Structured Notes According to

RADIOLOGY

Revision friendly **Fully Colored Book/Structured Notes**

For Best results, watch the video lectures along with reading notes

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(Author)

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In case of any discrepancy between book and videos, Authors's videos on PrepLadder app should be considered.

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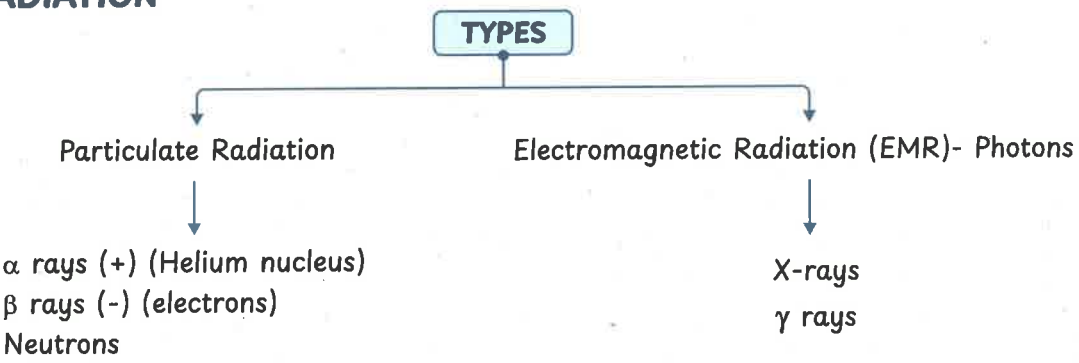
Radiology

1. BASICS OF X RAY/FLUOROSCOPY/ MAMMOGRAPHY

TYPES OF RADIATION

00:00:37



IONISING POWER AND PENETRATION

00:01:45

- Ionizing power → Amount of damage that occurs due to free radicals from radiation
  - AKA: [redacted]

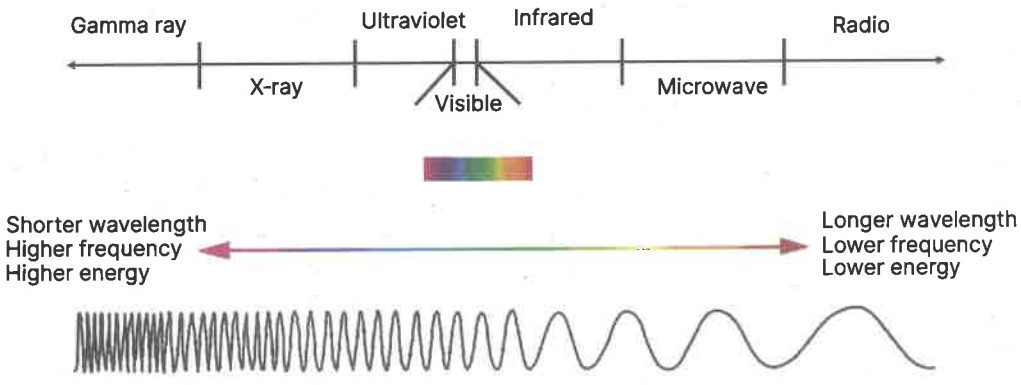
IONIZING POWER → α > β > X-Rays > γ rays

PENETRATION POWER → α < β < X-Rays < γ rays < Neutrons

TYPES OF INVESTIGATION

00:03:07

IONIZING	NON-IONIZING
• Radiography • CT scan (3D X-rays) • Contrast X-rays: → [redacted] • Gamma rays ○ Nuclear medicine → PET	• USG: Doppler, FAST • MRI: radio waves: → MRCP • Thermography



