Structured Notes According to

RADIOLOGY

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

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CONTENTS

RADIOLOGY

LIST OF IMPORTANT TOPICS

- **Imaging Of All Emergencies like Pneumothorax, Tension Pneumothorax, Pneumomediastinum, Pneumoperitoneum, Pneumocephalus, Aortic Dissection, Aortic Aneurysms & Rupture, pseudoaneurysms Yin yang sign , and Pulmonary Thromboembolism**

- **Stroke Imaging-Acute Infarct, Hyperdense MCA sign,**

- **Head Trauma-Epidural hematoma, swirl sign, subdural hematoma, subarachnoid hemorrhage**

- **Abdominal Trauma-FAST, CECT liver lacerations, Splenic injury**

- **Acute Abdomen-Acute Pancreatitis, small .and large Intestinal obstruction and Volvulus**

- **X rays - Concept of KVP ,MAS**
  - Important X ray views
  - Mammography
  - Hysterosalpinography images
  - Important IVP images

- **CT scan- Spiral CT, HRCT, MDCT, DUAL ENERGY CT,**
  - CT anatomy of brain, mediastinum, lungs and abdomen
  - Radiation protection-lead apron, TLD batch, AERB Guidelines

- **MRI -Indications/ contraindications**
  - TI, T2, FLAIR, STIR, DWI, DTI
  - MR spectroscopy
  - Axial, coronal, saggital MRI images of brain

- **USG**
  - FAST and EFAST
  - COLOR DOPPLER, SPECTRAL DOPPLER
  - umbilical artery, uterine artery and fetal MCA Doppler

Radiotherapy

Telethera py-Li nae,
sterotactic radiotherapy-cyber knife, gamma knife
IMRT
Craniospinal irradiation
Electron beam
Proton beam-Bragg Peak
Brachy therapy-permanent and temporary implants -pure beta emitters

Systemic Radiotherapy--I-131, strontium -89, P-32
Law of Bergonie and Tribondeau
Radiosensitivity of tissues and tumors

Different Iodine Isotopes-I131,I125,I124,II23 HALF LIFES Of important radioisotopes-18F, Tc99m,Iodine isotopes, P-32 ,CO-60,CS-137

- **Nuclear Medicine**
  - Meckel's Diverticulum
  - Thyroid Scintigraphy,Lingual Thyroid
  - DMSA,DTPA,MAG-3 SCAN
  - Myocardial Perfusion Imaging
  - Myocardial Infarct Imaging
  - Bone Scan
  - Sulfur Colloid Scan
  - Tc99m-Sestamibi Scan
  - Octreotide/ somatostatin receptor scintigraphy
  - PET scan-Warburg effect, 18FDG PET Pet Imaging of Heart NaF PET,CII-methionine Pet, DOPA-PET, DOTATOC -PET, DOTATATE-PET HMPAO-SPECT

- **Neuroradiology-Imaging of Meningioma**
  - Medulloblastoma Vs Ependymoma
  - Craniopharyngioma Vs Pituitary Adenoma
  - Arachnoid Cyst Vs Epidermoid Cyst
  - Important Named Signs-Mount Fuji Sigin,Humming Bird Sign,Racing Car Sign,PANDA Sign,
  - TB Meningitis,CJD
  - Imaging Stroke -Hyperdense MCA sign,Penumbra
  - Intracranial bleed-Extradural,Subdural,Subarachnoid,Intraparenchymal, Intraventricular Bleeds

- **Respiratory Radiology- Normal CXR**
  - PA VS AP VIEW
  - Collapse, consolidation, pleural effusion, Pneumothorax
  - Golden S sign, Luftsichel Sign, Sillouhette Sign,
  - Xrays of sarcoidosis, pulmonary edema, pulmonary thromboembolism
  - CT images of Bronchiectasis, ILD, pulmonary alveolar proteinosis
  - ASPERGILLOSIS-ABPA,AIR-CRESCENT SIGN, HALO SIGN
  - Hydatid of Lung/LUNG ABCESS/ FUNGUS BALL/HYDROPNEUMOTHORAX
  - Lucent Hemithorax/ FOREIGN BODY
  - CVS Radiology -Radiographs in congenital Heart Diseases like TOF/TGA/ASD/TAPVC
  - SIGNS OF Mitral stenosis/CHF

- **Muscloskeletal Radiology**-Bone tumors,Metabolic bone diseases,Arthritis, Osteomyelitis

- **Genitourinary Radiology-**Renal Tuberculosis, Renal Papillary Necrosis, Horse shoe kidney, ADPKD, ARPKD, DUPLEX KIDNEY

- **Contrast agents**-Radiocontrast agents, Iodinated contrast agents, USG contrast and MRI Contrast - Contrast Induced Nephropathy
- **Gastrointestinal Radiology**-Barium studies, Hypertrophic Pyloric stenosis, SMALL and large bowel obstruction, Intussuception, Volvulus and pneumoperitoneum all signs
- **Hepatobiliary and Pancreatic Imaging**-Acute and chronic pancreatitis signs, pancreatic carcinoma
- **Angiography images**-MR ANGIO, MR VENOGRAPHY

LEARNING OBJECTIVES

Introduction to Radiology

- We will study Names of scientists and discoveries , Basic Terminologies used in radiology, radiation units.

X – Ray Basic Concepts

- We will study about X ray tubes, types of radiography, mammography, types of X rays.

CT SCAN Basic Concepts

- We will study about CT machine, types of CT SCANS, identification of substances on CT.

MRI Basic Concepts

- We will study about the concept of MRI, differentiation between CT and MRI , contraindications to use of MRI.

USG Basic Concepts

- We will study the principles of USG, types of USG probes, modes of USG.

Radiological Investigations & Thumb Rules

- We will study about the thumb rules of use of all the radiological modalities like X ray, CT scan, MRI , USG .

Interventional Radiology Basic Concepts

- We will study about DSA, Vascular Arterial puncture, radiofrequency ablation.

Contrast agents

- We will study about various contrast agents used, Barium studies, side effects of contrast agents.

GIT radiology

- We will study various Barium studies, esophageal disorders , CHPS, various abdominal emergencies in adults and children.

Hepatobiliary radiology

- We will study about the investigations used in Liver malignancies, in liver infections, various Gall bladder pathologies.

Pancreatic radiology

- We will study the radiological findings seen in acute pancreatitis, CA Pancreas, Cystic neoplasms of Pancreas.

Genitourinary radiology

- We will study Intravenous pyelogram findings of various renal disorders, types of renal cysts , renal malignancies, renal calculi.

Neuroradiology

- We will study the approach to head trauma, types of brain injury , fractures of temporal bones, brain tumors.

Musculoskeletal radiology

- We will study about types of arthritis, malignancies of bones, metabolic and endocrine bone diseases, DEXA scan.

Women imaging

- We will study about the various modalities of USG used for uterus, radiological findings seen in various gynaecological disorders, Ovarian malignancy, and mammography.

Cardiovascular radiology

- We will study about the identification of various heart borders, radiological investigations used in cardiovascular emergencies, Congenital heart diseases.

Respiratory radiology

- We will study about the approach to study chest x ray and identification of various lung pathologies like collapse, consolidation on Chest X ray

Nuclear medicine

- We will study about the various nuclear medicine scans like HIDA scan , T^{99m} - pertechnate scan, Bone scan.

Radiotherapy

- We will study about various agents of radiotherapy, mechanism of action of radiotherapy , types of radiotherapy.

Radiological anatomy

- We will study how to identify normal anatomical organs on Radiological investigations.

1 INTRODUCTION TO RADIOLOGY

NAMES OF SCIENTISTS AND DISCOVERIES

00:00:46

W.C Roentgen
- Father of radiology
- Discovered X-ray on 8 Nov 1895
- 8 Nov: International day of Radiology
- 1907: Got Nobel price

Godfrey Hounsfield, Alan Cormack
- Discovered CT Scan
- Hounsfield unit [Comes from Godfrey Hounsfield's name]

Peter Mansfield, Paul Lauterbur
- Discovered MRI (Magnetic resonance imaging)

Felix Block and Purcell
- Discovered the concept of Nuclear Magnetic Resonance

Charles Dotter
- Father of interventional radiology

Henry Becquerel
- Father of radioactivity

Lars Leksell
- Discovered gamma knife [Stereotactic Radio surgery]

John wilde
- Discovered medical ultrasound

Lan Donald
- Discovered obstetric ultrasound

Important Information

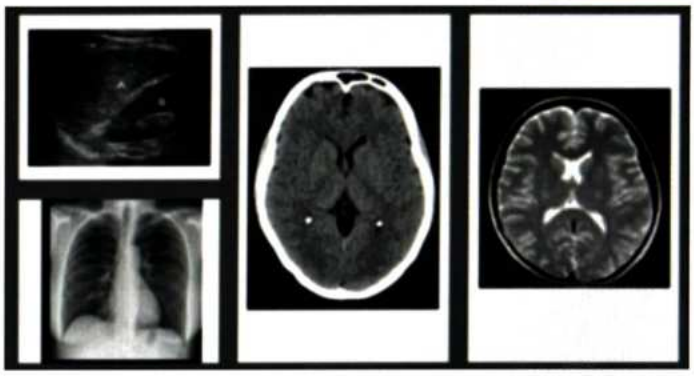
- CT scan works on the same principle as X rays except that it's a 3D sequence where X rays are used to generate cross sectional images.
- MRI does not use ionizing radiations. It works on the basis of nuclear motion. It uses radiofrequency waves which are nonionizing radiations.
- USG does not use any ionizing radiations. it uses sound waves.

Previous Year's Questions

Q. Who discovered gamma knife: (NBE 2015)

A. Wilhem Roentgen
B. Lars Leksell
C. Paul Lauterber
D. Godfrey Hounsefield

00:08:34



Important Information

- If Bones are white: it is CT Scan
- If Bones are black: it is MRI scan
- Remember: In MRI, peripheral thin white ring is not bone, it is thin layer of scalp fat.

BASIC TERMINOLOGIES

00:11:22

	Black	White
X- ray	Lucent	Opaque
CT (dense)	Hypodense	Hyperdense
MRI (intense)	Hypointense	Hyperintense
USG (echoic)	Hypoechoic	Hyperechoic

Important Information

- In USG: Anechoic means Absolutely black

Mechanism of action of Ionizing radiation: 2 methods 00:14:33

1. DNA damage: ds DNA damage (most commonly)
2. Free radicles formation

IONISING RADIATIONS 00:16:26

Rays			Particulate matter
Cosmic rays	γ – rays	X- rays	• α particles, • ß particles, • neutrons, protons
• No diagnostic value	• Radio-therapy • Nuclear medicine scan	• Radio-graphs, ○ Fluoro-scopy, ○ DSA • CT	• Radio-therapy

Previous Year's Questions

Q. All of the following investigations use ionizing radiation except: (AIIMS 2016)

A. SPECT
B. HSG
C. DEXA
D. FAST

Explanation

SPECT

- Single photon emission computed Tomography
- Nuclear medicine 3D investigation

HSG

- Hystero-salpingography

DEXA

- Dual energy X- ray absorptiometry
- For calculating bone mineral density (BMD)
- Gold standard investigation for osteoporosis

FAST

- Focussed assessment sonography in trauma

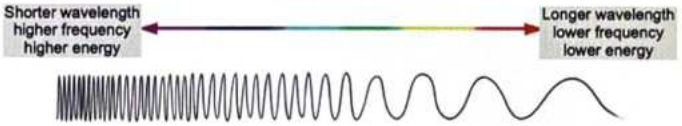
Previous Year's Questions

Q. SPECT stands for: (NBE 2017)

A. Single proton emission computed Tomography
B. Single positron emission computed Tomography
C. Single photon emission computed Tomography
D. Simple photon emission computed Tomography

Explanation: It is 3D nuclear medicine investigation which uses γ – rays

ELECTROMAGNETIC SPECTRUM 00:22:24



- Energy is directly proportional to frequency and inversely proportional to wavelength.
- **γ rays**
  - Higher energy
  - Higher frequency
  - Shorter wavelength
    - → X-rays, γ – rays: Ionising radiations
    - → Energy, frequency: γ rays > X – rays
    - → Wavelength: X- rays > γ rays

Previous Year's Questions

Q. X rays differ from gamma rays in all except: (JIPMER 2017)

A. Wavelength
B. Frequency
C. Origin
D. Velocity
E. Energy

Explanation

- X rays have higher wavelength, lower energy and lower frequency as compared to γ rays.
- X- rays have Extranuclear origin while γ rays have Nuclear origin (nuclear particle disintegration).
- All waves in electromagnetic spectrum have same velocity.

Important Information

	• Ionisation power = linear • Energy transfer = damaging Power	• Penetrating Power
Maximum	• Helium nucleus (α particle): It is the heaviest particle.	• Neutrons > γ rays
Minimum	• γ rays	• α particle

Previous Year's Questions

Q. True or False (PGI 2018)

A. Wavelength of gamma rays is more than X-ray: (F)

- (Energy & frequency of gamma rays is higher than X-rays)

B. Alpha rays have maximum ionization power: (T)

C. Wavelength of X-rays is 0.01 – 10 nm: (T)

D. X-rays are extra nuclear in origin while gamma rays are intra Nuclear: (T)

D. Gamma rays have maximum linear energy transfer- (F)

- (α – particle → have maximum linear energy transfer γ – rays → have minimum energy transfer)

INVESTIGATIONS

00:28:10

Non-ionising	Ionising: X-rays	Ionising: Gamma Rays
• MRI (uses the concept of NMR) • USG • Thermography	• Radiographs • CT scans • Fluoroscopy Ix: o (RGU/ MCU / HSG / ERCP) • DSA(Digital subtraction Angiography)	• Scintigraphy (2D) • SPECT(3D)

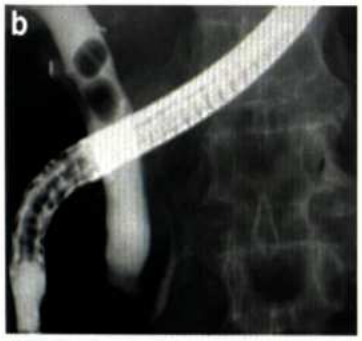
Important Information

- Ionising radiation investigations should not be used in a pregnant female.
- MRI is expensive and time consuming.
- USG is cheap and easily available and not time consuming
- Therefore, in emergency scenarios in pregnant females, always prefer USG as Ist line investigation.

IVP (Intravenous pyelography). It is a fluoroscopy technique

HSG (Hystero –salpingography) Leech Wilkinson cannula seen It is also a fluoroscopy technique

RCP (Magnetic Resonance Cholangio-pancreaticography)



ERCP(Endoscopic retrograde Cholangio-pancreaticography)

MRCP	ERCP
• No use of ionising radiation	• Ionising radiation used
• Non invasive	• Invasive
• No contrast is injected (T2 weighted MRI is used)	• Contrast is injected

- I.O.C for biliary pathologies (Black shadows in the image are signal voids and are calculi).
- Gold standard Ix for biliary pathologies as it is both diagnostic + therapeutic. (Filling defects are calculi and these can be removed as well)

RADIATION UNITS

00:40:50

Entity	SI Unit	Conventional unit
• Radioactivity	Becquerel / disintegration per second(dps)	Curie 1 Ci = 3.7×10^{10} Bq
• Exposure (basically means ionization)	Coulomb/kg	Roentgen 1 R = 2.5×10^{-4} C/kg
• Absorbed dose • Air kerma **(ABG RAD)**	Gray 1 Gy = 100 Rad	Rad
• Equivalent dose: W_R: radiation weighing factor (α = 20, X rays, γ rays = 1)	Sievert (Sv) 1 Sv = 100 Rem	Rem
• Effective dose W_T: Tissue weighing factor	Sv	Rem

Previous Year's Questions

Q. Identify the incorrect pair of radiation unit (NBE 2016)

A. Absorbed dose: Gray
B. Exposure: C/kg
C. Equivalent dose: Rad
D. Kerma: Rad

Explanation

Entity	SI unit	Conventional unit
• Absorbed dose	Gray	Rad
• Exposure	C/kg	Roentgen
• Equivalent dose	Sv	Rem
• Kerma	Rad	Rad

Maximum permissible dose according to AERB (atomic energy regulatory board)

00:48:30

	Occupational exposure	Public exposure
Overall	• 20 mSv/ year averaged over 5 • consecutive years • 30 mSv in any single year	• 1 mSv/year
Lens	• 150 mSv in a year	• 15 mSv/year
Skin extremities	• 500 mSv in a year	• 50 mSV/year
Pregnant female	• 2 mSv/year	• 1 mSv/year
Fetus	• 1 mSv/year	• 0.5 mSv/year

Previous Year's Questions

Q. Identify the incorrect pair of maximum radiation exposure limit according to AERB: (NBE 2017)

A. General public: 1 mSv/yr
B. Occupational worker: 2 mSv/yr
C. Lens of occupational worker: 150 mSv/yr
D. Skin of general public: 50 mSv/yr

Radiation exposure in various modalities

Modality	Dose
CXR	0.02 mSv
Skull X ray	0.07 mSv
Abdomen X ray	1 mSv
Mammography	0.5-0.7 mSv
CT head	2 mSv
CT chest	5 mSv
CT abdomen	10 mSv
PET	10-12 mSv
Barium meal follow through / enema	7-8 mSv
IVP	2-3 mSv

Important Information

- CXR has minimum radiation because of intrinsic high contrast resolution as lungs are seen as black and bones are seen as white whereas abdomen has all the soft tissues. therefore, high radiation needed for better resolution.

Previous Year's Questions

Q. Identify the incorrect pair: (NBE 2018)

A. CXR – 0.02 mSv
B. BMFT – 7 mSv
C. CT head – 2 mSv
D. CT abdomen – 9 mSv
E. Mammography – 5 mSv

Important abbreviations 00:56:52

- **PACS:** Picture Archiving & communication systems
  The images are available at whatever place they are needed in hospital like in ICU, wards, etc.
- **DICOM:** Digital imaging & communication in medicine (like we have jpeg files in our mobiles)
- **ALARA:** As low as reasonably achievable (This is with respect to radiation dose)
- **RFA:** Radiofrequency Ablation
  - At 60 - 100° C: coagulative necrosis starts.
  - Applications of RFA
    a. HCC
    b. RCC
    c. Rx of choice in osteoid osteoma
    d. WPW syndrome
- **THI:** Tissue harmonic imaging (used in USG)
- **HIFU:** High intensity focused USG (used for ablation of fibroids)
- **POCUS:** Point of care USG that is bedside USG.
  - eFAST
  - Covid USG
- **BLUE:** Bedside lung USG in emergencies
- **FALLS:** Fluid administered limited by lung USG (employed in patients with shock to check whether patient is in cardiogenic shock or hypovolemic shock)

EFFECTS OF RADIATION 01:05:59

Stochastic "chance"	Deterministic (can be determined)
No threshold	Threshold exists
Delayed	Immediate
Cancer, genetic mutations	Skin erythema (MC), cataracts epilation
↑dose α ↑ probabity	↑dose α↑severity of side effect
"All or none"	Gradation

Previous Year's Questions

Q. Which of the following statements about "Stochastic effects" of radiation is true: (Recent AIIMS)

A. Severity of effect is a function of dose
B. Probability of effect is a function of dose
C. It has a threshold
D. Erythema & cataract are common examples

Explanation: Remaining 3 options hold true for deterministic side effects 01:07:43

TLD BADGE

- Given to radiation personnel for its usage
- Personnel dosimeter
- Thermoluminiscent
- 3 monthly [sent for measurement in India]
- Made up of: CaSO4: Dysprosium [LiF can also be used]
- Worn below the lead apron at the level of the chest

LEAD APRON

01:09:48

- Minimum thickness: 0.25 mm
- M/C thickness used: 0.5 mm

Zero lead aprons

- Made of Ab, Ba, Bi (lighter in weight than usual lead aprons)

MRI

CT scanner

X-ray unit

- Fluoroscopy unit
- DSA unit (C-arm)

USG machine

Mammography
↓
Compression Paddles

DEXA scanner
↓
Bone mineral density

CLINICAL QUESTIONS

Q. Jacob is a 24-year-old male brought to the emergency department following a road traffic accident. He was riding his bike without his helmet and sustained significant damage and broken bones. To evaluate the damage better, one of the several Radiographic modalities were useD. Radiographic examinations are known to use different ionizing radiations to generate images non- invasively. Out the the following ionizing radiations, arrange the following based on increasing order of their penetration power.

A Alpha< Beta<Xray<Gamma< Neutron
B Neutron< Beta<Xray<Gamma< Alpha
C. Neutron< Xray
D. neutron< Xray<beta

Answer: A

Solution:

- Neutrons have the highest penetration power.
- The penetration power in increasing order is

Alpha< Beta<Xray<Gamma< Neutron

Q. Identify the true/false statements about radiation and it's effects.

1. Follicular thyroid carcinoma most commonly develops after radiation.
2. Most radio-resistant blood cell is platelet.
3. Most common hormonal deficiency after cranio-spinal irradiation is growth hormone.
4. Most radio-resistant organ is testes.
5. Tumour having p53 mutation are radiosensitive.

A FTTFF
B FFTFF
C. FFTFT
D. TFTFF

Answer: A

Solution

- If a tumor is associated with p53 mutation (Li Fraumeni syndrome) - it become Radioresistant
- Radiotherapy at G1 Phase cause - Chromosomal damage
- Radiotherapy at G2 Phase - Chromatid damage

- Most radiosensitive phase of cell cycle - G2M Phase > M phase
- Most radio resistant phase - Late S phase
- Most radio sensitive tissue - Bone marrow/ Gonads
- Most radio resistant tissue - Nervous tissue
- Most radio resistant organ - Vagina
- Most radio sensitive Blood cell - Lymphocyte
- Most radio resistant blood cell - Platelet

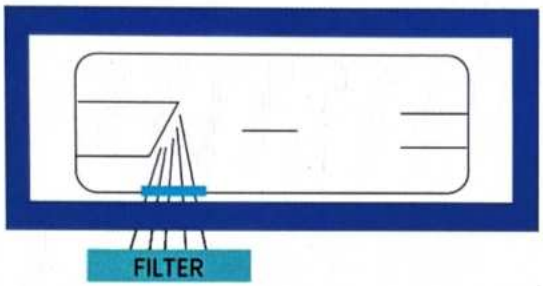
Craniospinal irradiation: It is done in

- Medulloblastoma - Prophylactic Craniospinal irradiation is done because of its drop metastases
- Pinealoblastoma
- Non-Hodgkin's lymphoma
- ALL
- Small cell Ca
- MC hormone deficient after Craniospinal irradiation: GH Deficiency
- MC thyroid cancer that develops after head neck radiation: Papillary Carcinoma of Thyroid

2 X - RAY BASIC CONCEPTS

X-RAY TUBE

00:00:44



- X-ray is generated in X-ray tube
- Glass tube is made up of Pyrex glass and it is quite heat resistant.
- Cathode filament:
  - θ vely charged
  - Made up of Tungsten + Thorium
    → Tungsten has high melting point so filament will not melt on heating to higher temperature
- Anode Filament
  - Positively charged
  - Made up of Tungsten + Rhenium
- Potential difference between cathode & anode is:
  KVP (Kilo voltage Peak)
  ↓
  will regulate the amount of energy produced with the X-ray

Thermionic Emission

On healing the cathode filament (θvely charged)
↓
Electrons are released from cathode

These electrons being ⊖vely charged repel each other & disperse
↓
Space charge effect
↓
In order to reduce this effect
↓
Focussing cup is used (made up of Ni)
(Function: To focus the electrons in a single line such that they strike the anode at a single point)
↓
Electrons strike the anode
↓
Interaction of electrons with +vely charged anode
↓
Produce 99% heat & 1% X-rays
↓
Through window (thinned out glass tube) electrons will leave the tube
↓
Pass through filter (Al + Cu ~ 2.5 mm) (function: to remove low energy X-rays)

- Outer box: Protective housing
  ↓
  Made up of Pb (prevents leakage of X-rays)
- In between the glass tube and the protective housing
  ↓
  Oil circulates (for conduction and convection of heat out)
  [Radiation is although the main mechanism through which heat is transmitted out]

00:07:54

Structure	Material
• X-ray tube	• Pyrex glass
• Cathode (-vely charged)	• Tungsten + Thorium
• Focussing Cup	• Nickel
• Anode = Target (+vely charged)	• Tungsten + Rhenium
• Window	• Glass
• Filter	• Al + Cu (~ 2.5 mm)
• Protective housing	• Pb

How to remember

- CT is an ART
  - C – Cathode
  - T – Thorium
  - A – Anode
  - R - Rhenium
  - T – Tungsten Common in both

Previous Year's Questions

Q. All of the following are true about modern X-ray tube except?
A. Rotating cathode is used
B. Target is made up of tungsten and rhenium
C. Filter is made up of 2.5 mm equivalent of copper plus aluminum
D. Outer protective housing is made of lead

X-RAY TUBE

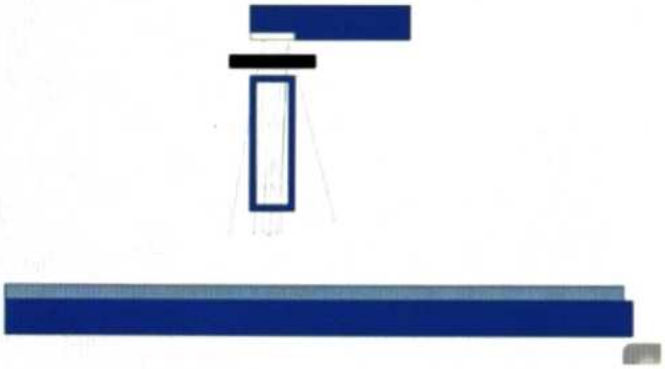
00:09:12

Most commonly
↓
Rotating anode disc is used
↓
To increase the heat dissipation (efficiency) of the X-ray tube

Types of X-ray Tube

Stationary	Rotating
• Portable / Ward X-rays	• M/C used
• Dental X-rays	• Used everywhere else

00:11:57

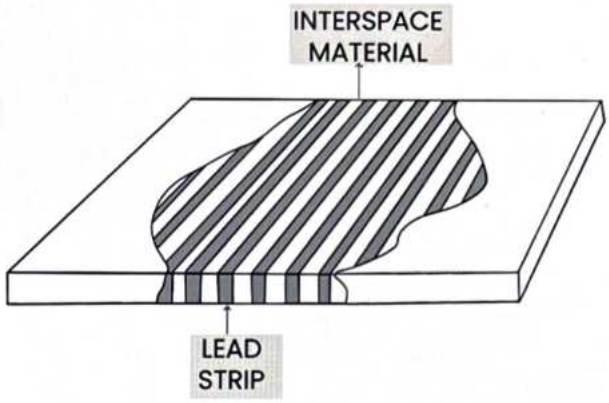


- **Collimator:** Focuses the beam of X-rays according to the part of interest

GRID

- Is movable
- B/w the patient and X-ray film
- Has Lead lines: For absorbing unnecessary radiation
- Has interspace Aluminium/plastic lines: will allow X-rays to go through
- Function is to ensure that only focused X-rays reach the X-ray film and eventually contribute to the final image.
- Allows only perpendicular X-rays to go through.

00:15:21



Disadvantages of GRID

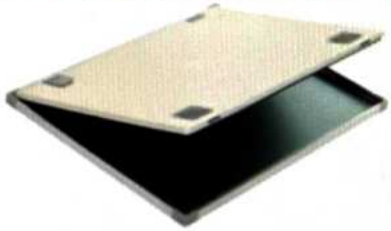
- GRID increases the eventual dose of the patient (although it improves the contrast (quality) of the film).

00:16:24

Conventional radiography	Computed Radiography	Digital Radiography
• Film is made up of Silver halide. Red light is the safe light for the development of these films	• Photostimulable phospher (PSP) is used. These PSP plates are reusable.	• Silicone / Selenium / Cs Iodide electrodes are Used

CONVENTIONAL RADIOGRAPHY

00:18:38



Casette

- Conventional radiography is also referred to as film-screen radiography

MAMMOGRAPHIC X-RAY TUBE VS NORMAL X-RAY TUBE

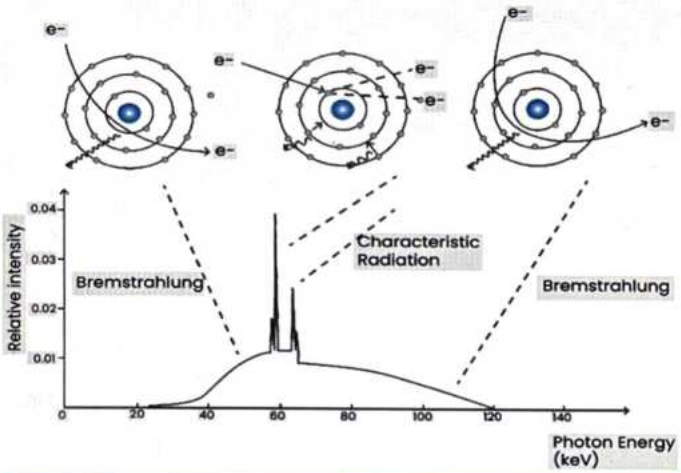
00:19:16

	Mammography	Radiography
Target	Molybedenum	Tungsten + Rhenium
Window	Berillyium	Glass
Filter	Molybedenum	Al + Cu

Types of X-rays: Depending on where the electrons strike on the target, 2 types of radiation are produced.

1. Characteristic radiation
2. Bremstrahlung (Braking) radiation

00:20:28



Characteristic radiation	Bremstrahlung (Braking) radiation
• Radiation depends upon the differences in the energy of the outer shells. • Characteristic of the element of which target is made up of Discrete peaks of range of energy	• Most common type of radiation • Radiation depends upon angle of scatter • Continuous spectrum of wide range of energies

00:25:20

Kilo-voltage peak (kVP)	Milli-amperage second (mAs)
• Determines the energy of the resultant X-rays	• Determines no. of electrons passing through the x ray tube.
• Determines the quality of Xray	• Determines the quantity of X-rays
• kVP: α penetration α 1 / contrast	• mAs contrast • mAs increases the blackening of X-ray

Understand with an example

- Obese patient: We need more penetration, so we will increase kVP but increase in kVP leads to decrease in contrast, so we also increase mAs to increase contrast.

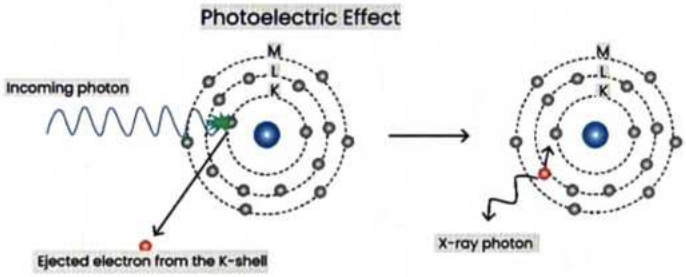
INTERACTION OF X-RAY WITH MATTER

00:29:40

- Photoelectric effect: contributes to the diagnostic image.
- Coherent scatter (occurs at low energy)
- Compton Scatter Contributes to scattered radiation
- Pair production (occurs at high energy radiation)
- Photo disintegration (occurs at high energy radiation)

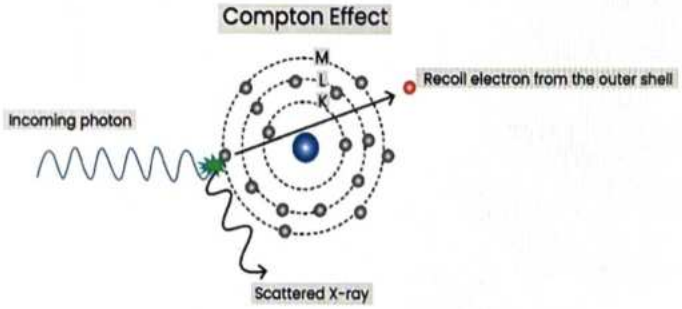
PHOTOELECTRIC EFFECT

00:31:10



- Seen with low energy X-rays
- Yields diagnostic effect
- Inner shell e is ejected

COMPTON EFFECT



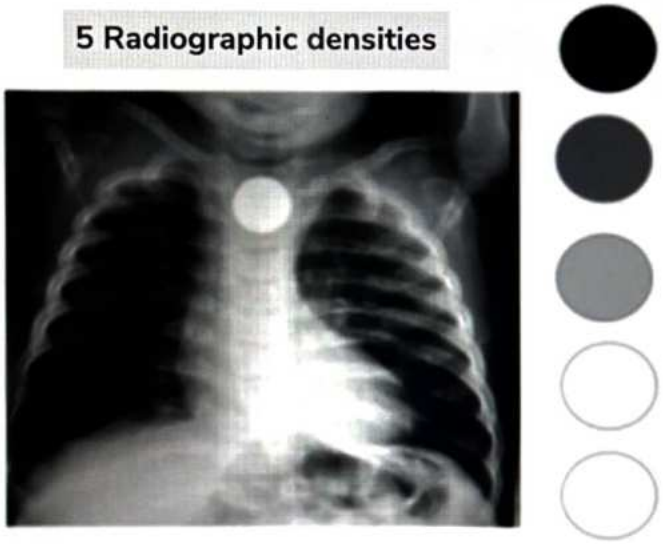
- Occurs with higher energy X-rays
- Results in non-diagnostic scatter radiation
- Outer shell e is ejected

Previous Year's Questions

Q. Photoelectric effect can be best described as an:
A. Interaction between high energy incident photon and the inner shell electron
B. Interaction between low energy incident photon and the outer shell electron
C. Interaction of the high energy incident photon and the outer shell electron
D. Interaction between low energy incident photon and the inner shell electron

5 RADIOGRAPHIC DENSITIES

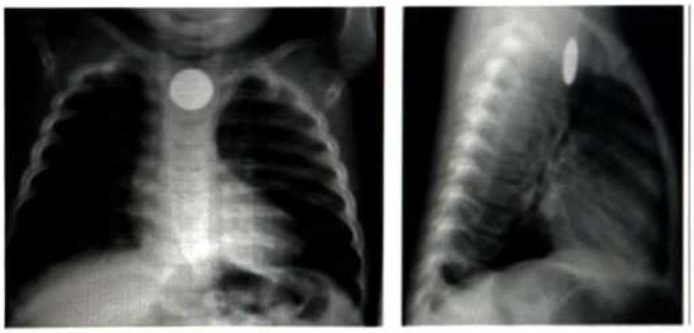
5 Radiographic densities



1. Air
2. Fat
3. Soft Tissue = Fluid
4. Bones
5. Metallic density

APPROACH TO FOREIGN BODY

00:35:55



On Frontal radiograph

- If foreign body seen enface completely, it is in esophagus.
- If foreign body seen in side profile, it is in the trachea.

On Lateral radiograph

- If we can see the foreign body behind the air column, it is in esophagus
- If we cannot see air column continuously, it is in trachea.

00:37:58

BUTTON BATTERY

- Has double margins at the periphery (for recognition purpose)
- Remove as soon as possible because can cause tissue necrosis.

CLINICAL QUESTIONS

Q. A 65-year-old male with a history of extended inferior myocardial infarction, moderately impaired left ventricular function and absence of reversible ischemia, received an ICD due to recurrent episodes of non-sustained VT. What is the BEST method to know the position and integrity of implantable cardioverter defibrillator?

A CT scan
B Plain Radiograph
C. MRI
D. USG

Answer: B

Solution

- Chest radiography is the preferred imaging modality to evaluate ICD's anatomic location, lead wire integrity, and help in identifying several complications.

Q. A 32 year old women Presented with c/o mass in the right upper quadrent of the breast . Mammography is performeD. Which of the following features suggesting malignant lesion on mammography?

A. Round well defined borders*
B. Macrocalcifications
C. Microcalcifications
D. Fat content

Answer: C

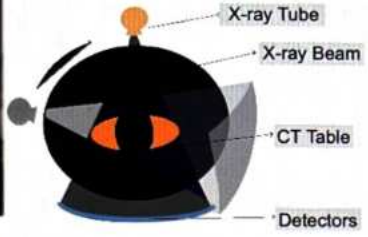
Solution

- Microcalcifications are suggestive of a malignant lesion
- Macrocalcification/ Popcorn calcifications are fibroadenomas which are benign lesions
- The pattern and shape of microcalcifications can also give radiologists clues about whether cancer may be present.
- Linear, rod-like calcifications raise suspicion of underlying breast cancer.
- Popcorn, eggshell, and rim-like calcifications are usually benign.

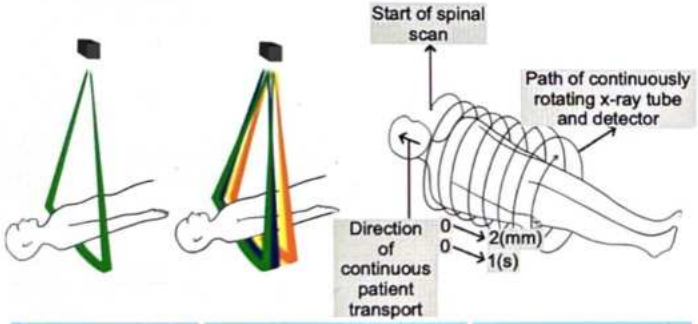
3 CT SCAN BASIC CONCEPTS

CT MACHINE

00:01:05



- X-ray ring is known as Gantry
- Most commonly used → 3rd generation CT scanner
- Combination of 2 rotations occur: one of the x ray tube in the gantry and other is the translation of patient known as rotation translation movement.
- Pitch: Table movement per rotation / slice thickness
  - Pitch ↑ses
    - → Quality of image ↓ses
    - → Dose ↓ses
  - Pitch ↓ses
    - → Quality of image ↑ses
    - → Dose ↑ses Thus, Pitch α 1/quality α 1/dose



Single detector CT	Multiple detector CT (MD CT) ↓	Helical motion / Spiral motion CT
	• ↑ses the speed markedly • ↑ses the quality	• ↑ses the speed markedly

Important Information

- Slip ring technology: Pre-requisite for discovery of spiral / helical CT

Previous Year's Questions

Q. All of the following are true statements about CT except: (JIPMER 2018)
A. Higher the pitch, higher will be the radiation dose
B. Helical CT is much faster than non-helical CT
C. Higher the pitch, lower will be the CT quality
D. Multiple detectors offer better 3D reconstruction

Explanation

- Pitch
  - α 1/quality
  - α 1/dose
- Multiple detectors offer better 3D reconstruction
  - Higher volumetric data
  - Motion artefacts ↓

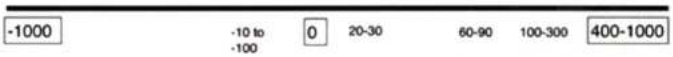
CONCEPT OF CT

- CT is based on linear attenuation of X-rays.

UNITS OF CT: HOUNSFIELD UNIT

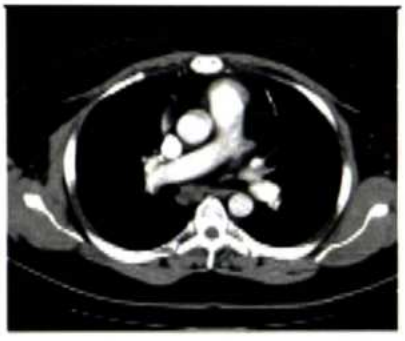
00:13:33

- Gives objective measurement of blackness / Whiteness.

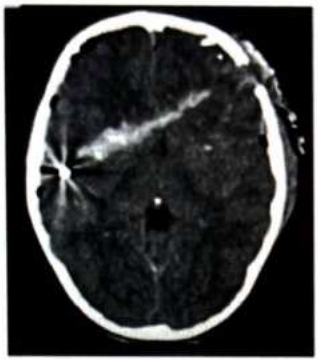


Air	Fat	Distilled water (reference)	Soft tissue	Acute haemorrhage (Hyperdense)	Iodinated contrast given i.v seen in blood vessels	Bone / Ca^{2+}

- Blacker than water: Negative hounsfield unit
- Whiter than water: Positive hounsfield unit



- Metallic foreign bodies (appear very very white) produce Streaking artefact 00:19:14
- Foreign body (bullet) in the brain producing Streaking artifact



Hypodense on CT
- Fat
- Air

Hyperdense on CT
- Acute Hemorrhage
- Calcification
- Bone cortex
- Metallic foreign body
- Iodinated contrast

Important Information

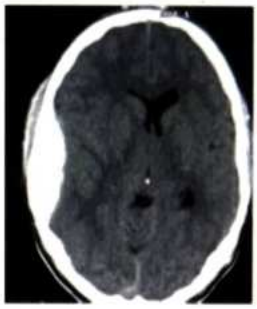
- Acute hemorrhage
- Calcification
- Bone cortex
- Metallic foreign body

} IOC • NCCT

Previous Year's Questions

Q. Identify the incorrect pair of HU on CT: (NBE 2016)
A. Air: 1000
B. Fat: 0 -20
C. Acute hemorrhage: 80-90
D. Bone : 800-1000

00:22:09



NCCT
- Hyperdense on NCCT with patient of trauma
  ↓
  Acute haemorrhage (Extradural hematoma)
- Doesnot cross suture lines.
- Lenticular biconvex shaped.

00:23:17

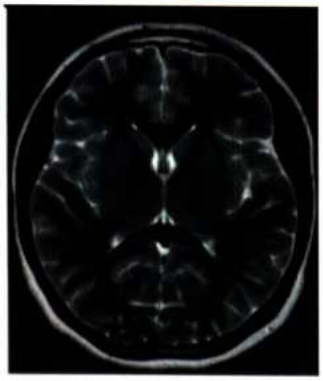
- CECT abdomen: Hypodense lesion in Right Kidney
- Angiomyolipoma: Fat containing lesion of the kidney

RENAL CYST

(Bosniak type 1 cyst= 0% risk of malignancy)
- Cyst (fluid containing lesion) (~ 0-10 HU)
- Well defined homogenous lesion
- Bosniak classification: Used for renal cyst on CT to determine the risk of malignancy.

00:26:13

Since bones are white: It is CT

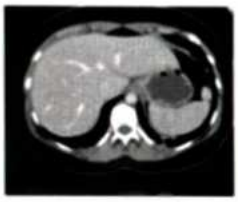


Since bones are black: It is MRI

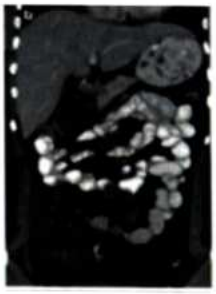
- NCCT or CECT ??: Just look at Vessels
- Isodense to soft tissues/muscle: NCCT
- Whit: CECT

PLANES IN CT SCAN

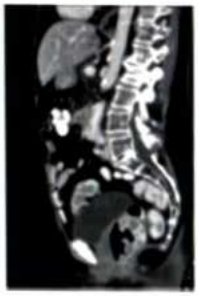
00:27:40



Axial / transverse



Coronal



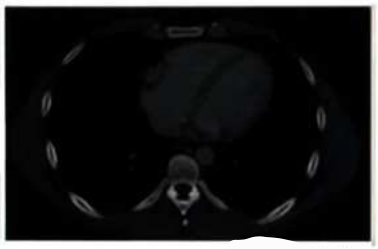
Sagittal

WINDOWS IN CT

00:29:06

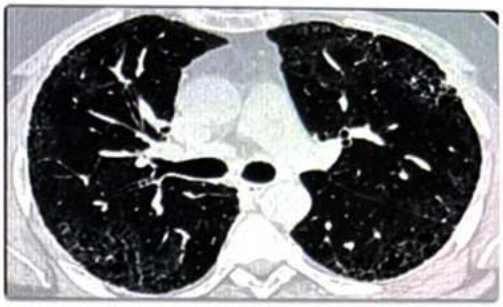
Mediastinal window /

Lung window soft tissue window



Bone window

SOME SPECIAL CT SCANS

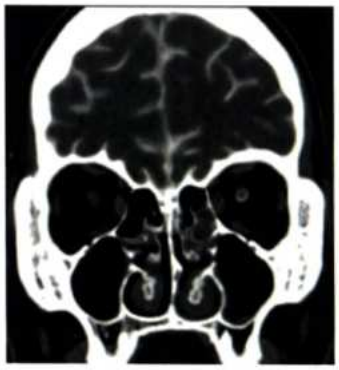


High Resolution CT

- It is I.O.C for evaluation of Lung parenchyma
- Interstitial lung disease
- Bronchiectasis
- COVID – 19 Evaluation
- The above image shows Honey combing appearance
- Seen in ILD (Usual interstitial pneumonitis)

High Resolution CT

- Temporal bones
- Skull base fractures
- Para nasal sinuses visualization



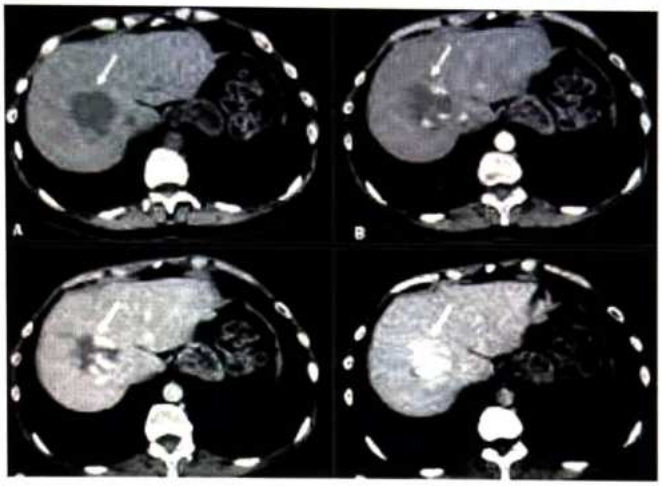
CT CISTERNOGRAPHY

- HRCT + intrathecal administration of iodinated contrast
- Iohexol contrast is approved which is a non ionic monomer
- Best Ix/I.O.C for studying CSF leaks

Triple phase CT 00:34:38

Triple phase CT: Contrast evaluated at

- ~ 20-30 sec: Arterial phase
- ~ 50-70 sec: Venous / portal venous phase
- ~ 3 min: Equilibrium / delayed phase
- I.O.C for focal liver masses (haemangioma, HCC, Adenoma)
- For liver masses: Triple phase MRI > Triple phase CT



- Progressively filling centripetal lesion: Hemangioma
- Single phase CECT / Routine CECT is done in **Venous phase**

CT UROGRAPHY OR CT RENAL MASS 00:38:21

Refer Picture 3.1

- **CT urography** showing pelvicalyceal system in the excretory phase (~ 10-15 min)

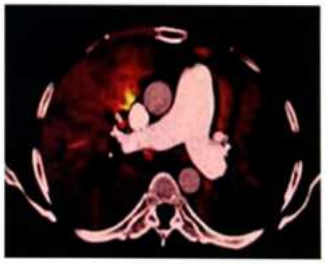
CT PULMONARY ANGIOGRAPHY (CTPA) 00:40:45

- It is CECT with maximum contrast is in the pulmonary circulation, thus helping in easy identification of thrombus in the pulmonary artery.

CT angiography: for aortic / arterial pathologies.

VOLUMETRIC RECONSTRUCTION TECHNIQUE (VRT) OR SHADED SURFACE DISPLAY (SSD) 00:42:21

DUAL ENERGY CT (DECT) 00:43:12



Perfusion Map

Uric acid crystals

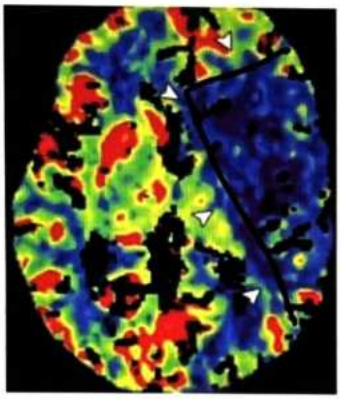
- 2 X-rays taken: 80 / 100 kVP & 120/140 kVP
- 2 different kinds of energies:
  - Dual energy
  - Dual source
- Material decomposition: Behaviour of material is compared with two different kinds of energy beams

Applications of DECT

- Uric acid crystals deposition in Gout
- To differentiate uric acid calculi from calcium calculi
- Perfusion map used in case of lung infarcts.

CT PERFUSION

00:46:13

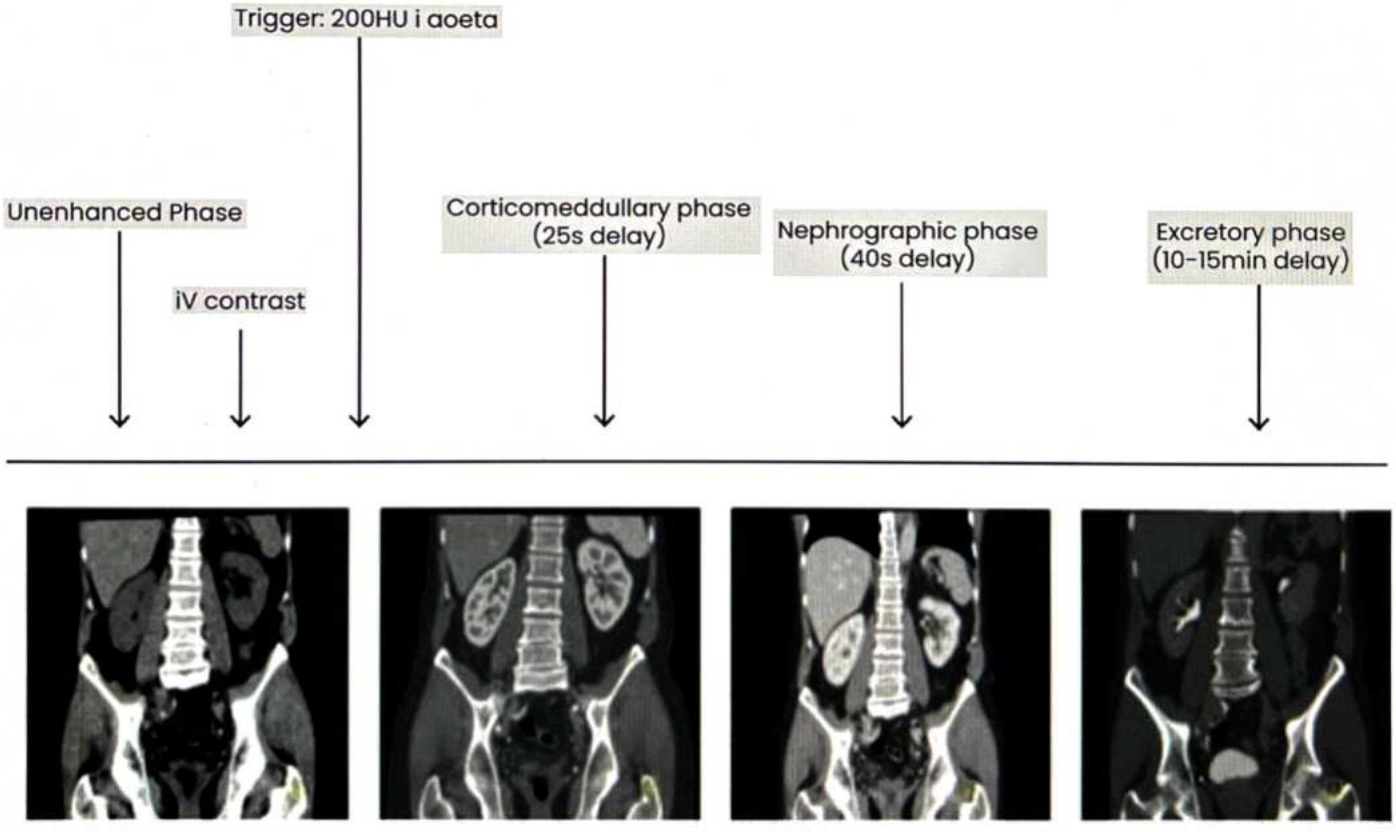


- Done in case of Stroke
- Used for diagnosing "Penumbra"
- Physiological parameters of blood flow e.g. blood volume, meanvtransit time etc can be calculated.

00:47:20

- Virtual bronchoscopy
- Virtual endoscopy
- Virtual colonography

Picture 3.1



CLINICAL QUESTIONS

Q. A 44 year old IT company employee presenting to her family physician with complaints of burning sensation on urination. On physical examination her vitals were significant for a slight fever. She reported that this pain started about a week ago. After evaluation, her doctor suspected the presence of kidney stone and advised her to do a CT scan to confirm the diagnosis and location of the stone. The doctor also decided, it was equally important to detect the chemical composition of the kidney stone. Which type of CT scan best detects the Chemical composition of the CT stone?

A. Spiral CT
B. Multidetector CT
C. Dual source CT
D. HRCT

Answer: C

Solution

- **Dual source CT** uses two different x-ray sources with different Kvp and based on the interaction with different elements can characterize the type of kidney stones.

Clinical dual-energy applications include:

1. Characterization of abdominal masses,
2. Chemical composition of renal calculi,

Q. A 65 year old male patient presented to emergency department with chest pain for last 6 hours. The ECG shows ST segment depression and cardiac troponin are elevated . which of the following imaging modality is suitable for imaging heart and blood vessels in this case?

A. Second generation CT
B. Third generation CT
C. Spiral CT
D. Multidetector CT

Answer: D

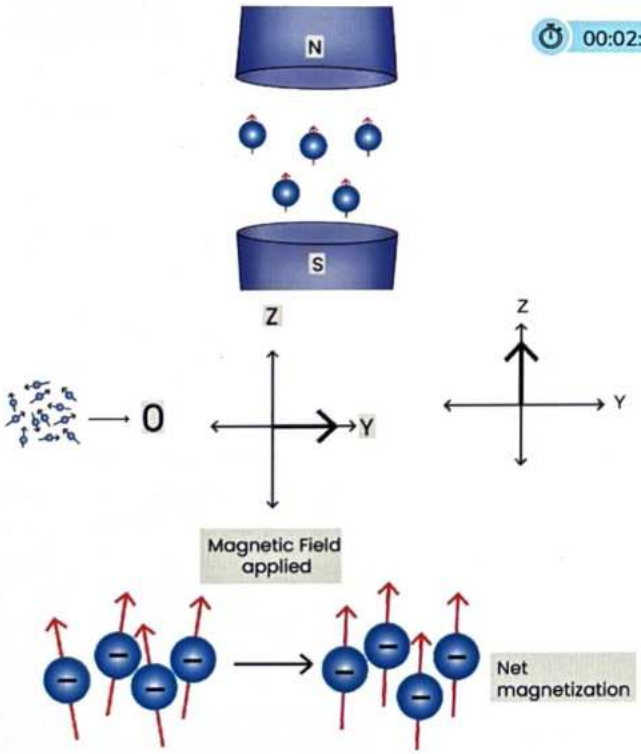
Multidetector CT

- It has **cone shaped beam** of **X-ray**
- Multiple slices of detectors and useful in Cardiovascular imaging.
- **Multi-detector CT** is particularly **suitable for imaging of the chest, heart and vessels.**
- It is also useful for imaging of trauma patients.

4 MRI BASIC CONCEPTS

- Ionising radiations are not used in MRI.
- Proton, a positively charged particle, is continuously spinning around its own axis and has thus created a magnetic field around itself.
- This concept is NMR: Nuclear Magnetic Resonance
- This concept is discovered by: Block & Purcell
- Paul Lauterberger & Mansefield: Discovered the instrumentation behind the MRI machine
- Net magnetization Vector (NMV): Zero (At rest / without any magnetic field)

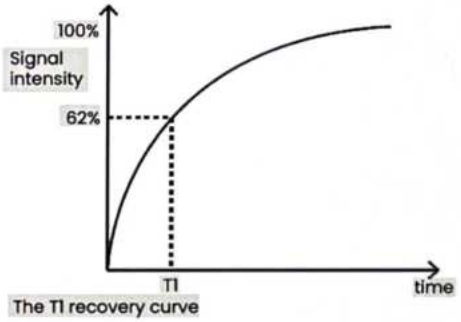
00:02:39



- In the external magnetic field: Magnetic machine of: 1.5 T, 3T
- NMV = ⊕ve
- When the magnetization is along the longitudinal axis, we cannot measure it.
- When the magnetization is along the transverse plane, we can measure it.
- MRI involves 2 steps
  1. Magnetic machine that aligns the movement
  2. **Radiofrequency pulse**: Flip the axis of net magnetisation vector along the transverse Plane
- On **switching off** the **RF pulse:** Transverse movement again goes back to its longitudinal state (Relaxation state).

SPIN LATTICE RELAXATION OR T1 RECOVERY

00:04:52



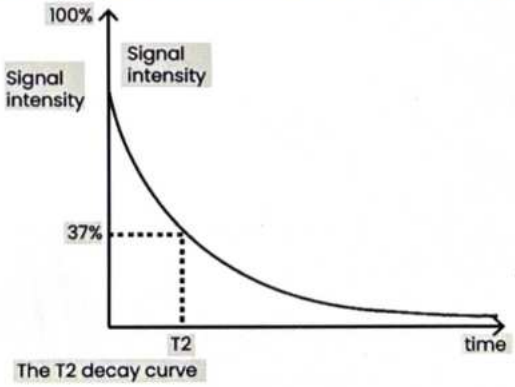
The T1 recovery curve

T1 recovery time

- Time at which 63% of longitudinal magnetisation is recovered
- Depends upon proton & surrounding crystal lattice

SPIN SPIN RELAXATION OR T2 DECAY

00:04:54

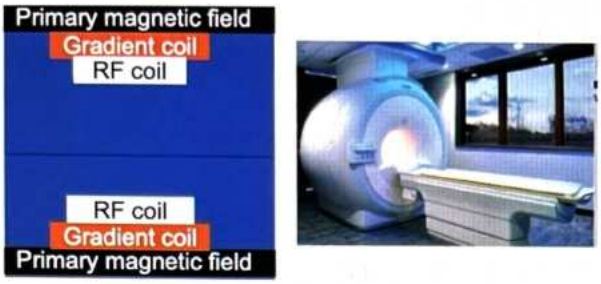


The T2 decay curve

- Time taken when transverse magnetisation reduces to 37% of its original value
- Depends upon interspin interaction

INSTRUMENTATION

00:06:56



MRI Machine

- Primary magnetic field: 1.5 T – 3T
- **RF Coils**: generate the RF signal
- **Gradient coil**: defines the plane of image (axial / coronal / sagittal).

