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.

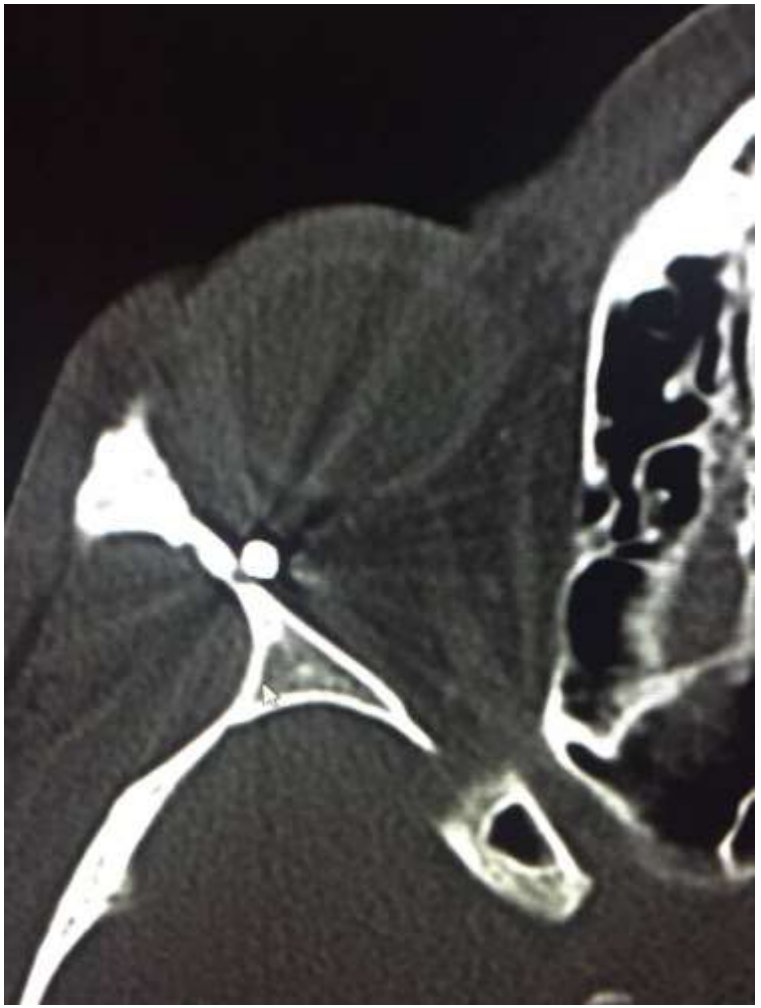
- Superior soft tissue contrast.
- Multiplanar capability.
- No ionizing radiation.
- Relatively safe contrast media.

Diagnostic and Interventional Radiology

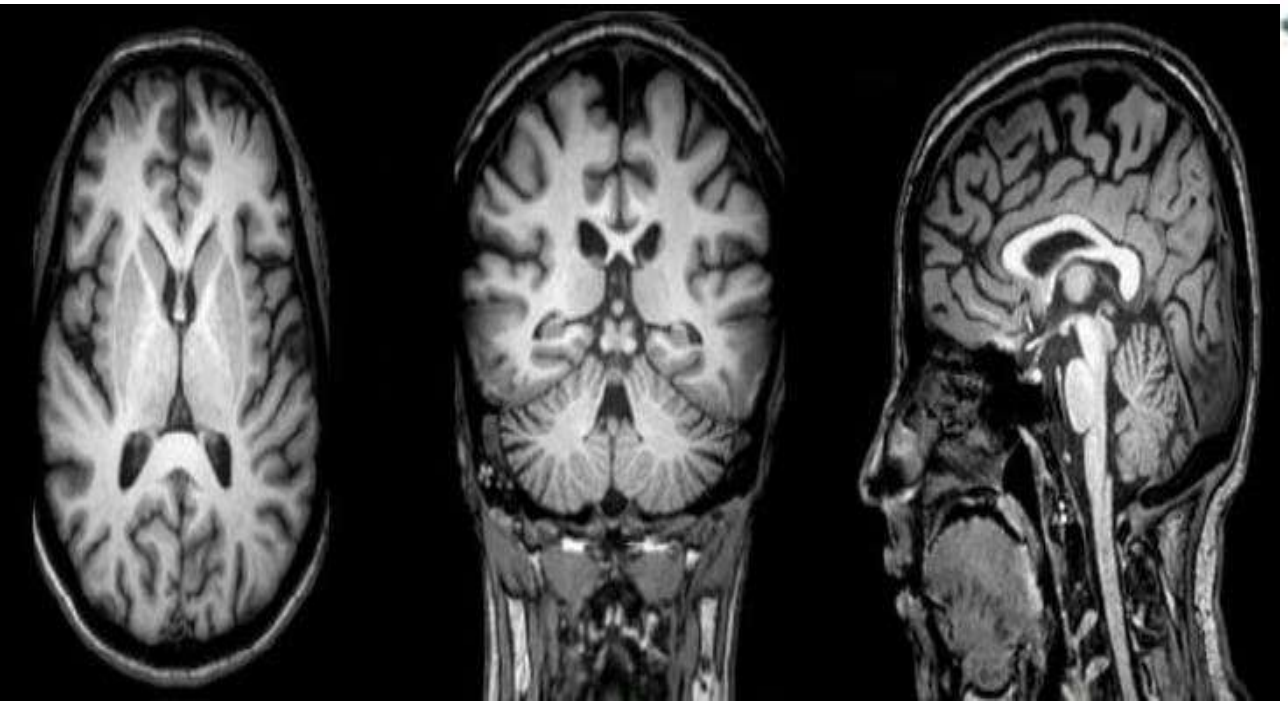
MRI Disadvantages

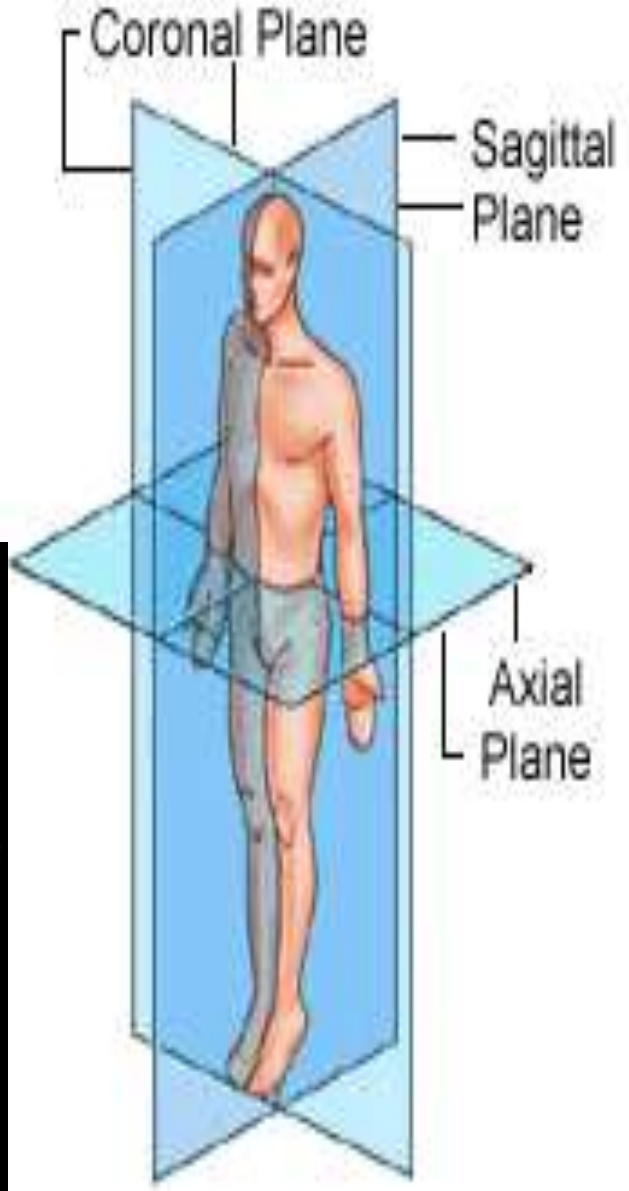
- Expensive
- Not widely available
- Claustrophobia
- Certain contraindications (pace maker, ect)

Metallic foreign body in the eye



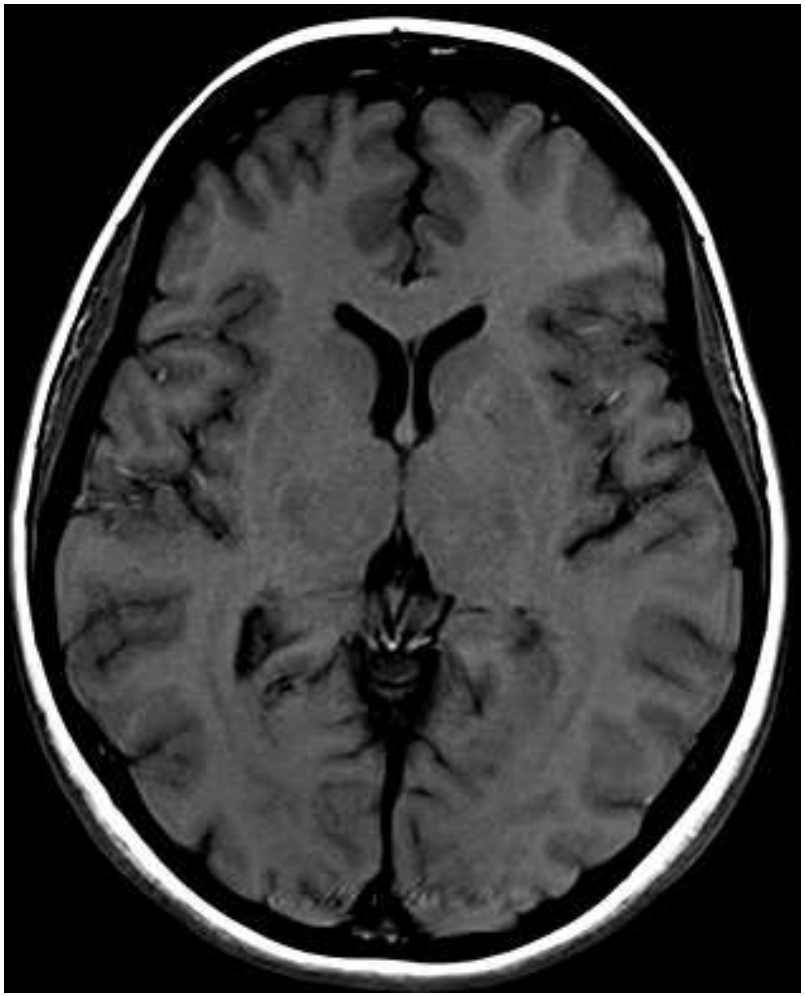
MRI planes





T1-weighted images (T1)

- ✓ **Recognition :**
  - **Ventricles dark**
  - Scalp bright
  - **White matter brighter than the grey matter.**
  - **Vessels mostly not seen**



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

T1-weighted images (T1)

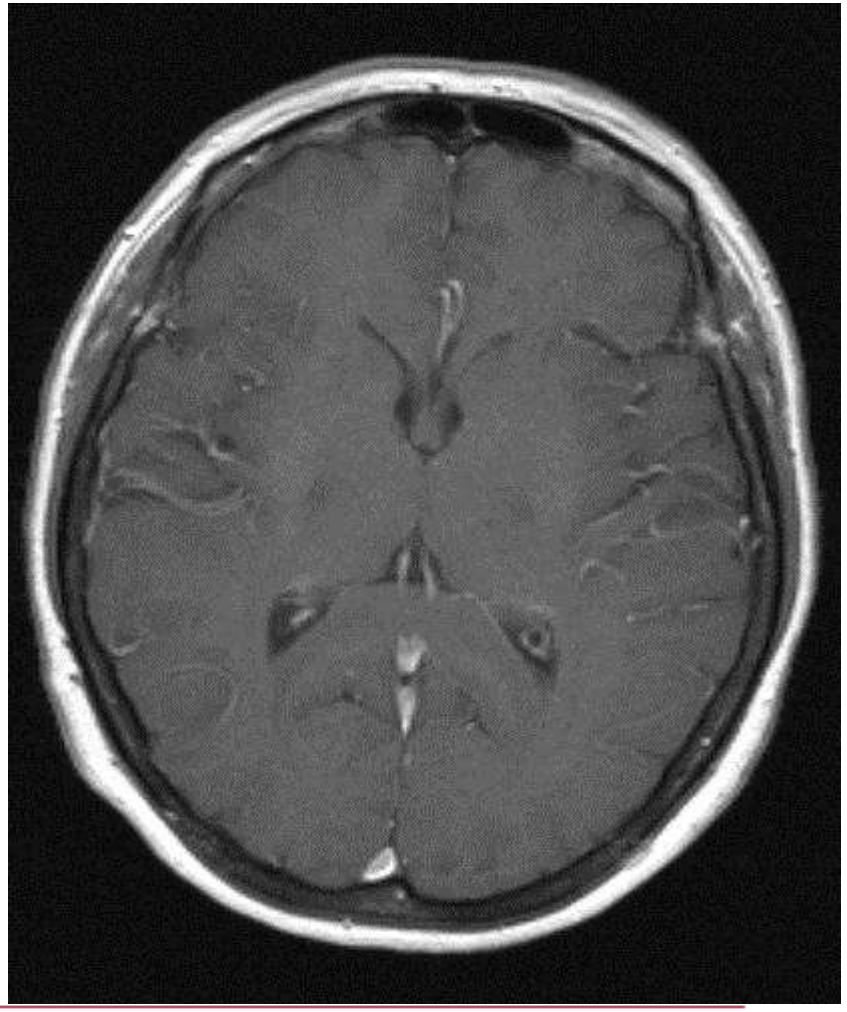
- ✓ **Black on T1 :**
  - Air
  - Calcium
  - Dense bone
- ✓ **Dark on T1 (long T1)**
  - CSF
  - Edema
  - Most lesions
- ✓ **Grey on T1**
  - White matter, gray matter
  - **(White matter brighter than grey matter).**
- ✓ **Bright on T1 (short T1)**
  - Fat
  - Blood (methemoglobin) (subacute hemorrhage)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

T1 hyperintense lesions

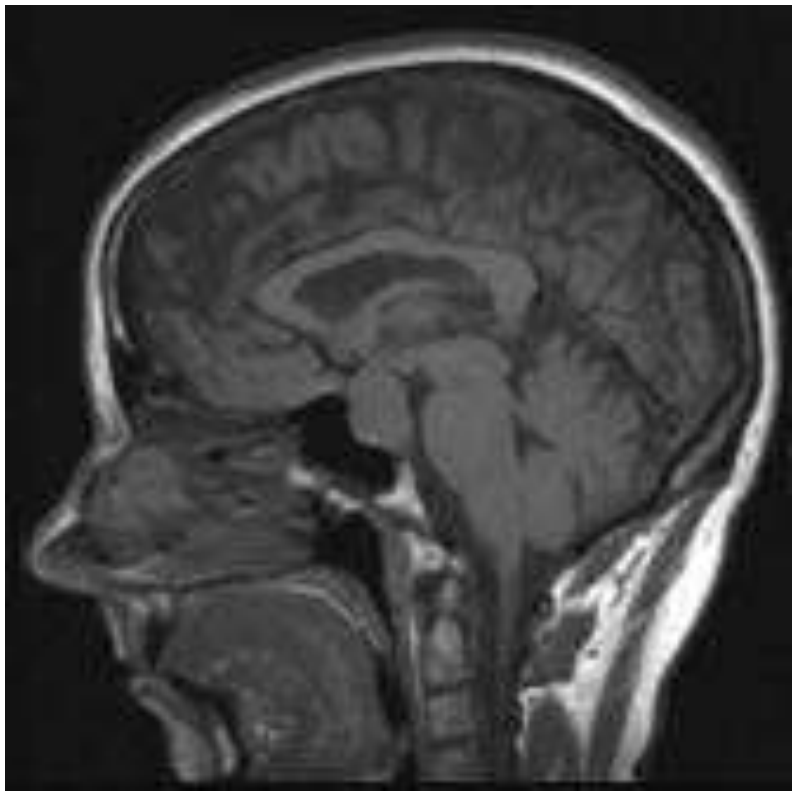
Content	Lesion/pathology
Methaemoglobin	Subacute blood
Fat/lipid	Lipoma, dermoid, craniopharyngioma
Melanin	Melanoma
Slow flow	Thrombosis
Manganese and copper	Metabolic disorders
Protein	Craniopharyngioma
Gadolinium	Contrast

