Influence of Whole Body Vibration Training in Balance and Gait of Patient with Spastic Cerebral Palsy: A Pilot Study

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Purpose To study influence of Whole Body Vibration Training(WBVT) in balance and gait of patient with spastic cerebral palsy. ***Methods*** The subjects for this study includes 20 ambulatory patients with spastic cerebral palsy of GMFCS level I~II. WBVT has been conducted in an inclined bed of 80 degrees with vibration frequency of 20Hz, 5 times a week, total of 6 weeks. Before and after the training, Pediatric Balance Scale (PBS) and 10-Meter Walking Test(10MWT) have been performed. ***Result*** WBVT result was improved compared to before training in PBS and 10MWT evaluation. Conclusion As a result of WBVT, the effect of improvement in PBS and 10MWT evaluation was that the vibration stimulation had an effect on the improvement of balance and gait function, and it is suitable as a training method for improving balance and gait function in spastic cerebral palsy.

Key words Cerebral palsy, Whole Body Vibration Training, Balance, Gait, Spastic

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Ⅰ. Introduction

Cerebral palsy is a non-progressive lesion of the brain in infants or children that accompanies compound disorders in sense, cognition, speech, and behavior. Furthermore, vision and auditory impairment incurs secondary disorder in learning and cognition, and disorder of postural adjustment and motor function restricts physical activity.[1)]

Children with cerebral palsy shows impaired postural adjustment and motor function due to vision, proprioception, and vestibular sensory integration disorder and abnormal muscular spasm.[2)] Furthermore, impaired motor function due to changes in muscular tension induces secondary sensory integration disorder. Deficiency of postural adjustment, unsymmetric movement, limited range of motion, compensatory movement restricts opportunities of sensory experience in different environment and abnormal muscular spasm acquires imprecise proprioception feedback. Such outcome causes children with spastic cerebral palsy to develop inappropriate response to external stimulus than normal children.[3)]

Spasm and involuntary movement caused by abnormal suppression of cortical pathway by non-progressive cerebral lesion of cerebral palsy causes secondary deformation of musculoskeletal system, and muscular weakness causes delayed insufficient development, resulting in motor cooperation, balance, and gait disability.[4)] Excessive simultaneous contraction of agonist and antagonist and impaired anticipatory postural adjustment impedes faster recovery to stable posture when sudden postural sway occurs.[2)] And balance training in children with spastic cerebral palsy is very crucial for maintenance of stable posture in response to external stimulus, and balance training requires considerable time.[5)]

90% of children with cerebral palsy exhibits gait disturbance.[6)] and independent gait has great influence in quality of life.[7)] Balancing while changing posture affects gait speed, step length, cadence.[8)]

For patients with central nervous system injuries, Whole Body Vibration Training(WBVT) has the effect of improving posture control ability through the input

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of proprioceptive sensory stimuli, allowing stable weight movement from sitting and standing while performing independent daily activities, and improving functional mobility. Training method[9)]

In WBVT, vibration stimulus stimulates Ia-afferent motoneuron in muscle spindles to activate α-motor neuron and increases motor unit firing rate, inducing strong muscular contraction by activating agonist and synergist.[10)]

WBVT improves postural adjustment in elderly, ultimately reducing risk of fall[11)], and mechanical stimulus onto muscle spindles by vibration increases muscular strength.[12)] WBVT in children with cerebral palsy strengthens weakened muscle and is suitable for muscle strengthening training that can replace muscular strength training that requires motivation of children. Therefore, WBVT can improve balance and gait in children with cerebral palsy.[13)]

Several studies have conducted WBVT in adult patient with impaired central nervous system, but few applies the training onto children with cerebral palsy. Current study is to learn influence of mechanical stimulation onto muscle spindle in balance and gait after implementing WBVT on children with spastic cerebral palsy and provide a clinical evidence for WBVT practice of children with spastic cerebral palsy. The pilot study of this study aims to present evidence of the WBVT physiotherapy intervention method applied to a single group of spastic cerebral palsy to present the diversity of physiotherapy intervention methods for cerebral palsy.

