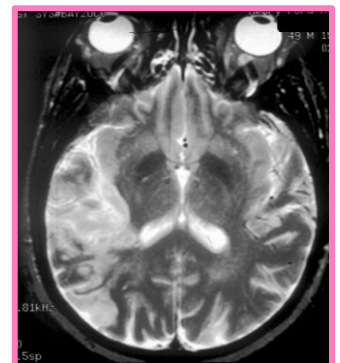
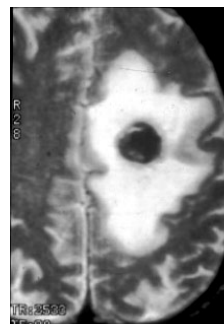
- ❖ Edema: Increase in tissue water
- ❖ CT: decreased density (looks black)
- ❖ MR - T1W: decreased signal
- ❖ MR - T2W: increased signal

Two important types:

- 1) Vasogenic (interstitial)
- 2) Cytogenic (intracellular)



- Vasogenic**
- Affects white matter only
 - Can be seen in neoplasm and abscess

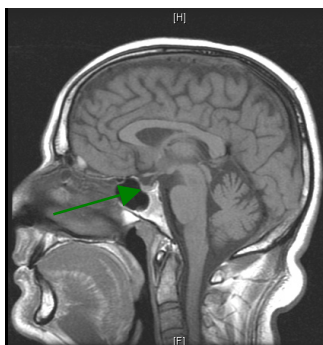


- Cytogenic**
- Affects both gray and white matter
 - Seen in infarction/stroke

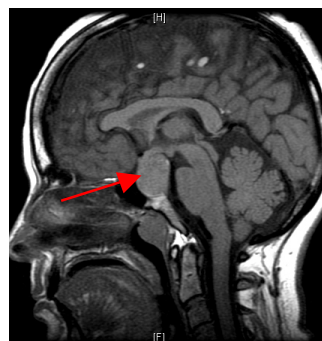
3) Pituitary Adenoma:

- ❖ Pituitary adenomas comprise 10% of intracranial tumors. **The majority are hormonally active.**
- ❖ The homogenous isointensity of the enlargement suggests pituitary macroadenoma as opposed to cystic, vascular, or inflammatory lesions/enlargements. **Clinical correlation is important.**
- ❖ The MRI scan demonstrates an isointense enlargement in the region of the pituitary characteristic of a pituitary adenoma. **(MRI is the modality of choice)**

Normal Pituitary



PITUITARY MACROADENOMA



4) Craniopharyngioma;

- ❖ 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).



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



MRI:

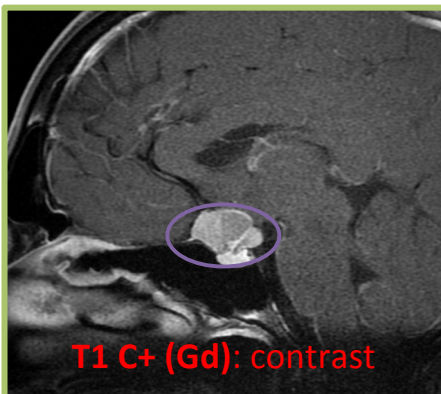
MR features can significantly vary depending on the histological subtype and on the size and content of the cysts.

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.

T2: signal is high in both solid and cystic components, but is variable depending on content of fluid.

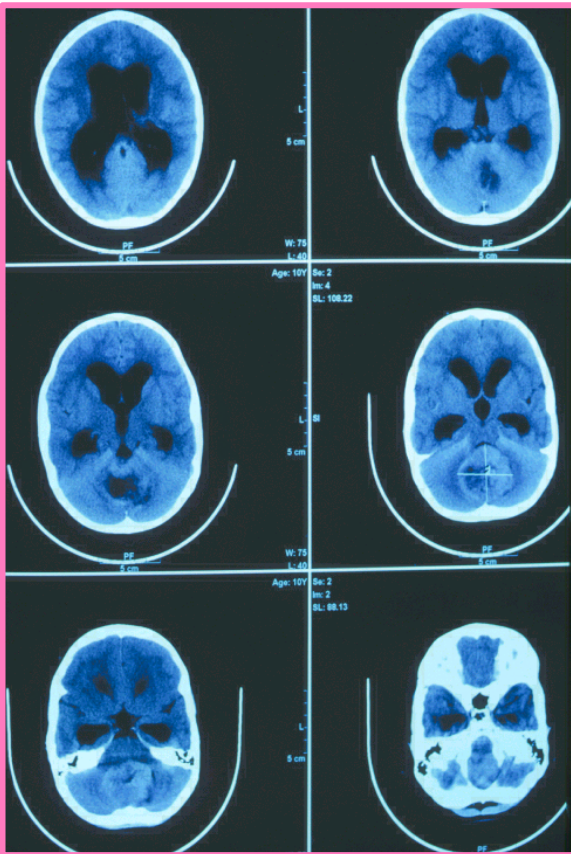
Fluid level appearance, which means that there is a cystic component and solid component in the lesion. The solid is more enhancing.



