



431

Radiology Team

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Lecture 3: Radiology of Bone Infection and Tumors



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◆ Important

◆ Doctor's notes

◆ Team's notes

We thank 430 Team for their helpful notes

- Dr said the most important thing is to know is how to identify the findings and where to look for depending on the Hx of the patient.

From
Slides

Extra
Images

Disorders include:

• Metabolic and Endocrine Disorders:

- Osteoporosis
- Osteomalacia
- Renal Osteodystrophy
- Hyperparathyroidism
- Acromegaly

• Arthritis

- Rheumatoid Arthritis
- Osteoarthritis
- Psoriaticarthritis
- Gouty Arthritis

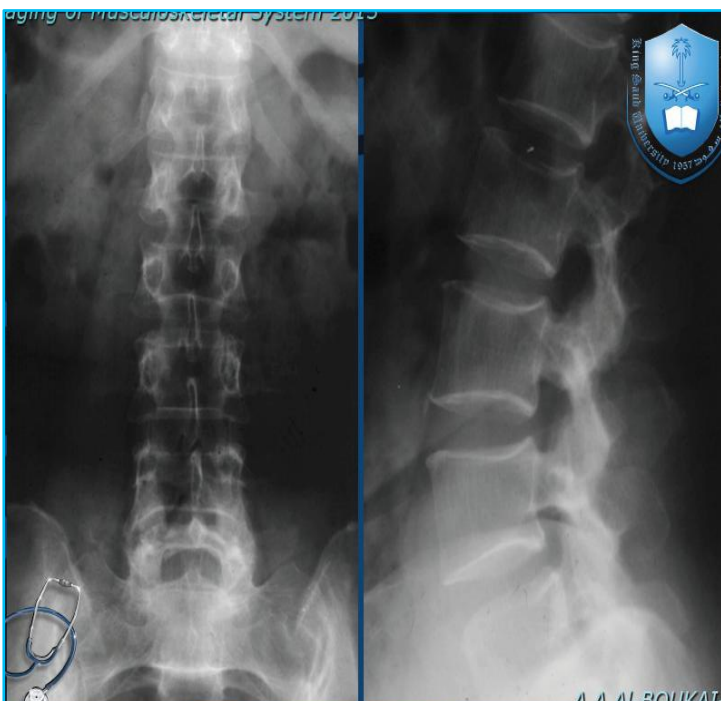
• Musculoskeletal Tumors

- Osseus, chondral, fibrous, soft tissue

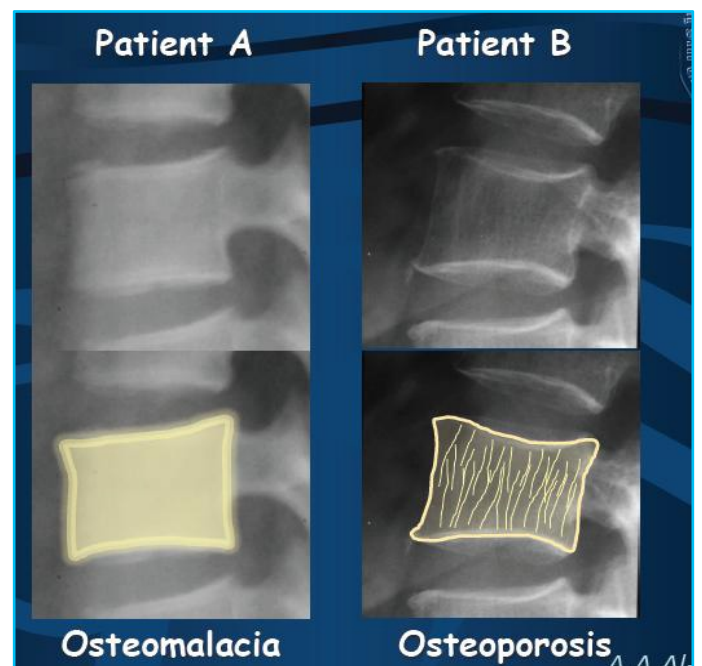
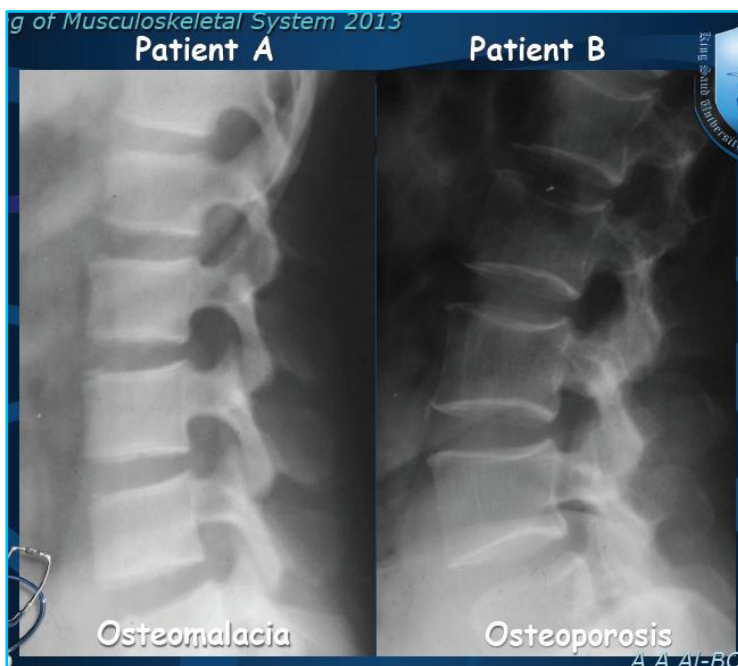
Metabolic & endocrine disorders

