Dual-Tracer Gated Myocardial Scintigraphy

**Primary Indications:** Evaluation of myocardial perfusion and viability in patients with known or suspected coronary artery disease. The most common indications include (1) diagnosing coronary artery disease in patients with clinical features indicating an intermediate probability of disease; (2) determining the pathophysiological significance of known coronary artery stenoses; (3) determining the extent of myocardial ischemia and assessing prognosis after myocardial infarction; (4) assessing for risk of cardiac events prior to noncardiac surgery; (5) detecting coronary restenosis after angioplasty and graft occlusion after bypass surgery; (6) evaluating the effectiveness of medical therapy; and (7) detecting viable myocardium in patients with ventricular dysfunction.

**Rationale:** Immediately following intravenous administration, TI-201 is distributed in myocardium in proportion to regional perfusion. Because TI-201 is a potassium analog, its distribution at later times (i.e., 1-3 hr after administration) reflects myocardial membrane function and, thus, myocardial viability. Consequently, TI-201 is retained by viable myocardium (either normal or ischemic), but is not retained by infarcted myocardium. Following intravenous administration, Tc-99m sestamibi and tetrofosmin are distributed in proportion to regional myocardial perfusion. Because Tc-99m sestamibi and tetrofosmin do not clear appreciably from the myocardium, images of perfusion can be obtained for several hours following the administration of these tracers.

Initially, under resting conditions, images are obtained following the administration of TI-201 to assess resting perfusion. Subsequently, images are obtained following the administration of Tc-99m sestamibi or tetrofosmin at peak stress to assess perfusion during stress. Normal myocardium will exhibit homogeneous uptake of both tracers. Myocardium with stress-induced ischemia will exhibit reduced uptake of Tc-99m sestamibi or tetrofosmin and homogeneous or near homogeneous uptake of TI-201. Infarcted myocardium will show reduced uptake of both tracers.

**Interfering Conditions:** Because of the low photon energy of TI-201 (70 keV), prior studies with other radiopharmaceuticals may interfere with thallium scintigraphy, and the potential effect of such prior studies should be discussed with the nuclear medicine physician before TI-201 is administered.

The pharmacologic effects of intravenous dipyridamole or adenosine are blocked by aminophylline and other methylxanthines (such as caffeine, which is found in coffee, tea, chocolate, and most soft drinks). Patients taking oral dipyridamole should undergo pharmacologic coronary vaso-dilatation with intravenous dipyridamole rather than with adenosine, because oral dipyridamole prolongs the pharmacologic effect of adenosine and the combination can have marked side effects.

The sensitivity of exercise-stress myocardial perfusion imaging for detection of coronary artery disease is reduced in patients under treatment with beta-blocking drugs and some
calcium-channel blocking drugs. Sensitivity will be improved if these drugs can be held for approximately 24 hours before the study.

Pharmacologic stress is generally preferable to exercise stress in patients with left bundle branch block, because of the lower frequency of false-positive results. Also, pharmacologic stress is generally preferable to exercise stress in patients with pacemakers who are unable to achieve an adequate chronotropic response to exercise.

Dobutamine may be preferred to dipyridamole or adenosine in patients with emphysema or asthma.

Precautions Assure intravenous position of the catheter before tracer administration, since subcutaneous extravasation of Tl-201 can lead to significant local radiation exposure (rarely leading to skin sloughing). If a large amount of a Tl-201 dose is extravasated, application of warm compresses to the injection site and elevation of the extremity will enhance absorption and reduce local radiation dose. The nuclear medicine physician should be notified in the event of significant Tl-201 extravasation.

Subcutaneous extravasation of a significant portion of an administered dose of Tc-99m sestamibi or tetrofosmin markedly reduces the diagnostic value of the study, since much of the radiopharmaceutical will not reach the myocardium at the point of maximum exercise stress or pharmacologic effect.

Radiopharmaceuticals: Tl-201 thallous chloride and either Tc-99m sestamibi (Cardiolite®) or tetrofosmin (Myoview®)

Adult Dose: Tl-201: 2.5 mCi

[A dose of 3.5 mCi of Tl-201 is used for patients with body weight ≥ 250 pounds or for patients who are to be imaged ≥ 8 hours following Tl-201 injection.]

