Diseases of bone and joints
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Parts of a long bone
- **Epiphysis** from subarticular plate to epiphyseal cartilage
- **Metaphysis** Area between epiphyseal plate to the area where bone develops its funnel or flute shape
- **Diaphysis** Body of bone, between metaphyses

Types of Bone
- **I. Lamellar** Forms the adult skeleton
  - // arrangement of collagen (type I) fibers
  - Few osteocytes
  - Uniform osteocytes in lacunae // to long axis of collagen fibers
- Lamellar bone may be:-
  a. **Cortical bone**: defines shape
  b. **Cancellous bone**: marrow bone
    - Mandible, maxilla
    - End of long bones in the medullary canal
- **II. Woven**
  - Irregular arrangement of collagen fibers.
  - Many osteocytes of various size and shape
  - In adults signifies always a pathologic condition

Bone cells
- **Osteoblasts** ...Produce the bone protein (osteoid)
- **Osteocyte** ...Osteoblast within bone in a lacuna
- **Osteoclast** Multinucleated ...Resorbs bone

**Important bone lesions include**
1- **Inflammations**.... Osteomyelitis
2- **Osteodystrophies** ...abnormal bone formation,growth and/or structure.
3- **Tumors**.
**Osteomyelitis**

**Acute suppurative osteomyelitis** may be

a) Hematogenous  
b) Non hematogenous

1- Direct Extension from an adjacent focus.
2- Traumatic implantation after an open trauma

**Acute hematogenous osteomyelitis**

- **Age**... children.... due to
  a) High vascularity of the growing bone.
  b) More liability for trauma with resulting hematoma which is a good cultural media for bacteria.
- **Organism**...mostly staphylococcus aureus.
  - E coli and streptococci in neonates.
- **Bones affected** ...Around the knee (lower femur, upper tibia, ankle, and hip)

**Sites** ...Metaphysis of long bones in children  why?
- Actively growing and highly vascular.
- Veins are wide leading to slowing of the blood stream and stasis of bacteria.
  In adults the vertebral bodies are commonly affected due to the same cause.

**Pathogenesis of hematogenous osteomyelitis**

1- Trauma results in the production of suppurative focus in the metaphysis.

2- Infection spreads to
  a. the medullary cavity
  b. Through the cortex...elevates the periosteum leading to subperiosteal abscess.
  c. Infection does not reach the joint cavity as the epiphyseal cartilage is highly
resistant to the spread of infection. (In the neonates, infection can spread through it)

3- The inflamed bone becomes necrotic due to...
   a. Bacterial toxins.
   b. Ischemia caused by inflammatory thrombosis and pressure by exudates.
   c. Periosteal elevation causes stretching of cortical blood vessels.

4- Osteoclasts erode the edges of the necrotic bone, separates it from normal bone......the separated necrotic bone is called Sequestrum.

5- The periosteum around the sequestrum deposits a shell of new bone called involucrum which shows holes called cloaca at sites of rupture of subperiosteal abscess which opens on the skin by multiple sinuses discharging pus.

Complications
1- Toxaemia and septicemia. 2- Pyemia (thrombophlebitis).
3- Direct spread to adjacent structures.
4- Pathological fractures. 5- Chronicity.

Chronic osteomyelitis
- Inadequately treated acute cases may change to chronic in which
  a. Acute inflammatory cells are replaced by chronic ones.
  b. There is increased reparative activity with fibroblastic proliferation.
  c. Large acute abscesses are surrounded by dense sclerotic bone and are called Bordie abscesses.
  d. The causative organism usually remains dormant in the lesion for years.
e. Rarely chronic osteomyelitis may be complicated by:
1. Secondary amyloidosis

Tuberculous Osteomyelitis
- Tuberculous osteomyelitis has become rare in areas of the world where good control of pulmonary and intestinal tuberculosis has been achieved.
- It is still common in many developing countries.
- The vertebral column is the commonest site of disease (Pott's disease of the spine)
2- Osteodystrophies

- A group of bone diseases characterized by abnormal bone growth, formation or structure.
  - **They include:**
    - A. Fibrous dysplasia.
    - B. Paget’s disease of bone.
    - C. Osteoporosis.
    - D. Rickets and osteomalacia.
    - E. Renal osteodystrophy.

A. Fibrous dysplasia

- A developmental abnormality affecting mainly long bones.
- Occurs in children and young adults.
- It is characterized by overgrowth of fibrous tissue inside bone. Bony trabeculae are thin and lack osteoblastic rimming.
- It may be monostotic or polyostotic.
- May be complicated by pathological fracture & fibrosarcoma.

B. Paget’s disease of bone.

- A disease of old age (above 50 years), affecting males more commonly than females & of unknown etiology (?? Viral infection).

