

EFFECT OF PARKINSON'S DISEASE ON STEP RESPONSE TO A BACKWARDS PULL

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INTRODUCTION

Postural instability leading to falls is one of the most disabling symptoms of Parkinson's disease (PD). The consequences of a fall can have severe physical, psychological, and economic impacts including fractures, fear of falling, and loss of independence (Balash, Y. et al. 2005, Tinetti, M.E. et al. 1994). 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. Differences in the step response strategy, kinetics, and kinematics have been shown in older adults who also have an increased risk of falling. Therefore, this study sought to investigate the step response in terms of response strategy, ankle plantarflexion angle, and impulse at landing for the first step taken during the response.

METHODS

Five subjects with idiopathic PD (age: 75 ± 4.5 yrs, mild severity: H&Y 2) and four healthy controls (HC) (age: 74 ± 5.1 yrs) participated in the in the protocol approved by the institution's human subject committee.

Task: Participants stood in an upright, 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 subject. The subject was asked to respond naturally to the disturbance.

The weight-drop device was loaded with a weight equal to 20% of body weight and pulled the subject backwards a distance equal to 8.7% of waist height, corresponding to a 5° equivalent disturbance angle (Luchies et al. 1994).

Data Collection: Force plate data were collected using three AMTI (Advanced Medical Technology Inc.; Watertown, MA) six-component force plates sampled at 1080 Hz. Kinematic data were collected at 120 Hz using reflective markers and a six camera Vicon 512 (Vicon Peak, Lake Forest, CA) motion analysis system. Markers were placed bilaterally on the 2nd metatarsal, ankle, heel, calf, and lateral femoral condyle. All responses were video taped.

Data Analysis: The consistency of the response was determined by analyzing video taken during the trials. An inconsistent response was defined as a change in the stepping limb for the first step across the multiple trials. Ankle plantarflexion (PF)/dorsiflexion (DF) angles were determined for the leg used during the first step in the response. Ankle angle from beginning of the trial to liftoff and from liftoff to landing of the first step was determined from the kinematic analysis within an inverse dynamics model (Vaughan, C.L. et al. 1992). The first step

landing impulses in the A-P, M-L, and vertical directions were determined from force plate data. T-tests ($p < 0.05$) were used to assess group differences.

RESULTS AND DISCUSSION

All subjects responded to the waist pull by taking at least one step backwards. HC were more consistent in the choice of stepping limb than PD (HC: 100%, PD: 60%). HC went into PF prior to liftoff of the first step. In contrast, PD tended to go into DF prior to liftoff. Figure 1 shows the mean normalized ankle angle both prior to liftoff and from liftoff to landing of the first step. At liftoff time, PD were in DF ($-5.7^\circ \pm 9.7^\circ$) while HC were in PF ($8.4^\circ \pm 2.7^\circ$). The initial angle is different between the groups because of the stooped posture that the PD tended to have when standing flat footed. The different angle prior to liftoff may indicate different muscle activations affecting the ankle joint. During the step and at landing, both groups show a similar pattern into DF, but PD tend towards deeper DF (PD: $15.4^\circ \pm 13.9$, HC: $4.5^\circ \pm 2.2^\circ$). Table 1 shows the landing impulse for the first step. PD and HC showed similar A-P and M-L impulse at landing. PD showed higher, although not significantly different vertical impulse compared to HC.

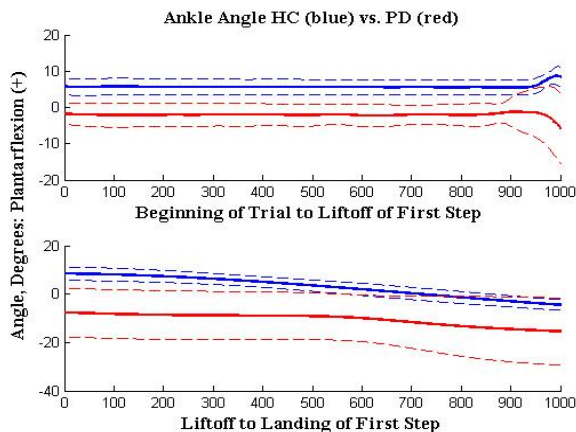


Figure 1: Mean (solid) \pm SD (dashed) of mean normalized ankle PF/DF angle prior to (top) and during (bottom) the first step for the two groups (HC: blue, PD: red).

Table 1. Impulse at Landing (N-s/kg)

	HC	PD	t-test
A-P	1.666 \pm 0.083	0.170 \pm 0.089	0.94
M-L	0.122 \pm 0.020	0.170 \pm 0.116	0.45
Z	2.045 \pm 0.444	2.928 \pm 1.183	0.20

SUMMARY/CONCLUSIONS

The results indicate that PD subjects respond differently to a balance disturbance. They were less consistent in the choice of stepping limb, and responded with a different strategy in that they did not respond to the pull by plantarflexing at the ankle before liftoff of the first step in the response. Even though the impulses at landing are similar, the ankle angle configuration at landing may have an effect in restoring postural control.

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