The short term-effects of both feet plantar vibration in post stroke patients balance

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Abstract

Background and Aim: Balance disorder is a common problem in post stroke patients. Vibration therapy is one of the interventions that is used to treat this impairment in physiotherapy. There are several studies on the effects of more affected foot plantar vibration on balance, however according to the researchers this cerebral lesion causes bilateral side effects in the body. So the aim of this study was to investigate the short-term effects of both feet plantar vibration on the balance of post stroke patients.

Methods: This pretest-posttest clinical study included 12 post stroke patients (8 male and 4 female, mean age 52.41 ± 9.03 years). The participants received one session of 5-min vibration stimuli (frequency, 100 Hz) to the plantar region on both feet. Mini-Balance Evaluation Systems Test (Mini-BESTest) score and plantar cutaneous sensation by Semmes Weinstein monofilament examination (SWME) were assessed before and immediately after the intervention.

Results: Mini-BESTest mean total score improved significantly (p ≤ 0.001) after both feet vibration and these results were supported by a large effect size (Cohen d = 2.83). Mean number of detected points by SWME decreased after vibration therapy (p = 0.06) but it was not statistically significant.

Conclusion: The findings suggest that local vibration applied directly to the plantar region of both feet in post-stroke patients could be an appropriate physiotherapy intervention to improve their balance.

Keywords: Vibration; balance; stroke

Introduction

Stroke is one of the most important causes of disability in adults which can happen at any time and to anyone. This brain disorder is the second commonest cause of death in the world [1]. A large number of survivors of stroke have a combination of sensory and motor impairments leading to a decrease in the quality of their daily living [2]. Impaired postural control which leads to a balance disorder has the greatest impact on individual independence. More than 90% of patients with chronic stroke suffer from balance
Another study on post stroke patients [13] reported, that if the patient not able to stand on his affected leg for 30s with eyes open and d) ability to walk independently. Exclusion criteria were: a) receiving any balance treatment, b) any other disease that effects balance according to a neurologist, c) lower-limb surgery during last year, and d) unwillingness to participate in the study.

Twelve post stroke patients enrolled in this study. They were interviewed to collect information about age, sex, height and weight for body mass index (BMI [kg/m²] = weight [kg]/height [m²]) and duration since stroke onset. The outcome measures were balance and plantar cutaneous sensation which were assessed in order by Mini-BESTest [14] and Semmes Weinstein monofilament examination (SWME) before and immediately after intervention.

The Mini-BESTest is a clinical balance test [14] which consists of 14 items and assesses balance using four subsystems (anticipatory postural adjustments, postural responses, sensory orientation, and balance during gate). Each item scored from 0 (lowest level of function) to 2 (highest level of function), so the maximum score is 28 [15]. This test is a reliable and valid
measurement tool for assessing balance in post stroke patients [16]. Monofilament testing was used to assess plantar cutaneous sensation. The 5.07/10 g monofilament has been recommended as the best indicator to determine peripheral neuropathy of the feet [17,18]. Participants were in supine position, with closed eyes and had rested for 5 minutes before the test. The assessor put a flexible nylon with perpendicular angle to one of the 10 points plantar surface in no specific order, including: nine plantar sites (distal great toe, third toe, and fifth toe; first, third, and fifth metatarsal heads; medial foot, lateral foot, and heel) and one dorsal site [19]. Then slight and steady pressure was applied until the monofilament began to bend. If the participant was able to detect the touch at this movement they said “Yes” (Fig. 1), the physiotherapist did this process for the other points and recorded the number of detected points [20]. This measurement tool is an easy-to-use, inexpensive, portable and reliable and valid tool to detect the peripheral neuropathy [21,22].

A custom-made vibratory device (Erteashate Tebbie Iranian Co, Tehran, Iran) was used to apply plantar vibration to both feet. The subject was in supine position on a treatment bed with knees flexed by pillows under them and barefoot. This device has two vibrators located within a box (dimension [width × length × height, 30×45×20 cm]) and two plates for the feet have been placed at the top of the box to deliver the vibration stimuli to the entire plantar regions (Fig. 2), the physiotherapist positioned both feet on the plates and fixed them with its Velcro straps. Participants received plantar vibration with 100 Hz frequency for 5 minutes and immediately were assessed after intervention once again.

