Osteomyelitis: Always a Diagnostic Puzzle

Osteomyelitis: Put the Pieces Together

HISTORY
- Clinical
- Surgical
- Recent

RADIOGRAPHS
- Active
- Recent

CT
- Chronic

MRI
- Active

Osteomyelitis: Topics
Definitions
- Active
- Chronic

Mechanisms
- Hematogenous
- Direct spread

Imaging
- Radiographs
- MRI

Bone Model
- Cortex
- Marrow

Osteomyelitis: Definitions

Osteomyelitis comes from Greek:
- osteon = bone
- myelos = marrow
- itis = inflammation

"Inflammation of bone marrow"
Infection of bone marrow

MRI
- Marrow

High Sensitivity
Low Specificity
Marrow inflammation from infection looks like inflammation from any other cause

Osteomyelitis: Definitions

Active Osteomyelitis
- "Aggressive"
- Resembles Tumor
  - Cortex Destruction
  - Periosteal Reaction

Chronic Osteomyelitis
Osteomyelitis: Always a Diagnostic Puzzle

**Active Osteomyelitis**
- “Aggressive”
  - Cortex Destruction
  - Periosteal Reaction

**Chronic Osteomyelitis**
- “Non-Aggressive”
  - Resembles Callus

3 Characteristics:
- **Involucrum**: “wrap”
  - Thick periosteum around infected bone
- **Sequestrum**: “set apart”
  - Piece of dead, infected, bone
- **Cloaca**: “sewer”
  - Opening in cortex through which pus can escape

**Clinical Followup**
- 16yoM distal fibula pain 3w after inversion injury

**RADIOGRAPHS**
Active ≠ Chronic

**Active vs Chronic Osteomyelitis**

**Active Osteomyelitis**
- 16yoM distal fibula pain 3w after inversion injury

**Chronic Osteomyelitis**
- 19yoM fibula pain 2.5 years later...

**CT**
- Involucrum
- Sequestrum
- Cloaca

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Chronic Osteomyelitis
Involucrum Developing
42yoM Diabetic
6 weeks later
10 more weeks

Chronic Osteomyelitis
Involucrum
27yoM s/p removal Rt Femoral Rod

Sequestrum
27yoM s/p removal Rt Femoral Rod

Involucrum
Sequestrum
Cloaca
27yoM s/p removal Rt Femoral Rod

Osteomyelitis: Mechanisms
Direct Spread → adjacent tissues
- Most common cause
- Decubitus ulcer
- Septic arthritis

Decubitus Ulcer → Ischium
52yoM Quadriplegic

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Osteomyelitis: Mechanisms

Direct Spread → adjacent tissues
- Most common cause
- Decubitus ulcer
- Septic arthritis

Puncture into bone
- Stepped on nail
- External fixator
- Ring sequestrum

Hematogenous
- Site related to patient age

Ring Sequestrum

Chronic Osteomyelitis
- Involucrum
- Sequestrum
- Cloaca
- Poor Union

Osteomyelitis: Mechanisms

Direct Spread → adjacent tissues
- Most common cause
- Decubitus ulcer
- Septic arthritis

Puncture into bone
- Stepped on nail
- External fixator
- Ring sequestrum

Hematogenous Osteomyelitis

Site related to patient age

- Physis
- Metaphysis
- Diaphysis

Infection occurs at metaphysis of immature bone

Infection occurs at end of mature bone

Hematogenous Osteomyelitis

1yoM strep pneumonia

3 months later

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Osteomyelitis: Imaging

Many Imaging Options:
- Radiographs
- CT
- MR
- US
- Nuc Med

What to order when?

Osteomyelitis: What to Order When

- Radiographs \(\ldots\ldots\ldots\ldots\text{ALWAYS!}\)
  - May show evidence of active infection
    - Bone destruction, periosteal reaction
  - May show evidence of chronic infection
    - Involucrum
    - Screen for metal
    - Orthopedic hardware, foreign bodies
    - Unexpected findings
    - Fractures, gas in soft tissues
    - Delineate current anatomy
    - Surgical resections, neuropathic deformity

RADIOGRAPHS NEED TO BE RECENT

Need for Recent Radiographs: Example

- Normal Lisfranc joint
- Neuropathic destruction of the Lisfranc joint

June

September

Osteomyelitis: What to Order When

- Radiographs \(\ldots\ldots\ldots\ldots\text{ALWAYS!}\)
- CT \(\ldots\ldots\ldots\ldots\text{Chronic Cases}\)
  - CT best for calcified structures
    - Involucrum
    - Sequestrum
    - Cloaca
  - CT of the extremities is insensitive for:
    - Bone marrow pathology
    - Soft tissue pathology

Osteomyelitis: MR Imaging

- MRI \(\ldots\ldots\ldots\ldots\text{Active Cases}\)
  - Shows extent of soft tissue edema
  - Excellent for demonstrating abscesses and other drainable fluid collections
  - Sensitive for bone marrow pathology
    - Can be overly sensitive at expense of specificity
    - Infected bone marrow resembles marrow edema due to other causes

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Osteomyelitis: Always a Diagnostic Puzzle

Path=Fluid
1. T1=Dark
2. T2=Bright
3. T1fs+Gd

Enhancement
✓ Inflamed
○ Uniform
✓ Abscess
○ Wall
✓ Cyst
○ Not

Detection of the non-enhancing pus pocket (abscess) is crucial
➢ Presence of soft tissue abscess proves the edema in underlying bone marrow is osteomyelitis.
➢ Site for aspiration for culture.
➢ If IV Gd doesn’t get into abscess, IV antibiotics won’t get in either, abscess may require drainage.

63yoM Diabetic
2 weeks earlier…

Intact cortex

More marrow edema
More tissue edema

Non-enhancing abscess pocket

63yoM Diabetic
2 weeks later…

Intact cortex

Cortical destruction

Marrow edema

Abscess Pocket
Osteomyelitis: Always a Diagnostic Puzzle

Decubitus Ulcer → Ischium

52yoM quadriplegic

T1 T1fs +Gd

Abscess?

T2fs

Abscess?

Osteomyelitis: MR Imaging

1yoF Swollen left lower leg

Periosteal Reaction

Metaphyseal lucency

Osteomyelitis: What to Order When

- Radiographs .......... ALWAYS!
- CT .................... Chronic Cases
- MRI .................. Active Cases
- US .................. Fluid/Abscess
  - US guided aspiration for culture
  - Cannot assess bone involvement
- Nuc Med ............ Problem Cases
  - Where MR specificity is decreased
    - Neuropathic feet
    - Infected hardware

Osteomyelitis: MR Imaging

1yoF Swollen left lower leg

Periosteal Reaction

Brodie Abscess

Metaphyseal

Non-enhancing abscess

Intra-osseous

T1fs IVGd

Infection around metal: MRI

T2fs

We can see soft tissues around bone

T1fs IVGd

Enhancing granulation tissue (phlegmon?)

Infection around metal: Nuc Med

Requires 2 Radiopharmaceuticals

1) Tc-Bone Scan (Active bone metabolism)
2) In-WBC Scan (Areas of WBC accumulation)

1) BS: Sen/Spec
2) WBC: Spec/Sen

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Infection around metal: Nuc Med
- Tc-Bone Scan
- In-WBC Scan
- Removed Tibia Plate
- Tibia Plate
- Tibia
- Femur

Charcot (Neuropathic) Foot
- Tc^{99m} MDP
- T1fs + IV Gd
- T2fs
- Abscess
- In^{111} WBC
- Infection

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