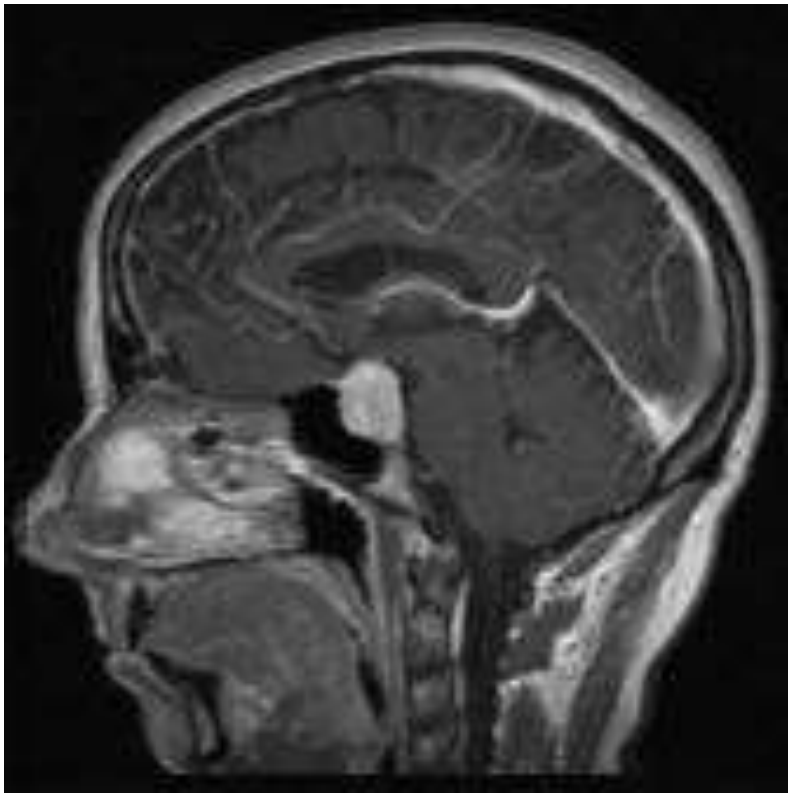
T1-weighted images with Gd contrast

- ✓ **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**



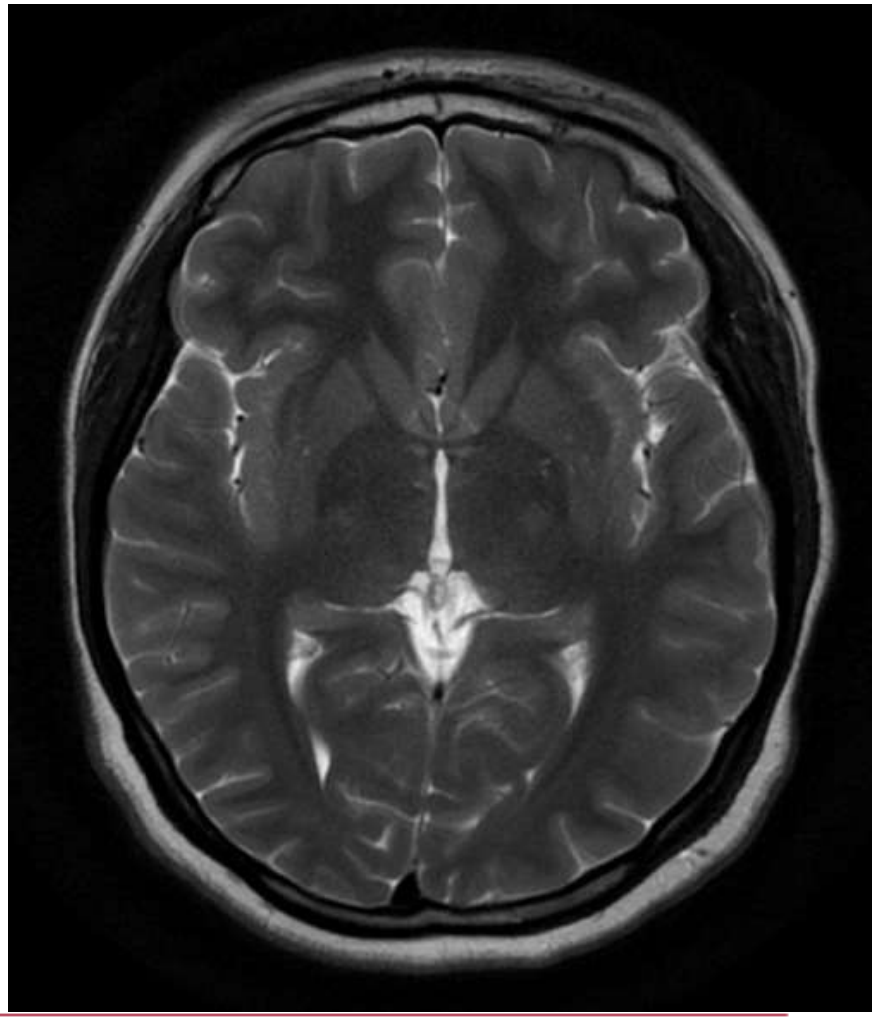
T1-weighted images with vs without Gd contrast





T2-weighted images (T2)

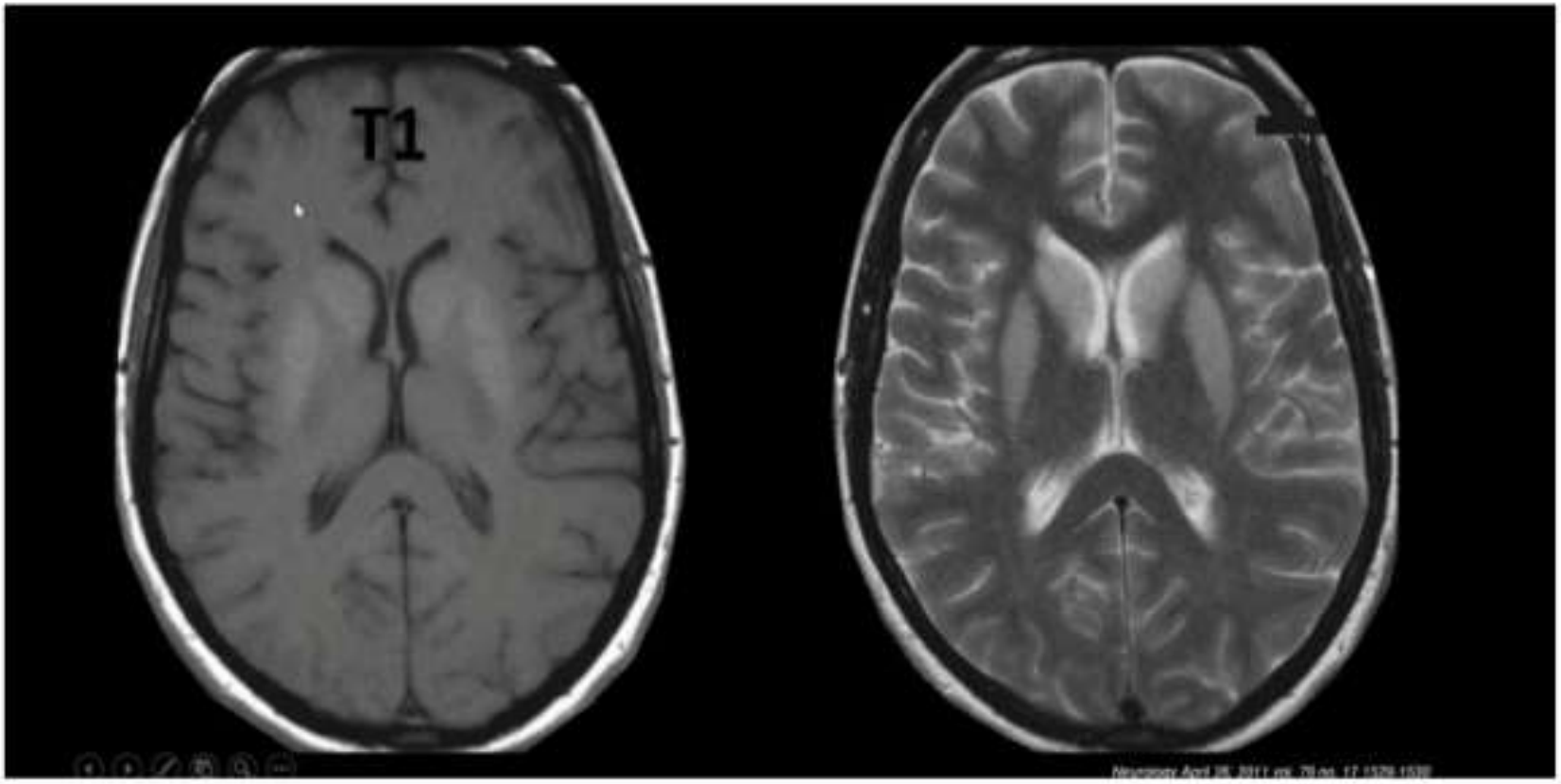
- ✓ **Recognition**
  - **CSF (ventricles, cisterns, sulci): bright**
  - Scalp: bright
  - **White matter darker than grey matter**
  - Vessels: black (flow void)
- ✓ **Useful for:**
  - Brain anatomy (shows CSF spaces)
  - Most brain lesions
  - **But can't distinguish lesions from CSF (ventricles,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



FLAIR (Fluid Attenuated Inversion Recovery)

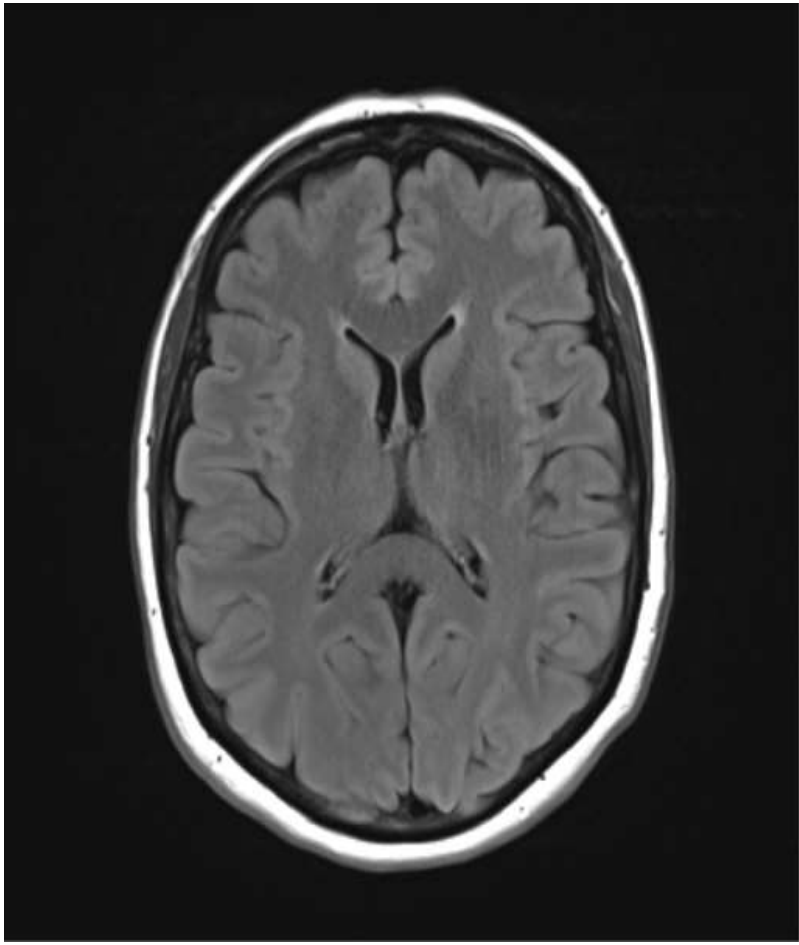
- **Same as T2 except free CSF (ventricles, cisterns, sulci) is suppressed (black)**
- Most pathology is **BRIGHT**

✓ **Recognition**

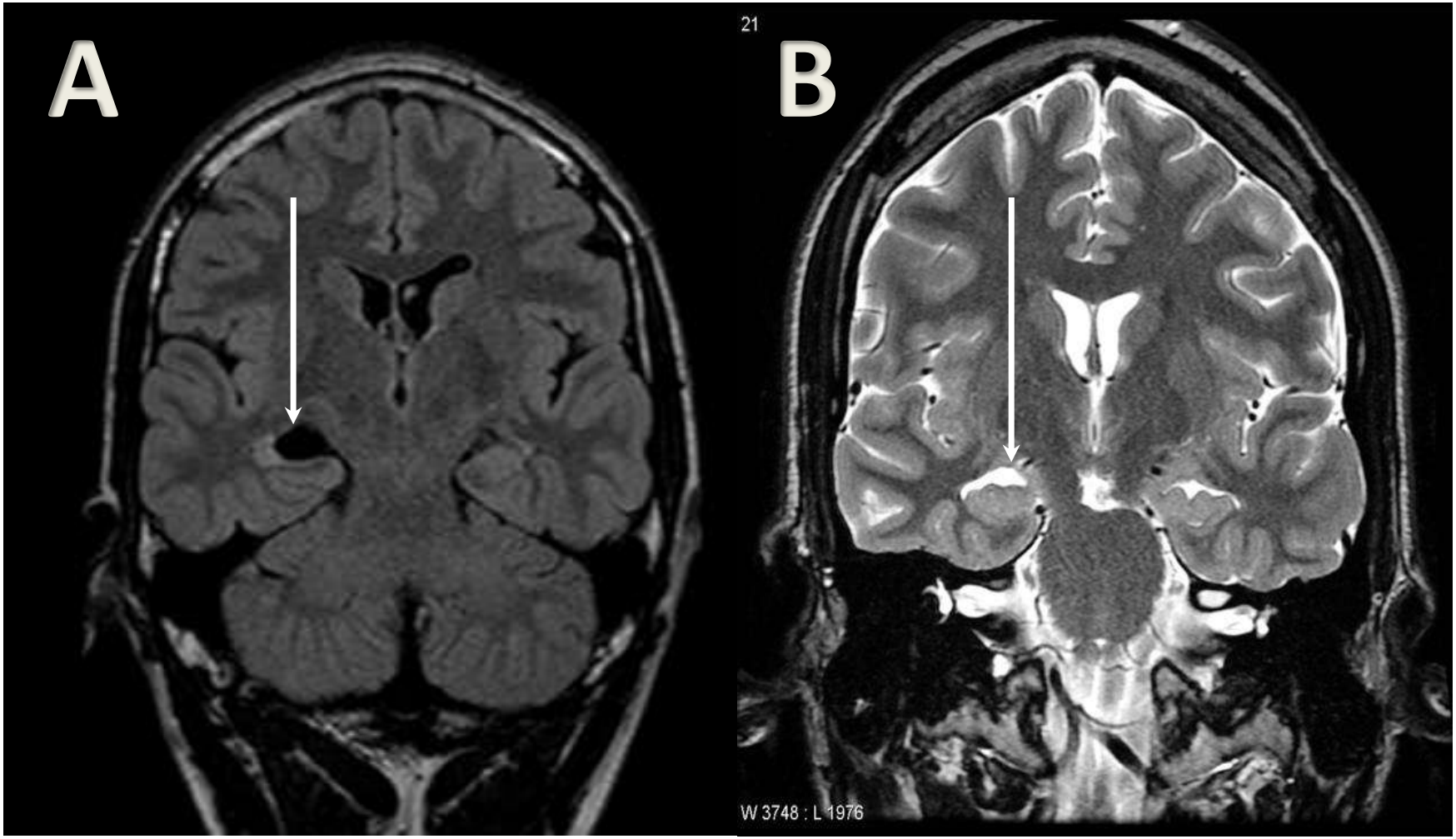
- Superficially resembles T1 **(but the white matter darker than grey matter)**

✓ **Useful for:**

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



T2 vs FLAIR



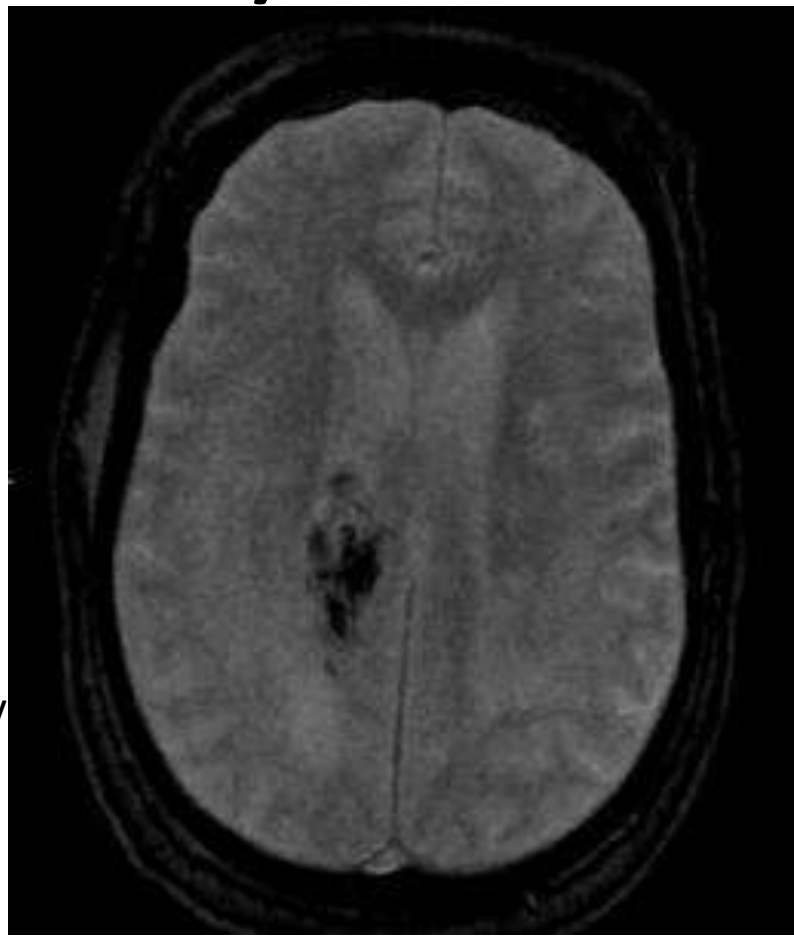
Susceptibilty weighted images
T2* (T2-star, or SWI)

