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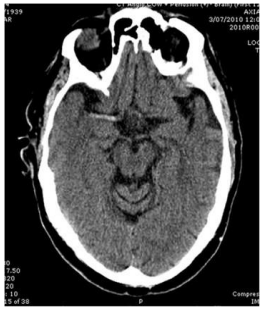
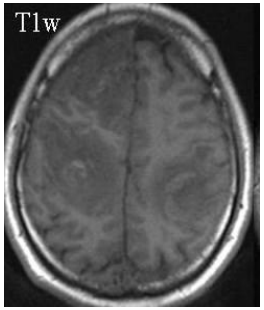
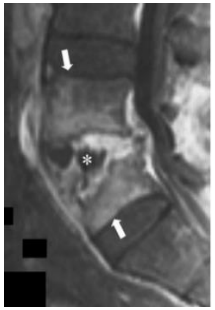
- **Dr. Aminur Rahman** has graduated from Sylhet M.A.G. Osmani Medical College under the University of Chittagong, Bangladesh. He has completed his MD in Neurology from the University of Dhaka, and his FCPS in Internal Medicine from the Bangladesh College of Physicians and Surgeons (BCPS), Dhaka. He has been awarded the FRCP (Edinburg), UK. He has also been honored as a Fellow of the ACP. He achieved his fellowship in Interventional Neuroradiology (FINR) from the University Hospital of Zurich, Switzerland, and also trained in Ramathibodi Hospital, Mahidol University, Thailand.
- He is now working as **Deputy Executive Editor** of the Bangladesh Journal of Medicine , **Joint Editor in Chief** Journal of the Bangladesh College of Physicians and Surgeons , and Editor of the Bangladesh Journal of Neurosciences . He is also serving as an international editorial board member of the **Journal of the Indian Medical Association** and the **Journal of Neurology and Neurorehabilitation Research, UK.** He has published more than **55 research papers** in reputed journals, both national and international. He is also the author of **three text books**: “Short Cases in Clinical Neurology, 3rd Ed (2024)," “Neuroimaging in Clinical Practice, 2nd Ed (2023),” and “Fundamentals in Clinical Neurology, 1st Ed 2023.”.

Neuroimaging in Clinical Practice







Dr. Aminur Rahman

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Objectives

- Introduction on neuroimaging
- Stroke in CT scan
- Stroke in MRI of brain
- Subarachnoid Hemorrhage in CT brain
- Ring enhanced lesions in brain
- MRI of spine in - degenerative diseases
- MRI of spine- infection
- MRI of spine - syringomyelia
- MRI of spine - demyelinating diseases
- MRI of spine – tumours

Neuroimaging

- Neuroimaging or brain imaging is the use of various techniques to either directly or indirectly image the structure, function / pharmacology of the nervous system.
- Neuroimaging plays a pivotal role in the diagnosis of central nervous system (CNS) disorders.
- **Main modalities** of neuroimaging techniques are CT scan and MRI.

Classification of Neuroimaging

It falls into two broad categories:

A. Structural imaging:

It deals with the structural lesion of intracranial disease (e.g. stroke, tumor, infection, demyelinating disease etc.) and injury.

B. Functional imaging :

It is used to diagnose metabolic diseases and as well as degenerative diseases of brain (e.g. Alzheimer's disease) and also for neurological and cognitive psychology research.

Indications of Neuroimaging

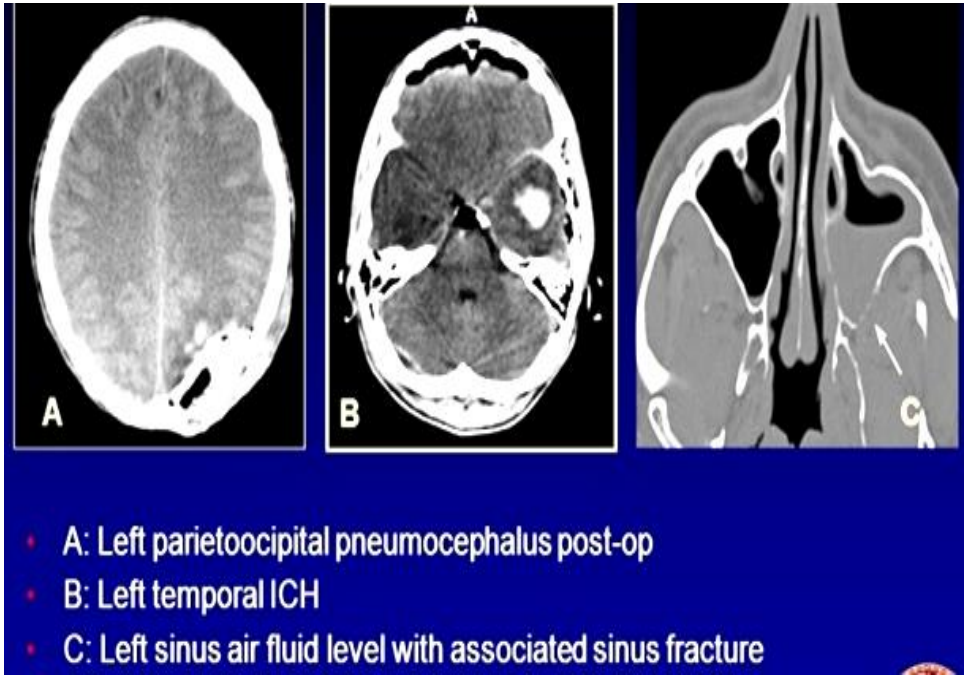
1. To investigate a patient who has or may have a neurological disorders such as stroke, headache, syncope, seizure disorder etc.
2. For stereotactic surgery or radiosurgery for treatment of intracranial tumors, arteriovenous malformations and other surgically treatable conditions.
3. To diagnose metabolic diseases and degenerative diseases (such as Alzheimer's disease, Parkinson’s diseases etc.) and also
4. For neurological and cognitive psychology research.

Techniques of Neuroimaging

1. Computed tomography (CT) or Computed Axial Tomography Scan (CAT Scan)
2. Magnetic resonance imaging(MRI)
3. Functional magnetic resonance imaging(fMRI)
4. Magnetoencephalography(MEG)
5. Positron emission tomography(PET)
6. Single-photon emission computed tomography(SPECT)
7. Computed tomography angiography(CTA)
8. Magnetic resonance angiography(MRA)
9. Magnetic resonance venography(MRV)
10. MR Neurography / MR Imaging of Peripheral Nerves (PNI)
11. Cerebral Digital Substraction angiography (DSA).

Approach to Review a CT scan : AABBCS (Mnemonic)

- **A**-Asymmetry
- **A**- Air-filled structures (artifacts/sinuses, mastoid air cells)
- **B**-Blood (subarachnoid, intracerebral, subdural, epidural hematoma)
- **B**- Brain tissue (infarction, edema, masses, brain shift
- **C**- CSF spaces (sulci, ventricles, cisterns, hydrocephalus, atrophy)
- **S**–Skull and scalp (fractures, Skull metastases)



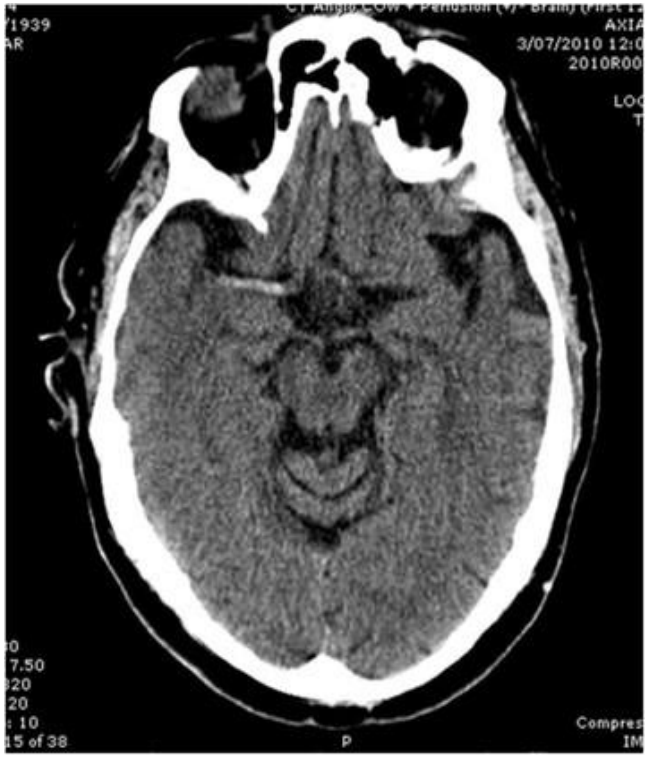
Senerio-1

- A 62-year-old man presented with sudden onset of left-sided weakness with slurring of speech.
- He is Hypertensive for 10 years and diabetic for 8 years. On examination, his blood pressure was 190/120 mmHg. His right sided planter was extensor. Within half an hour of onset of symptoms CT scan of brain was done.
- Study the CT image and answer the following questions:

Senerio-1

Questions

a. What does the CT scan show?
b. What is the diagnosis?
c. What is the basic mechanism of development of this sign?



NCCT scan of brain

Answers

a. Hyper dense MCA sign on Right
b.Hyper acute Ischemic stroke
c.Thrombosis of the proximal part of M1 MCA segment

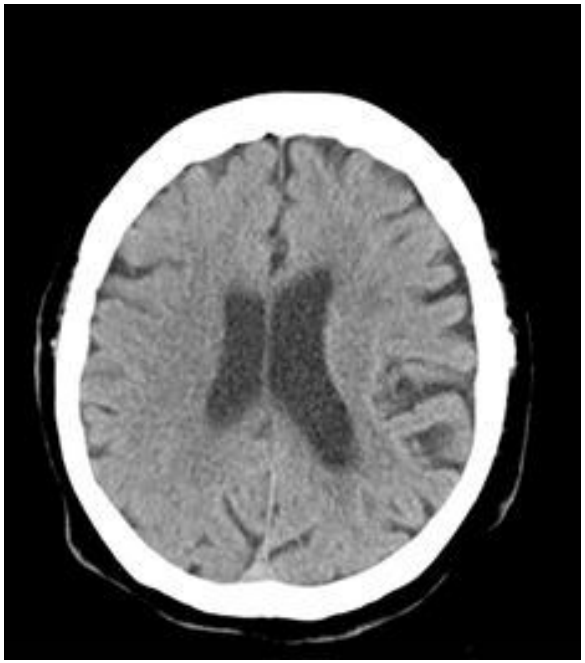
Scenario-2

A 65 years male visited to the emergency department with history of sudden onset of left sided weakness. A CT scan of brain and was done immediately.

Scenario-2

Questions

1. What does the CT scan show?
2. What is the diagnosis



Answers

1. Cortical hypodensity / hypoattenuated area / loss of gray-white matter differentiation
2. Hyperacute Ischaemic stroke

Acute Ischaemic stroke in CT scan

Role of CT in acute ischemic stroke

To diagnose stroke in CT scan of Brain

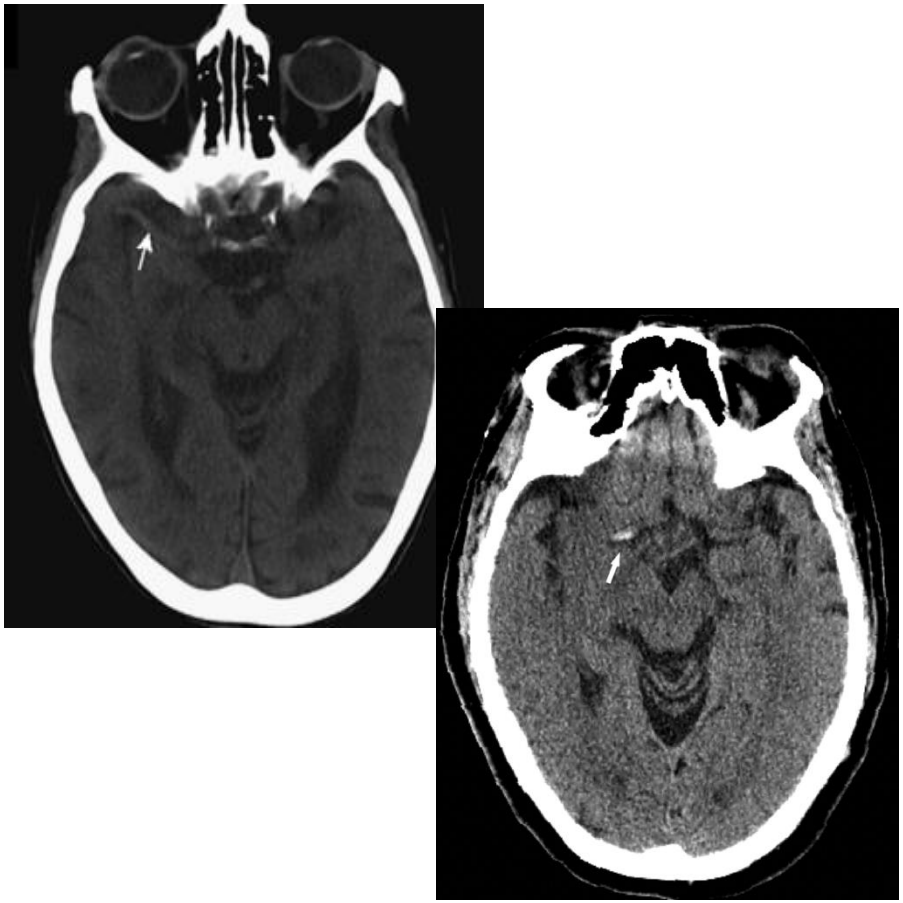
- The overall sensitivity 64% and
- The specificity is 85%.

Role of CT in acute ischemic stroke

A. To Rule out bleed: Non contrast CT is sufficient to rule out most important infarct mimic that is bleed which is an absolute contraindication for thrombolytic therapy.
B. Can detect **early stage acute ischemia** : by depicting features such as the
   1) Hyper dense vessel sign,
   2) Insular ribbon sign and
   3) Reduced parenchymal attenuation with effacement of cortical sulci.

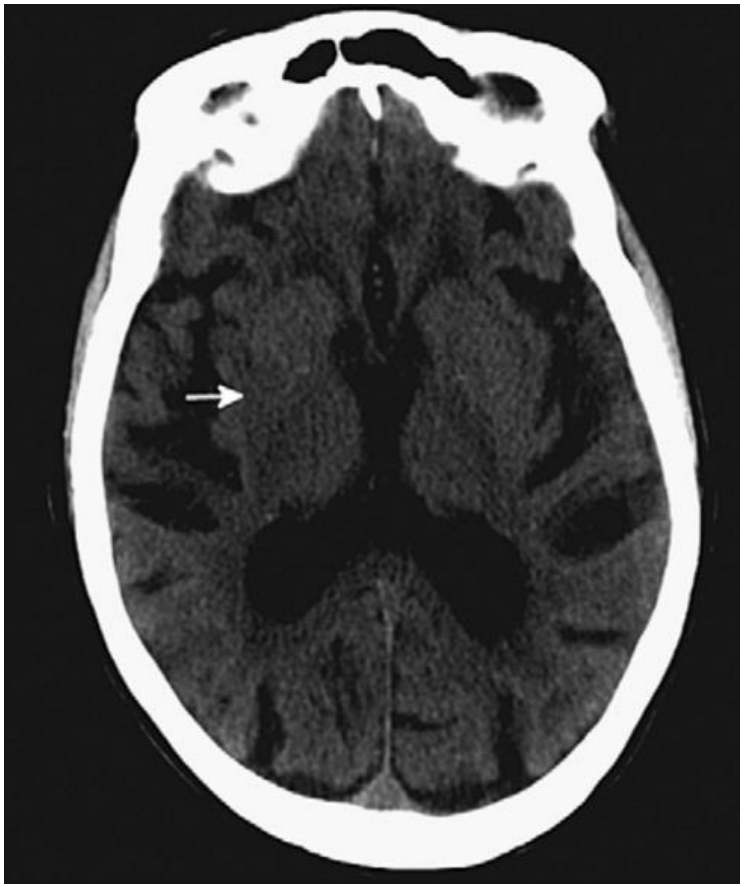
Time course of ischemic stroke on NECT

Hyperacute (< 6 hours):



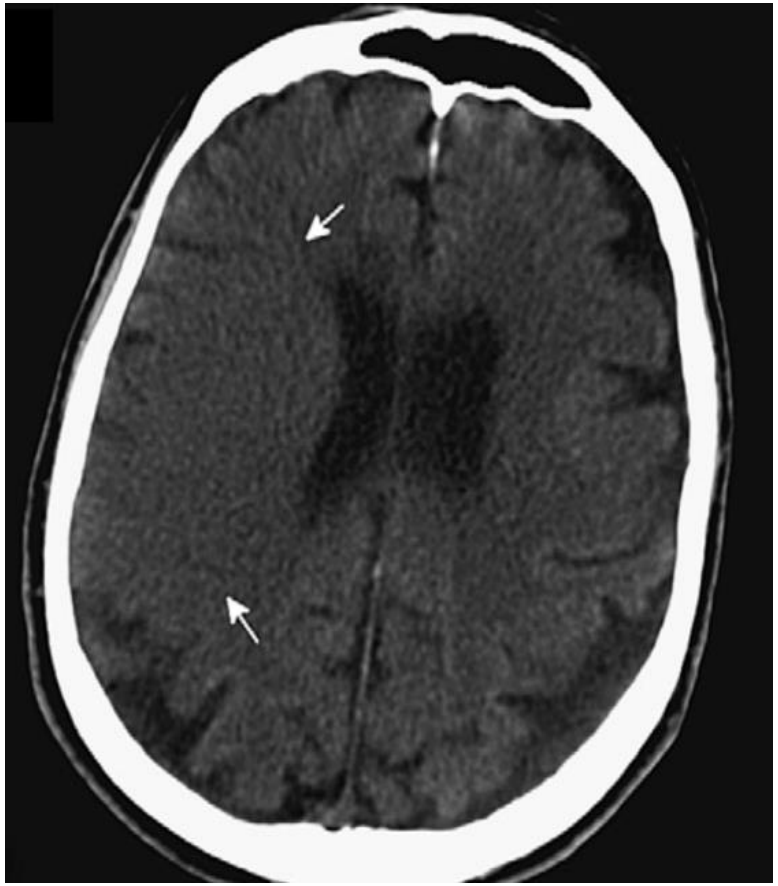
Shows the early CT sign (<6h) of ischemic stroke with hyperdensity of MCA representing an acute embolus lodged into left MCA known as **"hyperdense MCA sign".**

Hyperacute (< 6 hours):



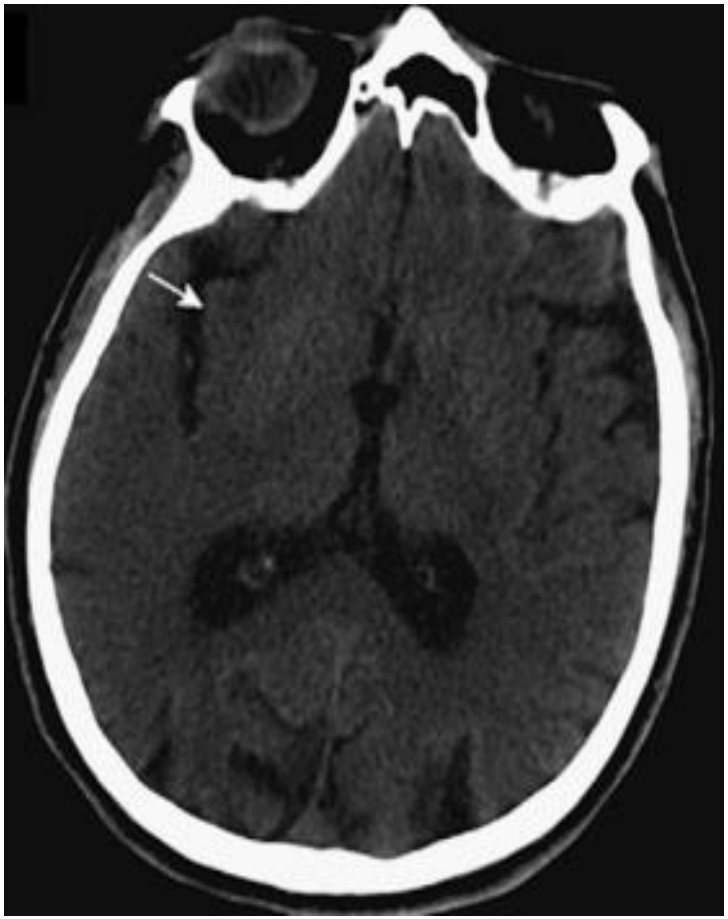
Shows the early CT sign (<6h) of ischemic stroke with **"loss of gray-white matter differentiation"** in basal ganglia.

Hyperacute (< 6 hours):



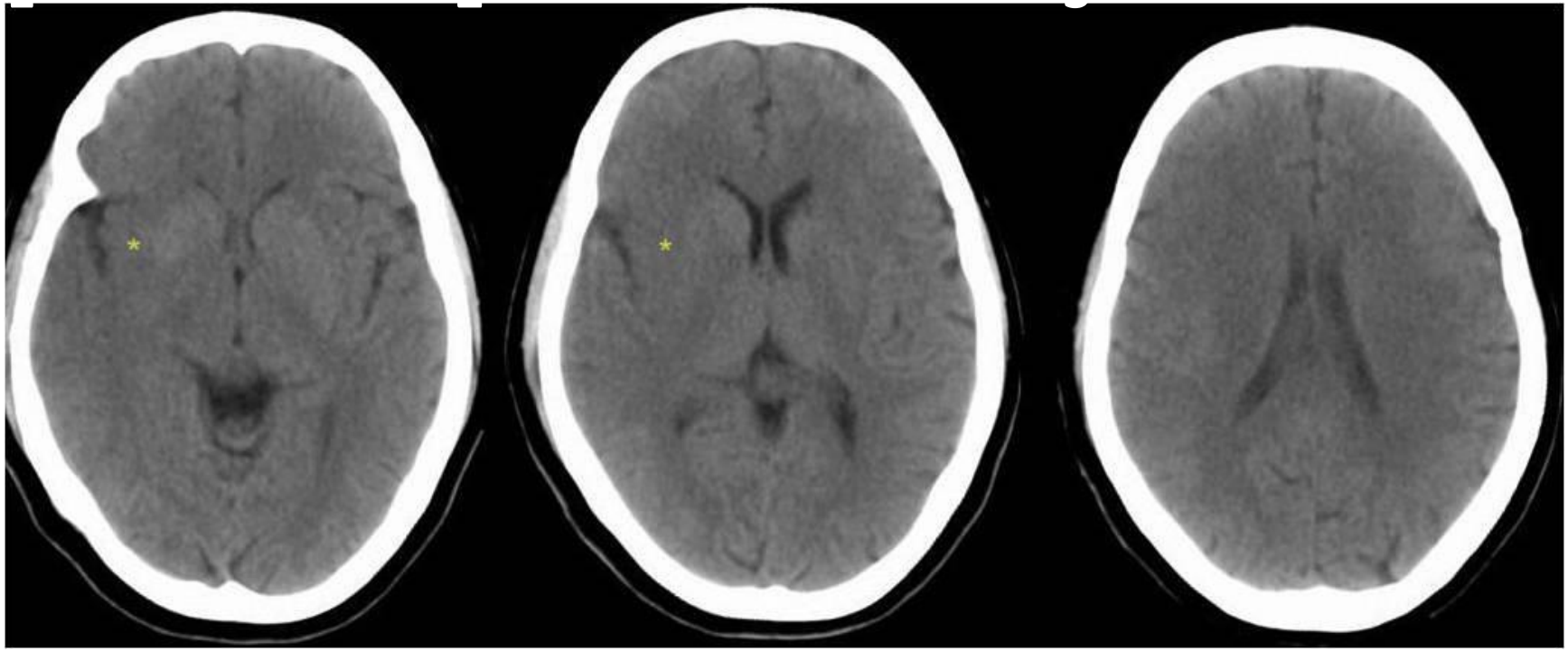
Diffuse cerebral swelling with loss of cortical sulci and compression of ventricular system (right).

Hyperacute (< 6 hours):



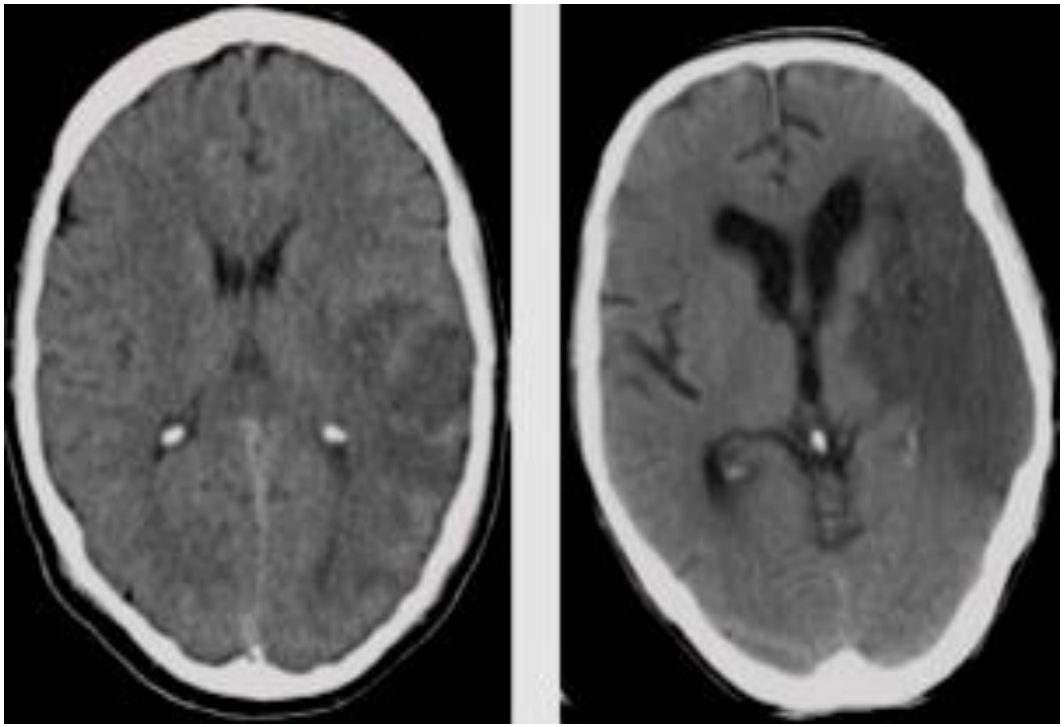
The hypodensity of insular cortex known as **“insular ribbon sign”.**

Hyperacute (< 6 hours):



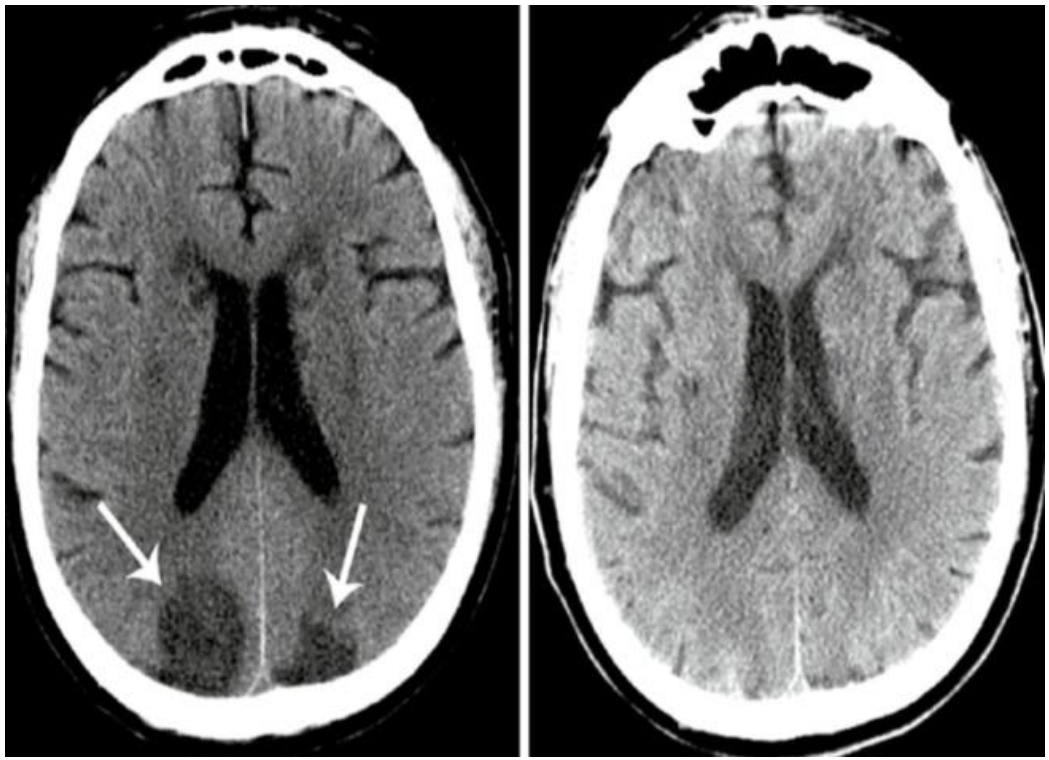
1. No bleed.
2. Faint low attenuation involving right insular cortex and adjacent basal ganglia - **'insular ribbon'** sign.
3. Effacement of right hemispheric cortical sulci.

Acute: 12 hours -7 days



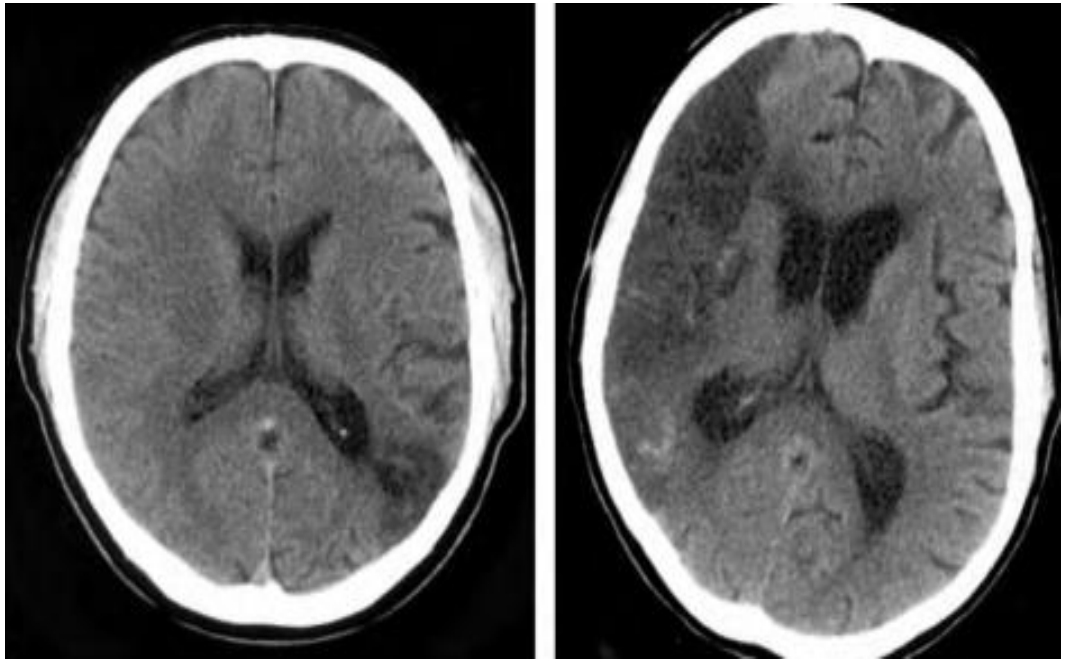
Large areas of hypodensity within the left and (Left) middle cerebral artery vascular territories, due to cytotoxic oedema.

Subacute:2 -4 weeks



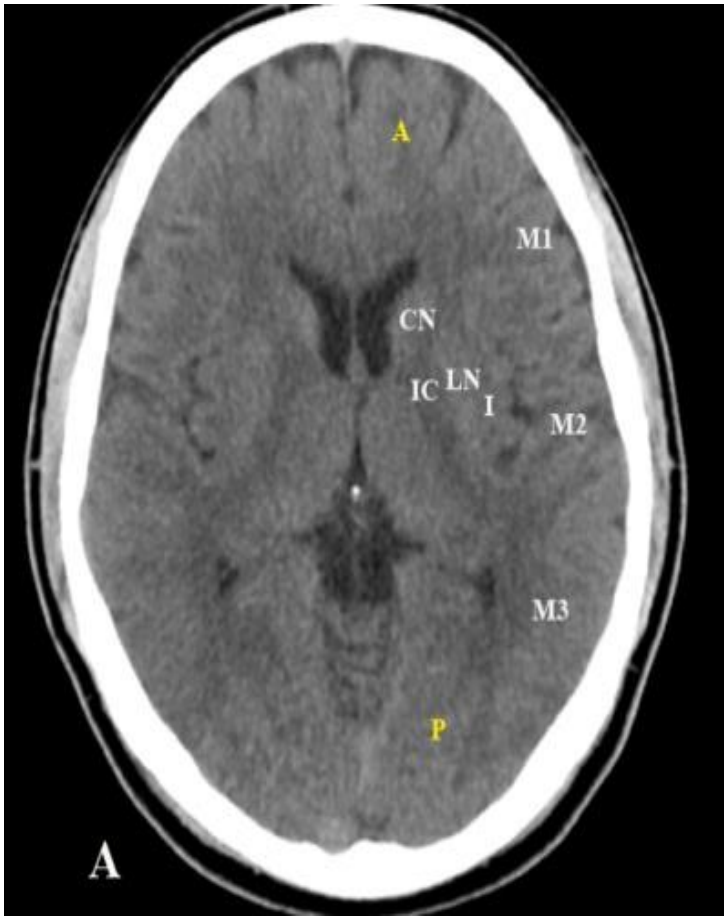
Shows the **"fogging effect"** occurs during subacute phase. Left CT image is obtained at 36hrs with bilateral occipital hypodensities. Right image is taken at 18 days showing the isodense appearance of previous infarct.

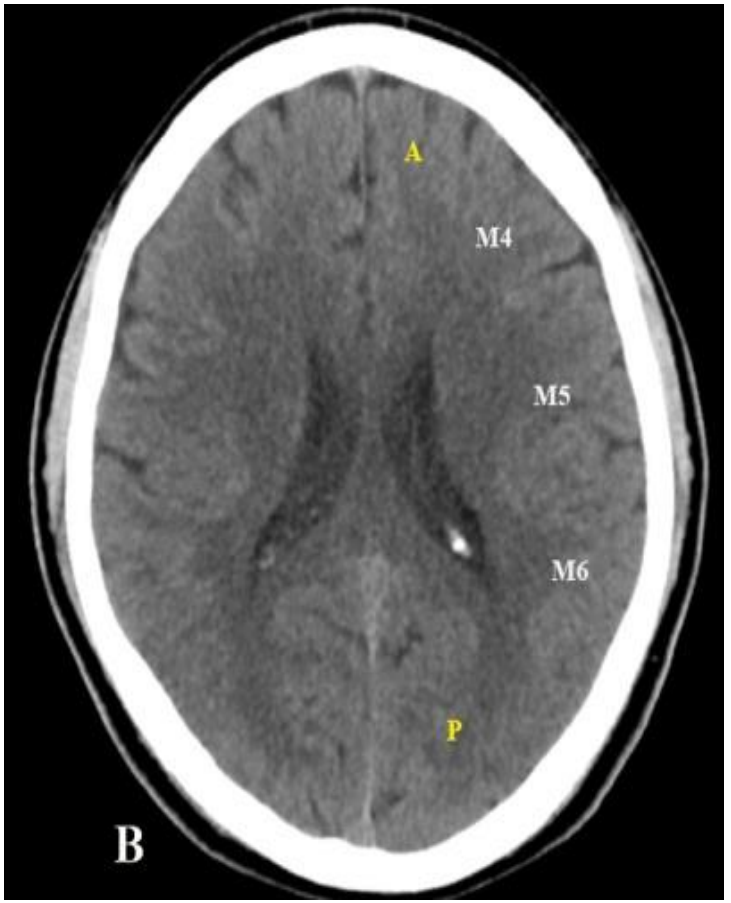
Chronic: ≥6 weeks– months



Shows the encephalomalacic changes in right fronto-parietal region

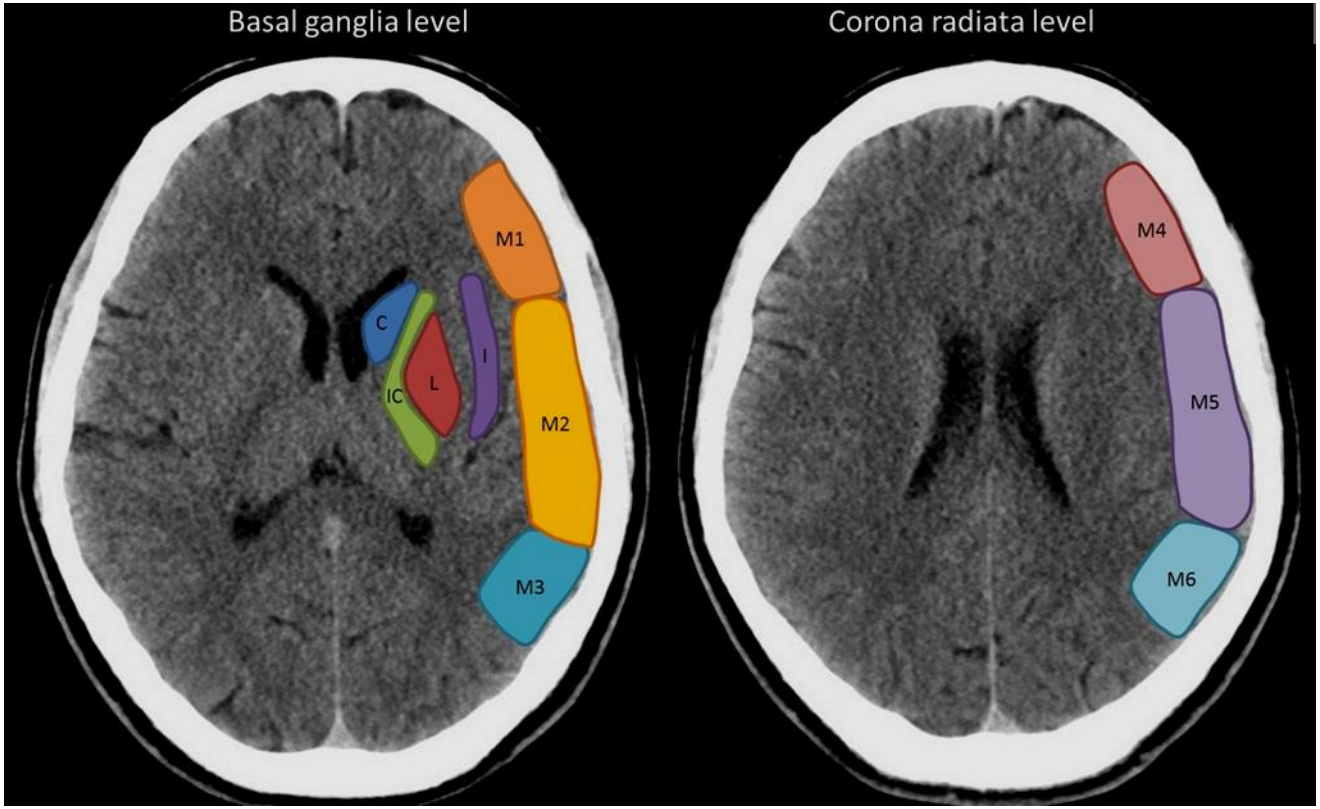
Alberta stroke program early CT score (ASPECTS)





Alberta stroke program early CT score (ASPECTS)

Middle cerebral artery (MCA) vascular territory



C-Caudaate.IC- Internal capsule,L-Lentiform nucleus, I-insular cortex

Alberta stroke program early CT score (ASPECTS)

- Segmental assessment of the **MCA vascular territory** is made and 1 point is deducted from the **initial score of 10** for every region involved:

  Caudate

  Putamen

  Internal capsule

  Insular cortex

  M1: "anterior MCA cortex," corresponding to frontal operculum

  M2: "MCA cortex lateral to insular ribbon" corresponding to anterior temporal lobe

  M3: "posterior MCA cortex" corresponding to posterior temporal lobe

  M4: "anterior MCA territory immediately superior to M1"

  M5: "lateral MCA territory immediately superior to M2"

  M6: "posterior MCA territory immediately superior to M3

Alberta stroke program early CT score (ASPECTS)

Posterior circulation - Alberta stroke program early CT score (pc-ASPECTS)

T-Thalamus, OL-Occipital lobe, M-any part of Midbrain, P- any part of Pons, C- Cerebellar hemisphere

Posterior circulation - Alberta stroke program early CT score (pc-ASPECTS)

- Variations of the ASPECT scoring system have been described for use in the posterior circulation and referred to as pc-ASPECTS
  - Thalami (1 Point Each)
  - Occipital Lobes (1 Point Each)
  - Midbrain (2 Points)
  - Pons (2 Points)
  - Cerebellar Hemispheres (1 Point Each)

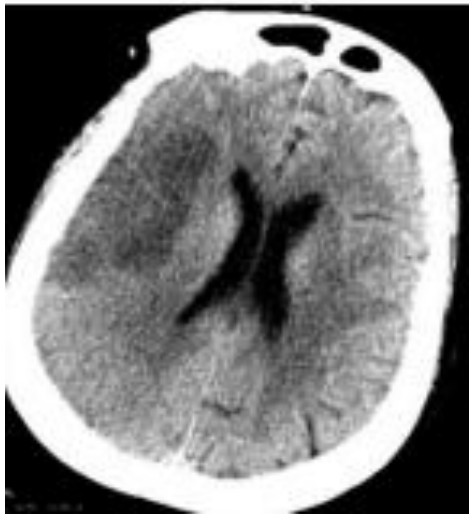
Clinical use of ASPECTS

- It has been used to prognosticate for example the score is a strong predictor of functional outcome.
  - An ASPECTS score **less than or equal to 7 predicts** a worse functional outcome at 3 months as well as symptomatic haemorrhage.
- It has also been used to direct therapies.
  - **ASPECTS score more than 8 treated** with thrombolysis with a good clinical outcome.
  - **Low ASPECTS score** suggesting large MCA treated with intra-arterial treatments increases the risk of haemorrhage.

Age determination of infarction in CT

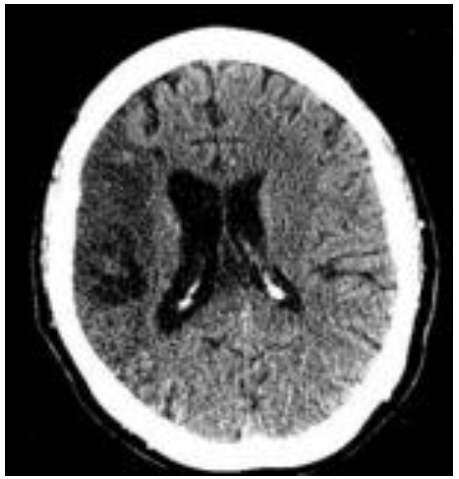
Recent / New infarct

1. Hypodense.
2. Larger.
3. Ventricles- pressure effect.
4. Sulcus obliterated in same side.



Old infarct

1. More hypodense
2. Smaller – due to gliosis in surrounding area.
3. Ventricles- no pressure effect but may be enlarged.
4. Sulcus prominent.



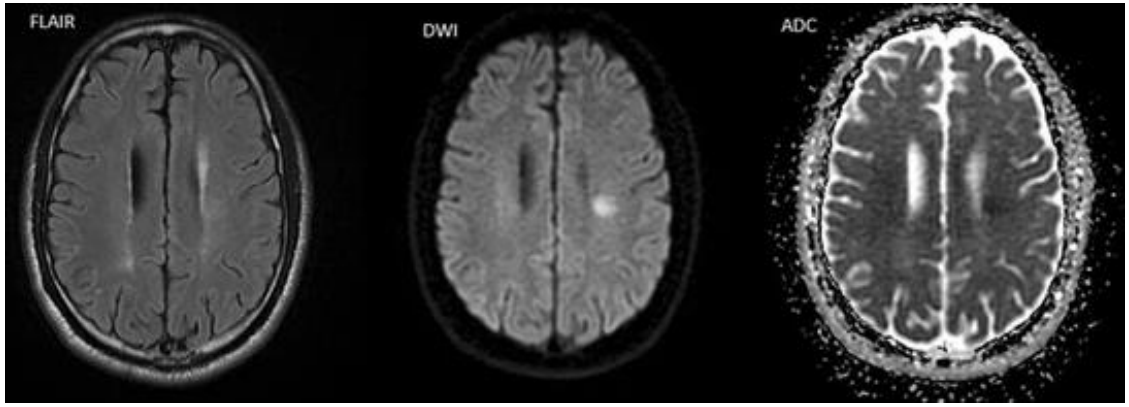
Scenario-3

- A 35 year old female patient was admitted with incomplete global aphasia and a fluctuating slight hypesthesia of the right hand. Her baseline National Institutes of Health Stroke Scale score (NIHSS) was 4 and arterial hypertension was the only vascular risk factor. MRI of brain was done immediately

Scenario -3

Questions

1. What does the CT scan show?
2. What is the diagnosis



Answers:

1. MRI of brain shows in DWI hyperintense lesion in temporal region with diffusion –Flair mismatched
2. Hyperacute ischaemic stroke

Illustrations of MRI brain in stroke

Introduction

- Magnetic resonance imaging (MRI) is increasingly being used in the diagnosis and management of acute ischemic stroke and is **sensitive and relatively specific** in detecting changes that occur after such strokes.

