Comparison between the end-diastolic images and the summed images of gated $^{99m}$Tc-sestamibi SPECT perfusion study in detection of coronary artery disease in women

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Background. End-diastolic images (EDI) can be easily derived from technetium $^{99m}$-sestamibi gated single photon emission computed tomography (SPECT) perfusion study (SGS). This may reduce the effect of myocardial wall thickening during systole and potentially improve the sensitivity of radionuclide perfusion imaging, especially in patients with small hearts.

Methods. This prospective study was conducted in 53 consecutive female patients to compare the diagnostic accuracy of EDI with that of the summed images (SI) of SGS. Fifty-three patients with suspected coronary artery disease (CAD), scheduled for coronary angiography within 2 months, were evaluated with SGS. Treadmill stress testing was used in 28 patients, and dipyridamole injection was used in the remaining 25 patients. A 2-day protocol was used as follows: stress test with 25 to 30 mCi of $^{99m}$Tc-sestamibi and a rest study performed at least 24 hours later with the same dose. Sixteen frames per cardiac cycle were acquired for both the rest and the stress studies. Three end-diastolic frames were used for EDI, and all the 16 frames were summed for SI. SI and EDI data reconstruction were interpreted by 3 experienced blinded observers (consensus reading) during two distinct reading sessions, one with SI alone and the second with EDI alone. The heart was divided into 17 segments.

Results. Coronary angiography showed >50% stenoses in 1 or more major coronary arteries in 38 patients and was normal in 15 patients. The sensitivity was 73.7% (28/38) and 84.2% (32/38), respectively, for SI and EDI. Three of 4 patients with CAD not detected by SI but seen with EDI were considered to have relatively small hearts. The specificity was 86.7% (13/15) and 80.0% (12/15) for SI and EDI, respectively. On a total of 901 segments, 106 ischemic defects were detected by SI and 173 by EDI ($P = .001$). The segmental agreement between the two techniques was 88.6% (798/901 segments).

Conclusion. EDI showed more ischemic defects than SI, and there was also a nonsignificant trend toward an improved sensitivity of EDI in comparison to SI in detection of coronary artery disease in women, especially in patients with small hearts. EDI may be a useful adjunct to the standard perfusion imaging with SGS in such a clinical situation. (J Nucl Cardiol 1999;6:169-76.)

Key Words: Gated SPECT • $^{99m}$Tc-sestamibi • end-diastolic images • myocardial perfusion imaging

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Because of the high count density of technetium $^{99m}$-sestamibi myocardial perfusion studies, acquisition of gated planar or single photon emission computed tomography (SPECT) images synchronized to the patient’s electrocardiogram (ECG) can be performed. Different qualitative and quantitative assessments can be obtained from a gated $^{99m}$Tc-sestamibi SPECT study.1-16 Global and regional wall motion is evaluated by analyzing the excursion of the endocardial surface of the ventricle cavity, the systolic wall thickening is assessed by...
analyzing changes in regional myocardial wall counts during the cardiac cycle, and left ventricular ejection fraction can be determined from gated 99mTc-sestamibi SPECT study.17 Another potential advantage of ECG-gating of radionuclide myocardial perfusion study is the ability to extract and analyze only the end-diastolic images from the complete cardiac cycle images. Theoretically, end-diastolic frames could present a better image resolution by reducing the “blurring” effect of cardiac motion on the final perfusion study and also demonstrate an improved sensitivity in detection of myocardial perfusion defects, especially in patients with small or hyperdynamic hearts.

Although quantitative assessment of myocardial perfusion abnormalities with nongated versus gated 99mTc-sestamibi SPECT has been previously compared, at the present time there is no study performed on a relatively large number of patients (undergoing coronary angiography) showing the diagnostic value of end-diastolic images obtained from both rest and stress 99mTc-sestamibi studies. Accordingly, the purpose of this study was to compare the diagnostic accuracy of end-diastolic images with that of the summed images of gated 99mTc-sestamibi SPECT study in women with known or suspected coronary artery disease (CAD).

**METHODS**

**Patient Group**

The patients for this prospective study consisted of a group of 53 consecutive women with known or suspected CAD scheduled for coronary angiography. Patients with the following criteria were enrolled: (1) All patients had to be scheduled for coronary angiography or had to have a previous coronary angiogram within 2 months of their participation in the study, provided that no change in cardiac status occurred between the times of the myocardial perfusion studies and coronary angiography. (2) The stress imaging procedure that led to the decision to proceed with coronary angiography was not included in this study; 99mTc-sestamibi imaging was performed for this study after the angiographic decision had been made. (3) Patients agreed to participate and signed an informed consent approved by the Institutional Review Board of Hotel-Dieu de Montréal. Patients were excluded from this study if they had undergone previous coronary bypass grafting or percutaneous transluminal coronary angioplasty, had unstable angina, a recent (<6 months) myocardial infarction, symptomatic valvular heart disease, congestive heart failure, or other contraindications for having either a treadmill stress test or pharmacologic vasodilation with dipyridamole.

**Study Design**

Once patients had given consent and were enrolled in the study, they underwent two gated 99mTc-sestamibi SPECT studies, one at stress (treadmill or dipyridamole) and one at rest, with a 2-day injection protocol with a time interval of 24 to 72 hours between the two studies. All studies were performed at the Department of Nuclear Medicine of Hotel-Dieu de Montréal. The choice of the stress modality for a given patient—treadmill stress test or pharmacologic vasodilation with dipyridamole—was determined by agreement between both the referring cardiologist and the nuclear medicine physician.

**Exercise Testing**

**Treadmill Stress Test.** Patients fasted for at least 8 hours before 99mTc-sestamibi treadmill stress testing. Whenever possible, beta-blockers, calcium channel antagonists, and nitrates were discontinued for 24 to 48 hours before the treadmill stress test. All patients underwent symptom-limited treadmill exercise testing with the Bruce protocol. A dose of 25 to 30 mCi of 99mTc-sestamibi was injected intravenously at peak exercise, and the patients exercised for an additional 1 to 2 minutes. The test was terminated when there was ischemic ST segment depression >2 mm, significant arrhythmia, moderate or severe angina pectoris, significant hypotension, excessive fatigue or shortness of breath, or achievement of 100% of the maximal predicted heart rate.

**Pharmacologic Vasodilation with Dipyridamole.** In patients who were unable to achieve an adequate level of exercise (ie, <85% of the maximal predicted heart rate), a dipyridamole infusion was used instead of the treadmill stress test. Patients were instructed to fast after midnight and were told specifically to avoid methylxanthine-containing medications and products such as tea, coffee, chocolate, or soft drinks. With the patient in