Dobutamine-Atropine Stress Echocardiography and Dipyridamole Sestamibi Scintigraphy for the Detection of Coronary Artery Disease: Limitations and Concordance

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OBJECTIVES
We sought to compare dobutamine-atropine stress echocardiography (DASE) and dipyridamole Technetium 99-m (Tc-99m) sestamibi single photon emission computed tomography (SPECT) scintigraphy (DMIBI) for detecting coronary artery disease (CAD).

BACKGROUND
Both DASE and DMIBI are effective for evaluating patients for CAD, but their concordance and limitations have not been directly compared.

METHODS
To investigate these aims, patients underwent multistage DASE, DMIBI and coronary angiography within three months. Dobutamine-atropine stress echocardiography and stress-rest DMIBI were performed according to standard techniques and analyzed for their accuracy in predicting the extent of CAD. Segments were assigned to vascular territories according to standard models. Angiography was performed using the Judkin’s technique.

RESULTS
The 183 patients (mean age: 60 ± 11 years, including 50 women) consisted of 64 patients with no coronary disease and 61 with single-, 40 with two- and 18 with three-vessel coronary disease. Dobutamine-atropine stress echocardiography and DMIBI were similarly sensitive (87%, 104/119 and 80%, 95/119, respectively) for the detection of CAD, but DASE was more specific (91%, 58/64 vs. 73%, 47/64, p < 0.01). Sensitivity was similar for the detection of CAD in patients with single-vessel disease (84%, 51/61 vs. 74%, 45/61, respectively) and multivessel disease (91%, 53/58 vs. 86%, 50/58, respectively). Multiple wall motion abnormalities and perfusion defects were similarly sensitive for multivessel disease (72%, 42/58 vs. 66%, 38/53, respectively), but, again, DASE was more specific than DMIBI (95%, 119/125 vs. 76%, 95/125, respectively, p < 0.01). Dobutamine-atropine stress echocardiography and DMIBI were moderately concordant for the detection and extent of CAD (Kappa 0.47, p < 0.0001) but were only fairly (Kappa 0.35, p < 0.001) concordant for the type of abnormalities (normal, fixed, ischemia or mixed).

CONCLUSIONS
Dobutamine-atropine stress echocardiography and DMIBI were comparable tests for the detection of CAD. Both were very sensitive for the detection of CAD and moderately sensitive for the extent of disease. The only advantage of DASE was greater specificity, especially for multivessel disease. Dobutamine-atropine stress echocardiography may be advantageous in patients with lower probabilities of CAD. (J Am Coll Cardiol 2000;36:1265–73) © 2000 by the American College of Cardiology

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Dipyridamole Technetium 99-m (Tc-99m) sestamibi single photon emission computed tomographic (SPECT) scintigraphy (DMIBI) and dobutamine-atropine stress echocardiography (DASE) are common tests for the evaluation of patients with known or suspected coronary artery disease (CAD) with limited exercise capacity (1–36). Dipyridamole Tc-99m sestamibi SPECT scintigraphy detects disturbances in resting myocardial perfusion and coronary flow reserve (2,37). Coronary artery disease is identified by fixed or reversible perfusion defects (2,37). In contrast, DASE detects alterations in resting myocardial function and demand ischemia-induced dysfunction (20). Coronary artery disease is identified by resting wall motion abnormalities (myocardial scarring, fixed dysfunction with wall thinning and increased echogenicity) and/or induced wall motion abnormalities (20).