- 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**

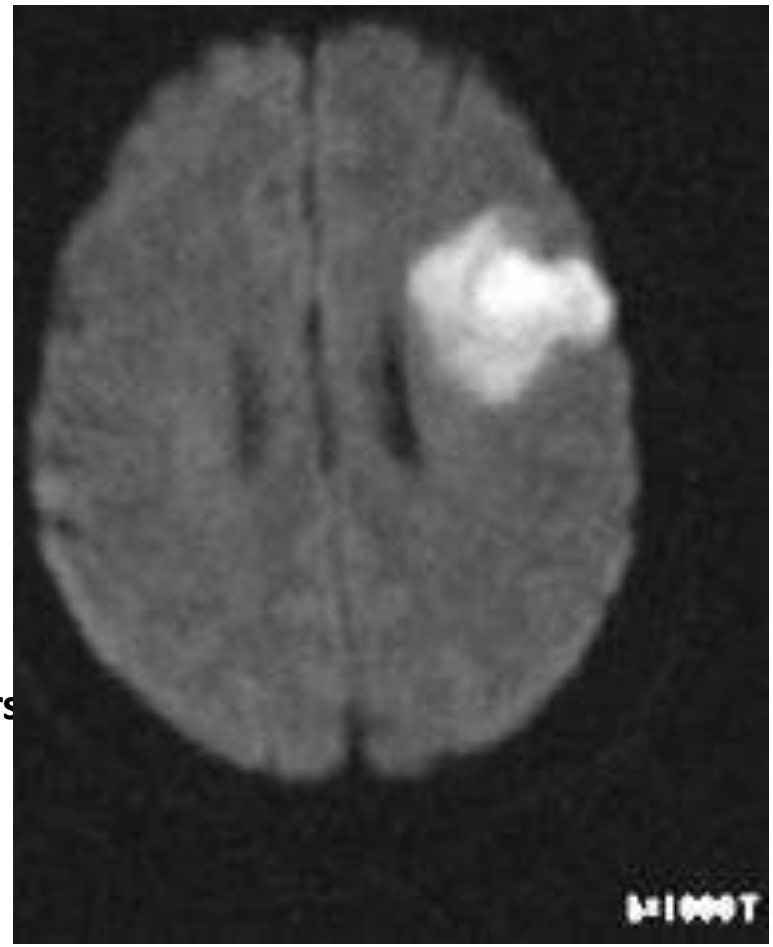


Diffusion-weighted image (DWI)

- ✓ 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.

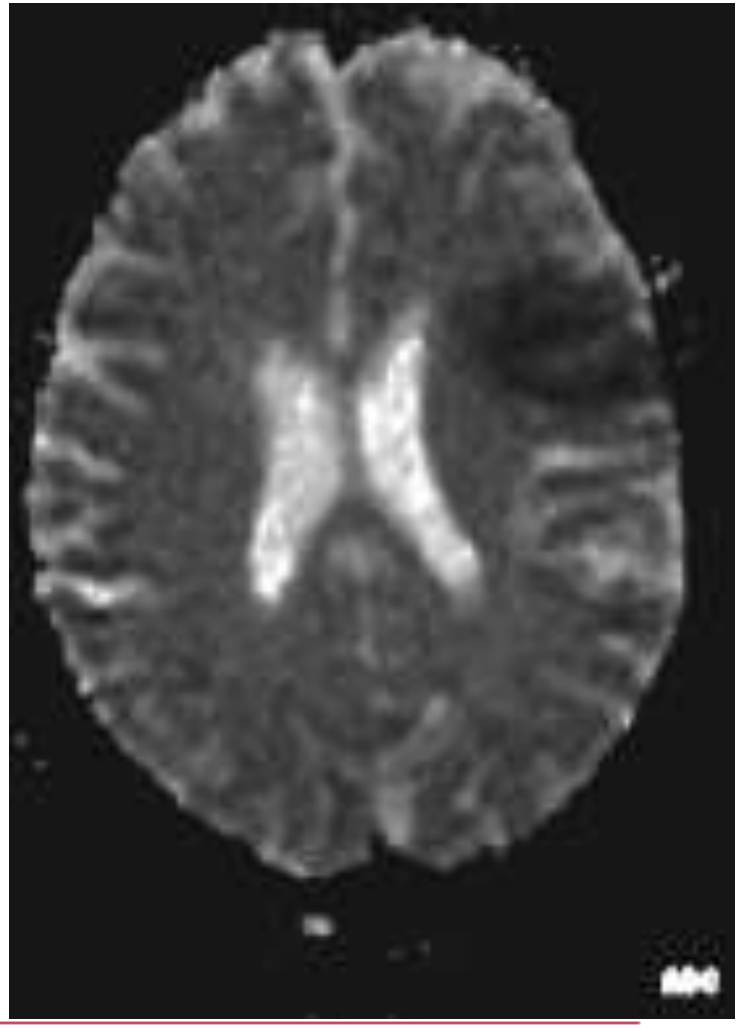
- ✓ **Look for: BRIGHT only**

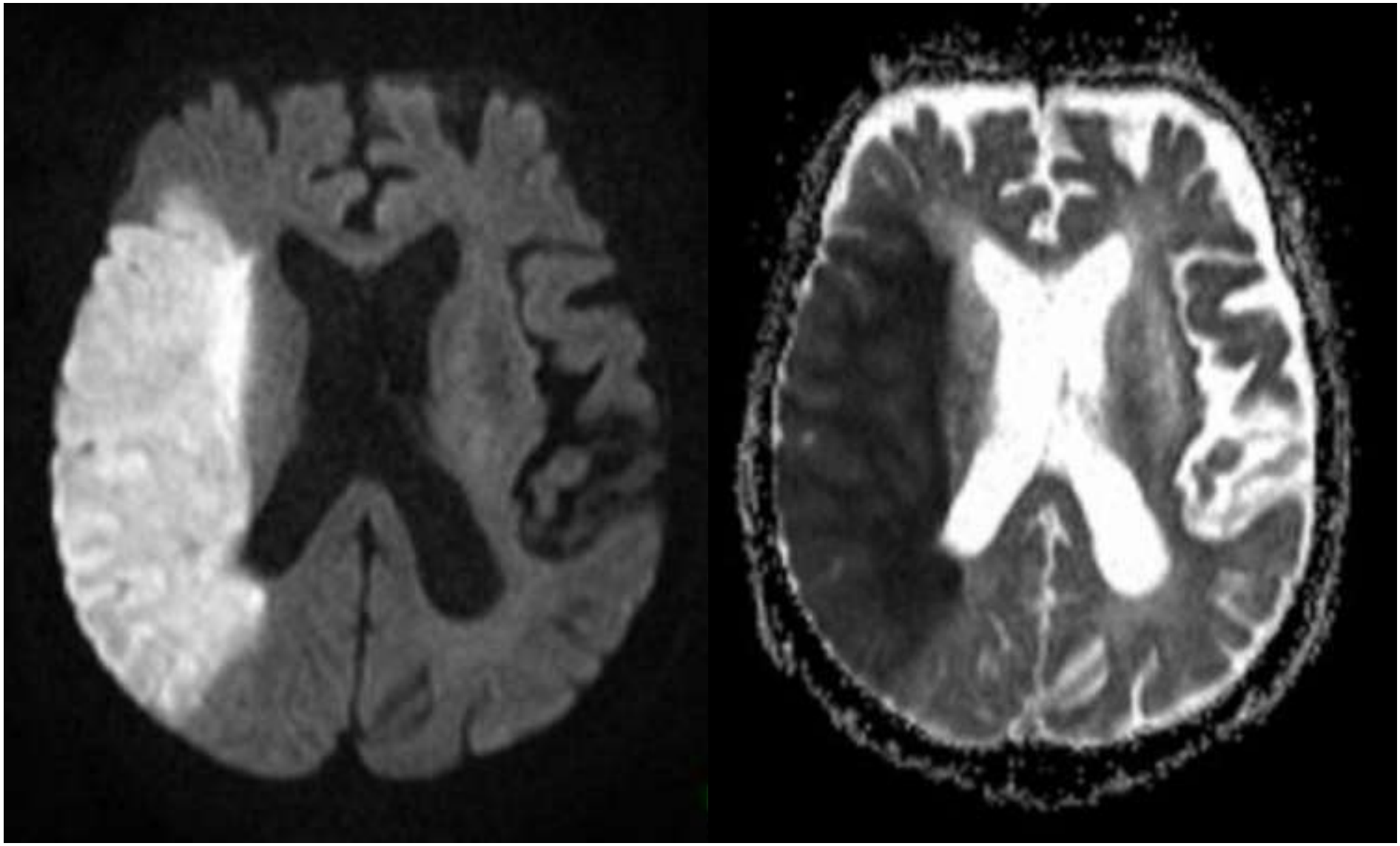
- ✓ **Restricted diffusion occurs in cytotoxic edema**:
  - Ischemia (possibly within minutes)
  - Abscess
  - **Not other structural lesions such as tumors vasogenic edema**



Apparent Diffusion Coefficient (ADC Map)

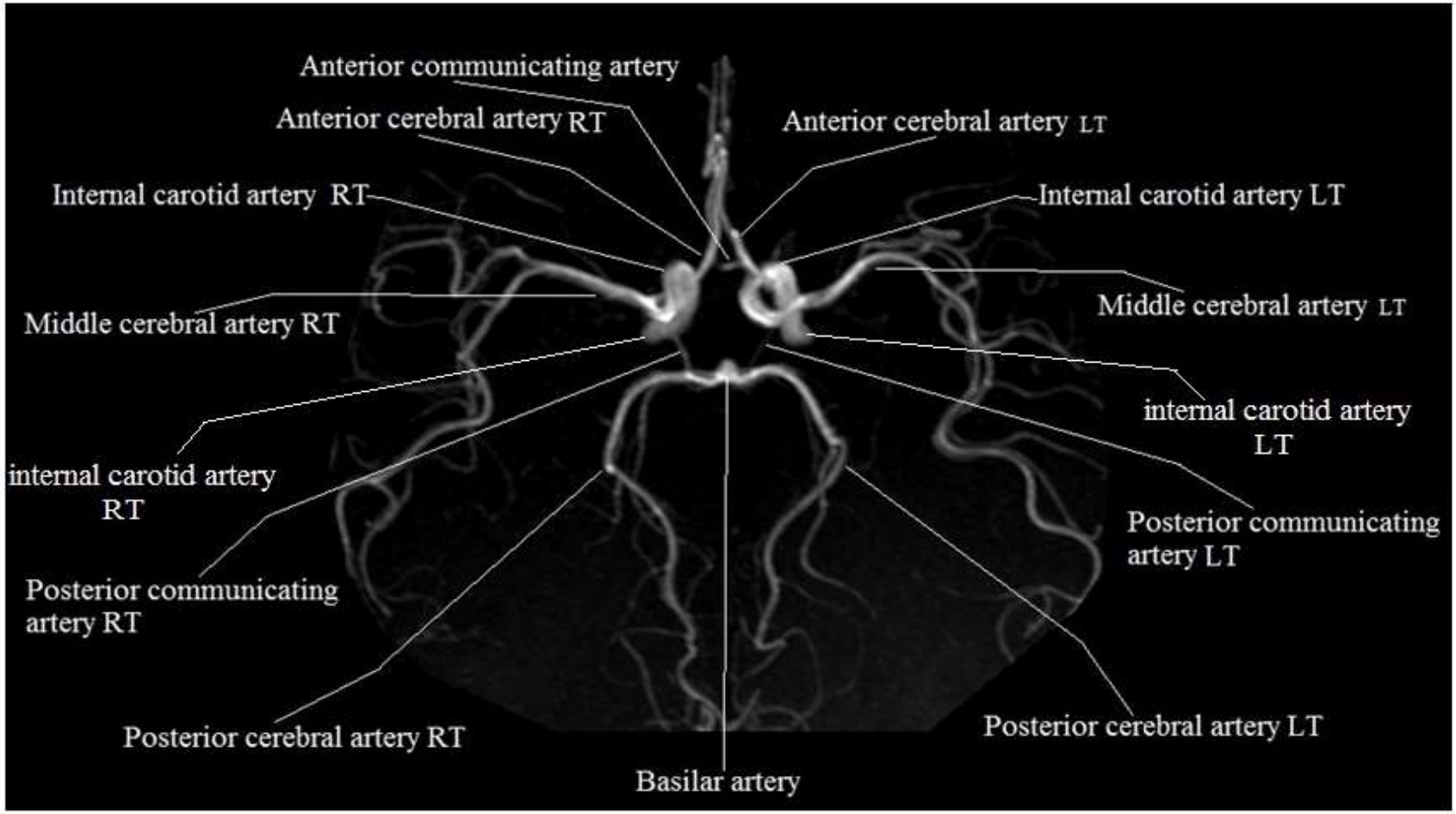
- ✓ Contains actual data relevant to diffusion image
- ✓ Areas of restricted diffusion **are *dark***
- ✓ **Useful for:**
  - Excluding T2-shine through
  - **Real restricted diffusion is bright on DWI, dark on ADC**
- ✓ **Look for: DARK only**
- ✓ **Recognition**
  - looks like T2 with no skull and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





