Journal of Pain & Relief
ISSN: 2167-0846

Maddalozzo et al., J Pain Relief 2015, 4:2
DOI: 10.4172/2167-0846.1000171

Case Report Open Access

Whole Body Vibration: An Effective Treatment for Painful Diabetic Neuropathy

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Abstract

Introduction: Painful diabetic neuropathy is a common complication of diabetes that affects multiple aspects of patients' lives, severely limiting daily functions and quality of life. The aim of this case study was to evaluate the efficacy of whole body vibration (WBV) to reduce pain and thereby improve quality of life, walking speed, and general clinical characteristics.

Methods: A 63-year-female with type-2 diabetes and seven years of pain symptoms volunteered for a 12-week WBV intervention receiving 12-minutes of WBV per day, three days per week. Pain severity and its interference in daily life, 0-10 Numeric Rating Scale to assess pain immediately before and after WBV, quality of life, walking speed, body composition, general clinical characteristics and medication usage were assessed.

Results: Pain severity and interference decreased by approximately 5.0 points post-intervention reducing the participant's pain levels from borderline severe to very mild. Pain levels immediately prior to and following WBV exposure decreased every week and continued to decrease throughout the intervention. The participant indicated at baseline that her foot pain had a significant impact on her ability to take part in leisure activities, made her physically dependent on others for help, significantly affected her relationships and her role in the family and significantly impaired her ability to perform activities of daily life. Post-intervention, she was able to take part in leisure activities, no longer felt dependent on others, improved her relationships and her role in the family and was now able to easily perform daily tasks. Her walking speed also improved by 13.7% thereby reducing her risk of death. Other beneficial changes included weight loss (15.91 kg) and decreases in fasting glucose, hypertriglyceridemia, lower limb and feet swelling, and hypertension while decreasing her daily intake of pain and diabetes medications.

Conclusion: WBV was effective at safely reducing pain and improving health related outcomes in our participant.

Keywords: Painful; Diabetic Neuropathy whole body vibration

Introduction

Diabetic peripheral neuropathy (DPN), characterized by sensory nerve damage and dysfunction, is one of the most common complications of diabetes, affecting 60-70% of all diabetics, [1] and poses major treatment challenges for a practicing physician. Pharmacotherapy has been accepted as the mainstream treatment strategy for painful DPN. However, this approach includes high cost, minimal pain reductions, side effects, and limited efficacy. In this report, we present the results of a novel therapeutic modality, whole-body vibration (WBV) to reduce lower extremity pain associated with DPN and to improve quality of life (QoL), walking speed, and general clinical characteristics.

Case Overview

The participant was a 63-year-female with type-2 diabetes that had been experiencing symptoms of DPN for seven years. Prior to the WBV intervention, a baseline assessment of her health status and history was taken (Table 1). She was diagnosed with hypertriglyceridemia, peripheral edema, and hypertension and her medications included daily administration of 75 mg *Lyrica* for neuropathy-associated pain, 1000 mg *Metformin* for diabetes, 20 mg Benazepril HCl for hypertension, 135 mg Trilipix for hypercholesterolemia, and 80 mg Furosemide for edema. She reported that the pain in her feet was severe enough that it interfered with her ability to sleep at night, limited her mobility and significantly reduced her QoL and interactions with family members. Significant swelling in the lower legs and feet made it very difficult to stand, walk and to regularly engage in activities of daily living (ADL).

Intervention and Assessment

Whole-body vibration intervention

WBV transmits a vibratory stimulus throughout the body when standing on a vibrating platform. This vibration is created by a mechanical, linear motion, which transfers energy upwardly through the body stimulating muscle contraction [2]. WBV has been successful in reducing back pain and fibromyalgia pain in women [3,4].

At the start of the intervention, the participant stood on the vibration platform for four 1-minute bouts of WBV with 1-minute rest intervals between bouts, three days per week for 12-weeks. While on the WBV platform, the participant stood without shoes with the knees slightly bent and holding onto a wall-mounted safety railing. The intensity (i.e., frequency) and duration of bouts gradually increased from 30-50 Hz (2.3-2.8 g) and from 1-3 minutes over the first four weeks

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Received December 17, 2014; **Accepted** January 29, 2015; **Published** February 05, 2015

Citation: Maddalozzo GF, Guzman RJ, Dvorak RV, Maddalozzo WA, Milroy DA, et al. (2015) Burden of Chronic Low Back Pain with a Neuropathic Pain Component: Retrospective Chart Review and Cross-sectional Survey among Adults Seeking Treatment in the United States. J Pain Relief 4: 171. doi:10.4172/21670846.1000171

