

Introduction to Radiology

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What you will learn ?

- What are we doing in radiology?
- What are our tools?
- What are the major indications for imaging?
- What exam should you order in specific situations?
- Which information will you get from the exam you ordered?

Learning objectives

- Introduce basics of radiologic imaging
- Clinical relevance of basic sciences
- Glossary of radiology terms
 - Learn the lingo
- Become an educated consumer of imaging
- Learn systematic approach to CXR

Definition of Radiology

- Radiology is a medical specialty using medical imaging technologies to diagnose and treat patients.



Role of Radiologist

- Identify abnormality (NI or Abnl)
- Characterize abnormality
- Extent of disease (Staging)
- Differential diagnosis
- Suggest further work up

Role of Clinician

- Relevant history
- Consult with radiologist
- Pursue further work up
- Treat or refer patient

Basic radiologic signs

- Size
- Number
- Density/Intensity/Echogenicity
- Shape
- Position
- Architecture/Texture
- Function

Subspecialties of Radiology

- Abdominal Imaging (Body CT, US, MRI, Fluoro studies such as UGI and SBFT, Biopsies)
- Breast Imaging
- Cardiopulmonary Imaging (Chest, Cardiac)
- Musculoskeletal Imaging (Bone, ER RR, MSK MRI' s)
- Neuroradiology (brain/spine CT & MRI; lumbar punctures)
- Nuclear Medicine (wide variety, PET-CT, bone scans, Cards)
- Pediatric Imaging (wide variety)
- Vascular-Interventional (wide variety)

Radiology

- Radiography (XR Plain Films)
 - Mammography
 - Fluoroscopy
- Nuclear Medicine (NM)
- Ultrasonography (US)
- Computed Tomography (CT)
- Magnetic Resonance Imaging (MR, MRI)

X Rays

- A form of radiant electromagnetic energy
- Invisible to human eye
- Passes through objects
- Opaque to light
- Causes fluorescence
- Exposes film etc..



Physical principles

- Radiographic density
 - Composition (W) of material
 - Electron density
 - Thickness of object (thicker has more density)
- Density Interface
 - Interface or edge seen only with density difference
 - "Silhouette sign" (don't see interface)
- Magnification
 - Object to film distance (farther object => larger shadow)
 - X-ray tube to film distance (closer tube magnifies more)
- Motion unsharpness
- Superimposition (planar imaging like CXR)
- Volume averaging (cross-sectional imaging e.g. CT, MRI)

Basic densities

- Gas (Air)
- Fat and Lipid
- Soft Tissue (Muscle)
- Calcium (Bone)
- Heavy Metal

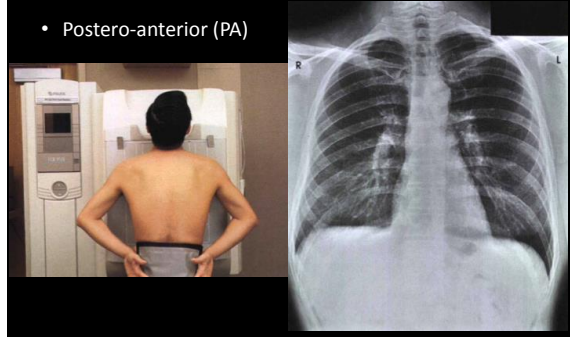


Terminology

- Direction of beam
 - (e.g. PA chest)
 - X-Rays pass from P to A
- Body part closest to film
 - (e.g. Left Lateral Chest)
 - X-Rays pass from L to R

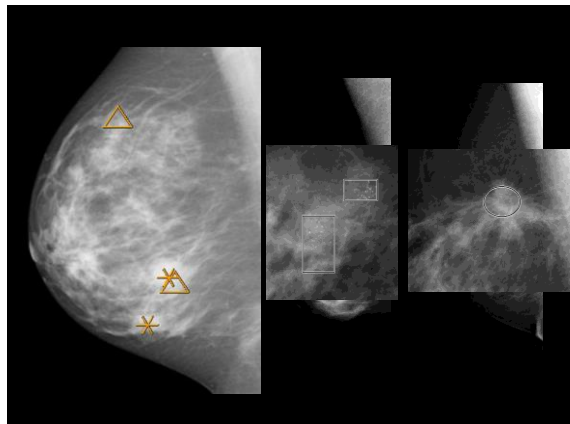
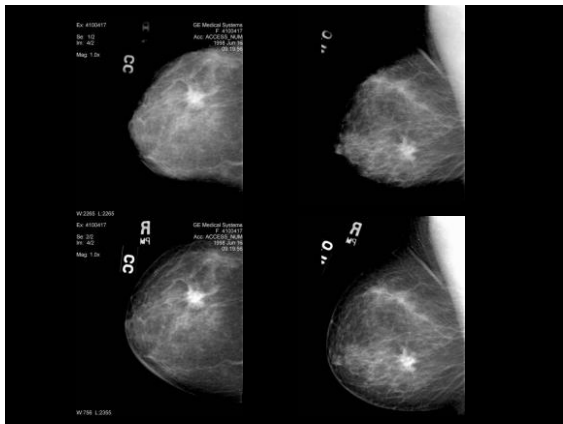
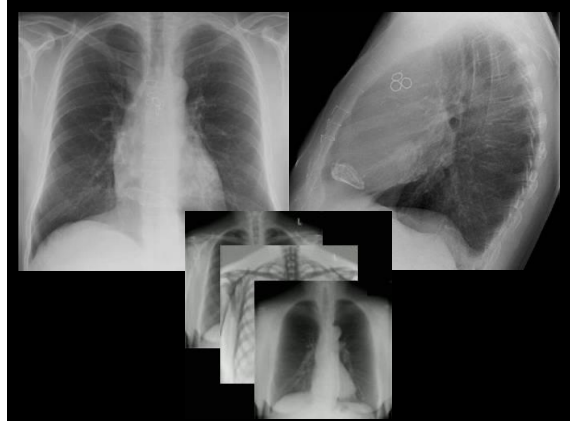
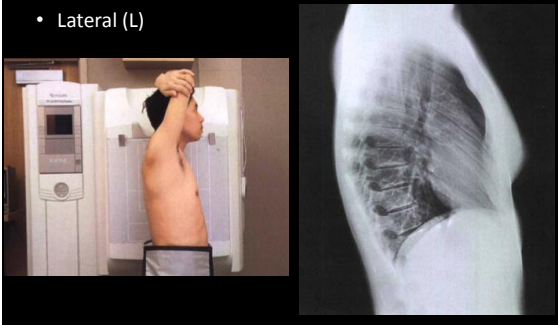
Radiographic positions

