THE RELATIONSHIP BETWEEN WALKING SPEED AND BRAIN VOLUME IN TYPE 2 DIABETES MELLITUS

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INTRODUCTION
Type 2 diabetes mellitus (DM) is associated with reduced walking speed, diminished independence and increased risk of falls [1]. Yet, we have demonstrated that walking-related outcomes are highly variable, even in DM patients with similar disease severity, muscular strength and peripheral sensory function [2]. These observations indicate that the degree of walking impairment associated with DM is also dependent upon yet-to-be-identified alterations and/or adaptation within the central nervous system.

The purpose of this experiment was therefore to determine the relationship between walking speed and brain volumes in older adults with and without DM. We hypothesized that as compared to controls, walking speeds in older adults with DM would be more dependent upon brain volumes, thus indicating increased reliance upon CNS elements of the motor control system.

METHODS
Fifty-nine adults with DM (aged 65±8 years) and 69 controls (aged 66±7 years) walked for 12min at preferred speed. Average walking speed was calculated.

Whole-brain 3-dimensional MRIs were performed on a 3-Tesla GE Signa Vhi scanner using a quadrature and phase array head coils (GE Medical Systems, Milwaukee, WI). High-resolution anatomical images were acquired using a 3D magnetization prepared rapid gradient echo (MP-RAGE) sequence: (TR/TE/TI = 7.8/3.1/600 ms, 3.0 mm slice thickness, 52 slices, bandwidth = 122 Hz per pixel, flip angle = 10°, 24 cm × 24 cm FOV, 256 × 192 matrix size), fluid attenuated inversion recovery (FLAIR) (TR/TE/TI = 11000/161/2250 ms, 5 mm slice thickness, 30 slices, bandwidth = 122 Hz per pixel, flip angle = 90°, 24 cm × 24 cm FOV, 256 × 160 matrix size), and diffusion weighted image (DWI) (b value of 1000 sec/mm², TR/TE = 10000/86.6 ms, 5 mm slice thickness, bandwidth = 250 kHz, 128 × 128 matrix size).

Brain volumes were calculated from MP-RAGE images using an inherently circular model with spatial normalization within the statistical parametric mapping software package (SPM, University College London, UK). A template of anatomical regions was applied to compute regional gray matter, white matter and cerebrospinal (CSF) volumes. Normalized volumes in each brain region were computed by dividing by intracranial cavity volume.

RESULTS AND DISCUSSION
The duration of DM was 11±8 years, and 14 had peripheral neuropathy. Groups were similar in age, sex and height. The DM group had greater body mass than controls (p=0.01).

The DM group walked slower than controls (1.04±0.15 vs. 1.11±0.17 m/s, p=0.01), yet this difference was not significant after adjusting for variance in body mass.

Global brain volumes did not differ by group. DM patients, however, had less gray matter volume in the temporal lobe (p=0.02) and more CSF volume in the frontal (p=0.04) and temporal (p=0.05) lobes.

In the control group, walking speed did not significantly correlate with global or regional brain tissue or CSF volumes. In the DM group, on the other hand, walking speed correlated with global gray matter volume (R=0.56, p<0.001) (Figure 1), global CSF volume (R=-0.38, p=0.004), gray matter volume in the frontal, temporal and parietal lobes (R=0.38-0.45, p<0.1), and CSF volume in the frontal lobe (R=-0.036, p=0.007).

The correlation between walking speed and frontal lobe gray matter volume was stronger (p=0.02) in DM patients with peripheral neuropathy as compared to those without.

Figure 1: The relationship between preferred walking speed and global gray matter volumes in older adults with and without type 2 diabetes mellitus.
CONCLUSIONS
Relationships between walking speed and brain volumes in DM patients, but not controls, suggests that these patients are more dependent upon the CNS to control walking, presumably to compensate for peripheral effects of DM on the body.

These observations suggest that gait and balance rehabilitative strategies for DM patients may be optimized by targeted efforts to maximize the structural integrity and function of the brain.

ACKNOWLEDGEMENTS
This project was supported by American Diabetes Association Grants (1-03-CR-23 and 1-06-CR-25) and the National Institute of Neurological Disorders and Stroke (1R01-NS045745-01A21)

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