

# CNS Case Discussion

**365 RAD**

**Prof. Ibrahim Al Orainy**

# Radiology Team 429

**In this team we used the outlines from the:**

**Doctor's slides**

**Lecture notes are in red boxes**

**427 Radiology team**

**Diagnostic Imaging –PETER  
ARMSTRONG – 6<sup>Th</sup> Edition**

Sorry we don't hold responsibility for any missing information or perhaps – perhaps -wrong material.

We tried our best to present this lecture in the best way, and we hope what we wrote is enough to cover the subjects.

**Team Leaders:**

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**Team Members:**

Dona Baraka, Hala Muneef, Marwah Hassounsah, Abdullah Alessa

Special thanks to Sarah Bin Hussain

**Best Wishes : )**

# Topics

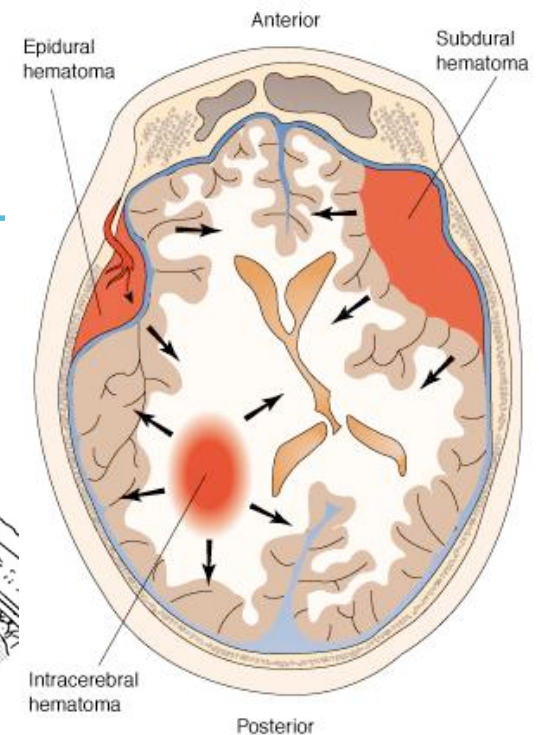
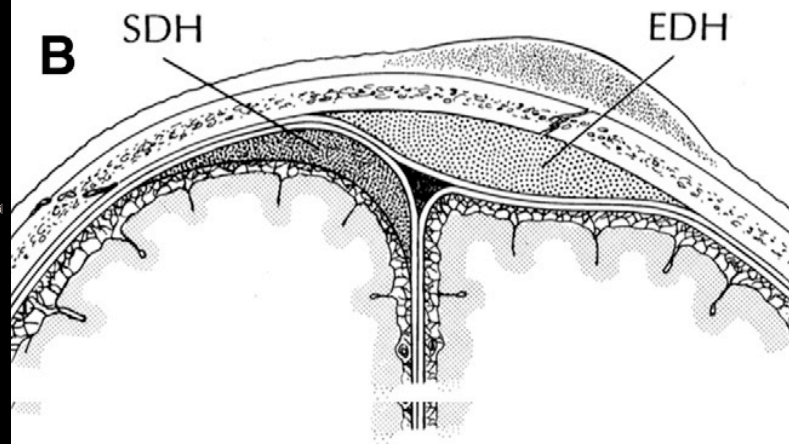
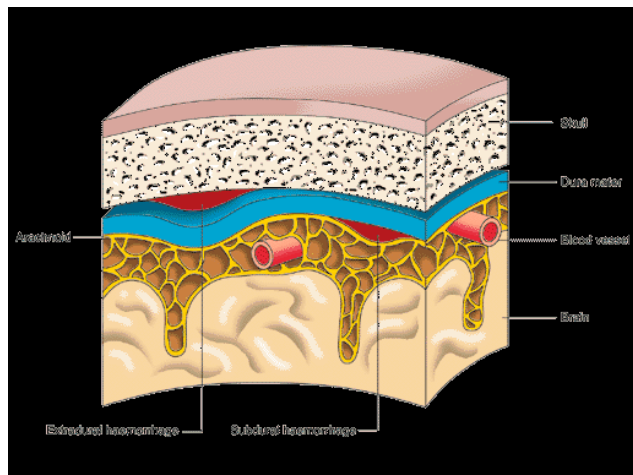
Neuroemergency and how imaging plays a role in the management of:

1. Intracranial bleeding
2. Brain infarctions
3. Brain edema
4. Herniation

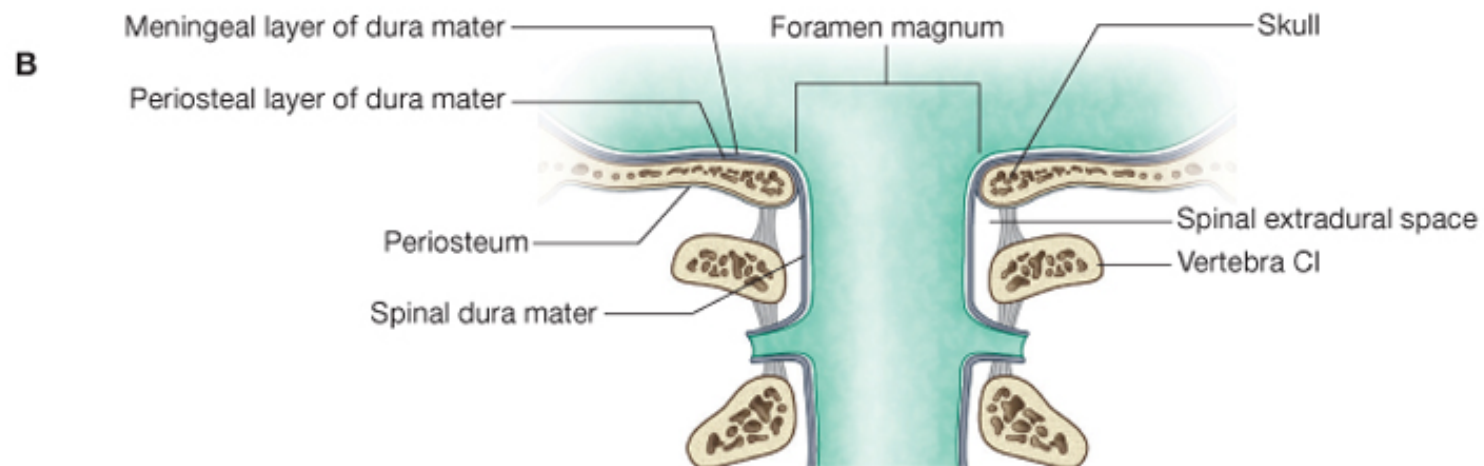
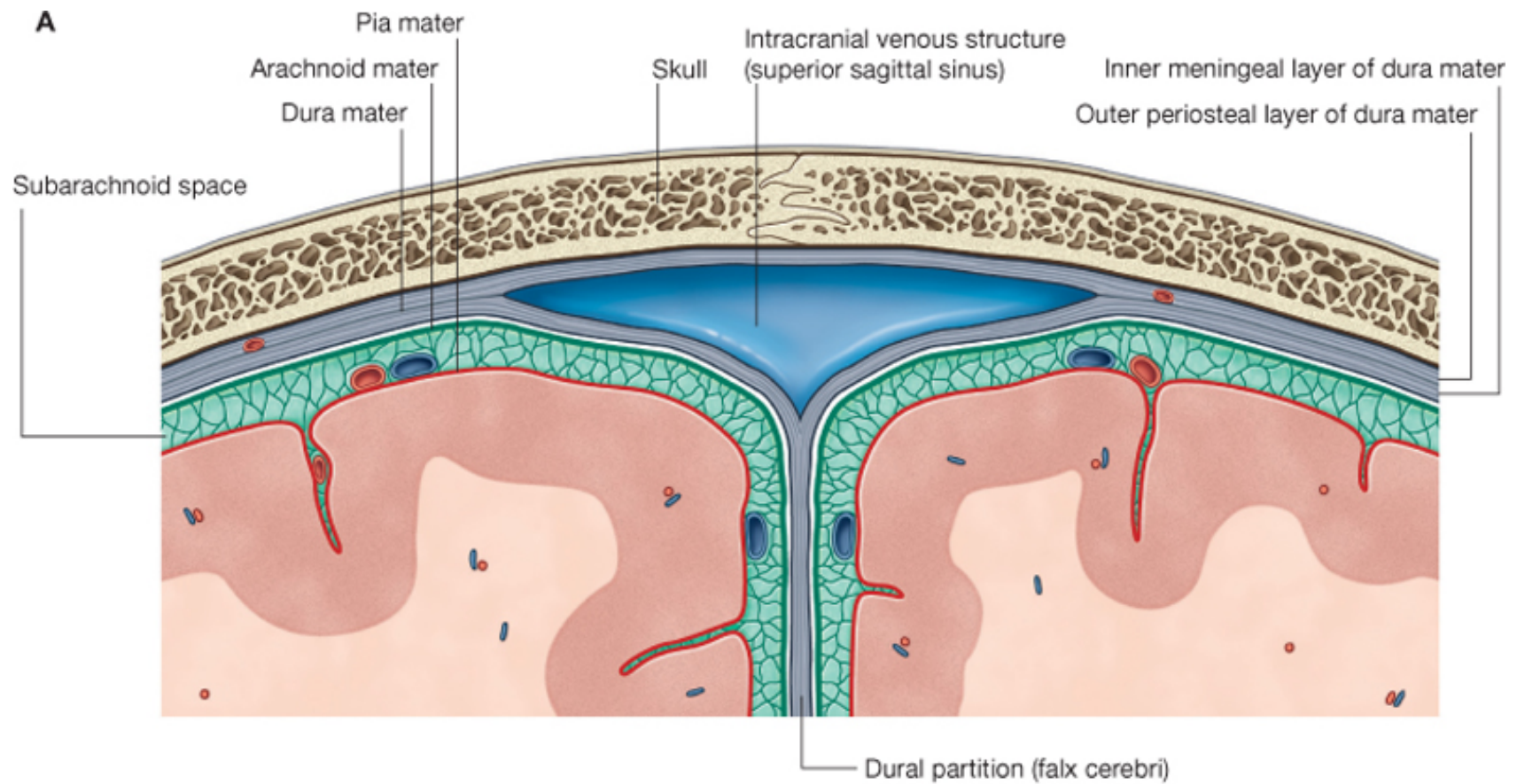
# 1. Intracranial Bleeding

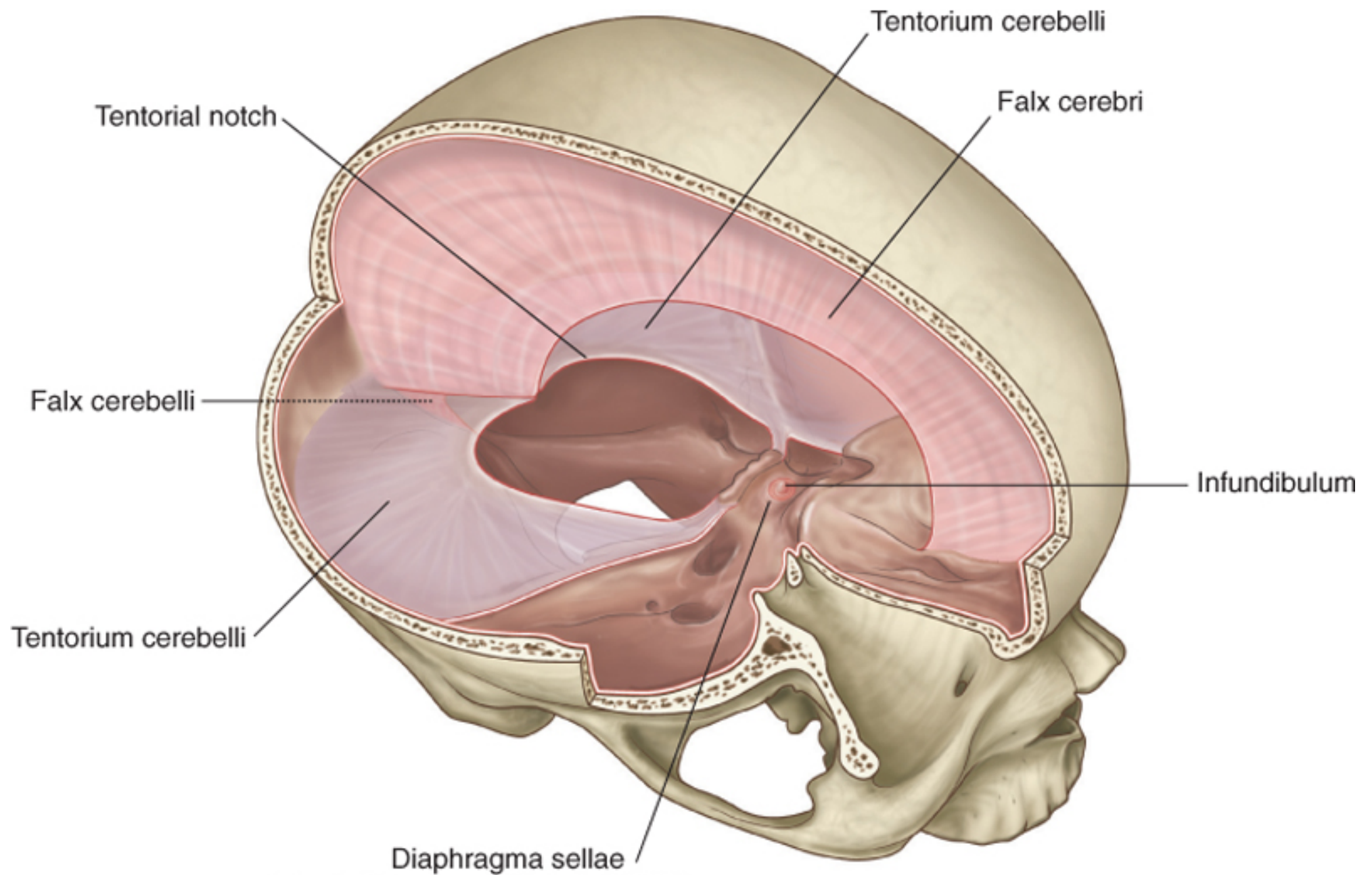
ICB is classified according to location

- Extradural: outside the dura “also called epidural”
- Subdural
- Subarachnoid
- Intraventricular
- Intraparenchymal









Drake: Gray's Anatomy for Students, 2nd Edition.

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# CT SCAN Anatomy

- A. Anterior Horn of the Lateral Ventricle
- B. Caudate Nucleus
- C. Anterior Limb of the Internal Capsule
- D. Putamen and Globus Pallidus
- E. Posterior Limb of the Internal Capsule
- F. Third Ventricle
- G. Quadrigeminal Plate Cistern
- H. Cerebellar Vermis
- I. Occipital Lobe

Internal capsule is white matter



# Anatomy

- The layers above the skull is the periosteum
- Beneath the skull immediately is the 1<sup>st</sup> layer of dura
- The 1<sup>st</sup> layer of dura is consider the endostium -like any other bone-, 2<sup>nd</sup> layer which reflects and come back to form the falxs and tentorium
  - so anything outside the 1<sup>st</sup> layer of dura “between bone and dura” especially at the fracture site is called epidural or extradural.
  - Any thing beneath the dura and above arachnoid is called subdural
- Blood in subdural space can't fill the sulci b\c the arachnoid layer will prevent it



Since the 1<sup>st</sup> layer of dura is the endostium what will happen to the dura when bones ends at the suture line: coronal and superior sagital?

- It will end with the suture like any end of bone.
- if you have epidural hematoma that reaches the suture line what will happen to the hematoma?
- stop at suture (it will not cross it)
- So any hematoma that stops at a suture line has to be epidural b/c there is no reason for subdural hematoma to stop at the fracture (it will continue).
- But subdural when reach the dural reflection can't cross it why? It has to go with dura down and come back again with it (stop at the falx or reflect with it into the inter hemispheric fissure and come back in the other side)
- Dural like endostium is similar to periosteum is firmly attach to bone and since that any blood will not go freely in the space, it has to be contained , and to be contained it will take the lentiform shape

- Distinguishing b/w EDH & SDH has no clinical importance in emergency setting b/c surgeon if he want to evacuate will open the skin & drill the skull. If blood comes before opening the dura it is EDH \ if he has to open the dura to get the blood its SDH.
- It's important in medico-legal issues such as child abuse there will be multiple subdural hematoma b/c of repeated trauma to the head not and not epidural



## Epidural hematoma

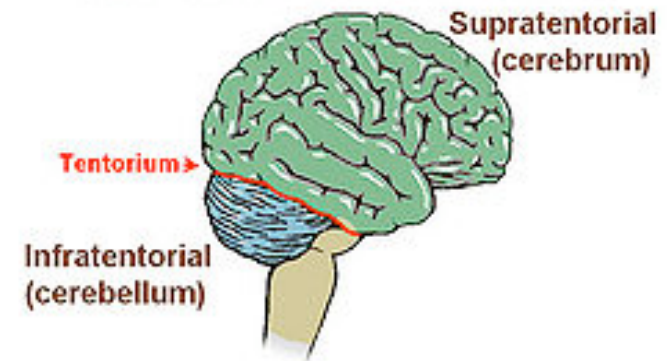
The site of hematoma can be determined by its shape. In this case, the lentiform shape is indicative of EDH

- CT of brain “bone is white dense structure”
- Abnormal Hematoma in the acute phase appears “whitish it’s not as dense as bone but not as gray as brain.”
- Layers of Dural & arachnoid are not visualized on CT & MRI, we can't figure out by tracing the layer itself
- We figure it out by the shape, location and relation to the adjacent structure (basically the suture lines of the calvarium and dural reflection of dura “falx and tentorium”).