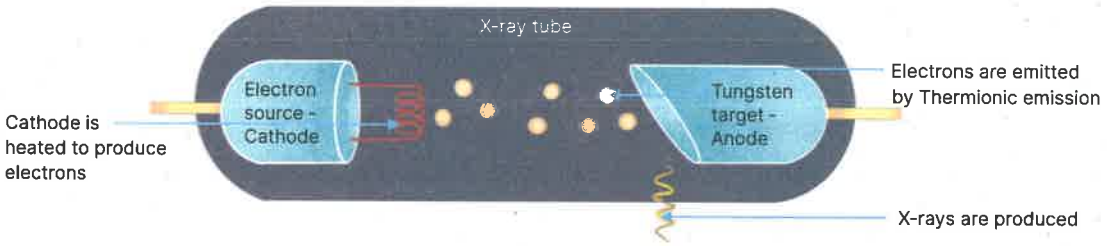
X-RAYS VS GAMMA RAYS

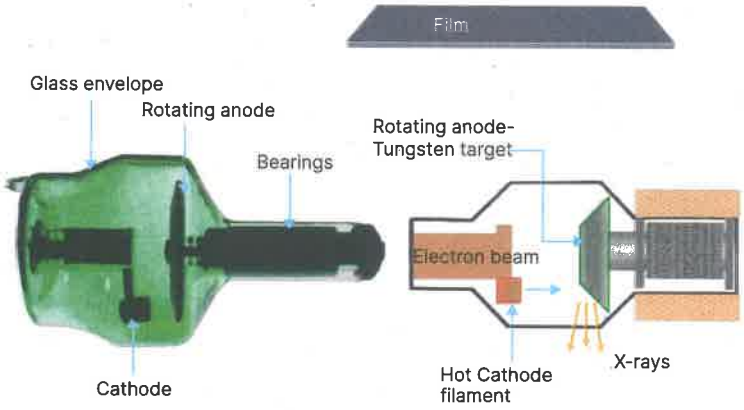
00:06:12

- Gamma rays → By nuclear disintegration
- X-rays →

X-RAY PRODUCTION

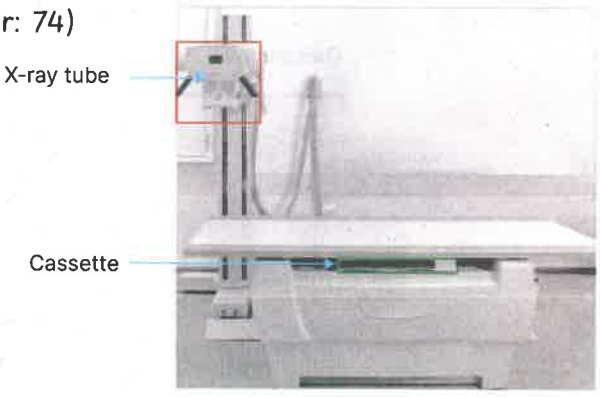
- **Cathode (Filament)**
  - Electron source emitting electrons via [redacted] when heated
- **Anode (Tungsten Target)**
  - Stops electron beams
  - Converting their energy into X-rays, which pass through the window and reach film
  - Rotating anodes: ↑ Life of anode
  - Stationary anodes: Emergency department and Dental clinics
- **Focusing cup** in X-ray tube: Prevents deviation of electrons





X-RAY TUBE COMPONENTS

- Glass envelope – Coated with lead (Pb)
- Cathode: Tungsten (W, Atomic number: 74) and Thorium
- Anode: Tungsten and Rhenium
- Focusing cup: Nickel



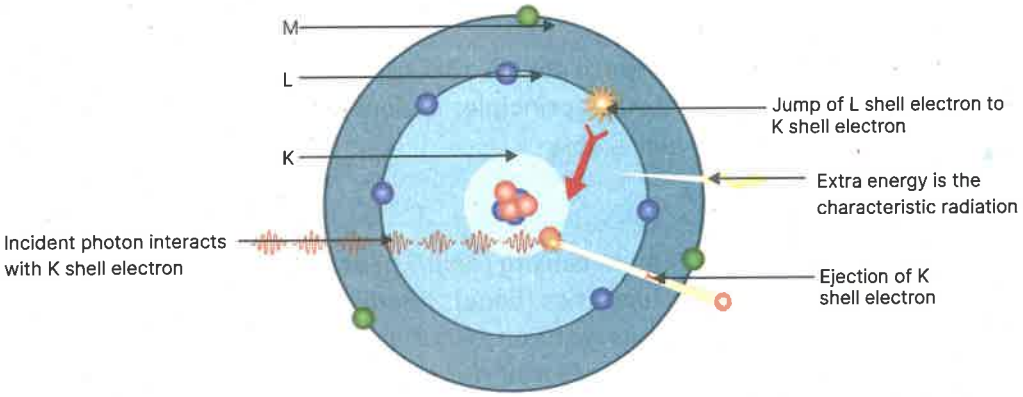
X-RAY PRODUCTION MECHANISM

Bremsstrahlung radiation

- Electron beam → towards anode → nucleus deflects beam → beam travels in different direction
- Deflection → ↓ in energy & emission of X-rays
- Aka: braking radiation

