APMA 2018 Radiology Track
Bone Tumors – When to say “Gulp!”

DANIEL P. EVANS, DPM, FACFAOM
Professor, Department of Podiatric Medicine and Radiology
Dr. Wm. Scholl College of Podiatric Medicine
I do not have any commercial conflicts of interest pertaining to this presentation.
OUTLINE

- Incidence of Bone Tumors
- Radiographic Evaluation
- Benign vs. Malignant
- Biopsy Considerations
Updated to 10,165 cases

- 3% of all benign neoplasms found in the foot.

- 1.3% of malignant neoplasms.

- Total: 1.8% of all neoplasms located in the foot.
INCIDENCE OF BONE TUMORS

Neoplasms of the Foot and Leg
- Donald R. Cole, M. D.
- Thomas M. DeLauro, D.P.M.
  Williams & Wilkins 1990

Bone Tumors
- Howard Dorfman, M.D.
- Bogdan Czerniak, MD, Ph.D.
  Mosby 1998

Bakotic, B, Huvos AG. Tumors of the bones of the feet: the clinicopathologic features of 150 cases.
INCIDENCE OF BONE TUMORS

Benign lesions are much more commonly encountered in the foot when compared to malignant lesions, regardless of tissue type.
PROGRESSION OF THOUGHT PROCESS

- Determination of Benignity vs. Malignancy.
- Evaluation of Anatomic Location of Tumor.
- Radiographic Presentation.
- Age and Gender of Patient.
- Is lesion Primary or Metastatic?
- Decision making process for evaluation of neoplasms – Monitor, Biopsy or Excise.
Benign Lesions:
- Geographic lesions. Short zone of transition.
- Minimal cortical involvement. May show thinning or expansion of cortex.
- Rare periosteal response.
- Rare soft tissue masses associated with lesion.
Benignity vs. Malignancy

- **Malignant Lesions**
  - Wide Zone of Transition.
    - Permeative, Moth-eaten, Invasive.
  - Cortical Involvement. Cortical thinning, bulging or breach.
  - Periosteal Response
    - Common - May be in the form of single layer, onion skin, perpendicular, or Codman’s triangle.
  - Soft Tissue Masses.
    - Common with aggressive processes.
PERIOSTEAL REACTIONS

- **Single Layer**: osteomyelitis, some benign tumors, osteosarcoma, Ewing’s sarcoma, rarely metastasis.

- **Onion Skin**: repeated insults (child abuse), osteomyelitis, osteosarcoma, Ewing’s sarcoma.

- **Perpendicular**: (spiculated, sunburst, velvet) *ominous sign*. Ewing’s, osteosarcoma.

- **Codman’s Triangle**: aggressive lesions. Osteomyelitis, osteosarcoma, ABC.
### Table 4. — Radiologic Features and Corresponding Potential Pathologic Diagnoses

<table>
<thead>
<tr>
<th>Features</th>
<th>Potential Diagnoses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Complete sclerotic rim</td>
<td>Benign lesion (95% accuracy)</td>
</tr>
<tr>
<td>Epiphyseal, solitary, lytic lesion with sclerotic border</td>
<td>Chondroblastoma, enchondroma, GCT</td>
</tr>
<tr>
<td>Epiphyseal, solitary, lytic lesion without sclerotic border</td>
<td>GCT, chondrosarcoma</td>
</tr>
<tr>
<td>&quot;Kissing&quot; bones (lytic lesions in contiguous epiphyses)</td>
<td>GCT, angiosarcoma, pigmented villonodular synovitis, infections</td>
</tr>
<tr>
<td>Cumulus cloud</td>
<td>Osteosarcoma, stress fracture</td>
</tr>
<tr>
<td>Ground glass</td>
<td>Fibrous dysplasia, osteoblastoma, grade I osteosarcoma</td>
</tr>
<tr>
<td>Ring-like to popcorn density</td>
<td>Enchondroma and secondary chondrosarcoma</td>
</tr>
<tr>
<td>Poorly demarcated, expansile lesion with windblown calcifications</td>
<td>Chondrosarcoma</td>
</tr>
<tr>
<td>Expansile, trabeculated lesion</td>
<td>Grade I sarcoma, GCT, myeloma</td>
</tr>
<tr>
<td>Finger-in-the-balloon</td>
<td>ABC</td>
</tr>
<tr>
<td>Fallen fragment sign</td>
<td>Simple bone cyst</td>
</tr>
<tr>
<td>Codman’s triangle</td>
<td>Osteosarcoma, osteomyelitis, ABC</td>
</tr>
<tr>
<td>Onion-skinning</td>
<td>Ewing’s sarcoma, osteosarcoma, osteomyelitis, eosinophilic granuloma</td>
</tr>
<tr>
<td>Bone expansion</td>
<td>Benign tumor (90% cases), grade I sarcoma, myeloma, metastasis</td>
</tr>
</tbody>
</table>

GCT = giant-cell tumor  
ABC = aneurysmal bone cyst  
http://www.moffitt.usf.edu/providers/ccj/v6n3/dept7.htm
TUMOR MATRIX

- **CARTILLAGENOUS**: Lucent, with “Spotty” punctate areas of increased density. “Salt and Pepper”

- **OSSEOUS**: May be Lytic or Blastic or Combined.

