Radiology
Handwritten Note

MBBS Help
http://mbbshelp.com
http://www.youtube.com/mbbshelp
http://www.facebook.com/mbbshelp.com

Name: _________________________________________

Subject: ___________________ Radiology ___________________
Q: What kind of radiotherapy do you use in skull base Chordoma
   a) x-rays
   b) uv rays
   c) protons
   d) [blank]

Q: Kernohan notch phenomenon is seen in?
   a) [blank] herniation
CT SCAN

Sir Godfrey Hounsfield
1972
Novel Prize – 1979
ENGLAND
He was working for EMI (Electrical Musical Instruments)
they also made BEATLES

Computed Tomography

X-Ray

Attenuation - x-ray stopping power of tissue

if tissue doesn't stop
x-ray
↓
Black.

Computed screen has expanded grey scale.

Hounsfield created a scale of attenuation values of each tissue

<table>
<thead>
<tr>
<th>White</th>
<th>Haemorrhage (60-70)</th>
<th>+1000 ← Bone, calcium</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Brain (30-60)</td>
<td>0 ← of water</td>
</tr>
<tr>
<td></td>
<td>Fat (-100)</td>
<td>-1000 ← AIR (much less)</td>
</tr>
</tbody>
</table>

Hounsfield Scale: attenuation
Homfeld value of fat = -100

More black than H2O

Less than water

Brain: 20-40

Hyperdense → white

BRAIN

Hypodense → Dark

target according to the organ

Q. -100 HU on CT — RECALL

a) Fat  

b) Water

c) Brain  

d) Bone

Q. AIIMS

Child → Bil Renal Tumour → CT Scan → -100 HU.

What is the mode of inheritance of this disease

Angiomyolipoma → Tubercular sclerosis → AD inheritance

Supero- Inferior Dimension Appreciation

1) Orbit

2) Sylvian fissure

3) A & P Horn of Lateral Ventricle

At level of orbit -

orbit → Temporal lobe → Brochmen

Cerebellum
P. No- 14

Inferior orbital canal
1st, 2nd, 3rd n/v

Olfactory nerve

Inf. Horn → Hippocampus
Trigeminal n/v

Basilar artery

Pons

Cerebellum.

Cerebellopontine angle → Cistern (Veibhilar cisternoma)
Nevee midline then laterally

N/V arising in front of Pons towards cavernous sinus
→ Trigeminal n/v.

Trigeminal n/v

Bilateral artery

⇒ T origin

Due to atherosclerosis of branch of Basilar artery
pulsating on Trigeminal n/v

⇒ Trigeminal Neuralgia

Rx → Carbamazepine
In early Hydrocephalus, Inf. horn in 1st part to be ballooned out.

Inferior horn of lateral ventricle.

Dense MCA
Earliest sign of CT. of Enforen.

1. Amygdala
Ant to the medial (meatal) Temporal lobe.

2. Uncus
Hook like structure.
Host medeal.

3. Hippocampus
1st part to degenerate in Alzheimers Disease.

Cranial Pharyngioma

Suprasellar Cistern
Below pituitary
Infundibulum is present

Pharyngeal part of Rathke's Pouch, remnant from Tx Craniopharyngioma

Pituitary Cranial Development Pharyngeal.
Above the level of orbit

1. Aqueduct of Sylvius
2. Optic tracts
3. Unicu
   - Unical Herniation
   \[\downarrow\]
   Lead to compression of mid brain
4. Basilar artery
   In Interpeduncular fossa \(\rightarrow\) it devides to form
   Post. cerebral artery & terminate here
   Unicu Herniation may comprer this \(\rightarrow\) leading to bleeding & blindness
**UNCAL HERNIATION**

Kernohan's notch.

↓

 tmpl opposite to the side of lesion (uncal herniation)

**FALSE LOCALIZING SIGN**

Weakness + on ipsilateral side

- deep to sylvian fissure
- ant horn of lateral ventricle
- foramen of Monro
- 3rd ventricle
Putamen is M/c Site for H/N haemorrhage in brain.

Body of lateral ventricle

Corpus callosum separates the lateral ventricles.

In case of Agenesis of corpus callosum
Parallel Lat. ventricle
"Racing Car Appearance
(Small Body = Big wheels)
SAH

Endovascular clipping → by neurosurgeon

If cannot be done

Endovascular clipping by neuro &

Venous Thrombosis

Venous Thrombosis is found in hypercoagulable state

Nephrotic syndrome

Superior Sagittal Sinus Thrombosis

Causes bilateral venous infarcts.

Venous infarcts are red infarcts. (Haemorrhage)

Arterial are white infarcts.

Internal cerebral vein thrombosis

Infarct of thalamus. (Red Infarct)

Sup. Sagittal sinus is medially posteriorly placed

Discontinuous data

Spiral CT

Helical CT

Continuous data
CT scan only with Axial (Transverse) Sections.

*Cardiac CT* → done for coronary calcium scoring

"AGATSON's SCORE"

used for screening of atherosclerosis

~ 130 - cut-off atherosclerosis

~ 400 - SEVERE

Ioc for: Anomalous coronary origin.

ALCAPA: anomalously coronary artery Pulmonary artery

↓

MI in childhood

Ioc = cardiac CT.

PAT
June 2015

Ionizing Radiations:

- γ
- β
- α
- X-Ray
- IR
- Light
- Sound
**α-RAYS**
- Made up of Helium nuclei \( \text{He}_4^+ \) - 2 protons - Heavy
- 2 neutrons - Charged
- Least penetration
- Maximum ionization potential
  - "" Biological Damage

**β-RAYS**
- Made up of electron particles
- Used in systemic radiotherapy
  - Iodine \( \rightarrow \) Thyroid
  - Phosphorus \( \rightarrow \) Bone

**γ-RAYS**
- High energy, high frequency electromagnetic waves
  - "Intranuclear"
- Max. penetration
  - \( ^{99}\text{Tc} \) Low energy
  - \( ^{60}\text{Co} \) High energy
  - Used in diagnosis
  - Used in therapy

**X-RAYS**
- High energy, high frequency electromagnetic wave
  - "Extranuclear" in origin
  - Not produced by radioactive decay
- Velocity of \( X \)-rays: \( 3 \times 10^8 \) m/s
- Wavelength of diagnostic \( X \)-rays: 0.1 to 1 Å
Addition's effect

Electron emitted through cathode

Melting pt. = >3000°

* X-Rays are produced when rapidly moving electrons are halted. They are called Bremsstrahlung X-Rays. They mean breaking or braking.

Rotating anode: Tungsten + 10% Rhenium.

X-Rays [continuous spectrum of energy].

Mech. of heat loss in modern X-Ray = RADIATION.

R → Rotating anode
Rhenium
Radiation.

10⁻¹⁰ m = 1A

Diameter of atom.
Characteristic X-RAYS

Low energy X-rays → no imaging

Intermediate... → cause ejection of electron from K-shell

Photoelectric effect
(occurring on K-shell)

Energy Released
[Characteristic X-rays]

Leading to formation of characteristic image on film.

Image formed is latent image

High energy X-ray →

Random scattering of electrons from outer shell due to high energy X-rays

COMPTON EFFECT

Bremsstrahlung... → these lead to exposure
Thickness of Pb apron = 0.5mm thick

Badge on chest = TLD Badge

\[ \text{Thermoluminescent Dosimetry} \]
check every 3 months

Max permissible dose v for occupational exposure of radiation

\[ \frac{20 \text{ mSv}}{\text{Annun.}} \]

Photosensitive emulsion
\[ \text{AgBr} + \text{Iodide} \]

Double coated film.

Most sensitive to → Blue Light

Least " " → Red Light

In dark room, safe light = Red Colour

Image can be processed → post.
K = contrast
V = voltage
P = penetrating power

KVP (Kilovolt Peak)

HAS (Hiliumphere second)
Blackening seen in the
Radiation dose received
by patient

Obese → KVP have to be ↑

High KVP
Low KVP

Contrast ∝ \frac{1}{KVP}

Penetration of KVP
Mammography
Made up of Molybdenum.

Characteristics:
X-Rays

When e- strikes Mb → they enter Mb

Released e- from inner shell → characteristic rays

Low Voltage

Routine mammography → CC (Cranio-Caudal)
MLO (Mediolateral Oblique)

Single Most Important X-Ray in Breast
= MLO

Mammography film = single coated
Radiation exposure in mammography = more than CXR.

