



**Radiology**  
Team 438

# Radiology of Brain diseases

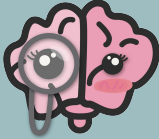
## Lecture 23

### Objectives

#### Learn about:

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

Reviewed By



Noura Alturki  
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Color Index:

♦ Important

♦ Doctor's Notes

♦ Extra

♦ Female slides

♦ male slides

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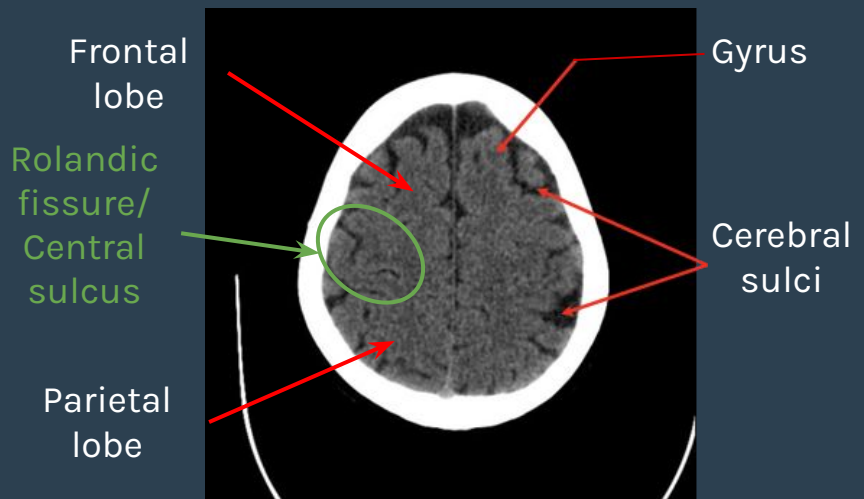
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### Notes by:

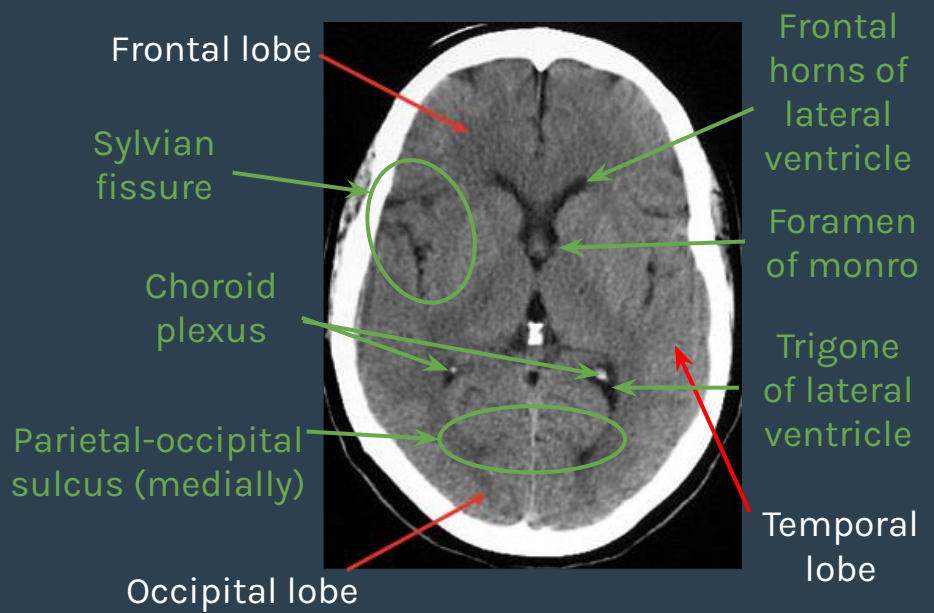
Amirah AlZahrani

## » Anatomy

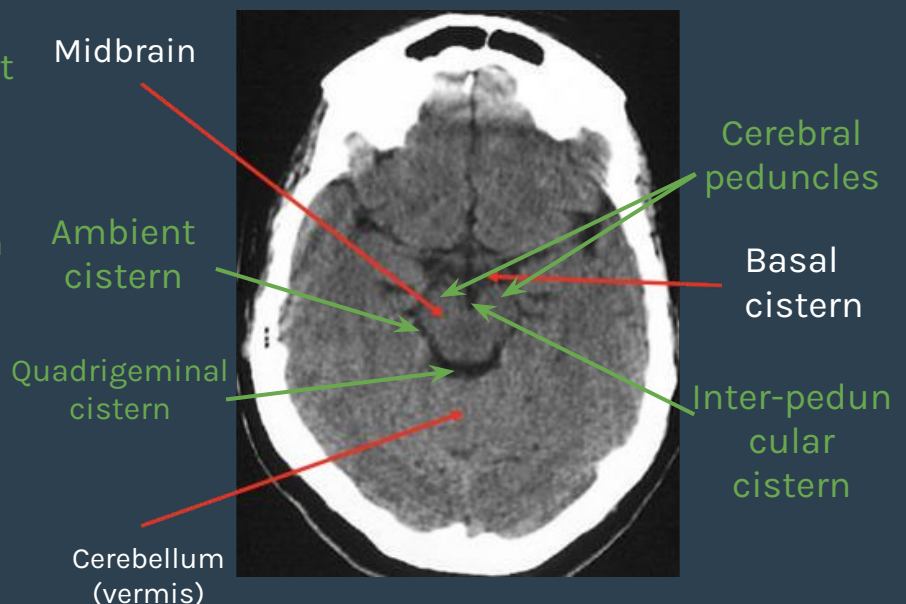
- **Rolandic fissure:** the demarcation between parietal and frontal lobes.
- **Gyrus:** has same density as the brain.
- **Cerebral sulci:** part of the extra-axial spaces and they're filled with CSF appears dark on CT.



- 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.



