Myocardial contrast quantitation during stress echocardiography

Please see page 217 for the article by Toledo et al. (doi:10.1016/j.euje.2005.07.012) to which this editorial pertains.

Quantification of functional and perfusion abnormalities with stress imaging techniques is an important challenge in the assessment of patients with known or suspected coronary artery disease (CAD). The standard technique for evaluation of CAD with echocardiography relies upon subjective observation of wall motion abnormalities during exercise or pharmacologic stress, with a semi-quantitative approach to evaluate the extent of functional abnormalities using a 16-segment or 3 coronary arterial territorial distribution model.1,2 This approach has permitted the diagnosis of CAD with moderate sensitivity and moderate-to-high specificity. However, the extent of CAD has been consistently underestimated with this method and the sensitivity remains modest particularly in patients with single vessel CAD.3 Furthermore, hard cardiac events are still observed in around 1% annually among patients with a normal wall motion study.4

Real time myocardial contrast echocardiography (RTMCI) has been shown to be a safe and feasible method for the assessment of myocardial perfusion during pharmacologic stress testing.8–10 The advantages of the technique include the ability to assess perfusion and wall motion at the bedside in one setting, shorter imaging time, no need for ionizing irradiation, immediate availability of the results, and the ability to determine the ischemic threshold. The combination of abnormal wall motion and perfusion during stress testing has identified patients at greatest risk of death and non-fatal myocardial infarction.11 However, like wall motion analysis, the identification of perfusion abnormalities in these studies was by subjective visual analyses of reduced myocardial contrast within a given perfusion bed during stress. This visual analysis improves the test accuracy when compared to wall motion analysis, but has reduced specificity.12 Preliminary studies using quantitative analysis of myocardial contrast enhancement during a continuous infusion of microbubbles have suggested that both sensitivity and specificity could be improved when compared to visual analysis.9

Quantitative analysis of myocardial blood flow changes with myocardial contrast echocardiography has been made possible by using techniques originally described by Wei et al.13 During a continuous infusion of microbubbles, RTMCI can detect changes in myocardial blood flow using modifications of Wei’s techniques. This is done by delivering a high mechanical index impulse (termed a flash impulse) for a sufficient duration to clear the myocardial capillaries of microbubbles. The subsequent rate of myocardial contrast replenishment in real time at a low mechanical index (which correlates with myocardial blood velocity) and the plateau intensity (which reflects capillary cross sectional area) are used to compute relative changes in myocardial blood flow.

In this issue, Toledo et al.14 studied the accuracy of these quantitative parameters by analyzing parametric perfusion images and validating it against coronary angiography. Contrast-enhanced images were obtained at rest and with dipyridamole in 34 patients with suspected CAD. Images were analyzed to generate parametric perfusion images of the standard contrast-replenishment model parameters $A$, $\beta$ and $A \times \beta$. In the Study group: flow reserve index (FRI) threshold was: LAD $= 0.95$ using $A / C_2 \beta$ FRI and non-LAD $= 0.68$ using $\beta$ FRI, and a minimal
number of abnormal segments were 4 and 2, correspondingly. Sensitivity, specificity and accuracy in the Test group were 75%, 67% and 71% in the LAD, and 75%, 75% and 75% in the non-LAD territories. The authors concluded that automated quantitative analysis of contrast echocardiographic parametric perfusion images was feasible and may aid in the objective detection of CAD.

This study provided some preliminary data regarding the feasibility of quantification of perfusion abnormalities during RTMCI. The sensitivity of FRI from quantitative parameters was still relatively low. Specificity was improved, which indicates that this new technique may be useful in differentiating artifacts from perfusion defects. The authors may have had improved accuracies if they had normalized their plateau intensities (A) for blood pool intensities, as others have done. It remains to be determined whether these quantitative methods will improve the overall accuracy of MCE in detecting coronary artery disease in larger patient populations, and the ability to risk stratify patients with known or suspected CAD. These larger patient subsets are needed, including a normal database, in order to further advance this lower cost higher resolution method of perfusion imaging.

During the previous years, continuous and rapid developments have occurred in the protocols used for the assessment of myocardial perfusion with MCE. The technique may compete in future with lower resolution, costly nuclear techniques with the advantages of lack of irradiation and ability to perform bedside studies. The study of Toledo et al. represents another important step in refining the analysis of perfusion with myocardial contrast echocardiography, and allowing us now to apply these FRI parameters in multi-center clinical trials.

References


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