• Radiological overview
• Anatomy
• Fractures
• Arthritis
• Bone lesions
• Non accidental trauma
• Radiological overview
• Anatomy
• Fractures
• Arthritis
• Bone lesions
• Non accidental trauma
Radiological overview

Imaging modalities:

• Radiograph
• Ultrasound (US)
• Computed tomography (CT)
• Magnetic resonance imaging (MRI)
Radiology overview: Radiograph

Radiograph utilizes ionizing radiation

Advantages:
• Rapid
• Cheap
• Detect fractures

Disadvantage
• Inability to evaluate soft tissue (eg. Ligaments, tendons, small joint effusion, and muscles)
• Inability to evaluate early osteomyelitis
Radiology overview: Radiograph

How finding are described on a radiograph?
- Radiolucent
- Radio-opaque

What are the views?
- Frontal
- Lateral
- Additional views (e.g. Oblique for joints).

- We need at least 2 views for any bone and at least 3 views for the joints and 4 views for scaphoid bone.
Radiology overview: Ultrasound

It has no significant role in MSK imaging
• Used to evaluate DDH
• To evaluate Painful hip in pediatric (to check for hip effusion or synovitis)

How findings are described in ultrasound?
• Hyperechoic=echogenic (Fat)
• Hypoechoic
• Isoechoic
• Non echoic (Fluid)
Radiology overview: CT

• CT is a diagnostic imaging procedure that uses x-rays (ionizing radiation) to build cross-sectional images ("slices") of the body.

• CT is best for the bone.
Radiology overview: CT

CT ankle shows Distal tibial fracture
Radiology overview: MRI

MRI is an imaging modality that does not use ionizing radiation to create useful diagnostic images. MRI scanner consists of a large, powerful magnet in which the patient lies.

Best for soft tissue injury, early bone infections, and evaluate bone contusion which is not detected on radiography

Advantages:
• Superior soft tissue contrast
• Multiplanar imaging (Axial, Coronal, and sagittal)
• No ionization radiation

Disadvantages:
• Images take longer time (minutes to an hour)
• Expensive
• Not safe for patients with metal implants or foreign bodies
Radiology overview: MRI

MRI shows PCL tear
Radiology overview: MRI
• Radiological overview
• **Anatomy**
• Fractures
• Arthritis
• Bone lesions
• Non accidental trauma
Anatomy: Shoulder
Anatomy: Shoulder
Anatomy: Shoulder

- Clavicle
- Acromioclavicular joint
- Acromion
- Glenohumeral joint
- Scapula
- Humerus
Anatomy: Shoulder
Anatomy: Shoulder
Anatomy: Elbow joint
Anatomy: Elbow joint
Anatomy: Elbow joint
Anatomy: Elbow joint
Anatomy: Elbow joint

Ossification centers

There are 6 ossification centres around the elbow joint.

- 1. Capitellum
- 2. Radial Head
- 3. Internal epicondyle
- 4. Trochlea
- 5. Olecranon
- 6. Lateral Epicondyle

- 1-3-5-7-9-11 years
  - C-R-I-T-O- L
Anatomy: Elbow joint
Ossification centers

<table>
<thead>
<tr>
<th>Anatomy</th>
<th>Age (years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capitellum</td>
<td>1</td>
</tr>
<tr>
<td>Radial head</td>
<td>3</td>
</tr>
<tr>
<td>Internal (medial) epicondyle</td>
<td>5</td>
</tr>
<tr>
<td>Trochlear</td>
<td>7</td>
</tr>
<tr>
<td>Olecranon</td>
<td>9</td>
</tr>
<tr>
<td>Lateral (External)</td>
<td>11</td>
</tr>
</tbody>
</table>

A well known helpful pneumonic for this is CRITOL or CRITOE:

Note that these ages vary but a broad guide of 1, 3, 5, 7, 9 and 11 years is easy to remember.
Anatomy: Elbow joint
Ossification centers
Anatomy: Elbow joint
Fat pad: Normal vs abnormal
Anatomy: Elbow joint
Fat pad: (A)Normal vs (B)abnormal
Anatomy: Elbow joint
Abnormal displaced anterior and posterior fat pads due to joint effusion effusion
Anatomy: Elbow joint

• Most common elbow fractures causing fat pad sign:

  ✷ Pediatric: Humeral supracondylar fracture
  ✷ Adult: Radial head fracture
Anatomy: Elbow joint
Supracondylar fracture

