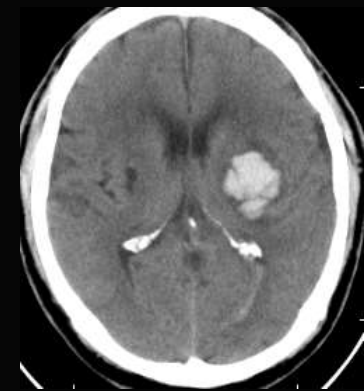


# Acute Non-traumatic Intracranial Hemorrhage *imaging approach*



Dr Manohar Aribandi MD, DABR

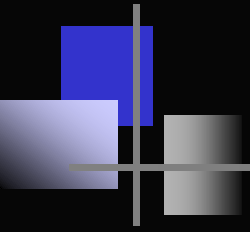


Senior Consultant Radiologist  
Teleradiology Solutions  
Hyderabad

# Acute Non-traumatic Intracranial Hemorrhage

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- Subarachnoid hemorrhage
- Intraparenchymal hemorrhage



# Subarachnoid Hemorrhage

# Subarachnoid Hemorrhage

- Acute severe headache – worst headache of life
- High mortality – 50%; high morbidity





# Subarachnoid Hemorrhage

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## Radiologist's role

- Diagnosis
- Etiology
- Complications

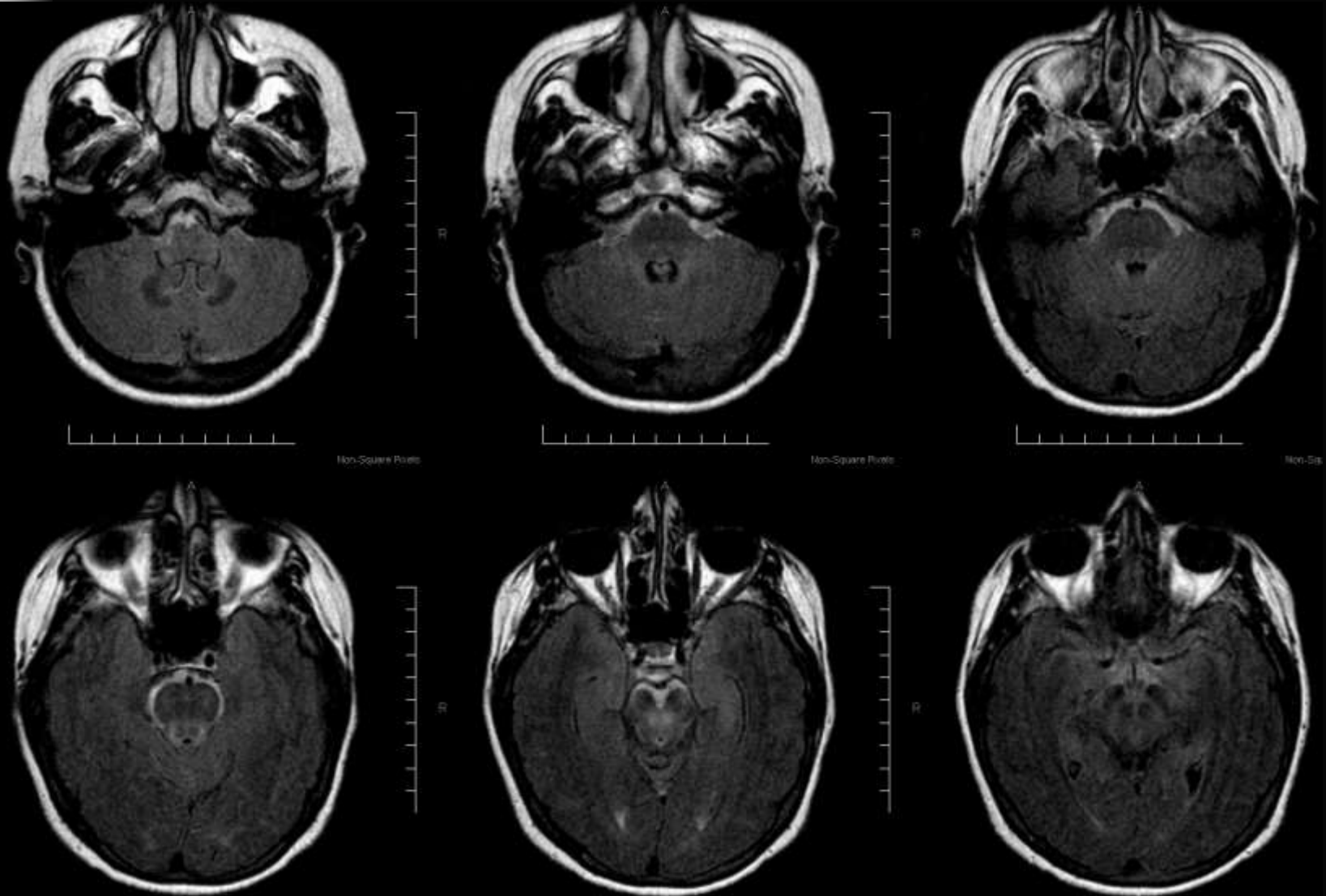
# Subarachnoid Hemorrhage

- Diagnosis
- Etiology
- Complications



- CT is best – 98%
- Hyperdensity in the Cisterns, sulci, surface
- Subtle SAH →
  - Interpeduncular
  - Perimesencephalic
  - Foramen magnum
  - Convexity sulci
- Pseudo SAH !
- > 12 hrs – LP (96%)
- MRI - FLAIR

# Subarachnoid Hemorrhage



FLAIR

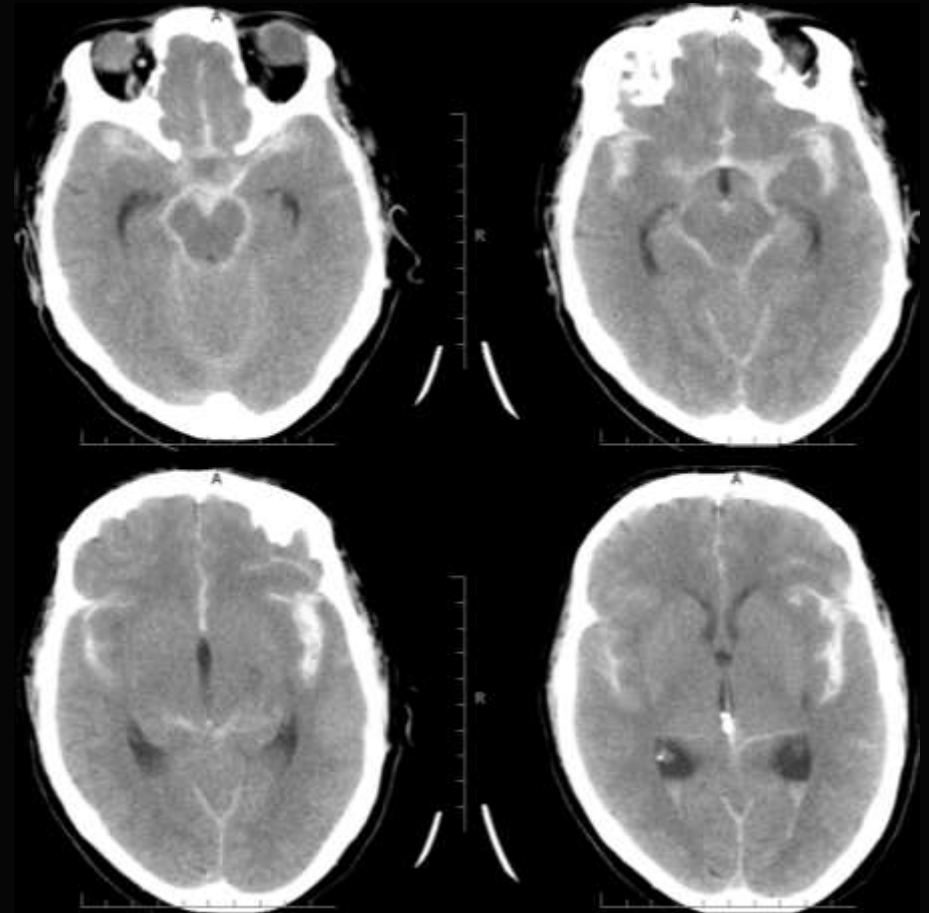
# Subarachnoid Hemorrhage

- Diagnosis
  - Etiology
  - Complications
- Aneurysm - 85%
  - Nonaneurysmal perimesencephalic hemg – 10%
  - Others – 5%



# Aneurysm

- Mild to severe  
(Fischer scale 1 -4)
- Basal cisterns
- Localizing value

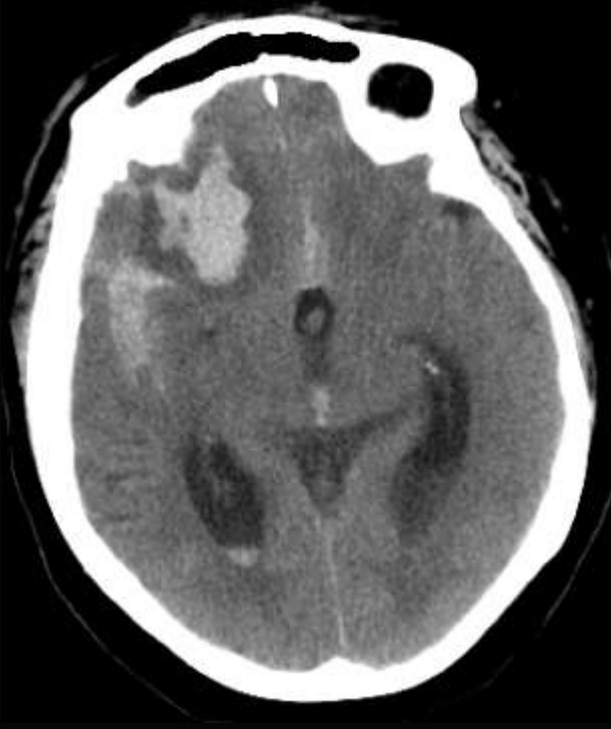


# Subarachnoid Hemorrhage

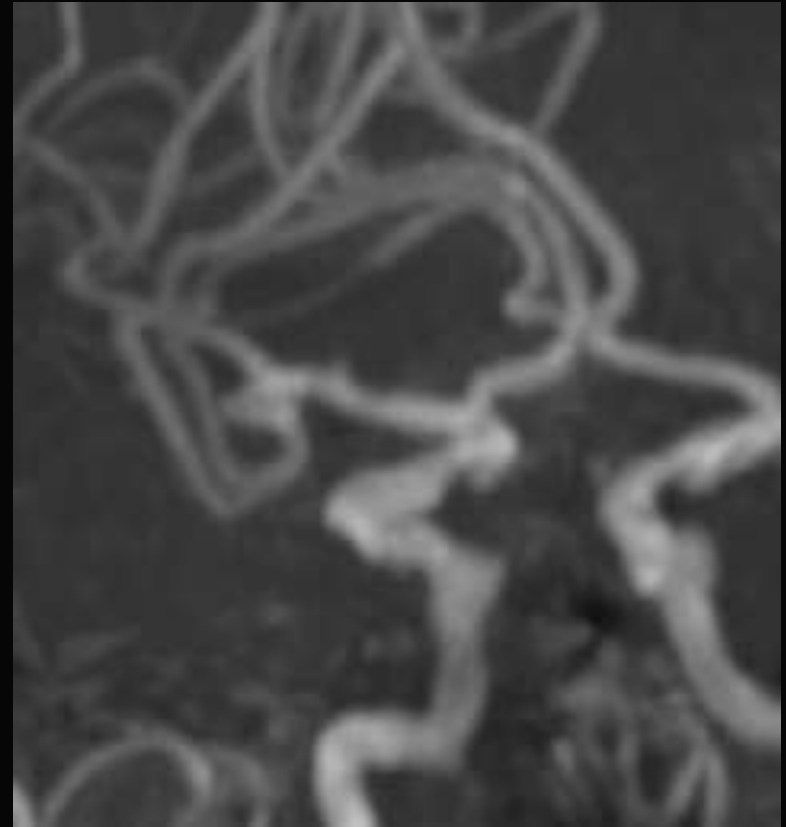
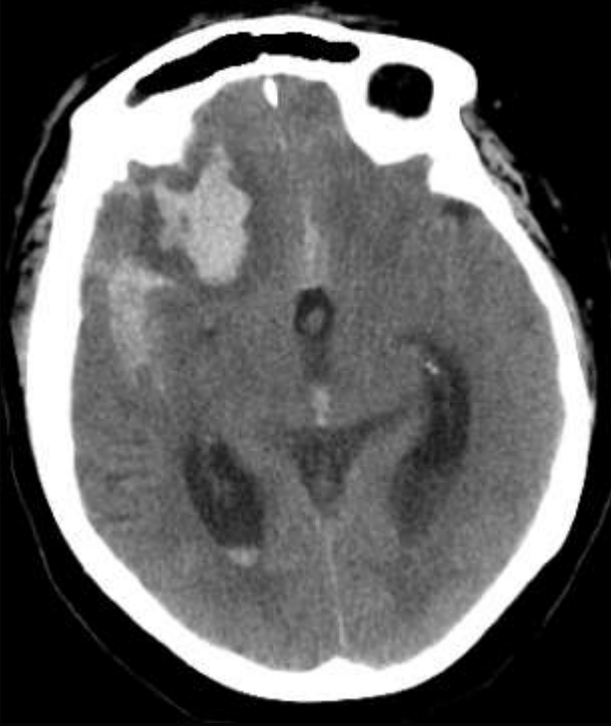
## Aneurysm

- CTA – 93% (metaanalysis in 2003)
- Quick, accurate, non-invasive
- Thin axials, sagittal and coronal reformatted images, MIP reformats, 3D
- Common locations – ACom, PCom, MCA,  
Basilar tip
- Multiple – 20% (which one has bled?)

