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Association between pre-frontal cortex activity and gait domains in people with Parkinson's disease

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Abstract

BACKGROUND AND AIMS: In people with Parkinson's disease (PD), walking impairments like reduced stability, speed, and stride length are common. These impairments involve a shift from automatic to compensatory control, mainly in the prefrontal cortex (PFC). Increased gait variability, seen in PD, suggests reduced automaticity and higher PFC activity, indicating greater attentional demand. However, it's unclear if specific gait domains correlate with changes in PFC activity. We hypothesize that increased PFC activity during walking may correspond to higher gait variability.

METHODS: In this ongoing study, 33 individuals PD with idiopathic PD (Mean: age 67.9, disease duration 9.6 years, MDS-UPDRS III 33.7) were included and tested while On Levodopa. Objective gait metrics were measured during 2-minute single- (ST) and dual-task (DT) walking using inertial sensors worn on head, sternum, lumbar, bilateral wrists and feet. PFC activity was measured using a continuous wave, portable fNIRS system with 50 Hz sampling frequency. The walking tasks included 20 s quiet stance, 120 s walking and turning, and 10 s quiet stance. We derived the following metrics for gait: mean and variability of gait speed (pace), cadence (temporal), arm velocity asymmetry (asymmetry), double support time (stability) and foot-strike angle (spatial). Pearson correlation was computed for association between fNIRS and gait metrics.

RESULTS: During ST walk, increased variability in foot-strike angle was significantly associated with increased PFC oxygenated blood level ($r = 0.53$, $p = 0.002$). Decreased asymmetry in arm swing velocity during DT was associated with decreased PFC oxygenated blood level ($r = -0.42$, $p = 0.02$).

CONCLUSION: We found that variability and asymmetry domains of gait are significantly associated with pre-frontal cortex activity. Our preliminary results suggest that loss of gait automaticity in people with PD may be explained by a relationship between a compensatory increase in executive control (PFC activity) and increased gait variability & asymmetry during walking. With the availability of more data towards the end of the study we may be able to confirm the findings in a larger sample size.