Gait & Posture xxx (2010) xxx–xxx

Contents lists available at ScienceDirect

Gait & Posture

journal homepage: www.elsevier.com/locate/gaitpost

Short communication

Assessment of postural asymmetry in mild to moderate Parkinson's disease

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ARTICLE INFO

Article history:
Received 4 June 2010
Received in revised form 19 September 2010
Accepted 20 September 2010

Keywords:
Posturography
Parkinson's disease
Postural instability
Asymmetry

ABSTRACT

Asymmetry of symptoms of Parkinson's disease is clinically most evident for appendicular impairments. For axial impairments such as freezing of gait, asymmetry is less obvious. To date, asymmetries in balance control in PD patients have seldom been studied. Therefore, in this study we investigated whether postural control can be asymmetrically affected in mild to moderate PD patients.

Seventeen PD patients were instructed to stand as still and symmetrically as possible on a dual force-plate during two trials. Dynamic postural asymmetry was assessed by comparing the centre-of-pressure velocities between both legs.

Results showed that four patients (24%) had dynamic postural asymmetry, even after correcting for weight-bearing asymmetry. Hence, this study suggests that postural control can be asymmetrical in early PD. However, future studies should investigate the prevalence of dynamic postural asymmetry, in a larger group of PD patients. It should also be further investigated whether this approach can be used as a tool to support the initial diagnosis or monitor disease progression, or as an outcome measure for interventions aimed at improving balance in PD.

1. Introduction

Motor symptoms in Parkinson's disease (PD) are typically asymmetrical [1]. This is clinically most evident for the appendicular impairments (e.g., upper and lower limb rigidity, bradykinesia and tremor). It is clinically less obvious whether axial impairments (i.e., stooped posture, shuffling gait, postural imbalance and freezing) are also asymmetric.

Recent studies showed that asymmetries of gait can be found in "de novo" PD patients who have never been treated with anti-parkinsonian medication [2], and linked asymmetries in bilateral leg coordination to freezing of gait [3].

Asymmetries in posture have thus far rarely been studied. Indeed, clinical scales used to assess disease severity (e.g., the Unified Parkinson's Disease Rating Scale, the UPDRS) do not explicitly evaluate asymmetries in axial impairments. One study using posturography showed a significant asymmetry in the Center-of-Pressure (COP) velocity and frequency characteristics in PD patients compared to healthy controls [4]. While important as "proof of principle", this study was not conclusive as the normal distribution of dynamic postural asymmetry in healthy subjects was not taken into account as a reference for assessing patients, nor was the possible influence of static (weight-bearing) asymmetry on the dynamic COP characteristics of each leg accommodated. Also, this study included relatively severely affected PD patients and did not relate the direction of the dynamic postural asymmetry to the clinical asymmetry.

It has not yet been investigated whether postural control is asymmetrical in a larger sample of relatively mildly affected and unselected PD patients (in [5] only two patients were tested). In addition, postural asymmetry as assessed with dual force plates has not been related to clinical asymmetry (i.e., appendicular symptoms). Therefore, in this study we investigated whether postural control can be asymmetrically affected in mild to moderate PD patients and whether postural asymmetry is associated with appendicular asymmetry.

2. Methods

2.1. Participants and task

Seventeen PD patients participated (Table 1). Motor UPDRS items 20–26 assessed appendicular asymmetry; this was defined as a difference between the right and left body side for at least one of these items. A postural instability-gait difficulty (PIGD) score was calculated for each patient (sum UPDRS items 27–30). The local medical ethical committee approved the study protocol; all subjects gave written informed consent.

Subjects stood barefoot on a force-plate against a fixed foot frame, which positioned the medial sides of their heels 8.4 cm apart and the toes outward at a 9°

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doi:10.1016/j.gaitpost.2010.09.018

Table 1
Clinical characteristics of the Parkinson's disease patients. The right column shows the symmetry index (SI) of the RMS COP velocity (V_{COP}) in the AP direction for individual patients. The bold values are outside the normal distribution of the reference values obtained from healthy controls.

