Indium-111 Leukocyte Scintigraphy: 
*A patient presentation & discussion*

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Overview

- Patient Presentation
- Background Information on Nuclear Medicine
  Scintigraphy
- Differential Diagnosis
- Menu of Tests
- Discussion of Our Patient
Our patient is a…

- 61yo male
- Recent history
  - persistent fever of unknown origin
- Reason for referral
  - evaluation for source of infection
- Type of procedure
  - Indium-111 oxine-labeled leukocyte scintigraphy

*This study is done as an outpatient procedure*
Let us begin with some background information.
Nuclear Medicine Background Information

- **What is In-111 oxine-labeled leukocyte scintigraphy?**
  - A diagnostic imaging test that displays radiolabeled white blood cells in the body

- **What is Indium-111?**
  - A group III element that decays by electron capture emitting 2 gamma photons of 173keV and 247 keV
  - Physical half-life of 67 hrs
Nuclear Medicine Background Information

- **What is oxine?**
  - Oxine (8-hydroxyquinolone) is a lipid-soluble complex that chelates metal ions

- **Leukocytes are removed from plasma for labeling**

- **How is it taken up?**
  - Indium-111 oxine complex diffuses through cell membranes
  - Once intracellular, the complex dissociates
  - Indium-111 binds nuclear and cytoplasmic proteins
  - Oxine diffuses back out of the cell
**Nuclear Medicine Background Information**

- **How are Indium-111 oxine-labeled leukocytes distributed?**
  - After infusion, radiolabeled leukocytes are distributed to the blood pool, lungs, liver, and spleen.
  - Imaging is done 18-24 hrs after injection when lung and blood pool activity are not normally seen.
Nuclear Medicine Background Information

**Why do we use it?**

- To obtain scintigrams of specific anatomic regions for suspected *infection and/or inflammation*
There are many indications for the use of this radiopharmaceutical.
Applications of 111-Indium Scintigraphy

- Detect sites of infection/inflammation in pts with FUO
- Localize unknown source of sepsis & detect additional site(s) on infection in pts with persistent or recurrent fever and known infection site
- Survey for site of abscess or infection in febrile post-op pt without localizing signs & symptoms

Palestro et al, Society of nuclear medicine procedure guideline for indium-111 leukocyte scintigraphy for suspected infection/inflammation. Version 3.0 2004
More appropriate indications for the use of Indium-111 radiolabeled scintigraphy in other types of patients.
Applications of $^{111}$-Indium Scintigraphy

- Detect site(s) and extent of IBD
  - Tc-99m labeled leukocytes may be preferable
- Detect and follow up osteomyelitis when in cases of...
  - Joint prostheses, nonunited fractures, or sites of metallic hardware from prior bone surgery
- Detect osteomyelitis in diabetic pts when...
  - Degenerative or traumatic changes, neuropathic osteoarthropathy, or prior osteomyelitis

Palestro et al, Society of nuclear medicine procedure guideline for indium-111 leukocyte scintigraphy for suspected infection/inflammation. Version 3.0 2004
And...
Applications of 111-Indium Scintigraphy

- Detect osteomyelitis in skull in post-op pts and for follow up of therapy
- Detect mycotic aneurysms, vascular graft infections, and shunt infections

Palestro et al, Society of nuclear medicine procedure guideline for indium-111 leukocyte scintigraphy for suspected infection/inflammation. Version 3.0 2004
In the case of Osteomyelitis:

- To detect *abnormal bone remodeling*
  - Three phase *bone scan* may be used in conjunction with leukocyte scintigraphy and
- To assess *marrow distribution* at suspected osteomyelitis sites
  - Tc-99m *sulfur colloid* is a useful adjunct


**Additional Background information**

- **Other useful nuclear medicine studies**
  - **Gallium scintigraphy**
    - Preferred in patients with neutropenia
    - Or nonsuppurative or lymphocyte-mediated infections
  - **Tc-99m HMPAO (exametazime)-labeled leukocyte scintigraphy**
    - Frequently used option for acute infections, particularly in pediatric patients
Additional Background information

