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EFFECTS OF RANDOM WHOLE-BODY VIBRATION ON POSTURAL CONTROL IN PARKINSON'S DISEASE

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We investigated spontaneous effects of random whole-body vibration (rWBV) on postural control in Parkinsonian subjects. Effects were examined in biomechanical tests from a total of 52 patients divided equally into one experimental and one control group. Postural control was tested pre- and post-treatment in two standardized conditions (narrow standing and tandem standing). *The intervention was based on rWBV (ŷ: 3 mm, f: 6 Hz 1 Hz/sec) consisting of 5 series lasting 60 seconds each. The main findings from this study were that (1) rWBV can improve postural stability in Parkinson's disease (PD) spontaneously (2) these effects depend on the test condition. Based on the results of this study, rWBV can be regarded as an additional device in physical therapy in PD.*

Keywords: postural control, postural instability, Parkinson's disease, random whole-body vibration

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INTRODUCTION

Since James Parkinson made first references to falls it is well known that postural instability (PI) is a hallmark of idiopathic PD (Bloem, Beckley, Van Hilten, et al. 1998). In general it occurrs in the late and most advanced stages of the disease (Marchese, Bove, and Abbruzzese 2003), but falls in the relatively early course of PD also have been reported (Bloem, Grimbergen, Cramer, et al. 2001). The high risk of falling in PD is confirmed by some retrospective studies (Ashburn, Stack, Pickering, et al. 2001; Koller, Glatt, and Vetere-Overfield 1989; Magalhaes et al. 2000; Smithson, Morris, and Jansek 1998). Wood et al. (2002) found that the risk of falling is approximately twice in PD patients when compared with that of healthy older people. Due to falls, a loss of functional independence and the risk of being admitted to a nursing home often are reported along with fear of future falls. With respect to the progression of PD Jankovic et al. (1990) speculated about a worse overall prognosis for subjects with a marked PI, which also is associated with an increased mortality in PD patients (Bennett, Beckett, Murray, et al. 1996).

Defectively functioning basal ganglia are an explanation for PI since it is known that this structure is important to control the agonist–antagonist relationship (Dimitrova Horak, and Nutt, 2004). Furthermore, the basal-ganglia quickly modify muscle activation patterns, which are necessary to maintain postural stability (Chong, Jones, and Horak. 2000). Furthermore, some studies have shown that postural reflexes in PD patients differ from those of normal subjects. These abnormalities are thought to contribute to PI (Bloem et al. 1995, 1999; Carpenter, Allum, Honegger, et al. 2004; Dietz, Zijlstra, and Assaiante, et al. 1993; Horak, Nutt, and Nasher 1992;). Moreover PI may relate in part to impaired proprioception and kinaesthesia, respectively (Jobst, Melnick, Byl, et al. 1997; Khudados, Cody, and O'Boyle, 1999; Klockgether, Borutta, Rapp, et al. 1995; Rickards and Cody 1997). Demirci and colleagues (1997) proposed that there is probably proprioceptive feedback present but patients are unable to use it properly for maintaining balance. An abnormal sensory organization like a "breakdown" in the central hierarchy of postural control is discussed in advanced PD as well (Bronte-Stewart, Minn, and Rodrigues et al. 2002).

Due to common problems of PI and a high incidence of falls in PD, further approaches to develop improved therapeutic strategies should be a priority (Bloem et al. 2001). A succesfull treatemt of PD, however, is difficult due to its multifactorial pathophysiology (Bronte-Stewart et al. 2002; Horak et al. 1992; Marchese et al. 2003). Many Parkinson patients have reported that their postural control is worse on medication (Bronte-Stewart et al. 2002). This observation is supported by investigators who pointed out that dopaminergic medication fails to improve postural stability in PD

despite improvements in voluntary movements (Bloem, Beckley, Van Dijk, et al. 1996; Bonnet, Loria, and Saint-Hilaire 1987; Frank, Horak, and Nutt 2000; Jankovic 2002; Koller et al. 1989; Marsden 1994). Moreover Bronte-Stewart et al. (2002) examined a worsening of balance control under L-dopa. In summary it is evident that PI is a severe problem in advanced PD that cannot be treated by medication and surgery sufficiently. But it has been suggested that the practice of physical activities counteracts PI significantly (Perrin, Gauchard, Perrot, et al. 1999).