- Postero-anterior (PA)



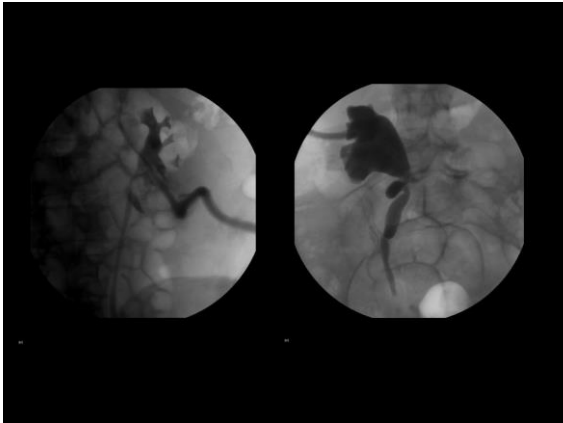
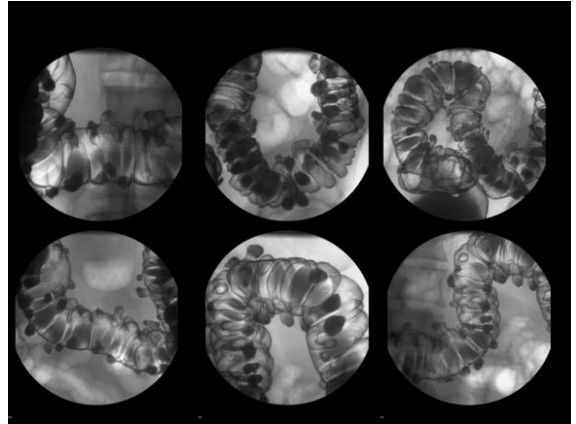
Radiographic positions

- Lateral (L)



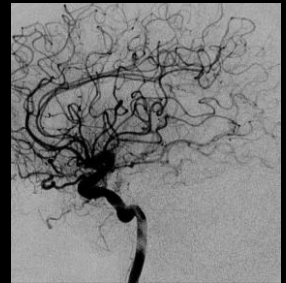
Contrast radiography

- Barium studies (BAS, UGI, LGI/BE)
- Cholecystography (Gall Bladder)
- Urography (Kidney function) (IV)
- Pyelography (Retrograde)
- Angiography/Venography
- Arthrography
- Hysterosalpingography
- Lymphangiography (Rare)

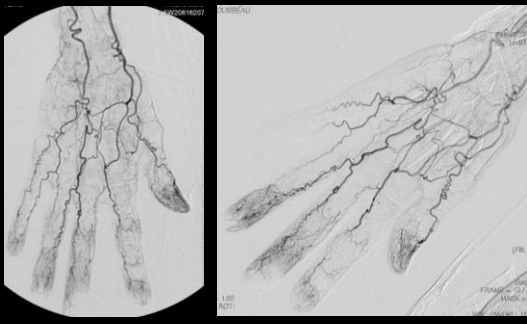


Angiography

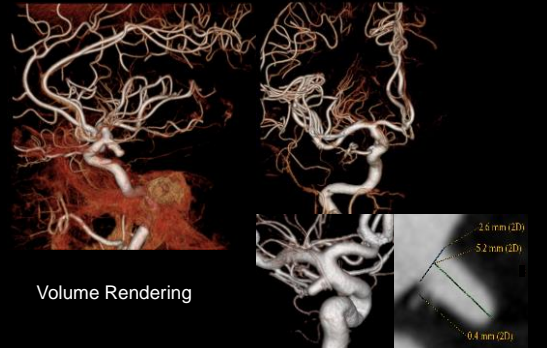
- Visualization of vessels
- Important in surgery
- Relatively invasive
 - (puncture vessel, inject contrast)
- Complications
 - (hemorrhage, embolus)
- Can be both diagnostic and therapeutic

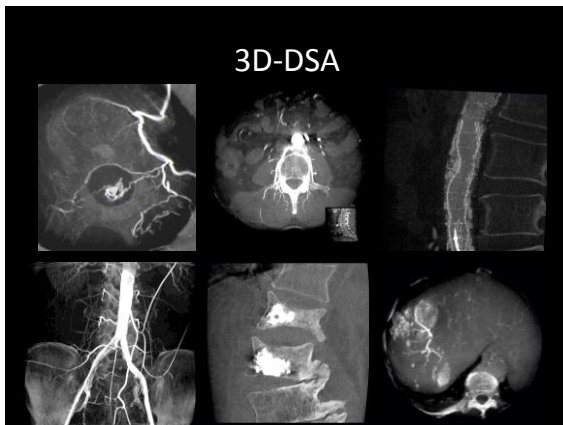
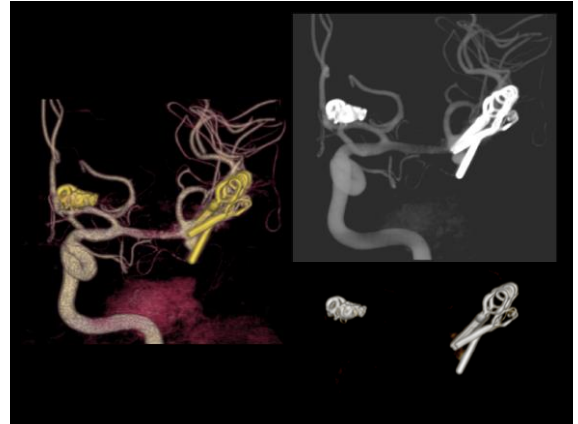
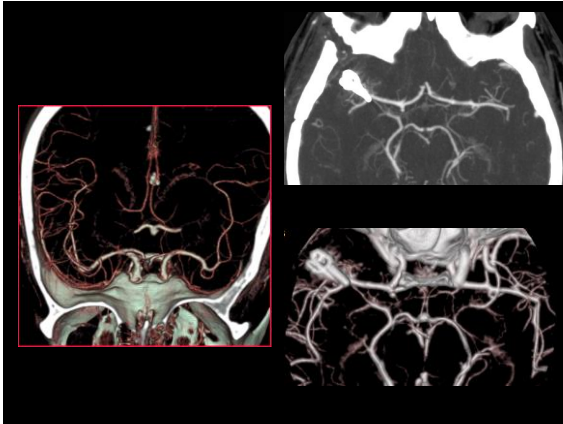


