5- ANATOMY AND INVESTIGATIONS OF NERVOUS SYSTEM ..

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The red : DR important notes

The green : additional note from:

our team , DR notes, 429 radiology team

The Radiological Investigation Used For Evaluation of The Brain and Skull

- 1.Plain x-ray Skull → rarely used for imaging

- 2.CT Scan

- 3.MRI

- 4.MRA, MRV & CTA

- MRA (magnetic resonance arteriography) and MRV (magnetic resonance venography) are non invasive (without the use of catheter and contrast) vascular imaging opposite to CTA.

- 5.Catheter angiogram

- 6.Duplex U/S of carotid arteries

- 7.Ultrasound for neonatal brain

The Radiological Investigation Used For Evaluation of The Brain and Skull

The newer imaging modalities have had a great impact on the diagnosis of diseases of the central nervous system.

CT and MRI have become the standard investigations for disorders of the brain.

Plain films are still the initial investigation for disorders of the bones of the skull – particularly fractures, but otherwise have limited uses.

Plain x-ray skull

- **<u>Indications:</u>**

Has limited role in imaging and CT is better

- trauma or (Fractures of the skull)
- congenital (eg: microcephaly)
- calcification: normal or abnormal (vascular ,neoplasm)
- metastasis to skull: lytic /sclerotic
- multiple myeloma
- metabolic disorders

:

Plain x-ray skull

Frontal sinus

Ethmoid sinuses

Petrous bone

orbit

mandible

Mastoid air cells

L

GROOVE FOR MCA

Coronal suture

**SELLA TURCICA**

EXT.AUD MEATUS

ORBITAL GROOVE
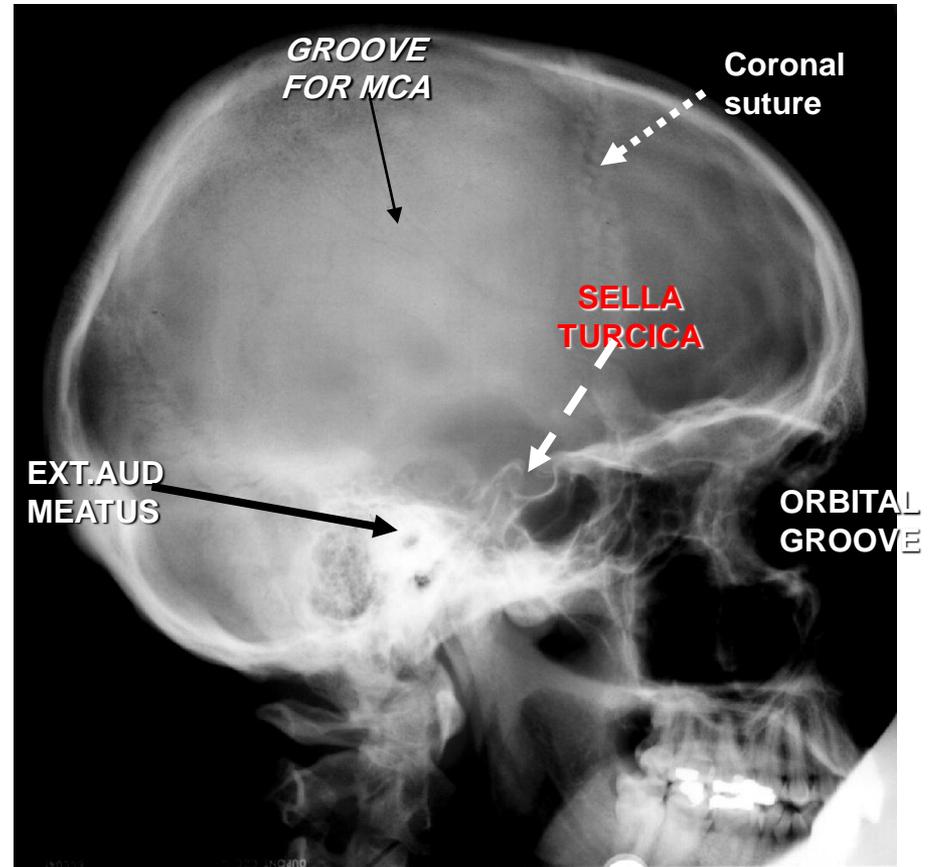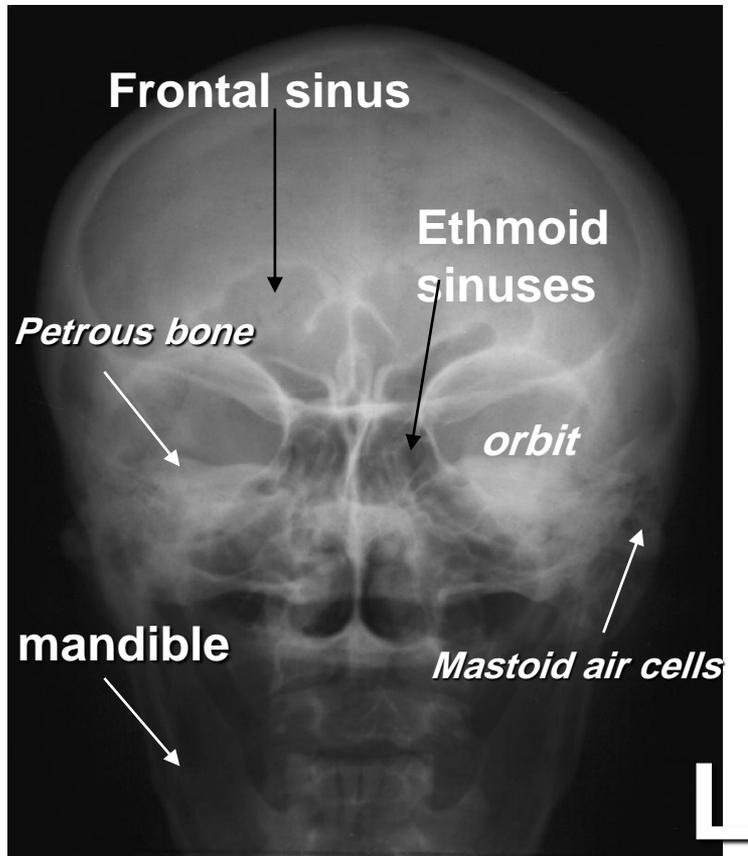
SKULL PA (also known as occipto-frontal view → means that the X-ray beam pass from posterior part to the anterior aspect of the skull)

Skull X-RAY LATARAL VIEW (note we can see here , the **sella turcica** clearly as an empty space in this view)

Plain x-ray skull

Foramen ovale

Foramen spinosum

Mandible

Carotid canal

Ant. arch C1

Occipital condyle

Odontoid

submentovertical VIEW

LAMBDOID SUTURE

IAMs

F.MAGNUM

Dorsum sellae
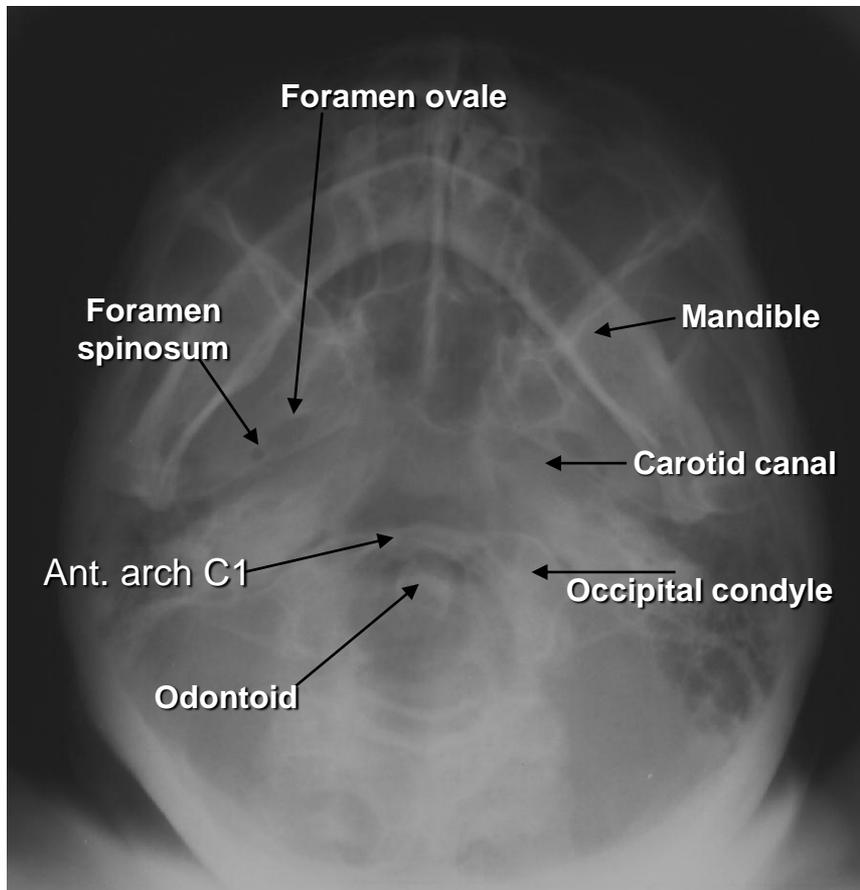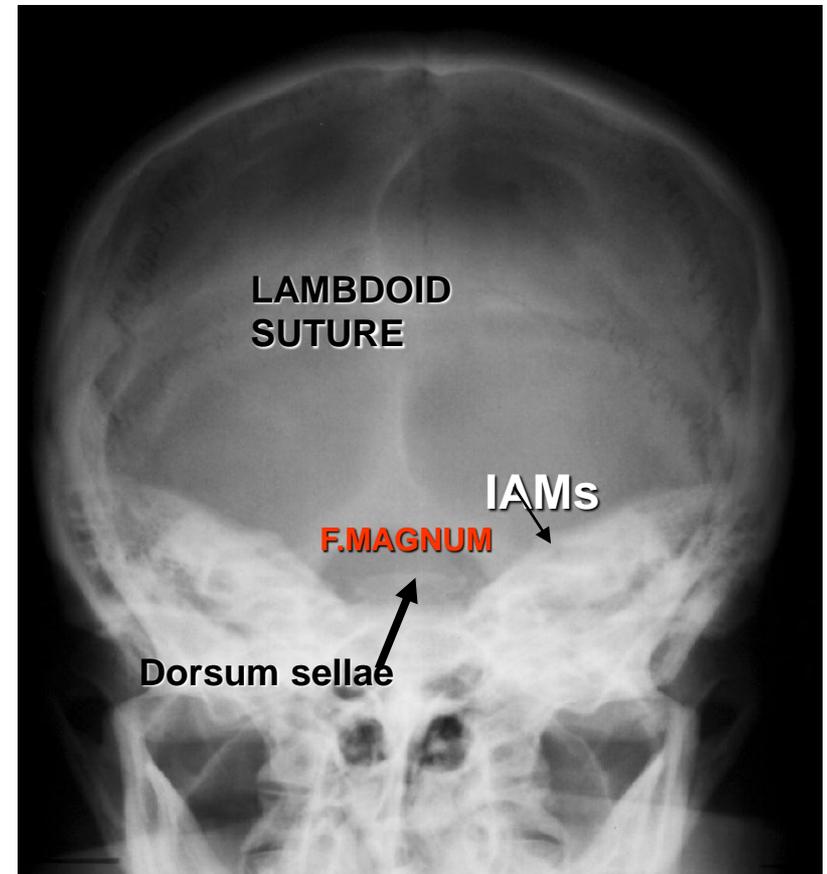
TOWENS VIEW (AP)

CT SCAN..