Routine Screening for Ductal Carcinoma In Situ
= Mammography

ACR = 40 yrs - annual mammogram

American = 45 yrs
LA Society (Better)
IoC for High Risk Screening DCIS \( \Rightarrow \) MRI

MRI \( \rightarrow \) DCIS = microcalcification = \text{False}

\[ \rightarrow \text{Ductal enhancement} \]

Also seen in Perimenstrual \& Physiology

\[ \rightarrow \text{False} \]

Breast MRI \( \Rightarrow \) Done in 2nd Week

Most Sensitive IoC for DCIS \( \Rightarrow \) MRI

IoC for Breast Implant \( \rightarrow \) MRI

evaluating

IoC for Breast Abscess \( \rightarrow \) USG.

IoC for Scar vs recurrence \( \Rightarrow \) HRI.

IoC for Solid vs cystic \( \rightarrow \) USG

\[
\text{IoC - Lump \quad young \, \text{female} \Rightarrow USG}
\]

USG has poor sensitivity for DCIS.

\[ \rightarrow \text{Capsule formed} \]

\[ \rightarrow \text{Implant} \]

\[
\text{If Both Ruptures} \quad \rightarrow \text{Implant would go in Breast parenchyma} \]

Inflammation

\[ \rightarrow \quad \text{Prefers in Inflamed Breast} \]
Intracapsular implant rupture in USG.

\[ \downarrow \]

STEP LADDER PATTERN

\[ \downarrow \text{stepladder pattern in abd} \rightarrow \text{small bowel obstruction} \]

BIRADS

Breast Imaging Reporting & Data System

PIRADs → Prostate

TIRADS → Thyroid

LIRADS → Liver

BIRADS 0

Inadequate for opinion
Advised - USG, mammography

BIRADS 1

Normal
Continue routine screening,

BIRADS 2

Benign

BIRADS 3

Probably benign, < 2% chance of malignancy
Short term 6 month follow up

BIRADS 4

Suspicious of malignancy

a = low

b = intermediate

c = high

By American College of Radiology
BIRADS 5
S/O malignancy \( \geq 95\% \)

BIRADS 6
R/o Biopsy proven malignancy

BIRADS -

a) mammogram
b) USG
c) MR HRI

d) All of above

Q 0- multiple Breast lesion -
one - benign,
other - malignant

BIRADS -?

\( \rightarrow \) single impression based on most malignant
lesion.

BIRADS used in MRI different from mammography.

Each breast given separate.

BIRADS
MRI

1.5 Tesla

Q. HRI magnet is switched off in both study & False.
always on.

Mag. field strength = 1.5 Tesla
" of earth
> 50 mT.

In 3T MRI = twice mag. field
Better Image Quality

7 Tesla & 0.5 Tesla are also in research.

RF pulse → Echo
H⁺ protons → DIPOLE

H⁺ ions get aligned in our body according to magnetic field
RF pulse when introduced → H⁺ ions will go toward RF pulse
When RF pulse switched off → H⁺ comes back to its normal position.
Spin lattice relaxation time -

Time required by $H^+$ to return to $\text{G}'$ position

$T_1$ - $\text{WI}$ based on $\text{spin-lattice}$ relaxation time

$T_2$ - $\text{WI}$ based on $\text{spin-spin}$ relaxation time

$T_E$ - Echo time short

$T_R$ - Repetition time short

Relative $\text{C/I}$

$\text{CSF} - \text{Hypointense}$

$\text{FAT} - \text{White}$

$T_1\text{WI}$ white

$T_2\text{WI}$ hyperintense

Claustraphobic

MRT - safe in $\Box$

Equally hyperintense on $\Box$
③ Cortical Bone
  Ca^{2+}
  Dark
  Dark

④ AIR
  Dark
  Dark

⑤ Tendon Ligament
  Hemiww
  Dark
  Dark

⑥ Hemosiderin
  Dark
  Dark

⑦ Flowing Blood
  Dark
  Flow void

⑧ Calcification & Hemosiderin
  Not visualized in MRI,
  can't be differentiated
  ↓
  To differentiate them
  Susceptibility weighted Imaging (SWI)
  Salt & pepper on MRI ⇒ Glomus Tumor

⑨ Vascularity
**T1 WI**
- CSF: Dark
- Oedema: Dark
- Melanoma: White
- Melanin (Magnetite): Dark

**T2 WI**
- White: White
- Preferred in Brain pathology

**FLAIR**
- Dark (free water)
- White

**Diagram**
- ACL
- PCL
- Cartilage is seen on MRI.
- ACL → from intercondyle to Ant. Tibia.
- Cinema Hall Pain -
  - Chondromalacia patella
  - Seen - Behind the patella → patellar cartilage softer

**Notes**
- Absence of Bow Tie = Meniscal Tear.
**PATELLA ALTA:**
Patella Higher than the knee position

**PATELLA "BAJA "**
Patella Lower than the knee position

**STIR MRI → for Bone Edema.**

<table>
<thead>
<tr>
<th>Short Tall Inversion Recovery</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1 WI</td>
</tr>
</tbody>
</table>

- **Hemorrhage → White**
- **Edema → Dark**

White White White Signal of marrow fat suppression

Injury to medio-collateral ligament → Conservative Management

More commonly injured

Degenerated tendon of adductor Magnus

**Achilles Tract**

**Gerdy's tubercle**
Bankart's Lesion
→ seen in antero-inf. glenoid labrum

Hill Sachs's Lesion
→ seen in postero-lateral Humerus

Reverse Hill Sachs → antero-medial
In post-Delabration

Hatchet Defect → In. Ankylosing Spondylitis

Supraglenoid labrum + → related to Long Head of Biceps.

1st Inv to be done in Rotator cuff tear = USG
IOC for Rotator cuff tear = MRI
Gold Std → Arthroscopy

CT
Ac. Head Injury
Ac. Brain H'ge
Calcification

IOC

Cortex of Bone → seen better in CT Scan
so, for # → CT,
for Marrow → MRI.

Stress # → may or may not be cortical #
so, Better seen in MRI

Bl. multiple stress # → Bone Scan
In Acute OMs ⇒ MRI.
Intraosseous Bone Juxta ⇒ MRI
AVN ⇒ MRI

Italian:
Q: Chronic alcoholie taking & red wine developed decrease of corpus callosum - is syndrome?
"MARCHIFAVA BIGNAMI"

LIPOMA in Brain? Yes

H/c Site of Lipoma in Brain = [Pericallosal]

( ) → Bracket shaped calcification

H/c Pineal Gland Tx = Germinoma
Pinealoblastoma → associated to Retinoblastoma
Pineal is located in post. part of 3rd ventricle
↓
Compress sup. colliculus & is required for vertical gaze
↓
So, in pineal enlarge, compress sup. colliculus

PERINAUD sx (upward gaze palsy)
Tuber Cerei

\[ \rightarrow \text{Ant to mamillary body} \]

\[ \rightarrow \text{Hypothalamic Hamartoma} \]

\[ \rightarrow \text{Presents in Precocious Puberty} \]

\[ \rightarrow \text{Gelastic Seizures} \]

\[ \rightarrow \text{Bouts of Laughter} \]

On MRI

\[ \rightarrow \text{White spot} \]

\[ \rightarrow \text{Post-Pituitary} \]

\[ \rightarrow \text{Pituitary gland} \]

\[ \rightarrow \text{Appears white due to Vasopressin (ADH), as it has magnetic properties.} \]

CV Jun ( Cranio Vertebral)

\[ \text{Clivus + Vertebrum + Occipital} \]

\[ \text{Basephenoid} \]

\[ \text{Basioccipital} \]

\[ \text{Ant \& Post arch of atlas} \]
Tonsil is above the level of foramen magnum.

* Small Posterior Fossa
  - Tonsil goes below foramen magnum
  - Tonsillar Herniation
  - Chiari - I Malformation
  - Arnold Chiari Malformation
  - Chiari - II Malformation
  - Spina Bifida/myelo meningocele

Q. Why when Chiari I malformation will present to hospital?

Any 2nd Decade → Syringomyelia

↓

Cauda T

Tx /\ → Trauma

Arnold Chiari malformation.

↓ Lemon sign ↑ in antenatal USU

Banana sign

Tectal Beaking

Luschkandel Skull → Locarno Skull
**DANDY WALKER**

- 4th ventricle freely communicate to esp. filled space behind cerebellum.
- Vermian agenesis
- Post. fossa cyst

0 presents quadriplegicae.

(Conc. C-V Junc' AbN)

- Rheumatoid arthritis → inflammation of synovium in C1-C2 region.
  - Distance Bet'w atlas & vertebral column [atlanto-axial dislocation].
  - Pressing on spinal cord.

