OBJECTIVES

- Describe the more common small round cell lesions of bone
- Develop a differential diagnosis based on age, sex, location and appearance
- Discuss lesions that may mimic

BRIEF INTRODUCTION

- small round blue cell tumors is a descriptive name given to members of sarcoma with specific morphologic, biological, immunophenotype and clinical features
- encompasses several lesions

SMALL ROUND BLUE CELL LESIONS OF BONE

- EWING'S SARCOMA
- NEUROBLASTOMA
- EOSINOPHILIC GRANULOMA
- LEUKEMIA
- RETICULUM CELL SARCOMA
- MULTIPLE MYELOMA

EWING'S SARCOMA

- Epidemiology
  - M>F
  - 4-15 years
  - rare over the age of 30
  - second most common malignant bone tumor in children (after osteosarcoma)
- Clinical Presentation
  - pain usually most common symptom
  - fever and leukocytosis
LOCATION

- both long and flat bones are affected in Ewing sarcoma
- lower limb 45% (femur most common), pelvis 20%, upper limb 13%

IMAGING FINDINGS

- Radiograph
  - poorly marginated, lytic, destructive lesion
  - permeative 76%, laminated periosteal reaction 57%
- "onion skin" is suggestive but NOT pathognomonic
- sclerosis CAN occur in up to 40%
- CT
  - used to evaluate bone destruction and extra-osseous involvement

IMAGING FINDINGS

- MRI
  - T1W: low signal intensity
  - T1WI with contrast: can be heterogeneous but usually prominent enhancement
  - heterogeneously high signal, may see hair on end low signal striations
NEUROBLASTOMA

• Epidemiology
  - M>F
  - infants and very young children
• Clinical Presentation
  - pain or palpable mass

LOCATION

• adrenal glands are the number one primary site
• bone is the second most common site for metastasis after the liver
• most common posterior mediastinal mass in children

IMAGING FINDINGS

• Radiographs
  - nonspecific; often pressure on adjacent bones can cause remodelling of ribs and vertebral bodies.
  - often with calcifications
• CT
  - primary site is heterogeneous with calcifications
  - metastatic lesions tend to be lytic
  - look for localized invasion and remodeling

Table 3

<table>
<thead>
<tr>
<th>Stage</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Localized tumor confined to the area of origin; somatic nerves, adrenal gland; involvement of cranial nerves, contralateral adrenal, or lymph nodes macroscopically negative</td>
</tr>
<tr>
<td>2</td>
<td>Localized tumor with extracapsular growth; involvement of adrenals, contralateral adrenal, or lymph nodes macroscopically negative</td>
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<tr>
<td>3</td>
<td>Bilateral tumor with complete or incomplete gross extension; with positive paraaortic, regional lymph nodes, identifiable contralateral lymph nodes macroscopically negative</td>
</tr>
<tr>
<td>4</td>
<td>Tumor involving paraspinal soft tissue or without regional lymph node involvement; or unilateral tumor with regional lymph node involvement, or bilateral tumor with no regional lymph node involvement</td>
</tr>
<tr>
<td>4b</td>
<td>Disseminated tumor to bone, bone marrow, liver, distant lymph nodes, and/or other organs (except as defined for stage 4b)</td>
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<tr>
<td>4v</td>
<td>Localized primary tumor (as defined for stage 1 or 2) with dissemination limited to liver, skin, and/or &lt;1% of bone marrow, with age &gt;1 year at diagnosis</td>
</tr>
</tbody>
</table>

From Broderick GM et al 2020
EOSINOPHILIC GRANULOMA

- Epidemiology
  - M:F 2:1
  - older children and young adults
- Clinical Presentation
  - may be asymptomatic or present with pain, swelling and tenderness around the lesion
- Location
  - Skull 49%, pelvis 23% and femur 17%

IMAGING FINDINGS

- Radiograph
  - solitary or multiple punched out lytic lesions
  - sharply marginated
  - BEVELED EDGE
  - spine associated with vertebra plana
  - Long bones mainly involves the diaphysis

- CT
  - findings are similar to radiographs with cortical erosion +/- soft tissue involvement

- MRI
  - T1WI: low signal
  - TW12: isointense to hyperintense
  - T1WI with contrast: often shows enhancement
LEUKEMIA

• General Considerations
  - leukemia: neoplastic disorder of white blood cells
  - may be myeloid or lymphoid in origin
  - may be acute or chronic

EPIDEMIOLOGY

• ALL: peak 2-10 years (most common childhood leukemia)
• AML: peak > 65 years (but constitutes 15-20% of childhood leukemia)
• CML: peak > 40 years (rare in childhood)
• CLL: 50-70 years

• Clinical Presentation
  - localized or diffuse bone

• Location
  - childhood leukemia: femur 24%, humerus 11%, ilium 17%, spine 14%
  - adult leukemia: axial skeleton predominates
IMAGING FINDINGS

• Radiographic
  - lesions may be so subtle that they are not recognizable on radiograph
  - compression fracture without significant trauma should raise suspicion
  - lucent metaphyseal lines “leukemic lines”
  - blastic or mixed lytic/sclerotic lesions are RARE

IMAGING FINDINGS

• CT
  - permeative bone destruction, lucent metaphyseal bands better seen
  - nonspecific in appearance

• MRI
  - T1WI: low signal
  - T2WI: variable
  - T1WI with contrast: avid enhancement