- ### Disadvantage:

 The ionizing radiation

- ### Advantages:

-Fast : The scan itself can take as little as 10 seconds and in case of the use of contrast , Spiral CT can perform a head scan in 15 minutes including the period of (pre &post contrast scan).

- Patient preparation: nil

- ### Type of the contrast medium:

- iodinated contrast (non ionic L.O.C.M) = (low osmolar contrast media) .

- ## <u>Indications:</u>

- Trauma :CT is the best and initial study to assess the trauma because it's ability in detection the blood and determine it's stage as a following :
  -**acute blood**: apears hyperdense (white)
  -**Sub acute**: isodense(the same as surrounding parenchyma)
  -**Chronic:** hypodense(black)
- Strokes (CT is used as initial investigation in case of stroke ,you know that anticoagulant drugs are contraindicated in case of hemorrhagic stroke, so here is the role of CT , it can determine whether the stroke is hemorrhagic or not and that is enough for the physician to determine The need of anticoagulant for the patient BUT MRI is better and more sensitive as what we will explain later)
- tumours
- infection
- Vascular disorders

- **<u>Relative Contraindications :</u>**

In the past we used to say pregnancy is absolute contraindication but now it became relative contraindication but

 we have to ensure the following :

-There is no other modality can assess the patient condition

-Tell the patient the possible hazard and take from the patient a written consent.

-Cover the patient abdomen .

CT SCAN..

- The axial plane is the routine projection but it is sometimes possible to obtain direct coronal scans.
- There are no sagittal section images can obtain directly in CT, it is done by CT reconstruction , so we can take only axial , coronal view directly

NORMAL CT BRAIN

- CSF is seen as water density (black) within ventricular system and subarachnoid space.

- Grey matter is differentiated from white matter (white matter is relatively darker than grey matter).MCQ

- The falx is denser than the brain.

- Large arteries and venous sinuses can be recognized when opacified by contrast medium.

- Posterior fossa may be obscured by artifacts from overlying temporal and occipital bone.

- Calcification appears white , note that not every calcification considered abnormal , there are certain calcification in certain location considered normal (eg: choroid plexus)

CT SCAN..

What is Artifact ?
(خطا وتداخل بالصورة)
Specially in narrow place eg: (posterior fossa) , the problem that if there is an infarction , it will be masked and hidden by the artifact , and that will minimize the sensitivity of CT in assessment of infarction as compared to MRI SO that explain why MRI is better in assessment of stroke than CT .

A. Orbit
B. Sphenoid Sinus
C. Temporal Lobe
D. Externa Auditory Canal
E. Mastoid Air Cells
F. Cerebellar Hemisphere
G. Medulla
H. Artifact

CT SCAN..
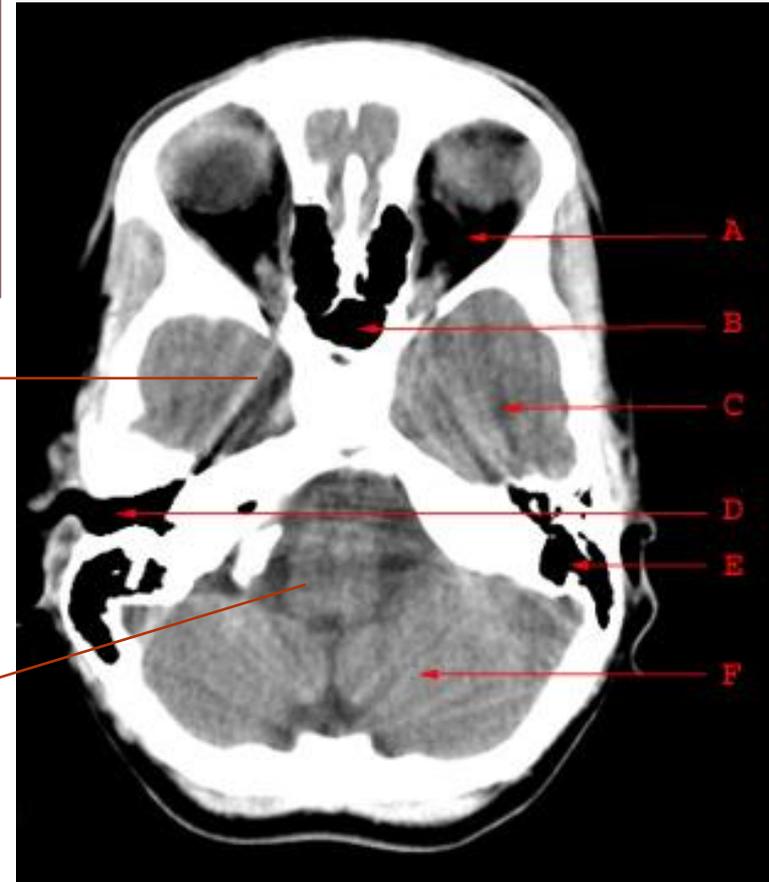
A. Frontal Lobe

B. Frontal Bone (Superior Surface of Orbital Part)

C. Dorsum Sellae

D. Basilar Artery

E. Temporal Lobe

F. Mastoid Air Cells

G. Cerebellar Hemisphere

H.Pon
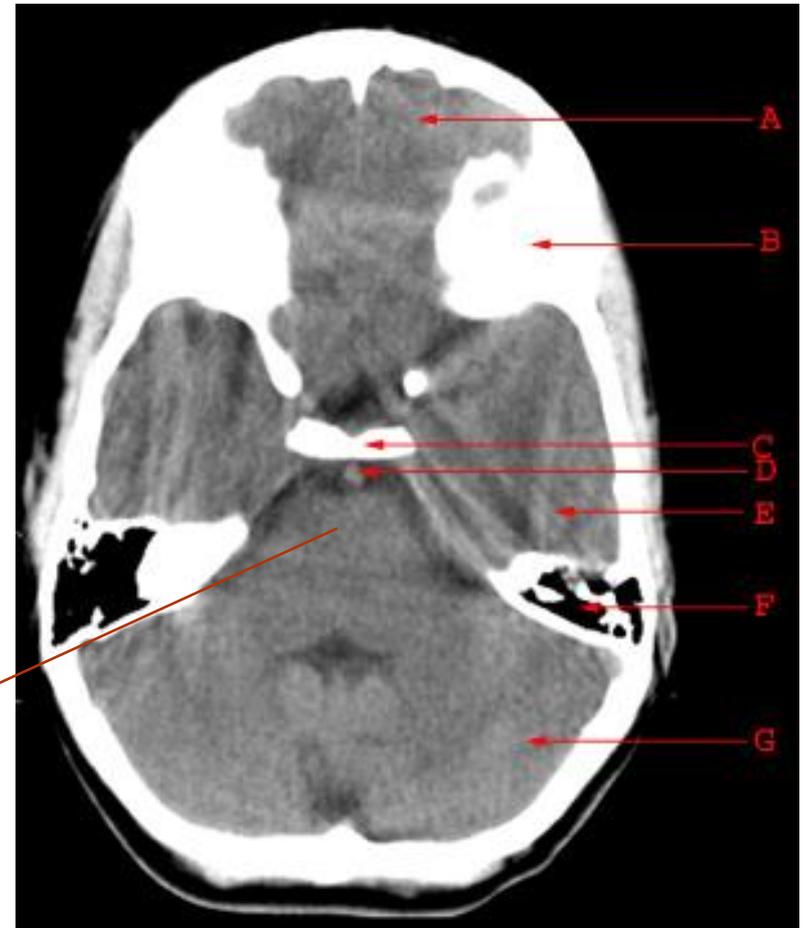
MCQ This is an important slide , the doctor said that (if he will give us a picture about the anatomy of CNS in CT it will be this) that because it includes the basal ganglia , internal capsule , 4th ventricle and thalami which are the most common sites of infarction .

A. Anterior Horn of the Lateral Ventricle

B. Head of Caudate Nucleus

C. Anterior Limb of the Internal Capsule

D. Putamen and Globus Pallidus (lentiform nucleus)

E. Posterior Limb of the Internal Capsule (internal capsule appears dark because it's a white matter)

F. Third Ventricle

O. Thalamus (beside the 3rd ventricle)

R. Genu of internal capsule (the junction between anterior and posterior limps)

G. Quadrigeminal Plate Cistern

H. Cerebellar Vermis

I. Occipital Lobe
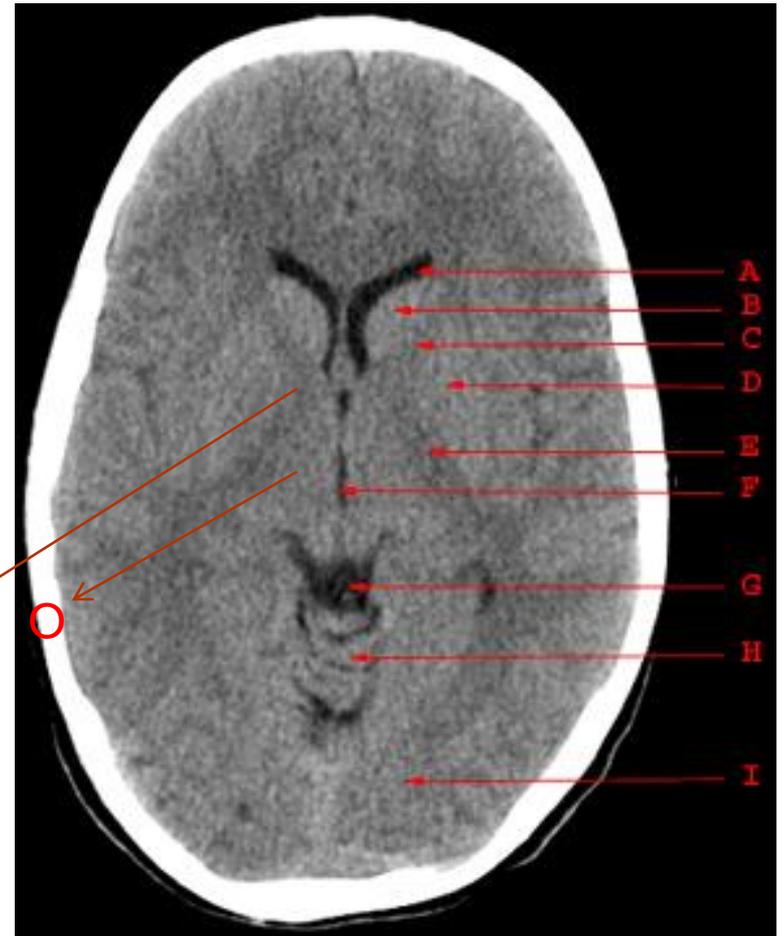
CT SCAN..

A. Falx Cerebri
B. Frontal Lobe
C. Body of the Lateral Ventricle
D. Splenium of the Corpus Callosum
E. Parietal Lobe
F. Occipital Lobe
G. Superior Sagittal Sinus
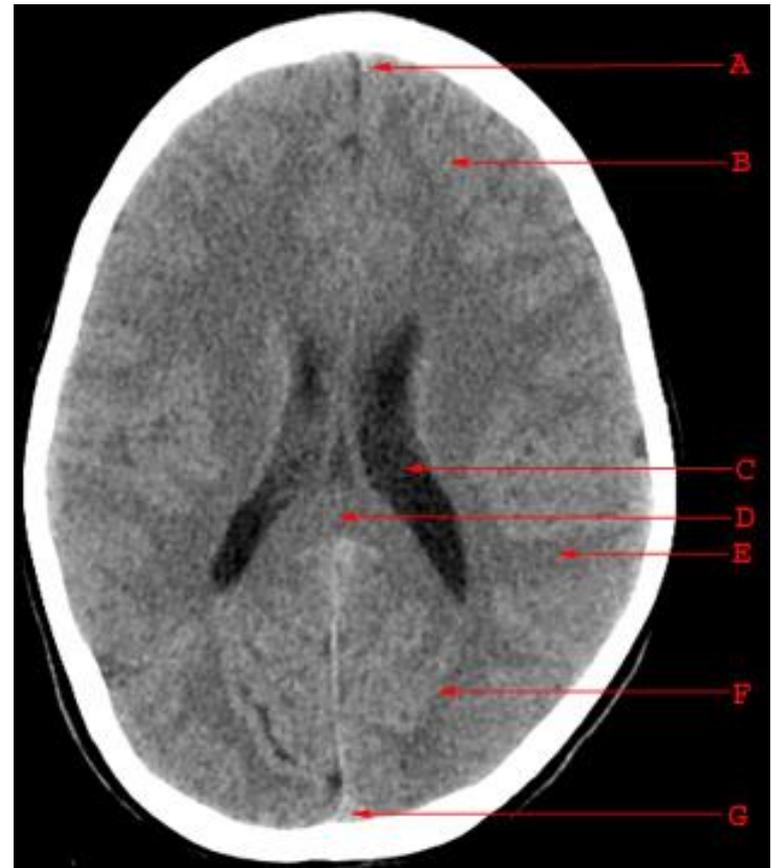
This is a supraventricular level , <u>the highest image section level</u> that you can get from brain , you can notice the disappearance of the ventricles

