Relative Coronary Flow Velocity Reserve Improves Correlation With Stress Myocardial Perfusion Imaging in Assessment of Coronary Artery Stenoses

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Study objective: To evaluate the angiographic and coronary flow velocity parameters that best correlate with the results of stress myocardial perfusion imaging.

Design: Criterion standard.

Setting: Tertiary care center.

Patients: Forty-eight patients undergoing diagnostic coronary angiography for angina or silent ischemia.

Interventions: We performed angiographic and coronary flow velocity measurements at rest and during hyperemia at the post-stenotic segment and in the adjacent angiographically normal branch of the left coronary artery. Relative coronary flow reserve (RCFVR) was calculated as the ratio of post-stenotic to reference vessel coronary flow reserve (CFVR). The best cutoff points for reversible perfusion defects were calculated using receiver operating characteristic curves.

Measurements and results: Post-stenotic CFVR showed fairly good correlations with minimal lumen diameter and percentage of diameter stenosis (r = 0.57 and r = 0.55, respectively; p < 0.001). RCFVR showed stronger correlations with these angiographic indexes of stenosis severity (r = 0.66 and r = 0.68, respectively; p < 0.0001). Based on receiver operating characteristic cutoff values (1.67 for post-stenotic CFVR and 0.64 for RCFVR), RCFVR had better agreement with myocardial perfusion imaging results, compared to post-stenotic CFVR (92% vs 75%, respectively). This agreement was more meaningful in patients with moderate coronary artery stenoses (50 to 75%). The area under the curve was 0.65 (not significant) for post-stenotic CFVR and 0.88 (p < 0.01) for RCFVR.

Conclusions: RCFVR describes better than post-stenotic CFVR the functional significance of coronary artery stenoses.

Key words: coronary artery disease; coronary flow velocity reserve; intracoronary Doppler angiography; thallium imaging

Abbreviations: APV = averaged peak velocity; AUC = area under the curve; BCV = best cutoff value; CAD = coronary artery disease; CFVR = coronary flow velocity reserve; DS = diameter stenosis; RCFVR = relative coronary flow velocity reserve; ROC = receiver operating characteristic

Angiography is used for measuring coronary artery lumen narrowing; however, it is not the ideal method for determining its physiologic significance. In many patients with chest pain and coronary artery stenosis of moderate angiographic severity, the results of noninvasive exercise tests are often inconclusive, contradictory, or dubious. A considerable percentage of these patients undergoes coronary revascularization, without definite evidence that the coronary stenosis is causing their symptoms.1 Thus,
an on-site diagnostic tool to evaluate functional stenosis significance is desirable.

Coronary flow velocity reserve (CFVR), the ratio of hyperemic to basal flow velocity, represents the summed result of flow through the coronary artery and myocardial microcirculation and has been used to determine lesion significance. The development of a Doppler-tipped angioplasty guidewire has made it possible to measure flow velocity distal to a coronary lesion in the clinical setting. This method has been validated extensively in vitro and in vivo.

Correlations between post-stenotic CFVR and angiographic or intravascular ultrasound measurements of stenosis severity turned out to be rather weak. Such weak correlations can be attributed to the fact that post-stenotic CFVR is determined not only by epicardial stenosis severity and complexity, but also by heart rate, preload, myocardial hypertrophy, blood viscosity, and structural or functional changes in the microvasculature. In the clinical situation, it is hard to differentiate which of these factors is responsible for the reduction in post-stenotic CFVR. Relative coronary flow velocity reserve (RCFVR) has been proposed to circumvent the limitations of poststenotic CFVR. This index in normal hearts with normal epicardial coronary arteries should be nearly equal to 1, and in patients with coronary atherosclerosis but hemodynamically insignificant lesions is > 0.8. We aimed to evaluate the relation of post-stenotic CFVR and RCFVR with the results of stress myocardial perfusion scintigraphy within the range of moderate and severe coronary lesion severity.

