Radiology of Common Brain Diseases

Lecture 23

Objectives

Learn about:

- – Intracranial hemorrhage.
- – Brain ischemia.
- – Intracranial tumors.
- – Intracranial infections.

Color index:

Black: Main text
Red: Important
Yellow: Golden notes
Green : Drs notes 439
Dark green : Drs notes 438
Gray: Extra

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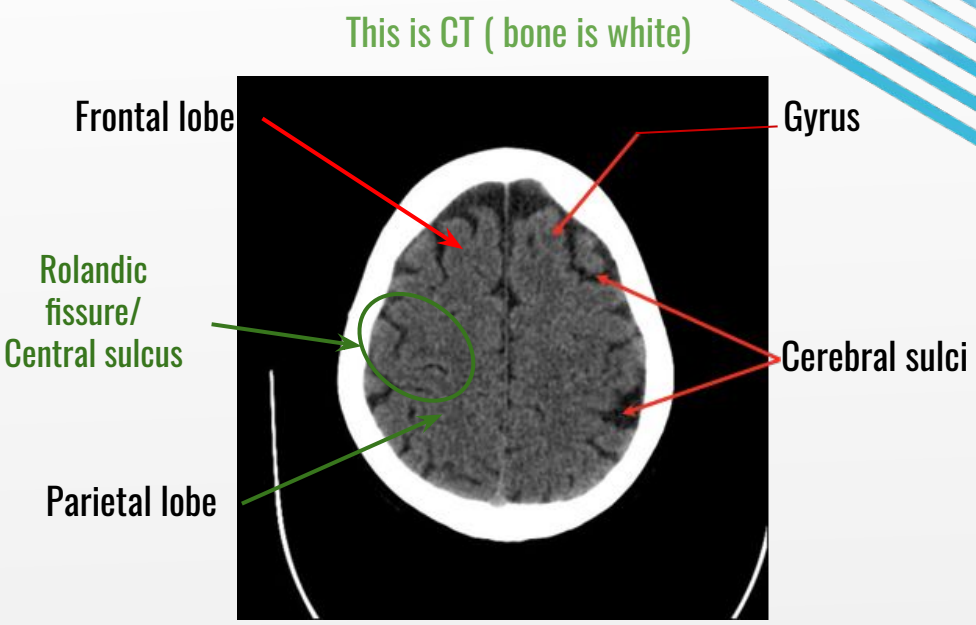
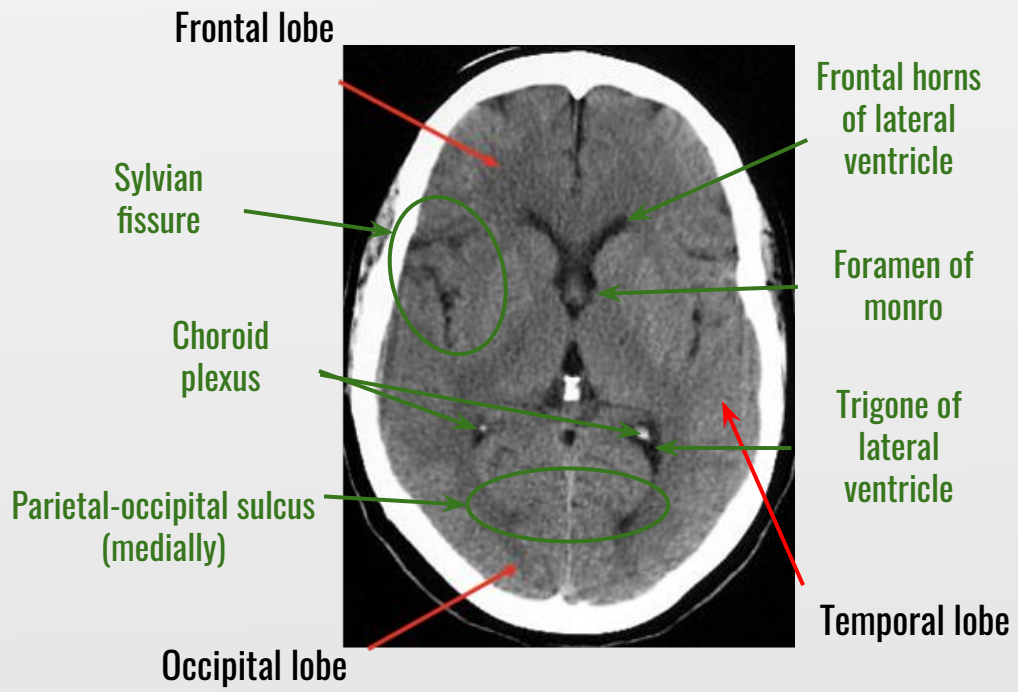
Normal brain imaging

Anatomy

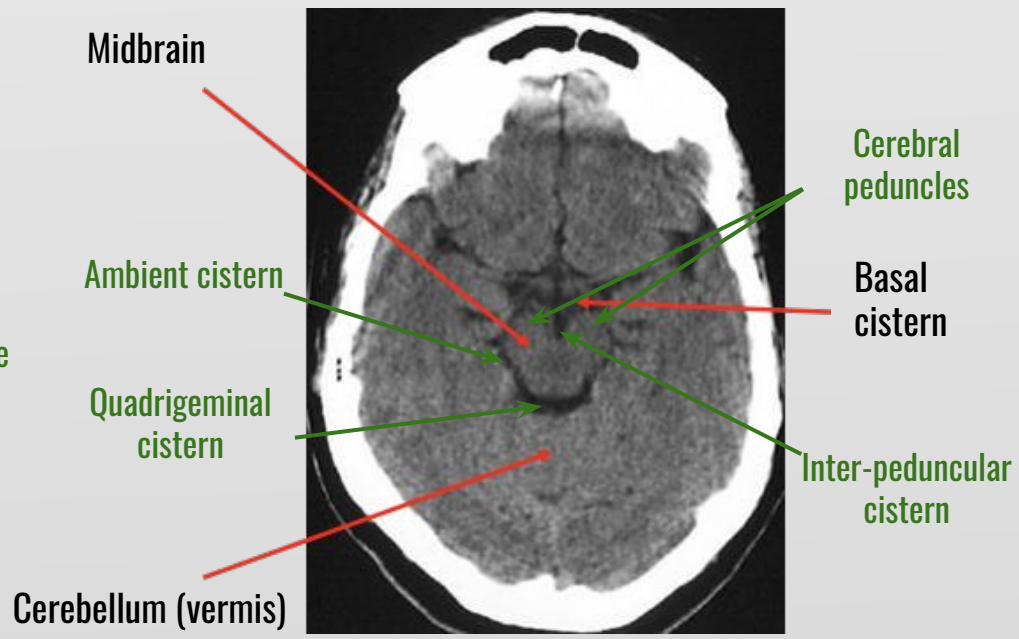
- **Rolandic fissure**: the demarcation between parietal and frontal lobes.
- **Gyrus**: has same density as the brain.
- **Cerebral sulci:** part of the extra-axial spaces and they're filled with CSF appears dark on CT.



- There's no demarcation between **occipital** and **parietal** lobes on the lateral surface of the brain.
- **Sylvian fissure:** separates the temporal, frontal and parietal lobes from each other.
- **Foramen of monro:** connects the frontal horns of lateral ventricle with 3rd ventricle.
- **Choroid plexuses** is frequently calcified.



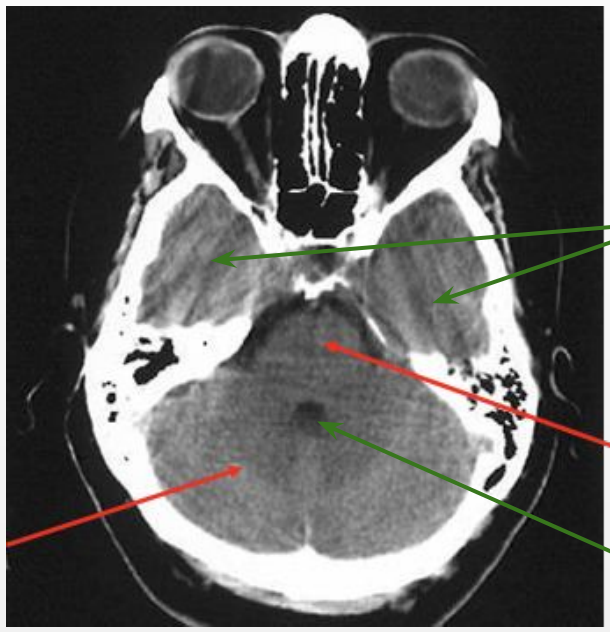
- **Midbrain** is the most superior part of the brain stem.
- **Cerebral peduncles** are the most anterior part of midbrain.
- **Ambient cistern** connect between interpeduncular and quadrigeminal cisterns.
- **Vermis** is the central part of cerebellum.
- **Cisterns** are like ventricles and they're filled with fluid hence they appear black on CT.



