HOSTED BY

ELSEVIER

Available online at www.sciencedirect.com

ScienceDirect

Journal of Sport and Health Science 6 (2017) 346–351

www.jshs.org.cn

Original article

Dual-frequency whole body vibration enhances vertical jumping and change-of-direction ability in rugby players

Wen-Wen Yang [a,b], Li-Wei Chou [b], Wei-Han Chen [a,c], Tzyy-Yuang Shiang [d], Chiang Liu [a,*]

[a] *Graduate Institute of Sports Equipment Technology, University of Taipei, Taipei 111, Taiwan, China*
[b] *Department of Physical Therapy and Assistive Technology, National Yang-Ming University, Taipei 112, Taiwan, China*
[c] *Department of Physical Education, National Taiwan Normal University, Taipei 106, Taiwan, China*
[d] *Department of Athletic Performance, National Taiwan Normal University, Taipei 116, Taiwan, China*

Received 24 April 2015; revised 13 August 2015; accepted 22 September 2015
Available online 24 December 2015

Abstract

Background: Traditional vertical and side-alternating whole body vibrations (WBV) can effectively improve muscle power performance but have a limited efficacy for enhancing change-of-direction (COD) ability. Novel dual-plate WBV uniquely providing various directions of movements with higher and distinctive frequencies for each leg may cause better acute effect on muscle power and stretch-shortening cycle efficacy contributing to COD ability. Therefore, the purpose of this study was to investigate the acute effect of dual- or single-frequency WBV on squat jumps (SJs), countermovement jumps (CMJs), eccentric utilization ratios (EURs), and COD ability in rugby players.

Methods: Fourteen male rugby players were recruited and performed a 4 min partial squat with 3 types of WBV protocols on a dual-plate WBV machine, including 1 dual-frequency WBV protocol (DFW) with the dominant leg receiving 35 Hz and the non-dominant leg receiving 45 Hz, and 2 single-frequency WBV protocols (SFWs) with 35 Hz or 45 Hz provided to both legs (SFW35Hz and SFW45Hz) on 3 different days.

Results: The results showed that all the vibration protocols significantly improved SJ and CMJ performances (SJ: $p = 0.008$; CMJ: $p < 0.001$), but did not significantly change EURs ($p > 0.05$). In addition, only the DFW significantly improved COD ability ($p = 0.001$ for the pre–post comparison).

Conclusion: A 4 min dual-frequency WBV session improved both vertical jumping and COD ability in rugby players, suggesting that this could be a potential warm-up protocol for athletes.

Keywords: Agility; Balance; Frequency; Strength; Stretch-shortening cycle; Training; Warm-up

1. Introduction

Whole body vibration (WBV) has become a reliable modality for enhancing muscular performance.[1,2] Most vibration-related research has indicated positive acute effects of muscle power following WBV,[3,4] which has been attributed to neural adaptation, including increased muscle activation and facilitated stretch reflex.[5] To date, there are 2 traditional types of WBV modalities: vertical WBV and side-alternating WBV. The traditional vertical WBV usually utilized higher vibration frequencies (30–50 Hz) and lower vibration amplitude (2–4 mm), resulting in vertical synchronous vibration to both legs and vertical direction movement of the body.[6] Conversely, the side-alternating WBV usually utilized lower vibration frequencies (15–30 Hz) and higher vibration amplitude (2–12 mm) applied alternately to the right and left legs, providing vertical and extra horizontal vibration forces resulting in various directions and asymmetric movements to the sides of the body.[6]

The parameters used in WBV could influence the neuromuscular responses induced and the efficacy of muscle power. For example, it has been documented that muscle activation of tibialis anterior was higher during vertical WBV than side-alternating WBV, but activation of lower limb extensor (vastus lateralis and gastrocnemius) was higher during side-alternating WBV than vertical WBV.[7] Additionally, higher vibration frequency could induce greater muscle activation and have positive effect on muscle power.[8,9] Thus, the differences in vibration methodology provide different perturbations of the body, resulting in various acute effects on muscle power.

Peer review under responsibility of Shanghai University of Sport.
* Corresponding author.
E-mail address: chiangliu1974@yahoo.com.tw (C. Liu)

http://dx.doi.org/10.1016/j.jshs.2015.12.009

Fig. 1. Dual-plate whole body vibration machine.