Pathogenesis

1- **Stage I:** Bone decalcification and softening with replacement by highly vascular granulation tissue then
2- **Stage II:** Mixed stage of combined bone resorption and new poorly mineralized bone formation by periosteum and endosteum resulting in bone thickening
3- **Stage III:** Osteosclerotic phase....Excess deposition of woven bone in an irregular pattern giving the affected area the *mosaic pattern*.
- **Site**... Axial skeleton  skull, vertebrae, pelvic bones & long bones ...May be monostotic or polyostotic.
  - Affected bone is thick, rough, porous, and deformed.
  ♠ Affection of the skull bones results in pressure on the cranial nerves.
  ♠ Affection of the vertebrae results in kyphosis.
  ♠ Affection of the tibia and femur... the affected bone bends forwards and outwards.

  - **Complications**
  1. High output heart failure... in the early phase due to increased bone vascularity.
  2. Pathological fracture.
  3. Fibro and osteosarcoma.

C. **Osteoporosis**.

- It is reduction of bone mass to a level below that is required for normal bone support. However, bone mineralization is **normal**.

  - **Causes**...
    - x Localized... prolonged immobilization
    - x Generalized....
    a. Senile   b. Vitamin C deficiency
    c. Osteogenesis imperfecta... hereditary condition with abnormal development of type I collagen.
    d. Endocrine disturbances... hyperthyroidism, cushing.

D. **Osteomalacia**

  - It is defective bone mineralization in adults.
    - **Causes:** Vitamin D deficiency due to
      - Defective intake, exposure to sun   - Increased demands.

    - **Clinical picture:**
      - Increased lumbar lordosis - Bending of femur and tibia.
      - Contracted pelvis leading to obstructed labor.
Rickets...

- A metabolic disorder characterized by failure of deposition of calcium and phosphorus in the osteoid tissue of the newly formed bone. (Childhood manifestation of defective bone mineralization).
- It starts after 6 months of age after depletion of maternal stores.

- Causes...
  Deficiency of Vit. D, Calcium & phosphorus due to
  a. Insufficient exposure to sunlight
  b. Decreased intake or absorption of Vit. D
  c. Prematurity...due to increased demands for Calcium and decreased hydroxylation of Vitamin D in the liver.

1- Normal
2- Rickets

1- Normally... Cartilage cells at the epiphyseal line proliferate forming column extending towards the shaft of the bone. The matrix inbetween the cell columns become calcified. Cartilage cells then degenerate and are replaced by capillary loops and osteoblasts which deposit osteoid matrix that becomes soon calcified and new bone is formed.

Pathogenesis
2- In Rickets... Due to defective levels of calcium, cartilage is not calcified and cartilage cells do not degenerate and continue to proliferate and lay down chondroid matrix causing thickening of the ends of long bones (rachitic metaphysis). - New bone formation is irregular and poorly calcified.

Rickets...Skeletal changes
- 1- Skull ..... Delayed closure of sutures and fontanels.
    ..... Craniotabes (flat occipital bones).
    ..... Squar-shaped head and frontal bossing.
    ..... Delayed dentition.
2- Chest.....Rosary chest (swelling of costochondral junctions).
.....Pigeon chest (flat sides, protrusion of sternum)
.....Harrison’s sulcus.
3- Vertebrae....Kyphosis, lordosis or scoliosis.
4- Long bones...Bow legs, prominent epiphyseal cartilage.
5- Pelvis....Trifoil pelvis.

E. Renal osteodystrophy
- Renal failure is associated with hypocalcemia which results from
  a. Phosphate retention.
  b. Decreased 1,25-dihydroxy vit.D
  c. Decreased intestinal absorption of calcium.
  - Hypocalcemia.....hyperparathyroidism..... mobilization of calcium from bone ....
  Osteomalacia.

Bone tumors
- May be primary or secondary (metastatic).
- Primary:-
  ① Osteogenic....B. osteoma      M.osteosarcoma
  ② Chondrogenic.... B. chondroma    M. chondrosarcoma.
  ③ Fibrogenic    B. Fibroma        M. Fibrosarcoma.
  ④ Tumors of unknown origin (disputed origin)
  ○ Giant cell tumor
  ○ Adamantinoma
  ○ Ewing’s sarcoma
  ○ Malignant fibrous histiocytoma.
  ⑤ Hemopoietic origin
     - Multiple myeloma
- Lymphoma & leukemia.

6 Others: vascular tumors, neurogenic, lipogenic

Secondary (metastatic) bone tumors
- More common than primary.
- Reach bone by blood.
- Primary sites are: breast, prostate, lung, thyroid and kidney.
- Most bone metastases are osteolytic (produce bone destruction) except cancer prostate that may be osteosclerotic.