Imaging of stroke in MRI

- More sensitive in early detection of acute ischaemic stroke .
- Can detect acute infarct **within 30 mints**

Imaging of stroke in MRI

- Once bleed is ruled on CT.
- MRI is to confirm an infarct with better evaluation.

Commonly used MRI techniques in Ischaemic stroke

1. T1-weighted imaging (T1-WI)
2. T2-weighted imaging (T2-WI)
3. Diffusion-weighted imaging (DWI)
4. Perfusion-weighted imaging (PWI)

Role of Diffusion-Weighted Imaging(DWI)

- Acute stroke causes excess intracellular water accumulation or **"cytotoxic oedema",** with an overall **decreased rate of water molecular diffusion within the affected tissue**.
- Areas of **cytotoxic oedema** (restricted motion of water molecules) appear **bright on DWI**
  - As early as **30 minutes** after onset of ischemia
  - High signal up to 5 days
  - Mildly increased signal 1-4 wks

Role of DWI….

- Mild hyperintense DWI with **pseudonormal** ADC from 1 -4wks .
- After several wks DWI signal varies (T2 effect) with increased ADC .
- DWI **alone cannot** be used and should always be compared with ADC to assess the age of infarct.

Changes of DWI with times

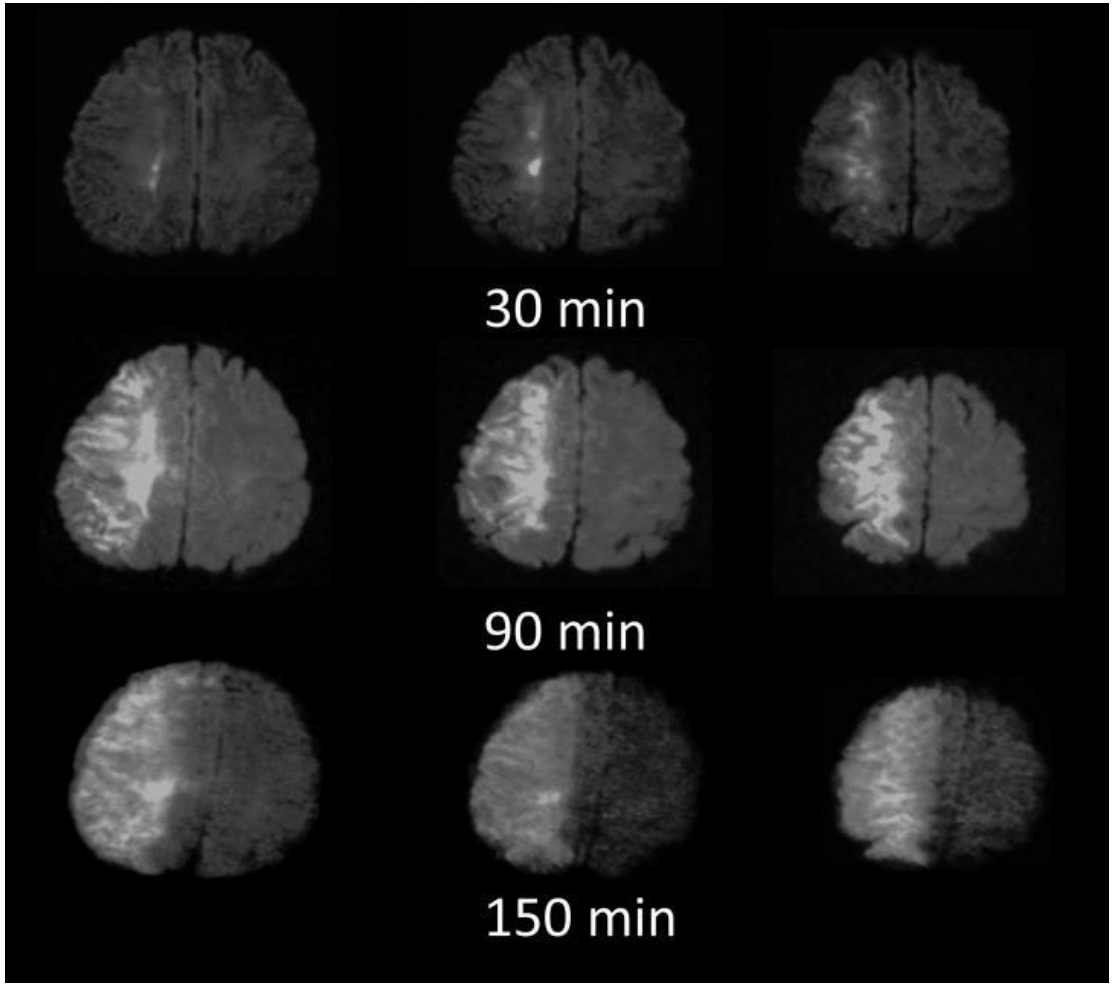


Figure: High rate of neuronal loss. The rate of neuronal loss in this individual is nearly 50 times higher than the Saver estimate

Accuracy of diagnosis ischaemic stroke in DWI

CT/ conventional MRI:

- Sensitivity and specificity < 50%

DWI:

- **Sensitivity 88-100%**
- **Specificity 86-100%**

False -ve DWI:

- Lacunar infarcts of brain stem
- Small deep grey matter infarcts

False +ve DWI:

- Abscess
- Cellular tumours like lymphoma

Role of Apparent Diffusion Coefficient maps (ADC Map)

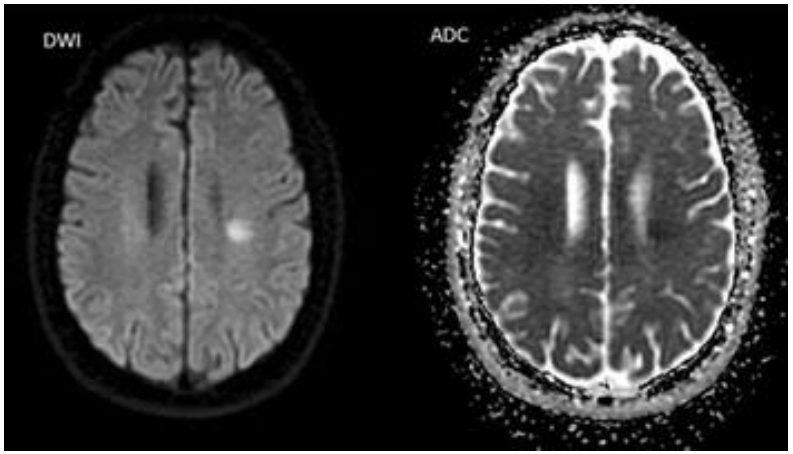
- Decreased from 30 minutes after onset to 5 days.
- Then increases and reaches normal in 1-4 weeks.
- Likely due to development of vasogenic oedema with cytotoxic oedema.

Role of FLAIR

- Sensitivity to pick an infarct is arbitrarily comparable to CT.
- If an infarct seen on diffusion and not seen FLAIR called **FLAIR / Diffusion Mismatch** indicate **hyper acute infarct** - reversible ischemic changes and salvageable tissue or tissue at risk.
- If changes are marked on FLAIR indicate already infracted and non salvageable tissue.

Early hyper acute (2 to 4 hours)

- Within minutes of arterial occlusion demonstrates
  - **Increased DWI signal (hyper intense) and**
  - **Reduced ADC values (hypo intense).**
- At this stage, the affected parenchyma appears normal on other sequences.



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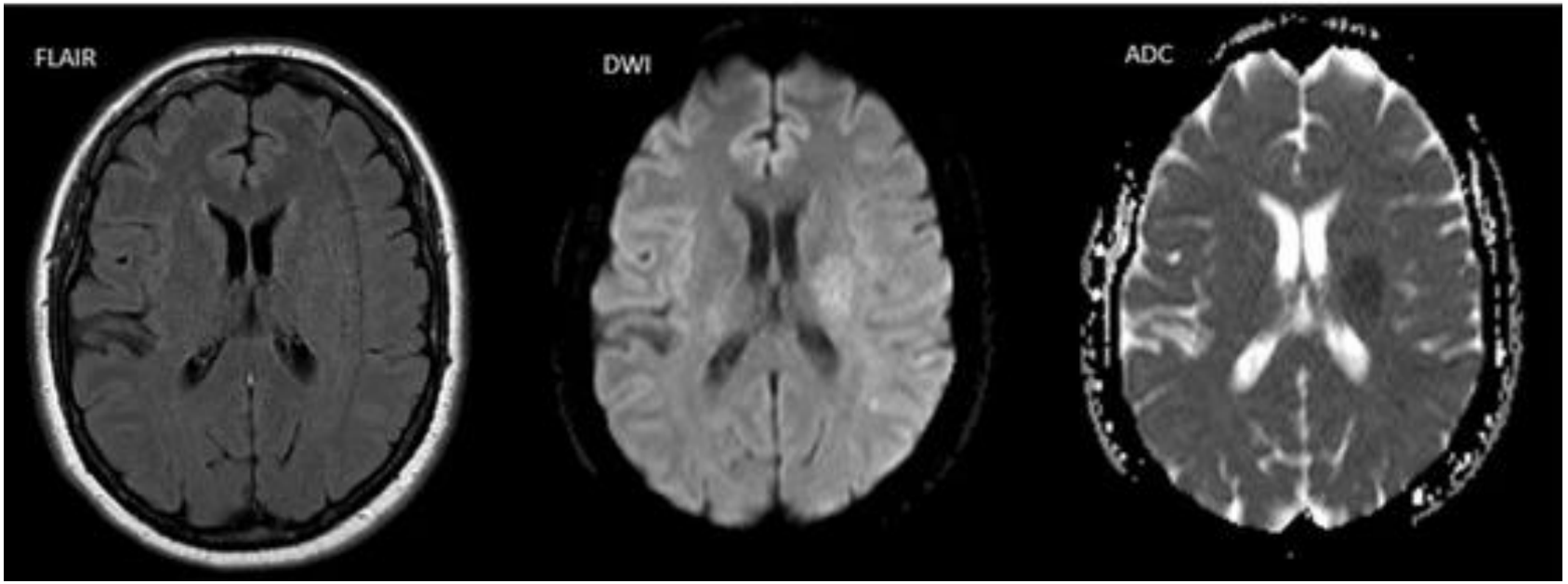
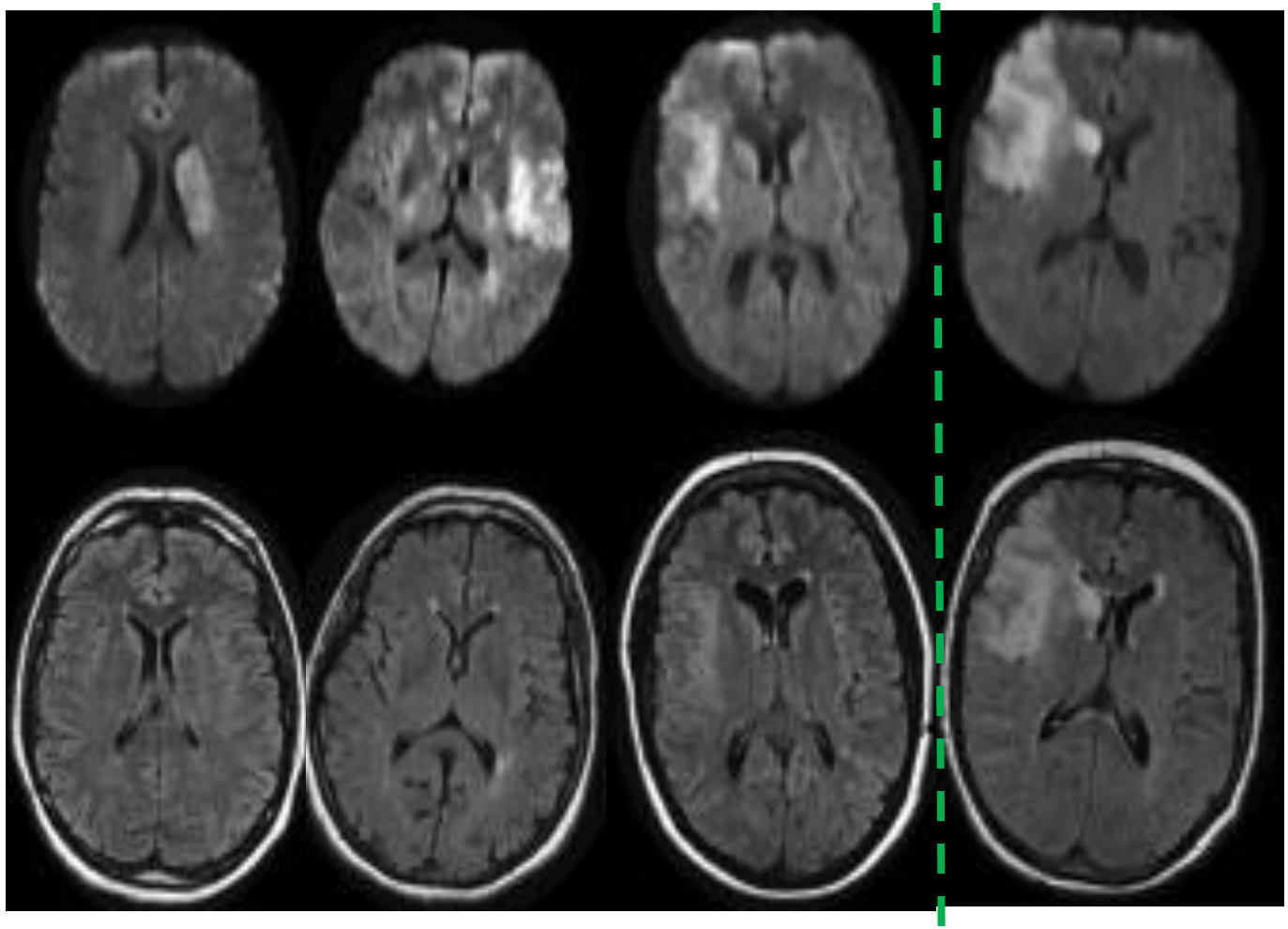
Early hyper acute (2 to 4 hours)



DWI= Hyperintense
ADC= Isointense
FLAIR= Isointense

Positive DWI, negative FLAIR

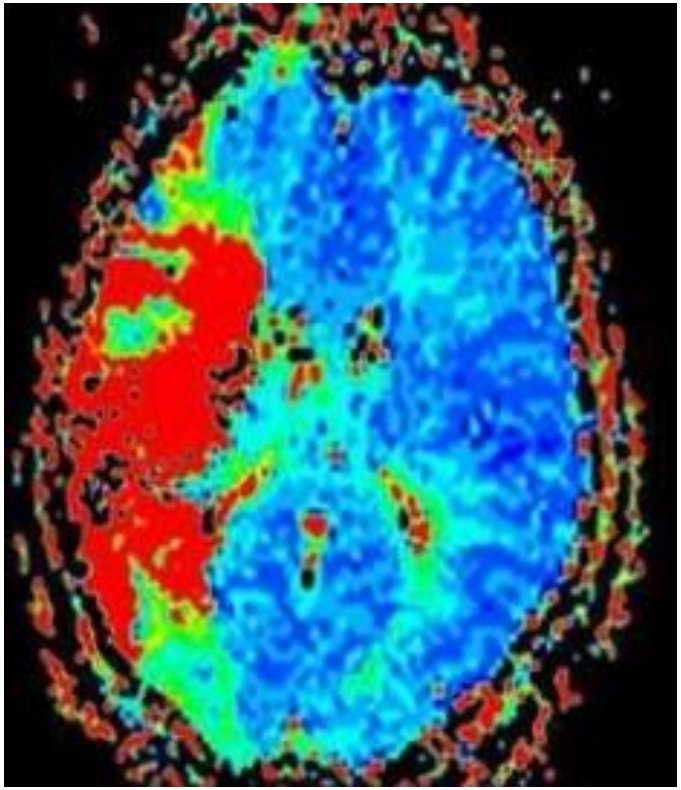
may identify strokes < 4.5 hours



Thomalla et al. Ann Neurol. 2009.

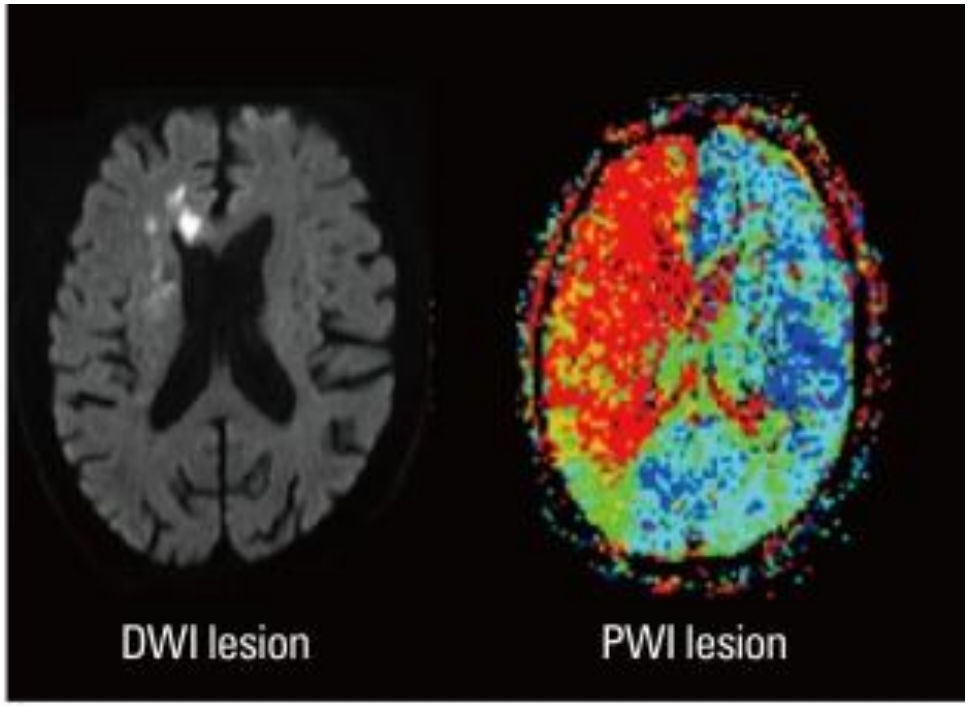
Perfusion-weighted imaging (PWI)

- Perfusion-weighted imaging (PWI) in which hemodynamically weighted MR sequences are based on passage of MR contrast through brain tissue .

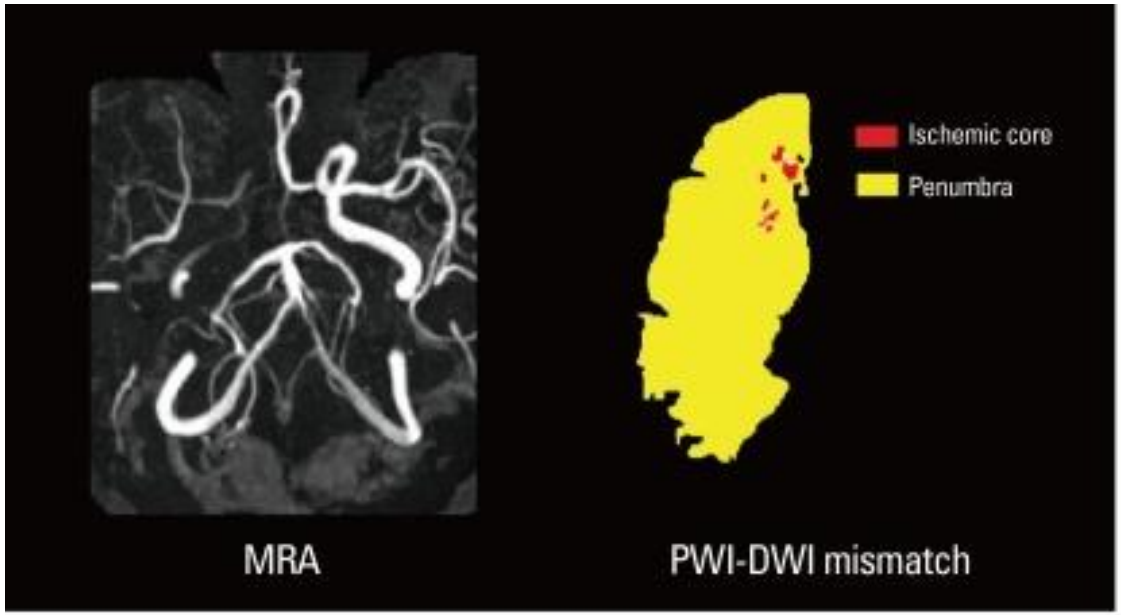


PWI-DWI mismatch

- Perfusion-weighted image (PWI) can identify **ischemic penumbral tissue**, whereas DWI-depicted lesions represent the ischemic core.
- Therefore, areas with PWI-DWI mismatch (i.e., when the perfusion lesion is larger than the diffusion lesion) have been considered representative salvageable tissue that require active treatment



PWI-DWI mismatch



Late hyper acute (≥ 6 hours-16 hrs)

- Generally, **after 6 hours**, hyper intense T2 signal will be detected, initially **more easily seen on FLAIR** than conventional Fast Spin Echo T2.
- This change continues to increase over the next day or second day.
- T1 hypo intensity is only seen after 16 hours and persists.

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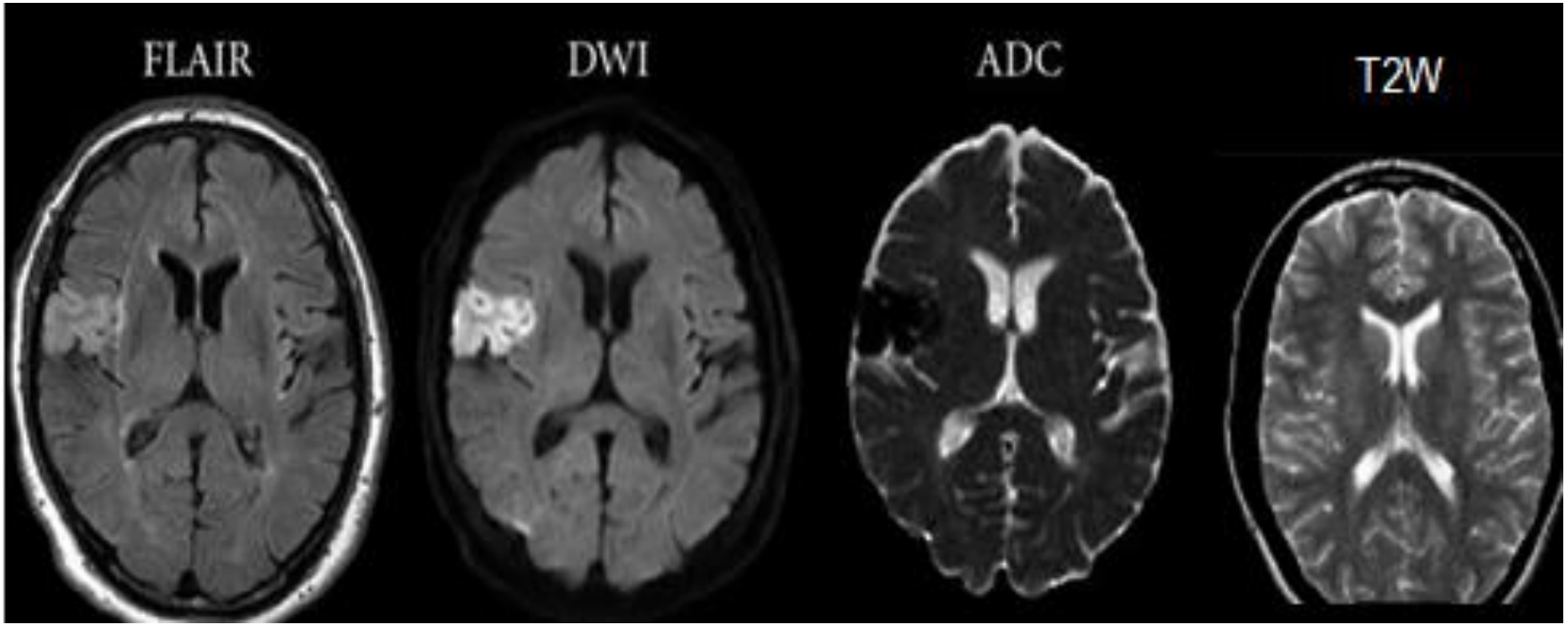

DWI= Hyperintense
ADC=Hypointense
FLAIR= Hyperintense
T2= Isointense

Late hyper acute (≥ 6 hours-16 hrs)

Acute (≤ first week)

- **During the first week,** the infarcted parenchyma continues to demonstrate
  - high DWI signal and low ADC signal, although by the end of the first week ADC values have started to increase.
- **As early as 3 days demonstrate**
  - T1 signal remains low, although some cortical intrinsic high T1 signal may be seen after infarction.
- **During the first 4 days**
  - The infarct remains hyper intense on T2 and FLAIR, with T2 signal progressively increasing **during the first 4 days.**
- **After day 5** the cortex usually demonstrates contrast enhancement on T1 C+ 1.

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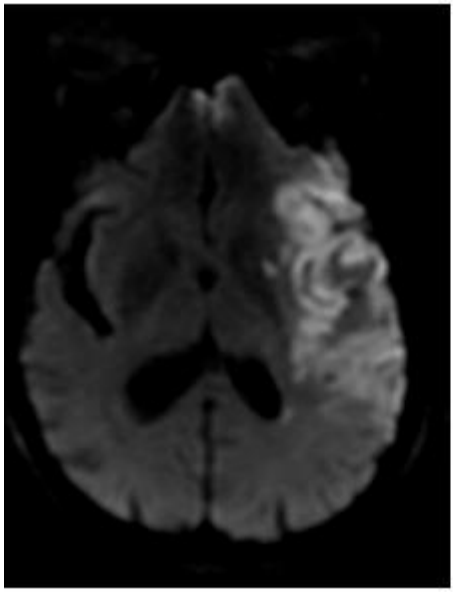
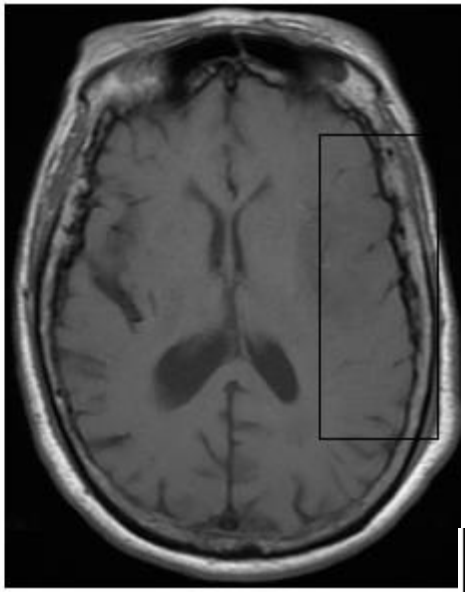
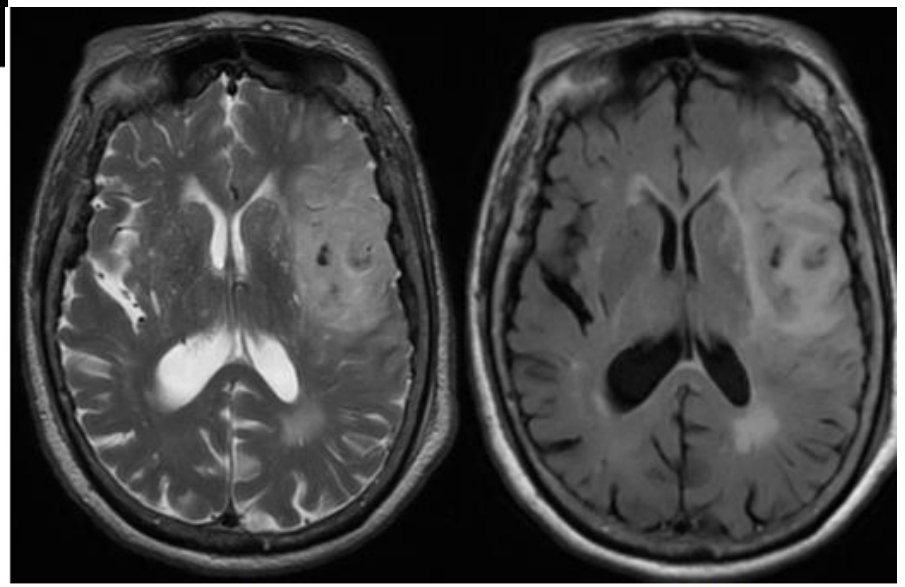


DWI



T1

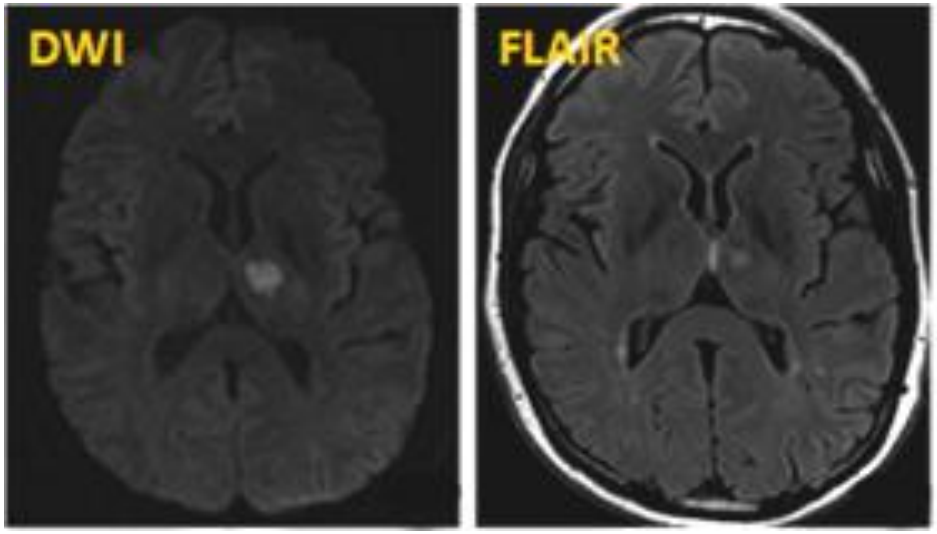
DWI= Hyperintense
FLAIR= Hyperintense
T2= Hyperintense
T1= Hypointense



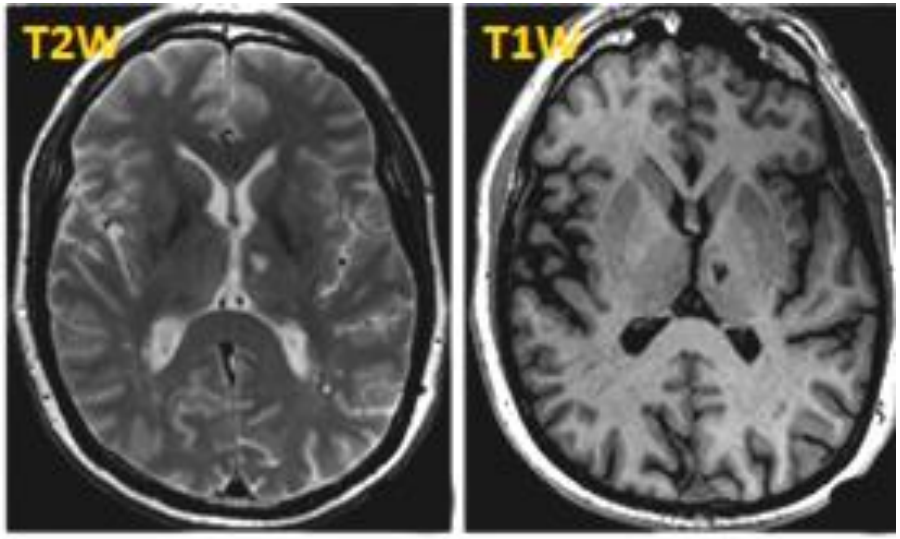
T2

FLAIR

Acute Ischaemic stroke (≤ 7days)



Acute lacunar infarct



DWI= Hyperintense
FLAIR= Hyperintense
T2= Hyperintense
T1= Hypointense

Francois Moreau.
DOI: (10.1161/STROKEAHA.111.647859)

Sub acute(between ≥1-2 weeks)

- ADC demonstrates **pseudonormalisation** typically occurring between **8-14 days**. As ADC values continue to rise, infarcted tissue progressively gets brighter than normal parenchyma.
- In contrast, DWI remains elevated due to persistent high T2/FLAIR signal **(T2 shine through) .**
- T2 fogging is also encountered typically between 1 and 5 weeks, most commonly around week 2.

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Sub acute(between ≥1-2 weeks)….

- T1 weighted sequences continue to show hypointensity with cortical intrinsic high T1 signal due to cortical **laminar necrosis or pseudolaminar necrosis**.
- Cortical enhancement is usually present throughout the subacute period.

- In cases of **true restricted diffusion**, the region of increased DWI signal will demonstrate low signal on ADC.
- In contrast, in cases of **T2 shine-through**, the ADC will be normal or high signal.

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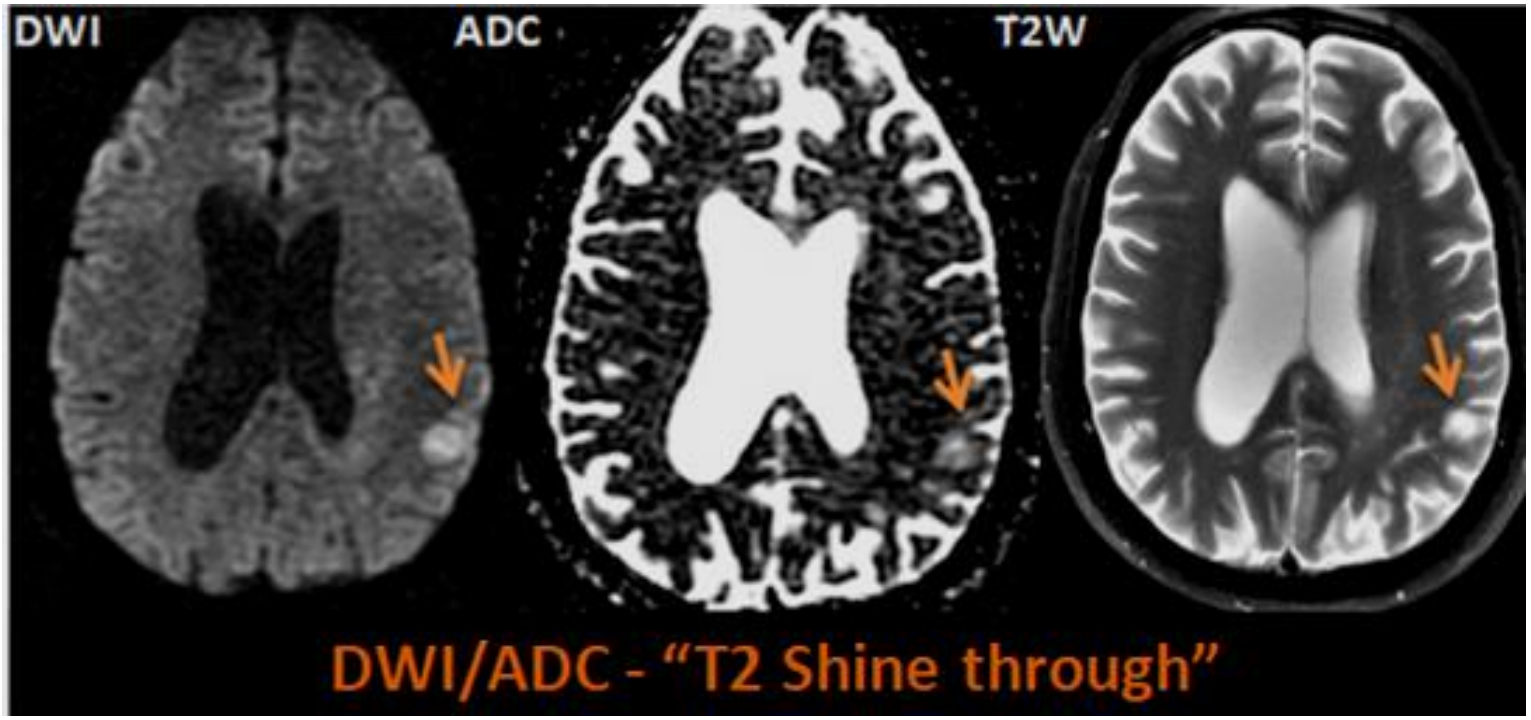
Sub acute(between ≥1-2 weeks)….



Chronic ≥ 4 wk

- T1 signal remains low with intrinsic high T1 in the cortex if cortical necrosis is present.
- T2 signal is high. Cortical contrast enhancement usually persists for 2 to 4 months.
- Importantly if parenchymal enhancement persists for more than 12 week the presence of an underlying lesion should be considered.
- ADC values are high, resulting in high signal.
- DWI signal is variable, but as time goes on signal progressively decreases.

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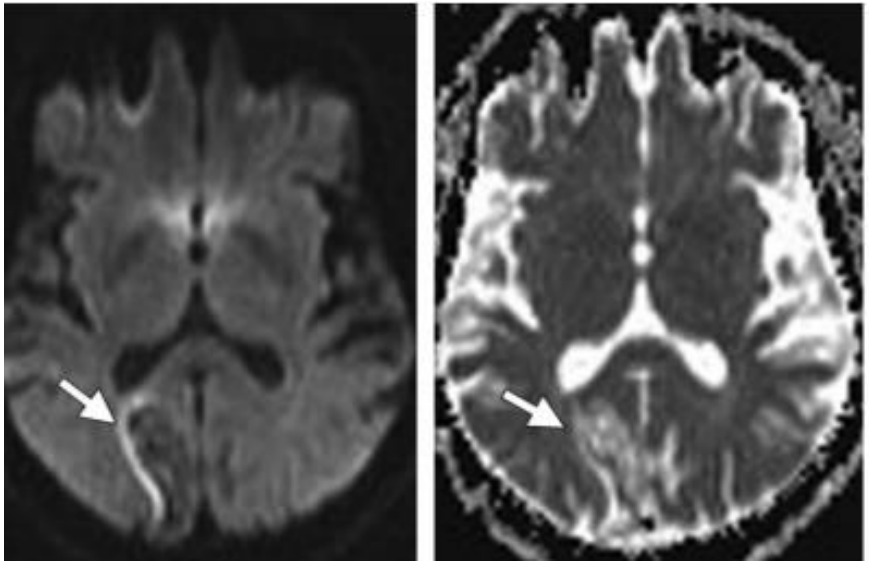
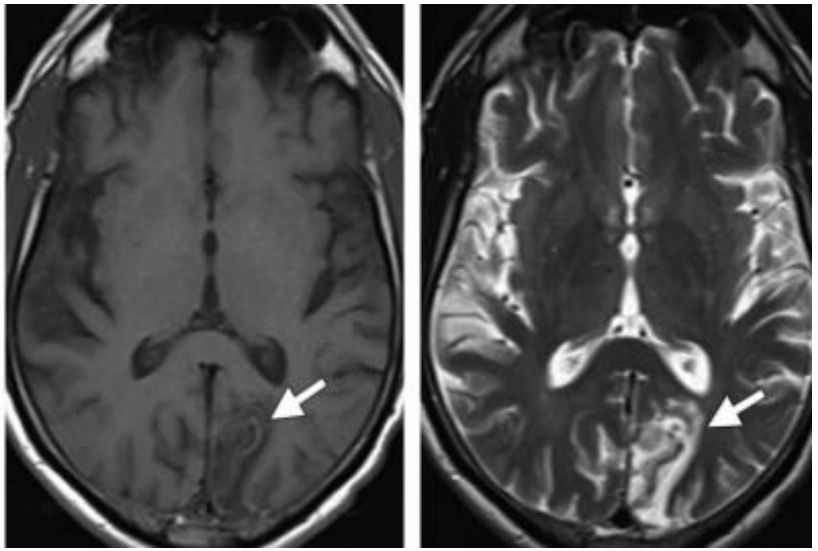




Chronic ≥ 4 wk

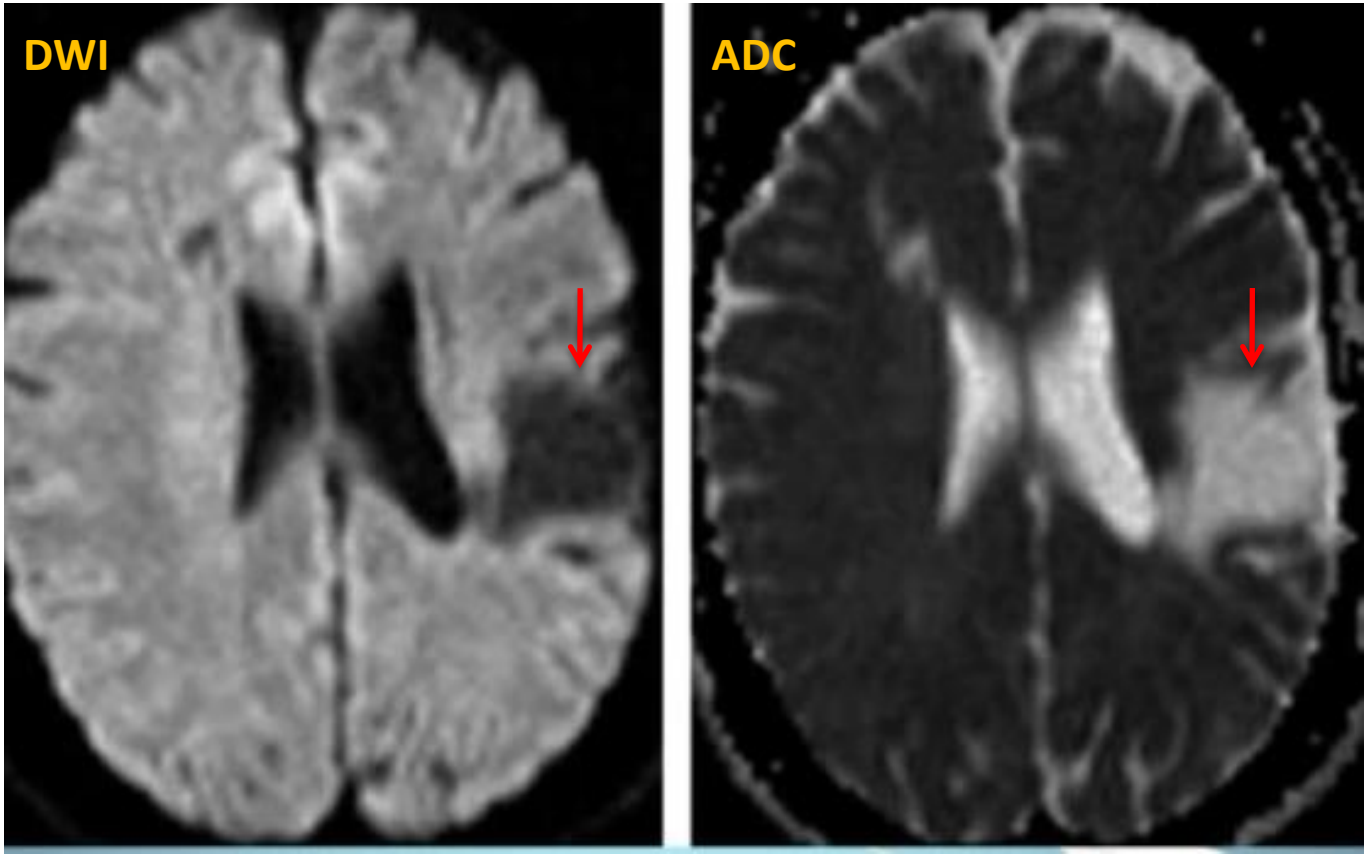
DWI= Hypointense

FLAIR= Hyperintense

T1= Hypointense

T2= Hyperintense

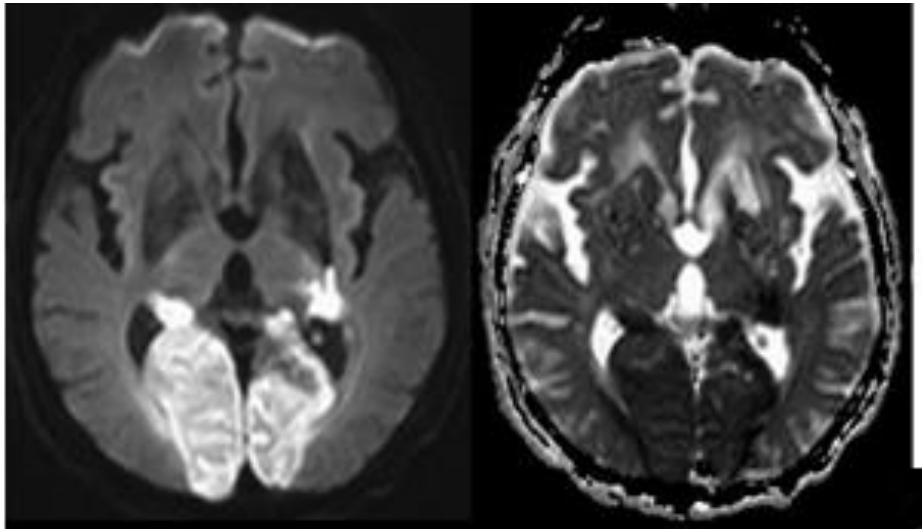
Laura M. Allen et. al



Chronic: DWI- Hypointensity ,
ADC- hyperintensity

Distinguish between new vs old Infraction

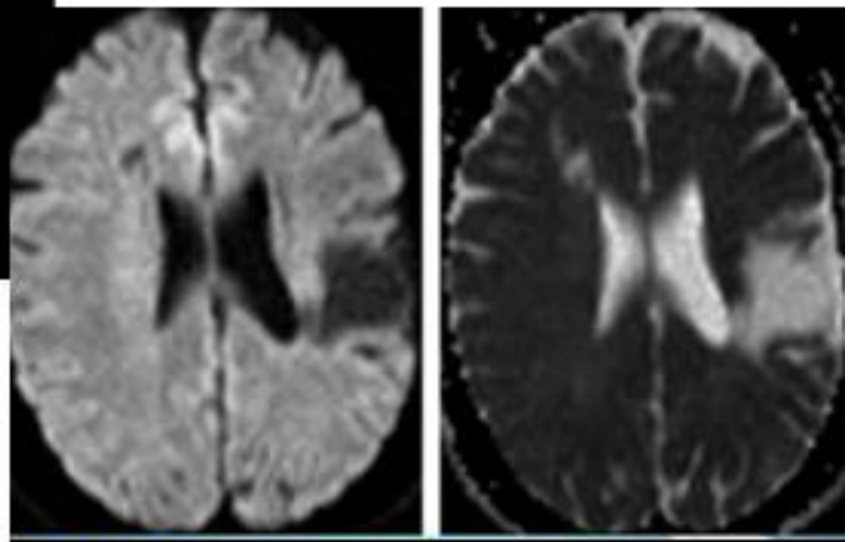
	DWI	ADC
• New / acute infraction :	Hyperintensity	Hypointensity
• Old / chronic infraction :	Hypointensity	Hyperintensity



