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ORIGINAL ARTICLE

Postural control in Parkinson's disease☆

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KEYWORDS
Parkinson disease;
Postural balance;
Vestibular function tests

Abstract
Introduction: Postural instability is one of the most disabling features of Parkinson's disease.
Objective: To evaluate postural balance in Parkinson's disease.
Methods: Thirty patients with Parkinson's disease were compared with controls using Tetrax™ interactive balance system posturography.
Results: For different positions, patients with Parkinson's disease showed a significantly higher weight distribution index, fall index, Fourier transformation at low-medium frequencies (F2–F4), and significantly lower right/left and toe/heel synchronization *versus* controls.
Conclusion: Postural imbalance in Parkinson's disease patients is characterized by the abnormalities of weight distribution index, synchronization index, Fourier transformation index, and fall index as measured by Tetrax™ posturography.

PALAVRAS-CHAVE
Doença de Parkinson;
Equilíbrio postural;
Testes de função vestibular

Controle postural na Doença de Parkinson

Resumo
Introdução: A instabilidade postural é um dos principais problemas na doença de Parkinson.
Objetivo: Avaliar o controle postural na doença de Parkinson.

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Método: Um grupo de 30 pacientes com doença de Parkinson foi comparado com um grupo controle à posturografia estática do Tetrax Interactive Balance System (Tetrax™).
Resultados: Em diferentes condições sensoriais, houve diferenças significantes entre os dois grupos, tendo sido encontrados nos parkinsonianos valores maiores do índice de distribuição de peso, do índice de risco de queda e da faixa de frequência F2-4 e valores menores da sincronização da oscilação postural direito-esquerda e dedos/calcanhares.
Conclusão: O comprometimento do controle postural em pacientes com doença de Parkinson é caracterizado por alterações na distribuição de peso, na sincronização da oscilação postural direita/esquerda e dedos/calcanhares, nas faixas de frequência de oscilação postural e no índice de risco de queda à posturografia do Tetrax™.

Introduction

Postural balance can be defined as the ability of human beings to stand up straight and perform movements with no oscillations or falls. Its maintenance is determined by the integration in the central nervous system of information originating from the vestibular, visual, and proprioceptive systems that trigger eye and spinal reflexes.[1–4] The vestibular-ocular reflex (VOR) generates eye movements, promoting the stabilization of gaze during head movement; the vestibulospinal reflex (VSR) generates compensatory body movements in order to maintain head and postural stability.[5]

Parkinson's disease is a chronic and progressive degenerative disorder of the central nervous system. It affects all age groups, but is most commonly found in the elderly population. Parkinson's disease can be considered the second most common senile neurodegenerative disease, affecting approximately 1% to 2% of the population above 65 years of age,[6] and occurs in different races and social classes in both genders, but is prevalent in males.[7]

Parkinson's disease is characterized by rigidity, bradykinesia, micrography, mask-like facial expression, postural changes, and resting tremor. Postural changes include lack of balance reaction, adopting the posture in flexion, and decreased trunk rotation.[8] It is considered that the fall risk in Parkinson's disease varies between 38% and 68%, and that recurrent falls occur more often in the later stages of the disease.[9]

The pathophysiology of Parkinson's disease is a progressive loss of cells in the substantia nigra of the midbrain. The degeneration of neurons in the substantia nigra results in decreased production of dopamine, with depigmentation of this structure.[7,8]

The etiology remains unknown, and it is believed that the pathogenic mechanisms involved are multifactorial: oxidative stress, mitochondrial abnormalities, excitotoxicity, glial and inflammatory factors, environmental neurotoxins, genetic factors, and brain aging.[10,11]

Patients with Parkinson's disease exhibit more difficulty in executing simultaneous movements and sequencial tasks *versus* simple tasks, requiring the complete execution of one movement before starting the next.[8]

Postural instability is a major problem in Parkinson's disease; it increases the frequency of fall episodes and their consequences, and the likelihood of occurrence of falls increases according to the extent and duration of the disease.[8,12]

Progression of the disease leads to an impairment of gait called festination, characterized by decreased speed and shortening of the stride, as if the person were chasing his own center of gravity, with a tendency to tip over forward. Festinant gait may be caused by a change of pressure and mass centers, resulting in a reduction of the responses of balance, or as a result of changes in gait kinematics.

Changes in gait kinematics include changes in joint excursion and in hip flexion, which can modify the excursion of the heel. Instead of a heel-toe progression, the patient makes contact with the ground with flat feet; or, with the advance of the disease, there is a heel-toe progression, significantly compromising the gait.[8,13]

Posturography measures postural instability, assists in the analysis of the functional aspects of whatever dysfunction causes the body imbalance,[8,14,15] complements conventional vestibular tests for diagnosis, and is relevant to the staging, treatment, and prognosis of Parkinson's disease.[16,17] It may also identify early signs of balance impairment in different conditions, such as with eyes open, eyes closed, and on unstable surfaces.[8,18]

Research has demonstrated that healthy individuals have better postural control and a higher stability limit than patients with Parkinson's disease in the *on* period, a phase where the patient is under the influence of anti-Parkinsonian medication and presents better motor performance, and in the *off* period, where there is no effect of medication and consequently a worsening of symptoms; Parkinson patients perform better in the *on* period than in the *off* period.[19,20]

Most posturographic devices in current use assume that the mechanisms involved in postural control can be measured by analyzing the postural oscillation manifested by a shifting of the center of gravity or pressure, while the subject remains standing on a platform sensitive to pressure.

In Tetrax™ (Sunlight Medical Ltd.) interactive balance system posturography, created by Kohen-Raz with four platforms, postural control is investigated through the difference in pressure on each platform. This equipment makes it possible to obtain and separately compare the values of forefoot and rearfoot (toes and heel) of each foot, and of each heel with the contralateral forefoot.[21]

The body balance of healthy individuals was analyzed with Tetrax™ in different sensory conditions (eyes open or eyes closed and with head turned 45° to the right or to the