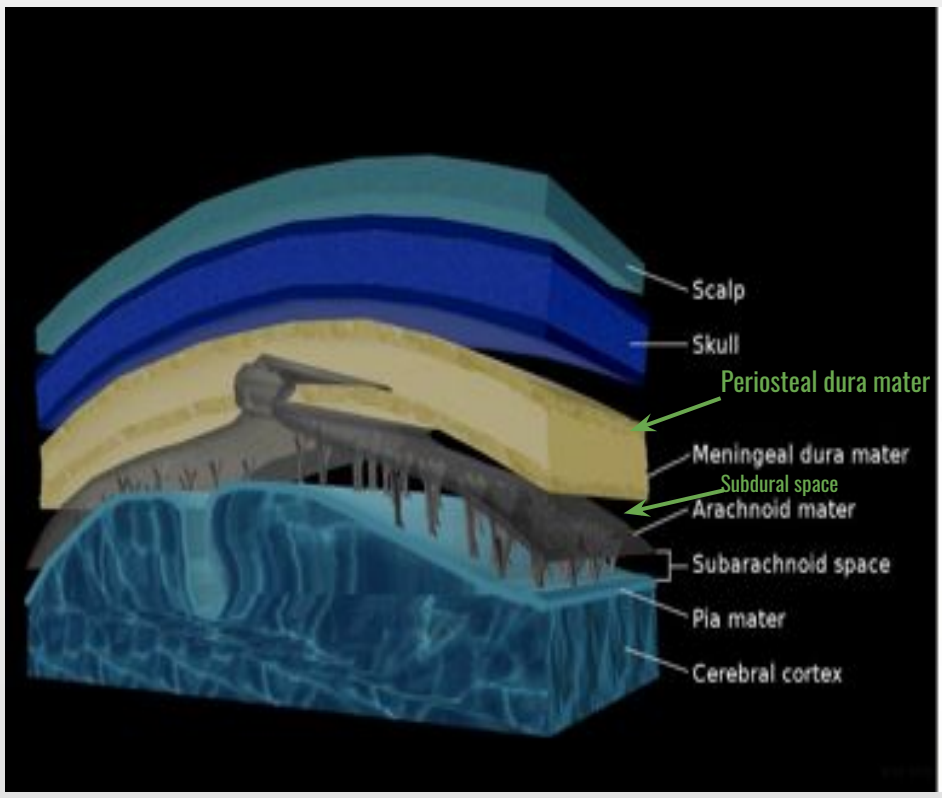
Normal brain imaging

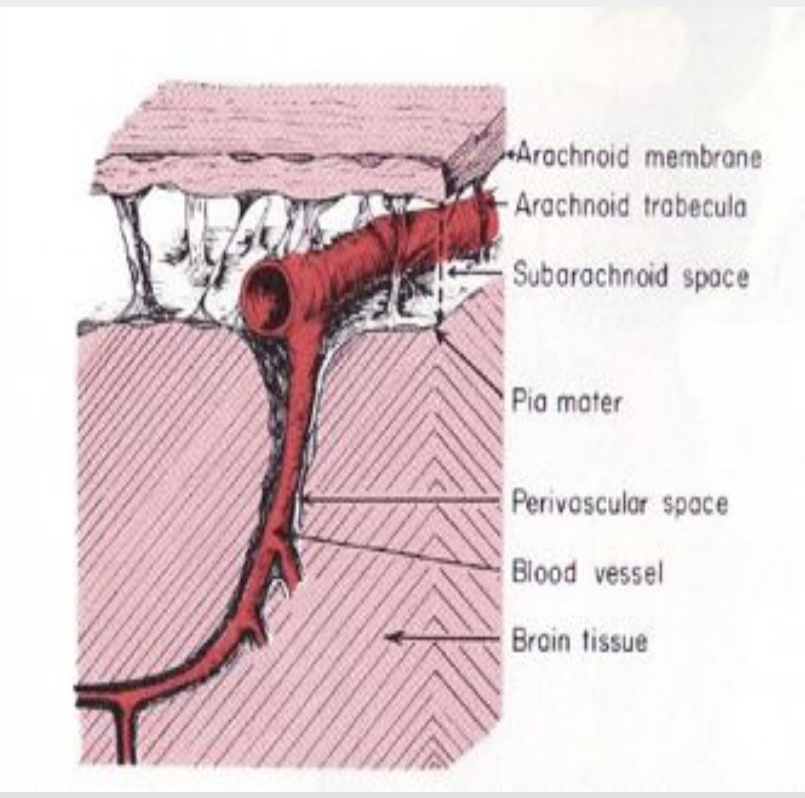
Anatomy

Cerebellum:
- Laterally: cerebellar hemispheres
- Centrally: vermis



* This is non enhanced CT because the basilar artery are NOT white, if it's white -> CT with contrast (enhanced)



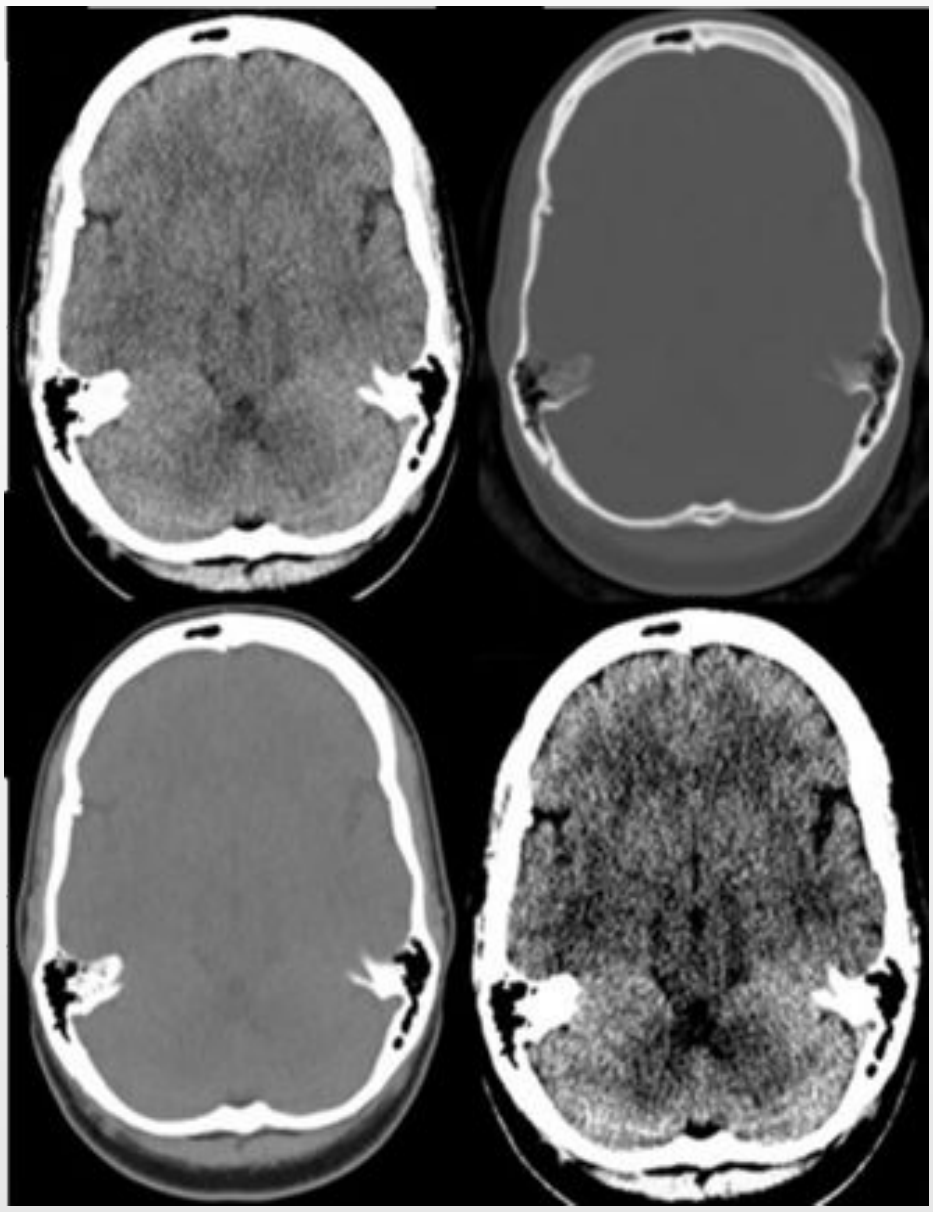


- **EDH:** between the skull and the dura mater
- **SDH:** between the dura and the arachnoid mater
- **SAH:** between the arachnoid mater and pia mater
- **Pia mater** is lined along the gyri that's why if there's SAH it'll take the shape of the brain

Normal brain imaging

Windowing

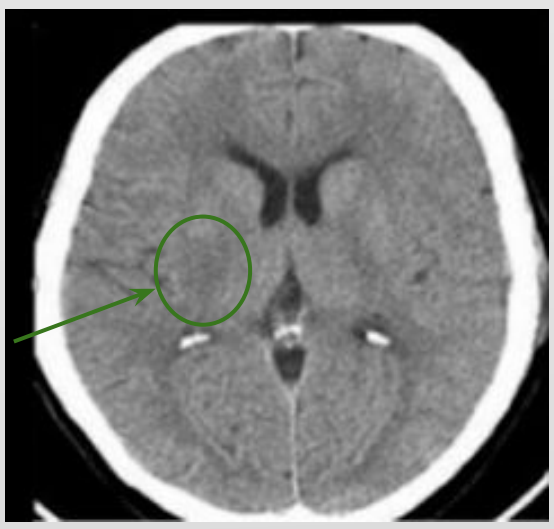
Brain window
(W 80, L 40)
Doesn't show details anatomy of the bone



Bone window
(W 3000, L 500)
Shows details of the bone anatomy but brain parenchyma won't be clear
Used to see the fractures better!

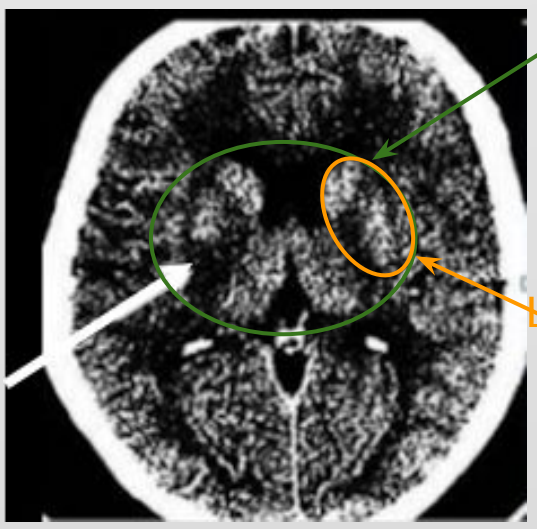
Subdural / soft tissue window
(W 260, L 80)
Important in case of hemorrhage because hemorrhage in the acute phase is very white and you might not see the difference between the hemorrhage and the bone

Stroke window
(W 40, L 40)
Very narrow window
Shows dramatic difference between white and grey matter and this helps in identifying areas of hypodensity and lesions



Brain window

Infract
(Focal hypodensity)



Stroke window

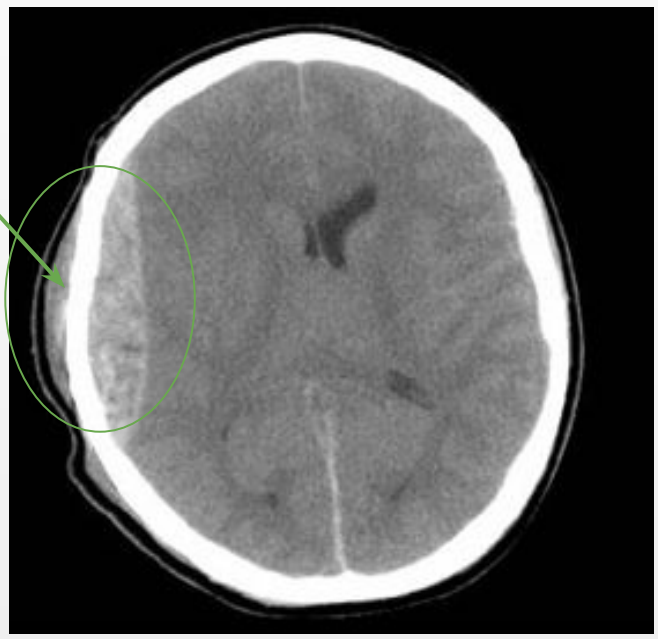
* presented with left sided weakness-> suspect stroke , in brain window there's a very subtle hypodensity which mistaken as normal -> change the window to stroke window which shows clearly hypodense infarct

