Assessment of postural balance among individuals with Parkinson's disease with and without effects from dopaminergic medications

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SUMMARY
The objective of the present study was to assess the effects of dopaminergic drugs on the postural balance of PD patients and ascertain whether their sway is greater along the mediolateral or the anteroposterior axis. Twenty-two patients awaiting operations for implantation of a deep brain stimulator at the neurology service of Hospital das Clínicas, FMUSP, were assessed. All of them were assessed on the AccuSway[Plus] portable force platform, through evaluating the center of pressure (CP). The patients stayed standing upright on both feet with eyes open and closed for 60-second periods. CP displacements along the mediolateral and anteroposterior axes, the displacement velocity and the elliptical area covered by 95% of the displacement were measured. Two assessments were made: without medication (at least 12 hours after the last administration) and with the effects from levodopa. The elliptical displacement area was greater when the patients were under the effects of the medication ($p < 0.05$). The CP displacements were greater along the anteroposterior axis than along the mediolateral axis. Levodopa worsened the postural balance of the PD patients evaluated on the force platform.

INTRODUCTION
Parkinson's disease (PD) is highly prevalent [1], and it had been estimated that 85 to 187 cases per 100,000 inhabitants occur within the age range from 50 to 70 years [2]. PD has a variety of manifestations and produces progressive functional impairment [3]. Postural instability causes great loss of the ability to walk, and this is due to loss of interaction between the vestibular, visual and proprioceptive systems [3]. Treatment with levodopa/benserazide or dopaminergic agonists is effective during the initial phases of the disease, but it loses efficacy as the disease evolves and, after a few years (five to seven years), patients may present motor complications produced by dyskinesia [4]. Few studies have shown the effects of dopaminergic drugs on balance, and thus the aims of the present study were to compare the postural balance of PD patients with and without the effects from dopaminergic medication and to ascertain these patients' axis of greatest displacement.

METHODS

Twenty-three individuals with PD were assessed. One individual was excluded from the study because of inability to accomplish the tests, and thus 22 individuals were included in the study. Their mean age was $58,38 \pm 11,09$ years (range: 53 - 75); 17 were male and five were female and the average duration of symptoms was $17,81 \pm 4,97$ years. The inclusion criteria were that the patients should have a clinical diagnosis of idiopathic PD in accordance with the international criteria [5], and they had to be intellectually capable of comprehending and signing the consent statement. All the patients were instructed to remain without taking the dopaminergic medication (levodopa) for at least 12 hours before the assessment. The first balance assessment was made without the medication. After this, all the patients took Prolopa® at their habitual dose and then repeated the same test 30 minutes later (test with medication). All the participants stayed standing upright on both feet, on a portable force platform: AccuSway[Plus] model, Advanced Mechanical Technology Inc. (AMTI), Watertown, Massachusetts, USA). To analyze postural balance, ground reaction forces and swaying from the CP were recorded. For this, forces (F) and moments (M) were recorded by the platform in three directions: mediolateral (X), anteroposterior (Y) and vertical (Z). The calculations were done using the CP positions in the anteroposterior and mediolateral directions. The Balance Clinic software was used for the data acquisition, configured at a frequency of 100 Hz with a fourth-order Butterworth low-pass filter of cutoff frequency 10 Hz. At each of the attempts (with eyes open or closed), the subjects were instructed to feel that they were trying to prevent movement. Three tests were done with eyes open and three with eyes closed, each of 60 seconds duration. The paired Student t test was applied to make comparisons between the postures, standing on two feet with eyes open and closed and with and without medication.

RESULTS AND DISCUSSION
Table 1 shows the results under the condition of eyes open. These were no statistically significant differences in the mediolateral displacement, anteroposterior displacement or displacement velocity. The elliptical area was bigger in the group with medication ($p = 0.006$). Table 2 shows the

results found under the condition of eyes closed. There were no statistically significant differences in mediolateral displacement, anteroposterior displacement or displacement velocity. The elliptical displacement area was bigger in the group with medication (p = 0.003). The increase in this area was easily correlatable with dyskinesia, since the change in movement quality impaired the patients' balance reactions, thus obliging them to make displacements over a wider area in order to remain on their feet. Thus, real situations that do not allow this type of adaptation may contribute towards the falls that are observed among PD patients [6]. **T**he comparison between the displacements along the anteroposterior and mediolateral axes, under the conditions of eyes open and eyes closed. There was more displacement along the anteroposterior axis. Greater anteroposterior displacement may be explained by the PD-related postural alterations, with predominance of trunk flexor action and displacement of the center of gravity anteriorly [7].

CONCLUSIONS
Levodopa worsened the postural balance of the PD patients evaluated on the force platform.

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Table 1. Postural balance among individuals with Parkinson's disease with and without medication, with eyes open.

	Without medication (off) Mean (SD)	With medication (on) Mean (SD)	*p*
Mediolateral displacement (cm)	-0.531 (1.362)	-0.145 (1.455)	0.33
Anteroposterior displacement (cm)	-2.739 (2.439)	-2.179 (2.086)	0.13
Sway velocity (cm/min)	2.425 (3.514)	2.387 (2.334)	0.06
Elliptical area (cm^2)	4.835 (5.571)	14.031 (13.167)	0.006*
Paired Student t test			*** $p \leq 0.05$**

Table 2. Postural balance among individuals with Parkinson's disease with and without medication, with eyes closed.

	Without medication (off) Mean (SD)	With medication (on) Mean (SD)	*p*
Mediolateral displacement (cm)	-0.286 (± 1.379)	0.013 (± 1.165)	0.22
Anteroposterior displacement (cm)	-2.588 (± 2.373)	-2.110 (± 1.885)	0.10
Sway velocity (cm/min)	2.099 (± 2.073)	3.016 (± 3.003)	0.90
Elliptical area (cm^2)	5.122 (± 6.668)	15.327 (± 17.777)	0.003*
Paired Student t test			*** p ≤ 0.05**