431

Radiology Team

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Lecture 11: Radiology of Common Brain Diseases (1)

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◆Important ◆Doctor's notes ◆Team's notes

- Red: important.
- Purple: doctor's notes and comments.
- Green: extra information.

From Slides

Extra Images

- **Remember: the reader's right side is the patient's left side and vice versa.**
- **CT: bone is white, MRI: bone is black.**

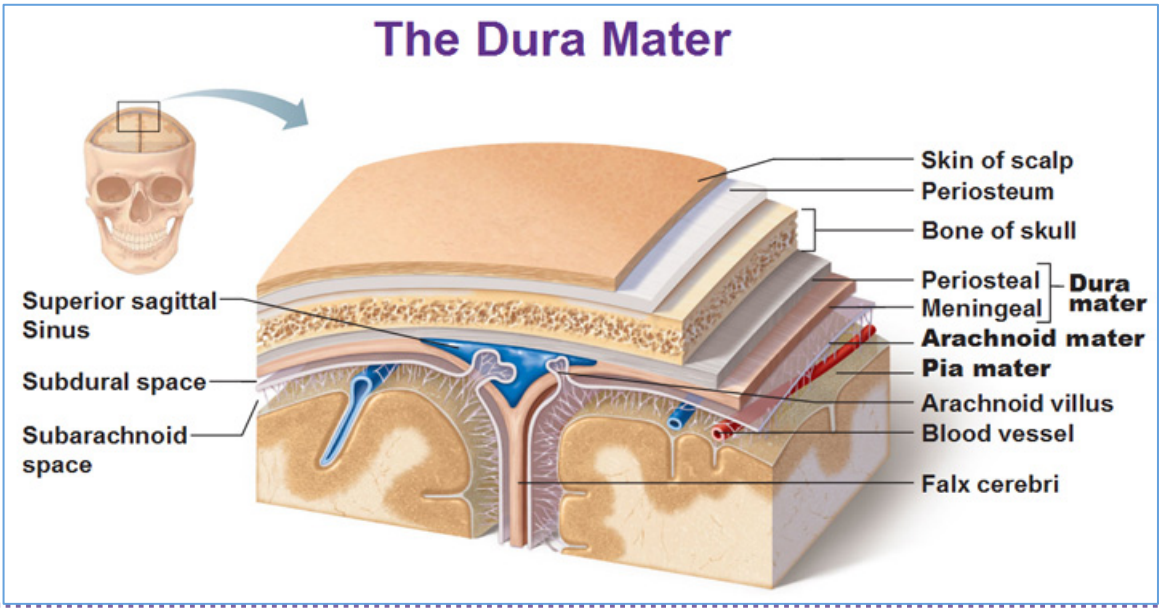
Radiology of common brain diseases

Scope:

- Intracranial bleeding
- Brain ischemia
- Brain edema

These will be discussed in the next lecture:

- Intracranial tumors
- Brain infections
- Brain inflammation

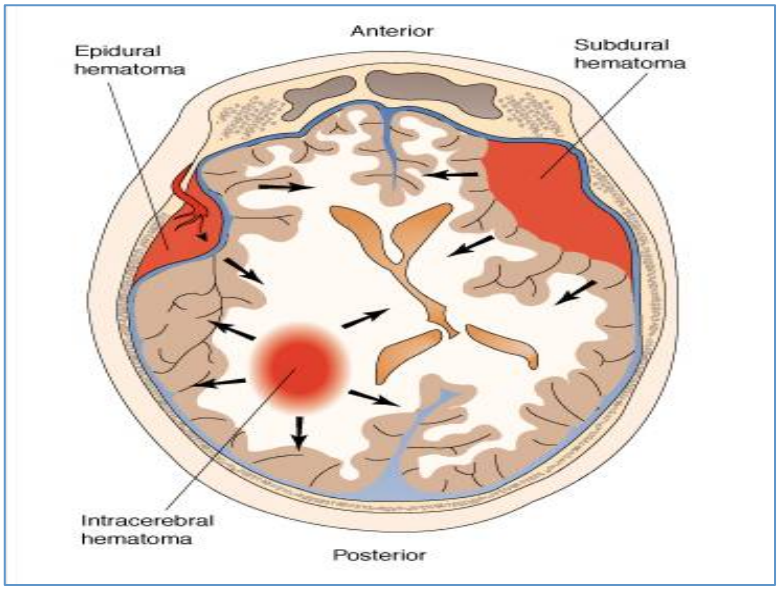


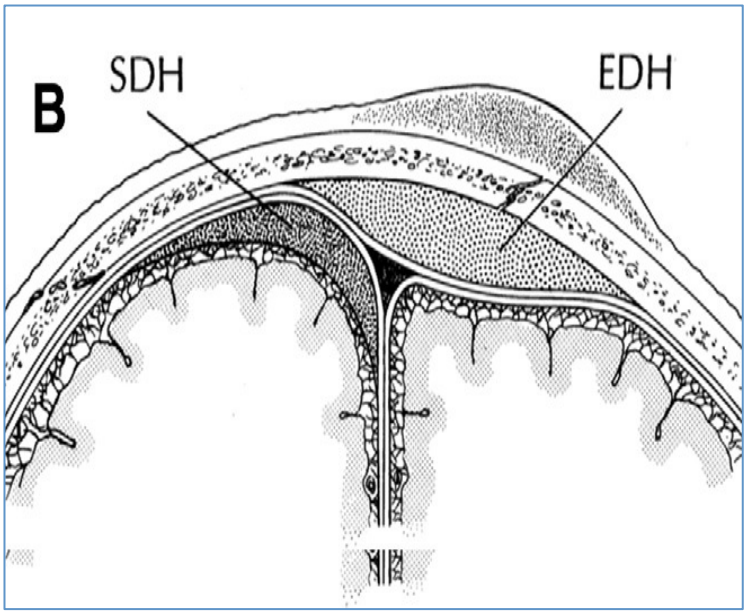
1- The inner Dura matter (meningeal) is attached firmly to the outer one (periosteal) there is no space in between, but one layer follows the bone like endostium and periosteum, the other layer reflects in the interhemispheric fissure or to the occipital lobe and cerebellum to make the dural reflections (falx cerebri & falx cerebelli).
2- Then after the Dura is the white layer called the arachnoid then the subarachnoid space (which contains the CSF)
3- Then the layer directly above the brain is the Pia matter.

So anything or any disease that is beneath the Dura should be called subdural, anything between the dura and the bone is called epidural, there is nothing between the two Dura layers so consider them one layer. Anything deep to the arachnoid is called subarachnoid, and because the subarachnoid is filled with CSF and CSF will fill these clefts (gyri and sulci) so any subarachnoid process will fill the sulci. And basically Pia matter is attached to the cortex (you can't strip it from the brain)so nothing is beneath the Pia matter , anything beneath it is intracerebral.

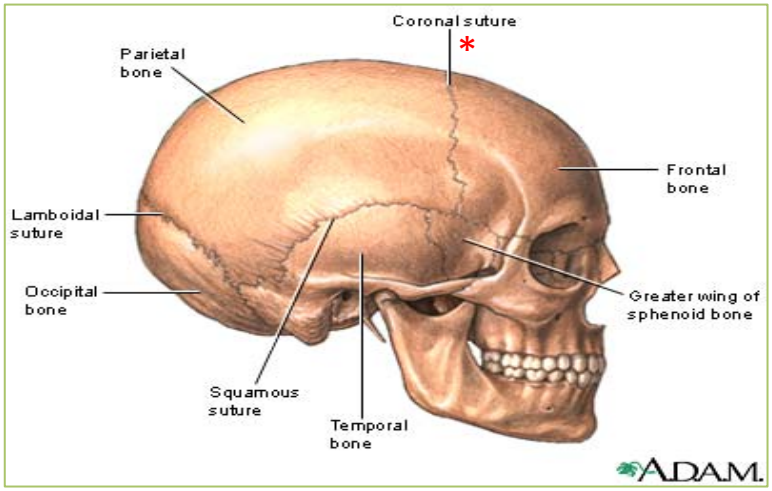
Intracranial Bleeding:

- Extradural (epidural)
- Subdural
- Subarachnoid
- Intraventricular
- Intraparenchymal





Just to remember the places of sutures to differentiate between subdual and epidural

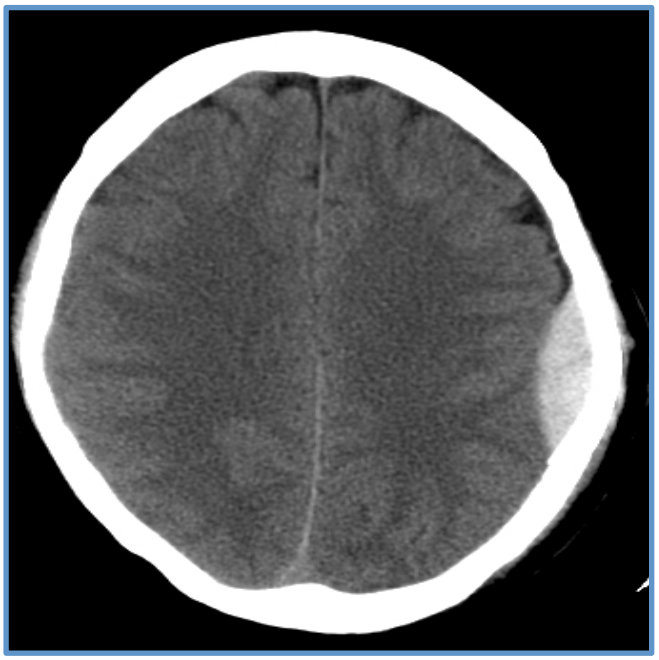


- Epidural hematoma, when it reaches the suture it would not cross because the dura will stop at the suture and the blood will be stuck between the bone and the dura. And it will cross the falx, inter-hemispheric fissure and any dural reflection because it is outside the dura anyway.

- It's vice versa with subdural hematoma, when it reaches a suture it will cross it and spread because it's far from the bone. And it will follow the dural reflections and enter the falx and fissures.

Extradural Hematoma (EDH):

1- Abnormal: biconvex thing that is outside the brain but within the cranium, we know it's outside the brain because it pushes the brain aside so this is extra-axial or extra-cerebral, it looks like a hematoma.
2- It's epidural because it is confined within a limited space not entering sulci

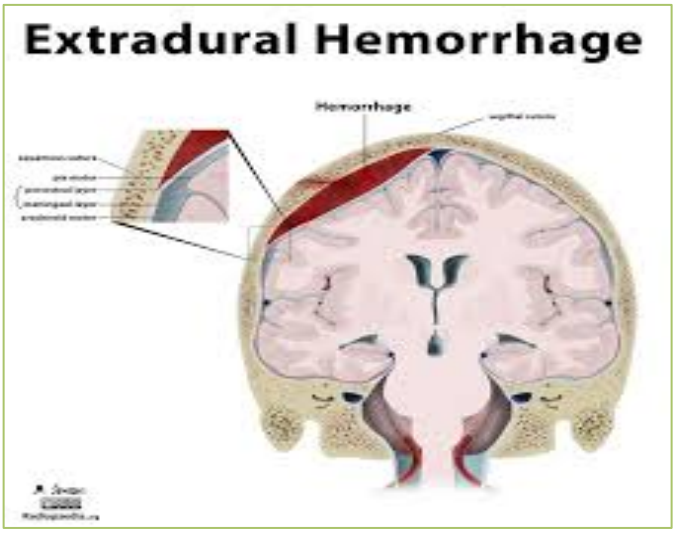


- Blood collection between inner table and dura.
- Biconvex (lentiform)
- Occur at site of impact
- 95% unilateral, supratentorial
- Does not cross sutures
- Can cross falx and tentorium

Doesn't cross sutures but crosses falx because it's not deep to the dura

- Skull fracture in 90%
- Air seen in 20%
- Arterial 90%, Venous 10%
- Non-traumatic causes are rare
- Lucid interval-50% = =after head impact lose of consciousness then becomes awake for sometime then lose it again.
- C/F: headache, nausea, vomiting, convulsions, herniation. If it's large → blurred vision respiratory arrest…… all are Symptoms of increased ICP.

