International Journal of Diabetes Mellitus (2011) xxx, xxx–xxx

Diabetes Science International

International Journal of Diabetes Mellitus

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CASE REPORT

Case study: Use of vibration therapy in the treatment of diabetic peripheral small fiber neuropathy

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Received 29 December 2010; accepted 25 January 2011

KEYWORDS

Whole body vibration;
Peripheral neuropathy;
Diabetes

Abstract The aim of the study was to describe a case of type II diabetic peripheral small fiber neuropathic pain treated with whole body vibration therapy after a failed trial of conventional drugs and interventional pain management. A 64-year-old male had chronic diabetic peripheral neuropathic pain in both his feet for about 2 years. The patient tried multiple pain medications and various interventional pain treatments without significant pain relief. After 4 weeks of whole body vibration treatment the patient's pain level and gait patterns significantly improved. These findings illustrate the importance of considering whole body vibration as a complimentary treatment in patients with diabetic peripheral neuropathic pain.

1. Introduction

Peripheral small fiber neuropathy is characterized by the presence of lesions on or dysfunction of the small nerve fibers, which innervate the epidermis. This disorder can affect both autonomic and somatic nerve fibers, and therefore presents a wide variety of symptoms ranging from pain and tingling sensations (somatic lesions) to skin discolorations, atrophy and sweat gland malfunction (autonomic lesions) [1]. These symptoms can also range anywhere from severe pain to mild tingling sensation or slight numbness.

Peripheral small fiber neuropathy is relatively common, affecting 1% of the world population, and 50% of the elderly diabetic population [2]. Due to its prevalence, diabetic peripheral neuropathy (DPN) is considered an epidemic, especially due to the fact that the number of people who are elderly and diabetic are quickly on the rise.

Treatment options for DPN are extremely limited; most treatment approaches focus on control of the patient's diabetes in order to prevent the DPN from getting worse. The only non-prophylactic treatments available are powerful medications such as antidepressants and antiepileptics [3]. There is only one drug approved by the Food and Drug Administration (FDA) specifically for treatment of DPN, and it is a powerful neurotransmitter reuptake inhibitor [4]. These medications are not a favorable treatment protocol for chronic conditions such as DPN, because the side effects they cause can become more debilitating than the original pathology.

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doi:10.1016/j.ijdm.2011.01.010

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Whole Body Vibration (WBV) is a relatively unexplored therapeutic modality, only having been used previously for strength, conditioning and neuromuscular training purposes. While whole-body-vibration recently has been shown to improve strength and balance in clinical population with stroke, fibromyalgia, and Parkinson's disease [5–7], it has yet to be applied as a treatment method for controlling pain and improving mobility disorders. The purpose of this study was to describe a case of type II diabetic peripheral small fiber neuropathy with whole body vibration therapy after a failed trial of conventional drugs and interventional pain management.

2. Description of case

A 64-year old male in Salem, Oregon, USA, diagnosed with type II diabetes six years previously, was recruited for this study two months after his physician confirmed diabetic peripheral neuropathy (DPN). The patient reported that he was active every day but was often unable to put pressure on his feet and would have to sit or lay down to relieve the pain. The only treatment he was receiving for DPN was taking acetaminophen (Tylenol) daily to control his pain, although this was not always effective. As an inclusion criterion and a screening process, his foot pain (both feet) was assessed with the neuropathy pain scale. He was instructed not to change his normal activity patterns during the study. The study was approved by the IRB and informed consent was obtained before any intervention.

The patient received four bouts of 3 min of vibration treatment (total 12 min) at 20 Hz five times a week for four weeks. The patient wore socks during treatment and stood with both feet on the platform, knees slightly bent for almost all bouts. Every week, the Neuropathy Pain Scale (NPS) variables were evaluated both pre and post treatment: intensity, sharpness, hot, dull, cold, sensitivity, itchy, unpleasant, deep and surface. During every day of treatment the patient reported the pain in each foot on a Visual Analog pain Scale, or VAS. Each week the patient's gait was analyzed on 8 m GAITRITE mat (CIR Systems, Clifton, NJ, USA). The patient's stride and step length, toe in/out, step and stride width, gait cycle time, step time, ambulation time, velocity and distance traveled were recorded.