New/ Acute infraction:

DWI- Hypointensity

ADC- Hyperintensity

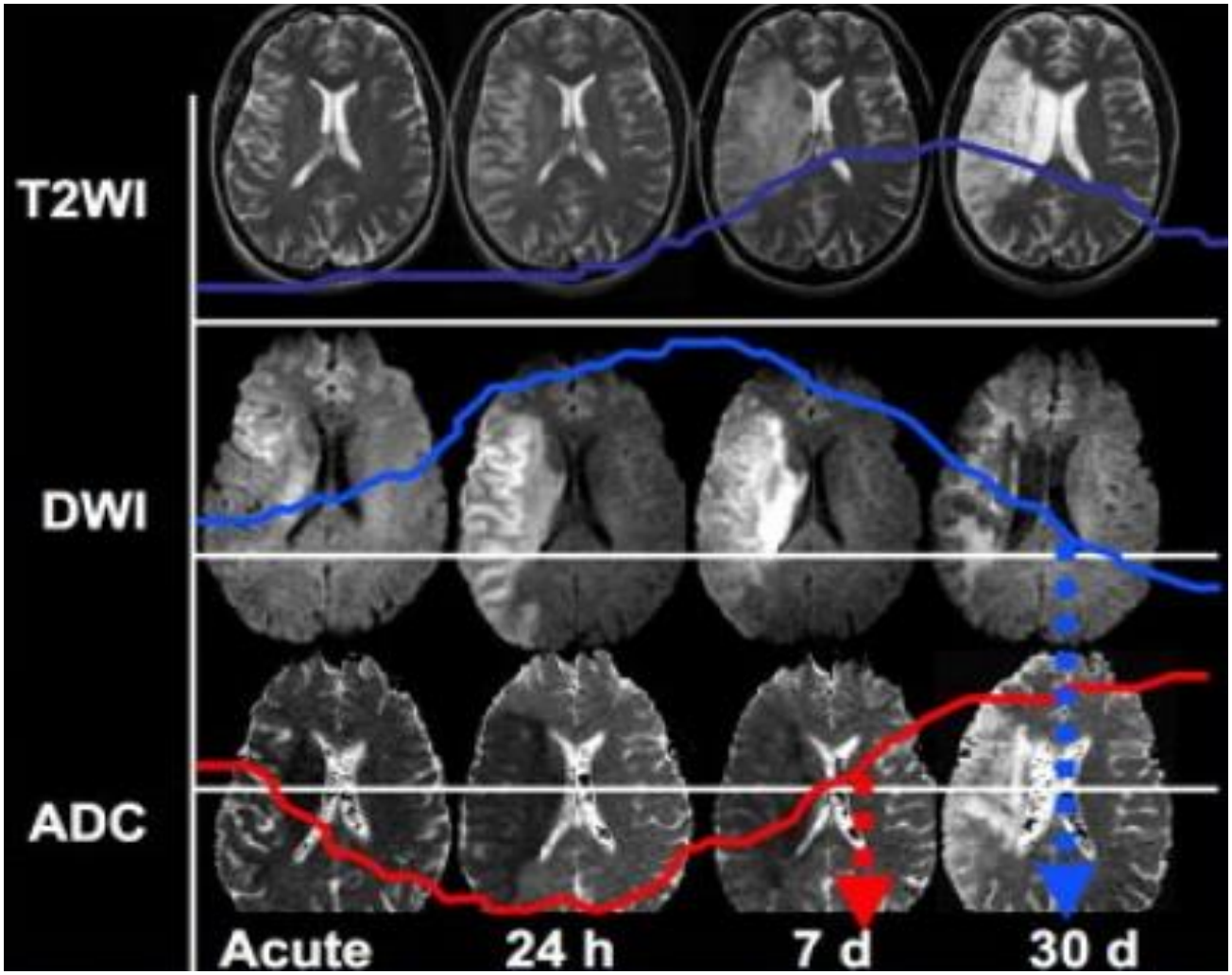


Old/ Chronic infraction:

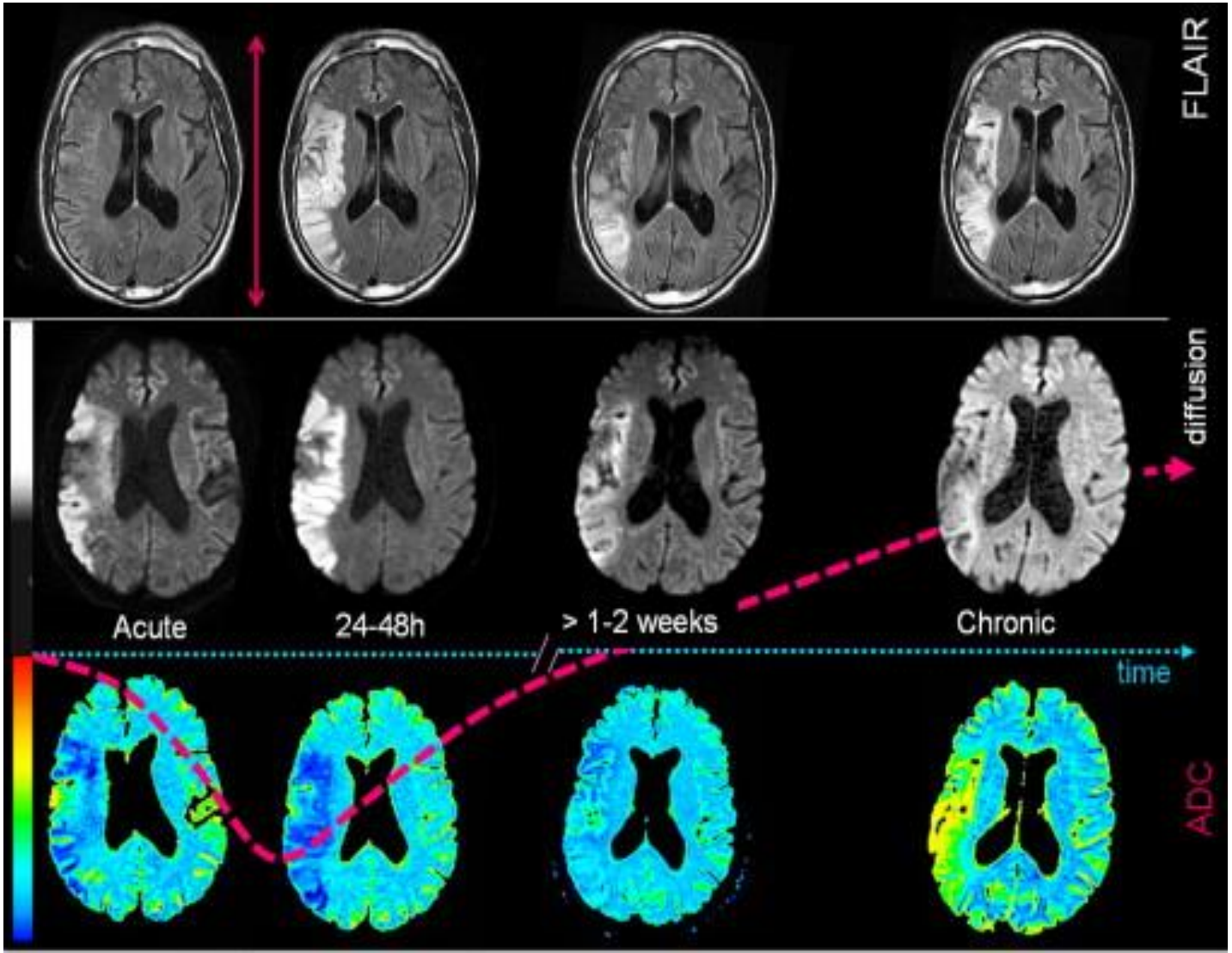
DWI- Hypointensity

ADC- Hyperintensity

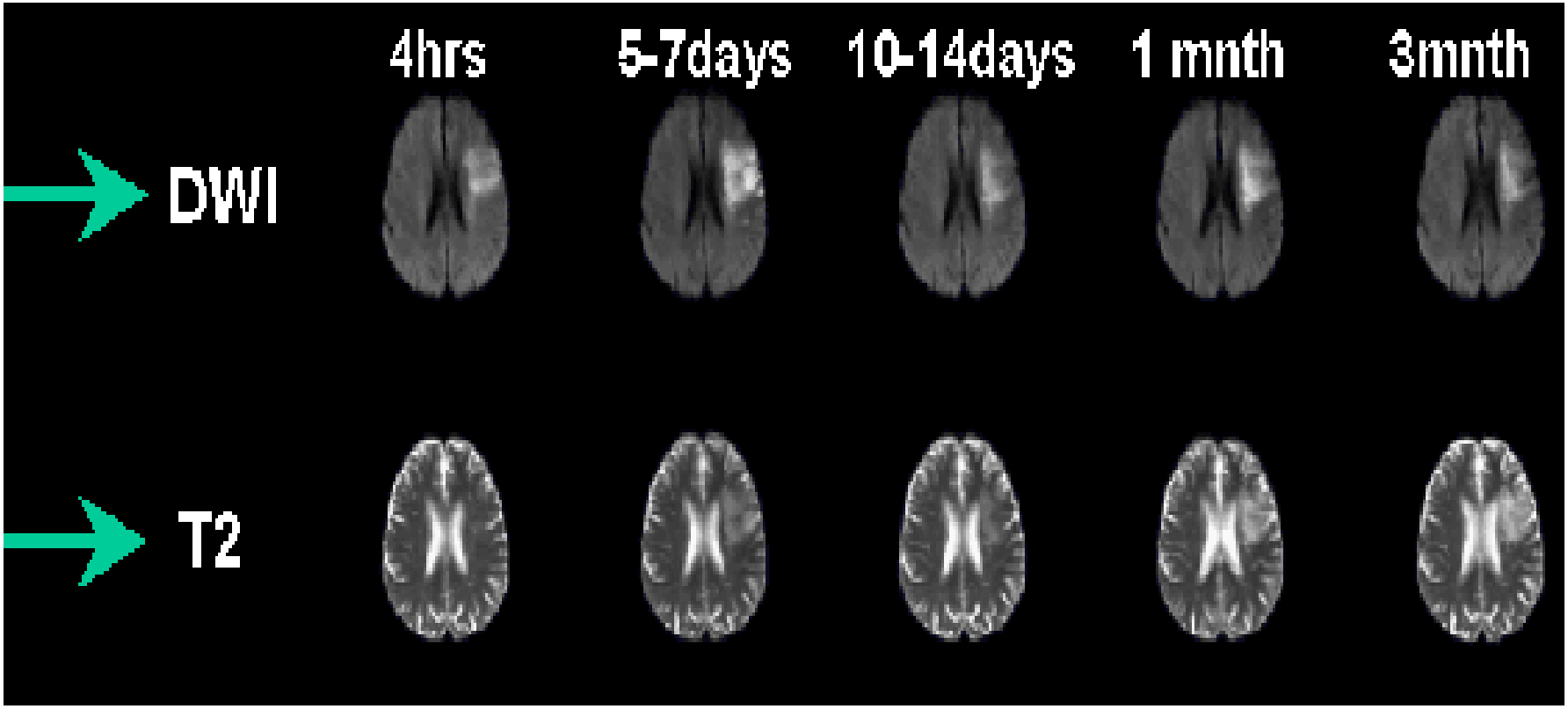
Comparison of the findings on T2WI with DWI and ADC in time to evaluate of Ischaemic stroke



Temporal changes on time in ischemia on FLAIR) and DWI and ADC map



Acute ischaemic stroke and DWI – sequential changes with time



MRI Evaluation of Intracranial Hemorrhage

Goals of MRI in the Evaluation of ICH

- To recognize the presence of blood
- To localize and differentiate hemorrhages (intra-axial versus extra-axial):
  - if **intra-axial**, to locate the specific neuroanatomical localization (stroke).
  - if **extra-axial**, to differentiate subarachnoid hemorrhage (SAH), subdural hematoma (SDH), and epidural hematoma (EDH);
- To determine the age of the hemorrhage.
- To identify the etiology.
- To aid in managing the bleed and in ascertaining the patient's prognosis.

Gradient-echo (GRE)

- GRE is **T2* - based sequence**, which is extremely sensitive to local magnetic field inhomogeneity and is especially useful for **detection of microhemorrhages**, which may be undetectable by other sequences.

- Microbleeds are usually defined as cerebral bleeds **less than 5-10 mm** in size

Table: MRI Evaluation of Intracranial Hemorrhage

Stages	Time	T1	T2	FLAIR	T2 GRE	DWI
Hyper acute	<24hours	Isointense	Hyperintense	Hyperintense	**Variable**	Hyperintense
Acute	>24 hr- <1week	Isointense/ Hypointense	Hypointense	Hypointense	**Hypointense**	Hypointense
Early Subacute	>1 wk- 2week	Hyperintense	Hypointense / Isointense	Hypointense / Isointense	**Hypointense / Isointense**	Hypointense
Late Subacute	>2wk-4 week	Hyperintense	Hyperintense	Hyperintense	**Hyperintense**	Hyperintense
Chronic	>4week	Isointense/ Hypointense	Hyperintense/ Isointense	Variable	**Isointense/ hyperintense**	Variable

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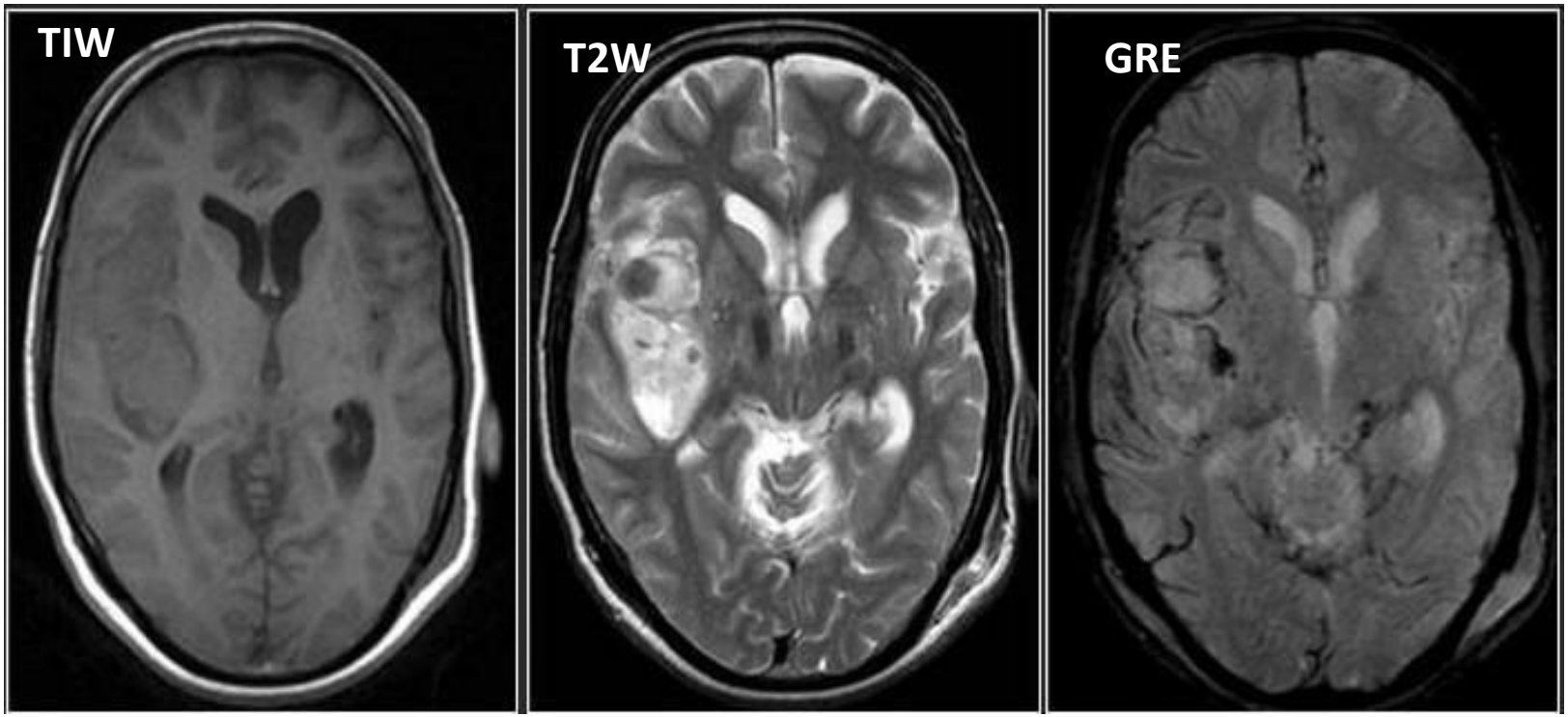
Mnemonic to help recall the signal changes at stages hemorrhage.

"It Be IdDy BiDy BaBy Doo Doo"		
Stages	T1W	T2W
Hyperacute (<24hrs)	Isointense	Bright
Acute (>24hrs-<1wk)	Isointense	Dark
Early subacute (>1wk-2 wk)	Bright	Dark
Late subacute(>2 wk-<4wk	Bright	Bright
Chronic >4 wks	Dark	Dark
I=Isointense B=Bright D=Dark		

Hyperacute hematoma <24 hour



Stages	Time	T1	T2	FLAIR	T2 GRE	DWI
Hyper acute	<24hours	Isointense	Hyperintense	Hyperintense	Variable	Hyperintense

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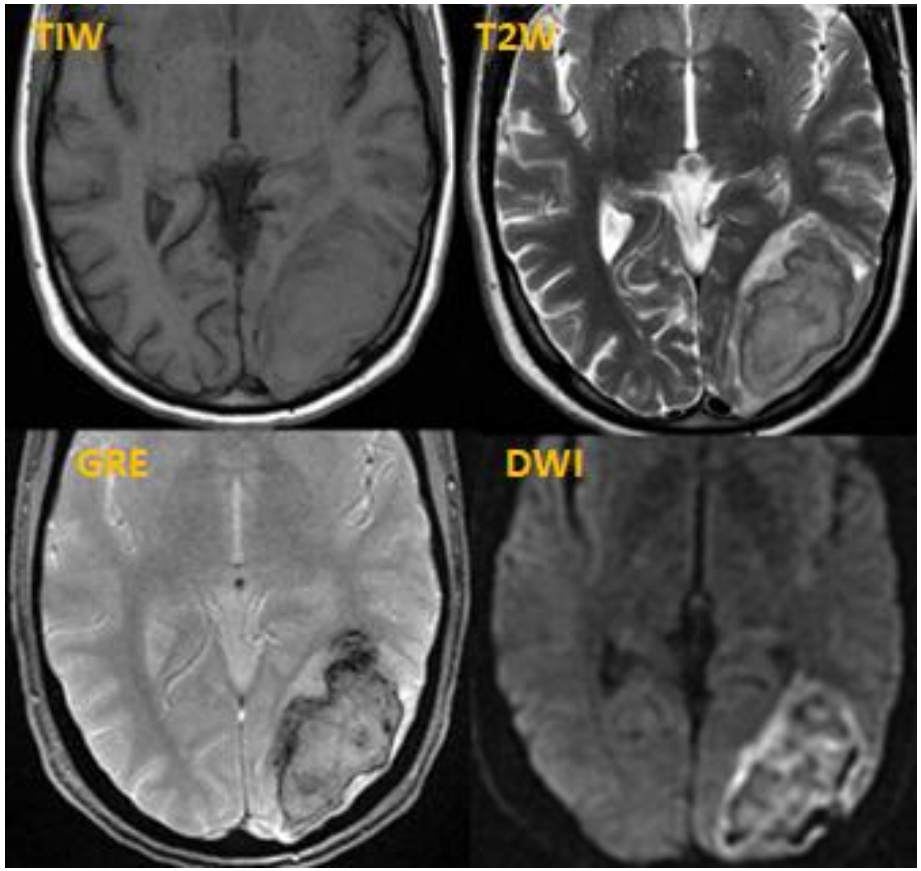
Hyperacute hematoma <24 hour



Stages	Time	T1	T2	FLAIR	T2 GRE	DWI
Hyper acute	<24hours	Isointense	Hyperintense	Hyperintense	Variable	Hyperintense

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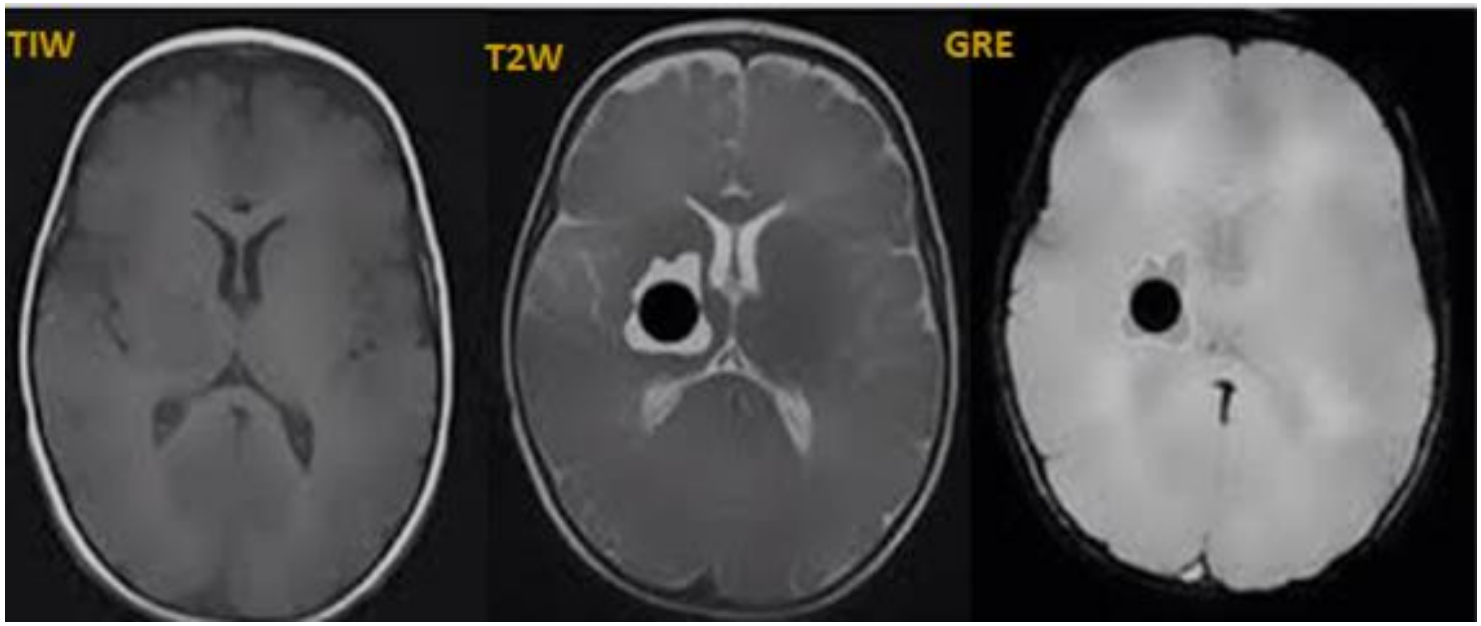
Acute hematoma >24 hr- < 1week



Stages	Time	T1	T2	FLAIR	T2 GRE	DWI
Acute	>24 hr- <1week	Isointense /hypointense	Hypointense	Hypointense	Hypointense	Hypointense

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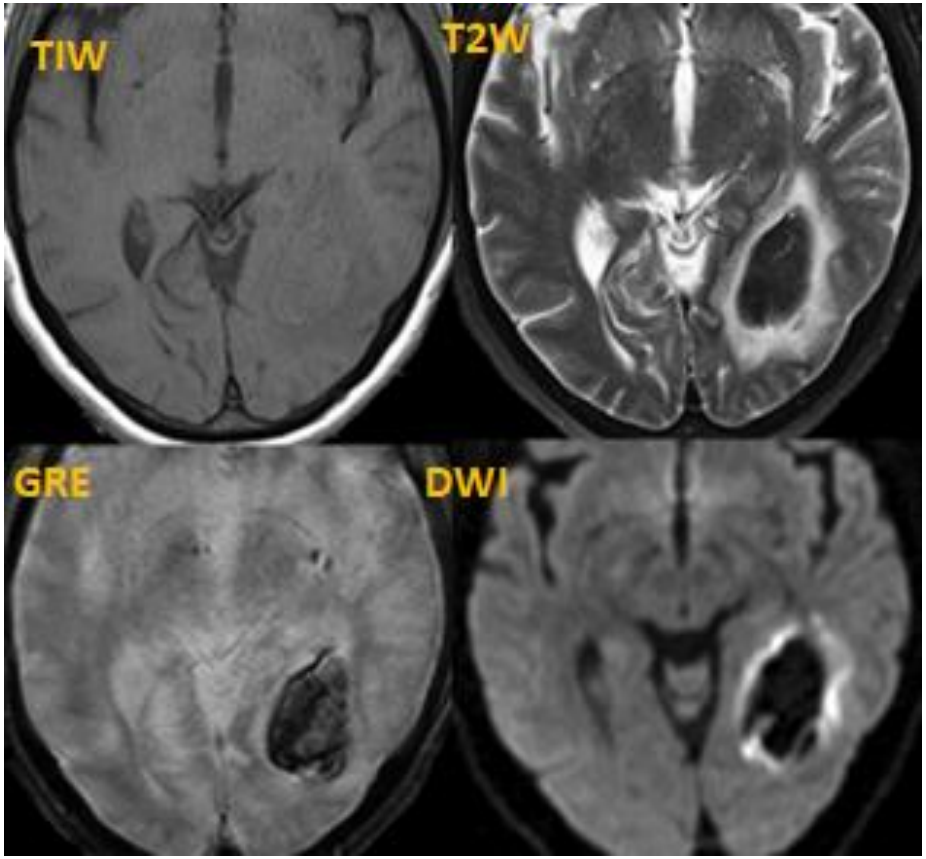
Acute hematoma >24 hr- < 1week



Stages	Time	T1	T2	FLAIR	T2 GRE	DWI
Acute	>24 hr- <1week	Isointense	Hypointense	Hypointense	Hypointense	Hypointense

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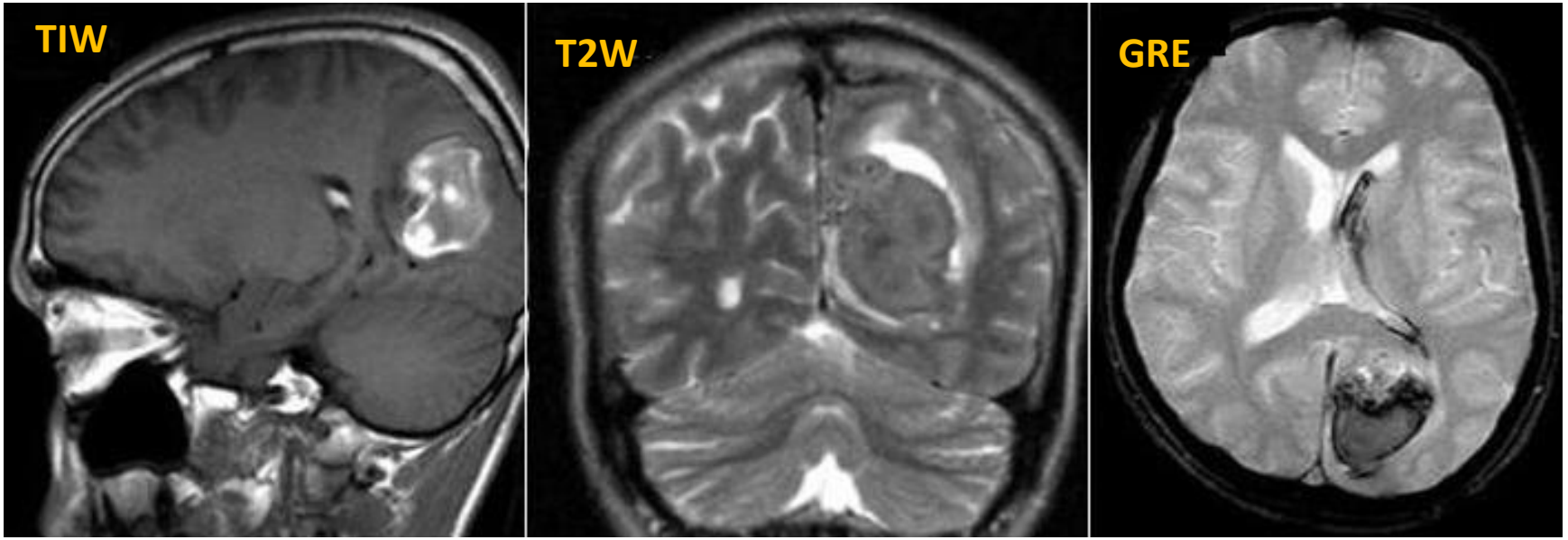
Early subacute hematoma >1 wk- 2week



Stages	Time	T1	T2	FLAIR	T2 GRE	DWI
Early Subacute	>1 wk- 2week	Hyperintense	Hypointense / Isointense	Hypointense / Isointense	Hypointense / Isointense	Hypointense

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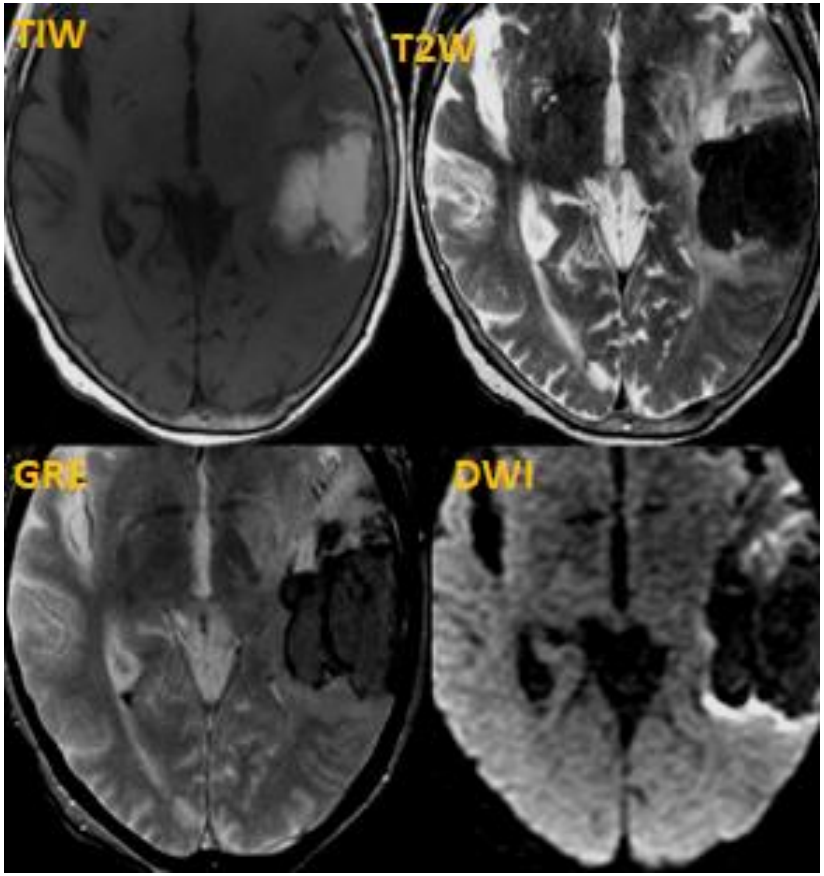
Early subacute hematoma >1 wk- 2week



Stages	Time	T1	T2	FLAIR	T2 GRE	DWI
Early Subacute	>1 wk- 2week	Hyperintense	Hypointense / Isointense	Hypointense / Isointense	Hypointense / Isointense	Hypointense

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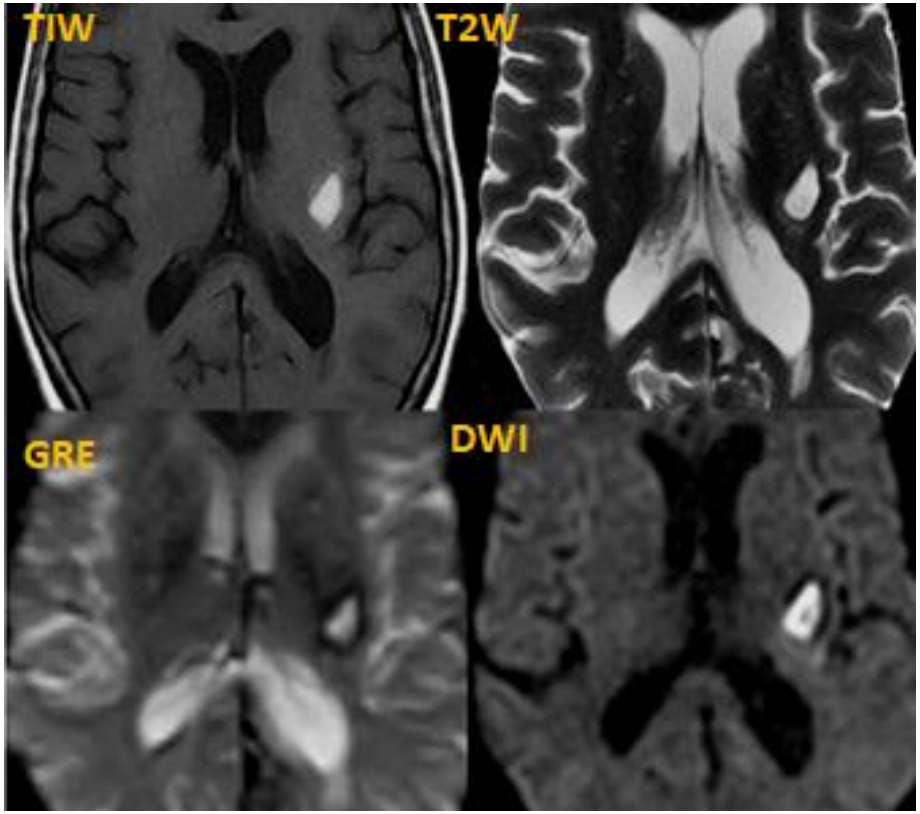
Late subacute hemorrhage >2week-4 week



Stages	Time	T1	T2	FLAIR	T2 GRE	DWI
Late Subacute	>2wk-4 week	Hyperintense	Hyperintense	Hyperintense	Hyperintense	Hyperintense

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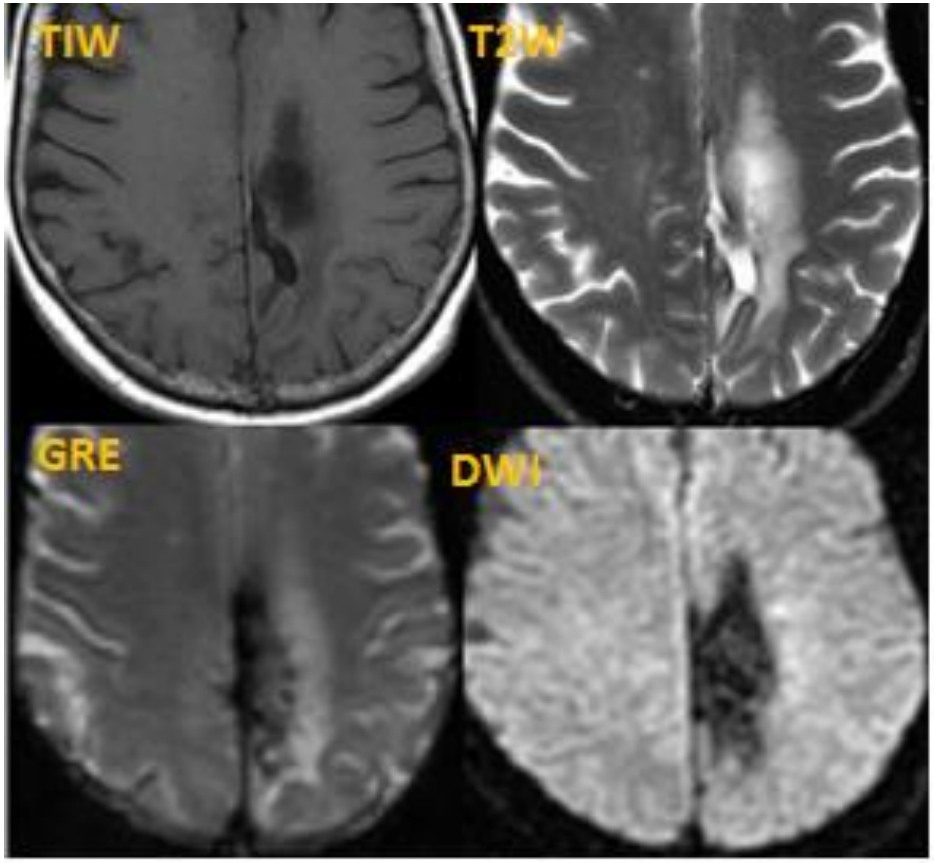
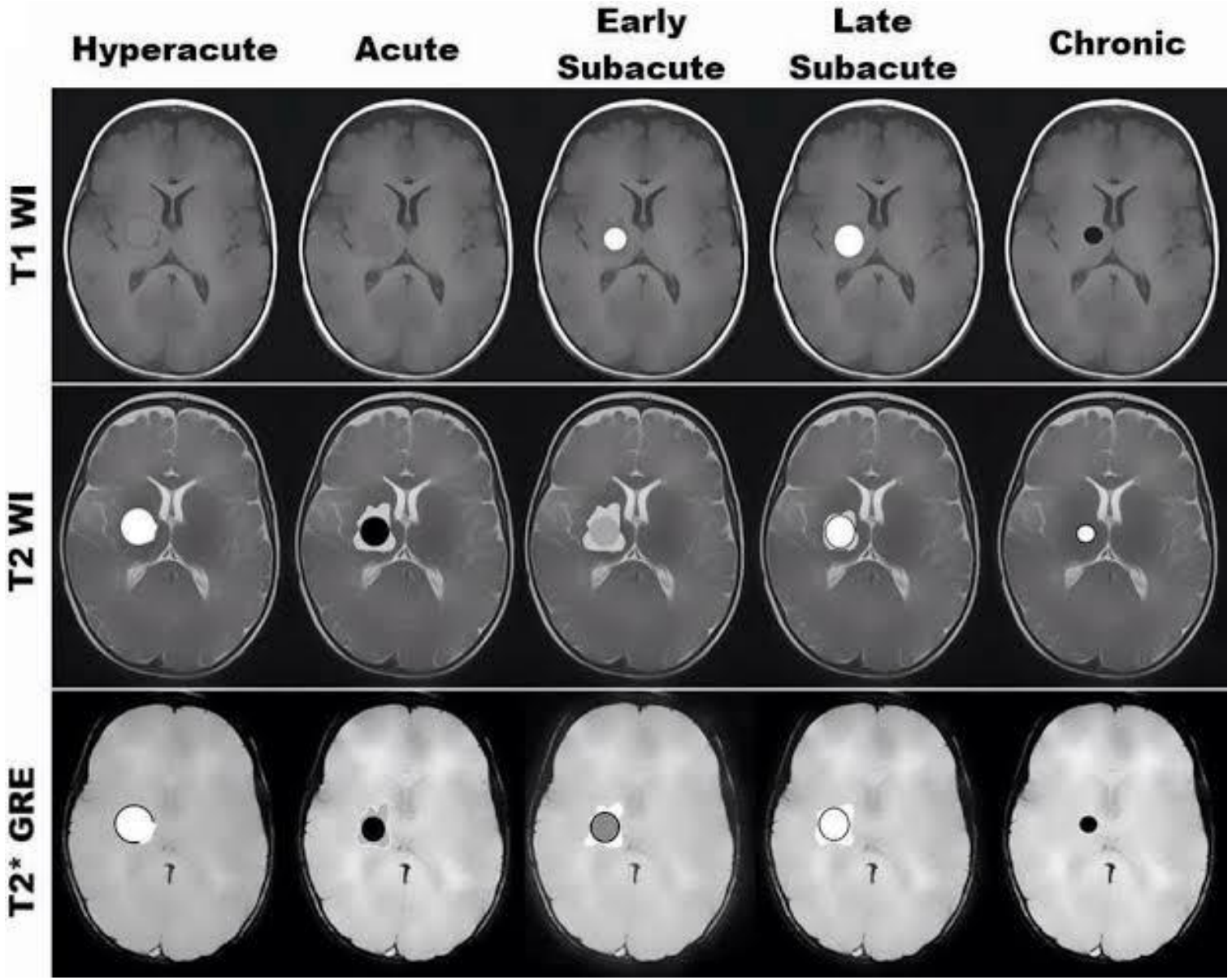
Chronic hematoma >4week



Stages	Time	T1	T2	FLAIR	T2 GRE	DWI
Chronic	>4week	Isointense/ Hypointense	Hyperintense/ Isointense	Variable	Isointense/ hyperintense	Variable

MRI findings of different stages of haemorrhage



Scenerio-4

- A 60-year-old man of no fixed abode was found ‘collapsed’ on the street by a passerby.
- An ambulance was called and he was taken to the emergency department.
- On examination, his GCS was 9 (M3, V2, E4).

Scenerio-4

Questions

a. What are the findings of non-contrast CT scan of head

b. What is the most likely diagnosis?

c. Which arterial lesion is it?