Because dura is firmly attached to the bone when there is blood between dura and bone, it needs high pressure for it to grow so the source is arterial



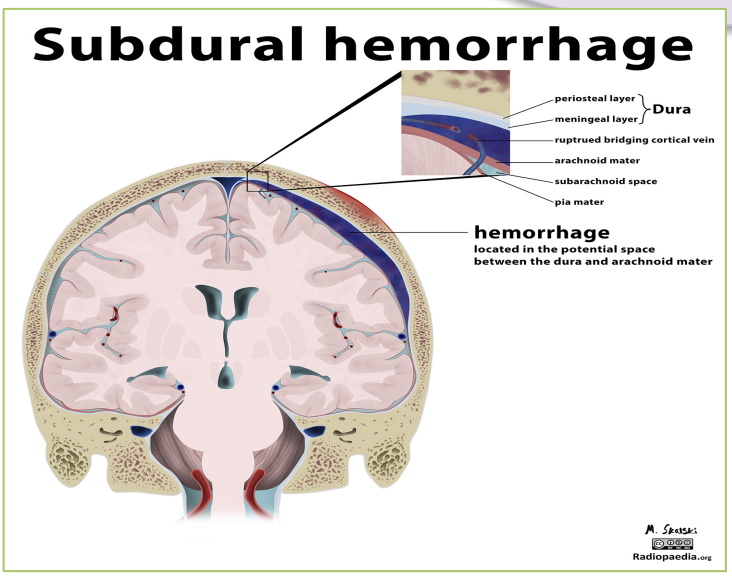
There is herniation and brain midline is shifted to the right and brain tissue is herniating to the other side, because there is something inside the cranium but outside the brain, it differs from the first case because the shape is different and it's large in size (no sutures) and there are black spots inside it indicating active bleeding, so when blood is clotted it becomes white on CT, the shape is convex from outside and concave inside so it's lunar.

Subdural Hematoma (SDH):

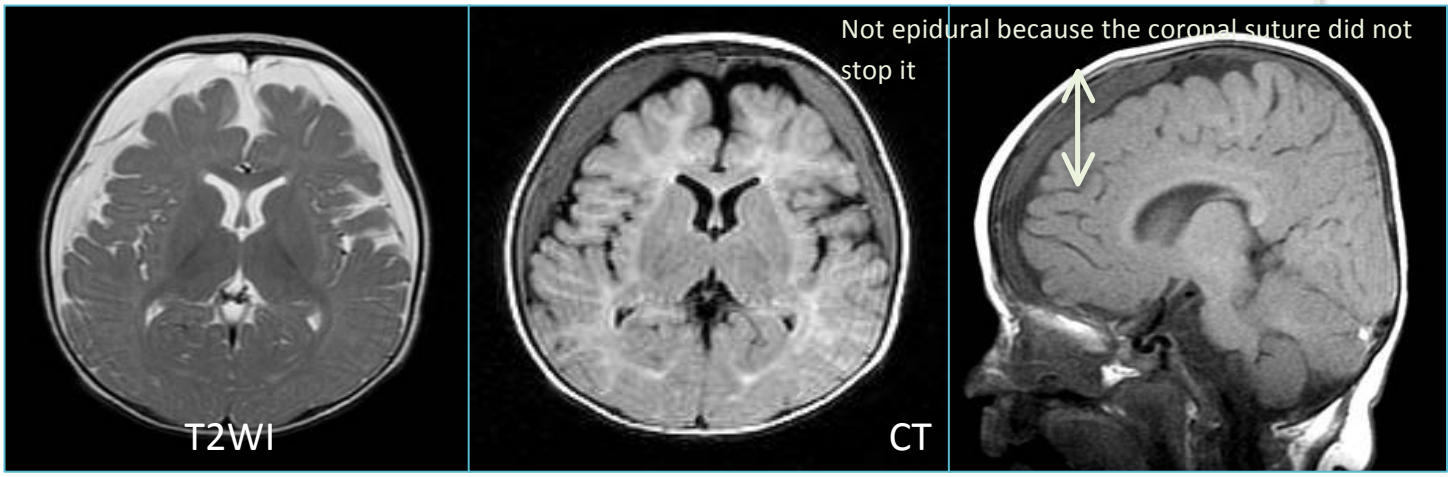
- Blood collection between dura and arachnoid.
- Crescent shape (lunar)
- Supratentorial
- Cross sutures, but not dural attachments
- May extend along falx and tentorium

- Trauma is the most common cause
- Acute: 6hr-3d
- Subacute: 3d-3w (it will become darker (greyer))
- Chronic: >3w (you will see it like CSF)

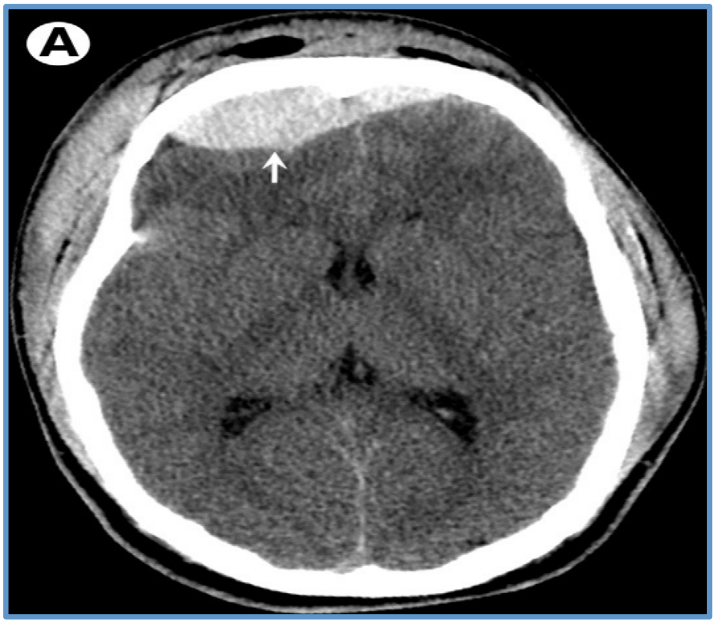
The place is low in pressure because there is nothing to stop it and it will leak into the falx, so according to this presentation subdural hematoma is more symptomatic (because of its large size and herniation)



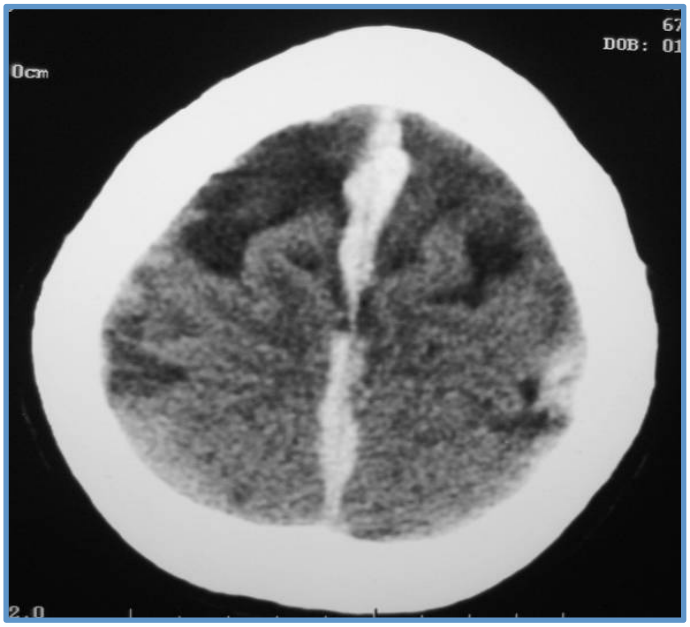
This is MRI because bone is black, and over it is the skin, which is white, here there is subdural hematoma, which is outside the brain and enters the dural reflections.



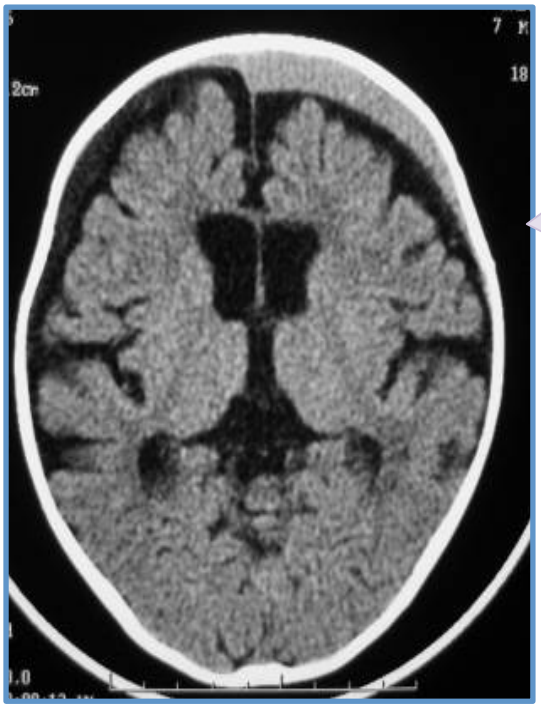
T2WI (MRI), the fluid is bright and hematoma is bright, so to differentiate we do CT scan, on CT fluid is dark and hematoma is grey, if hematoma is grey it means it's subacute or chronic. Here it is bilateral subdural hematoma.



Epidural – because it crosses the falx and it is convex



Subdural because it goes inside the falx

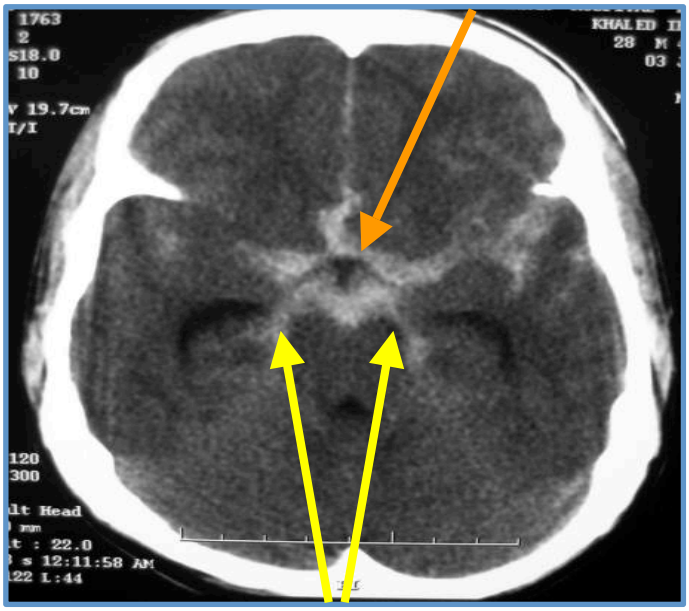


This subdural hematoma and not sub arachnoid, because the dark area is the subarachnoid space (which has CSF)

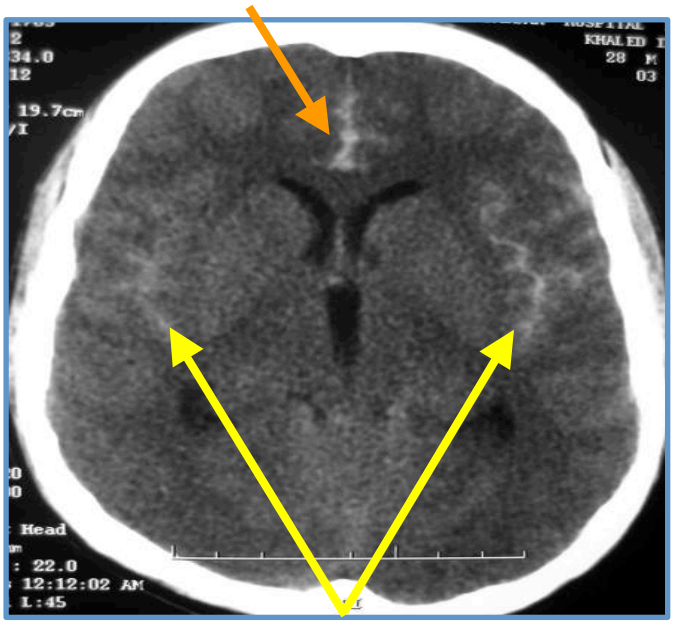
Baby with cerebral palsy who has bilateral subdural hematoma but has active bleeding and the blood has precipitated in the dependent part of the cavity. And there is ventricilo-peritonial shunt due to cerebral palsy

Subarachnoid Hematoma (SAH):

Blood in the suprasellar cistern



Blood in the interhemispheric fissure



Blood in the ambient /perimesencephalic cistern

Blood in the sylvian fissures

All of them are filled with white material, which is acute blood.
This is subarachnoid hematoma (because it is the place of CSF)

Blood in the 4th ventricle,3rd ventricle, and lateral ventricles, so this is subarachnoid hemorrhage