**Materials and Methods**

**Patients**

The study group consisted of 48 consecutive patients (43 men and 5 women; mean ± SD age, 60 ± 9 years) who underwent diagnostic coronary angiography for angina or silent ischemia and fulfilled the following inclusion criteria: normal left ventricular systolic function (ejection fraction > 55%) and single-vessel coronary artery disease (CAD) localized either in the left anterior descending coronary artery (38 patients) or in the left circumflex (10 patients). Patients with a history of myocardial infarction, primary myocardial or valvular heart disease, or evidence of left ventricular hypertrophy on echocardiographic examination were excluded. Patients with total occlusion, collateral circulation in the artery under evaluation, tandem stenotic lesions, diffuse coronary atherosclerosis, previous coronary artery bypass operation, or previous angioplasty were also excluded. All patients were continued on their medications as clinically indicated until the night before the study. A total of 96 arteries (48 target/48 reference) were studied. In all patients, stress 201TI myocardial perfusion tomography was performed within 2 weeks before the invasive procedure. Informed consent for the study was obtained in writing before the procedure.

**Quantitative Coronary Angiography**

Angiograms of the left coronary artery were recorded in orthogonal projections, and end-diastolic frames were chosen for analysis with the Quantitative Coronary Angiography Cardiovascular Measurement System (QCA-CMS, Medis; Leiden, the Netherlands). Minimal lumen diameter, percentage of diameter stenosis (DS), and reference vessel diameter were measured by an observer who was blinded to the Doppler angiographic flow-velocity measurements, and to the results of stress myocardial perfusion imaging.

**Intracoronary Doppler Angiography Measurements**

Coronary angiography was performed via the femoral approach, using 7F guiding catheters without side holes. After IV administration of 10,000 IU of heparin, a Doppler-tipped guidewire (Flowire; Cardiometrics; Mountain View, CA) 0.014 inches in diameter, was advanced distal to the stenosis, at a distance more than five times the vessel diameter to avoid post-stenotic turbulent flow. A second Doppler-tipped wire was advanced through the same guiding catheter to the midportion of the adjacent, angiographically normal major coronary artery, the left circumflex in patients with left anterior descending stenosis and right coronary. Care was taken to avoid placement in side branches. A good and stable position of the flow wire signals had to be obtained for reliable measurements. A bolus intracoronary injection of 200 μg of nitroglycerin was administered at least 3 min before angiography in order to achieve maximal vasodilation of the epicardial coronary arteries and to exclude spasm. Baseline flow velocities were recorded simultaneously with the two Doppler wires, as previously described. Subsequently, IV infusion (0.56 mg/kg over 4 min) of dipyridamole (n = 28), or intracoronary bolus injection of 18 μg of adenosine (n = 20) were administered to induce maximal hyperemia, while flow velocity was recorded continuously with the two Doppler wires. The time-averaged peak velocity (APV) [centimeters per second] was automatically calculated from instantaneous peak velocity waveforms on two consecutive cardiac cycles. CFVR was calculated as the quotient of hyperemic/basal APV. RCFVR was computed as the ratio of post-stenotic CFVR to CFVR in the adjacent angiographically normal coronary artery. Flow-velocity measurements were made by operators who were blinded to the results of stress myocardial perfusion imaging.

**Stress Myocardial Perfusion Imaging**

Single-photon emission tomography was performed according to standard stress, 4-h redistribution protocol. 201TI scintigraphy was performed using a large-field-of-view rotating gamma camera (Orbitel, 75 2LC; Siemens; Erlangen, Germany) equipped with a low-energy, high-resolution collimator interfaced to the computer (ICON AP; Siemens Gammasonics; Des Plaines, IL). Thirty-two frames were obtained over a 180° arc from the 45° left posterior oblique to the 45° right anterior oblique position at 6° intervals, for 40 s per frame. The data were stored on 64 × 64 × 8-byte matrix. Exercise stress test was performed in 20 patients, and 28 patients underwent IV dipyridamole stress. Heart rate and BP were monitored every minute during the first 20 min of the test. Reconstructed vertical long-axis, horizontal long-axis, and horizontal short-axis tomograms were scored as normal or abnormal. Stress and rest images were viewed simultaneously on the computer screen, and segmental defect maps were developed. Defects that demonstrated significant redistribution at 4 h, compared to stress, were classified as reversible. The result was considered “positive” when a reversible defect was allocated to the perfusion territory of the coronary artery of...
interest. Defects located in the anterior wall and septal region were allocated to the left anterior descending, and defects in the lateral wall were allocated to the left circumflex coronary artery. A perfusion test result was considered negative when a normal distribution of the radioisotope was present during exercise or pharmacologic test and at 4 h later.

