NEUROIMAGING

Homework:

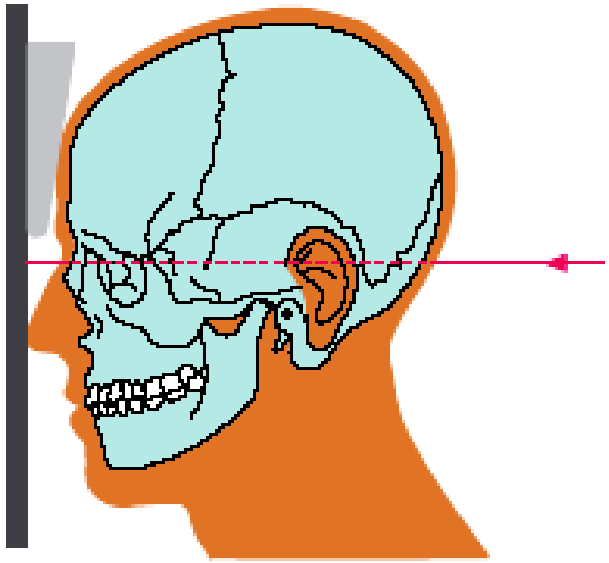
1. Radiography of the skull and spinal cord- projection, indications.
2. Computerized tomography of the skull. Indications, pathological signs.
3. MRI in neuroimaging- indications, contraindications.
4. Nuclear medicine methods used in pathology of the nervous system.
5. Algorithm of imaging diagnosis in ischemic and hemorrhagic stroke.

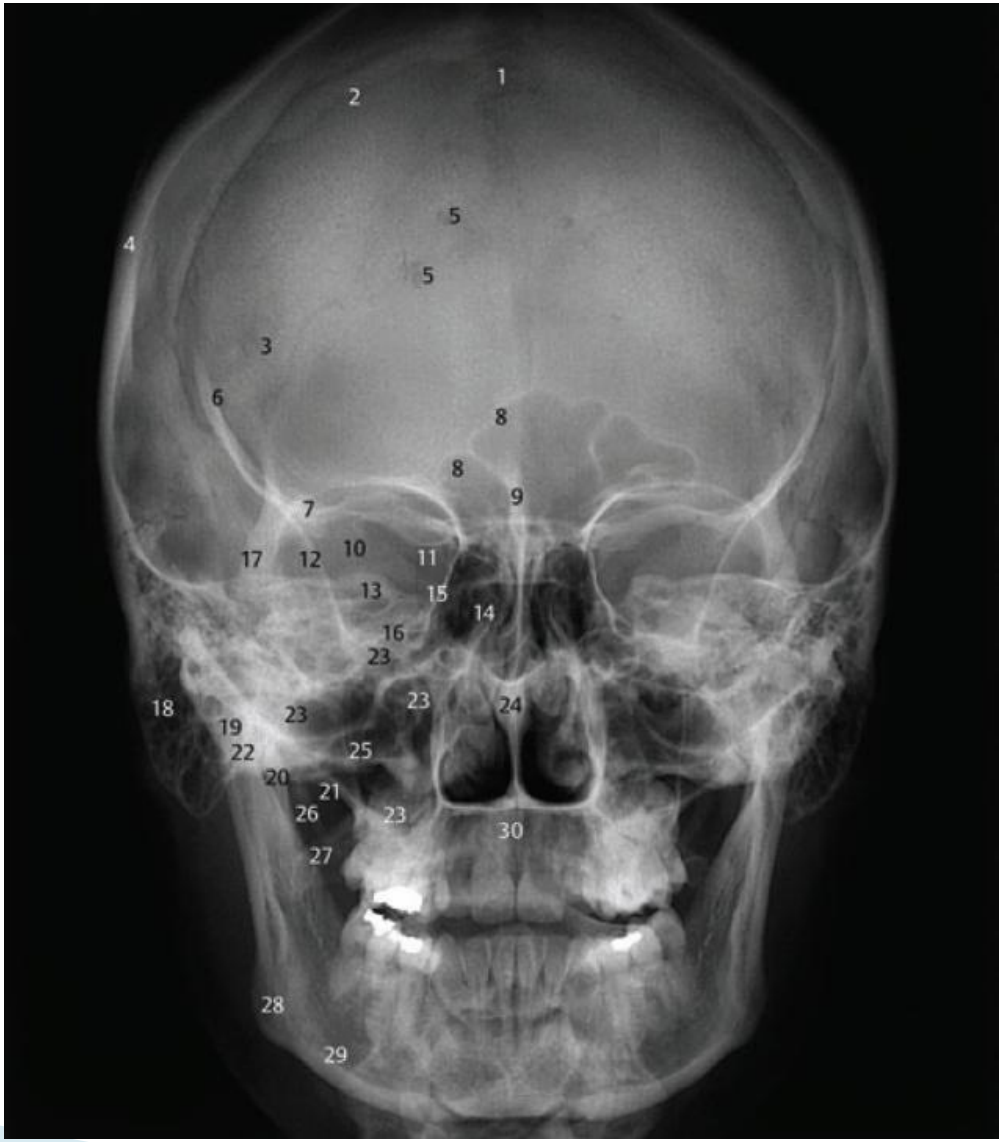
Imaging Modalities used in neuroimaging

- Conventional radiography
- CT scan / CT angio
- MRI scan / MRI angio
- Digital Angiography
- USG
- PET CT/ SPECT

Posteroanterior Skull Projection

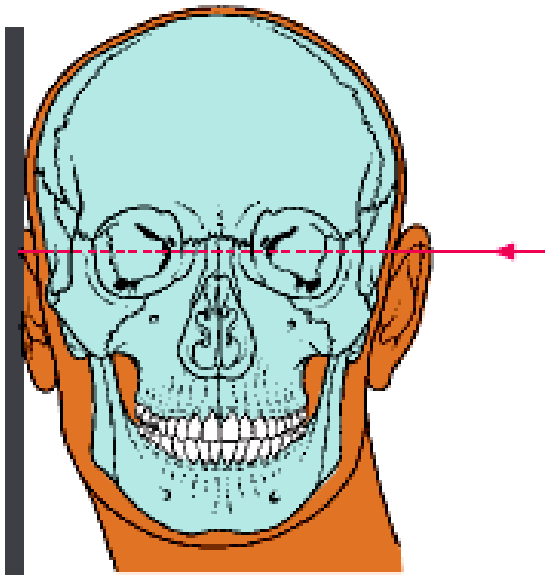
Is used for documentation of skull and facial skeletal asymmetries.

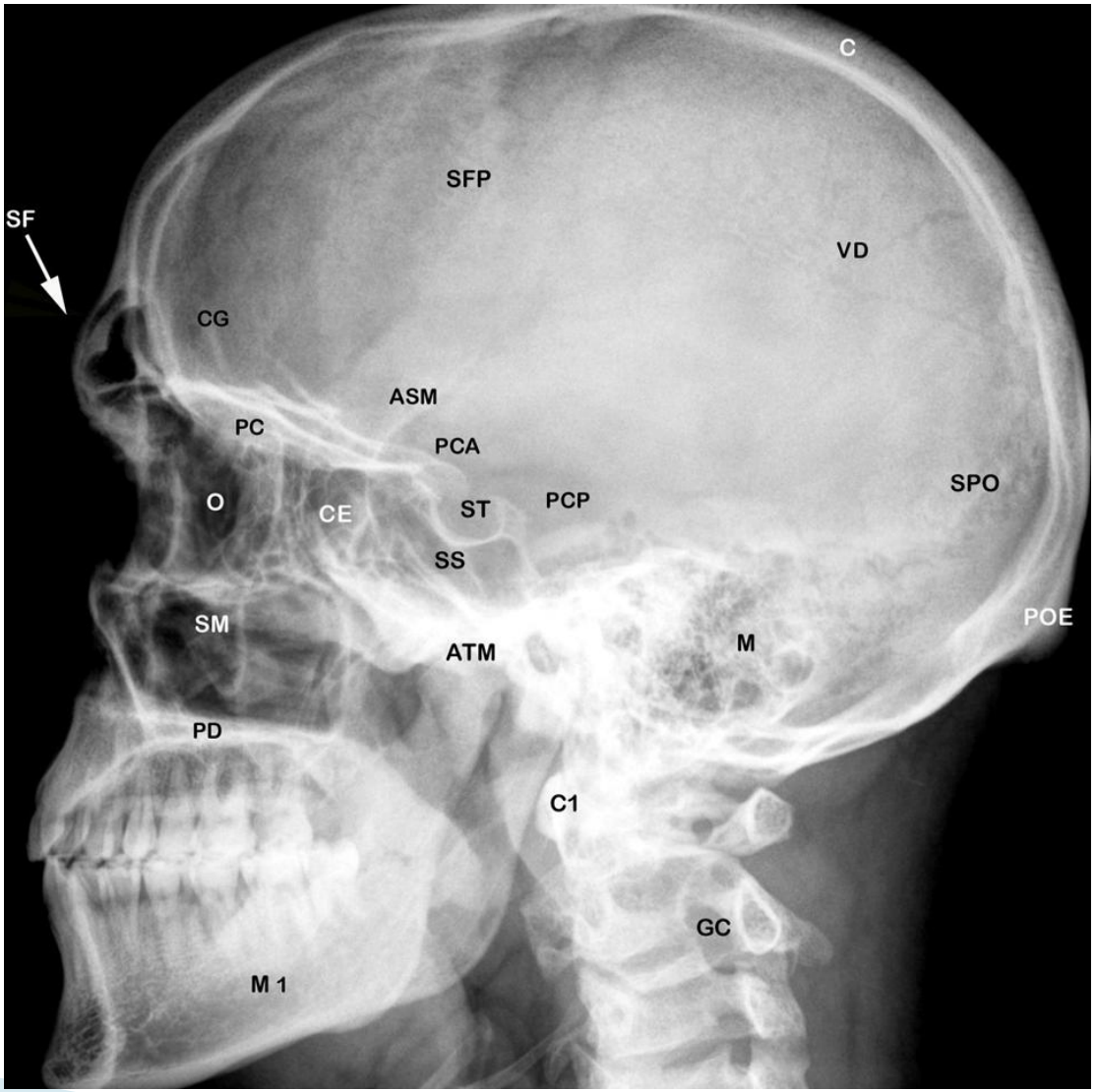




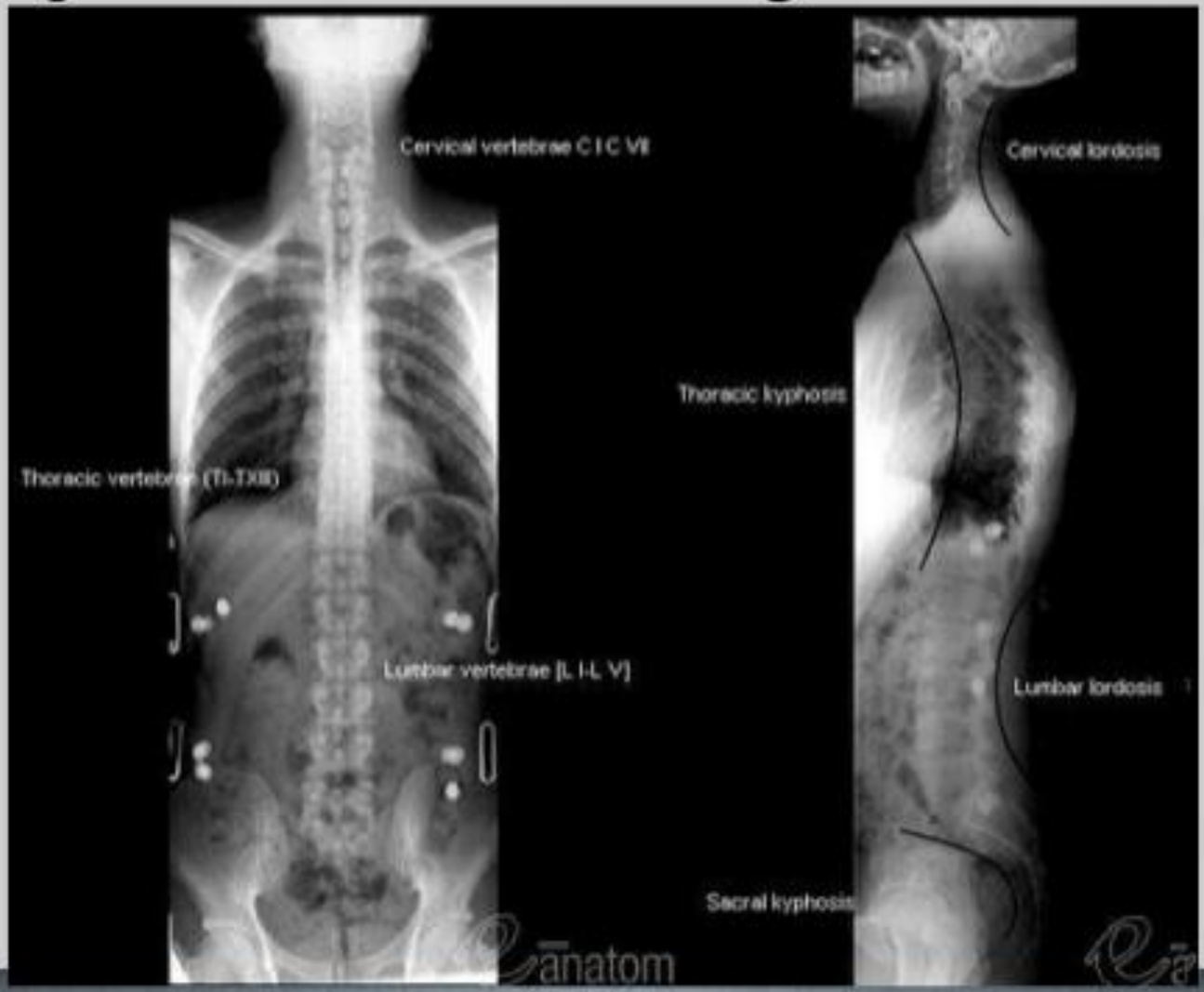
Lateral Skull Projection

Is used for documentation of skull and facial skeletal asymmetries.