A. Falx Cerebri
B. Sulcus
C. Gyrus
D. Superior Sagittal Sinus
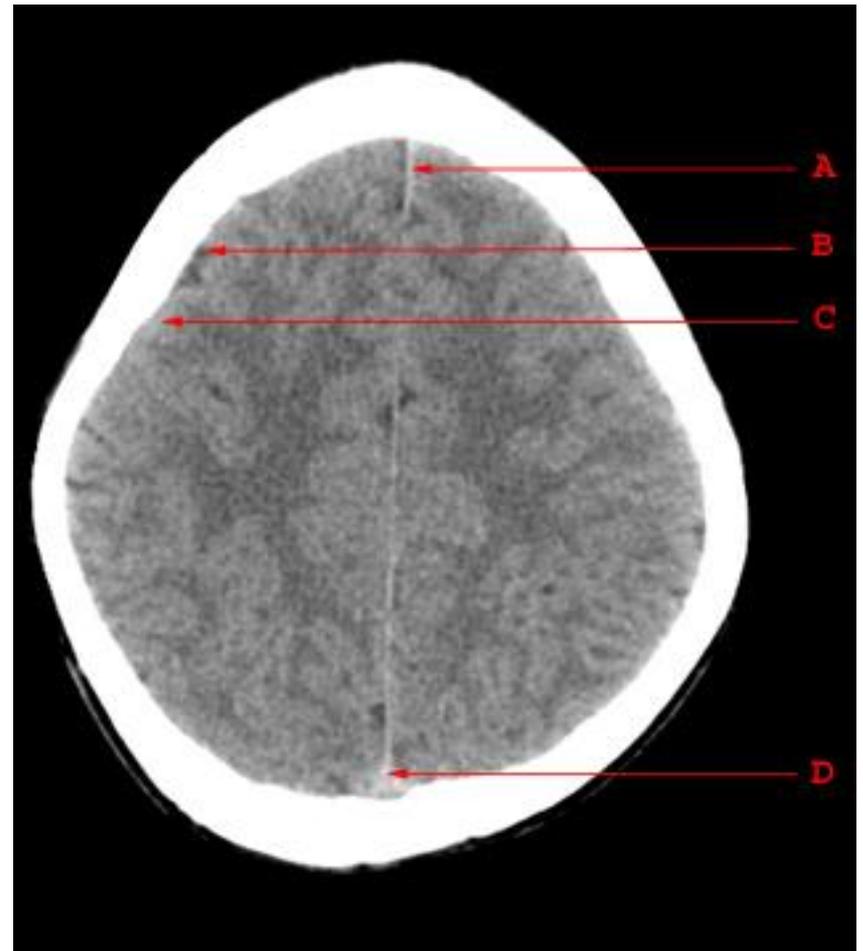
Contrast enhanced CT

Contrast enhanced CT:

IV injection of contrast medium is often given because the abnormality not seen in pre contrast scans may be rendered visible following contrast enhancement (consequence of breakdown of blood brain barrier allowing contrast to enter the lesion particularly in neoplasm, infection, inflammation and certain stage of ischemia).

Also it is helpful in demonstrating blood vessels

Straight sinus

Superior sagittal sinus

ACA

MCA

Basilar artery
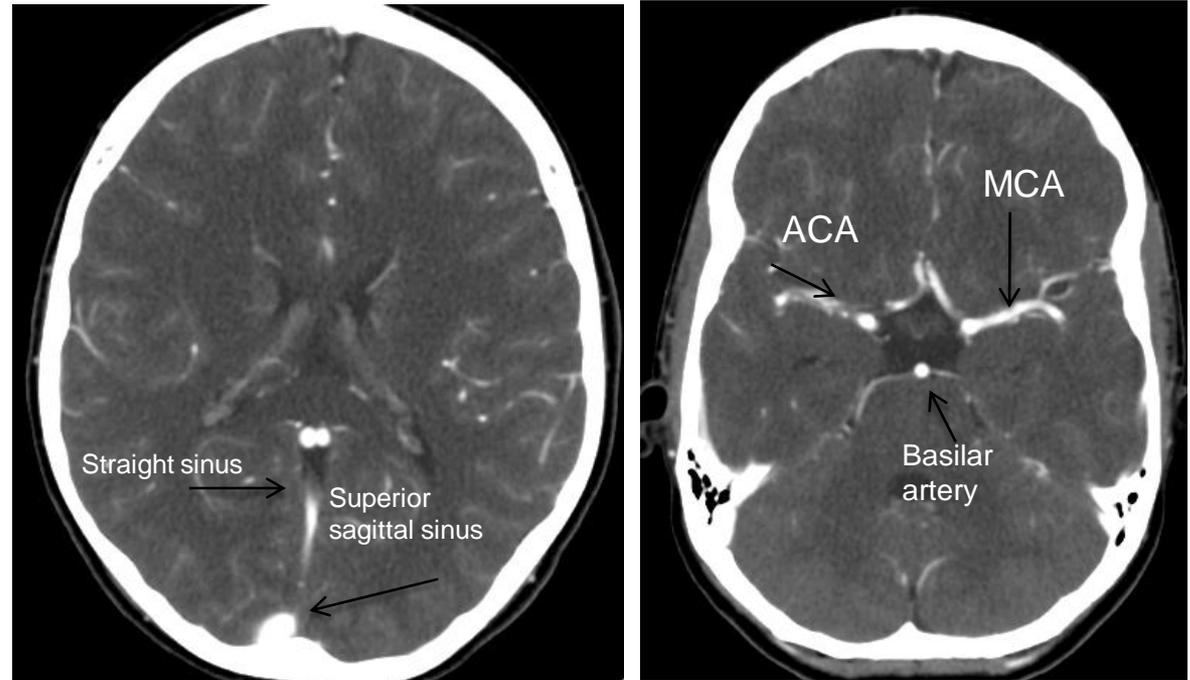
Normally , The parenchyma is not enhanced due to protective BBB but in some abnormalities eg: infection , the BBB will be broken which allow the contrast to leak within the vessels so you will see enhancement and for each disease specific pattern of enhancement so we can know the disease type.

CT sittings and characteristics:

1-Computer reconstructions:

can in selected circumstances be made from the axial sections which then provide images in coronal or sagittal planes.

2-Window setting :

is a computer setting and it is for reconstruction for better visualization to show the selected area :

Brain window : for brain parenchyma

Bone window : to assess bone outlines , will show the bone and excluded the brain parenchyma , hence better visualization
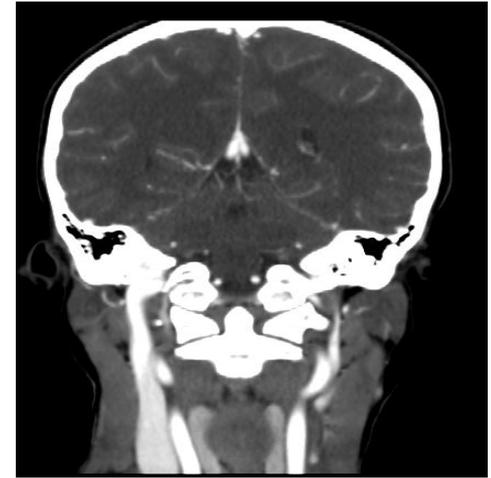
The window settings are selected for the brain, but may be altered to show the bones.

These two images were taken from the same patient

Bone window

Brain window

fracture

Acute extradural hemorrhage
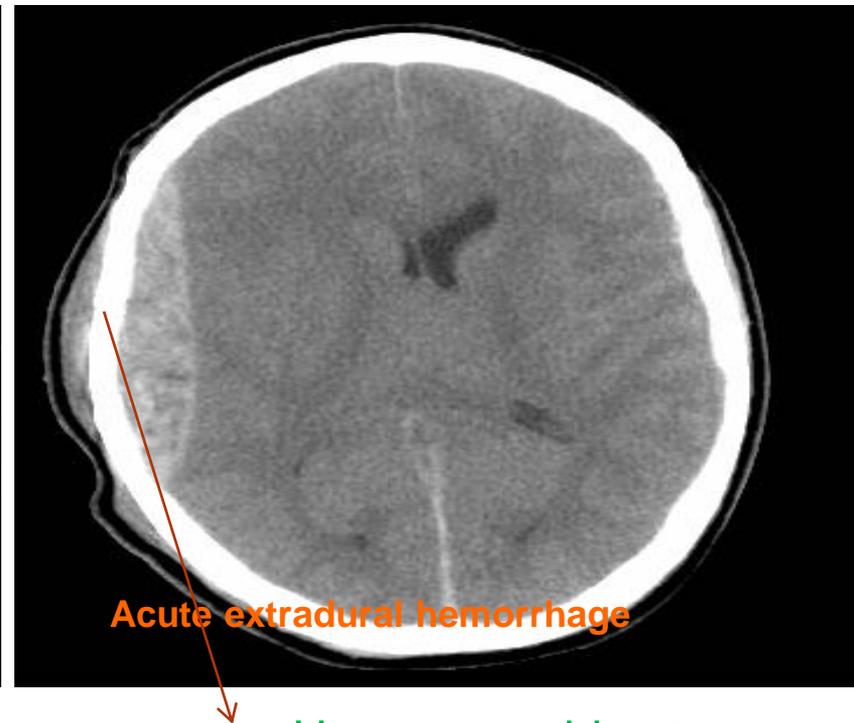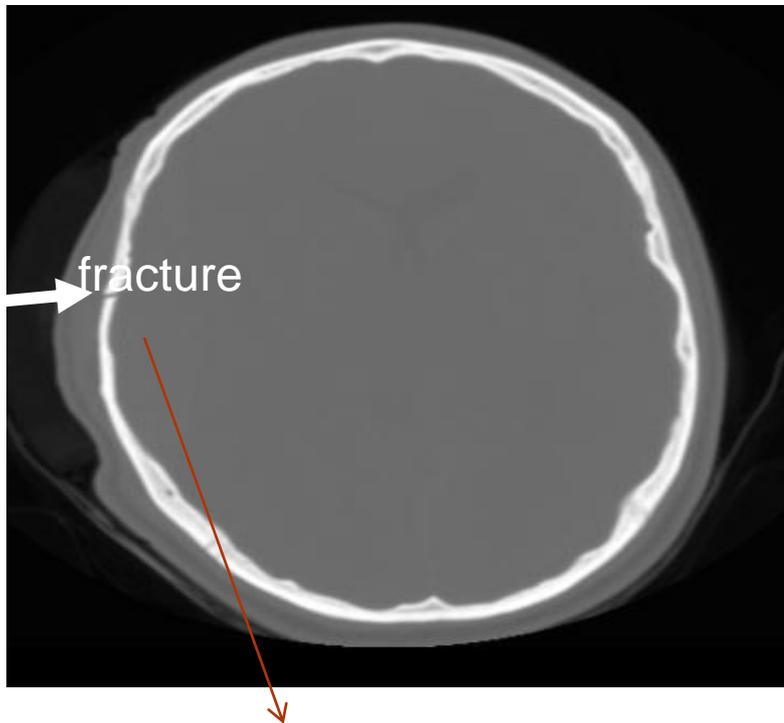
Note , We could not see the hematoma here

Here we could not see the fracture because brain window focus on parenchyma only.