CONTRAINDICATIONS TO MRI

00:08:46

- Metallic foreign body (intraocular foreign body mostly)
- Pacemakers, cochlear implants

Relative Contraindications

- In the first trimester (Fetal MRIs are done between 16 – 19 weeks)
- Claustrophobia
- Recent Orthopedic implants
- Tattoos

MRI SAFE

00:11:06

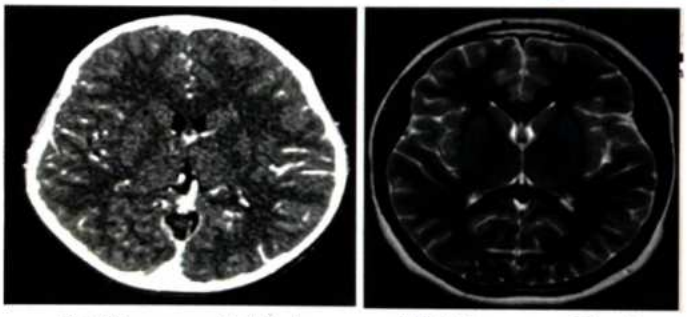
- Titanium implants
- Breast implants usually made of silicone / saline.

IOC for evaluation of breast implants: MRI

- IUCD
- Cholecystectomy clips
- CABG: Sternal sutures
- Pregnancy (except 1st trimester)

CT VS MRI ??

00:12:05



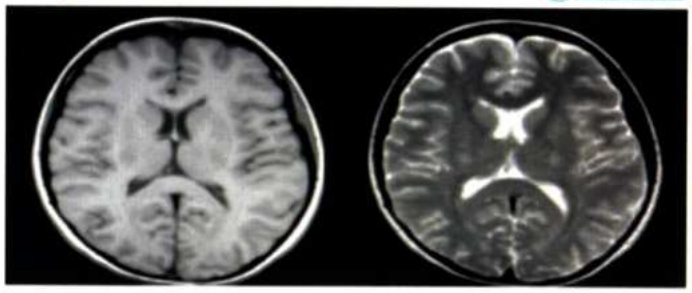
CT (Bones → White) MRI (Bones → Black)

Spine CT	Spine MRI

• Cortex of bone best visualized on CT
• Therefore I.O.C for fractures is CT
	• Soft tissues are better visualized on MRI
	• Therefor MRI is IOC for
	  ○ Bone marrow
	  ○ Intervertebral discs
	  ○ Spinal cord pathologies
	  ○ Ligaments

SEQUENCES OF MRI

00:13:55



- Since bones are black, it is MRI.
- Once recognized that it is MRI, look at CSF.
  - CSF is white, it is T2 WI. (Water / fluid is white on T2: WW2)

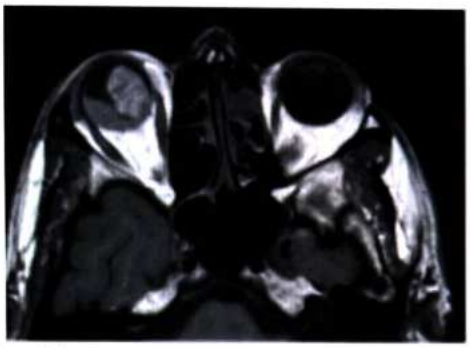
T_1 WI	T_2 WI
• Grey matter: Grey • White matter: White • T1 follows the anatomy.	• Grey matter: White • White matter: Darker/grey

T1 bright / Hyperintense	T2 bright /Hyperintense

• Fat
• Protein rich: Anything which has Keratin
  ○ Cholesteatoma
  ○ Epidermoid cyst
  ○ Craniopharyngioma
• Posterior pituitary
• Melanin
• Gadolinium (MR contrast agent)
• Subacute hemorrhage
	• Fat
	• Fluid (WW II)

Previous Year's Questions

Q. A 45 yr old female has unilateral vision loss. TI weighted image is shown. What is the diagnosis? (NBE 2018)



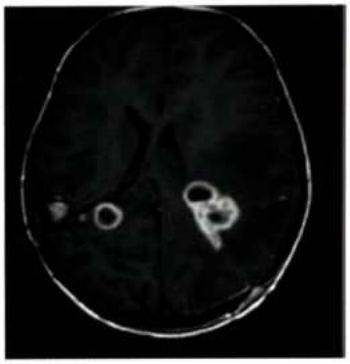
A. Retinoblastoma
B. Melanoma
C. Metastasis
D. PHPV

Explanation:
T1 hypertense intraocular lesion: Melanin: Melanoma

00:19:52

- MRI in sagittal section
- T1 weighted MRI (since CSF is black)
- Posterior pituitary appears as Hot spot (Because of presence of neurosecretory granules received from hypothalamus)

00:20:35



- Gd-MRI
- Ring enhancing lesions (central necrotic part + viable peripheral ring)
  - M - Metastases
  - A - Abscess
  - G - Glioblastoma
  - I - Infections: Neurocysticercosis / TB
  - C - Contusions → Subacute hemorrhage
  - D - Demyelinating lesions (rarely)
  - R - Radiation necrosis (rarely)

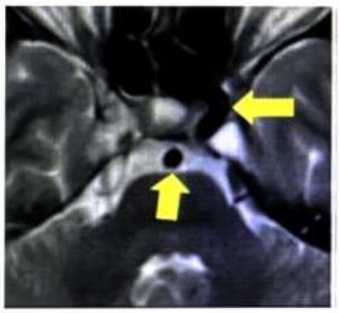
How to remember

- MAGIC DR

SIGNAL VOID

00:22:40

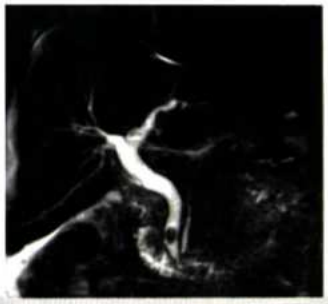
- Structures which are hypointense/black on all sequences of MRI that is they are not able to generate signal.



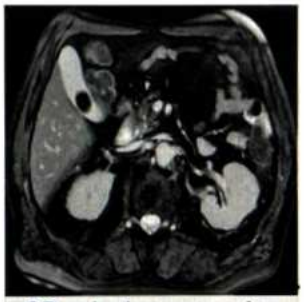
- This is T2 WI MRI as CSF in 4th ventricle is hyperintense/ white and it is a cross section at the level of Pons.
- Blood vessels (yellow arrows) that is arteries/ veins appear as Flow void that is they appear as hypointense/ black on T1, T2 or any other MRI.
  - If a vessel is showing signal that is appearing hyperintense, it means that there is thrombus formation in the vessel.

Other structures appearing as flow void are as follows

- Cortical Bone
- Air
- Calculi



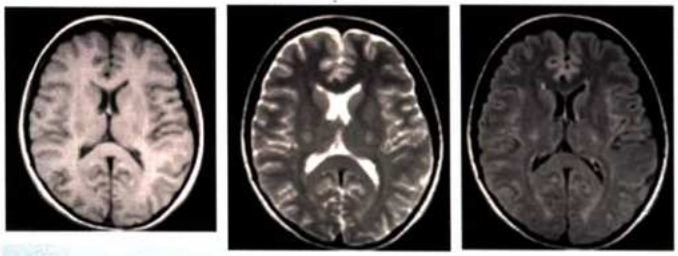
MRCP showing signal void which is a distal CBD calculus.



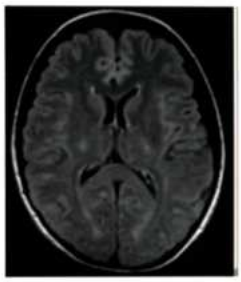
GB calculus appearing as a signal void.

00:25:14

T1	T2	T2 (CSF) (FLAIR)
• GM: Grey • WM: White	• CSF is white, so T2 WI. (WW2)	• CSF is not white • But GM is white • And WM is darker. Fluid attenuated inversion recovery T2 MRI. Pathology is more evident when CSF signal is suppressed within the ventricles



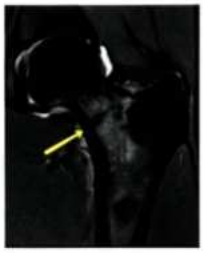
FLAIR SIGNAL MRI



- CSF signal in the ventricles is suppressed
- Periventricular white matter is hyperintense.
- FLAIR helps to pick edema in the periventricular area.
- Helpful in demyelinating lesions as in Multiple sclerosis (Dawson fingers)

STIR (SHORT TAU INVERSION SEQUENCE) MRI

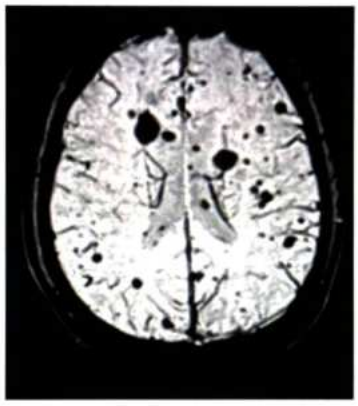
00:28:36



- It is T2 WI MRI in which fat signal is suppressed
- As both bone marrow and fat are hyperintense on T1 and T2, to differentiate between fat and bone marrow, fat signal is suppressed.
- I.O.C to look for Bone marrow edema as in cases of Osteomyelitis/Sacroiliitis/Stress fracture.

GRADIENT ECHO SEQUENCE OR T2* SEQUENCE OR SWI (SUSCEPTIBILITY WEIGHTED IMAGING)

00:30:38



- **Susceptibility artefact:** Substances that alter the magnetic field locally
- Picks up: Bleeding and Calcification
- A person with trauma & low GCS: SWI done
  - SWI shows Multiple foci of blooming
  - It is a case of DAI (diffuse axonal injury)
- Sequence of choice for picking up microhemorrhages particularly in DAI

DIFFUSION WEIGHTED IMAGING (DWI) MRI

00:32:33

- Relies on the concept of Brownian motion
- Stroke / infarct

  ↓

  Na^+ - K^+ pump stops working

  ↓

  Na+ & H20 accumulate inside the cell

  ↓

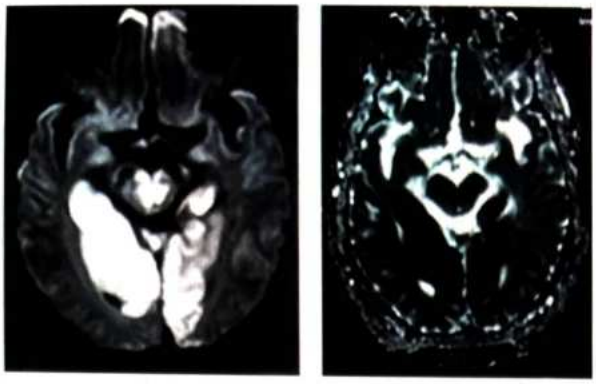
  Cell swelling (Cytotoxic edema)

  ↓

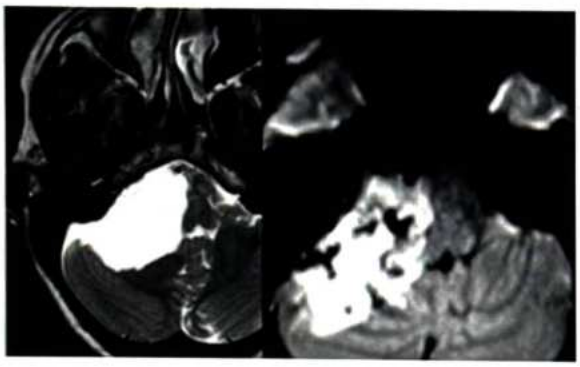
  Brownian motion is restricted

- Diffusion restriction: Restricted Brownian motion
  - Identified by DWI sequence

- DWI is used in cases of
  1. Stroke – ischemia (Most sensitive sequence: DWI)
  2. Epidermoid cyst (Keratinaceous)
  3. Abscess
  4. Hypercellular tumors

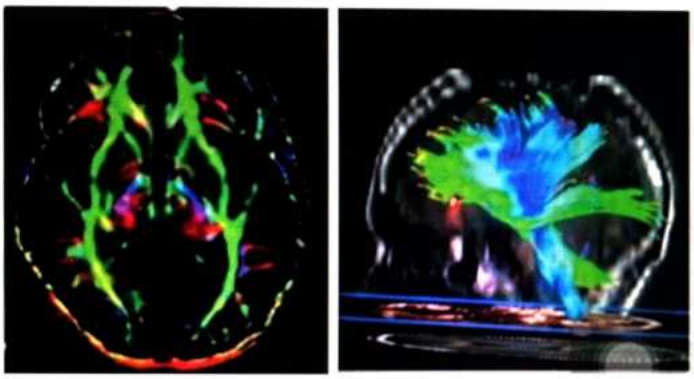


- PCA territory stroke shown in DWI and ADC (Apparent diffusion coefficient) MAP



- T2 image showing hyperintense lesion and DWI shows restriction

DTI (DIFFUSION TENSOR IMAGING) 00:36:50



- Anisotropy: To study white matter tracts
- DTI relies on the concept of anisotropy
- Preferrential diffusion along the neurons

Applications

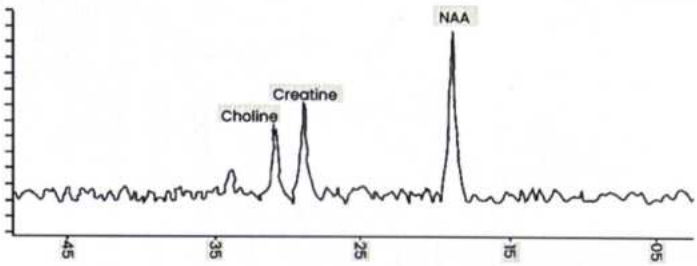
- Preoperative planning ·
- Trauma

TRACTOGRAPHY: 3D representation of DTI

HEAVILY T2 IMAGES (OF ABDOMEN) OR HASTE SEQUENCES 00:39:18

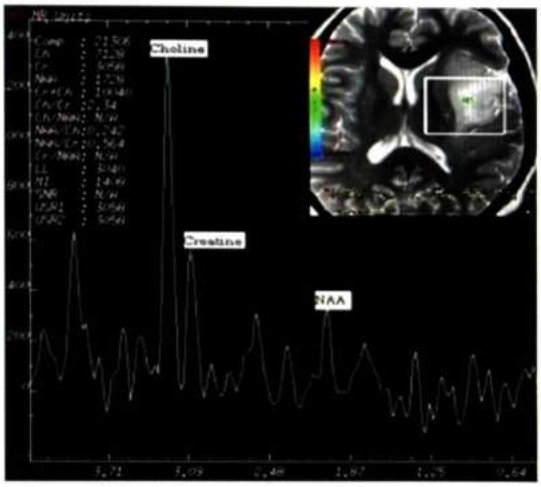
- No contrast is needed
- Non invasive

MR SPECTROSCOPY 00:40:54



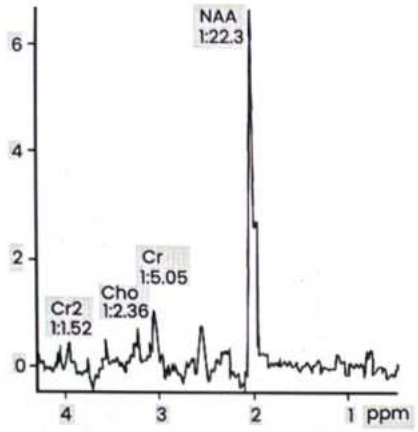
- To see biochemical metabolites within the lesion.
- Normal brain spectroscopy: 3 metabolites nt

1. **NAA (N-acetyl aspartate)**
   - seen at 2ppm
   - determines neuronal integrity
   - Any pathology of brain: NAA ↓ ses except: Canavan's disease
2. **Creatine**
   - Seen at 3 ppm
   - Determines the metabolism
   - Remains unaltered in any brain pathology (internal reference)
3. **Choline**
   - Seen at 3.2 ppm
   - ↑ses in hyper cellularity / tumors 00:43:57



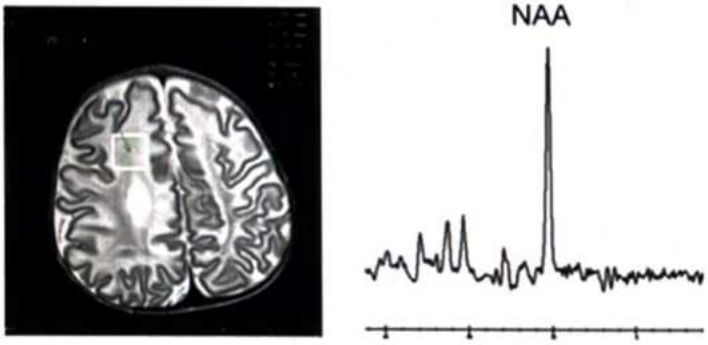
- MR Spectroscopy shows NAA ↓ and Choline ↑ thus it is a tumor.

00:44:38



- Lipid Lactate peak at 0.9 – 1.4 PPm
- Represents necrosis (Tb / toxoplasmosis)

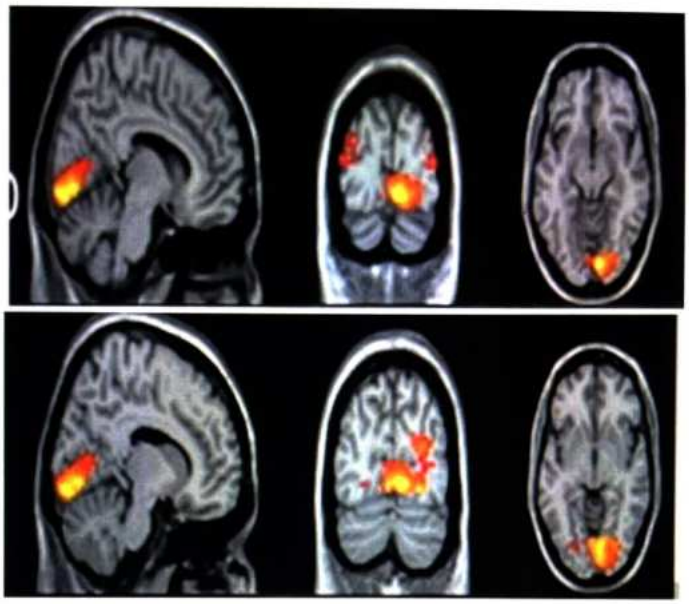
PEDIATRIC LEUKODYSTROPHY



- NAA peak seen in Canavan's disease

BOLD MRI (BLOOD OXYGENATION LEVEL DEPENDENT MRI)

00:45:37



- Functional MRI where we ask the patient to perform some work so as to know, which area of the brain is activated.

CLINICAL QUESTIONS

Q. A 6-month-old female presented with global developmental delay and history of generalized tonic seizures for 4 months. Her perinatal history and delivery were unremarkable. On physical examination, She had severe hypotonia, head lag, and hypertonicity in the extremities and would not interact socially. Brain magnetic resonance imaging (MRI) showed delayed myelinization at the corpus callosum, genu of the internal capsule, and posterior limB subsequently, proton magnetic resonance spectrometry (MRS) revealed a prominent NAA peak on the posterior deep white matter lobe. What is the most likely diagnosis?

A. Tuberculoma
B. Tumors
C. Canavans disease
D. Meningioma

Answer: C

Solution

- Canavan disease, also known as spongiform degeneration of white matter (not to be confused with Creutzfeldt-Jakob Disease) or aspartoacylase deficiency, is a leukodystrophy clinically characterized by megalencephaly, severe mental and neurological deficits, and blindness.
- It is an autosomal recessive disorder characterized by a genetic mutation on the short arm of chromosome 17. There is a deficiency of N-acetylaspartoacylase, a key enzyme in myelin synthesis, with resultant accumulation of N-acetyl aspartate in the brain, CSF, plasma, and urine.
- MRS (Magnetic Resonance Spectroscopy) of Canavan Disease shows NAA peak at 2 ppm.

Other salient points:

- Alanine peak is seen at 1.48ppm in meningioma
- Lipid lactate peak is seen at 1.33ppm in tuberculoma

Q. 18-month-old boy presented at the emergency department with left hip pain and a limp following a minor trauma .The child presented with a limited and painful range of motion of the left hip and could not bear weight on that side .Blood tests were performed and showed white blood cell (WBC): 25,000 cells/μL; neutrophils: 90%, C-reactive protein (CRP): 8.2 mg/dL; erythrocyte sedimentation rate (ESR): 56mm/h. X-rays of the pelvis and left hip showed a lytic lesion of the proximal femoral metaphysis . The doctor suspecting acute osteomyelitis . What is the investigation of choice to confirm the diagnosis ?

A. CT Scan
B. MRI
C. Bone scan
D. PET

Answer: B

Solution

- **MRI** is the investigation of choice for **Acute Osteomyelitis**
- **MRI** is the **Investigation of Choice**
  1. For evaluating Bone Marrow pathologies
  2. Avascular Necrosis of the femur
  3. Perthes disease
  4. Ankylosing Spondylitis
  5. Stress fracture

5 ULTRASOUND: BASIC CONCEPTS

Advantages of USG	Disadvantages of USG
• No use of ionizing radiation • Readily available • Real time investigation	• Operator dependent technique

PRINCIPLE

- Pulse echo principle
- Sound waves are generated & passed through the body / structures.
- Depending upon the behavior of particular structure to the sound waves, different kind of images are obtained.
- If the surface reflects the sound waves: that surface appears hyperechoic.
- If the surface absorbs the sound waves: that surface appears hypoechoic.
- Frequency of sound wave used for USG → 1-20 megahertz (range of diagnostic medical USG)
- UBM (Ultrabiomicroscopy) and IVUS (Intravascular ultrasound) have frequency of > 20 MHZ.

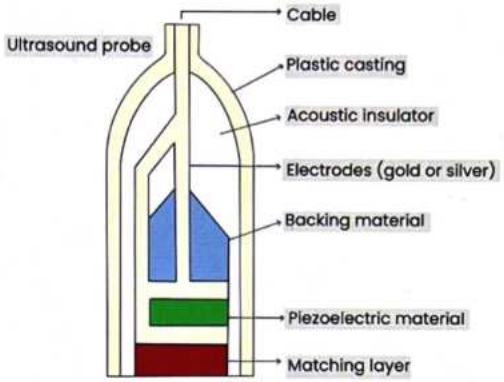
Previous Year's Questions

Q. All are true about USG except: (NBE 2015)
A. Frequency between 1-20 MHz is used
B. Involves ionising radiation
C. Portable
D. Operator Dependent

Explanation: It involves the use of sound waves.

TRANSDUCER

00:04:04



- Transducer is the USG probe which comes in contact with the skin.
- Piezoelectic crystals (backbone of transducer)
- These piezoelectric crystals are made up of Pb Zirconate titanate (PZT).
- When electrical energy is passed through piezoelectric crystals
  - Mechanical energy is generated on vibration of these crystals
  - This mechanical energy is converted into sound waves
  - These sound waves are transmitted through the body & give rise to image
  - These sound waves transmitted / reflected / refracted / absorbed go back to crystals
  - Mechanical energy generated (on vibration of these crystals) is again converted into electrical energy
- Thus, Piezoelectric crystals show the property of two way functioning
- Function of matching layer: Impedence matching
- Backing material: Controls the vibration of piezoelectric crystals

Previous Year's Questions

Q. All are true about USG probes except: (NBE 2016)
A. Frequency is directly proportional to penetration
B. Frequency is directly proportional to resolution
C. Curvilinear probe is used in abdominal ultrasound
D. Endocavitory probe is used for prostate biopsy

Explanation

- Frequency of USG
  - α resolution
  - $1/\alpha$ penetration

TYPES OF USG PROBES (DEPENDING ON THE FREQUENCY)

Refer Table 5.1

OTHER TYPES OF PROBES

Refer Table 5.2

MODES OF USG

Refer Table 5.3

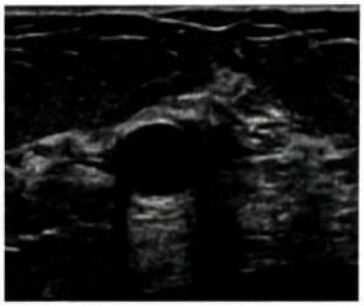
Terminology for USG

- Black: Hypoechoic
- White: Hyperechoic
- Completely black: Anechoic

POSTERIOR ACOUSTIC SHADOWING

- 90% gall stones are radiolucent
- Therefore, I.O.C. for gall stones is USG.
- On USG, gall stone appear as Hyperechoic in gall bladder.
- Posterior acoustic shadowing: Property a/w calculus

POSTERIOR ACOUSTIC ENHANCEMENT

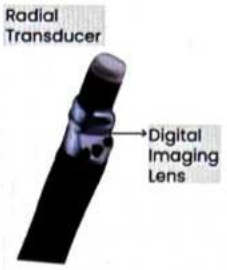


- Anechoic cyst (has the property of posterior acoustic enhancement)

SPECIAL TYPES OF ULTRASOUND

00:19:15

Endoscopic Ultrasound



Radial

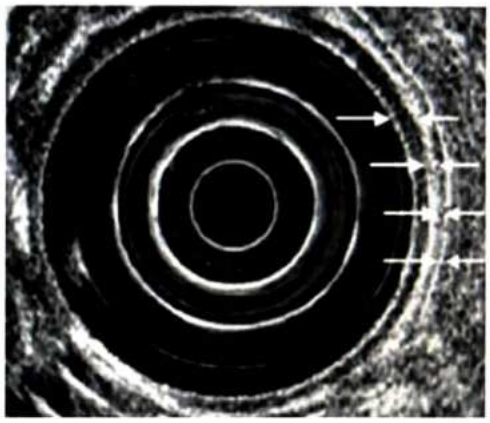
Linear (FNA)

Radial Probe

- Used along with upper GI endoscopy.
- Used in guidance for FNAC / biopsy

Layers on endoscopic ultrasound

00:20:25



- Radial EUS (Bowel)
- Various layers of bowel are seen separately on endoscopic USG
- Therefore, best modality for T-staging of GI malignances (particularly esophageal malignances)

Gut signature		
1 layer	Hyperechoic	Mucosa
2 layer	Hypoechoic	Muscularis Mucosae
3 layer	Hyperechoic	Submucosa
4 layer	Hypoechoic	Muscularis propria
5 layer	Hyperechoic	Adventitia

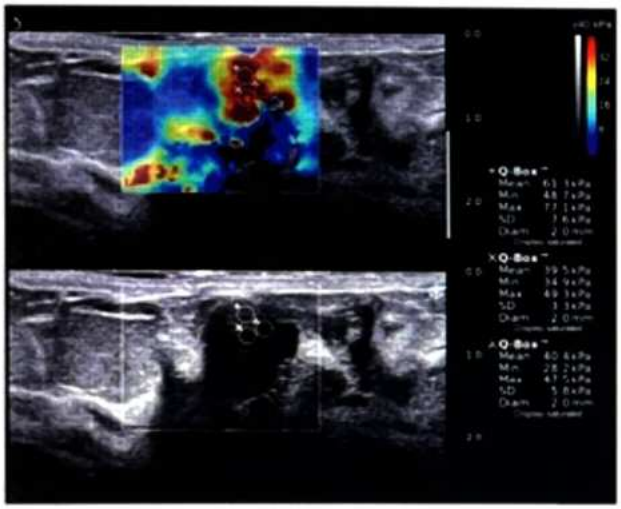
3-D USG

00:22:20

Applications

- Fetal scan
- Evaluation of mullerian duct anomalies
  - IOC: 3-D USG / MRI
  - Distinguishes septate & bicornuate uterus (Septate uterus → Outer contour is smooth, bicornuate uterus → outer contour is dipped down)

USG ELASTOGRAPHY (SHEAR WAVE ELASTOGRAPHY)



- Breast USG shown.
- Stiffness / elasticity of a lesion can be measured.
- Can distinguish b/w benign & malignant lesions (harder mass is more likely to be malignant)
- Helpful in thyroid/breast/endometrial masses.

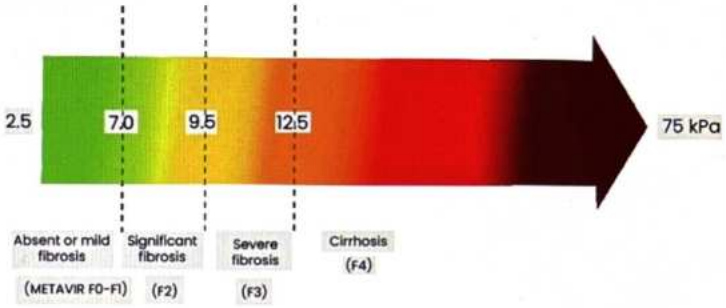
Previous Year's Questions

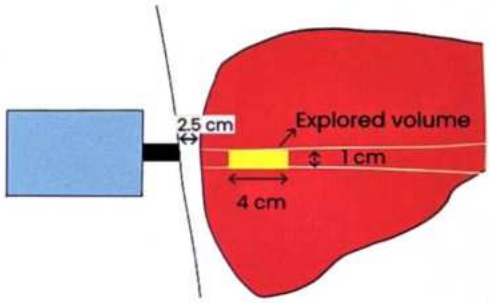
Q. All of the following are true about fibroscan except:

A. Non-invasive way to prognosticate liver fibrosis
B. Uses principle of elastography
C. Very useful in obese patients
D. Measured in the form of a cylinder
E. 10 readings taken

Explanation

- Fibroscan is also k/a transient elastography technique
- Used for liver
- Elasticity values for liver is correlated with the stage of fibrosis of liver in case of Chronic liver diseases





- Fibroscan values are correlated with metavir score.
- In fibroscan, we non-invasively try to estimate the grade of fibrosis of liver.
- In cases where liver is more than 2.5 cm from the abdominal wall like obesity, ascites
  - Elasticity can't be measured using Fibroscan (limitation of fibroscan)

Table 5.1

Curvilinear probe (2-5 MHz)	Linear probe (6-15 MHz)
• Higher operational depth • Resolution: Slightly lower • Uses: Abdomen USG, Pelvic USG	• Lower depth • High resolution • Thyroid USG, breast USG, Testicular USG (superficial structures)



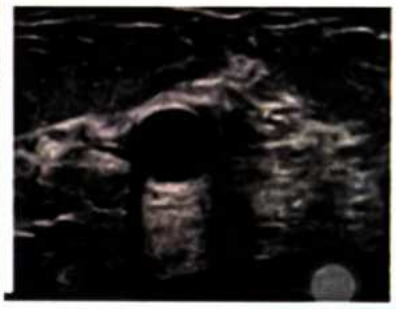
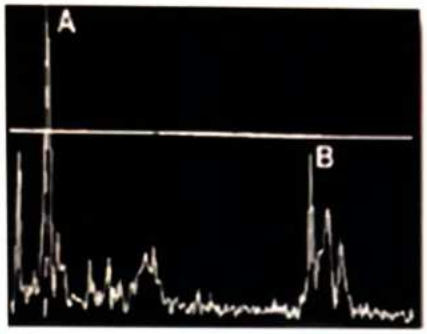



Table 5.2

Endocavitary USG (5-11 MHZ)	Sectoral probe/ Phased array probe/ ECHO probe	Hockey stick probe
	Uses	
• TVS (Transvaginal sonography) • TRUS Transurethral ultrasound (used for prostate)	• Echocardiography • Transcranial USG	• Musculoskeletal imaging



Table 5.3

A-mode	B-mode	M-mode
• (A → amplitude) • Used frequently in ophthalmology for measuring axial length. 	• (B → Brightness) • Used most common 	• (M → Motion) • Used for ○ Fetal heart rate ○ Pneumothorax 

CLINICAL QUESTIONS

Q. A 33 year old women develops abdominal pain ,fever and jaundice . Examination reveals tenderness in the right hypochondrium and positive murphy's sign. Which of the following is IOC to reveal acute cholecystitis?

A. CT
B. USG
C. Plain X ray
D. MRCP

Answer: B

Solution

- **Ultrasound** is the **Investigation of Choice for most Gall Bladder pathologies** like Acute Cholecystitis, Gb polyp, Gb calculus.
- Black is hypoechoic in USG
- White is hyperechoic in USG
- Completely black is anechoic
- Posterior acoustic shadowing is seen in gallbladder calculus
- Posterior acoustic enhancement is seen in anechoic cyst

Q. A 3 year old child with hydrocephalus sent to radiological department for transcranial USG. Which probe you will use for transcranial USG?

A. Linear
B. Curvilinear
C. Sectoral
D. Endocavitary

Answer: C

Solution

- Sectoral/phase arrayed probe has a smaller footprint and is used in Chest USG,Echo,and Transcranial USG

6 RADIOLOGICAL INVESTIGATIONS & THUMB RULES

X-RAY AS INVESTIGATION

00:01:12

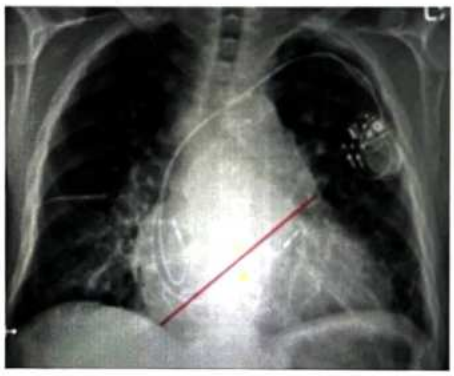
- Initial investigation for emergencies e.g. pneumoperitoneum, intestinal obstruction
  (Chest X-ray PA view → Most sensitive for detecting pneumoperitoneum)
- Initial investigation for fractures
- Initial investigation for foreign bodies
- Initial investigation for bone tumors
- IOC to know position of medical devices e.g. Position of ET tube, central line, Nasogastric tube

Refer Table 6.1

IOC to know position of lines, tubes and medical devices

- Normal placement of ET tube in the trachea.
- Normally, the tip of the ET tube should be 2-5 cm above the carina

00:07:23



PACEMAKER

- Location of prosthetic valves on x-ray.
  - Draw a line from the left hilum, take it to the right CP (cardiophrenic) angle
  - Above this line: Aortic valve
  - Below this line: Mitral valve

CT SCAN AS INVESTIGATION

00:09:02

Hyperdense on CT

- Bone cortex / Calcification
- IV contrast/ Iodinated contrast
- Acute Hemorrhage

NCCT

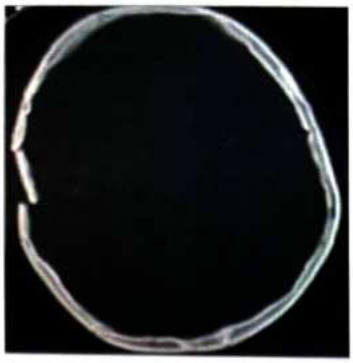
- IOC for head, spine trauma
- IOC for acute SAH
- IOC for intracranial calcification
- IOC for renal calculi
- IOC for IOFB (Intraocular foreign body)
- IOC for bone cortex
- Initial investigation in stroke (to rule out hemorrhage)

HEAD TRAUMA

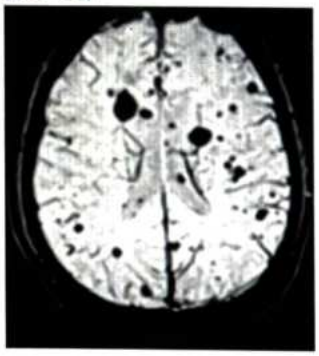
00:13:55

Acute Hematomas

- Right side EDH (Lenticular biconvex shaped)
- Left side SDH (Banana shaped, crosses suture line)



- Bone window image of CT showing depressed fracture.
- IOC for head trauma = NCCT
- Exception: Diffuse axonal injury (Patient underwent high speed road traffic accident and GCS is quite low and CT scan is normal)
  - IOC = MRI [Susceptibility weighted imaging] (SWI or Gradient sequence)



  - Gradient MRI Or SWI showing microbleeds which is shearing of axons

SUBARACHNOID HEMORRHAGE (SAH)

00:16:29

- IOC for acute SAH = NCCT
- IOC for chronic SAH = MRI
  - Chronic SAH on CT will be isodense and cannot be distinguished from CSF.

- Gold standard investigation for non-traumatic SAH (aneurysmal SAH) = DSA (Digital subtraction Angiography)

Important Information

- Any hemorrhage (EDH, SAH, SDH): IOC = NCCT
- Gold standard implies carrying diagnostic as well as therapeutic potential

SPINE TRAUMA

00:18:30

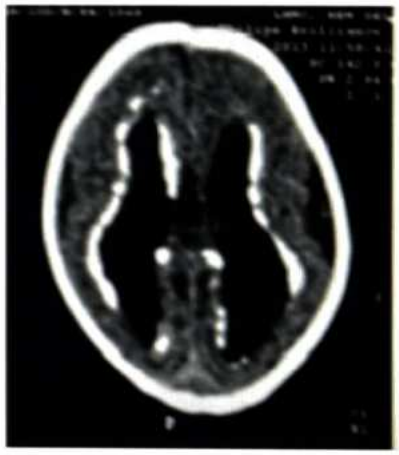
CT MRI

In general, for orthopedics

- Initial investigation = X-ray
- IOC for bony cortex, fractures = CT
- IOC for spine trauma (spine fracture & its morphology) = NCCT
- IOC for bone marrow, ligaments, spinal cord, nerves, IV disc = MRI

INTRACRANIAL CALCIFICATION

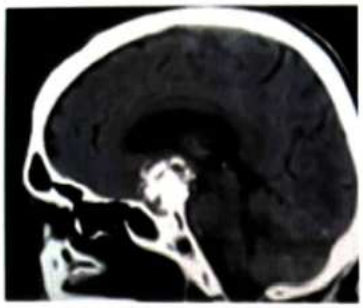
00:20:29



- IOC for intracranial calcification: NCCT
- NCCT showing Peri ventricular calcification

Important Information

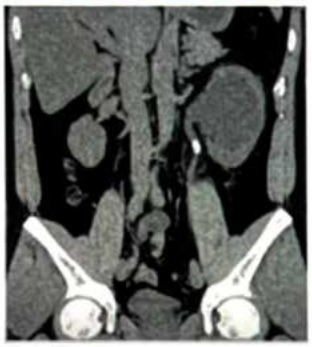
Periventricular calcification	Parenchymal Calcification
CMV	Toxoplasmosis



- Child with Bitemporal hemianopia → NCCT shows supracellular mass with calcification
- Diagnosis is Craniopharyngioma.

RENAL / URETERIC CALCULI

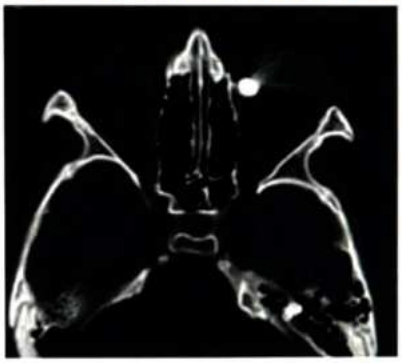
00:22:11



- IOC = NCCT
- Dual energy CT (DECT) = further characterizes these calculi

INTRAOCULAR FOREIGN BODY (IOFB)

00:23:07



- IOC = NCCT
- Contraindication = MRI

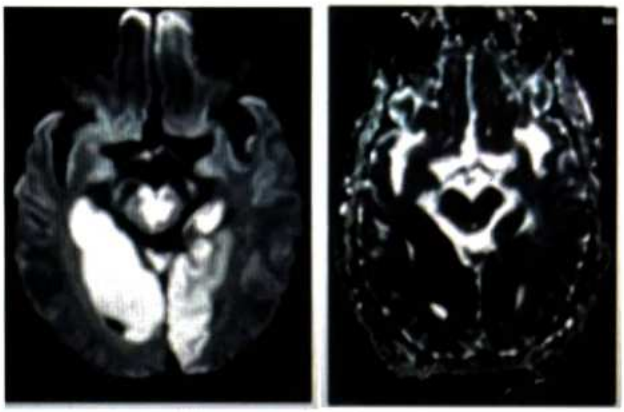
Important Information

Foreign body
- Initial investigation: X-ray
- Best/IOC: CT
- Contraindicated: MRI

STROKE

00:24:10

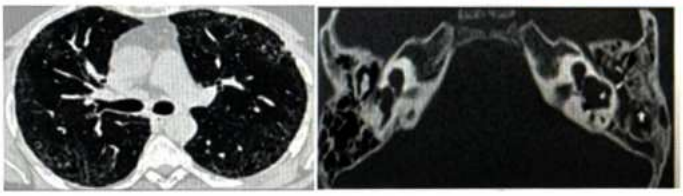
- Initial investigation (to rule out hemorrhage) = NCCT
- Most sensitive Ix/ IOC to detect ischemia = MRI (DWI)



DWI ADC MAP

HRCT

00:25:13

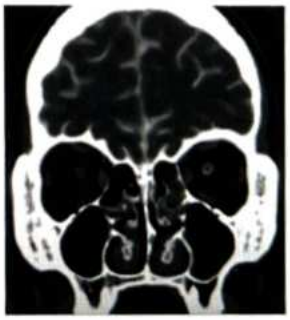


HRCT is IOC for

Lung Parenchyma pathology	Bones
Bronchiectasis	Temporal bone
Interstitial lung diseases	Paranasal sinuses

HRCT CISTERNOGRAPHY

- A young boy comes with a history of trauma and has constant fluid discharge from the nose. CSF rhinorrhea is suspected.
- Initial: Blot it on pape: Target Sign / Halo Sign
- To confirm CSF Rhinorrhea: B_2 transferrin test
- IOC / Best investigation for detecting the site of leakage: HRCT Cisternography (iodinated contrast iohexol is injected in the subarachnoid space)
  - Delineate the fracture and shows the contrast leak



CECT

00:28:43

Important Information

- To understand the pathology. Contrast is always likely to be given in any: Tumor . Inflammation . Infection.

- IOC for solitary pulmonary nodules (SPN) = PET – CT - CECT (PET-CT indicates functional nature of nodule)
  - Gold standard for diagnosing SPN: Biopsy
- IOC for lung tumors: CECT
  - Exception: Pancoast tumor → MRI
- IOC for renal tumors: CECT
- IOC for pancreatic carcinoma (dual phase CT): CECT
- IOC for liver tumors: Triple phase CT
- IOC for mediastinal masses → CECT
  - Exception: Posterior mediastinal masses → MRI (M/C posterior mediastinal masses = neurogenic tumors)
- IOC for acute pancreatitis → CECT
  - CT would be done 48-72 hrs after onset of symptoms
  - Aim of CECT in acute pancreatitis is to diagnose necrosis

CT ANGIOGRAPHY

00:33:06

IOC for

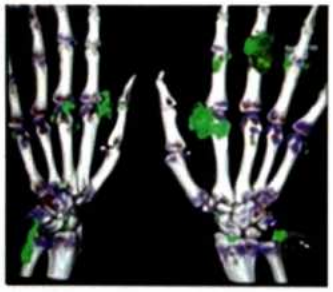
- Sequestration (systemic arterial supply)
- Aortic dissection
  - If the patient is unstable: Transesophageal echocardiography is preferred
- Aortic aneurysm
- Pulmonary embolism
  - IOC = CTPA (Pulmonary angiogram)
  - Most sensitive Ix = D-dimer
- Mesenteric ischemia

CT ENTEROGRAPHY

00:34:36

- For any small bowel pathology (Crohn's disease, tuberculosis): IOC = CT enterography
- Oral mannitol (for drinking) is given to the patient (oral mannitol being the osmotic substance, dilates the bowel loops)

DUAL ENERGY CT



- Predominantly used to identify uric acid in cases of Gout and urate calculi

MRI

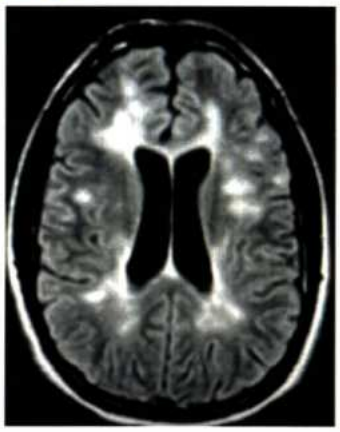
IOC for

- Brain and spine tumors
- Neurogenic lesions
- Pancoast tumors (brachial plexus involvement)
- Posterior mediastinal mass (Anterior & middle mediastinal mass → CECT)
- Chronic SAH (Acute SAH → NCCT)
- Diffuse axonal injury (DAI) → SWI/ Gradient MRI
- Most sensitive investigation for ischemic stroke: MRI (DWI)
- Brain tumors
- Spine tumors
- Infections
- Demyelinating Disorder

CE-MRI (Gd)

FLAIR SEQUENCE

00:38:56



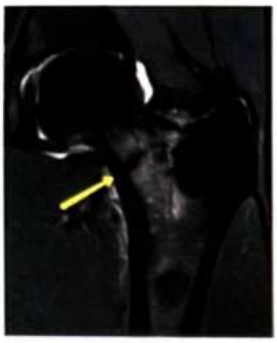
- Useful for picking demyelinating lesions
- Bone marrow pathology
  - Stress fracture
  - Acute Osteomyelitis
- Ligaments, Cartilage, IV disc, Spinal cord
- Soft tissue sarcomas
- Carcinoma rectum staging
- Choledocholithiasis → MRCP

} MRI

Important Information

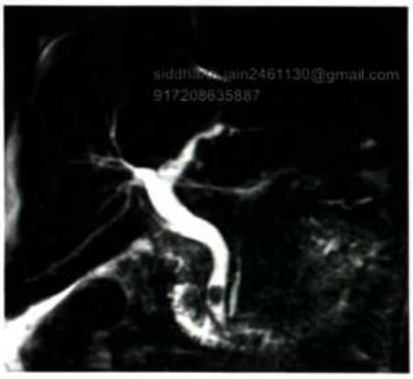
- Cortical fracture: NCCT
- Stress fracture: MRI

STIR Sequence (Short tau inversion recovery) 00:41:00



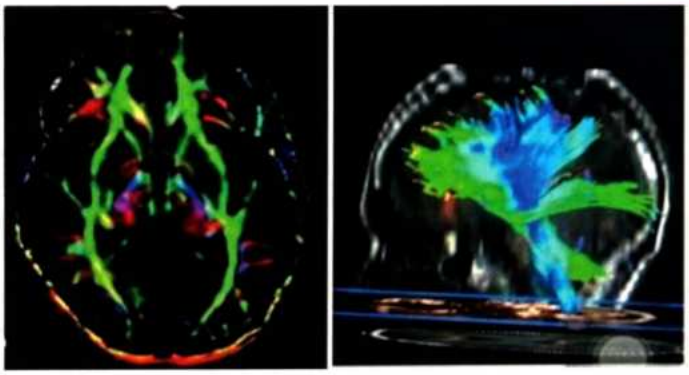
- Suppression of bone marrow fat
- For Bone marrow pathology or Stress fracture: IOC = MRI (STIR sequence)

MRCP (Magnetic Resonance Cholangiopancreaticography) 00:42:15



- Choledocholithiasis (CBD calculi)
  - IOC: MRCP
  - Gold standard Ix: ERCP

DTI (Diffusion Tensor Imaging) 00:43:53

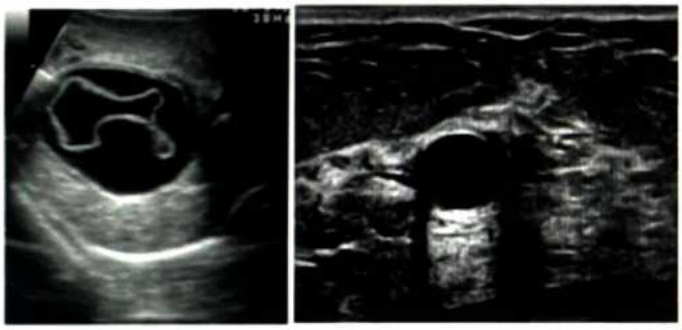


- White matter bundles (pre-operative evaluation of brain tumors)
- DTI 3D presentation is Tractography

ULTRASOUND 00:45:18

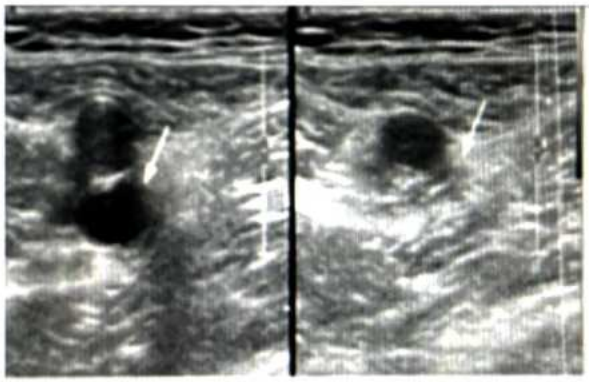
- Non ionising radiations
  - Pregnancy: All emergencies (IOC)
- Anything fluid: USG, Fluid appears anechoic on USG

- Gallstones
  - I.O C: USG
  - Most accurate: HIDA scan
- Acute Cholecystitis → IOC : USG
- Hydatid Cyst (IOC) (any cyst)
- Minimal pleural, pericardial effusion
- First investigation for blunt trauma abdomen: (eFAST)
- Infantile Hypertrophic Pyloric Stenosis (IOC)



- Radiological definition of cyst: Well defined black anechoic lesion
- Cyst showing Posterior Acoustic Enhancement

Deep venous Thrombosis 00:49:19



- IOC: USG + Doppler

- Normal vein shows monophasic flow

Table 6.1

Foreign body	Bone tumour	Fractures
• Radioopaque foreign body noted in the soft tissue	**Giant cell tumor** • Expansile lytic lesion • Soap bubble appearance • Distal end of radius • Skeletally mature patient (Growth plate is fused) • Epiphyseal tumor growing into metaphysis	

CLINICAL QUESTIONS

Q. A patient of brain stem injury is to be intubateD. What is the correct position of ET tube according to you?

A. 1-2 cm above carina
B. 2-5 cm below carina
C. 2-5 cm above carina
D. 1-2 cm below carina

Answer: C

Solution

- The position of an ET tube is 2-5 cm above the carina, but it varies greatly with neck position and rotation, so including the mandible is a useful indicator:
  - flexed: 3 cm (± 2 cm) above carina
  - neutral: 5 cm (± 2 cm) above carina
  - extended: 7 cm (± 2 cm) above carina
- The trachea is shorter in children, so the tip of the ETT should be 1.5 cm above the carina

Q. A patient with 1st MTP monoarticular red, inflamed, swollen joint came to opd. Which investigation will you do to identify urate crystals?

A. NCCT
B. Dual energy CT
C. MRI
D. X ray

Answer: B

Solution

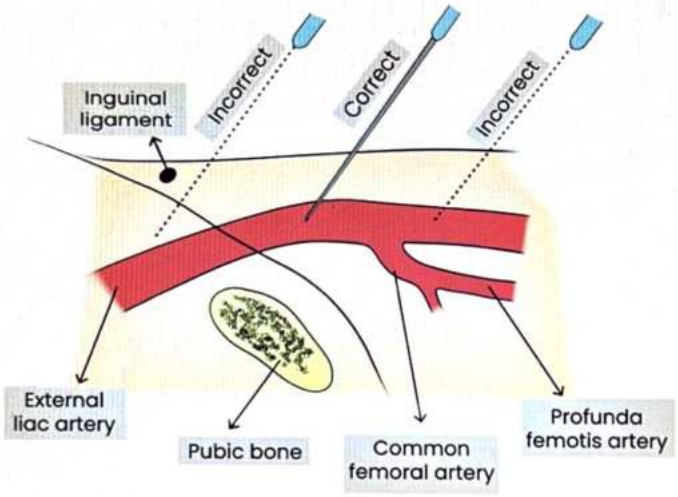
Dual-energy CT can distinguish between urate mineralization and calcification, which may be useful for cases where the clinical and biochemical presentation is atypical 11. Allowing for not only visualization and characterization, but also quantification of monosodium urate crystal deposits, it can be used for treatment monitoring as well.

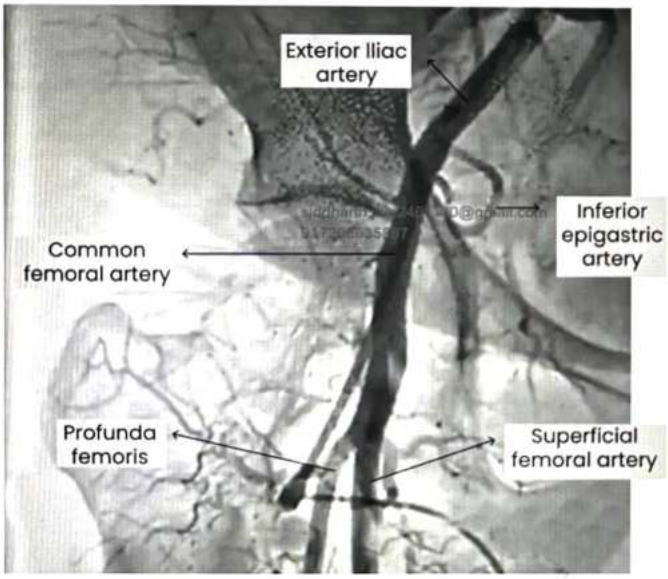
7 INTERVENTIONAL RADIOLOGY BASIC CONCEPTS

VASCULAR ARTERIAL PUNCTURE

- M/C artery to be punctured: Common femoral artery > Radial artery

00:02:29



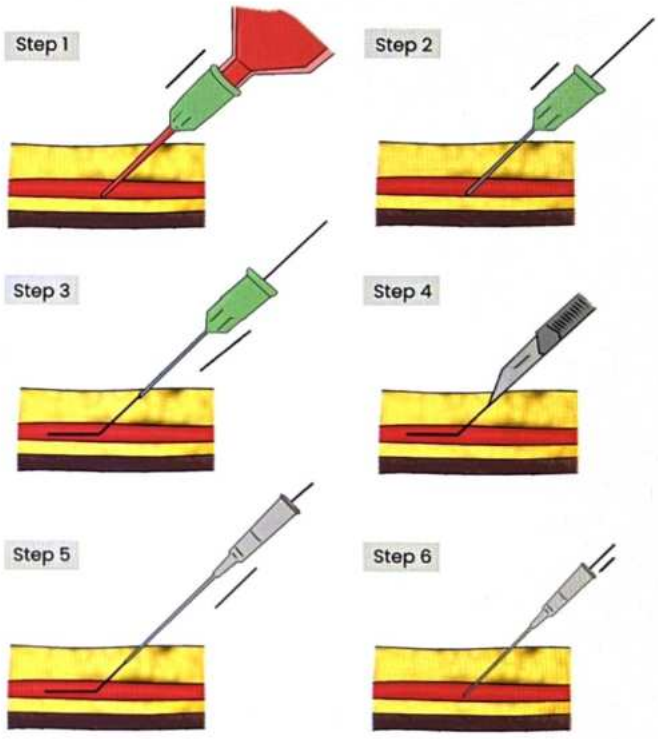


- Palpation of femoral artery: Draw a imaginary line connecting ASIS and pubic symphysis and palpate just below the midpoint.

- Ideal site of puncture: Lateral to medial most part of femoral head
- Femoral head provides the site of compression of femoral artery for homeostasis after the needle is withdrawn.
- Below bifurcation: Not punctured
  - Because of high risk of pseudoaneurysm
- Above inguinal ligament in femoral artery segment: Not punctured
  - Because Retro peritoneal hematoma can get formed (in case of inadequate compression).
- Guided puncture is preferred over blind puncture

PUNCTURE TECHNIQUE

00:06:25

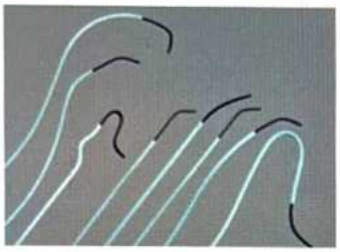


- Seldinger technique of arterial puncture is used
- Steps
  1. Puncture with the needle
  2. Guidewire is passed into the vessel
  3. Put a dilator
  4. Put vascular access sheath
- Single wall puncture is preferred if there is Risk of coagulopathy / deranged coagulation parameters

- Otherwise, double wall puncture is preferred
- Complication a/w single wall puncture: Arterial dissection as sometimes, only intima is punctured and the person starts putting guidewires through the intima on seeing gush of blood causing arterial dissection.

GUIDEWIRES/ANGIOGRAPHIC CATHETERS

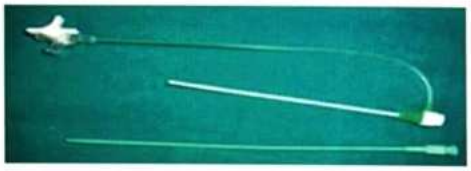
00:11:04

- Hydrophilic co-polymer coated, nitinol cored guidewires

VASCULAR ACCESS SHEATH

00:11:40



- Allows exchange of various guidewires & catheters through its head
- Two-way hemostatic valve is present

DSA (Digital Subtraction Angiography)

00:12:26

- Background is subtracted, only the artery is visible.
- Gold standard for most vascular pathologies: DSA

Refer Table 7.1

- AV malformation is one of the most important causes of intracranial bleed in young adults
- Spetzler-Martin grading is used for AV malformation of Head and Neck.

Juvenile Nasal Angiofibroma

- An adolescent male presenting with epistaxis
- Homan – Miller Sign (Bowing of posterior wall of maxillary sinus)

- Pre-operative DSA & embolization
  - To reduce intraoperative bleeding (since it is a highly vascular tumor)
- Most of the times, the supplier of JNA is internal maxillary artery

00:18:06


- Puff of smoke appearance
- Seen in Moya Moya disease

- Aneurysm
- Mx: Coil

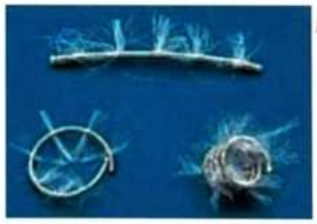
00:18:57


- Person at yoga practice developed sudden onset of neck pain, Vertigo, dizziness / Diplopia
- String sign: Seen with ICA dissection (sudden tapering of ICA)

- Carotid body tumor
- Lyre's sign: Splaying of ICA and ECA

AGENTS FOR EMBOLIZATION

00:20:48




- COILS coated with thrombogenic fibres
- Made up of platinum / stainless steel
- Uses: Aneuyrsm /pseudoaneurysm

- Endocryl (GLUE): N-butyl cyanoacrylate
- Used for AV malformations

00:22:42

Refer Table 7.2

00:24:19

- Occlusion of superficial femoral artery (because of atherosclerosis)

DSA PROCEDURE

00:24:36

- Balloon angioplasty catheter to open the occluded artery.