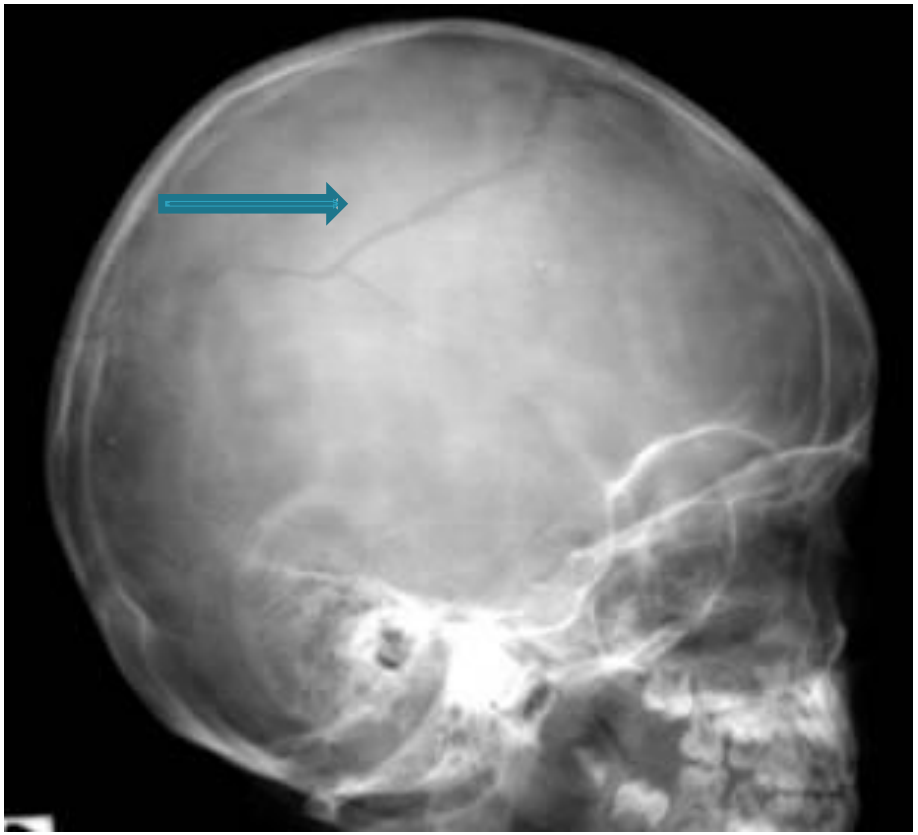
Anterior-posterior full-length view of the spine and Lateral full-length view of the



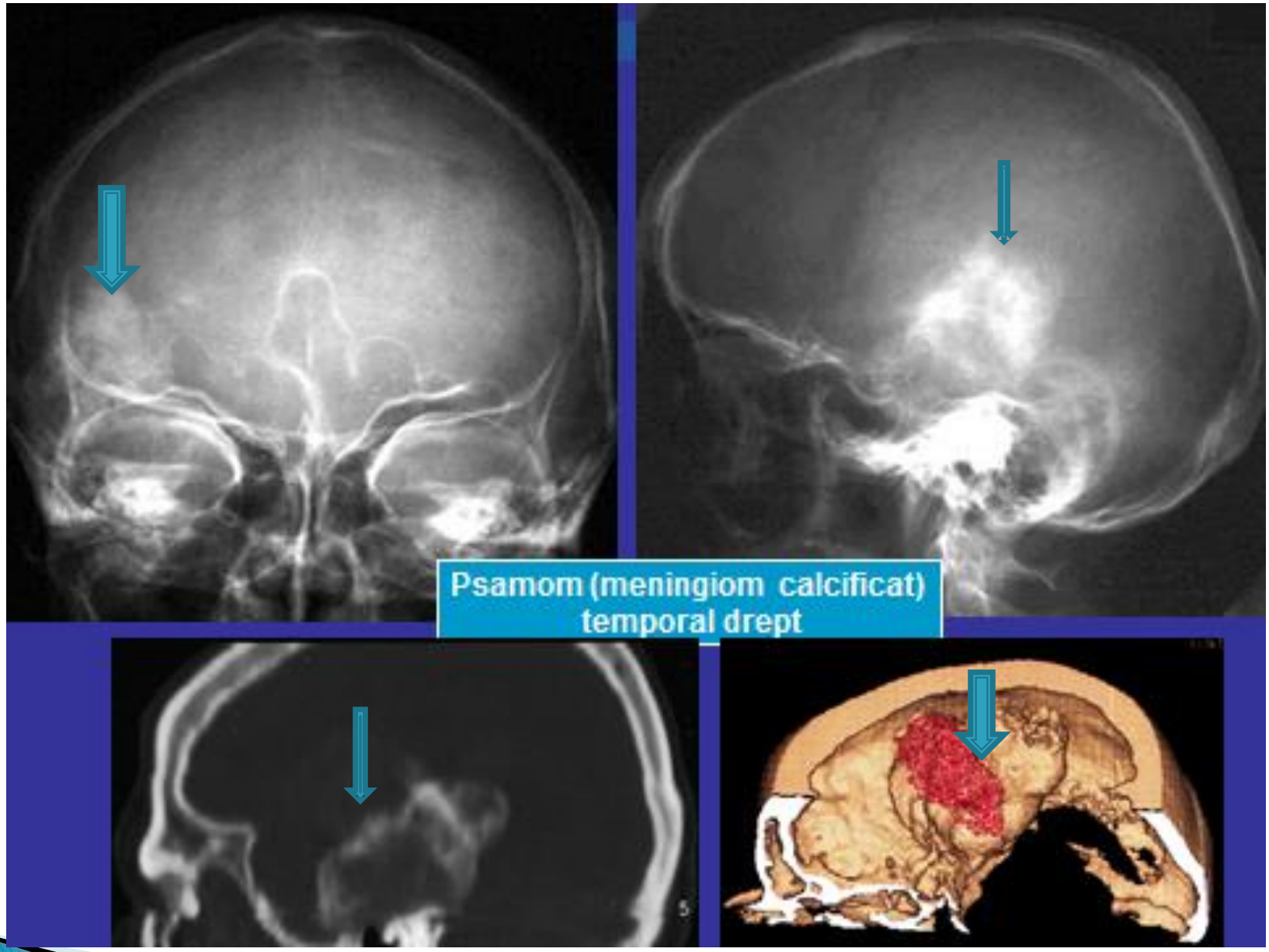
An X-ray is done to:

- To check injuries to the spine and skull, such as fractures or dislocations.
- Check the skull or the spine for effects from other problems, such as infections, tumors, or bone spurs.
- Sinusitis (paranasal sinuses).
- Check for abnormal curves of the spine, such as scoliosis, in children or young adults (static disorders).
- Check the spine for problems present at birth (congenital conditions), such as spina bifida, in infants, children, or young adults.

Simple linear fracture



Compression fracture L2



Calcified meningioma in right temporal lobe

Pre- and postoperative images: thoraco-lumbar scoliosis

Spina bifida

The principal advantages of CT

- may record images simultaneously, and produce clear, high-quality images as a result,
- most partial CT scans take just seconds, and a full scan of the entire body can be completed in about a half-hour. This speed helps in finding internal injuries and internal bleeding quickly enough to help save lives,
- CT scans have a less stringent requirement for patients to remain absolutely motionless during the scan as compared to Magnetic Resonance Imaging (MRI). CT scans, unlike MRI, have no prohibition on implanted medical devices.

Disadvantages of the CT

- Radiation

The CT scan inserts a high dose of radiation in the patient. It can increase the cancer rates of patients who need to go through repeated treatments. Caution is indicated in pregnant women, particularly during the first trimester to avoid fetal abnormalities. Risk-to-benefit considerations should be evaluated.

- Allergic Reaction

CT scans use iodine to scan patients. Some people are allergic to it. Symptoms are a metal taste in the mouth, irritation, rash and shortness of breath.

Indications of CT

- bleeding, brain injury and skull fractures in patients with head injuries,
- a blood clot or bleeding within the brain shortly after a patient exhibits symptoms of a stroke,
- a stroke, especially with a new technique called Perfusion CT,
- brain tumors,
- enlarged brain cavities (ventricles) in patients with hydrocephalus,
- diseases or malformations of the skull.

CT scanning is also performed to:

- evaluate the extent of bone and soft tissue damage in patients with facial trauma, and planning surgical reconstruction,
- guide the passage of a needle used to obtain a tissue sample (biopsy) from the brain,
- assess aneurysms or arteriovenous malformations through a technique called CT angiography.

What is bright/dark on CT?

- The more dense the tissue, the brigther it looks on CT.
- Any calcified structure (like bone) is white (appears bright) on CT.
- Also new hemorrhage is bright on CT.
- Water or CSF looks dark on CT.

Hounsfield scale

Substance	HU
Air	-1000
Fat	-120
Water	0
Muscle	+40
Contrast	+130
Bone	+400 or more

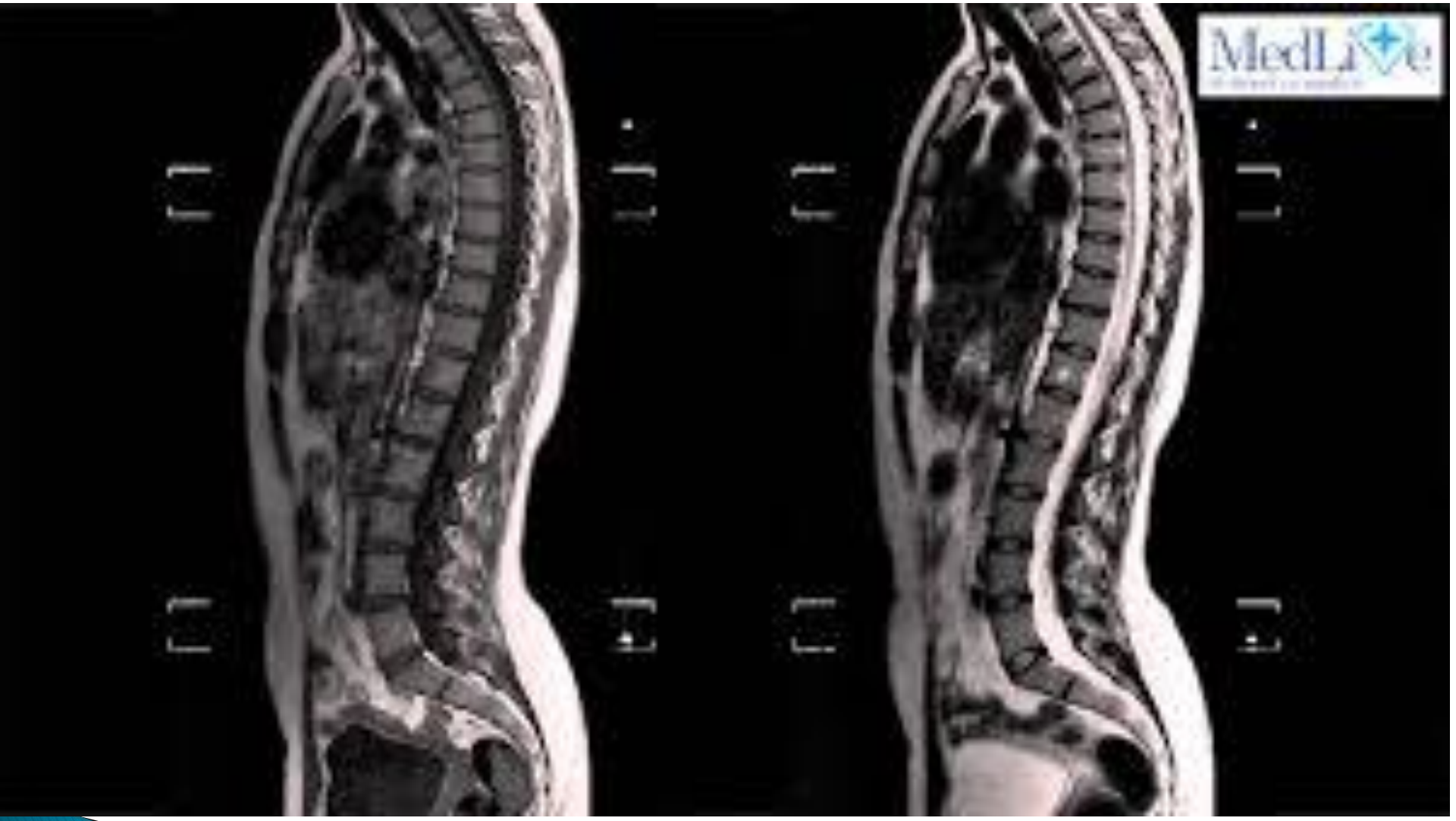
Magnetic resonance imaging (MRI)

Advantages:

- MRI is particularly useful for the scanning and detection of abnormalities in soft tissue structures in the body like the cartilage tissues and soft organs like the brain or the heart.
- There is no involvement of **any kind of radiations** in the MRI, so it is safe for the people who can be vulnerable to the effects of radiations such as pregnant women or babies.
- MRI scan can provide information about the blood circulation throughout the body and blood vessels and also enabling the detection of problems related to the blood circulation.

Disadvantages:

- MRI scanners are very expensive.
- The combination of being put in an enclosed space and the loud noises that are made by the magnets can make some people feel claustrophobic while they are having a MRI scan.
- MRI scanners can be affected by movement.
- Bone and calcium do not show up on an MRI scan.