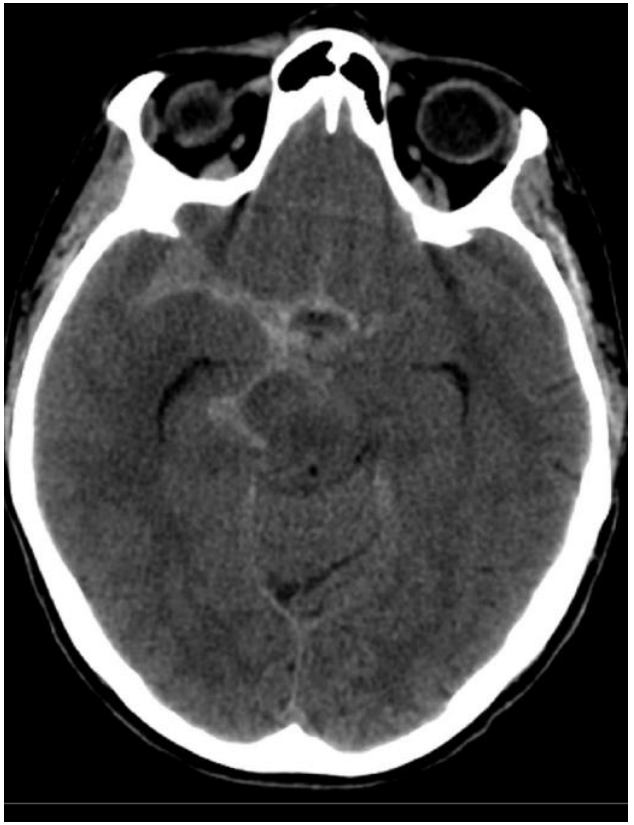


Figure: Non-contrast CT scan of head (axial section)

Answers

a. Findings are:

i)Hyperdensity in the basal cisterns and more in the right sylvian fissure

ii)Visualization of inferior horn

iii) Moderate brain swelling.

b. SAH with hydrocephalus

c.Right Middle cerebral artery

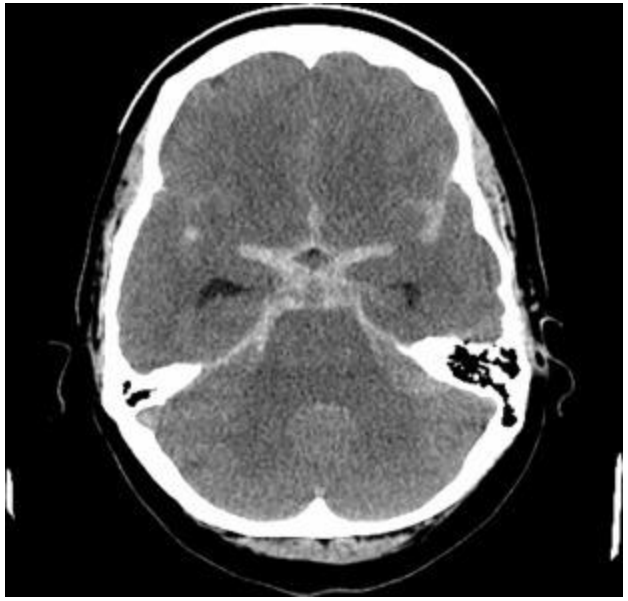
Scenario -5

- This 45-year-old male presented to the emergency department after an sudden severe headache followed by loss of consciousness and fall with head strike.
- He underwent CT. A non-contrast axial reformat is shown.

Scenario -5

Questions

- What is the most likely diagnosis?
- What may be the cause



Non-contrast CT Scan of brain

Answers

- SAH
- Rupture left Middle cerebral artery anaeurysm

Subarachnoid haemorrhage (SAH)

- **Location of aneurysm rupture**

1. Approximately **85%** of Saccular aneurysms occur in the anterior circulation.
2. The most common sites of rupture are as follows:
    a) Posterior communicating (PCom) junction **(40%).**
    b) Anterior communicating (ACom) artery/anterior cerebral artery **(34%).**
    c) Middle cerebral artery (MCA) **(20%).**
    d) Vertebrobasilar and other arteries **(5%).**

Location of aneurysm rupture

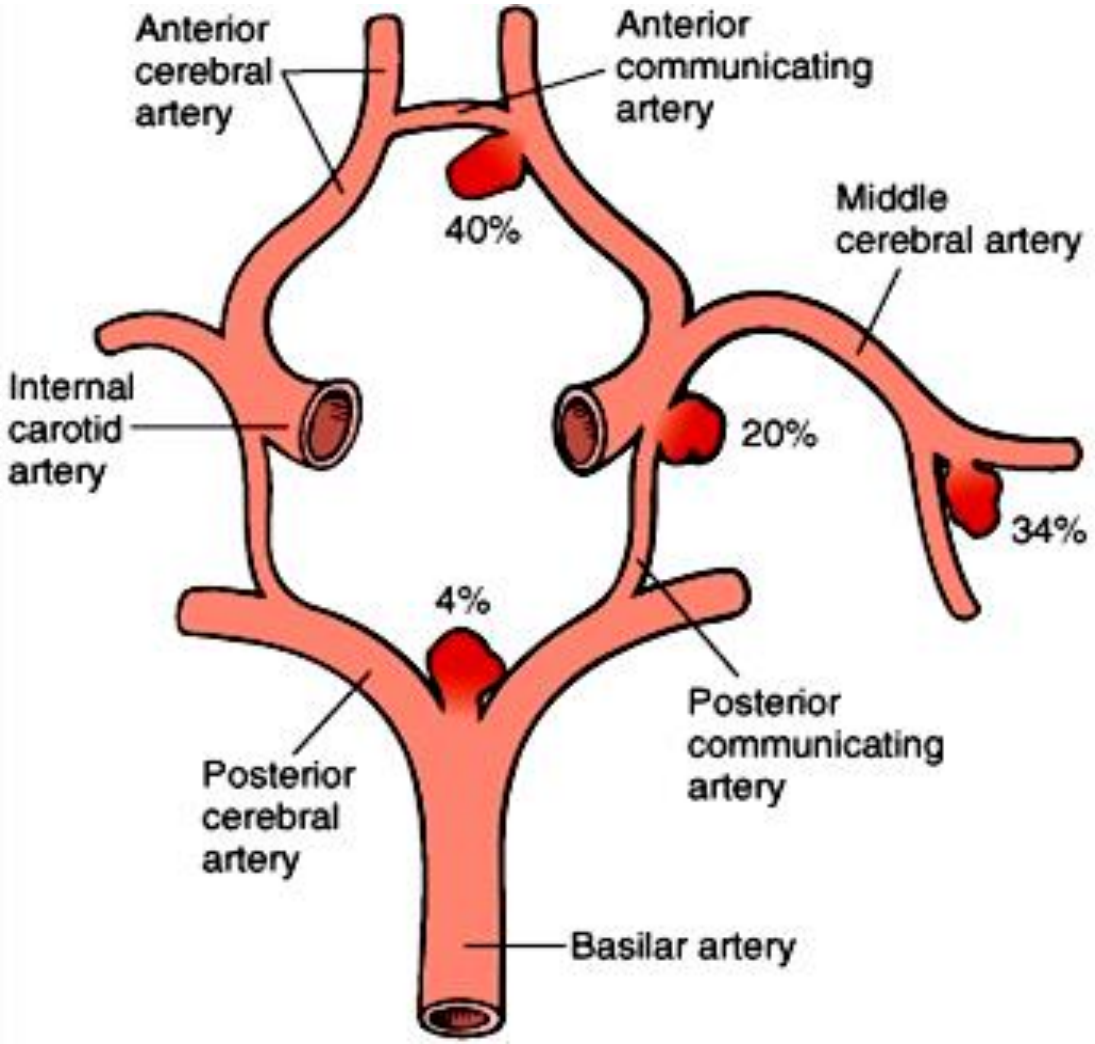


Figure: Schematic presentation of the most common sites of aneurysmal rupture

Key steps in looking for SAH

- Compare left and right
- Look for SAH in the sulci, remember blood will settle into the sulci not on the gyri.
- Look in the usual locations – **sylvian fissure, interhemispheric fissure, basal and prepontine cisterns.**
- Look for associated features like hydrocephalus, infarction, giant aneurysms and haematoma.
- Above ALL – remember the clinical history is your best clue!

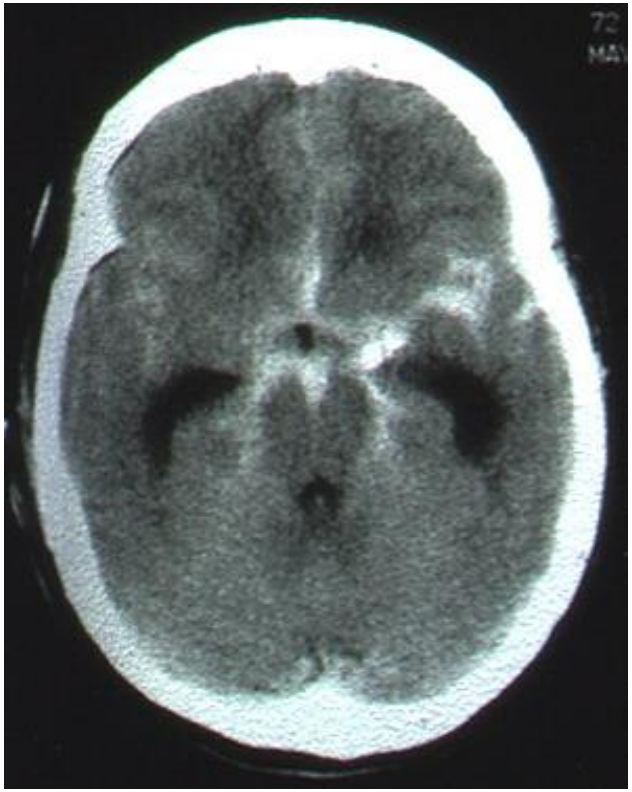
Sites of ruptures of SAH

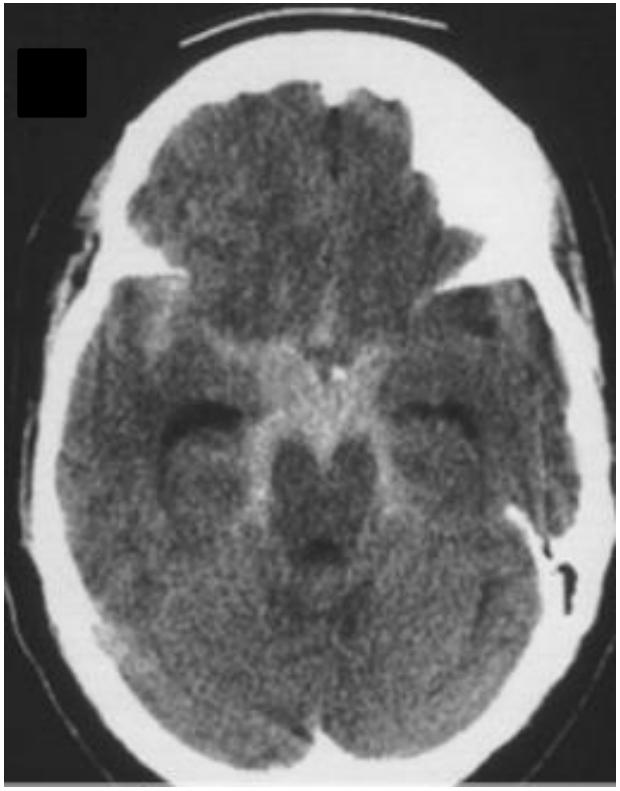
- Although anterior circulation rupture is more prevalent, causing 90% of bleeds.
- 20% of patients presenting with a SAH have multiple aneurysms.

Prediction sites of aneurysmal ruptures on CT Scan

- The bleed patterns on CT vary according to the site of aneurysmal rupture in SAH .

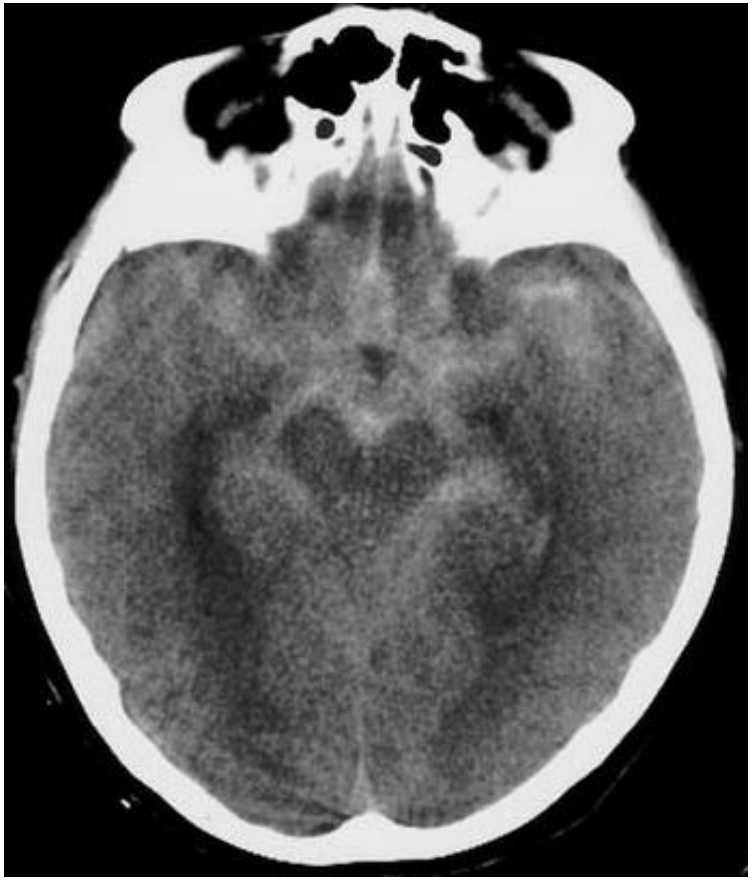
MCA artery aneurysm

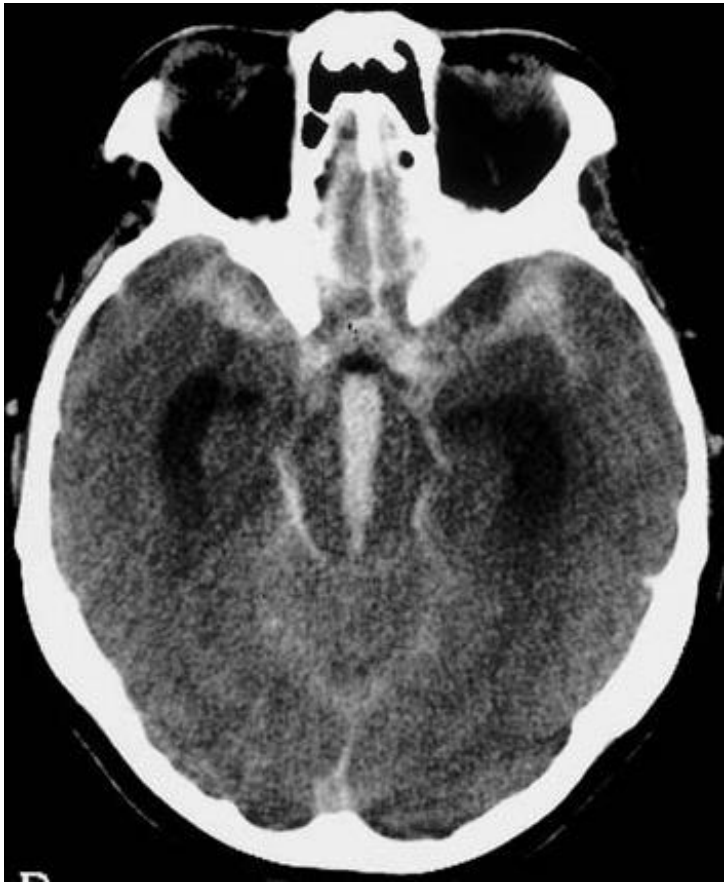




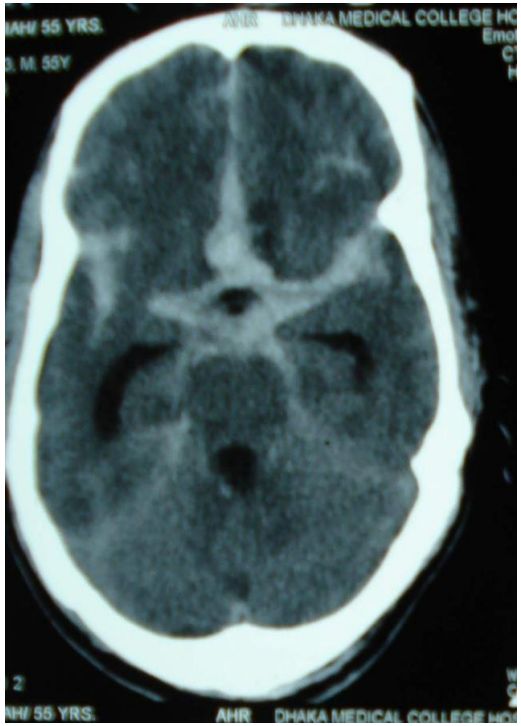
The typical appearance usually consists of a focal haematoma at the site of MCA aneurysmal rupture – adjacent to the **ipsilateral basal ganglia and sylvian fissure** but extending bilaterally into the basal cisterns.

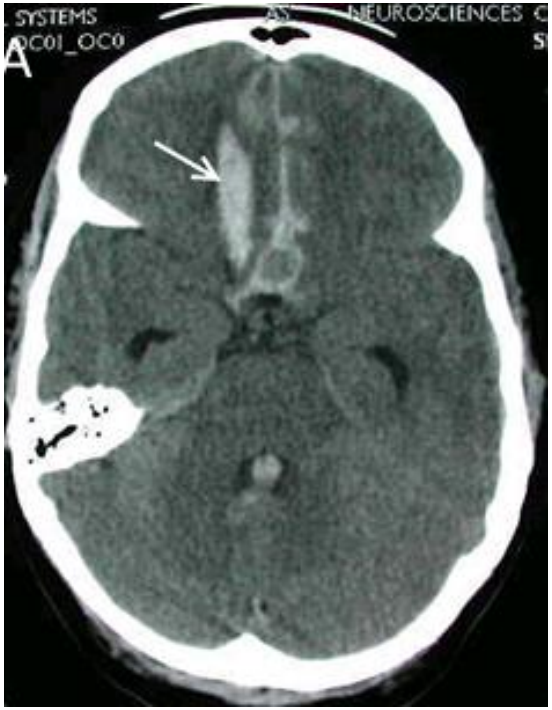
MCA artery aneurysm





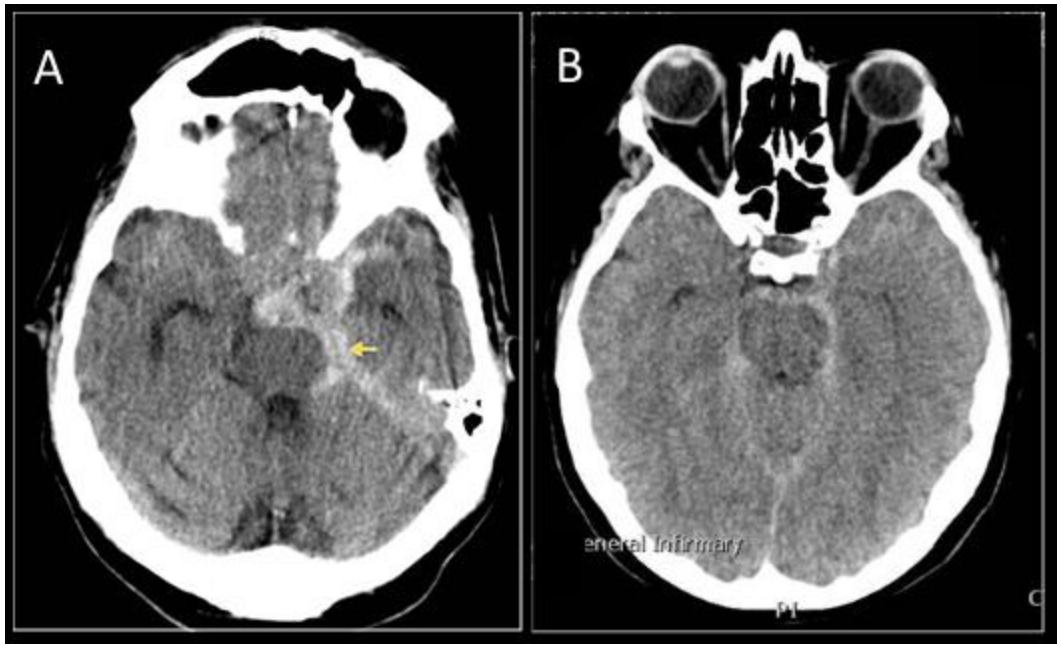
ACom aneurysm





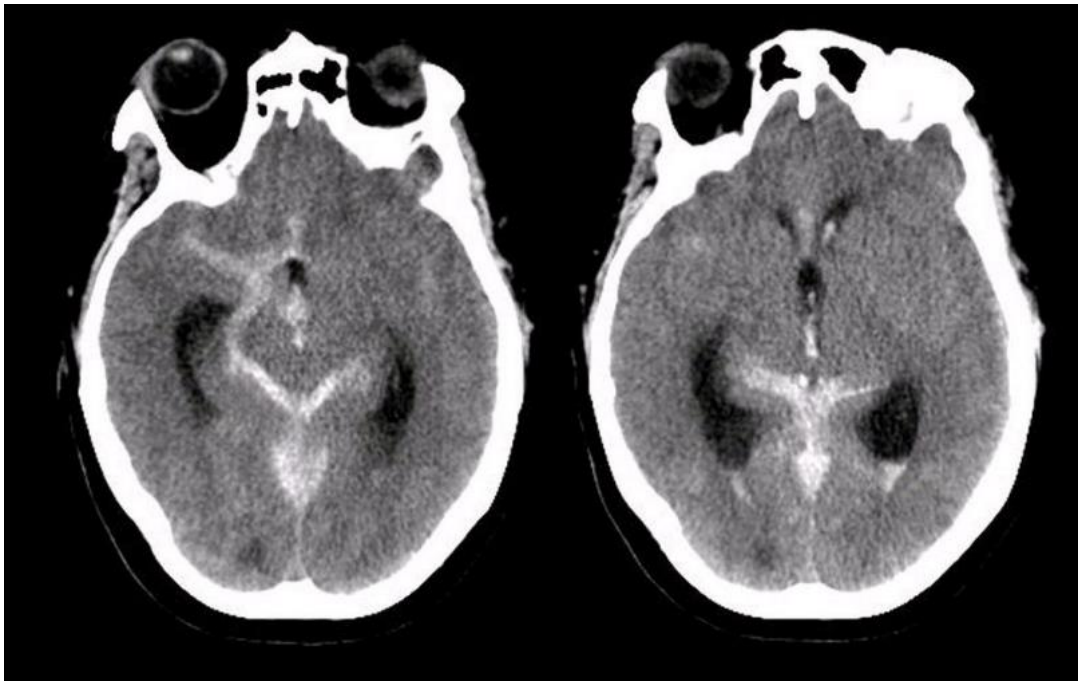
An ACOM aneursym often ruptures superiorly into the **frontal interhemispheric** fissure. There is usually a **"flame shaped"** haematoma located in the contralateral medial frontal lobe.

PCom aneurysm



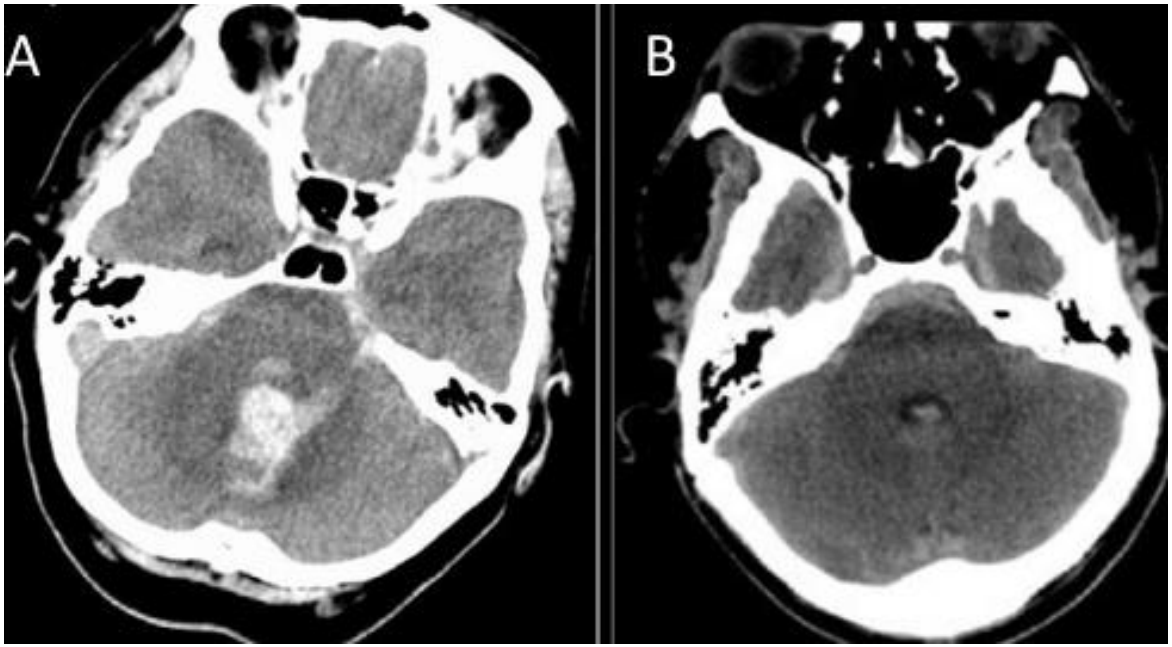
Typical PCOM aneurysmal rupture - commonly signified by focal haemorrhage around the **suprasellar cistern** with bilateral extension and an ipsilateral **medial temporal lobe haematoma**

Basilar artery aneurysm



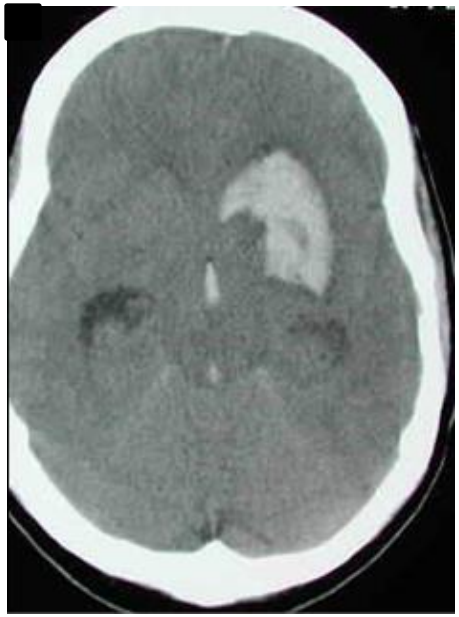
In a basilar aneurysm rupture, there is greater density in **the posterior fossa**. Intraventricular extension is possible, seen in the **third ventricle**

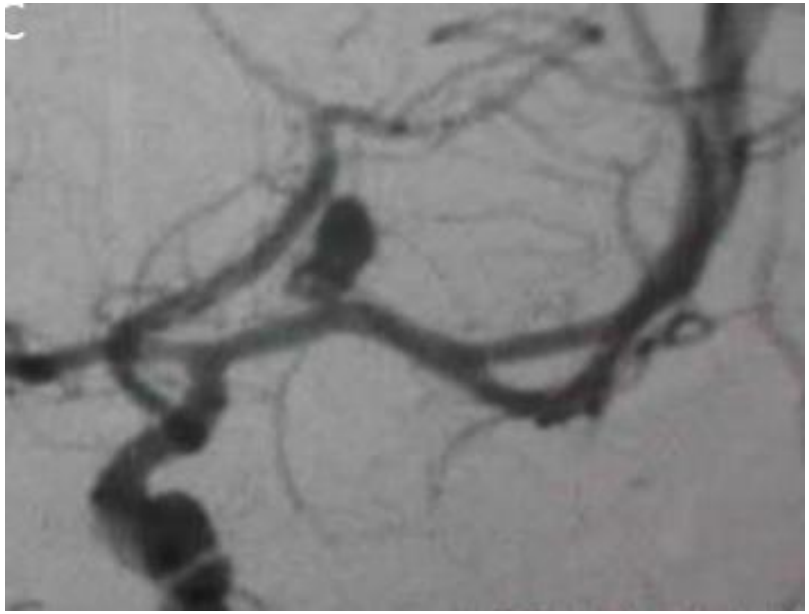
PICA Aneurysm



PICA Aneurysm rupture gives rise to haemorrhage which is often limited to the **posterior fossa and upper cervical region**. There is asymmetric blood in the cerebellopontine angle cisterns. In PICA rupture there is acute haemorrhage involving the 4th ventricle.

Cerebral DSA is the gold standard for diagnosis of Aneurysm





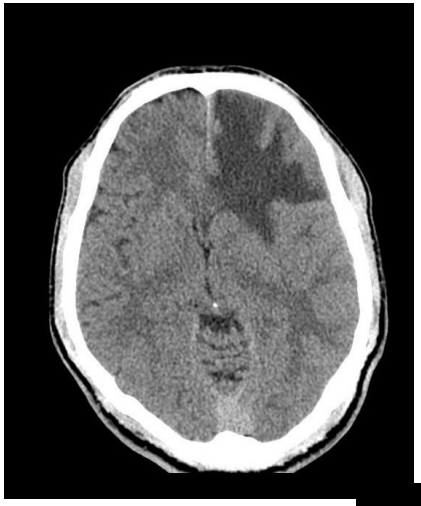
Senerio-5

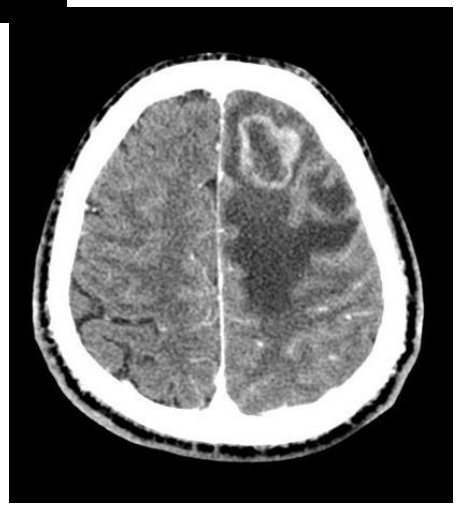
- A 45-year-old woman presented with chief complaints of chronic headache but now she complaints of early morning vomiting followed by hemiparesis.
- She was attended to a neurologist and A CT scan of brain with contrast was done.
- Answer the following questions.

Senerio-5

Questions

1. Describe abnormalities in this CT scan
2. Which of the following is the most likely cause?





Answers

1. Abnormalities in this CT scan :
   a) Hypodense lesion present in the left frontal lobe
   b) contrast enhancement with irregular thick wall of the lesion
   c) Marked surrounding vasogenic edema
2. Glioblastoma

Senerio-6

- This 30 years old patient has presented with history of fever, headache and vomiting for three days.
- He has history of chronic sinusitis.
- A CT scan of brain with contrast has done

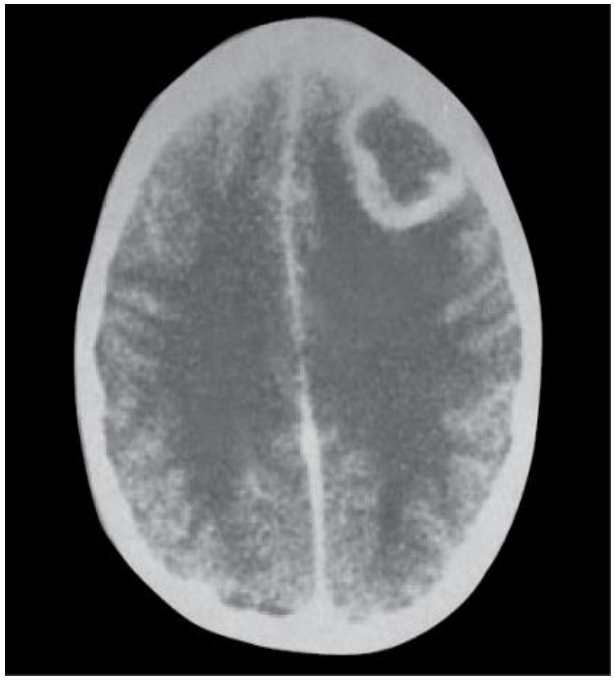
Senerio-6

Questions

1. What is the diagnosis?

Answer:

CT scan Brain with contrast shows enhanced lesions probably Brain abscess



CT Scan of brain with contrast

Senerio-7

- A 45-year-old female with no clear history of recent infection or a past record of sinusitis or otitis media.
- The patient was hospitalized due to symptoms of headache and right limb weakness for 1 week.
- A MRI of brain with contrasr was done

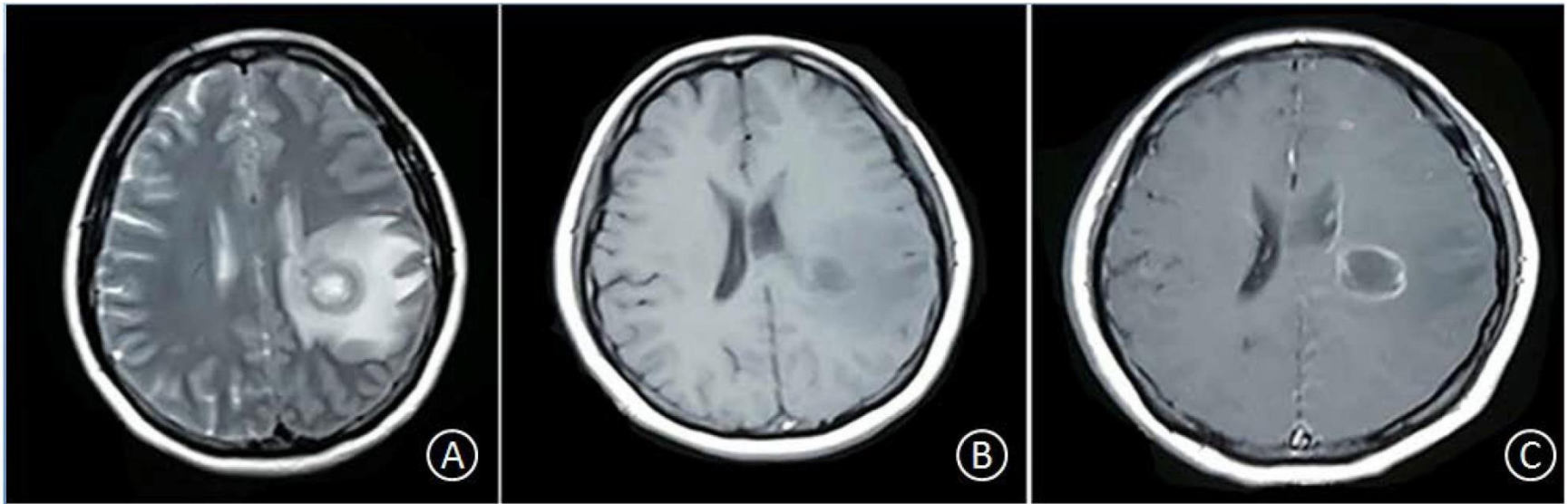
Senerio-7

Questions

1. Describe abnormalities in this CT scan
2. Which of the following is the most likely cause?

Answers

1. Abnormalities in this CT scan :
   a) circular space-occupying lesion with T2WI and lTW1 signal shadows was observed in the left basal ganglia
   b) contrast enhancement with irregular thick wall of the lesion
   c) Marked surrounding vasogenic edema
2. Brain abcess / Glioblastoma



Single ring enhanced lesion

1. Cerebral abscess
2. Primary brain tumour (usually glioma)
3. Single metastasis
4. Single tuberculoma

- ** Ring enhancement is due to **breakage of BBB** due to compression by rapidly growing SOL in brain

Single Ring enhanced lesions of brain

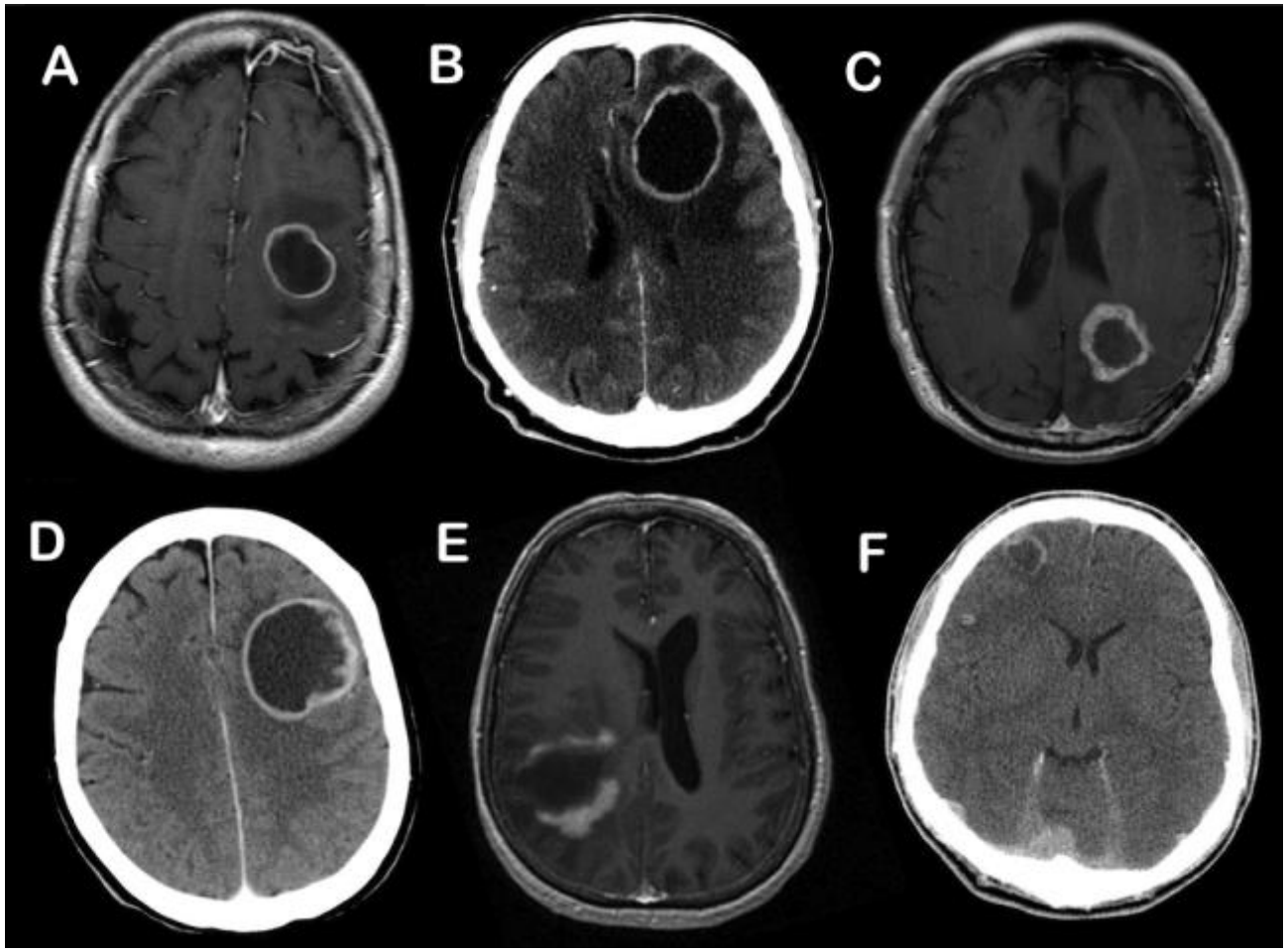


Figure: **Single Ring enhanced lesions of brain:** A = metastasis, B = abscess, C = radiation necrosis, D = GBM, E = demyelination, F = contusion.

Multiple ring enhanced lesions

1. Tuberculoma
2. Secondaries
3. Multiple abscess
4. Multiple metastasis

- Same D/D but sequence is changed:
- ** Tuberculoma and metastasis is usually multiple whereas cerebral abscess is usually single.

