Resting echocardiography and quantitative dipyridamole technetium-99m sestamibi tomography in the identification of cardiac allograft vasculopathy and the prediction of long-term prognosis after heart transplantation

G. R. Ciliberto¹, L. Ruffini², M. Mangiavacchi¹, M. Parolini³, R. Sara², D. Massa¹, R. De Maria³, E. Gronda¹, E. Vitali¹ and O. Parodi³

¹Department of Cardiology A. De Gasperis, the ²Nuclear Medicine Service and the ³CNR Clinical Physiology Institute of Pisa, Section of Milan, Niguarda Ca' Granda Hospital, Milan, Italy

Aims To evaluate the accuracy of echocardiography in conjunction with quantitative high-dose dipyridamole technetium-99m sestamibi tomography (SPECT) in detecting coronary allograft vasculopathy.

Methods and Results Seventy-eight consecutive heart transplant recipients underwent echocardiography while at rest and high-dose dipyridamole SPECT within 48 h of a yearly angiogram. Resting wall motion abnormalities were considered significant if present in two or more segments. SPECT was considered abnormal in the presence of reversible/fixed defects. The coronary angiogram was normal in 53, showed non-significant coronary allograft vasculopathy in 13 and significant (>50% stenosis) coronary allograft vasculopathy in 12 cases. Resting wall motion abnormalities were observed in nine cases and perfusion defects in 20. Echocardiography and SPECT were concordant in 59 cases (five positive and 54 negative); in these, accuracy was 100% for significant coronary allograft vasculopathy and 83% for any coronary allograft vasculopathy. Over 6·5 ± 2 years, 17 patients suffered coronary allograft vasculopathy-related events, including death in six and retransplantation in three. Resting wall motion abnormalities, SPECT perfusion defects and angiographic coronary allograft vasculopathy were significant predictors of cardiac events.

Conclusion Normal resting wall motion at echocardiography coupled to normal stress myocardial perfusion, rules out the presence of significant coronary allograft vasculopathy in many heart transplant recipients. Conversely, resting wall motion abnormalities and perfusion defects strongly predict cardiac events. Therefore, a strategy which reserves angiography for patients with resting wall motion abnormalities and/or perfusion defects may be safe and cost-effective.

Key Words: Heart transplantation, echocardiography, perfusion imaging, prognosis.

See page 895 for the Editorial comment on this article

Introduction

Cardiac allograft vasculopathy is the main factor limiting long-term survival after transplantation[1]. The process has been angiographically documented in 40–50% of patients surviving 5 years after transplantation[2]. Unfortunately, in the absence of warning anginal symptoms, caused by heart denervation, the clinical manifestations of coronary allograft vasculopathy are frequently severe, and include life-threatening ventricular arrhythmias, congestive heart failure, silent myocardial infarction or sudden death. Therefore, annual coronary arteriography has been introduced to monitor the development and progression of coronary allograft vasculopathy[3,4]; this procedure, however, has a number of major limitations: it is invasive and often insensitive to the diffuse concentric nature of the disease. Moreover,
the number of transplant recipients is increasing, so there is a growing need for a repeatable, accurate, non-invasive screening test, which should ideally recognize the presence and extent of both large vessel and microvascular coronary vasculopathy, as well as provide prognostic information.

Unfortunately, not all non-invasive techniques are routinely used because of their reported variable accuracy; furthermore the concomitant use of different imaging modalities and stress tests is costly and does not necessarily increase efficacy\[^{15-14}\].

Resting echocardiography is a low cost and routinely performed test in cardiac transplant recipients; its rather poor sensitivity in the detection of coronary allograft vasculopathy is balanced by its satisfactory specificity\[^{15,12}\], and the addition of stress perfusion scintigraphy might improve the detection of coronary allograft vasculopathy. Stress technetium-99m labelled perfusion agents such as technetium-99m sestamibi and single-photon emission computed tomography (SPECT) have been used to assess coronary allograft vasculopathy in transplant patients\[^{8,14}\]. The limited sensitivity observed in previous studies which used perfusion agents\[^{8,9,14}\] might be related to the lack of quantitative regional tracer uptake.