Abnormal anterior fat pad

Supracondylar fracture
Anatomy: Elbow joint
Radial head fracture
Anatomy: Wrist
Anatomy: Wrist
Anatomy: Wrist

- Capitate
- Hamate
- Triquetrum
- Hamate hook
- Trapezium
- Scaphoid
- Pisiform
Anatomy: Hip
Anatomy: Hip
Anatomy: Hip
Anatomy: Pelvis
Anatomy: Pelvis
Anatomy: Pelvis
Anatomy: Pelvis

Muscles attachments... Important for avulsion injuries
Anatomy: Knee
Anatomy: Knee
Anatomy: Knee
Anatomy: Knee
Anatomy: Knee
Anatomy: Knee MRI
Anatomy: Knee MRI
Anatomy: Knee MRI
Anatomy: Knee MRI

Sagittal MRI of the knee shows anterior and posterior horns of the lateral meniscus.
Anatomy: Knee MRI

Simple Horizontal Meniscus Tear Front View (Coronal)

Femur Tibia

www.Regenexx.com
Anatomy: Ankle
Anatomy: Ankle
Anatomy: Ankle
Anatomy: Ankle

- fibula
- tibia
- medial malleolus
- lateral malleolus
- talus (ankle bone)
Anatomy: Ankle
Anatomy: Ankle
Anatomy: Ankle
Anatomy: Foot
Anatomy: Foot
Anatomy: Foot
Anatomy: Foot
Anatomy: Foot
Anatomy: Foot
• Radiological overview
• Anatomy
• Fractures
• Arthritis
• Bone lesions
• Non accidental trauma
Fractures: Describing a fracture

- **Describe the radiograph**
  - What radiograph (or radiographs) are you looking at? Check the who, what, why, when, and where

- **What type of fracture?**
  - **complete**: all the way through the bone
    - **transverse**: straight across the bone
    - **oblique**: an oblique line across the bone
    - **spiral**: looks like a corkscrew
    - **comminuted**: more than 2 parts to the fracture
    - **Segmental**
  - **incomplete**: the whole cortex is not broken
    - **bowing**: the long bone has been bent
    - **buckle**: the fracture is of the concave surface
    - **greenstick**: the fracture is on the convex surface
  - **Salter-Harris**: fractures that involve the growth plate

- **Where is the fracture?**
  - **diaphysis**: the shaft of the bone
  - **metaphysis**: the widening portion adjacent to the growth plate
  - **epiphysis**: the end of the bone adjacent to the joint
  - If growth plate is closed describe as distal end, proximal end, and shaft.... No epiphysis, diaphysis, or metaphysis after physis (growth plate) closure.
  - If the fracture about the junction between epiphysis and metaphysis, it is called epimetaphysis
  - If the fracture about the junction between diaphysis and metaphysis, it is called metadiaphysis

- **Is it displaced?**
- **Joint involvement?**
Fractures: Describing a fracture
Fractures: Describing a fracture

- Transverse
- Stress
- Oblique, Displaced
- Greenstick
- Comminuted
Fractures: Describing a fracture

- Pathologic
- Longitudinal
- Spiral
- Greenstick
- Simple
- Compound
- Oblique
- Comminuted
- Transverse
Fractures: Describing a fracture
Fractures: Describing a fracture

Description of Location of #

- Which bone?
- Thirds (long bones)
  - Proximal, middle, distal third
- Anatomic orientation
  - E.g. proximal, distal, medial, lateral, anterior, posterior
- Anatomic landmarks
  - E.g. head, neck, body / shaft, base, condyle
- Segment (long bones)
  - Epiphysis, physis, metaphysis, diaphysis
Fractures: Describing a fracture
Fractures: Describing a fracture

- Fracture Without Significant Trauma
  - Abnormal Bone (pathological fracture)
  - Normal Bone
    - Sufficient Bone (stress fracture)
    - Insufficient Bone (osteoporosis)
Fractures

What type of fracture?

• Complete: all the way through the bone
  • Transverse: straight across the bone
  • Oblique: an oblique line across the bone
  • Spiral: looks like a corkscrew
  • Comminuted: more than 2 parts to the fracture
Fractures
Complete: Transverse

Transverse fracture through distal tibial shaft with lateral displacement (translation) of the distal fragment.
Fractures
Complete: Transverse

Transverse fracture through the distal end of radius
Fractures
Complete: Oblique

Oblique fracture through distal tibial diaphysis
Fractures
Complete: Spiral

Spiral fracture through proximal femoral shaft
Fractures
Complete: Comminuted
Fractures
Complete: Segmental
Fractures

What type of fracture?

