Bone imaging

By

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Aims of our lecture:

- To know the different radiological techniques used in bone imaging, and what are their advantages and disadvantages.
- To know different bone pathologies.
- To differentiate benign from malignant nature of a bony lesion.
- See some examples of bony lesions

Primary Malignant Bony tumor

- Metastatic malignant tumors are by far the commonest bone neoplasm
- Radionuclide bone scans show substantially increased activity in the lesion.
- MRI is the most accurate technique for showing the extension into both the medullary cavity and the soft tissues can be accurately defined, as can the relationship to important nerves and blood vessels. MRI provides this information better than CT

Osteosarcoma (osteogenic sarcoma)

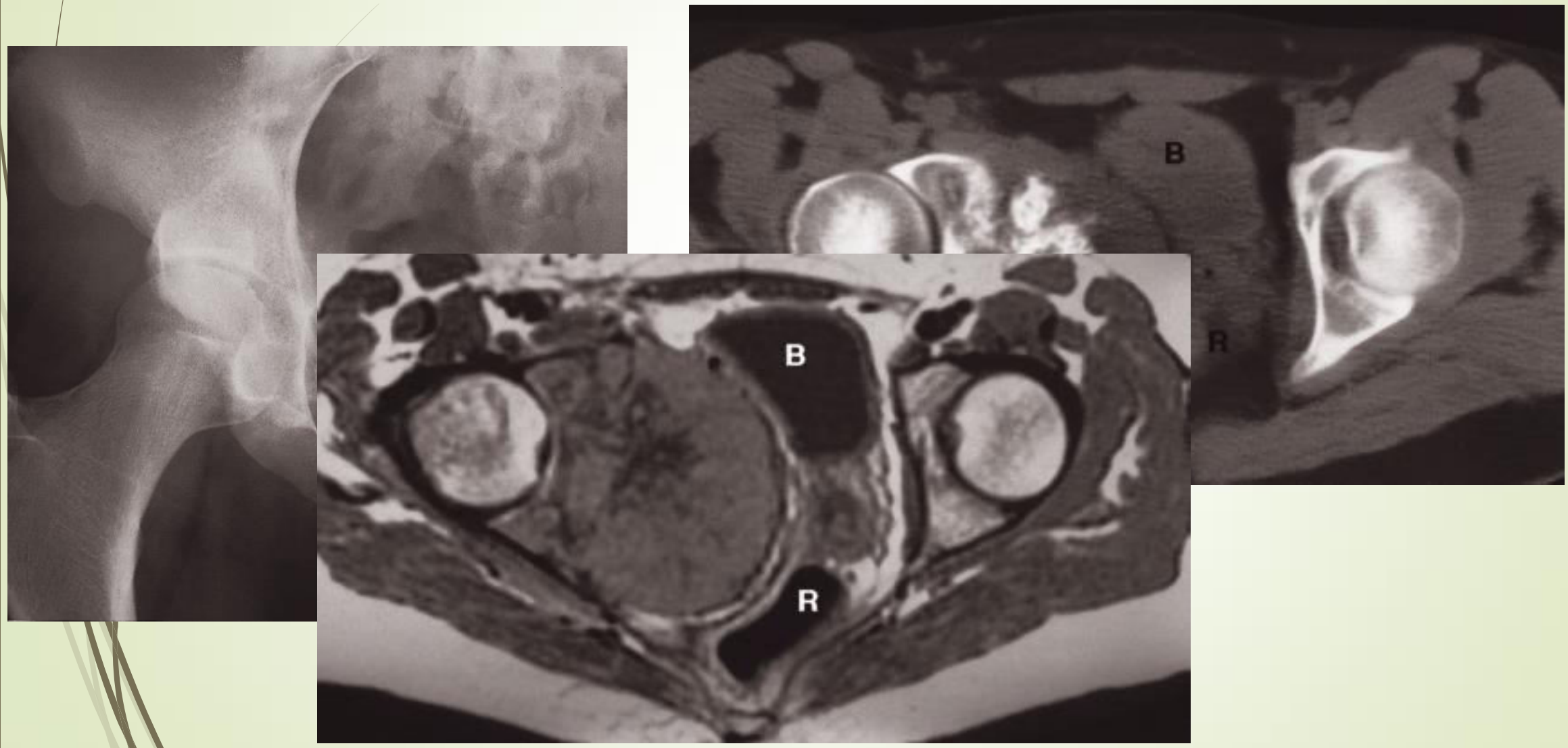
- Occurs mainly in the 5–20-year-old age group, but is also seen in the elderly following malignant change in Paget's disease.
- The tumour often arises in a metaphysis, most commonly around the knee.
- Florid spiculated periosteal reaction is present, the so-called sunray appearance
- The tumour may elevate the periosteum to form a Codman's triangle

Osteosarcoma (osteogenic sarcoma)

Chondrosarcoma

- 30–50-year-old age group
- Most commonly in the pelvic bones, scapulae, humeri and femora.
- A chondrosarcoma produces a lytic expanding lesion containing flecks of calcium.
- It can be difficult to distinguish from enchondroma, but it is usually less well defined and may show a periosteal reaction.
- A chondrosarcoma may arise from malignant degeneration of a benign cartilaginous tumour

Chondrosarcoma



Ewing's sarcoma

- A highly malignant tumour, commonest in children
- Arising in the shaft of long bones.
- It produces ill-defined bone destruction with periosteal reaction that is typically 'onion skin' in type

Giant cell tumour

- Has features of both malignant and benign tumours.
- It is locally invasive but rarely metastasizes.
- It occurs most commonly around the knee and at the wrist after the epiphyses have fused. It is an expanding destructive lesion, which is subarticular in position

Giant cell tumour

Primary lymphoma

- Bone involvement is rare
- Most osseous malignant lymphoma is associated with generalized lymph node disease.
- When solitary primary lymphomas are encountered they may produce sclerotic or lytic bone lesions
- Indistinguishable on imaging grounds from other malignant tumor

Primary lymphoma

Benign tumours and tumour-like conditions

- In general, benign lesions have an edge which is well demarcated from the normal bone by a sclerotic rim.
- They cause expansion but rarely breach the cortex.
- There is no soft tissue mass and a periosteal reaction is unusual unless there has been a fracture through the lesion.
- Radionuclide scans in benign tumours usually show little or no increase in activity, provided no fracture has occurred.

Enchondromas:

- Are seen as lytic expanding lesions most commonly in the bones of the hand.
- They often contain a few flecks of calcium and frequently present as a pathological fracture.