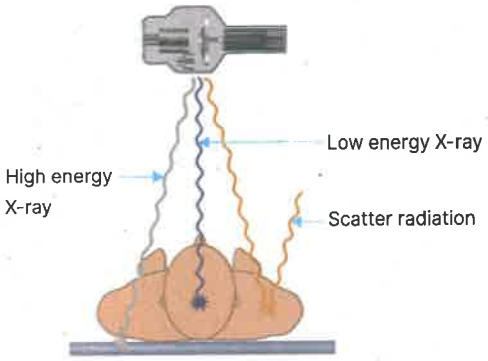
Characteristic radiation

- Generated when high-energy electrons eject inner-shell electrons of a target atom
- Outer-shell electrons fill the vacancy
- Releasing X-rays with energies unique to the target material's atomic number



FATE OF X-RAYS PRODUCED (Polychromatic)

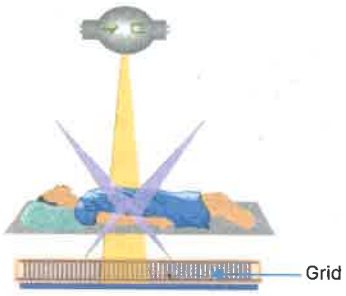
- High-energy X-rays penetrate → Image formation
- Low energy X-rays are absorbed patients body leading to radiation exposure.
- Scatter radiation.
  - Filter → [redacted]
    → Helps to remove the low-energy X-ray
- Lead apron → protect from scatter radiation

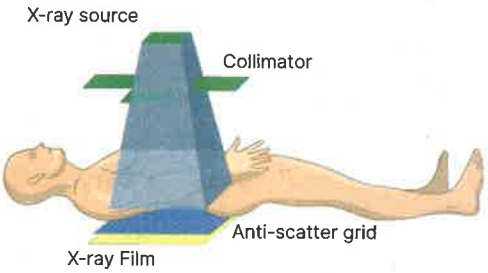


X-RAY INTERACTIONS

	Photoelectric Effect	Compton Effect
Shell	• Innermost	• Outermost
Energy	• Low energy photon	• High energy photon

Effects	• Good
	• Produces contrast in the films
		• Bad, produces scattered radiations on the film
		• Scatter radiation is reduced by
		  ○ Placing grid, btw patient and film.
		  ○ [redacted]

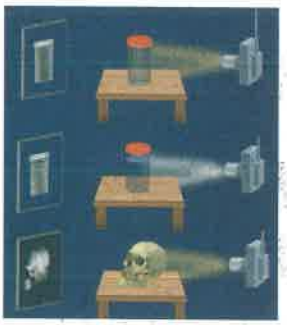




EXPOSURE FACTORS

- ↑ Kvp: ↑ penetration (used in obese pt.) & ↓ contrast
- ↑ mAs: ↑ Blackening of the film
-

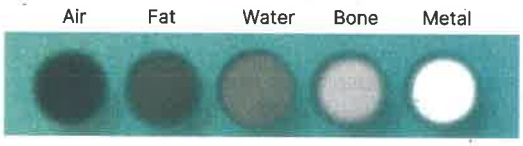
As distance double, radiation intensity become 1/4th
  - ALARA principle: as low as reasonably achievable



BLACK AND WHITE PRINCIPLE IN X-RAYS

- Minimum density (air): ↑ penetration → black appearance
- High densities (bone): ↓ Penetration, white
  - Lungs with consolidation, collapse, pleural effusionWhite
  - Pneumothorax Black

5 DENSITIES OF X-RAY



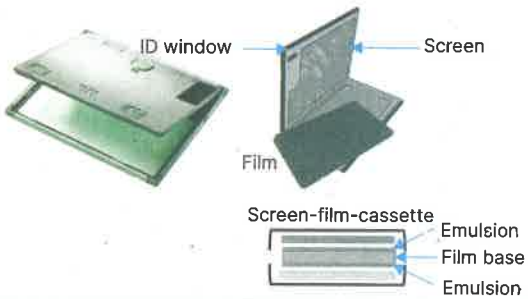
X-RAY FILM SIDE DETERMINATION

L → Left side of patient

TYPES OF RADIOGRAPHY

00:28:31

CONVENTIONAL/ FILM SCREEN RADIOGRAPHY



- X-ray Film: Made of [redacted] → Mainly silver bromi[redacted]
- Screen: Intensifies X-ray effects; films are light-sensitive and processed in dark rooms (has safe red light)
- Development: Takes ~ 45 minutes

CR (Computed Radiography)

- PSP plate: Photostimulable phosphor, plate
  - Replaces film, read by a scanner, sending images to a computer
- **Advantages over Conventional Radiography**
  - Faster
  - PSP is reusable
  - Images are editable, and number of retakes ↓

DR (DIGITAL RADIOGRAPHY)

- X-rays → emitted from tubes → detected by an electronic detector
- Image is available on computer
- **Advantages of DR**
  - No PSP plate
  - No film
  - Very fast
  - PACS (Picture archiving communication system) compatible (also CR is PACS compatible)