Angioplastic procedures that can be done for peripheral arterial disease

00:25:14

Balloon catheter

Stents

NON VASCULAR PATHOLOGIES

00:25:29

CT guided lung biopsy

- Location of mass
  - Central mass / nodule: Bronchoscopic Biopsy
  - Peripheral mass: CT guided biopsy
- Needle used in CT guided biopsy: Co-axial biopsy needle (18G)
- M/C complication of CT guided biopsy: Pneumothorax

Core biopsy needle or Trucut biopsy needle

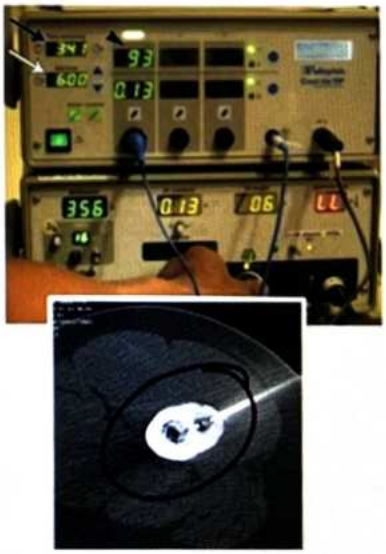
00:28:05

- For breast trucut biopsies: 14 G biopsy needle is preferred

RADIOFREQUENCY ABLATION

00:29:08

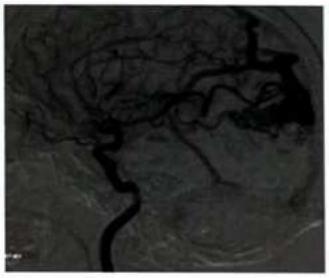
- For Osteoid Osteoma: CT guided radiofrequency ablation (Rx of choice)



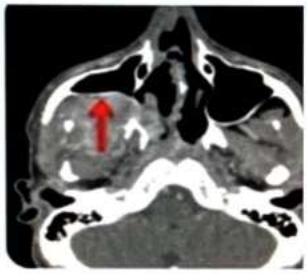
Other applications of radiofrequency ablation 00:29:50

- HCC (under USG guidance)
- RCC
- WPW syndrome

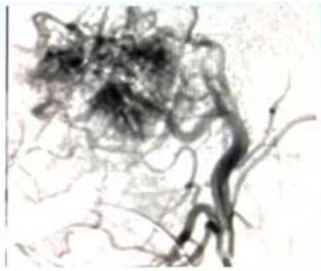
Table 7.1



- Middle cerebral artery DSA showing Arterialvenous (A-V) malformation

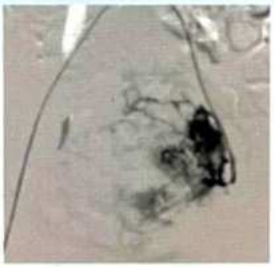


- Juvenile Nasal Angiofibroma CECT showing Homan Miller sign



- Tumor Blush: IMA supplying the JNA

Table 7.2



- **Uterine artery Embolization**
- Done in cases of Fibroid, Pregnancy (Adherent placenta)

- **Bronchial artery embolization :** Rx of choice for Massive hemoptysis

- **PolyVinyl Alcohol** (PVA)
- 300-500 μ

CLINICAL QUESTIONS

Q. A 55 year old male presented to the emergency department by ambulance with the complains of sudden onset chest pain and difficulty in breathing for 1 hour. previous history reveals he is on anti hypertensive therapy since last 5 years. O/E, Blood pressure is 90/70, pulse rate is unremarkable. Which of the following is the IOC in this case?

A. NCCT
B. CT-Angio
C. TEE
D. MRI

Answer: C

Solution

- In **Acute Aortic Dissection**
  - Stable Patient-**CT-Angio** (MDCT with contrast)
  - Unstable Patient-**TransEsophageal Echo(TEE)**

Q. A 50-year-old right-handed male visited AIIMS hospital presenting a mild right temporal headache for half-a-month and denied any sudden episodes of a severe headache or vomiting. Physical examination did not reveal any neck rigidity or other positive signs. he was ordered an MRI which showed an unruptured aneurysm of the right MCA. Which is the gold standard investigation for Intracranial aneurysms?

A. CT
B. MRI
C. Angiography
D. PET

Answer: C

Solution

Cerebral Angiography **is the** Gold standard **for the** detection of intracranial Aneurysms

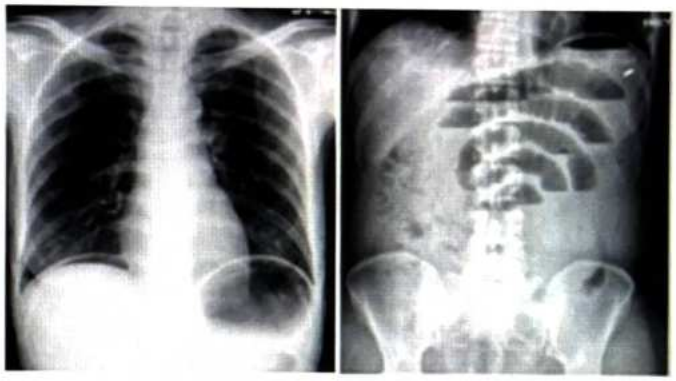
8 CONTRAST AGENTS

- Identify the incorrect pair 00:01:32
A. Iodinated contrast agent
B. USG contrast agent
C. Barium studies
D. CT contrast agent

- Multihance: Chelate of Gd (MRI contrast agent)
- Sonovue: USG contrast media
- Microbar: BaSO4
- Omnipaque
  - M/C iodinated contrast agent used
  - X-ray / CT contrast agent
  - Chemical name: Iohexol
- a, b, d: IV contrast agents
- c: Microbar → GI studies

MICROBAR 00:04:01

- BaSo4 (used for GI studies)
- Water insoluble
- Atomic no.-56
- Inert contrast agent
- Non – absorbable



Perforation **Small bowel obstruction**

- Barium leak into the body cavities leads to peritonitis, mediastinitis.
- Contraindications
  - Perforation
  - Intestinal obstruction
  - Post operative bowel Sx
  - Tracheo-esophageal fistula

} Water soluble iodinated water contrast is preferred

Various kinds of barium studies 00:08:40

- Barium is a ve contrast agent (makes the structure appear whiter)
- Air is a -ve contrast agent.

Ba swallow	Ba Meal
	

- Single contrast
- Only Ba is injected
- Esophagus oblique view

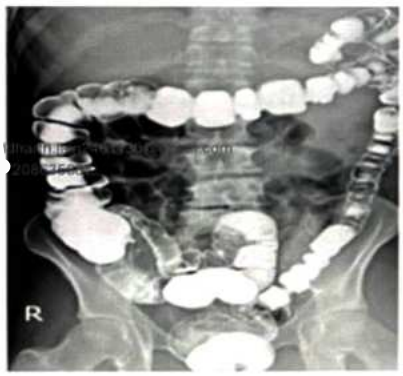
- Double contrast
- Ba + air is injected
- Mucosal details are better visualized
- Stomach + proximal part of duodenum

- Ba meal is replaced by upper GI endoscopy nowadays
- Upper GI endoscopy: IOC for stomach & duodenum

BMFT (Barium meal follow through)

- For Small bowel
- DJ flexure must cross to the other side of midline (left side) (Essential to rule out malrotation)
- DJ flexure must lie in the same plane as D1 (around transpyloric plane) which corresponds to L_1 (Essential to rule out malrotation)
- Jujenal folds: Feathery appearance because of Valvulae conniventes /valves of kerkering (complete mucosal folds)
- Ileal folds: Featureless

Barium enema



- To evaluate large bowel loops
- Barium is injected perectally.

Barium enteroclysis

- A tube is put upto DJ flexure
- Through the tube, Baand air are injected
- More distension of loops can be achieved

00:17:09

Previous Year's Questions

Q. Identify the procedure? (NBE 2017)

A. Barium meal
B. Barium swallow
C. Barium meal follow through
D. Barium enema

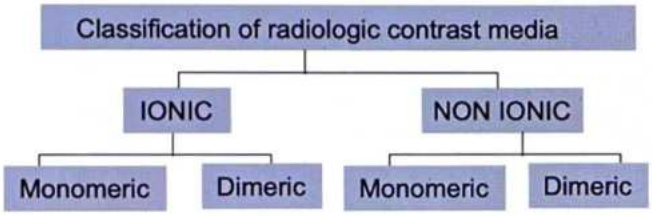
Explanation

- BMFT: Small bowel: Complete mucosal folds (valvulae conniventes) (valves of kerkering)
- Barium enema: Large bowel: Haustrations +nt: Incomplete mucosal folds

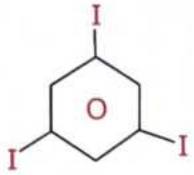
IODINATED CONTRAST MEDIA

00:18:20

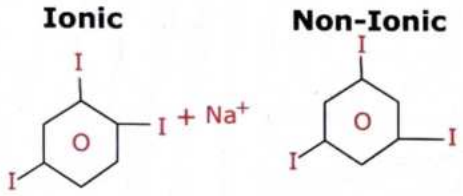
- M/C contrast agent to be used
- Used in CT as well as fluoroscopic investigations (MCU, RCU, ERCP, HSG)



- Basic structure of any iodinated contrast media

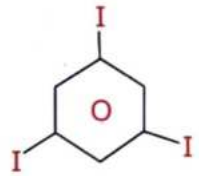


- **Ionic VS Non ionic**

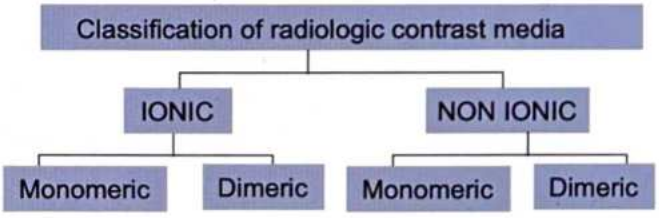


	Ionic	Non Ionic
No. of particles	2 (iodinated ring + Na^+)	1 (only iodinated ring)

- Thus, no. of particles decided by the fact whether it is ionic / non-ionic agent.
- **No. of iodine**



  - Monomer: 3 iodine particles
  - Dimer: 3 x 2 = 6 iodine particles
- No. of iodine: determine the whiteness of the contrast media
- No. of particles α osmolarity



Refer Table 8.1

Ionic monomers

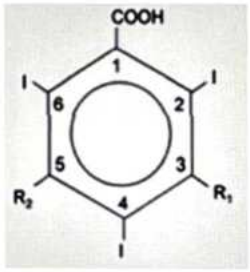
- Acetrizoate (Diaginol, Urokon)
- Diatrizoate (Angiografin, Hypaque, Renografin, Urografin, Urovison)
- Iodamide (Uromiro)
- Ioglicate (Rayvist)
- Iothalamate (Conray)
- Ioxithalamate (Telebrix)
- Metrizoate (Isopaque, Triosil)

Non Ionic monomers 00:28:37

- Metrizamide (Amipaque)
- Iohexol (Omnipaque)
- Iopamidol (Iopamiro, Isovue, Niopam, Solutrast)
- Iopentol (Imagopaque)
- Iopromide (Ultravist)
- Ioversol (Optiray)

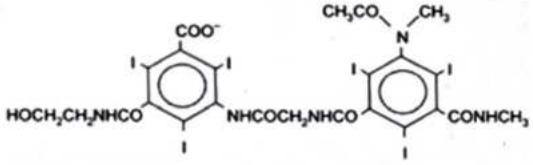
  - Iohexol (Omnipaque)
  - Omniscan: MRI contrast media (Gd contrast media)

Ionic monomer 00:29:15



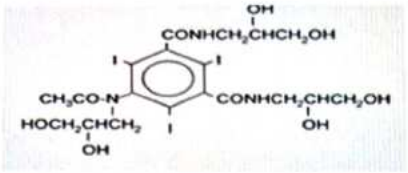
- I: P ratio: 3: 2
- E.g.: Urografin (Diatrozoate)

Ionic dimer 00:30:06



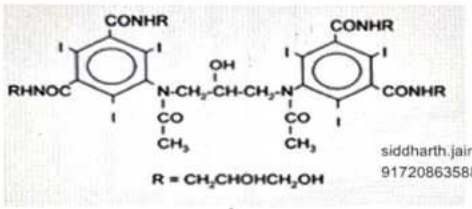
- I: P ratio: 6: 2
- E.g.: Ioxaglate

Non ionic monomer 00:30:34



- I : P ratio : 3 : 1
- E.g. : Iohexol

Non ionic dimer 00:31:00



- I : P ratio : 6 : 1
- E.g.: Iodixanol

Previous Year's Questions

Q. Which of the following is non-ionic dimer? (NEET 2015)

A. Iodixanol
B. Iohexol
C. Diatrazoate
D. Iohexol

Previous Year's Questions

Q. Which of the following contrast agents is the safest for use in the prevention of contrast induced nephropathy? (NEET 2017)

A. High osmolar iodinated contrast
B. Low osmolar iodinated contrast
C. Gadolinium
D. Iso-osmolar iodinated contrast

Explanation

Iodinated contrast media: Complications:

- Anaphylaxis
- Contrast induced nephropathy

Safety for use in prevention of contrast induced nephropathy

- Iso-osmolar iodinated contrast > Low osmolar iodinated contrast > High osmolar iodinated contrast
- Gadolinium is highly nephrotoxic

Previous Year's Questions

Q. Which of the following baseline investigations is performed before CECT? (NEET 2018)

A. X-ray abdomen
B. RFT
C. RBS
D. LFT

- For CECT: Iodinated contrast is administered
- For using iodinated contrast, screening of renal function test must be performed
  - RFT to determine baseline urea creatinine
  - eGFR: <60 ml/ min / BSA: No iodinated contrast agent is administered
- X-ray abdomen is performed before any barium studies to rule out intestinal obstruction
- Chest X ray is performed before any barium studies to rule out perforation
- RBS is tested before PET SCAN

CONTRAST INDUCED NEPHROPATHY (CIN)

00:35:21

- If there is increase in serum creatinine by 0.5 mg/dL or 25% increase from the baseline RFT ordered within 48 hours of contrast agent administration and any other explanation / cause for acute kidney injury is ruled out.

Risk factors for CIN

- Raised serum creatinine levels, particularly secondary to diabetic nephropathy
- Dehydration
- Congestive heart failure
- Age over 70 years old
- Concurrent administration of nephrotoxic drugs e.g. aminoglycosides, NSAIDs

In patients with risk factors: For reduction

- Hydration: 100 ml/hr; 4 hrs before to 24 hrs after contrast administration
- Use low or iso-osmolar contrast media (Non ionic media >ionic media), (Dimer> Monomer)
- Stop administration of nephrotoxic drugs for at least 24 hours

- Consider alternative imaging techniques not requiring administration of iodinated contrast agent (iodinated/ Gd)

Most effective method to prevent CIN: Hydration

Important Information

- Patient with manifest hyperthyroidism: Iodinated contrast media is the absolute contraindication
- If patient is on radioactive iodine treatment I-131: Patient not to receive iodinated contrast media for 2 months
- If patient has undergone isotope imaging thyroid I-123: Patient not to receive ICM for 2 months

Previous Year's Questions

Q. Gadolinium is contrast media for? (FMGE 2018)

A. CT
B. Xray
C. MRI
D. USG

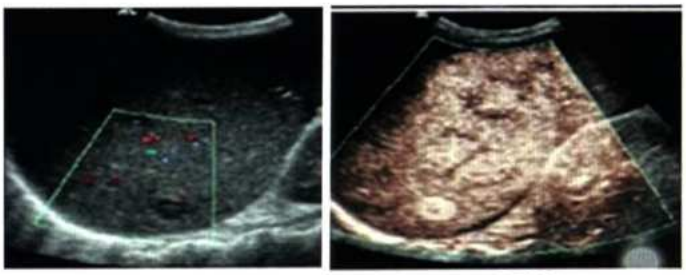
MRI CONTRAST MEDIA (GD) 00:39:49

- Gd is IV contrast media
- Gd is usually combined with chelates (isolated Gd is quite toxic).
- MRI contrast agents

T1 agents	T2 agents
• Predominant effect: Increase T1 relaxation • Increase signal intensity (positive contrast agents) • Eg. Paramagnetic contrast agents Gd	• Predominant effect: Increase T2 relaxation • Decrease signal intensity (negative contrast agents) • Used for reticuloendothelial system • E.g. Superparamagnetic contrast agents: USPIO, SPIO: For lymph node imaging

- Gd can't cross BBB: (Tumors enhancing with Gd thus)
  - GBM
  - Choroid plexus papilloma
  - Meningioma
- Gd is C/I in renal failure (if eGFR <60 ml/ min /BSA]
- Gd if given to person with deranged renal function: Nephrogenic Systemic Fibrosis (woody limbs)

ULTRASOUND CONTRAST AGENTS 00:44:18



B mode USG CEUS

- MC used ultrasound contrast agent is: Sonovue
- SF6 gas microbubbles (within a phospholipid shell are injected in the IV circulation)
  - Excreted through lungs (unlike Gd /iodinated contrast media-excreted through kidney)
  - Only IV contrast agents which are safe in renal failune
- C/I in
  - Sulfa drug allergy
  - Hepatopulmonary shunt
- CEUS: Low Mechanical Index Mode
- Action of microbubbles: Increase the back scatter

Conclusion: IV contrast agents

Iodinated	Gd	Sonovue
Contrast induced nephropathy	Nephrogenic Systemic Fibrosis	Safe in renal failure

Table 8.1

I : P ratio	3:2	6:2	3:1	6:1
Osmolarity	• ~ 1200 (High osmolar contrast media)	• ~ 600 (Low osmolar contrast media)	• ~ 600 (Low osmolar contrast media)	• ~ 300 (Iso osmolar)
Examples	• Diatrazoate ○ Urografin ○ Gastrografin	• Ioxaglate	• Iohexol (Omnipaque)	• Iodixanol (Visipaque)

9 GI RADIOLOGY

BARIUM STUDIES

- Barium swallow to study esophagus

- Barium meal to study stomach

- Barium meal follow through for evaluating small bowel

- Barium enema to evaluate large bowel loops

BMFT identification

- DJ flexure must cross to the other side of midline (left side) (Essential to rule out malrotation)
- DJ flexure must lie in the same plane as D1 (around transpyloric plane) which corresponds to L_1 (Essential to rule out malrotation)
- Jujenal folds: Feathery appearance because of Valvulae conniventes /valves of kerkering (complete mucosal folds)
- Ileal folds: Featureless
- Barium enema: Barium is injected perectally.

Barium studies can be

- Single contrast: Only Ba is injected
- Double contrast: Ba + air is injected
  - Mucosal details are better visualized

Barium Enteroclysis

- A tube is put upto DJ flexure
- Through the tube, Baand air are injected
- More distension of loops can be achieved

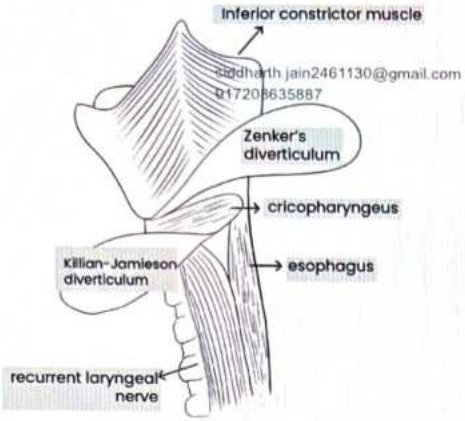
ESOPHAGEAL CONDITIONS

00:07:58

Zenker's diverticulum

- H/O elderly male with regurgitation/halitosis/dysphagia
- Pulsion's diverticulum
- Arises from killian's dehiscence (area b/w the thyropharyngeus and cricopharyngeus)
- Posterior outpouching from esophagus
- Located above cricopharyngeus
- Posterolateral diverticulum

Killian jamieson diverticulum



- Anteriorly located
- Below cricopharyngeus

Esophageal web

- It is a mucosal membrane arising from the anterior wall of esophagus
- Location: near the cricopharyngeus muscle (located in cervical esophagus)

Plummer winson syndrome

- Seen in young females
- Triad of iron deficiency anemia , atrophic glossitis, Esophageal web
- Higher risk of squamous cell carcinoma of pharynx

Schatzki ring 00:11:42

- B ring is common usually
- Located at squamocolumnar junction
- Complete Circumferential narrowing
- If significant narrowing is present: patient describes symptoms like food impaction in the distal part of esophagus when patient takes solid food : typically described as steak house syndrome
- Schatzki ring is associated with hiatal hernia

Hiatal hernia 00:13:30

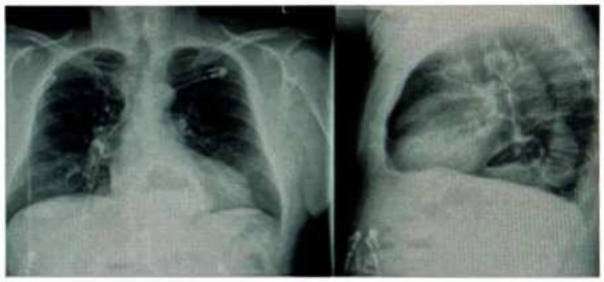
- Displacement through esophageal hiatus of GE junction or other parts of the stomach into the thoracic cavity
- Hiatal hernia is of 2 important types :

Sliding hiatal hernia

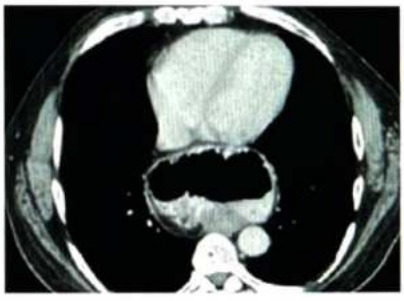
- GE junction is pulled into the thorax

Rolling hiatal hernia

- GE junction is normally placed but fundus of stomach is pulled up
- Much higher risk of volvulus



- Retrocardiac air fluid level: Typical for hiatal hernia
- I.O.C for hiatal hernia/Best Ix: CECT + oral contrast (Iohexol)
- To determine obstruction/volvulus: Oral contrast is given
- CECT provides 3D image of the part of the stomach herniating into the thorax



Achlasia cardia

- Younger patient complaining of dysphagia which worsens with liquids > solids/ liquids = solids
- Bird beak sign: Entire esophagus is massively dilated, complete narrowing in the distal esophagus near the level of LES.

Carcinoma Esophagus

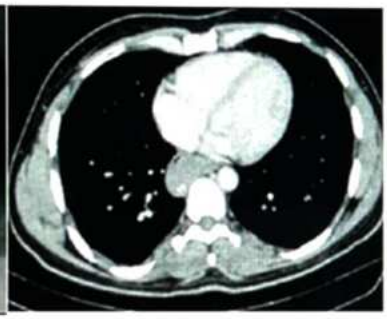
- Elderly patient complaining of dysphagia which worsens with solids > liquids.
- Rat tail appearance: distal part: irregular mucosal narrowing(shouldering)

SUBMUCOSAL LEIOMYOMA

00:18:50

- M/C benign esophageal tumor
- Esophagus is focally dilated.
- I.O.C: CECT

Submucosal leiomyoma



Specks of calcification (Hallmark)

Refer Table 9.1

Congenital diaphragmatic hernia

00:23:19

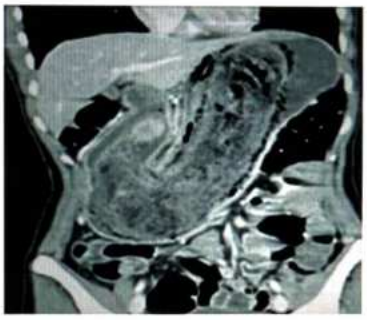
- Typical H/O newborn with respiratory distress
- 2 types

Morgagni hernia	Bochdalek hernia(BPL)
• Anterior defect • More common on the right side • Liver herniate	• Posterior defect • More common on left side • Bowel loops herniate

- Due to herniation of bowel loops, mediastinum is shifted on the opposite side which further leads to pulmonary hypoplasia.
- To confirm the diagnosis: Check the position of NG tube: NG tube turning upwards: suggestive of stomach herniating into the thorax

Trichotillomania

00:25:59



- H/O of psychiatric disorder in young female complaining of gastric outlet obstruction
- Bezoar

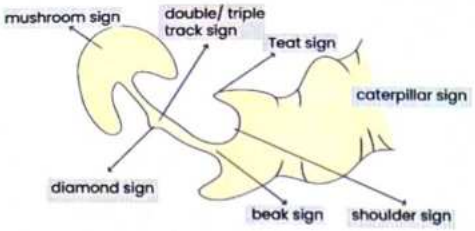
PEDIATRIC ABDOMINAL CONDITIONS

00:26:54

Congenital/Infantile hypertrophic pyloric stenosis

- A neonate around 6-8 weeks after the birth presenting with persistent non bilious vomiting on feeding.
- Olive shaped mass
- Baby is always hungry
- Gastric outlet obstruction is 2ndry to hypertrophied pyloric muscle
- I.O.C: USG (Thickened pyloric muscle)
  - Thickness >4mm
  - Length >16 mm

Associated signs with barium imaging:



- Beak sign
- Shoulder sign
- Caterpillar sign
- Teat sign
- Double/Triple track sign
- Mushroom sign
- Diamond sign
- It is more of medical emergency than surgical emeregency: Electrolyte abnormalities are present: ↓Na, ↓K, ↓Cl, metabolic alkalosis, severe dehydration, ↓BP with paradoxical aciduria

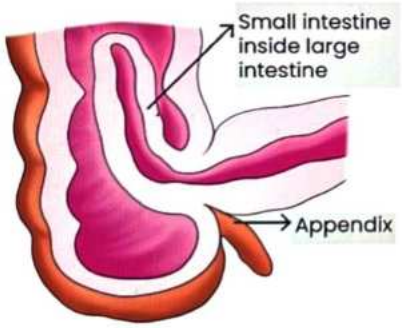
Refer Table 9.2

Important Information

- There is high risk of Duodenal atresia and Hirschsprung disease with down syndrome

INTUSSUCEPTION

00:33:48



- A child of 6 months to 1 year with excessive crying
- Intussuception is telescoping of one bowel loop into the other.
- M/C type: Ileocolic intussuception (due to accumulation of peyer patches in the terminal ileum)

Refer Table 9.3

Gold standard investigation for Intussusception:

- Barium Enema, Air enema: Under x ray fluoroscopy guidance
- Saline enema: Under USG guidance

- Barium enema shows Claw sign

- Coiled Spring sign (Indicates enema is able to treat the intussusception)

MID GUT VOLVULUS

00:38:59

- A neonate presenting with bilious vomiting

Upper GI contrast study: Cork screw sign

- DJ flexure is not crossing over to the left side

CECT shows Whirl pool sign

- It is twisting of mesenteric vessels and mesentry

- Best investigation: Upper GI contrast study

ACUTE APPENDICITIS

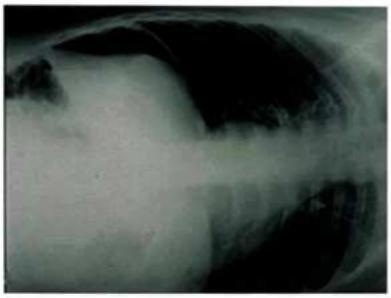
00:41:20

- A young adult /child presenting with right iliac fossa pain with tenderness
- Initial Ix: USG (Graded compression technique of USG)
- USG findings of acute appendicitis
  - Tubular structure
  - Aperistaltic
  - Non compressible
  - Dilated >6 mm in AP diameter
  - Mural stratification
- Best Ix/I.O.C : CECT : Arrow head sign , Cecal Bar sign
- Pregnancy with acute appendicitis
  - First Ix: USG
  - I.O.C: MRI

PNEUMOPERITONEUM

00:45:17

- A patient with acute abdominal rigidity and presentations suggestive of Peritonitis: Rule out Pneumoperitoneum
- Best Ix/ I.O.C / Most sensitive Ix: CT
- Most sensitive X ray: Chest X ray PA erect view: Air under both domes of diaphragm
- If the patient is too sick to stand: X ray can be done in Left lateral decubitus position for pneumoperitoneum



Signs a/w pneumoperitoneum

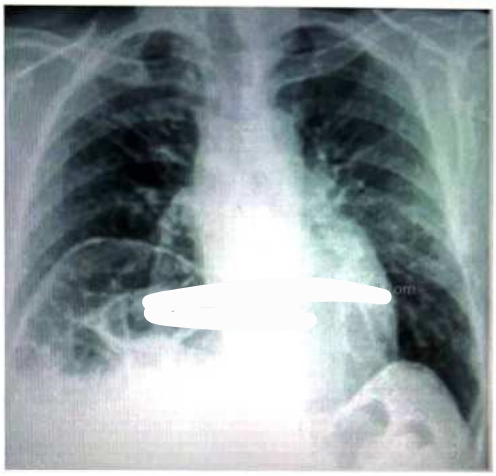
Refer Table 9.4

Other Signs a/w pneumoperitoneum

- Falciform ligament sign
- Uracus sign
- Tell tale sign

Pseudopneumoperitoneum

00:50:52



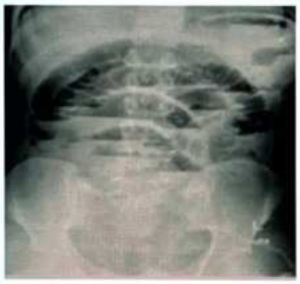
Chiladiti syndrome

- Transverse colon intercourses between the diaphragm and liver (can sometimes mimic air under the diaphragm)
- Presence of haustrations (Not seen in pneumoperitoneum)

INTESTINAL OBSTRUCTION

00:51:51

- Initial Ix
  - Chest X ray PA erect view erect (to rule out perforation)
  - Abdominal x ray: supine and erect to diagnose the obstruction
- I.O.C: CECT: Helps to find the site and know the cause



Small bowel obstruction	Large bowel obstruction
>3 cm dilated	>6 cm dilated
Step ladder pattern(Various air fluid levels)	Peripheral loops
Valvulae connivenetes seen: so jejunal obstruction	Haustrations(Incomplete)
	Along the anatomical orientation of colon

- >9 cm dilated: Caecal obstruction

- Dilated small bowel loops: Jejunal loops (complete mucosal folds extending through lumen)

- Haustrations (Incomplete folds)
- Large bowel dilatation

	Small bowel obstruction	Large bowel obstruction
M/C cause	Adhesions	Malignancy: CA colon in rectosigmoid junction most commonly
Distribution	Central	Peripheral
Diameter	>3 cm	>6cm/>9cm
Volvulae conniventes	++	-
String of pearl sign/ Step ladder pattern	++	-
Haustrations	-	+
Mx	Conservative: If not responding: Sx	Sx

String of pearl appearance: Seen in

- PCOS
- Small bowel obstruction
- Fibromuscular dysplasia on DSA imaging

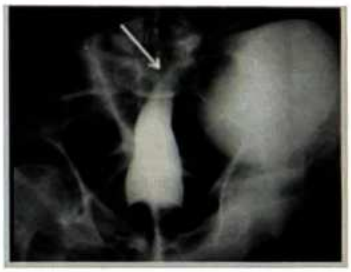
SIGMOID VOLVULUS VS CECAL VOLVULUS

01:00:15

- Volvulus: Bowel twists upon its own axis

	Sigmoid volvulus	Cecal volvulus
Direction	Anticlockwise	Clockwise
Predisposing factors	Elderly, constipation	Pregnancy, Plevic Sx
Starting from base	Left lower quadrant	Right lower quadrant
Apex	RUQ	LUQ
No of loops	Two	Single
Associated bowel loop dilatation	Large bowel	Small bowel
Haustrations	Ahaustral loops	Haustrae
Mx	Endoscopic resection	Sx

Sigmoid Volvulus	Cecal Volvulus
	
Two dilated loops without haustrations • Coffee bean sign (bent tube sign) • X marks the spot sign • Frihmann- dahl sign • Northern exposure sign	• C –sign (Single bowel loop with haustrations)



- In Sigmoid Volvulus. On doing Barium enema: Bird beak / bird of prey sign

CROHN'S DISEASE

01:05:41

Refer Table 9.5

- **IOC → CT enterography:** Patient is asked to drink Mannitol and it being a osmotic agent, provides better distension

Refer Table 9.6

ULCERATIVE COLITIS

01:10:32

- Continuous involvement of colon **(mucosal / submucosal involvement)**

- Earliest sign on barium: diffuse mucosal granularity

- Lead Pipe colon sign (Loss of all haustrations)

Toxic Megacolon: Complication of ulcerative colitis

01:11:27

IOC: Abdominal X-rays

- 6 cm dilatation of large bowel
- Loss of haustrations
- Obstruction

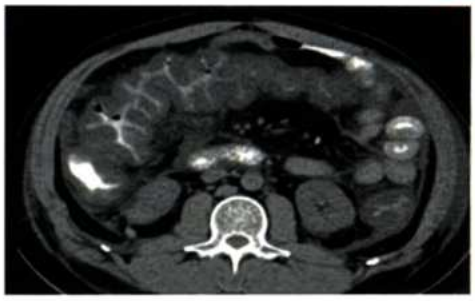
INTESTINAL TB

01:12:30

- M/C site: Ileocecal junction
- Sterlein sign
- Pulled up cecum
- Goose neck/ inverted umbrella appearance
- **IOC → CT enterography:** Necrotic mesenteric nodes (hallmark)

PSEUDOMEMBRANOUS ENTEROCOLITIS

01:14:01



- Bowel wall is diffusely thickened: Accordion sign
- Associated with clostiidium difficile
- Counterpart of it on X-ray: Thumb printing sign (mucosal edema)

Barium images

01:15:36

- Sigmoid diverticulosis (outpouching from sigmoid colon): Saw tooth sign

- Acute diverticulitis (fat stranding around diverticula)
- Hinchey classification is used clinically
- IOC = CECT

HIRSCHSPRUNG DISEASE

01:17:23

- H/O: Newborn not passing stools for > 48 hrs
- Ba enema
  - Recto-Sigmoid junction < 1 (normal diameter of recto sigmoid junction>1)
  - Transition zone
- It is a neural crest migration defect where ganglion cells do not reach rectum
- Functional obstruction because of absence of peristalsis
- High pre-disposition with down syndrome

ABDOMINAL TRAUMA

01:20:00

- **eFAST** (Extended Focussed Assessment with sonography in trauma)

Aim: Look for

- Hemoperitoneum (free fluid in abdomen)
- Pericardial effusion
- **Pneumothorax**
- Hemothorax

Refer Images 9.1

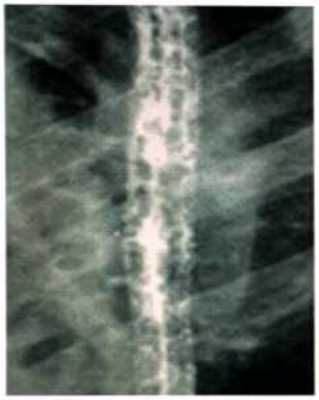
01:22:36

Limitations of e FAST

- Sensitivity to detect fluid: Upto 50–100 ml
- Mesentric injuries and Bowel Injuries may be missed
- Retroperitoneal hematoma
- Obese (morbidly obese patients)
- Subcutaneous emphysema

Table 9.1

- Serpiginious appearance
- Esophageal varices in portal hypertension



- Shaggy esophagus
- H/O immunosuppression
- Candidiasis

- Cork screw esophagus:
- Diffuse esophageal spasm

- Feline esophagus:
- Eosinophilic esophagitis

Table 9.2

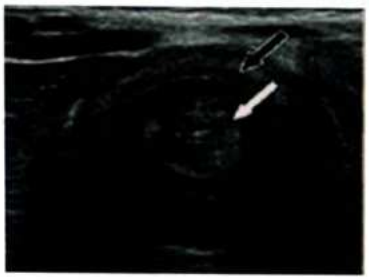
Single bubble sign
- Seen in GOO in children with CHPS

Double bubble sign (Obstruction at 2nd part of duodenum)
Seen in LAD
- Ladd bands
- Annular pancreas
- Duodenal atresia (most commonly)

Triple bubble sign
- Seen in jejunal atresia

Refer Table 9.3

X ray showing target sign



USG showing Donut/target sign (Presence of two bowel loops in the axial manner)

Longitudinal view
USG showing
- Pseudo kidney sign
- Sandwich sign

Refer Table 9.4

Foot ball sign

Cupola sign: Air layering against central tendon of diaphragm

Rigler sign: Presence of air on both sides of bowel wall

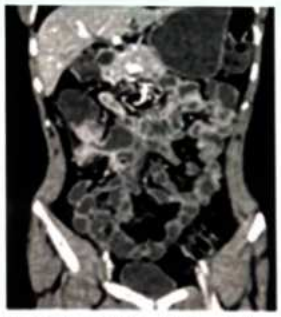
Refer Table 9.5

- Narrowing of terminal ileum
- String sign of kanter seen in
  - Tb: M/C Site in TB: Ileocecal junction
  - Crohn's disease: M/C site: Terminal Ileum

- Earliest sign in crohn's disease: Aphthous ulcer
- Cobble stoning sign

- Sacculations on the antimesenteric border (Barium finding)

Refer Table 9.6



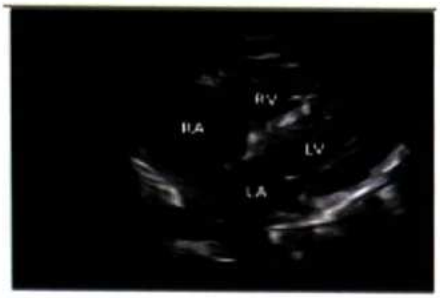
- Neutral oral contrast like Mannitol is given
- Steelate sign (Fistulae communicating)

- Positive oral contrast like Iohexol is given
- Strictures

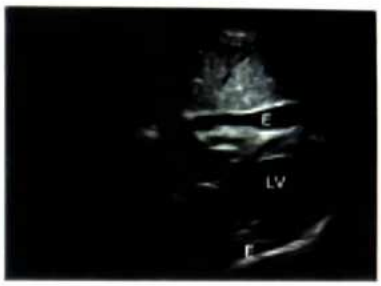
- Comb sign (mescenteric hyperemia)

Images 9.1

Subxiphoid/Epigastric



Normal/(-)ve FAST



Pericardial effusion (⊕ ve FAST)

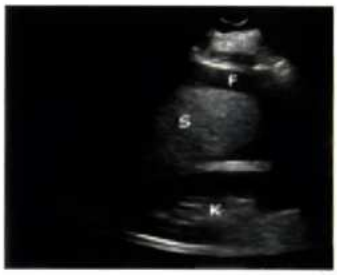
Hepatorenal (Morrision's Pouch)

Normal

(+)ve FAST

Spleno-renal pouch

Normal



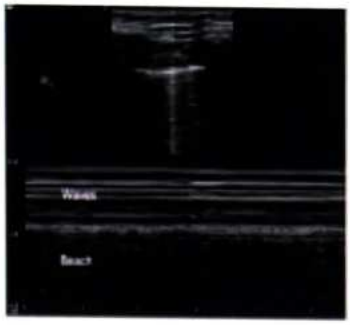
(⊕ ve FAST)

Pelvis

Normal

(+)ve FAST

Pleural cavity: Look for sliding movement



M-Mode (Seashore appearance)

Barcode/Stratosphere

CP angle

Normal CP angle

Hemothorax

CLINICAL QUESTIONS

Q. A neonate is brought with history of not having passed meconium. On examination there is no anal opening but a dimple. Investigation of choice would be?

A. X-ray in erect posture
B. MRI
C. CT Gastrograffin study
D. Invertogram

Answer: B

Solution

- Although biopsy and Barium enema is confirmatory for Hirschsprung's disease, here in this given options it goes towards MRI.
- MRI, due to excellent inherent soft tissue contrast, is best to define the relationship of the atretic segment to the levator ani pelvic sling and the integrity of sphincters and their nerve supply (anorectal malformation).

Q. A 63-year-old woman treated for sideroblastic anaemia with a pyrimidine analogue (antimetabolite), lenograstim and repeated red blood cell transfusions, received a 7-day course of β-lactam antibiotics for pharyngitis. Three weeks later, her condition deteriorated, with fever, lower abdominal cramping pain and diarrhoea the diarrhoea was bloody and mucoid with a jelly-like appearance which occurred 4 to 5 times per day. Sigmoidoscopy revealed multiple yellowish plaque lesions from the rectum to the sigmoid colon. CT Abdomen shows' Accordion sign'. What is the likely Diagnosis?

A. Pseudomembranous colitis
B. chrons disease
C. Ileocecal TB
D. Ischemic colitis

Answer: A

Solution

- The 'Accordion sign' (also known as 'concertina sign') is seen on CT examinations of the abdomen
- Refers to the similarity between the thickened oedematous wall of Pseudomembranous colitis and the folds of an accordion.
- This appearance is the result of hyperaemic enhancing mucosa stretched over markedly thickened submucosal folds.
- Also seen when contrast is trapped between oedematous haustral folds and pseudomembranes formed on the luminal surface of the colon.

10 HEPATOBILIARY RADIOLOGY

ONE LINERS

00:00:32

- M/C liver tumor : Metastasis (Secondaries)
- M/C primary benign liver tumor in adults: Hemangioma
- M/C primary malignant tumor in adults : HCC
- M/C primary Benign liver tumor in children : Infantile Hepatic Hemangioma
- M/C primary malignant liver tumor in children : Hepatoblastoma
  - "Pretext" staging is used for Hepatoblastoma.
- HCC & Hepatoblastoma are a/w high levels of α – fetoprotein

- Multiplicity of the lesion point towards metastasis

- Bull's eye/target appearnce seen in case of metastasis in Liver

LIVER TUMORS INVESTIGATIONS

Triple phase CT / Triple phase MRI		
Arterial phase	Venous phase (portal vein)	Delayed/equilibrium phase
~35 - 40 sec	~ 60 – 70 sec	~ 3 - 5 min

- 80% of the liver get its blood supply from the portal vein but HCC, gets preferential supply from the hepatic artery
- So in HCC, the mass preferentially takes up the contrast in the arterial phase known as Arterial Enhancement, while the remaining liver parenchyma will be hypodense.
- In the venous phase, rest of the parenchyma begins to show enhancement , the tumor mass will become hypodense known as Venous washout

CE-TPMRI (CONTRAST ENHANCED TRIPLE PHASE MRI)

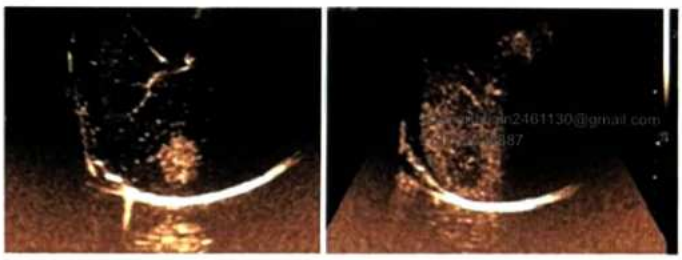
00:07:06

Refer Table 10.1

- Arterial enhancement + Venous washout + Capsular enhancement favors the diagnosis of HCC
- LIRADs Staging: For diagnosis of HCC in patients with cirrhosis

CONTRAST ENHANCED ULTRASOUND (CEUS)

00:09:31



Arterial phase enhancement | **Venous phase washout**

CEUS

- It is used in case of HCC with renal failure.
- It uses sonovue (SF6 gas microbubbles are used)

LIRADs scoring can be done on the following modalities

1. TPCT
2. TPMRI
3. CEUS

HEMANGIOMA

00:11:21

- M/C benign liver tumor in adults

Refer Table 10.2

FNH (FOCAL NODULAR HYPERPLASIA)

00:13:41

Refer Table 10.3

Liver mass with central stellate scar

Fibrous Nodular Hyperplasia (FNH)
- Sulfur Colloid scan shows Kupffer cells (typical for FNH)
- T2 hyperintense scar
- Calcification θ

Fibrolamellar Hepatocellular Carcinoma (FL-HCC)
- T2 hypo intense scar
- Calcification in the scar present

- FL-HCC : Calcification in scar

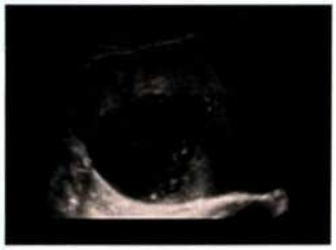
Important Information

- Renal mass with central stellate scar: Oncocytoma
- Pancreatic lesion with central stellate scar: Serouscystadenoma

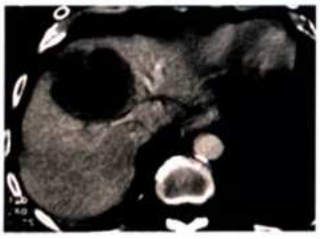
INFECTIONS

00:16:52

Abscess



- USG shows hypoechoic/anechoic lesion with Posterior acoustic enhancement with debris in the lesion: Abscess (complicated cyst)

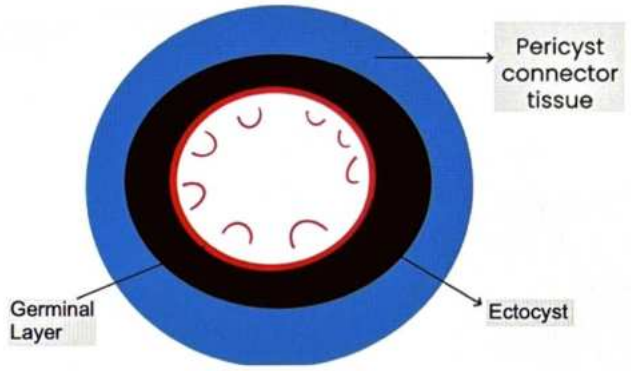


- CT in case of abscess shows Central part as hypodense (because of necrosis and pus)

Amoebic Abscess	Pyogenic Abscess
• H/O right upper quadrant pain • Fever / jaundice (Milder) • Persistent diarrhea • Flask shaped ulcers • Anchony sauce pus	• Fever • Comorbidities are +nt like DM and Immunocompromised patients • Polymicrobial gram negative infections • Multiple abscess • M/C route: Hematogenous (Ascending cholangitis rarely)

HYDATID CYST

00:20:00



- Caused by Echinococcus granulosus
- Humans: Accidental host

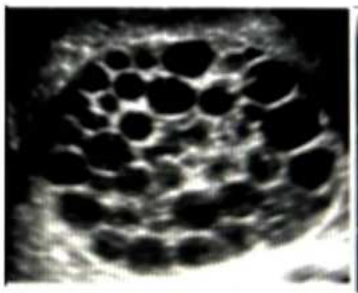
Gharbi classification and WHO classification 00:21:51

GHARBI	1	2	3	4	5
WHO	CE1	CE2	CE3	CE4	CE5

Refer Table 10.4

USG

00:24:04



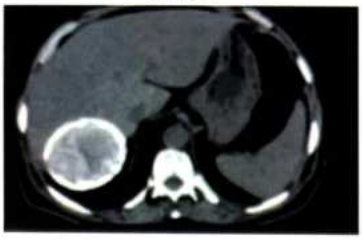
Honeycomb appearance

Water lily sign (hallmark)

CECT

Honeycomb appearance

NCCT



Calcified hydatid cyst

GALL BLADDER CALCULI (CHOLELITHIASIS)

00:25:10

- I.O.C for GB calculi: USG (90 % of GB calculi are Radiolucent)
- For renal calculi: I.O.C → NCCT

Refer Table 10.5

ACUTE CHOLECYSTITIS

00:29:46

- IOC = USG
- 3mm wall thickening
- Calculus (obstructive) causing the Posterior Acoustic Shadowing
- Sonographic Murphy sign
- Most accurate Ix → HIDA scan: Non visualised Gall bladder point towards Acute cholecystitis
- Tokyo classification is used for Acute cholecystitis

GB POLYP

00:32:25

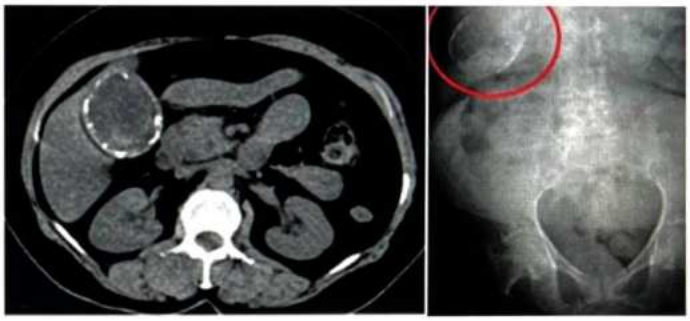
- Nondependent hyperechoic structure + no posterior Acoustic shadowing
- Any polyp > 1cm is an indication of elective cholecystectomy (because of higher risk of malignancy)

ADENOMYOMATOSIS

- Comet tail sign
- HRCT lung: Comet tail sign: Asbestosis round atelectasis

PORCELAIN GALL BLADDER

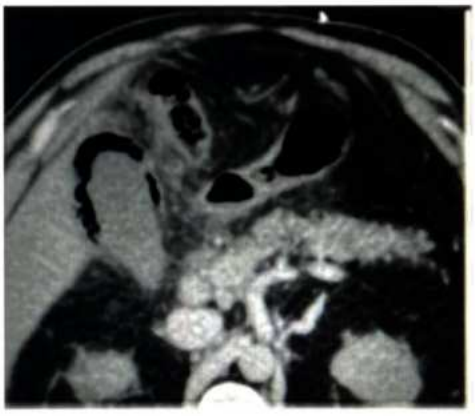
00:34:50



- Porcelain GB (peripheral calcification of wall): Premalignant condition : Indication of elective cholecystectomy

EMPHYSEMATOUS CHOLECYSTITIS

00:35:23



- Air within the gall bladder
- Sick patient with Comorbidity (DM / ICU / Sepsis)
- IOC: CT
- Bad prognosis

BILIARY TREE AND ITS PATHOLOGIES

00:36:34

MRCP	ERCP
• Heavily T2 weighted MRI • Non invasive • No radiation use • No contrast is injected	• Endoscope: Ampulla • Invasive • Fluoroscopy (X ray) • Iohexol contrast is injected

MRCP
- Magnetic resonance cholangio- pancreaticography
- IOC for biliary pathologies

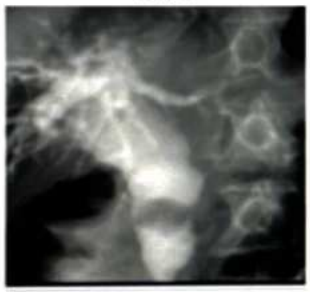
ERCP
- Endoscopic retrograde cholangio-pancreaticography
- Gold standard

CHOLEDOCHOLITHIASIS (CBD CALCULI)

00:41:42

MRCP

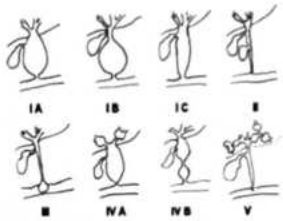
ERCP



- Stones appearing as Signal voids on MRCP
- Stones appearing as filling defects on ERCP
- IOC = MRCP
- Gold standard = ERCP

CHOLEDOCHAL CYSTS

00:42:42

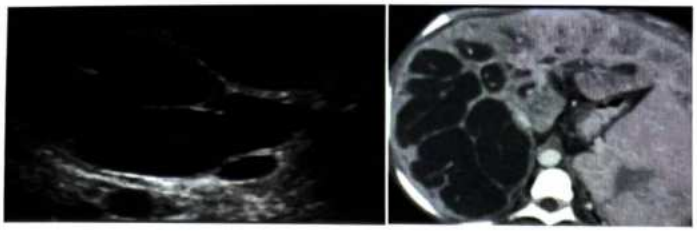


- It is cystic congenital dilatation of Common bile duct
- Todani classification: 5 types of choledochal cysts

Type I	• M/C type of choledochal cysts
Ia	• Fusiform dilation of CBD
Ib	• Saccular / focal
Ic	• Extrahepatic
Type II	• Diverticulum
Type III	• Choledochole
	• Type III is the only choledochal cyst which can be managed through endoscopic route
Type IV	• Multifocal dilatation strictures
Iva	• Intrahepatic + extrahepatic ducts involved (trick : a → all)
Ivb	• Extrahepatic ducts involved
Ivc Or Type V	• Intrahepatic duct involved : Caroli's disease

- Rx of choledochal cysts is important because they carry the risk of cholangiocarcinoma
- Rx is:
  - Resection of cyst
  - Hepatico-jejunostomy

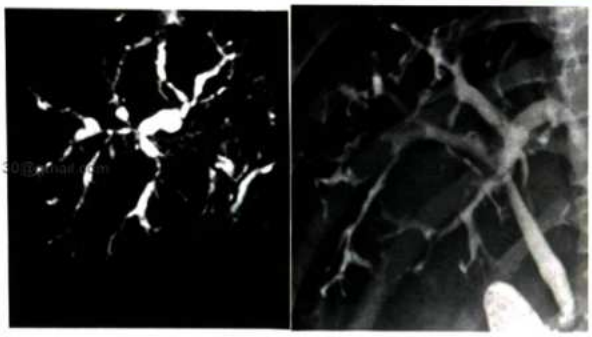
- MRCP showing Choledochal cyst
- IH + EH ducts involved : Type IV a



- Central dot sign for Caroli disease : Type V choledochal cyst
- Rx: Liver transplantation

PRIMARY SCLEROSING CHOLANGITIS

00:47:03



- MRCP and ERCP showing Multiple intrahepatic + extrahepatic strictures Followed by diverticulae Followed by strictures
- Beaded appearance (Hallmark of primary sclerosing cholangitis)
- Highly a/w inflammatory bowel disease (70-80% cases) (Ulcerative colitis > crohns disease)
- Onion – peel reaction is seen on histology in primary sclerosing cholangitis

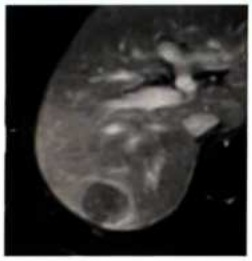
Table 10.1

Late arterial phase

Arterial enhancement

Venous phase

Venous washout



Delayed phase

Capsular enhancement

Table 10.2

CECT

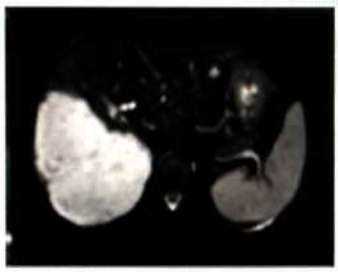
- Peripheral nodular enhancement in arterial phase

CECT

- Further filling in centripetal manner in Venous phase

USG

- Hyperechoic



T2 weighted MRI

- T_2 hyperintense lesion (Light bulb appearance)

Table 10.3

- Spoke wheel : Central vascularity of FNH

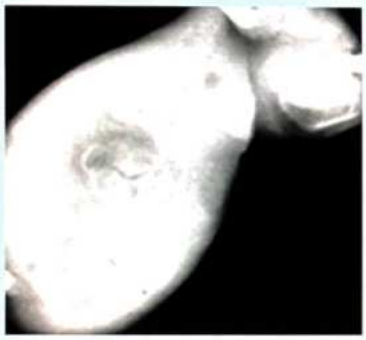
- T2 MRI hyperintense scar of FNH

- CECT shows No calcification in FNH

Table 10.4

GHARBI	1	2	3	4	5
WHO	CE 1	CE 2	CE 3	CE 4	CE 5
	Active stage	Active	Transitional	Degenerating	Inactive stage
	Double layer appearance	Honey comb appearance	Water lily sign	Hydatid sand/ cotton wool appearance	Completely calcified cyst

Table 10.5



- X ray showing Mercedes benz sign or Gull wing sign

- Hyperechoic calculus with Posterior acoustic Shadowing

- Wall echo shadow sign (WES sign): Contracted gall bladder: Chronic cholecystitis

CLINICAL QUESTIONS

Q. A 55-year old woman presented at the outpatient clinic with right upper quadrant pain and abdominal distention. A year before she was diagnosed with endometrial carcinoma, stage IA, and underwent abdominal hysterectomy and removal of both ovaries. She had not received oral contraceptives in the past. On CECT, a Delayed homogenous Centripetal Contrast Enhancement pattern is seen. What is the most likely diagnosis?

A. Hemangioma
B. Hepatocellular carcinoma
C. Metastasis
D. Hepatic Cysts

Answer: A

Solution

- Hemangiomas have initial peripheral nodular puddling of contrast with a delayed homogenous central enhancement pattern.
- HCC has an early arterial enhancement and Rapid Washout pattern (HCC supplied mainly by hepatic artery).

Q. A 25-year-female presented to the surgical outpatients department complaining of a colicky pain in the right upper abdomen and nausea over the past three days. On examination, she was found to be icteric and she displayed tenderness in the upper abdomen. Her laboratory investigations revealed low haemoglobin (9 gm%) and raised direct bilirubin (2.4 mg%) and alkaline phosphatase (304 IU).Abdominal sonography depicted a distended gallbladder and sludge in the common bile duct. ERCP image showing Linear filling defect. Most likely Diagnosis ?

A. Bile duct stone
B. Pancreatic duct stone
C. Worm in biliary tree
D. Stricture

Answer: C

Solution

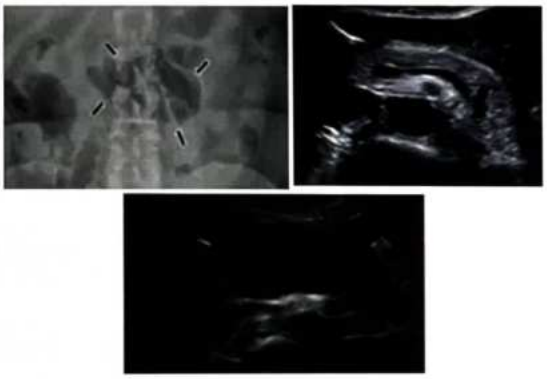
- Linear filling defect in main CBD is a characteristic feature of **BILIARY ASCARIASIS.**
- **ERCP is the gold standard but an invasive method.**
- It is used also in the extraction of CBD worms.
- The **worms** appear as a **hypointense structure** within the hyperintense CBD giving **linear filling defect on MRCP/ERCP**
- Bile duct stones on ERCP appear as focal filling defects.