## A. EDH

- Blood collection between inner table and dura.
- Biconvex (lenticiform)
- Occur at site of impact
- 95% unilateral, supratentorial
- Does not cross sutures
- Can cross falx and tentorium
- Skull fracture in 90%
- Air seen in 20%

### The Tentorium Cerebelli



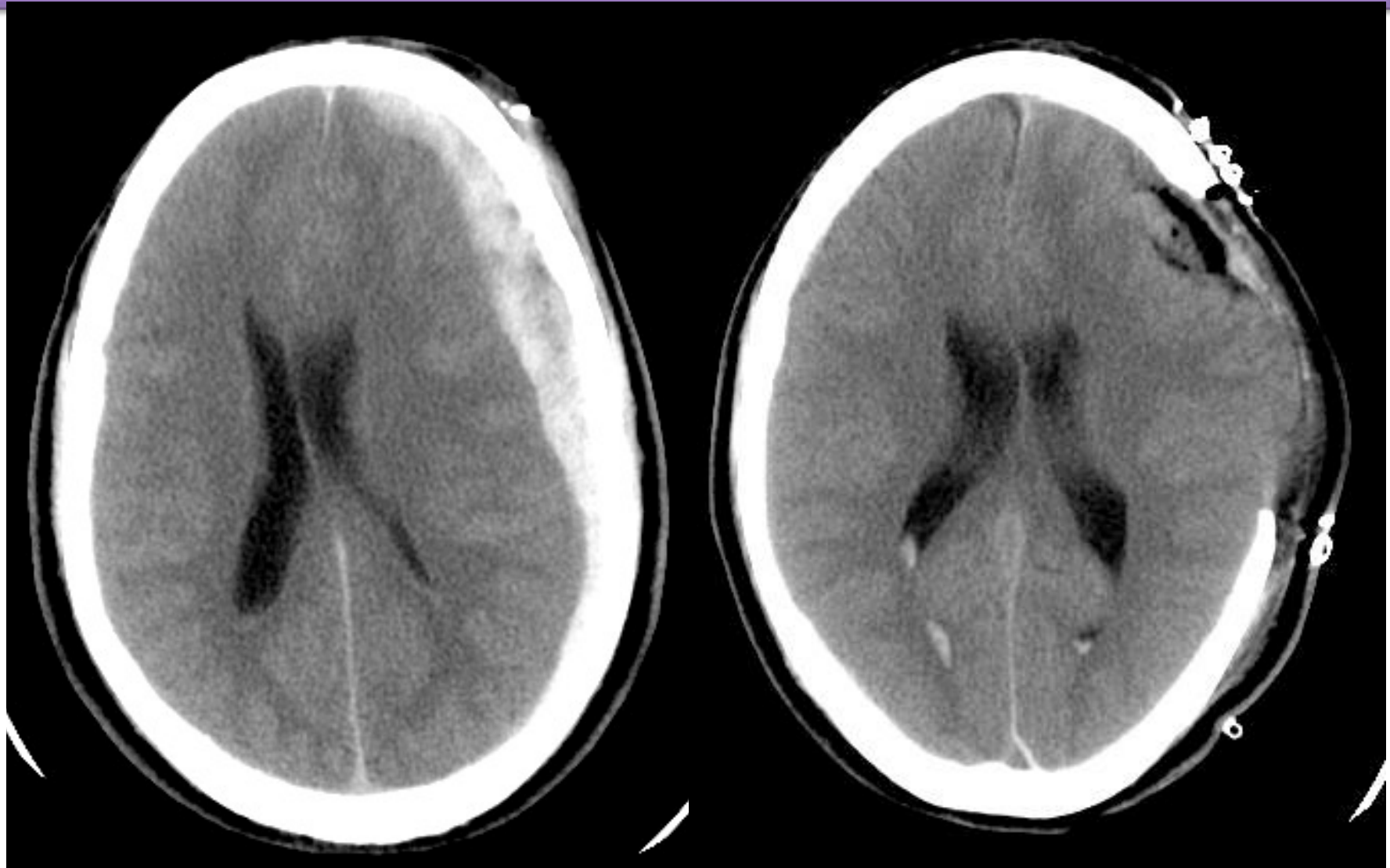


## A. EDH

- Arterial 90% (the source of bleeding is arterial b\c high pressure is needed to strip of the dura from the bone” –while subdural most of the time are venous)
- Venous 10%
- Nontraumatic-rare (very rare, but in subdural: non-traumatic cause are common “the commonest is trauma even in SDH”)
- Very unlikely to see EDH b\c of anticoagulation for example
- Lucid interval-50% May present as follows: trauma, loss of consciousness, regain consciousness, loss of consciousness again. Depends on size of lesion
- Clinical Features symptoms depends on space occupying lesion and size of the hematoma:
  - headache, nausea, vomiting, convulsions “if there is severe mass effect and mid line shift”, brain herniation “may end up into brain infraction or cranial nerve deficit”.

## B. SDH

SDH can be spontaneous, while EDH can not.

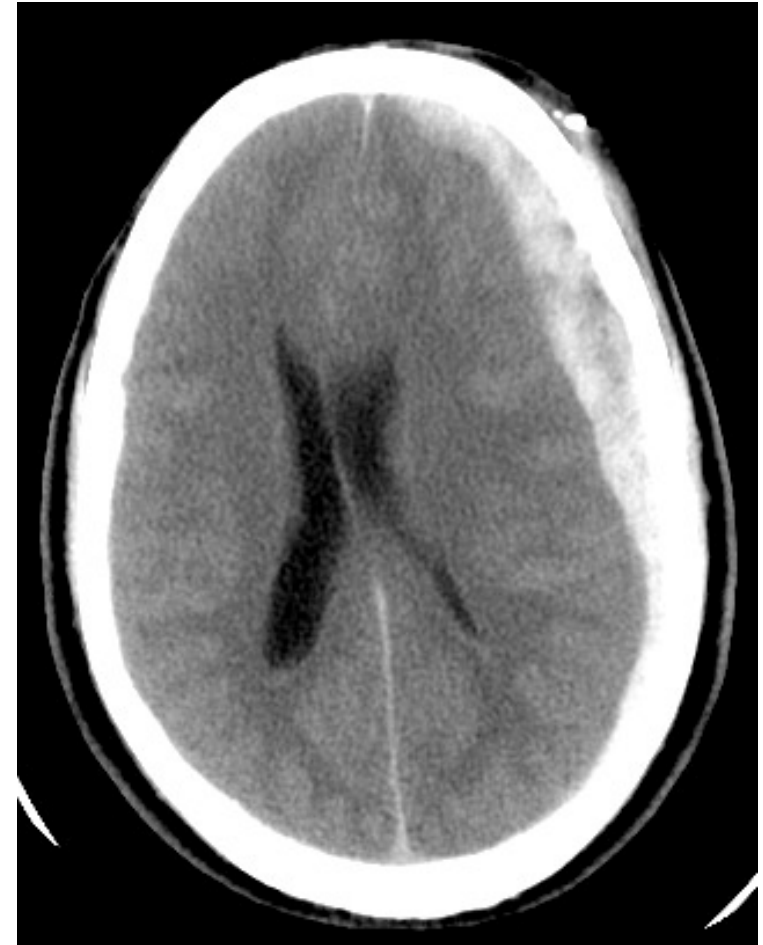


## B. SDH

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

Image:

- Midline Shift (mass effect)
- large hematoma
- needs intervention
- may expand which will increase the pressure and herniation of the brain



## B. SDH

- Trauma is the most common cause
- Acute: 6hr-3d
- Subacute: 3d-3w
- Chronic: >3w

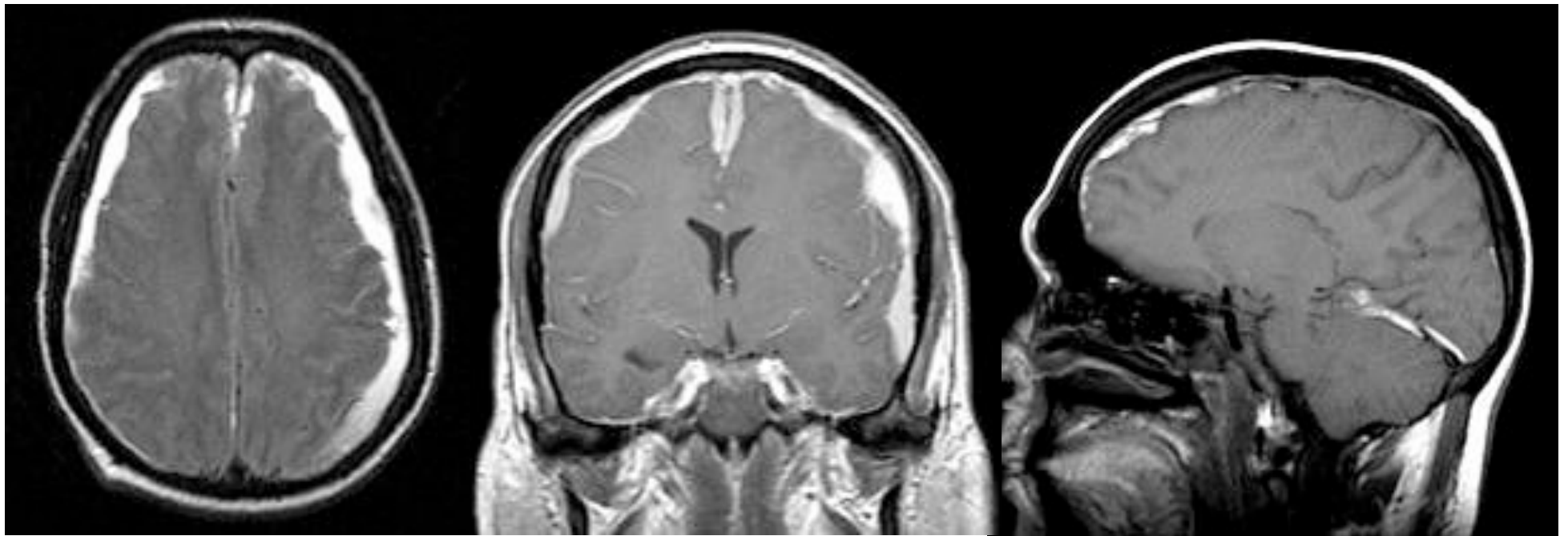
Important to know the age of the image

- Hyperacute: black
- Acute: starts as white
- Chronic: gray and may appear as fluid

Usually, SDH is larger than EDH → mass effect → deviation of mid-line + herniation (some times herniation blocks arterial flow → infarction)

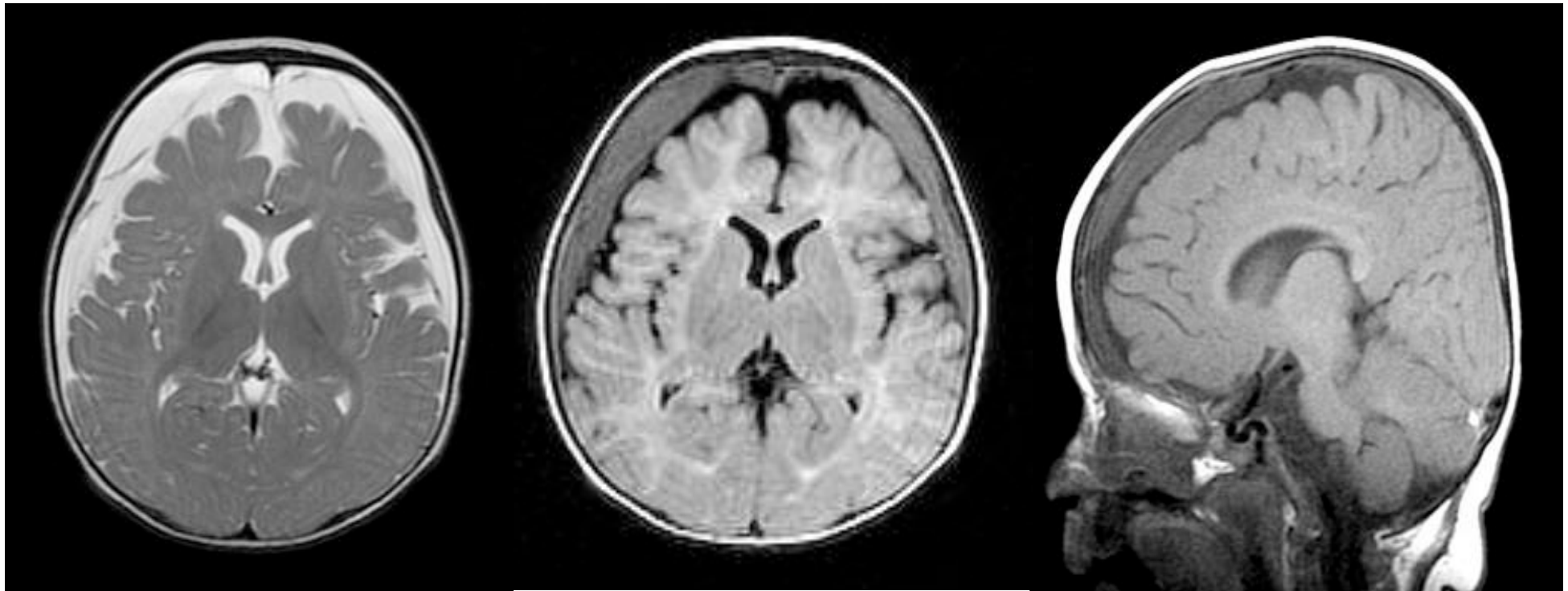


## B. SDH





## B. SDH



T1

Flair

Different sequences of MRI must be done to differentiate blood from CSF as in the left two pictures above.

SDH can be managed by drilling a hole into the brain, however, if the brain was edematous, craniotomy is done, where a part of the skull is taken off and then put back after the management of the SDH.



Image A: crosses the falx but not the suture, supraorbital area

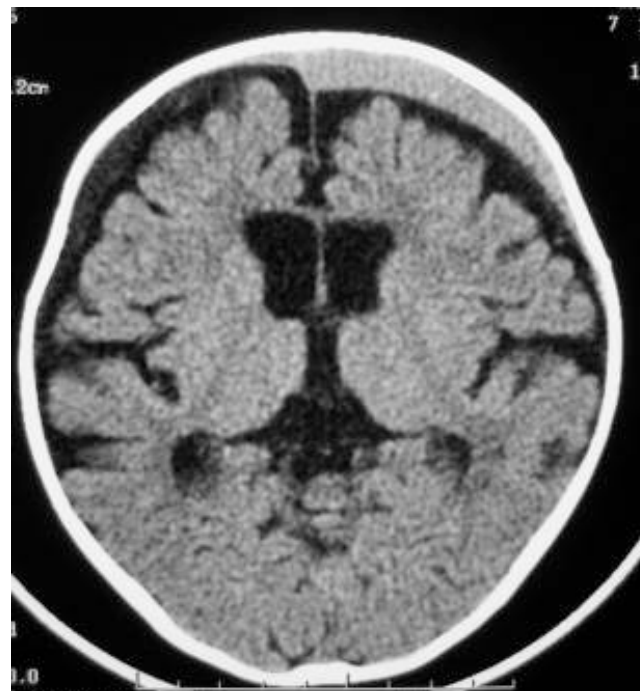


Sharp subdural hematoma  
Extends along the falx

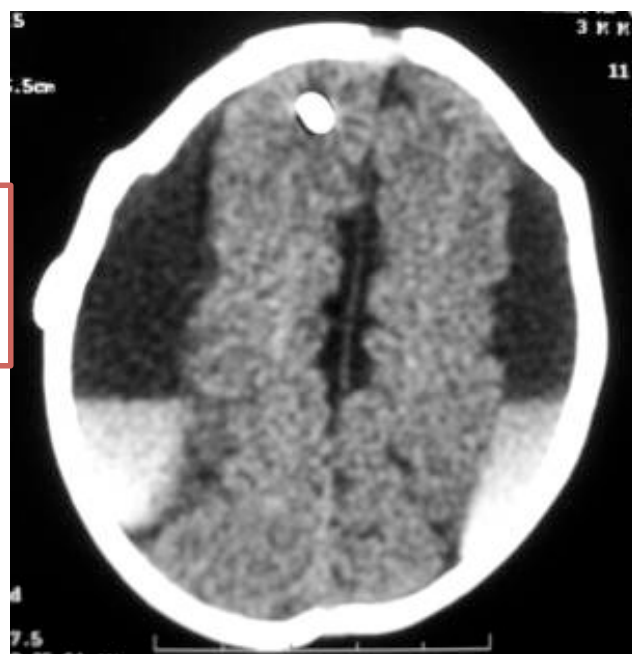
Hematoma within  
the Falx



Black  
subarachnoid  
space, two  
SDH, stopped  
at the falx



Acute on chronic  
Precipitation of RBC  
in the lower falx



Chronic  
SDH

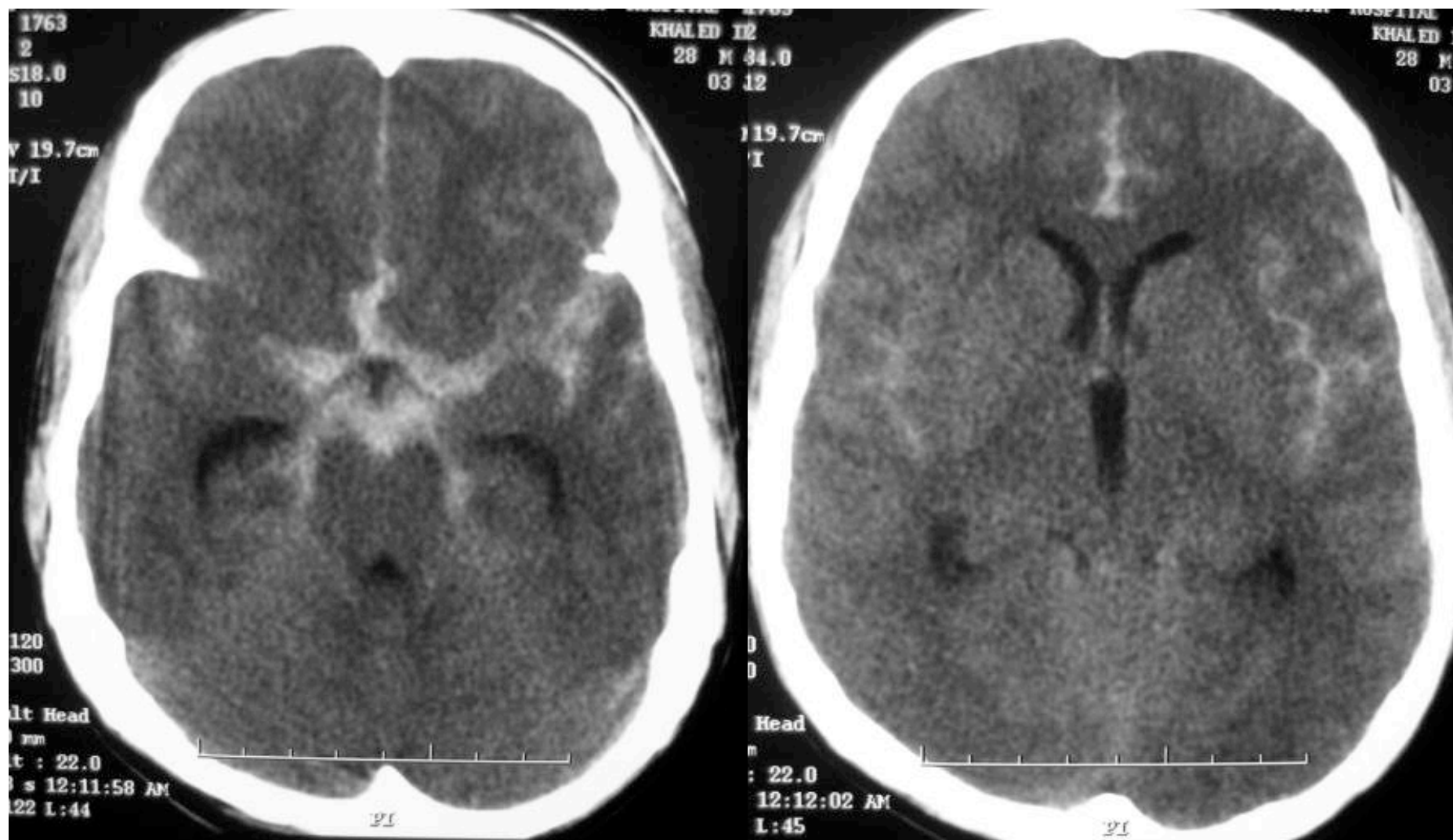




## C. SAH

- Blood between pia and arachnoid
- Traumatic (most common)
- Nontraumatic: (most common non-traumatic cause is ruptured aneurysm. It needs to be treated to prevent rebleeding where there is a higher mortality and morbidity)
- Clinical Features: headache, vomiting, blurred vision, neck rigidity (signs and symptoms of chemical meningitis)
- Complications: hydrocephalus (acute/delayed), vasospasm, rebleeding. (Causes include: Blood irritates the adventitia of the blood vessels, leading to vasospasm and strokes. Also, more production of CSF and less absorption which leads to dilatation of the ventricles and hydrocephalus)

