RADIOLOGY
TEAM 435

Radiology of common brain diseases

[Color index: Important ★ | Notes | Extra | Book's Notes]

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● Objectives:

- Identify cerebral infarction on images and know the clinical deficits associated with each type of infarction.
- Understand the imaging findings of the different types of intracranial bleeding.
- Recognize the cerebral edema signs on neuroimaging and differentiate between its types.

● Resources:

- 435 slides and notes
- 434 team

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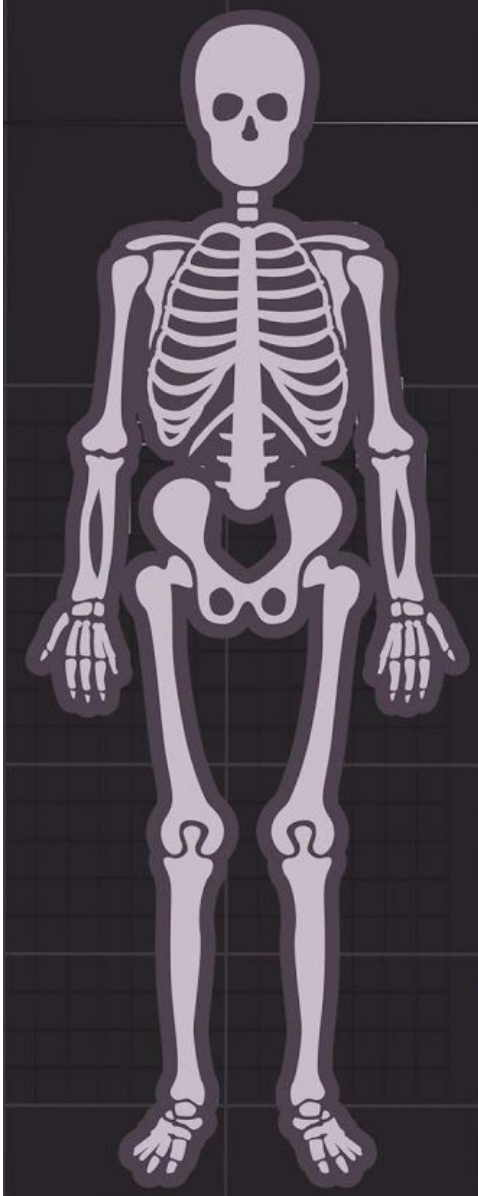
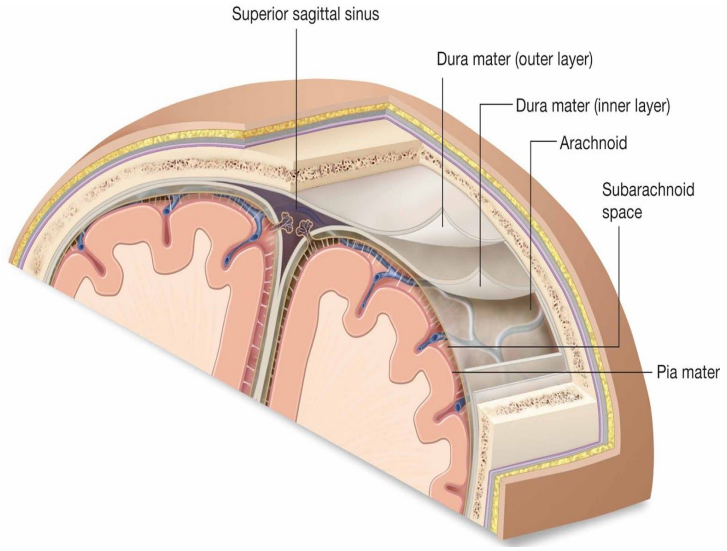
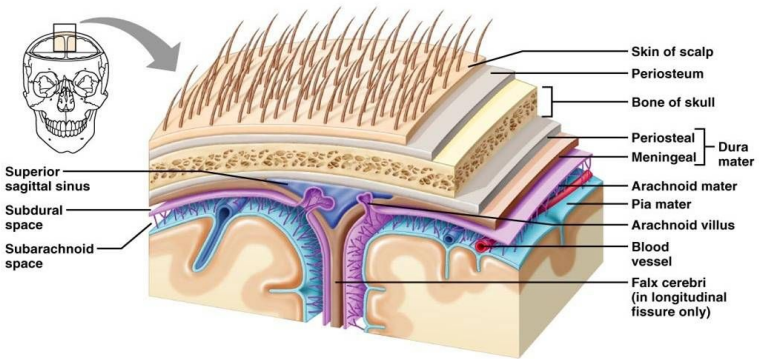
Thanks to Samar AlOatibi <3

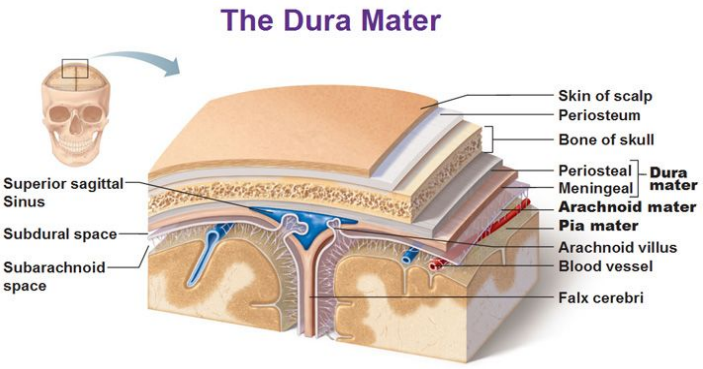


Introduction

The inner Dura (meningeal) is attached firmly to the outer one (periosteal) there is no space in between, so consider them one layer. The outer layer follows the bone and the inner layer reflects in the interhemispheric fissure or to the occipital lobe and cerebellum to make the Dural reflections (falx cerebri & falx cerebelli). So anything or any disease that is beneath the Dura should be called **subdural**, anything between the Dura and the bone is called **epidural**. Then after Dura is the white layer called the **arachnoid** then the **subarachnoid space** (which contains the CSF). The layer directly above the brain is the Pia mater.

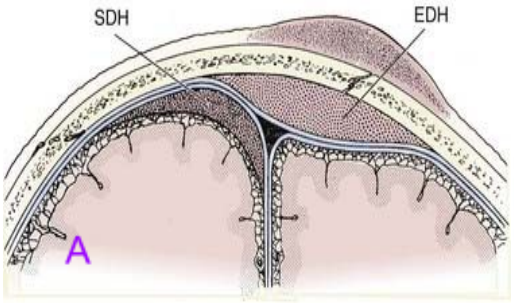


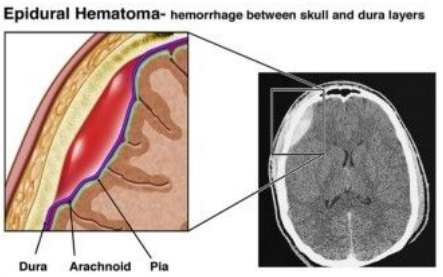


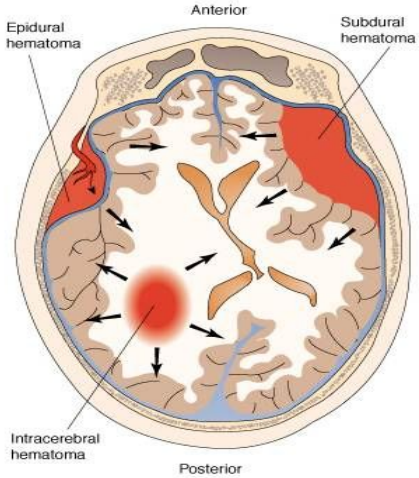


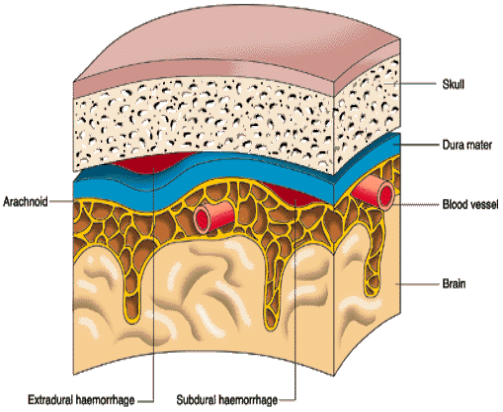
Intracranial Bleeding

- **Extradural (Epidural)**
- **Subdural**
- **Subarachnoid**
- **Intraventricular**
- **Intraparenchymal**