# Aneurysm



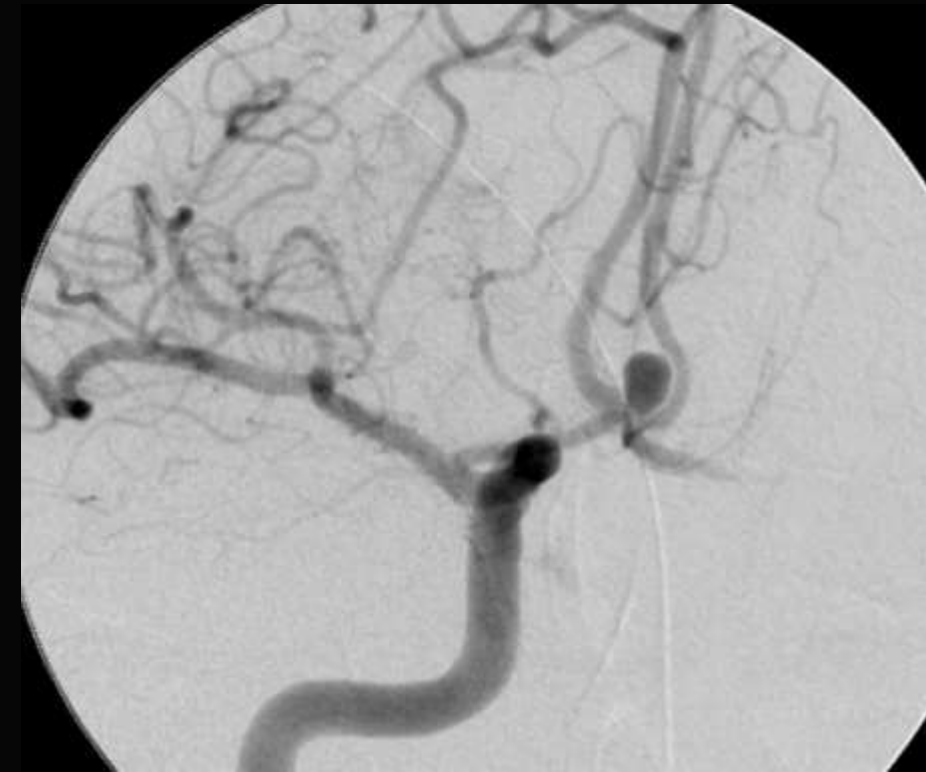
# Aneurysm



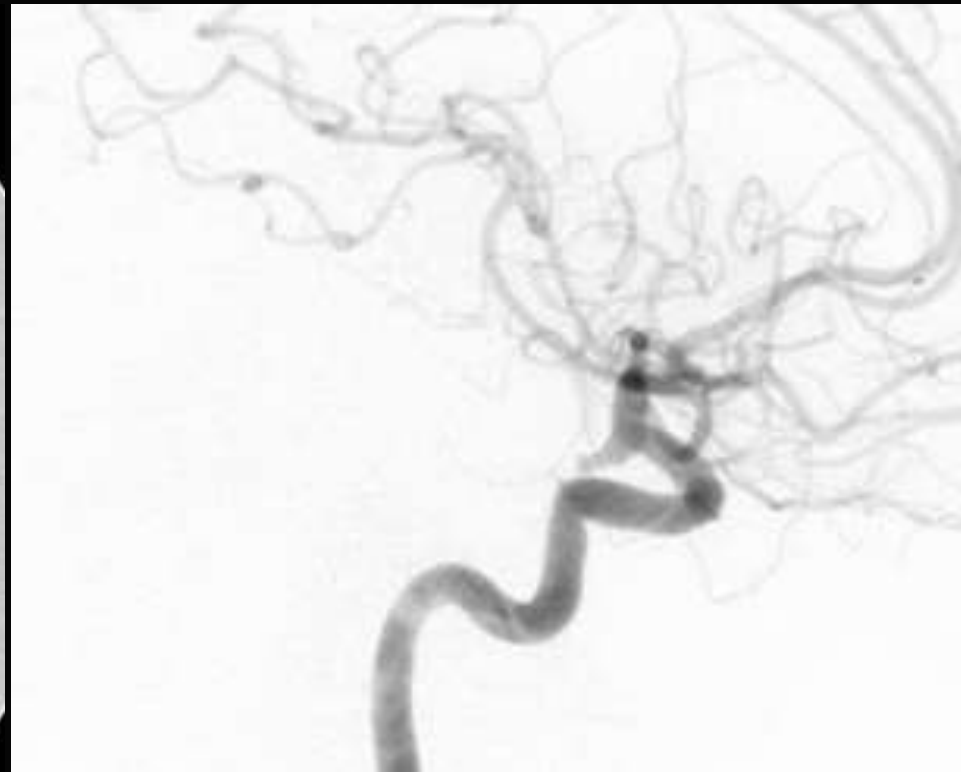
Rt MCA Aneurysm

# Aneurysm

## Multiple aneurysms



ACom



PCom

# Aneurysm

## Calcification in aneurysms



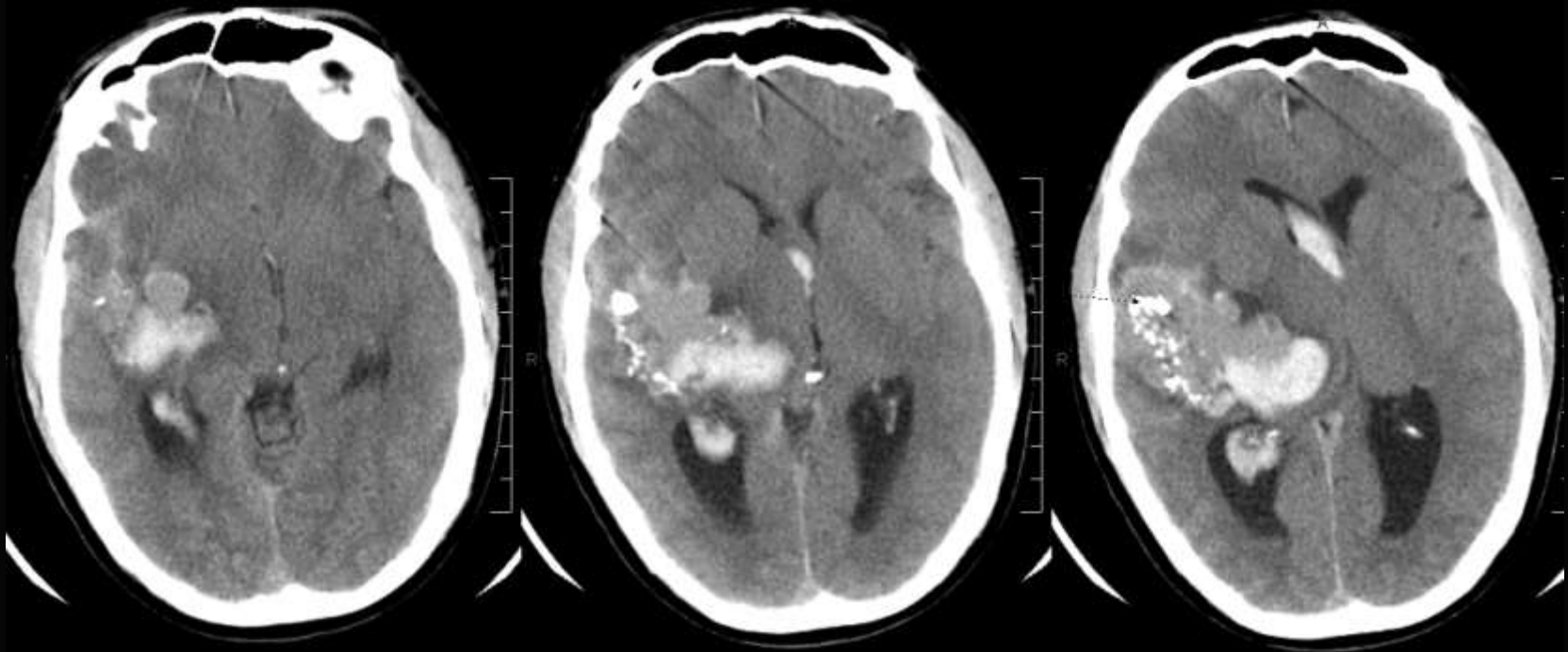
# Subarachnoid Hemorrhage

## Other causes

- AVM – mixed IPH + SAH
- Dural AV fistula
- Sinovenous thrombosis
- Nonaneurysmal perimesencephalic hemorrhage – no cause identified on CTA or angiography
- Other causes – vasculitis, RCVS

# Subarachnoid Hemorrhage

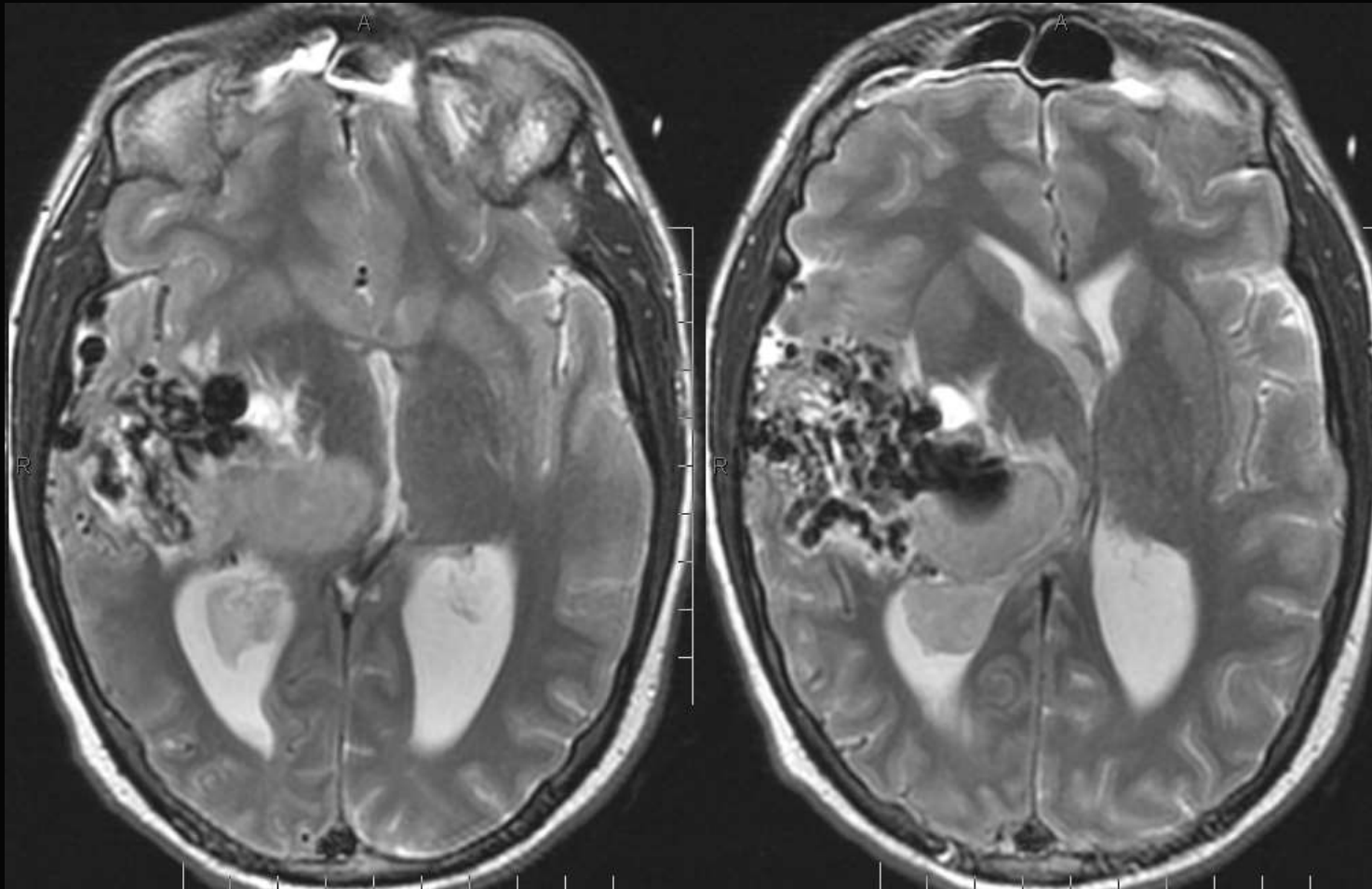
IPH + SAH due to AVM





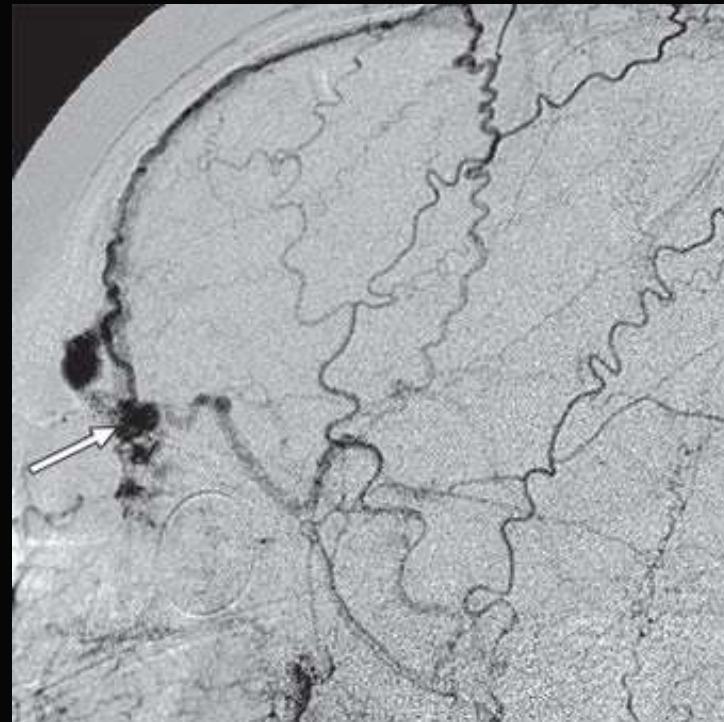
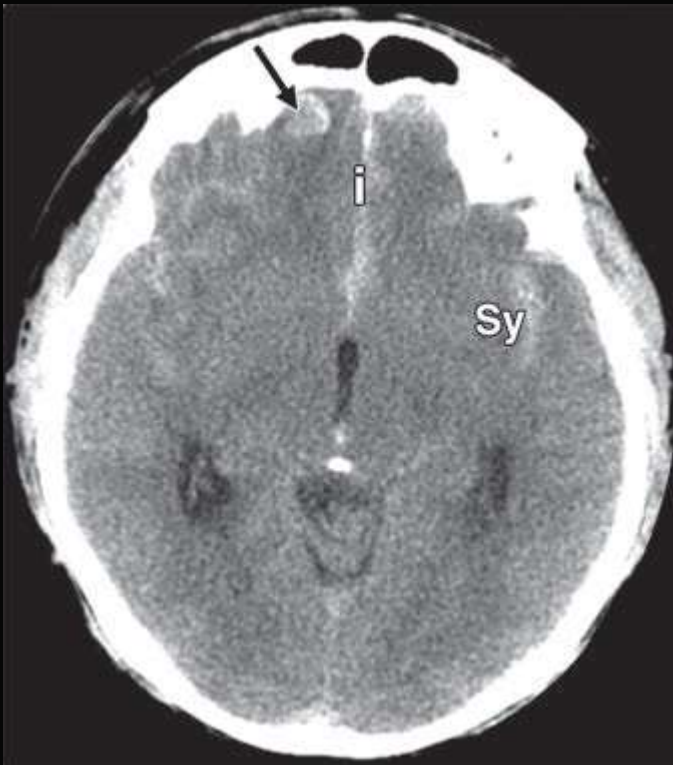
# Subarachnoid Hemorrhage

IPH + SAH due to AVM



# Subarachnoid Hemorrhage

SAH due to dural AV fistula





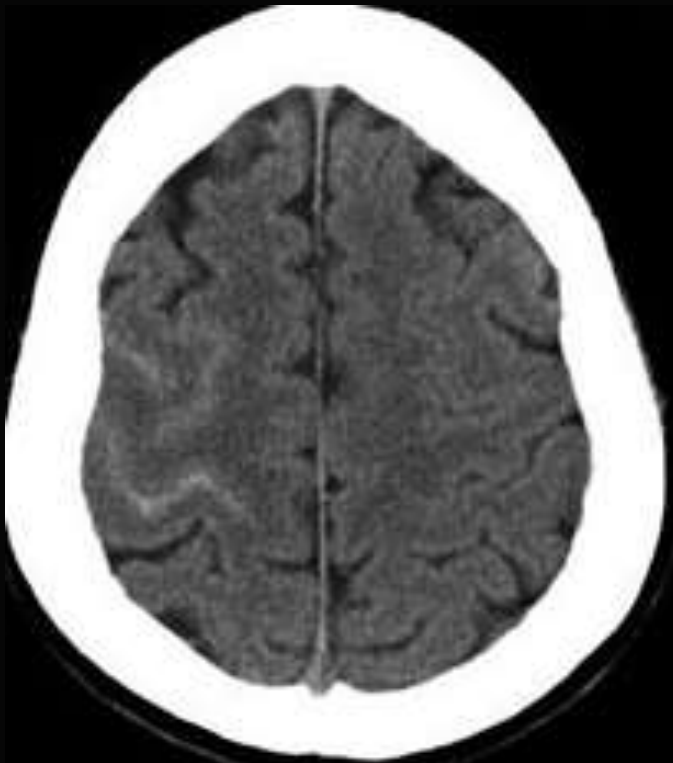
# Subarachnoid Hemorrhage

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Convexity sulcal SAH

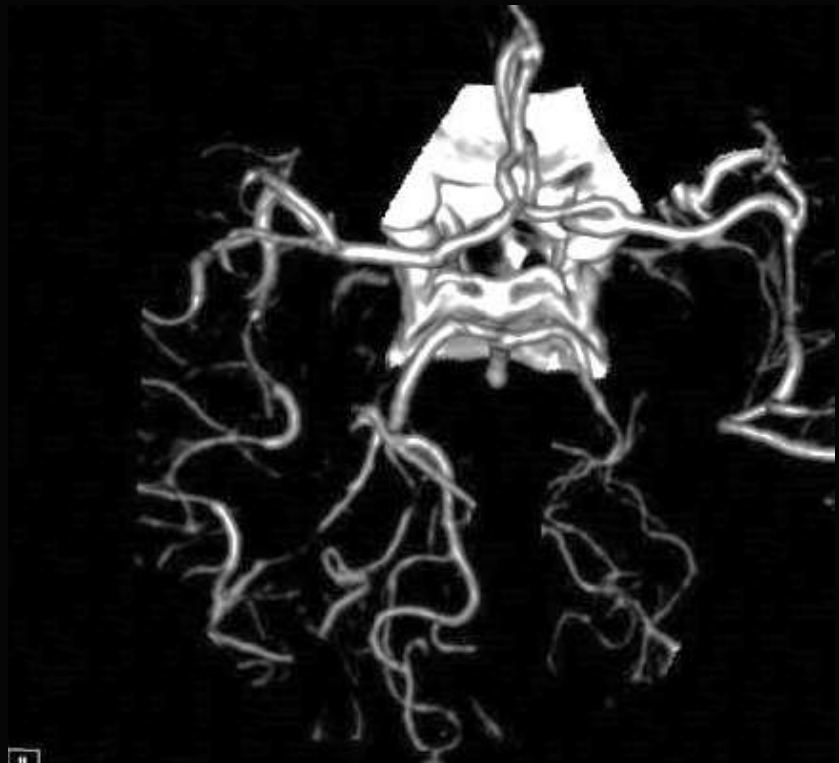
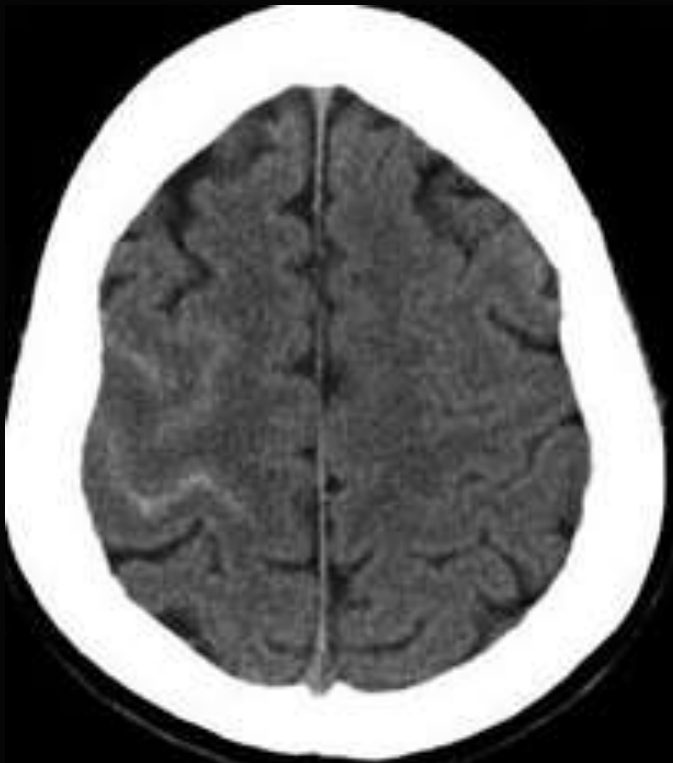
# Subarachnoid Hemorrhage

