Neuroscience Letters 533 (2013) 81–85

Contents lists available at SciVerse ScienceDirect

Neuroscience Letters

journal homepage: www.elsevier.com/locate/neulet

Human cutaneous sensors on the sole of the foot: Altered sensitivity and recovery time after whole body vibration

Anelise Sonza[a,b,*], Christian Maurer[a], Matilde Achaval[b], Milton A. Zaro[b], Benno M. Nigg[a]

[a] Human Performance Laboratory, Faculty of Kinesiology, University of Calgary, Calgary, Alberta, Canada
[b] Instituto de Ciências Básicas da Saúde, Universidade Federal do Rio Grande do Sul, Porto Alegre, RS, Brazil

HIGHLIGHTS

- Whole body vibration affects the discharges of fast-adapting skin mechanoreceptors.
- Recovery time provides a time window of how long the effects of WBV can last.
- Vibration induces a reduction in touch pressure and vibration sensitivity.
- No gender differences were found.

ARTICLE INFO

Article history:
Received 11 September 2012
Received in revised form 9 November 2012
Accepted 14 November 2012

Keywords:
Mechanoreceptors
Post vibratory effects
Whole body vibration
Human tactile sensitivity
Exercise

ABSTRACT

The goal of this study was to investigate the effect of whole body vibration (WBV) on human tactile sensitivity, both the immediate effects and the recovery time in the case of altered sensitivity. Twenty adults (25.3 ± 2.6 years, 10 males) participated in a 10-min WBV session, at a frequency of 42 Hz with 2 mm amplitude in a spiral mode. Sensitivity was measured before and four times after WBV exposure. Pressure sensation was determined using Von Frey monofilaments. Vibration perception thresholds for 30 and 200 Hz were measured using a custom built neurothesiometer. The sensation was measured in 5 anatomical regions of the right foot. Sensitivity of measured cutaneous perception was significantly reduced. Fast-adapting mechanoreceptors for 200 Hz and 30 Hz showed 5.2 and 3.8 times lower sensation values immediately after WBV, respectively. Pressure sensation was 2 times lower in comparison to the baseline condition. In general, tactile sensitivity recovery time was between 2 and 3 h. WBV influences the discharge of fast-adapting skin mechanoreceptors. By determining the recovery time, it might be possible to estimate how long the effects of WBV on tactile sensitivity last.

© 2012 Elsevier Ireland Ltd. All rights reserved.

1. Introduction

Whole body vibration (WBV) training platforms have been widely used for rehabilitation and/or performance purposes [19]. The reduced effort required to perform exercises in these machines, especially among patients with disabilities, might explain why this equipment has become so popular. It is important to investigate the responses to WBV in the human system in order to make safe recommendations for its use.

In WBV, the skin is the first tissue that receives the vibration stimulus. The feet have various receptors in the skin that provide feedback to the central nervous system [7,8,11]. The nervous conduction from the mechanoreceptors travels along large diameter afferent A_α/A_β sensory fibers. They are classified as slow (SA) or fast (FA) adapting receptors. The SA receptors produce sustained responses to static stimulation. The FA receptors are sensitive to the rapid application and release of a stimulus [9] and are particularly sensitive to mechanical vibrations [17]. FA mechanoreceptors can be divided into Meissner and Pacinian corpuscles, the former are related to low (30 Hz) and the latter to high (200 Hz) vibration frequencies.

WBV has been shown to influence large diameter fibers, with sensitivity being reduced immediately after its application, as shown by touch-pressure [16] and the vibration perception (200 Hz) threshold (VPT) [20]. Notwithstanding, there are very few studies which report the effects of WBV on foot sensitivity.

Abbreviations: WBV, whole body vibration; SA, slow adapting mechanoreceptors; FA, fast adapting mechanoreceptors; VPT, vibration perception threshold; TENS, transcutaneous electrical nerve stimulation.

* Corresponding author at: Instituto de Ciências Básicas da Saúde, UFRGS, Rua Sarmento Leite, 500, 90046-900 Porto Alegre, RS, Brazil. Tel.: +55 51 33083624; fax: +55 51 3308 3092.
E-mail address: anelise.sonza@gmail.com (A. Sonza).

0304-3940/$ – see front matter © 2012 Elsevier Ireland Ltd. All rights reserved.
http://dx.doi.org/10.1016/j.neulet.2012.11.036

The post-vibratory disturbances affecting skin mechanoreceptive afferent units were studied by microneurographic recordings after 10 min of local vibration. They showed a decrease in the fiber excitability which may last longer than few minutes [18].

Given that reduced mechanoreceptor sensitivity could increase the risk of falls [11], it is important to know the length of time the reduced sensitivity persists after WBV. However, to the best of our knowledge no study has investigated this subject. Therefore, the purpose of this study was to investigate the effects of WBV on human tactile sensitivity considering the mechanoreceptors for touch-pressure and vibration sensitivity. The specific hypotheses were: (A) sensitivity to touch pressure, 30 Hz and 200 Hz vibration receptors decreases after 10 min exposure to WBV; (B) the effects of WBV last for several hours.

