Tibial Osteomyelitis: Diagnostic MRI Imaging and Pathogenesis

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Learning Objectives

• Clinical presentation and physical exam findings of osteomyelitis
• Classical findings in plain film and MRI
• Pathophysiology and common microorganisms of osteomyelitis
Learning Objectives

- Clinical presentation and physical exam findings of osteomyelitis
  - Classical findings in plain film and MRI
  - Pathophysiology and common microorganisms of osteomyelitis
Our patient: History

• 82 F presents to the ED with worsening knee pain
• Fall 2 months ago -> progressing R knee pain -> difficulty ambulating
• Nursing home resident, walks with a walker at baseline
• PMH: dementia, DVT, a fib, HTN, UC s/p ileostomy
• Soc: No smoking or drugs, occasional EtOH
• Temp: 99.4, BP: 112/61, HR: 83, RR: 18, O2%: 96% RA
• PE: Erythema and warmth in right knee, painful to palpation, fluctuance, old cuts around posterior fossa
Our Patient: Lab findings

- WBC: 5.7
- Cr: 0.6
- INR: 2.3
- CRP: 65.5
- ESR: 105
- Cultures pending
Our Patient: Brief Summary

- R knee pain
- Nursing home resident
- T: 99.4
- History of fall + cuts around knee
- Erythema and warmth
- Fluctuance
- Increased ESR, CRP
Our Patient: Differential Diagnosis

• High:
  – Osteomyelitis
  – Septic Arthritis
  – Cellulitis
  – Tumor

• Low
  – Reactive Bone Marrow Edema
  – Trauma
  – DJD
  – Gout
Learning Objectives

✓ Clinical presentation and physical exam findings of osteomyelitis

➢ Classical findings in plain film and MRI

• Pathophysiology of and common microorganisms osteomyelitis
Choice of imaging

• Plain Film  Sensitivity: 43-75%, Specificity: 75-83%
• CT Scan  Sensitivity: 67%, Specificity: 50%
• MRI  Sensitivity: 82-100%, Specificity: 75-96%
• Ultrasound  TBD
• Bone Scintigraphy  Sensitivity: 60%, Specificity: 80%
Choice of imaging

- Plain Film
- CT Scan
- MRI
- Ultrasound
- Bone Scintigraphy
Normal Anatomy of the Knee

- Femur
- Lateral Epicondyle
- Lateral Femoral Condyle
- Lateral Tibial Condyle
- Head of Fibula
- Medial Epicondyle
- Patella
- Intercondylar Notch
- Medial Femoral Condyle
- Medial Tibial Condyle
- Intercondylar Eminence
- Tibia

Wikiradiography; http://www.wikiradiography.net/page/Knee+(non+trauma)+Radiographic+Anatomy; Date accessed: November 16, 2014
Our Patient: Plain Radiograph

AP

Cross Table Lateral
Our Patient: Radiograph Highlights

Plain Radiograph: AP View

Radiographic Findings:
- Cortical destruction/erosion
- Periosteal reaction
- Soft tissue swelling
- Ill defined area of lucency
Our Patient: Differential Diagnosis

• **High:**
  – Osteomyelitis
  – Septic Arthritis
  – Cellulitis
  – Tumor

• **Low**
  – Reactive Bone Marrow Edema
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Next Step in Imaging

MRI
# Interpreting a T2 C- MRI

<table>
<thead>
<tr>
<th>Object</th>
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<tr>
<td>Air</td>
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<tr>
<td>Blood</td>
<td>Dark</td>
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<tr>
<td>Bone (cortex)</td>
<td>Dark</td>
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<td>Bone (marrow)</td>
<td>Light</td>
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<tr>
<td>Fat</td>
<td>Light</td>
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Our Patient: T2 MRI Findings

Radiographic Findings:
- Tissue enhancement
- Cortical destruction
- Normal Cortex

Axial T2 C- MRI
# Interpreting a T1 FS C+ MRI

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Our Patient: T1 MRI Findings

Radiographic Findings:
- Non-enhancing fluid with thick rim enhancement
- Tissue enhancement
- Increased signal intensity in bone
- Normal Cortex

Axial T1 FS C- MRI
## Interpreting STIR MRI

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</tbody>
</table>
Our Patient: STIR MRI Findings

Radiographic Findings:
- Fluid collection
- Periosteal edema
- Edema

Axial STIR MRI
Our Patient: Review of Radiological Findings

• Plain Film
  • Cortical destruction
  • Periosteal reaction
  • Soft tissue swelling
  • Areas of lucency

• MRI
  • Abscess (loculated)
  • Cortical erosion
  • Periosteal edema
  • Bone marrow edema
Our Patient: Next Steps?