• Case 1:

54 years- old female with low back pain X-ray of lumbosacral spine requested



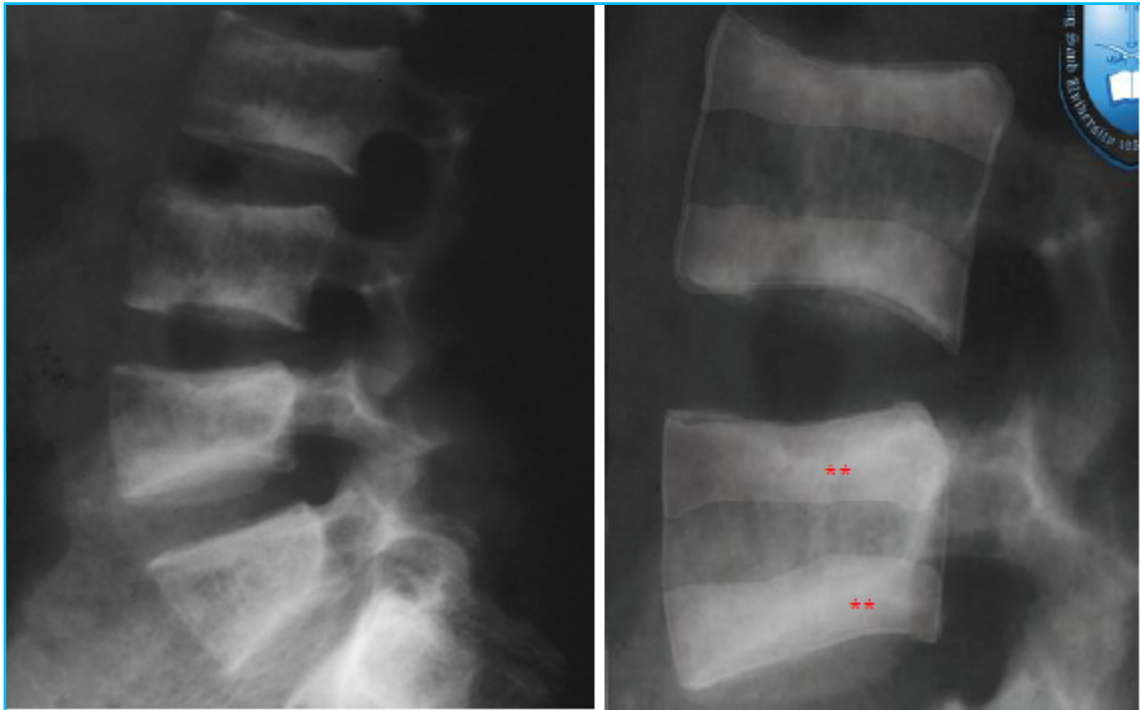
- The bone is too black, and to know if this is normal or abnormal , we compare it to the adjacent soft tissue and as we see here it's much blacker than the liver or spleen for example.
- Osteopenia (decreasing of bone density) is a FINDING not disease
- The edges of the vertebral body are **very sharps , well-demarcated and very easy to draw** and usually these edges are more homogenous with the rest of the bone.
- Usually the edges are straight line but here it's **concave** because it's softer
- to assess the texture we look at the trabeculae, in this case due to reduction of the matrix "bone density" horizontal trabeculae are lost and vertical ones still obvious to bear the vertical forces of gravity and weight of the patient.
- The best location to look for osteoporosis in x-rays is the lumbar spine & the femoral neck



- Patient A : patient with osteomalacia "Bone matrix is normal but there is a defect in mineralization" – Rickets in children
- In patient A, **the margins of the vertebral bodies are very hazy** " it's like when you take off your glasses" Bone density may be normal but bone is soft and there is a defect in mineralization and ill defined margins with no vertically oriented trabeculae.
- Patient B : patient with osteoporosis "Bone matrix reduced with normal mineralization" .There is reduction in bone density , sharp margins of the vertebral body with obvious vertically oriented trabeculae.

