



MR Imaging of the Brain and Spine

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Outline

- Introduction.
- Basic MRI sequences
- 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.

+CT

Contraste is iodine base
- allergic
- nephrotoxicity

+ This is not the case in MRI
Contraste its safer

axial / sagittal / coronal (helps in localization)



Closed
System MRI

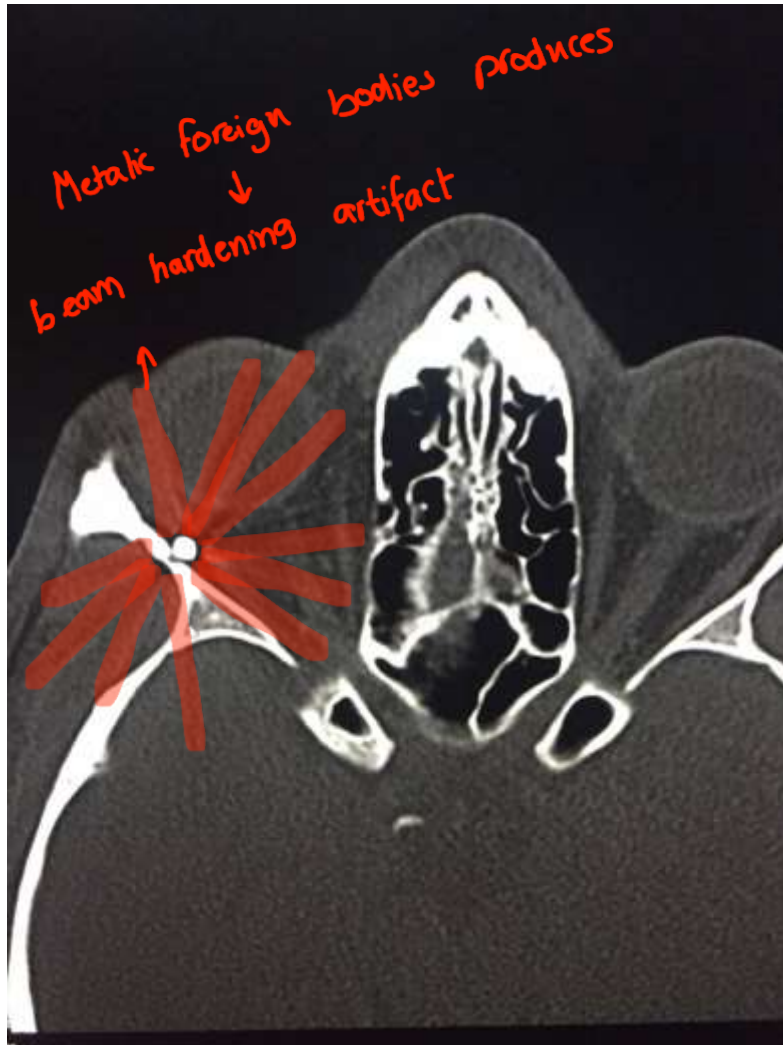
MRI Disadvantages

- Expensive
- Not widely available
- Claustrophobia
- Certain contraindications (pace maker, ect)

to
"Metals"
Not compatible to MRI



Metallic foreign body in the eye

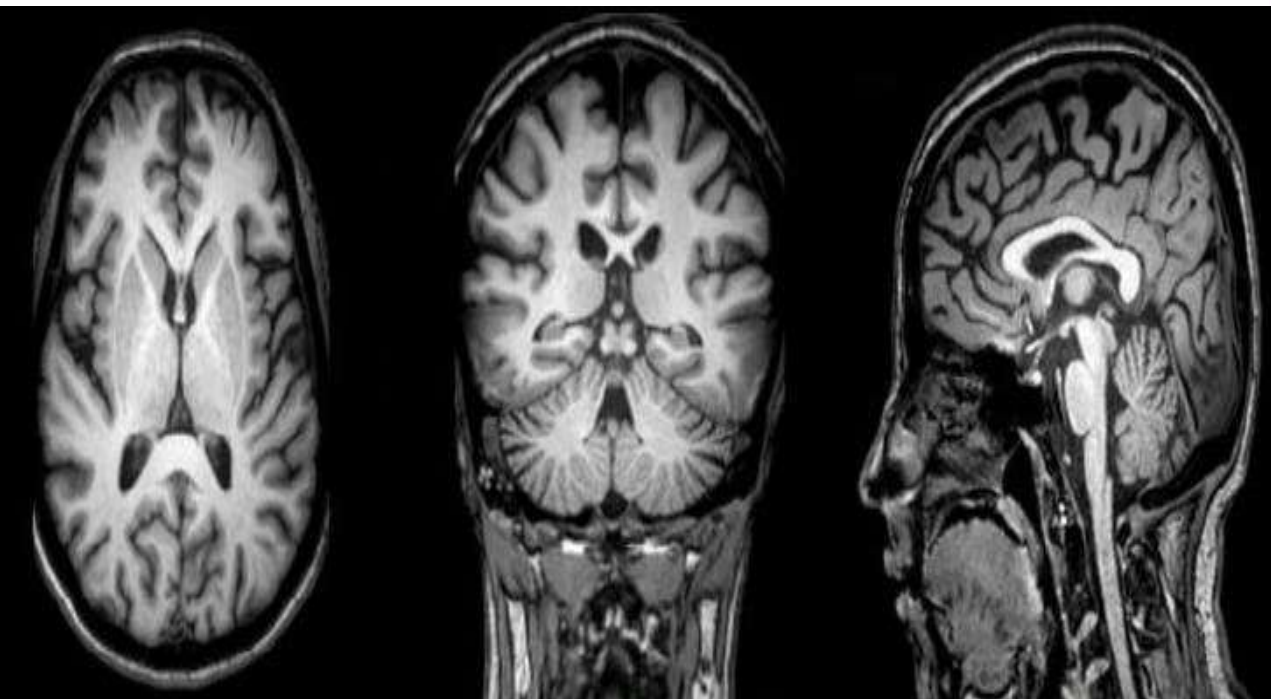
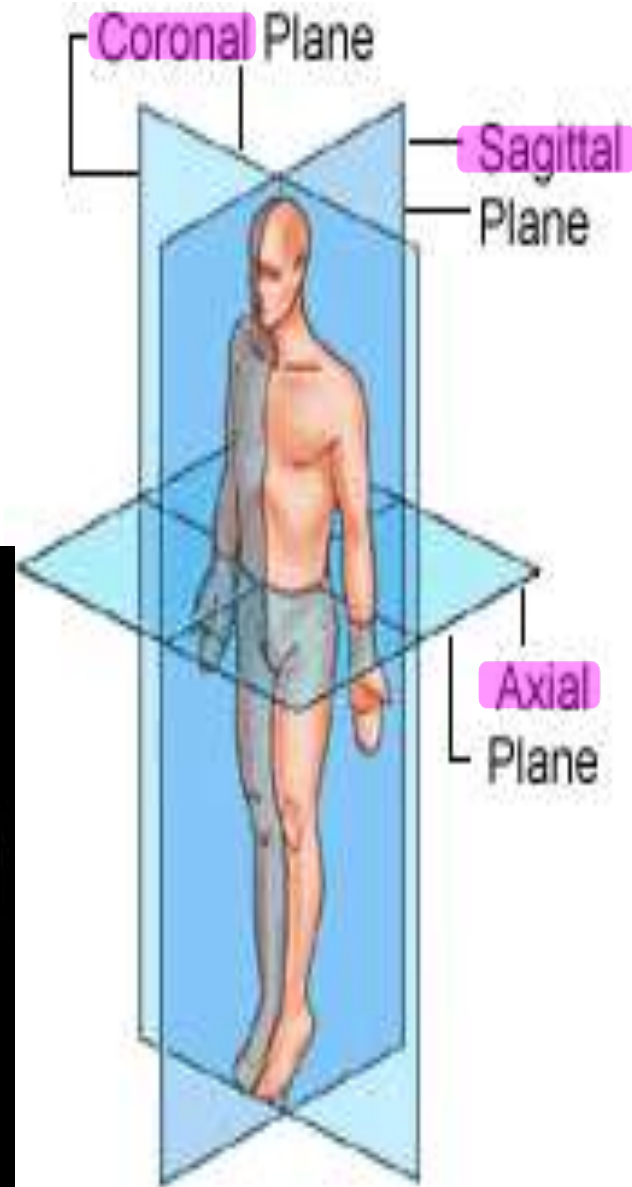




We use Intensity term
in MRI insted of density

- hyperintense
- hypointense

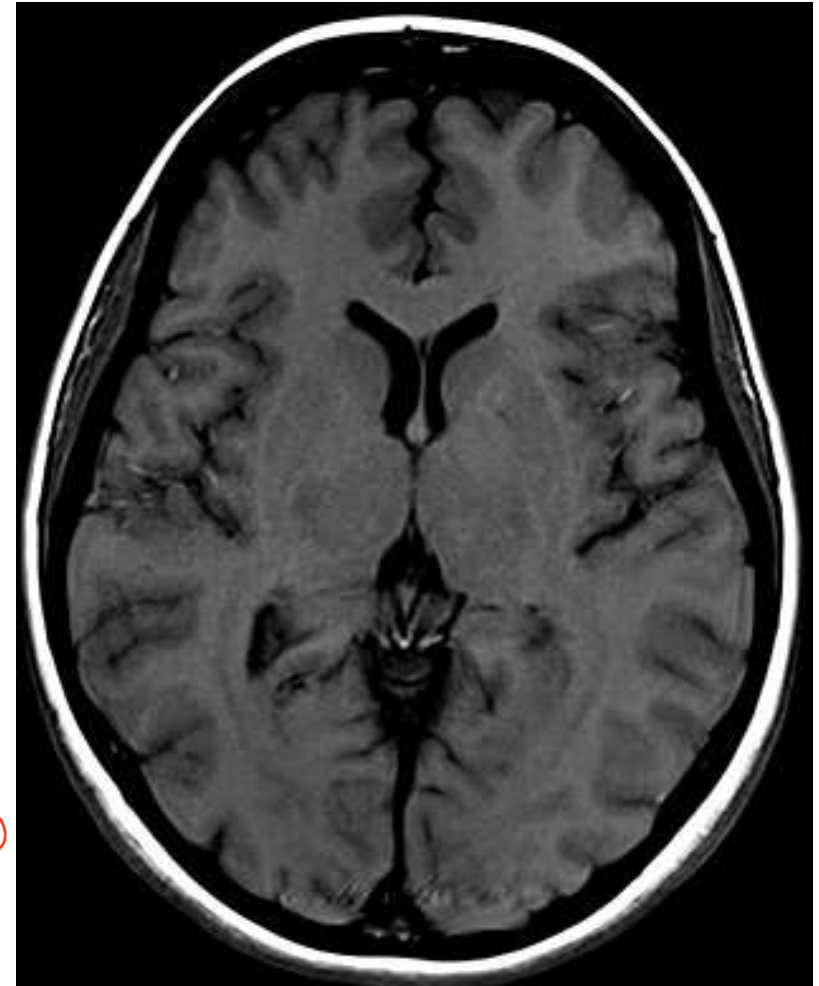
MRI planes



T1-weighted images (T1)

✓ Recognition :

- Ventricles dark (CSF / fluid)
↳ + subarachnoid space + basal cisterns
- Scalp bright
- White matter brighter than the grey matter. unlike CT
- Vessels mostly not seen



✓ Useful for:

- Anatomy.
- Borders between brain and CSF (e.g., sulci, ventricles, cysts).
- Not very sensitive to lesions (pathologies)
↳ hypo in top of gray

* except the hyperintense pathologies

- its the sequence used in Contrast MRI

T1-weighted images (T1)

- ✓ **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).



hemorrhage on
MRI is Challenging
due to the presence of iron

T1 hyperintense lesions

Content

Lesion/pathology

Methaemoglobin

Subacute blood

Fat/lipid

Lipoma, dermoid, craniopharyngioma

Melanin

Melanoma

Slow flow

Thrombosis

Manganese and copper (Metals)

Metabolic disorders

Protein

Craniopharyngioma

Gadolinium

Contrast

T1-weighted images with Gd contrast

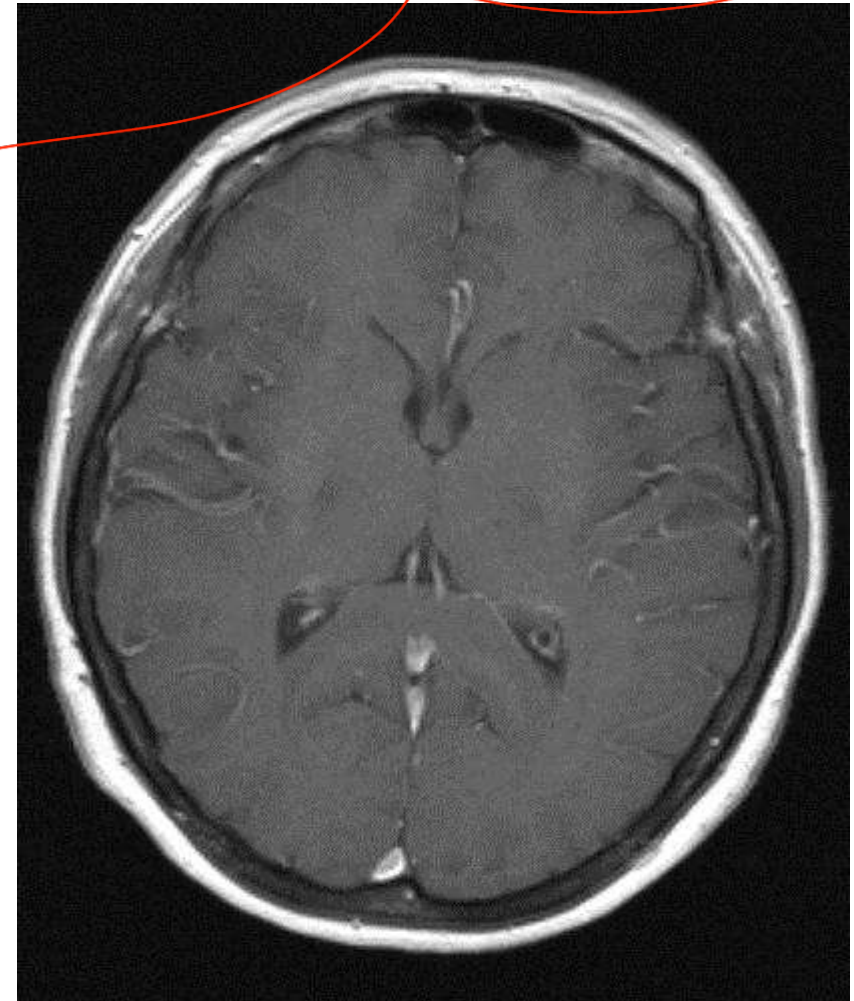
✓ Recognition:

- Like non-contrast T1 but **with bright arteries and veins**

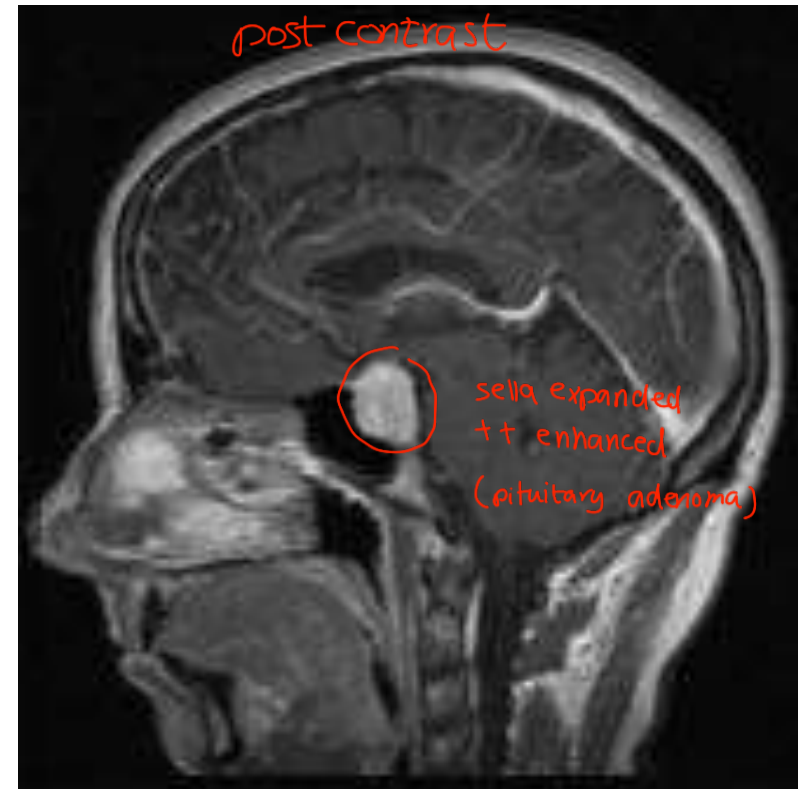
✓ Useful for visualization of:

- 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



T2-weighted images (T2)