* Upward migration of odontoid process into foramen magnum → **BASILAR INVAGINATION**

* **DOWN'S SYNDROME**

CV Junc' abnormalities:

So, before operating → X-ray neck is imp. in Down's syndrome

1. to look for CV Junc' Abnormality
MORQUI Syndrome
Mucopolysaccharidoses
W type ab ④

OSTEO-MALACIA
Softening of skull base
Osteogenesis Imperfecta
Paget's Disease

CHÂVUS [Skull Base Ab ⑧]

CHORDOMA
1. Remnant of notochord may form Tx
2. M/c — Sacrococcygeal area
3. Also seen in clavicle
4. Pharyngeal cells, cells of notochord

Radiotherapy

Congenital Medullary cyst / Thorne Waldert Cyst

Pharyngeal endoderm comes to join notochord
MR Spectroscopy

I

Choline ↑ → ↑ cell membrane = Malignancy

Creatine ↓ → metabolite ↓

NAAG → glioma at no neuron ↑↑

II

Elevated levels of NAAG

NAAG is metabolized by Asparatoacylase

So ↑ NAAG → ↑ of asparatoacylase

CARAVAN's $S_X$

III

Lipid ↑ → Tuberculoma.

↑ neurosis
Alanine Peak on HR spectroscopy \(\rightarrow\) MENINGIOMA

\[
\text{DW-HRI} \\
\text{Based on Brownian Imaging Moton} \rightarrow
\]

Ischaemia \(\rightarrow\) ATP↓ \(\rightarrow\) Na\(^+\)/K\(^+\) ATPase stop

Working

\(\uparrow\) neuron swelling

\(\text{cytotoxic oedema}\)

\(\downarrow\) endothelial cell damage

on routine CT/HRI \(\rightarrow\) vasogenic oedema

appear on 6-24hrs

3-30 min. of onset \(\rightarrow\) 4 h by DW-HRI.

use of thrombolysis can be done

Functional HRI

MRCP

Iod for choledochal cyst \(\rightarrow\) HRCp.

Lack of chain of these appearance \(\rightarrow\) on chr. Pancreatice

Linear filling defect in Bile Duct \(\rightarrow\) Worm

\(\text{Biliary Ascarisis}\)
Duct of Santorini → opening in Minor papilla

Pancratic Divisum

Opening in Major papilla

Minor papilla is narrow. So there is not much space for drainage.

Presents with Pancreatitis Recurrent

Diffusion Tensor Imaging

Pt. Underwent RTA 1 month back, since then he is comatose. CT scan looks 

CT scan

1. Diffuse Axonal Injury

Hlc site → Grey-white Junction

By diffusion tensor imaging → can be aneurysm

Mlc Berry aneurysm

Barclay Top aneurysm

More likely to rupture.

HR angiography is used to screen cerebral angiography

IOC for cerebral aneurysm → CT scan

ADPKD → have more chance of Berry aneurysm

HR angiography for screening
Single ACA \rightarrow Azygous ACA \rightarrow
\begin{align*}
&\text{If thrombosis occurs} \\
&\text{B/L infarction [ B/L infarct also venous thrombo.]} \\
&\text{Fetal PCA} \\
&\text{Blood supply from Int carotid artery}
\end{align*}

Thalamus derives blood supply from PCA.

In case of fetal PCA:
\begin{align*}
&\text{If thrombosis occurs} \\
&\text{B/L thalamus infarct.}
\end{align*}

\text{Artery of Percheron} \rightarrow \text{D/B venous}
\begin{align*}
&\text{Internal} \\
&\text{venous infarct}. \\
\end{align*}
Recurrent artery of Heubner

L. Branch of Ant. cerebral artery

commonly injured by Sx while clipping Ant. cerebral artery aneurysm.

cardate

area supplied by recurrent artery of Heubner

Q. Pt develops supraclinoid ICA stenose.

Ischemia + progressive collateral formation occurs gradually

MOYA-MOYA DISEASE

Puff of smoke appearance

collateral formation.
MR Venography

*Vein of Galen malformation*

Congenital AV fistula in mid brain.

Vein of Galen dilated

Hydrocephalus

High output cardiac failure

Joc: MR Venography

Dye

CT Scan \implies Iodinated contrast

Radio-opaque

He + soft tissue

Most radio-opaque dense soft tissue of body

= THYROID

Iodinated contrast

\text{Iodine}

Monomer \quad Demer

Non-Iodine

\text{Non-Iodine}

Monomer \quad Demer

Depending on Benzene Ring

\text{Monomer Demer}
Iodene : Particle ratio → 3:1

\( \text{Monomer} \quad 600 - 800 \text{mosm} \)

\( \text{Demer} \)

not used nowaday 

due to ↑ osmolarity property

\( \text{Diatrizoate} \)

\( \text{Ioxaglate} \)

\( \text{Non-Ionic} \)

\( \text{Monomer} \)

\( \text{Demer} \)

300 mosm (isotonic)

- Iohexol
- Ioversol
- Iopamidol

\( \text{Iodoxanol} \)

\( \text{Io tralan} \)
**Idiosyncratic**

Direct & Histamine Release

Anaphylactoid Rxn.

(Non-IgE)

Adrenaline - life saving

Test Dose prediction → No

**Tubulo-Interstitial Injury**

Non-oliguric Nephropathy

Transient

**Contrast Nephropathy**

Hike in S. creatinine at least 0.5mg or 25% baseline measured after 48 hrs.

Prevention → Hydration

the nonionic dye

\[ \text{[N-acetyl cysteine]} \]

[\text{Sod. bicarbonate}]

Preserve T1

2018 → No role of N-acetyl cysteine & Sod. Bicarbonate.

**Gadolinium**

Used in MRI

Lanthanide

Para-Magnetic Substance → Unpaired electron in outer shell (2)

Reduce T1

CE MRI →

1) T1 wt 2) T2 wt 3) FLAIR
It is used as chelated form → Gd-DTPA

Gadolinium in itself is toxic substance.

Cerebral parenchymal barrier ↓

Teratogenic
↓

Should be "avoided in pregnancy"

Gd-DTPA
↓

If eGFR < 30 ml/min = CRF
↓

Renal excretion
↓

Gad accumulates
↓

Painful, multisystem febrile
FATAL
↓

Nephrogenic Systemic Fibrosis

In case of renal failure → plain MRI, CT.

Gd-DTPA → doesn't cross BBB

If there is inflammation in brain or aggressive neoplasm.
↓

They take up dye

Determinant of enhancement in brain → BBB
↓

Other tissue → vascularity
$\text{CXR}$

**True or False**

1) **CXR - PA view is mandatory if RTA $\Rightarrow$ FALSE.**

2) **CXR - AP view - True**

2) **AP - CXR.**

   a) Erect
   b) Supine
   c) Both.

AP + PA view are according to rays.
Lateral + oblique views are according to pelvis kept.
Rt side $\Rightarrow$ Rt lateral
Left side $\Rightarrow$ Left lateral

By default, if side not mentioned $\Rightarrow$ Left Lateral

**Steeple Sign** on Neck X-Ray = CROUP


If not, called **Rotation**

Rotation of on CXR -

a) Asymmetry in lung lucency $\&$ can be mistaken as pathology

b) Asymmetry - HILAR

c) Apparent cardiomegaly
Apparent cardiomegaly in CXR is due to

1) supine view
2) inspiration view
3) Rotation

* Hilum = Br. of Pulmonary artery + upper lobe veins

↓
L.N.
Tx
Dilatation of P. artery

↑ L.N. ↑↑↑ Hilum will not be concave.
↑ will be convex

Bronchovascular markings are usually ↑↑↑ in
Medial 2/3rd of Lung

Plethora = ↑ BVM
= > Medial 2/3rd of Lung

Air Bronchogram seen in Pneumonia

<table>
<thead>
<tr>
<th>Fluid Detected</th>
</tr>
</thead>
<tbody>
<tr>
<td>By X Ray = 100 - 200 mL</td>
</tr>
<tr>
<td>(150 mL)</td>
</tr>
</tbody>
</table>
Vanishing Lung : BULLA

General Pleura not
- 'causent unlikely not parallel to chest wall,

- Vanishing Pleura Line Sign Absent

- RTA & Blunt Abd. Trauma → 1st STEP evaluation
  - FAST → Focused Assessment & Sonography in Trauma
  - Done by ER Physician.
  - Take under 5 min.

- Hemoperitoneum,

- How much Blood can be detected by FAST
  >200 ml (50-250 ml)

1. 1st epigastric = for cardiac tamponade
2. 2nd flank = for Morrison's pouch
3. 3rd flank = for splenic Blood
4. 4th → for pelvic collector

- eFAST = extended FAST
  for thoracic evaluation.
IOc for Blunt Abd. Trauma: CECT.

FAST & 1st Inv.

IOc for Blunt Abd. Trauma, haemodynamically unstable = FAST

**Collapse of Lung**

→ Loss of aeration.
→ Evidence of volume loss
↓
  Trachea
  mediastinum
  Fissure

In children, collapse of lung → F.B.