**What type of scintigrams can we produce?**

- Regional
- Whole-body
- Planar
- and/or Single Photon Emission Computed Tomography (SPECT)
Now Back to Our Patient
Our Patient’s WBC Study

- **Injection** of autologous white blood cells labeled with Indium-111

- **Images of whole body** obtained at 24 hours

- **Additional SPECT images** of chest
  - **Confirm findings**
Our patient’s whole-body image

- Normal spleen uptake
- Normal liver uptake
- Abnormal uptake
Chest frontal view

- Left shoulder region
- sternum
- Normal spleen uptake
Chest “repro” sagittal view

This image was reformatted from SPECT

Thoracic vertebral column

PACS, BIDMC
Our Patient’s WBC Study Findings

- **Marked increased activity** in region of **L shoulder**

- **Smaller foci** of activity
  - Superior aspect of sternum at **R sternoclavicular joint**
  - Within mid thoracic vertebral column
Interpretation Criteria

- **Normal Findings**
  - 18-24 hr: liver, spleen, bone marrow, minimal activity in major blood vessels
  - 4 hr: diffuse pulmonary activity

- **Abscess Detection**
  - 1/3 to ½ sites visualized by 4hr, >90% by 24 hr

- **Osteomyelitis**
  - Focal accumulation > adjacent background activity
  - Corresponds to bone site of increased bone radiopharmaceutical accumulation
Interpretation of Patient’s study

- Above findings are consistent with multiple sources of inflammation in
  - L shoulder
  - Sternum
  - Thoracic spine

- Review of recent plain films of L shoulder
  - No significant abnormality
Differential Diagnosis

1. Marked focus of activity within L shoulder
   - Infectious process: septic joint or septic bursitis
   - Osteomyelitis of L humerus or scapula cannot be excluded

2. Additional foci of activity within the sternum and mid thoracic spine
   - Multifocal infectious process: osteomyelitis or diskitis
Menu of tests for further imaging

- **Conventional Radiography**
- **Scintigraphic Techniques**
  - bone scan, gallium, labeled leukocytes, newer agents
- **Cross-Section Imaging**
  - US
  - CT
  - MRI
Our Patient’s Course

- **Travels to ED**
  - Receives antibiotic treatment
  - Receives acetaminophen
  - Shoulder joint aspiration

- Followed by Hospital Admission
On Admission

- **HPI**
  - 2 months of fevers to 104°F, weight loss, *L shoulder pain*
  - 1-2 weeks drenching night sweats
  - Outpatient: + tagged WBC scan, negative TTE, ESR 130

- **PMH**
  - HTN
  - *ETOH abuse* – quit 1 month ago
  - Hypercholesterolemia
  - Depression
  - Pancreatitis 4 yrs ago
On Admission

- **PE**
  - VS: 99.7 107-125 133/86 24 95%RA
  - + temporal wasting
  - **Sternal mass**
  - No occipital, no axillary, no auricular, no epitrochlear LAD
  - **Shoulder erythema, hot, indurated, pain with active/passive movement, decreased ROM**

- **Lab results**
  - ESR 130  CRP 12.56
  - Joint Fluid: WBC 130,500 97% PMNs
On Admission

- **Imaging**
  - **L shoulder 3 views (AP, neutral, ax)**
    - No fracture or osseous destructive change
    - Equivocal superior subluxation of humeral head within glenoid fossa
    - Acromioclavicular joint space narrowed with degenerative changes noted
  - **Chest (PA & lat)**
    - No interval change compared to previous exam 9 days prior
Our Patient’s CT of upper limb with large field of view on HD #2

Axial view of shoulder

- Humeral head
- Small glenohumeral joint effusion

To assess for osteomyelitis

PACS, BIDMC
**Our Patient’s CT of upper limb with large field of view on HD #2**

**CT shoulder coronal**

- clavicle
- acromion
- Glenoid fossa
- Head of humerus

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PACS, BIDMC

Can you appreciate the distended subacromial/subdeltoid and subscapularis bursae?

