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ORIGINAL ARTICLE

Effect of whole-body vibration on muscle strength, spasticity, and motor performance in spastic diplegic cerebral palsy children

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KEYWORDS

Whole body vibration;
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Abstract *Background and purpose:* Spastic diplegia is a common form of cerebral palsy (CP) and is characterized by spasticity and muscle weakness of both lower limbs resulting in decreased walking ability. The purpose of this study was to evaluate the effect of whole body vibration (WBV) training on muscle strength, spasticity, and motor performance in spastic diplegic cerebral palsy children after 12-weeks treatment.

Methods: Thirty spastic diplegic CP children (8–12 years) were randomized to two equal groups, control group and WBV group. The control group received a selected physical therapy treatment program for spastic diplegic CP and the WBV group received the same program in addition to WBV training. Measurements of isometric strength of knee extensors, spasticity, walking speed, walking balance and gross motor function were performed before and after 12 weeks of the treatment program.

Results: Isometric strength of knee extensors, spasticity and the walking speed were significantly improved only in the WBV group ($P < 0.05$). Growth motor function measure-88 (GMFM-88) (D%) was significantly increased ($P < 0.05$) in both groups in favor of the WBV group and GMFM-88 (E%) was significantly increased ($P < 0.05$) only in the WBV group, while walking balance did not change significantly in either group.

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Conclusion: The obtained results suggest that 12-weeks' intervention of whole-body vibration training can increase knee extensors strength and decrease spasticity with beneficial effects on walking speed and motor development in spastic diplegic CP children.

1. Introduction

CP is a syndrome characterized by poor control of movement and posture, which appears early in life and is considered as the most common cause for children handicapping representing nearly 2 per 1000 live births [1]. The most common form of CP is spastic diplegia and in this form both legs are more involved than the arms so that walking ability is affected [2]. The imbalance of muscle strength and tone causes muscle weakness and atrophy over time, as well as soft tissue contracture and eventual joint deformity. Children with spastic diplegia usually walk independently but most have gait disorder that is known as spastic diplegic gait which includes walking with plantar flexed feet, flexed hips and knees and an anteriorly tilted pelvis with exaggerated lumbar lordosis .This gait disorder makes them walk at a decreased speed with high energy expenditure and restricted functional capability when compared with their healthy peers [3–7].

Improving the ability to walk or perform other functional activities is often the primary therapeutic goal for spastic diplegic children [8]. Adaptive equipment that try to compensate for reduced mobility consume a large proportion of the costs related to CP [9], thus measures that improve mobility in children with CP could potentially result in substantial savings for health care systems.

Muscle strengthening is an important method to train weak muscles responsible for impaired walking ability like quadriceps muscle in spastic diplegic children. WBV is now a rapidly developing method used to increase muscle strength in clinical conditions [10–12]. It is a neuromuscular training method that was initially used by elite athletes to improve both speed and strength. Several reports state that WBV can have a beneficial effect on strength and power, however, there is a lack of scientific researches supporting the benefits of WBV on fitness and health [13,14]. In WBV training, the subject stands on a platform that produces vertical vibrations which stimulate the muscle spindles resulting in reflexive muscle contraction [15].

In adults with spastic diplegic CP, WBV has been shown to improve muscle strength and reduce spasticity of the knee extensor muscles [16]. Also, in individuals with multiple sclerosis, WBV has been associated with improvements in knee muscle performance [17]. Bosco et al. [18,19] found an increase in force power, velocity and jump performance immediately after one session of WBV training. Another study showed that WBV improves isometric strength of the quadriceps muscle and vertical-jump performance [20].

Cardinale et al. [21] suggested that vibration is effective in enhancing strength and the power capacity of humans. Also, it was suggested that WBV training resulted in neuromuscular adaptations similar to the effect produced by strength training [22].

The aim of this study was to evaluate the effect of WBV training on muscle strength, spasticity, walking speed, walking balance, and gross motor ability after 12 weeks in spastic diplegic CP children.

2. Subjects and methods

2.1. Subjects

Thirty spastic diplegic CP children of both sexes with ages ranging from 8 to 12 years (9.63 ± 1.41 years), who are able to walk with or without walking aids with an abnormal pattern of gait, who can understand or follow instructions, with a degree of spasticity ranging from 1 to 2 according to the modified Ashworth scale [23] not being engaged in regular organized physical activities were included. The exclusion criteria include children with fixed musculoskeletal deformities, with a history of recent surgery (less than 1 year) or unhealed fractures, who were medically unstable as determined by history and medical records, any case of epilepsy or visual or auditory problems and those under treatment with botulinum toxin. These children were selected from the outpatient clinic, college of Physical therapy, Cairo University. They were equally randomized to intervention with either control group or WBV training group. This work is carried out in accordance with the code of Ethics of the World Medical Association (Declaration of Helsinki) for experiments involving humans. Parents of the children signed a consent form prior to participation as well as acceptance of the Ethics Committee of the University.

2.2. Materials

2.2.1. For evaluation

2.2.1.1. Handheld dynamometer. Nicholas Manual Muscle Tester, Model 01160; Lafayette Instrument, Lafayette, IN, a commercial device was used to assess isometric knee extensor muscle strength. Hand-held dynamometers have been shown to be reliable instruments for measuring knee extension strength [22], and they have been used successfully in measuring muscle strength in children with spastic diplegia [24].

2.2.2. For treatment

2.2.2.1. Whole body vibration. A commercially available device (Power Plate; Northbrook, IL) with a side-alternating vibration platform, which generates vibration by allowing separate and unsynchronized multidimensional oscillations along the sagittal axis was used. In this study the device was set to produce a peak- to peak-sinusoidal vibration with an amplitude ranging from 2 to 6 mm. There were three positions illustrated on its platform marked as "1", "2", "3" corresponding to peak-to- peak displacements of 2 mm, 4 mm, and 6 mm. The vibration frequency ranged from 12 to 18 Hz for the aim to prevent adaptations of the neuromuscular system. In addition, these stimuli cannot generate resonance catastrophes or kinesthetic illusions [25].