MedLive

MRI Indications

- MRI can be useful in evaluation of the following:

1. Ischemia/infarct
2. Vascular anomalies
3. Hemorrhage
4. Infection
5. Tumors and masses
6. Trauma and diffuse axonal injuries
7. Neurodegenerative disorders and dementias
8. Inflammatory conditions
9. Congenital abnormalities
10. Low back pain

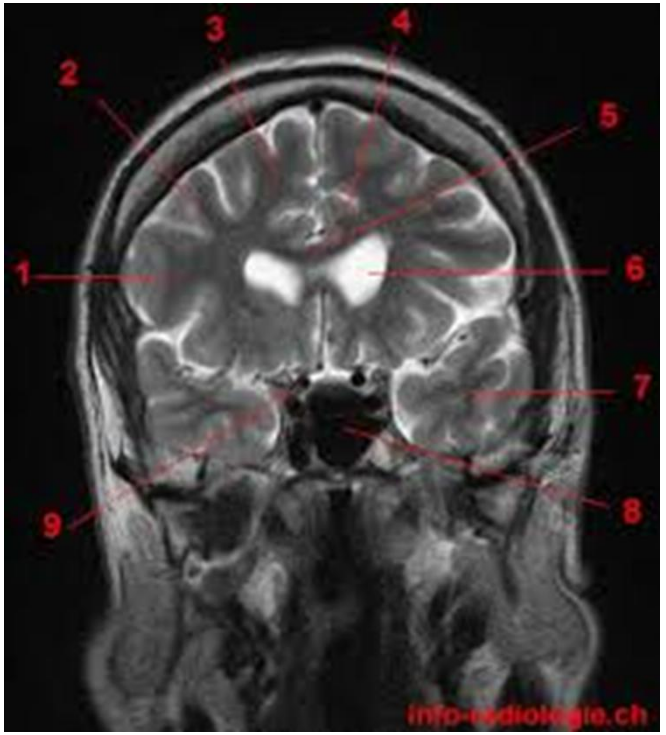
Strict contraindications

- Implanted electric and electronic devices are a strict contraindication to the magnetic resonance imaging, and in particular:
- heart pacemakers (especially older types)
- insulin pumps
- implanted hearing aids
- neurostimulators
- intracranial metal clips
- metallic bodies in the eye

Relative contraindications

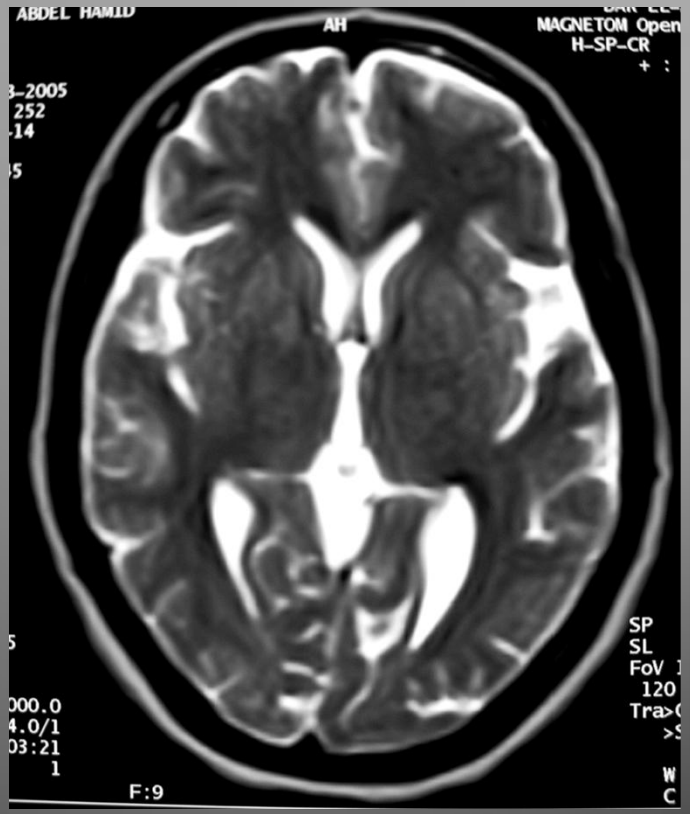
- Metal hip replacements, metallic teeth, sutures or foreign bodies in other sites are relative contraindications to the MRI.
- The first trimester of pregnancy is also a relative contraindication against the examination.
- The radiologist makes the final decision as to whether to proceed with the examination.

- There are several types of MR sequences/images, each of which have unique characteristics and are good for different purposes or in combination can help discern tissue composition. The two most basic image types are T1 and T2 images.
- Other image types include T2 FLAIR, T2* (hemo), PD (proton density), and DWI (diffusion weighted imaging). Fat saturation can also be applied to make fat look dark instead of bright. Contrast, in the form of gadolinium, can be administered to highlight different structures or pathology.



Cerebral MRI

T1 Weighted Image



T2 Weighted Image

Diffusion Weighted Imaging (DWI)

DWI is the most sensitive sequence for stroke imaging.
DWI is sensitive to restriction of Brownian motion of extracellular water due to imbalance caused by cytotoxic edema.
Normally water protons have the ability to diffuse extracellularly and loose signal.
High intensity on DWI indicates restriction of the ability of water protons to diffuse extracellularly.

When describing findings on MR, we use words that refer to signal intensity.

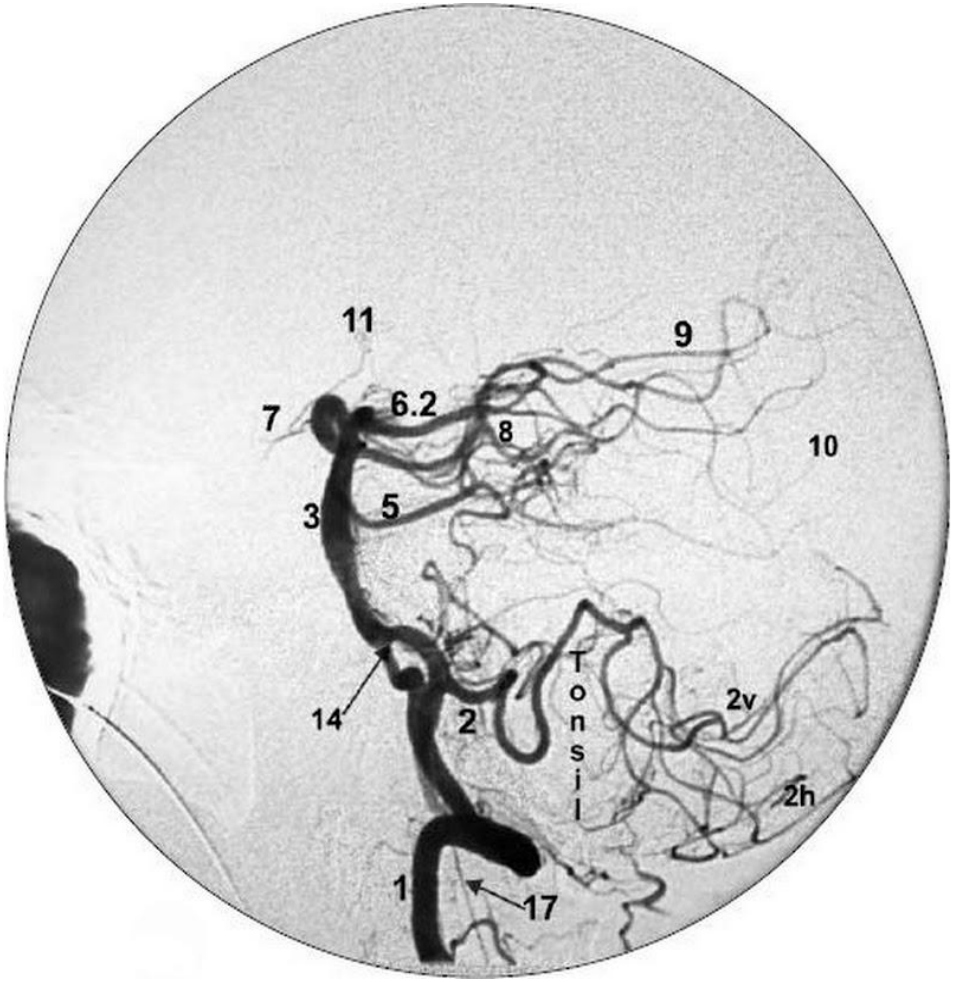
Hyperintense (more intense): If an abnormality is bright (white) on MR, we describe it as hyperintense.

Isointense (the same intensity): If an abnormality is the same intensity to a reference structure, we describe it as isointense.

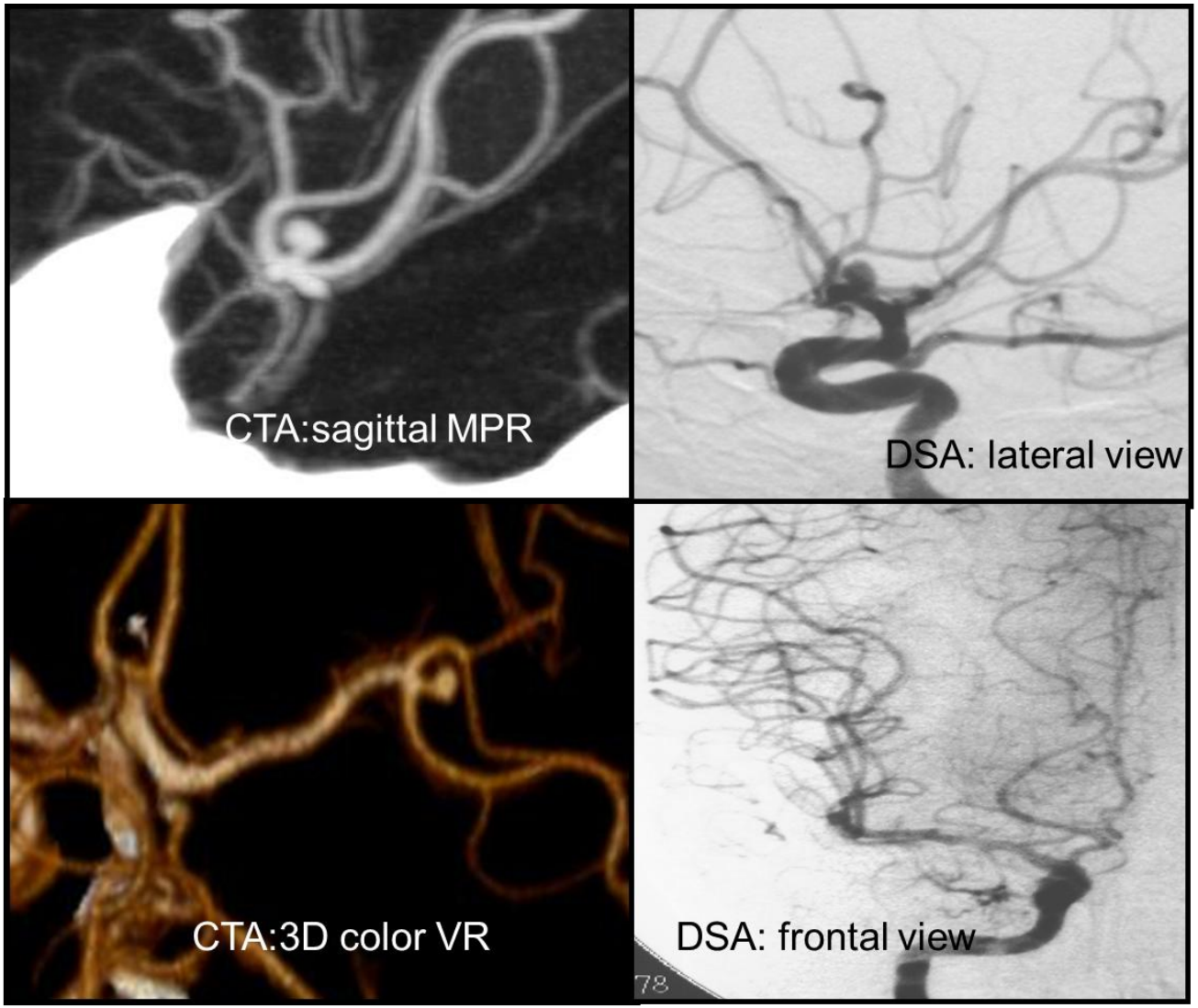
Hypointense (less intense): If an abnormality is dark on MR, we describe it as hypointense.

Digital substraction angiography (DSA)

- is a type of technique used in interventional radiology to clearly visualize blood vessels in a bony or dense soft tissue environment. Images are produced using contrast medium by subtracting a 'pre-contrast image‘, leaving a clear picture of the artery which can then be studied independently and in isolation from the rest of the body.



1 vertebral artery
2 posterior inferior cerebellar artery (PICA)
2v vermian branch of PICA
2h hemispheric branch of PICA
3 basilar artery
4 anterior inferior cerebellar artery (AICA)
5 superior cerebellar artery (SCA)
5h hemispheric branch of SCA
5v vermian branch of SCA
6 posterior cerebral artery (PCA)
6.2 P2 segment of PCA
8 posterior temporal branch of PCA
9 parieto-occipital branch of PCA
10 calcarine branch of PCA
12 posterior thalamoperforating arteries
13L lateral posterior choroidal artery
16 pontine perforating artery
* blush of choroids plexus



Aneurysm at the right MCA bifurcation in a 46-year-old woman with sudden headache and previous CT showed SAH at the suprasellar cistern and the right sylvian fissure.

Transcranial Ultrasound is a non-invasive ultrasonic technique measuring local blood flow velocity and direction in the proximal portions of large intracranial arteries.
TCD's principal use is in the evaluation and management of patients with cerebrovascular disease.