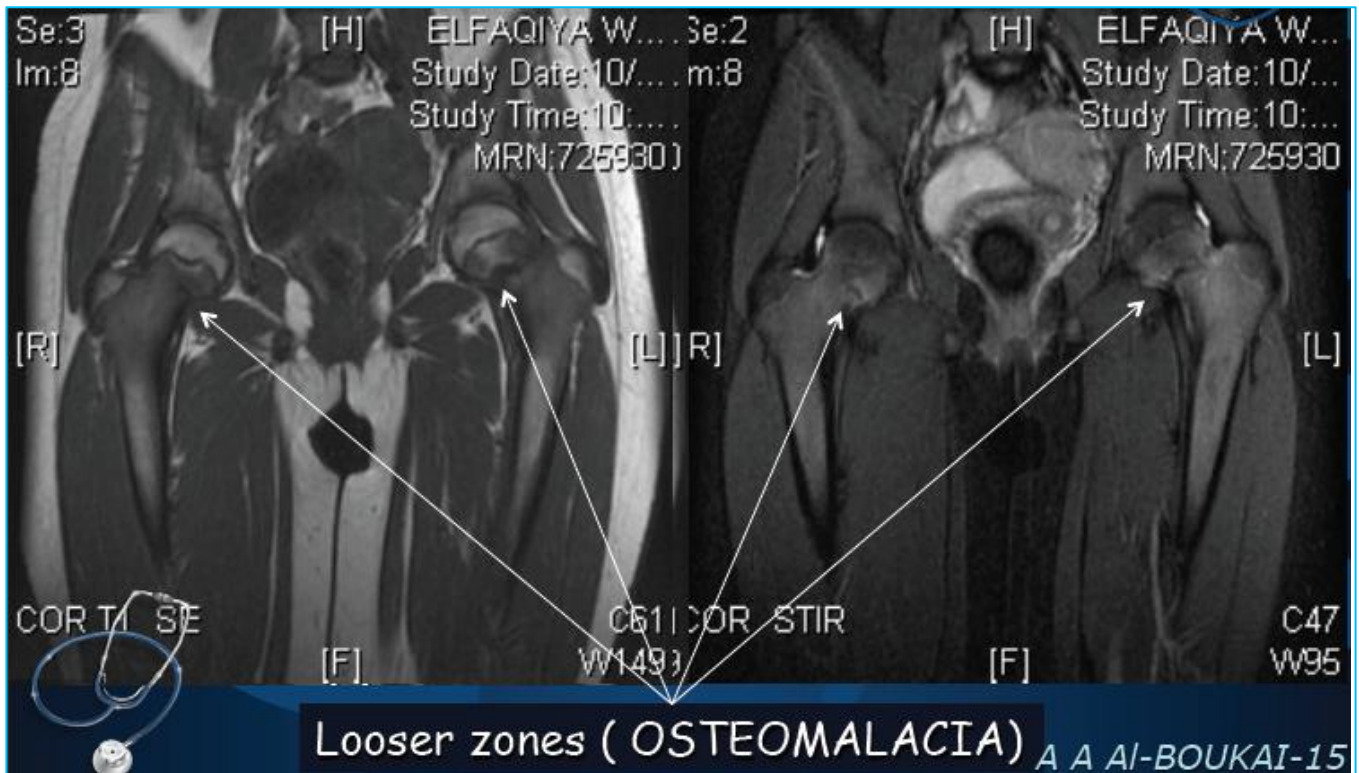
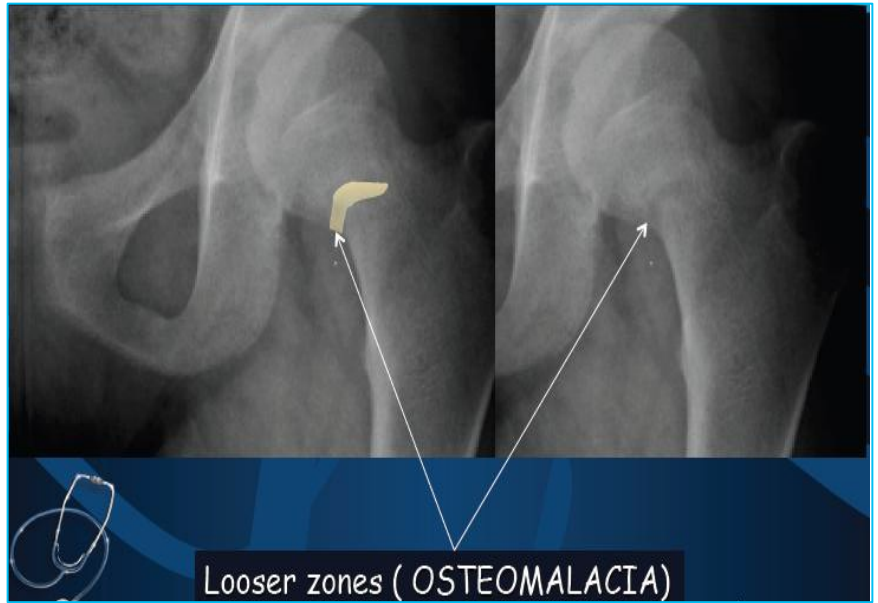
- **Case 2:**

27 years- old male with long standing history of renal failure. X-ray of lumbosacral spine requested.



- Renal failure can lead to disturbance of the metabolism of vitamin D and parathyroid hormone consequently can lead to changes in the bone.
- Bone density is decreased within the central portion (osteopenic) when you compare it with the end plate of the vertebral body (margins) which are whitish, sclerotic thick margins.
- Soft bone + hazy margins -- > means Osteomalacia
- Soft bone + sharp margins -- > means Osteoporosis.
- Trabeculae present -- > means Osteoporosis.
- There is alternating bands within the vertebral bodies called "Rugger Jersey Spine**" which diagnostic of osteosclerosis.
- Here we can see soft bone + hazy margins and also there is vertical trabeculae -- > so, it is a combination of Osteoporosis and Osteomalacia. In addition to osteosclerosis.
- Final diagnosis is -- > renal dystrophy.
- Components of Renal Osteodystrophy:
 1. Osteomalacia
 2. Osteoporosis
 3. osteosclerosis
 4. Changes that result from secondary hyperparathyroidism

- A young lady, presented with back pain .

