A comparison of Tl-201, Tc-99m sestamibi, and Tc-99m tetrofosmin myocardial perfusion scintigraphy in patients with mild to moderate coronary stenosis

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Background. **Thallium 201, technetium 99m sestamibi (MIBI), and Tc-99m tetrofosmin differ in their myocardial uptake characteristics. This may make the technetium tracers less sensitive for detecting mild to moderate coronary stenosis.**

Methods and Results. **We identified 163 patients with angiographic mild to moderate stenosis (50%-89%) and coexistent severe disease (88/163 patients) from a previous study of patients who received either thallium, MIBI, or tetrofosmin for myocardial perfusion scintigraphy. Summed segmental uptake scores were used to assess myocardial perfusion of territories supplied by the mildly to moderately stenotic vessels. Mean (± SD) summed stress uptake scores in the left anterior descending artery territory were 21.4 ± 3.8, 21.6 ± 4.2, and 22.1 ± 2.3 for thallium, MIBI, and tetrofosmin, respectively ($P = .7$); mean summed difference uptake scores were 1.2 ± 1.8, 1.1 ± 1.9, and 1.0 ± 1.1, respectively ($P = .8$). In the non–left anterior descending artery territory, mean summed stress uptake scores were 32.5 ± 6.3, 34.0 ± 6.3, and 34.5 ± 4.7 for thallium, MIBI, and tetrofosmin, respectively ($P = .4$), whereas mean summed difference scores were 1.9 ± 2.6, 1.7 ± 2.2, and 1.7 ± 2.3, respectively ($P = .9$).**

Conclusion. **There were no significant differences between the tracers for the summed uptake scores. This suggests that the 3 tracers are comparable in clinical practice for assessing the extent and severity of perfusion abnormalities arising from mild to moderate coronary artery stenosis, especially in the presence of coexistent severe disease. (J Nucl Cardiol 2006;13: 488-94.)**

Key Words: Coronary stenosis • myocardial perfusion scintigraphy • thallium • sestamibi • tetrofosmin

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In the assessment of patients with coronary artery disease it is important to distinguish individuals with nonsignificant coronary stenosis who can be treated medically from those with significant narrowing of the arterial lumen who might require intervention. X-Ray coronary angiography is good at identifying both normal coronary arteries and those with severe stenoses, but in patients with mild to moderate stenoses the distinction between those with hemodynamically significant lesions and those with insignificant lesions is more difficult.[1-3] Myocardial perfusion scintigraphy (MPS) can make this distinction.[4,5] Limited previous data suggest that the different pharmacokinetic properties of the 3 most widely used tracers lead to variable perfusion defects and may reduce the sensitivity of the technique when the technetium tracers are used in patients with mild to moderate stenoses.[6,7] The aim of this study was to compare the uptake abnormalities of thallium 201, technetium 99m sestamibi (MIBI), and technetium 99m tetrofosmin MPS in patients with mild to moderate coronary artery stenosis.

METHODS

Study Design

Our experience indicates that, overall, thallium produces more profound and extensive defects of myocardial perfusion than technetium 99m.[8] We hypothesized that any differences in the depth and extent of inducible perfusion abnormalities between thallium, MIBI, and tetrofosmin would be more apparent in the setting of mild to moderate coronary stenosis (50%-89% luminal diameter reduction[9]). The patients in this study are a subset of those already reported in the ROBUST (Royal Brompton and UCL Study of Thallium and Technetium) study, in which 2560 patients referred for a clinically indicated MPS scan received either thallium, MIBI, or tetrofosmin.[8] On the basis of a 17-segment myocardial uptake score system, the study showed that the extent and depth of perfusion abnormalities was greater with thallium, but no difference was found between MIBI and tetrofosmin. It was concluded that the 3 tracers perform well in clinical terms with comparable accuracies for the detection of angiographic coronary disease.