In chronic smoker → Bronchogenic Cancer

**Silhouette Sign**

Mediastinal Border can only be obscured by pathology if are in direct contact anatomical.

Q. Avulse knob is quite obscured by:

A) LUL - Ant.
B) LUL - Post.
C) Lingular
D) LLL.
Aortic knob = post. part.

L, application of silhouette sign.

- Aortic knob
  - Posterior part
  - Of aortic arch.
  - From where descending aorta is visible.

* Lingula = part of L upper lobe

LUL collapse
- Oblique fissure go anteriorly.
- Hyperinflation of lower lobe.

LUL - collapse → not easy to see as hyperinflation of LL obscures collapse of UL.

Difference Betw. Collapsed → Consolidation

Q. Air Bronchogram is a sign of Alveolar Pathology.

* Pores of Kohn [appear white]
  - Put spread through pores of Kohn & not by Bronchus.

Causes:
1) Pneumonic consolidation
2) Pulmonary edema = alveolar fluid.
3) Hyaline Membrane Disease
   → Alveolar collapse due to absence of surfactant.
   - But bronchus don't = air Bronchogram.
If Bronchus is occluded $\Rightarrow$ alveole + Bronchus occluded
$\Rightarrow$
So, no air Bronchogram

* Air Bronchogram usually absent in Bronchogenic cancer except in adenocarcinoma in situ (Bronchoalveolar Ca)

Adenocarcinoma in situ

architecture is maintained
only alveole involved

II Pulmonary Lymphoma

* Vocal Pneumonia
  Mycoplasma
  Pneumocytes xerost pneumone

** Interstitial Pneumonia
  alveole of wall are thickened
  No alveolar exudate

= RETICULAR OPACITIES ON CXR

Interstitial Lung Disease

Silicosis $\Rightarrow$ thickening of alveolar wall is even more

RETICULONODULAR OPACITIES ON CXR

HONEY COMB LUNG, Irreversible changes e, ILD.
IOC for ILD = HRCT

Thickness of section = 1-2mm
These sections are widely spaced
Then reconstruct image by Bone Image Reconstruction Algorithm.

Q. HRCT of Lung Infection
a) thick slice thickness
b) Large field of view
c) Bone algorithm.

 IOC for Bronchiectasis = Volumetric HRCT

Thin continuous section
It enables 3D reconstruction of image

Ball Valve Mechanism
In some bacterial pneumonia
air gets trapped inside, so air cyst formation occurs

(Pneumatocele)
1) Staph. Pneumoniae
2) Klebsiella
3) Hydrocarbon poisoning
4) Lung injury

Pneumonysta Tenovus
Pneumocystis Jiroveci
= Reticular pattern.opaque.
= Pneumatocele

*PEX effusion.*

**Aspergillus**

17 Immuno compromised
- Angio-invasive aspergillosis

Red infarcts formed around fungus

CT = HALO SIGN

Reverse Halo Appearance on CT scan = ATOLL SIGN

Ocean
Lake
ATOLL
(Reverse Halo)
Halo
Invasive aspergillosis
Cryptogenic Organizing Pneumonia
(Bronchiolitis obliterans)
HYDATID

1) IOC = CEOT.
2) "GHARBI" classification → USG HYDATID
   (Egypt endemic for Hydatid)
3) Preparation of percutaneous
tore crescent sign [air perforate
   - endocyst
    = ectocyst].
    Oncor peel CXR
    or
    Curbo sign

If only endocyst ruptures but outer layers are intact
   → fluid comes out
   Daughter cells

Water-Lilly Sign = CAMALOTE
   Sign
   Rising Sun Sign

SIGNS ON X-RAY DEPENDENT ON OUTER LAYER PERFORATES

   Outer layer → Air crescent sign.
   Outer 2 layer → Oncor peel
   Innermost layer → Watch-Lily
                    or
                    Camalote sign.
DUPLEX DRAINING SYSTEM

- Urinary anomaly of upper urine tract
- Weigert–Meyer Law: upper moiety drains lower in the abs
- Upper pole is more prone to obstruction, lower pole more prone to reflux.
- If waters get fused, waters water.<br>Water reflux may occur<br>Yo-Yo reflux.

Q. All these are features of EXR - HYDATID except:

a) Water lily
b) Drooping lily

c) Floating lily

d) Rising sign

Ans:

Q. 21 yr old male & haemoptysis & X-ray - Canon-Ball as TB

4) Tubercular Tx

Adolescents:

Osteosarcoma

Child:

Wilms Tumour.

Neuroblastoma go to Bone.
STAGING OF SARCOIDOSIS ON CXR (SCADDING 'S)

1. LN - 1
2. LN + Parenchymal - 2
3. Parenchymal - 3
4. Fibrosis - 4

ROUND 'ATELECTASIS'
Pleural Pathologies

Pleura

Bronchovascular markings

Pulled

COMET-TAIL SIGN ON CT

ASBESTOSIS

Ant

Post
PCWP↑
↓
Fluid around vessels capillaries in lower lobe (LL)
(there is gas exchange)
↓
Hypoxia develop in LL
↓
Vaso constriction
↓
1st CXR = CEPHALISATION OF BLOOD FLOW

③ KERLEY A Lines
Phantom Tx, Thickeneg of Horizontal fissure

② LL lymphatics get [ Kerley B lines], Horizontal lines at lung base from bottom
Batwing appearance = Alveolar edema

8-12 mm Hg = (N) PcWP
13-19 mm Hg = Perivascular cuff < cephalization of
'LOWER LOBE'

20-24 mm Hg = Interstitial edema Kerley B
25mm Hg = Alveolar edema (Batwing
Pleural effusion)

ARDS

Non-cardiogenic Pulmonary edema

PcWP → (N)

Here, Pulmonary capillaries permeability ↑
No LL dominance
Here, Diffuse Opacity occurs
No cephalization
Cardiac size - (N)
Newborn lung is sunray appearance at hilum + thickened by horizontal fissure

TRANSIENT TACHYPOEDEA OF NEWBORN upto 48 hrs - CXR

Sunray appearance are due to lymphatic engorged

Smallest unit of lung - i.e CT visible

= 2° Pulmonary Lobule

\[ \text{Centrilobular (Ss)} \]

Endobronchial TB

Veins + Lymphatics in interlobular septa

Lymphatic (Any Disease)

Interlobular Septa

\[ \downarrow \]

Septal Lines on CT = Kerley B Lines on CXR

Kerley B Lines CXR. (Septal Lines on CT)

1) LVF
2) Sarcoidosis - nodules are around in lymphatic
3) Lymphangitic Carcinomatosis - cancer spreading through lymphatics of lung

Lymphatics are involved in all the 3.
ALVEOLAR PROTEINOSIS

CRABY PAVEMENT

RHD
Left atrial enlargement \rightarrow straightening of
\( \text{1. Border} \)
\( \text{2. Auricle} \)
present below MPA

Q. Earliest - CXR - RHD.
\( \text{a. straightening of} \) Heart Border
\( \text{b. Bulge below MPA} \)

\( \text{3. Mösle Mogul Sign on CXR} \)

If atrium gets enlarged due to other cause.
\( \text{\rightarrow 3. Mösle Mogul Sign is absent} \)

EBSTEIN'S ANOMALY

RA enlargement

Narrow vascular pedicle as reaches below \rightarrow get widened

\( \text{Box-shaped Heart} \)

\( \text{Pulm. Oligaemia} \)
Box-shaped Heart

LA enlargement

widens carina pushes oesophagus posteriorly

Hoffman Rigler sign.

enlarges anteriorly

Obliteration of retrosternal space

Retrosternal space widening on chest X-ray → EMPHYSEMA on lateral chest X-ray

HOFFMAN RIGLER SIGN ⇒ LV enlarged posteriorly to IVC

MILLER SIGN ⇒ CT ⇒ ANGIOFIBROMA
Pad of fat in front of heart

on Pericardial effusion

Separation Epidural Fat Pads on Lateral view = Oreo cookie sign

Oligemia =
  + Box shaped heart = Ebstein's anomaly
  + Boot = Tof

CARDIAC MRI
Most accurate Inv for Ventricular Func Assessment (Gold Std.)

