Angiographical and Doppler flow-derived parameters for assessment of coronary lesion severity and its relation to the result of exercise electrocardiography


1 Academical Medical Center, Amsterdam, The Netherlands; 2 Thoraxcenter, Rotterdam, The Netherlands; 3 Centro Cuore Columbus, Milano, Italy; 4 Clinique Universitaire de Mont-Godinne, Yvoir, Belgium; 5 Universitair Ziekenhuis, Antwerp, Belgium; 6 Kardiologische Universitätsklinik, Wien, Austria; 7 Onze Lieve Vrouwe Kliniek, Aalst, Belgium; 8 Clinique Universitaires de Saint-Luc, Brussels, Belgium; 9 Deutsches Herzzentrum, Berlin, Germany; 10 Universität Essen, Essen, Germany; 11 Ospedale di Circolo, Varese, Italy; 12 Onassis Cardiac Surgery Center, Athens, Greece; 13 Université Paris XII Val de Marne, La Creteil, France; 14 Sahlgrenska Hospital, Göteborg, Sweden; 15 Universitätsklinik für Innere Medizin, Innsbruck, Austria; 16 Academisch Ziekenhuis, Groningen, The Netherlands

Aims Evaluation of angiographical and intracoronary Doppler-derived parameters of coronary stenosis severity.

Methods and Results A total of 225 patients with one-vessel disease were studied before PTCA and at 6 months follow-up. Exercise electrocardiography was performed to document presence (n=157) or absence (n=138) of an ST segment shift (≥0.1 mV). Intracoronary blood flow velocity analysis was performed to determine the proximal/distal flow velocity ratio, the distal diastolic/systolic flow velocity ratio and coronary flow velocity reserve. Receiver operator characteristic curves were calculated to assess the predictive value of these variables compared with the exercise test. The distal coronary flow velocity reserve demonstrated the best linear correlation for both percentage diameter stenosis and minimum lumen diameter (r=0.67 and r=0.66; P<0.01), compared to the diastolic/systolic flow velocity ratio and coronary flow velocity reserve. Receiver operator characteristic curves were calculated to assess the predictive value of these variables compared with the exercise test. The distal coronary flow velocity reserve demonstrated the best linear correlation for both percentage diameter stenosis and minimum lumen diameter (r=0.67 and r=0.66; P<0.01), compared to the diastolic/systolic flow velocity ratio and coronary flow velocity reserve. Logistic regression analysis revealed that the percentage diameter stenosis or minimum lumen diameter and coronary flow velocity reserve were independent predictors for the result of stress testing.

Conclusions The distal coronary flow velocity reserve is the best intracoronary Doppler parameter for evaluation of coronary narrowings. Angiographical estimates of coronary lesion severity and distal coronary flow velocity reserve are good and independent predictors for the assessment of functional severity of coronary stenosis, emphasizing the complementary role of these parameters for clinical decision making. (Eur Heart J 2000; 21: 466–474)

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Key Words: Angiography, coronary stenosis, intracoronary Doppler, exercise electrocardiography.

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Introduction

Quantitative coronary angiography is an accurate technique for the assessment of coronary lesion severity.
velocity indices for determination of coronary lesion severity, including the proximal/distal blood flow velocity ratio, the distal/systolic blood flow velocity ratio and the distal blood flow velocity reserve \(^8,^9\). Recently, the predictive value of Doppler blood flow velocity indices following balloon angioplasty with respect to the clinical outcome was evaluated in the DEBATE study (Doppler Endpoints Balloon Angioplasty Trial Europe) \(^10\). In the present study, the setting of this multicentre trial study was used to assess the relationship between angiographical and Doppler flow-derived estimates of coronary lesion severity. Moreover, the predictive value of these parameters for assessment of the functional significance of coronary narrowings was evaluated by means of exercise electrocardiography.

**Methods**

**Patient selection**

The study population consisted of 225 patients undergoing percutaneous transluminal coronary balloon angioplasty (PTCA) for chest pain and/or documented signs of myocardial ischaemia (electrocardiographic, scintigraphic or echocardiographic). The patient’s anginal status was classified according to the criteria of the Canadian Cardiovascular Society (CCS). Patients scheduled for PTCA of one major native coronary artery, but with a normal left ventricular function were included. Exclusion criteria were: multivessel disease, previous transmural myocardial infarction in the territory distributed by the vessel to be dilated, acute myocardial infarction less than 1 week prior to PTCA, previous PTCA of the actual coronary segment, total or functional coronary occlusion, presence of left bundle branch block, second- or third-degree atrioventricular block, atrial fibrillation, open bypass graft distal to the lesion to be treated, extreme tortuosity of the vessel to be dilated, and intended alternative or additional interventional treatments, such as directional and rotational atherectomy or stent implantation. The study protocol was approved by the institutional review boards of the participating centres. All patients gave written informed consent.

