65 slide

MR Imaging of the Brain and Spine

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Outline

- Introduction.
- Basic MRI sequencies
- MRI of the brain , examples.
- MRI of spine , examples

Introduction

MRI is a very important diagnostic tool in neuroimaging.

- Superior soft tissue contrast.
- Multiplanar capability.
- No ionizing radiation.
- Relatively safe contrast media.

Diagnostic and Interventional Radiology

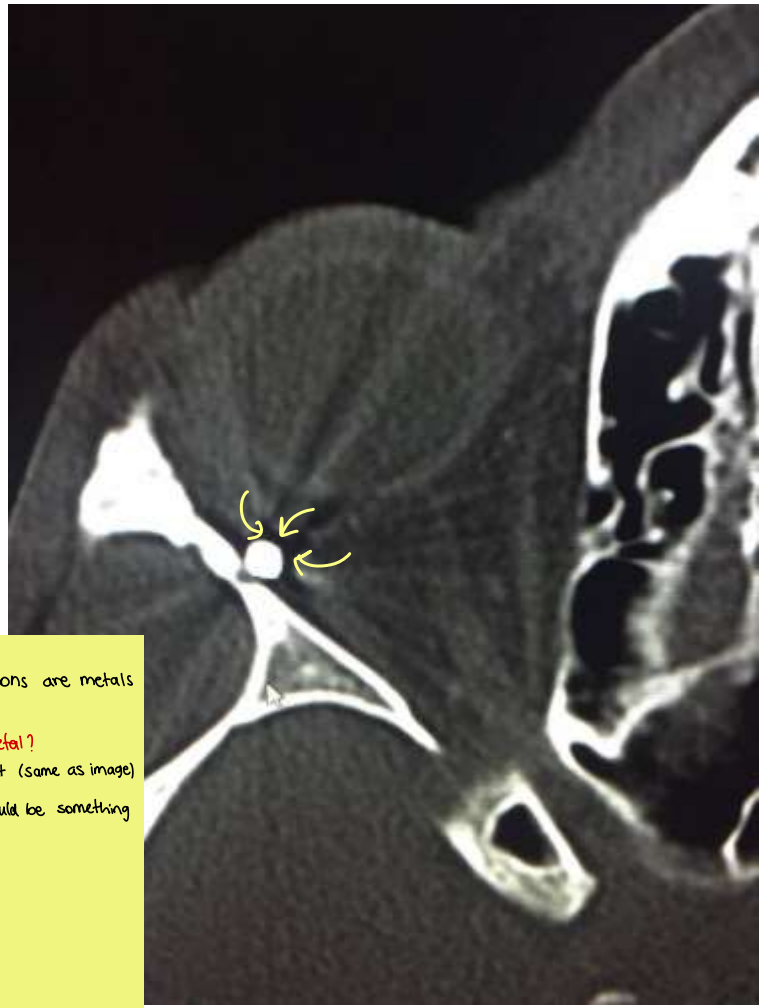
MRI Disadvantages

- Expensive
- Not widely available
- Claustrophobia can sedate these pts
- Certain contraindications (pace maker, ect) + metals in body

new open system MRI for claustrophobic pts

cord compression
cauda equina emergency for MRI, cannot be delayed

Metallic foreign body in the eye



not all hyperintense lesions are metals

how to know if metal?

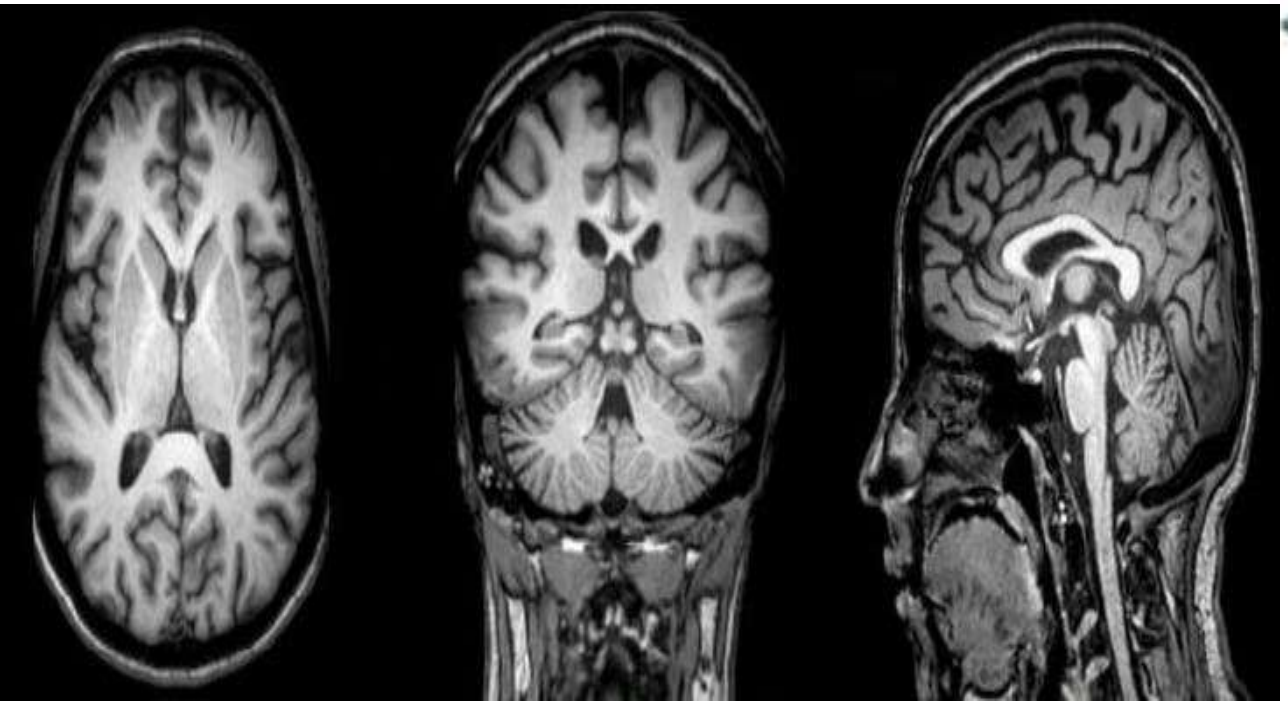
↳ if metal artifact is present (same as image) this is metal, if not it could be something else

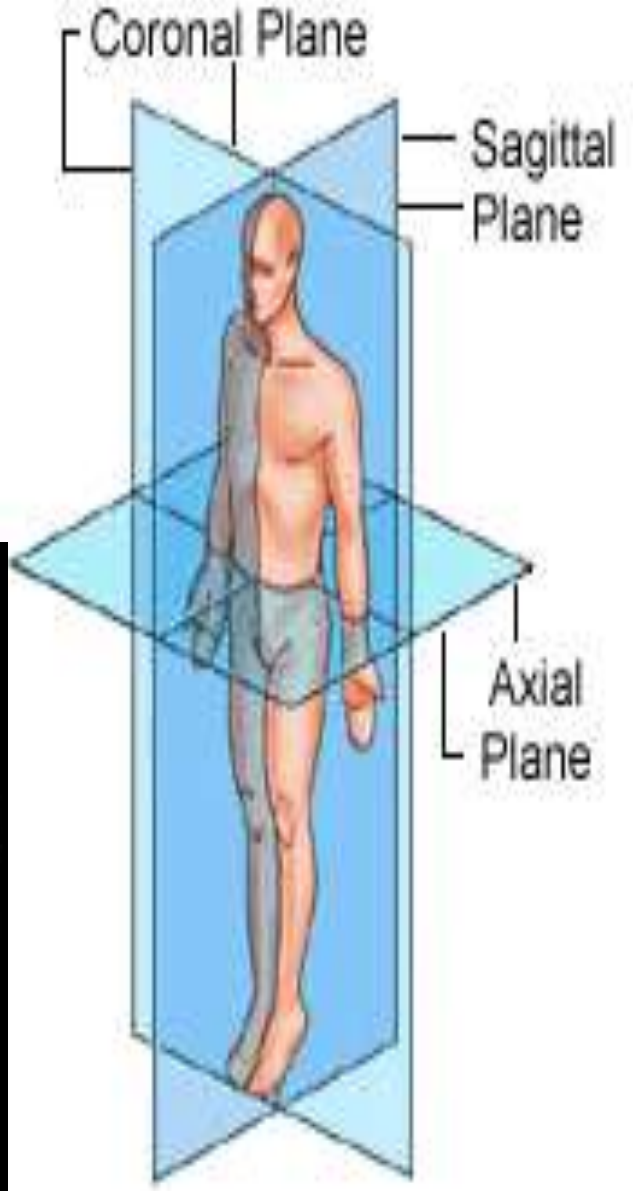
Me

high magnetic strength

MRI planes

* Important*





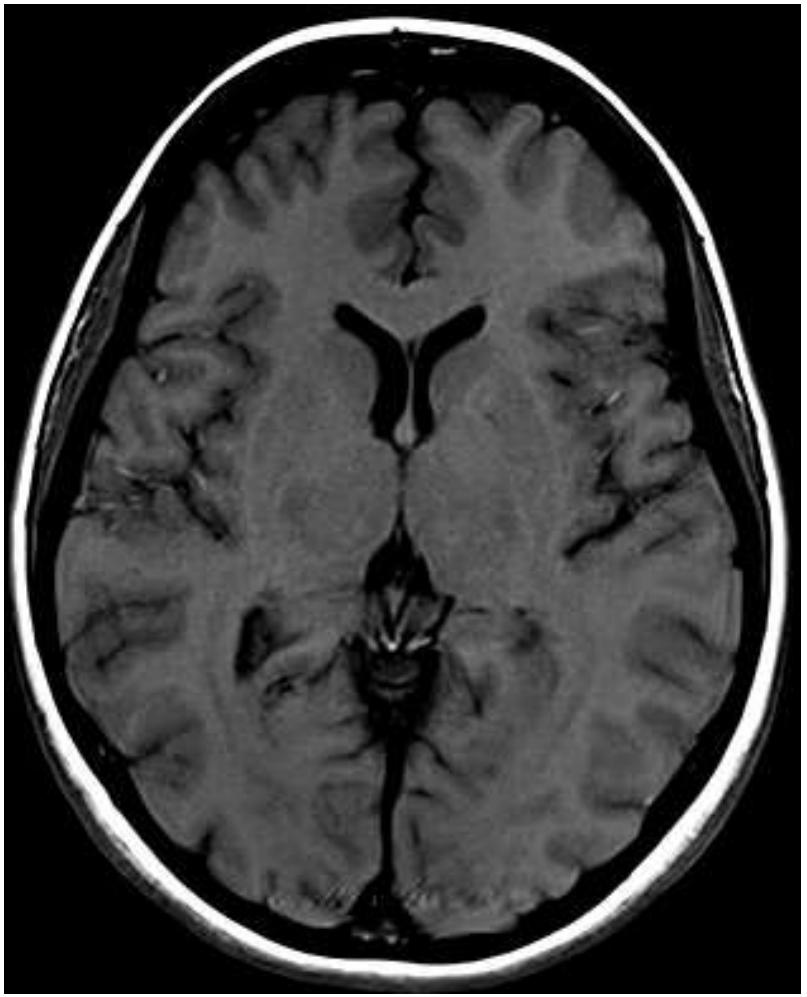
T1-weighted images (T1)

Shows anatomy

✓ Recognition :

- **Ventricles dark**
- Scalp bright
- **White matter brighter than the grey matter.** white matter signal stronger than grey
- **Vessels mostly not seen**

in exam must know the type : T_1, T_2, ADC



✓ Useful for:

- Anatomy.
- Borders between brain and CSF (e.g., sulci, ventricles, cysts).
- Not very sensitive to lesions

T1-weighted images (T1)

T1 important in subacute hemorrhage

- ✓ **Black on T1 :**
  - Air
  - Calcium
  - Dense bone
- ✓ **Dark on T1 (long T1)**
  - CSF
  - Edema
  - Most lesions
- ✓ **Grey on T1**
  - White matter, gray matter
  - **(White matter brighter than grey matter).**
- ✓ **Bright on T1 (short T1)**
  - Fat
  - Blood (methemoglobin) (subacute hemorrhage)
  - Melanin
  - Gadolinium (Gd, contrast).
  - Calcification (sometimes).

Sagittal section

T1 hyperintense lesions

Content	Lesion/pathology
Methaemoglobin	Subacute blood
Fat/lipid	Lipoma, dermoid, craniopharyngioma
Melanin	Melanoma
Slow flow	Thrombosis
Manganese and copper	Metabolic disorders
Protein	Craniopharyngioma
Gadolinium	Contrast

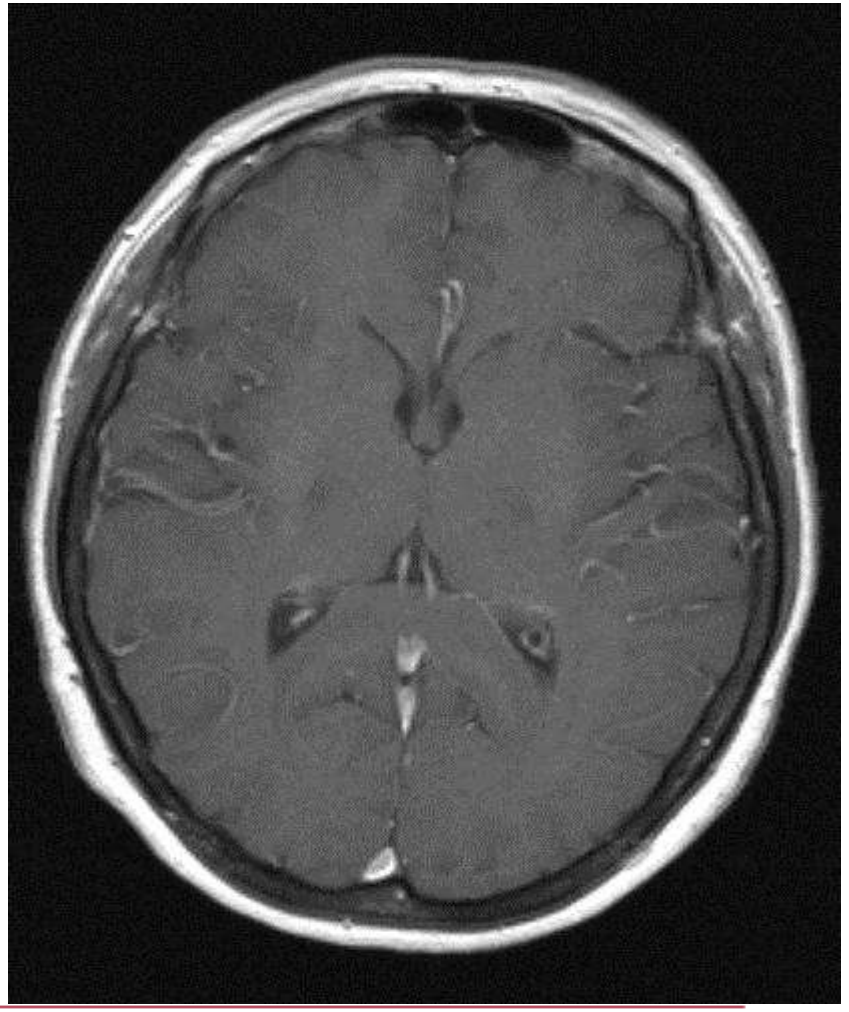
+teratoma

→white basal ganglia + hepatic encephalopathy
↓
wilson

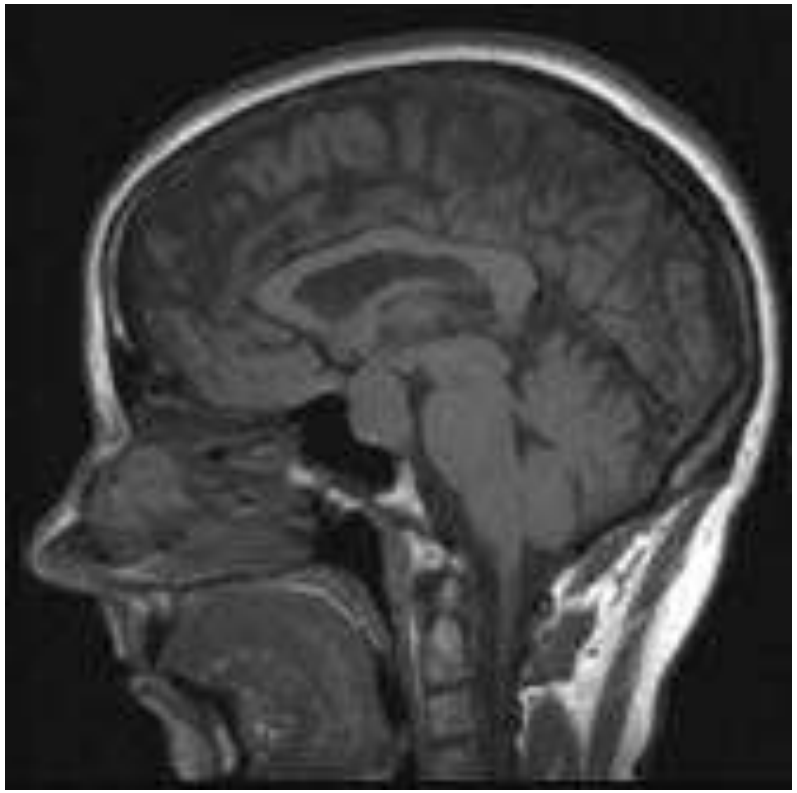
white without contrast

T1-weighted images with Gd contrast

- ✓ **Recognition:**
  - Like non-contrast T1 but **with bright arteries and veins**
- ✓ **Useful for visualization of:**
  - Normal vessels
  - Vascular changes
  - Disruption of blood-brain barrier
  - Enhancing lesions
- ✓ **Look for: Bright on Gd and NOT bright on noncontrast**



