Neuroradiology

Dr. Aws Q. Hamdi

M.B.CH.B-CABS-Rad.

Tikrit university /college of medicine

5th stage

Main Topics

1-introduction to the CT &MRI.

2- stroke (ischemic stroke).

3-intracranial hemorrhage.

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Objectives:-

1- to recognize simple basic principles of computed tomography & Magnetic resonance in neuro-imaging.

2- to estimate the role of brain MRI in early diagnosis of ischemic stroke.

3- to evalute the role of brain CT scan in diagnosis of acute hemorrhagic stroke.

4- to determine the types of intracranial hemorrhage according to the anatomical locations.

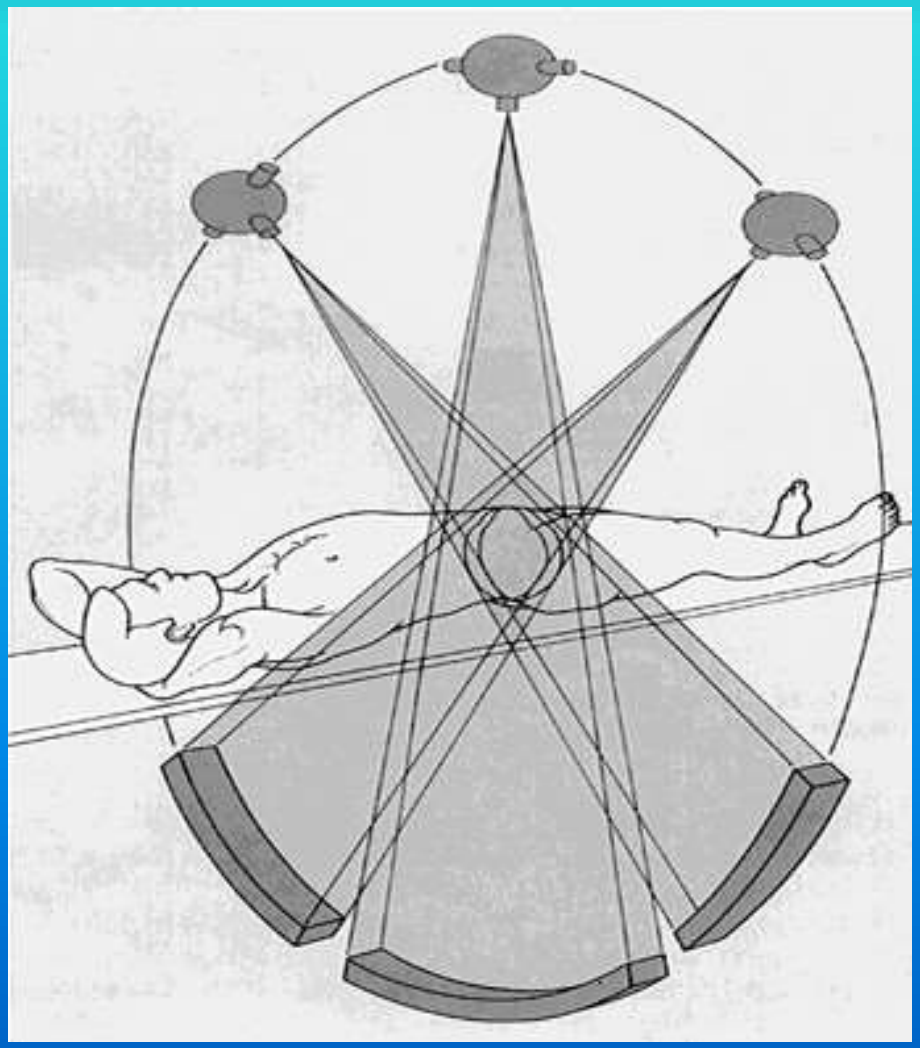
Lecture 1

Computed Tomography

CT scan used a computer to reconstruct a cross- sectional images of the body from measurements of x-ray transmission through thin slices of patient tissue. CT displays each imaged slice separately, without the superimposition of blurred structures that is seen with conventional tomography. Sensitive detectors on the opposite side of the patient measure x-ray transmission through the slice. These measurements are systematically repeated many times from different directions

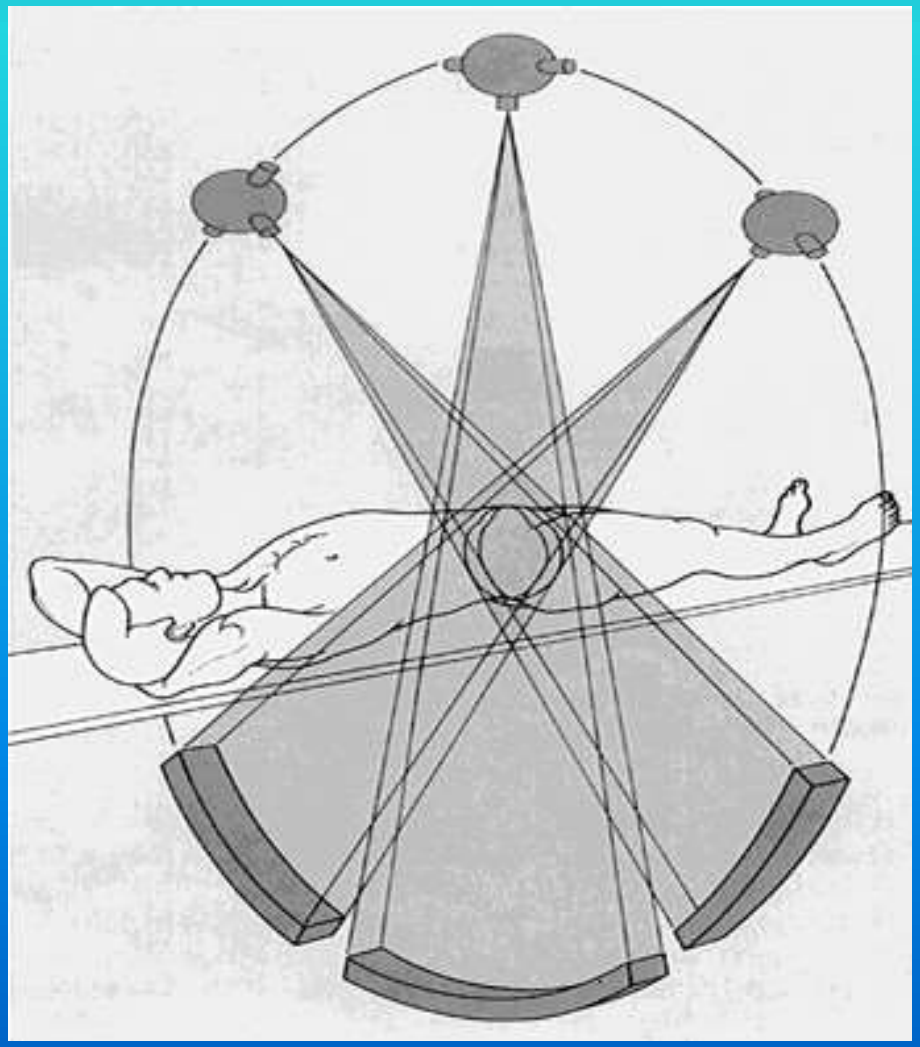
Computerized Axial Tomography (CAT)

In this process a small beam of x-ray is passed through a plane of the body while the x-ray tube moves in an arc or a circle around the body



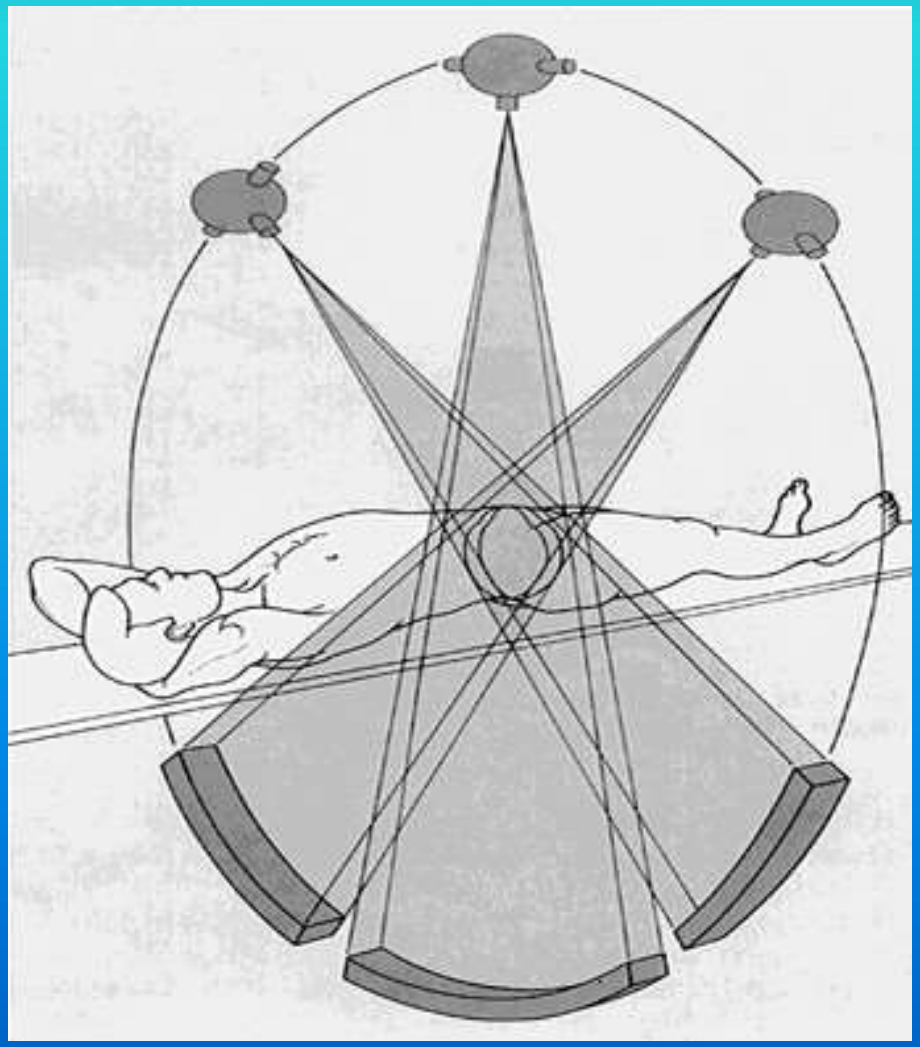
Computerized Axial Tomography (CAT)

