Stress/rest myocardial perfusion scintigraphy in patients without significant coronary artery disease

Umar Adamu, MD,[a] Daniela Knollmann, MD,[b] Bader Almutairi,[a] Wael Alrawashdeh,[a] Verena Deserno,[a] Felix Vogt, MD,[a] Eduard Kleinhans, MD,[b] Wolfgang M. Schäfer, MD,[b] and Rainer Hoffmann, MD[a]

Aim. **To define the prognostic impact of stress myocardial perfusion scintigraphy (MPS) in patients with angiographic exclusion of significant coronary artery disease.**

Methods. **Angiographic and MPS databases were matched to define patients without significant coronary artery disease by quantitative angiography (diameter stenosis <50%) who underwent stress MPS and coronary angiography within a time period of 3 months. A total of 118 patients were identified and followed for a mean of 6.3 ± 1.2 years for death, a composite of death, myocardial infarction, bypass surgery, or percutaneous coronary intervention [MAE]) as well as occurrence of symptoms (angina or dyspnoe class CCS II to IV). Stress and rest MPS (using ^{99m}Tc-MIBI or tetrofosmin) were analyzed by quantitative perfusion SPECT (QPS) for summed stress and rest scores (SSS/SRS).**

Results. **There were 16 deaths, 29 MAE, and 76 patients with MAE or significant symptoms during follow-up. Significant differences in SSS were found between patients who died (9.5 ± 6.9 vs. 5.4 ± 5.6, $P = 0.012$), had MAE (8.7 ± 7.2 vs. 5.2 ± 5.0, $P = 0.010$), or had MAE or significant clinical symptoms (7.2 ± 7.1 vs. 4.6 ± 6.2, $P = 0.042$) compared to those without the respective event. Logistic regression analysis demonstrated SSS to be a predictor of death (OR = 1.074 [95% CI: 1.004-1.149], $P = 0.026$) and MAE (OR = 1.087 [95% CI: 1.004-1.181], $P = 0.027$).**

Conclusions. **In patients without significant angiographic coronary artery disease, the result of stress MPS is a predictor of long-term prognosis. Quantitative analysis of MPS allows definition of patients with a higher likelihood to develop clinical events or symptoms. (J Nucl Cardiol 2010;17:38–44.)**

Key Words: Coronary artery disease • myocardial perfusion scintigraphy • prognosis

See related editorial, pp. 8–12

INTRODUCTION

Myocardial perfusion scintigraphy (MPS) has been shown to have high accuracy in the identification of coronary artery disease and to provide prognostic information on future cardiac events.[1-4] Although the prognostic value of myocardial perfusion imaging has been demonstrated in a number of studies, these study cohorts included patients with and without prior myocardial infarction, with prior revascularization, angiographically proven, or clinically suspected coronary artery disease.[4-6] The prognostic value of myocardial perfusion SPECT in patients in whom significant coronary artery disease was excluded by coronary angiography and in whom medical therapy was chosen based on the results of coronary angiography has not been examined. Still, myocardial perfusion defects in patients

From the Medical Clinic I,[a] University RWTH Aachen, Aachen, Germany and Department of Nuclear Medicine,[b] University RWTH Aachen, Aachen, Germany.

Umar Adamu and Daniela Knollmann have contributed equally to this work.

Received for publication Apr 8, 2009; final revision accepted Jul 16, 2009.

Reprint requests: Rainer Hoffmann, MD, Medical Clinic I, University RWTH Aachen, Pauwelsstraße 30, 52057 Aachen, Germany; *rhoffmann@ukaachen.de*.

1071-3581/$34.00

doi:10.1007/s12350-009-9133-6

without significant stenosis in the epicardial coronary vessels may reflect advanced coronary atherosclerosis.

This study sought to define the prognostic value of stress myocardial perfusion SPECT in a patient population with invasive exclusion of significant coronary artery disease. This is a patient population which is likely to have rather minor perfusion defects and should have limited risks for subsequent clinical events in comparison to patients with obvious significant coronary artery disease. A quantitative analysis of perfusion images with the ability to detect and differentiate also minor perfusion defects may be of advantage to a subjective visual analysis.