00:33:39

FLUOROSCOPY

- Video X-ray or Cine X-ray
- Used for moving objects/structures

Blood	DSA
GIT peristalsis	Barium study
Diaphragm	Palsy
C-arm	Used in ortho OT.
Contrast X-rays	Dye study

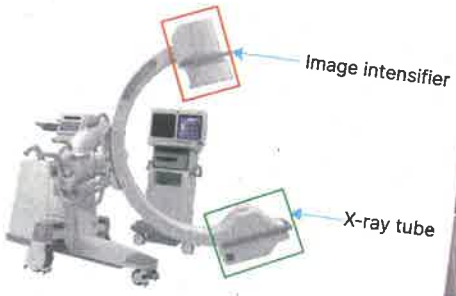
- Fluoroscopy: More radiation exposure than X-ray

00:36:2

C-ARM

- C-shaped machine with an [redacted]
- Image intensifier converts images into a video on the screen

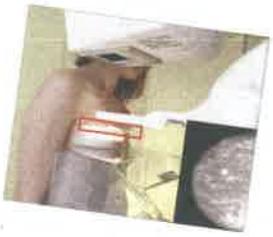
...ack ...(may appear black)
...and MR angio, vessels → white



MAMMOGRAPHY

MAMMOGRAPHY

- X-ray of breast.
- Has compression plates



INDICATION

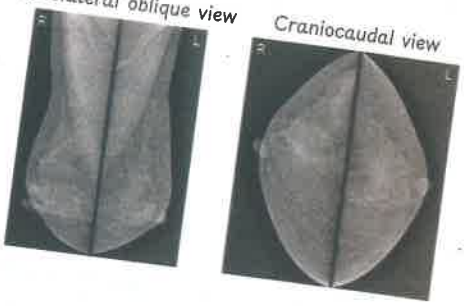
- Screening for breast cancer

CONTRAINDICATIONS

- Acute painful conditions: mastitis, breast abscess
  -
- Young female due to dense fatty breast (indicated >40 years)
- DCIS (MRI is more sensitive)

2 VIEWS

- CC view
- MLO View → axilla



MAMMOGRAPHY VS X-RAY

- Important finding: Microcalcification
  - BIRADS 5
- ↑Contrast ↓ KVP
- Anode made up of molybdenum and rhodium
- Window made up of Beryllium

Important Information

- BI-RADS 1 → Normal mammography

MCQ's

Q. Which of the following types of radiation has the highest penetrating power?

a. Alpha
b. Beta
c. Gamma
d. Neutron radiation

Ans: (d)

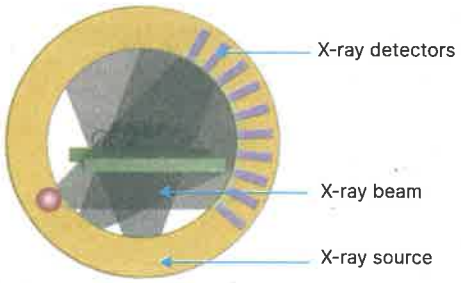
Q. What are the essential requirements for achieving effective mammography?

a. Low resolution and high radiation dose
b. Low resolution and low radiation dose
c. High resolution and high radiation dose
d. High resolution and low radiation dose

Ans: (d)

2. BASICS OF CT

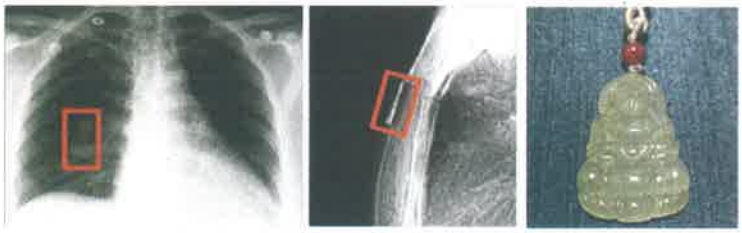
CT PRINCIPLE

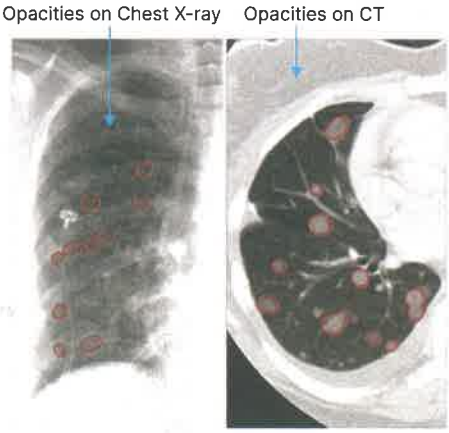


- CT (Computed Tomography): X-ray tubes
- Pitch
  - Distance the table moves for every gantry rotation
  - Inversely proportional to image quality and radiation dose

CT Vs X-RAY

00:02:37





- In X-ray →
  - Two perpendicular views are essential for localization
- CT imaging allows precise localization of nodules
  - No superimposition

Important Information

- Walls of CT room is coated with lead.