Normal brain imaging

Windowing

Brain window

Soft tissue swelling

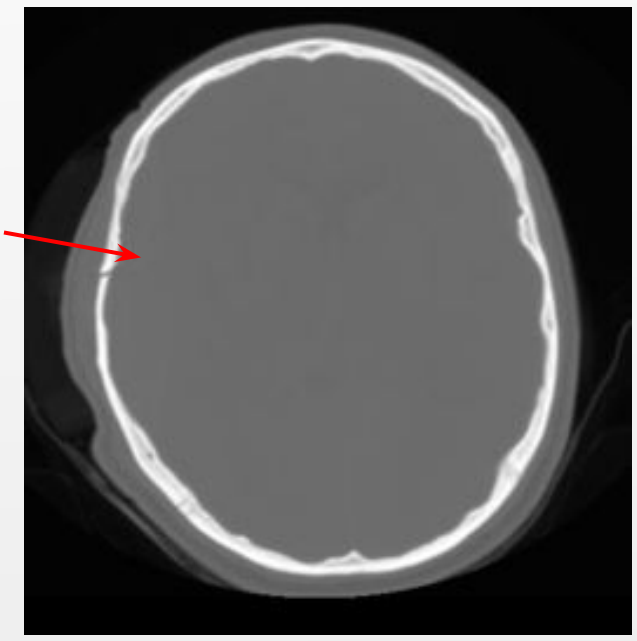


Acute epidural hemorrhage

Patient will have acute history of trauma.
Commonly associated with fracture.
We have to change to bone window to see it clearly

Bone window

Fracture

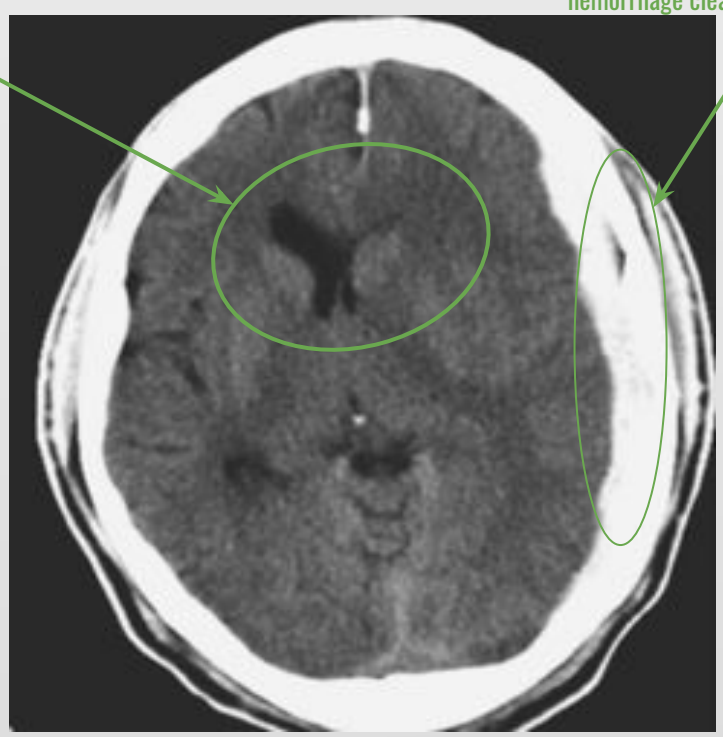


When we changed the window we saw the fracture

Dilated right ventricle and compressed left ventricle due to the mass effect of the hemorrhage

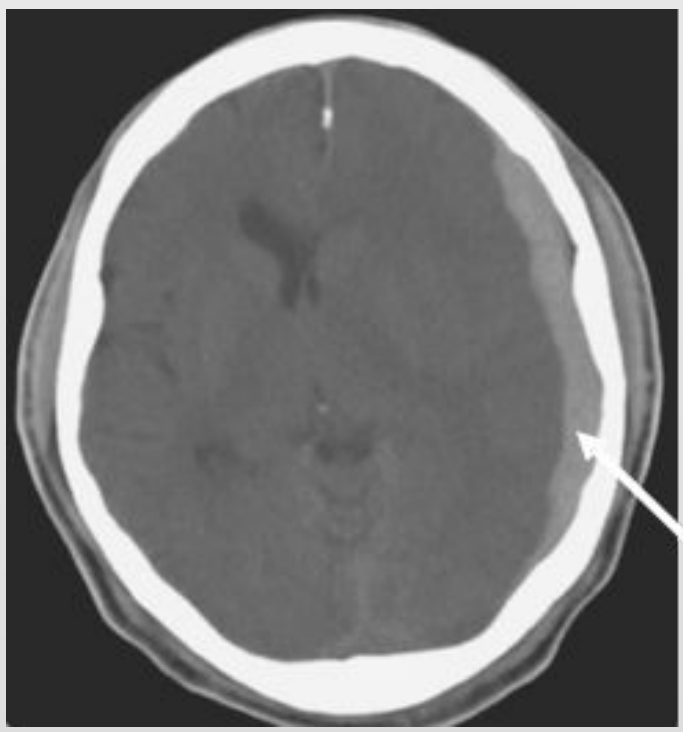
Bleeding (hyper-dense)
Appears white like the bone-> change the window to subdural/ soft tissue window to see the hemorrhage clearly

Brain window



Hemorrhage is not very clear and might appear as part of the bone although there's mass effect on the left lateral ventricle and midline shift

Subdural / soft tissue window



SDH

Very clear difference between the bone and the hemorrhage

Intracranial Hemorrhage

Epidural hematoma:

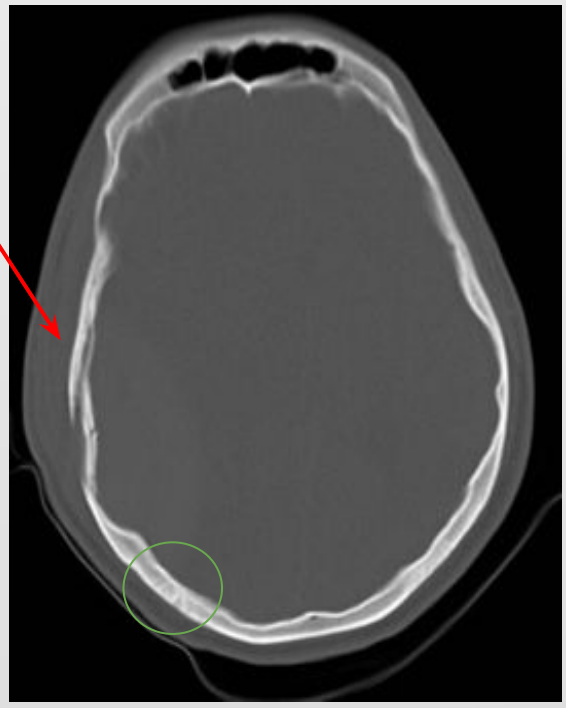
- **Lentiform (Biconvex)** (زي العدسة) collection between the dura and skull.
- **Almost always traumatic.**
- Associated with skull fracture It is important to change the window into bone window to see the fracture clearly.
- Typically arterial in nature, **MMA** (middle meningeal artery) **mostly** but could be from venous sinuses.

★ Epidural hematomas:
  - Hyperdense
  - Lentiform (Biconvex)
  - Causing mass effect.
  - May cross midline but doesn't cross sutures.
  - Quick to develop (1 hour post trauma)

- Typical clinical scenario: The patient has lost consciousness after an RTA. He wakes up and appears relatively well only to pass out again
  - The first time he lost consciousness was from the trauma (Concussion)
  - The second time was from the bleeding epidural hematoma

Acute EDH

Skull Fracture



Brain window: soft tissue thickening and injury

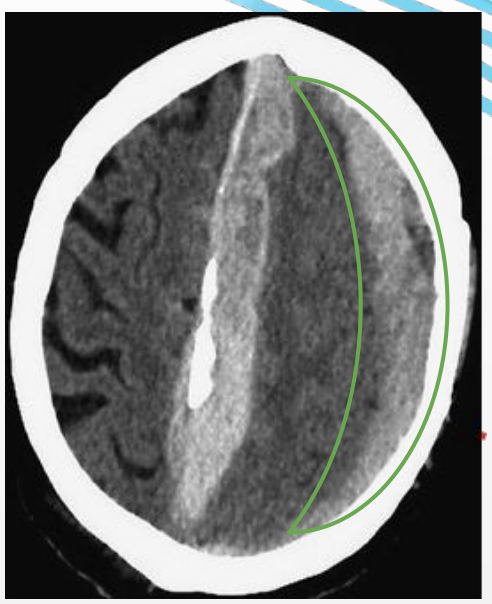
Bone window: comminuted fracture in parietal and temporal bones

We can see that the bleed stopped at the site of the suture (Green circle).
Because the dura is attached to the suture.

Intracranial Hemorrhage

Subdural hematoma:

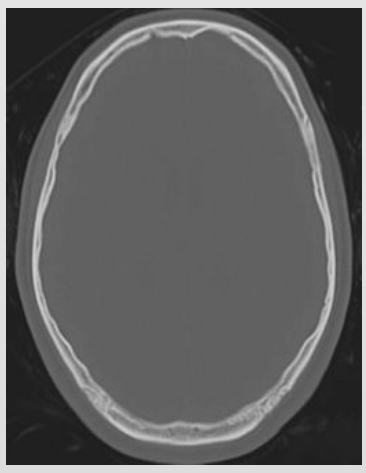
- **Crescentic** (زي الهلال) collection between the dura and arachnoid.
- Usually caused by trauma.
- Can be related to anticoagulation especially in elderly as they have more space and the brain can hit the bone and even minor injuries might lead to bleeding due to the fragile vessels.
- Can also be seen in child abuse
- Typically venous in nature.
- **It does not cross midline** but they can go along the dural reflection.
- Crosses sutures
- Occur in the opposite site of trauma and it takes more time to develop

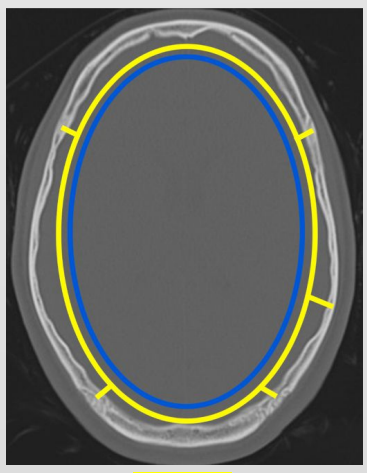


Acute SDH

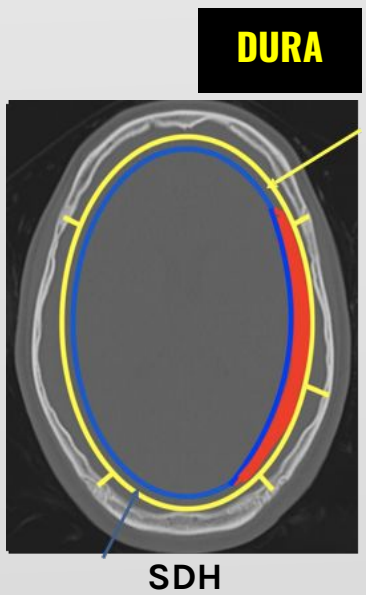
Why do Subdurals occur in the opposite side?
When there is trauma. The brain is moved inside the skull from the trauma to the opposite side. This causes the weight of the brain to land and damage on the opposite sided bridging veins which causes the bleed