## Convexity sulcal SAH



# Subarachnoid Hemorrhage

## Convexity sulcal SAH



**Reversible cerebral vasoconstriction syndrome**

J Korean Neurosurg Soc. 2014 Nov;56(5):419-422

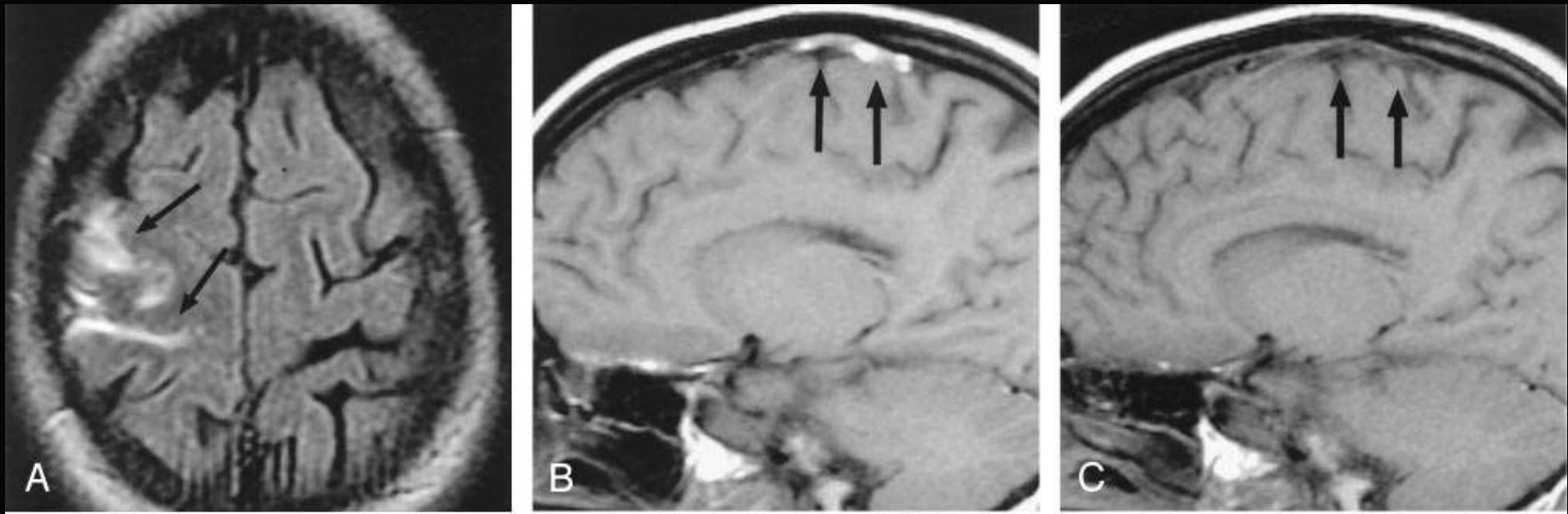
# Subarachnoid Hemorrhage

## Convexity sulcal SAH

- Complications are rare
- Etiology
  - Cortical vein thrombosis (CVT)
  - Cerebral amyloid angiopathy (CAA)
  - Posterior reversible encephalopathy syndrome (PRES)
  - Reversible cerebral vasoconstriction syndrome – **younger patients**
  - Vasculitis

# Subarachnoid Hemorrhage

## SAH due to cortical vein thrombosis



Follow up

# Subarachnoid Hemorrhage

Perimesencephalic nonaneurysmal  
subarachnoid hemorrhage (pnSAH)





# Subarachnoid Hemorrhage

## Perimesencephalic nonaneurysmal subarachnoid hemorrhage (pnSAH)

- 10 % of all SAH
- Around the pons, midbrain
- CTA negative - Angio negative
- Probably venous bleed
- Benign outcome – no rebleed, vasospasm, or ischemia



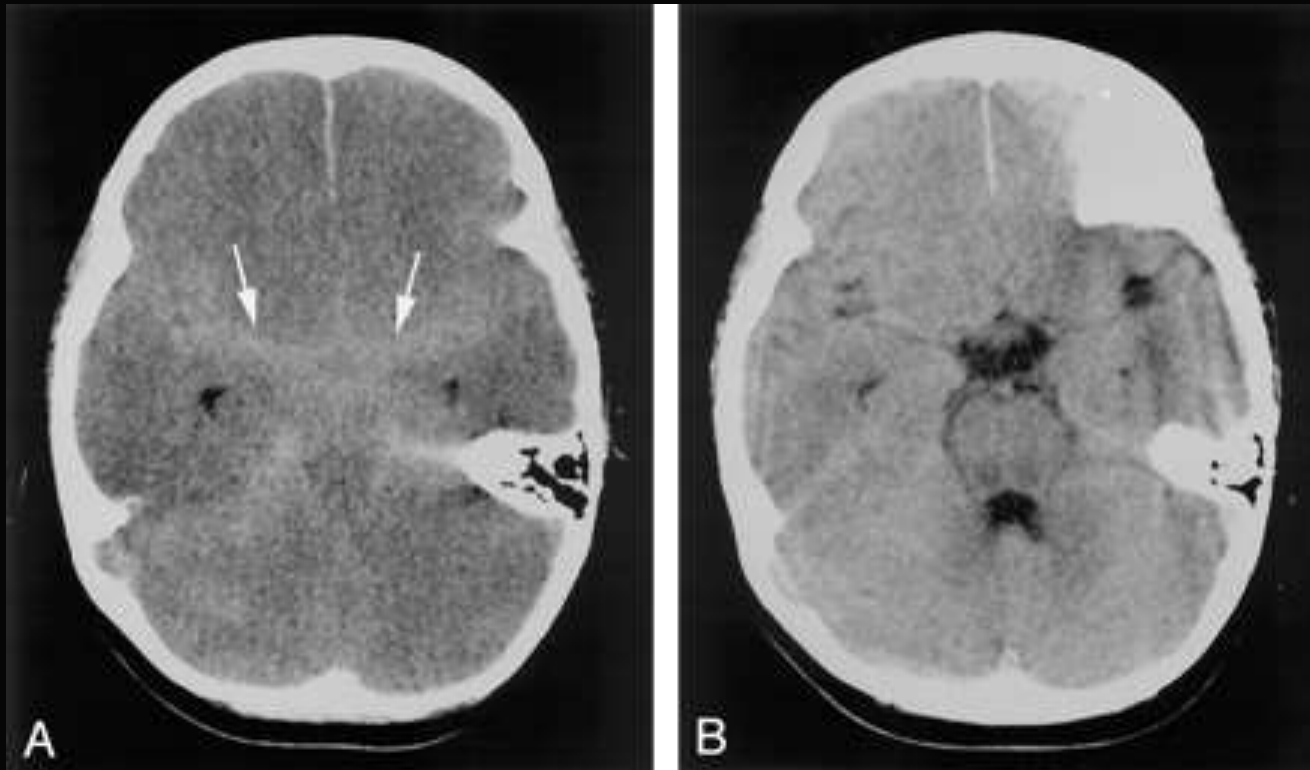
# Subarachnoid Hemorrhage

## Pseudo SAH !!

- Meningitis – pyogenic, carcinomatosis
- Diffuse cerebral edema, Global Hypoxia
- Contrast – delayed imaging, intrathecal
- Venous angioma on NCCT
- Cortical vein thrombosis

# Subarachnoid Hemorrhage

**Pseudo SAH !!**



A

Diffuse Hypoxia

B

3 days prior - Normal

# Subarachnoid Hemorrhage

## Radiologist's role

- Diagnosis
- Etiology
- Complications →
  - Hydrocephalus
  - Rebleed
  - Vasospasm/Ischemia

# Subarachnoid Hemorrhage

## Complications



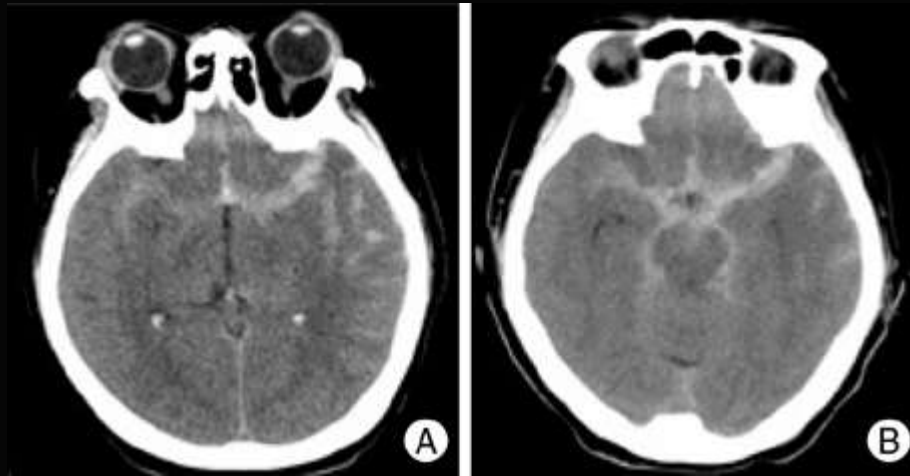
- Hydrocephalus
- Rebleed
- Vasospasm/Ischemia

# Subarachnoid Hemorrhage

## Complications

Initial CT

8 hrs later



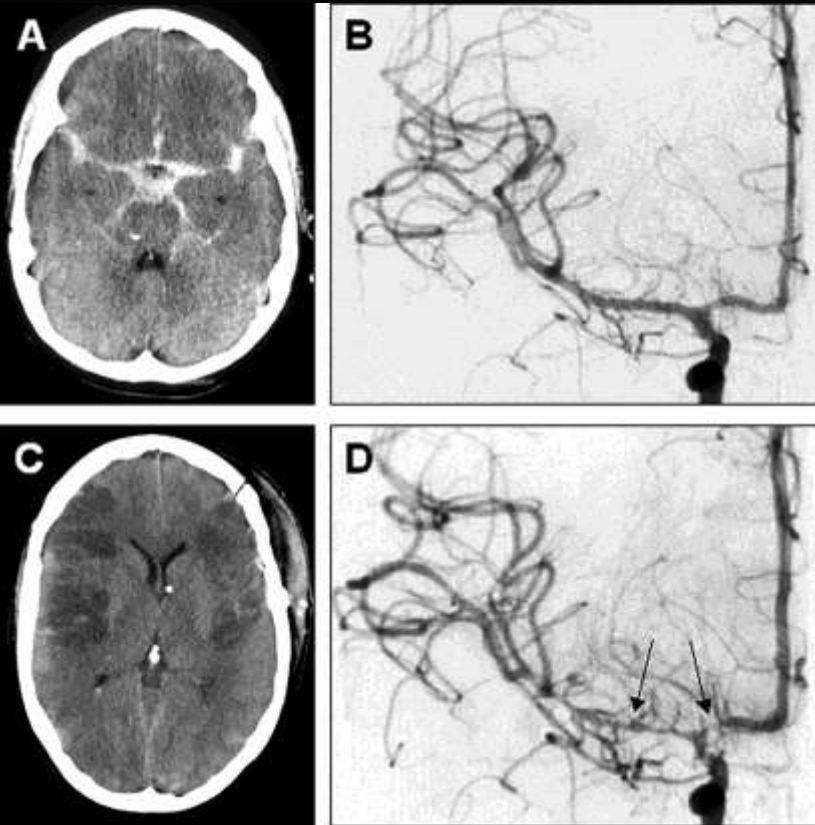
Ruptured Lt MCA aneurysm

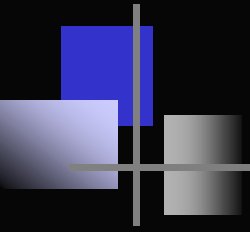
- Hydrocephalus
- Rebleed
- Vasospasm/Ischemia

# Subarachnoid Hemorrhage

## Complications

- Hydrocephalus
- Rebleed
- Vasospasm/Ischemia





# Intraparenchymal Hemorrhage





# Intraparenchymal Hemorrhage

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## Radiologist's Role

- Diagnosis
- Etiology
- Complications



# Intraparenchymal Hemorrhage

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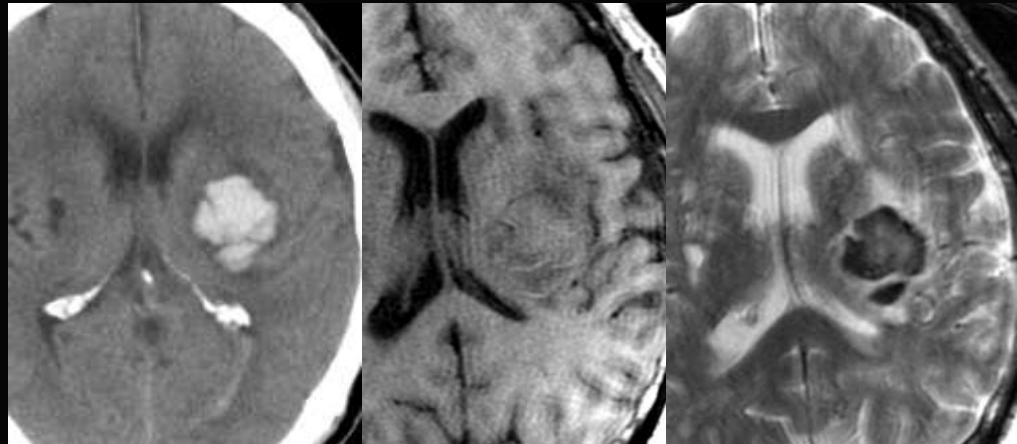
## Diagnosis

- CT
- MRI
  - acute
  - Subacute
  - chronic

# Intraparenchymal Hemorrhage

## Diagnosis

- CT
- MRI
  - acute
  - Subacute
  - chronic

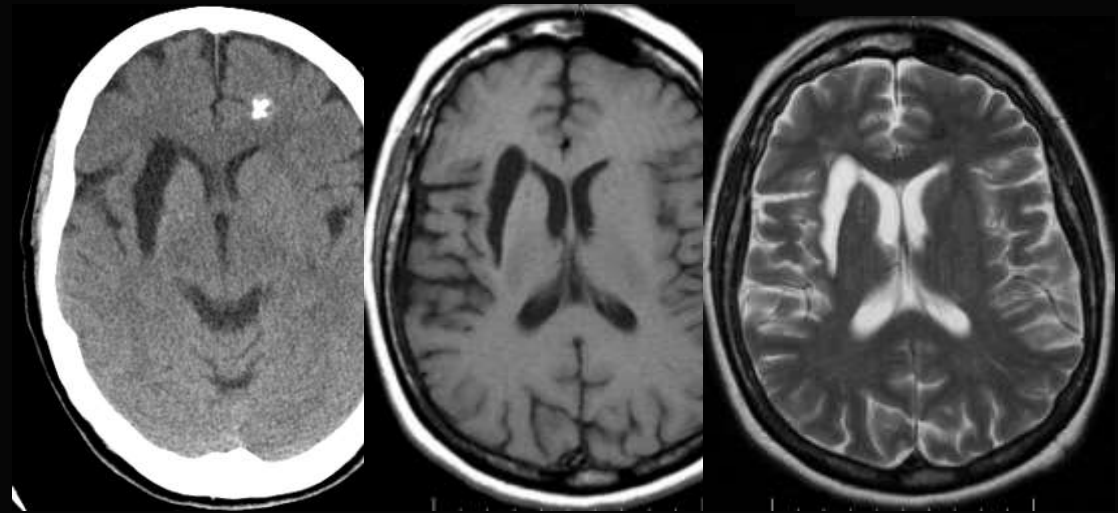
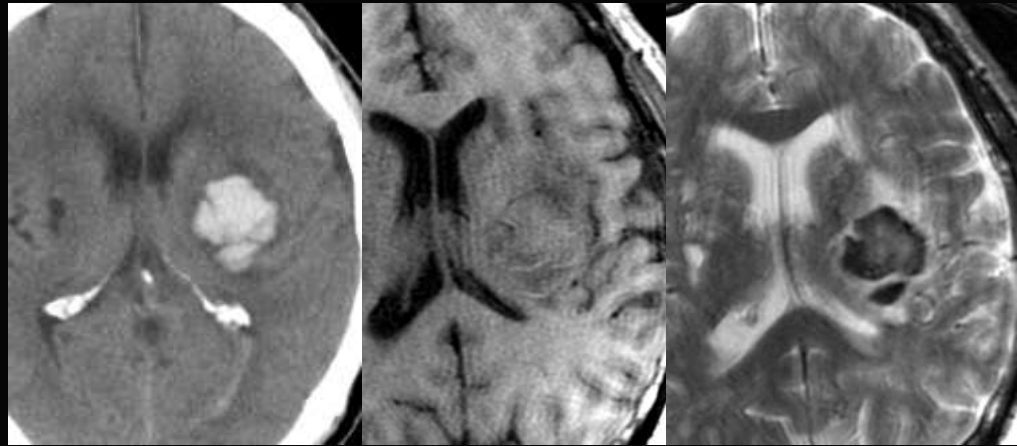