CT Vs MRI

00:04:11

CT SCAN	MRI SCAN
Radiation present	No radiation
Round gantry	Long tunnel
Faster	Takes longer time.

Preferred in emergency conditions

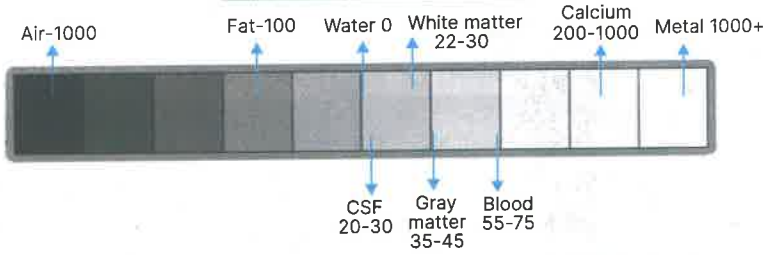
Not preferred in emergency conditions

HOUNSFIELD UNITS (HU)

- Godfrey Hounsfield invented the CT scan
- Based on attenuation of the X-rays
- Depends on radiodensity of substance

HU VALUE

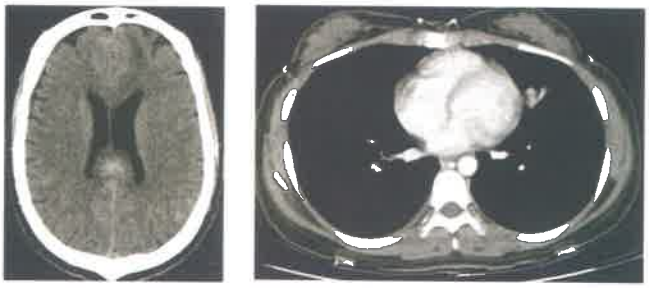
- Bones -
- Air - least attenuation (-1000)
- Water → reference substance: 0 HU value → Grey
- Less dense than water → -ve HU → black
- More dense than water →



CT number ranges in Hounsfield units (HU)

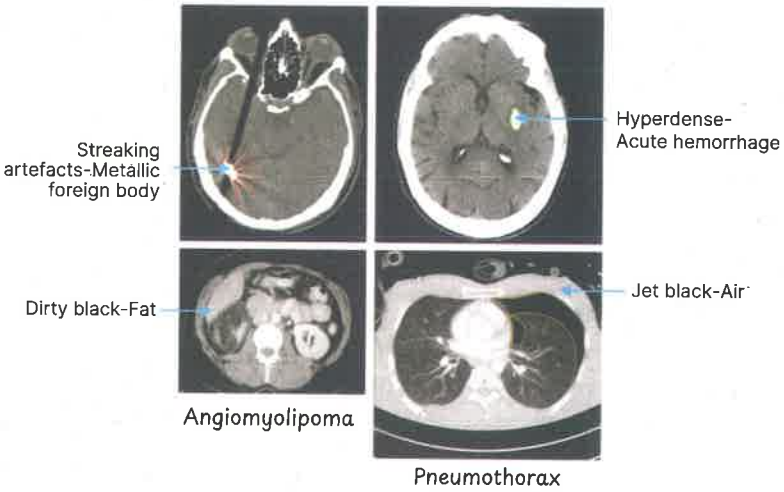
Bone	+1000
White matter	+20 to 30
Muscle	+20 to 40
Gray matter	+30 to 40
Hemorrhage	+65 to 95
CSF (water)	0
Fat	-30 to -70
Air	-1000