T1-weighted images with vs without Gd contrast

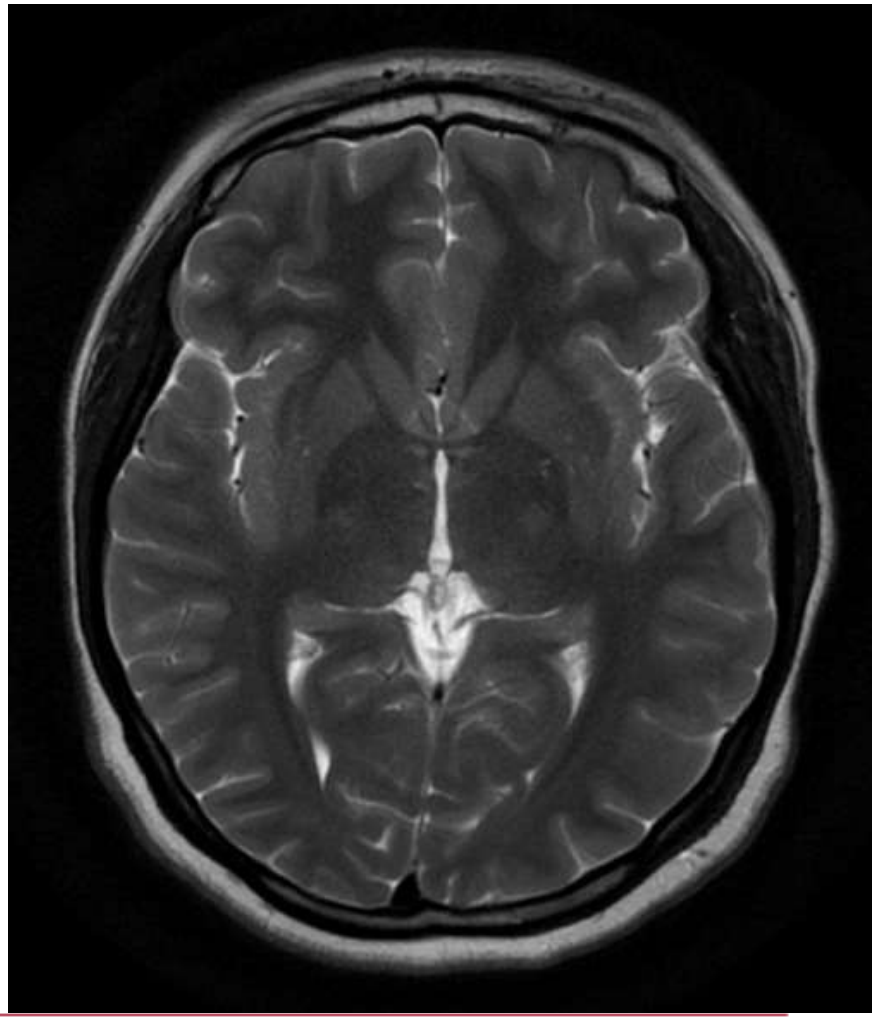


pituitary macroadenoma on sella turcica

here the problem is not the enhancement, the size is big
↳NL enhancing pituitary

T2-weighted images (T2)

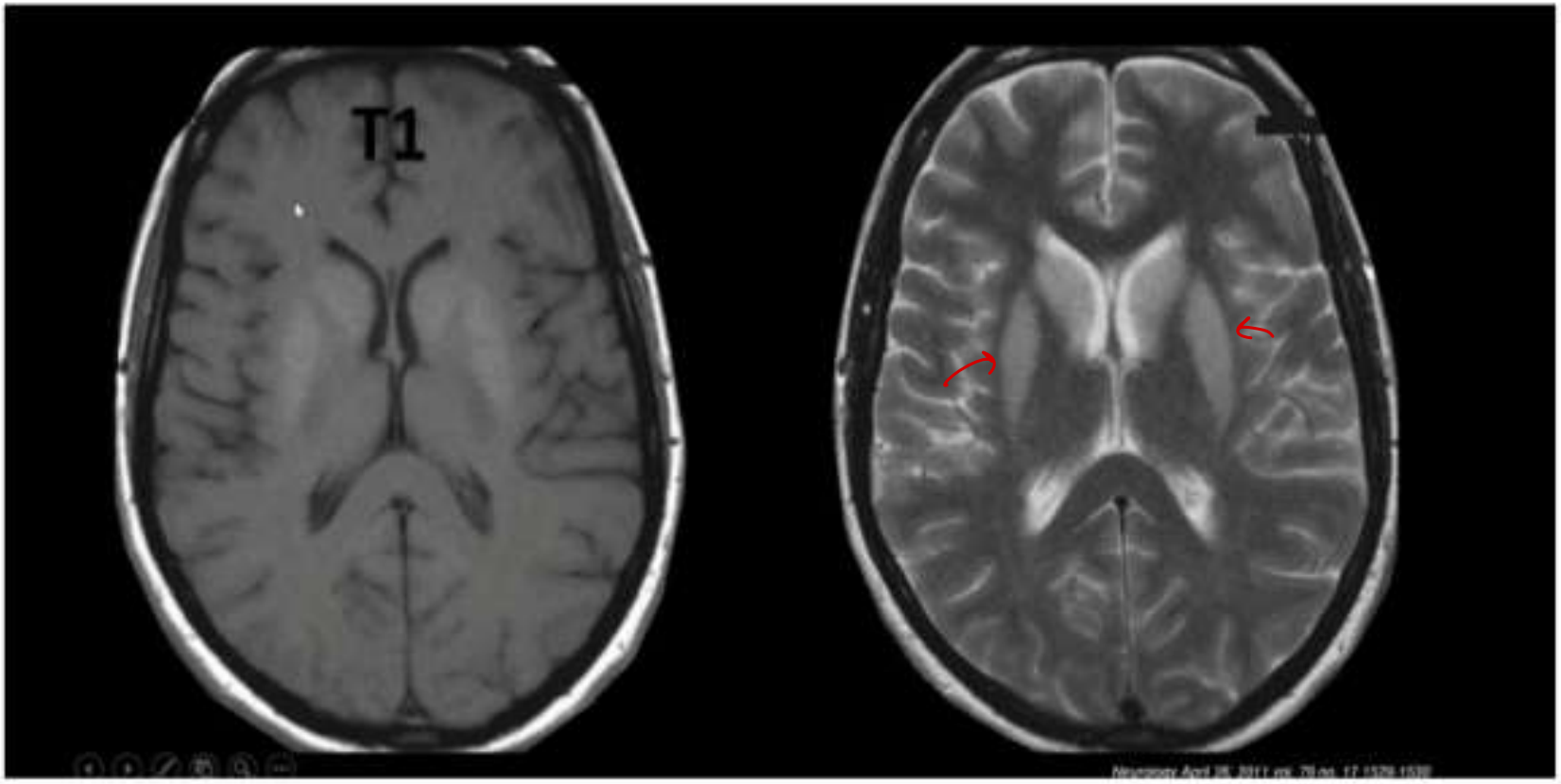
- ✓ **Recognition**
  - **CSF (ventricles, cisterns, sulci): bright**
  - Scalp: bright
  - **White matter darker than grey matter**
  - Vessels: black (flow void)
- ✓ **Useful for:**
  - Brain anatomy (shows CSF spaces)
  - Most brain lesions
  - **But can't distinguish lesions from CSF (ventricles, sulci)**



T2-weighted images (T2)

- ✓ **Black on T2 (no protons)**
  - Air
  - Calcium
  - Dense bone
  - Flow
- ✓ **Dark on T2 (long T2)**
  - White matter and Gray Matter
  - White matter darker than grey matter
- ✓ **Bright on T2 (short T2)**
  - CSF
  - Blood (except deoxyhemoglobin)
  - Edema
  - Most lesions
-

T1 Vs T2



Putamen & caudate
whitish → pathology

FLAIR (Fluid Attenuated Inversion Recovery)

T2 + cancel CSF signal (black instead of white)

important : differentiate than T1

- **Same as T2 except free CSF (ventricles, cisterns, sulci) is suppressed (black)**
- Most pathology is **BRIGHT**

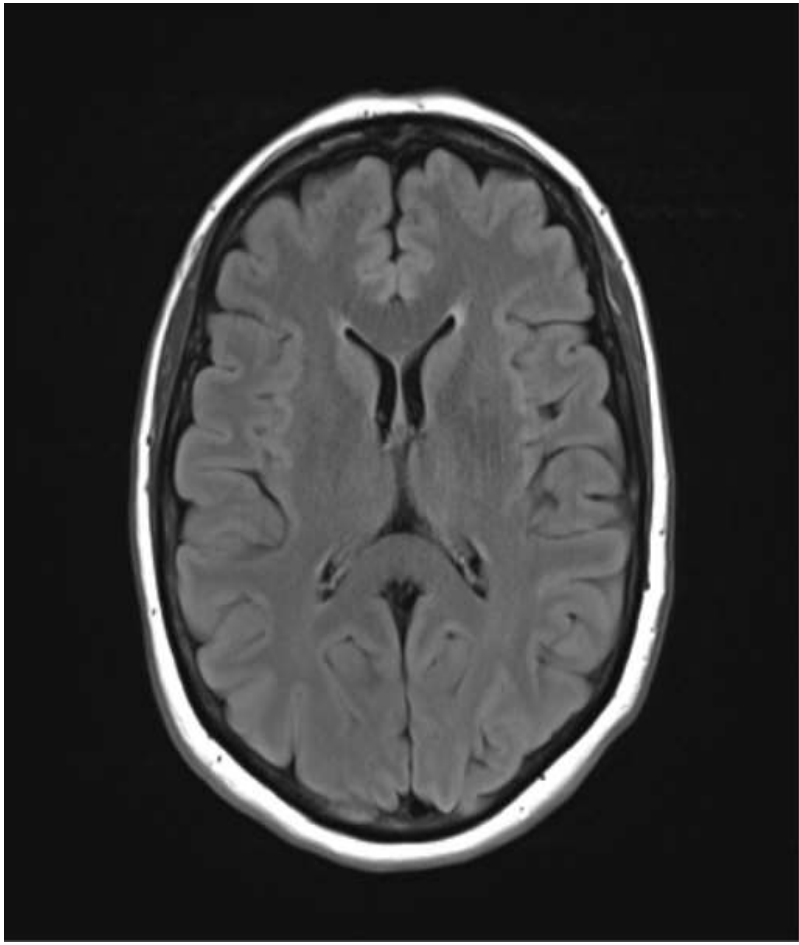
✓ Recognition

- Superficially resembles T1 **(but the white matter darker than grey matter)**

very sensitive

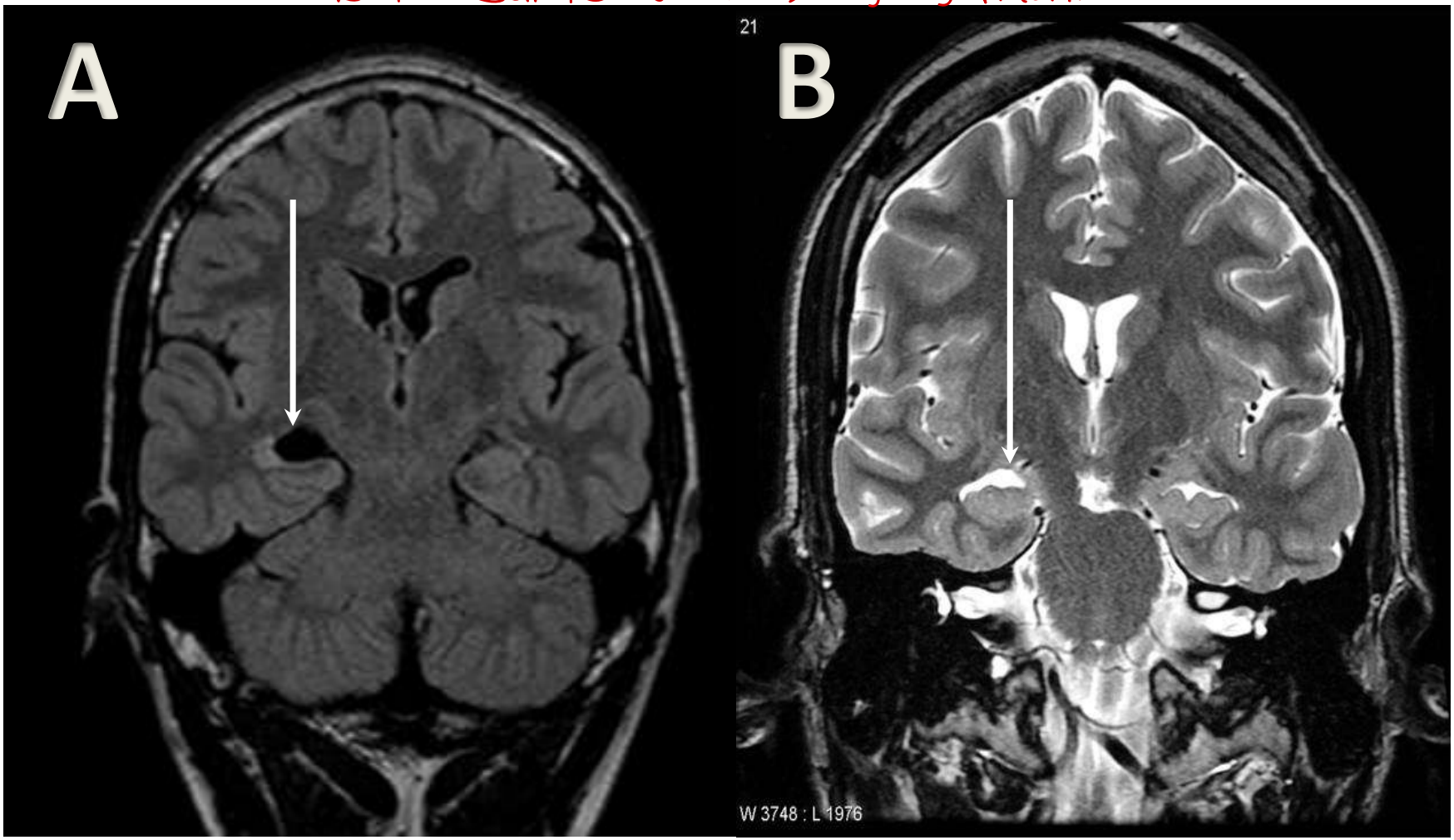
✓ Useful for:

- Same as T2
- Most lesions
- Especially good for lesions near ventricles or sulci (MS)



T2 vs FLAIR

both same white & grey matter



Susceptibilty weighted images
T2* (T2-star, or SWI)

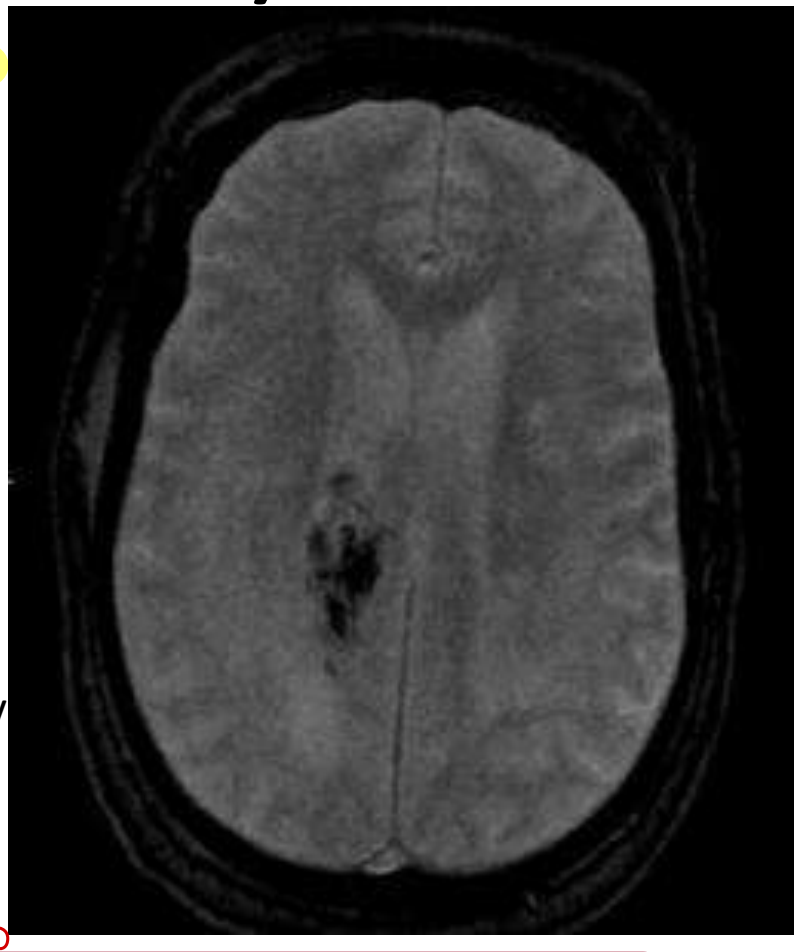
- Form of T2-weighted image which is susceptible *iron or calcium*
- Blood, bone, calcium appear *dark*
- Area of blood often appears much larger than reality ("blooming")

✓ Recognition: Like T2 except
  - Cranium, scalp are dark or absent
  - Dark areas near frontal and temporal bones
  - Hemorrhage is darker than brain.

✓ **Useful for:**
  - Identification of early hemorrhage
  - Identification of old hemorrhage (secondary hemosiderin deposition)
  - Identification hemorrhage in tumors.

✓ **Look for: DARK only**

can be calcifications too



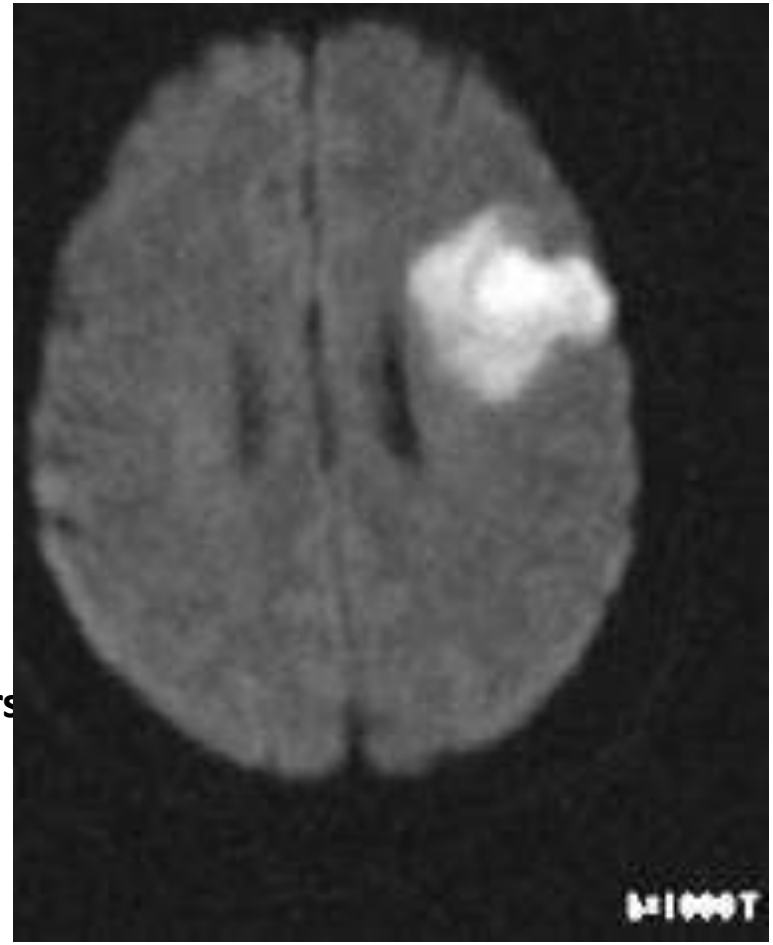
Diffusion-weighted image (DWI)

- ✓ Sensitive to passive diffusion of water
- ✓ **Areas of restricted diffusion are *bright***
- ✓ Recognition
  - Low-resolution image (typically 20 slices).
  - Looks like FLAIR but with no skull.