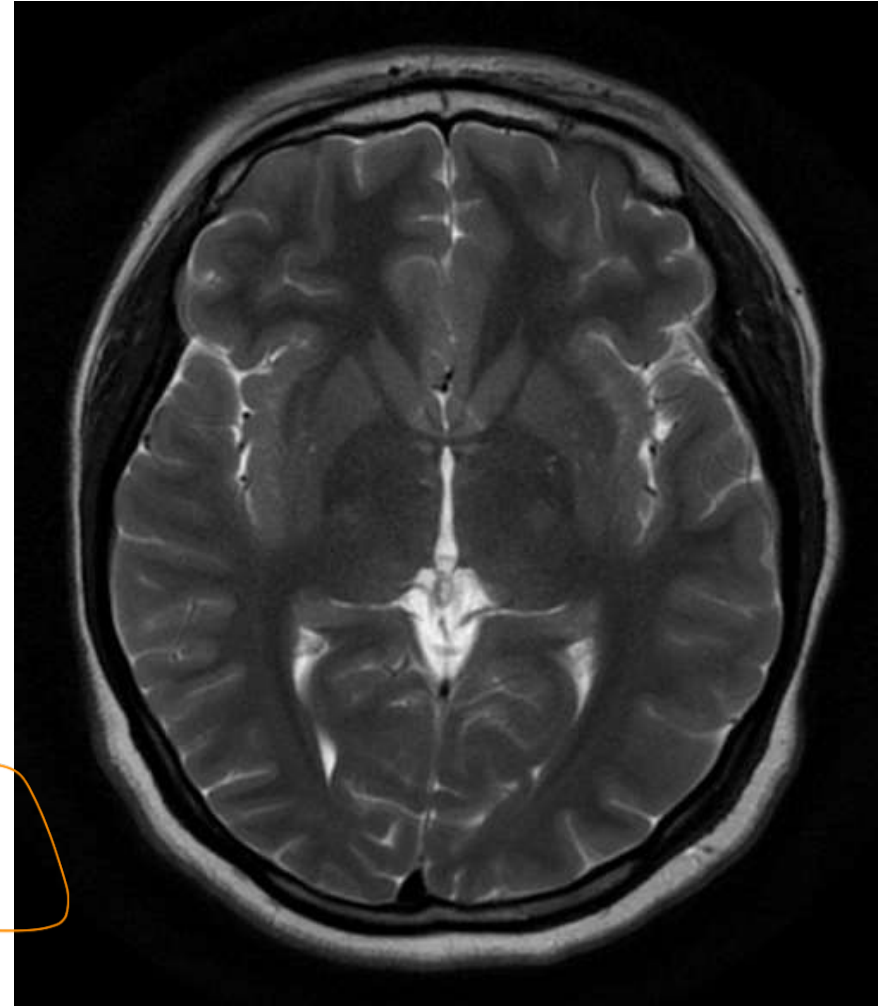
✓ Recognition

- CSF (ventricles, cisterns, sulci): bright
- Scalp: bright
- White matter darker than grey matter *as CT*
- Vessels: black (flow void)

✓ Useful for: "pathologies"

- Brain anatomy (shows CSF spaces)
- Most brain lesions
- But can't distinguish lesions from CSF (ventricles, sulci) *its already bright*

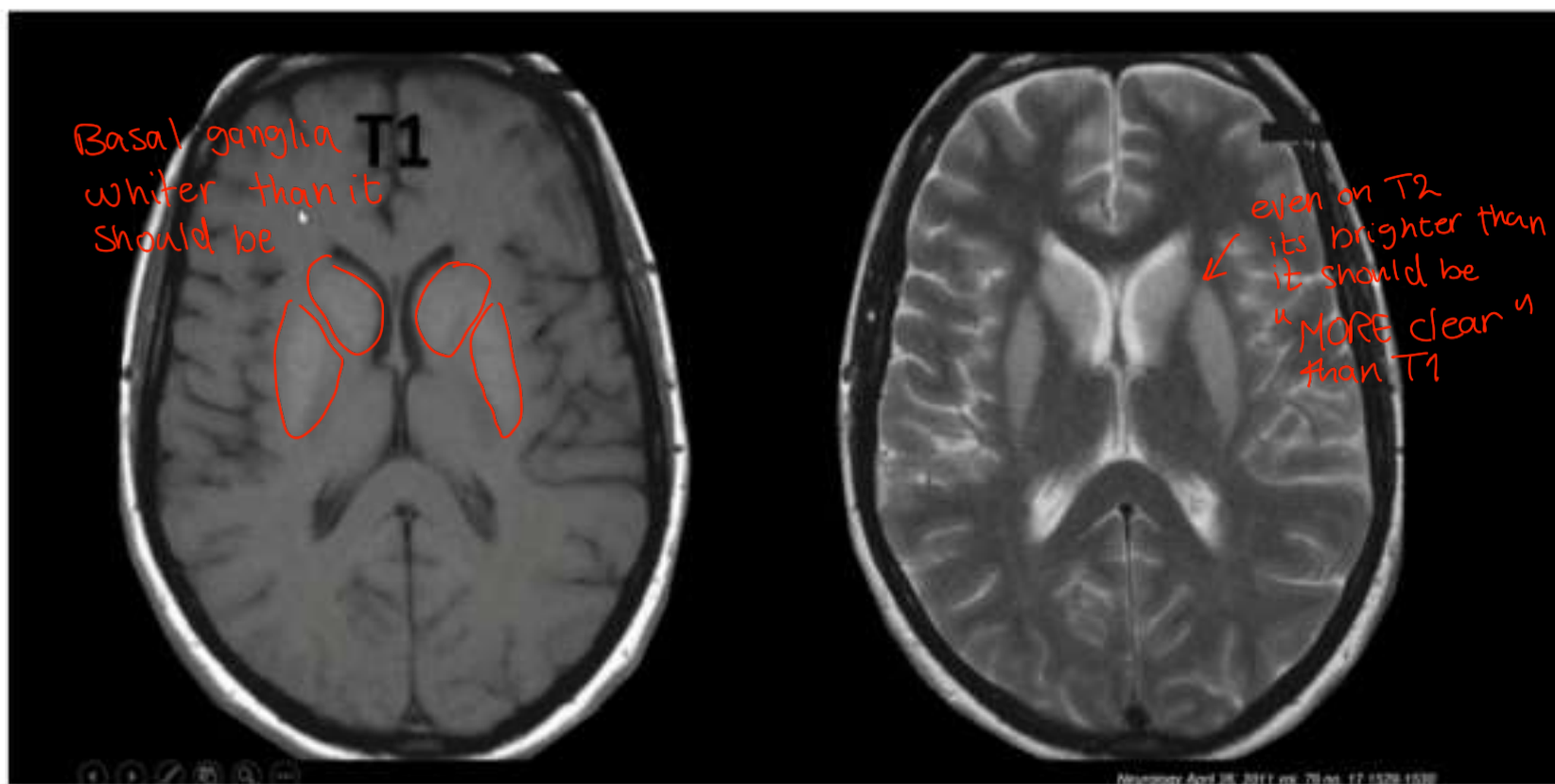
to avoid this we use
FLAIR



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
-

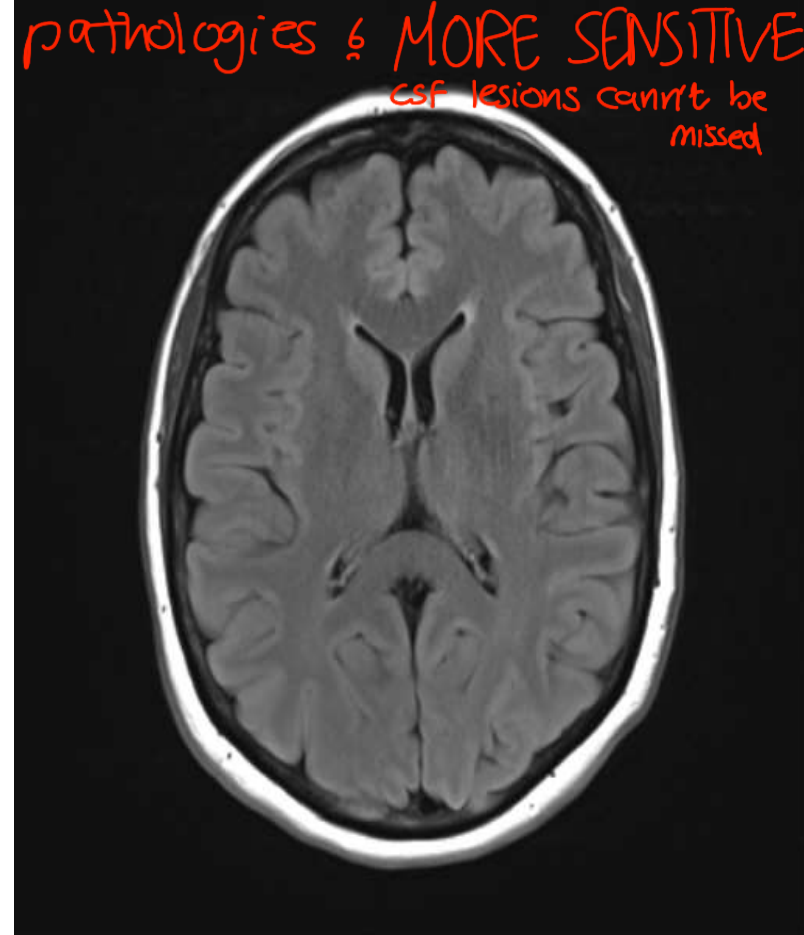
T1 Vs T2



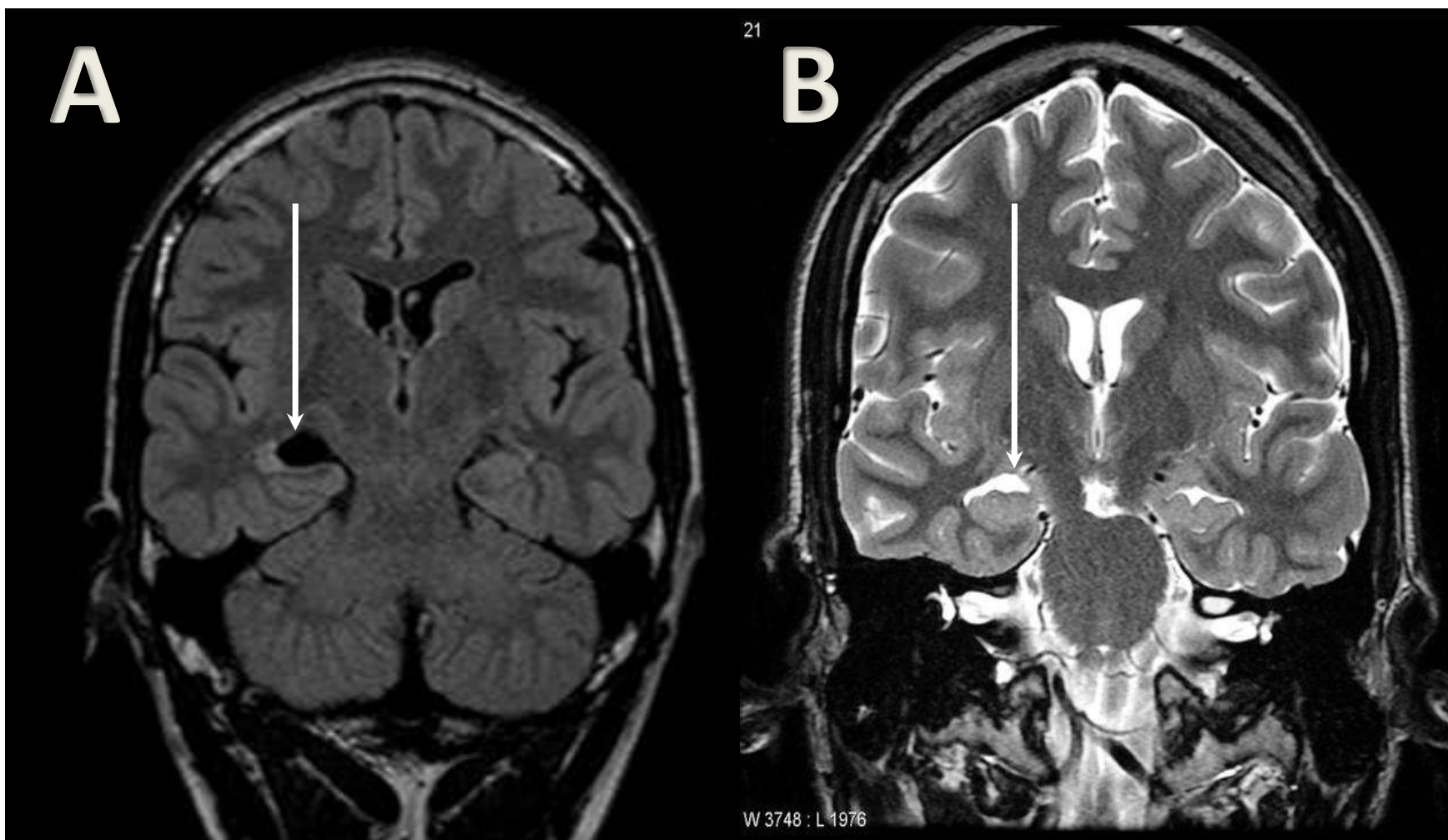
FLAIR (Fluid Attenuated Inversion Recovery)

Best sequence to detect pathologies & MORE SENSITIVE
CSF lesions can't be missed

- Same as T2 except free CSF (ventricles, cisterns, sulci) is suppressed (black)
- Most pathology is BRIGHT $\Rightarrow$ same as T2
- ✓ **Recognition**
 - Superficially resembles T1 (but the white matter darker than grey matter) as T2
- ✓ **Useful for:**
 - Same as T2
 - Most lesions
 - Especially good for lesions near ventricles or sulci (MS)



T2 vs FLAIR



Susceptibility weighted images

T2* (T2-star, or SWI) FOR hemorrhage

- 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**



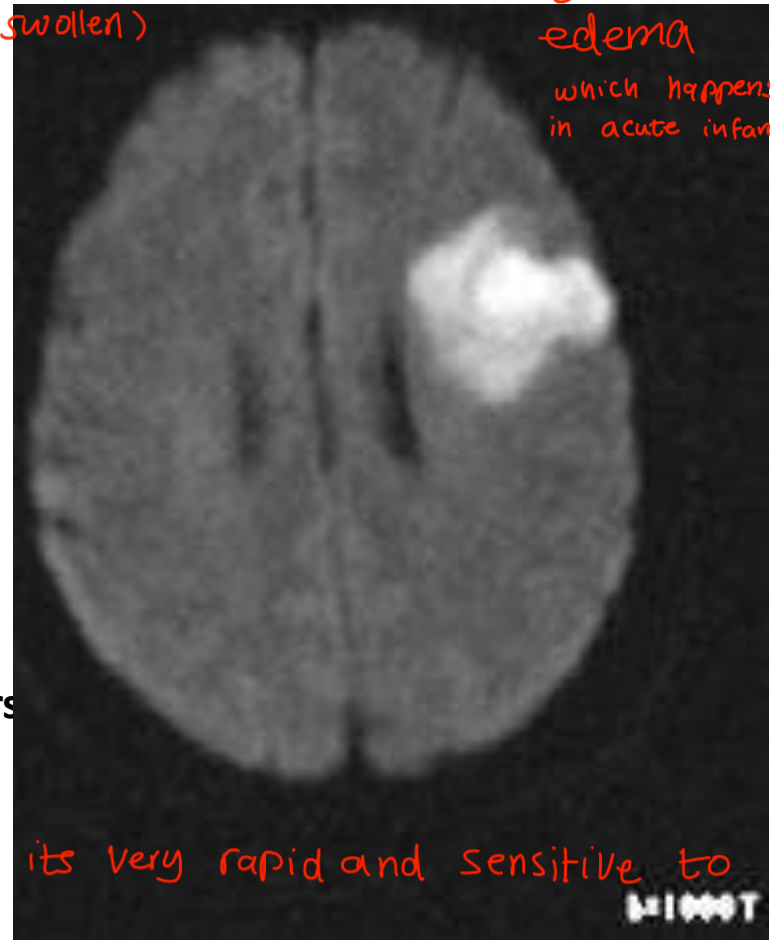
Diffusion-weighted image (DWI) *for Cytotoxic edema*

- ✓ Sensitive to passive diffusion of water (*cellular swollen*)
- ✓ 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 or vasogenic edema**

