Rad Path
Bone Lesions

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Case 1 - History

• 58 y.o. male presents to the ED with proximal right thigh pain and swelling
• Found to have vastus lateralis tendon tear with associated hemorrhage on MRI
• Bone lesion also found in this region
Case 1 - Imaging
Case 1 - Imaging
Bone Tumor Differential Diagnosis

• Lesion Appearance
  – Lytic versus sclerotic
  – Zone of transition
  – Periosteal reaction, cortical destruction

• Location within Bone
  – Diaphyseal, Metaphyseal, Epiphyseal

• Location within Skeleton

• Patient – age, history
Bone Tumor Differential Diagnosis
## Bone Tumor Differential Diagnosis

<table>
<thead>
<tr>
<th>Age</th>
<th>Well-defined</th>
<th>ill-defined</th>
<th>Sclerotic</th>
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<tbody>
<tr>
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<tr>
<td>0 - 10</td>
<td>EG, SBC</td>
<td>EG - Ewing Osteosarcoma Leukemia</td>
<td>Osteosarcoma</td>
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<tr>
<td>10 - 20</td>
<td>NOF, Osteoblast Fibr dysplasia EG SBC ABC Chondroblast CMF</td>
<td>Ewing EG Osteosarcoma</td>
<td>Osteosarcoma Osteosarcoma Fibr dysplasia EG</td>
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<tr>
<td>20 - 40</td>
<td>Giant CT Enchondroma Chondrosarcoma (low grade) HPT - Brown tumor Osteblastoma</td>
<td>Giant CT</td>
<td>Enchondroma Osteoma Bone island Parosteal Osteosar</td>
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<tr>
<td>40+</td>
<td>Metastases Myeloma Geode</td>
<td>Metastases Myeloma Chondrosarcoma (high grade)</td>
<td>Metastases Bone island</td>
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<tr>
<td>All ages</td>
<td>Infection</td>
<td>Infection</td>
<td>Infection</td>
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Case 1 - Differential Diagnosis

• Well-defined lytic lesion in the proximal femur

• Fibrous Dysplasia
• Solitary/unicameral bone cyst
• Brown tumor
• Intraosseous Lipoma
• Liposclerosing myxofibrous tumor
Case 1 Pathology
“Chinese characters”
Bland fibrous stroma with vague storiform appearance
Woven bone without osteoblastic rimming
Woven bone
Case 1 Differential Diagnosis

- Fibrous dysplasia
- Osteofibrous dysplasia – similar appearance, but with osteoblastic rimming
- Nonossifying fibroma – numerous histiocytes; lacks metaplastic bone
- Parosteal sarcoma – surface lesion, not central; radiologic correlation
Fibrous Dysplasia
Unicameral (Solitary) Bone Cyst
Brown Tumor
Case 1 Diagnosis

Bone, right proximal femur, biopsy:
   – Fibroosseous lesion most consistent with fibrous dysplasia (see comment).

Comment: Clinical and radiographic correlation is recommended.
Fibrous Dysplasia

• Benign congenital process
• Found predominately in children and young adults
• Painless, usually incidental finding
• Susceptible to pathologic fractures
• Single site: ribs, femur, tibia, craniofacial
• Polyostotic: often one limb, femur, tibia, pelvis
Fibrous Dysplasia

• Radiographs
  – Lucent (cystic) or sclerotic
  – Well-circumscribed

• CT
  – Ground-glass, homogeneously sclerotic, cystic
  – Well-defined borders
  – Expansion of bone with intact overlying bone

• Bone Scan
  – metabolically active into adulthood
Case 2
Case 2 - History

• 28 y.o. female with no known significant PMH, presents to ED with right knee pain and swelling after falling down stairs.
Case 2 - Imaging
Case 2 - Imaging
Case 2 - Differential Diagnosis

• Well-defined lytic lesion in the distal femur (with pathologic fracture)

• Giant cell tumor
• Aneurysmal bone cyst
• Chondroblastoma
• Osteomyelitis
Case 2 Pathology
Hemorrhage
Xanthogranulomatous appearance
Giant cells, reactive bone formation
Fibrous membrane
Case 2 Differential Diagnosis

- ABC – bland cells, fibrous stroma, reactive new bone formation
- Telangiectatic osteosarcoma – cytologic atypia in septae
- Giant cell tumor – larger giant cells, no reactive bone formation
Aneurysmal Bone Cyst
Aneurysmal Bone Cyst
Giant Cell Tumor
GCT with Secondary ABC
Case 2 Diagnosis

Bone, right distal femur, curettage:
– Consistent with aneurysmal bone cyst.
Aneurysmal Bone Cyst