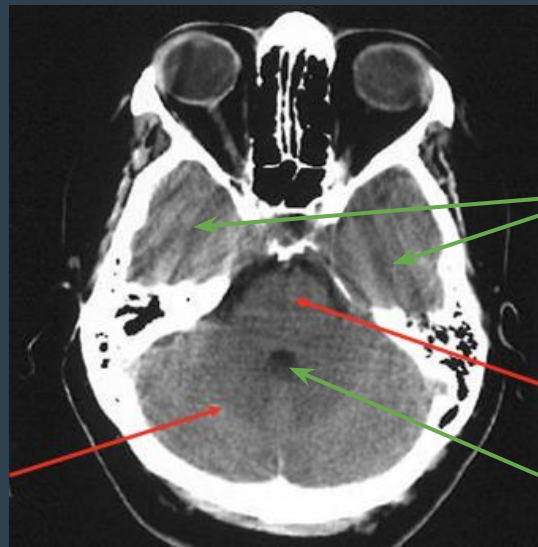
# Normal brain imaging

## » Anatomy

### Cerebellum:

- Laterally: cerebellar hemispheres
- Centrally: vermis

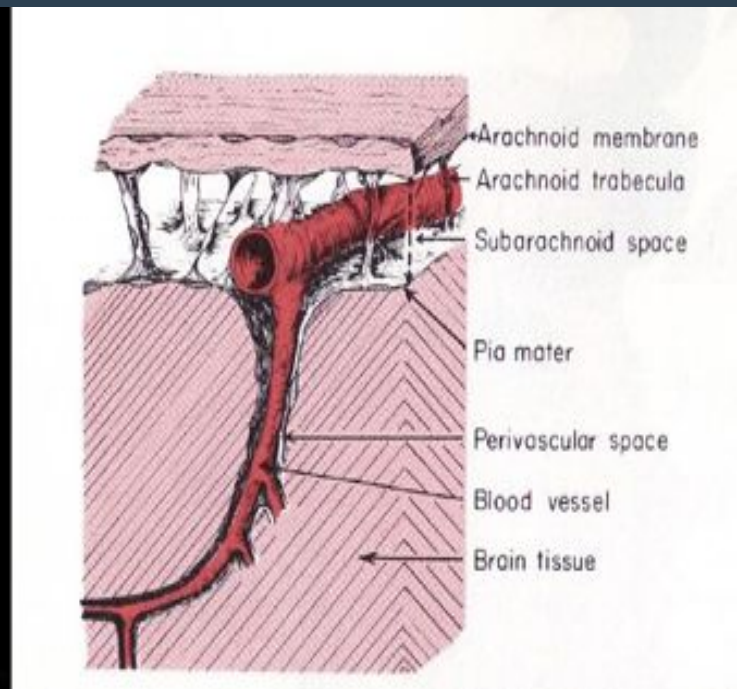
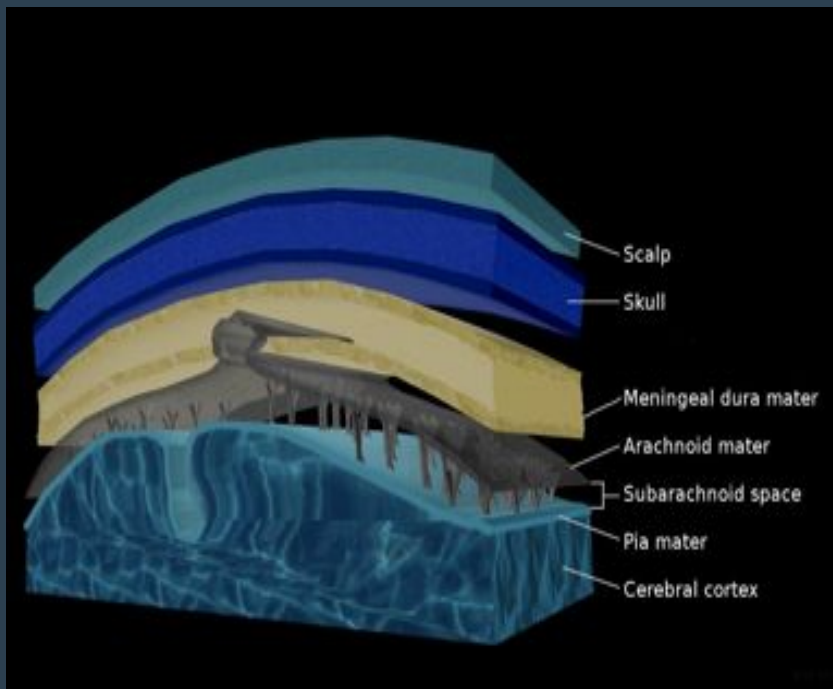
Right Cerebellum



Temporal lobes

Pons (middle part of midbrain)

4th ventricle



- **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

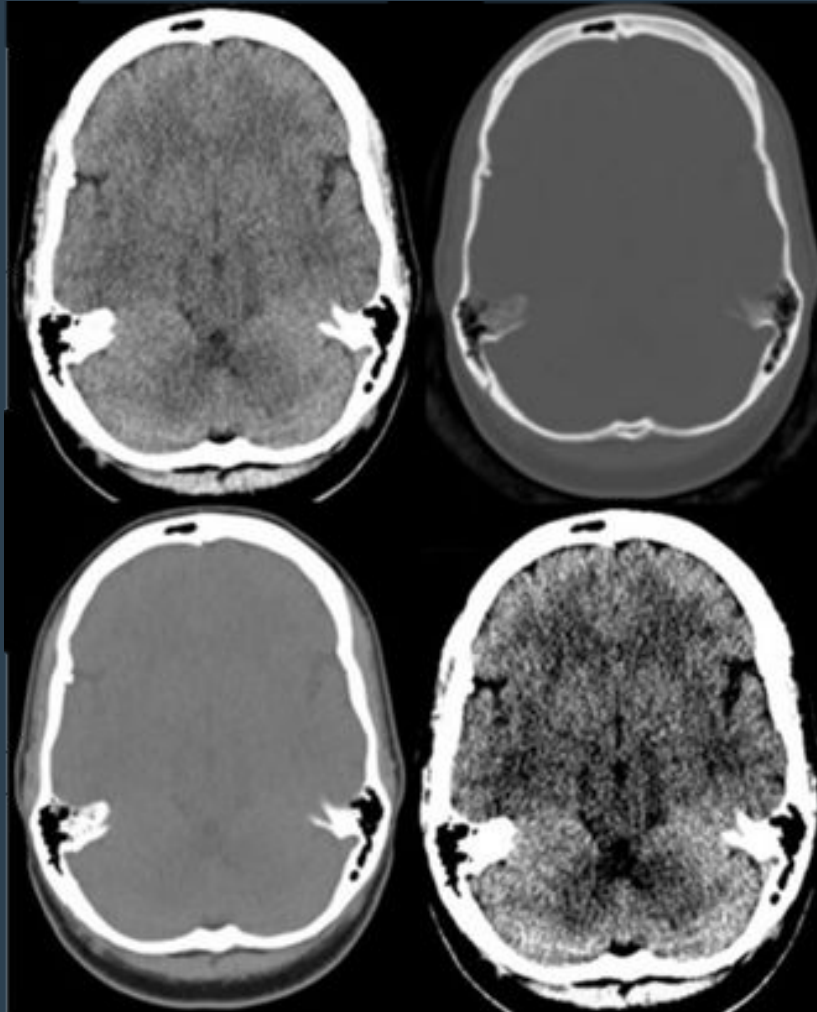
## » Windowing

**Brain window**  
(W 80, L 40)

Doesn't show details anatomy of the bone

**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

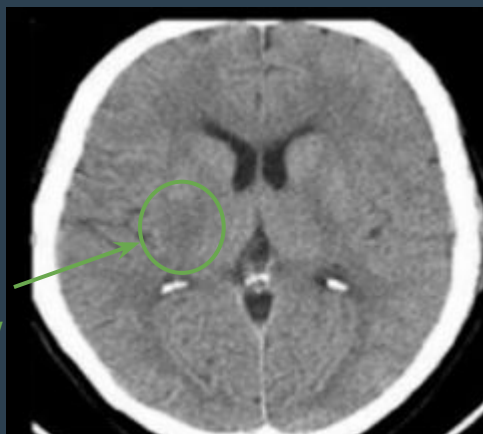


**Bone window**  
(W 3000, L 500)

Shows details of the bone anatomy but brain parenchyma won't be clear

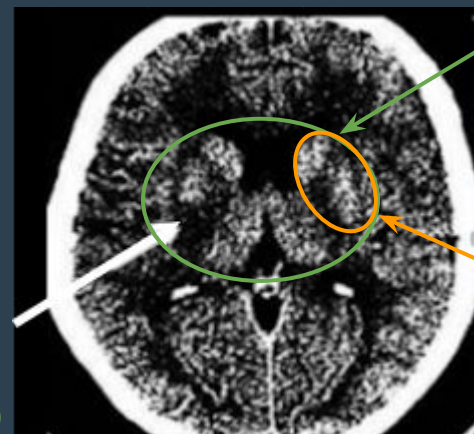
**Stroke window**  
(W 40, L 40)

