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The Effect of Whole Body Vibration Treatment on Balance and Gait in Patients with Stroke

İnmeli Hastalarda Tüm Vücut Vibrasyon Tedavisinin Denge ve Yürüme Üzerine Etkisi

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ABSTRACT

Introduction: In patients with neurological disorders Whole Body Vibration (WBV) has been reported to improve motor function. Our aim was to assess the effects of WBV on both balance and walking performance in adult stroke patients.

Methods: Forty three post-stroke patients were randomly divided into two groups. One would receive WBV therapy (WBV group) while the control group would not. All patients participated in a conventional rehabilitation program for three weeks while the vibration group also received WBV over the same period. Patients balance and walking performance were evaluated using the Berg Balance Scale (BBS), Timed Up and Go Test (TUG) and computerized gait analysis. All evaluations were performed before and after therapy.

Results: The median (range) age of all patients was 51.00 (18–66) years. The groups numbered 26 and 17 patients for the WBV and control groups respectively. After intervention, significant improvements were found in the WBV group for BBS score (p=0.004), TUG score (p=0.035), step length (p=0.004) and walking speed (p=0.031) when compared to the controls.

Conclusion: WBV is effective for the improvement of balance and gait performance in stroke patients.

Keywords: Stroke, rehabilitation, gait, whole body vibration treatment

ÖZ

Amaç: Tüm Vücut Vibrasyon (TVT) uygulamasının, nörolojik rahatsızlıkları olan hastalarda motor fonksiyonların iyileştirilmesi için etkili bir tedavi olduğu gösterilmiştir. Bu çalışmada erişkin inmeli hastalarda TVT'nin denge ve yürüyüş performansı üzerine etkilerini değerlendirmeyi amaçladık.

Yöntem: Kırk üç inmeli hasta iki gruba randomize edildi: vibrasyon grubu ve kontrol grubu. Tüm hastalara üç hafta süre ile konvansiyonel rehabilitasyon programına katıldı. Vibrasyon grubuna konvansiyonel tedaviye ek olarak üç hafta süre ile TVT uygulandı. Hastaların denge ve yürüyüşleri Berg Balans Testi (BBT), Kalk Yürü Testi (KYT) ve bilgisayarlı yürüme analizi ile değerlendirildi. Tüm değerlendirmeler tedavi öncesi ve sonrası yapıldı.

Bulgular: Tüm hastaların ortanca yaşı 51,00 (18–66) yıl idi. Hastalar sırasıyla vibrasyon (n: 26) ve kontrol (n: 17) olarak ikiye ayrıldı. Tedavi sonrasında vibrasyon ve kontrol grupları arasında istatistiksel olarak anlamlı farklılıklar gözlendi. TVT alan hastaların BBT (p=0,004), KYT (p=0,035), adım uzunluğu (p=0,004) ve yürüme hızı (p=0,031) parametrelerinde anlamlı gelişmeler saptandı.

Sonuç: TVT tedavisi inmeli hastaların denge ve yürüme performansının geliştirilmesinde etkili bir yöntemdir.

Anahtar Kelimeler: İnme, rehabilitasyon, yürüme, tüm vücut vibrasyon tedavisi

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INTRODUCTION

Whole body vibration (WBV) has been used to improve the physical condition of professional athletes and has gained popularity more widely for exercise training. The utility of WBV in the treatment of neurological disorders including Parkinson's disease, multiple sclerosis, stroke and spinal cord injury has also been recognized recently.

WBV is defined as standing or exercising on a vibrating platform that transmits vertical sinusoidal oscillations via the feet to the entire body (1). WBV is commonly used to improve athletic performance in professionals and young adults by its beneficial effects on muscle activity, improving both strength and power (1–3). Increased neuromuscular activation during WBV, and which persist for some time following WBV, lead to improvements in both muscle strength and power. The primary mechanism proposed to explain the effects of WBV is that mechanical vibration elicits a tonic vibration reflex that results in an increase in electrical activity in the muscles (4, 5).

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Several studies have reported on the clinical effects of WBV in a range of neurological conditions including Parkinson's disease, Multiple Sclerosis and spinal cord injury (6–11). However, limited information is available regarding the use of WBV in stroke patients. Many of these studies are case reports and randomized controlled trials. Several studies have investigated the short-term effects of WBV on neuromuscular deficits in stroke patients (12–14). A few randomized controlled studies have reported the effects of WBV in stroke patients over longer periods with varying results (15–18).

To the best of our knowledge there is only one study from Turkey investigating the effect of WBV in stroke patients (14). However, a limitation of that study was that computerized gait analysis of the patients was lacking. Thus, the aim of our study was to examine the effects of WBV in stroke patients, not only on balance but also on gait performance as assessed by computerized gait analysis.