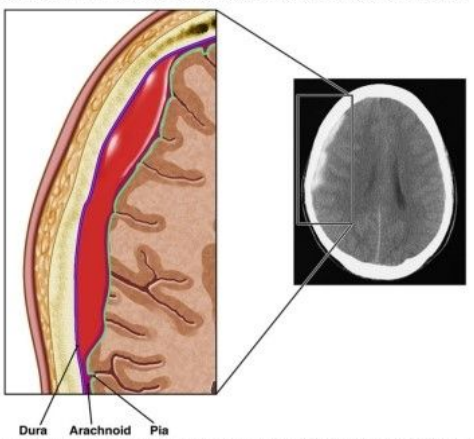
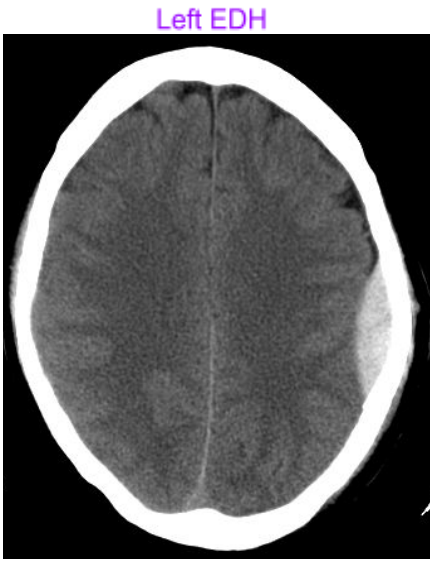


Fig. 10. SDH and EDH shown in artistic diagrams and on CT. SDHs look crescentic, like a cres cent moon, and do not respect cranial suture lines because SDH are below the dura mate (subdural). EDHs, however, are lens-shaped and typically respect cranial suture lines becaus they are above the dura.

1) Epidural Hematoma (EDH) imp

EDH:



- Blood collection between inner table (of skull bone) and dura.
- Biconvex (lentiform)
- Occurs at site of impact **"Coup injury"**. truma is the most common cause of brain bleeding.
- 95% unilateral, supratentorial[1]
- Does **not** cross brain sutures
- **Can cross falx**[2] (since they are located above the dura they can cross it) and tentorium
- Skull fracture in 90% "truma"; Non-traumatic is rare
- Air seen in 20%
- Source of bleeding: Arterial 90%, Venous 10%[3]
- Lucid interval-50% : means that After head impact there is loss of consciousness followed by awakeness for a period of time then loss of consciousness again
- **C/F[4]:** headache, nausea,vomiting, convulsions, or herniation (brain).

2) Subdural Hematoma (SDH) imp

SDH: حطو ابالكم SDH يسبح بالدماخ من كلمة Sub تذكروا الناس اليي يجون من تحت لي تحت عكس الابي ديورال محترم ما يتعدا حدوده

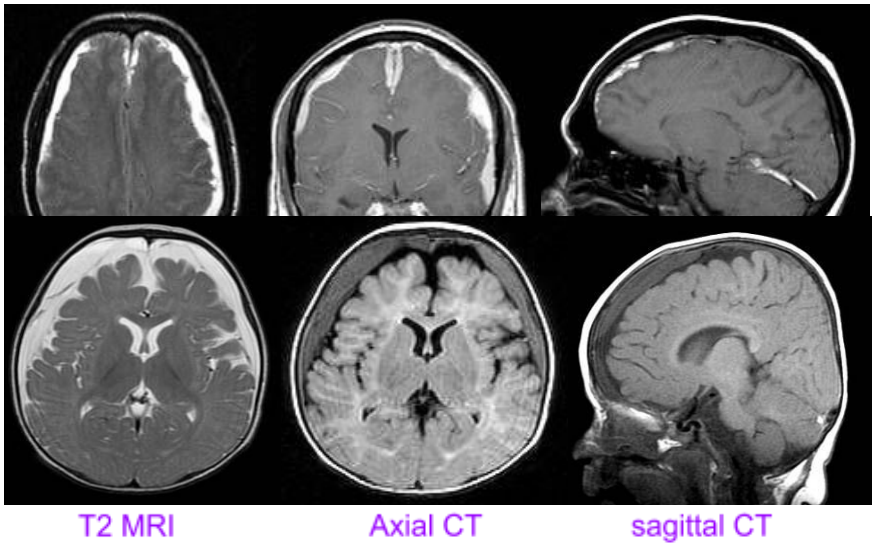
- Blood collection between dura and arachnoid. in old age
- Normally **venous** bleed from the bridging veins. On the **side opposite to the head impact** (**contrecoup** injury) or may be bilateral following a shaking injury.
- Crescent shape
- Supratentorial
- Cross sutures, but not dural attachments (= cannot cross falx)
- May extend along falx and tentorium
- Trauma is the most common cause.

Blood in CT: (Density of the blood reduces with time)

- Acute: hyper-dense 6h-3d **(white)**
- Sub-acute isodense from 3d-3w **(gray).**
- Chronic: hypo-dense **(black)** more than 3W

MRI : subdural hematoma, which is outside the brain and enters the Dural reflections.

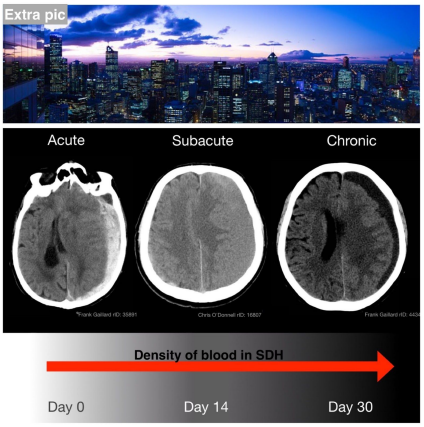
T2 (MRI), the fluid is bright and hematoma is bright, so to differentiate we do CT scan. On CT, fluid is dark and hematoma is grey, if hematoma is **grey** it means it's **subacute**

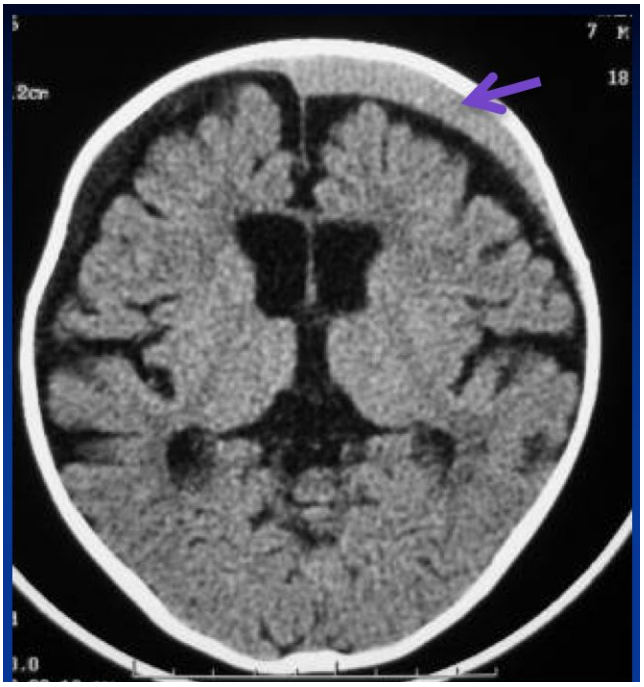


[1] the supratentorial region of the brain is the area located above the tentorium cerebelli. contains the cerebrum, while the infratentorial region contains the cerebellum.
[2] **Falx cerebri** its sickle-like form. It is a large, crescent-shaped fold of meningeal layer of dura mater that descends vertically in the longitudinal fissure between the cerebral hemispheres of the human brain.
[3] Arteries mainly in the epidural while veins in subdural/arachnoid space
[4] Clinical features

