NUCLEAR MEDICINE EMERGENCY STUDIES: VQ, GI BLEED, HIDA

Amir H. Khandani, MD
Associate Professor & Division Chief, Nuclear Medicine
Department of Radiology
UNC School of Medicine
VQ Scan
• To diagnose pulmonary embolism
• Two scans: Lung perfusion scan and lung ventilation scan
• Mismatched defects: Defect on perfusion scan and essentially normal ventilation scan
• Ventilation: 133-Xe: 10 mCi
• Perfusion: 99m-Tc MAA: 4 mCi
• CXR within 24 hours
Xe-133

Photon energy: 80 KeV
Physical half life: 5.3 days
Xenon Delivery System
Perfusion Scan

- Visualization of normal lung due to capillary blockade by radiolabeled small particles: **Tc-99m MAA (macroaggregated albumin)**
- Embolic lung would not light up since the radiotracer cannot get there!
Capillary size: 7-10 μm; MAA size: 10-30 μm; <1 in 1000 of the capillaries are blocked, although 95% of the injected MAA remains in the lungs.

Minimum number of particles needed in adults for PE evaluation: 100 K; Optimal: 200K – 600 K; Standard: 500 K; Pregnancy, severe pulmonary hypertension, s/p pneumonectomy: 250K

R-to-L shunt evaluation: 100K
Perfusion-only study (no ventilation) if

- Patient cannot cooperate with ventilation
  - Intubated, dyspnea, anxious
  - Increase 99m-Tc MAA dose if needed to shorten the scanning time:
    - 8-10 mCi

- Pregnant patient
  - Half of the standard 99mTc-MAA dose: 2 mCi
Perfusion only Scan: Normal

Case #1
Assessment of the seize of the embolic area of the lung
Multiple Bilateral PEs

Case #2

123.4 MBq (3.30 mCi) MAA 99m Technetium
Segmental left lower lobe pulmonary artery PE: Underestimation of the extent of the PE on CTA
VQ vs CTA
- Dose of the maternal breasts definitely much higher with CTA
- Dose to the fetus is probably higher with CTA
- VQ Protocol in pregnant patient:
  - Perfusion-only scan
  - Reducing the MAA dose to half (need to double the acquisition time)
CXR within 24 hours?

- Generally yes
  - Sometimes helps explaining patient’s symptoms (no VQ needed)
  - Sometimes helps with interpretation of VQ scan

- But not an absolute necessity
  - Don’t refuse to do the VQ scan if no CXR
  - CXR can still be obtained right after VQ if needed
Case #3
Case #3

PE
Multiple Bilateral PEs
Multiple Bilateral PEs
Multiple Bilateral PEs
Multiple Bilateral PEs

Case #5

![Images of lung scans with labels]

- **Lt** (Left): Posterior Superior
- **Rt** (Right): Posterior Superior

**Anterior** and **Posterior** views are provided for both Left (Lt) and Right (Rt) sides.

**Ph:1 Fr:1 80K0 9sec Duration 128x128 Pix:3.9mm 133Xenon**

**Ph:1 Fr:1 113K0 9sec Duration 128x128 Pix:3.9mm 133Xenon**

**99m Technetium**

Additional information:
- **570.0 MBq (10.00 mCi)** for Xenon
- **122.1 MBq (3.30 mCi)** for MAA
Case #6

Perfusion only (No ventilation Scan was Obtained)

PE
Case #7

PE

Posterior 493K
Superior
Lt  Lt
%  100

RPO 498K
Superior
Rt  Ant
%  100

RT LAT 497K
Superior
Post  Rt
%  100

RAO 498K
Superior
Case #9

No PE
Case #9

No PE
Rat Bite Appearance:
Small, Peripheral ("chronic", recurrent) PEs
Small, Peripheral ("chronic", recurrent) PEs
Large PE on the Right
Large PE on the Right
PE Improved: “Chronic”, partially resolved PE
Case #12