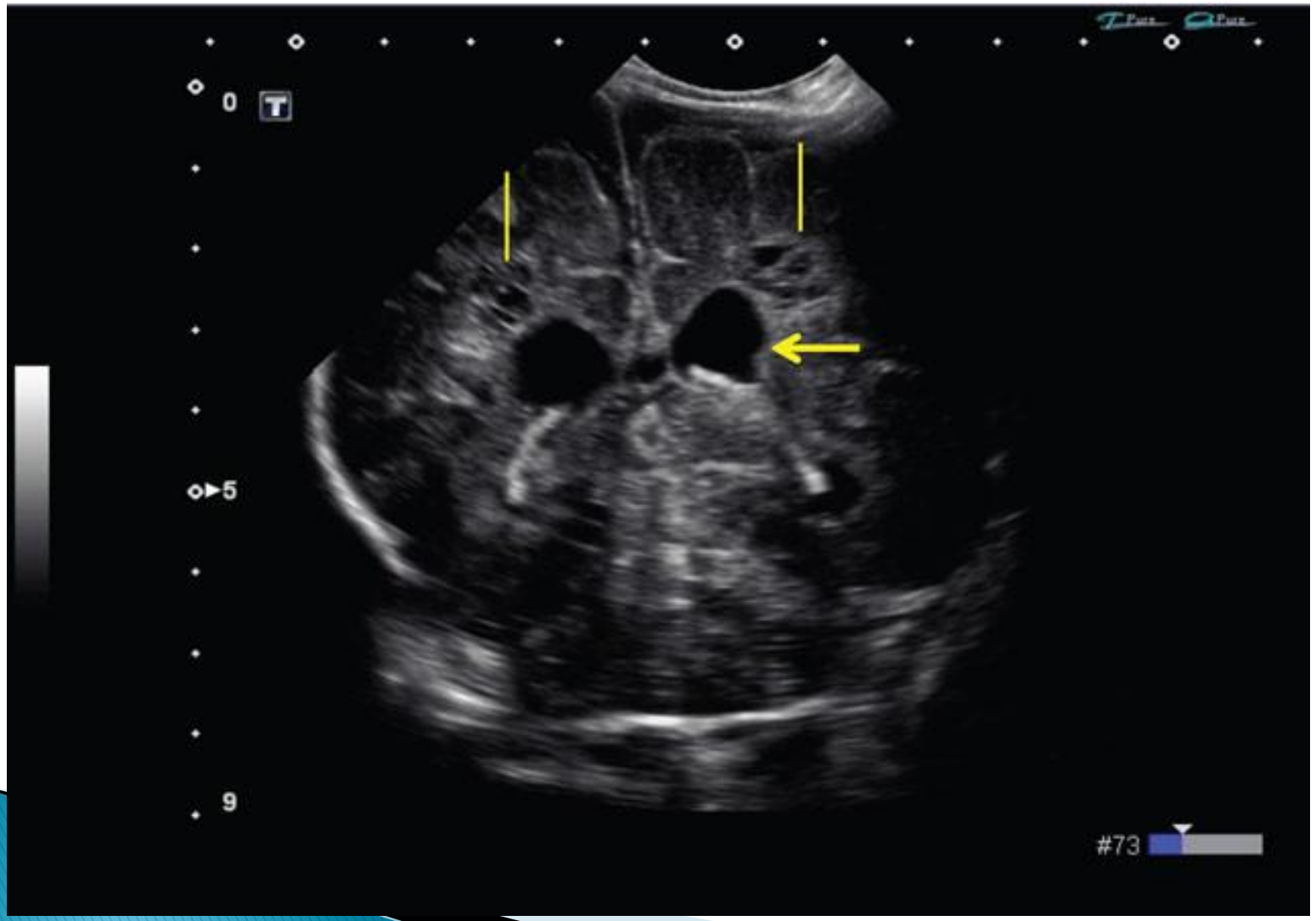
Advantages of TCD:

- non-invasive
- can be performed at the bedside
- easily repeated or used for continuous monitoring
- is generally less expensive than other techniques

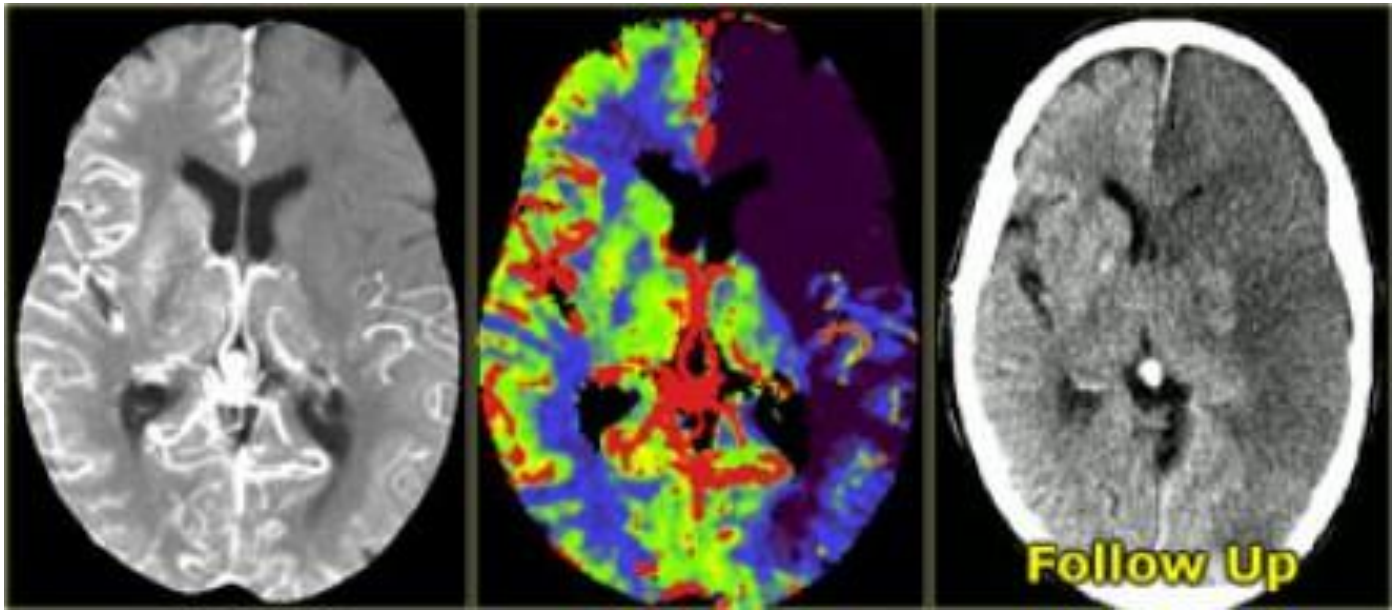
Limitation of TCD:

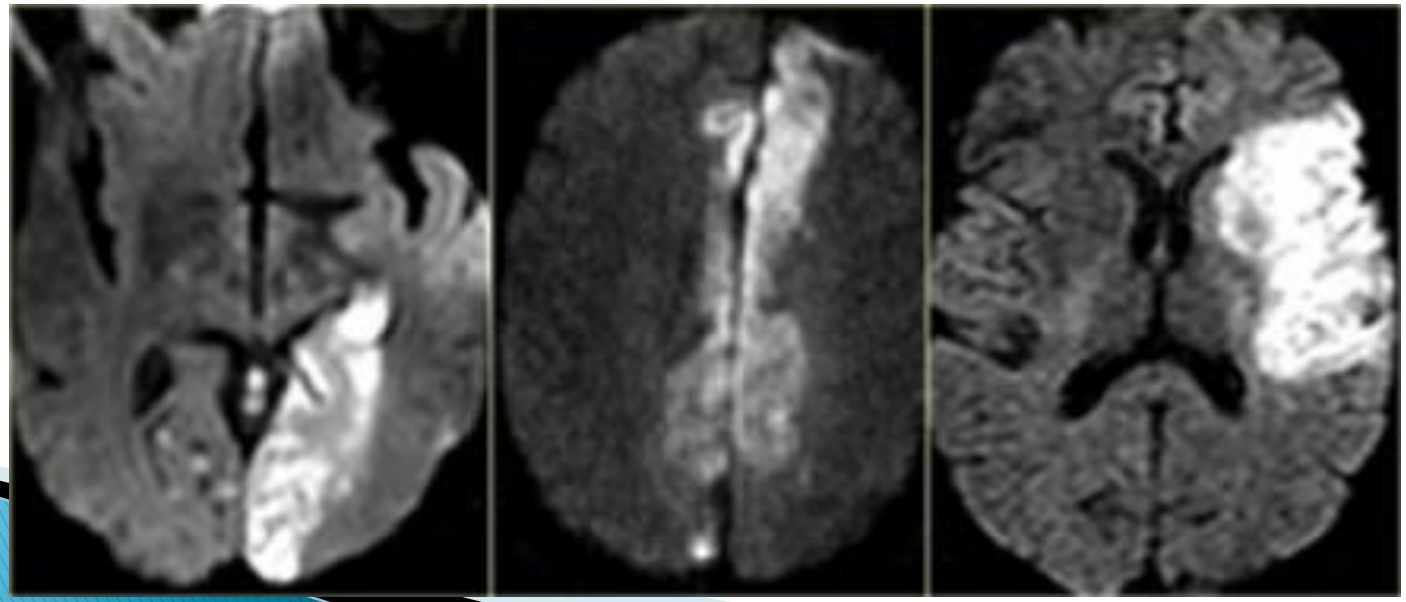
- examination of cerebral blood flow velocities in certain segments of large intracranial vessels
- detects indirect effects (abnormal waveform characteristics) suggesting of proximal hemodynamic or distal obstructive lesions
- more valuable in specific conditions

Cystic Periventricular Leukomalacia



PET CT/ SPECT

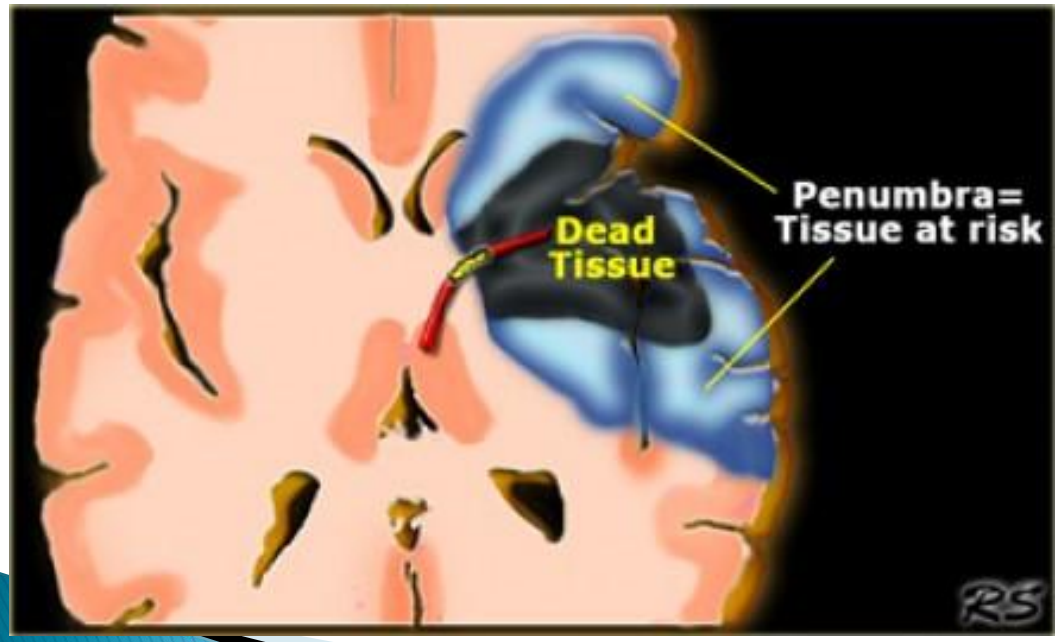




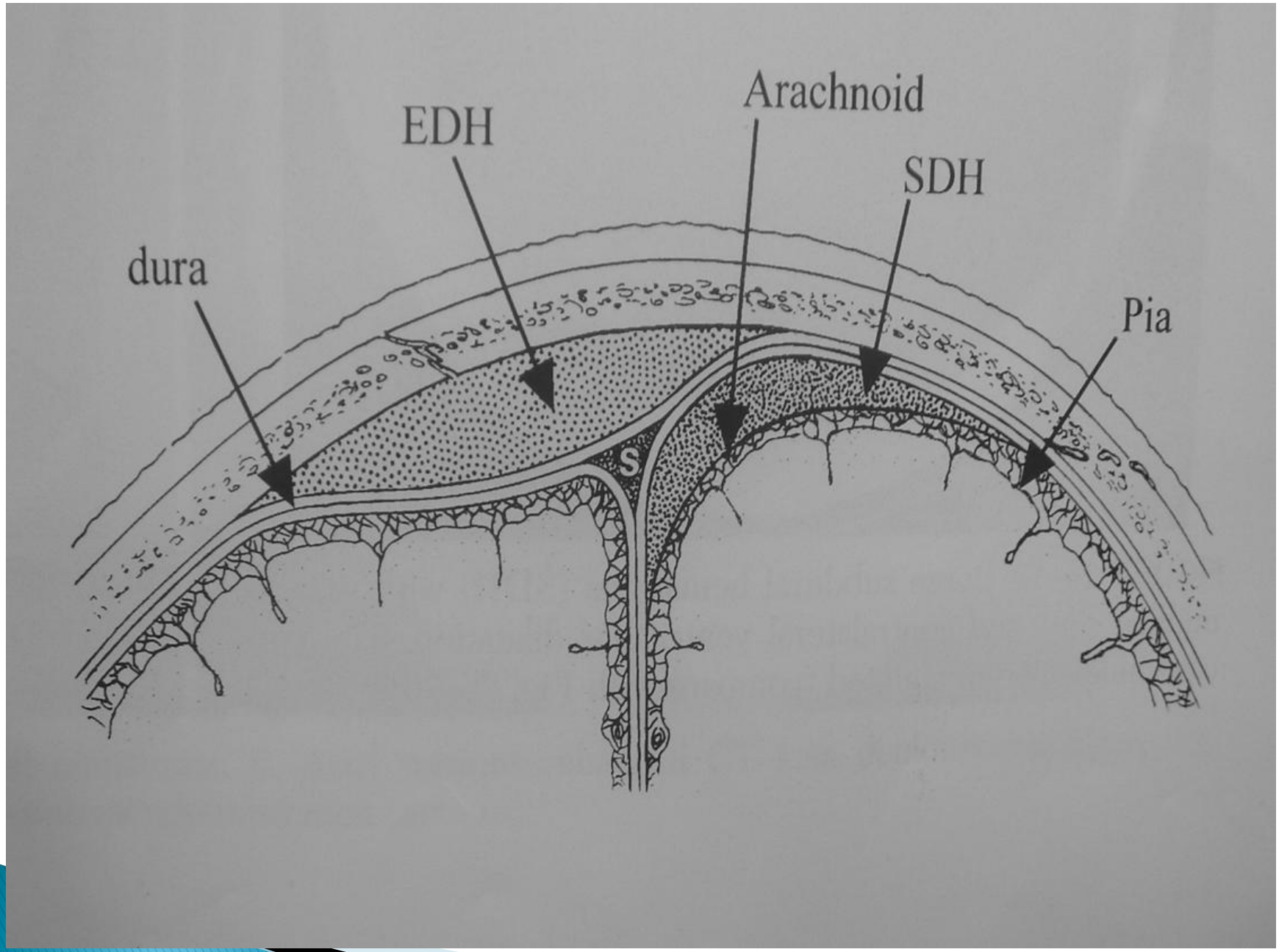
Cerebral STROKES

- The goal of imaging in a patient with acute stroke is:
- Exclude hemorrhage
- Differentiate between irreversibly affected brain tissue and reversibly impaired tissue (dead tissue versus tissue at risk)
- Identify stenosis or occlusion of major extra- and intracranial arteries.
  In this way we can select patients who are candidates for thrombolytic therapy.

