NEURO-RADIOLOGY
THE ESSENTIALS

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INTRODUCTION

- Knowledge of the basic neuro-anatomy is essential to establish the diagnosis.
- Several imaging modalities are currently available to evaluate CNS disorders.
- Its important for physicians to be able to request the correct radiological study depending on the symptoms and suspected diagnosis.

Imaging Modalities

- Plain X ray.
- Computerized radiography(CT).
- Magnetic resonance imaging(MRI).
- Myelogram.
- Angiogram.
- Ultrasound.

Plain X Ray

- Plain X-ray is essential modality for initial assessment of the vertebral column.
- Good display of bony details
- Skull X ray is of limited value in evaluation of head trauma since it may not reflect underlying CNS damage.
- However, skull X ray helps in classification of skull fractures and its extent and therefore further management.

Computerized Tomography
CT

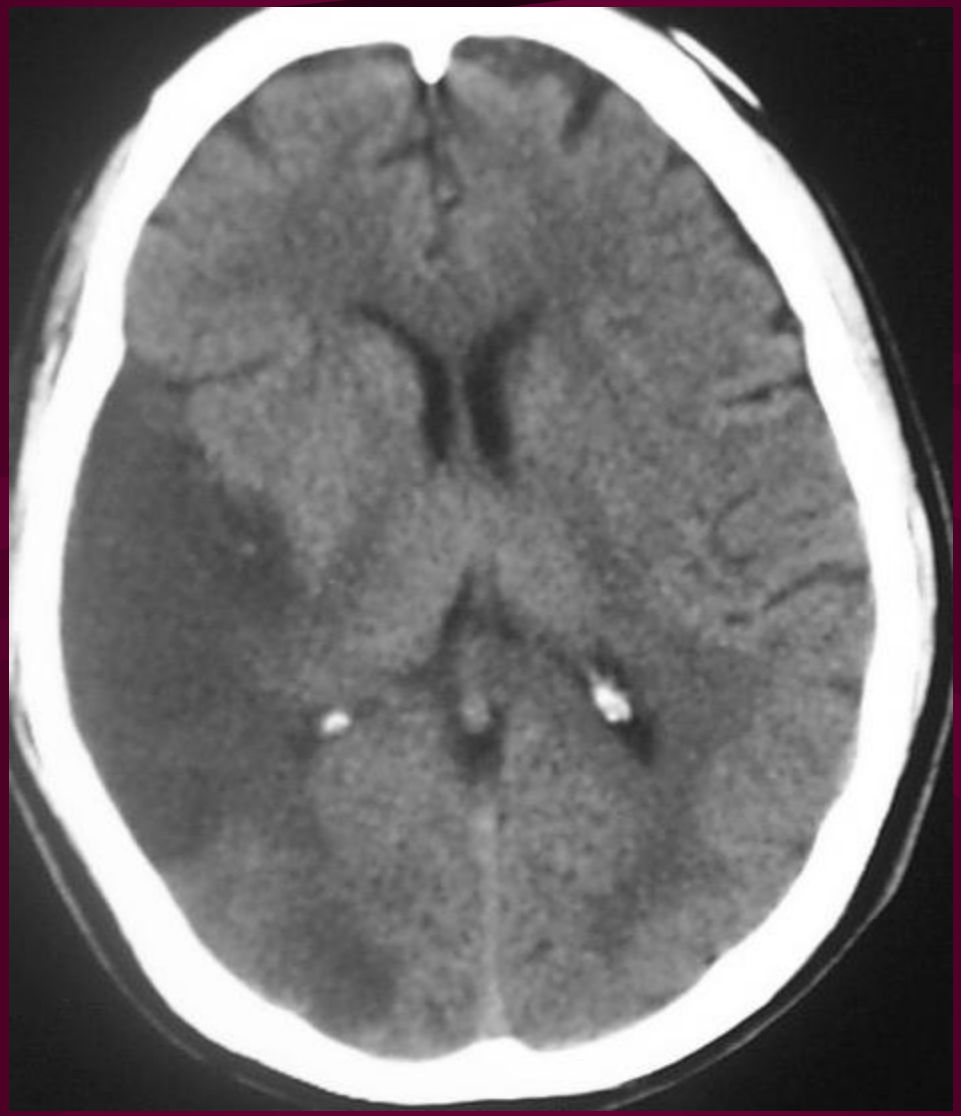
- Readily available fast modality for evaluation of intracranial structures.
- Rapid acquisition of axial images.
- The procedure of choice for evaluation of patients with head trauma and stroke patients.
- Provides fine details of the bony structures.

Magnatic Resonance Imaging MRI

- Provides fine details of the brain and spine.
- Does not involve irradiation.
- Needs special equipment for patient monitoring.
- Few specific contraindication, e.g. pacemakers, old cerebral aneurysms clips, cochlear implants.

Brain edema

- Appears as hypo-dense area on CT scan.
- Three types:
  - Cytotoxic:
    - Results from cell death.
    - Involves the gray matter.
  - Vasogenic:
    - Results from disruption of the BBB.
    - Mainly involves the white matter.
  - Interstitial:
    - Trans-ependymal edema related to hydrocephalus.



Cytotoxic edema

Vasogenic edema

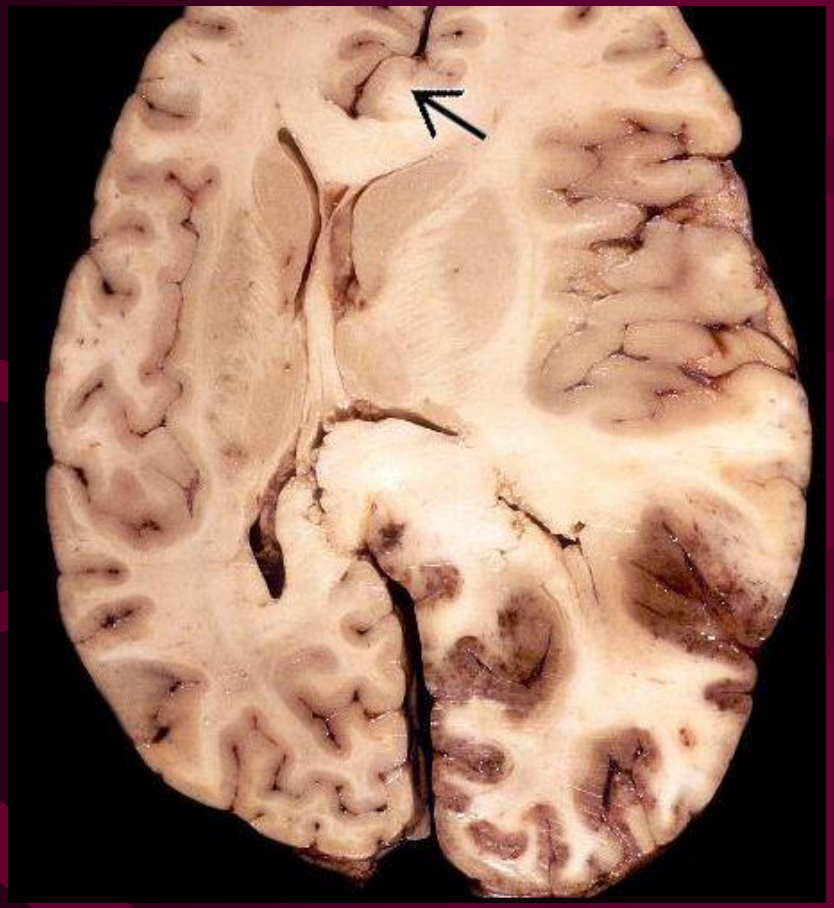
Trans-ependymal edema

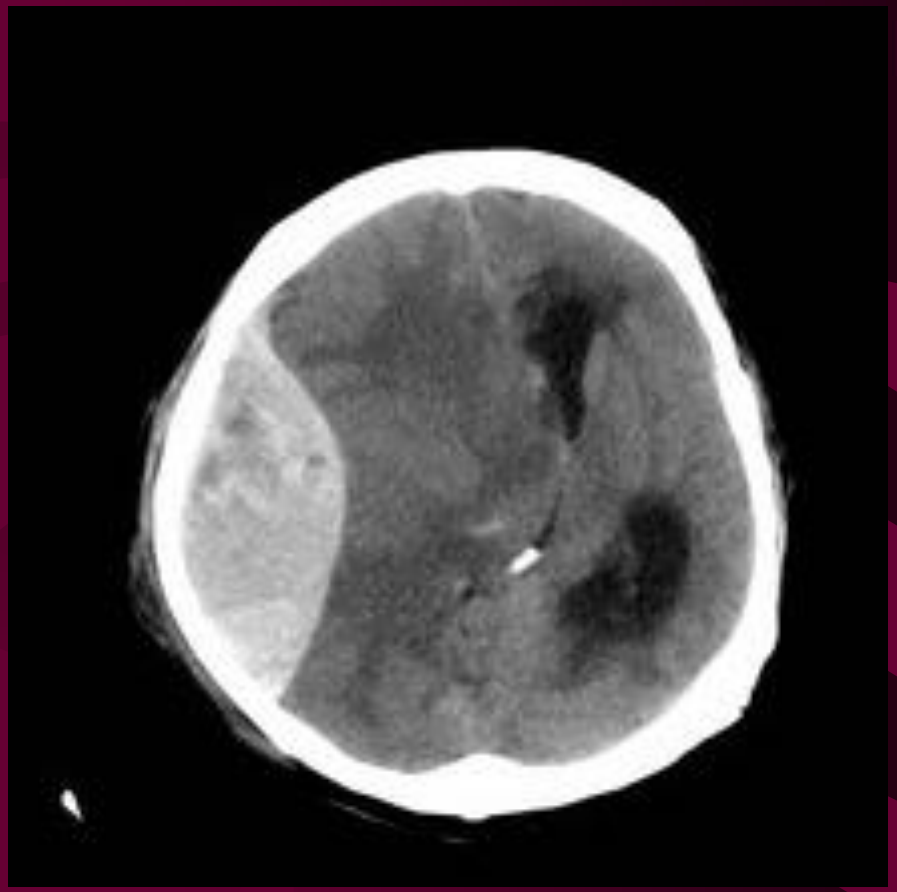
Brain Herniation

- Compartmental increase in intracranial pressure results into displacement of brain tissue from one compartment to another.
- Types:
  - Subfalcine herniation:
  - Transtentorial herniation:
  - Tonsillar herniation:

Brain Herniation

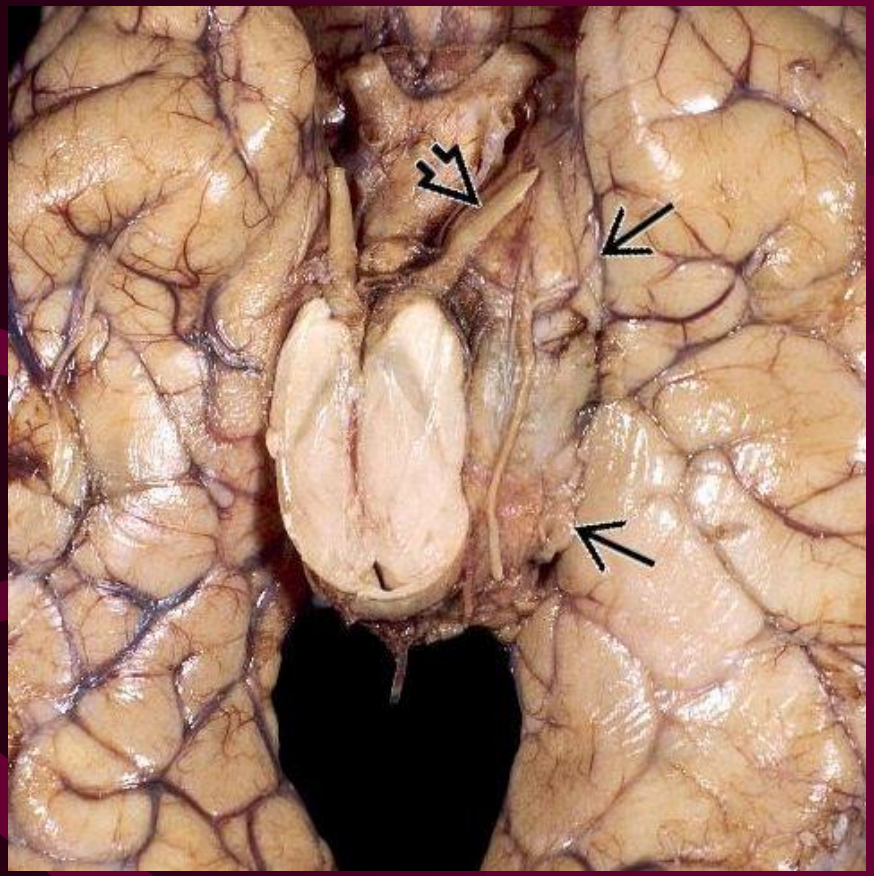
- Subfalcine herniation:
  - Displacement of the cingulate gyrus under the falx.
  - Features:
    - Shift in the midline.
    - Compression of the ipsilateral ventricle.
    - Dilatation of the contralateral ventricle.

