



Full length article

Depression and posture in patients with Parkinson's disease

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ABSTRACT

Background: Depression is an important non-motor symptom of Parkinson's disease (PD) that significantly impacts the daily activities of affected patients. Furthermore, the stooped posture that characterizes patients with PD has also been associated with depression. The purpose of this study was to investigate the relationship between the presence of depressive symptoms and body posture in patients with PD.

Methods: Forty-six patients with mild-to-moderate PD were recruited. The patients were divided into depression and no depression groups based on Beck Depression Inventory scores. All patients underwent kinematic analysis conducted in the upright standing posture with a motion capture system.

Results: There were no differences in clinical characteristics between the depression ($n = 22$) and no depression groups ($n = 24$). In the standing position, patients with depression showed anterior tilting of the head from the pelvis and an increased distance between head and pelvis. The severity of depression was correlated with the degree of flexion at the lower trunk level and the degree of anterior tilting of the head, neck, and trunk from the pelvis and base of support.

Conclusions: Patients with PD and depression showed increased flexion at pelvis level, which caused the trunk to tilt anteriorly. In addition, the severity of depression was correlated with the degree of anterior tilting of the head and trunk. These findings suggest that stooped posture, especially from the pelvis level, could be a marker of depression in patients with PD.

1. Introduction

Parkinson's disease (PD) is a slowly progressing neurodegenerative disease accompanied by non-motor symptoms such as psychiatric, cognitive, sensory, gastrointestinal, and autonomic symptoms [1–3]. Depression is an important non-motor symptom of PD, and the proportion of individuals with depression is significantly higher among patients with PD than in the general population [4]. The reported prevalence of depression among patients with PD ranges from 2.7% to more than 90%, and the average reported prevalence is 35% [4,5]. Depression has a significant impact on sleep disorders, fatigue, and activities of daily living in patients with PD [6–8]. Schrag et al. [9] reported that depression was the factor most closely associated with quality of life in these patients.

Posture, defined as the relative arrangement and position of body parts, is related to emotion [10,11]. An upright posture promotes positive thoughts, whereas a stooped or slumped posture promotes negative thoughts [12,13]. A stooped posture is included in the physical and diagnostic characteristics of patients with depression [12], and

these patients exhibit greater cephalic flexure and thoracic kyphosis than healthy controls do [10]. However, identifying depression in patients with PD can be difficult, considering that patients with PD and those with depression exhibit similar characteristics such as dampened facial expressiveness, fatigue, psychomotor retardation, loss of appetite due to a decreased sense of taste and smell, insomnia, a stooped posture, decreased walking speed, and short strides [4,14,15].

We therefore hypothesized that there are postural differences between patients with PD and comorbid depression and those without comorbid depression. This study's primary objective was to investigate such between-group postural differences, and the secondary objective was to test for correlations between depression severity and body posture in patients with PD.

2. Methods

2.1. Participants

Forty-six patients diagnosed with PD based on the UK Parkinson's

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Disease Society Brain Bank Clinical Diagnostic Criteria were recruited from our outpatient clinic [16]. The patients were divided into a depression group and a no depression group using Beck Depression Inventory (BDI) [17] scores, with a score of ≥ 14 being regarded as indicating depression [18,19]. The inclusion criteria were as follows: mild-to-moderate idiopathic PD (i.e., Hoehn and Yahr stage 1–3) [20,21], a score of ≥ 24 on the Korean version of the Mini-Mental State Examination (K-MMSE) [22], use of stable doses of anti-PD medications, and the ability to stand without assistance. Patients with a history of any other neurological, psychiatric, and/or musculoskeletal disorder were excluded. The study was approved by the institutional review board and conformed to the principles of the Declaration of Helsinki. All patients provided written informed consent prior to participation.

2.2. Demographic and clinical characteristics

Data regarding demographic and clinical characteristics, including age, sex, symptom duration, treatment duration, and levodopa equivalent dose, were collected from all patients. In addition, scores on the modified Hoehn and Yahr scale, Unified Parkinson's Disease Rating Scale [23], K-MMSE, and BDI were determined for all patients.

2.3. Experimental procedure

Postural assessment for an upright stance was performed using a three-dimensional motion capture system (Vicon MX-T10, Oxford Metrics, Oxford, UK) with six infrared cameras and a sampling rate of 100 Hz. A global reference system was established such that the positive x-axis represented the right direction, the positive y-axis represented the forward direction, and the positive z-axis represented the upward direction.