The aim of this study was to evaluate the reliability and accuracy of resting echocardiography in conjunction with quantitative high-dose dipyridamole technetium-99m sestamibi SPECT in the identification of patients with significant coronary allograft vasculopathy, and those with a poor or relatively benign prognosis.

**Methods**

**Study population**

Between January 1992 and June 1993, we studied 78 consecutive cardiac transplant recipients (71 men and 7 women) with a mean age of 45 ± 13 years (range 14–66 years) at a mean distance of 2.7 ± 1.9 years from heart transplantation. All patients received triple-drug immunosuppression including cyclosporine, prednisone, azathioprine. Resting two-dimensional echocardiography and high-dose dipyridamole technetium-99m sestamibi SPECT were performed within 48 h of the annual post-transplant evaluation, which usually included coronary angiography. Patients were then followed-up for 6.5 ± 2 years (range 1 month–9 years).

The study protocol was approved by the Institutional Ethical Committee of Niguarda Ca Granda Hospital. The enrolled patients gave their informed consent to participate.

**Cardiac catheterization**

All patients underwent percutaneous right and left catheterization, right endomyocardial biopsy and selective coronary angiography. Endomyocardial biopsies were interpreted according to Billingham’s classification\[^{15}\]. The coronary angiograms were analysed by an experienced operator, who had no knowledge of the results of the other diagnostic tests. Coronary stenoses were classified according to Gao et al\[^{15}\]: coronary arteries were angiographically defined as normal or having grade 1 coronary allograft vasculopathy (minor diffuse irregularities or focal stenosis <50%) or grade 2, i.e. significant, coronary allograft vasculopathy (luminal narrowing >50% and/or diffuse small vessel narrowing).

**Echocardiographic examination**

Two-dimensional echocardiograms were performed using a commercially available 3.5 MHz transducer in the parasternal long- and short-axis, and apical two- and four-chamber views. The 16-segment model of the American Society of Echocardiography\[^{16}\] was used to evaluate regional wall motion. For each segment, wall motion was graded as normal=1, hypokinetic=2, akinetic=3 or dyskinetic=4, and a wall motion score index was derived by adding together all wall scores and dividing the results by the number of segments visualized. Postoperative sepal motion was classified as normal when there was a thickening of the septum. Both systolic wall thickening and inward wall motion were visually evaluated and the data analysed off-line by two independent observers, who were unaware of the clinical, scintigraphic and angiographic findings. Resting wall motion abnormalities were considered significant if they were present in two or more segments. The left ventricular ejection fraction was derived from end-diastolic and end-systolic volumes calculated by the biplane plane area–length method.

**Scintigraphic examination**

All patients underwent myocardial scanning 1 h after the intravenous injection of 740 MBq (20 mCi) of technetium-99m sestamibi at the end of a 10 min 0·84 mg . kg\(^{-1}\) dipyridamole infusion, as previously described\[^{17}\]. Scanning was repeated at rest within the following 3 days. The images were acquired using a rotating gamma camera (Starcam 3000, General Electric) equipped with a high-resolution low-energy, parallel-hole collimator (32 frames over a 180° circular orbit, from a 45° right anterior oblique to a 45° left posterior oblique projection, 30 s/frame, 64 × 64 matrix, zoom 1:33), and a 10% energy window centred on the 140 KeV peak. From the raw data, short axis tomograms were reconstructed by means of filtered back projection using a Butterworth filter (frequency cutoff 0·5 cycles/pixel, order 3:5) and no attenuation correction. Tracer uptake was quantitatively scored from three representative short axis slices (apical, mid-ventricular and basal) using a 16-segment model that matched the echocardiographic segmentation (six basal, six mid-ventricular and four apical segments) and was
automatically drawn using a computer program with the mean radioactivity being calculated within the myocardial edges. The uptake was expressed as a percentage of the maximum of all short axis sections. A perfusion defect in one region was defined when the percent radioactivity fell below two standard deviations of the mean value observed in the corresponding region in a group of normal gender-matched subjects, who had a less than 5% likelihood of coronary artery disease. The quantitative stress and rest data were compared segment by segment: a perfusion defect revealed after dipyridamole was defined as reversible or partially reversible if the resting sestamibi uptake in that segment normalized or increased by more than 10%. Scintigraphic images were analysed by two experienced independent reviewers who were unaware of the results of the other diagnostic tests.

