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Original Article

Effects of mental practice on normal adult balance ability

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Abstract. [Purpose] This study aimed to examine the effects of mental practice on the balance abilities of normal individuals. [Subjects and Methods] Thirty subjects were randomly assigned to an experimental or control group (n=15 each). Participants in both groups performed balance training in a seated position on a gym ball for 20 minutes per session, five sessions per week, for 4 weeks. Members of the experimental group also performed mental practice for 10 minutes before the balance training. After the intervention, balance measuring equipment (Good Balance, Metitur, Finland) was used to quantitatively measure balance ability. [Results] Significant post-training gains were observed in the mediolateral, index of balance function, and time variables of participants of the experimental group. [Conclusion] The application of mental practice with balance training positively affected balance ability.

Key words: Mental practice, Balance, Adults

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INTRODUCTION

Balance is the ability to maintain one's center of gravity with minimum shaking within the basal plane, while postural balance is the ability to continuously maintain equilibrium within the basal plane according to one's center of mass (COM) and maintain postural control to cope with diverse motions and external swaying[1)]. Balance abilities are complicated functions derived from integration of the nervous and musculoskeletal systems that involve diverse functional factors such as integration of the stimuli emanating from the visual, hearing, and vestibular organs; proprioceptors and sensory receptors in the central nervous system; visual spatial cognitive ability; muscle tone that responds to environmental changes both quickly and accurately; muscular endurance; and joint flexibility[2)].

Mental practice, which is frequently used to improve balance ability, was recently presented in diverse areas for the purpose of mastering motor skills and improving motor learning[3)]. Mental practice is a motor learning method that imparts and improves motor skills and involves imagining movement scenes without making any body movements. Gerardin et al.[4)] reported that imagining movement scenes and performing exercises identically activated the frontal lobe. Although diverse studies on mental practice have been conducted to date, most addressed improving the upper limb functions of stroke patients, while few have examined mental practice as an approach to improving balance ability. Therefore, the purpose of the present study was to examine the effects of mental practice on the balance abilities of normal individuals.

SUBJECTS AND METHODS

Thirty subjects were randomly assigned to an experimental or control group (n=15 each). The selection criteria utilized were as follows: no history of orthopedic surgery on a lower limb, never taken any drug due to a neurologic problem, and no

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musculoskeletal system disease. The general characteristics of the study subjects are summarized in Table 1. The Research Ethics Committee of Eulji University Hospital approved the study, and all subjects provided informed written consent prior to participating.

Participants in both groups performed balance training in a seated position on a gym ball for 20 minutes per session, five sessions per week, for 4 weeks. Participants in the experimental group also completed a mental practice regimen for 10 minutes before each balance training session.

The gym ball exercises included maintaining proper posture in a seated position on a gym ball, laterally moving one's body weight, and moving one's body weight back and forth. For the mental practice sessions, the subjects were allowed to maintain a comfortable seated position on a chair and the laboratory environment was kept dark and as quite as possible. The subjects listened to a voice file describing the imaginary act of maintaining balance in a seated position on a gym ball. During the warm-up stage, muscle relaxing training was implemented for 2 minutes to ensure psychological stability. In the recordings, the first-person viewpoint was used as described by the classification methods presented by Mahoney and Avener[5]. During the mental practice exercises, each subject was allowed to maximally feel the sole pressure and proprioceptive sensory information from the ankles, knees, and hip joints when carrying out the weight shift training; the mental practice was performed for 6 minutes. The cooling down stage was used to direct the subject back to reality and become psychologically stabilized. This stage lasted 2 minutes.

After the intervention, balance measuring equipment (Good Balance, Metitur, Finland) was used to quantitatively measure each subject's balance ability. To measure balance function, the subject was instructed to stand on a triangle platform and maintain a symmetrical posture with the feet shoulder width apart. A visual fixed point was located in front of the subject to minimize head movements. The subject's arms were placed comfortably at the hip joints and the center of pressure (COP) was measured for 30 seconds in the standing posture with the eyes open. COP was measured three times and average values were calculated.