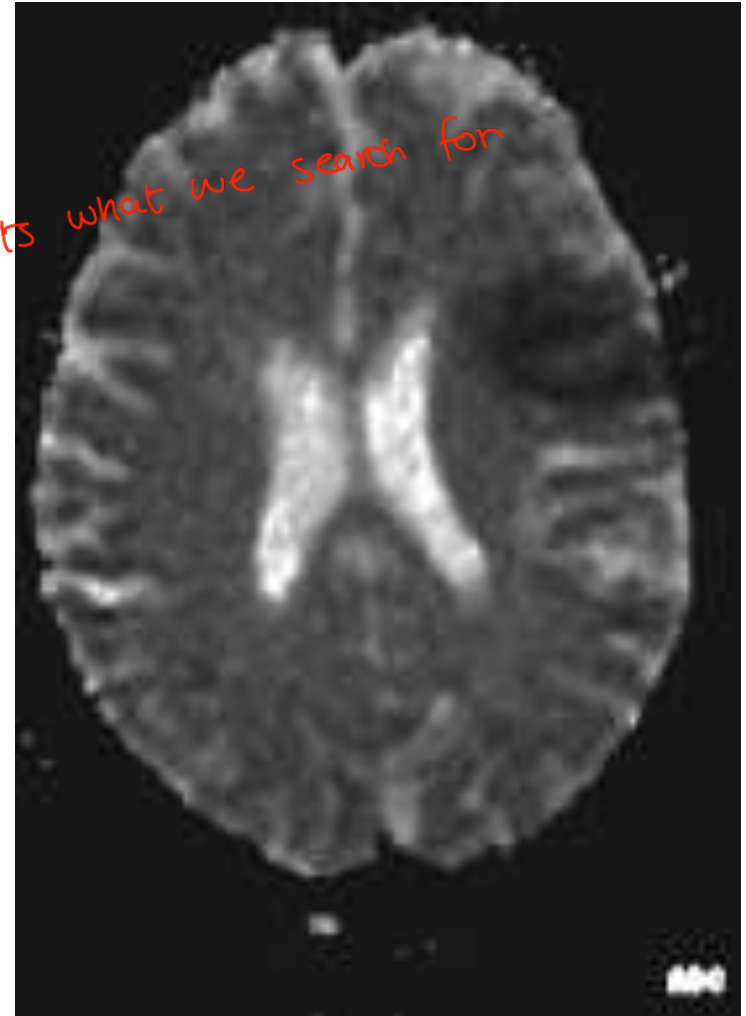
→ within 30m DWI may be abnormal so its very rapid and sensitive to infarctions



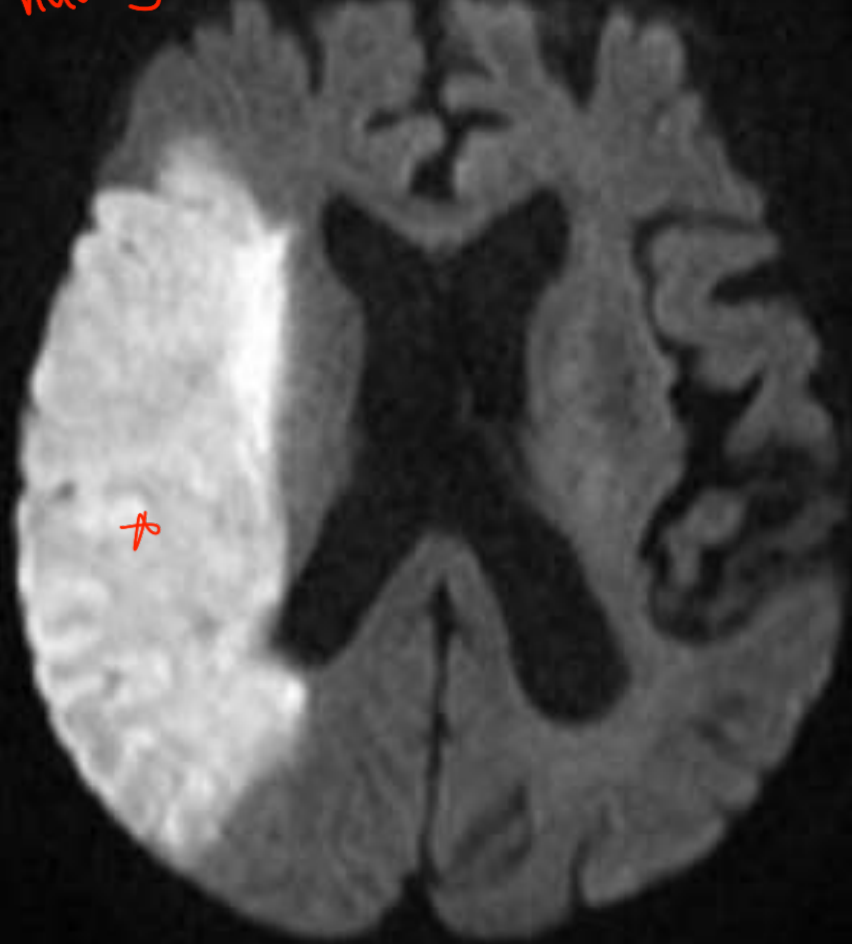
Apparent Diffusion Coefficient (ADC Map)