Follow-up

Patients were prospectively followed until death or until March 2000. The follow-up data were obtained by reviewing the hospital or clinic visit records. Follow-up angiography was performed every 1–2 years after cardiac transplantation, depending upon the clinical and instrumental findings. Patient outcome was assessed using event-free survival: only cardiac events related to coronary allograft vasculopathy (cardiac death, retransplantation, non-fatal myocardial infarction, hospital admission for congestive heart failure) were considered. Myocardial infarction was confirmed by the appearance of pathological Q waves and/or a typical increase/decrease in cardiac enzymes. Target lesion revascularization was performed in the presence of critical coronary narrowing (>70% diameter stenosis on coronary angiography) and included percutaneous transluminal coronary angioplasty and coronary artery bypass surgery.

Cost–benefit analysis

The analysis was performed from the viewpoint of the Regional Health Authority that acts as a third-party payer. The cost–benefit ratio of the proposed non-invasive strategy vs the conventional coronary angiography strategy was calculated for the whole spectrum of post-transplant distances and separately for the first post-transplant year, and expressed as cost-savings in Euros for each correctly diagnosed coronary allograft vasculopathy (CAV) case. Costs imputed for the conventional coronary angiography strategy included the current reimbursement price of resting echocardiography plus rest and dipyridamole technetium-99m sestamibi SPECT; the additional conventional strategy costs were added in patients in whom angiography was deemed necessary according to the non-invasive test results.

Statistical analysis

Data are expressed as mean ± SD. Statistical analysis of discrete variables was performed with the chi-square test, and the Fisher’s exact test was used when appropriate. Diagnostic accuracy and the prognostic value of the non-invasive tests were separately evaluated both by pooling the normal and CAV 1 angiograms and comparing the results with CAV 2 (significant CAV) angiograms and by comparing normal angiograms with CAV 1 and CAV 2 positive angiograms (any CAV).

The Cox proportional hazards model (BMDP 2L, Dept. of Biomathematics, University of Los Angeles, CA, revised 1987) was used to assess the relationship between cardiac event-free survival and the diagnostic tests potentially relating to the patient’s prognosis. Using a stepwise selection process, variables were entered, or removed, from the regression equation on the basis of computed significance probability. A series of Kaplan–Meier survival curves were constructed, in order to evaluate differences in survival between patients with negative or positive tests, and the statistical significance was determined by the Mantel–Cox test. Survival time was measured from the date of the diagnostic procedure to the onset of any cardiac event. Only the first cardiac event was considered in patients with >1 event. A P value <0·05 was considered statistically significant.

Results

Out of 78 coronary angiograms, 53 cases (68%) showed no coronary allograft vasculopathy, 13 (17%) had CAV 1 lesions, while 12 cases (15%) had CAV 2 lesions. Endomyocardial biopsies were negative in all patients. Left ventricular ejection fraction at resting echocardiography averaged 0·57 ± 0·06 (range 0·35–0·65).

Diagnostic power of non-invasive tests

Wall motion was normal in 69 studies, while significant wall motion abnormalities were present in nine patients (Table 1); in these latter cases the wall motion score index averaged 1·79 ± 0·41. Dipyridamole technetium-99m sestamibi scans were normal in 58 studies and abnormal in 20 (Table 1); perfusion defects were classified as totally or partially reversible in eight, fixed in four, both fixed and reversible in eight studies.
Sensitivity, specificity, predictive values, and accuracy of the non-invasive tests in the detection of any CAV or significant CAV lesions are depicted in Table 2.

Normal regional wall motion at echocardiography correctly identified 96% of patients with non-coronary allograft vasculopathy or CAV 1 lesions, while a positive dipyridamole technetium-99m sestamibi scan correctly identified 92% of patients with significant coronary lesions (CAV 2). Rest echocardiography and stress scintigraphy provided similar accuracy (87% and 88%), the former being more specific and the latter more sensitive.