Acute

# Intraparenchymal Hemorrhage

## Diagnosis

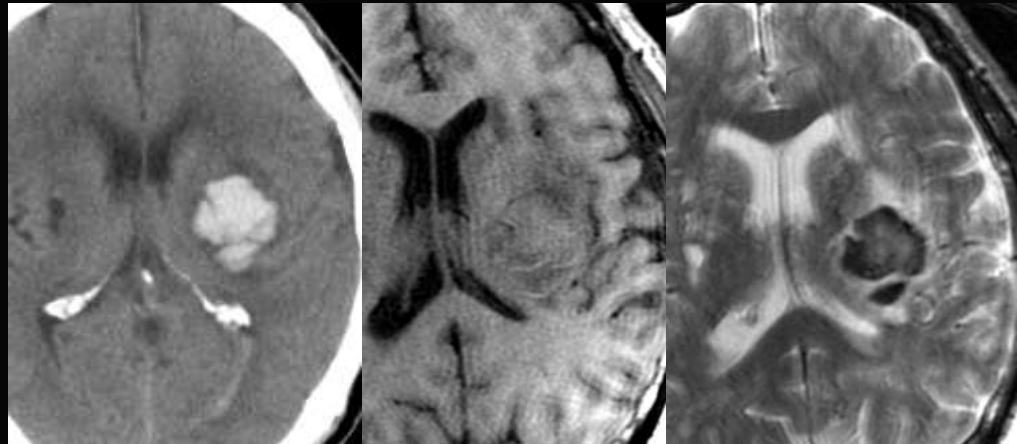
- CT
- MRI
  - acute
  - Subacute
  - chronic



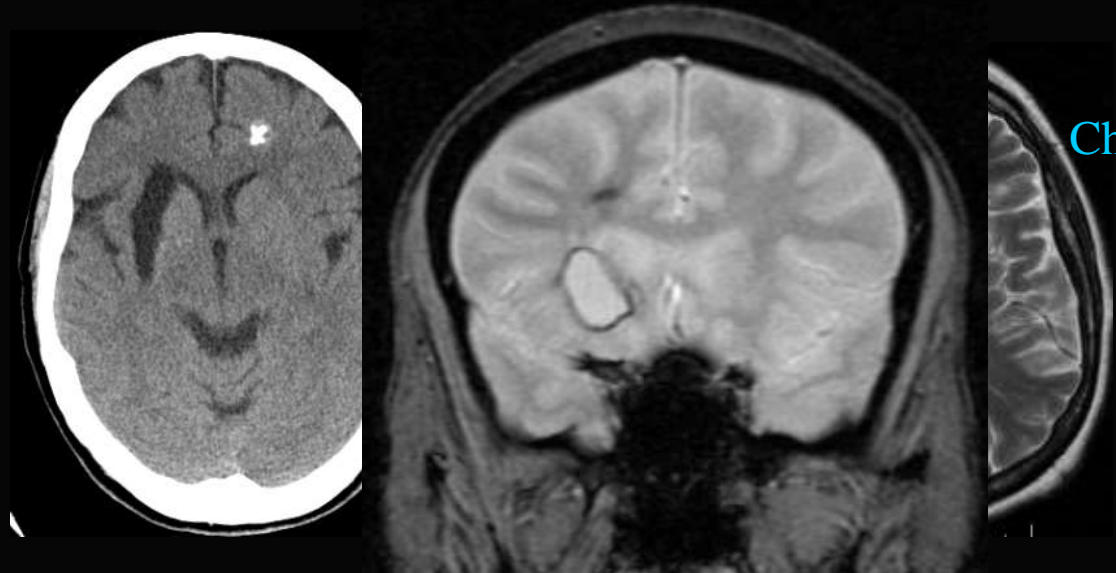
# Intraparenchymal Hemorrhage

## Diagnosis

- CT
- MRI
  - acute
  - Subacute
  - chronic



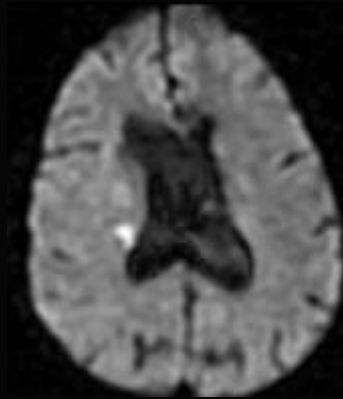
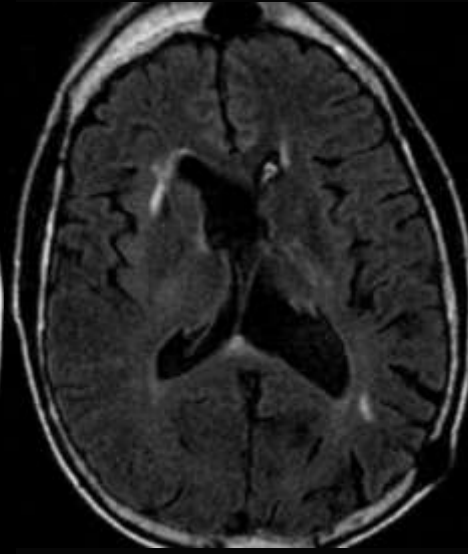
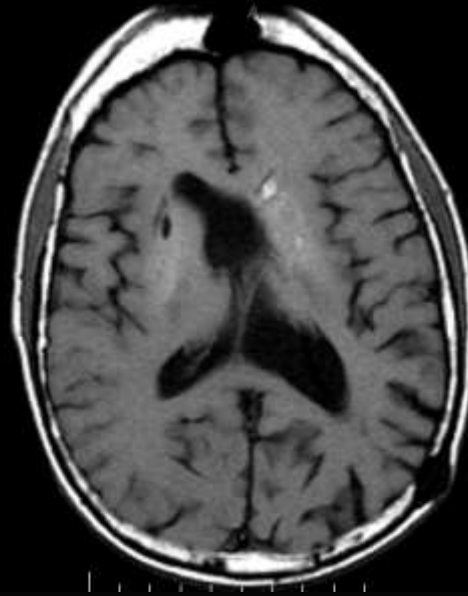
Acute



Chronic

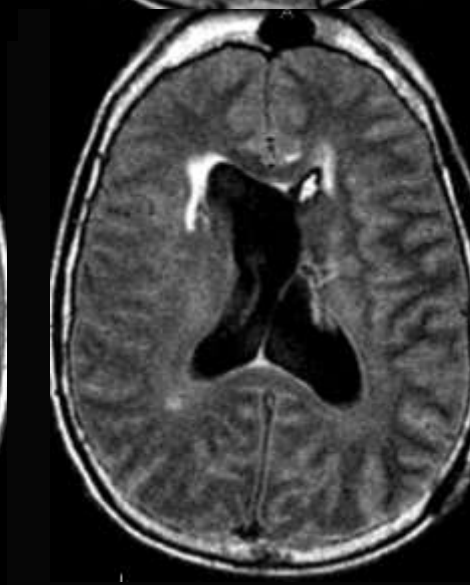
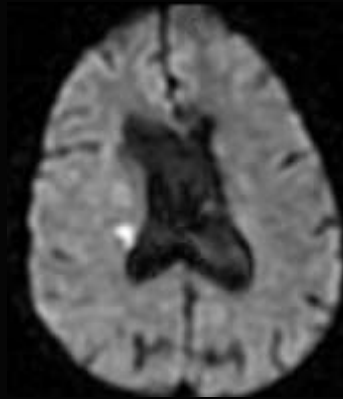
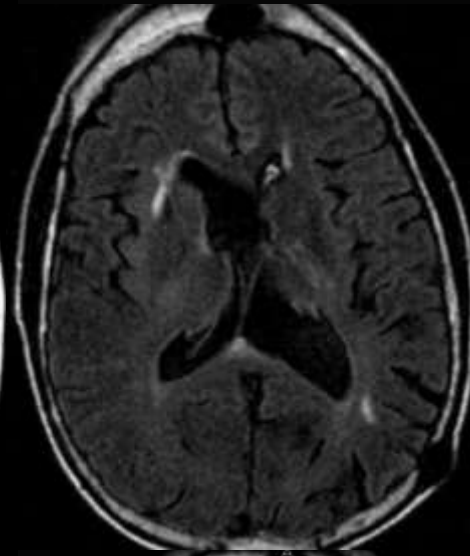
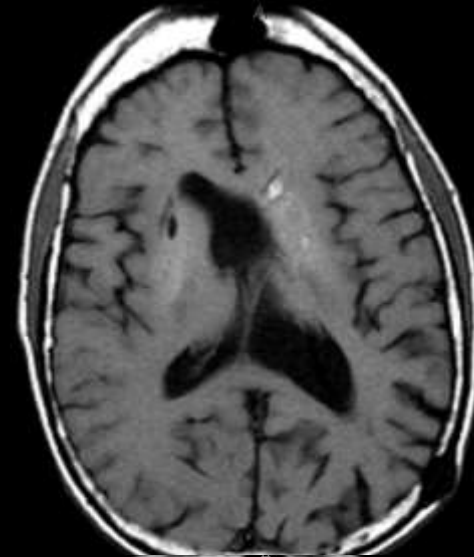
# Intraparenchymal Hemorrhage

Acute Hemorrhage??



# Intraparenchymal Hemorrhage

Acute Hemorrhage??



1 yr Prior

# Intraparenchymal Hemorrhage

## Etiology

- Hypertension
  - Amyloid angiopathy
  - Vascular – AVM, Cav Hemang
  - Neoplastic – GBM, Metastases
  - Coagulopathy
- 80% -90%



# Intraparenchymal Hemorrhage

## Common causes by Location

- Basal ganglia
  - Elderly - HTN
  - Young - Drug abuse
- Lobar
  - Elderly - Amyloid, HTN, neoplasm, SVT
  - Young – AVM, coagulopathy, SVT
- Gray-white interface
  - Metastases, septic emboli, fungal infection

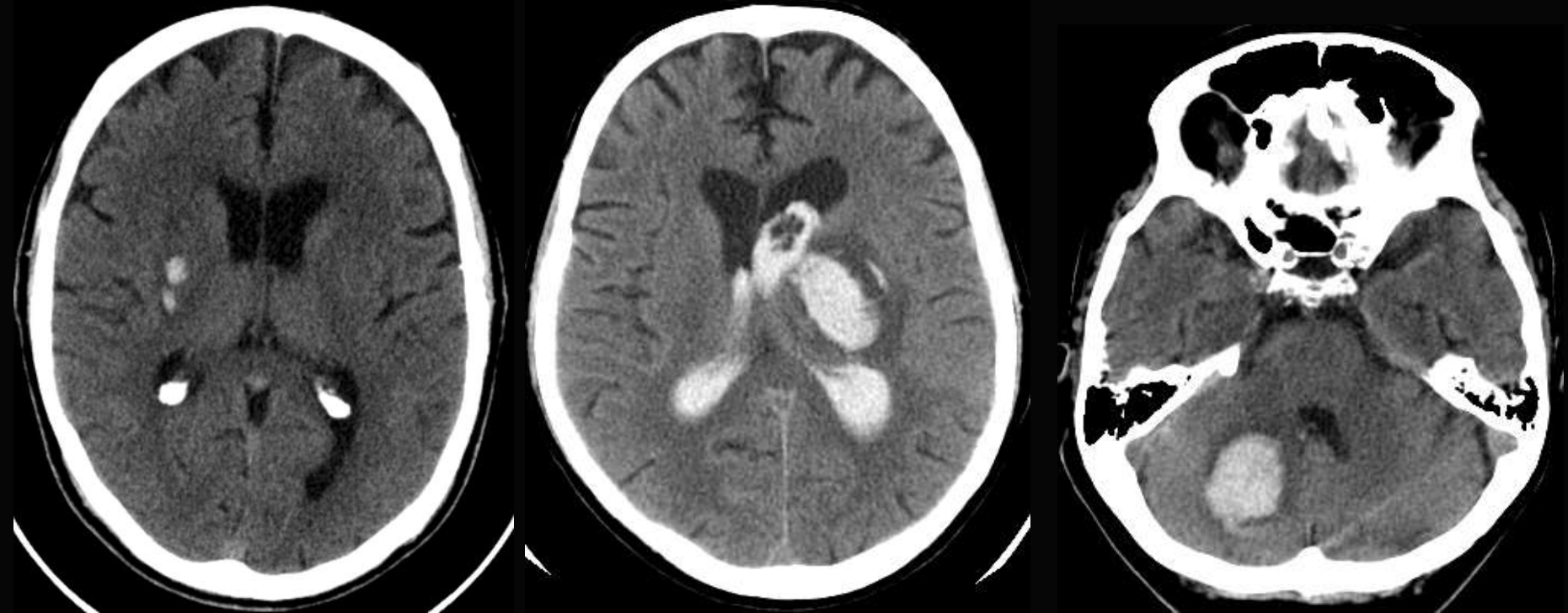
# Intraparenchymal Hemorrhage

## Hypertensive hemorrhage

- Lentiform nucleus: 50% - 60%
- Thalamus: 10% - 25%
- Pons: 5% - 10%
- Cerebellum: 5% - 10%

# Intraparenchymal Hemorrhage

## Hypertensive hemorrhage



# Intraparenchymal Hemorrhage

## Amyloid angiopathy

- Increased incidence with older age
- Lobar hemorrhage: F>P>O>T
- Recurrent hemorrhages – 10% per yr