MCQ : Which window in the CT is this ?
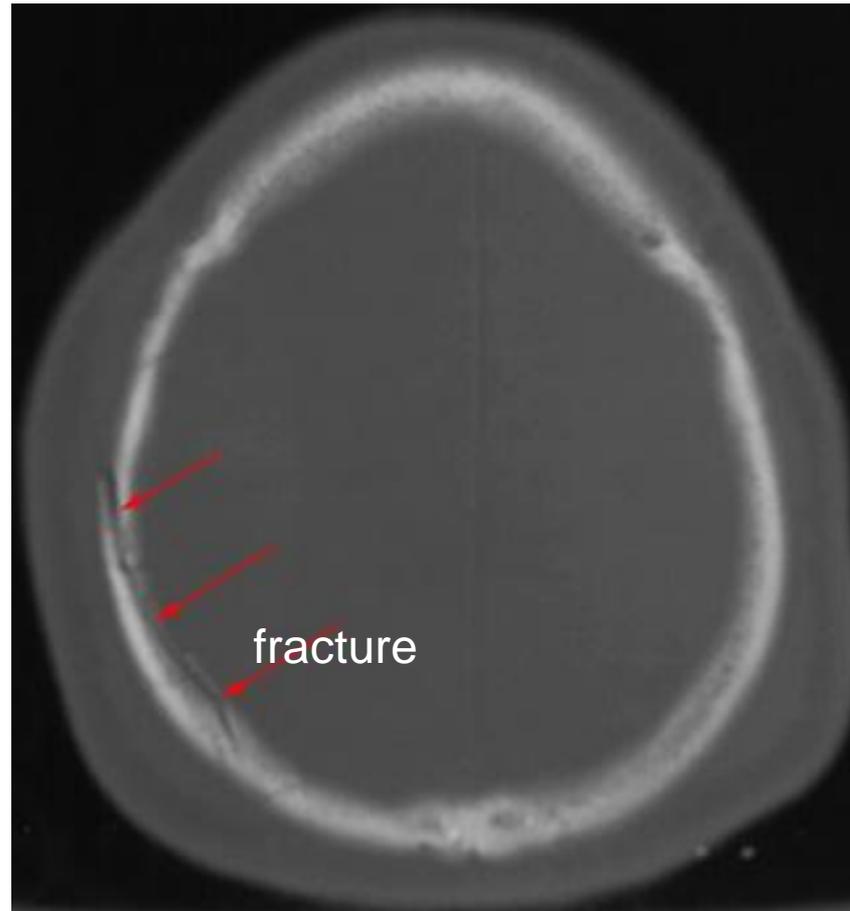

It's Bone window
(we could not see
the parenchyma)

CT angiography is helpful in diagnosis of vascular diseases and abnormalities such as stenosis, occlusion or vascular malformation

CTA

Time is a factor
for controlling the appearance
of the vessels, so depend on the time that the image will be taken in .we can divide the CTA into 2 phases :
1- **arterial phase** (which is the early phase) : where the arteries start to appear
2- **venous phase** (delayed phase) :
when the veins start to appear
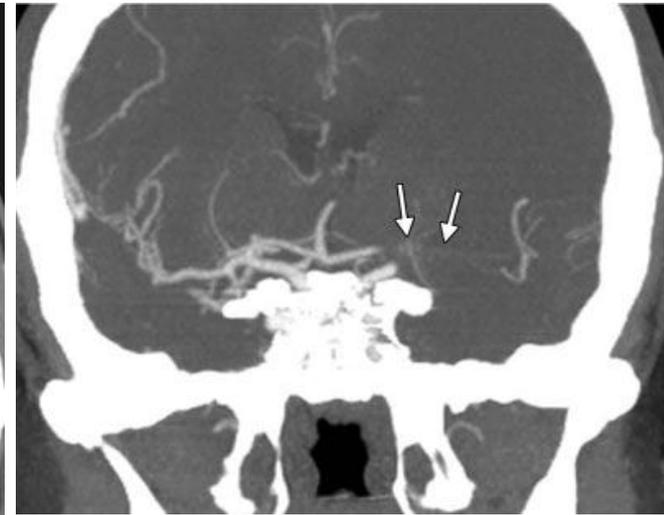
Occlusion of left middle cerebral artery:
middle cerebral artery is seen on the right side but not seen on the left because it is occluded

CT PERFUSION

a.

b.
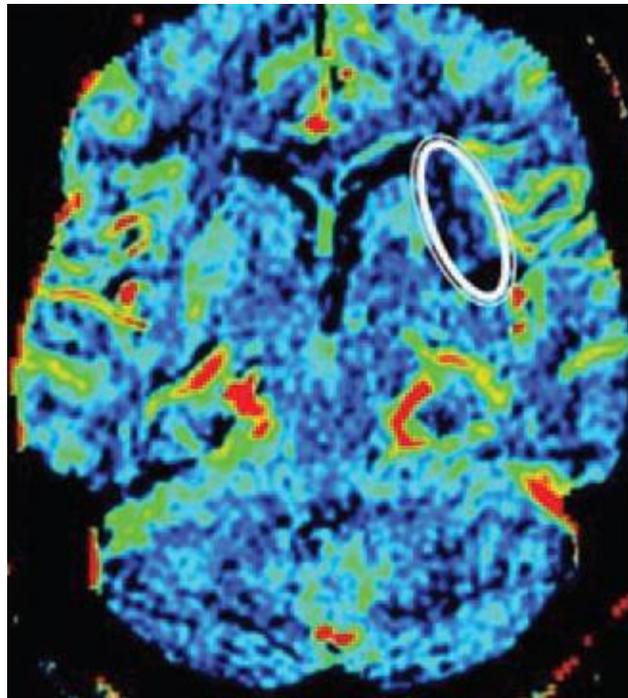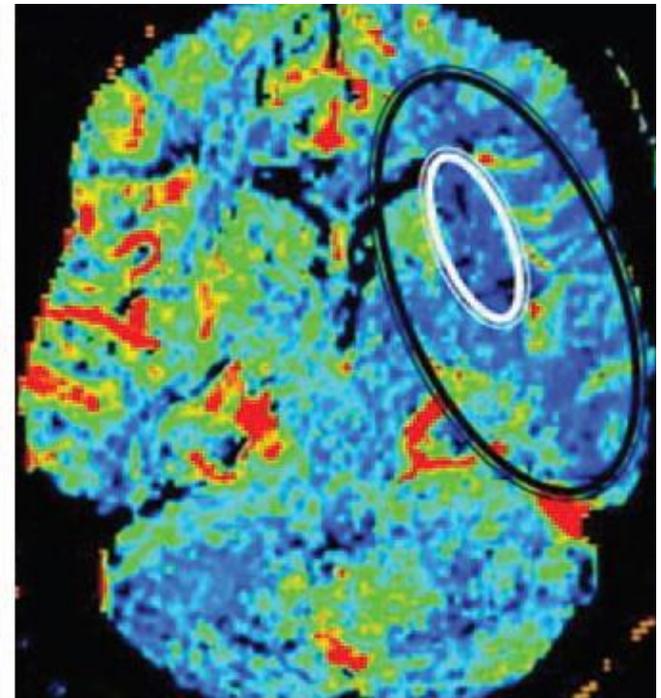
cerebral blood volume   cerebral blood flow

MRI..

- ## Advantages:

-No ionizing radiation

-Patient preparation: Nil unless fasting for general anaesthesia.

- ## Contrast medium:

Gadolinium

- ## Indications:

- Strokes ⟶ in early infarction the best modality is MRI because In acute stroke, very early cranial CT may be normal **MCQ**
- tumours
- infection
- Vascular disorders
- white matter disease , in this condition it's better than CT eg: multible sclerosis .MCQ
- some cases of trauma

MRI..

Relative Contraindications

cardiac pacemaker

cochlear implants

ocular prostheses

intraocular ferrous foreign body

neurostimulators (eg:insulin pumb)

pregnancy (1st trimester)

claustrophobia

MRI..

MRI is a multiplanar technique (can produce images in Sagittal, axial and coronal planes) which is useful for assessment of extent of brain tumors and for better visualization of structures of posterior fossa and cranio-cervical junction, which is difficult to assess in CT

MRI is a multisequential technique (can create images in T1WI, T2WI, FLAIR, gradient and other sequences).

It is possible to recognize flowing blood and therefore large arteries and veins stand out clearly without the need for contrast medium injection.in the opposite , CT need contrast

MRI..

The Characteristic signal intensity of brain structures in different MRI sequences **IMP** :

|	Grey matter	White matter	CSF
T1WI	grey	light	dark
T2WI	light	dark	white
FLAIR	light	dark	dark

MRI..

You can notice that the white matter which inside is lighter than the gray matter which is in periphery

In these pictures , just you have to identify which sequence of MRI it is ?MCQ

White matter

Gray matter

Cerebral peduncle

3rd v

Pons

Medulla

cord

MRI BRAIN (CORONAL T1WI)

