November

Imaging Pediatric Osteomyelitis

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Agenda

Discuss:

1. Overview of pediatric osteomyelitis
2. Imaging pediatric osteomyelitis by different modalities
   - Plain film
   - Bone scan
   - MRI
   - CT
   - Ultrasound
3. Initial assessment of child with suspected osteomyelitis

Our Patient: I.B.

- 12 year old male with no past medical history presents to the Children's Hospital ED with 10 days worsening right hip pain
- Pain is worse with weight bearing and pt is unable to walk, though he reports pain at rest as well
- Pt has been taking motrin which does not improve his pain
- Pt denies fever, rash, or recent history of trauma
- Pt complains of decreased appetite and 10 lb weight loss

Our Patient I.B.: Exam and Labs

Exam: Temp = 36.4

Gen: Alert, lying in substantial pain

Pulm: CTA B

CV: RRR, normal S1 and S2

Ab: soft, NT/ND

Skin: no rash

MSK: no swelling, erythema, or deformity of any joints. Right hip movement elicits tremendous pain.

Labs: WBC 10.3 HCT 36.5 ESR 94

Our Patient I.B.: Differential Diagnosis

1) Osteomyelitis
2) Septic arthritis
3) Toxic synovitis
4) Slipped Capital Femoral Epiphysis
5) Legg-Calve-Perthes
6) Trauma (e.g. femoral neck fracture)
7) Tumor (Ewing's, osteosarcoma, osteoid osteoma, chondroblastoma, neuroblastoma, eosinophilic granuloma, metastasis to bone)

[8) Ureteral calculus]

Our Patient I.B.: Plain Film

Original films demonstrated entire area and showed:

- No fracture, subluxation, or dislocation
- No effusions or soft tissue swelling
- No focal lucencies or opacities

Our Patient I.B.: Post-radiograph DDx

1) Osteomyelitis
2) Septic arthritis
3) Toxic synovitis
4) Legg-Calve-Perthes

[5) Ureteral calculus]

Pediatric Osteomyelitis: Overview

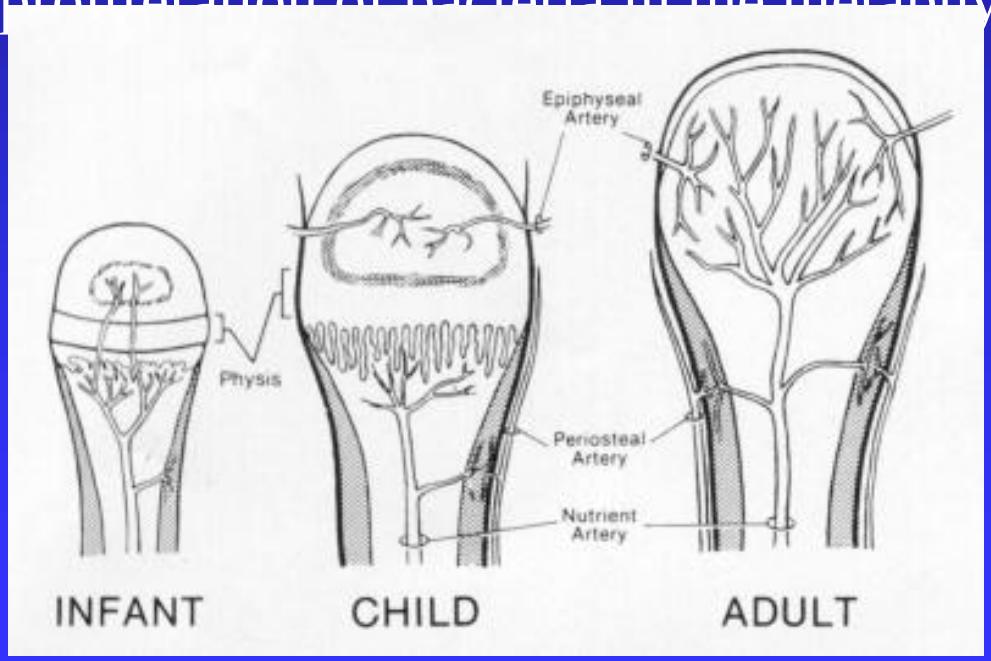
- Osteomyelitis = inflammation of any part of bone
- Bimodal age distribution: under 20 and over 50
- Typical clinical signs include triad of fever, local pain, and tenderness; may also see swelling and erythema
- ESR is elevated in >90% of cases; WBC may be elevated
- Organism is staph. aureus in 56-90% of cases
- Infection of the bone leads to marrow edema, cellular infiltration, and vascular engorgement