# Intraparenchymal Hemorrhage

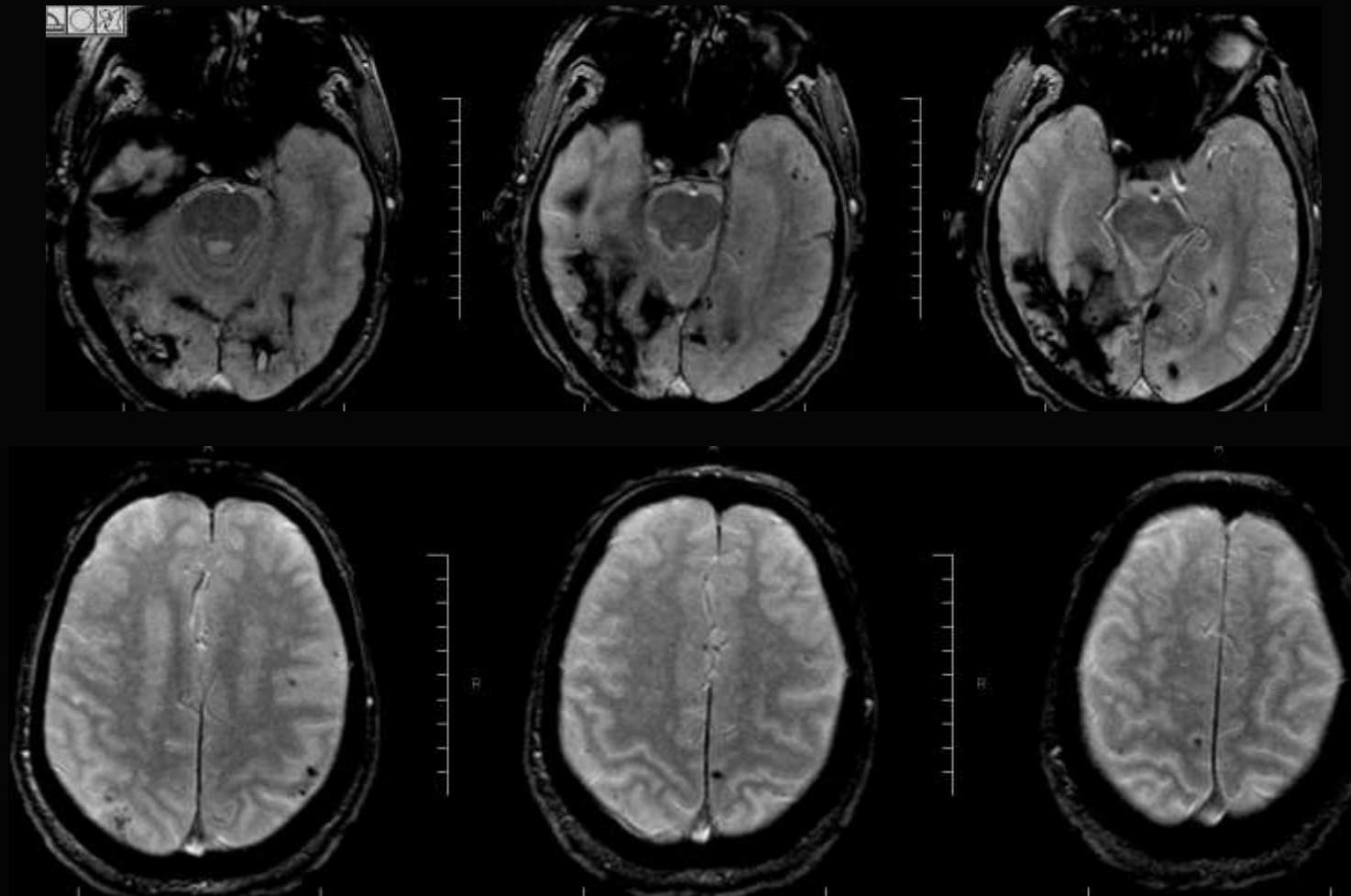
## Amyloid angiopathy



3 mo later

# Intraparenchymal Hemorrhage

## Amyloid angiopathy



# Intraparenchymal Hemorrhage

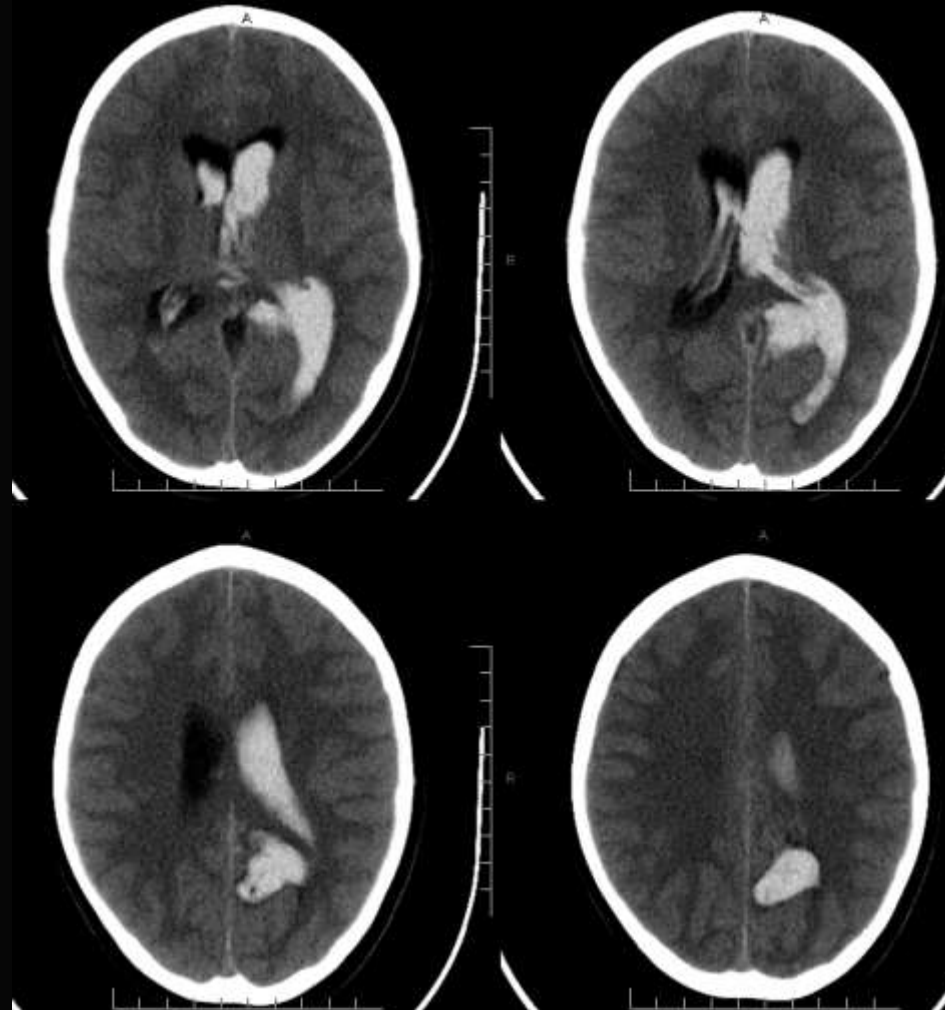
## AVM

- Bleeding from the nidus or the proximal portion of the draining veins
- Hemg - parenchymal, intraventricular, SAH
- NCCT – Hemg, calcification
- CTA/angiography – diagnostic
  - can be negative initially (20%)
  - repeat angio after clot has resorbed
- High chance of recurrence of hemorrhage

# Intraparenchymal Hemorrhage

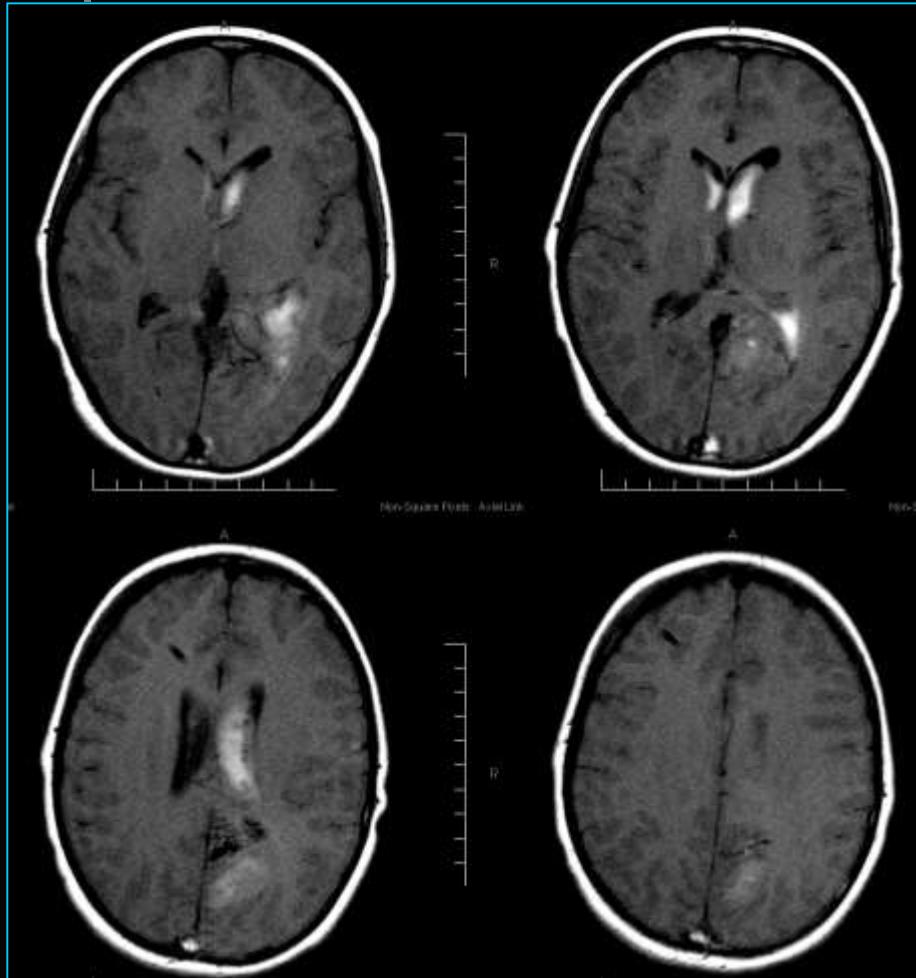
12 yr Boy

AVM

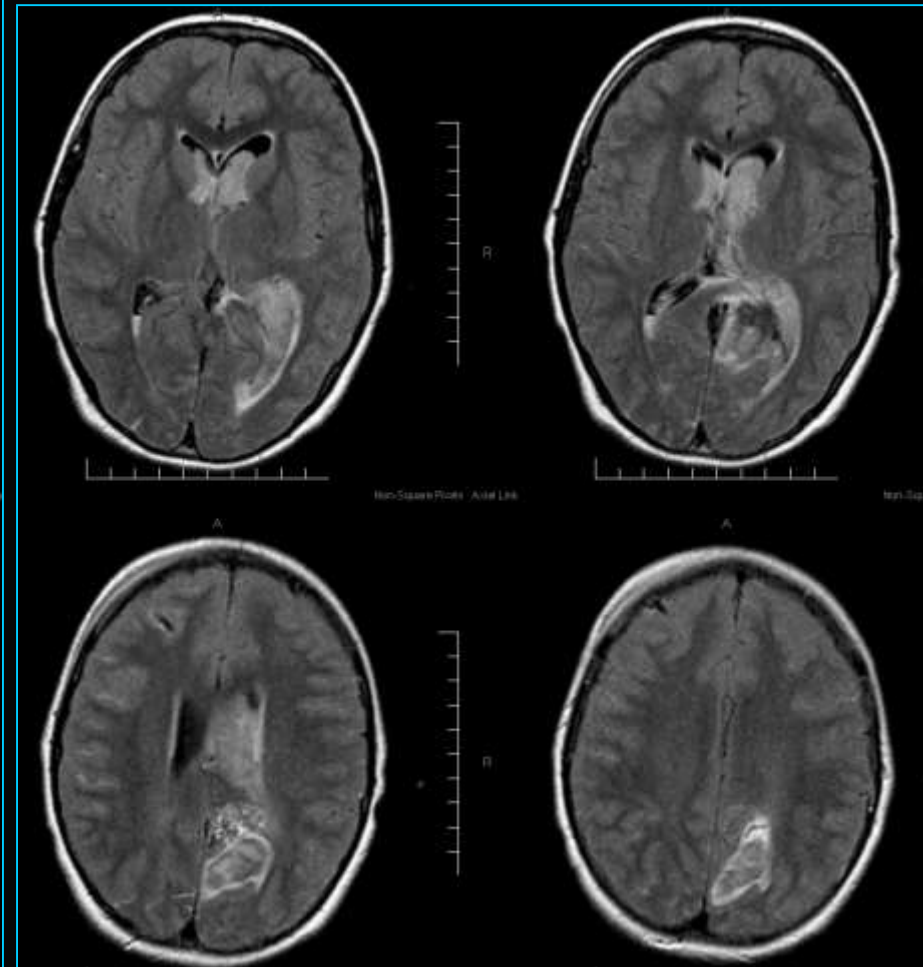




# Intraparenchymal Hemorrhage



T1 w



FLAIR

# Intraventricular Hemorrhage

12 yr Boy

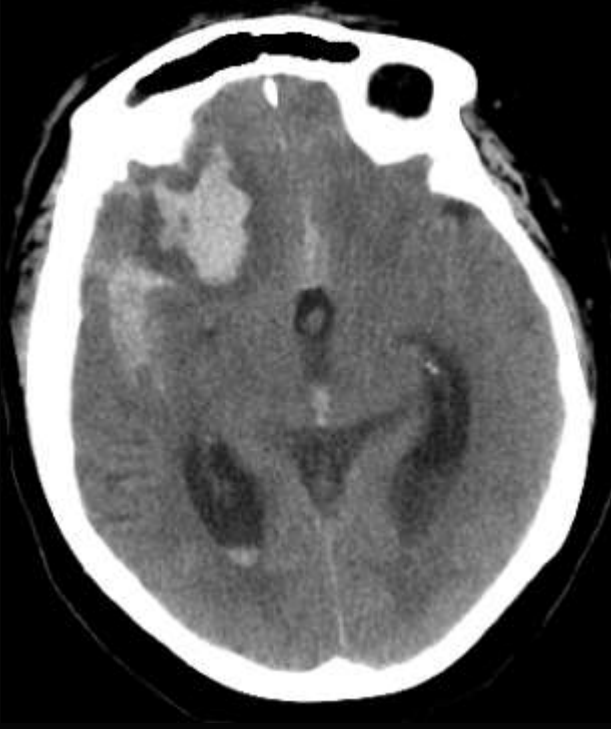


# Intraparenchymal Hemorrhage

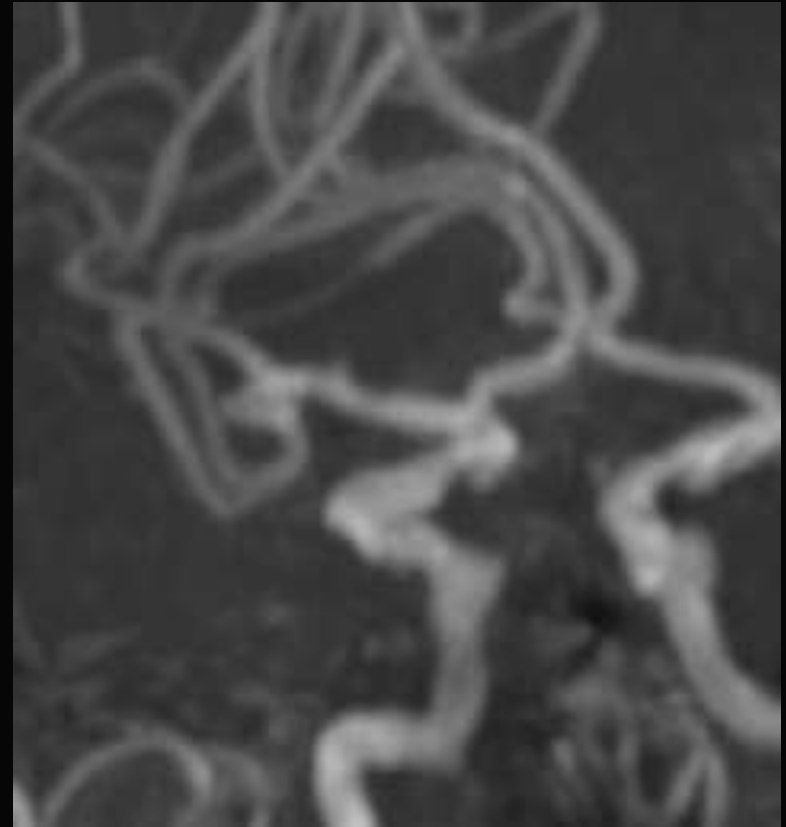
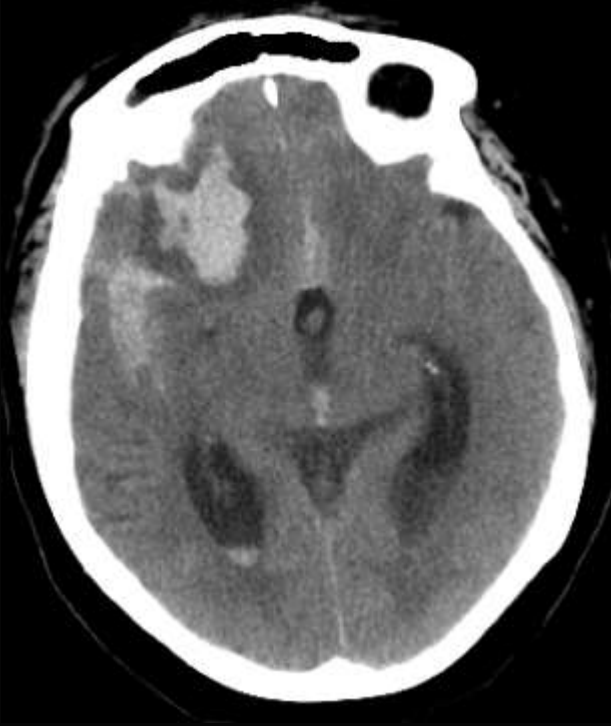
## Aneurysm

- Specific sites
  - MCA aneurysm - deep frontal lobe
  - ACom aneurysm – gyrus rectus
  - dACA – corpus callosum, medial frontal lobe
- NCCT – curvilinear calcification