Iodine → for Cardiac Tx
Iodine → for Pericardial Thickness
Indicated for Myocardial Evaluation.
  Scar Assessment → Delayed Enhancement
Indicated for Iron Deposit → Hemosiderosis
Apical HCM
Arrhythmogenic RV Dysplasia (ARVD)
  Peripatry Replacement of RV wall
PET (CARDIAC)

Ioc for Myocardial vitality

USG

PZT (Pb Zirconium Titanium)

PIEZO ELECTRIC EFFECT

Parameters

1) velocity of sound \( \propto \) Density of medium

\[ \text{AIR} = 330 \text{ m/s} \]

\[ \text{Humon Body} = 1540 \text{ m/s} \]

2) Wavelength depends on thickness

\[ \lambda = 2T \]

\[ T = \text{thickness} \]

\[ \frac{C}{\lambda} = \text{FREQUENCY} \]

3) Frequency \( \propto \) Image Resolution

\[ d = \frac{1}{\text{depth penetration}} \]
Routine abdominal USG

Frequency = 3.5 to 5 MHz

TVS/TRUS - 5-7.5 MHz

- Superficial orbit
- Thyroid
- Breast

Endoscopic USG - 12-20 MHz

That's why USG is not a good modality for Pancreas.
But endoscopic USG is a good modality for Pancreas.

Frequency Higher = good Resolution.

![Diagram](attachment:image.png)

- Water doesn't reflect sound, let go.
- Some amount to reflect some amount of to fragment.

Anechoic

[Black]

Well → Air filled structure on USG appears [Hyperchoic]
Full Bladder req for looking at pelvic organs by abdominal (Abd.) USG. At full bladder, bowel loops (Hypercho) are displaced upward.

In TVS → Empty Bladder

Acoustic shadow: Anything that reflect sound have a shadow

On USG:
- CBD
- PV
- Double Barrel USG
- CBD obstruction → Surgical

Double Duct Sign → Periampullary Cancer

IoC for Gall Stone = USG
- X-Ray → 10% gallstones are radio-opaque

IoC for Acute Cholecystitis = USG
- Distended GB
- Thick edematous wall
- Pericholecystic fluid
- Sonographic 'Murphy' +ve
Best Inv for Ac. cholecystitis = Tc HIDA

(Hepato-biliary Imenon
Di-acetic acid)

HIDA taken up by liver

- HIDA tracer is in biliary
  But in Ac. cholecystitis => cystic duct is blocked,
  Dye can't reach there

  Non-visualisation of biliary on Tc HIDA => Ac. cholecystitis

  => To differentiate between solid & cystic => USG

Doppler

Moving RBCs => Doppler

Any moving object producing sound will produce frequency shift

Color coded Doppler is based on frequency

Doppler

1. IOC - DVT

2. Computed tomography screening

3. Ultrasonic torsion
Q. Tissue Harmonic Imaging now used in
   a) CT  
   b) MRI  
   c) USG  
   d) PET

US-ELASTOGRAPHY
For hardness of Tissue
Guide Breast Biopsy
Fibroscan → LIVER

MRI guided HIFU
High Intensity Focussed US
Thermo coagulation → FIBROIDS

PACS (Picture Archiving & Communication System)
Software & connects Radiology & other part of hospital
Std Digital Format = DICOM
(Digital Imaging & Communication in Medicine)
Iod for urinary tract stones = NECT

Ureteric X-ray → Radiodense
CT → Visible

X-ray → Indinavir
CT → Pure Matrix stone

Diagnosed on ureteroscopy

Iod for urinary tract TB = CECT (not IVP)

TB ON IVP

Calyceal irregularity = Moth eaten calyces
Feathery appearance of calyces

Hi ked 'up pelvis
Kerr’s kink appearance

Saw tooth ureter → Saw tooth color
Diverterulosis

Ureter → Saw tooth
Pepe stem

Golf hole ureteric orifice on
Cystoscopy

Small low capacity thick walled bladder
In TB → Kidney Calcifies
Not the Bladder
↓
Cement / Putty / Autonephrectomy

Q. Calcified Bladder, resembling fetal skull
= SCHISTOSOMIASIS

Q. Elongated, Hypertrophied = Christmas Tree Bladder
Bladder
Pine Tree
= NEUROGENIC BLADDER

Q. Tear Drop or Pear
- PELVIC HEMATOMA

can be seen physiologically in
Pelvic Lipomatosis

Pubic Symphysis

Extraperitoneal Rupture
Dye accumulates in Prevesicle Space

MOLAR TOOTH SIGN on CT Abdomen

Molar Tooth Sign on MRI Brain = Joubert’s Syndrome

Vermis absent
Mid Brain abnormal
Joubert's Syndrome

Papillary Necrosis → DM.

- Egg in cup on IVP
- Egg in cup on CXR
- Lesion constructive pericarditis

Golf Ball on Tee Sign

- Lobster claw sign

Ring Sign

Cyst

Kidney Cyst

Bosniak Classification

Ureterocele

Adden Head appearance on IVP.
Simple cyst $\cdot$ Ignore

- Calci
cation
- Nodular septal calci
cation
- Thick enhancing septa
- Solid enhancing

2F $\rightarrow$ follow up

3 $\rightarrow$ indeterminate

4 Clearly Malignant

PKC

2 Types

$\text{AD} \rightarrow \text{AR}$

Larger cysts scattered
Smaller cysts radiating from hilum

Dye taken up by kidney tissue not by cyst

SWISS CHEESE NEPHROGRAPH

Dye taken by Renal Tumors not by cyst

SUNRAY - IVP
STRIATED NEPHROGRAPH
SPIDER LE4 - IVP
BELL-SHAPED CALYCES

MULTICYSTIC DYSPLASTIC KIDNEY

→ U/L
→ Developmental

Non-Visualized Kidney on IVP

\[ \text{No renal tissue \text{→} no \text{t} \text{t} \text{n} \text{t} \text{e} \text{t} \text{e} \text{r} \text{e} \text{t} \text{u} \text{e} \text{r} \text{e} \text{d} \text{d} \text{y} } \]

ACUTE PYELONEPHRITIS

Wedge shaped areas of infarction
or coagulative necrosis

"STRIATED NEPHROGRAM"

Infants do not take up the dye

WHITE MATTER DISORDERS

MRI is the most sensitive modality

MS
Demyelinating

Demyelinating

Leukodystrophy

Metabolic disorders
MULTIPLE SCLEROSIS

PERI-VENULAR predominant Disorder

Ms is white matter or gray matter. Both

↓
or

white matter

Lateral Ventricle

Dawson's FINGER

↑

1st to lateral ventricle
But seen in "SAGITTAL PLANE"

Ms has a Flapping Hemitransient course

'Active Demyelination'

Plaque should have advancing edge towards white matter.

↑

Dye when given is taken by inflammatory area.

C9 = OPEN RING SIGN

Open end = cortical side

Q. Child come to you with developmental delay

MRI shows Abnormal signal in white matter

↓

Inborn errors of metabolism

[DYSMYELINATION]
Child & White Matter = Large Head

- Alexander
  1) Frontal lobe - begins
     (frontal predominant)
  2) Rosenthal fibres
  3) Fibrinoid Leukodystrophy

- Canavan's
  1) Diffusely entire white matter
  2) Spongiform Leukodystrophy

MR Spectroscopy: ↑ NAA
[Aspa → aspartoacylase → break] NAA

*Subcortical 'U' fibres are spared.*

1) Krabbe → Globoid Leukodystrophy [Thalamic]
2) Metachromatic Leukodystrophy

- Periventricular sparing ⇒ TIGROID PATTERN

Peroxisome Dise

* Peroxisome Disorder, *X* Linked Adrenoleukodystrophy
  Occipital Predominant
  ⇒ Lorenzo's Oil → effective in this disease

PML (Progressive Multifocal Leukoencephalopathy)

- Seen in HIV +
- Caused by JC virus
  ↓ involve oligodendrocyte
  ↓ no myelination
Usually PMI is non-enhancing (don't take up the dye) being there is no inflammation, so BBB is preserved.

* Chronic Ischaemia [White matter problem due to chronic ischaemia]
  - Age-related narrowing

  - Subcortical arteriole sclerosis
  - Leukodystrophy
  - (Binswanger Disease)
  - Presents as dementia
  
  - Genetic Causes
    - (Notch-3 mutation)
    - (CADASIL)
  - Cerebral autosomal dominant arteriopathy with subcortical infarcts and leukoencephalopathy
  - Mjoe form of hereditary stroke disorder.

