Freezing of Gait in Parkinson’s Disease

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Abstract
Parkinson’s disease is a progressive disorder of the nervous system that afflicts movement. The disease develops gradually, sometimes starting with a barely noticeable tremor in just one hand. Although a tremor may be the most widely known sign of Parkinson’s disease, the disorder also causes freezing of gait (FOG). Findings from studies examining FOG have shown that the brainstem is unable to function and gait and upper limb variability are present during a FOG episode. Studies have also identified an association between FOG and speech disturbances. The purpose of this presentation is to display an overview of FOG and its relationship to these disorders and to discuss the need for future research to determine how FOG may be associated with other structures in the motor and cognitive cortex.

Introduction
Freezing of gait (FOG) is a disabling feature of Parkinson’s disease. This phenomenon is defined as “a brief, episode of marked or momentary pausing or reduced speed of gait” (Barbe et al., 2013). Research suggests that FOG may be associated with speech disturbance and the dysfunction of the pedunculopontine nucleus, pontomesencephalic reticular formation, brain stem, and upper limb variability. It’s hypothesized that the disrupted walking pattern that is observed with FOG is associated with upper limb variability (Barbe et al., 2013) and may be a systematic motor control impairment. Speech disturbances and FOG are axial symptoms that are common in Parkinson’s disease and may be closely related (Park et al., 2013).

Muscle Response in Gait Initiation
Nonnieske et al. (2014) studied whether brainstem dysfunction, known as the StarReact effect would be nonexistent in gait and ankle dorsiflexion in subjects with FOG. Subjects included 12 patients with FOG, 14 without FOG, and 15 healthy controls.

Gait and Upper Limb Variability
Barbe et al. (2013) studied gait and upper limb variability in PD subjects with and without FOG. The study consisted of 34 PD patients, 17 freezers and 17 non-freezers. The subjects participated in a walking task that consisted of situations that provoked FOG. An ultrasound measuring system recorded the movements of alternating finger tapping and alternating (shadokinetikos) quick succession forearm movements. The researchers came to three conclusions: “1. Patients with FOG have a higher spatial gait variability between FOG episodes than non-freezers. 2. Freezing-like episodes of the upper limb occur in PD patients and are more pronounced among freezers. 3. Spatial and temporal upper extremity variability is equally affected in freezers and non-freezers and does not correlate with gait variability” (Barbe et al., 2013 pg. 339).

FOG and Speech Disturbance
Using a three-dimensional gait analysis system in subjects with and without FOG, Park et al. (2013), evaluated gait velocity, stride length, and cadence as subjects walked seven meters back-and-forth with visual and auditory cues. Using the Prait software program, speech was also analyzed as subjects read ten sentences that were syntactically complex and lengthy as syllables under three conditions: baseline, with visual cues, and with auditory cues.

Conclusion
Although all studies had certain limitations, there was a common trend between Parkinson’s subjects who had FOG and those who did not. The initiation of gait, big strides, and maneuvering through narrow spaces is much more difficult for those with FOG (Nonnieske et al., 2014). However, FOG may be associated with other cognitive functions. Barbe et al. (2013) failed in correlating FOG with upper extremity variability, but Park et al. (2013), was successful in relating speech disturbances with FOG. Overall, more research is needed to associate impairments of gait in Parkinson’s Disease with other cognitive and motor control networks (Nonnieske et al., 2014; Barbe et al., 2013; Park et al., 2013).

References

Tibialis anterior Accelerometer

Results identified an accelerated effect of a startling auditory stimulus in FOG subjects with the initiation of gait and reactive ankle dorsiflexion. The StarReact effect was not completely absent in FOG subjects, but was reduced and differentiated FOG from non-FOG patients. Subjects with FOG also demonstrated shorter step lengths in their first step to initiate gait. However, both freezers and non-freezers had smaller amounts of anticipatory postural adjustments (APAs) compared to the controls. The reduced step length and smaller amplitudes of APAs were attributed to reduced brain activity.

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