- Bone - White
- Fat - Dirty black
- Air - Jet black

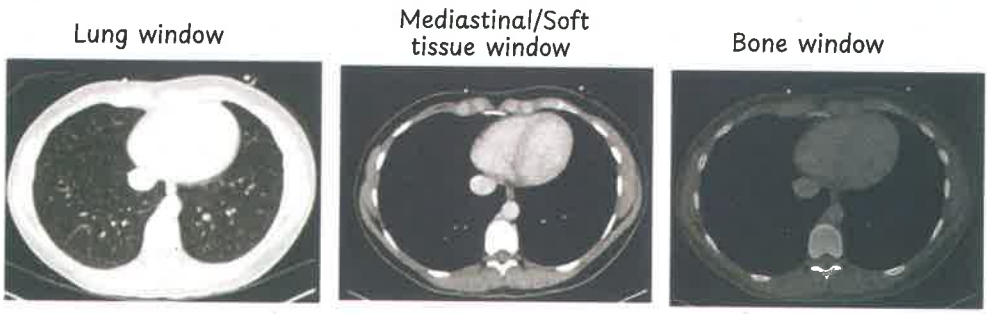


PATHOLOGIES ON CT

- Air → Jet black → Pneumothorax
- Fat → Dirty black → Angiomyolipoma of kidney in tuberous sclerosis



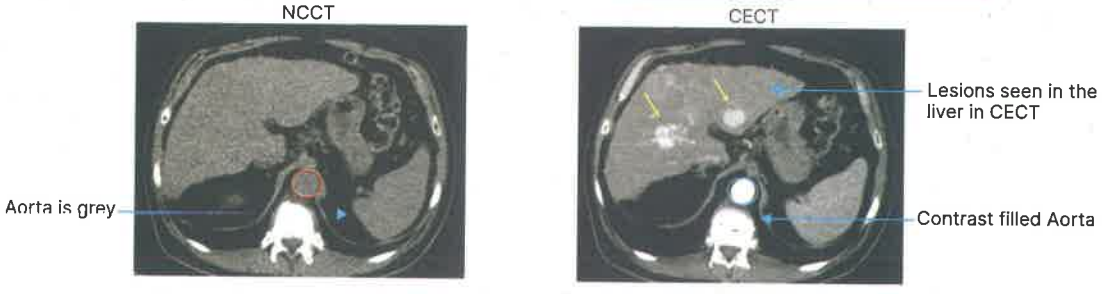
CT WINDOW



NCCT Vs CECT

00:11:53

	NCCT (NON-CONTRAST CT)	CECT (CONTRAST-ENHANCED CT)
Aorta	Grey	White

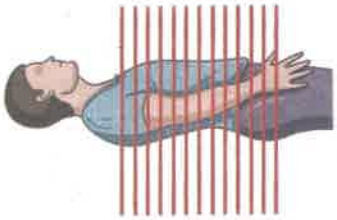


Liver Lesions	Not seen	Seen
Indications	• Calcification (Renal stones) • Acute hemorrhage - Hyperdense (chronic hemorrhage- SWi MRI) • Head Trauma except DAI (Diffuse axonal Injury →MRI)	• Lesions (space occupying lesions like liver, brain tumor, etc.) • Infective/inflammatory pathology

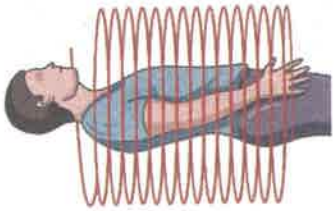
AXIAL CT VS SPIRAL CT

00:16:41

	AXIAL CT	HELICAL/SPIRAL CT
Movement	• Gantry bed moves after each X-ray tube rotation • Patient and gantry do not move simultaneously	• Patient and gantry move simultaneously due to slip ring technology
Time	Time-consuming	Quick whole-body scans are possible
Applications	Suitable for brain CT	Suitable for whole-body, cardiac (done in mid-diastolic phase), lung, and abdominal scans
Technology	Traditional setup	Uses multi-detector CT (MDCT) with slip ring technology
Reconstruction	Limited reconstruction capability	Allows multi-planar reconstruction



Axial CT



Helical/Spiral CT

HIGH-RESOLUTION COMPUTED TOMOGRAPHY - HRCT

00:20:05

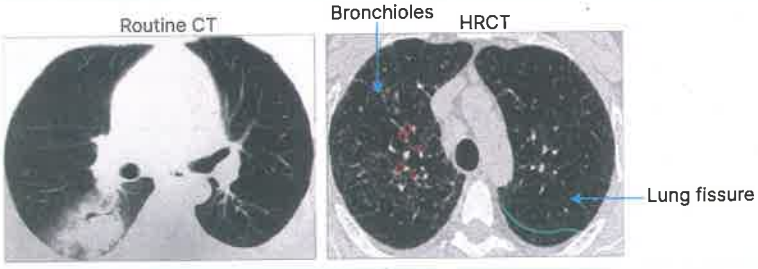
Uses

- Used in air containing cavities surrounded by bones
  - In chest : Bronchiectasis and ILD
  - PNS (Paranasal sinuses)
  - Temporal bone fractures