• Incomplete: The whole cortex is not broken
  • **bowing**: the long bone has been bent
  • **buckle**: the fracture is of the concave surface
  • **greenstick**: the fracture is on the convex surface
Fractures
Incomplete: Bowing

With greater force, the loaded bone undergoes plastic deformation resulting in clinically evident and radiographically proven bowing of the bone.
Fractures
Incomplete: Buckle (Torus)

• **Buckle fractures**, also known as **torus fractures**, are incomplete fractures of the shaft of a long bone that is characterized by bulging of the cortex. They result from trabecular compression due to an axial loading force along the long axis of the bone. They are usually seen in children, frequently involving the distal radial metaphysis.
Fractures
Incomplete: Buckle (Torus)
Fractures
Incomplete: Buckle (Torus)
Fractures
Incomplete: Buckle (Torus)
Fractures
Incomplete: Greenstick fractures

• They are incomplete of long bones and are usually seen in young children, more commonly less than 10 years of age. They are commonly mid-diaphyseal, affecting the forearm and lower leg.

Plain radiograph

• usually mid-diaphyseal
• occur in tandem with angulation
• incomplete fracture, with cortical breach of only one side of the bone
Fractures
Incomplete: Greenstick fractures
Fractures
Incomplete: Greenstick fractures
Fractures: Salter-Harris

• Fractures in pediatric involving the physis (growth plate).

• Classification:
  ❖ Type I: Slipped physis
  ❖ Type II: Above physis with physis fracture
  ❖ Type III: Below physis with physis involvement
  ❖ Type IV: Above and below physis with physis involvement
  ❖ Type V: Ruined physis
Salter-Harris Classification Scheme of Physeal Fractures

- Normal
- Type I
- Type II
- Type III
- Type IV
- Type V
Fractures: Salter-Harris

- **type I**:
  - slipped
  - 5-7%
  - fracture plane passes all the way through the growth plate, not involving bone
  - cannot occur if the growth plate is fused
  - good prognosis
Fractures: Salter-Harris

- **type II**

- above

- ~75% (by far the most common)

- fracture passes across most of the growth plate and up through the metaphysis

- good prognosis
Fractures: Salter-Harris

• type III

• lower

• 7-10%

• fracture plane passes some distance along with the growth plate and down through the epiphysis

• poorer prognosis as the proliferative and reserve zones are interrupted
Fractures: Salter-Harris

- type IV
- through or transverse or together
- intra-articular
- 10%
- fracture plane passes directly through the metaphysis, growth plate, and down through the epiphysis
- poor prognosis as the proliferative and reserve zones are interrupted
Fractures: Salter-Harris

• **type V**

• ruined or rammed

• uncommon <1%

• crushing type injury does not displace the growth plate but damages it by direct compression

• worst prognosis
Fractures: Salter-Harris
Fractures: Salter-Harris (Type 1)
Fractures: Salter-Harris (Type 1)
Fractures: Salter-Harris (Type 2)
Fractures: Salter-Harris (Type 2)
Fractures: Salter-Harris (Type 2)
Fractures: Salter-Harris (Type 3)
Fractures: Salter-Harris (Type 3)
Fractures: Salter-Harris (Type 4)
Fractures

• Is the fracture displaced?

• **translation**
  • known by a couple of other names:
    • "translocation"
    • "displacement"
  • describe
    • the direction of translation of the **distal** fracture component
    • the amount of translation (as a percentage of bone width)

• **angulation**
  • a line drawn down the center of the bone is angled at the fracture
  • describe
    • direction of angulation of the distal fracture component
    • the amount of angulation in degrees (estimate)

• **rotation**
  • a difficult thing to assess on plain radiographs
  • usually evident clinically and common in spiral fractures
Fractures: Displacement

Displaced and Non displaced

Non displaced = normal alignment

Displaced = pulled out of normal alignment
Fractures: Displacement

- displaced
- angulated
- rotated
Fractures: Displacement

Displaced  Angulated  Shortened  Rotated
Fractures: Displacement
Fractures

• Is there articular involvement?
Other few fractures you need to know:
  Toddler
  Colles
  Smith
  Boxer
  Scaphoid
  5th metatarsal
  Clavicular fracture
  Hip fracture
Toddler fracture

- A **toddler fracture** is a minimally or undisplaced spiral fracture, usually of the tibia, typically encountered in toddlers.