DSA



Flat-panel DSA





Nuclear Medicine

- Radioactive isotopes (Physiologic analogues)
- Gamma rays from radioactive nucleus
- Multiple images
- Dynamic studies
 - Bolus injection
 - Bleeding (labeled RBC's)
 - Gall Bladder secretion

Nuclear Medicine

- Skeleton
- Liver
- Lungs
- Thyroid/Parathyroid, Adrenal
- Heart
- Kidney
- Abscess and Inflammation

Cross Sectional Imaging

- US - Ultrasound
- CT - Computed Tomography
- MRI - Magnetic Resonance Imaging
- PET and SPECT Scanning
- MagnetoEncephaloGraphy (MEG)

Ultrasound

- Sound waves propagated through body
- Waves reflected by tissue interfaces
- Information processed and displayed (like RADAR)
- "Echogenicity" characteristics
 - Solid vs. Cystic



Ultrasound

- No ionizing radiation
- Ideal for OB/GYN, children
- Morphologic and dynamic information (peristalsis)
- Doppler technique shows flow
- Real-time Images (biopsy, fetal movement, heart, etc.)



US Terms

- Anechoic
 - Fluid
- Hypochoic
 - Most lesions
- Isoechoic
 - Tissue
- Hyperechoic
 - Calcium, Air



Computed Tomography

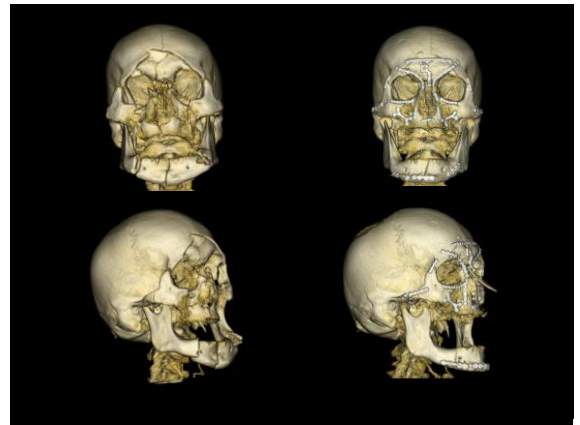
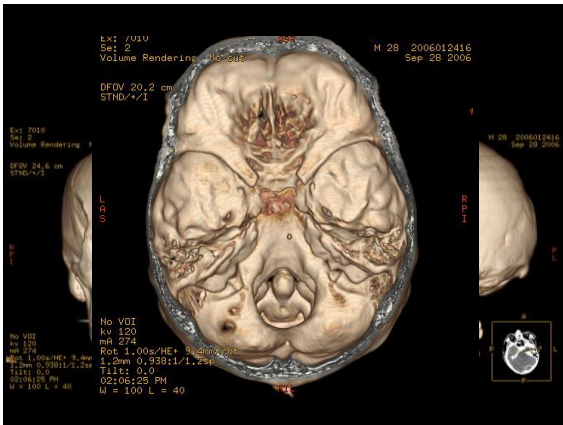
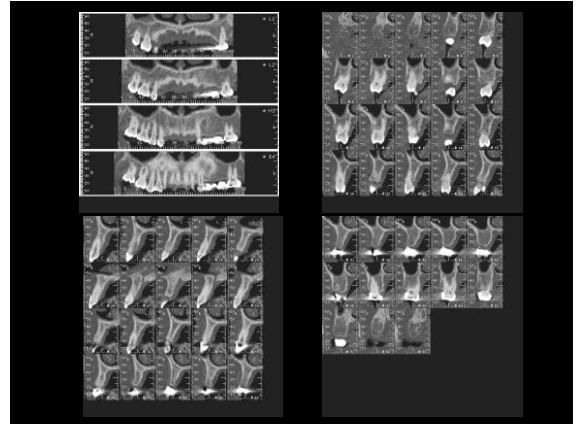
- Advantages
 - Rapid
 - Low cost
 - Available
- Disadvantages
 - Volume averaging
 - X-rays used