Characteristic	Pre-WBV	Post-WBV
Weight (kg)	95.45	79.54
Fasting total cholesterol	270	229
Fasting HDL	35	44
Fasting glucose	125	96
Fasting triglycerides	564	277
Fasting hemoglobin A1c	6.2	5.1
Body composition (% Fat) Bioelectrical impedance	59.7	37.9
Blood pressure	145/80	108/80
Walking speed		
Normal pace (ms/second)	1.0680	1.2140
Numeric rating scale (0-10)		
First and last weeks of intervention	6.0	1.0
Brief pain inventory-short form		
BPI-sf interference index (mean)	6.14	1.4
BPI-sf severity index (mean)	6.25	1.38
BPI-sf pain classification	Moderate pain	Mild pain

Table 1: General clinical characteristics, BPI-sf Mean Pain Indices, Mean NRS Pain Scores and Walking Speed at Pre- and Post-Intervention.

of the intervention and according to the participant's tolerability. From weeks five to 12, the participant received 36 minutes of WBV per week. Before the initial WBV exposure and after each subsequent exposure, the participant reported her pain levels using a 0-10 numeric rating scale (NRS). This scale was used during the intervention to evaluate the acute effect of WBV on pain immediately following each exposure [5,6].

Outcome measures

Pain Severity and Interference: Brief Pain Inventory-short form

The Brief Pain Inventory-short form (BPI-sf) is a self-report questionnaire that measures pain severity and the impact of pain on routine activities (i.e., pain interference) during the 24 hours prior to administration [7,8].

Immediate effect of WBV: numeric rating scale

A 0-10 NRS was used to assess pain levels immediately prior to and following each WBV exposure.

Quality of Life: Neuropathy-Specific Quality of Life (NeuroQoL).

The NeuroQoL instrument was used to evaluate our participant's QoL [9]. This instrument asked her to consider how her foot problems, specifically pain, had affected her QoL over the prior four weeks pre- and post-intervention.

Walking speed

Slow walking speed (<1.09 ms/s) is associated with increased risks for all-cause [10] and cardiovascular [11] mortalities and is strongly correlated with a higher risk of falls and cognitive impairment [12]. Our participant walked at her normal pace on a walkway system (GAITRite) to assess her walking speed at pre- and post-intervention.

General Clinical Characteristics

Results

Key outcomes of this intervention are presented in Table 1.

Discussion

At the conclusion of the intervention, both pain severity and interference scores decreased by approximately 5.0 points (6.25 and 6.14 at baseline versus 1.4 and 1.38, respectively at post-intervention) thus decreasing her pain classification from moderate to mild.

At baseline, her responses on the NeuroQoL instrument indicated that her foot pain had a significant impact on her ability to take part in leisure activities, made her physically dependent on others for help, significantly affected her relationships with others and her role in the family and significantly impaired her ability to perform ADLs. With regards to her self-perception of how foot pain affected her quality of life, she indicated feelings of loss of self-confidence, and frustration, depression, embarrassment, and that the pain made life a struggle. She also felt older and rated her overall QoL as very poor. She reported significant burning sensations in her legs and feet as well as numbness, pins and needles sensation and throbbing pain. Post-intervention, she reported no longer experiencing burning sensations, numbness, pins and needles or throbbing in her legs and feet. Additionally, she reported that as a result of this significant decrease in pain, she experienced significant improvements in self-confidence, no longer felt frustrated, depressed, embarrassed, and felt that her life was no longer a struggle. She was now able to take part in leisure activities, no longer felt dependent on others for help, improved her relationships with others and her role in the family and was now able to easily perform tasks around the home.

There is also anecdotal evidence reported by our participant regarding improvements in lower extremity functioning and strength. Our participant reported being able to walk longer distances and at faster speeds than before beginning the WBV intervention. She also reported improvements in her sleeping patterns, that is, she was able to sleep throughout the night without awaking. It is unknown as to whether this observation is attributable to a reduction in pain or some other phenomena. However, the anecdotal evidence and findings, strongly suggests that WBV may be a suitable method of ameliorating the effect of pain on daily living in this population. Given that the BPI-sf evaluates the effect of pain on sleeping, walking, mood, and other constructs, we can reasonably attribute the decrease of 4.87 points from pre- to post-intervention to changes in these items.

Pain classifications have been consistently associated with patient outcomes and medical utilization [1], and in the United States pain is the leading cause of physician consultation. A review of three studies concluded that, for a 0–10 numerical pain rating scale similar in content to the BPI-sf, pain rating changes of approximately two points represent "meaningful," "much better," or "much improved" reductions in chronic pain [5].