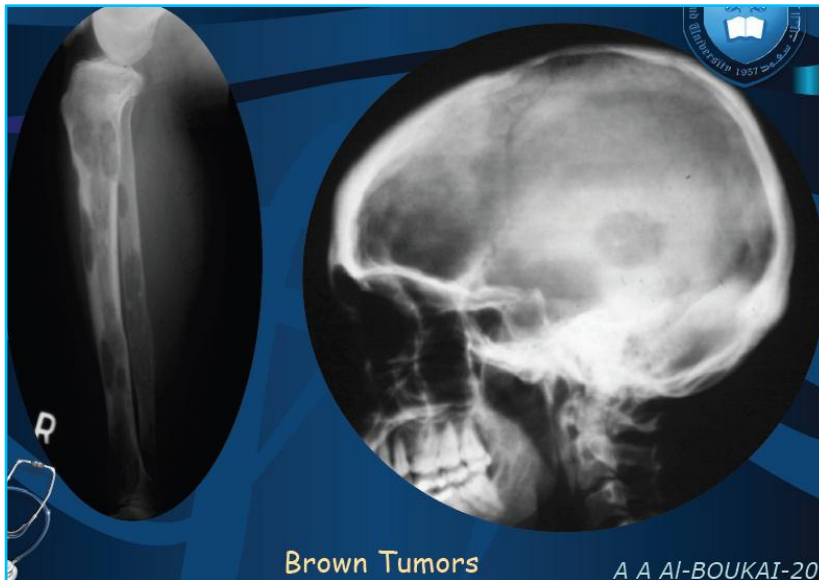


- usually the pt present with no Hx of trauma
- **Looser zones:** presents as pain during movement, lower limb weakness.
- looser zones or lines mean smooth fracture (clean fracture) usually seen in metabolic disorders
- **Osteomalacia** --> hazy thick margins + soft bone + looser zones.
- MRI is the best to check changes in the bone marrow.
- most common sites are femoral neck & scapula.

- Hyperparathyroidism:
 - Hyperparathyroidism Changes:
 1. Bone Resorption (erosions or erased trabeculae in certain area)
 2. Bone Softening (the bone in total is being soften)
 3. **Brown Tumors** (not true tumors – excessive areas of osteoclasts deposition in mass like)
 4. Osteosclerosis
 5. Soft tissue calcifications
 - You might see only one of them not all should be present.



- **Irregularity** of the cortical outline at the middle and distal phalanges -- > usually in the lateral aspect (**radial side**) -- > and it **is often in the middle and distal phalanges**.
- Bone outline is asymmetrical and irregular in the radial side



- These are the lucent (lytic) areas within the bone which are **Brown tumors**.
- Have a sharp outline but with no obvious margins

• **Case 3:**

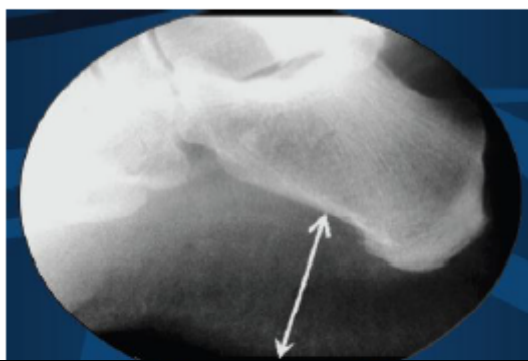
- 45 year old male presented with a history of bone enlargement. X-ray of the skull and hand requested.



- Sella turcica enlarged
- Mandible is enlarged and out of proportion to the maxilla, you can see the discrepancy between upper and lower jaw.
- There is **bony bridge** or tubercle at the **area of Frontal sinus**.



- Widening of the joint space between metacarpophalangeal and interphalangeal joints due to enlargement of interphalangeal cartilage in between.
- Enlargement of the soft tissues of the hand



- This is the **Heel pad sign**, one of acromegaly signs
- It is an increase of the thickness of the heel pad. normally not more than 26 mm.

Arthritis

• Case 4 :

- Elderly male patient presented with joint pain of the hands X-ray of hand request.



- It is important to differentiate between **Erosive** and **Non erosive arthropathy**.
- **Non erosive arthropathy**: e.g. **osteoarthritis** (Changes are more destructive at the distal parts). "case5"
- **Erosive arthropathy**: e.g. **rheumatoid arthritis**. "case4"
- § There is **periarticular osteopenia** or osteoporosis localized around the joint. In addition, bone will be eroded.
- § There is destruction of the carpal bone and metacarpophalangeal joint (A)
- § **Periarticular erosion** of V shaped defect at the metacarpal head (B)



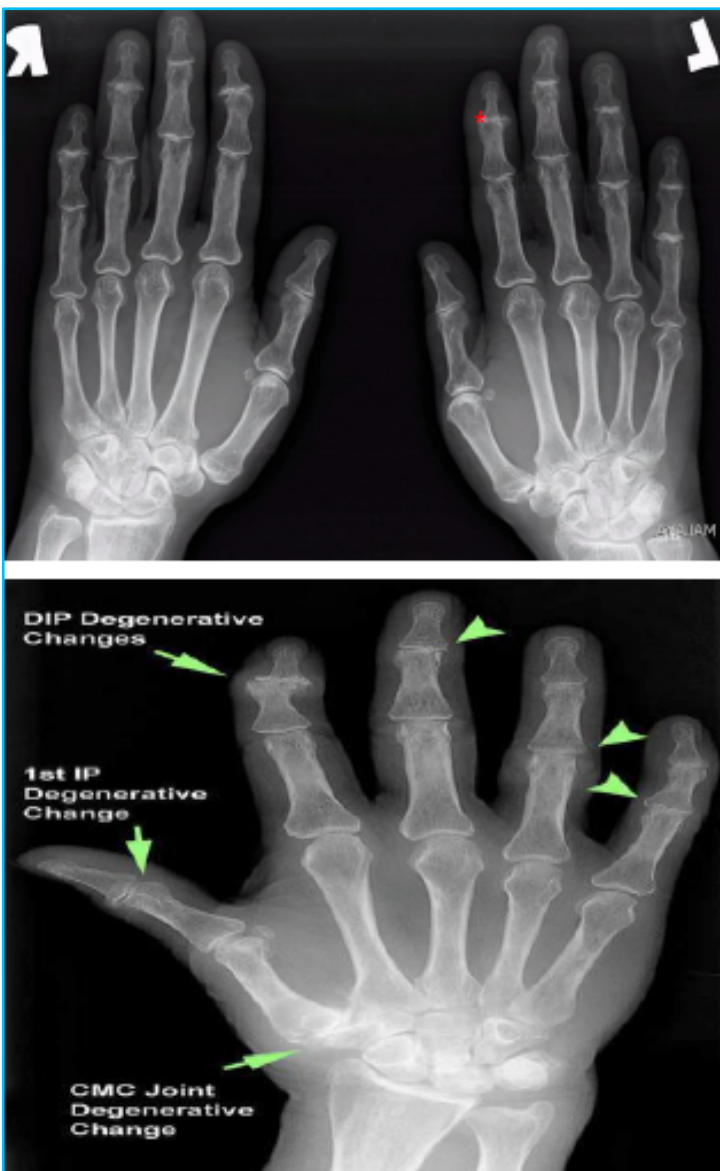
- Decreased bone density
- Oblique view: alignment is disturbed (first metacarpal)
- Carpal bones are destroyed and eroded
- Reduced distance between radius and carpal bones