**Statistical Analysis**

Linear regression analysis was performed between percentage of DS, minimal lumen diameter, and post-stenotic CFVR and RCFVR. Differences between proportions were determined by χ² testing. Continuous data were compared using a nonparametric test. The predictive value of post-stenotic CFVR and RCFVR for the presence of reversible perfusion defects on ³¹¹Tl was evaluated by the area under the curve (AUC) of the receiver operating characteristic (ROC) curves. Accuracy was calculated for the best cutoff value (BCV) of the current data set, defined as the highest sum of sensitivity and specificity. κ statistics were used to determine the strength of the agreement between flow-velocity measurements, and stress myocardial perfusion imaging studies. Statistical significance was stated at the 0.05 probability level.

**Results**

Patients were classified in two groups according to the results of stress myocardial perfusion imaging:negative perfusion test results (n = 13), and positive perfusion test results (n = 35). Baseline clinical and angiographic characteristics of the 48 patients studied are shown in Table 1.

**Angiographic and Coronary Flow Velocity Data**

Patients with positive perfusion test results had more severe coronary artery stenoses. The mean percentage of DS was 81% (range, 72 to 87%) in patients with positive perfusion test results, and 71% (range, 54 to 78%) in patients with negative perfusion test results (p < 0.01). The coronary flow velocity data are shown in Table 2. There were no significant differences in reference vessel basal and hyperemic flow velocities in patients with positive or negative perfusion test results. Patients with positive perfusion test results had significantly lower post-stenotic hyperemic flow velocities in comparison to patients with negative perfusion test results or to their matching reference vessel. This blunted hyperemia was associated with significantly lower post-stenotic CFVR in patients with positive perfusion test results. RCFVR was significantly lower in patients with positive perfusion test results than in patients with negative perfusion test results. Simple linear regression analysis was performed for both post-stenotic CFVR and RCFVR and lesion severity. In the total range of coronary artery narrowing, RCFVR showed better correlation to percentage of DS (Fig. 1) than post-stenotic CFVR (r = 0.68, p < 0.0001 vs r = 0.55, p < 0.001, respectively). The comparison between these two correlations (RCFVR-percentage of DS and post-stenotic CFVR-percentage of DS) was borderline significant (p = 0.05). Similar results were observed between RCFVR or post-stenotic CFVR and minimal lumen diameter (r = 0.66, p < 0.0001 and r = 0.57, p < 0.0001; respectively). There was also a strong linear relation between post-stenotic CFVR and RCFVR in the total range of coronary artery stenosis severity (r = 0.84, p < 0.0001).

**Correlation Between CFVR and Myocardial Perfusion Imaging**

The AUC as measured by ROC curve analysis was 0.79 (p < 0.005) for post-stenotic CFVR and 0.91

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**Table 1—Baseline Clinical and Angiographic Characteristics**

<table>
<thead>
<tr>
<th>Variables</th>
<th>Negative Perfusion Test Result (n = 13)</th>
<th>Positive Perfusion Test Result (n = 35)</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean age, yr (SD, range)</td>
<td>59 (11, 42–83)</td>
<td>61 (10, 34–77)</td>
<td>0.65</td>
</tr>
<tr>
<td>Male sex</td>
<td>11 (84.6)</td>
<td>32 (91.4)</td>
<td>0.60</td>
</tr>
<tr>
<td>Hypertension</td>
<td>2 (15.4)</td>
<td>8 (22.9)</td>
<td>0.71</td>
</tr>
<tr>
<td>Hypercholesterolemia</td>
<td>6 (46.2)</td>
<td>22 (62.9)</td>
<td>0.34</td>
</tr>
<tr>
<td>Diabetes mellitus</td>
<td>3 (23.1)</td>
<td>3 (8.6)</td>
<td>0.32</td>
</tr>
<tr>
<td>Smoking</td>
<td>5 (38.5)</td>
<td>20 (57.1)</td>
<td>0.34</td>
</tr>
<tr>
<td>Family history of CAD</td>
<td>2 (15.4)</td>
<td>11 (31.4)</td>
<td>0.47</td>
</tr>
<tr>
<td>% DS, median (IQR)</td>
<td>71 (64–78)</td>
<td>81 (72–87)</td>
<td>0.01</td>
</tr>
</tbody>
</table>

*Data are presented as No. (%) unless otherwise indicated. IQR = interquartile range.