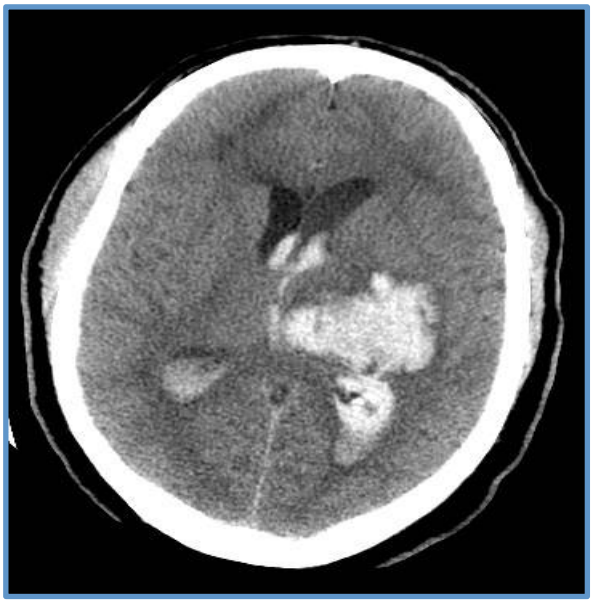
Worst headache in life and meningismus (stiff neck and photophobia) due to chemical irritation (not bacterial) of blood to the subarachnoid space

Subarachnoid Hematoma (SAH):

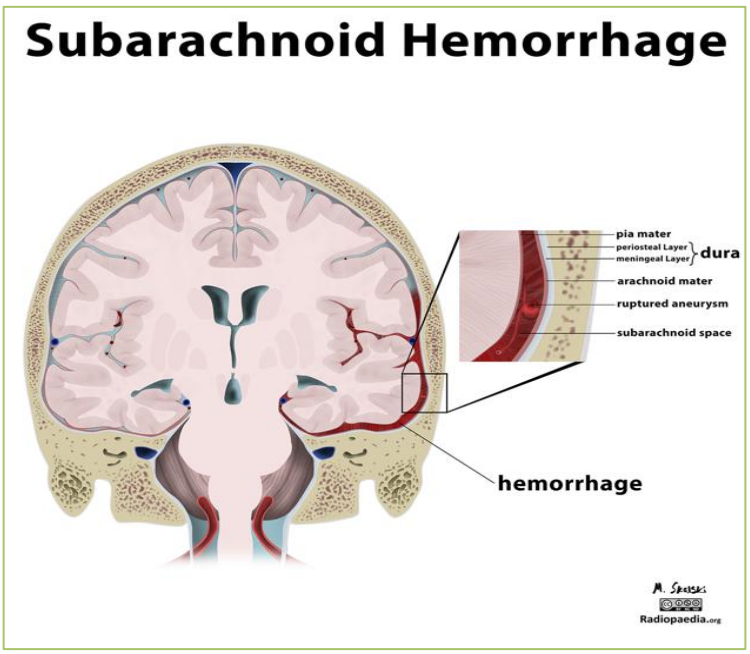
- Blood between pia and arachnoid
- Traumatic (most common)
- Nontraumatic (most common cause is ruptured aneurysm because most aneurisms are in SAS)
- C/F: headache, vomiting, blurred vision, neck rigidity
- Complications: hydrocephalus (acute/delayed), vasospasm, rebleeding.

Hydrocephalus= because blood clots may occlude Foramen Monro ,Foramen of Magendie or Luschka or cerebral aquiduct.and cause acute hydrocephalus or occlude the arachnoid villi which reabsorb the CSF and cause chronic hydrocephalus

Vasospasm= vessels will penetrate the dura and will run in the subarachnoid space to penetrate the brain, so if blood touches the adventitia it will irritate it and cause spasm



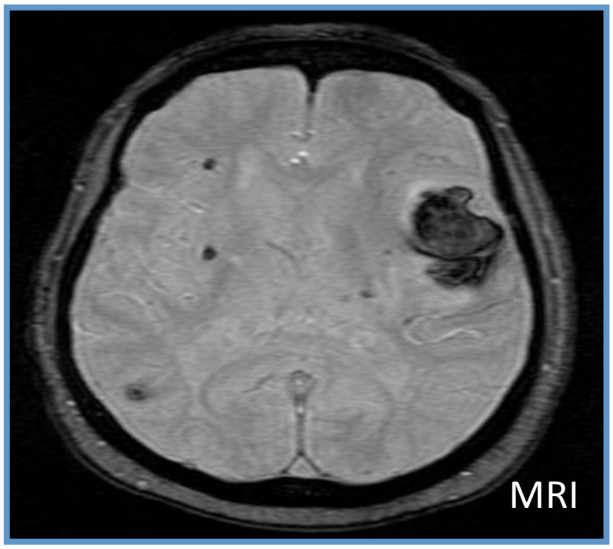
Blood in the ventricles and in the parenchyma, so Subarachnoid & intraparynchemal hemorrhage



Parenchymal bleed:

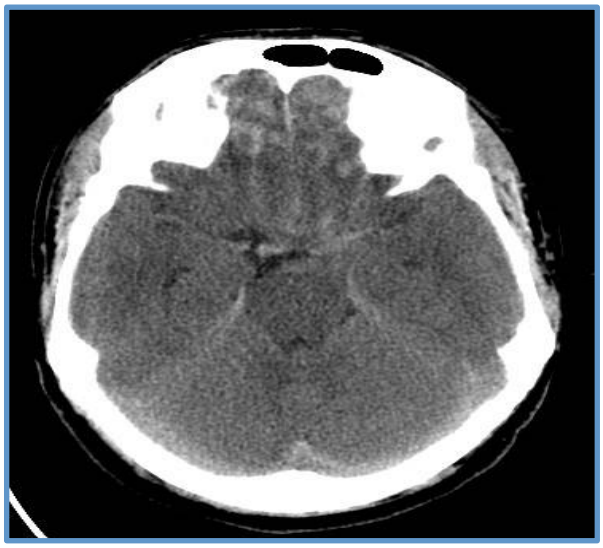
- Causes:

HTN, trauma, AVM(Atrterio-venous malformations) they rupture in the parenchyma, aneurysm (rarely rupture in parenchyma), permaturity, tumors (can present as hematoma so after follow up when the hematoma disappears the tumor will be revealed), infarction, coagulopathy.



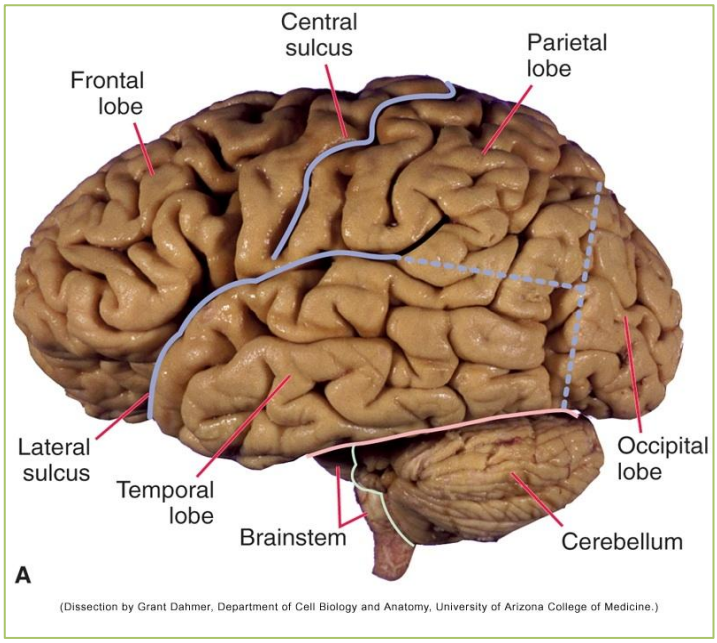
Blood in the parenchyma only and when you do MRI we see black spots, which are micro-bleeds and are asymptomatic and can't be seen by CT scan.

Trauma:



-intraparenchymal bleeding (arrow)

-subarachnoid bleeding (lines filling sulci)

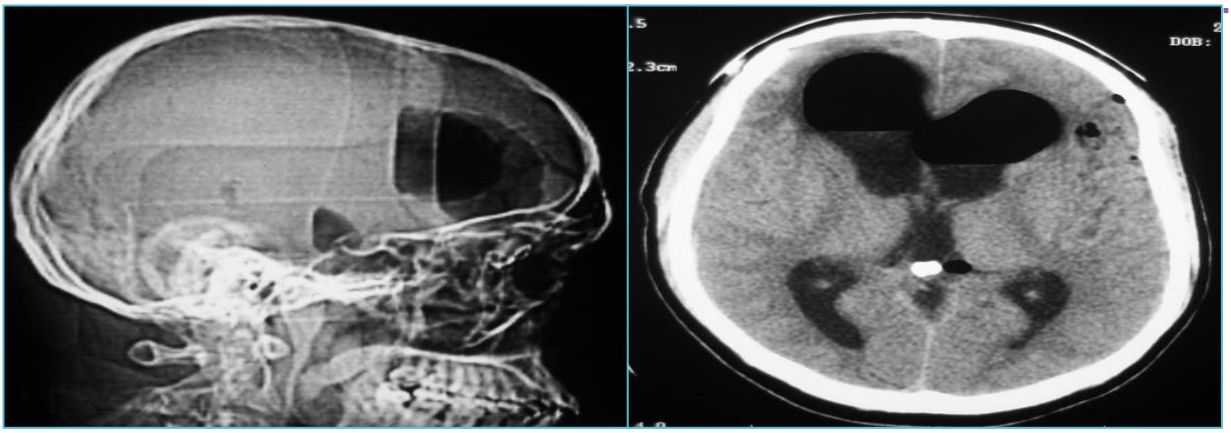


Subarachnoid bleeding in the sylvian fissure (lateral sulcus) → black arrow.

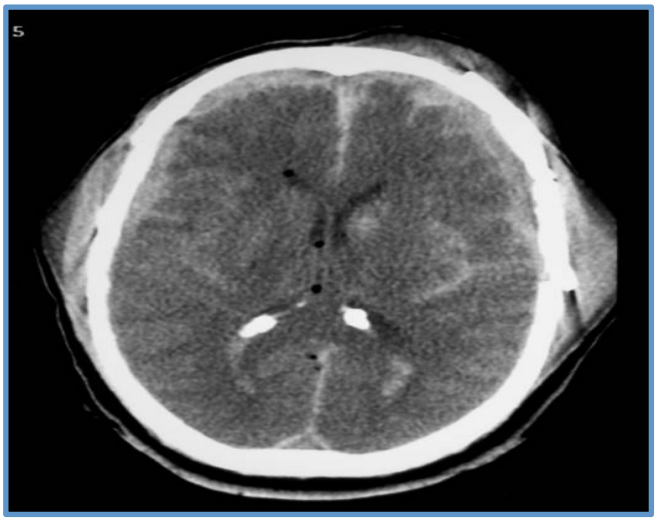
There are two skull fractures

Black areas of air (pneumo-cranium)=pneumo-cephalous , air enters the cranial cavity by fracture with skin laceration or a fracture in the paranasal sinus (in the base of the skull) or air cavity, so here if there is no skin laceration ,the fracture in the frontal sinus explains the pneumo-cranium.(light arrow)

There is bleeding inside the frontal sinus. (light arrow)



Pneumo-cephalous within the ventricles



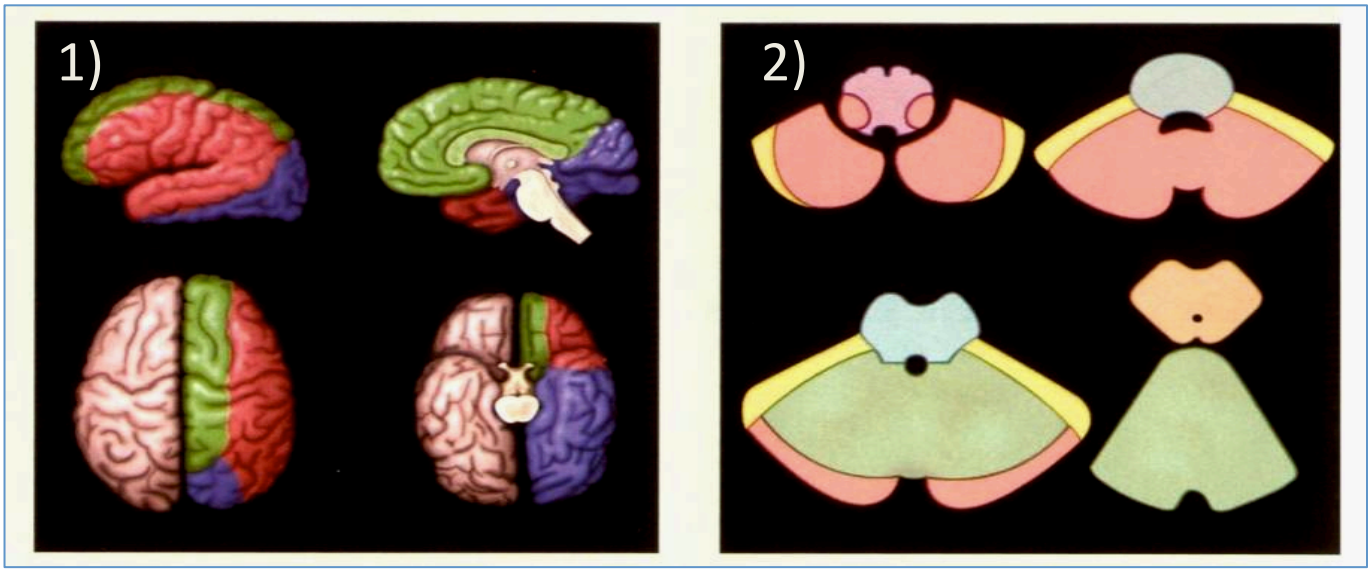
Subarachnoid bleeding (blood in sulci, fissure and sylvian fissure)+Intraparenchymal bleeding + Pneumo-cephalous

+Subdural hematoma(because there is nothing that frames the brain except SDH)+Intraventricular bleeding.