- ✓ 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

that's what we search for



having white on DWI



and black on ADC map

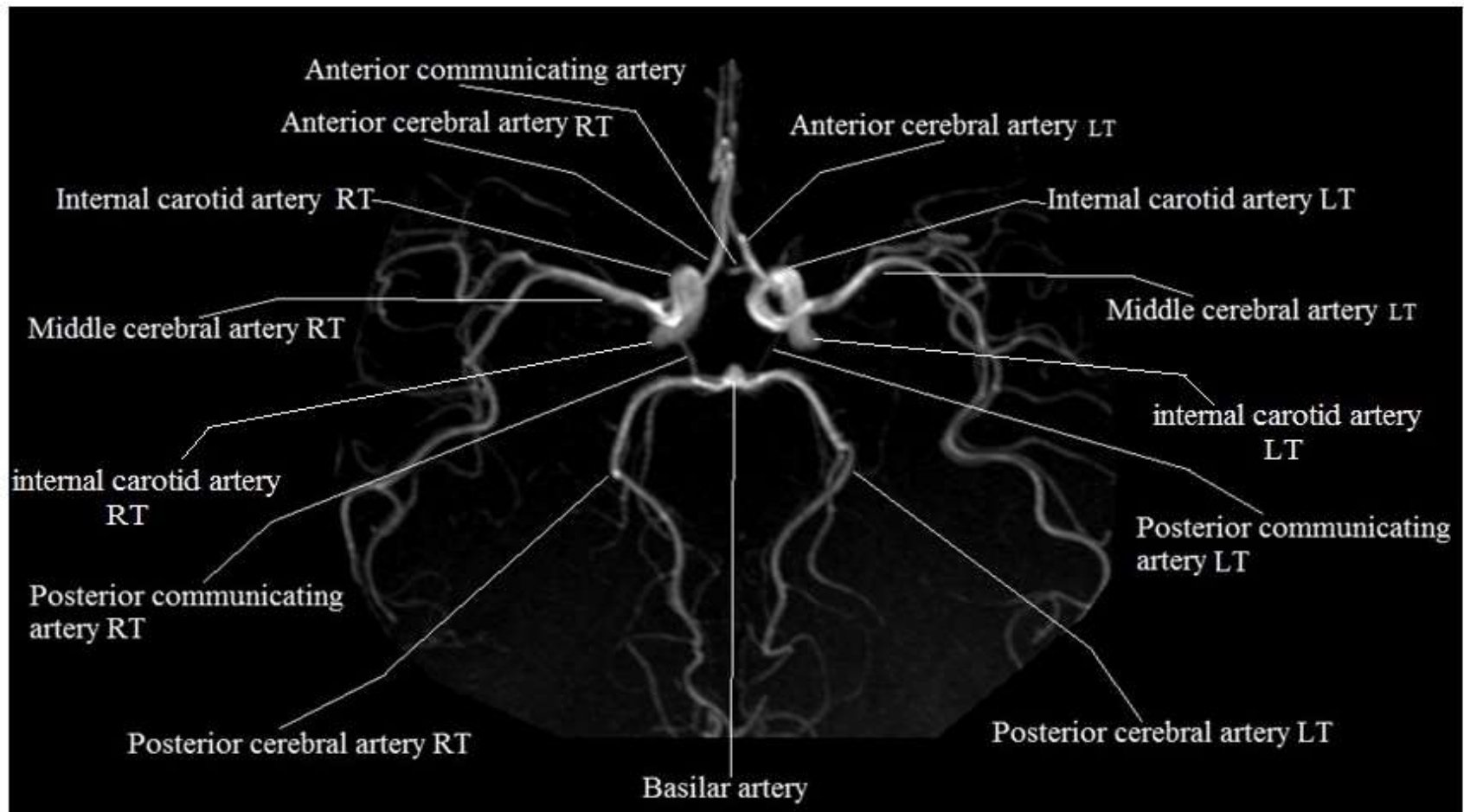


MR Angiography

Clear without contrast

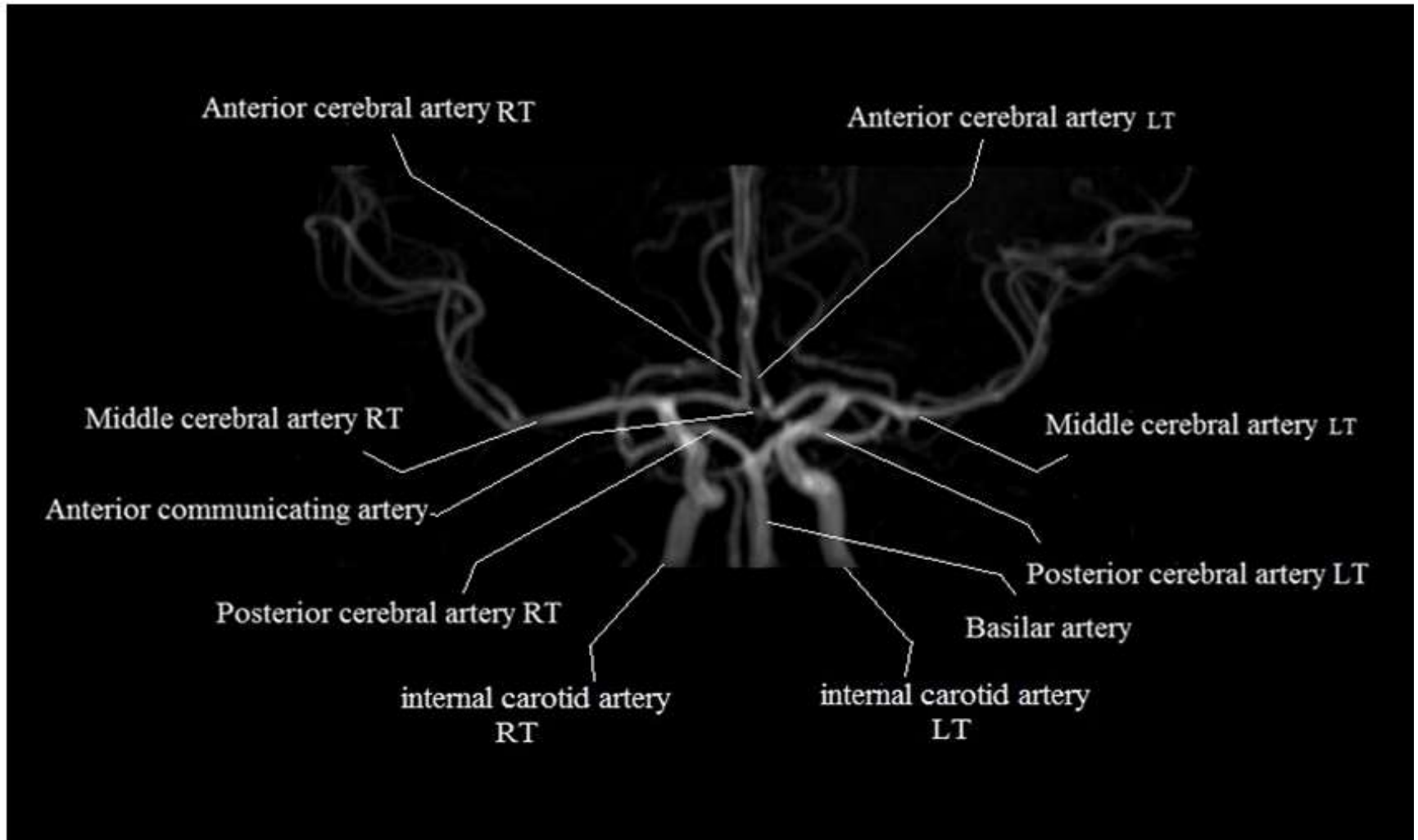
MRA

Axial arterial anatomy of brain



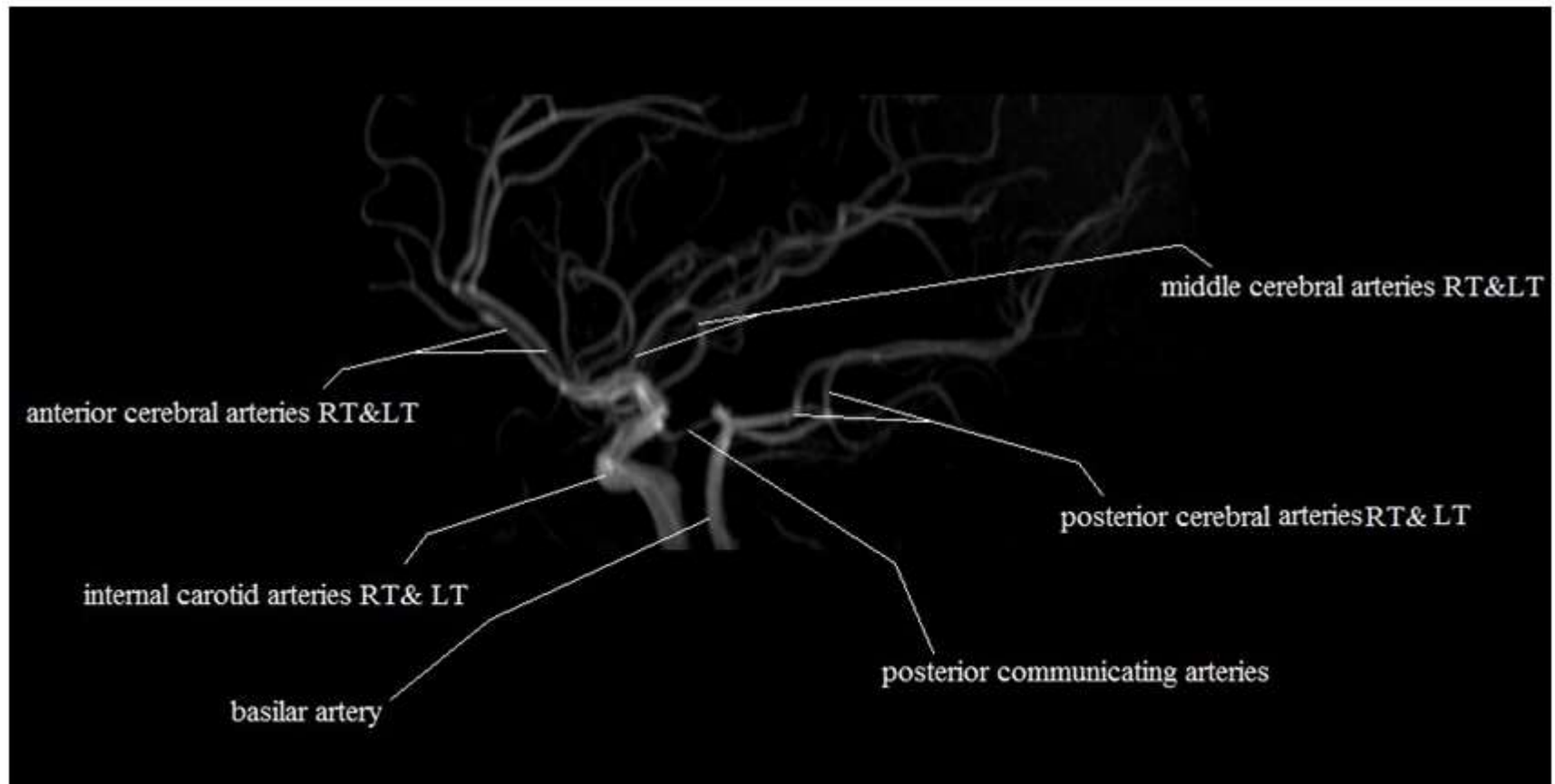
MR Angiography

Coronal arterial anatomy of brain

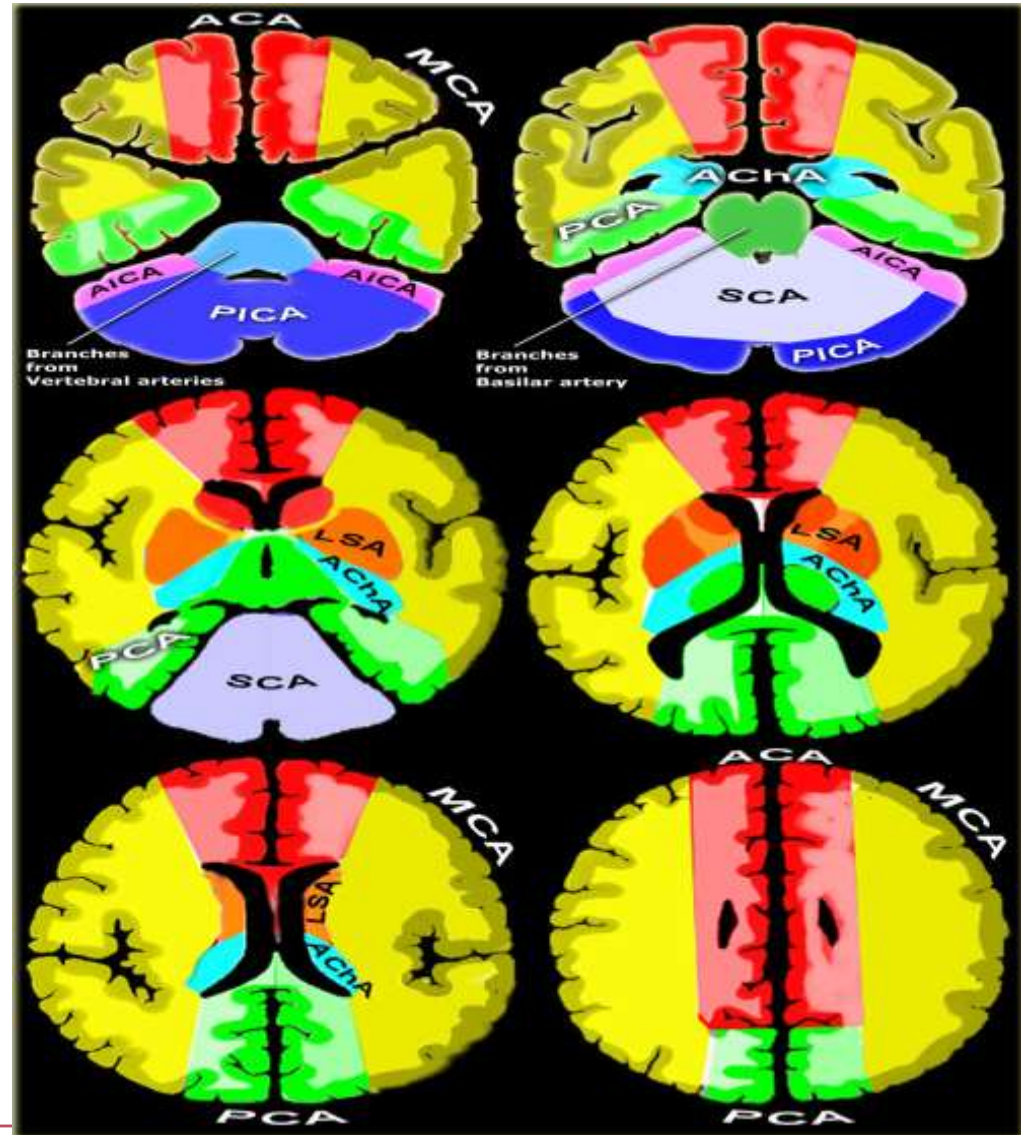


MR Angiography

sagittal arterial anatomy of brain



Brain Vascular territories



Brain pathology examples

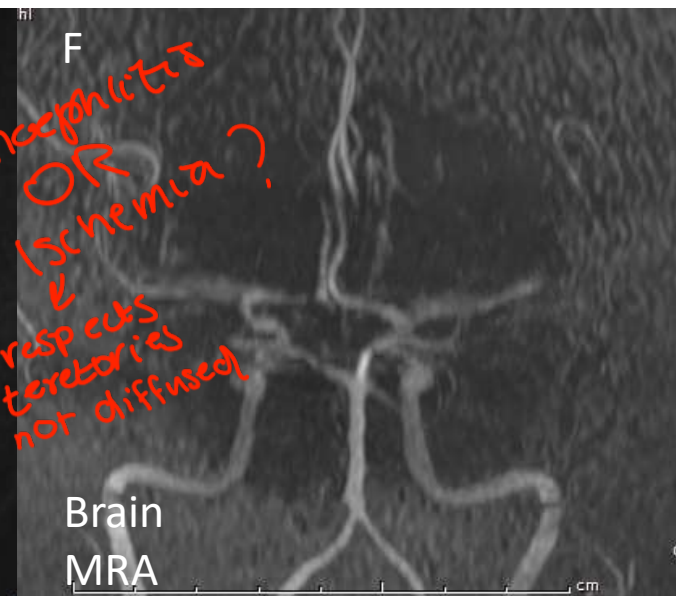
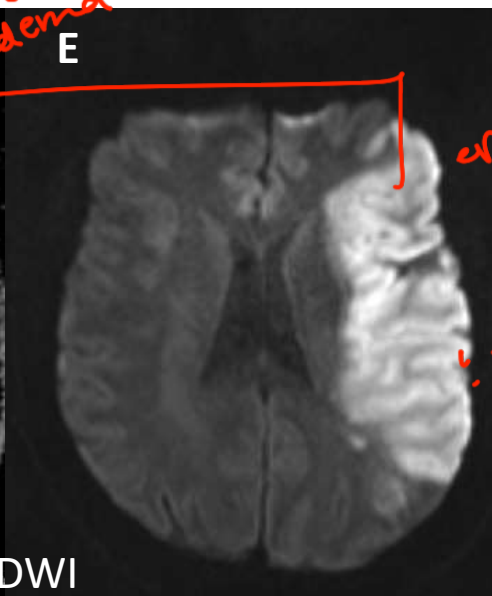
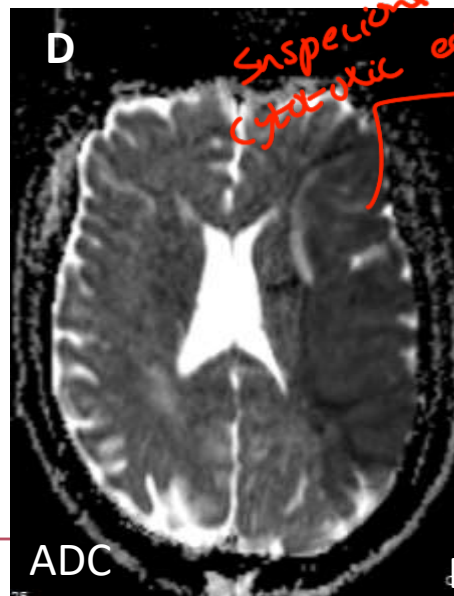
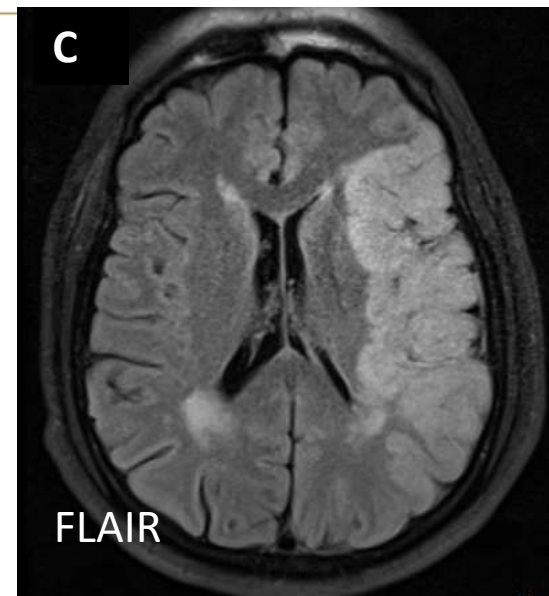
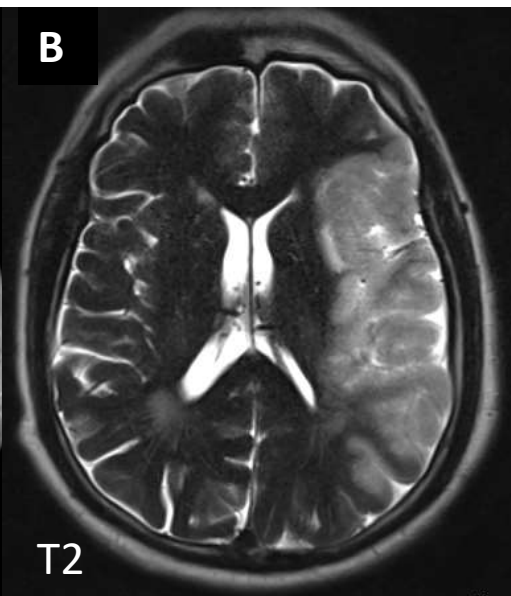
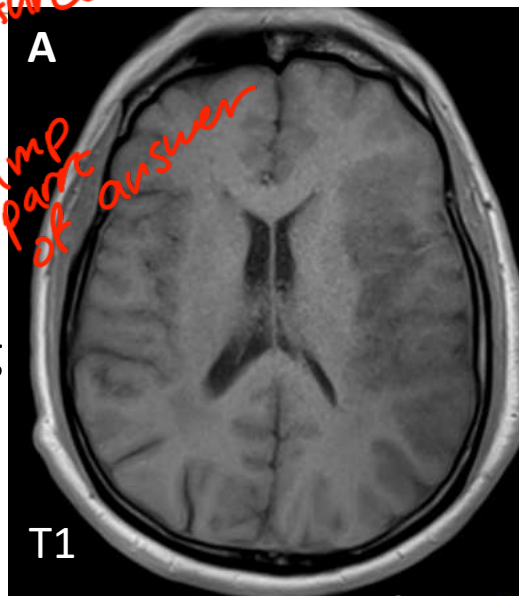
Cerebral ischaemia

- 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

University of Jordan
recent infarction
imp part of answer

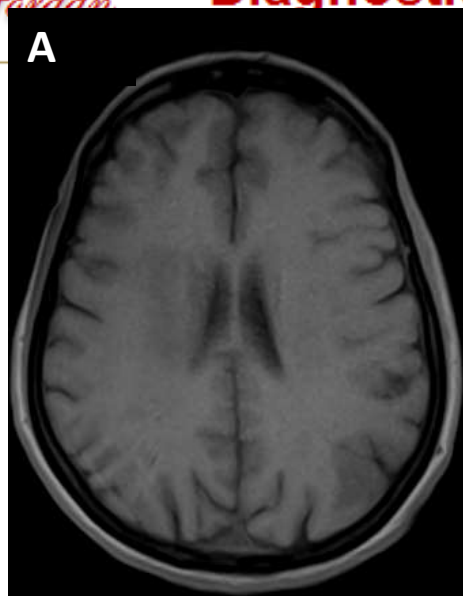
Diagnostic and Interventional Radiology

58 year old male patient is complaining of right sided weakness

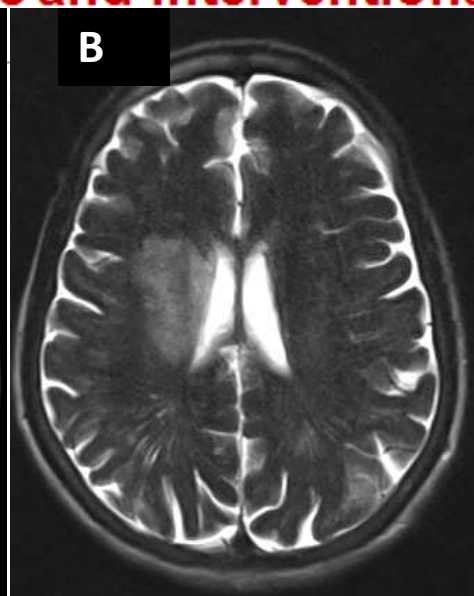


suspicion for cytotoxic edema

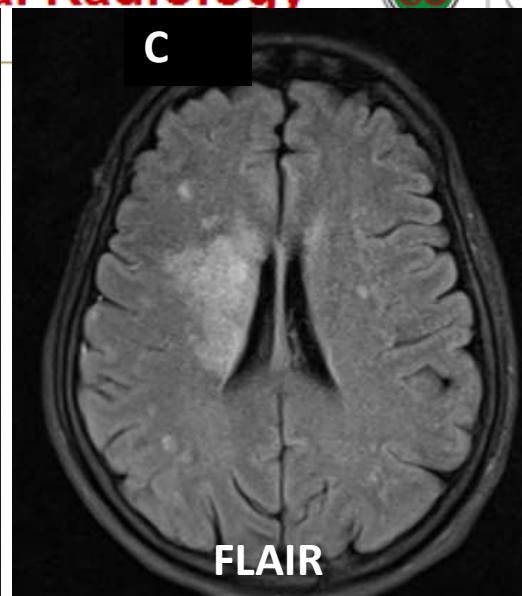
encephalitis OR ischemia?
respects territories not diffusely



T1

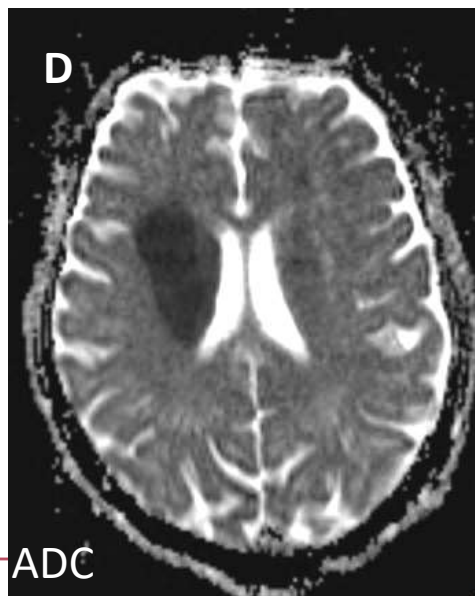


T2

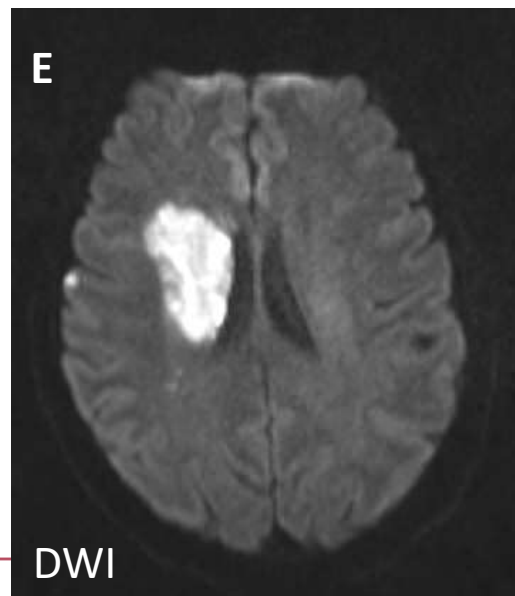


FLAIR

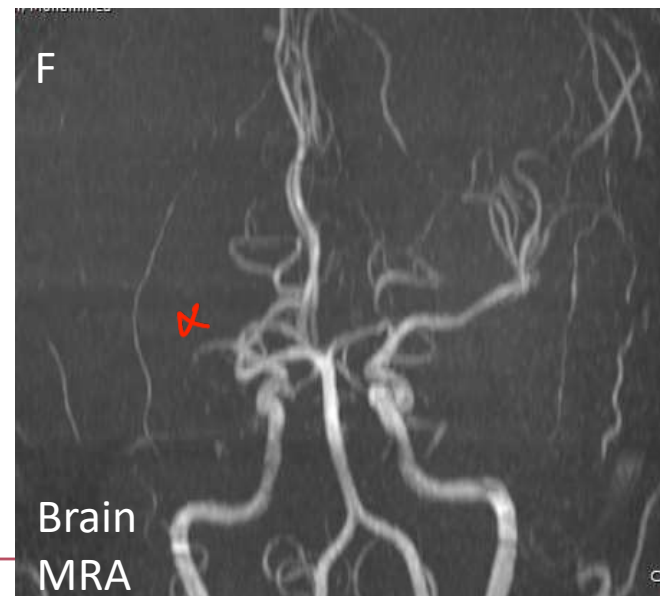
56 year old
male patient
is
complaining
of headache