- With CT and MR-**diffusion** we can get a good impression of the area that is infarcted, but we cannot preclude a large ischemic penumbra (tissue at risk). With **perfusion** studies we monitor the first pass of an iodinated contrast agent bolus through the cerebral vasculature.
  Perfusion will tell us which area is at risk.



The area with abnormal perfusion can be dead tissue or tissue at risk. Combining the diffusion and perfusion images helps us to define the tissue at risk, i.e. the penumbra.

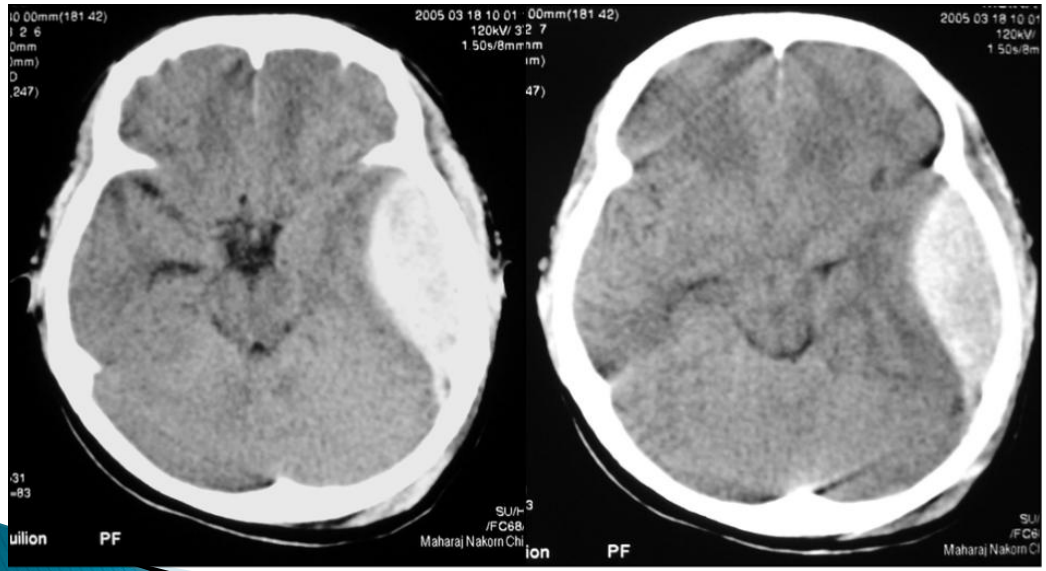

Arachnoid
EDH
SDH
dura
Pia
S

Findings: axial CT shows biconvex hyperdense extraaxial mass at left temporal convexity with non-displaced linear fracture of the overlying temporal bone. The midbrain is shifted away from the herniating temporal lobe.

Diagnosis: Skull fracture with left temporal epidural hematoma (EDH)

Discussion:

- Acute hematoma is high density or high attenuation on CT.
- Classic finding of EDH: well-defined biconvex or lentiform-shaped hyperdense extraaxial mass.



20-year-old woman with motorcycle accident

Findings: axial CT shows biconvex hyperdense extraaxial mass at left temporal convexity. The left temporal lobe is displaced medially. The midbrain is shifted away from the herniating temporal lobe.

Diagnosis: Skull fracture with left temporal hematoma

Discussion:

- Acute hematoma is high density or high attenuation on CT.

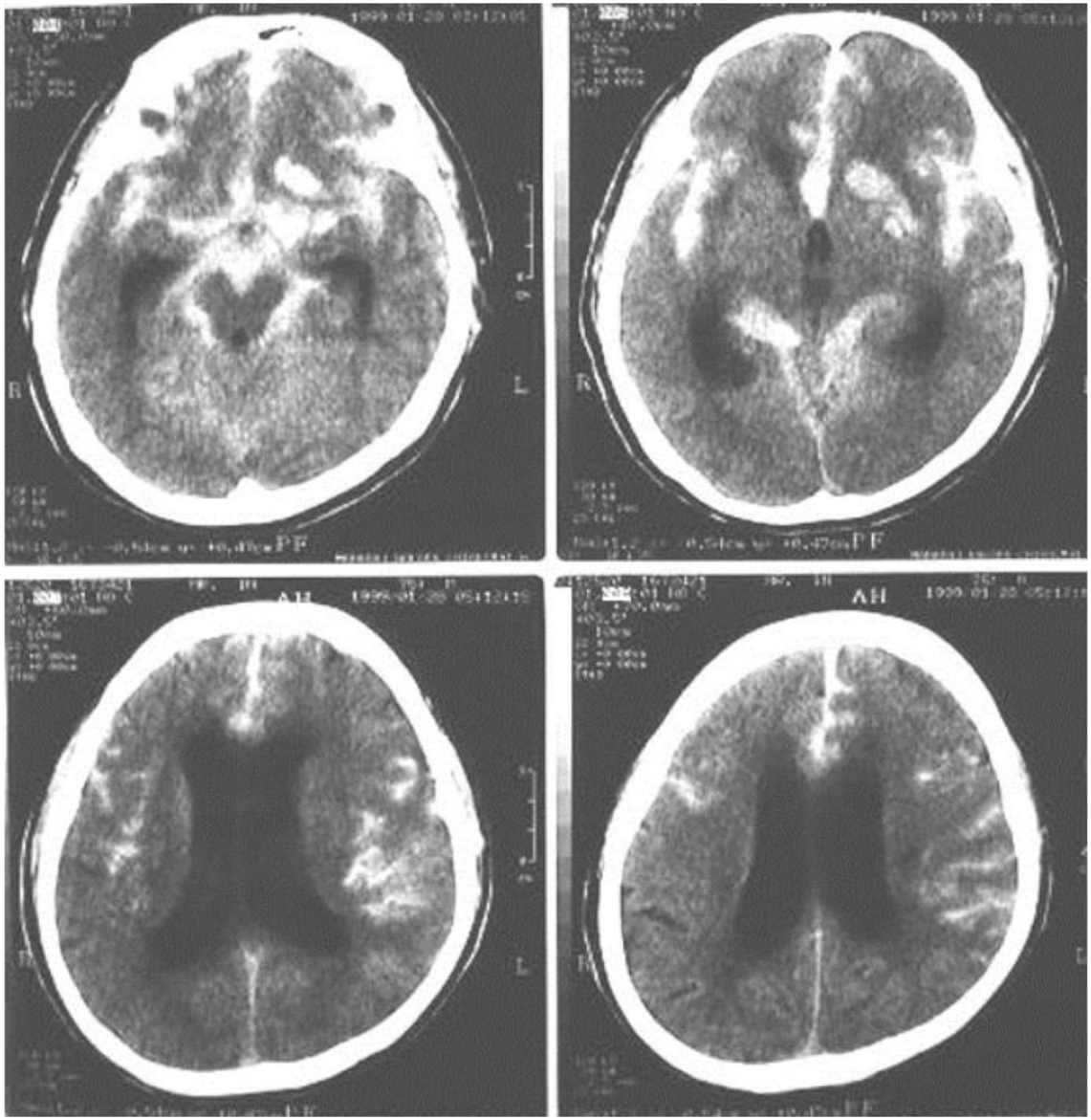
25-year-old man with motorcycle accident


LEMON V BANANA
EXTRADURAL V SUBDURAL HAEMATOMA

63-year-old patient with hypertension and left hemiparesis

Findings: axial CT shows a hyperdense mass at right thalamus and deep white matter with extension into the right lateral ventricle.

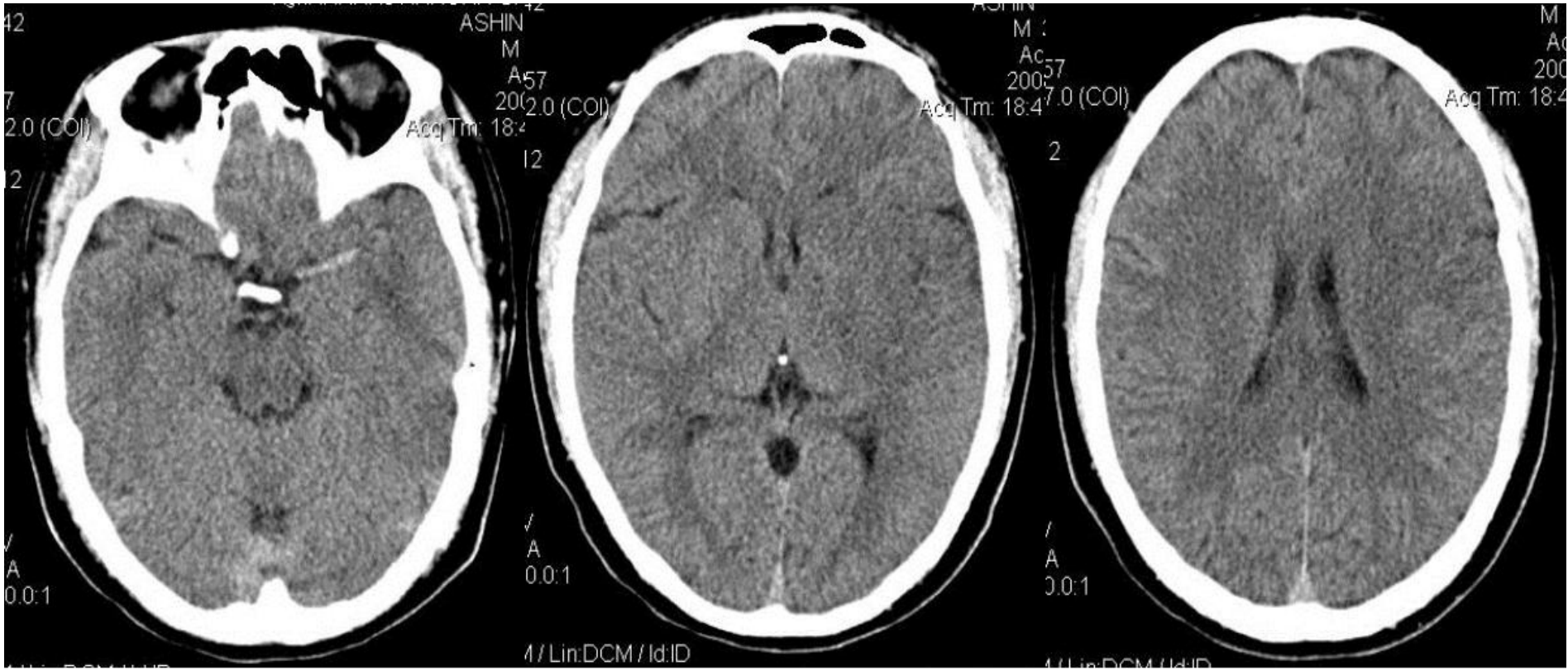
Diagnosis: Acute hypertensive intraparenchymal hemorrhage with accompanying intraventricular hemorrhage (IVH).



A patient with sudden onset of headache and alteration of consciousness

Findings: axial CT shows diffuse high attenuation or high density within the basal cisterns, Sylvain fissures and cortical sulci. Small focal hyperdense hematoma is seen at the left inferior frontal lobe. Small amount of hyperdense IVH is also present in occipital horns with dilatation of temporal horns from hydrocephalus.

Diagnosis: Diffuse subarachnoid hemorrhage (SAH) with small intraparenchymal hematoma, small amount of IVH and hydrocephalus.



A man presented with right hemiparesis 6 hours PTA

Findings: axial CT shows a linear hyperdensity within the left MCA

Diagnosis: hyperacute left MCA infarction

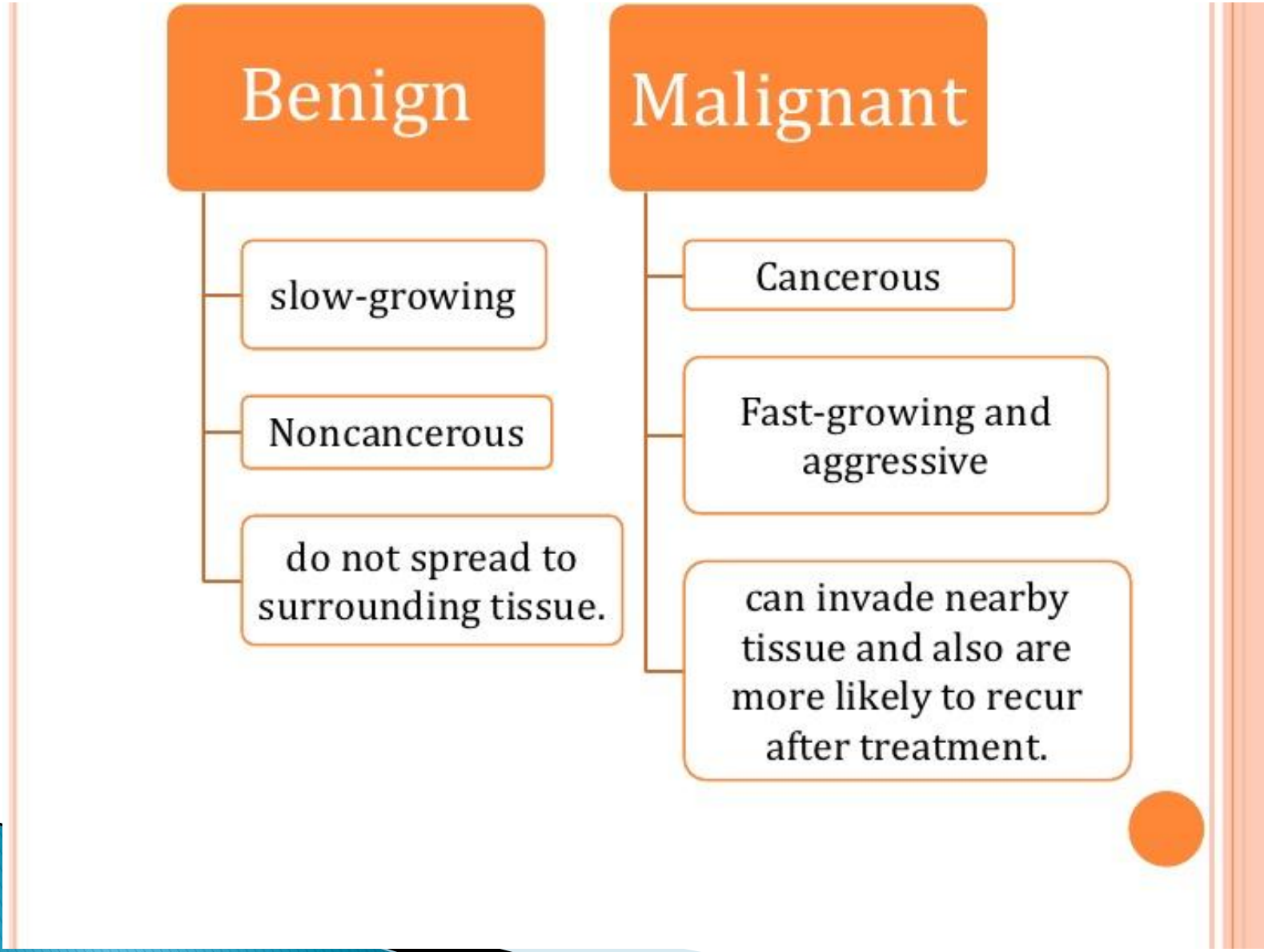
Discussion:

- The CT findings in acute cerebral infarction evolve with time.
- CT scans can detect early signs of MCA infarction within 6 hours in up to 82% of patients.
- Early signs of MCA infarction include a hyperdense acute intraluminal thrombus in the MCA (hyperdense MCA sign).