METHODS

Angiographic and myocardial perfusion scintigraphy databases of the University Aachen were matched for the time period between January 1, 2000 and December 31, 2003 to define patients without significant coronary artery disease by quantitative angiography (diameter stenosis <50%) who had stress SPECT studies. The angiographic database included 20,384 patients during this period, and the myocardial perfusion scintigraphy database included 4903 patients. A total of 1667 patients were found to have stress MPS and coronary angiography performed within 3 months during the above-mentioned time period without a coronary event between stress MPS and coronary angiography. Patients with previous coronary revascularization, myocardial infarction, valvular heart disease, left bundle branch block, or cardiomyopathy were excluded from the analysis. A total of 118 patients were finally identified to have nonsignificant coronary artery disease by quantitative coronary angiography and an available stress MPS study.

Quantitative Coronary Angiography

Quantitative coronary angiography was performed in case a coronary lesion was defined by visual analysis. Analysis was performed using a computer-assisted, automated, edge detection system (Philips Easy Vision). The person analyzing the angiograms was blinded to clinical and MPS data. The guiding catheter was used as a scaling device. The minimal lumen diameter and the proximal and distal reference vessel diameters were determined to allow calculation of the percent diameter stenosis. Significant coronary artery stenosis was excluded if (1) by visual analysis no coronary lesion could be identified or (2) quantitative coronary angiography on coronary lesions identified by visual analysis had less than 50% diameter stenosis.

Cineventriculography performed in 30° RAO projection with injection of 30 cc of contrast agent and acquisition of 30 frames/sec was used to evaluate left ventricular ejection fraction. Analysis of ejection fraction was performed using computer-assisted, automated, edge detection system (Philips Easy Vision).

SPECT Acquisition Protocol

Stress and rest studies were done in a one-day (1×300 MBq followed by 1×750 MBq) or a two-day (2×450 MBq) protocol using ^{99m}Tc-Tetrofosmin or MIBI. A total of 67 patients were stressed by bicycle exercise stress and 51 patients with pharmacological stress using dipyridamole. In case of bicycle exercise stress, ^{99m}Tc-Tetrofosmin or MIBI were injected during maximal or symptom-limited exercise with the workload increased by 25 W every 2 minutes and at rest. In case of dipyridamole stress, ^{99m}Tc-Tetrofosmin or MIBI were injected 3 minutes after completion of a 4-minute dipyridamole infusion (0.56 mg dipyridamole/kg body weight) and at rest. The SPECT protocol usually started with the stress part, followed by SPECT at rest either the same day (one-day protocol; $N = 54$) or a few days later (two-day protocol; $N = 64$). Antianginal drugs were stopped on the day of the stress test while β-blockers were discontinued 2 days before the test. In case of dipyridamole stress, patients were instructed not to consume any food or beverages containing caffeine before the stress test. Acquisition was done in a 64×64 matrix on a Siemens MULTISPECT 3 (triple-head gamma camera; Siemens Gammasonics Inc., Hoffman Estates, IL) 60 minutes after tracer injection, with 60 views using a zoom factor of 1.23. All data sets were reconstructed from 360° data using filtered back projection (third-order Butterworth filter, critical frequency 0.5 Nyquist). The data sets were transferred to a Siemens e.soft system, where they were reoriented according to the cardiac long axes, yielding oblique data sets.

SPECT Image Analysis Protocol

Using an automatic quantitative analysis package of perfusion SPECT images (Cedars Sinai QPS 2008, Cedars-Sinai Medical Center, Los Angeles, CA), the stress and rest data sets of the 118 patients were analyzed in fully automatic operation mode. The summed stress score (SSS), summed rest score (SRS), and summed difference score (SDS) values were calculated based on comparison with the corresponding gender-specific institutional normal database. The left ventricular myocardium was divided into 20 segments[2,7] and scored for extent and severity of perfusion abnormalities in each segment during stress and rest according to a 5-point scale: 0: normal, 1: slight reduction, 2: moderate reduction, 3: severe reduction of radiotracer uptake, and 4: no radiotracer uptake. The SSS and SRS are the sum of scores in these 20 segments.[2,7,8] In case the segmental rest score had a higher value than the stress score it was assigned the stress score value. The sum of the differences between each of the 20 segments on the stress and rest images was defined as SDS, also called the reversibility score. It is an index of jeopardized myocardium. SSS and SRS were classified using the following classification system: <4: normal, 4-8: mildly abnormal, 9-13: moderately abnormal, and ≥14: severely abnormal.[2,9,10]