-Extensive rheumatic arthritis changes including dislocation of the joints.

• **case5:**

- Elderly male patient presented with joint pain of the hands X-ray of hand request.

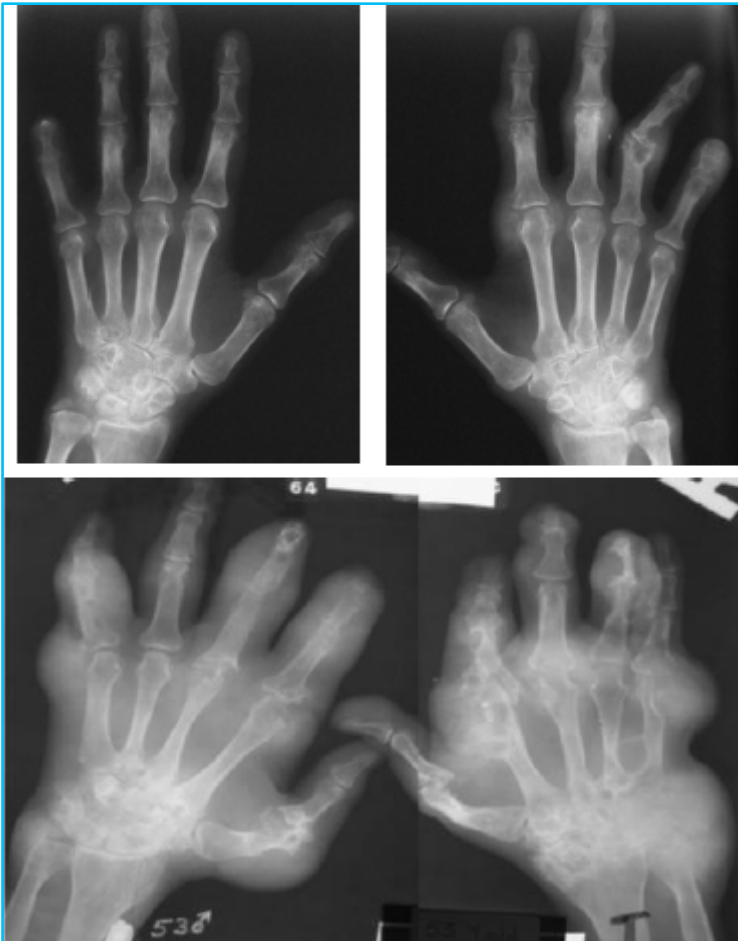


- joint space narrowing.
 - subcondral sclerosis (under cartilages)
 - Osteophytes changes (bone protrusions)
 - Distal bones are more whitish*
 - swelling around the joint
 - osteoarthritis occurs in the joint that we use most. hand is not common except for the thumb(1st carpal & metacarpal joints) and also the distal interphalangeal joints)
 - Changes are more distal which is the opposite from rheumatoid arthritis



- **Case6: (gout)**

- 43 year-old male patient presented with hands and feet pain and swelling X-ray of hand requested.



- Erosions.
- Misalignment.
- Around the joints there is a swelling "crystals deposition or tophi gout" (white areas).

Musculoskeletal tumors

Tumors can arise from any of these components :

- Osseous -- > e.g. Osteosarcoma
- Chondral -- > e.g. Chondroma
- Fibrous -- > e.g. Fibroma, Fibrosarcoma
- Soft tissue -- > Tumors of soft tissue structures such as muscles, tendons

KEY FEATURES

- Morphology (**geographic, Moth-eaten, Permeative**)
 - o Pattern of bone destruction
 - o Size, shape, margin of the lesion
 - o Texture of lesion matrix
 - o Cortex and periosteal reaction
- **Behavior of lesion** · Age of patient · Site (Location)