All patients wore a fitted shirt and shorts and were barefoot during measurements. Thirty-nine reflective markers (14-mm spheres) were placed over bony landmarks on the patients according to the Vicon plug-in-gait model. The unilateral markers were placed over the clavicle, sternum, and the C7 and T10 vertebrae. The bilateral markers were placed over the front and back of the head, shoulder, lower third of the upper arm, lateral humeral epicondyle, lower third of the forearm, medial and lateral wrist styloid processes, third metacarpal head, anterior superior iliac spine (ASIS), posterior superior iliac spine (PSIS), lower third of the lateral thigh, lateral femoral epicondyle, lower third of the lateral shank, calcaneus, lateral malleolus, and second metatarsal head.

The patients stood with their arms stretched along their trunk and with their feet spaced approximately 10 cm apart in the heel-to-heel position. They were instructed to look at a target on a wall and to hold an upright posture for 5 s. The evaluators were blind to each patient's depression status during the postural assessment. Measurements were obtained in the clinically 'on' state, typically within 1–2 h after taking anti-PD medications.

2.4. Data analysis

Kinematic data were analyzed with Nexus software (version 1.83, Oxford Metrics) and low-pass filtered with a second-order Butterworth filter at a cut-off frequency of 6 Hz. Data obtained within 5 s after the start signal were analyzed.

2.5. Definitions of points, angles, and tilts

The definitions for all points, angles, and tilts were modifications of those from previous studies (Fig. 1) [24–28]. The head point was defined as the midpoint of the frontal and occipital markers. The cervical point was defined the midpoint of the clavicle and C7 markers. The thoracic point was defined the midpoint of the sternal and T10 markers. The pelvis point was defined as the midpoint of the ASIS and PSIS

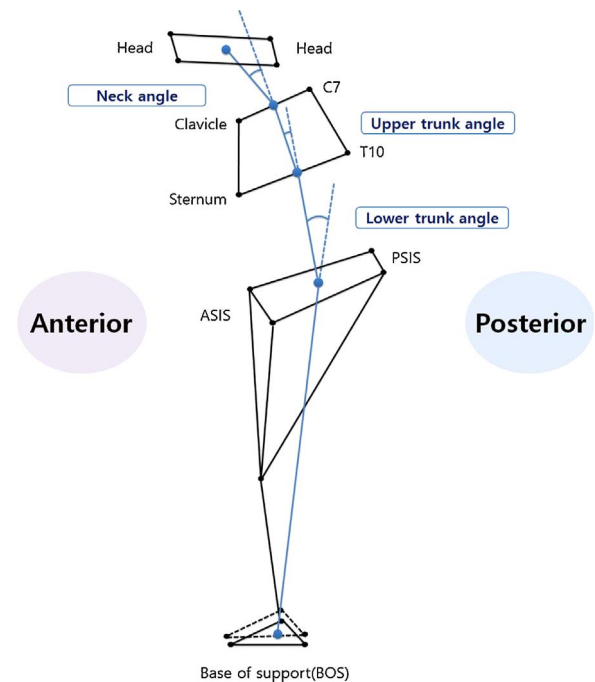


Fig. 1. Definitions of points and angles used for postural measurements in patients with Parkinson's disease.

Abbreviations: BOS, base of support; ASIS, anterior superior iliac spine; PSIS, posterior superior iliac spine.

markers. The base of support (BOS) point was defined as the midpoint of the toe and heel markers.

The neck angle was defined as the sagittal plane inner angle between the vector from the cervical point to the head point and the vector from the thoracic point to the cervical point. The upper trunk angle was defined as the sagittal plane inner angle between the vector from the thoracic point to the cervical point and the vector from the pelvis to the thoracic point. The lower trunk angle was defined as the sagittal plane inner angle between the vector from the pelvis point to the thoracic point and the vector from the BOS point to the pelvis point.

Tilt was defined as the sagittal plane inclination angle between the vector of two points and the vertical axis. The head-pelvis distance was defined as the horizontal distance between the head point and pelvis point. The cervical-pelvis distance was defined as horizontal distance between the cervical point and pelvis point.

2.6. Statistical analysis

Statistical analyses were performed with SPSS 21.0 software (IBM, Armonk, NY). Variable values are shown as means \pm standard deviations. Normality testing was performed with the Shapiro–Wilk test. Between-group differences were analyzed with the Mann–Whitney *U* test, and Pearson's correlation coefficients were determined to assess the correlation between the BDI scores and postural measurements. A *p*-value of < 0.05 was considered statistically significant. Effect sizes were calculated with Cohen's *d* formula [29].

3. Results

The depression and no depression groups did not significantly differ in demographic and clinical characteristics apart from BDI scores (Table 1).

Significant between-group differences were observed for the head-pelvis tilt and head-pelvis distance, both of which were greater in the depression group than in the no depression group (Table 2).