5) Medulloblastoma:



- ❖ A medulloblastoma is **the most common paediatric posterior fossa tumour** and accounts for 30 - 40% of such entities.
- ❖ They are **a type of CNS primitiv neuroectodermal tumour**.
- ❖ 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**.

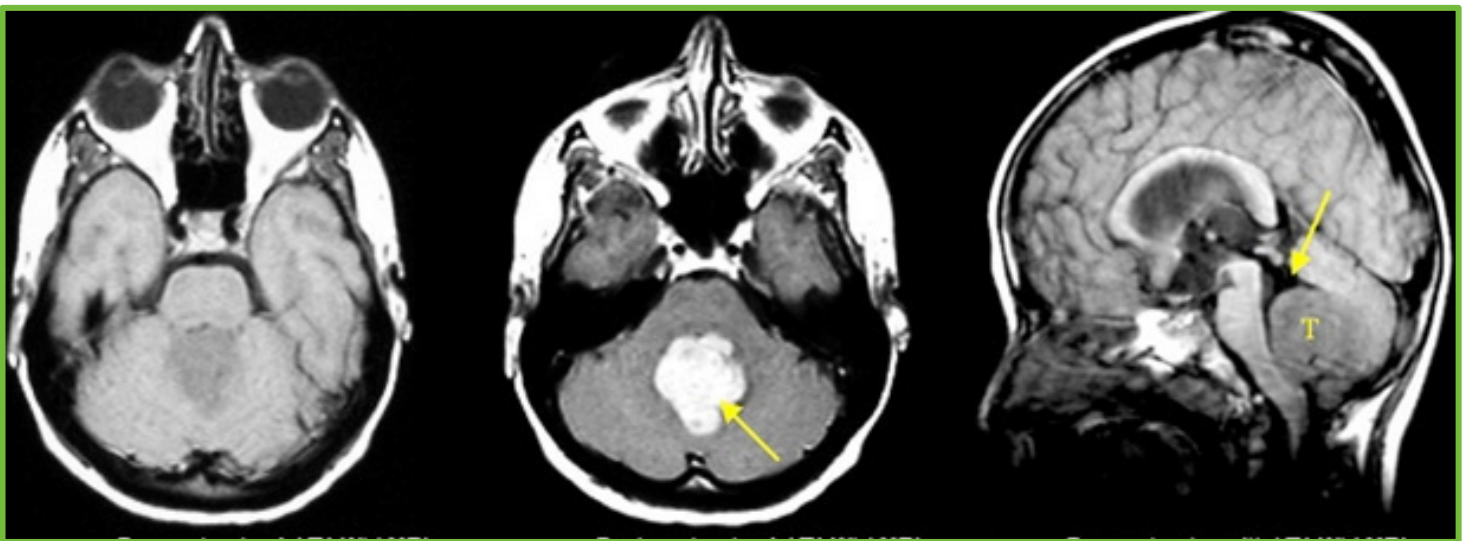


CT:

- 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 hyperdense (90%) and cysts formation / necrosis is common (40 - 50%), especially in older patients.
- Calcification is seen in 10 - 20% of cases.
- Enhancement is present in over 90% of cases and is usually prominent.