The amount of radiation absorbed by different elements of the chosen plane varies according to X ray absorptions by different tissues



Computerized Axial Tomography (CAT)

A computer stores a large amount of data from a selected region of the body, making it possible to determine the spatial relationship of the radiation-absorbing structures within it



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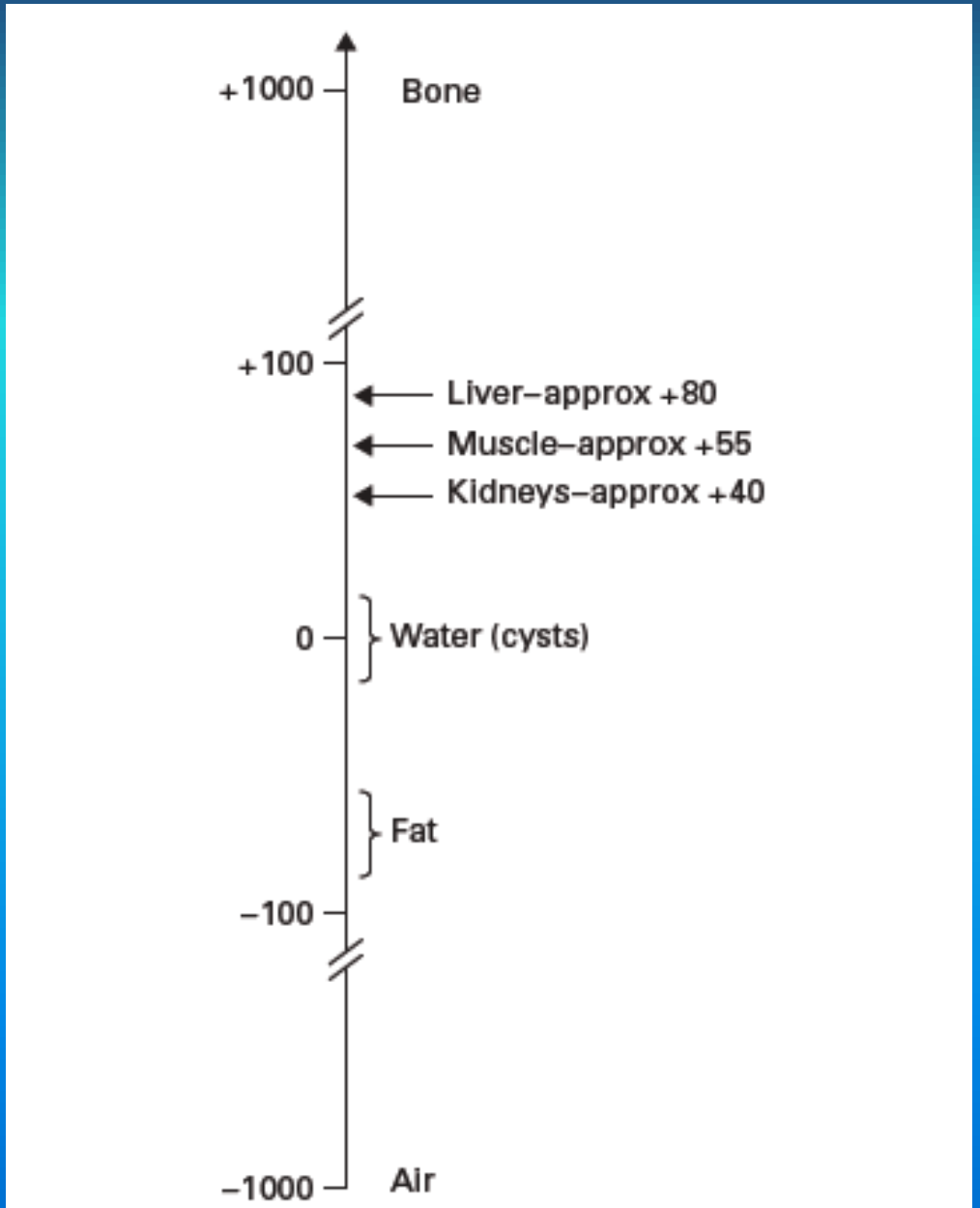


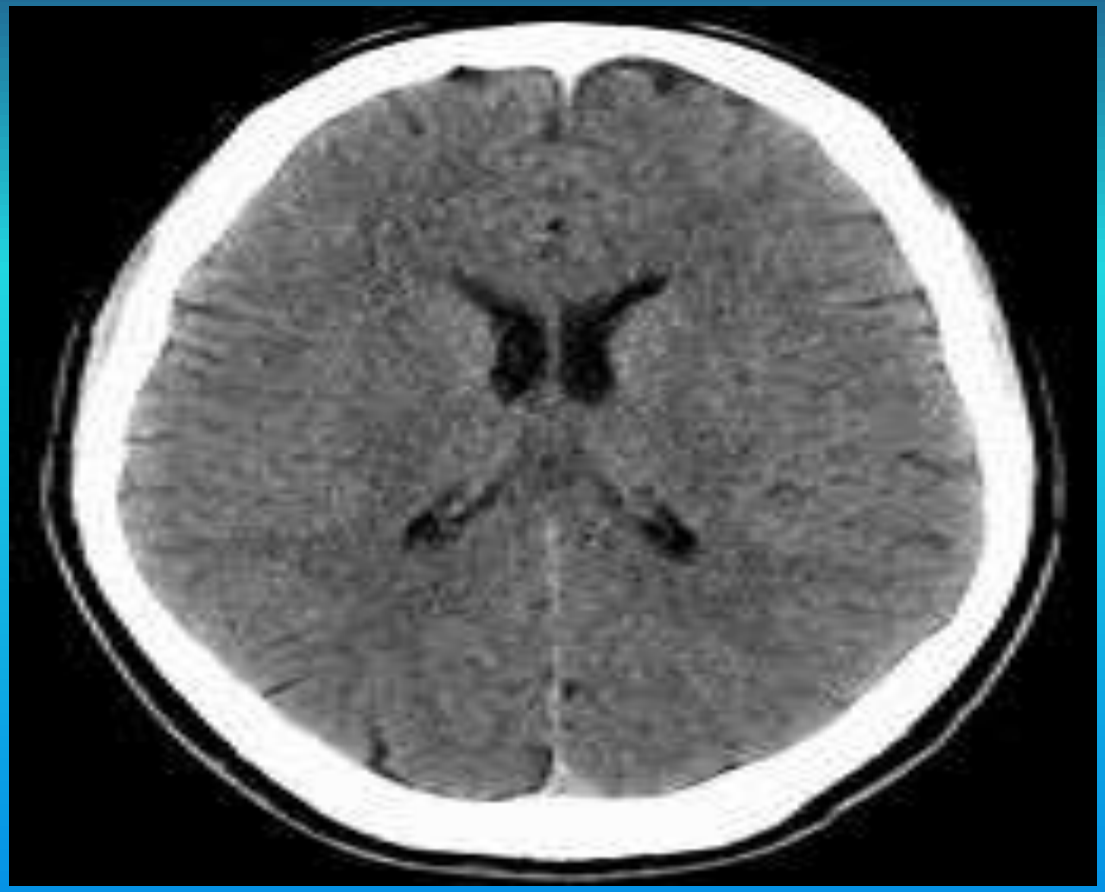
Fig. 1.2 Scale depicting the CT density (Hounsfield units) of various normal tissues in the body.