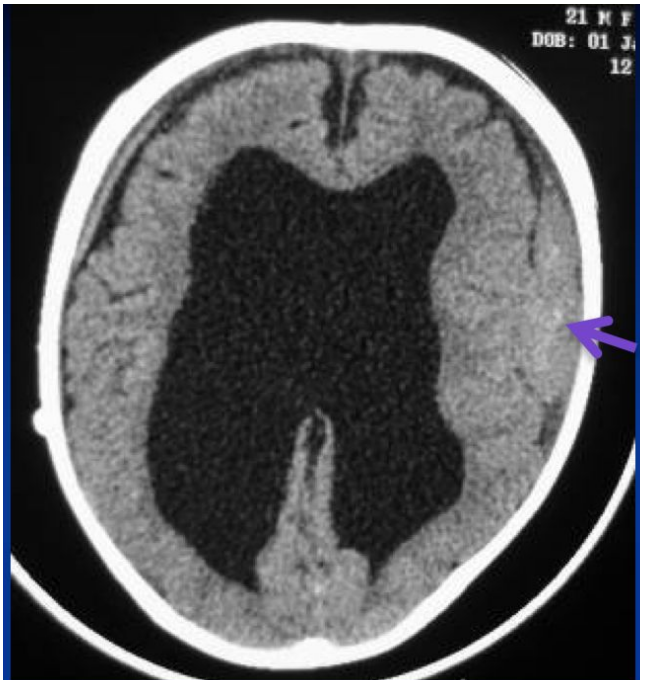
Things that you only see in acute SDH:

- mass effect
- midline shift
- effacement of sulci (يعني ما تقدر تشوف السالساي)





SDH : bilateral - subacute (gray)



SDH: subacute (gray)

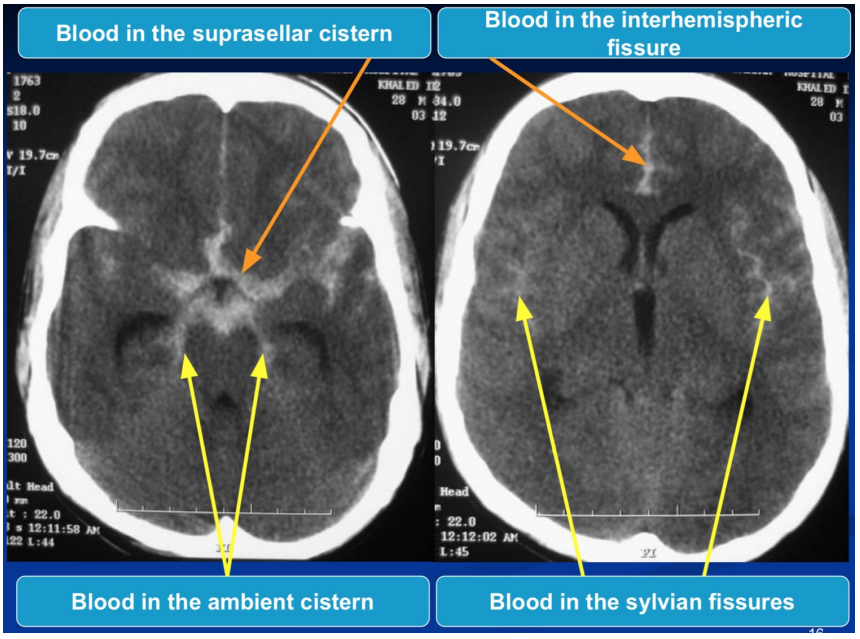
SDH: acute on top of chronic

SDH: crescent shape - chronic - bilateral

3) Subarachnoid Hemorrhage (SAH)

SAH[5]:

- Blood between pia and arachnoid
- Traumatic (most common) or Non-traumatic
- C/F: **headache**, vomiting, blurred vision, **neck rigidity** (like symptoms of meningitis Except No fever)
- Complications: hydrocephalus (acute/delayed), vasospasm,rebleeding.



Hallmark:

We see a blood in spaces that should be filed with CSF.

➔ When young patient come complaining of **worst headache in his life** think about SAH.

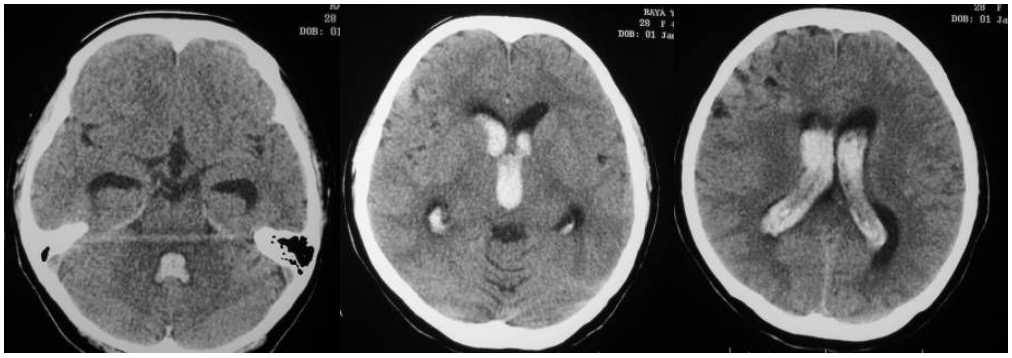
- Most common non traumatic cause for SAH is **Rupture Aneurysm.**
- Most important step in the management is to **prevent the vasospasm** because it will lead to infarction.
- It mimics Meningitis but without fever so, they describe it as chemical Meningitis.

4) Intraventricular and Parenchymal Bleed

Causes of parenchymal bleeding:

- **HTN**, trauma, AVM, aneurysm, **prematurity**, tumors, infarction, coagulopathy.
- NOTE: Premature neonate are caring risk to have parenchymal and intraventricular bleeding .

intraventricular blood in the 4th ,3rd ,and lateral ventricles.
- blood is white (like the bone)
- CSF: black

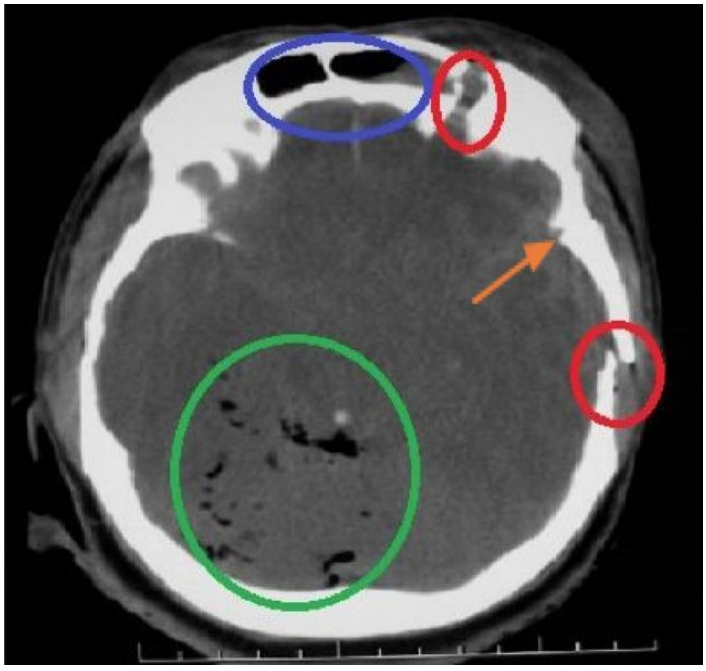


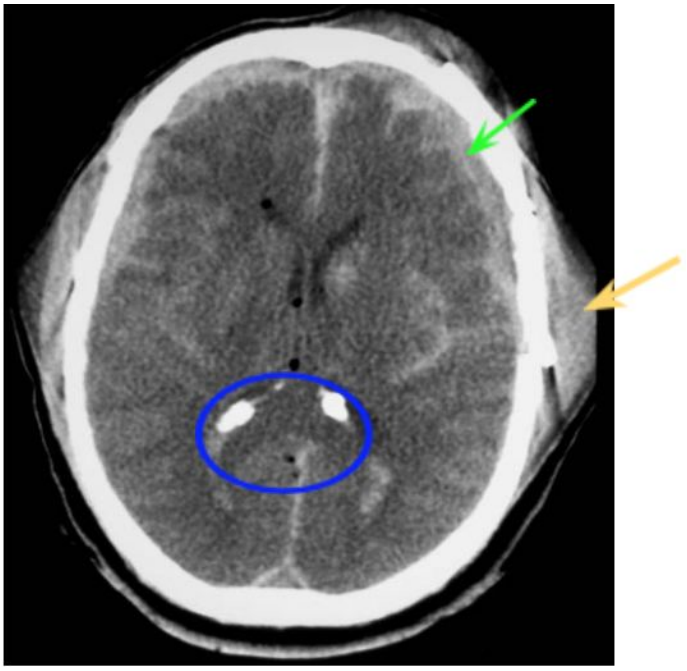
intraventricular and intraparenchymal hemorrhage

[5] CT is the **best initial** investigation to diagnose a SAH and to demonstrate the site of bleeding.