**Exercise test**

A symptom-limited exercise test (bicycle or treadmill) was performed according to the institutional protocol before PTCA and at 6 months follow-up. Antianginal medication was withheld prior to the stress test unless the responsible physician considered continuation of the medication mandatory. Heart rate and blood pressure were recorded before the exercise test and at maximal exertion; the expected maximal heart rate, according to the institutional protocol, was also recorded. The result of the exercise test was evaluated by the presence of horizontal or down-sloping ST-segment depression (≥0.1 mV) or ST-segment elevation (>0.1 mV) measured 80 ms after the J-point. The exercise-test was recorded as positive, negative or non-diagnostic as determined by the respective exercise testing laboratories.

**Angioplasty procedure and blood flow velocity assessment**

The study protocol has been reported in detail elsewhere \(^10\). Briefly, the protocol included premedication of patients before angioplasty with heparin and acetylsalicylic acid. A 0.014 inch Doppler tipped guide wire was used as the primary angioplasty guide wire (FloWire; Endosonics, Rancho Cordova, CA, U.S.A.) \(^10\). The Doppler guide wire was introduced into the proximal segment of the artery to be dilated and baseline and hyperaemic blood flow velocity measurements were obtained in an angiographically normal segment of the artery. Next, the Doppler guide wire was advanced distal to the lesion and additional blood flow velocity recordings were obtained under baseline and hyperaemic conditions. For both proximal and distal measurements, a distance from the stenosis greater than five times the vessel diameter was maintained in order to avoid pre-stenotic acceleration of flow or post-stenotic turbulent flow. Maximal hyperaemia was induced by an intracoronary bolus injection of adenosine, 12 μg for the right coronary artery and 18 μg for the left coronary artery. The Doppler guide wire was left in place and blood flow velocity was continuously monitored throughout the procedure. Only angiographic criteria (diameter stenosis <50% in any angiographic view) were used to determine the end-point of the angioplasty procedure. The site of the blood flow velocity measurements was recorded on cinefilm.

**Quantitative coronary angiography**

Cine-angiography was performed after the intracoronary administration of 0.1–0.3 mg nitroglycerin or 1–3 mg isosorbide dinitrate, to achieve maximal coronary vasodilatation. A lesion was considered proximal when it was located in the right coronary artery before the acute marginal branch, in the left anterior descending coronary artery before the first septal branch and in the left circumflex coronary artery before the first marginal branch. At least two cine-angiograms, in orthogonal projections, were obtained before coronary angioplasty and repeated at late follow-up. All cinefilms were analysed by an independent core laboratory without knowledge of the clinical information and the Doppler flow data. Matched views and frames were selected for off-line quantitative computer-assisted analysis (CAAS II system, Pie Medical Data, Maastricht, the Netherlands). Automatic edge-detection of the luminal
dimensions (minimum lumen diameter, reference diameter) and videodensitometric analysis (minimum lumen cross-sectional area, reference area) were performed using the guiding catheter filled with contrast as a scaling device. A coronary narrowing of intermediate severity was defined as a lesion with a 40–70% diameter stenosis.

**Blood flow velocity analysis**

During the angioplasty procedure, the Doppler flow velocity signals were recorded continuously on videotape using a Doppler flow spectral analyser (FloMap; Endosonics, Rancho Cardova, CA, U.S.A.). By means of the time-averaged peak velocity (normalized to the cardiac cycle), the proximal and distal blood flow velocity measurements were used to calculate the proximal/distal blood flow velocity ratio during baseline and hyperaemic conditions, the distal diastolic to systolic blood velocity ratio, distal diastolic/systolic blood velocity signals were recorded continuously on videotape, the proximal and distal baseline blood velocity. The appropriate-ness of the Doppler flow measurements were verified by an independent core laboratory.

