Detection of Coronary Artery Disease with Myocardial Elastography with validation against myocardial perfusion imaging and coronary angiography

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Background, Motivation and Objective:
Myocardial Elastography (ME) is a radiofrequency (RF)-based technique that can image 2-D cardiac strains *in vivo*. Prior studies have shown that ME with conventional beamforming can detect abnormal function of coronary artery disease (CAD) patients and identify the territories affected by occluded arteries. Early detection of CAD can prevent patients from undergoing invasive catheterization or ionizing procedures. The objective of this study was to evaluate the performance of ME in detecting and characterizing abnormal myocardial perfusion, infarct scars or coronary occlusion in patients using ME with diverging wave imaging.

Statement of Contribution/Methods:
In this study, two set of patients were investigated: patients scheduled for a nuclear stress test (N = 36) and patients scheduled for a coronary angiography (N = 23). All patients recruited for this study were imaged with ME prior to and on the same day as their nuclear stress test or their coronary angiography. Diverging wave imaging was used to acquire transthoracic images in short-axis view using a Verasonics system and a 2.5 MHz center frequency probe. Channel RF data were acquired at 2kHz and ECG was acquired synchronously. Incremental axial and lateral displacements were estimated using normalized 1-D cross-correlation (window size: 5.9 mm, 90% overlap) in a 2-D search and then accumulated during systole. Axial and lateral cumulative strains were computed by applying a least-squares estimator on the axial and lateral cumulative displacements (kernel size: 6.6mm) before converting to radial and circumferential cumulative strains. The radial strain were computed in the total cross-section of the myocardium and in each region perfused by the LAD, the LCX and the RCA.

Results/Discussion/Conclusions:
For patients who had the nuclear stress test, the average radial end-systolic cumulative strain in the total cross-section of the myocardium was significantly higher in the normal patients (18.3±12.1%) than in the patients with abnormal perfusion or scar (6.1±9.1%, $p < 0.05$). In the LCX territory, the average radial end-systolic cumulative strain was higher in normal patients (14.1±16.4%) than in patients with abnormal perfusion or scar (-2.6±5.9 %, $p < 0.05$). For patients who had the coronary angiography, the average radial end-systolic cumulative strain in the total cross-section of the myocardium was significantly higher in the normal patients (11.2±8.9%) than in the patients with obstructive CAD (1.0±8.6%, $p < 0.05$). In the LAD territory, the average radial end-systolic cumulative strain was higher in normal patients (14.3±11.5%) than in patients with obstructed LAD (-0.9±6.2 %, $p < 0.05$). These preliminary clinical findings indicate the potential of ME to noninvasively differentiate patients with a normal myocardial perfusion or coronaries from patients with a perfusion defect, a scar or an obstructed coronary with the highest significance in the LCX and LAD territory.