Methods of Quantification of Myocardial Perfusion

Date: 7/12/00, from 16:30 to 18:00

Location: Room 7A

Chairpersons:

L. Galiuto (Rome/IT)
F. J. Ten Cate (Rotterdam/NL)

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Quantitative myocardial contrast echocardiography in evaluation of coronary microcirculation in essential hypertension

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We have analyzed the Coronary Microcirculation (CM) in essential hypertension both in at rest and after vasodilator stimulus (dipyridamole), with quantitative myocardial contrast echocardiography (MCE). Ten healthy (C) and 10 hypertensive subjects (H), all males, without CAD, diabetes or obesity, were studied. Sonos 5500 (Agilent Technologies) with 54 transducer was used; Levovist as ultrasonic contrast agent (400mg/ml) was e.v. injected, using an infusion pump. Digitized images of MCE were collected in four chamber views with Power Harmonic Doppler (Angio), with an end-systolic trigger. After 5 minutes of the stop of contrast, coronary hyperemia was induced with e.v. injection of 0.56 mg/kg of dipyridamole; two minutes after dipyridamole infusion, another Levovist injection was administered. Using dedicated PC software, Angio images, in a colored scale, was analysed placing a Region of Interest (ROI) on septum. MCE analysis resulted in a time-intensity curve (polynomial fit). The following parameters were then analysed: peak intensity (PI), PI half-time (HT); area under curve of appearance (AUCwi) and disappearance of microbubbles at 2/3 of PI (AUCwo); ratio between PI and AUCwo after dipyridamole and PI and AUCwo at rest (which reflect the coronary flow reserve), were obtained. Indexed left ventricular mass (LVMi) is significantly higher in H (135g/m2±25 vs.105 g/m2±11 in C; p<0.005). PI significantly increases after dipyridamole both in C (p<0.001) and in H.

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Physiological response of the endo-epicardial microvascular flow gradient to dipyridamole in humans

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Background: Experimental work has shown that myocardial contrast echocardiography (MCE) has the spatial resolution to measure the resting and hyperemic endocardial to epicardial blood flow ratio (EER), which is equal to unity in normal coronary beds. Coronary beds supplied by stenosed arteries have a resting EER significantly lower than normal coronary beds.

Methods: We performed MCE in 13 healthy volunteers selected for adequate acoustic windows (ages 22-32, 8 women, no risk factors/symptoms of CAD) before and after dipyridamole administration using intravenous DefinityTM (total dose 900 mL, DuPont Pharmaceuticals Company,USA). Imaging was performed in the apical four chamber view using both Triggered MCE (mechanic index 0.8-1.3; intervals of 1:1, 1:4, 1:8) and Real Time MCE (mechanic index 0.1, 20 Hz, Acuson Corp., USA). Video intensities were measured from digitally stored data by drawing ROIs over the endo/epicardium. The endocardium and epicardium were defined as the inner and outer one thirds of the apex, respectively. EER was defined as the ratio of the peak video intensities of the endocardium to epicardium.

Results: EER was comparable at incremental triggering intervals before and after dipyridamole suggesting that the myocardial blood flow in endocardium was equivalent to the epicardium. Real time MCE also showed data supportive of endocardial-epicardial blood flow equivalency. (EER's in table shown as mean±1 SD)

Conclusions: (1) MCE in humans has the spatial resolution to measure EER, (2) Both resting and hyperemic EER in normal humans was approximately 1.0, and (3) Both Triggered and Real Time MCE showed comparable data. These data may serve as the reference normal values of resting and hyperemic EER's when EER is used to detect myocardial ischemia during stress MCE.

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A dream comes true: non-invasive delineation of endocardial blood flow and endocardial/epicardial flow ratio quantitation by myocardial contrast echocardiography

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It was previously shown in animal models that myocardial blood flow (MBF) can be quantitated using myocardial contrast echocardiography (MCE) by measuring the rate of intrabuble replenishment after their initial destruction by ultrasound (US) during a constant infusion of contrast. It remains uncertain, however, if this technique has sufficient spatial resolution to resolve endocardial blood flow and endocardial/epicardial (endo/epi) flow ratio, the most sensitive index of myocardial ischemia. Accordingly, we used power modulation imaging, a new technology which is designed to assess possible replenishment kinetics in real-time, to test the ability of MCE with PESDA to quantify MBF selectively in the endocardium and the epicardium and to recognize the inversion of the endo/epi flow ratio during ischemia. For this purpose, we studied 6 chronically instrumented dogs with coronary stenosis during adenosine induced hyperemia and occlusion. Real-time MCE-derived A (an index of myocardial blood volume), f (an index of intrabuble velocity), and A/B (an index of myocardial blood flow) from the endocardium and epicardium were compared to radiolabeled pS (85Sr) in the same regions of interest. As expected, radiolabeled pS showed an endo/epi flow ratio >1 in the nonischemic zones (NIZ) and an endo/epi flow ratio <1 in ischemic regions, respectively. f (0.8-0.9 vs. 0.7-0.8; p<0.001). In both NIZ and IS, MCE-derived A was similar in both the endocardium and endocardial (respectively, 13.3±2 vs. 12.6±2; p=0.05; 12.9±2 vs. 8.6±2; p=0.001). By contrast, MCE-derived f and A/B endo/epi ratios were >1 in the NIZ (respectively, 1.5±0.4 and 1.4±0.5) and <1 in the IS (respectively, 0.7±0.1 and 0.8±0.2; p<0.001 vs NIZ). Both MCE-derived f and MCE-derived A endo/epi ratio correlated strongly with both pS-MBF and pS-endo/epi ratio (respectively, r=0.77 and r=0.79). These data suggest that the real-time power modulation MCE allows accurate quantification of absolute MBF as well as it helps to achieve spatial resolution to resolve endocardial blood flow and endo/epi ratio to detect myocardial ischemia.