Clinical Follow-Up

Follow-up information on patient survival was obtained in all patients by dedicated research personnel. Data were obtained by telephone contact with the patient, with one of his or her immediate relatives and complemented by information obtained by the patient's general physician or patient charts

from recurrent hospital admissions. In case neither patient nor relatives could be contacted and patient's general physician did not know about the patient's outcome, the local population registries were contacted to obtain information about the patient's possible death or current location. Patients were followed for at least 4.5 years (mean of 6.3 ± 1.2 years) for hard events defined as death, nonfatal myocardial infarction, or myocardial revascularization procedure. Myocardial infarction was verified by hospital document and the diagnosis was based on the accepted criteria of characteristic chest pain, electrocardiographic, and enzyme changes. In addition, a composite of major adverse events (MAE: death, nonfatal myocardial infarction, bypass surgery, or percutaneous coronary intervention) was evaluated. Furthermore, using a standard medical questionnaire, the level of current limitations due to angina pectoris considering the CCS (Canadian Cardiology Society) class and dyspnoe considering the NYHA (New York Heart Association) class were determined at the end of the follow-up period. Patients with symptoms determined as CCS class II-IV and/or NYHA class II-IV within the last 2 months prior to follow-up questionnaire were considered as symptomatic.

Statistical Analysis

Values are expressed as mean ± SD or as percentages. For the comparisons of clinical and angiographic characteristics and the extent of SPECT perfusion defects, the Student's *t*-test for unpaired samples and analysis of variance to evaluate differences between different groups was used as indicated. Proportions were compared by Chi-square test or with Fischer test when appropriate. Receiver operating characteristics (ROC) curves were constructed to define the optimal cut-off values of SRS and SSS for prediction of death or MAE during follow-up. These allowed definition of diagnostic accuracy of SRS and SSS for clinical events. The areas under the curve of the ROC curves were expressed as the area ± SD. Patient survival without adverse events was analyzed and Kaplan-Meier curves were constructed. Differences between survival curves were evaluated using the log-rank test. Cox proportional hazard regression analysis was used to determine univariate and multivariate predictors of death as well as MAE at follow-up. Age, gender, diabetes, stress level, SRS, SSS, and SDS were included in the analysis. A P-value < 0.05 was considered statistically significant.

RESULTS

Clinical characteristics of the 118 patients included in the study are given in Table 1.

Clinical Outcome Events

There were 16 deaths, 9 myocardial infarctions, and 11 coronary revascularization procedures during follow-up. Thus, annual mortality rate during follow-up was 2.1%. The total number of patients with major adverse events was 29. A total of 64 patients had symptoms of dyspnea (NYHA II-IV) and/or chest pain (CCS II-IV) at follow-up. A total of 76 patients had either MAE or symptoms during follow-up.

Table 1. Baseline clinical characteristics

	Study group (n = 118)
Male, n (%)	77 (65)
Age, years	61 ± 11
Diabetes mellitus, n (%)	15 (13)
Smoking, n (%)	37 (31)
Arterial hypertension, n (%)	52 (44)
Hyperlipidemia, n (%)	59 (50)
Ejection fraction, %	59 ± 12
Concomitant medication	
Aspirin, n (%)	56 (47)
ACE inhibitors, n (%)	38 (32)
ARBs, n (%)	9 (8)
Beta-blockers, n (%)	29 (24)
Nitrates, n (%)	17 (14)

Arterial hypertension: arterial pressure >160/90 mmHg or medically treated.
Hyperlipidemia: serum cholesterol >240 mg/L or medically treated.

Analysis of SPECT Studies

By quantitative analysis of SPECT studies mean SRS was 3.1 ± 5.4 and mean SSS was 5.9 ± 5.9. There were 81 patients with a SRS of <4, 19 patients with a SRS of 4-8, and 18 patients with a SRS of >8. The SSS was <4 in 48 patients, 4-8 in 35 patients, 9-13 in 16 patients, and ≥14 in 19 patients. The SDS was <4 in 77 patients, 4-8 in 35 patients, and ≥8 in 6 patients.