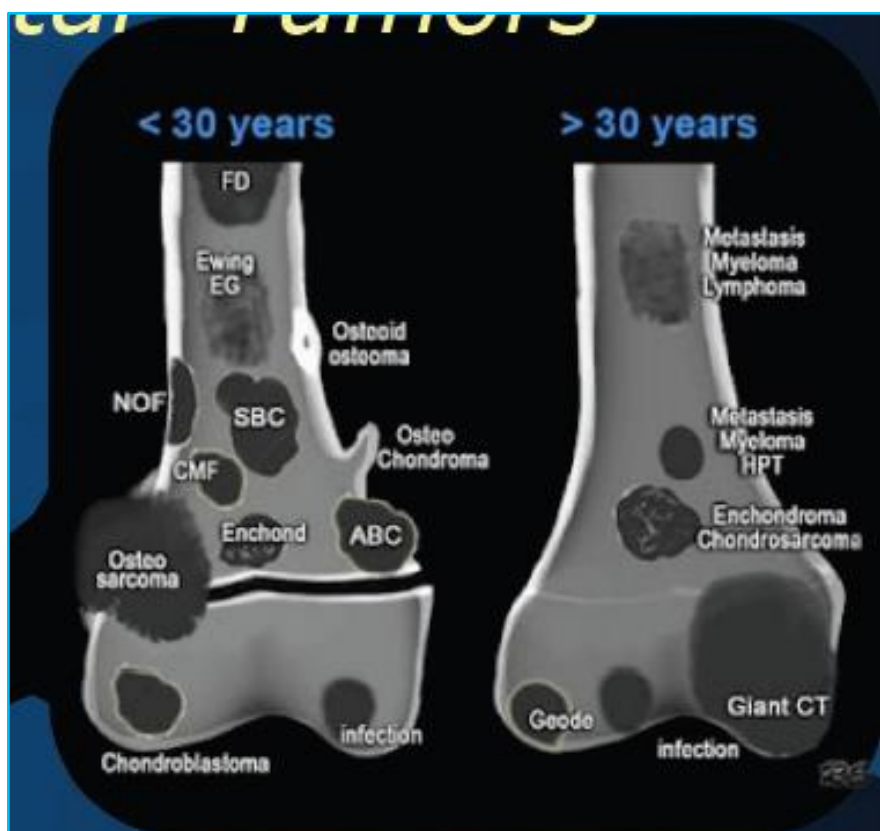
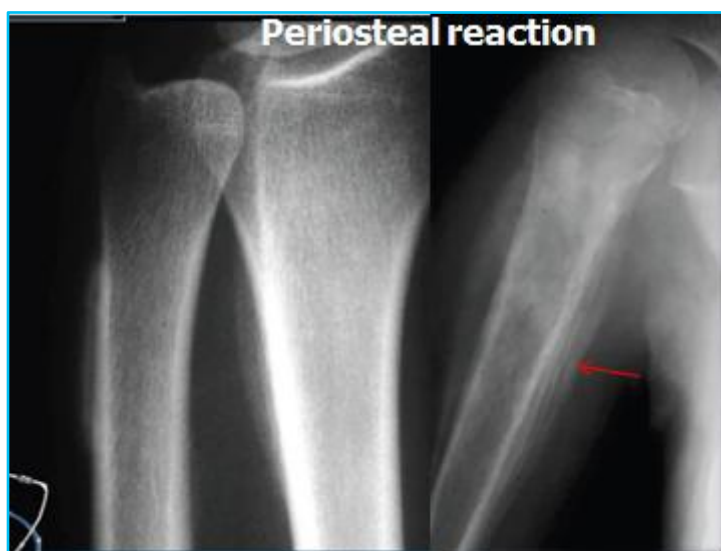


- Lucent osteolytic lesion **, Eaten bone
- **Sharply demarcated margins** (the margin of the lesion)
- **we call it geographic** (because it occurs at certain locations in the body)
- geographic lesions are usually **benign**

- **Lucent osteolytic lesion with ill-defined margin**
- It has **tiny black dots**** in between.
- It is called **Moth-eaten** appearance
- **Moth-eaten appearance means Infiltrative type of pathology** (aggressive) but it doesn't mean cancer, it could be infection

- **Permeative** lesion**, It permeate through the bone (that's why it is called Permeative lesion)
- Margins of the lesion is hazy + **areas of destruction**
- **Transition zone: transition between the lesion and the normal bone**
- A sharp margin means narrow transition zone which indicates benign lesion
- Hazy margin means wide transition zone which indicates malignant lesion (aggressive) either malignant neoplastic or malignant infection e.g. osteomyelitis

- Periosteum is a thin layer of a membrane to keep the bone intact.
- Any insult (trauma, neoplasm or inflammation) to the bone --> leads to --> Periosteal reaction which is excess bone produced by the Periosteum --> e.g. Periosteum reaction to fractures for example is attaching the two bones by a **callus** formation (bone bridging in between the bones) by osteoplastic activity
- If it is a **slowly progressing process**, it will **allow time to periosteal reaction** to form and surround the pathology --> will lead to thickening of the cortex.
- If the lesion is **aggressive and fast** --> **periosteal reaction will not surround it completely** because of the ongoing destructive process so you will see multiple layers of bone due to the alteration between constructive and destructive effect of osteoplastic activity. This is called "**lamellated type**" of periosteal reaction. (red arrow)
- In some cases the periosteum will form **perpendicular** to the lesion and it is called "**sunray appearance**"



- The younger the pt, the more likely is going to be benign . the older the pt the more likely is going to be malignant

- **Osseous Lesions either :**

- **Sclerotic** (osteoplastic activity -- > activate osteoplastic -- > appears **white** in the X-ray)

- **Osteolytic (lytic)** (destructive of the bone -- > appears **lucent** in the X-ray)

- **Mixed** (usually the aggressive type)

- Usually, metastasis from other organs of the body appears either sclerotic or osteolytic according to the origin e.g. skin -- > usually sclerotic and kidney -- > osteolytic.