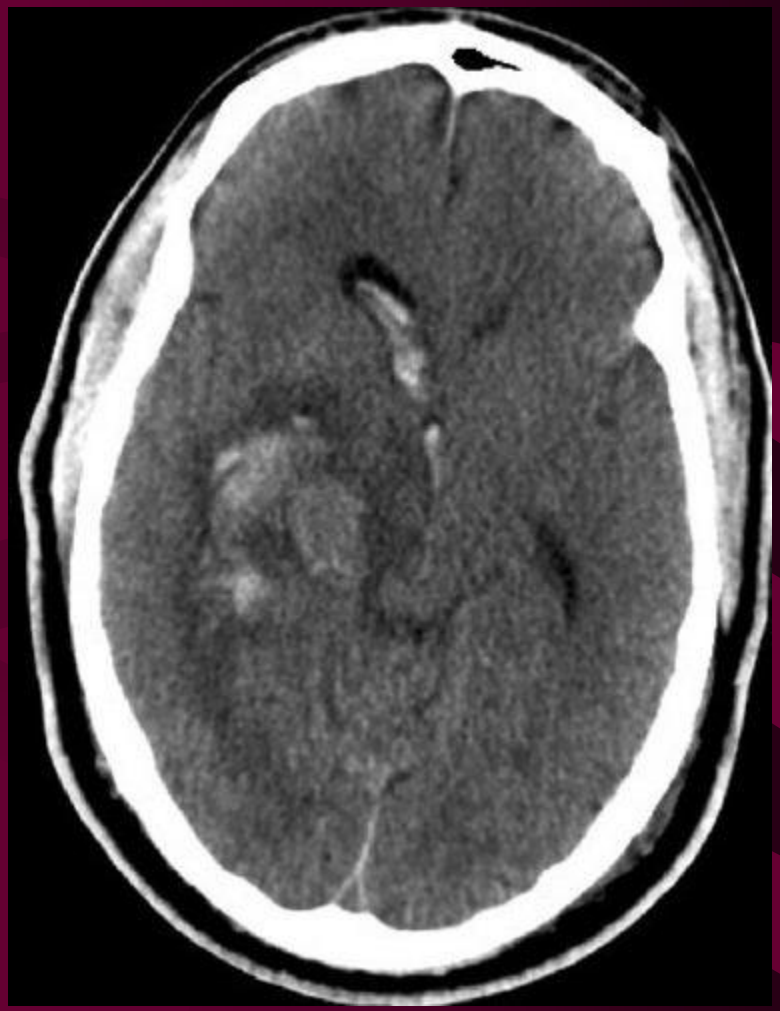




Brain Herniation

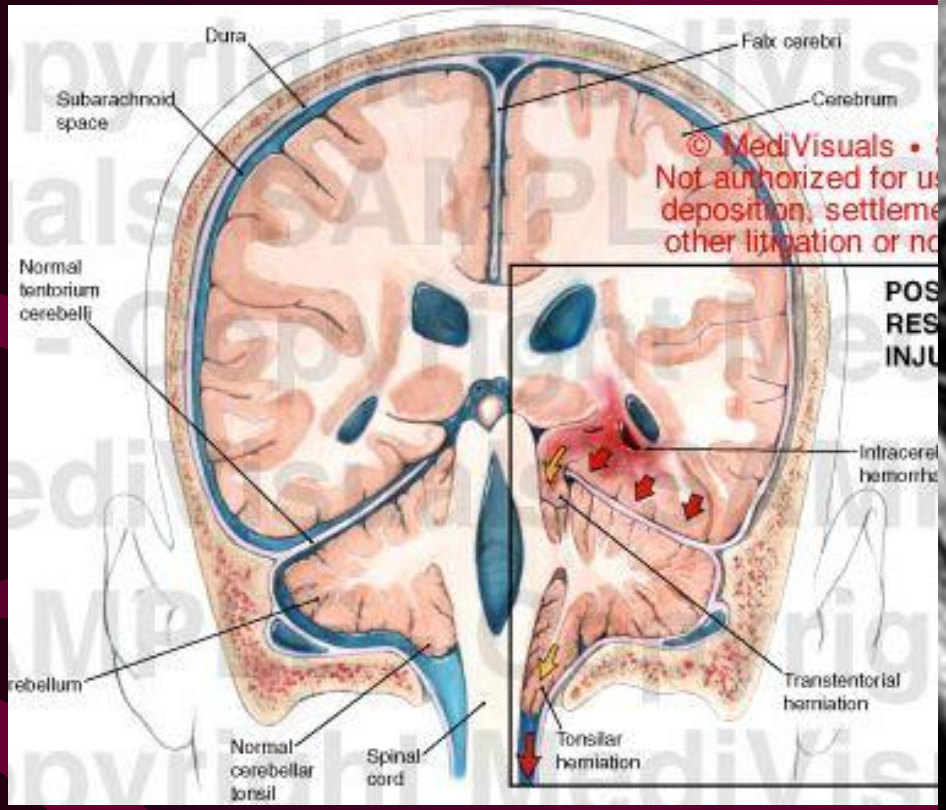
- Transtentorial herniation:
  - Displacement of the medial temporal lobe into the incisura.
  - Results into mass effect on the brain stem.





Brain Herniation

- Tonillar herniation:
  - Downward impaction of the cerebellar tonsil into foramen magnum.
  - Results into compression of medulla oblongata.


Dura
Falx cerebri
Subarachnoid space
Cerebrum
Normal tentorium cerebelli
Transtentorial herniation
Tonsillar herniation
Normal cerebellar tonsil
Spinal cord

Trauma

- CNS trauma is a major cause of morbidity and mortality.
- Prompt and precise diagnosis is critical for further management.
- CT is the best initial investigation of brain injury.
- Plain films are critical to evaluate vertebral/spinal injury.

Trauma

- Axial injury:
  - Concussion:
    - Brain damage at the microscopic level.
    - Usually associated with normal imaging
  - Contusion:
    - Focal area of edema that can be associated with hemorrhage..
    - Usually involves the fronto-temperal lobes

Trauma

- Shear injury(diffuse axonal injury):
  - significant brain damage results from acceleration/deceleration mechanism.
  - Associated with poor prognosis.
  - MRI is more accurate in evaluating the extent of injury.

Trauma

- Extra-axial injury:
  - Blood can accumulate in different spaces around the brain.
  - Subarachnoid hemorrhage is usually has a benign self-limiting course.
  - Its presence is suggestive of significant trauma.

Trauma

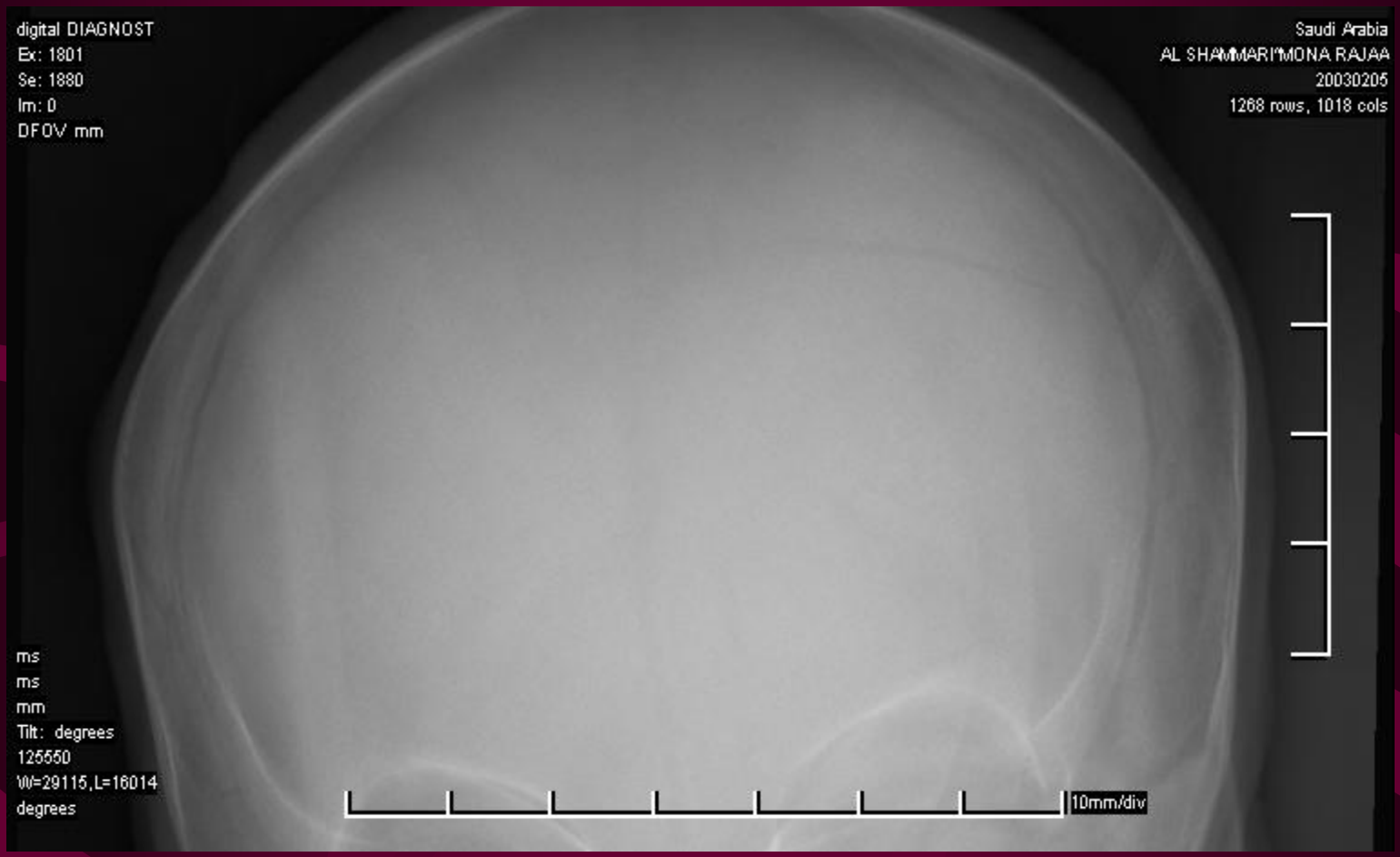
- Subdural hematoma:
  - Usually of venous origin.
  - Slowly enlarging blood collection between the dura and the subarachnoid space.
  - Has the characteristic crescent shape.
  - It crosses the suture line.

Trauma

- Extradural (Epidural) hematoma:
  - More than 90% occurs supratentorial and more than 95% are unilateral.
  - Usually attain their final size quickly.
  - Only 23% of EDH will enlarge, mostly within 36 hours.
  - Has the characteristic lucent period.

