Imaging of Bisphosphonate-Related Osteonecrosis of the Jaw

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Presentation Agenda

• Introduction to BRONJ
• Menu of Radiologic Tests
• Anatomy and Terminology
• Cases
• Role of Imaging
Bisphosphonate-Related Osteonecrosis of the Jaw

• Bisphosphonates
  – Anti-osteoclastic
  – Indications
    • Mets to bone (i.e., prostate, breast)
    • Multiple myeloma
    • Osteoporosis

• BRONJ
  – Non-healing area of exposed bone for 8 weeks w/o XRT
  – Symptoms: pain, swelling, foul taste, loss of teeth
  – Incidence: 1-10% IV, 0.1 – 1% oral
  – Complications: tooth/bone loss, infection, pathologic fractures
BRONJ: Pathophysiology

- Pathophysiology is uncertain
- Hypotheses
  1. Over-suppression of bone turnover leading to necrosis
  2. Response to infection
  3. Ischemia due to anti-angiogenic effects of BPNs
  4. Mucosal injury leading to exposed bone

Menu of Radiologic Tests

1. Plain film
2. CT
3. MRI
4. Bone Scan
Radiologic Tests: Plain Film

1. Plain film
   – Panoramic radiograph
Radiologic Tests: CT

1. Plain film
   – Panoramic radiograph

2. CT
Radiologic Tests: MRI

1. Plain film
   - Panoramic radiograph
2. CT
3. MRI
Radiologic Tests: Bone Scintigraphy

1. Plain film
   - Panoramic radiograph
2. CT
3. MRI
4. Bone Scan
Craniofacial Anatomy

http://img.tfd.com/MosbyMD/thumb/maxilla.jpg
Anatomy on Panoramic Radiograph

Normal patient: 24 year-old healthy male
Anatomy on Panoramic Radiograph

Normal patient: 24 year-old healthy male

- Condyle
- Nasal cavity
- Sinus
- Gutta percha
- Ramus
- Angle
- Body
- Symphysis
- Mental foramen
- IAN canal

Panoramic Radiograph

MGH Dixie
Terminology

- **Pathologic fracture**: fracture due to disease process that led to weakness of bone
- **Sequestrum**: piece of necrotic bone that has become separated from viable bone
- **Involucrum**: new bone that forms around area of necrotic bone
- **Oro-antral fistula**: abnormal communication between oral cavity and sinus
- **Oro-nasal fistula**: abnormal communication between oral and nasal cavities
- **Oro-cutaneous fistula**: abnormal communication between oral cavity and skin
Index Patient # 1: Presentation

CC
• “Jaw pain and foul odor.”

HPI
• 68 yof with metastatic breast cancer treated with chemotherapy
• No history of XRT
• IV zoledronate for 5 years

Clinical photo from patient 1
Patient 1: Panoramic Radiograph

- Anterior maxillary superimposition of cervical spine
- Anterior maxillary dentoalveolar bone loss
Patient 1: CT

Representative CT images shown in bone windows

- **Sclerosis** of anterior maxilla with loss of cortico-medullary differentiation
- **Oro-nasal communication**
- **Nasopalatine canal**
- Normal appearing mandible with a distinct cortex and marrow space
Patient 1: Bone Scintigraphy

- Increased uptake in maxilla (BRONJ)
- Increased uptake in T8 (breast cancer metastasis)
Index Patient # 2

CC
• “Persistent pain and exposed bone after tooth extraction.”

HPI
• 59 yof with osteoporosis on alendronate for past 8 years
Patient 2: Panoramic Radiograph

- Loss of superior cortex of left mandible
- Radiopacity surrounded by radiolucency suggestive of sequestrum
Patient 2: CT Scan

- Sclerosis of left mandible
- Sequestrum
- Periosteal reaction
You have just seen examples of two patients with BRONJ. Patient one demonstrated BRONJ of the maxilla secondary to IV BPN use for the treatment of cancer-related skeletal disease. Patient two demonstrated BRONJ of the mandible secondary to oral BPN use for treatment of senile osteoporosis. You viewed the appearance of these lesions on panoramic radiographs, CT, and bone scintigraphy. Next, you will be shown companion patients which further illustrate the appearance of BRONJ on various radiologic images.
Companion Patient 1 with BRONJ: Panoramic Radiograph and CT

- Sclerosis with loss of corticomedullary differentiation
- Sclerosis with cortical erosion

Panoramic Radiograph

CT axial view

Companion Patient 2 with BRONJ: MRI

- Decreased signal intensity on non-contrast T1 MRI
- Increased signal intensity of surrounding soft tissues on contrast-enhanced T1 fat-sat MRI
Companion Patient 3: Bone Scan

- Increased uptake at bone scintigraphy is noted in a majority of ONJ cases due to surrounding inflammation or periosteal reaction