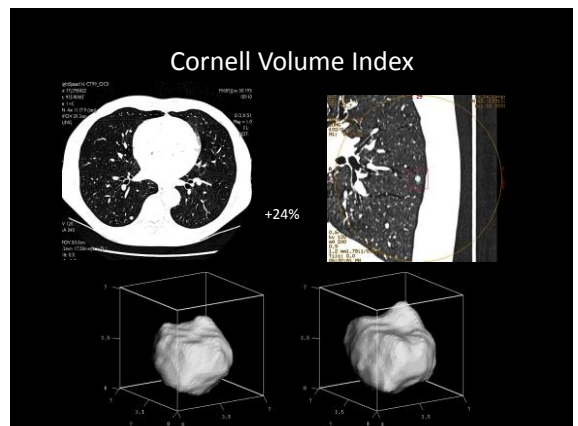
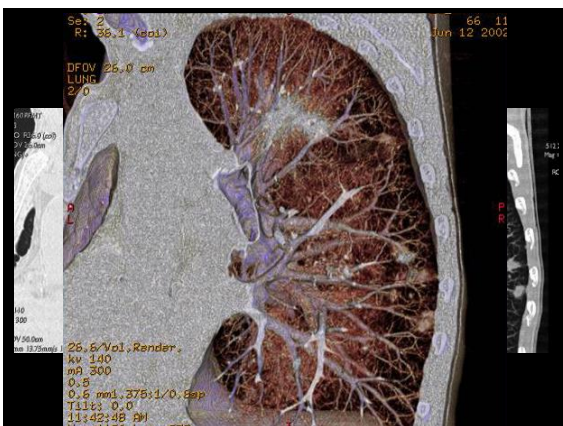
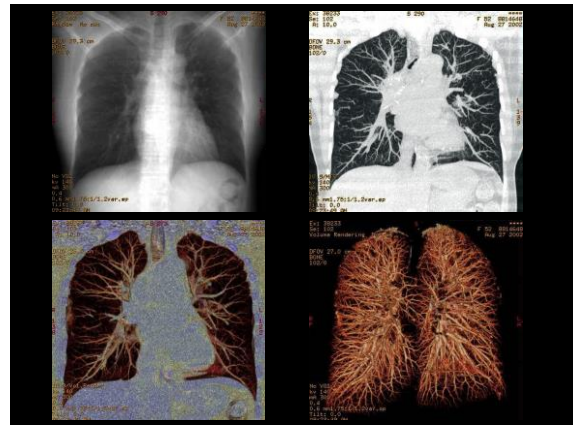
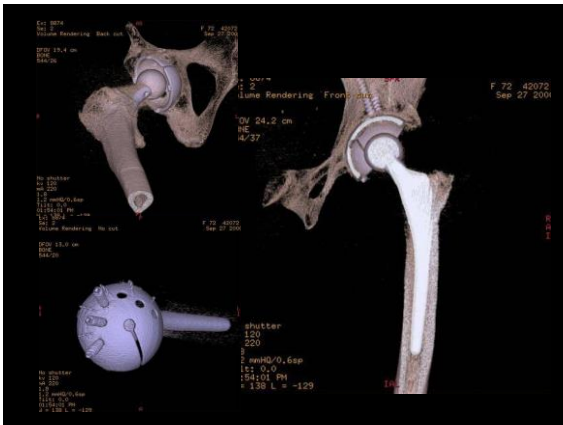
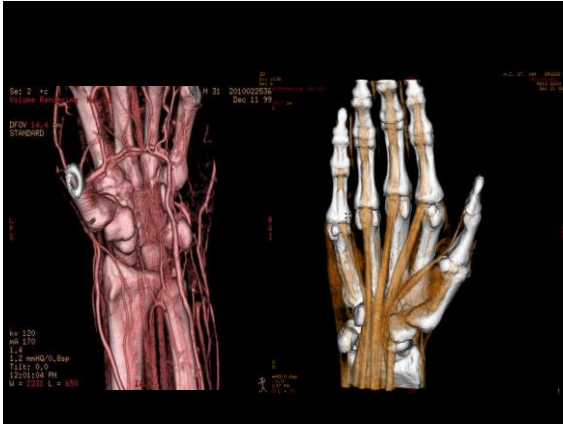


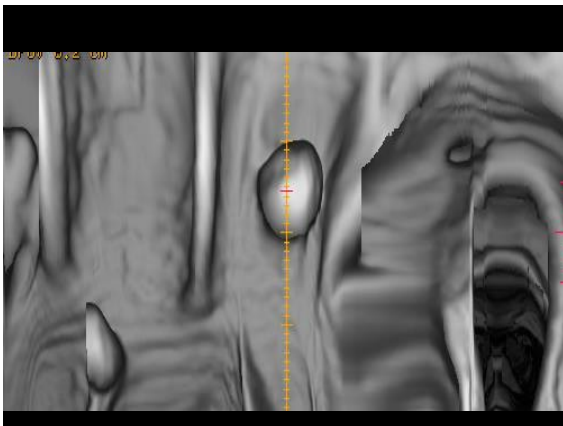
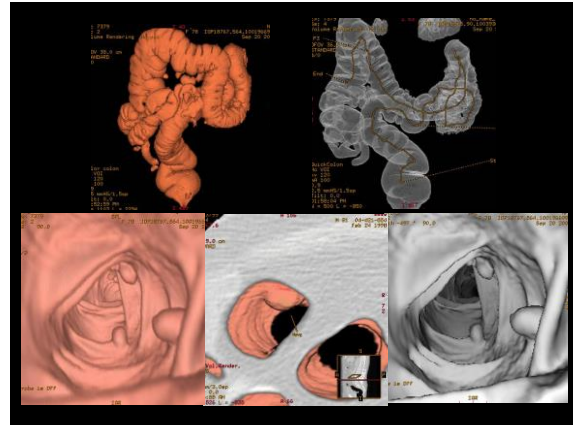
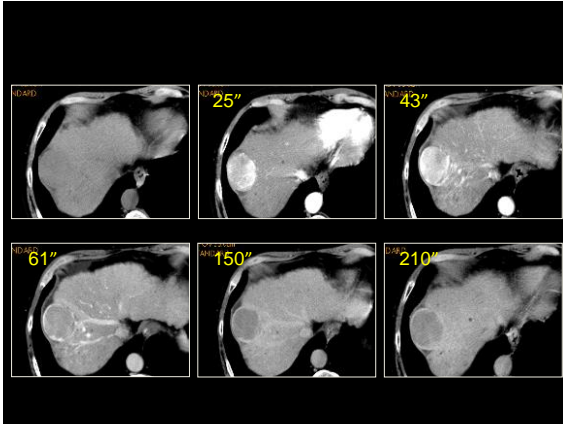
CT Terms

