RADIOLOGY
TEAM 435

Introduction to Radiology

[Color index: Important | Notes | Extra]

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• Objectives:

1. Introduce the various Medical Imaging Modalities.
2. Understand the basics of image generation.
3. Relate imaging to gross anatomy.
4. Appreciate constraints and limitations.
5. Develop imaging vocabulary in the interpretation.

• Resources:

- 435 Slides
- 434 Team
- 435 Notes

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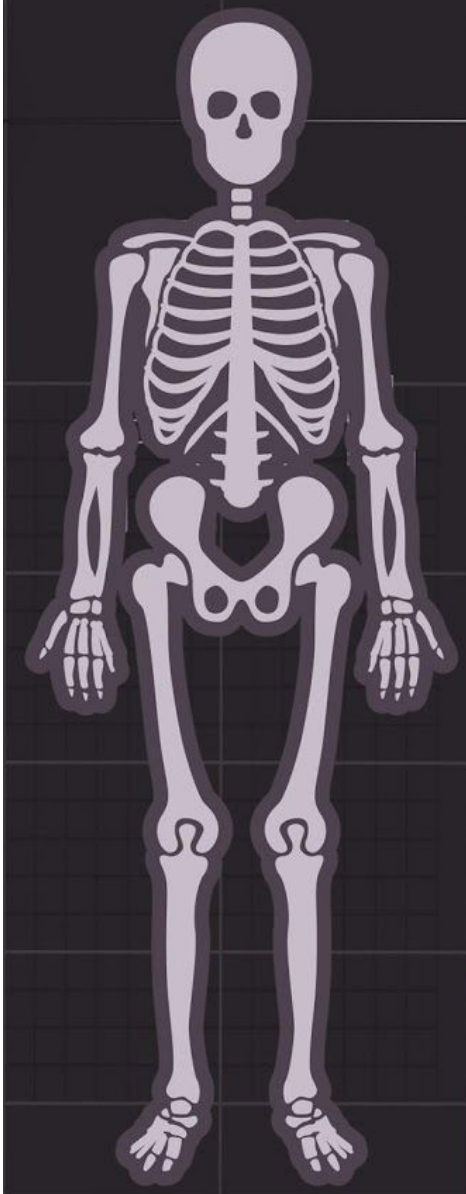


Introduction

WHAT IS RADIOLOGY?

Supervises & perform then interpret the Images and reports the findings to the physicians to help patient's management.

Radiological Modalities					
Plain X-Ray	**CT**	**Angiography**	**Nuclear Medicine**	**MRI**	**Ultrasound**
Ionizing Radiation			Minimal Ionizing radiation	Non-Ionizing Radiation	

Contrast Media

Natural contrast in the body:

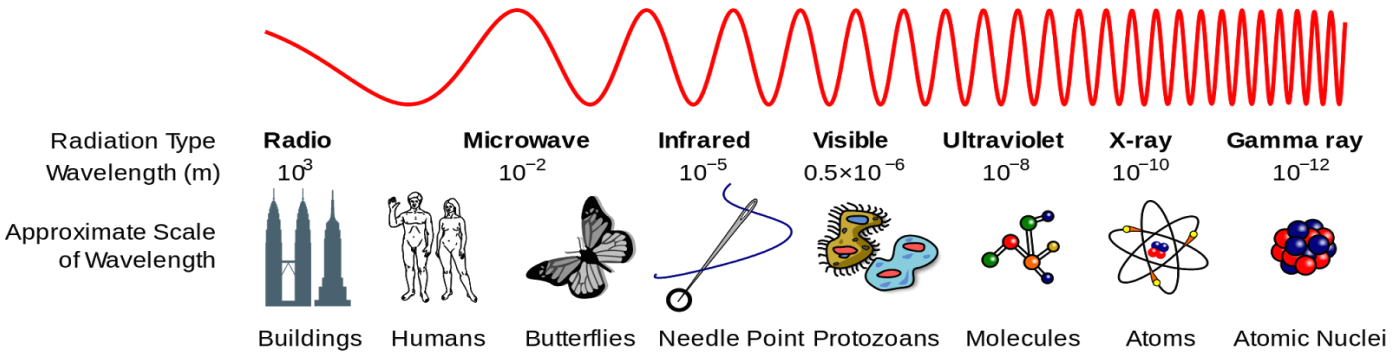
- Air.
- Fat.
- Bone.

Added contrast in the body:

- Barium sulfate: only orally.
- Iodine (Water Soluble): IV , orally.