- ✓ **Look for: BRIGHT only**

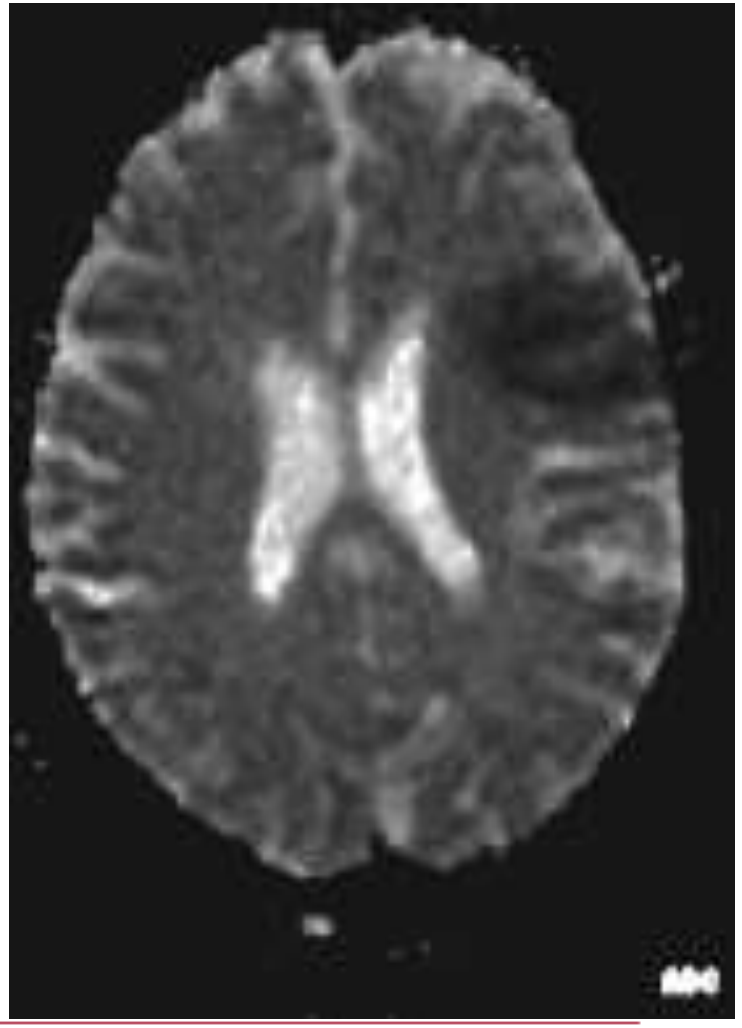
- ✓ **Restricted diffusion occurs in cytotoxic edema**:
  - Ischemia (possibly within minutes)
  - Abscess
  - **Not other structural lesions such as tumors vasogenic edema**

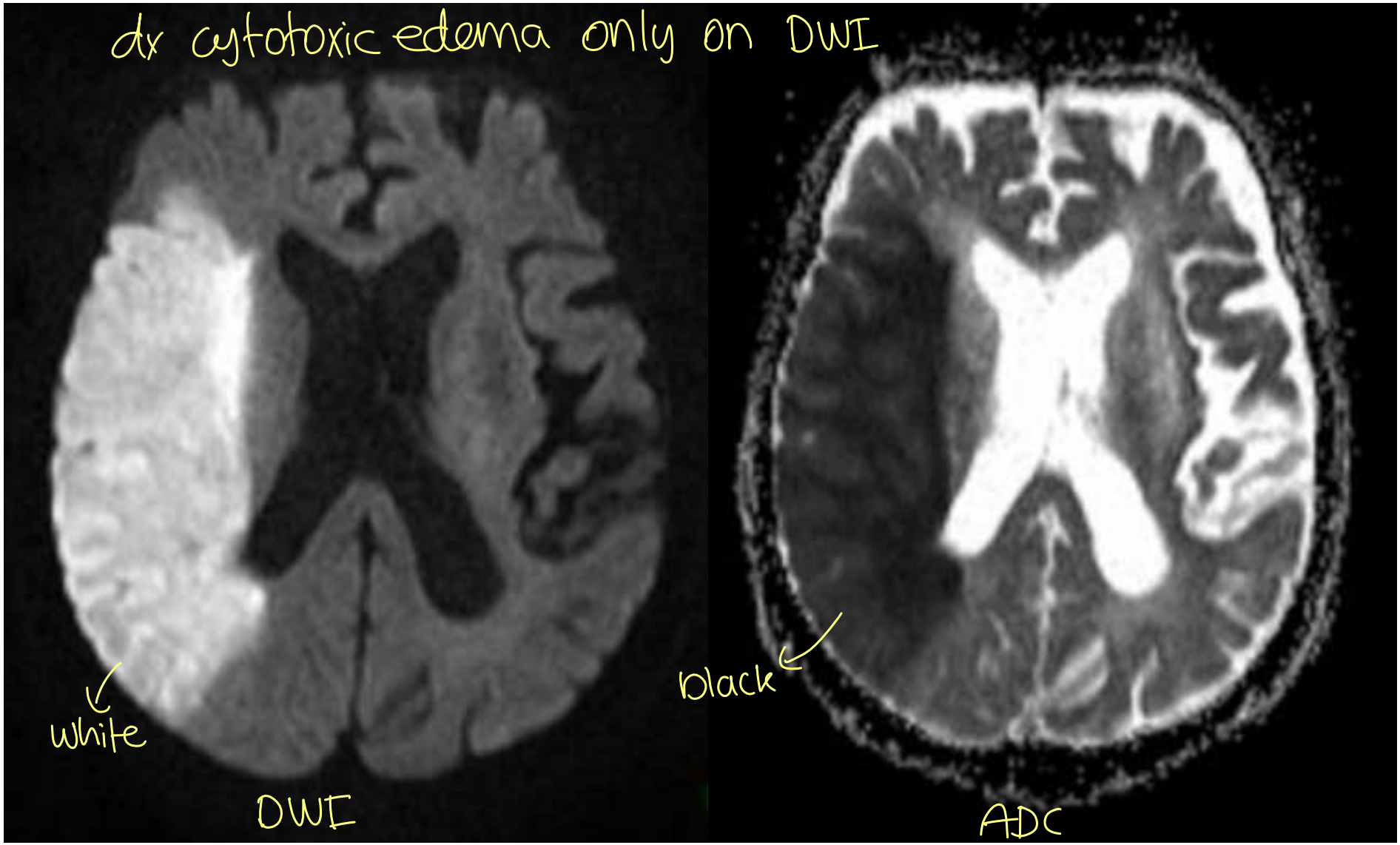
- FLAIR vs DWI
  skull present no skull



Apparent Diffusion Coefficient (ADC Map)

- ✓ Contains actual data relevant to diffusion image
- ✓ Areas of restricted diffusion **are *dark***
- ✓ **Useful for:**
  - Excluding T2-shine through
  - **Real restricted diffusion is bright on DWI, dark on ADC**
- ✓ **Look for: DARK only**
- ✓ **Recognition**
  - looks like T2 with no skull and pixlated outline