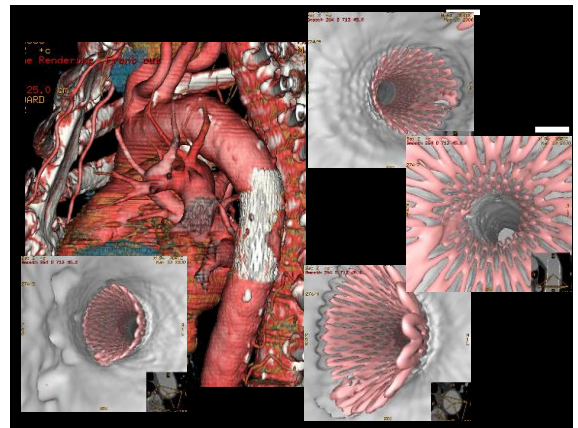
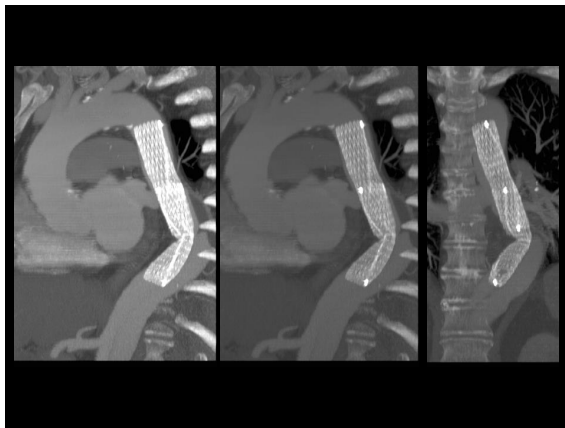
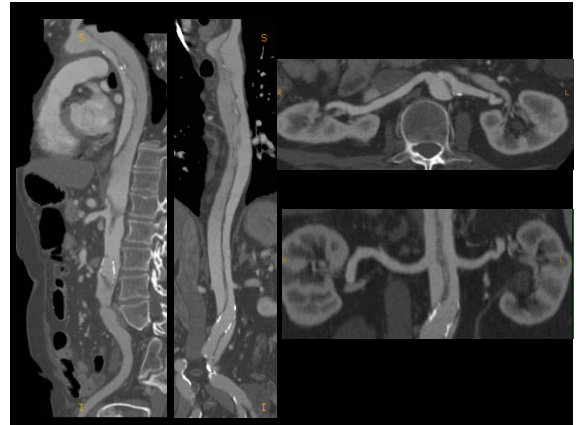
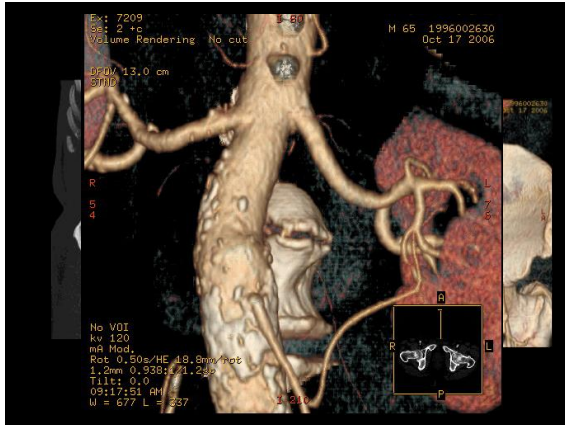
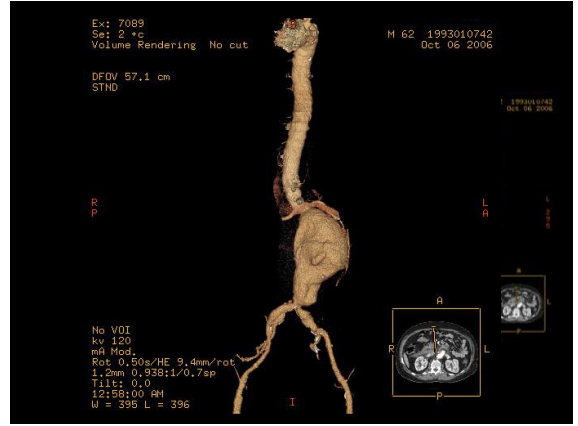
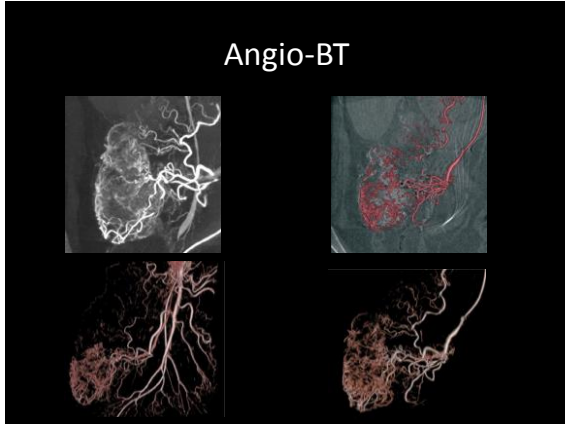
- Attenuation (density)
 - X-ray beam is blocked
- Hounsfield units
 - Inventor of CT
- Low attenuation
 - Black (gas)
- High attenuation
 - White (bone)
- Tremendous density resolution
 - 1500x better than X-ray
- 1-2 sec scan time is routine