The severity of depression was positively correlated with the lower

Table 1
Demographic and clinical characteristics of patients with Parkinson's disease with and without comorbid depression.

	Depression group (n = 22)	No depression group (n = 24)	p
Age (y)	70.9 ± 5.3	69.9 ± 6.3	0.560
Sex (M:F)	12:10	12:12	0.760
Height (m)	1.6 ± 0.1	1.6 ± 0.1	0.428
Body mass (kg)	59.5 ± 9.6	57.4 ± 7.2	0.495
Symptom duration (y)	3.5 ± 1.9	3.5 ± 2.2	0.982
Treatment duration (y)	2.7 ± 1.9	2.5 ± 2.0	0.684
LED (mg/day)	497.8 ± 263.0	504.0 ± 236.0	0.529
Total UPDRS score	45.9 ± 11.0	40.2 ± 10.1	0.088
Hoehn & Yahr stage	2.4 ± 0.5	2.4 ± 0.4	0.770
K-MMSE	27.5 ± 1.7	27.4 ± 2.6	0.533
BDI*	23.5 ± 8.0	9.2 ± 3.5	0.000

Values are means ± standard deviations.
Abbreviation: F, female; M, male; BDI, Beck Depression Inventory; K-MMSE, Korean version of the Mini-Mental State Examination; LED, levodopa equivalent dose; UPDRS, Unified Parkinson's Disease Rating Scale.
* p < 0.05.

trunk angle. Depression severity was also positively correlated with head-pelvis tilt, cervical-pelvis tilt, thoracic-pelvis tilt, head-BOS tilt, cervical-BOS tilt, head-pelvis distance, and cervical-pelvis distance but negatively correlated with pelvis-BOS tilt (Table 3) (Figs. 2 and 3).

4. Discussion

In the present study, we assessed the relationship between depression and body posture in patients with PD. The major result was that patients with PD and comorbid depression exhibited postural differences relative to those without comorbid depression. Specifically, in the standing position, patients with comorbid depression exhibited significantly increased flexion at pelvis level, which increased the head-pelvis tilt and distance.

Several studies have reported a relationship between depression and body posture. Rosario et al. [30] reported that depression and sadness were associated with shoulder protrusion and suggested that depression and sadness may affect posture. Canales et al. [10] reported that patients with depression showed increased cephalic flexion and thoracic kyphosis relative to healthy controls. These findings are broadly consistent with the relationship between depression and body postures observed in this study, but there are discrepancies in the details. For example, we did not observe the differences in neck or upper trunk angles reported by Canales et al., probably because increased pelvic

Table 2
Postural variables in patients with Parkinson's disease with and without comorbid depression.

	Depression group (n = 22)	No depression group (n = 24)	p	Effect size (Cohen's d)
Neck angle (°)	9.0 ± 6.5	10.0 ± 7.6	0.725	0.60
Upper trunk angle (°)	6.9 ± 3.7	9.5 ± 4.8	0.068	-0.61
Lower trunk angle (°)	9.7 ± 11.3	8.1 ± 5.7	1.000	0.18
Head-pelvis tilt (°)*	8.7 ± 8.5	4.9 ± 3.8	0.045	0.58
Cervical-pelvis tilt (°)	6.9 ± 9.4	3.6 ± 5.0	0.202	0.44
Thoracic-pelvis tilt (°)	7.0 ± 10.4	4.3 ± 7.2	0.442	0.30
Head-BOS tilt (°)	3.1 ± 2.8	1.8 ± 1.6	0.059	0.57
Cervical-BOS tilt (°)	1.7 ± 2.2	0.8 ± 1.4	0.312	0.49
Thoracic-BOS tilt (°)	0.6 ± 1.0	0.4 ± 1.4	0.852	0.16
Pelvis-BOS tilt (°)	-1.1 ± 1.9	-0.5 ± 1.5	0.461	0.35
Head-pelvis distance (cm)*	9.4 ± 8.7	5.3 ± 4.1	0.048	0.60
Cervical-pelvis distance	5.2 ± 6.8	2.6 ± 3.8	0.180	0.47

Values are means ± standard deviations.
Abbreviation: BOS, base of support.
* p < 0.05.

Table 3
Pearson's correlation coefficients for the associations between postural variables and depression severity in patients with Parkinson's disease.

Postural variable	Participants (n = 46)	
	r	p
Neck angle	-0.11	0.475
Upper trunk angle	-0.15	0.330
Lower trunk angle*	0.47	0.001
Head-pelvis tilt*	0.55	< 0.001
Cervical-pelvis tilt*	0.53	< 0.001
Thoracic-pelvis tilt*	0.47	0.001
Head-BOS tilt*	0.49	0.001
Cervical-BOS tilt*	0.47	0.001
Thoracic-BOS tilt	0.21	0.169
Pelvis-BOS tilt*	-0.44	0.002
Head-pelvis distance*	0.54	< 0.001
Cervical-pelvis distance*	0.53	< 0.001

Values are means ± standard deviations.
Abbreviation: BOS, base of support.
* p < 0.05.