Automatic Quantitative Analysis of SPECT and Follow-Up Events

Considering quantitative analysis of MPS, there was a significant difference between patients with and without death during follow-up in the SRS (6.4 ± 6.7 vs. 2.6 ± 5.0, $P = 0.048$) but no significant difference between patients with and without MAE in the SRS (5.4 ± 7.7 vs. 2.4 ± 6.27, $P = 0.073$). There were significant differences in SSS between patients who died and those alive at follow-up (9.5 ± 6.9 vs. 5.4 ± 5.6, $P = 0.012$). Similarly, there were significant differences in SSS between patients with and without MAE at follow-up 8.7 ± 7.2 vs. 5.2 ± 5.0, $P = 0.010$, respectively. Patients with any MAE or significant clinical symptoms during follow-up had also higher SSS than those without the respective event, 7.2 ± 7.1 vs. 4.6 ± 6.2, $P = 0.042$.

The SDS was not significantly higher for patients who died (3.1 ± 2.4 vs. 2.6 ± 2.4), had MAE (2.9 ± 2.4 vs. 2.7 ± 2.4), or MAE or significant clinical symptoms (2.8 ± 2.5 vs. 2.7 ± 2.5) at follow-up compared to those without the respective event.

ROC analysis demonstrated for SRS an area under the ROC curve of 0.64 (95% CI: 0.53-0.72, cut-off SRS >6) for death during follow-up. For any MAE, ROC analysis demonstrated for SRS an area under the curve of 0.56 (95% CI: 0.47-0.66, cut-off SRS >6). ROC analysis demonstrated for SSS an area under the curve of 0.70 (95% CI: 0.60-0.79, cut-off SSS >13) for death during follow-up. For any MAE, ROC analysis demonstrated for SSS an area under the curve of 0.61 (95% CI: 0.51-0.69, cut-off SSS >13) (Figure 1). Annual mortality rates were 1.3% in patients with a SSS ≤13 and 4.5% in patients with a SSS >13. Figure 2 demonstrates the impact of SSS level on rate of survival (left panel) and rate of MAE-free survival (right panel) during the follow-up period. The prognosis of patients with a SSS level >13 was found to be significantly worse than in those with a lower SSS.

Predictors of Follow-Up Events

Univariate Cox regression analysis demonstrated age and SSS to be a predictor of death, whereas SSS remained the only predictor of death in the multivariate analysis (Table 2 and Figure 3). Diabetes and SSS were univariate predictors of MAE at follow-up. They remained also predictors of MAE in a multivariate analysis (Table 2).

DISCUSSION

The aim of this study was to determine the prognostic value of stress MPI in patients with insignificant

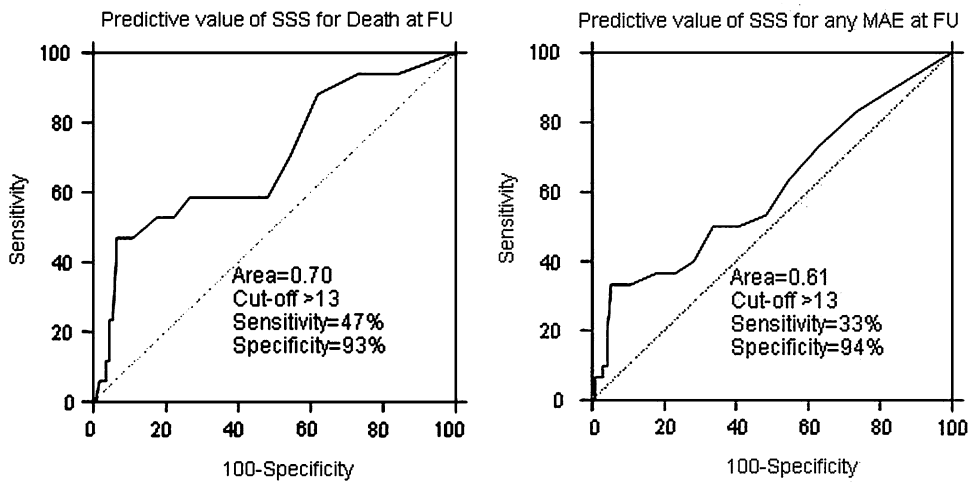

Figure 1. Receiver operator characteristics curves for death at follow-up considering SSS (*left panel*) and for MAE at follow-up considering SSS (*right panel*).