Both DMIBI and DASE have been compared with other noninvasive test modalities for the detection of CAD but not to each other (1,3,5,9–12,16,24–30,32–35). Regional abnormalities on both techniques have been shown to correlate with the location of coronary artery stenoses by coronary angiography (8,10,15,16,19,20,33–35). Each technique has been shown to be safe, even in patients with acute myocardial infarction (MI), abdominal aortic aneurysms, severe ischemic cardiomyopathies and left main CAD (15,38–41). Knowledge of the relative limitations
Abbreviations and Acronyms

CAD = coronary artery disease  
DASE = dobutamine-atropine stress echocardiography  
DMIBI = dipyridamole Technetium-99m sestamibi single photon emission computed tomographic scintigraphy  
LAD = left anterior descending coronary artery  
LCX = left circumflex coronary artery  
MI = myocardial infarction  
RCA = right coronary artery  
SPECT = single photon emission computed tomography  
Tc-99m = Technetium 99-m

and concordance of the two tests will be useful in patient management.

The aim of this study is to directly compare the accuracy and limitations of DMIBI and DASE in the detection of the presence and extent of CAD. To investigate this aim and their concordance, we enrolled 183 consecutive patients who underwent DMIBI, DASE and coronary angiography.

METHODS

Patient selection. Patients with known or suspected CAD underwent DASE, DMIBI and coronary angiography within three months of each other at Froedtert Memorial Lutheran Hospital or the Zablocki Veterans Affairs Hospital in Milwaukee, Wisconsin between July, 1992 and June, 1996. All gave informed consent. Exclusion criteria were: recent MI (<1 month), unstable angina, hypertension (systolic blood pressure > 220 mm Hg), hypotension (<90 mm Hg), pregnancy or age ≤18 years. One patient was excluded due to poor acoustic windows.

Dobutamine infusion. Beta-adrenergic antagonists were not stopped before the test. The 5 min stages of dobutamine infusion were 10, 20, 30 and 40 μg/kg/min in patients with normal resting wall motion and 5, 10, 20, 30 and 40 μg/kg/min in those with resting wall motion abnormalities (36). Intravenous atropine (0.2 to 0.4 mg every 2 min to a maximum of 2 mg) was infused to achieve target heart rates if:

1) heart rate was submaximal at a maximal dose of dobutamine or
2) cyclic variability in heart rate >10 beats per min, hyperdynamic wall motion (end-systolic left ventricular diameter < 1 cm) or nausea with retching occurred at submaximal doses of dobutamine.

A 12-lead electrocardiogram and blood pressure were monitored (36). End point doses were: maximum dose, heart rate ≥85% of age predicted maximum, limiting chest pain, headaches, vomiting, hypotension (systolic blood pressure <90 mm Hg), hypertension (systolic blood pressure ≥240 mm Hg), ventricular tachycardia (>5 complexes at cycle lengths <600 ms) or sustained supraventricular tachyarrhythmias (23,36). Esmolol (0.1 to 0.5 mg/kg intravenously every 2 min up to 1.5 mg/kg) or nitroglycerin (0.4 mg sublingually every 5 min up to three doses) were administered after stopping the infusion if chest pain was severe or did not resolve in ≤4 min.

Six echocardiographic views (parasternal long and short axis, apical four-chamber, two-chamber, long axis and short axis) were videotaped at rest and at each stage (36). Images were digitized online at rest, 5 or 10 μg/kg/min, peak dose and recovery with a CineView (Tomtec Imaging, Louisville, Colorado) R-wave triggered acquisition system and stored in a quad screen, continuous loop format on 3.5-inch floppy or optical discs (36,41).

Echocardiographic analysis. The digitized echocardiographic images were analyzed by two experienced readers without knowledge of clinical, electrocardiographic or angiographic data (36,41). When there was disagreement, a third investigator viewed the images, and differences were resolved by consensus. Videotape recordings were not routinely used but were available. Images were analyzed according to the previously described 16 segment model and scoring system (1 = normal, 2 = hypokinetic, 3 = akinetic, 4 = dyskinetic) (9). Inadequately visualized segments were not scored. All studies were technically adequate.

