BALANCE IN SINGLE- AND DUAL-TASK IN PARKINSON'S DISEASE

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BACKGROUND

Parkinson's disease (PD) is a chronic, progressive and neurodegenerative disorder affecting over 4 million people worldwide[1,2,3]. Postural stability and, therefore, balance control are essential components of any locomotion system. Postural control is defined as the ability to maintain the body's centre of gravity over the body's support base while standing or moving. Individuals with PD face a number of mobility deficits, including difficulties in transfers, walking, posture and balance[4]. Furthermore, it has been stated that gait and balance become more deteriorated in these individuals when they are simultaneously performing a second task[1, 5]. Several studies have shown that individuals with PD have serious difficulties in processing simultaneous or sequential tasks adequately[2]. The number of falls tends to increase, just as the patients' dependency of others, leading to a poor self concept, self esteem and quality of life[1,4, 6].

OBJECTIVE

The aim of this study was to investigate the difficulties in balance, in single- (standing) and dual-task (standing + cognitive task) in individuals with PD.

METHODS

Sample

A non-probability sample of 50 individuals with PD, aged 50 years old or more was used.

Procedures

The data collection was carried in the Hospital Center between Douro and Vouga, EPE, Santa Maria da Feira, Portugal, being the purpose and procedures of the study clarified to every patient. If they were willing to participate in the study, they signed a declaration of informed consent, according to the Helsinki Declaration, guaranteeing anonymity and confidentiality.

Measures

Every assessment was performed individually, with the administration of a sociodemographic questionnaire, the UPDRS - III and a balance measurement, using a pressure platform.
The balance under single-task condition was assessed in two tasks: eyes open (EO) and eyes closed (EC). In dual-task condition was also assessed in two tasks: the participants were asked to execute EO while performing a semantic fluency task (named as many animals (ANI) as possible); and the participants were asked to execute EO while performing a phonemic fluency task (enunciated as many words as possible, beginning with the letter R (WR)[7]. The order of each test changed randomly, from individual to individual, in order to avoid a learning effect and fatigue.
The centre of pressure (CoP) based parameters were further analyzed considering the most stable 30-second period of each test.

Statistical Analysis

For the statistical analysis, Predictive Analytics Software (PASW) was used. Paired samples t test was used to verify if there were significant differences between the balance in single- and dual-task.

Results

Table 1: Individual variables features of the participants with PD. ($p < 0.05$)

		M (SD)
Age (years)		68.3 (7.3)
Level of Education (years)		5.2 (3.9)
Height (cm)		165.0 (8.5)
Weight (Kg)		72.8 (13.0)
Body Mass Index		26.7 (4.2)
MMSE		27.0 (1.9)
		Frequency
Gender	Female	19
	Male	31
Walking Aids	Yes	7
	No	43

The PD sample comprised 50 subjects (62% male), with a mean age of 68.3 years old (SD=7.3) and a mean education of 5.2 years (SD=3.9). Most of these participants were classified in stage 2 of the Hoehn and Yahr scale, and had a mean UPDRS score of 19.1 (SD= 7.9). The information about the sample under study is shown in Table 1.

Table 2: Values for single- and dual-task in every component ($p < 0.05$), for individuals with PD. The values in bold correspond to the variables that present significant differences.

		M (SD)	T	Df	Sig.
Mediolateral Displacement	EO/EC	-0.273 (0.953)	-3.008	109	**0.003**
	EO/ANI	-0.612 (1.970)	-3.008	109	**0.002**
	EO/WR	-0.605 (1.978)	-3.210	109	**0.002**
	EC/ANI	-0.339 (2.202)	-1.613	109	0.110
	EC/WR	-0.347 (2.228)	-1.564	109	0.121
	ANI/WR	0.006 (1.007)	0.068	109	0.946
Anteroposterior Displacement	EO/EC	-0.387 (0.879)	-4.614	109	**0.000**
	EO/ANI	-0.385 (1.617)	-2.498	109	**0.014**
	EO/WR	-0.232 (1.388)	-1.758	109	0.082
	EC/ANI	0.002 (1.689)	0.010	109	0.992
	EC/WR	0.154 (1.400)	1.153	109	0.251
	ANI/WR	0.152 (0.969)	1.650	109	0.102
Total Velocity	EO/EC	-0.279 (0.351)	-8.335	109	**0.000**
	EO/ANI	-0.373 (0.961)	-4.067	109	**0.000**
	EO/WR	-0.328 (0.994)	-3.458	109	**0.001**
	EC/ANI	-0.943 (1.064)	-0.929	109	0.355
	EC/WR	-0.489 (1.088)	-0.471	109	0.638
	ANI/WR	0.045 (0.329)	1.448	109	0.151

Eyes-open task (EO), eyes-closed task (EC), semantic fluency task (SF), phonemic fluency task (PF)

A clear distinction in terms of performance was found between the tasks, being the CoP oscillation significantly different in the single-task EO, relatively to the remaining tests, as can be verified in Table 2.