# Aneurysm



# Aneurysm



Rt MCA Aneurysm

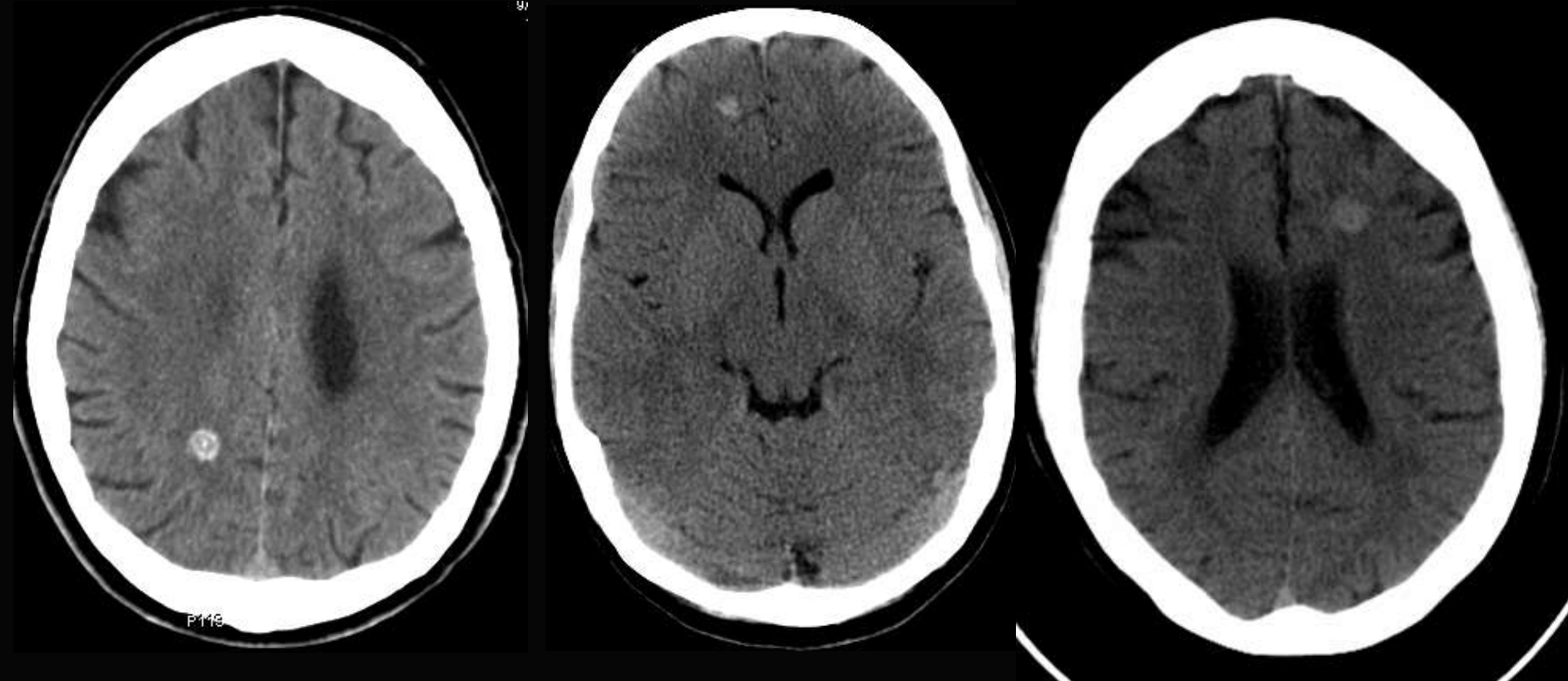
# Intraparenchymal Hemorrhage

## Cavernous angioma

- Recurrent microscopic hemorrhages
- Enlarge slowly; sometimes catastrophic
- NCCT – slightly hyperdense, no edema
- MRI – diagnostic; hemg of various ages

# Intraparenchymal Hemorrhage

## Cavernous angioma



# Intraparenchymal Hemorrhage

4 yr girl  
Seizures

## Cavernous angioma

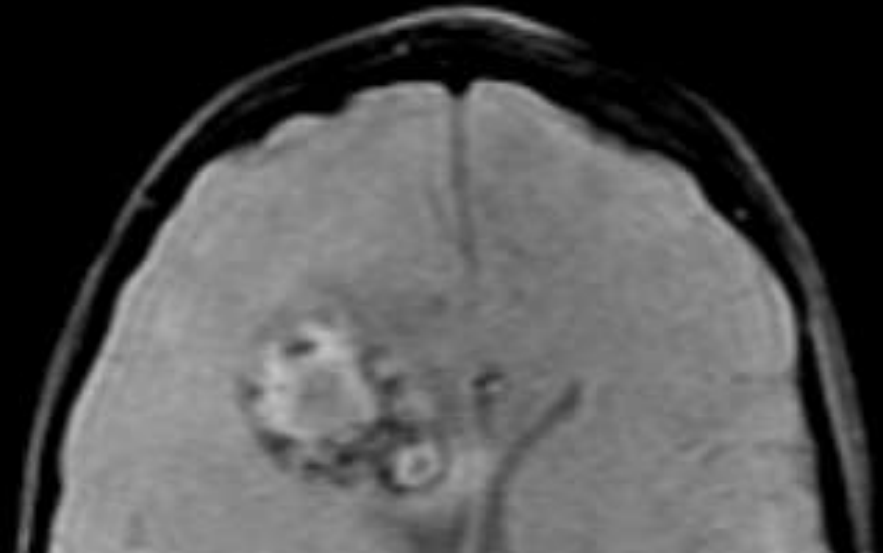
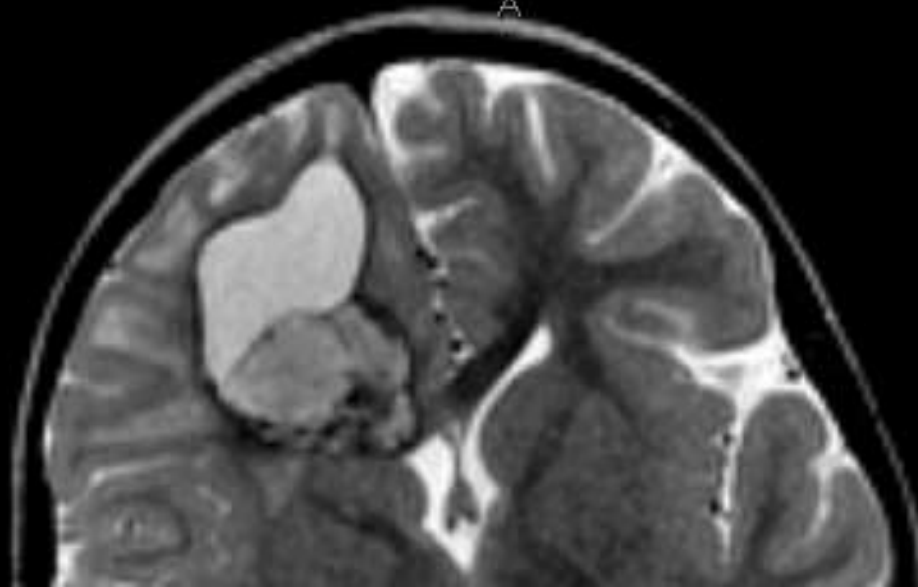
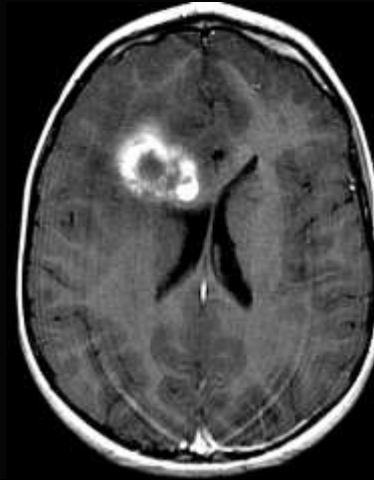
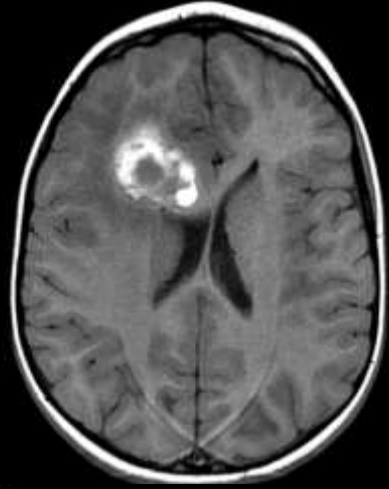




# Intraparenchymal Hemorrhage

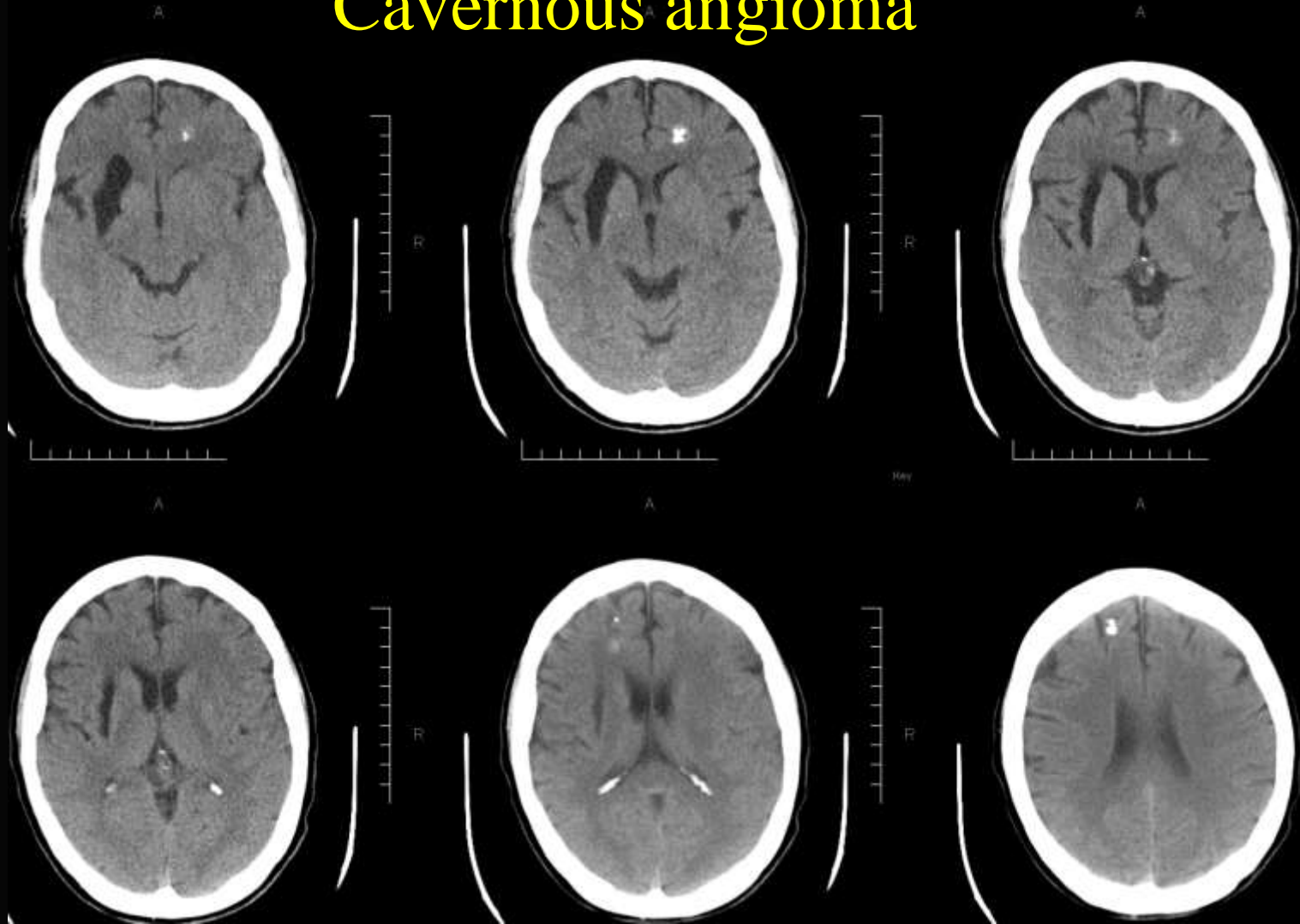
## Cavernous angioma

4 yr girl  
Seizures



# Intraparenchymal Hemorrhage

## Cavernous angioma



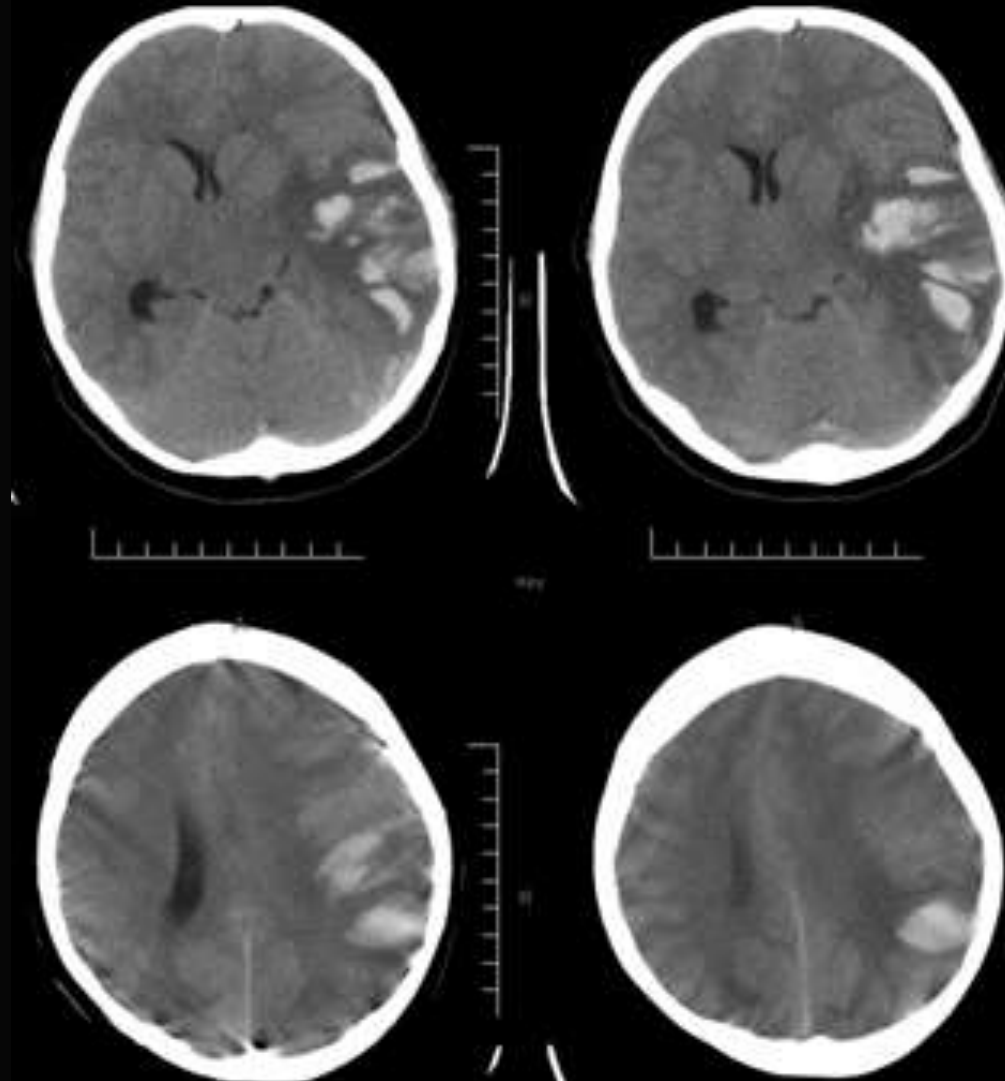
# Intraparenchymal Hemorrhage

## Venous sinus thrombosis

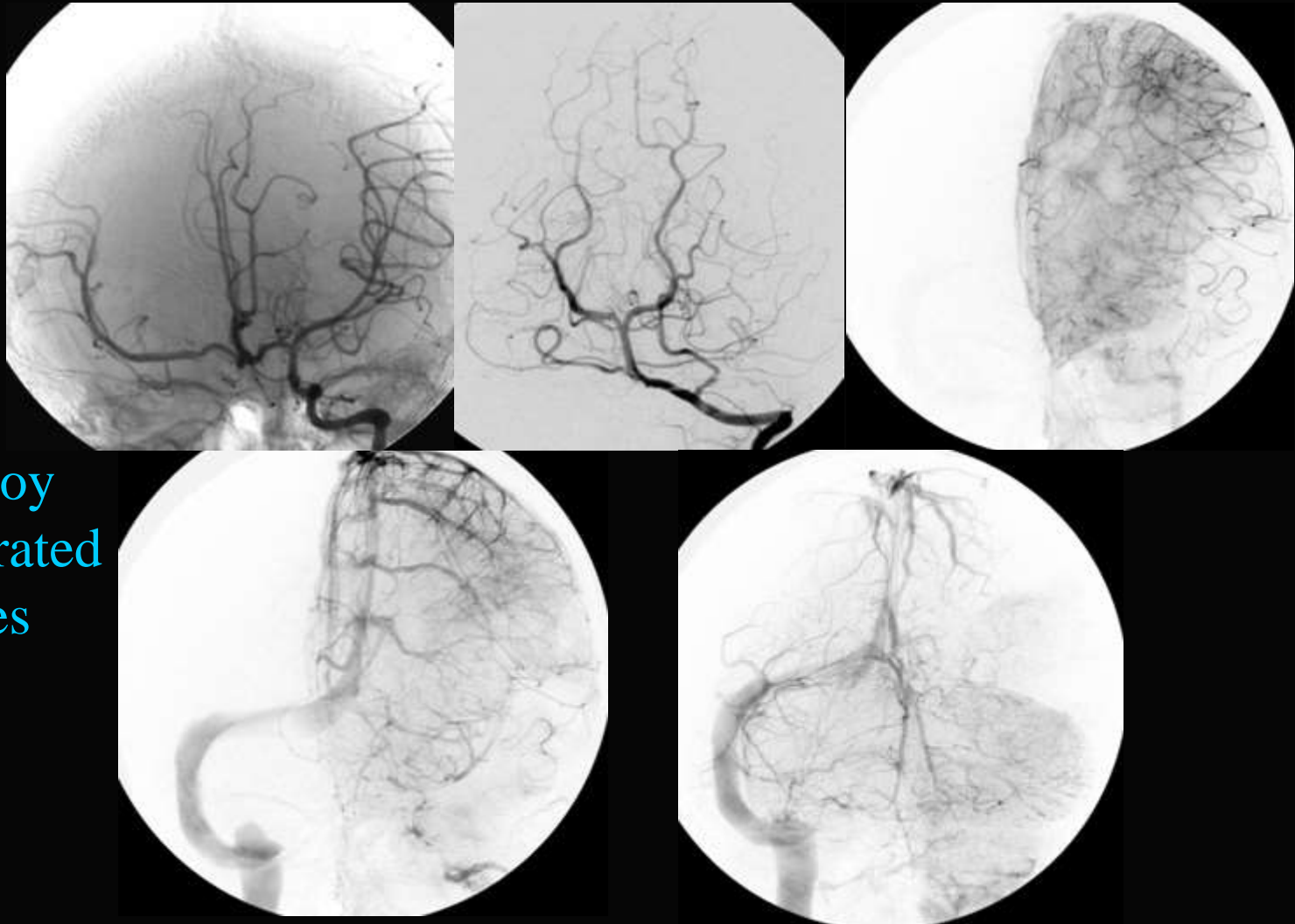
- Predisposing factors – dehydration, local neoplasm/infection, hypercoagulation, Polycythemia, drugs (OC pills, L-Asparaginase, Tamoxifen )
- NCCT – thrombosed sinuses, cortical veins edema, hemorrhage, venous infarct
- CECT – filling defects
- MRI, MRV

