

## **Myocardial Perfusion**

**Responsible Division:** Division of Nuclear Medicine, Department of Radiology, UT Southwestern

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### **POLICY BASIS FOR PROCEDURE**

- To establish a clinical protocol for Myocardial Perfusion Study

### **DESCRIPTION OF STANDARD PROCEDURE**

#### **SCOPE**

- All Nuclear Medicine Technologists and Physicians must adhere to these guidelines

### **PROCEDURE**

#### **Indications:**

- Detecting the presence, location, and extent of coronary artery disease
- Risk stratification of coronary artery disease
- Evaluating the physiologic significance or sequelae of coronary artery stenosis
- Evaluating ventricular function

#### **Contraindications:**

- High risk unstable angina
- Decompensated or inadequately controlled congestive heart failure
- Systolic BP at rest >200mm Hg or diastolic BP at rest >110mm Hg
- Uncontrolled cardiac arrhythmias (causing symptoms or hemodynamic compromise)
- Severe symptomatic aortic stenosis
- Acute pulmonary embolism
- Acute myocarditis or pericarditis
- Acute aortic dissection
- Severe pulmonary hypertension
- Acute myocardial infarction less than 2-4 days old
- Acute symptomatic medical illness

#### **Examination Time:**

- The exact timing and duration for stress and rest exam depends on the chosen protocol and method of stress.

#### **Patient Preparation:**

- Nothing should be eaten at least 3 hours prior to the test
- Caffeine should be avoided at least 12 hours prior for all patients

- For optimal results the patient should discontinue all antianginal medications for a time sufficient to obviate their pharmacologic effect as they reduce the sensitivity of the stress test. (Beta-blockers, calcium channel blockers and nitrates)
- Patients undergoing a treadmill stress test shall be advised to wear comfortable clothing and shoes. External attenuating objects shall not be worn or removed if possible.

#### **Equipment & Energy Windows:**

- Gamma camera: Rotating gamma camera for SPECT, preferably a dual head system with the heads at 90 degrees or SPECT-CT camera.
- Collimator: Low energy, high resolution, parallel hole.
- Computer with SPECT capability.
- EKG image gating device.
- Energy window: For Tc99m, 20% window centered at 140 keV.

#### **Radiopharmaceutical, Dose, & Technique of Administration:**

- Radiopharmaceutical:
  - Rest- Tc99m Sestamibi or Tc99m Tetrofosmin
  - Stress-Tc99m Sestamibi or Tc99m Tetrofosmin
- Dose - 1 day protocol maintaining a 3:1 ratio is imperative to counter any “shine through” or “cross talk” of Tc99m tracers:
  1. Rest dosing Rest: 8-12 mCi Tc99m Sestamibi or Tc99m Tetrofosmin
    - $\leq 25 \text{ kg/m}^2$  8 mCi Tc99m Sestamibi or Tc99m Tetrofosmin
    - $> 25\text{-}30 \text{ kg/m}^2$  9 mCi Tc99m Sestamibi or Tc99m Tetrofosmin
    - $> 30\text{-}35 \text{ kg/m}^2$  10 mCi Tc99m Sestamibi or Tc99m Tetrofosmin
    - $> 35 \text{ kg/m}^2$  10-12 mCi Tc99m Sestamibi or Tc99m Tetrofosmin (necessitates a two day protocol)
  2. Stress: 24-30 mCi Tc99m Sestamibi or Tc99m Tetrofosmin
    - $\leq 25 \text{ kg/m}^2$  24 mCi Tc99m Sestamibi or Tc99m Tetrofosmin
    - $> 25\text{-}30 \text{ kg/m}^2$  27mCi Tc99m Sestamibi or Tc99m Tetrofosmin
    - $> 30\text{-}35 \text{ kg/m}^2$  30mCi Tc99m Sestamibi or Tc99m Tetrofosmin
    - $> 35 \text{ kg/m}^2$  30-36 mCi Tc99m Sestamibi or Tc99m Tetrofosmin
- Dose - 2 day protocol:
  - Rest: 30 mCi Sestamibi or Tc99m Tetrofosmin
  - Stress: 30 mCi Sestamibi or Tc99m Tetrofosmin
- Technique of administration:
  - Rest: Routine intravenous injection.
  - Stress: Intravenous line is placed prior to the beginning of exercise. The radiopharmaceutical is injected once the patient has reached their target heart rate or when determined by the study proctor

### **Patient Position & Imaging Field:**

- Patient position: Supine; prone is an option for diaphragmatic or breast attenuation in addition to the supine imaging
- The arms are placed above the patient's head. (If the patient is unable to keep the right arm above the head, clearly mark on the requisition that the images were acquired with the right arm by the patient's side.) The left arm must be placed out of the field of view. Any attenuating materials in the field of view shall be removed.
- Imaging field: Chest.