Advantages of CT scan

- CT is very good for imaging bony structures and calcifications.
- Good soft tissue and spatial resolution .
- Short examination time (suitable for pediatric and some emergencies)
- Suitable for Coronary and cardiac examination (advance multi detector CT scan)

Disadvantages

- Radiation : single CT scan may give radiation equivalent to more than 400 chest X ray
- Contrast : CT scan may need injection of contrast material which may cause some adverse reactions or allergy in some patients or it may be contraindicated in some patients
- CT scan have poor soft tissue contrast in comparison to MRI

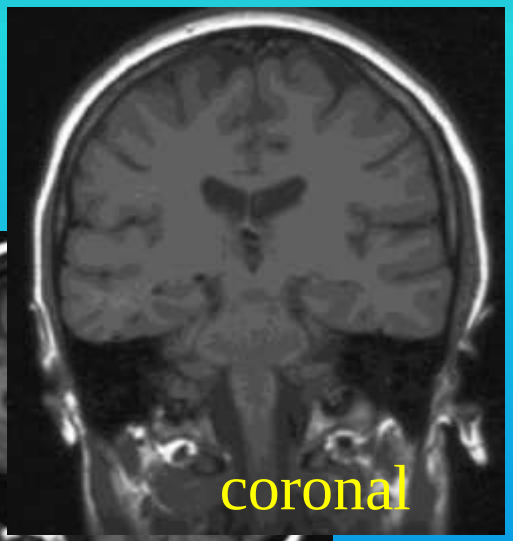


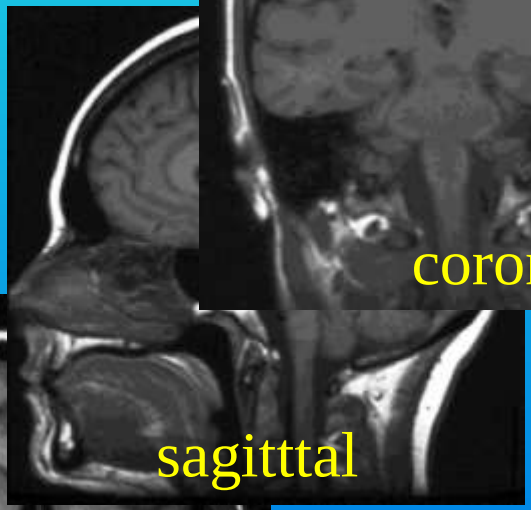
Normal Brain CT scan

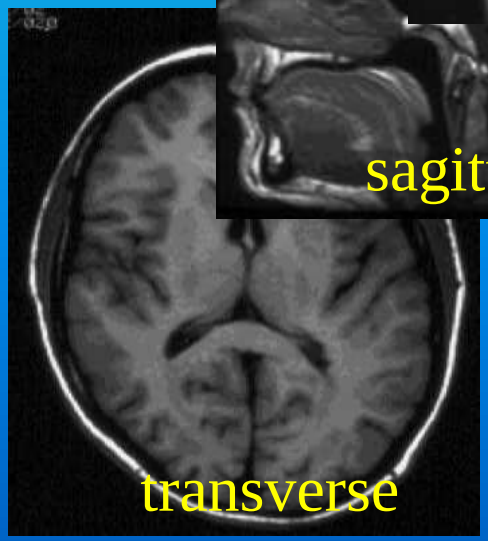
Magnetic Resonance Imaging (MRI)

Uses non-ionizing radiation and has no demonstrated adverse biological effects.

Magnetic resonance images can be obtained in any tissue plane

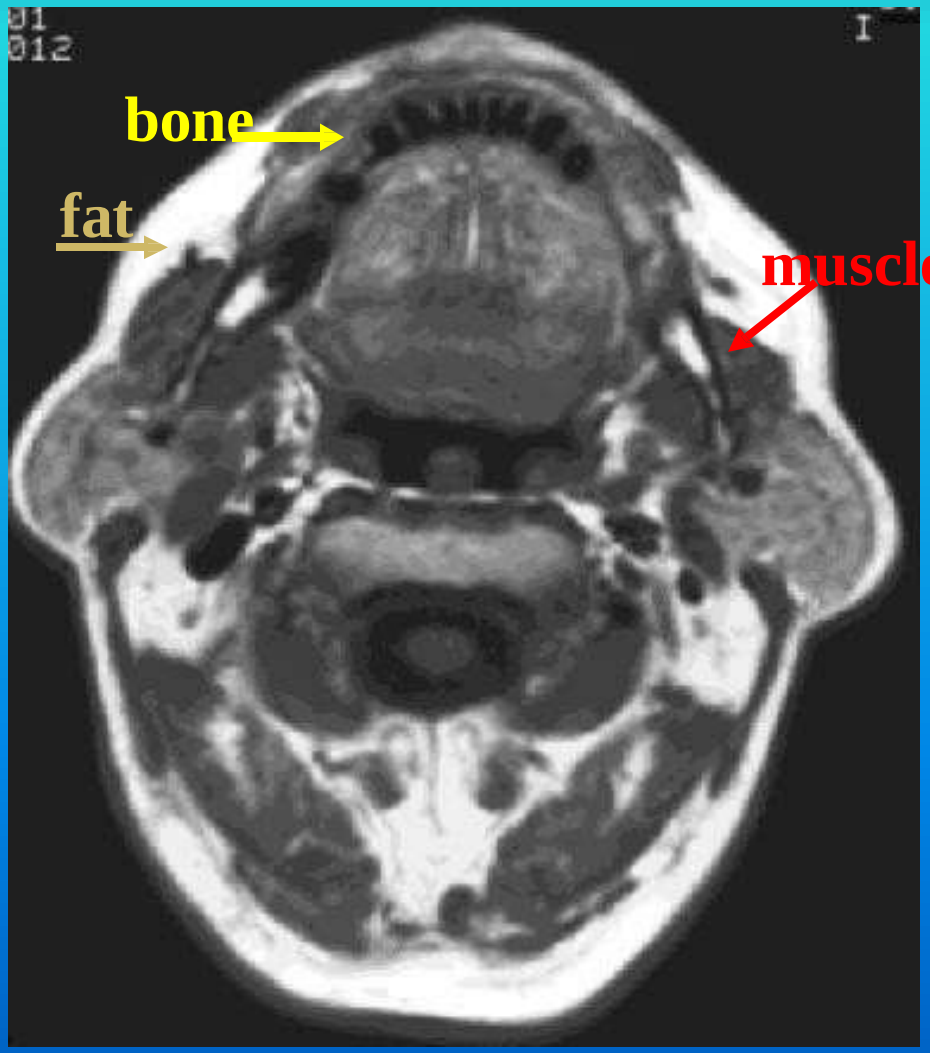




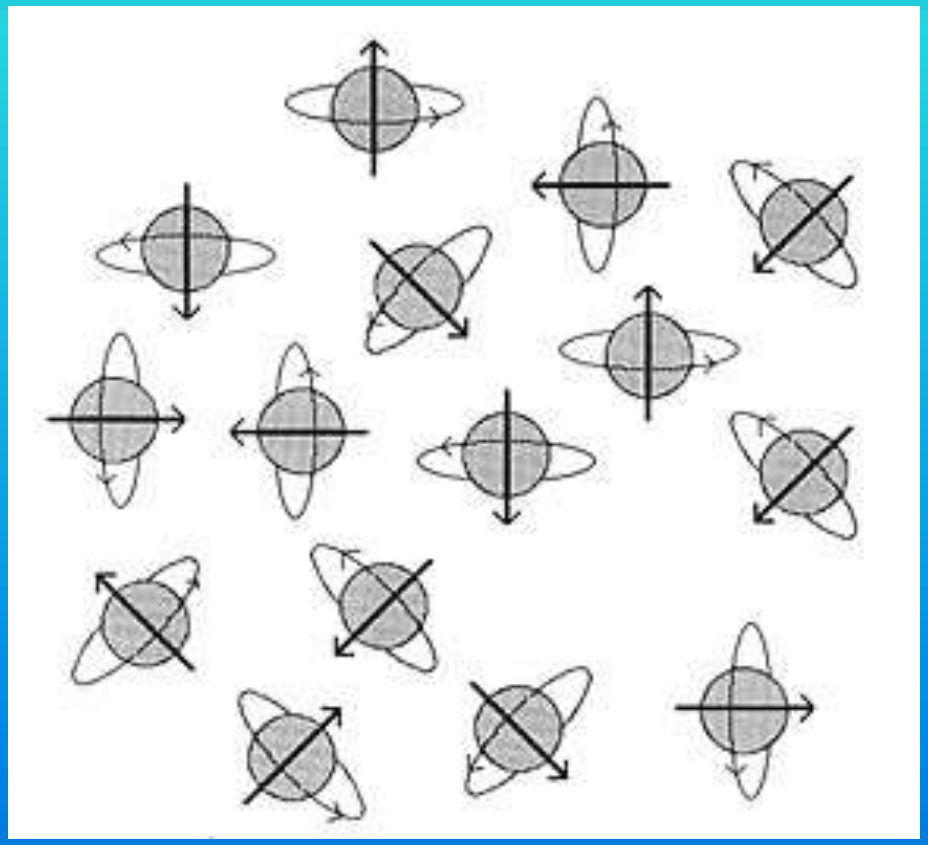


Magnetic Resonance Imaging (MRI)

The appearance of an MR image is a function of the chemical composition of the various types of tissue



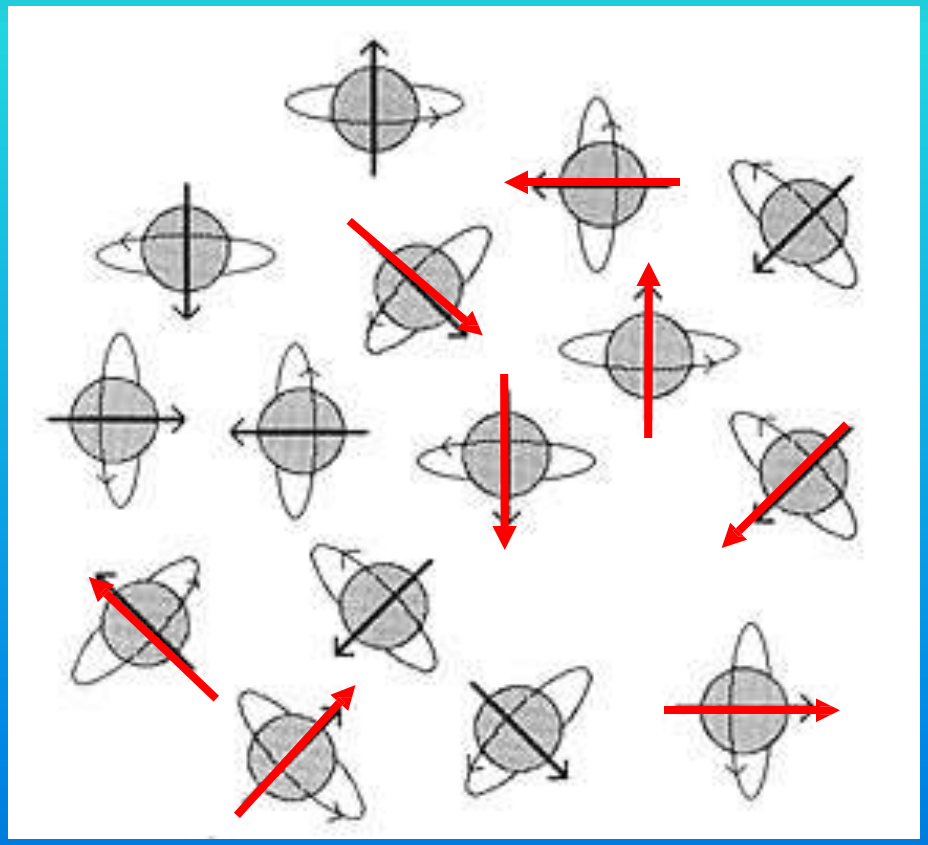
Magnetic Resonance Imaging (MRI)



At the atomic level, water and fatty tissue are composed of hydrogen, oxygen, carbon, and phosphorus atoms. The ***hydrogen atom*** contains a proton and an orbiting electron.

