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Department of Physical Therapy, School of Public Health, Sehan University,
1113 Noksaek-ro, Samho-eup, Yeongam-gun, Jeollanam-do 58447, Korea
E-mail: office@kptjournal.org / Homepape: www.kpt.or.kr

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Original Article

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Effects of Whole Body Vibration Exercise on Lower Extremity Muscle Activity and Balance Ability in Football Player with Chronic Ankle Instability

Yong-Sik Jeong[1], Je-Ho Kim[2]

[1]Department of Physical Therapy, Graduate School, Sehan University, Yeongnam; [2]Department of Physical Therapy, Sehan University, Yeongnam, Korea

Purpose: The purpose of this study was to determine the effects of whole body vibration exercise (WBVE) on lower extremity muscle activity and balance ability according to different methods of exercises in football player and use it as basic data for the rehabilitation training of chronic ankle instability.

Methods: Thirty subjects were randomly divided into two groups: the two groups, which each group have 15 members, are WBVE group and neuromuscular training (NMT) group according to training method. The exercise program was conducted for six weeks. Subjects were measured on lower extremity muscle activity and balance ability.

Results: The muscle activity increasement of the WBVE group was significantly higher than that of the NMT group ($p < 0.05$) and the balance ability decreasement of the WBVE group was significantly higher than that of the NMT group ($p < 0.05$).

Conclusion: These findings of this study suggest that WBVE may have a beneficial effect on improvement of lower extremity muscle activity and balance ability in football player with chronic ankle instability.

Keywords: Chronic ankle instability, Whole body vibration exercise, Muscle activity, Balance

INTRODUCTION

The ankle joint plays an important role in stability and shock absorption, and is one of the most frequently injured joints in athletes and non-athletes.[1] The lateral collateral ligament of the ankle is composed of tissues with a relatively weak structure; upon landing during sports activities or when walking on an uneven surface, sudden plantar flexion and adduction can cause injury to the lateral collateral ligament, resulting in joint instability.[2] Ankle sprain causes reduced dorsiflexion range of motion (ROM), and especially affects the gait pattern during walking and running, which increases the risk of re-injury.[3,4] In addition to the ankle ligaments, ankle sprain also causes injury to neural tissue in the ankle, including mechanoreceptors. This leads to deficits in kinetic sense and position sense, and 31–40% of subjects who experience ankle sprain show chronic ankle instability (CAI).[5,6]

CAI is defined as recurrent ligament injury and reinjury after ankle sprain. CAI is classified as mechanical ankle instability, characterized by reduced ligament stiffness and arthrokinematic changes, and functional ankle instability, characterized by recurrent ankle instability resulting from injury to the proprioception and neuromuscular systems.[7] CAI presents with symptoms of recurrent ankle sprain, pain, edema, instability, and giving way, and can persist for 6–18 months after the initial ankle injury.[8] Patients with CAI show activation of the peroneus longus muscle at initial contact during walking, whereas healthy individuals show activation after initial contact.[9] CAI patients also show less anticipatory muscle activity than healthy individuals upon landing from a jump,[10] reduced balance ability because of inaccurate proprioception after the initial injury, and impaired postural control as an adaptive response of the

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Corresponding author Je-Ho Kim
E-mail albam20@naver.com

central nervous system.[11]

Individuals with CAI have shown improved ankle stability, balance, and ankle muscle activity using various interventions, including spiral taping, Mulligan technique, and neuromuscular training (NMT).[12-14] Each intervention method should include sensory-motor and balance training.[15] However, high intensity sensory-motor training, such as plyometric training, consists of various jumping and change-of-direction movements and requires sufficient musculoskeletal body condition; if the individual's condition is deficient, this type of training can cause ligament, tendon, and joint injury.[16] Whole body vibration exercise (WBVE) has been receiving attention as a safe exercise method that was recently developed to overcome these limitations.[17]

WBVE acts by application of mechanical vibration to muscles, which stimulates the primary motor endings of the muscle spindles, increasing the sensory input of Ia afferent neurons, generating stronger alpha motor neuron output, and thereby increasing the recruitment rate of motor units to enhance muscle activity.[18,19] In addition, WBVE is effective at improving balance ability in the elderly, athletes, and individuals with neurological injury, via an increase in somatosensory input.[20-22] Thus, the effectiveness of WBVE has been documented, but few studies have demonstrated an objective effect of WBVE in individuals with CAI.

Therefore, the present study aimed to implement a WBVE intervention in soccer players with CAI, to investigate the effects on balance and ankle muscle activity, and to provide basic data for rehabilitative exercise in individuals with CAI.

METHODS

1. Subjects

The subjects received a thorough explanation of the study content and aims and gave written consent before commencing the study. Among 50 university soccer players from Jeollanam-do, 30 subjects were selected who had complained of physical discomfort in one ankle with associated apprehension for at least 6 months, and had a score of less than 25 points on the Cumberland ankle instability tool,[23] with no ankle edema, and were able to support their body weight on the unstable ankle. The CAIT consists of 9 questions that answered separately for the right and left ankle. It is scored on a 30 point scale, with lower scores indicating decreased stability. The CAIT has excellent test-retest reliability. Initially, a cutoff score of ≤ 27 was reported for discriminating between in individuals with and without CAI. However, more recent research challenged the initial value and provide evidence that a lower score (≤ 25) should be used to indicate the presence of CAI. We excluded individuals with a history of ankle surgery or fracture within the prior 6 months, or with balance impairment due to vestibular system or other neurological disorders. The selected subjects were randomly allocated into a WBVE group and an NMT group, with 15 in each group (Table 1).

2. Experimental methods

1) Methods of exercises

(1) WBVE

For the WBVE intervention, a Wellengang START (Wellengang GmbH, Bayern, Germany) was used. Whole body vibration is programmed exercise which use randomly mixed a frequency of 5 to

Table 1. General characteristics of subject

	WBVE (n=15)	NMT (n=15)	p-value
Age (year)	22.51±2.62	21.94±2.54	0.643
Height (cm)	173.65±8.34	172.74±9.48	0.541
Weight (kg)	69.89±7.49	70.57±8.39	0.574
CAIT (score)	19.93±4.29	19.86±3.94	0.687
Dominance side (Lt/Rt)	3/12	2/13	

Values are group mean±SD.
WBVE: whole body vibration exercise, NMT: neuromuscualr training, CAIT: Cumberland ankle instability tool.

Table 2. Exercise scheme of 6 weeks whole body vibration

	1 Week	2 Week	3 Week	4 Week	5 Week	6 Week
Frequency	5-25 Hz (mix)			5-25 Hz (mix)		
Amplitude	3-6 mm (mix)			3-6 mm (mix)		
Exercise	One-legged stance			One-legged stance with eyes shut		
	Cross legged sway			Cross legged sway with resistance elastic band attached to the ankle		
	Runner's pose			Runner's pose with single leg heel raises		
	Catching and throwing a volley ball against wall			Catching and throwing a tennis ball against wall		

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