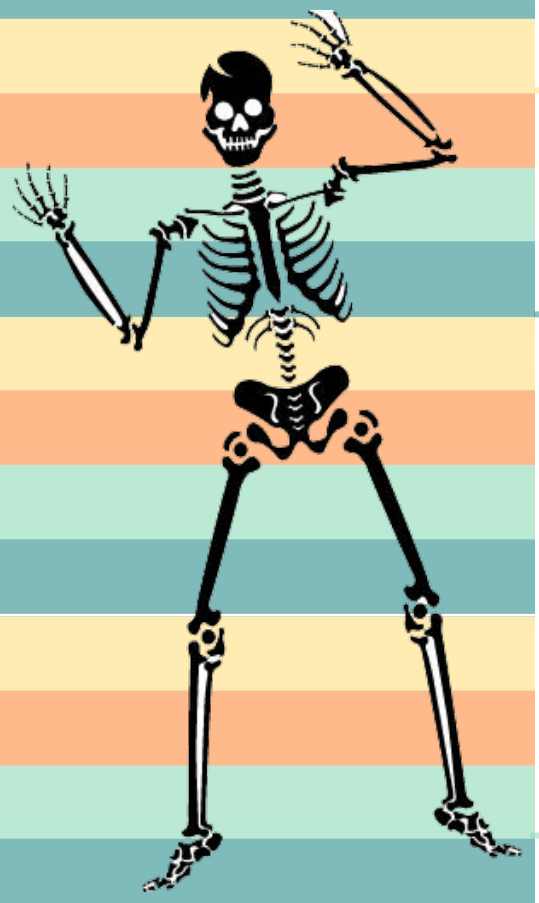
436 Teams

Radiology Teams 436

Radiology of brain diseases - Part 2

Objectives

Objectives were not provided.



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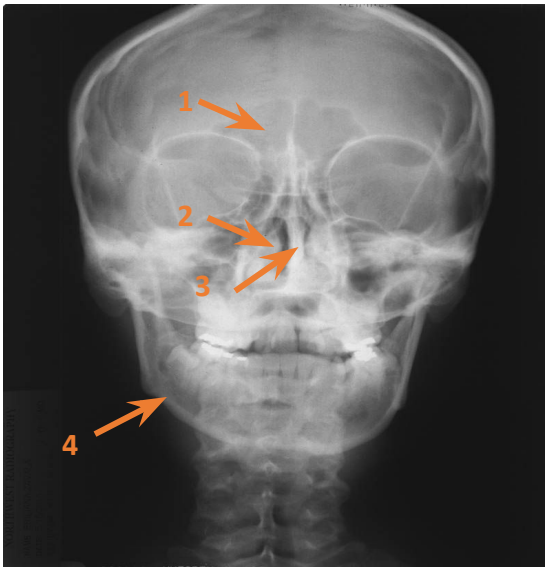
Color Coding

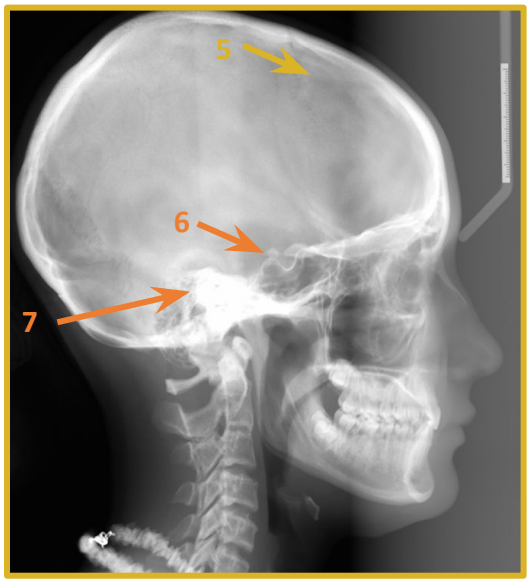
Important | Notes | Extra

Editing File

Name the normal anatomical areas



Skull AP view

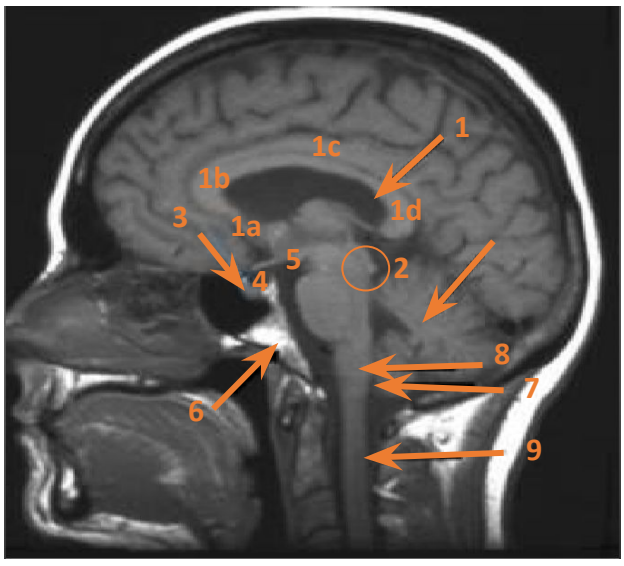


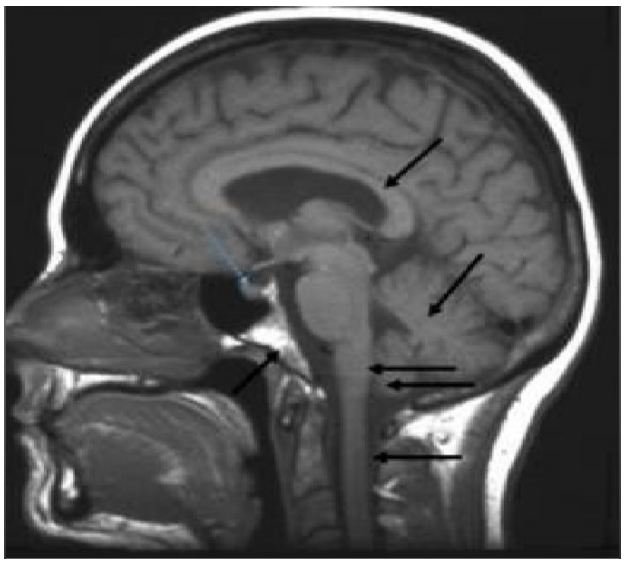
Skull X-ray lateral view

Labels:
1- Frontal sinus.
2- Ethmoid sinus.
3- Nasal septum.
4- Mandible.
5- Coronal suture.
6- Sella turcica.
7- External auditory meatus.

The images were changed to provide better quality. To see the original ones, click here.

Where is the infarction area?



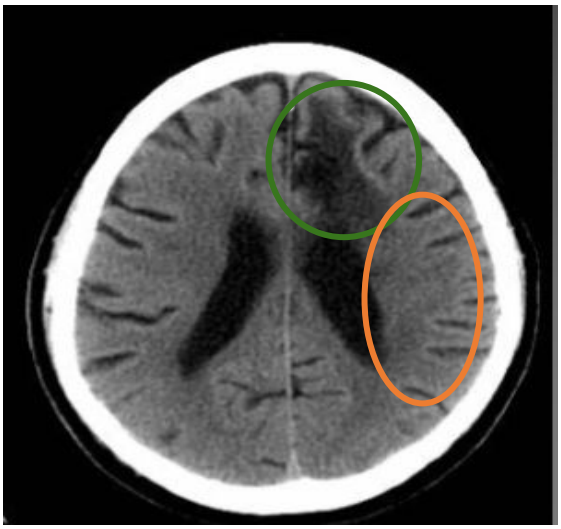


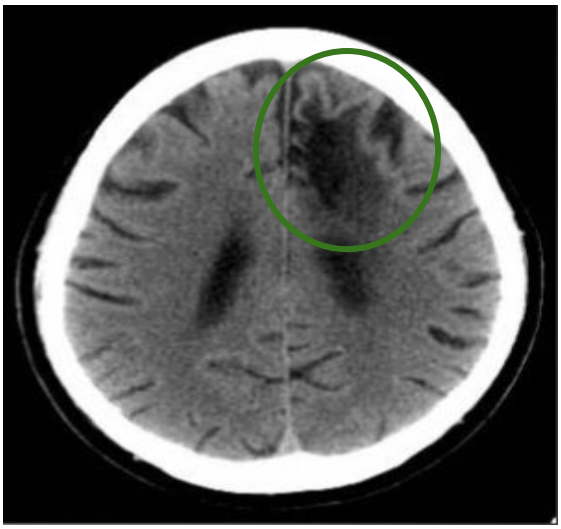
Sagittal view in MRI T1, because the CSF is dark. White color in MRI T1 indicates fat.

