Postural stability in patients with Parkinson's disease versus patients with type 2 diabetes mellitus

Soha M. Hamada

Department of Audiology, Hearing and Speech Institute, Giza, Egypt

Correspondence to Soha M. Hamada, MD, Department of Audiology, Hearing and Speech Institute, Giza, Egypt. Tel: 02 26238151; e-mail: sohahamada@hotmail.com

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Background
Postural control is defined as the control of body's position in space for balance purpose. Postural control in static conditions is known as postural steadiness, whereas in the dynamic volitional perturbations, it is noted as postural stability. Postural stability can be affected owing to central or peripheral lesions; one of the central lesions with postural instability is Parkinson's disease (PD). However, peripheral neuropathies that affect stability are one of the most common complications of diabetes mellitus.
Aim
The aim was to assess postural stability in patients with PD and those with type 2 diabetes as examples of central and peripheral lesions, respectively, and to compare the results with the findings obtained from the normal control group.
Patients and methods
The patient group in the study was divided into two subgroups: subgroup 1 consisted of 15 patients diagnosed as having PD and subgroup 2 included 15 patients with type 2 diabetes mellitus. Control group consisted of 15 normal age-matched participants. Postural assessment was performed using computerized dynamic posturography. This included the automatic motor assessments tests, including motor control test and adaptation test, and functional limitation tests such as tandem walk.
Results
This research showed that there is a statistically significant difference between control group and subgroup with PD in all tested parameters. A statistically significant difference was found between control group and subgroup with diabetes in all parameters of adaptation test and speed test. Moreover, there is a statistically significant difference between the two subgroups in most of tested parameters, with the highest value in PD group.
Conclusion
The findings reflect that postural stability is more affected with central lesion than peripheral lesion.

Keywords:
diabetes mellitus, Parkinson's disease, postural stability

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Introduction

Postural control is defined as the control of body's position in space for balance purpose. Postural control is obtained from sensory feedbacks of the body, which are the vestibular, visual, and somatosensory system [1]. Postural control in static conditions is known as postural steadiness whereas in the dynamic volitional perturbations, it is noted as postural stability [2].

Postural stability can be affected owing to central or peripheral lesions; one of the central lesions with postural instability is Parkinson's disease (PD). However, peripheral neuropathies that affect stability are one of the most common complications of diabetes mellitus [3].

PD is a progressive, chronic, and neurodegenerative disease stemming from the atrophy of gray matter [4]. The prevalence of Parkinson's ranges from 0.3% among individuals younger than 60 years to 1% among those aged 60 years or older [5]. The progressive nature of the disease causes both motor and nonmotor alterations. PD leads to abnormalities in the two main components of postural control: orientation (maintaining a normal postural arrangement and alignment) and stabilization (maintaining equilibrium) [6].

The four key motor symptoms that are associated with PD include tremor, rigidity, bradykinesia, and postural abnormalities [7]. The main motor alterations are associated with the risk of falls, which leads to a

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sedentary lifestyle, and the reduction in activities of daily living exerts a negative effect on clinical aspects [8].

Type 2 diabetes mellitus is the predominant form of diabetes. The increase in prevalence is predicted to be much greater in developing than in developed countries (69 vs. 20%) [9]. Patients with type 2 diabetes mellitus (T2DM) may present with this complication after only a few years of known poor glycemic control; sometimes, these patients already have neuropathy at the time of diagnosis.

Neuropathies and musculoskeletal complications such as limited joint range and insufficient muscle strength are among the most common of all the long-term complications of diabetes [10]. Decline in muscular function together with peripheral neuropathies may increase risk for functional dependency and frailty in patients with T2DM [11].

Diabetic neuropathy affects sensory, autonomic, and motor neurons of the peripheral nervous system. Moreover, every organ system in the body that relies on innervations for function is consequently participant to pathology. Therefore, diabetic neuropathy describes a number of unique syndromes that are primarily classified by the nerve fibers affected [12].

Postural stability can be estimated through automatic motor assessment including motor control test (MCT) and adaptation test (ADT) and with functional limitation assessment with tandem walk (TW), which quantifies characteristics of gait.

Aim

The aim of the work was to assess postural stability in patients with PD and those with T2DM as examples of central and peripheral lesions, respectively, and to compare the results with the findings obtained from the normal control group.

Patients and methods

Participants

The study included two patients subgroups as follows:

(1) Subgroup 1 consisted of 15 patients diagnosed as having PD, with duration ranging from 3 to 7 years. Their age ranged from 40 to 60 years. Patients with neurological disease (other than PD) and also, patients complaining of visual or vestibular disorders or those with severe motor disability were excluded.