### **Acquisition Protocol – One Day**

- Imaging sequence
  - Rest study first, followed by stress study.
- General:
  1. The patient is imaged supine.
  2. SPECT acquisition parameters:
    - a) 180° collection arc from 45° RAO to 45° LPO.
    - b) Orbit: Elliptical
    - c) Projections: 64 images (3° intervals over 180°).  
32 images (6° intervals over 180°) may be substituted.
    - d) Dwell time: 30 - 35 seconds per stop for Tc99m.
    - e) Image matrix: 128x128 matrix.
  3. Attenuation correction should be used if available.
  4. Gate stress acquisitions
- Rest-stress protocol:
  1. Obtain blood pressure, if elevated advise proctor and proceed as instructed.
  2. Place an intravenous line, preferably 22g or larger in the antecubital area.
  3. Inject radiopharmaceutical for resting images.
  4. Rest imaging begins 45-60 mins post injection. 150ml of water or whole milk should be given to patients 10 mins prior to rest imaging.
  5. Two hours post rest injection the stress injection may be given. Thirty minutes prior to stress injection the patient shall be escorted to the stress lab for placement of electrodes/leads (ensure good electrical contact; this can be done by preparing the skin with methyl alcohol and/or extra-fine sandpaper and shaving the area with a disposable razor, if needed and other pre stress test preparation.
  6. Patients exercising on the treadmill should achieve the desired heart rate of 85% of the age-predicted maximum predicted heart rate or a workload of at least 5 mets.
  7. Stress imaging to be performed:
    - Sestamibi exercise stress: 15-20 minutes post injection.
    - Pharmacologic stress: 45-120 minutes post radiopharmaceutical injection

### Acquisition Protocol – One Day

- A Body Mass Index of 35 or greater necessitates a two protocol:
  - Day One: Perform stress test as indicated. Consult with the reading cardiologist to decide if the resting portion of the study will be needed. If so, the patient is to return as soon as possible for the rest portion of the exam. The faculty will be notified of the return visit.
    - a. Stress : 30 mCi Tc99m Sestamibi or Tc99m Tetrofosmin
    - b. Wait 45 – 60 minutes post stress for imaging
  - Day Two : Perform resting test
    - a. Rest : 30 mCi Tc99m Sestamibi or Tc99m Tetrofosmin
    - b. Wait 45-60 minutes post injection for rest imaging

### Data Processing:

- The reconstruction process includes:
  1. Check the images for patient motion and apply a motion correction algorithm if indicated if not optimal.
  2. Indicate the superior and inferior limits of the heart so that computer time is not expended in reconstructing tomograms outside of the heart.
  3. The computer then constructs tomograms through the heart that are transaxial to the long axis of the body using iterative reconstruction. (These initial tomograms will be oblique to the long and short axes of the left ventricle.)
  4. 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 quantitatively analyzed and compared to normal ranges for perfusion at stress and change from stress to rest, e.g. bullseye display and analysis

### Optional Maneuvers

- In patients who cannot exercise, “stress” may be induced pharmacologically with Regadenoson or Adenosine
  1. A physician experienced in managing cardiac emergencies must be immediately available in case of complications.
  2. Contraindications:
    - a) severe asthma or bronchospasm.
    - b) severe chronic obstructive pulmonary disease
    - c) unstable angina.
    - d) recent myocardial infarction, e.g. less than 48 hours.
    - e) sick sinus syndrome, and 2nd and 3rd degree AV block unless the patient has a functioning cardiac pacemaker.