Pediatric Osteomyelitis: Classification

1) Hematogenous: bacteremia leads to bone infection
   - most common in children
2) Contiguous-focus: bone infection due to adjacent contaminated or infected soft tissues
   - caused by cellulitis, abscesses, enteric infection, open fractures, or surgery
3) Osteomyelitis associated with vascular disease: seen in diabetes due to peripheral arterial disease
4) Chronic: not responsive to treatment

Acute Hematogenous Osteomyelitis

- In children, nutrient vessels end in the the metaphysis where they have a tortuous course and slow, turbulent flow flow
- With bacteremia, organisms seed in these areas, causing proliferation of bacteria in the metaphysis



Juhl; Paul and Juhl's Essentials of Radiologic Imaging

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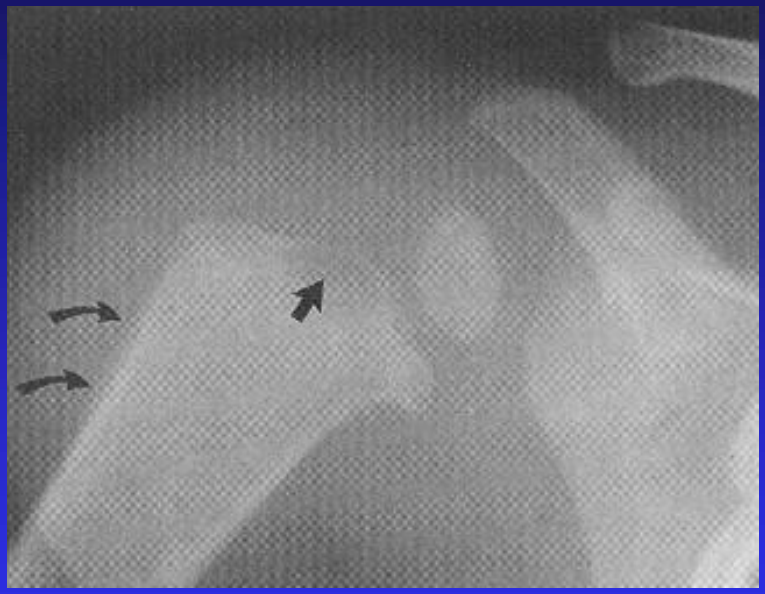
Patient 2: Plain Film

Classic findings:

1) Lytic areas of cortical bone destruction (large arrow)
2) Periosteal reaction (curved arrows)
3) Swelling of soft tissues adjacent to bone



Kothari et al.; Radiol Clin North

- **Bone destruction is not evident by radiograph until approximately 2 weeks after the onset of the infection**

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Patients 3 and 4: Plain Film

Osteo of distal tibia

Kothari et al.; Radiol Clin North Am

Sclerotic and lytic changes consistent with osteo of proximal tibia

Rosen; Emergency Medicine: Concepts and Clinical Practice

- Actual disease process is usually much more extensive than radiograph indicates

Our Patient I.B.: What Next?????

