Altered Response to a Backwards Pull in Parkinson's Disease

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INTRODUCTION

Postural instability is one of the primary symptoms of Parkinson's disease (PD). In the early stages of the disease, postural instability is usually evident in the response used to recover from a postural perturbation (pushed or tripped) but as the disease progresses it may deteriorate to the point that support is needed to stand or sit. Postural instability often leads to falls, fear of falling, reduced mobility and quality of life (Adkin et al. 2003; Bloem et al. 2001). The mechanics of postural instability are not known but one hypothesis is that PD impairs the ability to make fast and accurate postural responses to a perturbation because of slower reaction and movements. This study attempts to answer the question of whether PD patients, compared to aged matched healthy controls, require more time to initiate and to execute responses to a postural perturbation.

METHODS

Subjects: Five healthy elderly adults (EA: mean age = 74.8, SD = 4.1) and five Parkinson's disease patients (PD: mean age = 68.2, SD = 6.5) with idiopathic PD and moderate impairment of postural control (H&Y = 2) participated in this study after signing an informed consent as approved by the KUMC Human Subjects Committee.

Task: Data were collected to quantify the response used to recover from a normalized backwards displacement at the waist. The destabilizing pull was produced using an electronically released weight and cable system which allowed the subject to sway freely prior to the onset of pull. The weight drop was 20% of the subject's body weight and the pull distance was 8.7% of the waist height, which corresponds to 5.0° equivalent disturbance angle (Luchies et al. 1994). The waist pull was applied to a waist harness, which incorporates padded adjustable blocks to secure contact with the anterior-superior iliac spines to transmit the disturbing force to the body. The subject stood upright, looking straight ahead, arms folded across the chest and feet placed in a shoulder width stance position with a force plate under each foot.

Data: Kinematic marker data were collected at a sampling rate of 120 Hz while force plate data (AMTI, Watertown, MA, USA) and surface EMG data (Noraxon, Scottsdale, AZ) from the tibialis anterior and gastrocnemius (medial head) were sampled at 1080 Hz using a Vicon 512 system (Vicon Peak, Lake Forest, CA).

Analysis: The disturbance onset time, EMG onset time, step foot liftoff time and step foot landing time were determined. The reaction time (RT): time between the disturbance onset and EMG onset time; the liftoff time (LT): time between disturbance onset time and step foot liftoff time; the weight shift time (WST): time between EMG onset and step foot liftoff time; and the step duration time (SDT): time between step foot liftoff time and step foot landing time were extracted. The step length (STL) was defined as the distance traveled by the heel marker between step foot liftoff and step foot landing. The center of pressure trajectories (COP) prior to the disturbance and up to step foot liftoff were also calculated from the force plate data.

T-tests were used to look for group differences (p<.05) in the temporal outcomes.

RESULTS AND DISCUSSION

Table 1 demonstrates temporal parameter results. Significant group differences were found in the LT, WST, and STL. Group differences were observed in the COP trajectories: for all EA subjects the COP trajectory moved anterior after disturbance onset; in four of the five PD subjects the COP trajectory moved posterior.

Table 1. Temporal and Step Length Results for EA and PD groups (mean (SD))

	EA	PD	t-test
RT	138.0 (43.3)	138.1 (30.0)	.994
LT	373.6 (42.4)	557.2 (83.0)	.002*
WST	235.6 (67.7)	419.0 (65.4)	.002*
SDT	153.9 (41.4)	118.4 (48.6)	.249
STL	209.8 (70.0)	105.6 (64.5)	.04*

Our results indicate that in response to a posterior waist pull, moderate severity PD patients, compared to healthy controls, have similar EMG latencies, require more time for step foot liftoff, have similar step duration times, but utilize a significantly shorter first step which is often inadequate to arrest a fall. The increased WST along with the differences in the COP trajectories indicate a different recovery strategy in PD.

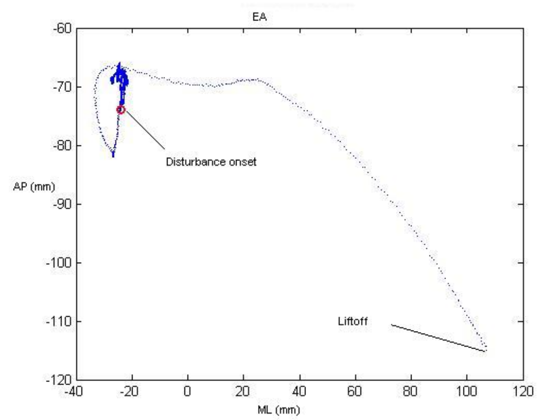

Figure 1. COP trajectory from EA subject.

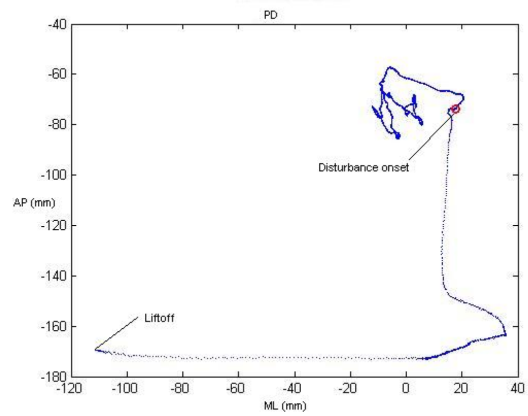

Figure 2. COP trajectory from PD subject.

SUMMARY/CONCLUSIONS

The group differences observed point to a different motor plan in PD. A stepping response is initiated immediately after the perturbation in PD patients whereas in healthy controls an attempt at regaining balance is made before the step is initiated.

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