Shows dramatic difference between white and grey matter and this helps in identifying areas of hypodensity and lesions



Very subtle hypodensity

**Brain window**



Infract  
(Focal hypodensity)

Basal ganglia

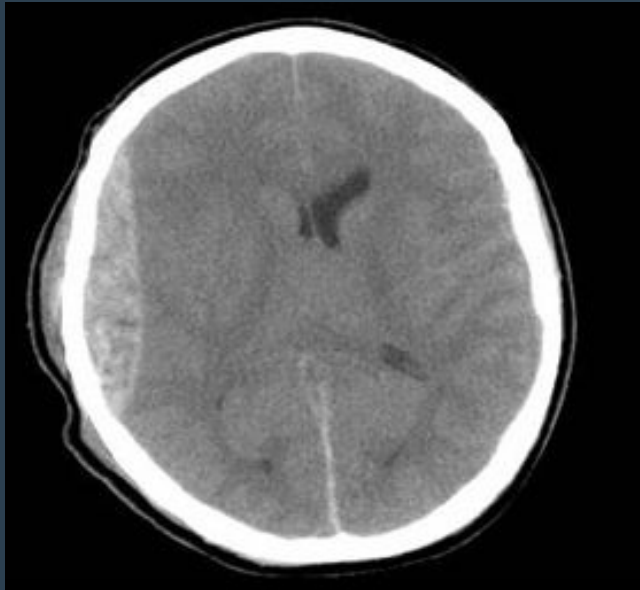
Lentiform nucleus

**Stroke window**



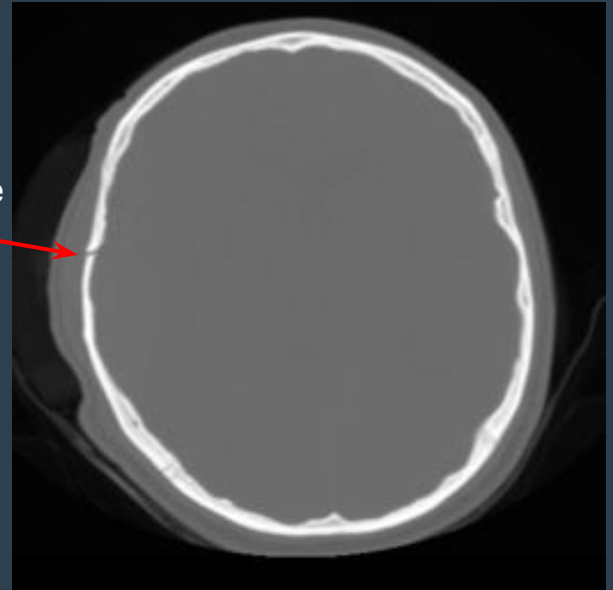
## » Windowing

Brain window



Bone window

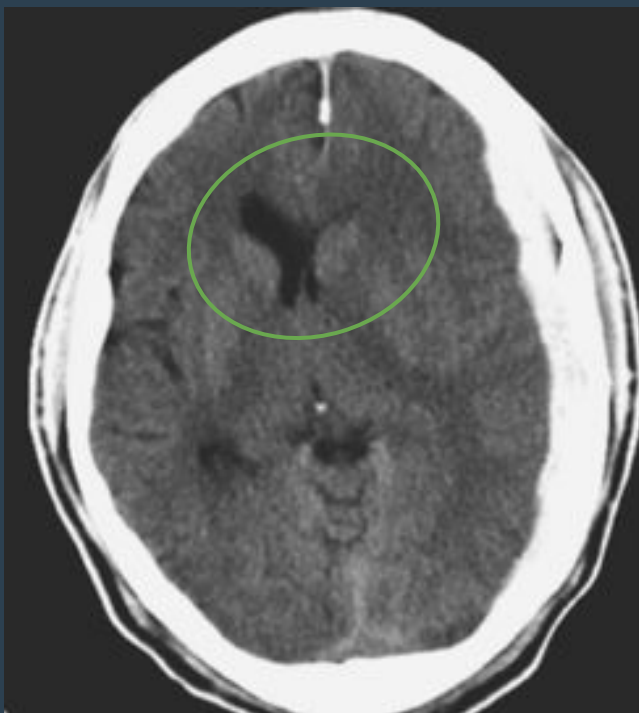
Fracture



### Acute epidural hemorrhage

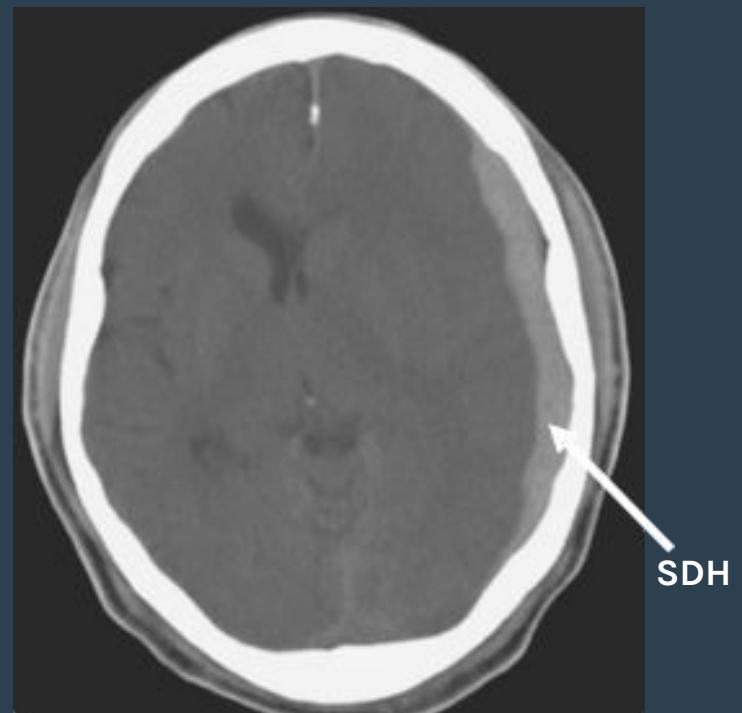
Patient will have acute history of trauma.  
Commonly associated with fracture.