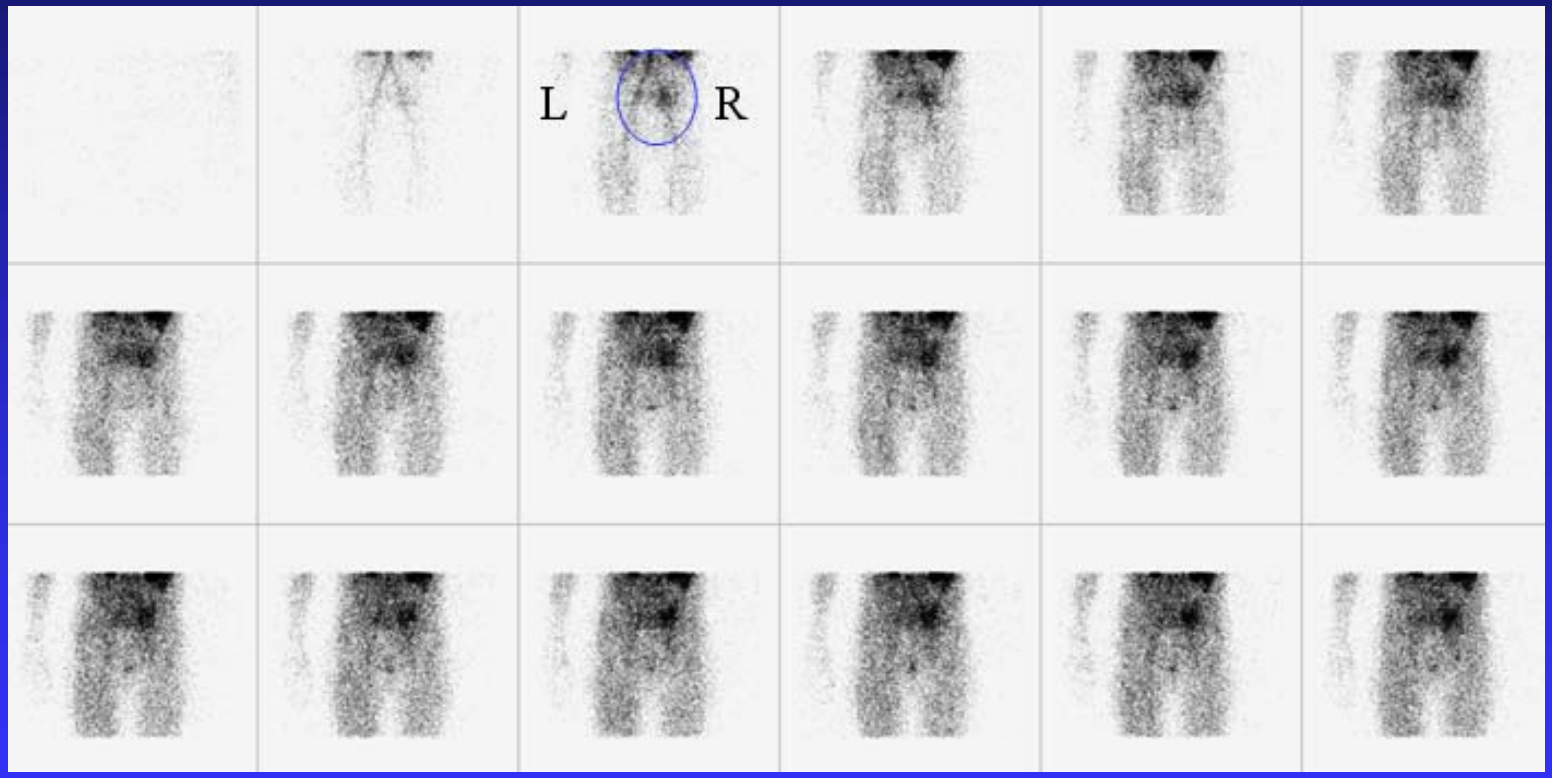
What is the next imaging study of choice?

Pediatric Osteomyelitis: Bone Scan

- Technetium-99m methylene diphosphonate bone scan
- Hyperemia and bone resorption allow concentration of the isotope at the focus of infection
- 3-phase bone scan for osteomyelitis:
  1. 1st 60 seconds → blood flow to area of concern
  2. 5-15 minutes → blood pool phase
  3. 2-4 hours → delayed image
- Areas of osteo. show increased uptake on all three phases
  - Cellulitis does not show increased uptake in delayed image
- Sensitivity: 69-100%
- Specificity: 38-
- Detects osteo. within 48-72 hours after the onset of infexn

Our Patient I.B.: Bone Scan

Posterior view of flow phase to pelvic region:



CHMC

Increased uptake in area of right sacro-iliac joint

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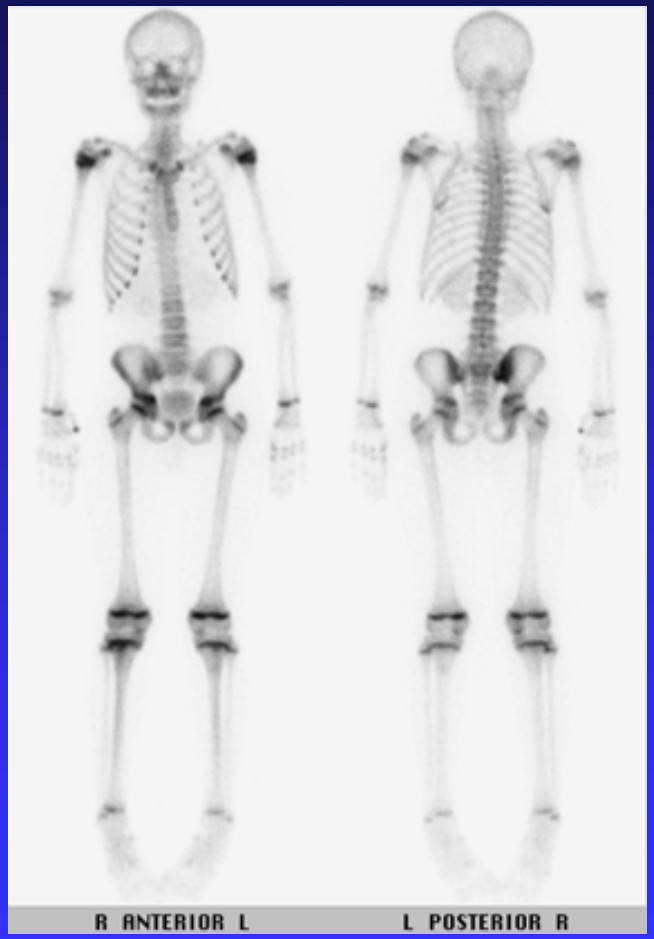
Our Patient I.B.: Bone Scan



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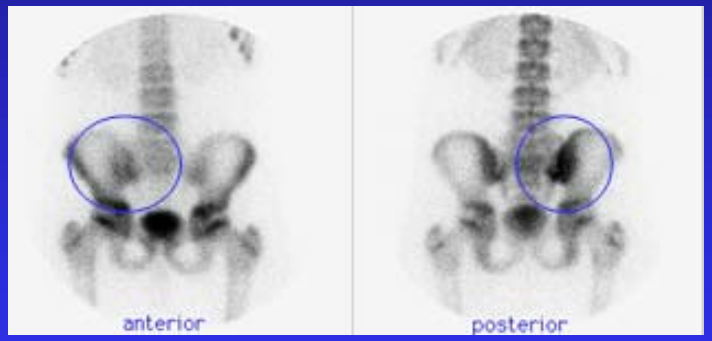
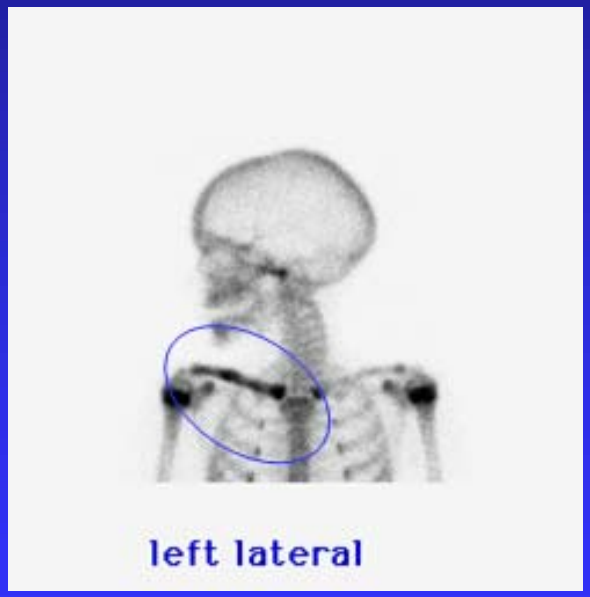


CHMC

Delayed-phase scans show continued increased uptake on both sacral and iliac side of right S-I joint

Patient 5: Another Bone Scan in Osteomyelitis

8 year old male with 5 days fever, neck/shoulder pain, and normal shoulder radiograph



CHMC

High tracer localization along right clavicle consistent with right clavicular osteomyelitis