X-Rays

- **It is a form of ELECTROMAGNETIC ENERGY that travel at the speed of light.**
- **Discovered and named by Dr. W. C. Röentgen at University of Würzburg, 1895.**
- **Electromagnetic energy wave spectrum:**



X-Rays are emitted (produced) and detected in cassette generating, either a hard copy film or a digital image. The X-Ray beam (Emission of electromagnetic radiation or particles from the X-Ray tube) interaction with body tissue can:

1. **Pass all the way through the body**
   - Render (make) the film **DARK, BLACK, Radio-LUCENT.**
   - Air has a low atomic number ⟶ X-rays get through ⟶ image is **DARK.**
2. **Be deflected, scattered or absorbed**
   - Render (make) the film **LIGHT, WHITE, Radio-OPAQUE.**
   - Bone has a high atomic number ⟶ X-Rays are blocked ⟶ image is **light**.

In conclusion, the darkness of the image depends on the thickness of the tissue.

ADVANTAGES	DISADVANTAGES
❑ Widely available. ❑ Inexpensive. ❑ Doesn't require advanced technologist knowledge. ❑ Can be performed quickly. ❑ Can be Portable.	❑ Ionizing Radiation. ❑ Relatively insensitive (superimposed structures).[1] ❑ Requires patient cooperation.

[1] Structures lay on top of each other, so you can't see anatomical or pathological structures clearly.

Fluoroscopy

Combination of:

1. X-Rays.
2. Contrast agents.

Technique:

- **Real-time imaging**: dynamic, detect the movement of the contrast fluid in certain organs e.g. to assess esophagus leakage after swallow in the GIT).
- **Using intensifier:** to magnify the X-Rays without increasing the amount of radiations for patient's safety.

Used in:

1. GIT imaging.
2. Genitourinary imaging (commonly used for UTIs).
3. Angiography (vascular system).
4. Intraoperative (during surgery).
5. Foreign body removal.
6. MSK.

ADVANTAGES	DISADVANTAGES
❑ Widely Available. ❑ Inexpensive. ❑ Functional + Anatomical imaging. ❑ No sedation required.	❑ Requires ingestion/injection of contrast medium. ❑ Patient cooperation. ❑ Time consuming.

Computed Tomography

How does CT work?

By rotating an X-Ray tube with the X-Ray detector, and the patient will go through these rays. Then, we will receive cross-sectional images (like slices). Each slice is an image by itself. We reconstruct these images to create other images from different views (coronal for example), which are 3D images.

- Relies on X-Rays transmitted through the body.
- Images consist of sections (slices) through the body, and are taken horizontally.
- To show coronal (frontal) or Sagittal images, data are manipulated (reconstructed) by a computer.
- Differs from conventional radiography (traditional X-Ray) in that a more sensitive X-Ray detection system is used.
- It has the capability to measure the density by analyzing the chemical component of tissue.

- **It has two windows:**
  1. **Wide window:** to visualize **more structure within a certain organ** such as bronchi, vessels and alveoli in the lung (Lung window).
  2. **Narrow window:** to visualize **certain structures within certain region** such as major vessels and heart in mediastinum (mediastinum window).

- CT often requires a contrast. however, an example that doesn't require a contrast is stone imaging.
- Density is measured by Hounsfield Unit[2] (HU).
- Has very small differences in X-Ray absorption values compared with conventional radiography; the range of densities recorded is increased approximately 10-fold.

Densities					
Air	Fat	Water	Soft Tissue	Blood	Bone / Ca
-1000	-150	0	20-80	45-75	>100->100

ADVANTAGES	DISADVANTAGES
❑ Can give: Cross sectional, Sagittal and Coronal Images. ❑ More sensitive.	❑ High radiation. ❑ Expensive.

[2] Read more about it here.

Uses of CT	
Neuro-imaging	- Acute head trauma, **acute intracranial hemorrhage.** - We can use CT on patient that presents with headache to diagnose brain tumor. - Low sensitivity for: 1. Early ischemic stroke. 2. Intracranial metastatic disease. 3. White matter degenerative disease.
Head and Neck imaging	Soft tissue of neck, paranasal sinuses, temporal bone, and orbital wall.
Body imaging	- Chest, Abdomen, Pelvis (with enteric and IV contrast) - Pulmonary nodules, Renal Calculi (without contrast). - Acute appendicitis (with enteric and IV contrast).
Specialized protocols	Liver masses, pancreatic tissue, renal masses, and adrenal masses.
Acute abdomen	Decrease rate of false laparotomy (a surgical incision into the abdominal cavity, for diagnosis or in preparation for surgery).
Trauma spine imaging	(cervical, thoracic, lumbar) It can miss fractures.
Other osseous structures	(pelvis and extremities).
Vascular imaging	CT angiography i.e. coronary arteries.

So gradations of density within soft tissues can be recognized, e.g. brain substance from cerebrospinal fluid, or tumor from surrounding normal tissues.