(2) Subgroup 2 consisted of 15 patients with T2DM for at least 5-year duration. Their age ranged from 40 to 60 years. None of them had a chronic or acute illness that may affect balance.

Patients of both subgroups received medical treatment.

Control group

It consisted of 15 normal age-matched participants with no symptoms or signs of otologic, vestibular, or neurologic disease that may affect postural stability.

(1) Each participant signed a written informed consent after receiving information about the test with explanation of the test procedure, benefits, and possible risk.

Procedure

All participants in this study were subjected to the following:

(1) Full history taking and otological examination.
(2) Postural assessment using computerized dynamic posturography long forceplate (Neurocom version 4 Smart Balance Master, Natus Medical Incorporated, San Carlos, USA). This included the following:
    (a) Automatic motor assessment:
        (i) MCT: it measures the automatic postural responses in response to sequences of small, medium, and large platform translations in forward and backward directions. The following parameters were measured: weight symmetry, response latency, and response strength symmetry.
        (ii) ADT: the response time was measured to slow toes up and toes down rotations at 8°. Measuring the ability to suppress inappropriate responses to the external disturbance.
    (b) Functional limitation tests:
        (i) TW: the measured parameters were step width, speed, and endpoint sway velocity in response to walking heel to toe along a 10-foot line.

Results

The research study group participants were divided into two subgroups and a control group. Subgroup 1 included 15 patients with PD. Their age ranged from 40 to 60 years, with a mean age of 52.6 years (SD=4.6

years). There were 11 males and four females. Subgroup 2 consisted of 15 patients with T2DM for at least 5-year duration. There were eight males and seven females. Their age ranged from 40 to 60 years, with mean age of 54.4 years (SD=3.8 years).

The control group included 15 normal age-matched participants (nine males and six females), with mean age of 48 years (SD=4.2 years).

Table 1 and Fig. 1 show mean and SD of control group and the study subgroups regarding MCT parameters, weight symmetry, response latency, and response strength symmetry. There is a statistically significant difference among control, subgroup 1, and subgroup 2 in all tested parameters except weight symmetry forward and strength symmetry forward, with highest value in PD group. Table 2 shows a statistically significant difference between control group and subgroup with PD in all parameters. However, no statistically significant difference was found between control group and subgroup with diabetes. There is statistically significant difference between the two subgroups in all parameters, with exception of strength symmetry forward.

There is a statistically significant difference between mean and SD of control group and the study subgroups regarding ADT parameters as shown in Table 3 and Fig. 2, with highest values in PD group. A statistically significant difference was found between control group and subgroup with PD and subgroup with diabetes in all parameters (Toes up and down). Moreover, there is statistically significant difference between the two subgroups in all parameters (Table 4).

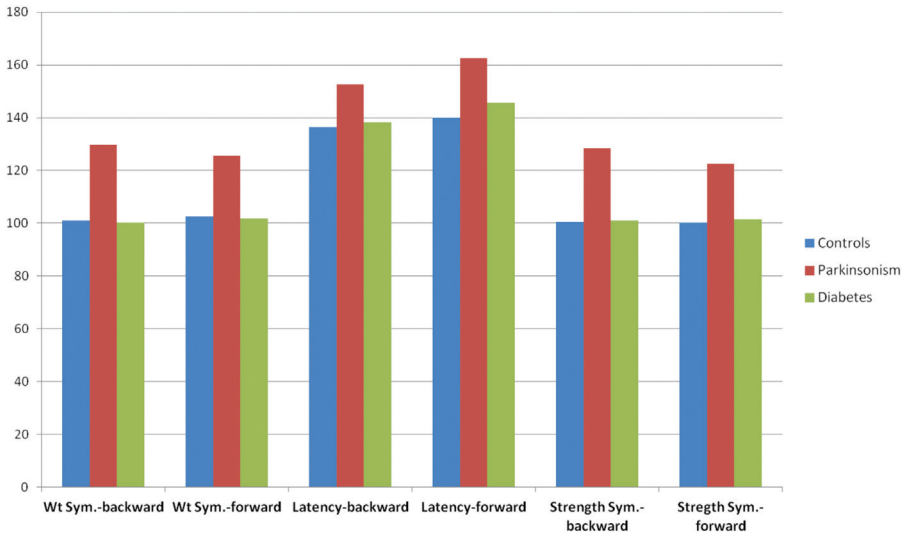
Table 5 and Fig. 3 shows mean and SD of control group and the study subgroups regarding TW test parameters, step width, speed test, and end sway, with statistically significant difference between all groups, with least speed test in PD. There is a statistically