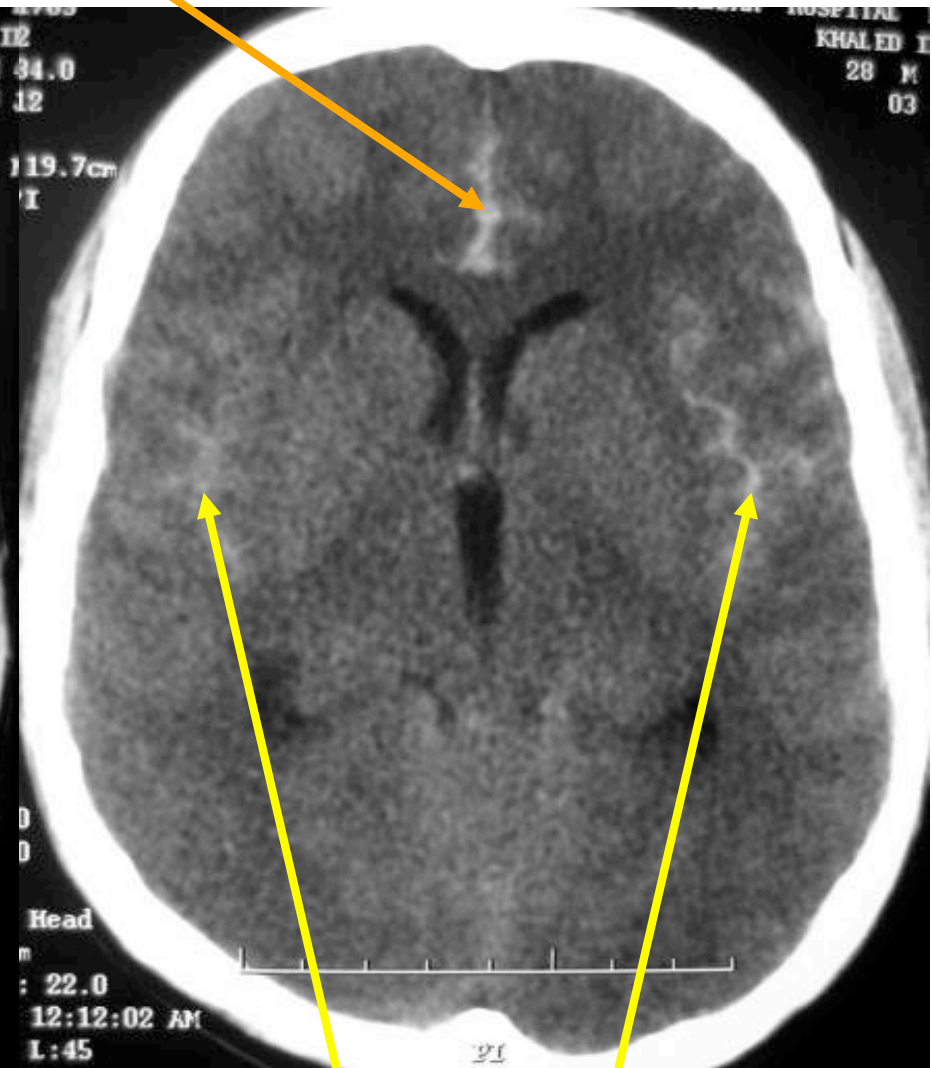
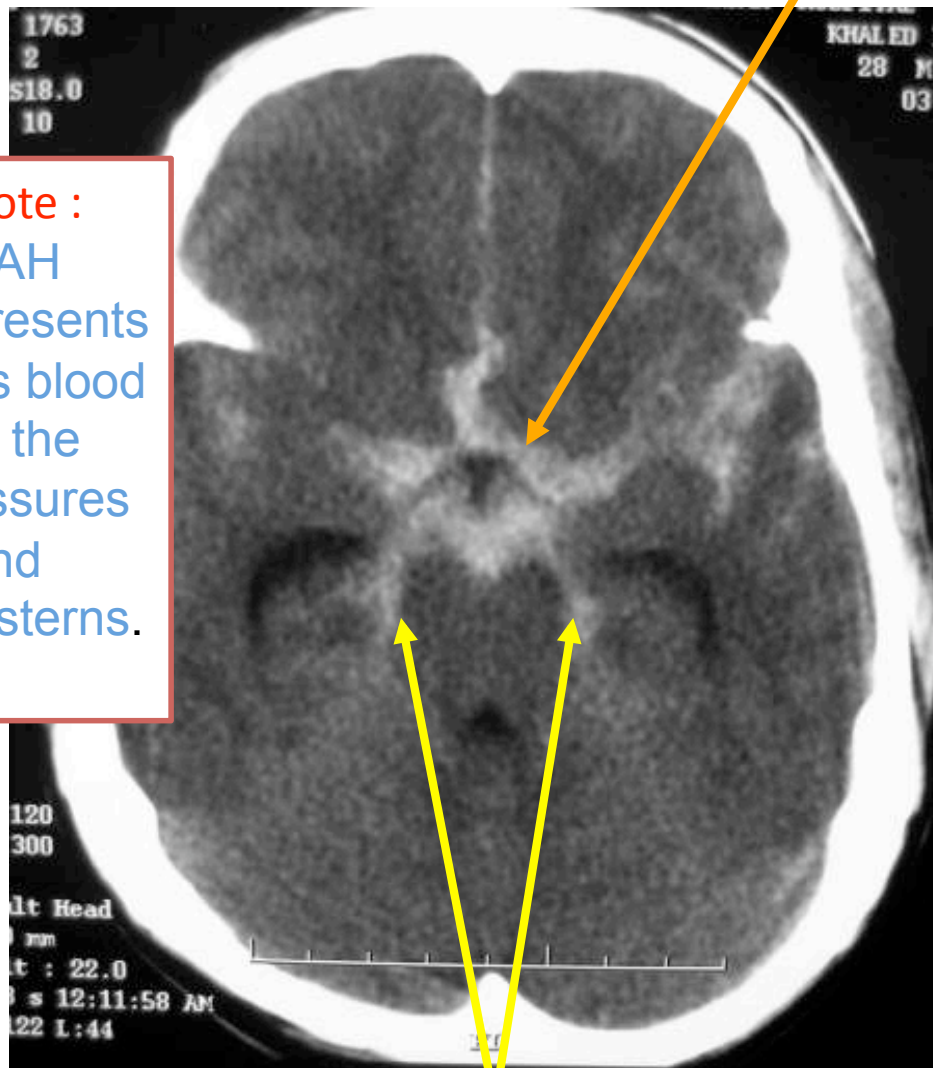
Ruptured aneurysm is the most common cause of non-traumatic cause of SAH.  
Needs to be treated to prevent rebleeding and higher mortality and morbidity  
SAH irritates the adventitia of the arteries → vasospasm → infarction  
SAH=Acute severe headache



**Blood in the suprasellar cistern**

**Blood in the interhemispheric fissure**

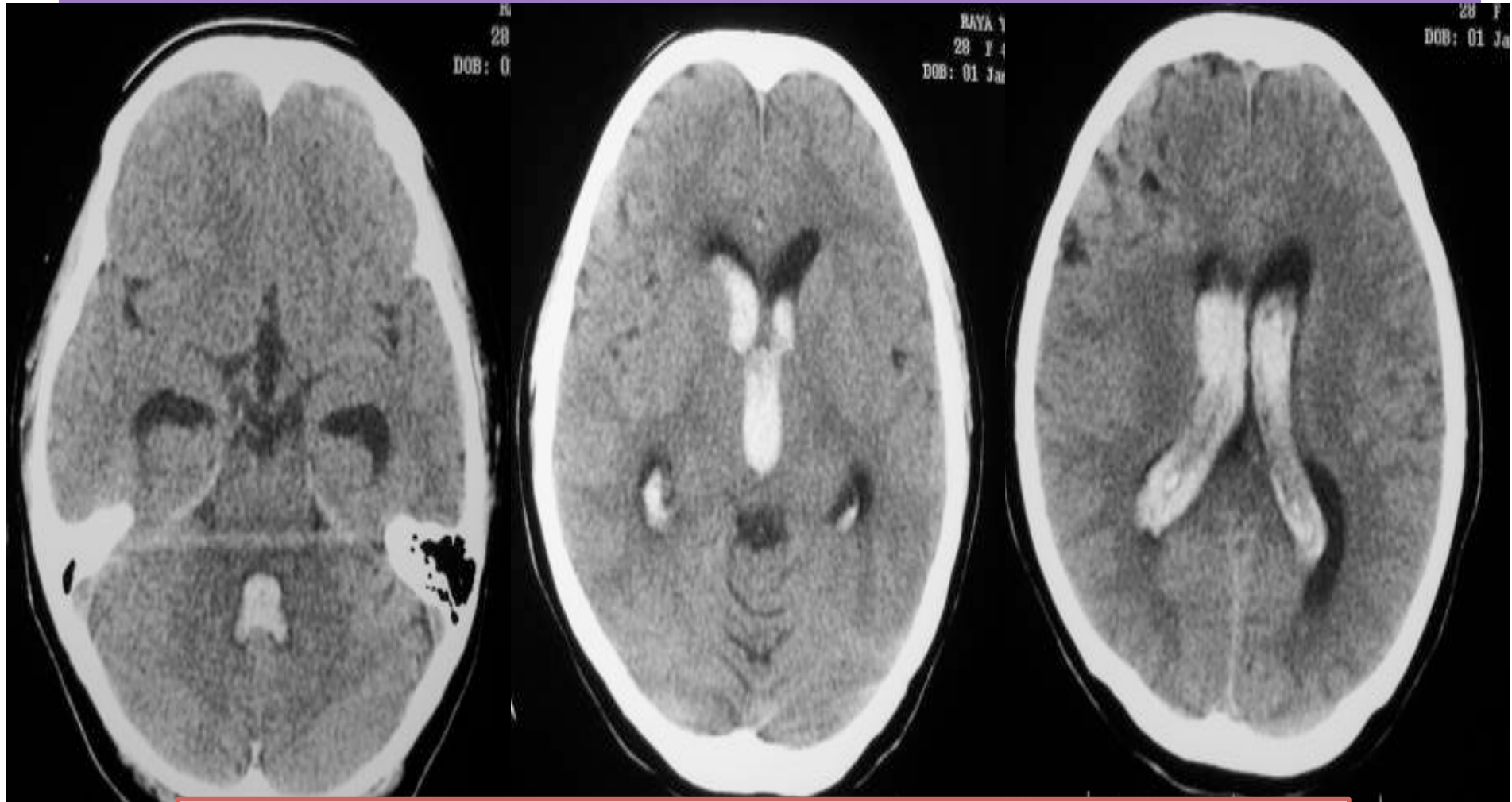
**Note :**  
SAH  
presents  
as blood  
in the  
fissures  
and  
cisterns.



**Blood in the ambient cistern**

**Blood in the sylvian fissures**

## D. Intraventricular hemorrhage



### Intraventricular hemorrhage/hematoma

- Causes of IVH: Trauma, hypertension, vascular malformation
- Blood is replacing the CSF

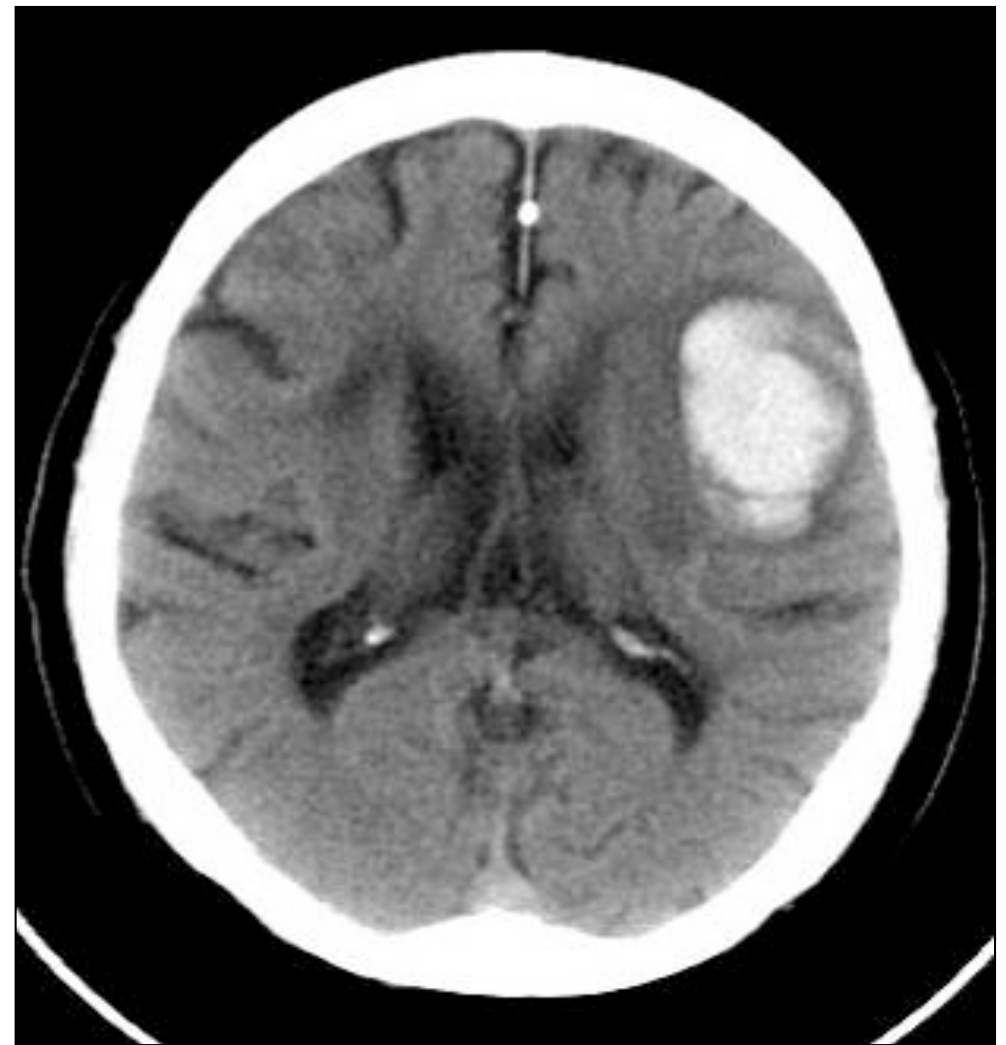
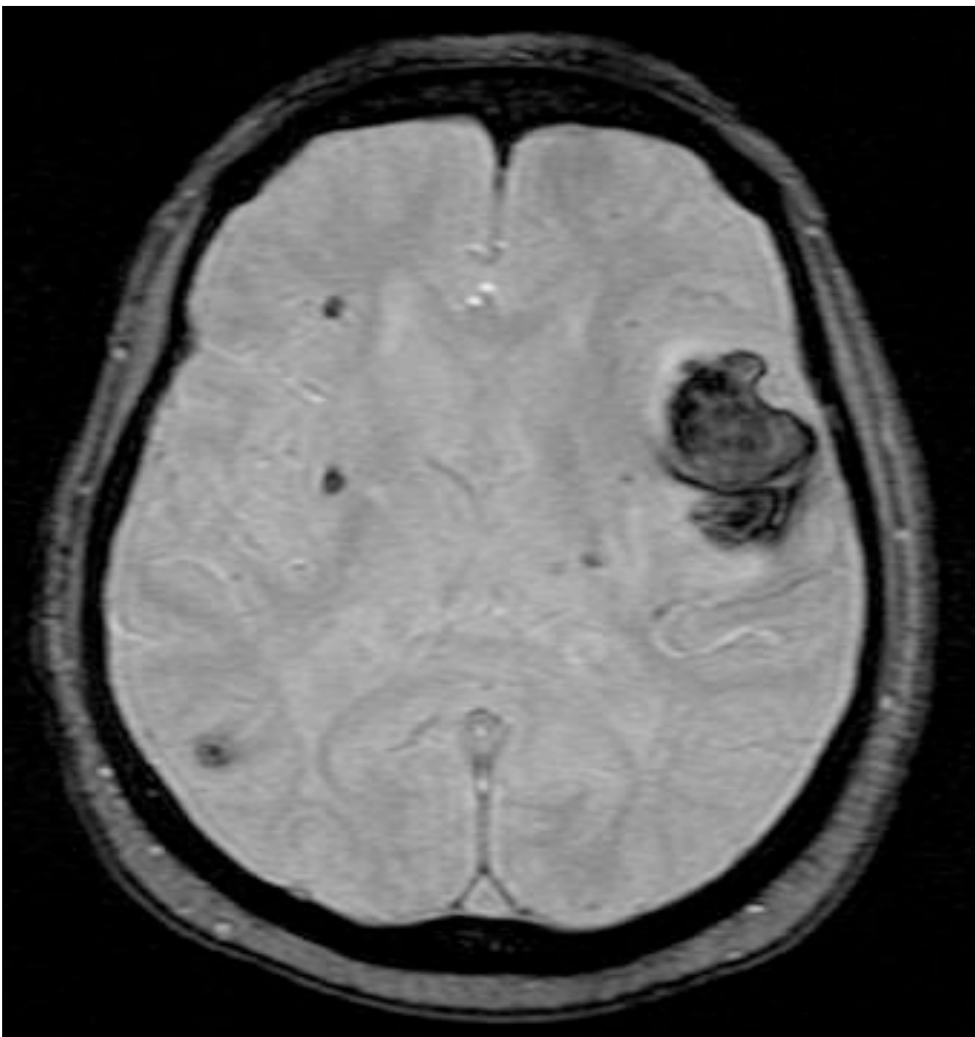




Intraventricular  
and  
Intraparenchymal  
Hemorrhage/  
Hematoma  
Most common  
cause:  
Hypertension

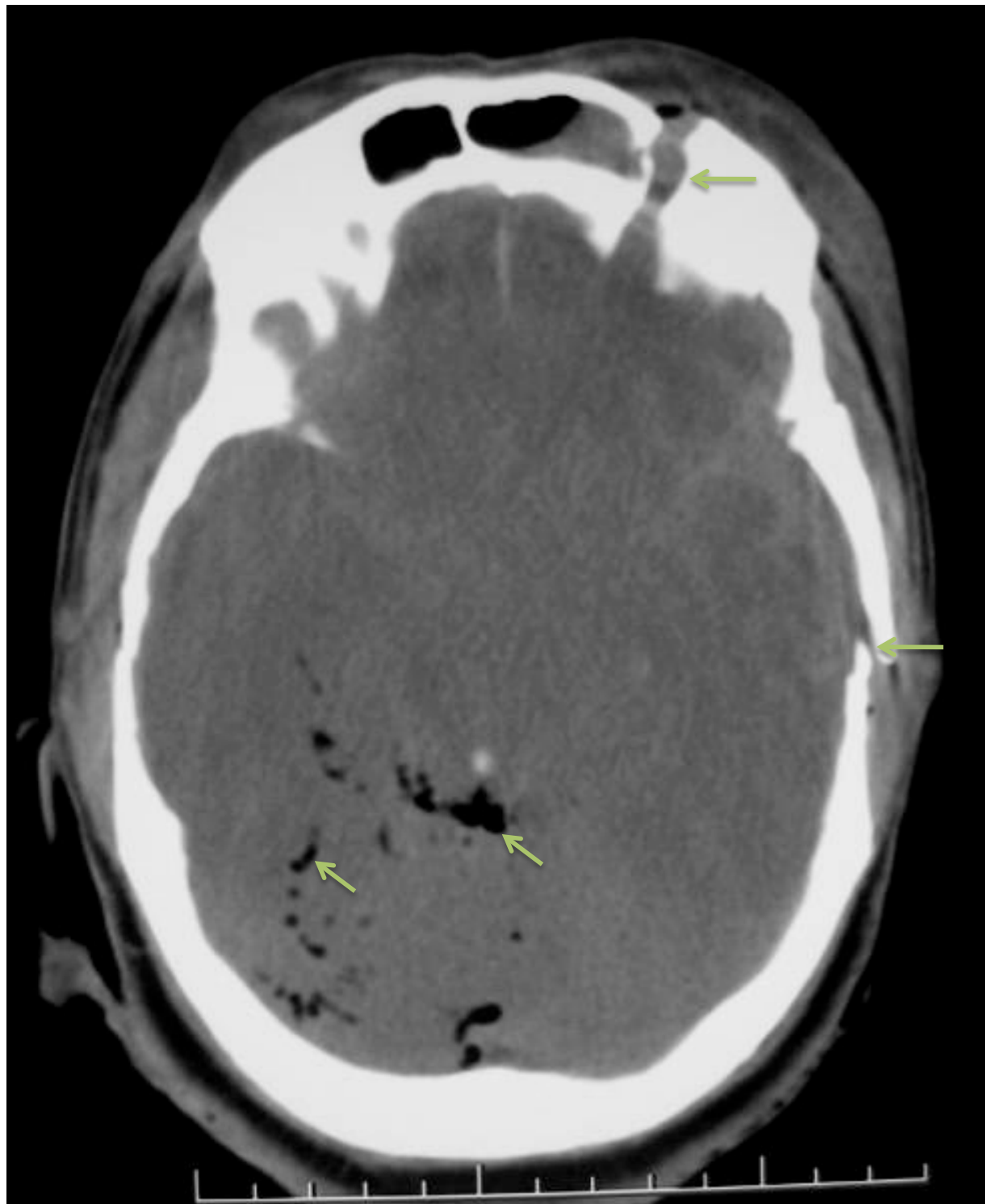
## E.Parenchymal bleeding

- Causes:
  - HTN
  - Trauma (Also, minor brain trauma can cause brain function loss especially if it was repetitive)
  - AVM (arterio-venous malformations)
  - Aneurysm
  - Permaternity
  - Tumors
  - Infarction
  - Coagulopathy.