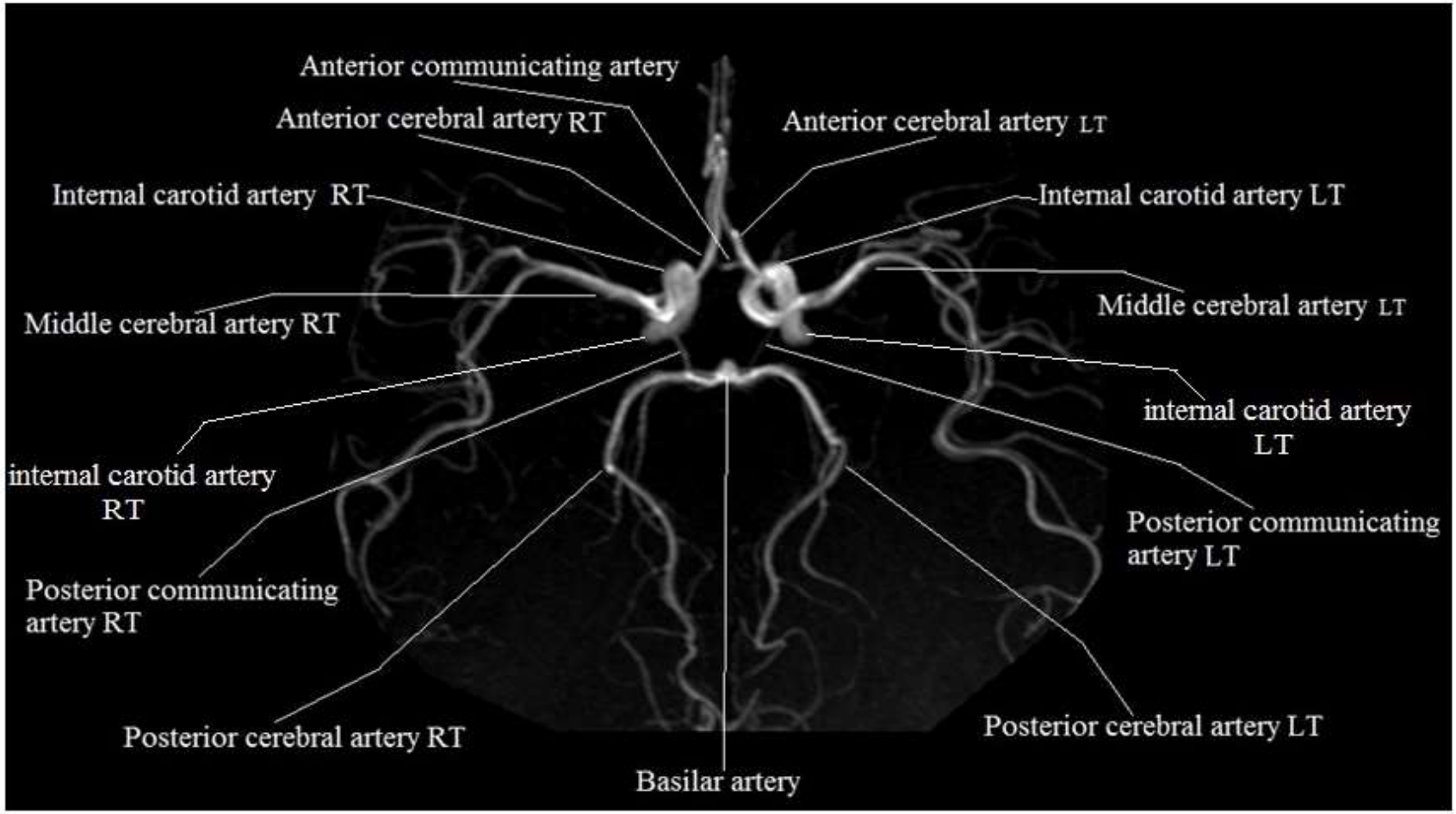


restricted diffusion → cytotoxic edema

MR Angiography

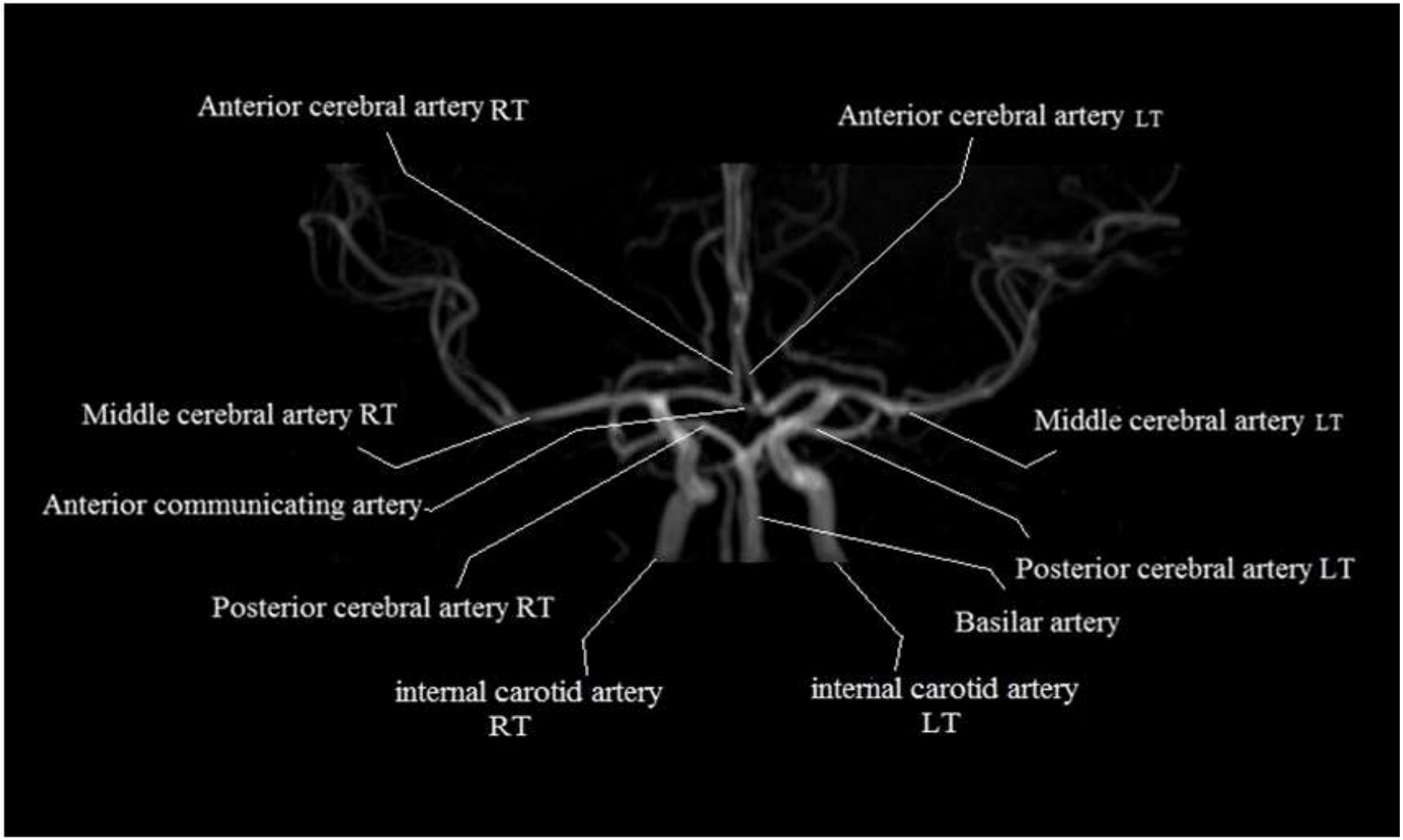
no contrast

Axial arterial anatomy of brain



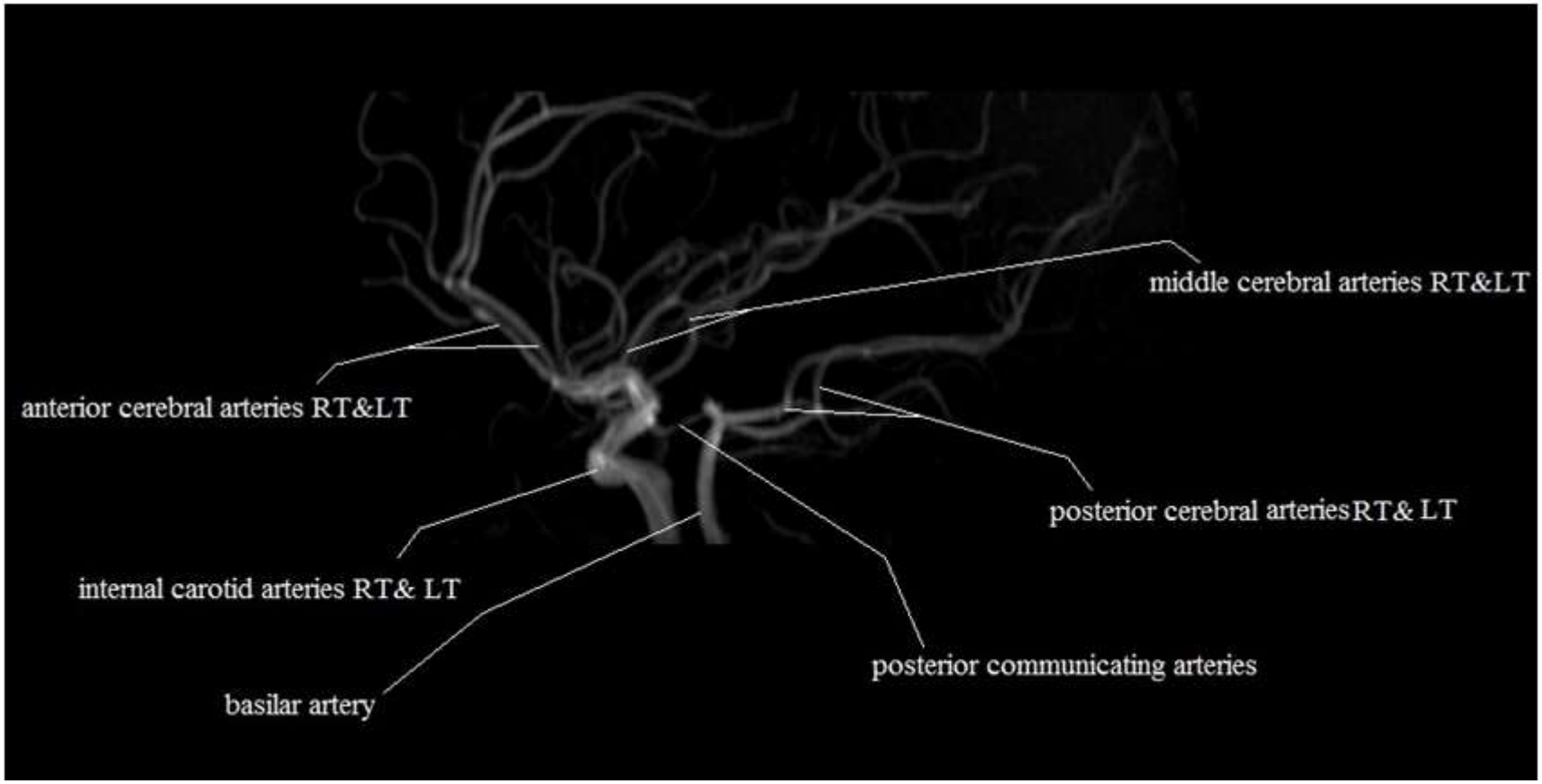
MR Angiography

Coronal arterial anatomy of brain



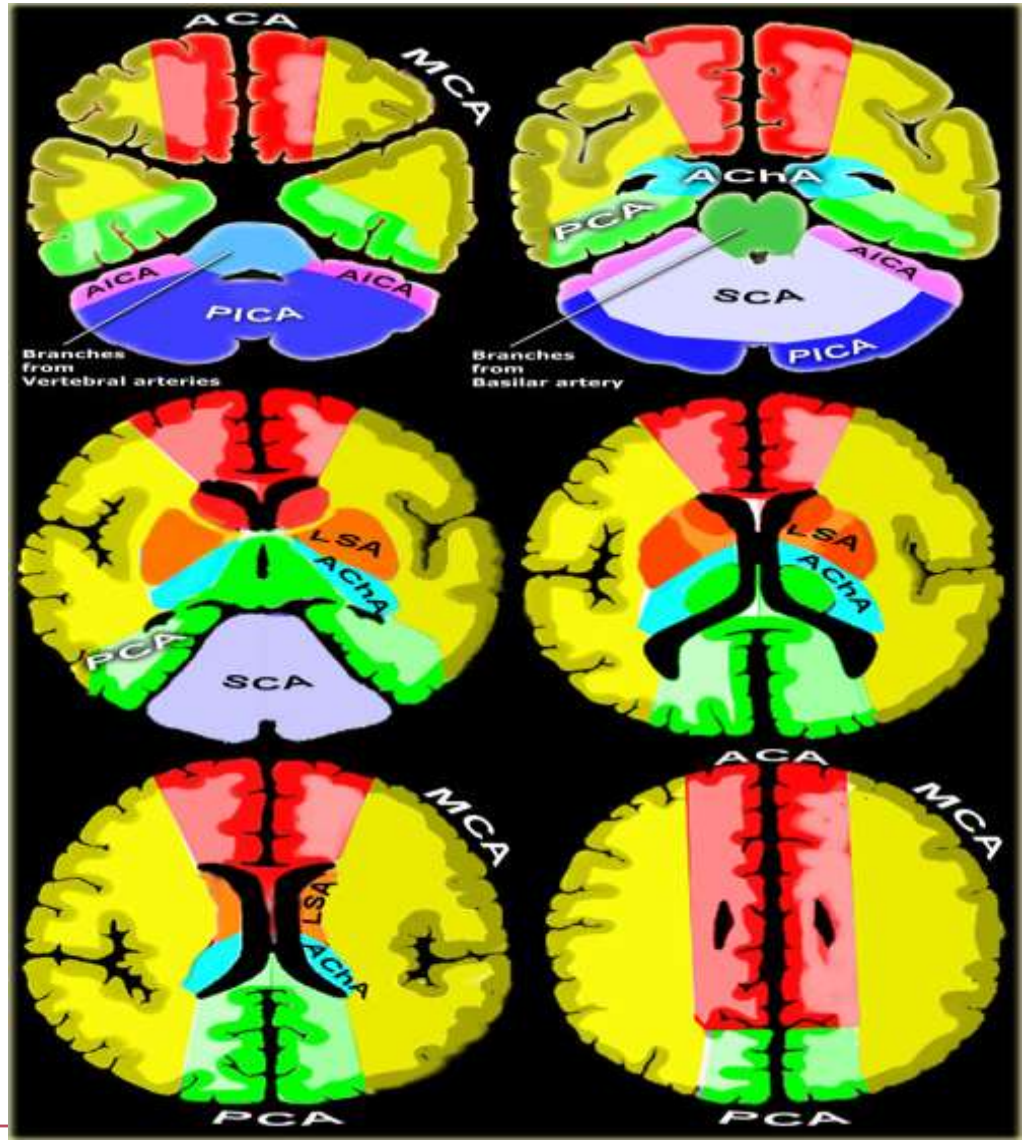
MR Angiography

sagittal arterial anatomy of brain



memorize
each artery &
which terratory supplies

Brain Vascular territories

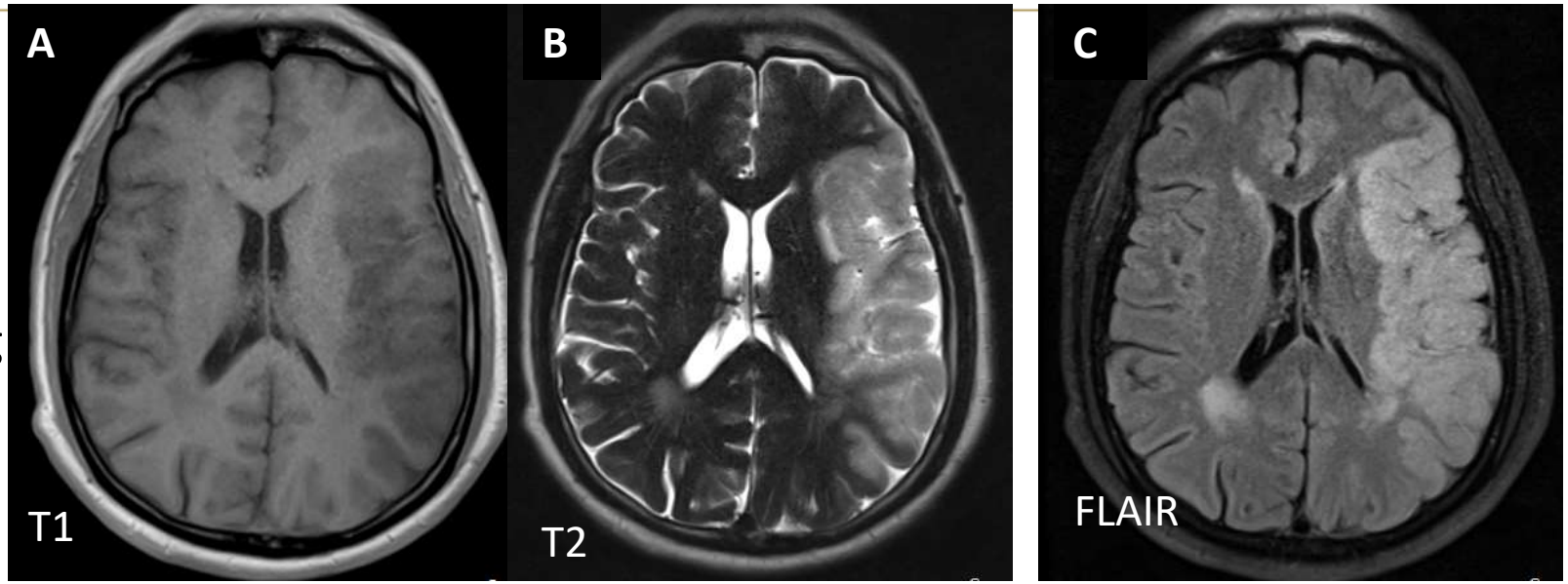


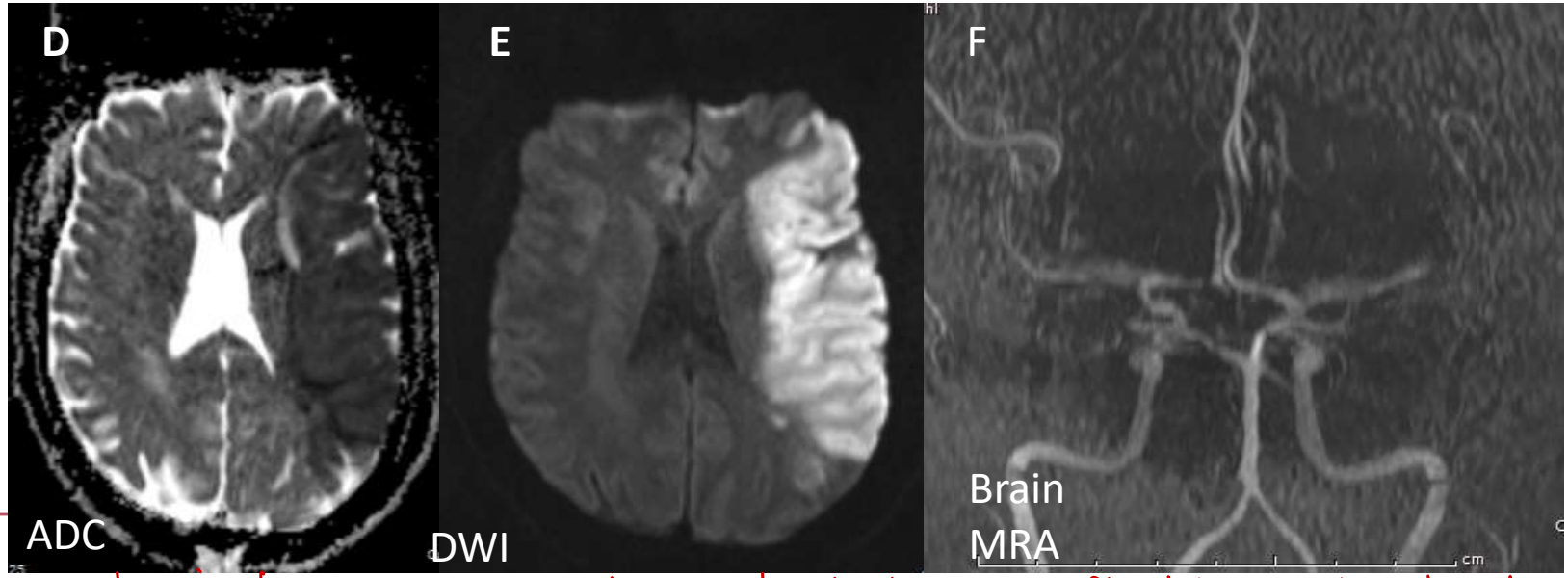
Brain pathology examples

Cerebral ischaemia

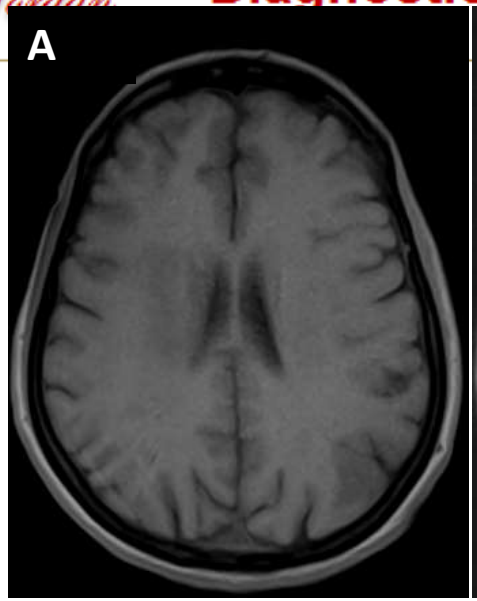
- Diffusion weighted imaging is the main diagnostic sequence in acute infarctions.
- Abnormal signal intensity of both white and grey matter in a VASCULAR TERRITORY.
- Diagnosis and assessment after intervention (thrombolysis).
- MRA

58 year old male patient is complaining of right sided weakness

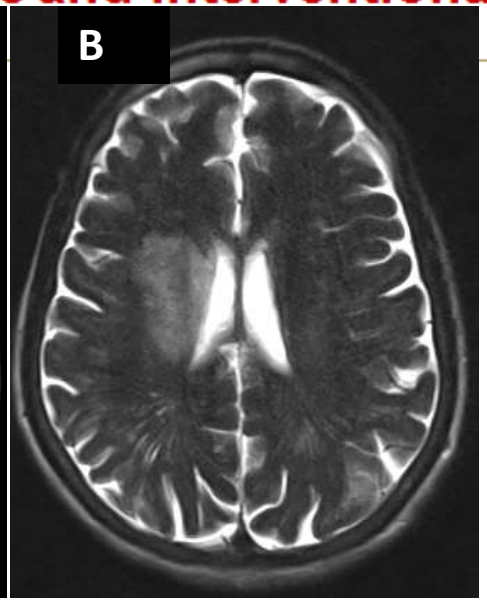




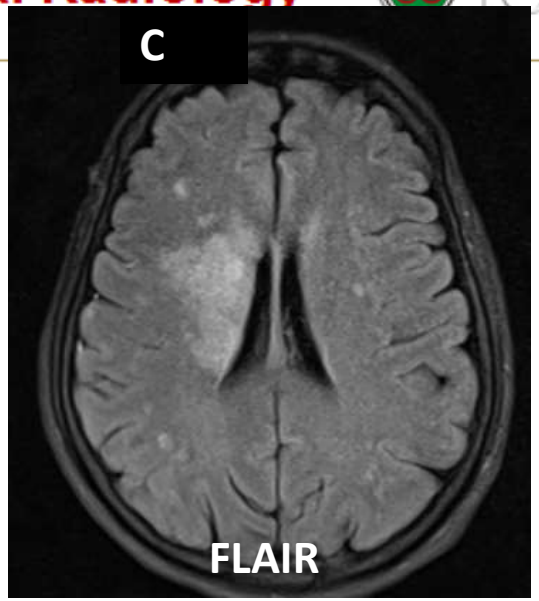
acute ischemia not encephalitis bc it's confined to vascular territory



T1

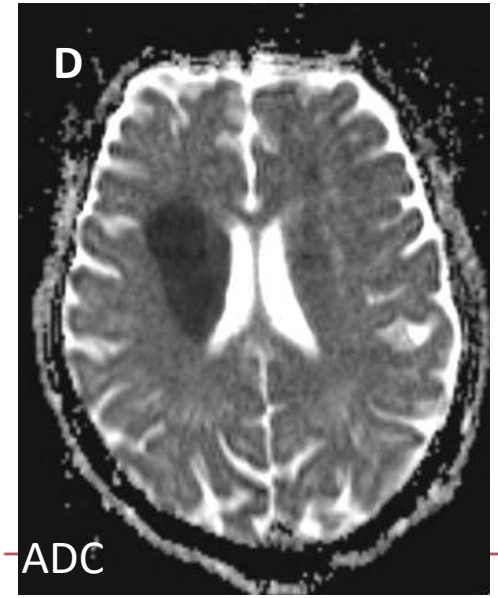


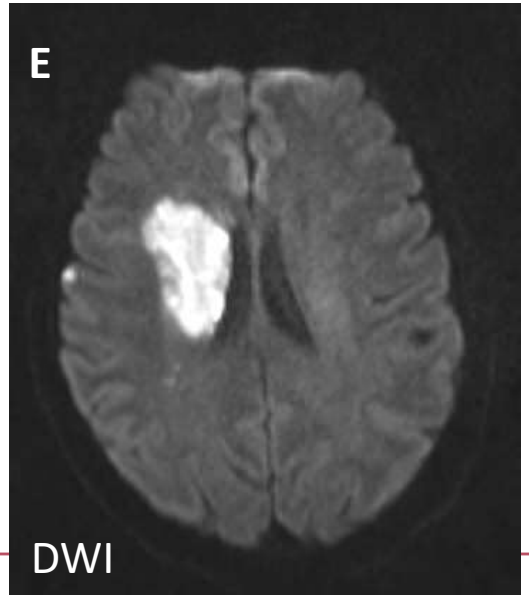
T2

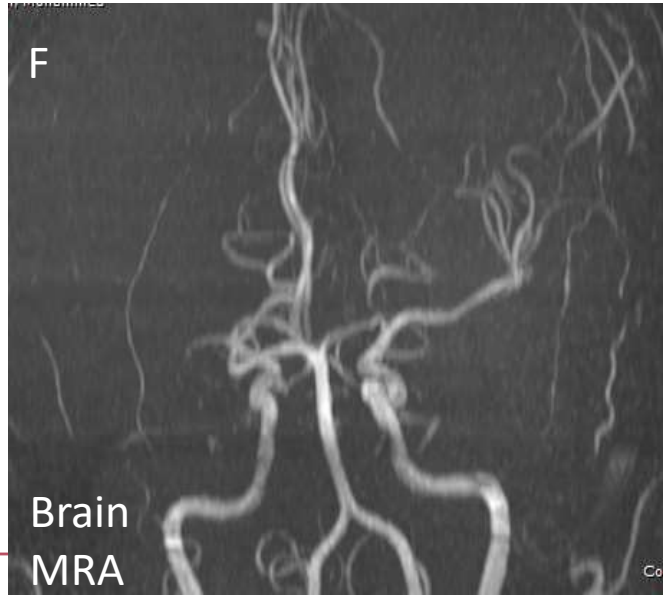


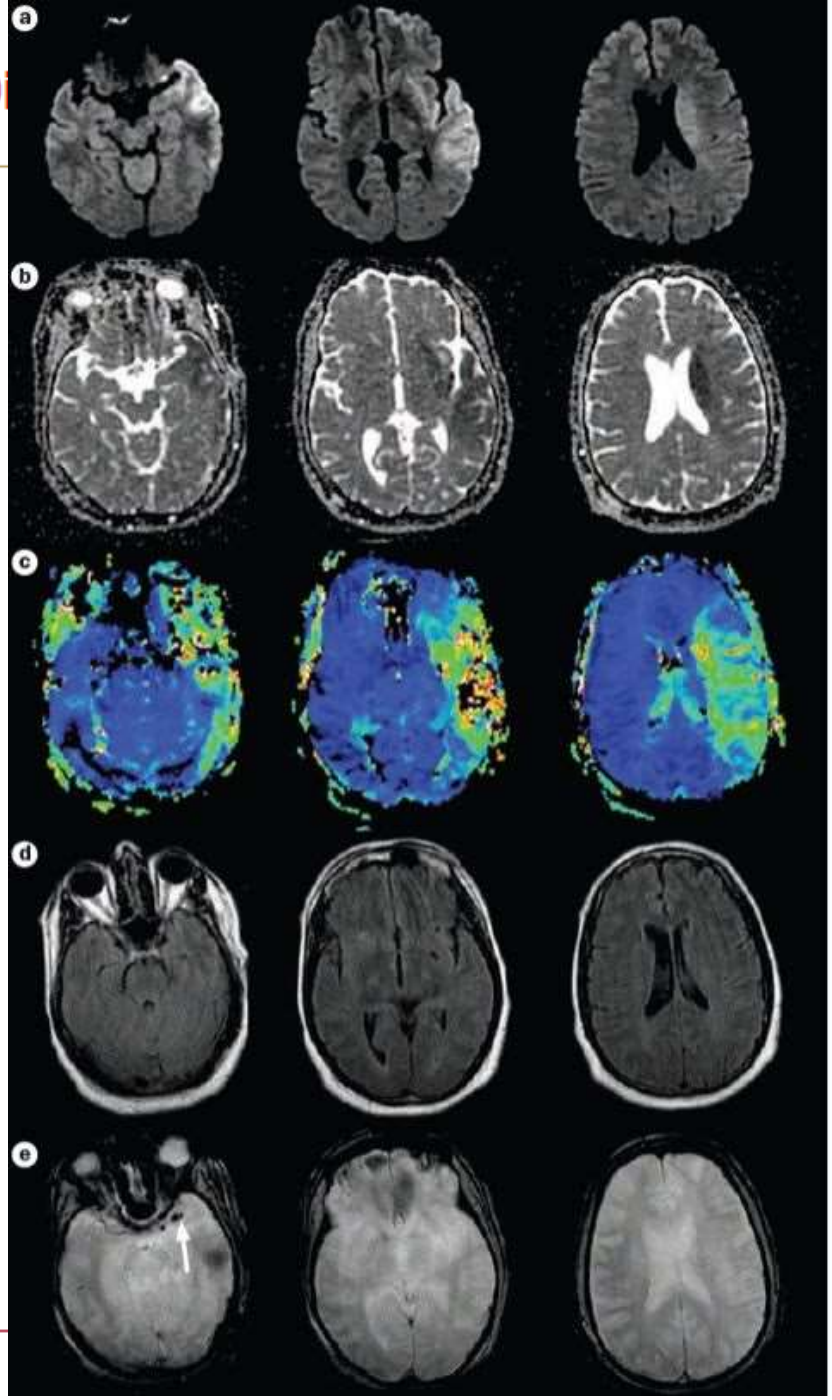
56 year old male patient is complaining of headache

recent infarct in Rt MCA









FLAIR

lft MCA occlusion

internal carotid also chronically occluded bc we see collaterals

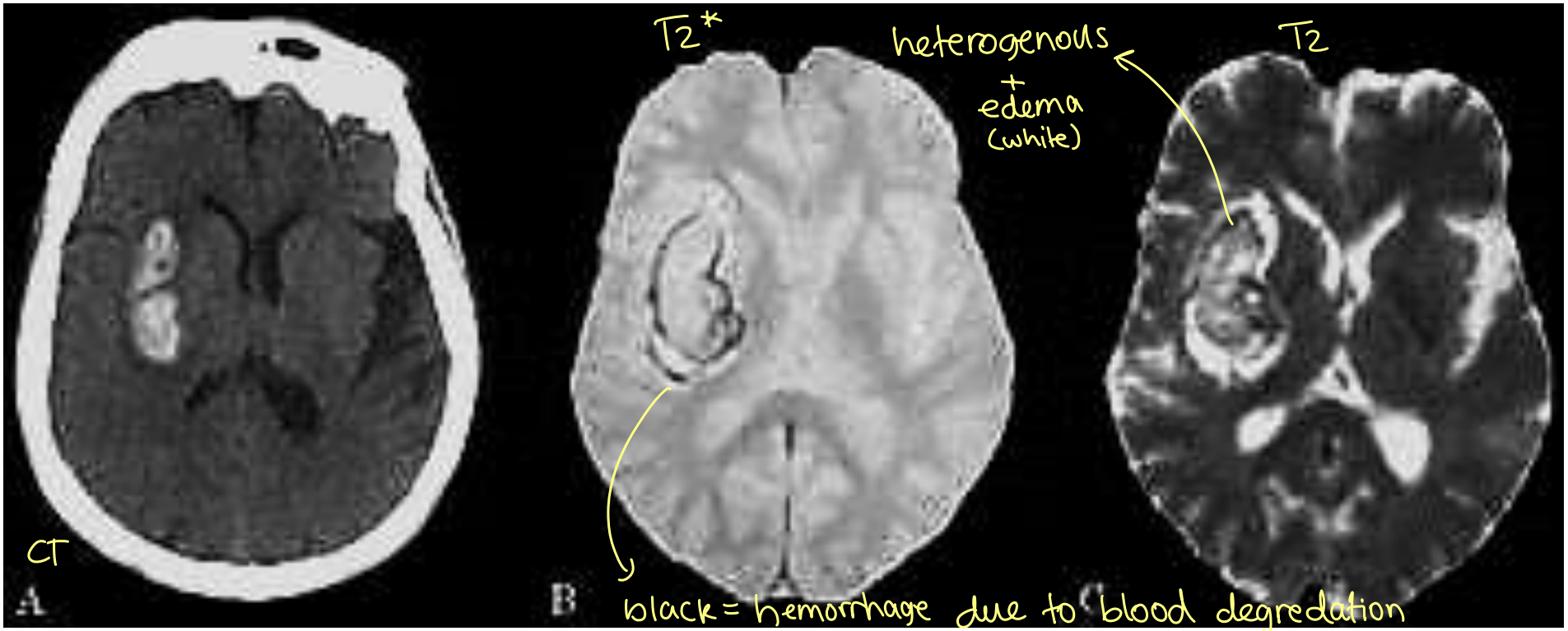
If no pathology on FLAIR = early presentation → pt is in treatment window