Note fluid density surrounding the joint
Our Patient’s CT of upper limb with large field of view on HD #2

Bone windows

R sternal clavicular joint fragmentation
Our Patient’s CT of upper limb with large field of view on HD #2

Soft tissues

Small foci of calcifications
Our Patient’s MRI of Chest/Mediastinum on HD #2

Reason:
Soft tissue mass versus joint fluid collection

High intensity noted surrounding joint on STIR
Our Patient’s MRI of Chest/Mediastinum on HD #2

Just another coronal STIR image
Our Patient’s MRI of Chest/Mediastinum on HD #2

A Coronal T2-weighted image

Notice the asymmetry of the joints.
Our Patient’s MRI of Chest/Mediastinum on HD #2

There is motion artifact. Again, we can appreciate the asymmetry and the peripheral enhancement of the distended bursa on the left with effusion.
Our Patient’s MRI of Chest/Mediastinum on HD #2

Axial T2 weighted image

Another view of high intensity signal surrounding the shoulder
Our Patient’s MRI of Chest/Mediastinum on HD #2

Post contrast axial T1 weighted image with fat saturation

Final axial MRI image depicting the joint effusion
Our Patient’s Course

- **Surgical Procedures on HD #2**
  - Arthroscopic L shoulder irrigation & debridement and subacromial bursa irrigation & debridement
  - Incision & drainage of the R sternal clavicular joint
Our Patient’s Course

- Surgical Procedures on HD #5
  - Open irrigation & debridement of L glenohumeral joint and subacromial bursa
  - Irrigation & debridement of R sternoclavicular joint incision with VAC dressing placement
Our Patient’s Course

- Our Patient remained febrile.

- Recall the positive radiolabeled white blood cell scan in the thoracic region…
Our Patient’s MRI of entire spine on HD #5

Evaluation for abscess or other evidence of infection. 
Can you find the lesion?

Osteomyelitis on T2 weighted image: 
Increased signal intensity

T2 image of spine
Our Patient’s MRI of Chest/Mediastinum on HD #2

Osteomyelitis on T1 weighted image: low medullary signal intensity

Gadolinium enhancement of T7-8 lesion

T1 pre contrast

T1 post contrast

PACS, BIDMC
Our Patient’s MRI of Chest/Mediastinum on HD #2

Thoracic region abnormal signal at T7 & T8 and in the intervening disc space consistent with discitis and osteomyelitis.

Osteomyelitis of spine spreads regionally via anastomosing venous channels to involve at least 2 adjacent vertebral bodies and intervening disc. This lesion is pathognomic.
Summary of Hospital Course

- Admitted
- Joint aspiration & antibiotics
- OR: irrigation & debridement by orthopedics
- OR: manubrium and R 1\textsuperscript{st} rib removed, VAC device placed by thoracics
- Post-op compl. R pneumothorax $\Rightarrow$ chest tube placement
- Post-op compl. Persistent R pleural effusion
- Significant delirium, elective intubation
- OR repeat debridement shoulder & sternum for continued fevers
- Sternal debridement grew \textit{coag neg staph} and \textit{group B strep}
- Presumed endocarditis $\Rightarrow$ TEE neg
- Other areas: \textit{MRA brain}, LP, bronchoscopy, abdominal CT
- \textit{MRI spine} – diskitis and osteomyelitis prolonged antibiotics
- Pt improving
- Fever $\Rightarrow$ blood, urine, urine/serum eosinophils $t/o$ drug fever
Patient Summary

- 61yo male with PMH of ETOH abuse, pancreatitis, and hypercholesterolemia
  - presented with fevers/NS/wt loss and L shoulder pain/ sternum mass
  - found to have
    - L septic shoulder
    - manubrium/R sternoclavicular joint osteomyelitis
    - T7-8 thoracic spine diskitis/osteomyelitis
- Negative blood cultures, negative TEE, negative LP, normal MRA brain
Summary of Patient Presentation

Although radiolabeled scintigraphy does not show bony detail or distinguish osteomyelitis from soft tissue infections, nuclear medicine imaging can detect osteomyelitis 10-14 days before changes are visible on plain radiograph.

Our patient greatly benefited from Indium-111 oxine labeled leukocyte scintigraphy in this case of fever of unknown origin.
Our Patient’s Plan

- Continue antibiotics for at least 6 weeks
- Repeat MRI of spine in 2 months and follow up with an appointment.
References

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