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

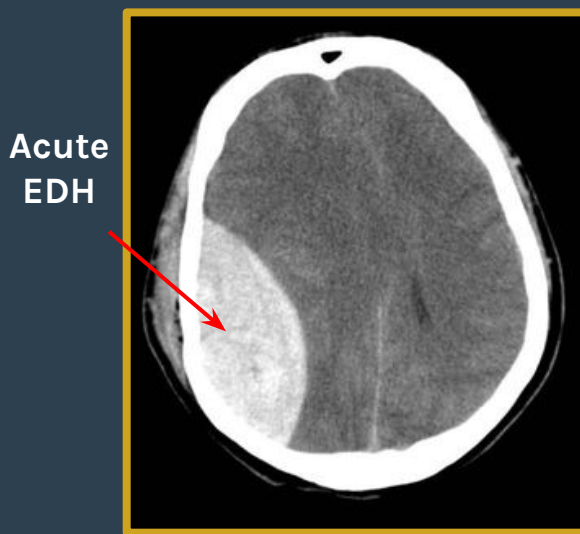
Subdural / soft tissue window



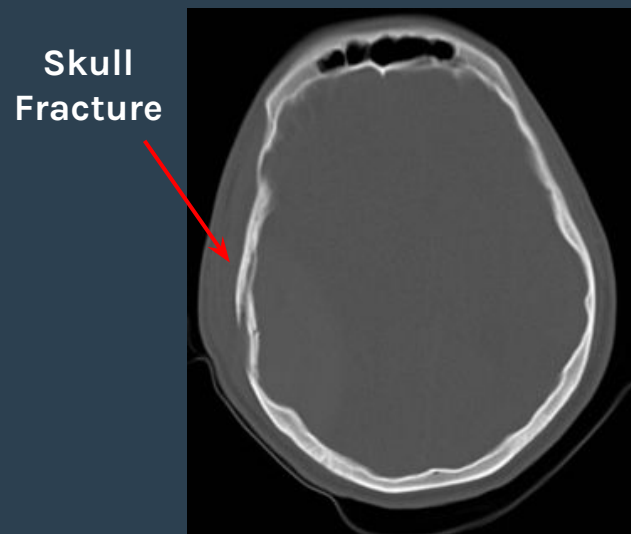
Very clear difference between the bone and the hemorrhage

## » Epidural hematoma:

- **Lentiform (Biconvex)** (زبي 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.
- ★ It **doesn't crosses sutures** but crosses midline.



Brain window: soft tissue thickening and injury

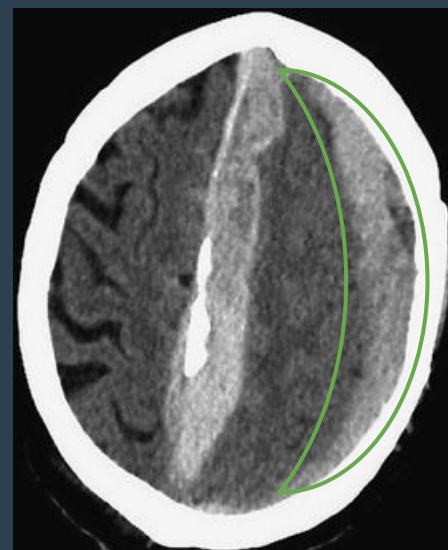


Bone window: comminuted fracture in parietal and temporal bones

# Intracranial Hemorrhage

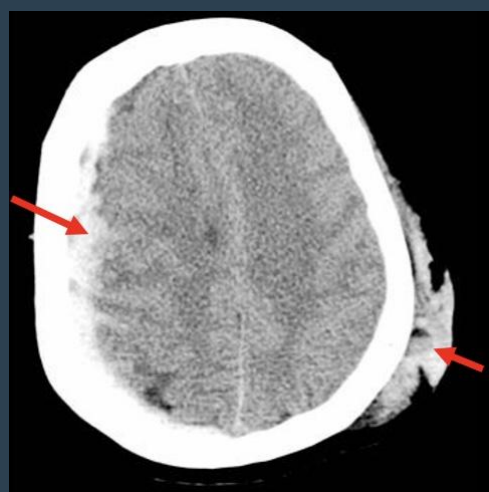
## Subdural hematoma:

- **Crescentic** (زبي 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.
- Typically venous in nature.
- **It does not cross midline** but they can go along the dural reflection.



Acute SDH

Subdural hematoma

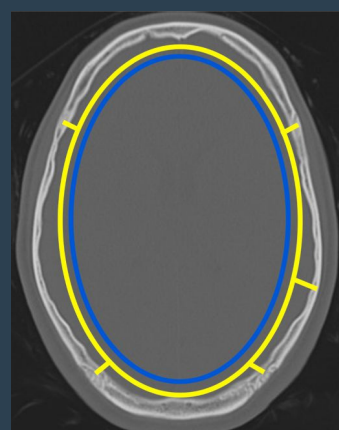
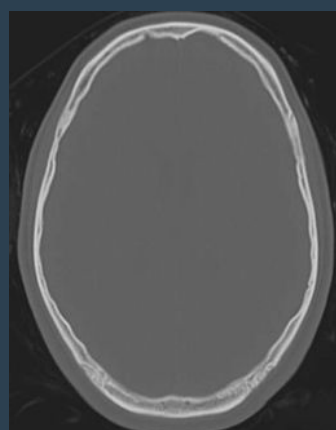


Soft tissue swelling

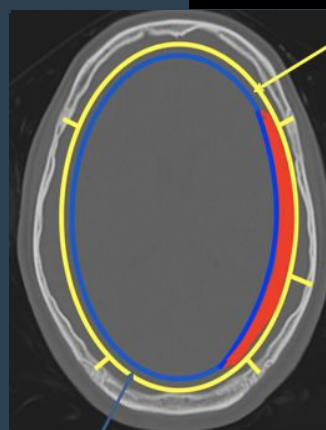


SDH

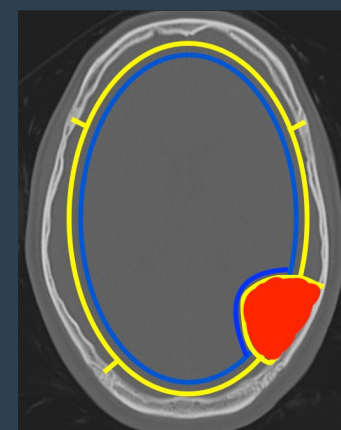
## SDH vs EDH



**DURA**  
Arachnoid



**DURA**  
SDH  
Crescent shape



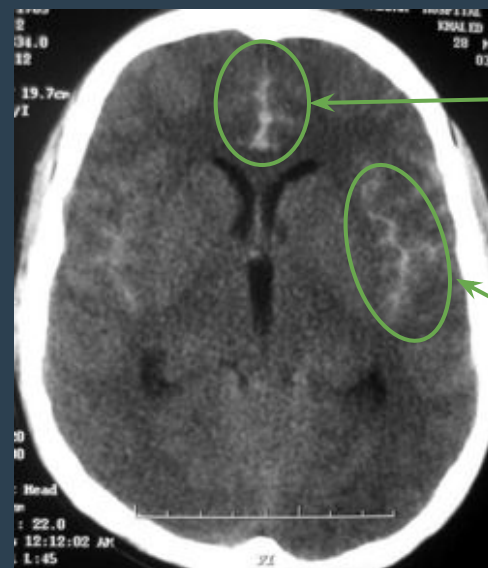
**EDH**  
Lentiform shape.  
The dura is connected with the sutures; that's why we see EDH as Biconvex