11 PANCREATIC RADIOLOGY

ACUTE PANCREATITIS

00:00:37

- Acute epigastric pain radiating to the back: Acute pancreatitis
- Initial Investigations for any case of acute abdomen: X-ray of Abdomen with chest X-ray PA view to rule out perforation as well as USG of abdomen
- For diagnosis of acute pancreatitis: Revised Atlanta Classification
  - The criteria describes three features
    1. Characteristic clinical finding: Pain radiating to the back
    2. Biochemical markers: Amylase, lipase (Raised to more than 3 times the upper limit of normal)
    3. Radiological findings consistent with the diagnosis of acute pancreatitis
  - To make diagnosis of acute pancreatitis: Any two out of the three are needed.



Non-Specific X-ray findings for acute pancreatitis

- Sentinel loop sign (nonspecific) (dilated bowel loop indicating that it is in the state of ileus) (Can be seen in any pathology appendicitis, pancreatitis)
- Colon cut off sign (dilated colon loop)
- Gasless abdomen (because of fluid intake)

USG features of acute pancreatitis:

- Bulky edematous pancreas
- Collections

IOC for pancreatitis: CECT

- CT is not done at the time of presentation
- It is done only 48-72 hours after the onset of pain
- The main aim of doing CT in pancreatitis → is to delineate the type of pancreatitis (Edematous type / necrotic type)
- Necrosis appear as Hypodense areas

Revised Atlanta Classification 00:06:56

Refer Flow Chart 11.1

Acute peripancreatic fluid collection	Pseudocyst
• Homogenous collection • Does not have wall	• Homogenous collection • Well defined wall

Acute necrotic collection	Walled off necrosis (WON)
• Heterogenous collection • No wall	• Heterogenous • With Wall

Interstitial edematous pancreatitis

Necrotizing pancreatitis

RADIOLOGICAL SEVERITY SCORING FOR PANCREATITIS

00:10:55

Balthazar, CTSI, Modified CTSI (CT severity index)

- Pancreatic Inflammation

- 0 - Normal pancreas
- 2 - Intrinsic pancreatic abnormalities with or without inflammatory changes in peripancreatic fat
- 4: Pancreatic or peripancreatic fluid collection or peripancreatic fat necrosis

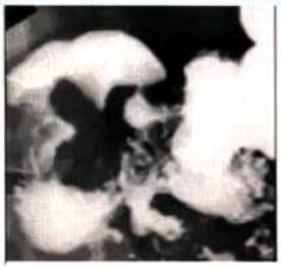
- Pancreatic necrosis
  - 0 - None
  - 2 - 30% or less
  - 4 - More than 30%

- Extra Pancreatic Complications
  - 2 - One or more of pleural effusion, ascites ,vascular complications (Splenic artery pseudoaneurysm, splenic vein thrombosis), parenchymal complications and / or gastrointestinal involvement

- Total Score: Total points are given out of 10 to determine the grade of pancreatitis and aid treatment
  - 0-2 - Mild
  - 4-6 - Moderate
  - 8-10 - Severe

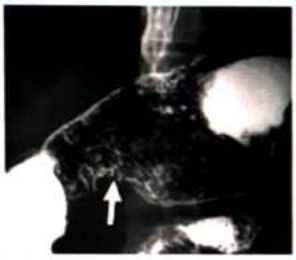
CARCINOMA PANCREAS 00:13:11

- Appearances seen with Ca pancreas in barium studies



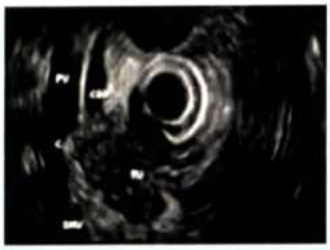
- Frostberg 3 sign/ Reverse 3 sign (Irregular appearance of eaten up part of medial part of duodenum

Causes
- Head of pancreas Ca
- Ampullary Ca
- Medial duodenal Ca



- Antral fat pad sign (Non specific) (Irregular necrosis in the antrum)

Seen with
- Ca pancreas
- Pancreatitis
- Inflammed Gall bladder

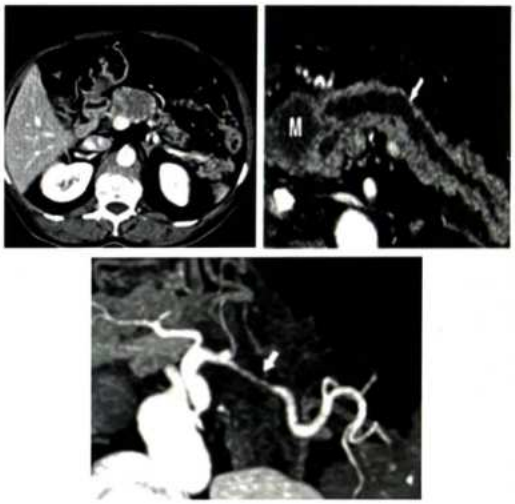


- MRCP showing Double duct sign (dilated CBD and pancreatic duct due to obstruction)
- Endoscopic ultrasound

Other investigations useful in Ca Pancreas 00:16:08

- Obstruction can be produced by: All periampullary tumors:
  - Head of pancreas Ca
  - Duodenal Ca
  - Ampullary Ca
  - Distal cholangiocarcinoma
- Gold standard investigation for all periampullary masses around the head of pancreas = endoscopic ultrasound
- IOC for Ca pancreas = CT (Dual phase CT) (Pancreatic phase + Venous phase)

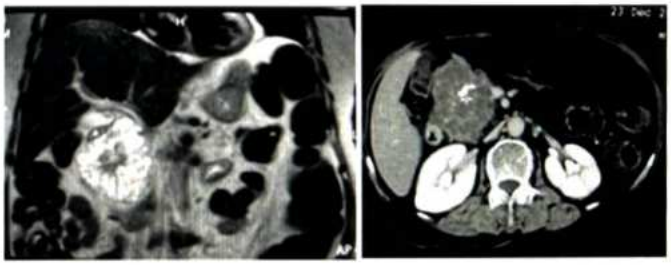
- Hypodense, Hypovascular mass causing obstruction in the main pancreatic duct & dilating it
- CECT for Ca pancreas helps to look for adjacent vascular invasions (SMA invasion, SMV invasion)



CYSTIC NEOPLASMS OF PANCREAS 00:20:57

- M/C pancreatic tumor = Pancreatic Adeno Ca

Serous cystadenoma



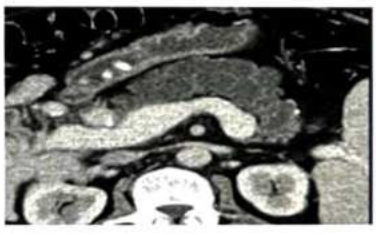
T2 W MRI CECT

- Grandmother lesion that is more common in 60's and in females.
- Micro cysts with a central scar & calcification in the centre.
- M/C seen in the head of pancreas
- Benign tumor with no malignant potential
- H/P: Glycogen – rich cuboidal epithelium
- Aspirate
  - Normal Amylase levels
  - Normal CEA levels
- Removed if symptomatic or size > 3 cm.

Mucinous Cystadenoma 00:23:30

- Seen in mothers
- Macrocyst, peripheral calcification
- More commonly seen in the body and tail
- H/P:
  - Mucin producing columnar epithelium
  - Ovarian Stroma
- Aspirate
  - CEA Levels ↑
  - Amylase levels: Normal
- Because of its malignant potential, it needs to be resected

IPMN (Intraductal Papillary mucinous Neoplasm) 00:25:04



- 2 types: Main duct IPMN and Side Branch IPMN
- Male predominance (Grandfather)
- Fish mouth appearance on endoscopy (due to lot of mucin produced)
- Dilatation of duct, mucin globules
- Has malignant potential, Tanaka Criteria is used to define the risk of malignancy
- Aspirate
  - Amylase ↑
  - CEA ↑

Refer Table 11.1 00:27:14

SPEN or SPT (Solid pseudopapillary epithelial tumor neoplasm of pancreas) 00:28:24

- More commonly in younger females
- Heterogenous: Solid cystic tumor
- These tumors also show the presence of hemorrhage
- Has malignant potential
- Rx: Resection (Treatment of Choice)

CHRONIC PANCREATITIS 00:29:40

- Main imaging findings:
  - Pancreatic dilatation of the main duct as well as side branches
  - Atrophy of parenchyma
  - Calcifications: Can be Intraductal calculi or inside the atrophying pancreas

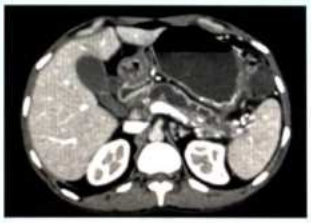
X ray

- CCP (Chronic Calcific Pancreatitis)

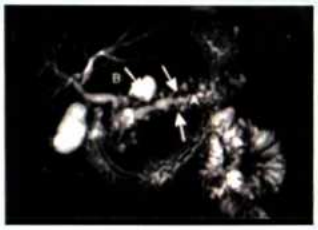
Endoscopic Ultrasound

- Dilated ducts
- Calcifications

00:31:42



CT

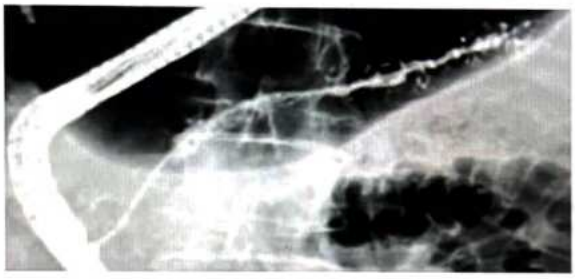


Secretin induced MRCP

- Dilated main pancreatic duct
- Atrophied pancreas
- Calcifications

- Depending upon dilatation after administering secretin , both function as well atrophy of pancreas can be estimated.
- Done for grading the severity of pancreatitis

ERCP 00:33:30

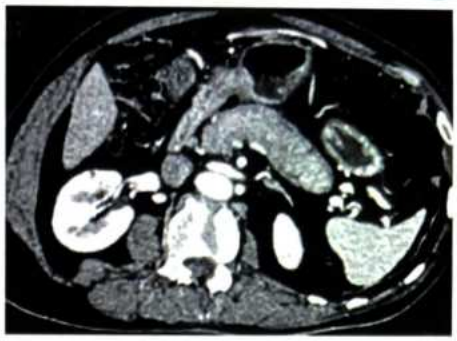


- Chain of Lakes appearance / String of pearls appearance (Indicates dilatation & tortuosity of the ducts 2° to the atrophy)
- Gold Standard for Chronic pancreatitis
- Can give diagnosis, severity, scoring and various interventions can be done through endoscopic route (Stenting, Stone Retrieval).

Cambridge criteria for Chronic Pancreatitis on ERCP 00:33:30

Stage	Typical Changes
Normal	Normal appearance of side branches and main pancreatic duct
Equivocal	Dilatation / obstruction of <3 side branches; normal main pancreatic duct
Mild	Dilatation / obstruction of >3 side branches; normal main pancreatic duct
Moderate	Additional stenosis and dilatation of main pancreatic duct
Severe	Additional obstructions, cysts, stenosis of main pancreatic duct; calcull

IGG4 RELATED DISEASE 00:35:05



- Autoimmune pancreatitis (AIP)
- Hallmark features of autoimmune pancreatitis
  - Sausage shaped pancreas on imaging
  - Fibrous hypodense rim around the pancreas

Mayoclinic Criteria (For diagnosis of AIP) 00:36:13

Criterion: **H - H**istology (at least one of the following)	• Periductal lymphoplasmacytic infiltrate, obliterative phlebitis, storiform fibrosis • Lymphoplasmacytic infiltrate, storiform fibrosis, abundant IgG4+ cells (10 HPF)
Criterion: **I-I**maging of pancreas	• Typical-diffusely enlarged gland with delayed (rim) enhancement; diffusely irregular, attenuated main pancreatic duct • Others: Focal pancreatic mass/enlargement; focal pancreatic duct stricture; pancreatic atrophy; pancreatic calcification; pancreatitis
Criterion: **S - S**erology	• Elevated serum IgG4 (normal: 8-140 mg/dL)
Criterion: **O - O**ther organ involvement (can be confirmed by biopsy)	• Hilar/intrahepatic biliary strictures; persistent distal biliary stricture; parotid/lacrimal gland involvement; mediastinal lymphadenopathy, retroperitoneal fibrosis

Criterion: **R** - **R**esponse to steroid therapy	• Resolution or marked improvement of pancreatic / extrapancreatic manifestation with steroid therapy
Diagnostic of autoimmune pancreatitis when any of the following is fulfilled	• Criterion H • Criterion I+S • Strong clinical suspicion of autoimmune pancreatitis (idiopathic pancreatic disease + Criterion S and/or O)+Criterion R

How to remember

- HISORT

Flow Chart 11.1

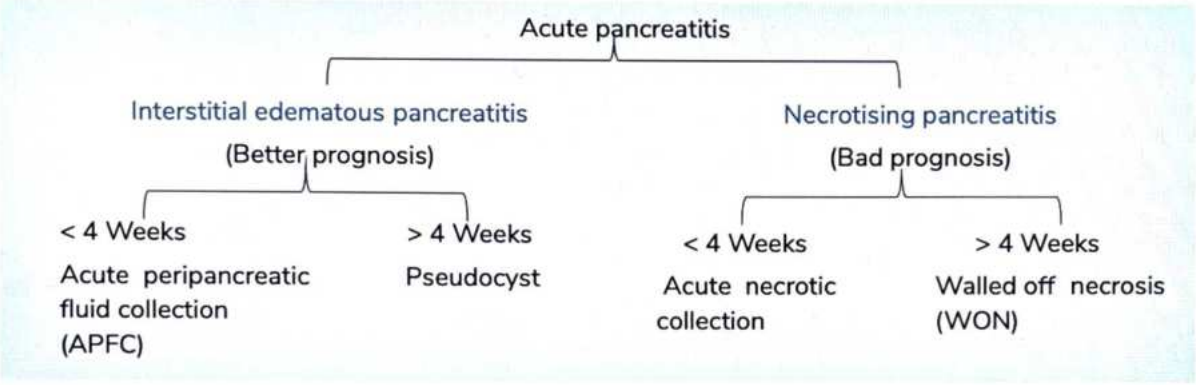


Table 11.1

Features	Serous CA	MCN	IPMN
• Age	Grand mother	Mother	Grand father
• Pathology	Benign	30% malignant	65% malignant at 5 yr
• Appearance	Microcysts <2cm	Larger cysts, septations	Pleomorphic, nodules
• Calcification	30%, central scar	Rare, peripheral	Rare
• Hemorrhage	Rare	Rare	Rare
• Pancreatic duct	Normal	Dilatation +/-	Dilated; communications +
• Epithelium	Glycogen rich Cuboidal	Columnar mucin-producing	Columnar mucin producing
• Aspirate	Low CEA, Low amylase	High CEA, Low amylase	High CEA, High amylase

CLINICAL QUESTIONS

Q. A patient came with acute abdomen and his erect xray abdomen shows following findings. What is the probable diagnosis?

A. acute pancreatitis
B. large bowel obstruction
C. sigmoid volvulus
D. Diverticulitis

Answer: A

Solution

The given image is of colon cutoff sign which is suggestive of acute pancreatitis

X ray findings of acute pancreatitis:

1. Sentinel loop sign: focal area of adynamic ileus close to intra-abdominal inflammatory process.

2. Colon cutoff sign: functional spasm at the splenic flexure due to inflammation
3. Renal halo sign: it is the edema around the kidney due to involvement of paranephric fat which results in obliteration of psoas shadow and localised ground glass appearance.
4. Gasless abdomen: due to fluid intake

12 GENITOURINARY RADIOLOGY

INTRAVENOUS PYELOGRAM (IVP) / INTRAVENOUS UROGRAM

00:00:55

- IV iodinated contrast (MC iohexol) is injected
- X rays are taken at various time points
  - At 1 minute: Cortex of kidneys is visualized: Nephrographic phase
  - At 5-10 minutes: Pelvicalcyceal system, ureter is visualized: Pyelographic phase
  - Delayed phase is taken, where bladder is visualized

URETEROCELE

- Cystic dilatation of distal ends of unilateral / bilateral ureters
- Adder head/ cobra head appearance
- Ureterocele can be of two types

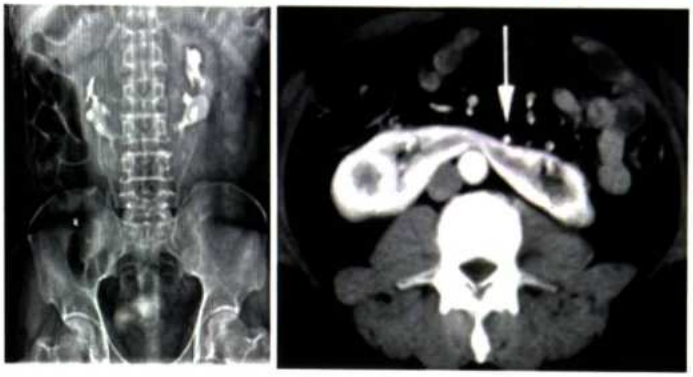
Simple	Ectopic
• Cystic dilatation in the course of the normal ureter	• Ureterocele a/w ectopic ureteric opening • More common than simple ureterocele

Pseudo-ureterocele

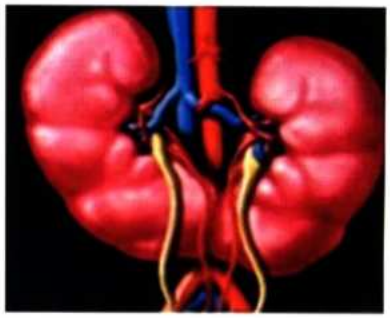
- Thick & non-uniform halo around the cystic dilatation
- Indicates calculus/ tumor (Calculus / malignancy mimics ureterocele)

HORSE SHOE KIDNEY

00:05:21



IVP CT



- Horse- shoe kidney is the mc congenital fusion anomaly of kidney
- **IVP appearance** of horse shoe kidney
  - Kidneys are much more low lying than the normal position
  - Shaking hand calyces / Flower vase appearance (lower pole calyces appear closer to each other and medial rotation of pelvis
- **Horse – shoe kidney on CT**
  - Both the kidneys are much more medially located and fuse in the midline via isthmus
- Inferior mesenteric artery stops the ascend of the fused kidneys
- Isthmus corresponds to the level of L3 (isthmus is located lower than its normal expected position)

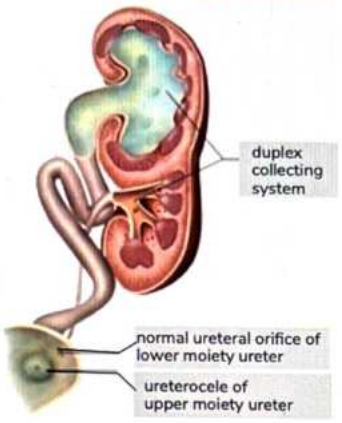
Clinical implications of horse shoe kidney

- Being more close to vertebra, horse shoe kidneys have higher incidence of getting injured in trauma (compared to normal kidneys which are protected in the retroperitoneal space)

- Higher chances of stasis of urine (because ureters are coursing much more medially) which can result in UTI and Calculi
- Increased incidence of transitional cell carcinoma (due to chronic irritation because of stasis)
- There is no increased incidence of RCC with horse shoe kidney.

DUPLEX COLLECTING SYSTEM

00:10:00



- Drooping Lily sign a/w duplex collecting system
- **Weigert–Meyer Law**
  - It tells about complications a/w upper moiety (upper part of collecting system) and lower moiety (lower part of collecting system) (trick: vowels stick together)
  - Upper moiety is a/w
    → Ureterocele
    → Obstruction
    → Ectopic insertion (Inferomedial insertion)
  - Lower moiety is more prone to vesico-ureteric reflux

RETROPERITONEAL FIBROSIS

00:12:33

- Maiden waist sign (medial deviation of ureters d/t pulling by fibrous tissue)
- Various causes of RPF:

1°	2°
• Idiopathic: Armond disease	• IgG4 related disease • Radiotherapy • Drugs: Methysergide, ß blockers, Hydralazine

FISH HOOK URETER

00:14:24

- Retrocaval ureter (J-shaped ureter): ureteric compression results because of IVC abnormally
- 55 year old man with lower urinary tract symptoms
- Fish hook ureter in the distal aspect is a/w BPH

BLADDER EXSTROPHY / ECTOPIA VESICAE

00:16:14

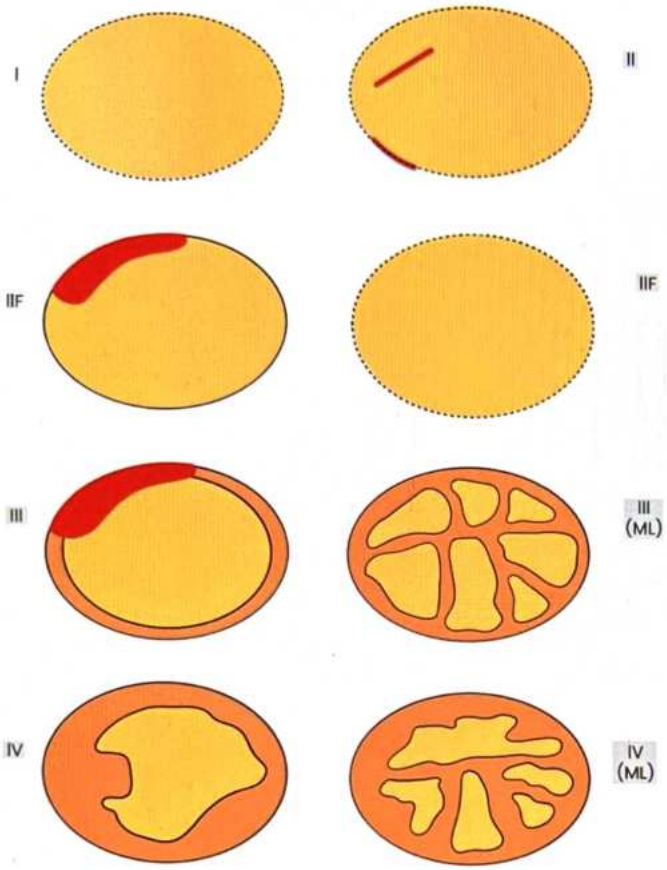
- Hurley stick appearance
- Ureters are oriented superiorly & laterally
- A/w adenocarcinoma of bladder
- Public diastasis (Manta ray sign)
- Unfused public symphysis

RENAL CYST

00:17:28

Bosniak classification: Described on CT scan

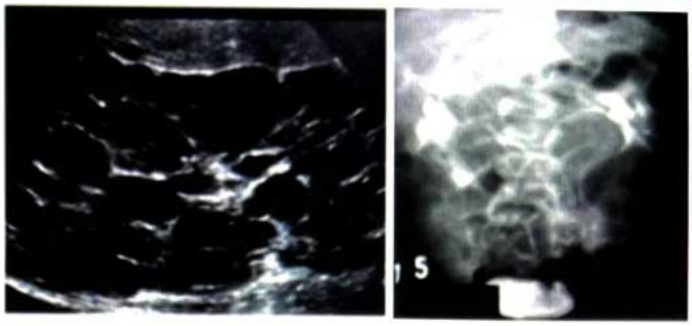
- Classifies the cyst into four types depending upon the increase in the risk of malignancy based on its morphological appearance



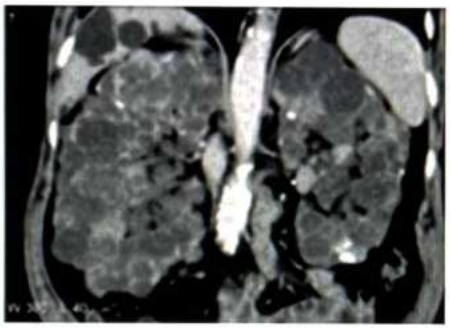
Grade	Likelyhood of malignancy	Management
I: (simple anechoic cyst)	0%	Benign; no follow up needed
II: (Minimally complicated)	0%	Benign; no follow up needed
II F: (Nodular calcification in the wall / multiple septations)	10-12%	Follow up imaging
III: (Moderately complex, Thickened wall / Multiple thick septations)	50-60%	Resection
IV: (Very complicated, Obvious solid component showing enhancement)	Malignant until proven otherwise 100%	Resection

POLYCYSTIC KIDNEY DISEASE

00:20:57



USG IVP



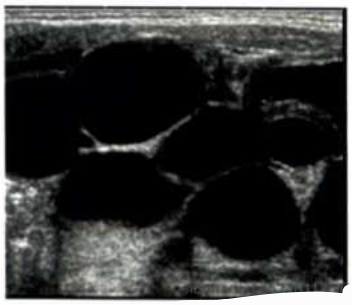
CT

Autosomal dominant type: PCKD

- Adults presenting in 30-50 with end stage renal disease (ESRD) with family history of bilateral cystic renal diseases
- CT coronal image shows multiple bilateral large cysts , plus there are also hepatic cysts visible.
- USG shows large anechoic lesions which are the cysts.
- On IVP, nephrogram at 5-10 mins show Swiss cheese appearance and pyelography shows Spider leg appearance
- Can be a/w: colonic diverticulosis, mitral valve prolapse, berry aneurysm

MCKD (Multicystic Kidney dysplasia)

00:22:55



- A neonate presenting with unilateral flank mass
- Non-functional kidney with multiple non communicating cysts which are replacing the parenchyma

Autosomal recessive: PCKD 00:24:02

- A neonate presenting with renal failure or sometimes can present with B/L abdominal lumps
- Reniform shape of kidneys is maintained
- B/L renomegaly
- Increased echogenicity of kidneys
- Outer margin is smooth (Gross specimen)

MCKD	AD PCKD	AR PCKD
Neonate	Adults	Neonate
Large Cysts	Large Cysts	Tiny Cysts
U/L	B/L	B/L

Medullary sponge kidney 00:26:02

- Paint brush appearance or Bouquet of flowers appearance
- Medullary nephrocalcinosis
- Congenitally dilated collecting ducts with accumulated calcium
- Other causes of medullary nephrocalcinosis
  - Hyperparathyroidism (Hypercalcemic conditions)
  - Hyperoxaluria

PRUNE BELLY SYNDROME 00:27:28

- Congenital absence of abdominal wall muscles: Herniation of bowel loops
- A/w Genito urinary abnormalities
  - Undescended testis
  - Urinary tract abnormalities (Hydroureteronephrosis, vertical bladder, vertical posterior urethra)

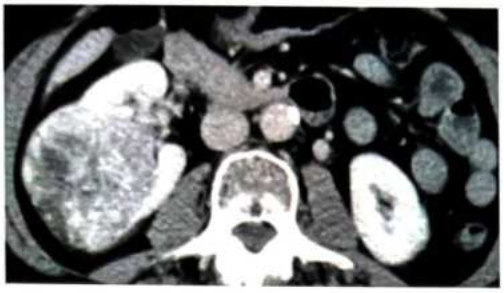
CROSSED ECTOPIA 00:29:09

- Kidney is crossing over to the other side (but ureter is draining in the normal fashion)
- 2 Types
  1. Fused: Pancake kidney is the variant of crossed fused ectopia
  2. Unfused

RENAL TUMORS

00:30:20

- Best investigation for suspected RCC: CECT
- IVC invasion better determined by MRI
- M/C histopathological type of RCC: Clear cell carcinoma



- CT scan shows Hypervascular, Necrotic ball type lesion typical of Clear cell RCC.

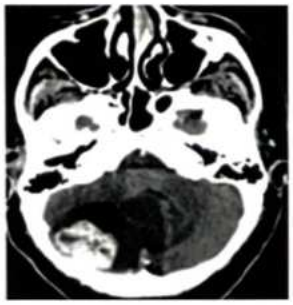
Ball type lesion of kidney	Bean type lesion of kidney
• Lesion growing out of the kidney like a ball	• Tumors infiltrating in to the kidney but reniform shape is maintained
• Prototype: RCC	• Prototype: TCC

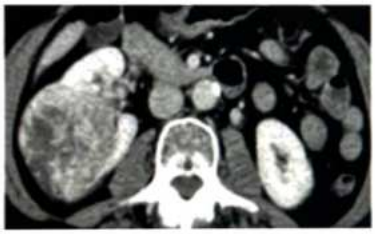
- Hypervascular primaries:
  - Clear cell RCC
  - Follicular Ca thyroid

Syndromes associated with clear cell RCC: VHL syndrome

00:33:25

- VHL syndrome is associated with mutation in chromosome 3P



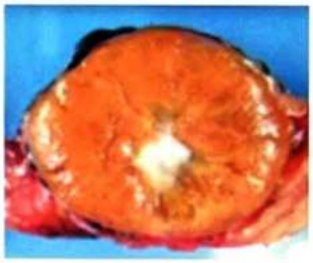


VHL syndrome components

- CECT shows a cyst with mural nodule in adult: Cerebellar hemangioblastoma
- Cyst with mural nodule in child: Pilocytic astrocytoma
- Pheochromocytoma
- Retinal hemangioblastoma
- Spinal hemangioblastoma
- Multiple Cysts
  - Renal
  - Pancreatic
- Serous cyst adenoma, neuroendocrine tumors
- Epididymal cysts
- Clear cell RCC

ONCOCYTOMA

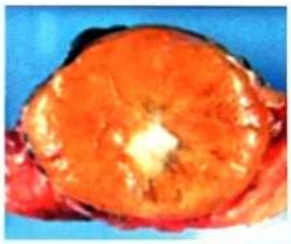
00:35:10



- Central stellate scar (hallmark)
- Radiologically indistinguishable from chromophobe RCC

Gross specimen

- Round mass with central stellate scar
- Tan colour

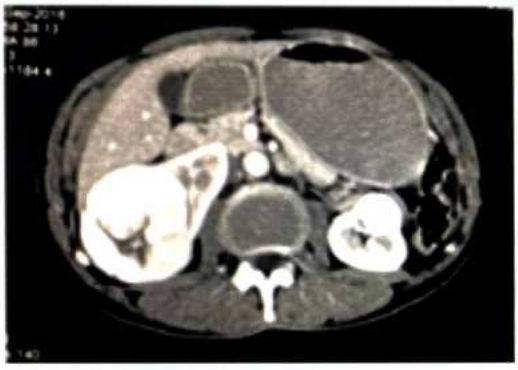


- Liver tumors with central stellate scar
  - Fibrous nodular Hyperplasia
  - Fibrolamellar HCC
- RCC with best prognosis: Chromophobe RCC

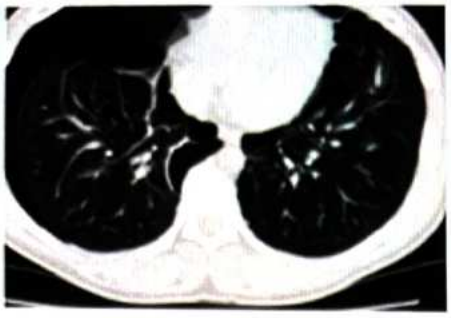
Syndrome a/w oncocytoma /chromophobe RCC: Birt-Hogg-Dube syndrome

00:36:29

- Associated with mutation in folliculin gene



Oncocytoma / chromophobe RCC



Lung Cyst / pneumothorax

Fibrofolliculomas

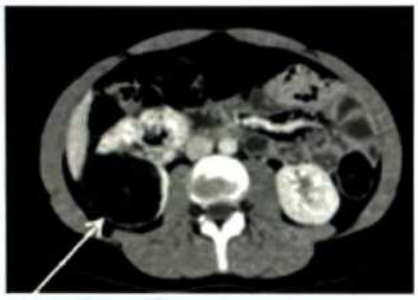
ANGIOMYOLIPOMA

00:37:34

- Hamartomatous lesion of the kidney involving 3 components:
  1. Blood vessels: Aneurysms located within the mass (can bleed at times) → Wunderlich phenomenon: Phenomenon of retroperitoneal bleeding because of angiomyolipoma
  2. Soft tissue
  3. Lipoma

Syndrome associated with Angiomyolipoma: Tuberous sclerosis

00:39:27



Renal angiomyolipoma in adult

Adenoma sebaceum

Calcified sudependymal nodules

- Tuberous sclerosis can also have Lymphangioliomyomatosis (cystic disease in the lung).

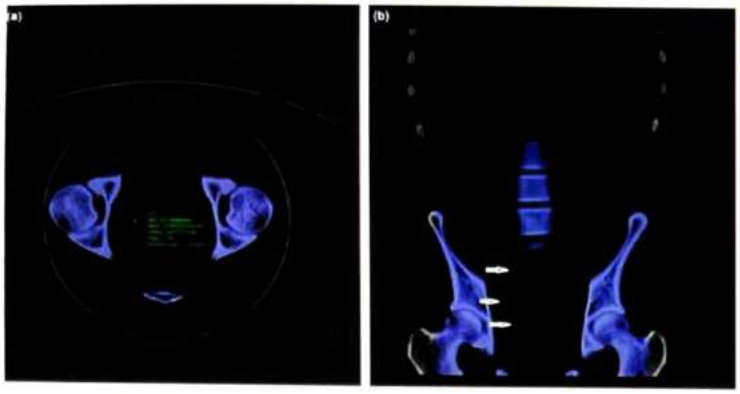
RENAL/URETERIC CALCULI

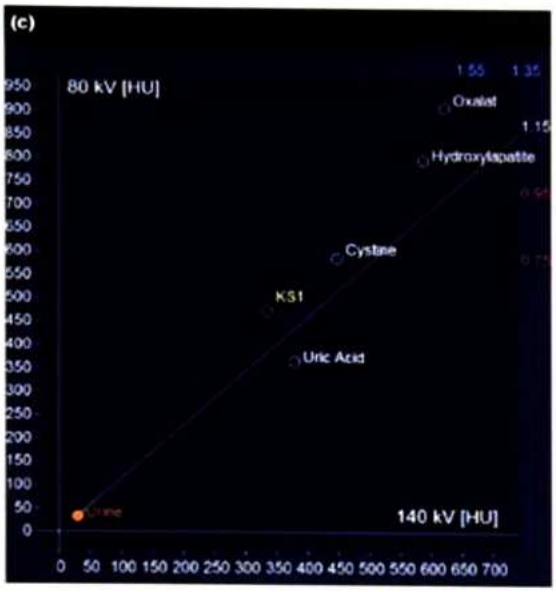
00:40:25

- A young male presented with acute colicky flank pain on the left side
- 1st investigation: USG
- Best investigation /IOC to evaluate renal/ureteric calculi: NCCT
- USG is showing distended pelvicalyceal system due to obstruction caused by calculi
- NCCT can pick all type of renal stones except medication caused indinavir stone which is radiolucent.

Dual energy CT (DECT)

00:43:06





- DECT can characterize the type of calculus
- DECT also has application in evaluation of Monourate sodium deposition in Gout
- Principle of DECT: Material decomposition

VARIOUS NAMED APPEARANCES OF URINARY BLADDER

00:44:17

Neurogenic bladder

- Vertically oriented bladder
- Diverticulations / Sacculations arising from bladder
- Pine tree / Christmas tree bladder

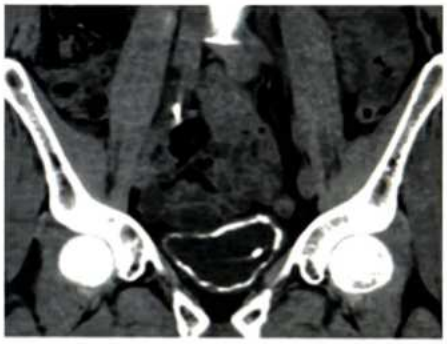
Tear drop / Pear shaped bladder

00:44:52

- Vertically oriented bladder
- Tear drop / pear shaped bladder (d/t any extrinsic compression)
- seen with
  - Pelvic lipomatosis
  - Pelvic hematoma
  - Any extrinsic mass/ tumor

Fetal skull appearance

00:45:44



- NCCT shows bladder wall calcification: Fetal skull appearance seen in Schistosomiasis
- ↑sed risk of squamous cell Ca

GU TB

00:46:41

- Moth eaten calyces seen on IVP
- Caliectasis (Phantom calyx)

- Golf-stem ureter or pipe stem ureter
- Kerr's kink [kinking of proximal ureter]
- Thimble bladder

- Putty kidney (lobar calcification of kidney)
- Autonephrectomy

- Occurs 2° to pulmonary infection
- Spread by hematogenous route
- The first area to be affected is glomeruli
- Earliest finding: moth eaten calyces (irregularity of calyces d/t inflammation caused by TB bacillus)
- Pathognomonic hallmark of GU Tb → strictures all over the tract

PAPILLARY NECROSIS

00:50:12

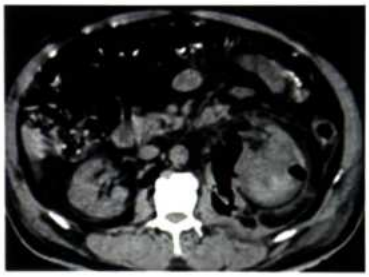
Causes of papillary necrosis: Trick

- N - NSAID
- S - Sickle cell anemia
- A - Analgesia
- I - Infections: TB
- D - DM

- Ring in dot sign
- Signet ring sign (necrosed, sloughed off papilla going into the calyx)
- Lobster claw sign

EMPHYSEMATOUS PYELONEPHRITIS

00:51:49



- A sick patient with sepsis or H/O uncontrolled diabetic presenting with flank pain
- Seen with gram ⊖ ve /anaerobic infections (usually polymicrobial in nature)
- Complete air is replacing the renal fossa (air foci collecting in the kidney)
- Poor prognosis
- Urgent drainage is required: If no response → Nephrectomy is to be done

RGU (RETROGRADE URETHROGRAM)

00:53:16

- To visualise urethra
- Part best seen on RGU: Anterior urethra
- IOC for urethral trauma: RGU
- Anterior urethral strictures on RGU in 2nd image

MCU/VCU/ MICTURATING / VOIDING CYSTOURETHROGRAPHY

00:55:58

Structures evaluated

- Bladder
- Posterior urethra
- Best Ix for posterior urethra: MCU / VCU
- Functional Ix in which patient actually voids.
- MCU is Ix of choice in following conditions:
  - Posterior urethral valve, anterior urethral valve
  - Vesico – ureteric reflux

00:58:15

Previous Year's Questions

Q. A 2 year old baby presents to the tertiary care with recurrent UTI. MCU is done and is shown. What is your diagnosis? (NBE 2018)

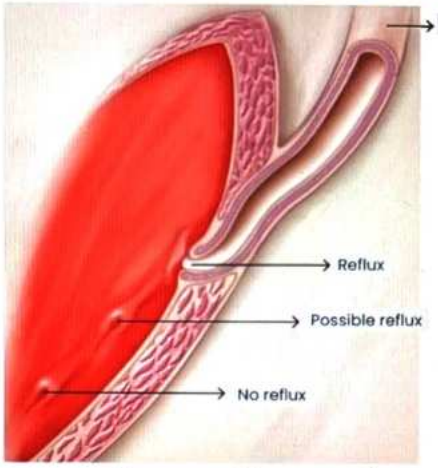
A. Ureterocele
B. Vesico-ureteric reflux Grade 2
C. Posterior urethral valve
D. Vesico-ureteric reflux Grade 5

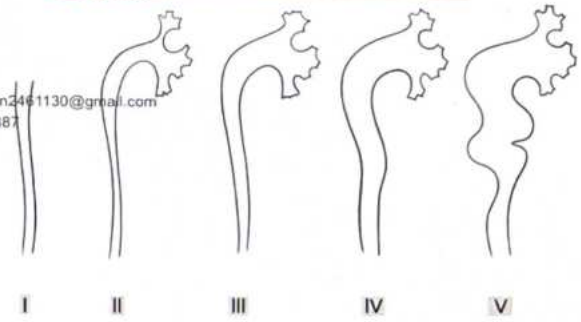
Explanation

- Gross dilatation of ureter and pelvic calyceal system and Ballooning out of calyces

VESICO-URETERIC REFLUX (VUR)

00:59:03





- IOC: MCU
  - Grade 1: undilated ureter
  - Grade 2: Mild dilatation
  - Grade 3: Moderate dilatation
  - Grade 4: Gross dilatation (papillary impressions are preserved)
  - Grade 5: gross dilatation (Papillary impressions are lost)
- Mx for Grade 4,5: surgical management

POSTERIOR URETHRAL VALVE

01:00:29

- Keyhole sign on USG (enlarged posterior urethra)

- Obstruction at the level of posterior urethra
- Can present antenatally with porter sequences
- A/w Oligohydroamnios because fetus cannot pass urine and thus can lead to Pulmonary hypoplasia
- IOC: MCU / VCU

WOLMAN DISEASE

01:01:49

- B/L adrenals are enlarged
- Adrenal calcification bilaterally in a child
- Deficiency of Lysosomal acid lipase

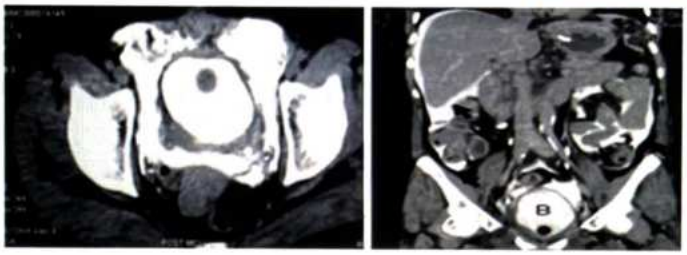
URETHRAL INJURY

01:02:43

- Triad of clinical findings
  - Inability to void
  - Blood at external urethral meatus
  - High riding prostate on DRE
- Uretheral injury suspected: IOC / Next step: RGU
- If injury is + nt: Suprapubic cystostomy is done
- If injury is -nt: Foley's catheterisation is attempted
- Uretheral injury manifests as extravasation of contrast on RGU.
- Anterior urethral injury is most commonly a/w straddle injury
- Posterior urethral injury is a/w pelvic fractures

BLADDER INJURY

01:04:49

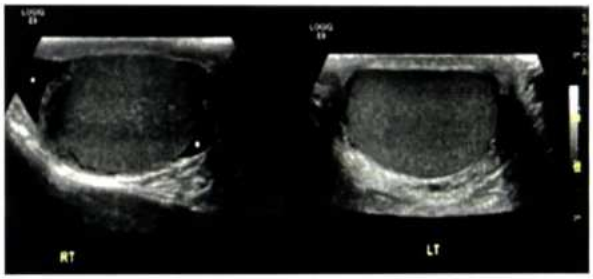


- IOC / best investigation to evaluate bladder injury in a patient with pelvic fracture with hematuria: CT cystography
- CT cystography: Put foley's catheter and inject contrast (Iohexol diluted with saline)
- Any rupture / injury to the bladder: Contrast leaks out

• Leak spreads in extraperitoneal space (extraperitoneal bladder rupture)	• Leak spreads in intraperitoneal (intraperitoneal bladder rupture)
• ~ 85% cases (M/C rupture)	• ~ 15% cases, seen in distended bladder
• Conservative Mx	• Sx management
	• D/t defect in bladder dome

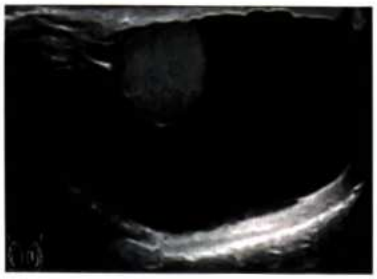
TESTICULAR PATHOLOGIES

01:07:00



- Best Ix for evaluating testicular pathologies: USG + Doppler
- Image shows normal appearance that is well defined homogenous hyperechoic.

Hydrocele 01:07:28

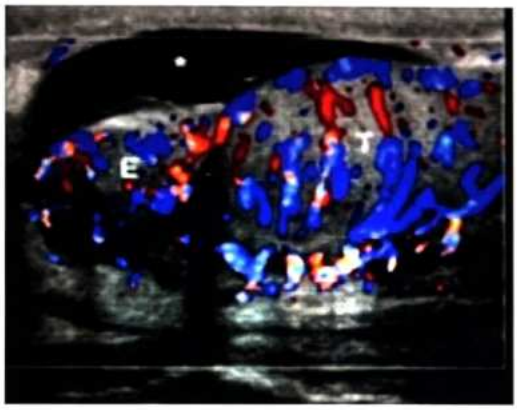


- Testis surrounded by Anechoic fluid

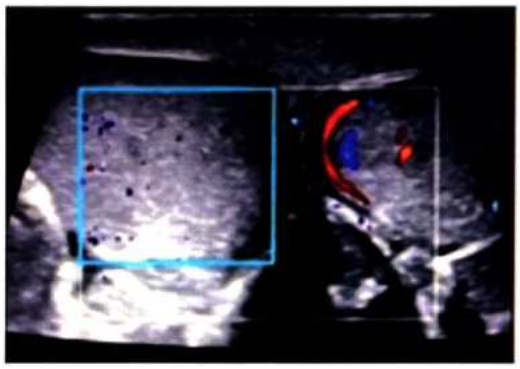
ACUTE EPIDIDYMO ORCHITIS / ACUTE ORCHITIS VS TESTICULAR TORSION 01:07:50

- Both present with acute testicular pain and swelling in a young adult
- Next step / IOC: USG+ Doppler

- Acute epididymo-orchitis
- Increased vascularity of epididymis of testis

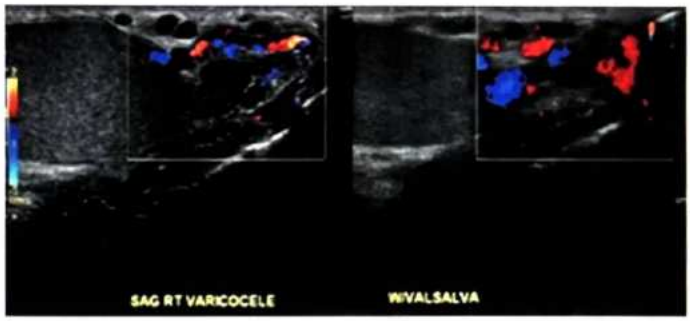


- Testicular torsion
- Reduced vascularity



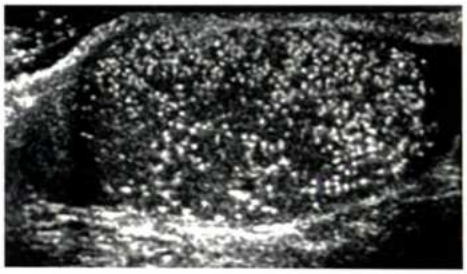
- Tc 99 scan showing Photopenic area in Testicular torsion

VARICOCELE 01:09:38



- Bag of worms appearance

TESTICULAR MICROLITHIASIS 01:10:23



- Snowstorm appearance
- Patient needs to be on follow up because of higher risk of GCT (germ cell tumor)

CLINICAL QUESTIONS

Q. A 5 year old boy brought to your clinic because he has had a life-long problem of day and night urine incontinence. An ultrasound showed keyhole appearance and mild hydronephrosis bilaterally. What is the Most likely diagnosis?

A. Polycystic kidney
B. horseshoe kidney
C. TB kidney
D. Posterior urethral valve

Answer: D

Solution

- Key hole appearance on antenatal scan is a feature of posterior urethral valve.

Posterior urethral valve

Ultrasound image showing multiple variable sized cystic lesions involving the renal parenchyma s/o polycystic kidney disease.

Q. A 65-year-old man with coronary artery disease and diabetes mellitus, hypertension, hyperlipidemia, and renal insufficiency presents to the emergency department with a chief complaint of shortness of breath. His condition improves after treatment with intravenous diuretics, however, his blood pressure remains elevated with systolic BP over 170 mmHg. A renal Doppler ultrasound is performed which shows direct evidence of bilateral renal artery stenosis. Which of the following is the gold standard investigation for renal artery stenosis?

A. Renal scan
B. Ultrasound Doppler
C. Renal angiography
D. 3D Contrast-enhanced MRA

Answer: C

Solution

- **Angiography is the gold standard** and definitive means to **diagnose RAS**, except for the risk of contrast reaction.
- In screening for stenosis of the main renal arteries and differentiation from fibromuscular dysplasia, the use of 3D contrast-enhanced MRA provides an optimum method for its detection and allows the demonstration of small accessory renal arteries and segmental branches
- Doppler evaluation has limited application as a screening modality.
- The clinical signs of renal artery stenosis include Renovascular hypertension and azotemiA

13 NEURORADIOLOGY PART 1

HEAD TRAUMA

00:00:27

- Initial I.O.C for head trauma: NCCT head
- IOC for head trauma: NCCT Head
- MRI SWI (IOC): Diffuse axonal injury (High acceleration road traffic accident, Low GCS , CT scan almost normal)
- CT angiography indications:
  - Transverse foramina fracture
  - Base of skull fracture
  - Subarachnoid hemorrhage (SAH)

Indications of head CT in trauma

00:03:12

(Canadian CT head rule, new Orleans criteria NEXUS, Denver criteria)

- Major head injury (GCS < 13)
- Minor head injury (GCS 13-15) with any one of the following findings:
  - Suspected open or depressed skull fracture
  - Any sign of basal skull fracture
  - Two or more episodes of vomiting
  - 65 years or older
  - Amnesia before impact of 30 or more minutes
  - Dangerous mechanism

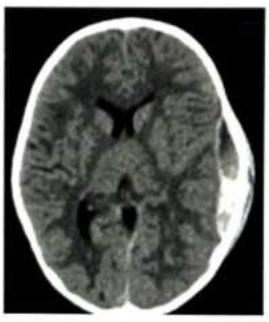
00:04:38

Extra-axial bleeding: Outside the brain (parenchyma). It includes	**Intraaxial bleeding**: Intraparenchymal injuries. It includes
• SDH • EDH • SAH • IVH	• Cerebral contussions • DAI

Refer Table 13.1

EDH

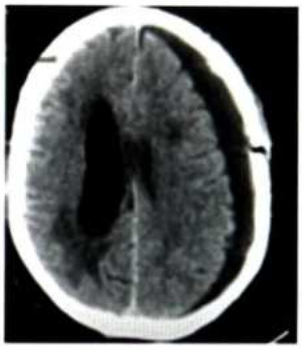
00:10:16



- Sign of ongoing active bleeding within a hematoma: Swirl sign
- Has poor prognosis because of high rate of bleeding
- Decompression needs to be done.

Chronic SDH

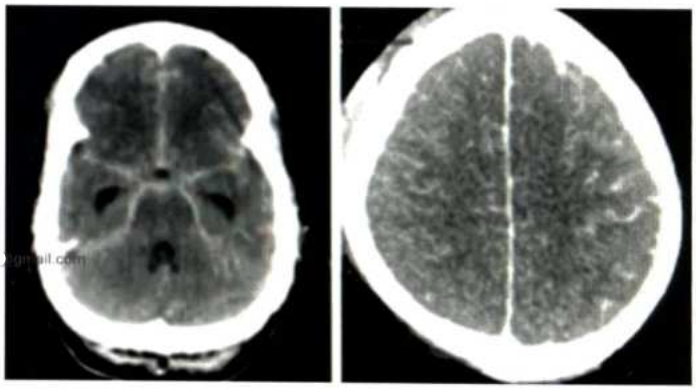
00:11:35



- Left side
- SDH (able to cross sutures but can't cross the midline)
- Chronic (Hypodense Hematoma)
- Indication of decompression: Midline shift of brain > 5 mm

Acute SAH

00:13:35

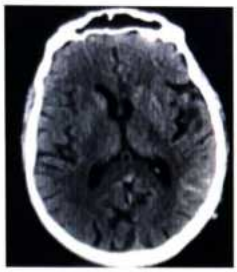


- Hyperdensity in the basal cisterns along the sulcal spaces
- M/C cause of SAH: Trauma
- M/C cause in spontaneous non traumatic SAH: Aneurysmal bleed

Previous Year's Questions

Q. A middle-aged female with sudden onset of headache and neck rigidity. There is no history of trauma. CT scan image is shown below. What could be the probable diagnosis in this patient?

(NEET Jan 2020)



A. SAH
B. Meningitis
C. Intracranial hemorrhage
D. IVH

Intraventricular hemorrhage

00:15:08

- Hyperdensity within the ventricles
- Shearing of intraependymal blood vessels

INTRAPARENCHYMAL INJURY OR CEREBRAL CONTUSIONS

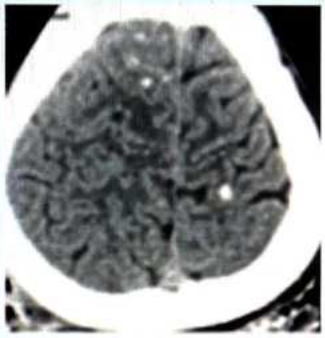
00:15:30

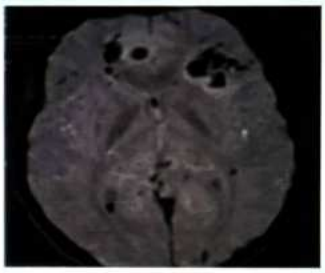
- Hyperdense intraparenchymal foci
- Intraparenchymal hematoma with surrounding edema suggestive of cerebral contusions
- M/C site of cerebral contusions in the brain: Frontal & temporal lobes
- Frequently a/w coup-countercoup mechanism

Diffuse axonal injury

00:17:22

- A patient with High energy trauma (road traffic accident) with Low GCS score





- NCCT done may be normal or may show tiny microbleeds (d/t shearing of axons)
- Next step/ IOC = MRI (SWI/ Gradient imaging / T2 *)
- Foci of blooming represent bleeds

Staging of diffuse axonal injury

00:19:52

- Adam staging → for severity scoring of diffuse axonal injury

Grade	Affected
Grade 1	• Grey-white matter junction • M/C site to be affected in DAI
Grade 2	• Corpus collosum
Grade 3	• Brain stem

- Severity increases as we move from grade-1 towards grade 3
- Prognosis becomes poor as we move from grade 1 towards grade 3

Previous Year's Questions

Q. A young male with head trauma is brought to emergency in an unconscious state. He is intubated with low Glasgow Coma Scale. NCCT brain and spinal imaging are normal. What could be the likely diagnosis? (INI CET NOV 2020)

A. Cerebral Contusion
B. DAI
C. Cerebral Concussion
D. PRES

TENSION PNEUMOCEPHALUS

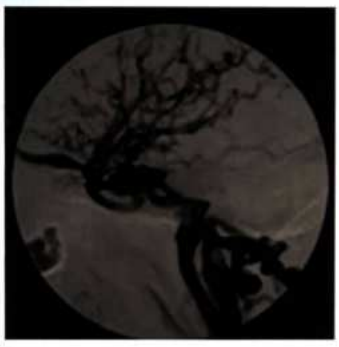
00:20:55

- NCCT showing Mount Fuji sign

CAROTICO-CAVERNOUS FISTULA

00:22:02

- A patient with H/O trauma develops chemosis of one eye, has pulsatile proptosis and develops conjunctival redness: Ist d/d is CCF (Carotico cavernous fistula)



- DSA (Gold standard investigation) as it provides diagnosis as well Rx.

- CT Angiography CECT shows
  - Cavernous sinus is bulky
  - Superior ophthalmic vein is dilated

FRACTURES

00:24:38

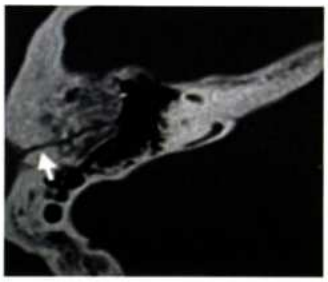
- Best investigation for fractures: CT

Refer Table 13.2

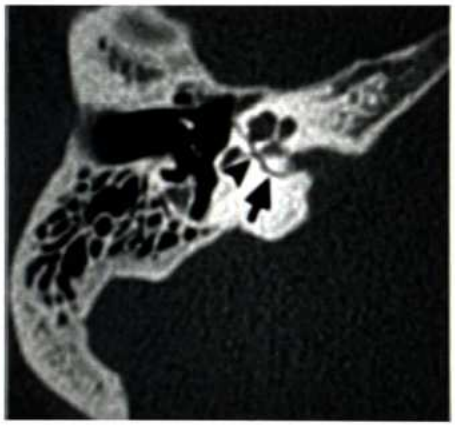
TEMPORAL BONE FRACTURE:

00:27:20

- IOC for all temporal bone pathologies → HRCT of temporal bone
- A 45-year old male presents with h/o trauma to head. He is complaining of bleeding from ear. HRCT of temporal bone is shown.



- It is Longitudinal fracture of temporal bone (Fracture line is along the petrous apex)
- Complications a/w longitudinal temporal fracture (involves middle ear cavity commonly)
  - Conductive Hearing Loss: ossicular injury
  - Hemotympanum



Transverse fracture of temporal bone

- Fracture line is ⊥to petrous apex
- Complications associated: (involves inner ear more commonly)
  - SNHL; 8th CN
  - 7th Cranial nerve palsy

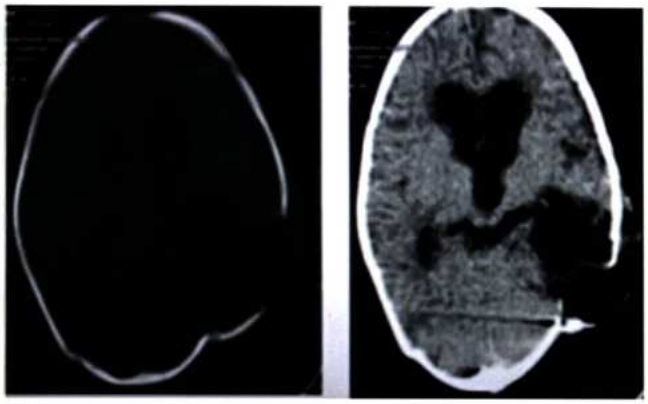
Ulrich Classification 00:30:29

Longitudinal	Transverse
• Parallel to long axis of petrous temporal bone • Conductive hearing loss • Ossicular injury, TM rupture • Otic capsule involvement is rare	• Perpendicular to long axis of petrous temporal bone • Sensori-neural hearing loss • facial nerve paralysis • Injury to Labyrinth and cochlear nerve is more common.