1 - Corpus Callosum.
1a - Rostrum.
1b - Genu.
1c - Body.
1d - Splenium.
2 - Superior & Inferior Colliculus.
3 - Anterior Pituitary gland (inside sella turcica).
4 - Posterior Pituitary gland (appears white because of fat).
5 - Mammillary Body.
6 - Clivus.
7- Cerebellar tonsils, herniation of this the the part is sign of increased intracranial pressure.
8- Medulla oblongata.
9- Spinal cord.

Where is the infarction area?

a. Old CT

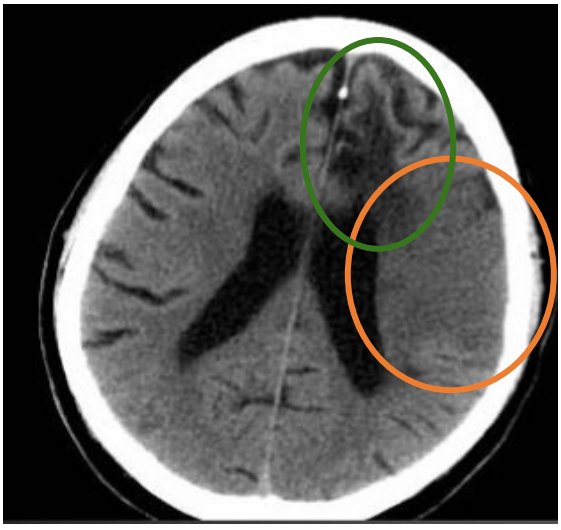


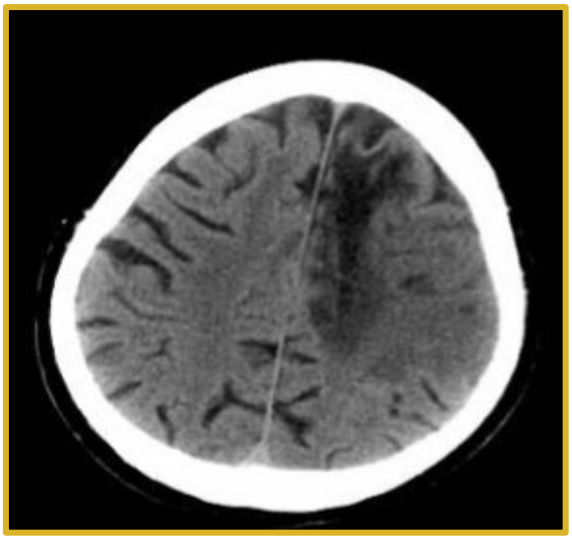


ACA Area
MCA Area

The lesion in the medial aspect of left frontal lobe, has a similar density of CSF (dark) which means it is an old infarct which is called a cystic encephalomalacia. Being old means there is no mass effect (no edema), and we can see that the sulci are maintained.

b. Recent CT





In the same picture, we can see two lesions, a new acute infarction and an old infarction. The sign of volume loss is obvious with the old one, while signs of an increase in volume and edema and mass effect are obvious in the acute one.

In this case:
1- Chronic infarction of the left ACA.
2- Acute infarction of the left MCA.

The signs of acute infarction are:
1- Diffuse hypodensity (dark).
2- Sulcal effacement.
3- Loss of gray-white differentiation.

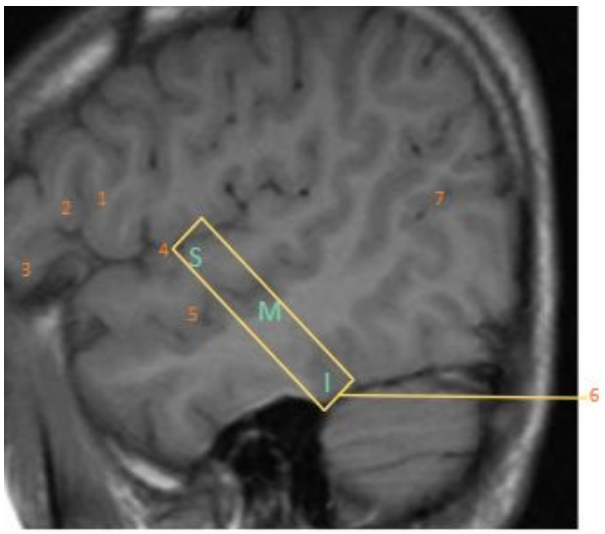
Sagittal brain anatomy

Inferior frontal gyrus divided into 3 parts:

1. Pars opercularis.
2. Pars triangularis.
3. Pars orbitalis.

4. Sylvian fissure.
5. Superior temporal sulcus.
6. Transverse temporal gyri.
7. Parieto-occipital sulcus.

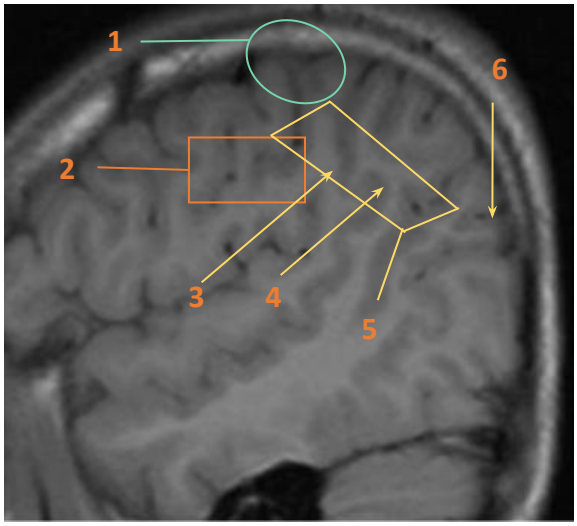
Sylvian fissure is an important fissure which separates the temporal from frontal.



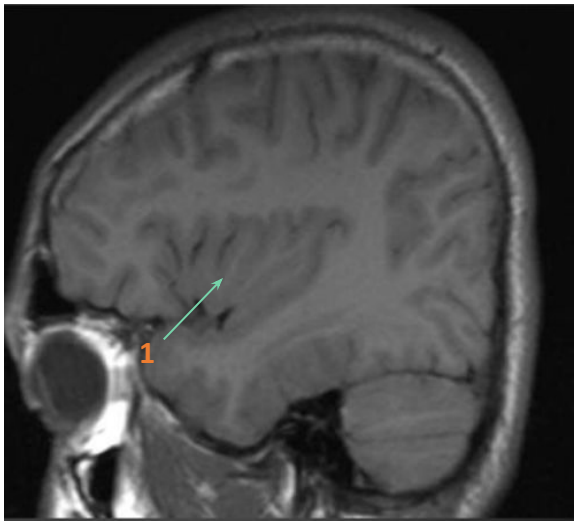
Paracentral lobes (motor anteriorly and sensory posteriorly) are separated by the central sulcus.

1. Paracentral lobule.
2. Subcentral lobule.
3. Supramarginal gyrus.
4. Angular gyrus of temporal lobe.
5. Inferior parietal lobule.
6. Parieto-occipital sulcus.

Each brain lobe contains multiple lobules.

