“Approach to Lower Extremity Osteomyelitis”
A radiologic tour of a patient encounter
Our learning goals

- Review lower extremity anatomy
- Discuss menu of available tests
- Demonstrate classic findings of osteomyelitis on plain film and MRI
- Develop and refine the differential diagnosis for osteomyelitis
Meet our patient, Mr. J

- 39 year-old homeless male with history of HIV, ETOH abuse, and traumatic R ankle fracture s/p ORIF 3 years ago

- Arrives in ED with a painful, swollen right ankle
Our patient: HPI

- First noticed pain 3 weeks ago in his right ankle while walking
- 5 days ago, medial right ankle became red and swollen with burning sensation
Our patient: differential diagnosis #1

- Cellulitis
- Osteomyelitis
- Fracture
- Septic arthritis
- Osteoarthritis
- Rheumatoid arthritis
- Gout
- Tumor

What radiologic test should we order first?
Menu of tests

- Plain Film
- MRI
- CT
- Ultrasound
- Nuclear medicine
  - Three-phase bone scan
  - WBC scan
  - FDG PET
  - Gallium
Anatomy: review

- Before we continue to the plain film findings, we will review the anatomy of the ankle region
Anatomy: bones of the foot

![Foot anatomy diagram]

www.sportspodiatry.co.uk/foot_footanatomy.htm
Anatomy: the mortise joint

Tibia
Fibula
Lateral Malleolus
Medial Malleolus
Talus

Normal Ankle Xray, Mortise View

Mortise joint
Tibial plafond
Talar dome

www.usuhs.mil/fap/resources/imag/AnkleX-Rays
Our patient: plain film

- Now back to our patient
- We will start with earlier images for baseline comparison
Our patient: ankle plain film, 3 months prior
Our patient: plain film highlights, 3 months prior

- Disruption of trabecular lines
- Metallic washer
- Increased sclerosis
- Narrowing joint space
- Osteoarthritis, secondary to infection or fracture
Our patient: ankle plain film, current

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Our patient: plain film highlights, current

- **Area of increased lucency** in medial aspect of distal tibial metaphysis
- **Area of increased sclerosis** in distal tibia
- **Increased soft tissue swelling**
- **Cortical erosion**
- **Periosteal** new bone formation

Ankle X-ray, Mortise View
Our patient: summary from plain films

There is a process occurring in the...

- **Soft tissue:**
  - Swollen

- **Bone:**
  - Chronic process: causing **sclerosis**
  - Acute process: causing **lucency**

- **Joint:**
  - Narrowing ➔ loss of cartilage ➔ arthritis
Our patient: differential diagnosis #2

- Cellulitis
- Osteomyelitis
- Fracture
- Septic arthritis
- Osteoarthritis
- Rheumatoid arthritis
- Gout
- Tumor

What test should we order next?
Menu of Tests

- Plain Film
- MRI
- CT
- Ultrasound
- Nuclear medicine
  - Three-phase bone scan
  - WBC scan
  - FDG PET
  - Gallium
Our patient: normal anatomy on T1 MRI

- Fat
- Tendons
- Ligaments
- Muscle
- Cortex
- Bone marrow

Axial T1 MRI, distal R lower extremity
Our patient: T1 MRI findings

On T1...
- Fluid is dark, fat is bright
- Gives the broad “anatomy” view

Abnormalities
- Bone: lesion that is hypointense to marrow
- Soft tissue: lesion that is isointense to muscle

Axial T1 MRI, distal R lower extremity
Our patient: T2 MRI findings

On T2...
- Fluid is bright, fat is dark.
- Gives “pathology” view

Abnormalities
- Soft tissue: improved view of loculated fluid collection

Axial T2 MRI, distal R lower extremity
Our patient: STIR MRI findings

**On STIR (Short Tau Inversion Recovery)**
- Fat is subtracted out, leaving fluid bright
- We show normal STIR for comparison

**Abnormalities**
- Diffusely increased signal in tibia → bone marrow edema
- Cortical erosion
- Periosteal edema
Our patient: T1 post-gad MRI findings

On T1 post-gad...
- IV contrast (gadolinium) shows disruption of tissue boundary
- We show T1 pre-gad shown for comparison

Abnormalities
- Decreased signal in marrow ➔ necrotic bone
- Sinus tract and abscess
Our patient: summary from MRI

