



The Never-ending Story: Assessing coronary collateral circulation with myocardial perfusion imaging

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The role of coronary collateral circulation has been thoroughly studied, and myocardial perfusion imaging has been a frequently employed method. Even angiographic invisible collaterals can support some degree of tracer uptake, but the clinical role of this evaluation is still uncertain, and this remains the main issue that should be clarified.

Key Words: CAD • SPECT • MPI

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“But that’s another story and shall be told another time.”.
Michael Ende, *Die Unendliche Geschichte* (The Never-ending Story).

Coronary collateral circulation has been thoroughly studied, but its assessment remains nevertheless an ill-defined entity in terms of clinical usefulness. In the setting of acute coronary syndromes and acute myocardial infarction, it was a well-accepted fact that patients with chronic coronary artery disease and long-lasting anginal symptoms could attain better response to primary percutaneous interventions, as it was demonstrated by more limited infarct size according to enzymatic measurements, cardiac magnetic resonance, and myocardial perfusion imaging.¹ In particular, the importance of collaterals in possibly preserving tissue during acute myocardial infarction was proven by means

of myocardial perfusion imaging.² Thus, it was suggested that coronary collateral circulation could explain the protective role of previous history of stable angina and therefore an assessment of its extent could in theory be helpful to explain part of the variability of the final treatment results that can range from infarct abortion to an extensive myocardial damage.^{1,3} However, other studies suggested that the role of collaterals is not crucial, and it is overcome by many other parameters, such as time delay and pre-treatment TIMI flow.^{4,5} Moreover, this is not a fundamental issue in the clinical practice since the therapeutic strategy remains in any case to achieve revascularization as early as possible.⁶ Thus, there is presently no actual role for a specific assessment of coronary collateral circulation in acute myocardial infarction patients, although the desirable evaluation of the myocardium at risk could expand the role of myocardial imaging techniques or dedicated angiographic approaches in this setting.¹

Similarly, collateral circulation plays an important role in the setting of chronic total occlusion of a coronary artery.⁷ Several studies have explored the capability of coronary collateral circulation to protect from ischemia the myocardium subtended by the occluded vessel, or to sustain viability within it.^{8,9} Again, however, no specific diagnostic evaluation for collaterals is performed in this scenario, whilst the focus is on ascertaining the presence of inducible ischemia or of viable myocardium, as appropriate.

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Finally, in case of chronic coronary artery disease, together with the above-mentioned different outcome in case of acute myocardial infarction, the extent of collateral circulation could explain the variability of symptoms. The relationship between angiographic demonstration of collaterals and myocardial tracer uptake in the territory of stenotic vessels was investigated and it has been demonstrated that they have a potential role in causing ischemia through coronary steal.¹⁰ Another approach for evaluating collaterals is exploring what happens during balloon occlusion of the involved vessel. Assessing the hemodynamic responses by means of intracoronary measurements made possible to evaluate the factors influencing the development of collaterals, and the relative role of collaterals versus ischemic preconditioning in patients with stable effort angina.^{11,12} With similar purposes, myocardial perfusion tracer injection during balloon occlusion was performed as well.¹³ According to this paradigm, in the present JNC issue, Reid et al. have compared the degree of tracer uptake after injecting it during balloon occlusion with the perfusion pattern obtained injecting the tracer in baseline conditions at rest.¹⁴ The derived uptake ratio appears to be relatively high and well over the 50% threshold. The Authors emphasize that their result has a particular value because they have selected a group of patients without visually detectable collaterals during coronary angiography. Accordingly, they state to have provided the first demonstration of recruitment of dormant coronary collaterals in subjects with chronic coronary artery disease and without chronic total occlusion. Although the study protocol is certainly both rigorous and demanding, the value of their conclusions must be questioned from several perspectives. The Authors admit that the present article is based on studies performed many years ago and that the patient cohort is a subgroup of a previously published population.¹³ However, they fail to mention two other studies that performed a quite similar protocol and that certainly included a portion of patients without evident collaterals.^{15,16} The results of all these studies are alike in indicating that even not angiographically visible collaterals are able to allow a detectable uptake of the perfusion tracers in the territory subtended by the transiently occluded vessel. Unfortunately, the technical details of the present study are obsolete and based on a very high administered tracer dosage, which is not acceptable nowadays, and therefore at the same out-of-date methodological level of those two other mentioned old articles.^{15,16} Thus, the present paper does not update the collateral circulation findings to the state-of-the-art methodology of myocardial perfusion imaging. The further limitations of the protocol, beside the small patient population, are also comparable with those of the

other reports and include the lack of attenuation correction and of absolute blood flow measurements. This last approach is possible using PET and currently is becoming feasible as well using SPECT with the last generation CZT cameras.^{17,18} Moreover, its superiority over the simple visual assessment of perfusion has been demonstrated.¹⁹

Then, which are the merits, if any, of the article by Reid et al.? Maybe the sole noteworthy point is the renewed focus on the collateral circulation as a useful parameter in the setting of chronic coronary artery disease and on the proposal of quantifying it noninvasively, instead of through coronary angiography and hemodynamic measurements. This suggestion by Reid et al., however, is not fulfilled by their study itself, which is based on a research protocol that does not appear feasible in the clinical routine, also because it is based on the administration of the perfusion tracer during coronary angiography (and during a potentially dangerous procedure such as prolonged balloon occlusion). On the other hand, is it foreseeable that noninvasive methodologies specifically able to classify the collateral circulation capability to support the myocardial perfusion in stenotic territories could reach an easy feasibility in the common practice? Probably not, and therefore, as authoritatively pointed out, the issue of collateral circulation will for now remain part of that comprehensive assessment of myocardial perfusion that should be pursued, and that should go well beyond the sole detection of the degree of vessel stenosis or of the relative tracer uptake in the ventricular walls.²⁰

Thus, although it does not offer any noteworthy new piece of information, the merit of the present paper is to remind us that also invisible collaterals play a role in the complex scenario of myocardial perfusion. To take them into account we must optimize the evaluation of the functional status of the entire coronary system and possibly make it the most refined and comprehensive as possible.²⁰ On the other hand, this does not imply that we must perform a dedicated assessment of collaterals in the routine clinical setting. As demonstrated by the circumstance that data obtained many years ago are presented now, the study of coronary collateral circulation seems a sort of parallel, never-ending story that accompanies and will keep on accompanying our awareness of the complexity of myocardial perfusion. The possibility of addressing it separately in a feasible manner and in clinically useful terms is nevertheless so far precluded in the majority of patients with chronic coronary artery disease. Whether, as proposed by Reid et al., this will be possible in the future is another story and shall be told another time.

Disclosures

Authors have no conflicts of interests to declare.

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