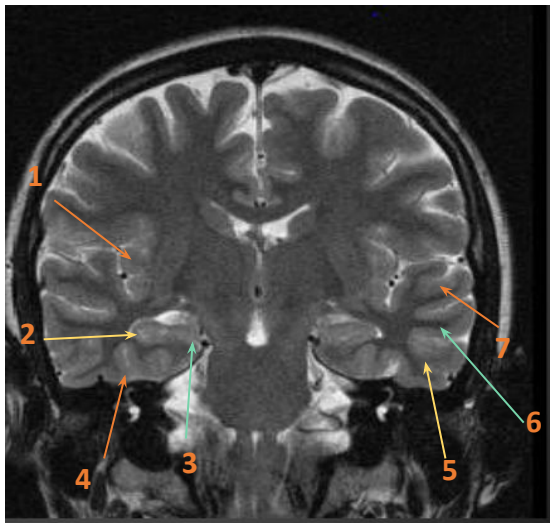


1. Insular cortex.

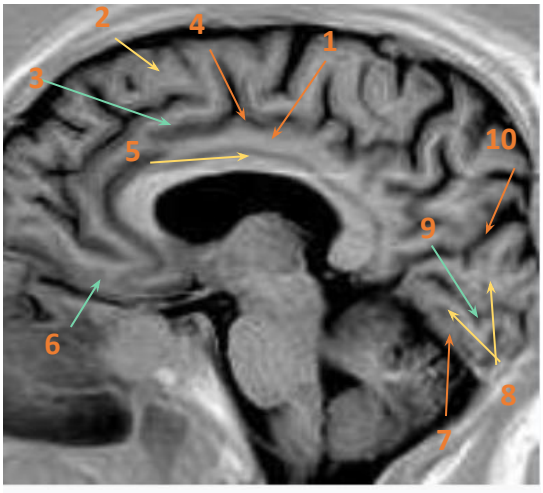


Sagittal images in MRI T1

1. Insula a small region of the cerebral cortex located deep within the lateral sulcus.
2. Hippocampus usually affected in case of partial complex seizure, it is the medial part of the temporal lobe, a small organ located within the brain's medial temporal lobe and forms an important part of the limbic system, the region that regulates emotions.
3. Parahippocampus is a grey matter cortical region of the brain that surrounds the hippocampus and is part of the limbic system. This region plays an important role in memory encoding and retrieval.
4. Lateral occipito-temporal gyrus.
5. Inferior temporal gyrus.
6. Middle temporal gyrus.
7. Superior temporal gyrus.



Coronal section



1. Cingulate gyrus.
2. Superior frontal gyrus.
3. Middle frontal gyrus.
4. Cingulate sulcus.
5. Callosal sulcus.
6. Gyrus rectus.
7. Medial occipitotemporal gyrus.
8. Striate cortex.
9. Calcarine sulcus.
10. Parieto occipital sulcus.

Approach to brain mass

- Location. It is very important because each area of the brain has its own differential diagnosis: Is it a mass or an infection? Is it extra-axial, such as a meningioma, or intra-axial, such as a glioma? Is it infratentorial or supratentorial? Is it related to the posterior fossa? Is it cortical or subcortical? intraventricular or paraventricular?
- Pattern. How does the lesion appear in a radiological image? Is it hypo or hyper dense?. In MRI it is important to know how it'll appear in T1 and T2. Is it enhanced post contrast or not and in which way?
- Age / Sex. Pituitary adenomas are more common in females, while adrenoleukodystrophy is a genetic disease common in males. There are also certain types of tumors that are related to the pediatric age group.
- Clinical data. Is the onset sudden (stroke) or progressive (tumor or infection)?
- Pathological entity. It means to be broad in the way we think. Is it neoplastic or not? if yes, is it primary or secondary? Is it an infection or not? if yes, Is it pyogenic or not? if it's non-pyogenic we can think of fungal or TB infection.

Localization

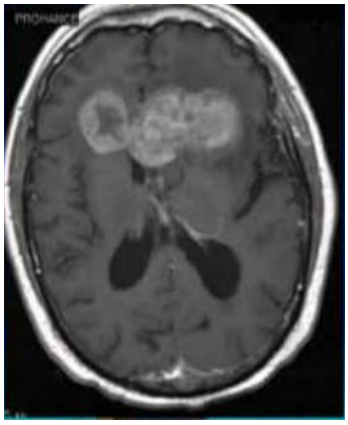
- Intra or extra axial tumor?

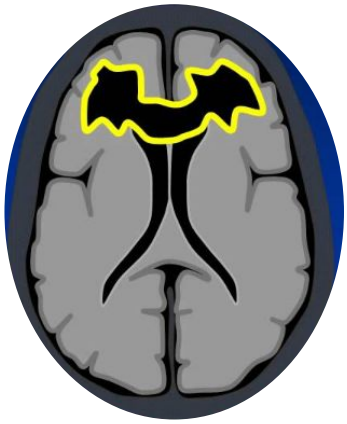
Intra-axial tumor:
Tumor is located within brain parenchyma.
Extra-axial tumor: even within the meninges
Tumor is located outside the brain parenchyma, such as Skull, CSF, cisterns and ventricles.

Pattern Analysis: Location

Basic Approach:

- Where is the lesion?
  - Extraaxial.
  - **Intraaxial.**
  - Intraventricular.
- Where is the lesion?
  - Supratentorial.
  - Infratentorial related to posterior fossa and cerebellar.
- How old is the patient?
  - Child.
  - Adult
- What about Sex?



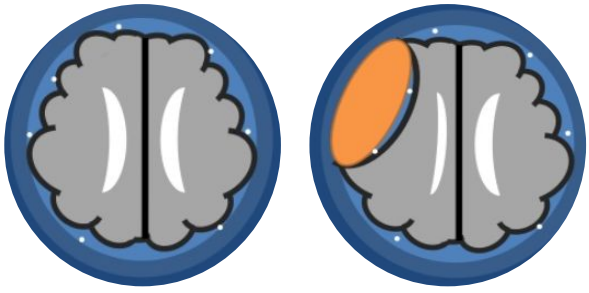


Sign of extra-axial location

It is an important point to narrow our differential diagnosis

Definitive sign

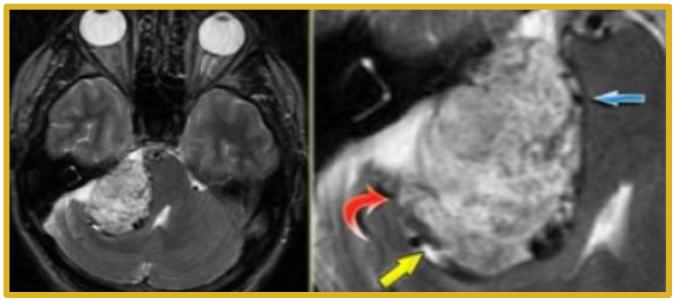
- CSF cleft between brain and lesion which means the lesion is lined by CSF.
- Vessels interposed between brain and lesion are pushed by the mass effect.
- Cortex between brain and lesion, so it'll be related to grey matter not white matter.
- Dura (Meninges) between brain and lesion, so we can see it as flat line.



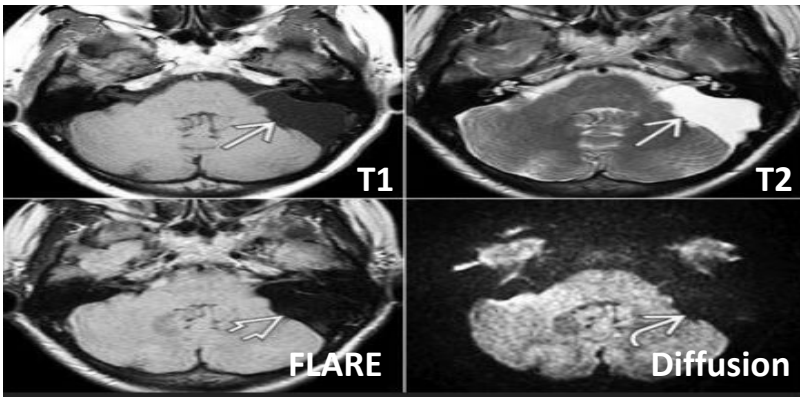
The white dots represent blood vessel within the subarachnoid space.