A spinning charged particle (the proton) produces a local magnetic field

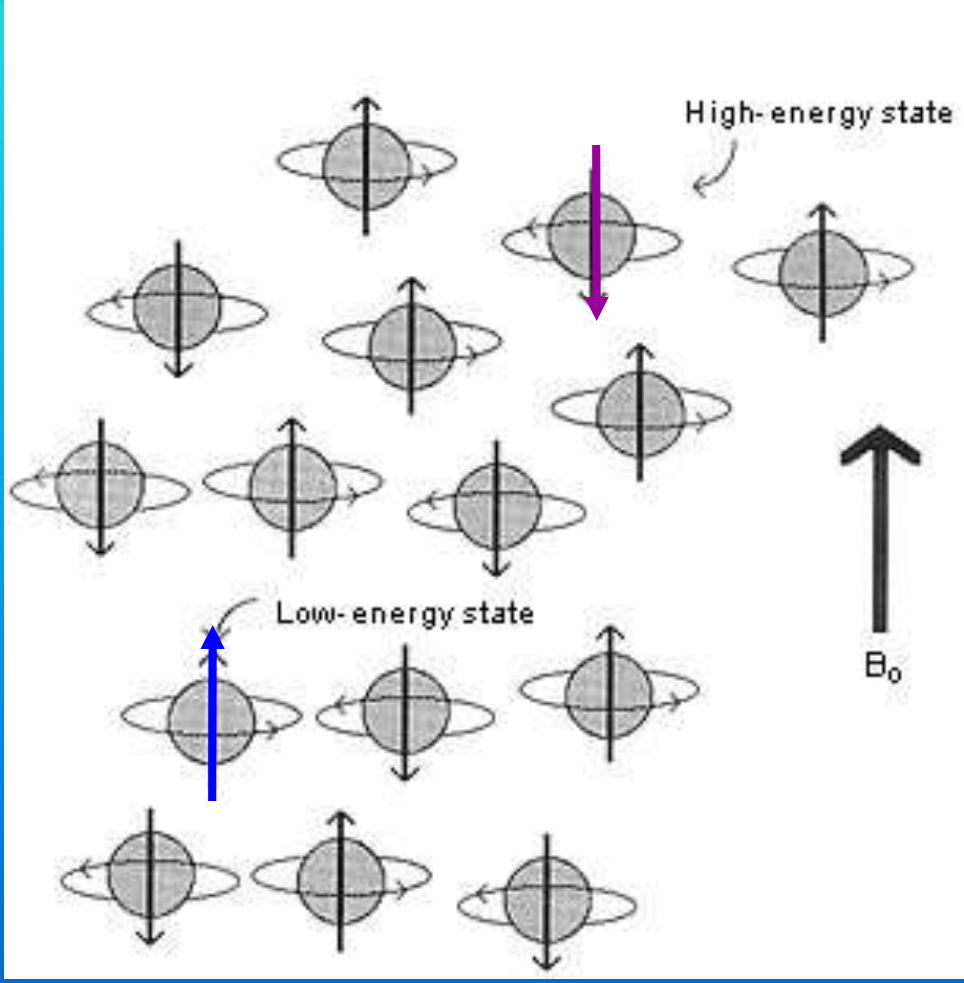
Magnetic Resonance Imaging (MRI)



In the absence of any external forces, the magnetic moments of protons in tissue are oriented randomly

Magnetic Resonance Imaging (MRI)

If the protons are placed in a strong magnetic field, their magnetic dipoles align ***with*** and ***against*** the strong magnet

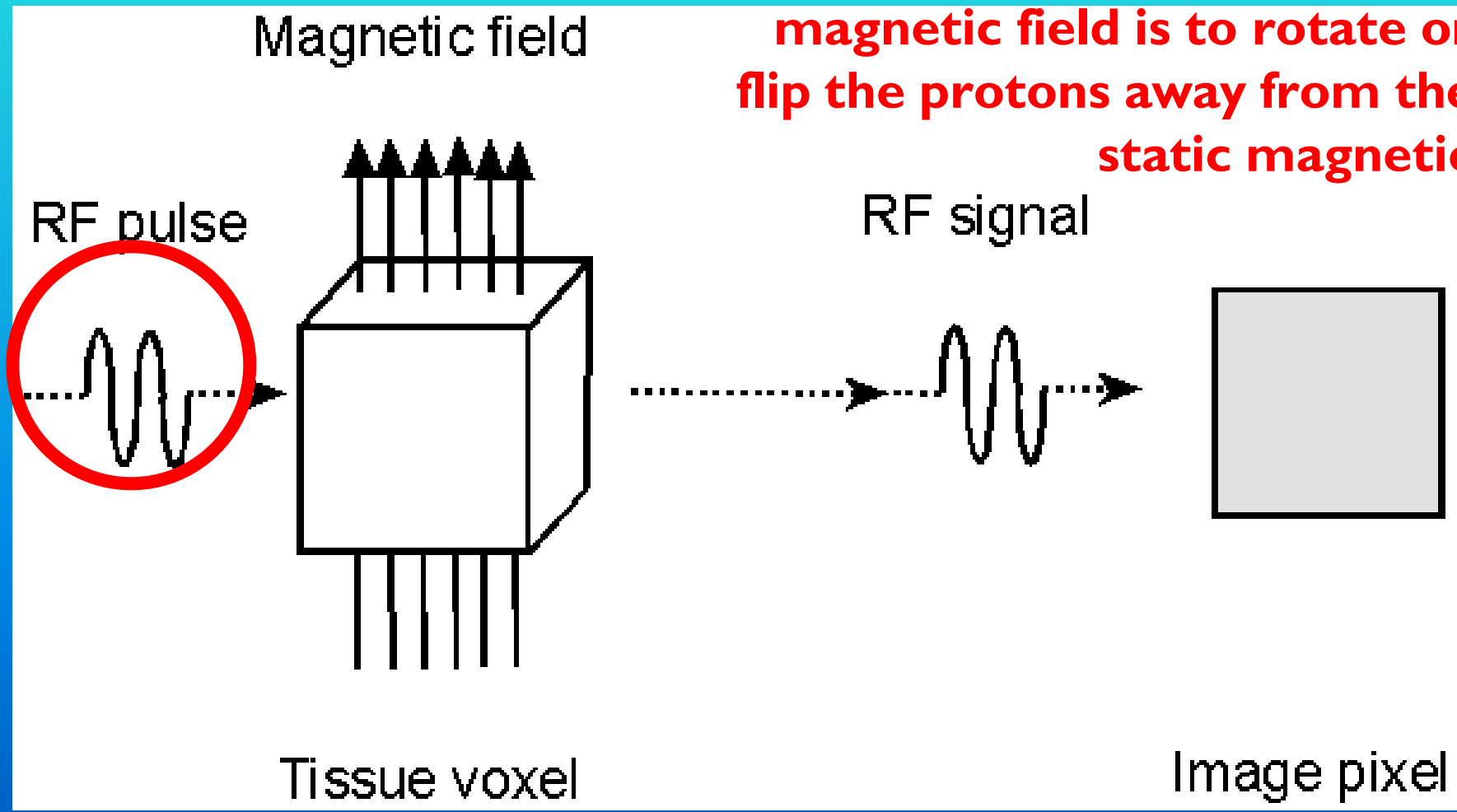


Magnetic Resonance Imaging (MRI)

Magnetic resonance imaging (MRI) combines a strong magnetic field and radiofrequency (RF) energy to study the distribution and behaviour of hydrogen protons in fat and water