- Usually need more than 1 view. If, despite multiple views, no fracture can be identified, follow-up radiographs usually will demonstrate slight sclerosis and periosteal reaction.
Colles fracture

- **Colles fractures** are very common extra-articular fractures of the distal radius that occur as the result of a fall onto an outstretched hand. They consist of a fracture of the distal radial metaphyseal region with dorsal angulation and impaction, but without the involvement of the articular surface.
Smith fracture

- are fractures of the distal radius with associated volar angulation of the distal fracture fragment(s). Classically, these fractures are extra-articular transverse fractures and can be thought of as a reverse Colles fracture.
Boxer fracture

• are minimally comminuted, transverse fractures of the 5th metacarpal and are the most common type of metacarpal fracture
Scaphoid fracture

- Non union occurs in 5-15% especially in fractures involve the distal pole of scaphoid.... Risk of avascular necrosis
5th metatarsal fracture vs apophysis

- The **proximal 5th metatarsal** is the site of a number of fractures and variants which mimic fractures.

  - Fracture is transverse
  - Normal apophysis is longitudinal
5\textsuperscript{th} metatarsal fracture
Hip fractures
Clavicular fracture

Report checklist:

• fracture
  • location of the fracture along the shaft
  • angulation and fracture end displacement (including direction)
  • comminution
  • degree of overlap (measurement is useful)

• associated findings and relevant negatives
  • acromioclavicular joint and sternoclavicular joint alignment
  • coracoclavicular distance
  • glenohumeral joint

• associated traumatic injuries
  • Rib fractures
  • vertebral fractures
  • Scapula fractures
  • pneumothorax
Clavicular fracture

Transverse fracture through lateral end of the left clavicle with inferior displacement of the lateral fragment
Fractures: **Summary**

- **describe the film**
  - what type of radiograph are you looking at?
  - what views have you got to look at?

- **fracture type**
  - first thing to mention when describing a fracture
  - complete (transverse, oblique, spiral, comminuted)
  - incomplete (buckle, greenstick)

- **fracture location**
  - what bone
  - part of the bone (epiphysis, metaphysis, diaphysis, apophysis)
  - some bones have specific named parts, e.g. neck of femur

- **fracture displacement**
  - is the bone offset, or pointing in the wrong direction. *Describe distal fragment in relation to proximal fragment*

- **fracture complications**
  - evidence of compound fracture (through the skin)
  - does the fracture enter the joint
  - is there another fracture (e.g. in paired bones)
Can you repeat the part of the stuff where you said all about the things?
• Radiological overview
• Anatomy
• Fractures
• Arthritis
• Bone lesions
• Non accidental trauma
Arthritis

• Disease affecting the joints

• There are many classifications described.

• Our aim is to identify most important diseases encountered in practice
Arthritis

Polyarticular arthritis

Noninflammatory
- Osteoarthritis, fibromyalgia, metabolic bone and muscle disease, neuropathic pain, malignancy and paraneoplastic syndromes

Systemic rheumatic disease
- Rheumatoid arthritis, seronegative spondyloarthropathy, SLE, systemic vasculitis, inflammatory myopathy, sarcoidosis, Still's disease, Behcet's, relapsing polychondritis, autoinflammatory diseases

Inflammatory
- Crystalline arthropathy
  - Gout, calcium pyrophosphate deposition arthritis
- Infectious arthritis
  - Bacterial, viral, fungal, mycobacterial, spirochete (Lyme)
- Postinfectious arthritis
- Reactive arthritis
- Inflammatory osteoarthritis

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Arthritis

Joint Space Narrowing

Symmetric: erosions; soft tissue swelling

Inflammatory

1 Joint
- Infection

Proximal: No Bony Proliferation
- Rheumatoid Arthritis

Distal: +Bony Proliferation
- Seronegative Spondyloarthropathy

>1 Joint

Asymmetric: osteophytes; sclerosis

Degenerative

Typical Osteoarthritis

Unusual distribution, severity, age

Atypical Osteoarthritis

Trauma, Crystal Deposition, Neuropathic, Hemophilia
Important diseases you should know:

- Rheumatoid arthritis
- Osteoarthritis
- Ankylosing spondylitis
- Septic arthritis
- Gout
Rheumatoid arthritis

• is a chronic autoimmune multisystemic inflammatory disease which affects many organs but predominantly attacks the synovial tissues and joints.