## » 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



SAH that fills the basal, ambient and interpeduncular cisterns



SAH filling interhemispheric fissure

SAH filling sylvian fissure

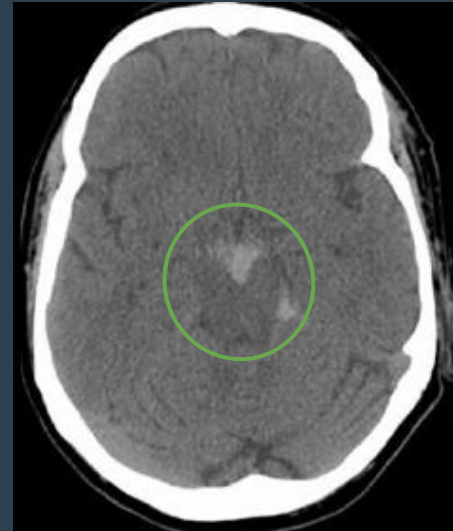
SAH follows the contour of the brain



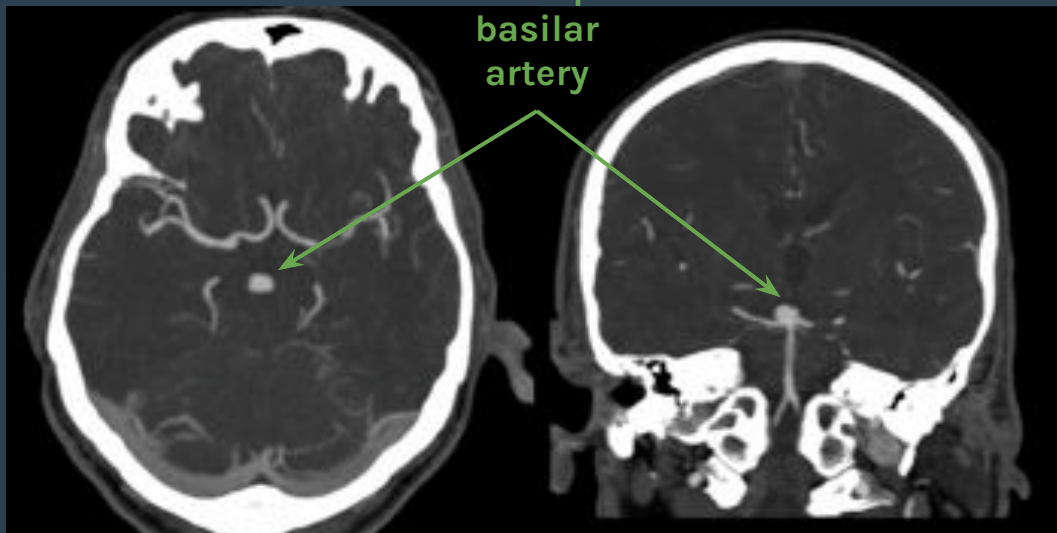
## » Aneurysmal SAH

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

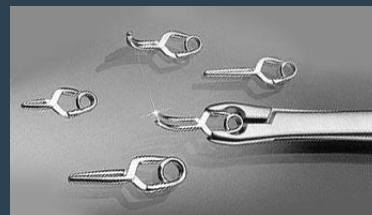


CTA of basilar tip aneurysm

## » 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.



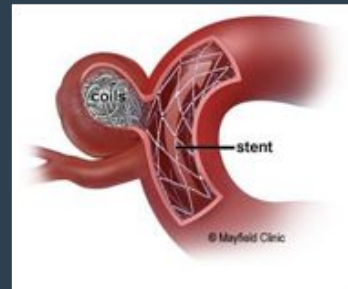
## Endovascular Treatment of intracranial aneurysms

- 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

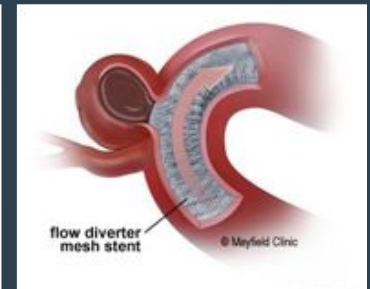
Done by catheter/cerebral angiogram as it can be used for both treatment and diagnosis



Coiling

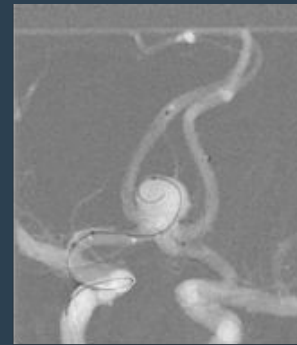
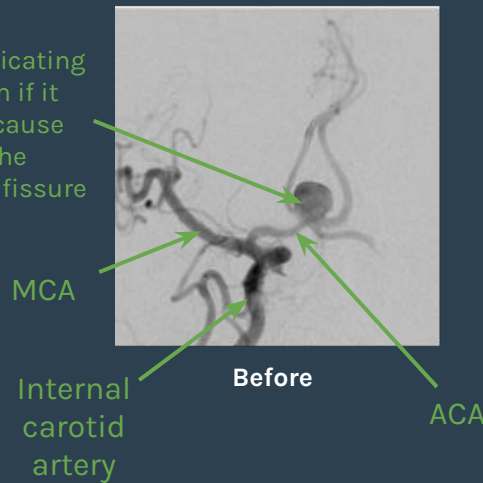