00:30:58

Previous Year's Questions

Q. A 2 year old child with history of fall one year back with parietal bone fracture now presented with painful and growing parietal swelling? (AIIMS 2017)



A. Growing scalp hematoma
B. Growing skull fracture
C. Subdural hygroma
D. Chronic abscess

Growing Skull fracture or Leptomeningeal Cyst 00:32:15

- It is the delayed complication of the fracture seen in children because of the presence of the fracture and associated dural tear.
- Typically patient presents 3 months-1 year after the trauma
- Because of the tear, CSF constantly leaks out resulting in the formation of Leptomeningeal cyst and because of the cyst → fracture is growing (misnomer → growing skull fracture)

BRAIN TUMORS 00:33:43

Brain tumors in Adults

- M/C brain tumor: Secondaries (metastasis)
- M/C benign 1° brain tumor in adults: Meningioma
- M/C malignant 1° brain tumor in adult: Glioblastoma

MENINGIOMA 00:34:46

- Grade 1: MC
- MC benign tumor of adults
- More common in young women (age 30-40)
- Progesterone receptors ⊕ nt → therefore, tends to ↑ se in size in pregnancy
- NF-2 (Syndromic association of meningioma)

Important Information

- Multiple inherited schwannomas. meningiomas and ependymomas are more commonly seen with neurofibromatosis-2 (MIS ME)

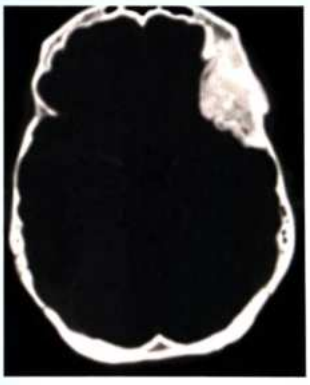
Features

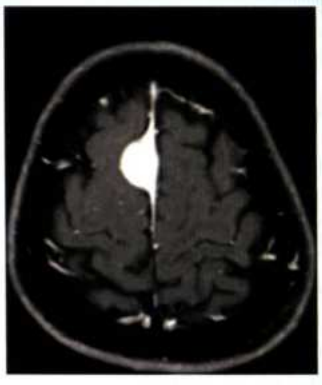
- Extra-axial (outside the brain parenchyma)
- Falcine, Parasagittal
- CP angle
- Arises from Meningo – endothelial cells of arachnoid

Important Information

- M/C tumor of CP angle : vestibular schwannoma
- Second m/c tumor of CP angle: meningioma

Imaging findings in meningioma





CT Bone window
- Hyperostosis
- Califications

MRI
- Increase enhancing mass
- Dural tail sign

- CSF cleft sign → useful for distinguishing b/w intraaxial v/s extraxial lesion
- Spoke wheel sign (seen on DSA) → vascularity is radiating like a spoke
- Mother-in-law phenomenon (arterial supply is too early & venous washout is delayed)
- MRS (MR Spectroscopy): Alanine peak

Important Information

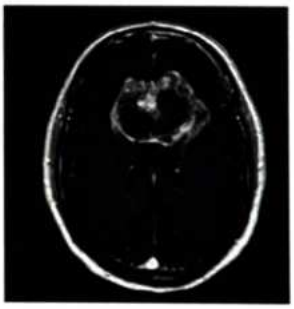
- Best for bone cortex / calcification: CT
- IOC for brain tumors: CE - MRI

Histopathology

- Psammoma bodies
- Vold like pattern

GLIOBLASTOMA MULTIFORME

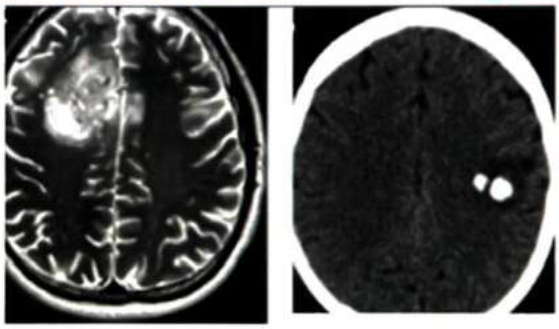
00:41:46



- M/C malignant tumor in adults
- Grade IV tumor
- Associated with Turcot syndrome (intestinal polyps + Medulloblastoma + GBM)
- Fronto-temporal lobes
- Crosses midline
- "Butterfly glioma" (spreads through corpus callosum into contralateral side)
- Necrotic tumor
- Heterogeneous
- Shows Diffusion restriction
- Can have drop metastasis in the spinal canal

OLIGODENDROGLIOMA

00:43:19



- Grade 2 tumor
- 30s – 40s M > F
- Supratentorial
- MC location: Frontal lobe
- Cortical based tumor
- Shows calcification frequently
- Ip/19q codeletion attributes to good prognosis
- IDH mutant

Important Information

Tumors in adults which show calcification:

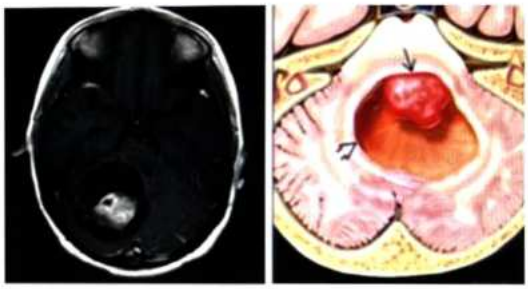
- Meningioma
- Oligodendroglioma

BRAIN TUMORS IN CHILDREN

- M/C benign 1° brain tumor in children: Pilocytic astromyoma
- M/C malignant 1° brain tumor in adult: Medulloblastoma
- In adults, supratentorial brain tumors are more common while in children infratentorial brain tumors are most common

PILOCYTIC ASTROCYTOMA

00:45:18



- Grade 1
- Common site involved:
  - Cerebellum
  - Optic nerve
- Syndromic association: NF1
- Cyst with mural nodule
- Good prognosis

Important Information

- Cerebellar Cyst with mural nodule in children: Pilocytic astrocytoma
- Cerebellar Cyst with mural nodule in adult: Cerebellar hemangioblastoma
  - Most likely a/w Von Hippel Lindau syndrome

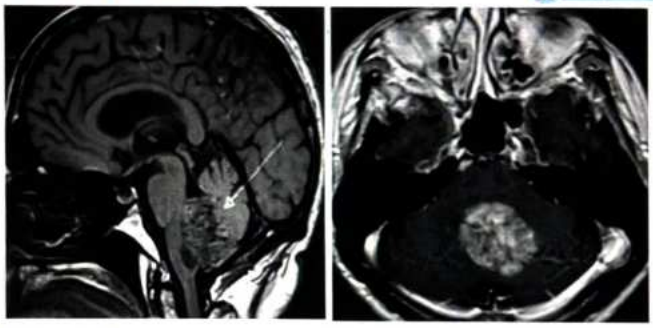
SEGA (SUBEPENDYMAL GIANT CELL ASTROCYTOMA)

00:47:58

- Mental retardation, multiple facial lesions (adenoma sebaceoum)
- Associated with Tuberous sclerosis
- Location: Foramen of monro

EPENDYMOMA

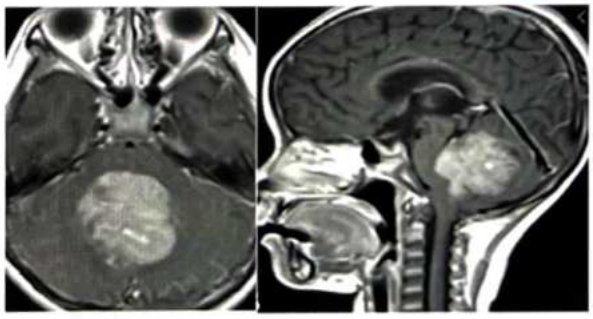
00:49:50



- Grade 2
- 10-20s (more common in 2 decade)
- Location: Floor of 4th ventricle
- Syndrome association:NF-2
- **Features**
  - Plastic tumor
  - Obstructive hydrocephalus
  - Heterogenous: Cyst, hemorrhage, calcification
  - A/w CSF drop metastasis
- Two variants of ependymomas:
  - RELA – fusion ependymoma: Presents as supratentorial mass (seen in young children)
  - Myxopapillary ependymoma: Seen in conus/ Filum terminale (Seen in older adults)

MEDULLOBLASTOMA

00:50:56

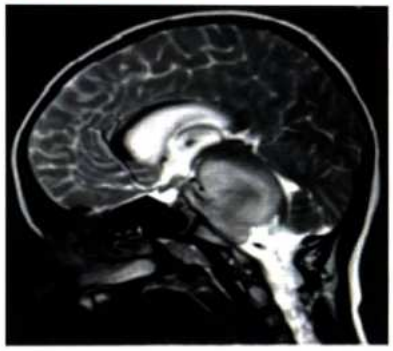


- Grade 4 tumor
- 0-10 yrs (More common in 1 decade)
- Cerebellum
- Location: Roof of 4 ventricle
- Can cause obstructive hydrocephalus
- Shows diffusion restriction (Hypercellularity)
- Associated with CSF drop mets

Medulloblastoma	Ependymoma
• Homogenous	• Heterogenous
• More common in younger kids	• More common in older kids
• Location Roof of 4th ventricle	• Floor of 4th ventricle

DIFFUSE PONTINE GLIOMA

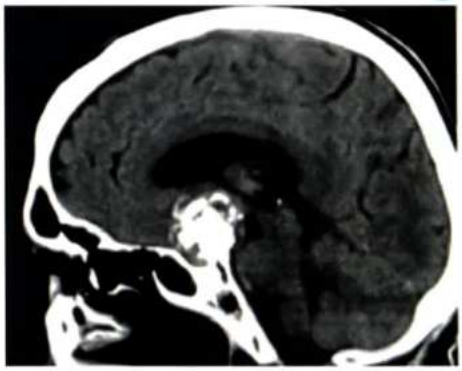
00:55:03



- Grade 4
- 0-20 yrs
- Involves Pons
- Fat Pons appearance
- H3 K27 mutant (Hallmark)
- Poor prognosis

CRANIOPHARYNGIOMA

00:55:59



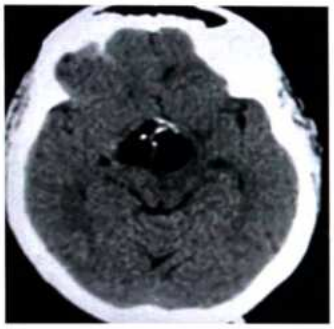
- Grade 1
- 5-15 yrs
- Subrasellar compartment
- Results in Bitemporal hemianopia

- 4Cs
  - Craniopharyngioma
  - Calcification
  - Cystic tumor
  - Children

- **2 variants:**
  1. Adamantinomatous variety
     → Cyst
     → Calcification
     → T1 hyperintense (because of ⊕nce of keratin)
     → Cords / nests of palisading squamous epithelium
     → Machine-oil fluid filled cysts
     → Wet keratin nodules
  2. Papillary
     → 40 yrs
     → Solid

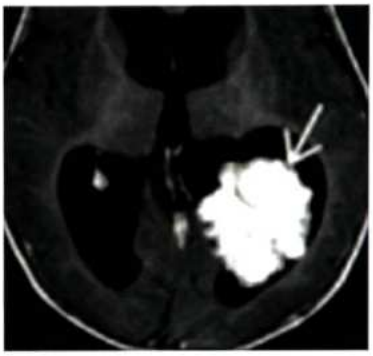
Previous Year's Questions

Q. A 10-year-old child presents to the emergency with sudden onset of vision loss in the bilateral temporal fields .NCCT head was done. what is the likely diagnosis? (NEET Jan 2020)



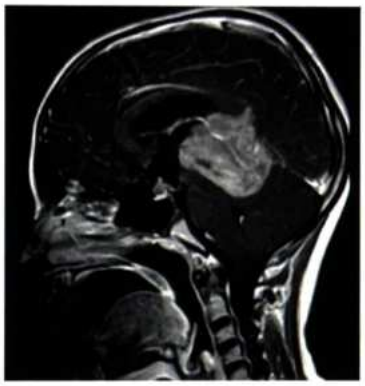
A. Pituitary adenoma
B. Craniopharyngioma
C. Rathke Cleft Cyst
D. Meningioma

CHOROID PLEXUS PAPILLOMA 00:58:14



- Grade 1
- Arises from choroid plexus
- < 1 yr
- M/C location: lateral ventricle
- Can turn malignant
- In adults: Location - 4th ventricle
- Lobulated
- Strongly enhancing (d/t absence of BBB in choroid plexus)
- Hydrocephalus (because of over secretion of CSF)
- CSF drop mets

PINEALOBLASTOMA 01:00:01



- Grade IV
- 0-10yrs
- Location: pineal gland
- Calcification (peripheral)
- Parinaud Syndrome (Upgaze palsy because of compression of mid brain by pineal mass)
- Heterogenous
- Shows diffusion restriction
- Obstructive hydrocephalus
- Drops mets (All blastomas have potential to cause drop metastasis)
- It is part of trilateral retinoblastoma (Bilateral retinoblastoma + Pinealoblastoma)
- Poor prognosis

NEUROCUTANEOUS SYNDROMES 01:02:30

Neurofibromatosis – 1

- Autosomal dominant inheritance
- Chromosome 17 mutation which encodes for Neurofibromin which is a Tumor suppressor gene for RAS pathway

Refer Table 13.3

Diagnostic criteria of NF-1

- Cutaneous Lesions:
  - ≥6 Cafe Cu Lait spots (earliest manifestation)

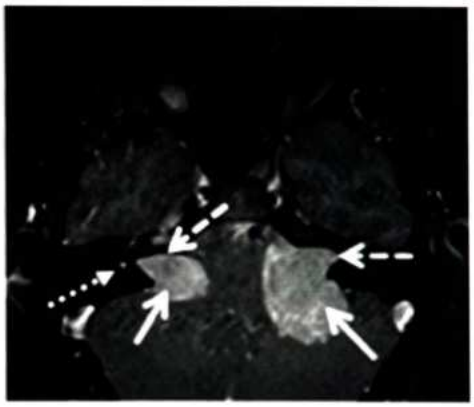
→ Prepubertal ≥ 0.5 cm
→ Post pubertal ≥ 1.5 cm
- Freckling of armpits or gain (Crowe sign)
- ≥2 neurofibromas (any type)
- 1 Plexiform neurofibroma

- Eye Abnormalities
  - ≥2 Lisch nodules (pigmented iris hamartomas)
  - Optic pathway pilocytic astrocytoma

- Distinctive Bone lesion
  - Sphenoid dysplasia / absence (bare orbit sign)
  - Long bone cortex dysplasia / thinning (pseudoarthrosis)

- Family History
  - First – degree relative with NF1

Neurofibromatosis -2 01:07:30



- Mutation in chromosome 22 which encodes for Schwamomin / Merlin gene
- Hallmark of Vestibular schwannoma: Ice-cream cone appearance

Diagnostic criteria of NF2
- Bilateral vestibular schwannomas
- First – degree relative with NF2 & unilateral VS diagnosed before 30years of age

- Or first degree relative with NF2 and 2 of the following:
  - Meningioma
  - Glioma
  - Schwannoma
  - Juvenile posterior subcapsular lenticular opacities or cataracts

Tuberous Sclerosis 01:10:03

Refer Table 13.4

- Vogt's triad: epiloia
  - Epilepsy
  - Adenoma sebaceum
  - Low IQ
- Mutation in
  - Chromosome 9: Hamartin gene
  - Chromosome 16: Tuberin gene

Sturge Weber syndrome 01:13:23

Refer Table 13.5

- NF 1, NF2 and Tuberous sclerosis have autosomal dominant inheritance
- Sturge weber syndrome has sporadic inheritance
- Congenital glaucoma is also associated with sturge weber syndrome

Von Hipple Lindau syndrome (VHL) 01:14:05
- Mutation in chromosome 3P
- Vascular tumors are associated with upregulation of HIFα (Hypoxia inducible factor α)

Refer Table 13.6

Table 13.1

Extadural hematoma (EDH)

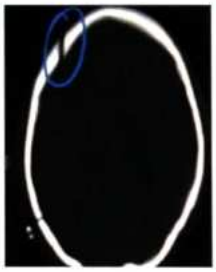
- High energy trauma
- A/w fractures (M/C: Pterional fracture)
- M/C site: Temporal bone
- Source of bleeding: middle meningeal artery (arterial)
- Lucid interval is the feature of EDH
- Lens / Idii shaped
- EDH does not cross the sutures
- Can cross the midline

- Acute hemorrhage appear hyperdense on NCCT

Subdural hematoma (SDH)

- Trivial trauma
- usually no fracture associated
- M/C site: along cerebral convexities
- Source of bleeding Venous → cortical / bridging veins
- Crescent / banana shaped
- SDH can cross the sutures
- Can't cross the midline

Table 13.2



- Linear fracture
- M/C variety

- Depressed fracture (signature #)
- Worst prognosis

- Ping Pong fracture /Pond #
- Typically seen in infants

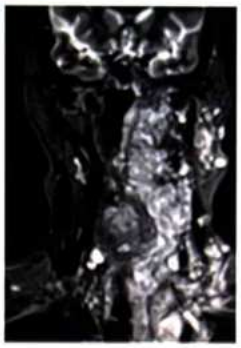
- Sutural diastasis (diastatic type of fracture)

- Communited fracture

Table 13.3

- VRT (Volume reconstruction technique)
- Bare orbit sign
- Sphenoid Dysplasia

- X ray showing Dermal NFs (Hallmark)
- Can mimic cannon ball appearance

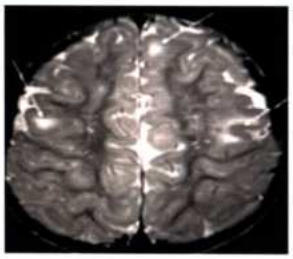


- MRI shows Plexiform NF (Pathognomonic)

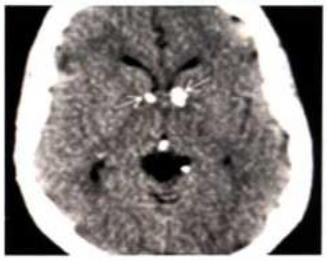
- Target Sign
- Café Cu Lait spots

Table 13.4

Angiomyolipoma (AML)



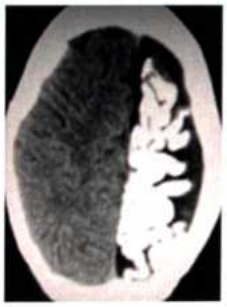
Cortical tubers



Calcified subependymal nodules (candle wax appearance)

Lymphangio liomyomatosis(LAM)

Table 13.5



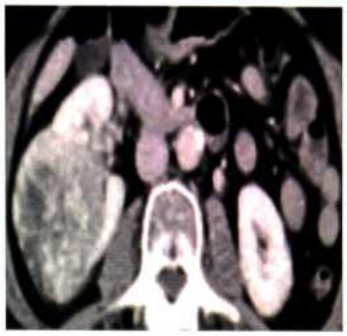
- Cerebral arophy with calcification

- Tram track sign (x ray)

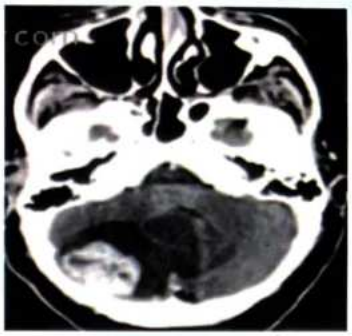
- Facial nevus a.k.a Nevus flammeus
- Portwine stain
- M/C located along V1

Table 13.6

- T2 Hyperintense
- Light bulb sign
- Pheochromocytoma



- Clear cell RCC
- Cysts: Renal, pancreas
- Pancreatic neuroendocrine tumors, serous cyst adenoma)



- Cyst with mural nodules (cerebellar hemangioblastoma)
- Strongly associated with VHL

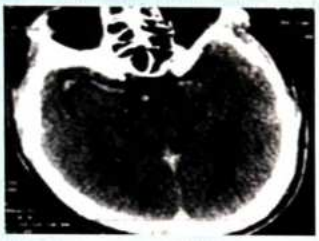
14 NEURORADIOLOGY PART 2

STROKE AND VASCULAR PATHOLOGY

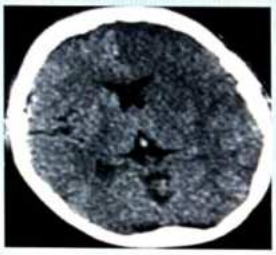
- Stroke is irreversible focal neurological deficit
- Initial investigation for stroke: NCCT
  - Main aim of NCCT is to pick up hemorrhagic type of stroke (Hyperdense on NCCT)
- Best investigation / most sensitive investigation for ischemia=MRI (DWI)

NCCT signs of Acute stoke

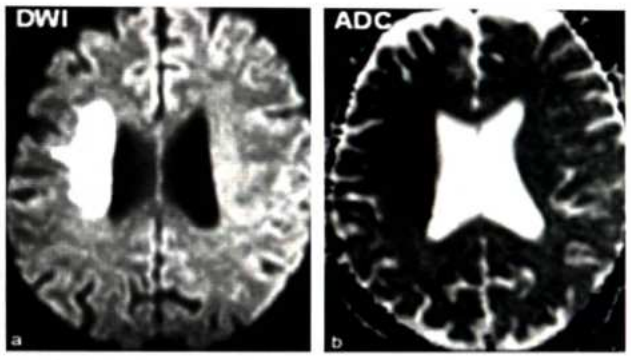
00:02:00



- Hyperdense MCA sign
- Denotes presence of thrombus in the vessel



- Wedge shaped edema
- Blurred basal ganglia sign
- Insular ribbon sign (insular cortex becomes hypodense)



- IOC/Most sensitive investigation to pick up ischemia: DWI (Diffusion weighted Imaging) ADC (Apparent diffusion coefficient)
- True diffusion restriction: Any lesion very hyperintense on DWI and hypointense on ADC

Diffusion restriction

- Normally water molecules show brownian motion
- In Stroke, there is no blood supply: Na^+ K^+ ATP ase pump of a cell stops working leading to retention of Na^+ and water in the cell leading to Cytotoxic edema (Pathological). Now motion of water molecules will be restricted (due to ↑se in cell size). This is known as Diffusion restriction
- Hypercellular tumors: Cells no. ↑ ses , so water molecule unable to diffuse freely thus leading to Diffusion restriction
- Diffusion restriction is seen with
  - Acute stoke
  - Hypercellular tumors
  - Abscess
  - Epidermoid cyst (Keratinaceous material)

Epidermoid cyst	Arachnoid cyst
• Shows diffusion restriction	• No diffusion restriction

CT perfusion and its role in stroke

00:08:32

- Whenever there is stroke or there is cut off to blood supply
- One part in the ischemic area is completely dead k/a Infarct core (non-salvageable)
- Around the infarct core lies Penumbra (Salvageable part)
- For Penumbra imaging: CT perfusion is needed

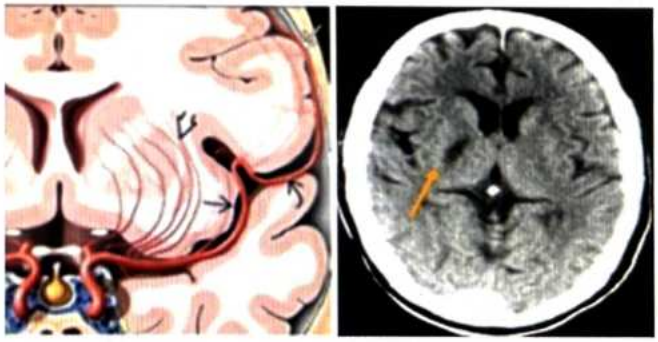
Refer Table 14.1

- CBF and MTT shows both core and penumbra
- CBV shows only penumbra and thus the mismatch

NEURORADIOLOGY IN VASCULAR PATHOLOGIES

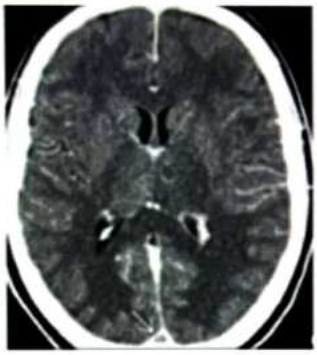
00:14:00

Lacunar stroke



- It is a small vessel ischaemic stroke
- Lenticulostriate vessels from MCA are affected
- Gangliocapsular location is affected i.e basal ganglia and internal capsule region
- Imaging shows a small hypodense area in gangliocapsular location.
- Lipohyalnosis / Microatheroma formation of small vessels lead to their complete obstruction

Superior sagittal sinus thrombosis 00:15:54



- On CECT, Triangular filling defect is seen known as Empty delta sign
- On NCCT, Acute thrombus appear as Hyperdense known as Cord sign

Intracranial hemorrhage 00:17:30

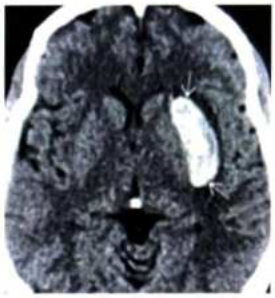
- NCCT-IOC for acute hemorrhage
- Elderly, hypertensive patient develops Intra cranial hemorrhage
- M/C site of Intra cranial hemorrhage: Basal ganglia → Putamen

Pathophysiology

- Chronic Hypertension → Lenticular striate vessels develop micro aneurysms
- These microaneurysms are referred to as: Charcot-Bouchard micro aneurysms which rupture resulting in bleed.

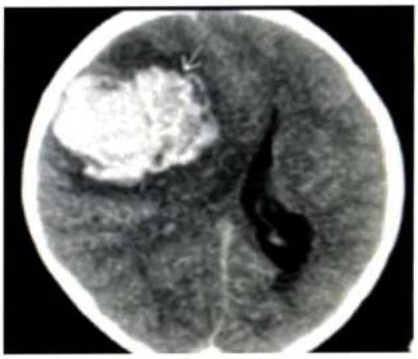
Previous Year's Questions

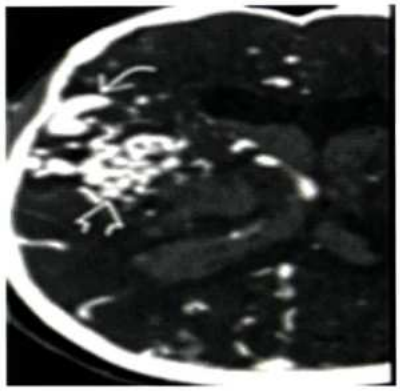
Q. A 56 year old male presents with sudden onset of right hemiplegia. What is the likely diagnosis?
(FMGE Aug 2020)



A. Hypertensive hemorrhage
B. Berry aneurysm rupture
C. Pontine hemorrhage
D. Intraventricular hemorrhage

Cortical bleed 00:19:30



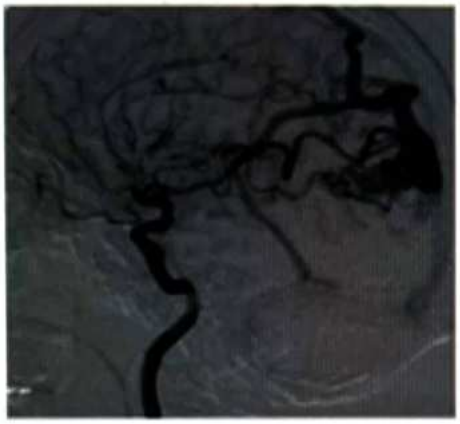


CT angiogram showing nidus

- Young male presents with intracranial hemorrhage: 2 possibilities:
  - AV malformations (rupture)
  - Drugs: Cocaine (sympathomimetic agent)

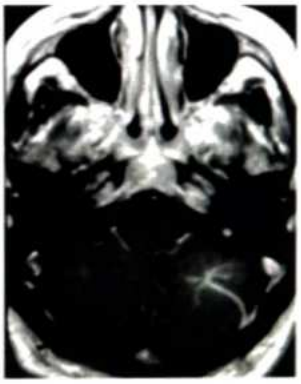
AV malformation

- It is the abnormal communication between the artery and the vein through a cluster of malformed vessels named as nidus
- Nidus is the hallmark of AV malformation



- Gold standard investigation for AV malformation: DSA as it is diagnostic + therapeutic.
- DSA shows early opacification of veins in AV malformation.
- Spetzler-Martin grading system is used prognosis of AV malformation based on:
  - Location
  - Size of AV malformation
  - Draining veins
- Differential diagnosis of AV malformation is AV fistula (no nidus)
- In AV fistula, H/O trauma to the peripheries is given (gun shot injury)

DVA (Developmental venous anomaly) 00:23:56



- CE-MRI shows Palm tree appearance Or Medusa head appearance
- Mostly asymptomatic (incidental finding)
- M/C vascular anomaly in the brain

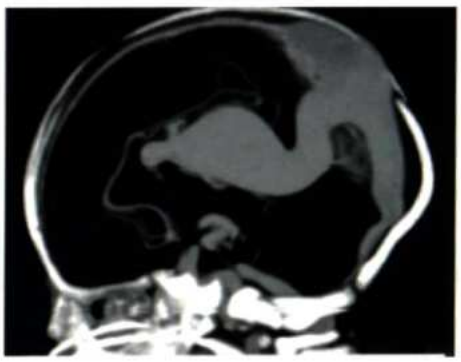
Cavernous angioma / cavernoma 00:25:09

- Gradient MRI (to look for hemosiderin accumulation)

- Popcorn lesion of brain (Hypo intent lesion)
- Associated with focal neurological deficit
- Zabramski classification is used

PEDIATRIC VASCULAR ANOMALIES 00:26:32

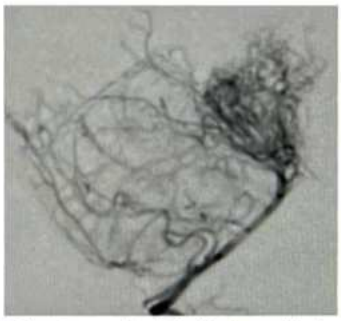
Vein of Galen malformation (VOGM)



A neonate presenting with high output cardiac failure

- Intracranial "Bruit" is ⊕nt
- VOGM is a misnomer because it is a congenital AV fistula
- Embryonic precursor of vein of galen: Median prosencephalic vein
- Gold standard → DSA (dx + Rx)
- Yasargil classification

Moya-Moya disease 00:29:16



- Supraclinoid ICA stenosis: Multiple collateral leaks: Puff of smoke appearance

- Suzuki staging is used
- Rx: Superficial temporal artery (STA) - Middle Cerebral artery (MCA) bypass

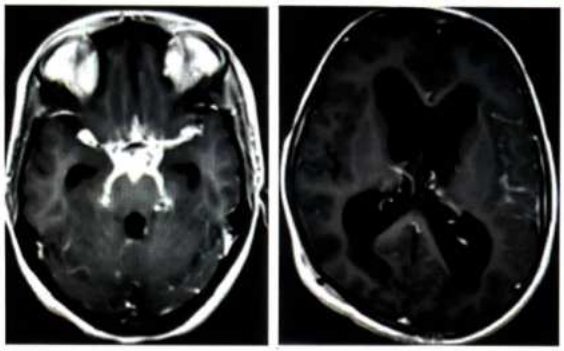
CNS INFECTIONS

00:30:42

- IOC for CNS infections: CE-MRI

TB Meningitis

00:31:04



- At basal cisterns – star of death is seen
- Meningial enhancement seen is suggestive of Basal exudates
- Vasculitis which can result in → Ischemic stroke
- Hydrocephalus
- Meningitis generally show ↑↑ enhancement of Leptomeninges in the CSF cisterns.

Tuberculomas

00:33:15

Refer Table 14.2

Tuberculomas	Neurocysticercosis
• Ring enhancing lesions around the brain stem	• Ring – enhancing lesions around the grey white matter junction (supratentorial compartment)
• T_2 Hypointense	• T_2 Hyper intense (cyst with scolex)
• Lipid lactate peak on MRS	• No such features

Neurocysticercosis

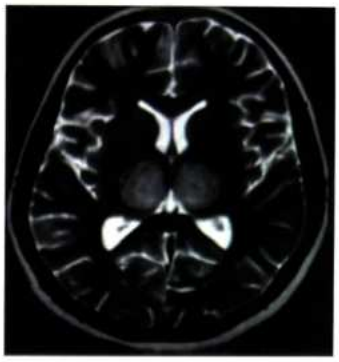
00:36:06

- ESCOBAR Staging is used

Refer Table 14.3

Japanese Encephalitis

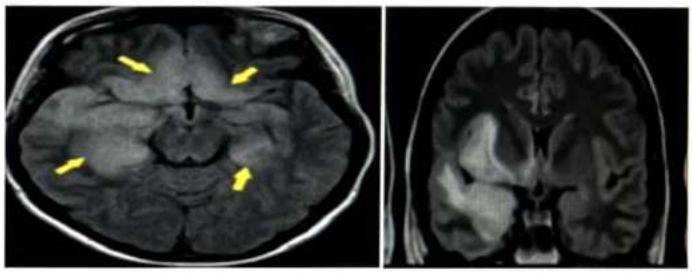
00:39:30



- T2 MRI shows Hyperintense bilateral thalami
- T2 hyperintense bilateral thalami D/D
  - Artery of Perchron infarct(Single vessel supplies both the thalami)
  - Deep venous sinus thrombosis
  - Metabolic & leukodystrophies

HSV Encephalitis

00:41:30



- A child with fever & behavioral abnormalities
- Hyperintense areas on imaging:
  - Medial temporal lobe
  - Cingulate gyrus
  - Insular cortex
- Hemorrhage on SWI shows "Blooming"
- Xanthochromia / RBCs in the CSF
- D/D: Autoimmune encephalitis (can also be a paraneoplastic syndrome)

HIV / AIDS patient with basal ganglia lesions

00:43:26

- 3 differential diagnosis

Refer Table 14.4

LEUKODYSTROPHIES

00:47:13

- Abnormalities in the white matter of the brain

Dysmyelinating	Demyelinating	Hypomyelinating
• Abnormal myelin deposition	• Normal myelin begins to lose	• Reduced amount of myelin

- Macrocephaly
  - C - Canavan's disease
  - A - Alexander's disease
  - T - Taysachs disease
  - S - Sondhoff disease

How to remember

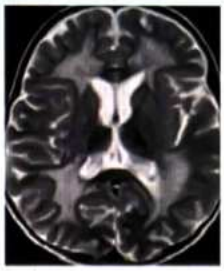
- CATS

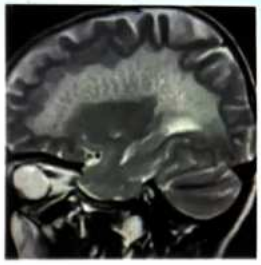
MRI findings

Clue	Diagnosis
• NAA peak on MRS+ Macrocephaly	• Canavan's / Spongiform leukodystrophy
• Anterior WM involvement + Macrocephaly	• Alexander's
• Adrenal insufficiency + Posterior WM involvement	• X-linked adrenaleukodystrophy. It shows contrast enhancement
• Diffuse involvement+ Tigeroid appearance (perivenular sparing)	• MLD (Metachromatic leukodystrophy)
• Thalamic Hyperdensity + Optic atrophy	• Krabbe's disease
• Lactate peak on MRS	• Mitochondrial disorders
• Subcortical cysts + Megalencephaly	• Van der Knaap's disease a.k.a megalencephaly leukoencephalopathy
• B/L subdural collections + Batwing sylvian fissure + BG abnormally	• Glutaric aciduria

Refer Table 14.5

Metachromatic Leukodystrophy 00:55:45





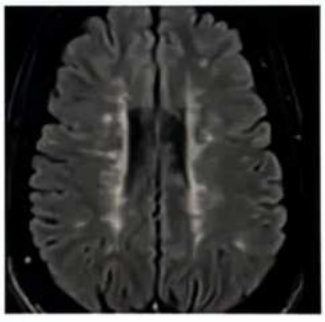
- Tigeroid / Leopard skin appearance

Van der Knaap disease 00:56:17

- Megalencephaly + Subcortical cyst

DEMYELINATING DISORDERS 00:56:50

Multiple Sclerosis



- T_2↑↑
- FLAIR Sequence → Periventricular WM (Dawson fingers)
- Post contrast → Optic nerve involvement suggest Optic neuritis

- MC Donald's Criteria: For diagnosis of multiple sclerosis: dissemination in time and space is required.
- IOC – CE-MRI: 2 types of lesions

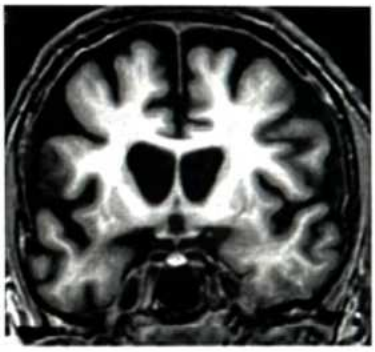
- Enhancing (active demyelinating plaque: T_2 hyperintense)
- Non-Enhancing

- Asymmetrical optic neuritis is present in multiple sclerosis

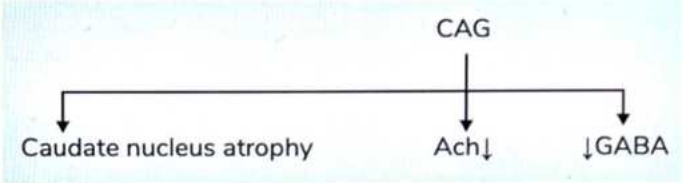
Osmotic demyelination syndrome (Central pontine myelinosis) 00:59:52

- Trident sign is Central pons enhancement
- Piglet sign
- Alcoholic found in altered sensorium: Rapid Vigorous correction of Na+ levels
- Osmotic balance of brain gets altered

Huntington's disease 01:01:32

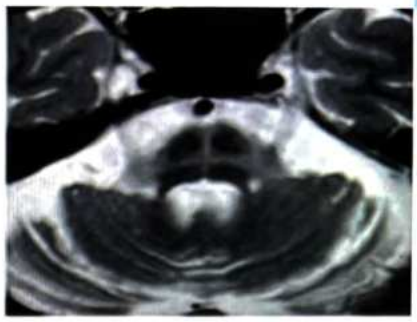


- Box car ventricles (ventricles dilate d/t caudate nucleus atrophy)
- Genetic disorder (trinucleotide repeat disorder): CAG
- Inheritance via Chromosome 4



- Dopamine ↑ses
- Caudate atrophy results in Chorea (hallmark)
- Clinical features
  - Emotional disturbances
  - Dementia

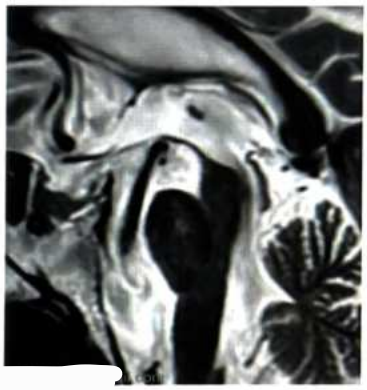
MSA – C type (Multisystem atrophy of cerebellar type) 01:03:24



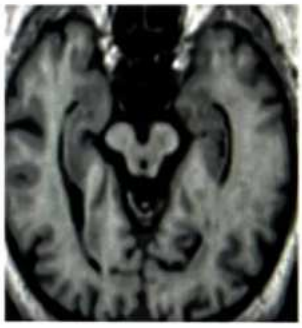
- Hot cross bun sign (cruciate hyperintensity in the pons)
- MSA: P type has Putaminal rim sign

Progressive supra nuclear palsy 01:04:08

Normal saggital section of brain stem



Humming Bird sign/Penguin sign: marked atrophy of mid brain ventrally

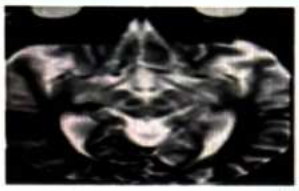


Mickey mouse sign

- Patient will have downgaze palsy and ataxia and other symptoms of Parkinson disease.
- Morning glory sign

Wilson disease

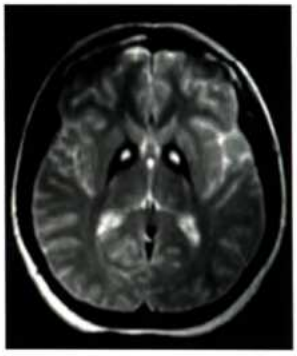
- K-F rings



- Face of a panda sign (Hyperintensity involving the mid-brain)

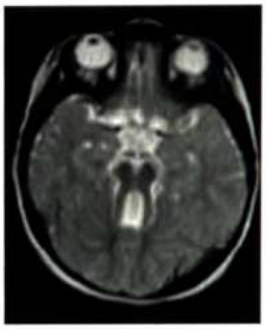
PKAN (Panthothenate kinase) associated neuro degeneration disease or hallevordan spatz disease

01:06:02



- T2 weighted MRI showing Eye of a tiger sign (Hypointense globus pallidus)
- Neurodegenerative diseases with brain iron accumulation (NBIA)
- Eye of a tiger sign
  - Background: Hypointensity (d/t Fe accumulating in globus pallidus)
  - Centre: Hyperintensity (Gliosis)

Joubert Syndrome 01:07:57

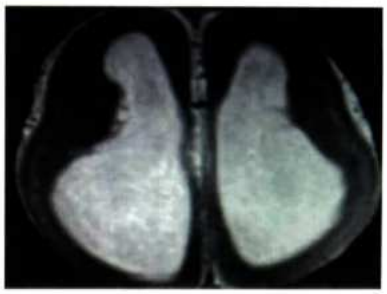


- Molar tooth sign

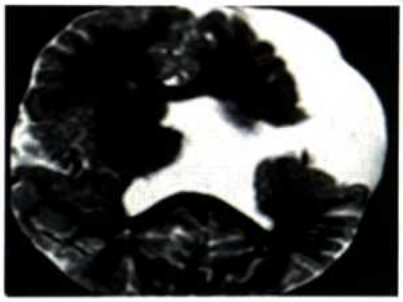
Neuromigration Defects 01:08:19

Lissencephaly

- Smooth outer surface of brain without gyri & sulci



Schizencephaly 01:09:13



- Split in the brain (Ventricle communicates with the subarachnoid space)
- 2 types: Open Lip and Closed Lip

Holoprosencephaly 01:10:06

- Seen with Patau syndrome (Trisomy 13)
- Single fused monoventricle: Brain appears as pancake

Corpus Callosum agenesis 01:10:55

Corpus callosum agnesis

Viking Helmet Sign

- Probst bundles (abnormal bundles)
- Colpocephaly(Dilated posterior horn): parallel oriented ventricles: Racing car ventricles
- Corpus callosum agenesis is a/w Aicardi syndrome

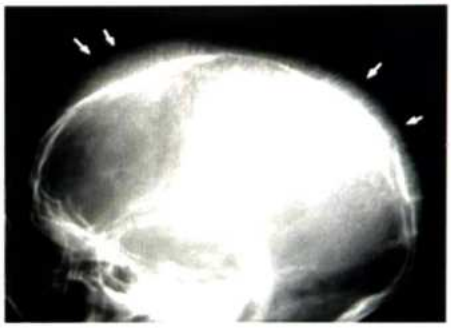
Rain drop skull appearance 01:13:00

- Punched out lytic lesions/Rain drop skull appearance
- Predominantly seen with:
  - Multiple myeloma
  - Lytic mets

Langerhan cell histiocytosis 01:13:47

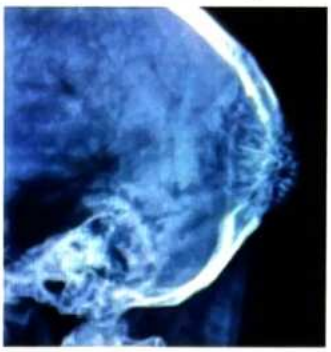
- A child presents with scalp/ calvarian swelling
- Child has
  - Diabetes insipidus
  - Exopthalmos
- Large geographical lytic lesions with bevelled margins (hallmark)

Hair on end sign 01:14:48



- Seen with: Hemolytic anemia (Sickle cell anemia, Thallesemia)

Intraosseous / Intracalvarial hemangioma 01:15:14

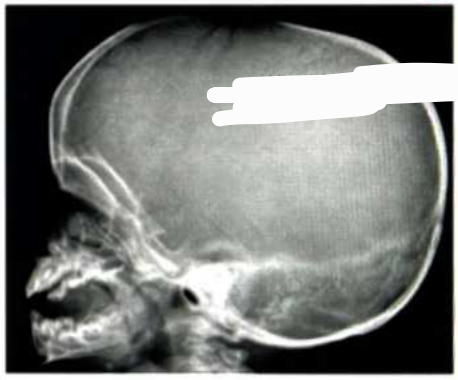


- Focal "hair on end" appearance

Raised ICP 01:16:06

- Earliest radiographical sign of raised ICT in:
  - Children: Sutural diastasis (widening of sutures > 2mm)
  - Adults: Dorsum sella erosion
- Skull appearance: Copper beaten skull

J-Shaped Sella 01:17:19



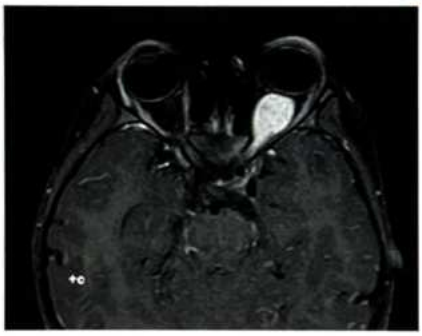
- Associated with
  - Mucopolysacchridosis
  - Achondroplasia
  - Optic chiasma glioma

How to remember

J – shaped sella:

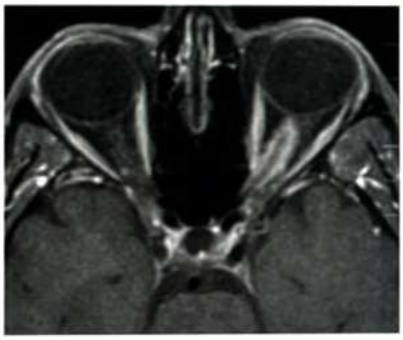
- C - Chronic HCP
- O - Optic chiasm glioma, OI
- N - NfI
- M - MP
- A - Achondroplasia
- N - Normal variant

Optic glioma 01:18:32



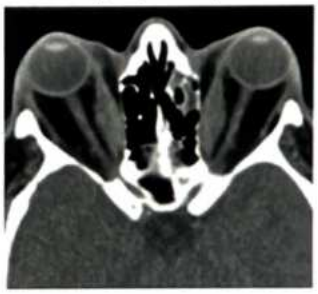
- CE-MRI shows Fusiform enlargement of optic nerve
- Seen with NF (Most commonly)

Optic nerve meningiomas 01:19:18



- CE-MRI shows calcification around optic nerve
- Tram track sign
- Associated with: NF2

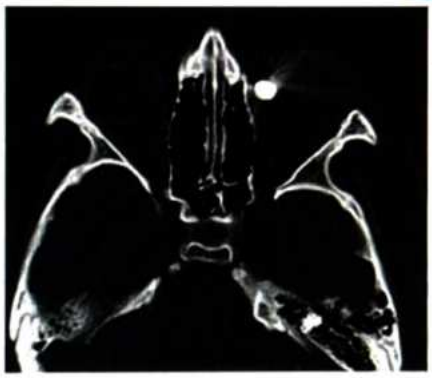
Thyroid eye disease (Thyroid ophthalmopathy) 01:20:11



- Cola bottle sign (Extraocular muscles are bulky with sparing of tendinous insertion)
- **Orbital pseudotumor**: Bulky extraocular muscles without sparing of tendinous insertion (IgG4 related disease)
- Order of involvement of muscles in thyroid eye disease

I	M	S	L	O
Inferior rectus	Medial recuts	Superior recuts	Lateral rectus	Obliques

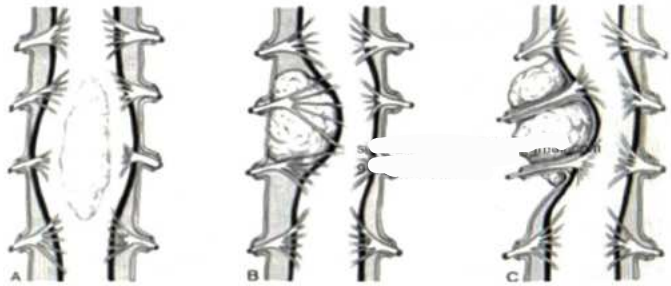
Intraocular foreign body 01:22:04



- Metallic foreign body: Hyperdense structure with streaking artifact
- IOC : CT
- MRI is contraindication

Myelographic appearances of spinal tumors 01:23:09

- IOC for spinal tumors: MRI- CE



Intramedullary tumors	Intra dural extramedullary tumors (IDEM)	Extradural tumors
• Astrocytomas (children)	• Neurofibroma / Schwannoma	• Metastasis (M/C)
• Ependymomas (adults)	• meningioma	• Bony tumors

- Normal
- Trouser leg sign
- Expansion of subarachnoid space
- Meniscus sign
- Feathery appearance

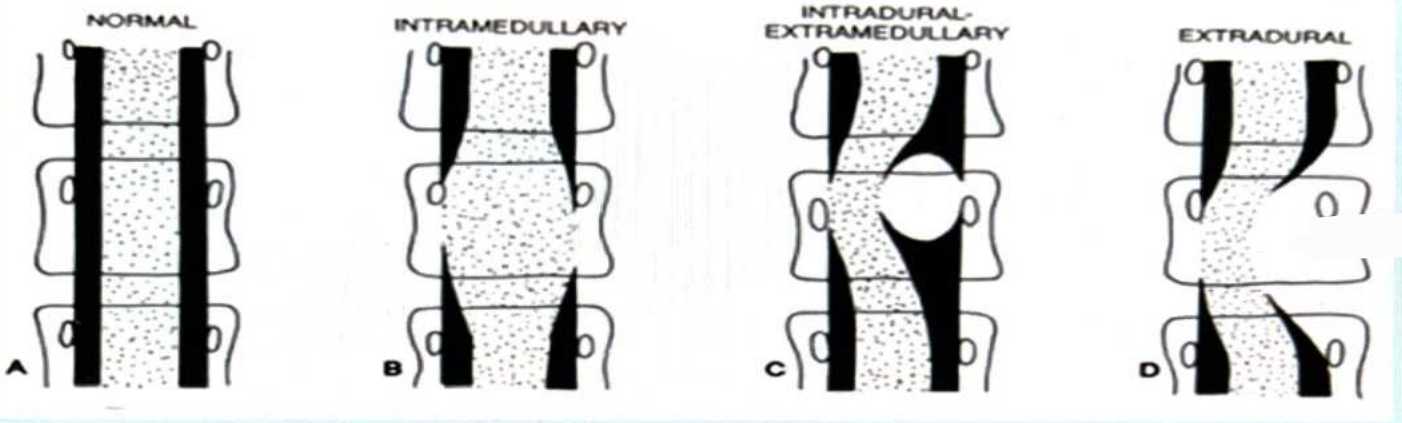
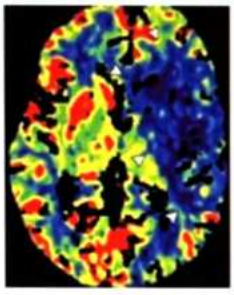
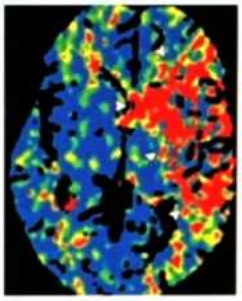


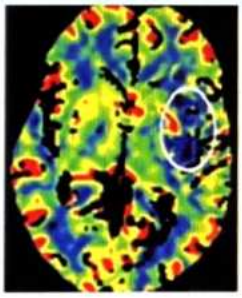
Table 14.1



Cerebral blood flow (CBF)



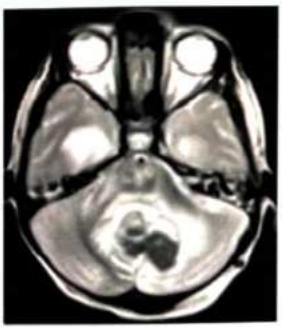
Mean transit time (MTT)



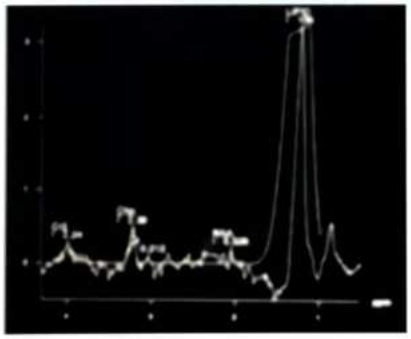
Cerebral blood volume (CBV)

Core	↑se	↓	↓
Penumbra	↑se	↓	Normal -↑

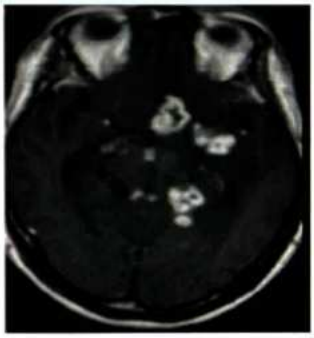
Table 14.2



T_2 hypointense lesions because of caseous necrosis



MRS (MR spectroscopy): Lipid lactate peak indicate necrosis



Ring – enhancing lesions around the brain stem

Table 14.3

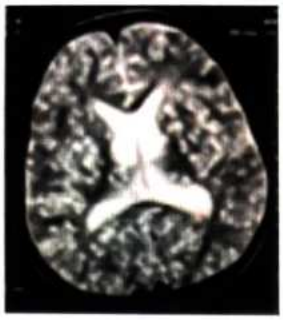
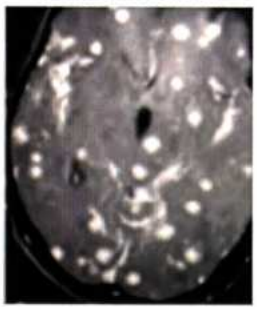
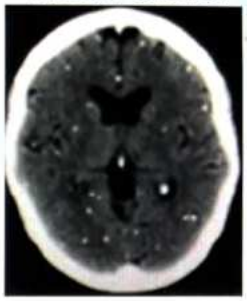
Vesicular	Colloid vesicular	Granular nodular	Nodular calcified
			
• Cyst (Hallmark) • T_2 hyperintense lesion (Central hypointense Scolex)			• Not active cyst • Calcified cystic lesion
• No edema • No contrast enhancement • Asymptomatic patient	• Edema • Rim enhancement • Seizures	• Edema ↓ • Enhancement ↓ • Patient can have symptoms	• Asymptomatic patient

Table 14.4

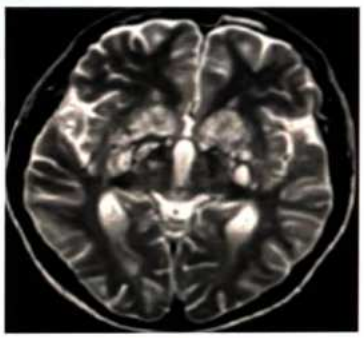
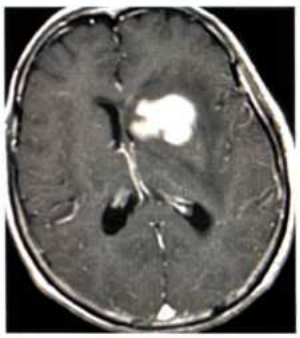
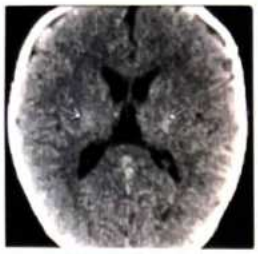
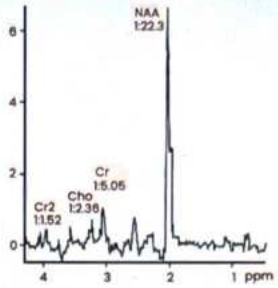
		
Cryptococcomas • Multifocal T2 hyperintense lesions involving bilateral basal ganglia • Soap bubble appearance • Gelatinous pseudo cysts • Dilated perivascular spaces (virchow robin spaces)	Toxoplasmosis • B/L basal ganglia lesions • Target sign / Ring enhanced lesions • MRS: Lipid Lactate peak	Primary CNS lymphoma Homogenously enhancing mass • Single lesion • Periventricular location • MRS: Choline peak (Cellular proliferation)

Table 14.5



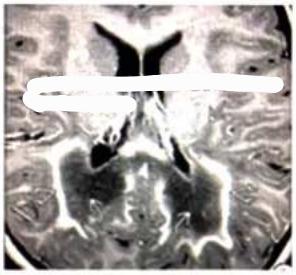
- Hyperdensity in the thalamus

- Optic chiasma thickening



- MRS (NAA peak)

- Anterior white matter involvement
- Alexander's disease



- Posterior white matter involvement
- ALD – Adrenoleukodystrophy

CLINICAL QUESTIONS

Q. A 52 years male presented in emergency department with acute confusion, visual hallucination, persecutory idea , upward gaze palsy of the left eye, gait ataxia, restlessness and nonfluctuating disorientation for 4 days .He had history of alcohol consumption for last 25 years with average daily consumption of more than 1 liter of alcohol .initial diagnosis of Wernicke's encephalopathy was made . Which area of thalamus is involved in this condition ?

A. Mammillary Bodies
B. Dorsomedial Nucleus
C. Ventroposterolateral nucleus
D. Anterior Nucleus

Answer: B

Solution

- **Dorsomedial nuclei** of the thalamus and mamillary body of the hypothalamus are involved **in Wernicke's encephalopathy.**
- **The mammillary bodies, hypothalamus, medial thalamic nuclei (adjacent to the third ventricle), tectal plate, and periaqueductal gray matter are most commonly affected.**
- Caused by a deficiency of vitamin B1 (thiamine). The classic clinical triad of ocular dysfunctions (nystagmus, conjugate gaze palsy, ophthalmoplegia), ataxia, and confusion is observed only in 30% of cases.

Q. A 37 yr old man was referred to NIMHANS Neurology opd with history of 2 episodes of GTCS, Headache, weakness on right side of body, behavior and personality changes. NCCT is given below. what is the most probable diagnosis can be made?

A. Meningioma
B. Oligodendroglioma
C. Glioblastoma
D. Craniopharyngioma

Answer: B

Solution

- **Oligodendroglioma** has **chicken wire calcifications**.
- Above given NCCT image shows ill-defined hypodense lesion in left frontal lobe with dense foci of calcification in the centre.
- Both low- and high-grade oligodendroglial tumors express proangiogenic mitogens and may contain regions of **increased vascular density** with finely branching capillaries that have a 'chicken wire' appearance.
- Up to 90% of oligodendrogliomas contain visible calcification on CT, which can be central, peripheral or ribbon-like.
- Meningioma is dural-based and appears hyperdense on NCCT.
- Craniopharyngioma is supra-stellar in location.
- GBM usually doesn't show calcification.