MRI

- **T1** : hypo intense to grey matter
- **T1 C+ (Gd)** : 90% enhance, often heterogeneously
- **T2** heterogeneous due to calcification, necrosis and cyst formation
- overall are iso to hyper intense to grey matter



A: Pre-contrast axial T1 Wtd MRI

B: Post-contrast axial T1 Wtd MRI

C: Pre-contrast sagittal T1 Wtd MRI

Findings:

A: pre-contrast sagittal T1-weighted MR image

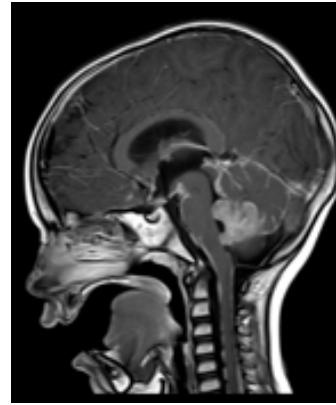
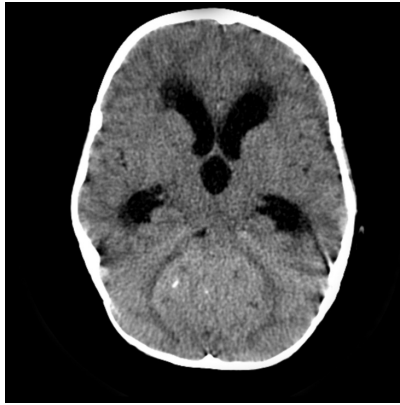
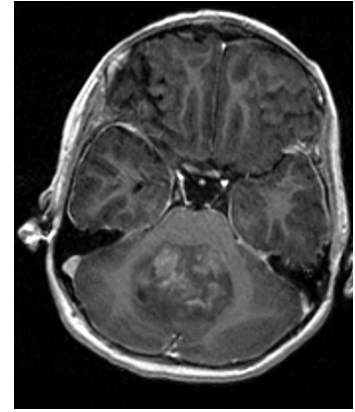
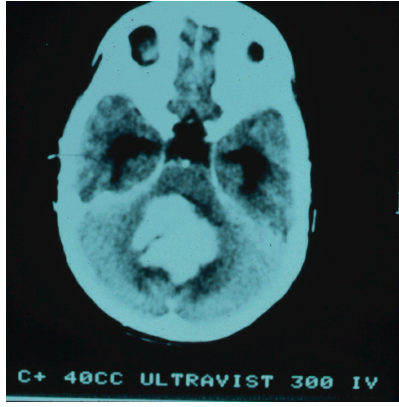
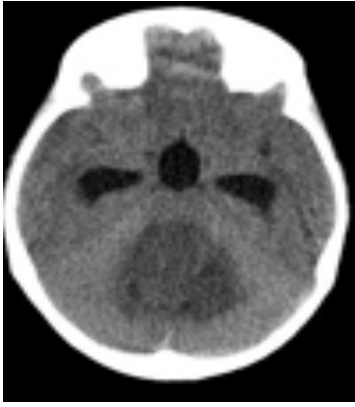
B: an enhancing tumor (yellow arrow) seen posterior to the IV ventricle.

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.



Secondary Brain Tumors (Brain Metastases):

- ❖ A metastatic, or secondary, brain tumor 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.**
- ❖ **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)

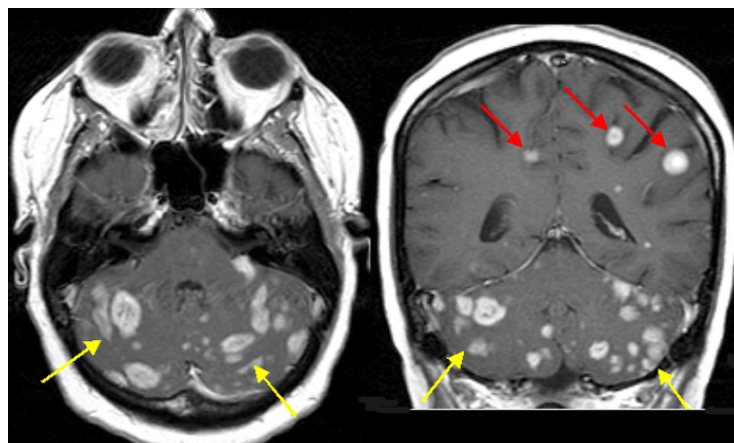


Brain metastases

- ❖ 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).

Post-contrast Axial
T1 Wtd MRI



Post-contrast Coronal
T1 Wtd MRI

Intracranial Tumors

Role of imaging in neurooncology

- **Diagnosis**
 - Ddx: 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

2) Inflammation in the brain

- ❖ Neuronal damage in classic neuroinflammation
- ❖ “secondary” neuroinflammation 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:

Multiple sclerosis (MS) is a relatively common acquired chronic relapsing demyelinating disease involving the central nervous system. It is by definition disseminated not only in space (i.e multiple lesions), but also in time (i.e lesions are of different age).