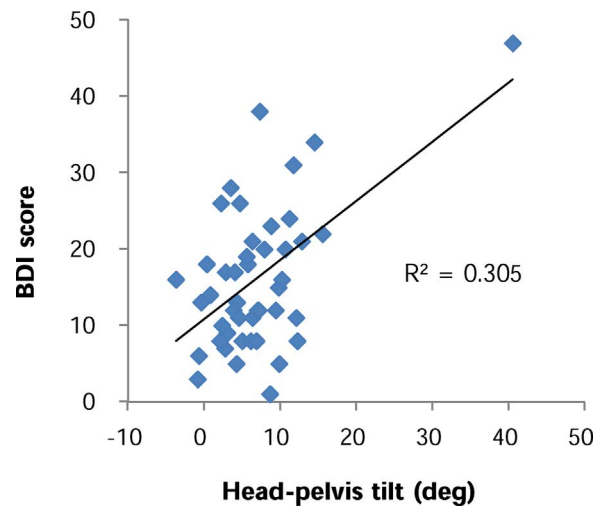


Fig. 2. Correlation between the Beck depression inventory (BDI) score and head-pelvis tilt in all patients.

flexion in patients with PD and comorbid depression may result in compensatory extension in thoracic segments.

In our correlation analysis, we found significant correlations between the severity of depression and the lower trunk angle, head-pelvis tilt, cervical-pelvis tilt, thoracic-pelvis tilt, head-BOS tilt, cervical-BOS

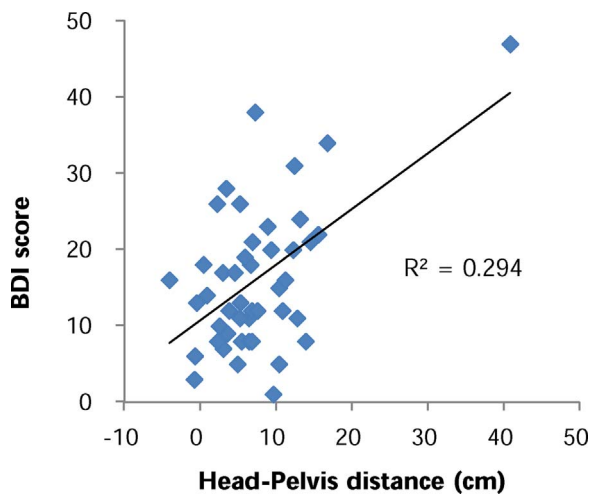


Fig. 3. Correlation between the Beck depression inventory (BDI) score and head-pelvis distance in all patients.

tilt, pelvis-BOS tilt, head-pelvis distance, and cervical-pelvis distance. These findings suggest that postural abnormalities in the pelvic region are associated with each other in patients with PD.

A study investigating whether changes in posture in patients with mild-to-moderate levels of depression could reduce negative thoughts and fatigue found that upright postures increased positive thoughts and reduced fatigue [31]. Canales et al. [10] also reported that after 8–10 weeks of taking antidepressants, patients exhibited improved cephalic flexure and lessened thoracic kyphosis, which indicates that depression negatively affects posture. Alleviation of depression is related to improved posture, and upright posture has a positive effect on patients with depression. Bartolo et al. [32] researched the effects of a trunk rehabilitation program in patients with PD who had lateral trunk flexion and showed that the rehabilitation program decreased trunk flexion and tilt in the static condition and significantly increased the ranges of trunk flexion and tilt during the trunk flexion task. Therefore, treating depression in patients with PD may affect both depression levels and body posture.

This study has several limitations. First, the small sample size limited the study's statistical power and the generalizability of the results. Second, posture was analyzed in only the sagittal plane. Further studies should analyze posture in the frontal plane. Finally, we do not understand the causal relationship between depression and posture, and depression and posture are both influenced by PD itself. Prospective studies are therefore warranted to investigate how depression and posture are related and how PD affects them.

5. Conclusions

In terms of posture, the patients with PD and comorbid depression showed increased flexion at pelvis level, which caused the trunk to tilt anteriorly. In addition, the severity of depression was correlated with the degree of anterior tilt of the head and trunk. This study's findings suggest that stooped posture, especially from the pelvis level, could be a marker of depression in patients with PD.

Conflict of interest

None.

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