Patient	Gender	Age (yr)	Hoehn & Yahr stage (0–5)	UPDRS motor score (0–56)	UPDRS PIGD score (0–16)	Clinically most affected side	MMSE (0–30)	Goetz dyskinesia rating scale (0–16)	SI V_{COP}
1	F	42	1	12	0	Right	30	0	**67.3**
2	F	53	1.5	9	0	Right	29	0	−43.6
3	F	55	2	8	0	Right	29	0	**82.2**
4	F	62	2	14	4	Right	29	0	−2.0
5	F	65	2	15	1	Left	28	0	19.7
6	F	73	3	23	5	Left	30	0	−17.1
7	F	74	2.5	16	0	Left	27	1	44.1
8	M	43	1.5	7	1	Right	29	0	2.3
9	M	44	2.5	14	0	Left	27	0	33.8
10	M	49	2.5	20	0	Right	28	0	11.5
11	M	51	3	20	3	Indifferent	29	0	−64.5
12	M	57	2.5	14	1	Left	27	0	−22.8
13	M	63	2	7	0	Left	28	0	**−101.1**
14	M	67	3	9	1	Left	28	0	**−72.4**
15	M	67	1.5	9	1	Left	30	0	−23.9
16	M	71	3	14	2	Left	28	0	42.3
17	M	74	3	16	4	Right	29	1	−32.0
Mean		59	2.4	13	1.4		29	0	

Inclusion criteria: idiopathic PD according to established criteria [6], a Hoehn & Yahr score ≤2 and ability to stand independently for at least 1 min. Exclusion criteria: (i) other, concomitant diseases impairing balance or posture [7]; (ii) psychiatric disorders; (iii) use of medication known to impair balance; and (iv) dyskinesias that could affect postural sway. The coordinates of the COP were filtered with an additional off-line low-pass Fourier filter using a cut-off frequency of 3 Hz, because three patients showed small rhythmic (6 Hz) oscillations in their COP (most likely related to Parkinsonian leg tremor and not to postural regulation).

angle from the sagittal midline. They were instructed to stand as still and symmetrically as possible, for two 30 s, eyes open, quiet-standing trials. Subjects were tested during their subjectively best ON phase [8].

2.2. Apparatus

Two separate aluminium plates were each placed on three force transducers, connected to a personal computer. Signals were sampled at 500 Hz, amplified, and led through a first-order low-pass filter (cut-off frequency 30 Hz). The COP of the resultant of the ground reaction forces was determined in a 2-dimensional transverse plane by means of digital moment-of-force calculations for each set of force samples.

2.3. Data analysis

Postural asymmetry was calculated based on the differences in anterior–posterior COP velocities (V_{COP}, in mm/s) between both feet, averaged for both trials. These differences were expressed in a symmetry index [9]:

$$SI = \frac{2 \times (V_{cop_{Left}} - V_{cop_{Right}})}{V_{cop_{Left}} - V_{cop_{Right}}} \times 100\% \quad (1)$$

An absolute SI > 66 indicates asymmetrical balance control (based on the findings in [9]). Static weight bearing asymmetry was determined as the difference between the vertical reaction forces on each force plate normalized to the total vertical force. Consistency between trials was calculated with the intraclass correlation coefficient (ICC).

3. Results

3.1. Postural asymmetry

Table 1 shows the SIs of individual patients. Fig. 1 depicts the individual absolute SIs versus the individual UPDRS motor scores. Four of the seventeen PD patients had an absolute SI > 66, indicating an abnormal level of postural asymmetry. Two of these patients also showed a significant degree of static (weight-bearing) asymmetry (10% and 12%). The SIs of these patients remained above the 95% upper limits of the control data after correction for their weight-bearing asymmetry (cf [9]). Consistency between trials was high ($ICC_{(case = 2)} = 0.911$, $p = 0.000$). Fig. 2 shows the SIs compared to the clinically most affected side. In all patients, the postural asymmetry corresponded to the most affected side as assessed with the UPDRS.

4. Discussion

This study investigated the presence of dynamic postural asymmetry in a group of unselected mild to moderate PD patients using relatively simple dual-plate posturography. Four out of seventeen patients (24%) showed clear signs of dynamic postural asymmetry, even after correcting for weight-bearing asymmetry. This suggests that postural asymmetry can be present in early PD, although it is not apparent in all patients. These results extend earlier reports of asymmetries in parkinsonian gait [2,3] and postural control [4,5]. Note that age did not influence the normal limits of postural asymmetry in a previous study of healthy young and elderly [9]. Thus, the dynamic postural asymmetry of PD patients in the present study appears to be attributable to the disease itself and not to ageing [2,3].