Suggestive Sign

- Peripheral, broadly base along calvarium.
- Overlying bone change.
- Enhancement of adjacent meninges.
- Displacement of brain from skull.
- CSF Cleft (yellow arrow).
- Displaced Subarachnoid artery (blue arrow) medially.

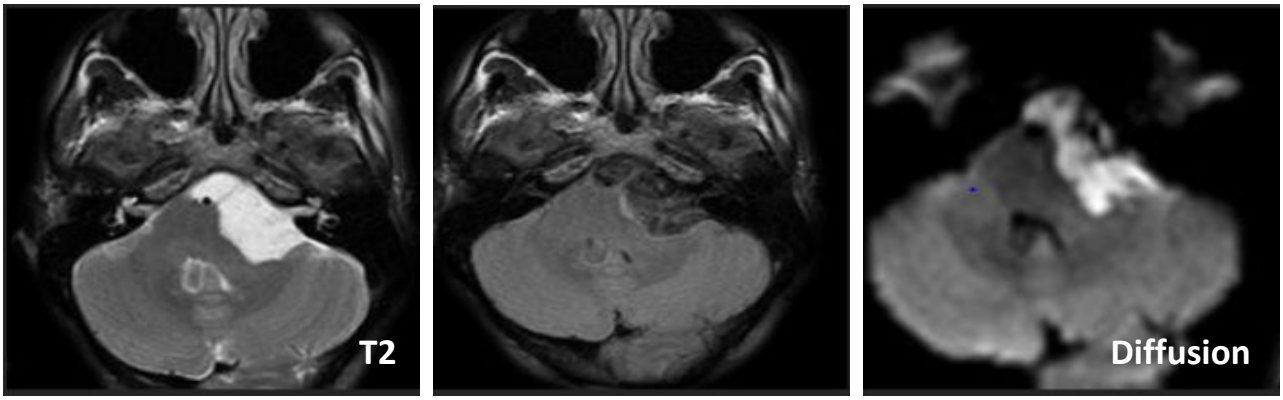


The lesion here is in the cerebellopontine angle, so we think about meningioma in this angle or schwannoma related to the nerves here, but it can never be a brainstem glioma or medulloblastoma.



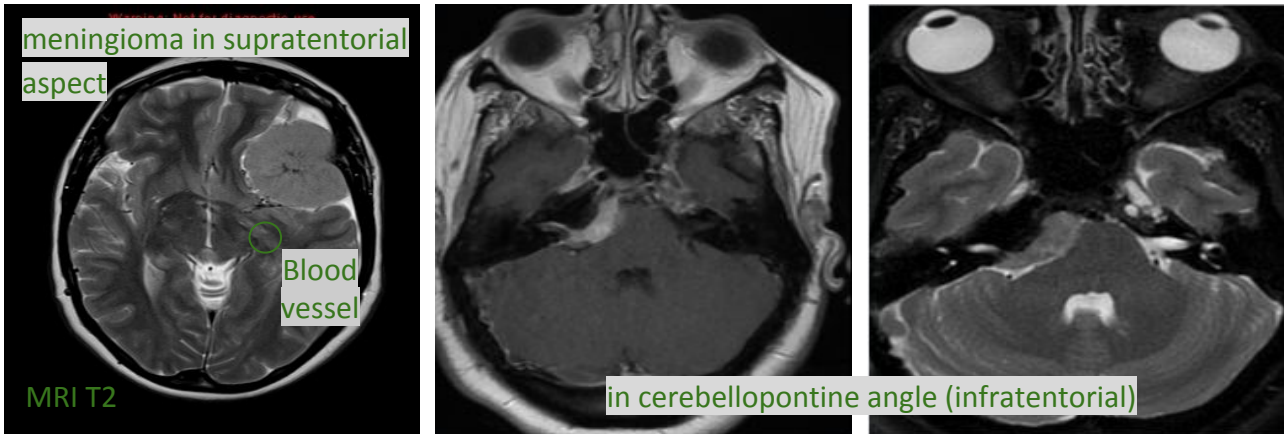
Arachnoid cyst (no need for treatment) low signal on T1WI and high signal on T2WI, without restriction on DWI (diffusion). FLARE is suppressed (FLAIR: T2 but with clear fluid suppression) if it is homogeneously suppressed, then it only contains fluid. All these characteristics are found in arachnoid cyst or epidermoid mass, and we differentiate between them by diffusion, if it is negative (dark) as in this case it is gonna be an arachnoid cyst.

Epidermoid Cyst



- High on T2WI, with restriction on DWI. It is similar to an arachnoid cyst in T1 & T2 and in the space, both of them don't enhance postcontrast. The difference however is in diffusion which will be restricted in Epidermoid (restricted diffusion → high signal on DWI.
- It needs surgical treatment so the differentiation is important.

Meningioma

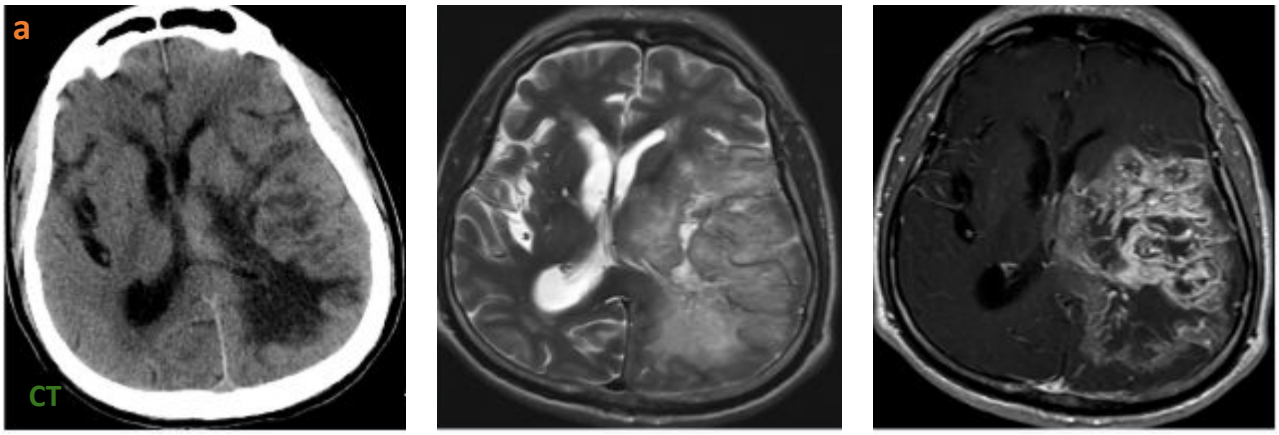


- Extraaxial brain tumor (outside of the brain) displacing the brain.
- Enhances with gadolinium. Homogenous, unlike cystic lesions (epidermoid and arachnoid).
- Has a dural tail or flat line attachment with dura and there is CSF cleft, and the blood vessels are displaced. So the meningioma is a solid lesion which is low to intermediate signal in T2 and homogeneous enhancement post contrast. It can be supra or infratentorial.

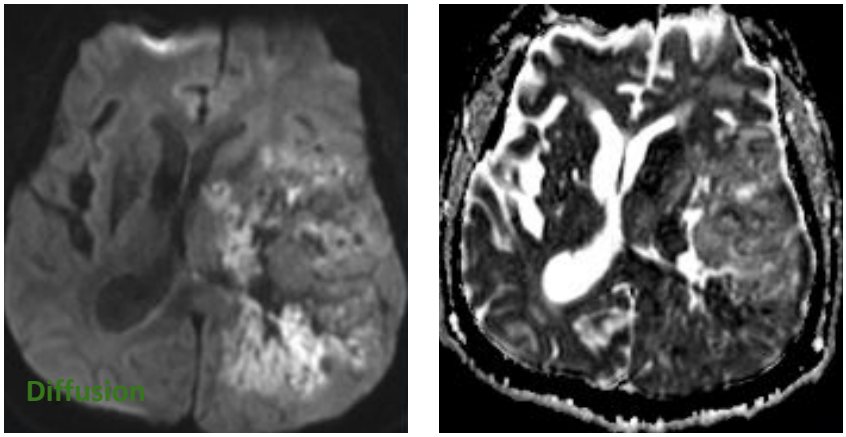
Glioblastoma Multiforme GBM

- WHO grade IV.
- Most common 1ry brain tumor and the most malignant.
- Can occur at any age even in neonates and infants.