CC

PITUTARY

Sphenoid sinus

PONS

CEREBELLUM

MEDULLA

clivus

Spinal cord
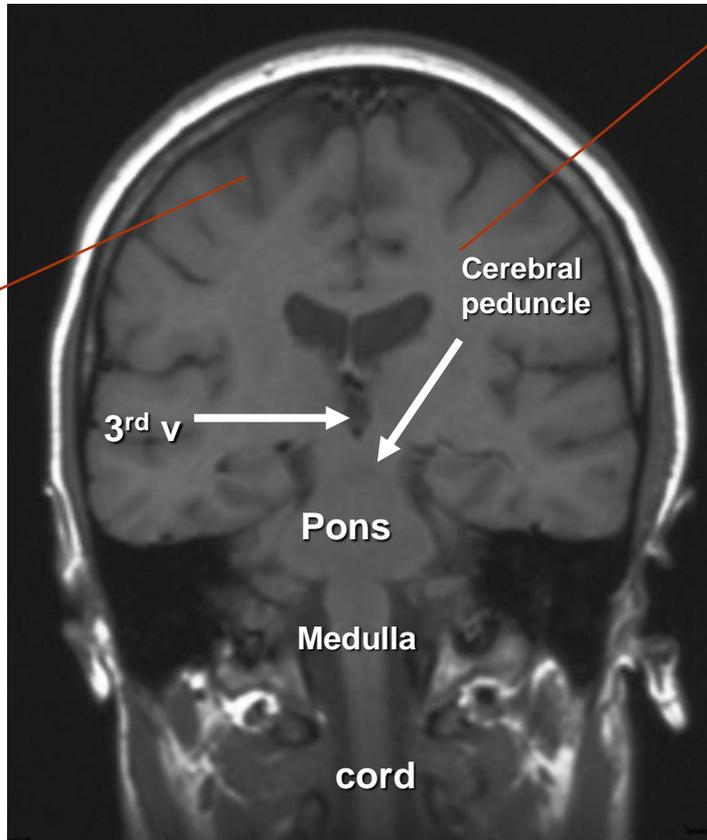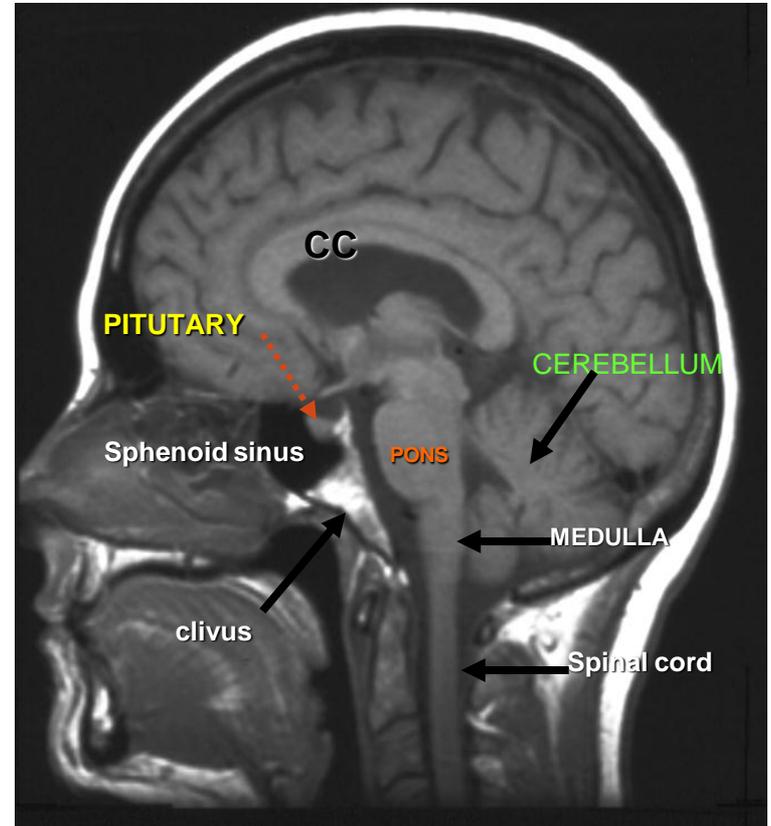
MRI BRAIN (SAGITTAL T1WI)

MRI..
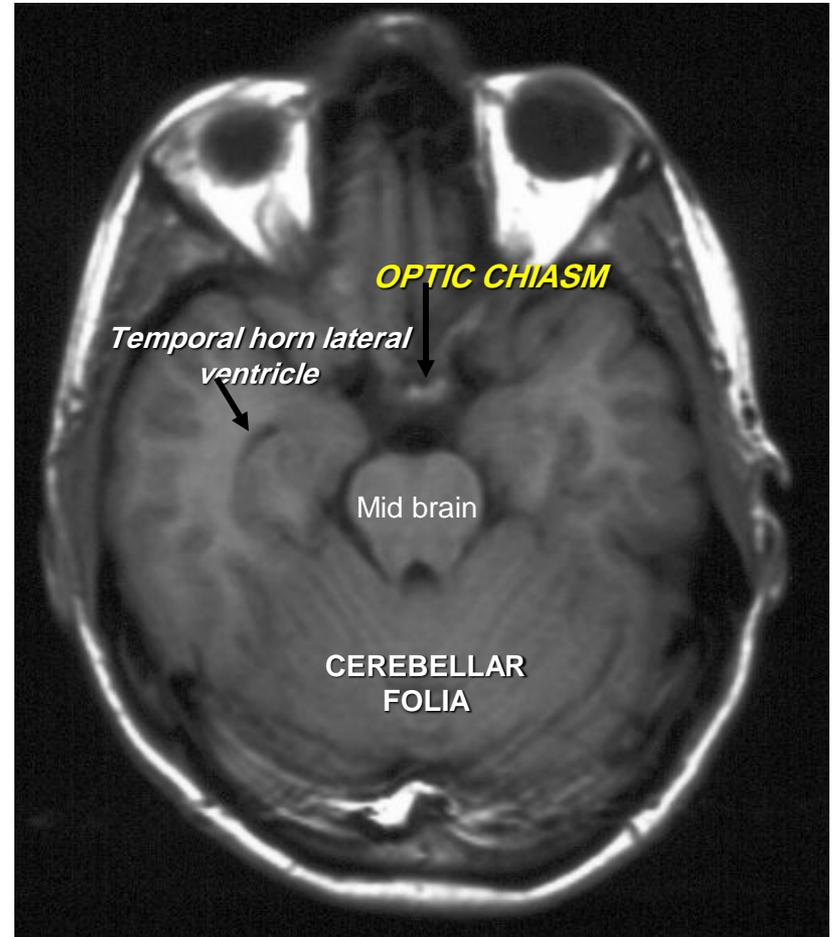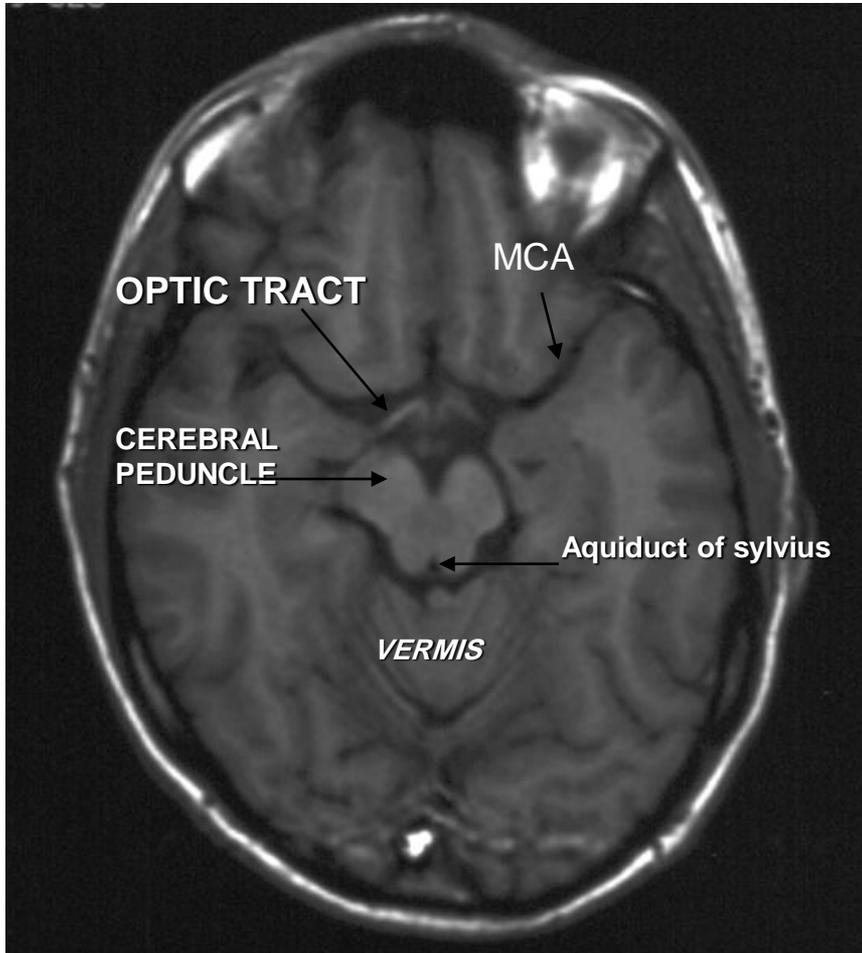
MRI BRAIN (AXIAL T1WI)

MRI..
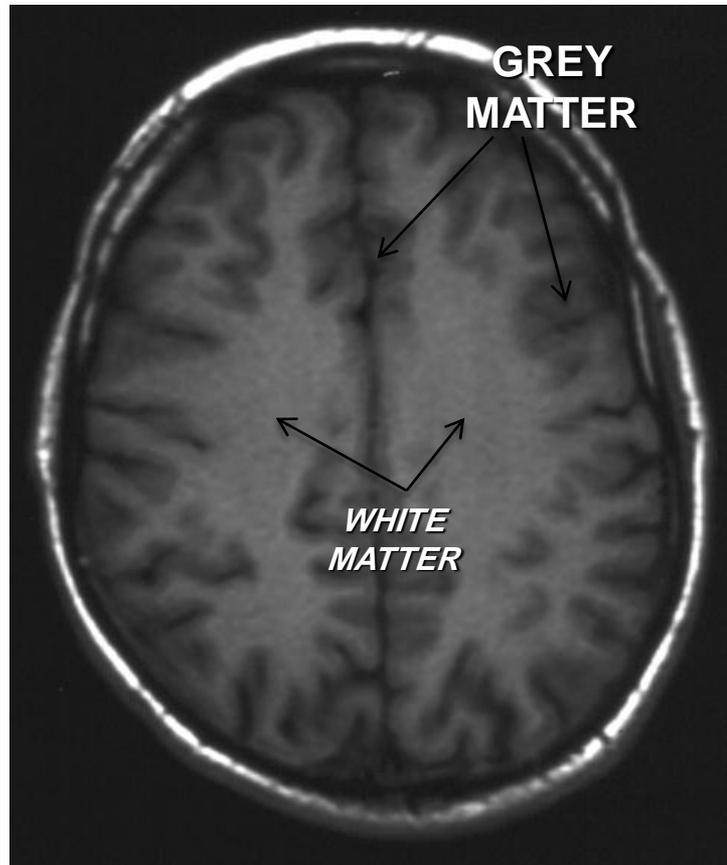
MRI BRAIN (AXIAL T1WI)

# MRI..

When you see white CSF , it is always T2W1
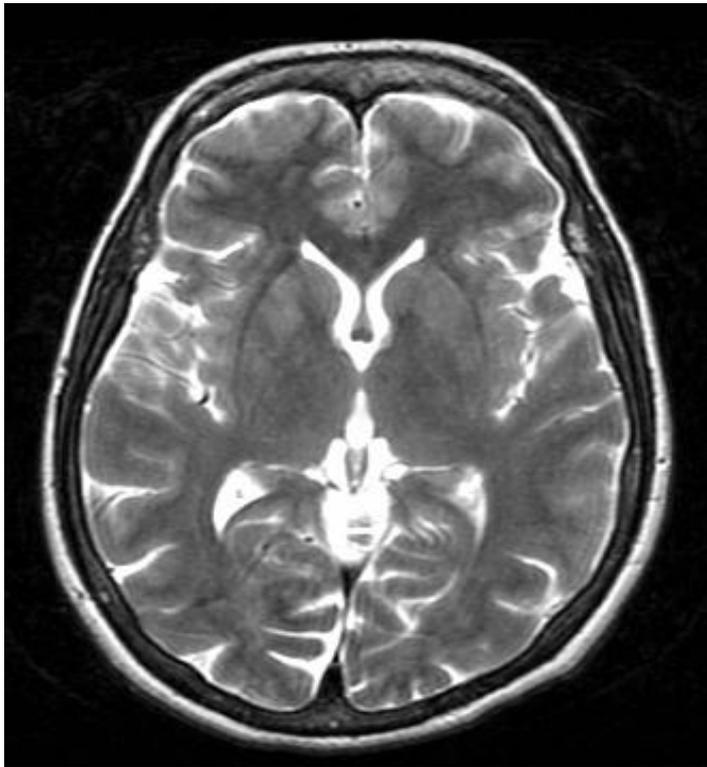
You can notice the white matter (inside) darker than the gray matter (periphery)


T2WI
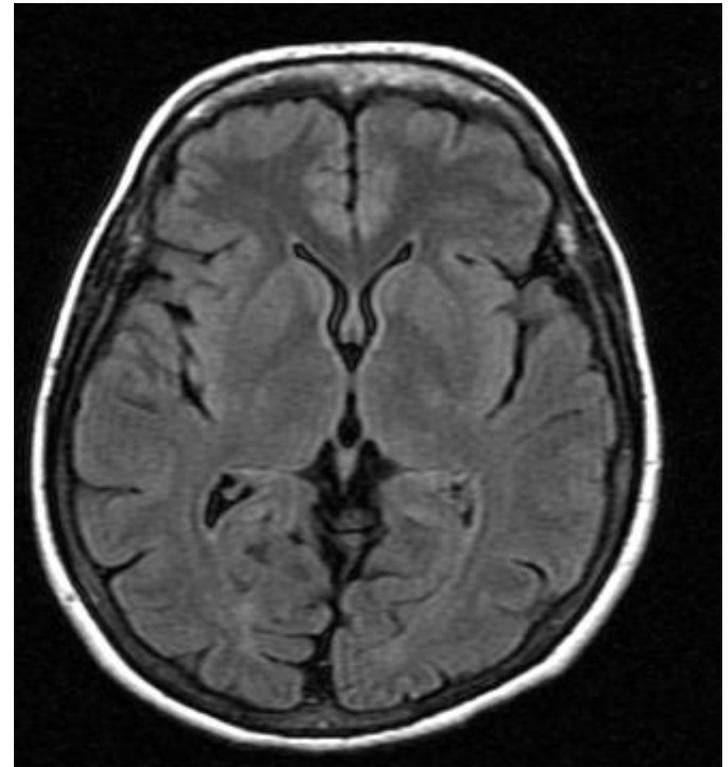
FLAIR

MR Angiography..