• Benign, expansile lesion (blood-filled channels)
• Children and adolescents
• Pain (pathologic fracture), palpable lump, restricted movement
• Location:
  – Metaphysis of long bones (lower > upper)
  – Spine (posterior elements, extension into vertebral body)
Aneurysmal Bone Cyst

- Radiographs
  - Sharply defined, expansile radiolucent lesion
- CT
  - Fluid-fluid level (blood/serum)
- MRI
  - Variable signal – rim of low T1 and T2 signal
  - High T1 and T2 – blood of variable age
- Bone Scan
  - Increased uptake peripherally, photopenic center
Case 3 - History

• 68 y.o. female presents with left lower leg pain.
Case 3 - Imaging
Case 3 - Imaging
Case 3 – Full History

- 68 y.o. female with PMH of right breast cancer diagnosed in 2009 with positive axillary lymph nodes, status post mastectomy, chemotherapy, and adjuvant radiation therapy, presents with left lower leg pain.
Case 3 - Differential Diagnosis

• Ill-defined lytic lesion in the tibial diaphysis, causing cortical destruction, that is hypermetabolic on PET

• Metastatic disease

• Multiple Myeloma

• Primary Bone Tumor - Fibrosarcoma

• Osteomyelitis
Case 3 Pathology
Case 3 Bone Met Differential Diagnosis

- Most common tumors to bone (paired and midline organs):
  - Breast, especially ER positive
  - Prostate
  - Thyroid
  - Lungs
  - Kidneys

- Tend to retain morphology of primary tumor
Estrogen receptor, Biopsy
Estrogen receptor, bone tumor
GATA 3 – transcription factor, regulates luminal epithelial cell differentiation in the mammary gland
Case 3 Diagnosis

- **Bone, left tibia, curettage:**
  - Metastatic carcinoma, consistent with breast primary.

- **Breast, left, 6:00, core biopsy:**
  - Invasive ductal carcinoma, nuclear grade 3
  - ER positive, PR negative, HER2 equivocal
Bone Metastasis

• ~70% of all malignant bone tumors
• Lung, breast, renal, and prostate primaries
• Local bone pain, mass effect, fractures
• Vertebrae, pelvis, proximal femur/humerus, skull
• Lytic – thyroid, renal, adrenal, melanoma, lung
• Sclerotic – prostate, TCC
• Mixed – breast
Bone Metastasis

• Radiographs
  – Lytic, sclerotic, or mixed
  – Cortical destruction, sclerosis
  – In general, periosteal reaction is limited or absent

• CT
  – Assess extent, risk of pathologic fracture

• Nuclear Medicine
  – Increased uptake, photopenic defect (lytic lesions)
Multiple Myeloma
Fibrosarcoma
Case 4
Case 4 - History

• 22 y.o. male with no significant PMH, who initially presented with several months of low back pain unresponsive to NSAIDs.
• Found to have multiple foci of signal abnormality in his lumbar spine and pelvis on outside MRI read as indeterminate lesions.
• Follow-up PET/CT is ordered.
Case 4 - Imaging
Case 4 - Imaging
Case 4 - Differential Diagnosis

- Multiple hypermetabolic lesions within the bones and lungs
- Some bone lesions occult and some sclerotic on CT
- Metastatic disease
- Lymphoma
Case 4 Pathology
Large cells, possibly Reed-Sternburg cells
Case 4 Differential Diagnosis

- Anaplastic large cell lymphoma – Large T cells
- Diffuse large B cell lymphoma – Large B cells
- Hodgkin lymphoma – Atypical large B cells with unique phenotype
CD3
CD30 (activated but not resting B and T cells)
CD45
Case 4

Previous lung biopsy from OSH

– Minute fragment of tissue with an atypical lymphocytic infiltrate, highly suspicious for classical Hodgkin lymphoma
CD15, neutrophils and RS cells
Case 4 Hodgkin lymphoma

Classic Hodgkin lymphoma.
- Nodular sclerosis
- Lymphocyte rich
- Lymphocyte depleted
- Mixed cellularity

Nodular lymphocyte predominant Hodgkin lymphoma
Case 4 Diagnosis

Bone, right iliac, core biopsy:
- Hodgkin lymphoma, classic type (see comment)

Comment: Bone presentation of Hodgkin lymphoma is unusual but well-described.
Hodgkin Lymphoma

• Bimodal age distribution – 15 to 34, >55
• Typical presentation is painless lymphadenopathy, night sweats, weight loss
• Generally involves contiguous lymph node spread
• Extranodal disease – pulmonary, musculoskeletal, abdominal, cardiac, CNS
• Bone involvement in Hodgkin’s: 5 to 20%
• Spine, pelvis, ribs, femur, sternum
Hodgkin Lymphoma