- Cerebral hemispheres.
- Subcortical.
- Periventricular and across compact tract (pyramidal tracts).
- Basal ganglia and thalamus.



MRI with post contrast shows heterogeneous enhancement

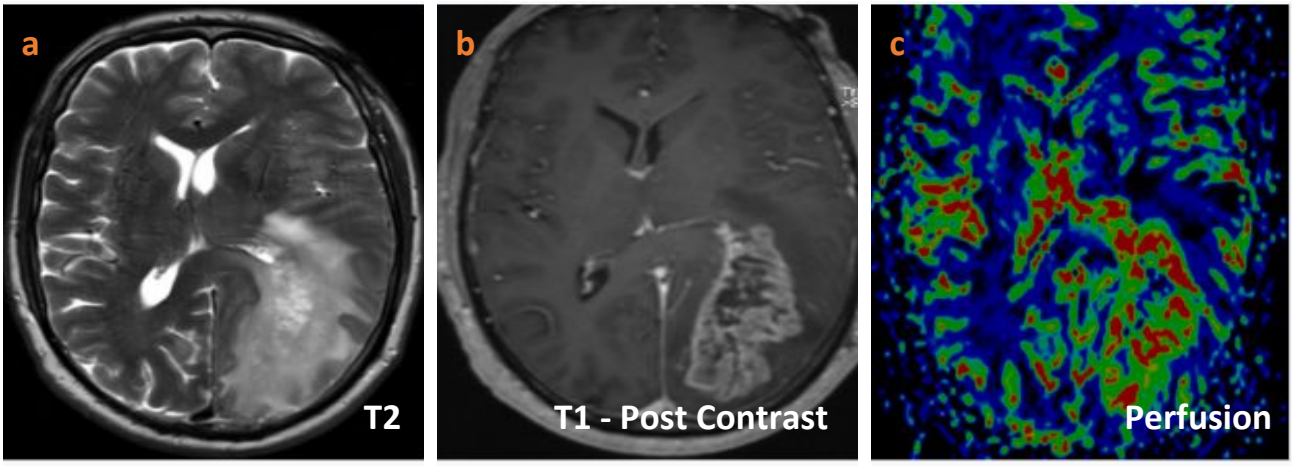


Pic a: CT shows an asymmetrical hemisphere with shifting of midline and an intracranial lesion with vasogenic edema in black on the left side. We have two types of edema in the brain: 1- Cytogenetic with stroke or arterial involvement or 2- Vasogenic edema in case of infection with abscess or TB or high grade tumor or venous involvement.
Vasogenic cerebral edema refers to a type of cerebral edema in which the blood brain barrier (BBB) is disrupted (cf. **cytotoxic cerebral edema**, where the BBB is intact). It is an extracellular edema which mainly affects the white matter via leakage of fluid from capillaries.

General findings:

1- Intra-axial large mass.
2- Partially infiltrating the corpus callosum.
3- Heterogeneous enhancement.
4- Diffusion restriction.
5- Midline shift.
So the diagnosis here is a high grade intracranial tumor (GBM).

Diffusion is very important:
- In stroke it means it is acute.
- Also it helps in differentiating between epidermoid and arachnoid cyst.
- In a tumor there is the high grade (dense cellular) part of the tumor and a second part consisting of necrotic tissue. It is important for surgeons and for pathological samples or biopsy.



a, b. Linear nodular central areas of enhancement with thicker peripheral enhancement. Also look for diffusion restricted areas corresponding to enhancement.
c. Very high rCBV values on perfusion MRI in enhancing part with intermediate perfusion values in immediate surrounding non-enhancing areas indicating tumor infiltration.

Other case of GBM; intra-axial, supratentorial affecting the left parietal lobe. High signal in T2, with mass effect and a midline shift.
In post contrast, there is heterogeneous thick irregular granular enhancement, this pattern gives us three differential diagnoses (GBM or TB or metastatic) to rule out TB we can use perfusion. If it is high perfusion it can never be an infection (like TB).
Neoplastic lesions are enhanced when a contrast is given because of the high perfusion related to the angiogenesis.

Wanna understand More? Check the links below!

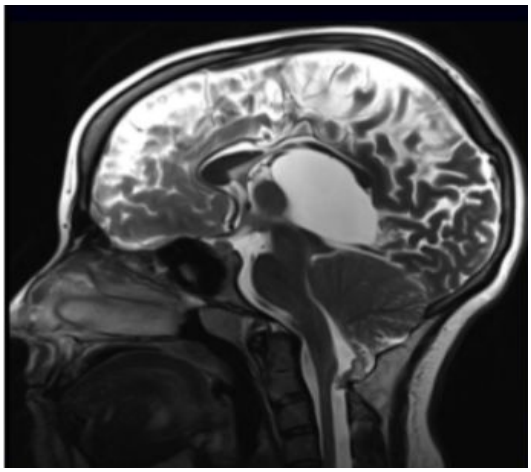
Understanding glioblastoma

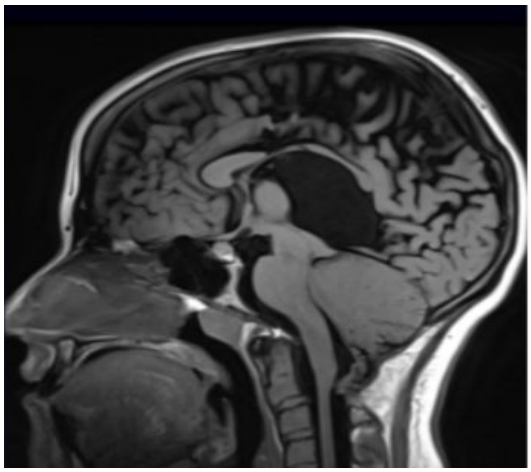
Glioblastoma - Radiopaedia

Vasogenic edema - Radiopaedia

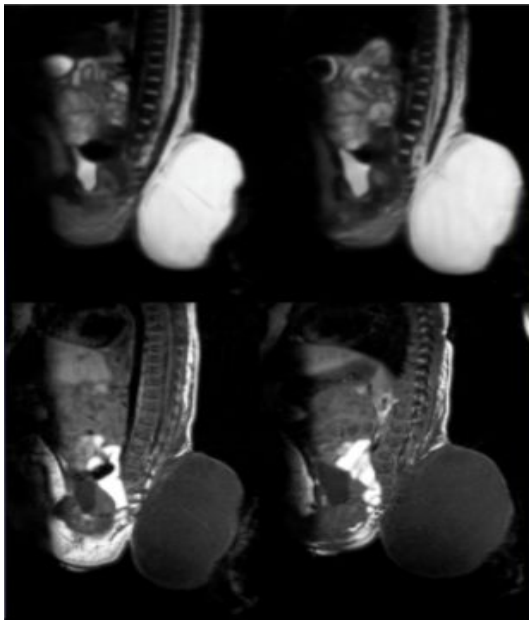
Diffusion weighted imaging - Radiopaedia

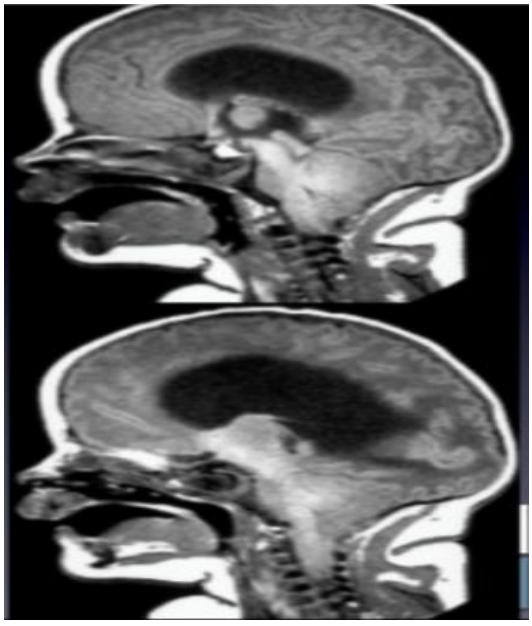
Chiari malformation (Type 2)