Table 1 Mean and SD of control group and the study subgroups regarding motor control test parameters using analysis of variance and Kruskal–Wallis

MCT	Control group		Subgroup 1		Subgroup 2		*P* value
	Mean	SD	Mean	SD	Mean	SD	
Weight symmetry backward (scores)	101.00	6.81	129.75	24.27	100.30	5.98	0.043*
Weight symmetry forward (scores)	102.60	4.55	125.75	30.26	101.80	3.88	0.061 (NS)
Latency backward (ms)	136.3	10.6	152.58	17.75	138.30	9.32	0.042*
Latency forward (ms)	140.10	13.70	162.58	22.08	145.60	9.55	0.013*
Strength symmetry backward (scores)	100.60	11.27	128.58	40.38	101.00	11.00	0.015*
Strength symmetry forward (scores)	100.30	14.87	122.44	27.69	101.60	13.19	0.080 (NS)

There is a significant difference between control, subgroup 1 and subgroup 2 in all tested parameters except weight symmetry forward and strength symmetry forward; MCT, motor control test; $P<0.05$, significant.

Figure 1



Mean and SD of control group and the study subgroups regarding motor control test.

Table 2 Comparison of motor control test parameters between the control group and the study subgroups and between the two study subgroups using Mann–Whitney test

MCT	Control group and subgroup 1	Control group and subgroup 2	Subgroup 1 and subgroup 2
Weight symmetry backward	0.003 (S)	0.673 (NS)	0.006 (S)
Weight symmetry forward	0.006 (S)	0.621 (NS)	0.044 (S)
Latency backward	0.032 (S)	0.443 (NS)	0.044 (S)
Latency forward	0.012 (S)	0.178 (NS)	0.029 (S)
Strength symmetry backward	0.015 (S)	0.849 (NS)	0.015 (S)
Strength symmetry forward	0.050 (S)	0.178 (NS)	0.350 (NS)

MCT, motor control test; S, significance.

Table 3 Mean and SD of control group and the study subgroups regarding adaptation test scores using analysis of variance and Kruskal–Wallis

ADT	Control group		Subgroup 1		Subgroup 2		*P* value
	Mean	SD	Mean	SD	Mean	SD	
Toes up (ms)	48.35	6.96	86.52	21.40	56.94	7.92	0.00*
Toes down (ms)	31.51	4.98	60.40	20.16	39.81	5.64	0.00*

There is a statistically significant difference between mean and SD of control group and the study subgroups regarding adaptation test parameters; ADT, adaptation test. *Means (S).

Table 4 Comparison between the control group and the study subgroups and between the two study subgroups in ADT using Mann–Whitney Test

ADT	Control group and subgroup 1	Control group and subgroup 2	Subgroup 1 and subgroup 2
Toes up	0.000 (S)	0.034 (S)	0.000 (S)
Toes down	0.000 (S)	0.003 (S)	0.003 (S)

ADT, adaptation test; S, significant.

Table 5 Mean and SD of control group and the study subgroups regarding tandem walk test parameters using analysis of variance and Kruskal–Wallis

TW	Control group		Subgroup 1		Subgroup 2		*P* value
	Mean	SD	Mean	SD	Mean	SD	
Step width (cm)	6.95	3.11	11.58	6.043	8.32	2.44	0.050*
Speed test (cm/s)	28.78	6.58	8.93	4.73	19.81	3.30	0.000*
End sway (deg/s)	3.68	1.68	6.62	1.83	4.78	1.05	0.004*

There is a statistically significant difference between control group and the study subgroups in all tested parameters; TW, tandem walk. *Means (S).

significant difference between control group and subgroup with PD. However, a statistically significant difference between control group and subgroup with diabetes is found in speed test only. There is a statistically significant difference between two subgroups in all parameters except for step width (Table 6).

Discussion

PD is typically an asymmetrical disease [13]. Asymmetries in balance control (i.e. when one leg is producing more force than the other leg in order to keep the body upright). Pilot studies using posturography have shown that balance control can also be asymmetrically affected in PD [14,15]. These findings matched with results of this study as shown in Tables 1 and 2 and Fig. 1.