Stent-assisted coiling



Flow diverter stenting

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



Aneurysm lumen is completely occluded and not opacified anymore

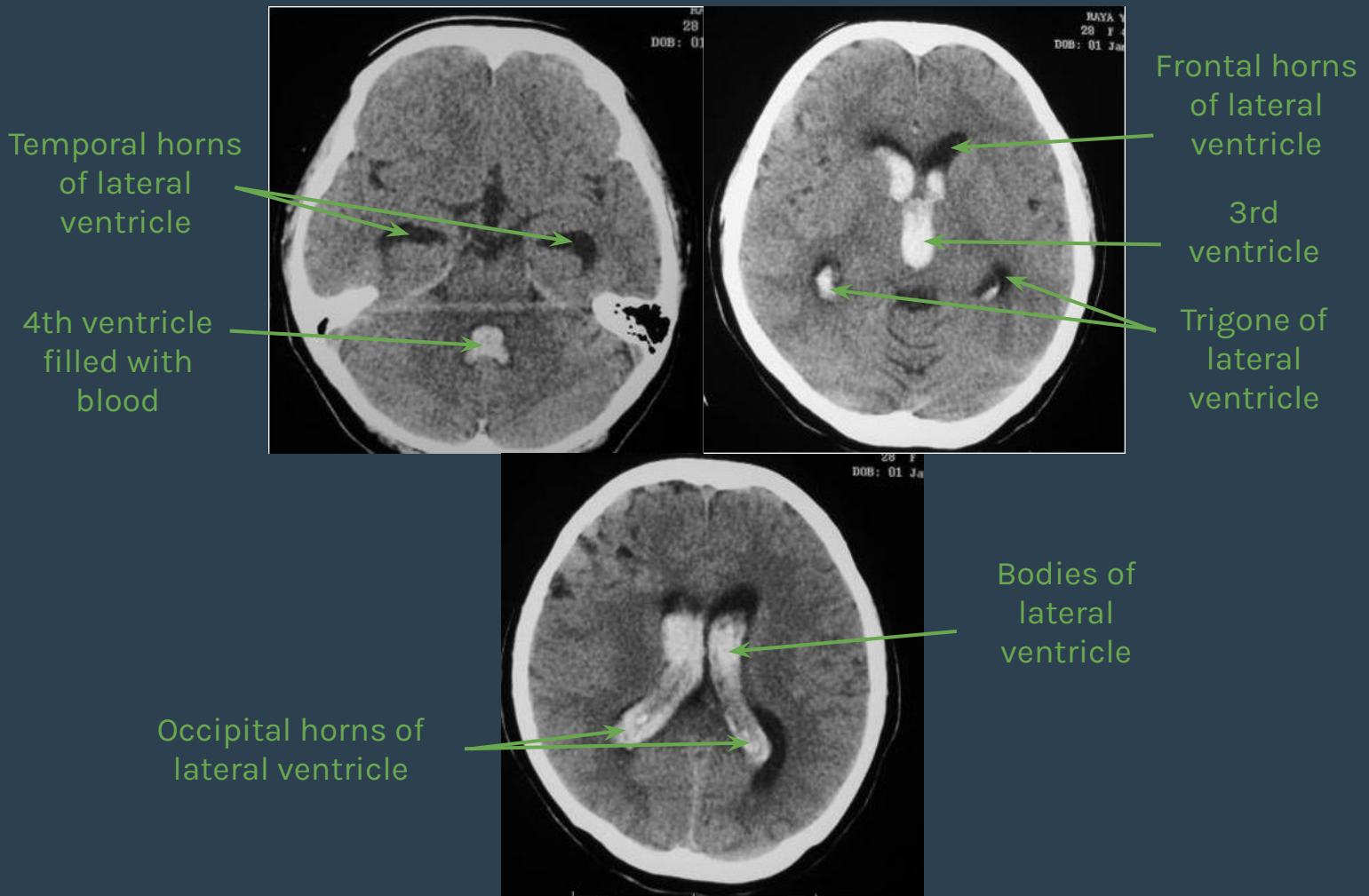
## Intraventricular hemorrhage

- 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

## » 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.

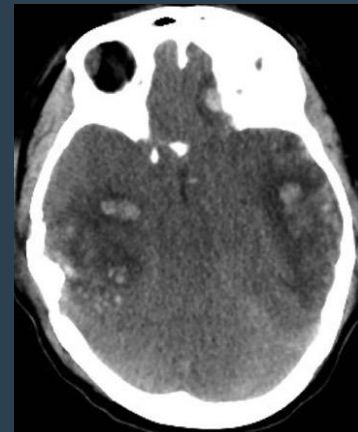
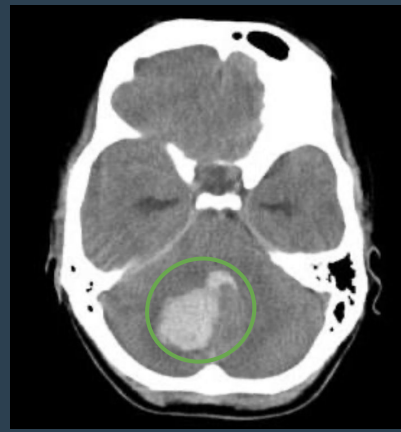
## » Parenchymal hemorrhage

Hemispheric bleeding, example of cerebral amyloid angiopathy



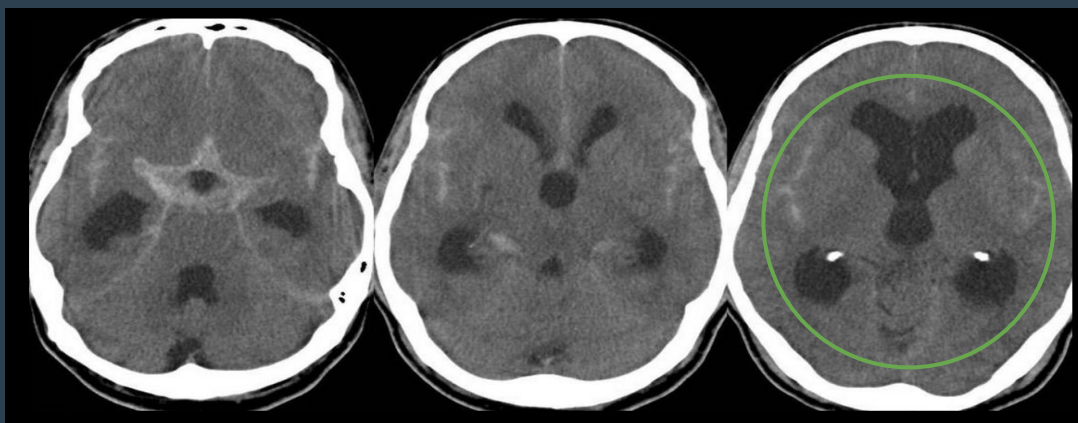
Hemorrhagic contusions

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.