Peripheral or ring enhancing cerebral lesions

Includes:

1. **Cerebral abscess**
2. **Tuberculoma**
3. **Neurocysticercosis**
4. **Metastasis**
5. **Glioblastoma**
6. Subacute infarct /haemorrhage /contusion
7. Demyelination (incomplete ring)
8. Tumefactive demyelinating lesion (incomplete ring)
9. Radiation necrosis
10. Postoperative change
11. Lymphoma - in an immunocompromised patient

Cerebral ring enhancing lesions

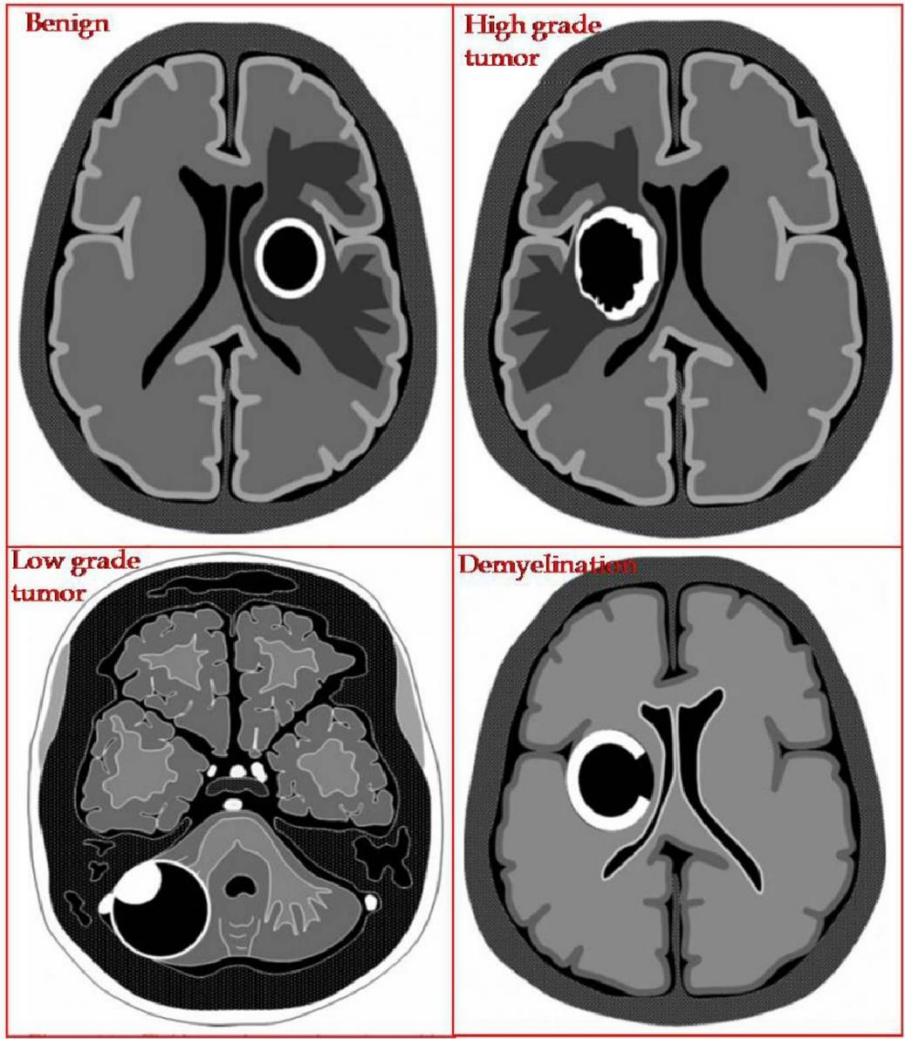
Mnemonic: **MAGIC DR**

- **M** - Metastasis
- **A** - Abscess
- **G** - Glioblastoma multiforme
- **I** - Infarct (subacute phase)
- **C** - Contusion
- **D** - Demyelinating disease (eg. tumefactive MS)
- **R** - Radiation necrosis

Characteristics of ring enhancing lesions

- **Enhancing wall characteristics**
  1. **Thick** and nodular favours neoplasm
  2. **Thin** and regular favours abscess
  3. **Incomplete ring** often opened toward the cortex favours demyelination
  4. Intermediate to low T2 signal capsule favours abscess
  5. Restricted diffusion of enhancing wall favours GBM or demyelination

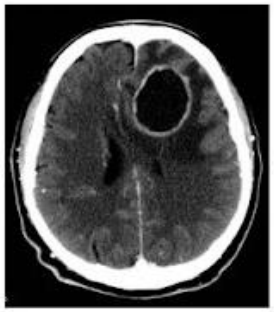
Enhancing wall characteristics



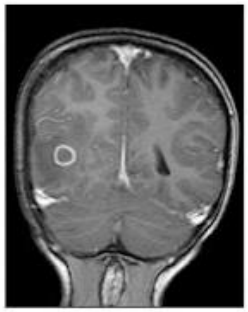
Border of wall characteristics

Infection

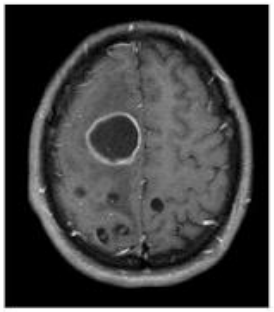
Thinner borders, regular borders
Diffusion restriction! (ask for DWI)



Bacterial abscess



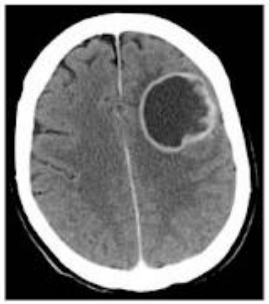
Tuberculoma

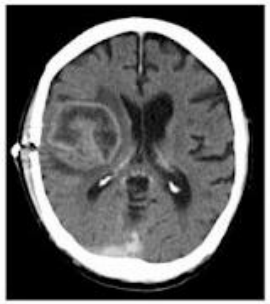


Neuro-cysticercosis

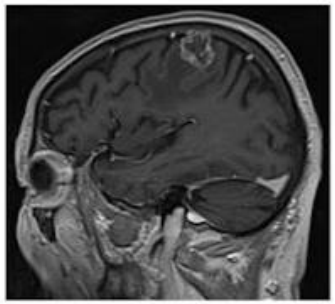
Malignancy

Thick, irregular borders





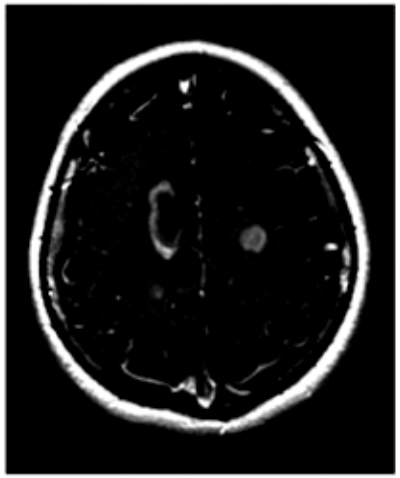
Glioblastoma



Metastasis

Ring completeness

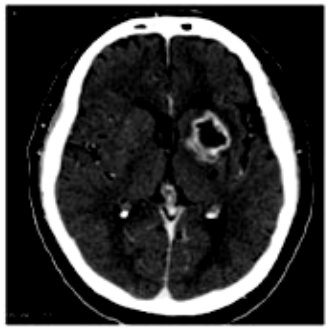
Incomplete



Demyelinating disease

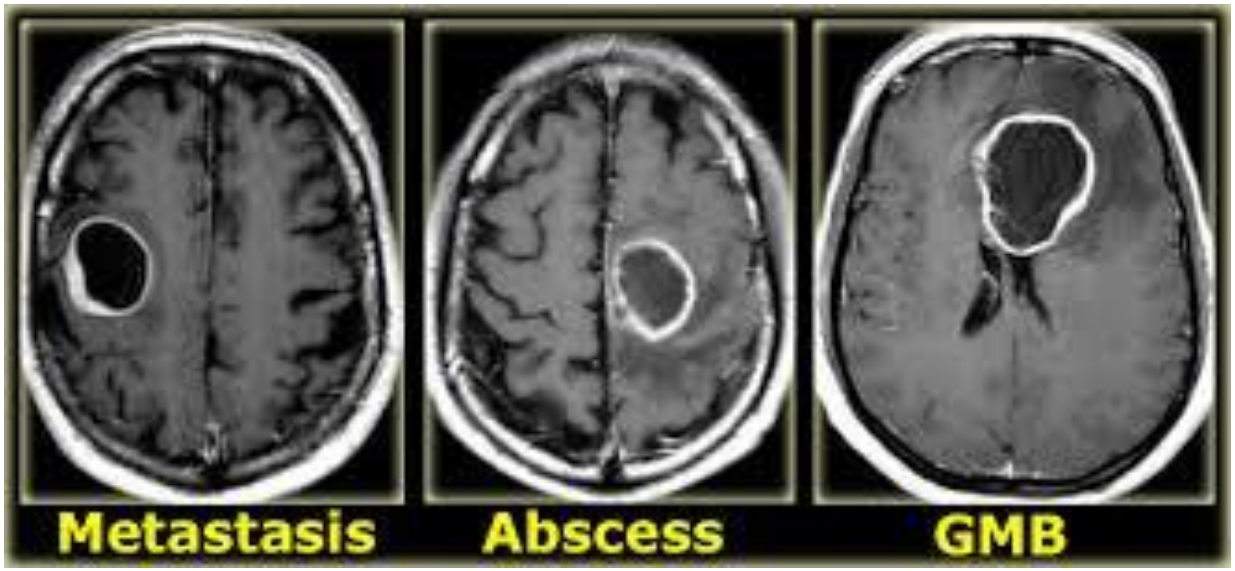
Complete

Metastasis
Autoimmune
Glioblastoma
Infection/Infarct
Contusion

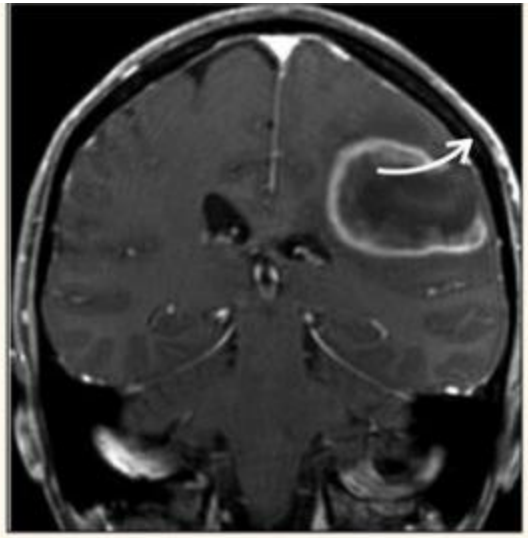


Subacute stroke

Closed ring lesions

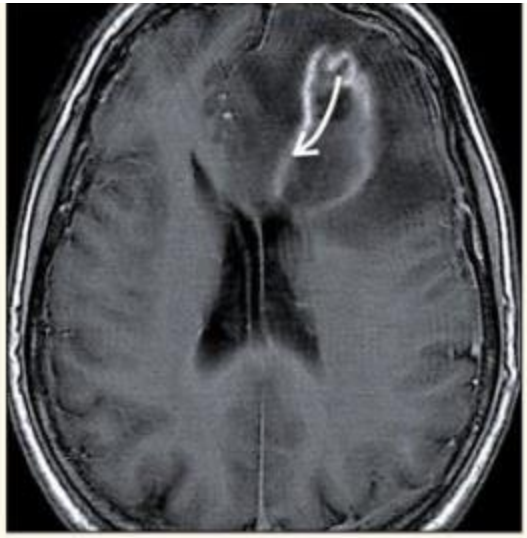


Open ring enhancement



Open towards periphery

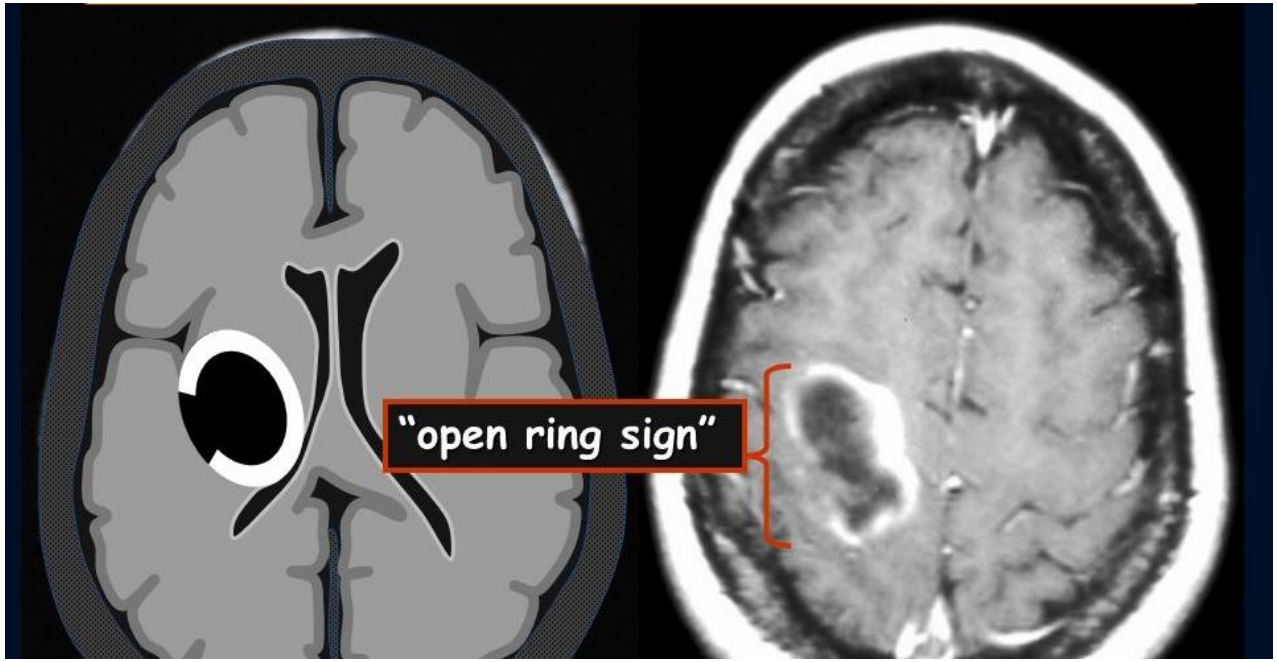
Demyelinization



Open towards ventricle

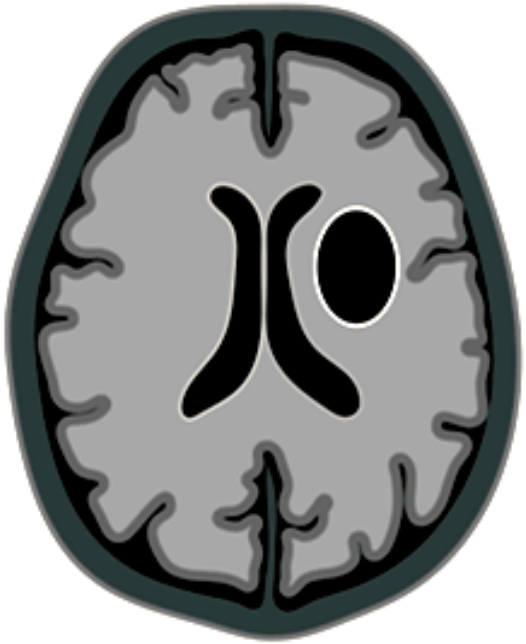
Abscess

Open ring lesions



Incomplete ring often opened toward the cortex favors **demyelination** with oedema

Smooth ring pattern

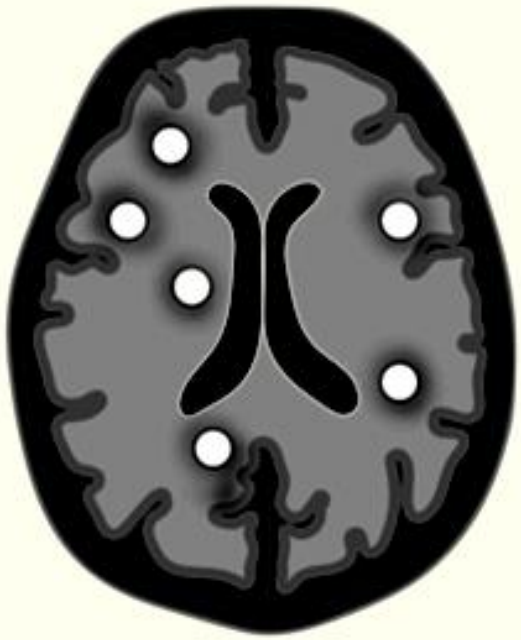


- Abscess
- Low grade glioma
- Resorbing hematoma
- MS
- Toxoplasmosis
- Subacute infarction

Irregular ring pattern

- Necrotic tumor
- Metastases
- Resorbing hematoma
- GBM
- Lymphoma in immunocompromised

Nodular – solid enhancement



- Metastases
- Lymphoma
- Multiple Sclerosis
- Septic emboli

Peripheral or ring enhancing cerebral lesions

- **Surrounding oedema:**
  1. Extensive oedema relative to lesion size favours abscess
  2. Increased perfusion favours neoplasm (metastases or primary cerebral malignancy)

Peripheral or ring enhancing cerebral lesions

- **Central fluid content:**
  1. Restricted diffusion favours abscess
  2. Absence of diffusion restriction favour a tumour with a central necrotic component (classically a metastases)

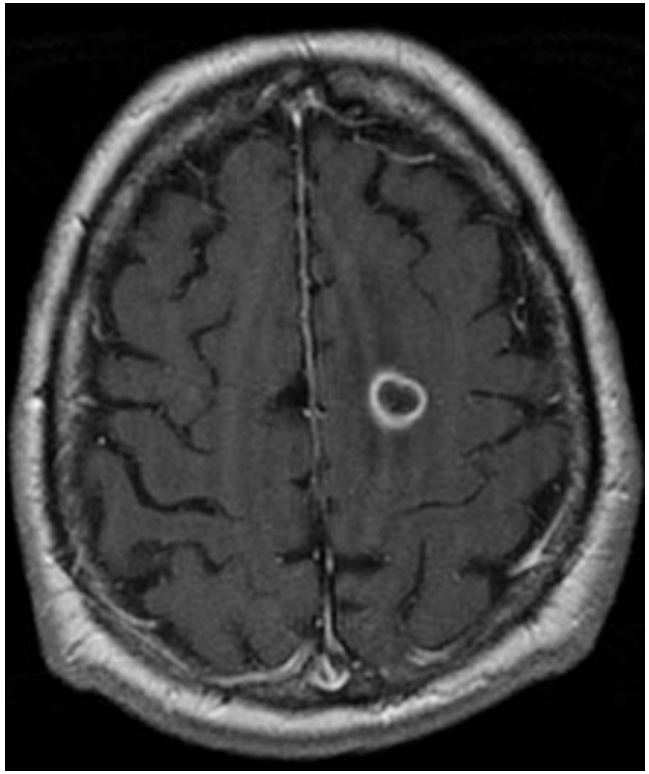
Peripheral or ring enhancing cerebral lesions

- **Number of lesions:**
  1. Similar sized rounded lesions at grey-white matter junction favours metastases or abscesses
  2. Irregular mass with adjacent secondary lesions embedded in the same region of 'oedema' favours GBM
  3. Small (<1-2cm) lesions with thin walls especially if other calcific foci are present suggest neurocysticercosis.

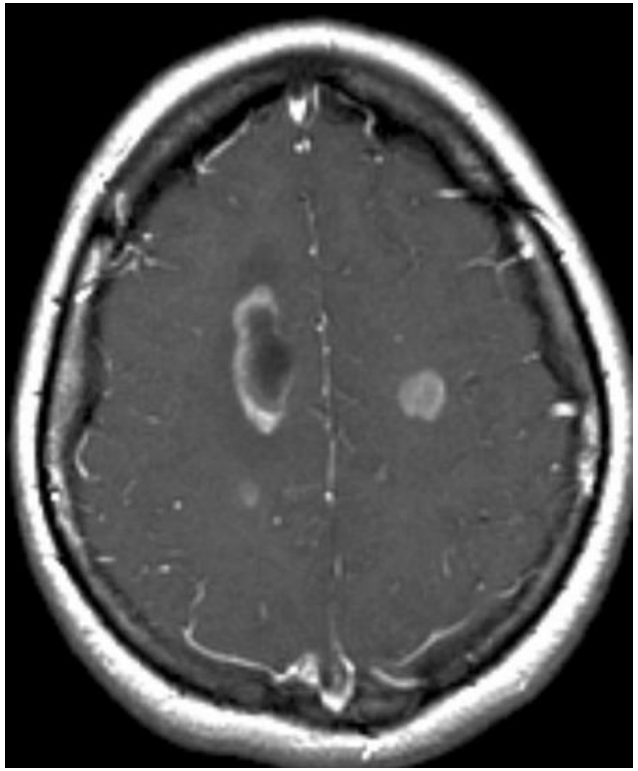
Differentiation of Infection and Infraction is aided by DWI and PWI in MRI

	DWI	PWI
Infection	Restricted	Increased
Infarction	Restricted	Decreased

Ring enhancing cerebral lesions

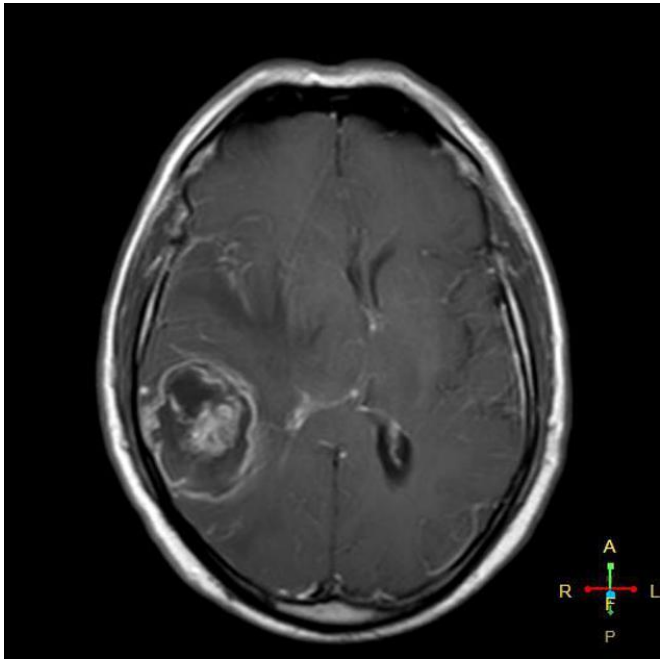


Abscess

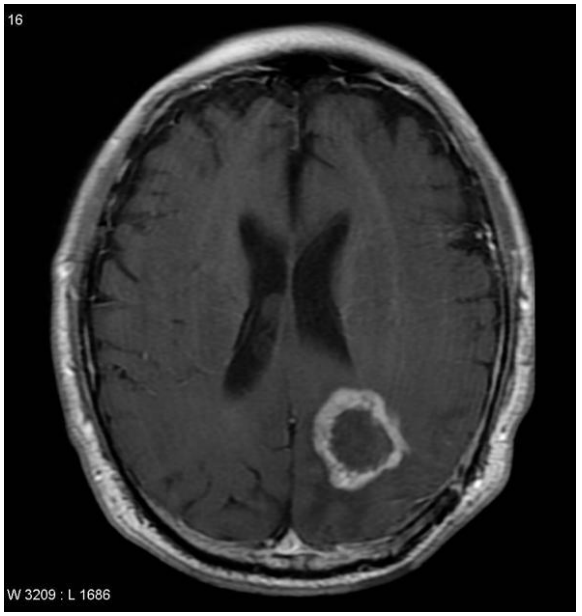


Acute disseminated encephalomyelitis

Single Ring enhancing cerebral lesions

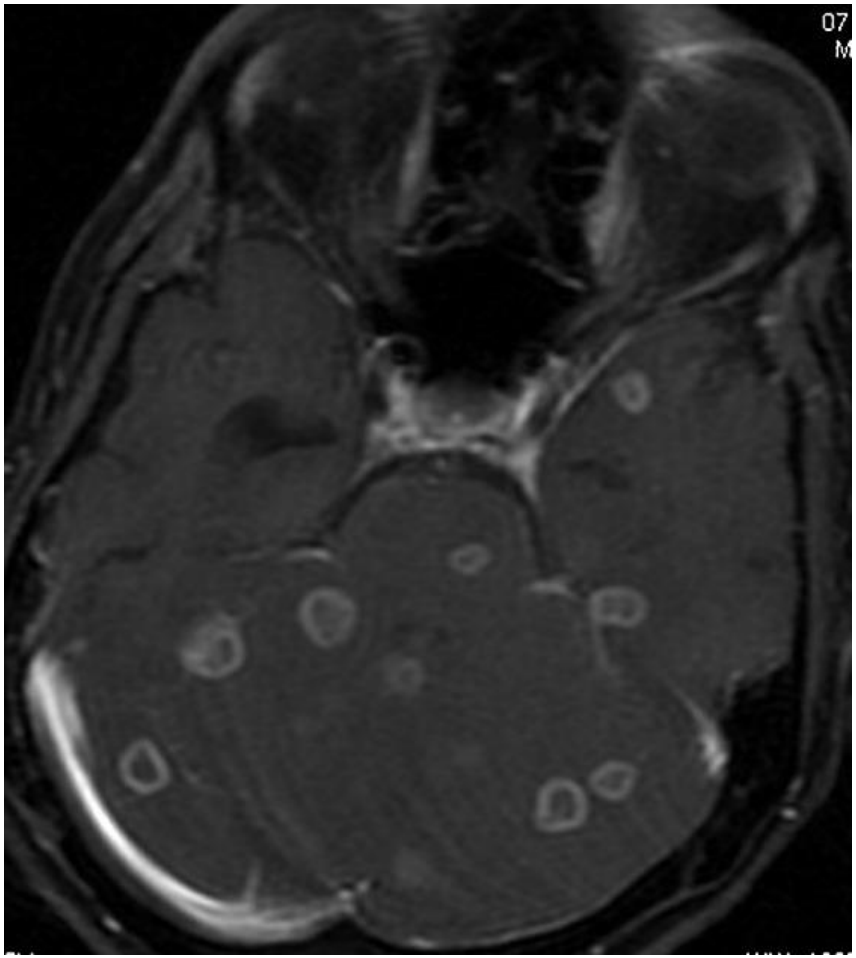


Glioblastoma (GBM)

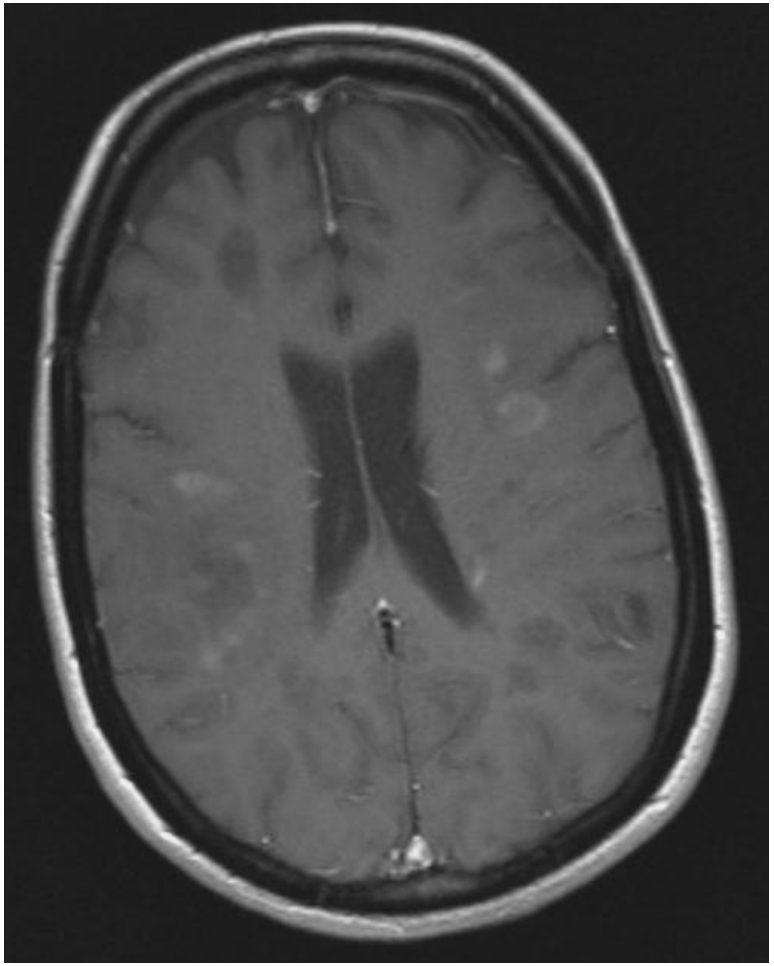


Radiation necrosis

Multiple Ring enhancing cerebral lesions

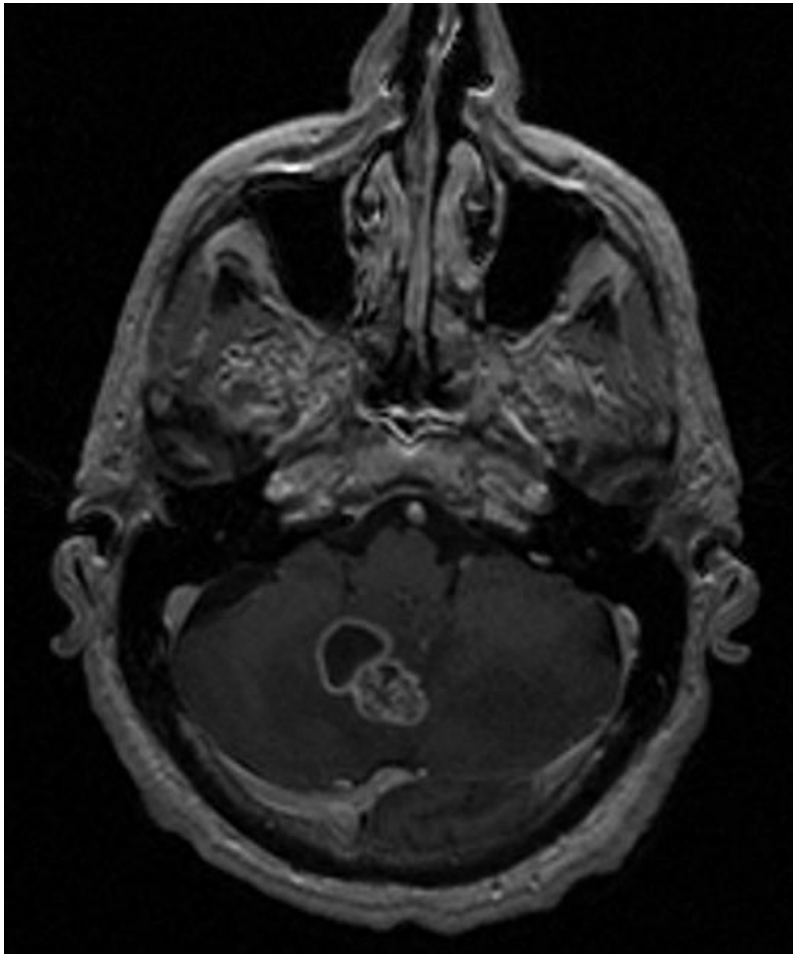


Tuberculomas

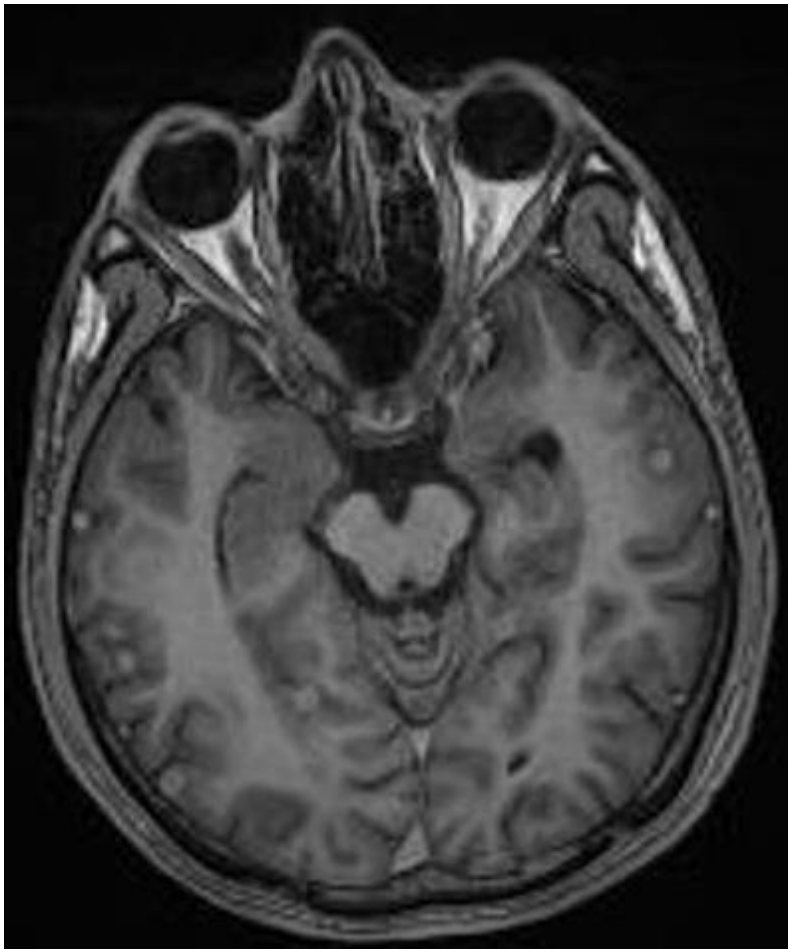


Multiple Sclerosis

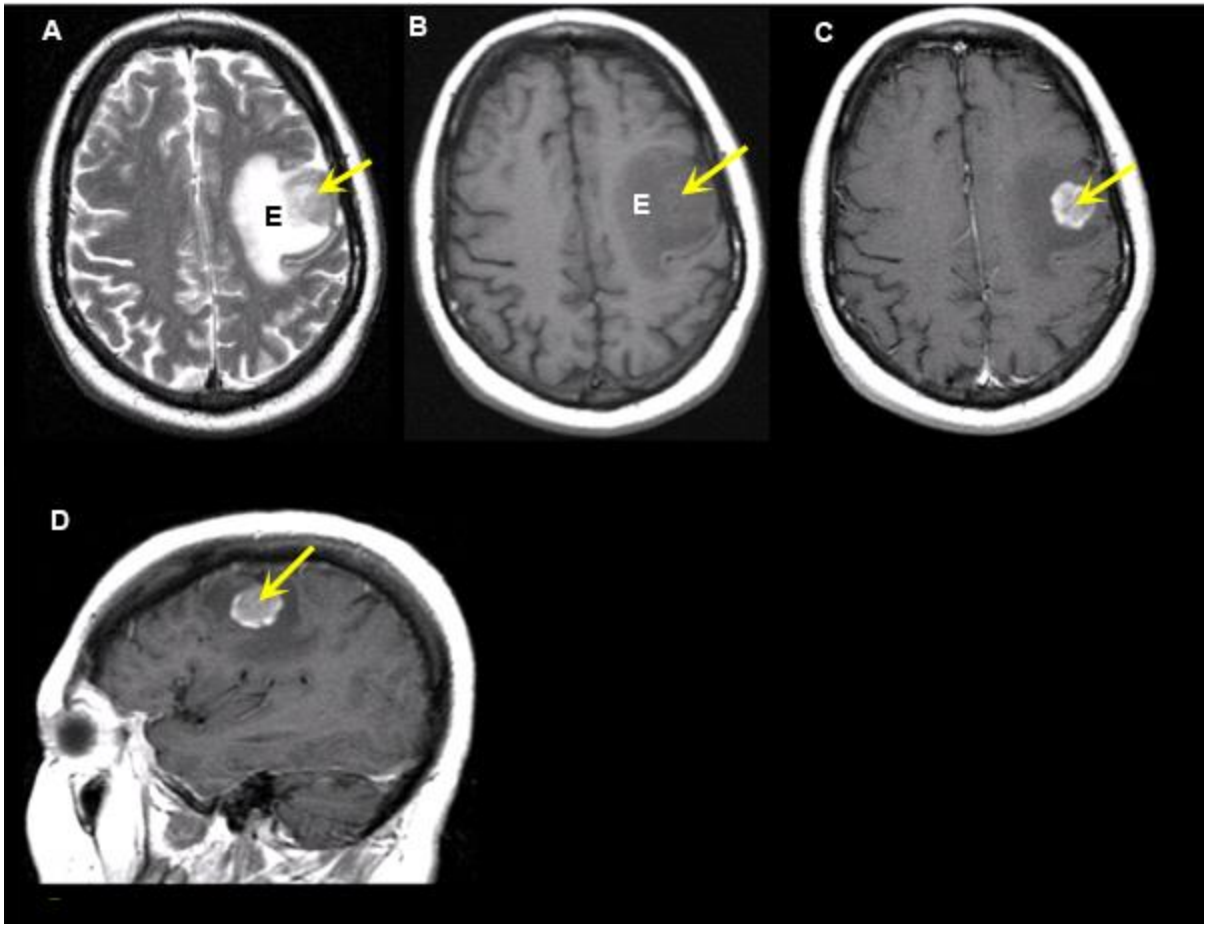
Multiple Ring enhancing cerebral lesions



Metastases



Tuberculoma



Solitary metastatic tumors

A. pre-contrast axial T1 wtd. MRI (fig. B).Well defined enhancing tumor is seen in post-contrast axial and sagittal T1 wtd. MRI (figs. C, D) surrounded by edema. Edema (E) is seen surrounding the tumor on T1 wtd. image (fig. B), but better appreciated on T2 wtd. image (Fig. A) as edema appears bright on this sequence and, thus, readily visible.

Secondary tumors in brain

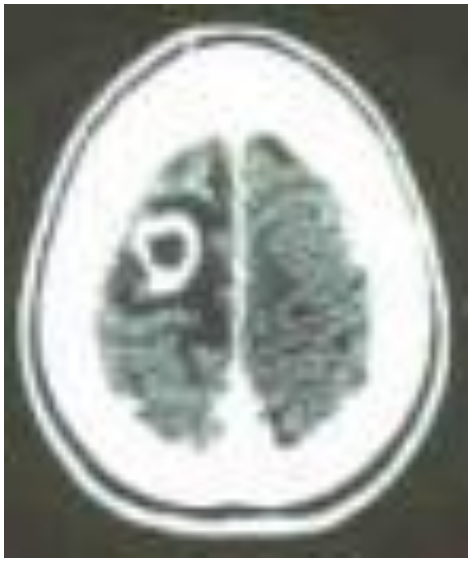
Originate from malignant tumors located primarily in other organs (BRCoLTS)

- Lung - Small-cell lung
- Skin - Malignant melanoma
- Kidney - Hypernephroma
- Breast – Breast carcinoma
- Colon – Colon carcinoma
- Thyroid – Papillary thyroid carcinoma

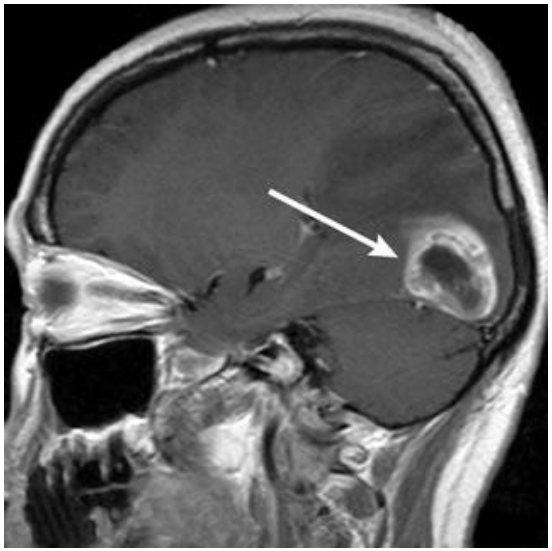
❖ These tumors cells reach the brain via the blood-stream

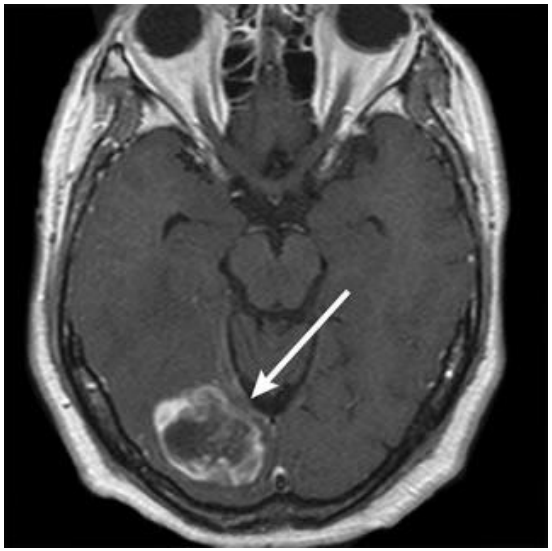
❖ 10% to 26% of patients who die from their cancer will develop brain metastases.

Secondary tumors



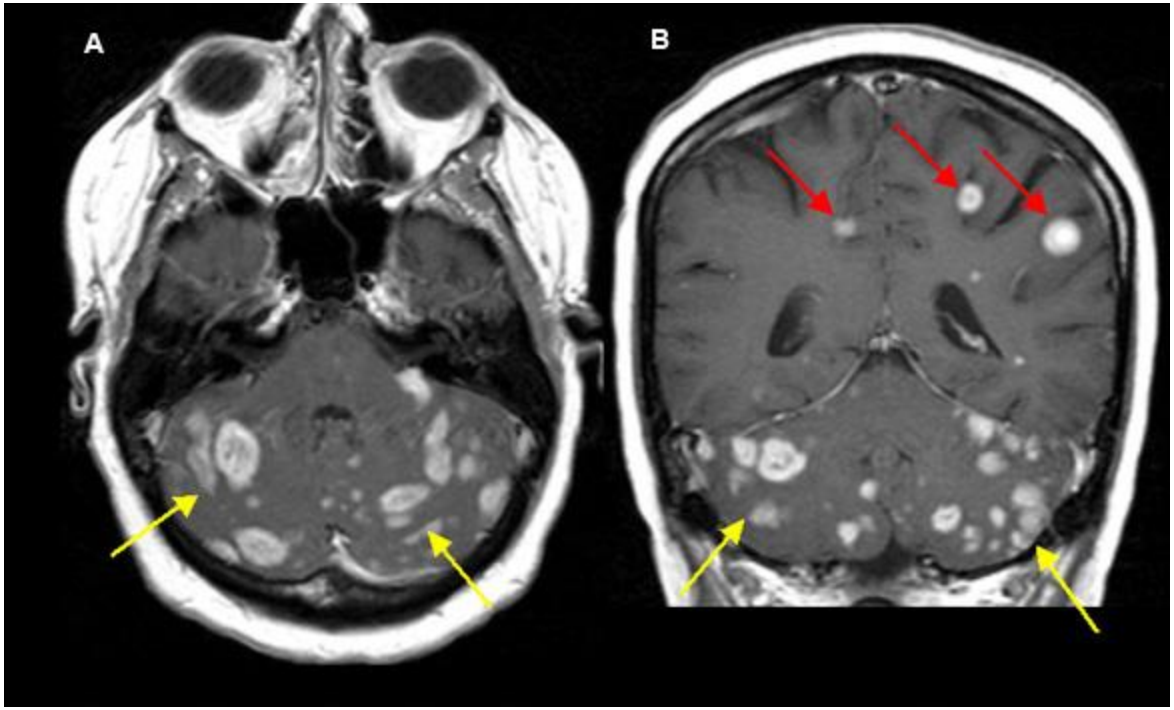
CT





MRI

Multiple metastases to the brain



TWI +Gd shows of numerous metastatic enhancing lesions are seen closely packed together within both cerebellar hemispheres (yellow arrows), and a few lesions also seen within both posterior frontoparietal lobes (red arrows in Fig. B).

MR spectroscopy (MRS)

- MRS alone can reach up to 82.5% accuracy
- 100% sensitivity and 91.1% specificity on predicting tumor type

Server A, Josefsen R, Kulle B, et al. *Acta Radiol.* 2010;51:316–325.

Technique of MRS

1. NAA is contained almost exclusively within neurons in adult brain and therefore provides an indication of neuronal/axonal dysfunction, damage, or loss.
2. Choline are prominent in membranes.
3. Myoinositol may act as an osmolyte.

Common MRS abnormalities in CNS diseases

1. Reduced **NAA** in tumours, infarcts, multiple sclerosis plaques, and a variety of neurodegenerative disorders;
2. Increased **NAA** in Canavan's disease;
3. Increased **Cho** in some tumours and acute multiple sclerosis plaques;
4. Reduced **Cho** in spinocerebellar degeneration;
5. In all processes which destroy normal brain tissue, NAA is absent in CNS infection .
6. Within bacterial abscess cavities, **lactate, alanine, cytosolic acid and acetate** are elevated/present
7. Increased **lactate** in infarctions, some tumours, mitochondrial disease, and Huntingdon's disease.

MR spectroscopy of Glioma

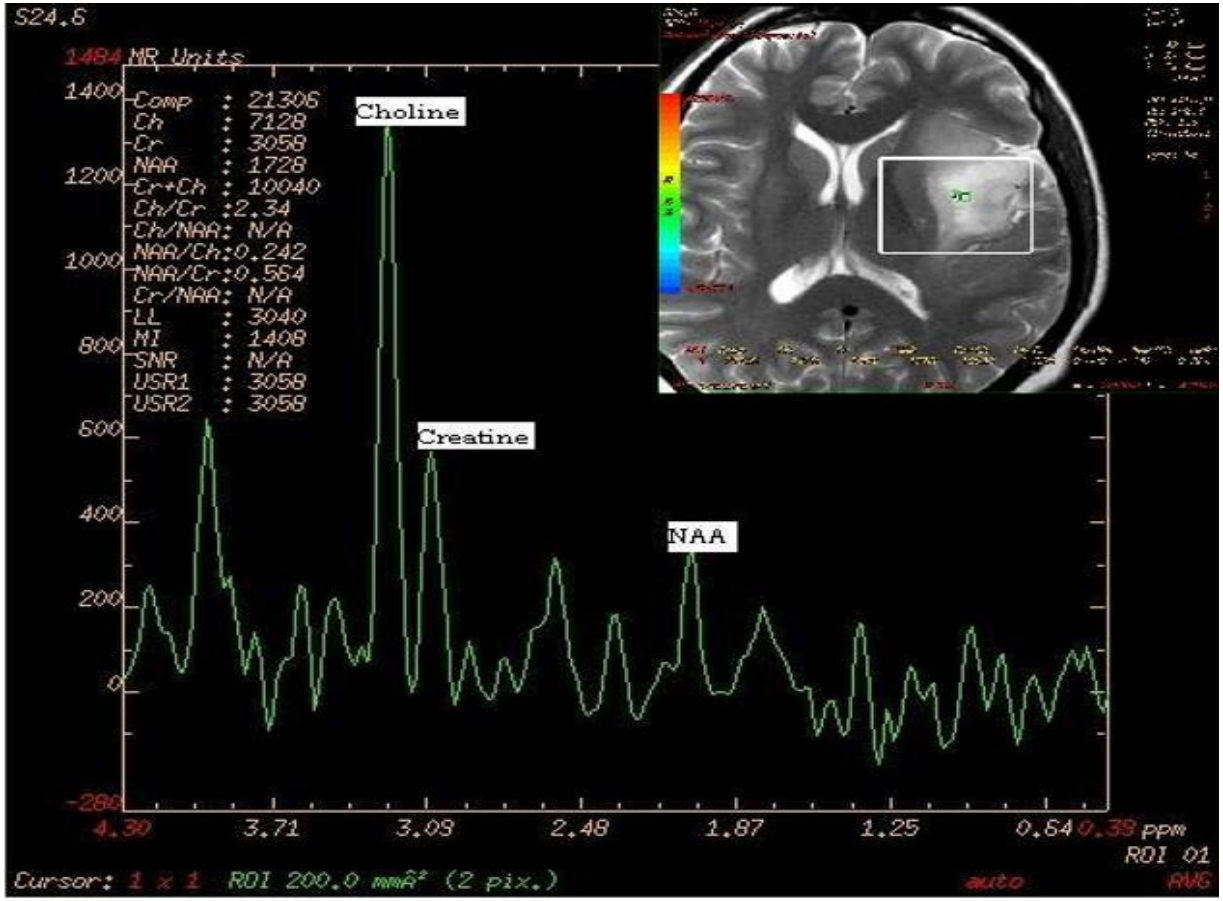


Figure: Shows a raised choline peak with a depressed N-acetyl aspartate peak. Increased choline and choline/creatine ratio and decreased NAA levels.