**Follow-up procedures**

At 6 months (± 4 weeks), the patient’s anginal status was documented, a symptom-limited exercise test was repeated as prior to PTCA and quantitative coronary angiography was performed in the same views as during the initial procedure. The proximal and distal baseline and hyperaemic blood flow velocity recordings were obtained in the same position as before PTCA. Revascularization was performed before 6 months in case of recurrent angina and/or objective signs of myocardial ischaemia in the presence of coronary narrowing with a diameter stenosis greater than 50%. Intracoronary blood flow velocity measurements were not performed in this situation.

**Statistical analysis**

Continuous variables are expressed as mean ± standard deviation. Differences in angiographical and Doppler flow parameters before PTCA and at late follow-up in patients with and without restenosis were evaluated by two-way analysis of variance (ANOVA). The angiographical and Doppler-flow variables obtained before PTCA and at late follow-up were combined. The relationship between angiographical estimates of coronary lesion severity (diameter stenosis, minimum lumen diameter, area stenosis, minimum lumen area) and Doppler flow-derived variables (proximal/distal blood flow velocity ratio, distal diastolic/systolic blood flow velocity ratio and distal blood flow velocity reserve) were evaluated by linear regression analysis. These variables were subsequently entered in a univariate logistic regression analysis to determine significant predictors for the result of the exercise test. Contributing factors were entered into a multivariate logistic regression analysis to determine independence. The predictive value of angiographical and Doppler flow-derived estimates of coronary lesion severity, compared with the exercise test, was evaluated by the area under the receiver operator characteristics curves. The best cut-off value of a predictive variable separating a positive or negative exercise test was defined as the value characterized by similar sensitivity and specificity. These variables were further used to calculate the positive and negative predictive value of angiographical and Doppler flow derived parameters. For all tests, a P-value <0.05 was considered statistically significant.

**Results**

The baseline clinical and angiographical characteristics of the 225 study patients are shown in Table 1. A stress test was performed 1 day (median) before cardiac catheterization (interquartile range 1–2 days). The flow chart in Table 2 summarizes the number of patients in whom a comparison of Doppler flow data with angiographical
variables or the result of stress testing was performed. Doppler data were available in 225 patients before PTCA and in 183 patients at 6 months follow-up. A proximal/distal flow velocity ratio could not be determined in approximately 10% of the observations due to an inadequate proximal signal. Matched angiographic data were available in only 202 patients due to patient refusal of re-catheterization (n=19), technical failure (n=3) or loss at follow-up (n=1). A stress test was not performed in 59 patients before PTCA and in 19 patients at late follow-up, most often because of logistic reasons. At 6 months follow-up, 99 patients were treated with beta-blockers, 99 with calcium antagonists and 70 with nitrates. There were no significant differences in use of medication between patients with (44% mono -, 51% double -, 34% triple therapy) and without restenosis (56% mono -, 35% -, 8% triple therapy).

Angiographical and Doppler-derived estimates of coronary lesion severity

Seventy-two of the 202 patients demonstrated angiographical restenosis (diameter stenosis <50%) at 6 months follow-up. The matched angiographical and Doppler flow velocity measurements before PTCA and at 6 months follow-up in patients with and without restenosis are summarized in Table 3. The differences in coronary flow reserve and the hyperaemic proximal/distal flow velocity ratio between values before PTCA and at late follow-up were significantly different in patients with restenosis compared to patients without restenosis (ANOVA, P=0.0001 and P=0.02 respectively). The correlation between the angiographical estimates of coronary lesion severity and Doppler-derived variables are shown in Table 4. The distal coronary flow velocity reserve yields the best linear correlation with angiographical estimates of coronary lesion severity compared with the other Doppler-derived variables. The relationship between the diameter stenosis and minimum lumen diameter of the coronary narrowings before

Table 2 Flowchart of the study patients

<table>
<thead>
<tr>
<th>Timing</th>
<th>Doppler</th>
<th>Angiography</th>
<th>Exercise-test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre PTCA</td>
<td>225</td>
<td>225</td>
<td>166</td>
</tr>
<tr>
<td>Follow-up</td>
<td>183</td>
<td>202</td>
<td>183</td>
</tr>
<tr>
<td>Combined</td>
<td>406</td>
<td>427</td>
<td>349</td>
</tr>
</tbody>
</table>

Table 3 Angiographical and Doppler flow-derived parameters for assessment of coronary lesion severity

Table 4 Correlation coefficient between angiographical and Doppler flow velocity indices