SDH vs EDH



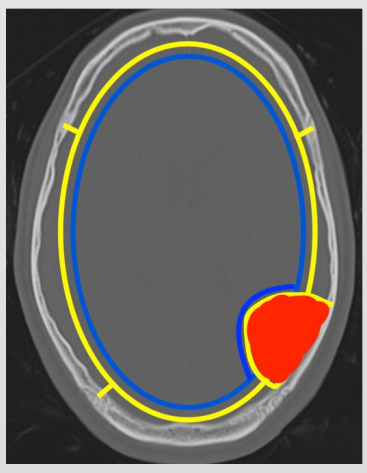


DURA
Arachnoid



SDH

The blood Can pass because it's not attached to the sutures so the blood can extents that's why we see SDH as crescent shape



EDH

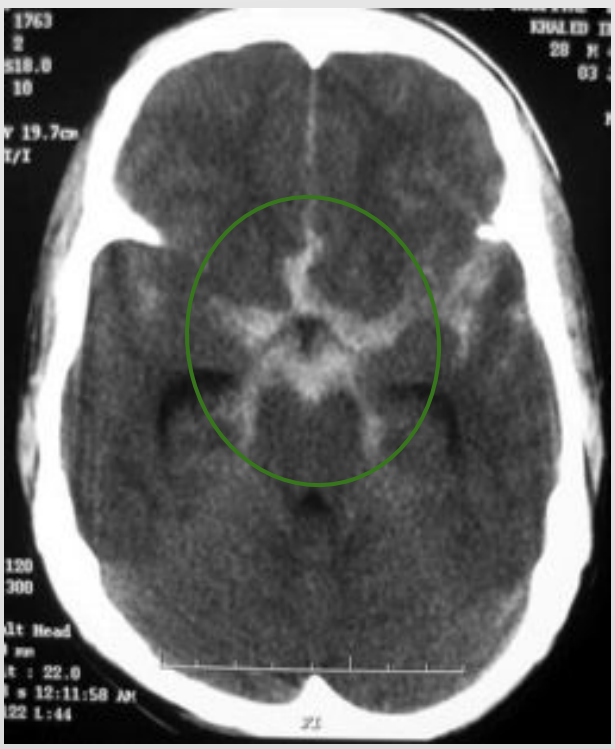
Lentiform shape.
The dura is connected with the sutures;so it's bounded by the sutures (the blood cannot pass or extend * عالق بين السيوتشرز*)

Intracranial Hemorrhage

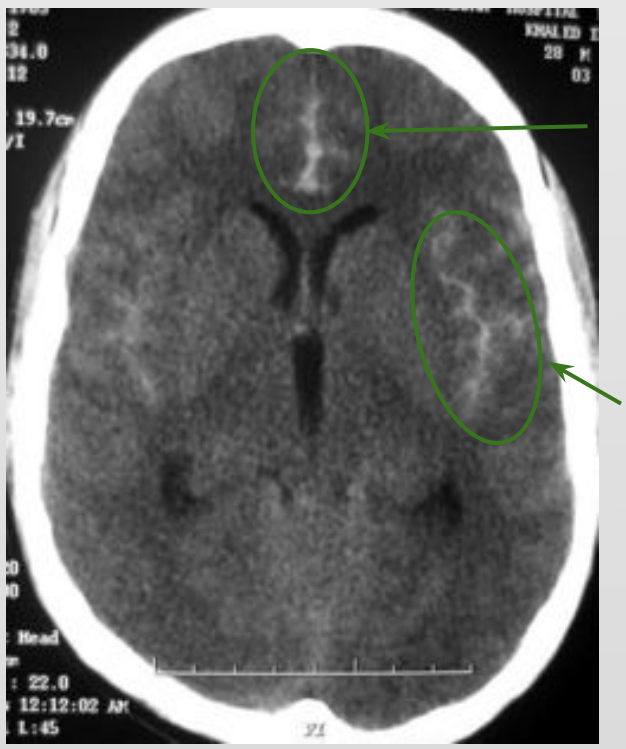
Subarachnoid hemorrhage:

- Collects between the arachnoid and pia
- SAH takes the shape of the sulci.
- Trauma is the most common cause of subarachnoid hemorrhage (SAH).
- Aneurysm rupture is the most common cause of non-traumatic SAH (The location of the bleeding can give you a host where the aneurysm is).
- No cause of SAH is seen in up to 20% of cases.
- **Clinically**, non-traumatic SAH presents with **thunderclap headache (patient describe it as worst headache of his life)** and **meningismus**.
- Patient presenting with Severe headache and neck stiffness: you should suspect SAH

The bleeding On the surface of the brain followed the sulci



Star of death sign: Most people with this sign die
SAH that fills the basal, ambient and interpeduncular cisterns
blood in the CSF



SAH filling inter hemispheric fissure

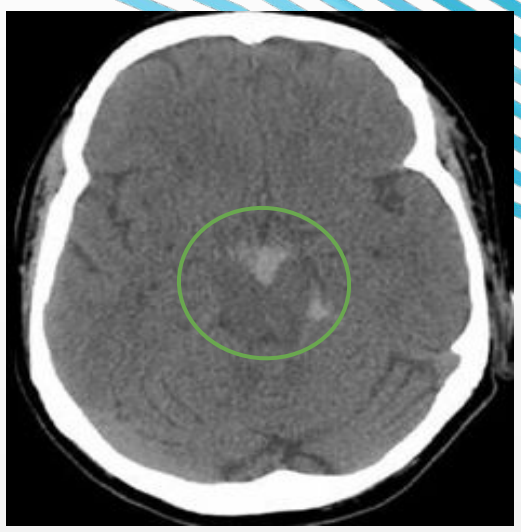
SAH filling sylvian fissure

SAH follows the contour of the brain

Intracranial Hemorrhage

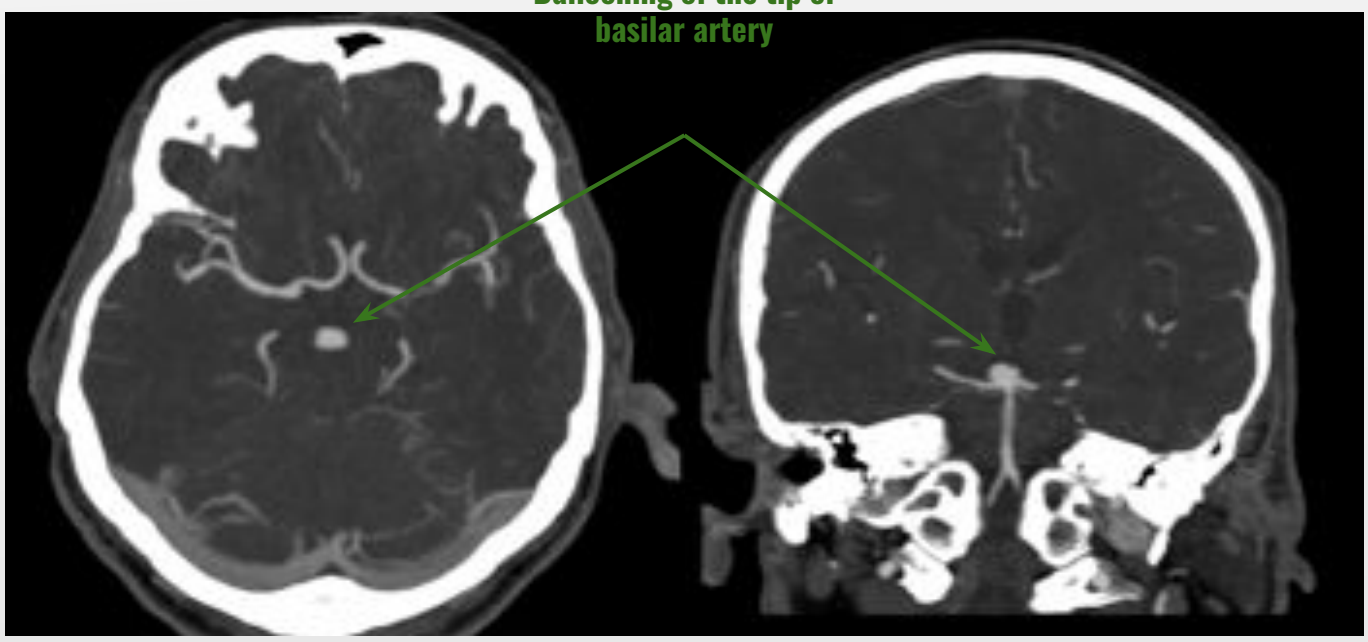
Aneurysmal SAH

Basilar tip aneurysm (5% of aneurysms)



- Blood collected in interpeduncular cistern extending to ambient cistern on the left side.
- In case of posterior SAH you should suspect basilar artery aneurysm.

Ballooning of the tip of basilar artery

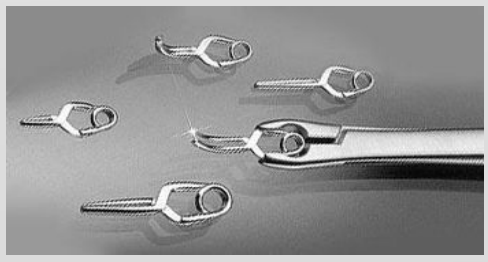


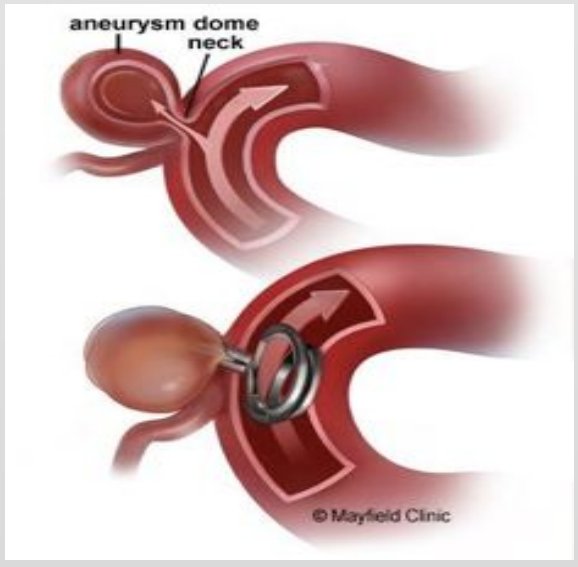
CTA of basilar tip aneurysm

Surgical Treatment of intracranial aneurysms

Surgical Clipping

They do craniotomy and open the skull and clip the neck of the aneurysm and prevent blood flow into the aneurysm which if continued might stretch the aneurysm and increase risk of bleeding.