Findings of the current study show that there is a statistically significant difference between control group and the study subgroups regarding ADT parameters, with highest score in subgroup with PD (Tables 3 and 4 and Fig. 2). This result could be explained as performance on the ADT requires adequate ankle range of motion and muscle strength as well as effective motor adaptation, which is absent in PD. These results agree with those of Fisher [16] who reported that during the first (unexpected) trials, the initial disruptive responses are corrected by secondary responses in the opposing muscles. With each subsequent trial, initial reactions are attenuated and secondary responses strengthened to reduce overall sway.

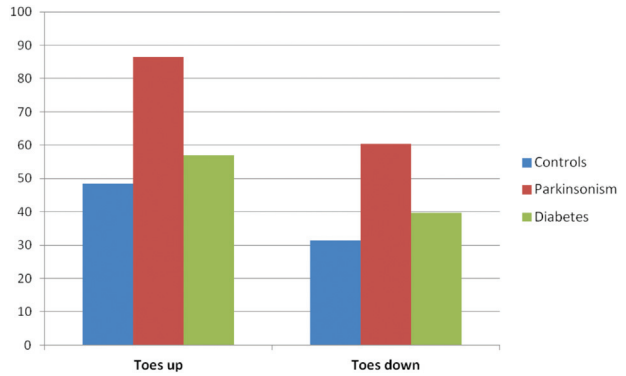
Haas *et al*. [17], reported that TW is one of the greatest difficulties experienced in individuals with

Table 6 Comparison between control group and the study subgroups in tandem walk using Mann–Whitney Test

TW	Control group and subgroup 1	Control group and subgroup 2	Subgroup 1 and subgroup 2
Step width	0.041 (S)	0.058 (NS)	0.209 (NS)
Speed test	0.000 (S)	0.005 (S)	0.000 (S)
End sway	0.004 (S)	0.096 (NS)	0.025 (S)

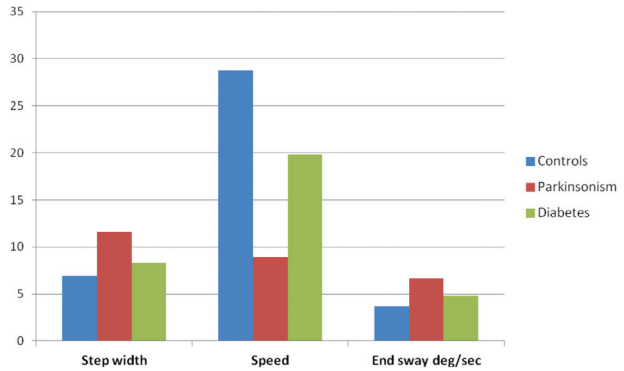
TW, tandem walk; S, significant.

Figure 2



Mean and SD of control group and the study subgroups regarding adaptation test.

Figure 3



Mean and SD of control group and the study subgroups regarding tandem walk.

PD in overall mobility and gait. This is especially apparent as the disease progresses, it increases the risk of falling and decreases overall mobility. These findings matched with the results of the current study as shown in Tables 5 and 6 and Fig. 3).

Speed of the forward progression was statistically significant less but response latency and endpoint sway velocity were more in the diabetic subgroup in comparison with control group as shown in Tables 1 and 5. This matched with Jauregui-Renaud [18] who found that during upright stance, compared with healthy participants, recordings of the center of pressure in patients with diabetic neuropathy have shown larger sway.Mokhtar *et al*. [19] found that automatic response latencies showed significant prolongation in diabetic patient group compared with the control group; this agreed with the results of this study that showed increased in response latencies relative to control group as shown in Table 1.

Other researchers concluded that patients with diabetic peripheral neuropathy have been demonstrated with postural instability and gait imbalance that contribute to fall incidence. Moreover, patients with diabetic peripheral neuropathy exhibited significant deficit in sensorimotor function, balance, and gait. [20]. These findings agreed with the results of the current study regarding ADT parameters, as shown in Tables 3 and 4, and for speed test in TW, as shown in Table 6.

Conclusion

(1) There is a statistically significant difference between control group and subgroup with PD in all parameters of MCT. No statistically significant difference was found between control group and subgroup with diabetes. However, there is a statistically significant difference between the two subgroups in all parameters with the exception of strength symmetry forward with highest value in PD group.
(2) A statistically significant difference was found between control group and subgroup with PD and subgroup with diabetes in all parameters of ADT (Toes up and down). Moreover, there is a statistically significant difference between the two subgroups in all parameters, with highest value in PD group.
(3) There is a statistically significant difference between control group and subgroup with PD. However, a statistically significant difference between control group and subgroup with diabetes was found in speed test only. There is a statistically significant difference between the two subgroups in all parameters of TW, except for step width.
(4) The findings reflect that postural stability is more affected with central lesion than peripheral lesion.

