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INFLUENCE OF WHOLE-BODY VIBRATION STATIC EXERCISE ON QUADRICEPS OXYGENATION

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1. INTRODUCTION

Whole-body vibration (WBV) is a neuromuscular training method recently designed to improve muscle strength and flexibility.[1-9] More recently, WBV has been proposed to be a suitable training method as efficient as conventional resistance training to improve knee-extension strength and speed of movement and counter movement jump performance in older women.[10] The acute effects of vibration seem to be connected to the duration of the stimulation, the characteristics of the subjects (well trained vs. untrained), and the magnitude of the vibration stimulus (amplitude, frequency and acceleration). When the human body undergoes vibratory stimuli, muscle activity is necessary for damping the vibratory waves. It is assumed that vibrations evoke muscle contraction, probably via the monosynaptic stretch reflex. Although the electromyography (EMG) activity of the *vastus lateralis* (VL) muscle during WBV has been investigated,[4] there are no studies about the effects of WBV on the oxygenation (oxidative metabolism) of leg skeletal muscles.

This study aimed at investigating the oxygenation response (measured as tissue oxygenation index (TOI)) in *rectus femoris* (RF) and VL muscle groups during different frequencies of WBV.

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2. METHODS

Seven volunteers (age: 23±2 years; body mass: 79±9 kg) participated in this study. Subjects were physically active although none were engaged in daily, intensive or specific training programs. All subjects gave their informed consent prior participation after a full oral and written explanation of the experiments. Subjects were asked to stand in half-squat (HS) position (knee angle 110°) on a vibration platform (NEMES, OMP, Italy) in the following conditions: no vibrations, and randomly 30, 40, and 50 Hz WBV. Each condition lasted 110 s, and the interval between sets was 45 min. Muscle oxygenation was monitored by a 2-channel NIRO-300 oximeter (Hamamatsu Photonics, Japan). The emission and detection probes were kept at a constant geometry and distance (4.5 cm apart) by a rigid rubber probe holder. Muscle O_2 saturation in RF and VL was measured as TOI (%). TOI reflects the balance between O_2 supply and O_2 consumption in the examined muscle volume. TOI was also measured during the standing (S) position that preceded the HS position at the beginning of each set. Concomitantly total hemoglobin volume changes (ΔtHb, μM*cm) were monitored. The sampling rate of NIRS data was 6 Hz. Adipose tissue thickness underlying the monitored VL and RF area was measured with a skinfold caliper. Adipose tissue thickness (ATT) was 4.2±0.9 mm and 4.4±1.8 mm for VL and RF, respectively. These similar ATT values allowed the correct comparison of NIRS data between the two muscle groups.

Data are reported as mean ± standard deviation of TOI and tHb changes (average over the last 5 s in every subject) for each condition. TOI and changes in tHb were compared between conditions by repeated measures analysis of variance. Significance level was set at $P<0.05$.

3. RESULTS

Oxygenation responses observed in VL and RF of one representative subject for each experimental condition are reported in Fig. 1. A significant TOI decrease was observed in RF muscle after about 40 s of WBV at 30 Hz. Concomitantly, tHb was almost stable. TOI slightly decreased in VL over the last 50 s of WBV exposure, and tHb gradually increased. TOI did not change in RF and VL in the remaining conditions, whilst tHb tended to increase. Furthermore, the pattern and the amplitude of tHb raise were different among WBV frequency conditions. Considering the averaged response over the 7 subjects (Fig. 2), WBV did not affect TOI value in VL muscle, while induced a consistent decrease of TOI in RF muscle only at a frequency of 30 Hz compared to TOI measured during baseline condition (standing). Comparing TOI of half-squat condition with TOI during WBV condition provoking the highest TOI decrease, a significant difference was found in RF (from 59.3±5.3 to 53.0±6.4%, $P=0.04$) and VL (57.6±2.5 to 50.3±7.9%, $P=0.03$).

4. DISCUSSION

Initially, WBV training was used in elite athletes to improve speed-strength performance. More recently, it is becoming extremely popular in European health and fitness clubs as an alternative training method. However, a consistent scientific support