Trauma and Brain infarction

Skull fracture





- The black area is air (green circle), it is called (Pneumo-cranium) or (Pneumo-cephalous).
- Air can escape to brain parenchyma by fracture to base of skull (air will be coming from THE SINUS) or laceration of skin with the skull fracture seen in red circles. (SKIN needs to be lacerated in case of pneumocranium, if not lacerated and air is found inside then think of base skull fracture)
- orange arrow: Subarachnoid bleeding in the sylvian fissure (lateral sulcus).
- Blue circle: bleeding to the frontal sinus accompanied the skull fracture.

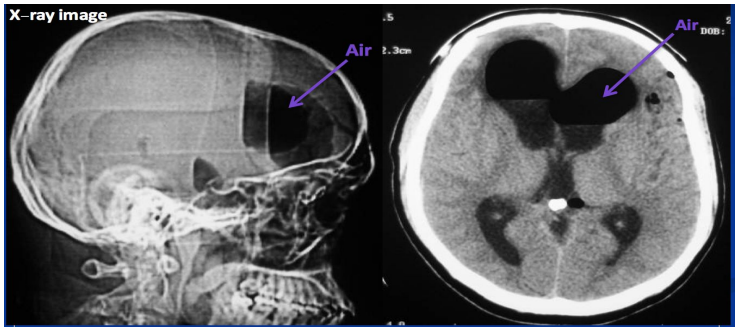
- Blue circle: area of calcification.
- Green arrow: Subdural hemorrhage.
- Yellow arrow: External hemorrhage (hematoma) صعرور

NOTES: Untreated base skull fracture complications:

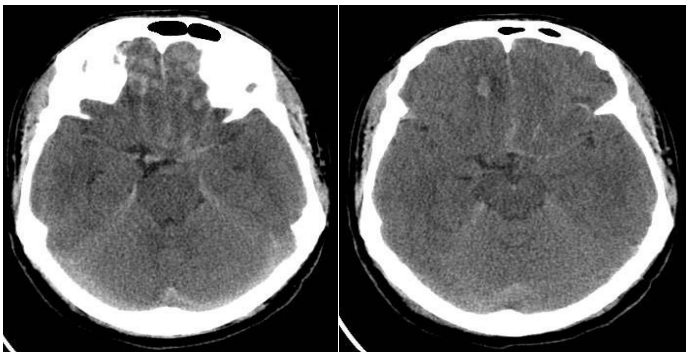
- Normal flora and other pathogen will escape to the brain causing repetitive meningitis.
- CSF leaking through sinus leading to CSF rhinorrhea.
- Pneumocranium

Massive (pneumo-cranium)

Air seen on CT as locules of very low density gas.

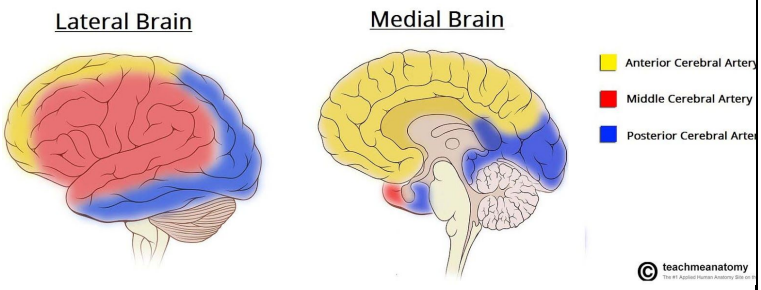


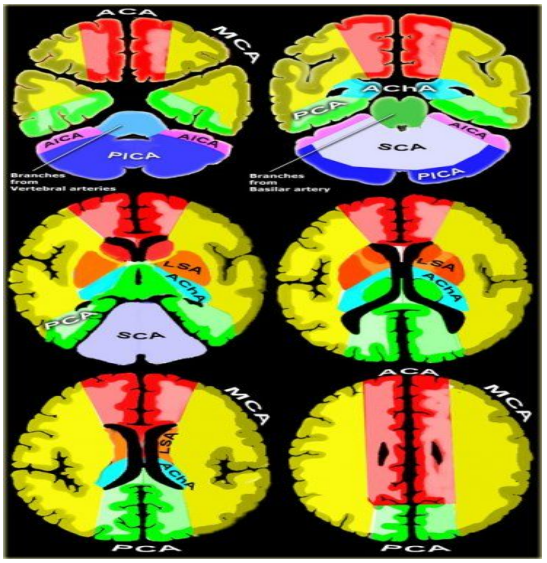
Trauma



SAH

Review Anatomy :

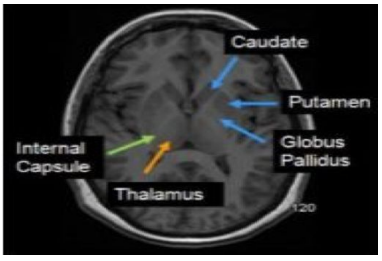


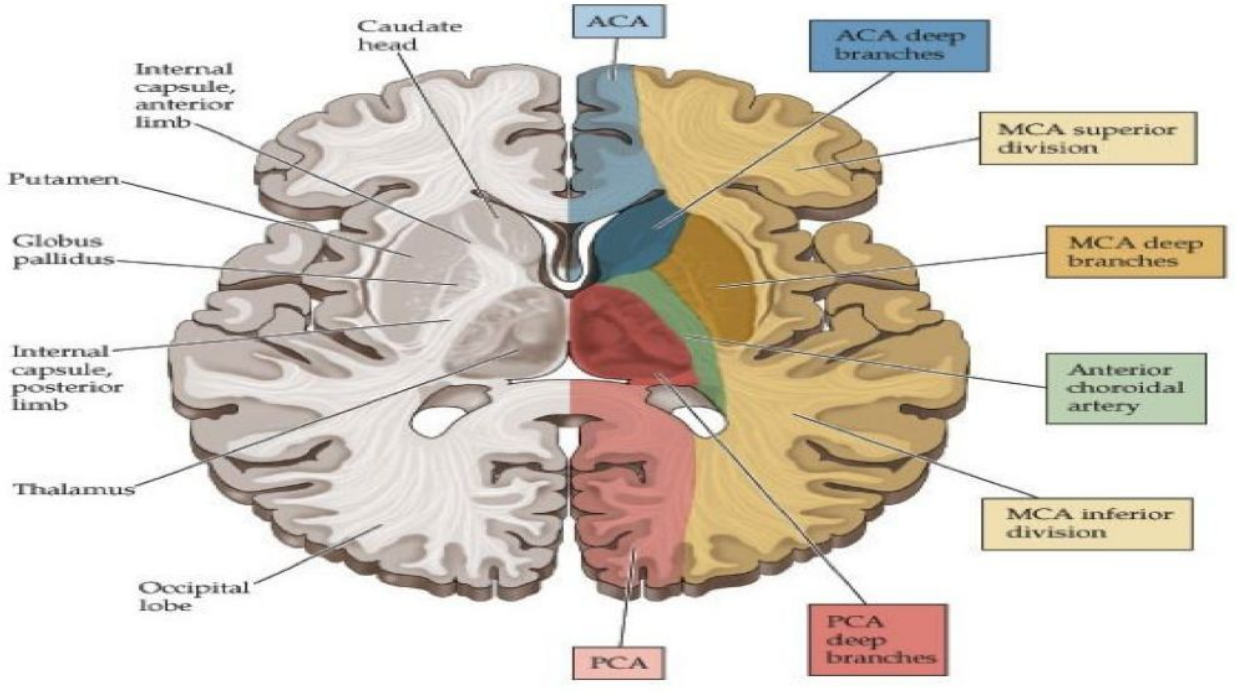


- The lateral aspect of the brain is supplied by middle cerebral artery (MCA).
- The medial aspect of the brain (around Sylvian fissure) is supplied by anterior cerebral artery (ACA).
- The inferior part of temporal lobe and occipital aspect are supplied by posterior cerebral artery (PCA).

