Applicable Neuroradiology

For the Clinical Neurology Clerkship
LSU Medical School
New Orleans

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Introduction
The field of Radiology first developed following the discovery of X-Rays by Wilhelm Roentgen in 1895. This resulted in widespread clinical use before the damaging effects of ionizing radiation were fully appreciated.
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Plain Films of the Skull were the first application of radiological techniques to the field of Neurology and became widespread beginning around 1905.
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- Plain Films of the Skull
  - Good for detecting Ca^{++}
  - Good for Skull Fx’s
  - Good for Foreign Bodies
  - Quick way to look for pneumatization of cranial sinuses

- Plain Spine Films
  - Good for vertebral fractures and dislocations
  - Used in evaluation of scoliosis
  - Does NOT image cord however
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**Pneumoencephalogram**
- Air injected into thecal sac through LP
- Reveals the ventricular system
- Causes Headaches (pneumocephaly)
- First use in 1918

parenchymal Ca++ and hydrocephalous due to congenital Toxoplasmosis
Cerebral Angiography

- First used in 1927 via direct percutaneous internal carotid artery puncture
- Useful for defining cerebral vasculature
- Was used to infer tumors or other mass lesions based on the displacement of vascular structures
Computed Axial Tomography

- First developed in the 60’s
- Digital geometry is used to create a 3 dimensional image of the internal aspects from a large series of 2 dimensional X-ray images taken around a single axis of rotation
Computed Axial Tomography

- Has advantages of quick acquisition time
- Excellent for picking up acute intracranial blood
- Uses “Houndsfield Units” to determine the density of structures identified
- Contrast can be used to better define edema or any process where there is breakdown of the BBB
- Bolus contrast administration provides vascular anatomy (CT Angiogram)
- Contrast administration is contraindicated for use with renal insufficiency or prior allergy
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CT Angiogram showing a Large MCA aneurysm

Contrast-enhanced CT showing brain abscess and edema
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Computed Axial Tomography

- 5 “B” things that are bright (hyperdense) on CT
  - Blood
  - Bone (or Ca++]
  - Brain
  - Bullet (or foreign body)
  - “Bontrast” for “Contrast”
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Cranial Ultrasound

- Cranial U/S developed in the 70’s
- Used in infancy as a non-invasive way to view ventricles and look for intraventricular hemorrhage using the anterior fontanelle as a portal
- Used in adults for carotid stenosis/dissection or for cerebral vasospasm
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Neonatal Head U/S with Grade III IVH

Carotid Doppler Ultrasound showing ICA stenosis

Cranial Doppler with MCA stenosis
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**SPECT**
- Single Photon Emission Computed Tomography
- Developed in 60’s (along with CT)
- Gamma ray-emitting long-acting isotope (Technetium-99m) shows regional CBF
- Can help localize seizure onset (Ictal-SPECT)
- Can be superimposed on CT or MRI
- More available than PET
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Ictal SPECT superimposed upon brain MRI
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**PET**
- Positron Emission Tomography
- Developed in the 70’s
- Detects gamma rays released by a radionuclide tracer linked to a marker
- FDG (Fludeoxyglucose) most commonly used
- Other markers include specific neurotransmitters or their receptors
- Requires cyclotron to make short half-life tracers so not as available as PET
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PET showing loss of regional stores of Dopamine in patients with Parkinson’s disease
Magnetic Resonance Imaging

- Developed in the 80’s
- Powerful magnetic fields cause water molecules to align along their dipoles
- Radiofrequency waves produce an electromagnetic field which transiently knocks the molecules out of alignment
- When water molecules re-align within the magnetic field they release energy (photons) which are detected by scanners and following a lot of computer mumbo-jumbo an image is produced
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Magnetic Resonance Imaging

- T-1 Imaging
  - Water is dark. Fat (Myelin) is bright
  - Gadolinium contrast used to show breakdown of BBB

- T-2 Imaging
  - Water is bright. Fat is dark.
  - FLAIR (same as T2 except water is “blacked out”)

- Diffusion Imaging
  - Shows restricted Diffusion of water suggesting cell death
  - ADC Mapping takes into account brightness of background T2 signal
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Blood on MRI is paradoxical and evolves

- Note the intensity changes as the blood cells break down and lose oxygen
- For ACUTE Blood they are similar to FAT
  - T1 = White
  - T2 = Black
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Axial T1 Acute Hemorrhage  Axial T2 Acute Hemorrhage
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T1 MRI Axial Plane