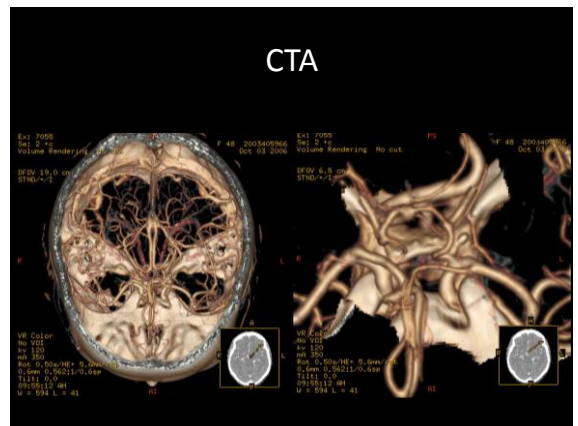
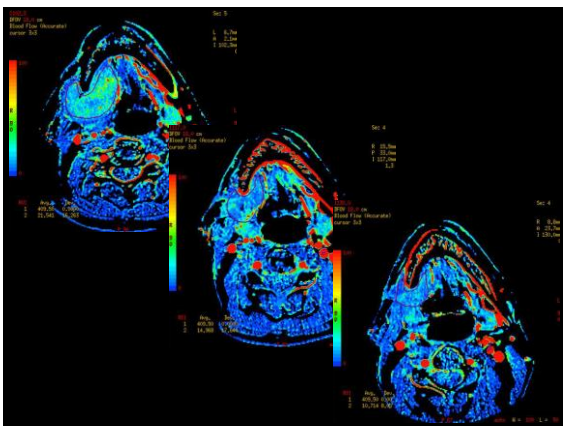
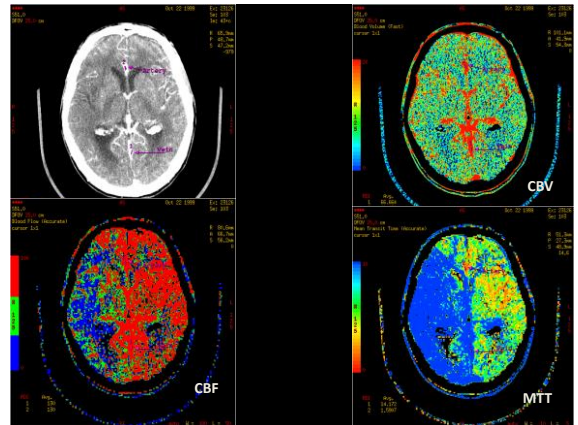
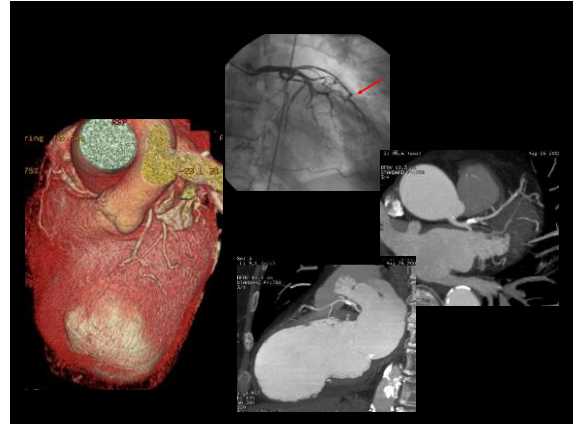
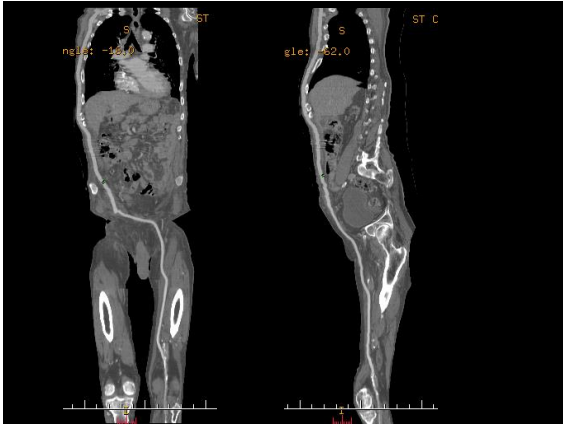




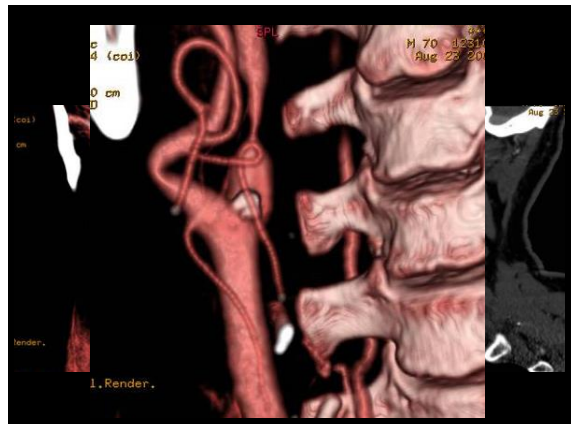
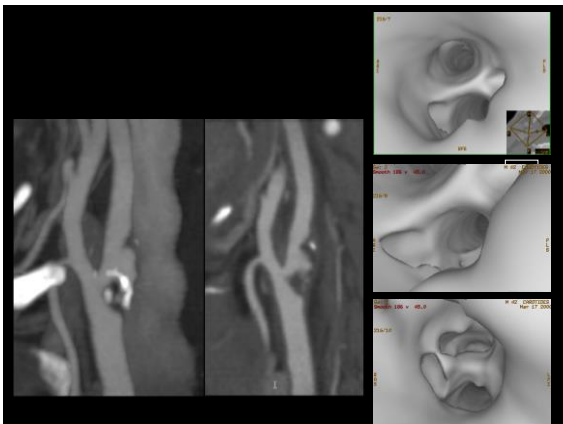
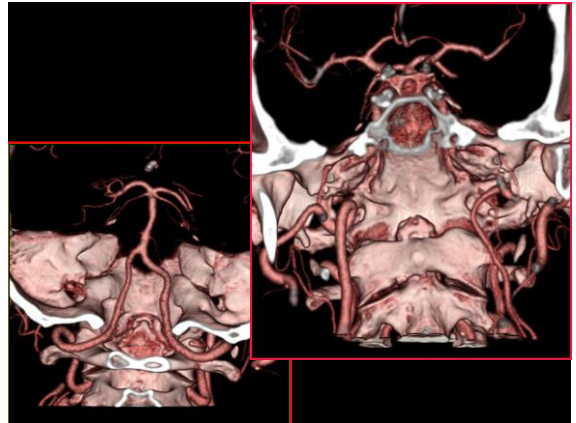
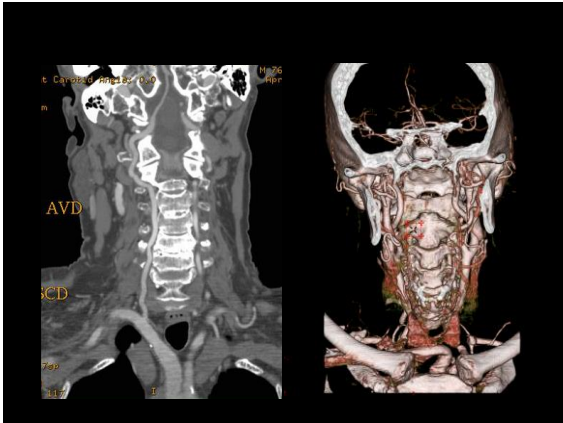
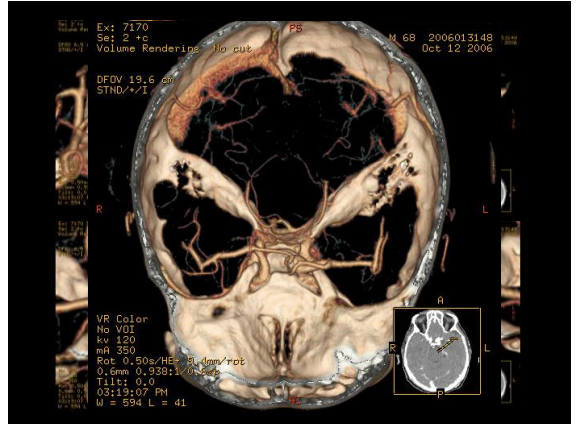
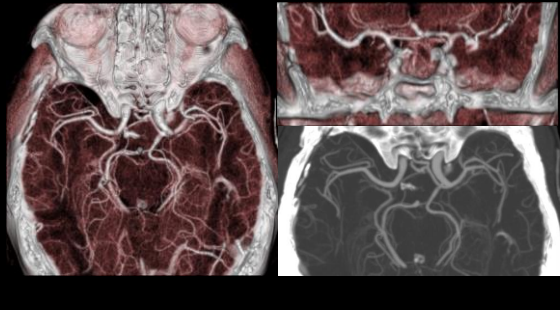








