Common Musculoskeletal Correlative Findings on Hybrid Imaging

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You are reading a bone scan for prostate cancer with rising PSA

Cystoprostatectomy: urinary drainage bag

But also foci of abnormal uptake near right SI joint, lower LS spine, and elsewhere

Degenerative or Metastatic?

Can SPECT with your knowledge of CT help?
L-Spine – Degenerative with Confidence
Right SI Region – Metastasis with Confidence
Added Confidence of Metastases from CT Alone
Or bone scan ordered for decub ulcer but you first look at the CT originally read as “negative”
Is the bone scan still needed?
PET Normal Uptake and Variants - Marrow

- Marrow activity
  - Normally less than blood pool
- Chemotherapy and rebound - mild uptake
- GCSF
  - Many patients have it added to chemotherapy
    - Diffuse, intense
    - Splenic uptake
PET Normal Uptake and Variants - Marrow

  - Found mild increase with chemotherapy (9/11 patients) but much more with G-CSF (5/5)

  - Marrow uptake declined after G-CSF but elevated over baseline for up to 4 weeks post-completion

- Marked GCSF uptake can reduce FDG bioavailability to tumor
PET Normal Uptake and Variants - Marrow

Stable rebound from chemotherapy alone
PET Normal Uptake and Variants - Marrow
Brown Fat

- May be symmetric or asymmetric as a benign finding
- Correlate with normal areas on CT and typical locations
PET Normal Uptake and Variants – Muscle

- **Muscle activity**
  - At rest, fatty acid metabolism prevails
  - With activity, increased O₂ demand and tissue oxidative capacity so more glucose needed
  - Activity during uptake phase or strenuous activity the day before (replenishing glycogen stores)
  - Insulin and increased glucose increases muscle uptake
  - Can be focal at origin and insertion
Normal Uptake and Variants – Muscle

Paravertebral muscle uptake
PET Normal Uptake and Variants - Muscles
Normal Uptake and Variants – Muscles

Focal paravertebral muscle uptake
Joints: Also be degenerative uptake with FDG or MDP confirmed by your knowledge of CT

AC joint uptake. SUV is 2.9
Normal Uptake and Variants – Degenerative Uptake on FDG PET
It is helpful to know the CT appearance of benign characteristic bone abnormalities since not everything that is hot is malignant.
Neck Pain

- Outside plain films read as “negative”
- Remote history of noninvasive melanoma
- Patient had a few other aches and pains
- 55 years old
- Bone scan ordered
SPECT at this level

What would you do now?
Look at plain films yourself!

Mag view on next page
Paget’s Disease

- Enlarged bone with thickened trabeculations on plain film
  - Think Paget’s
  - Usually very hot on bone scan
    - Can be normal in sclerotic burned out lesions
- Confirmed with CT
- Treated with bisphosphonates and improved
  - Follow-up bone scan next slide
We see many bone scans read outside of Emory called positive for metastasis when correlation could have answered question.
Paget’s again...

- Characteristic osseous expansion, trabecular coarsening, and cortical thickening
- Starts at end of long bone and advances as V-shaped lytic defect
- Bone scan is 94% sensitive with marked increased uptake in lytic and sclerotic phases but may revert to normal in burned-out lesions
Bone Scan for Prostate Cancer

- 70 year old male
- History prostate cancer
- Radical prostatectomy 4 years ago
- Rising PSA
- Bone scan to rule out metastases
Is the humerus uptake benign or malignant?

Get a plain film.
Classic benign enchondroma in humerus

Rings and arcs of calcification. Will look similar on CT.
Left Hip Pain

- 76 male
- Newly diagnosed colon cancer
- Left hip pain
- Rest of bone scan normal
Somewhat sclerotic and irregular superior femoral head on plain film
AVN both left greater than right hips on MR
AVN Imaging

- **Bone scan**
  - Hot in most adults since reactive phase
  - Children, get pinholes, seen earlier so cold
- **MRI**
  - Early: low on T1, reactive interface w/sharp inner and blurred outer border (often reaches subchondral bone or surrounds epiphyseal bone)
  - T2 double line sign. Inner high signal (granulation tissue), outer low signal band (probable chemical shift)
  - Late: low on T1, variable on T2
Back Pain

- Young man with unexplained back pain
- Planar bone scan shows scoliosis, otherwise normal
SPECT abnormal uptake
Since you know classic findings on CT of unilateral spondylolysis, you can correlate in the report.
Spondylolysis

- Pars interarticularis defect between superior and inferior articulating processes at the weakest portion of the spinal unit
- 3-7% of the population
- Early childhood; M:F=3:1
- Trauma and/or congenital
- L5 (67-95%); L4 (15-30%); L3 (1-2%)
- 75% bilateral
- Can be hot on affected and/or contralateral
Another 18 year old with back pain...
Even on low resolution hybrid SPECT-CT we now know what spondylolysis looks like.
Also looks similar on MR
26 year old male...

