Association between Left Ventricle Sympathetic Innervation and Torsion in Patients with Type 1 Diabetes

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Introduction
In type 1 diabetes (T1DM), left ventricular (LV) dysfunction often precedes significant coronary artery disease or hypertension. Cardiac autonomic neuropathy (CAN) is associated with an increased prevalence of silent myocardial ischemia and is an independent risk factor for cardiac mortality. Longitudinal studies of CAN subjects have shown 5 year mortality rates between 16-50% (1), particularly in patients with sympathetic CAN. Sympathetic imbalance associated with CAN may critically influence myocardial glucose utilization and contribute to regional ventricular wall motion abnormalities and functional deficits.

We have developed the use of positron emission tomography (PET) with [11C]meta-hydroxyephedrine ([11C]HED) as a sensitive technique to explore the integrity of the LV sympathetic innervation (Figure 1). We observed that [11C]HED tracer retention deficits affected 36-40% of the LV in early-stage T1DM patients, despite normal cardiovascular reflex testing, consistent with sympathetic neuronal dysfunction (2).

MRI tagging techniques allow assessment of regional and global cardiac tissue deformations such as torsion and strain. MRI tagging techniques have been used to detect early contractile dysfunction in diabetics with normal LV ejection fraction and mass, normal blood pressure, and tight glycemic control (3). In this study we examine the relationship between sympathetic innervation and LV torsion in patients with T1DM.

Methods
Cardiac MRI with tagging was used to assess LV torsion in 3 subjects with T1DM and CAN (CAN+), mean age 45±7 years, HbA1c 8.8±1.1% and in 4 subjects with T1DM without CAN (CAN–), mean age 41±4 years, HbA1c 8.5 ±1. 7%. All subjects had normal LV ejection fraction. Tagged MR images were acquired using a SPAMM sequence on a Philips Achieva 1.5 T unit (Philips Medical Systems, Best, The Netherlands) with a sixteen-element phased-array coil dedicated to cardiac imaging. Torsion (angular difference between basal slice and apical slice divided by slice distance) was measured using harmonic phase software (4) developed in-house (Matlab, The MathWorks, Natick, MA). In one patient with T1DM and CAN+, both the regional LV sympathetic innervation as assessed by [11C]HED PET and regional LV torsion and as assessed by cardiac MRI with tagging were obtained and the results compared by linear regression.

Results
Figure 2 demonstrates that CAN+ subjects have significantly increased peak LV torsion (12.57±2.70 deg/cm) compared with CAN- subjects (3.26±0.96 deg/cm, P=0.0013). Figures 3A-C show that the PET map of sympathetic innervation is inversely related to the regional amount of LV torsion generated in the midline (outer circle) and the apex (inner circle) in one CAN+ patient.

Conclusion
These preliminary results suggest that subjects with T1DM without coronary artery disease or heart failure may present with abnormal LV torsion and that increased torsion is related to sympathetic dysfunction. These findings are illustrated by the significantly higher torsion rates in CAN+ subjects and by the high degree of correlation of LV rotation in the distal apical regions with regions of sympathetic denervation.

References