Intracranial Hemorrhage

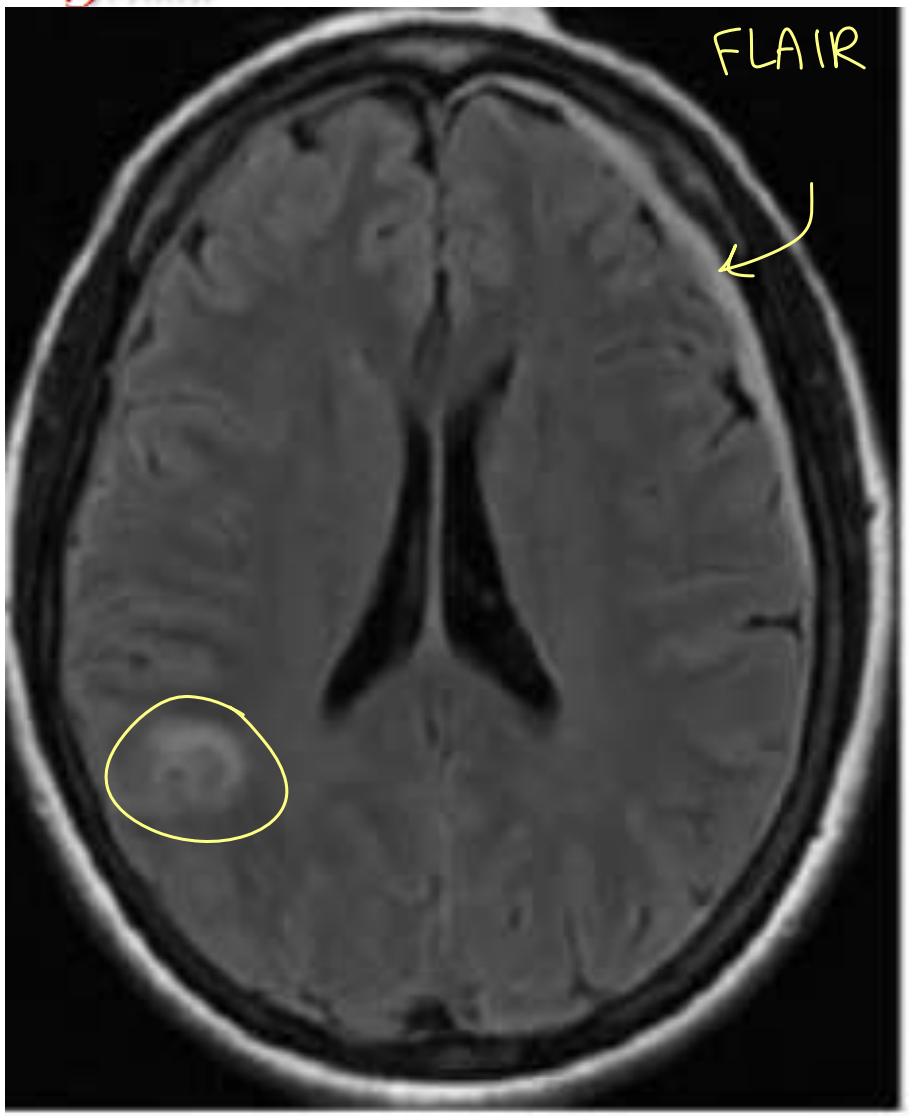
- Blood products have variable complex signal intensity on MRI according to the age of the hematoma.
- Gradient echo and susceptibility weighted images.
- FLAIR is sensitive for subarachnoid hemorrhage.

hemorrhage doesn't take enhancement

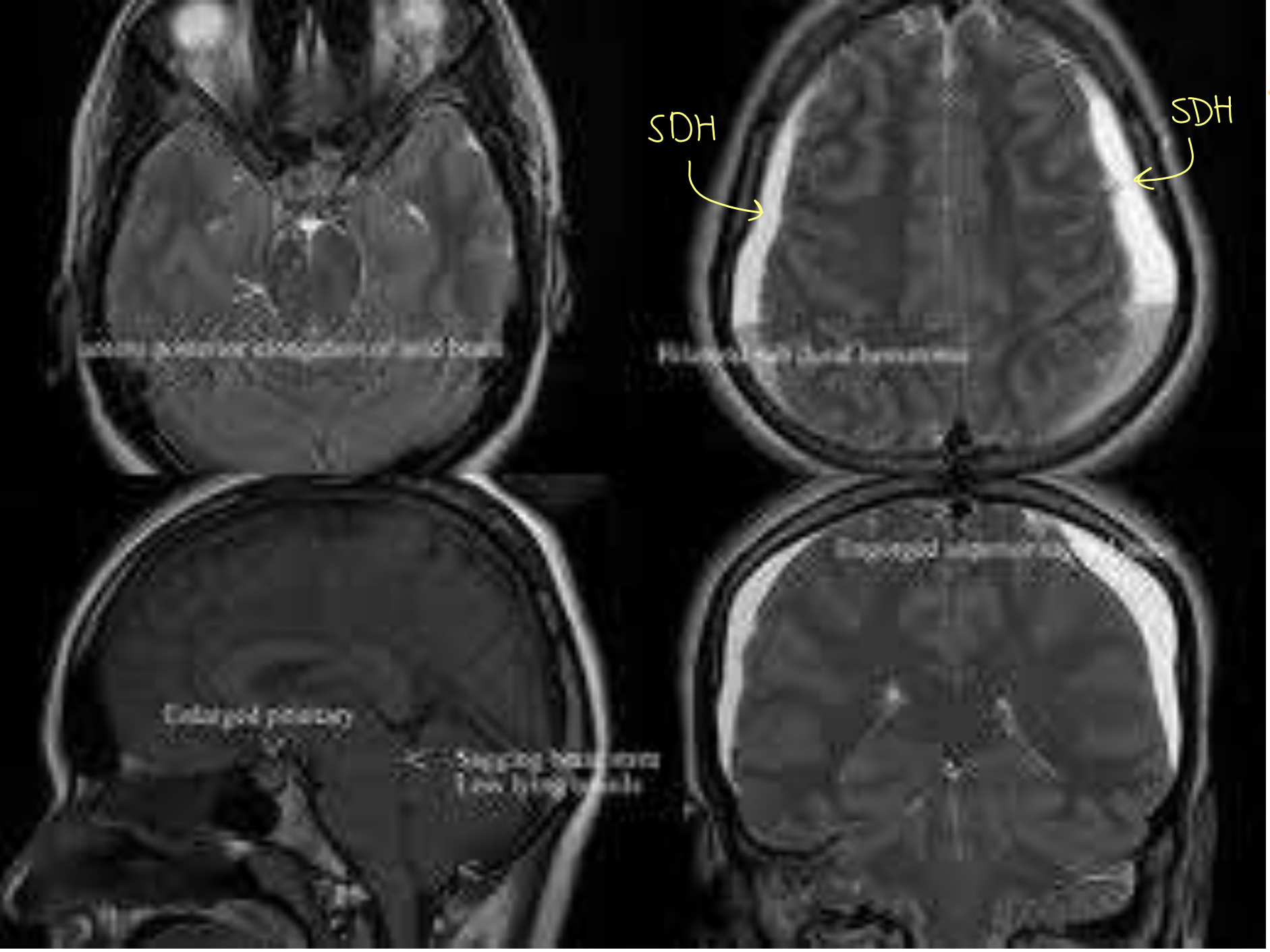
Rt putamen hemorrhage due to htn



HTN hemorrhage — thalamus
— putamen
— cerebellum



diffuse axonal injury


SDH
SDH
Enlarged pituitary

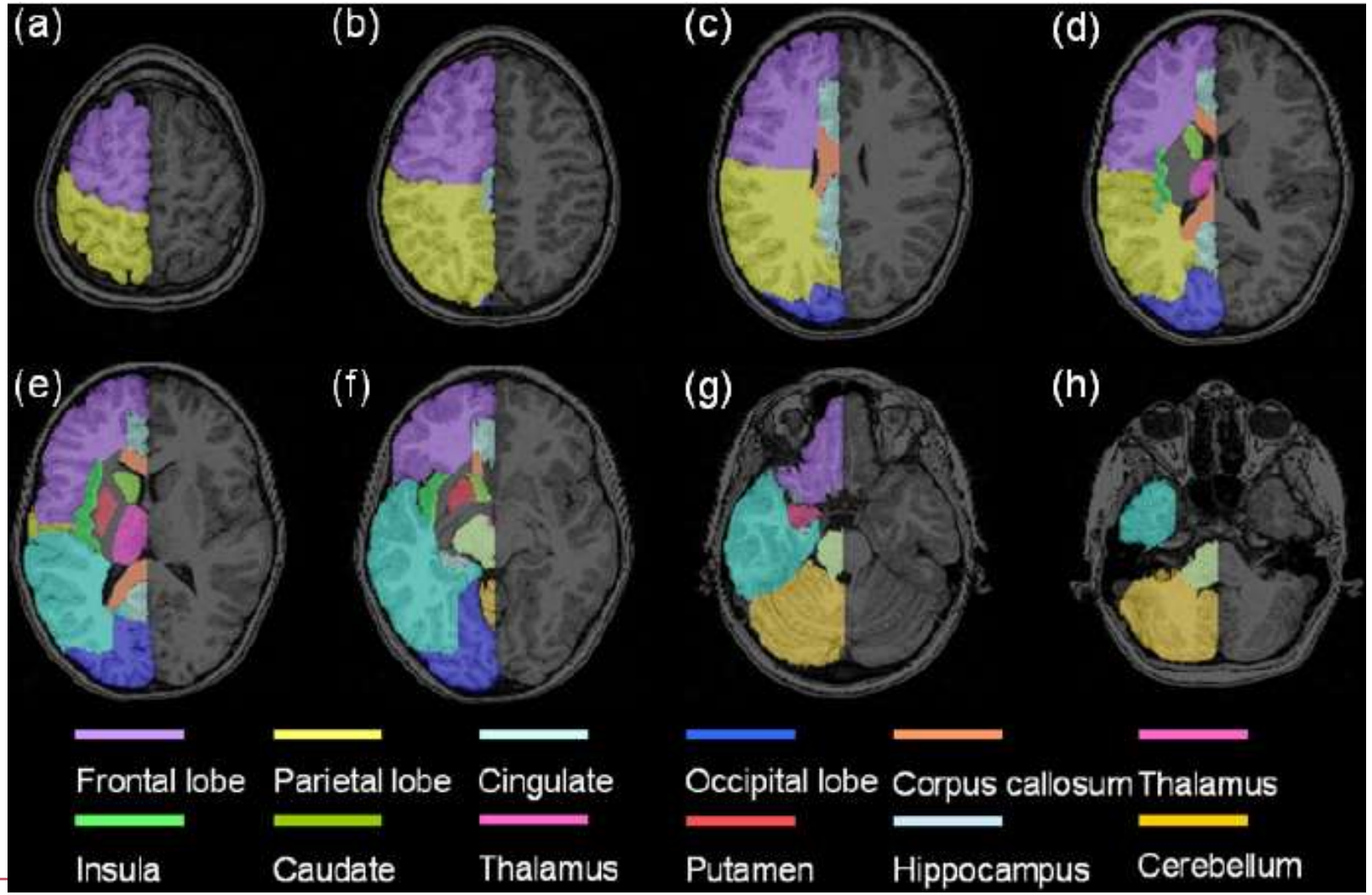
TUMOURS

- Localisation — intra-axial / extra-axial
- Intraxial vs Extra axial.
- T1 with gadolinum contrast

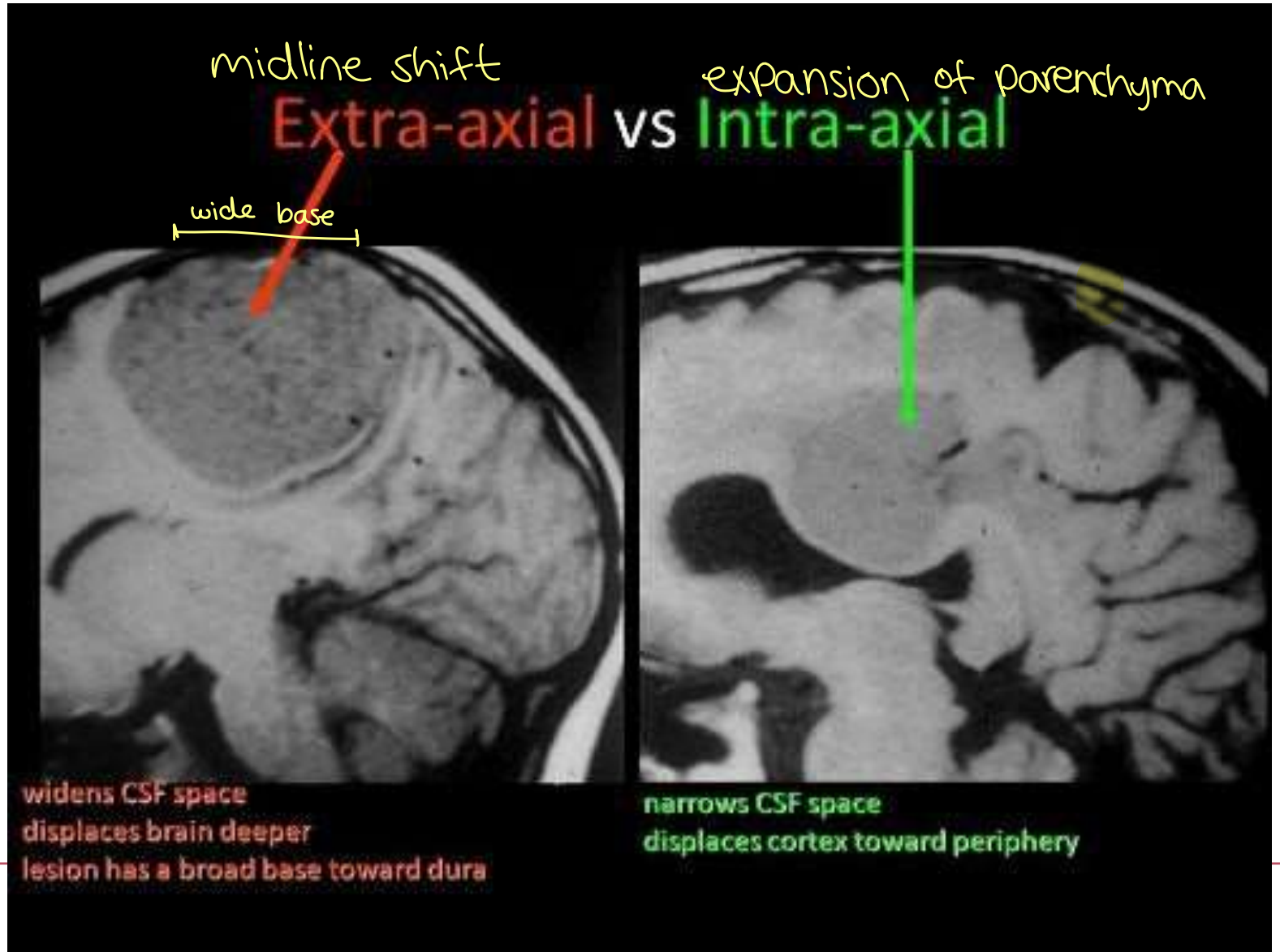
Analysis of a Potential Brain Tumor

- Age of the patient
- Localization
  - Intra- vs Extra-axial
  - What Compartment
  - Midline crossing
- CT and MR Characteristics
  - Calcification, Fat, Cystic
  - T1, T2, DWI
- Contrast Enhancement
- Effect on surrounding structures
  - Mass effect - Edema
- Solitary - Multiple
- Pseudotumor ?

