EDITORIAL COMMENT

Open Perforator Hypothesis

Bridging Epicardial and Microvascular Circulation*

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Successful reperfusion after acute myocardial infarction (MI) has traditionally meant restoration of the patency of the epicardial coronary artery. However, increasing evidence suggests that microvascular dysfunction and inadequate tissue perfusion are frequently present despite an open infarct-related artery (1,2). Therefore, optimal reperfusion is being redefined to include patency of infarct-related coronary artery, intact myocardial microvasculature, and tissue perfusion (3). Coronary angiography and Thrombolysis In Myocardial Infarction (TIMI) flow grades have been the gold standard for failed or successful reperfusion (4). However, TIMI 3 flow as well as newer angiographic methods including corrected TIMI frame count and myocardial blush (5) may provide incomplete measures of successful reperfusion.

In this issue of the Journal, Voci et al. (6) report that recanalization of intramural perforators emerging from the left anterior descending coronary artery (LAD) reflect adequate reperfusion in patients with acute anterior MI. They also report that such recanalization has a positive impact on long-term recovery of left ventricular (LV) function. Voci et al. (6) used simple bedside transthoracic Doppler echocardiography to image both the epicardial arteries, that is, LAD and septal perforators. Supporting what they call the “Open Perforator Hypothesis,” their data show that the recanalization score better predicts LV functional recovery than restoration of TIMI flow grade 3. This noninvasive Doppler technique has advantages over intracoronary Doppler for predicting myocardial viability (7). Not only it is safe, but it also can measure velocities from regions inaccessible to intracoronary Doppler. However, only limited territory of LAD can be imaged, and there is no data regarding imaging of right or left circumflex coronary artery imaging. Unfortunately, invasive and noninvasive Doppler ultrasound fail to assess microvascular function and tissue perfusion, both crucial for successful reperfusion.

In summary, the ideal technique to determine the success of reperfusion should be noninvasive, assess epicardial coronary artery patency, microvascular integrity, and tissue perfusion. Currently, only two methods are well-positioned to fulfill these requirements: MRI and cardiac ultrasound. Voci et al.’s (6) use of transthoracic echocardiography/Doppler to image epicardial/intramural vessels appears promising, and has a high specificity for recovery of LV function. A combination of this technique with the new developments in MCE may enable ultrasound to provide a comprehensive evaluation of myocardial reperfusion.

An alternate technique for assessing reperfusion, myocardial contrast echocardiography (MCE), was first performed during angiography by injecting sonicated contrast solution into the recanalized infarct-related artery (8,9). Since then MCE has shown that up to 25% of patients with acute MI do not have adequate restoration tissue perfusion in the infarct region despite TIMI flow grade 3 in the infarct-related artery. The development of new contrast agents and introduction of improved imaging methods (9) should enable MCE in combination with color Doppler imaging of the epicardial artery to provide a comprehensive evaluation of reperfusion.

Magnetic resonance imaging (MRI) has the potential to be the most comprehensive technique to evaluate reperfusion as it evaluates epicardial coronary flow, microvascular dysfunction, tissue perfusion, as well as infarct size and LV function (10,11). Wu et al. (13) were the first to assess microvascular integrity with contrast-enhanced MRI in patients with acute MI. Their data demonstrated that, after infarction, microvascular obstruction was a strong prognostic marker even after control for infarct size. However, high costs, long procedure time, and the difficulty in accommodating the unstable patient precludes its widespread application at this time. Future technical advances should help.

In vivo microvascular integrity has been studied by techniques that use radioactive tracers such as thallium-201, technetium-99m pertechnetate, and rubidium-82 (12–15). Thallium-201 is directly taken up by myocardial cells and allows imaging of perfusion independent of infarct-related artery patency. Similarly, positron emission tomography (PET) is a popular technique to assess myocardial perfusion and microvascular function, specifically when combined with vasodilators as adenosine and dipyridamole. Unfortunately, both thallium and PET are difficult to perform in the acute phase of MI, and the ideal time to perform follow-up imaging remains unclear. Kondo et al. (15) have used intracoronary technetium-99m macroaggregated albumin to evaluate microvascular damage at the time of cardiac catheterization.

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REFERENCES