Q. A 70 year old hypertensive male presents complaining of a brief episode of slurred speech and left sided weakness previous evening. He gives a history of two transient episodes of sudden loss of vision in his right eye last month. His Neurological examination is normal now. What is most appropriate next diagnostic test?

A. CT Scan
B. DW-MRI
C. Cerebral Angiography
D. Carotid Doppler

Answer: D

Solution

- Symptoms of contralateral transient ischemic attacks and ipsilateral transient monocular blindness(Amaurosis fugax) suggest **extracranial internal carotid artery disease** and have high likelihood of developing strokes
- The Appropriate next step to confirm the suspicion of carotid stenosis **is Doppler ultrasound of carotid vessels** to look for atheromatous plaques and stenosis.
- Angiography is invasive, expensive, and carries a risk of causing stroke

15 ARTHRITIS

- Radiological hallmark of arthritis on X ray: Definite joint space reduction
- On MRI: Articular cartilage destruction is visible.

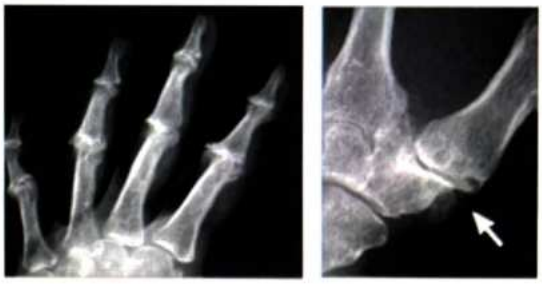
Osteoarthritis: Non inflammatory / degenerative arthritis

- An old person with chronic joint pain which resolves with rest.
- Asymmetrical Joint space narrowing (Medial joint space is affected more than the lateral joint space)
- Subchondral sclerosis
- Osteophytes (new bone formation)
- Subchondral cysts (Geodes)
- Older person
- Associated wear & tear
- H/O trauma / avascular necrosis of the joint
- Larger joints are more commonly involved (e.g. Hip joint / knee joint)

Hip radiograph

- Lateral space of hip joint is more commonly involved
- Osteophytes
- Subchondral sclerosis

Erosive osteoarthritis of hand



- Erosive variant of osteoarthritis
- PIP and DIP joints are involved
- Central erosions
- Gullwing appearance / sea gull sign.
- 1st carpo-metacarpo joint (DIP + PIP) is most commonly involved in osteoarthritis of hand

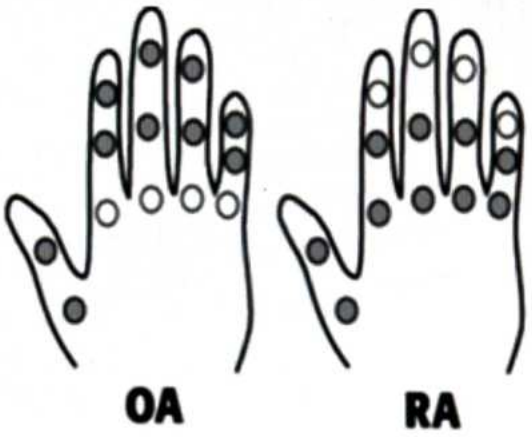
INFLAMMATORY ARTHRITIS: RHEUMATOID ARTHRITIS

- Diffuse involvement of wrist joint
- Younger female (~30-35 yrs old) complains of bilaterally symmetrical small joint (wrist joint) involvement with inflammatory kind of pain (pain happens with rest for long time) (has morning stiffness & pain gets better with activity)

Features

1. Symmetrical joint space narrowing (bilateral symmetrically is commonly seen)
2. Periarticular osteopenia
3. Marginal erosions are +nt

- MC joint involved in rheumatoid arthritis is metacarpophalangeal joint
- Joint typically spared in rheumatoid arthritis is distal interphalangeal joint
- Ball catcher's view (Bewerton's view) for Rheumatoid arthritis (for looking up metacarpophalangeal joint involvement)



OA	RA
• Typical involvement of DIP + PIP	• Typical DIP sparing
• M/C joint involved: 1st carpo metacarpo joint	• M/C joint involvement: metacarpo phalangeal joint
• Central erosions are ⊕ nt in erosive form of OA	• Marginal erosions

Jaccoud 's arthropathy

- Non erosive arthritis with deformity (deforming non erosive arthropathy)
- A/w SLE

Psoriatic arthritis 00:14:06

- PIP and DIP joints are predominantly involved.
- M/C joint involved: DIP joint
- M/C type: Oligoarthritis
- History
  - Skin involvement (associated skin lesions with silvery plaques/ scales)
  - Nails involvement (pitting, oil droplets)
- Gross destruction is ⊕nt

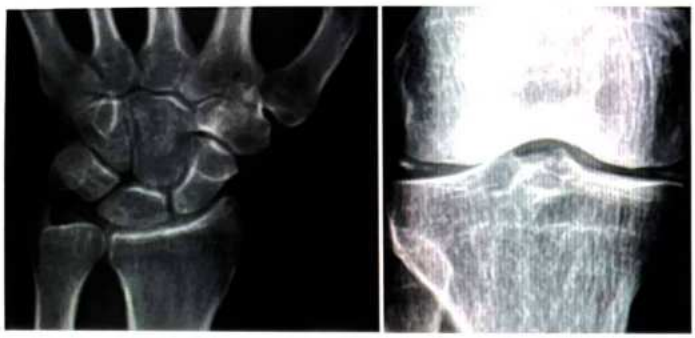
Radiological findings:

- Arthritis mutilans
- Pencil-in-cup appearance
- Telescoping of bones into one another
- Opera hand deformity
- Clinically → "Sausage digits" appearance

GOUT 00:16:00

- An older male (40s – 50s) after binge drinking episode comes with: Acute monoarticular pain
- M/C joint involved in gout: 1st metatarsophalangeal joint
- Rat-bite erosions (erosions with overhanging margins)
- Martel G sign
- Synovial aspiration → Monosodium urate crystals: needle shaped: show negative birefringence on polarising microscopy
- **Dual energy CT works** on the principle of material decomposition
- Dual energy CT shows Monosodium urate crystals deposition in the subcutaneous space as well as joint space

Pseudogout 00:19:49



- CPPD [Calcium pyrophosphate dihydrate] crystals are depositied
- Long standing history (unlike gout → acute monoarthritis)
- Risk factors a/w pseudo gout:
  - Hypothyroidism
  - Hyperparathyroidism
  - Hemochromatosis
- Joints commonly affected
  - Knee
  - Wrist
- Radiological Hallmark: Chondrocalcinosis
- X ray shows TFCC (triangular fibro cartilage complex) ligament calcification and Meniscal calcification
- CPPD Crystals are Rhomboid shaped and weakly positive birifringent on polarising microscopy

Neuropathic/Charcot joint 00:22:23

- Patient with H/O long standing diabetes mellitus /leprosy/ syrinx in the spinal cord / spinal cord damage
- Gross joint destruction present
- M/C cause: DM
- M/C joint affected: Ankle / midfoot joints

6Ds associated with Charcot joint

- **D - D**istension
- **D - D**ensity ↑ses
- **D - D**ebris
- **D - D**islocation
- **D - D**isorganisation
- **D - D**estruction

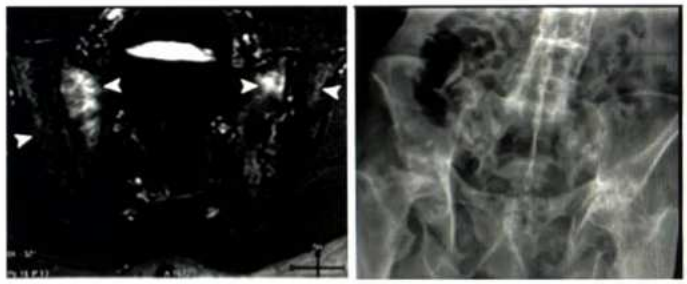
Hemophilic arthopathy 00:26:12

- A young boy has recurrent swelling in his knee most commonly & comes with other pseudo tumors/swellings in the muscle
- X-linked recessive condition
- M/C joint affected: Knee
  - Widened intercondylar notch
  - Squaring of patella
  - Epiphyseal enlargement

Important Information

- Epiphyseal enlargement D/D: Hemophilic arthropathy and Juvenile idiopathic arthritis
- Epiphyseal dysgenesis: Congenital Hypothyroidism

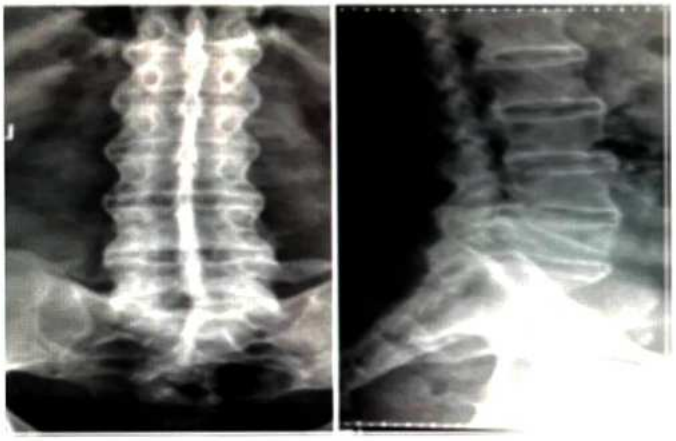
ANKYLOSING SPONDYLITIS 00:28:18



- A young male presenting with low back ache which resolves with activity
- 1st joint to be affected: Sacroiliac joint
- Typical HLA marker: HLA B27
- Sacroilitis
  - Bone marrow edema around sacroiliac joints
- Most sensitive Ix to detect early sacroilitis / IOC: MRI → STIR sequence involves suppression of fat

- Sacroiliac joint fusion → Oblique sacroiliac joint X ray (better)

- **Enthesopathy** (insertion site of ligaments & tendons becomes inflammed)
- Hallmark of Ankylosing spondylitis (and other spondyloarthropathies)
- Shiny corner sign
  - Reactive sclerosis of bones at the insertion site
  - Earliest finding on X-ray to suggest spine involvement



- **Syndesmophytes** are the vertical projections which cause pan joint fusion
- Ligament calcification: Dagger sign
- Tram track sign (complete fusion)
- Bamboo sign (spine becomes completely fused)

Important Information

Tram track sign / appearance
- On skull radiograph : Sturge weber syndrome
- Around optic nerve : Optic nerve meningioma
- HRCT chest: Bronchiectasis
- Ankylosing spondylitis
- Membranous proliferative glomerulonephropathy
- Hemophilus Ducryi

Complications associated with Ankylosing spondylitis
1. Anderson lesion (inflammation → spondylodiskitis)
2. Carrot stick fracture (any trivial trauma can cause)

- DISH (Diffuse idiopathic skeletal hyperostosis)
- Candle wax dripping appearance

- Ankylosing spondylitis
- Bamboo spine

- A 55-year-old gentleman with mild neck pain
- DISH is also k/a Forrestier's disease.
- In DISH, ossification is along anterior longitudinal ligament
- Joint space is normal (no joint fusion)

Dish
- Ossification is along anterior longitudinal ligament

OPll / Japan's Disease
- Ossification along posterior longitudinal ligament
- More significant clinically (can result in spinal cord compression)

CLINICAL QUESTIONS

Q. A one year old child presented with multiple fractures seen in various stages of healing. The most probable diagnosis in this case is?

A. Scurvy
B. Rickets
C. Battered baby syndrome
D. Sickle cell disease

Answer: C

Solution

Battered baby syndrome

Caffey (1946) described a syndrome of SDH, associated with multiple fractures of long bones, and often in various stages of repair, now known as battered infant.

Radiographic findings of Battered baby syndrome:

1. Fracture in different stages of healing.
2. Periosteal reaction (particularly in bones of distal forearm or leg).
3. Multiple growth recovery lines.
4. Injury of skull and ribs.
5. Fractures at unusual sites.
6. Epiphyseal separations and metaphyseal infarctions.

Q. A 40 year old man presented with acute onset severe pain in his right big toe, which was accompanied by inflammation and erythema of the joints .On X-ray ,Rat Bite Erosions with over hanging edges are seen.Most likely cause

A. Rheumatoid arthritis
B. Gouty Arthritis
C. Osteoarthritis
D. Ankylosing Spondylitis

Answer: B

Solution

- Rate Bite Erosions with over hanging edges(Martels sign) is feature of Gouty Arthritis

Radiographs in Gout:

- Marginal erosion with overhanging edge
- "Rat bite"

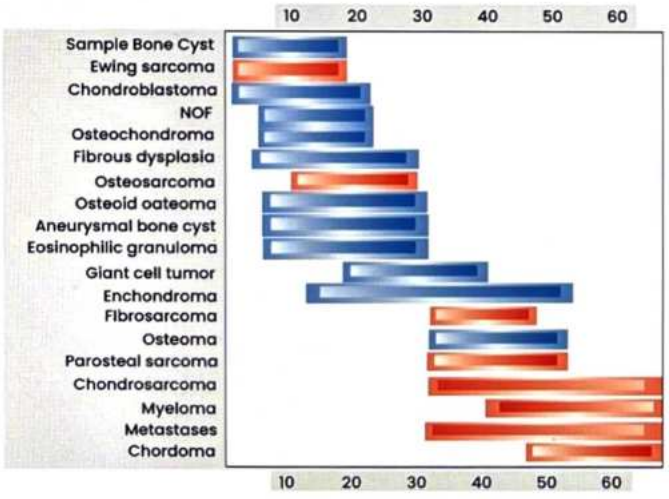
16 BONE TUMORS

- The first investigation to be done for evaluation of any orthopedic complaint on musculoskeletal related problems: X-ray
- Best investigation for delineating the extent of tumor: MRI
  Exception: Osteoid Osteoma: Best investigation: CT > MRI
- Gold Standard investigation for diagnosis of any tumor: Biopsy

Approach: Following are the parameters assessed for approaching to diagnosis of lesion on X-ray:

- Age of the patient
- Location of tumor
  - Type of bone affected (Long/flat)
  - Location within the bone (Epiphysis/ Metaphysis/ Diaphysis)
  - Location in a transverse axis (centric vs eccentric)
- Other supplementary parameters (to decide whether it is benign / malignant lesion):
  - Pattern of cortical (bony) destruction
  - Periosteal reaction
- To find out tissue of origin of tumor, parameter useful is:
  - Matrix mineralization

Age of the patient 00:05:06

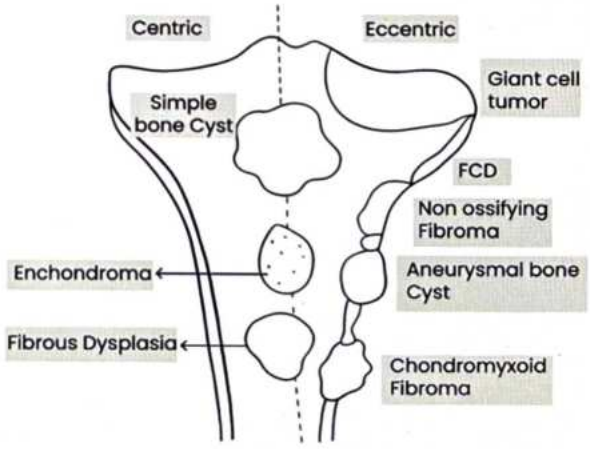


- Secondary osteosarcoma also seen in old age.
- **Cystic lesions in metaphysis:**
  - Simple bone cyst: More common in 1st decade
  - Aneurysmal bone cyst: More common in 2nd decade
- **Malignant tumors in children:**
  - Ewing Sarcoma (Epiphyseal tumor): More common in 1st- 2nd decade
  - Osteosarcoma (Metaphyseal tumor) More common in 2nd decade
- **Epiphyseal tumors:**
  - Chondroblastoma: More common in 1st-2nd decade
  - Giant cell tumor: More common in 3rd– 4th decade

Location of tumor

- Epiphyseal tumors: (ECG)
  - **E** – **E**piphyseal tumors
  - **C** – **C**hondroblastoma (0-20 yrs)
  - **G** – **G**iant cell tumor (30-40 yrs
- Diaphyseal tumors (Vowels stick together)
  - Osteoid osteoma (Osteoid osteoma can be metaphyseal but more commonly it is diaphyseal)
  - Ewing sarcoma
  - Adamantinoma (tumor of tibia)

Location of tumor in a transverse axis (centric vs eccentric)



Centric tumors (SEF)

- S – Simple bone cyst
- E – Enchondroma (tumor of short bones of hands)
- F – Fibrous dysplasia

Eccentric Tumors

- Giant cell tumor
- Fibrous cortical defects
  - Both are Pseudotumors (These are the congential defects with improper ossification)
- Non ossifying fibroma
- Aneurysmal bone cyst
- Chondromyxoid fibroma

Matrix mineralization 00:11:50

Refer Table 16.1

Pattern of destruction 00:14:29

Refer Table 16.2

Periosteal reaction 00:16:31

Refer Table 16.3

EPIPHYSEAL TUMORS (ECG) 00:20:16

Chondroblastoma

- Child (growth plate is not fused)
- Ring & arc type calcification

Giant cell tumor

- 20-40 yrs (fused growth plate)
- Soap-bubble appearance (multiple trabeculations)
- Tumor grows from epiphysis into metaphysis
- Favoured site of GCT: distal end of radius

Previous Year's Questions

Q. A 35 year old male presents with swelling at the lower end of femur. What is the likely diagnosis? (NEET 2016)

A. Chondroblastoma
B. GCT
C. Osteoid Osteoma
D. Aneurysmal bone cyst

Explanation

- Tumor moving into metaphysis
- Age (35 yrs old patient)

DIAPHYSEAL TUMORS 00:23:23

"Vowels stick together"

- Osteoid Osteoma
- Ewing's sarcoma
- Adamantinoma

Ewing's sarcoma

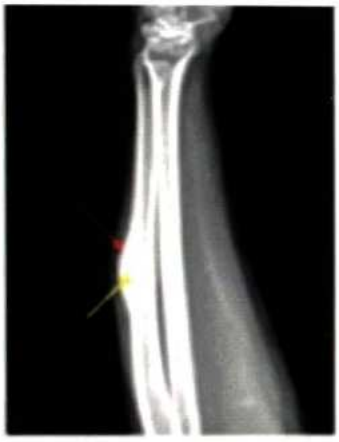
- A diaphyseal tumor with aggressive periosteal reaction in a child (0-10yrs)

Adamantinoma

- Diaphyseal tumor of tibia

> **Important Information**
>
> Following three lesions share same histopathological features
> - Adamantinoma
> - Ameloblastoma (seen in mandible)
> - Craniopharyngioma

Osteiod Osteoma



- H/O nocturnal bone pain
- The pain is relieved on taking NSAIDS
- Diaphyseal lesion
- Cortical based (eccentric)
- Nidus is present in the centre which releases Prostaglandins (responsible for pain)
- CT > MRI (Osteoid Osteoma is a cortical based tumor so cortical thickening is present & for evaluating any cortical pathology CT is perferred)
- Nidus is typical pathognomomic (hallmark) feature of Osteoid Osteoma
- Treatment of Choice:
  - CT guided radiofrequency ablation

METAPHYSEAL TUMORS

00:29:13

Simple bone cyst

A very well defined homogenous geographic lytic lesion in the metaphysis of a child

- Location: Proximal humerus
- 0-10 yrs (epiphysis is not fused)
- Metaphyseal lesion
- Benign lesion (Geographic type of destruction, No periosteal reaction)
- Fallen fragment / leaf sign (fracture has occurred) (cortical discontinuity)

Aneurysmal bone cyst

- 10-20 yrs
- Soap bubble appearance seen in the metaphysis

Simple bone cyst	Aneurysmal bone cyst
• 0-10 yrs	• 10-20 yrs
• Location: Central	• Location: Eccentric
• Homogenous appearance	• Soap bubble appearance

Osteochondroma (Exostosis)

- Growing away from the growth plate
- Has bony component as well as cartilaginous component (osteosarcoma + chondrosarcoma)
- Investigation of choice to evaluate cartilage cap = MRI(cartilage is not seen on X-ray / CT)
- It has a risk of chondrosarcoma (1% risk in overall population)
- Hereditary Multiple exostosis (HME) or Diaphyseal aclasis has higher risk of malignancy (5-20%)
- Cutoff to rule out chondrosarcoma: Thickness of cartilage cap if 1.5 cm / > 2cm, Likely to become malignant
- If exostosis grows after skeletal maturity → indicates malignancy (chondrosarcoma)
- Sudden ↑se of lot of pain → chondrosarcoma (bursitis needs to be ruled out)

Osteosarcoma

- Location: Metaphysis
- Aggressive
- Permeative pattern of destruction
- Codman's triangle (periosteal reaction) + sunburst reaction
- Ivory kind of matrix
- 0-20 yrs (more in 2 decade)

- MRI with blood fluid horizontal levels are present (indicates haemorrhage of various age inside tumors)

Differentials

- Giant cell tumors
- Aneurysmal bone cyst
- Telengiectatic Osteosarcoma
- Hemarrhagic metastasis
  - Follicular Ca thyroid
  - Renal cell carcinoma (clear cell carcinoma)

Enchondroma 00:39:05

- Short tubular bones of hand
- Calcification: Chondroid/ cartilaginous type of matrix
- Central location
- They have malignant potential (can rarely turn into chondrosarcoma)

Multiple enchondromas

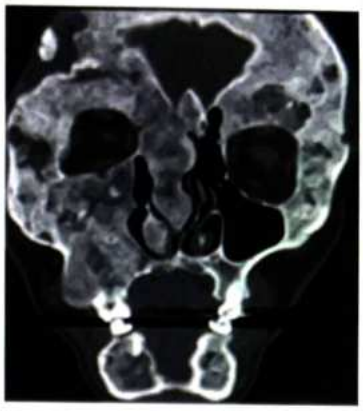
- Only: Ollier's syndrome
- With Hemangiomas: Maffucci syndrome

Fibrous Dysplasia

- Meta-diaphyseal lesion in the neck of the femur
- Ground glass matrix
- Central
- Shepherd crook deformity
- Rind sign (well defined sclerotic ring around the tumor)

Polystotic fibrous dysplasia

- Precocious puberty, endocrinopathies, Café-au Lait macules (CALM) MC cune Albright syndrome
- Myxomas (soft tissue myxomas) Mazzabraud syndrome



- Craniofacial polystotic fibrous dysplasia

Previous Year's Questions

Q. A 12 year old presents to you with this facial appearance. X-ray of the lower limb shows multiple such lesions. What is the diagnosis?
(NEET 2016)

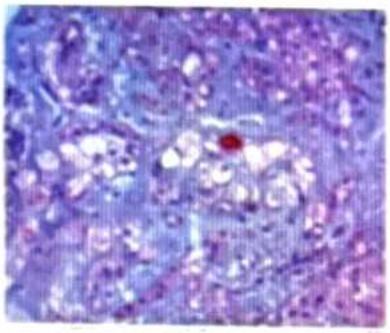
A. Tuberous sclerosis
B. VHL
C. NF1
D. NF2

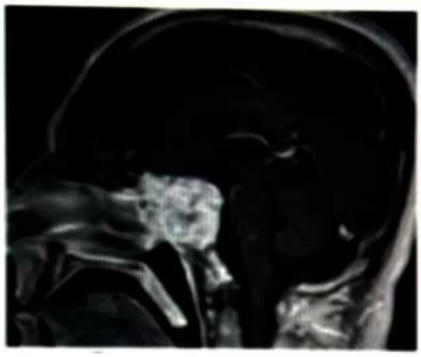
Explanation

- Plexiform neurofibroma
- X ray shows Geographical, Eccentric (Cortical based) lesion.
- Multiple NOFs (Non ossifying fibromas)
- Soap bubble appearance
- Typical location: distal end of tibia
- Do not touch lesions (no treatment required)

CHORDOMAS

00:46:03





- Arises from notochordal remnants
- Always occurs in the midline
- M/C site: Sacro-coccygeal
  - 2nd M/C site: Clivus (base of skull)
- Physaliferous cells on histopathology
- T2 Hyperintense: Soap bubble appearance on MRI

Intraosseous Lipoma

- Geographic lytic lesion of calcaneum with central calcification

INTRAOSSEOUS HEMANGIOMA

00:47:59

- M/C benign lesion of the spine

Refer Table 16.4

Multiple lesions (multifocal lytic lesions of bone)

- Metastases (more common in elderly age group)
- Multiple myeloma (elderly patient with hypercalcemia, renal, failure, anemia, bony lesions)
- Enchondroma (multiple hand bony lesions)
  - Ollier
  - Mafucci
- Osteochondroma (Multiple bony outgrowths)
  - Hereditary multiple exotosis or diaphyseal aclasis
- Fibrous Dysplasia
  - Mccune Albright (Precocious puberty, endocrinopathies, CALM)
  - Mazabrauds (multiple myxomas)
- Fibrous cortical defect / non-ossifying fibromas (NoF): NF-1
- Brown tumors (pseudotumor) (Hyperparathyroidism)
- Langerhans cell histiocytosis (LCH): Multifocal systemic lesions with multiple lytic lesions

Table 16.1

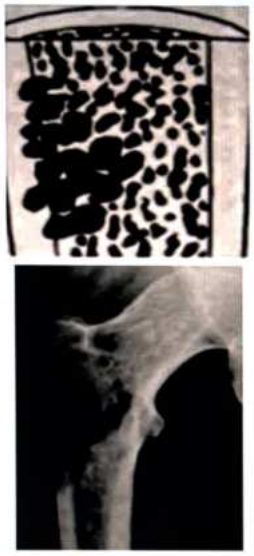
- Ivory like matrix
- Osteoid origin

- "Ring and arc" like matrix
- Chondroid origin

- "Ground glass matrix
- Fibrous dysplasia

Table 16.2

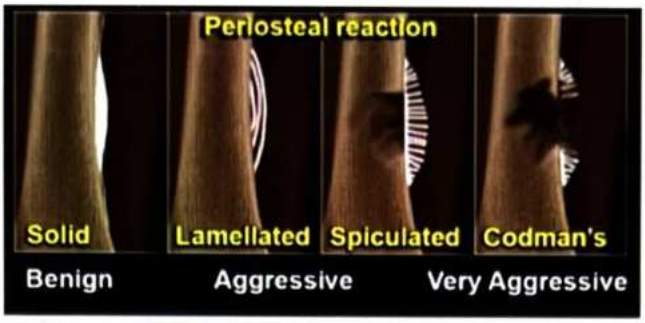
- Geographical type
- Well defined lytic lesion
- More likely to be benign lesion (not very aggressive tumor)



- Moth eaten type
- Property of aggressive bone tumors

- Permeative type
- Aggressive bone tumors

Table 16.3



Solid
- Osteoid osteoma
- Inflammatory pathologies

Lamellated (Onion peel reaction)
- Ewing's sarcoma

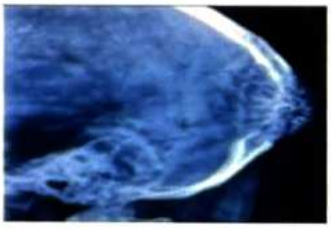
Spiculated (sunburst rxn)
- Osteosarcoma

Codman's triangle
- Osteosarcoma

Table 16.4

- Jailbar/ Coudroy cloth appearance (vertical trabeculations)

- Polka dot appearance



- Hemangioma of calvarium of skull
- Focal hair on end appearance of skull

CLINICAL QUESTIONS

Q. 16 yr old, obese female presented with history of bilateral hip pain from a long duration. Endocrinology tests show hypothyroidism. She has a painful limping gait. Which of the following investigation is of no use in diagnosis of this condition?

A. X-Ray
B. MRI
C. CT
D. USG

Answer: D

Solution

- History given is suggestive of SCFE (Slipped capital femoral epiphysis).
- X-Ray showsà Trethowan's sign
- CT is used for Acute/Chronic slip
- MRI is IOC.
- USG has no role in diagnosing this condition.

17 MUSCULOSKELETAL RADIOLOGY

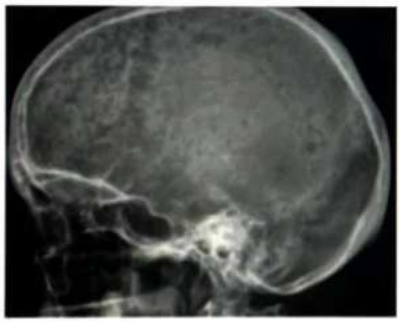
METABOLIC AND ENDOCRINE BONE DISEASES

Primary hyperparathyroidism

- 35 year old female presents to you with colicky pain abdomen
- Low feeling with loss of energy & reduced sleep since few months
- Calcium: raised, phosphate – low & PTH – raised
- A diagnosis of primary hyperparathyroisim is made.
- Next investigation: Sestamibi scan + Skeletal survey
- Best Ix / IOC to localize PTH adenoma → Sestamibi scan (nuclear medicine scan)

Secondary Hyperparathyroidism (Renal osteodystrophy)

- Secondary to CKD
  - ↑PO4 (Kidney not able to filter phosphate)
  - ↓ Ca (Kidney is unable to produce 1alpha hydroxylase)
  - ↑PTH (d/t hypocalcemia, 2° PTH ↑se)
- Common Radiological findings of both primary hyperparathyroidism and secondary hyperparathyroidism



- Subperiosteal bony resorption (in the proximal & middle phalanges of 2nd & 3rd fingers)
- Salt and pepper skull appearance (Multifocal trabecular resorption)
- Subligamentous resorption
- Intracortical resorption
- Loss of lamina dura

Loss of lamina dura

Lamina Dura (normal)

Brown Tumor (Osteitis Fibrosa Cystica)

- Hemosiderin Deposition
- Bony lysis d/t raised PTH
- Multifocal, multiple lytic lesions with soap bubble appearance variably located in epimetaphyseal region

	Primary Hyper-parathyroidism	Secondary HPT
• Etiology	PTH adenoma (Ca↑, PO 4↓,PTH↑)	Secondary to CKD (Ca ↑/ normal, PO4↑, PTH ↑)
• Bone density	Low	Low + High (mixed pattern → Lysis + sclerosis)
• Brown Tumors	↑↑ (incidence)	-
• Chondrocalcinosis	↑	-
• Soft tissue, vascular calcification	-	↑

- Rugger jersey spine
- Pathognomonic of Secondary hyperparathyroidism (Sclerosis + reduced bone density)

- Chondrocalcinosis (triangular calcification)
- Calcification of menisci

Important Information

Chondrocalcinosis
1. I° Hyperparathyroidism
2. Pseudogout (calcium pyrophosphate deposition)

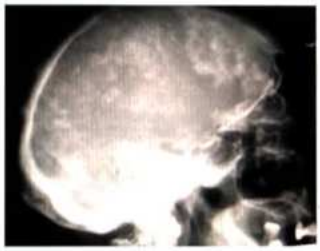
- **Osteopetrosis**
- Bone within bone appearance
- Sandwich vertebrate
- A child with diffusely increased bone density
- Hepatosplenomegaly
- Pancytopenia

- Secondary hyperparathyroidism
- Rugger jersey spine

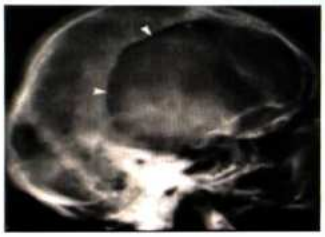
- Multiple calcifications in the basal ganglia/ subcortical white matter
- D/d
  1. Pseudo hypoparathyroidism
  2. Hypoparathyroidism
  3. Fahr syndrome
  4. Cochayne syndrome
  5. Hyperparathyroidism
- Basal ganglia calcification is normally seen in elderly (at times)

Paget's disease 00:14:28

- 75 year old male with dull aching pain with difficulty hearing on both sides
- Serum calcium, phosphate & PTH normal
- Serum ALP raised
- ↑se in Hat size
- Disease of elderly
- M/C bone to be involved in Paget's disease → Pelvis
- Various phases are present
  - Sclerotic
  - Lytic
  - Mixed



- Cotton wool skull appearance



- Osteoporosis Circumscripta (Predominant lytic phase)

- Blade of grass sign or Flame shaped appearance

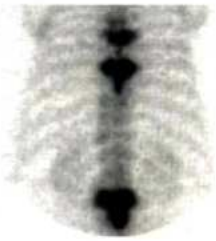
- Picture frame vertebra (mixed phase)

Ivory vertebra

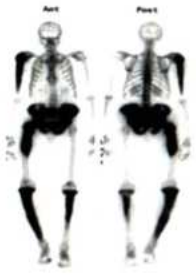
- Complete vertebra is sclerotic
- Ivory vertebra is seen in:
  - Paget's disease
  - Sclerotic / blastic metastasis (Prostate Ca, Breast Ca)
  - Hodgkin's Lymphoma
  - End stage of tuberculosis

Bone scan appearances 00:18:00

- Bone scan: T 99M – MDP c



Mickey mouse sign



Banana sign/#

Lincoln sign

Acromegaly 00:20:06

- Spade Phalanx (overgrowing bone)

- Increased Heel pad thickness
- >23 mm: Females
- >25 mm: Males

- Prognathism
- Sinuses expanded
- Calvarial thickening

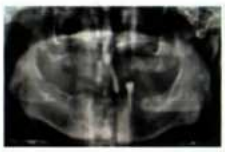
- Acromegaly (GH overproduction): Most likely d/t pituitary adenoma

Langerhan cell histiocytosis (Handschuller Christian disease) 00:22:14

- 1.5year old male child with polyuria & polydipsia with proptosis
- Triad of Diabetes insipidus, Proptosis and Calvarial lesion
- There can be Multifocal bone involvement + Hepatosplenomegaly + Skin involvement
- M/C cause of vertebra plana in children
- Vertebra plana is not a specific feature of LCH. It can be seen in conditions like leukemia, lymphoma, Ewing sarcoma. (any destructive lytic lesion of bone → vertebra plana)

Geographical lytic

Vertebra plana



Floating teeth sign

Previous Year's Questions

Q. All of the following are the causes of vertebra plana except? (PGI 2018)

A. Eosinophilic granuloma
B. Leukemia
C. Trauma
D. Lytic metastases
E. Osteosarcoma

Explanation

- Eosinophilic granuloma: Type of LCH with solitary involvement

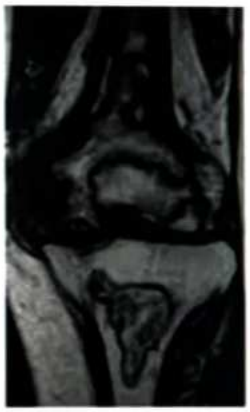
LCH is of 3 main types

1. Eosinophilic granuloma (solitary type)
2. Handschuller Christian histiocytosis
3. Letterer Sieve disease (multisystemic LCH)

- Osteosarcoma causes sclerosis.

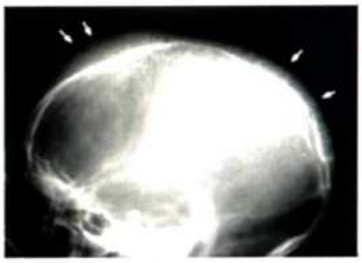
Sickle cell anemia 00:26:34

H-shaped vertebra (also seen in Thanatophoric dysplasia)



MRI shows bone infarcts (serpiginous lesions) (double rim sign)

- Outer rim → Sclerosis
  Inner rim → Granulation tissue



Hair on end appearance

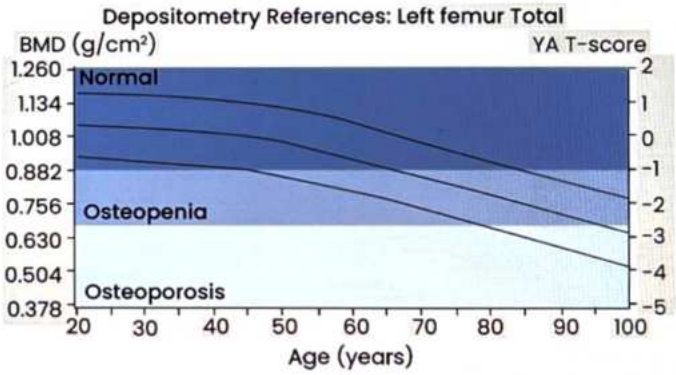
- Sickle cell anemia
- Thallesemia

OSTEOPOROSIS 00:29:09

Codfish appearance

Compression fracture

- Generalised reduction in bone mineral density
- IOC for osteoporosis: DEXA SCAN(Dual energy X-ray absorptiometry)



DEXA SCAN

- Used to determine actual bone mineral density
- Bone mineral density is represented by:

T-score	Z-score
• BMD of a patient is compared with a young adult	• BMD of a patient is compared with age matched adult

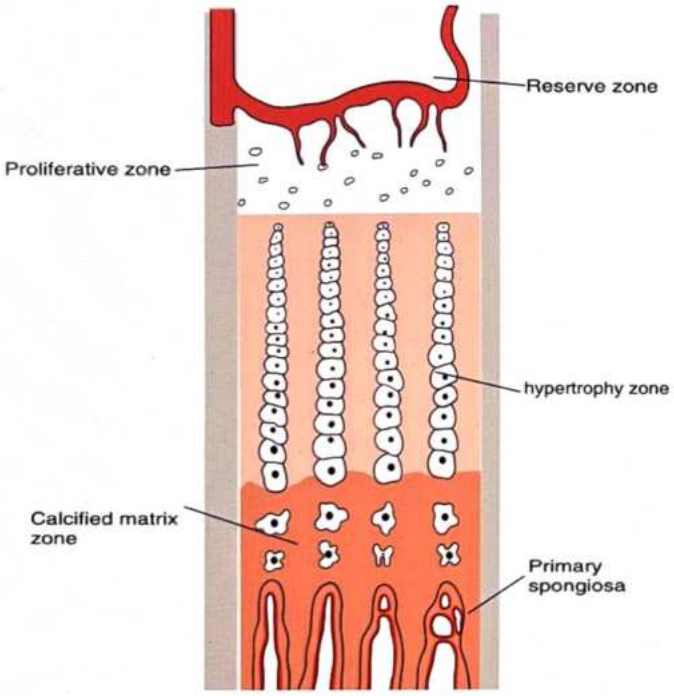
- WHO scoring uses T-score for Osteoporosis
- According to WHO:

- -1 to -2.5 SD → Osteopenia
- < - 2.5 SD → Osteoporosis

- Common areas for measuring bone mineral density includes femur, Lumbar spine
- Quantitative CT, Quantitative USG are recent advances used to diagnose osteoporosis.
- Biochemical profile in osteoporosis: Ca, PO4, PTH, ALP: Normal

RICKETS

00:34:07



- ↑ sed accumulation of unmineralised osteoid causes widening of growth plate (earliest effect) (unmineralised zone of provisional calcification)
- Wrist radiograph shows
- Cuppling
- Splaying
- Fraying

} metaphysis → hallmark of rickets

Healing rickets

- Earliest change in healing rickets: white metaphyseal line upon Treatment

SCURVY

- Features common between Rickets & scurvy:
  - Bone density is low (d/t nutritional deficiency)
  - Rosary (widening of costo-costal junction)

- Radiological findings in scurvy:
  - White line of Frenkel (white metaphyseal line)
  - Wimberger sign (well defined epiphysis like a ring)
  - Trummer field zone (Lucent zone)
  - Pelkan spurs
- No collagen formation → No osteoid matrix formation (deficiency of Vit C)
- No collagen → bleeding manifestations
- Subperiosteal hemorrhage: Painful for child: therefore, scurvy also referred to as pseudo paralysis

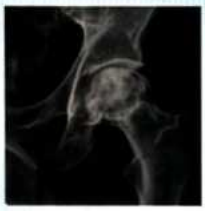
Osteomalacia

00:40:25

- Adult counterpart of Vit D deficiency
- Bone density ↓
- Pseudo fracture / Milkman fracture/ looser zone (area of unmineralised osteoid d/t vit D deficiency)
  - B/L symmetrical
  - Perpendicular to cortex
  - Limited to one side of cortex
- Favoured sites of Looser's zone:
  - Femur neck fracture
  - Public rami
  - Scapula

Avascular necrosis of hip 00:42:00

- A person with H/O insidious onset of hip pain with one of the risk factors as:
  - Chronic steroid Rx
  - Sickle cell anemia
  - Alcoholic
- Best Ix / IOC / most sensitive Ix for avascular necrosis → MRI (bone marrow edema)



X-rays

- Crescent sign

Bone scan

- Hot spots +nt
- Donut sign

MRI

10-2 o' clock position (in the superior part of femoral head in left femur)

- Double line sign

Right femoral head has started to collapse

FICAT & Arlet classification of AVN

Refer Table 17.1

SKELETAL DYSPLASIA 00:48:26

Achondroplasia

- Metaphysis is predominantly affected
- M/C skeletal dysplasia
- Mutation in FGFR3
- Rhizomelic shortening(Proximal bones are short)

Refer Table 17.2

Mucopolysacchridosis 00:52:20

- J-shaped Hella (not specific: can be seen in achondroplasia, glioma, osteogenesis imperfecta, can also be a normal variant)

- Inferior tapering of iliac blades wings
- Malformed acetabulum

- Oar shaped ribs (widened ribs)

- Bullet shaped metacarpals (proximal tapering)

- Predominantly skeletal manifestations are present in type IV MPS (Morquio MPS)

Morquio vs Herler: Beaking of vertebrae is present in both of them.

Morque: Central beaking

Herler: Antero-inferior beaking

OSTEOPETROSIS

00:55:49

- Defective acidification receptors of osteoclast
- Reduced remodelling of bone
- Hallmark: diffusely increased bony density
- Clinically child has:
  - Pancytopenia (bone marrow is obliterated)
  - Hepatosplenomegaly (extramedullary hemopoiesis)

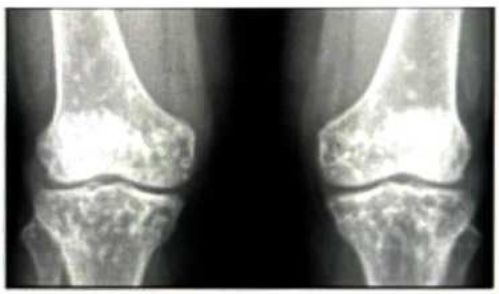
- Bone within bone appearance (sandwich vertebrae)

- Erlen Mayer flask deformity (non- specific) (all metaphyseal dysplasia including achondroplasia & lysosomal storage diseases can show this deformity)

- Bone within bone appearance

Sclerosing Dysplasia

00:58:41



- Osteopoikilosis

- Osteopathia striata

- Melorrheostosis "candle wax dripping"

Important Information

- Candle wax dripping is a/w:
  - DISH
  - Tuberous sclerosis
  - Melorrheostosis

Nail patella syndrome

- Iliac horns (Pathognomonic)
- Recurrent knee dislocation
- Recurrent elbow dislocation

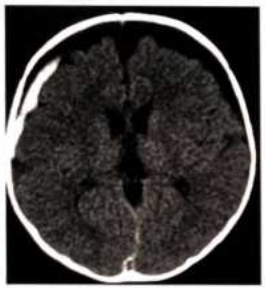
Radial Ray anomaly

- A/w
  - Fanconi anemia
  - Holt oram syndrome
  - VACTERL
  - Trisomy 18
  - Thrombocytopenia with absent radius (TAR syndrome)

CHONDRODYSPLASIA PUNCTATA

- Inheritable dysplastic condition
- Stippling of cartilage
- Associated with warfarin intake

Non accidental injury/ Battered baby syndrome 01:04:41



- B/L subdural collections
- Hemorrhage of different ages in the skull

- Metaphyseal corner fractures (bucket handle fractures)

- Fractures of different ages: Rib fractures (located in posterolateral aspect)
- Fundoscopic examination : Retinal hemorrhages

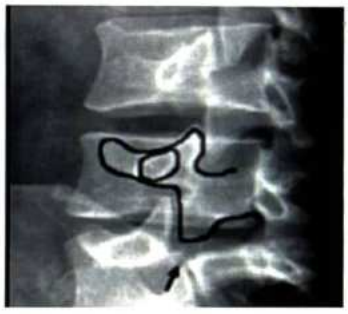
Osteogenesis imperfecta 01:06:36

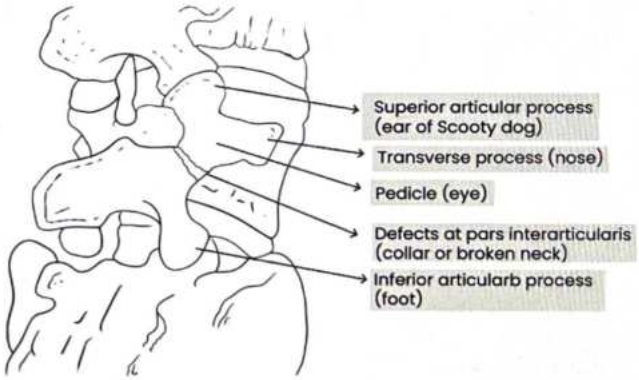
- Collagen – I abnormality (bones are weak)
- Fracture of different ages
- Bone density reduction
- Hearing loss/ dentigenous abnormalities/ blue sclera
- Multiple diaphyseal fractures + ↑↑sed callus formation
- Bent bones

- Popcorn sign (metaepiphyseal stippling)

- Zebra line a/w Rx of osteogenesis imperfecta by bisphosphonates

SPINE





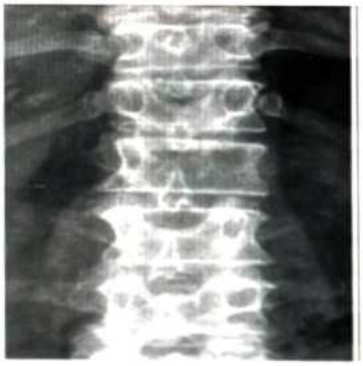
- Scotty dog appearance: Normal appearance when spine radiograph is taken in oblique view

Part of dog	Formed by
Eye	• Pedicle
Ear	• Superior articular process
Nose	• Transverse process
Foot	• Inferior articular process
Neck	• Pars interarticularis

- Pars interarticularis fracture: Spondylolysis: Collar formation on X ray
- IOC for spondylolysis: NCCT
- Spondylolisthesis: Forward movement of spine because of underlying spondylolysis
- Least sensitive X-ray for spine: AP view: Inverted Napolean hat sign (late, non specific sign)

- Spondylolysis

- Spondylolisthesis



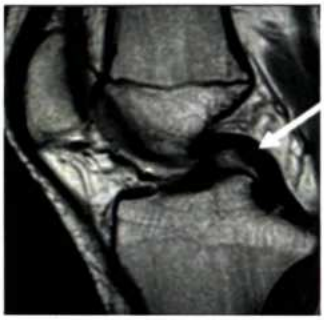
- Winking of owl sign: Lytic metastasis involving the pedicle of vertebra (posterior elements)

KNEE

01:14:18

- IOC for ligaments injuries: MRI
- Gold standard for ligaments: Arthroscopy
- Normal ACL & PCL: Sagittal MRIs of knee
- Ligaments appear hypointense on all sequences on MRI
- If the ligament appear hyperintense: there is tear in ligament.

Anterior cruciate ligament



Posterior cruciate ligament

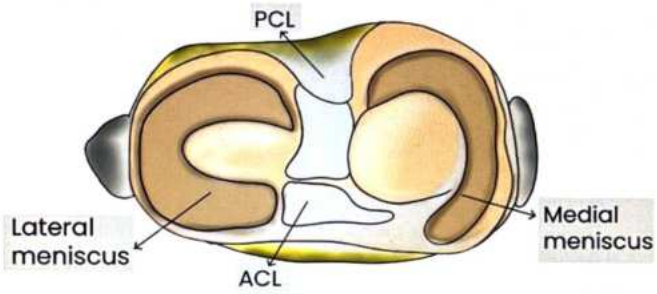
Anterior cruciate ligament (ACL) injury

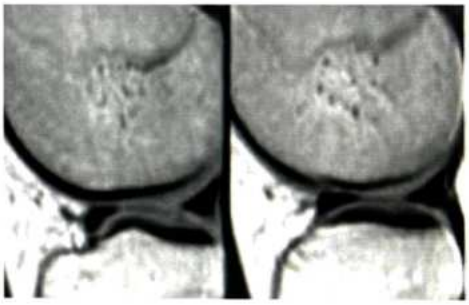
- Segond fracture → It is avulsion of lateral capsular ligament.
- It is associated with ACL injury

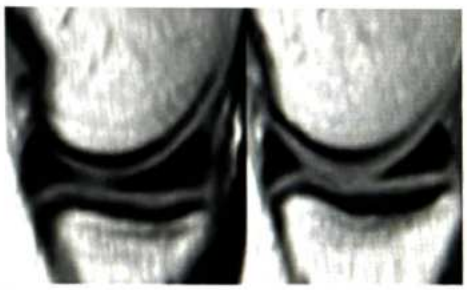
- ACL tear
- kissing contusions: edema in surrounding bones

ANATOMY OF MENISCUS

01:18:47







Lateral meniscus	Medial meniscus
• C – shaped	• Banana shaped
• Anterior & posterior horns are symmetrical	• Anterior horns are smaller than posterior horns

- Largest horns: Posterior horns of medial meniscus
- M/C injured horn: Posterior horns of medial meniscus (Firm attachment to joint capsule)

Osgood – Schladder disease

- Fragmentation of tibial epiphysis
- Adolescent
- Persistent pain & tenderness at tibial tuberosity

Table 17.1

	X RAY	MRI	BONE SCAN	CLINICAL SYMPTOMS
Stage 0	Normal	Normal	-	Nil
Stage I	normal or minor osteopenia	Oedema	increased uptake	pain typically in the groin
Stage II	mixed osteopenia &/or sclerosis	geographic defect	increased uptake	pain and stiffness
Stage III	crescent sign & eventual cortical collapse	same as X ray	pain and stiffness+/-	radiation to knee and limp
Stage IV	End stage with evidence of secondary degenerative change	same as X ray		pain and limp

Table 17.2

- Trident hand (wide separation between 3rd and 4th digits)

- Rhizomelic shortening
- Chevron sign (V-shaped metaphysis)

- Elephant ear/ tombstone iliac wings
- Champagne glass pelvis

- Inter pedicle distance reduces (as we go caudially)

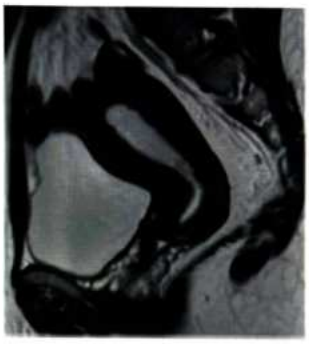
- Bullet shaped vertebrae (Posterior scalloping)

18 WOMEN'S IMAGING

NORMAL UTERUS ON TRANSVAGINAL USG

Refer Table 18.1

NORMAL UTERUS ON MRI



- T2 weighted sagittal view
- Normal Endometrium: T2 hyperintense
- Junctional Zone (Hypointense) (separates endometrium & myometrium)
- Thickening of junctional zone: Adenomyomatosis

Post menopausal female

- Normal endometrium thickness ≤ 4 mm
- If Endometrium thickness > 4 mm: Endometrial aspiration → 1st line sampling to rule out malignancy
- Patients on Tamoxifen: If endometrial thickness > 8 mm: Endometrial aspiration

Previous Year's Questions

Q. A 45 year old female presents with abnormal uterine bleeding. USG is shown here. What is the likely diagnosis? (NEET 2020)

A. Ovarian dermoid
B. Endometrial Hyperplasia
C. Endometrial Carcinoma
D. Endometrial polyp

Explanation

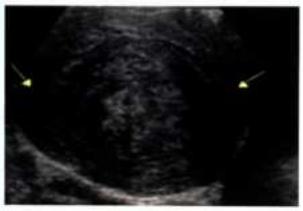
- Endometrial lesion with feeding vessel sign: Endometrial Polyp (focal pathology)
- Endometrial hyperplasia, endometrial Ca → Endometrial thickness ↑ (diffuse pathologies)

Endometrial Polyp

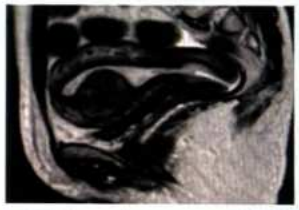
- Feeding vessel sign on Doppler

- Saline infusion Sonography helps in distinguishing focal vs diffuse mass

Fibroid



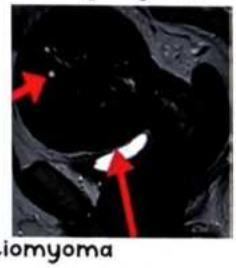
- Heterogenous + Areas of shadowing



- T2 hypointense + degeneration

Previous Year's Questions

Q. A 45 year old patient presented with complaints of chronic pelvic pain and menorrhagia. The MRI is shown here. What is the likely diagnosis? (NEET 2019)



A. Intramural leiomyoma
B. Adenomyosis
C. Pelvic inflammatory disease
D. Asherman syndrome

Explanation

- Intramural leiomyoma: Clinically, asymmetrically enlarged uterus
- Adenomyosis: Diffuse symmetrical enlargement of uterus
  - A/w tenderness & chronic pelvic pain
  - Thickening of junctional zone (T2 hyperintense foci): Salt & pepper appearance

PCOS

00:14:25

- Multiple peripheral follicles (String of pearls appearance)
  - 2-8 mm
  - 12 in no. (> 20)
- B/L ovaries: bulky volume > 10 cc
- Raised stromal volume & echogenicity (Most specific finding of PCOS)
- No dominant follicle

B/L ovaries enlarged, large follicles, no stromal volume ↑se

- Patient undergoing infertility treatment with IUI / IVF
- OHSS (Ovarian hyperstimulation syndrome)

Theca lutein cysts

- Uterine mass (patient has amenorhoea, Hyperemesis)
- Size of uterus > POG

- **Hydatidiform mole**: "Cluster of grapes"/ "Snowstorm appearances"
- Increased HCG leads to Theca lutein cyst formation.

BENIGN V/S MALIGNANT OVARIAN LESIONS ON RADIOLOGY

- IOTA "Simple" rules
- **Benign lesions**

Refer Table 18.2

- **Malignant lesions**

Refer Table 18.3

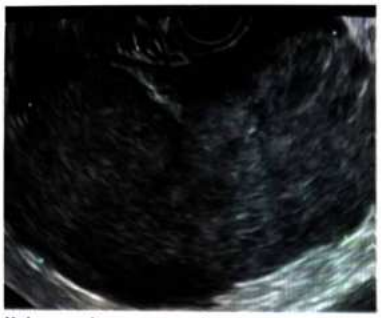
Hydrosalpinx

- Incomplete septation (tubular like morphology)
- Cogwheel sign / Waist Sign

Meig's Syndrome: Triad

Right pleural effusion

Ascites



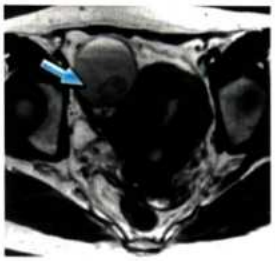
Solid ovarian mass in a young female

- Meig's syndrome is typically associated with fibroma /Thecoma / Fibrothecoma
- **Pseudo Meig's Syndrome:** A/w Fibroid of uterus / other lesions of ovary

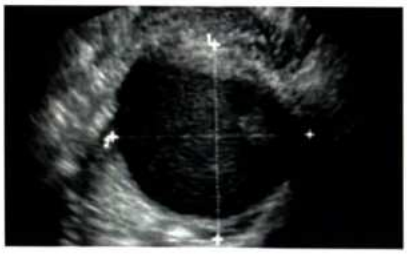
+

same findings of triad of Meig's syndrome

Endometrioma



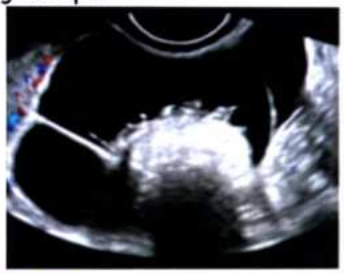
T2 Shading MRI



USG: Low level echoes

Previous Year's Questions

Q. All of the following signs are seen in the following pathology except? (NEET 2018)

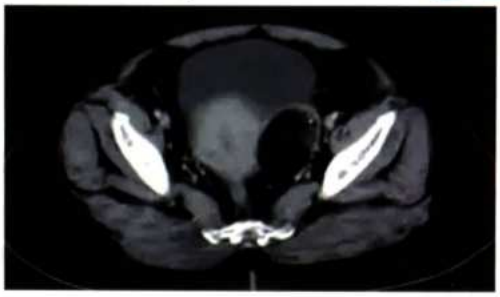


A. Ring of fire sign
B. Rokitansky nodule
C. Dot & dash sign
D. Tip of the iceberg sign

Explanation

- Anechoic cystic lesion/septations/ peripheral blood flow: Benign lesion
- Hyperechoic lesion producing hypoechoic shadow: Posterior acoustic shadowing
- Cyst with solid nodule producing posterior acoustic shadowing: **Teratoma / dermoid cyst**
- Ring of fire sign – associated with ectopic pregnancy (adenaxal cyst)

CT features of dermoid cyst: CECT axial 00:29:54



- Heterogenous mass containing Fat + Calcification + Soft tissue
- Rule out torsion (if such female comes with acute abdomen)
- Ovarian torsion: Arterial vascularity can be intact but venous vascularity goes off
- Ovarian torsion is a complication of ovarian cyst

OBSTETRIC IMAGING 00:31:00

Early pregnancy scans
- To confirm presence of intrauterine pregnancy
- To confirm No. of pregnancies
- To confirm the viability

- **NT-NB scan or level 1 scan** (Nuchal translucency -Nasal bone scan)

- **Level II scan or Anomaly scan** or TIFFA (Targetted imaging for fetal anomalies)

USG

- Transvaginal sonogram (TVS)
  - Gives higher resolution
  - Can detect all events by a lead period of one week
- Transabdominal sonogram (TAS)

EARLY PREGNANCY SCANS

Gestational Sac

- Anechoic cystic lesion
- Slightly eccentric location within the endometrial cavity: Intradecidual sign

- Double decidual sign
- Gestational Sac is the earliest finding of pregnancy
- Seen from 4 weeks+5 days POG (TVS)
- Measured by mean Sac diameter
- Gestational Sac increases by 1mm/day in early pregnancy

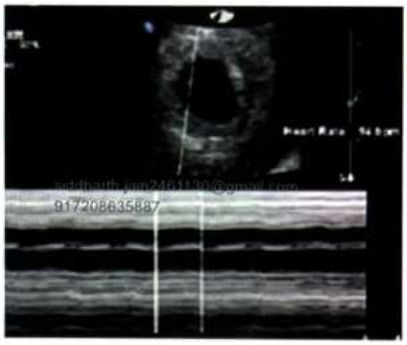
Yolk Sac

- 5-5.5 weeks POG (TVS)(yolk Sac develops within the gestational Sac)
- Sign of confirmation of intrauterine pregnancy: Visualization of yolk sac

Embryo / fetal pole

- 6-6.5 weeks (TVS)
- Should be seen if MSD of 25 mm
- Large gestational Sac (>25mm) with no embryo: it is a sign of early pregnancy failure (Blighted ovum)
- Crown Rump Length (CRL) → Most accurate measurement of POG

Fetal Heart rate



- M-Mode
- 6-6.5 weeks (TVS)
- Should be present when CRL is 7 mm

	TVS	TAS
Gestational Sac	4-4.5 weeks	5-5.5 weeks
Yolk Sac	5-5.5 weeks	6-6.5 weeks
Embryo	6-6.5 weeks	7-7.5 weeks
Fetal Cardiac activity	6-7 weeks	7-8 weeks

Previous Year's Questions

Q. All of the following are true about the parameter measured except? (NEET 2020)

A. Best parameter for gestational age
B. Measured upto 13+6 weeks
C. Measured with maximum neck extension
D. More than 7 mm without cardiac activity is suggestive of missed abortion

Explanation

- CRL is being measured.
- CRL is measured in 1 trimester
- Neck must be in neutral position (while measuring CRL)

Criteria for early intrauterine fetal demise

- CRL ≥7 mm with no heartbeat (missed abortion)
- MSD≥ 25mm with no embryo (blighted ovum)

POG in days = CRL +42 days

NT – NB SCAN (NUCHAL TRANSLUCENCY - NASAL BONE SCAN)

- Mid sagittal section
- Neck must be in neutral position
- Diencephalon and hard palate must be in the same plane
- Done at 11-13+6 weeks POG
- Specific CRL→ 45-84 mm CRL
- Nasal bone presence (equal to sign is present)
- Nuchal translucency > 3 mm is abnormal finding seen in
  - Aneuploidies
  - Congenital heart diseases
- Absent nasal bone seen in Aneuploidies.