CJD
- Prion Disease
- Cortical Spongiform [Grey Matter]
  - Cortex
  - Caudate
  - Putamen

  - Ring Enhancing Lesions

Neurocysticercosis
- Vesicular
  - Initially nce is alive [Viable stage]
  - Cyst and scolex

  - Visceral stage
    - (filled with clear water)
Membrane is intact in vascular stage
  ↓
  So, no surrounding inflammation
  ↓ → No BBB damage
  So, non-enhancing

Colloidal
  * When parasite is dying degenerating
  ↓
  Fluid becomes turbid [COLOIDAL STAGE]
  ↓
  Membrane will degenerate
  ↓
  Attack by immune system
  ↓
  Now BBB damage
  ↓
  Dye is taken up
  ↓
  Ring Enhancing Lesions

Granular stage
  on MRI: Thick walled enhancing lesion

Dead stage
  No inflammation
  No enhancement
  Nodular calcified
**Toxoplasmosis**
- Ring enhancing lesion
- HIV+

**BRAIN ABCEESS**

![Diagram of a brain abscess with annotations]
- Ring enhancing lesion
- Pur in centre → thick × vision
- Diffuse mate wated - MRI = Bright

**Metastasis**
- M/s site & grey-white matter junction

**Thyroid Ophthalmopathy**

**COCA-COLA BOTTLE appearance**
- Tendon & ν
- Body of M/s broad

**BRAIN TUMOURS**

1. C Tx shows Caleification
   "Ca²⁺ come"
2. C = Cranopharyngioma
3. A = Astrocytoma
4. C = Choroid plexus papilloma
5. O = Oligo dendrogleoma
6. H = Meningeoma
7. E = Apendymoma
Q. & of the following Brain Tumor Not Glioma 77
a) astrocytoma
d) Ganglioglioma → Neuronal cell origin Tumor ependymoma d) Oligodendroglioma

Q. Neurocytoma → neural cell origin Tumor

Q. Ganglioglioma → (B) glial + neural origin

Q. Child has large head. CT scan reveals calcified Tumor in his lateral & ventricle. III, IV ventricles are dilated.

Ans → Choroid plexus Papilloma over production Hydrocephalus

Oligodendroglioma →

- Glial Tumor has cortical extensions.

H/O seizure

→ Show calcification.

- Frontal lobe of Brain.

Ependymoma →

- Glial Tumor

- Children → 4th ventricle

- Adult → Spinal cord & Supratentorial Region

• Fried Egg Appearance on Microscopy

• Chicken Wire like Vasculature
Ependymoma
+ Shows CSF spread contiguous → Cisterna magna (space behind cerebellum)

Hence from IV ventricle it spreads to Cisterna magna & CP Angle Cistern.

Q: A young man came to you with headache. MRI shows man on IVth ventricle extending into surrounding CSF spaces

Ans: Ependymoma

CP Angle Tx

1. Vestibular schwannoma
2. Meningioma
3. Epidermoid cyst

Rich in keratin like fluid

Arachnoid cyst

CSF located in middle cranial fossa

Epidermoid cyst

Brownian Motion
So, Non-enhancement on DW-MRI - Bright
4) Ependymoma
   It spreads to CP angle

MEDULLOBLASTOMA

- Posterior fossa "midline"
- It arises from vermis & sup. medullary vellum.

3) Malignant Tx

   ↓

   Invades sup. part of 4th ventricle.

4) Earlier considered PNET (Primitive Neuroectodermal Tx)

   ↓

   From WHO 2016 no term can has been changed to "Embryonal Tumour"

5) Radiosensitive Tx

6) The flow of CF in 4th ventricle causes

   CSF - DROP metastasis → Leptomeningeal Metastasis

   ↓

   to spinal cord

   🍯 Ice cream

   Sugar Icing or coating - MRI
   or
   "Zuckerguss"
CRANIOPHARYNGIOMA

*Histologically*

- Adamantinous
- Papillary

Cystic
Children
Calcification

Cystic
Solid
Adult
No calcification

GLIOBLASTOMA → Butterfly glioma

- Tx is conduced in centre due to condensation of fibres in corpus callosum.
- C Crows Medullar, highly malignant
- Other Tx & Crows Medullar → "Lymphoma"
  - Go to HIV pt.
  - Steroid Responsive Tx
    - So, Biopsy should be taken before starting steroid

MENINGIOMA

'Dural Based Tx' on MRI
Dural Tail Sign
Shows intense enhancement becoz of extra-axial location.
Mother - In Law Sign
Hyperostosis Skull
VESTIBULAR SCHWANOMA - CP angle

H/o - Hearing Loss
Tinnitus.

Neurospate Neurosurgical Surgery - Antony A
B
Vestibular Bodies.

On MRI - Ice cream cone appearance
Associated - NR - 2

PITUITARY ADENOMA

Diaphragma sella → to protect from pressure
opening for infundibulum

Hormonadome of size > 10mm

Signs on MRI -
1) Snowman.
2) Cottage loaf
3) Figure of 8

Congenital defective diaphragma sella

ICP in hyperpituitary
↓
Cavern balloning of sella
"EMPTY SELLA SYNDROME "-1"

2° Pseudotumour cerebri
Due to Tetrazycline
Vit A ore toxicity
J-shaped sella
- seen in mucopolysaccharidoses

X-ray skull:
- erosion of post clinoïd process
- elevated CT
  clinoïd

**NEUROCUTANEOUS SYNDROME**

**STORGE-WEBER SYNDROME** or **ENCEPHALO-TRIGEMINAL ANGIOMATOSIS**

- Port wine stain
- H/o seizure
- Not inherited disorder
- No brain Tx
- Congenital glaucoma

**TUBEROUS SCLEROSIS**

- AD
- Seizure + MR + Adenoma sebaceae
  Cardiac Tx associated with tuberous sclerosis
  = "Rhabdomyoma"

- CMV "+ve" → Periventricular calcifications
Tuberculosis has also association with tumors of lung.

Q. A smoker comes in with honeycomb lung. In upper lobe. Bizarre arrangement. AP:
Answer: LCH (Langerhans cell histiocytosis).

NF1

1) Cafe-au-lait spots (coast of California)
2) Peripheral spinal NF
3) Plexiform NF
4) Associated with mesodermal dysplasia

Dumbell Tumour
Skeletal/Bony defects

Sphenoidal Dysplasia

Lateral wing of sphenoid
Greater wing of sphenoid

Empty Bace Orbit sign
due to absence of greater wing
is due to sphenoidal dysplasia.
Bone Tx

5 steps:

1. Look pre whether
   Immature
   Mature

2. Location
   a) single/multiple
   1. metastatic

3. Bone

4. Where in the bone -
   Epiphysis
   Metaphysis
   Diaphysis

5. Pattern of destruction
   Wall: margined
   Geographic Lytic
   Lesion

6. Matrix
   Osteoid
   Stippled
   Pseudocartilage
   Floculent
   Popcorn
   Areas
   Rings

Chondroid
- Lung Hamartoma → CXR → Popcorn appearance

- Pulmonary Chondroma → Associated w/ GIST → Paraganglioma
  ↓ Carney’s TRIAD
  ↓ Pop-corn

57 Beyond the Bone or not
↓
Cortical Break → Can also be due to #

- Missing
- No missing fragment
- Malignancy
- #

- Periosteum elevated → Periosteal React

  - Continuous lamellar periosteal heel

  → Acute osteomyelitis

  - Solid

  → Chronic osteomyelitis
  - Osteoid ostium

  → Tx grows in spurts

  - Multilamellar = Onion Peel X-ray = Ewing’s Sarcoma
Periosteum is attached to bone by Sharpy's fibres.

- ... → Spindle cell → Ewing's sarcoma (less aggressive)

- Divergent mineralization of Sharpy's fibres
  → Osteogenic sarcoma (more aggressive)

- Codman's delta
  → Malignancy

**Benign Lesions in Bone**

1. Haemangioma
   - Found in vertebra

2. Lipoma

**Metastatic**

- Osteoblastic
  - Prostate
  - Breast

- Osteolytic
  - Breast

- Rule out thyroid RCC
DEXA Scan.

\[ \downarrow \]

Bone Mineral Density

Osteoporosis

\[ \text{Z score} = \text{comparing Bone Density to some age \& some sex} \]

\[ \text{T score} = \text{comparing Bone Density to young age} \]

WHO Scoring:

\[ -2 \quad -1 \quad 0 \quad 1 \quad 2 \]

\[ \text{young} +1 \quad +2 \]

\[ \text{adult} \]

\[ \text{T score < -2.5 } \Rightarrow \text{osteoporosis} \]

\[ \text{T score -1 to -2.5 } \Rightarrow \text{osteopenia} \]

Rx - Bisphosphonates

Acute OM

Earliest X-ray sign \Rightarrow Blurring of tissue planes or soft tissue swelling

7-10 Days \Rightarrow Bony changes

Iod \Rightarrow MRI \Rightarrow marrow oedema (24-48 hrs of onset)

\[ \text{using STIR} \]

\[ \text{Involucrum} \Rightarrow \text{new bone formation.} \]

\[ \text{Sequestrum} \Rightarrow \text{Pathognomonic of CHRONIC OM} \]

\[ \text{Dead Bone} \]

\[ \text{Dense on X-ray \& no demineralisation} \]

\[ \text{Sequestrum} \Rightarrow \text{PYOGENIC OM} \]
Pyogenic OM → bony extension new bone.