T2 start, shows hemosiderin (black area)

Intraparenchymal  
hemorrhage/hematoma



Gradient-echo  
sequence: detect  
 hemosiderin (will show  
 blood as black)

Subarachnoid bleeding  
and pockets of air in the  
subarachnoid space  
(usually due to a fracture  
in the sinus or a defect in  
the skin)

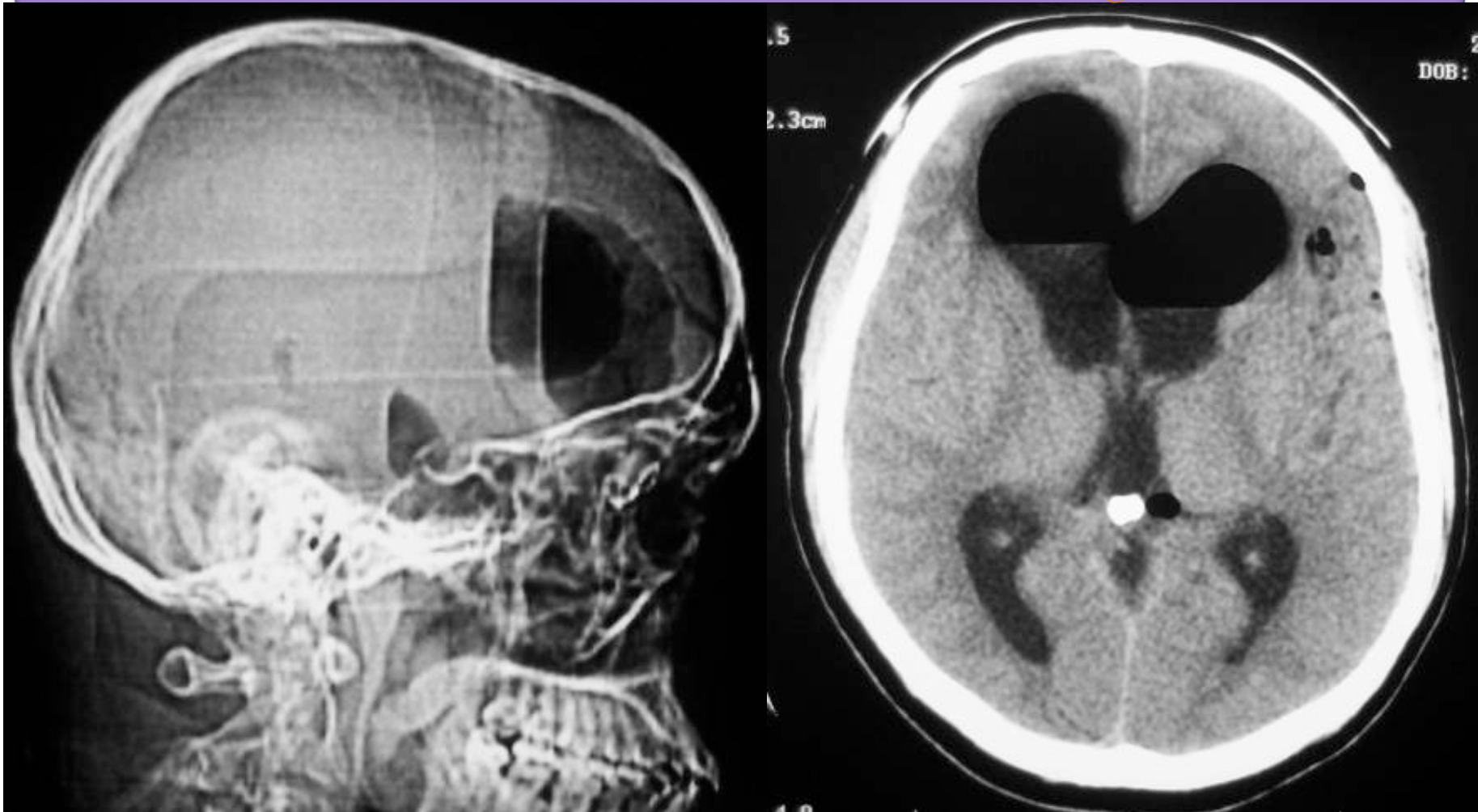
Pneumocephalus: air in  
the cerebrum, usually  
due to fracture through  
the sinus

Fracture through the  
sinus can cause:  
meningitis (flora of the  
sinus) and puts the  
patient at risk for  
recurrent meningitis



# Trauma

Image shows fluid and air level



IPH presenting with intraparenchymal air “Pneumocephalus” ( most commonly due to fracture of the base of the skull, because it communicates with the air spaces. Also, a fracture in other places other than the base of the skull)

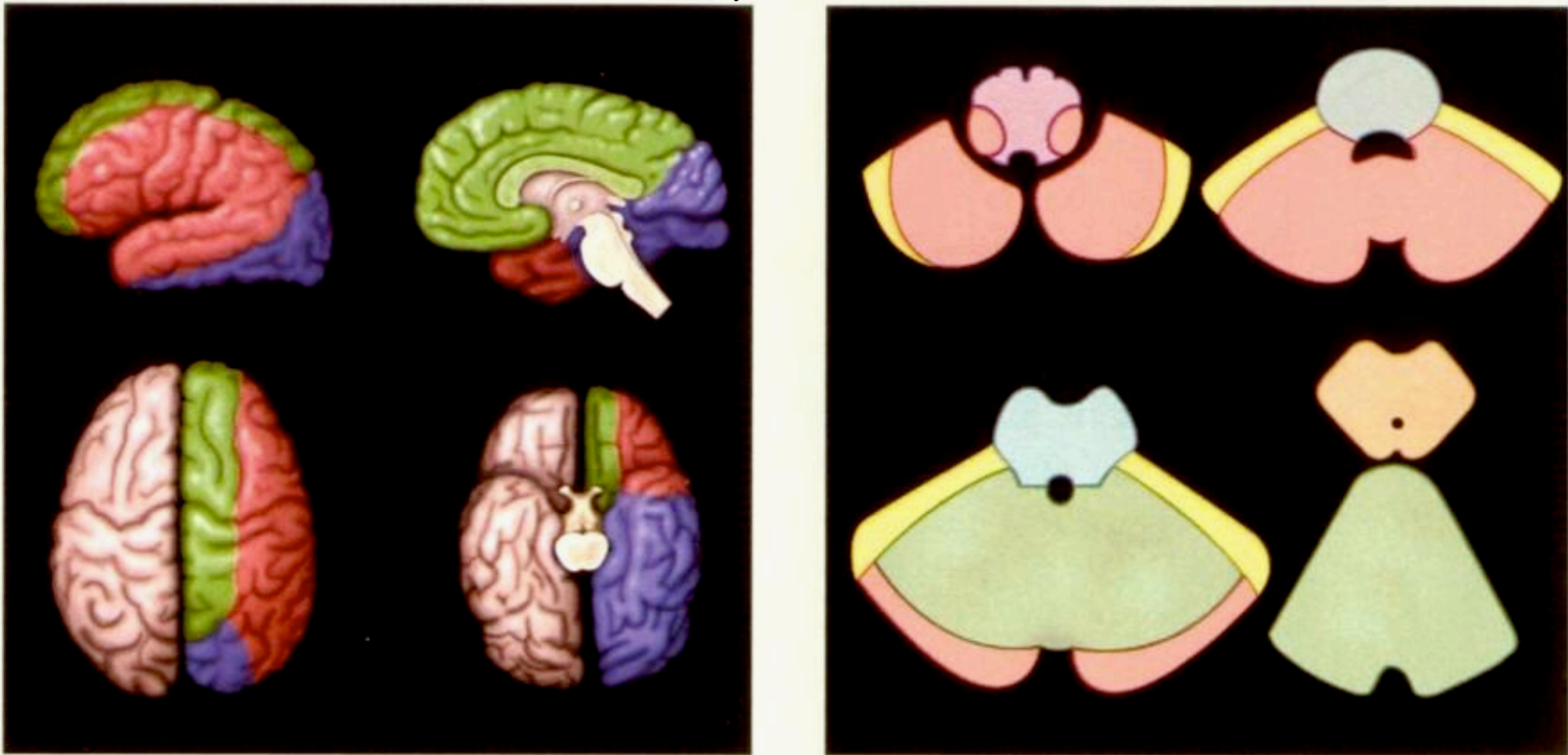
5



Calcified choroid  
plexus (hyper  
dense objects) =  
normal  
physiological in  
old people.  
There is also  
SDH, SAH, IPH  
and  
pneumocephalis.

## 2. Infarction

Courtesy: Osborn AG



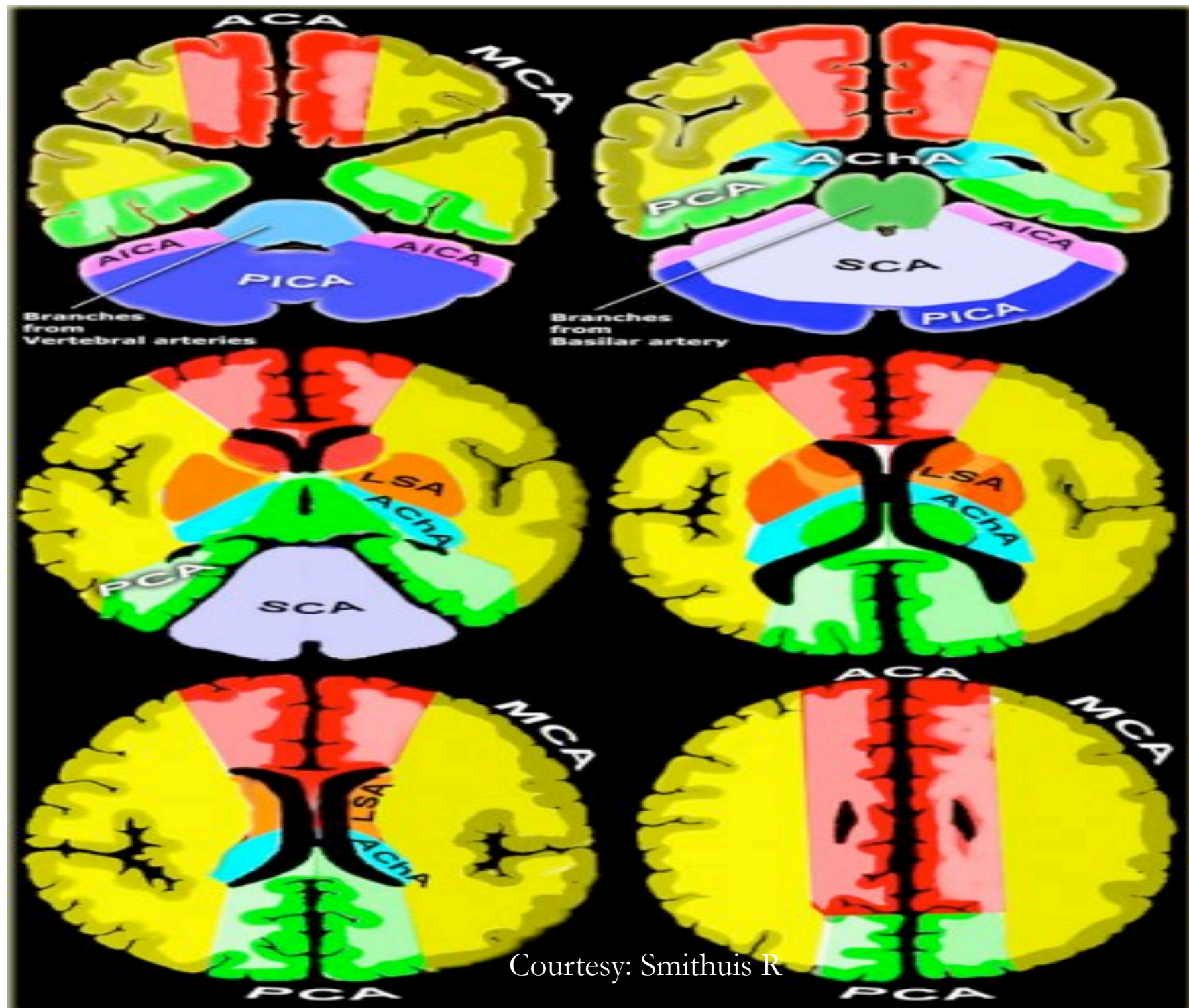
**Note:** Know the location of the arteries and its target areas

Interpretation of the infarction, understand blood supply

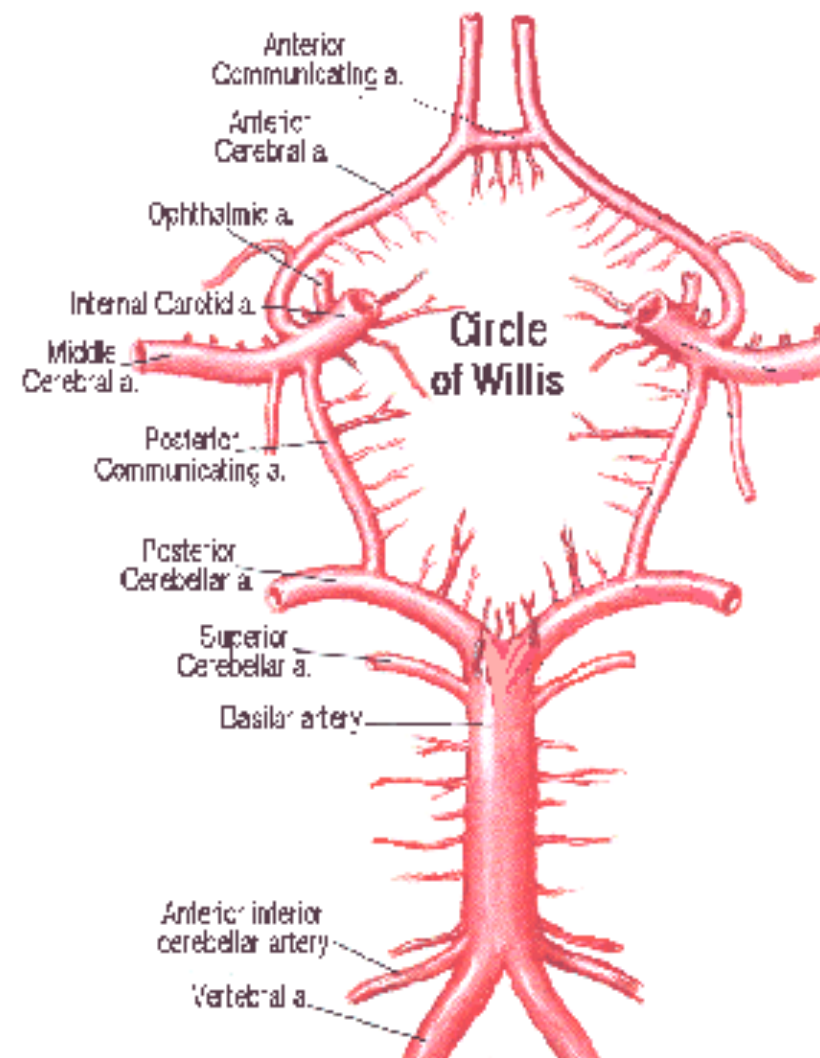
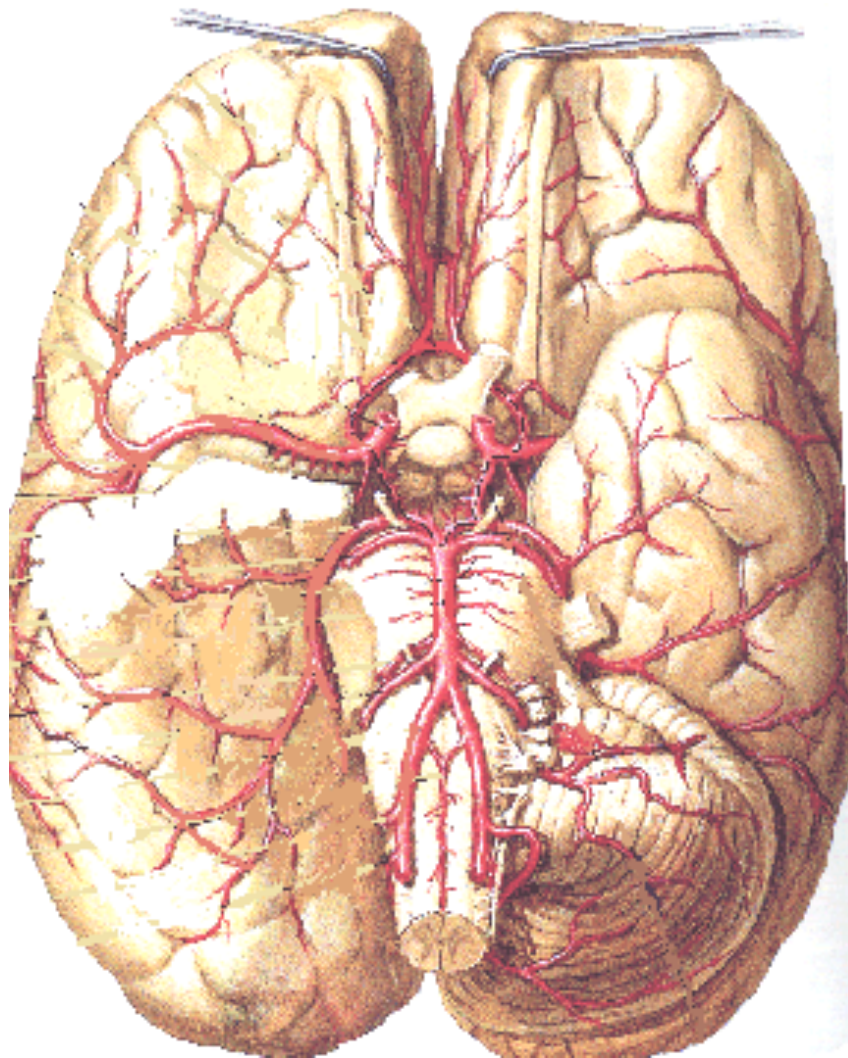
Cerebrum blood supply: ACA, MCA, PCA