Trauma

- Extradural (Epidural) hematoma:
  - Usually associated with skull fracture(85-95%).
  - Results from injury to middle meningeal artery or one of its branches.
  - About 10% are of venous origin.
  - It has the characteristic biconvex shape.
  - Limited by the suture lines.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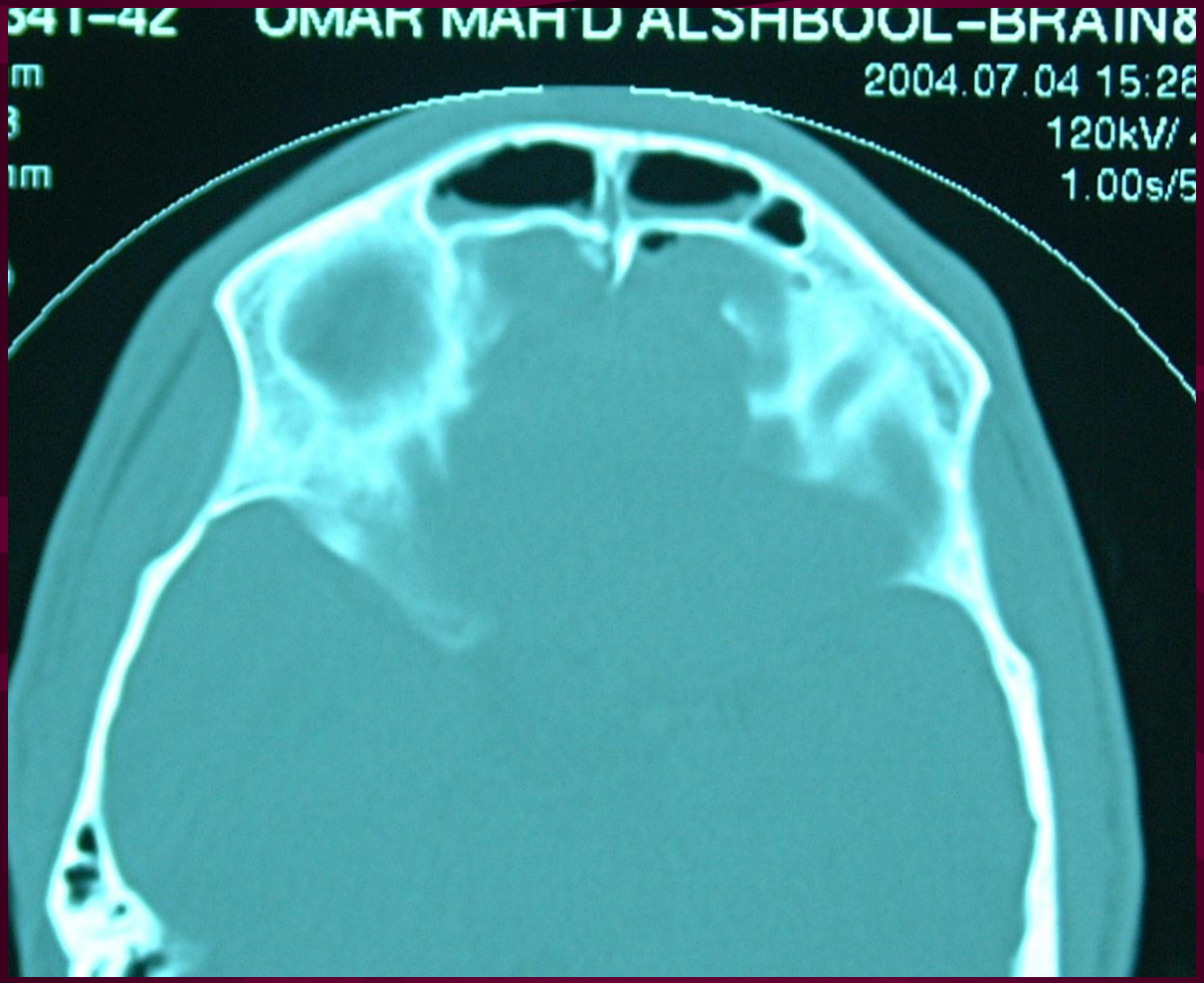
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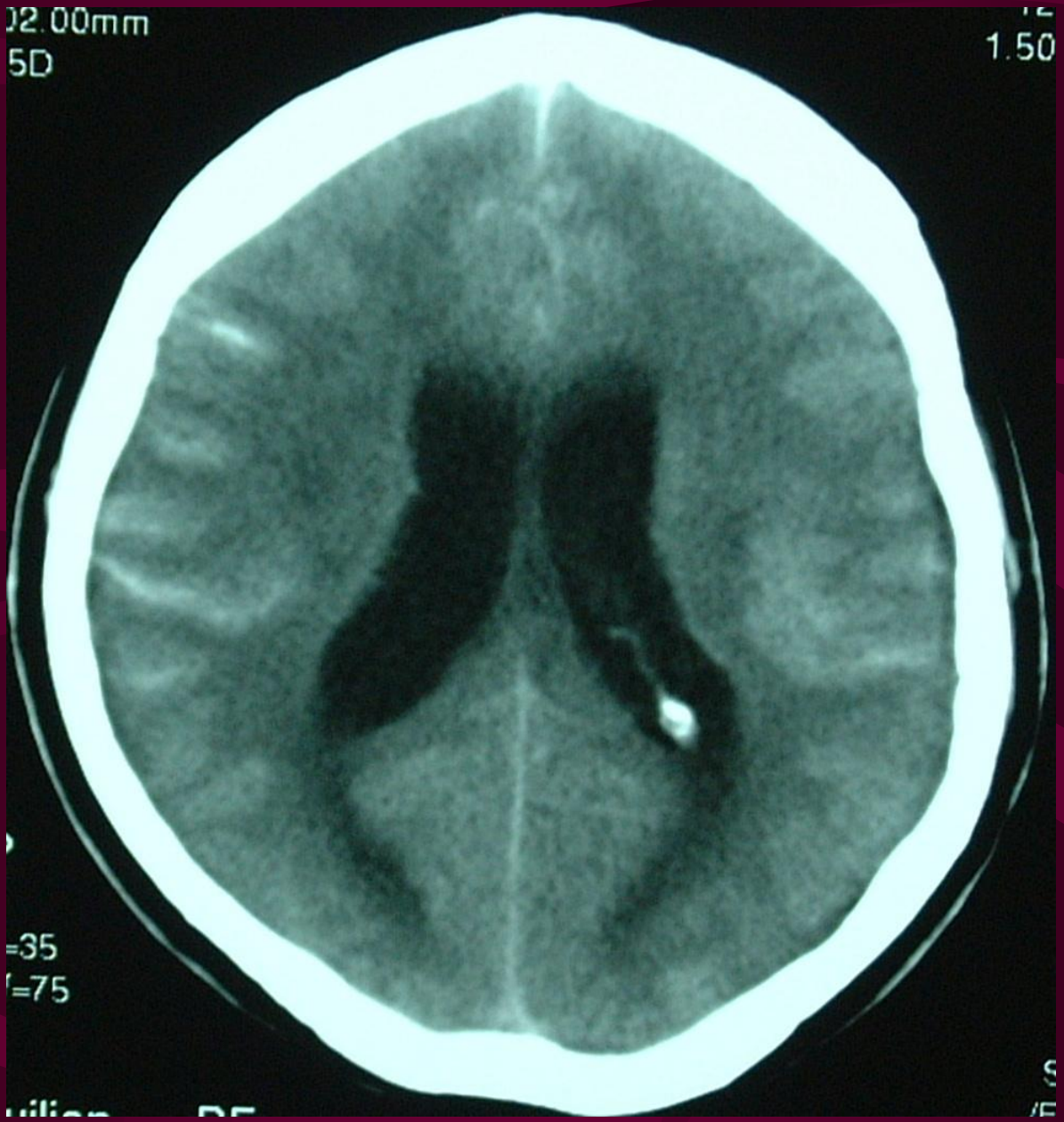
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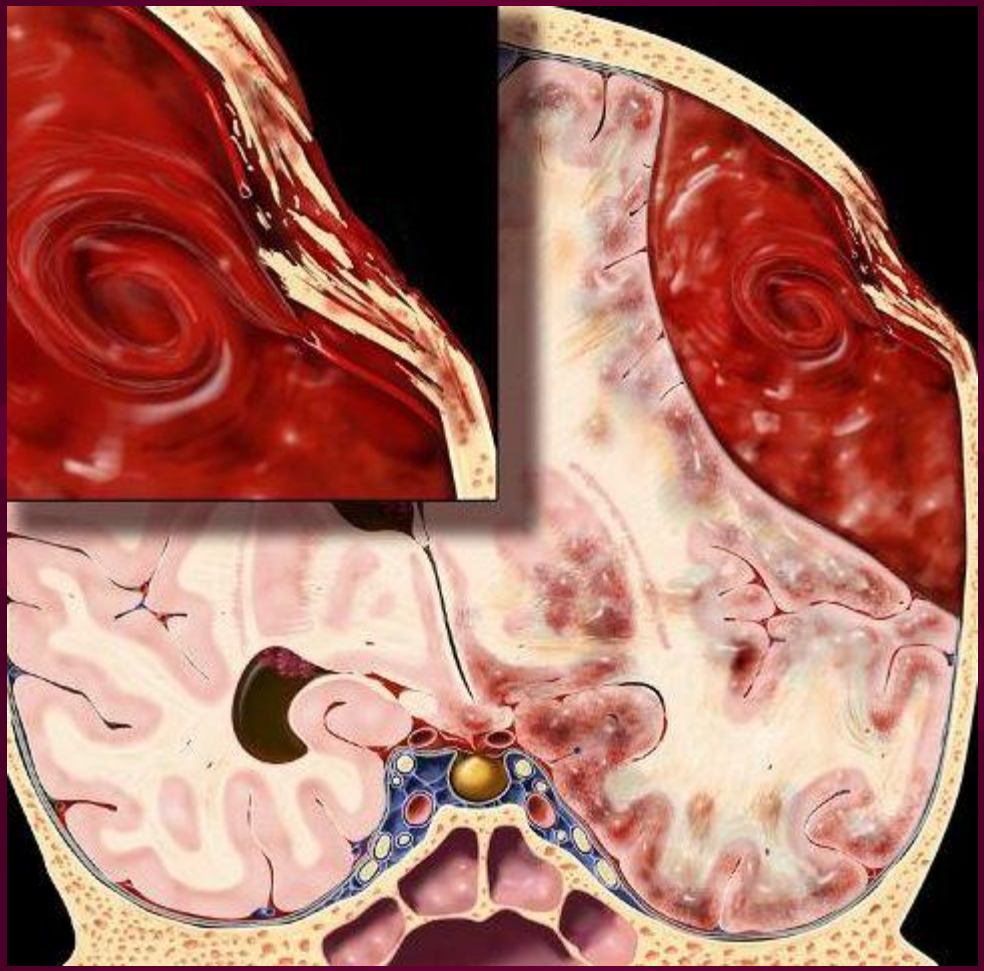


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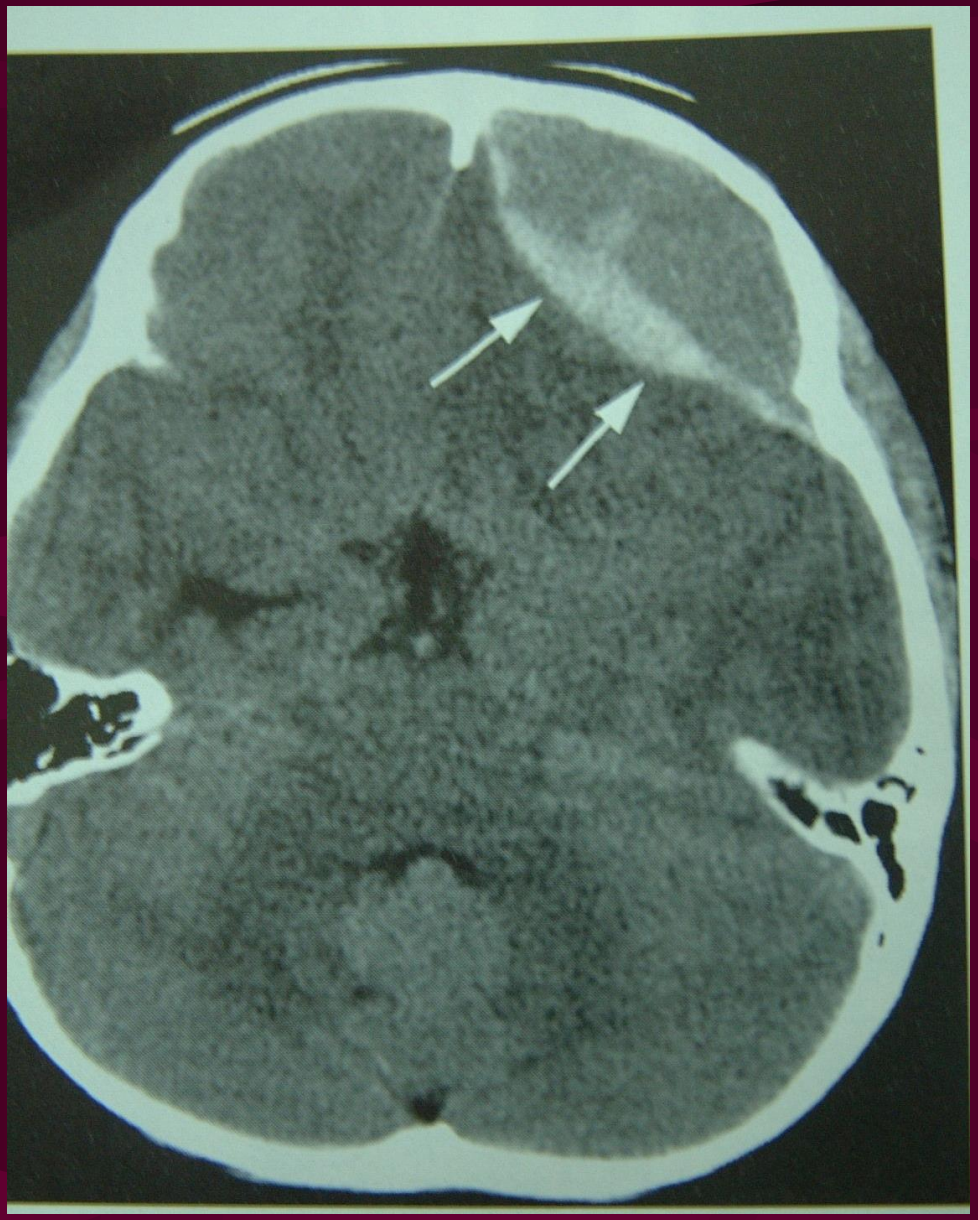