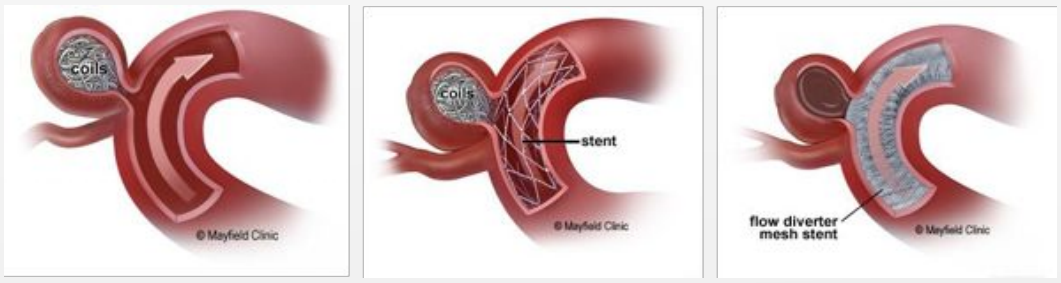
Intracranial Hemorrhage

Endovascular Treatment of intracranial aneurysms

- ACA is the most common site for aneurysm
- We use Stent-assisted coiling if the neck of the aneurysm is wide, so the coils doesn't move

Done by catheter/cerebral angiogram as it can be used for both treatment and diagnosis

We use stent assisted coiling instead of regular coling if the neck of the aneurysm is wide to prevent the coils from falling back into the artery

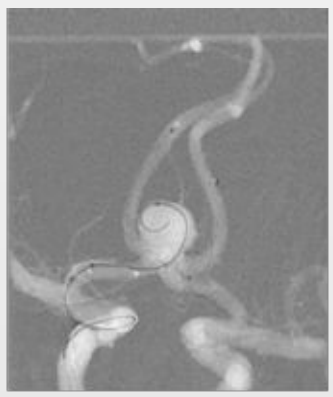


Anterior communicating artery aneurysm if it ruptures it will cause bleeding in the interhemispheric fissure

Coiling

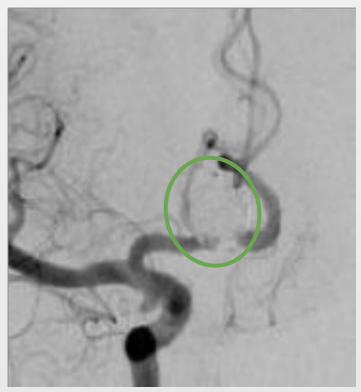
Before

Stent-assisted coiling



During coiling

Flow diverter stenting



After
Aneurysm lumen is completely occluded and not opacified anymore

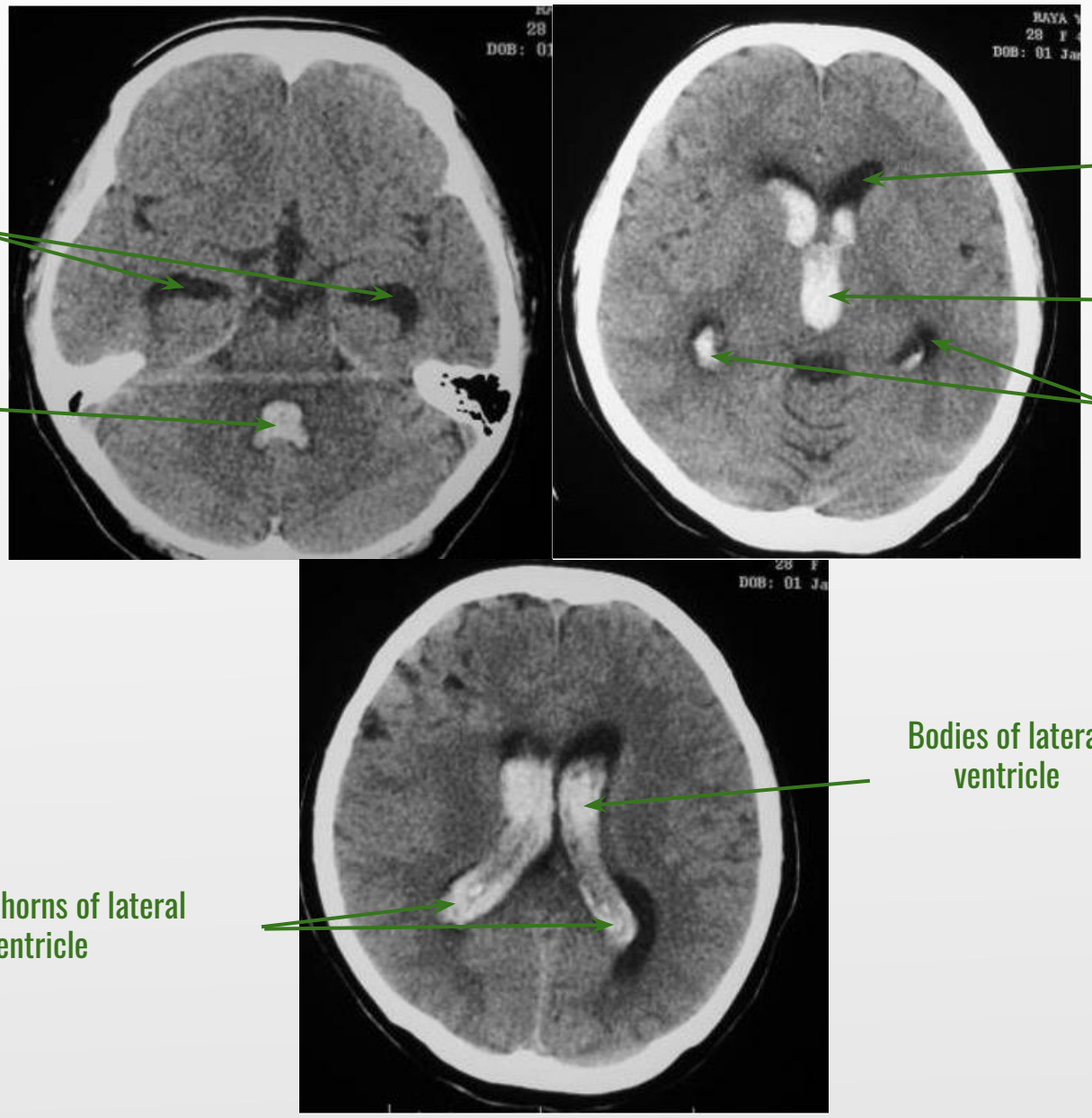
Intraventricular hemorrhage

- Most commonly traumatic
- Can be Primary:
  - Hypertension.
  - AV malformations, If it is adjacent to the ventricle.
  - Anticoagulation.
  - Intraventricular tumor.
- Or Secondary:
  - Intraparenchymal.
  - SAH.

Secondary large intraparenchymal hemorrhage that dissected into the ventricle

Intracranial Hemorrhage

Intraventricular hemorrhage



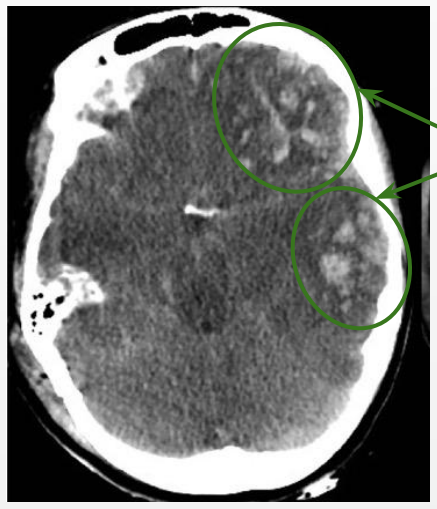
Parenchymal hemorrhage

- Can be caused by trauma, usually hemorrhagic contusions and associated with EDH, SDH also skull fractures.
- Other causes include:
  - Hypertension, most commonly causes hemorrhage in the basal ganglia specifically lentiform nucleus, could also affect the thalamus and cerebellum.
  - AV malformations, depends on its location and could be anywhere .
  - Cerebral amyloid angiopathy, usually the patient is 60+ and have cerebral hemispheric/peripheral bleeding mostly micro bleeds which cannot be detected on CT. So if a patient presents with large hemispheric bleed and you suspect amyloid angiopathy you need to do MRI with susceptibility weighted image.

Intracranial Hemorrhage

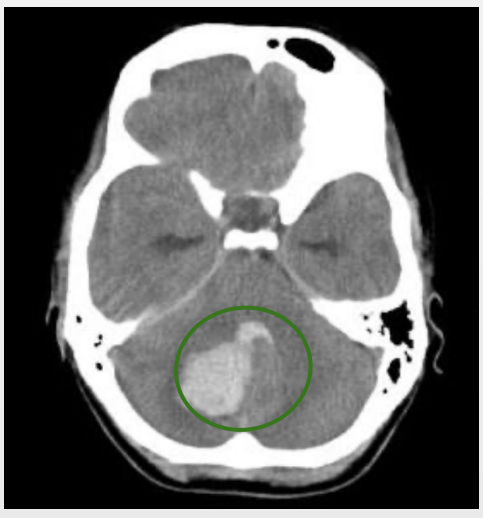
Parenchymal hemorrhage

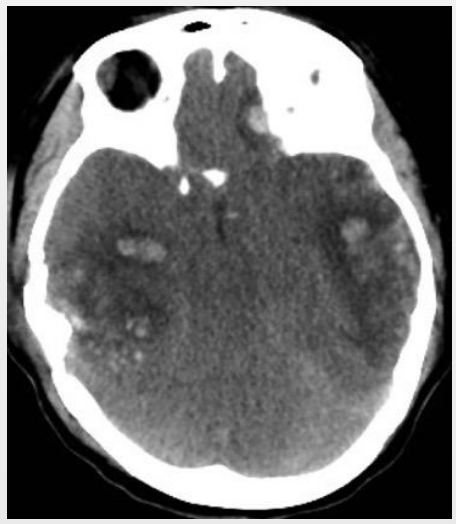
Hemispheric bleeding, example of cerebral amyloid angiopathy



Hemorrhagic contusions

Patient with history of HTN, cerebellar hemorrhage dissecting into the ventricle causing secondary intraventricular hemorrhage

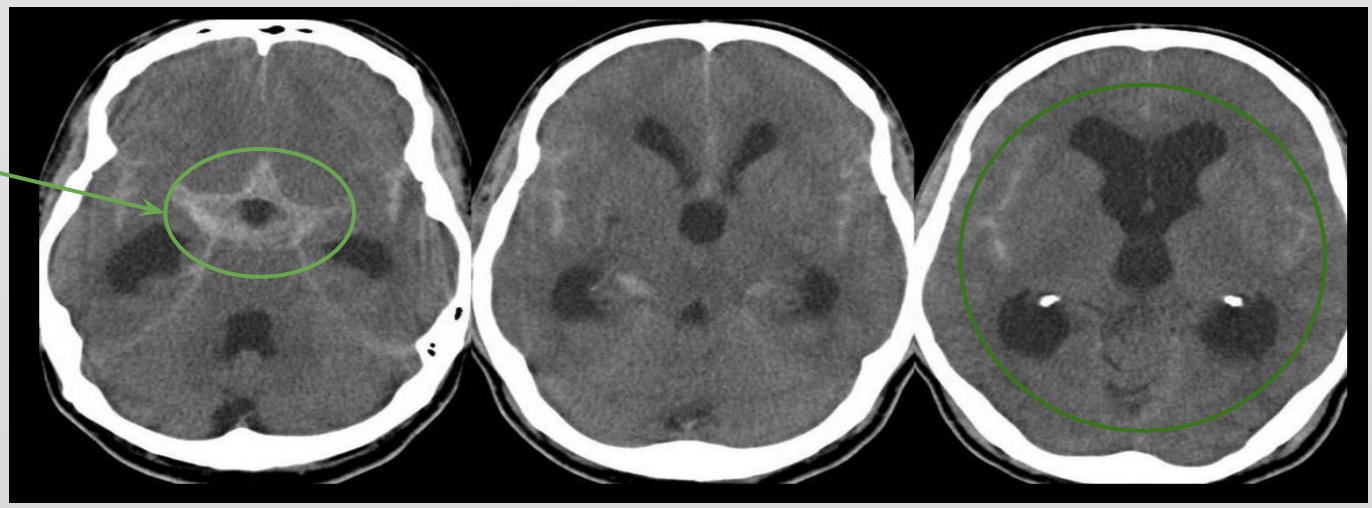




Intracranial hemorrhage

- Complication:
  - Acute hydrocephalus due to the limitations of the resorption of CSF.
  - The most sensitive part to assess acute hydrocephalus are the temporal horns of lateral ventricle as they're the first to be affected.