Features of HRCT

- Slice thickness is thinner than routine CT
- Field of view is small →
- Bone algorithm is used for reconstruction → of sharper images

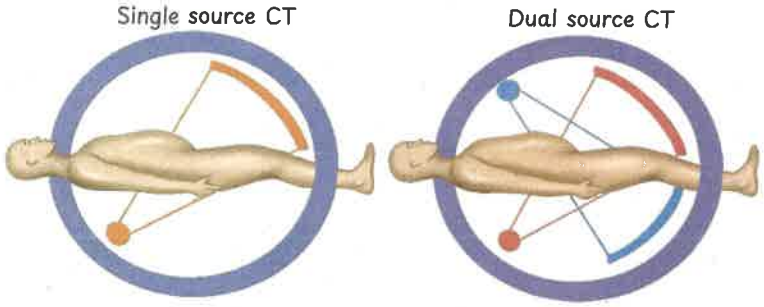
Routine CT Vs HRCT



DUAL ENERGY CT

00:20:00

- Identifies radiolucent stones (e.g., uric acid stones in gout)
- Uses two different x-ray tubes: Low and high Kv tubes



OTHER SPECIAL CT

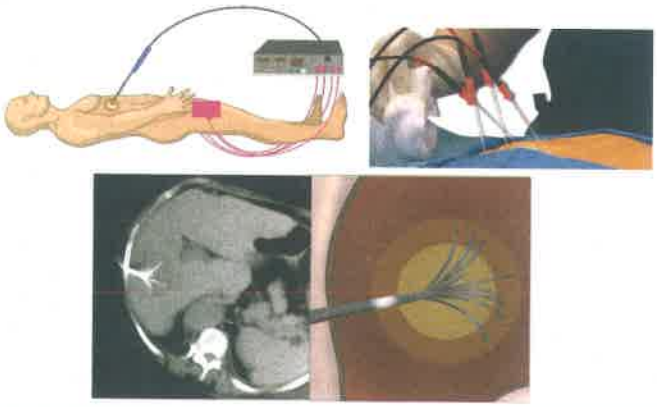
00:23:00

OTHER SPECIAL CT	USES
CTPA (CT Pulmonary Angiogram)	IOC: pulmonary embolism.
CT Cisternography	To pick up the site of CSF leak
Virtual colonoscopy/ bronchoscopy	
CT perfusion	Ischemic penumbra
CT Urography	Counterpart of X-ray IVP
Triple phase CT	Liver lesion characterization

THERAPEUTIC APPLICATIONS OF CT

CT-GUIDED RFA

- For location identification
- HCC, Osteoid osteoma



MCQ's

00:25:20

Q. Which of the following has a negative HU value
   a. Water
   b. Fat
   c. Bone
   d. Metal

   Ans: (b)

Q. CT is investigation of choice for
   a. Chronic hemorrhage
   b. Minimal pleural effusion
   c. Head trauma
   d. ACL tear

   Ans: (c)

3. BASICS OF USG

USG

00:00:23

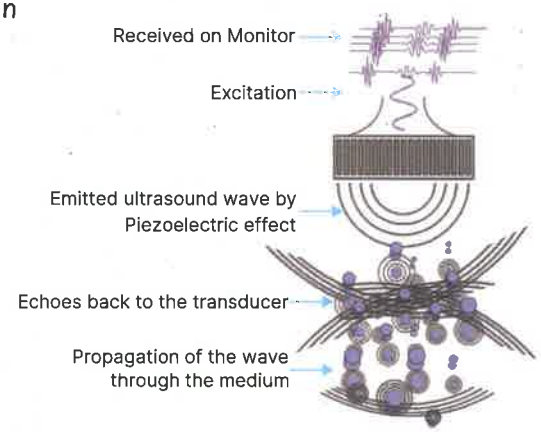
00:01:16

- Frequency of sound in ultrasound → 1-20MHz
- Human audibility range - 20Hz to 20kHz
- Radiation : No

PRINCIPLE

- Pulse echo/Piezoelectric effect

Crystals in probe receive electrical signals
↓
Produce sound waves
↓
Crystal receives sound energy back from patient's body
↓
Converts into electrical signals
↓
Form an image on screen



- Air b/w skin and probe :
- Gel (hydrogel) : Remove air → Medium for transmission of sound
- Crystal Material (PZT) = Lead Zirconium Titanate (Previously used- Quartz)
- USG machine has multiple probes with different frequencies of sound

FREQUENCY OF PROBE DECIDES

- Depth of penetration
- Resolution of image

If frequency ↑

- Higher/faster attenuation
- Superficial penetration
- High resolution

CONVEX PROBE

- Low frequency : 2 to 5 MHz
- Low resolution ↑ Depth
- Used in abdomen/ obstetrics scanning