METHODS

Forty-six patients with chronic stroke who were treated at the University Hospital Department of Physical and Rehabilitation Medicine were included in the study. The patients were randomly assigned to two groups: the vibration group (WBV; n=26) and the control group (Controls; n=20). The inclusion criteria were: aged between 18 and 70 years, medically stable, a post-stroke interval of at least 12 weeks and a score of less than 40 on the Berg Balance Scale (BBS) indicating moderate to severe balance impairment. Patients were excluded if they had severe spasticity (Modified Ashworth Scale (MAS) of 3 or higher) in the lower extremity muscles; joint limitations (contractures); congestive cardiac failure; peripheral arterial disease; severe dementia; language difficulties; painful orthopedic conditions involving the pelvis, hips, knees or ankles; or were already undergoing vibration treatment. All subjects provided informed, written consent prior to taking part in the study. This study was approved by the University Ethical Committee (KAEK 2014/103).

The demographic characteristics were recorded in all patients. The balance and gait of the patients were evaluated using the BBS (19), Timed Up and Go Test (TUG) (20) and gait analysis (cadance, single support, double support, step length, step time, walking speed). All evaluations were performed before treatment and after 3 weeks of therapy.

Patients received WBV using the Power Plate vibration platform (Performance Health Systems). The amplitude of the vibration was 2 mm and the frequency was 35–40 Hz. Subjects stood on the platform, with their feet placed symmetrically at a standardized distance from the axis of platform rotation. Patients were allowed to hold the support bar. Patients performed the following exercises: standing straight, knees flexed to 30 or 40 degrees (high squat) and knees flexed to between 70 and 80 degrees (deep squat). An experienced physical therapist supervised the WBV administration. The control group did not receive WBV. In addition, both groups received traditional therapy for the trunk, arm and leg muscles, including range of motion (ROM) exercises, stretching exercises, strengthening exercises and ambulation training. All patients were treated at the rehabilitation center on each working day over a 3-week period. The WBV treatment comprised four one minute sessions of stimulation, with one-minute rest pauses between each session, to prevent muscle fatigue.

All patients completed the intervention successfully and compliance was excellent. No adverse effects from WBV therapy were reported and training was well tolerated.

The data were assessed using the Statistical Program for Social Sciences (13.0) statistical software. Data were compared using the Mann-Whitney U test and Wilcoxon test.

RESULTS

A total 46 patients were included in the study. Three patients in the control group were excluded from our analysis because they discontinued the study due to social reasons. A total of 43 patients (vibration group n=26, control group n=17) completed the study. There were no significant demographic differences between the groups (see Table 1).

No significant differences were found between the two groups in the pre-treatment evaluation based on the BBS and TUG scores (p=0.687 and p=0.289, respectively). After treatment, statistically significant improvements were found in the WBV group for both the BBS (p=0.004) and TUG (p=0.035) scores when compared to the control group. The pre-treatment and post-treatment BBS and TUG scores of the participants are shown in Table 2.

On gait analysis, statistically significant differences between the two groups were observed in two of the parameters assessed. Significant increases in step length (p=0.004) and walking speed (p=0.031) were observed in the WBV group. The gait analysis results of the patients are presented in Table 3.

Table 1. Comparison of patient demographic data between the WBV and control groups

	WBV group (n=26)	Control group (n=17)	p
Mean age ± SD* (years)	46.8±15	51.6±10	0.451
Gender n (%)	14 (53.8%) F 12 (46.2%) M	9 (52.9%) F 8 (47.1%) M	0.409
Hemiplegic side n (%)	17 (65.4%) R 9 (34.6%) L	11 (64.7%) R 6 (35.3%) L	0.473
Mean ± SD* duration since stroke (months)	34.5±25	35.5±20	0.520
Stroke etiology	21 ischemic 5 hemorrhagic	11 ischemic 6 hemorrhagic	0.401
Dominant hand n (%)	22 (84.6%) R 4 (15.4%) L	14 (82.4%) R 3 (17.6%) L	0.576

*SD: Standard Deviation

Table 2. Comparison of BBS and TUG scores between the WBV and control groups before and after WBV treatment

		Pre-treatment	Post-treatment	p**
BBS	WBV Group (Mean score ± SD)	25.7±4.9	36.9±5.2	<0.001
	Control Group (Mean score ± SD)	24.0±10.9	26.4±11.0	<0.001
	p*	0.687	0.004	
TUG	WBV Group (Mean score ± SD)	17.5±4.0	10.7±3.1	<0.001
	Control Group (Mean score ± SD)	19.5±3.6	13.2±3.7	<0.001
	p*	0.298	0.035	