Cases like this are usually due to road traffic accidents

White spots that are as dense as bone: normal physiologic calcification in the choroid plexus, hemorrhage is never dense as bone

Ischemia:

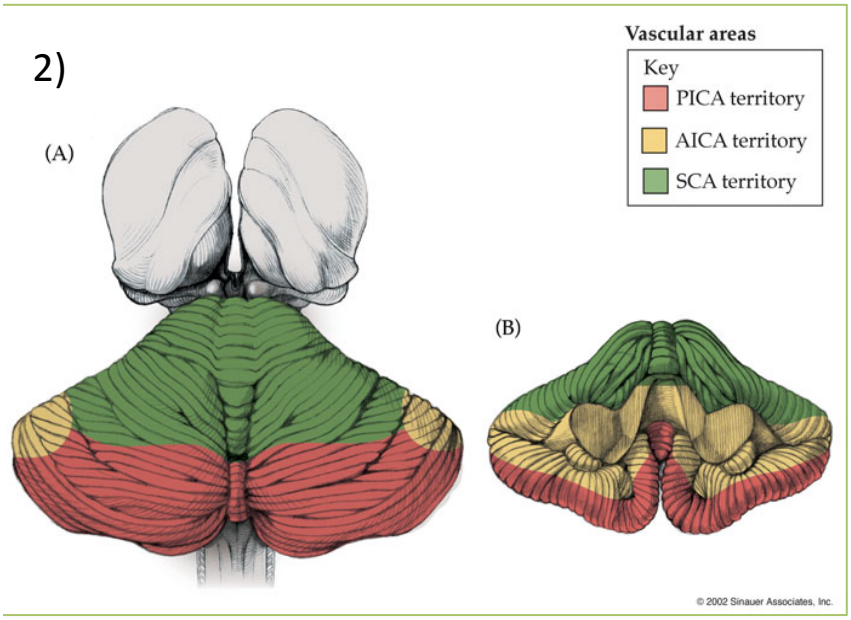


In Ischemia, we need to know by heart the vascular distribution

Pic 1)The lateral aspect of brain Is supplied by Middle Cerebral Artery

The medial aspect of brain (around the sylvian fissure) is supplied by Anterior cerebral Artery

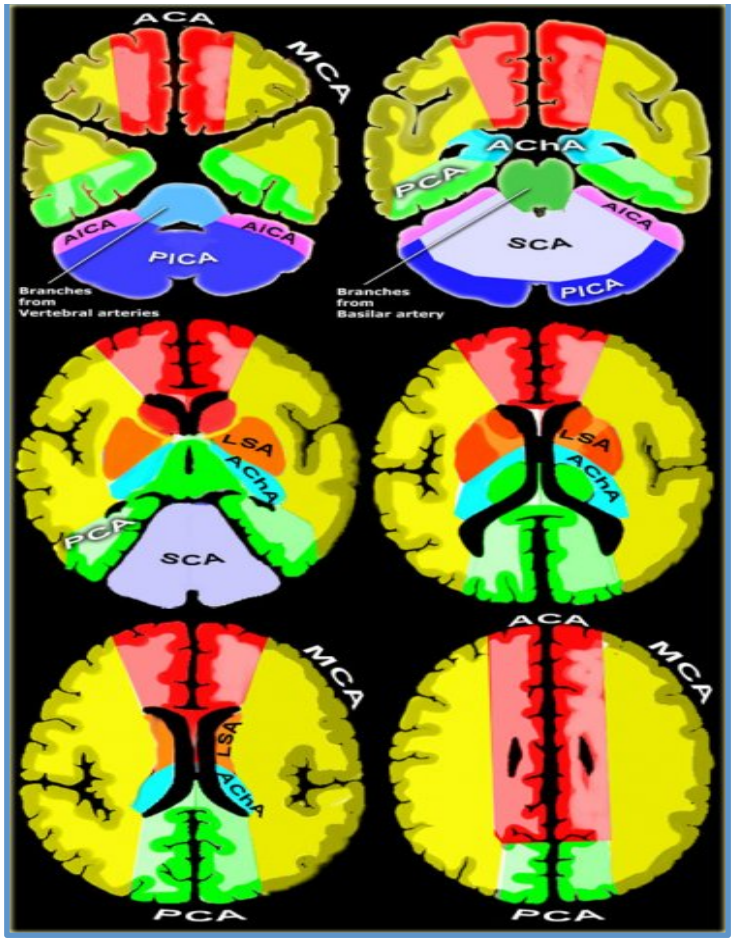
The temporal &occipital lobes are supplied by posterior Cerebral Artery



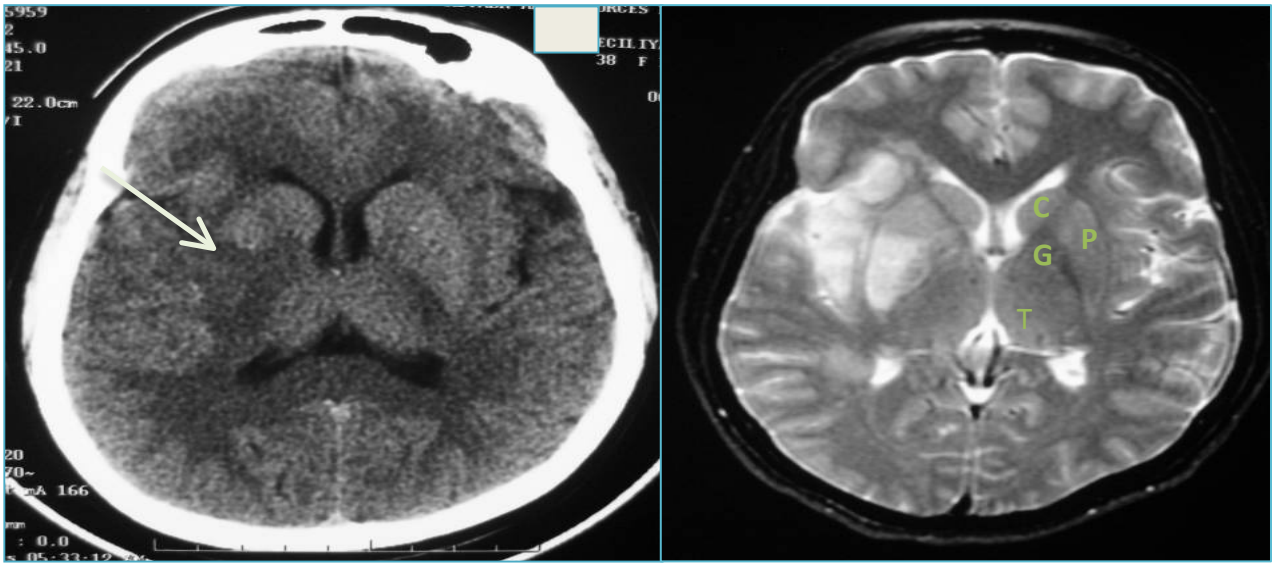
Pic 2)If we go to the posterior fossa, the inferior part of the cerebellum and the lateral part of the medulla are supplied by posterior inferior cerebellar artery (PICA)

If we go higher up, the anterior part of the cerebellum is supplied by anterior Inferior Cerebellar Artery (AICA)

Higher up the at the top of the cerebellum it is supplied by Superior Cerebellar Artery



If you see a lesion that follows vascular territory then think of Ischemia (thrombus)

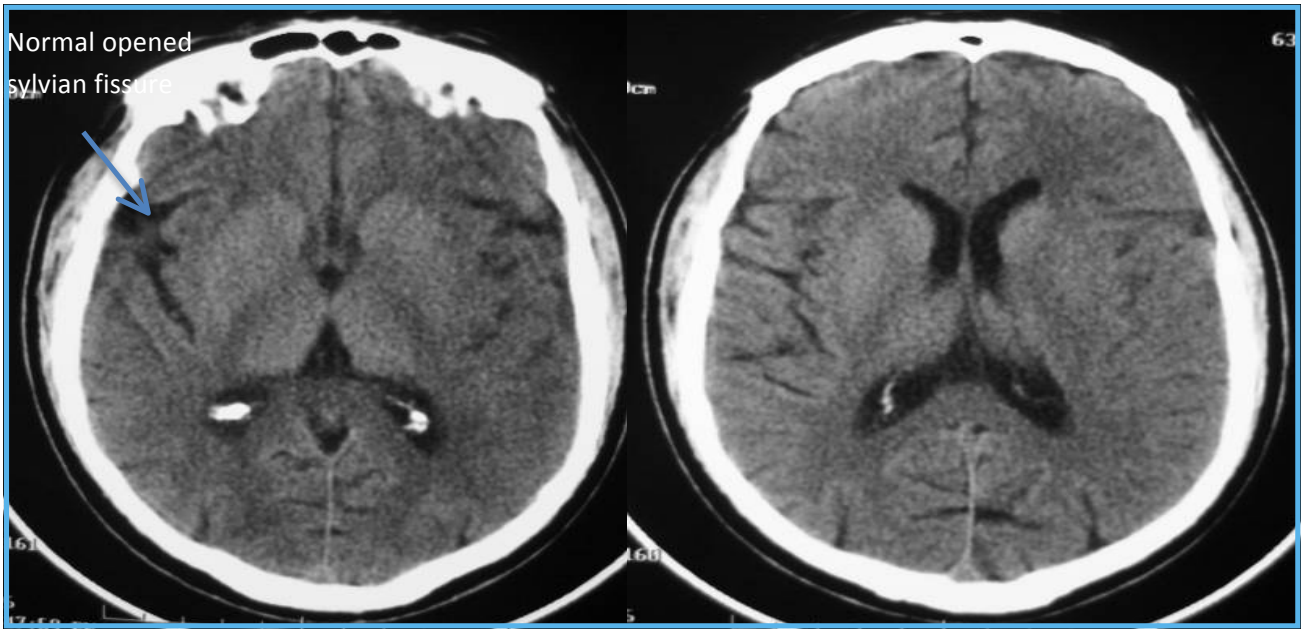


C=Caudate nucleus , P=Putamen ,G=Globus pallidus ,T=Thalamus

The putamen & the Globus pallidus are abnormal on the right side, they are dark. The sylvian fissure which is normally widely open, here it is small because there is ischemia in this region, so if there is ischemia there is edema(fluid) so we lose density(lose appearance of the structure).

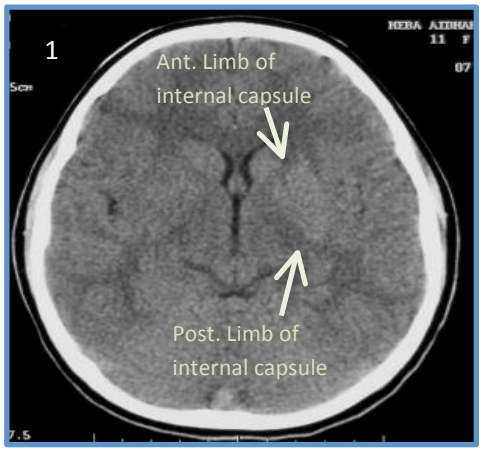
2- T2WI- MRI shows fluid in the ventricle and abnormal fluid in the area of infarction. So this area (basal ganglia) and the sylvian fissure, which is surrounded by the insular cortex, are supplied by the middle Cerebral Artery

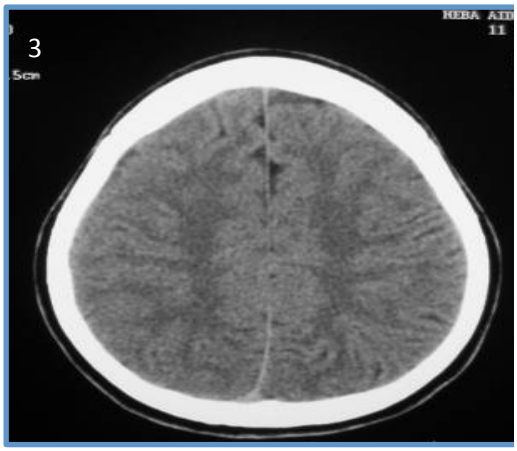
Case: This patient presented with sudden right hemiplegia, what is the finding in this CT scan?