• 2-3 times more common in women

• Onset is generally in adulthood, peaking in the 4th and 5th decades
Rheumatoid arthritis

Radiological findings:

- soft tissue swelling
  - fusiform and periarticular; it represents a combination of joint effusion, edema and tenosynovitis
  - this can be an early/only radiographic finding

- osteoporosis: initially juxta-articular, and later generalized.

- joint space narrowing: **symmetrical** or concentric

- marginal erosions: due to erosion by pannus of the bony “bare areas”
Rheumatoid arthritis

**Hands and wrists**
- There is a predilection for:
- PIP and MCP joints (especially 2\textsuperscript{nd} and 3\textsuperscript{rd} MCP)
- ulnar styloid
- triquetrum
- As a rule, the DIP joints are spared.

- Late changes include:
  - Subchondral cyst formation: the destruction of cartilage presses synovial fluid into the bone
  - subluxation causing:
    - ulnar deviation of the MCP joints
    - boutonniere and swan neck deformities
  - ankylosis

**Spine**
Erosion of the dense (C2)
Rheumatoid arthritis
PA graphic of a PIP joint shows progressive destruction of the joint. (A) is normal, with intact cortex, cartilage, bone density, and capsule. (B) shows early disease, with only synovitis and effusion. (C) shows juxtaarticular osteopenia, with cortex becoming indistinct, the dot-dash pattern. (D) shows thinning of cartilage and marginal erosions in the portion of bone which is intracapsular but not protected by cartilage. (E) shows progression of osteopenia and subchondral erosions extending through cartilage defects. (F) shows arthritis mutilans, with pencil-in-cup deformity, seen in end-stage disease.
Rheumatoid arthritis
Osteoarthritis
PA radiograph shows juxtaarticular osteopenia and cartilage narrowing at the MCPs (white solid arrow). Cortical indistinctness on the MC heads (white curved arrow) is the dot-dash pattern, indicating early erosive change.
PA radiograph shows a typical case of marginal erosions in RA (white curved arrow). These are seen early in the erosive process, occurring in bone that is intracapsular but not protected by cartilage. This is the region of bone that is most vulnerable to the inflammatory process.
Osteoarthritis

• Osteoarthritis (OA), or degenerative joint disease (DJD), is the most common form of arthritis
• not primarily an inflammatory process
Osteoarthritis

Radiological findings:

- **Joint space narrowing**
  - characteristically asymmetric
- **Sclerosis**
  - sclerotic changes occur at joint margins
  - frequently seen unless severe osteoporosis is present
- **Osteophytosis**
  - i.e. development of osteophytes
- **Subchondral cyst**
  - also known as a geode
Osteoarthritis
Osteoarthritis
Osteoarthritis
Osteoarthritis
Osteoarthritis
Osteoarthritis
Osteoarthritis
Osteoarthritis vs Rheumatoid arthritis

Rheumatoid Arthritis
- Inflamed joint capsule and synovial membrane
- Loss of space in synovial cavity
- Cartilage destruction
- Loose cartilage particles

Osteoarthritis
- Bone spur
- Severe cartilage destruction
Osteoarthritis

Figure 1

Figure 2

Normal joint space

Narrowed joint space from loss of cartilage

Bone spurs
AP radiograph shows near-complete cartilage loss in the medial compartment (white solid arrow) resulting in varus abnormality. There is slight subchondral sclerosis, but no significant osteophyte formation is seen. This is a typical appearance of moderate OA.
AP radiograph shows lateral compartment OA (white solid arrow). Osteophytes and complete cartilage loss are seen with valgus deformity. Although medial compartment involvement is considered typical of OA, lateral compartment predominance may be seen.
AP radiograph shows classic hip OA. There is mild superolateral subluxation, and cartilage narrowing is seen superolaterally (white curved arrow). A ring osteophyte is seen (white solid arrow), as is extensive buttressing (white open arrow) of the calcar (medial femoral neck) & lateral femoral neck.
Ankylosing spondylitis

- seronegative spondyloarthropathy, which results in fusion (ankylosis) of the spine and sacroiliac joints (SI), although involvement is also seen in large and small joints.
- There is a male predilection of 3:1 or more. It usually manifests in young adults,
Ankylosing spondylitis

Radiological findings:

• Sacroiliac joints

• **sacroiliitis** is usually the first manifestation and is symmetrical and bilateral
  • the SI joints first widen before they narrow
  • subchondral erosions, sclerosis and proliferation on the iliac side of the SI joints
  • at end-stage, the SI joint may be seen as a thin line or not visible
Ankylosing spondylitis