Fibrous cortical defects (non-ossifying fibromas):

- Are common chance findings in children and young adults.
- They produce well-defined lucent areas in the cortex of long Bones

Enchondroma

Fibrous cortical defects

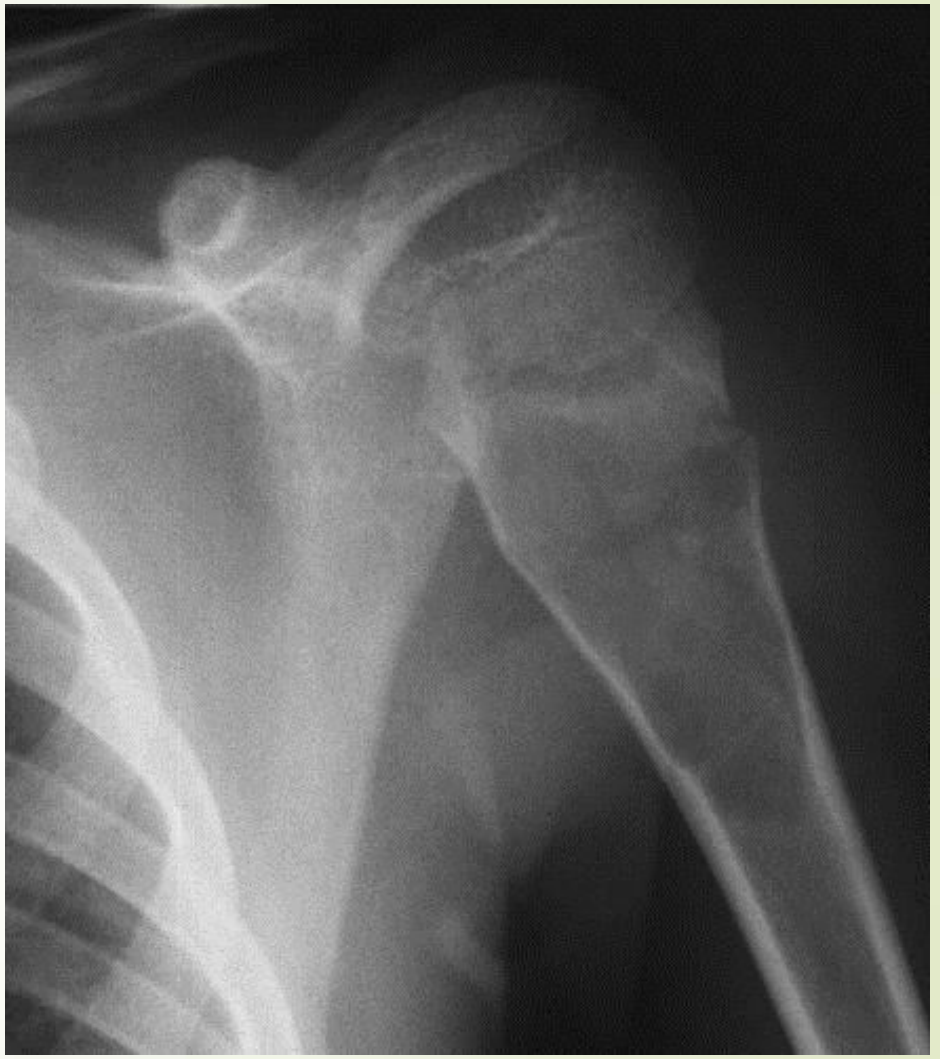
Fibrous dysplasia

- May affect one or several bones.
- Affects the long bones and ribs as a well defined lytic lesion and may expand the bone.
- There may be a sclerotic rim around the lesion.

Simple bone cyst

- Has a wall of fibrous tissue and is filled with fluid.
- It occurs in children and young adults, most commonly in the humerus and femur.
- The cortex may be thin and the bone expanded.
- Pathological fracture.

Fibrous dysplasia



Simple bone cyst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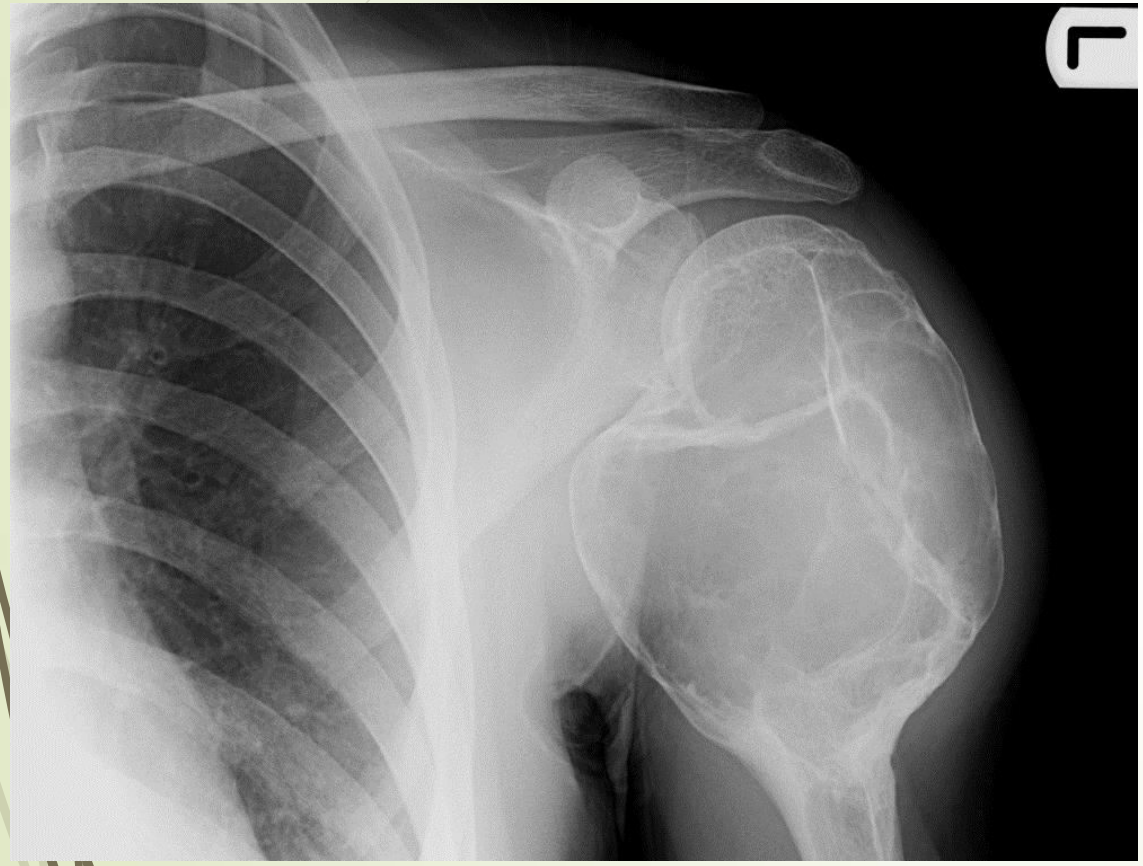
Aneurysmal bone cysts

- Mostly they are seen in children and young adults
- Affects the spine, long bones or pelvis.
- These lesions are purely lytic and cause massive expansion of the cortex, hence the name 'aneurysmal'. They may grow quickly and appear very aggressive but are, nevertheless, benign lesions.
- Computed tomography and MRI may show the blood-fluid level within the cyst.
- The major differential diagnosis is from giant-cell tumour.