The left side is hypo-dense (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. Again in the middles cerebral artery

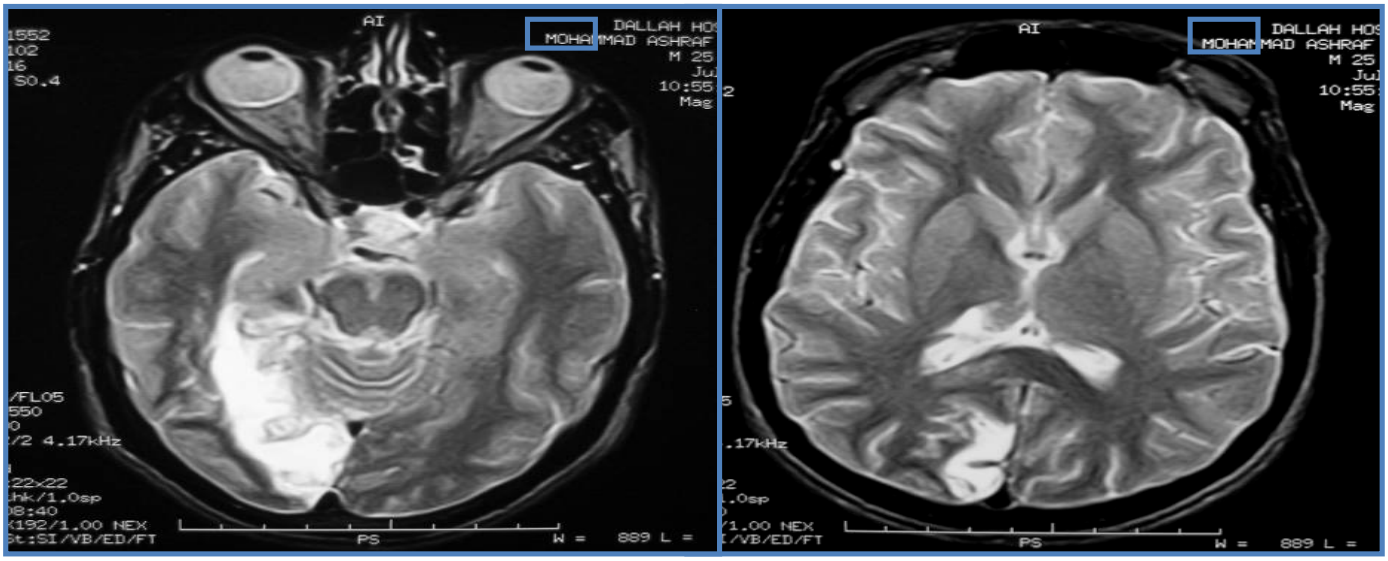
An 11-year-old child presented with left side hemiplegia



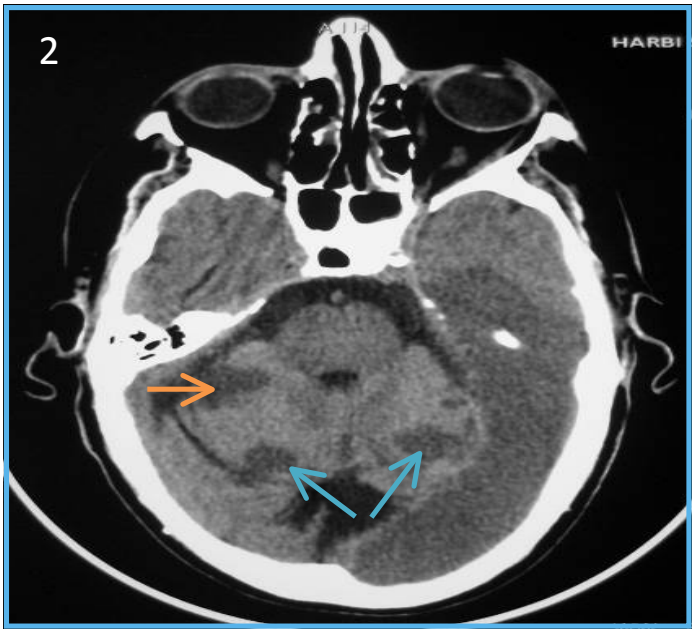


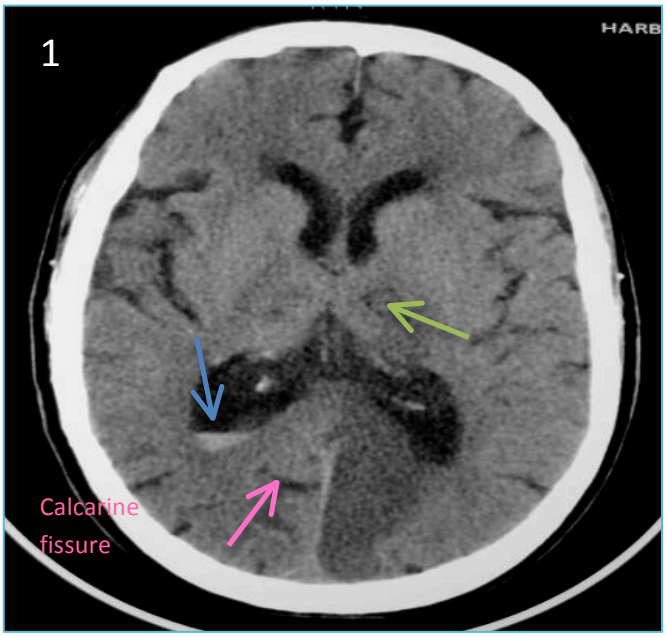
Right side is abnormal →1-caudate is clear but putamen and globus pallidus are not clear
2-caudate nucleus in the right is not as clear as in the left
3- in the left side normal sulci (open) but in the right they are gone (closed) because the whole hemisphere is swollen.

Why do patient who have Middle cerebral Artery ischemia in the basal ganglia develop hemiplegia?
Because as motor fibers descend from the motor cortex to the spinal cord (corticospinal tract), they pass through the posterior limb of the internal capsule which is part of the basal ganglia



MRI showing big old ischemia affecting the occipital lobe and affecting the posterior part of the thalamus which is supplied by posterior cerebral artery, so if we see a lesion affecting the occipital lobe, temporal lobe and posterior part of thalamus then this is PCA ischemia behavior.



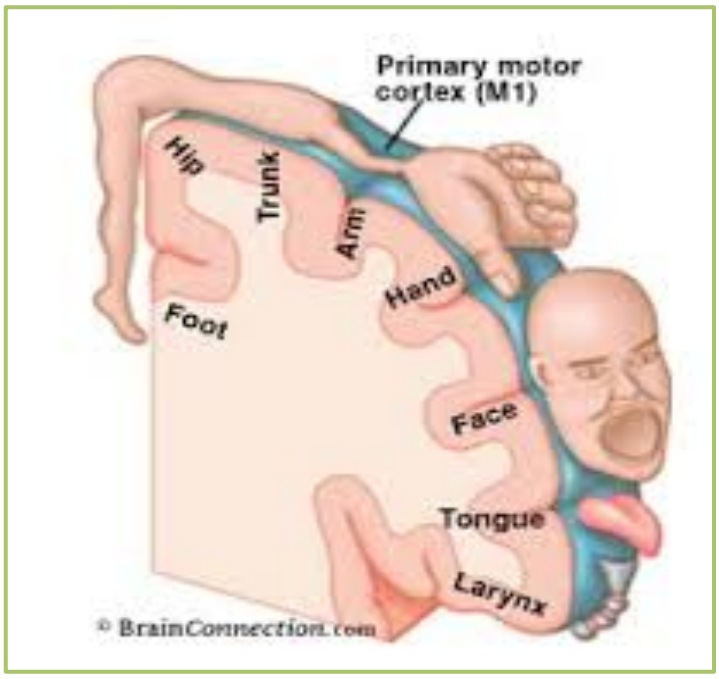


1-This is also PCA infarction, which is affecting the posterior part of thalamus (green arrow)

The calcarine fissure is absent which indicates a swelling, and when it is swollen it means it is acute not chronic

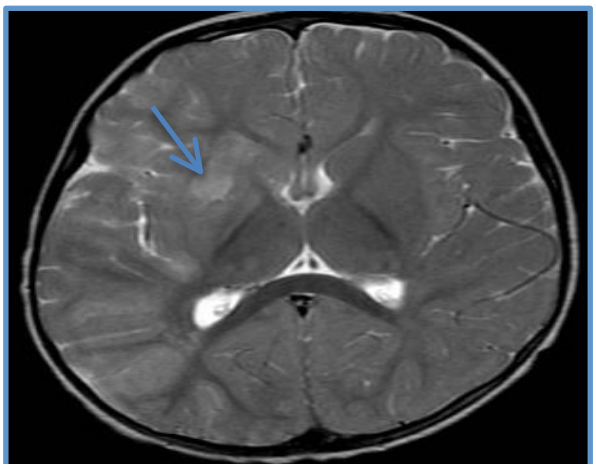
There is bleeding in the ventricle (blue arrow)

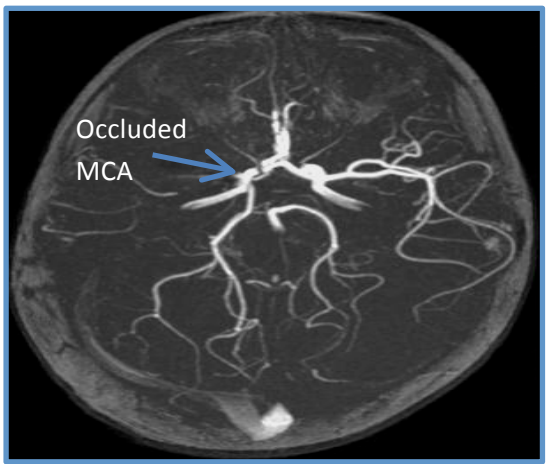
2-and there are other infarctions in the cerebellum by the superior cerebellar artery and inferior cerebellar artery

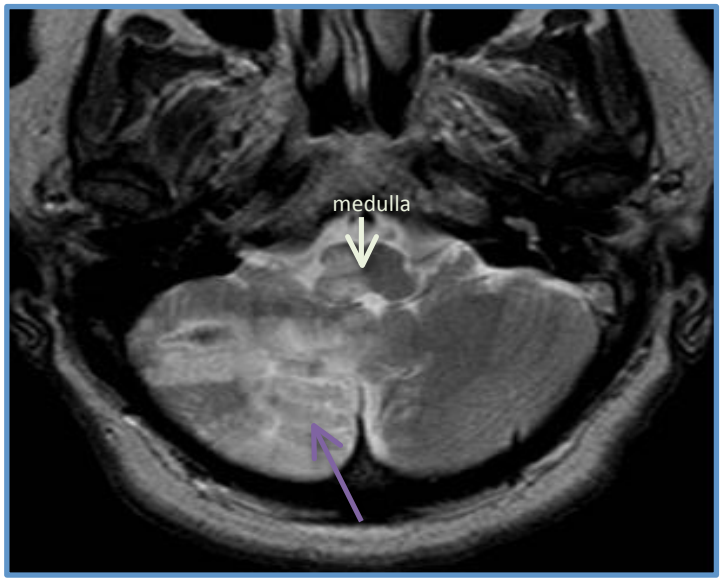


Infarction in the anterior cerebral artery, the calcarine sulcus is not seen here and the falx is pushed to the other side (edema)so this indicates that this is acute ischemia, but if it's shrunk then it's chronic. This will lead to paralysis of the right leg (monoplegia) but the hand and face will not be affected because they are represented downwards.