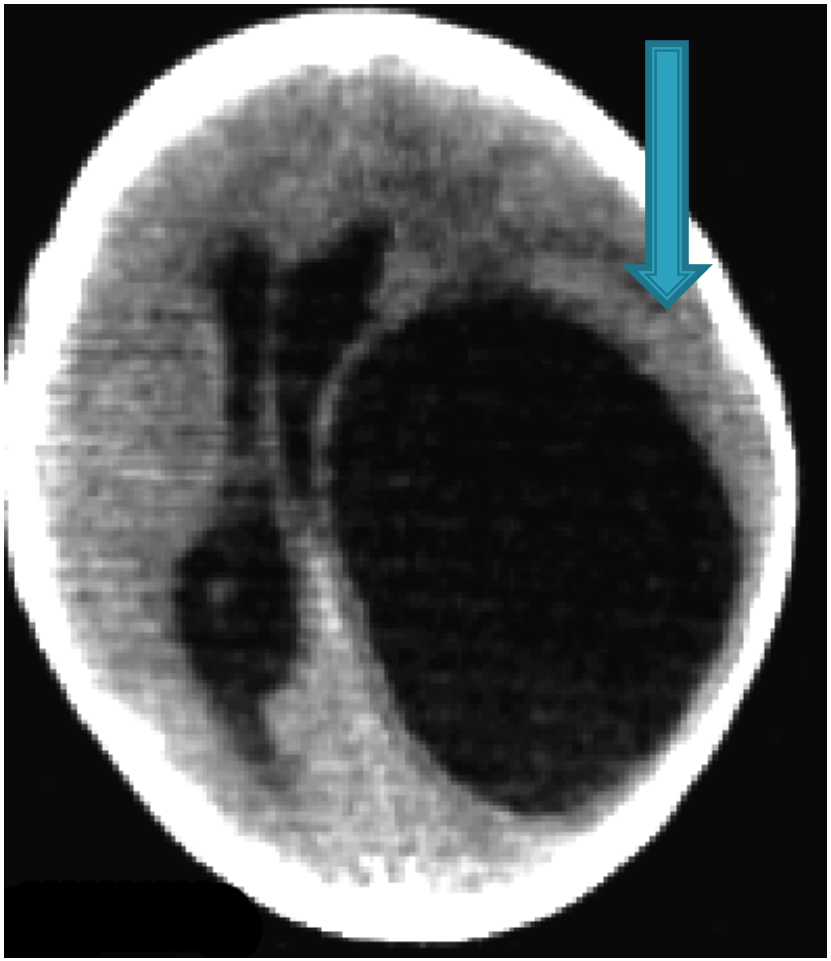
conclusion

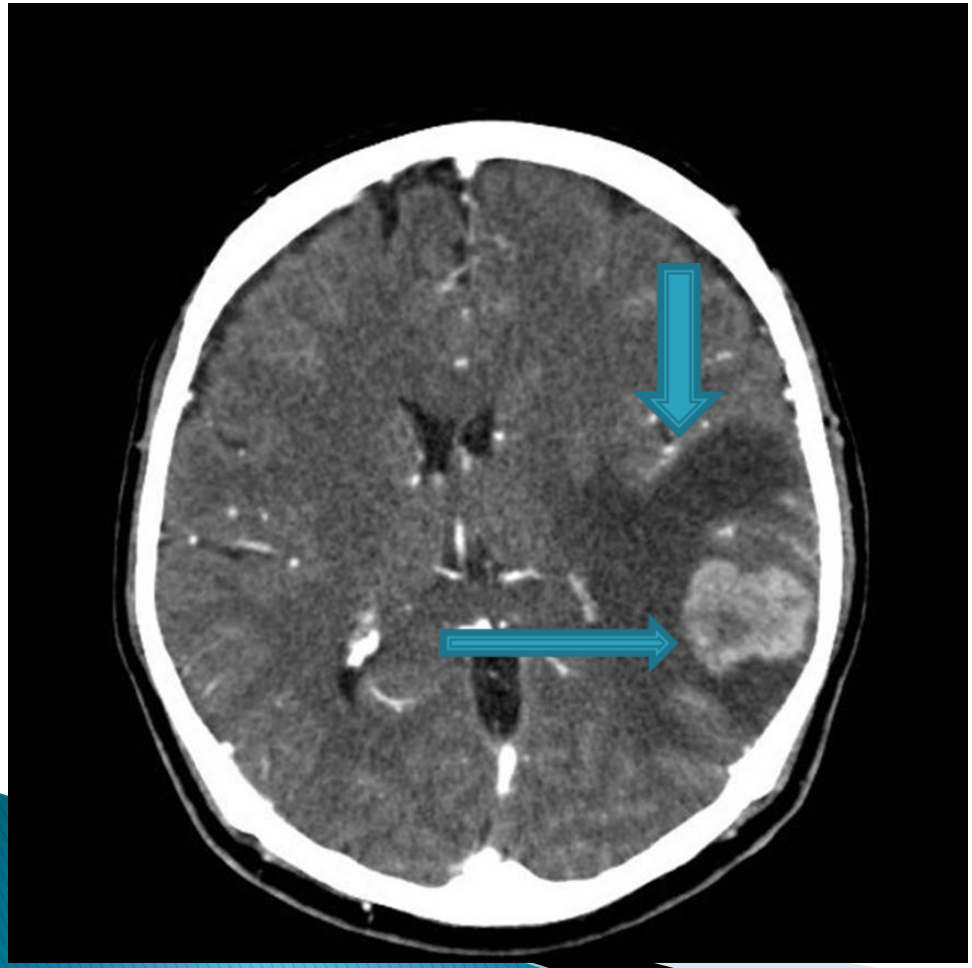
- There are sequence of events in cerebral strokes :
- Hyperacute
- Acute
- Subacute
- Chronic
- CT is best for hemorrhagic
- MRI is best to detect the ischemic at the onset

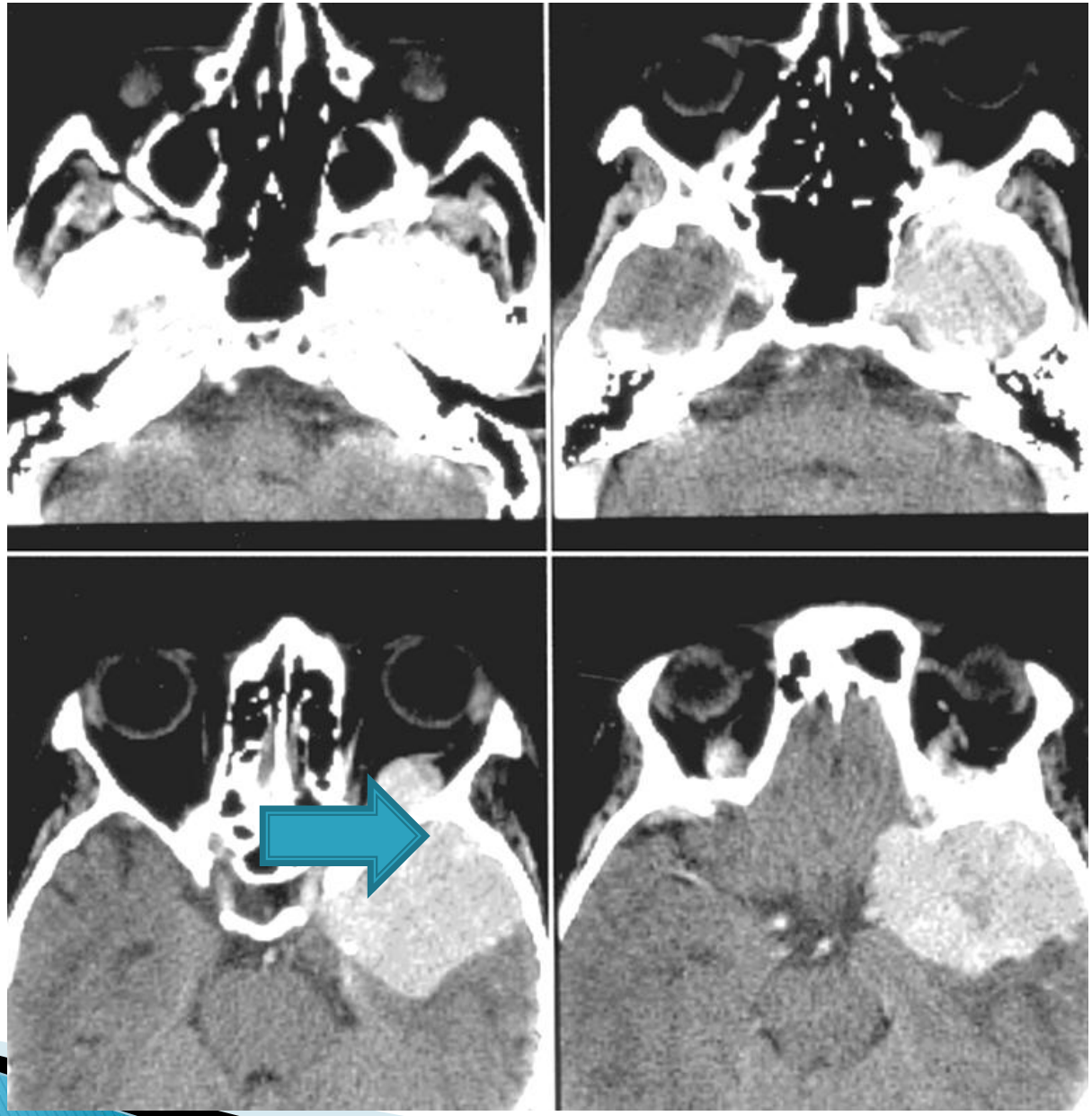
Tumors MRI and CT

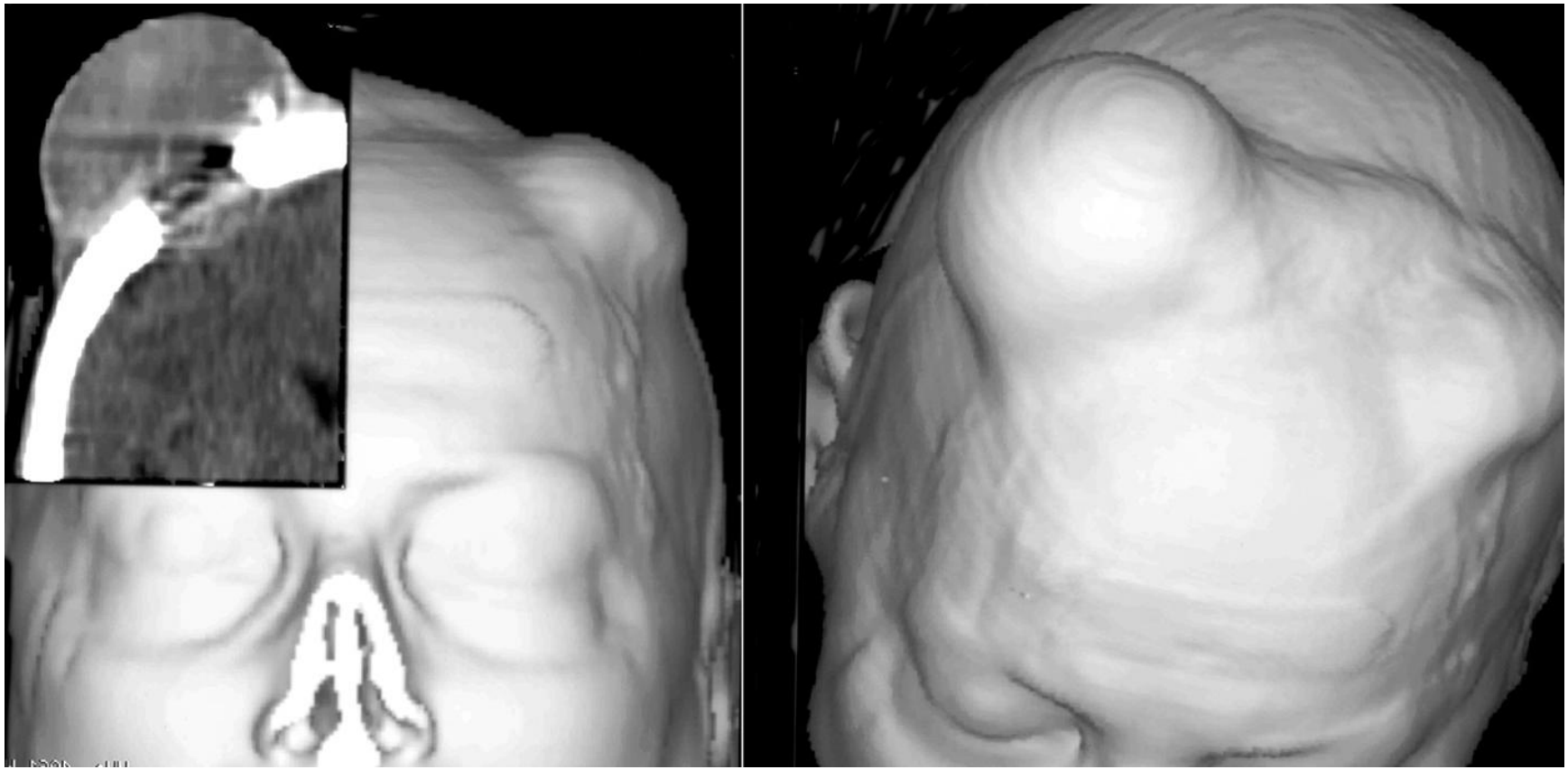


- MR +/- gadolinium or CT+ iodine contrast agent
- - Procedure of choice for imaging brain tumors
- - Sensitive for edema
- - Sensitive for small tumors near bone
- - Gadolinium-DPTA enhances regions of blood-brain barrier disruption (T1), increases sensitivity of neoplasm detection