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**Table 2—Coronary Flow Velocity Data**

<table>
<thead>
<tr>
<th>Variables</th>
<th>Negative Perfusion Test Result (n = 13)</th>
<th>Positive Perfusion Test Result (n = 35)</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>APV, reference</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baseline</td>
<td>19 (14–22)</td>
<td>17 (13.2–22)</td>
<td>0.684</td>
</tr>
<tr>
<td>Hyperemia</td>
<td>40 (34–49)</td>
<td>46 (34.6–57)</td>
<td>0.728</td>
</tr>
<tr>
<td>APV, post-stenotic</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baseline</td>
<td>12 (9.6–14)</td>
<td>9 (5–13)</td>
<td>0.131</td>
</tr>
<tr>
<td>Hyperemia</td>
<td>18 (16.7–24)</td>
<td>11 (6–17)</td>
<td>0.010</td>
</tr>
<tr>
<td>CFVR, reference</td>
<td>2.60 (2.10–2.80)</td>
<td>2.56 (2.24–3.00)</td>
<td>0.246</td>
</tr>
<tr>
<td>Post-stenotic CFVR</td>
<td>1.69 (1.36–1.96)</td>
<td>1.25 (1.07–1.44)</td>
<td>0.002</td>
</tr>
<tr>
<td>RCFVR</td>
<td>0.67 (0.65–0.70)</td>
<td>0.49 (0.41–0.58)</td>
<td>&lt; 0.001</td>
</tr>
</tbody>
</table>

*Data are presented as median (interquartile range).
(p < 0.001) for RCFVR (Fig 2) in the total range of coronary artery narrowing. χ values indicated good agreement (75%) at the BCV for post-stenotic CFVR (sensitivity, 71%; specificity, 85%) and excellent agreement (92%) for RCFVR (sensitivity, 91%; specificity, 92%) [Table 3]. For lesions of intermediate severity (50 to 75%) [n = 21], the AUC was 0.65 (not significant) for post-stenotic CFVR and 0.88 (p < 0.01) for RCFVR (Fig 3). The agreement between post-stenotic CFVR and myocardial perfusion imaging results was 67% (sensitivity, 54%; specificity, 81%) and increased to 90% using RCFVR (sensitivity, 85%; specificity, 98%). For significant lesions (>75% DS) [n = 27], the AUC was 0.88 (p < 0.01) for post-stenotic CFVR and 0.92 (p < 0.005) for RCFVR. Direct comparison of the ROC curve analysis by the AUC (post-stenotic CFVR

![Figure 1. Correlation between percentage DS and post-stenotic CFVR (top) or RCFVR (bottom).](image)
ROC Analysis for poststenotic CFVR

Area under the curve = 0.7912 (p < 0.005)

ROC Analysis for RCFVR

Area under the curve = 0.9143 (p < 0.001)

This study shows that RCFVR has better agreement with myocardial perfusion imaging than post-

Discussion

This study shows that RCFVR has better agreement with myocardial perfusion imaging than post-

vs RCFVR) did not differ significantly for the total range of coronary artery stenosis (p = 0.05), and showed a significant difference in patients with moderate lesions (p = 0.04).
stenotic CFVR. RCFVR measurements are more useful in patients with moderate coronary artery stenosis (50 to 75%).

**Post-stenotic CFVR and RCFVR**

At rest, flow is independent of the driving pressure over a wide range of pressures (60 to 180 mm Hg). This phenomenon is described as autoregulation of the coronary circulation. During maximal hyperemia, flow becomes linearly related to the driving pressure. A pressure drop is generated by viscous and turbulent resistances across a flow-limiting stenosis, so that the driving pressure distal to the stenosis decreases exponentially with the velocity of blood. It has been shown that a decrease in flow reserve may discriminantly detect a lesion of increasing severity. Nevertheless, CFVR is influenced by factors independent of the hydrodynamic characteristics of the stenosis. Flow reserve is by definition a ratio, and similar ratios may be obtained at very different levels of resting and hyperemic flow. The ratio may be considerably affected by changes in resting flow without significant changes in hyperemic flow; however, the hyperemic flow/driver relation is influenced by factors such as heart rate, preload, myocardial hypertrophy, and structural or functional changes in the microcirculation.