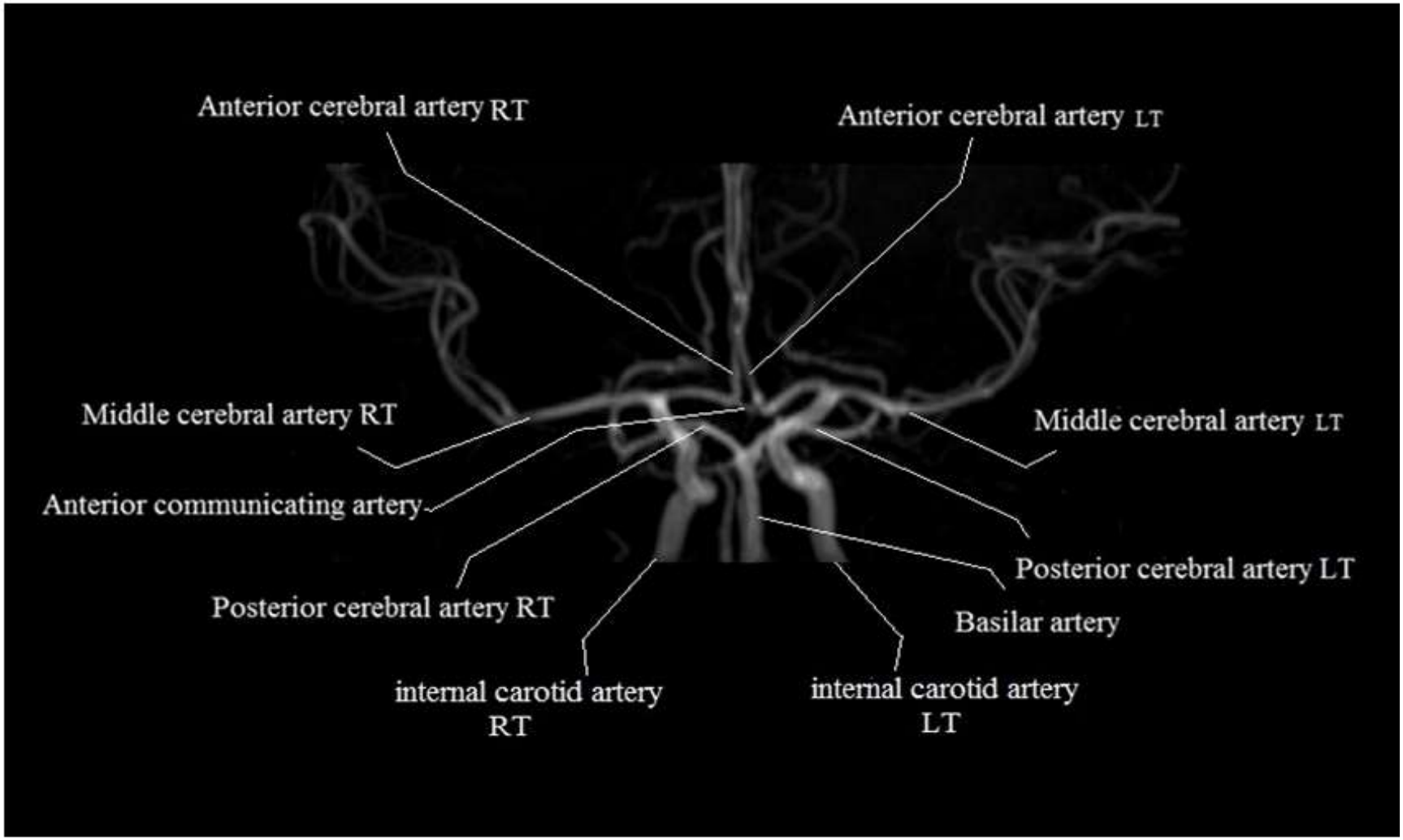
MR Angiography

Axial arterial anatomy of brain



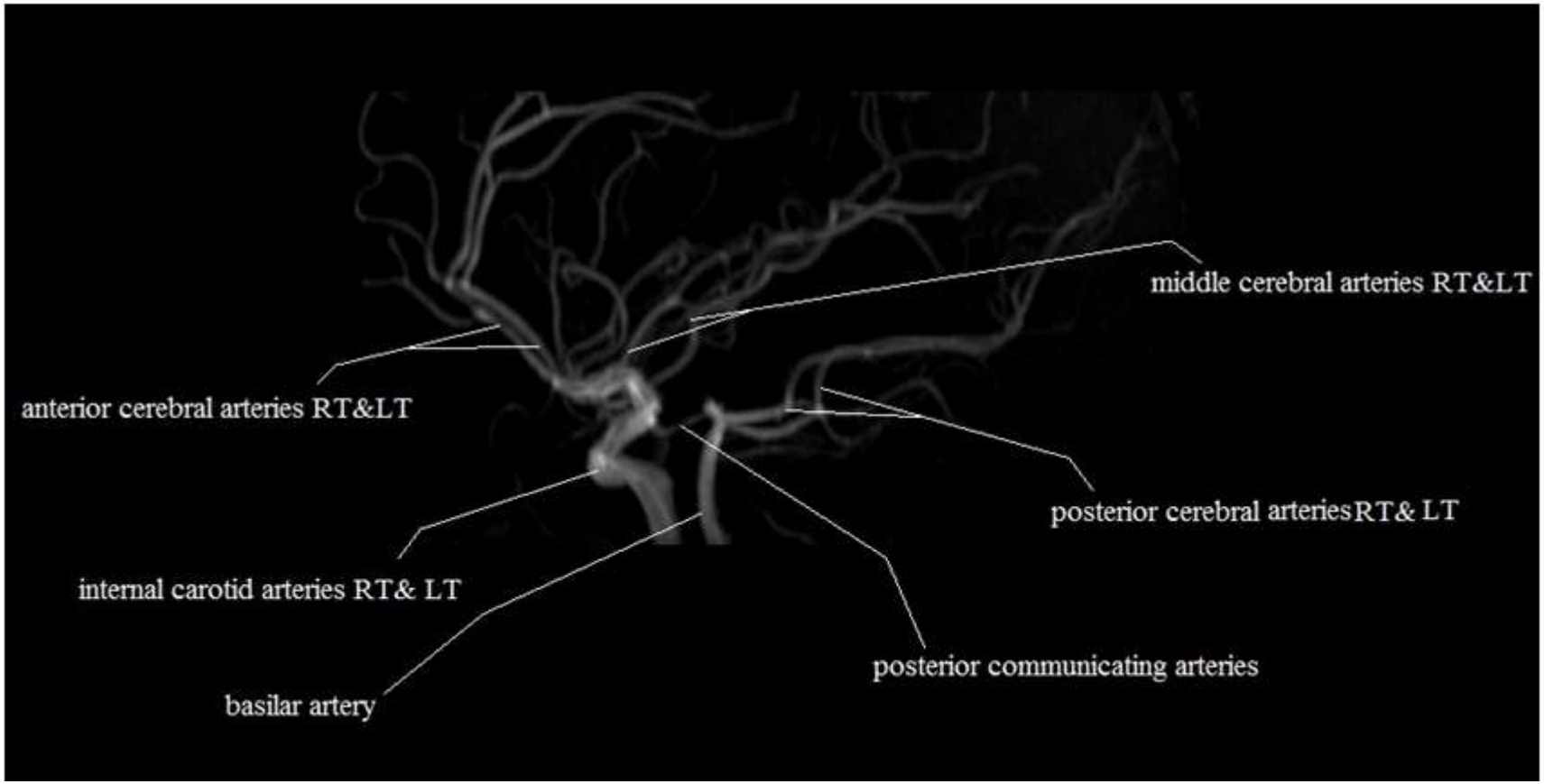
MR Angiography

Coronal arterial anatomy of brain

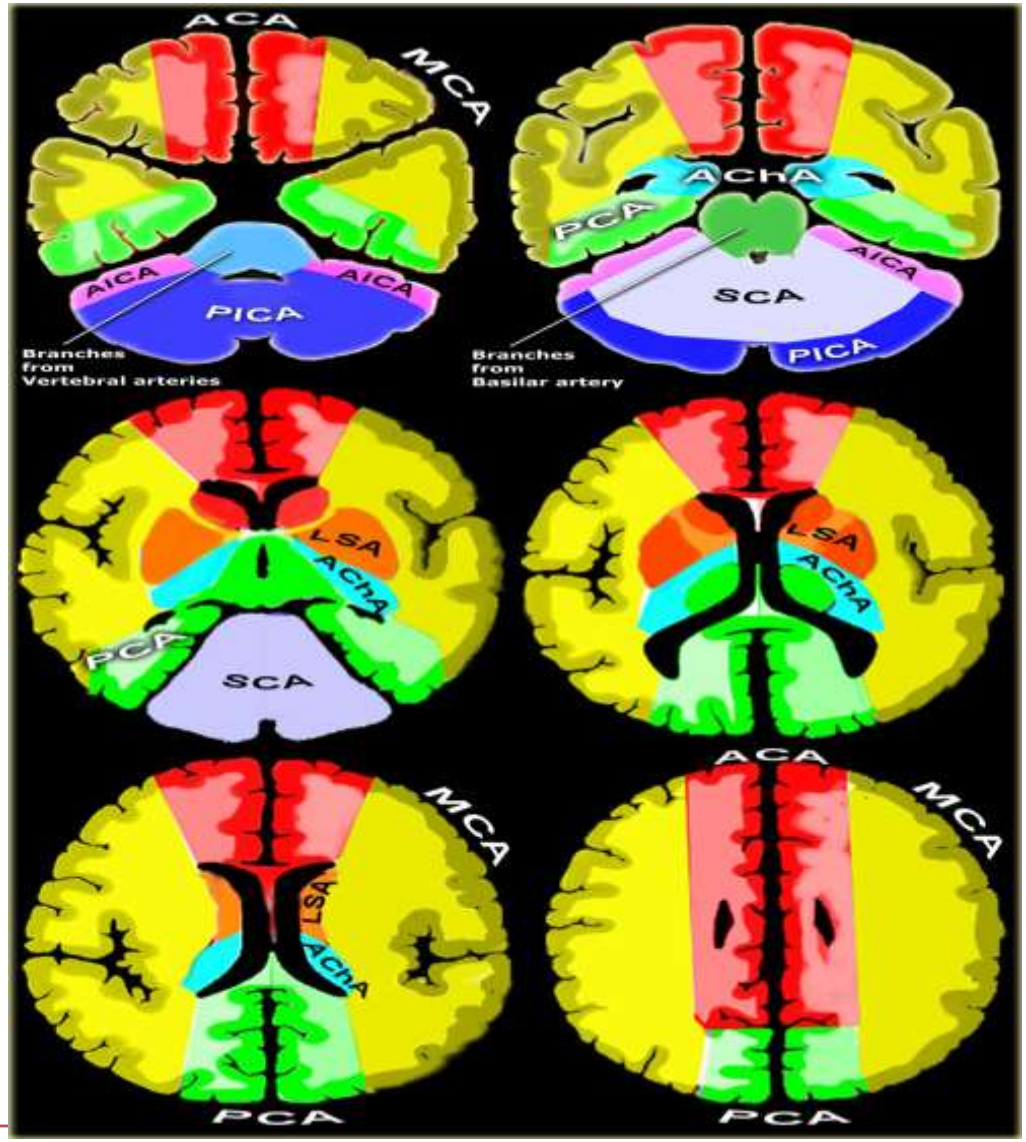


MR Angiography

sagittal arterial anatomy of brain



Brain Vascular territories

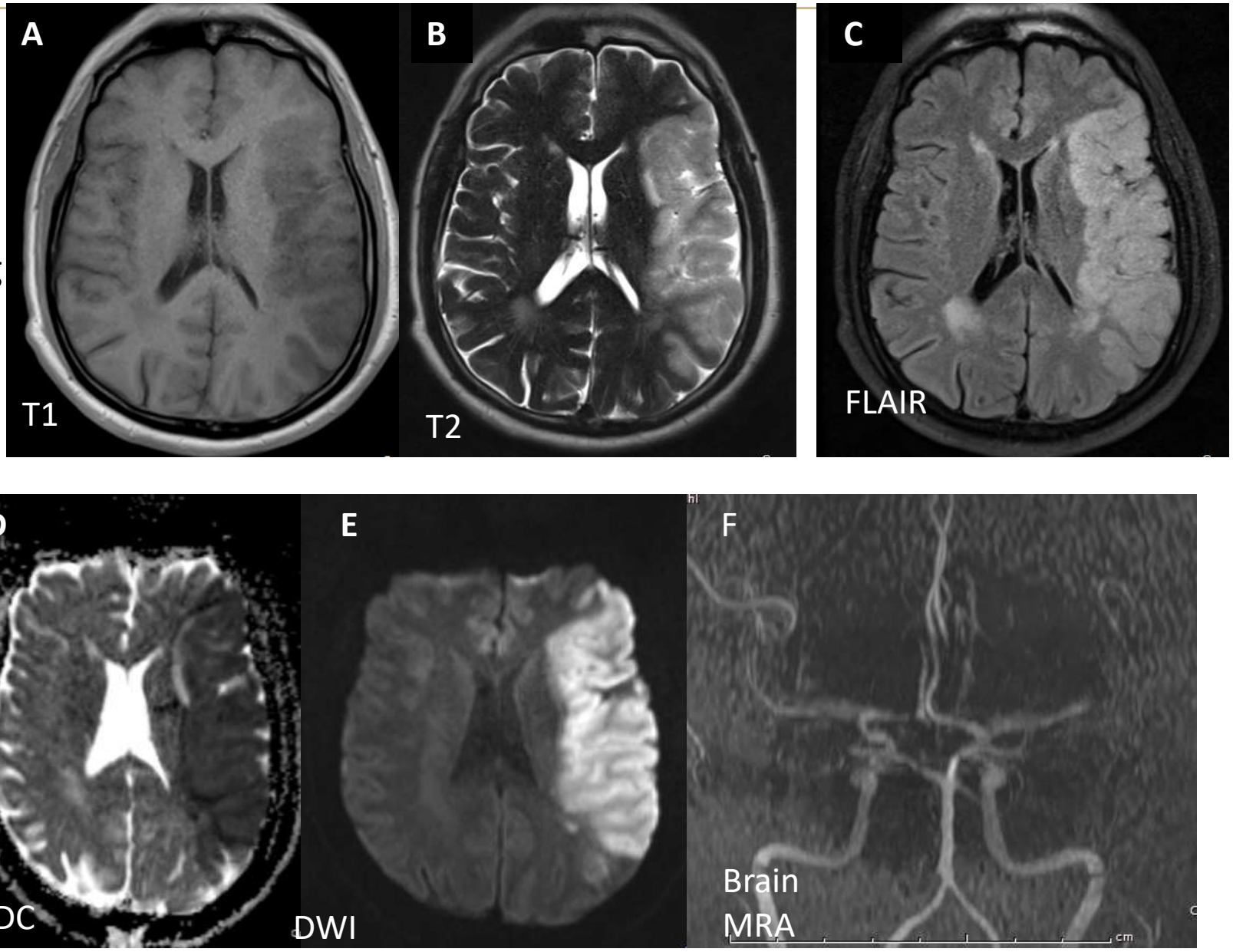


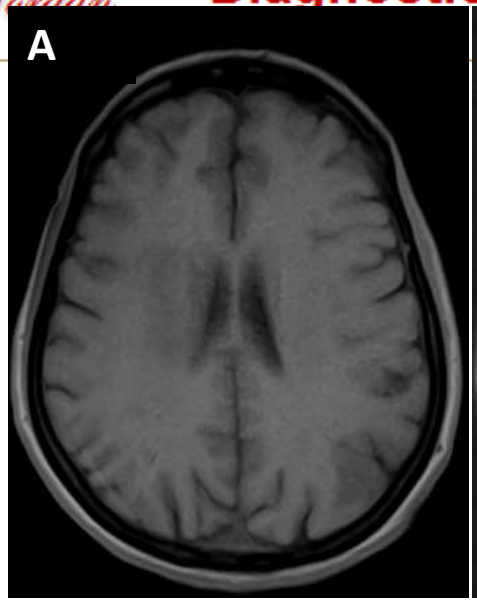
Brain pathology examples

Cerebral ischaemia

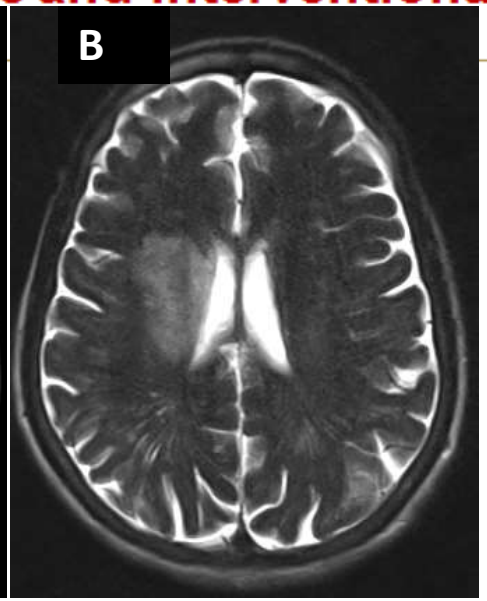
- Diffusion weighted imaging is the main diagnostic sequence in acute infarctions.
- Abnormal signal intensity of both white and grey matter in a VASCULAR TERRITORY.
- Diagnosis and assessment after intervention (thrombolysis).
- MRA