PE Improved: “Chronic”, partially resolved PE
GI Bleed Scan
GI Bleeding Scan

• To demonstrate and/or localize **active bleeding into the gastrointestinal lumen**
• Essentially a test for lower GI bleeds
• May or may not be preceded by colonoscopy
• Often followed by Interventional Radiology Procedure
GI Bleeding Scan

• Labeling of patients own RBCs with 20 - 25 mCi 99mTc and reinjection

• Very sensitive: Bleeding of 0.1 mL/min (conventional angiography: 1.0 mL/min)

• Standard protocol: Anterior abdominal and pelvic dynamic acquisition (cine) for 90-120 minutes
  – Lateral image: Differentiating rectal bleed from penile perfusion
  – Delayed images out to 24 h without reinjection for intermittent bleeding
# RBC Labeling Methods

<table>
<thead>
<tr>
<th>Method</th>
<th>Description &amp; considerations</th>
<th>Labeling efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>In vivo</strong></td>
<td>The patient is injected with stannous pyrophosphate 1 mg IV, circulating for 20 minutes. This is followed by an intravenous injection of 555-1110 MBq $^{99m}$Tc pertechnetate. This technique is generally not recommended as secondary to its low labeling efficiency, but is reserved for patients who will not receive blood products for religious reasons.</td>
<td>75-80%</td>
</tr>
<tr>
<td><strong>Modified in vivo</strong> (aka “in vitro”)</td>
<td>The patient is injected with stannous pyrophosphate 1 mg IV, circulating for 20 minutes. A vial of blood is then mixed with 555-1110 MBq of $^{99m}$Tc pertechnetate. This is allowed to incubate for 10 minutes before intravenous injection into the patient.</td>
<td>85-90%</td>
</tr>
<tr>
<td><strong>In vitro</strong></td>
<td>A vial of blood is withdrawn from the patient that is added to the vial containing stannous pyrophosphate. After 5 minutes, the first vial “A” is added which contains sodium hypochlorite to destroy the extracellular Sn$^{2+}$. The citrate buffer (“B”) is then added. $^{99m}$Tc pertechnetate 555-1110 MBq is added and incubates before intravencously administering to the patient.</td>
<td>≥97%</td>
</tr>
<tr>
<td>TECHNIQUE</td>
<td>ADVANTAGES</td>
<td>DISADVANTAGES</td>
</tr>
<tr>
<td>----------------------</td>
<td>-----------------------------------------------------------------------------</td>
<td>-------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>CT Angiography</td>
<td>Readily available, Quick, Easy to perform, Accurate localization, Possible information about etiology</td>
<td>Intermittent bleeding, Radiation exposure, IV contrast Pre-existing high attenuation material in bowel</td>
</tr>
<tr>
<td>Radionuclide Imaging</td>
<td>Most sensitive (0.1 mL/min), Delayed imaging for intermittent bleeding, Non-invasive, low radiation, exposure, No patient prep</td>
<td>Limited afterhours availability, Time-consuming</td>
</tr>
</tbody>
</table>
# Radiation Exposure

<table>
<thead>
<tr>
<th>Technique</th>
<th>Radiation dose (mSv)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pediatric GIBS with 80-784 MBq $^{99m}$Tc RBCs</td>
<td>0.559-5.488</td>
</tr>
<tr>
<td>Adult GIBS with 555-1110 MBq $^{99m}$Tc RBCs</td>
<td>3.885-7.77</td>
</tr>
<tr>
<td>CTA protocolled for GI bleeding without initial unenhanced CT phase</td>
<td>18.2</td>
</tr>
<tr>
<td>CTA protocolled for GI bleeding with initial unenhanced CT phase</td>
<td>27.3</td>
</tr>
</tbody>
</table>

Grady, JNM 2016
Image Interpretation

• Focus that:
  – Moves and/or
  – Intensifies over the course of the scan
    • Atypical patterns not uncommon
Case #1