ADC



DWI

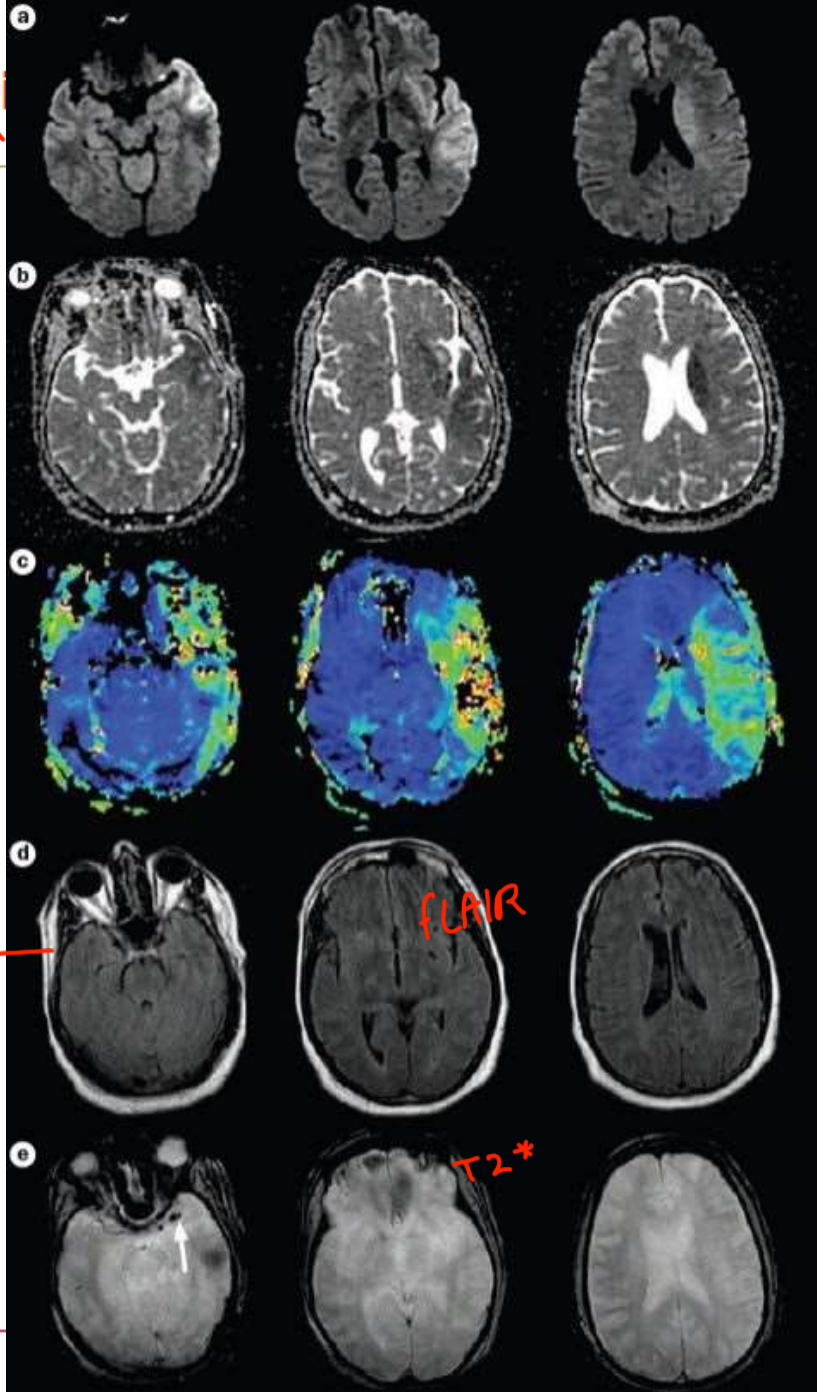


Brain
MRA

DWI

ADC

its normal
not presented
early

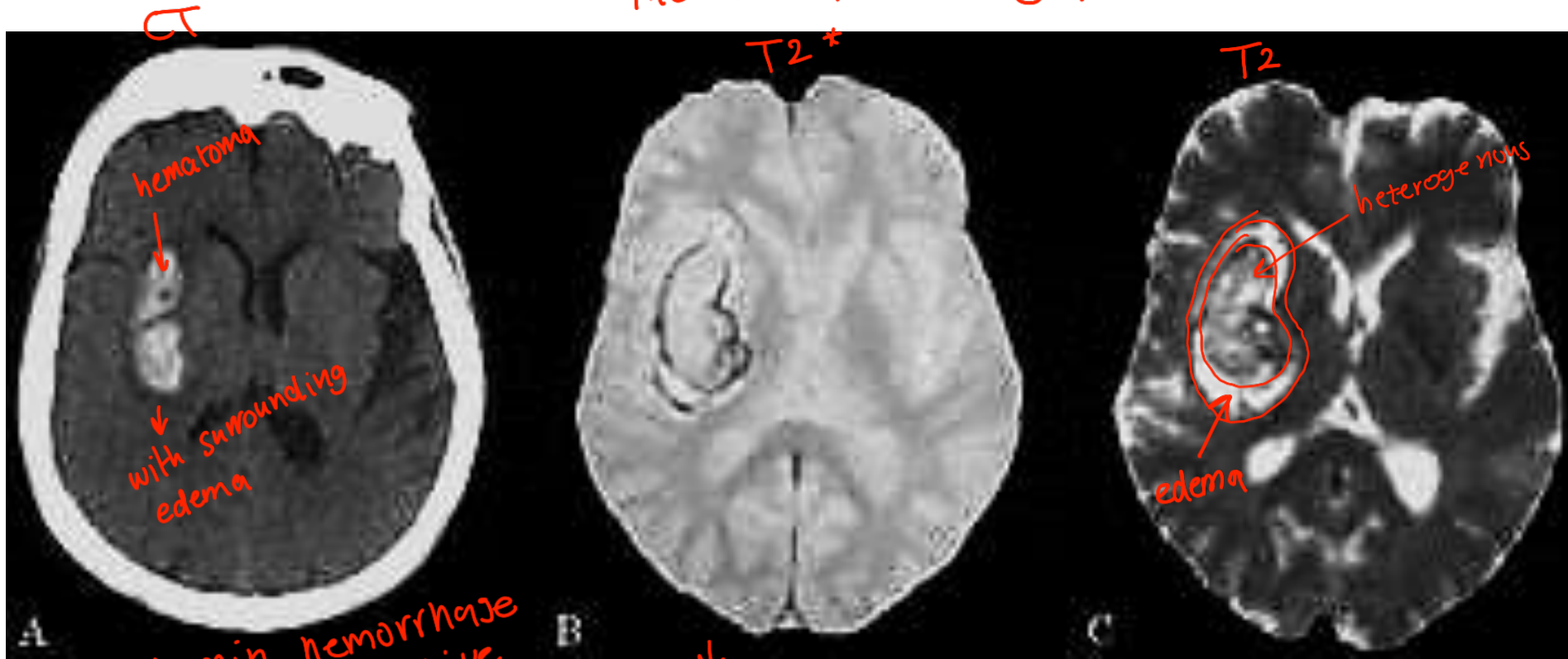


So although FLAIR is the best sequence to detect pathologies DWI is the best one to detect early pathologies

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.

- MRI helps for knowing the cause / underlying pathology



Putamin hemorrhage
means hypertensive
hemorrhage

↓
* if there's black here
raises suspicion of
hemorrhage

* black periphery on lesion means early hemorrhage
as it goes toward the center its chronic





Bilateral
subdural



TUMOURS

- Localisation
- Intraxial vs Extra axial.
- T1 with gadolinium contrast

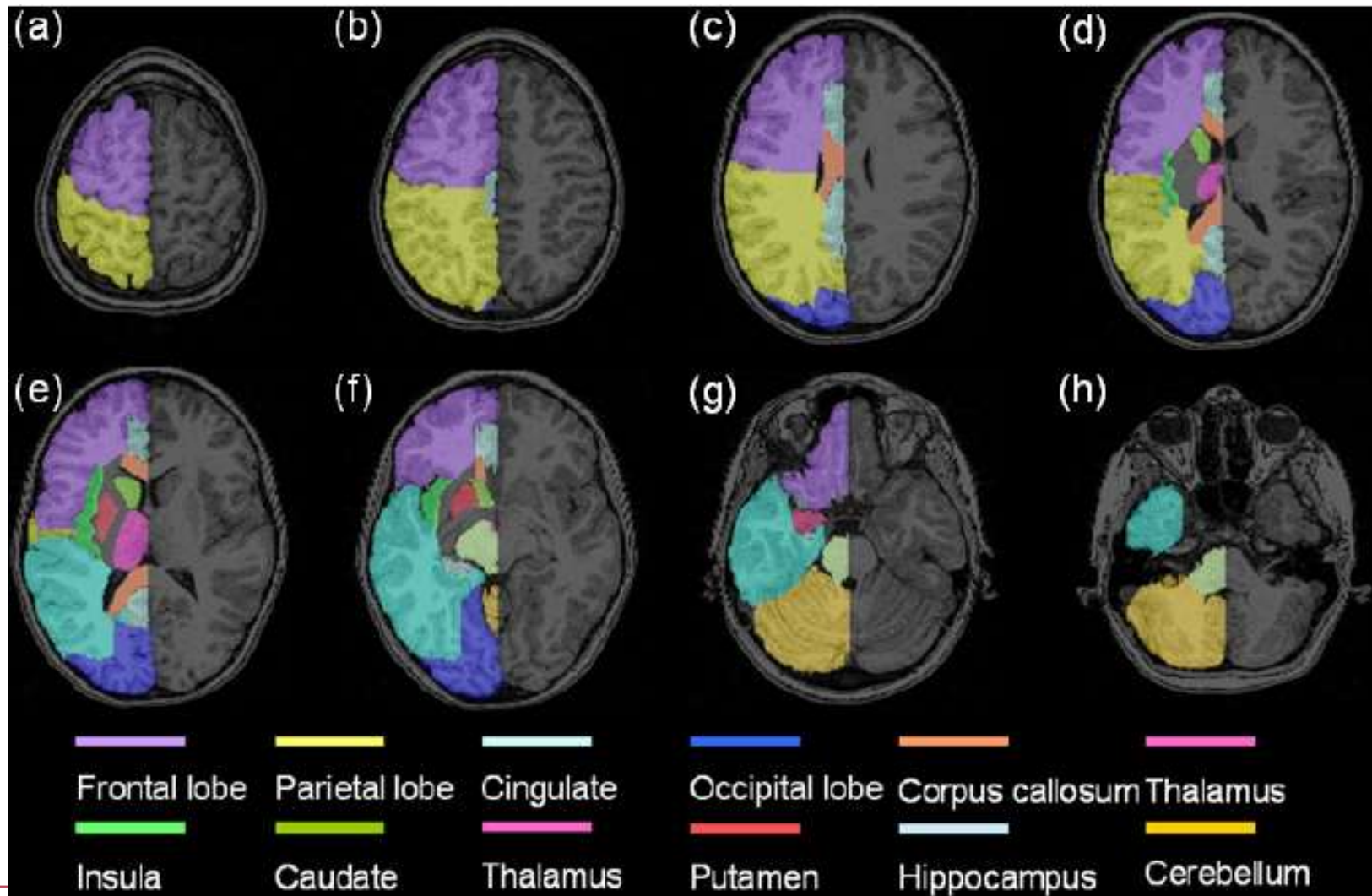
Analysis of a Potential Brain Tumor

- 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 ?