Segments were assigned to coronary vascular territories according to known distributions. Global wall motion score index was calculated by the standard formula (36). An abnormal response was defined as:

1) fixed, abnormal wall thickening in ≥2 contiguous segments at rest without change at low or peak dose;
2) mixed, resting wall motion abnormality with worsening or a new abnormality in ≥2 segments at peak dose or
3) ischemia, normal resting wall motion with a induced wall motion abnormality in ≥2 contiguous segments (36).

A normal response was defined as a progressive increase in wall thickening from rest to peak dose.

DMIBI. The dipyridamole infusion protocols used the standard intravenous dose protocol in the morning in the fasted state (42). Preinfusion heart rate, 12-lead electrocardiogram and blood pressure measurements were obtained in the supine position and at 2-min intervals thereafter. The infusion protocol was 0.142 mg/kg/min for 4 min with or without arm crank exercise for 2 min. Technetium 99-m sestamibi was infused 3 min after the completion of the infusion. Cardiac medications were not interrupted, but methylxanthine-containing medications were withheld for 48 h before these studies. Parenteral aminophylline (125 mg) was given at the end of the study or when patients developed severe chest pain, shortness of breath or hypotension. Sublingual nitroglycerin was available to reverse persistent side effects as needed.

Stress and rest Tc-99m sestamibi SPECT scintigraphy was performed at 1 h after injecting 370 MBq (10 mCi) and 1,100 MBq (30 mCi) of Tc-99m sestamibi, respectively.
Coronary angiography. Coronary angiography was performed by the Judkin’s technique. Results were analyzed by an experienced angiographer without knowledge of the clinical and echocardiographic data. Percent luminal diameter stenosis of all coronary stenoses was determined by the caliper technique (36). The diameter of the most stenotic region was compared with the most normal-appearing region proximal to the stenosis. The criterion for coronary stenosis was ≥50% luminal diameter stenosis of any epicardial coronary artery or major branch.

Statistical analysis. Chi-square analysis or Fisher exact test was used to compare categorical DASE and DMIBI data (43). A Student paired t test was used to compare the size and severity of abnormalities of the two tests and identify differences. Continuous data are reported as mean ± standard deviation. Correlations among quantitative coronary angiography, DASE and DMIBI data were evaluated using the Kappa statistic (True Epistat software, Richardson, Texas) and the Fisher z test (43). Kappa values <0.00 are indicative of poor concordance, 0.00 to 0.20 of slight concordance, 0.21 to 0.40 of fair concordance, 0.41 to 0.60 of moderate concordance, 0.61 to 0.80 of substantial concordance and 0.81 to 1.00 of almost perfect concordance. Differences were considered significant at a two-tailed p <0.05.

RESULTS

Patient data. The 183 study patients consisted of 133 male and 50 female patients with a mean age of 60 ± 11 years. Testing was done for typical angina pectoris in 48 patients (26%), atypical chest pain in 99 (54%), assessment of the significance of known CAD in 18 (10%) and preoperative screening in 18 (10%). Medical therapy included aspirin in 53 patients (29%), beta- adrenergic blocking agents in 49 (27%), calcium channel blockers in 73 (40%), diuretics in 31 (17%), digoxin in 14 (8%), nitrates in 41 (22%) and diuretics in 31 (17%). Dobutamine-atropine echocardiography and DMIBI were performed before angiography in 165, after angiography in 15 and one before and the other after angiography in three.

Coronary angiography. Significant CAD was detected in 119 patients (65%). There were 64 patients with no CAD (35%) and 61 (33%) with single-, 40 (22%) with two- and 18 (10%) with three-vessel disease. The 61 patients with single-vessel disease consisted of 18 with left anterior descending coronary artery (LAD), 30 with right coronary artery (RCA) and 13 with left circumflex coronary artery (LCX) disease. The 40 patients with two-vessel disease consisted of 17 with RCA and the LCX, 16 with LAD and the RCA and 7 with LAD and the LCX disease.