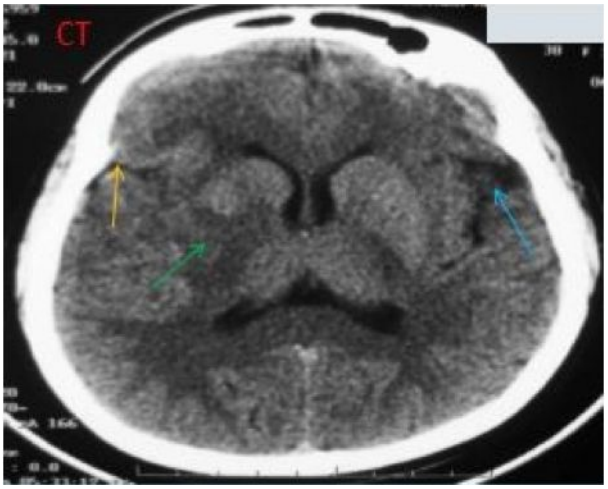
- NOTES:
  - ACA supply the medial aspect of the frontal lobe.
  - Basal ganglia including the internal capsule is supplied by MCA (MCA cores in sylvian fissure).
  - PCA supply thalamus.

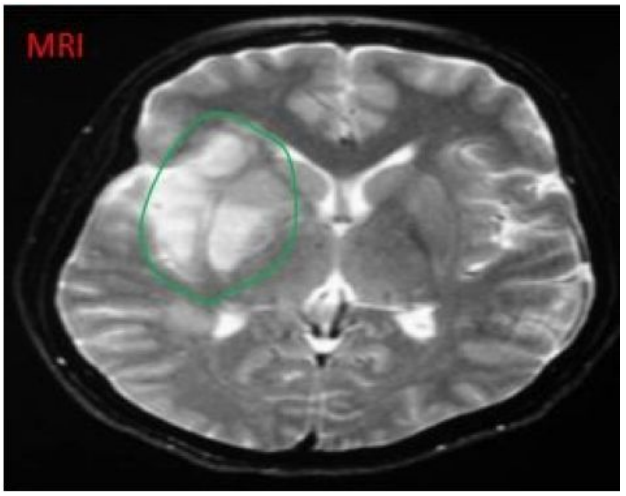
- The inferior part of cerebellum and the lateral part of medulla is supplied by Posterior inferior cerebellum artery (PICA), which is branch of vertebral artery.
- The anterior part of cerebellum is supplied by anterior inferior cerebellar artery (AICA), which is a branch of basilar artery.
- Top of cerebellum is supplied by Superior cerebellar artery (SCA).





Infarction





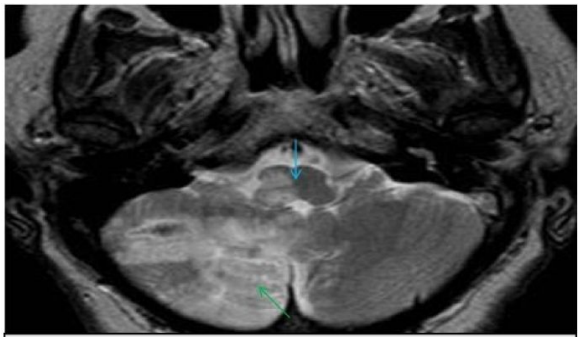
- Green arrow: The Putamen & the Globus pallidus are abnormal on the right side, they are dark compared to left side which is normal.
- Blue arrow: The sylvian fissure which is normally widely open in the left side compared to right side (yellow arrow), which is small and that indicates edema is compressing the Sylvian fissure because of ischemia so, if there is ischemia there is edema (fluid) so, loss appearance of the structure.

T2WI-MRI shows:

- Green circle: shows abnormal fluid (edema), which is formed because of infarction. The basal ganglia and the Sylvian fissure are the affected parts with some surrounding structures (insular cortex).

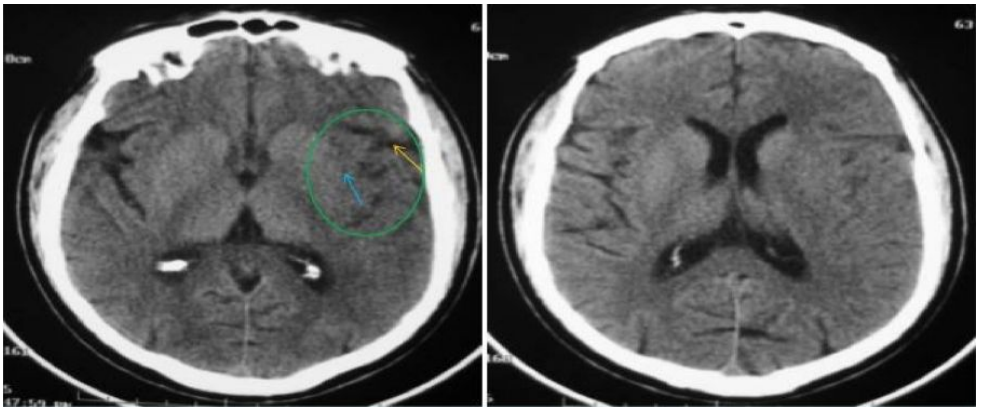
- NOTE: The basal ganglia, Sylvian fissure and insular cortex are supplied by the middle cerebral artery.

- Lower Part of cerebellum is infarcted.
- We know it is lower because of medulla oblongata is seen and these structures is supplied by PICA.
- This condition is called **Lateral medullary syndrome**.



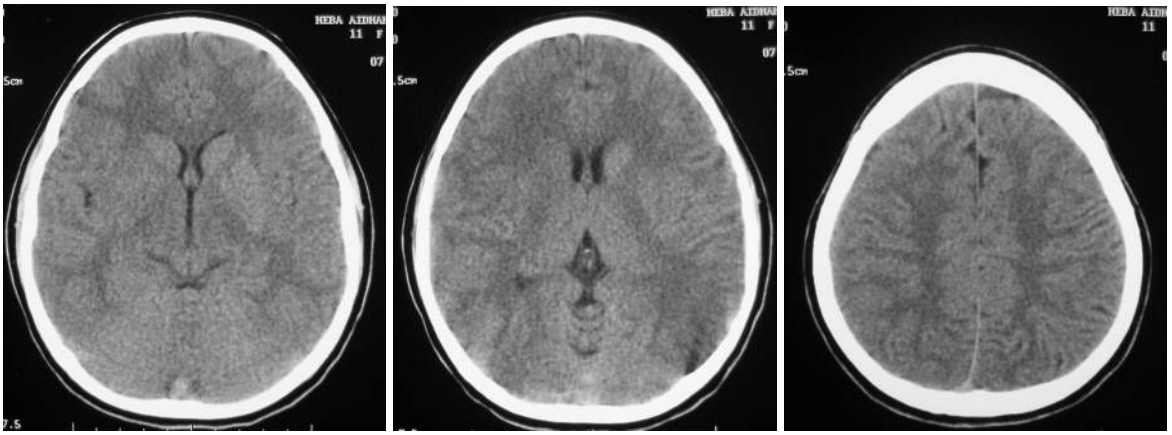
MCA manifestation:

Patient presented with <u>sudden right hemiplegia</u>



- The left side is hypodense (darker) in comparison to the other side.
- The triangle (putamen & globus pallidus) is not clear.
- Also the sylvian fissure is closed because of the swelling of the cerebral hemisphere so CSF will be squeezed from the sulci & that's a sign of ischemia.

Cont, MCA...