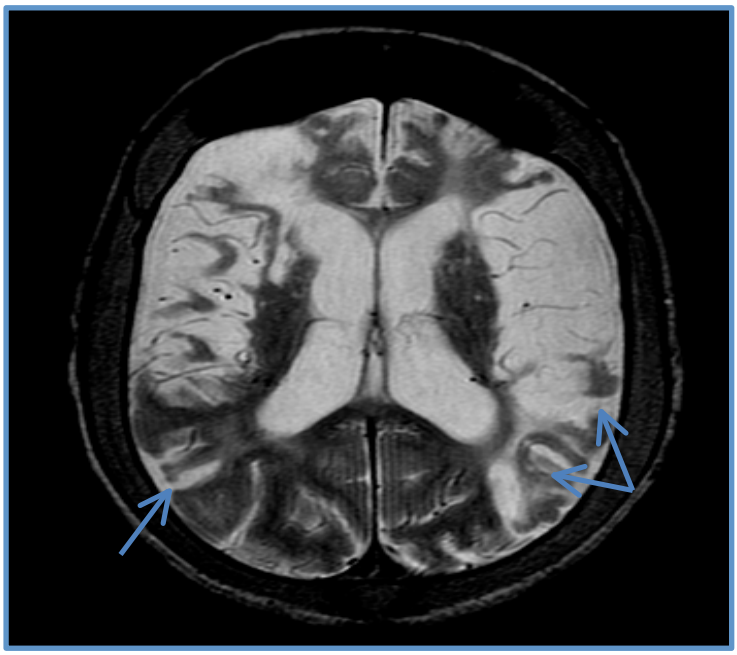
There is bilateral Anterior Cerebral Artery ischemia due to anterior cerebral artery aneurysm, which has bled before & thus, caused spasm then infarction



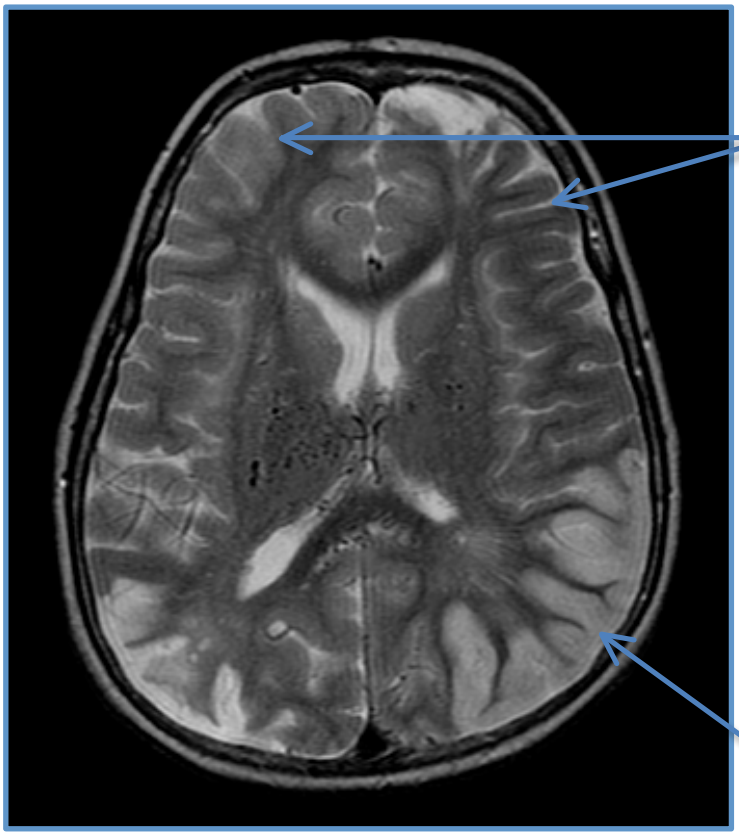




Lower part of the cerebellum is infarcted (purple arrow). We know it's lower because the medulla oblongata is seen, and those structures are supplied by the PICA



bilateral middle cerebral artery infarction and it is chronic because the sulci are large and there is liquefaction (because there necrosis doesn't happen in brain, so the non functioning cells are replaced by fluid) and the brain tissue is shrunk



There is something similar to gyri in the left side

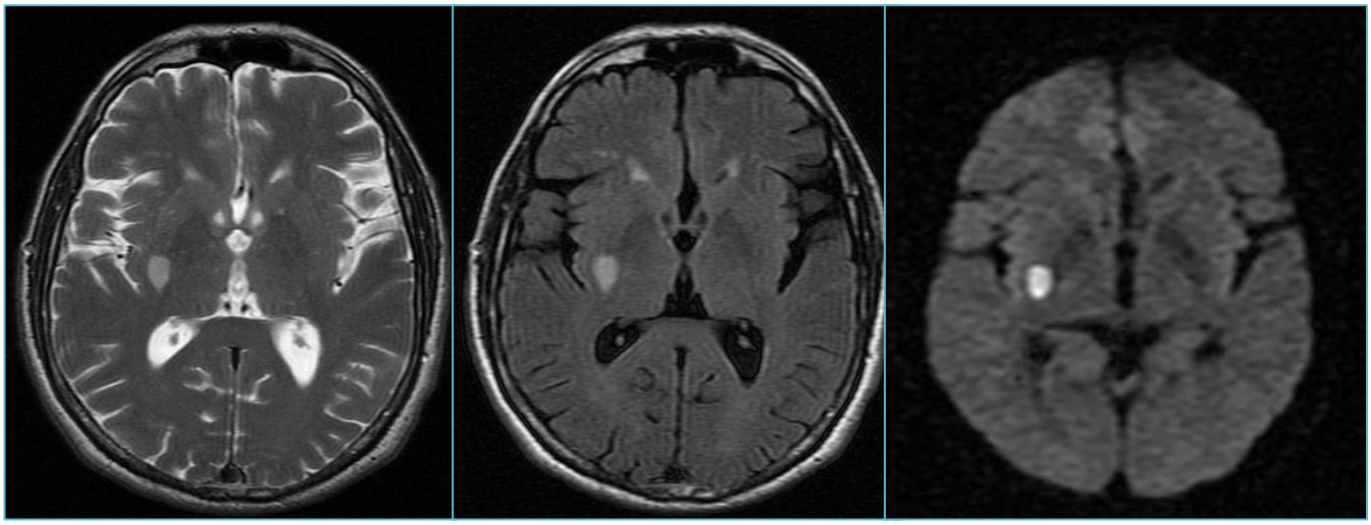
Here the gyri are small and the sulci are big and long, so there is brain tissue loss →this is chronic infarction on both hemispheres.

This patient has 2 chronic infarcts and one new (acute)

If there were multiple infarcts in a patient at different times then we must think of risk factors, for example in a child's brain we should think of sickle cell anemia, cardiac diseases and valvular problems…etc.

No sulci, gyri are swollen and bright and this indicates acute infarction

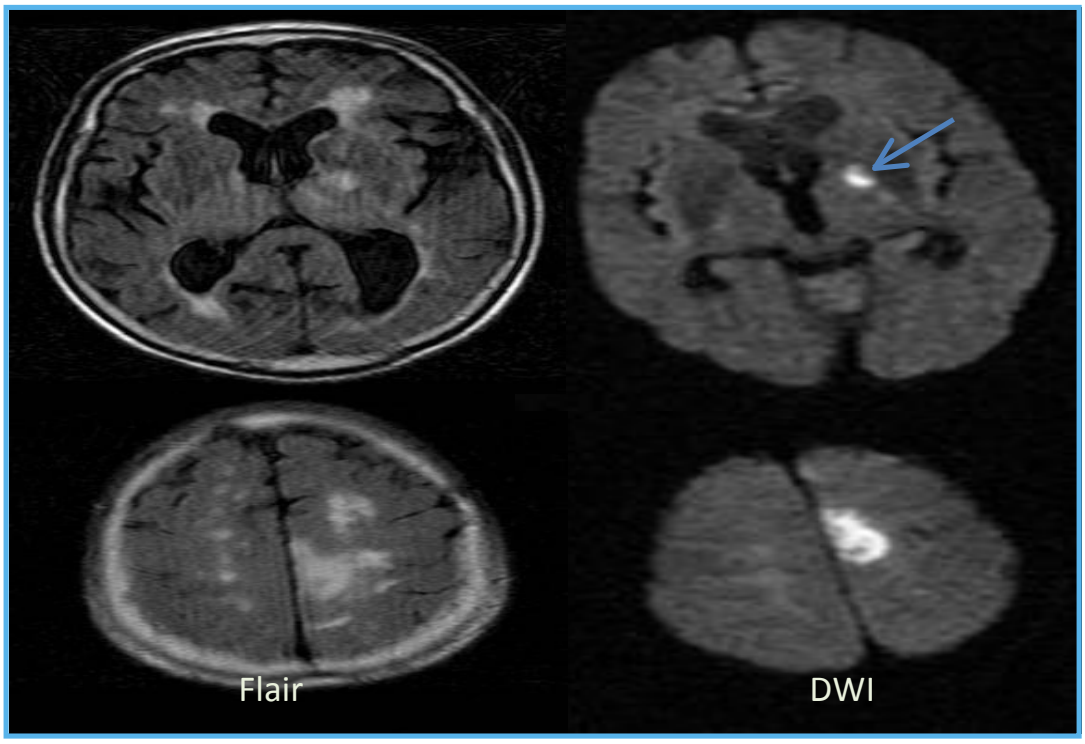
T2WI FLAIR DWI



T2WI= fluid is white

FLAIR= fluid is dark (like air)

DWI= diffusion weighted image → shows you a white bulb which is the infarction, this is the area of fluid restriction or diffusion restriction



This is an elderly patient whose white matter is abnormal because of chronic ischemic changes, he repeatedly comes with infarctions due to HTN and atherosclerosis, then presented with new motor deficits.

How would you know from this sequence which is old & which is new?

You can't unless you apply DWI , which shows new infarction in the posterior limb of internal capsule (arrow) and presents as right hemiplegia. He also has one in the cortical (motor) strip, which will also cause hemiplegia.

DWI is an advanced sequence that allows early diagnosis of infarction, it will be + in less than 1 hour

Edema:

- Vasogenic: fluid leaks from intravascular to extravascular compartment (interstitium)

  Causes: Trauma/infection/inflammation/tumors

- Cytotoxic: fluid accumulates inside the cells and not in the interstistium, typical with ischemia

  Causes: Ischemia/trauma

- Both could be generalized or localized
- Both may co-exist

Generalized vasogenic edema in meningitis or generalized inflammation

Generalized cytotoxic edema like in hypoxia like in arrhythmias and drowning.

Imaging findings:

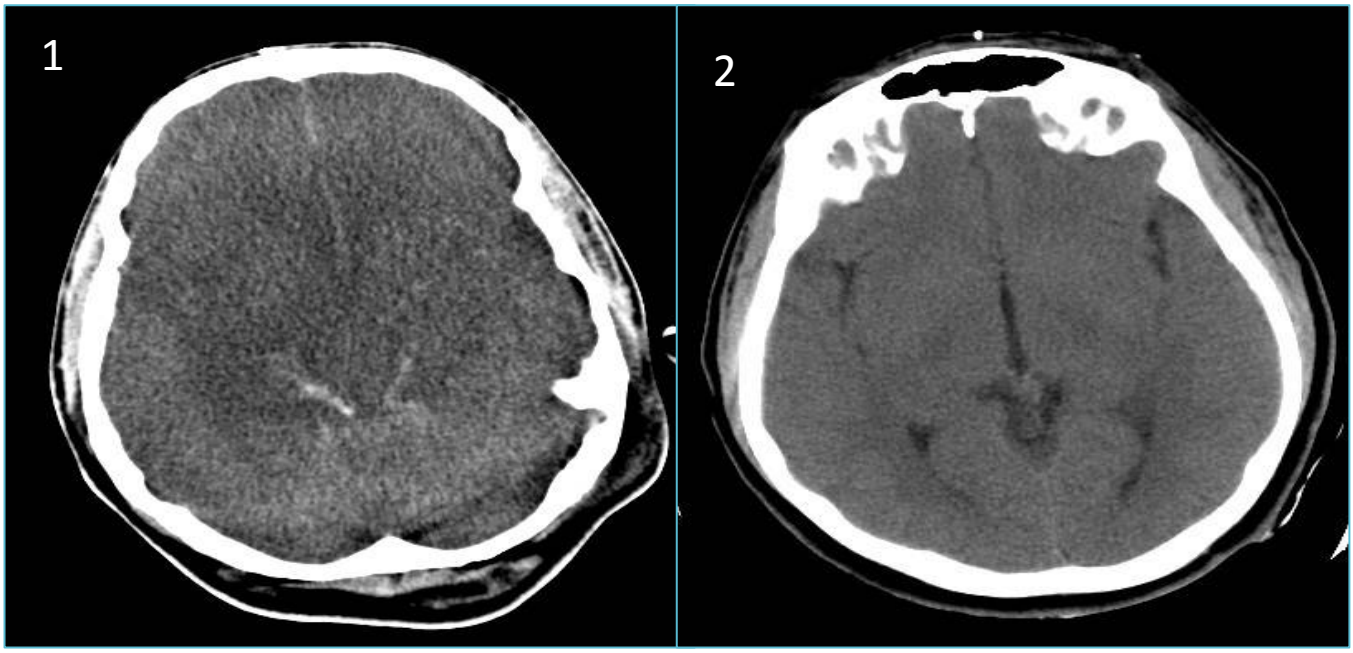
- Hypodensity on CT
- Low signal on T1, high signal on T2 & FLAIR (b/c it is fluid)
- Loss of GM/WM interface because it will be soaked with fluid
- Compressed ventricles
- Effaced sulci & Cisterns
- Dense cerebellum (because cerebellum is a posterior fossa structure along with the brain stem, and usually when there is suffocation the posterior circulation is more resistant to ischemia because it has mature compensatory mechanisms, which is the last to shut down. So the density of cerebellum is relative, because other structures are dark due to ischemia so it is an optical illusion)