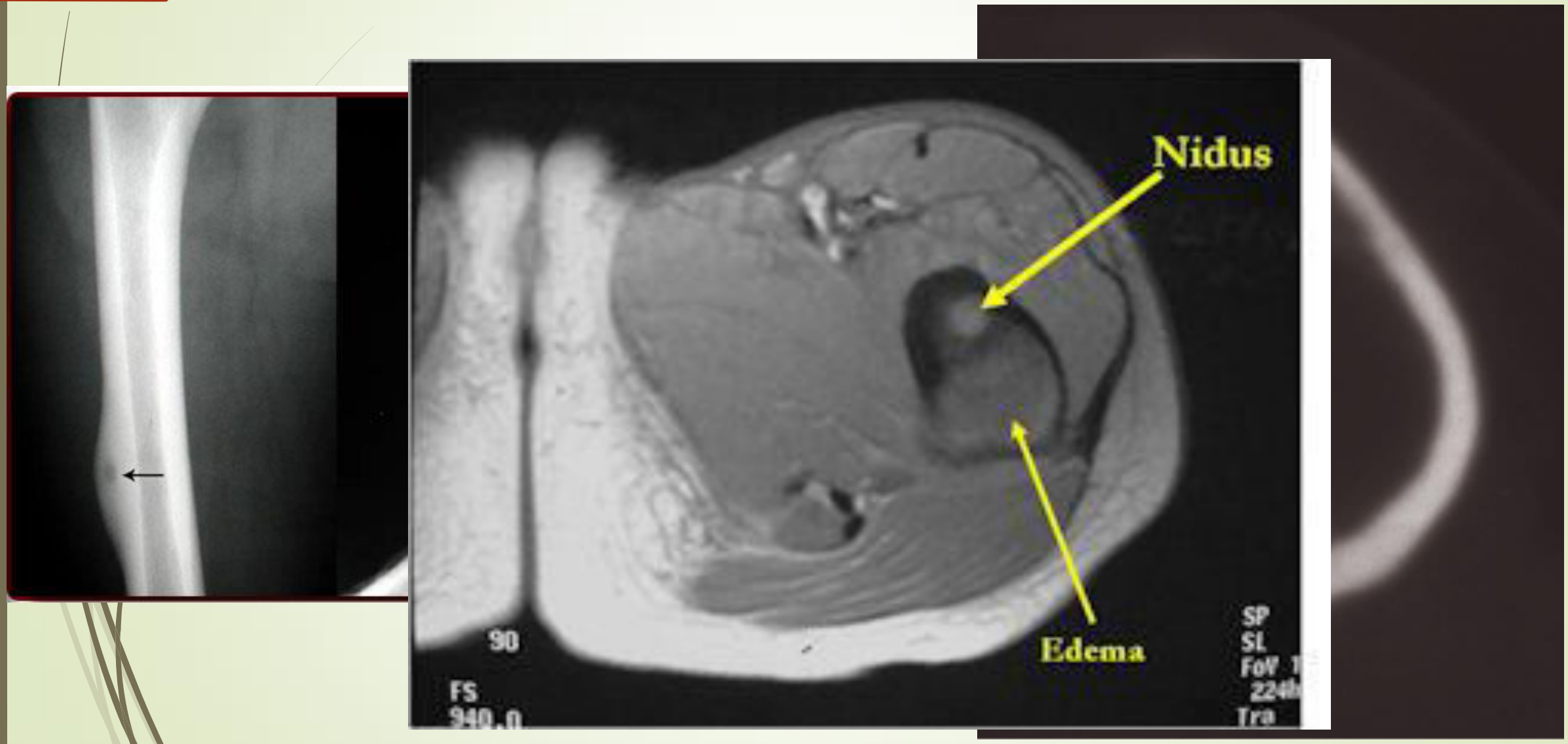
Aneurysmal bone cysts



Osteoid osteoma

- Is a painful condition found most commonly in the femur and tibia in young adults.
- Characteristic radiological appearance: a small lucency, sometimes with central specks of calcification, known as a nidus, surrounded by dense sclerotic rim.
- A periosteal reaction may also be present.
- Radionuclide bone scanning: shows marked focal increased activity.

