

MYOCARDIAL PERFUSION & VIABILITY STUDY (Thallium-201)

Overview

- @ The Myocardial Perfusion & Viability Study demonstrates the distribution of perfusion as well as viability throughout the myocardium

Indications

- @ Detection of coronary artery disease by way of classification of the left ventricular myocardium as normal, irreversibly ischemic, and reversibly ischemic
- @ Detection of hibernating myocardium
- @ Detection of myocardial perfusion abnormalities secondary to causes other than coronary artery disease.
- @ Evaluation of the septum in patients with left bundle branch block (must use pharmacologic stress rather than exercise)

Examination Time

- @ Initial stress acquisition: 1 hour
- @ Delayed redistribution & reinjection acquisition at rest: 30 minutes

Patient Preparation

- @ For optimal results the patient should discontinue all cardioactive medications before the study:
 1. Beta-blockers, eg. propranolol, for at least 24 hours
 2. Long acting nitrates for at least 4 hours, nitroglycerin for at least 1 hour.
 3. Calcium channel blockers
 4. Caffeine for 24-36 hours prior to pharmacologic stress with dipyridamole or adenosine
- @ The patient will undergo a stress electrocardiogram (EKG) on a treadmill or bicycle in the upright position. It is important that the patient accomplish the maximum amount of exercise that he/she can safely perform.
- @ The patient should be fasting and should eat nothing until after the redistribution acquisition

- @ Record the patient's height, weight, and, for females, bra size; this information assists in identifying attenuation artifacts in the tomographic images
- @ For females, bind the breasts up away from the left ventricle (may not be necessary if the prone position is used)
- @ Carefully instruct the patient not to move during the SPECT acquisition

Equipment & Energy Windows

- @ Gamma camera: Rotating gamma camera for SPECT, preferably a dual head system with the heads at 90 degrees
- @ Collimator: Low energy, high resolution, parallel hole
- @ Energy windows:
 - o One pulse height analyzer: 25% window centered at 75 keV.
 - o Two pulse height analyzers: 25% window centered at 75 keV and 20% window centered at 167 keV.
 - o Three pulse height analyzers: 25% window centered at 75 keV, 20% window centered at 167 keV, and 15% window centered at 135 keV.
- @ Computer with SPECT capability

Radiopharmaceutical, Dose, & Technique of Administration

- @ Radiopharmaceutical: Thallium-201 as thallos chloride
- @ Dose (should be weight adjusted):
 1. 3 mCi (111 MBq) at stress.
 2. 1.5 mCi (55.5 MBq) 5 minutes prior to rest/redistribution imaging, ie. reinjection technique
- @ Technique of administration: Since the injection is made while the patient is exercising, and, therefore, moving, an intravenous line is placed prior to the beginning of exercise. The intravenous line should be placed in the medial (brachial) vein of the antecubital fossa. The radiopharmaceutical is then injected 1-2 minutes before the anticipated end of the patient's exercise endurance.

Patient Positioning & Imaging Field

- @ Patient position: Supine.
 - o Prone position may be used
- @ The left arm is placed above the patient's head. (If the patient is unable to keep the left arm above the head, planar imaging may need to be substituted for SPECT imaging.)
- @ Imaging field: Lower chest.

Acquisition Protocols

- @ General:
 1. The stress study is performed first followed by the rest study approximately 3 hours later
 - o Attenuation correction is helpful if available
- @ Stress study:
 1. Imaging should begin about 10 minutes after the end of the EKG stress. (It is important that the EKG stress lab is located in close proximity to the nuclear medicine department.) Ten minutes represents a compromise between beginning later which decreases the sensitivity of the study for reversible ischemia and beginning earlier which causes image artifacts secondary to "cardiac creep."
 2. SPECT acquisition parameters:
 - a) Collection arc: 180E beginning at 45E RAO and ending at 45E LPO.
 - b) Orbit: Usually elliptical
 - o Circular may be used
 - c) Projections: 32 images (6E intervals over 180E)
 - o 64 images (3E intervals over 180E) may be substituted
 - d) Dwell time (may be decreased with dual 90E heads): 40 seconds
 - o 25 seconds for 64 images
 - e) Image matrix: 64 x 64 matrix
 3. The patient is instructed to return in 3-4 hours for the rest study
- @ Rest study:
 1. 3-4 hours following the initial injection, an additional dose of thallium is injected at rest, ie. reinjection technique.
 2. 5 minutes after the resting injection of thallium, redistribution/rest SPECT images are acquired using the same acquisition parameters that were used for the stress acquisition.