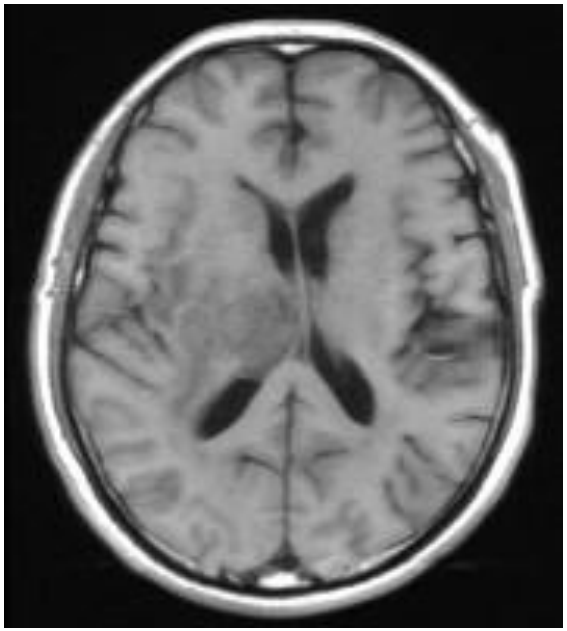


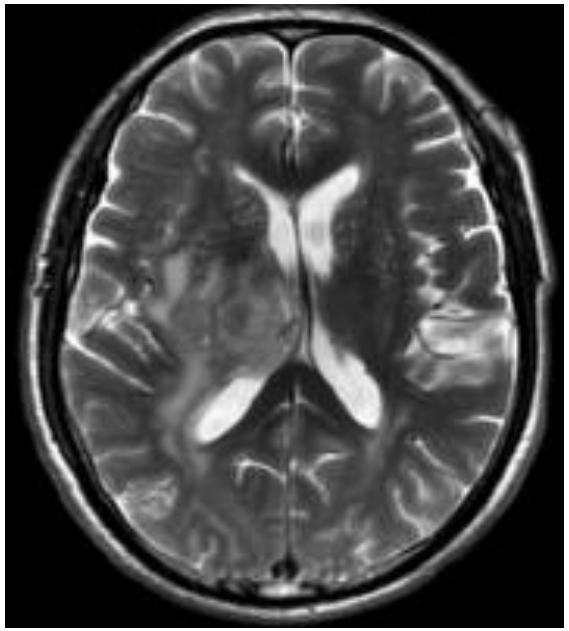


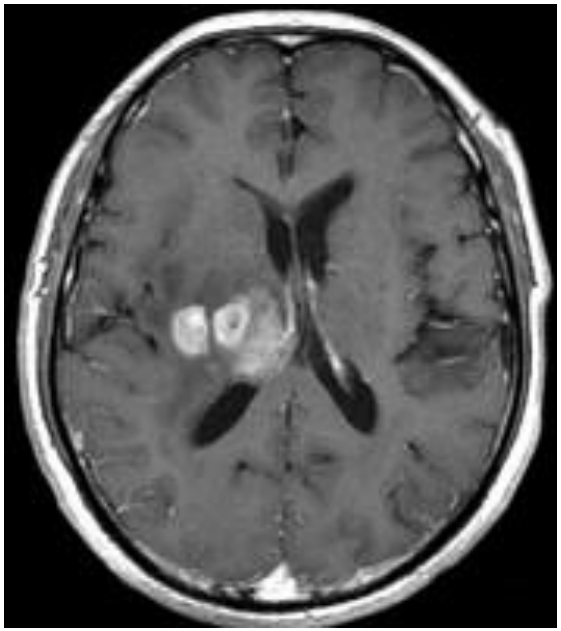
Mts of the vertex

Imaging Findings:

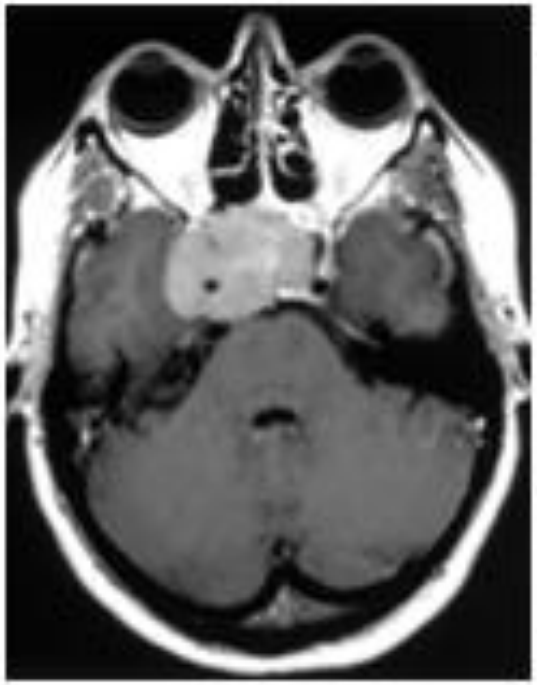
An irregular intraaxial lesion is displayed in the upper part of right thalamus, with accompanying vasogenic edema in the adjacent white matter. The mass extends to the lateral ventricle, and compresses and infiltrates adjacent brain tissue. On post contrast scans, the tumor has prominent enhancement, predominantly nodular in character, with no enhancement in the adjacent area of vasogenic edema.

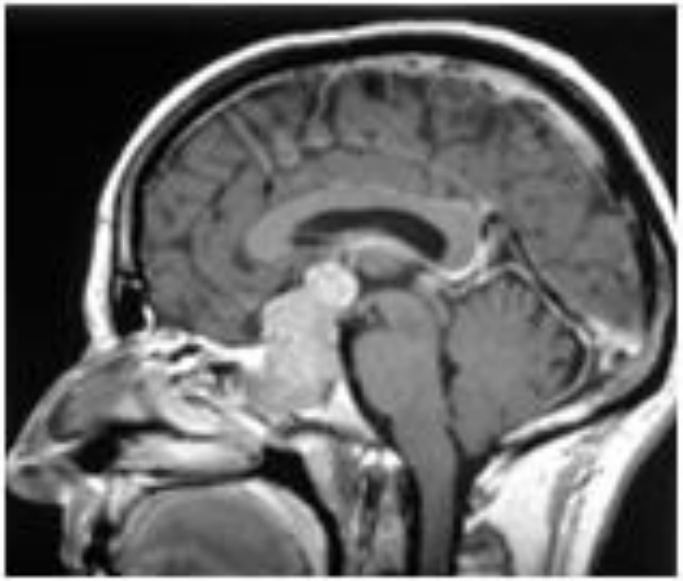


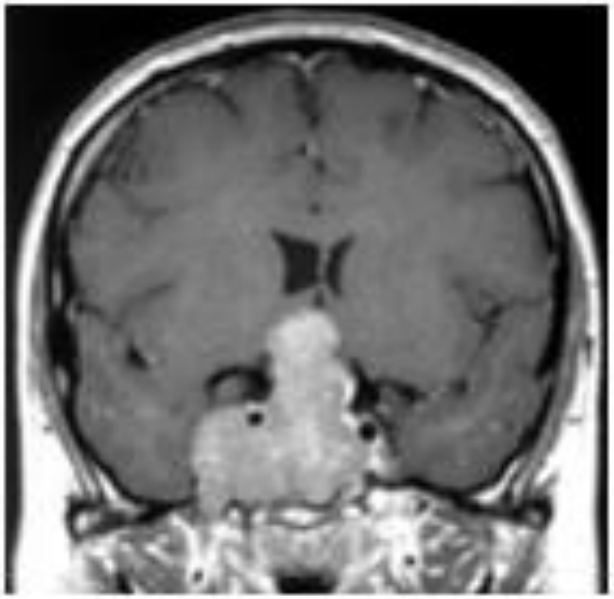




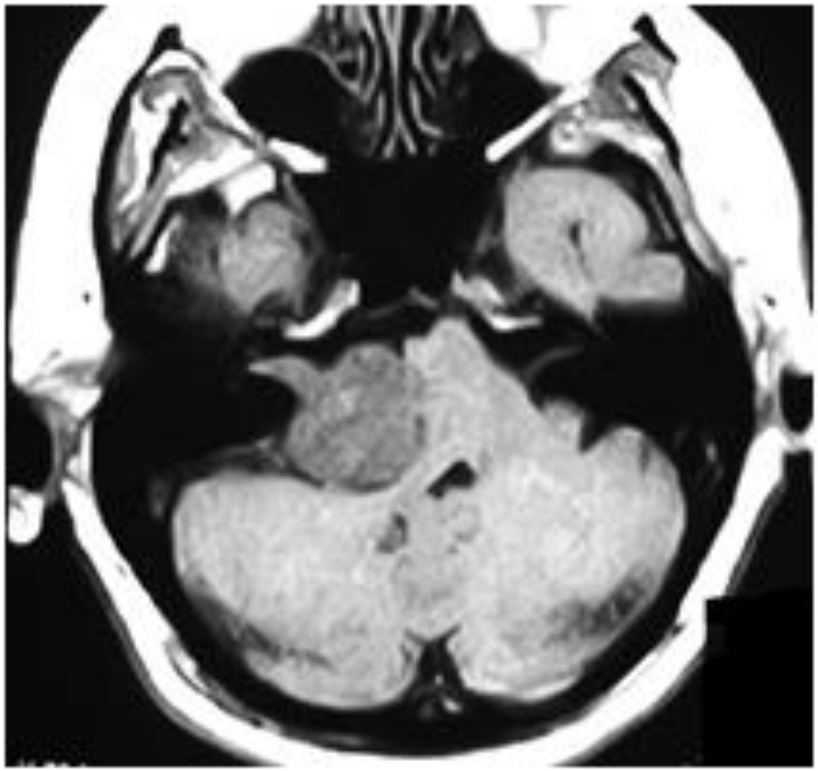
Pituitary Adenoma



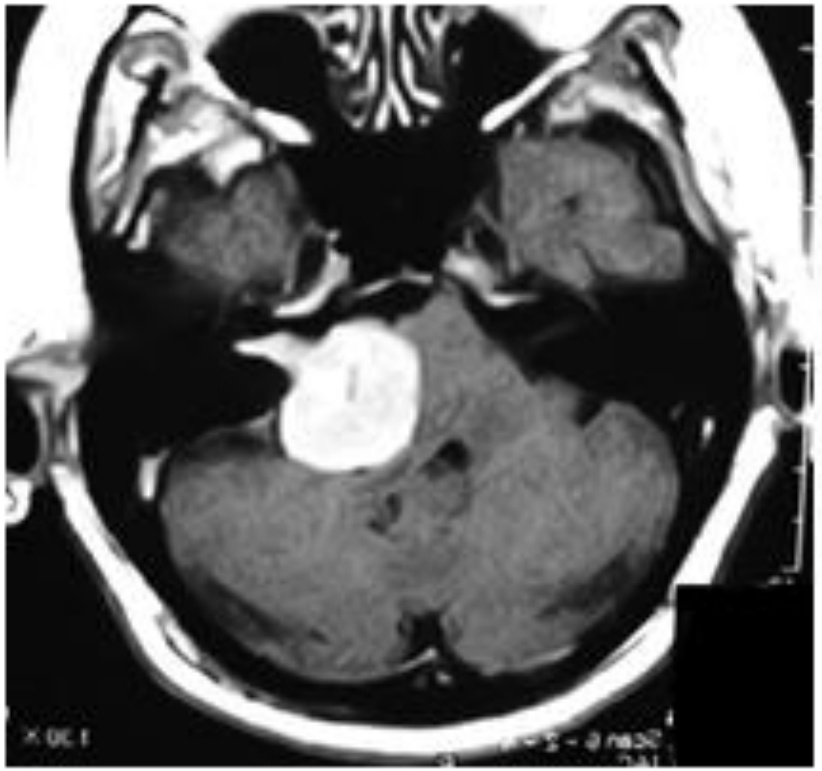




Acoustic Neurinoma



T1 WI



T1 WI Post Contrast

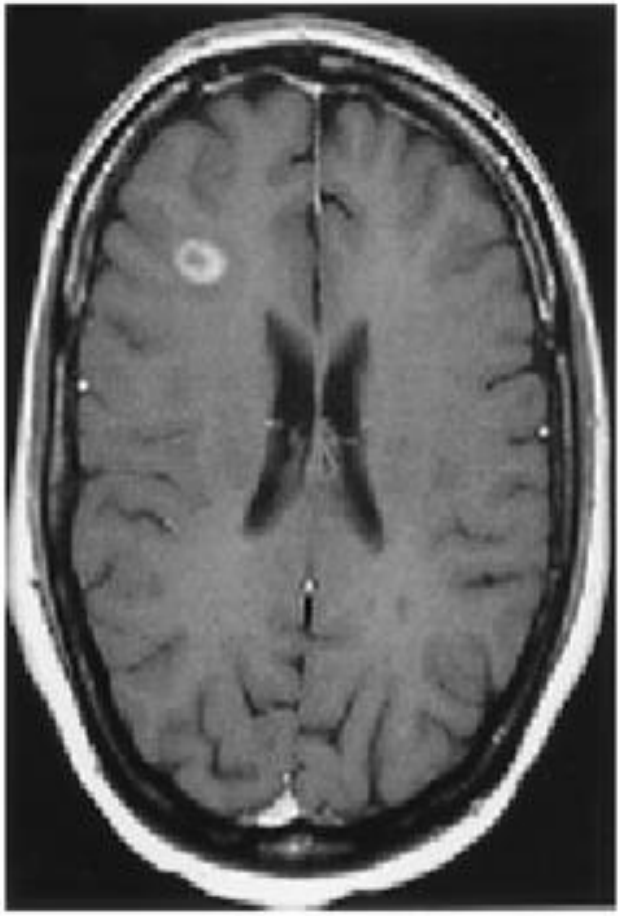
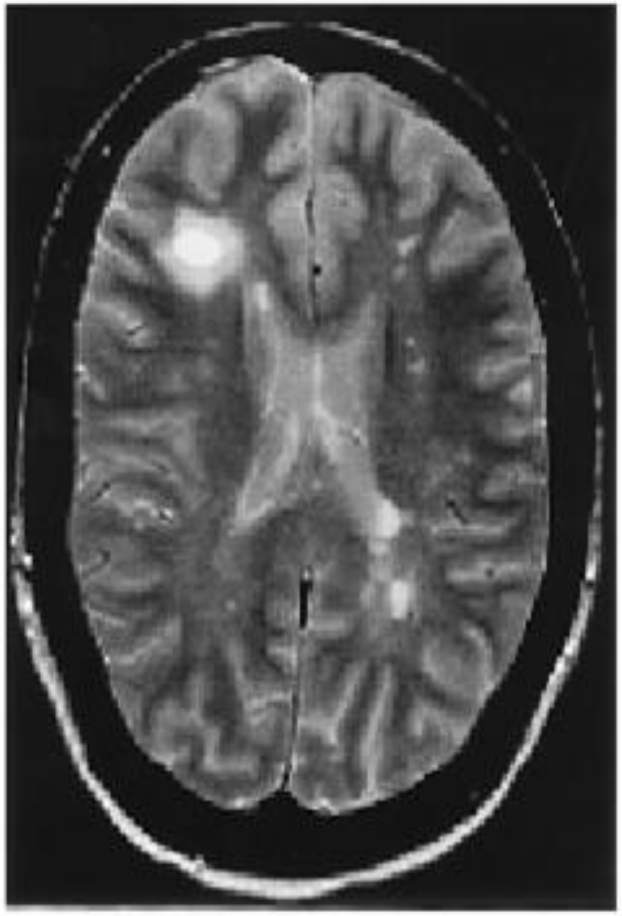
MRI