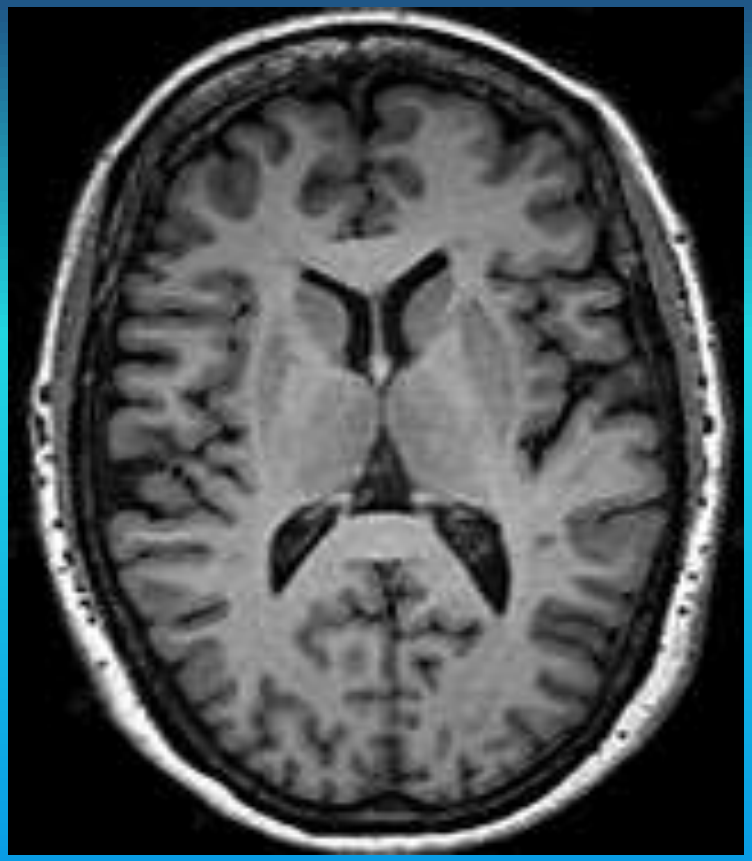
RF energy is used to generate a second magnetic field, perpendicular to the static magnetic field of the machine.

The result of this second magnetic field is to rotate or flip the protons away from the static magnetic

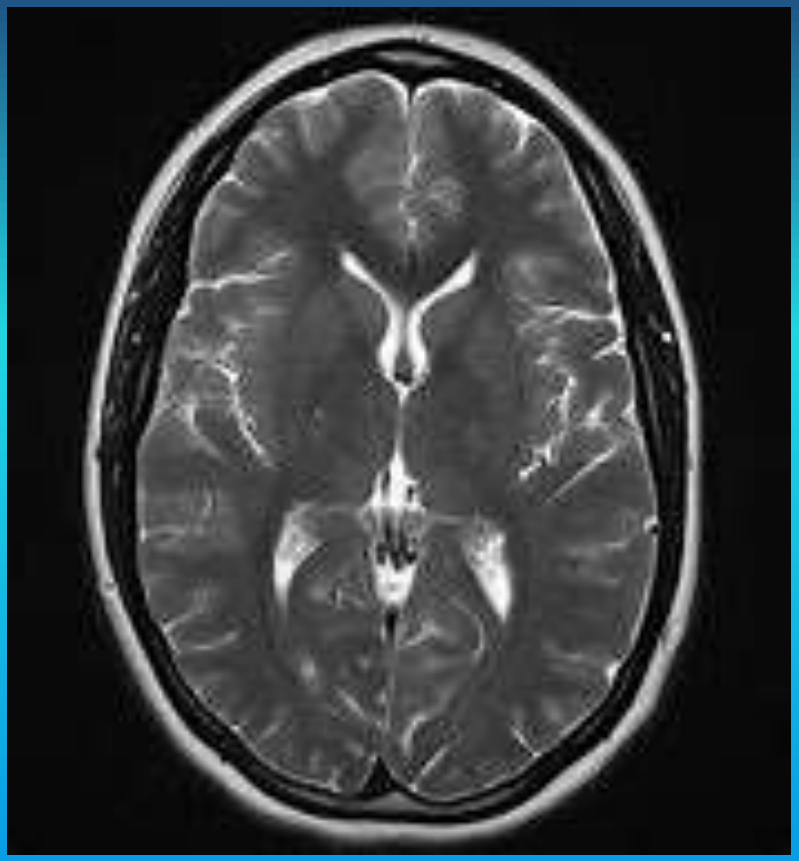


Box 1.1 Appearance of water and fat on different magnetic resonance (MR) sequences

Sequence	Water signal intensity	Fat signal intensity
T1-weighted	Low	High
T2-weighted	High	High
T1 with fat saturation	Low	Low
T2 with fat saturation	High	Low

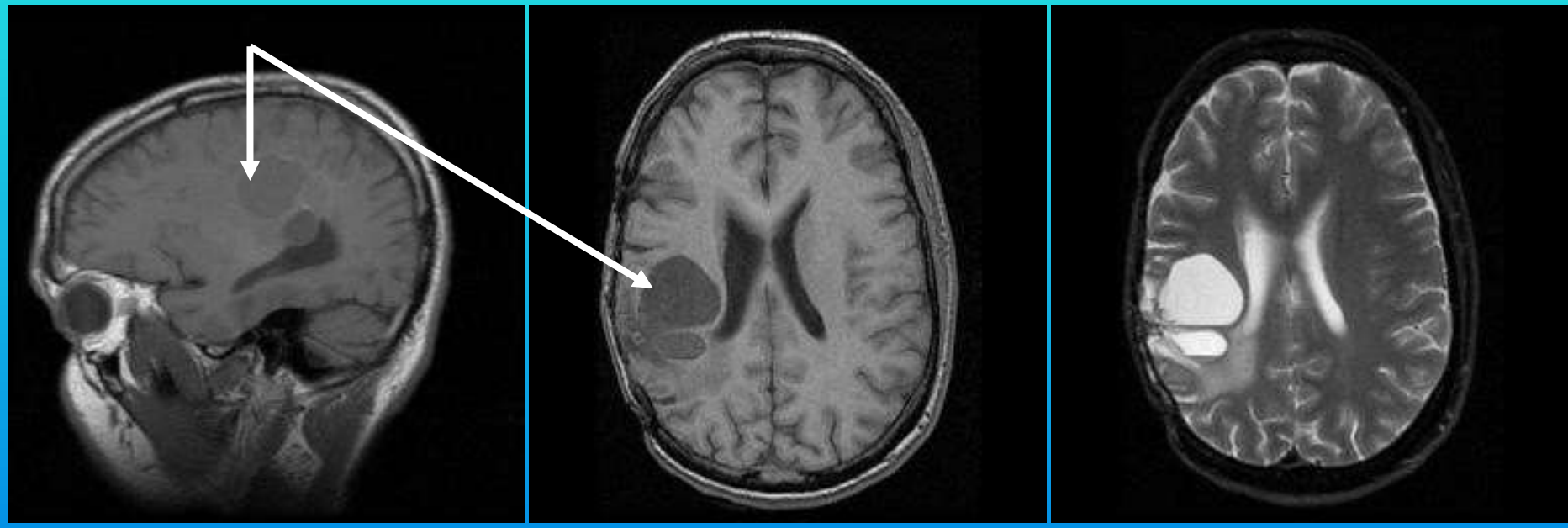


Normal Brain MRI T1WI



Normal Brain MRI T2WI

Brain Tumor Imaging



T_1-weighted Sagittal **T_1-weighted Axial** **T_2-weighted Axial**

Advantage of MRI

- Non ionizing radiation
- Multiplanar images (cross section , saggital and coronal views)
- The ability of imaging vessels without contrast (MR angiography)
- Have a good soft tissue contrast

Contraindication of MRI

- Patient with pacemaker
- Patient with bullet injury or ferromagnetic F.B ,or surgical clip (because of heat and missile effect)
- Pregnancy especially first trimester
- Claustrophobia reported that between 1 % and 10 % of patients experience some degree of claustrophobia which in the extreme cases results in their refusal to proceed with the scan

DISADVANTAGES OF MRI

- Expensive
- Long scan times
- Audible noise (65-115dB)
- Isolation of patient (claustrophobia, monitoring of ill patients)
- Exclusion of patients with pacemakers and certain implants

Stroke

Stroke is a clinical diagnosis that refers to a sudden focal neurological deficit of presumed vascular origin.

It is generally divided into two broad categories:-

1- ischemic stroke :- account for about 87% of cases.

2- hemorrhagic stroke (synonymous for intracranial hemorrhage) :- it account for about 13% of cases.

Ischemic stroke

Is an episode of neurological dysfunction due to focal infarction in the central nervous system ,which is caused by arterial thrombosis ,embolization, or critical hypoperfusion.

Epidemiology :- the stroke is the second most common cause of morbidity world wide after myocardial infarction, and is the leading cause of acquired disability.

Risk factors:- the risk factors for ischemic stroke mirror the risk factors for atherosclerosis and include hypertension, hypercholesterolemia ,DM, smoking , aging ,family history.

Clinical presentation:-

The ischemic stroke presented with rapid onset of neurological deficit, which determined by the area of brain involved (according to vascular distribution and its territories).