MRA

Can be done without injection of contrast medium using time of flight technique in opposite of CT which could not assess the vessels without the use of contrast.

Can be used to assess intra and extra cranial arteries for any vascular abnormalities such as stenosis, occlusion


MRA
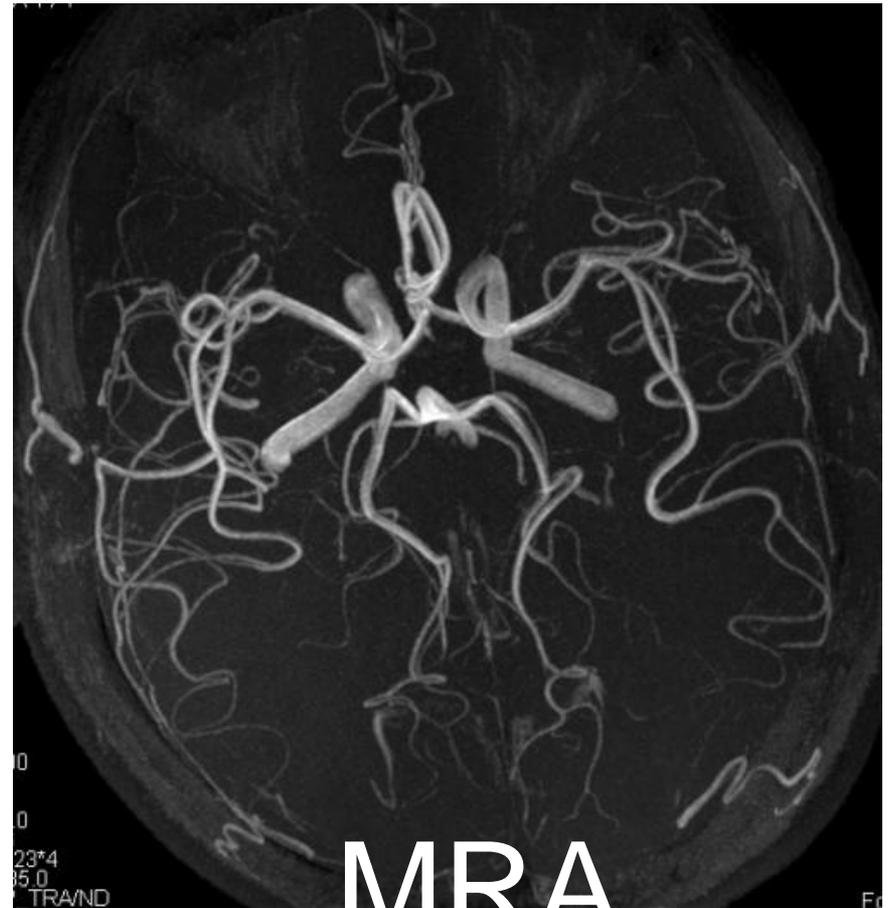
MR Venography..

MRV

Can be done either with or without injection of contrast medium.

Assess venous dural sinuses superficial and deep venous system.

Can confirm presence of venous thrombosis
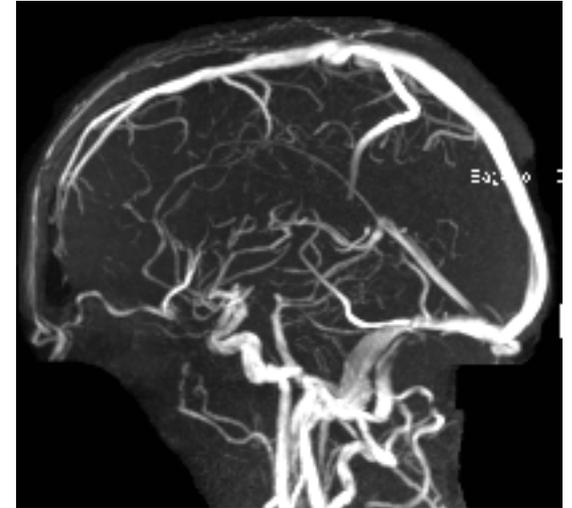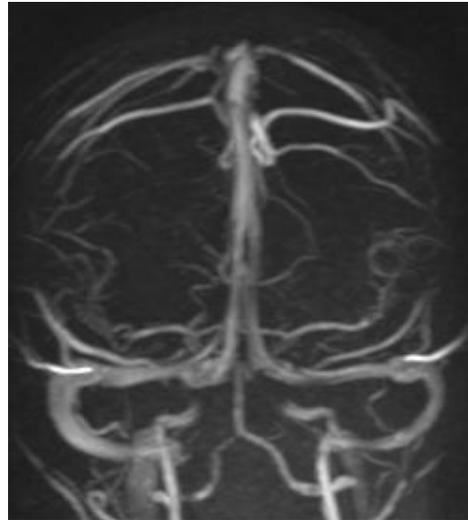
MRI Diffusion..

You need this two picture to assess the infarction , when you have these you will have a <u>true diffusion sequence</u> ,(ADC map is post processing image) . **<u>Just know this , no further details are required.</u>**
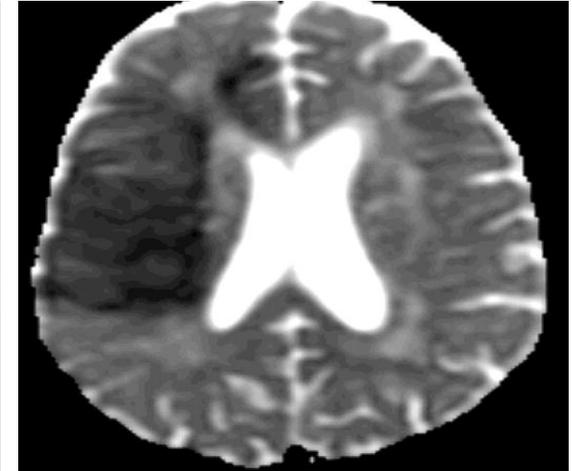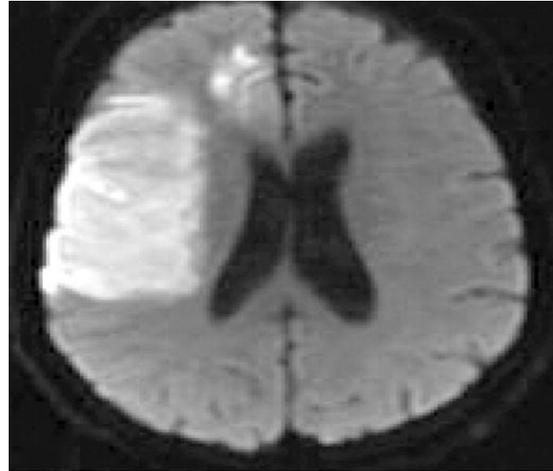
MRI diffusion

Very helpful in assessment of:

- **Early brain infarction. MCQ**

- **Brain abscess.**

- **Certain types of brain tumor.**

DWI

ADC map

MCQ

Q: what is the best modality to assess stoke or infarction ?
MRI

**Q: what is the best sequence in MRI to assess the stroke ?**
MRI diffusion

MRI..

Meningioma
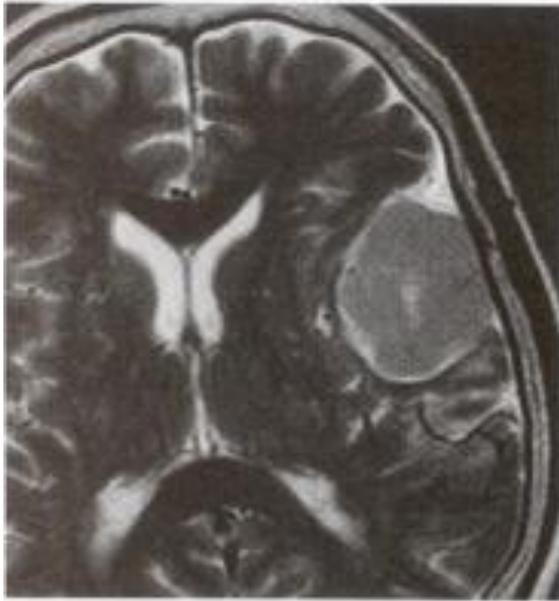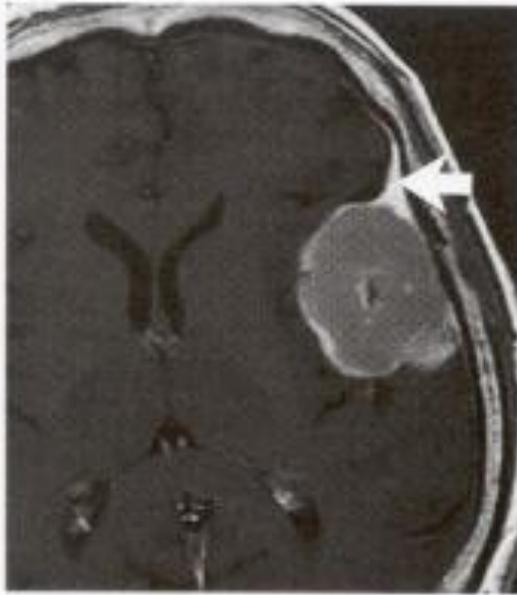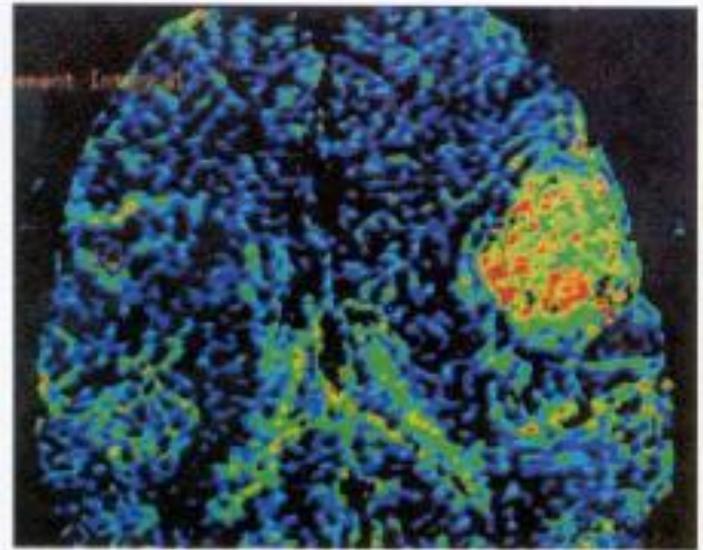

T2   Contrasted T1   Perfusion-Weighted

MR Spectroscopy..