Tc-99m sestamibi (Cardiolite®) or tetrofosmin (Myoview®): 20 mCi

[A dose of 30 mCi of Tc-99m sestamibi or tetrofosmin is used for patients with body weight ≥ 250 pounds.]

Pediatric Dose: Tl-201: 35 μCi/kg

Tc-99m sestamibi or tetrofosmin: 280 μCi/kg

Radiation Dosimetry: Tl-201

Adult. Critical organ (kidney): 5.00 rem.

Effective dose: 2.12 rem.


Effective dose equivalent: 3.77 rem.
Tc-99m sestamibi (based on resting distribution)

Adult. Critical organ (gallbladder): 2.89 rem.
   Effective dose: 0.63 rem.

   Effective dose: 0.50 rem.

Tc-99m tetrofosmin (based on resting distribution)

Adult. Critical organ (gallbladder): 2.66 rem.
   Effective dose: 0.56 rem.

   Effective dose: 0.43 rem.

Combined

Adult. Effective dose: ~2.7 rem.

Infant (1-year). Effective dose: ~4.2 rem.

**Route of Administration:** Intravenous through pre-established, freely infusing cannula. In adults, 22-gauge is the minimum recommended cannula size.

**Patient Preparation:** Patients generally should be fasting for 8-12 hours prior to test. If Tl-201 is to be injected the night before the study, this should be done at least 2-3 hours after the last meal, and the patient should then be kept fasting after midnight. A minimum fasting interval of 4 hours is recom-mended when the longer duration of fasting is not possible.

Medications that effect cardiac function such as beta-blockers (see above), calcium-channel blockers, digoxin, and nitrates ideally should be discontinued if the goal of the test is to detect coronary artery disease with maximum sensitivity (but this decision is left to the discretion of the patient’s referring physician). Other drugs that diminish the effect of dipyridamole or adenosine (see above) should be discontinued at least 24 hours before the study. Although these drugs may affect the diagnostic accuracy of the study by attenuating the level of exercise stress or pharmacologic effect achieved, they should not otherwise affect the distribution of either tracer in myocardium.

**Equipment Setup:** Gamma Camera: SPECT imaging, with gated acquisition for Tc-99m sestamibi or tetrofosmin if possible, is preferred for both adult and pediatric patients. In patients who are unable to tolerate SPECT, planar imaging should be performed with a LFOV camera for studies in adults and a SFOV or zoomed-LFOV camera for studies in small children.

Collimator: Low-energy high-resolution

Energy Window:
TI-201—72 keV with 20% window or 74 keV with 30% window (as designated by bench manual for a particular camera)

and

167 keV with 15% window (unless otherwise designated by bench manual for a particular camera)

Tc-99m sestamibi or tetrofosmin —140 keV with 20% window

**Patient Positioning: SPECT:** The patient should be positioned supine, with the arms comfortably positioned above head; the arms should NOT be physically restrained above the head. A hand grip for the patient to hold and/or a wedge pillow placed under knees may be used for patient comfort. The arm should not be lowered midway through the study (e.g., after the camera passes one side). It is essential that the patient remain motion-less during the entire SPECT acquisition.

Planar: The patient will be placed in the supine position for the 35° left anterior oblique (LAO) view and anterior view. The patient will be placed in the right lateral decubitus position with the left arm above the head for the 70° LAO view.

**Procedure: TI-201 Rest Study.** The patient is injected in the upright position; imaging is begun a minimum of 15 minutes later. To optimize detection of viable myocardium, longer intervals (≥ 4 hours) between injection and imaging are preferable and, when possible, inpatients will be injected the night before the study is performed. SPECT imaging should be performed in all patients who can tolerate SPECT. In patients unable to tolerate SPECT, a standard set of three 10-min planar images in 35° LAO, anterior, and 70° LAO projections is to be performed. Before proceeding to the stress portion of the protocol, the TI-201 images must be reviewed for patient motion. If significant patient motion has occurred, then the patient’s ability to remain motionless should be reassessed and either a repeat SPECT acquisition or standard planar imaging should be performed.