Abbreviations as in Table 2; AS=area stenosis (%); MLA=minimum lumen area; *An adequate proximal blood flow velocity signal could not be obtained in approximately 10% of the procedures.
PTCA and at late follow-up and the distal coronary flow velocity reserve is demonstrated in Fig. 1(a) and (b). This figure depicts the inter-patient variability of coronary flow reserve, showing a wide range of values in lesions of intermediate severity (diameter stenosis 40–70%) and less severe coronary narrowings. The correlation between percentage diameter stenosis and minimum lumen diameter with distal coronary flow velocity reserve was moderate in the range of coronary narrowings before PTCA, \( r = 0.41; r = 0.49 \) respectively, at 6 months follow-up \( r = 0.53; r = 0.51 \) and in lesions of intermediate severity \( r = 0.47; r = 0.52 \).

\[
y = 4.274 - 0.042x \\
\text{r} = 0.66 \\
P < 0.0001
\]

\[
y = 0.25 + 1.37 \\
\text{r} = 0.66 \\
P < 0.0001
\]
Table 5 Predictive value of angiographical and Doppler flow variables for the result of the exercise test

<table>
<thead>
<tr>
<th>Predictive variable</th>
<th>AUC ± SE</th>
<th>95% CI</th>
<th>BCV</th>
<th>Sensitivity/ specificity</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Angiography</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DS</td>
<td>83 ± 3</td>
<td>78-88</td>
<td>52</td>
<td>77%</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>MLD</td>
<td>82 ± 3</td>
<td>77-87</td>
<td>1.31</td>
<td>75%</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Doppler</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CFR</td>
<td>83 ± 3</td>
<td>78-88</td>
<td>2.1</td>
<td>76%</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>DSVR-distal</td>
<td>61 ± 3</td>
<td>54-67</td>
<td>1.7</td>
<td>59%</td>
<td>0.022</td>
</tr>
<tr>
<td>PDR-baseline</td>
<td>55 ± 4</td>
<td>47-62</td>
<td>1.38</td>
<td>55%</td>
<td>0.486</td>
</tr>
<tr>
<td>PDR-adenosine</td>
<td>64 ± 4</td>
<td>57-61</td>
<td>1.66</td>
<td>61%</td>
<td>0.0012</td>
</tr>
</tbody>
</table>

Abbreviations as in Table 2; AUC = area under the curve (%) (see methods); BCV = best cut-off value.

Angiographical and Doppler-derived indices of coronary lesion severity in relation to the result of exercise testing

Exercise electrocardiography was positive in 146 (45%), negative in 125 (39%) and non-diagnostic in 50 (16%) of the 321 tests performed before PTCA and at late follow-up. Univariate analysis revealed that diameter stenosis, minimum lumen diameter, coronary flow reserve, distal diastolic/systolic blood flow velocity ratio and hyperemic proximal/distal flow velocity ratio were significant predictors of the result of the exercise test (Table 5). Logistic regression analysis revealed that the percentage diameter stenosis or minimum lumen diameter and distal coronary flow velocity reserve were independent predictors of the result of the exercise test in the range of coronary narrowings before PTCA and at late follow-up as well as in the range of intermediate coronary lesion severity. The areas under the curve and best cut-off values, corresponding with the receiver operator characteristic curves of angiographical and Doppler-derived parameters of coronary lesion severity, compared with the result of the exercise test are shown in Table 5. The best cut-off value of coronary flow reserve in lesions of intermediate severity was 1.9. There was no significant difference between the area under the curve of the percentage diameter stenosis, minimum lumen diameter and distal coronary flow velocity reserve. There was a significant difference between the area under the curve of the distal coronary flow velocity reserve and the area under the curve of the other Doppler-derived variables.

The positive and negative predictive value of diameter stenosis compared with the result of the exercise test was 81% and 73%, respectively. The positive and negative predictive value of coronary flow reserve compared with the result of the exercise test were 80% and 73%, respectively. These values increased to 86% and 79%, respectively, in the 82% of patients with concordant data for diameter stenosis and distal coronary flow reserve. Exercise electrocardiography was positive in 26 of 49 (53%) tests in the remaining 18% of the patients with disconcordant data for diameter stenosis and distal coronary flow reserve.