- **Soft tissue:**
  - Loculated **abscess**
  - Sinus tract to bone

- **Bone:**
  - Diffuse tibial **bone marrow edema**
  - **Cortical erosion and periosteal edema** → inflammatory process
  - Necrotic bone → **sequestrum**

**Diagnosis?**
Our patient: diagnosis of osteomyelitis

Definition: infection of the bone marrow
- **Acute**: evolves over **days to weeks**
- **Chronic**: evolves over **months to years**, with relapses
  - Bacteria remain in sequestra, where antibiotics cannot reach

Route of spread
- **Contiguous spread**
  - Trauma, bone surgery, foreign body implant
- **Vascular insufficiency**
  - Diabetic foot ulcer
- **Hematogenous spread**
  - Nidus of infection, more often in children

Risk factors
- Drug abuse, trauma, HIV, transplant, diabetes, foreign bodies

Our patient: treatment summary

- Orthopedics performed **drainage and debridement** twice and got bone biopsy
- Bone biopsy returned positive for **Pseudomonas**
- Received 6 weeks of **IV Cefepime**
- Prognosis: Mr. R will likely return with **acute** exacerbations of **chronic** osteomyelitis
Review of imaging approach

- **Plain Film**: good first step, but limited sensitivity (14%)*
- **MRI**: the preferred modality, showing extent of soft tissue and bone marrow inflammation
  - 91% sensitivity, 82% specificity**
- **CT**: modality of choice when MRI is unavailable
- **Ultrasound**: limited use, sometimes for pediatrics and sickle cell
- **Nuclear medicine**: similar sensitivity to MRI, but bone turnover can be non-specific
  - Three-phase bone scan
  - WBC scan
  - FDG PET
  - Gallium


Fake-outs on MRI

- Findings on MRI can be non-specific
  - Fracture
  - Postsurgical changes
  - Osteonecrosis
  - Adjacent arthritis
  - Neoplasm

- The following examples demonstrate the importance of considering clinical history with imaging findings
Companion Pt 2: Lesion on MRI

- 64 yo M with CML and lung cancer presenting with ankle pain
- MRI shows distal fibular lesion, but biopsy needed to distinguish among
  - Osteomyelitis
  - Inflammatory arthritis
  - Tumor

Lung cancer metastasis!

Axial T2 MRI, distal L fibula
Companion Pt 3: Lesion on MRI

- 22 yo M with left anterior leg pain
- MRI shows **mid-tibial lesion** with cortical erosion and **soft tissue involvement**: tumor or infection?

Ewing’s sarcoma! 

Axial T2 MRI, L mid-tibia
Selected examples of alternative modalities

- Plain Film
- MRI
- CT
- Ultrasound
- Nuclear medicine
  - Three-phase bone scan
  - WBC scan
  - FDG PET
  - Gallium

Most commonly used first-line

Other available approaches
Companion Pt 4: Osteomyelitis

Gallium/Bone Scan

- 37 yo M with history of IV drug use presents with fevers, chills, rigors and back pain

- Gallium/bone scan shows increased uptake at right sacroiliac joint

Acute osteomyelitis

Courtesy of Dr. Donohoe
Companion Pt 5: Osteomyelitis on FDG PET/Bone scan

- 69 yo M with HTN, IV drug use presented with “10/10 back pain”
- Received PET scan following incidental lung mass found on CT
- Increased uptake in vertebra!

L1-T12 vertebral osteomyelitis (confirmed with MRI)

Courtesy of Dr. Donohoe
Plain film and MRI are the modalities of choice for suspected osteomyelitis

Classic findings for chronic osteomyelitis include:
- Plain film: lucent or sclerotic change, cortical erosion, periosteal reaction
- MRI: bone marrow edema, abscess or sinus tract, sequestra

Differential diagnosis of osteomyelitis should include tumor and inflammatory arthritis

Imaging findings can be non-specific, so clinical history is paramount to diagnosis
Acknowledgments

- Erica Gupta
- Mary Hochman
- Kevin Donohoe
- Jim Wu
- Corrie Yablon
- Gillian Lieberman
- Maria Levantakis
References

- Websites
  - [www.sportspodiatry.co.uk/foot_footanatomy.htm](http://www.sportspodiatry.co.uk/foot_footanatomy.htm)
  - [www.usuhs.mil/fap/resources/imag/AnkleX-Rays](http://www.usuhs.mil/fap/resources/imag/AnkleX-Rays)