Multiple sclerosis (MS) is a relatively common acquired chronic relapsing demyelinating disease involving the central nervous system, and is the second most common cause of neurological impairment in young adults, after trauma. Characteristically, and by definition multiple sclerosis is disseminated not only in space (i.e multiple lesions in different regions of the brain), but also in time (i.e. lesions occur at different times). Location of the plaques can be infratentorial, in the deep white matter, periventricular, juxtacortical or mixed white matter - grey matter lesions.

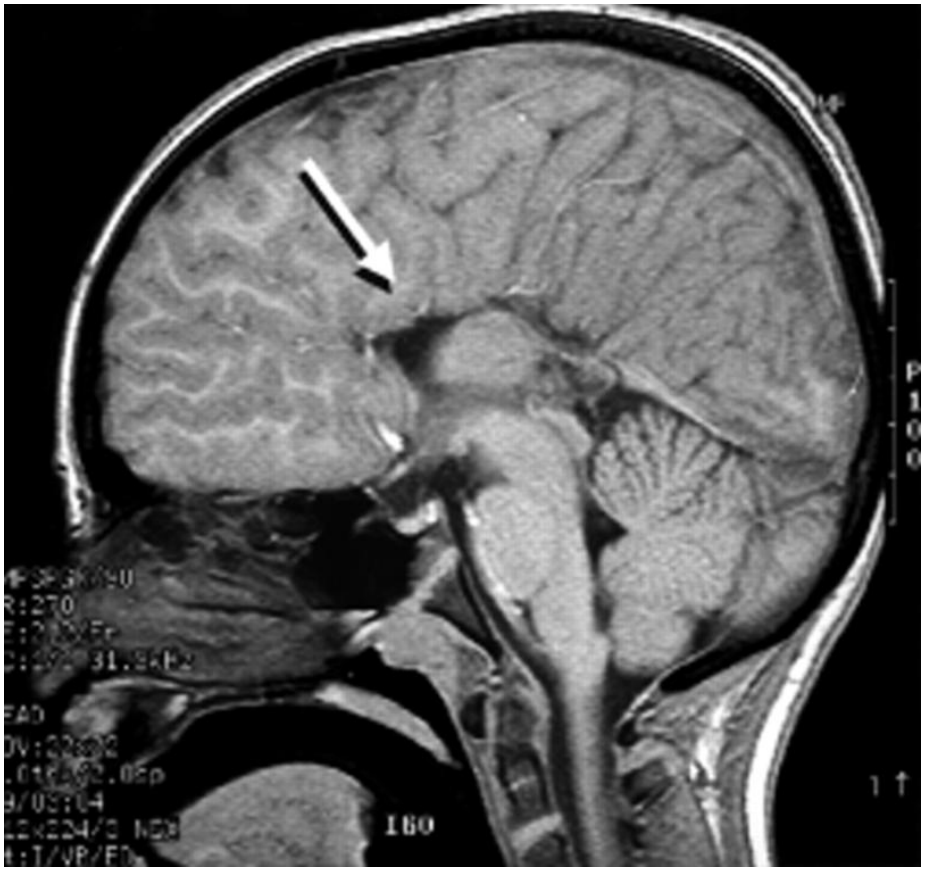
CT features are usually non-specific, and significant change may be seen on MRI with an essentially normal CT scan.

MRI has revolutionised the diagnosis and surveillance of patients with MS. Not only can an MRI confirm the diagnosis (see McDonald MRI criteria for multiple sclerosis), but follow-up scans can assess response to treatment and help determine the disease pattern.

- T1 - lesions are typically iso- to hypointense
- T2 - lesions are typically hyperintense
- acute lesions often have surrounding edema
- T1 C+ (Gd)
  - active lesions show enhancement
  - enhancement is often incomplete around the periphery (open ring sign)

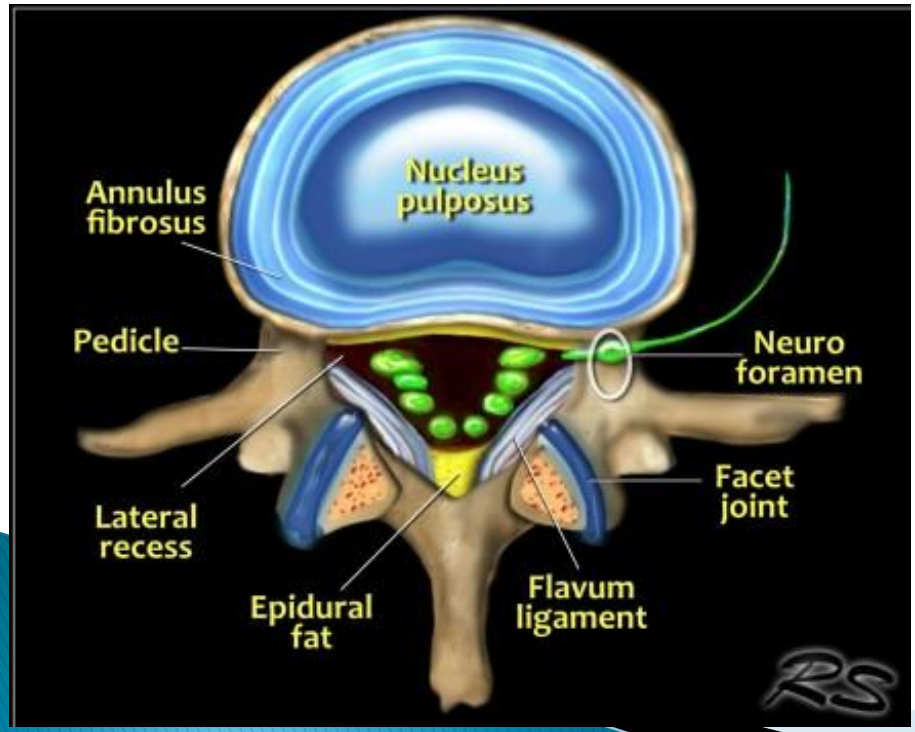
Congenital abnormalities of the central nervous system

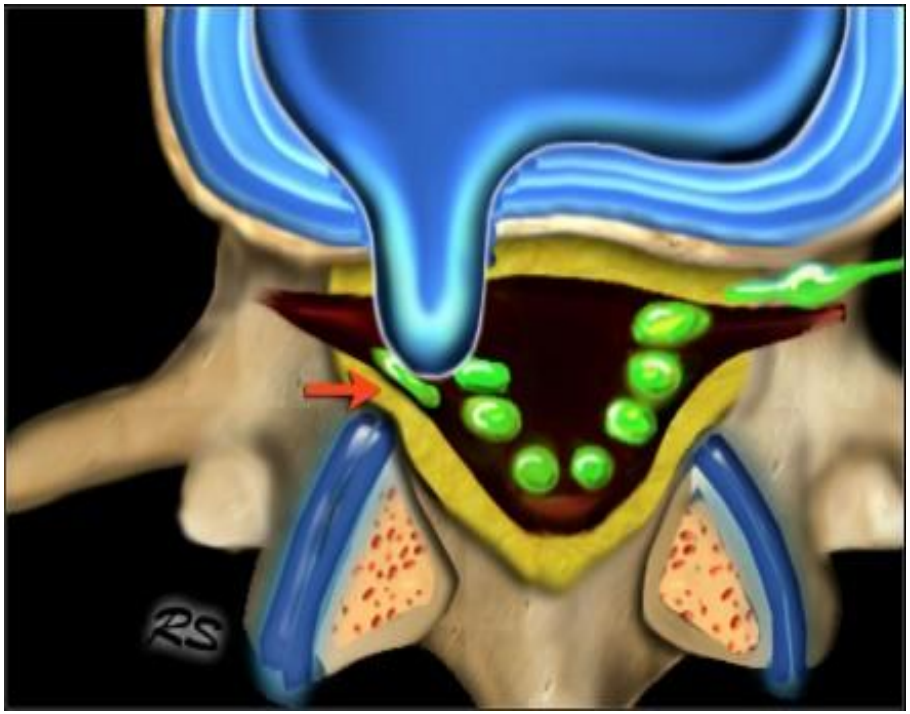


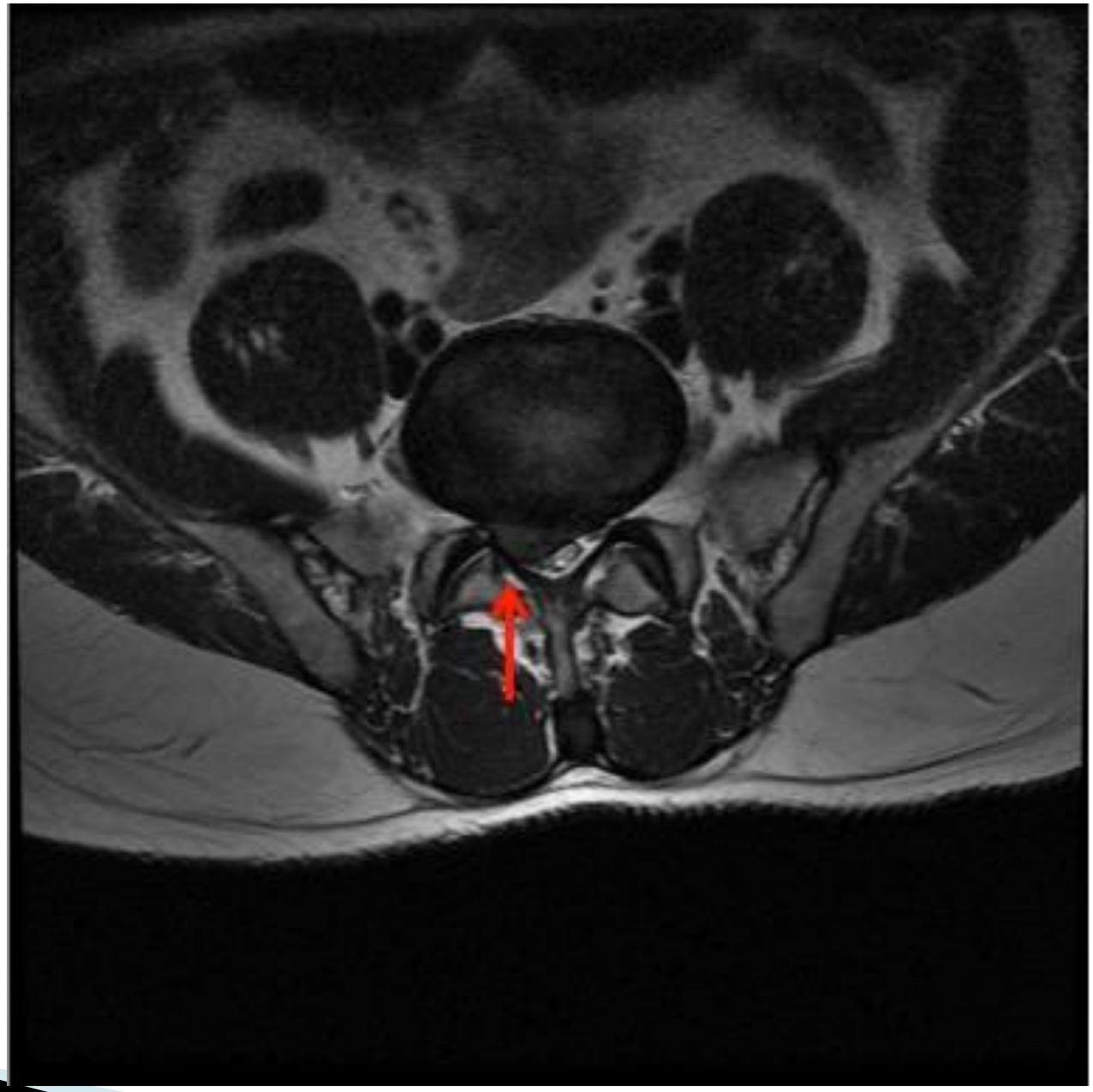
Agenesis of corpus callosum

The herniation of cerebellum through foramen magnum: Arnold-Chiari I

Herniation is defined as a localized displacement of disk material beyond the limits of the intervertebral disk space. The disk material may be nucleus, cartilage, fragmented apophyseal bone, anular tissue, or any combination thereof. Preferred examinations for the evaluation of disk herniation include MRI of the spine (lumbosacral, thoracic, or cervical images). Obtaining correct clinical diagnosis is crucial, as the choice of treatment options will be guided by the diagnosis. Patients are well advised to never accept a diagnosis based solely on findings radiographic test or CT.








Thank You