# Dural Sinus Thrombosis

10 yr boy  
Dehydrated  
Seizures



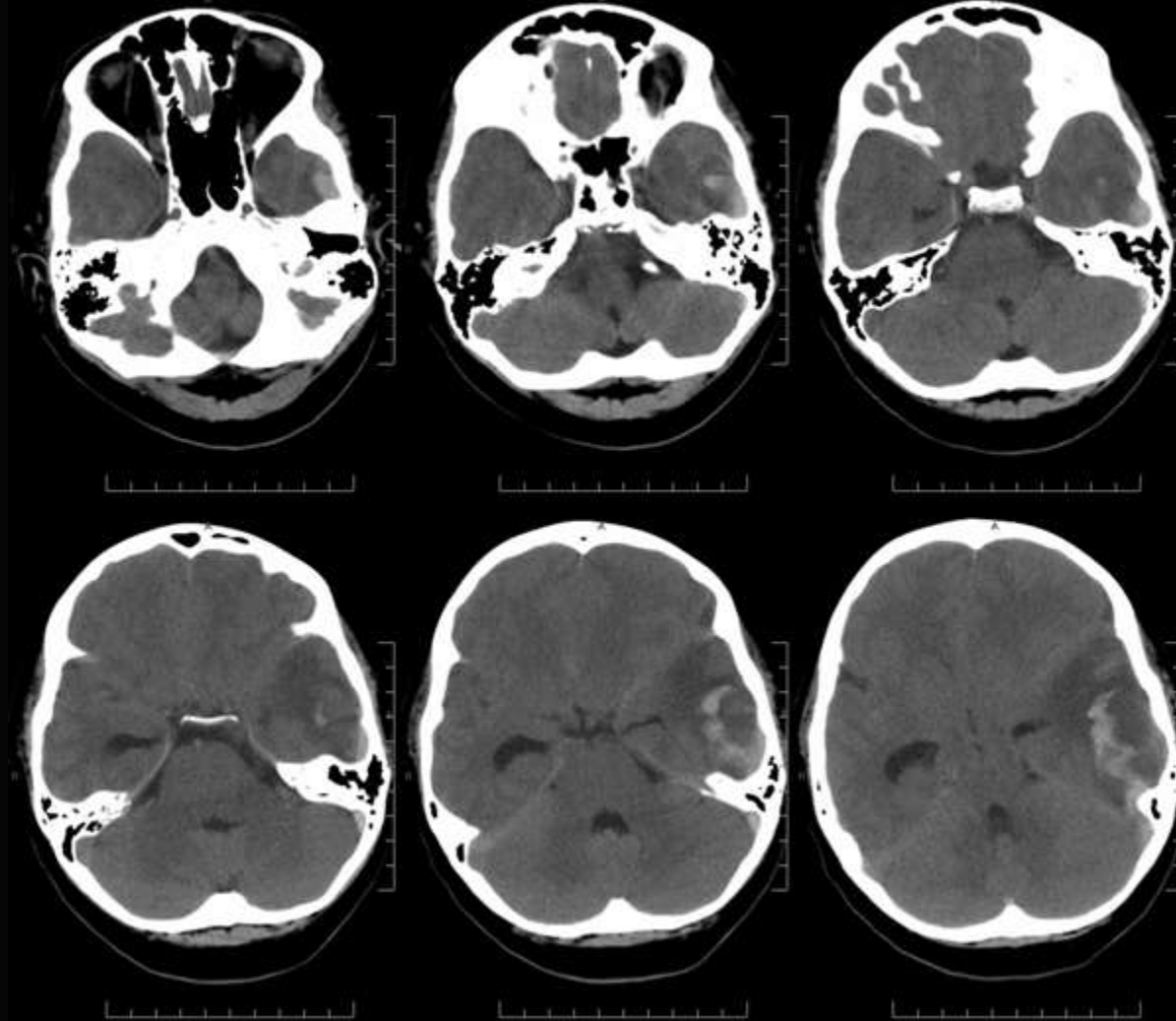
# Dural Sinus Thrombosis



10 yr boy  
Dehydrated  
Seizures

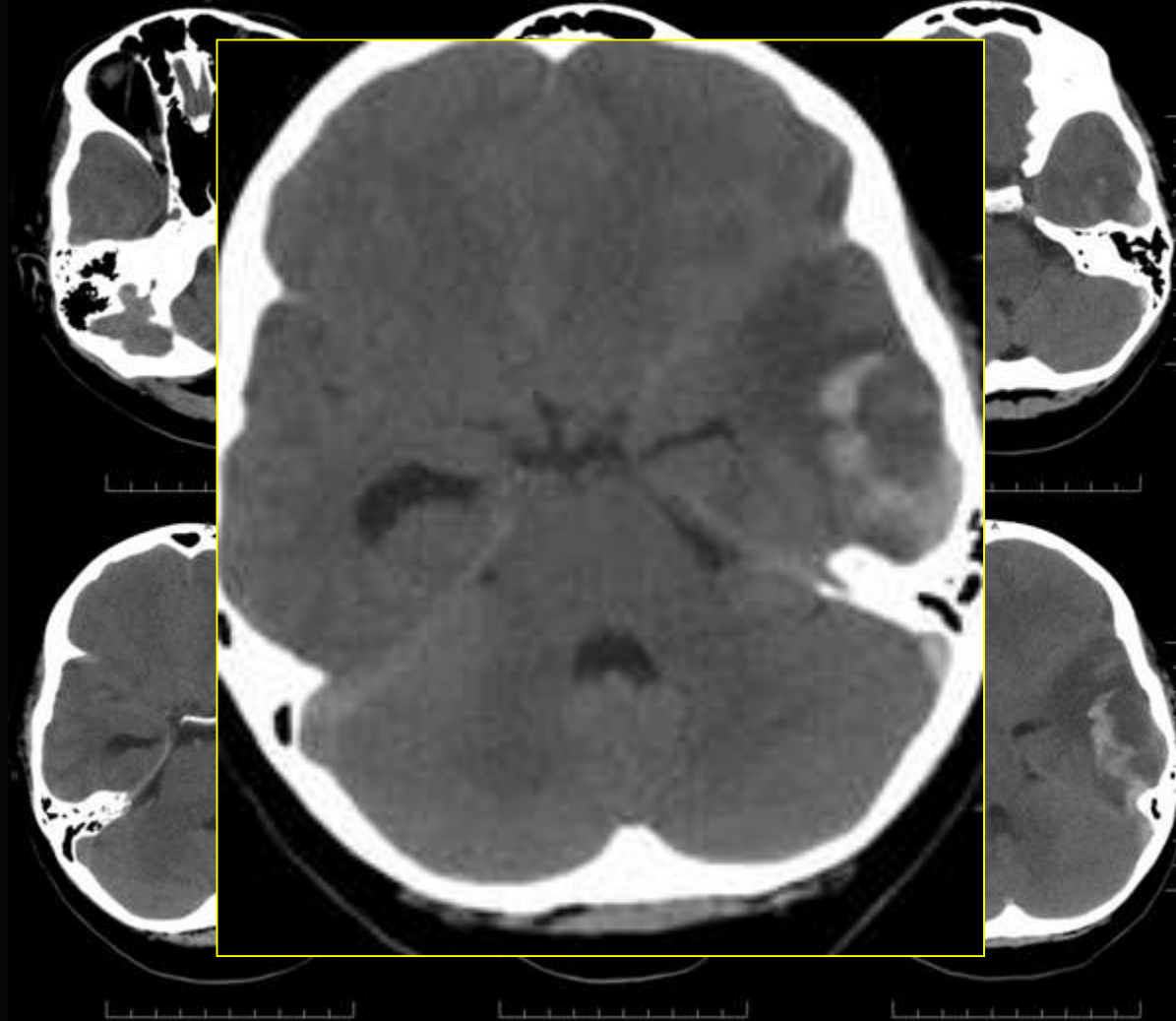
# Dural Sinus Thrombosis

10 yr boy  
Dehydrated  
Seizures



# Dural Sinus Thrombosis

10 yr boy  
Dehydrated  
Seizures



# Intraparenchymal Hemorrhage

## Neoplasms

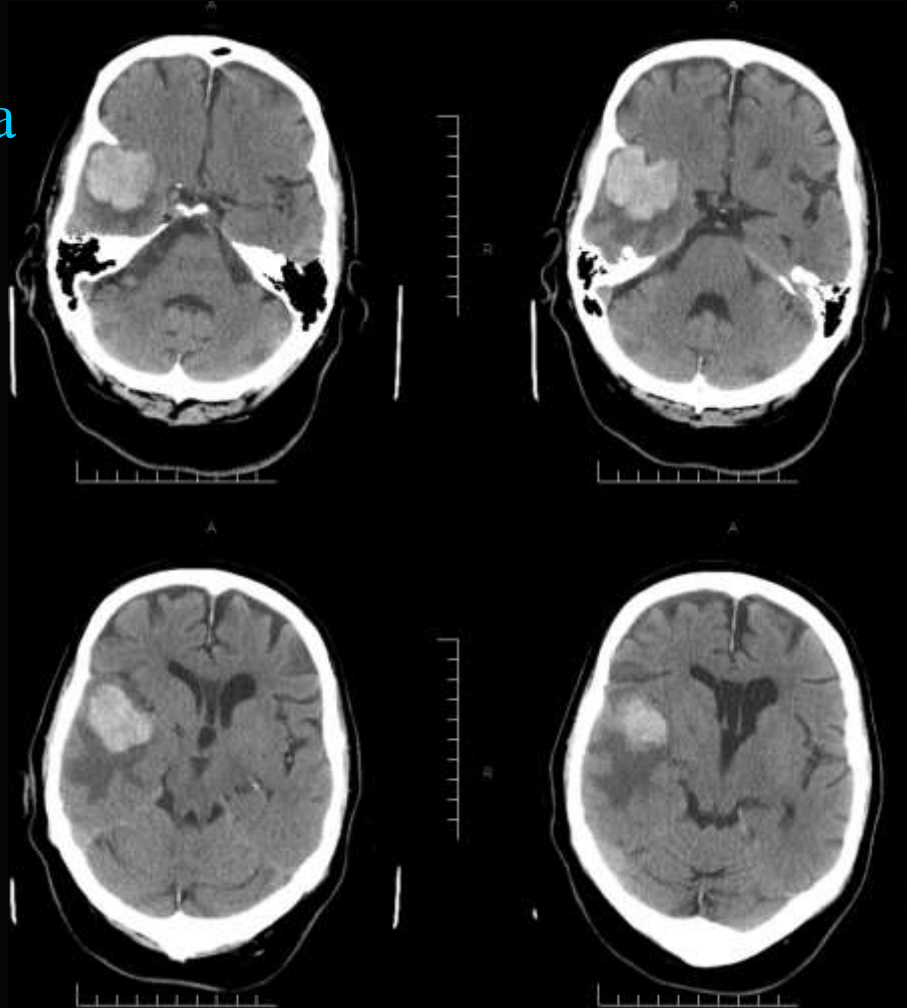
- Metastases – melanoma, renal, lung, breast Ca, chorio carcinoma
- Pituitary adenoma
- Primary tumors – GBM, choroid plexus ca
- NCCT – hemg, edema +++
- CECT – some enhancement



# Intraparenchymal Hemorrhage

## Neoplasms

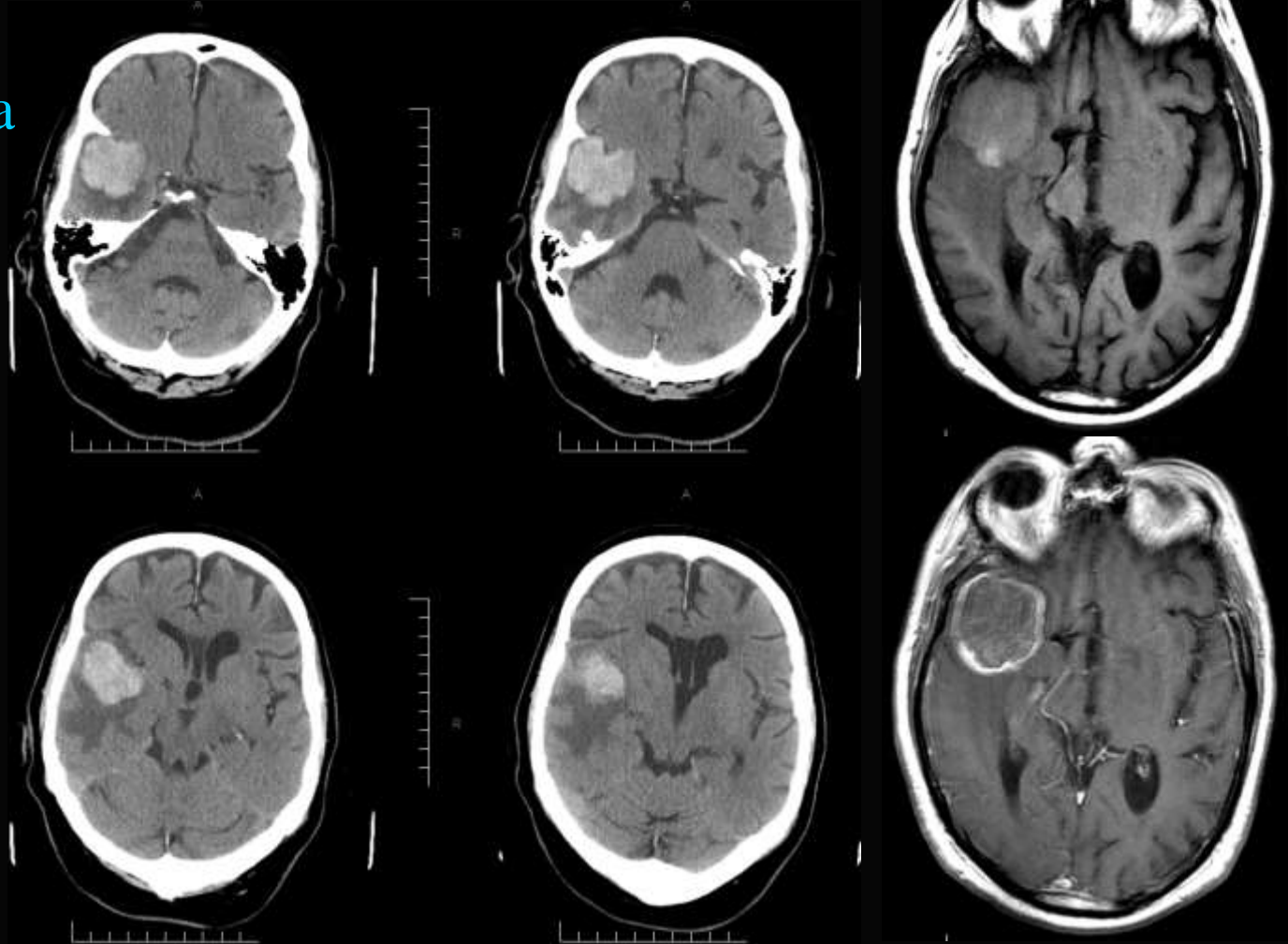
Adenocarcinoma  
Esophagus



# Intraparenchymal Hemorrhage

## Neoplasms

Adenocarcinoma  
Esophagus



# Intraparenchymal Hemorrhage

## Coagulopathy

- Anti coagulation therapy
  - 7 to 10 times higher risk at therapeutic levels
  - 2/3 are IPH; 1/3 are SDH
- Thrombolytic therapy ( STK, UroK, TPA )
  - 1% - 2 % risk for acMI
- Aspirin therapy – slightly increased risk

