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Original Research

Effects of Whole Body Vibration on the Horse: Actual Vibration, Muscle Activity, and Warm-up Effect

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ABSTRACT

Whole body vibration (WBV) exercise has been introduced into human and recently also into equine training. Only a few studies about physical and physiological effects on horses are available. This study should clarify the actual physical vibration of a commercially available WBV plate itself and on the horse as well as the muscular activity in the limbs and back. Furthermore, the effects of WBV warm-up on clinical parameters and body surface temperatures were compared to standard warm-up exercises. Ten sound horses (vibration and muscle activity of six horses) were recorded while standing (control) and during 15 and 25 Hz (manufacturer information) vibration exercise. The vibration of plate, hoof, fetlock, withers, and sacrum was analyzed for frequency, peak-to-peak displacement, and peak acceleration. Activity of M. triceps, quadriceps, and longissimus dorsi was assessed using surface electromyography. Warm-up effects were compared between four different warm-up scenarios: standing (control), 10-minute vibration, 10-minute lunging (walk), and 12-minute lunging (walk and trot). Maximal body surface temperature of upper forelimb, thigh, and back was measured. Actual plate vibration frequency was 7 or 11 Hz with a maximum peak-to-peak displacement of 9 mm in longitudinal direction. WBV exercise induced no increase in electromyographic activity, clinical parameter, or body surface temperature. It was concluded that actual plate vibration was mainly longitudinal with a lower frequency than proposed and 10-minute exercise had no significant effect. Different vibration protocols and vibration acting in the vertical direction might enable more effective exercise in horses.

1. Introduction

Whole body vibration (WBV) has gained wide popularity in human fitness and training centers as a safe training device and also in human medicine as a physical therapeutic method especially in elderly and osteoporotic patients [1,2]. Scientific evaluations of WBV effects analyzed various aspects of athletic performance like warm-up effects, flexibility, range of motion, sprint performance, force and power development, or balance [1–4]. The potency of WBV as a training method, however, is quite controversial. Although WBV has been reported to show positive effects on warm-up, flexibility, and range of motion [2] or reduced muscle soreness [5], the effects on athletic performance are small and inconsistent [6]. On the other hand, vibration might offer several possibilities for clinical applications. Especially in elderly people, postural sway may be reduced and balance improved [1]. These effects might be especially beneficial in Parkinson's disease or multiple sclerosis [7]. However, a simple transfer from

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studies on healthy subjects cannot be transferred to patients as the complex neurologic, cognitive, and behavioral components have to be taken into account [8].

Generally, WBV seems to be a safe modality, producing no adverse side effects or harm. However, reasons for quite diverse results about WBV effects might be based on differences in protocols and study designs as well as variations of physical aspects of the vibration device. Therefore, recommendations for the reports about WBV studies have been published and can help to improve the quality of WBV trials [9].

Based on experiences in human exercise physiology and rehabilitation, increasing interest also evolved in the equine sports industry and many applications are proposed also for rehabilitation purposes in horses (http://www.vitafloor.com/ [5.4.2016], http://www.equivibe.com/ [5.4.2016], http://www.theraplate.com/ [5.4.2016], http://equinevibrationplate.reviews/ [5.4.2016], http://www.marquis-vetec.com/produkte/marquis-vms/ [5.4.2016]). However, only few scientific studies deal with effects on equine locomotion or physiology. Although the investigated device was well tolerated by horses, only very little physiological effects were reported, like a small step length increase [10] or decrease of creatine kinase and cortisol [11]. However, many aspects of the vibration intervention remained unclear, like type and direction, actual frequency, and extent of the vibration (displacement). Furthermore, the amount of the transmission of the vibration to the equine body is not known. However, such parameters are crucial to the assessment of the vibration intervention [9]. Similarly, WBV effects on warm-up parameters like core or muscle temperature compared to effects of other warm-up regimen are not known.

The aim of this study was to analyze the effects of a commercial WBV device for horses using two approaches: at first, in a descriptive study, the actual vibration of the plate with its physical effects on limb vibration was measured as well as the resultant activation of limb and back muscles. Furthermore, in a comparative study, it was tested whether WBV exercise effects on clinical parameters and body surface temperature were different to effects of standard warm-up regimen.

2. Materials and Methods

2.1. Ethical Approval

The study design was discussed and approved by the institutional Ethics Committee in accordance with Good Scientific Practice guidelines and national legislation.

2.2. Vibration Device

For the WBV, the Marquis VMS device (Marquis Tiermedizin GmbH, Germany http://www.marquis-vetec.com/produkte/marquis-vms/ [5.4.2016]) was used with the horse standing within the box on four independent moving vibration plates, each for one foot. According to the manufacturer, the vibration frequencies can be chosen between 15 and 25 Hz and the plates move in horizontal as well as vertical directions. There were no specific technical vibration data offered by the manufacturer regarding the direction and the amount of vibration.

The study was designed in two different parts:

2.3. Part 1: Physical Effects and Muscular Activity

2.3.1. Horses

Six sound Quarter Horses were used to measure physical vibration parameters in limbs and trunk. There were three mares and three geldings, with an age between 2 and 6 years (median: 5) and a weight between 450 and 564 kg. All of them were habituated to exercise on the vibration device.

2.3.2. Study Design

At first, a control measurement on the plate without any activity and vibration was done to get basic electromyographic (EMG) data. Then, three recordings each of 10 seconds with vibration at 15 Hz (producer specification) and 25 Hz were done. Finally, a second control recording with the horse standing without vibration was done. The vibration was recorded with sensors combining electromyography and three-dimensional accelerometry (Delsys Trigno Wireless EMG System). For the accelerometry, the sensors were placed on one vibration plate (right front), the right front and right hind hoof and fetlock, the withers, and sacrum (see Fig. 1, red marks). The muscular activity of the muscle groups in the region of left and right M. quadriceps, M. triceps, and M. longissimus dorsi (see Fig. 1, blue marks) was recorded using the electromyographic data of the sensors, which were orientated parallel to the directions of the muscular fibers. At these positions, the horses were shaved and the skin was cleaned with alcohol for EMG electrodes. All sensors were placed before the first control measurement and not removed between the various recordings, to exclude influences due to skin preparation, location, impedance, or crosstalk. The locations of the sensors at the three muscle groups were chosen because these groups are main actors for forelimb, hind limb, and stabilizators for back posture, respectively [12,13].

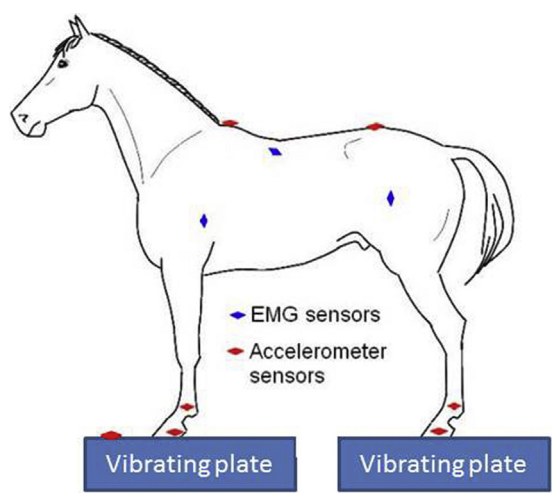

Fig. 1. Sensors' location on the horse and the vibration plate. EMG, electromyographic.