SARCOMA/PRIMARY LYMPHOMA OF BONE

• Epidemiology
  - slight male predominance
  - vast majority are non-Hodgkin lymphoma
  - > 40 year old patients

• Clinical Presentation
  - bone pain common presenting symptom
  - can cause a swelling of the limb and limit movements of the arm or leg
  - symptoms of lymphoma like fever and weight loss are NOT common
LOCATION

- long bones 71%, flat bones 25%
- often a solitary lesion

IMAGING FINDINGS

- Radiographic
  - lytic lesions with wide zone of transition, permeative bone destruction and periosteal reaction
  - may contain sclerotic bone in 30%
- CT
  - helps to differentiate primary and secondary of bone
  - often demonstrates subtle cortical involvement
- MRI
  - T1WI: low signal
  - T2WI: high signal
  - T1WI with contrast: enhancing lesion

MULTIPLE MYELOMA

- Epidemiology
  - M:F 2:1
  - 70% of cases are diagnosed between the ages of 50-70
- Clinical Presentation
  - intermittent bone pain, anemia (usually normocytic/normocytic)
  - hypercalcemia
  - renal failure/proteinuria
  - pathological fractures
LOCATION
- Osteoporosis is most common skeletal abnormality in this disease
- Over 50% of solitary lesions are found in vertebrae
- If lesions are usually multiple usually found in vertebrae, ribs, skull, pelvis, and femur

IMAGING FINDINGS
- Radiograph
  - Majority of lesions are purely lytic, sharply defined/punched out with endosteal scalloping when abutting cortex
  - “Punched out” lytic lesion
- CT
  - Does not provide a large role in the diagnosis
  - Helps to classify extra-osseous soft tissue component in patients with large disease burden
  - Intramedullary soft tissue mass producing lytic lesions

IMAGING FINDINGS
- MRI
  - MRI is generally more sensitive in detecting multiple lesions compared to the standard plain film skeletal survey
  - T1WI: diffuse or focal: signal ≤ muscle/disk
  - STIR: untreated disease has high signal intensity
  - T1WI C+ FS: untreated disease enhances with contrast
LESIONS THAT MAY MIMIC

- Osteomyelitis
  - bone destruction, intramedullary gas and fat-fluid level, periosteal reaction, sequestrum, involucrum
  - tendency to occur in metaphyses or metaphyseal equivalents (bone next to cartilage, e.g., calcaneal apophysis and acetabulum)
- Osteolytic osteosarcoma
  - 91% in metaphysis and 9% diaphysis
  - long bones 70-80%
  - permeative, destructive lesion, eccentrically located
- Metastasis

PUTTING EVERYTHING TOGETHER

<table>
<thead>
<tr>
<th>LESION</th>
<th>AGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>NEUROBLASTOMA</td>
<td>USUALLY INFANTS</td>
</tr>
<tr>
<td>EOSINOPHILIC GRANULOMA</td>
<td>5-15 YEARS</td>
</tr>
<tr>
<td>ACUTE LEUKEMIA</td>
<td>5-15 YEARS</td>
</tr>
<tr>
<td>EWING'S SARCOMA</td>
<td>TEENAGER-EARLY 20'S</td>
</tr>
<tr>
<td>RETICULUM CELL SARCOMA</td>
<td>AVERAGE AGE 30'S</td>
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<tr>
<td>MULTIPLE MYELOMA</td>
<td>AVERAGE AGE 60-70</td>
</tr>
<tr>
<td>CHRONIC LEUKEMIA</td>
<td>AVERAGE AGE 60-70</td>
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LOCATION

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<td>NEUROBLASTOMA</td>
<td>ADRENAL GLANDS, VARIABLE METASIS</td>
</tr>
<tr>
<td>EOSINOPHILIC GRANULOMA</td>
<td>SKULL, PELVIS, FEMUR</td>
</tr>
<tr>
<td>LEUKEMIA</td>
<td>ADULT: AXIAL SKELETON</td>
</tr>
<tr>
<td></td>
<td>CHILDHOOD: FEMUR, HUMERUS, ILIUM</td>
</tr>
<tr>
<td>EWING'S SARCOMA</td>
<td>LOWER LIMB, METAPHYSAL/DIAPHYSAL</td>
</tr>
<tr>
<td>RETICULUM CELL SARCOMA</td>
<td>LONG BONES, FLAT BONES</td>
</tr>
<tr>
<td>MULTIPLE MYELOMA</td>
<td>50% SOLITARY LESIONS IN AXIAL</td>
</tr>
<tr>
<td></td>
<td>SKELETON, MULTIPLE: VERTEBRAE, RIBS, SKULL</td>
</tr>
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</table>

YOU KNOW YOU'RE A RADIOLOGIST WHEN...

- You switch off all the room lights when watching TV or when you are at the computer
- The strawberry milkshake at McDonald’s turns you off (It looks like a barium preparation for a swallow)
- Someone asks a favor from you in the middle of the night, you say, “Will it make much of a difference if I do it for you tomorrow morning, instead?”
- You refer to dust on your wedding photo as “artifacts”
- You always wonder what’s that thing hanging around other doctor’s necks, and then suddenly it hits you – it’s a stethoscope!

THANK YOU
3. https://my.statdx.com/STATdxMain.jsp?rc=false&dxContent;leukemia_dx1
17. http://ep.bmj.com/content/95/2/47.long

References
