CSPAMM assessment of systolic and diastolic left ventricular apical rotation in obesity

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Introduction
Obesity is a major health problem, affects 1/3 of the adult population in the US and carries increased morbidity and mortality. Cardiac pathology is frequently found in obese individuals, even in their absence of hypertension or diabetes, suggesting a possible causal association between obesity and abnormal cardiac anatomy and function. Several echocardiographic studies have demonstrated an increase in left ventricular (LV) mass among obese subjects. Echocardiographic indexes of diastolic function, including peak transmitral E to A-wave flow velocities, isovolumic relaxation time, and E wave deceleration time, have also been shown to be abnormal in the obese. Following weight loss, LV mass tends to decrease and LV diastolic function also improves. Echocardiography is commonly suboptimal in obese subjects due to poor acoustic windows. Although cardiac MRI has confirmed the LV mass increase in obese individuals (1), the MR evaluation of LV rotation in systole and diastole has not been previously explored in obesity. Thus we used Complementary SPAtial Modulation of Magnetization (CSPAMM) to assess the apical LV rotation in otherwise healthy obese individuals and lean controls. Systolic rotation and untwisting diastolic velocity have been previously shown to be correlates of ventricular diastolic dysfunction in patients with significant left ventricular hypertrophy due to aortic stenosis (2).

Methods
In an ongoing investigation, we evaluated 14 healthy male adult subjects, age range 20-40 years, of whom 8 were obese (defined as having body mass index BMI>30 kg/m2 age 29+7 yrs; BMI 34.3 kg/m2) and 6 were lean (defined as having BMI 19-25 kg/m2 age 27+3 yrs; BMI 23.2 kg/m2). Imaging was performed using a 1.5T whole body scanner (Gyroscan NT/ACS, Philips Medical Systems, Best, The Netherlands) with advanced cardiac software (CPR6) and enhanced gradient hardware (1T 0.001, 21 mT/m, slew rate 100 mT/m/sec). Single breath-hold (duration 15-20 sec) ECG-gated slice following CSPAMM images (2) were acquired at the apical LV (approximately 1 cm from the apex). Seventeen to 20 cardiac phases per RR interval, extending throughout ventricular diastole were acquired. The following parameters were used: FOV 300 mm; matrix 128 (in-plane resolution 2.3 x 2.3 mm); tagged slice thickness 8 mm, with imaged volume thickness 20 mm; 9 EPI readouts for each RF excitation; TE of 5.4 msec. Temporal resolution was 35 msec. A standard breath-hold FF-EPI sequence was used to obtain short axis cine images to cover the whole LV. Manual segmentation of endo- and epicardial borders was performed offline on an analysis workstation (Easyvision, Philips Medical System, NL) for determination of LV mass. Tagged image analysis was done offline on a Linux workstation using a restrom-L V tag analysis package (3) written on PV-Wave 6.0® platform (Visual Numerics, Houston, TX). The apical LV wall thickness-to-cavity radius ratio, LV rotation (°) and LV twisting velocity (°/sec) were measured.

Results
All subjects successfully completed the examination. There was a tendency for increased absolute LV mass in obese subjects (170±16g) compared to lean controls (162±20g). Similarly, the LV wall thickness to cavity radius ratio was slightly smaller in the obese (0.59±0.07) compared to lean controls (0.67±0.10). CSPAMM analysis demonstrated that the peak LV systolic rotation in obese individuals (11.9±1.5°, zenith of curve in Figure 1) was slightly higher, compared to lean controls (10.7±1.4°), and also occurred with slight delay (90%ES vs. 80%ES, obese vs. lean, respectively).

Discussion
Obese apparently healthy subjects may have subclinical LV changes of cardiac dysfunction, as evidenced by increased and delayed peak systolic rotation, and increased maximal untwisting diastolic velocity of apical LV. These parameters have been previously shown to be significantly altered in patients with marked left ventricular hypertrophy due to aortic stenosis (2). Although currently limited by relatively small sample size, the LV tagging evaluation of the obese subjects suggests early abnormalities of apical LV rotation pattern, possibly related to early LV hypertrophy.

Bibliography