Osteoma
- Ovoid, radiodense lesion
- Sites: Usually in the skull, jaws & sinuses
- Sharply demarcated from the surrounding soft tissue
- Formed of cortical type bone

M/E: It is usually composed of lamellar or an admixture of lamellar and woven bone.

- Prognosis: Osteomas are slow growing and indolent. Only symptomatic lesions need to be treated, which should consist of simple excision.

Osteoid osteoma
- Affects adolescents and young adults (10-25 Ys) - males > females.

- Sites: Cortex of metaphysis of long bone near the articular surface

- N\E: - Sharply circumscribed lesion.
  - Brown or gray.
  - Less than 2 cm. in diameter.

- M\E: - A center of osteoid tissue (nidus) surrounded by atypical, dense calcified bone.

- S&S: - Severe pain
Osteoblastoma

- Osteoblastoma is a rare, benign, bone-forming tumor that by definition is larger than 2 cm in greatest dimension.
- Resembles osteoid osteoma but larger in size.

Osteosarcoma

- **Incidence**....The commonest malignant bone tumor ....Male:Female = 2:1 .....Age 15-25 years (except after paget’s disease or after irradiation......older age group).
  - **Predisposing factors**.....Trauma
    Paget's disease.
    Irradiation.

- **Site**.....metaphysis of long bones 50% around the knee joint (lower femur and upper tibia).
  - **X-ray appearance**.....Sun ray pattern - Codmann’s triangle.

- **Grossly**. Fusiform mass with hemorrhage and necrosis which occupies the medullary cavity then passes to the bone cortex, elevates the periosteum.
Chondroma
1- Enchondroma

* A true benign tumor of cartilage. *It affects young adults.

-SITES:- The medullary cavity of

a) Short bones of hands & feet.
b) Long tubular bones esp. femur & humerus.
c) Flat bones "pelvis, shoulder girdle, ribs, sternum". These sites are considered to be malignant even when histologically benign. They tend to grow faster than chondromas of other sites.

-N\E:- -A capsulated tumor. It causes expansion thinning of the cortex.
-Hard in consistency. -Rounded.
-C\S: lobulated, bluish-gray, semi translucent.

-M\E:- The tumor is formed of:-

a) Islets of cartilage made of hyaline pale blue matrix chondrocytes arranged irregularly and often singly.
b) A fibrous capsule that sends fibrous septa inside the tumor
2- Osteochondroma
* The commonest benign bone lesion.
  *It is a hamartoma. *Occurs in children & adolescents
  -N\E:- - May be single ,more common, they are multiple" familial"
    - Uncapsulated.
    - Formed of a small projecting bone covered by a cap of proliferating epiphyseal cartilage.
    - The outer shell and medulla of the tumor are continuous with that of the mother bone

Chondroblastoma
- Chondroblastoma is a rare, benign tumor derived from chondroblasts.
- Age 10-25
- It is found in the epiphysis of long bones, usually of the lower extremity.
- M/E chondroblasts +giant cells +chondroid matrix + calcification

Chondrosarcoma
  - Chondrosarcoma is a malignant neoplasm with cells that produce cartilage matrix.
  - Characteristically seen in adults in the fifth and sixth decades of life
● it occurs most frequently in the pelvis and in the medullary cavity of the femur, humerus, and ribs

● Patients initially complain of persistent mild pain and often of local swelling.

Grossly
- Large, lobulated mass with bluish tinge.
- Variable consistency & calcification.
- C/S.. Grayish- white with secondary changes.

- Microscopically
  - Malignant chondrocytes with pleomorphism, spindle forms and increased mitotic figures, in a chondroid matrix.
  - Spread..local, slow rate of growth
    - Late blood
  - Prognosis.- Better than osteosarcoma. GrI 90% Gr III 30% 5year cure rate.

Ewing's sarcoma/PNET
Primitive Neuroectodermal Tumor of Childhood
- Malignant tumor of disputed origin.?? From endothelial cells.

Incidence- Rare
- Age...5-20 years.- Males more than females.
  - Site- Diaphysis of long tubular bones
  - X-ray appearance
    - Onion skin appearance due to reactive periosteal and endosteal new bone formation
Ewing sarcoma

- **Grossly** - Grayish-white firm tumor with secondary changes.

**Microscopically**
- Uniform, small rounded cells arranged around blood vessels.
- Extensive necrosis.
- **Spread** - local
- Blood to the lungs and liver
- **Prognosis** - Fatal within 2-3 years.

**Giant cell tumor**
Locally malignant tumor of disputed origin

**Incidence** - Age 20-40 years

- **Site** - Epiphysis of long bones mostly around the knee

- **X-ray appearance**
- Multicystic tumor covered by a thin shell of reactive bone.