T1 MRI with Gadolinium showing a brain tumor
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T1 Sagital Plane

T1 Coronal Plane
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T2 Axial image

T2 and FLAIR of Multiple Sclerosis
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Diffusion/Perfusion Mismatch
L MCA Stroke
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T.O.F. MR Angiogram of The Cerebral Vessels

Gadolinium Contrast Injected MR Angiogram of the Cervical Vessels
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MR Venogram of the Cerebral Sinuses and Draining Veins
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Neuroanatomy: CSF Review

- The majority of CSF is produced from in the choroid plexus in the two lateral ventricles.
- It passes through the interventricular foramina to the third ventricle.
- Then, the cerebral aqueduct to the fourth ventricle.
- The fluid passes from the 4th ventricle to enter the subarachnoid space.
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Neuroanatomy

Name The Structures
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- Globe
- Ethmoid S.
- Mastoid Air Cells
- Clivus
- Frontal S.
- Sphenoid S.
- Int. Acoustic Meatus
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- Sylvian Fissure
- Caudate Head
- 3rd Ventricle
- Lateral Ventricle
- Midbrain
- Frontal Lobe
- Temporal Lobe
- Occipital Lobe
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- Lateral Ventricle
- Falx Cerebri
- Frontal Lobe
- Occipital Lobe
- Parietal Lobe
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T1 Sagital MRI
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T1 Saggital MRI
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T1 Saggital MRI

- Frontal Sinus
- Sphenoid Sinus
- Pituitary
- Clivus
- Tentorium Cerebelli
- Tongue
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T1 Sagital MRI
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T2 Axial MRI
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T2 Axial MRI

- Temporal Lobe
- Cerebellar Hemisphere
- Medulla
- Vermis
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T2 Axial MRI
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T2 Axial MRI

- Temporal Lobe
- Basilar Artery
- Pons
- 4th Ventrical
- Cerebellar Hemisphere
- Ethmoid Sinus
- Sphenoid Sinus
- Int Carotid Artery
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T2 Axial MRI
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T2 Axial MRI

- Frontal Sinus
- Frontal Lobe
- Internal Carotid
- Temporal Tip of Lateral Ventricle
- Temporal Lobe
- Occipital Lobe
- Midbrain
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T2 Axial MRI
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T2 Axial MRI
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T2 Axial MRI

- Splenium of CC
- Frontal White Matter
- Frontal Grey Matter
- Anterior Horn of Lat Ventricle
- Putamen
- Thalamus
- Head of Caudate
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T2 Axial MRI
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T2 Axial MRI

- Caudate Head
- Putamen
- Globus Pallidus
- Thalamus
- Anterior Limb Internal Capsule
- External Capsule
- Genu of Internal Capsule
- Posterior Limb of Internal Capsule
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T2 Coronal MRI
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T2 Coronal MRI

- Superior Sagittal Sinus
- Cingulate Gyrus
- Hippocampus
- Sylvian Fissure
- Temporal Lobe
- Basilar Artery
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MR Angiogram of Cerebral Vessels
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MR Angiogram of Cerebral Vessels
MR Angiogram of Cerebral Vessels
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MR Angiogram of Cerebral Vessels
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MR Venogram of Cerebral Vessels
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MR Venogram of Cerebral Vessels
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MR Venogram of Cerebral Vessels

- Superior Sagittal S.
- Straight Sinus
- Transverse S.
- Torcula
- Internal Jugular Vein
What is the Abnormality?
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Large MCA Stroke
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Intracerebral Hemorrhage
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Hemorrhagic Conversion
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T1 Axial MRI

FLAIR Axial MRI
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- DWI restriction
- ADC Map
- Old Gliosis
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- Mass Effect
- Sub Dural Hematoma
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Mass Effect

Epidural hematoma
Applicable Neuroradiology
Applicable Neuroradiology

Subarachnoid Hemorrhage
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MRI Scans

Without MGd

With MGd
Metastatic Brain Tumors
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Hydrocephalus

Transependymal Edema
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Applicable Neuroradiology

Syringomyelia
Bonus Round
T2 Axial MRI

4 y.o. with Gelastic Seizures
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T2 Axial MRI

4 y.o. with Gelastic Seizures

Hypothalamic Hamartoma
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T2 Axial MRI

10 y.o. with Developmental Delay and Epilepsy
T2 Axial MRI

10 y.o. with Developmental Delay and Epilepsy

Schizencephaly/Polymicrogyria
The End