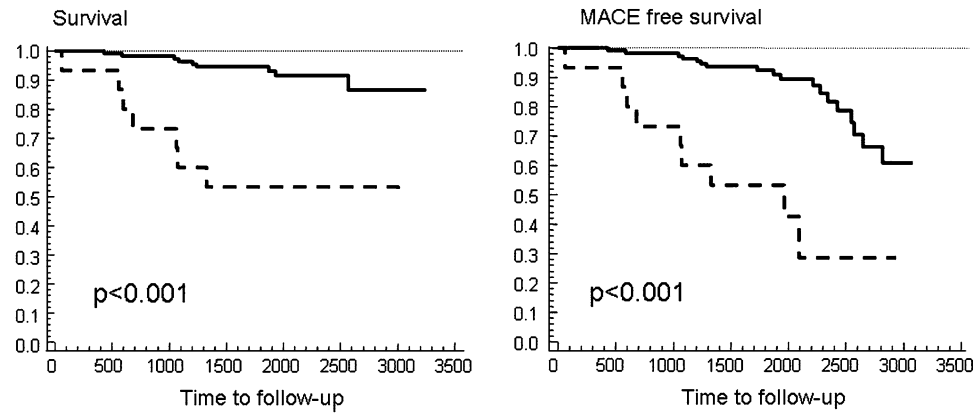

Figure 2. Kaplan-Meier curves for survival (*left panel*) and MAE-free survival (*right panel*) for patients with a SSS ≤13 (*continuous line*) and for patients with a SSS >13 (*interrupted line*).

Table 2. Univariate and multivariate predictors of death and major adverse events (MAE: death, myocardial infarction, revascularization)

	OR	95% CI	*P*
Univariate predictors of death			
Age (per year)	1.066	1.003-1.130	0.022
SSS (per additional score)	1.082	1.019-1.159	0.010
Multivariate predictors of death			
SSS (per additional score)	1.074	1.004-1.149	0.026
Univariate predictors of MAE			
Diabetes	3.399	1.098-10.587	0.036
SSS (per additional score)	1.066	1.002-1.170	0.029
Multivariate predictors of MAE			
Diabetes	5.003	1.152-20.541	0.037
SSS (per additional score)	1.087	1.004-1.181	0.027

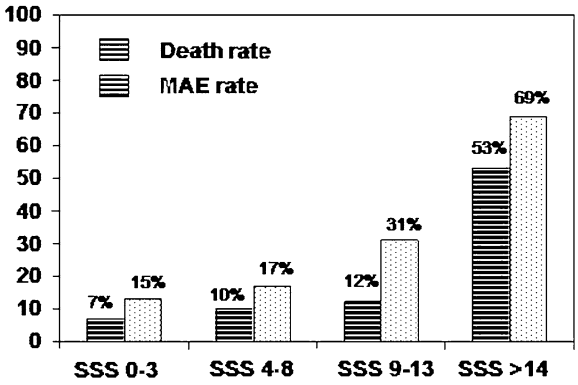

Figure 3. Death rate and rate of major adverse events during total follow-up for the SSS categories ranging from 0 to 3, 4 to 8, 9 to 13, and ≥14.

CAD as defined by coronary angiography for subsequent hard and soft events. The prognostic value of myocardial SPECT in patients with known or suspected CAD is well established, while its value in patients in whom coronary angiography demonstrated insignificant coronary artery disease is not defined. This study demonstrates that in patients with angiographically proven insignificant coronary artery disease, stress MPI has incremental predictive value for future events.

Comparison to Previous Studies

A number of previous studies have evaluated the prognostic implications of stress thallium MPS in patients with suspected CAD. Several of these studies on patients with ''suspected CAD'' included patients with known prior myocardial infarction. Based only on their clinical history these patients represent a high-risk group. The total width of patient risks just considering the clinical factors was comparatively high in these studies. Consequently, annual event rates ranged by a factor of up to 10 between low-risk patients and high-risk patients of these studies.[2,6,10-13] In particular, negative perfusion scintigraphy studies have been proven to be associated with very low event rates.[14]

In contrast, the patient population included in this study was very selective. All patients have had coronary angiography. Thus, clinical history implied a high likelihood of significant coronary artery disease. However, the insignificant coronary artery disease determined by angiography indicates that very high-risk patients were excluded from the analysis. Thus, patients included in this study had a smaller width of risks as determined by clinical and angiographic findings than in several previous studies.[2,12,13] The relatively narrow range of patient risks creates a difficult situation for separation of different patient risks. Perfusion defects tended to be rather small with a low prevalence of large myocardial perfusion defects. Thus, accurate quantitative analysis appears to be required to detect even minor differences, while a visual analysis may be too crude in this preselected patient cohort.