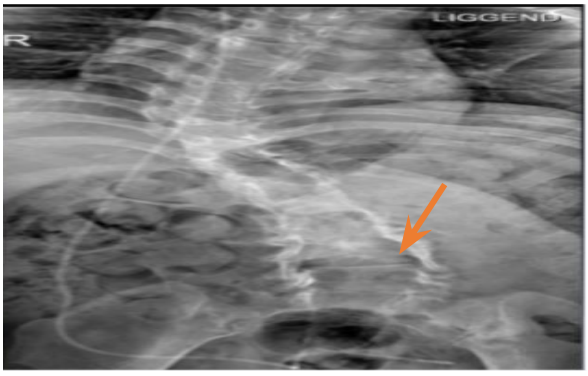


1- Small size posterior fossa with very narrow 4th ventricle.
2- Tectal beaking refers to the fusion of the midbrain colliculi into a single beak pointing posteriorly and invaginating into the cerebellum.
3- Deformity of the clivus.
4- Tonsillar herniation in the cervical below the level of foramen magnum more than 4 mm (Normally it is less than 3-4 mm).
5- Corpus callosum not clearly outlined and there is dysgenesis.





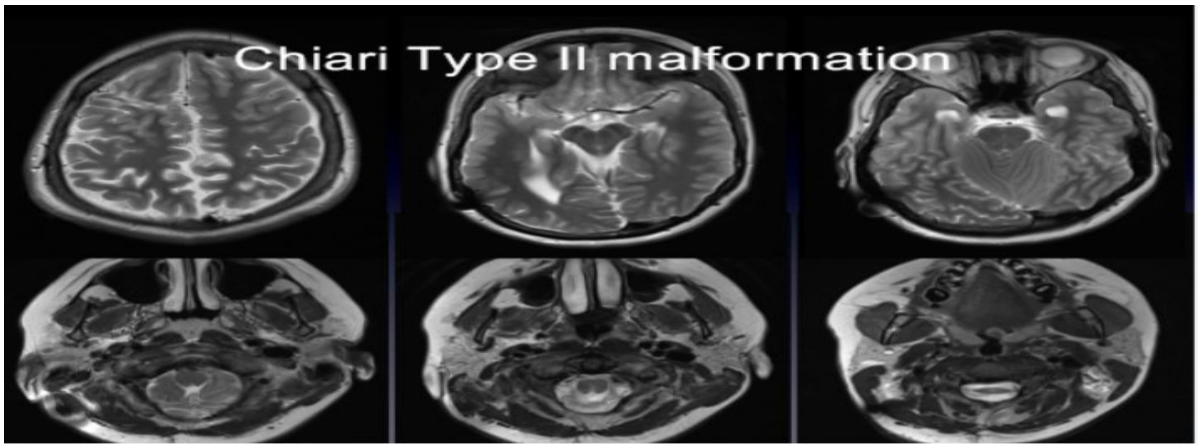
Type 2 is usually present with myelomeningocele then diagnosed with Chiari-2. The myelomeningocele can be removed surgically but the brain malformation will still be there.



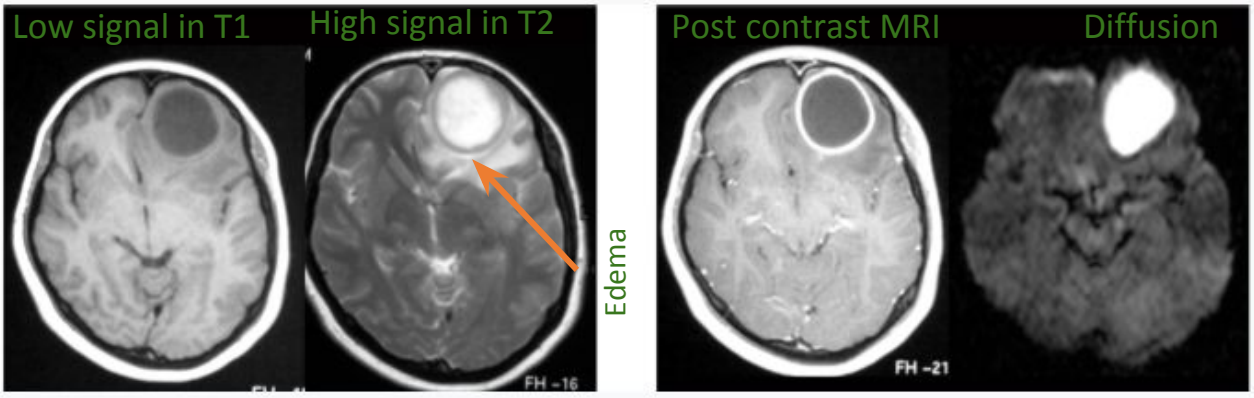
Here we can see widening of spinal canal due to the presence of myelomeningocele. There is no posterior elements, which is why it is called “spina bifida”.
These patients usually have hydrocephalus and need a shunt to relieve the pressure.

Chiari malformation type 2

The most severe type with more brain malformation



Brain abscess



1- Intra Axial.
2- Well demarcated.
3- Continuous ring enhancement
an area of decreased density (see radiodensity) surrounded by a bright rim from concentration of the enhancing contrast dye. This enhancement may represent breakdown of the blood-brain barrier and the development of an inflammatory capsule.
4- No enhancement of the internal content.

In post contrast we can see smooth regular wall, unlike what we saw in GBS. One of the differential diagnosis is pyogenic abscess. If it is very bright in diffusion we confirm the pyogenic abscesses.

Abscess; CT and MRI findings:

Capsule is thin-regular and shows a uniform enhancement.

<u>The rim is:</u>

Hypersignal on T1W1 is not specific.

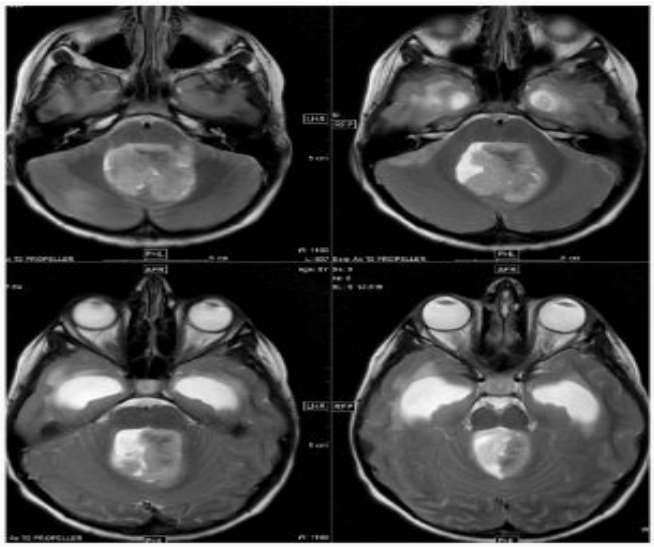
Hyposignal on T2W1 is not specific.

<u>Abscess and neonates:</u>

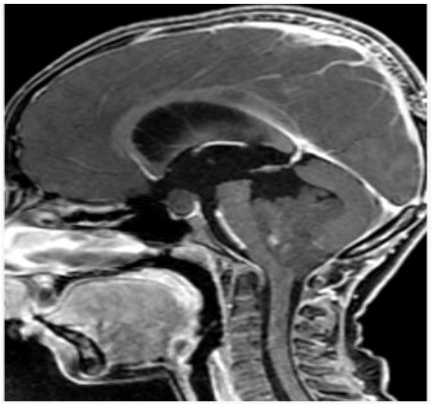
Large size, thin capsule, typically in the periventricular white matter.