Recommendation

Assessment of postural stability should be included in evaluation of patients with diseases that may affect balance for early detection of disorders and developing rehabilitation programs.

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Nil.

Conflicts of interest

There are no conflicts of interest.

References

1 Jáuregui-Renaud K. Postural balance and peripheral neuropathy. Instituto Mexicano del Seguro Social, México: INTECH; 2013.

2 Chaudhry H, Findley T, Quigley KS, Bukiet B, Ji Z, Sims T, Maney M. Measures of postural stability. J Rehabil Res Dev 2004; 41:713–720.

3 Timar B, Timar R, Gai?ă L, Oancea C, Levai C, Lungeanu D. The impact of diabetic neuropathy on balance and on the risk of falls in patients with type 2 diabetes mellitus: a cross-sectional study. PLoS One 2016; 11:e0154654.

4 Uhrbrand A, Stenager E, Pedersen MS, Dalgas U. Parkinson's disease and intensive exercise therapy – a systematic review and meta-analysis of randomized controlled trials. J Neurol Sci 2015; 353:9–19.

5 Lenka A, Jhunjhunwala KR, Saini J, Pal PK. Structural and functional neuroimaging in patients with Parkinson's disease and visual hallucinations: a critical review. Parkinsonism Relat Disord 2015; 21: 683–691.

6 Vaugoyeau M, Azulay J. Role of sensory information in the control of postural orientation in Parkinson's disease. J Neurol Sci 2010; 289:66–68.

7 Tolosa E, Gaig C, Santamaría J, Compta Y. Diagnosis and the premotor phase of Parkinson disease. Neurology 2009; 72:S12–S20.

8 Lopes JBP, du Lameira de Melo GE, Lazzari RD, Santos CA, Franco de Moura RC, *et al.* Measures used for the evaluation of balance in individuals with Parkinson's disease: a systematic review. J Phys Ther Sci 2016; 28:1936–1942.

9 Shaw JE, Sicree RA, Zimmet PZ. Global estimates of the prevalence of diabetes for2010 and 2030. Diabetes Res Clin Pract 2010; 87:4–14.

10 Ilksan D, Nursen I, Barı G, Candan A. The effect of type 2 diabetes mellitus on the motor behaviour of elderly individuals during sit to stand activity. J Marmara Univ Inst Health Sci 2012; 2:72–77.

11 Kim R, Edelman S, Kim D. Musculoskeletal complications of diabetes mellitus. Clin Diabetes 2001; 19:132–135.

12 Jeremiah D, Keith C, Stephen M, John W, Kristin A. Diabetic neuropathy: an intensive review. Am J Health Syst Pharm 2004; 61:2.

13 Djaldetti R, Ziv I, Melamed E. The mystery of motor asymmetry in Parkinson's disease. Lancet Neurol 2006; 5:796–802.

14 Rocchi L, Chiari L, Horak FB. Effects of deep brain stimulation and levodopa on postural sway in Parkinson's disease. J Neurol Neurosurg Psychiatry 2002; 73:267–274.

15 Van der Kooij H, van Asseldonk EH, Geelen J, van Vugt JP, Bloem BR. Detecting asymmetries in balance control with system identification: first experimental results from Parkinson patients. J Neural Transm 2007; 114: 1333–1337.

16 Fisher I. Reliability and validity of the modified functional reach test at the sub-acute stage post-stroke. Disabil Rehabil 2009; 31:243–248.

17 Haas C, Turbanski S, Kessler K, Schmidtbleicher D. The effects of random whole-body-vibration on motor symptoms in Parkinson's disease. NeuroRehabilitation 2006; 21:1878–6448.

18 Jauregui-Renaud K. Postural balance and peripheral neuropathy Instituto Mexicano del Seguro Social. Mexico: InTechOpen; 2013.

19 Mokhtar M, Mostafa M, Abd El Halim N, Helmy M, Samir W. Postural control and central motor pathway involvement in type 2 diabetes mellitus: dynamic posturographic and electrophysiologic studies. Alex J Med 2013; 49: 299–307.

20 Mustapa A, Justine M, Mohd Mustafah N, Jamil N, Manaf H. Postural control and gait performance in the diabetic peripheral neuropathy: a systematic review. Bio Med Research International 2016; 2016:9305025.