

THE EFFECT OF PARKINSON'S DISEASE ON THE RESPONSE TO A BACKWARDS PULL: CENTER OF PRESSURE

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INTRODUCTION

Postural instability is one of the most disabling symptoms of Parkinson's disease (PD) and often leads to falls. Falls can have severe physical, psychological, and economic impacts including fractures, fear of falling, and loss of independence (Bloem, Grimbergen et al. 2001). The response to a large balance perturbation often involves a step response to reconfigure the base of support, which must be done quickly and appropriately in order to prevent a fall. PD impairs the step response and subjects typically use shorter than normal steps, multiple anticipatory postural adjustments, have a longer step foot liftoff time, and are less consistent in the choice of stepping limb (Jacobs, Horak et al. 2005; Jacobs and Horak 2006). The goal of this study was to investigate the effect of low severity PD on the center of pressure movement during the step response to a backwards pull. The response was characterized in a group of PD participants at Hoehn & Yahr stage 2, with no signs of postural instability, and a group of age-range matched healthy controls.

METHODS AND PROCEDURES

Participants: Ten subjects with idiopathic Parkinson's disease and 10 healthy controls (PD: age range 48-77, mean age 63.2 ± 8.9 years; HC: age range 48-79, mean age 67.2 ± 10.9 years) were tested. All participants gave informed consent for the study as approved by

the Institutional Review Board at the University of Kansas Medical Center.

Task: Each participant stood in an upright and relaxed position, with arms crossed at the chest. A rigid waist harness was attached to a cable and weight-drop mechanism, which when released, delivered a posterior waist pull to the participant. The participant was asked to respond naturally to the disturbance. The weight-drop mechanism was loaded with a weight equal to 20% of body weight and pulled the participant backwards a distance equal to 8.7% of waist height, corresponding to a 5° equivalent disturbance angle (Luchies, Alexander et al. 1994).

Data Collection: Foot-floor reaction forces were measured by three force plates (Advanced Medical Technology, Inc.; Watertown, MA) sampled at 1080 Hz.

Data Analysis: The whole body center of pressure (COP) was calculated for the time period of disturbance onset to liftoff of the first step, and divided into two stages. Stage one was defined as disturbance onset to weight shift onset. Stage two was defined as weight shift onset to step foot liftoff. Weight shift onset was defined as the last change in the location of the COP in the medial-lateral

(ML) direction prior to liftoff. The anterior-posterior (AP) and ML distance traveled and the duration of each stage were calculated. Statistical analysis was performed with SPSS (SPSS, Inc., Chicago, IL, USA). T-tests were used to assess group differences with p-values <0.05 considered statistically significant.

RESULTS AND DISCUSSION

Group differences were evident in the COP patterns in response to the backwards pull. In the first stage, the PD group, compared to controls, took longer to shift their weight and the COP traveled further backwards. In the second stage, the duration of the stage and the COP distance traveled were similar between groups. The results suggest that the increase in liftoff time observed in PD may be due to a delay in weight shift to the stance foot in preparation for a step in response to an external perturbation.

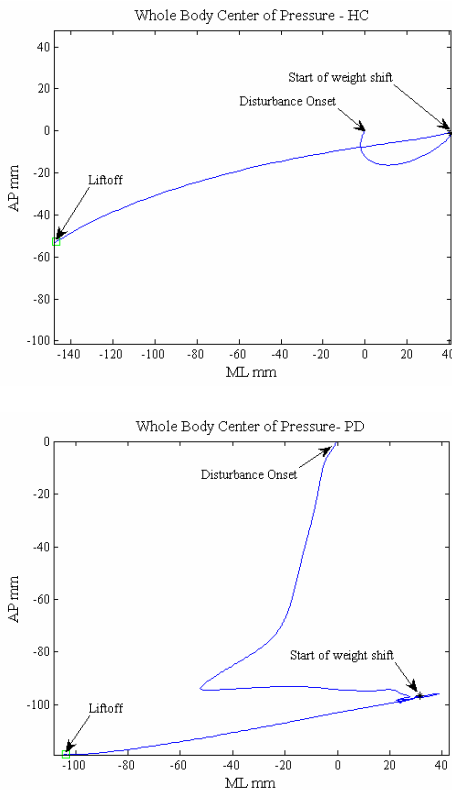


Figure 1. Whole body COP in HC and PD.

	HC	PD	t-test
AP distance S1 (mm)	-3.81 (36.10)	-54.97 (44.12)	.024*
ML distance S1 (mm)	12.45 (11.79)	19.40 (38.72)	.635
Duration of S1 (ms)	198.75 (73.39)	468.53 (275.54)	.018*
AP distance S1 (mm)	-25.47 (17.86)	-9.95 (22.50)	.149
ML distance S1 (mm)	-140.91 (18.43)	-142.26 (56.53)	.950
Duration of S2 (ms)	146.86 (40.16)	154.19 (38.58)	.715

Table 1. COP parameters; S1= disturbance onset to weight shift onset, S2= weight shift onset to liftoff; *indicates $p < .05$

SUMMARY

These results suggest that PD impairs the ability to respond quickly and effectively to a backwards pull. PD increased the time required for weight shift and the posterior distance traveled by the COP prior to weight shift onset. This altered response may represent an impairment that reduces the effectiveness of the step response to a postural disturbance for PD patients.

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