MRI

MRI has revolutionised 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 the imaging modality of choice.**

T1:

Lesions are typically iso to hypo intense (chronic).

T2:

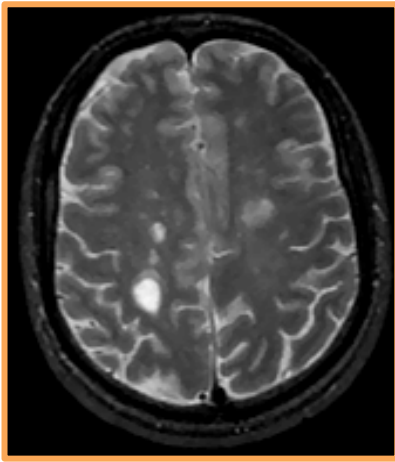
Lesions are typically hyper intense.

FLAIR:

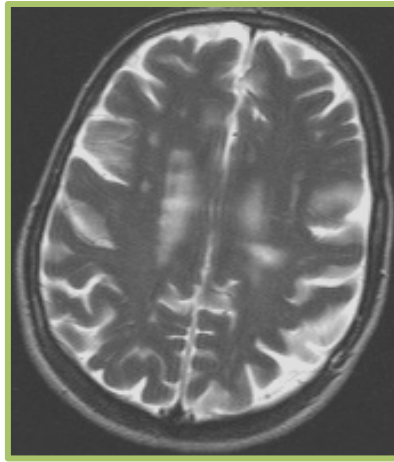
- Lesions are typically hyper intense.
- When arranged perpendicular to lateral ventricles, extending radially outward (best seen on parasagittal images) they are termed **Dawson fingers**.

T1 C+ (Gd) :

- Active lesions show enhancement.
- Enhancement is often incomplete around the periphery (**open ring sign**).



- Multiple lesions in periventricular white matter
- T1: Hypointense.
- T2: Hyperintense.
- T2 images are extremely sensitive for MS plaques



- T2 weighted images:
- CSF is bright
 - Demyelinated areas are bright



- Periventricular Region
"Dawson's fingers" represent lymphocytic infiltration along periventricular medullary veins.

Dawson fingers are a radiographic feature depicting demyelinating plaques through corpus callosum, arranged at right angles along medullary veins (calloseseptal location).

3) 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**.

1) Brain abscess:

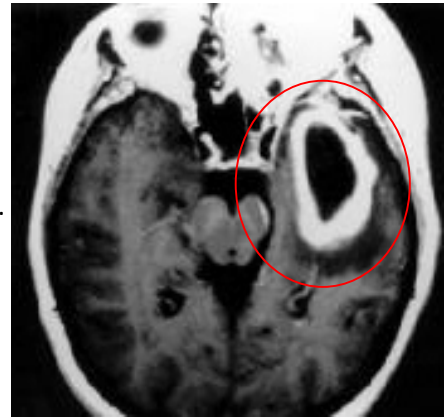
Ring enhancing lesion, thin rim with uniform enhancement

T1

- Central low intensity (hyperintense to CSF).
- Peripheral low intensity (vasogenic oedema).
- **Ring enhancement.**
- Ventriculitis may be present, in which case hydrocephalus will commonly also be seen.

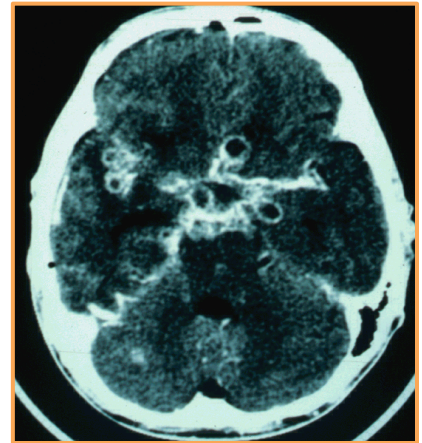
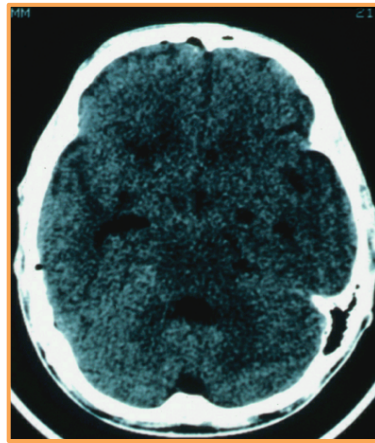
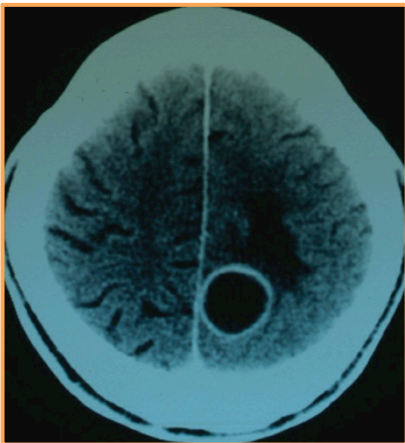
T2 / FLAIR