Medulla: posterior inferior cerebellar artery PICA, superior, inferior anterior AICA

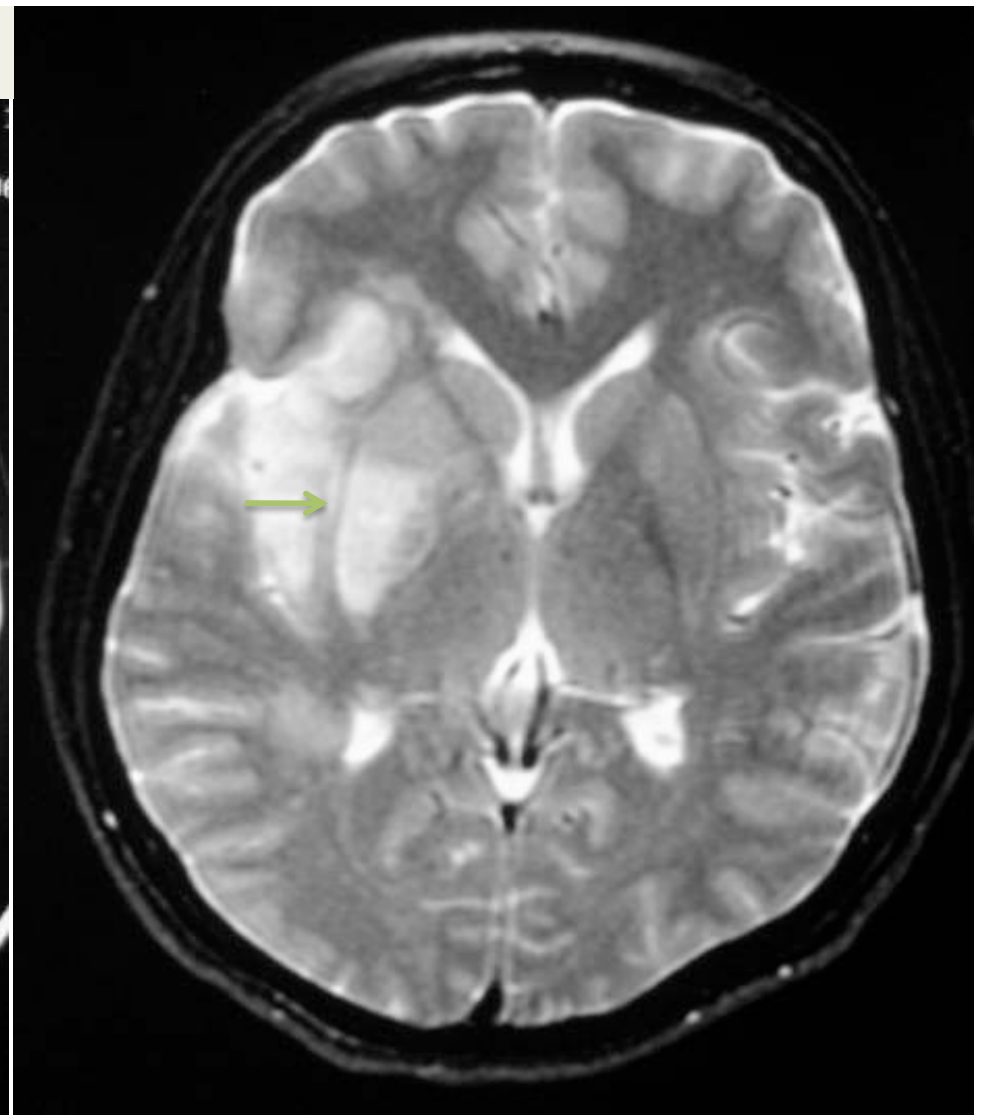




Courtesy: Smithuis R



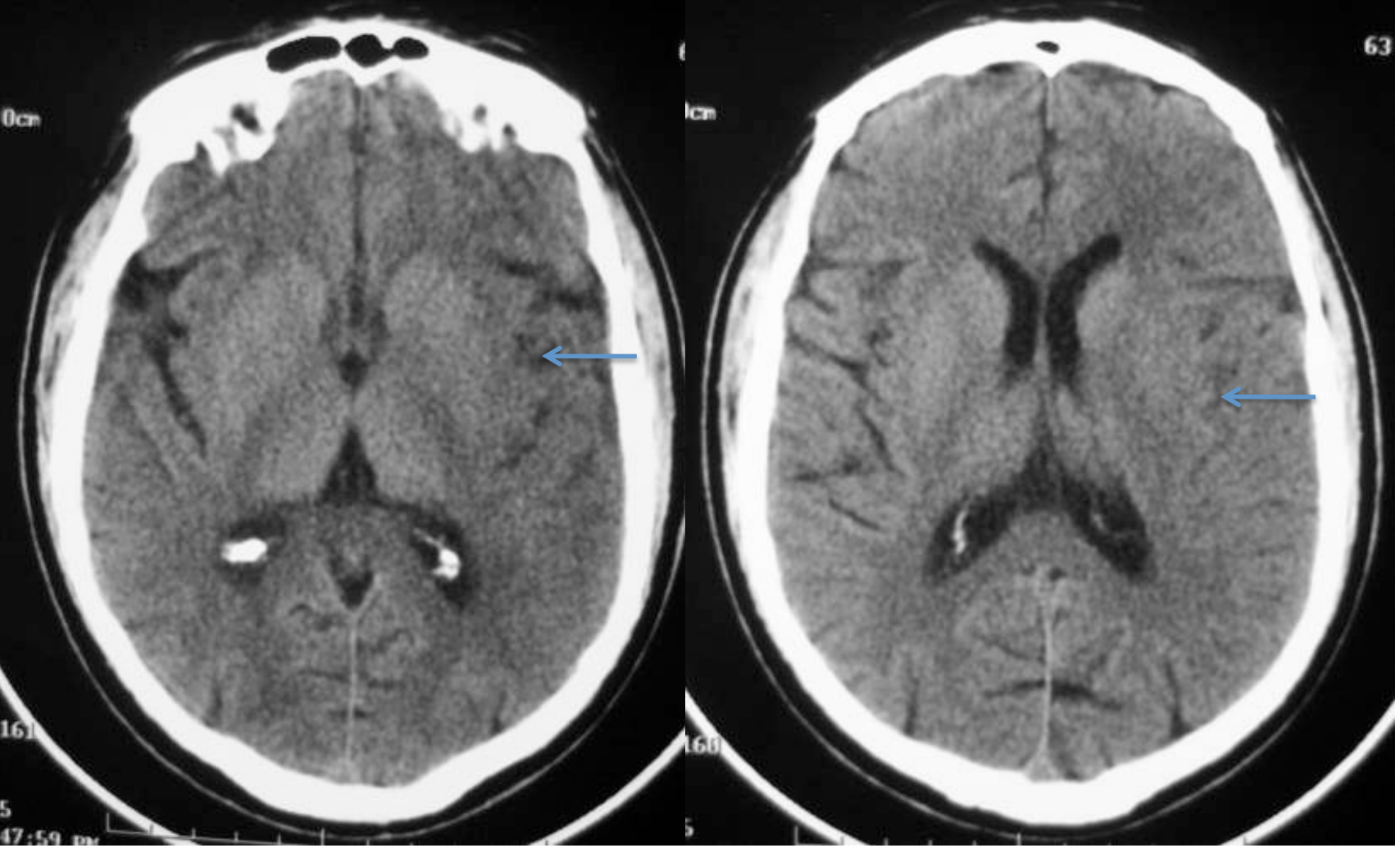


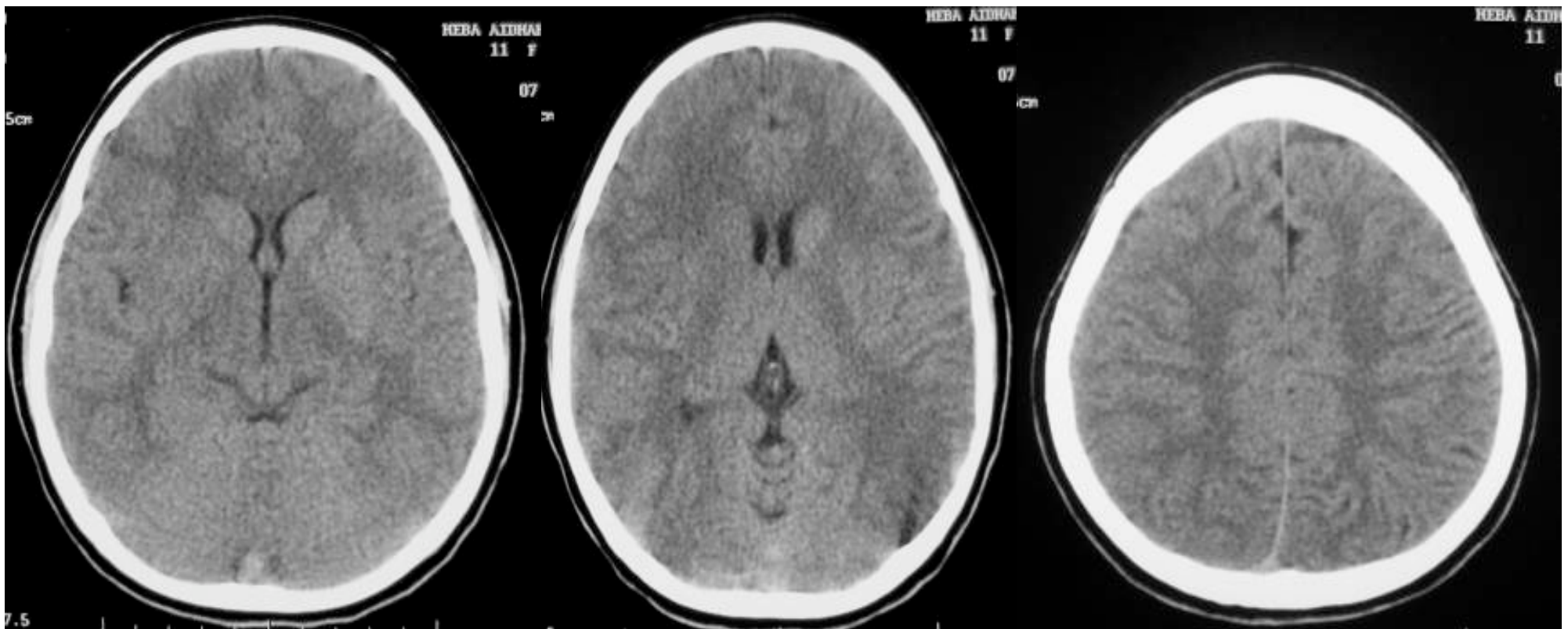


Loss of the triangular shape of the  
caudate

Infarction in the MCA, CT

An early image of a patient with stroke. The image may seem normal.  
Sulci is absent brain parenchyma is swollen, fluid will accumulate will be dark with time  
Basal ganglia, left side affected

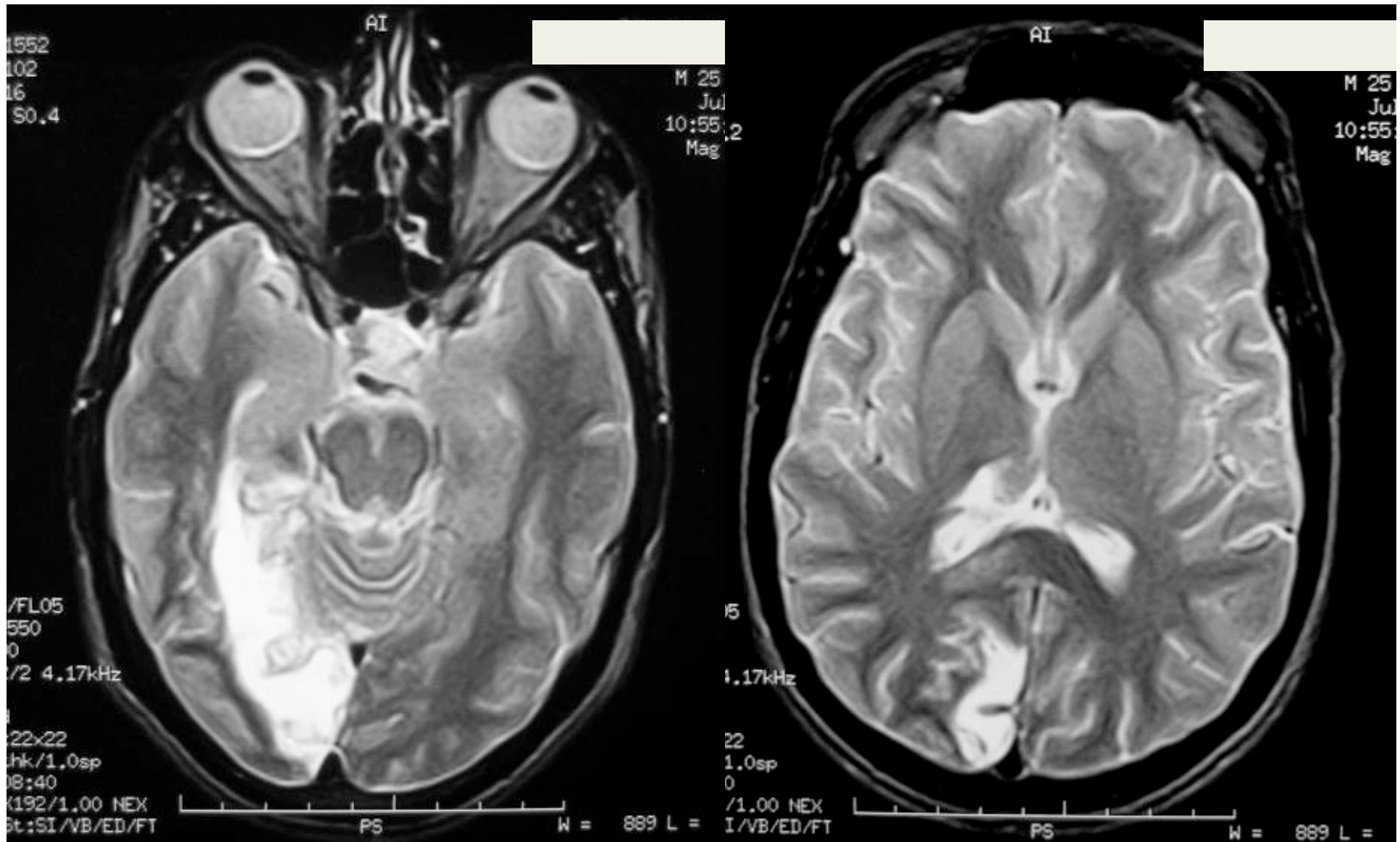




CT caudate nucleus, basal ganglia , right side affected, MCA infarction

Sulci and fissures effacement (due to edema that happens in acute cases of infarction. However, the brain is atrophied in chronic cases, as in the next slide)  
Only the area infarcted show effacement

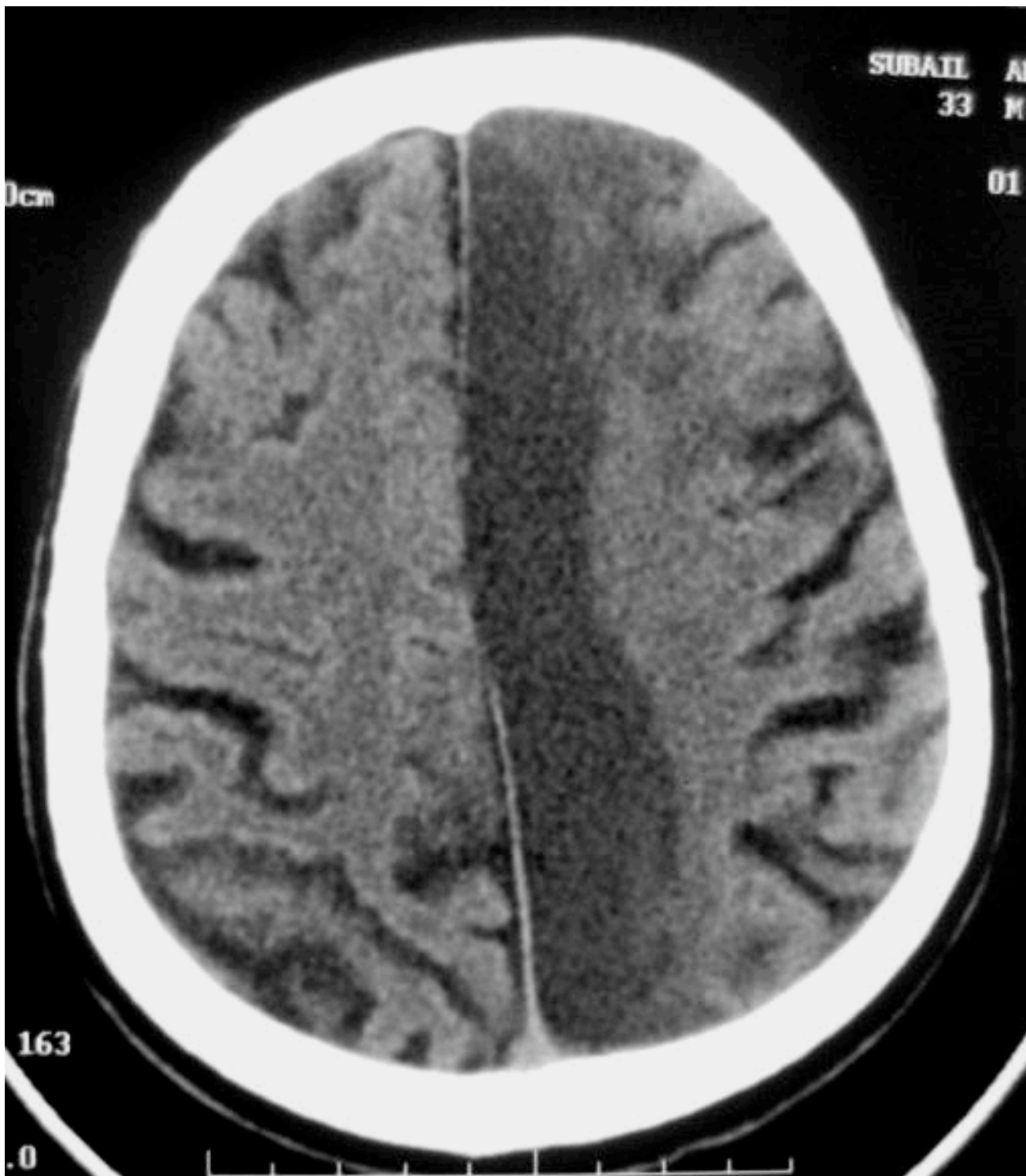




MRI, PCA supplies posterior medial aspect of thalamus, medial aspect of medial lobe (sulci is larger, tissue is replaced by fluid)