- Nuchal translucency
- Nasal bone present (normal)

- Absent nasal bone(absent)
- ↑sed nuchal translucency(abnormal)

Nuchal fold thickness

- Thickness of the neck measured in 2nd trimester
- >6 mm nuchal fold thickness: Abnormal finding
- Most predictor soft marker of down syndrome: Nuchal fold thickness

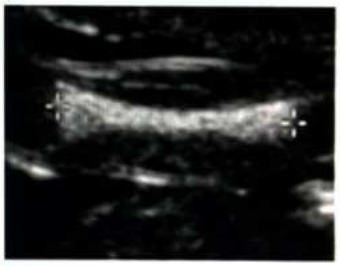
LEVEL – II SCAN

- 18-22 weeks scan
- Anomaly scan
- TIFFA: Targetted imaging for fetal anomalies

Fetal biometry

- Single best parameter for gestational age in 2nd trimester: Biparietal diameter (BPD)
- **Correct plane for measuring BPD**
  - Cavum septum pellucidum
  - Midline 3rd ventricle
  - Bilateral thalamie

  } must be visualised
  - Cerebellum should not be visualised



- Best parameter gestational age for 3rd trimester: Femur length
- Best parameter for fetal growth / IUGR / macrosomia: AC (Abdominal circumference)

- Correct plane for measuring abdominal circumference:
  - Stomach and Portal vein must be visualised
  - Kidneys and Umbilical cord attachment must not be visualised

Trans cerebellar diameter (TCD)

- At 19-22 weeks → TCD = POG

ACCURACY OF USG DATING

Trimester	Accuracy in weeks	Best parameter used
1st Trimester	+/- 0.5	CRL
2nd Trimester	+/- 1.5	BPD
3rd Trimester	+/- 3.5	FL

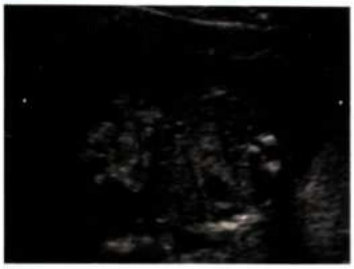
ANOMALIES

Anencephaly

- **Acrania:** Earliest anomaly to be picked up on USG

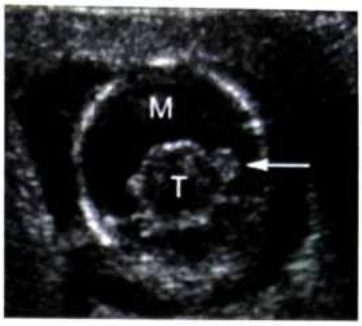
- Anencephaly
- Frog eye / Mickey mouse sign

Abdominal herniation defects



- Gastroschisis
- Bowel loops herniate outside the abdominal wall (free floating bowel loops)
- Umbilical attachment is lateral

- Omphalocele
- Bowel loops are enclosed within the membrane.
- Umbilical cord is attached to the dome of herniation
- More associated anomalies
- Solid organ (liver) herniation is associated with omphalocele



Holoprosencephaly

- Mono midline Ventricle + single fused thalamus
- A/w trisomy 13/ patau syndrome

Congenital diaphragmatic hernia (stomach herniates into thorax)

Thoracopagus (chest are fused)

- Spalding sign (overlapping fetal skull bones)
- Late sign of Intrauterine demise
- Robert sign: Air foci in the heart {also a/w intrauterine demise}

SOFT MARKERS OF DOWN'S SYNDROME

00:58:55

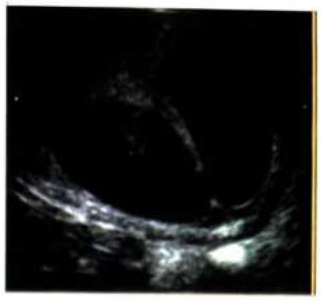
Marker	Risk of aneuploidy
• Increased nuchal fold thickness: >6 mm measured in 2nd trimester	• Likelihood ratio 18.6 times (average 2.5 %; changes with age)
• Nasal bone hypoplasia	• Increased 2.4 - fold with every 1-mm decrease in nasal bone length
• Mild ventriculomegaly (atrial thickness [illegible] mm)	• [illegible]%
• Echogenic bowel	• 1.4%
• Echogenic focus / foci in heart	• 1%
• Isolated choroid plexus cyst	• 0.36% (mother < 35 years) • 2.4% (mother > 35 years)
• Single umbilical artery	• < 1% if in isolation
• Short humerus / femur	• 0.3%
• Isolated renal pyelectasis (≥ 4 mm before 33 weeks/ ≥ 7 mm after 33 weeks)	• 0.33% (mother < 36 years) • 2.22% (mother > 36 years)

Findings of Down syndrome on antenatal scan

Double bubble sign
2° to duodenal atresia
(a/w Down syndrome)

Sandal gap

Types of twin



Dichorionic-diamniotic Twins
- Lambda sign / Twin peak sign
- Thickened membrane having both chorion and amnion

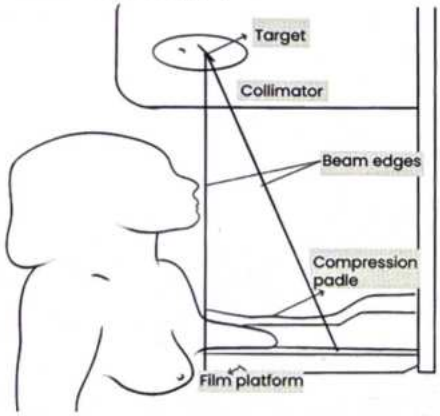
Monochorionicdiamniotic twins
- T sign
- Thin membrane having only amnion
- Chorion is shared

Monochorionic-Monoamniotic twins
- Shared chorion
- No amnion to separate them

BREAST IMAGING

01:03:21

Technique of Mammography



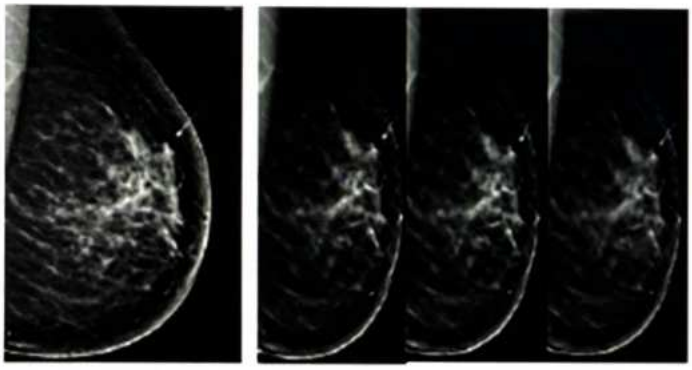
- Mammography is a low KVP radiography[20-30](to increase the contrast)(KVP α 1/contrast)
- High spatial resolution is required for mammography(to pick up microcalcifications)
  - Focal spot: Small
  - Compression paddles (to avoid geometric distortion)
- Target (anode): Made up of Mo (low KVP)
- Window: Made up of Be
- Filter: Made up of Molybdenum

Standard views in mammography

Craniocaudal view (CC)

Mediolateral oblique view(ML0)
- Pectoralis major seen

- DBT: Digital breast tomosynthesis: Helps in picking tiny spiculated masses
- CAD: Computer Aided detection



MLO DBT

Previous Year's Questions

Q. Which is the screening technique that has proven benefit in reducing mortality?
A. Pap smear
B. Colonoscopy
C. Mammography
D. PSA levels

American Cancer society Guidelines for breast cancer screening

Age	Clinical examination	Mammography
20-29	every 3 years	not recommended
40 and over	Annually	Annually

BIRADS

01:16:40

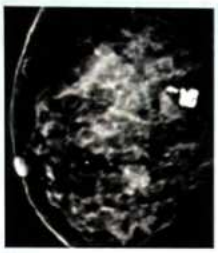
- Breast Imaging Reporting and Data system
- BIRADS can be assigned for USG, MRI & mammography.

BIRADS	Category	% risk of cancer	Further management
0	Incomplete	N/A	Complete study
1	Normal	0	Continue screening annual mammography
2	Benign	0	Continue screening annual mammography
3	Probably benign	0-2%	Follow up after 6 months
4	Suspicious for malignancy		
4a	Low suspicion	2-10%	Biopsy
4b	Moderate suspicion	10-50%	
4c	High suspicion	50-95%	

5	Highly suggestive of malignancy	>95% •Spiculated lesion •Micro-calcifications clustered	Biopsy
6	Known biopsy proven malignancy	N/A	According to plan

BENIGN BREAST LESIONS

01:23:06



Involuting fibroadenoma
- Popcorn calcification

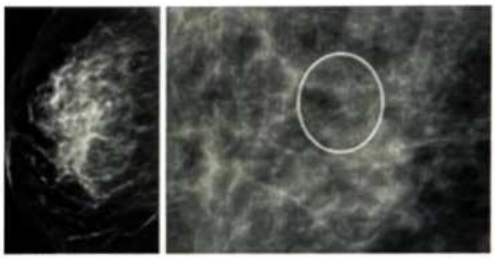
Breast hamartoma
- Breast with in breast appearance

Oil cyst
- Egg shell calcification

- Egg shell calcification in the lymph nodes: Sarcoidosis / Silicosis

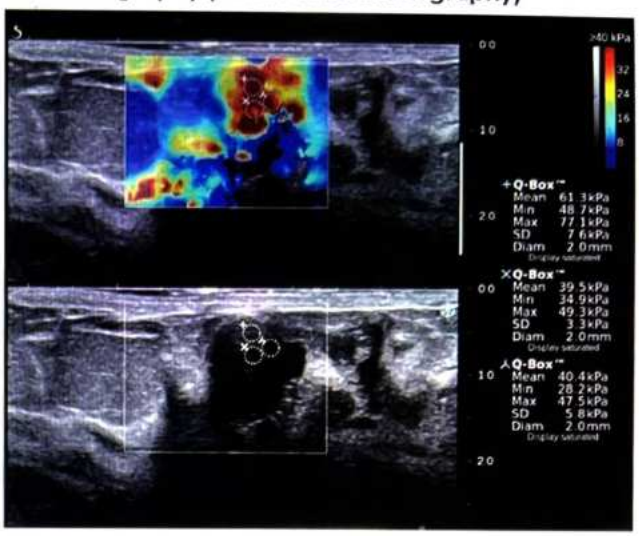
MALIGNANT FEATURES

Spiculated margins Malignancy (BIRADS-5)



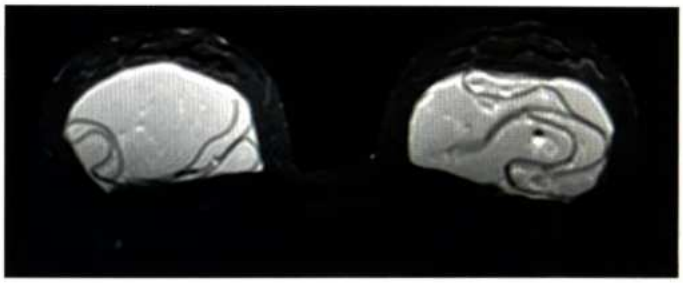
Tiny calcifications: Magnification view
Malignancy (BIRADS-5)

USG Elastography (Shear wave elastography)



- Helps in finding the hardness of the lesion
- Unit of elastography: Kilopascals

Breast MRI



- Breast MRI showing b/l bilateral implants.(T2 hyperintense)
- Linguine sign: Indicates intracapsular implant rupture
- Keyhole / tear drop sign (other name)
- IOC for breast implants imaging: MRI

Dynamic CE MRI

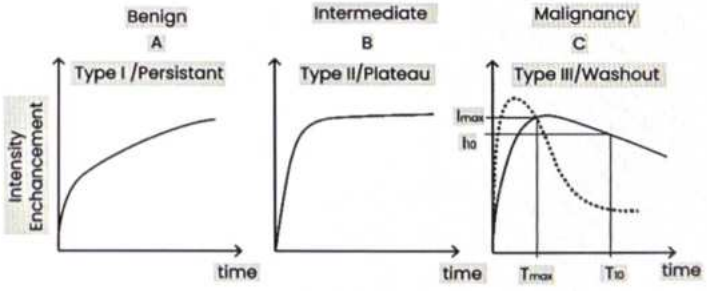


Table 18.1

Menstrual phase/Early proliferative phase

- Endometrial thickness ~ 3-6 mm

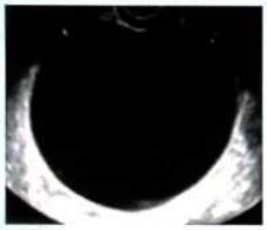
Late proliferativephase

- Trilaminar appearance
- Endometrial thickness ~ 7-11 mm

Secretory phase

- Endometrial thickness ~ 11-16 mm
- Anehoic lesions seen are Nabothian cysts

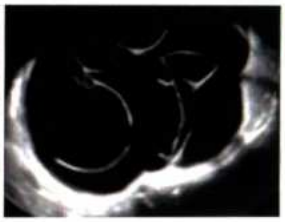
Table 18.2



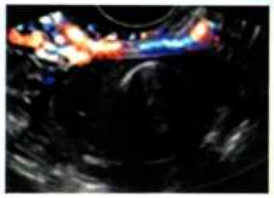
- Unilocular

- Solid components with diameter <7mm
- Echogenic foci in the wall: Endometrioma

- Acoustic shadow is seen in teratoma and is due to Rokitansky protuberance



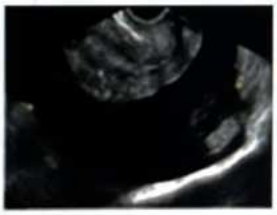
- Multiloculated lesions with largest diameter <10 cm



- Peripheral vascularity
- No internal vascularity

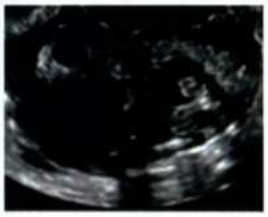
Table 18.3

- Irregular solid tumor

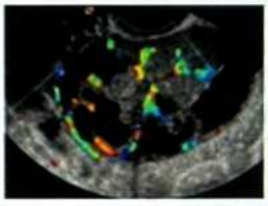


- Presence of ascites

- Solid papillary structures



- Multilocular solid tumor with diameter >10cm



- Internal vascularity

CLINICAL QUESTIONS

Q. A G1P0 woman comes to the gynaecology OPD for evaluation. An ultrasound examination is done which shows a characteristic " T Sign". Which among the following best explains the "T sign" in the ultrasound examination?

A. Diamniotic Monochorionic
B. Dichorionic Diamniotic
C. Monochorionic monoamniotic
D. Dichorionic Monoamniotic

Answer: A

Solution

The "T sign" and Twin-peak sign(or lambda (λ)sign) and is used in ultrasound assessment of multifetal pregnancy.
T sign refers to the thin intervening septa denoting a Monochorionic **pregnancy**.
Twin peak sign/Lambda sign denotes Dichorionic Diamniotic Twin Gestation

Q. A medical student is attending a lecture on "Antenatal Radiological Evaluation" by the Gynecology department head. He is asked a question by the doctor which he was not sure of the answer. He was asked the following question " By which week does the early diastolic notching of uterine artery disappears"?

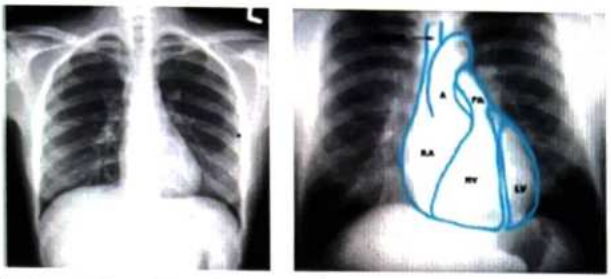
A. 20
B. 21
C. 22
D. 24

Answer: C

Solution

Diastolic Notching in uterine artery Doppler usually disappears beyond 22 weeks of gestation. Persistence of uterine notch beyond 22 weeks is indicator of preeclampsiA

19 CVS RADIOLOGY



Right heart border

- SVC: Forms the topmost part of the right heart border
- Right atrium: Forms the main portion of the right heart border
- IVC: Forms the minor part of the right heart border
- Right ventricle does not form the right heart border
- Right ventricle contributes to the base/ inferior boundary
- In the elderly population, because of the aortic unfolding (d/t loss of elastin), ascending aorta rarely can contribute to the right heart border formation.

Left heart border

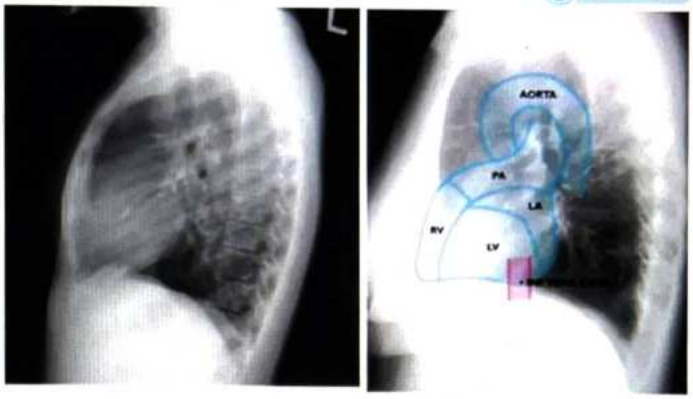
There are various projections (Moguls) ⊕nt on the left heart border.

- 1st mogul: Formed by the aortic knuckle (arch of aorta)
- 2nd mogul: Formed by the main pulmonary artery
  - In between the aortic knuckle and pulmonary artery, we have pulmonary window in which lies left recurrent laryngeal nerve and lymphatics.
  - In cases of lymph node enlargement of aorto-pulmonary window group of lymph nodes, patient can come with hoarseness of voice (d/t left recurrent laryngeal nerve compression.)
- 3rd mogul: Contributed by the left auricle (left atrial appendage)
- 4th mogul: Contributed by left ventricle (Main bulk)
- 5th mogul: Abnormal projection
  - d/t to mass arising in the left cardiophrenic angle (Most commonly the mass is pleuropericardial cyst)

Important Information

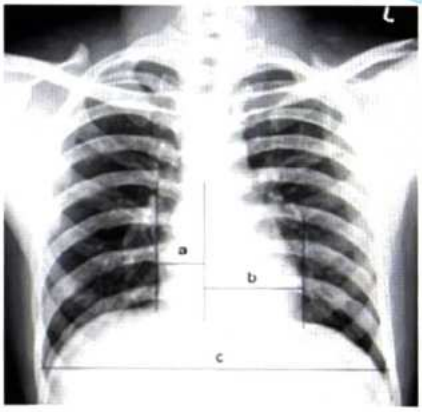
- Left atrium does not contribute to the formation of any heart border on the frontal projection
- Left atrium is located posteriorly. Therefore, to visualize the left atrium, transesophageal echocardiography is needed to be done

Lateral Chest X-rays 00:07:33



- Anteriormost heart chamber: Right ventricle
- Posteriormost heart chamber: Left atrium

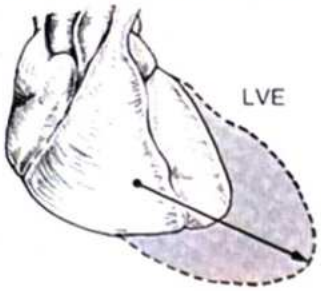
Cardiothoracic ratio 00:08:13

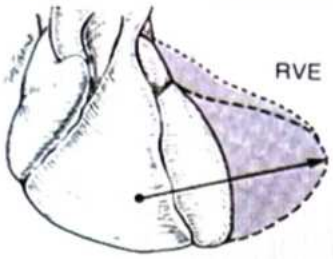


- It tells about expected normal cardiac diameter w.r.t thorax on PA view
- How to calculate cardiothoracic ratio:
  - Draw a line through the midline
  - Draw the line which marks the widest point of the right heart border (here 'a')
  - Draw the horizontal line which marks the widest point of the left heart border (here 'b')
  - Add the two (a+b): widest cardiac diameter
  - c = widest thoracic diameter
  - Cardiothoracic ratio = a+b/c
- Normal ratio: <0.55 in adults, In neonate < 0.6
- Any value greater than these considered as cardiomegaly

CHAMBER ENLARGEMENT

00:10:09





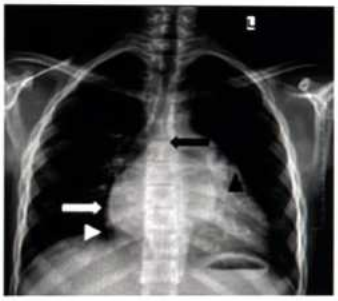
LVE (Left ventricular enlargement)	RVE (Right ventricular enlargement)
• Apex grows: down and out	• Upturned apex • Boot shaped heart in TOF

RVH (Apex is turned upwards)

LVH (Apex is shifting downwards & outwards)

LA enlargement

00:11:50



- Mitral stenosis (common component of chronic rheumatic heart disease) leads to LA enlargement.
- LA does not contribute to any heart border on the frontal projection. It is posteriorly located chamber.

Changes caused by LA enlargement on frontal radiograph

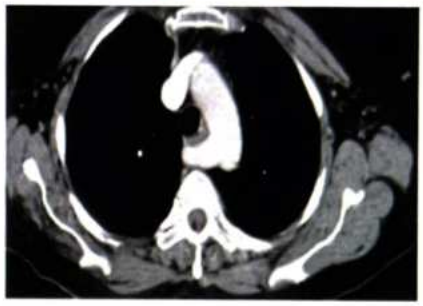
1. Straightening of left heart border (∵ of enlargement of left auricle/ left atrial appendage)
2. Splaying of carina (> 90°, carinal angle becomes widened)
3. Double density sign/ double right heart border sign

On Lateral radiograph

- Walking man sign in left atrial enlargement (lifting of left mainstem bronchus)
- Because of the posterior growth of left atrium, compression of few posteriorly located structures occurs
  1. Esophagus: Dysphagia
  2. Recurrent laryngeal nerve: Hoarseness of voice (Ortner syndrome)

DYSPHAGIA LUSORIA/ ABBERANT RIGHT SUBCLAVIAN ARTERY(ARSA)

00:16:34



- A patient presenting with dysphagia
- Barium swallow shows Posterior indentation of esophagus
- It is because of vascular anomaly (anatomical variation in the branching of arch of aorta) in which right subclavian artery arises separately as the 4th branch of the arch and courses posteriorly in the mediastinum posterior to esophagus, indenting it and producing symptoms in few patients
- Diverticulum of komerall: Aneurysmal dilatation

FINDINGS IN CARDIOGENIC PULMONARY EDEMA

- As a result of left ventricular failure: Pressure in the left atrium ↑ses which further gets transmitted to pulmonary veins which can be measured in terms of pulmonary capillary wedge pressure (PCWP)
- Normal PCWP = 9-12 mmHg

Refer Table 19.1

	Cardiogenic pulmonary edema	Non-cardiogenic pulmonary edema (ARDS)
• Distribution	Central / perihilar batwing	Peripheral consolidations
• Septal lines, Kerley lines	⊕	⊖
• Cardiomegaly	⊕	⊖
• Pleural effusion	⊕	⊖

ARDS/ Non cardiogenic pulmonary edema

- Bilateral confluent opacities
- Randomly distributed

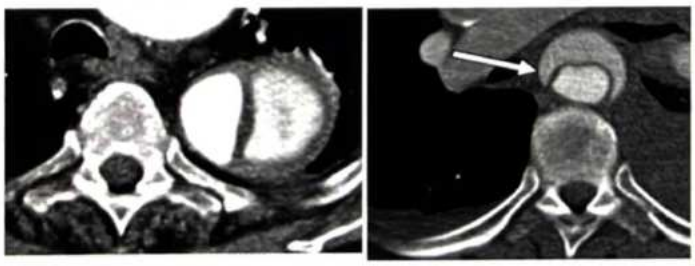
ACUTE AORTIC SYNDROMES

00:28:18

- Aortic dissection
- Aortic Aneurysm
- Intramural hematoma (Hematoma in the wall of the aorta)
- Penetrating aortic ulcer (PAU)

Aortic dissection 00:27:37

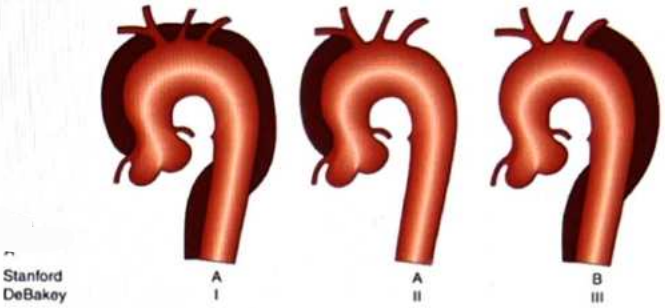
- Risk factors a/w aortic dissection:
  - Hypertension
  - Connective tissue disorder (Marfan syndrome, Ehler Danlos syndrome)
- D/t to intimal tear in aorta: blood will track from the true lumen into the wall & form the false lumen inside the wall of the aorta
- IOC (for stable patients): CTA (CT angiography)
- IOC for unstable patients: TEE (Transesophageal echocardiography)



CT features

- True lumen: Contrast density is more (whiter)
- False lumen:
  - Larger than true lumen
  - Cobweb sign (content of wall) → manifest as hypodense debris
  - Beak sign

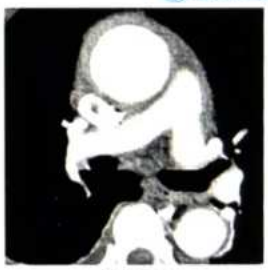
Classification of Aortic dissection 00:31:52



Stanford classification	Debakey classification
A → dissection involves ascending aorta • Managed surgically	I. Involvement of ascending aorta + descending aorta II. Ascending aorta alone is involved
B → dissection involves only descending aorta (does not involve ascending aorta) • Managed medically	III. Descending aorta alone is involved

Intramural hematoma 00:33:29

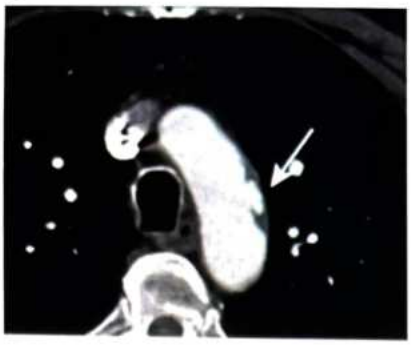
NCCT



CECT

- No intimal tear but there is injury to vaso vasorum that supplies the vessel wall
- Hematoma is formed within the wall itself. No breach of any layer occurs
- Focal crescentric thickening of the vessel wall at the site of hematoma (picked up on NCCT better)

Penetrating aortic ulcer 00:35:07



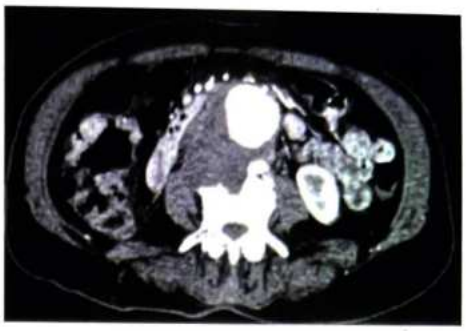
- Focal outpouching of the lumen into the wall of the vessel
- No intimal tear

Aortic aneurysm 00:35:41

2 types	
True aneurysm	**Pseudoaneurysm**
• It contains all three anatomic layers (intima, media & adventitia) • Usually fusiform aneurysm • Can be followed conservatively • Atherosclerosis is the most common cause • M/C seen in infrarenal descending abdominal aorta	• Contained by adventitia or periadventitial tissue • Usually saccular aneurysm with narrow neck • Requires active intervention as risk of rupture is more • Trauma is the mc cause • Pancreatitis is another cause

CT angiography (IOC)

USG (Yin & Yang sign)



- Contained rupture (Draped aorta sign)

Indications of treatment of abdominal aorta aneurysm 00:40:44

1. Symptomatic patient
2. Contained rupture (CT sign)
3. Asymptomatic patient (≥ 5.5 cm)
4. Rapidly growing aneurysm
   - ≥ 6 mm in 6 months
   - ≥ 1 cm in 1 year

Previous Year's Questions

Q. All are true about the technique shown in the image except? (NEET 2018)

A. CT angiography is used
B. Score > 400 indicates poor prognosis
C. Radiation dose of 1-2 mSV
D. Overall calcium burden is calculated

Agaston's calcium scoring

- Prognostic scoring
- NCCT is used.
- Aim: to look for calcified coronary arteries
- Semiautomated technique to determine calcification burden of coronary arteries
- Score is calculated on the basis of
  - HU of calcification
  - Volume
- Calculated calcium burden is correlated with the prognosis
- Score > 400 indicates poor prognosis

Table 19.1

PCWP	Findings on radiograph
• **13-18 mmHg** 	• **Cephalisation / redistribution** of pulmonary blood flow • In upper lobe, bronchovascular markings become more prominent • Pulmonary venous pressure has ↑sed which gets transmitted through the upper lobes bilaterally • Stage Antler sign/ Reverse moustache sign

• **19-25 mmHg**  	**Interstitial edema**
	• HRCT: Smooth interlobular septal thickenings.
	• It represents dilatation of pulmonary veins of the congestion
	• X-ray: Kerley lines
	  ○ B lines
	  → Seen at the lung Bases
	  → Horizontal lines
	  → Reach the pleura
	  ○ A lines
	  → seen near the lung Hilum
	  → Oblique lines
	  → Do not reach the pleural surface

• **>25 mmHg** 	**Alveolar edema** Batwing pulmonary edema • Central edema • In the perihilar location • Represents severe ↑se in PCWP

CLINICAL QUESTIONS

Q. A 65 year old hypertensive patient presents with acute onset chest pain, difficulty in breathing for one hour. chest X ray shows presence of mediastinal widening . which of the following is the IOC for this condition ?

A. Usg
B. CT-angio
C. Mr-Angio
D. Doppler

Answer: B

Solution

IOC for acute Aortic Dissection is CT-Angio

In Unstable patients- Transesophageal Echocardiography

MRI is NOT used in Acute conditions but is helpful in chronic dissections to better delineate the true and false lumen

- Dissection of arterial wall forming shreds within false lumen - COB WEB SIGN
- False lumen form an acute angle giving BEAK SIGN in aortic dissection

20 APPROACH TO CHD (CONGENITAL HEART DISEASES)

APPROACH TO CONGENITAL HEART DISEASES

Step I — Cyanotic Vs Acyanotic

Step II — Plethora Vs Oligemia

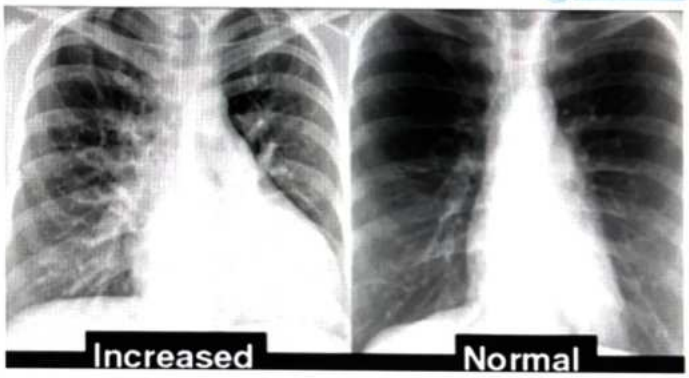
- Plethora: ↑sed pulmonary blood arterial flow
- Oligemia: Reduced pulmonary blood flow

Step III

- Clues: ECG findings, chest X-rays appearances, various signs

Plethora on X-ray

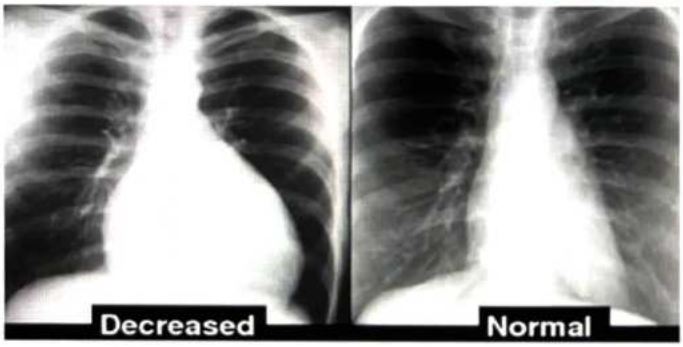
00:01:40



- RDPA (Right descending pulmonary artery) is frequently used to analyse the status of pulmonary arterial flow
- ↑sed diameter of RDPA (w.r.t. tracheal diameter) RDPA > trachea suggest plethora
- Pulmonary vascular bundles (bronchovascular bundles reach up to peripheral 1/3) suggest plethora

Oligemia on X-rays

00:03:57



- RDPA becomes small in diameter
- Diffusely reduced markings

ACYANOTIC HEART DISEASES

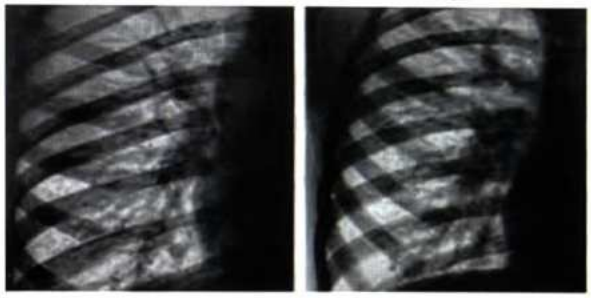
00:04:26

Plethora	Ⓝ pulmonary blood flow (PBF)
1. ASD 2. VSD 3. PDA	1. Coarctation of Aorta

Diagnosis of ASD

00:06:21

1. Hilar dance



- Fluoroscopy (↑sed PBF)

2. Wide & fixed split of S2

Diagnosis of VSD

- Pansystolic murmur

Diagnosis of PDA

- Continuous machinery like murmur in the infrascapular region

Features seen in Coarctation of Aorta

00:07:59

- 3 sign (results from narrowing at the level of Aorta) stenotic segment with a prestenotic dilatation and post stenotic dilatation.

- Barium swallow: Reverse 3 sign

- Rosler's Sign: Refers to inferior rib notching. MC seen in 3-9 ribs.
- In coarctation of aorta because of narrowing in aorta, vessels of upper limb and head & neck have increased blood flow whereas lower limb does not get enough blood supply.
- So, to compensate this discrepancy of blood flow to lower limb, Anterior intercostal arteries (branches of subclavian artery) communicate with Posterior intercostal arteries which drain into Descending aorta.
- Thus, because of the dilatation and pulsality of intercostal arteries, inferior rib notching is ⊕nt

Goose neck deformity 00:11:34

- Observed on ventriculography
- Seen in AVSD/ Endocardial cushion effect (associated with down syndrome)

CYANOTIC HEART DISEASES 00:12:27

Oligemia	Plethora
• Tetralogy of Fallot • Tricuspid atresia • Ebstein's anomaly	• TAPVC • TGA (Transposition of great arteries) • PTA (persistent truncus arteriosus)

Tetralogy of Fallot

- M/C cyanotic heart disease
- Right axis deviation (on ECG)
- Boot shaped heart/ Coer-en-sabot/ upturned apex on X-ray (indicates right ventricular hypertrophy)
- Seen in older kids more commonly
- 4 components of Tetralogy of Fallot
  1. Right ventricular hypertrophy
  2. VSD
  3. Infundibular pulmonary stenosis
  4. Overriding aorta
- Pentalogy of Fallot: TOF + ASD

Tricuspid atresia

- Left axis deviation (on ECG)

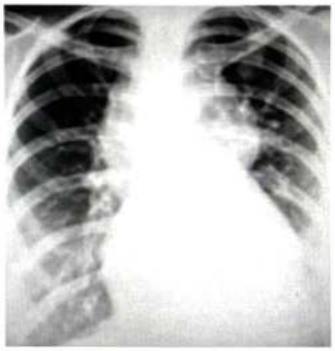
Ebstein's anomaly

- Himalayan P-waves (on ECG)
- Atrialization of RV: Indicate enlargement of right atrium, RV size reduces.
- Right bundle branch block
- Wolf Parkinson like associated symptoms on ECG
- On X-ray: Box shaped heart
- Associated with maternal intake of Lithium

Box shaped heart

TAPVC (Total anomalous pulmonary veins circulation)

- **3 types**
- Type I (Supracardiac variant) (M/C type)
  - Snowman shaped heart /figure of 8 appearance of heart is seen in this



- Type II (Cardiac variant)
  - Pulmonary veins directly drain into coronary sinus
- Type III (Infra cardiac variant)
  - Rarest type
  - Worst prognosis
  - Highest risk of obstruction

TGA (Transposition of great arteries)

d-TGA

- Egg on string/side appearance of heart
- Globular heart with narrow mediastinum
- A/w ventriculoarterial discordance

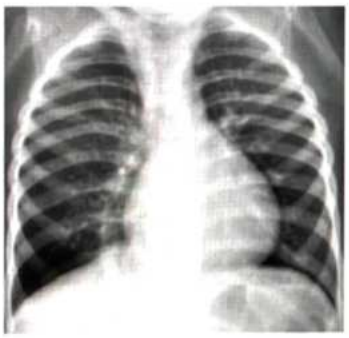
L-TGA

- Congenitally corrected TGA
- In addition to ventriculo-atrial discordance, atrio-ventriculo discordance is also present

PTA (persistent truncus arteriosus)

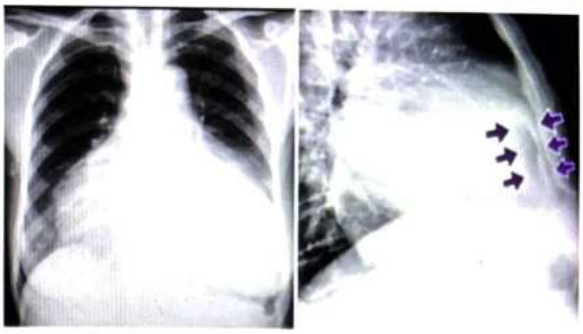
- Sitting duck sign

Partial anomalous pulmonary venous circulation (PAPVC)



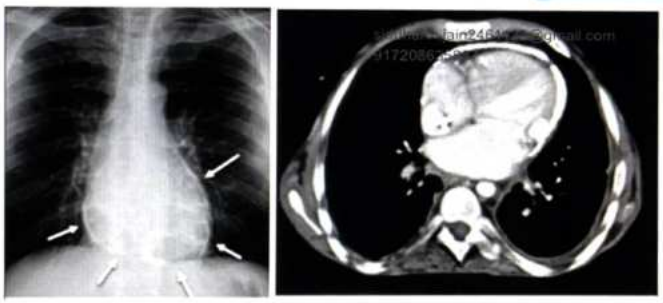
- All the veins are not anomalous
- Only the pulmonary veins of right side drain into IVC
- Scimitar Sign
- Scimitar Syndrome: Combination of PAPVC & right lung hypoplasia

Other named appearances of heart 00:25:01



- Cardiomegaly
- Diffuse globular shaped heart
- Leather bottle sign
- Seen in pericardial effusion
- On Lateral view: Oreo-cookie sign

Chronic calcific pericarditis 00:26:15



- M/C associated with TB
- Egg in cup sign

CLINICAL QUESTIONS

Q. A young female presents with history of dyspnoea on exertion. on examination, she has wide, fixed split S2 with ejection systolic murmur in left second intercostal space. on fluoroscopy, Great hilar dance sign is seen. The most probable diagnosis is

A. PDA
B. ASD
C. VSD
D. MS
E. ASD

Answer: B

Solution

- Great Hilar Dance is Vigorous pulmonary arterial pulsations seen due to increased blood flow, seen fluoroscopically in patients with Atrial septal defects.

Other signs seen in ASD

- signs of increased pulmonary flow (pulmonary plethora or shunt vascularity)
  - enlarged pulmonary vessels
  - upper zone vascular prominence
  - vessels visible to the periphery of the film
  - eventual signs of pulmonary artery hypertension
- chamber enlargement
  - right atrium
  - right ventricle
  - note: left atrium is normal in size unlike VSD or PDA
  - note: aortic arch is small to normal

21 RESPIRATORY RADIOLOGY

CHEST X RAY

Technical factors

- Source to image receptor distance is 180cm/6ft
- Posterior to Anterior-x ray beam passes

} Both are done to reduce heart magnification

- End Inspiration
  - 6 anterior and 10 posterior ribs should be seen, so as to say that patient has made adequate inspiration
- There should be no rotation as rotation of patient leads to unilateral hyperlucent lung
  - If the distance between spinous process and medial ends of clavicle is equidistant on both the sides, that means there is no rotation

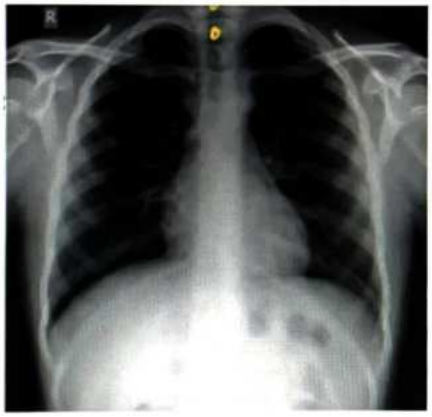
Hilum

- Major contribution of the hilum opacity is by pulmonary artery.
- Superior pulmonary vein, Bronchus, lymphatics also contributes to the hilum
- Inferior pulmonary vein doesn't contribute to the hilum
- Left hilum is higher than the right

Diaphragm

- Right diaphragm is higher
- Flattening of diaphragm is defined as flattening of dome <1.5 cm
  - Most reliable sign of hyperinflation: Diaphragmatic flattening
- Diaphragmatic asymmetry: Difference between the height of domes of diaphragm on two sides should be > 3cm. Seen in diaphragmatic palsy
  - IOC for diaphragmatic palsy: Fluroscopy
    → USG
    → Sniff test

Reading CXR



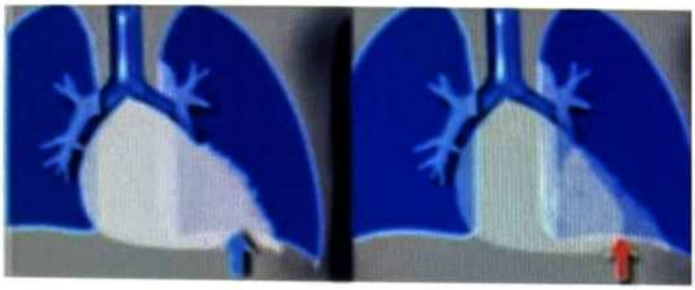
A-Abdomen: Air under the diaphragm: Pneumoperitoneum
B-Bones
C-Chest: Inside - outside approach

- Airway: Look for tracheal deviation, Splaying of carina
- Mediastinal and cardiac contour
- Hilum: Left hilum is usually higher than right, most common cause of hilar lymph node enlargement is TB
- Lung fields: Lucency is symmetrical or not, consolidation, nodules (<3 cm), mass(>3cm), interstitial opacities
- CP angles: Blunting indicate pleural effusion
- Diaphragm: Asymmetry >3cm; Flattening: <1.5 cm

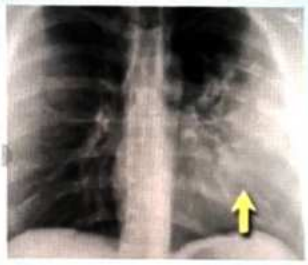
Lordotic view/ Apicogram

- To visualize apex and lung middle lobes

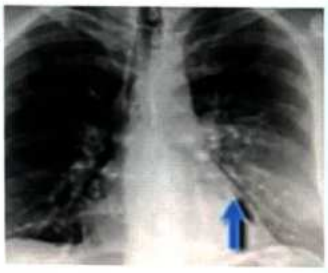
SILHOUETTE SIGN



- When two structures having same radiographic density come in contact with each other, loss of silhouette occurs.
- Helps in localization of abnormalities in different lobes of lungs



- Silhouetting positive(loss of margin) of Left heart border: It is in contact with Lingula



- LHB is seen very clearly differently from the opacity: Silhouetting negative : Opacity is in left lower lobe of lung and not in lingula

- Right Paratracheal stripe - RUL
- Aortic knuckle - LUL (Apico posterior segment)
- RHB - RML
- LHB - Lingula
- RT Hemidiaphragm - RLL
- Lt Hemidiaphragm - LLL

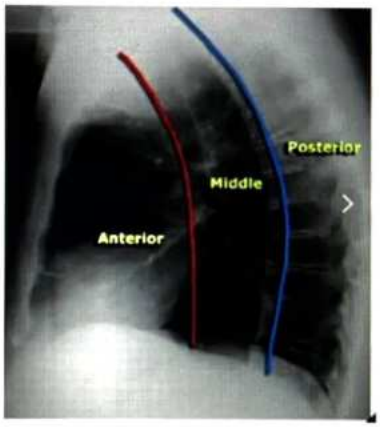
- Silhouetting of LHB is present
- On frontal radiograph, it can be localized to Lingula

- On lateral radiograph, any lung lobe that projects over the heart in a triangular manner corresponds to the middle lobe

- Spine sign: Lower lobe opacity on lateral radiograph corresponds posteriorly

MEDIASTINUM COMPARTMENTS

Felson classification

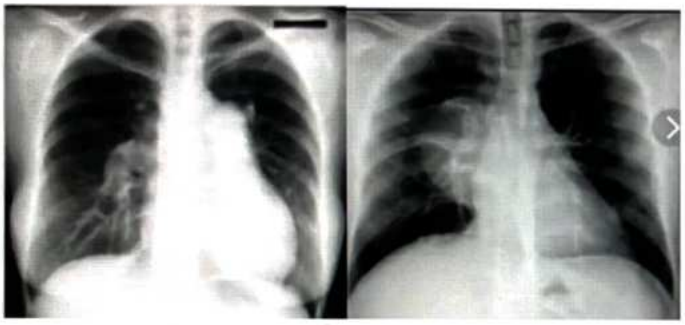


Compartment	Main structures/ tissues	Mass found
Anterior	• Fat, Lymph nodes, Thymus, heart, Ascending aorta	• Thymoma, Teratoma, Retrosternal thyroid extension, Terrible lymphoma
Middle	• Trachea, Bronchi, Lymph nodes, Esophagus, Desc. aorta	• Bronchogenic cyst, Esophageal mass, LN enlargement, Lymphoma
Posterior	• Paravertebral soft tissues	• Neurogenic tumor

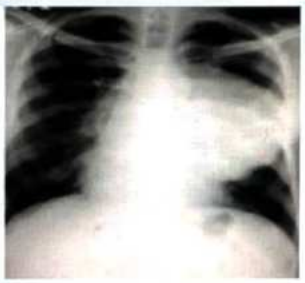
- Initial Ix for mediastinal masses: Chest radiograph
- Best Ix for anterior and middle mediastinum: CECT scan
- Best Ix for posterior mediastinum: MRI

- The mass is silhouetting the right heart border and heart is a content of anterior mediastinum. So this mass is in anterior mediastinum

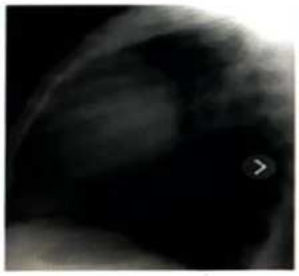
- Hilum overlay sign: Hilum is seen separately and hilum is in middle mediastinum, so the mass is either in anterior or posterior mediastinum



- **Hilum convergence sign**: Pulmonary vessels converging onto the hilum, it means it is a Pulmonary artery mass/PA enlargement seen in Pulmonary artery hypertension
- So this sign tells vascular origin of a mass vs non vascular origin of mass

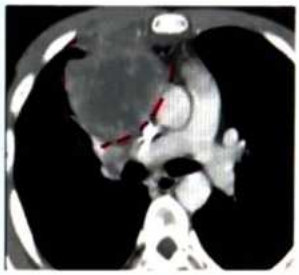


- Mass is silhouetting the LHB: so it is in anterior mediastinum



- On lateral radiograph, the mass is overlying the heart

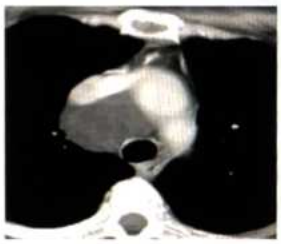
- **CECT is I.O.C** for anterior and middle mediastinal masses.
- Heterogenous mass, Calcification seen, Fat present
- So, this is most likely teratoma



- Homogenous mass: Most likely Thymoma
- Thymoma is associated with Myasthenia gravis, hypogammaglobulinemia(Good syndrome)

- Mass present in anterior and middle mediastinum: Most likely lymphoma

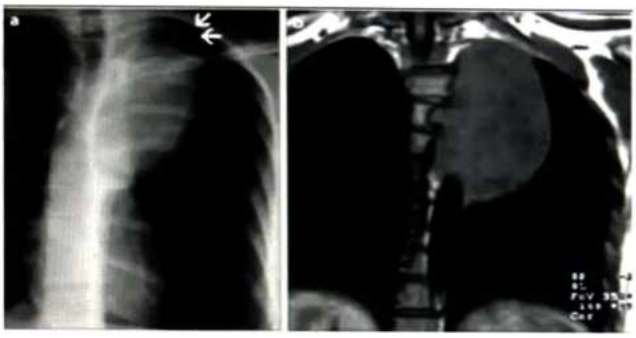
- Heart border can be seen separately from the mass, so the mass is not in anterior mediastinum
- So the mass is in middle or posterior mediastinum



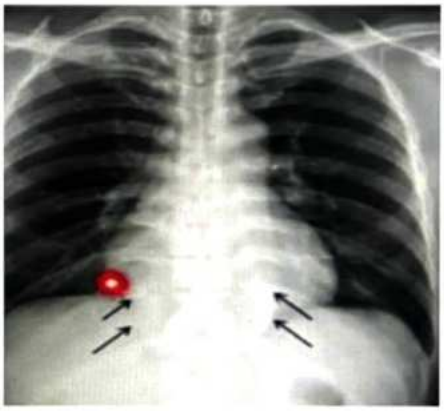
- CT shows a low density mass which is a cyst: Bronchogenic cyst in middle mediastinum

- **Mediastinal Lymph nodes**: 2 D/Ds
  - Sarcoidosis: Raised ACE levels, young women, hypercalcemia (Non necrotic LN's)
  - Tuberculosis (Necrotic LN's)

POSTERIOR MEDIASTINAL MASS

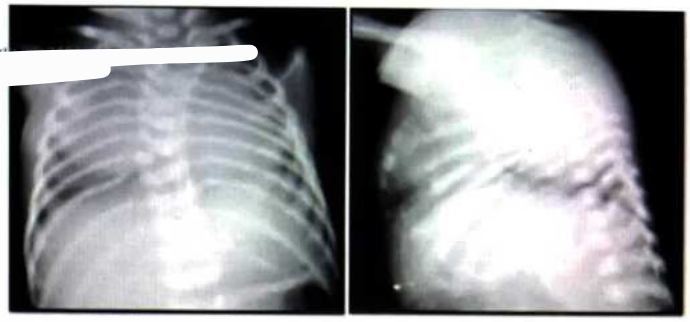


- Mass has broad base towards the mediastinum and extends above the clavicle: Cervicothoracic sign
- Mass has very clear margin. So the mass is a Posterior mediastinal mass
- MRI shows dumbbell sign.
- The ist d/d is neurogenic tumor



- Mass extending below the diaphragm: Thoracoabdominal sign: Posterior mediastinal mass

Neuroenteric cyst



- Pediatric posterior mediastinal mass
- Vertebrae segment/ Fusion anomalies

OPACIFICATION IN RIGHT UPPER LOBE

- Consolidation: Air in the alveoli is replaced by pus (Pneumonia), water (Pulmonary edema), blood (Pulmonary hemorrhage).

- No fissural displacement of horizontal fissure that is no volume loss of lung

- Fissure is bulging down: Bulging Fissure sign: seen in Klebsiella Pneumonia
- Typically seen in alcoholics, ICU patients

- Fissure is displaced superiorly
- Mediastinum is also shifted in the same direction
- This suggests collpase

COLLAPSE

00:54:40

Previous Year's Questions

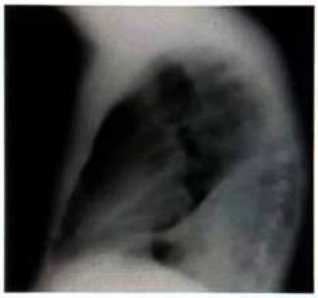
Q.All of the following are direct signs of collapse except
A. Lung Opacification
B. Fissural displacement
C. Bronchovascular displacement
D. Diaphragm elevation

Direct signs	Indirect signs
• Opacity • Fissural displacement • Brochovascular displacement	• Mediatinal shift / I/L tracheal shift • Diphragm shift/tent • Hilum displaced • Shifting granuloma sign • C/L lung hyperinflation • Rib crowding

- RUL collapse

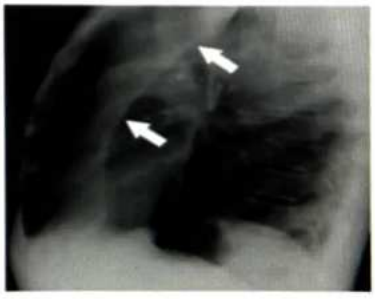
- Golden S sign: RUL collapse because of central obstructive mass

- Flat waist sign
- Left diaphragm is silhouetting: Therefore left lower lobe collapse



- Lateral radiograoh: Spine sign

- RHB is not visualized properly
- Lateral radiograph: Triangular opacity falling over the heart: Middle lobe collapse

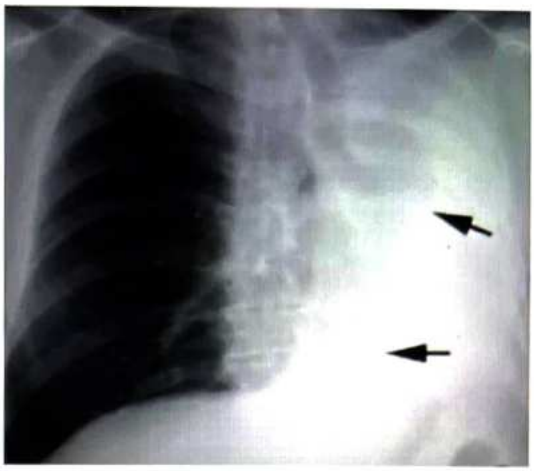


- Frontal radiograph: Luftsichel sign
- Seen in LUL collapse
- Lateral radiograph: Veil like opacity

Previous Year's Questions

Q. All of the following are causes of opaque hemithorax except:
A. Large consolidation
B. Pleural effusion
C. Main stem bronchus obstruction
D. Tension pneumothorax

Explanation: Pneumothorax will appear as hyperlucent



OPAQUE HEMITHORAX

- **No tracheal shift:** Consolidation
- **Trachea shifted to C/L side:** Massive Pleural Effusion
- **Trachea shifted to I/L side:** Pneumonectomy, Collapse

- Complete opacification of left hemithorax: trachea shifted to I/L side

CLINICAL QUESTIONS

Q. A patient presents with cough and fever. On X ray examination, a homogenous opacity silhouetting the right heart border with ill-defined lateral margins is seen . What would be the most probable diagnosis?