- Central high intensity (hypointense to CSF, does not attenuate on FLAIR).
- Peripheral high intensity (vasogenic oedema).
- The abscess capsule may be visible as an intermediate to slightly low signal thin rim.



CT Brain

- Central low density.
- Peripheral low density (vasogenic oedema).
- **Ring enhancement.**
- Iso / hyperdense ring.

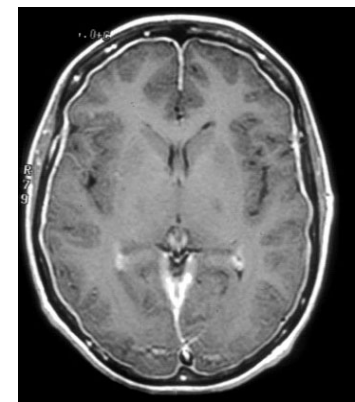
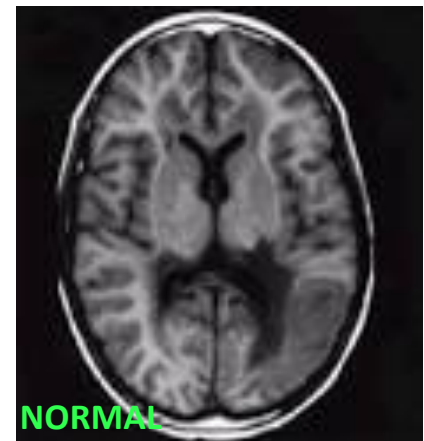
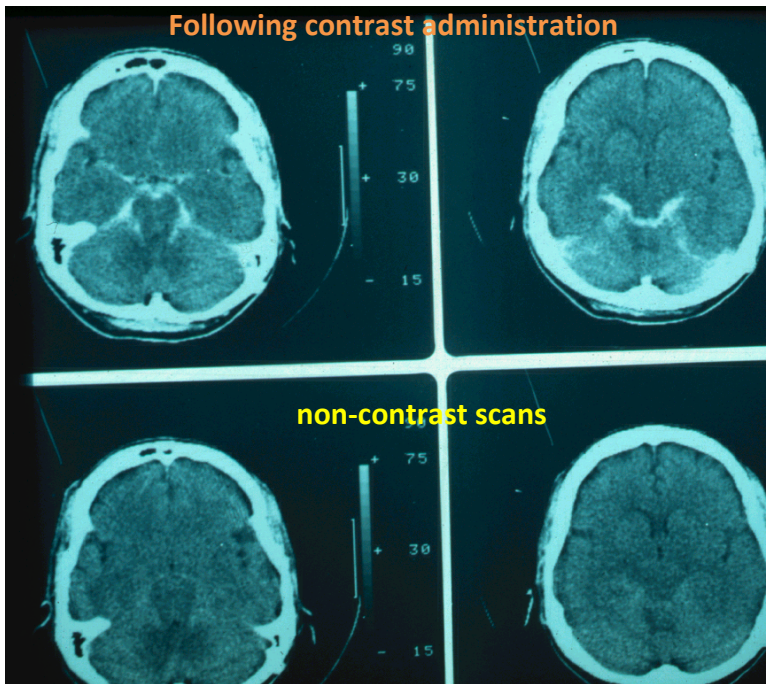