58 year old male patient is complaining of right sided weakness

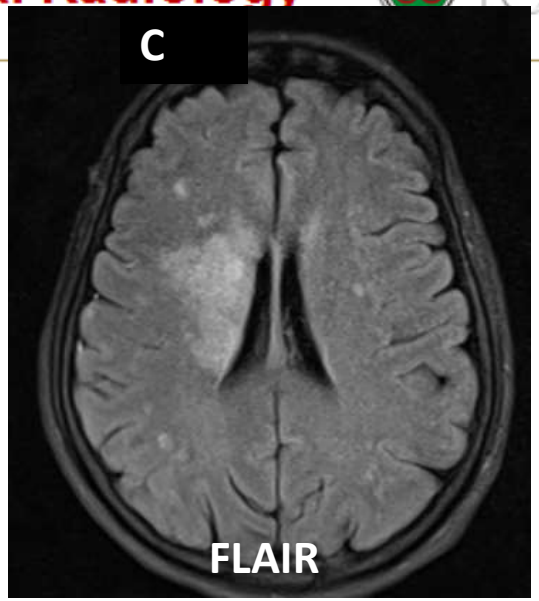




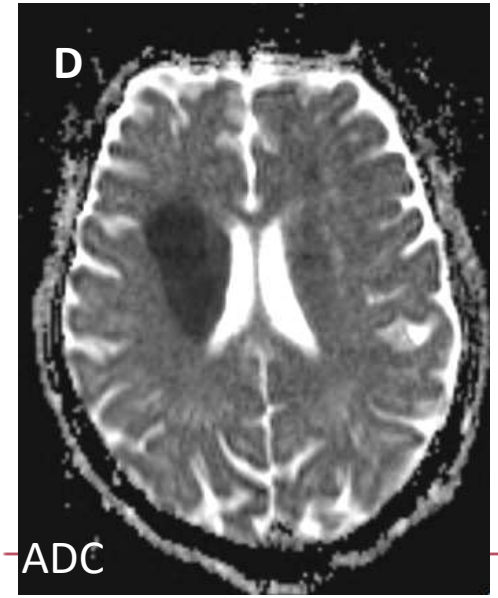
T1

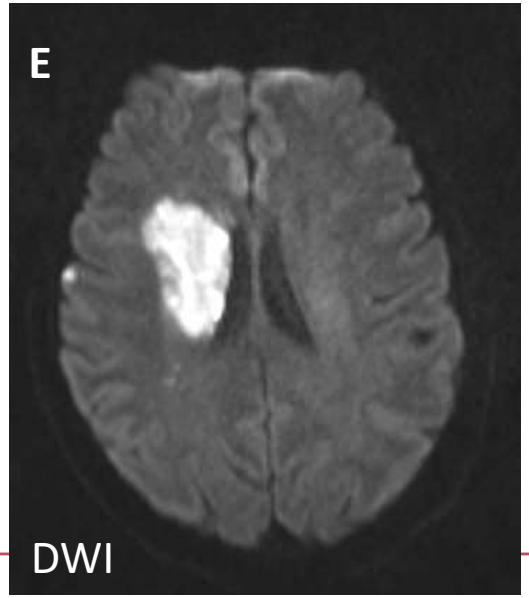


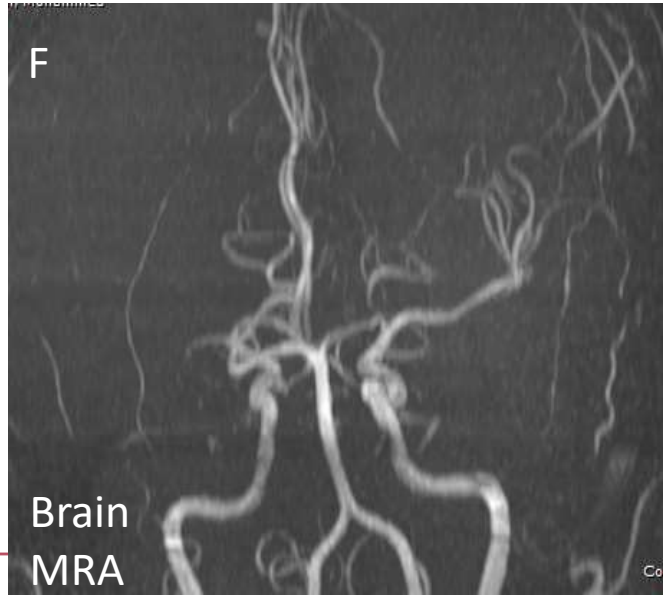
T2

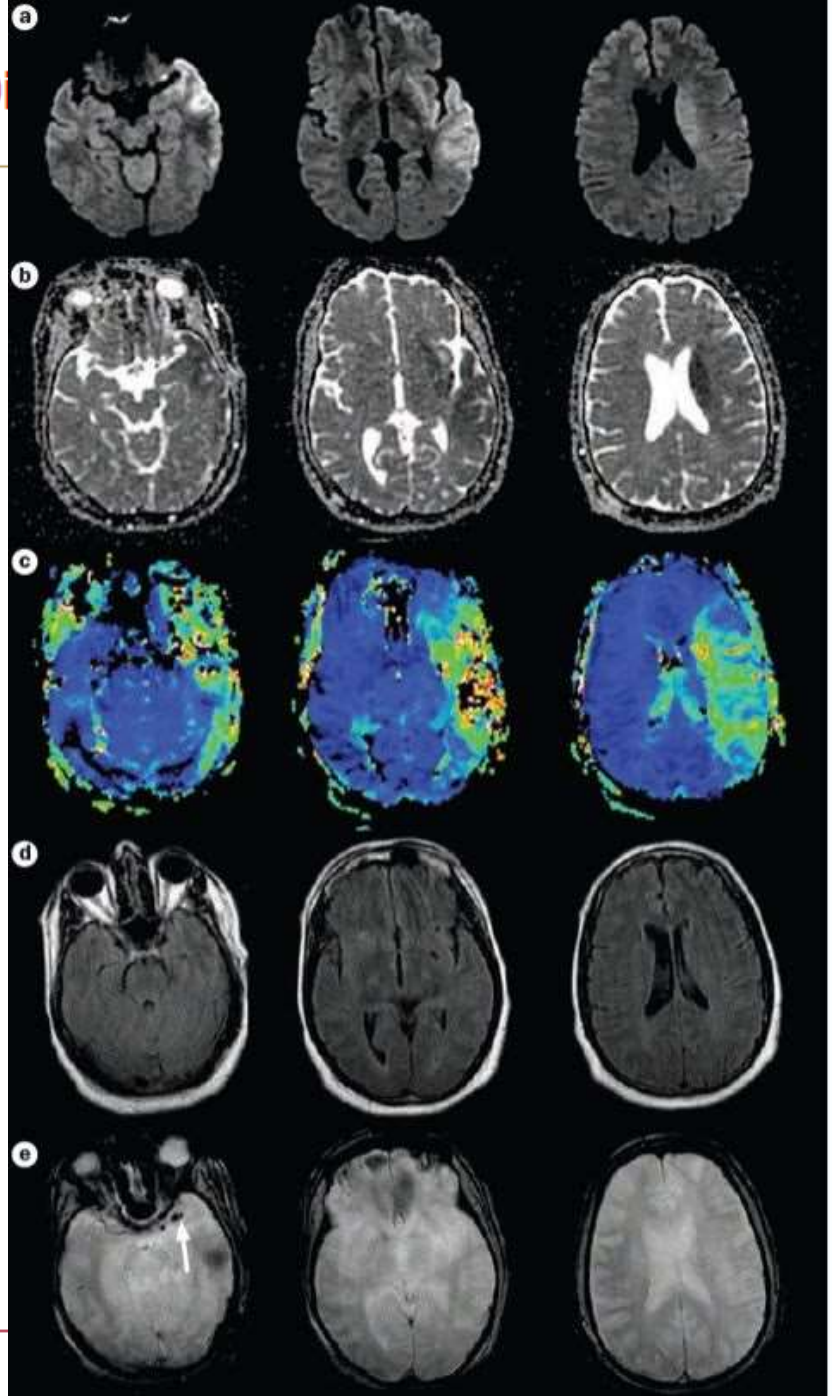


56 year old male patient is complaining of headache





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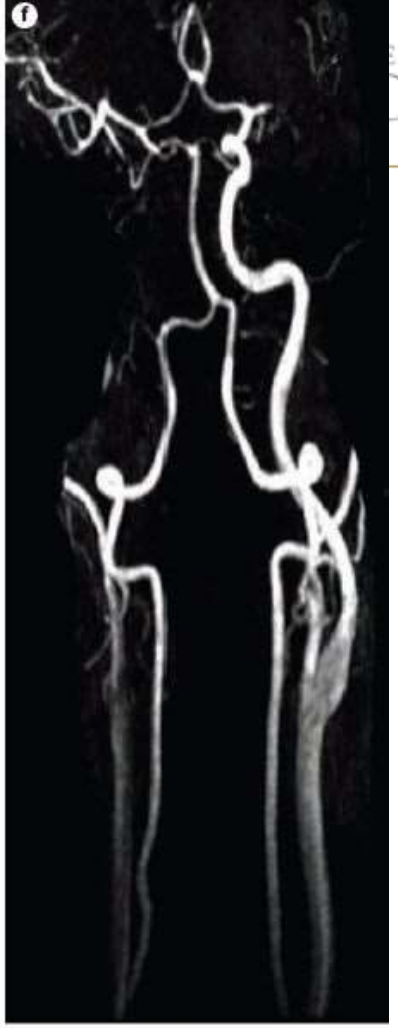
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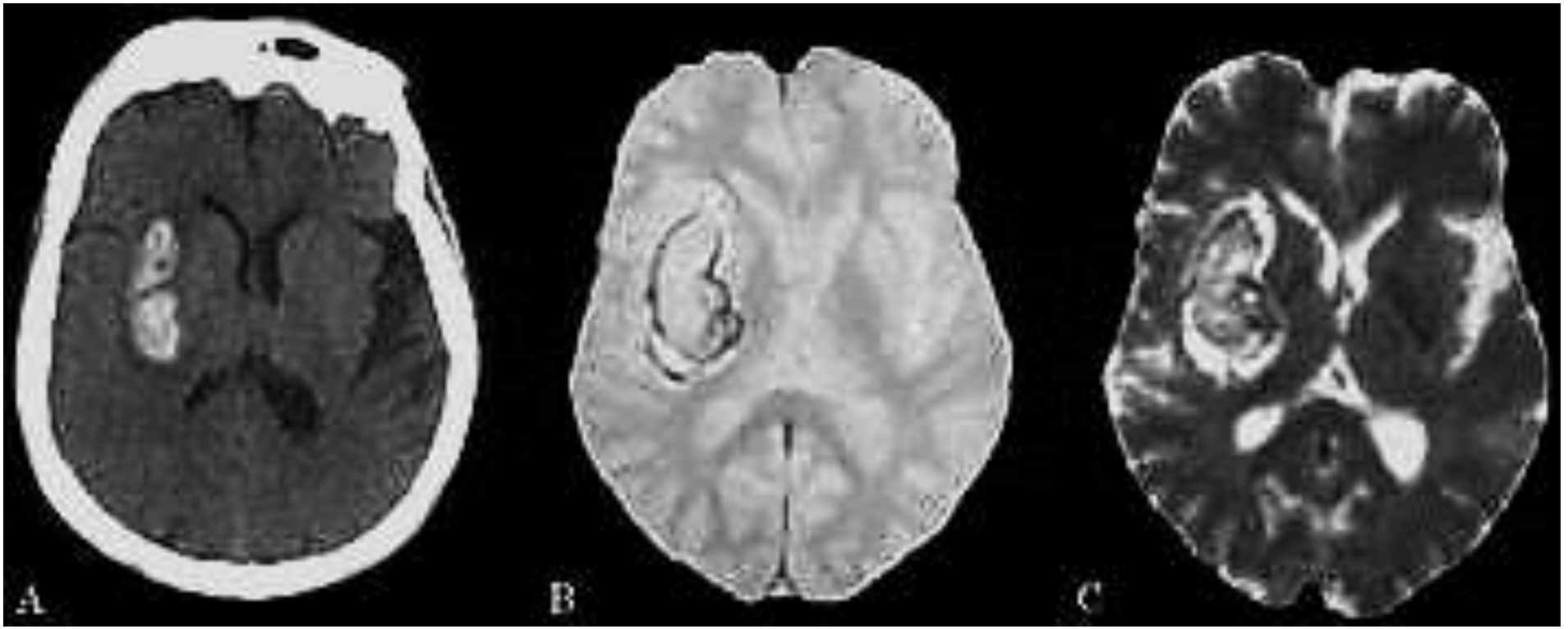
Intracranial Hemorrhage

- 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.


A
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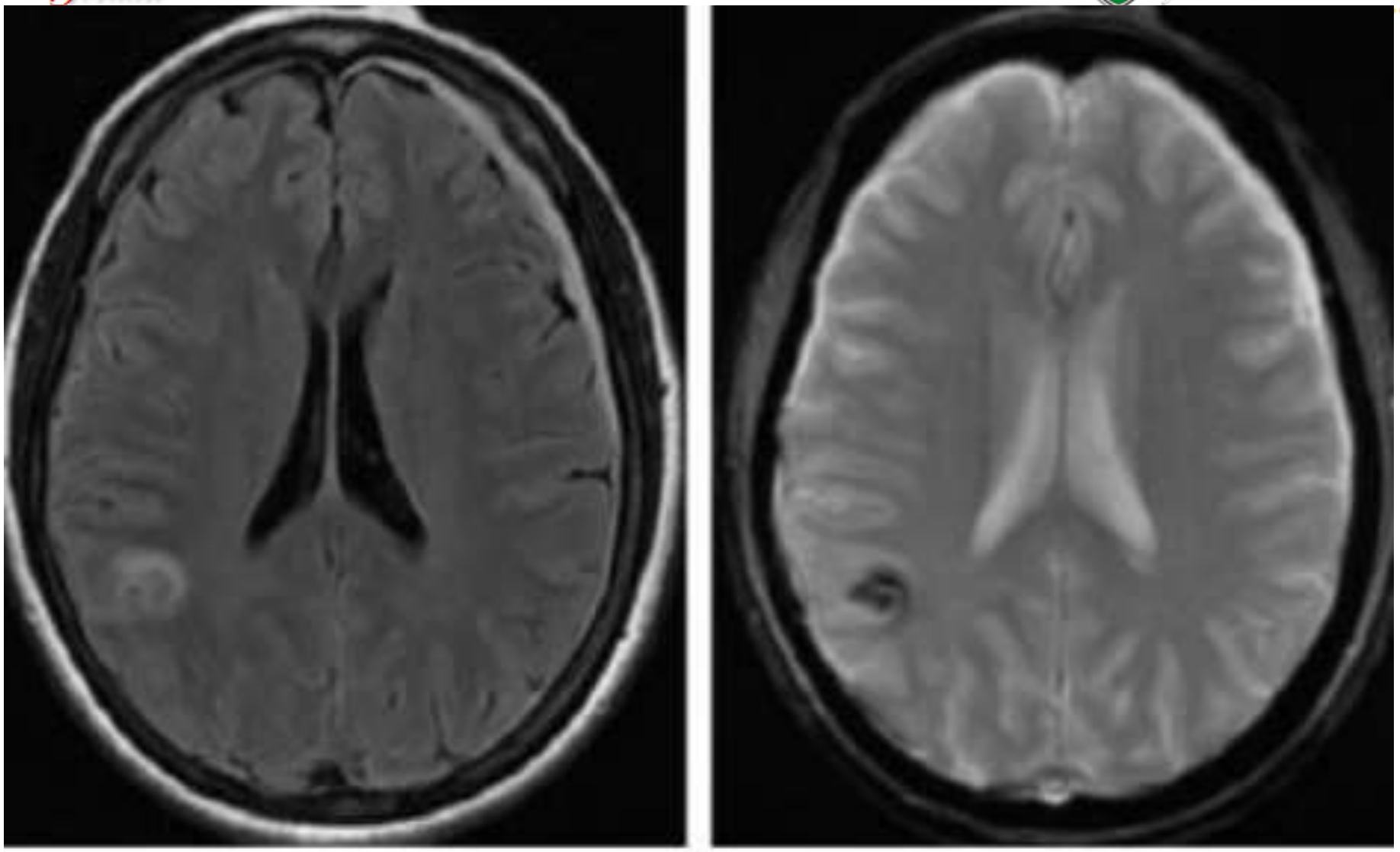