The symptoms often evolve over hours and may worse or improve (depending on the fate of the ischemic penumbra)

➢The vascular territory infarction is very important in determined the exact symptoms and clinical behavior of the insult. & it include:-

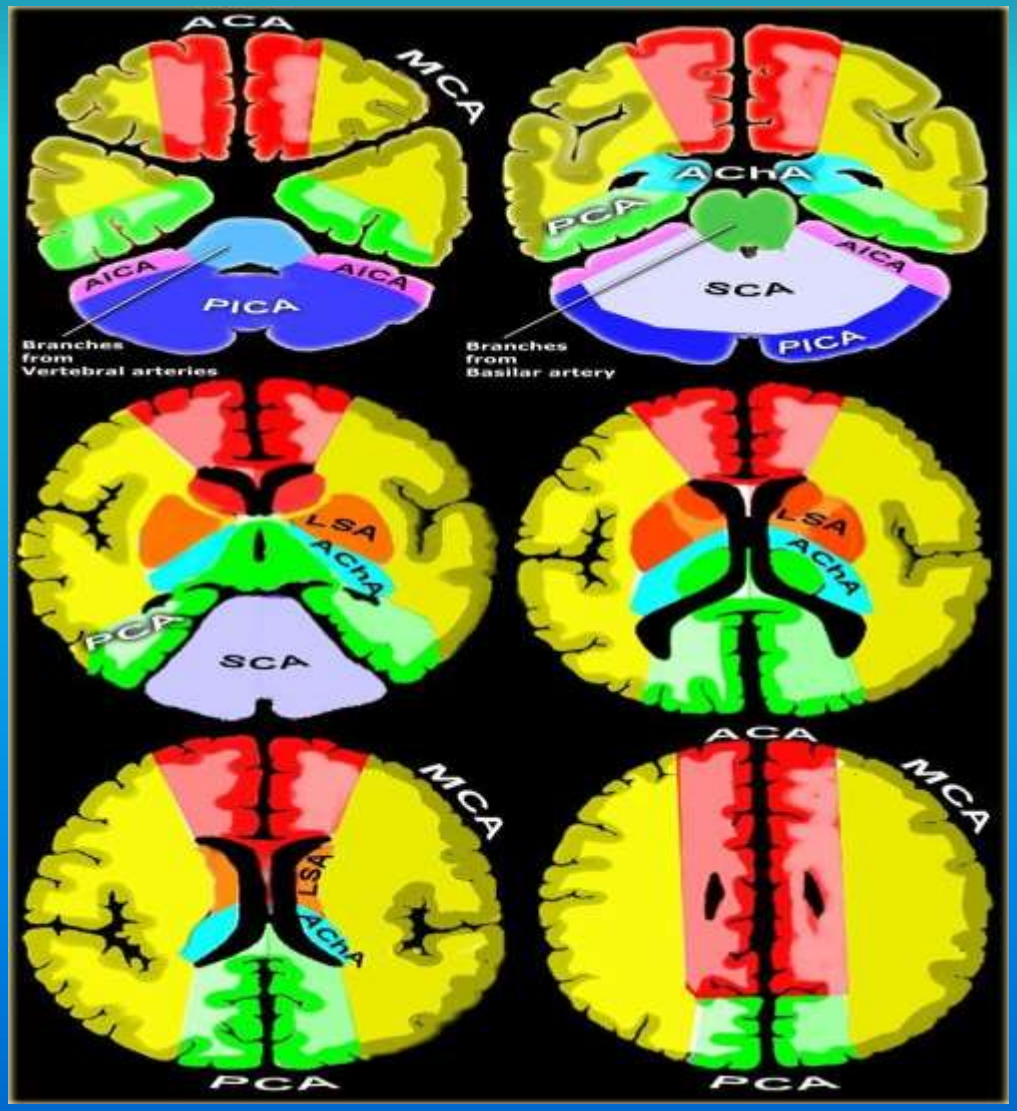
1-anterior circulation infarction

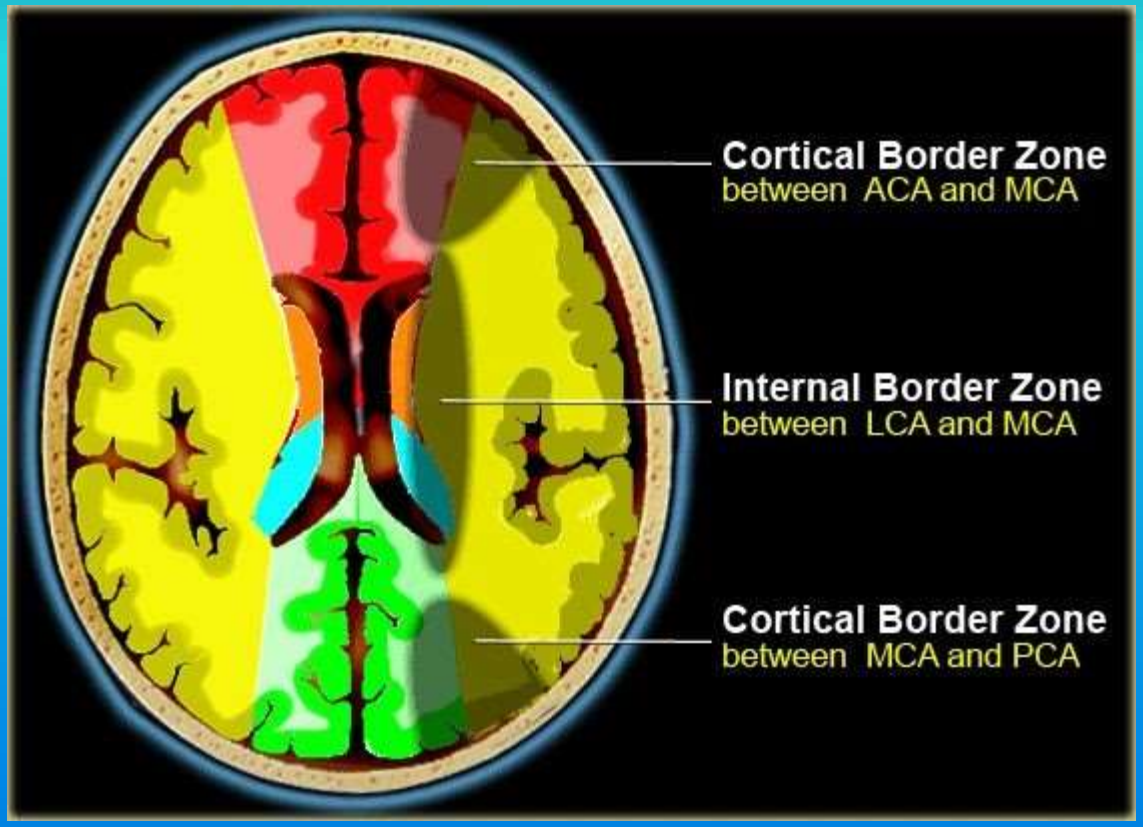
- anterior cerebral artery infarction.
- Middle cerebral artery infarction.
- Lacunar infarction (small infracted foci (less than 15mm) that seen mainly in basal ganglia).

2- posterior circulation infarction

- Posterior cerebral artery infarction.
- Cerebellar infarction.
- Brain stem infarction.

Arterial circulation




Cortical Border Zone
between ACA and MCA
Internal Border Zone
between LCA and MCA
Cortical Border Zone
between MCA and PCA

The modalities use in diagnosis of ischemic stroke includes:-

1- non-enhanced CT scan.
2- CT angiography.
3- MRI.

❖Brain CT scan .

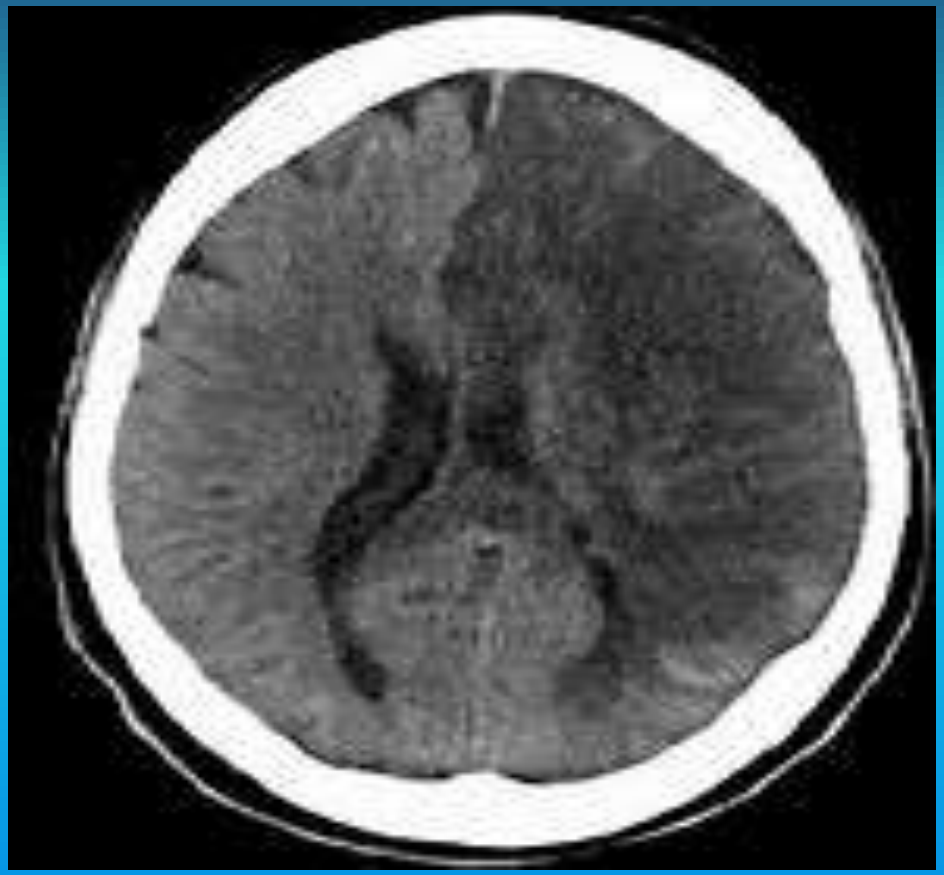
The goals of Non-enhanced (Native) brain CT in patient with hx of acute stroke:-

1- exclude intracranial hemorrhage, which preclude thrombolysis.
2-look for any features of ischemia.
3- exclude other intracranial pathologies that may mimic stroke ,like tumor.