GM/WM

= grey matter/white matter

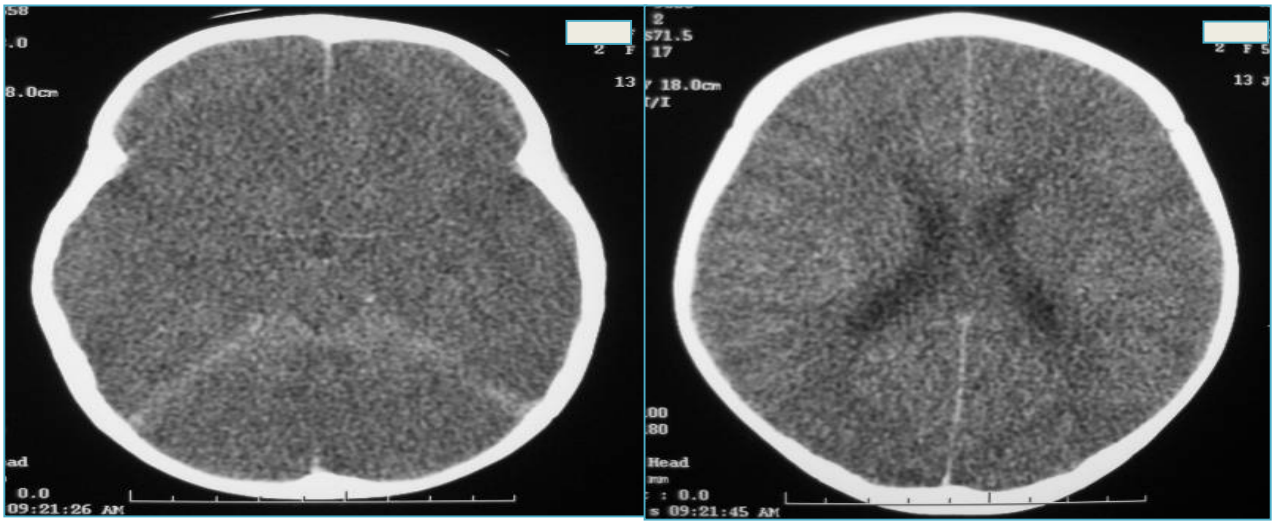
- Brain herniation (The cranial cavity will not accommodate the swollen brain so it will herniate into foramen magnum and subsequently will compress the brain stem leading to cardiac and respiratory arrest)

- Vascular compression-ischemia

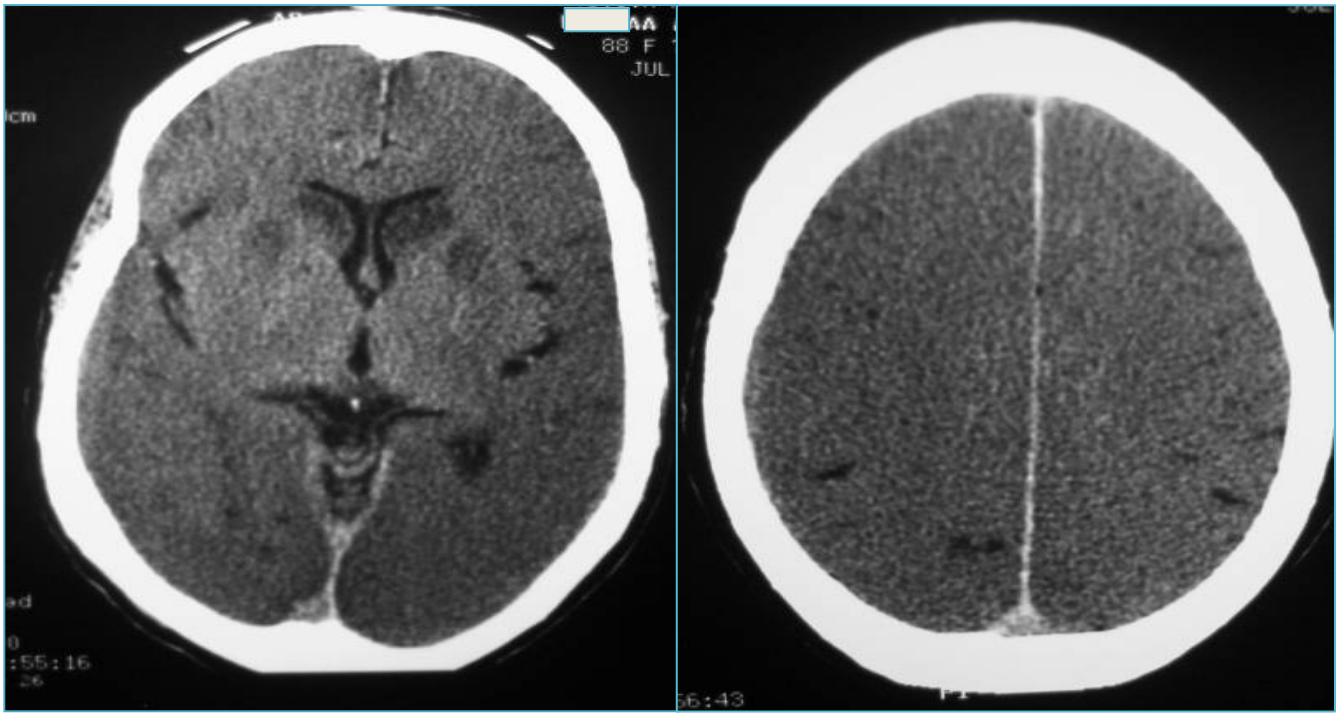


1- You can't differentiate between grey and white matter, you see grainy picture, no sulci, no basal cystirns, no ventricles, and cerebellum is a little bit dense

2- 3 weeks after treatment we started to see the ventricles, sylvian fissure, occipital horns so that's an improvement

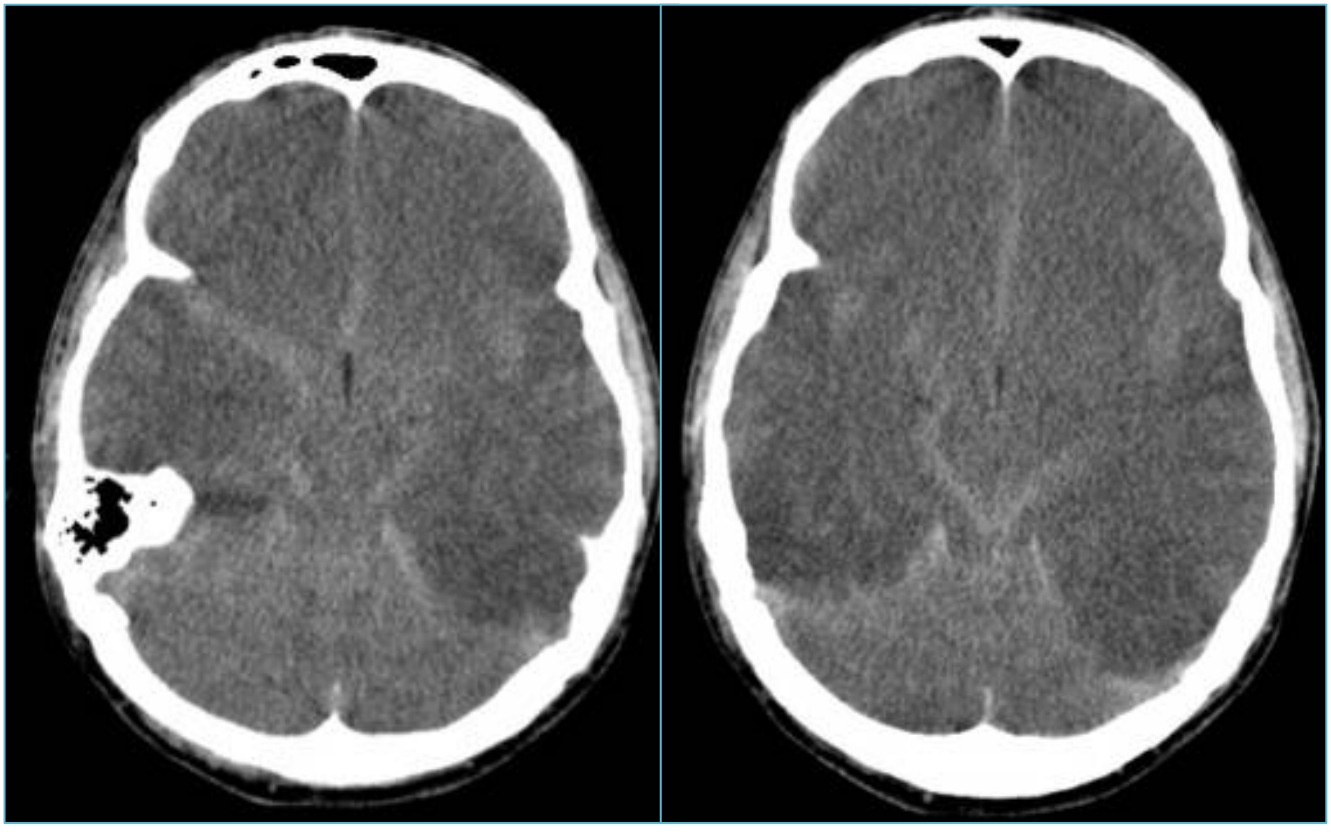


2 year old female child who nearly drowned in a swimming pool, ventricles are not compressed yet but the differentiation between GM & WM is not that good it is a very grainy image, sulci are not clear (effaced), no basal cisterns because the brain started to herniate, we can see a little bit dense cerebellum or tentorium. These 2 cases were generalized.



We see sylvian fissure, some sulci, some GM/WM differentiation but the other side looks like one tissue

We go up and we don't differentiate GM & WM

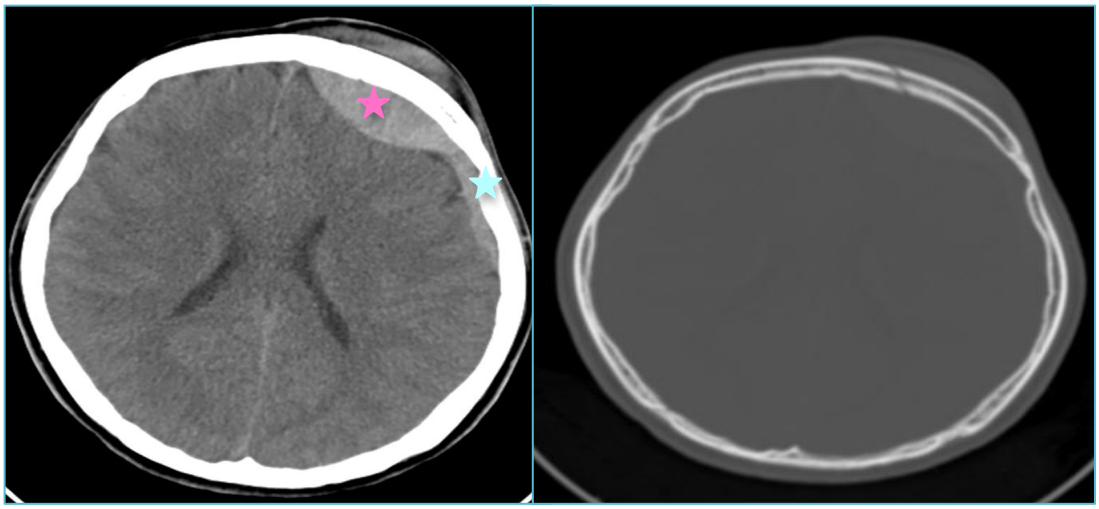


Dense cerebellum, effaced basal cistern and sylvian fissure, and very small third ventricles

	Vasogenic	Cytotoxic
Location	White matter (it's part of the interstitium =fibers)	Gray matter (in the cell)
DWI	Non-restricted	Restricted (appear like white bulb)
Shape	Finger-like (fibers)	Diffuse (like basal ganglia or gyri)

Quiz:

1-



Dx: Epidural & Subdural Hematoma

-Subdural because it crosses the coronal suture (blue star)

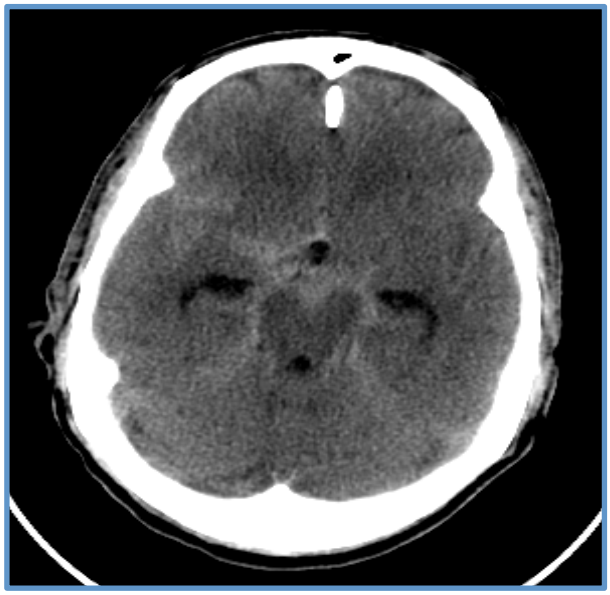
-Trauma can cause both together, there is a sign of trauma, which is scalp swelling.

