A New Method of Lateral Compensation of Acoustic Power for Homogenous Acoustic Field: Its Efficacy at Intravenous Myocardial Contrast Echocardiography

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Background: Myocardial opacification by myocardial contrast echocardiography (MCE) is naturally homogeneous in the normal heart. However, the opacification was not always homogeneous, because of weak acoustic power in the lateral field at use of electronic sector probe. Recently, a new device has been developed to compensate the heterogeneous power.

Purpose: The aim was to elucidate the efficacy of lateral compensation at myocardial contrast echocardiography.

Methods: Toshiba SSA-770A (Apio) with a new transducer (1.4/2.8 MHz) was used, in which lateral compensation was performed at both transmission and receiving. In tilted scan line, at transmission, the aperture of acoustic source was expanded in expectation of decline of beam intensity according to element factor. At receiving, the beam intensity was compensated by gain control in every scan line. The contrast intensity of the anterior and lateral walls in the short axis view was examined during Definity infusion in open chest dogs. Other setup of equipment was the same between on and off of lateral compensation mode.

Results: The intensity ratio of lateral to anterior walls was 75±17% without lateral compensation, showing heterogeneous opacification. On the other hand, its ratio was 97±6% with lateral compensation, showing homogeneous opacification. The intensity of the anterior wall was equivalent between on and off of lateral compensation.

Conclusions: The new lateral compensation mode is superior for homogeneous myocardial opacification in comparison with conventional transmitting mode.

Second Harmonic Modality Improves Capability of Integrated Backscatter in Detecting Viable Myocardium During Echocardiography

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Background: During acute myocardial infarction the integrated backscatter cycler variations (IBCV) are reduced in the infarcted myocardial segments. Echocardiographic images obtained with second harmonic tissue modality show less artifacts than fundamental harmonic. We hypothesized that second harmonic adds to IBCV the capability of identifying viable myocardial segments during dobutamine infusion.

Methods: We studied 12 patients within 48 hours of acute myocardial infarction with transsthoracic low dose echo dobutamine test for viability. In parasternal long axis view we analysed fundamental and second harmonic IBCV during 10 mg/Kg/min infusion of dobutamine, in 24 remote, and 24 dyskinetic myocardial segments. The dyskinetic segments were considered viable or non-viable depending on myocardial functional recovery at 30 days echocardiographic follow up.

Results: During dobutamine infusion the IBCV obtained in fundamental were slightly greater in the remote (9.8±4.2 dB) and in the viable segments (9.5±2.1 dB) than in the non viable segments (5.1±1.7 dB; p=ns versus remote and viable segments, ANOVA + test Newman-Keuls).

Conclusions: The second harmonic technology during echo dobutamine test can add accuracy to the use of IBCV in the detection of viable myocardium.

Value of Novel Ultrasonic Radio Frequency Signals Analysis in Assessing Effect of Aldosterone Inhibition on Cardiac Structural Abnormality

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RALES study showed beneficial effects of aldosterone inhibition on the mortality of congestive heart failure without hemodynamic changes, and previous in vitro studies suggest that this result is attributed to inhibition of ventricular fibrosis. Recently, analysis of ultrasonic radio-frequency (RF) signals has become available and may have a potential of detecting damaged myocardium or myocardial fibrosis non-invasively. The purpose of this study is to elucidate effect of aldosterone inhibition on cardiac structure by analysis of RF signals. We analyzed RF signals obtained from M mode echo in 12 DCM patients before and after 6 months spironolactone oral administration by a time-delay embedding technique to construct a continuous three-dimensional trajectory. Hemodynamic and echo parameters, such as blood pressure, heart rate, left ventricular (LV) end-diastolic diameter, ejection fraction and LV mass, did not change by spironolactone administration. Although all attractors formed a thin ring-like structure consisting of a relatively empty, roughly circular core (quasi-periodic pattern) before administration, aldosterone inhibition changed the attractors chaotic and increased the value of correlation dimension towards a normal level (2.7±0.2 vs. 3.2±0.2, p<0.05). Aldosterone inhibition may have a possibility of improving structural abnormality, especially fibrosis, and this change may be detected by a RF signals-based marker of tissue characterization.

Diagnostic Digital Echocardiography on Devon Island via Telemedicine as a Mars Analog

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Background: Echocardiography will mostly be used for human research in space. Since novices in ultrasonic imaging will be performing exams in harsh conditions, devices need to be small and portable. Devon Island (DI) is a suitable analog for conditions on Mars.

Purpose: We sought to determine the feasibility of obtaining diagnostic echocardiographic images acquired remotely by novice sonographers and transmitted using a NASA communication setup.

Methods: Images acquired on a portable ultrasound unit on DI were relayed via satellite to Mission Control in Houston and then to the Cleveland Clinic Foundation (CCF) for interpretation. Since personnel on DI are unlikely to have significant cardiac pathology, loops from 5 pathologic cases were chosen by an expert at the CCF and forwarded to DI for compression and transmission. Images were graded for diagnostic content (DC) (1 = fully diagnostic, 2 = usable, 3 = marginal, 4 = unusable) and quality (Q) (1 = excellent, 2 = good, 3 = fair, 4 = poor). Results: A total of 111 images were transmitted; 99% were diagnostic and 95% were of good/excellent quality. For the pathologic cases, 32/35 (91%) abnormalities were identified.

Conclusions: 1) Remote telediagnostic performed by novices using a small, portable ultrasound system is feasible. 2) Remote interpretation of compressed echocardiographic studies may be performed with diagnostic accuracy.

Color M-Mode Estimation of the Spatial Distribution of the Diastolic Intraventricular Pressure Gradient With a Left Ventricular Aneurysm

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Background: Atrial LV aneurysm may affect diastolic intraventricular blood flow. Color M-mode (CMM) provides a spatiotemporal velocity distribution from which intraventricular pressure gradients (IVPG) may be calculated. We sought to evaluate in the normal and diseased hearts the spatial distribution of IVPG using CMM and to define spatial gradient during diastole.

Methods: A total of 15 different hemodynamic conditions in 4 sheep, with surgically created chronic aneurysms, were examined by echocardiography and catheterization simultaneously. We used a dual-sensor micromanometer catheter with 5-cm spacing between the sensors to obtain pressure difference between LVapex and LVbase, CMM of mitral inflow during early diastole obtained from apical four-chamber view were analyzed using customized software using the Euler equation, from which pressure gradients were calculated every 5mm from base to apex.

Results: 1) The overall pressure difference between LVapex and LVbase, by Miller catheter and by CMM correlated well (r = 0.91, fig 1). 2) CMM showed that intraventricular pressures decreased normally in the normally contracting portion of the ventricle, but flattened abruptly in the aneurysm and then remained constant (fig 2).

Conclusions: 1) Analysis of CMM with the Euler equation can accurately estimate IVPG noninvasively in LVS with aneurysms. 2) Pressure is nearly constant within the aneurysm. 3) Such analysis may help identify patients at risk for post-infarct thrombus formation.