The Brain CT scan show :-

1- loss of gray –white matter differentiation.
2- cortical hypodensities ,associated with parenchymal swelling /gyral effacement.
3- mass effect on the surrounding normal brain tissue ,ventricles, and mid line shift in severe form..
4- in early hyperacute state , the vessel which involved by thrombus may appear dense (dense vessel sign) .
4- in chronic stage ,the mass effect resolve & the affected brain tissue decrease in volume & may be associated with dilated adjacent ventricle.

Ischemic stroke involving the Lt frontal lobe (Lt anterior cerebral artery)



Brain CT scan show acute ischemic stroke involving the Lt anterior circulation , & show cortical hypodensity with loss of gray-white matter differentiation, & associated mass effect on the adjacent normal brain parenchyma & Lt lateral ventricle with mild Rt sided mid line shift.

CT scan show subacute ischemic infarction involving the Rt MCA territories.

CT scan show Rt Cerebellar infarction

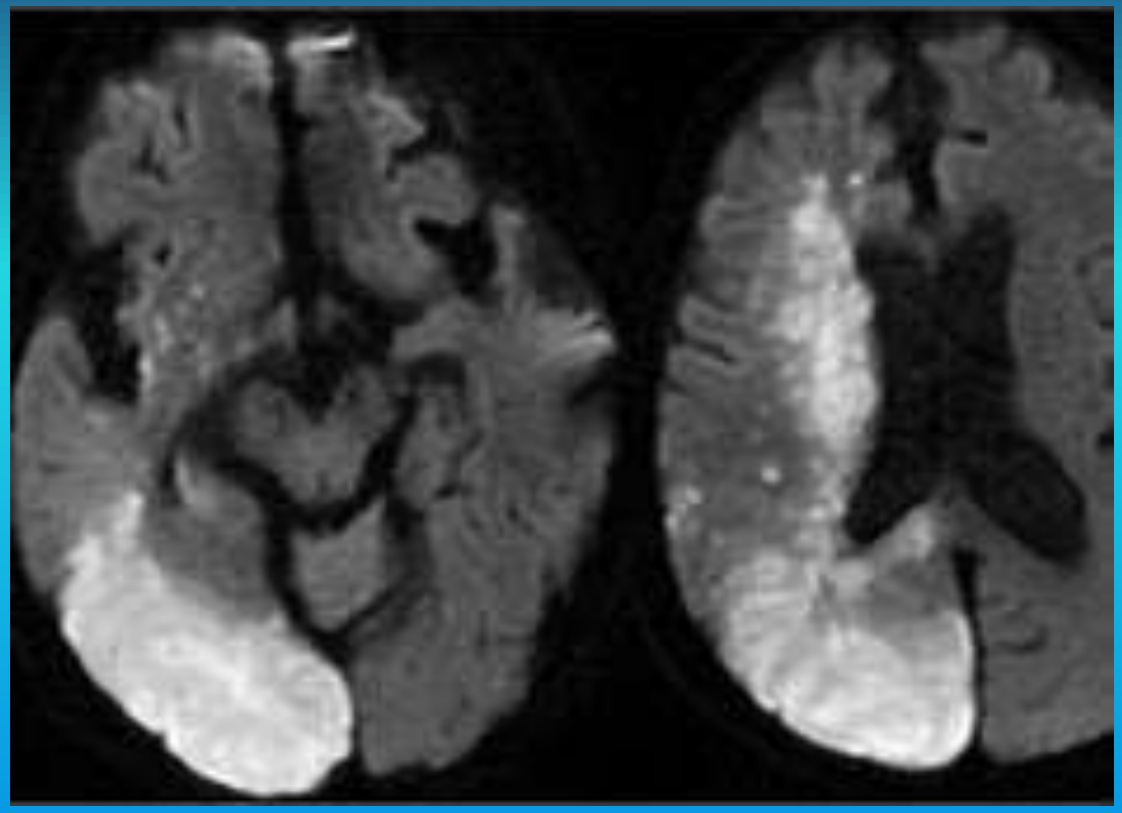
Brain CT angiography show occlusion of Rt proximal MCA & ACA

❖Brain MRI

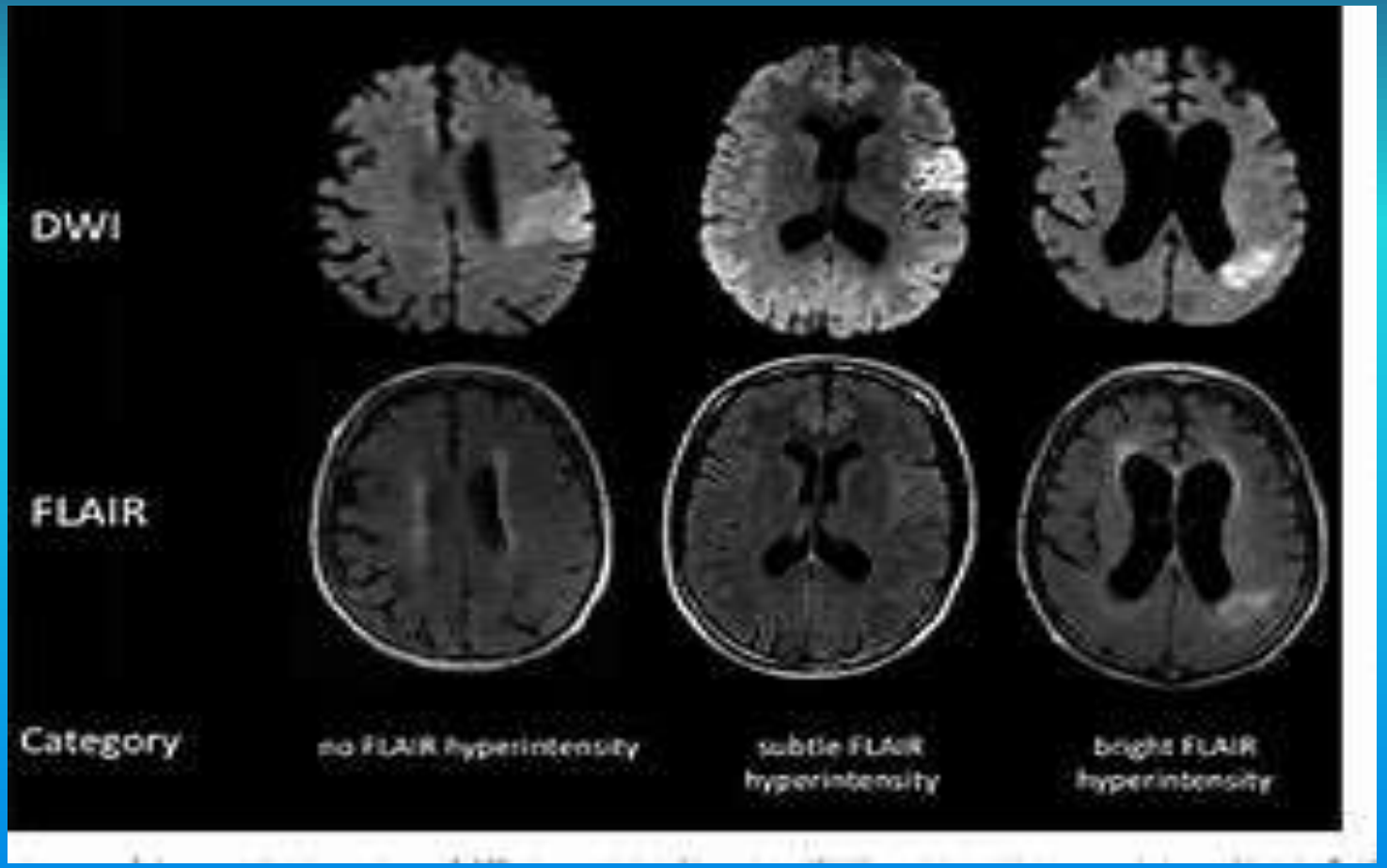
The brain MRI show significantly higher sensitivity & specificity in diagnosis of acute ischemic stroke in first few hours after onset (which may appear normal in Native CT scan).

Sequences used in brain MRI includes(T1WI,T2WI,FLAIR,DWI & ADC map).