MRS in Meningioma

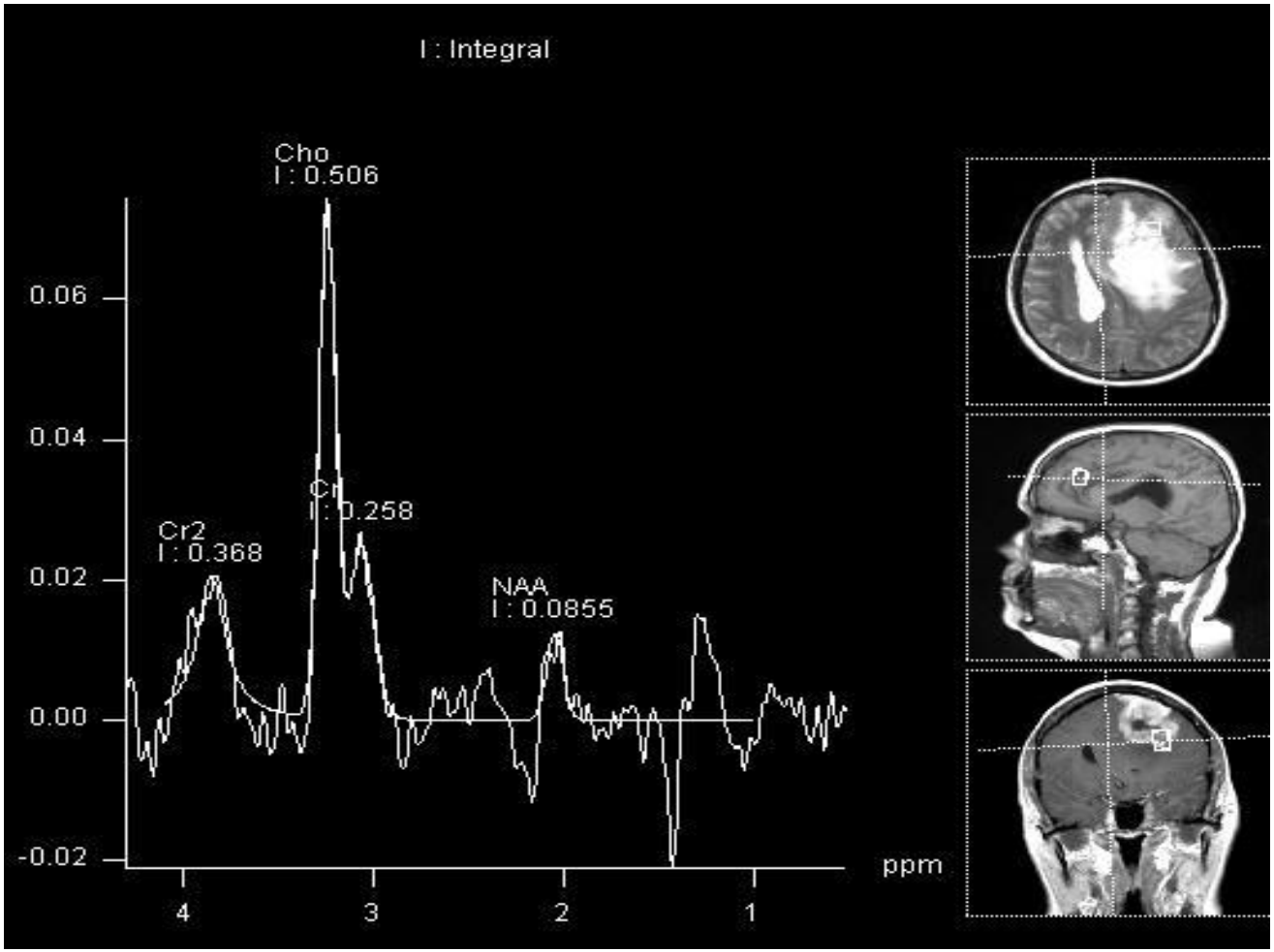


Figure: Demonstrates elevated choline and low NAA levels and low Cr / Cho ratio

MRS in Primary CNS Lymphomas

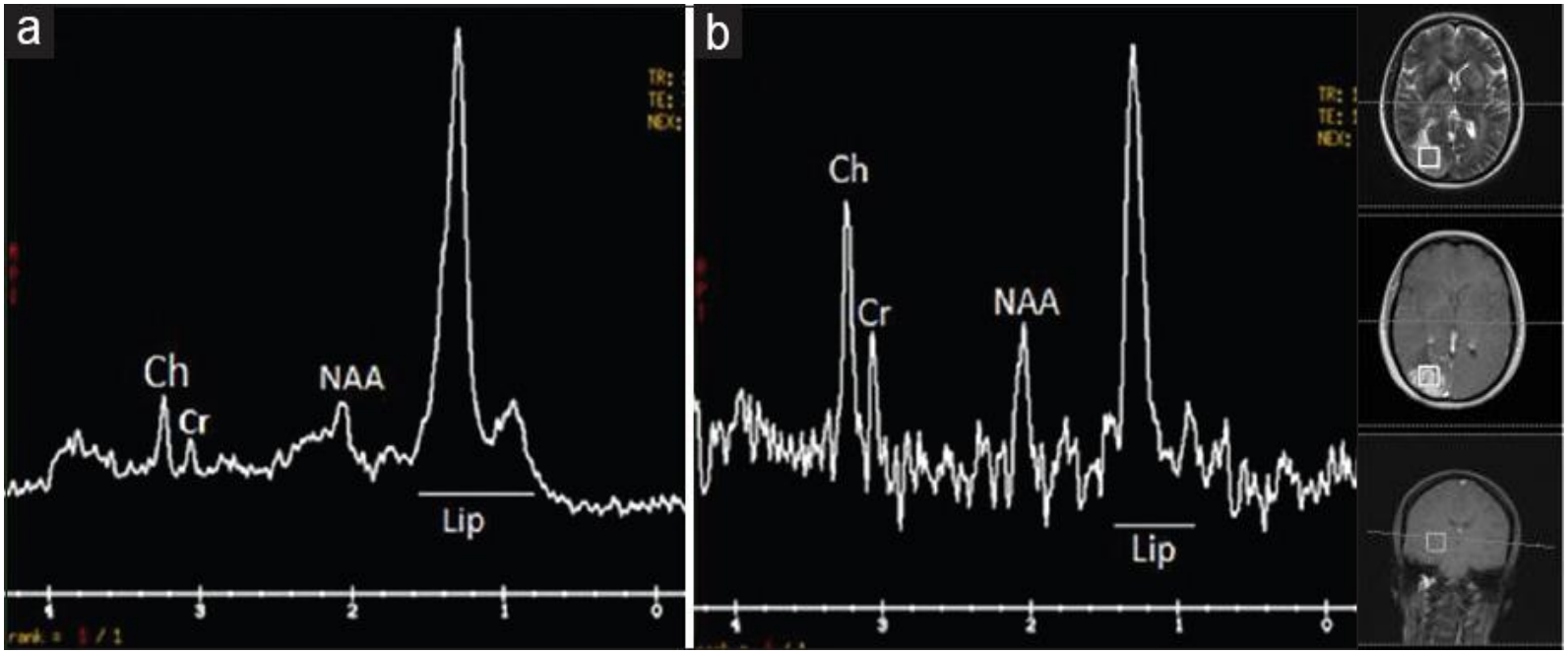


Figure : Showed a very high lipids peak (a). There was also elevated Choline peak (b)

MRS in metastasis

Left medial frontal lobe brain metastasis from primary lung

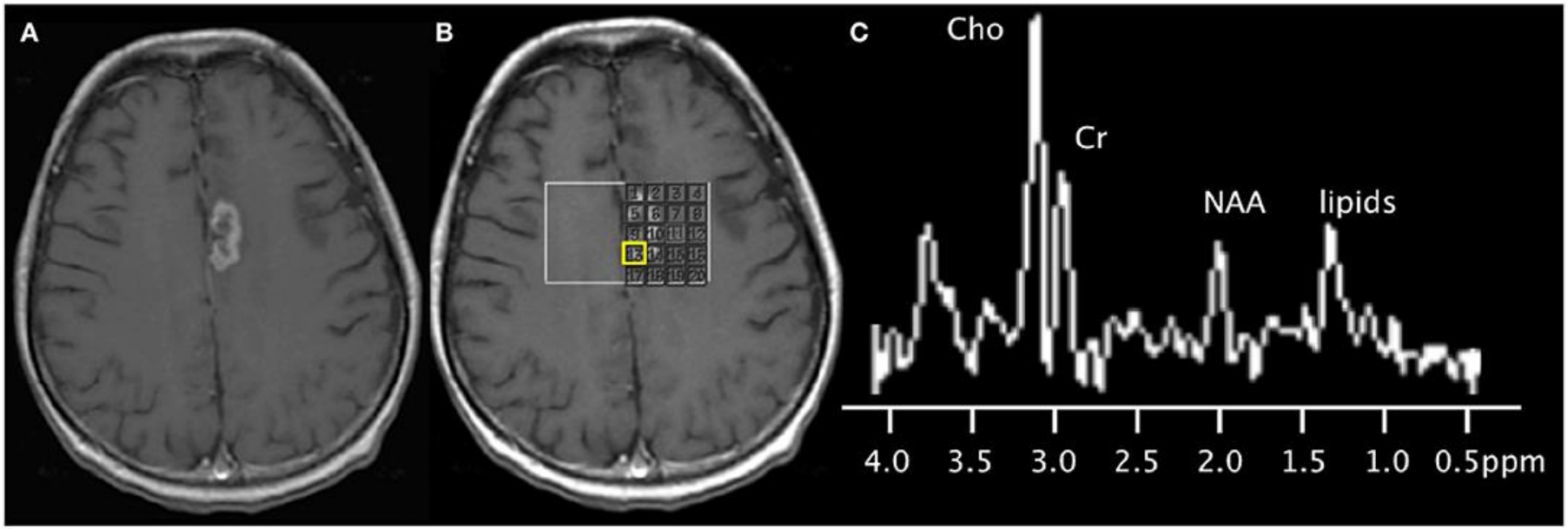


Figure: Shows findings of disease progression, with the presence of a high Cho peak, increased Cho/NAA and Cho/Cr ratios and lipid peak (indicative of necrosis),, and

Scenario- 8

- A 58-year-old man was admitted to hospital having experienced pain in the lower back and left leg for 2 years and a sudden exacerbation of the symptoms for 5 days before admission.
- MRI of the lumbar spine has done and shown below.

Scenario -8

Questions:

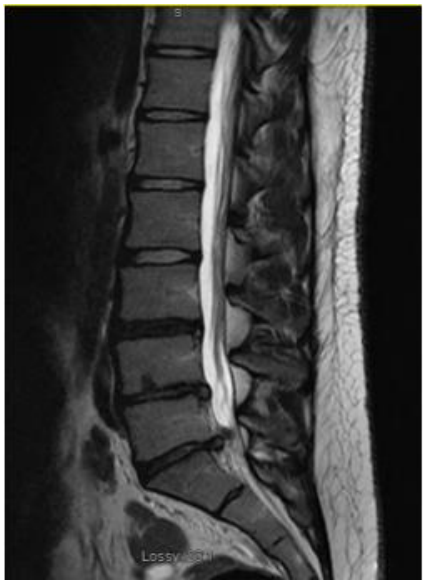
1. What are the findings of MRI?(3findings)
2. What is the diagnosis?

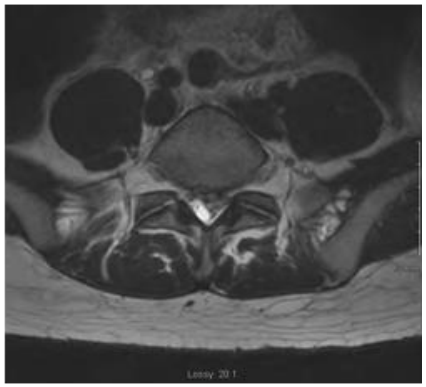
Answers:

1 a)Sagittal and axial T2WI MRI showing left paracentral L5-S1 disc herniation

b)The extruded (free-floating) fragment compressing the nerve.

2. Left-sided L5-S1 disc herniation with extruded fragment





Scenario -9

- A 45 year-old man developed neck pain radiating to both shoulders.
- Gait was stiff and awkward.
- Examination was notable for increased reflexes in the arms and legs, and bilateral Babinski responses.
- MRI of the cervical has done and shown below.

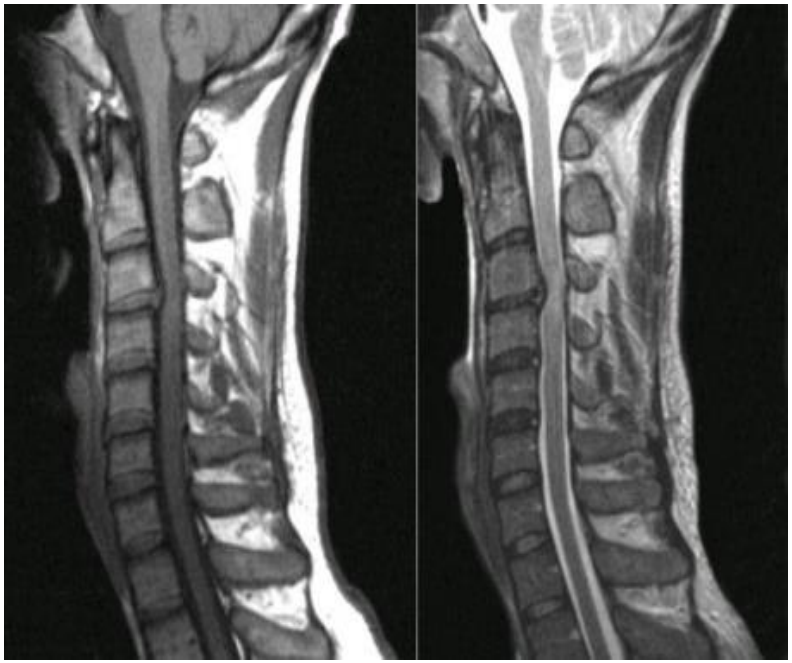
Scenario -9

Questions:

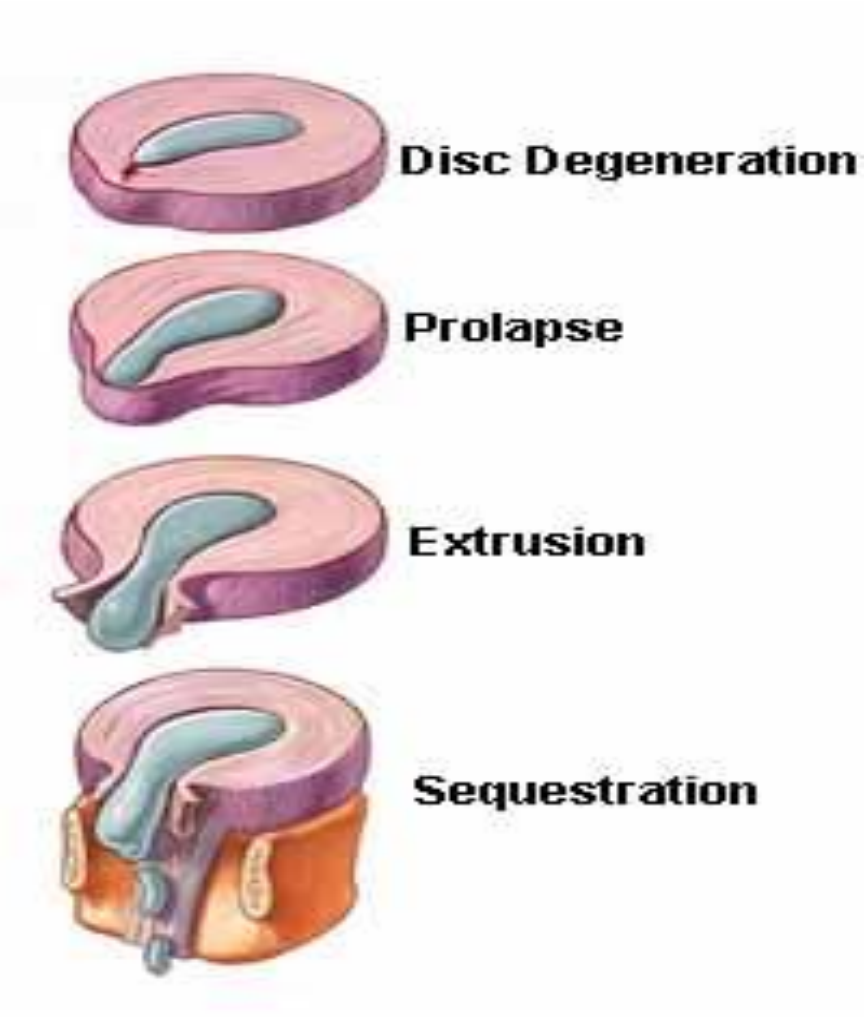
1. What are the findings of MRI?(3findings)
2. What is the diagnosis?
3. What is the most likely cause?

Answers:

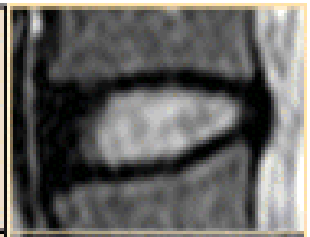
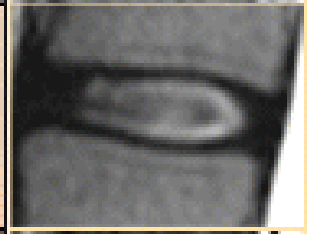
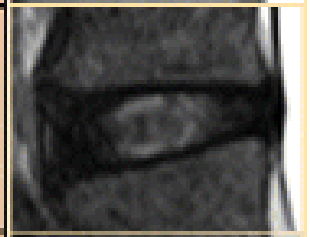
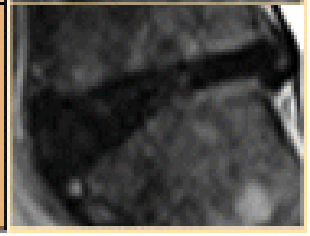
1. Sagittal MRI scans of the cervical spine; (Left) T1-weighted; (Right) T2-weighted show a large disk herniation between the C3 and C4 vertebral bodies, deforming the spinal cord at that level.
   - Thecal indentation is noted
   - Myelopathic changes / hyperintensity is noted at the level C3 and C4.
2. Cervical disc herniation at the level C3 and C4
3. Trauma



Types of disc herniation according Anatomic localization



Grading of disc herniation

Grade I	Disc has a uniform high signal in the nucleus on T2.	
Grade II	Central horizontal line of low signal intensity.	
Grade III	High intensity in the central part of the nucleus with lower intensity in the peripheral regions of the nucleus.	
Grade IV	Low signal intensity centrally and blurring of the distinction between nucleus and annulus.	
Grade V	Homogeneous low signal with no distinction between nucleus and annulus.	

Disc herniation

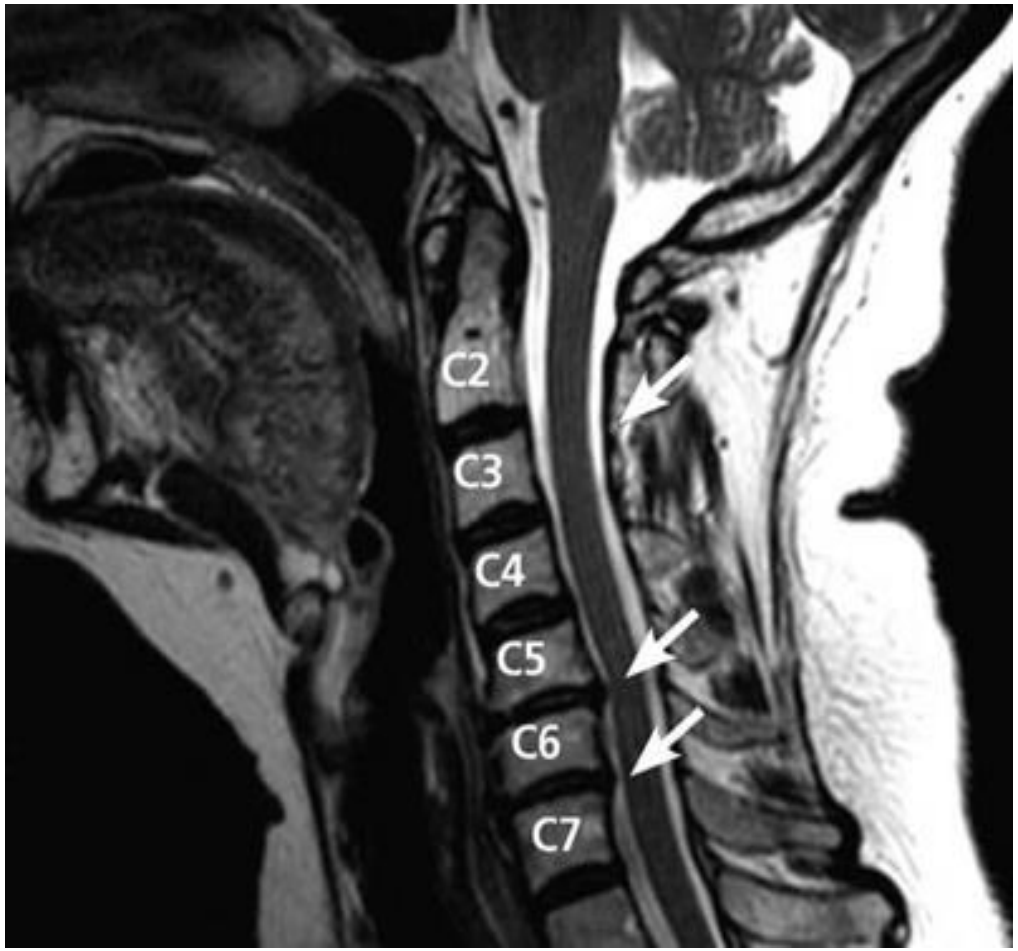


Figure: MRI (side view) shows a disc herniation between the C5 and C6 vertebrae and C6 and C7 indenting upon the thecal sac and ventral aspect of the spinal cord.

Disc herniation

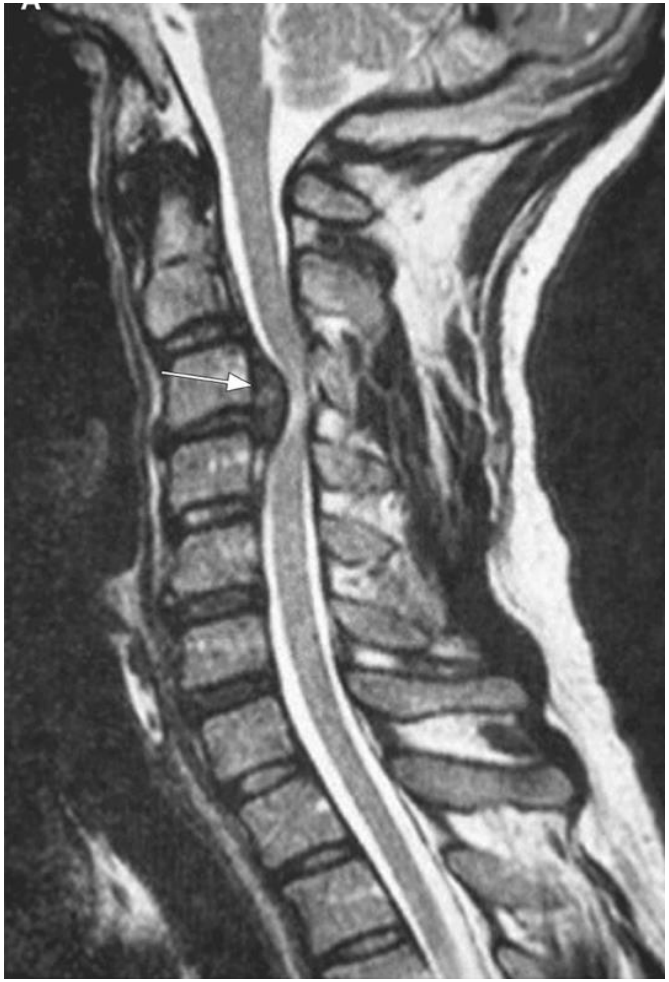


Figure: Sagittal T2-weighted magnetic resonance imaging scan showed bulging C3–C4 disk herniation, with signs of spinal stenosis, severe spinal cord compression (arrow) and spinal cord edema. The C3–C4 disk was almost collapsed.

Disc herniation

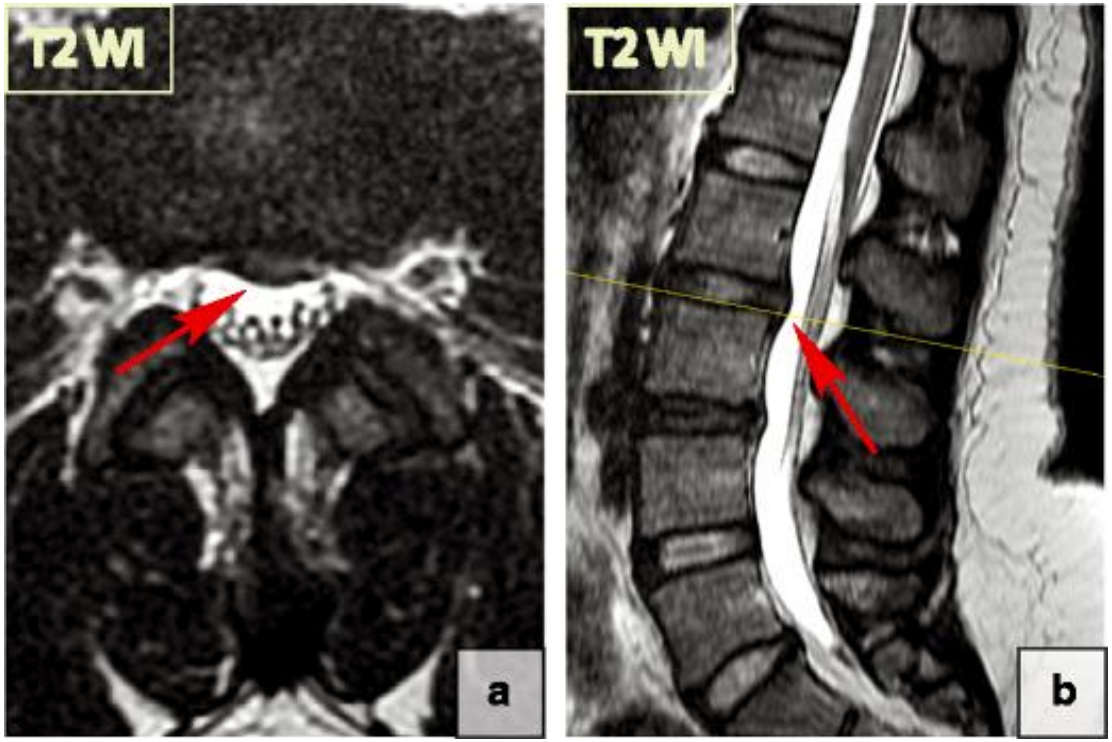


Figure: Focal disc displacement protrusion. T2-WI (a+b) axial and sagittal MRI of lumbar spine scans demonstrate focal left L2-L3 paracentral posterior protrusion. There is no disruption of the fibres of the overlying annulus fibrosus or the posterior longitudinal ligament.

Disc herniation

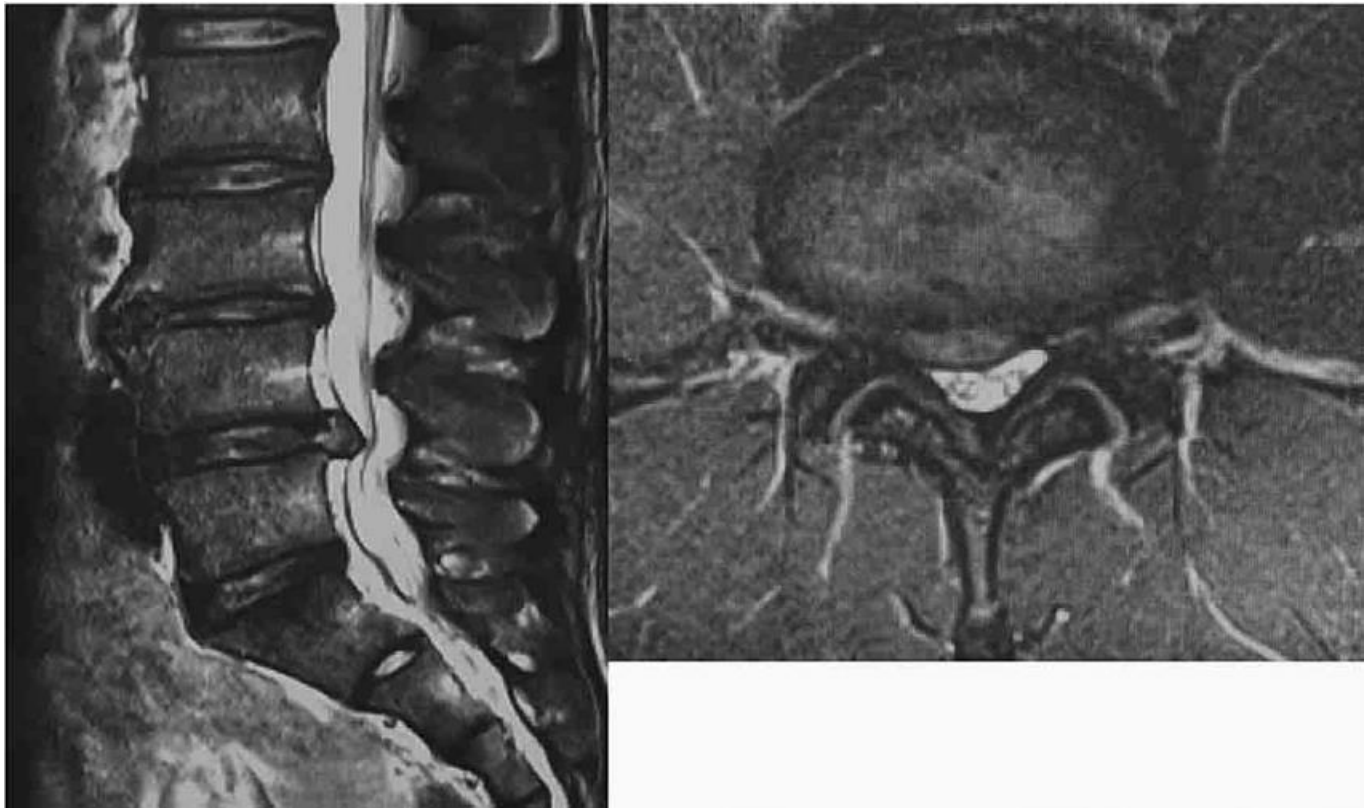


Figure:T2-WI sagittal and axial MRI of lumbar spine at L4/5 level showing the right paracentral disc protrusion at L4/5 level compressing the L5 root.

Scenario- 10

- A 53-year-old housewife presented with history of weakness and wasting of the right forearm and hand since 1 year.
- She also complained of significant almost disabling parasthesias in all four limbs involving both hands and feet since 6 months.
- MRI of cervical has done.

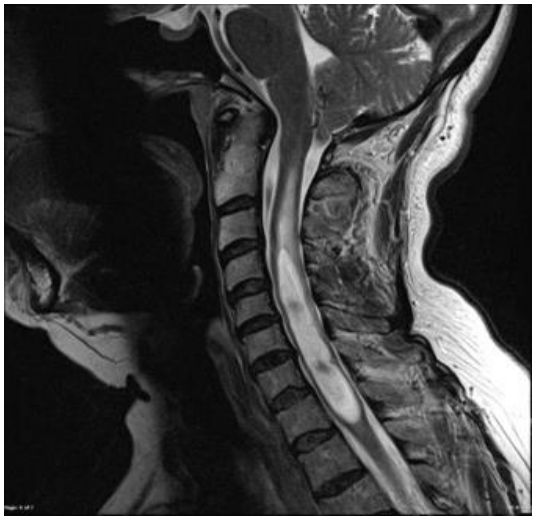
Scenario-11

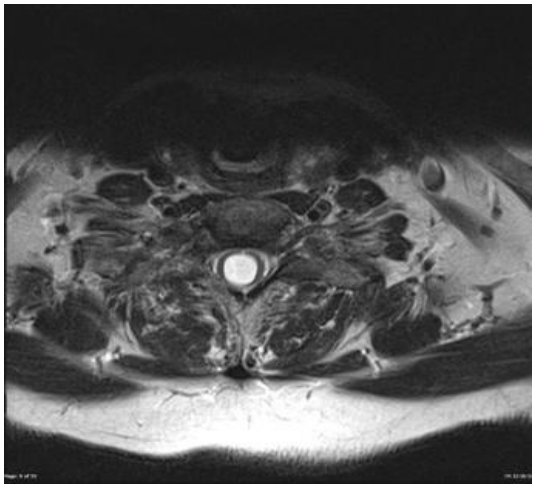
Questions

1. What are the findings of the MRI?
2. What is the diagnosis?

Answers:

1. T2 hyperintense, non enhancing ovoid region is seen within the spinal cord spanning from C2 to T1 level.
2. Syringomyelia at C2-T1





Syringomyelia :Definition

- Syringomyelia is the development of a fluid-filled cyst (syrinx) within the spinal cord.

Causes of syringomyelia

- The majority of causes of syringomyelia are **Chiari malformations**.
- Other causes of syringomyelia include
  - Tethered cord syndrome,
  - Meningitis (arachnoiditis),
  - Certain tumors of the spinal cord, and
  - Trauma.

Syringomyelia

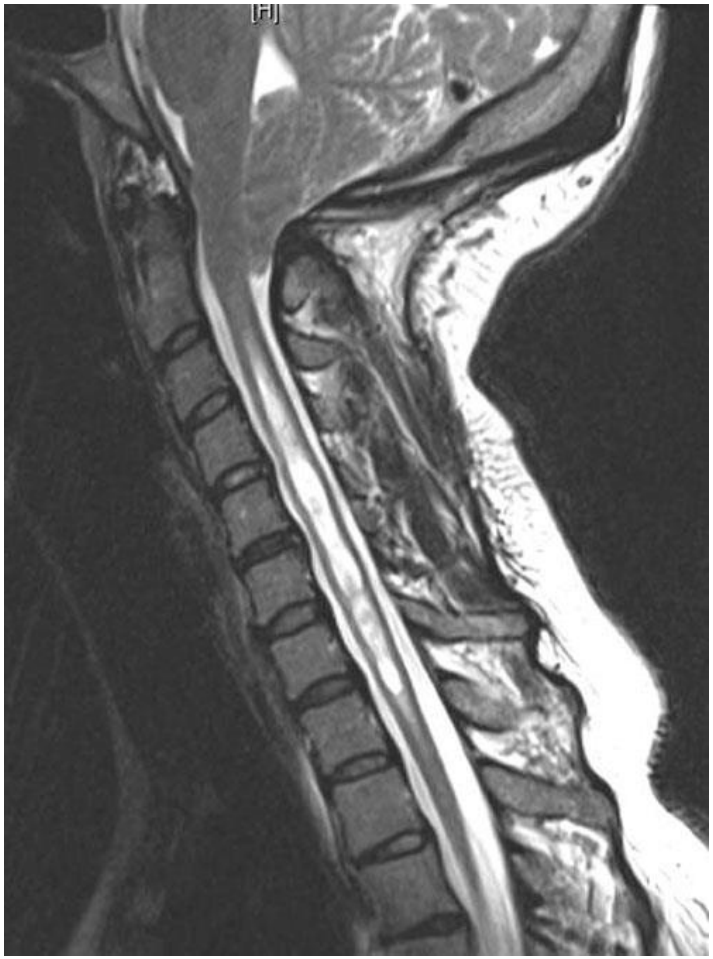


Figure: Sagittal T2-weighted MR images demonstrate significant multi-compartmental syringomyelia at the C2- T1 the spinal cord.

Syringomyelia

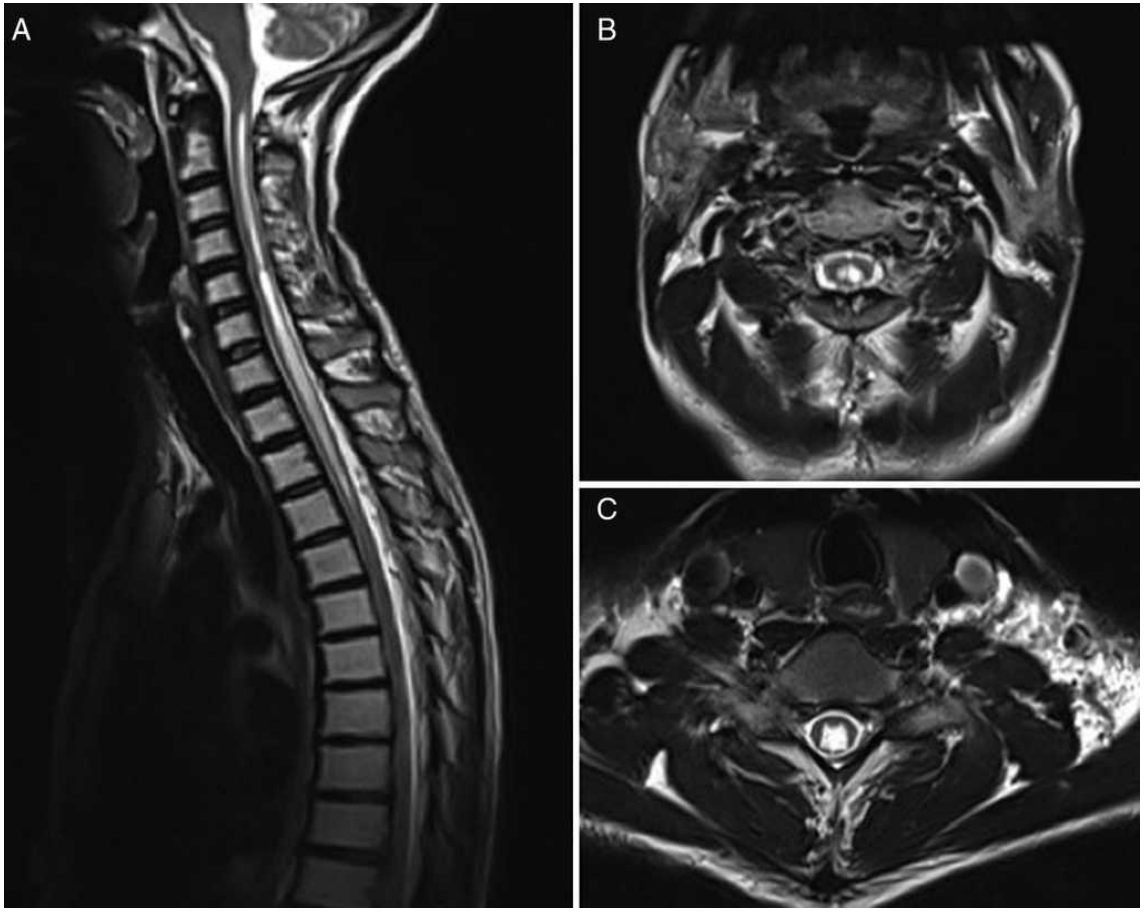


Figure: (A) Sagittal T2-weighted MRI sequence of a patient with **syringomyelia** unrelated to Chiari malformation. (B) Axial T2-weighted MRI sequence at the C2 level. (C) Axial TWI MRI sequence at C6 level

Syringomyelia

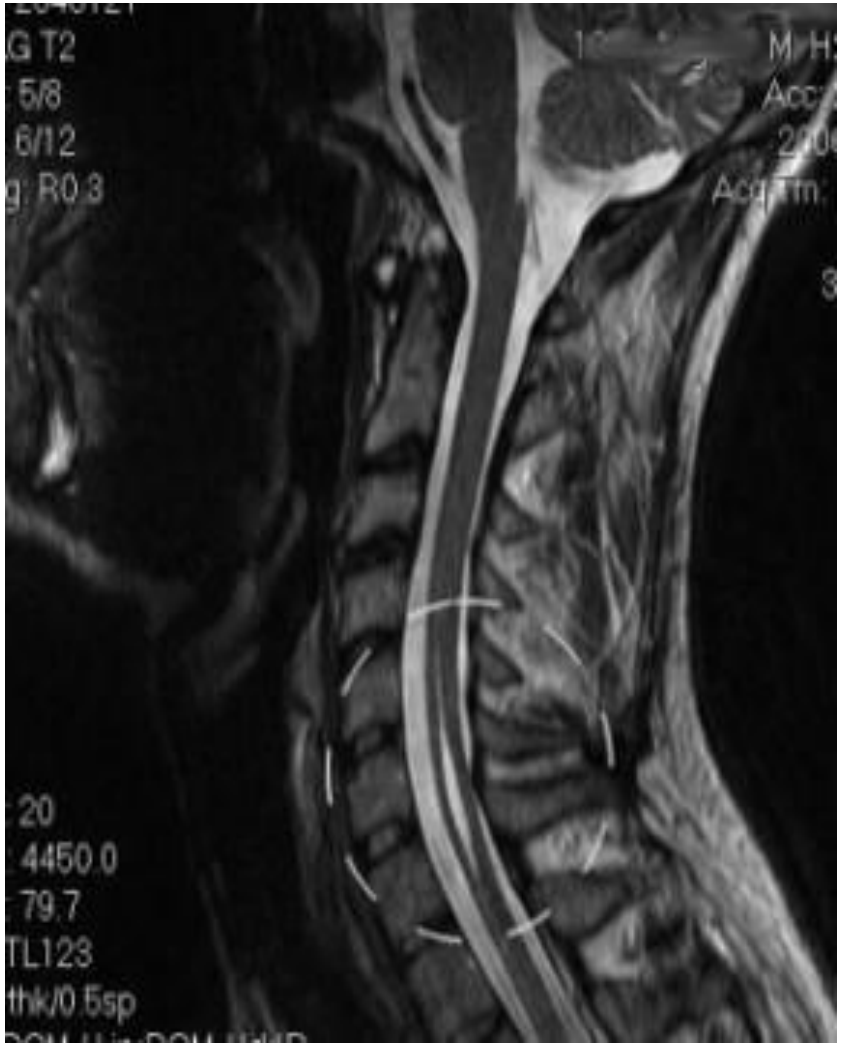


Figure: Sagittal T2-weighted MR images demonstrate a significant syrinx in the C4-6 cervical spinal cord.

Scenario- 12

- A 13-year-old boy with no significant past medical history presented to our outpatient clinic due to back pain with fever.
- He had been well until approximately 4 months before admission, when he occasionally had high fever.
- His symptoms did not improve in spite of acetaminophen administration. A MRI has done(Figure).

Scenario- 12

Questions:

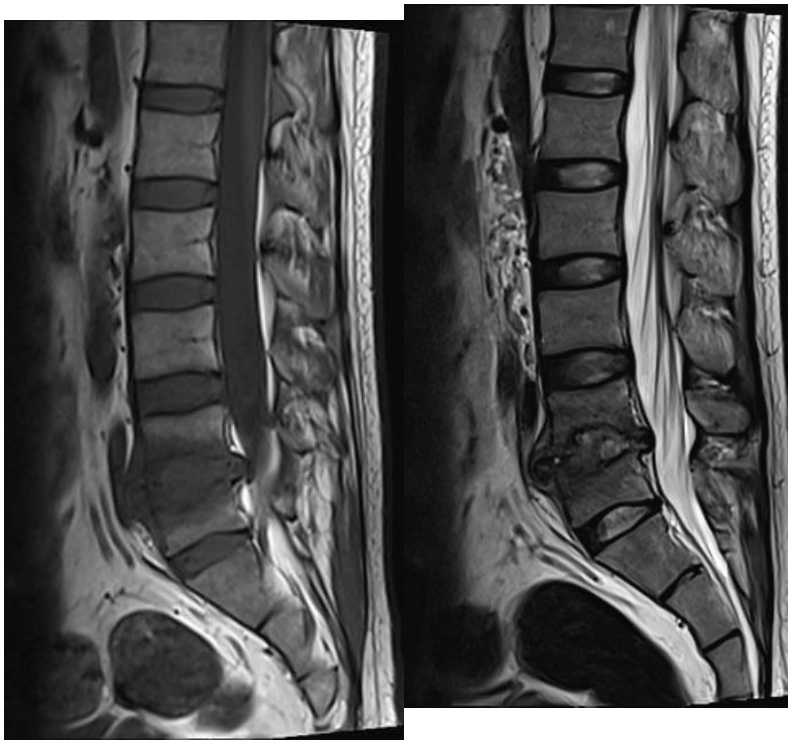
1. What are the findings of the MRI
2. What is the diagnosis?

Answers:

1.a.MRI Sagittal T1WI (A) shows destruction of L5-S1 the intervertebral disc space and endplates of the adjacent vertebral bodies is marked, vertebral body alignment is normal.

b.MRI Sagittal T2WI (B) shows diskitis and destruction of the endplates of the adjacent vertebral bodies.

2. Tuberculous spondylitis



Scenario- 13

- 45-year-old man presented with low back pain of 1.5 months duration, which increased in severity over the last 15 days. The pain was radiating to the left lower limb and was associated with tingling and numbness.
- The patient had a history of low-grade fever, weight loss, and malaise over the last 2 months. There was history of cough with expectoration,.
- On examination, there was mild pallor and no other significant findings. There was localized tenderness over lumbosacral spine.
- MRI of lumbosacral spine was done.

Scenario- 13

Questions:

a. What are the findings of MRI of lumbosacral spine?
b. What is the most likely diagnosis?