No GI Bleed

Heart → Heart

Liver → Heart
Linear Pattern = Large Bowel Bleed

Bleeding in the Splenic Flexure
Case #3

Bleeding in the Hepatic Flexure

↓

Spleen

↓
“Zigzag” Pattern = Small Bowel Bleed
Case #5

Rectal Bleed → Bladder
Bleeding in Hepatic Flexure

Patient subsequently underwent Partial Colectomy b/c of Diverticulosis
Bleeding in Hepatic Flexure
Case #7

Pseudoaneurysm
with Contrast Extravasation in the Colon Lumen
Brisk Bleeding Distal Descending Colon
Angiodysplasia
Bleeding in Proximal Ascending Colon
Active Extravasation from a Distal Branch of the Right Colic Artery
No Zigzag or Linear Pattern,
No Change in Intensity over Time =
No Active Bleeding into the Bowel Lumen
Diffusely Infiltrating Pancreatic Carcinoma
Bleeding in the Region of the Cecum

Anterograde Flow

Retrograde Flow

Bladder
Meckel's Diverticulum
(86 yo Male with BRBPR)
No Zigzag or Linear Pattern but Increase in Intensity over Time = Concerning for Active Bleeding into the Bowel Lumen
Bleeding at the Anastomosis Site

SPECT/CT
Pseudoaneurysm of a Jejunal Artery at the Anastomosis Site
Bleeding in Left Mid Abdomen
Case #13

Negative Angio
Bleeding in Small Bowel
Case #13

Negative Angio
Bleeding in Left Lower Abdomen, Probably Small Bowel
No GI Bleed on CT
HIDA Scan
Hepatobiliary Scan

- Visualization of the biliary system
  - (Functional) Obstruction of cystic duct (Cholecystitis), biliary leak, biliary atresia
- 5 mCi 99mTc-Mebrofenin (Choletec, BRIDA)
  - Other agents: Hepatolite, DISIDA and HIDA (no longer in use)
- False positive: 2 h > Fasting > 24 h
- Fasting > 24 hours:
  - Kinevac (CCK) 0.02 mcg/kg of over 30 minutes
- No opioids < 8 hours (SNMMI: 4 half-lives): Non visualization of small bowel
Hepatobiliary Scan

• Anterior abdominal images for 60 minutes
• No gallbladder filling by 60 minutes
  – Imaging out to 4 hours or morphine (0.04 mg/kg IV over 3 minutes)
• More delayed imaging if hepatocellular dysfunction or suspected leak
• GB Ejection Fraction: Kinevac (CCK) 0.02 mcg/kg over 60 minutes
  – Normal GB EF > 38%
Gallbladder Visualized: Negative Scan

Case #1
Case #1

Gallbladder Visualized: Negative Scan
Case #2

Gallbladder not Visualized on Regular Images (60 minutes)
Case #2

Gallbladder Visualized on 24-h Delayed Images: Negative Scan
Gallbladder not Visualized on Regular Images (60 minutes)

---

Case #3
Case #3

Gallbladder not Visualized on 24-h Delayed Images: Positive Scan

4 h Delay

24 h Delay
Case #3
Fasting > 24 hours and No CCK pre Treatment: False Positive Scan
Case #4

Repeat Scan Next Day with CCK pre Treatment: Negative Scan
Gallbladder not Visualized on Regular Images (60 minutes)
Case #5

Gallbladder Visualized 20 minutes Post Morphine
Case #5

Confirmed on SPECT/CT
Case #6

Status Post Cholecystectomy, Fluid in the Gallbladder Fossa
Is there a Bile Leak?
Case #6

s/p Cholecystectomy, Fluid in the Gallbladder Fossa

Bile Leak
Status Post liver Transplant
Suspected Biliary Leak
Leak in Middle Third of CBD
Case #7

Stent
Status Post liver Resection
Suspected Biliary Leak

Fluid
Case #8

Negative Initial Images
Case #8

Delayede (24-h) Planar Images

Bile Collection: Biliary Leak
Case #8

24-h SPECT/CT

SPECT/CT

Biliary Leak Clearly Localized
Thank you!