Normally filled with CSF but here filled with Blood



If the ventricles are surrounded by low density or dark areas you should raise the possibility of acute hydrocephalus

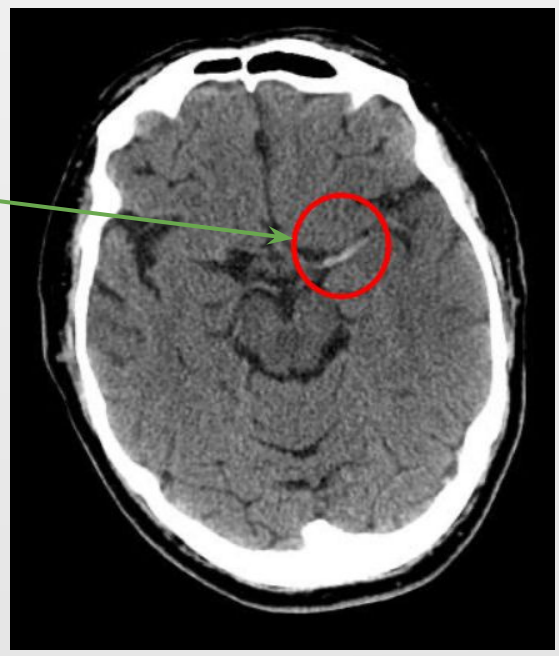
Brain ischemia

Ischemic stroke

- What will you see on head CT **immediately** after an ischemic stroke?
    - Normal head CT That's why we need to do multiple diffusion weighted MRI to see if there's stroke or not.

- What will you see on head CT in the **HYPERACUTE** phase?
    - Hyperdense sign indicates the clot within the vessel and it's one of the earliest signs.

Left MCA occlusion



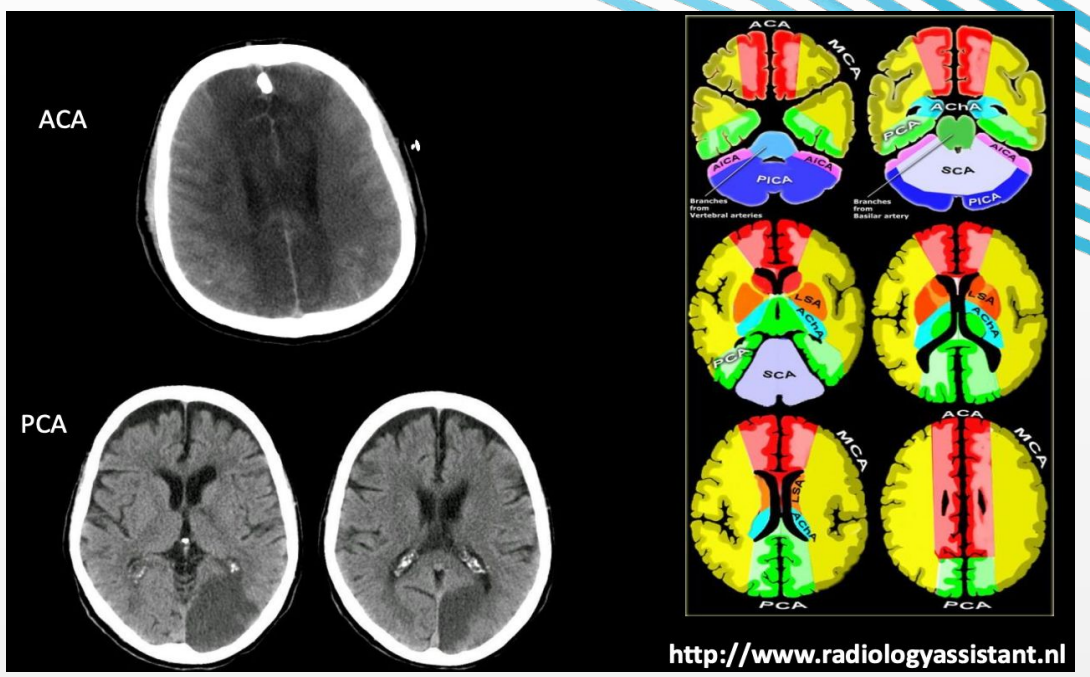
After several hours

- Middle cerebral artery infarct
- Hazy dark area with ill definition of white and grey matter
- Early infarct along the distribution of MCA

Brain ischemia

Ischemia

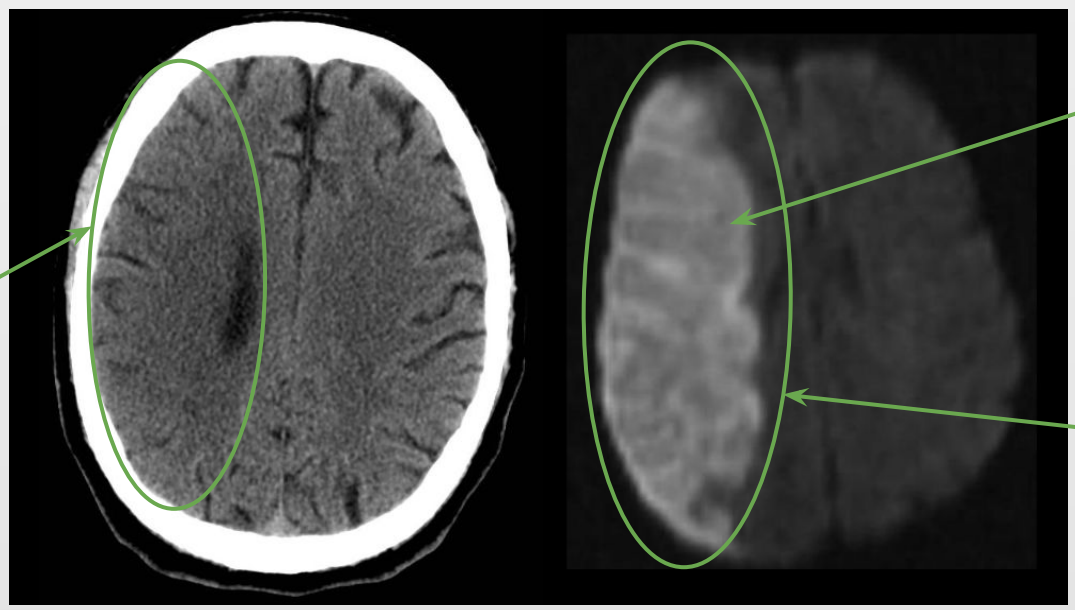
- **ACA infarct**: usually para-Sagittal midline hypodensity.
- **PCA infarct:** usually affect occipital lobe.
- **ACA:** supply medial, para-Sagittal part of frontal and parietal lobes.
- **MCA:** supply lateral part of frontal and temporal lobes.
- **PCA:** supply posterior temporal, parietal and occipital lobes as well as posterior thalami.



Where is the stroke?

There's some hypodensity but locating the stroke is difficult on CT

Here we can't differentiate between grey and white matter (the side of the stroke)



This patient had right MCA infarct

Large area of diffusion restriction in the right cerebral hemisphere

CT

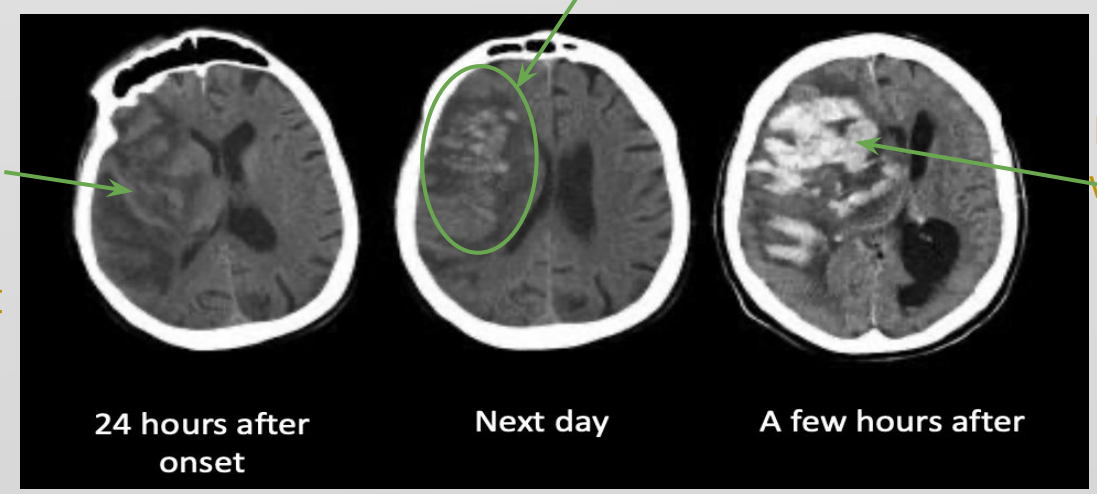
MRI (Diffusion weighted image)

Complications

- Hemorrhagic transformation

Some hyperdense dots indicating hemorrhagic transformation

Patient had massive infarct in right MCA and there's hypodensity in the MCA territory on the right side
There's edema and midline shift
Also mass effect on the lateral ventricle



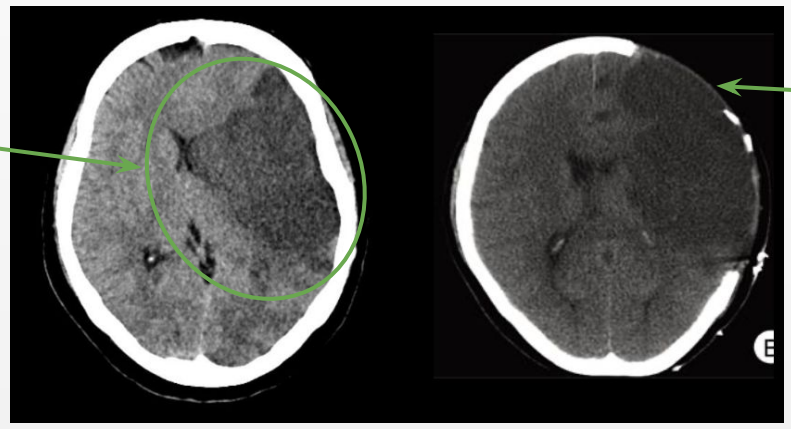
Massive bleeding with midline shift and herniation

Brain ischemia

Complications cont..