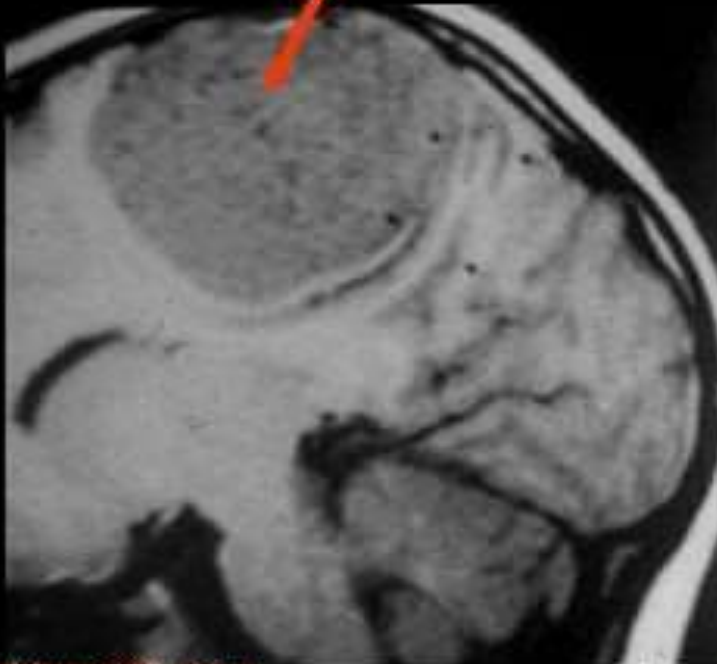
RS

Localisation

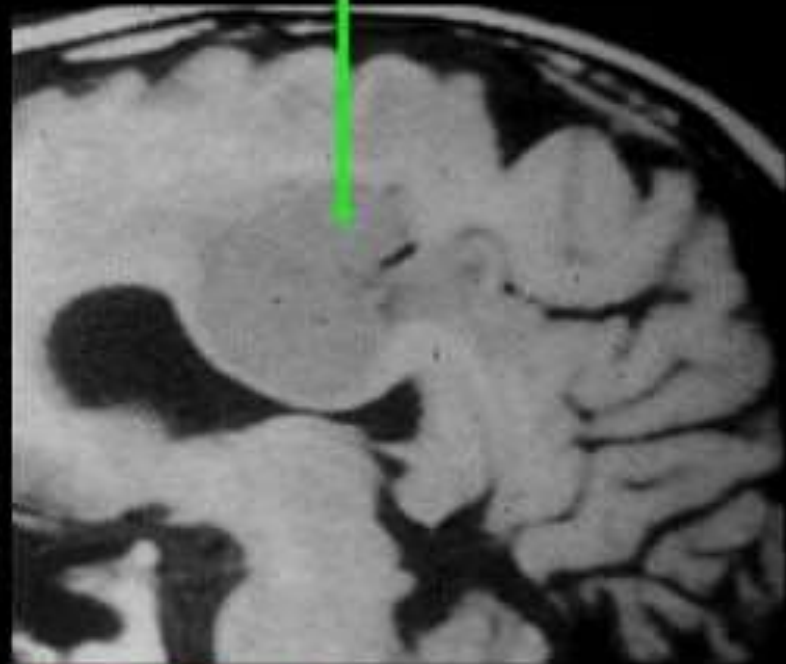


Extraaxial vs Intraaxial

Extra-axial vs Intra-axial



widens CSF space
displaces brain deeper
lesion has a broad base toward dura

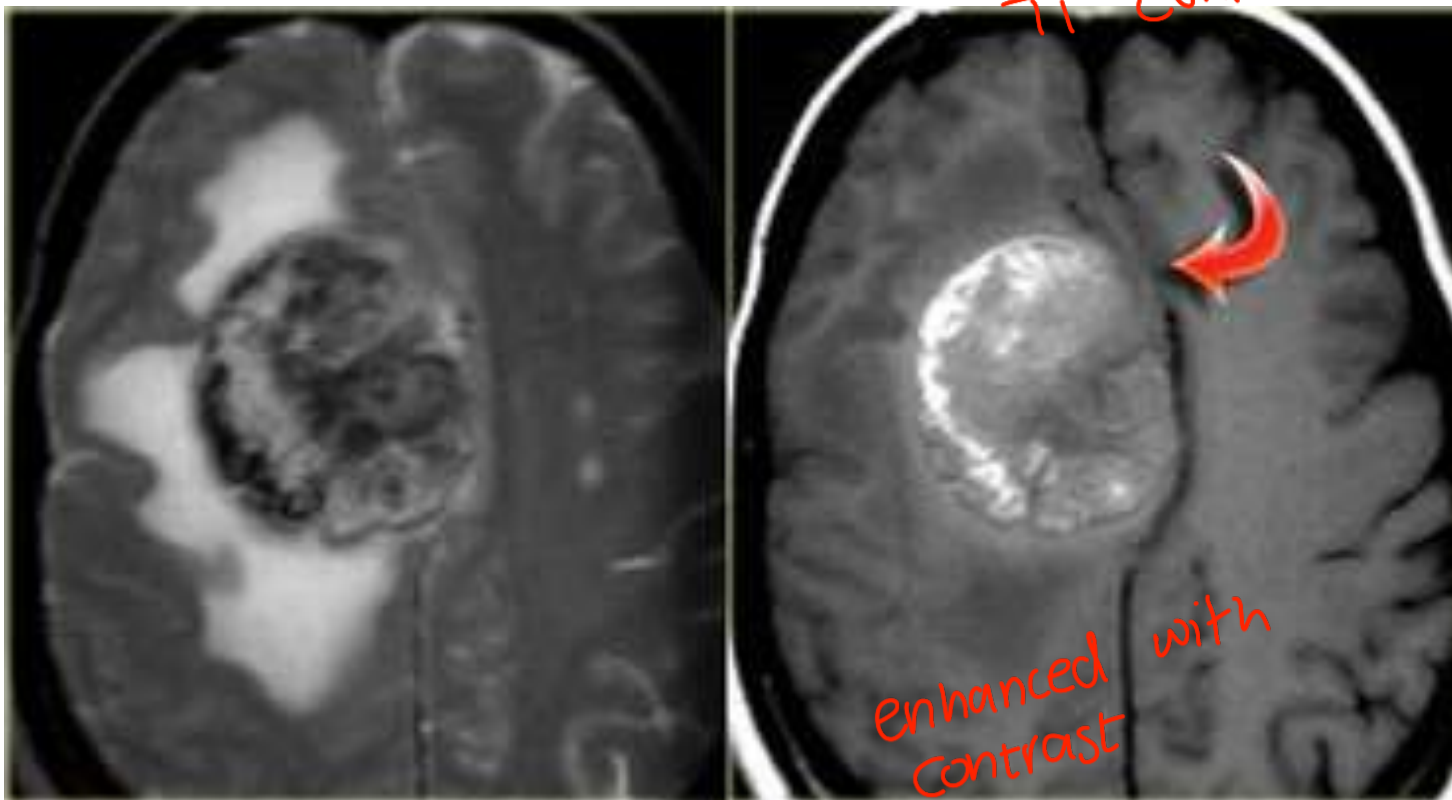


narrows CSF space
displaces cortex toward periphery

Melanoma

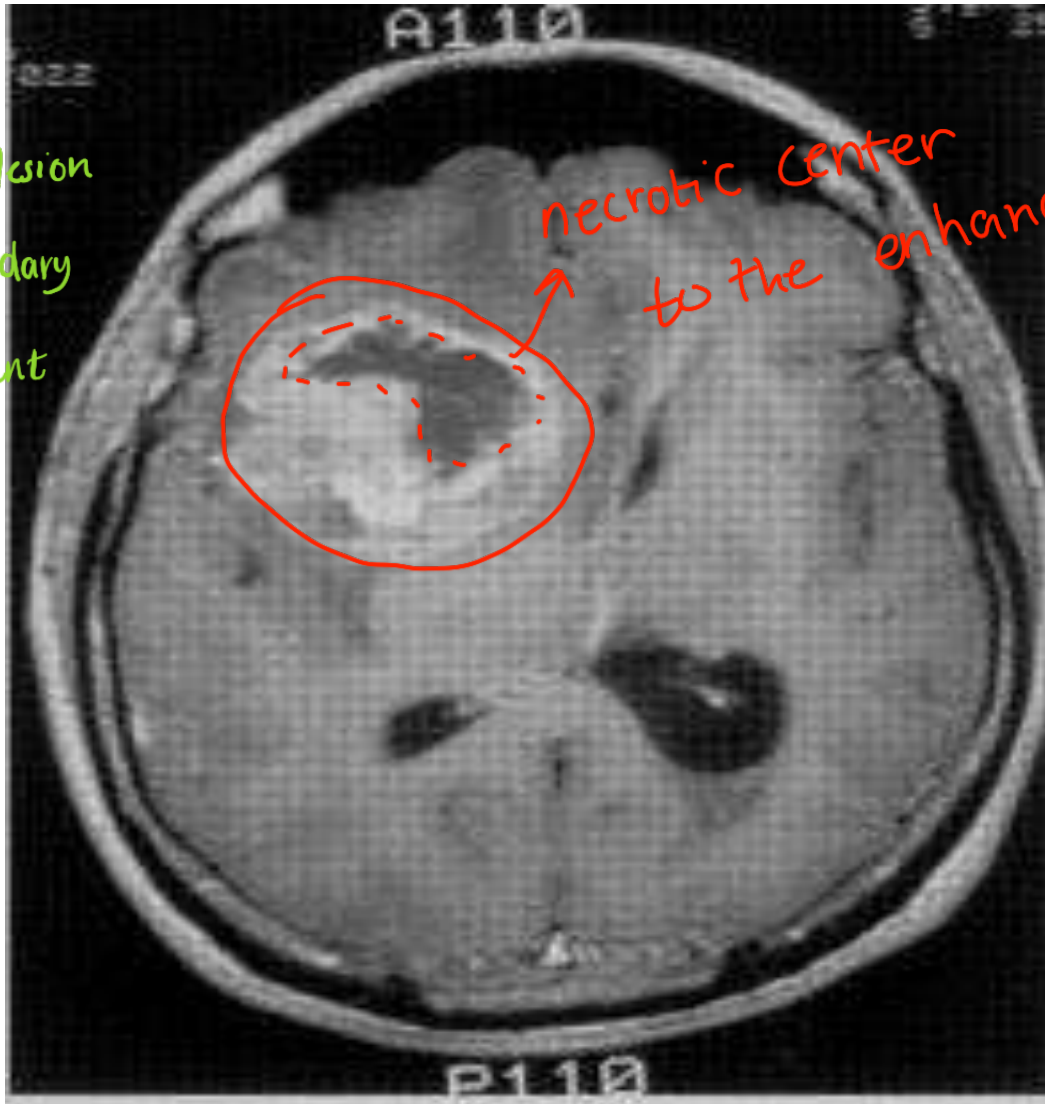
intraaxial

T1 Contrast



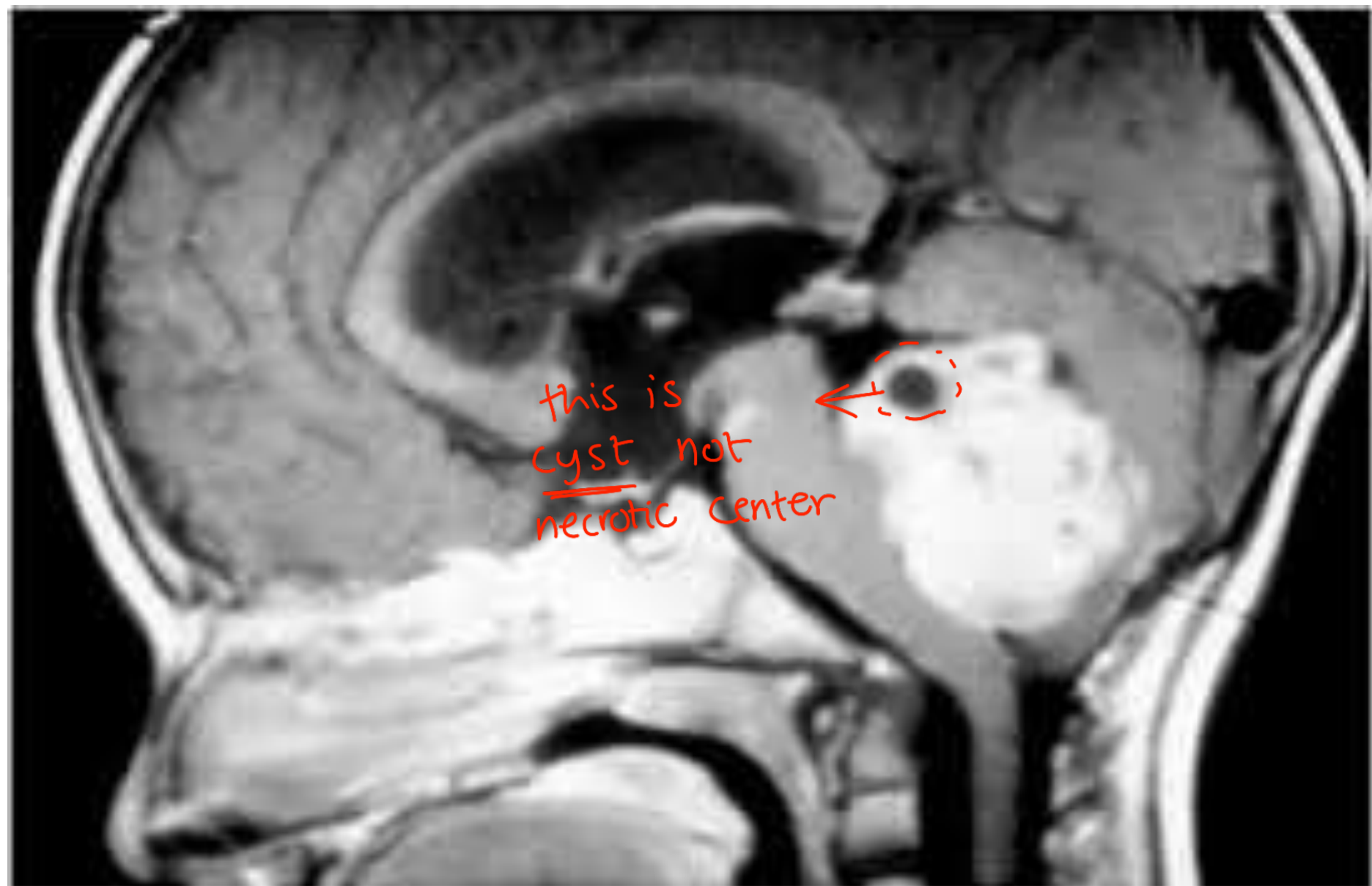
Ask yourself

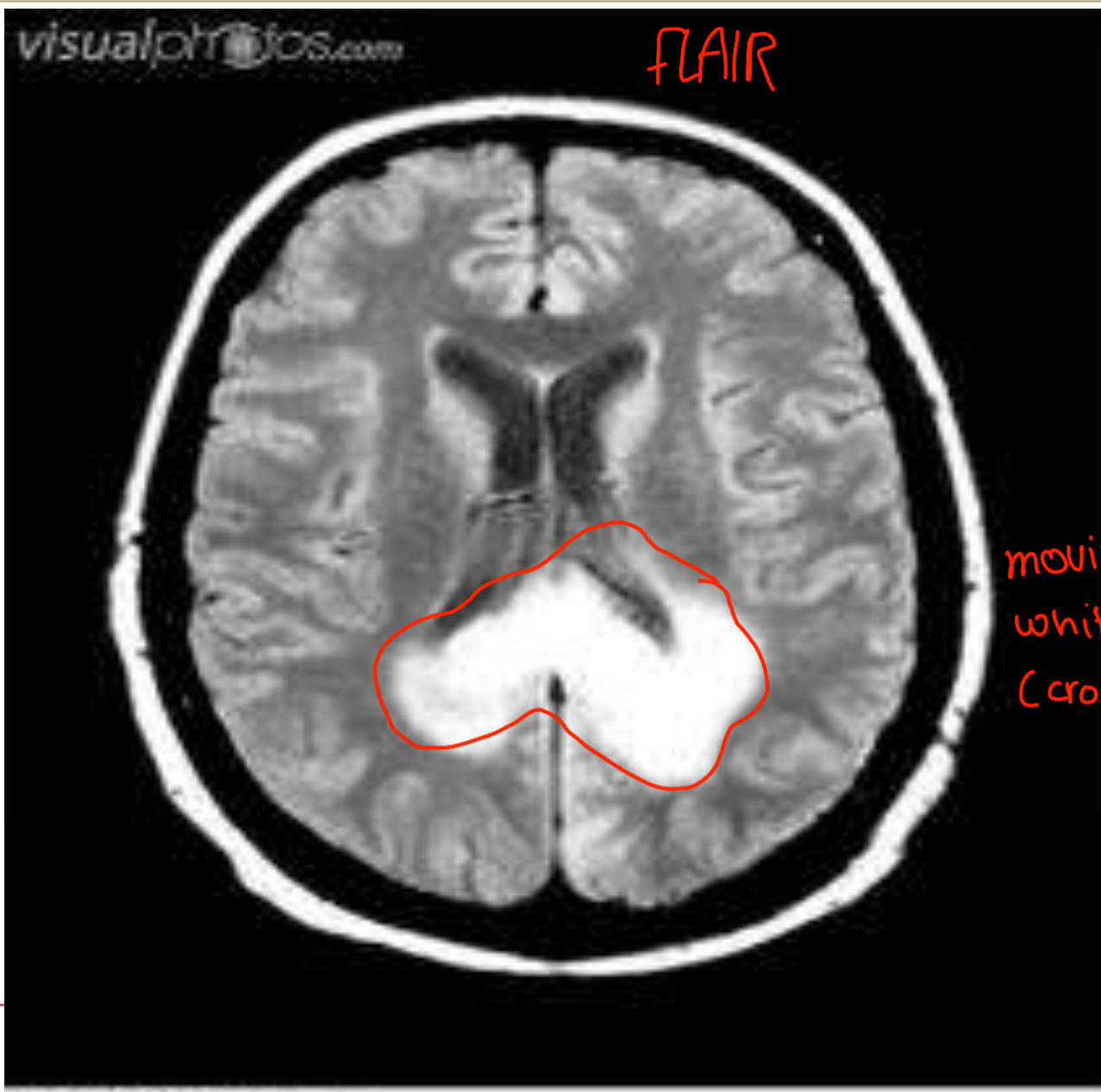
1. what is the lesion
2. primary / secondary
3. benign / malignant



attached to meninges
(meningioma)

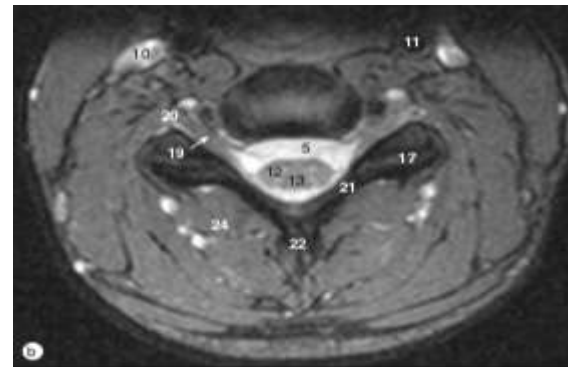






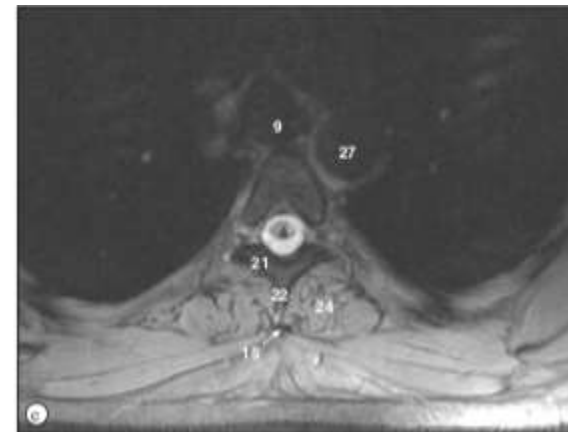
moving along the
white matter
(crosses the midline)

SPINE



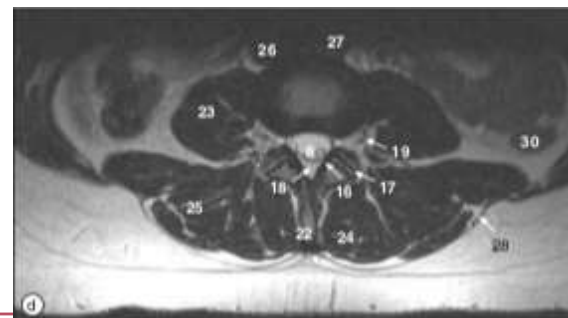
CERVICAL

7



THORACIC

12



LUMBAR

5

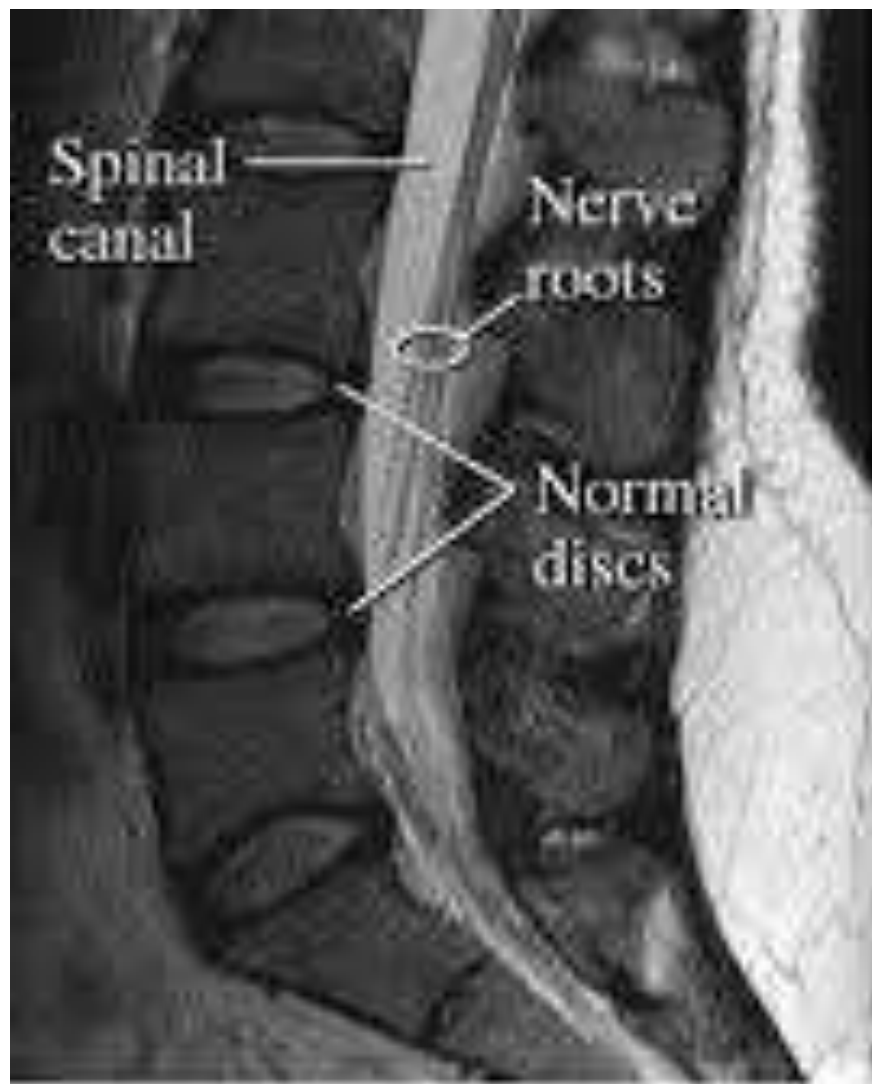
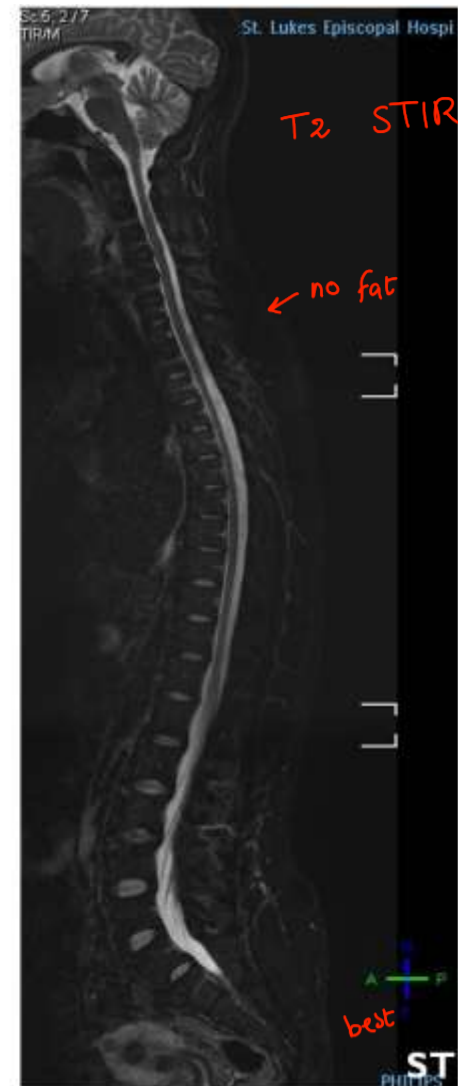
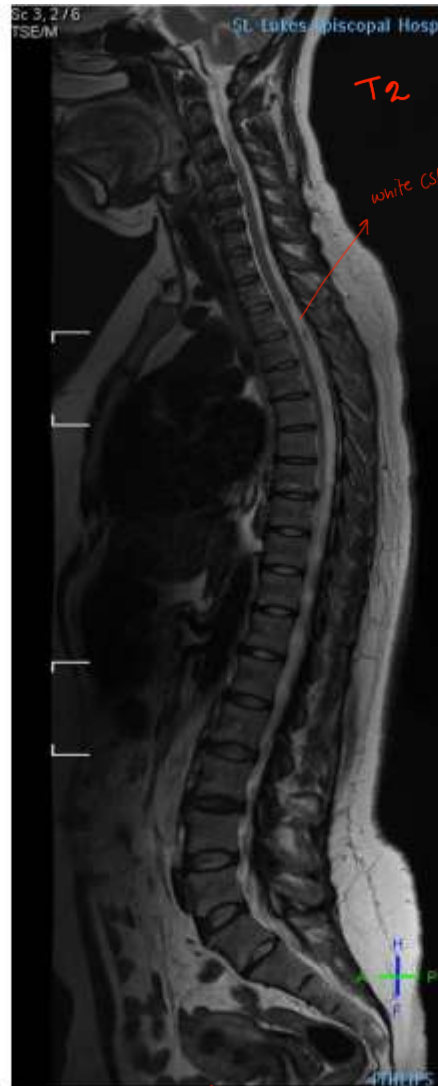