A. Pneumonia affecting medial zone of right middle lobe
B. Pneumonia affecting superior zone of right lower lobe
C. Loculated pleural effusion
D. Pneumonia of anterior zone of right middle lobe

Answer: A

Solution
Silhouette sign

Obscuration of a mediastinal border	• occurs by a pathology which is in close anatomical contact with it
Obscuration of Rt Heart Border	• Rt Middle Lobe Pathology
Obscuration of Left Heart Border	• Lingular Pathology
Obscuration Of Aortic Knuckle	• Left Apicoposterior pathology
Obscuration of Hemidiaphgrams	• Lower lobe pathologies

22 NUCLEAR MEDICINE

Outline

1. m c studies } γ – rays involved, source of
2. PET scan } gamma rays is intranuclear

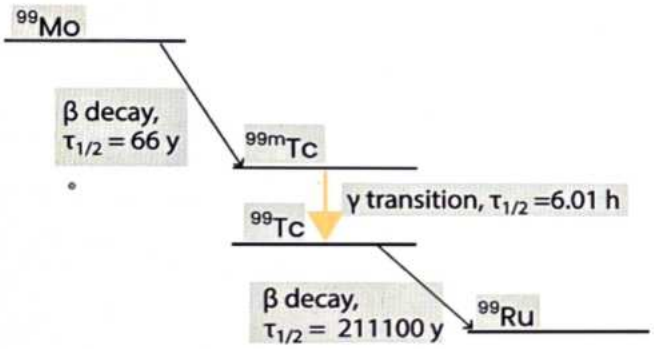
↓

Hence the name nuclear medicine

Concept

- T_c^{99} m is combined with Ligand
- E.g. Bone scan: T_c^{99} m is combined with MDP (ligand): Place the patient inside the gamma camera / Anger camera: Visualise the gamma rays getting emitted from the patient

Nuclear medicine	Radiological modalities
• Patient himself emits gamma rays & we image these gamma rays with the camera	• (X rays , CT) • Extrinsic X-ray tube produces X-rays



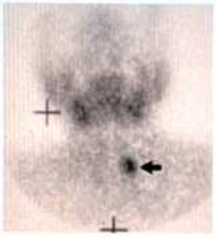
One liners

- Source of T_c^{99} m: ^{99}MO
- 'm' in 99 mTc stands for: Metastable
- 99Tc: Stable form

Anger camera/gamma camera

Modalities 00:04:26

PTH adenoma



Scintigraphy (2D studies)
- Tc99m- sestamibi scan

SPECT (single photon emission CT) (3D studies)

Previous Year's Questions

Q. Not true about Tc99 m
A. Half life is 6 hours
B. Produced in a generator from Ni-60
C. Most commonly used agent in radionuclide studies
D. Stannous chloride is used as a reducing agent

HIDA SCAN (HEPATOBILIARY IMINODIACETIC ACID) 00:06:41

Captopril 50 mg PO
Furosemide 40 mg IV

- Normal HIDA Scan: Small bowel opacification within 24 hrs of injection

Applications of HIDA Scan

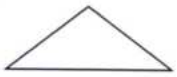
1. Acute Cholecystitis
- IOC: USG (inflamed obstructed gall bladder)
- Most accurate Ix: HIDA Scan: Non visualization of gall bladder

2. EHBA (Extrabiliary Hepatic Atresia)

- New born baby presents with neonatal jaundice: D/ds are neonatal hepatitis & EHBA.
- 1st Ix/Initial Ix in these children: USG
- USG findings in EHBA

- Triangular cord sign
- Measured: Anterior to right portal vein in sagittal plane: > 4 mm (significant)
- Ghost Gall bladder sign:

GB < 19mm

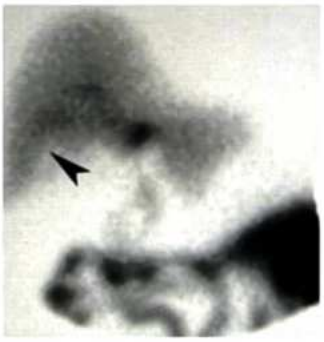


Irregular contour ill-definedmucosa

- IOC to rule out EHBA: HIDA Scan
- Gold standard Ix: Intra-op cholangiogram > Biopsy

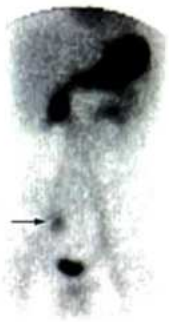
3. Bile leaks

- Initial Ix for a case of suspected biliary leak: USG
- IOC: MRCP
  - Absence/presence of bile leak
  - Localisation
- Most sensitive Ix: HIDA scan
  - ⊕nce/⊖nce of bile leak
  - No localisation
- Gold standard: ERCP



- HIDA Scan shows Non visualization of gall bladder: Acute cholecystitis

T^{99m} PERTECHNATE SCAN



- A young child with painless lower GI bleed / Red currant jelly stools
- Meckel's diverticulum
- **Rule of 2**
  - Seen in children less than 2 yrs of age
  - 2% of population
  - Measures 2 inches in length
  - Located 2 feet away from ileocolic junction
  - Has 2 kinds of mucosa
    → Gastric mucosa
    → Pancreatic mucosa
  - d/t presence of ectopic gastric mucosa: lower GI bleed
  - T 99m pertechnate has the property of binding to gastric mucosa

Uses of Tc99m– pertechnate

1. Salivary gland: Warthin tumor: Shows hotspot with Tc99m
2. Meckel's diverticulum
3. Thyroid scan: Ist choice: I – 123, If not available: Tc99m pertechnate

Previous Year's Questions

Q. Tc -99m Sulphur colloid scan shows uptake in all except: (NEET 2017)

A. Fibrolamellar HCC
B. Splenunculus
C. Occult abscess
D. Fibrous nodular hyperplasia

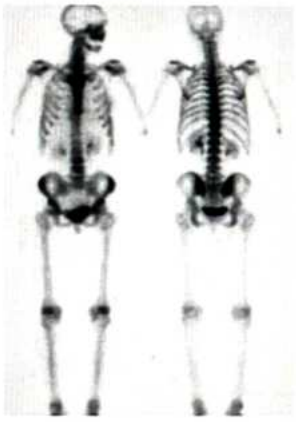
Explanation

- Sulphur colloid goes to Reticulo endothelial system.
- FNH shows uptake with Tc -99m sulphur colloid d/t ⊕nce of Kupffer cells

- **Sulfur Colloid Scan shows FNH**

BONE SCAN

Normal bone scan



Diffuse homogenous uptake

- Tc99m (source of gamma rays) is combined with MDP (Methylene diphosphonate)
- MDP takes Tc99m to Osteoblastic activity region
- Hot spots (Tc99m gets deposited in the areas showing osteoblastic activity)
- Hot spots
  - Tumors
  - Metastasis (Osteoblastic > Osteolytic)
  - Osteoarthritis
  - Trauma (fractures)
  - Osteomyelitis
  - Epiphyses
  - Paget's disease (predominantly in Sclerotic & mixed phases)

Previous Year's Questions

Q. All of the following will show a hot spot on bone scan except: (NBE 2016)

A. Bone Metastases
B. Acute Osteomyelitis
C. Multiple Myeloma
D. Paget's disease
E. Fracture

Explanation

- Multiple myeloma (inspite of having lytic lesions) will never show hot spot on bone scan because of plasmacytic infiltration
- Multiple myeloma (lytic lesions) produces cold spots on bone scan

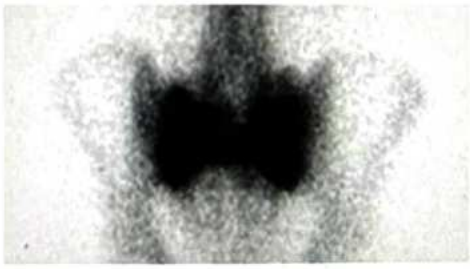
BONE METASTASIS

00:24:20

- **Order of preference of various investigations:**
  - NaF PET > 18-FDG PET > MRI > Bone scan
- Best Ix for bone metastasis: NaF PET
- MRI →can show bone marrow metastasis as well

- Hot spots: Multifocal areas of sclerotic metastasis

Sacral insufficiency fractures



H sign "Honda sign"

Acute Osteomyelitis

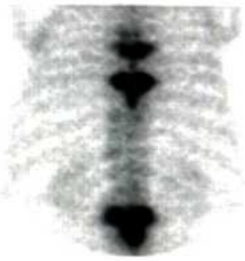
Flow Blood Pool Bone

- Triple phase bone scan: Shows Hyperemia
  1. Flow phase
  2. Blood pool
  3. Bone phase
- Triple phase CT: Liver SOL

Paget's Disease

00:27:03

Banana fractures



Mickey mouse sign

Lincoln sign

- M/C bone to be involved in Paget's →Pelvis

SUPERSCAN

00:28:42

- All the bones show diffusely increased uptake whereas kidneys are not visualised
- A/w
  - Metabolic bone diseases
  - Sclerotic bone metastasis ↑↑
  - Renal failure

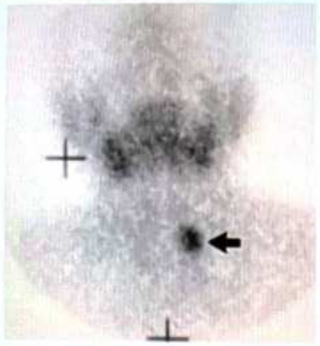
Q. A 35 year old female, known case of depression, presents to you with colicky pain abdomen. Lab evaluation reveals raised PTH. High calcium and low phosphate. What is the best test for localization of abnormality? (INICET July 2021)

A. USG neck
B. CECT neck
C. Sestamibi scan
D. USG abdomen

Explanation

- Raised PTH, high calcium & low phosphate: 1° hyperparathyroidism (Parathyroid adenoma)
- USG abdomen is done in case of 2° hyperparathyroidism (chronic kidney disease)
- USG neck: Initial Ix for PTH adenoma but has Low sensitivity
- CECT neck
  4DCT investigation for PTH adenoma →NCCT, arterial, venous
- Sestamibi Scan: Most sensitive functional/ Best Ix for PTH adenoma

Parathyroid Imaging



Scintigraphy (2D studies)
- Tc99m- sestamibi scan
- **Th / Tc99 pertechnate subtraction**: Both thyroid & parathyroid will show uptake on administration of Thallium
- Tc99 pertechnate: Only thyroid shows uptake

SPECT (single photon emission CT) (3D studies)
Tc99 sestamibi scan: Parathyroid adenoma:Can also pick Ectopic PTH adenomas

CARDIAC SCANS

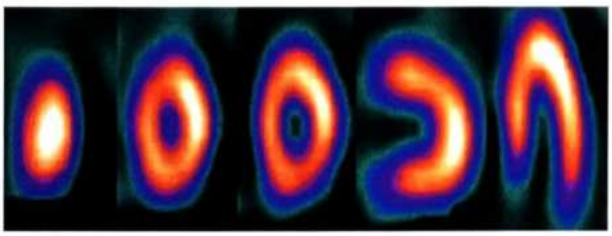
00:32:31

Myocardial perfusion imaging (MPI)= (ischemia)
- Tc99 – sestamibi
- Th – 201
- Tc99m tetrofosmin
- Ischemic area appears as cold spot

Infarct imaging
- Tc99 Pyrophosphate scan
- Infarct area appears as hot spot

Previous Year's Questions

Q. All of the following are used for the investigation shown except? (Recent AIIMS)



A. Thallium – 201
B. Tc99 – Tetrofosmin
C. Tc99 – Sestamibi
D. Tc99- Pyrophosphate

Explanation
- This is MPI: Homogenous blood flow throughout the heart
- Tc99–Pyrophosphate →Infarct Imaging

VENTRICULAR FUNCTION STUDIES

00:36:34

- Tc99m – RBC: For MUGA Scan (Multigated acquistion)
- Echocardiography
- MRI
  - Best/IOC to evaluate ventricular function
  - Delayed contrast enhancement (DCE) scan: used for infarct imaging
  - IOC for evaluating cardiomyopathies (Restrictive cardiomyopathy particularly)

Previous Year's Questions

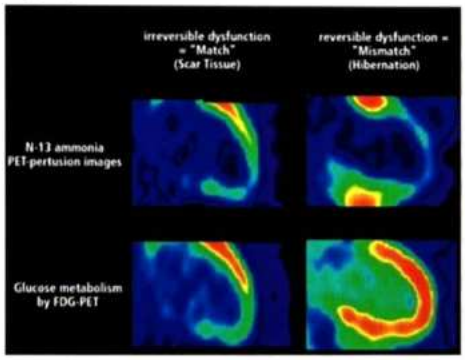
Q. Which of the following is the best investigation to calculate ejection fraction of the heart?
A. Thallium MPI
B. 18-FDG PET
C. Cardiac MRI
D. Pyrophosphate scan

Previous Year's Questions

Q. IOC for hibernating myocardium is? (Recent NEET)
A. 18 FDG PET with N-13 ammonia PET
B. MUGA scan
C. Thallium scan
D. Pyrophosphate scan

18 FDG PET with N-13 ammonia PET
- 18 FDG PET tells about metabolism that is glucose utilization by cells / active glucose metabolism and in heart, stunned myocardium uses gluocse
- N-13 ammonia PET: Perfusion

Hibernating Myocardium



Tc99m–LABELLED RBC SCAN

00:42:16

- Heart: MUGA scan
- Liver SOL: Hemangioma
- GI bleed: Occult

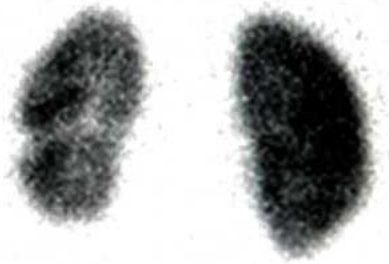
Sensitivity

- Tc99m–RBC: 0.05 ml/min
- DSA: 0.5 ml/min
  - Advantage: dx + Rx
  - Disadvantage: Less sensitivity

RENAL SCANS

00:43:38

DMSA Scan



- Morphological scan (morphology of kidneys)
- Static scan
- Aim: Look for cortical scar
- M/C cause of cortical scars in children: Vesico – ureteric reflux

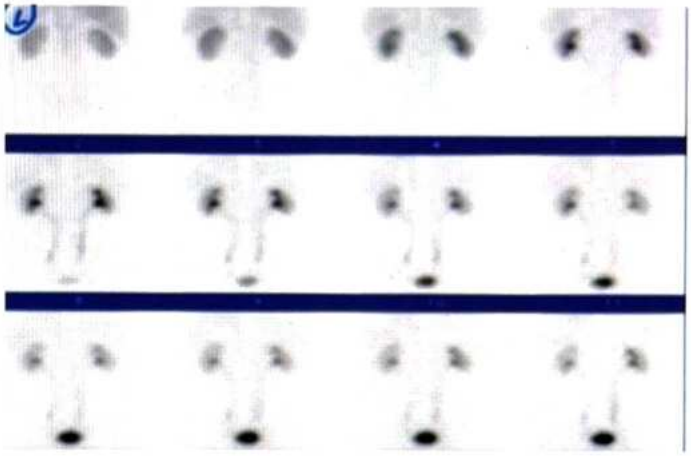
Previous Year's Questions

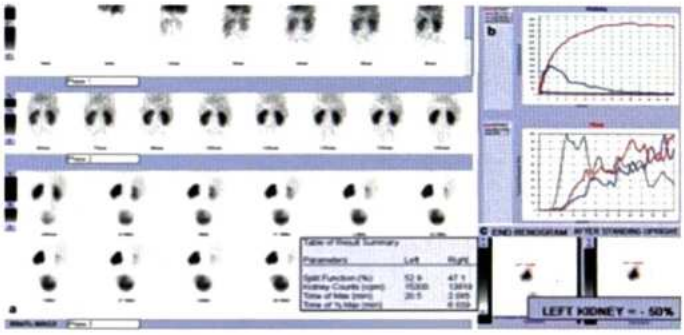
Q. Radioisotope of choice of measuring GFR: (Recent NEET)

A. DMSA
B. DTPA
C. MAG 3
D. OIH

Explanation

- DMSA: Static Scans
- DTPA, MAG 3, OIH are Dynamic Scans
- DTPA: Exclusively filtered by glomerular filtration
- MAG 3: GFR + tubular secretion (dual mechanism of excretion)
- Thus, DTPA: for GFR and MAG 3: for overall renal function

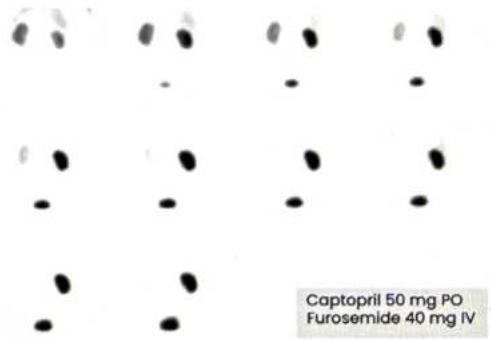




- The scan shows Obstructive Uropathy at pelviureteric junction.
- Diuretic renography: to differentiate between partial obstruction & complete obstruction

RENAL ARTERY STENOSIS

00:49:13



- U/L Renal artery stenosis: Captopril induced renography / Captopril induced DTPA
- Initial Ix for renal artery stenosis: Renal USG with Doppler
- IOC: CT angiography < MR angiography < Captopril induced renography
- Gold standard Ix: DSA (DSA has role in angioplasty)

Summary

Scan	Use
• Tc99m - DMSA	• Static scan: Cortical scarring
• Tc99m- DTPA	• Best for GFR
• Tc99m -MAG 3	• Best for renal function
• Diuretic renography	• Obstructive uropathy
• Captopril renography	• Renal artery stenosis

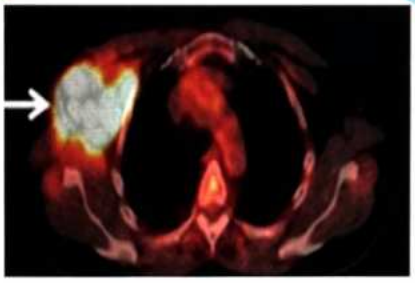
Tc99m: HMPAO

00:52:59

- Used for CNS perfusion
- Indications:
  - Evaluation of epilepsy: Ictal scan and Interictal scan
  - Brain death: Hot nose sign
  - Dementia

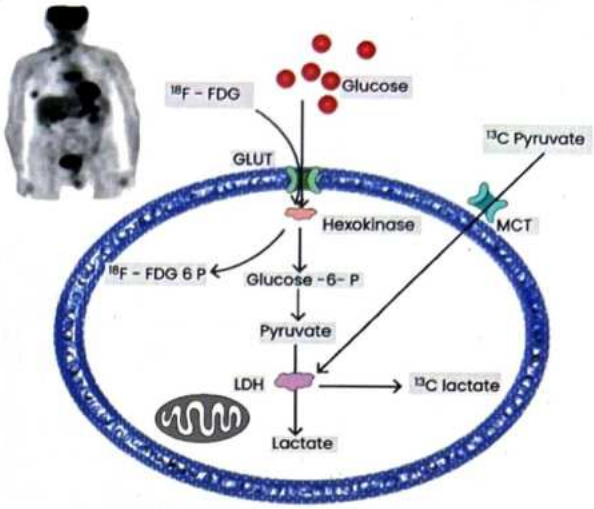
PET SCAN

00:54:24



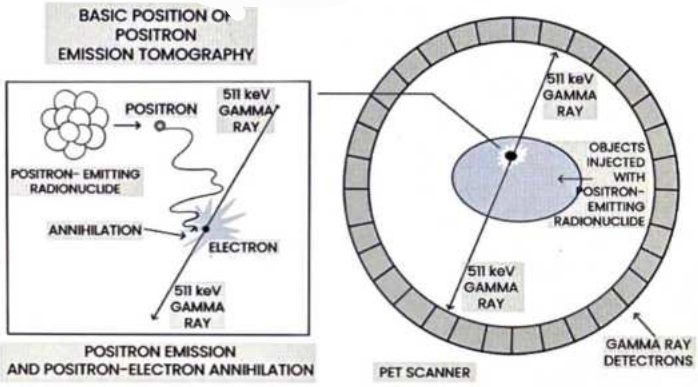
- PET Ct scan: Positron emission tomography CT scan
- 18 F is combined with deoxyglucose (ligand): To look for malignant cells
- Functional metabolism

Warburg Effect



- Malignant cells selectively take up glucose and undergo anaerobic glycolysis

Principle of PET scanner



- Coincidence: Annihilation reaction
- Coincidence: Only the gamma rays coming at 180° simultaneously will be picked up by the scanner
- Pre-requisite before performing PET scan: Blood glucose measurement

Previous Year's Questions

Q. All are true about the PET except? (Recent AIIIMS)
A. Produces 3 D functional imaging data
B. Better contrast resolution than MRI
C. High radiation exposure
D. Malignant cells show high uptake d/t increased metabolism
E. Used to detect tumor recurrence in brain tumors post - RT

Explanation

PET Scan

- MRI has best contrast resolution
- M/C indication of PET CT is to pick up metastasis in malignancies
- High radiation exposure is given to whole body in PET CT

Previous Year's Questions

Q. All of the following can be used as positron emitters except: (Recent PGI)

A. 131 – I
B. 18 – F
C. 13 – N
D. 15 – O
E. 11 - C

Explanation

- 8 – F
- 13 – N
- 15 – O
- 11 – C

} Positron emitters

- M/C positron emitter: 18 – F

131 – I: Radioisotope of iodine

- Dx + Rx
- Emits γ+ ß rays

Previous Year's Questions

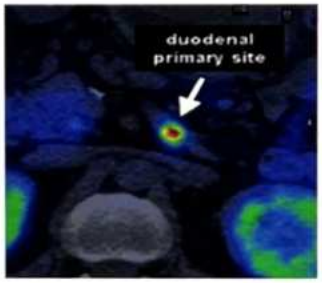
Q. Identify the incorrect pair: (Recent NEET)

A. NaF PET – Bone metastases
B. Choline PET – Endometrial carcinoma
C. PMSA PET – Prostate carcinoma
D. DOTA NOC PET – Neuroendocrine tumor
E. C – 11 METHIONINE PET – Brain tumors

Explanation

- Best investigation to pick up bone metastasis: NaF PET
- Choline PET , PMSA PET – Prostate Ca

SSI, Ga – 68 DOTANOC PET Scan 01:02:38



- Somatostatin (SSTR) Receptors
- Useful for
  - Pancreatic NET particularly Gastrinomas Except: insulinomas
  - Carcinoid

Carcinoid Tumors (3 grades)

	G1	G2		G3	
		Low	High	Low	High
Ki-67 %	2	3-20		>20	
SSTR PET/CT	++	++	+	+	-
FDG PET/CT	-	-	+	+	++

- Typical carcinoids: Not +ve on PET

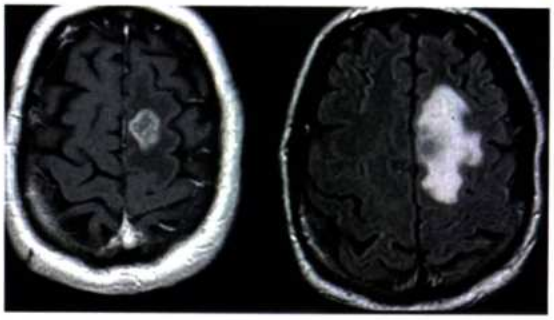
SUMMARY

Radioisotope	Test
Tc 99m – MDP (methylene diphosphonate)	• Bone scan
Tc 99m – HIDA	• Acute cholecystitis • EHBA • Bile leaks
Tc 99m- Sestamibi	• PTH adenoma • MPI
Tc 99m -Sulphur colloid scan (RES)	• FNH • Occult abscesses • Splenenculi
Tc 99m -tagged RBCs	• GI bleed • Hemangioma • MUGA
Ga-67,In-111 tagged WBC	• Inflammation , Occult abscesses
I-123 / I-131 MIBG	• Neuroblastomas
SRS, In-111 octreotide	• NET, carcinoids
DOTANOC, DOTATATE, DOTATOC PET	• NET, carcinoids
Tc 99m tetrofosmin, sestamibi, Th-201	• MPI
Tc 99m HMPAO / ECD SPECT	• CNS perfusion (Hot nose sign in brain death)

DaT SPECT (I-123 ioflupane)	• Parkinsons disease
Tc 99m pyrophosphate	• Infarct "Hot spot"
18-FDG PET	• M/C used metabolic scan
NaF PET	• Bone scan
Choline PET, PMSA PET	• Ca Prostate
DOPA PET	• Pheochromocytoma, Paragangliomas
C 11 Pittsburg compound b PET	• Alzheimer's disease
C-11 METHIONNINE PET, FLUROTHYMIDINE PET	• Brain Tumors
MISO PET	• Hypoxia imaging (RT planning)

Previous Year's Questions

Q. Useful to distinguish post-radiotherapy necrosis from recurrence of brain tumors (PGI)



A. CE-MRI
B. DECT
C. FDG-PET
D. Diffusion weighted imaging
E. MRI perfusion
F. MR spectroscopy
G. Biopsy

Explanation

- MRS
  - Choline peak: Hypercellularity → tumors
  - Lipid lactate peak: Necrosis
- Biopsy: Best investigation (IOC / Gold standard) to distinguish active tumor from necrosis

CLINICAL QUESTIONS

Q. A middle-aged female presents with pathological fracture of clavicle, ribs, and X-ray shows periosteal resorption of 2nd and 3rd metatarsals and phalanges. The doctor decided to send her for a Radionuclide scan of the parathyroid glanD. Which of the following finding can be seen in this case?

A. Cold spots
B. Hot spots
C. Panda sign
D. Hawkin sign

Answer: B

Solution

Super scan

- Resembles normal bone scan but kidney is not visible
- Seen with
  - Renal Failure
  - Difffuse metastatic disease
  - Diffuse metabolic bone disease like Hyperparathyroidism
- In active hyperparathyroidism, a superscan of generalized increased activity(Hot spot) is seen on technetium bone scan.

23 RADIOTHERAPY PART-1

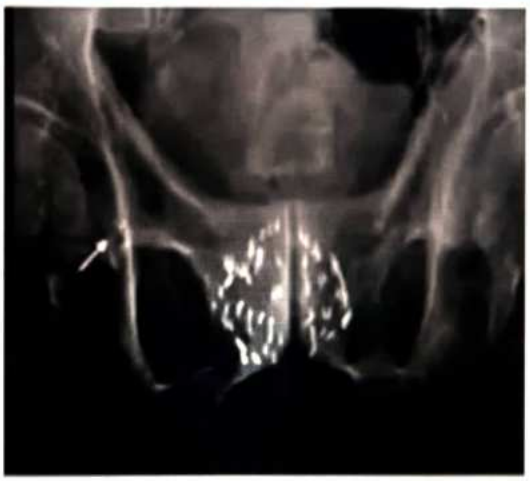
MECHANISM OF ACTION OF RADIOTHERAPY

1. Ionisation: Free radicle generation
   - Main mechanism of action of radiotherapy
   - Oxygen is a radiosensitizer as it increases the formation of free radicals
2. DNA damage: dsDNA > ss DNA

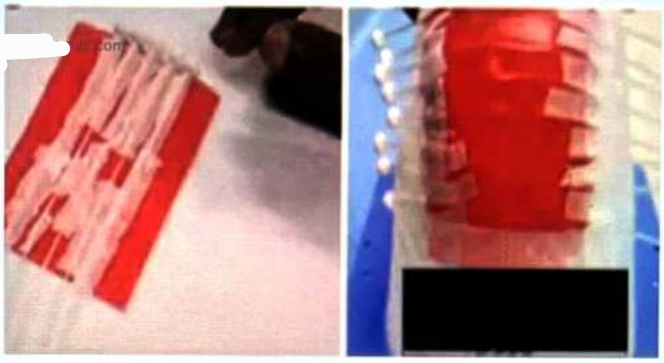
Types of Radiotherapy

- Teletherapy: also known as External beam radiotherapy (EBRT)
- Brachytherapy (radiation is given at a short distance)
  - Intracavitary: Used for Ca cervix
  - Interstitial: Used for Prostate Ca
  - Mold: Superficial Malignancy like Penile Ca, Eyelid Ca, Lip Ca
- Systemic
  - I-131: Used for Rx of Well differentiated thyroid cancer
  - P-32: Used for Rx of Polycythemia vera
  - Sa , Sr: Used for ablation of bone metastasis

What mode of radiotherapy is shown here?



- Interstitial Brachytherapy being given for Prostate Ca



- Mold Brachytherapy

AGENTS FOR RADIOTHERAPY

Gamma rays	X-Rays (M/C agents used for radiotherapy)	Electrons	Protons
• Co-60 $t\frac{1}{2}$=5.2 yrs. • Cs-137 $t\frac{1}{2}$=30 yrs	• Ortho: < 500 kev • Super: 500-1000 kev • Mega: >1 mev	• LINAC (Linear Accelerators) : Gives rise to electrons as well as X-rays	• Cyclotrons (Particle accelerator): Give Rise to protons

Previous Year's Questions

Q: The following machine is used for generation of: (NEET 2017)

A. Gamma rays
B. X-rays
C. Protons
D. Neutrons

Explanation

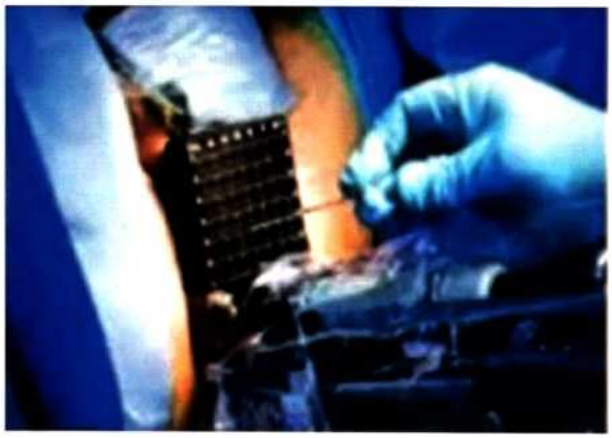
- Teletherapy being given via Linear Accelerator (LINAC): Used for generation of X-rays and electrons.

LINAC

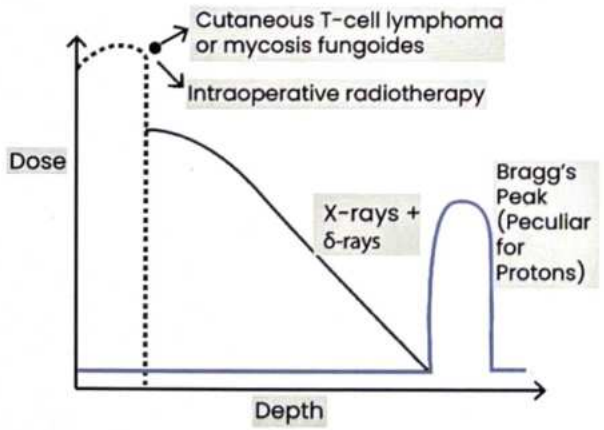
Cyclotron

Remote after loading

- A patient with prostate Ca & Interstitial Brachytherapy is planned for him.
- Remote afterloading is used for brachytherapy (DNB 2016)
- To prevent unnecessary radiation exposure to the operator as well as the surrounding staff.



Dose Depth Curve 00:13:29



- Action of various radioactive agents and how they behave with increasing depth from the source.
- **Electrons:** They act quite superficially on the skin
  - Applications
    - → Cutaneous T-Cell Lymphoma or Mycosis fungoides
    - → Intraoperative Radiotherapy e.g. Pancreatic malignancies
- **Protons:** Have marked effect at the increased depth in the soft tissues
  - Bragg's peak is their peculiar feature (NEET 2020)
  - Ideal agents for treating deep seated tumors
  - Agent of choice for treatment of clival chordomas
- **X-rays & γ-rays:** As the depth increases, their effect goes down
  - Advantage of X-rays: their energy can be modulated depending upon the depth at which their action is required
  - M/C used agents for radiotherapy

Previous Year's Questions

Q: Agent of choice for intra-operative radiotherapy (NEET 2017)

A. X-ray
B. Electron
C. Gamma rays
D. Protons

Previous Year's Questions

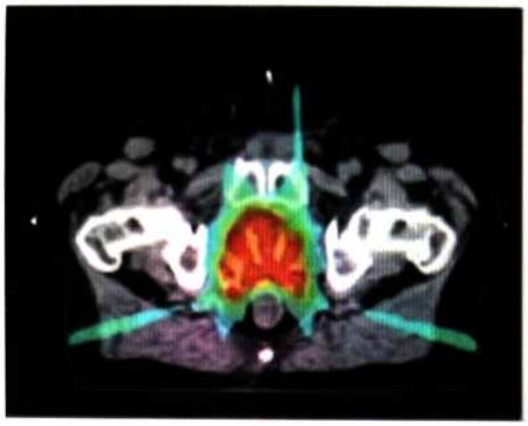
Q. Agents of choice for clival chordoma? (DNB 2016)

A. X-ray
B. Electron
C. Gamma rays
D. Proton

Inverse Square Law

- This law states that Intensity of radiation (d= distance from the source)
- Has role in radiation protection [↑sed distance from machine (xray tube) →lesser is the radiation exposure]
- Most common side effect of radiotherapy: Erythema (because of its maximum intensity on the skin)

IMRT (INTENSITY MODULATED RADIOTHERAPY) 00:21:13



- Maximum radiation should go to the tumor site and other organs should have less effect.
- Multi-leaf collimators
- Type of Conformal Radiotherapy (Conformation to the shape of the primary organ)

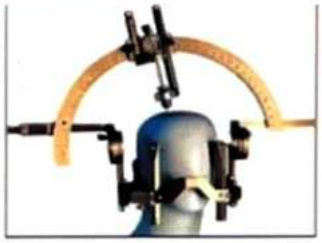
IGRT (Image – guided Radiotherapy)

- For real time visualization so as to better the administration of radiotherapy
- Gating is used to see patient breathing phases. (NEET 2016)

Stereotactic Radiotherapy 00:25:20

- Also called as stereotactic radiosurgery
- Targetted radiotherapy is given

Gamma knife	Cyber Knife
• Gamma rays (Source: Co-60)	• X-rays (produced using LINAC)
• Brain pathology	• Can be performed anywhere in the body
• Helmet / frame is used	• Robotic arm is used, No frame is needed
• Lars Leksell discovered it. • Laksell frame	



Applications of Gamma Knife

- Solitary brain metastasis
- Vestibular schwanomma (M/C tumor of cerebellopontine angle)
- Pituitary adenomas
- Glomus tumor (vascular tumors) (Endothelium is radiosensitive)
- Arterio-venous mal formation
- Refractory trigeminal neuralgia {Ist line drug for trigeminal neuralgia: Carbmazepine}

Previous Year's Questions

Q. Stereotactic radiosurgery is used for all except: (NEET 2017)

A. Vestibular Schwannoma
B. Trigeminal neuralgia
C. AVM
D. Tuberculoma

24 RADIOTHERAPY PART-2

RADIOSOTOPES OF IODINE

Radioisotopes	T1/2	Use
• 1-123	13 hrs	• Diagnostic radioiodine Scans • In India, for thyroid- TC99 pertechnate scan is used
• 1-124	4 days	• Positron emitter
• 1-125 (12X5)	60 days	• Used for brachytherapy implant (particularly for prostate malignancies) • Used as permanent implant
• I-131 (1+3+1 +3)	8 days	• Emit both ß + γ rays • Most carcinogenic radioisotope of iodine • Used for therapeutic purpose for treatment of thyroid malignances

Previous Year's Questions

Q Radioisotope used for ablation of thyroid gland? (NEET 2018)

A. I-123
B. I-124
C. I-125
D. I-131

- I-131 - Emits ß + γ rays: used for systemic radiotherapy of well differentiated thyroid malignancies.

Elements and half lives

Element	Half life
18 –FDG: Used in PET Scan	110 min
Tc 99: Nuclear medicine scans	6 hrs
I-123	13 hrs
I-124	4 days
I-125	60 days
1-131	8 days
P-32 (3-2)	14 days
Ir-192 (9-2)	74 days
Co-60	5.2 yrs
Cs-137	30 yrs
Au-198, yt-90	2 days
Radium-226	1622 yrs

Pure Beta emitters (PSYchiatry)

P- P-32	S- Sr	Y- Ytruim
• Systemic radiotherapy agent used in the RX of polycythemia vera	• Systemic radiotherapy agent used for bone metastasis	

Alpha+Beta+Gamma emitter: Ra-226 (t1/2-1622yrs)

Previous Year's Questions

Q. Gamma radiation are produced by all except: (NEET 2018)

A. Co-60
B. Cesium-137
C. P-32
D. Iridum-192
E. Ra-226

BRACHYTHERAPY IMPLANTS

00:13:32

Temporary	Permanent
• Longer t1/2 ○ Cs-137 ○ Co-60 ○ Ra-226	• Shorter t1/2 relatively ○ G - Au(Gold) ○ I - I 125 ○ P-Palladium ○ C - Cs 131 ○ Y – Ytrium

How to remember

- GIPSY

Radiosensitizers	Radioprotectors
• Hyperbaric O2 ○ Smoking is strictly contraindicated in people going radiotherapy • Metronidazole, Misinidazole • 5- flurouracil, Gemcitabine (all anticancer drugs can act as rodio senitizers Except: Cyclophosphamide	• Amifostine-can't cross BBB • Antioxidants-Vit A, C, E • Pentoxiphylline • GM-CSF

Law of Bergonie

- Radiosensitivity (of any tissues/cells) ∝ 1/differentiation

Type	Most radiosensitive	Least radiosensitive
• Cell type	Undifferentiated, rapidly dividing cells	Well differentiated, quiescent cells
• Blood cells	Lymphocytes	Platelets
• Cell cycle phase	G2-M	S
• Ocular structure	Lens	Sclera
• Retinal layer	Retinal vascular endothelium	RPE>GCL
• Organ	Gonads	Vagina
• Tissue	Bone Marrow	CNS

Acute radiation syndrome 00:25:54

- Occurs with accidental exposure of very high dose radiation.
- Result of nuclear accidents

Hematopoetic syndrome	GI syndrome	CNS-CVS syndrome
• Threshold: 2-8 Gy	4-12 Gy	20-100 Gy
• Death: days-weeks	Hrs-days	< 48 hrs

Radiosensitive tumors	Radioresistant tumors
• **W** - Wilms tumor	• **H** - Hepatocellular Ca, RCC
• **E** - Ewing sarcoma	• **O** - Osteosarcoma
• **L** - Lymphoma, lukemia	• **M** - Melanoma
• **M** - Multiple myeloma	• **P** - Pancreatic Ca
• **S** - Seminoma/ Dysgerminoma	

How to remember

- WELMS

How to remember

- HOMP

Prophylactic Craniospinal irradiation:

- There is no metastasis but because of very high predisposition of micrometastasis, prophylactic craniospinal irradiation is given
  - Small cell carcinoma lung
  - ALL
  - Medulloblastoma

Drop metastasis

- Contrast enhanced MRI showing Sugarcoated spine / Zuckerguss appearance of drop metastasis
- Brain tumors which have predisposition for drop metastasis:
  - Medulloblastoma

- Glioblastoma
- Pinealoblastoma
- Ependymoma
- Choroid plexus carcinoma
- Germinoma, lymphoma, leukemia

Important one-liners

- M/C side effect of radiotherapy: Erythema
- M/C RT-induced Malignancy: Leukemia
- M/C brain tumor after cranio-spinal radiotherapy: Meningioma
- M/C RT-induced thyroid carcinoma: Papillary ca thyroid
- M/C bone cancer after RT: Osteosarcoma

FRACTIONATED RADIOTHERAPY

00:38:20

- A patient with Ca Cervix, Total targeted dose for her RT = 60Gy but 60 Gy can't be given in one go because it can be harmful for organs situated around cervix. So, total dose is divided into various fractions.
- **Conventional fractionation:** 60 Gy is divided into 30 fractions of 2 Gy each (5 days a week OD), then stopped for 2 days and then again 5 days a week same is repeated.
- **Hyper fractionation:** 60Gy is given as 1.1 Gy BD (5 days a week BD),then stopped for 2 days and then the same is repeated
- **CHART (Continuous hyperfractionated accelerated radiotherapy)**
  - Used for Non small cell Ca lung
- **Hypofractionated Radiotherapy**
  - Radiation used as Palliative method.
  - The entire dose is given as single regime.
  - Commonly used in bone metastasis(~ 8 Gy dose) for palliation.
- **Fractionated RT: 5Rs**
  1. Repair -for normal surrounding cells
  2. Repopulation
  3. Reoxygenation
  4. Reassortment/Redistribution
  5. Radiosensitivity

Previous Year's Questions

Q. Five 'R 'of fractionated radiotherapy are all except: (PGI 2019)

A. Repopulation
B. Reoxygenation
C. Repair
D. Redistribution
E. Radiation recall

RADIATION RECALL SYNDROME

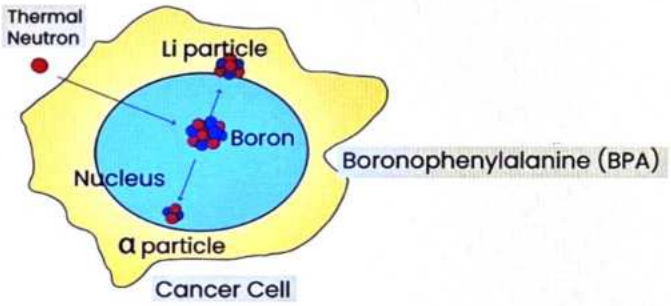
- Occurs weeks -months after radiation
- Occurs with the administration of chemotherapeutic drugs
- M/C seen with Anthracyclines

HODGKIN'S LYMPHOMA RADIOTHERAPY

00:48:30

Refer Table 24.1

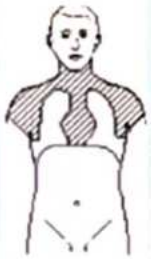
Boron neutron capture therapy (BNCT)



Two steps procedure

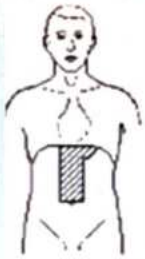
1. IV injection of BPA (boronophenylalanine): Preferentially enters into cancer cells
2. Irradiate the patient with isothermal neutrons

Table 24.1

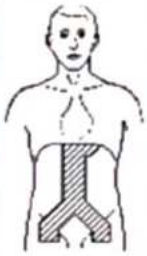


Mantle field radiotherapy

- Bilateral cervical nodes
- Bilateral supra clavicular as well as infraclavicular nodes
- Bilateral axillary lymph nodes
- Bilateral hilar lymph nodes
- Bilateral mediastinal lymph nodes



Paraortic lymph node field

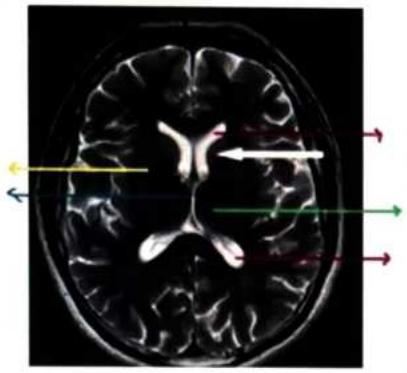


Inverted Y field

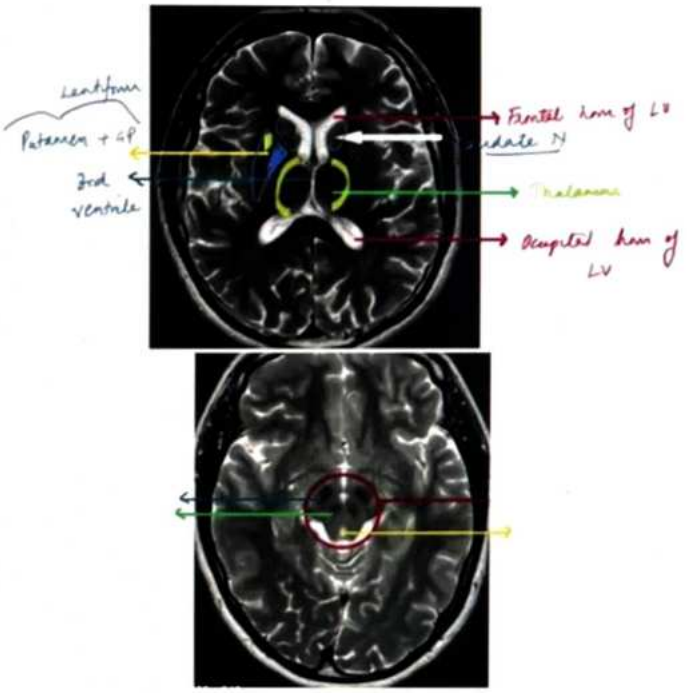
- Paraortic lymph nodes
- Pelvic lymph nodes
- Inguinal lymph nodes
- Spleen

Total nodal irradiation

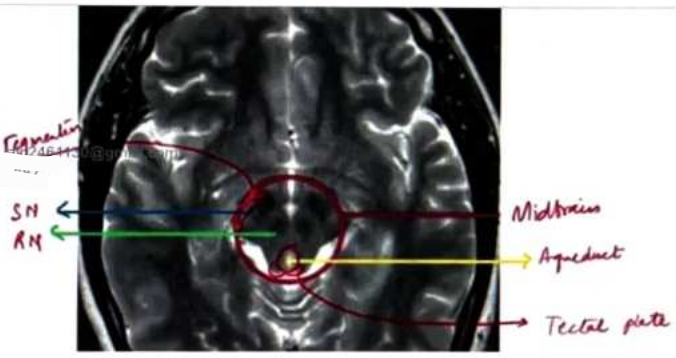
25 RADIOLOGICAL ANATOMY

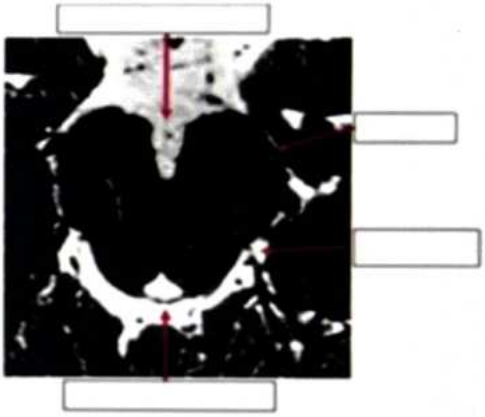


- T2 MRI axial section through the brain at the level of basal ganglia
- Two frontal horns of lateral ventricle are separated by septum pellucidum
- Red arrow: Frontal and occipital horn of Lateral ventricle
- Green arrow: Thalamus
- Yellow arrow: Lentiform nucleus: Putamen laterally and Globus pallidus medially
- White arrow: Caudate nucleus
- Blue arrow: 3rd ventricle
- B/w caudate and lentiform: Internal capsule
- Lateral to lentiform nucleus: External capsule
- Lateral to external capsule: Clostrum
- Lateral to clostrum: Extreme capsule



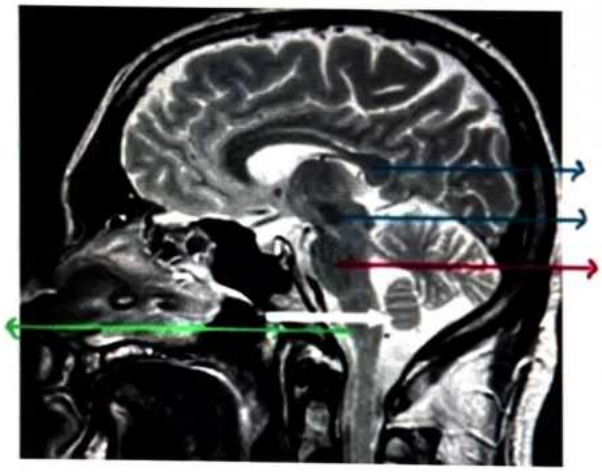
- Section at mid brain
- Red circle is entire mid brain
- Blue arrow: Substantia nigra, It is filled with melanin and appears hypointense on MRI
- Anterior to substantia, tegmentum is there
- Green arrow: Red nucleus
- Yellow arrow: Aqueduct of sylvius
- Posterior to sylvius are the coliculi(superior and inferior) which form the tectal plate





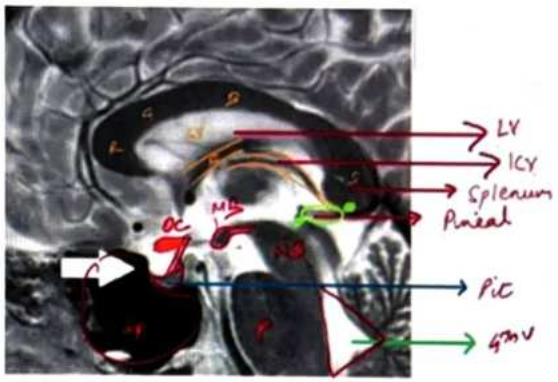
- Cisterns around mid brain are known as perimesencephalic cisterns {ICAQ}
- Anteriorly between the cerebral peduncles is interpeduncular cistern
- Crural cistern
- Ambient cistern(PCA runs in this)
- Quadrigeminal cistern

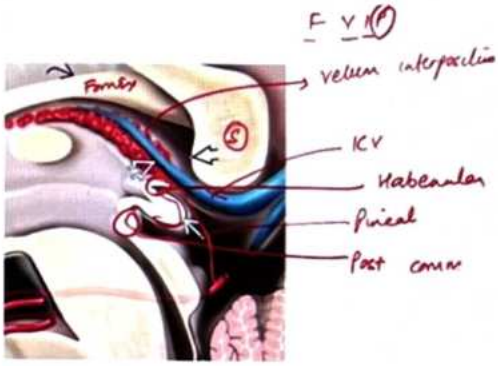
- Section at Pons
- White arrow: Flow void on MRI is Basiliar artery



- T2 MRI
- Lower Blue arrow: Mid Brain
- Red arrow: Pons
- Green arrow: Medulla
- At the inferior most part of 4th ventricle, there is nucleus gracilis: Beyond this point, medulla continues as Cervical cord
- White arrow: Cerebellar tonsil
- Corpus collosum has 4 parts: Rostrum, Genu, Body , Splenium
- Upper blue arrow: Splenium is marked

- Red arrow: lateral ventricle
- Above red arrow: Corpus collosum
- Famous VIP
  - Superiorly Fornix
  - Vellum interpositum
  - Internal cerebral vein
  - Pineal gland
- Above pineal gland: Hebenullar commissure
- Below pineal gland: Posterior commissure
- White arrow: Pituitary gland



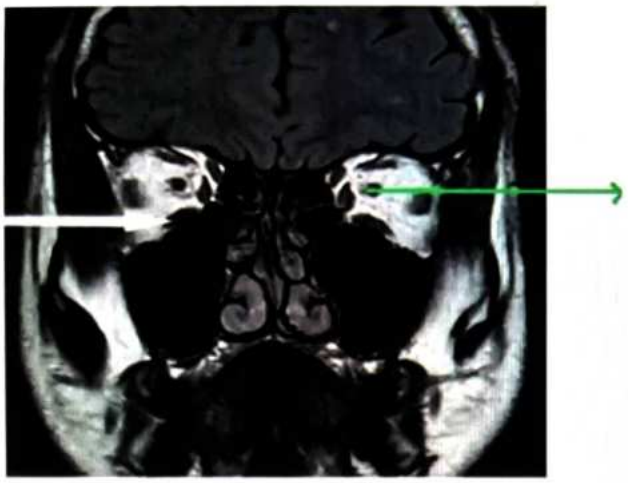


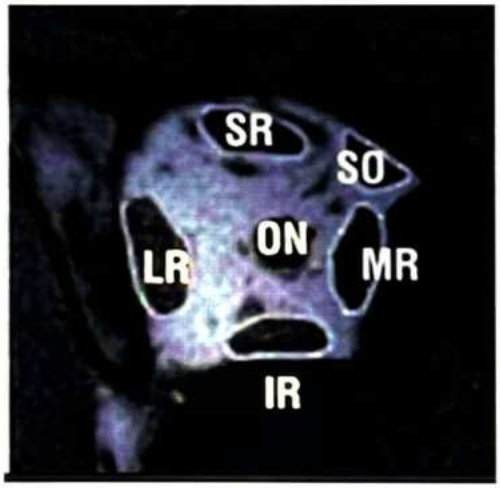
Previous Year's Questions

Q. Identify the structure marked by arrow: (FMGE 2020)

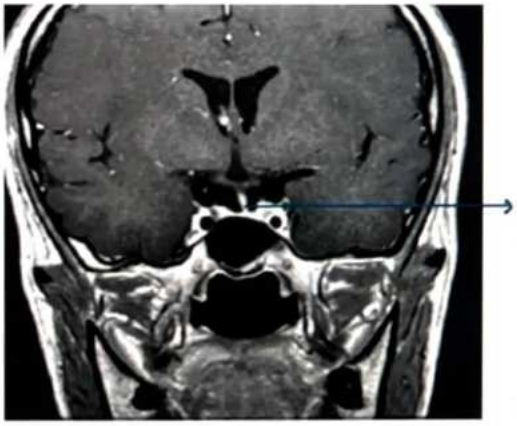
A. Optic nerve
B. Right medial rectus
C. Left medial rectus
D. Right lateral rectus

Explanation: As the bones are white, so it is a CT scan. Structure marked is right medial rectus.

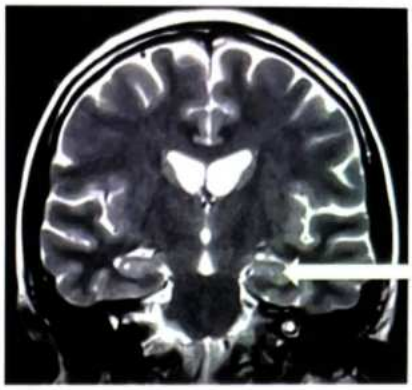




- This is a MRI coronal section, green arrow marked is optic nerve

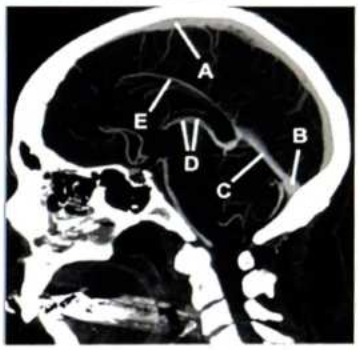


- Coronal image at the level of sella
- Blue arrow shows infundibulum/stalk arising from the pituitary
- Superior to the infundibulum is the optic chiasma



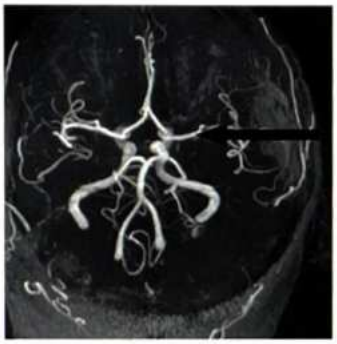
- White arrow: Hippocampus
- Hippocampus undergoes atrophy in mesial temporal lobe sclerosis.

VENOUS SINUSES ANATOMY



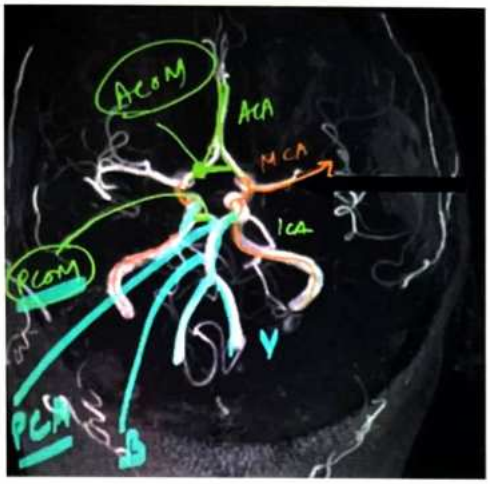
- CT venography is shown
  A - Superior saggital sinus
  B - Confluence of dural venous sinuses
  C - Straight sinus
  D - Internal cerebral veins
  E - Inferior saggital sinus
- Internal cerebral veins combine to form vein of gallen.
- At the confluence: TOSS
  - Transverse sinus
  - Occipital sinus
  - Superior saggital sinus
  - Straight sinus

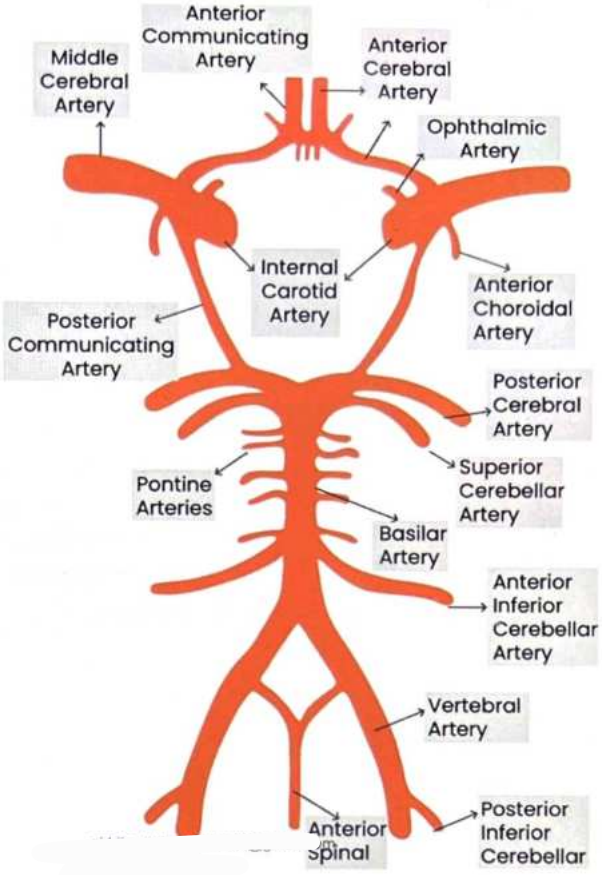
ARTERIAL ANATOMY AT THE LEVEL OF CIRCLE OF WILLIS



MR angiography

- Black arrow: Middle cerebral artery, does not form a part of circle of willis
- Junction of ACOM: MC site of aneurysm





PREP NUGGETS

Prep Nuggets

	Ionization Power	Penetrating power
Maximum	_____	_____
Minimum	_____	_____

Prep Nuggets

	Mammography	Radiography
Target	_____	_____
Window	_____	_____
Filter	_____	_____

Prep Nuggets

Modality	Dose
CXR	Bacterial cause
Skull x ray	_____
_____	1 msv
_____	2msv

Prep Nuggets

Bubbles	Seen in
Single bubble	_____
_____	Duodenal atresia
Triple bubble	_____

Prep Nuggets

Test	Lecal volvulus
_____	Clockwise rotation
Haustra absent	_____
_____	Single loop

Prep Nuggets

Tumors

Radiosensitive	Radioresistant
_____	_____
_____	_____
_____	_____
_____	_____