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BALANCE REHABILITATION

The effectiveness of a single session of Whole-Body Vibration in improving the balance and the strength in type 2 diabetic patients with mild to moderate degree of peripheral neuropathy: A pilot study

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Summary Peripheral neuropathy is a common complication of diabetes mellitus. Muscle strength and the balance deficits are seen in these patients. Whole-Body Vibration (WBV) is a time-efficient method which may be beneficial for them. The immediate effects of WBV on muscle strength and balance have not been studied yet. The aim of this study was to investigate the effects of one session of WBV on muscle strength and the balance of diabetic patients. Ten diabetic patients with peripheral neuropathy took part in this study. Outcome measurements were total strength, strength of tibialis anterior and quadriceps femoris muscles and the balance parameters including Unilateral Stance Test and Timed Up and Go Test. Tibialis anterior muscle strength and Timed Up and GO Test parameters showed significant differences post-exercise in comparison to baseline. A session of WBV had positive effects on muscle strength and the balance in patients with type-2 diabetes associated with neuropathy.

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Introduction

Peripheral neuropathy is a common complication of diabetes mellitus (DM). Up to 36% of patients suffering from type 2 diabetes are affected by this condition, which is believed to be progressive and irreversible (Emam et al., 2010; Hijmans et al., 2008; Pieber et al., 2010). Muscle strength and the balance can be impaired in patients with DM. Patients with diabetes have a 17% and 14% reduction of strength of ankle flexors and ankle extensors, respectively. At the knee, strength of extensors and flexors was reduced by 7% and 14%, respectively (Andersen et al., 2004).

As the ability of postural control diminishes with neuropathy and aging, falling due to the imbalance is a common cause of morbidity and mortality (Kim and Robinson, 2006). The loss of sensory perception deleteriously affects postural stability (Simoneau et al., 1994). Diabetic Patients with sensory neuropathy are more susceptible to experience a higher risk of falling (Lafond et al., 2004), which can be attributable to the lack of accurate proprioceptive feedback from the lower limbs (Oppenheim et al., 1999). Medication therapy, losing weight, and physical exercise have been identified as a controlling factor in glycemia and should be prescribed, as appropriate, for every patient with diabetes. Aerobic exercise is considered as the main strategy to treat the patients living with type-2 diabetes (Praet and van Loon, 2007). However, majority of the patients are also suffering from several coexisting problems such as obesity and articular complications in addition to the adverse effects of diabetes. Therefore, a good substitution or complementary method for aerobic and resistive exercises might be Whole Body Vibration (WBV). WBV is a convenient to use and it is also beneficial in the elderly as well as the healthy people.

WBV is a training program that exposes the entire body to mechanical vibrations while the patient stands on the vibrating plate. It is a somato-sensory stimulation which can be beneficial for improving muscle strength and balance in healthy elderly people (Machado et al., 2010). However, the effects of WBV on muscle strength and the balance in patients living with type-2 diabetes with neuropathy is not clear yet, hence the aim of this study was to investigate the immediate effects of a single session of WBV on the muscle strength and balance of patients with diabetes type 2 associated with peripheral neuropathy.

Methods

Ten patients living with type-2 diabetes with peripheral neuropathy (6 female, 4 male; mean age 56 $\pm$ 5.16 years; mean duration of diabetes mellitus 11.6 $\pm$ 5.1 years, Body Mass Index (BMI): 27.9 $\pm$ 2.8) were recruited from Diabetes and Metabolic Diseases center of Tehran University of Medical Sciences. The inclusion criteria were history of type 2 diabetes according to the American Diabetes Association (ADA) guidelines 2001 (Sacks et al., 2002) or using oral hypoglycemic agent; HbA1C $<$ 8.5%; BMI between 25 and 35; Michigan Diabetes Neuropathy Score (MDNS)(Fedele et al., 1997; Feldman and Stevens, 1994) between 13 and 29 (mild to moderate neuropathy) and age between 50 and 70 years. The patients gave their informed voluntary consent to participate in the study according to the protocol approved by the ethics committee of Endocrinology and Metabolism Research Center (EMRC) in accordance with the standards of Helsinki declaration and the guideline of Iranian Ministry of Health and Medical Education.

Muscle strength was assessed both locally and generally. To evaluate muscle strength locally, dynamometry (MIE, Medical Research Ltd., England) was performed for two muscles of the dominant limb: quadriceps femoris and tibialis anterior. To evaluate quadriceps muscle strength, the subject lay prone on a plinth. The dynamometer was fixed to a frame over the plinth. Trunk and the non-dominant limb were fixed to the frame by straps. With 90° flexion of the knee of the dominant limb, three isometric contractions performed and the average of three trials was calculated. To evaluate tibialis anterior muscle strength, subject sat at the edge of the plinth, the non-dominant leg was fixed with straps. The ankle joint of the dominant leg was fixed in neutral position (between dorsi- & plantar flexion). The dynamometer was fixed to the frame inferiorly. The subject was asked to perform isometric dorsi flexion. Three trials were performed and the average of the three was calculated.

To assess the strength generally, a Back-Leg-Chest dynamometer (Baseline USA) was applied. Subject stood on the plate of dynamometer and with straight elbows and knees and then pulled-up the grip bar three times sequentially with a minute rest between trials. General strength was estimated as the mean of the three trials.

Balance was evaluated using Unilateral Stance Test (UST) and Timed Up and Go Test (TUGT). UST is a commonly-used measure of balance capabilities, and a significant predictor of falls (Hurvitz et al., 2000) and peripheral neuropathy (Hurvitz et al., 2001). With the arms folded across the chest, participants stood on the dominant leg and lifted the other limb approximately 5 cm above the medial malleolus of the stance leg. Three experimental trials of UST were recorded and then the average of three was calculated.

TUGT is a valid test for mobility and dynamic balance (Podsiadlo and Richardson, 1991). Participants were asked to rise from a chair, walk 3 m toward a symbol that was drawn on the floor at their usual comfortable safe pace, turn around the symbol and return to their initial seated position. TUGT was scored as the mean time of the three subsequent trials.

After recording all the above parameters, participants had a session of WBV (Power-Plate, Next Generation, USA) which consisted of five bouts of 30-second vibration with 1 min elapsed between the bouts. They stood barefooted with an even distribution of weight over both feet on the plate with 30° knee flexion. All participants were asked to contract the muscles of the lower limbs during exposure to vibration and to bear weight more on their forefoot in order to dampen the vibration (Abercromby et al., 2007). Participants were not allowed to touch the handle of vibrating plate. The applied frequency was 30 Hz and the amplitude was 2 mm.

After applying WBV, all the above parameters were immediately recorded and compared with the pre exercise data.