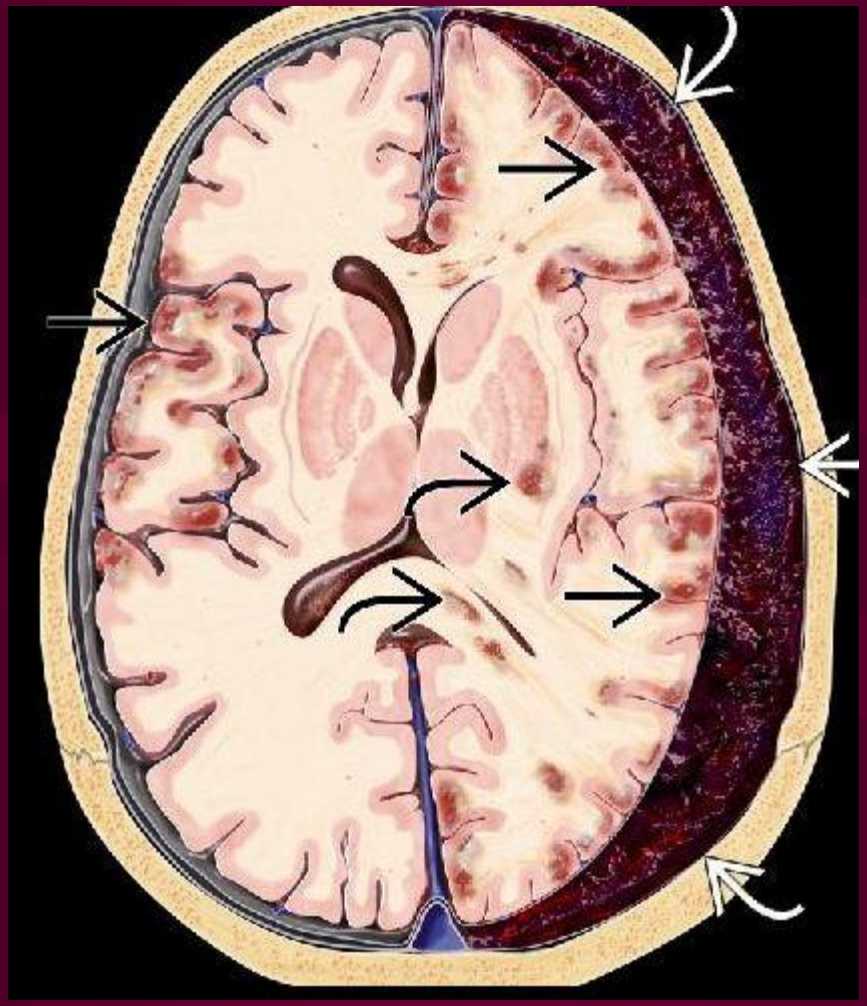

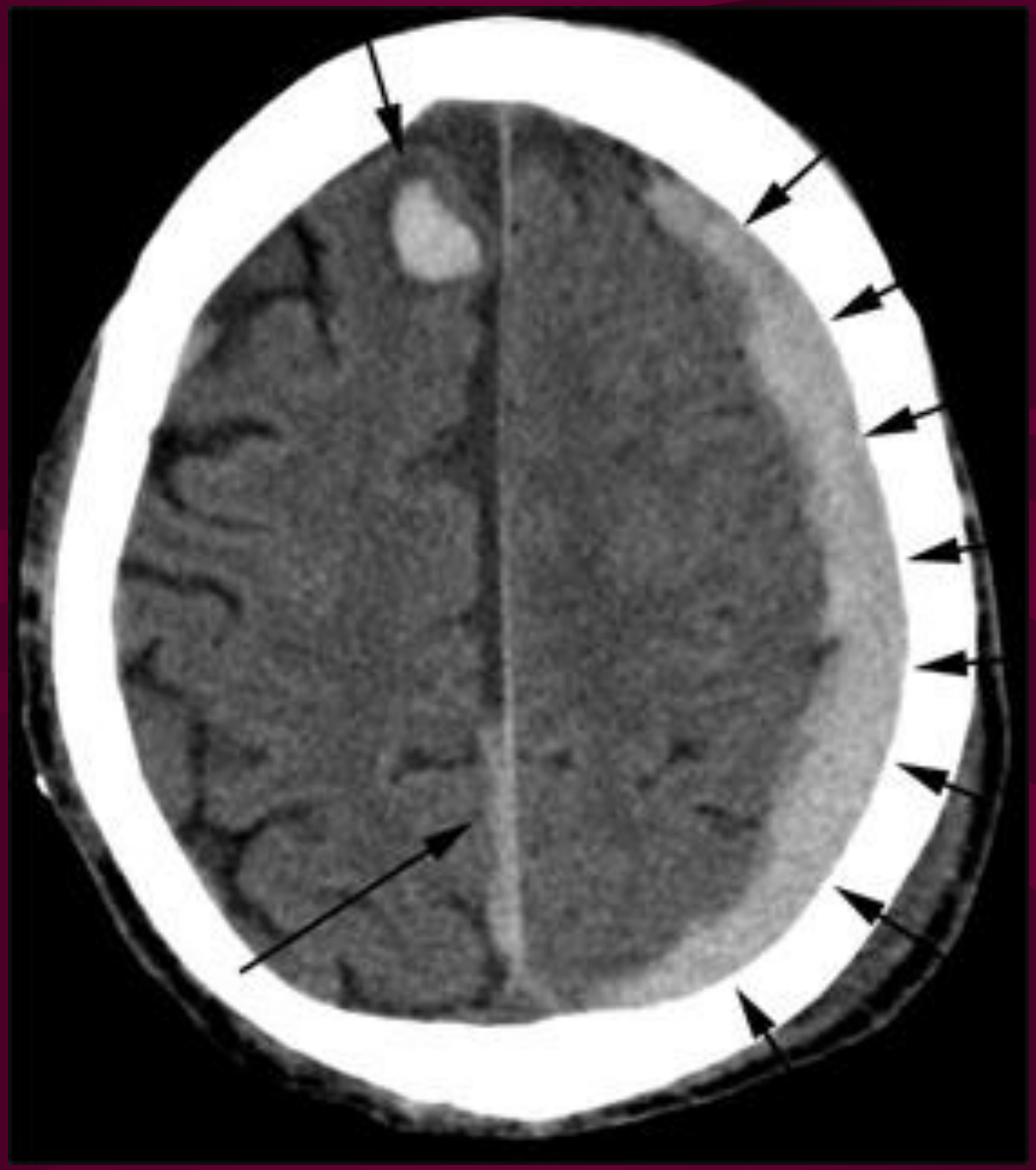

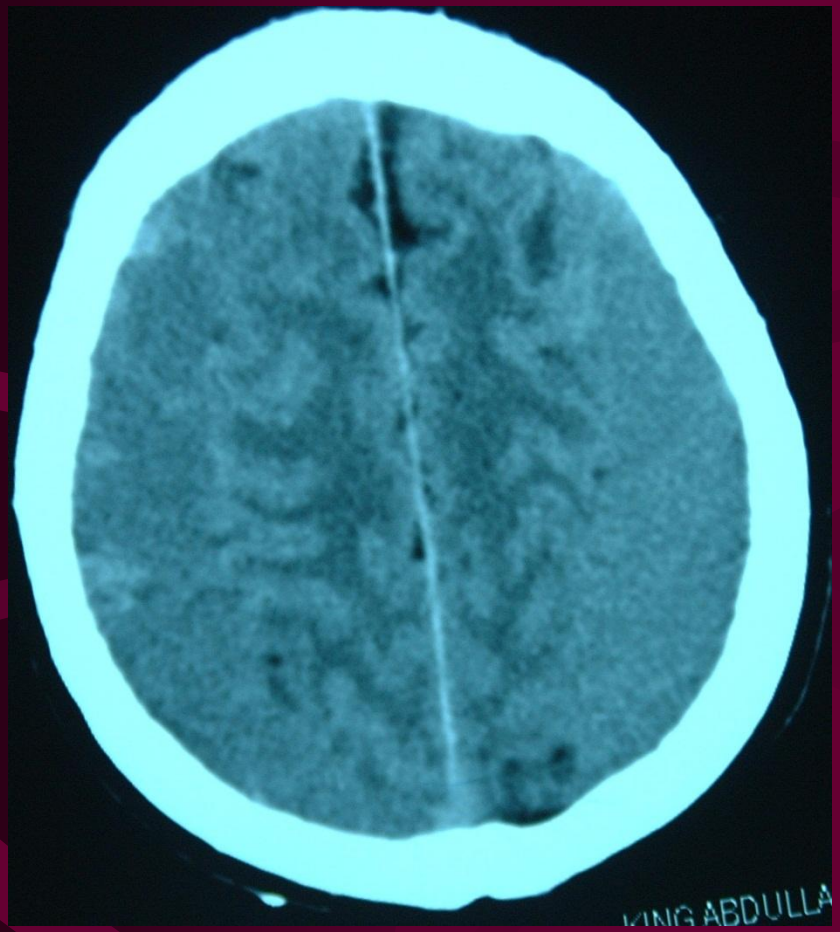
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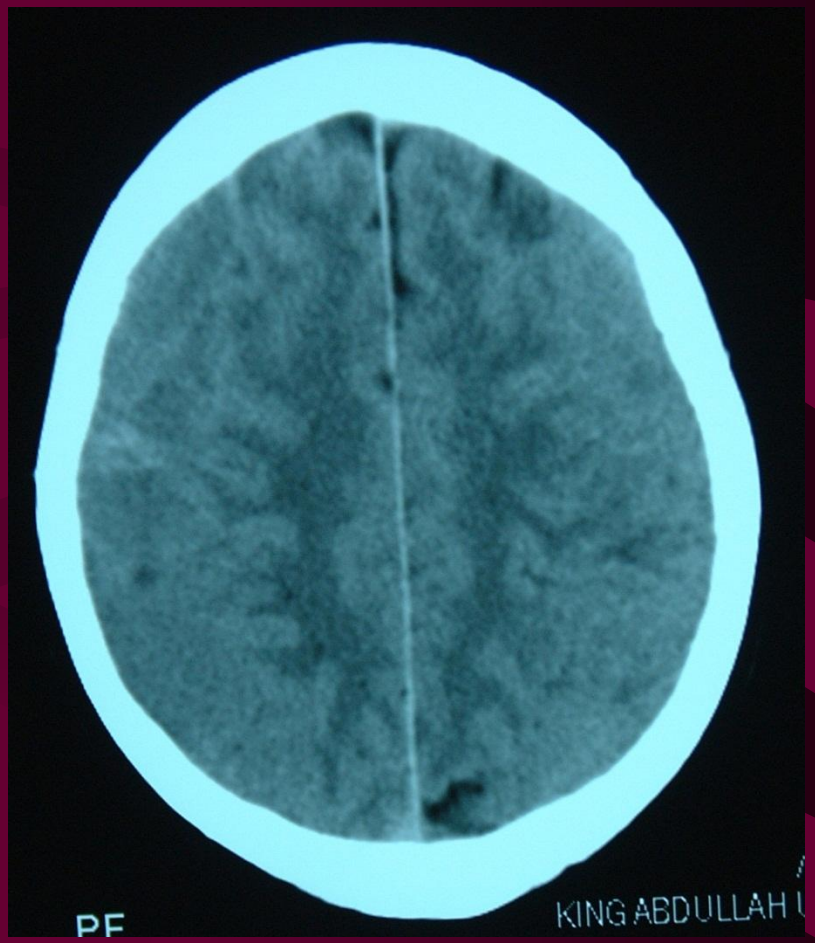
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Neoplasm

- Divided into two major categories:
  - Intra-axial:
    - The tumor is within brain parenchyma.
    - Metastasis is the most common etiology in adults.
  - Extra-axial:
    - Arising from the brain coverings or nerve sheaths.

Inta-axial Tumors

- Primary brain neoplasm:
  - Gliomas are the most common types.
  - Wide variety of pathological types: astrocytoma, oligodendroglioma, ependymoma.
- Metastasis:
  - Lung, breast and colon are common primary sites.
  - Usually multiple, can be hemorrhagic.

Extra-axial tumors

- Meningiomas are the most common pathological type.
- Nerve sheath tumors are less common, e.g. schwannoma, neurofibroma.
- Metastasis is less common than intra-axial ones.