Dobutamine echocardiographic data. Resting heart rate and resting blood pressure were 71 ± 13 beats/min and 128 ± 21 mm Hg, respectively. The mean peak dose was 31 ± 12 μg/kg/min. Atropine was used in 78 (43%). Peak heart rate and blood pressure were 127 ± 17 beats/min and

(42). All patients were encouraged to eat a fatty meal after the stress injection to promote bile flow and increase the liver and gallbladder clearance of activity. Single photon emission computed tomography was performed by acquiring 32 projections over 180° (from 45° RAO to 135° LAO) on a circular, 400-mm field of view gamma camera equipped with a high-resolution collimator interfaced to a computer. All data were stored in 64 × 64 matrices. After prefiltering by a Butterworth filter with a frequency cut-off of 0.4 cycles/cm and an order of 5, filtered back-projection with a Ramp filter was done to form transaxial sections 6-mm (one pixel) thick. Data was obliquely reoriented using 6 mm slices into 12 mm (two pixel) thick slices in three orthogonal planes (seven to eight slices from apex to base in the short axis and five to six in the vertical and horizontal long axis planes). Acquisition time per projection was 40 and 20 s for stress and rest studies, respectively. Intensity was maximized for rest and stress images to the hottest pixel in each image set. All planar images from the stress and rest studies were photographed along with the reconstructed SPECT images. Planar images were used to document patient movement and evaluate extracardiac uptake.

Myocardial territories were evaluated by the same 16 segment model used in echocardiographic analysis (36,42). The long axis of the left ventricle was divided into basal, mid and apical thirds, the apex into four segments (septal, anterior septal, anterior, lateral and inferior) and the mid and basal thirds into six segments (septal, anterior septal, anterior, lateral, posterior and inferior). Landmarks were the connections of the right ventricle to the left ventricle. Segmental uptake was defined as: normal (maximal and a score of 1); mildly reduced (normal thickness with slightly reduced uptake, score 2); moderately reduced (normal thickness with significantly reduced, but easily discernible, uptake, score 2.5); severely reduced (only a rim of activity with barely detectable uptake, score 3); or absent (no visually apparent uptake, score 4).

Images were reviewed by two independent expert observers using both radiographic film and computerized displays of corresponding rest and stress oblique tomograms. A perfusion defect was defined as decreased activity in ≥2 segments in poststress images. Perfusion defects were subclassified as: 1) fixed, a resting defect in ≥2 contiguous segments that did not change after dipyridamole infusion; 2) mixed, resting defect with worsening of ≥1 grade or a new defect in ≥2 segments after dipyridamole; or 3) ischemia, normal resting perfusion with new defects in ≥2 contiguous segments after dipyridamole. Apical segments were counted as defects only when contiguous segments were abnormal. A high correlation (96%) has been previously reported between expert visual analysis of defect extent and quantitative analysis of the SPECT images (32). The average segmental uptake score was calculated at rest and peak stress for all segments and each perfusion territory. The percentage of segments with abnormal uptake and ischemia was also calculated for each patient and each perfusion territory.
145 ± 33 mm Hg, respectively. Patients tolerated the procedure well without sustained ventricular tachycardia or MI. Only four patients rated the side effects as intolerable (dyspnea in one, chest pain in two and nausea in one).

Wall motion abnormalities were detected in 110 patients (60%) including 18 (10%) fixed, 50 (27%) mixed and 42 (23%) ischemic abnormalities. The 110 patients with wall motion abnormalities consisted of 62 (34%) in one, 28 (15%) in two and 20 (11%) in all three vascular territories. The 62 single abnormalities were located in the LAD territory in 18 patients, the RCA in 32 and the LCX in 12. The 28 dual wall motion abnormalities were located in the RCA and LCX territories in 15 patients, the LAD and the RCA in 9 patients and the LAD and the LCX in 4 patients.

**DMIBI.** Hemodynamics did not change during dipyridamole infusion. There were no episodes of sustained ventricular tachycardia, prolonged chest pain or hypotension or MI. Only two patients rated the side effects as intolerable (chest pain in one and flushing in one).