Osteoid osteoma



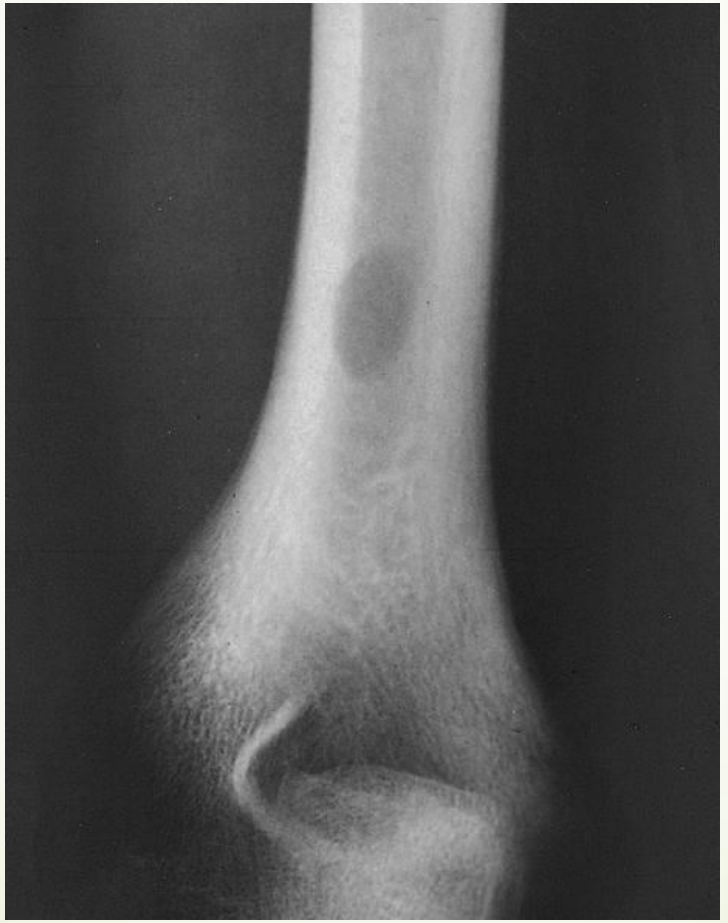
osteoma

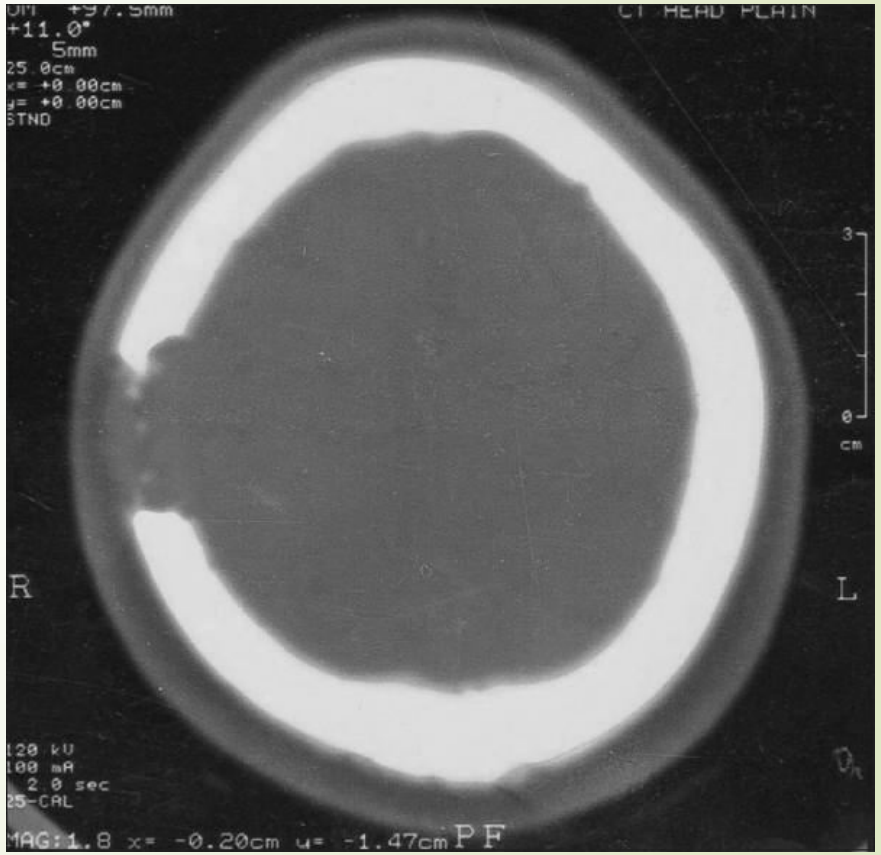
- An is a benign tumour consisting of dense bone. They may occur in the paranasal sinuses.

Eosinophil granuloma

- Is the mildest and most frequent form of Langerhans histiocytosis.
- It occurs in children and young adults
- Lytic lesions which may be single or multiple, most frequently in the skull, pelvis, femur and ribs.
- May have the features of an aggressive lesion, or well defined and may have a sclerotic rim.
- A periosteal reaction is sometimes seen.

Eosinophil granuloma





Osteomyelitis

- Most often caused by Staphylococcus aureus and usually affects infants and children.
- The initial radiographs are normal as bone changes are not visible until 10–14 days after the onset of the infection, but the 99mTc radionuclide bone scan and MRI show changes much earlier in the course of the disease within a day or two.
- Typically, acute osteomyelitis affects the metaphysis of a long bone, usually the femur or tibia.
- The earliest signs on plain radiographs are soft tissue swelling and bone destruction in the metaphysis, with a periosteal reaction that eventually may become very extensive and surround the bone to form an involucrum.
- A part of the original bone may die and form a separate dense fragment known as a sequestrum.

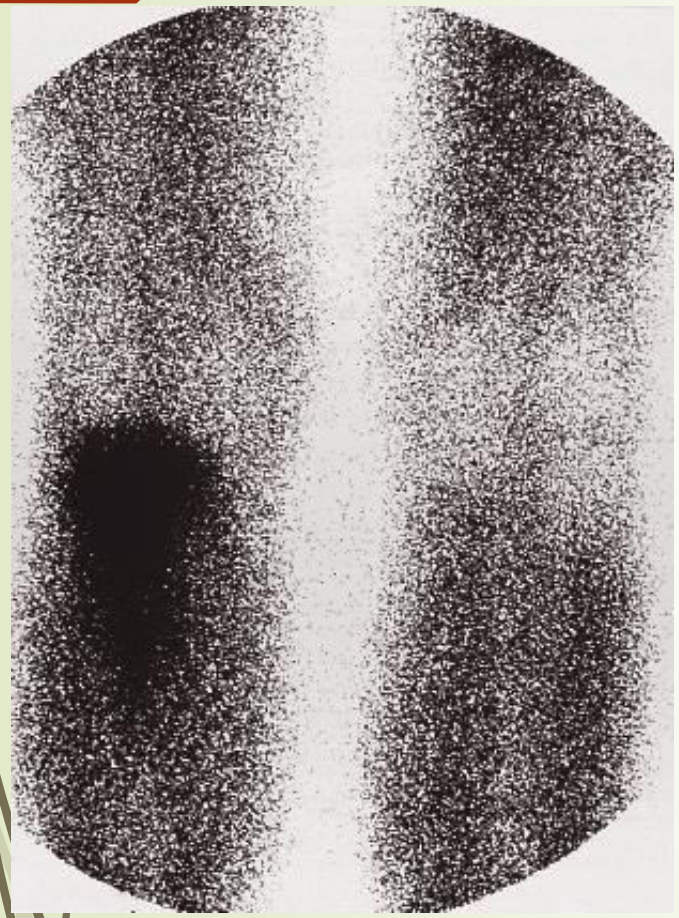
Osteomyelitis

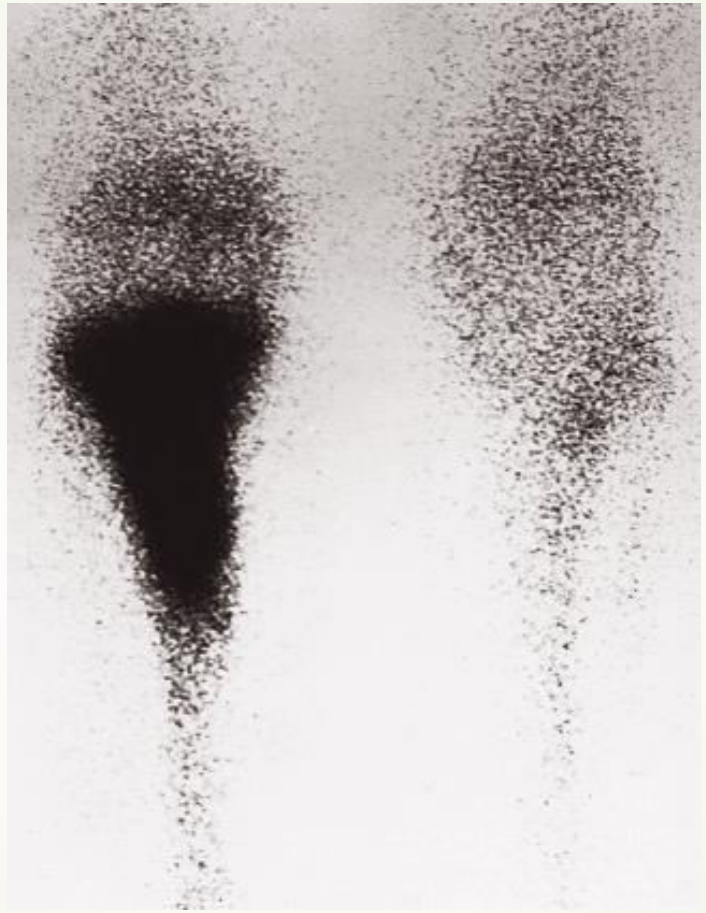
- In chronic osteomyelitis, the bone becomes thickened and sclerotic with loss of differentiation between the cortex and the medulla. And may produce well defined lytic lesion within the bone known as a Brodie's abscess