- Smooth, well defined
- Most likely bacterial abscess

- Post contrast
- Tuberculous abscess

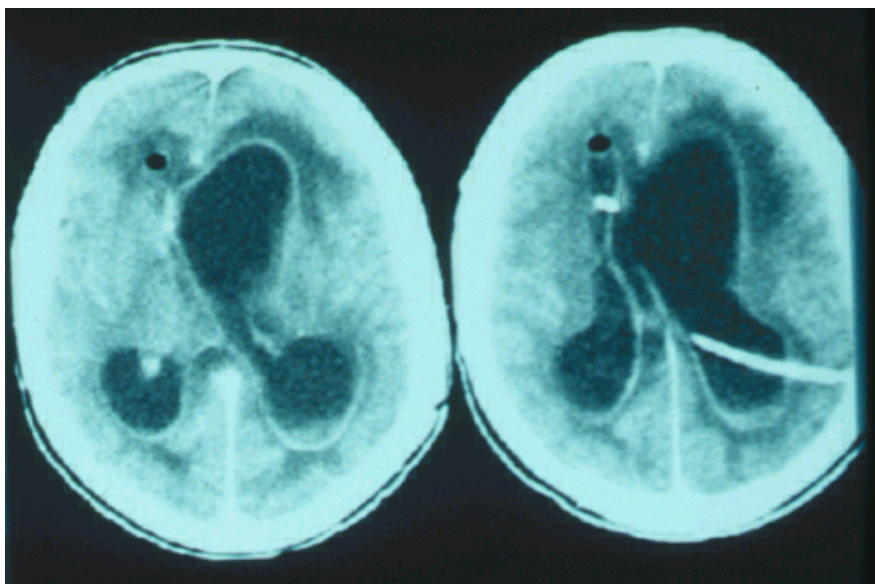
	T1	T2 / FLAIR	CT
Central	Low intensity (hyperintense to CSF)	High intensity (hypointense to CSF, does not attenuate on FLAIR)	Low density.
Peripheral	Low intensity (vasogenic oedema)	High intensity (vasogenic oedema)	Low density (vasogenic oedema)
Enhancement	Ring enhancement	The abscess capsule may be visible as an intermediate to slightly low signal thin rim	Ring enhancement

2) Meningitis:



- Basal enhancing exudates.
- Leptomeningeal enhancement, along sylvian fissures, tentorium.

3) Ventriculitis:



ventriculitis may be present, in which case hydrocephalus will commonly also be seen

SUMMARY

1) Glioblastoma multiforme:

- ❖ The most common and most aggressive primary brain malignancy in adults
- ❖ MRI is the imaging modality of choice for diagnosis (definitive diagnosis by pathology).

2) Meningioma:

- ❖ A meningioma is the most common type of extra-axial neoplasm
- ❖ Originates from the arachnoid cap cells of the meninges.
- ❖ Specific signs:
 - CSF Cleft sign.
 - Dural tail seen in 60 - 72%. (Note that a dural tail is also seen in other processes)

3) Vasogenic edema:

- ❖ Affects white matter only.
- ❖ Can be seen in neoplasm and abscess.

4) Cytogenic edema:

- ❖ Affects both gray and white matter.
- ❖ Seen in infarction/stroke.

5) Pituitary Adenoma:

- ❖ The majority are hormonally active.
- ❖ The homogenous isointensity of the enlargement suggests pituitary macroadenoma.
- ❖ Clinical correlation is important.

6) Craniopharyngioma:

- ❖ They derive from remnants of the craniopharyngeal duct.

7) Medulloblastoma:

- ❖ Common pediatric brain tumor.
- ❖ Common location is posterior to the IV ventricle. Involving the vermis.

8) Multiple sclerosis:

- ❖ "Dawson's fingers" represent lymphocytic infiltration along periventricular medullary veins.

9) Brain abscess:

- ❖ Ring enhancing lesion, thin rim with uniform enhancement.

10) Meningitis:

- ❖ Basal enhancing exudates.
- ❖ Leptomeningeal enhancement, along sylvian fissures, tentorium.

11) Ventriculitis:

- ❖ Hydrocephalus will commonly also be seen with it
-

MCQs

Q1: Which one of the following is a specific radiology sign for Meningioma?

- A) Stippled calcification.
- B) CSF cleft sign.
- C) Ring enhancement.
- D) Effacement of the fourth ventricle

Q2: Which of one of the following tumors is derived from remnants of the craniopharyngeal duct?

- A) Pituitary Adenoma
- B) Glioblastoma multiforme
- C) Medulloblastoma
- D) Craniopharyngioma

Q3: The most common and most aggressive primary brain malignancy in adults is:

- A) Meningioma
- B) Pituitary Adenoma
- C) Glioblastoma multiforme
- D) Craniopharyngioma

Answers:

- 1) B
- 2) D
- 3) C

For extra information:

<http://radiopaedia.org/> (Some of the doctor's images are from this website)



Good Luck!