Localisation

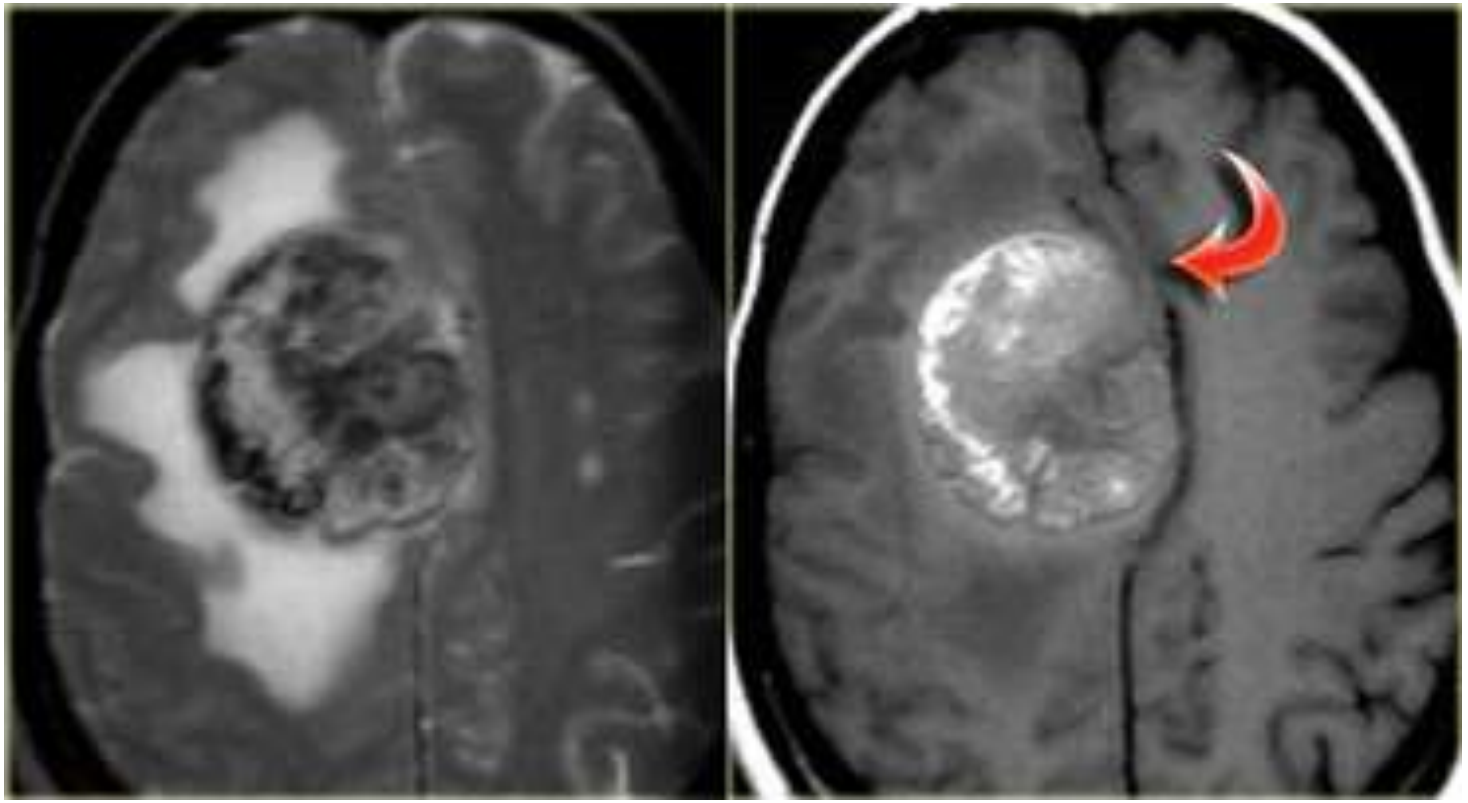


Extraaxial vs Intraaxial



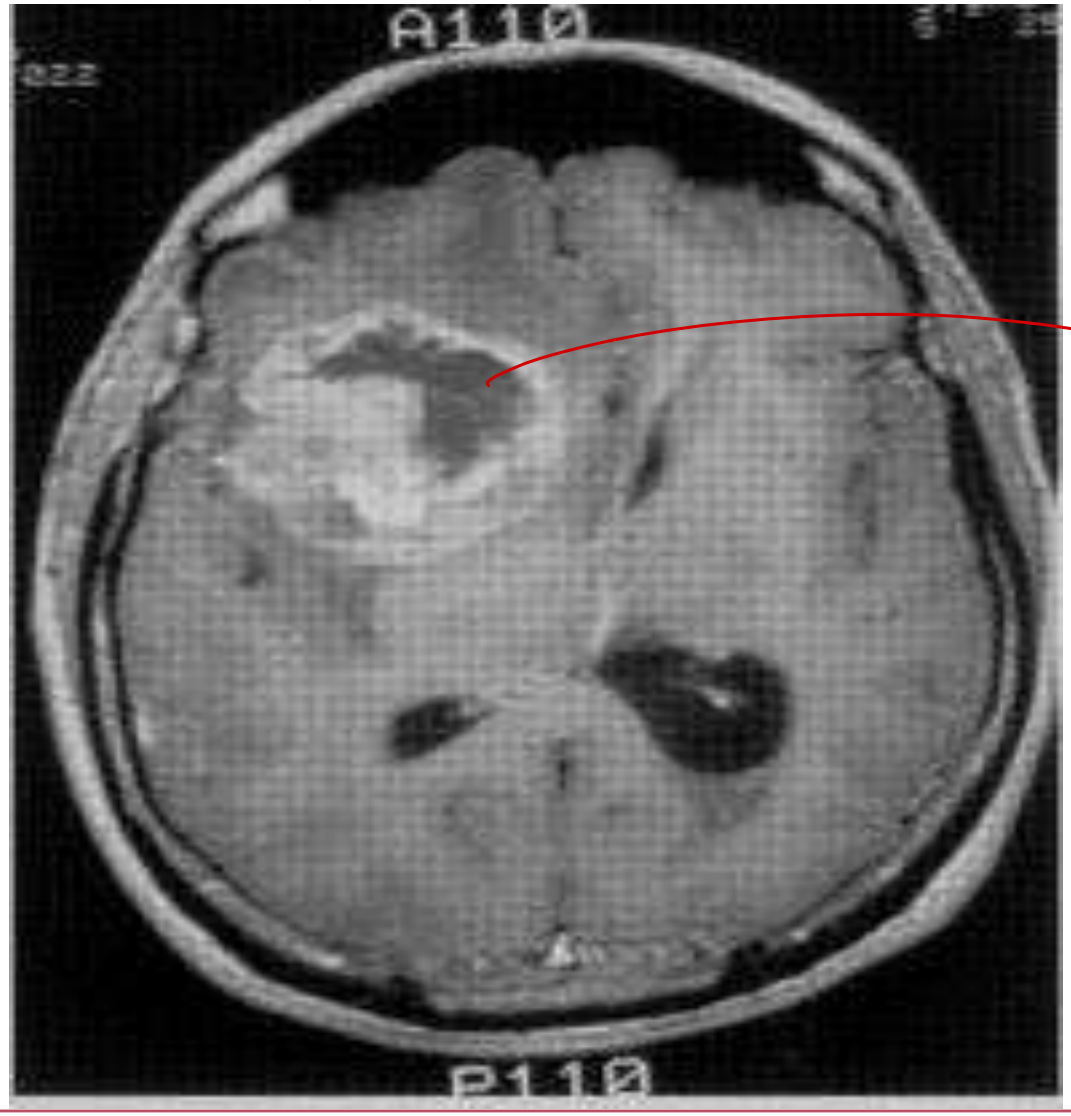
intra-axial

Melanoma



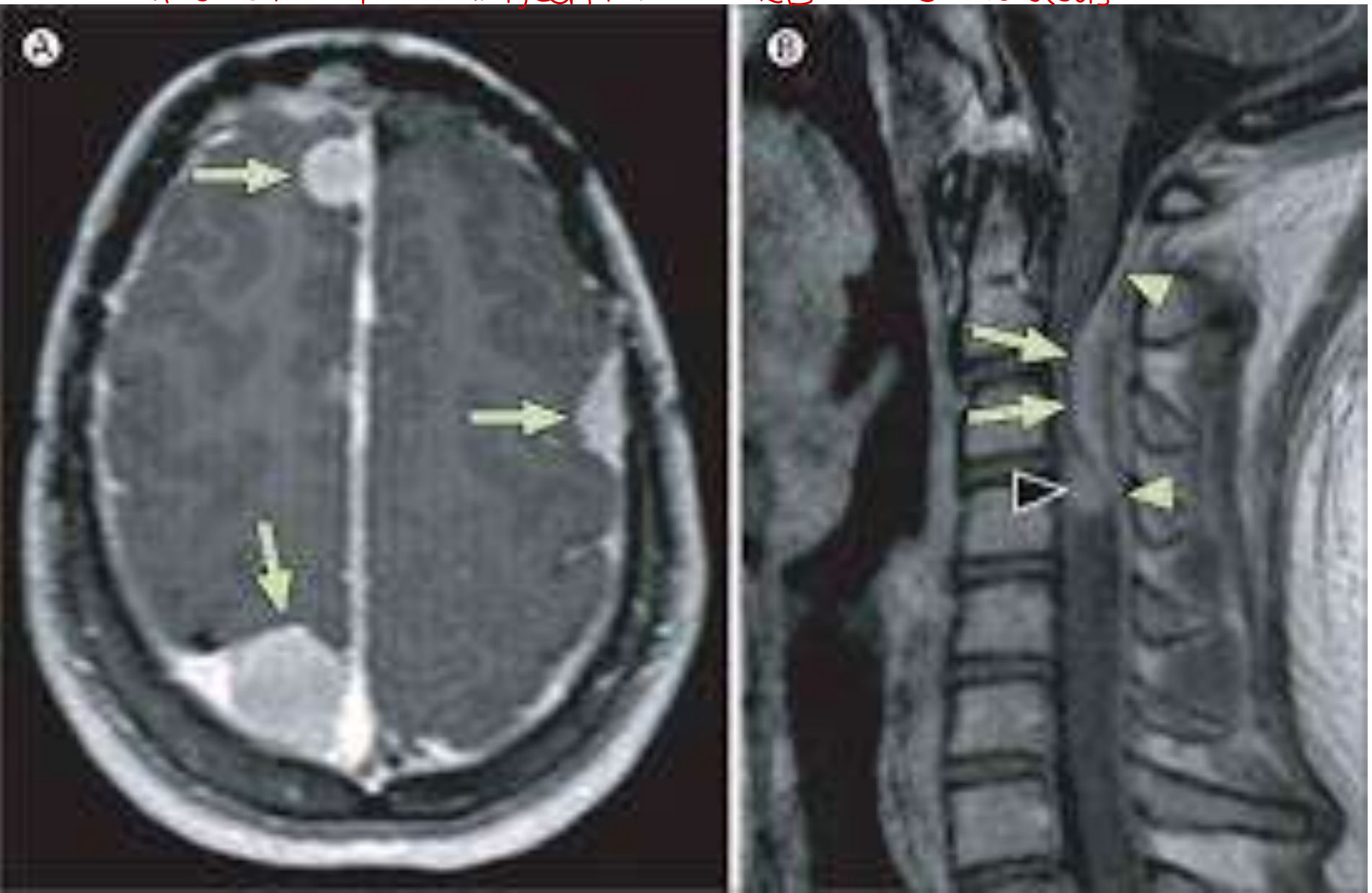
1ry lesion

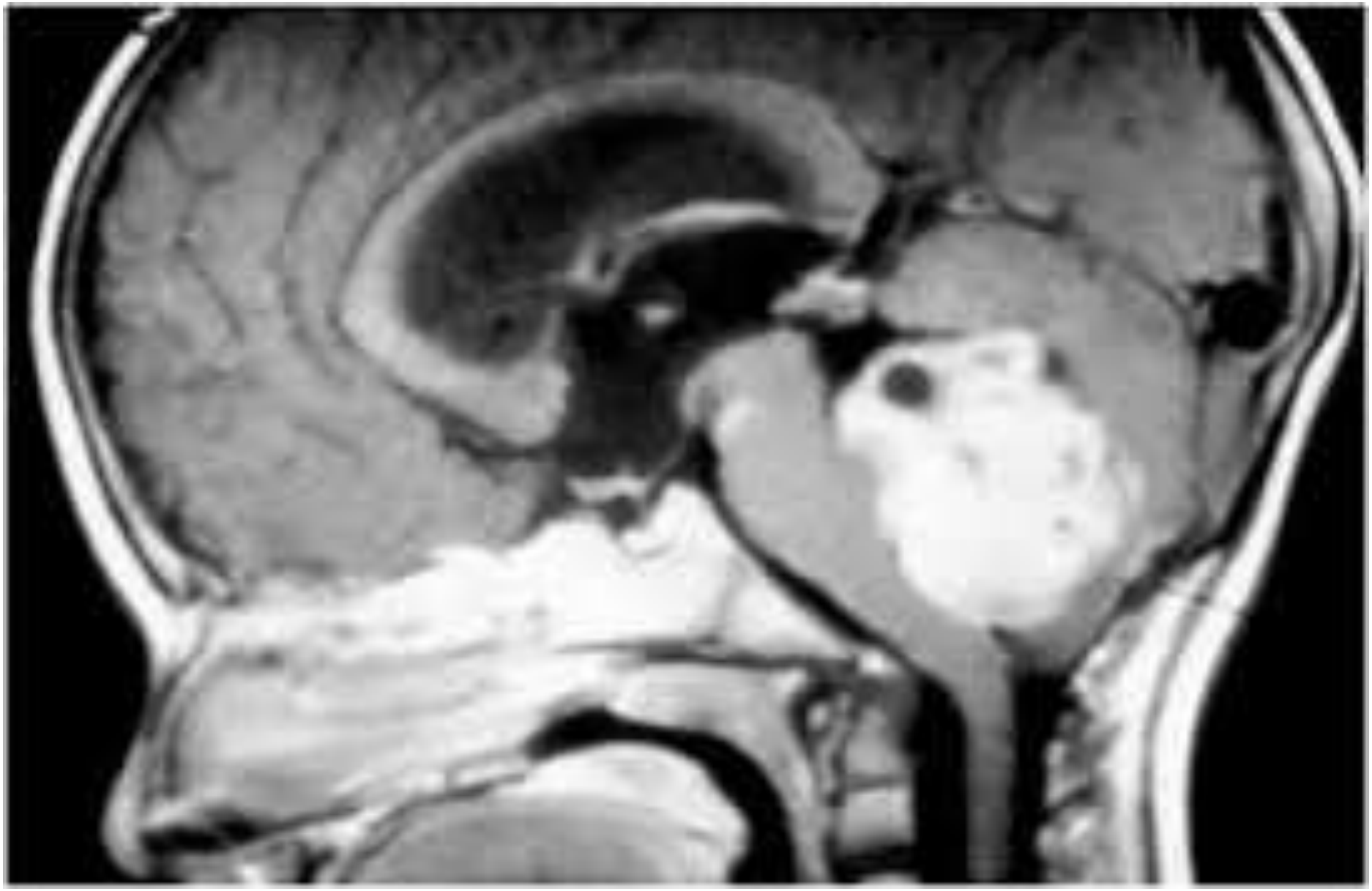
instead of saying malignant & benign, we say high & low grade tumors