Figure 1



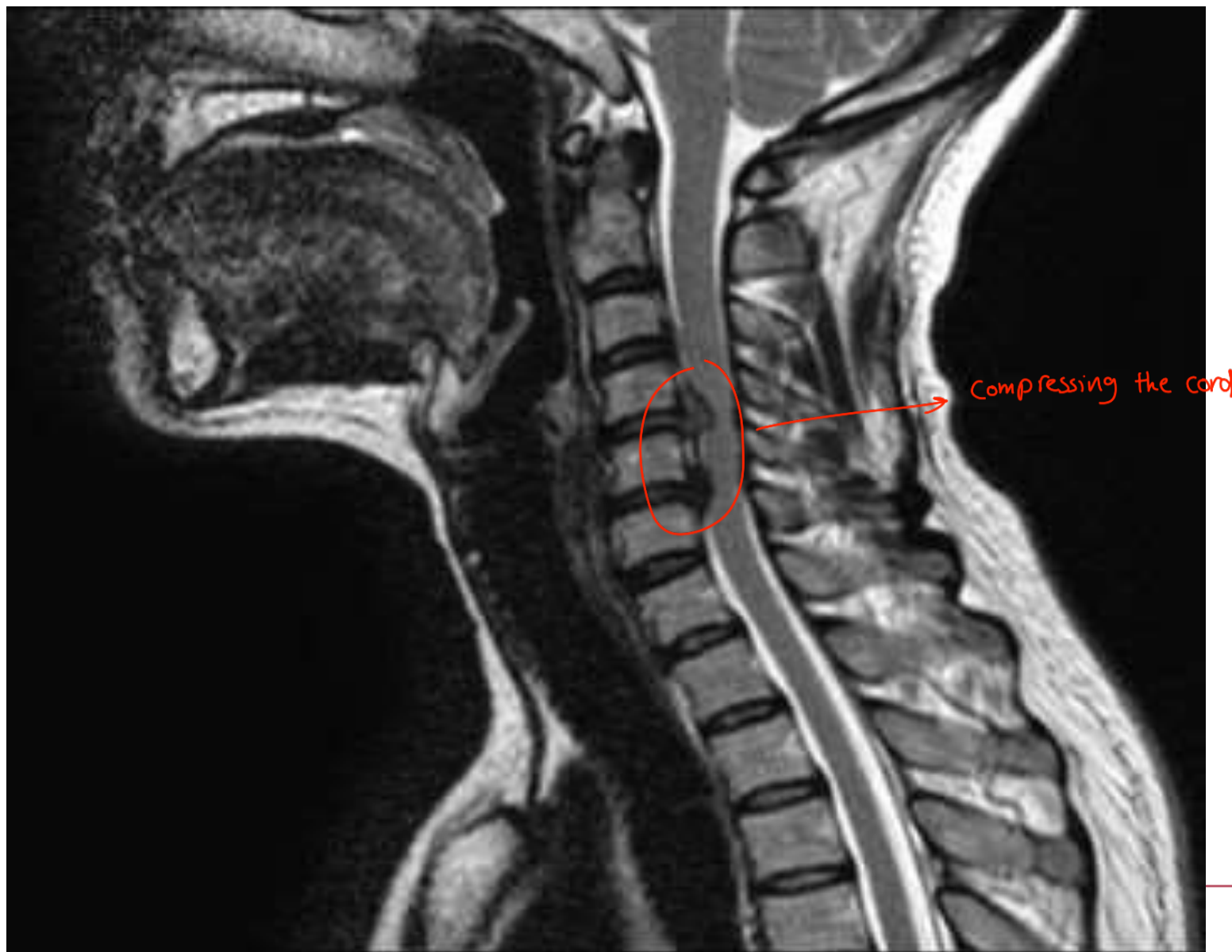
Figure 2

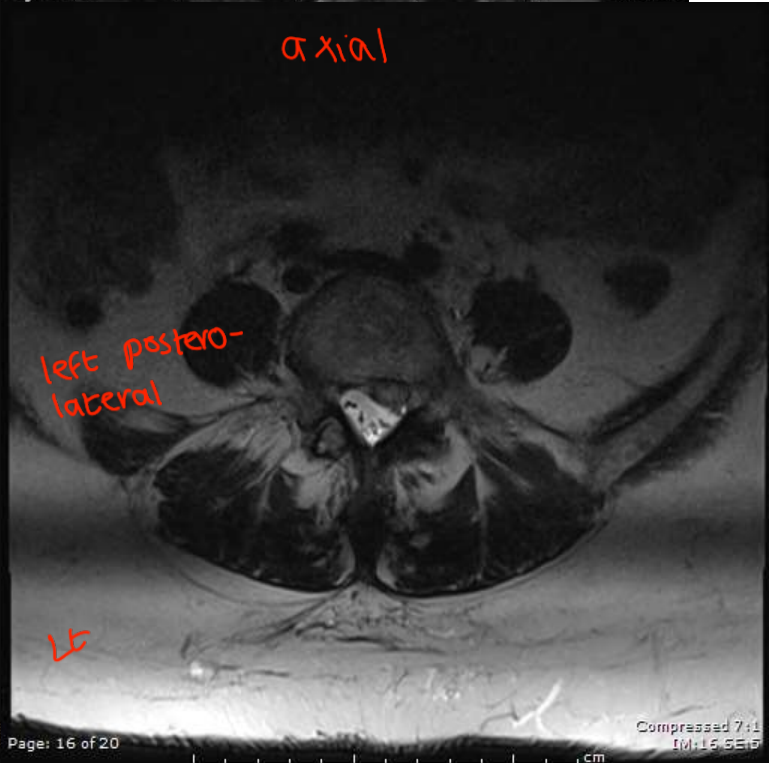
Sequences

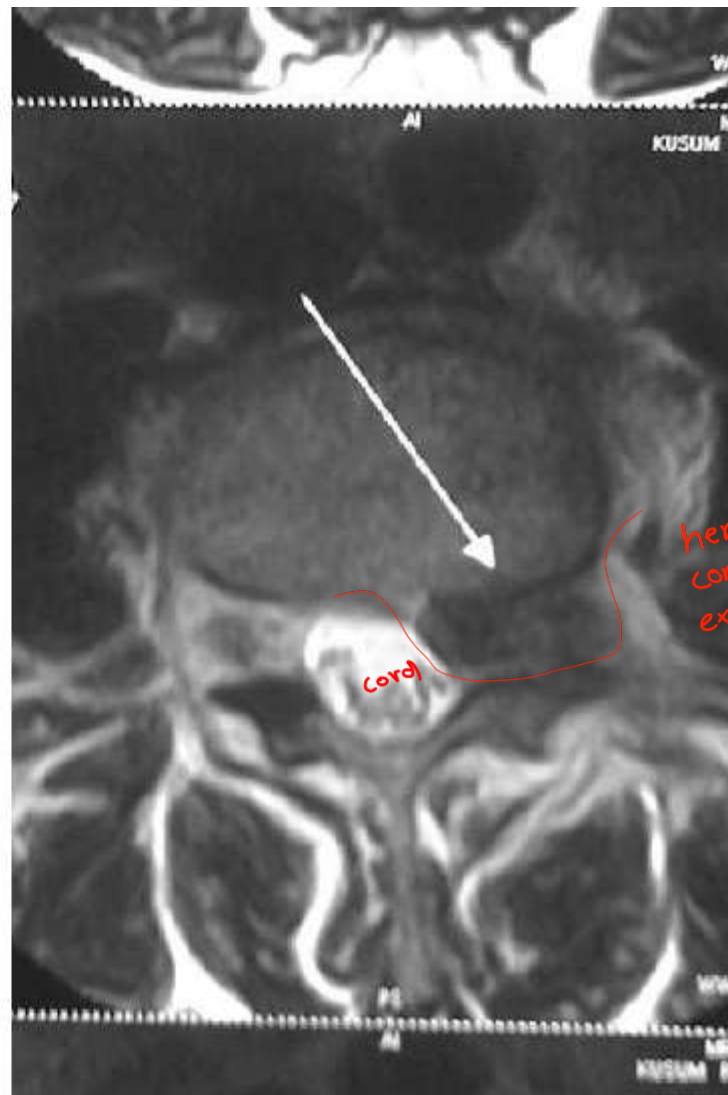
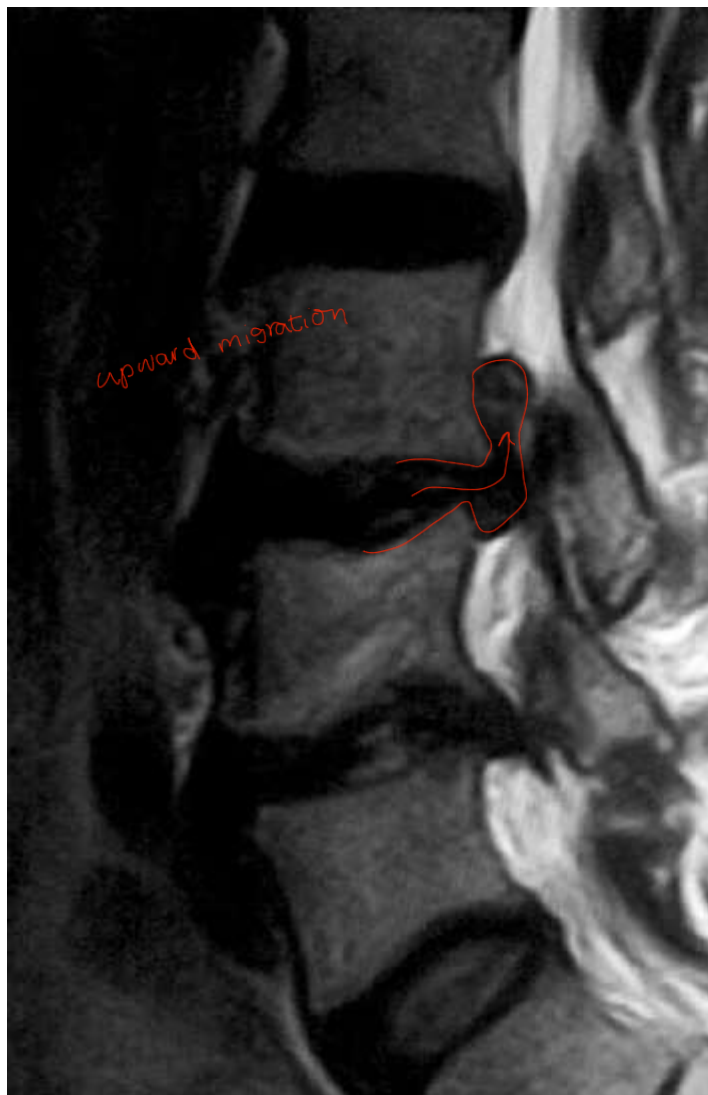


Spine MRI

Disc pathology

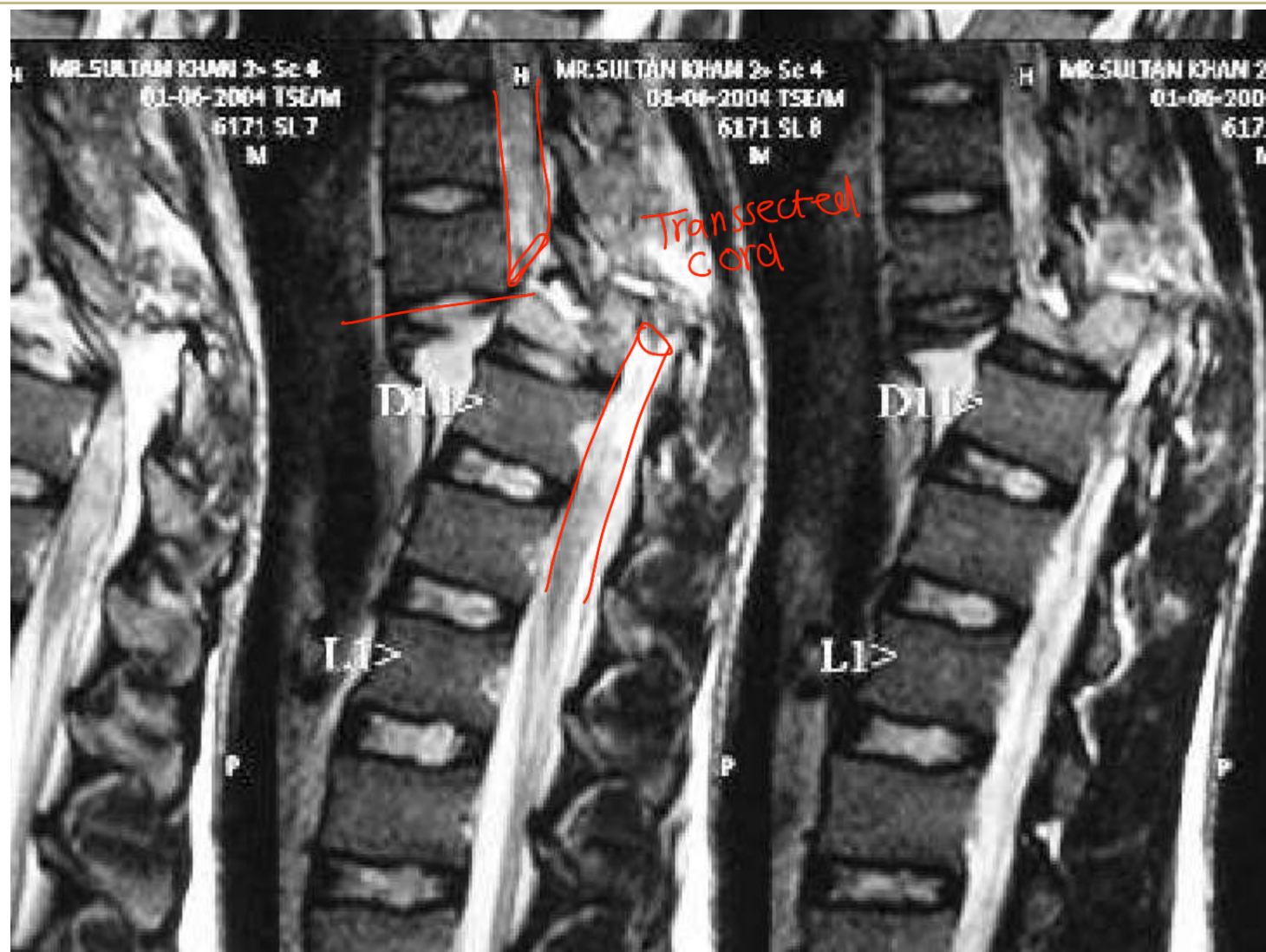






Spine MRI

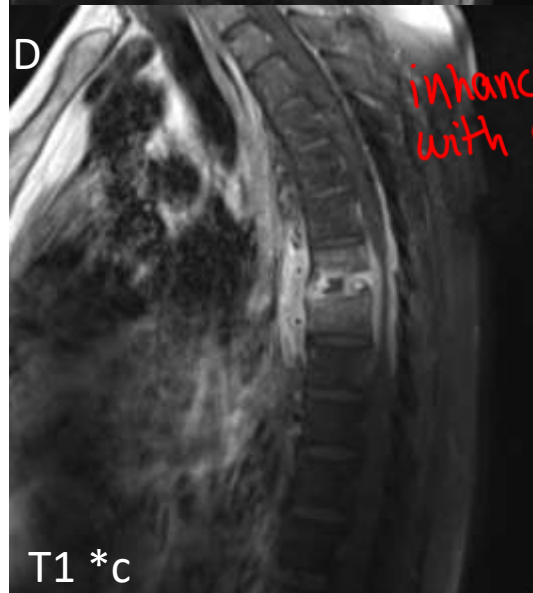
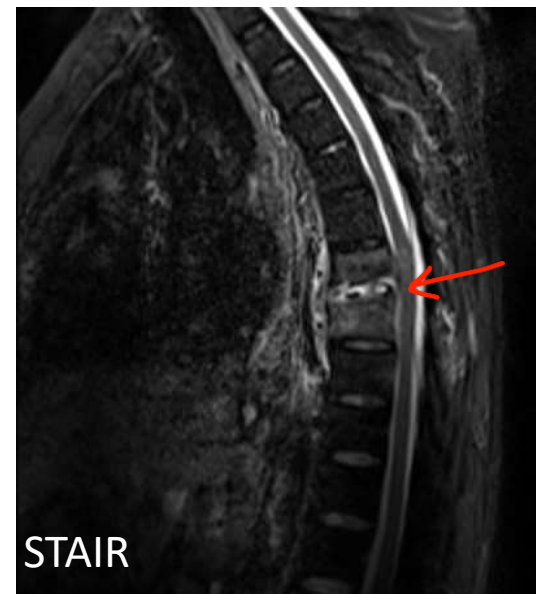
fractures