Enlarged pituitary

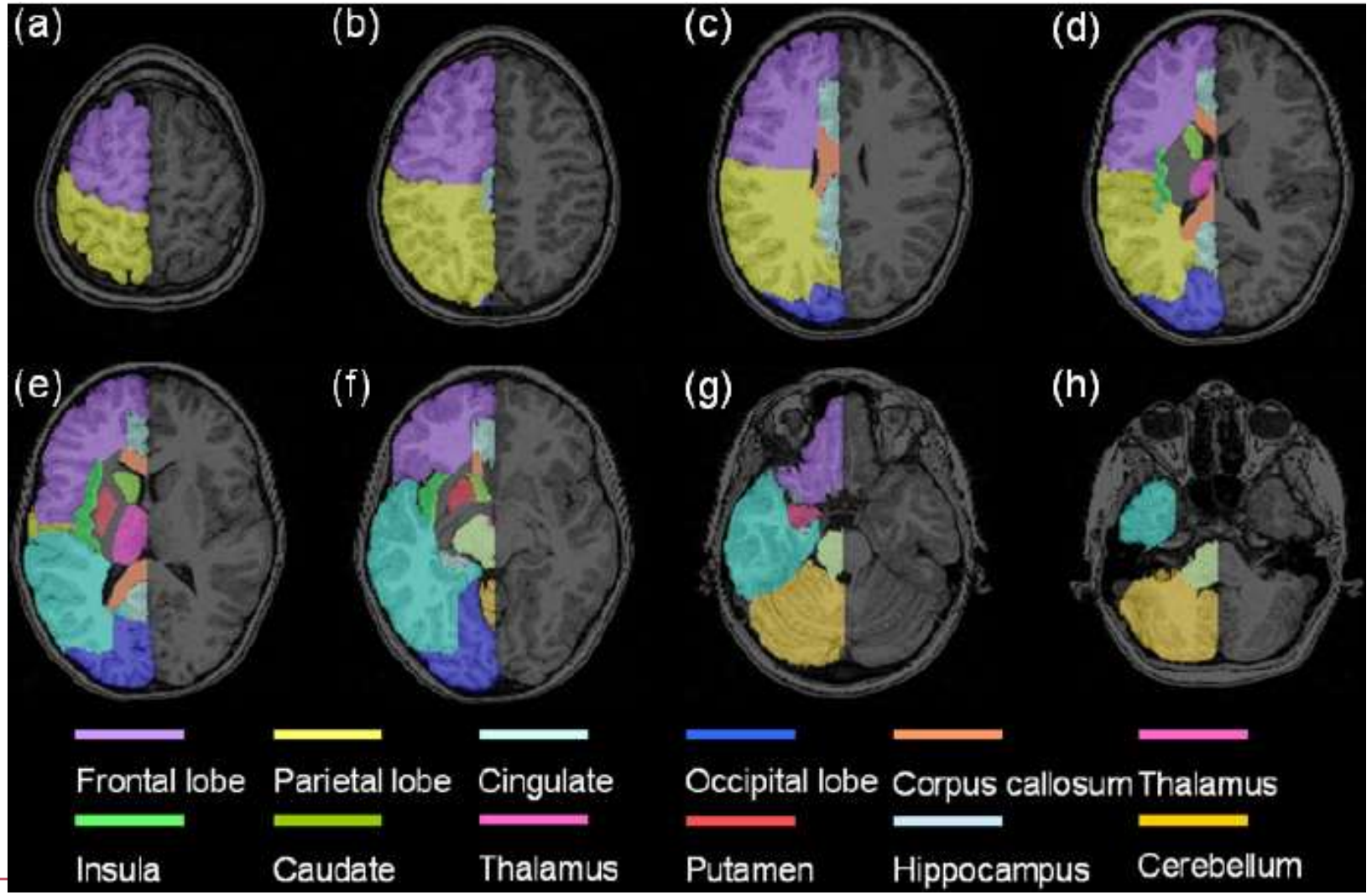
TUMOURS

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

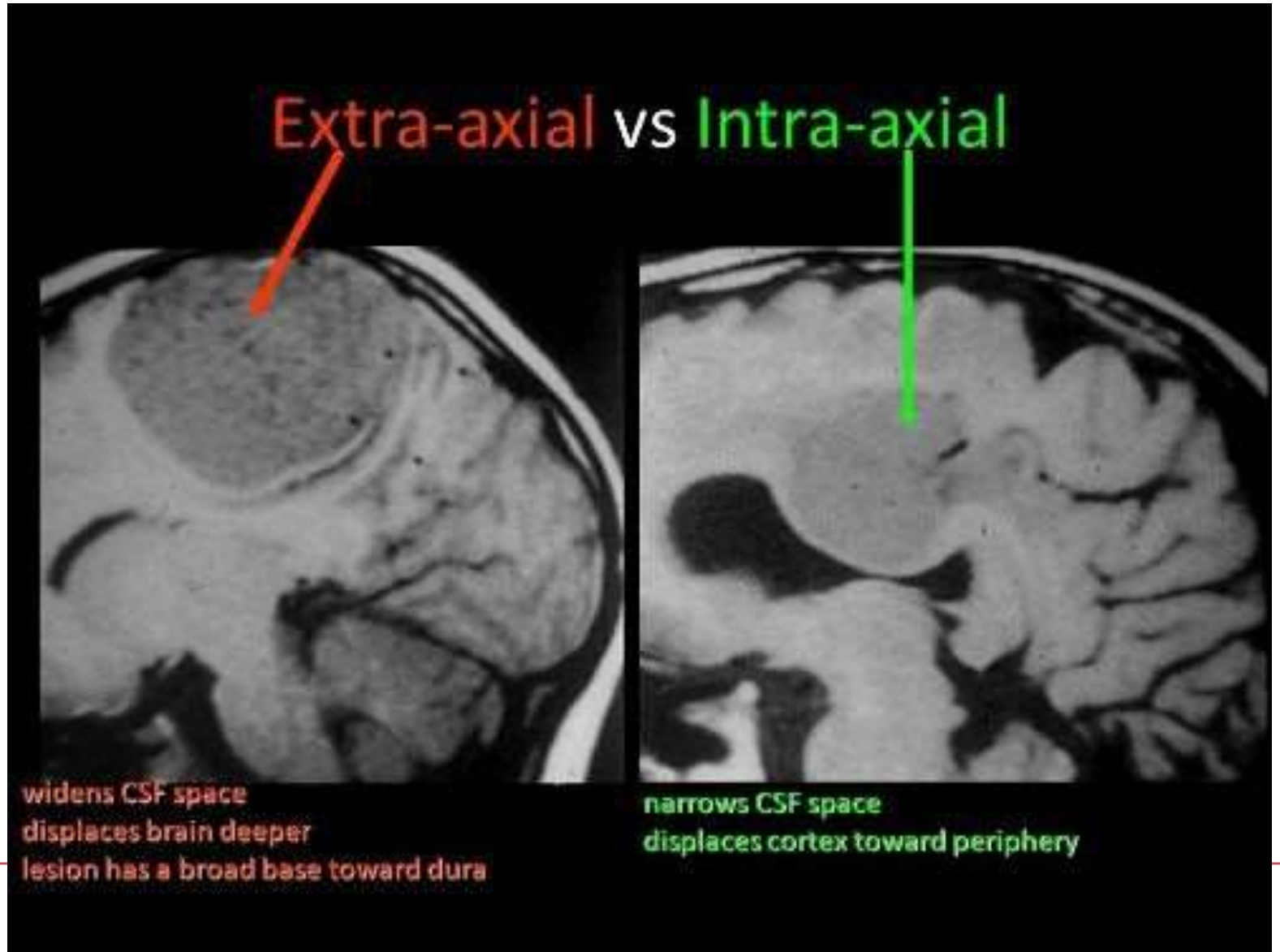
Analysis of a Potential Brain Tumor

- 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 ?

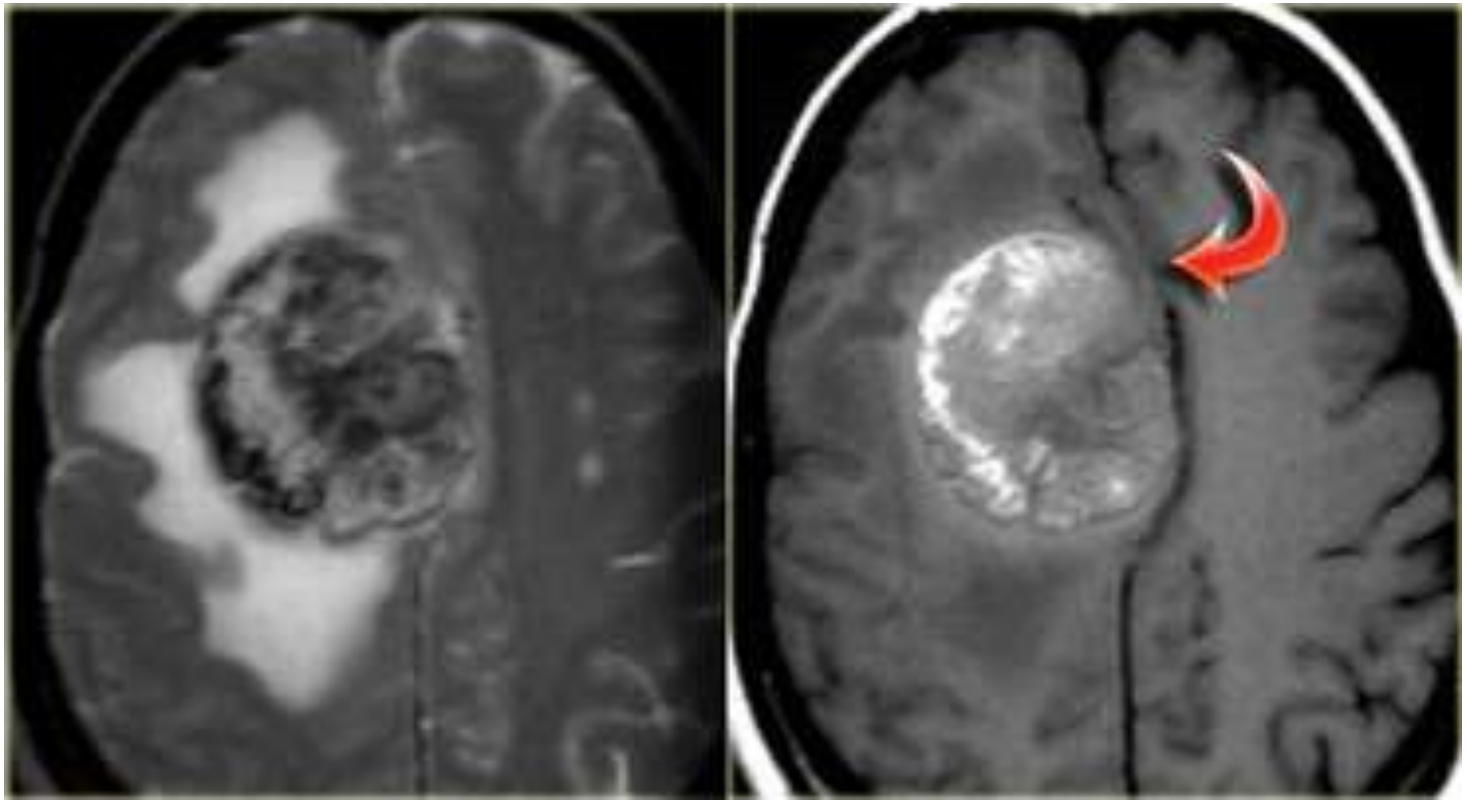
Localisation



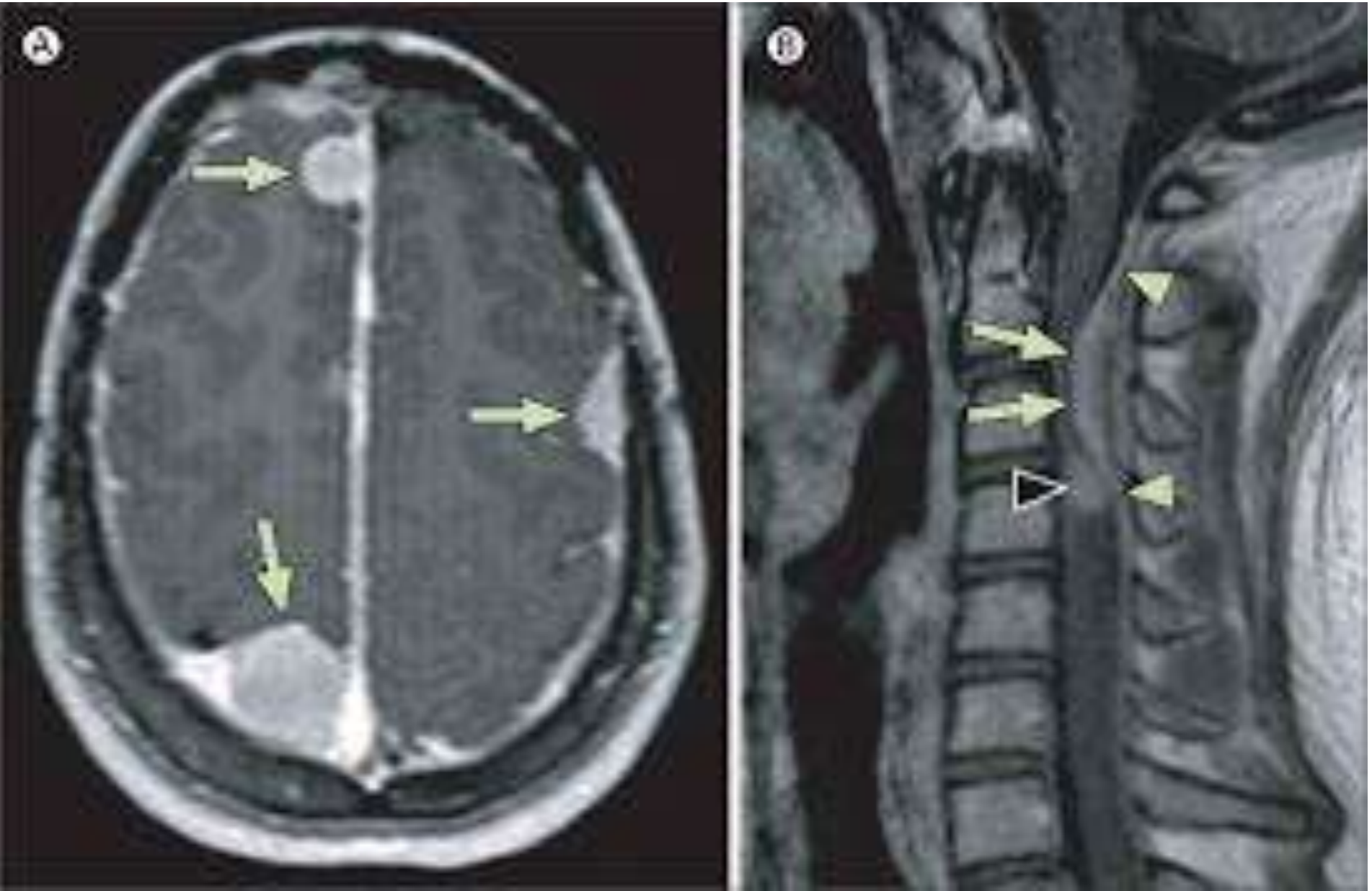
Extraaxial vs Intraaxial



Melanoma




A1 1
P1 1


A
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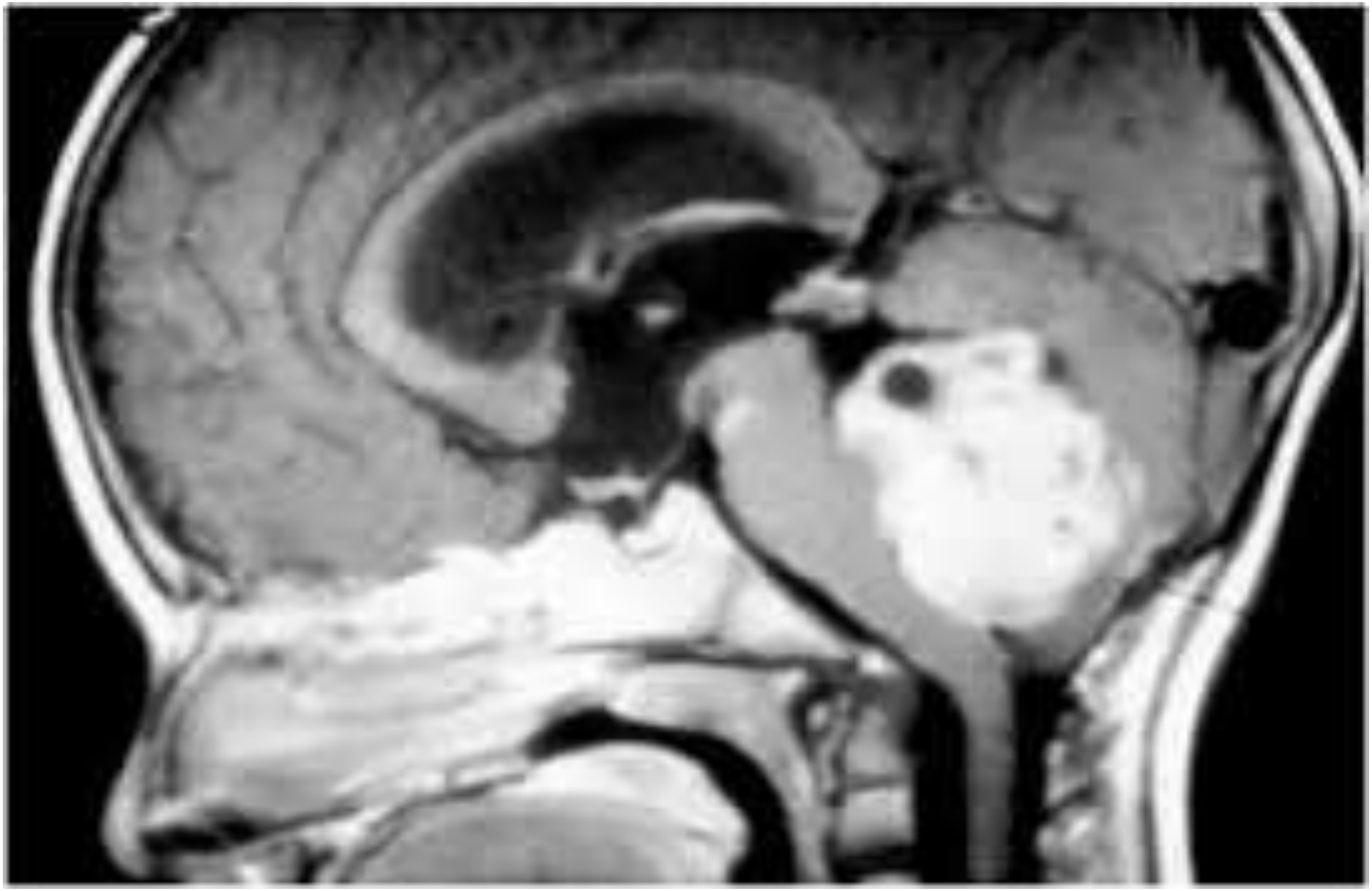