Values of CFVR measured in normal vessels are not different among the perfusion territories of the three major coronary arteries. Factors such as diabetes mellitus, hypertension, hypercholesterolemia, and smoking are expected to affect the microcirculation of the myocardium in a more-or-less homogeneous manner. Thus post-stenotic CFVR is determined by the integrity of both the epicardial conduit artery and the distal microvascular bed. RCFVR is focusing on the contribution of epicardial narrowing by correcting for microcirculatory disturbances. In the present study, angiographic indexes of stenosis severity were found to correlate better with RCFVR than with post-stenotic CFVR. Similar results have been reported previously. Baumgart et al found no correlation of percentage area stenosis with post-stenotic CFVR ($r = 0.27$, $p = 0.21$), but they found a significant correlation with RCFVR ($r = 0.63$, $p < 0.0001$). El-Shafei et al reported a stronger correlation of percentage of DS with RCFVR ($r = 0.79$, $p < 0.0001$) than with post-stenotic CFVR ($r = 0.47$, $p < 0.005$).

**Myocardial Perfusion Scintigraphy Results vs Post-stenotic CFVR and RCFVR**

Several previous studies have shown a good agreement between myocardial perfusion scintigraphy and post-stenotic CFVR ranging from 81 to 94%. In comparison to the studies mentioned above, in our study, in the total range of coronary narrowing the agreement between Doppler-derived indexes and myocardial perfusion imaging was lower (75%) using the BCV of 1.67. Similar results have been reported recently by Chamuleau et al in patients with two-vessel disease; the agreement between post-stenotic CFVR and the presence or absence of reversible defects was 77% (BCV of 1.7). For lesions of intermediate severity, the agreement between post-stenotic CFVR and myocardial perfusion imaging in our study was lower (67%); similar results have been reported by Verberne et al in patients with single-vessel disease. In that study, the agreement between post-stenotic CFVR and myocardial perfusion imaging was 81% for the total range of coronary artery stenosis and 73% for lesions of intermediate severity (30 to 75% DS).

There are only few studies showing the myocardial perfusion imaging/RCFVR correlation. These studies performed in patients with single or multivessel disease have shown no additive value of RCFVR over post-stenotic CFVR for the agreement with myocardial perfusion imaging. In our study, RCFVR showed better agreement with myocardial perfusion imaging than post-stenotic CFVR (92% vs 75%, respectively). RCFVR measurements were more useful in patients with moderate coronary artery lesions. RCFVR reflects the effect of a stenosis on myocardial blood flow, and should eliminate or minimize the confounding effects of microvascular abnormalities and hemodynamic variations that can produce an abnormal post-stenotic CFVR and ob-

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**Table 3—Prediction of 201Tl Scintigraphy Results**

<table>
<thead>
<tr>
<th>Variables</th>
<th>BCV</th>
<th>$\kappa$</th>
<th>p Value</th>
<th>Sensitivity, %</th>
<th>Specificity, %</th>
<th>Agreement, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total range of % DS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Post-stenotic CFVR</td>
<td>1.67</td>
<td>0.47</td>
<td>0.0003</td>
<td>71</td>
<td>85</td>
<td>75</td>
</tr>
<tr>
<td>RCFVR</td>
<td>0.64</td>
<td>0.80</td>
<td>0.0000</td>
<td>91</td>
<td>92</td>
<td>92</td>
</tr>
<tr>
<td>Intermediate range (50–75%) DS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Post-stenotic CFVR</td>
<td>1.50</td>
<td>0.37</td>
<td>0.03</td>
<td>54</td>
<td>81</td>
<td>67</td>
</tr>
<tr>
<td>RCFVR</td>
<td>0.60</td>
<td>0.81</td>
<td>0.0001</td>
<td>85</td>
<td>98</td>
<td>90</td>
</tr>
</tbody>
</table>

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Figure 3. ROC curve analysis of post-stenotic CFVR (top) or RCFVR (bottom) and myocardial perfusion imaging in patients with moderate lesion severity (50 to 75%). ns = not significant.
sure the functional importance of a stenosis as evaluated by post-stenotic CFVR. Several explanations can be postulated for the differences observed between our results and the previous studies. In our study, we acquired simultaneous CFVR measurements in the diseased vessel and in the adjacent angiographically normal vessel, using two Doppler guide wires during infusion of hyperemic agents. The study of Verberne et al. included patients with single-vessel disease; however, for RCFVR calculations they used the CFVR in the reference vessel that was assessed immediately after balloon angioplasty. Impaired CFVR in the reference vessel may be observed following balloon angioplasty, due to an acute attenuation of the microcirculatory vasomotor response. In this study, using logistic regression analysis for the total range of coronary artery severity, both percentage of DS and RCFVR were independent predictors for the outcome of the scintigraphy results. In moderate lesions (30 to 75%), RCFVR was the only independent predictor for the results of myocardial perfusion imaging. In the study of Chamuleau et al., patients with two-vessel disease were included. It is known that in multivessel disease perfusion scintigraphy has a limited capability to assign the perfusion defect to a specific epicardial coronary narrowing. Even in the study of El-Shafei et al., where RCFVR and post-stenotic CFVR had similar agreement, sensitivity, specificity, and positive predictive value with myocardial perfusion imaging, concordant values of RCFVR and post-stenotic CFVR increased the predictive accuracy of the test. The observed BCVs for post-stenotic CFVR (1.67) and RCFVR (0.64) in our study were in accordance with the results of previous studies (cutoff values of 1.7 to 2.0 for post-stenotic CFVR, and 0.65 for RCFVR).19–21

