Myocardial Perfusion Imaging: a game of acronyms

MIBI, Thal, ETT & SPECT

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Objectives

- Review indications for when myocardial perfusion scans should be ordered
- Learn the difference between thallium and MI BI
- Understand the protocol and process of obtaining these scans
- Review coronary and SPECT anatomy
What is a myocardial perfusion scan?

- A nuclear cardiology study in which radioisotope tracers are injected into the body that emit gamma photons
- Gamma ray cameras are used to capture image
- The concentration of the radioisotopes is proportional to blood flow of myocardium
- The scan can be done at rest or at stress
Role of Nuclear Cardiology

- Noninvasive detection of coronary artery disease
- Assessment of disease extent and severity
- Prognostication of cardiac events in patients with known or suspected CAD
Non-invasive diagnostic modalities for CAD

- Exercise treadmill testing (ETT) with ECG
- Stress echocardiography using exercise or pharmacologic agents
- Planar myocardial perfusion imaging with thallium or sestamibi
- SPECT myocardial perfusion imaging with thallium or sestamibi
Mr. P

- **HPI**: 39 yo HIV positive male, presents with substernal chest pain radiating to shoulder that is relieved with sublingual nitroglycerin.

- **PMH**: HIV (13 years), hypercholesterolemia, anal cancer (s/p chemo/XRT), 30-yr hx of smoking

- **Studies**: normal ECG and cardiac enzymes $\rightarrow$ ETT and cardiac stress imaging study ordered
Who gets a scan?

- Those unable to exercise to a level high enough to produce meaningful results on exercise ECG
- Those with baseline ECG abnormalities
- Patients who have undergone prior revascularization, known significant disease, diabetes, or a previous positive nuclear study
- Women
Chest Pain Algorithm

- hx and physical exam
- assess risk factors
- ECG
- ETT
- myoperfusion scan

Diagram taken from: http://individual.uptodateonline.com/application/image.asp?file=card_pix/algori2.gif
Thallium (TI-201)

- $T_{\frac{1}{2}} = 73$ hours
- Low photon energy
- Potassium analogue that enters normal myocytes
- Peak myocardial activity occurs 5-15 mins after injection
- Intracellular concentration of thallium depends on vascular supply and membrane function
- Does not remain fixed in myocyte, redistributes
MI BI

- Technetium-99m ($^{99m}$Tc) labeled methoxy-isobutylisonitrile, aka $^{99m}$Tc-sestamibi
- $T_{1/2} = 6$ hours
- Lipophilic molecule that passes myocyte membrane passively
- Higher photon energy
- Minimal redistribution, stays fixed in myocyte giving a snapshot at time of injection

Diagram taken from: http://brighamrad.harvard.edu/education/online/Cardiac/sestamibi.htm
**TI-201 vs. MIBI**

- Equally sensitive in detecting areas of ischemic or scarred myocardium
  - Dual isotope protocol: 91% and 96% sensitivity for > 50% CAD and >75% stenoses, respectively
- Thallium better for detecting myocardial viability (i.e. hibernating myocardium) because it redistributes
- Larger doses of MIBI (up to 25 mCi) for a single study compared to thallium (3 mCi) → better image quality
- MIBI allows for greater flexibility in protocol for imaging because of the lack of redistribution
Patient Prep

- Do not eat/drink anything containing caffeine 12 hours before the test
- Do not smoke for 2 hours before test
- Do not eat anything for at least 2 hours before test
- Test will take 2-3 hours
Dual Isotope Protocol

• **STEP 1:** Thallium injected upon patient entering
• **STEP 2:** @ 15 mins, rest images taken
• **STEP 3:** Stress test (Bruce Protocol)
• **STEP 4:** 1 minute prior to patient reaching quitting limit, MIBI injected
• **STEP 5:** @ 45 mins, delayed images taken

Courtesy Dr. Donohoe
SPECT Imaging Camera

Diagram taken from:
http://info.med.yale.edu/intmed/cardio/imaging/techniques/spect_camera/index.html
SPECT Cross-Sections

- Cut perpendicular to long axis:
  - Coronal short axis

- Cuts perpendicular to short axis:
  - Sagittal long axis
  - Horizontal transaxial

http://brighamrad.harvard.edu/education/online/Cardiac/anatomic-orient.html
SPECT Anatomy

http://info.med.yale.edu/intmed/cardio/imaging/techniques/spect_anatomy/index.html
Short Axis Views

Normal Coronary Anatomy


Gray’s Anatomy.
Coronary Perfusion

http://brighamrad.harvard.edu/education/online/Cardiac/coronary-artery-territory.html
Coronary Perfusion

http://info.med.yale.edu/intmed/cardio/imaging/
Normal Scan
Color Enhanced Images

http://brighamrad.harvard.edu/education/online/Cardiac/96/96.html
Mr. P’s ETT Results

- Test terminated due to progressive angina
- Peak intensity 9/10
- Ischemic ECG changes:
  - 2.0 – 3.0 mm of ST elevation in leads V1-3
  - 1.0-1.5 mm of gradual upsloping ST segment depression in inferior leads
Mr. P’s Scan

ANT

SEP

LAT

INF

ANT

APEX

INF

APEX

SEPT

LAT

Courtesy Dr. Donohoe
Gated Study

- Multiple images taken at intervals produce a dynamic flow
- Allows for assessment of ventricular function
- Ejection fraction calculated
- Mr. P’s EF = 53%

Courtesy Dr. Donohoe
Mr. P’s Course

- Referred to cath lab for elective cardiac catheterization

- Coronary angiography performed
  - Proximal LAD $\rightarrow$ 90% stenosis
  - Mid-LAD $\rightarrow$ 60% stenosis
  - Diagonal 1 $\rightarrow$ 90% stenosis
  - Diagonal 2 $\rightarrow$ 80% stenosis
Mr. P’s Treatment

• Directional coronary atherectomy of the first diagonal and the proximal LAD

• PTCA performed with stent placement in LAD
Take home points

• Combined myocardial perfusion and function results from cardiac stress imaging is important for risk stratification of CAD and assessing severity.

• Overall accuracy of myocardial perfusion is higher than exercise ECG stress test in detecting ischemic changes.

• Myocardial perfusion imaging gives important prognostic information in patients with known/suspected CAD:
  - Normal scan associated with low risk of future cardiac events (<1% annual mortality)
  - Abnormal scan with hi risk findings predict annual mortality rate of 3% and should be referred for coronary revascularization
References

- [http://brighamrad.harvard.edu/education/online/Cardiac/Intro](http://brighamrad.harvard.edu/education/online/Cardiac/Intro)
- [http://info.med.yale.edu/intmed/cardio/imaging/](http://info.med.yale.edu/intmed/cardio/imaging/)
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