

Myocardial Contrast Echocardiography in Acute Myocardial Infarction: the Importance of Assessing Coronary Microcirculation

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Cardiology was revolutionized some fifteen years ago by the introduction of reperfusion treatment to the management of acute myocardial infarction (AMI). Numerous clinical trials had shown that recanalizing the occluded coronary artery significantly improved both the short and long term prognoses of patients with AMI.¹ Only at the beginning of the 1990's, however, did it start to become clear that the restoration of normal blood flow in the epicardial coronary artery did not imply the normalization of myocardial perfusion. Despite the restoration of patency, prolonged ischemia and the secondary lesions caused by reperfusion treatment can cause microvascular dysfunction to persist and even lead to the obstruction of myocardial capillaries. The clinical existence of no-reflow, described years before in experimental models,² was thus confirmed. The appearance of this phenomenon was found to be of prognostic value; the incidence of complications and of adverse remodeling of the left ventricle was found to be greater in patients with microvascular lesions.³ Increasing importance has therefore been placed on the study of the myocardial microcirculation in AMI, and several techniques have been developed to this end.

The resolution of ST segment elevation following reperfusion is a simple and valuable method which correlates well with other perfusion evaluation techniques. It is also a good predictor of functional recovery.⁴ The final angiographic result after primary angioplasty, as evaluated by the TIMI flow grade system, is useful for identifying the most serious cases of no-reflow (i.e., patients with a result of TIMI-2). It

is not very sensitive, however, and more than 25% of patients with TIMI-3 flow can show modifications of myocardial perfusion of varying severity.⁵ Recently, new angiographic parameters have been proposed for improving the performance of this technique, such as the TIMI myocardial perfusion grade or myocardial blush grade.⁶

Several cardiac imaging techniques for evaluating myocardial perfusion have also been the subject of important developments, such as contrast echocardiography and magnetic resonance. The basic concept underlying contrast echocardiography is that microvascular damage and no-reflow only occur in areas of severe myocardial necrosis (almost certainly non-viable areas), which appear as perfusion defect zones. The ideas behind magnetic resonance perfusion studies (which usually involve the administration of gadolinium) are similar. This technique has the advantage of providing excellent quality images, but has the drawback that gadolinium diffuses rapidly into the extracellular spaces. Echocardiography contrast media, on the other hand, are exclusively intravascular.

In summary, there are currently many tools for studying microvascular function in AMI, but it is not clear which is best. Few studies have compared all those available.

The paper by Bodí et al⁷ in this issue of the REVISTA ESPAÑOLA DE CARDIOLOGÍA is an important contribution to the study of the coronary microcirculation in patients with AMI and ST segment elevation in whom the patency of the epicardial artery responsible for the infarction has been restored. Sixty-seven percent of their patients received fibrinolytic treatment, and all were referred to the catheterization laboratory with confirmed permeability of the artery responsible for the infarction. The work discusses the use of magnetic resonance at one of Spain's most experienced centers (although this technique is not widely used in Spanish hospitals), as well as the use of intracoronary contrast echocardiography and of the myocardial blush grade in post-angioplasty coronary

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arteriography. The use of magnetic resonance to calculate the ventricular volumes and the left ventricular ejection fraction provided very precise data and therefore more solid results, even though the number of subjects involved was relatively small.

As in other studies, a TIMI-2 flow grade always indicated poor reperfusion, as demonstrated by contrast echocardiography. But poor reperfusion was also seen in 25% of patients with a TIMI-3 flow grade. This shows the limitations of the TIMI flow grade system in identifying anomalies in myocardial perfusion.⁵ The use of the myocardial blush grade improved the results somewhat; in patients with a TIMI-3 flow grade, a trend towards a greater probability of reperfusion was seen in those whose blush grade was normal. In agreement with other studies,⁸ the perfusion variables corresponding to the different techniques (angiography, magnetic resonance, etc) improved during follow-up.

Perhaps the most novel piece of information provided by this study is that the data that best correlated with the recovery of left ventricular function during follow-up were those provided by contrast echocardiography. In multivariate analysis, echocardiography was the only independent predictor of the telediastolic volume and ejection fraction. Therefore, this is the technique which best predicts left ventricular remodeling. This is particularly noteworthy when it is remembered that in this study the contrast echocardiography results were obtained immediately after restoration of arterial flow, when, theoretically, there could be a certain interference from the reactive hyperemia that appears shortly after reperfusion.⁹ Two possibilities are therefore apparent: either post-reperfusion reactive hyperemia is not as clinically important as was thought, or a contrast examination performed 24-48 h after reperfusion could be even more necessary for evaluating functional changes during follow up.

The data provided by Bodí et al indicate that, taking contrast echocardiography as a reference, magnetic resonance with gadolinium tends to underestimate perfusion status—to the extent that a normal perfusion result obtained with this method almost guarantees the same will be obtained with contrast echocardiography. In contrast, the angiographic index of the myocardial blush grade was relatively poor at revealing changes in perfusion. Some 25% of the patients studied showed significant perfusion defects in contrast examinations despite having a final myocardial blush grade of 2-3 as their final angiographic result. This could be related to the inferiority of this system, compared to contrast echocardiography, in predicting the functional recovery of the left ventricle, as reported by other authors.¹⁰

Other important information coming out of this

study concerns the safety of post-angioplasty intracoronary contrast echocardiography and the time required to perform it—data available for the first time from Spain. No important side effects were seen after the administration of the contrast medium, and the procedure lasted less than ten minutes. Despite this excellent profile, the administration of an intracoronary contrast medium to evaluate the final result of an angioplasty is rarely performed in catheterization laboratories even though it could provide useful information, especially when final angiographic data are inconclusive.

During the 1990's, much effort went into developing echo contrast agents capable of passing through the pulmonary filter after administration via a peripheral vein, and therefore of reaching the left chambers of the heart. Several agents are approved for clinical use in Spain, and these offer the possibility of examining myocardial perfusion non-invasively wherever the patient may be, including the heart unit. The question this work poses is whether the excellent results obtained with intracoronary contrast echocardiography can be extrapolated to intravenous contrast echocardiography (which is much easier to perform). This is not easy to answer since the two techniques have substantial differences. The intravenous administration of the contrast medium is performed in different conditions to intracoronary administration, in which high pressure injections (which are hardly physiological) are involved, and the quantity of microbubbles that enter the microcirculation is very different. The first results published in this area are very encouraging. The capacity of contrast echocardiography to predict the functional recovery of the left ventricle seems to be greater than that of post-angioplasty angiographic data.¹⁰

Discussions are now underway regarding other improvements of the techniques for studying the microcirculation, and about whether these might furnish even better prognostic information. Among these is the quantitative analysis of contrast echocardiography and of angiographic variables such as the TIMI frame count, as well as the combination of the myocardial blush grade and ECG parameters.¹¹

CONCLUSIONS

The paper by Bodí et al shows the importance of systematically studying the status of the coronary microcirculation in patients with AMI, in whom patency of the causal artery has been restored, if good risk stratification is to be achieved. This, after all, is a fundamental predictor of medium term ventricular recovery. Several techniques are available for evaluating the microvascular integrity of the post-infarction patient, among which contrast

echocardiography is an excellent option. It is not only safe and simple to perform but predicts ventricular recovery well—better than the alternative techniques currently available.

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