Answers:

a. i) Destruction and signal alteration involving L5 and S1 bodies,
ii) Altered signal intensity involving L5-S1 disc, and
iii)Thecal sac compression
iv)Paravertebral and prevertebral collection extending from L5 to S3 level.

b. Lumbosacral spinal tuberculosis/ Pott's disease

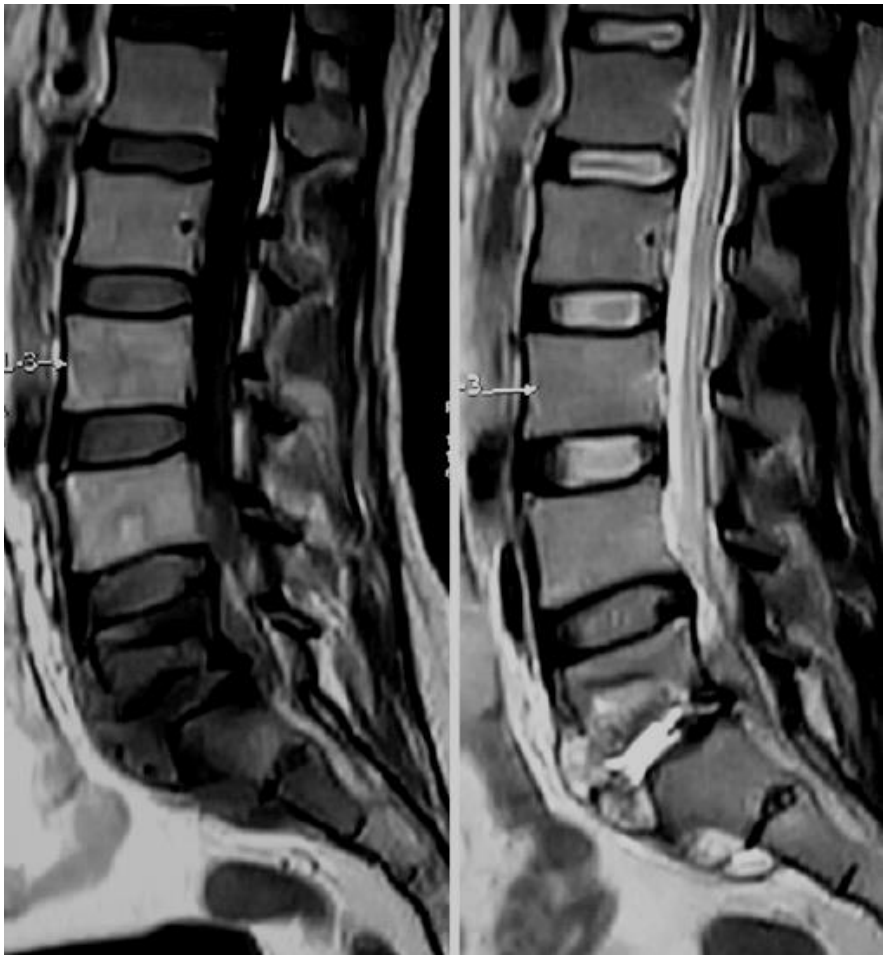


Figure: MRI of lumbosacral spine T1-weighted and T2-weighted sagittal images of the patient

Distinguishing features between tuberculous and pyogenic spondylitis in MRI

- **T1+C :** Rim enhancement of abscess on MRI can be observed in both tuberculous and pyogenic spondylitis.
  - **TB Spondylitis:** Thin and smooth enhancement of the abscess wall and well-defined paraspinal abnormal signal(>3 vertebral level) with Involvement of the posterior element and disc spared or mild destruction .
  - **Pyogenic Infections:** Thick and irregular enhancement of abscess wall and ill-defined paraspinal abnormal signal (<2 vertebral level) and disc moderate or severe destruction .

Difference between Tuberculous and Pyogenic spondylitis

	TB SPONDYLITIS	PYOGENIC SPONDYLITIS
Spinal and paraspinal abscesses	+++	+
Abscess wall	Thin, smooth	Thick, irregular
Post-contrast margins	well defined	ill defined
Abscess rim enhancement	Intraosseous+/-disc	Involves the disc
Number of vertebral bodies	Multiple	No more tan 2
Location	Lower thoracic-upper lumbar	Lumbar
Disc	Spared or mild destruction	Moderate to severe destruction
Vertebral bone	Severely involved	Less severe
Reactive sclerosis	-/+	++

Tuberculous/ Pyogenic spondylitis

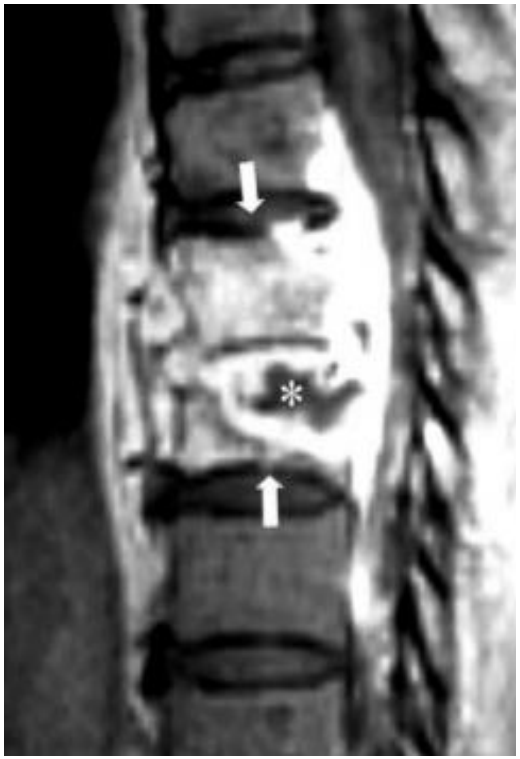


Figure: Sagittal T1+C MR image shows smooth enhancement of intraosseous abscess (asterisk).

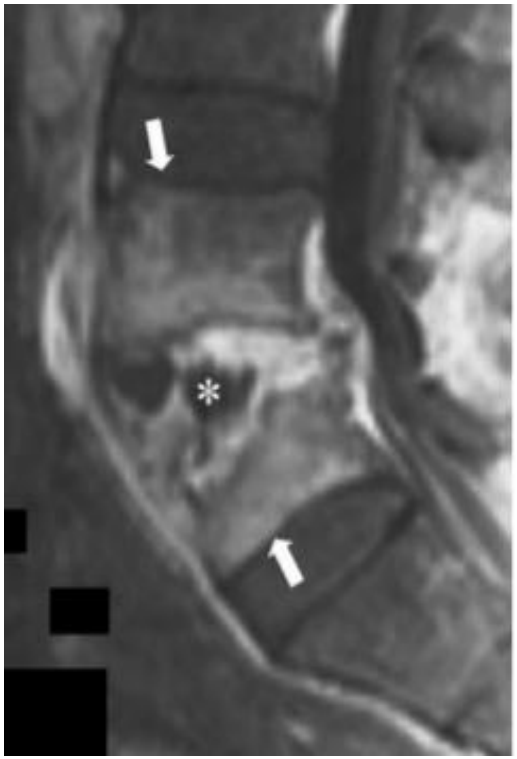


Figure: Sagittal T1+C MR image in pyogenic abscess shows irregular enhancement of abscess (asterisk) presents in L4-5 disk space extending to L5 vertebral body.

Infectious spondylitis

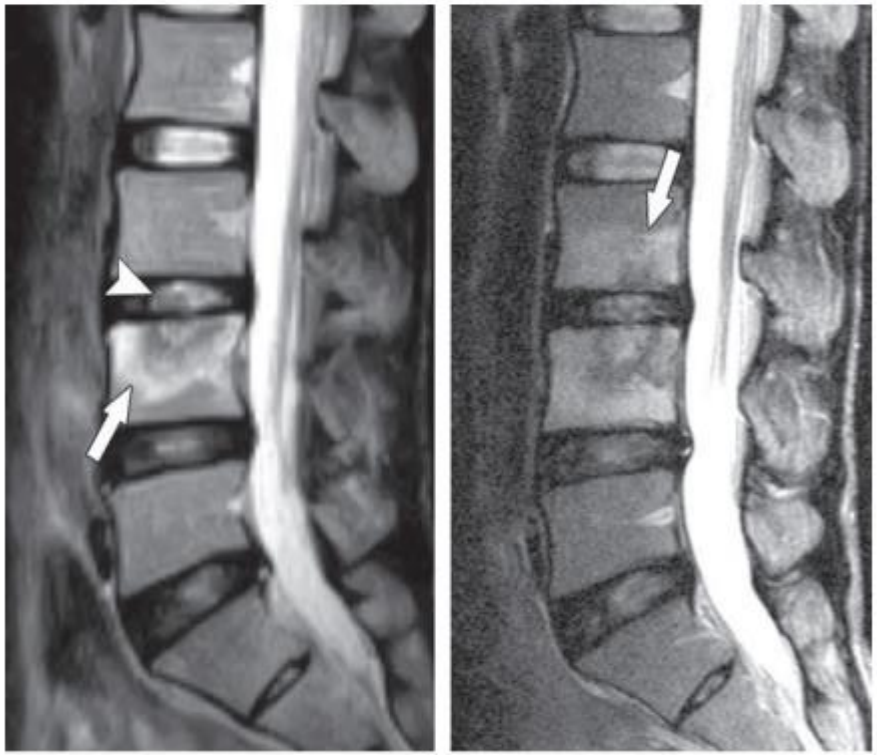


Figure (a) Sagittal T2-weighted MR image shows signal intensity abnormalities in the L4 vertebral body (arrow) and the L3-4 disk (arrowhead). (b) Sagittal T2-weighted MR image acquired 3 months after the initial study demonstrates extension of the disease to the suprajacent L3 vertebral body (arrow). The typical pattern of infectious spondylitis can now be seen.

Tuberculous spondylitis

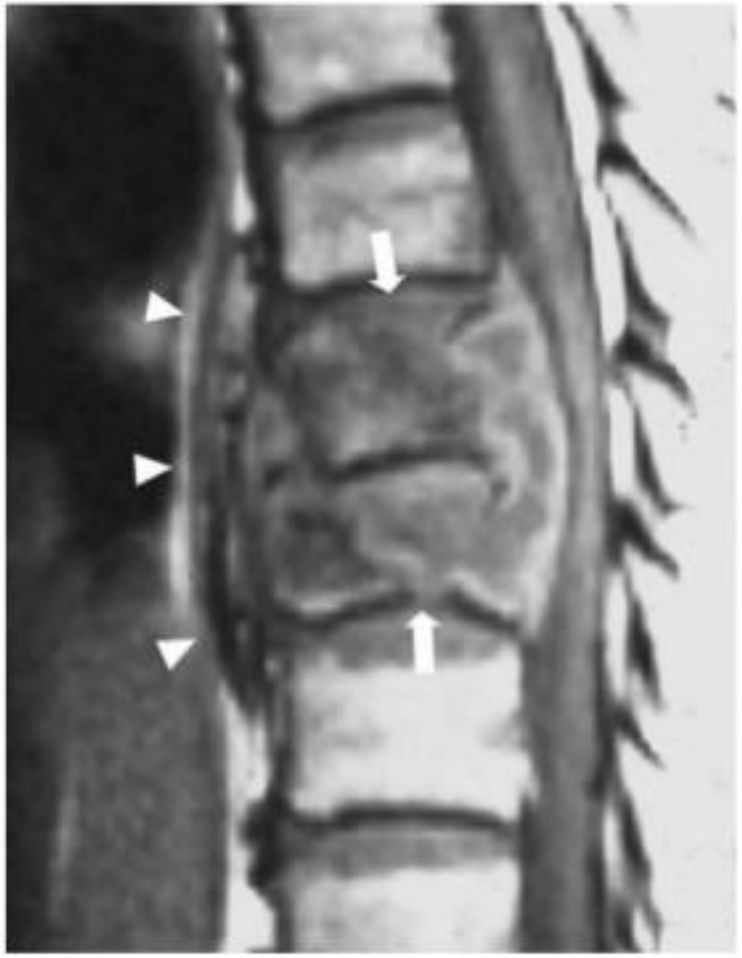


Figure: T1 shows heterogeneously hypointense signal (arrows) in T8-T9 vertebral bodies with epidural mass and subligamentous spread (arrowheads) from T7 to T10. My radiological diagnosis is Tuberculous spondylitis

Scenario-14

- 24yr old female university student with no significant personal past or family history presented with backache for past 3 months which was aggravated during exertion relieved with analgesics.
- Since 1month she had shooting type of sensation across the back of thigh while bending forwards .These complaints were continuing till two week back, when she had felt weakness of left lower limb including proximal and distal muscles associated with urinary incontinence and paraesthesia.
- But she was able to appreciate all the normal sensations. She also felt band like sensation over the level of umbilicus

Scenario-14

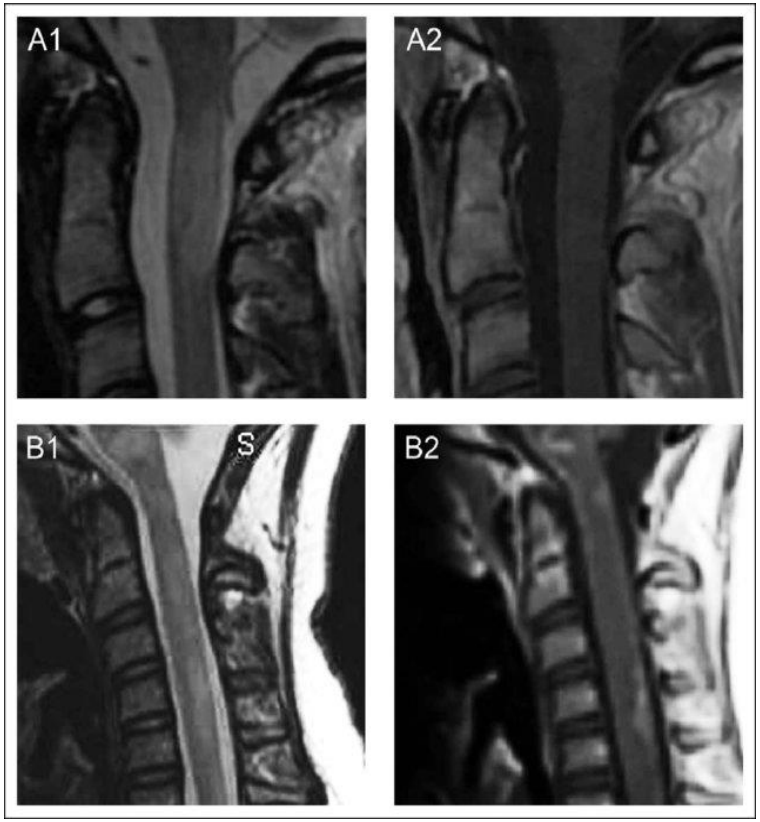
Questions:

1. What are the findings of the MRI
2. What is the diagnosis?

Answers:

1. Cervical spine magnetic resonance imaging (MRI). (A1-B2) Sagittal cervical spine MRI slices demonstrate demyelinating lesions in the cervical spinal cord <2 segments). (A1, B1) T2W1. (A2, B2) TIWI+Gd.

2. Primary progressive Multiple sclerosis

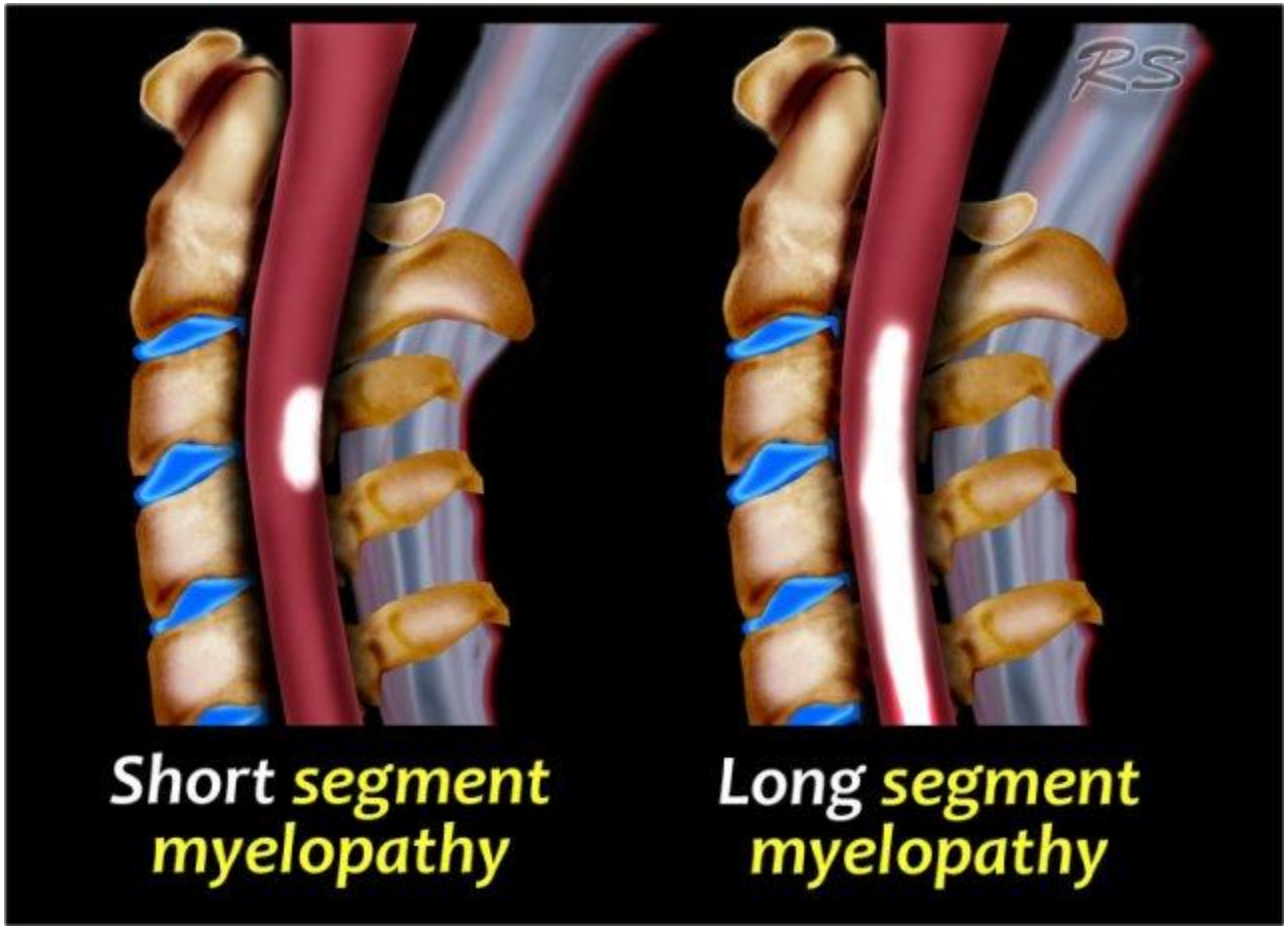


Myelopathy according to spinal segment involvement

A. **Short segment involvement (<2 segments)**
   - **Common in:**
     - MS
     - Degenerative
   - Uncommon in:
     - Transverse myelitis - partial form

B. **Long segment involvement(>2 segments)**
   - **Common in:**
     - Transverse myelitis - complete form
     - Neuromyelitis Optica
   - Uncommon in:
     - MS
     - Degenerative

Myelopathy according to spinal segment involvement



Radiological features for Spinal MS

1) Typical multiple spinal cord lesions in MS are relatively small and peripherally located.
2) They are most often found in the cervical cord and are usually l**ess than 2 vertebral segments** in length
3) In the cord there are some well-defined lesions, but also some ill-defined foggy lesions.
4) The transverse image shows the dorsal location and the typical **triangular shape.**
5) Continue with the contrast-enhanced image
6) Proton density weighted image (PDWI) is crucial for studying the spinal cord.
   - On PDW-images the spinal cord has a uniformly low signal intensity (like CSF), which gives the MS lesions a good contrast against the surrounding CSF and normal cord tissue.

Spinal Multiple sclerosis

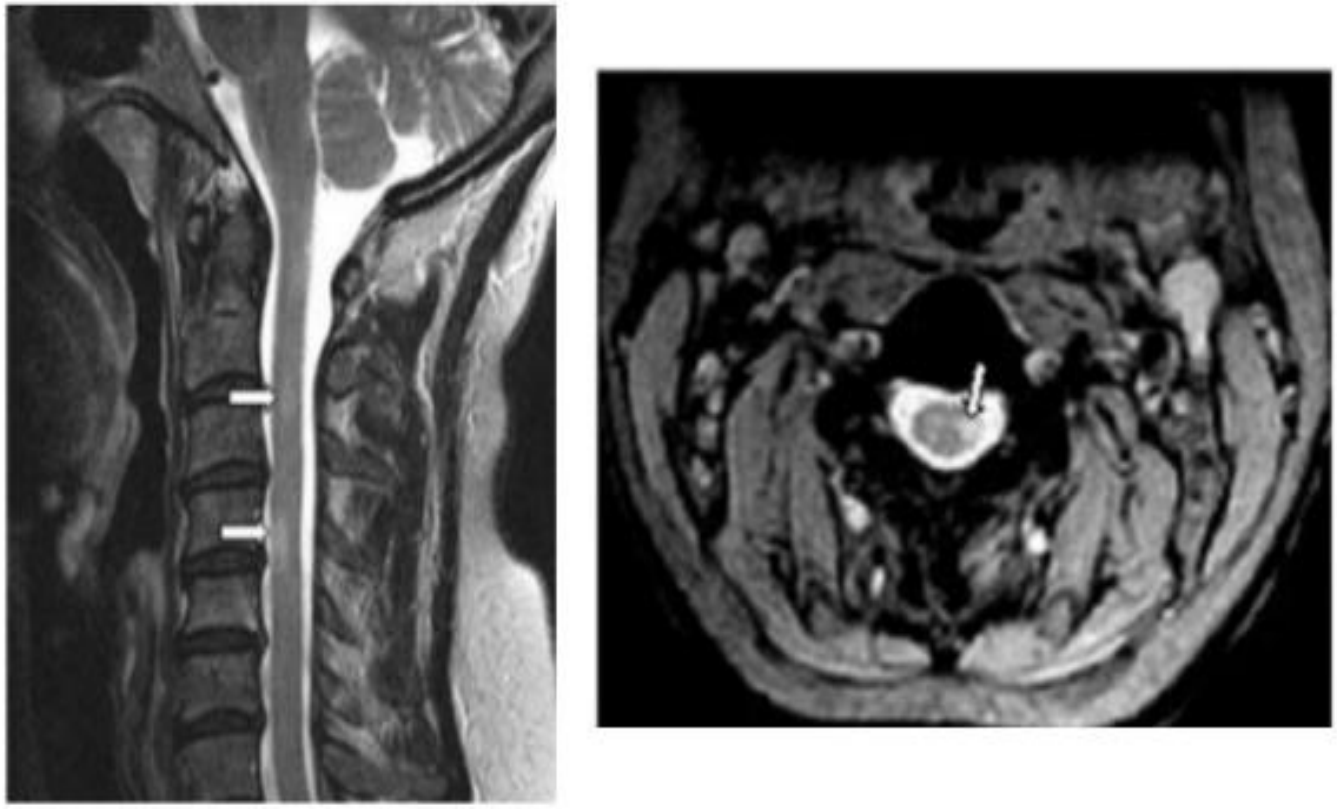


Figure: (Right) Sagittal T2 shows discrete lesions without cord swelling (between arrows), (left) On an axial T2-weighted image a triangular shape and are located laterally (arrow head) is involved and shows a hyperintense signal suggesting MS.

Spinal Multiple sclerosis

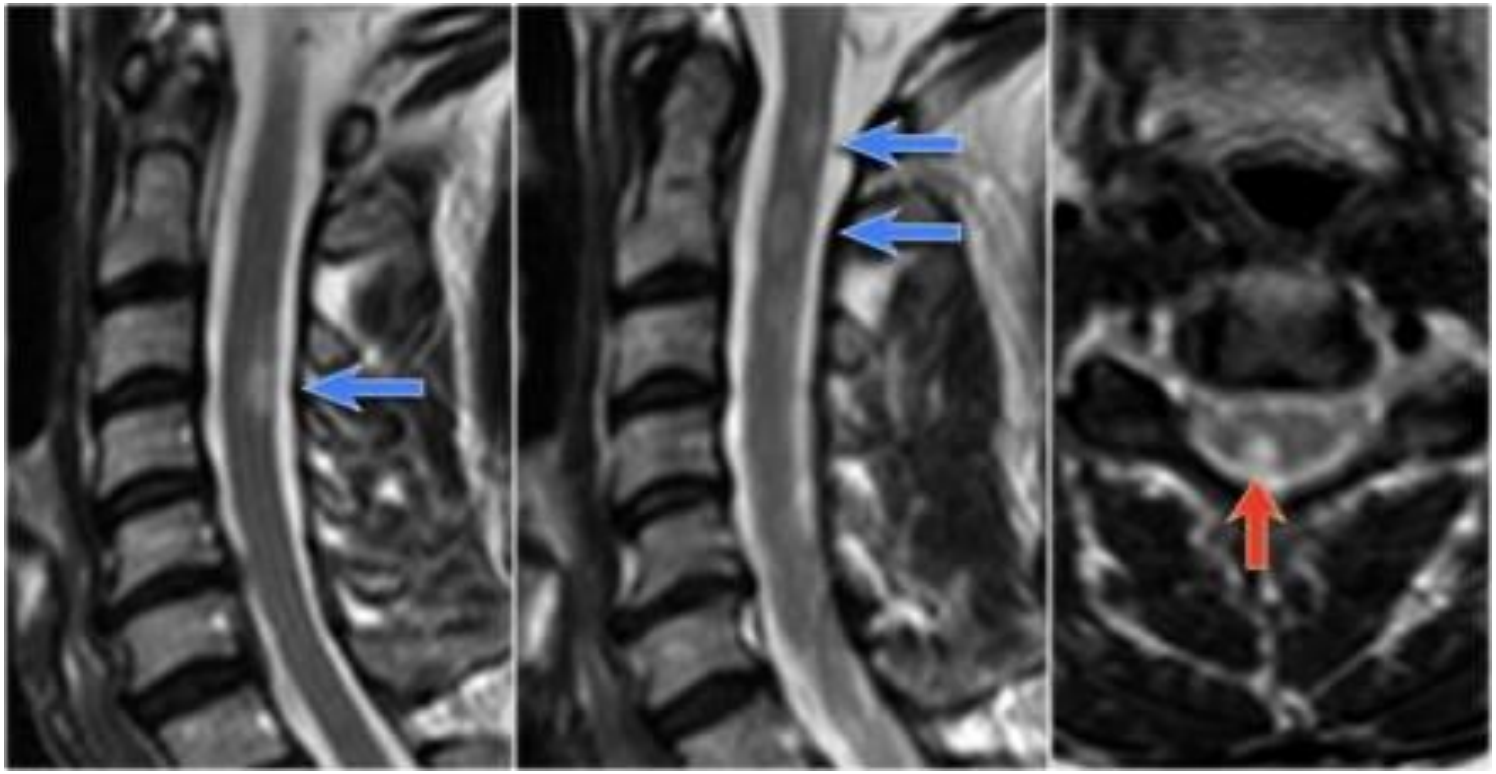
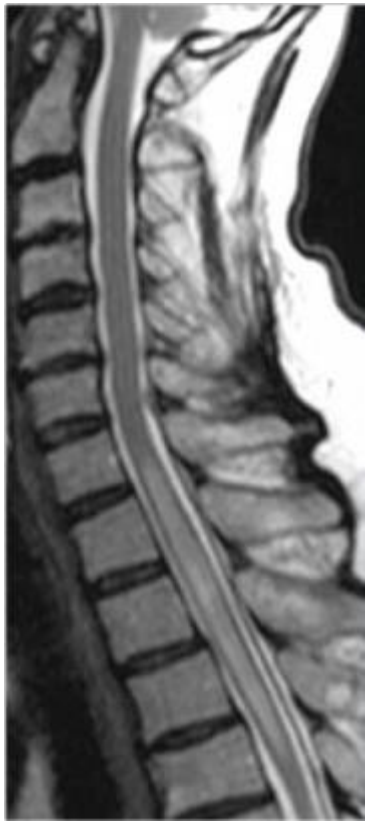


Figure: 40.8 T2-WI sagittal MRI of cervical spine demonstrate extending from mid-c2 to mid-c3 (between arrows) and mildly expanding the cord (a). The demyelinating lesion is hyperintense on the contrast enhanced sagittal T1-weighted image (b). On an axial T2-weighted image at the mid-C2 level round or triangular shape and are located **posteriorly or laterally** is involved and shows a hyperintense signal (c) suggesting MS

Radiological features of TM

1. There is a large variation in lesion size; however, they most commonly extend for 3-4 spinal segments.
2. More than 2/3 of the cross sectional area is involved.
3. Lesions typically occupy greater than two-thirds of the cross-sectional area of the cord.
4. There is variable enlargement of the spinal cord.
5. The sagittal image shows a large segment of hyperintensity on T2WI.
6. Enhancement + / -.

Transverse myelitis



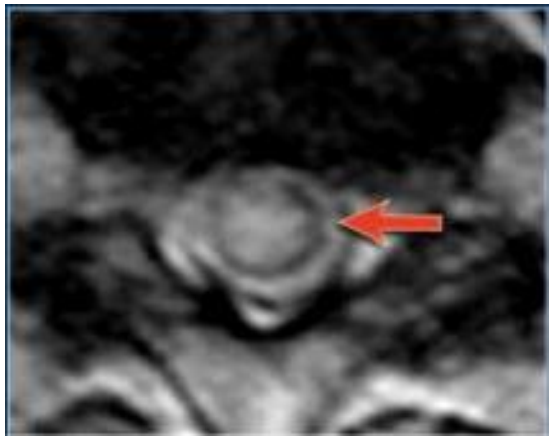


Figure: T2-WI sagittal MRI of cervical spine demonstrate extending from lower-C6 to mid-D3 (between arrows) and mildly expanding the cord (a). (b). On an axial T2-weighted image at the D1 level most of the cord is involved and shows a hyperintense signal **suggesting TM**

Transverse myelitis

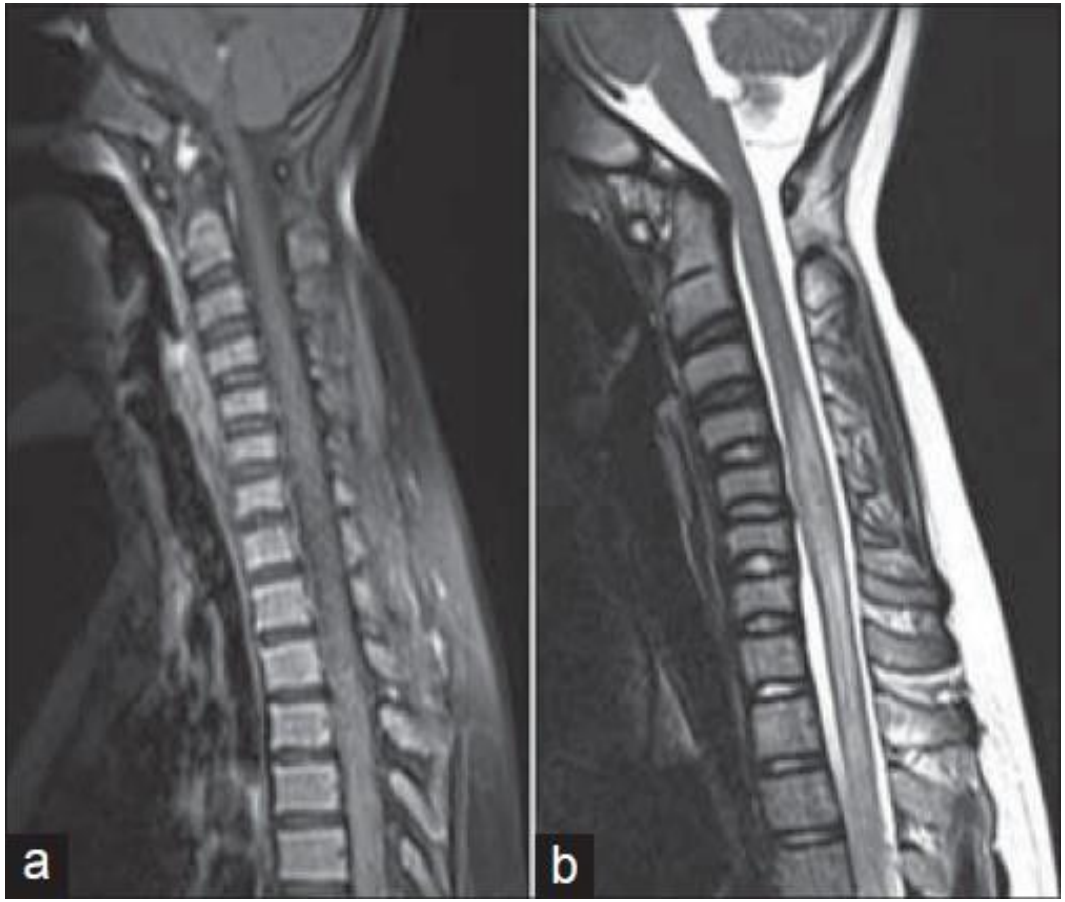


Figure 37.6: Magnetic resonance imaging of spinal cord (sagittal view) showing normal spinal cord in T1-weighted image (a) and hyperintensity within the cord adjoining C-5 to D-4 vertebrae in T2-weighted image (b), suggesting long segment acute transverse myelitis.

Difference between MS and TM/NMO

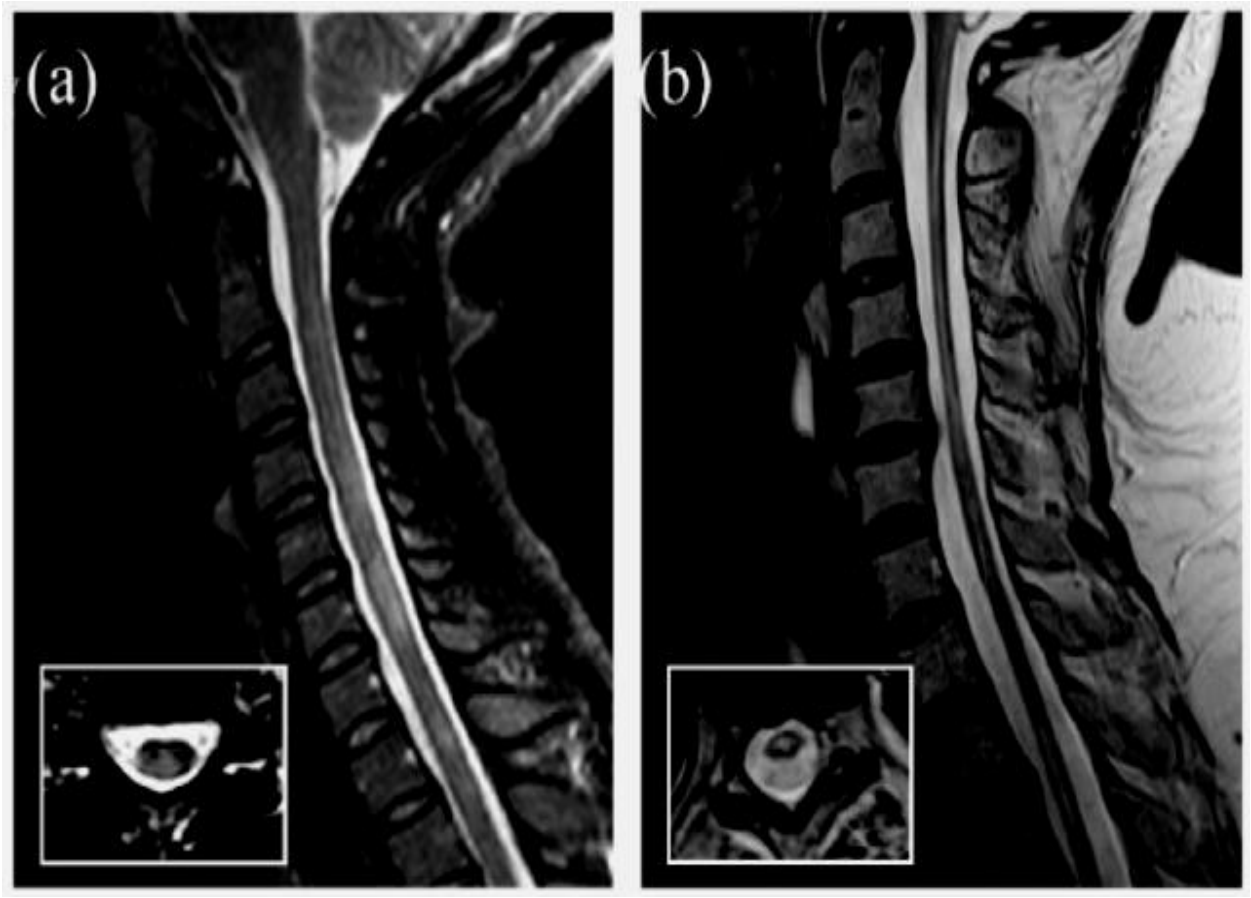


Figure: **In MS** (A), MRI shows areas of T2 hyperintensity which extend for a single vertebral level, involve both grey and white matter in the lateral-posterior part of the cord and have a cylindrical shape on the sagittal and a wedge shape on the axial view. **NMO**(B), there is a longitudinally extensive transverse myelitis from C1 to C5 and a lesion at T2–T3, with preferential involvement of the central spine.

Subacute Combined Degeneration

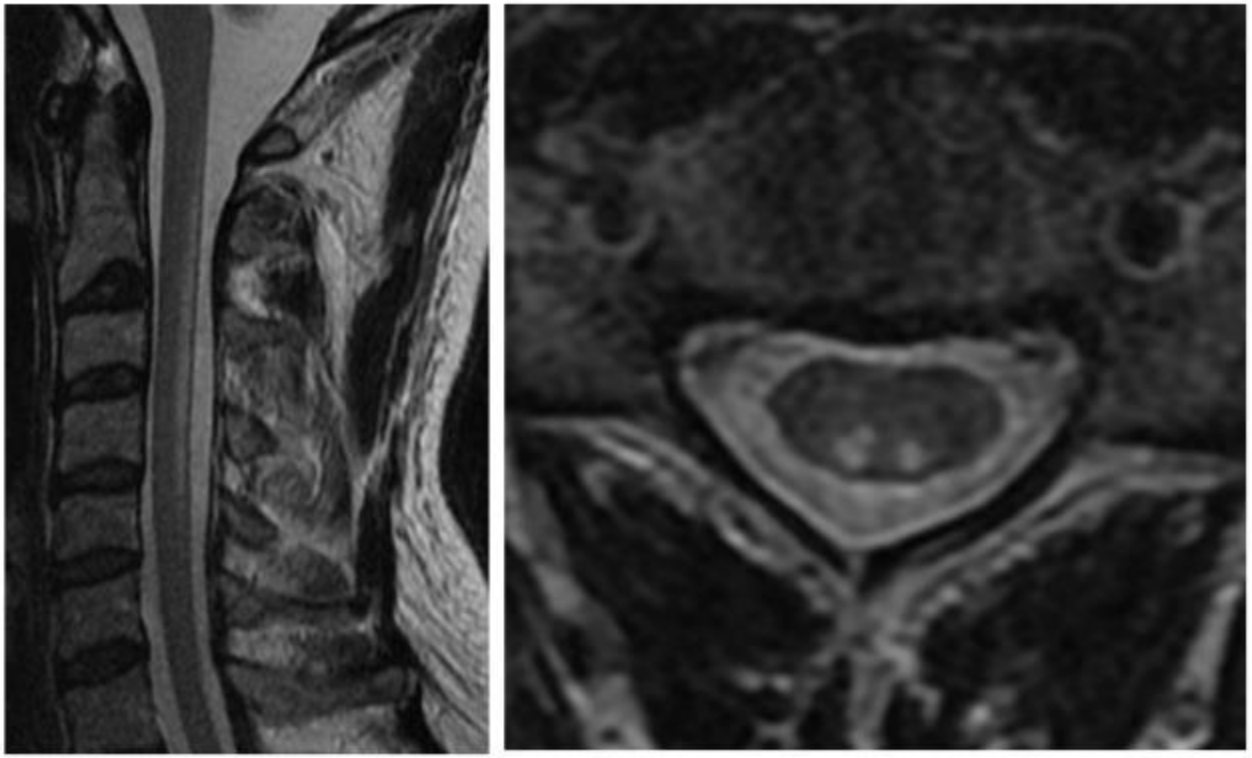


Figure:T2WI shows hyperintensity (arrows) in the dorsal aspect of the cord spinal extending from the level of C2 to the level of C5. Axial T2 obtained through the cervical spinal cord at three separate levels from C3 to C4 show bilateral symmetric signal intensity abnormality within the dorsal columns **(arrows-Inverted V sign)**
So my radiological diagnosis is **Subacute Combined Degeneration**

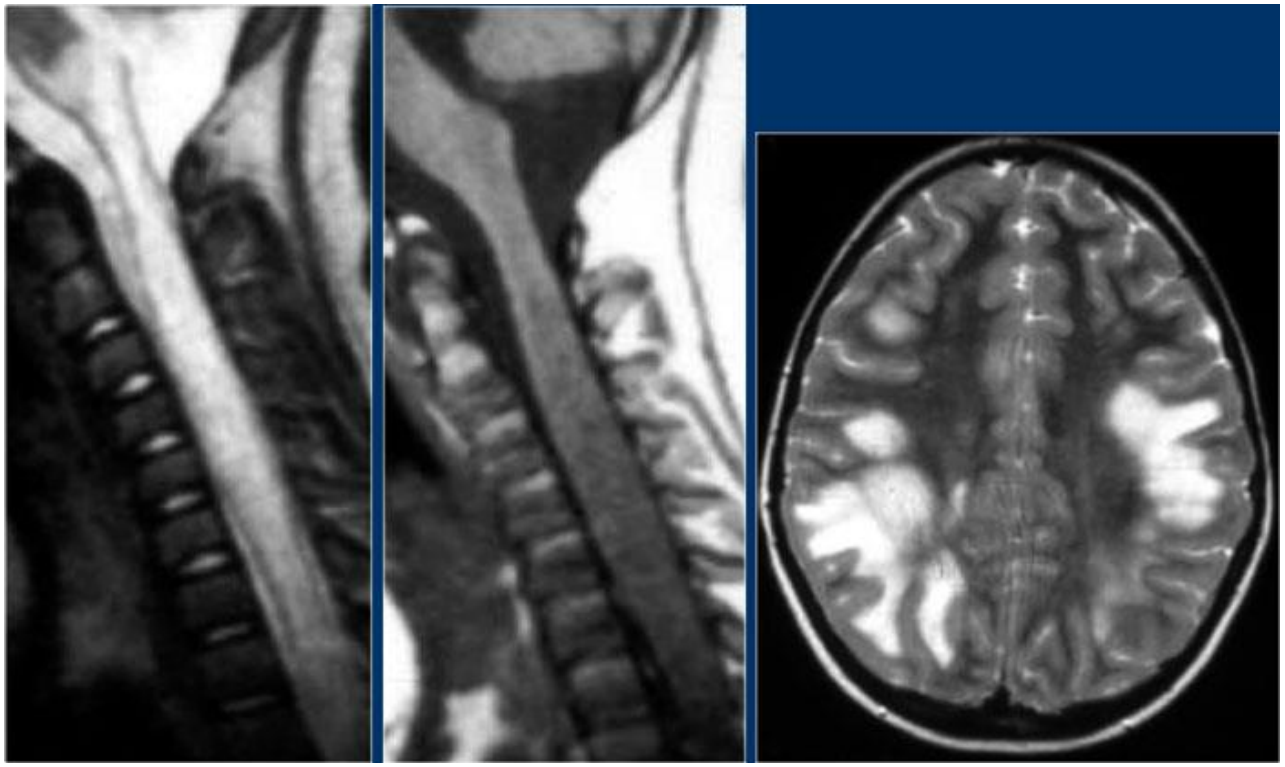


Figure:T2WI sagittal MRI of cervical spine demonstrate diffuse involvement of the **spinal cord extending from C1 to C7** (between arrows) and mildly expanding the cord. The lesion is isointense on the T1WI and in T1+Gd (contrast) nonenhanced. Again there is also involvement is involvement of the brain suggesting ADEM.