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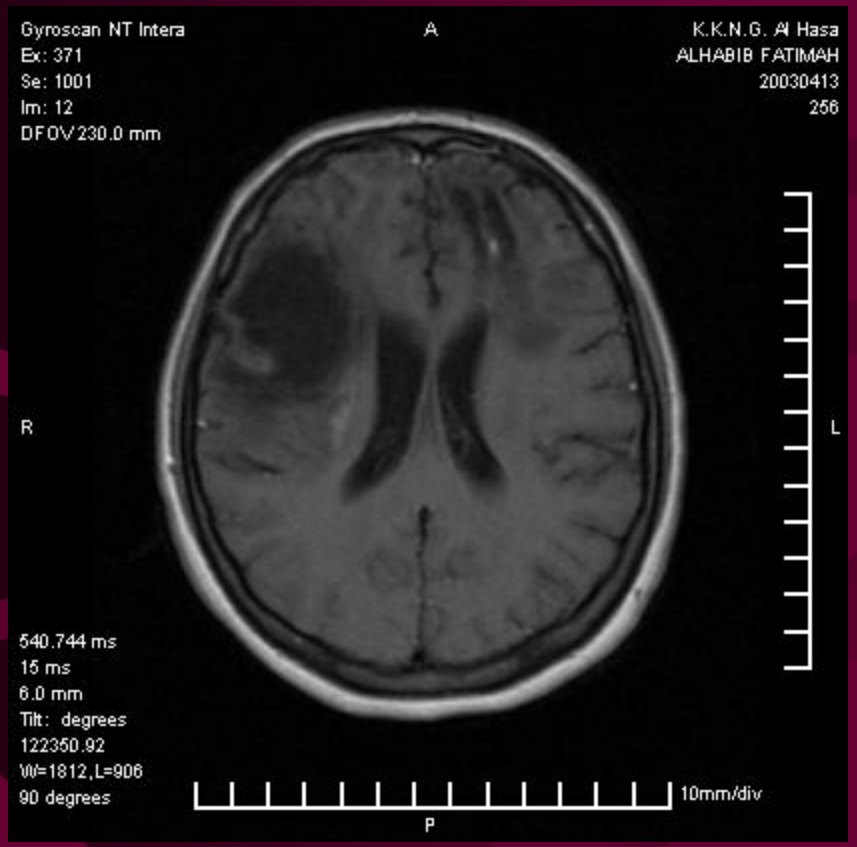
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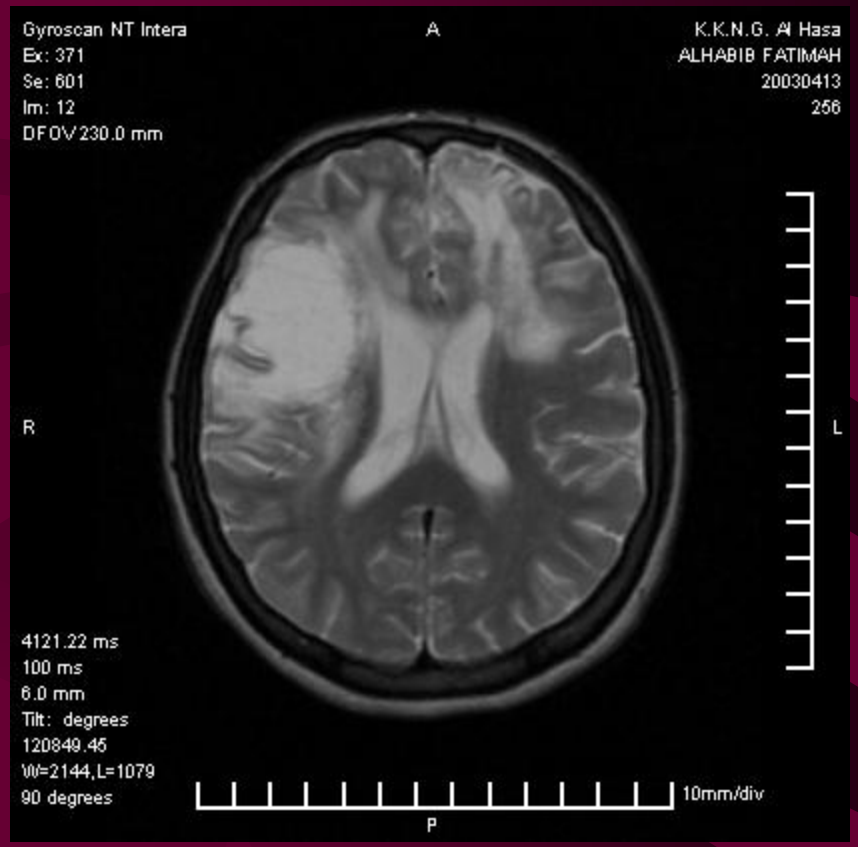
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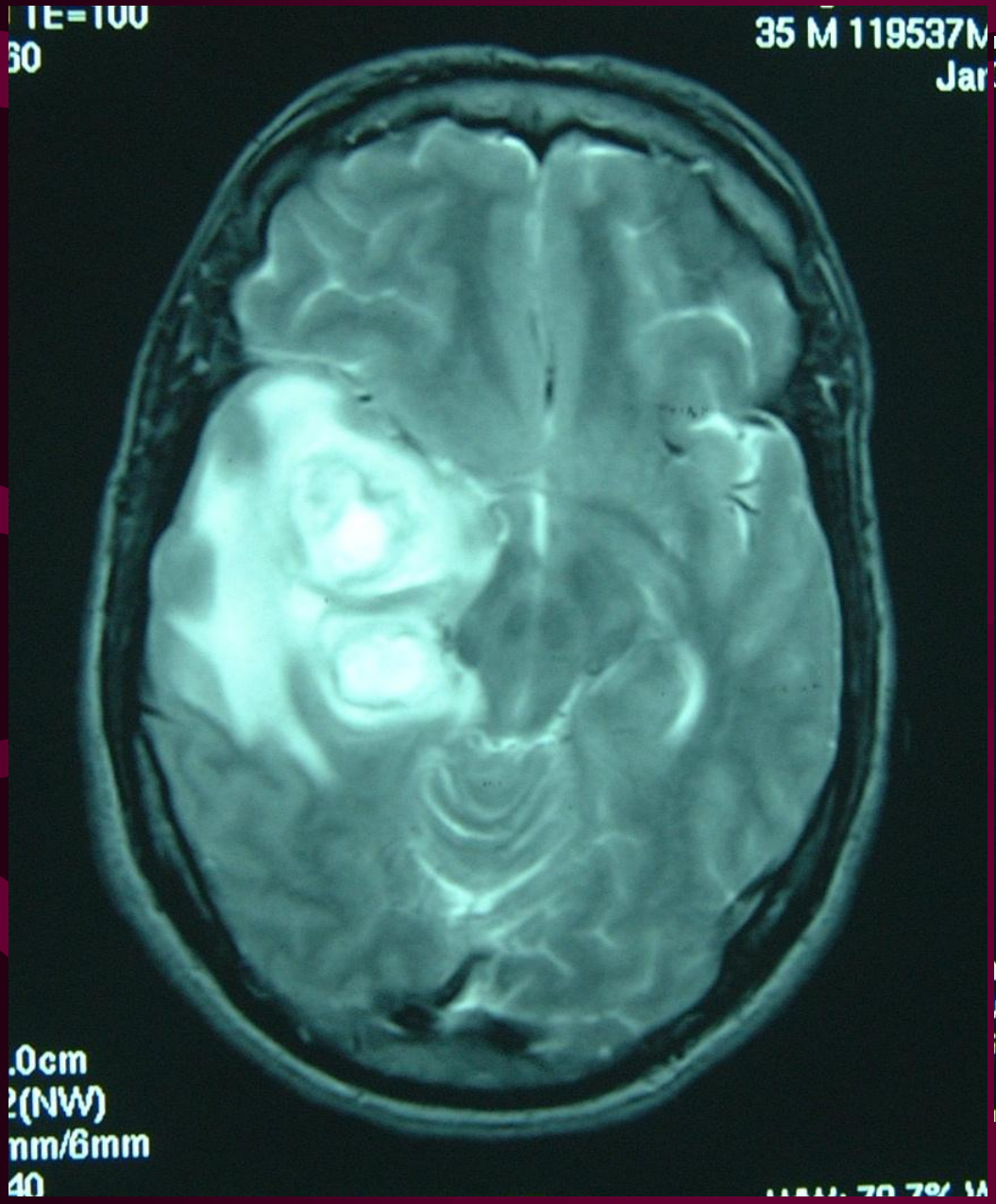
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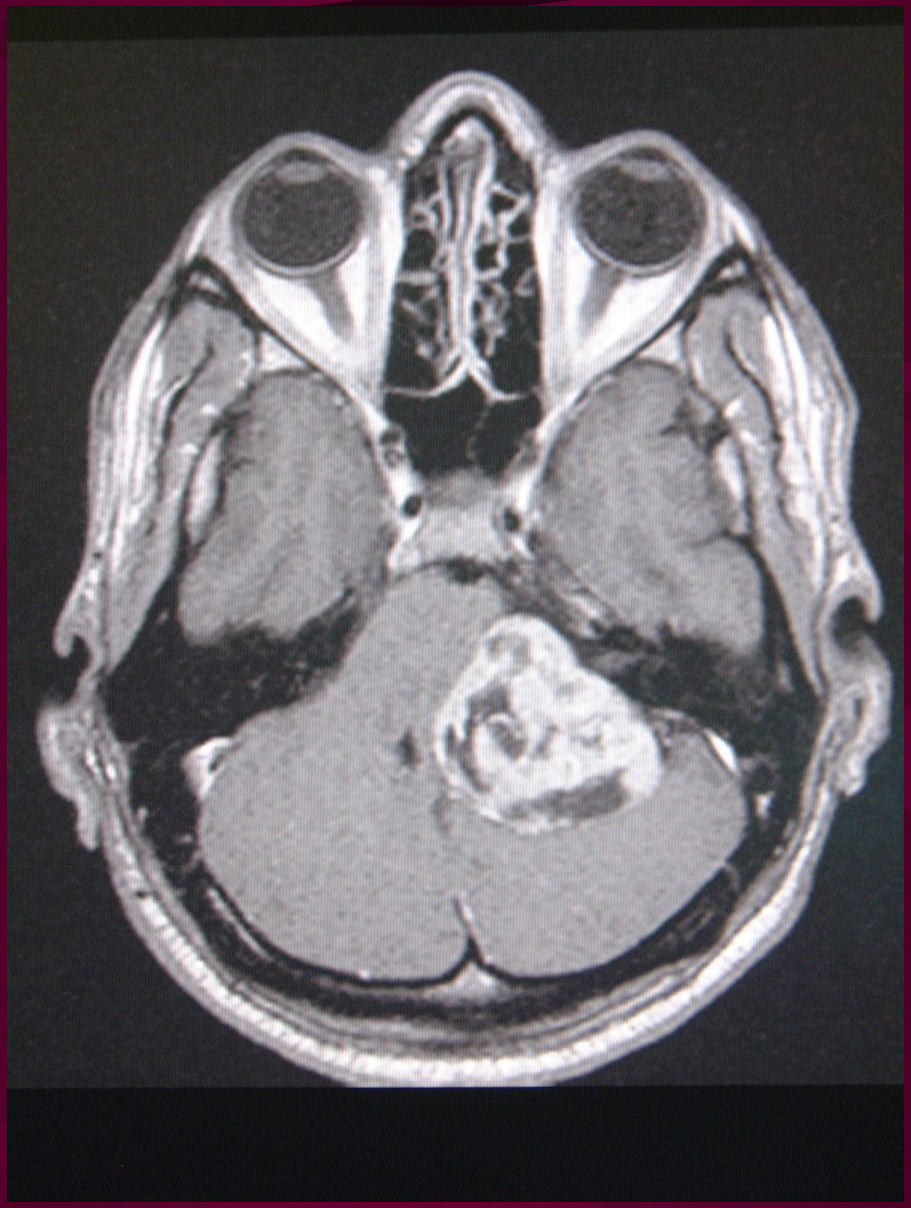


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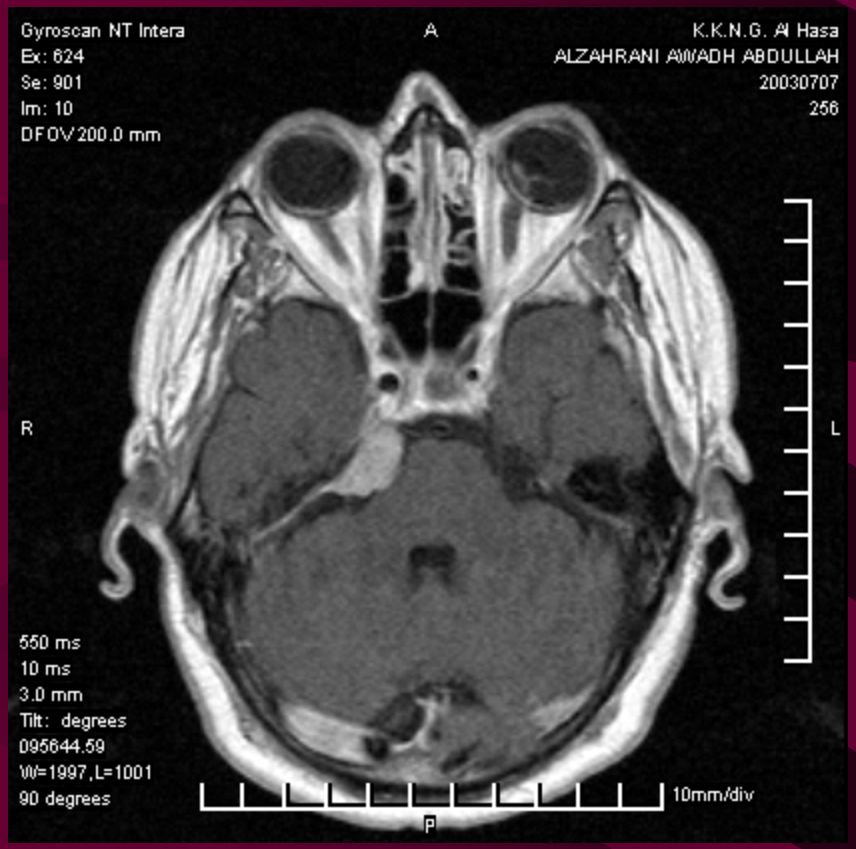
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CNS Infection

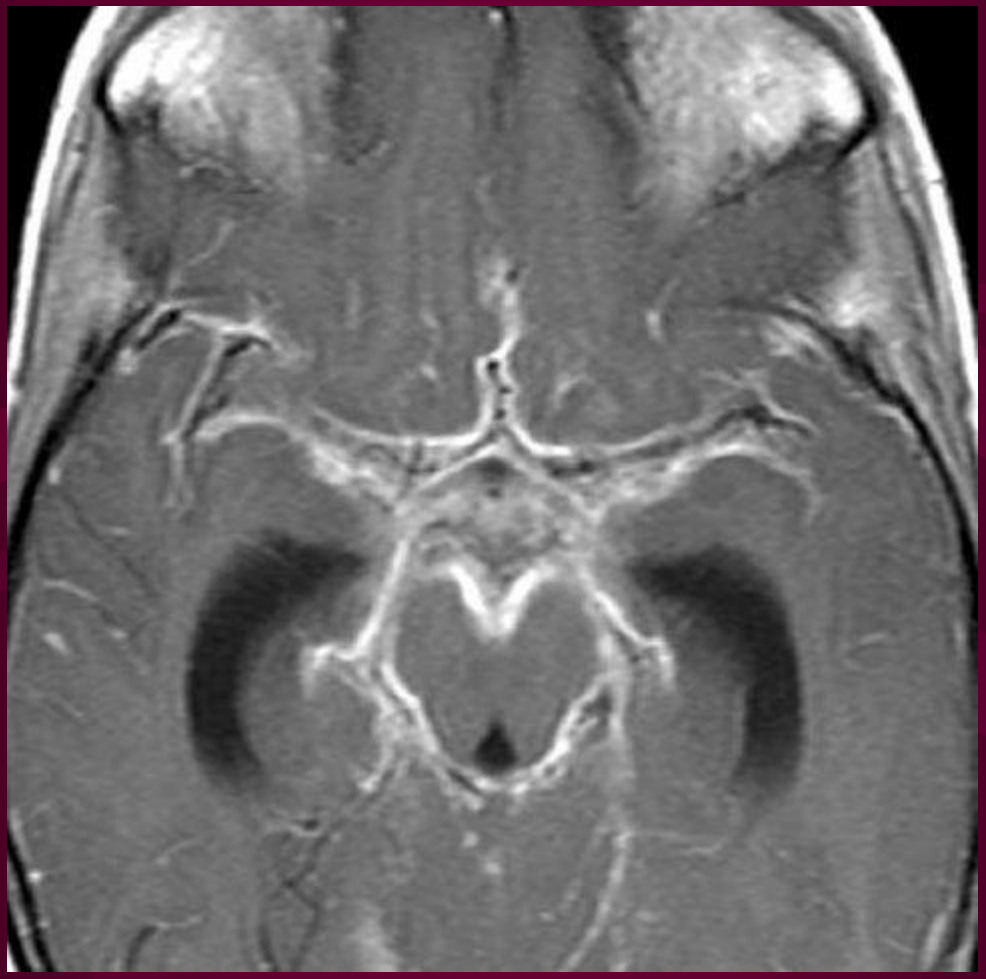
- Meningitis is the most common form of CNS infection.
- Its clinical and lab diagnosis.
- Imaging is helpful in excluding secondary complications.
- Diffuse meningeal enhancement is a common finding.
- Normal CT or MRI does not exclude the diagnosis.

CNS infections

- Sub-dural effusion:
  - Common in children especially with H. influenza meningitis.
  - Can be treated conservatively.
- Brain abscess:
  - Usually secondary to hematogenous spread of microbes.
  - May not be distinguished from brain tumor.

CNS infections

- Viral infections:
  - MRI is very sensitive for diagnosis of viral encephalitis.
  - Herpatic encephalitis has a characteristic bilateral temporal lobe involvement.