The DR say , no details are required , just know that this method measure the metabolite to assess different disease , for example : eg: if lactate is high → it means infection

Very helpful in:

•Differentiating neoplastic from non neoplastic processes.

•Differentiating benign from malignant

• tumors.

•Determination of certain types of tumors.

•Assessment of white matter diseases

•Assessment of neurodegeneartive diseases
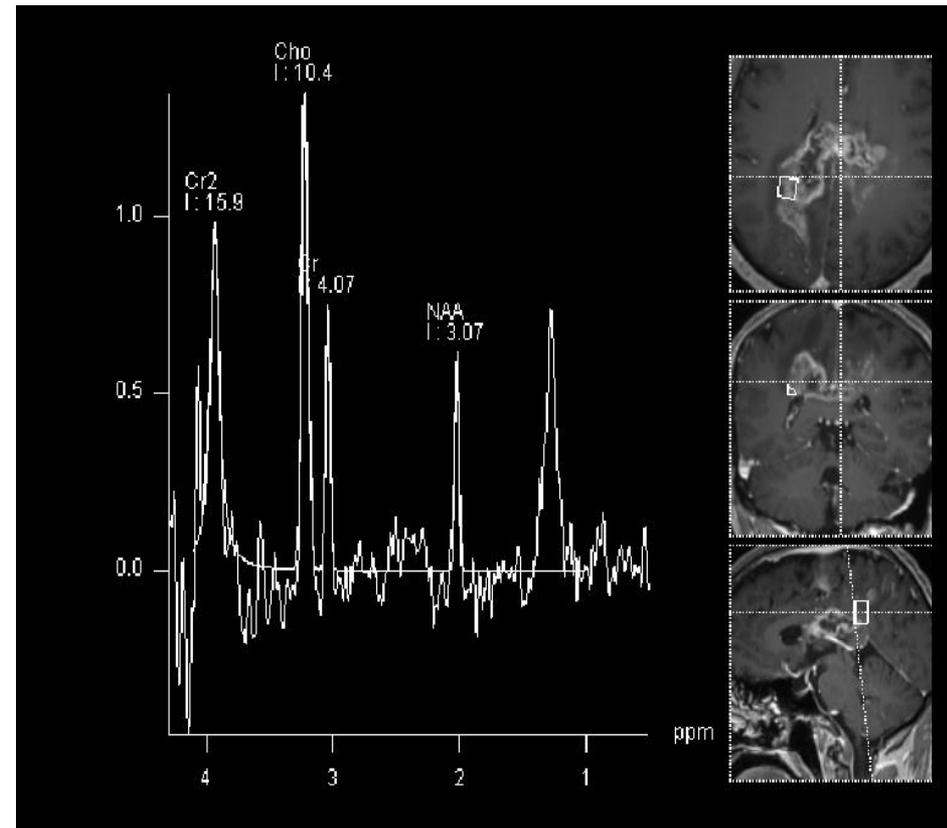
MR Spectroscopy in GBM

CEREBRAL ANGIOGRAM..

It is the gold standard technique for assessment of intra and extra cranial vessels. (it was used as a first line to detect abnormalities but now it is used if other modalities do not show the abnormalities and it's considered now a gold standard as interventional and treatment tool only)

It can demonstrate different vascular diseases (stenosis, occlusion, vascular malformation and blood supply of brain tumors.

It is an invasive technique.

Recently its main role for intervention purposes such as treatment of vascular malformaion (aneurysm/arterovenous malformation) or pre operative embolization of vascular supply of tumor.→ Now after CT and MRI , the role of it decrease as diagnostic tool , it just used as interventional part and plan (treatment) , it can be used in decreasing the vascularity of the lesion then kill it .

CEREBRAL ANGIOGRAM..

ACA   MCA

Internal carotid artery
Cavern.
Pterous
cervical
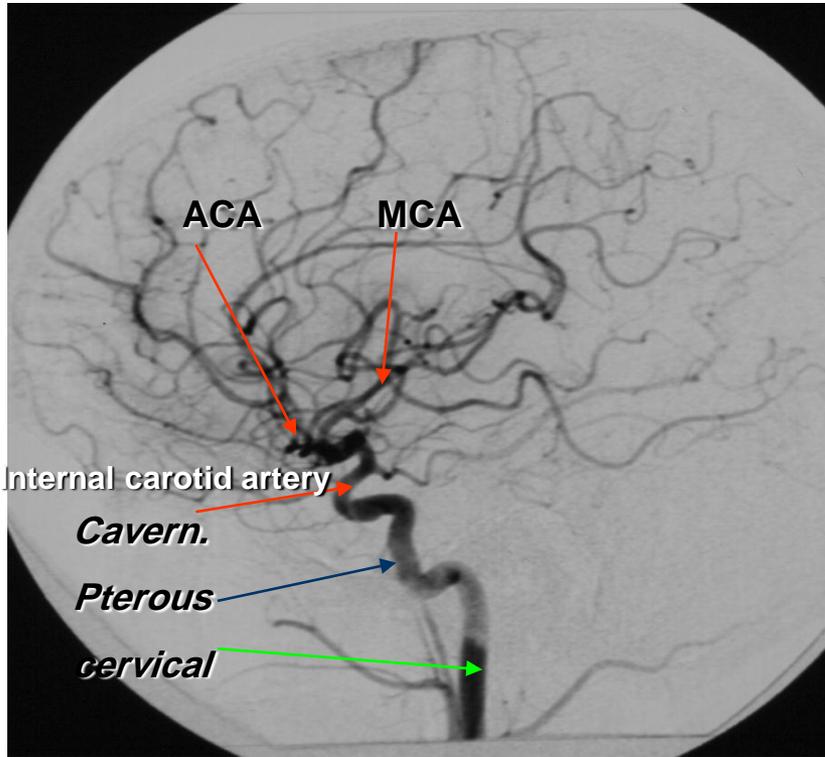
Internal carotid angiogram lateral view