The data analysis was performed using SPSS version 20.0 (SPSS Inc., Chicago, IL, USA). Means and standard deviations were calculated for all variables. Before the intervention, group differences in general characteristics were compared using the independent t-tests and χ^2 tests. Intragroup comparisons of variables before and after training were conducted using paired sample t-tests. Intergroup comparisons of pre- and post-test differences in variables were performed using the independent t-test. Intergroup effect sizes were calculated using the Cohen d coefficient[6], where an effect size <0.2 reflected a negligible mean difference; 0.2–0.5, a small difference; 0.5–0.8, a moderate difference; and >0.8, a large difference. The statistical analysis was performed at the 95% confidence level, and p values <0.05 were considered significant.

RESULTS

Table 1 provides a summary of the subjects' clinical and demographic features (n=30). No significant intergroup differences were observed for baseline characteristics (p>0.05). All 30 subjects (experimental group=15; control group=15) completed the experiment. The characteristics of the two groups before and after intervention are shown in Table 2. The

Table 1. General characteristics of the study subjects (n=30)

Characteristic	EG (n=15)	CG (n=15)
Age (years)	21.8 (2.0)	22.6 (1.3)
Height (cm)	166.5 (5.4)	169.7 (3.3)
Weight (kg)	60.2 (8.1)	62.2 (6.5)

EG: experimental group; CG: control group.
Values are expressed as mean (SD).

Table 2. Pre- versus post-test balance variables in the experimental and control groups

	EG (n=15)		CG (n=15)	
	Pre-test	Post-test	Pre-test	Post-test
Mediolateral[a] (mm/s)	135.24 (35.62)	110.25 (36.58)*	137.69 (30.24)	130.85 (20.31)
Anteroposterior (mm/s)	195.21 (38.21)	182.62 (40.21)	193.26 (40.13)	187.84 (41.74)
Index of balance function (score)[a,b]	75.43 (12.12)	82.64 (8.56)*	74.23 (7.32)	79.35 (6.24)*
Time (s)[a,b]	22.72 (3.52)	13.52 (2.54)*	23.74 (3.62)	18.45 (2.45)*

EG: experimental group; CG: control group.
[a]Group gains were significantly different, p<0.05
[b]Effect size >0.80
Values are presented as mean (SD). *Significant difference from pre-test, p<0.05

experimental group showed significant increments in the mediolateral, index of balance function, and time variables compared to the pre-intervention results ($p<0.05$). In addition, the control group showed significant increments in the index of balance function and time variables compared to the pre-intervention results ($p<0.05$). Significant intergroup differences were observed for post-training gains in the mediolateral, index of balance function, and time variables ($p<0.05$). The effect sizes of the gains in the experimental and control groups were high for the index of balance function and time variables (effect sizes=1.12 and 0.86, respectively).

DISCUSSION

Mental practice could be described as "imagining movements for body activities without any gross motor activity"[6]. Mental practice enhances motor skills by facilitating the imagining of proprioceptive senses such as visual, auditory, tactile, motor, olfactory, and taste without any external stimuli.

Theories that explain the mechanism of mental practice include Paivio's theory[7], the psychoneuromuscular theory[8], and the cognitive–symbolio learning theory[9].

Paivio's theory proposes that visually imagining the carrying out of movements promotes cognitive function and motivation[7], whereas the psychoneuromuscular theory purports that practicing tasks to be performed in advance using imagination reinforces the neurological pathways necessary to conduct the required movements, thus enhancing one's ability to perform the movements[8]. On the other hand, the cognitive–symbolio learning theory proposes that imagining movements provides opportunities to practice their order and enables advanced planning, thus improving efficiency when the movements are actually carried out[9].

Weiss et al.[10] reported that excitation was observed in the same brain regions during mental practice and physical training, especially the supplementary motor area of the brain during mental practice.

Based on the results of previous studies, it can be said that the neuromuscular responses that appear when movement performance is imagined are similar to those observed when the movements are actually performed. Therefore, imagining the movements that are used to carry out a task reinforces the neurological pathways required to actually perform the movements, thereby improving one's ability to perform them. The results of the present study suggest that balance ability is improved in accordance with the psychoneuromuscular theory.

The limitations of the present study are that it was difficult to evaluate whether the imagining practice learning level was appropriate and the intervention period was too short to generalize the results. In addition, subjects could not be controlled after the experimental period and the number of subjects was small. Therefore, in future studies, if the experimental intervention period is extended and environmental factors are more thoroughly addressed, positive generalizable results might be obtained. In addition, if visual and perceptive sources of stimuli were applied with the auditory stimulus, the effects of the mental practice exercise might be further enhanced.

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