# Intraparenchymal Hemorrhage

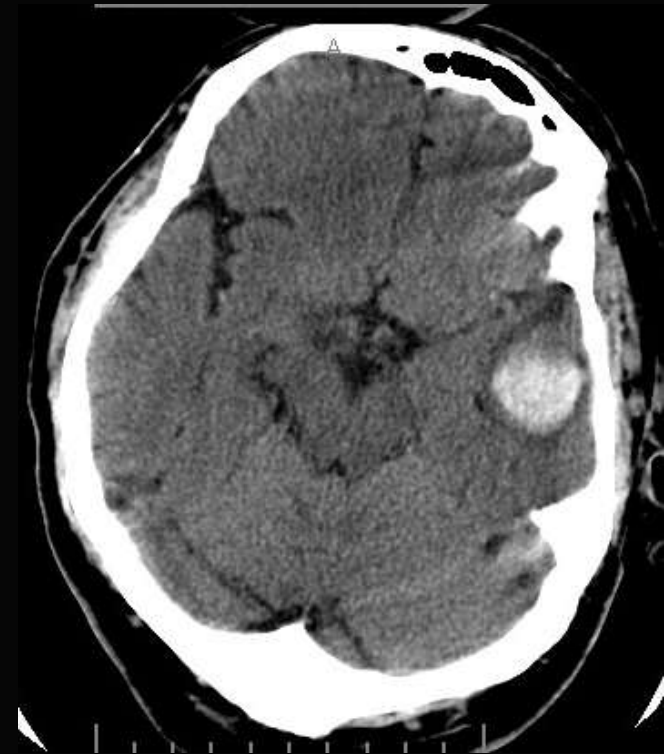
## Coagulopathy



Post TPA for AcMI

# Intraparenchymal Hemorrhage

## Coagulopathy



Post TPA for AcMI

# Intraparenchymal Hemorrhage

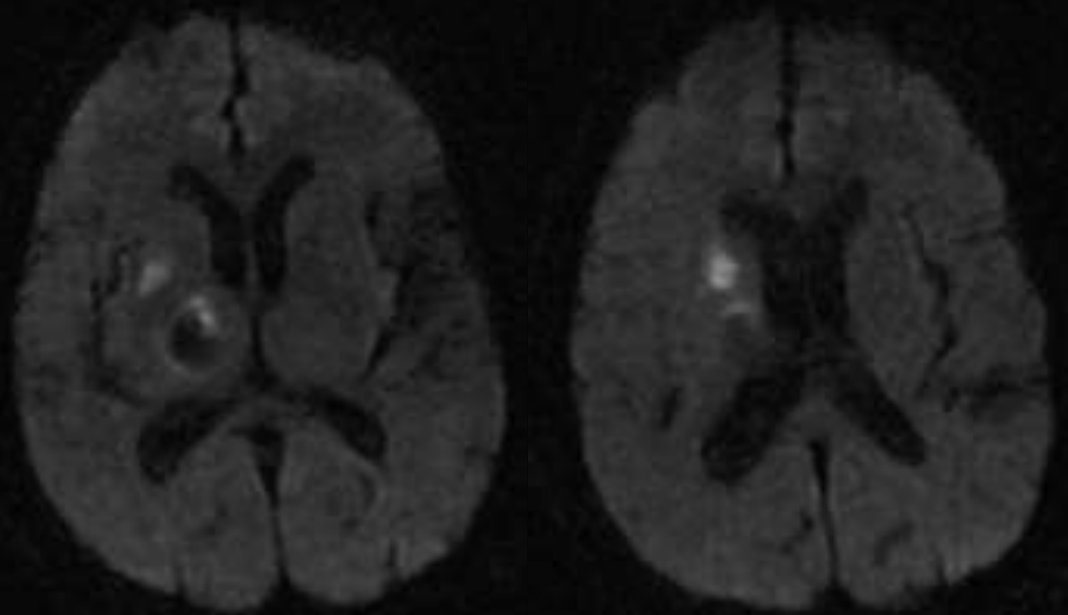
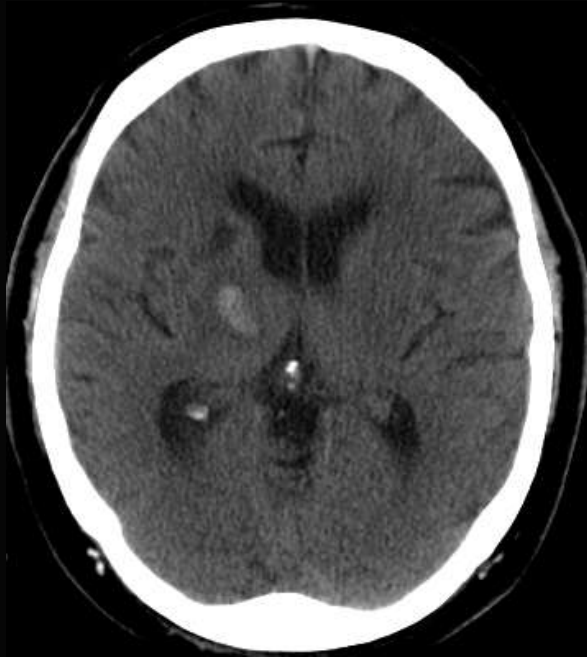
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## Hemorrhagic infarct

- Edema in arterial territory
- Hemorrhage develops later – hours to weeks
- Hemorrhage in the cortical areas

# Intraparenchymal Hemorrhage

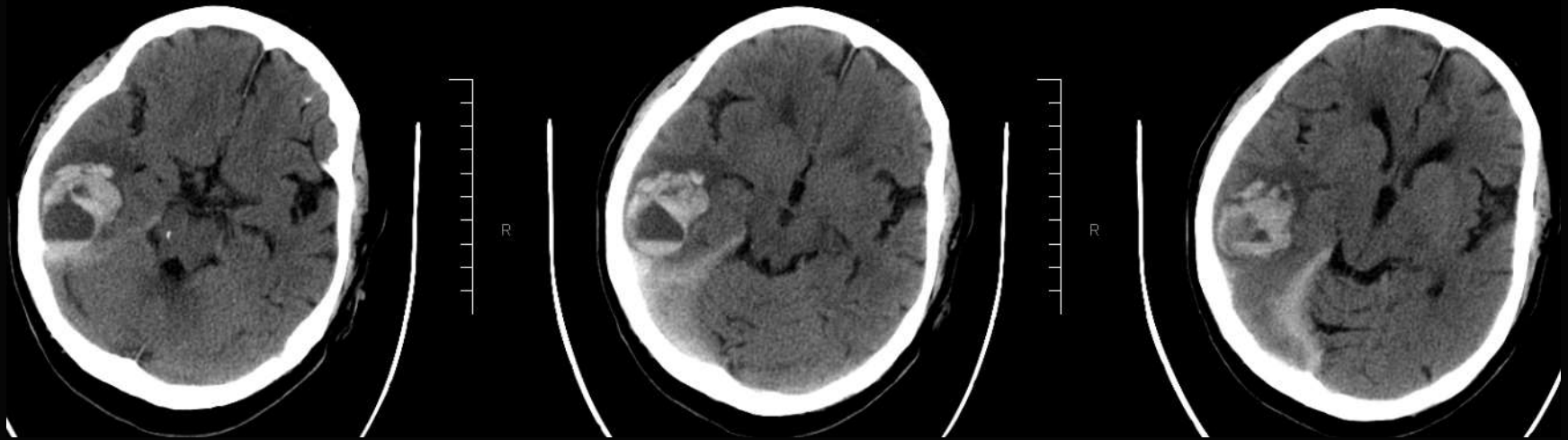
## Hemorrhagic infarct



Lt weakness

# Intraparenchymal Hemorrhage

## Hemorrhagic infarct

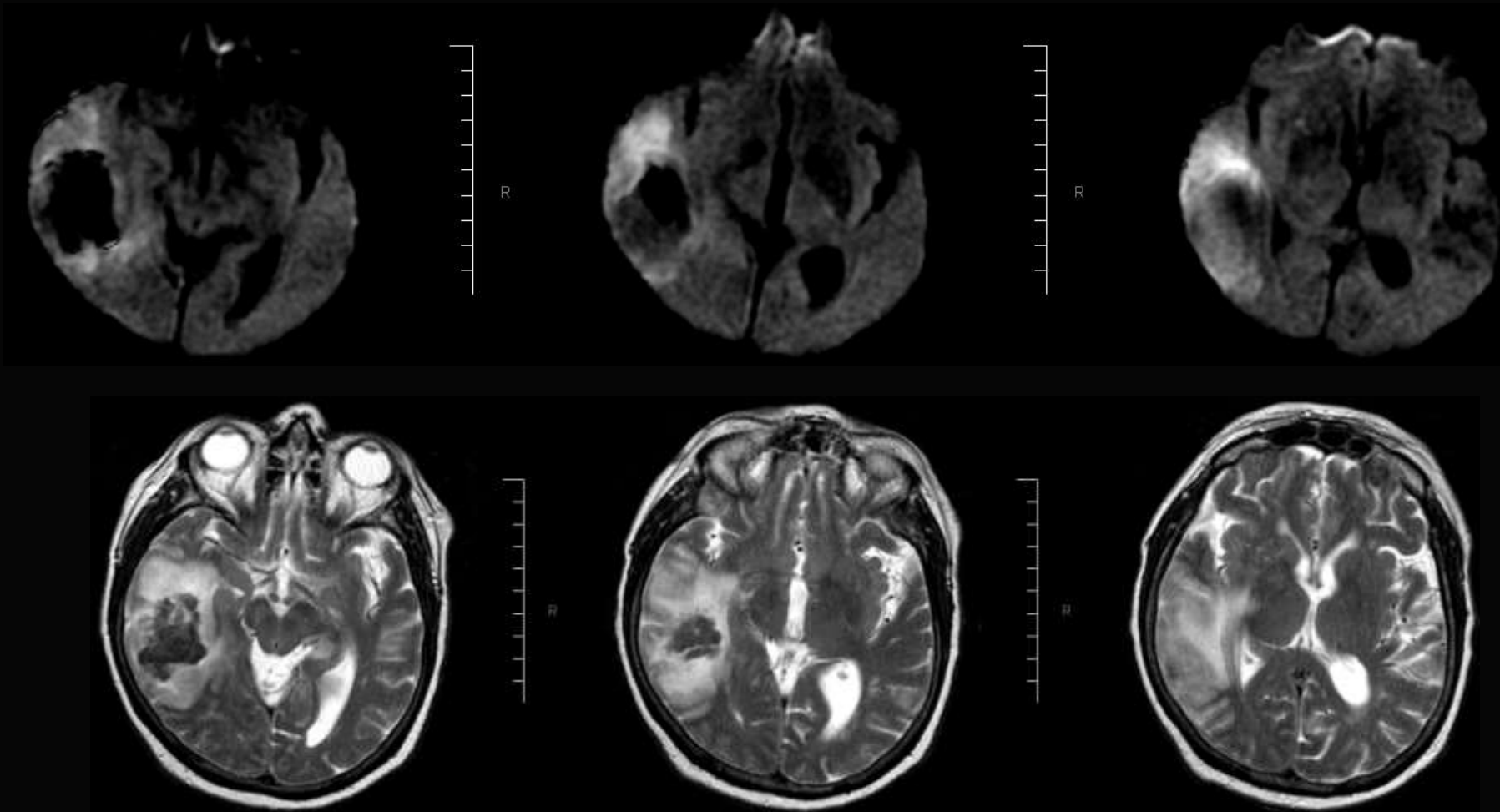


Infarct 3 weeks prior  
Now on Anti-coagulation



# Intraparenchymal Hemorrhage

## Hemorrhagic infarct



# Intraparenchymal Hemorrhage

## Drug abuse

- Cocaine – similar to HTN hemg
  - Aneurysms and AVMs may also bleed due to HTN surge
- Heroin, Amphetamines, phencyclidine
- Vasculitis like picture with angiography

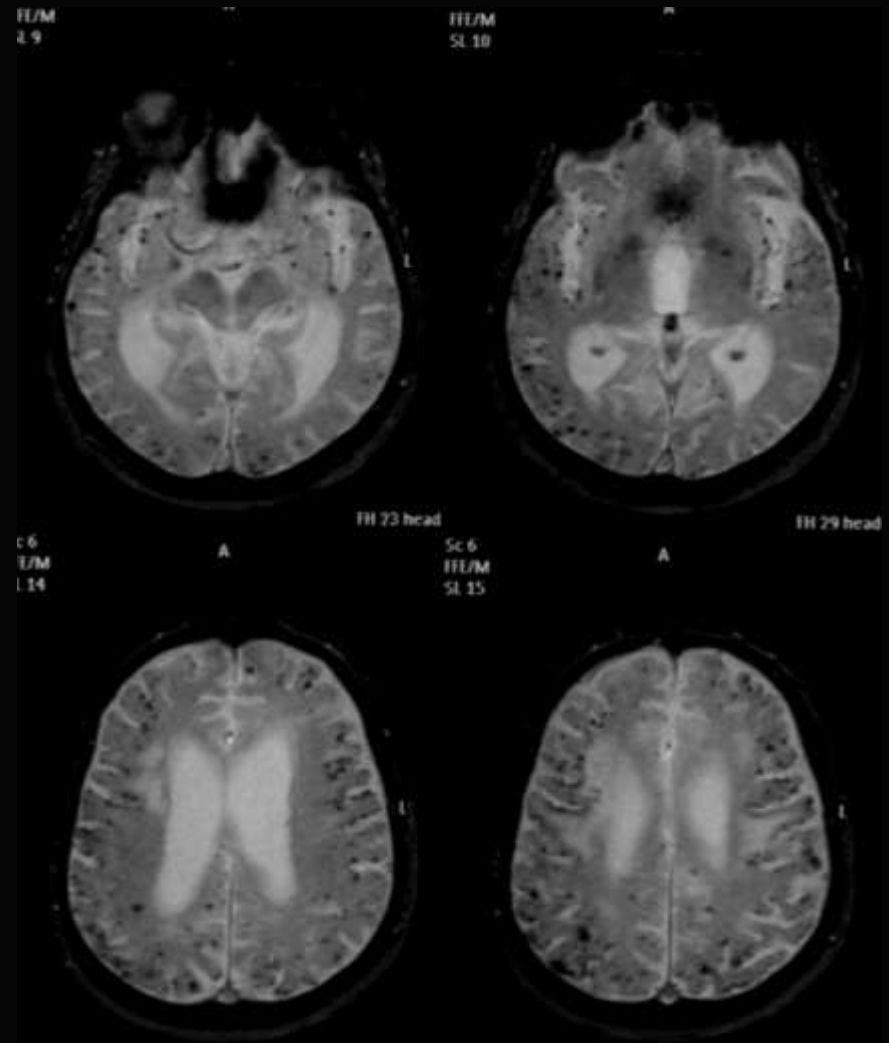
# Intraparenchymal Hemorrhage

Acute Thalamic hemorrhage  
in a Cocaine user



# Multiple Parenchymal hemorrhages of different ages on MRI

- Elderly
  - Chronic hypertension
  - Amyloid angiopathy
- Young
  - Cavernous angiomas
  - Hematologic disorders



# Intraparenchymal Hemorrhage

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## Other causes

- Acute hemorrhagic leukoencephalopathy
- PRES
- Septic emboli
- Mycotic aneurysms



# Intraparenchymal Hemorrhage

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## Complications

- Increased intracranial pressure
- Rebleed
- Edema, Herniation, infarcts
- Intraventricular extension, hydrocephalus

## Imaging guidelines

- NCCT – imaging of choice for suspected ICH
- Surgical candidates without known cause – CTA
- Old hypertensive patients – no need for CTA
- Suspected mass/cavernous hemangioma – MRI
- If CTA is not possible – MRA or catheter angiography

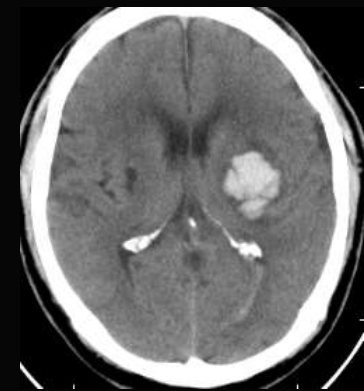
# Radiologist's Responsibility

- Diagnose
- Guide further imaging
- **Communicate !**





**Acute Non-traumatic  
Intracranial Hemorrhage**  
*imaging approach*



**Thank You**

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# Acute Non-traumatic Intracranial Hemorrhage

*imaging approach*



**Thank You**

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