II. Method

1. Subject

Hospitalized children, medically diagnosed with cerebral palsy, in S hospital in Seoul have were selected for the subject, and 20 ambulatory children with GMFCS level Ⅰ~Ⅱ were finally chosen as subjects. Furthermore, children selected in the study were at least 6 months past recent surgery or Botox and guardian's agreement was acquired.

Exclusion criteria are as following: those with uncontrolled seizure, those with visual, auditory, or perception impairment, and those with respiratory or orthopedic problem.

2. WBVT method

WBVT device (Galileo delta A Kipptisch, Novo tec, Germany) used in the study creates a cross-vibration that vibrates bilateral sides up and down, creates vibration of 5Hz~30Hz, and can be used in standing position at bed inclination of 0~90 degrees while bearing body weight.

The subjects received 3 minutes per set, 4 sets total while maintaining legs aligned at bed inclination of 80 degrees. 1 minute rest was given between the sets. Vibration was at 20Hz, and the training was conducted 5 times a week for 6 weeks. It is a tilt-table and diaphragm used in WBVT equipment, and a remote control. (Figure1.2)

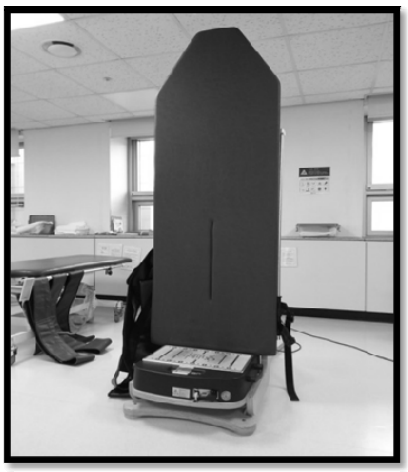

Figure 1.Whole body vibratio

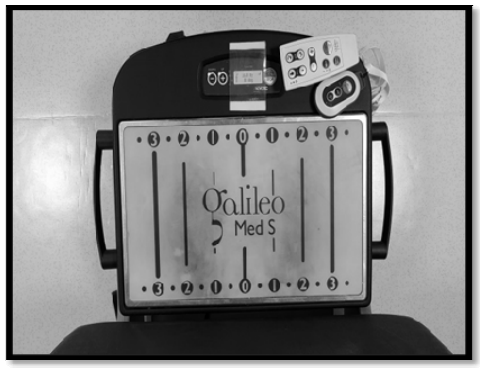

Figure 2. Whole body vibration

3. Measurement

1) Pediatric Balance Scale (PBS)

Pediatric Balance Scale (PBS), which Franjoine et al,[14] has revised and supplemented BBS for children, has been used for evaluation of static and dynamic uprighting balance. PBS is a balance evaluation tool that has reduced static position time at 2,3,7 category for children with mild to moderate dyskinesia at age 5~15 to 30 seconds and revised and supplemented instructions to be simpler and clearer.

All 14 categories consists of 3 fields of sitting, standing, and postural change, and 4-scale score with minimum of 0 to maximum of 4 incorporates quantitative and qualitative aspect and provides diversity of evaluation. Total score is 56, and higher the score, the better uprighting balance is.

2) 10-Meter Walking Test(10MWT)

10M walking test was conducted to measure gait capacity. Start and finish line were depicted with tape on the floor. Children were measured 3 times and the average of the 3 measurements was recorded. 10MWT showed high reliability of 0.81.[15]

4. Statistic analysis

All statistic analysis of the study was conducted with SPSS ver. 18.0. General characteristic of the subject was portrayed of its result with descriptive statistics, and comparison between and after whole body vibration was conducted of paired T-test with significance level(α) of 0.05.

Ⅲ. Result

1. General characteristic of the subjects

20 subjects were selected for the study, with average age of 7.30±0.80, height, 36.35±31.76cm, and weight, 26.10±2.95kg. 14 were diplegic and 9 were hemiplegic. 9 were GMFCS level Ⅰand 11 were level Ⅱ (Table. 1).