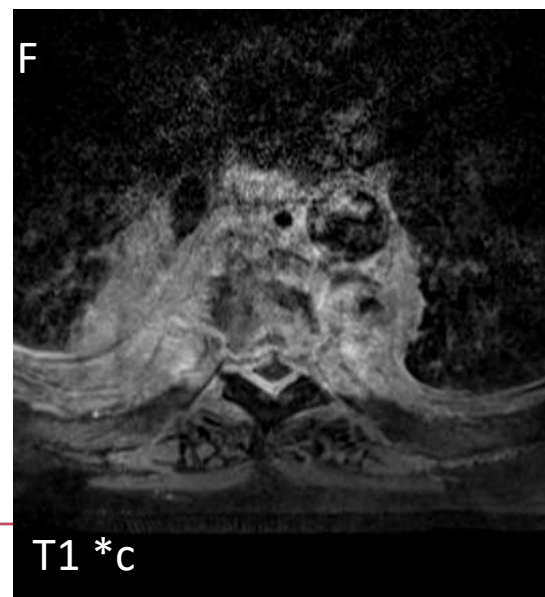
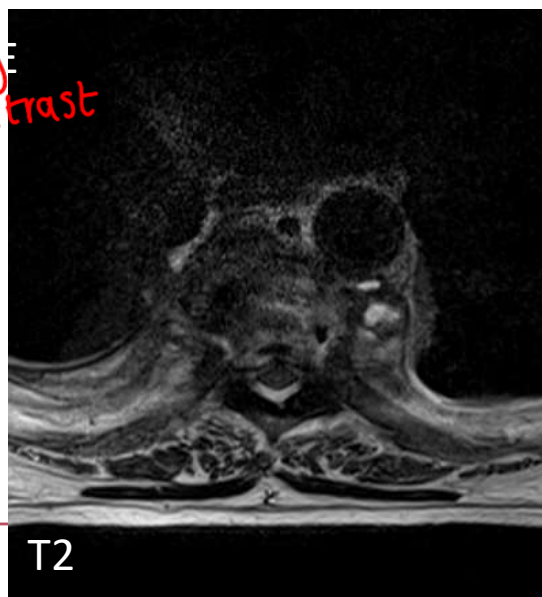


Spine MRI

Infection of the vertebrae
is called spondylitis



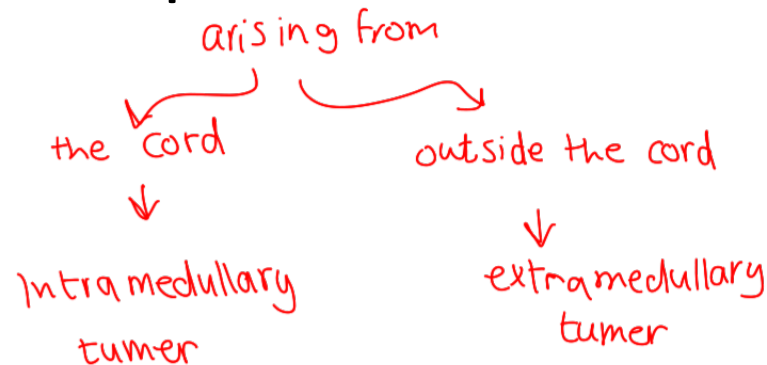
enhancing
with contrast



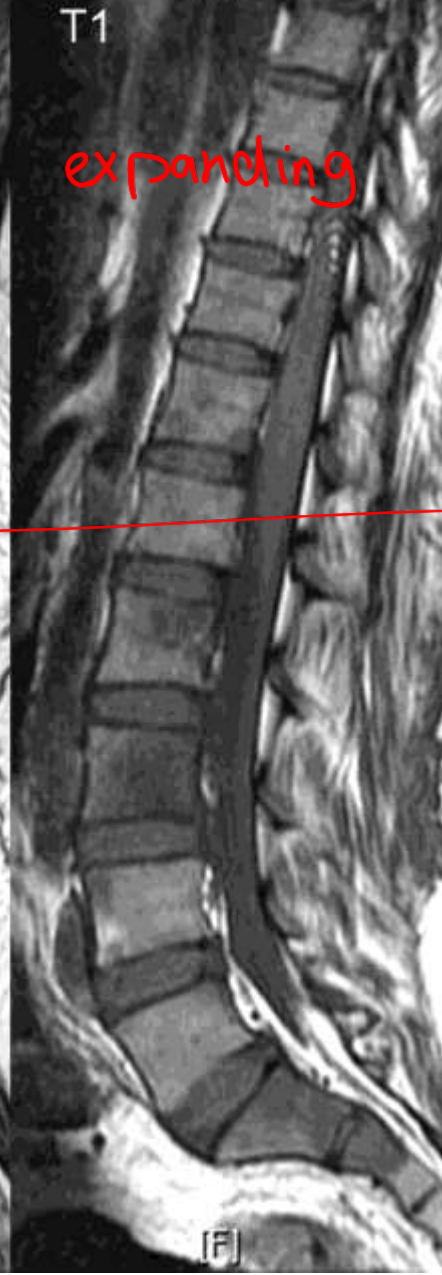


Spine MRI

Spine tumors





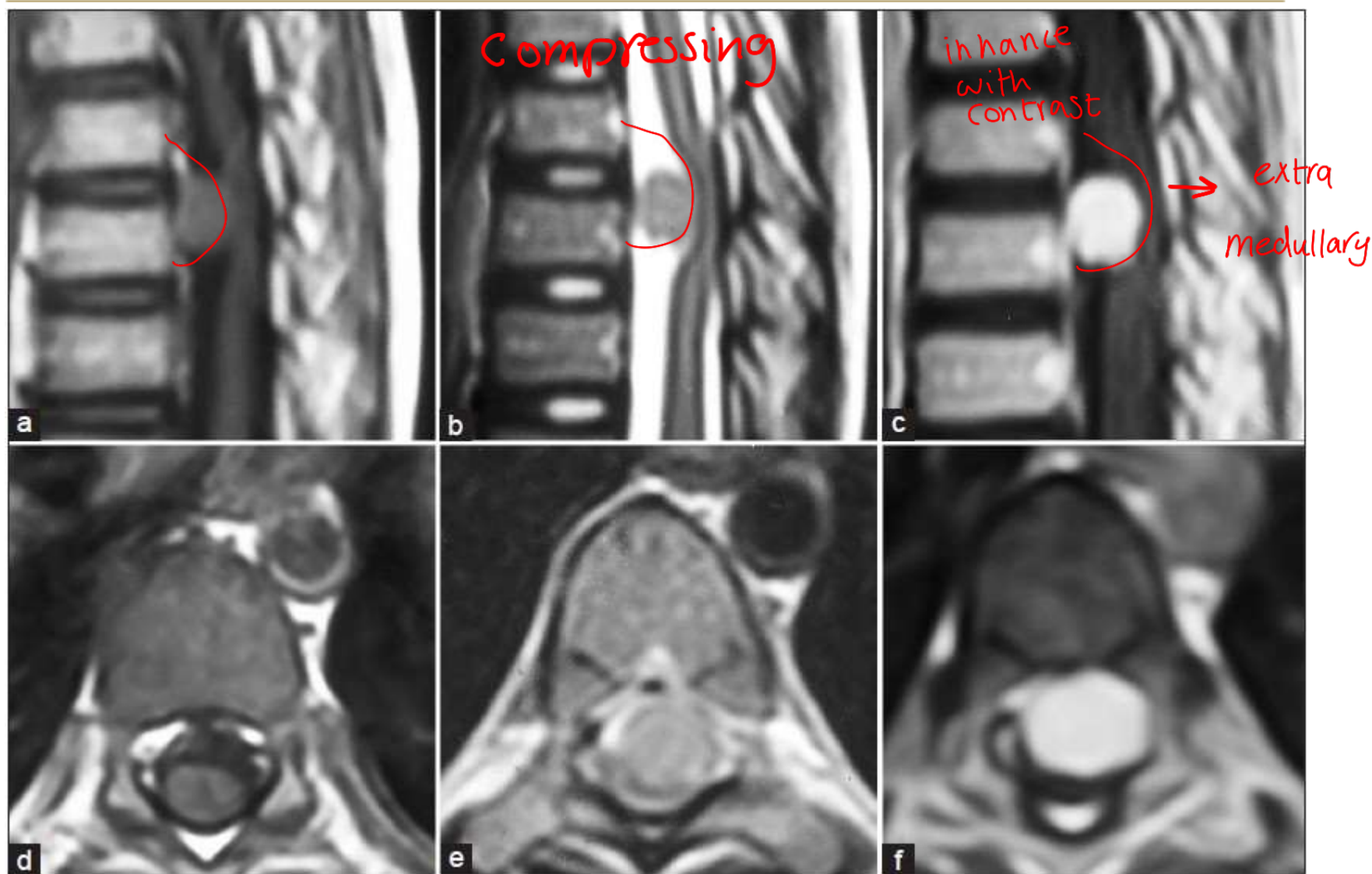


expanding

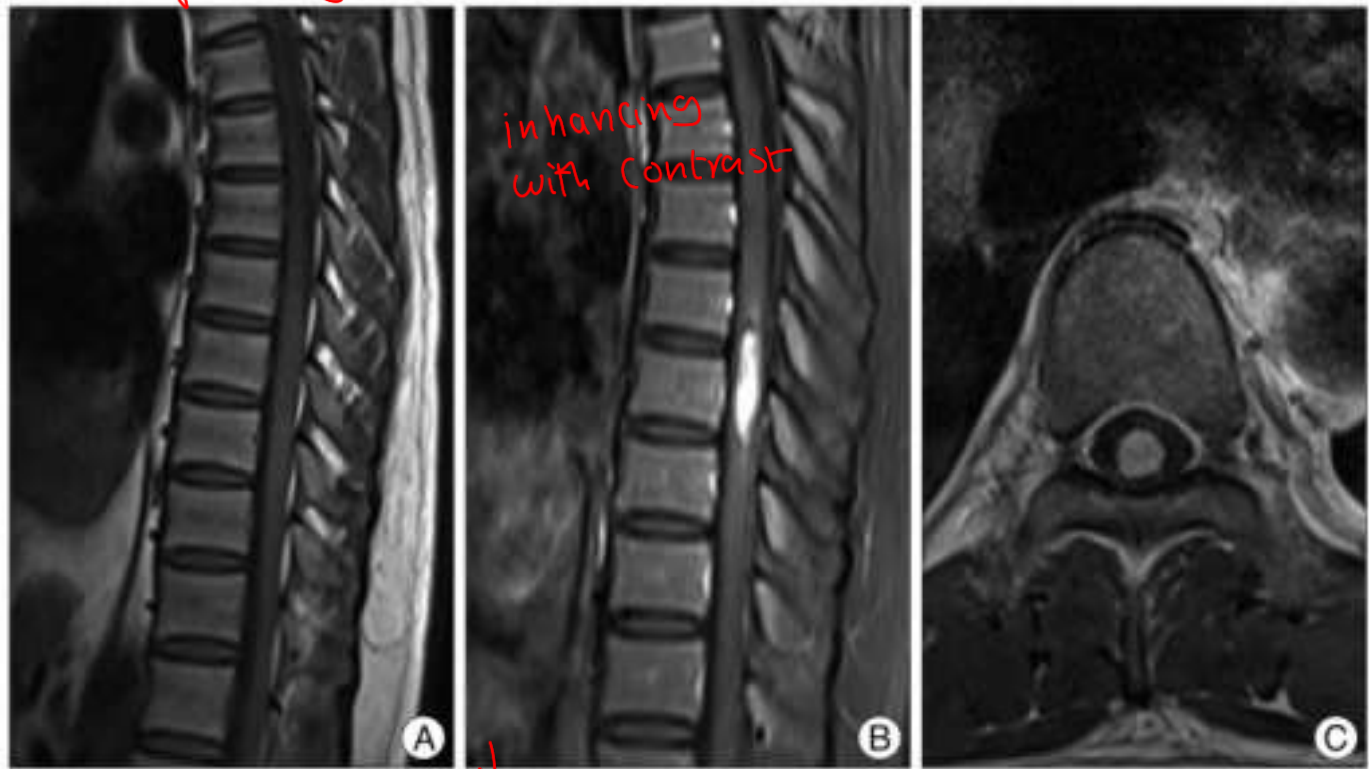
inhance with contrast

intra medullary

multiple mets

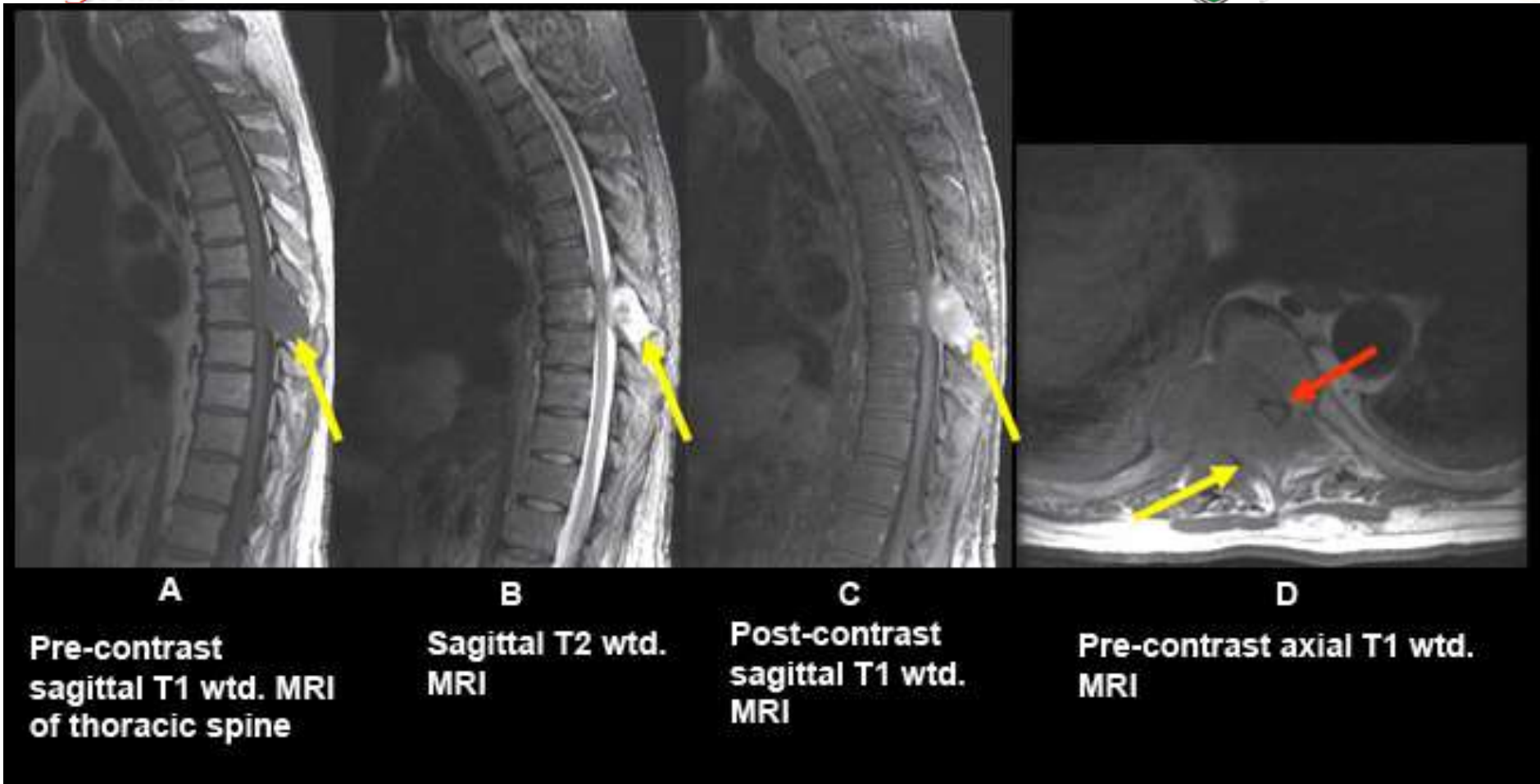


expanding



enhancing
with contrast

intra
medullary



abnormal spinous process

THANK YOU