Study Population

Subjects were selected from 2560 patients whose clinical, imaging, and angiographic data have previously been reported.[8] All patients were referred for MPS at one of the participating centers (Royal Brompton Hospital and Middlesex Hospital, London, United Kingdom). The subset of patients with mild to moderate stenosis in at least 1 major vessel on coronary angiography performed within 1 year of MPS was included in this study. Patients with a history of previous myocardial infarction, prior percutaneous coronary intervention or coronary artery bypass grafting, and left bundle branch block on resting electrocardiography were excluded from the study, as these might lead to scintigraphic abnormalities unrelated to the angiographic findings.

Imaging Procedure

All patients underwent 1-day stress-rest MPS by use of adenosine with submaximal exercise for stress or dobutamine infusion when adenosine was contraindicated. Patients were asked to avoid caffeine-containing products for a minimum of 12 hours before the test. Medications were not altered except for dipyridamole, which was discontinued for a minimum of 24 hours beforehand.

In patients receiving thallium, 80 MBq (2.2 mCi) was injected during stress, and images were acquired 5 minutes after injection. Redistribution images were obtained 3 to 4 hours later with reinjection of 40 MBq (1.1 mCi) thallium at rest 5 minutes after the administration of 800 μg of sublingual nitroglycerin if redistribution was considered by the supervising physician to be incomplete. In patients receiving MIBI or tetrofosmin, 250 MBq (6.7 mCi) was injected during stress, with image acquisition 30 to 60 minutes later. Three to four hours after stress imaging, 750 MBq (20.3 mCi) was given at rest under nitrate cover, with imaging 30 to 60 minutes later.

Emission tomographic imaging was performed with a dual-headed gamma camera (Optima; IGE Medical Systems, Milwaukee, Wisc) equipped with a low-energy, all-purpose collimator for thallium imaging and a high-resolution collimator for technetium imaging. Patients were in the supine position, and 64 projections were acquired over a semicircular 180° arc from 45° right anterior oblique to 45° left posterior oblique. We used 20% symmetric energy windows at 72 and 169 keV for thallium and at 140 keV for technetium. The acquisition time was 20 seconds per projection for stress thallium, reinjection thallium, and rest technetium images and 25 seconds for stress technetium and redistribution thallium images. Transverse tomograms of the left ventricle were reconstructed by use of a Hanning prefilter with a cutoff frequency of 0.75 cycles per centimeter and a ramp filter during backprojection. Transaxial slices were reoriented to obtain oblique-angle tomograms parallel to the long and short axes of the left ventricle. Short-axis, horizontal long-axis, and vertical long-axis views of the left ventricle were obtained according to current recommendations.[10] No attenuation, scatter, or motion correction was used.

Image Interpretation

The images were analyzed independently by 2 experienced readers, and differences were resolved by consensus. Unprocessed planar images were displayed in the cine format to assess patient motion, breast, or diaphragmatic attenuation. The tomograms were divided into 17 segments, and tracer uptake in each segment was graded semiquantitatively by use of a 5-point scale, in which 0 indicated absent uptake (tracer activity, 0%-9% of maximal myocardial activity), 1 indicated severe reduction (10%-29%), 2 indicated moderate reduction (30%-49%), 3 indicated mild reduction (50%-69%), and 4 indicated normal uptake (tracer activity ≥70% of maximum), but the scores took account of the overall clinical impression to reflect routine practice. For instance, account was taken of an artifact such that a segment with normal uptake but reduced counts caused by attenuation was scored as 4. This was an uptake score, therefore, as opposed to a defect score and is similar to uptake scores used elsewhere,[11] but it is inverted compared with another commonly used system of defect scoring.[12] Each segment was classified further as having a fixed, reversible, or partially reversible (mixed) defect or as normal. Myocardial segments were allocated to 1 of 2 coronary vascular territories as left anterior descending artery (LAD) (6 segments) and non-LAD (left circumflex plus right coronary artery) (10 segments) to overcome the problem of overlap between the left circumflex and right coronary territories. Because of the variable nature of perfusion to the apex and the presence of concomitant severe disease in some patients, this