Table 1. General characteristics of the subjects

		subjects (n=20)
Age(years)		7.30±0.80
Hight(cm)		136.35±31.76
Weight(kg)		26.10±2.95
Diagnosis	diplegia	14
	hemiplegia	6
GMFCS	Ⅰ	9
	Ⅱ	11

2. Comparison of PBS and 10MWT before and after WBVT

PBS in the subjects after WBVT was 46.00±7.85 before the training and increased to 49.20±6.76 after the training, showing statistical significance ($p<.05$), and 10MWT was 16.98±14.43 seconds before the training and decreased to 13.80±9.24 seconds after the training, which was statistically significant ($p<.05$) (Table. 2).

Ⅳ. Discussion

WBVT for safer and easier muscle strengthening for athletes that has been introduced from late 1990.[12] In upright position on a vibration platform, vibration stimulus is transmitted from feet to other body parts and tonic vibration reflex in which mechanical stimulus of the vibration is transferred to the muscle causes muscle to contract. Reflex muscular contraction is caused by simultaneous activation of α and γ motor neurons by mechanical vibration, and mechanical stimulus by WBVT improves neuromuscular system to cause more voluntary muscular activation.[16]

WBVT as a new training program stimulates pro-

Table 2. The comparison of PBS, 10MWT within pre-test and post-test

Subjects (n=20)	Pre	Post	*t*	*p*
PBS(score)	46.00±7.85	49.20±6.76	-6.92	.00
10MWT(sec)	16.98±14.43	13.80±9.24	2.64	.01

*p<.05.

prioception to increase agonist contraction as it increases motor unit fire rate and activates neuromuscular function. Furthermore, it is shown to have positive influence onto all systems, such as increased bone density, increased oxygen intake, increased blood flow, and decreased body fat, but scientific evidence of the positive influence by WBVT is insufficient. However, it is appropriate as a training program that can increase efficiency of workout with minimal effort in healthy individual or athlete.[17)]

Whole body vibration activates sensory region of brain and decreased heightened muscular tension in the patients with spasticity due to impaired central nervous system, and rapid vibration stimulates Ia-afferent motor neuron to secrete acetylcholine neurotransmitter for muscular contraction. Thus, constant vibration depletes neurotransmitter, reducing excitement of motor neuron and muscle contraction. Therefore whole body vibration can reduce spasticity caused by impairment of central nervous system.[18)]

After performing WBVT onto patients with subacute stroke in knee-bent position on a vibration platform, the patients showed increased activity of lower limb muscle[19)] and strength of knee flexor was increased in chronic stroke patient with whole body vibration, showing identical outcome as active knee strengthening training and positive influence in BBS and TUG evaluation.[20)]

After conducting WBVT with children with cerebral palsy of GMFCS level Ⅰ Ⅱ, increase in their lower limb muscular thickness improved strength and helped improvement of gross motor function.[21)] Children with spastic cerebral palsy showed decreased spasticity after WBVT and positive results in TUG and 6MWT. Decreased spasticity of lower limb also allowed functional movement. Such outcome is due to muscular contraction caused by stimulated muscle spindles and α-motor neuron. It has advantage in that its effect is immediate after the training, but there is safety issue during the training.[13)] Also, WBVT increases PBS score, shortens 10MWT time, and improves gross motor function, making it ideal for balance and gait training in children with spastic cerebral palsy.[22)]

In this study which WBVT has been conducted in children with spastic cerebral palsy, showing increased PBS score and shorter 10MWT time which is consistent with the preceding study. It is considered to be due to vibration that strengthens weakened muscle and positive influence of spasticity reduction training in balance and gait of children with spastic cerebral palsy.

Children with spastic cerebral palsy has impaired posture adjustment and motor function as proprioceptive input is abnormal due to dyskinesia and developmental disability. WBVT is appropriate as a training to improve balance and gait with proprioception feedback.

The study has its limitation in that its subjects are single-grouped and variables to the outcome from WBVT are limited. In this study, the pilot study applying WBVT to spastic cerebral palsy was intended to provide a variety of physical therapy intervention methods in clinical practice, and a study supplementing the study subjects and evaluation methods is needed to verify the reliability of the effectiveness of WBVT in spastic cerebral palsy.

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