middle cerebral artery

Anterior cerebral
artery

ICA

CAVERNOUS

PTEROUS

CERVICAL

AL
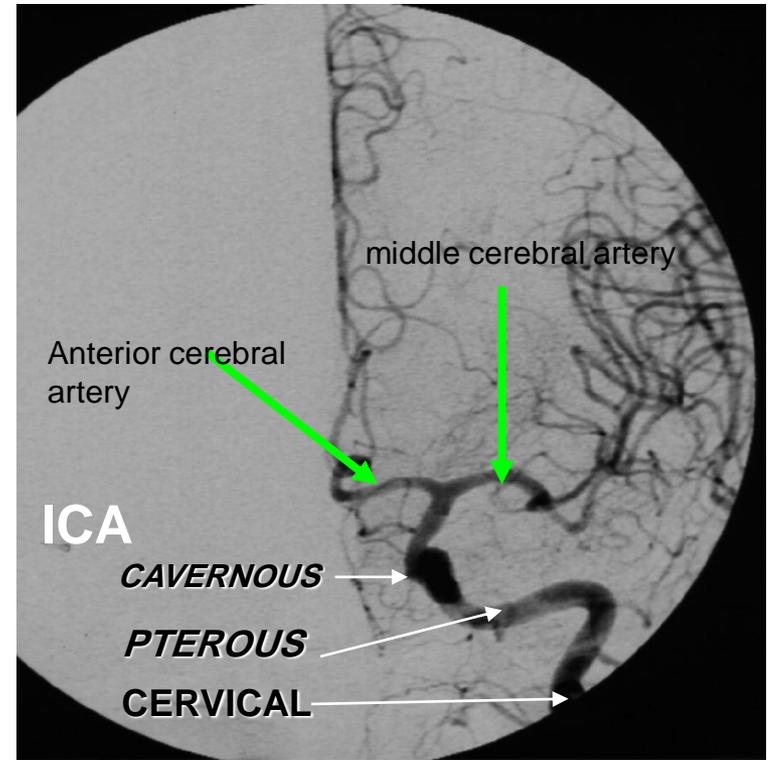
Internal carotid angiogram AP

VENOUS PHASE CEREBRAL ANGIOGRAM..
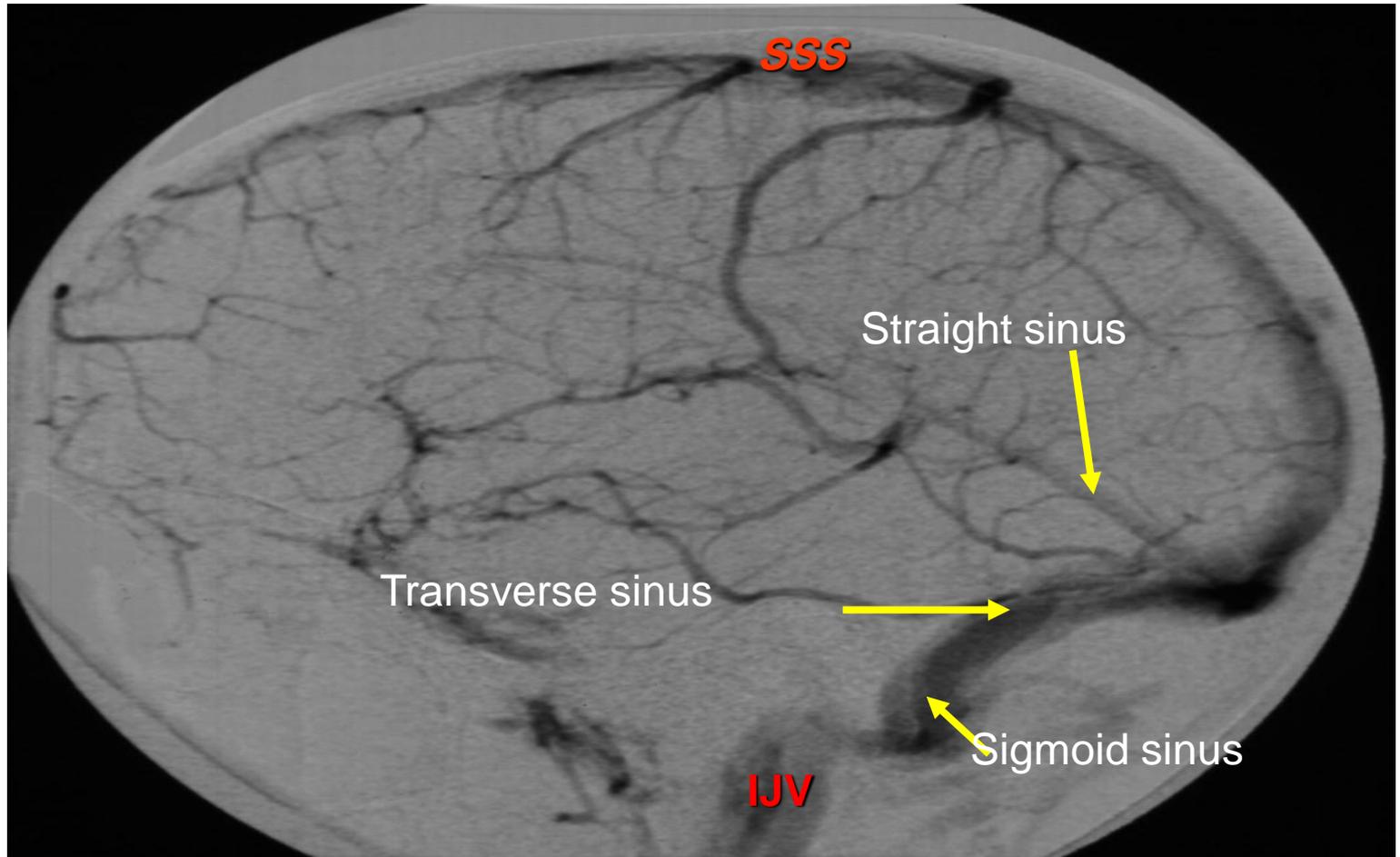
CAROTID DOPPLER..
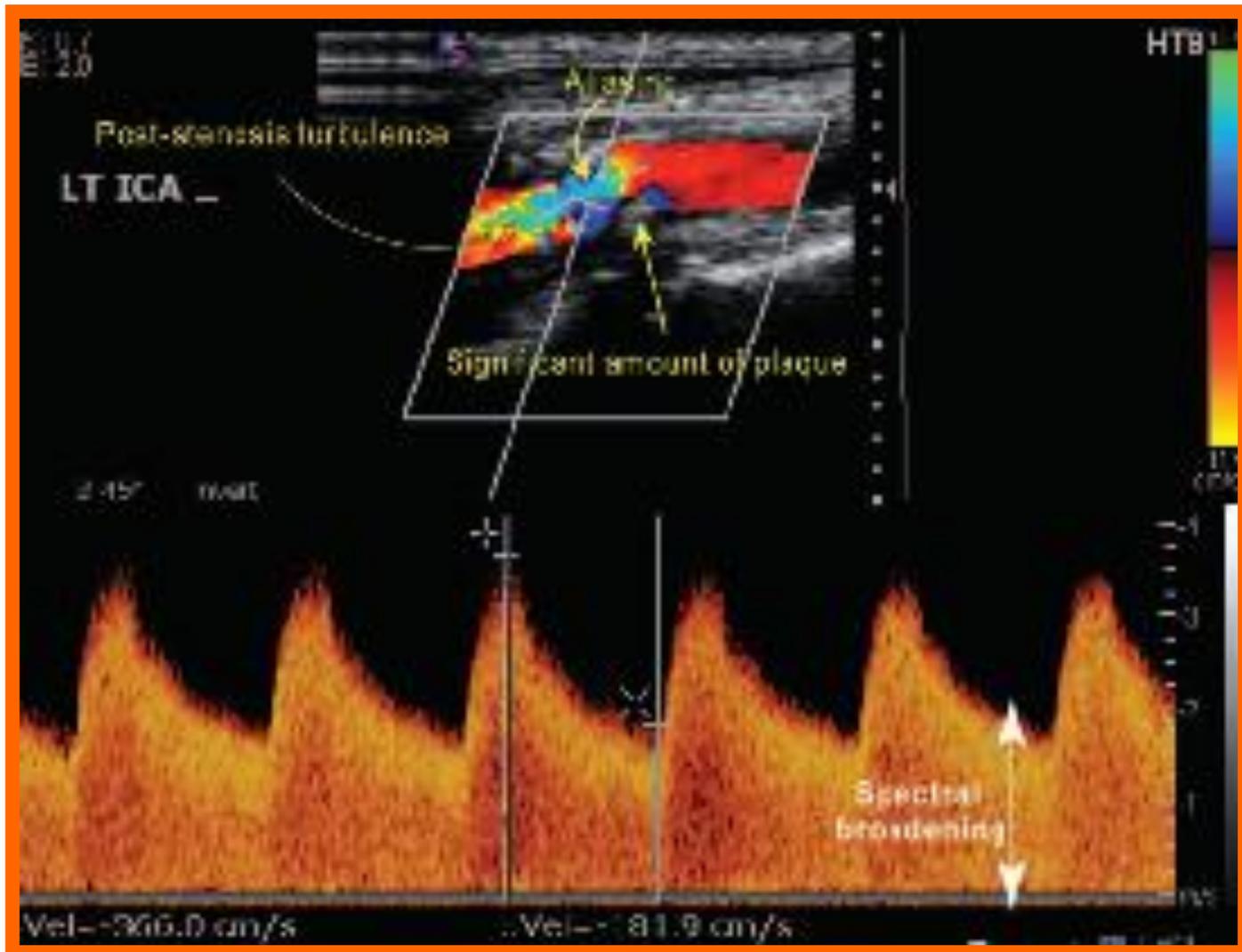
ULTRASOUND NEONATAL BRAIN..

Characteristic:

-Not using ionizing radiation

-Little discomfort to the baby.

-Readily carried out even on ill babies in intensive care units.

Main indication:

-It has proved particular useful in detecting mainly ventricular dilatation (hydrocephalus), intracerebral hemorrhage and congenital abnormality of the brain but it will not show details about parenchyma or white matter disease

-Scanning is best done through an open fontanelle.

What is this imaging modality and what is it assessing ? Could be MCQ

ULTRASOUND NEONATAL BRAIN
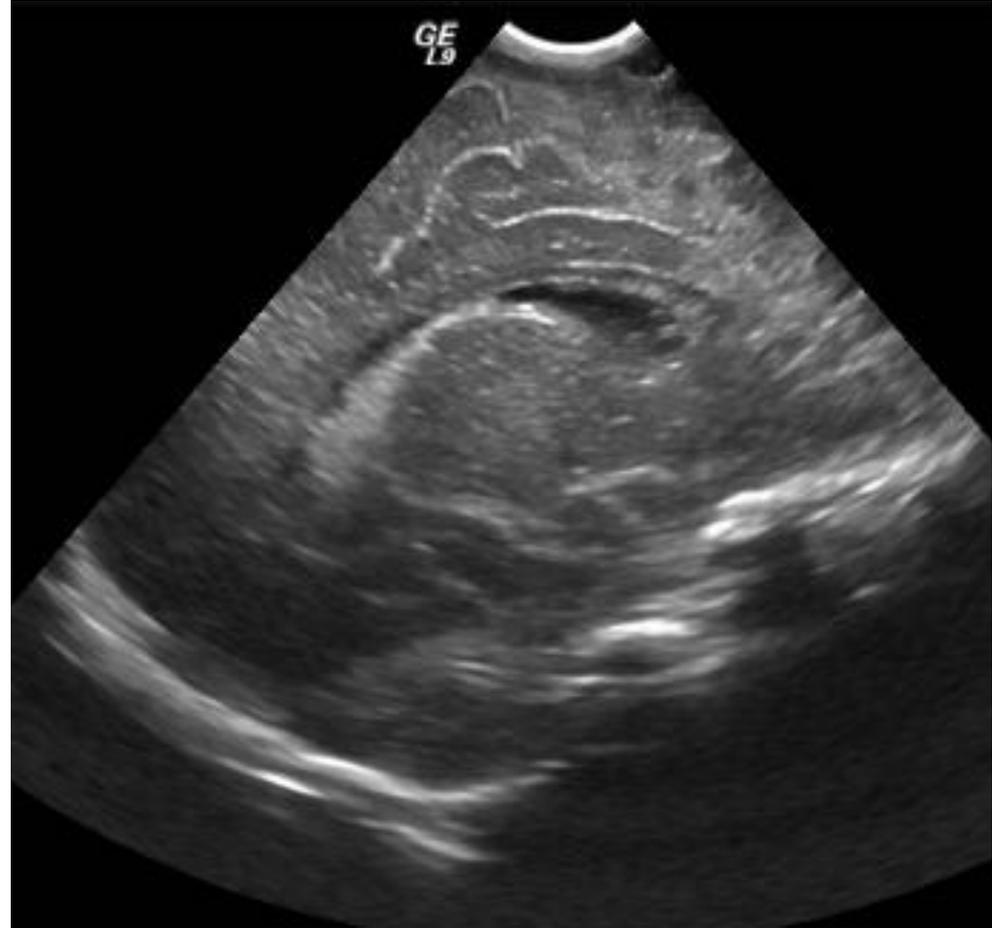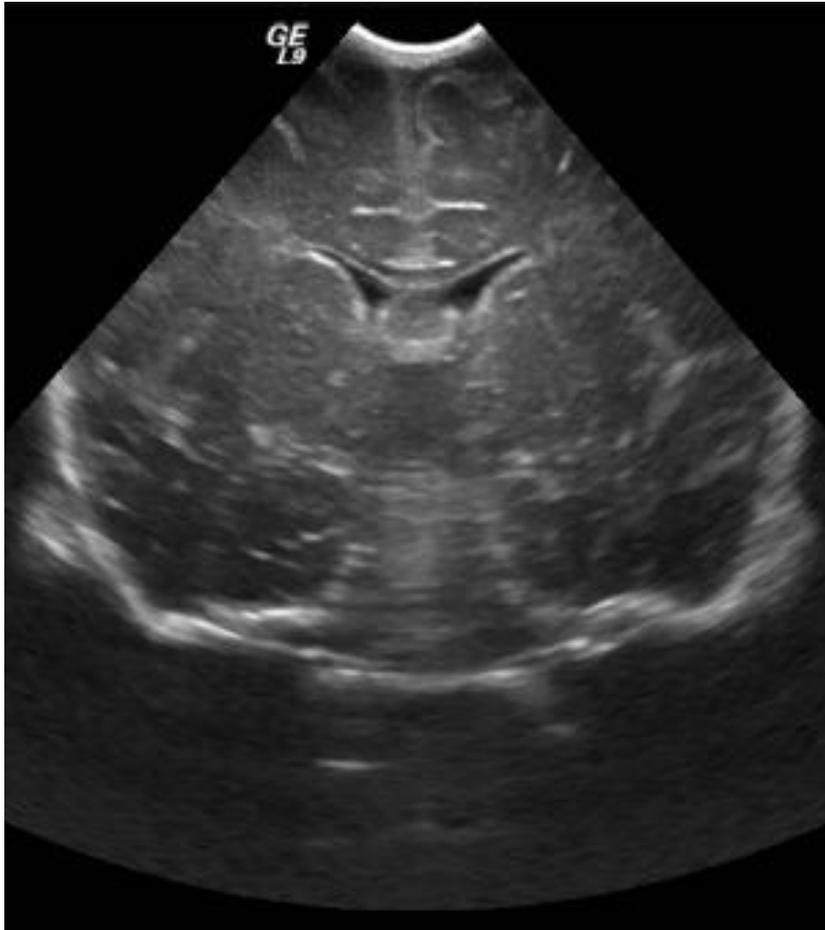
Note:

- The following two slides (it's from the lecture) and it's extra information , read it in case and for better understanding.

CT PERFUSION

- In acute stroke, very early cranial CT may be normal. Perfusion CT shows great promise in refining the selection of patients suitable for thrombolysis, as it can accurately determine infarct core from potentially salvageable ischemic penumbra.

- Some cerebral tumors are associated with angiogenesis and a breakdown of the blood-brain barrier. Angiogenesis can be detected as an increase in flow and volume parameters, and blood-brain barrier breakdown can be quantified as contrast accumulates in the interstitial space. Such aggressive features can distinguish malignant from benign tumors when standard imaging may not

MR Spectroscopy..

- Unlike MRI, the technique of MRS does not generally produce images, instead creating spectra (see figure). Each peak in the spectrum arises from different brain metabolite (NAA, N-acetylaspartate; Cre, Creatine; Cho, Choline; *myo*I, *myo*-Inositol; Lac, lactate; Glx, Glutamate and Glutamine; GABA, gamma amino butyric acid). The height of each peak is an indication of metabolite concentrations. The NAA peak arises from the neurons in the brain. Loss of this metabolite indicates damage or loss of neurons.