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



## » 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



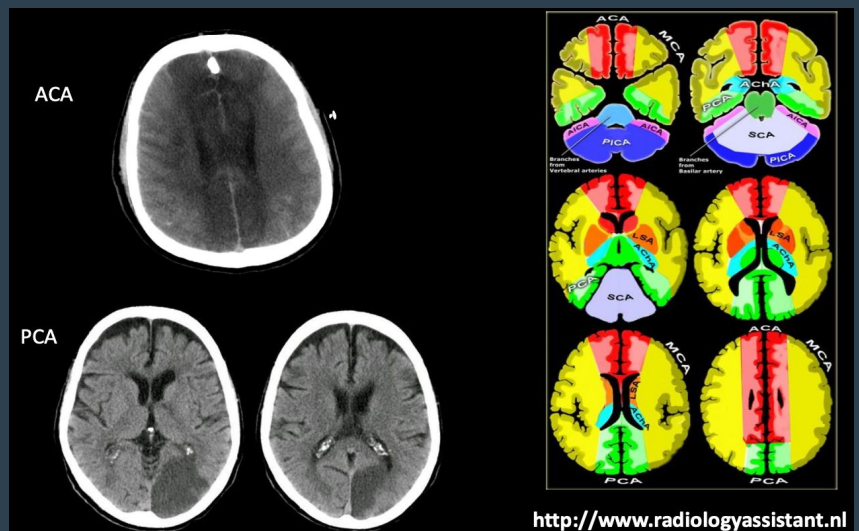
After several hours

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



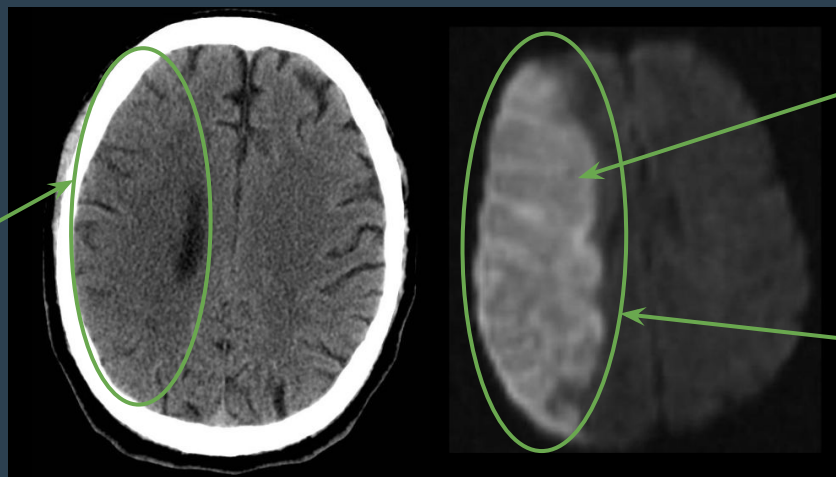
## » Ischemia

- **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



This patient had right MCA infarct

Large area of diffusion restriction in the right cerebral hemisphere

CT

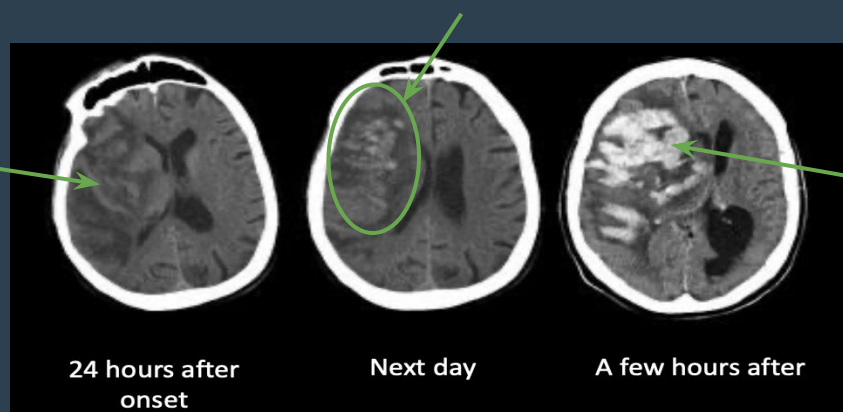
MRI (Diffusion weighted image)

## » 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

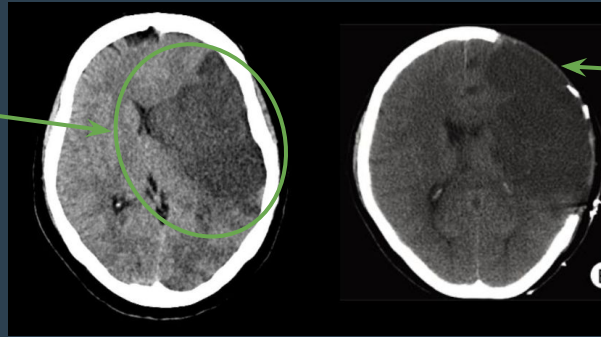


Massive bleeding with midline shift and herniation

## » Complications cont..

- Malignant stroke

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



MCA infarct

Decompressive craniectomy

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

3 Hrs                      12 Hrs                      3 Days                      3 months

Hyperdense sign in left MCA

Clear hypodensity and loss of definition of grey-white matter junction

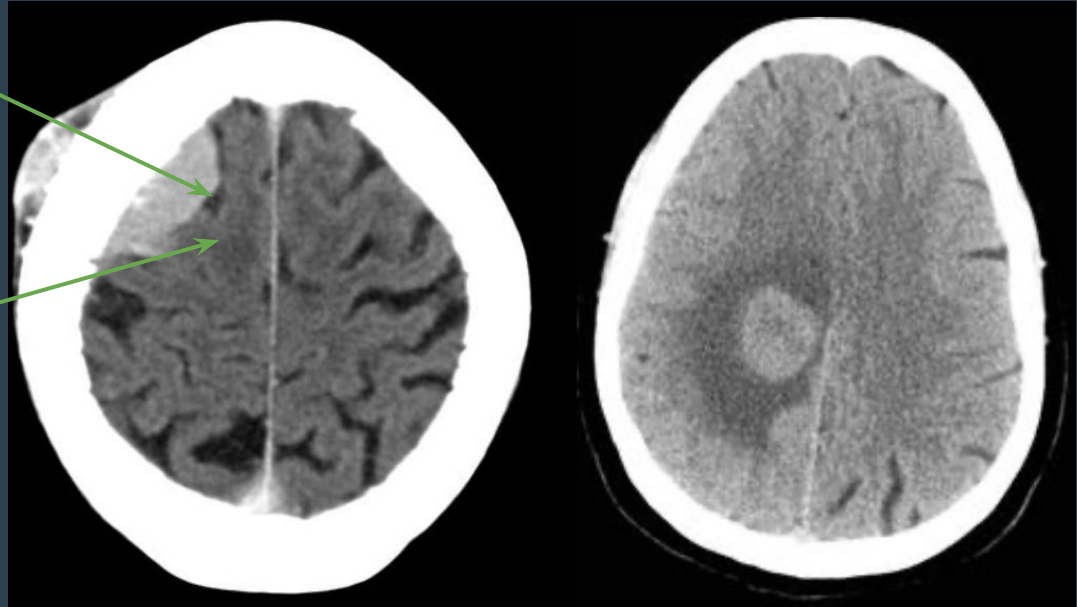
We reach maximum edema and mass effects on the ventricles and midline shift

Volume loss of the damaged brain is replaced by cystic encephalomalacia and due to volume loss the ventricles on the same side will be large and this is called ex vacuo dilatation of the ventricle

# 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

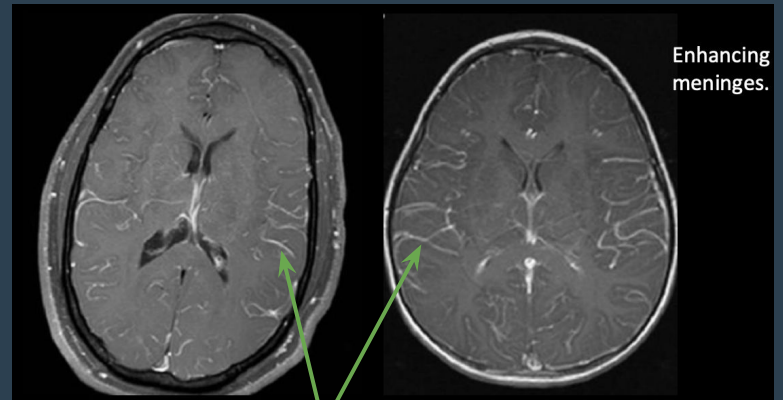
- Meningioma, most common tumor.
- Cranial nerve schwannoma, commonly occurring in the posterior fossa, vestibular Schwannoma of the 8th cranial nerve is located in internal auditory canal.
- Metastasis.

- 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



## » 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.

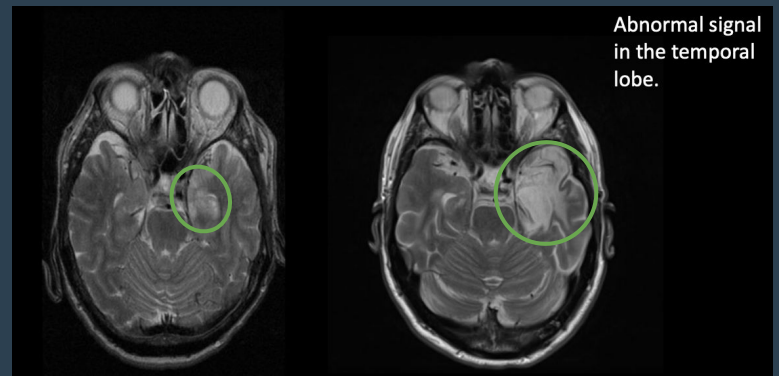


Enhancing meninges.

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.



Abnormal signal in the temporal lobe.