3. Results

After 4 weeks of vibration treatment, the patient's pain in both feet decreased and gait improved significantly. One week after the treatment ended, the patient reported that the pain in both feet was still significantly lower than before treatment; his right foot was 1 on the VAS and his left foot 2. Two weeks after treatment had ended the patient reported that both feet were around 2–3 on the VAS. This indicates that, while pain may slowly return after a long period of time, whole body vibration has positive long term effects on neuropathic pain.

4. Discussion

The results of this study indicate that whole body vibration reduces both acute and long-term pain in diabetics suffering from peripheral neuropathy. Due to the nature of peripheral neuropathy, finding a cure is unrealistic. Thus, finding a treatment to relieve symptoms is a more pragmatic approach to this condition. Whole body vibration is a treatment option that can reduce pain, and improve ability to participate in activities and over-all quality of life for DPN sufferers. It is a non-invasive treatment and has no known side effects.

Over the course of the treatment this therapy showed a significant reduction in reported VAS (Fig. 1). It also showed a significant reduction in all monitored NPS variables (Fig. 2). We chose to only display the intensity, sharpness, unpleasantness and deep pain, due to the fact that these were the only variables that were relevant to this case. Other NPS variables were monitored but no significant results were found.

The result of our case study revealed a notable acute pain reduction after each vibration treatment. The pain level (Fig. 4) measured immediately after each treatment was averaged 2.68 and 1.20 for the right and left foot, respectively (Fig. 3). With this significantly reduced pain level, we also measured how long this immediate effect would last. The results showed that pain was reduced after each therapy session for an average of three hours and that the level of pain, which returned after this period was still reduced compared to the original pain level (Fig. 4). This is clinically significant due to the fact that most neuropathy patients yearn for some level of pain relief and because pain level is so closely associated with the patients' quality of life.

One of the plausible mechanisms by which whole body vibration reduces pain can be found in both peripheral and central mechanisms. According to the gate control theory of pain, the strength of synaptic transmission at the dorsal horn and, similarly, at the trigeminal ganglia junctions is decreased, probably by pre-synapatic inhibition, when large, non-pain-signaling axons within the nerve are stimulated [8]. These are touch receptors and vibration receptors (Pacinian corpuscles and Meissner's corpuscles). According to Longe et al. in a discussion postulating the responsible mechanism for pain reduction by vibration "The mechanism of action of these procedures is generally explained by the gate-control theory of pain inhibition in which large diameter sensory fibers (A–β), conducting impulses from the selective activation of low threshold mechanoreceptors, reduce the painful input of the small diameter nociceptive afferents (C-fibers) by triggering local inhibitory circuits in the substantia gelosa of the dorsal horn" [9]. In the cat model, vibration has also shown to inhibit nociceptive receptors in the dorsal horn neuron [10]. Acting in a central location, vibrotactile and pain sensations are known

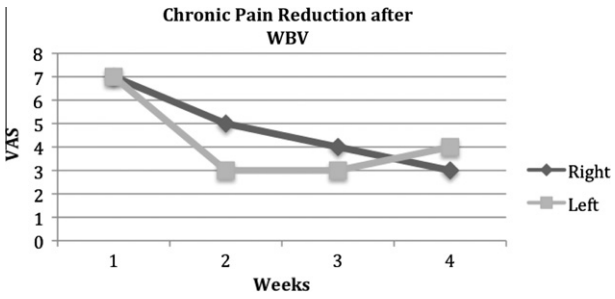

Figure 1 Changes in pain perception before WBV treatment over the study period.

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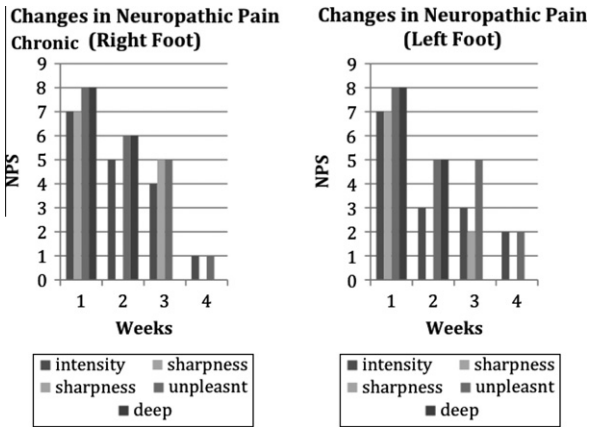

Figure 2 Changes in specific neuropathic pain variables in both feet.