- Tissue biopsy
- Bacterial cultures
- Debridement
- Bone biopsy to rule out tumor
Our Patient: CT S/P Debridement

Radiographic Findings:
- Evacuated Bone

Physical Findings in Surgery:
- Pockets of necrotic tissue
- Scalloped areas of proximal tibia
Our Patient: Pathology Results

• Bone:
  • Acute inflammation
  • Granulation tissue
• Blood culture:
  • Negative
• Tissue culture:
  • Pseudomonas aeruginosa
Our Patient: Differential Diagnosis

- **High:**
  - Osteomyelitis
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  - Cellulitis
  - Tumor

- **Low**
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  - Trauma
  - DJD
  - Gout
Our Patient: Outcome

- Managed with antibiotics (IV cefepime BID for 6 weeks)
- Recovery: able to ambulate with a walker + improvement in strength
- No recurrence as of 2 months
Learning Objectives

✓ Clinical presentation and physical exam findings of osteomyelitis
✓ Classical findings in plain film and MRI

➢ Pathophysiology and common microorganisms osteomyelitis
Osteomyelitis: Initiation

- **Hematogenous seeding**
  - Children/elderly patients

- **Contiguous spread**
  - **Trauma**, surgery, prosthetics

- **Vascular insufficiency**
  - Diabetics, vascular insufficiency
Osteomyelitis: Pathogenesis

1. Infection
2. Inflammation
   1. Reactive hyperameia -> osteoclastic activity
   2. Destruction of soft tissue -> decreased vascular supply to bone
3. Extension into cortex

Osteomyelitis: Pathogenesis

4. Areas of dead bone (sequestra)
5. New bone formation at periphery
6. Sinus tract formation

Osteomyelitis: Differentiating Acute vs. Chronic

• **Acute**
  – Several days to weeks
  – Acute inflammation

• **Chronic**
  – Weeks to years
  – Low-grade inflammation
  – Presence of dead bone (sequestrum)
  – Sinus tracts
  – Relapses
# Osteomyelitis: Common Organisms

<table>
<thead>
<tr>
<th>Organism</th>
<th>Association</th>
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</thead>
<tbody>
<tr>
<td>S. Aureus</td>
<td>Most frequent; adhesins</td>
</tr>
<tr>
<td>S. Epidermis</td>
<td>Foreign bodies</td>
</tr>
<tr>
<td>P. Aeruginosa</td>
<td>Puncture wound</td>
</tr>
<tr>
<td>Anaerobes</td>
<td>Fist to tooth; diabetic ulcer</td>
</tr>
<tr>
<td>Salmonella</td>
<td>Sickle cell disease</td>
</tr>
<tr>
<td>Pasteurella</td>
<td>Bites</td>
</tr>
<tr>
<td>M. Tuberculosis</td>
<td>Endemic area</td>
</tr>
<tr>
<td>Fungal</td>
<td>Immunocompromised</td>
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Summary

• Clinical presentation and physical exam findings of osteomyelitis
  – R knee pain
  – Nursing home resident
  – T: 99.4
  – History of fall + cuts around knee
  – Erythema and warmth
  – Fluctuance
  – Increased ESR, CRP

• Classical findings in plain film and MRI
  • Plain Film
    • Cortical destruction
    • Periosteal reaction
    • Soft tissue swelling
    • Areas of lucency
  • MRI
    • Abscess (loculated)
    • Cortical erosion
    • Periosteal edema
    • Bone marrow edema

• Pathophysiology and common microorganisms of osteomyelitis
  – 3 mechanisms of infection
  – Acute vs. chronic
  – Common microorganisms and associations
References

- Wikiradiography; http://www.wikiradiography.net/page/Knee+(non+trauma)+Radiographic+Anatomy; Date accessed: November 16, 2014
Acknowledgements

Dr. Gillian Lieberman
Dr. Justin Kung
Dr. Mark Masciocchi
Mr. Joseph Singer