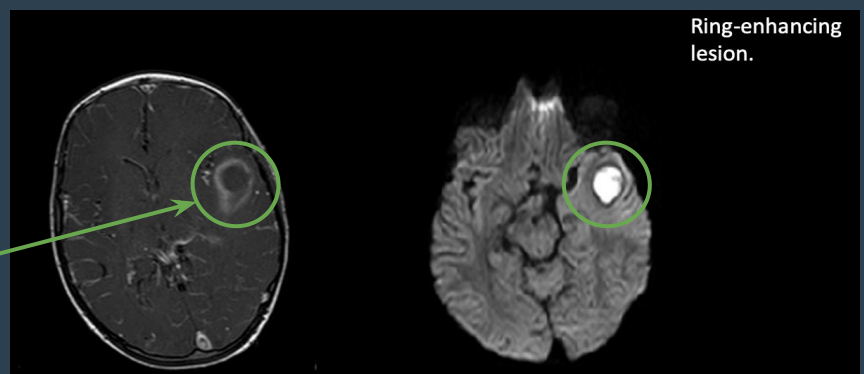
High signal intensity in the left temporal lobe mainly cortical

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

## Brain abscess

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

Space occupying lesion that demonstrate peripheral enhancement post contrast administration

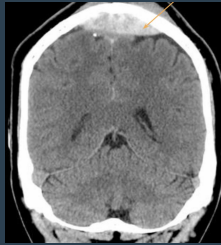
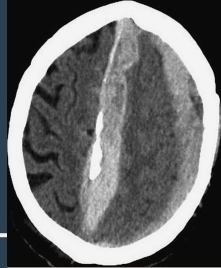


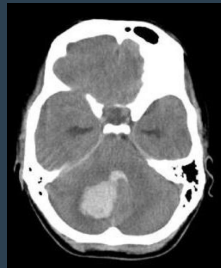


Ring-enhancing lesion.


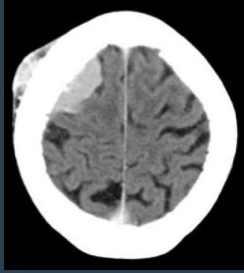

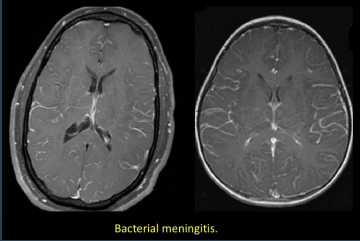
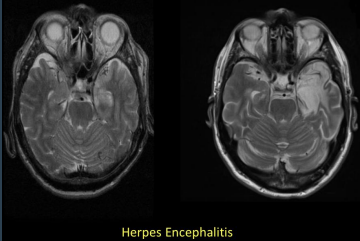
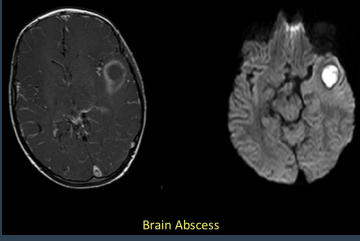
Post-contrast MRI

Diffusion weighted MRI: diffusion restriction

# Summary

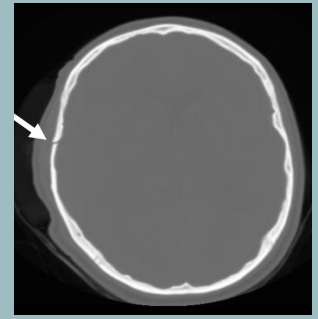
Intracranial Hemorrhage	Findings	Picture
Epidural Hematoma	<ul style="list-style-type: none"> <li>• Lentiform collection between the dura and skull.</li> <li>• traumatic.</li> <li>• Associated with skull fracture</li> <li>• Typically arterial in nature. <b>MMA</b> (middle meningeal artery) but could be from venous sinuses.</li> </ul>	
Subdural Hematoma	<ul style="list-style-type: none"> <li>• Crescentic collection between the dura and arachnoid.</li> <li>• Usually caused by trauma.</li> <li>• Typically venous in nature.</li> </ul>	
Subarachnoid Hemorrhage	<ul style="list-style-type: none"> <li>• Collects between the arachnoid and pia</li> <li>• <b>Clinically, non-traumatic SAH presents with thunderclap headache and meningismus</b></li> </ul>	
Intraventricular Hemorrhage	<p><b>Primary:</b></p> <ul style="list-style-type: none"> <li>• Hypertension.</li> <li>• AV malformations.</li> <li>• Anticoagulation.</li> <li>• Intraventricular tumor.</li> </ul> <p><b>Secondary:</b></p> <ul style="list-style-type: none"> <li>• Intraparenchymal.</li> <li>• SAH.</li> </ul>	
Parenchymal Hemorrhage	<ul style="list-style-type: none"> <li>• Can be caused by trauma</li> <li>• Other causes include: <ul style="list-style-type: none"> <li>• Hypertension.</li> <li>• AV malformations.</li> <li>• Cerebral amyloid angiopathy.</li> </ul> </li> </ul>	

# Summary

	Findings	Picture
Brain Ischemia	Ischemic Stroke: <b>Hyperdense sign</b> is what we will see on head CT in the HYPERACUTE phase.	
Intracranial Tumors	A-Extra-Axial masses <ul style="list-style-type: none"> <li>• Meningioma</li> <li>• Cranial nerve schwannoma</li> <li>• Metastasis</li> </ul>	
	B-Intra-Axial masses <ul style="list-style-type: none"> <li>• Metastasis</li> <li>• Glioblastoma</li> <li>• Astrocytoma</li> </ul>	
Intracranial Infections	<b>Bacterial meningitis</b> <ul style="list-style-type: none"> <li>- <b>Clinically:</b> Headache, Fever, Neck stiffness</li> <li>- <b>Radiologically:</b> Enhancing meninges</li> </ul>	 Bacterial meningitis.
	<b>Herpes Encephalitis</b> <ul style="list-style-type: none"> <li>- <b>Clinically:</b> Headache, Fever, Decreased level of consciousness</li> <li>- <b>Radiologically:</b> Abnormal signal in the temporal lobe</li> </ul>	 Herpes Encephalitis
	<b>Brain Abscess</b> <ul style="list-style-type: none"> <li>- <b>Clinically:</b> Headache, Fever.</li> <li>- <b>Radiologically:</b> Ring-enhancing lesion.</li> </ul>	 Brain Abscess

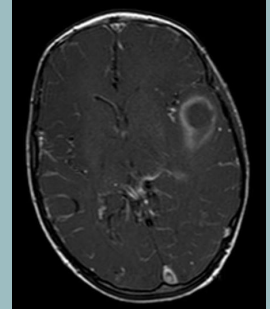
1-Regarding this Brain CT, which statement is correct?

- 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?

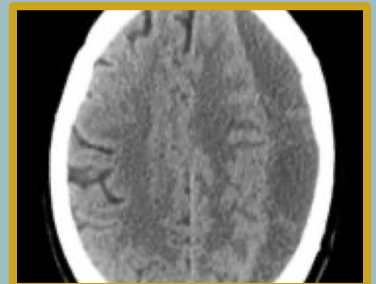
- a. Hummingbird sign
- b. Hyperdense sign
- c. Pulvinar sign
- d. cystic encephalomalacia

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