Results

Twelve stroke patients (4 females, 8 males, mean age, 52.41 ± 9.03) participated in the present study (Table 1). Kolmogorov-Smirnov (K-S) test showed all the data were normally distributed. The significance was set at p ≤ 0.05. Paired t-test was employed to compare the pre/post data. Cohen d was calculated to determine treatment effect size [23]. Participants improved significantly not only on the Mini-BES Test mean total score (p ≤ 0.001) but also on all mean scores of subscales after both feet vibration and this result was supported by a large effect size (Cohen d = 2.83). Mean number of detected points by SWME decreased from 8.5 to 7.5 after vibration therapy (p = 0.06) but it was not statistically significant (Table 2).

Discussion

The results of this study showed significant improvement in balance after plantar vibration of
both feet in patients after stroke. The balance improvement after one foot plantar vibration in post stroke patients was reported previously [9-11]. This is the first study, to our knowledge, which has investigated the short-term effects of both feet plantar vibration on the balance of these patients.

The mean of Mini-BES Test total score improved after both feet plantar vibration (on average 3.7 score) which was supported by a large effect size (Cohen d = 2.83). As Minimal Detectable Change (MDC) for Mini-BES Test was 3.5 score and Minimal Clinical Important Difference (MCID) was 4 score [24], therefore, after both feet plantar vibration the changes in the mean of Mini-BES Test total score were more than MDC and close to MCID. Whilst Karimi-Ahmad Abadi et al. reported the mean of Mini-BES Test total score after 5 minutes had affected foot plantar vibration more, with frequency 100 Hz, and had a significant improvement (on average 3.5 score, Cohen d = 0.85). Also she reported that plantar vibration of the affected foot was effective for improving ankle plantar flexor spasticity, and ankle dorsiflexion passive range of motion in post stroke patients [10]. A case study reported the positive effects of another 5 minutes affected foot plantar vibration, frequency 100 Hz, on balance improvement in a patient after stroke [19]. Another study found that the plantar vibration, frequency 100 Hz, had beneficial effects in improving balance of older women [8]. Recently a study on the immediate effects of one foot plantar vibration on balance dysfunction in patients with stroke showed that, 5 minutes vibration with frequency 100 Hz can improve the functional mobility and dynamic balance in patients with stroke [11].

The exact mechanism is unclear for balance improvement occurring after local vibration. The explanation for improvement in balance might be that the vibration, by stimulating cutaneous and proprioceptive receptors, has positive effects on the sensory system. Therefore, the sensory system provides more efficient information about the surroundings to the central nervous system and better neuromuscular responses will be produced for posture [8,25]. In addition, corticorticalic neurons originating from motor area descend ipsilaterally and bilaterally, and are involved in postural responses and can produce postural widespread effects [26,27]. Thus, balance improvement after both feet plantar vibration may be because of its effects on postural control. In this study, the mean number of detected points in monofilament examination decreased after intervention, but it was not statistically significant. A randomized clinical trial recently reported that the acute response of the vibro-tactile threshold to one whole body vibration session increased but the 48 hour short-term response of this threshold decreased in healthy young adults [27]. It is highly likely that the load of vibration leads to adaptation of sensory receptors and immediate assessment of plantar cutaneous sensation did not allow them to return to their initial sensitivity and were in a fatigue phase. It is hoped that long term plantar vibration can improve postural control and consequently balance in post

| Table 1. Demographic characteristics of patients with stroke (n = 12) |
|--------------------------|--------------------------|
| Characteristic           | Mean (SD)                | Range        |
| Age (year)               | 52.41 (9.03)             | 33–69        |
| Body mass index (kg/m²)  | 25.34 (4.34)             | 16.6–30.5    |
| Duration of stroke (year)| 5.29 (5.6)               | 0.8–17       |

SD: standard deviation

| Variable                              | Pre-treatment | Post-treatment | p     |
|---------------------------------------|---------------|----------------|-------|
| Mini-BESTest mean (SD) total score    | 20.08 (3.42)  | 23.83 (2.08)   | ≤ 0.001 |
| Mean (SD) number of detected points (SWME) | 8.5 (1.78)   | 7.5 (2.11)     | 0.06  |

SD: standard deviation, SWME: Semmes Weinstein monofilament examination

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stroke patients.

Conclusion
In conclusion, vibratory stimuli at a frequency of 100 Hz applied to both feet plantar region of patients after stroke could have beneficial effects on their balance disorders.

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Conflict of interest
There are no conflicts of interests to be declared.

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Sajedifar et al. 58
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