Gait asymmetry in people with Parkinson’s disease is linked to reduced integrity of callosal sensorimotor regions

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Introduction

Transcallosal communication via the corpus callosum between the left and right hemisphere of the brain plays a key role in the production of integrated motor behavior to generate appropriate, coordinated motor responses on both sides of the body. In separate cohorts of people with idiopathic Parkinson’s disease (PD) it has previously been shown that reduced transcallosal structure is associated with impaired gait and balance control and that people with PD have increased gait asymmetries - i.e. impaired gait coordination. The goal of this study is to compare the integrity of the corpus callosum connecting homologous sensorimotor cortical regions in people with PD and healthy controls and to evaluate the relationship between callosal integrity and gait asymmetry.

Methods

Participants

- 39 people with idiopathic Parkinson’s disease (PD)
- 20 healthy controls (HC)

Procedures

Gait Acquisition

Spatial and temporal gait asymmetry was assessed using an instrumented walkway (GAITRite®).

Neuromaging Acquisition

White matter microstructural integrity was assessed in transcallosal fibers connecting the following homologous sensorimotor cortical regions:

- pre-supplementary motor areas (pre-SMA)
- supplementary motor areas (SMA)
- primary motor cortex (M1)
- somatosensory cortex (S1)

3T Siemens Magnetom Tim Trio with a 12-channel head coil

1. T1-weighted magnetization-prepared gradient-echo image (repetition time (TR) = 2,300 ms, inversion time (TI) = 900 ms, echo time (TE) = 3.58 ms, flip angle = 10°, 1 mm³ voxels, 160 slices, FOV = 256 x 256 mm)

2. T2-weighted image for accurate registration of T1-weighted over 50 TR = 497 ms, 1 mm³ voxels, 160 slices, FOV = 256 x 256 mm)

3. HARDI using an Echo Planar Imaging (72 different gradient directions, b-value = 3,000 mm/s², TR = 7100 ms, TE = 112 ms, 2.5 mm³ voxels, 48 slices, FOV = 230 x 230 mm).

Results

Gait Asymmetry

People with PD exhibited significantly more temporal and spatial gait asymmetry than healthy controls (p < 0.009 and p < 0.0001, respectively).

Transcallosal Fiber Tract Integrity

People with PD had significantly reduced white matter microstructural integrity of the transcallosal fibers connecting homologous regions of the pre-SMA and SMA, but not M1 and S1.

Conclusion

People with PD showed significantly increased step length asymmetries and decreased microstructural integrity of callosal white matter tracts connecting the pre-supplementary motor and supplementary motor areas. Transcallosal fibers connecting the pre-supplementary motor areas, and those connecting the homologous S1, were also negatively associated with step length asymmetries. The current results indicate that reduced transcallosal structural connectivity may be a significant mechanism underlying bilateral gait asymmetries in those with PD.

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