TB OM → osteoporosis ++
almost no periosteal reaction
no new bone formation

MADURA MYCETOMA
MRI: edema
fungal lesion
DOT in a circle sign

ARTHURITIS
OSTEO ARTHRITIS
- Wear & tear of articular cartilage
- Loss of joint space
- In wt. bearing (medial tibiofemoral compartment)
  - Horizontal spur
  - Subchondral sclerosis
  - Cyst
  - Loose Bodies

RHEUMATOID ARTHRITIS
Synovial inflammation
- Hyperemia
- Periarticular osteoporosis
  - Bare area - erosions
    as in inflamed synovium initially eat up bare area
  - Joint space narrowing
    (asymmetrical)
  - Dislocated Deformities
    - Swan neck
    - Boutonniere
  - Deformity & out erosions
    ↓
    SLE
    JACOUD'S ARTHRITIS
TB Arthritis
Inflammatory Jt. Disease

Hyperemia

\text{Periarticular osteopenosis} \quad \leftarrow \text{earliest sign of TB knee}

\text{Erosion}

\text{Joint space narrowing}

\text{Phemister's TRIAD}

\text{POTT'S SPINE}

\text{pulposus}\quad \text{nucleus}\quad \text{annular pulposus}

\text{para distal}

Blood supply of Disc \rightarrow \text{"AVASCULAR"}

\text{earliest finding in TB spine} \rightarrow \text{"Disc space narrowing"}

People not consuming

\text{BRUCELLOSIS} \rightarrow \text{OM of spine}

People not consuming 
parturient milk

\text{Anterosuperior corner} 

\text{PEDRO PON SIGN}
On X-ray -
Density ↑
Debris +
Distension
Dislocation
Desorganization

Ans. Charcot's Jt
   e.g. DM

⇒ 1st MTP
   • Punched out
   • Rat bite erosion
   away from articular surface

⇒ PSEUDOGOUT → Deposit of CPPD (Calcium pyro-phosphate deposit).
   Chondrocalcinosis

⇒ In DIP
   • Pencil in cup ⇒ Psoriatic Arthropathy
   Bone Density □

Metabolic Diseases
⇒ Rickets
   Earliest X-ray finding - Loss of provisional zone of calcification.
On giving Vit D → Recovery of provisional zone
(Healing Rickets) → White line of Frenkel.

OSTEOMALACIA

PELVIS

1) Pubic Rami
2) Neck of femur

Ribs
Scapula (outer)

Dilate Z Looser's Zone
1) Osteomalacia
2) Febrile Dysplasia
3) Paget's Disease

\[ \text{Champange Glass Pelvis} \]

\[ \text{ACHONDROPLASIA} \]
- AD
- Rhizomelic Dwarfism
  (proximal bone shorter)
- Trident Hand
  (limbic)
- Caudal Stenosis
- Foramen Magnum Stenosis

\[ \text{Chevron Sign} \]
THANATOPHORIC DWARFISM
- Lethal cond.
  - B.

* EPIPHYSEAL ENLARGEMENT -
  17 JRA (In Child)
  27 Hemophilic arthropathy
  37 Bony Dysplasia → TREVOR'S

* EPIPHYSEAL DYSGENESIS -
  1) Hypothyroidism
     \[ \xrightarrow{\text{Delayed Bone Age}} \]
     \[ \xrightarrow{\text{Wormian Bones}} \]
     \[ \xrightarrow{\text{Prominent Intracranial Skull Bones}} \]
     Osteogenesis Imperfecta
     Down's Syndrome
     Rickets
     Pyknodystosis
     Hypothyroidism

Osteogenesis Imperfecta ≠ Diaphyseal ≠
\[ \xrightarrow{\text{Different Stage of Healing}} \]
(Battered Baby Syndrome)

In accidental trauma → same stage of healing.
* SCURVY

Osteoid formation ↓

An copper Deficiency → Pseudo scurvy

Thin Bone → only margin is prominent (Pencil thin cortex).

Wimberger Ring (epiphysis).

Provisional Zone becomes → White line of Frenkel dense

Mineralization → Scurbutic zone or doesn’t occur → Hummerfeld zone

Pelikan spur

Long Syphilis

[Diagram of erosive tubular → Wimberger metaphysis sign]

"Congenital syphilis"

Long Rubella striations.

Celery stalk stalk
ANKYLOSING SPONDYLITIS

Sacro-vertebral Spondylitis

Earliest sign → Sacro-iliitis

IOc → "MRI"

X-Ray 1st → Blurring of subchondral cortex on the iliac side of SI joint

→ Pseudowidening SI joint

Changes in vertebrae are due to enthesitis

ROMANUS LESION

ANDERSON LESION

SHINY CORNER SIGN

Inflammation of Disc-vertebral space

# in ankylosing spondylitis = through and through (CARROT STICK #)

 Syndesmophyte

Vertically arranged outer Disc fibres

DAGGER SIGN (Internal disc fibres)

BAMBOO SPINE
PAGET'S DISEASE

Mozaic

- Lytic
- Mixed
- Blastic

Initially - osteolytic lesions

Osteoblastic lesion

\( \rightarrow \) cotton wool spots

Skull become elongated

\[ \text{Bone of grass} \]

"Tam o' Shanter" skull

Scottish cap

Signs

- Skull
  - Cotton wool
  - Osteoporosis circumscripta

- Spine
  - Picture frame
  - Ivory

- Long bones

Tam o' Shanter skull

OSTEOPETROSION

Defect of osteoclast
THALASSEMIA
- Diploric Widening
- Hair on end skull

SICKLE CELL ANAEMIA
- Bone Infarct
- Snow cap Humeral vertebra

LEUKEMIA
- Presence of Metaphyseal Lucency

NUCLEAR MEDICINE

- Nuclear scan
- Scintigraphy
- SPET
- PET

NUCLEAR SCAN

- M/C isotope → Te 99m → metastable isomer,
  \[ t \frac{1}{2} \rightarrow 6 \text{ hours} \]
- Produced by Molybdenum Generator
  - Gamma rays
  - Energy → 140 KEV
- Ligand → Te-HIDA
  - Te-MDP
Cardiac Sestamibi Sestamibi

Thallium
Tc - Tetrofosmin
Tc - Sestamibi

Ischaemia \(\rightarrow\) COLD

Tc - Rb
MUGA scan \(\rightarrow\) [multi-uptake gated acquisition]

Ventricular function

[DYNAMIC RENOGRAM]

Tc - MAG 3

Tubular secretion +
GF

\[\text{acer. Renal func} \]

Tc - DTPA

Purely GF

\[\text{acer. CFR} \]

[STATIC RENOGRAM]

- Tc - DMSA
- Structure
- Scarring
- Reflux

Post-urinatal value

\[\text{acer. Distribution of Renal Func} \]
* Tc - RBC
  To localize the site of lower GI bleeding
  at least at 0.1 mL/min

* Tc Heat Damaged - RBC
  To localize locket for residual spleen tissue
  post-splenectomy

* Tc - Perfatechnet
  Physiologically
    - choroid plexus
    - salivary gland
    - thyroid
    - gastric mucosa

Salivary gland
  only to salivary gland Tc Hot on Tc-Scan
  \[\Rightarrow\] Warthin's Tc (OK)
  \[\Rightarrow\] Adeno-lymphoma

Gastric Mucosa
  ectopic gastric mucosa
  Meckel's
  \[\Rightarrow\] Diverticulum
  \[\Rightarrow\] Bladder

Tc = Tc perfatechnet

* Tc - Sulfur colloid
  Taken by macrophages
    - reticular endothelial system
    - liver & Kupffer cell & imm
  \[\Rightarrow\] Hepatic lesion. Rich in Kupffer HOT on Tc - colloid scan
  \[\Rightarrow\] FNH focal nodular hyperplasia
**SPECT**

- Single Photon Emission Computed Tomography

- Tc 99m
- I 123

3D

* Tc-SESTAMIBI SPECT
  - Used for 3D localization of Parathyroid Adenoma
  - for Myocardial Perfusion

* Tc-HMPAO-SPECT at NIMHANS
  - Cerebral Perfusion

* DAT SCAN
  - J (123) Ioflupane
  - Comma shaped appearance
  - Caudate & putamen
  - In Parkinsonism
  - "period"
PET Scan
(Position Emission Tomography)

- Cyclotron generated Isotope
  ↓
  particle accelerator
  accelerator

  Protons → O_{18} → F_{18}

  $t_{1/2} = 110 \text{ min}$
  (short lived)

  Position, (e+)

  $e^{-}$ electron MATTER

  Anti-matter

  Anihilation.

  18 Fluoro - Deoxy Glucose (FDG).
  non-metabolizable glucose analogue

  FDG → FDG-6-P_{6},

  'WARBURG EFFECT'.

