ACC.13
62nd Annual Scientific Session & Expo
TCT@ACC-i2

E1090
JACC March 12, 2013
Volume 61, Issue 10

Imaging

NOVEL APPLICATION OF ACOUSTIC RADIATION FORCE IMPULSE IMAGING IN TRANSTHORACIC ECHOCARDIOGRAPHY

Poster Contributions
Poster Sessions, Expo North
Monday, March 11, 2013, 9:45 a.m.-10:30 a.m.

Session Title: Imaging: CRT/New Technology
Abstract Category: 18. Imaging: Echo
Presentation Number: 1312-336

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Background: Non-invasive assessment of tissue stiffness is limited in transthoracic echocardiography (TTE). Acoustic radiation force impulse (ARFI) imaging is an ultrasound-based method that uses high energy pulses to induce displacement in tissues. This displacement then allows for correlation with tissue stiffness because soft tissues displace further than stiff tissues. ARFI imaging can differentiate malignant from normal tissue in stationary structures such as human breast. However, application of ARFI methods in human TTE has not been reliably demonstrated. This study represents the first human study of ARFI imaging in TTE.

Methods: Six healthy subjects were imaged using a Verasonics ultrasound scanner. This scanner targeted myocardium with ARFI pulses while obtaining displacement data. Two pulse sequences with either a mechanical index (MI) of 1.9 or 3.0 were used in each subject. ARFI excitations were acquired at 25 Hz for two seconds and were gated to the electrocardiogram. The focus of the pulses was the left ventricular apex from a four-chamber apical view. Tissue displacements were measured along the center line at the apex. Analyzed parameters were mean tissue displacements during systole and diastole over at least three acquisitions.

Results: Mean displacement was greater in diastole than systole for an MI of 1.9 (1.8 ± 0.68mm vs 1.3 ± 0.57mm, $p < 0.01$) and an MI of 3.0 (4.0 ± 1.5mm vs 2.7 ± 1.2mm, $p < 0.01$) for all patients. The mean ratio of displacement in diastole versus systole was not different between all subjects ($p > 0.05$). No ectopic beats were noted throughout the ARFI pulses.

Conclusions: We report the first study that demonstrates the feasibility and safety of transthoracic cardiac ARFI imaging in humans. Higher measured displacements in diastole compared with systole correlate with stiffer tissue during systole. Ratios of diastolic to systolic displacement are similar across patients, suggesting that this is a reproducible parameter in normal patients. The ability to differentiate tissue stiffness between systole and diastole suggests that transthoracic cardiac ARFI could be utilized to noninvasively identify cardiac pathology such as infarct or other abnormal tissue.