CT: PCA infarction, acute infarction (swollen tissue, sulci disappeared), blood in the ventricle, multiple infarction in the medulla (multiple is systemic)

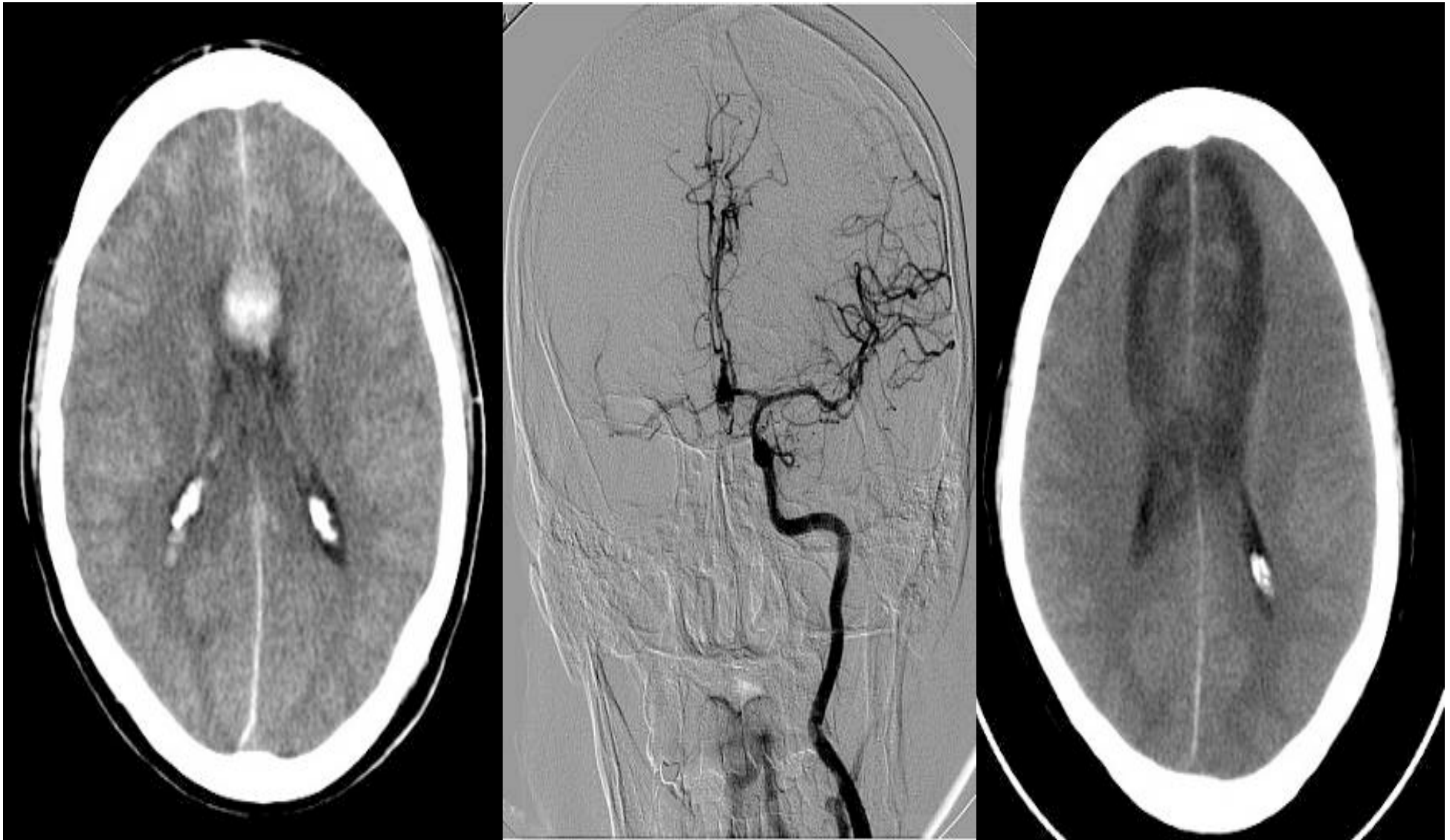


The effacement  
is shown in the  
affected area  
only

CT ACA  
infarction, acute  
because it is  
swollen

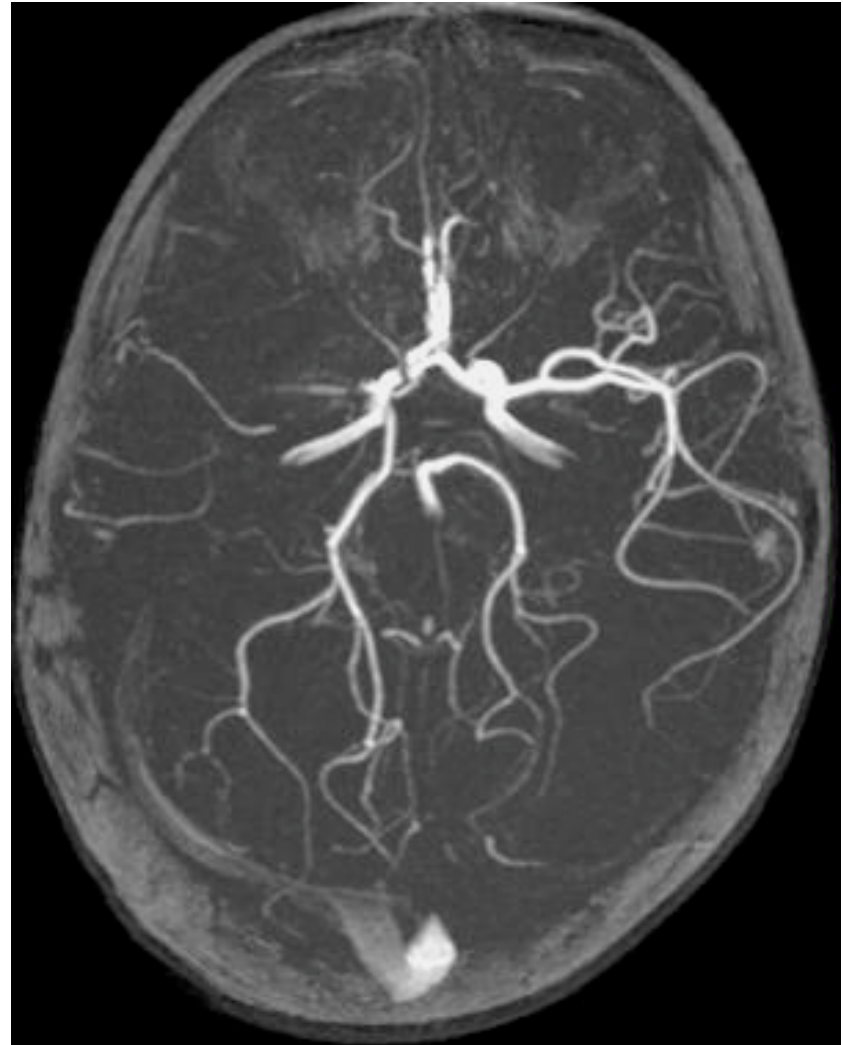
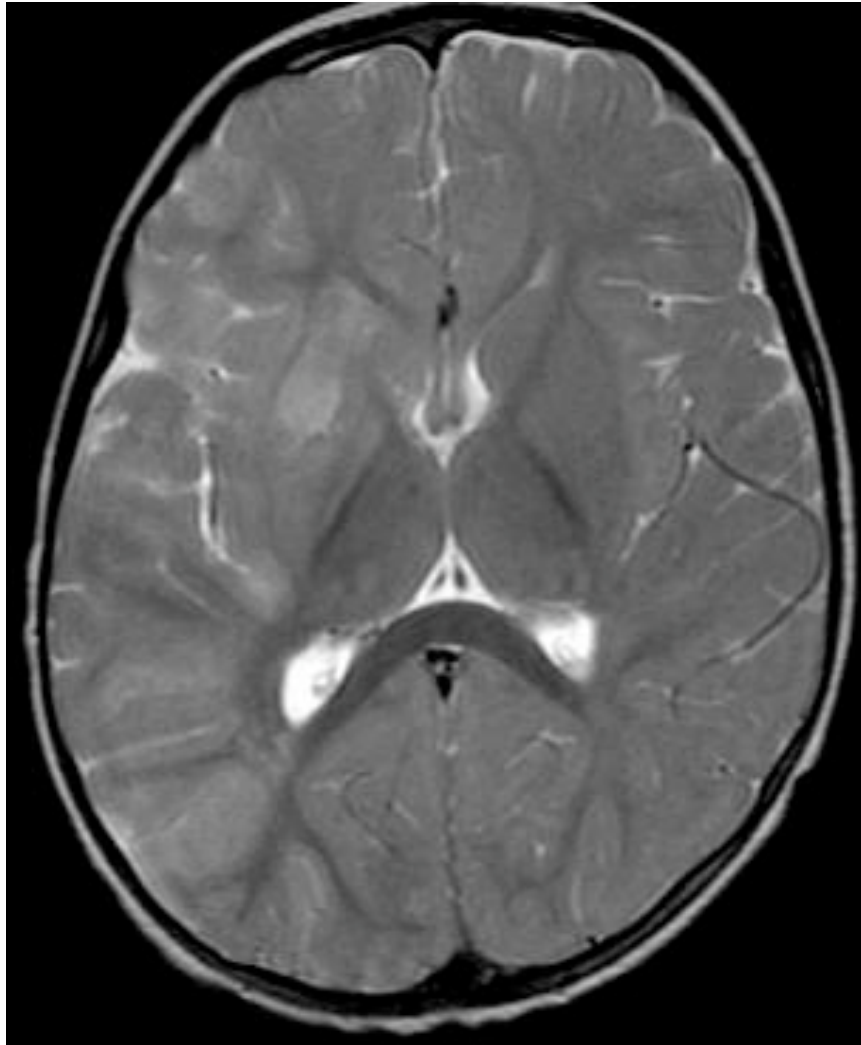


CT bilateral ACA, after an aneurysm clipping





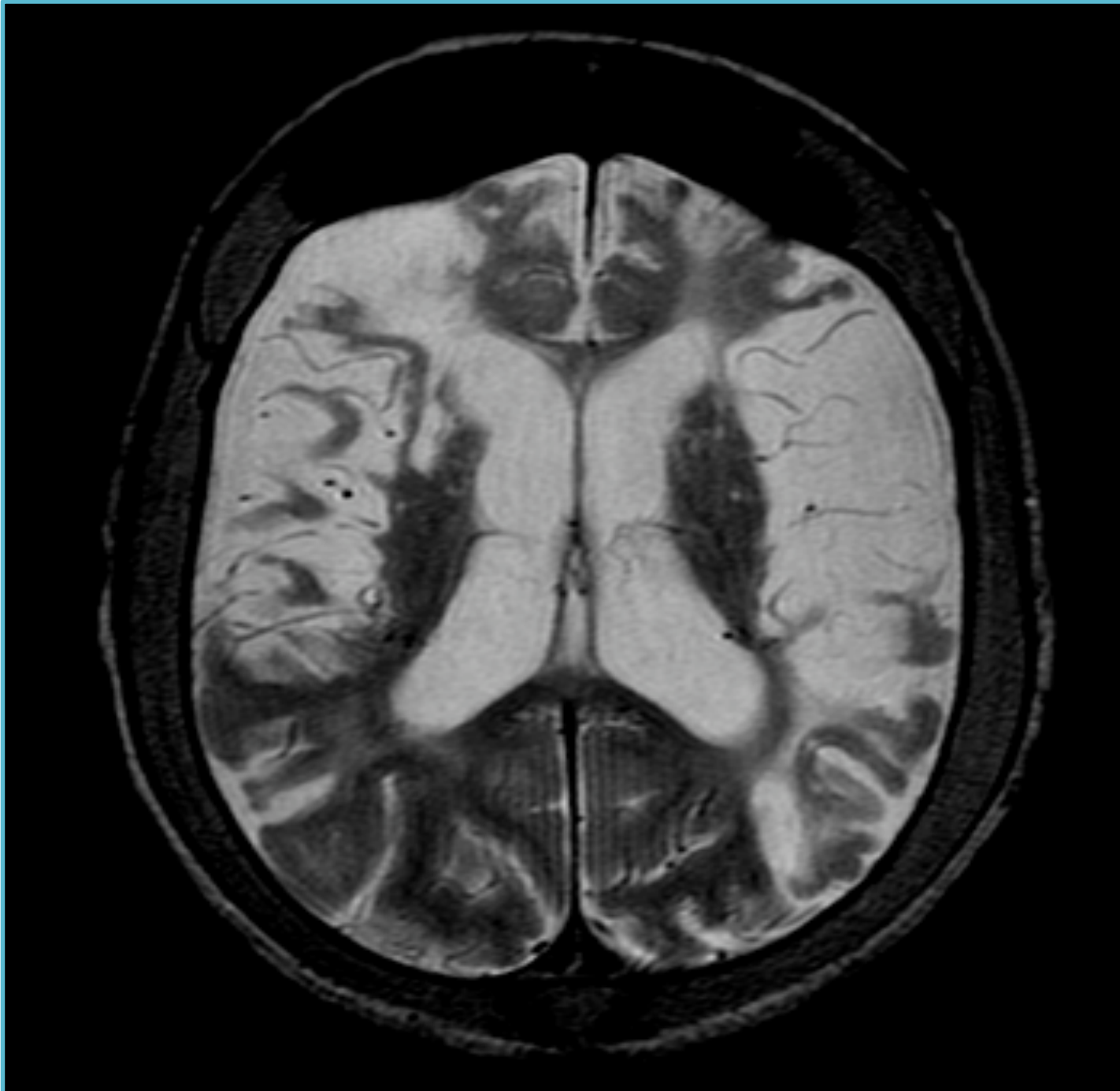
with contrast, MCA infarction, MCA occluded



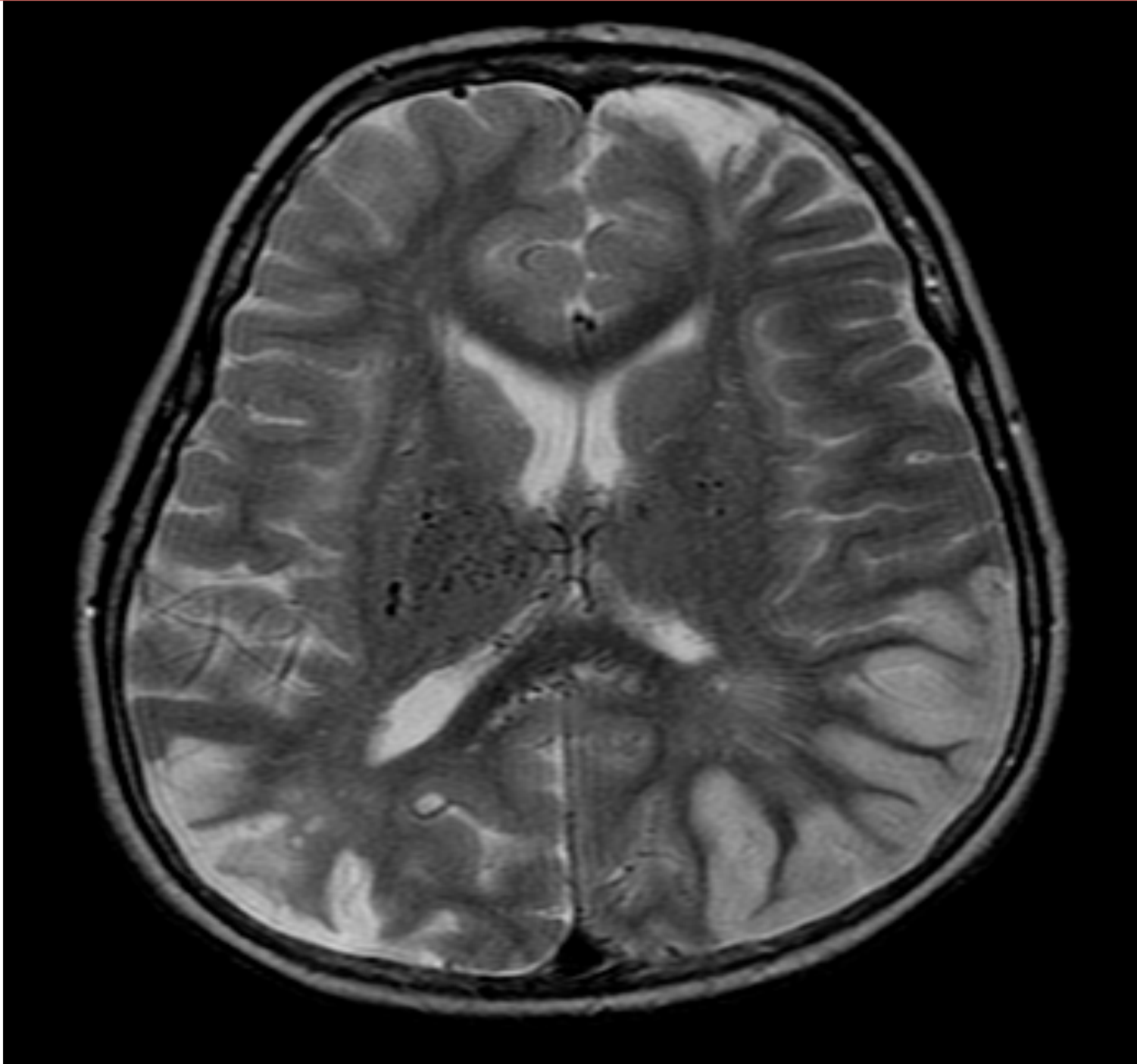


Infarction  
due to  
PICA  
aneurysm

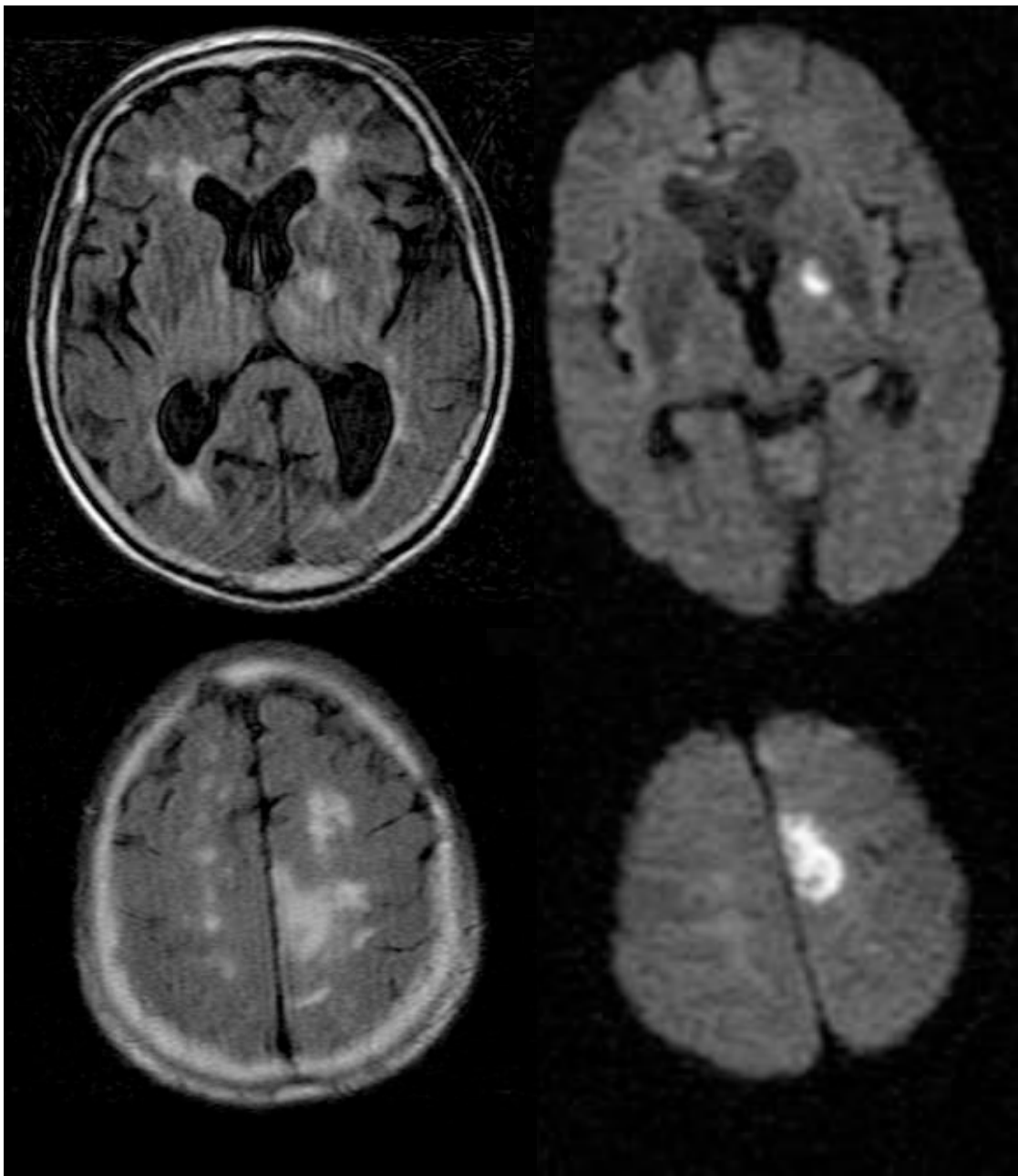
Bilareal MCA, tissue loss, chronic, large ventricles