Discussion

The results of the present study demonstrate that the distal coronary flow velocity reserve yields a better correlation of angiographical estimates of coronary lesion severity than other Doppler blood flow velocity variables. The percentage diameter stenosis, minimum lumen diameter and the distal coronary flow velocity reserve are equally predictive with respect to the result of a symptom-limited exercise test. However, angiographical estimates of coronary narrowings and the distal coronary flow velocity reserve are independent variables that underline the complementary role of angiographical and physiological parameters for clinical decision making in an individual patient.

Angiographical and Doppler-derived estimates of coronary lesion severity

The discrepancy between angiographical estimates of coronary lesion severity and the results of functional tests has stimulated research into the evaluation of coronary haemodynamics during cardiac catheterization [8,9,13-17]. Guide wires equipped with miniaturized sensors allowed assessment of pressure or flow velocity distal to coronary narrowings. Initial reports regarding intracoronary blood flow velocity analysis defined several Doppler-derived estimates of coronary lesion severity [8,9,16,18].

The present multicentre study is the first report evaluating these Doppler-derived parameters in a large cohort of patients and may reflect more appropriately the potential contribution of intracoronary flow velocity measurements in diagnostic clinical practice than previous single-centre reports. Moreover, the present study combined the measurements before coronary
angioplasty and at 6 months follow-up, while some of the aforementioned single-centre studies evaluated the results before and immediately after coronary angioplasty to determine the relationship between coronary lesion severity and distal blood flow velocity reserve[19,20]. The data obtained directly after angioplasty were not included in the present analysis because quantitative coronary angiography directly after PTCA may be hampered by the occurrence of coronary dissections and/or haziness of the dilated segment. The results of blood flow velocity alterations directly after PTCA were reported previously[10]. The present analysis shows that the distal blood flow velocity reserve yields the best correlation with angiographical estimates of coronary lesion severity within the range of coronary narrowings encountered before PTCA and at late follow-up. This indicates that the other Doppler flow parameters are poor markers of angiographical estimates of coronary lesion severity. The correlation between the distal coronary flow reserve and the percentage diameter stenosis in the selected group of patients before PTCA or at 6 months follow-up, as well as in the range of intermediate severity, was moderate. This latter finding is in accordance with a recently published multicentre study evaluating intracoronary Doppler flow vs perfusion scintigraphy in intermediate coronary narrowings[21]. The observed scatter of data between angiographical estimates of coronary lesion severity and Doppler flow measurements in intermediate coronary lesions in the present study, as well as in previous reports, illustrates the discrepancy between angiographical and physiological estimates of coronary lesion severity and raises the question: which parameter is the better estimate of the functional significance of coronary narrowings?

Angiographical and Doppler-derived indices of coronary lesion severity in relation to myocardial ischaemia

The areas under the receiver operator characteristic curve of diameter stenosis, minimum lumen diameter and distal coronary flow velocity reserve (Table 4) indicate that the parameters are equally predictive with respect to the result of a symptom-limited exercise test. Moreover, this analysis demonstrates that the distal coronary flow velocity reserve is a better predictor than other Doppler-derived parameters. The additional role of intracoronary blood flow velocity assessment is demonstrated by the increase in positive and negative predictive values with respect to the result of a symptom-limited exercise test. Furthermore, logistic regression analysis showed that diameter stenosis or minimum lumen diameter and distal coronary flow velocity reserve are independent predictors of the result of the exercise test, both in the range of coronary narrowings before PTCA and at late follow-up, as well as in the range of intermediate coronary lesion severity.

The predictive value of the distal coronary flow velocity reserve for myocardial ischaemia was evaluated in the present study by a symptom-limited exercise test, while other single-centre studies used exercise or pharmacologically induced hyperaemic perfusion scintigraphy for documentation of myocardial ischaemia. Nevertheless, the best cut-off value of the distal coronary flow reserve of 2:1, for the outcome of the stress test, is in accordance with these studies involving a relatively small number of patients with intermediate lesions in single- or multivessel disease[22–24].

A recently published multicentre study by Heller et al. reported a best cut-off value of 1:7 for the distal coronary flow reserve in relation to the results of thallium perfusion scintigraphy in patients with intermediate lesions, of whom the majority had single-vessel disease[21]. In the present study, a best cut-off value of 1:9 was documented in patients with intermediate lesions, as compared to 1:7 in the study of Heller et al. A symptom-limited exercise test was performed in both studies and evaluated in the present study by electrocardiographic signs of ischaemia, considered to be less sensitive than perfusion scintigraphy[25]. Nevertheless, an analysis by perfusion scintigraphy in a subgroup of patients yielded findings similar to the present study[26]. It is therefore conceivable that the conclusions of the present study, i.e. the independent predictive value of angiographical and Doppler-derived parameters, are not influenced by the evaluation of exercise electrocardiography or perfusion scintigraphy.