Combined non-invasive testing strategy

An echocardiogram while at rest and dipyridamole technetium-99m sestamibi SPECT were concordant in 59 studies, 54 negative and five positive, (76%) and discordant in 19. When only concordant tests were considered, the accuracy of the combined testing strategy was 100% for significant CAV and 83% for any CAV.

Out of the 19 discordant results between the two tests, seven occurred in patients with significant (CAV 2) coronary lesions, three in cases with CAV 1 and nine in cases with normal angiography; five of these developed coronary allograft vasculopathy during follow-up. Table 2 depicts the sensitivity, specificity, the positive and negative predictive value and the accuracy of concordant positive plus discordant test findings (either positive echocardiography or positive SPECT) in the detection of any CAV or significant CAV.

Follow-up and cardiac events

During the 6.5 ± 2 years follow-up, 13 patients died from non-coronary allograft vasculopathy-related causes (two from acute rejection, five from neoplasms, one from acute pancreatitis, four from chronic liver failure, one from ruptured aortic aneurysm).

Coronary allograft vasculopathy progression during follow-up could be analysed in the 71 patients who survived to undergo at least one subsequent coronary angiogram: in 30 cases new coronary allograft vasculopathy lesions or worsening of pre-existing coronary allograft vasculopathy were observed during follow-up. Three patients with CAV 2 lesions underwent coronary revascularization by percutaneous transluminal coronary angioplasty of a critical stenosis 0, 1 and 6 years after the baseline study (Fig. 1).

Seventeen patients (22%) suffered major coronary allograft vasculopathy-related events: six patients died (two died suddenly, one of acute myocardial infarction, three of congestive heart failure); three were retransplanted because of severe coronary allograft vasculopathy and progressive heart failure. Hospital admissions for congestive heart failure were considered the first cardiac event in 14 cases; of those, three subsequently died and three were retransplanted as described above.
The clinical characteristics of patients who developed cardiac events were not statistically different from those of patients without cardiac events (Table 3).

A stepwise multivariate Cox proportional hazards model was constructed by sequentially entering variables that were significant at univariate analysis. When resting echocardiography and dipyridamole SPECT were included in the model, patients with a positive resting echocardiogram had a 10-fold relative risk (95% confidence intervals 3.5–30, \( P < 0.0001 \)) in cardiac events at follow-up, while a positive dipyridamole SPECT conferred a 4.1 relative risk (95% confidence intervals 1.5–11, \( P = 0.007 \)) of cardiac events (Table 4). When a positive coronary angiogram for any coronary allograft vasculopathy was entered into the model, SPECT was no longer a significant independent predictor (Table 4), while resting echocardiography still showed the strongest predictive value for cardiac events.

Cardiac event-free survival curves, stratified according to a positive or negative resting echocardiogram (22% vs 84%, \( P < 0.0001 \)), dipyridamole SPECT (53% vs 84%, \( P = 0.001 \)), and coronary angiography (57% vs 86%, \( P = 0.001 \)), are presented in Figs 2 and 3.

### Table 3 Baseline characteristics in patients with and without cardiac events

<table>
<thead>
<tr>
<th>Variable</th>
<th>Events (n=17)</th>
<th>No events (n=61)</th>
<th>( P ) value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male gender</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ischaemic heart disease</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Donor age</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diabetes</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dyslipidaemia</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cholesterol</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Triglycerides</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Abnormal ECHO</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Abnormal SPECT</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Any CAV</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Significant CAV</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

For abbreviations see Table 1.

**Cost–benefit analysis**

The application of the non-invasive strategy in our 78 patients would lead to deferral of coronary angiography in 54 patients with concordant negative echocardiography and SPECT, and to the additional performance of coronary angiography (hospital admission under diagnosis-related-group code 125) in five cases with concordant positive tests and in 19 patients with discordant results.

Assuming the point of view of the Regional Health Authority, for each correctly diagnosed CAV 2 case, the conventional invasive strategy had an average cost of 1884 Euro, while the non-invasive strategy, including switching to the conventional strategy when needed, would have an average cost of 1019 Euro, with a saving of 865 Euro (Table 5). For each correctly diagnosed case with any CAV, the non-invasive strategy, including switching to the conventional strategy when needed, would have an average cost of 1260 Euro, with a saving of 624 Euro.

