Skeletal Scintigraphy

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• **FINANCIAL DISCLOSURE**: I have no financial arrangements or affiliations to disclose

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Tc-99m diphosphonate

- Older agents—gallium, pyrophosphate
- “Newer” agents—FDG, F-18
- HDP or MDP are comparable
- dose: 20 - 25 mCi (adults) IV
- T1/2 = 6 hrs
- 140 keV
Diphosphonate distribution

• localization by chemisorption
  – especially to new (amorphous CaP) bone and soft tissue pathology!
• tracer distribution affected by
  – tracer delivery (typically regional blood flow)
  – osteoblastic activity: bone (not marrow) turnover
• local increase or decrease of tracer is a combination of both of these factors
• very sensitive, though often not specific
  – tease out as much specificity as possible
Image acquisition

- single phase (delayed)
  - acquire 2-4 hours post injection
  - high first pass extraction – waiting for soft tissue clearance
  - can delay further: 24 hours or “fourth phase”
Image acquisition

• three phase
  – angiographic for one minute during injection
  – immediate static for extracellular fluid component
  – routine delays
• evaluates perfusion and blood pool
  – Cellulitis vs. osteomyelitis
  – reflex sympathetic dystrophy (RSD)
  – any focal issue
    • E.g. Pelvis (before bladder fills)
Bad things happen around the physis

• Important for pediatric cases
  – infection, tumor, abuse
Bad things happen around the physis

- Important for pediatric cases
  - infection, tumor, abuse
  - common location, hard to see

peds

adults
Bone Scintigraphic Patterns

- **Positive Osseous Foci**
  - monostotic
  - polyostotic
  - diffuse

- **Negative Osseous Foci**
  - absent uptake
  - decreased uptake

- **Non-osseous (soft tissue) Uptake**
  - Includes kidneys
Bone Scintigraphic Patterns

• Be as specific as you can
  – location, size, intensity
  – precise location: medullary, cortical/periosteal
  – axial or appendicular
  – focal or linear
  – exophytic / expansile
Monostotic increased uptake

- Common
  - Trauma: fracture, stress fracture, shin splints
  - Tumor: primary or solitary metastasis
  - Infection (3 phase helpful)
    - BIG 3!!
  - Arthridites: joint centered
Monostotic Increased Uptake

• Less Common
  – Benign solitary bone lesion: bone island, exostosis, osteoid osteoma, fibrous dysplasia, etc
  – Pagets: usually multiple
  – Infarct: subacute to chronic
  – Meningioma: can commonly simulate a solitary skull lesion
Bone scan = whole body survey
Polyostotic Increased Uptake

• Common:
  – Metastasis
  – Pagets
  – Arthridites: joint centered, exophytic
  – polytrauma: non-accidental trauma, underlying metabolic bone process (e.g. rickets / osteomalacia with insufficiency fx, OI, etc.)
Polyostotic Uptake

• Less common:
  – osteomyelitis: especially pediatrics
  – multiple infarcts: think sickle cell
  – Bony dysplasias / syndromes:
    • polyostotic fibrous dysplasia, Olliers, osteopetrosis, multiple hereditary exostoses, Englemanns, neurofibromatosis, etc.
Bone metastatic appearance

• Location, location, location
  – Axial
  – Medullary
  – Not joint centered (not both sides)

• DDx: Metastases, fractures (ribs), DJD (spine), Pagets
Common trouble spots: ribs and spine

- Rib: met vs fracture
- Spine: met vs DJD
Rib lesion

• Rib fracture
  – focal / perpendicular
  – can be extreme rib end (a joint)
  – several in a row

• Rib metastasis
  – parallel to the rib (“longer than tall”, may not be “full rib thickness” if tiny)
  – not extreme rib end
  – not several in a row
Spine lesions

- **Spine DJD**
  - Exophytic
  - Facets (joint centered)
  - Loss of height / gain of width (compression fx) or linear endplate
  - Lumbar predominates

- **Spine metastasis**
  - Within the bone (especially pedicle)
  - Not joint or disk centered

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Cortical bone metastases

- “True” bone metastases
- Not bound by red marrow (can be distal)
Pagets—the great mimic
Metastatic appearance

• Location, location, location
  – Red marrow
  – Central—axial and proximal appendicular
  – Medullary
  – Not joint centered (not both sides)
  – Ribs and spine DDx
  – Never forget Pagets
Diffuse uptake - superscan

- Increased ratio of bone to S.T. (incl kidney) uptake
- Axial >> Appendicular ("Metastatic superscan")
  - Prostate, breast
  - You know why!—red marrow
- Axial = Appendicular ("Metabolic superscan")
  - ROD with hyperparathyroidism, osteomalacia, hypervitaminosis D, myelofibrosis
- Pagets
Diminished uptake

- Aggressive metastases
  - renal and thyroid
- Multiple myeloma
  - typically normal, not decreased
  - will likely detect some lesions in a patient
- Bone infarction / AVN
  - decreased early
  - often increased later
Extraosseous (soft tissue) uptake

- Neoplasm: primary or metastatic
  - particularly mucinous, ossifying, or necrotic
  - lung (1o or 2o), hepatic (colon mets), breast, melanoma, neuroblastoma, renal, meningioma

- Necrosis
  - microscopic release of calcium
  - soft tissue necrosis, ischemic bowel, heart, brain, post RT
Extraosseous (soft tissue) uptake

- Myositis ossificans
  - activity decreases with maturity
- Calcified cartilage and vessels
- Hypercalcemia
  - gastric, renal, and lung uptake
- Free Tc
  - gastric, thyroid, salivary glands
Extraosseous (soft tissue) uptake

• Breasts
  – can be normal if symmetric

• Placenta
  – contains calcifications
  – will not visualize fetal skeleton: tracer does not cross placenta

• Renal

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Radiation effect
Special considerations

- Reflex sympathetic dystrophy (RSD)
- Pediatric cases: abuse, neuroblastoma mets
- Flare phenomenon
- Hypertrophic osteoarthropathy
- Sacral insufficiency fracture
- Sickle Cell Disease
- SPECT
- Osteomyelitis
Speaking of osteomyelitis…

- Bone scan good if bone otherwise normal
- If not, decreased specificity, e.g.
  - Painful prosthesis (infx vs loosenig):
    - WBC/SC discongruency
  - Diabetic foot (infx vs Charcot):
    - WBC/bone scan congruency
Diabetic foot: WBC and bone scan (no red marrow)
SPECT

• Increase sensitivity

• Increase specificity

• Best for T and L spine
Summary

• Tracer delivery alone can markedly alter scan
  – Hyperemia
  – Arterial injection

• Bone = marrow + cortex

• Metastases
  – go to central and medullary skeleton (red marrow)
  – ribs: mets (segmental) vs fracture (focal or rib end)
  – spine: mets (intraosseous esp. pedicle) vs. DJD (exophytic / facets)
Summary

• Don’t forget Pagets!
• Pediatrics: stare at the growth plates for symmetry
Summary

• Osteomyelitis:
  – Bone scan if underlying bone is normal
  – WBC / SC discongruency for joint prosthesis
  – WBC / bone scan congruency for diabetic foot

• SPECT increases sensitivity and specificity