- Back pain
- Subtle uptake mid-thoracic spine
SPECT confirms. But patient happened to have an MR available to correlate.
MRI shows classic hemangioma: bright on T1 and T2 sequences.
Hemangiomas

- Most hemangiomas are neutral on bone scan
  - But can be hot or cold
      - 15 patients: 11 hemangiomas normal on SPECT
      - 3 out of 4 that were 3cm or larger had increased or decreased uptake on SPECT
- Hemangiomas can cause back pain
- Honeycombed appearance on CT
Knowing appearance of infection on CT and MR is very helpful as well.
FUO

- 54 year old male
- ETOH. Cirrhosis. Hepatitis C.
- Admit with 4 day history chest pain on inspiration
- Chest CT read as negative
- Temperature 101.1 f
- 4/6 blood culture positive for Staph Aureus
- After negative CT, Indium WBC scan done
Since we knew paravertebral fat should be clean on CT, we were able to correlate our findings with “negative” CT and infection was confirmed on MR.
Vertebral osteomyelitis on MR
Different case: emergency bone scan ordered for decub ulcer but aborted by reviewing CT
Soft Tissue vs Osteomyelitis
Trauma is commonly hot on PET but knowing CT appearance can help differentiate from tumor.

Characteristic benign callous formation: healing rib fracture.
Normal Uptake and Variants – Surgery and Trauma

SUV is 4.7

Median sternotomy
Patient with lymphoma: iliac, sternal and rib lesions on MR called aggressive malignancy
But classic benign healing fractures on PET-CT: SUV 2.3-3.5
But when fracture has an underlying soft tissue component think pathologic...
Solitary right hip uptake post trauma. CT obtained.
Pathologic fracture through bubbly expansile lesion.
Chondroblastoma

- **Chondroblastoma**
  - 1% of primary bone neoplasia
  - 90% in 10-26 years old, before cessation enchondral bone growth
  - 23% proximal femur and greater trochanter; 20% distal femur; 17% proximal tibia, 17% proximal humerus
  - Almost always benign, may become aggressive, rare metastases
Bubbly Expansile Lesions…

“FOG MACHINES”

- Fibrous dysplasia
- Fibrous cortical defect
- Osteoblastoma
- Giant cell
- Myeloma
  - Mets renal, thyroid, breast
- ABC
  - Angioma
- Chondromyxoid fibroma
  - Chondroblastoma
- Histiocytosis X
  - Hyperparathyroid brown tumor
  - Hemophilia
- Infection
- Non-ossifying fibroma
- Enchondroma
  - Epithelial inclusion cyst
  - Simple bone cyst
Another Bone Scan…

- 51 ♂ with large cell lung cancer
Rib uptake from trauma but tibial uptake unexpected so plain films ordered

FNA demonstrates metastatic large cell carcinoma
Hip pain in patient with cancer
Hard to see on plain films but easier on CT
More obvious pathologic fracture
Appearance of Bone Metastases

Metastases that are typically purely lytic
  Kidney, Bladder, Thyroid, Multiple myeloma

Usually mixed lytic and sclerotic
  Lung, Breast

Metastases that are usually purely blastic
  Prostate, Medulloblastoma, Carcinoid
Other common fractures and lesions you may see with hybrid imaging
Osteoid Osteoma
Osteosarcoma
Sickle Cell Disease
Plasmacytoma
Langerhans Cell Histiocytosis (EG)
Myeloma
Intraosseous Lipoma
Insufficiency fractures commonly seen on Nuclear Medicine studies. This is what they look like on CT and MR.
Classic Insufficiency Fracture
Clinical suspicion stress fracture – Early plain films
Stress Fracture – Lucency and Callus Seen Later
In conclusion…

Knowledge of cross sectional anatomy, normal variants, and basic CT and MR appearance of common pathology will inform and improve your interpretation of hybrid imaging.
The End....

For real