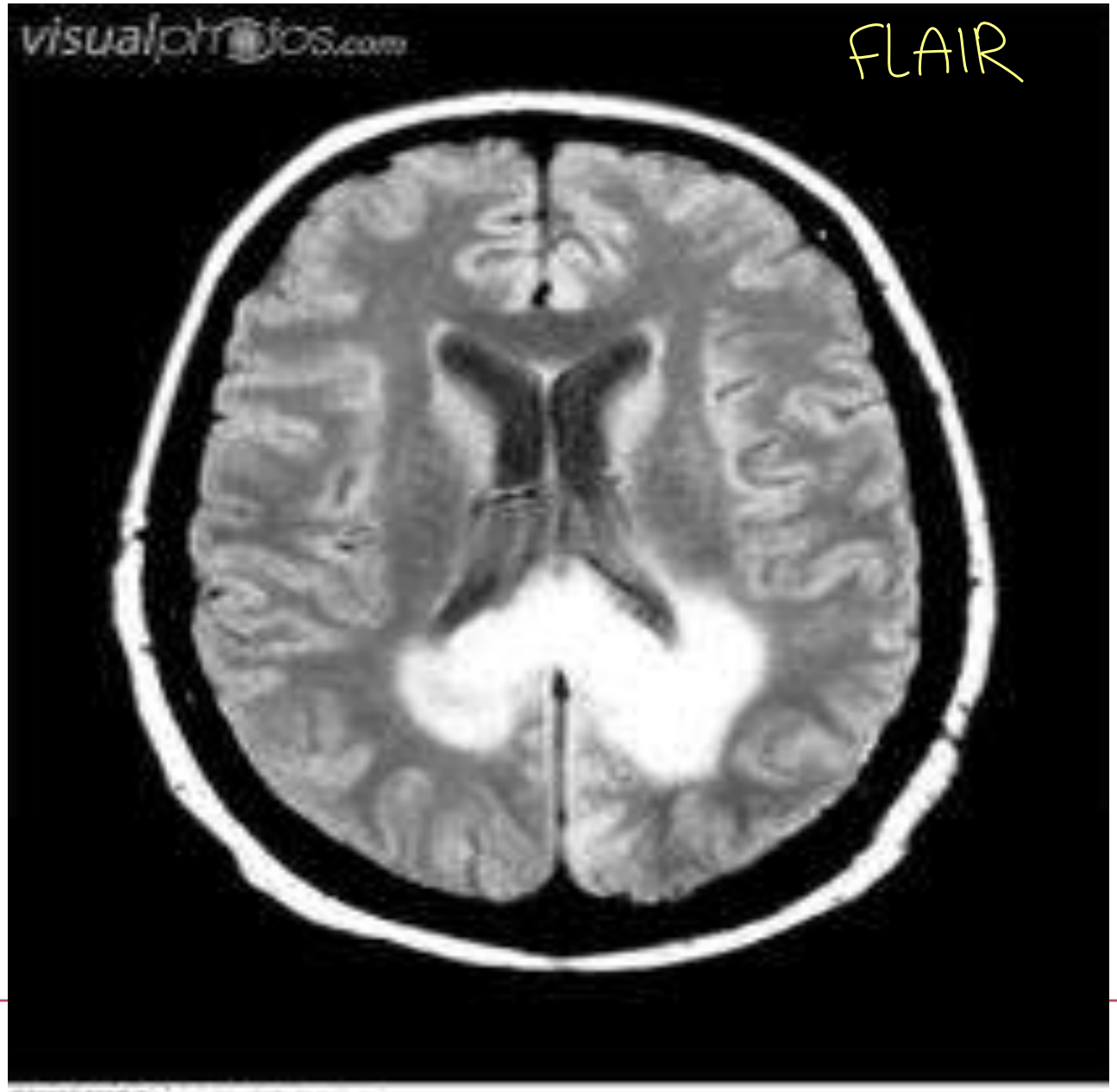


necrosis ↴
high grade lesion

extra-axial, meningeoma or mets or sarcoidosis

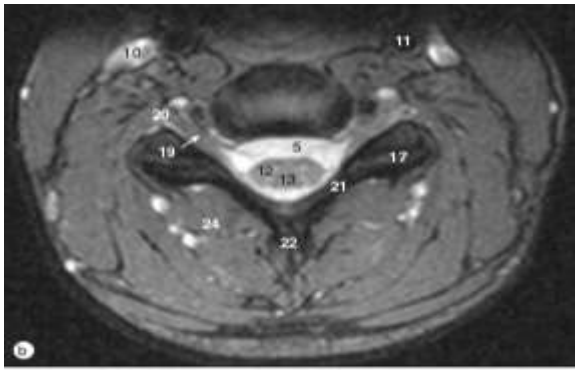




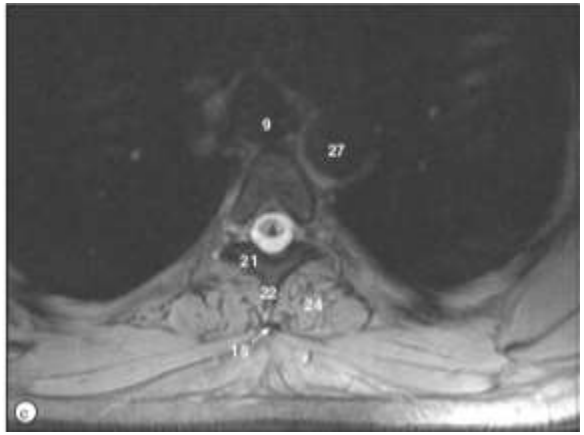


neoplasm bc it crosses the midline

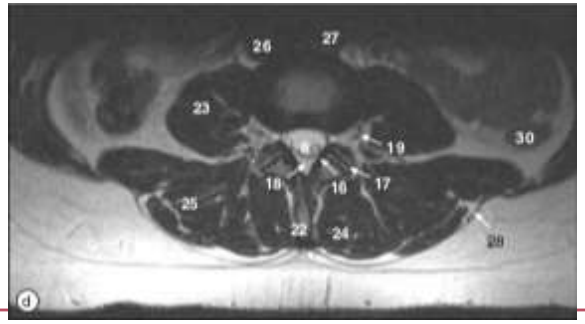
SPINE



CERVICAL



THORACIC



LUMBAR

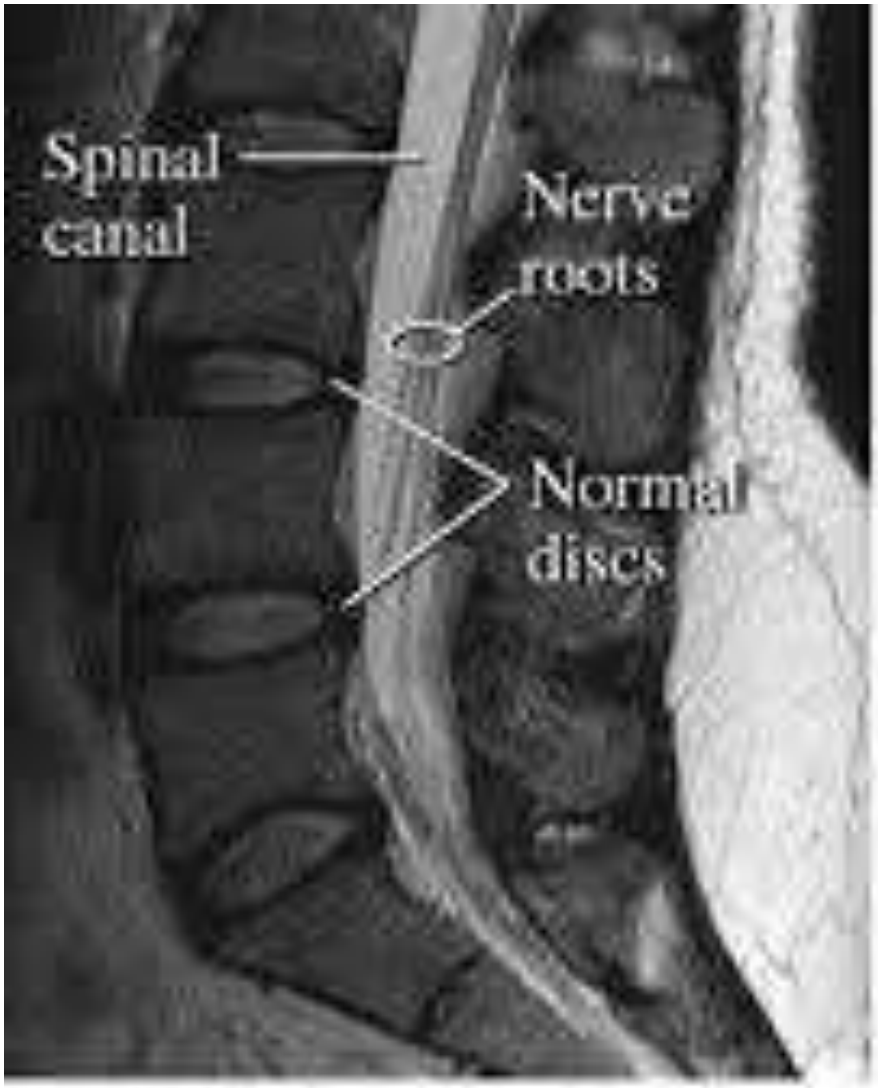


Figure 1

Figure 2

Sequences

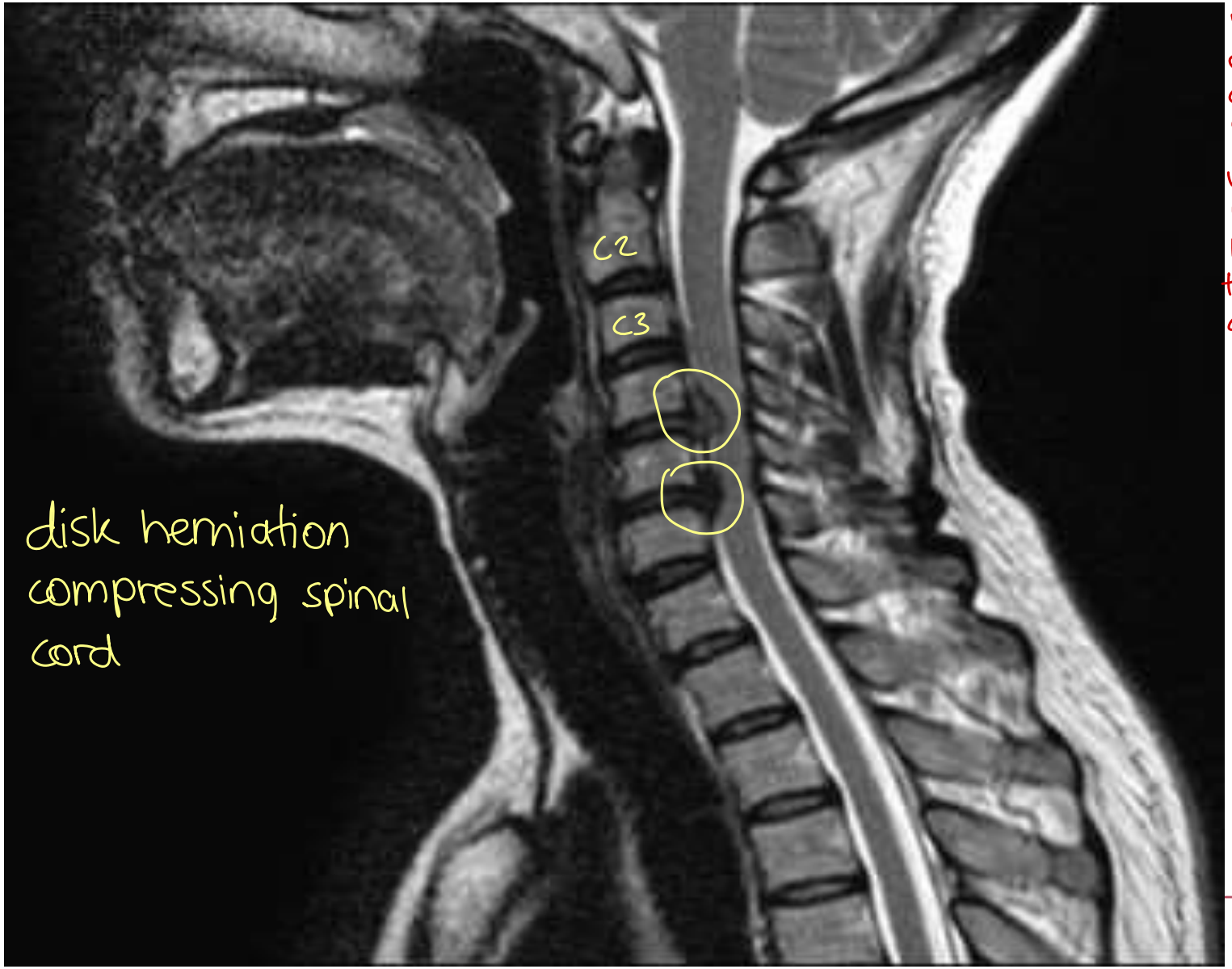
fat: T_1 & T_2 looks white same as pathology, Stir is T_2 minus fat

shows pathology of spine

Spine MRI

Disc pathology

Should know disk on which level

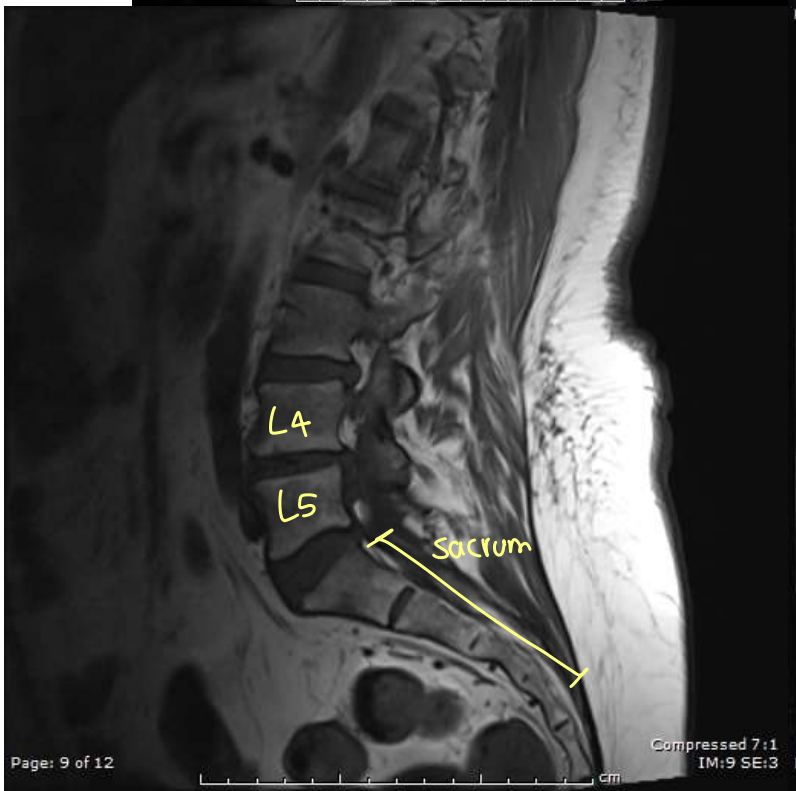


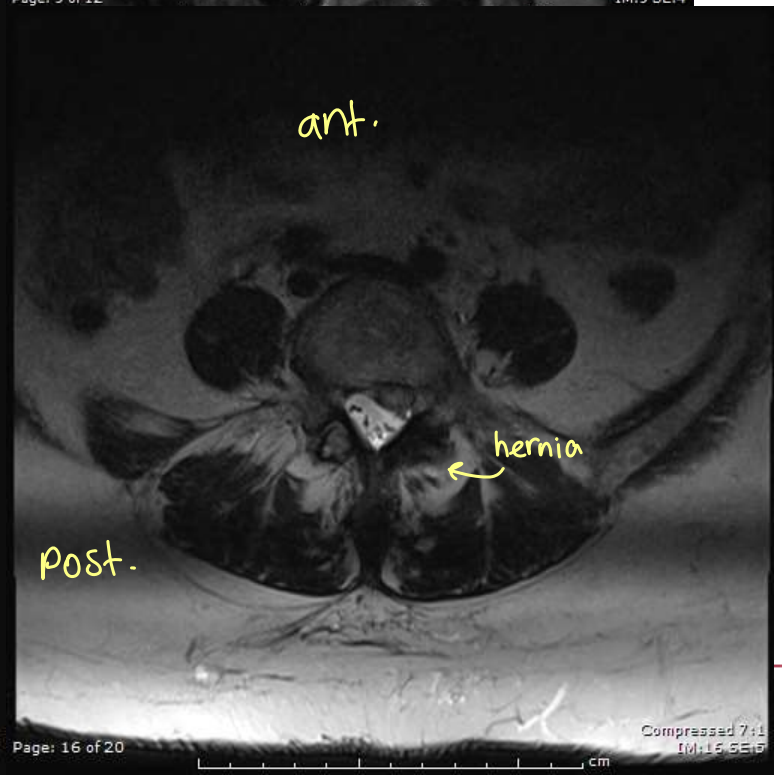
when counting the discs in cervical area, count from up to down