Restricted intraparenchymal ring enhancement lesion → abscess.

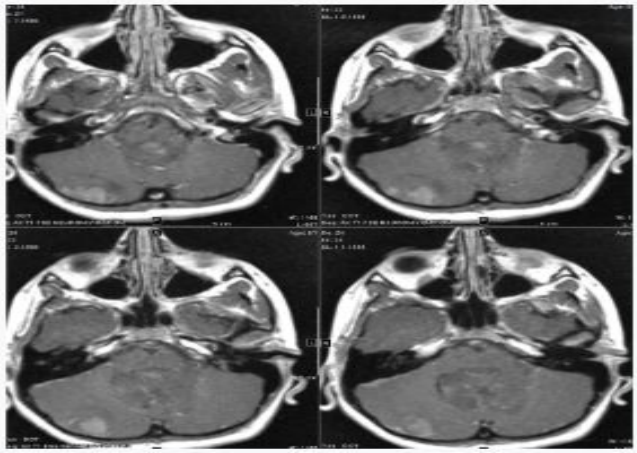
Medulloblastoma



- Infratentorial midline mass in child, we have four main differential diagnoses (medulloblastoma - pilocytic astrocytoma - ependymoma - brain stem glioma). The medulloblastoma has a unique characteristic that differentiates it from others. It is the only one which will appear hyperdense in CT, and low to intermediate in T2, and diffusion restriction.
- Medulloblastoma is the most common malignant brain tumor of childhood. They most commonly present as midline masses in the roof of the 4th ventricle with associated mass effect and hydrocephalus.
- Medulloblastoma on CT often appears as a mass arising from the vermis, resulting in effacement of the fourth ventricle / basal cisterns and obstructive hydrocephalus. They can also occur more laterally in the cerebellum.



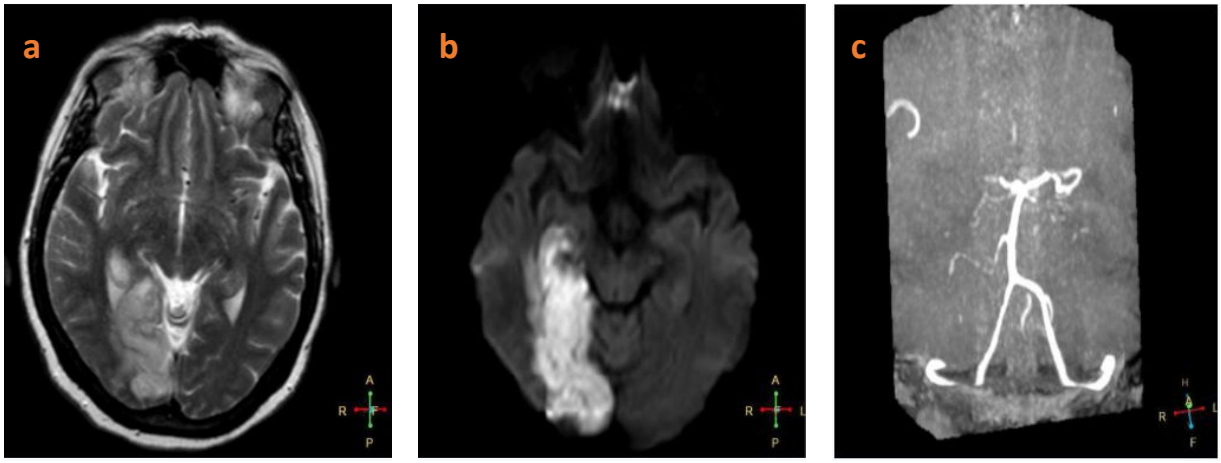
Sagittal section shows advanced case of medulloblastoma with metastatic inside sella turcica.



Treatment:

- Treatment typically consists of surgical resection, radiation therapy, and chemotherapy. In general, the tumors are quite radiosensitive.

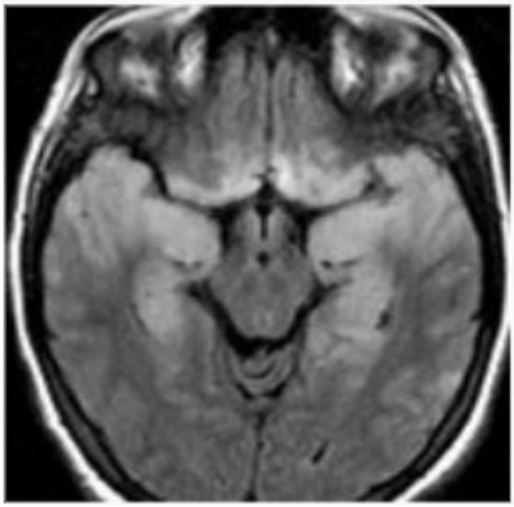
Acute PCA territory cerebral infarction



- Right occipital gyral and inferior temporal swelling and altered signal in cortical and subcortical area exhibiting restricted diffusion in DWI, bright signal in T2.
- MRA reveals occluded P1 segment of right PCA.
- Diagnosis: Right PCA territory acute cerebral infarction. If the patient present with sudden onset.
- If the same picture occurs with more than one territory with no history of sudden onset we can think of herpes encephalitis.
- **Pic C:** MRI angiography, there is filling defect in right branch of PCA.

The abnormalities on this MRI are due to:

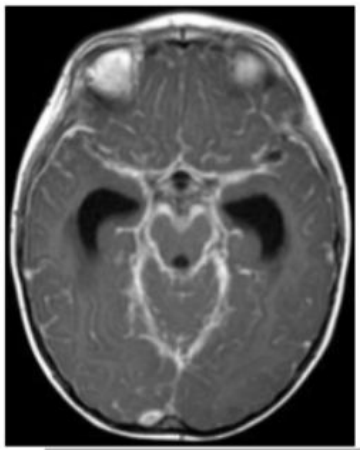
- Multiple sclerosis? not correct because in this image most of the abnormality is seen in gray matter and MS is a white matter disease.
- Brain tumor**?** no, the lesion is bilateral and cortical.
- Meningitis? no, the lesion is cortical.

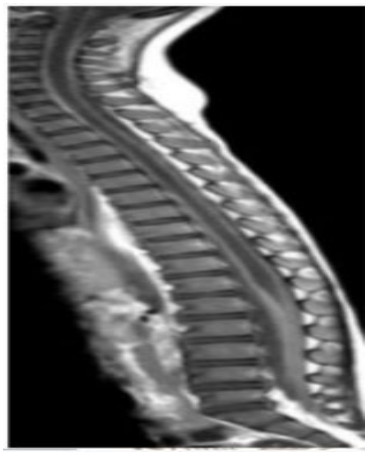


Diagnosis: Herpetic encephalitis.

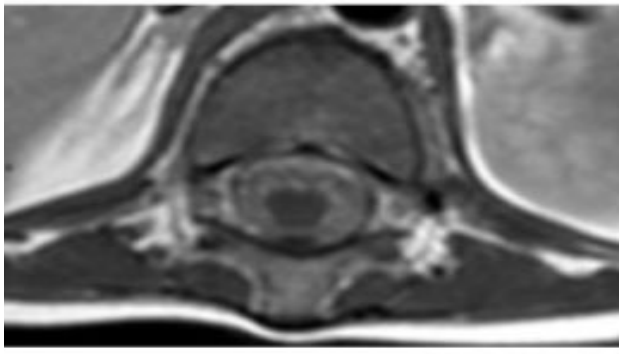
- Typical pattern of herpetic encephalitis which is bilateral.
- High signal in T2.
- It starts unilateral then becomes bilateral.
- In this picture it involves temporal lobes and hippocampus and part of the frontal lobes which is a typical distribution of herpes.
- We can see swelling due to edema and infection.