- f) hypotension, e.g. resting systolic pressure < 80 mm Hg.
  - 3. The patient should be NPO for 3 hours prior to the study (both drugs may cause nausea and vomiting).
    - a. Drug administration:
      - Regadenoson: Inject 0.4 mg (5 ml single dose) intravenously over 10 seconds followed immediately by a 5 ml saline flush. At 30 seconds inject the radiotracer followed by 5ml of saline.
      - Adenosine: Infuse 0.14 mg/kg per minute intravenously for 6 minutes. Then inject at 3 min
  - 4. Acquire images as described above beginning 60-120 minutes following the infusion.
  - 5. Side effects: Similar for both drugs although the reported frequencies vary. The side effects are similar to exercise stress plus bronchospasm.
  - 6. Treatment of severe side effects
    - Regadenoson: Aminophylline or normal saline may be given.
    - Adenosine: Termination of infusion. Aminophylline or normal saline may also be given.
- In patients who cannot exercise and who cannot be stressed pharmacologically with Adenosine or Regadenoson may be induced pharmacologically with Dobutamine (1,2,3):
    1. A physician experienced in managing cardiac emergencies must be immediately available in case of complications.
    2. Mechanism of action: Dobutamine increases myocardial contraction by direct stimulation of the heart's beta-1 receptors.
    3. Contraindications:
      - a) severe aortic stenosis.
      - b) unstable angina.
      - c) recent myocardial infarction, e.g. less than 48 hours.
      - d) history of tachyarrhythmias.
      - e) hypertension, e.g. resting systolic pressure > 200 mm Hg.
      - f) poor left ventricular function
    4. Withhold beta blockers for 24 hours.
    5. The patient shall be NPO for 3 hours prior to the study.
    6. Monitor the blood pressure and electrocardiogram every minute during administration of the drug and for 6 minutes afterwards.
    7. Dobutamine administration and radiopharmaceutical injection:
      - a) infuse dobutamine at 5 µg/kg/min for 3 minutes followed by stepped increases to 10, 20, 30, and 40 µg/kg/min for each successive 3 min.
      - b) inject radiopharmaceutical 1 minute following initiation of the maximum dose or target heart rate, over a 1 minute time period.
      - c) continue dobutamine infusion as instructed by proctor.
    8. Acquire images as described above beginning 60 minutes following injection of the radiopharmaceutical.
    9. Side effects: The side effects are similar to exercise stress.
    10. Treatment of severe side effects: Intravenous beta blockers.

Principle Radiation Emission Data - Tc-99m

- Physical half-life = 6.01 hours.

Principle Radiation Emission Data

Radiation	Mean % per disintegration	Mean energy (keV)
Gamma-2	89.07	140.5

Dosimetry- Tc-99m-Tetrofosmin (at stress) (2,3)

Organ	Rads/25 mCi	mGy/925 MBq
Gallbladder wall	3.08	30.8
Upper Large Intestine	1.88	18.8
Urinary bladder wall	1.45	14.5
Lower large intestine	1.43	14.3
Small intestine	1.13	11.3
Kidneys	0.98	9.8
Ovaries	0.73	7.3
Thyroid	0.40	4.0
Red marrow	0.38	3.8
Testes	0.33	3.3
Liver	0.30	3.0

Effective dose	Rems/60 mCi	mSv/2,220 MBq
Whole body	0.80	8.0

Dosimetry- Tc-99m-Sestamibi (at stress) (2,3)

Organ	Rads/25 mCi	mGy/925 MBq
Upper large intestine	4.66	46.6
Lower large intestine	3.22	32.2
Gallbladder wall	2.89	28.9
Small intestine	2.78	27.6
Kidneys	1.67	16.7
Ovaries	1.22	12.2
Thyroid	0.82	8.2

Red marrow	0.72	7.2
Whole body	0.46	4.6
Liver	0.43	4.3
Testes	0.29	2.9

Effective dose	Rems/60 mCi	mSv/2,220 MBq
Whole body	0.71	7.1

## REFERENCES

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3. Sharmila Dorhala, Marcelo F. Di Carli, Dmonique Delbeke, Suhny Abbbara, E. Gordon DePuey, C. Moore, Michael G. Stabin, and Paul Shreve: SNMMI?ASNC/SCCT Guideline for Caridac SPECT/CT and PET/CT 1.0.Jun 18 2013

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