- Malignant stroke

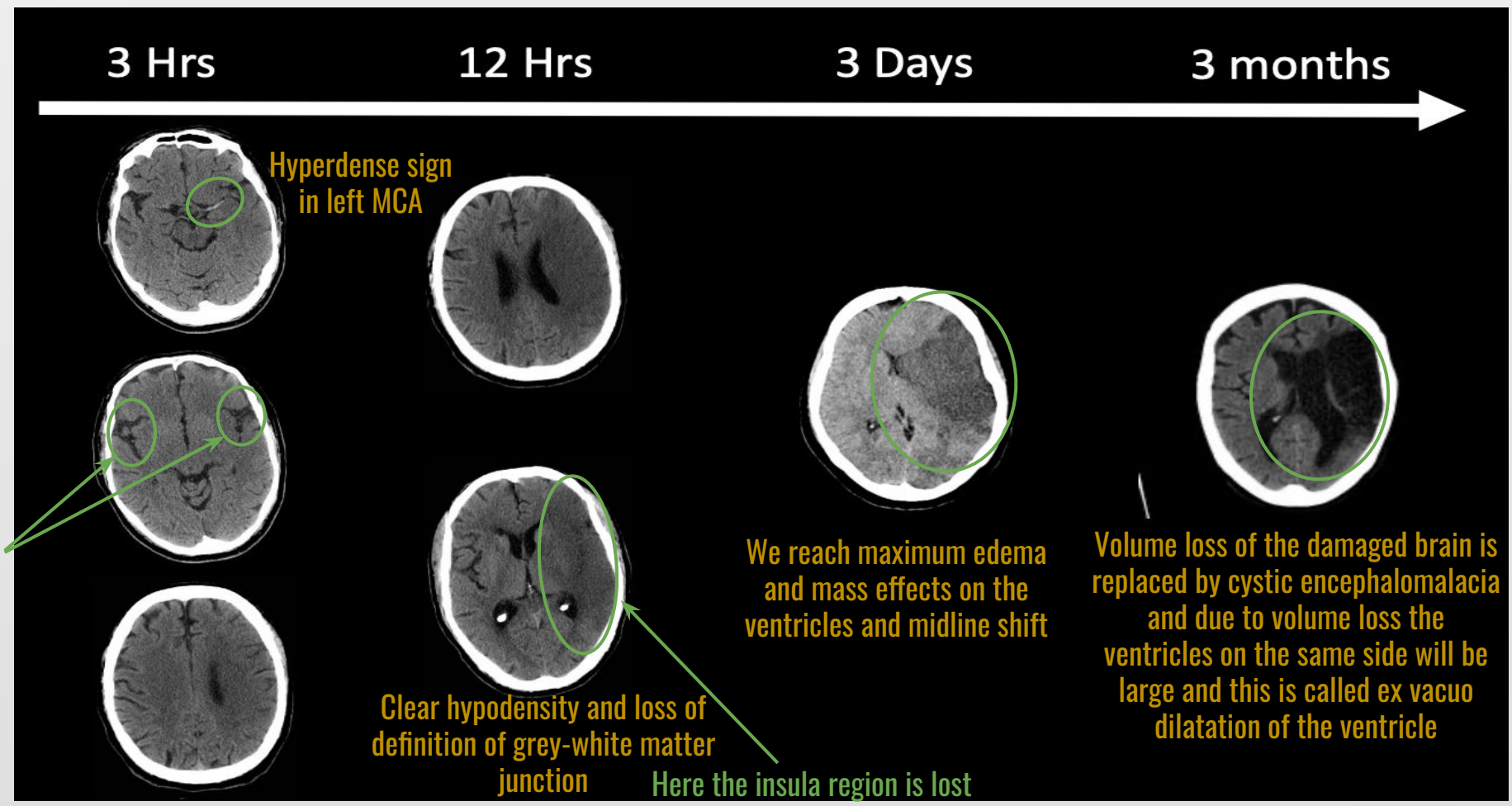
Hypodensity in MCA territory and loss of grey-white matter junction
There's mass effect and midline shift



This patient underwent surgery because he has mass effect and midline shift indicating risk of increased ICP
During surgery the bone was removed to create some space and the brain came out of the confinement of the skull

MCA infarct

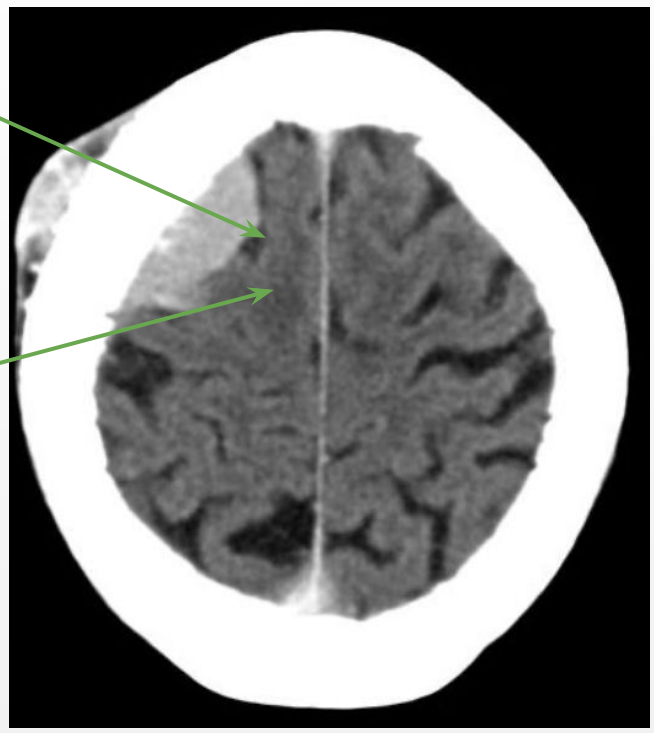
Decompressive craniectomy

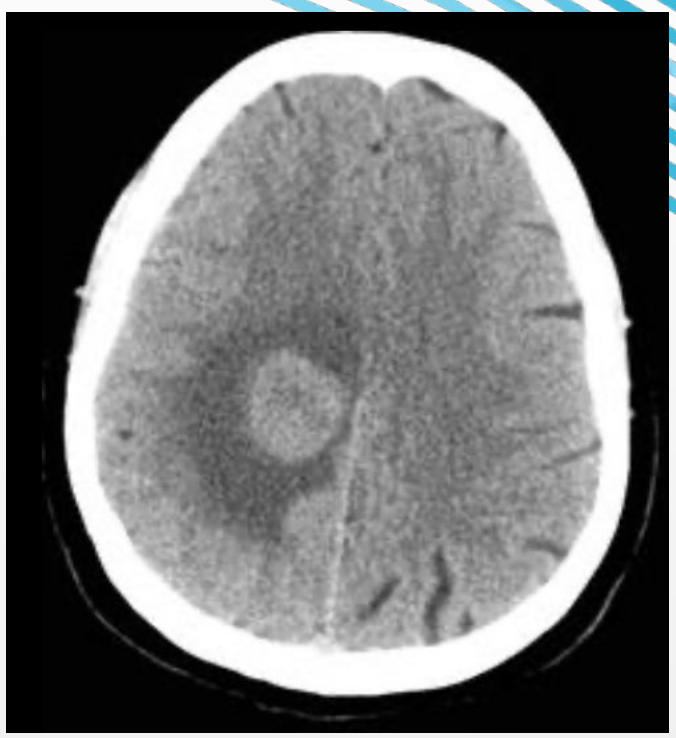


Intracranial tumors

Cleft of CSF

Buckling of grey-white matter junction as it become shifted inward because the lesion is located outside the brain parenchyma





Extra-axial: outside the brain parenchyma, underneath the bone immediately and there's a cleft of CSF between the lesion and the brain parenchyma

Intra -axial: within the brain parenchyma and we don't see any cleft of CSF

Extra-axial masses

VS

Intra-axial masses

- Meningioma, most common tumor.
- Cranial nerve schwannoma, commonly occurring in the posterior fossa, vestibular Schwannoma of the 8th cranial nerve is located in internal auditory canal.
- Metastasis.

- Metastasis, most commonly in the grey-white matter junction and if they're multiple you should suspect metastasis. Characteristics: lesions are small with massive surrounding edema, edema is out of proportion to the size of the lesion, enhancement pattern is variable (can be solid enhancement or complete peripheral enhancement)
- Glioblastoma, WHO grade 4 brain tumor
- Astrocytoma, can be grade 1,2 or 3

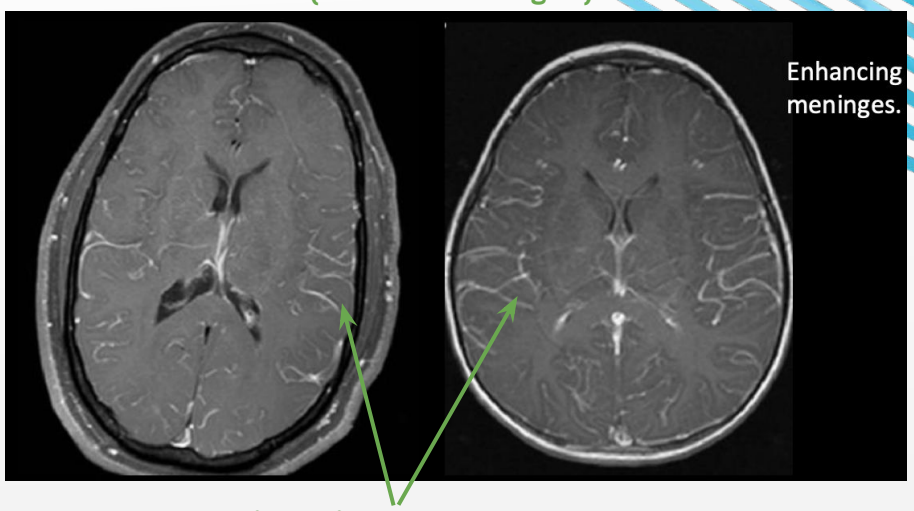
Doctor hinted that there will be a question here
(image of an intra axial mass) which of the following cannot be diagnosis?
Meningioma (or any other extra axial choice)

Intracranial infections

Bacterial meningitis

- Headache, fever and neck stiffness.
- In case of tumor and infection we need to give contrast because we usually see enhancement in these cases.
- No parenchymal abnormality.
- Many times MRI can be normal in meningitis OR you can see edema, leptomeningeal enhancement and hydrocephalus.