There is major risk behind CT scan:

1. One brain CT scan radiation = 200 X-Ray radiation.
2. One pelvic CT radiation = 400 X-Ray radiation.

So don’t request a CT scan unless needed, and we can't use it for a pregnant women unless absolutely necessary.

Magnetic Resonance Imaging

- MRI sees tissues based upon sub-atomic characteristics (magnetism).
- Proton nucleus of Hydrogen has small magnetic field that can be used to detect tissues containing hydrogen.

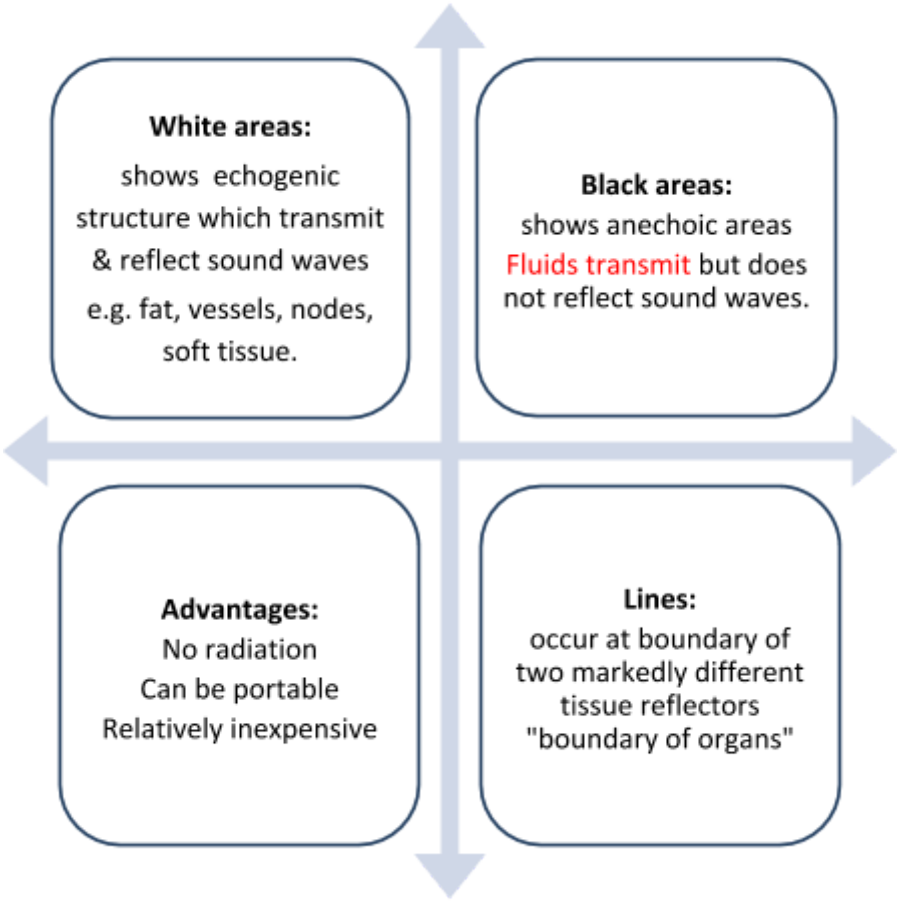
Hydrogen Atoms (protons) in water molecules and lipids:

1. Magnetism affects all protons causes them to line up in one direction.
2. Magnets can be switched on and off to change the direction of the magnetic field.
3. Whenever the water molecule spin around they give a light radio wave.
4. MRI machine can detect it and shows it as an images.
5. Like CT, gradation of density within soft tissues can be recognized.

ADVANTAGES	DISADVANTAGES
❑ Best for soft tissue imaging (tumors and infections). ❑ No ionization. ❑ Can be done for pregnant women. ❑ Images can be obtained in any plane.	❑ Expensive. ❑ Time consuming. ❑ May evoke phobias Claustrophobia (narrow places). ❑ No metals allowed. ❑ Motion.

Ultrasound

- Ultrasound is sound waves with frequencies which are higher than those audible to humans (>20,000 Hz).
- Ultrasonic images also known as sonograms are made by sending pulses of ultrasound into tissue using a probe.
- The sound echoes off the tissue; with different tissues reflecting varying degrees of sound.
- The echoes are recorded and displayed as an image to the operator.



Nuclear Medicine

- Uses gamma rays to produce an image (Counts or Activity).
- Radioactive nuclide given IV, per os, per rectum etc.
- Rays emitted from the patient.
- Physiologic imaging (Abnormal function, metabolic activity).
- Poor for anatomical information.
- Radioactivity stays with the patient until cleared or decayed.