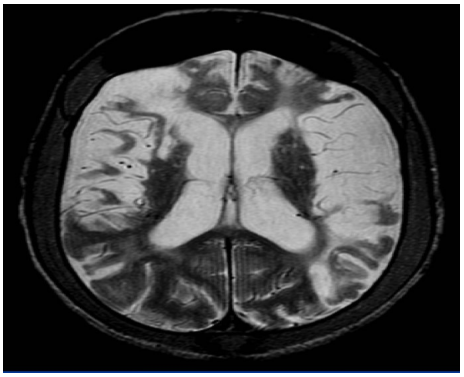


MCA infarction that involved basal ganglia:

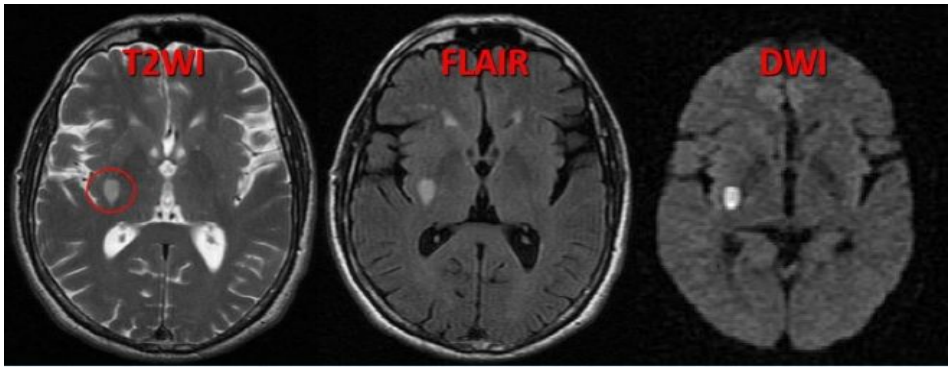
- They present with motor deficit either hemiparesis or hemiplegia.
- If Sylvian fissure gets involved, they'd present with aphasia (Sylvian fissure contains wernicke's and broca's areas).

NOTE:

- Basal ganglia > hemiparesis or hemiplegia.
- Sylvian fissure > aphasia
- Infarction > edema



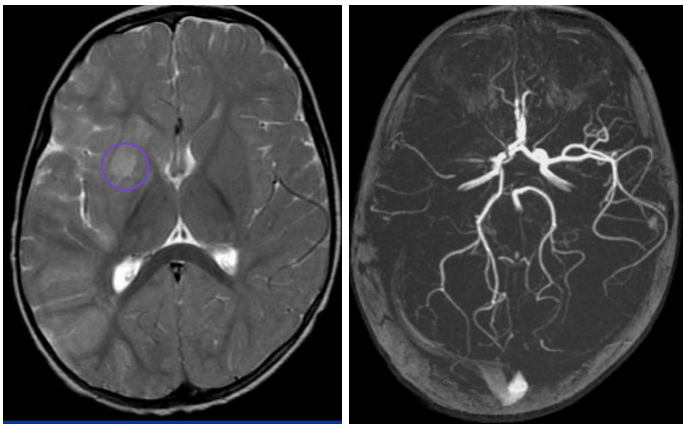
Chronic Bilateral MCA infarction



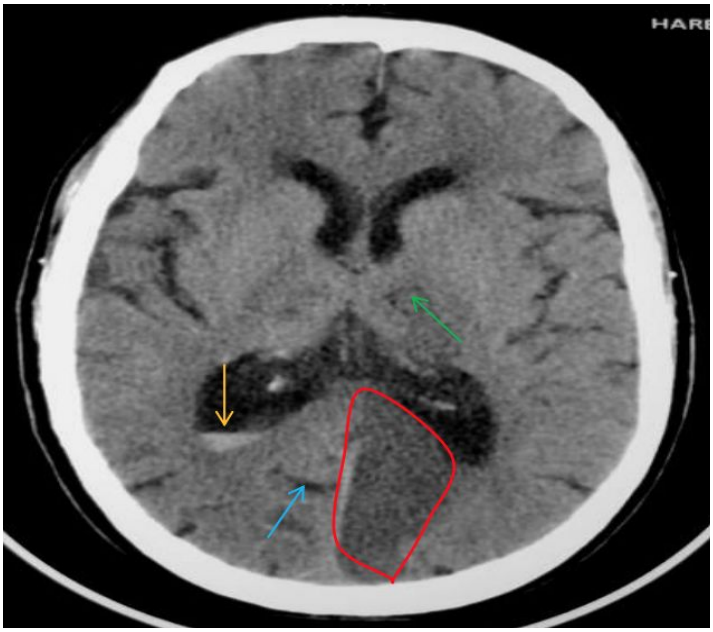
-Infarction of basal ganglia (posterior limb of internal capsule) which is supplied by MCA.
-Corticospinal tract passes through the infarction causing contralateral hemiplegia.
-DWI: Diffusion weighted imaging.

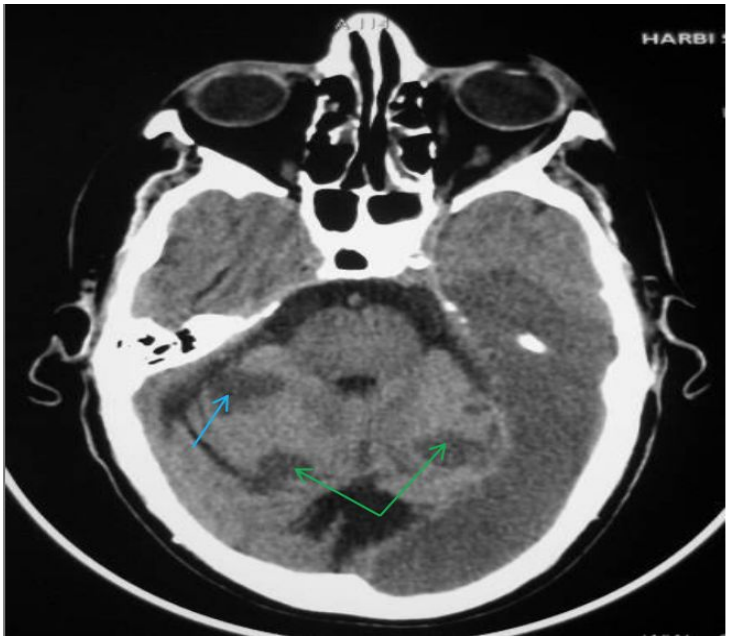
- It has superior benefit because it will show the recent infarction only (7 days).
- The other will show infarction irrelative to the time of infarction but this can catch the infarction within one hour (very sensitive).
- Acute infarction: early destruction to cells >>يطلع لي fluid >> causing micro-edema (edema will appear bright in DWI). (Acute : less than 7 days >> bright)

➔ **another pic for MCA infarction :**



PCA manifestation:
Patients usually presents with vision loss (hemianopia)

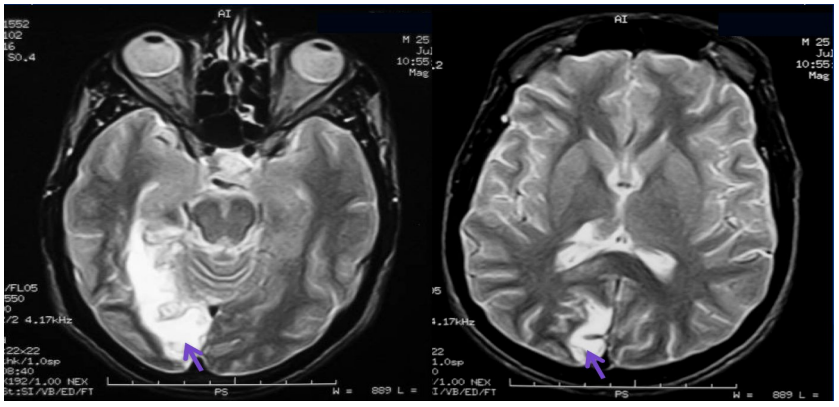




- Red circle: This is PCA Infarction involving occipital lobe and it affects posterior part of the thalamus.
- Blue arrow: The Calcfarine fissure is absent in the left side which indicates a **swelling** (= acute not chronic).
- yellow arrow: Bleeding in the ventricles.

- There are other infarctions in the cerebellum by the superior cerebellar artery and inferior cerebellar artery.