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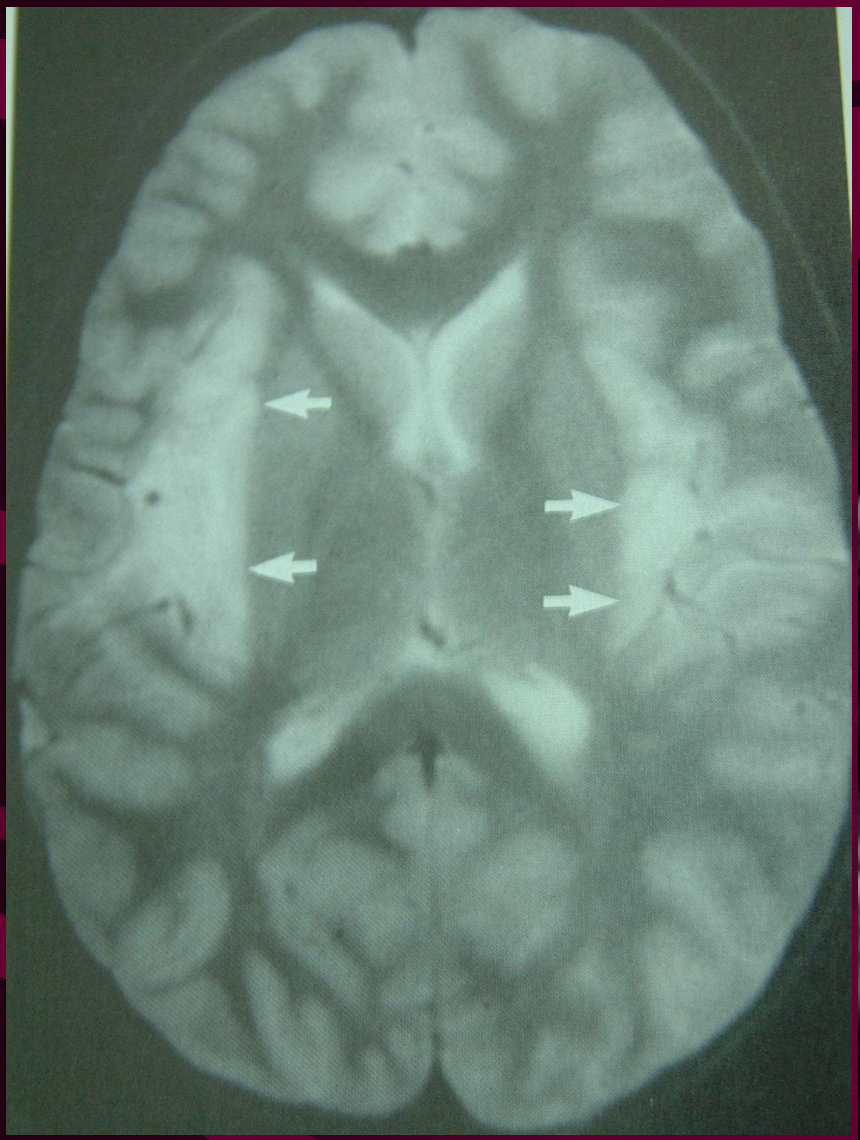

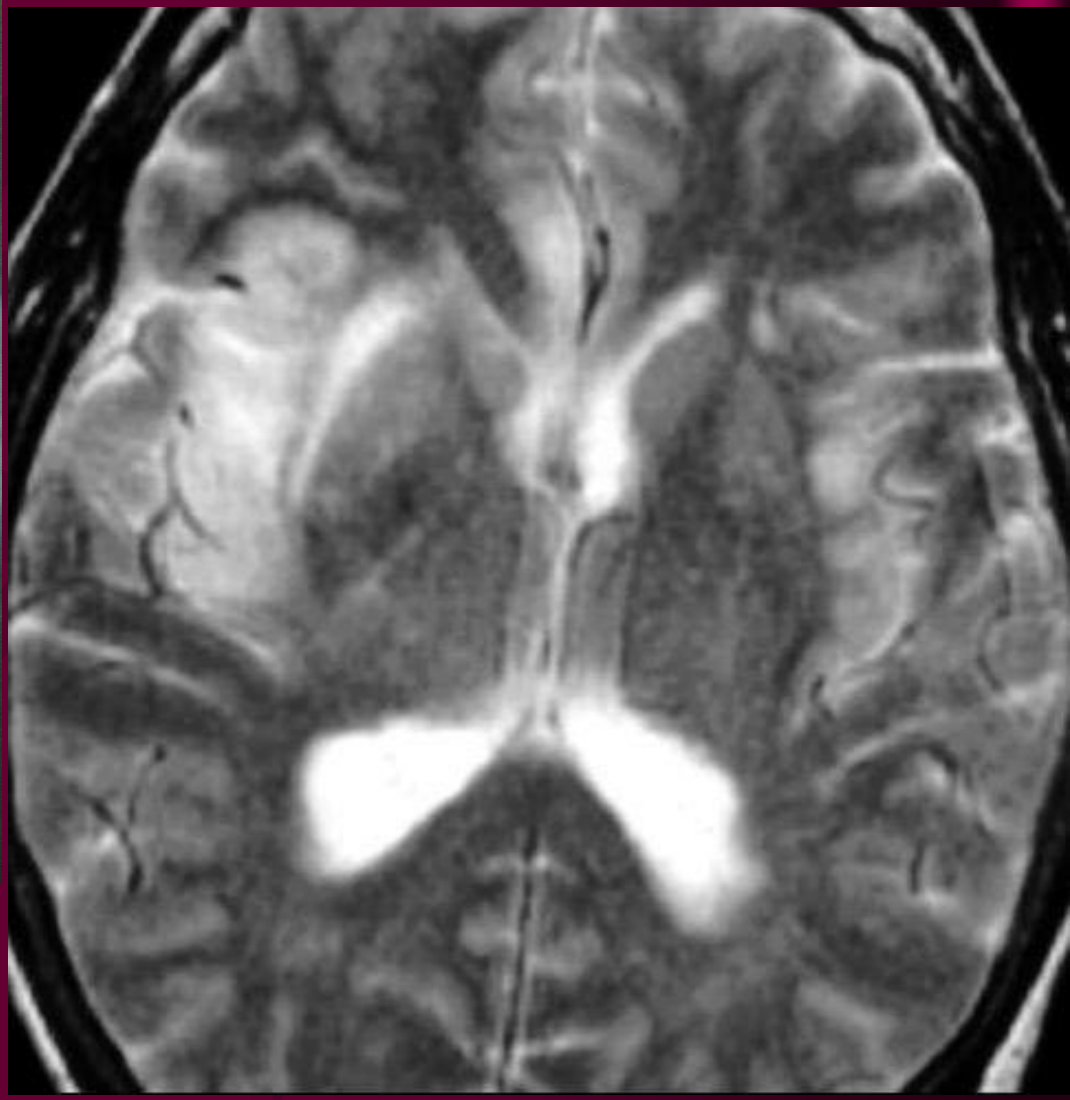

Vascular Disorders

- Stroke is a major source of mortality and morbidity.
- Most stokes are ischemic, result from vascular occlusion by a thrombus or embolus.
- CT is usually the initial modality to evaluate these patients.

Vascular Disorders

- CT:
  - Usually becomes positive in 12-24hours after onset of neurological deficit.
  - Edema in a vascular distribution.
  - Helpful to rule out ICH or hemorrhagic conversion.

Vascular Disorders

- MRI:
  - It becomes positive earlier than CT.
  - Diffusion weighted images can become positive in few minutes from onset.
  - MRA can be obtained at the same time to evaluate vascular occlusion.

Vascular Disorders

- Vascular abnormalities:
  - Aneurysms:
    - usually manifest in the form of subarachnoid hemorrhage.
  - AVM:
    - presents with either ICH or headache.
    - Can be diagnosed with enhanced CT or MRI.
    - Angiogram is diagnostic and therapeutic.


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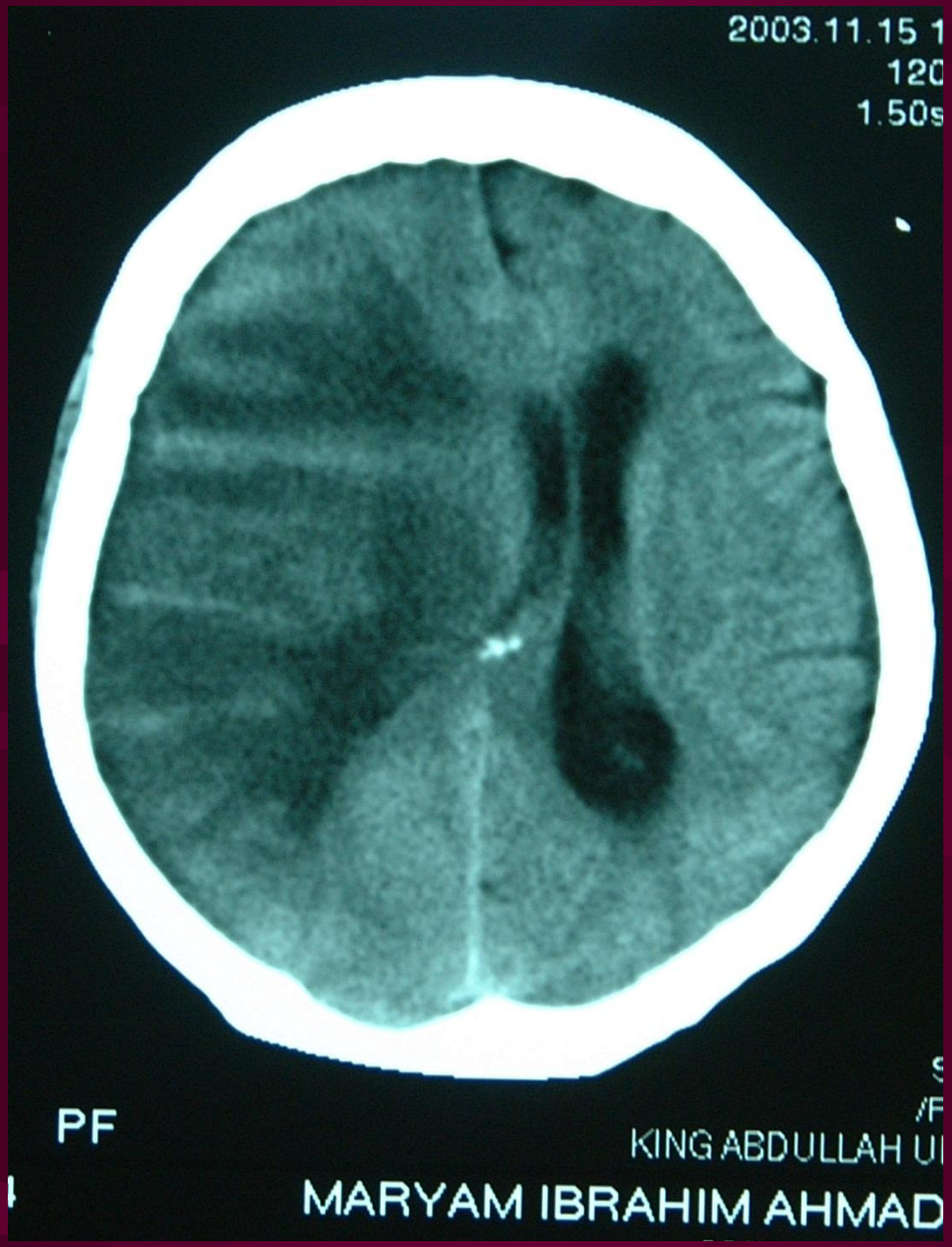
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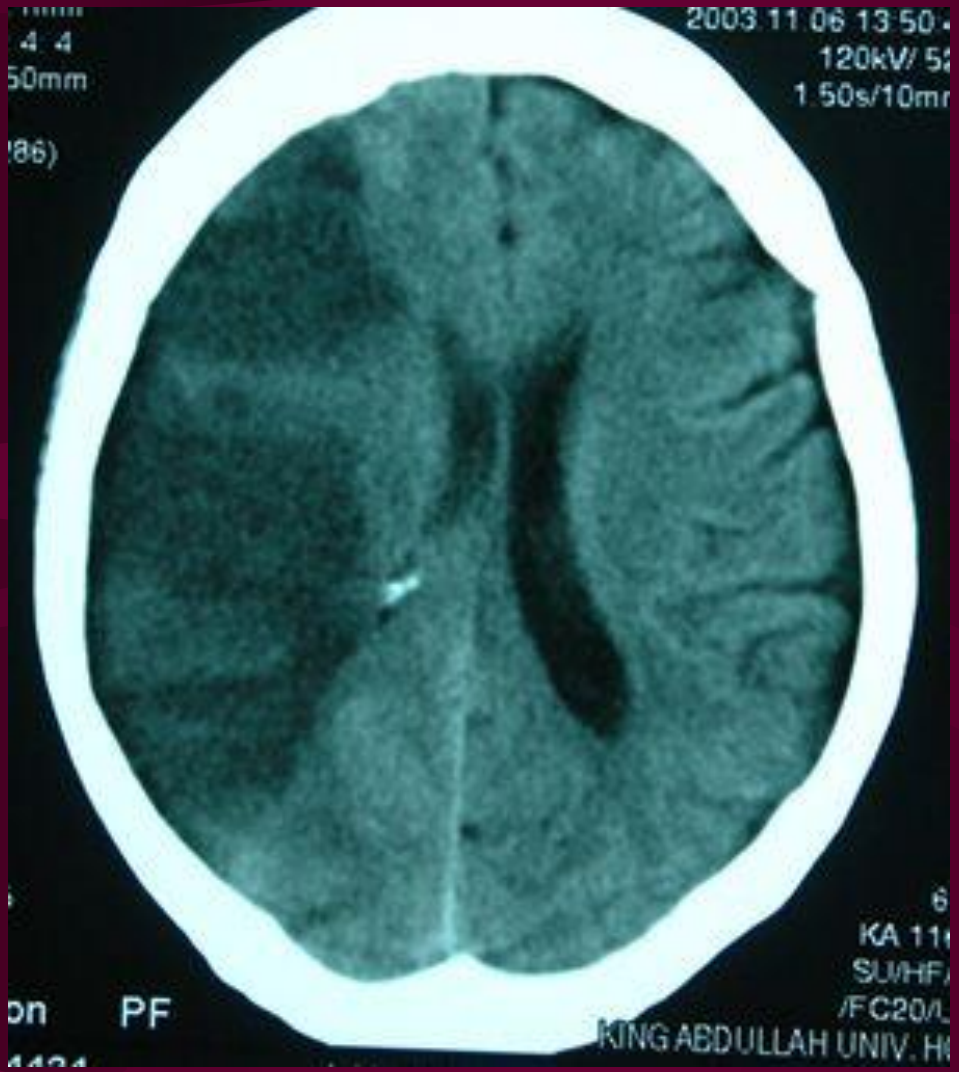
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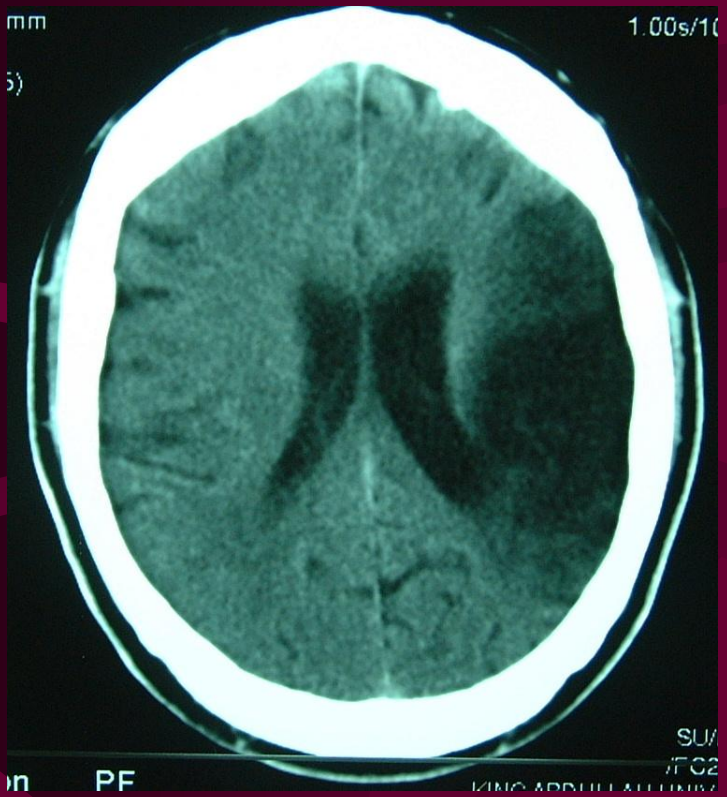
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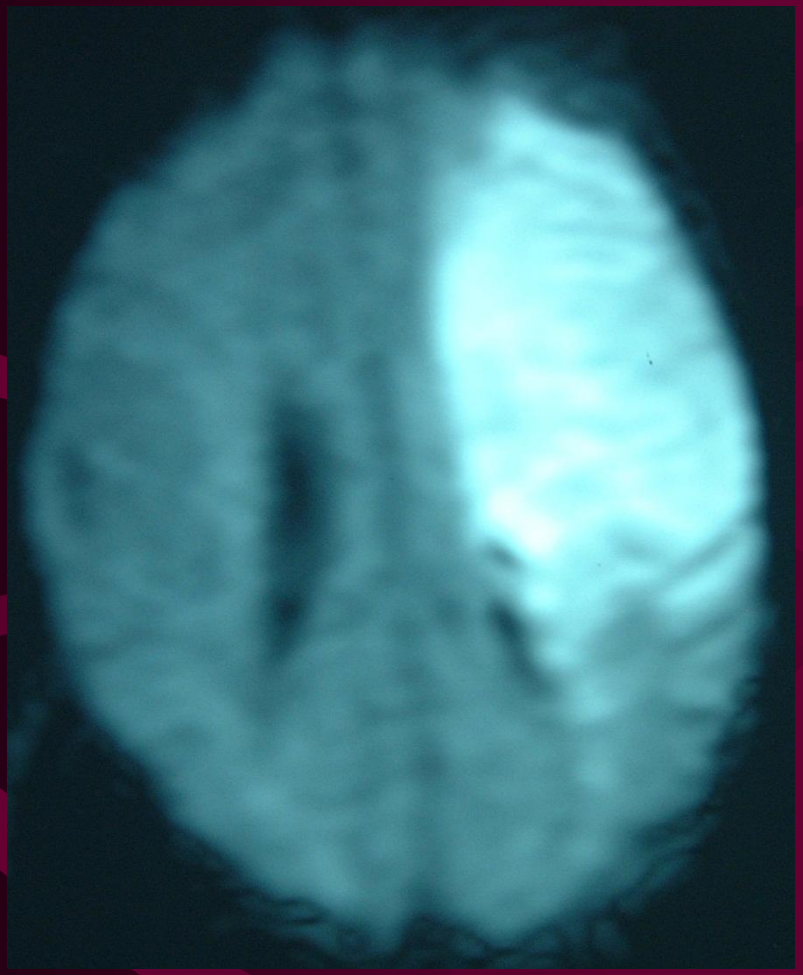