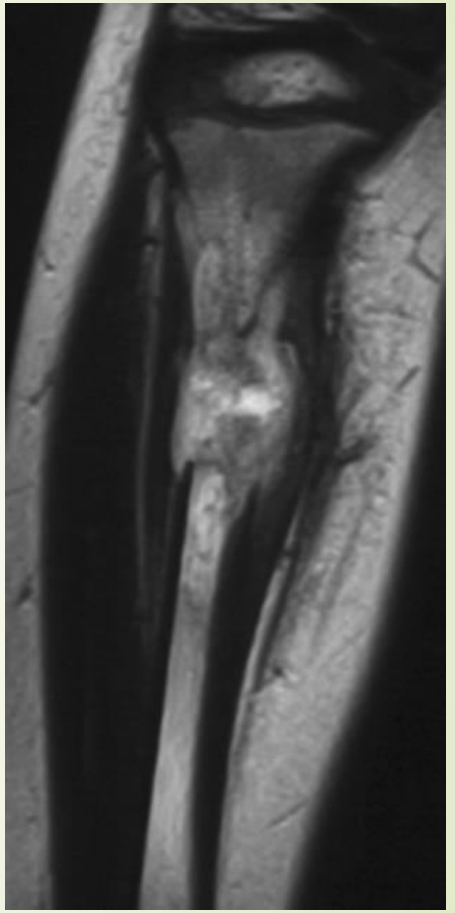
- Tuberculous osteomyelitis is a particular problem in African and Asian populations and patients with AIDS.

- The spine is the most frequent site of infection, followed by the large joints, but any bone may be affected. The disease is relatively indolent and produces large areas of bone destruction which, unlike pyogenic osteomyelitis, may be relatively asymptomatic in the early stages.







Bone infarction

- Causes: caisson disease, sickle cell disease or following radiation therapy or seen in elderly people without known cause

- Once healed, they appear as irregular calcification in the medulla of a long bone


A
B

Multiple focal lesions

1. Metastases:

- Commonest malignant bone tumour
- Metastases may be sclerotic, lytic or a mixed.
- Bones mostly affected are those containing red marrow: the spine, skull, ribs, pelvis, humeri and femora.
- Most of metastases are lytic
- Metastases and myeloma are virtually the only causes of multiple obvious lytic lesions in bone.

- Sclerotic metastases: mainly from prostate CA in male and breast CA in female
- Mixed lytic – sclerotic metastasis are mainly from breast CA.
- Metastases with bone expansion occur in primary tumours of the kidney and thyroid.
- Neuroblastoma metastasis may cause periosteal reaction

- Radionuclide bone scan: best modality, reveals 30% of lesions that are not evident on X ray.
- MRI: better sensitivity than radionuclide. Disadvantage?
- CT scan: less sensitive than MRI, need bone window


Blastic
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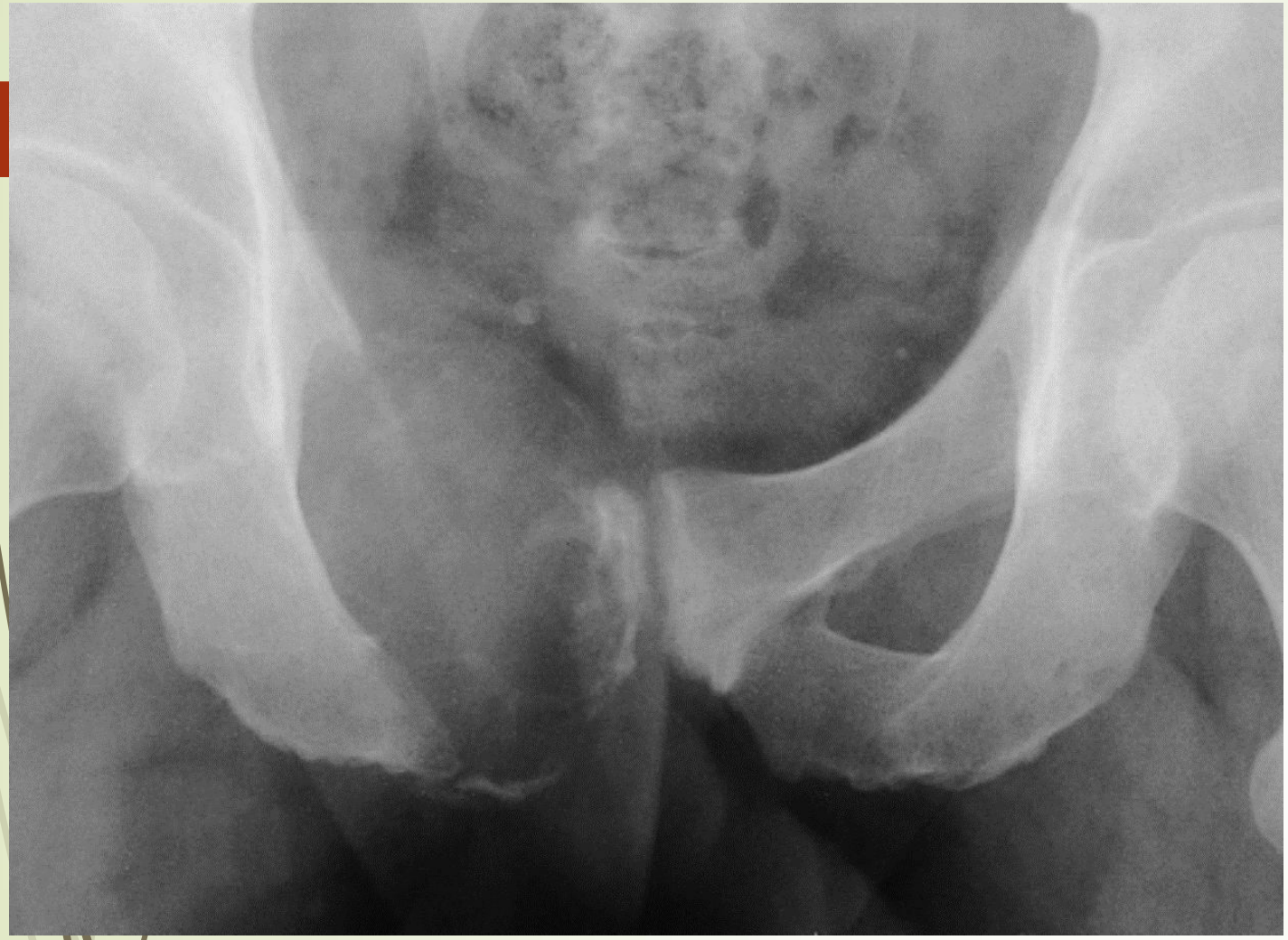


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2- Multiple myeloma:

- Most frequently seen in bones with active haemopoiesis.
- The bone lesions may resemble lytic metastases in every way, but are often better defined and may cause expansion of the bone
- Diffuse marrow involvement may give rise to generalized loss of bone density, producing a picture similar to that of osteoporosis


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Multiple periosteal reactions