Perfusion defects were detected in 112 patients (61%) including 17 (9%) fixed, 48 (26%) mixed and 47 (26%) ischemic defects. The 112 patients with perfusion defects consisted of 44 (24%) with defects in one, 38 (21%) in two and 30 (16%) in three vascular territories. The 44 single perfusion defects were located in the LAD territory in 18 patients, the RCA in 20 and the LCX in 4. The 38 dual defects were located in the RCA and LCX territories in 16 patients, the LAD and the RCA in 19 and the LAD and the LCX in 3.

**Detection of CAD.** The sensitivity and specificity of DASE and DMIBI for the detection of CAD by at least one abnormality are listed in Table 1. Both tests were sensitive, but DASE was more specific. Both tended to be more sensitive in multivessel than in single-vessel disease and were least sensitive in single-vessel LCX disease. The sensitivity was similar in all subsets of patients with single- or multivessel coronary disease. False positive DASE occurred only in the inferior wall (6), while the false positive DMIBI occurred in all myocardial regions (15 anterior/septal and 11 inferior/posterior/lateral).

**Detection of multivessel CAD.** Abnormalities in multiple vascular territories during DASE and DMIBI were moderately sensitive for multivessel CAD (Table 1), but DASE was more specific (p < 0.01). The sensitivity of the tests was similar in all angiographic subsets. Both were more sensitive (p < 0.05) in three-vessel than they were in two-vessel disease. Multiple wall motion abnormalities did not occur in patients without disease and were rare in single-vessel...
Multiple perfusion defects were more common (p < 0.05) than multiple wall motion abnormalities in patients without disease and were common in single-vessel disease.

The accuracy of the tests for the detection of disease in specific vascular territories are also listed in Table 1. Dobutamine atropine stress echocardiography was more specific than DMIBI in the LAD and RCA vascular territories. The specificity of the two tests was similar in the LCX vascular territory. The sensitivities of the tests were similar all vascular territories.

**Comparison of the extent and severity of abnormalities.** Table 2 compares the size, extent of ischemia and severity of the perfusion defects on DMIBI to that of wall motion abnormalities at DASE. Overall, the differences were the larger size, greater severity and larger extent of ischemia of perfusion defects in patients without CAD and the greater severity of wall motion abnormalities in patients with two-vessel RCA and LCX disease. In the LAD vascular territory, the only difference was the larger size, greater severity and larger extent of ischemia of perfusion defects in patients without CAD. In the RCA vascular territory, the differences were the greater severity of perfusion defects in patients with single-vessel LAD and the greater severity of wall motion abnormalities in patients with RCA and LCX disease. In the LCX vascular territory, the difference was the larger size, greater severity and larger extent of ischemia of perfusion defects in patients with single-vessel LAD and RCA disease and no disease. Ischemia was more common on DMIBI in patients with two-vessel disease, but defect size and severity was similar. No differences were noted in patients with three-vessel disease.

**Concordance.** Concordance data for the extent and character of abnormalities are presented in Table 3. There was moderate concordance among DASE, DMIBI and coronary angiography for the extent of CAD. The concordance was moderate in those without disease and those with multivessel disease but was only fair in those with single-vessel disease. The concordance was only fair for the type of abnormalities. The concordance was moderate in those without CAD but was only fair in those with single-vessel and multivessel disease. Mixed or ischemic abnormalities were similarly common in patients with CAD but were more common on DMIBI in those without disease.

**Intra- and inter-observer variability.** Intra- and inter-observer variability of wall motion analysis was minimal in a representative subset of 60 patients including 40 patients with and 20 patients without CAD. The interpretations of the two investigators regarding the presence or absence of any or multiple perfusion defects agreed in 93% (56/60) and 92% (55/60), respectively. Intra-observer variability was assessed by one investigator. The two readings were concordant regarding the presence or absence of any or multiple wall motion abnormalities in 97% (58/60) and 95% (57/60), respectively.