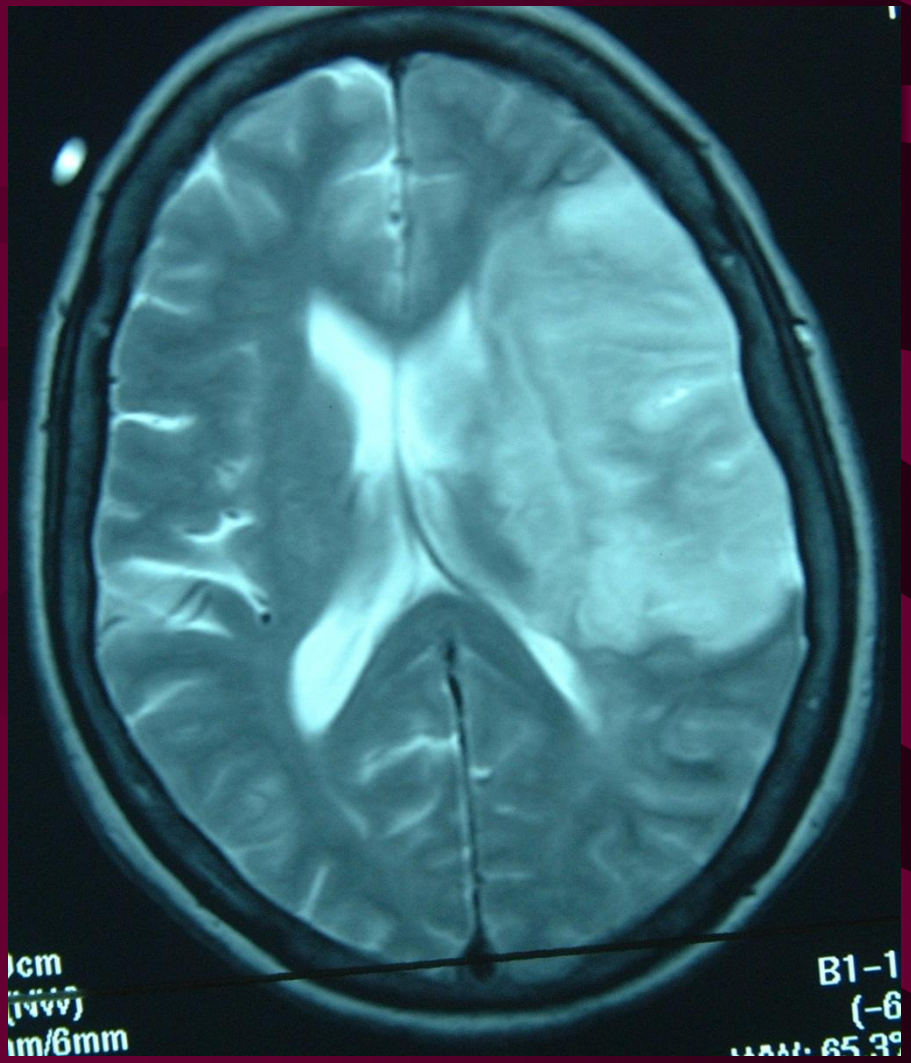
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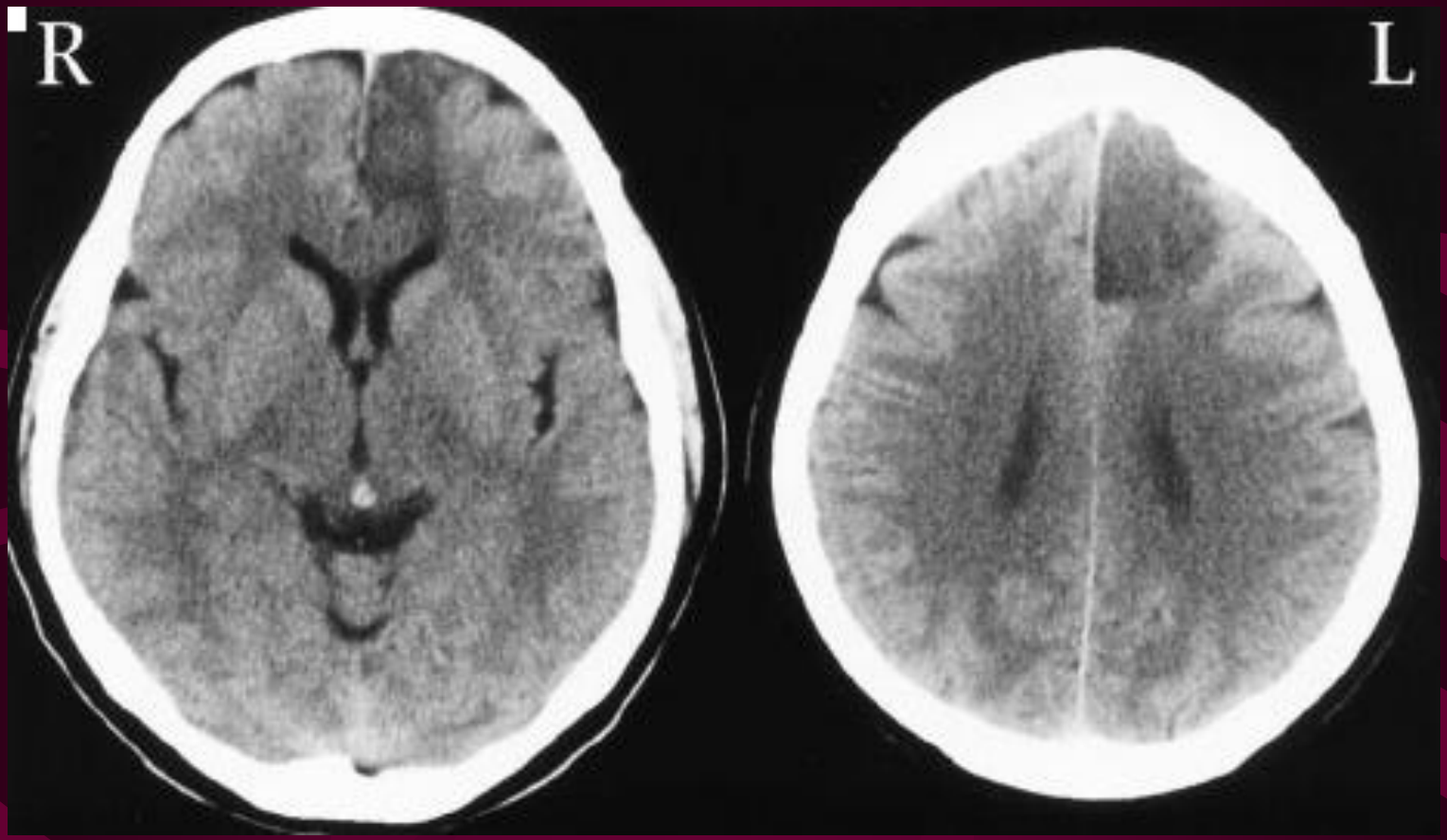
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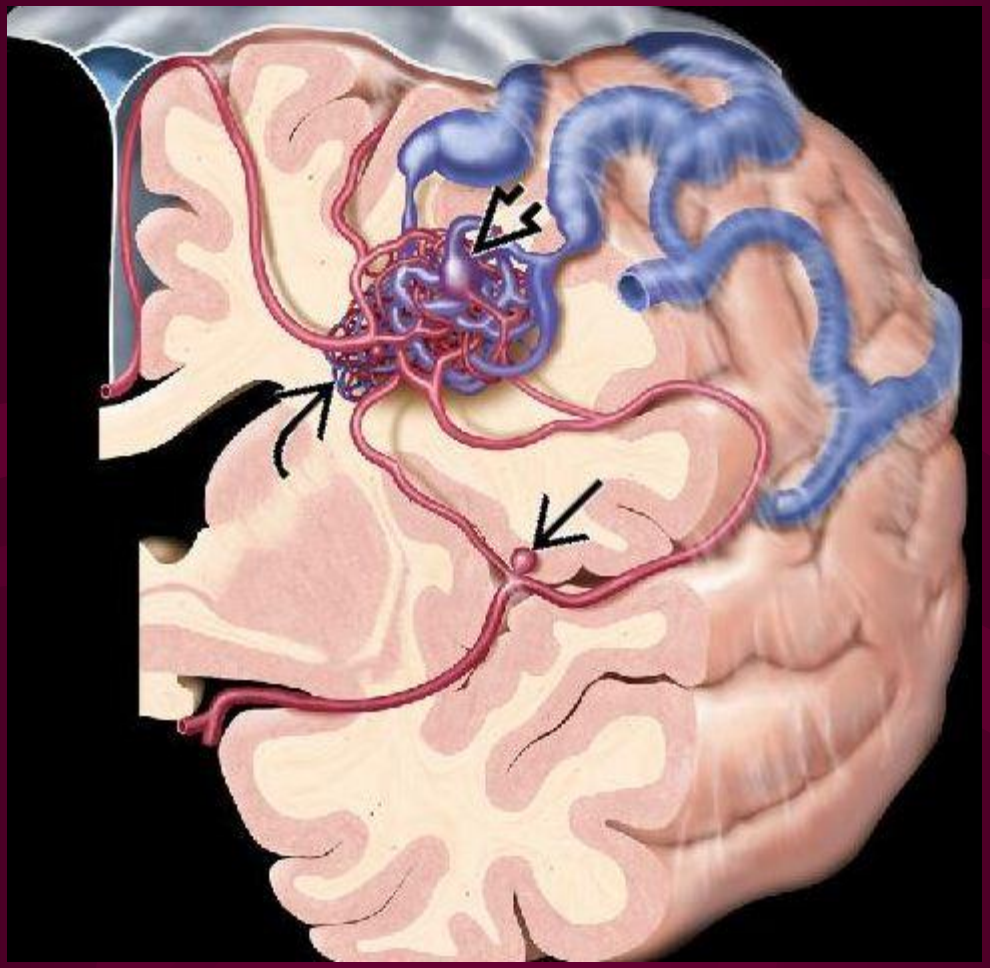