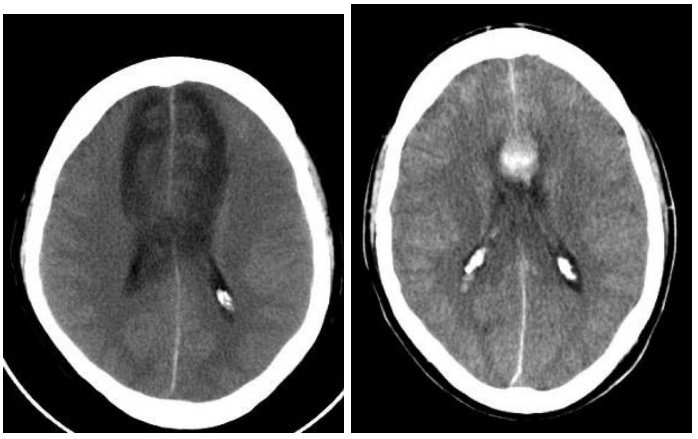
➔ **another pic for PCA infarction :**



Acute ACA Infarction:

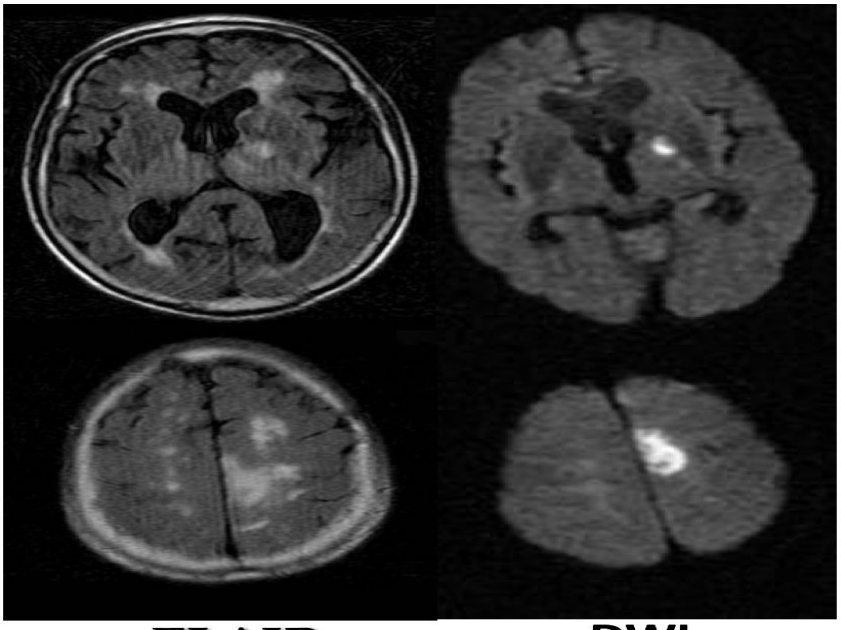
- **Infarction in the anterior cerebral artery.**
- The calcarine sulcus in the left side is not seen here and the falx is pushed to the other side (edema) > this indicates **acute ischemia**. But if there is shrinking of the brain tissue > indicates chronic ischemia.
- <u>How will this patient present clinically?</u>

Paralysis of the right leg (monoplegia). The hand and face will not be affected because they are represented downwards. (more laterally)

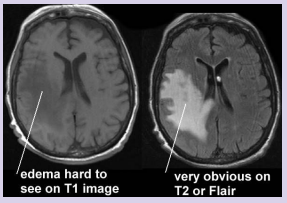


- Bilateral anterior cerebral artery ischemia due to anterior cerebral artery aneurysm.
- Clinically presentation: Paralysis of both legs (Paraplegia)

➔ **pic for ACA and MCA infarction :** multiple infarctions



Brain Edema

Edema	Vasogenic	Cytotoxic
Definition	The edema is extracellular and found within the interstitium.	The fluid within the cell and this will kill the cell because water is toxic to cells.
	- Both could be generalized or localized - Both may co-exist	
Example	Trauma,Infection and Inflammation.	Ischemia/infarction /trauma is the usual cause why? Because hypoxia will diminish NA/K pump this will lead to water shift intracellular causing the edema.
Imaging Findings	❑ Hypodensity on CT ❑ Compressed ventricles ❑ Effaced sulci & cisterns ❑ Denser cerebellum in relative to other structures. ❑ Edema is fluid thus will appear dark in CT scan ❑ Low signal on T1, high signal on T2 & FLAIR ❑ Loss of GM/WM interface ❑ Brain herniation ❑ Vascular compression-ischemia.	

Remember:

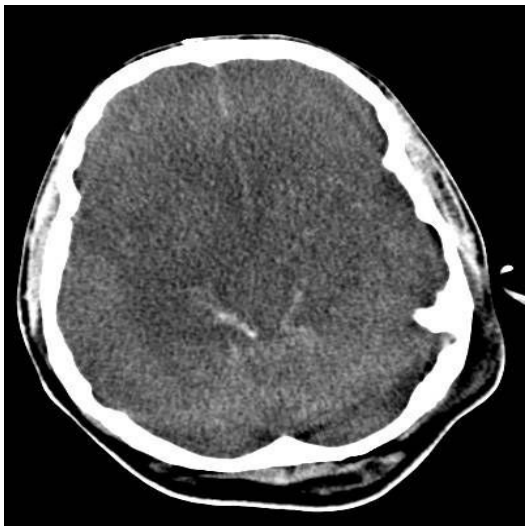
- Edema will lower the contrast between gray and white matter so you won't be able to differentiate between them, specially if edema is within the gray matter.
- Severe edema will compress the vessels causing ischemia that will increase the edema again >> (brain death).

Edema	Vasogenic[6]	Cytotoxic[7]
Location	white matter	Gray matter
DWI	Non-restricted	Restricted
Shape	Finger- like	Diffuse

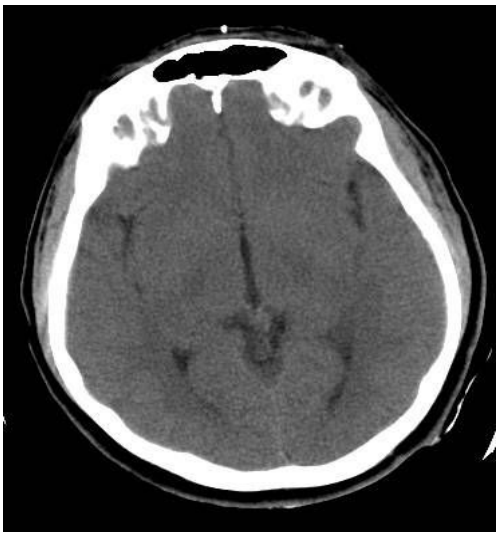
[6] Vasogenic oedema is limited to the white matter and characteristically shows finger-like projections into the subcortical white matter in the gyri.

[7] Low density in CT can be due to cytotoxic oedema associated with infarcts, or to vasogenic oedema, which commonly surrounds neoplasms, abscesses and other areas of inflammation.

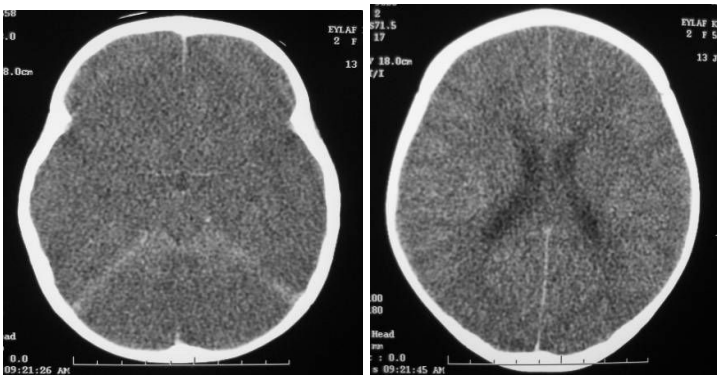
Brain Edema: (Important: you have to differentiate between SAH and Edema)