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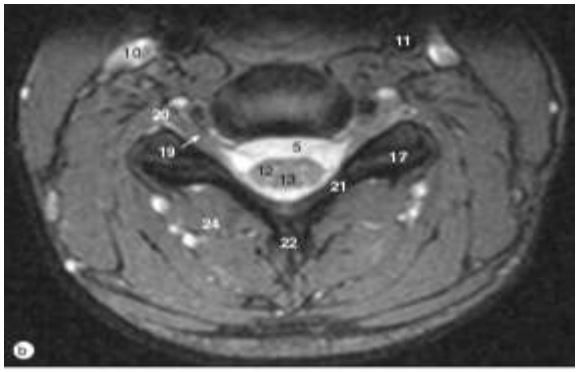
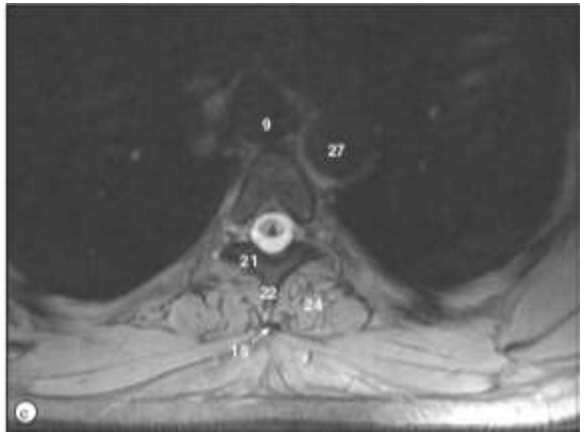
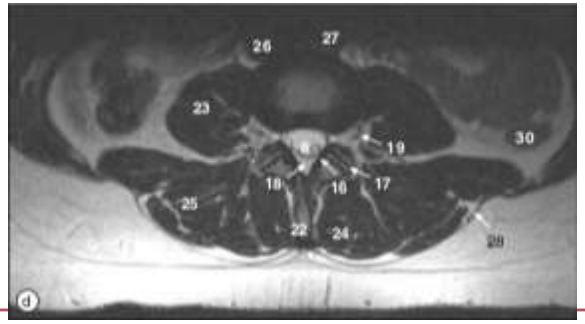
SPINE



CERVICAL



THORACIC



LUMBAR

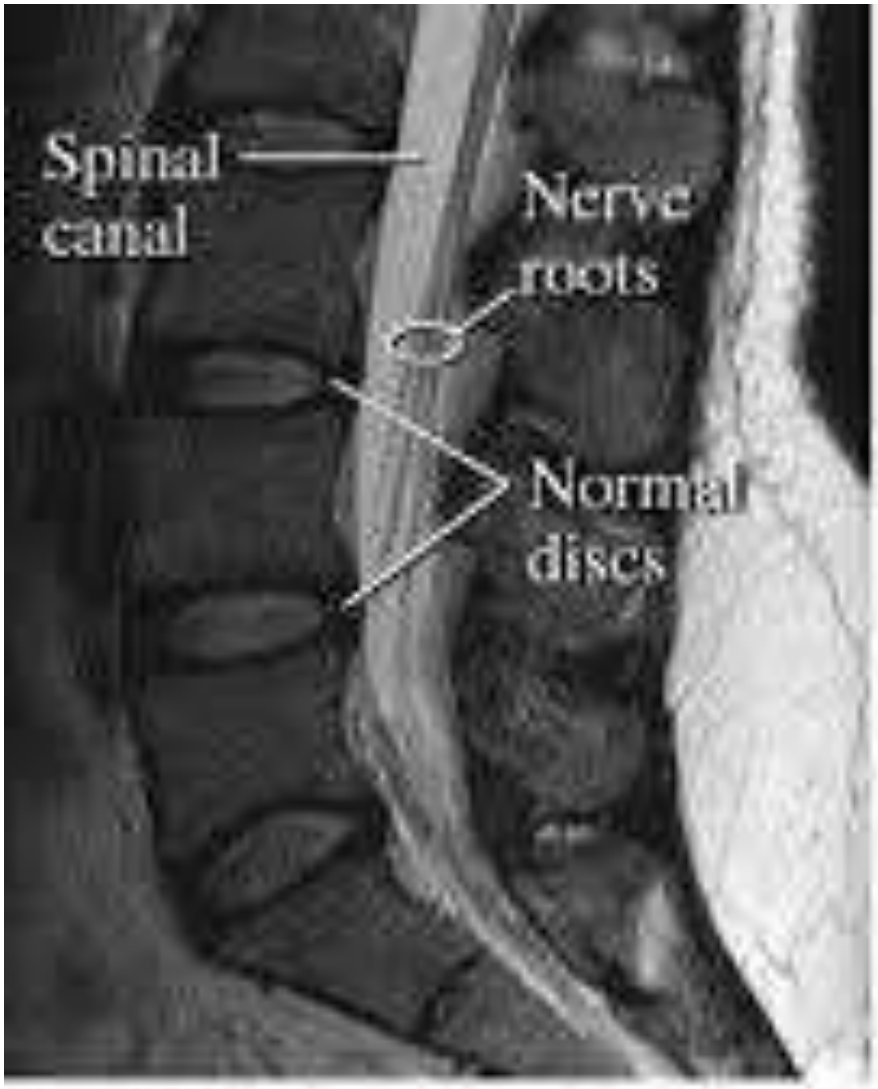


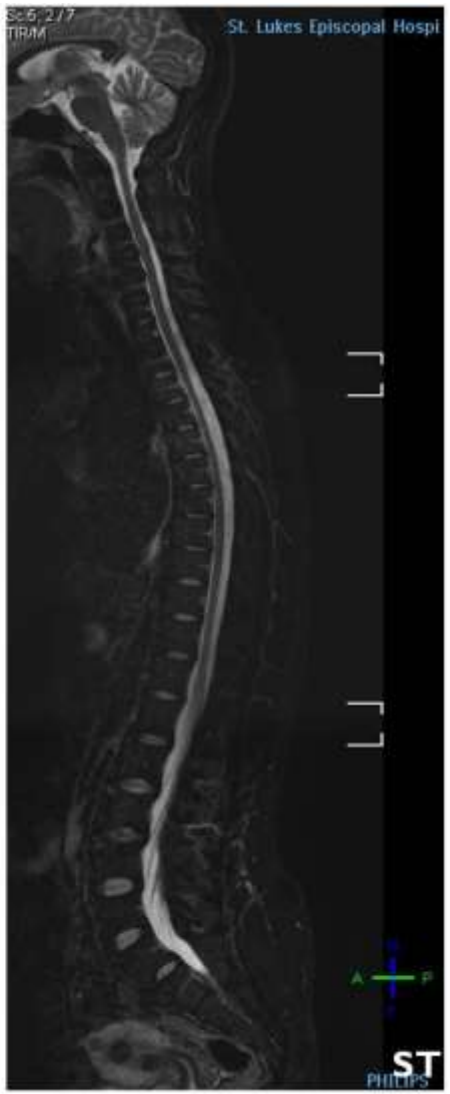
Figure 1

Figure 2

Sequences


Sc 4, 2 / 6
TSE/M
St. Lukes Episcopal Hospi
PHILIPS


Sc 3, 2 / 6
TSE/M
St. Lukes Episcopal Hospi


Sc 6, 2 / 7
TIR/M
St. Lukes Episcopal Hospi
ST
PHILIPS

Spine MRI

Disc pathology


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


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


Page: 9 of 12
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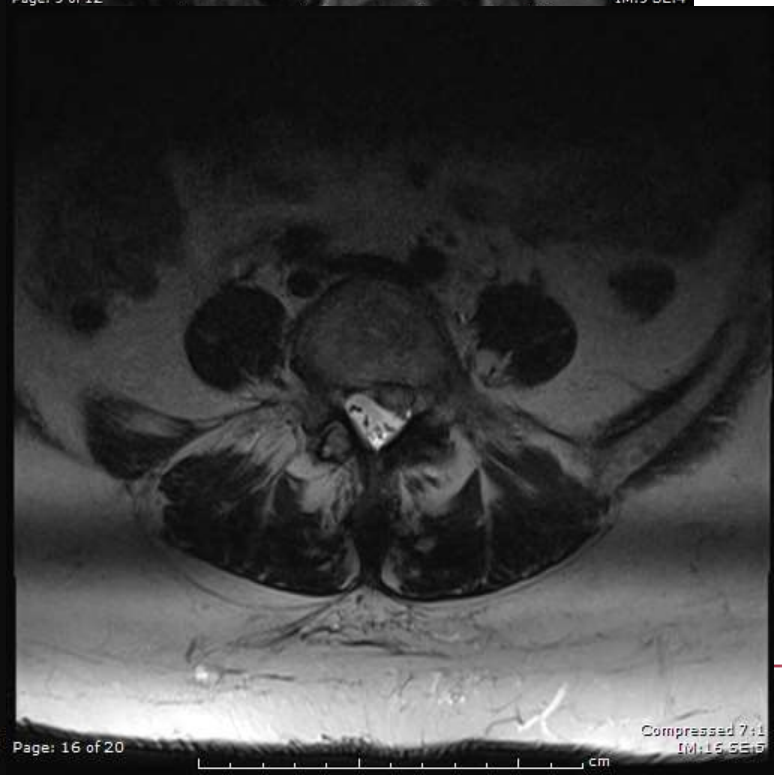
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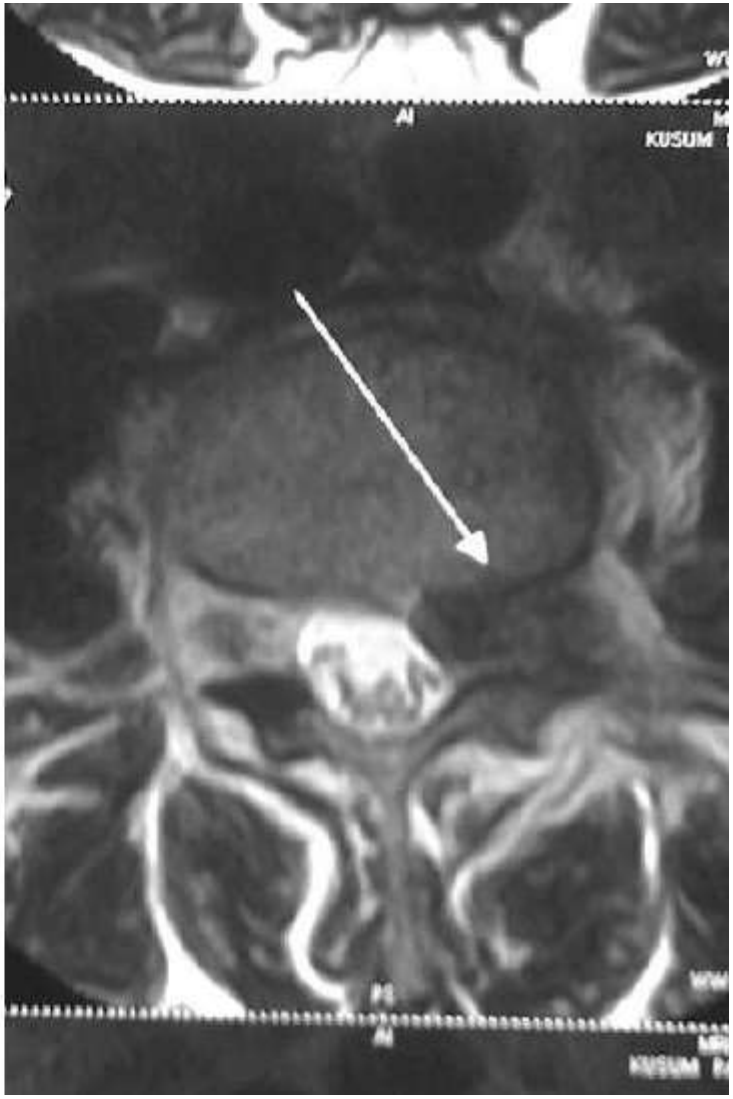
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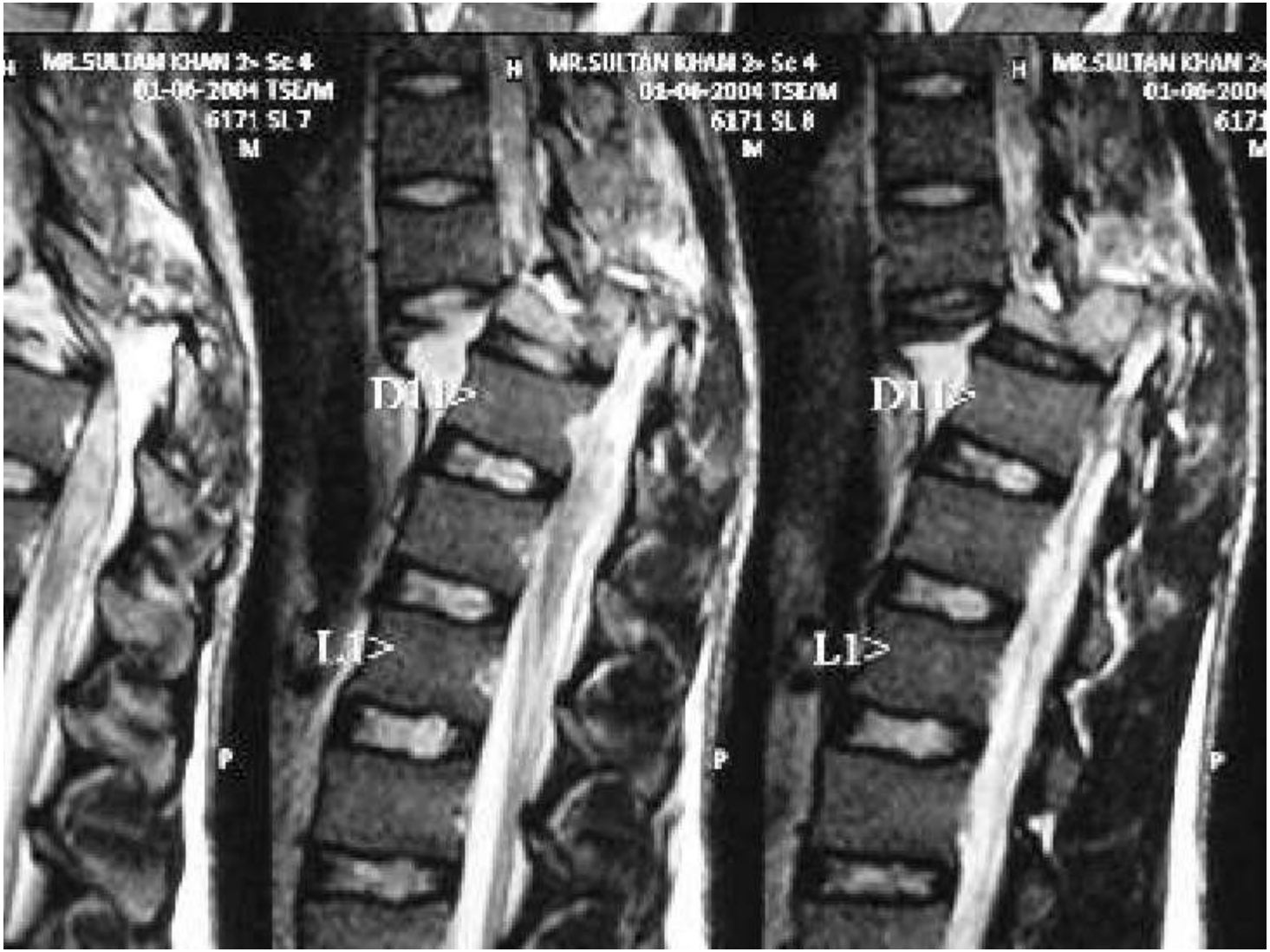
Spine MRI

fractures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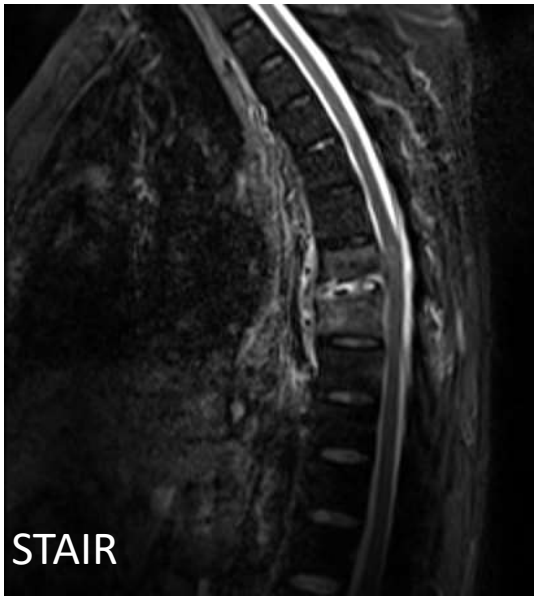
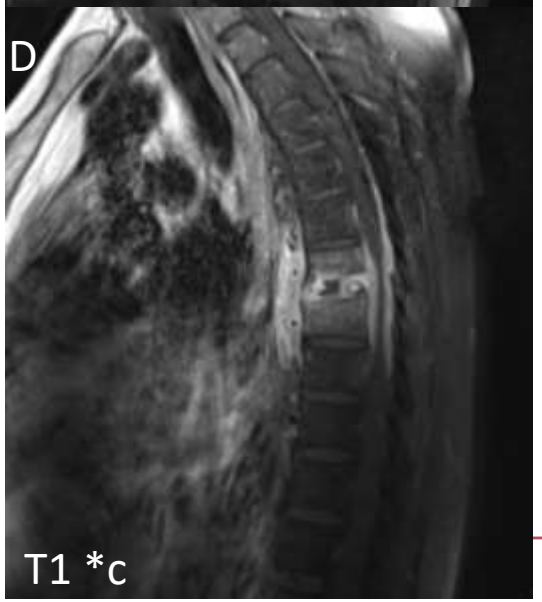
Spine MRI