Willis circle



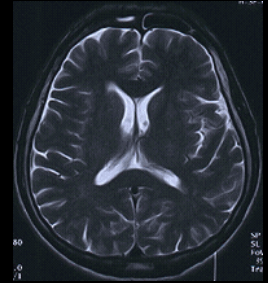
Magnetic Resonance Imaging

- Advantages
 - Rapid (sometimes faster than CT)
 - Cost (>>CT)
 - Generally Available (~ CT)
- Disadvantages
 - Claustrophobia
 - Metal and other artifacts
 - Magnetic Field and RF create image



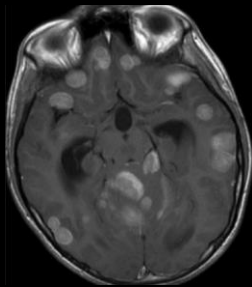
MRI

- Large Magnetic Field
- RF (MHz range)
- Measure PROTON Resonance
- Cross-sectional Anatomy
- Sensitivity vs. Specificity
- Flow Imaging (MR Angiography)
- Speed and Resolution ~ CT



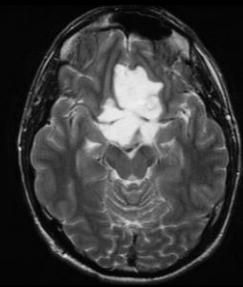
MRI Terms

- Signal Intensity
- T1 Weighted
 - Short T1 is BRIGHT
- Proton Density (in between)
- T2 Weighted
 - Long T2 is BRIGHT



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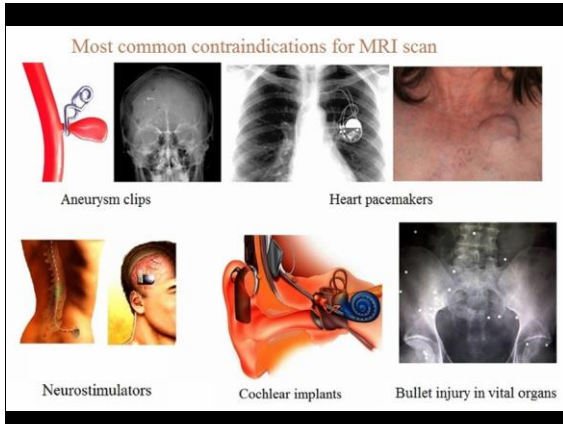


Indications for MRI

- White matter (leukoencephalopathy)
- Acute brain infarction?
- Spinal cord problems
- Posterior fossa
- Pediatric (or any ? of radiation)
- Head trauma
- Liver
- Normal CT

Contraindications for MRI

- Cranial Metal (Head, Brain, Orbit)
- Pacemaker (sensing)
- Hx of Metal Work, Shrapnel, etc
- Claustrophobia