LINEAR PROBE

- ↑ frequency :
- ↑ resolution
- Used for superficial structures like thyroid, breast, and scrotum

PHASE ARRAY PROBE

- Used for Echocardiography

TVS PROBE

Used for

- Transvaginal USG for uterus and ovary sonography
- TRUS : Transrectal USG for prostate
- Higher resolution

ADVANTAGES AND DISADVANTAGES OF USG

00:07:09

ADVANTAGES

- Uses sound waves : No radiation
- Preferred investigation in pregnancy
- Cost - effective
- Easily available
- Portable

DISADVANTAGES

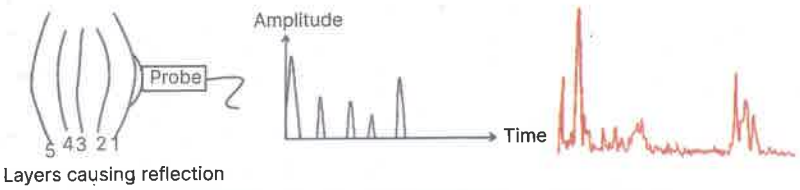
- Operator dependent

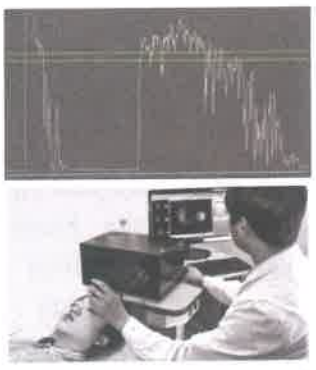
MODES OF ULTRASOUND

00:07:59

A-SCAN

- Used to measure axial length of eyeball
- Done before cataract surgery
- When a probe is placed →
- The depth of peaks is measured



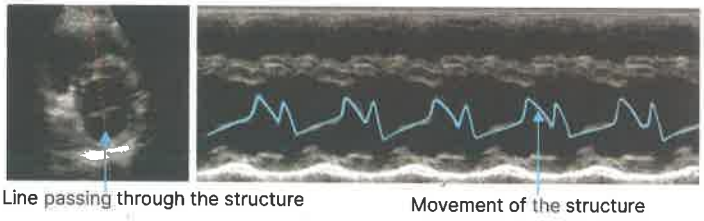


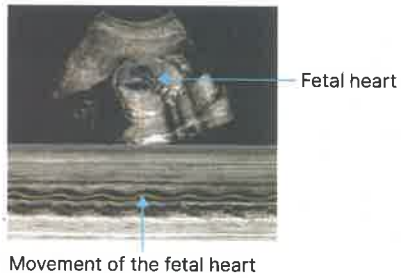
B-SCAN

- M/c used
- Brightness is measured according to the grayscale
- Helps to evaluate posterior segment of eye

M-SCAN

- M scan : Motion/movement





- Used to measure fetal heart rate
- Used in suspected diaphragmatic palsy
- Also used to check for eFAST pneumothorax →

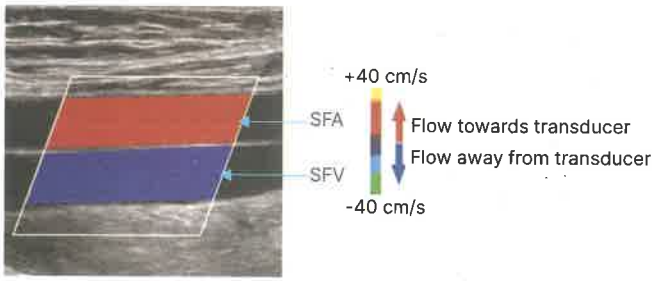
DOPPLER EFFECT

00:10:50

- Doppler : To visualize the blood flow → Based on Doppler shift or effect

COLOUR +

- Red & Blue indicate direction of blood flow
- Intensity of color indicates velocity of blood flow
- Mnemonic : red tower blows away



NO COLOUR

- Indicates no flow due to thrombus formation
- False absent flow due to technical error
  - Cos θ is involved
  - When Doppler is done at 90° (perpendicular to blood flow)
    → Cos 90° is 0
    → Velocity of sound waves is 0 → Absent blood flow
  - Maximum velocity → Doppler at 0°
- Doppler should be done at an angle < 60°
- If angle is > 60° false results / absent blood flow

SPECTRAL DOPPLER / DUPLEX DOPPLER

- Graph of the blood flow → Measures : Velocity, Resistance index, PI (Pulsatility index), S/D ratio, etc