Data Processing

- @ The exact procedure for processing SPECT myocardial perfusion images depends on the computer software being used. This varies with the manufacturer and, in general, the manufacturer's protocol should be followed.

- @ The reconstruction process in general terms is:
 1. Correct the 32 planar images for uniformity (camera non-uniformity) using a high count, eg. 30 million count, cobalt-57 flood acquisition.
 2. Check the images for patient motion and apply a motion correction algorithm if indicated and if available.
 3. Indicate the superior and inferior limits of the heart so that computer time is not expended in reconstructing tomograms outside of the heart.
 4. Specify the filters to be used in the reconstruction process and the pixel thickness of the tomogram (usually 1 or 2 pixels).
 5. The computer then constructs tomograms through the heart that are transaxial to the long axis of the body using filtered backprojection. (These initial tomograms will be oblique to the long and short axes of the left ventricle.)
 6. In order to obtain images in standardized anatomic orientations, indicate the long axis of the left ventricle; the initial tomograms are then reoriented to give transverse, sagittal, and coronal tomograms of the left ventricle relative to the long axis of the left ventricle.

- @ The transaxial tomograms of the left ventricle are then quantitatively analyzed and compared to normal ranges for perfusion at stress and change from stress to redistribution, eg. bullseye display and analysis:
 1. This analysis usually requires the technologist to indicate the center and outer limits of the left ventricle in each transaxial tomogram.
 - o Use separate normal ranges for males and females if available.

- @ The following are routinely recorded on film and submitted for interpretation:
 1. Tomograms of myocardial perfusion for both stress and rest in the transaxial, sagittal, and coronal planes
 2. Bullseye or bullseye equivalent displays of:
 - a) Myocardial perfusion at stress and redistribution in a continuous gray scale
 - b) Myocardial perfusion at stress and rest by standard deviations from normal reference standards
 - c) Normal, irreversibly ischemic, and reversibly ischemic areas
 - d) With some software it is possible to also quantitate the percent of left ventricular myocardium that is normal, reversibly ischemic, and irreversibly ischemic.
 3. Time from injection of the radiopharmaceutical to the start of the

- acquisition.
4. Images of the line used to indicate the long axis of the left ventricle.
 5. All of the parameters used in the reconstruction process.
 6. The patient's predicted heart rate, 85% of predicted heart rate, and achieved heart rate.
 7. Patient's height, weight, and, for females, bra size.

Optional Maneuvers

- @ The average lung to maximum heart activity ratio may be calculated using SPECT tomographic images or the ANT planar image at stress (The planar image must have been acquired as a digital image.).
- @ In-patients who cannot exercise, "stress" may be induced pharmacologically with adenosine or dipyridamole. Refer to the Sestamibi protocol for the pharmacological stress procedure.

Principle Radiation Emission Data - Tl-201

- @ Physical half-life = 3.05 days.

Radiation	Mean % per disintegration	Mean energy (keV)
Gamma-4	2.7	135.3
Gamma-6	10.0	167.4
ce-K, gamma-8	15.4	84.3
K alpha-1 x-ray	46.2	70.8
K alpha-2 x-ray	27.2	68.9
K beta-1 x-ray	10.5	80.3

Dosimetry - Tl-201 as Thallous Chloride

Organ	rads/3 mCi	mGy/111 MBq
Kidneys	4.8	48.0
Thyroid	2.6	26.0
Liver	2.2	22.0
Heart wall	2.0	20.0
Testes	2.0	20.0
Ovaries	1.9	19.0
Gastrointestinal tract		
stomach wall	1.7	17.0
small intestine	1.5	15.0
upper colon	1.0	10.0
lower colon	0.8	8.0

Total body

0.8

8.0