  Cancer cells have
  more glucose transporter → 
  Aerobic Glycolysis

  Cancer cells take up FDG and form FDD-6-P_{6},
  But it doesn't undergo glycolysis,

  So cancer cells now emit radiation due to FDG,
  So used in staging of cancer.
  Recurrent Tumour.
Response to therapy

- as metabolism is faster than the size of the tumour or chemotherapy

**Drawbacks of FDG**

1. **Hyperglycemia**
   - FDG will not be taken up in case of hyperglycemia due to competitive effect of GLUT receptor.

2. **Low metabolism rate**
   - carcinoid
   - BAC

3. **Brain**
   - glucose hungry organ
   - High uptake of FDG
   - So, brain Tx are missed
   - Brain is FDG-avid

4. **Brown Fat**
   - metabolically active fat (thermogen) found in supraclavicular area
   - So, up uptake of FDG in this region.
   - Bilateral symmetrical supraclavicular uptake of FDG

   Prevention/Minimize
   - Keeping pt warm
   - Pre-medication with BZD.
Alternatives to FDG

1. C11-methionine PET
   Preferred for Brain Tx evaluation (NIMHANS)

2. NaF PET
   for Bone Metastasis
   Better than MDP

 IOC for clinically suspect Phaeochromocytoma

= MRI Abdomen

Extra-adrenal → Paraganglioma

On MR I → Light Bulb Sign

- Hepatic Haemangiona
- Meningioma
- Phaeochromocytoma

Light Bulb appearance on X-Ray
Post Dislocation of shoulder.

[Dislocation is more easily diagnosed by X-Ray]

4. Anterior Dislocation.

Extra-abdominal Phaeo = Paraganglioma seeking

3. Fluoro-2DPA PET

4. I123 MIBG (norepinephrine analogue)
⑤ 68-Gallium DOTATATE PET Scan
  DOTATOC
  → Neuroendocrine Tx.
  (for sarcoidosis - 67 gallium)
⑥ 68-Gallium PSMA PET
  [Prostate specific membrane antigen]
  → for prostate malignancy
⑦ PET/CT
⑧ PET/MRI

**Prostate**
→ MRI is preferred
→ PI-RADS

 IOC for Fistula In Ano → a) Fistulogram
  b) MRI
  c) CT
  d) PET

Intersphincteric...
HRI → Due to relation of sphincter to fistula
LUTETIUM - 177

$^{1/2} = 6.7$ days

Strong $\beta$ emitter, weak $\gamma$ emitter

* Lu - DOTATATE

Used for inoperable neuroendocrine Tx.

RADIOEMBOLISATION

Used in liver Tx.

Radioactive agent through catheter directly to liver

$^{90}$Yttrium - 90 microspheres

"Pure $\beta$ rays"

Phosphorus $\gamma$ Bone seeking $\beta$ emitter

Strontium

Samarium

Phosphorus

1. $\beta$-emitter
2. More penetrating power
3. marrow suppression safe

Strontium

$\beta$-emitter

Less safer

RADIUM - 223

$^{1/2} = 11.4$ days

$\alpha$-emitter

Bone seeking
more safe than strontium due penetration.

I$^{123}$ - $\text{Thy}-13$ hours

I$^{125}$ - $\text{Thy}-60$ days

I$^{131}$ - $\text{Thy}-8$ days

I$^{123}$ - cyclotron generated
  - Gamma emitter
  - Function

I$^{125}$ - for RIA
  - Brachytherapy

I$^{131}$ - produce both $\beta$ & $\gamma$
  - Well differentiated thyroid cancer
  - Imaging

TELEThERAPY / EXTERNAL BEAM

The method of Radiotherapy
  Machine used -> Cobalt machine

Co 60 - Artificial
  $t_{1/2} = 5.2$ years

Co 60 $\gamma$ N0 60 $\gamma$ (1.25 Mev)
  Gamma rays are killing

Tx.
Drawbacks:

1) Decay product
2) Half life
3) Fixed energy emission

Hence, nowadays machine used = LINAC (Linear accelerator)

\[ \rightarrow \text{electrons} \rightarrow \text{X-Rays} \rightarrow \text{electrons} \]

\( \text{MeV radiation used } \text{in cancer therapy} \)

\( \text{MeV } \text{for deep seated T} \rightarrow \text{X-rays} \)

\( \text{Electron used for superficial lymphoma} \)

\( \text{MYCOIDES FUNGIOIDES} \)

Intra-operative RT

LINAC vs COBALT

No isotope related concerns
No half life
Switch off/on.

 alter energy — orthovoltage, supervoltage, megavoltage (MV)

Maximum skin burns.

a) cobalt
b) orthovoltage
c) supervoltage
d) megavoltage
CONFORMAL RT

Intensity modulated RT

- multileaf collimator

- Multileaf Collimator

- Gamma knife → invented by LAR LEKSEIL

- Gamma Knife

STEREOTACTIC Radio Sx

- Gamma knife → invented by LAR LEKSEIL

- Gamma Knife

- Indications:
  - 1) Vestibular schwannoma
  - 2) Pituitary adenoma
  - 3) meningioma
  - 4) Trigeminal neuralgia
  - 5) Cerebral metastasis <10
  - 6) AV malformation

- Leksell’s Frame

- (x, y, z)

- Cobalt

- R knife
Focused radiations on T

\[ \downarrow \]

Initial cell swell

\[ \downarrow \]

DNA gets damaged

\[ \downarrow \]

then shrinking

\[ \rightarrow \]

\( \text{if Tx near optic chiasma} \)

\[ \rightarrow \]

\( \text{Y- knife wouldn’t be used as it swell initially} \)

\[ \text{AV malformation} \]

\[ \begin{array}{c}
\text{A} \\
\text{A} \\
\text{NIDUS}
\end{array} \]

HTN Bleed

11. Putamen
2. Caudate
3. Thalamus
4. Pons
5. Cerebellum

A young pt in emergency shows lobar HGE may be AV Malformation
Q. old pt c non HT lobar HP
↓
Amyloid angiopathy
↓
Ke knife cause thrombosis of nodu
↓
thus damaging malformation

* STEREOTACTIC Body RT / Cyberknife
  → Based on LINAC
  → Whole Body
  → Frameless

* PROTON BEAM THERAPY
  x-Ray y Gamma rays, wave
  r Ray, j Photon

.. protons - heavy charged
   Clew
   Proton
   i Chordoma

2) Pediatric Brain Tx → tx is preserved compared to RT
   But now role of proton
   Beam therapy.

3) Uveal Melanoma
BRACHYTHERAPY

- Done - fix in contact cavity substance.
  Adv -
  Disadv -
  High Dose To Tx
  Radiation exposure to Doctor

REMOTE AFTER LOADER -
  new update
  ↓ radiation exposure to doctors

M/C isotope used in Brachytherapy

- Iridium 192
  $t_{1/2} - 74$ days

- Cesium 137
  $t_{1/2} - 30$ years

Types

- Low Dose
  0-4 to 2 Gy/Hr

- High Dose
  > 12 Gy/Hr

* Permanent Implants
  - Palladium
  - I-125

Gold → for malignant ascites.

oldest isotope → Radium 226
  $t_{1/2} - 1600$ yrs.
Radium no longer used being of harmful decay products.

Environment:

\[ \text{Indoor} \rightarrow \text{Outdoor} \]

- **Radon**
  - \( t_{1/2} = 3.8 \text{ days} \)
  - Lung cancer.

How to measure radiation exposure?

**Definition** (Def.

- Total Radiation exposure
- Absorbed radiation

**Common**

- Roentgen
- RAD

**SI unit**

- Coloumb
- Gray
- Sievert

**Biological equivalent effectiveness**

- REM

How to measure radioactivity

**Common**

- Curie

- Becquerel

- \( 1 \text{ Curie} = 3.7 \times 10^{10} \text{ d/s} \)

**SI**

- 1 d/s

MOA of Radiation Injury = Free Radicle DNA-mediated damage

- Most sensitive phase of cell cycle = G2M
- Least sensitive phase of cell cycle = Late S
Fetus most sensitive at ~ 6-15 weeks.
Max. permissible dose = 0.5 RAD.
Cong. malformation is seen after ~ 5 RAD.
* Cell Blood most sensitive = Lymphocyte.
* Tissue ~ Bone marrow.

**GIT**

Iod for CHPS -> USG.
Iod in pediatric Ac. Abdomen -> USG.

**Intestinal Obstruc.**

Iod -> ECT.
Best X-Ray -> X-Ray Abd. (supine).

**Bowel TB**

Ideal structure:
- Strong sign
- Inverted umbrella sign
- Fleischner sign

Conical valve
ileo-caecal valve

Asc. colon shorten -> pull up caecum.
So, go no more 90°.
goose neck (obtuse angle)
ileum