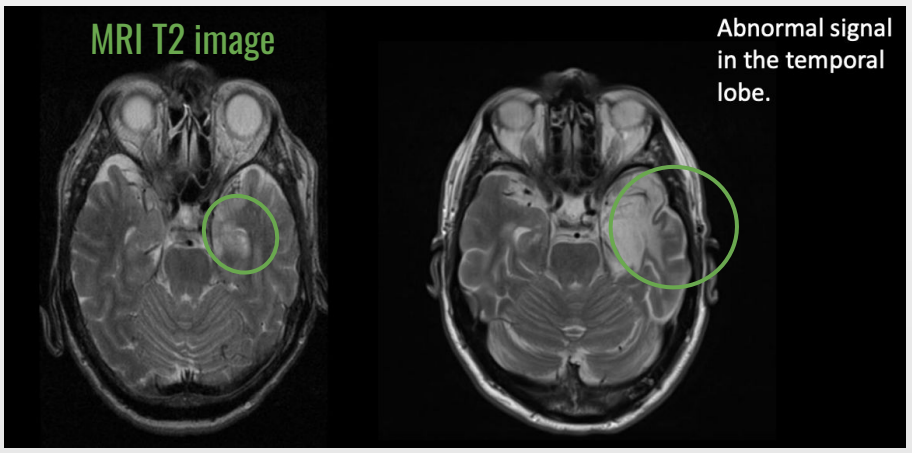
MRI T1 with contrast (vessels are bright)



These white lines are called leptomeningeal enhancement

Herpes encephalitis

- Headache, fever and decreased level of consciousness.
- If you see signal abnormality with or without associated enhancement in the temporal lobe you should raise the possibility of herpes encephalitis.
- Herpes encephalitis usually involves the temporal lobes bilaterally but the abnormality seen is usually asymmetric.



High signal intensity in the left temporal lobe mainly cortical

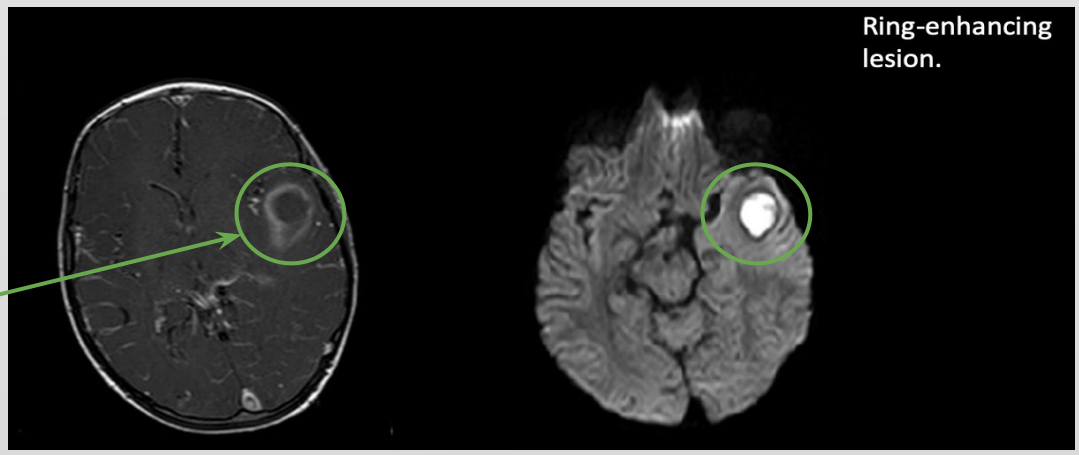
End stage of herpes encephalitis after resolution of symptoms and patient took treatment and improved now he has cystic encephalomalacia in the left temporal lobe and dilatation of temporal lobe

- Very aggressive disease. Treat as soon as you suspect it even before MRI

Brain abscess

- Headache and fever
- This history and this image indicates brain abscess

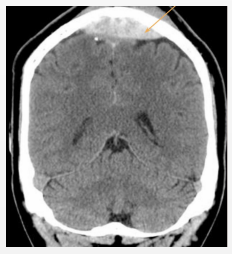
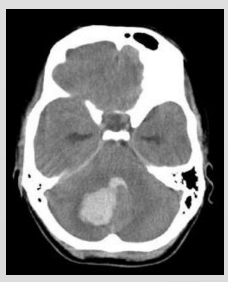
Space occupying lesion that demonstrate peripheral enhancement post contrast administration



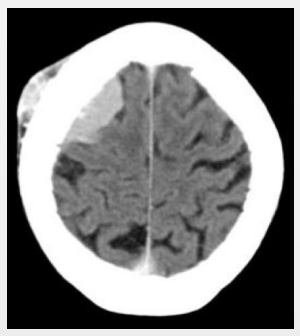
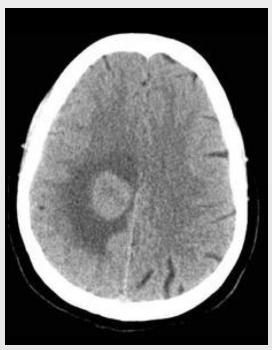
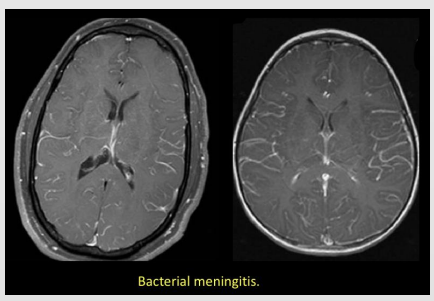
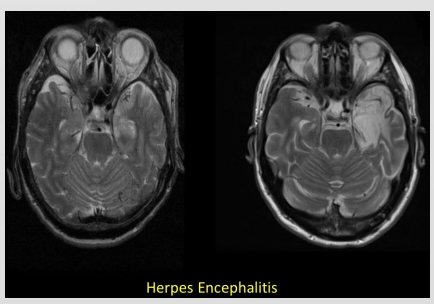
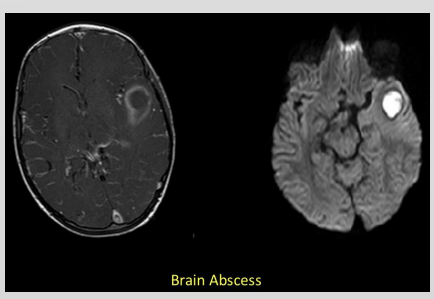
T1 with contrast

Diffusion weighted MRI: diffusion restriction

Summary

Intracranial Hemorrhage	Findings	Picture
Epidural Hematoma	●Lentiform collection between the dura and skull. ● traumatic. ● Associated with skull fracture ● Typically arterial in nature. MMA (middle meningeal artery) but could be from venous sinuses.	
Subdural Hematoma	● Crescentic collection between the dura and arachnoid. ● Usually caused by trauma. ● Typically venous in nature.	
Subarachnoid Hemorrhage	●Collects between the arachnoid and pia ● Clinically, non-traumatic SAH presents with thunderclap headache and meningismus	
Intraventricular Hemorrhage	**Primary**: • Hypertension. • AV malformations. • Anticoagulation. • Intraventricular tumor. **Secondary**: • Intraparenchymal. • SAH.	
Parenchymal Hemorrhage	• Can be caused by trauma • Other causes include: • Hypertension. • AV malformations. • Cerebral amyloid angiopathy.	

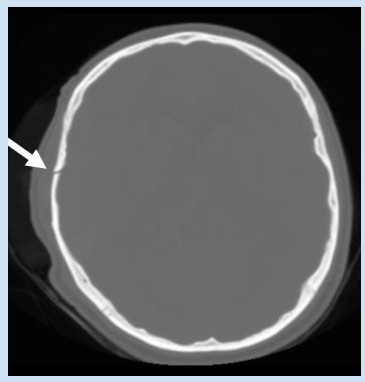
Summary

	Findings	Picture
Brain Ischemia	Ischemic Stroke: Hyperdense sign is what we will see on head CT in the HYPERACUTE phase.	
Intracranial Tumors	A-Extra-Axial masses ● Meningioma ● Cranial nerve schwannoma ● Metastasis	
	B-Intra-Axial masses ● Metastasis ● Glioblastoma ● Astrocytoma	
Intracranial Infections	**Bacterial meningitis** - **Clinically**: Headache, Fever, Neck stiffness - **Radiologically**: Enhancing meninges	
	Herpes Encephalitis - **Clinically**: Headache, Fever, Decreased level of consciousness - **Radiologically**: Abnormal signal in the temporal lobe	
	Brain Abscess - **Clinically:** Headache, Fever. - **Radiologically**: Ring-enhancing lesion.	

Quiz

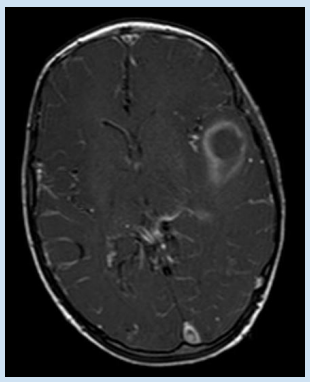
1-Regarding this Brain CT, which statement is correct?

a. Stroke window shows infarction.
b. Brain window shows fracture.
c. Bone window shows fracture.
d. Brain window shows infarction.



2- What is your diagnosis?

a. Astrocytoma
b. Glioblastoma
c. Brain Abscess
d. Parenchymal Hemorrhage



3- Which one has Crescentic collection between the dura and arachnoid?

a. Acute SDH
b. Acute EDH
c. Acute SAH
d. Acute IVH

4- Non-traumatic that presents with thunderclap headache and meningismus

a. Acute SDH
b. Acute EDH
c. Acute SAH
d. Acute IVH

5- In Ischemic Stroke what you will see on head CT in the hyperacute phase?

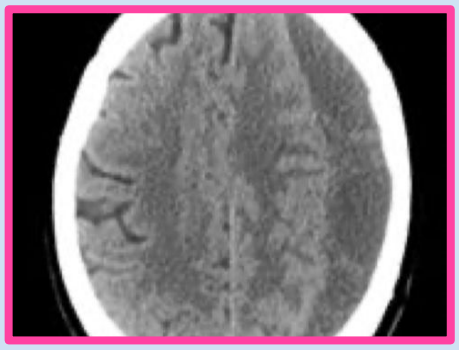
a. Hummingbird sign
b. Hyperdense sign
c. Pulvinar sign
d. cystic encephalomalacia

6- what Complication you will see in Ischemic Stroke?

a. Enhancing meninges
b. Hemorrhagic transformation
c. Ring-enhancing lesion
d. All

7) Q30: A 50-year-old man was found unconscious in a street and was brought to the ED. A head CT was done. What does it show?

a. Subdural hematoma
b. Epidural hematoma
c. Brain edema
d. Subarachnoid hemorrhage



Answers
1) c
2) c
3) a
4) c
5) b
6) b
7)A

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- Bandar Alharbi

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- Sara Alrashidi
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- Ibrahim Alabdulkarim
- Mohamed Albabtain
- Abdulaziz Alamri
- Abdulrahman Alswat
- Munib Alkhateb
- Mohammed Alkathiri
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