**Limitations**

RCFVR cannot be determined in patients with three-vessel disease. Nevertheless, the critical question of intermediate lesion assessment usually arises in patients with single- or two-vessel disease in whom a reference vessel is present. In patients with three-vessel disease, fractional flow reserve may serve for clinical decision making.23

Intravascular ultrasound was not performed, and plaque burden may have been missed by angiography. In patients with chest pain, normal coronary angiography and positive stress test sestamibi single-photon emission tomography findings, Verna et al. found significantly lower CFVR in vessels with 46 ± 14% relative cross-sectional plaque area (plaque area/vessel area) by intravascular ultrasound, compared to vessels with 12 ± 18% relative cross-sectional plaque area (2.3 ± 0.5 vs 3.1 ± 0.6, respectively; p = 0.0001). Therefore, occult atherosclerosis (missed by angiography) may reduce CFVR in the angiographically normal reference coronary artery, resulting in higher RCFVR values, and leading to underestimation of the lesion in the stenosed artery. Furthermore, a reduction in reference vessel CFVR due to an old myocardial infarction in the respective perfusion territory may lead to a near-normal RCFVR despite the presence of an angiographically severe coronary lesion in the target vessel.6

The concept of RCFVR relies on the assumption that risk factors for CAD affect the coronary circulation homogeneously, and thus the microcirculations of the stenotic and reference vessels are expected to behave similarly. Even if the microcirculation is affected by atherosclerotic and fibrotic alterations in a stochastic manner, similar to that in the epicardial vessels, the measured flow velocity values integrate over many microcirculatory units such that any alterations are averaged and thus comparable between the post-stenotic and reference microcirculations. Many studies have found similar values for CFVR in the perfusion territories of the three major vessels,13 and thus support the assumption of a homogeneous microcirculation. However, Wofford et al.25 reported significant spatial heterogeneity of the coronary circulation in some cardiac transplant recipients.

Evidence for submaximal coronary vasodilation after administration of dipyridamole in the standard dose of 0.56 mg/kg has been reported.26 Recently, similar diagnostic accuracy was reported for exercise stress testing and administration of adenosine or dipyridamole in inducing maximal hyperemia for myocardial perfusion imaging.27 Furthermore, no difference in the hyperemic response was observed, as measured by intracoronary Doppler flow velocity, between adenosine (both IV and intracoronary administered) and papaverine.28 In patients who underwent thallium scintigraphy with exercise stress testing, we used intracoronary adenosine for CFVR measurements, because this medication is widely used in clinical practice. Patients with dipyridamole myocardial perfusion scintigraphy had dipyridamole infusion during cardiac catheterization for CFVR measurements, to avoid the use of different agents and routes of administration for vasodilation and scintigraphy; however, both agents are equally effective in producing myocardial hyperemia.29 We used myocardial perfusion imaging as the ischemic standard because of its widespread clinical application for decision making regarding intervention. Nonetheless, false-positive imaging results are commonly identified, due to a variety of both clinical and technical factors.30
CONCLUSIONS

RCFVR, similar to post-stenotic CFVR, correlates with myocardial perfusion imaging results for severe (>75%) coronary artery stenosis. This indicates that both indexes may be used for diagnostic purposes. However, RCFVR has significant incremental prognostic value over post-stenotic CFVR for myocardial perfusion imaging in patients with moderate (50 to 75%) coronary artery narrowing. Therefore, it is a more useful hemodynamic variable for clinical decision making during cardiac catheterization in patients with moderate coronary artery narrowing. This is very important in view of the increasing number of percutaneous coronary interventions that are performed as a one-stage procedure after diagnostic angiography.

REFERENCES