ROC analysis demonstrated a SSS of 13 to be the cut-off value for a high risk of subsequent clinical events. This cut-off value relates to reports by Georgoulias et al[15] on 246 consecutive asymptomatic patients evaluated after coronary artery stenting. In this study, the cumulative hard event-free rate at 10 years was 30.7% for patients with a SSS >13, whereas it was 97.3% for patients with a SSS <13. The annual mortality rates were similar to a report on MPS in patients with normal baseline electrocardiograms in which mortality rates of 1.1% in patients with normal perfusion and 3.4% in patients with reversible defects were reported.[16]

The study allows important insights into the clinical impact of minor severity coronary artery disease found to be nonsignificant by coronary angiography. Thus, it extends the prognostic evaluation of coronary artery disease to a level below those defined by significant epicardial lesions as determined by coronary angiography. Myocardial perfusion defects of increasing severity were associated with an impaired prognosis. This may be due to perfusion defects caused by atherosclerotic disease on the microvascular level which remains undetected by coronary angiography.

The findings of this study confirm results of a recent report by Alqaisi et al[17] which demonstrated significant differences in patient prognosis between MPS positive and negative patients having angiographically insignificant coronary artery disease. However, this study demonstrates additionally that the extent of test positivity has important incremental information to test positivity alone.

Limitations

The number of patients included in this analysis is limited. However, we applied strict inclusion criteria to evaluate the predefined study targets. Patients with valvular heart disease, history of myocardial infarction, or revascularization procedure or cardiomyopathy were excluded. Furthermore, patients with no significant coronary artery disease and no revascularization being performed based on the angiographic results and an available perfusion scintigraphy represent only a small fraction of the patients presenting for MPS assessment. However, this is a patient subgroup which allows important insights into the impact of coronary artery disease of minor severity as determined by angiography. The relatively small number of patients was in part substituted by a relatively long follow-up period of more than 6 years. To choose medical therapy without revascularization in patients with signs of coronary artery disease by angiography and finding of perfusion defect by stress MPI may imply that hemodynamically significant coronary stenosis were not treated adequately. Some of the patients included in the analysis may have had hemodynamically significant stenosis in spite of an angiographically determined diameter stenosis of <50%. However, treatment strategy in each patient was decided upon by two interventional cardiologists based on the full knowledge of all findings. Still, medical therapy was chosen primarily based on the angiographic assessment of a nonsignificant disease not requiring revascularization therapy. Coronary angiography was performed after MPS in all patients. Fifty patients included in the study had a SSS <4. It may appear inadequate to perform coronary angiography on a patient with a negative MPS. However, coronary angiography was performed based on clinical symptoms and the potential for balanced ischemia. In this study, two different radionuclide tracers were used. However, this should not have had an impact on the study results as both tracers have high sensitivity to detect perfusion defects.

CONCLUSION

In patients without significant coronary artery disease by coronary angiography, the result of stress MPS is a significant predictor of long-term prognosis. Quantitative analysis allows definition of patients with a higher likelihood to develop clinical events or symptoms.