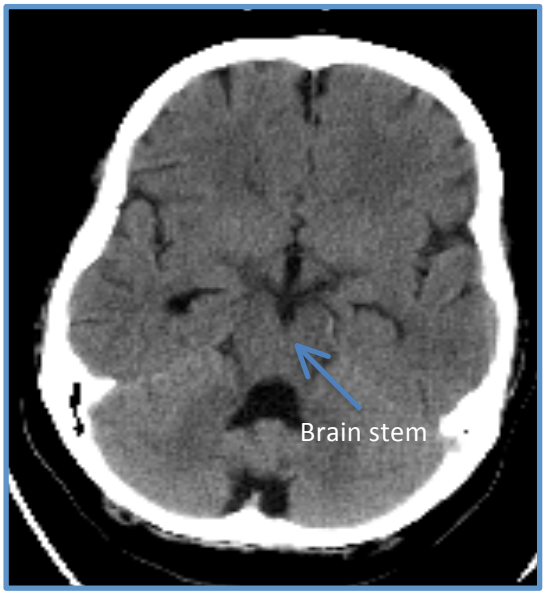
-The epidural hematoma is typically located at the site of trauma (pink star)

-There is a fracture

normal

2-

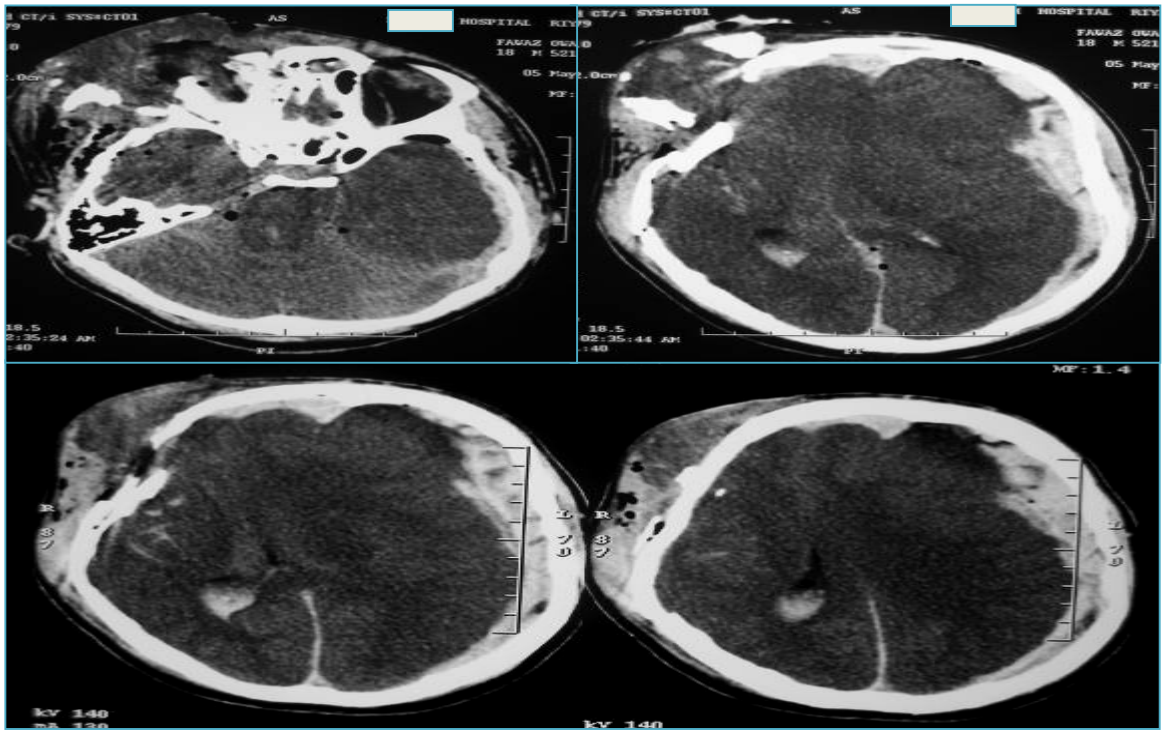




Dx: Subarachnoid hemorrhage because the cisterns and the brain stem and the sylvian and interhemipheric fissures are filled with blood.

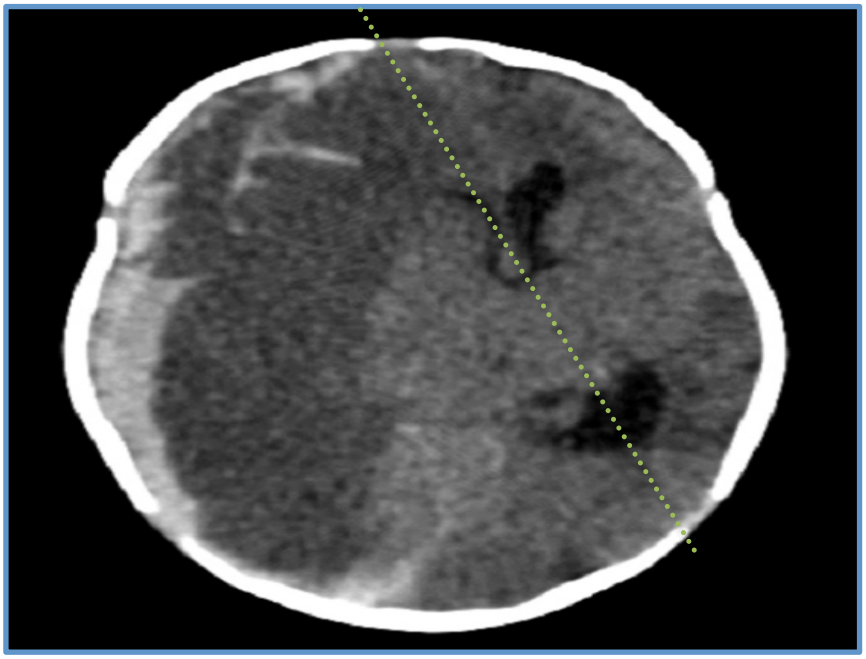
There could also be edema

3-



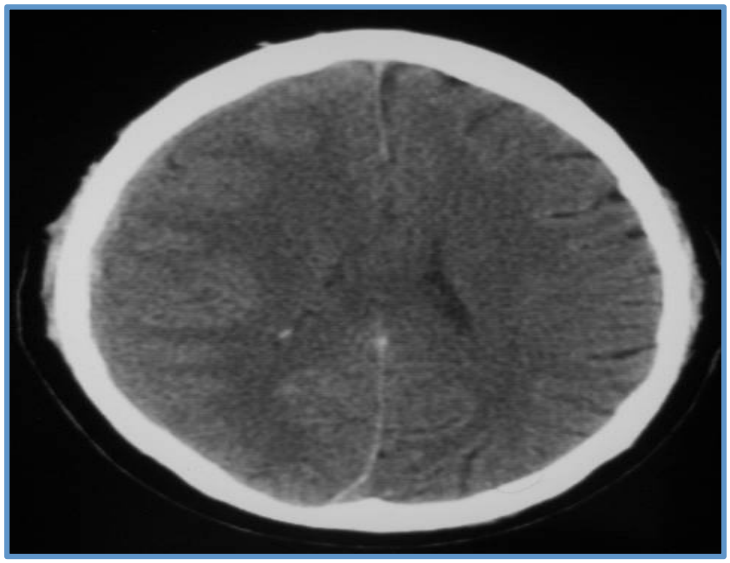
Severe trauma to the face and head, there is intraventricular bleeding, air, subarachnoid bleeding in the sylvian fissure and subdural bleeding

4-

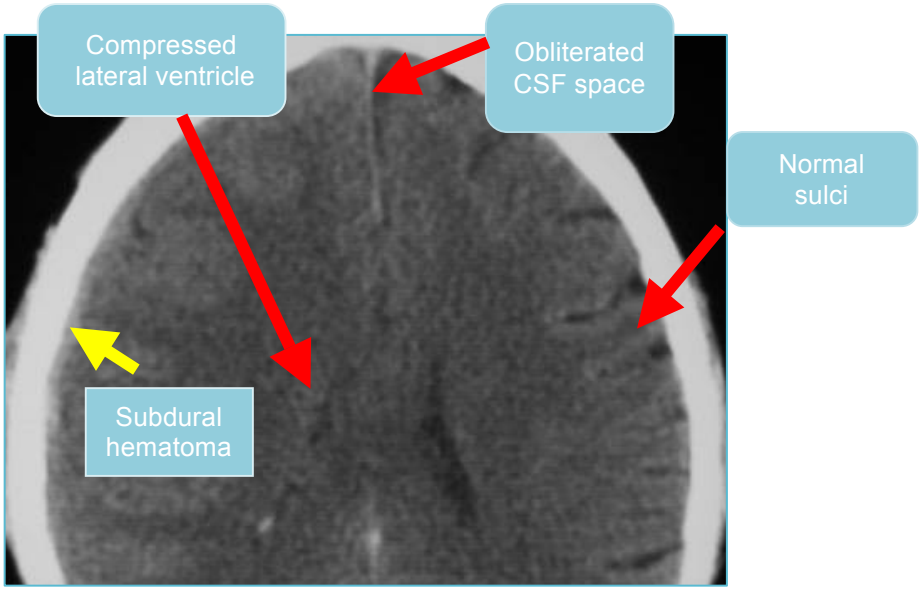


This is a case of midline shift and herniation in a child with large ischemia in the right hemisphere, with subarachnoid bleeding and large subdural hematoma crossing the coronal suture with a black area indicating active bleeding

5-



There is abnormality in the right side, no sulci but we can differentiate between GM & WM so it is not edema, in fact there is something compressing the sulci outside the brain (very small subdural hematoma) it's not a big issue if you miss something like this because it is usually asymptomatic but keep an eye on it because it may grow with time.



Summary

- Epidural hematoma doesn't cross sutures
- Subdural hematoma goes with the dural reflections
- Subarachnoid hematoma fills the normal places of CSF
- We can use T2WI,FLAIR and DWI in brain ischemia or infarction
- DWI gives a fast diagnosis of new infarctions
- Brain gyri are swollen and sulci become smaller in acute ischemia due to edema while it's the opposite with chronic ischemia
- Edema compresses ventricles and fissures and results in loss of GM/WM differentiation

MCQs

1- Regarding epidural hemorrhage, choose the correct answer:

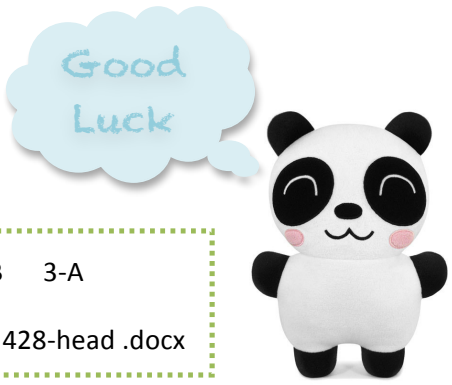
a- It occurs in older age group compared to subdural hemorrhage.
b- It's curvilinear in shape.
c- It occurs between the dura matter and the brain tissue.
d- It's usually caused by trauma
e- It's not limited by sutures

2- Cytotoxic edema can be caused by which of the following:

a- Gliomas.
b- Cerebrovascular accident (CVA).
c- Infection.
d- Metastasis
e- Dehydration.

3- John is 20 years old, he had a car accident and came to you in the Emergency Department of KKUH. After that you did a CT scan to him, the findings were some hemorrhage that was limited by sutures. Based on this finding the pathology is most likely:

A- Epidural hematoma.
B- Subdural hematoma.
C- Subarachnoid hematoma.
D- Intra parenchymal hematoma.
E- Intra ventricular hematoma.



Answers: 1-D 2-B 3-A

MCQs source from 428-head .docx