1) Non-accidental injury
2) Widespread bone infection, e.g. congenital syphilis, neonates with infected intravenous catheters
3) Venous stasis and ulceration of the legs
4) Hypertrophic pulmonary osteoarthropathy
5) Scurvy

chronic venous stasis

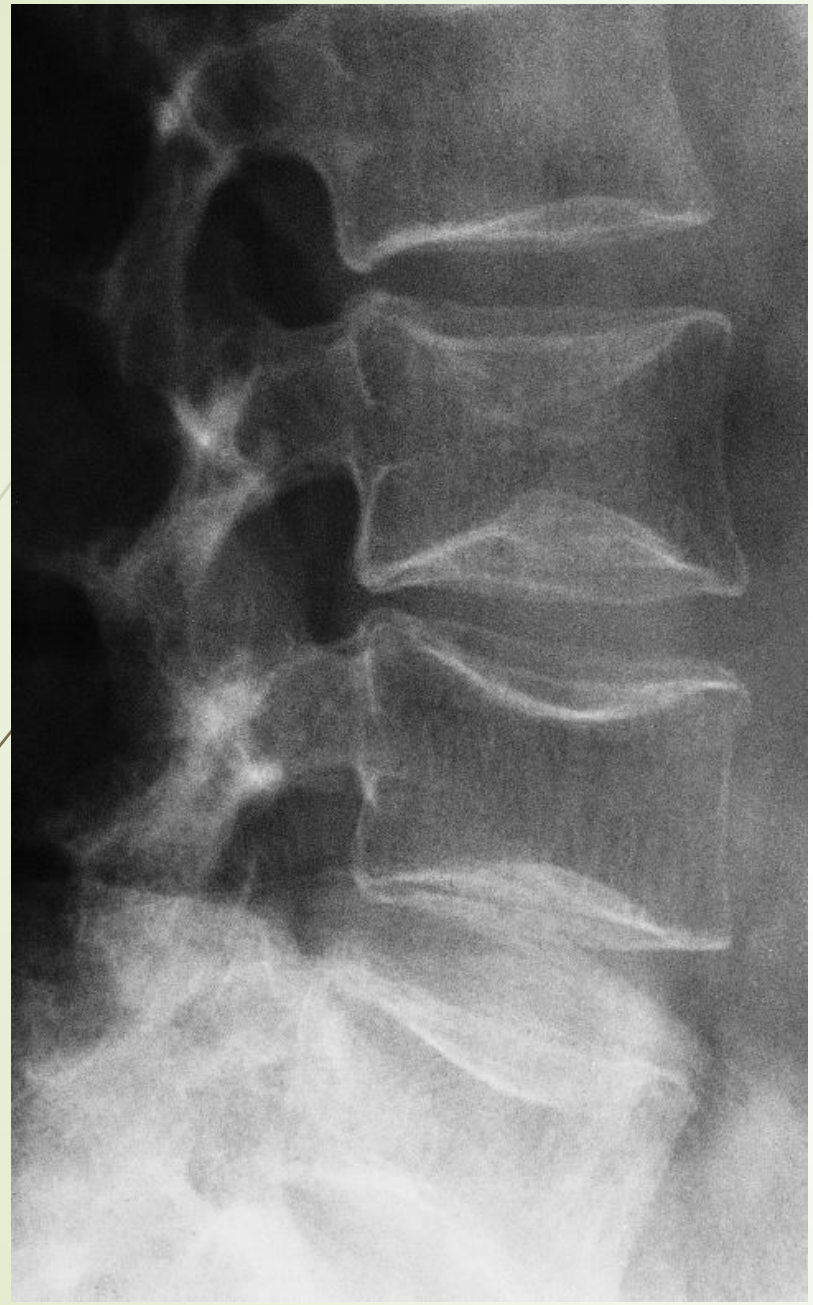
Hypertrophic pulmonary osteoarthropathy

Generalized decrease in bone density (osteopenia)

- osteoporosis
- osteomalacia
- hyperparathyroidism
- multiple myeloma

Osteoporosis

- Osteoporosis is the consequence of a deficiency of protein
- Osteoporosis predisposes to fractures
- The changes of osteoporosis are best seen in the spine
- Causes:
  - **idiopathic**, often subdivided according to age of onset, e.g. juvenile, postmenopausal, senile.
  - **Cushing's disease and steroid therapy**
  - **disuse**.



Senile osteoporosis, penciled cortex

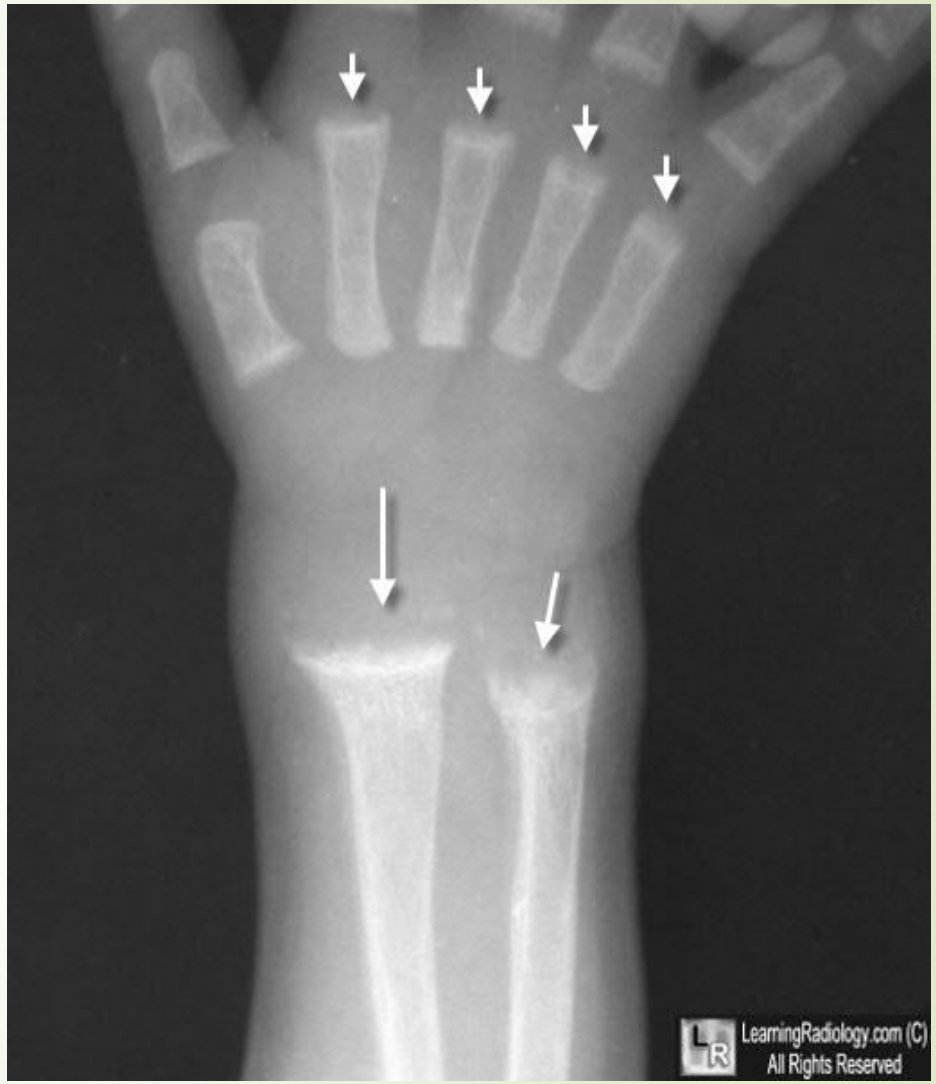
Disuse osteoporosis

Rickets and osteomalacia

- Poor mineralization of osteoid
- The main causes:
  - Dietary deficiency of vitamin D, or lack of exposure to sunlight.
  - Malabsorption.
  - Renal disease.

