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Editor's Note

Reperfusion of Myocardium Does Not Necessarily Equate with Epicardial Coronary Artery Blood Flow

Key words: myocardial perfusion, coronary blood flow

Introduction

Several years ago, in an editorial concerning evaluation of the coronary microcirculation, I made the point that in order to evaluate the microcirculation during coronary angiography, one needs to allow the cine camera to run longer than usual to assess perfusion of the distal coronary circulation. Often a microcirculatory blush can be seen just prior to the venous phase of the coronary angiogram. I thought this was useful information, particularly in the case of a patient whose ventricle may not be contracting normally in that coronary distribution. I also indicated that the presence of a myocardial blush defines a viable myocardium. A myocardial blush is relatively easy to identify, but grading the blush is quite subjective.

As reperfusion therapy evolved, an objective assessment of flow in the coronary circulation after recannalization either by thrombolytic therapy or by angioplasty was needed.

Epicardial Blood Flow

To assess epicardial blood flow the Thrombolysis in Myocardial Infarction (TIMI) epicardial flow score was developed.

The TIMI flow score has been a useful way to communicate what is happening in the epicardial coronary circulation.

TIMI Epicardial Flow Score

TIMI flow 0 (zero) is obviously no antegrade flow;

TIMI 1 flow is a trickle of contrast but no myocardial perfusion;

TIMI 2 flow is somewhere between a trickle and normal flow (generally, slow filling of the epicardial artery and slow emptying compared with other "normal" arteries);

TIMI 3 flow is "normal coronary flow" and myocardial perfusion, that is, rapid filling and emptying of the epicardial artery.

Myocardial Perfusion

To assess myocardial perfusion, the TIMI myocardial perfusion score was developed.

Most now agree that myocardial blush grade is the best invasive predictor of myocardial perfusion. Thus, an additional grading system evolved.

TIMI myocardial perfusion (TMP) grade is determined by assessing the myocardial blush of radio-opaque contrast in the myocardium subtending the epicardial artery perfusing that myocardium.

TIMI Myocardial Perfusion Score

TMP grade 0 is failure of the contrast to enter the microvasculature, indicating no tissue-level perfusion.

TMP grade 1 is slow entry of the contrast but its failure to exit the microvasculature in the distribution of a culprit lesion. This can be seen as a ground-glass appearance (blush). In this situation, contrast is often present on the next injection.

TMP grade 2 is the delayed entry or exit of radio-opaque contrast from the microvasculature. The usual ground-glass appearance persists at the end of three cardiac cycles. It may diminish slightly in intensity during washout.

TMP grade 3 is normal entry and exit of radio-opaque contrast from the microvasculature. Initially, a ground-glass appearance (blush), which usually disappears after three cardiac cycles of the washout phase, is seen in the distribution of the culprit lesion.

Additional Laboratory Assessment of Myocardial Perfusion

In the catheterization laboratory, assessment of coronary flow reserve is also a measure of microcirculatory perfusion. Myocardial contrast echocardiography showing microcirculatory enhancement should also equate with microcirculatory perfusion and myocardial viability. Nuclear imaging also defines the status of the microcirculation, as does magnetic resonance imaging, which is probably the most sophisticated, sensitive method but also the most costly.

Clinical Studies of Myocardial Perfusion

Some clinical studies of myocardial perfusion are worthy of comment. Recently, Pavlides and Cokkinos (see Suggest-

ed Reading, No. 6) reported that in patients receiving thrombolytic therapy for acute myocardial infarction, approximately 57% achieved TIMI 3 epicardial coronary artery flow. However, 23% had no myocardial perfusion. Thus, in this study, patients with true myocardial reperfusion constitute 34% of the initial population. These investigators opined that establishing TIMI 3 flow is critically important for reperfusion therapy and that anything less results in an even greater loss of myocardial perfusion.

The Stent versus Thrombolysis for Occluded coronary arteries in Patients with Acute Myocardial Infarction (STOPAMI) trials revealed that TIMI myocardial perfusion grades 2–3 were associated with better myocardial salvage, smaller final infarct size, and lower one-year mortality than TIMI myocardial perfusion grades 0–1 (see Suggested Reading, No. 3).

The crucial issue here is reperfusion at the tissue level. Gibson reported that among patients with successful lysis and TIMI grade 3 flow, there is a seven-fold range in mortality (see Suggested Reading, No. 2). For example, in that group of patients with TMP grade 3, mortality was 0.7%; with TMP grade 2, mortality was 2.9%; and with TMP grade 0–1, it was 5.4%. Thus, to quote Gibson, not all TIMI grade 3 flow is created equal.

Clinical Evaluation of Myocardial Tissue Perfusion after Reperfusion Therapy for Acute Myocardial Infarction

I recently heard a discussion of the clinical evaluation of myocardial tissue perfusion after reperfusion therapy for acute myocardial infarction by Bernard Gersh. Several points were made that are worth emphasizing. He pointed out that the evaluation of myocardial tissue perfusion can be accomplished in several ways, but the most practical way is resolution of ST-segment elevation. ST-segment elevation equates with coronary artery occlusion. Thus, resolution of the ST segment toward baseline should equate with opening of the vessel and myocardial tissue perfusion. After angioplasty for acute myocardial infarction, myocardial blush grades correlate with ST-segment resolution on the electrocardiogram, with enzymatic infarct size and left ventricular ejection fraction, and are independent predictors of long-term mortality. Thus, the simplest, most clinically useful, and best indicator of myocardial reperfusion seems to be resolution of the ST segments.

In the Controlled Abciximab (ReoPro™) and Device Investigation to Lower Later Angioplasty Complications (CADILLAC) trial, ST-segment resolution was used as a parameter to assess reperfusion. In this trial, mortality was greater in patients in whom the ST segment failed to resolve than it was in those with partial resolution of the ST segment; and in those with partial resolution of the ST segment, mortality was greater than in those who had complete resolution of the ST segment. In the CADILLAC trial, 1,301 patients were evaluated for TIMI flow and myocardial blush. TIMI flow grade 3 was found in 96.1% of the patients who underwent angioplasty. However, only 17.4% of patients in this study had TIMI grade 3 myocardial blush. Following up on these 1,301 patients revealed that those with TIMI grade 3 myocardial blush had a 365-day mortality of 1.4% compared with 3.9% for patients with myocardial blush grade 2, and 5.7% for patients with a myocardial blush grade score of 0–1.

Comments about the Mechansims of Poor Myocardial Perfusion

The subject of mechanisms of poor myocardial perfusion is complex—multiple etiologies may be responsible for poor myocardial perfusion. The most obvious mechanism for poor perfusion of the microcirculation is microvascular obstruction due to thrombus, athero-emboli, platelet micro-emboli, or even microvascular spasm. In addition, when the myocardium is reperfused, other things, such as infusion of free oxygen radicals, tissue edema, and neutrophil plugging, can occur. All of these can result in myocardial necrosis secondary to poor perfusion of the microcirculation.

Unfortunately, clinical trials to prevent all of these mechanisms have failed.

Much more work remains to be done to increase myocardial perfusion in patients whose epicardial coronary arteries are rendered patent but whose downstream myocardium is not perfused. It seems reasonable to assume that if myocardial perfusion is attained at the TMP grade 3 level in most patients, the clinical outcome will be dramatically improved.

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Suggested Reading

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