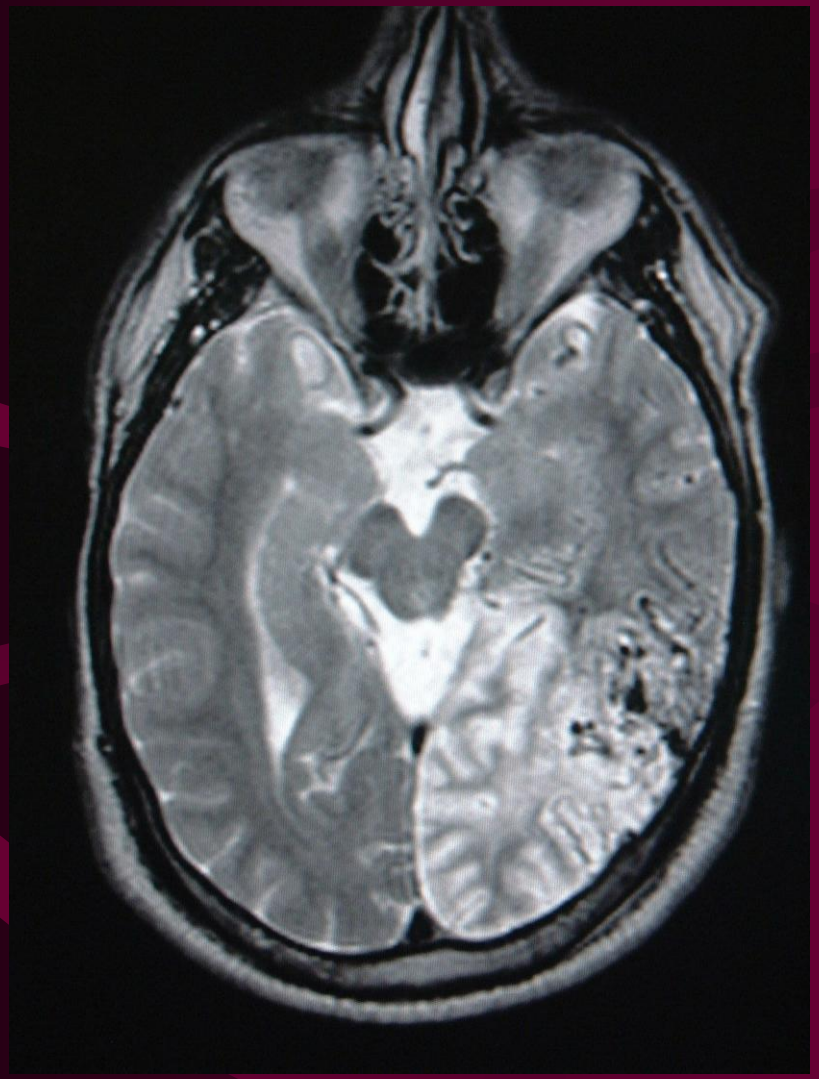

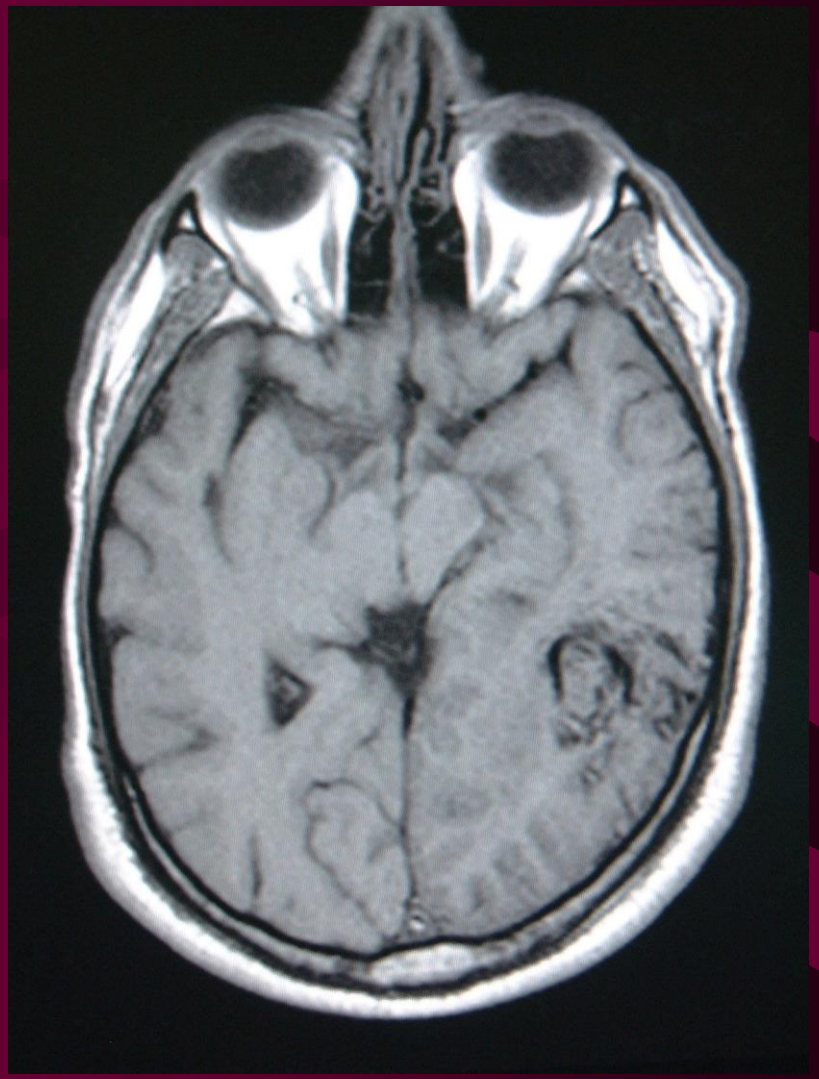

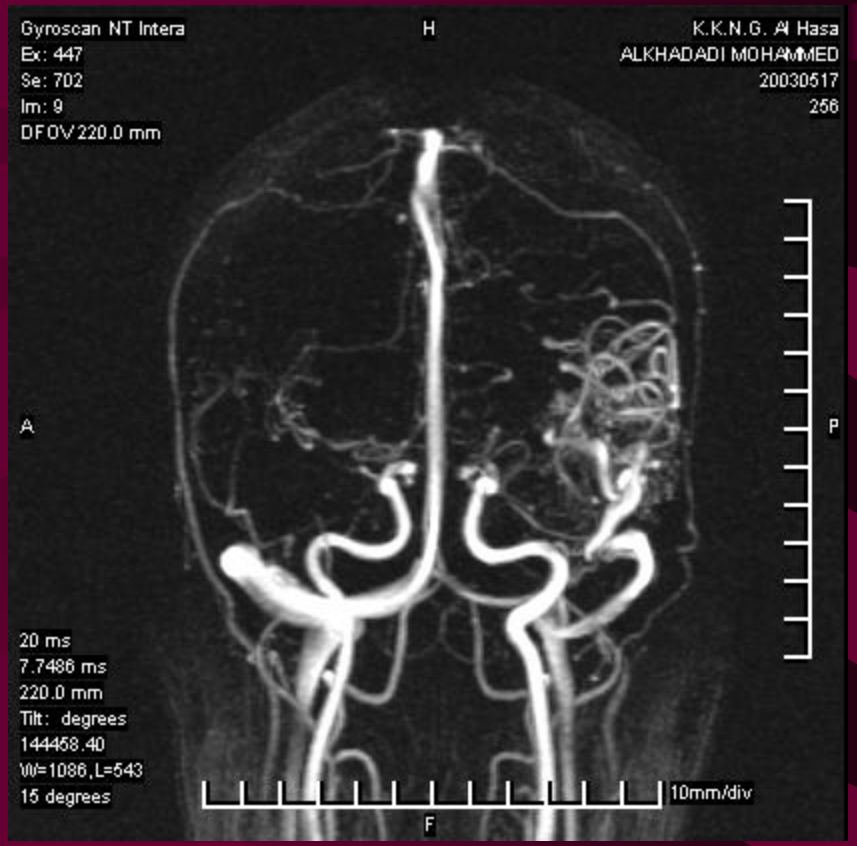
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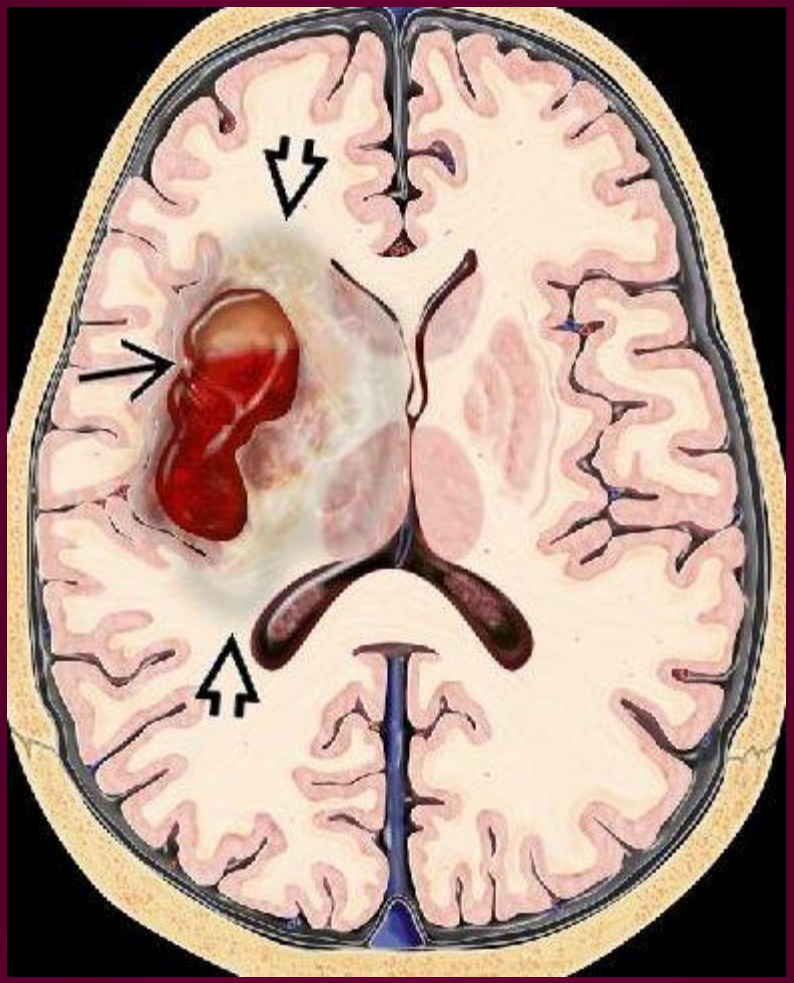

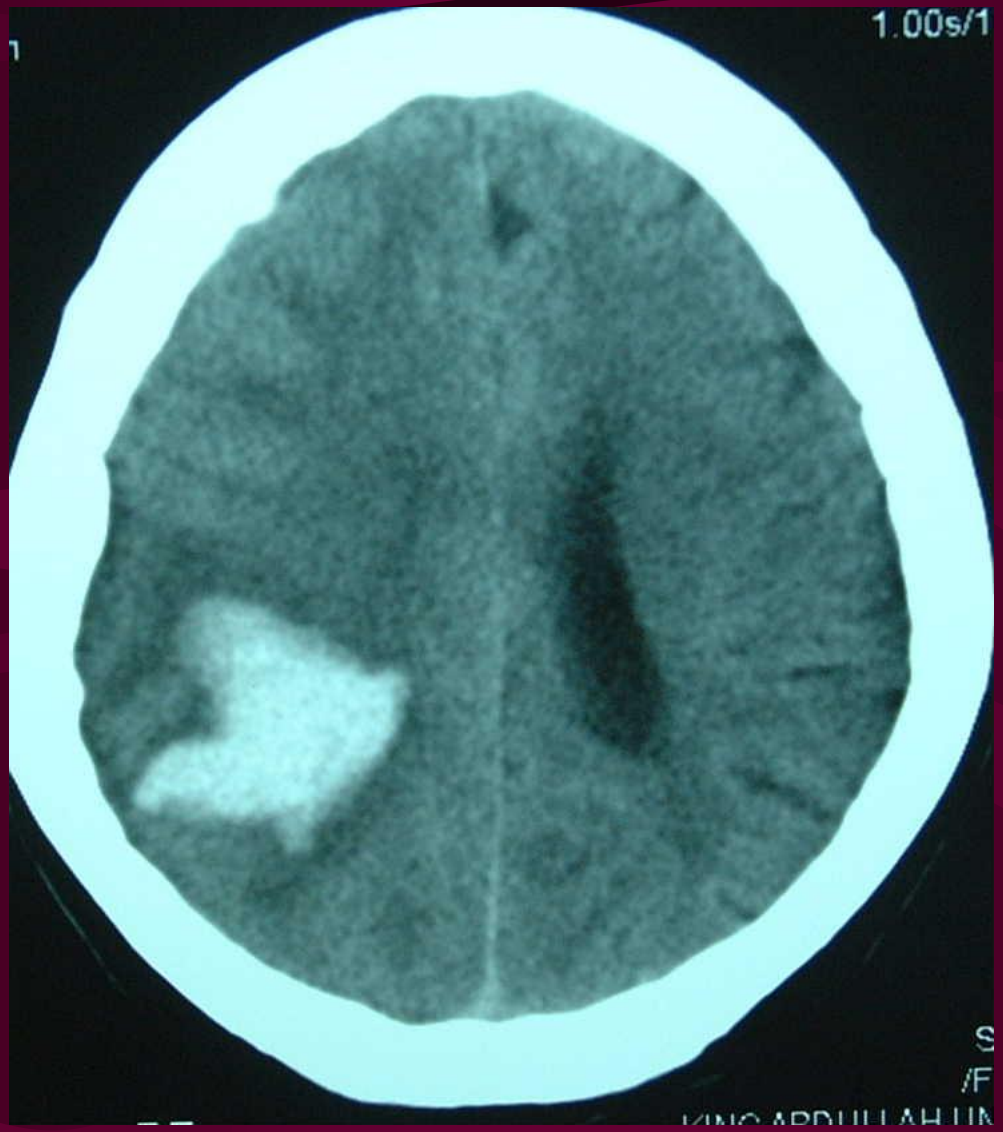
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Pediatric Application

- Head US:
  - High resolution images of the brain.
  - It uses the fontanelles as acoustic window.
  - Procedure of choice to evaluate for ICH.
  - Helpful in evaluating for congenital anomalies and peri-natal hypoxemia.