A novel dual-plate WBV machine (Fig. 1) consists of 2 isolated platforms with separate vibration motors and can provide different frequencies to each leg (dual-frequency WBV). This dual-plate WBV machine can generate higher vibration frequency (30–50 Hz) with lower vibration amplitude (2 mm). The features of single-frequency and traditional vertical WBVs are similar, both of which provide a vertical direction movement to the body, and may cause the same effect on muscle power. On the contrary, the dual-frequency WBV provides vertical vibration with different frequencies for each leg, which induces the beats phenomenon. This unique feature of the dual-frequency WBV creates both vertical and horizontal vibration forces which are asymmetric perturbations of the body, leading to different challenges in movement control, which is similar to side-alternating WBV. However, compared with traditional WBVs, this novel dual-frequency WBV provides higher vibration frequency and various directions of movement, which could potentially provide more neural adaptation and a more rapid rise of muscle temperature in lower extremities and contribute to enhancement in muscle power. Moreover, bilateral strength asymmetry between dominant and non-dominant sides is commonly observed in athletes due to handedness, training, or specific sport demands[10] and this asymmetry is related to sport performances and injuries.[11,12] This dual-frequency WBV can apply a lower and a higher frequencies to the dominant and non-dominant legs, which may be a better way to minimize the effect of bilateral strength imbalance in lower extremities. However, the efficacy of dual-frequency and single-frequency WBVs on muscular performance in athletes has not been investigated.

Muscle power of lower extremities is an important attribute of rugby players to push, pull, cut, and jump during games,[13] and is commonly estimated by means of the vertical jump test.[14] It has been well documented that WBV is an effective modality for improving squat jumps (SJs) and countermovement jumps (CMJs).[3,9,15] Moreover, stretch-shortening cycle (SSC) efficacy, also as an indicator of muscle power, is an essential ability in rugby players.[16] The ratio of the height of CMJs to that of SJs, called the eccentric utilization ratio (EUR), is used to estimate SSC efficiency.[16] WBV could facilitate stretch reflexes to improve muscle activation,[5] which may also benefit the EUR. Reasonably, the dual-frequency WBV and single-frequency WBV should potentially improve vertical jumping and EUR among rugby players.

Agility, containing both decision-making and change-of-direction (COD) ability components, is also important for rugby players to rapidly accelerate, decelerate, and alter direction during sprinting in response to a stimulus or a ball during a real game.[17] COD ability is related to the muscle power of lower extremities.[18] It appears that traditional WBVs could have a positive effect on COD ability; however, previous studies have reported no acute or short-term positive effects. Torvinen et al.[3] showed that COD ability (shuttle run) did not improve after acute side-alternating WBV (vibration frequency of 15–30 Hz, amplitude of 10 mm). Cloak et al.[19] demonstrated that a bout of 30 s vertical WBV (40 Hz; 8 mm peak-to-peak amplitude) did not provide any benefit to the 505 test either. In addition, Cochrane et al.[20] reported no enhancement in the 505 test after a 9-session side-alternating WBV training course (vibration frequency of 26 Hz and amplitude of 12 mm). The absence of the improvement in COD ability may be due to only limited stimulation provided by traditional WBVs. However, the dual-frequency WBV that can provide various direction and asymmetric movements and higher frequencies may cause a better acute effect on muscle power and SSC efficacy, and subsequently COD ability.

Traditional WBVs can effectively improve muscle power performance but have a limited efficacy for enhancing COD ability. A novel dual-plate WBV with different frequencies applied to each leg may cause better muscle power and result in enhanced COD ability. However, the efficacy of dual-plate WBV on muscle power and COD ability is unclear. Therefore, the purpose of this study was to investigate the acute effect of dual-frequency and single-frequency WBVs in rugby players on SJs, CMJs, EUR, and COD ability. Enhancing muscle power and COD ability is critical for rugby players, and dual-plate WBV may prove a reliable and effective method for players and coaches.

2. Methods

2.1. Participants

Fourteen male rugby players (age: 18–23 years; height: 175.6 ± 6.6 cm; mass: 84.2 ± 11.2 kg; playing experience: >3 years; dominant leg: right leg) were recruited from Taipei Physical Education College rugby team, one of the top 3 teams at the university tournament level in Taiwan, China. Experiments were conducted during the beginning of their off-season training period. During the intervention, no players had neuromuscular injuries or musculoskeletal problems. Before the