Tc-99m sestamibi or tetrofosmin **Stress Study.** Once the adequacy of the rest images has been confirmed, this portion of the study can be performed. The same type of image acquisition (SPECT or planar) should be performed as for the rest study. Whenever possible, gating (8 frames/RR interval) should be performed. Attach three nuclear-medicine-computer electrocardiographic leads to the patient. Confirm that the electrocardiographic gating is functioning properly. If there is an arrhythmia, obtain a rhythm strip, if possible, and attach it to the requisition. If not possible, note the presence of an arrhythmia on the requisition.

The patient will undergo exercise or pharmacologic stress under the supervision of staff of the Cardiovascular Division, and Tc-99m sestamibi or tetrofosmin is injected intravenously at peak exercise or at the time of peak pharmacologic effect. Where exercise is used as the form of stress, the patient should be encouraged to continue exercising for approximately 1 minute after the injection of the radiopharmaceutical. Imaging can be initiated 30 minutes after the administration of the radio-pharmaceutical. When pharmacologic stress testing is performed, imaging can be initiated 45-60 minutes after the administration of
the radiopharmaceutical. All required information should be entered on the imaging quality control form (e.g., patient height and weight, body habitus, brassiere size, arm counts). Before the patient leaves the Division of Nuclear Medicine, the images should be reviewed for patient motion and the amount of hepatic activity. If significant patient motion has occurred, the patient’s ability to remain motionless should be re-assessed and either repeat SPECT acquisition or standard planar imaging should be performed. If excess hepatic activity may be causing an apparent inferior wall perfusion defect, repeat SPECT acquisition should be performed after a delay of an hour or more.

<table>
<thead>
<tr>
<th>View</th>
<th>Digital Acquisition</th>
<th>Film Display (If Applicable)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rest Tl-201 SPECT Study: SPECT Acquisition</td>
<td>64 projection views covering 180° (45° RAO to 135° LPO); 64 x 64 word-mode Roving 1.5 zoom (Cardiotrac) 30 secs/view Total imaging time - ~ 16 minutes [30 sec/view x 32 views (with 2 heads)] Other acquisition specifics depend on camera (see bench manual)</td>
<td>Images to be displayed along with corresponding stress images</td>
</tr>
<tr>
<td>Rest Tl-201 SPECT Study: SPECT Reconstruction</td>
<td>No attenuation correction (see bench manual)</td>
<td></td>
</tr>
<tr>
<td>Rest Tl-201 Planar Study: (3 views)</td>
<td>256 x 256 word-mode 10-minute images</td>
<td>Images to be displayed along with corresponding stress images</td>
</tr>
<tr>
<td></td>
<td>35° LAO and anterior views with patient supine</td>
<td></td>
</tr>
<tr>
<td></td>
<td>70° LAO view with patient in right lateral decubitus position</td>
<td></td>
</tr>
</tbody>
</table>
### Stress Tc-99m sestamibi or tetrofosmin SPECT Study: SPECT Acquisition

<table>
<thead>
<tr>
<th>Description</th>
<th>Details</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>64 projection views covering 180° (45° RAO to 135° LPO); 64 x 64 word-mode.</td>
<td>Total imaging time - ~ 11 minutes [20 sec/view x 32 views (with 2 heads)] 8 Frames/RR interval, when-ever possible Other acquisition specifics depend on camera (see bench manual) Formatted SPECT display</td>
<td>Image of stress-rest slices and image of ED, ES, motion, thickening bull's-eyes.</td>
</tr>
<tr>
<td>Roving 1.5 zoom (Cardiotrac) 20 secs/view</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Stress Tc-99m sestamibi or tetrofosmin SPECT Study: SPECT Reconstruction

- No attenuation correction (see bench manual)

### Stress Tc-99m sestamibi or tetrofosmin Planar Study: (3 views)

<table>
<thead>
<tr>
<th>Description</th>
<th>Details</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>35° LAO and anterior views with patient supine</td>
<td>256 x 256 word-mode 8-minute images</td>
<td>Images to be displayed along with corresponding rest images</td>
</tr>
<tr>
<td>70° LAO view with patient in right lateral decubitus position</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Items Required For Complete Study:

1. Completion of the imaging quality control form.
2. Processing of the SPECT and/or planar images.
4. Planar Study: Film of planar images.
5. Documentation of the successful loading of previous studies onto workstation.
6. Copy of nurse’s notes.