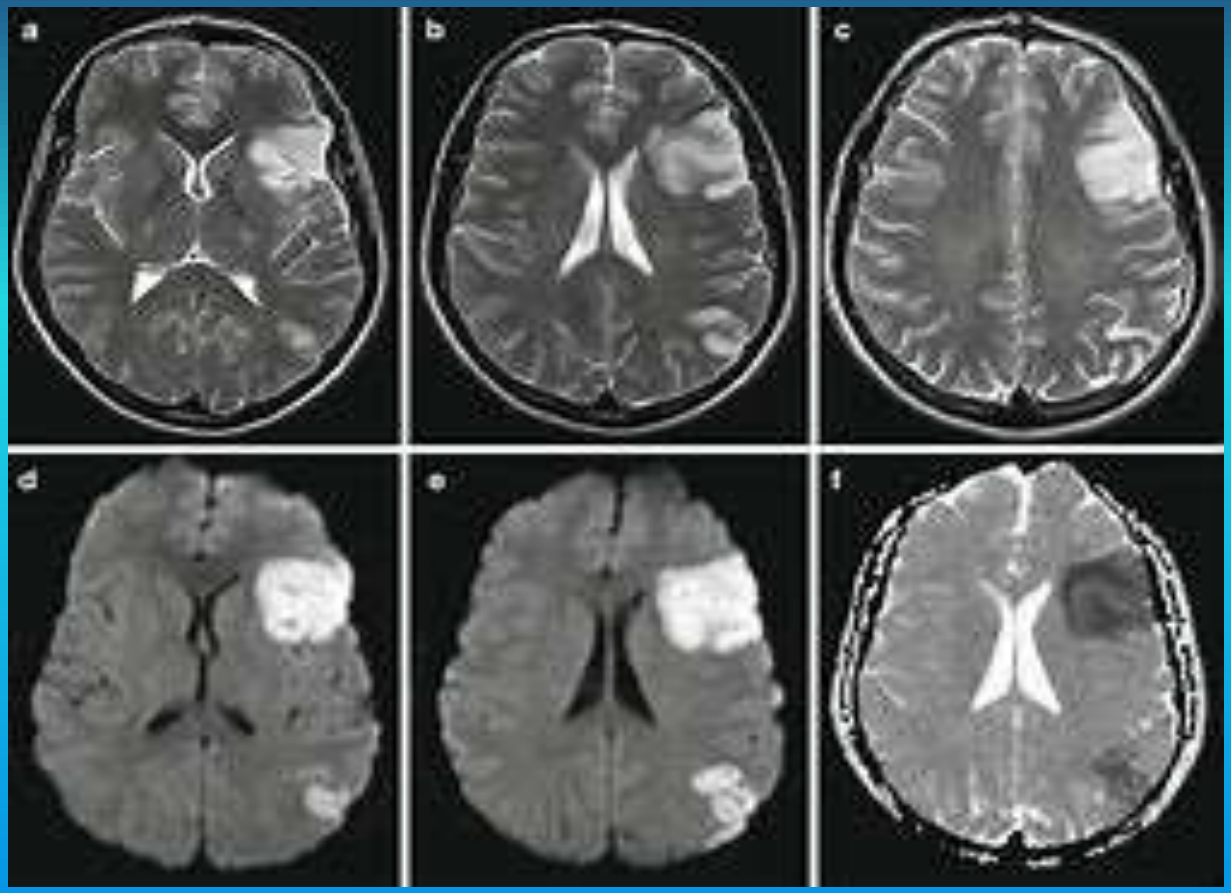
DWI represent the most important sequence that used in diagnosis of acute ischemic stroke ,& the affected area demonstrate increase signal within minutes of arterial occlusion. while the affected parenchyma may appear normal in the other sequences.



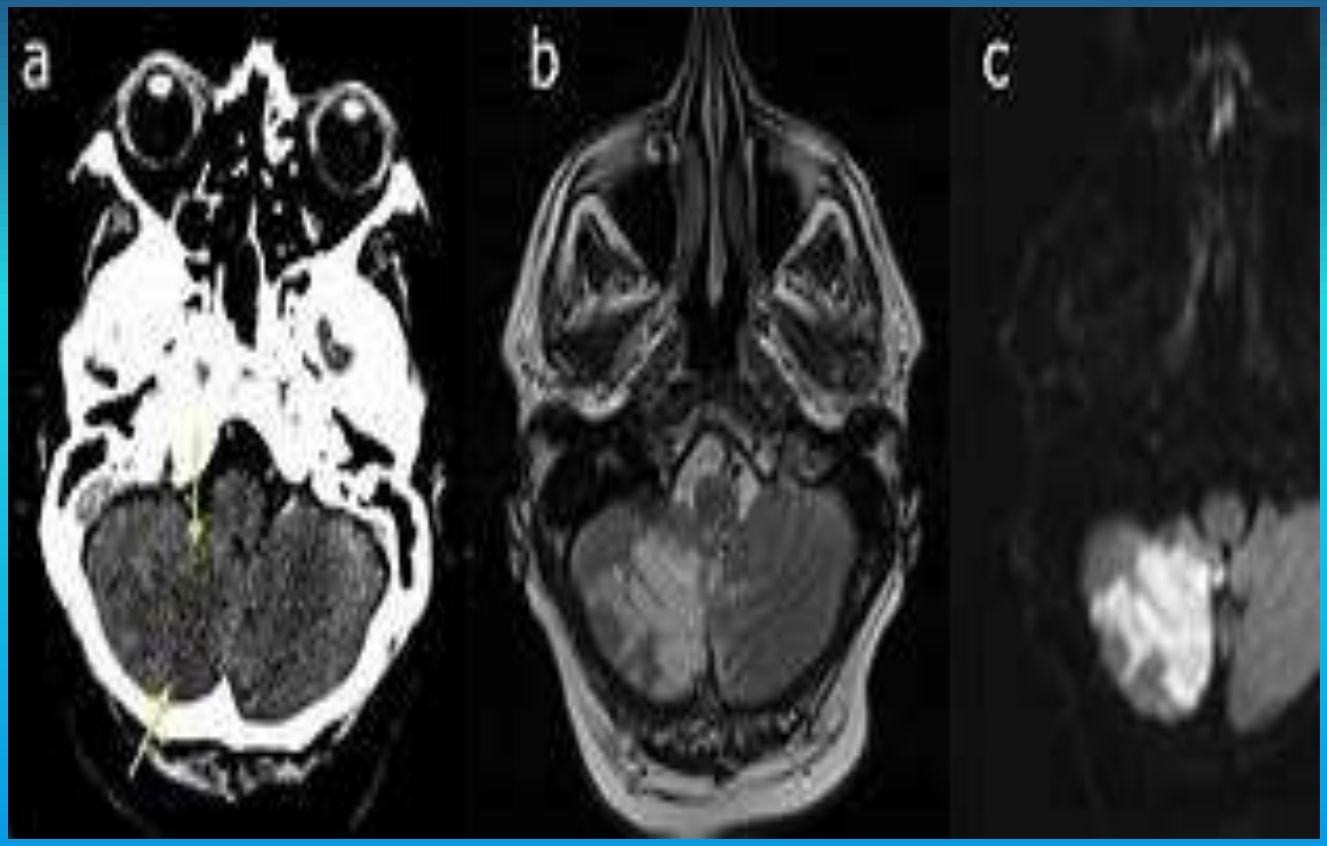
DWI show increase signal in the infracted area



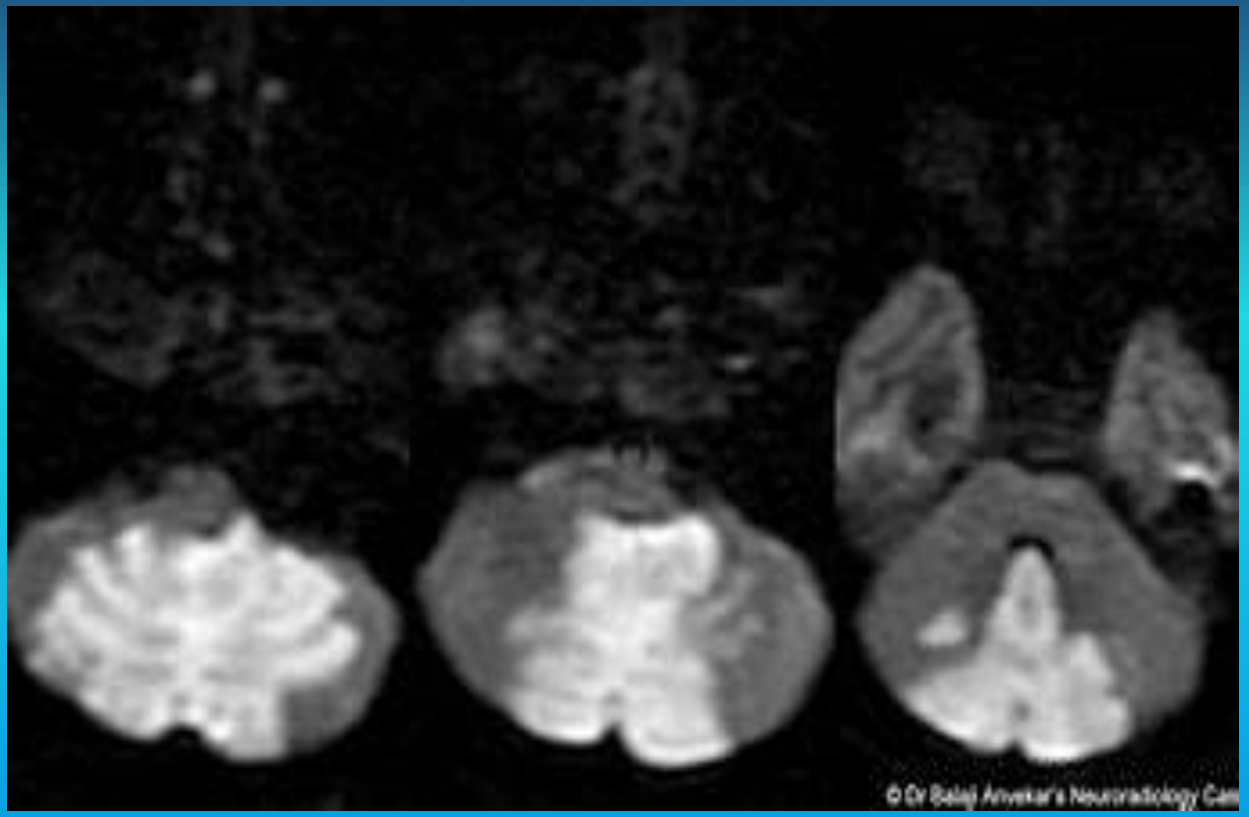
DWI show high sensitivity in detection of acute ischemia



Brain MRI show acute ischemic infarction involving the Lt parietal lobe (MCA territory)



Different modalities in diagnosis of acute ischemic stroke



Brain MRI with DWI sequence show Acute Cerebellar infarction

Thanks