In previous studies we examined effects of rWBV on reflex activity and postural control in athletes and orthopaedic patients. In both groups the treatment led to significant improvements in postural control, which, were connected with changes in neuromuscular activation patterns (Haas et al. 2004c). Based on theoretical consumptions we also analysed treatment effects on the unified Parkinson's disease rating scale (UPDRS) motor score in PD (Haas et al. 2004b). Significant improvements were primarily found in rigidity, gait, and posture items. Referring to the UPDRS test, we find that postural control is commonly assessed by the retropulsion test. But the value of this test is limited by the lack of normative data, the lack of analysing postural control in medial–lateral direction, and difficulties in standardisation across different subjects (Bloem et al. 1998; Marchese et al. 2003). It also fails to predict falls in PD patients (Bloem et al. 2001). Based on our previous studies the aim of this study was to use biomechanical analyses to prove the effects of rWBV on postural control in PD patients.

MATERIALS AND METHODS

Participants

Fifty-two patients with idiopathic PD participated in this study divided equally into one experimental group (E) and one control group (C). Groups were matched for PI based on the UPDRS. Most of the participants were moderately affected by postural impairment (average UPDRS score for postural control: 1.5+/−1.1). Patients were informed about the test situation and gave witnessed informed and written consent to take part in the experiment. All subjects involved in this study were first neurologically assessed in a PD hospital.[1] Patients with dementia, heart diseases, neurological diseases apart from PD, significant dyskinesias, and orthopaedic injuries were excluded. No patient had any features to suggest an atypical or secondary Parkinsonian syndrome.

[1]Parkinson-Klinik Bad Nauheim.

Measurements

We used standard assessments of PD severity to get information about the clinical characteristics of the patients—the UPDRS motor score (Fahn, Elton et al. 1987) and the Hoehn and Yahr disability scale (Hoehn, and Yahr 1967); see Table 1. The severity of Parkinsonism ranged from stage III to IV on the Hoehn and Yahr scale, where a wide range of motor disabilities was observed.

Subjects were tested in two standardized conditions on their ability to maintain postural stability on a movable and instable platform (Coordex® - Fa. Ruf, Germany). Condition I was *narrow standing* and condition II was *tandem standing* (see Figure 1). These two conditions are modifications of the "four-test balance scale" (Gardener, Buchner, Robertson, et al. 2001; Rossitier-Fornhoff, Wolf, Wolfson, et al. 1995). The aim was to analyze postural stability in two different positions to obtain information about the influence of the test condition on the result. From a biomechanical point of view, condition II primarily focuses postural control in the medial–lateral direction (M–L), whereas condition I is mainly in the anterior–posterior direction (A–P).

All subjects were able to stand independently during test sessions. They were asked to stand as still as possible for 32 seconds with their arms at their side. This period is long enough to detect differences between subjects clearly, but fatigue is minimized compared with longer testing times (Haas Turbanski, Kaiser, et al. 2004a).

The platform displacements were measured by a two-dimensional acceleration sensor that was attached to the platform. By integrating both acceleration signals twice we got information about the platform displacements in both directions (A–P and M–L). All displacements were summed up for each trial to get an objective value of body sway and to evaluate postural stability. First, three *pretests* were assessed in all subjects in both conditions (*narrow standing* and *tandem standing*). Afterward the treatment was applied to subjects of group E while C subjects had a moderate walk in the hospital lasting as long as the intervention (approximately 15 minutes). Finally, all subjects were retested again for both conditions in three *post-tests*. All patients were tested in the on-phase at peak dose in the levodopa cycle.

Table 1. Clinical Characteristics of the 52 Patients Involved in This Study

	Age (years)	Duration of illness (years)	Hoehn & Yahr (score)	UPDRS motor score	Postural stability (UPDRS)	Levodopa (mg/day)	Distribution of sex
Mean ± SD	69,1 ± 8,9	8,5 ± 0,7	3,3 ± 0,6	40,0 ±11,2	1,4 ±1,1	493,6 ± 192,2	male: 38 female: 14