Case -14

- A 65-year-old man presented at our service with a 6-year history of pain mid back with visible spine scoliosis and a 1-year progressive motor disability of bilateral lower limbs.
- MRI of spine with contrast had done

Case -14

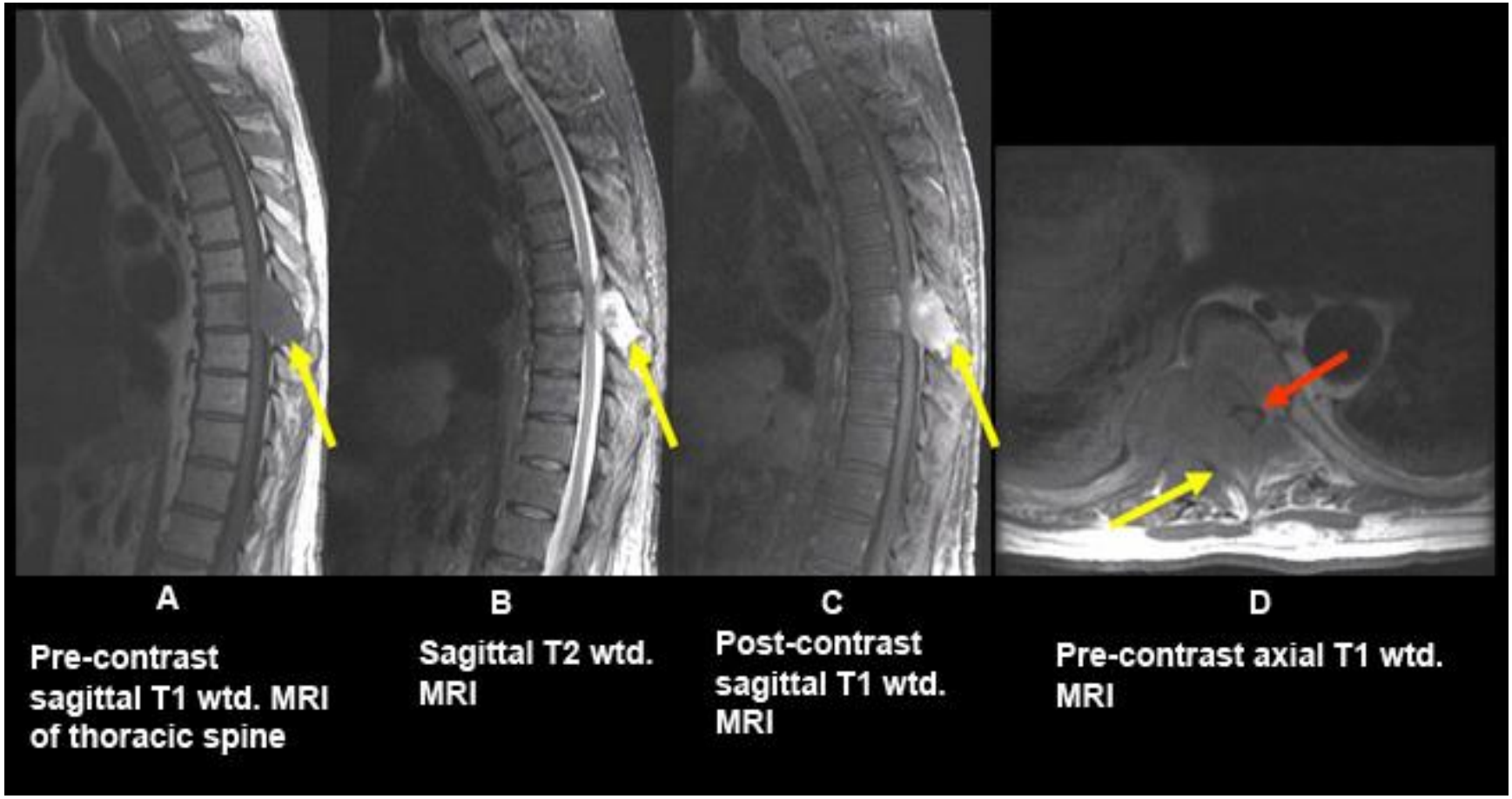


Figure: Bony metastasis with epidural tumor producing cord compression.

Case -14

Questions:

1. What are the findings of the MRI
2. What is the diagnosis?

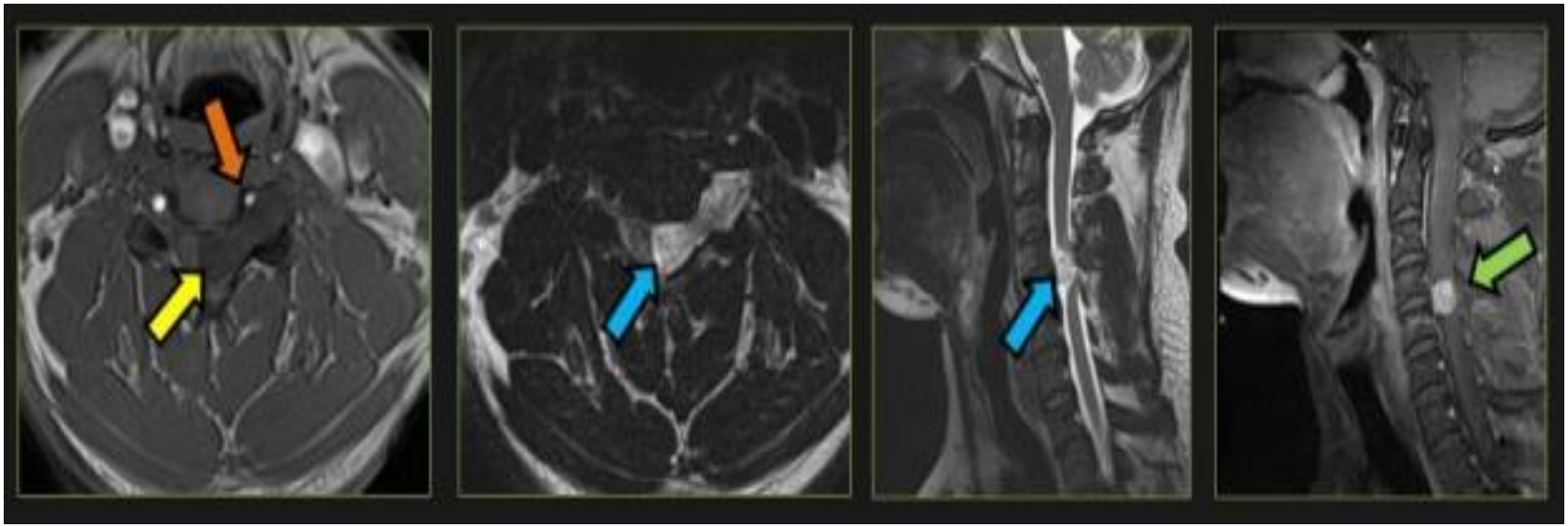
Answers:

1. Thoracic spine MRI. (A)- Sagittal cervical spine MRI slices demonstrate hypointense lesions and (B) Hyperintense lesion with encroach at the bone. After giving contrast (TWI+Gd) that lesion was enhanced

2. Bony metastasis with epidural tumor producing cord compression.

Case -15

- A 35-year-old man presented to our hospital with a five-month progressive paresthesia, weakness of the limbs,.
- MRI of spine had done



Case -15

Questions:

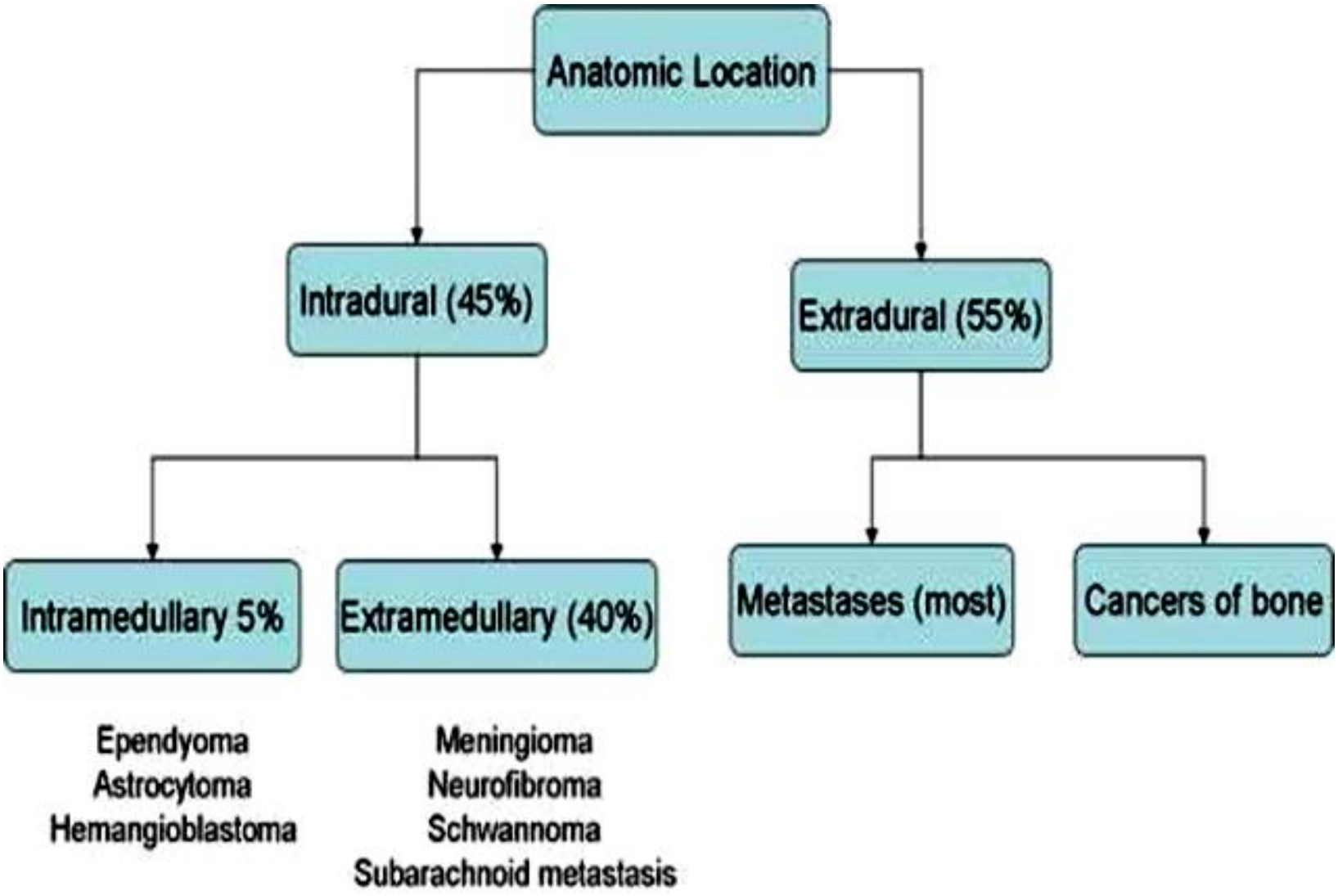
1. What are the findings of the MRI
2. What is the diagnosis?

Answers:

1. **Dumbbell shape of tumor** with intraspinal component producing cord compression and paraspinal tumor extension through an enlarged neural foramen following the exiting nerve root at C5 level.

2. **Intradural extramedullary tumor**, possibly **schwannoma** (nerve sheath tumor)

Classifications of Spinal cord tumours



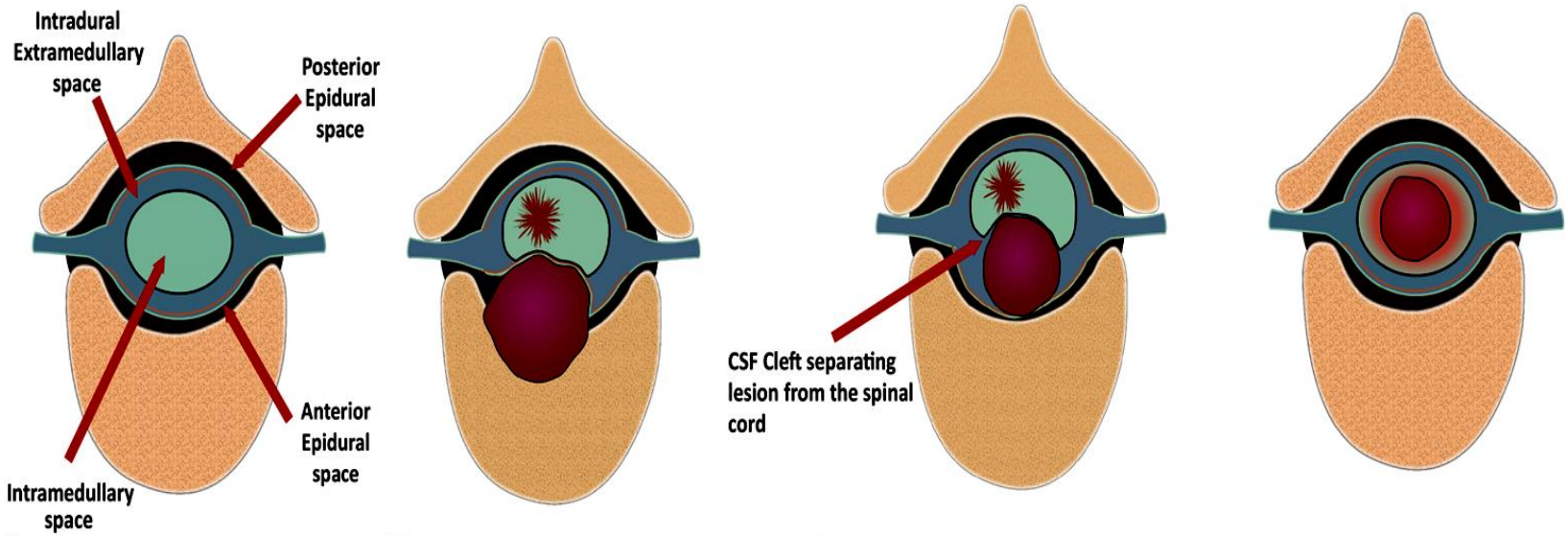


Figure: Schematic presentations of spinal cord tumours

Extradural (Epidural) Tumors

1. Epidural tumors are usually from metastatic involvement of vertebral bodies.
2. Lung cancer, breast carcinoma, thyroid carcinoma, renal cell carcinoma are common sites of primary that metastasize to vertebral bodies.
3. Primary vertebral body tumors (less common): Osteoma, Osteogenic sarcoma, Chondroma, Chondrosarcoma and Chordoma.

Epidural tumours with metastasis

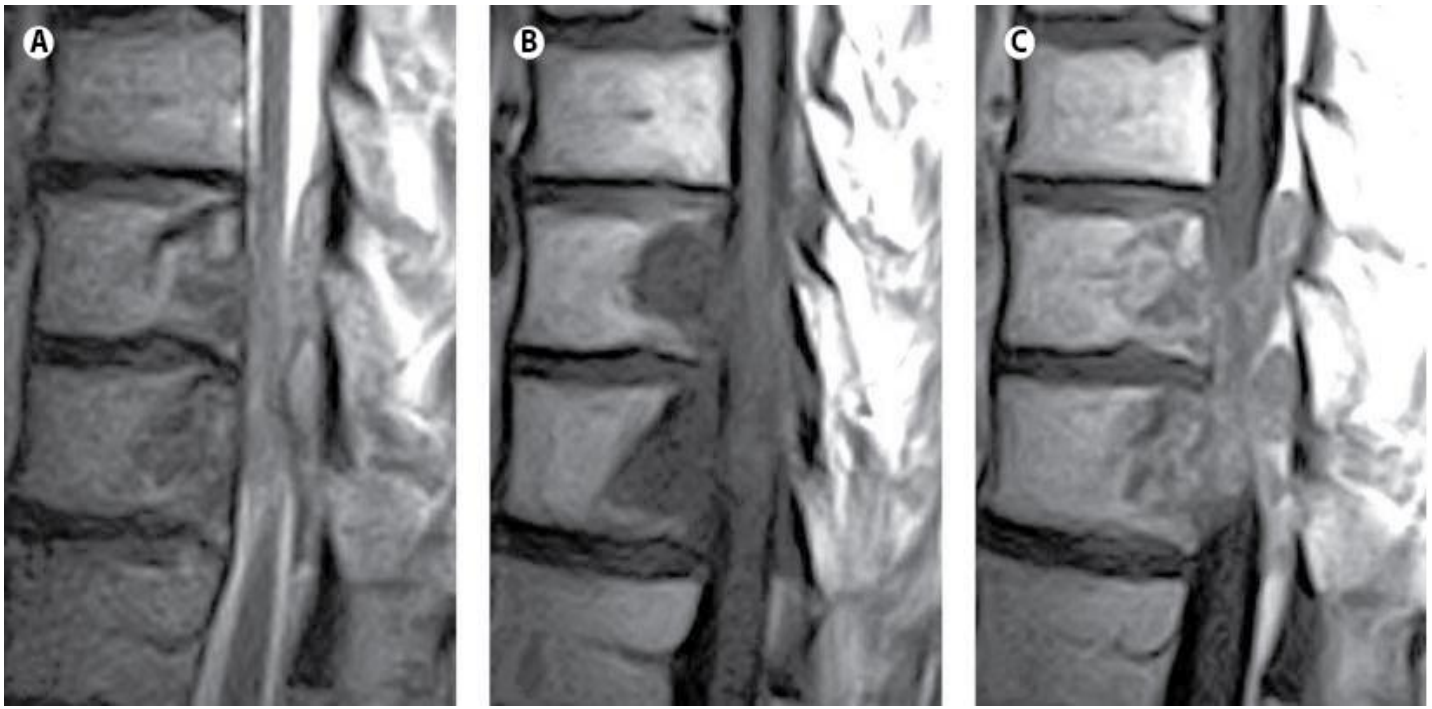


Figure: Vertebral metastatic disease , with epidural extension and severe cord compression

Epidural mass- Lymphoma

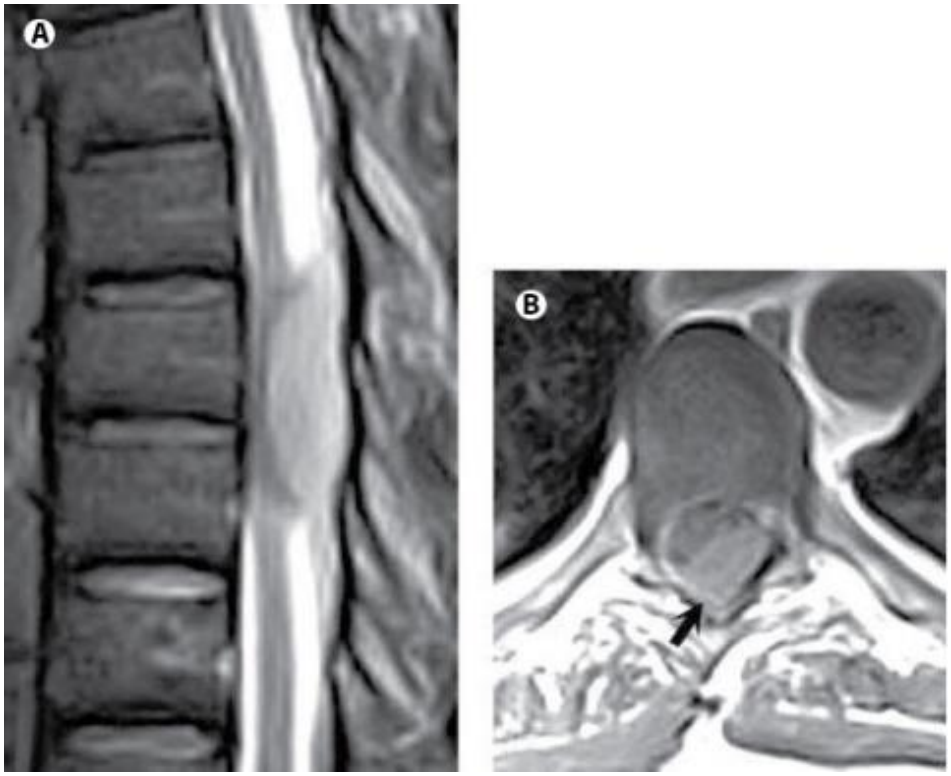


Figure: A.T2WI midline sagittal image reveals a large hyperintense epidural mass at the T8-9 level posterior to and compressing the cord.

B. The axial T1+C image reveals moderate homogeneous enhancement of the lesion (**black arrow**), with the cord displaced and compressed anteriorly (and to the right).

So my radiological diagnosis is **Lymphoma.**

Intradural extramedullary tumour-Schwannoma

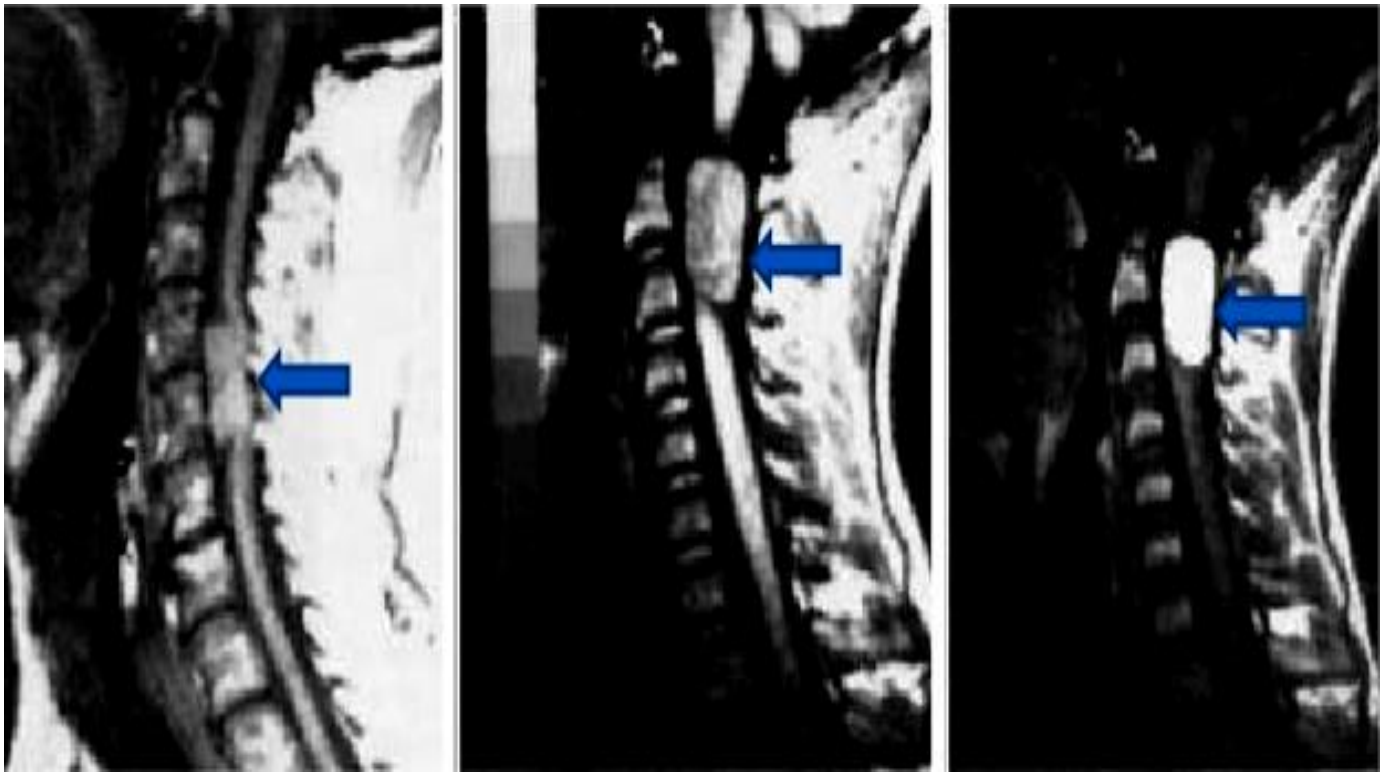


Figure: Intraspinal component producing cord compression and paraspinal tumor extension through an enlarged neural foramen following the exiting nerve root. This is characteristic of nerve sheath tumor.
An enhancing intradural extramedullary nerve sheath tumor.
So my radiological diagnosis is **schwannoma.**

Intradural Extramedullary Tumors

1. Meningioma and schwannoma are common intradural extramedullary tumors.
2. Nerve sheath tumors are pathologically classified as neurofibroma or schwannoma.

Intradural extramedullary tumor -Meningioma

Figure: An intradural extramedullary enhancing tumor. MRI Sagittal section TIWI and T2WI sequences shows ventrally located hypointense lesion with contrast enhanced which produced cord compression with displacement of the right postero-lateral location of the thoracic cord. So my radiological diagnosis is **meningioma.**

Intradural extramedullary tumour-Schwannoma

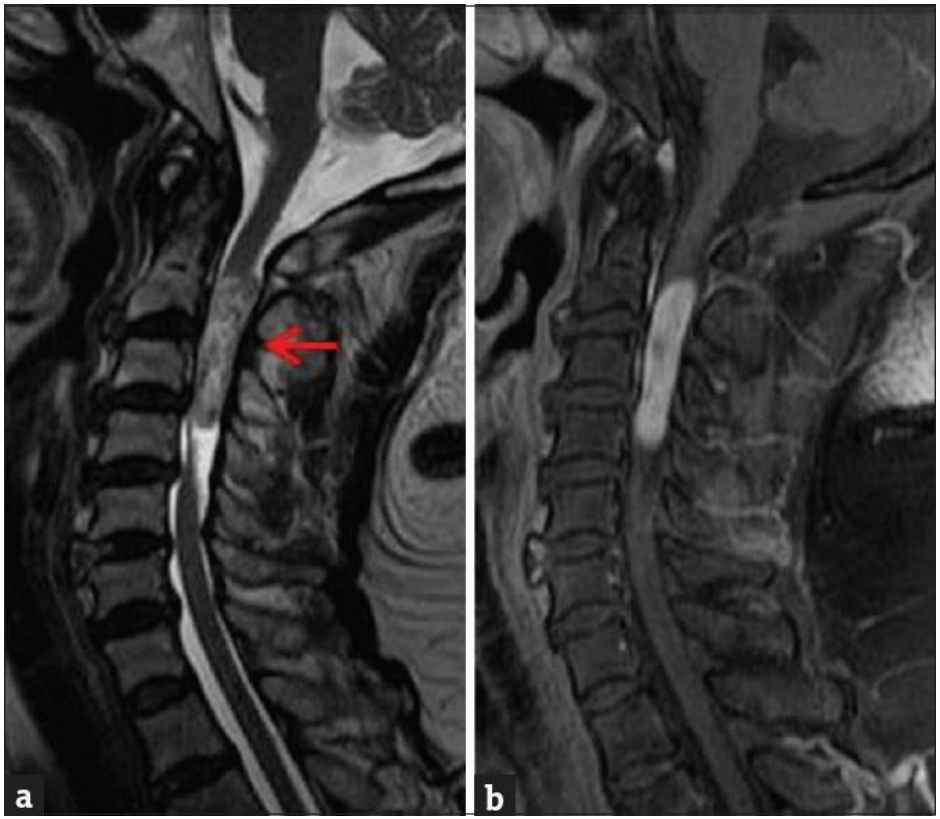


Figure: MRI cervical spine magnetic resonance imaging (a) Sagittal T2-weighted sequence demonstrates heterogeneously T2 hyperintense intramedullary mass extending from C2-C4 spinal segments. (b) Enhanced T1-weighted sequence demonstrates nearly homogeneous mass enhancement. Pathology was consistent with **schwannoma.**

Intradural extramedullary tumour-Schwannoma

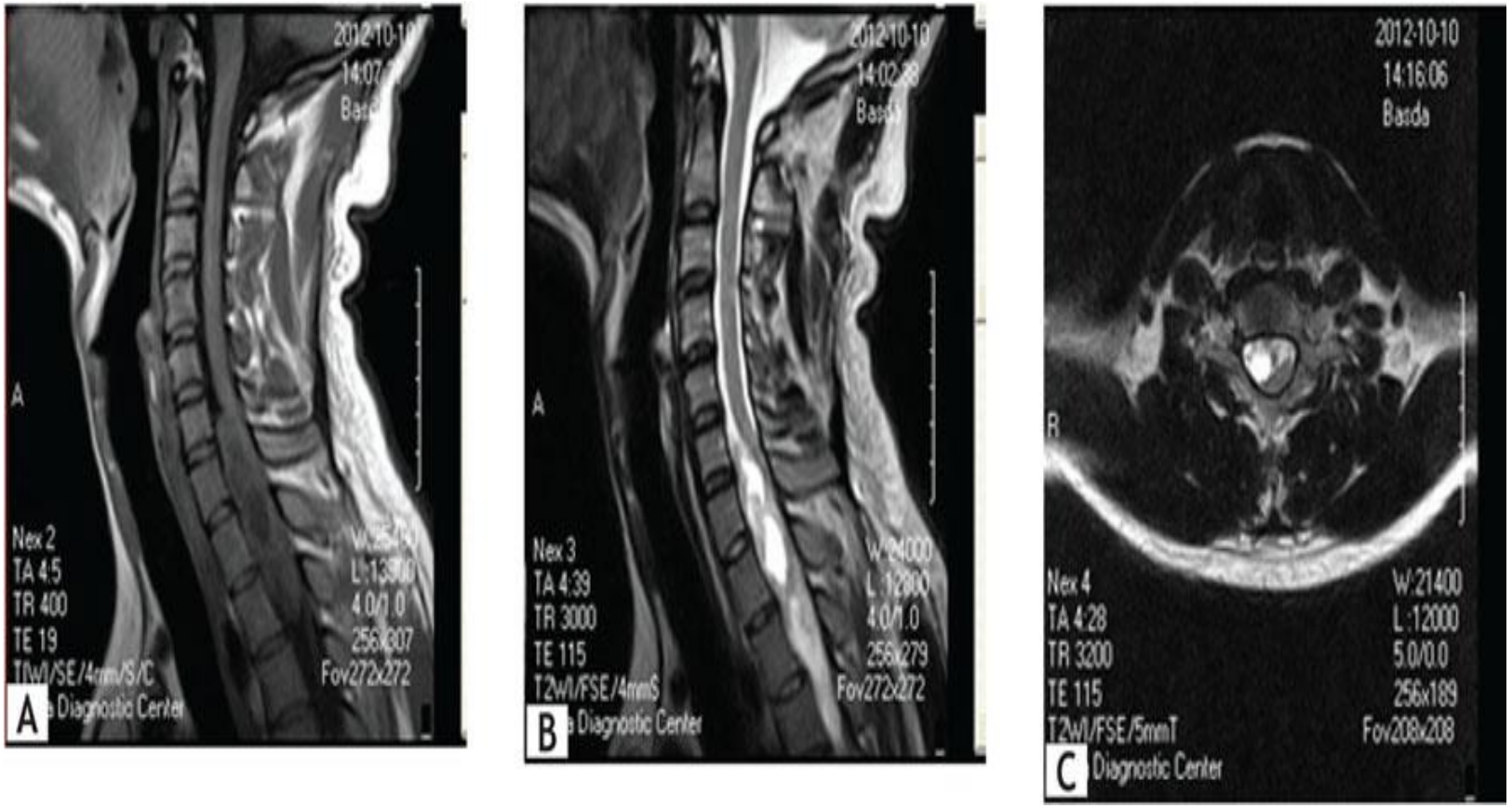
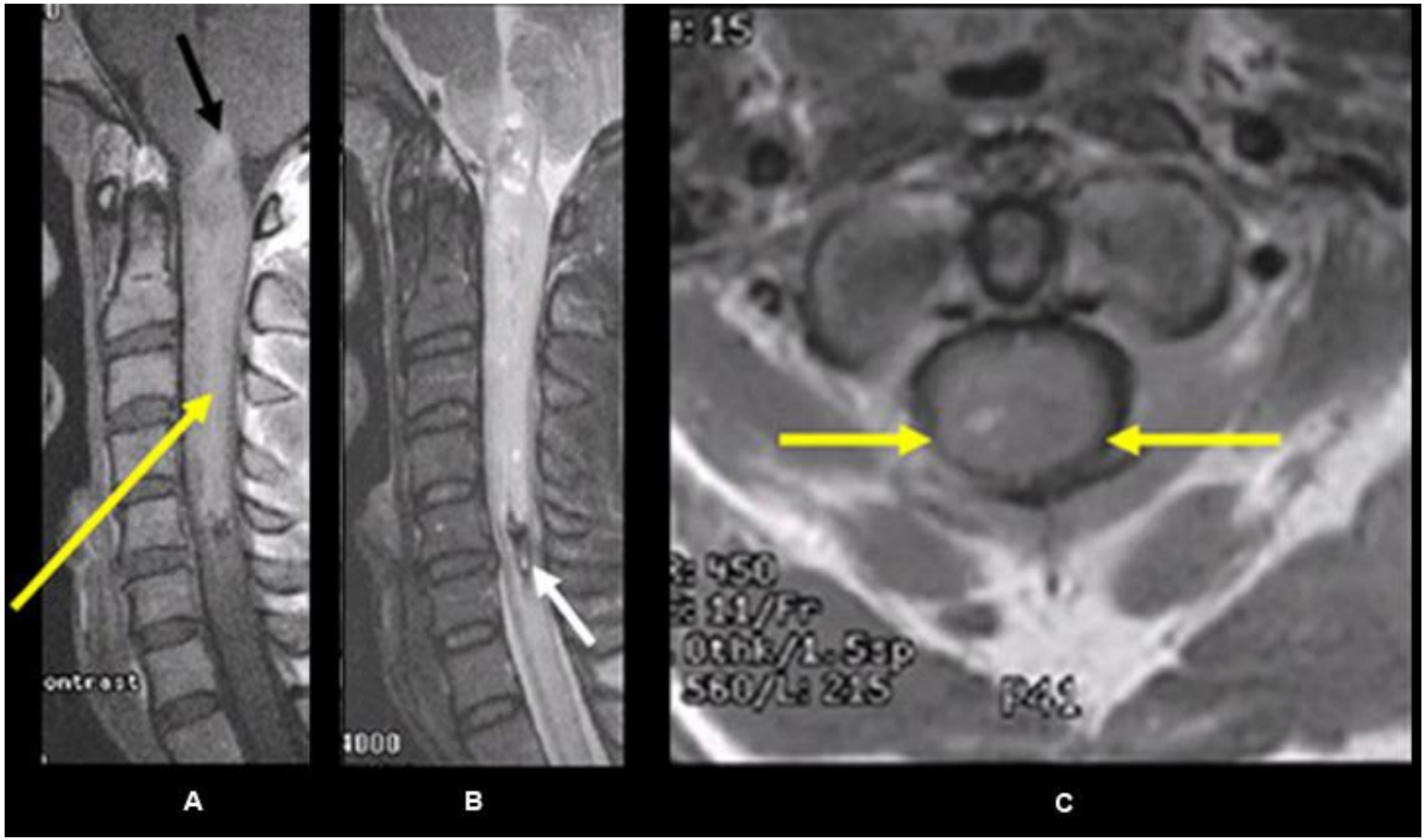


Figure: MRI cervical spine magnetic resonance imaging (a) SagittalT1WI & T2WI sequence demonstrates hypointensity in T1WI and heterogeneously T2WI hyperintense intramedullary mass extending from C2-C4 spinal segments. (b) Enhanced T1-weighted sequence demonstrates nearly homogeneous mass enhancement. Pathology was consistent with **schwannoma.**

Intradural Intramedullary Tumors

1. Intradural Intramedullary tumors are Ependymomas, Astrocytoma, Hemangioblastoma and Metastasis.
2. Intraspinal cord tumors are classified as intramedullary when they originate from the spinal cord itself.
3. Ependymoma and astrocytoma are common intramedullary tumors.
4. In intramedullary tumors, the cord expands both in sagittal and axial projections



This is intramedullary tumor because the cord has expanded in both sagittal and axial projections . It is centrally located . Intensely enhancing tumor.
So my radiological diagnosis is **ependymoma.**

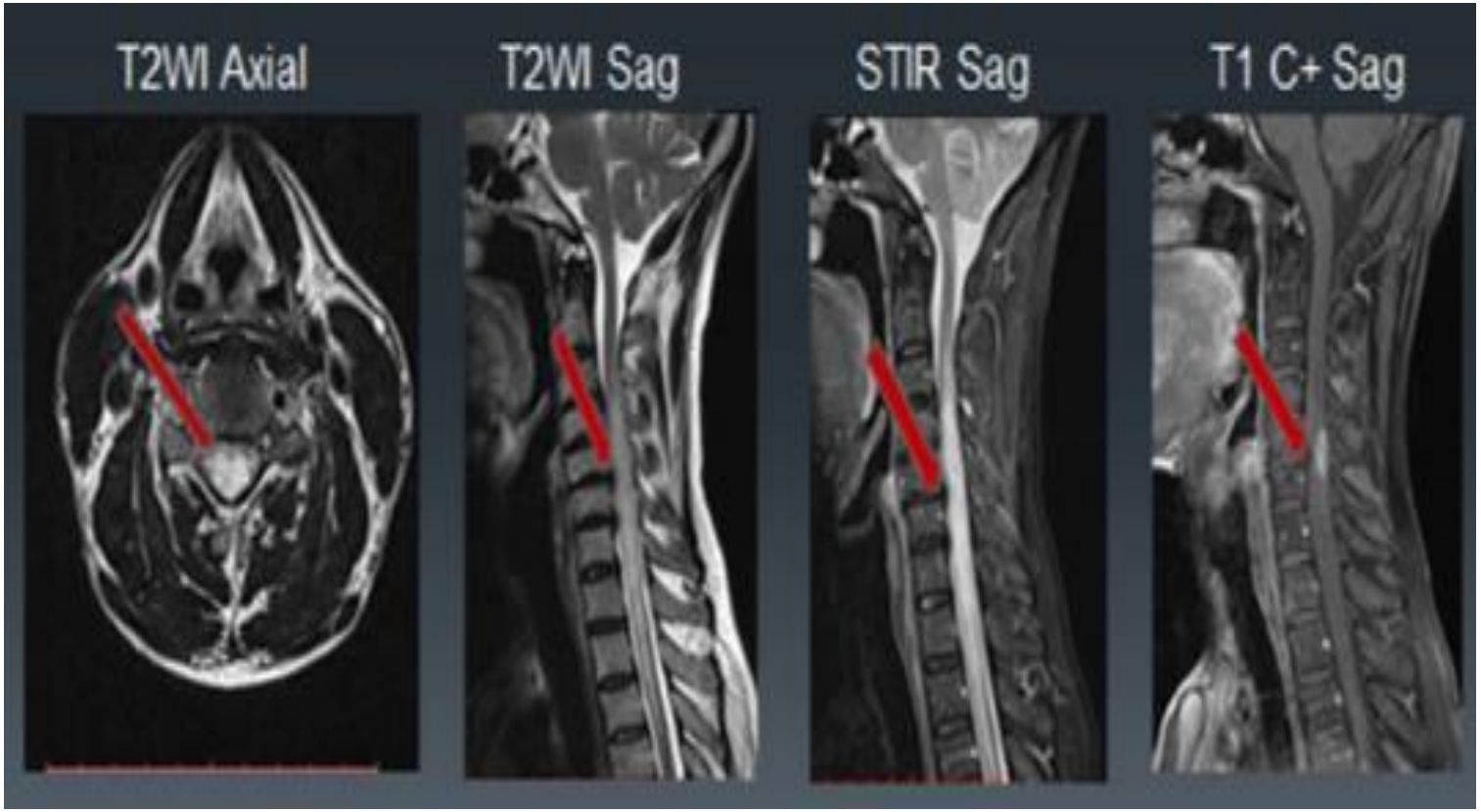


Figure: MRI of cervical spine showing axial & Sagittal T2 and STIR images Shows homogenous hyperintensity(red arrow) mass lesion situated eccentric and posteriorly of spinal cord .Post-contrast axial T1wtd. MRI (C+). The same lesion with **enhancement.** So my radiological diagnosis is **Astrocytoma**

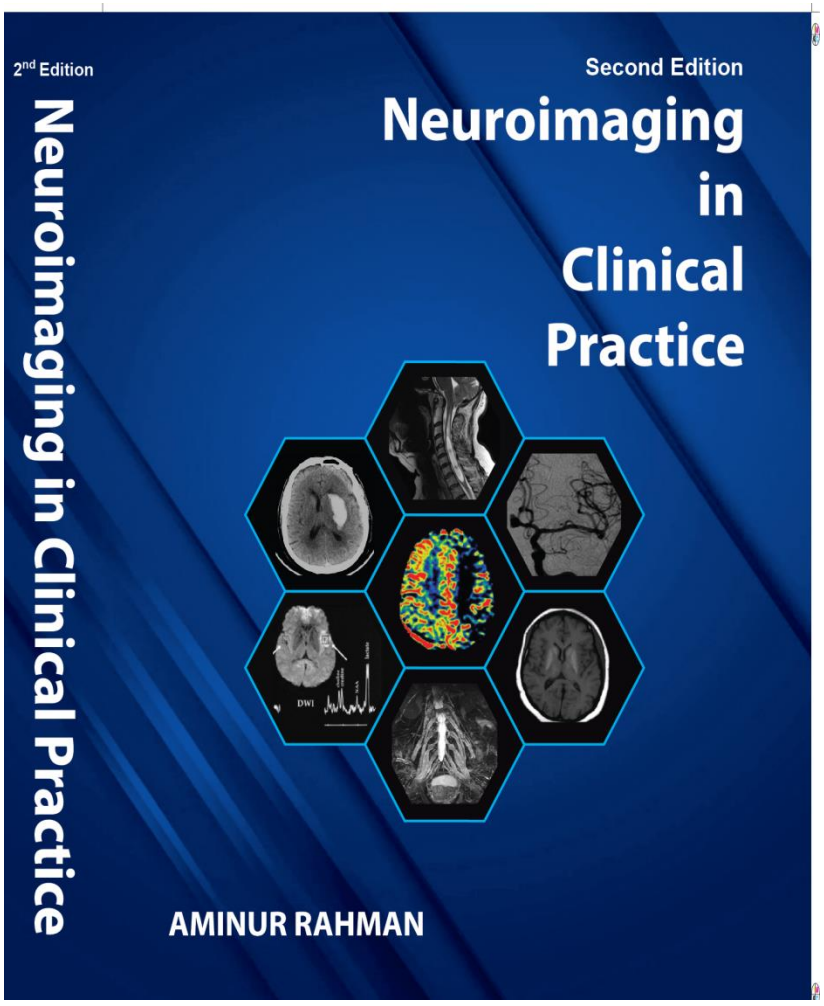
Conclusion

- Magnetic resonance imaging is now an established clinical imaging modality with applications extending from investigative radiology to functional imaging in neurosciences.
- As hemorrhage evolves, it passes through 5 well-defined and easily identified stages, as seen on MRI.
- Knowledge of these stages may be useful for dating a single hemorrhagic event or for ascertaining if multiple hemorrhagic events occurred at different times.

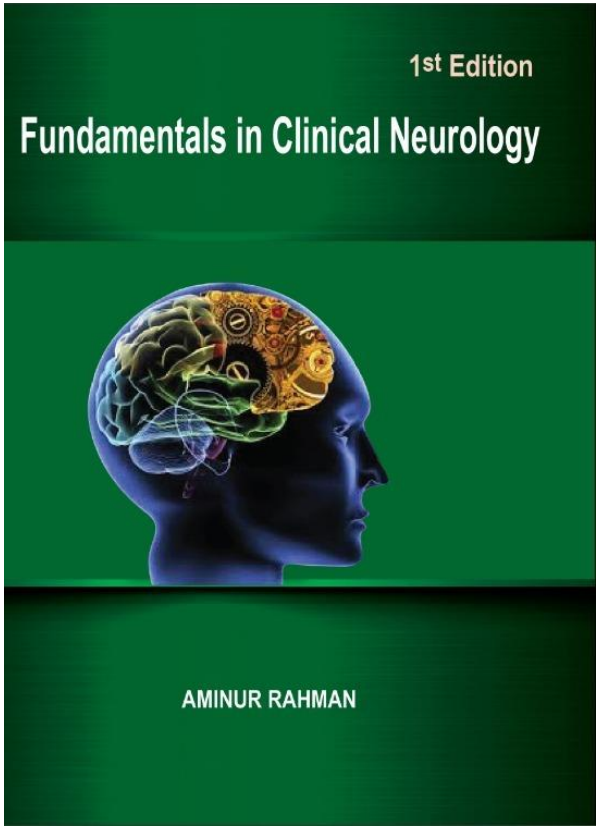
Conclusion

- Although CT may be more useful than MRI for detecting hyperacute parenchymal hemorrhage or early subarachnoid hemorrhage (SAH) or intraventricular hemorrhage (IVH), MRI is certainly more sensitive after 12-24 hours.
- MRI is also more specific than CT in determining the age of a hemorrhage.
- Both T1- and T2-weighted MRIs should be obtained to adequately characterize and stage a hemorrhage.

Books on Neuroimaging



Thank you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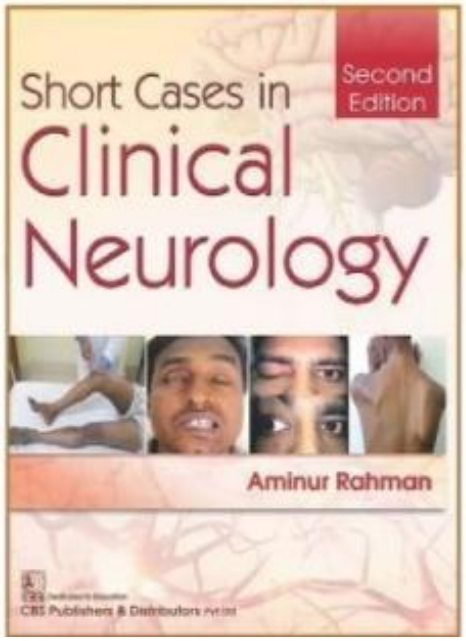
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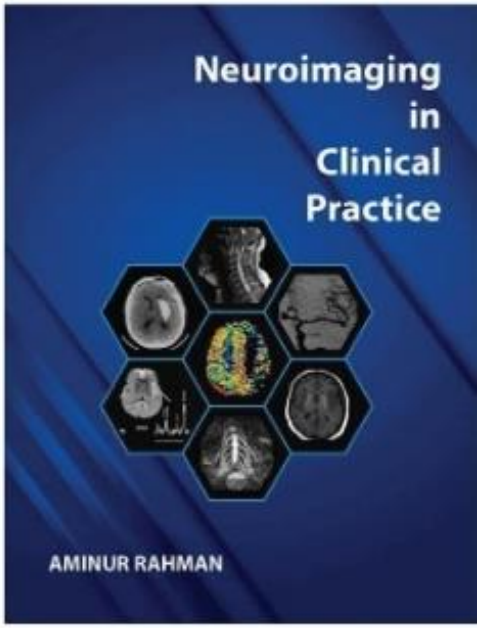
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