Bacterial meningitis





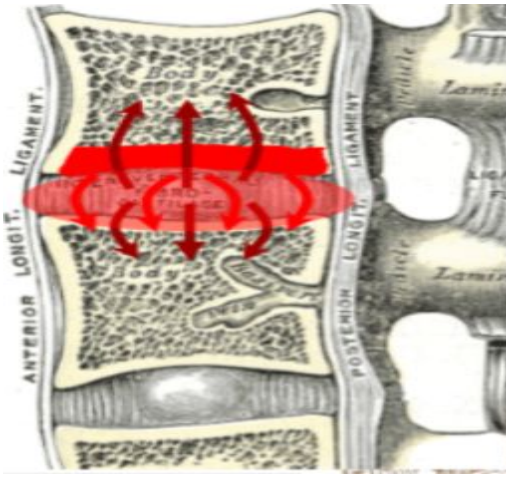
- Infectious process involving the dura, leptomeninges (the inner two meninges, the arachnoid and the pia mater, between which circulates the cerebrospinal fluid) and CSF.
- Imaging studies usually not performed.
- The disease is treated on a clinical basis.



- Diffuse leptomeningeal enhancement.
- Post-Gadolinium T2-like contrast.

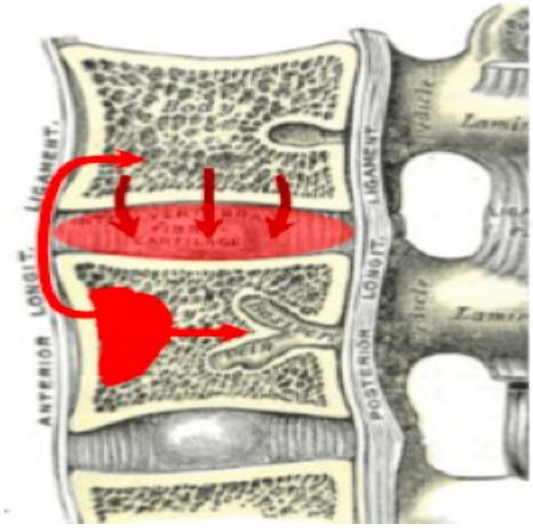
Bacterial spondylodiscitis

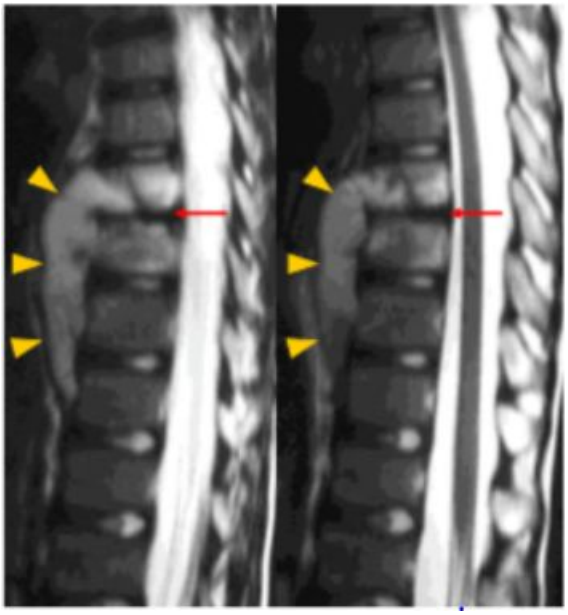
- Staphylococci, Streptococci from septic emboli (arterial and venous).
- Traditionally believed to begin into the hypervascular pediatric disc.
- Probably infection starts in the vertebral body adjacent to the endplate, then proceeds to the disc, and eventually spreads to both adjacent bodies. That's why it is called spondylodiscitis.
- **Clinical features:** acute onset with back pain, refusal to walk (child), irritability, fever, local tenderness.



TB spondylitis

- Usually secondary to extraspinal infection.
- May be the initial manifestation of the disease in children.
- Recrudescence of cases in Western countries.
- Infection usually starts in the anterior vertebral body and spreads under the anterior longitudinal ligament to adjacent vertebrae. The difference between the tumor and infection in spine, that the infection spreads through the ligament (subligmental) while a tumor will be confined within the vertebral bodies.





Coronal **Sagittal**

1- Ring enhancement lesion: abscess.

- In sagitta, two vertebrae with soft tissue component.
- In coronal post contrast, we can see multiple large paravertebral abscesses.

Summary

Approach to brain mass:

1. CT → MRI → MRI sequences (T1,T2,post contrast, diffusion, and perfusion).
2. Location.
3. Pattern.

Infarction:

1. Diffuse hypodensity (dark). 2. Sulcal effacement. 3. Loss of gray-white differentiation.

- ## Extra-axial lesion:

1. CSF cleft. 2. Vessels interposed between brain and lesion.
3. Dura (Meninges) between brain and lesion (flat line).

Arachnoid cyst & Epidermoid :

Both of them appear (low signal on T1WI and HIGH signal ON T2WI)
we differentiate by diffusion (DWI), with restriction → Epidermoid / without restriction → Arachnoid.

Meningioma:

it is a solid lesion which is low to intermediate signal in T2 and homogeneous enhancement post contrast. It can be supra or infratentorial or within cerebellopontine angle.

- ## Intra-axial lesion:

GBM:

High signal in T2 with mass effect & midline shift. We can use perfusion to confirm the diagnosis.

Medulloblastoma:

Infratentorial midline mass in child .
Hyperdense in CT, and low to intermediate in T2, and diffusion restriction.

Brain Abscesses:

In post contrast → smooth regular wall unlike what we see in GBS.
If it is very bright in diffusion we confirm the pyogenic abscesses.
Restricted intraparenchymal Continuous ring enhancement lesion → abscess.

Chiari-II malformation:

Small size posterior fossa, narrow 4th ventricle, deformity of the clivus, tonsillar herniation, corpus callosum dysgenesis. Usually present with myelomeningocele.

Herpetic encephalitis:

Typical distribution of herpes is involving temporal lobes, hippocampus and part of frontal lobes. it can be Bilateral. We can see swelling due to edema and infection.

Spinal cord:

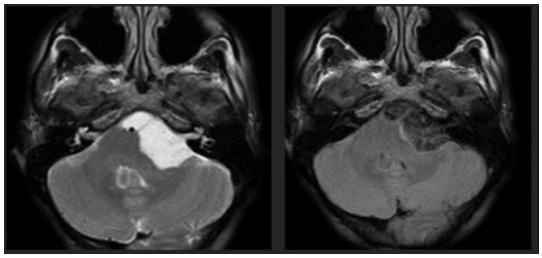
- **Bacterial spondylodiscitis:** Infection starts in the vertebral body adjacent to the endplate, then proceeds to the disc, and eventually spreads to both adjacent bodies.
- **TB spondylitis:** Infection usually starts in the anterior vertebral body and spreads under the anterior longitudinal ligament to adjacent vertebrae.

Questions

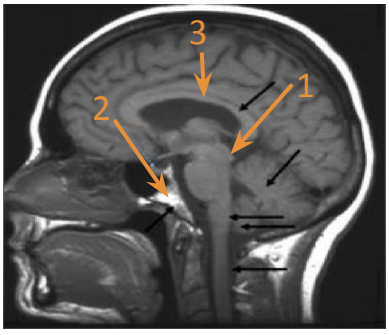
1) Which of the following is a sign of infarction:
A- Diffuse hypodensity
B- Restricted diffusion
C- Midline shift
D- Continuous ring enhancement

2) An abscess is enhanced when a contrast is given:
A- True
B- False

3) Regarding the lesion in picture which of the following is false:
A- Diffusion restriction
B- It contains fluid
C- Homogeneously suppressed in T2
D- It doesn't need treatment



4) what is the name of the structure num 1?
A- pons
B- Mamillary body
C- Splenium
D- Superior & Inferior Colliculus



5) what is the name of the structure num 2?
A- Pituitary gland
B- Sphenoidal sinus
C- Clivus
D- Rostrum

6) which part of the corpus callosum is num 3?
A- Genu
B- Splenium
C- Body
D- Thalamus

Answers:
1-A
2-B
3-C & D
4-D
5-C
6-C