Rickets

- The changes are maximal where bone growth is occurring, so they are best seen at the knees, wrists and ankles.
- The zone of provisional calcification is deficient and the metaphyses are irregularly mineralized, widened and cupped
- Widened growth plate
- Generalized decrease in bone density
- Deformities of the bones
- Greenstick fractures are common.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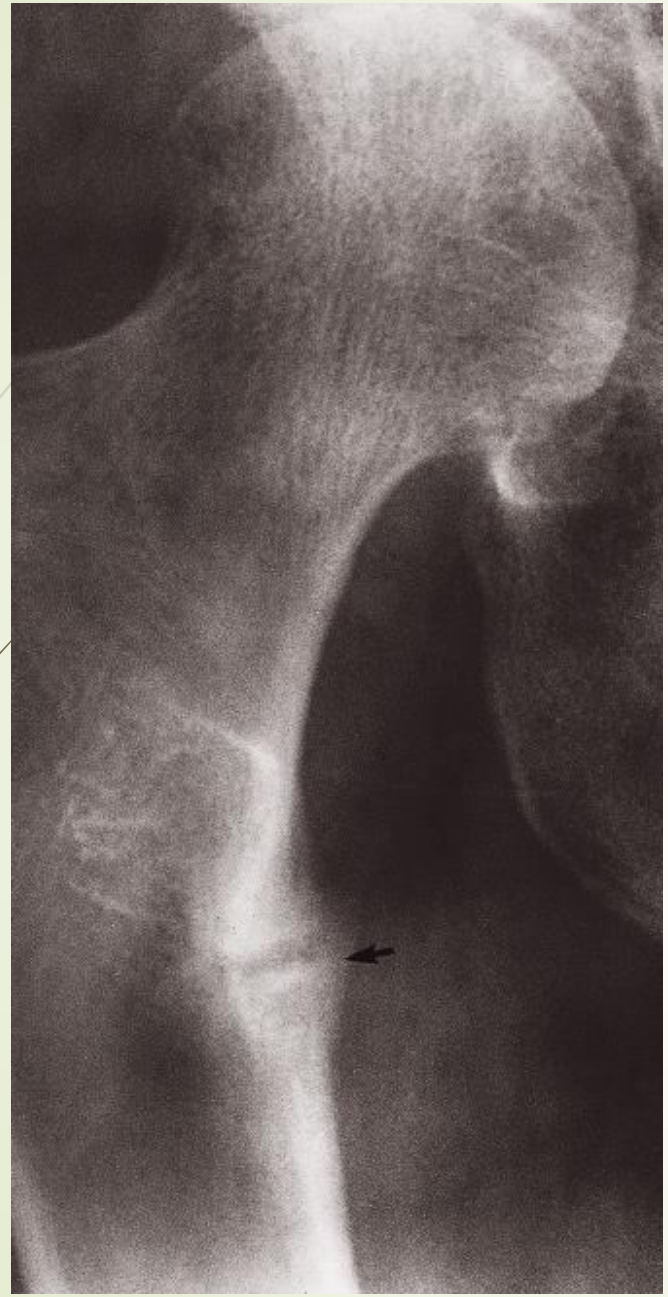
Osteomalacia

- Loss of bone density
- Thinning of trabeculae and cortex
- Looser`s zones (pseudofractures): commonest in the scapulae, medial aspects of the femoral necks and in the pubic rami.
- Bone deformity: biconcave vertbebra. Bowing of long bones. Triradiate pelvis



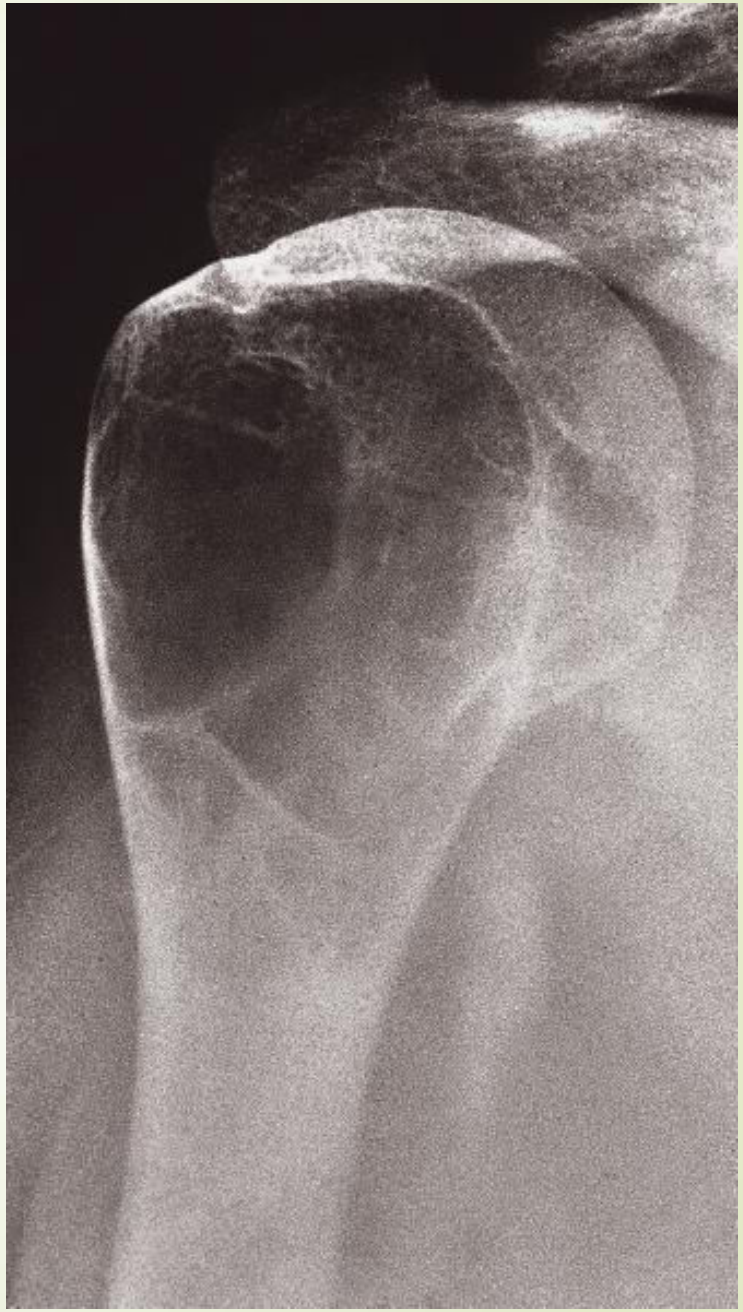
Hyperparathyroidism:

- Excess parathyroid hormone secretion mobilizes calcium from the bones, resulting in a decrease in bone
- Primary: hyperplasia or a tumour of the parathyroid glands
- Secondary: chronic renal failure
- A generalized loss of bone density, with loss of the differentiation between cortex and medulla. The trabecular pattern may have a fine lacework appearance. With advanced disease there may be marked deformity of the skeleton.