If the analysis is restricted to the first post-transplant coronary angiogram, the application to a hypothetical yearly caseload of 35 newly transplanted patients of a non-invasive testing strategy that avoids coronary vasculopathy was entered into the model, SPECT was no longer a significant independent predictor (Table 4), while resting echocardiography still showed the strongest predictive value for cardiac events.
angiography in cases with concordant negative echocardiograms and SPECT (negative predictive value for significant coronary allograft vasculopathy 100% and for any coronary allograft vasculopathy 93%) would result in average cost-savings for each correctly diagnosed case of 1014 and 906 Euro, respectively.

### Discussion

Development and implementation of accurate and reliable non-invasive testing for coronary allograft vasculopathy is a critical issue in the long-term management of heart transplantation. The main findings of the present study are that the association of resting echocardiography and quantitative dipyridamole technetium-99m sestamibi SPECT provides accurate information on the occurrence of coronary allograft vasculopathy in this population and that the alternative use of this strategy has a favourable impact on transplant-associated costs. Stress perfusion scintigraphy was more sensitive than resting echocardiography in the detection of coronary allograft vasculopathy, underscoring the value of perfusion studies in the assessment of macrovascular and microcirculatory abnormalities after heart transplantation. Nevertheless, resting echocardiography was more specific and the strongest prognostic predictor of cardiac events.

At present, the mainstay of diagnosis of accelerated coronary allograft vasculopathy remains coronary angiography; however, this procedure is considered inadequate for a correct evaluation of the morphology and prognostic significance of the lesions. Furthermore, coronary angiography carries an increased morbidity in cyclosporine-treated transplant recipients, whose kidney function is frequently altered. When coronary allograft vasculopathy is angiographically severe, therapeutic options can be revascularization or retransplantation in some patients, while the approach to patients with angiographically mild or moderate coronary stenosis is still doubtful. Therefore, alternative methods are needed for both diagnostic and prognostic purposes. The advent

![Graph](https://via.placeholder.com/150)

**Figure 2** Event-free survival curves for patients with normal (—) and abnormal (—) resting echocardiography; event-free survival curves according to presence (——) or absence (….) of cardiac allograft vasculopathy at coronary angiography are shown for comparison.

![Graph](https://via.placeholder.com/150)

**Figure 3** Event-free survival curves for patients with normal (—) and abnormal (—) dipyridamole sestamibi SPECT; event-free survival curves according to presence (——) or absence (…) of cardiac allograft vasculopathy at coronary angiography are shown for comparison.

### Table 4

<table>
<thead>
<tr>
<th>Cardiac events</th>
<th>β</th>
<th>SE</th>
<th>RR</th>
<th>95% CI</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>ECHO and SPECT</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ECHO</td>
<td>2.32</td>
<td>0.55</td>
<td>10</td>
<td>3.5–30</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>SPECT</td>
<td>1.40</td>
<td>0.52</td>
<td>4.1</td>
<td>1.5–11</td>
<td>0.007</td>
</tr>
<tr>
<td>ECHO, SPECT and coronary angiography</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ECHO</td>
<td>2.39</td>
<td>0.55</td>
<td>11</td>
<td>3.7–32</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>SPECT</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coronary angiography positive for any CAV</td>
<td>1.56</td>
<td>0.53</td>
<td>4.8</td>
<td>1.7–14</td>
<td>0.003</td>
</tr>
</tbody>
</table>

SE=standard error; RR=relative risk; CI=confidence interval.; RHTx=retransplantation; for other abbreviations see Table 1.
of intracoronary ultrasound has improved the early detection of this disease by directly imaging the coronary arterial wall[18,19]; however, this technology is expensive and provides little definite information regarding microvascular coronary circulation. The use of non-invasive tests is hampered by their variable sensitivity and specificity in the assessment of transplant-associated vasculopathy[20]; yet non-invasive tests seem to have a significant prognostic value in heart transplant recipients[21,22].