2. Material and methods

2.1. Subjects

Based on the literature [16] the sample size was chosen to include 10 male and 10 female healthy subjects (male: mean (SD in brackets) age 25.9 (±3) years, height 177.2 (±10.2) cm and weight of 73.2 (±12.3) kg; female: mean age 24.7 (±2.3) years, height 167.4 (±6.3) cm and weight of 60.3 (±6.9) kg). All subjects were invited to the Human Performance Laboratory of the University of Calgary (Canada), where the experiment was conducted. Nineteen subjects were physically active with a mean of 5.8 h of exercise per week. None of them had trained on vibration platforms before the intervention. They were free from muscle–skeletal disorders and cognitive dysfunctions. Exclusion criteria were mainly based on contra-indications for WBV [2].

All procedures were approved by the Ethics Committee of the University of Calgary (protocol number 24334) and were in accordance with Declaration of Helsinki.

2.2. Data collection

Data collection included measuring the sensitivity of the foot to touch-pressure and vibration before, immediately after and 1 h, 2 h and 3 h after 10 min exposure to WBV. Each session lasted approximately four and a half hours. WBV training was performed on a vibration platform (TBS100A, Total Image Fitness, Inc., CA). The settings for the WBV exposure (42 Hz, 2 mm amplitude and spiral mode) were chosen based on the results of a prior pilot study because they were found to produce the greatest sensation in the lower legs and feet. The greatest sensation was quantified by the subjects who gave a vibration sensation rating or the highest discomfort level (where they felt the vibration most in their body) to a systematic change of vibration stimuli. The subjects stood, bare foot, on 3 mm of EVA foam with straight legs in an upright position and fixed support base.

Sensitivity to touch-pressure and vibration were measured in 5 anatomical regions of the right foot: heel, the mid-foot (medial arch for touch-pressure sensitivity and lateral for vibration sensitivity), the 1st and 5th metatarsal heads and the hallux. Skin temperatures were monitored using a digital thermometer probe (Fluke Thermometer (50A K/J, John Fluke MGF. Co., Inc., USA) and maintained between 25 °C and 32 °C. The temperature of the foot was taken before each measurement procedure. Subjects whose foot temperature changed more than 2 °C in relation to the control measurement (taken before the WBV exposure) were excluded from the analysis because a significant change in plantar vibration sensitivity was reported for temperature changes of around 5 °C [21].

The tests took place in a quiet environment, with a room temperature of between 20 °C and 23 °C. The subjects spent 10 min without shoes prior to the measurements being taken in order to adjust to the room temperature.

2.3. Touch-pressure sensitivity

To evaluate touch-pressure sensitivity, Semmes–Weinstein monofilaments (Touch-Test™ Sensory Evaluator, 20 piece Kit, 58011, Stoelting Co., USA) were used. Each filament has a specific diameter and a known buckling force. The filaments were numbered in such a way that each number represented the $\log_{10}$ (F[mN]), where the applied force value is in milli-Newtons. The order in which the foot regions were measured was randomized. The subject laid supine with closed eyes. A modified 4, 2, 1 stepping algorithm, proposed by Dyck [5], was used for the protocol procedure. Five repetitive stimuli, including a null stimulus, were given with each tested filament [13].

2.4. Vibration sensitivity

The vibration perception threshold (VPT) is defined as the amplitude of a vibration stimulus that is perceptible to a subject. The VPTs were measured using a custom built device that could alter both the frequency and amplitude of a vibrating metal probe (TACLAB, SJB Research Laboratories, NY, USA). Sinusoidal vibration stimuli were delivered to the skin with the probe connected in series to a magnetic shaker (model V203/32 UNF-CE, LDS, UK). The 9 mm diameter circular probe was introduced through a footrest platform and applied to the plantar surface of the foot. The tip of the probe was initially adjusted to protrude 2 mm above the level surface of the wooden platform. A protocol presented by Nurse and Nigg [15], was used. The experimenter increased the vibration amplitudes slowly at about 1 μm in 5 s [7] and manually. When the subjects announced the stimulus recognition, the values were taken by the experimenter. All measurements were performed by the same researcher to increase the reliability of the collected data.

Skin contact force was set to 1 N (±10%), and monitored with a capacitive sensor (FSR 402 0.5″, Interlink Electronics, USA) mounted between the shaker and the probe. The threshold for the vibration sensitivity was measured in dB and converted to the vibration amplitude in μm using a calibration table that was measured prior to the experiment.

Visual feedback about the force they applied on the probe was provided and subjects were asked to keep the force level constant. Five repetitions of the sensitivity measurement were performed at each anatomical location. Considering the optimal response of the Vater-Pacini corpuscles at frequencies between 200 and 250 Hz [12] and Meissner corpuscles at a frequency of 20–50 Hz [22], thresholds were measured at 200 Hz and 30 Hz.

2.5. Recovery time

It was quantified using the half-life time, which is the time period needed to reduce the changes after WBV exposure by a factor of 2. This time can also be thought of the time it takes for the subject's sensitivity to return to half the normal level.

2.6. Statistical analysis

The mean and the standard error were calculated for the control measurement and between gender, which was the measurement taken before exposure to WBV. All data were normalized to the subject specific control value in order to reduce subject specific differences. Changes in sensitivity in relation to the control condition were tested for normal distribution using the Lilliefors test. Due to the non-parametrical nature of the data, a Wilcoxon signed rank test was used. The level of significance was corrected by means

Download English Version:

https://daneshyari.com/en/article/6283804

Download Persian Version:

https://daneshyari.com/article/6283804

Daneshyari.com