- **Spine**
  - early spondylitis is characterized by small erosions at the corners of vertebral bodies with reactive sclerosis: Romanus lesions of the spine (shiny corner sign)
  - Vertebral body squaring
  - diffuse syndesmophytic ankylosis can give a "bamboo spine" appearance
    - Syndesmophytes are classically described as paravertebral ossification running parallel to the spine.
  - interspinous ligament ossification can give a "dagger spine" appearance on frontal radiographs
  - ossification of spinal ligaments, joints and discs
  - apophyseal and costovertebral arthritis and ankylosis
  - enthesophyte formation from enthesopathy
  - Dural ectasia
Ankylosing spondylitis: dagger sign
Ankylosing spondylitis: dagger sign
Ankylosing spondylitis: dagger sign
Ankylosing spondylitis: bamboo spine
Ankylosing spondylitis: bamboo spine
Ankylosing spondylitis: bamboo spine
Normal SI joints
Ankylosing spondylitis: sacroiliitis
Sacroileitis (early and late)
Ankylosing spondylitis

AP radiograph is immediately recognizable as a case of AS. The bridging vertical syndesmophytes (white solid arrow) show column fusion and associated diffuse osteoporosis. The inferior SI joints are eroded (white curved arrow) and undergoing early fusion.
Septic arthritis

• **Septic arthritis** is a destructive arthropathy caused by an intra-articular infection that usually is related to severe symptoms such as pain and decreased range of motion. This condition requires prompt treatment aiming to avoid permanent damage to joint, which may result in chronic deformity or mechanical arthritis.
Gout

• is a crystal arthropathy due to deposition of monosodium urate crystals in and around the joints.
Gout

Joints
• Joint effusion (earliest sign)
• preservation of joint space until late stages of the disease
• an absence of periarticular osteopenia
• eccentric erosions
• the typical appearance is the presence of well-defined “punched-out” erosions with sclerotic margins in a marginal and juxta-articular distribution, with overhanging edges

Bone
• punched-out lytic bone lesions
• overhanging sclerotic margins
• mineralization is normal

Surrounding soft tissues
• tophi
• Olecranon and prepatellar bursitis
• periarticular soft tissue swelling
Gout
Gout
AP radiograph shows early gout with a well-margined erosion in a juxtaarticular position near the 1st MTP (white solid arrow). Joint space and bone density are normal. No intraarticular erosions are seen at this joint, though there is one at the 5th MTP (white curved arrow).
AP radiograph shows much more advanced gout. Tophi are seen at several sites (white solid arrow) along with highly destructive erosive disease. By this point in the process, cartilage destruction is seen as well. Given the tophi, gout is the only possible diagnosis.
Radiograph shows a classic appearance of gout with soft tissue swelling at the 5th MCP. A juxtaarticular erosion has an overhanging edge (white solid arrow), extending perpendicularly from the metaphysis. Note that the cartilage width is normal.
• Radiological overview
• Anatomy
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• Non accidental trauma
Bone lesions

The main features that should be assessed when a potentially neoplastic bone lesion is discovered include:

• **location in the body** (i.e. which bone)
• location within a bone
• zone of transition: narrow or wide? rim? ill defined or well defined?
• matrix
• morphology
• periosteal reaction
• Size
• cortical involvement
Bone lesions

The main features that should be assessed when a potentially neoplastic bone lesion is discovered include:

• location in the body (i.e. which bone)
• location within a bone
• zone of transition: narrow or wide? rim? ill defined or well defined?
• matrix
• morphology
• periosteal reaction
• Size
• cortical involvement
Bone lesions

Ddx depend on the location!
Bone lesions

The main features that should be assessed when a potentially neoplastic bone lesion is discovered include:

• location in the body (i.e. which bone)
• location within a bone
• **zone of transition**: narrow or wide? rim? ill defined or well defined?
• matrix
• morphology
• periosteal reaction
• Size
• cortical involvement
Bone lesions
Zone of transition
Bone lesions
Zone of transition
Bone lesions
Zone of transition

ZONE OF TRANSITION

NARROW ZONE

WIDE ZONE
Bone lesions

The main features that should be assessed when a potentially neoplastic bone lesion is discovered include:

• location in the body (i.e. which bone)
• location within a bone
• zone of transition: narrow or wide? rim? ill defined or well defined?
• matrix
• morphology
• periosteal reaction
• Size
• cortical involvement
Bone lesions