sulci disappeared and gyri are large, repeated infarction, new vessel formation (dots)







**FLAIR**

### DWI

DWI (diffusion weighted MRI)

The type of MRI sequence used to identify areas of an organ, such as the brain, which have recently been damaged or injured.

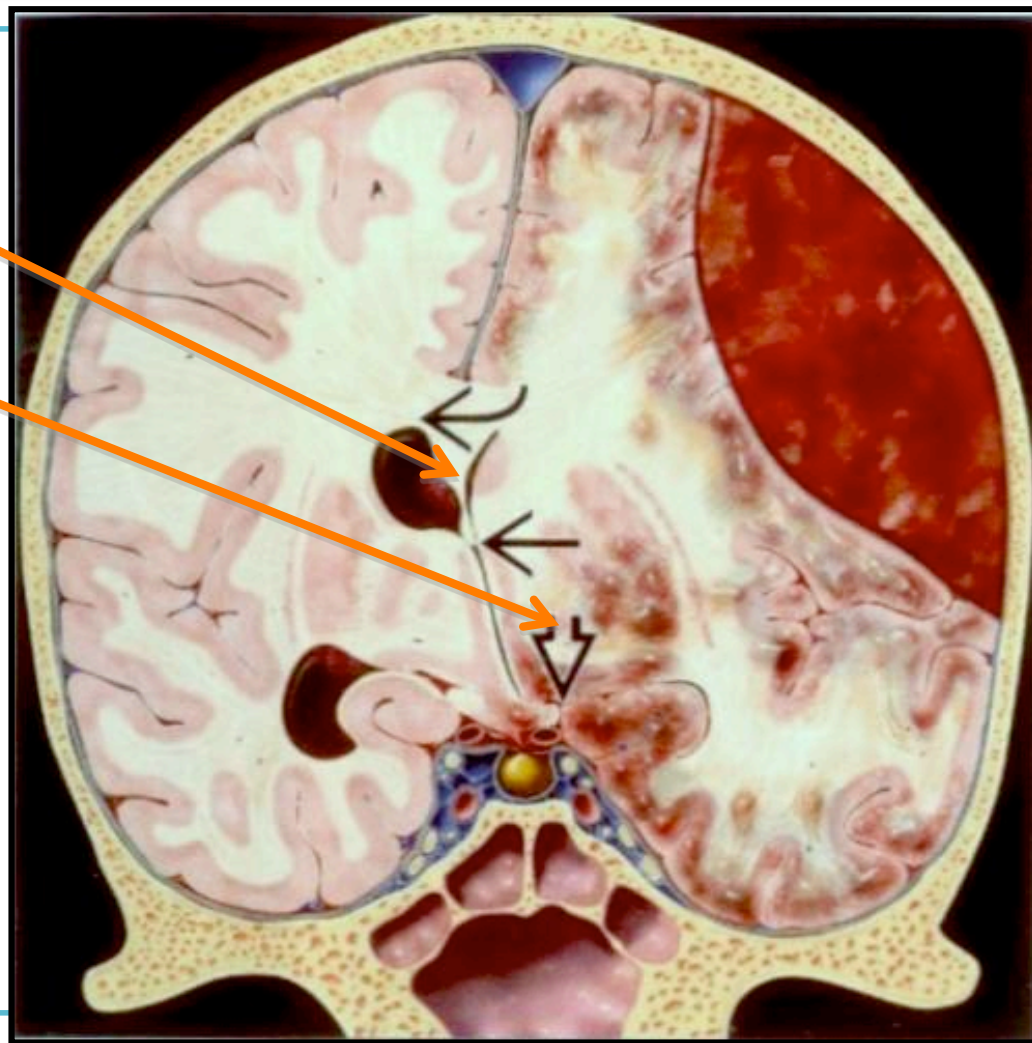
Picks up new and recent infarction

### 3. Intracranial herniations

- Subfalcine:
  - Mass effect
- Transtentorial
  - Unilat/Bilat

Large lesion → mass effect →  
hernia → blocks artery →  
infarction

Subfalcine → ACA  
Transtentorial → PCA



### 3. Intracranial herniations



- Herniations may lead to: Cranial neuropathy, compress vessels depending on the direction, may lead to infarction
- Image: hyperacute: severe mass effect, right ventricle herniated

## 4. Brain edema

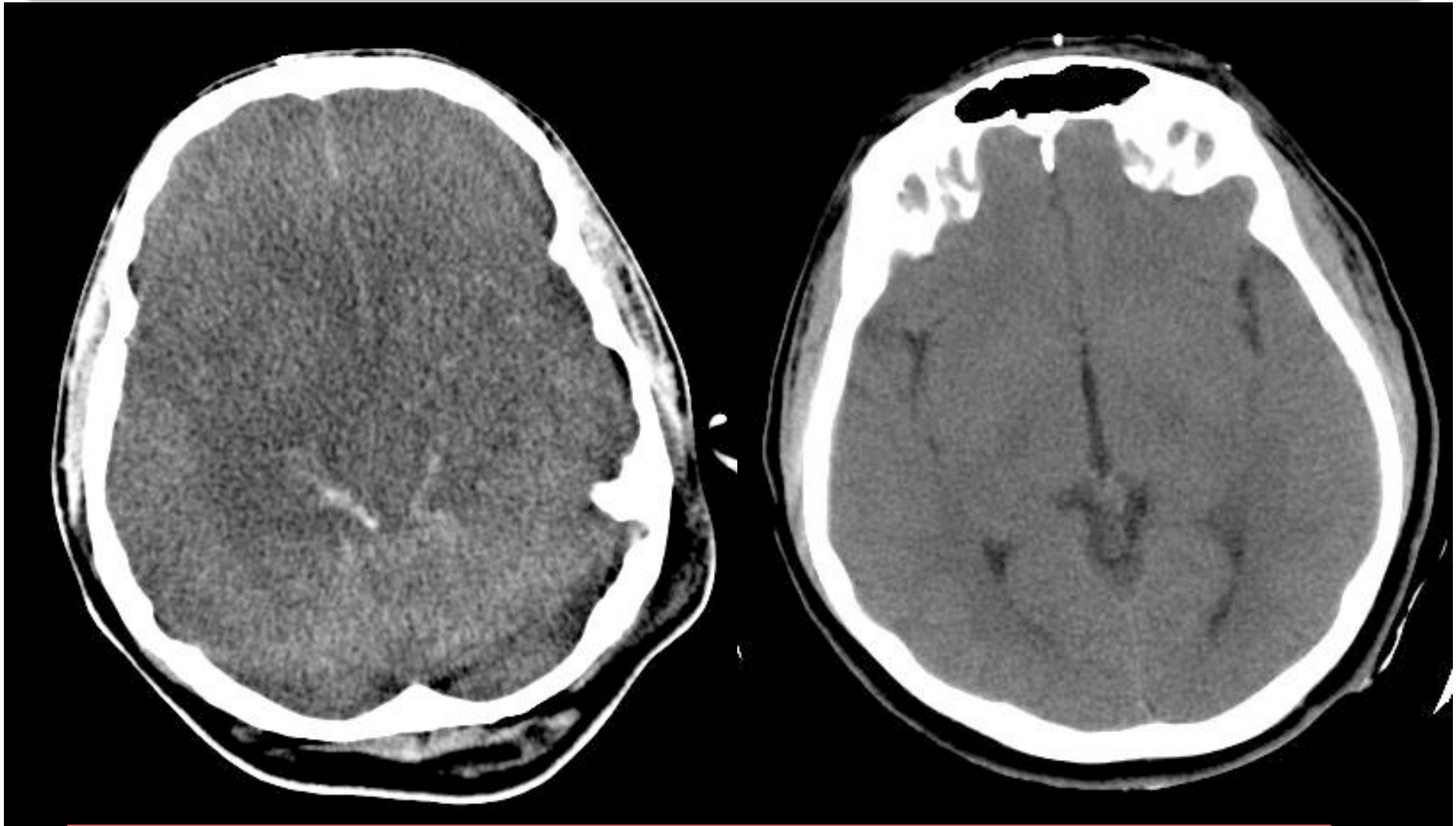
- Vasogenic:
  - Trauma/infection/inflammation/tumors
- Cytotoxic:
  - Ischemia/trauma
- Both could be generalized or localized
- Both may co-exist
- localized ex. ischemia or generalized ex. global ischemia in drowning



## 4. Brain edema

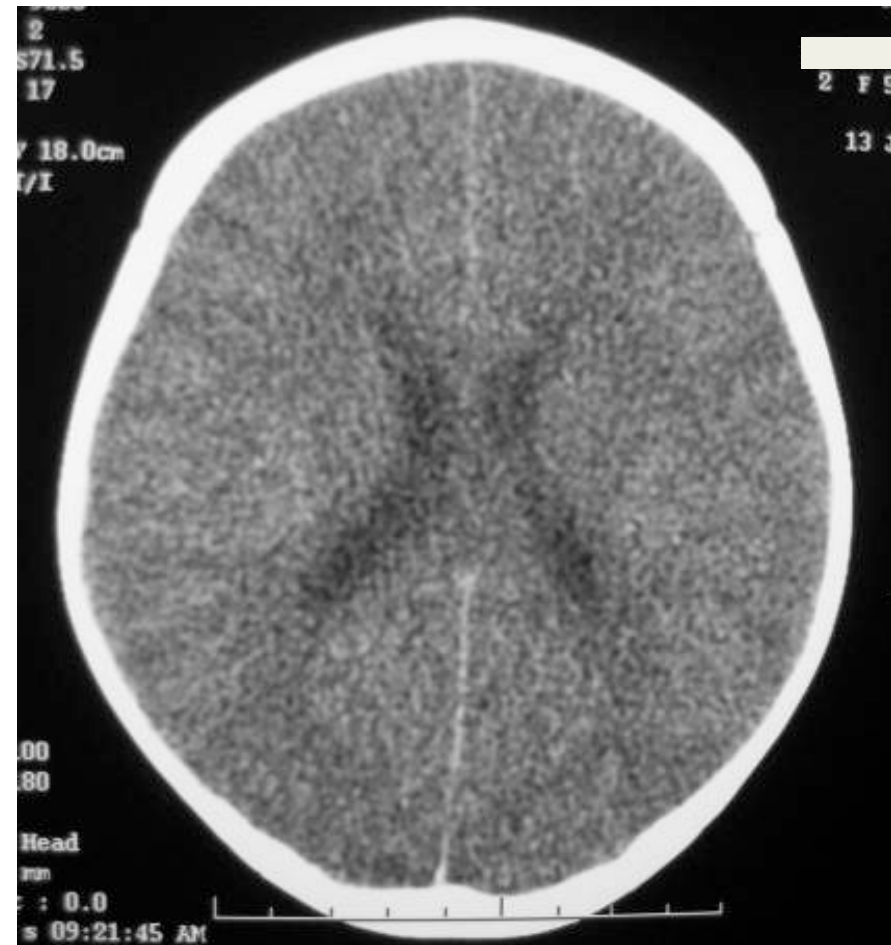
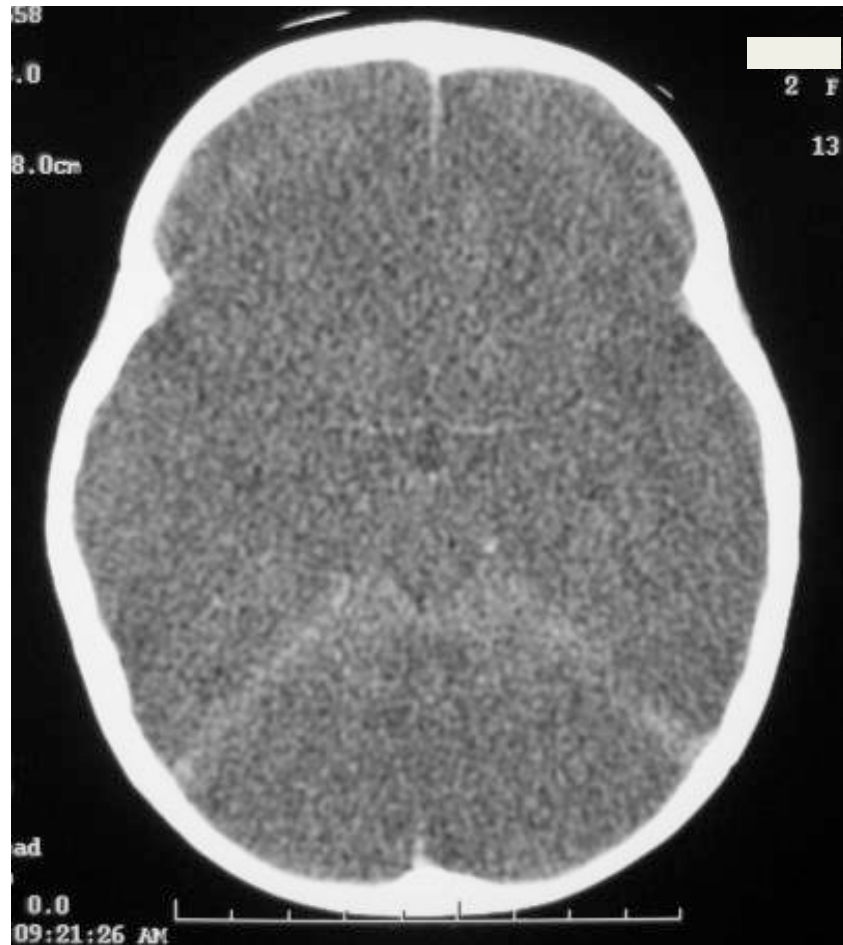
- Imaging findings:
  - Hypodensity on CT
  - Low signal on T1, high signal on T2 & FLAIR
  - Loss of GM/WM interface
  - Compressed ventricles
  - Effaced sulci & Cisterns
  - Dense cerebellum
  - Brain herniation
  - Vascular compression-ischemia

## 4. Brain edema



Interstitial (vasogenic) -Cytotoxic within the cells both generalized or localized