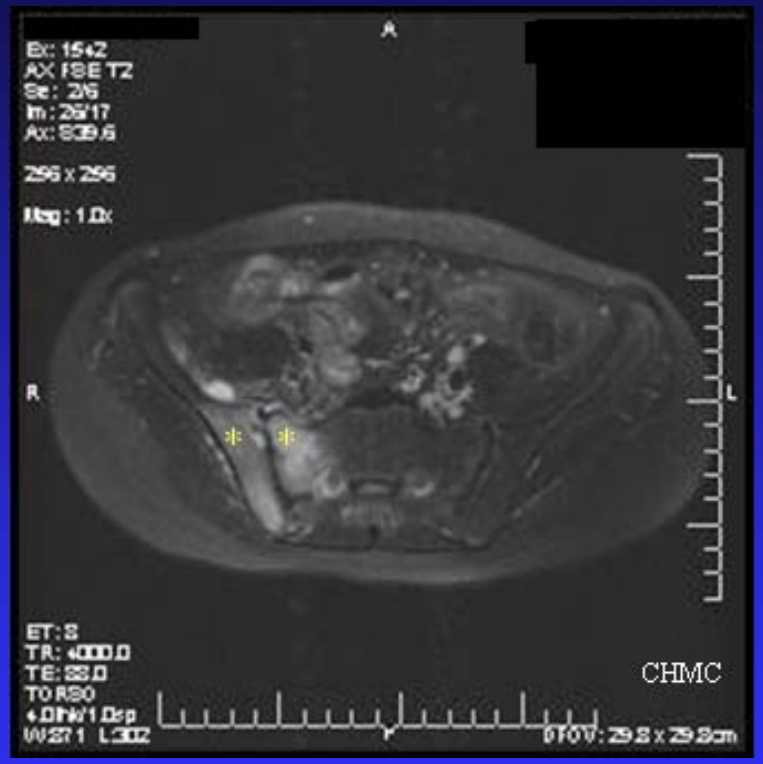
Pediatric Osteomyelitis: MRI

- Anatomic resolution better than seen on bone scans
- Soft tissue contrast better than seen on CT and plain film
- Demonstrates changes in marrow well before they are evident on a radiograph
  - Also demonstrates soft tissue edema, abscesses, tracts
- Bone marrow edema causes decreased intensity of marrow on T1 and increased intensity on T2
  - Key to distinguishing osteo. from soft tissue infection
- Gadolinium helps distinguish devitalized from normally perfused bone → active inflammation will enhance
- Sensitivity: 86-98%
- Specificity: 77-100%

Our Patient I.B.: MRI

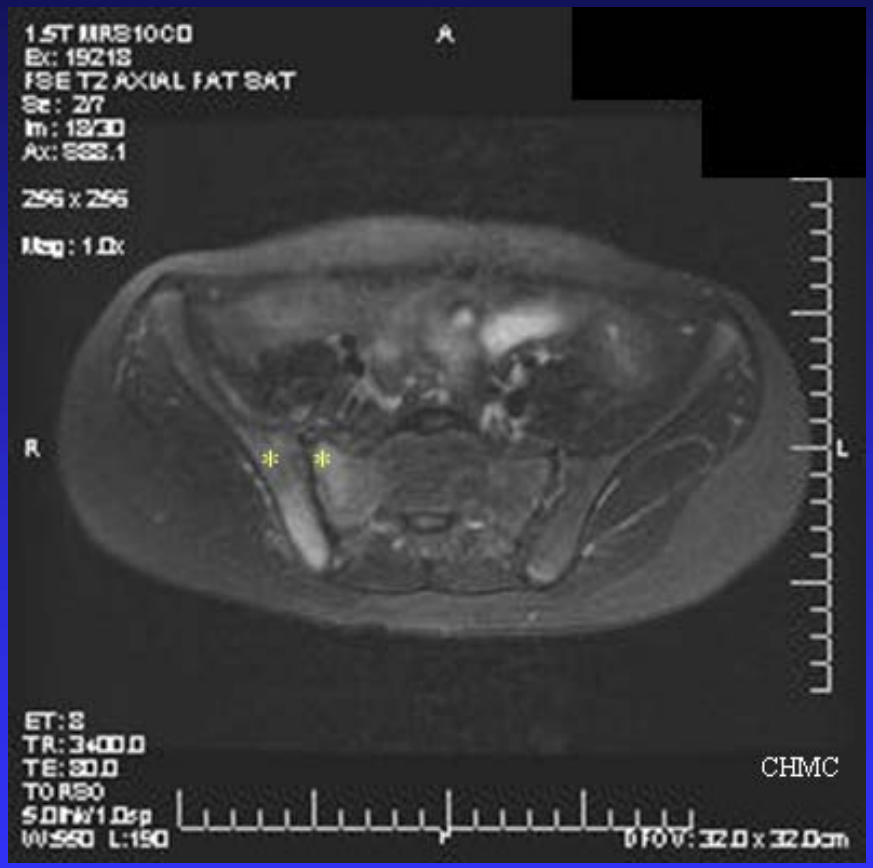
- Coronal T1 (left): areas of low-signal in R ilium extending into sacrum (**) → indicative of bone marrow edema
- Axial T1 fat-sat post-gad. (right): areas of enhancement in R ilium and sacrum (**) → indicative of inflammation