**Discussion**

Previous studies. In patients with known or suspected CAD who are not able to perform an exercise stress test, available noninvasive modalities include thallium-201 scintigraphy, Tc-99m sestamibi scintigraphy and echocardiography with dipyridamole, adenosine, atrial pacing or dobutamine with atropine (1–36). High-dose dobutamine and atropine produce demand ischemia through both chronotropic and inotropic effects (20). In contrast, dipyridamole and adenosine preferentially vasodilate normal coronary segments to create a steal or relative hyperperfusion in arteries with flow limiting stenosis (2,4).

Technetium 99-m sestamibi is becoming the stress radionuclide of choice due to its sharper image quality and more flexible scanning properties (1–17). Planar and SPECT dipyridamole (0.56 to 0.82 mg/kg) Tc-99m sestamibi scintigraphy is accurate for CAD (1–17). Single photon emission computed tomography imaging enhances sensitivity (7). Sensitivity has been shown to be consistently high at 80% to 100%, but specificity has been more variable at 28% to 100%. Other studies have shown that DMIBI is accurate for the extent of CAD and the presence or absence of lesions in specific vascular territories (8,10,15,16).

Echocardiography is another commonly used modality to detect CAD by exercise and pharmacologic stress tests (18–36). Dobutamine stress echocardiography is accurate for CAD (18–36). The addition of atropine may enhance sensitivity, especially in patients treated with beta-blockers (22). Sensitivities have ranged from 54% to 96% and specificities from 66% to 100% (18–36). Doses of up to 50 \( \mu g/kg/min \) of dobutamine and up to 2 mg of atropine have been safely infused in several safety trials (38–41). Dobutamine-atropine stress echocardiography may also be accurate for the extent of CAD and the presence or absence of lesions in specific vascular territories (19,20,23–25,34).

Previous studies have compared DMIBI with dipyridamole SPECT thallium-201 scintigraphy and exercise SPECT Tc-99m sestamibi scintigraphy: 1,3,5,9,12,16. Sensitivity and specificity were similar for the detection of CAD. Dobutamine-atropine stress echocardiography has also been compared with exercise echocardiography, adenosine Tc-99m sestamibi SPECT scintigraphy, dobutamine Tc-99m sestamibi SPECT scintigraphy, dipyridamole echocardiography and dipyridamole SPECT thallium-201.
### Table 2. Segmental Findings on DMI and DASE According to Vascular Territory and Angiographic Data (Peak Stress Data)