You have now seen the radiologic appearance of bisphosphonate-related osteonecrosis of the jaw on plain film, CT, MRI, and bone scintigraphy. Next, you will be introduced to the role of imaging in the diagnosis and staging of this condition.
Role of Imaging

- Diagnosis
- Staging
Role of Imaging: Differential Diagnosis

- BRONJ
- Osteomyelitis
- Osteoradionecrosis
- Metastasis
- Osteosarcoma
Image Gallery of Conditions Mimicking BRONJ on CT

- Osteomyelitis
- Osteoradionecrosis
- Osteosarcoma
- Breast cancer metastasis

C- CT axial view

Nithyanand A et al. Spec Care Dentist 2006
### Staging of BRONJ

| Stage 0 | • No exposed bone  
|         | • Unexplained symptoms, i.e., pain, swelling  
|         | • Radiographic changes: i.e., sclerosis  |
| Stage 1 | • Exposed bone  
|         | • Asymptomatic  
|         | • No evidence of infection  |
| Stage 2 | • Exposed necrotic bone  
|         | • Symptomatic  
|         | • Infection showing pain and erythema  |
| Stage 3 | • Exposed necrotic bone  
|         | • Infection with purulence  
|         | • Pathologic fracture or fistula formation  |
## Narrowing The Differential Diagnosis

<table>
<thead>
<tr>
<th>Diagnosis</th>
<th>Density</th>
<th>Exposed Bone</th>
<th>Sequestrum/Involucrum</th>
<th>Periosteal Reaction</th>
<th>Borders</th>
</tr>
</thead>
<tbody>
<tr>
<td>BRONJ</td>
<td>Lytic, sclerotic, mixed</td>
<td>Yes, but not in stage 0</td>
<td>Common</td>
<td></td>
<td>Regular, Moth-eaten</td>
</tr>
<tr>
<td>Osteomyelitis</td>
<td>Lytic, sclerotic, mixed</td>
<td>Yes or no</td>
<td>Common</td>
<td></td>
<td>Regular, Moth-eaten</td>
</tr>
<tr>
<td>Osteoradionecrosis</td>
<td>Lytic, sclerotic, mixed</td>
<td>yes</td>
<td>Common</td>
<td></td>
<td>Regular, Moth-eaten</td>
</tr>
<tr>
<td>Metastasis</td>
<td>Lytic, sclerotic, mixed</td>
<td>no</td>
<td>Uncommon</td>
<td></td>
<td>Regular, Moth-eaten, Permeative</td>
</tr>
<tr>
<td>Osteosarcoma</td>
<td>Lytic if chondroblastic, sclerotic, mixed</td>
<td>no</td>
<td>Uncommon</td>
<td></td>
<td>Regular, Moth-eaten, Permeative</td>
</tr>
</tbody>
</table>
Narrowing The Differential Diagnosis

• The diagnosis of BRONJ is largely clinical, however, the following pearls may be useful
  – Presence of sequestra favor BRONJ, ORN, or osteomyelitis
  – Permeative borders favor metastasis or osteosarcoma
  – A discontinuous or sunray periosteal reaction favors osteosarcoma or metastasis
  – The presence of exposed bone clinically is probably the most important factor favoring BRONJ, ORN, or osteomyelitis, but remember that stage 0 BRONJ does not exhibit exposed bone
Summary

• Introduction to BRONJ
  – Background
  – Pathophysiology

• Menu of Radiologic Tests
  – Plain film: Panoramic radiograph
  – CT
  – MRI
  – Bone Scan

• Anatomy and Terminology
  – Clinical
  – Radiologic

• Cases
  – 68 yof with metastatic breast cancer taking IV BPN
  – 59 yof with osteoporosis taking oral BPN
Summary Continued

• Radiologic Appearance
  – Plain film: Mixed radio-opaque and radio-lucent, loss of cortical white lines, sequestrum, pathologic fracture
  – CT: Lytic, sclerotic, mixed, narrowing of marrow space, loss of corticomedullary differentiation, cortical erosion, periosteal reaction, fistula formation, pathologic fractures
  – MRI: Decreased signal intensity on T1, surrounding tissue may enhance with contrast. Variable on T2
  – Bone scintigraphy: Often increased uptake due to surrounding inflammation

• Role of Imaging
  – Diagnosis
    • BRONJ, osteomyelitis, osteoradionecrosis, metastasis, osteosarcoma
  – Staging
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References


Salvatore R DMD, MD, Dodson T, DMD MPH, Assael L DMD. Landesberg DMD, PhD, Marx R, DDS, Mehrota B, American Association of Oral and Maxillofacial Surgeons Position Paper on Bisphosphonate-Related Osteonecrosis of the Jaw – 2009 Update Approved by the Board of Trustees January 2009 Task Force on Bisphosphonate-Related Osteonecrosis of the Jaws*