The Recipe for the MR Scan

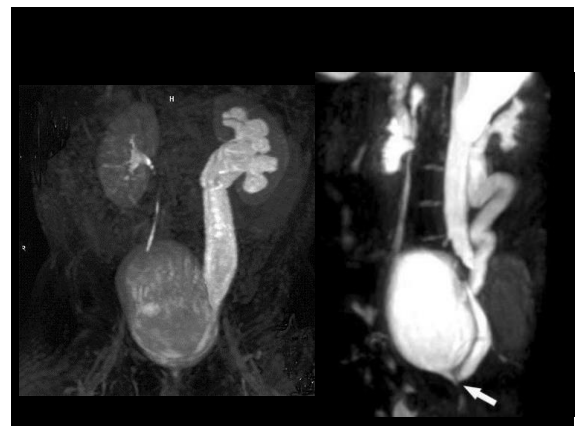
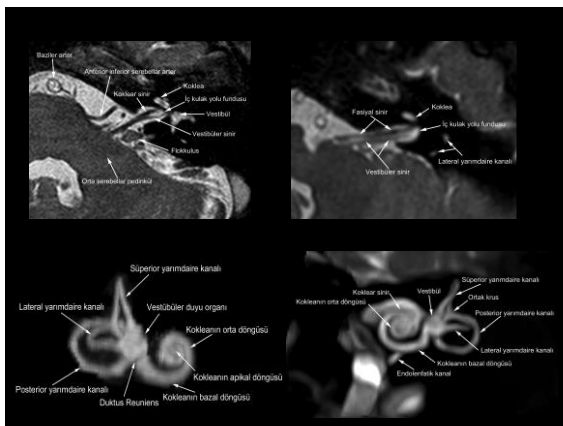
- TR - Repetition Time (between sets)
- TE - Echo Time (delay for listening)
- IR - Inversion Time

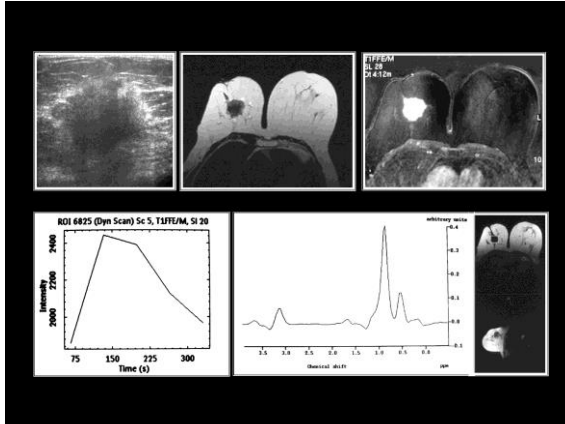
MRI

- Signal Intensity (S.I.) related to "proton density" and resonance properties of those protons
- Low S.I. (dark on many sequences)
 - Air
 - Cortical bone ,
 - Flowing blood
 - Fibrous tissue
 - Water/Edema (on T1W)
- High S. I. (white)
 - Fat (and other lipids)
 - Hemorrhage
 - High protein
 - Melanine
 - Microcalcifications
 - Water/Edema (on T2W)

MRI Advantages

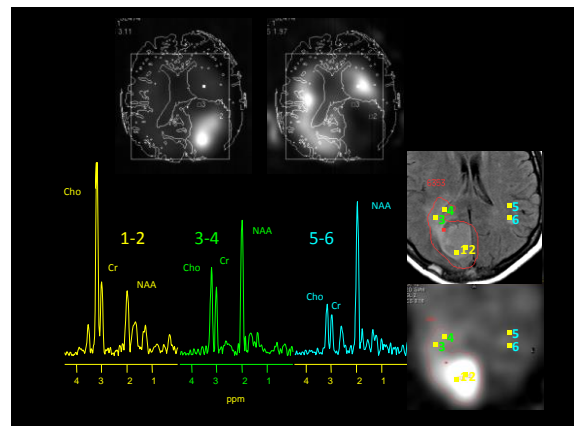
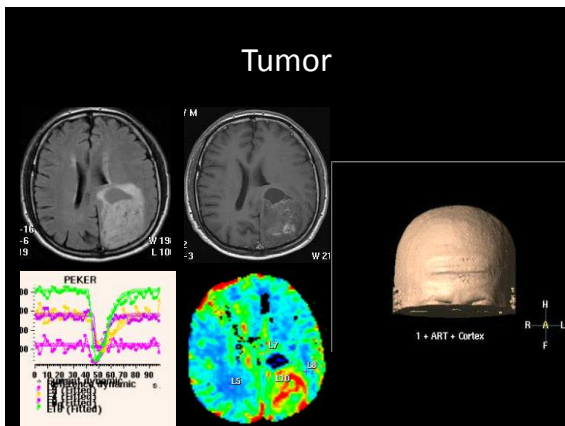
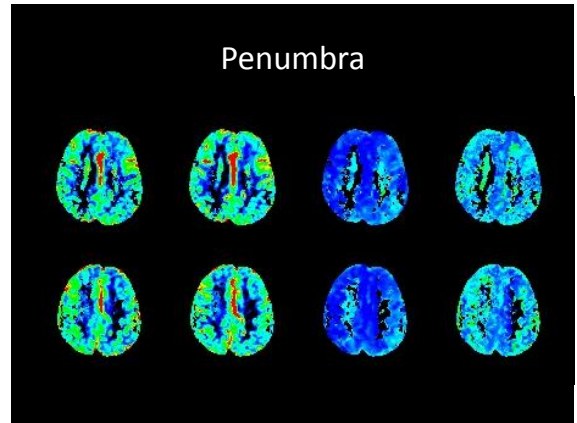
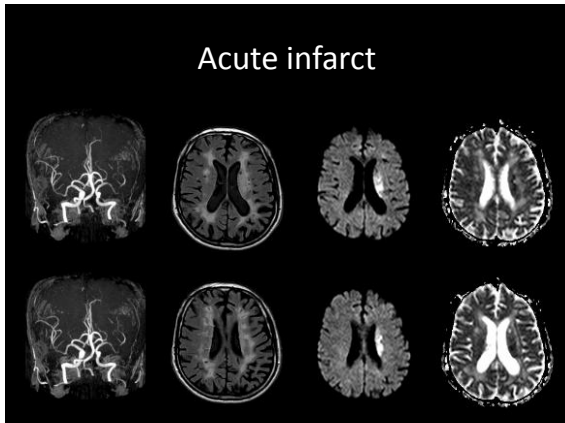
- No ionizing radiation
- Multi planar imaging
- High contrast resolution
- Non-invasive vascular imaging





MRI

- Turbo SE T2 W
- Turbo FLAIR
- EPI DWI
- EPI PWI
- MRA (2D-PC)
- Turbo SE T1 W
- Turbo GE T2 W



Cortical connections