A recent study by Pijls et al. indicated that the fractional flow reserve, i.e. the distal coronary pressure during hyperaemic conditions expressed as a ratio of the aortic pressure, can be used to evaluate the haemodynamic severity of a coronary narrowing[17]. It has been postulated that the pressure-derived assessment of coronary lesion severity is preferable due to its independence from haemodynamic factors such as variations in preload, afterload and myocardial contractility that may affect coronary flow reserve measurements[27]. It is conceivable that further studies, regarding a direct comparison between pressure and flow-derived parameters for diagnostic purposes, can be expected. Moreover, the current literature on intracoronary pressure measurements merely reflects single-centre experiences while its evaluation in multicentre studies is awaited.

Limitations

Intracoronary blood flow velocity assessment is a sensitive technique for the detection of alterations in coronary blood flow, but his method is also prone to technical failures, and accurate measurements depend on the time, skill and experience of the operator[27]. Furthermore, blood flow velocity reserve measurements may be influenced by fluctuations in the diameter of the epicardial coronary segment. Nitroglycerin (i.c.) was administered before PTCA and at follow-up in order to minimize this confounding factor. The site of the repeated blood flow velocity measurements was determined by angiography, although this method for
making repeated measurements may have been a contributing factor in the variations noted. The findings in the present study concern the absolute coronary flow velocity reserve, unrelated to the value of an angiographically normal reference artery: i.e. the relative coronary flow velocity reserve\(^{(28,29)}\).

This is a post-hoc analysis of a large multicentre study and the result of the present analysis for clinical decision making requires evaluation in a prospective study. The blood flow velocity measurements reflect the readings of a core-lab facility, although this analysis cannot exclude operator bias of the obtained data. A symptom-limited exercise test was not performed in 59 of 225 patients (26%) before PTCA and 19 of 202 patients (9%) at follow-up. This may have introduced selection bias. The analysis of the exercise test was left to the discretion of the participating institution and was not centrally analysed. A negative or non-diagnostic test was encountered in 43 of 166 patients (26%) before PTCA, illustrating a lower sensitivity of exercise electrocardiography for documentation of myocardial ischaemia compared to other diagnostic tests such as perfusion scintigraphy\(^{(323)}\). This study focused on a selected group of patients with one-vessel disease and normal left ventricular function, indicating that these data cannot be extrapolated to other patient groups without any reserve. It has been demonstrated that administration of calcium antagonists causes transient vasodilation of coronary resistance vessels, resulting in decreased coronary reactive hyperaemia after transient occlusion\(^{[20,31]}\). The patients studied before PTCA and at follow-up showed marked difference in the use of calcium antagonists. This non-uniformity in medication, as well as the additional effect of concomitant drugs, may have contributed to the inter-patient variability of the coronary flow velocity parameters.

Clinical implications

The present study underlines the complementary role of measuring a physiological parameter for the interpretation of coronary narrowings. This latter finding is potentially relevant for clinical decision making during cardiac catheterization after inconclusive stress testing in patients with intermediate coronary lesions. An increasing number of angioplasty procedures are performed directly after diagnostic coronary angiography\(^{(322)}\). The assessment of physiological parameters may obviate the need for additional stress testing and re-hospitalization for coronary angioplasty, resulting in potentially significant cost savings. Assessment of a physiological parameter allows the haemodynamic severity of a coronary narrowing to be identified and may serve as an alternative for documenting the necessity for coronary intervention. The result of a recently published multicentre trial demonstrated the value of measuring coronary flow reserve after PTCA as an important indicator for the short- and long-term clinical outcome\(^{(239)}\). This study initiated the conduction of several other prospective multicentre studies using pressure or Doppler flow parameters of coronary lesion severity for deferral of PTCA or to optimize the result of coronary angioplasty [DEFER, DEBATE II, DESTINI, FROST, ILIAS (Intermediate Lesions: Intracoronary Flow Assessment versus 99m-Tc MIBI SPECT) study]\(^{(235–236)}\). The results of these studies are awaited to define the role of intracoronary physiological parameters for diagnostic and therapeutic purposes.

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References


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