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Original Article

Immediate effects of the trunk stabilizing exercise on static balance parameters in double-leg and one-leg stances

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Abstract. [Purpose] The purpose of this study was to evaluate the immediate effect of stabilizing exercise using the PNF technique on standing balance in one-leg and double-leg stances. [Subjects and Methods] The present study recruited 34 healthy participants from a local university. The Participants performed four balance tests (double-leg stance with and without vision, one-leg stance with and without vision), before and after exercise. The exercise consisted of exercises performed using PNF techniques (stabilizing reversal and rhythmic stabilization), which were applied to facilitate trunk musculature. To examine balance ability, total displacement of the center of pressure was measured during balance tests. [Results] The total anterior–posterior center of pressure displacement was significantly reduced after applying rhythmic stabilization compared before exercise regardless of the balance test conditions. [Conclusion] The present results suggest that trunk stability exercise using rhythmic stabilization could effectively enhance balance ability under one-leg and double-leg conditions.

Key words: Balance exercise, COP, PNF technique

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INTRODUCTION

Regaining balance ability is a fundamental component of the clinician's goals for patients with a variety of disorders[1, 2)]. Although controlling distal segments such as the ankle, knee, and hip is known to be a major component of balance ability, co-contraction of the abdominal and paraspinal muscles also contributes to maintaining the center of mass within the base of support[1–4)]. Therefore, facilitating trunk musculature is one of the exercise assessments for enhancing balance ability[3, 4)].

Previous findings have suggested that impairments in postural control during walking are a major risk factors for falling[5, 6)]. Kim et al. also suggested that spine stabilization exercise protocols could be helpful for improving overall postural stability in a standing posture[6)]. Although various trunk stabilization exercises have been suggested in the clinical literature and studies, however, there still remains a question regarding which exercise form is effective for enhancing balance ability through trunk exercises[7, 8)].

Proprioceptive neuromuscular facilitation (PNF) interventions classically suggest two stabilizing exercise techniques, which are referred to as stabilizing reversal (SR) and rhythmic stabilization (RS)[9)]. SR is characterized by alternating isotonic contractions opposed by resistance to prevent motion, which allowing small movements. RS is characterized by isometric contractions against the resistance provided by the therapist, with the subject trying to maintain their position as the therapist changes the direction of resistance[9)].

The primary purpose of the present study was to investigate whether the SR and RS techniques are effective for enhancing balance ability. The secondary purpose was to determine which exercise is effective for improving trunk stability.

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SUBJECTS AND METHODS

Thirty-four asymptomatic subjects were recruited from a local university. They were 20 to 26 (21.9 ± 2.8) years old, their mean height and weight were 174.9 ± 5.6 and 66.5 ± 5.3 kg respectively. Participants were excluded if they had any history of musculoskeletal problems within the last 6 months. Each subject provided informed consent before participating in the study. This study was approved by the Choonhae University Faculty of Health Sciences Human Ethics Committee. The center of pressure (COP) data for under the feet were collected by using a pedoscan (International GmbH, Schlangenbad, Germany). For the pre-exercise balance test, each subject stood on the pedoscan plate under the following conditions: double-leg stance with the eyes open (DLS-O), double-leg stance with the eyes closed (DLS-C), one-leg stance with the eyes open (SLS-O), and one-leg stance with the eyes closed (SLS-C). Measurement was performed under each balance test condition during an 11 s period, and the data for the first and last three second seconds of the period were eliminated. The primary researcher performed stabilizing reversal and rhythmic stabilization for each subject to facilitate trunk musculature in a randomized order. The period was 3 min for each exercise, and the period between exercise conditions was one day. Immediately after the SR and RS exercise, the COP was measured again under the during four balance test conditions using the pedoscan. The data were expressed as total and mean COP movement during balance tests[12]. Two-way repeated ANOVA was conducted to examine differences. Significance was accepted for values of $p<0.05$, and PASW Statistics 18.0 was used for statistical analyses.

RESULTS

Descriptive statics of the balance test and total COP movement are represented in Table 1. There were significant difference in movement of COP when compared according to both exercise and balance test conditions ($p<0.05$). Subsequent post hoc testing revealed that RS significantly reduced total COP movement compared with the pre-exercise values ($p<0.05$). In factor of the balance test, the total COP displacements were gradually altered in serial conditions of double leg stance with eyes-open, double-leg stance of eyes-closed, one-leg stance with eyes-open, one-leg stance with eyes-closed ($p>0.05$).

DISCUSSION

Evaluation of balance ability in a standing posture is clinically well evidenced, and this includes evaluation under one-leg and double-leg stance and presence of vision[1, 6, 8]. Our data suggested that the double-leg stance with eyes open and double-leg stance with eyes closed, one-leg stance with eyes open and one-leg stance with eyes closed were well differentiated between conditions according to difficulty of conditions. Mitchell et al. reported that the presence of vision critically affects standing balance[10], but the present results indicated that a narrow base of support has a major effect on the balance ability of young subjects.

RS significantly reduced anterior-posterior COP displacement, compared with the values after SR and those before exercise. Some previous studies have reported that RS increased co-contraction, which is necessary for enhancing upright trunk posture[11]. Theoretically, balance is defined as the ability to maintain the center of mass (COM) within the base of support[12]. Furthermore, the COM is positioned approximately anterior to the sacrum in a standing position[12]. Therefore, co-contraction of the trunk muscle could reduce COM displacement through the RS technique.

Although the results of the present study showed significant decreases in COP displacement with the RS technique, the present study could not affirm that SR is less useful than RS. In elderly subjects or patients with insufficient muscle strength, SR, which induces alternating contractions might be easier to perform than RS for enhancing stability. The present study suggests that standing balance could be improved with the rhythmic stabilization technique in asymptomatic subjects. And balance tests with variations of vision and support surface could be well differentiated and could be applied for stepwise assessment.

Table 1. The average and standard deviation (SD) of total anterior-posterior center of pressure (A-P COP) movement values before and after stabilizing reversal (SR), and post rhythmic stabilization exercises

Trial	Total A-P COP movement (Mean ± SD, mm)			
	DLS with eyes open	DLS with eyes closed	SLS with eyes open	SLS with eyes closed
Before exercise (mm)	43.4 ± 17.2	53.9 ± 22.6	92.8 ± 49.6	158.9 ± 58.7*
After SR (mm)	44.5 ± 13.7	57.0 ± 31.9	81.4 ± 27.9	132.6 ± 48.9*
After RS (mm)	38.2 ± 9.6	45.4 ± 17.8	76.9 ± 29.8	149.7 ± 53.1*

DLS: double-leg stance, SLS: one-leg stance.
*Significant difference between conditions.

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