when counting lumbar area, localize sacrum then count from down to up

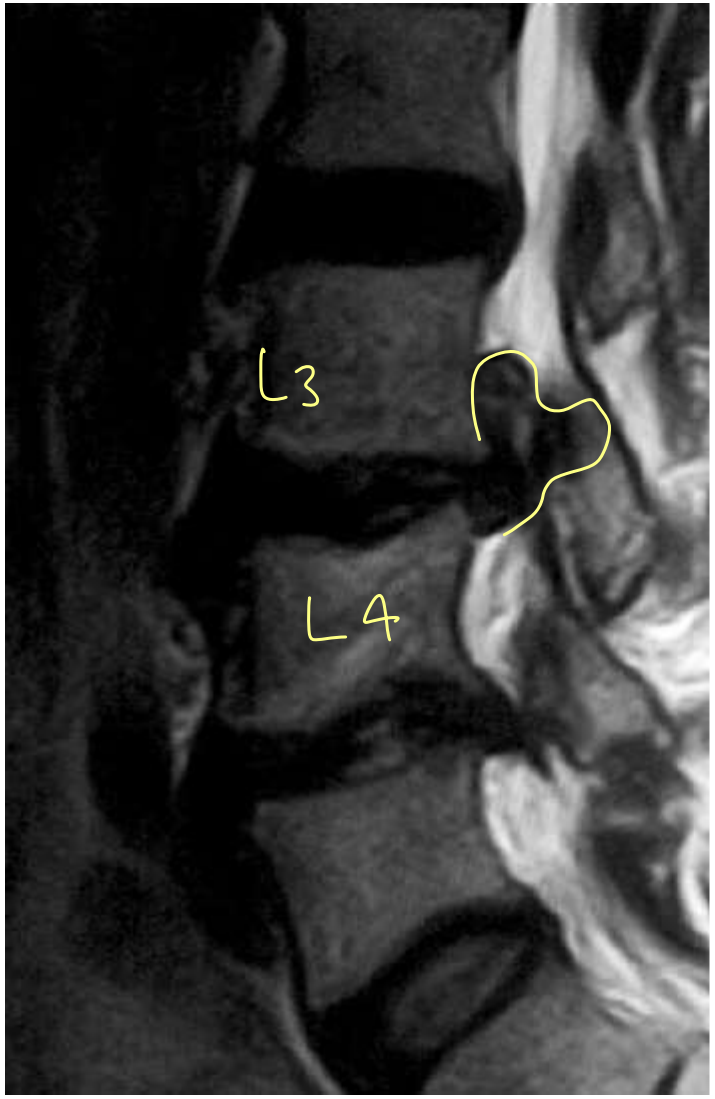

Page: 9 of 12
Compressed 7:1
IM:9 SE:2
cm

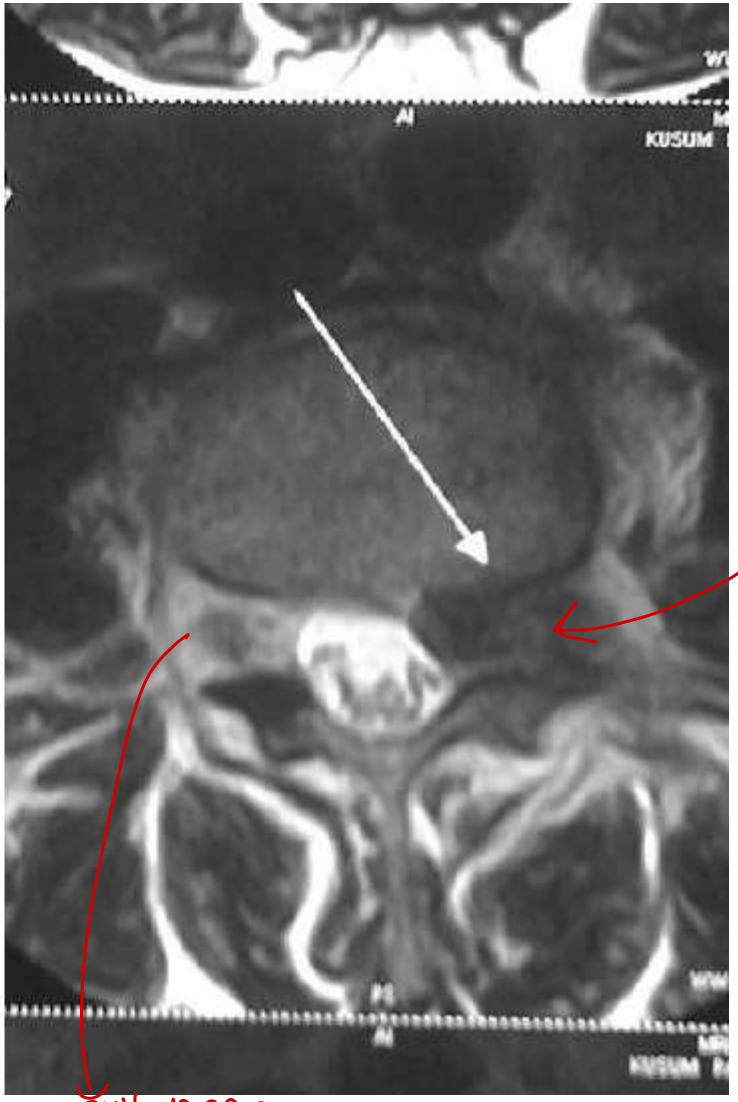

Page: 9 of 12
Compressed 7:1
IM:9 SE:4


L4
L5
sacrum
Page: 9 of 12
Compressed 7:1
IM:9 SE:3
cm


ant.
hernia
post.
Page: 16 of 20
cm

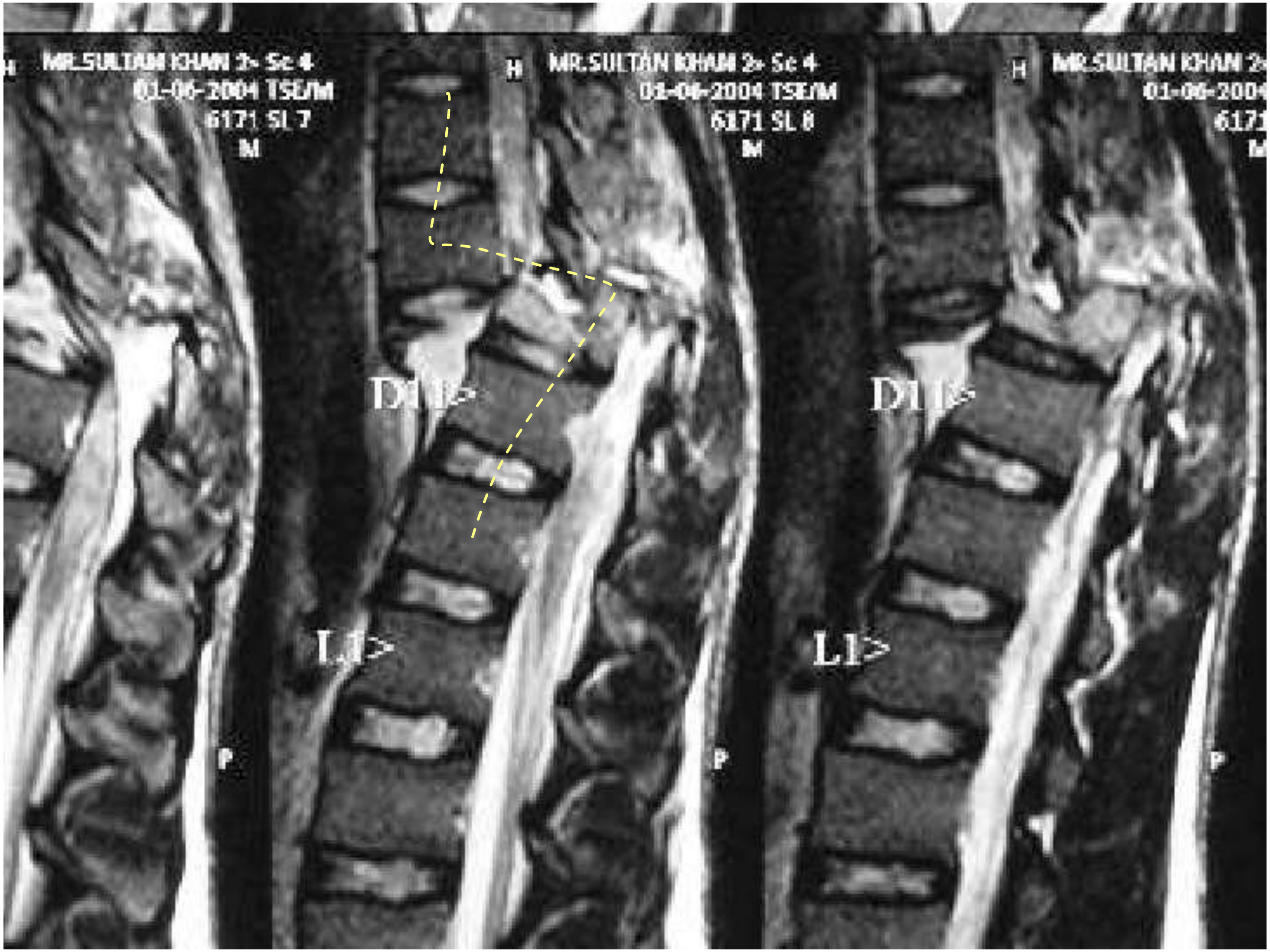
disc L3 / L4





Spine MRI

fractures



cord transection

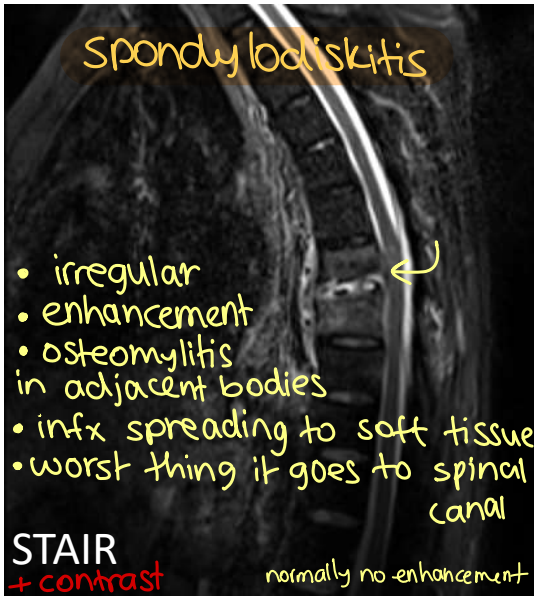
cord injury

Spine MRI

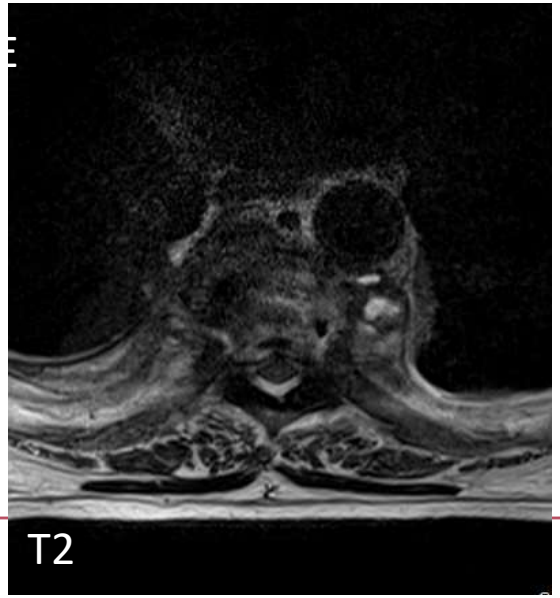
Infection

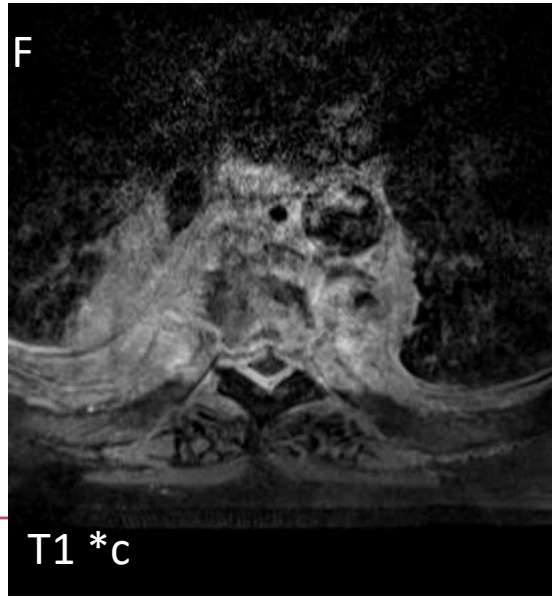

A
T1


B
T2


Spondylodiskitis
• irregular
• enhancement
• osteomylitis in adjacent bodies
• infx spreading to soft tissue
• worst thing it goes to spinal canal
STAIR
+ contrast
normally no enhancement


D
T1 *c


E
T2


F
T1 *c

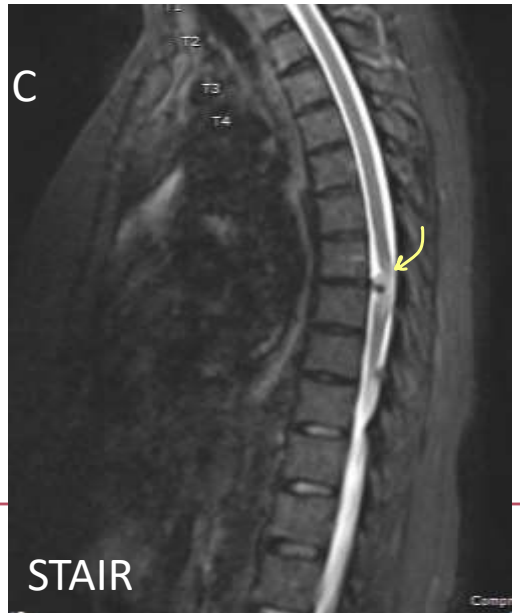
Diagnostic and Interventional Radiology

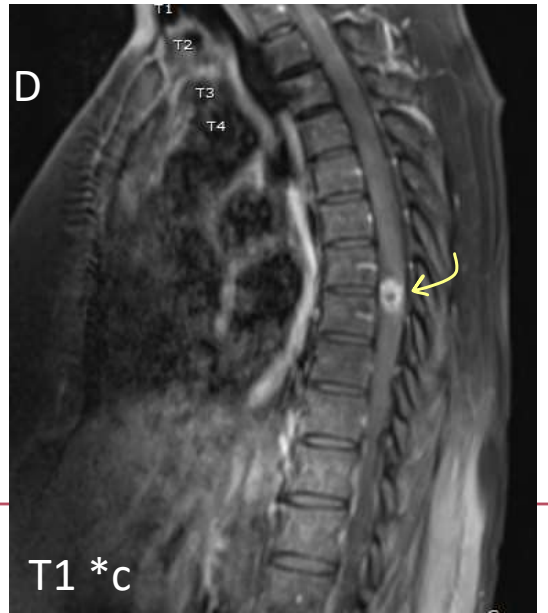
Spine MRI

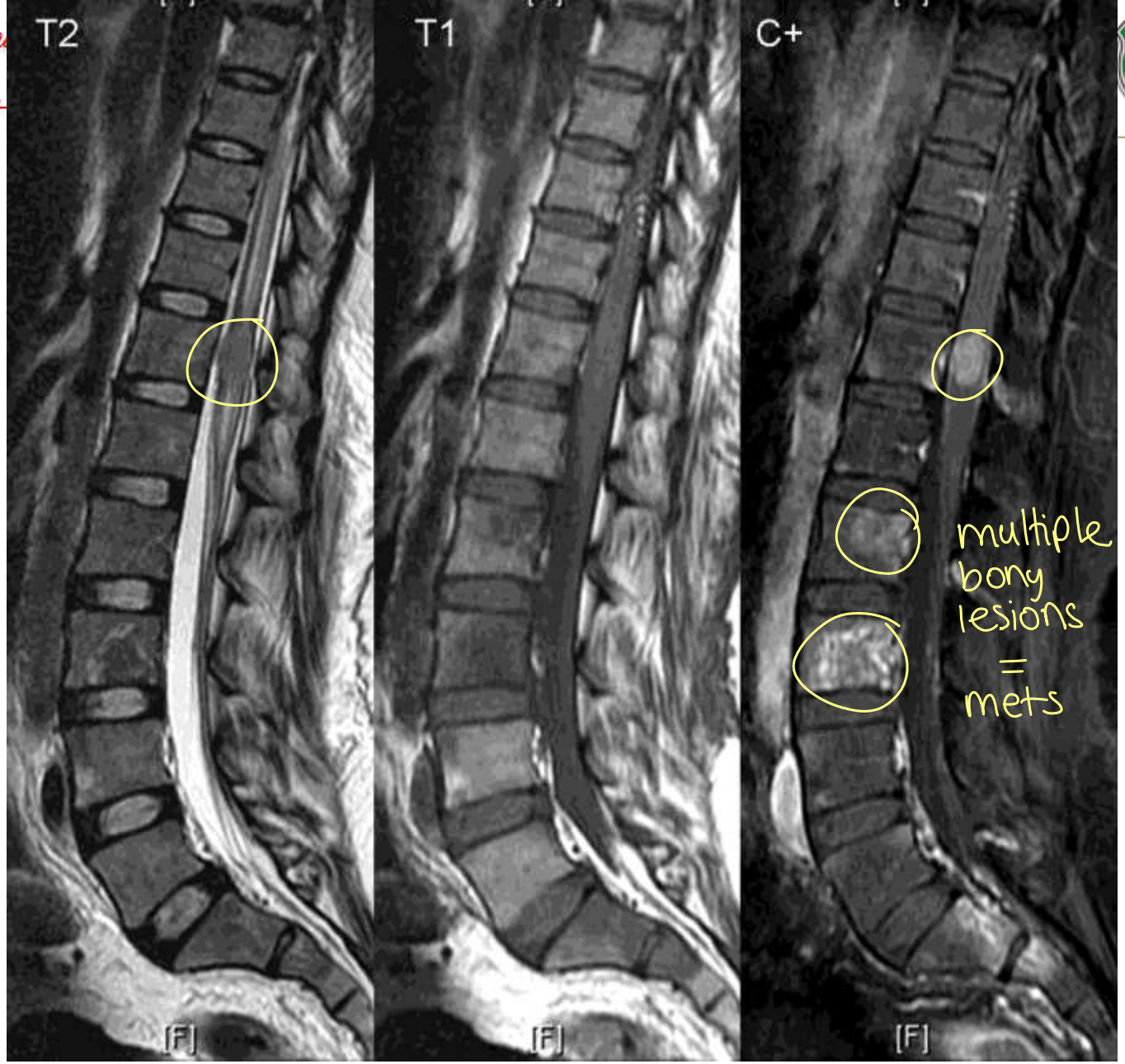
Spine tumors


A
T2
T3
T4
T1


B
T2
T3
T4
T2

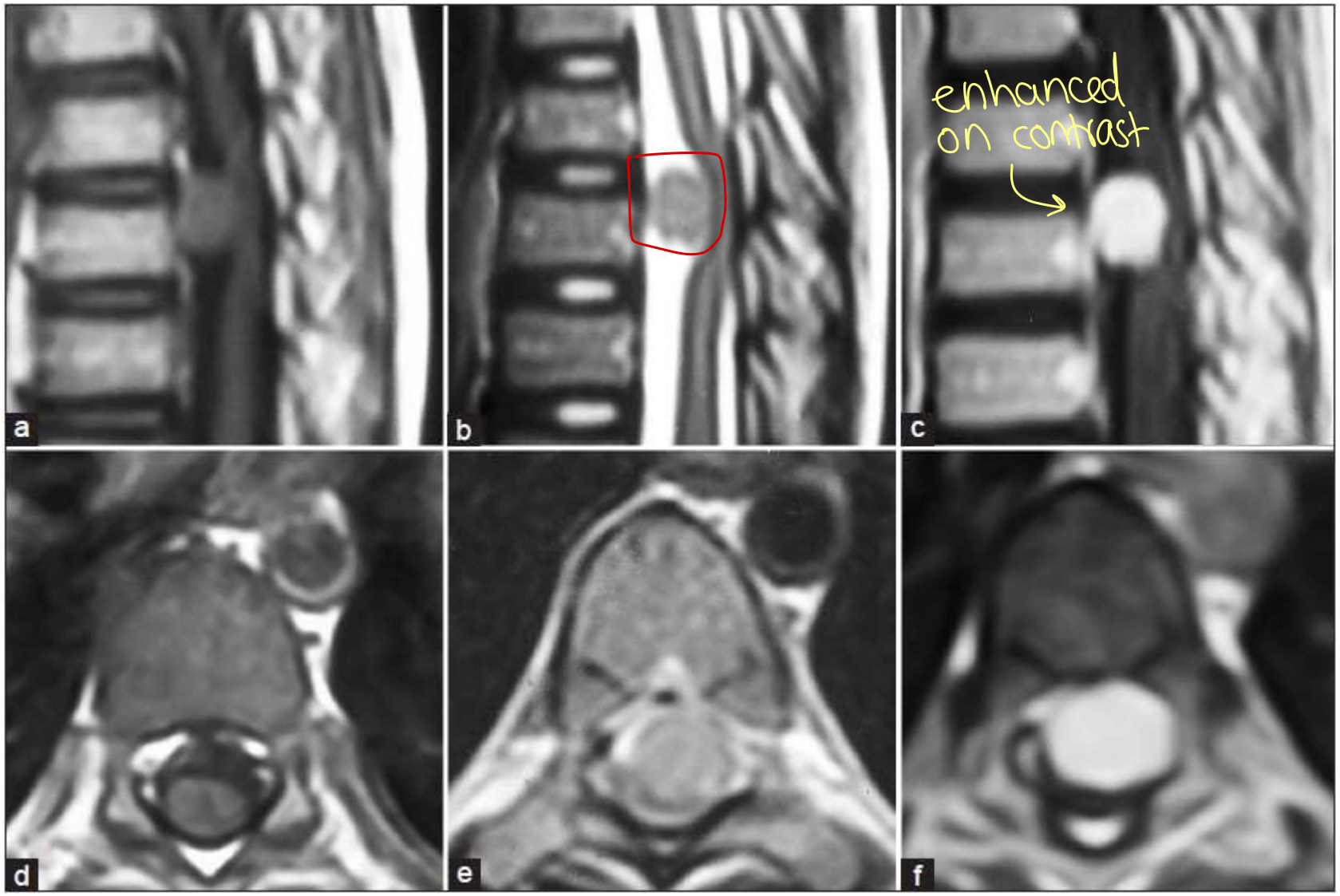

C
T2
T3
T4
STAIR


D
T2
T3
T4
T1 *c

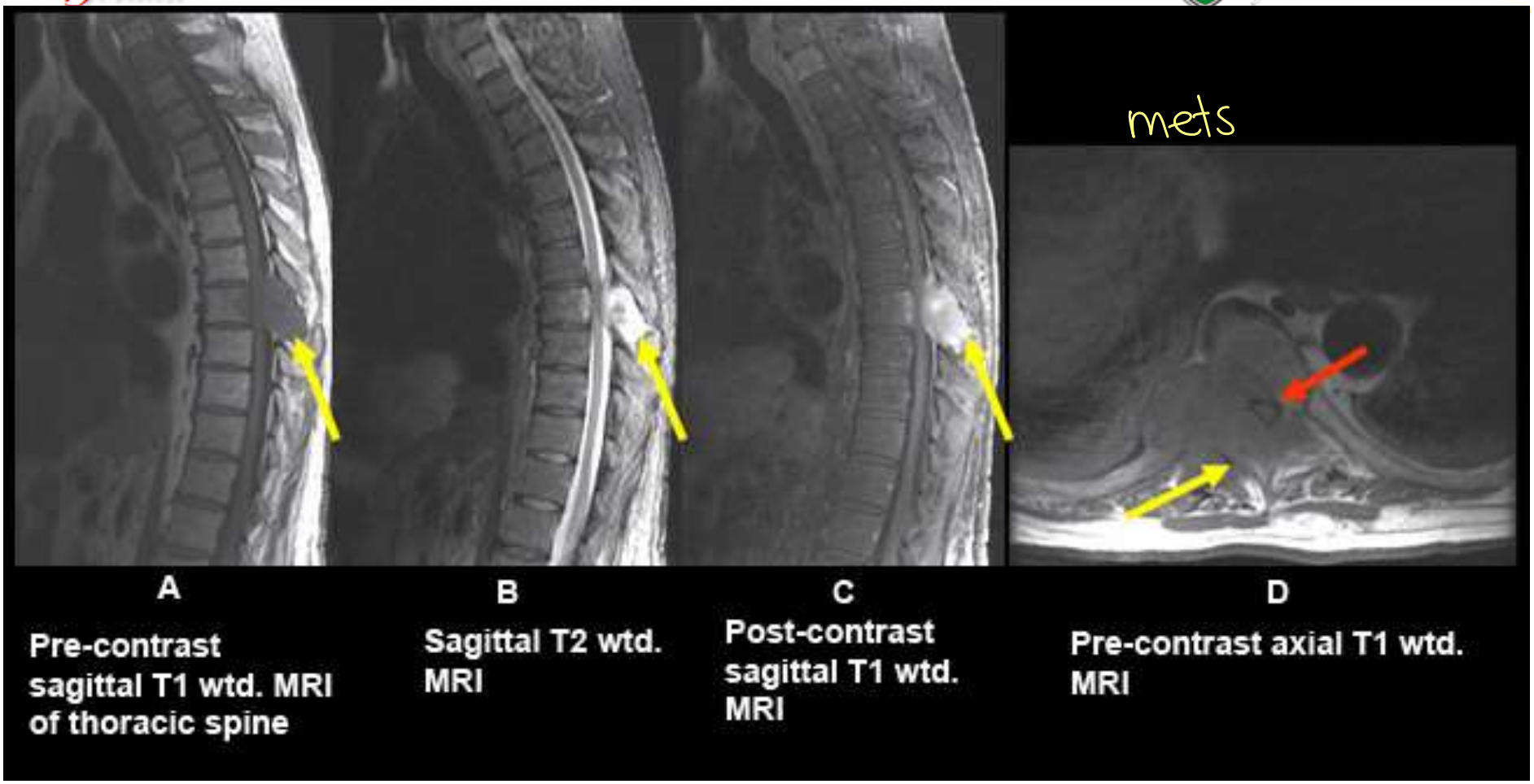

T2
T1
C+
[F]
[F]
[F]
multiple bony lesions = mets

Diagnostic and Interventional Radiology

extramedullary intradural mass



ependimoma
1ry cord tumor


mets
A
Pre-contrast sagittal T1 wtd. MRI of thoracic spine
B
Sagittal T2 wtd. MRI
C
Post-contrast sagittal T1 wtd. MRI
D
Pre-contrast axial T1 wtd. MRI

THANK YOU