- **case8:**

- 13 year-old boy patient presented with knee pain and swelling X-ray of knee requested



- **Osteolytic, Geographic**** -- > because it is sharply demarcated -- > it is in the metaphyseal lesion -- > indicates **a benign** lesion

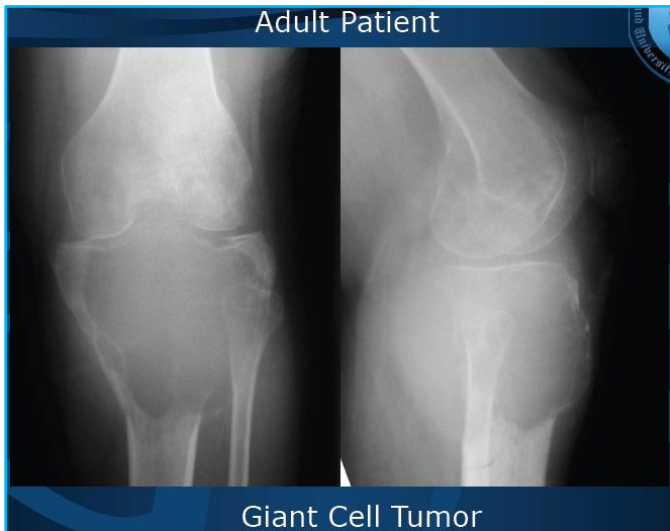
- DDx -- >

- **Either simple bone cyst** -- > which is simple content that involve the bone and it occur in **pediatrics** age group and it is in the metaphyseal portion of proximal humerus or tibia

- Or **aneurysmal bone cyst** (cyst that contain blood)

- The lesion was found in the X-ray but to get more details about tissue character we need CT and MRI.

- There is fluids with different densities we call it **fluid-fluid level**** -- > confirms that it is an **aneurysmal cyst**.



Appears osteolytic -- > in some areas it is sharply demarcated and other it is not -- > so, it is mixed margin -- > it is aggressive behavior although it is osteolytic because the margins

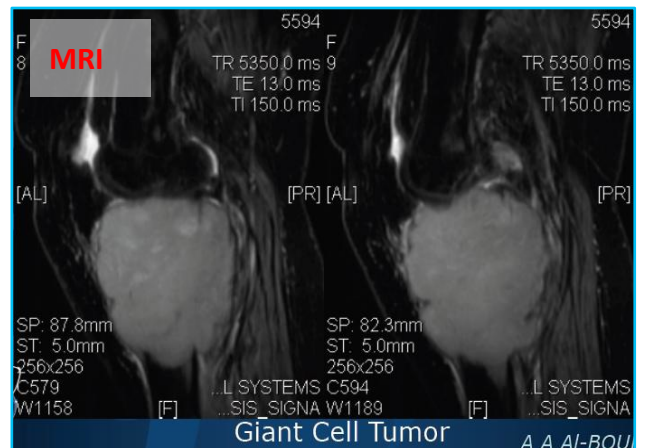
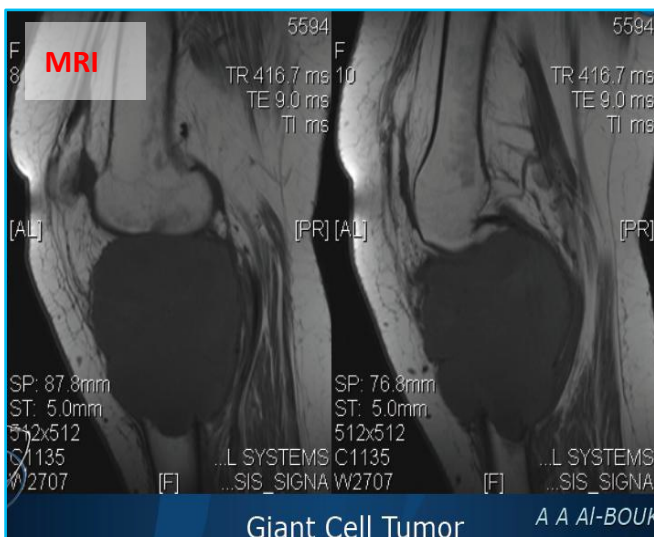
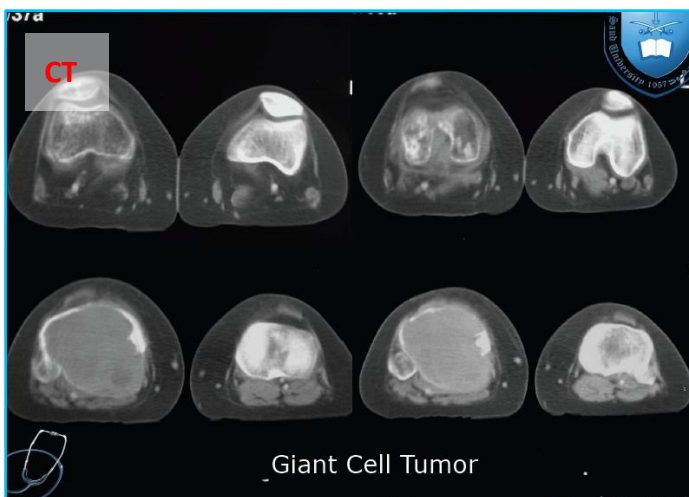
- The bone here looks like it is extending to the soft tissue plane behind the bone.