Patient I.B.: MRI



Coronal T1 from previous slide now shown next to T2 image demonstrating abnormal areas of bright signal involving the R iliac and sacrum (**) → indicative of bone marrow edema

Patient I.B.: MRI



Axial T2 fat-sat 6 wks post-admission shows the signal abnormality is unchanged (**)

Patients 6 and 7: More Osteo. on MRI

Kothari et al.; Radiol Clin North Am

- T1 MRI of 5-year-old with osteo. of distal tibia
- Heterogenous low signal intensity in distal metaphysis (**)

Oudjhane and Azouz; Radiol Clin North Am

- T2 MRI of 19-month-old with early osteo. of proximal tibia
- Increased signal in front of tibia and in epiphysis and metaphysis (**)

Pediatric Osteomyelitis: CT

- Used mainly to delineate areas of infection in bones with complex anatomy
  - eg. sternum, vertebrae, pelvic bones
- Findings are similar to plain film, but may appear earlier
  - CT will still likely miss osteomyelitis unless the disease has been present for more than 1 week
- Greatest role is in guiding surgeon in debridement and resection of affected bone

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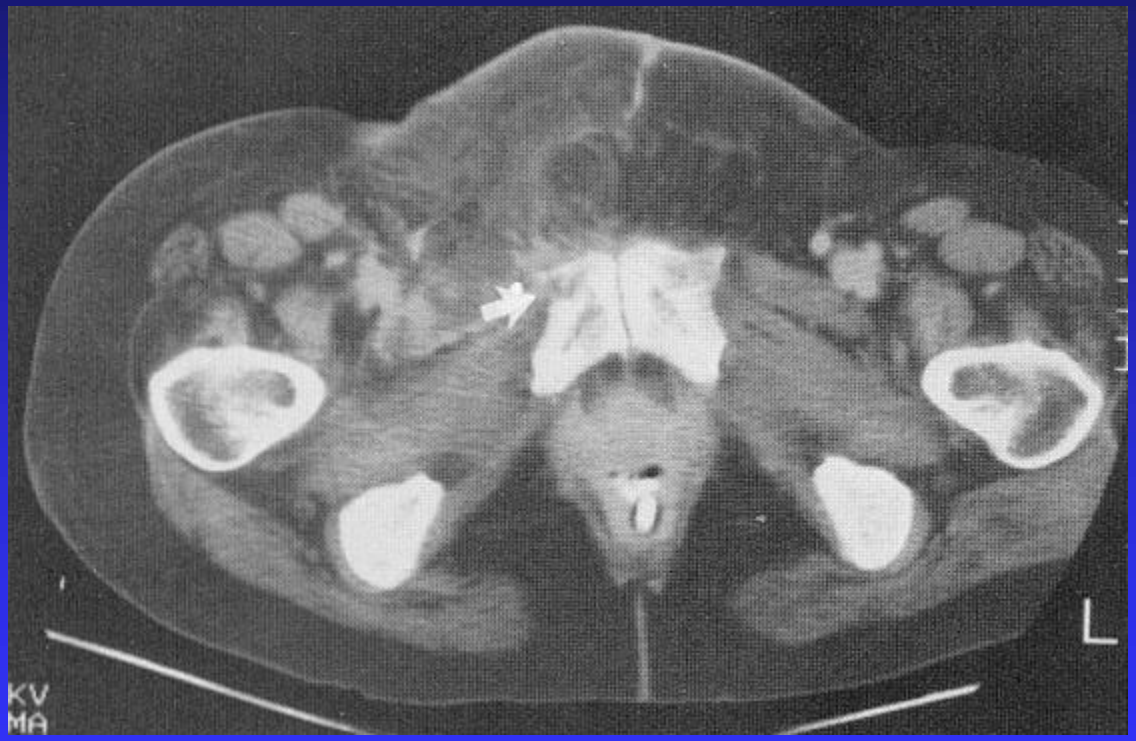
Our Patient I.B.: CT

CT with soft-tissue windows reveals focal 2 cm fluid collection anterior to R iliac bone