<table>
<thead>
<tr>
<th>Extent of CAD</th>
<th>Overall</th>
<th>LAD</th>
<th>RCA</th>
<th>LCX</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Abn Seg %</td>
<td>Ischemic</td>
<td>Average Seg Score</td>
<td>Abn Seg %</td>
</tr>
<tr>
<td>DMI</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All Patients</td>
<td>27 ± 29</td>
<td>17 ± 21</td>
<td>1.44 ± 0.51</td>
<td>21 ± 31</td>
</tr>
<tr>
<td>No CAD</td>
<td>10 ± 20*</td>
<td>8 ± 17*</td>
<td>1.15 ± 0.31*</td>
<td>12 ± 26*</td>
</tr>
<tr>
<td>CAD</td>
<td>36 ± 29</td>
<td>22 ± 22</td>
<td>1.59 ± 0.52</td>
<td>25 ± 33</td>
</tr>
<tr>
<td>Single-vessel CAD</td>
<td>28 ± 26</td>
<td>20 ± 22</td>
<td>1.45 ± 0.44</td>
<td>19 ± 32</td>
</tr>
<tr>
<td>RCA</td>
<td>34 ± 29</td>
<td>22 ± 23</td>
<td>1.69 ± 0.48</td>
<td>51 ± 39</td>
</tr>
<tr>
<td>LAD</td>
<td>32 ± 24</td>
<td>18 ± 24</td>
<td>1.29 ± 0.43</td>
<td>5 ± 15</td>
</tr>
<tr>
<td>LCX</td>
<td>43 ± 30</td>
<td>23 ± 22</td>
<td>1.75 ± 0.56</td>
<td>32 ± 33</td>
</tr>
<tr>
<td>LAD &amp; RCA</td>
<td>38 ± 30</td>
<td>15 ± 23</td>
<td>1.60 ± 0.62</td>
<td>26 ± 34</td>
</tr>
<tr>
<td>LAD &amp; LCX</td>
<td>42 ± 35</td>
<td>35 ± 26</td>
<td>1.85 ± 0.44</td>
<td>46 ± 35</td>
</tr>
<tr>
<td>Three-vessel CAD</td>
<td>47 ± 37</td>
<td>30 ± 25</td>
<td>1.93 ± 0.61</td>
<td>46 ± 34</td>
</tr>
<tr>
<td>DASE</td>
<td>23 ± 27</td>
<td>13 ± 16</td>
<td>1.43 ± 0.50</td>
<td>17 ± 30</td>
</tr>
<tr>
<td>No CAD</td>
<td>25 ± 26</td>
<td>25 ± 16</td>
<td>1.05 ± 0.15</td>
<td>0 ± 0</td>
</tr>
<tr>
<td>CAD</td>
<td>35 ± 26</td>
<td>20 ± 17</td>
<td>1.64 ± 0.50</td>
<td>26 ± 34</td>
</tr>
<tr>
<td>Single-vessel CAD</td>
<td>35 ± 19</td>
<td>16 ± 12</td>
<td>1.44 ± 0.37</td>
<td>16 ± 29</td>
</tr>
<tr>
<td>RCA</td>
<td>43 ± 20</td>
<td>16 ± 12</td>
<td>1.41 ± 0.36</td>
<td>4 ± 16</td>
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<tr>
<td>LAD</td>
<td>32 ± 18</td>
<td>18 ± 23</td>
<td>1.62 ± 0.40</td>
<td>48 ± 30</td>
</tr>
<tr>
<td>LCX</td>
<td>16 ± 15</td>
<td>13 ± 13</td>
<td>1.27 ± 0.26</td>
<td>0 ± 0</td>
</tr>
<tr>
<td>LAD &amp; RCA</td>
<td>46 ± 27</td>
<td>24 ± 20</td>
<td>1.85 ± 0.53</td>
<td>36 ± 37</td>
</tr>
<tr>
<td>LAD &amp; LCX</td>
<td>44 ± 27</td>
<td>23 ± 21</td>
<td>1.81 ± 0.52</td>
<td>35 ± 38</td>
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<tr>
<td>Three-vessel CAD</td>
<td>47 ± 27</td>
<td>21 ± 17</td>
<td>1.88 ± 0.56</td>
<td>27 ± 33</td>
</tr>
</tbody>
</table>
| *p < 0.05 vs. DASE. Abn Seg = abnormal segments with reduced sestamibi uptake or abnormal wall thickening at peak stress; Average Seg Score = average sestamibi uptake score or wall motion score in the vascular territory or entire heart (overall). All other abbreviations as in Table 1.
scintigraphy (24–30,32–35). Sensitivity and specificity were similar for the detection of CAD, but DASE may be more specific than dobutamine Tc-99m sestamibi SPECT scintigraphy.

Dipyridamole Tc-99m sestamibi SPECT scintigraphy has not been compared with DASE. Vasodilator stress may be a better method to detect hypoperfusion. Dipyridamole is a commonly used vasodilator stress modality. Previous studies have not resolved several issues:

1) Do the tests provide comparable data?
2) Are the tests sensitive and specific for the extent of CAD?
3) Do the tests have the same strengths and limitations?
4) Are there differences in patient tolerance?

