

SCA 110

ASSESSING MYOCARDIAL PERFUSION IN THE OPERATING ROOM WITH CONTRAST ENHANCED ULTRASONOGRAPHY: IS IT READY FOR PRIME TIME?

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Introduction: Myocardial contrast echocardiography (MCE) has emerged as a modality for assessing myocardial perfusion.¹ MCE involves the intravascular injection of tracers (gas filled microbubbles with rheological properties similar to red blood cells) that can scatter ultrasound. Recently MCE has also been employed to assess coronary blood flow reserve,² myocardial viability,³ and the spatiotemporal discordance between perfusion and function.⁴ These advances provide a means to evaluate the success of surgical coronary revascularization but no studies to date have assessed the use of MCE in the operative environment. Accordingly, the purpose of our study was to examine: 1) the feasibility of MCE in the operating room using a prototype TEE probe, 2) to quantify myocardial perfusion using both triggered-mode and real time imaging techniques, and 3) to assess the discordance between myocardial perfusion and function in patients undergoing cardiac surgery.

Methods: Following IRB approval and informed consent, 10 patients undergoing off-pump coronary artery bypass surgery were enrolled into the study. Using a prototype Omni 3 TEE transducer (Phillips Ultrasound), trans-gastric short axis views of the left ventricle (LV) were obtained at baseline and during a constant infusion of microbubbles (Definity™). Triggered harmonic imaging was conducted at a Mechanical Index (MI) of 1.0 with a pulsing interval of 1, 3, 5, 8, 10, 15, and 20 beats. Real time imaging using power modulation employed a MI of 0.3 with 10-15 beat acquisitions after impulse delivery. Image acquisition was conducted prior to sternotomy and again after revascularization (chest closure). Digitally stored images were then analyzed off-line using custom software and previously validated methodology (MCE v2.7, Yabko, LLC – Charlottesville, VA). Tissue video intensity (VI) versus pulsing interval (PI) plots were fitted to an exponential function [$VI = A(1 - e^{-\beta t})$] using Igor Pro (Wavemetrics Inc.). Tissue blood volume fraction (A), microbubble velocity (β), and myocardial blood flow ($A \times \beta$) were derived from the VI versus PI plots (Figure 1). Regional LV myocardial function and the presence of contrast agent within the myocardium were assessed both visually by an investigator blinded to the computer analysis, and by the software using standard segmentation schemes and criteria for wall motion analysis.

Results: MCE was successfully performed in all 10 patients and there were no adverse events related to the administration of the contrast agent. Microbubbles were consistently visualized only in the septal (94%), inferior (94%), and posterior (88%) wall segments when triggered harmonic imaging was employed (anterior (6%), anteroseptal (63%), lateral (50%)). Real time imaging, however, yielded more consistent microbubble visualization in all 6 segments (83-100%) (Figure 2). Myocardial blood flow could be readily assessed and quantified pre and post revascularization (Figure 1). A disparity between perfusion and function was detected in 4 segments.

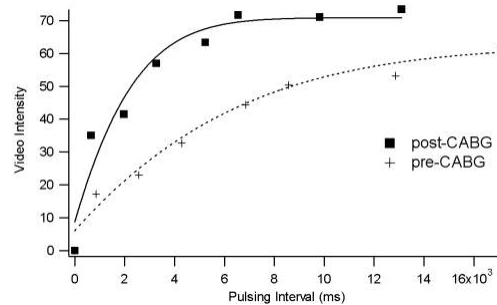


Figure 1: VI versus PI plot showing increased blood flow post revascularization

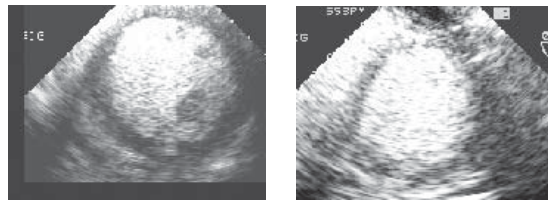


Figure 2: MCE with triggered mode (left) and real time mode (right)

Conclusions: MCE is a safe, noninvasive, and easy-to-use method of assessing myocardial blood flow in the operating room. Consistent imaging of all myocardial segments using the triggered harmonic mode requires further technological advances in TEE probe and transducer design (increased power, lower frequency). Real time imaging appears to be currently preferable for the intraoperative TEE assessment of surgical coronary revascularization. MCE offers the potential to correlate myocardial flow with function.

References:

1. Wei K, et al. Circulation 1998.
2. Wei K, et al. Circulation 2001.
3. deFiippi CR, et al. Circulation 1995.
4. Leong-Poi H, et al. Circulation 2002.