The observed dynamic postural asymmetry always corresponded with the individually identified appendicular asymmetry. Hence, simple dual-plate posturography can be used to identify an asymmetric contribution of the legs to postural control in PD patients. As such, it provides a first indication that this method may

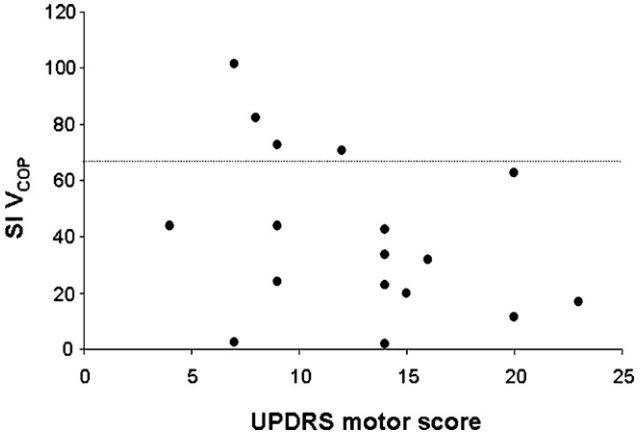

Fig. 1. Individual absolute symmetry indices (absolute SIs) derived from the V_{COP} values in the AP direction versus UPDRS motor scores. The horizontal dashed line indicates the 95% upper limit of the normal reference values (absolute SI = 66).

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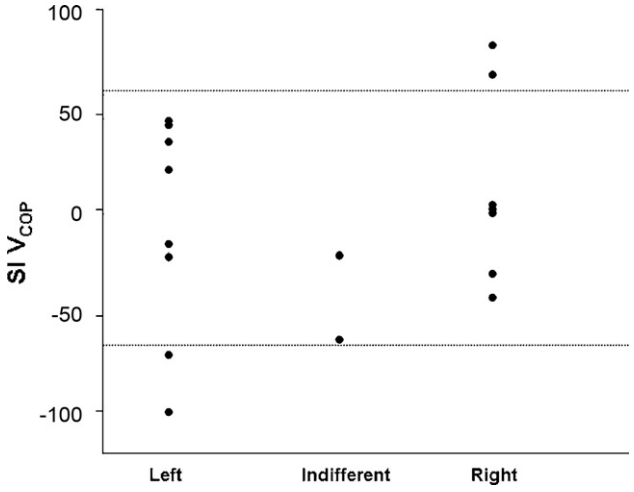

Fig. 2. Individual symmetry indices (SIs) derived from the V_{COP} values in the AP direction versus clinically most affected body side (appendicular asymmetry). The horizontal dashed lines indicate the 95% limits of the normal reference values (SI = −66 and 66).

possibly support a diagnosis of PD [10]. Moreover, assessment of postural asymmetry – rather than "overall" postural control – might prove useful for monitoring disease progression, or as an outcome measure for interventions aimed at improving balance in PD. A recent discussion [11,12] about postural imbalance in early PD highlighted the need for clearly defined outcome measures to determine balance abnormalities in patients. We suggest that for PD patients both static and dynamic aspects of postural asymmetry should be taken into account when investigating balance abnormalities.

Our study investigated a limited sample of PD patients. Therefore, we do not intend to report prevalence rates of postural asymmetry, but rather to provide an indication that balance control can be asymmetrical in early PD. Future studies should investigate the prevalence of postural asymmetry in a larger sample of patients, its relation with disease severity and progression, and its value for initial diagnosis and therapy evaluation.

Acknowledgements

This work was supported by a ZonMw VIDI research grant (number 016.076.352, to B.R. Bloem) and by the BrainGain Programme to T.A. Boonstra (both general support). We thank B. Nienhuis for his technical support, L. Derikx and M. Zwerink for their contribution to the measurements

Conflict of interest statement

A conflict of interest does not exist for any of the authors.

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