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Effects of disease severity and medication state on postural control asymmetry during challenging postural tasks in individuals with Parkinson's disease

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ABSTRACT

The aim of this study was to investigate the effects of disease severity and medication state on postural control asymmetry during challenging tasks in individuals with Parkinson's disease (PD). Nineteen people with PD and 11 neurologically healthy individuals performed three standing task conditions: bipedal standing, tandem and unipedal adapted standing; the individuals with PD performed the tasks in ON and OFF medication state. The participants with PD were distributed into 2 groups according to disease severity: unilateral group ($n = 8$) and bilateral group ($n = 11$). The two PD groups performed the evaluations both under and without the medication. Two force plates were used to analyze the posture. The symmetric index was calculated for various of center of pressure. ANOVA one-way (groups) and two-way (PD groups × medication), with repeated measures for medication, were calculated. For main effects of group, the bilateral group was more asymmetric than CG. For main effects of medication, only unipedal adapted standing presented effects of PD medication. There was PD groups × medication interaction. Under the effects of medication, the unilateral group presented lower asymmetry of RMS in anterior–posterior direction and area than the bilateral group in unipedal adapted standing. In addition, the unilateral group presented lower asymmetry of mean velocity, RMS in anterior–posterior direction and area in unipedal standing and area in tandem adapted standing after a medication dose. Postural control asymmetry during challenging postural tasks was dependent on disease severity and medication state in people with PD. The bilateral group presented higher postural control asymmetry than the control and unilateral groups in challenging postural tasks. Finally, the medication dose was able to reduce postural control asymmetry in the unilateral group during challenging postural tasks.

Abbreviations: PD, Parkinson's disease; H&Y, Hoehn & Yahr; MMSE, Mini Mental Status Examination; UPDRS, Unified Parkinson's Disease Rating Scale; CoP, center of pressure; RMS, root mean square; AP, anterior–posterior; ML, medio-lateral; MA, most affected limb; D, dominant limb; LA, least affected limb; ND, non-dominant limb.

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1. Introduction

Previous studies have indicated that postural control during bipedal standing tasks is asymmetric in people with Parkinson's disease (PD) (Rocchi, Chiari, & Horak, 2002; Carpenter, Allum, Honegger, Adkin, & Bloem, 2004; Geurts et al., 2011). Asymmetric dopaminergic degeneration in the substantia nigra in regions of the cerebral hemisphere is one explanation for the motor and balance differences between the body sides (Kumar et al., 2003; Foster, Black, Antenor-Dorsey, Perlmutter, & Hershey, 2008; Lewis et al., 2009). This pattern of asymmetry appears to remain unaltered during disease progression (Djaldetti, Ziv, & Melamed, 2006), which seems to indicate no difference in the level of asymmetry between early – unilateral – (Geurts et al., 2011) and moderated – bilateral – (Rocchi et al., 2002) stages of PD during bipedal standing tasks. Medication therapy, principally levodopa, is frequently taken to decrease the motor asymmetry caused by PD (Kumar et al., 2003). However, pharmacological treatment does not appear to improve postural control asymmetry in bipedal standing, which is probably explained by poor responses of body sway and muscular stiffness to dopaminergic medication (Bloem et al., 1996; Rocchi et al., 2002; Carpenter et al., 2004). On the other hand, Boonstra et al. (2014) and Boonstra, van Vugt, et al. (2014) indicated that people with PD in OFF medication state increased postural control asymmetry during postural tasks with perturbation in the sagittal plane (force plate movement), differently of patients in ON medication state (Geurts et al., 2011). Therefore, studies investigating balance asymmetries in ON and OFF medication state are needed in order to test the hypothesis that depletion of levodopa increase postural control asymmetry in PD. This is the first study to investigate the influence of disease severity on postural control asymmetry under (without) effects from medication during challenging postural tasks.

In a previous study, we found that postural control asymmetry is dependent on postural task challenge (Beretta et al., 2015). Individuals with PD presented higher postural control asymmetry in challenging postural tasks, such as tandem adapted standing and unipedal standing, compared to neurologically healthy individuals (Beretta et al., 2015). In addition, challenging postural tasks presented higher postural control asymmetry than bipedal standing in people with PD (Beretta et al., 2015). Previous studies have suggested that difficulty in adapting the magnitude and patterns of postural responses according to changes in postural demand (Horak, Dimitrova, & Nutt, 2005) may explain the increase in postural asymmetry during challenging postural tasks. The combination of our findings, those of Boonstra and collaborators and the scarce knowledge related to asymmetries in balance, especially in a challenging posture (Mitchell, Collins, De Luca, Burrows, & Lipsitz, 1995; Rocchi et al., 2002), raise the question of effects of disease severity and PD medication on postural control asymmetry during challenging tasks.

Therefore, the aim of this study was to investigate the effects of disease severity (unilateral and bilateral disease) and medication state (OFF and ON medication state) on postural control asymmetry during challenging tasks (tandem adapted standing and unipedal adapted standing) in people with PD. We hypothesized that disease severity and PD medication would not influence postural control asymmetry in the bipedal standing condition. However, for challenging postural tasks, we hypothesized that unilateral and bilateral individuals with PD would present similar asymmetry in postural control parameters since asymmetry remains unaltered during disease progression (Djaldetti et al., 2006), but higher asymmetry than neurologically healthy individuals. Regarding the effects of PD medication on postural control asymmetry, we expected that people with PD would display benefits of PD medication in reducing postural control asymmetry during challenging postural tasks, which would create more difficulty.

2. Experimental procedures

2.1. Participants

Nineteen people with PD and 11 neurologically healthy individuals (control group – 6 men) participated in this study. The participants with PD were referred to the current study by local neurologists. Diagnoses were confirmed by an expert neurologist according to the UK Brain Bank Criteria (Hughes, Daniel, Kilford, & Lees, 1992). The individuals with PD were distributed into two groups according to disease severity (Hoehn & Yahr – H&Y –Hoehn & Yahr, 1967; Schenkman, Wei Zhu, Cutson, & Whetten-Goldstein, 2001): unilateral group ($n = 8$ – 4 men; H&Y from 1 to 1.5) and bilateral group ($n = 11$ – 6 men; H&Y from 2 to 3). The inclusion criteria of this study were: (i) aged equal to or over 60 years; (ii) have a current clinical diagnosis for idiopathic PD; (iii) score between stages 1 and 3 on the H&Y scale (scores above PD stage 3 indicate disabling motor deficiencies and very different motor patterns to the previous stages, with, sometimes, loss of balance and independence); (iv) no signs of dementia based on results of the Mini Mental Status Examination (MMSE) (Folstein, Folstein, & McHugh, 1975), adjusted according to patients' education level for the Brazilian population (Brucki, Nitrini, Caramelli, Bertolucci, & Okamoto, 2003); (v) demonstrate no signs of other neurological diseases associated with PD; (vi) patients with PD had to be taking PD medication. Due to the inclusion criteria, ten people with PD were excluded from the study.

2.2. Experimental design

The study was approved by the research ethics committee of the São Paulo State University at Rio Claro – Brazil (#0227/2012). The participants provided written informed consent to participate in the clinical and postural evaluation.