References

1. Hachamovitch R, Berman DS, Kiat H, Cohen I, Cabico JA, Friedman J, et al. Exercise myocardial perfusion SPECT in patients without known coronary artery disease: Incremental prognostic value and use in risk stratification. Circulation 1996;93:905-14.
2. Hachamovitch R, Berman DS, Shaw LJ, Kiat H, Cohen I, Cabico JA, et al. Incremental prognostic value of myocardial perfusion single photon emission computed tomography for the prediction of cardiac death: Differential stratification for risk of cardiac death and myocardial infarction. Circulation 1998;97:535-43.
3. Pollock SG, Abbott RD, Boucher CA, Beller GA, Kaul S. Independent and incremental prognostic value of tests performed in hierarchical order to evaluate patients with suspected coronary artery disease. Circulation 1992;85:237-48.
4. Berman DS, Hachamovitch R, Kiat H, Cohen I, Cabico A, Wang FP, et al. Incremental prognostic value and cost implications of normal and equivocal exercise Tc-99m sestamibi myocardial perfusion SPECT. J Am Coll Cardiol 1995;26:639-47.
5. Metz LD, Beattie M, Hom R, Redberg RF, Grady D, Fleischmann KE. The prognostic value of normal exercise myocardial perfusion imaging and exercise echocardiography: A meta-analysis. J Am Coll Cardiol 2007;49:227-37.
6. Kaul S, Lilly DR, Gascho JA, Watson DD, Gibson RS, Oliner CA, et al. Prognostic utility of the exercise thallium-201 test in ambulatory patients with chest pain: Comparison with cardiac catheterization. Circulation 1988;77:745-58.
7. Bermann DS, Xingping K, Nishina H, Slomka PJ, Shaw LJ, Hayes SW, et al. Diagnostic accuracy of gated Tc-99m sestamibi stress myocardial perfusion SPECT with combined supine and prone acquisitions to detect coronary artery disease in obese and nonobese patients. J Nucl Cardiol 2006;13:191-201.
8. Sharir T, Xingping K, Germano G, Bax JJ, Shaw LJ, Gransar H, et al. Prognostic value of poststress left ventricular volume and ejection fraction by gated myocardial perfusion SPECT in women and men: Gender-related differences in normal limits and outcomes. J Nucl Cardiol 2006;13:495-506.
9. Lima RS, De Lorenzo A, Soares AJ. Relation between postexercise abnormal heart rate recovery and myocardial damage evidenced by gated single-photon emission computed tomography. Am J Cardiol 2006;97:1452-4.
10. Mazzanti M, Germano G, Kiat H, Kavanagh PB, Alexanderson E, Friedman JD, et al. Identification of severe and extensive coronary

artery disease by automatic measurement of transient ischemic dilation of the left ventricle in dual-isotope myocardial perfusion SPECT. J Am Coll Cardiol 1996;27:1612-20.
11. Piccini JP, Horton JR, Shaw LK, Al-Khatib SM, Lee KL, Iskandrian AE, et al. Single-photon emission computed tomography myocardial perfusion defects are associated with an increased risk of all-cause death, cardiovascular death, and sudden cardiac death. Circ Cardiovasc Imaging 2008;1:180-8.
12. Berman DS, Kang X, Van Train KF, Lewin HC, Cohen I, Areeda J, et al. Comparative prognostic value of automatic quantitative analysis versus semiquantitative visual analysis of exercise myocardial perfusion single-photon emission computed tomography. J Am Coll Cardiol 1998;32:1987-95.
13. Klocke FJ, Baird MG, Lorell BH, Bateman TM, Messer JV, Berman DS, et al. ACC/AHA/ASNC guidelines for the clinical use of cardiac radionuclide imaging-executive summary: A report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (ACC/AHA/ASCN Committee to Revise the 1995 Guidelines for the Clinical Use of Cardiac Radionuclide Imaging). Circulation 2003;108:1404-18.
14. Soman P, Parsons A, Lahiri N, Lahiri A. The prognostic value of a normal Tc-99m sestamibi SPECT study in suspected coronary artery disease. J Nucl Cardiol 1999;6:252-6.
15. Georgoulias P, Demakopoulos N, Tzavara C, Giannakou S, Valotassiou V, Tsougos I, et al. Long-term prognostic value of Tc-99m tetrofosmin myocardial gated-SPECT imaging in asymptomatic patients after percutaneous coronary intervention. Clin Nucl Med 2008;33:743-7.
16. Elhendy A, Schinkel AF, van Domburg RT, Bax JJ, Valkema R, Huurman A, et al. Prognostic value of exercise stress technetium-99m-tetrofosmin myocardial perfusion imaging in patients with normal baseline electrocardiograms. Am J Cardiol 2006;98:585-90.
17. Alqaisi F, Albadarin F, Jaffery Z, Tzogias L, Dawod M, Jacobsen G, et al. Prognostic predictors and outcomes in patients with abnormal myocardial perfusion imaging and angiographically insignificant coronary artery disease. J Nucl Cardiol 2008;15:754-61.