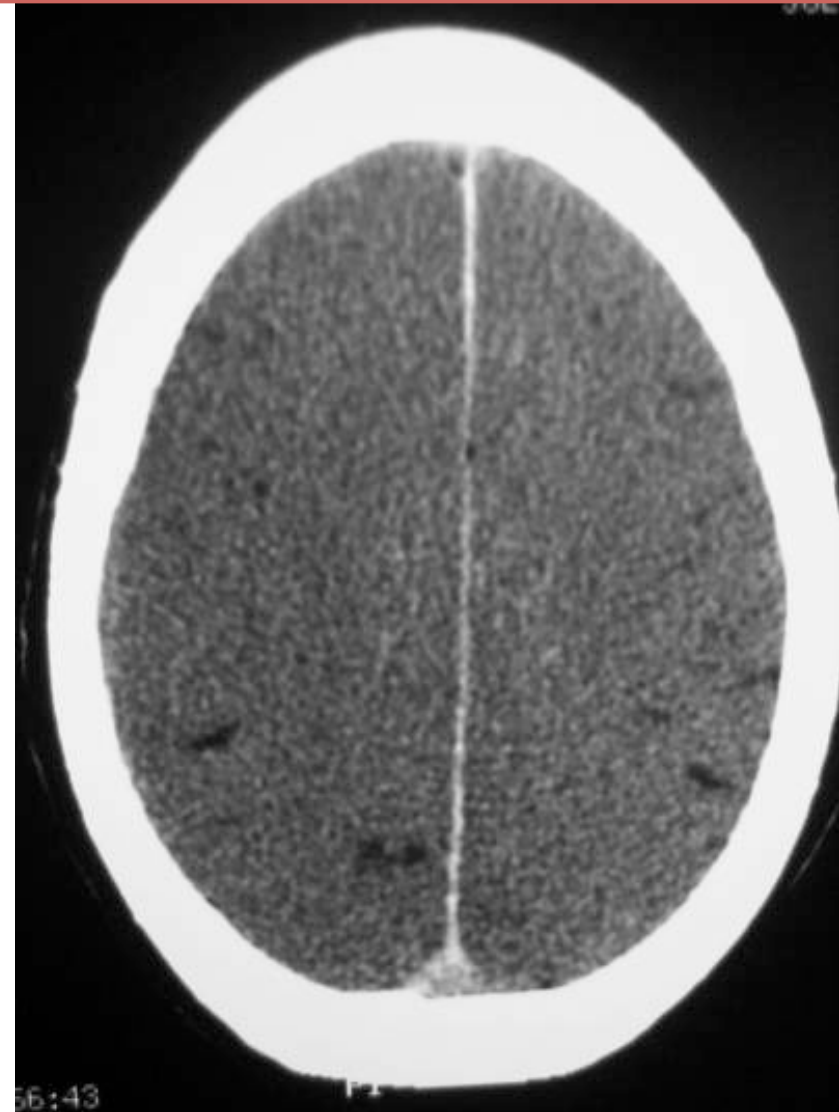
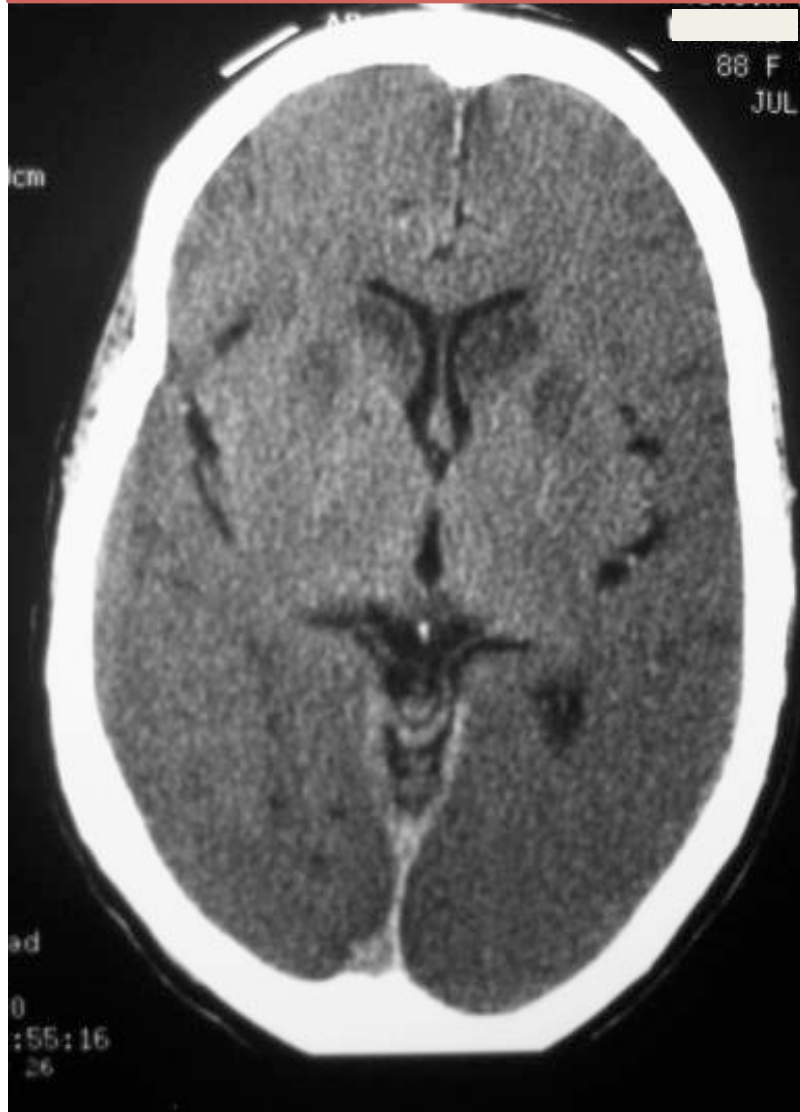
## 4. Brain edema



White and grey matter are the same color

## 4. Brain edema

CT left side, no ventricles or sulci, no differentiation between white and grey matter





## 4. Brain edema



Grainy image

## 4. Brain edema

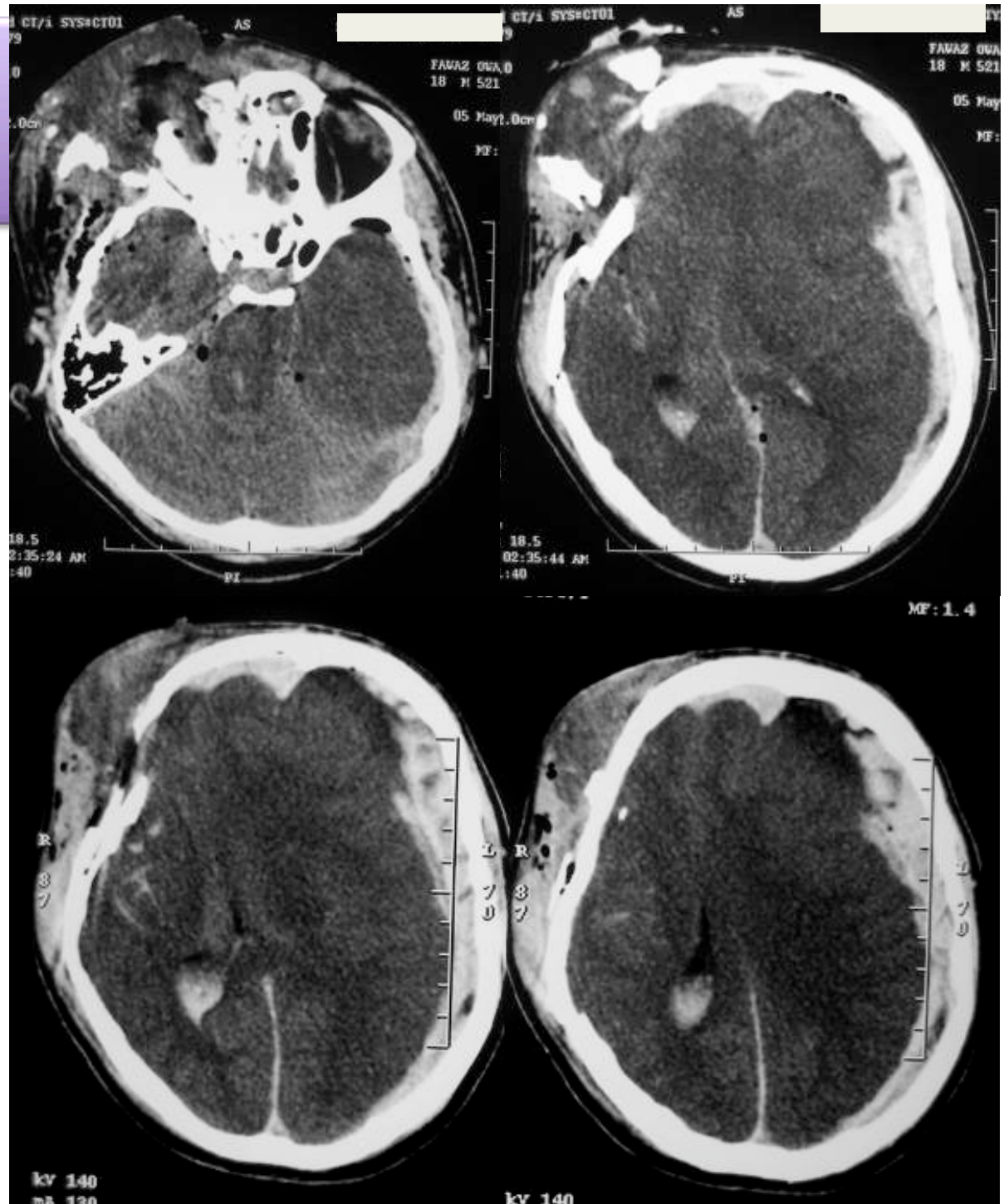
	Vasogenic	Cytotoxic
Location	White matter	Gray matter
DWI	Non-restricted	Restricted
Shape	Finger-like	Diffuse

Note: Restricted = Picked up  
by imaging

??

Pneumocephalis  
+ IVH + SDH +  
SAH

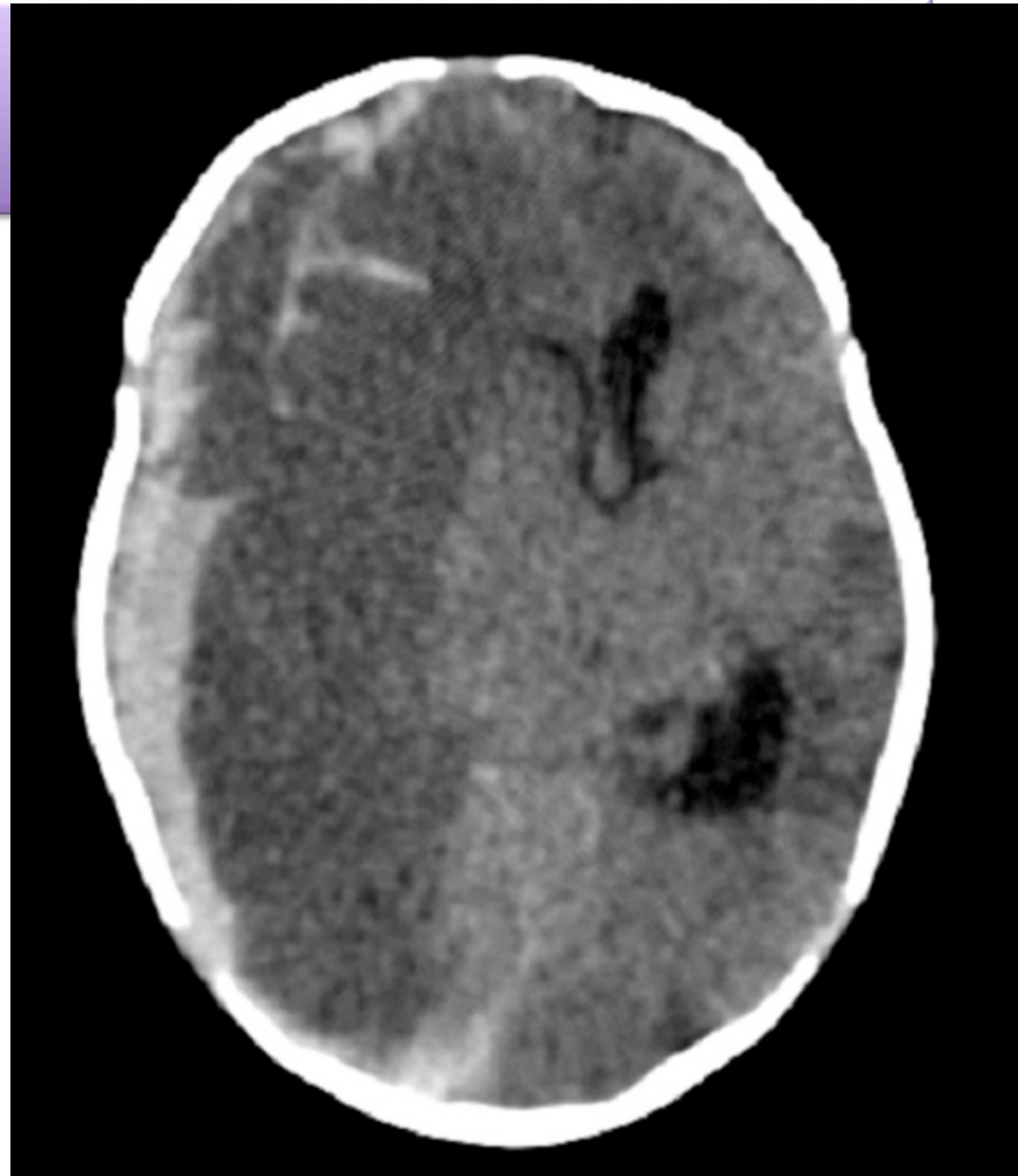
severe face trauma, face  
smashed  
Pneumocephalus, subdural,  
intraventricular,  
subarachnoid, brain  
herniation, cistern



??

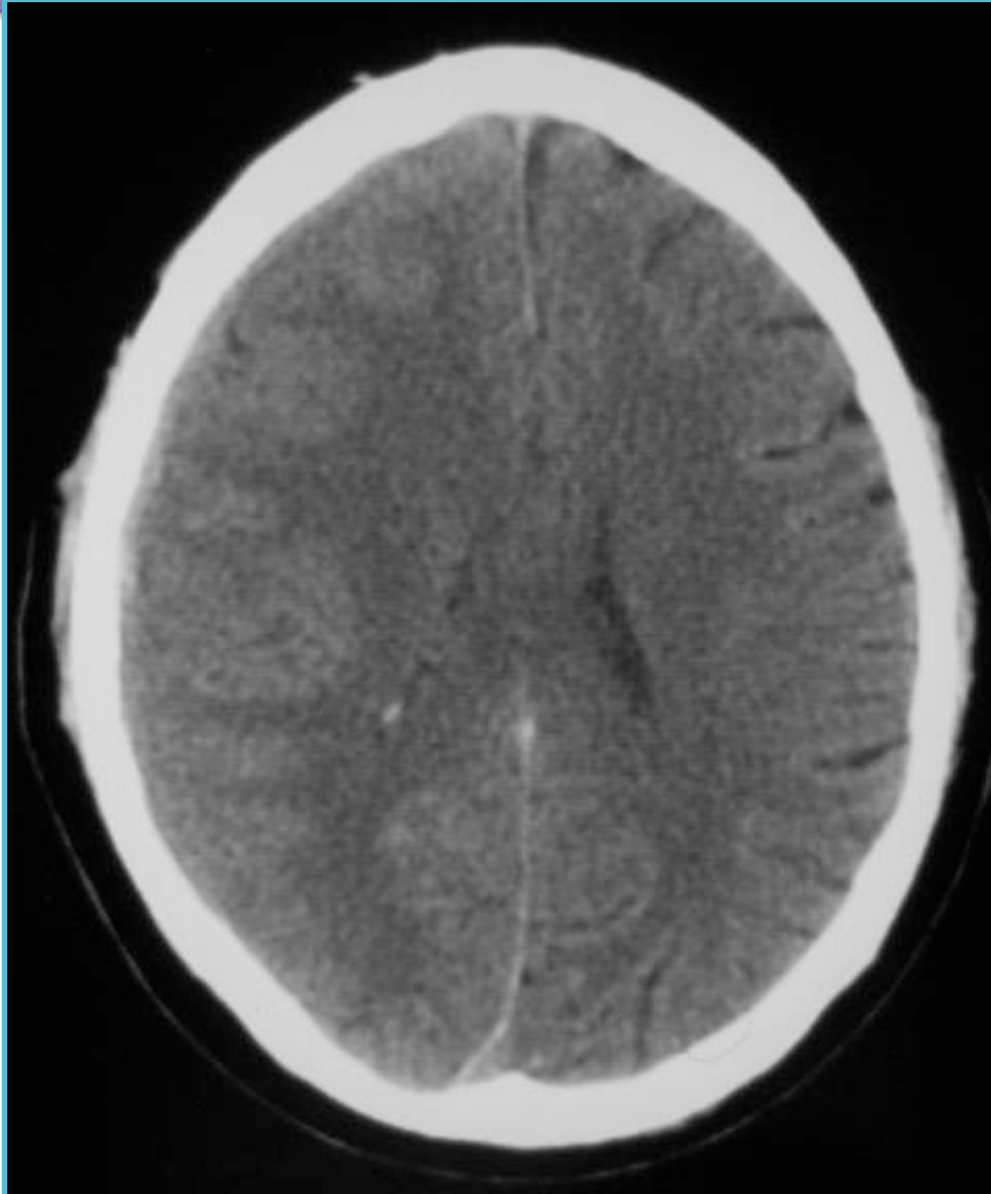
Infarction  
+ edema  
+ SAH

subdural hematoma, infarction  
due to vascular herniation





??



Right edema + SDH  
Not in the exam

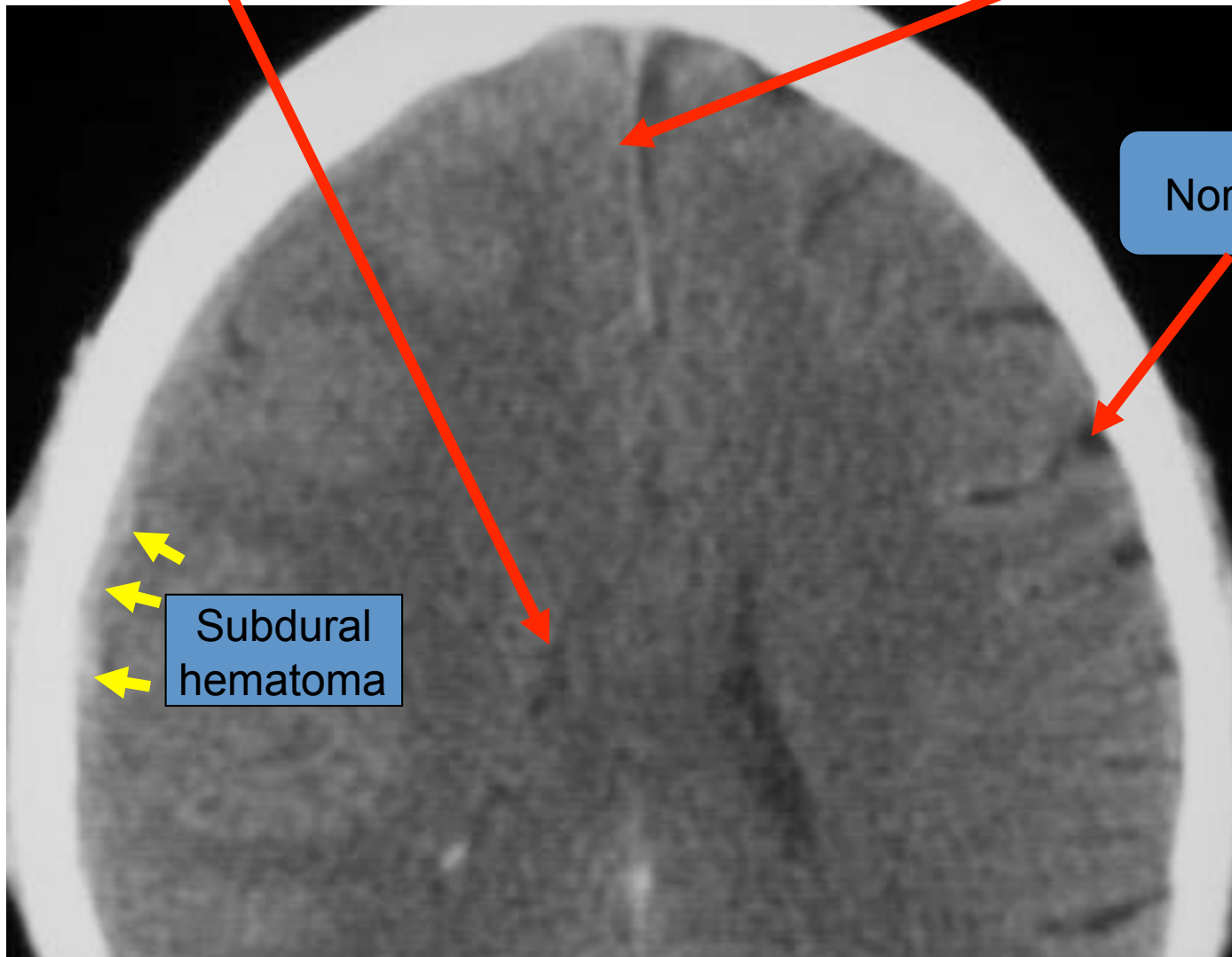
small band, subdural  
hematoma compresses  
the brain


Compressed  
lateral ventricle

Obliterated  
CSF space

Normal sulci

Subdural  
hematoma





Intracranial bleeding  
Brain infarctions  
Brain edema/herniation



"Success doesn't come to  
you . . . you go to it."