Among non-invasive approaches to coronary allograft vasculopathy detection, different studies have shown that dobutamine stress echocardiography provides accurate diagnosis[11-13,20] as well as useful prognostic information in cardiac transplant recipients[21,24]. In a recent study, Spes et al. suggest that serial routine coronary angiography could be deferred in transplant patients with normal dobutamine stress echocardiography, as the prognostic value of this test was comparable to that of intracoronary ultrasound and angiography[25]. However, dobutamine stress echocardiography is not routinely used and is limited by the variability of image quality and inter-observer variability[26].

Resting echocardiography has shown limited sensitivity in the detection of coronary allograft vasculopathy, but a number of studies showed that resting wall motion abnormalities are more frequently observed in patients with coronary allograft vasculopathy[25,10,11,23] or in those who experienced a cardiac event[11,12,23]. Spes et al.[25] reported that resting wall motion abnormalities in any left ventricular area at rest had a 90% positive predictive value, and an 88% specificity, despite a 57% sensitivity in detecting coronary allograft vasculopathy. Furthermore normal resting echocardiography had a 90% negative predictive value for cardiac events that, although lower than those of dobutamine stress echocardiography (98%) and intracoronary ultrasound (100%), compared favourably with the 94% negative predictive value of coronary angiography.

The present study is consistent with previous findings[11,12,23,25] and confirms the limited sensitivity, but high specificity in the diagnosis of coronary allograft vasculopathy and the excellent prognostic value of resting echocardiography for cardiac events in cardiac transplant recipients. Regional perfusion and coronary flow reserve may be measured in transplanted hearts by positron emission tomography[27,28]. However, the accuracy of this technique in the detection of coronary allograft vasculopathy has not yet been tested, the method is expensive and often not clinically feasible.

Quantitative stress perfusion scintigraphy by technetium-99m sestamibi SPECT, because of its high sensitivity, might improve detection of early coronary allograft vasculopathy in heart transplant recipients, and effectively complement resting echocardiography. Technetium-99m sestamibi SPECT provides better quantification of regional tracer distribution and less attenuation artifacts that Thallium-201 SPECT. In our study, the sensitivity of quantitative technetium-99m sestamibi SPECT favourably compares with previous studies that used either thallium-201 scans[9,24,29] or visual interpretation of cardiac imaging in transplant recipients[6,4]. High dose dipyridamole may further increase differences in regional tracer distribution among areas with different coronary vasodilating capability, improving the detection of minor coronary lesions[17].

To date, no previous studies have evaluated regional coronary flow vasodilation by quantitative technetium-99m sestamibi SPECT in a large population of heart transplant recipients. Our findings indicate that quantitative technetium-99m sestamibi SPECT is sensitive in the detection of significant coronary allograft vasculopathy and that its combination with resting echocardiography can be a safe and reasonable non-invasive imaging approach in heart transplant recipients. Using simultaneous perfusion and functional evaluation by dual isotope SPECT imaging, Pouillart et al.[29] obtained similar accuracy. However, echocardiography provides a more complete and repeatable evaluation of cardiac performance than gated sestamibi SPECT imaging.

In the present study concordant negative tests occurred in over two-thirds of cases, in whom non-invasive testing had an optimal accuracy in excluding significant coronary allograft vasculopathy. In such instances, coronary angiography may be avoided. This suggestion is reinforced by the excellent ability of either normal imaging test to select patients with a good long-term prognosis, as shown by event-free survival curves. This strategy is associated with significant cost-savings and allows better allocation of the invasive laboratory time and resources.

Conversely, coronary angiography is mandatory when the two non-invasive tests are concordantly
positive, as a 100% occurrence of significant coronary lesions is expected. Moreover, invasive testing should be recommended in cases with discordant results, in view of the negative prognostic impact of wall motion abnormalities and the good sensitivity of quantitative dipyridamole technetium-99m sestamibi SPECT in the detection of coronary allograft vasculopathy.

In conclusion, a strategy based on resting echocardiography and quantitative stress technetium-99m sestamibi SPECT permits the concomitant exclusion of significant coronary allograft vasculopathy and unfavourable prognosis, and is safe and cost-effective in heart transplant recipients.

References