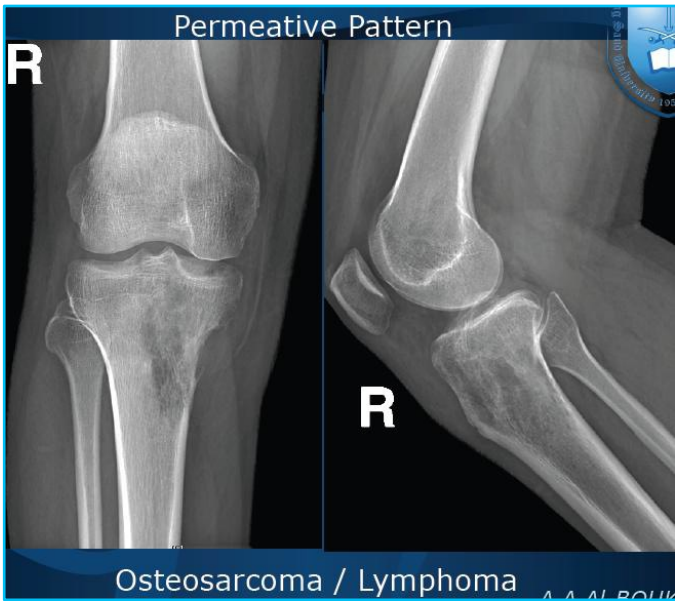
- You need more investigation -- > either CT or MRI

- In CT --> two different densities

- In MRI -- > lytic lesion

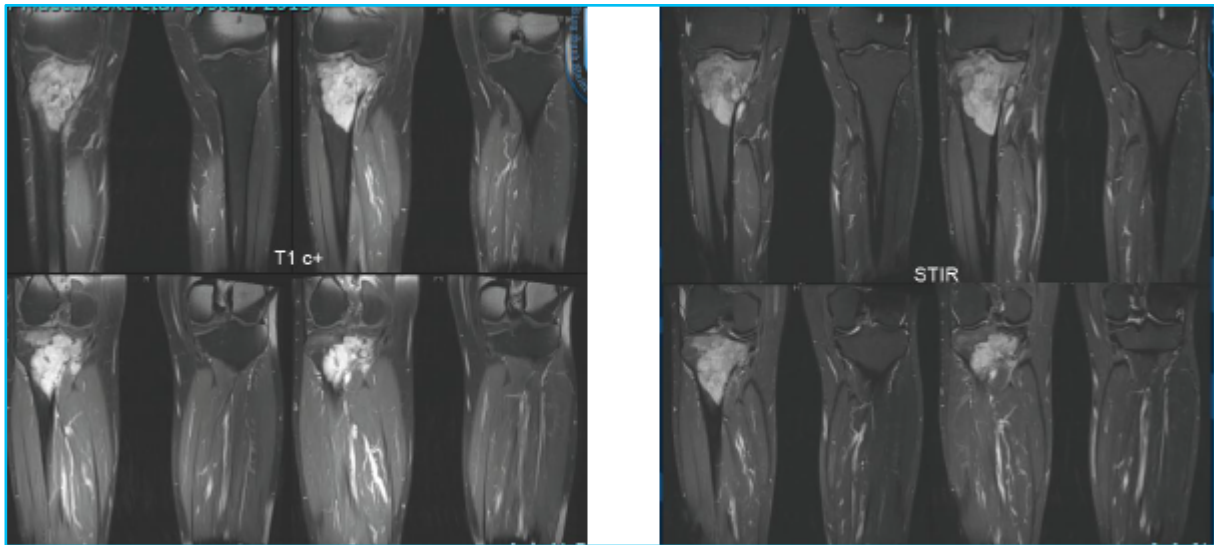
- The lesion after using enhancement in MRI -- > this whitish appearance indicate that it is vascular lesion.





- Permeative pattern* --> because the margins are not clear --> which indicates an aggressive lesion like neoplastic or infectious lesion but it is more likely a malignant process because if it is infectious, the lesion will be all around the bone not skipped lesion like here.

- Here it is osteosarcoma and one of the differential is lymphoma, leukemia, infection or sarcoma in younger pts.



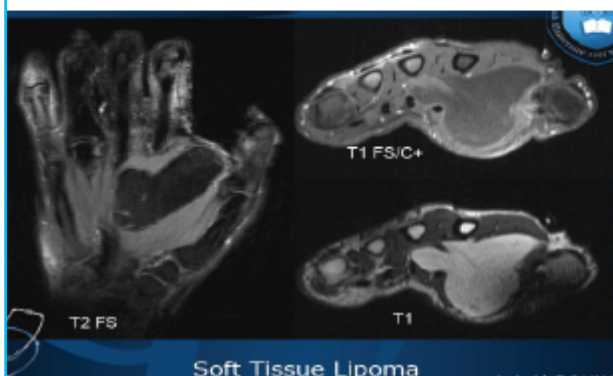
MRI: heterogeneous, extends beyond cortex

- **Case8:**

- Adult female patient presented with hand swelling. X-ray of hand requested.



- **Soft tissue swelling*** but no bone is disrupted, so it is only a swelling.
- This mass lesion can arise from any soft tissue structure from skin to the bone including skin, **fat***, vascular structures or nerves
- Differential diagnosis -- > **lipoma**, angioma, Schwannomas, neuromas or



After determining the differential diagnosis we come to tissue characterization in CT scan or even better in **MRI** as in this image.

- In the usual MRI which is T1 -- > subcutaneous fat appears white similarly the lesion is white. We suppressed the Fat signal in T1FS/C+ with contrast and the lesion got suppressed as well -- >this indicates that the lesion is composed of fat.
- **Soft tissue lipoma was the diagnosis**

- **Case9 :**

57 years old female patient presented with bone ache and had history of **breast carcinoma**



There are **patches of white areas*** (**Osteosclerosis**) which are involving the whole bone.

- Whenever there are multiple bone lesions (with sclerotic or lytic), it is more suggestive of a systemic disorder rather than a localized lesion.
- **Breast metastasis -- > sclerotic lesion. " and prostate cancer as well"**
- If you have a Patient above 50 with multiple bone lesions, you should think of metastasis or multiple myeloma (**lytic**) as a differential diagnosis in particular of **lytic or lung or thyroid tumor**