* Statistically not significant
** Statistically significant
BBS: Berg Balance Scale, TUG: Time Up and Go Test

DISCUSSION

This study aimed to investigate the effect of WBV on balance and gait in stroke patients. We hypothesized that WBV would result in significant

Table 3. Comparison of gait analysis parameters between the WBV and control groups, before and after WBV treatment

Gait Analysis		Before Treatment	After Treatment	p**
Cadence (steps/min)	WBV Group	78.30±18.15	89.42±20.86	0.000
	Control Group	80.41±22.38	79.94±21.32	0.413
	p*	0.931	0.223	
Single support (seconds)	WBV Group	0.47±0.12	0.44±0.09	0.239
	Control Group	0.45±0.06	0.44±0.07	0.307
	p*	0.565	0.601	
Double support (seconds)	WBV Group	0.60±0.41	0.49±0.39	0.000
	Control Group	0.65±0.45	0.62±0.38	0.711
	p*	0.784	0.196	
Step length (meter)	WBV Group	0.44±0.08	0.52±0.07	0.000
	Control Group	0.38±0.13	0.41±0.13	0.209
	p*	0.117	0.004	
Step time (seconds)	WBV Group	0.95±0.54	0.84±0.40	0.001
	Control Group	0.84±0.25	0.83±0.24	0.484
	p*	0.950	0.411	
Walking speed (m/s)	WBV Group	0.58±0.14	0.74±0.21	0.000
	Control Group	0.59±0.21	0.61±0.18	0.049

All data are shown as mean ± SD
* Statistically not significant
** Statistically significant

improvement in balance and gait performance in stroke patients. Indeed, we found statistically significant differences between the vibration and control groups with respect to several parameters. Significant improvements were recorded in the BBS scores, TUG scores, step length and walking speed. Our results support our initial hypothesis that WBV would be an effective adjunct therapy to conventional rehabilitation therapies in stroke patients.

No patients withdrew from the WBV study group as the intervention was of short duration, simple to perform and did not cause any adverse reactions. All participants in both groups continued to perform their conventional training, which included stretching exercises, strengthening exercises and ambulation training.

We have shown that balance and some gait parameters improved significantly after WBV treatment in comparison to the control group. The improvement in balance in the WBV group, which is subjected to disturbances in ankle proprioception input, may have occurred because of both increased muscle strength and improved proprioception feedback as a direct result of vibration training. WBV is reported to stimulate proprioception and to result in long-lasting postural improvement (21). WBV has also been reported to result in modification of correction movements and increased postural sway. The application of WBV with its standardized stimuli can enhance the physiological effect of patient therapy (7).

Choi et al. examined the effect of WBV in stroke patients in terms of postural control and neuromuscular function (16). They examined the effect of WBV on both static and dynamic sitting balance while performing a range of task-oriented actions. After the intervention, the vibration group showed significantly better scores in the Modified Functional Reach Test (16). In another study, Tankisheva et al. reported significant improvements in muscle strength and balance in chronic stroke patients after a six week WBV training program. The authors suggested that intensive WBV could be useful for improving both leg muscle strength and postural control in stroke patients (17).

Liao LR et al. showed in a systematic review that WBV has no consistent benefits for skeletal remodeling, leg motor function and mobility, balance and fall rate or for improvement in normal daily activities. However, adverse events as a result of WBV were minor (22). Another systematic review and meta-analysis conducted by Yang et al. claimed that there was no clear evidence suggesting that WBV produces beneficial effects with respect to balance, mobility and gait performance in stroke patients (23).

Our study has two limitations. First, the patient cohort was small and larger, randomized controlled trials would be required to confirm our findings which suggest a beneficial effect in the rehabilitation of some stroke patients. Second, neither the subjects nor the researcher were blinded to the WBV and control groups, as the same researcher supervised all sessions and all measurements.

This is the first Turkish study investigating the effect of WBV on stroke patients using computerized gait analysis. In conclusion, we have shown that WBV treatment significantly improves both balance and walking ability in stroke patients when used in tandem with conventional rehabilitation therapies. These results have shown that WBV treatment can provide additional benefits to conventional therapy in stroke rehabilitation and is easily tolerated by the patients. Further study with larger groups, duplicating the intervention used here, would provide more data on the benefits of this form of intervention in balance and gait in adult stroke patients. We hypothesis that, given the striking improvements obtained in this study, WBV may have a role to play in the rehabilitation and treatment of other neuromuscular patient groups such as Parkinson Disease, Multiple Sclerosis and Cerebral Palsy patients.

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Ethics Committee Approval: This study is approved by Kocaeli University Ethical Committee (KAEK 2014/103).

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