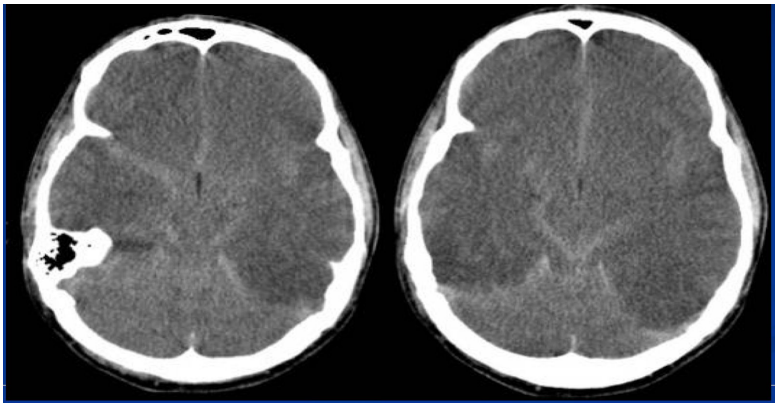
before treatment: loss of differentiation between white and gray matter



post treatment (3w later)



If you see a lesion that follow the vascular territory then think of ischemia (thrombus)

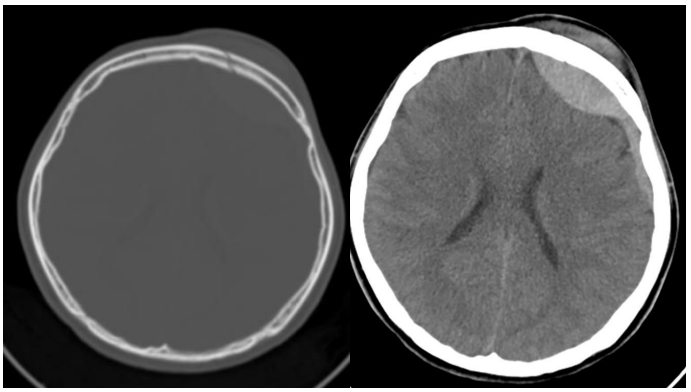


-Denser cerebellum.
-Pseudo Subarachnoid hemorrhage (with edema).

Doctor's Questions

The cause of this hematoma is:
A.Anticoagulation
B.Hypertension
C.Ruptured aneurysm
D.Trauma (epidural)

Ans: D

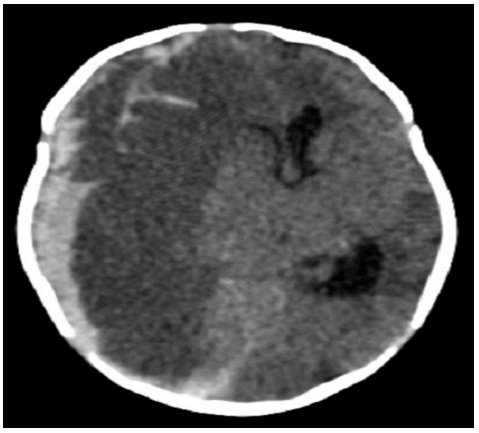


This CT shows:
A.Epidural
B.Subdural
C.Subarachnoid
D.Intraparenchymal

ans: A

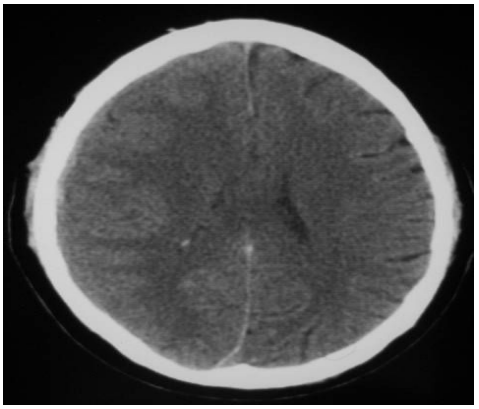
This CT shows:
A.Subdural hematoma
B.Subarachnoid hemorrhage
C.MCA infarction
D.All of the above

Ans: D

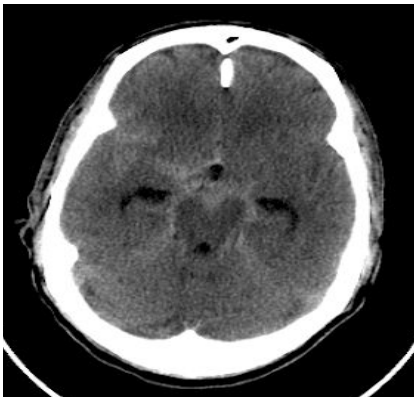


This CT shows:
A.Epidural hematoma
B.Subdural hematoma
C.MCA infarction
D.Normal brain

Ans: B
- the lateral ventricle is compressed,
- Left hemisphere has normal sulci, see



Are they Normal or Not?



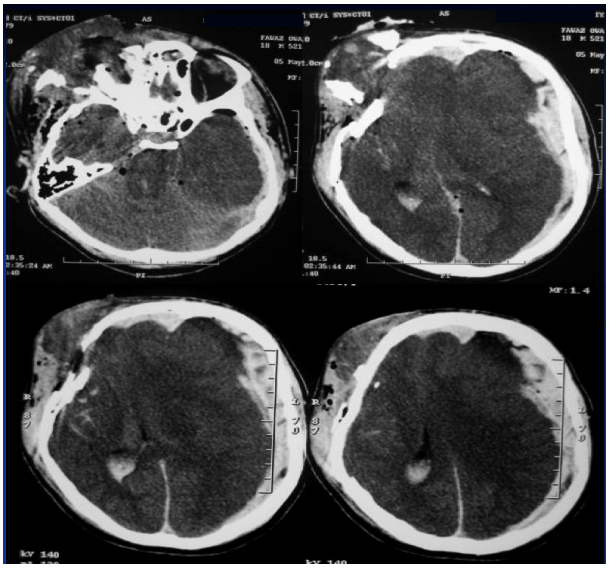
Subarachnoid (SAH)

Normal

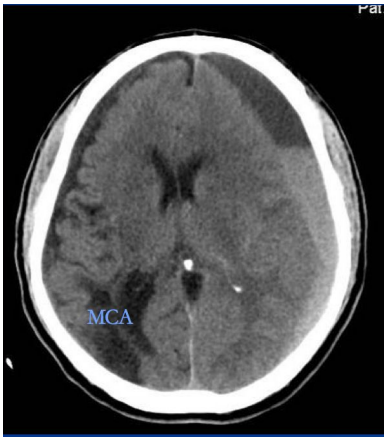
Trauma (fracture and brain herniation) findings:

1. SDH
2. IVH
3. SAH
4. Pneumocephalus
5. Edema

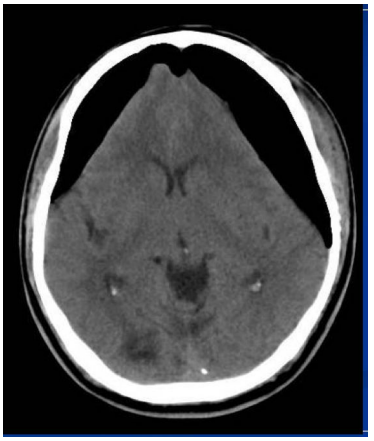
No epidural hematoma



What do you see in the following images ?



- SDH: acute on top of chronic
- MCA



tension Pneumocephalus (EMERGENCY)

"Book's Extra Notes"

In CT:

- ➢ The brain parenchyma does not normally enhance following an intravenous injection of contrast medium due to the BBB), unless there is a breakdown of the BBB such as with ischaemia, inflammation and neoplasms.
- ➢ There is also **no BBB** in the pituitary, pineal and choroid plexuses, which will normally enhance.
- **Calcification** is normally seen in the pineal gland and choroid plexus particularly in the lateral ventricles.

The key signs of an abnormality on a CT scan are:

- ➢ Abnormal tissue density.
- ➢ Mass effect.
- ➢ Enlargement of the ventricles.

Then there are the early signs of a stroke seen on CT:

- ➢ The **dense artery sign** is high density clot visualized within a major intracranial artery.

Brain Infections:

- ➢ **In acute meningitis** CT and MRI are usually **normal** and antibiotics should start immediately and not await the result of a scan.
- ➢ The commonest cause of viral **encephalitis** is **herpes simplex.**

In MRI:

- ➢ **Haemorrhage** can be seen on MRI and the blood can be aged as haematomas develop a specific signal pattern owing to the breakdown products of haemoglobin, such as methaemaglobin or hemosiderin.