Using CT guidance, 3 cc of purulent fluid was aspirated from soft-tissue abscess

Patient 8: Another example of pediatric osteomyelitis on CT

R



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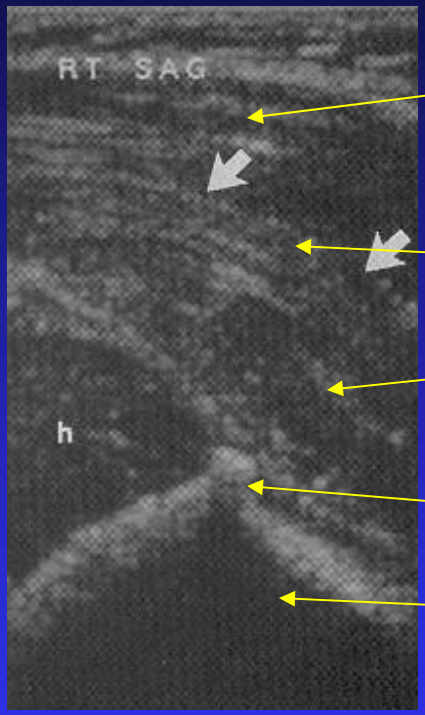
Juhl; Paul and Juhl's Essentials of Radiologic Imaging

This example reveals a discontinuity of the cortex (arrow) and soft-tissue edema anterior to right pubis that are typical of osteomyelitis imaged on CT

Patient 9: Characteristic Ultrasound

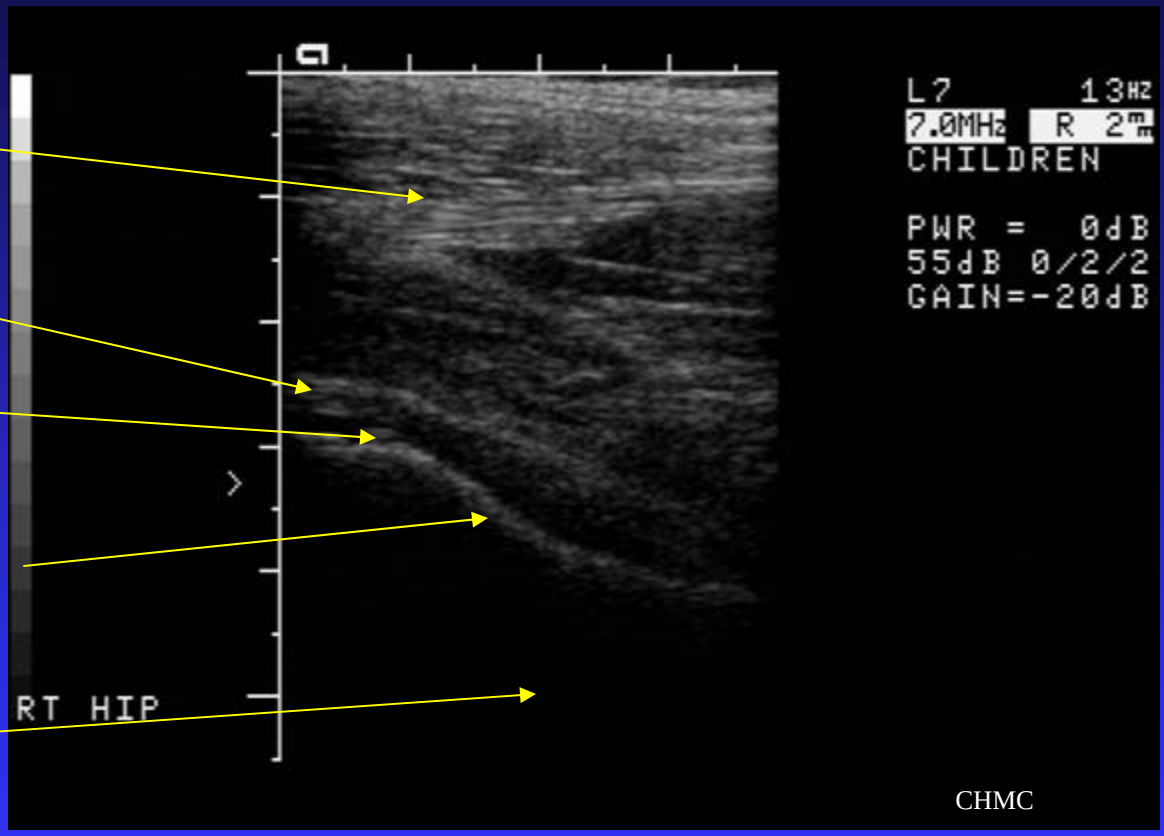
Osteomyelitis of the humerus:



Bellah; Radiol Clin North

- Elevation and thickening of joint capsule is seen on this ultrasound of the humerus → indicative of complicated effusion or soft tissue reaction consistent with osteomyelitis
- Also look for subperiosteal fluid on ultrasound

Our Patient I.B.: Ultrasound



Ultrasound of right hip reveals no evidence of effusion or soft tissue changes

Pediatric Osteomyelitis: Complications

Brodie's abscess (patient 11): in advanced stages of disease, plain radiographs reveal a central lytic defect with surrounding sclerosis. It is chronic and may produce minimal symptoms.