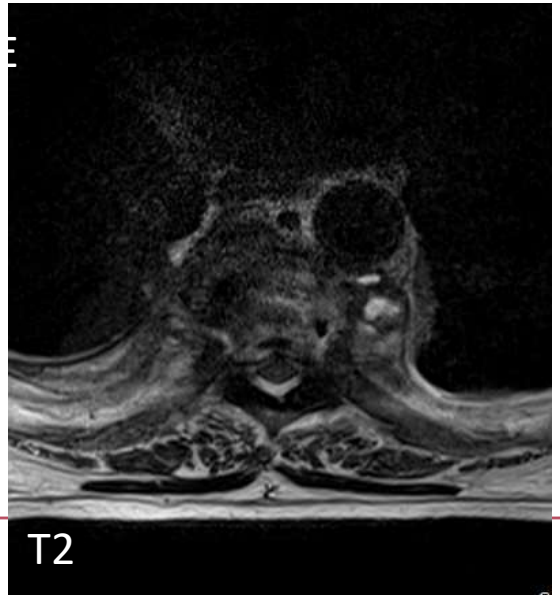
Infection

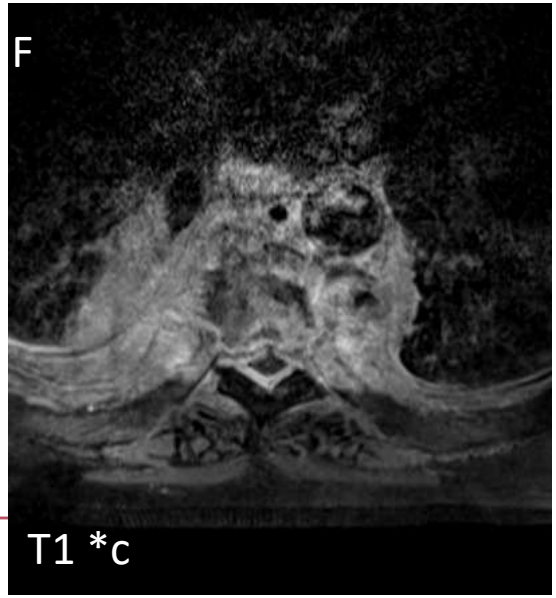

A
T1


B
T2


STAIR


D
T1 *c


E
T2


F
T1 *c

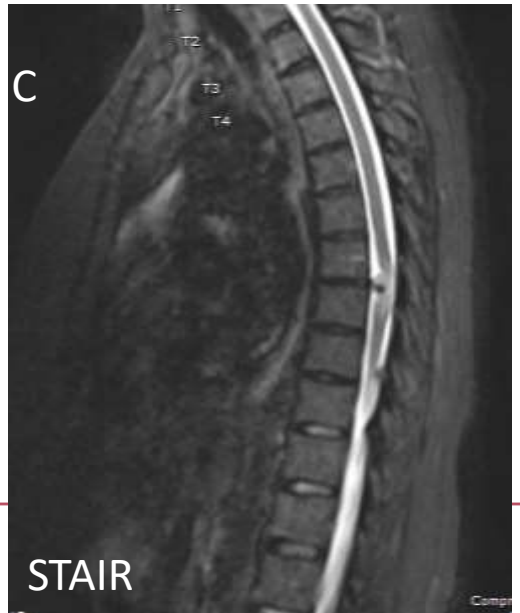
Diagnostic and Interventional Radiology

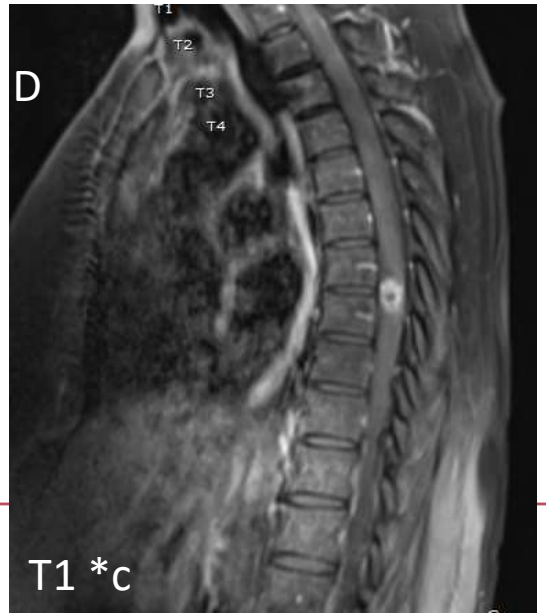
Spine MRI

Spine tumors

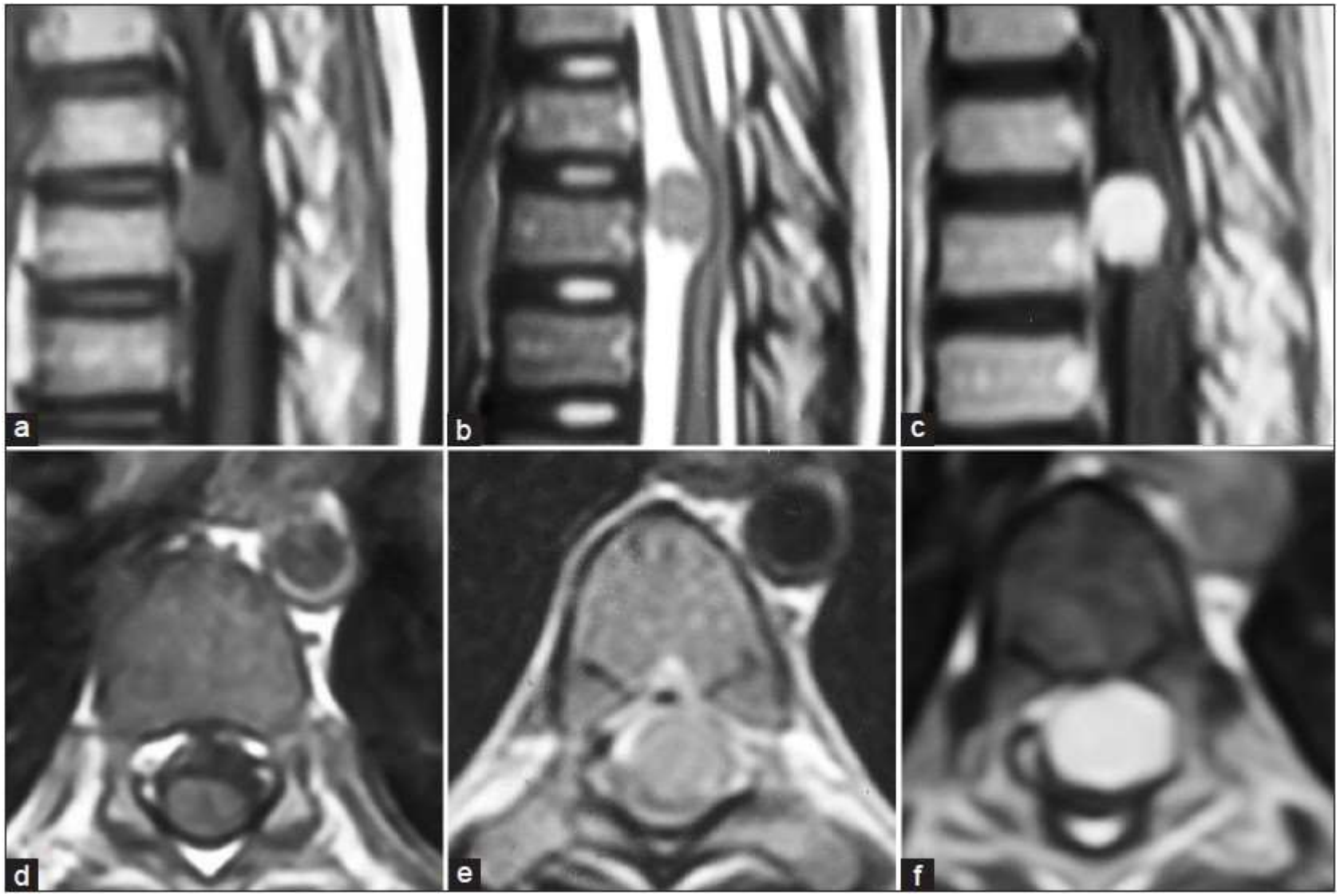

A
T2
T3
T4
T1

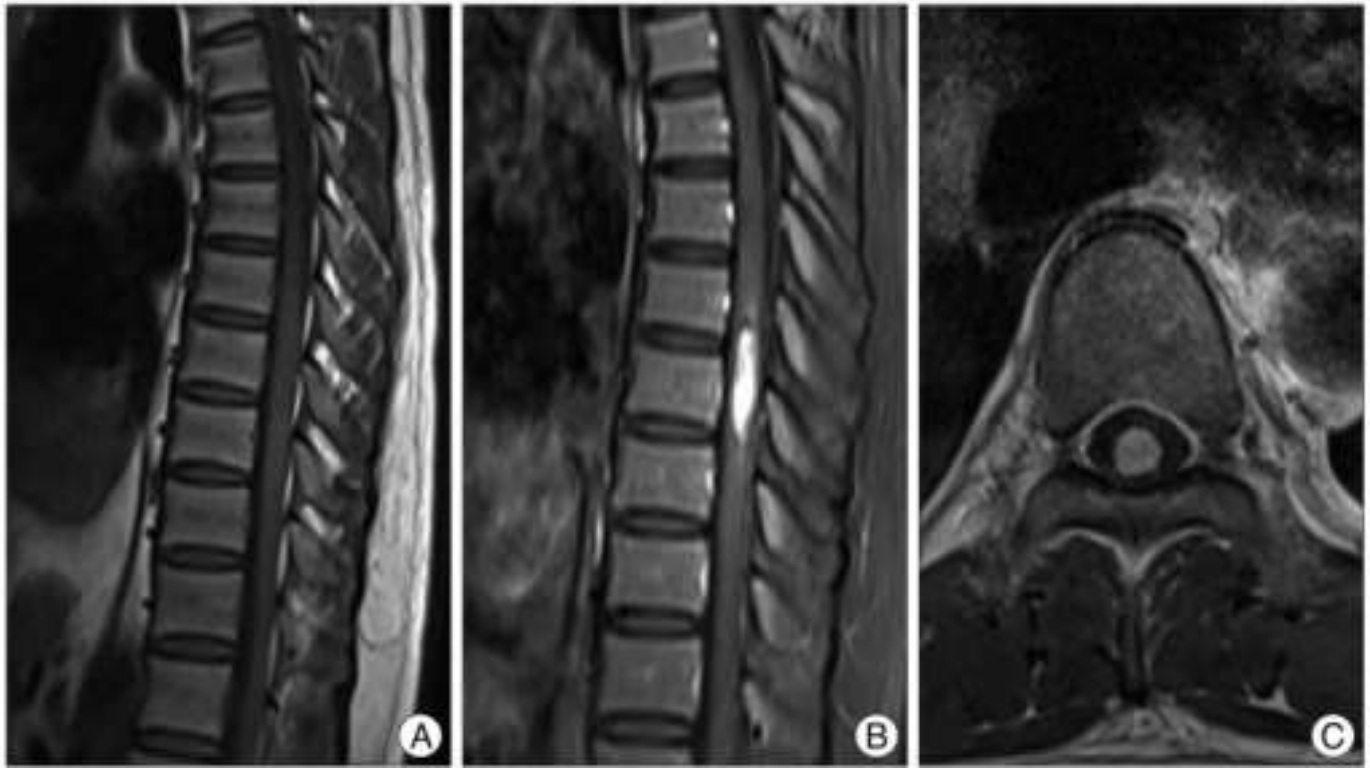

B
T2
T3
T4
T2

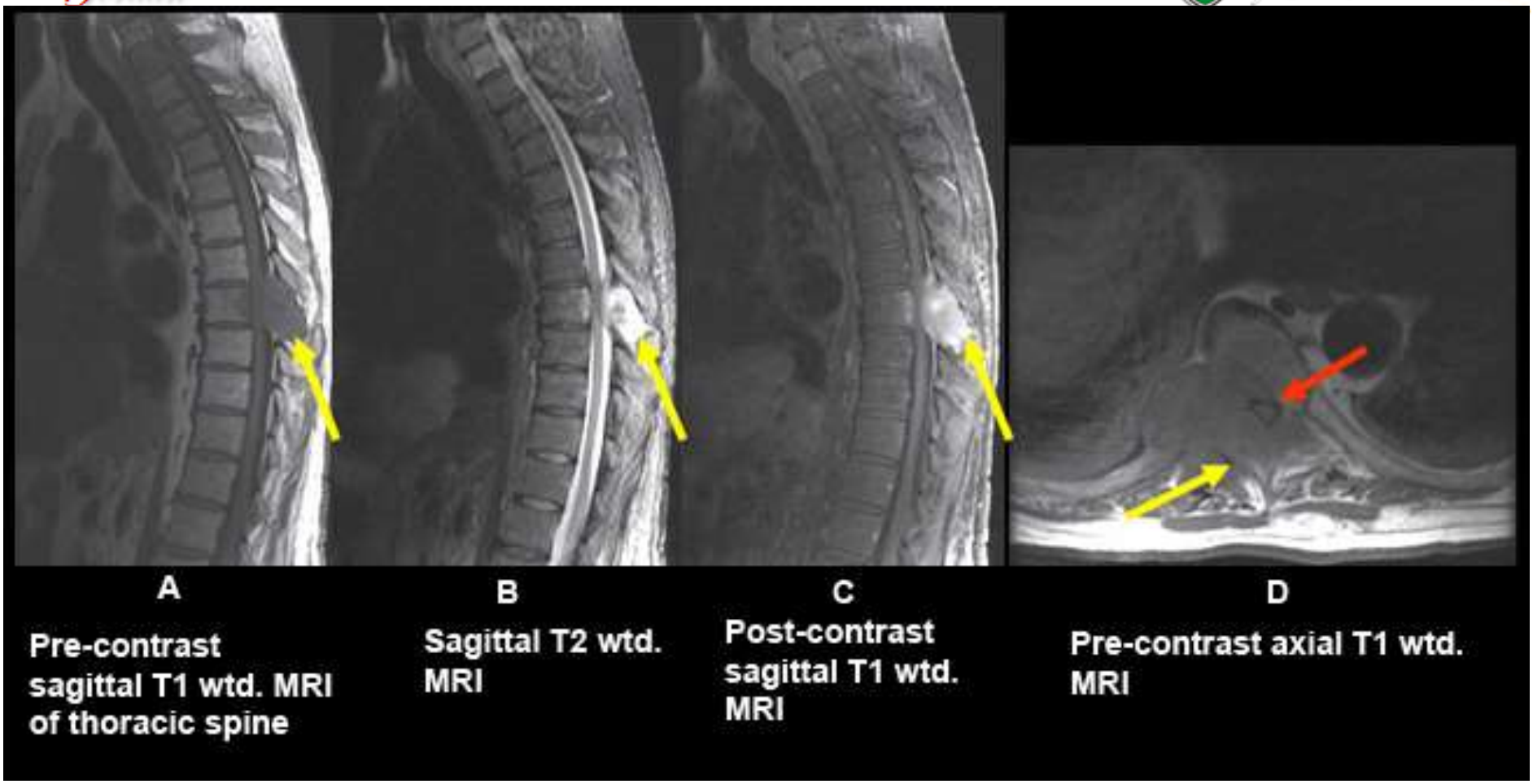

C
T2
T3
T4
STAIR


D
T2
T3
T4
T1 *c


T2
T1
C+
[F]
[F]
[F]


a
b
c
d
e
f


A
B
C



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

THANK YOU