- **FIBROUS**: “Ground - Glass” appearance.

- **CYSTIC**: Lucent, may show fluid levels.
CARTILLAGENOUS TUMOR MATRIX

- Radiolucent matrix with punctate or spotty areas of calcification.

- ENCHONDROMA
- OSTEOCHONDROMA
- CHONDROBLASTOMA
- CHONDROSARCOMA
ENCHONDROMA

- Location: 60% found in tubular bones of hands and feet.
- Age: 10 - 50.
- Medullary – “In-chondroma”
- X-Ray: Geographic lucent lesion which may be expansile. Occ. Fractures may occur.
- Multiple Enchondromatosis
- Maffucci’s Syndrome
CT Enchondroma
3 D Rendering Enchondroma
ENCHONDROMA (CON’T.)

- Multiple Enchondromatosis: “Ollier’s Disease”
  - First described in 1900. Dyschondroplasia.
    - Generally diagnosed prior to skeletal maturity.
    - Will almost always have hand & feet involvement.
    - 30% malignant transformation to Chondrosarcoma.

- Maffucci’s Syndrome: M.E. + hemangiomas.
  - First described in 1881.
  - Hemangiomas of skin, S.T. and viscera.
  - Malignant transformation is even higher.
OSTEOCHONDROMA

Most Common Benign Tumor Like Lesion, accounting for ~ 35% of Benign Bone Tumors.

Age: 10 - 30   Males 2:1   Females

Cartilage-capped bony excrescence that arises from and is continuous with the cortical surface of bone.

Shape: Pedunculated, Plateau and Calcific.

Malignant Degeneration: Single : 1- 2 %   Multiple : 5 -25 %.
CHONDROBLASTOMA

Location: **EPIPHYSIS**

- Symptoms: Usually present with joint pain.
- X-Ray: Lytic, geographic lesion in central aspect of epiphysis with punctate stippling.
- Tarsal Bones; Talus & Calcaneus
- 10% recurrence rate.
- Rare malignant transformation.
OSSEOUS TUMOR MATRIX

May appear as areas of marked sclerosis or areas of lytic destruction or both sclerosis and lysis in combination.

OSTEOID OSTEOMA
OSTEOBLASTOMA
OSTEOSARCOMA
OSTEOID OSTEOMA

- First described by Jaffe - 1935.
- “Pain At Night Which is Relieved by Aspirin” - Nerve tissue has been isolated within the nidus.
- Common: 10 % of Benign lesions.
- Age: 5 -25 Males 3 : 1 Females
- Common in feet, hands.
- X-Ray: 1cm or less lucent/sclerotic lesion surrounded by reactive bone formation.
- May mimic stress fx; osteomyelitis.
OSTEOSARCOMA

- Most Common Primary Malignant Tumor of Bone.

- Age: Bimodal - 10 - 20; >50; M > F

- Location: Distal Femur, Proximal Tibia, Pelvis Metaphysis (50 % of all cases).

- Less than 1 % are found in the feet.

- Incidence of Metastasis: 15 %.

- May be seen with Paget’s, Post radiation.
OSTEOSARCOMA

X-Ray: May be Lytic, Sclerotic or combined. “Cloudlike” dense bone formation.

Calcaneus / Talus = 75%
Metatarsals = 20%
Phalanges = 5%

5 year survival: 60 - 70 % if no metastasis.

Parosteal Osteosarc: 85 - 90 % 5yr survival.
OSTEOSARCOMA ASSOCIATED DISEASES

- **Pagets**: Malignant degeneration is rare 2 - 5 %, of those that degenerate, 50 % go to osteosarcoma.

- **Radiation Induced Osteosarcoma**: High grade lesions may develop within 3 years of treatment.

- **Familial Osteosarcoma**: rare

- **Retinoblastoma**: Patients have a 100 x risk.

- **Treatment**: Excision or Amputation.