- **Grossly**
- Multiple cysts having eggshell crackling.
- **Microscopically**
  - Reactive osteoclastic type giant cells in a background of small mononuclear, oval or spindle shaped cells with variable degree of pleomorphism.

- **Spread**
  - Local - Only 10% metastasize.

- **Prognosis**
  - 50% recurrence rate. - Pathological fracture is common
  - May change to sarcoma (fibro, giant cell or rarely osteosarcoma)

- **Giant cell tumor**

  - **Adamantinoma**

    **Incidence** - A rare locally malignant tumor
    - Affects any age. - Originates from the enamel of teeth.

    **Site** - Mainly the lower jaw

    **X-ray appearance** - Multicystic tumor

    **Grossly** - Cysts containing motor-oil like fluid.

    **Microscopically** - Basaloid cells in a myxoid matrix.

    **Spread** - Local

- **Multiple Myeloma**

  - Uncommon tumor of plasma cells

  **Incidence** - Old age > 60 year
  - Males > females

  **Site** - Red bone marrow of vertebrae, skull, iliac crest

  **X-ray appearance**
  - Singel or multiple osteolytic bone defects

  **Grossly** osteolytic bone lesions
- **Microscopically** Malignant plasma cells at different stages of differentiated with little stroma.

Multiple myeloma...Effects

1- **Plasma cells secrete Ig (G&A).**
   - What is **Bence-Jones** protein
     - A light chain protein.
     - Monoclonal (either κ or λ) light chain.
     - Excreted in urine and used in diagnosis of the tumor.
     - It coagulates by heating to 55c then dissolves again at 85c.

2- **Osteoporosis**

3- **Hypercalcemia due to bone destruction leading to metastatic calcification.**

4- **Anemia and bleeding tendency.**

5- **Myeloma kidney**
   a. Precipitation of Bence-Jones protein in the renal tubules forming hyaline casts.
   b. Increased liability for infection...pyelonephritis.
   c. Primary amyloidosis.
   d. Metastatic calcification.
   e. Renal failure.

   - **Prognosis**
     - A progressive disease with median survival of 2-4 years.
Diseases of joints

Inflammation of joints (Arthritis)

1- Acute arthritis
   - Suppurative
   - Traumatic
   - Rheumatic

2- Chronic Arthritis
   a. T.B & S
   b. Rheumatoid arthritis
   c. Osteoarthritis
   d. Gout... Increased serum uric acid leads to deposition of uric acid crystals in joints......inflammation with foreign body giant cell reaction (Tophi) mainly in the metatarsophalangeal joint of the big toe.
   e. Hemophilic joint....intrarticlar bleeding leading to organization by fibrous tissue.
   f. Charcot's joint (neuropathic joint)... loss of joint sensitivity leading to traumatic injury and degenerative changes.

Gouty arthritis

Rheumatoid arthritis

- **Definition:** Chronic systemic collagen disease affecting peripheral joints
- **Joint affected:** Small joints of hands and feet
- **Peak age:** 30-40 year
- **Sex:** More in females
- **Pathogenesis:** Autoimmune. Anti-IgG antibodies (rheumatoid factor)....ag-ab reaction initiating inflammatory reaction
Pathology

1- Synovial membrane
- Hyperplasia and inflammation which creeps over the articular cartilage (pannus)
- Organization of pannus leads to fibrous ankylosis.

2- Articular cartilage
- Erosion of the articular cartilage mainly at the periphery.

3- Bone
- Increased osteoclastic activity and osteoporosis.
**Rheumatoid arthritis**

- **Rheumatoid nodules** :- Present
- **Internal organs** :-
  - Affected Vasculitis
  - Lymphadenopathy
  - secondary amyloidosis
- **Serology** :-
  - Rheumatoid factor (RF) - ANA

**Osteoarthritis**

- **Definition** :-
  Degenerative disease of articular cartilage that may be primary or secondary.
- **Joint affected** :- Large joints
- Hip joint in males
- Knees & hands in females
- **Peak age** :- 60-80 years
- **Sex**: Females = males
- **Pathogenesis**: Degenerative changes which may be primary due to aging or secondary to mechanical stress.

![Osteoarthritis Diagram]

**Pathology**

1. **Synovial membrane**
   - Congestion and non-specific chronic inflammation.
2. **Articular cartilage**
   - The central part undergoes degeneration and separation exposing the underlying bone.
3. **Bone**
   - Thickening and sclerosis of exposed bone.
   - Small bony projections are formed at the joint periphery, "osteophytes"

**Tumors of joints**

1. **Pigmented villonodular synovitis**.... Benign tumor
   - Fibroblasts + histiocytes + giant cells (fibrous histiocytoma).

2. **Malignant synovioma**.... Young age
   - M/E. biphasic tumor (epithelial + mesenchymal).
   - Slow growth... Blood spread