- Radiographs
  - Solitary or polyostotic
  - Ill-defined margins, may have sclerotic margin
  - Predominately osteolytic, may be sclerotic/mixed

- MRI/CT
  - Better characterization of adjacent soft tissue mass

- Nuclear Medicine – increased uptake
Hodgkin Lymphoma
Hodgkin Lymphoma
Hodgkin Lymphoma
Primary Bone Lymphoma

Figure 2. (Top left) Initial coronal T<sub>1</sub> weighted MRI image (Patient 4) showing a small intraosseous lesion (arrows) and minimal periosteal reaction (curved arrows). Results of initial radiographs of the right tibia were normal. (Center left) Initial axial T<sub>1</sub>-weighted fat-suppressed MRI image after intravenous injection of gadopentetate dimeglumine show subtle linear foci penetrating the cortex (arrowheads) as well as marked enhancement of the intraosseous mass (M) and the periosteal reaction (arrows). Note the normal low signal intensity fat-suppressed marrow the adjacent fibula (F) as well as normal fibular cortex (Patient 4). (Bottom left) Axial proton density (TR 2000/TE 20 ms) MRI image obtained 9 weeks later showing high signal intensity foci (arrowheads) penetrating the low signal intensity cortex in addition to intraosseous and extraosseous mass (Patient 4). (Top right) Corresponding T<sub>1</sub>-weighted 20/TE 80 ms MRI image showing multiple high signal intensity low foci penetrating the cortex plus extraosseous mass (arrows) (Patient 4). (Bottom right) Axial T<sub>1</sub>-weighted fat-suppressed MRI image after intravenous administration of gadopentetate dimeglumine with multi linear bands penetrating the cortex (arrowheads). Enhancing extraosseous mass (arrows) and the intraosseous tumor (Patient 4).
Case 5
Case 5 - History

• 47 y.o. female with several months of achiness and pain in her left shoulder.
Case 5 - Imaging
Case 5 - Imaging
Case 5 - Differential Diagnosis

• Partially calcified, expansile lesion of the scapula

• Enchondroma/Chondrosarcoma

• Osteochondroma (sessile)
Case 5 Pathology
Permeation through viable lamellar bone
Spindle cells
Case 5 Differential Diagnosis

- Enchondroma
- Chondrosarcoma – destructive cortical changes, permeative growth
- Chondroblastic osteosarcoma – osteoid; sheets of tumor cells
Case 5 Chondrosarcoma
grading and staging

Grading of conventional chondrosarcoma is based on cellularity, cytologic atypia, and mitotic figures.
  - Grade 1 (low-grade): hypocellular and similar histologically to enchondroma.
  - Grade 2 (intermediate-grade): more cellular than grade 1 chondrosarcoma; has more cytologic atypia, greater hyperchromasia and nuclear size; or has extensive myxoid stroma.
  - Grade 3 (high-grade): hypercellular, pleomorphic, and contains prominent mitotic activity.

Staging
  - pT1: Tumor 8 cm or less in greatest dimension
  - pT2: Tumor more than 8 cm in greatest dimension
  - pT3: Discontinuous tumors in the primary bone site
Case 5 Diagnosis

- Bone and soft tissue, left scapula medial mass, resection:
  - Conventional chondrosarcoma, grade 2 (intermediate grade)
  - Margins uninvolved (2mm to deep margin)

- pT1
Chondrosarcoma

- Malignant cartilaginous tumors
- Typically seen in 4\textsuperscript{th} and 5\textsuperscript{th} decades
- Pain (pathologic fracture), lump/mass
- Primary vs Secondary
  - Osteochondroma, enchondroma
- Long bones, pelvis, ribs, spine, scapula
- Often large masses at time of diagnosis
- Abrupt change in calcification pattern, pain in absence of fracture
Chondrosarcoma/Enchondroma

• Radiographs/CT
  – Calcifications – rings/arcs, popcorn
  – Lytic (50%)
  – Endosteal scalloping, cortical remodeling

• MRI
  – Low to intermediate T1, high on T2
  – Blooming of calcified portions on GRE
  – Post-contrast – enhanced septations (low grade)

• Bone Scan
  – Increased uptake – chondrosarcoma 4x > enchondroma
Enchondroma/Chondrosarcoma
Enchondroma/Chondrosarcoma
Osteochondroma
Selected References

- LearningRadiology.com, Radiopaedia.org, and www.tumorlibrary.com websites