DISCUSSION

The difficulty of maintaining the balance with eyes closed has been seen in other study[8] and can be explained by the fact that with increasing age and the consequent sensory losses, individuals tend to rely more on their vision to control their balance[9, 10]. Thus, when the individuals had to perform a task without using their vision, they instantly showed increased instability; the same happened when they had to cope with a second task. The difficulties in performed dual-task compared with single-task EO, may be explained by the serious difficulty of individuals with PD in processing simultaneous or sequential tasks adequately[2]. In fact, when two tasks are performed at the same time, competition for the limited resources results in dual-task interference and deterioration in the performance of one or both tasks[6].
Additionally, recently, studies have shown that individuals with PD can more easily generate words from a certain letter of the alphabet, than generate words belonging to a semantic category[4, 5]. These two tasks activate distinct parts of the brain and represent a different level of complexity for different people[5]. However, there is a gap in regard to the objective assessment of balance during these tasks, as well as evaluations in the early stages of PD. Here, no significant differences were found between the dual-task, ANI and WR.

CONCLUSION

The present study showed that the balance of individuals with PD is worse in dual-task condition or when they perform a task with eyes closed. This evidence should provide some guidance for further studies and for the planning of therapeutic interventions, with the aim to improve the functional performance of individuals with PD and delay oncoming/further disabilities.
Future studies should focus on how different cognitive tasks affect the balance, as well as to further investigate the relationship between the single task condition with eyes closed and the remaining single- and dual-task conditions, in PD.

REFERENCES

1. Brauer SG, Woollacott MH, Lamont R, Clewett S, OSulivan J, Peter S, et al Single and dualtask gait training in people with Parkinson's Disease A Protocol for a randomised controlled trial. BMC Neurology 2011;11. 2. Matinoli M. Balance, Mobility and Fall sin Parkinson's Disease Finland: University of Oulu; 2009. 3. Murphy S, Tickle-Degnen L. The Effectiveness of Occupational Therapy-Related Treatments for Persons with Parkinson's Disease: A Meta-Analytic Review American Journal of Occupational Therapy 2001;55:385-92. 4. Kara B, Genca A, Colakoglu BD, Cakmur R. The effect of supervised exercises on static and dynamic balance in Parkinson's disease patients. Neurorehabilitation. 2012;30:351-7. 5. Brauer SG, Morris ME. Can people with Parkinson's disease improve dual tasking when walking? Gait & Posture. 2010;31:229-33. 6. Kelly VE, Eusterbrock AJ, Shumway Cook A. A Review of Dual-Task Walking Deficits in People with Parkinson's Disease: Motor and Cognitive Contributions, Mechanisms, and Clinical Implications. Parkinson's Disease 2012. 7. Cavaco S, Goncalves A, Pinto C, Almeida E, Gomes F, Moreira I, Fernandes J, and Teixeira-Pinto A. "Semantic Fluency and Phonemic Fluency: Regression-based Norms for the Portuguese Population". Arch Clin Neuropsychol. 2013. 28(3):262-71. 8 Fernandes A, Rocha N, Santos R, and Tavares JMRS. in Press. "Effects of dual-task training on balance and executive function sin Parkinson's disease: A pilot study" Somatosensory & Motor Research:1369-1651 (online). 9. Targho V R, Freire AdNF, Sousa ACPdA, Maciel NFB, Guerra RO. Effects of a dual-task training on dynamic and static balance control of pre-frail elderly: a pilot study. Fisioterapia em Movimento 2012;25(2):351-60. 10. Ricci NA, Gazzola JM, Coimbra IB. Sistemas sensoriais no equilibrio corporal de idosos Arquivos de Ciências da Saúde. 2009;3(2):94-100.

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