Noninvasive Vessel-Selective Perfusion Imaging With Intravenous Myocardial Contrast Echocardiography

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**Background and Purpose:** Intravenous myocardial contrast echocardiography (IV-MCE) cannot identify each perfusion area of coronary vessels separately. During MCE, low mechanical index (MI) imaging by destroying microbubbles passing through specific vessels with high power ultrasound, vessel-selective perfusion imaging (SPI) could be feasible.

**Methods:** In 8 open-chest dogs, short-axis images were obtained every 8 cardiac cycles during Definity continuous infusion using Sequoia 512. For SPI, an S3 probe coupled to a vertical line array (Vevo1100) was used for analysis. Round region of interest having 8mm diameter was placed on the ventricular septum or lateral wall. A rectangular grid was superimposed on the image which was divided into 16 segments. Time-intensity curves of each segment were recorded and calibrated by that of the adjacent cavity (LV cavity). A rectangular grid was superimposed on the image which was divided into 16 segments. Time-intensity curves of each segment were recorded and calibrated by that of the adjacent cavity (LV cavity).

**Result:** At MI=0.1 (15.9±4.22 vs. 15.9±4.22). At relative high MI, thin and dot-like echoes were demonstrated in the myocardium and the blood volume of arterioles was calculated as 17.7±4.08. The blood flow velocity presented as dB value at arterioles level was significantly higher than that at capillary level (1.07±0.37 vs. 0.35±0.09: p<0.001).

**Conclusion:** MCE reflects the blood flow and volume in each level of coronary arteries.

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Quantitative Myocardial Contrast Echocardiography Is Useful to Evaluate Transmural Extent of Microvascular Damage in Patients With Myocardial Infarction

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Ischemic myocardial damage initially appears in subendocardium but the relationship between severity of subendocardial damage and wall motion abnormality remains unclear in MI patients. We developed a new calibration technique to quantitate microvascular integrity using myocardial contrast echocardiography (MCE). We aimed to establish quantitative relationship between subendocardial and subepicardial microvascular damage and wall motion abnormality.

**Method:** We performed triggered MCE with injection of Levovist and recorded end-systolic 1.5 harmonic (Toshiba) or ultraharmonic (Philips) images (4C view) in 24 patients with anterior MI. Relative myocardial contrast intensity (RMCI, dB) was calculated as the difference of contrast intensity of myocardium minus that of the adjacent LV cavity with VoluMap system. Ventricular septum was divided into 4 segments and RMCI was measured in RV half and LV half in each segment. From RMCI value, we estimated myocardial blood volume fraction (ml/100g) of each segment, since the blood volume of LV cavity is 100 ml/100cc.

**Results:** RMCI decreased with worsening of asynergy both RV- and LV-halves. Estimated MBV in hypokinetic segments was about 50% of normal segments and MBV reduced to 25% of normals in akinetics.

**Conclusion:** It is the first clinical to quantify transmural extent of microvascular damage in MI patients with MCE. RMCI provides an estimate of MBV, thus determined by capillary volumes, and MBV reduces with worsening of wall motion abnormality.
**Background:** Real-time myocardial contrast echo (MCE) is increasingly used to assess microvascular perfusion. However, objective methods for evaluating MCE are not yet widely available. We sought to validate the ability of Fourier analysis applied to MCE to assess signal changes in microvascular perfusion during coronary occlusion and reperfusion.

**Methods:** Six pigs underwent 45 min of LAD occlusion followed by 120 min of reperfusion. Real-time MCE was performed during coronary occlusion and reperfusion. Signal intensities from replenishment curves were fitted to an exponential function to obtain plateau A and the rate of rise B. MCE images were mathematically transformed using a first-harmonic Fourier algorithm displaying the sequence of myocardial intensity changes as phase angles in parametric images. The phase difference (PD) of posterior versus anterior region was calculated as an index of myocardial opacification heterogeneity and compared to MCE index of myocardial blood flow Aβ.

**Results:** After initial hyperemia, a progressive reduction in flow was observed during reperfusion. During LAD occlusion signal intensities were significantly reduced in anterior regions (Aβ = 0.02±0.64) compared to baseline (Aβ=0.3±0.3, p<0.01) and approached higher levels post recanalization (Aβ = 1.48±0.6) but gradually decreased during 120 min of reperfusion (Aβ=0.5±0.3, p<0.01). Similarly, profiles of phase angles in LAD perfusion territories were consistently modified during reperfusion. The mean PD at baseline was 18±15°, decreased during coronary occlusion to −105±38°, increased to 28±19° post recanalization but decreased to −61±35° after 120 min of reperfusion. PD significantly correlated with Aβ (r = 0.8, p<0.0001) and Bβ (r = 0.73, p<0.0001).

**Conclusions:** The progressive reduction in postischemic myocardial perfusion was accurately detected by real-time MCE. Fourier phase imaging is able to quantify dynamics of myocardial opacification in a simple and objective format and is a promising approach for the clinical interpretation of contrast echocardiograms.

**REFERENCES**


