GUEST EDITORIAL

Expanding the Non-invasive Coronary Physiology Assessment with Transthoracic Doppler Echocardiography

Please see page 214 for the article by Auriti et al. (doi: 10.1016/S1525-2167(03)00014-3) to which this editorial pertains.

Coronary angiography has been considered the ‘gold standard’ for defining coronary anatomy for more than four decades. Nevertheless, this technique has intrinsic limitations because it only delineates coronary ‘luminology’, and it has been clearly shown that there is marked disparity between the severity of lesions and their physiological effects in ischemic heart disease (CAD)[1]. Both coronary angiography and intravascular ultrasound can only give anatomic information and cannot provide sufficient functional information which is crucial for clinical decision making, especially in intermediate stenoses. It conveys that physiologic variables, such as coronary flow velocity reserve (CFVR), are more widely accepted and used as an additional approach to complement coronary ‘luminology’ and assess the functional status of a patient as much as or more than anatomic variables[2]. Methods of measurement of coronary flow and CFVR including intracoronary Doppler flow wire, nuclear technique such as PET and echo technique such as transesophageal echocardiography (TEE) have been explored in the past years[2–5]. In the clinical setting CFVR is usually measured in the cardiac catheterization laboratory by means of small Doppler guide-wires positioned in the coronary lumen. This method is certainly very precise, but not repeatable for its obvious invasivity and high cost. PET is a promising technique of the non-invasive measurement of CFVR, but since it is extremely expensive, it is scarcely available. Recently, accurate non-invasive assessment of CFVR by means of the transthoracic second-harmonic Doppler echocardiography (TTDE), with eventual use of intravenous injection of contrast, has become possible[6–11]. The major advantages of coronary flow assessment by TTDE are that it is completely non-invasive, relatively inexpensive, and furthermore, gives objective and accurate information on the physiological significance both in epicardial native coronary stenosis[6,8,9] as well as in detecting coronary restenosis following coronary percutaneous interventions[12,13]. Another important value of TTDE study of CFVR is the assessment of microvascular coronary circulation after acute myocardial ischemia[14] but also has been proven accurate and safe in determining coronary stenosis in patients admitted for acute ischemia and then programmed for an angiographic morphologic study[9,15]. On the other hand, although assessment of LAD stenosis represents the most important diagnostic task in the clinical setting of CAD, one of the major limitations of TTDE has been the restriction of investigation only to this territory. Nevertheless, increasing evidence for accurate detection of coronary blood flow and CFVR also in the posterior descending artery (PDA) has been recently brought up by several research groups[16–18]. The rationale of these efforts comes from the fact that PDA is the terminal branch of either the right coronary or the circumflex artery and an alteration of flow (i.e. CFVR) in this vessel reflects a narrowing in the supplying artery. The paper of Auriti et al. adds strength to the feasibility of spreading up the study of flow physiology in different coronaries other than LAD, in particular in the PDA territory[4,19]. Providing a new echocardiographic plane, to better delineate PDA imaging, the authors demonstrated a better delineation of the coronary flow in the PDA with an increasing feasibility by TTDE. They reported an overall feasibility of 80%, which is comparable with that of recently reported studies[18] and a detection of a good or very good signal by transthoracic echo in 48% of patients (without contrast enhancement). The authors made a correlation between score index of PDA visualization on TIMI flow and no correlation was found.
Furthermore, none of the patients with TTDE score 0 had significant coronary stenosis. This is not surprising in that the score index (i.e. the capacity to assess in a semi-quantitative way the color flow of the coronary vessel) is influenced by different technique variables and not only by the grade of flow in the explored vessel. Eventually, a detection of flow acceleration could be a marker of coronary stenosis, in which it is tentative to account for lumen loss and maintain normal flow at rest\(^{20}\). It is to be mentioned, however, that the aim of the study was not to assess CFVR and so the use of a vasodilator such as adenosine which in turn can affect total feasibility due to hyperventilation was not investigated. It is important to recall that CFVR detected by Doppler velocity represents an ‘absolute value’ which can be influenced by the ‘branch steal phenomenon’\(^{21}\). In these circumstances the presence of one or more large vessels (e.g. diagonal or marginal branch) localized before a significant coronary stenosis can provide, after dipyridamole or adenosine injection, a low-resistance alternative pathway that bleeds off flow from the narrowed vessel and gives a false normal value because of the recruitments of ‘normal’ territory explored by Doppler interrogation. This explains why measurements of CFVR in the distal portion of the vessel are more precise and useful in assessing stress perfusion defects or quantifying anatomic stenosis severity. We therefore need to sample flow at the end of the vessel and at this point, the limitation of studies on the flow of circumflex artery by TTDE arises, in that, this artery can be visualized in some patients only in the proximal portion, because of echocardiographic view limitations. This results in the need, as Auriti et al. did in their study for PDA, of further studies to find and assess feasibility of other anatomic echocardiographic views to better explore the distal portion of this coronary artery.

Therefore, what can be expected from non-invasive TTDE assessment of coronary flow? It is now quite clear and evident that TTDE with or without contrast enhancement is a non-invasive approach to detect CFVR, it is a highly feasible, accurate, repeatable and a cost-effective method. Because it allows CFVR measurement in a non-invasive and therefore, repeatable way it is particularly useful not only in the evaluation of the severity of CAD involving the LAD, but also in all clinical conditions in which the effects of therapeutic interventions aimed to improve CFVR need to be monitored. Besides, CFVR can be abnormal in a large variety of cardiac diseases such as hypertension, dilated cardiomyopathy, microvascular disease (syndrome X, diabetes), and hypercholesterolemia. Evaluation of CFVR in these kinds of patients is of vital importance for clarifying the pathophysiology and evaluating the effects of medical treatment. These alterations cannot be detected by coronary angiography, but exclusively by techniques capable of measuring coronary flow velocities in baseline conditions as well as during drug induced vasodilatation. However, this technique has its limitations. First, CFVR assessment can be invalidated if measurements are performed at the vessel stenosis site\(^{4}\). Second, flow in the branches could be erroneously interpreted as the flow in the main trunk. In particular, this could happen for LAD in the two-chamber or in the short-axis view, where a long diagonal branch or the first septal perforator might also be visualized\(^{7,9}\). Third, blood flow can be easier and better visualized in the LAD, whether or not a more prolonged learning curve is necessary to improve flow detection in the PDA and in the circumflex artery. Nevertheless, having taken these limitations into consideration, non-invasive detection of coronary blood flow by TTDE seems to have become in the recent years a very simple and accurate non-invasive method in studying coronary blood flow and CFVR in cardiac patients. Considering the higher feasibility reported from different echocardiographic laboratories all over the world, the time for multicenter trials for definitive clinical validation of this promising methodology in various cardiac pathology has surely come.

M. RUSCAZIO
R. MONTISCI
S. ILCETO
Department of Cardiology, University of Padua, Italy

References