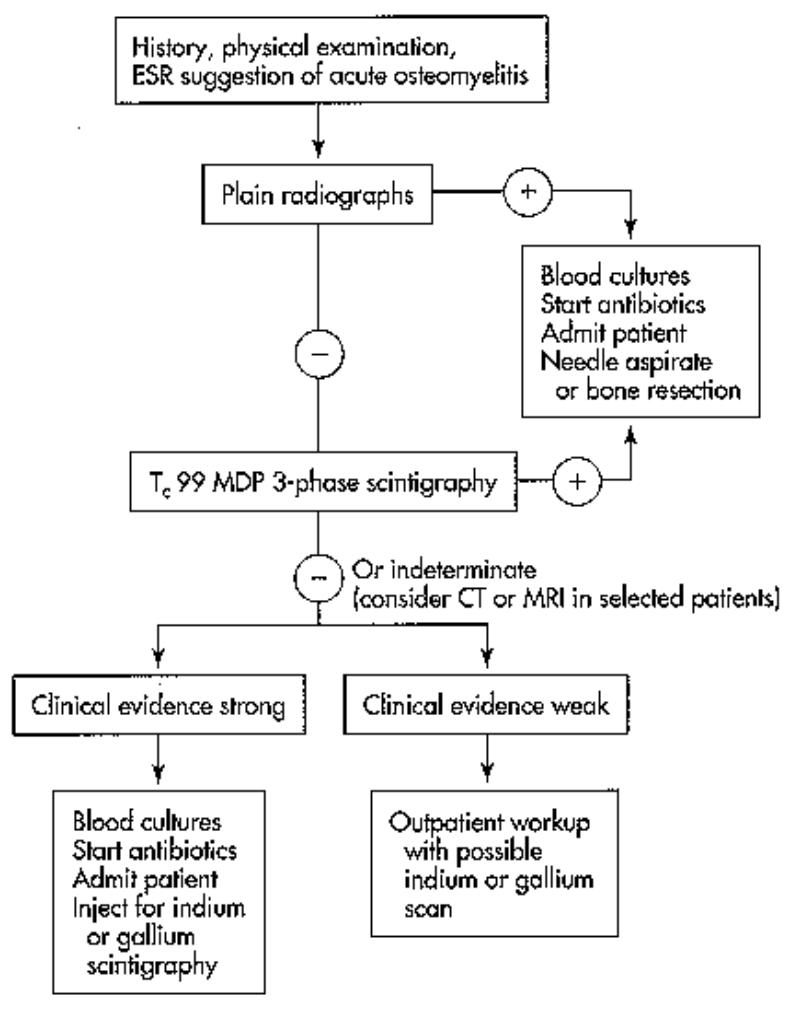
Brodie's abscess in proximal tibia:

www.bonetumor.or

Sequestrum: segments of cortical bone isolated within a focus of chronic infection and devoid of blood supply→ areas of dense bone surrounded by zones of lucency

Involucrum: a shell of bone formed by the periosteum that surrounds a sequestrum

Summary: Approach to the Child with Suspected Osteomyelitis



- Scintingraphy is typically recommended over MRI for initial assessment due to factors such as cost, accessibility, and less need for sedation
- Advantages of MRI include greater specificity, anatomic detail, and soft tissue contrast

Rosen; Emergency Medicine: Concepts and Clinical

Our Patient I.B.: Course/Treatment

- I.B. remained in the hospital for 3 weeks
- He was given a 6 week course of antibiotics, including 3 weeks of IV oxacillin followed by 10 days of IV clindamycin
- His symptoms improved gradually over several weeks and were accompanied by a decrease in his ESR to nearly normal levels
- Now, 8 weeks after his initial presentation, he continues to be followed by MRI to ensure his osseous changes return to baseline

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www.bonetumor.org/page171.html

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