- **Chemotherapy Pre & Post excision.**
FIBROUS TUMOR MATRIX

- “Ground - glass” or “smoked - glass” appearance.
- FIBROUS CORTICAL DEFECT
- NONOSSIFYING FIBROMA
- FIBROSARCOMA
Fibrous Cortical Defect vs. Nonossifying Fibroma

- Histologically identical lesions.
- Small defects that arise either from the cortex or endosteal surface. Seen in metaphysis/diaphysis region.
- Spontaneously Regress: “NO TOUCH LESION”
- X-Ray: Geographic lesion with sclerotic rim. “Flame-like”
- No need to biopsy.
CYSTIC TUMOR MATRIX

- Geographic radiolucency which may show fluid levels.

- UNICAMERAL BONE CYST
- INTRAOSSEOUS LIPOMA
- ANEURYSMAL BONE CYST
- GIANT CELL TUMOR
- EWING’S SARCOMA
UNICAMERAL BONE CYST

- Benign, cyst-like lesion.
- Commonly encountered in the calcaneus.
- Males: Females 2:1
- Asymptomatic, however may fracture.

- “Fallen Fragment” or “Fallen Leaf” sign - area of increased density within lesion.
ANEURYSMAL BONE CYST

- Lytic, expansile lesions. Probably do not represent a true neoplasm.
- Aggressive lesion - cortical expansion, loculated, compartmentalized lesion.
- Risk for Pathologic Fracture.
GIANT CELL TUMOR

- Locally aggressive lytic lesion. No evidence of calcific or ossified matrix.
- 6% are found in the small bones of hands/feet (Memorial Sloan Kettering Cancer Center). Talus most common.
- Age: 20 - 40 Females > Males Rare in African Americans
- Location: **Epiphyseal** extending into Metaphysis.
- X-Ray: Eccentrically located, may destroy cortex and have assoc. soft tissue masses.
- Potential for malignant degeneration.
**EWING’S SARCOMA / PNET**

- **PNET =** Primitive Neuro Ectodermal Tumor. Malignant lesion of round cell lymphohematopoietic origin.
- Genetic in 90% of cases: Expression of a new chimeric EWS/FLI-1 Protein.
- **Age:** 10 - 20, rare after 30. Rare in blacks.
- **Location:** Femur, long bones - diaphyseal or metaphyseal. Calcaneus most common pedal bone.
- **5 year Survival:** <40%
12 y/o male with cc pain and swelling of right foot.

Note lamellar as well as perpendicular periosteal response.
Look for other lesions!

Chest X-Ray
Bone Scan - Nuclear Imaging
CT
MRI
METASTATIC LESIONS

- 50% of mets. to the foot will involve the tarsal bones (Calcaneus most common).

- Bronchogenic CA: Acral metastases.

- Multiple Sites of Involvement.

- Similar lesions of different sizes.
Bronchogenic Carcinoma
Flow Chart For Decision Making For Neoplastic Lesions

- **PLAIN FILM**
  - PRIMARY LESION
    - C.T.
    - MRI
  - MULTIPLE LESIONS
    - NUCLEAR IMAGING
  - METASTATIC
    - CXR
    - C.T. / MRI
    - NUC. IMAGING
Pre-Biopsy Considerations

**DIAGNOSTIC CATEGORIES**

- Benign Primary Bone Tumor
- Malignant Primary Bone Tumor
- Metastatic Bone Tumor
- Marrow Cell Tumor

If findings are consistent with a Higher Grade Tumor, consideration should be made for referral **PRIOR** to biopsy.
“The Hazards of the Biopsy, Revisited”.

597 Patients from 21 Institutions. Looked at primary malignant musculoskeletal sarcomas. The incidence of significant problems in patient management caused by inappropriate biopsy technique is 20%.

Errors, complications, and changes in the course of outcome were two to twelve times greater when the biopsy was initially done in a referring institution instead of a treatment center.

“The Hazards of the Biopsy, Revisited”.

597 Patients from 21 Institutions.

If a surgeon or institution is not prepared to do accurate diagnostic studies and proceed with definitive surgical management, outcomes are affected.

The patient’s outcome will be significantly enhanced by transfer to a referral center prior to biopsy rather than afterward.

Specimen

- Direct hand off for Frozen Section.
- Since infection is often misdiagnosed as tumor, take specimens for culture.
- Tissue Imprints, cytological studies, immunofluorescence, immunohistological tests may be considered by the Pathologist - requiring different tissue preservation.
SUMMARY of Thought Process

- Determine if lesion is benign or malignant.
- Evaluate tumor matrix for tissue type.
- Evaluate if lesion is primary or metastatic.
- Consider advanced imaging modality options.
- Consider list of differential diagnosis.
- Ultimate diagnosis based on histological analysis.

- BIOPSY IF ANY DOUBT EXISTS AS TO DIAGNOSIS!
Thank You!

DANIEL P. EVANS, DPM, FACFAOM
Professor, Department of Podiatric Medicine and Radiology
Dr. Wm. Scholl College of Podiatric Medicine