Present study. The present study directly compared the accuracy of DASE and DMIBI for the detection of CAD and its extent in a set of patients who underwent both tests and coronary angiography. All studies were performed within a three-month period. Both tests were tolerated well without major side effects or complications. Patient tolerance was good, and most patients were willing to repeat the tests. Chest pain tended to be more common with dobutamine echocardiography.

The two tests were fairly comparable for the detection of CAD. Sensitivity was similar for the detection of CAD. There were no differences in any of the angiographic subsets. The only difference was the greater specificity of DASE. In patients without CAD, the difference in specificity resulted from the more common detection of ischemic abnormalities by DMIBI in the LAD vascular and LCX territories. No clinical or hemodynamic factor accounted for the differences.

The two tests were also fairly comparable for the extent of CAD. The sensitivity of the two tests was similar in all angiographic subsets with multivessel CAD. Defect size, severity and extent of ischemia were similar in patients with CAD, but ischemia was more commonly detected in the LCX vascular territory by DMIBI in patients with two-vessel CAD. The other difference was in specificity. The lower specificity of DMIBI for multivessel CAD mainly resulted from the common detection of multiple perfusion defects in patients with single-vessel CAD. False positive perfusion defects in remote territories of patients with single-vessel disease mainly occurred in the RCA and LCX vascular territories. No clinical or hemodynamic factor accounted for differences.

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The two tests were fairly to moderately concordant. The tests and angiography were moderately concordant for the detection of CAD. The tests and angiography were moderately concordant for the detection of CAD.
extent of CAD, especially in patients without disease and those with multivessel disease. Concordance was only fair in patients with single-vessel disease. In contrast, the concordance between the types of abnormalities (normal, fixed, ischemia or mixed) was only fair. Concordance was moderate in patients without CAD but was only fair in those with single- or multivessel disease. Mixed or ischemic abnormalities were similarly common in patients with CAD but were more common on DMIBI in patients without disease.

The tests were feasible in this unselected population. Only one patient was excluded due to poor acoustic windows. Both tests were least sensitive for disease in patients with single-vessel LCX disease. False positives occurred in the all vascular territories for DMIBI but only occurred in the RCA vascular territory for DASE.

Study limitations. Dobutamine-atropine stress echocardiography, DMIBI and coronary angiography were not done on the same day. While the interval between studies was up to three months in some cases, the majority (80%, 146/182) were performed within one week of each other. None of the patients had intervening ischemic events. Dipyridamole Tc-99m sestamibi SPECT scintigraphy did not include patients who had intervening ischemic events. Dipyridamole Tc-99m sestamibi SPECT scintigraphy did not include patients who had intervening ischemic events. Dobutamine-atropine stress echocardiography and DMIBI were analyzed by similar segmental models, but segments may not have been perfectly matched. These data may have influenced some of the concordance data for vascular territories but could not have influenced the results regarding the detection of CAD or its extent. Finally, concordance data was moderate for the extent of abnormalities, indicating that this effect was minor. Thus, the discordance resulted from intrinsic differences in mechanisms of detection of CAD.

Clinical implications and conclusion. Dobutamine-atropine stress echocardiography and DMIBI are comparable tests for the detection of CAD. Both are sensitive for the detection of CAD and moderately sensitive for the presence of multivessel disease. The only advantage of DASE was its greater specificity. False positive wall motion abnormalities only occurred in the RCA vascular territory. Multiple wall motion abnormalities did not occur in those without disease and were uncommon in single-vessel disease. In contrast, false positive perfusion defects occurred in all vascular territories, and multiple defects were commonly detected in patients with single-vessel disease. The concordance was moderate for the extent and severity of abnormalities but was only fair for the type of defects. Dobutamine-atropine stress echocardiography may be advantageous in patients with lower probabilities of CAD.

REFERENCES