Matrix

• Fibrous – ground glass e.g. fibrous dysplasia
• Osteoblastic – cumulus cloud e.g. osteosarcoma
• Chondroid – popcorn or arcs and rings e.g. chondrosarcoma
Bone lesions
Matrix: Fibrous

Sagittal bone CT shows severe polyostotic fibrous dysplasia (FD) involving skull, facial bones, and cervical spine. Some areas are "ground-glass" (white curved arrow), others are purely lytic (white solid arrow), and there are a few foci of calcified cartilage (white open arrow).
Bone lesions
Matrix: Osteoblastic

Axial bone CT shows an aggressive-appearing, densely ossified mass characteristic of osteosarcoma. Mass involves both the sacrum and the ilium, crossing the sacroiliac joint. Immature ossification extends into the soft tissues (white curved arrow).
Bone lesions

Matrix: Chondroid

Enchondroma with rings and arcs calcifications
Bone lesions

The main features that should be assessed when a potentially neoplastic bone lesion is discovered include:

• location in the body (i.e. which bone)
• location within a bone
• zone of transition: narrow or wide? rim? ill defined or well defined?
• matrix
• morphology
• periosteal reaction
• Size
• cortical involvement
Periosteal reaction

**Continuous**
- eggshell
- solid
- lobulated
- single layer
- multilayered (onion skins)
- spiculated (hair on end)
- sunburst

**Interrupted**
- wedge-shaped
- Codman triangle
- interrupted onion skins
- interrupted spiculae
Periosteal reaction: Codman triangle
Periosteal reaction: Sunburst
Periosteal reaction: Solid
An aggressive lesion may represent a malignant bone tumor or infection (osteomyelitis).

Check:
Endosteal cortical erosion (internal scalloping)
Evidence of soft tissue extension
Bone lesions

The main features that should be assessed when a potentially neoplastic bone lesion is discovered include:

• location in the body (i.e. which bone)
• location within a bone
• zone of transition: narrow or wide? rim? ill defined or well defined?
• matrix
• morphology
• periosteal reaction
• **Size**
• cortical involvement
Bone lesions

Size

Size is used to differentiate between some tumors

- Osteoid osteoma <2cm vs osteoblastoma >2cm
- Fibrous cortical defect <3cm vs non ossifying fibroma >3cm.
Important bone lesions:

• Malignant:
  Osteosarcoma
  Ewing sarcoma

• Benign:
  Osteoid osteoma
  Osteoblastoma
  FCD / NOF
  Aneurysmal bone cyst
  Simple bone cyst
  Osteochondroma
osteosarcoma

malignant bone forming tumors and the second most common primary bone tumor after multiple myeloma.

They account for ~20% of all primary bone tumors and occur in primary and secondary forms

• primary osteosarcoma: typically occurs in young patients (10-20 years) with 75% taking place before the age of 20 because

• secondary osteosarcoma: occurs in the elderly; usually secondary to malignant degeneration of Paget disease, extensive bone infarcts, post-radiotherapy for other conditions, osteochondroma, and osteoblastoma

About 50% arise in the metadiaphysis around the knee, either in the distal femur or proximal tibia -sites of greatest skeletal growth activity-.
AP radiograph in a 25-year-old woman shows dense sclerotic tumor osteoid replacing metadiaphyseal marrow (white solid arrow) and a soft tissue mass containing both dense (white open arrow) and amorphous (white curved arrow) tumor osteoid. Osteosarcoma is the only possible diagnosis.
AP radiograph shows horizontal periosteal reaction (white solid arrow), termed "sunburst." It indicates an aggressive process. Note that there is permeative destruction of the radius, with tumor osteoid formed in both the bone and soft tissue mass. The only possible diagnosis is OS.
osteosarcoma

Osteosarcoma

Hair-on-end periosteal reaction
osteosarcoma
osteosarcoma
Ewing`s Sarcoma

They usually present as moth-eaten destructive permeative lucent lesions in the shaft of long bones (femur) with large soft tissue component without osteoid matrix and typical onion skin periostitis. It may also involve flat bones ([elvis) and appears sclerotic in up to 30% of cases.

10-20 yrs

Presentation is non-specific with local pain being by far the most common symptom. Systemic symptoms including fever may be present. ESR is also elevated.