Hyperparathyroidism:

- The hallmark of hyperparathyroidism is subperiosteal bone resorption, particularly at the radial side of the middle phalanges and at the tips of the terminal phalanges.
- There may also be resorption of the outer ends of the clavicles.
- Soft tissue calcification, vascular calcification and chondrocalcinosis: more in the secondary type
- Brown tumours: seen more in primary type. Lytic lesions, single or multiple, of varying size and may be expensile. They occur most commonly in the mandible and pelvis.

Courtesy M. Kricun, MD



Renal osteodystrophy

- Three distinct pattern of bony involvement:
  - **Osteomalacia** in adults; **rickets** in children
  - **Hyperparathyroidism**
  - **Sclerosis**, Rugger jersey spine or sclerosis of the metaphyses of the long bones.

Rugger jersey spine
(Renal osteodystrophy)

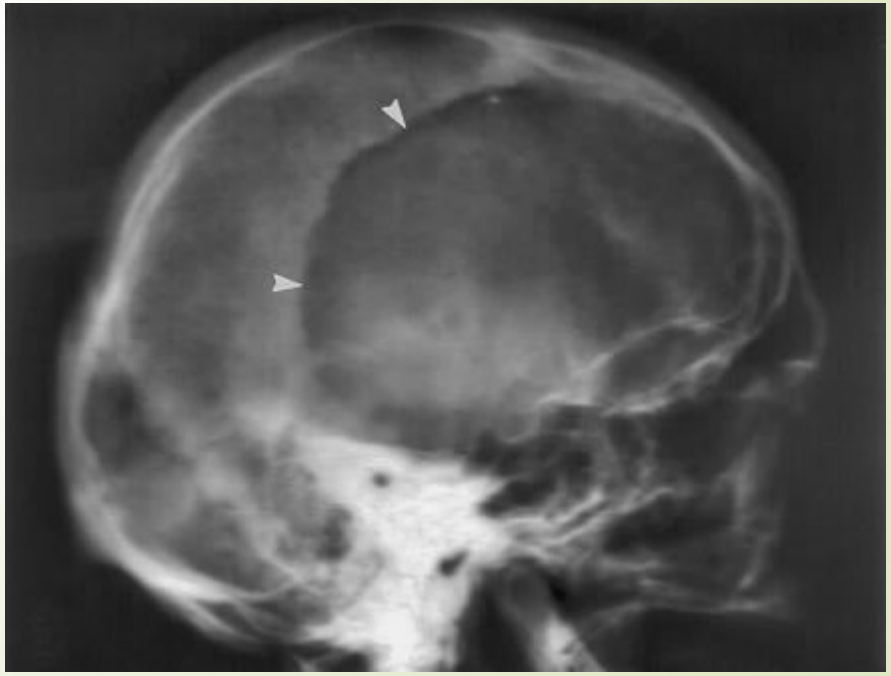
Generalized increase in bone density

- Sclerotic metastases
- Osteopetrosis (marble bone disease): congenital disease.
- Myelosclerosis: is a form of myelofibrosis, replacement of bone marrow by fibrous tissue. Splenomegally.

Osteopetrosis

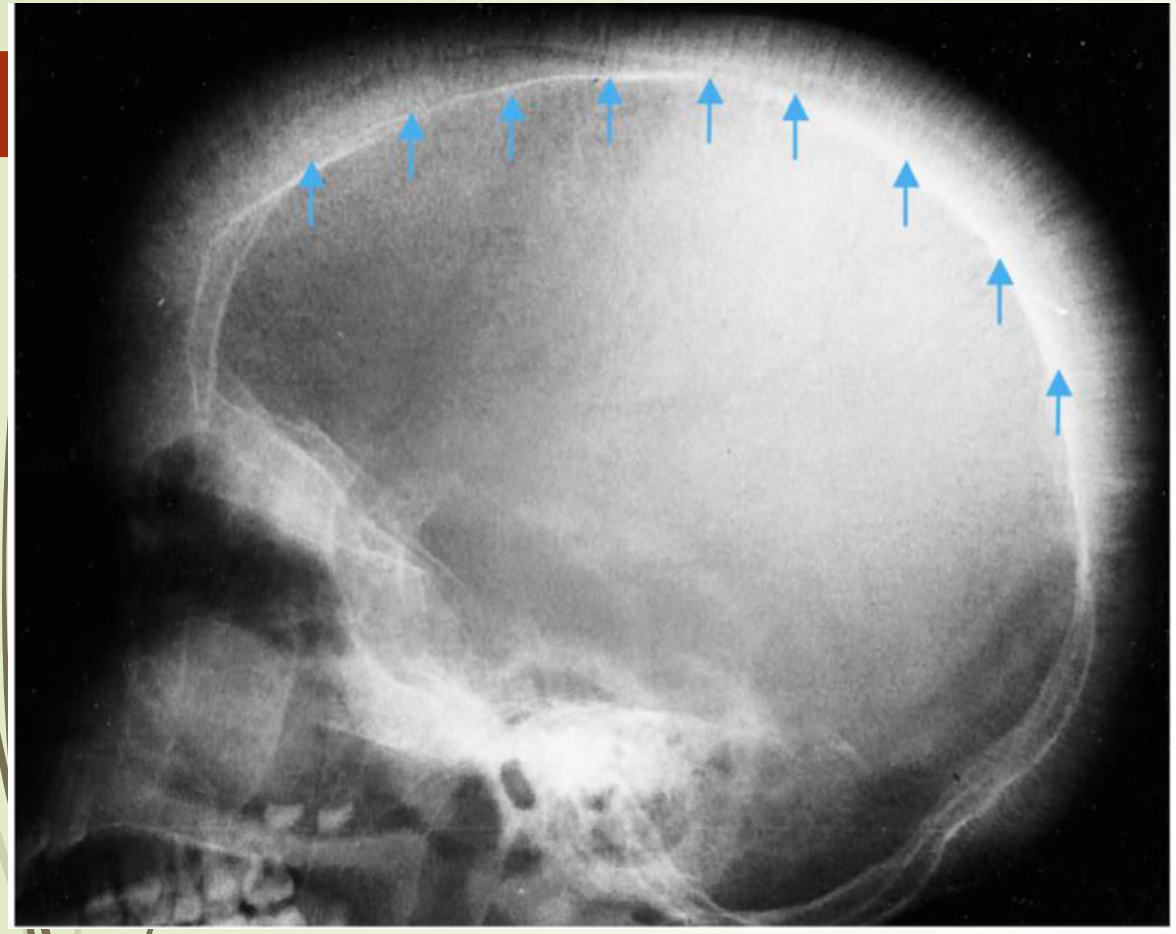
Alteration of trabecular pattern and change in shape

- **Paget disease**:
  - Elderly
  - Thickening of trabecula. Enlargement of affected bone, loss of CM differentiation.
  - Thickened calvarium with cotton wool appearance.
  - One form is lytic: osteoporosis circumscripta of skull.
  - Risk of malignant changes



Alteration of trabecular pattern and change in shape

- **Hemolytic anemia:**
  - Marrow hyperplasia: phalanges, skull: hair on end
  - Infarction and infection



Thank you