Analyses of the mean acute NRS scores for each treatment session indicate that there was no acute decrease in pain levels through the first 23 sessions (8 weeks) (Figure 1). Starting on the 24th treatment session, NRS scores were observed to decrease during each session and continued to decrease throughout the remaining intervention (Figure 1). However, it is possible that the NRS scores may have improved sooner. The patient started to observe that her edema in her lower legs and feet was decreasing. She was able to once again wear shoes rather than slippers, remain standing longer without discomfort and gradually increase her walking distances. When standing on the vibration platform in stocking feet, the feet and lower limbs experience a significant tingling feeling that can last up to 2-3 minutes. Since our patient started the intervention with minimal feelings of texture and sensations in her feet determined by the Semmes-Weinstein

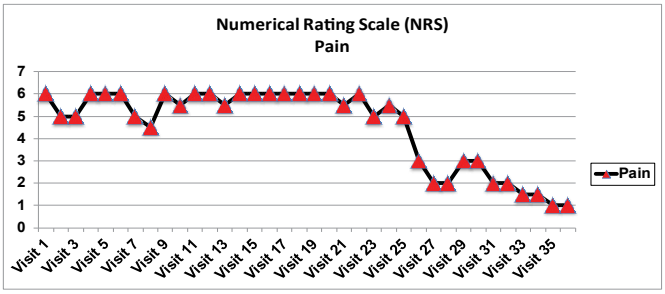

Figure 1: Represents the mean NRS pain score for each treatment. Each treatment consisted of four, 1-minute bouts of WBV with 60 seconds of rest between bouts of WBV. The participant received WBV 3 day/week for 12 weeks for a total of 36 treatments.

monofilament examination, it is possible that these new tingling sensations were initially interpreted as pain. Unfortunately we did not attempt to distinguish differences between tingling and pain. By the 12th week, NRS pain levels were five points (6.0 versus 1.0) lower when compared to the values reported during the first week of the intervention (Figure 1) and correspond with the decreases observed from the BPI-sf pain severity index (Table 1). This is considered clinically significant given the change of pain severity classification from moderate (4-6) to mild (1-3) [6,13].

Although we do not identify a specific mechanism for the change in the sensory aspect of pain, painful symptoms related to neuropathy in diabetics have been strongly associated with poor blood glucose control [14]. Our patient noted significant improvements in her fasting glucose and HbA1c or glycated hemoglobin (Table 1). Hemoglobin A1c levels between 5.7% and 6.4% indicate increased risk of diabetes whereas, levels between 4% and 5.6% are considered normal. Our patients, Hemoglobin A1c level decreased from a baseline measure of 6.1 to 5.1 at the conclusion of the intervention. The decrease our patient observed in her HbA1c support the findings of Lee et al. [15] who also report significant decreases in HbA1c in the elderly with DNP following WBV training.

Our results indicate that consistent use of WBV is associated with an increase in walking function, as defined by walking speed. Our patients' baseline walking speed of 1.068 m/s classified her at a higher risk for all cause mortality. Women with walking speeds <1.09 m/s are associated with a higher risk of death [12]. Post-intervention, her walking speed increased to 1.214 m/s, a 13.7% improvement thus reducing her risk of death. In healthy older adults, a change in walking speed of 0.05 m/s is considered clinically meaningful [16], our patient observed an increase in walking speed of 0.146 m/s. This improvement is consistent with changes observed in elderly adults [17] and individuals with Parkinson's disease [18] receiving WBV therapy. The application of WBV has been shown to increase muscular activation [19], strength and power [20,21], peripheral blood flow circulation [22-24], acutely decreases arterial stiffness in healthy young men (age 26.6 ± 1.9 years) [25], and acutely improve skin blood flow when directly applied to the forearm in diabetics [24] Additionally, WBV has been shown to increase blood flow and activate muscle activity in patients with Friedreich's ataxia and neurodegenerative disease [26] that causes damage to the nervous system. With increased muscle activity, blood flow rate to the active muscles will increase by as much as 20 times the resting rate. We attribute the improved walking function directly to the significant decrease in pain and edema, potentially a result of improved blood circulation in the lower legs resulting from the WBV therapy.

At the completion of the WBV intervention, our participant reported that as the pain in her feet decreased, her physical activity levels increased and she eventually joined a fitness center. This in turn, lead to other significant health benefits including a decrease in fasting glucose (121 to 106), hypertriglyceridemia (drop of 287 points), and a decrease in peripheral edema. Moreover, her pain and hypertension symptoms improved to the extent that her Lyrica and Benazepril HCl were stopped, and her Metformin was reduced by 50%. Additionally, our patient observed a weight loss (15.91 kg) and decrease in percent body fat of 36.5%. We have shown experimentally that WBV has beneficial effects related to weight gain prevention in female rats [27].

Conclusions

This case study provides first evidence that WBV could be an effective and relatively inexpensive therapeutic modality compared to prescription drugs to treat patients with painful diabetic neuropathy. Of course, appropriately powered studies are needed to fully elucidate its therapeutic potential. However, the magnitude and broad spectrum of improvements provides a basis to expeditiously embark on such an investigation.

Acknowledgment

John C. Erkkila, M.D. Endowment For Health and Human Performance.

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