Plain X-ray: permeative, poorly marginated destructive lesion, endosteal erosion, cortical disruption, periosteal reaction (maybe interrupted ).
Lateral radiograph shows typical diaphyseal Ewing sarcoma. The permeative osseous destruction can be difficult to visualize on radiograph. There is aggressive-appearing periosteal reaction (white solid arrow) and a large soft tissue mass, which is not well seen due to the lack of fat planes in this child.
Ewing`s Sarcoma
Ewing`s Sarcoma
Common benign bone tumors

• Osteoid osteoma
• Osteoblastoma

• Fibrous cortical defect (FCD)
• Non ossifying fibroma (NOF)

• Aneurysmal bone cyst
• Simple bone cyst
• Osteochondroma
Osteoid osteoma

- **benign bone-forming tumors** that typically occur in children (particularly adolescents).
- They have a characteristic lucent nidus <2 cm and a surrounding solid periosteal reaction.
- Causes night pain that is relieved by the use of salicylate analgesia, e.g. aspirin.
- Long bones of the limbs: femur most common (especially neck of femur)
- May be normal or may show a solid periosteal reaction with cortical thickening. The nidus is sometimes visible as a well-circumscribed lucent region, occasionally with a central sclerotic dot.
Lateral radiograph shows a cortical diaphyseal OO, with prominent thickening of the posterior cortex of the tibia (white solid arrow). The thickened reactive bone obscures the nidus itself.
AP radiograph of a intracapsular OO, with an oval lytic lesion and central sclerosis (white solid arrow) is shown. There is surrounding sclerosis, as well as sclerotic reaction extending down the calcar (white open arrow). Effusion is demonstrated by the distended fat pad (white curved arrow).
Osteoid Osteoma

Hip X-Ray shows:
* fusiforme cortical thickening (blue arrow)
  with a small rounded lucent center
  representing nidus (red arrow)*
Fibrous cortical defect

- **Fibrous cortical defects (FCD)** are benign bony lesions and are a type of fibroxanthoma, histologically identical to the larger non-ossifying fibroma (NOF).

- Fibrous cortical defects typically occur in children (usually 2-15 years)

- Most common benign bony lesions, which combined with non-ossifying fibromas are seen in up to 40% of skeletally immature children/adolescents
Fibrous cortical defect

- Lucent intra cortical defects outlined by a thin rim of sclerosis no involvement of the underlying medullary cavity no periosteal reaction

- Size less than 3 cm
Fibrous cortical defect

• As these lesions are benign, characteristic in appearance and self-limiting, no treatment, biopsy or even follow-up is required in typical cases.

• If associated with pathological fracture (more common in NOF) then cast immobilization until the fracture has healed, followed by biopsy with or without curettage, and bone grafting may be necessary
Fibrous cortical defect
Non ossifying fibroma

• The most common type of non-neoplastic fibrous bone lesion and are a larger version (>3 cm) of a fibrous cortical defect; both are encompassed by the term fibroxanthoma or metaphyseal fibrous defect.

• NOFs are typically a multiloculated lucent lesion with a sclerotic rim. They are located eccentrically in the metaphysis, adjacent to the physis. As the patient ages, they seem to migrate away from the physis.

• They have no associated periosteal reaction, cortical breach or associated soft tissue mas
Non ossifying fibroma
Fibrous Cortical Defect and Non-ossifying Fibroma
Osteoblastoma
Osteochondroma
Simple bone cyst
Aneurysmal bone cyst
Hang In There... We're Almost Done!
• Radiological overview
• Anatomy
• Fractures
• Arthritis
• Bone lesions
• Non accidental trauma
Non accidental injury (Child abuse)

Clinical presentation:

- Injury in the non-ambulatory/totally dependent child
- Injury and history given are inconsistent
- Delay in seeking medical attention
- Multiple fractures

A skeletal survey is performed in cases of suspected abuse to assess and document the extent of previous skeletal injuries.
Non accidental injury (Child abuse)

Fractures that are highly specific to NAI

- Metaphyseal corner fractures
- Rib fractures, especially posteriorly.
- Skull fractures
- Scapular fractures
- Sternal fractures
- Outer third clavicular fractures
- Spiral femoral diaphyseal fractures
Non accidental injury (Child abuse)

Multiple fractures of different ages
Child abuse
Spiral femoral diaphyseal fracture
Metaphyseal corner fracture
Metaphyseal corner fracture
Posterior rib fractures
THIS CHART DISPLAYS WHAT I LEARNED TODAY FROM YOUR LECTURE
THE END