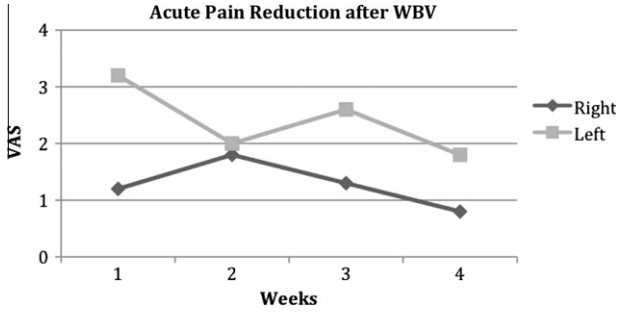

Figure 3 Changes in acute pain reduction over the study period.

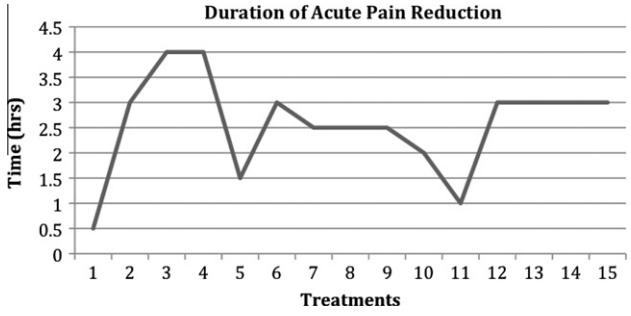

Figure 4 Changes in acute pain reduction duration over the study period.

to produce activation in similar regions within the somatosensory cortices of the brain [11].

Regarding the interaction of vibration and pain, Kakigi and Shibasaki confirm the role of vibration in alleviating pain [12]. In a later study Kakigi and Watanabe show that both the gate control theory and diffuse noxious inhibitory control accounted for the pain relief following CO_2 laser stimulation, rather than simple changes in the subjects' attention [13]. The authors suggested that the vibratory pain relief effect is not simply at the level of the dorsal horn but also in the brain. They further explained that the responsible sites for this phenomenon are the dorsal horn of the spinal cord, the brainstem and some parts of the brain such as the second sensory cortex and the cingulate cortex.

Table 1 Changes in gait parameters after 4 weeks of vibration therapy.

	Pre	Post
Ambulation time (s)	4.44	3.7
Velocity (cm/s)	99.10	119.80
Cadence (steps/min)	108.10	113.5
Step time		
L	0.55	0.52
R	0.56	0.55
Cycle time		
L	1.11	1.05
R	1.11	1.06
Swing times		
L	0.38	0.38
R	0.39	0.40
Step length		
L	55.26	64.05
R	54.71	62.74
Stride length		
L	111.47	128.74
R	110.21	127.20
Base of support		
L	12.00	8.00
R	12.08	10.52

As well as improving quality of life in patients by reducing pain, WBV also has great potential to reduce their risk of serious injury. The gait variables examined before and after 4 weeks of vibration therapy (Table 1) showed that the patient's gait notably improved in most of the variables. Step time, stride length, and cadence all increased, and gait velocity and ambulation time decreased. Specifically, the coefficient of variations of temporal gait variables was decreased indicating that the gait of the patient became more consistent. The idea that WBV can improve confidence in gait makes it a desirable treatment option considering the majority of DPN patients are elderly and are prone to falls, and at a higher risk of injury [14,15].

This study indicates that the whole body vibration treatment reduces neuropathic pain, and improves gait in a patient with type II diabetic peripheral neuropathy. Although, research on this topic is in its infancy, the incorporation of whole body vibration into other therapeutic treatment protocols for diabetic peripheral neuropathy patients may offer promise. In this single subject study, possible placebo and learning effects cannot be completely excluded. Our report is intended to further a discussion about the possible use of whole body vibration in patients with diabetic peripheral neuropathic pain. Whole body vibration treatment warrants further investigation over the course of a longer, prospective study; in addition, long term follow up is required to help us understand if any side effects are associated with this possible therapeutic modality.

Acknowledgments

The authors are grateful for the support of Dr. Peter Harmer and the iHuman Sciences Initiative (iHSI) at Willamette University.

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