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The Effects of Balance Exercise on an Unstable Platform and a Stable Platform on Static Balance

The purpose of this study is to observe how balance exercise on an unstable platform and on a stable platform affects balance ability. The subjects were 35 adults in their 20s and were randomly assigned to a stable platform group and an unstable platform group. They performed balance exercise three times per week for six weeks. Balance exercise introduced by previous research was modified and complemented for use in this study. Balance ability of the subjects was measured through center of pressure(COP) area, medial-lateral displacement, and anterior-posterior displacement using a portable balance platform BT4. There was significant difference in the COP area between the unstable platform exercise group and the stable platform exercise group. In comparison in differences between the unstable platform exercise group and the stable platform exercise group after the exercise, there was significant difference in anterior-posterior movement. Therefore, exercise on an unstable platform is more effective than exercise on a stable platform in strengthening balance ability.

Key words: *Static Blance; Unstable Platform; Stable Platform; Balance Exercise*

Nyeon Jun Kim[a], Kyung Tae Yoo[b], Ho Jung An[c], Hee Joon Shin[d], Ja Pung Koo[a], Bo Kyoung Kim[e], Hong Rae Kim[f], Jung Hyun Choi[b]

[a]Pohang College, Pohang; [b]Namseoul University, Cheonan; [c]Dongnam Health College, Suwon; [d]Kyungwoon University, Gumi; [e]International University of Korea, Jinju; [f]Hyoja Geriatric Hospital, Yongin, Korea

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Address for correspondence
Jung Hyun Choi, PT. Ph.D
Department of Physical Therapy, Namseoul University, 21 Maeju-ri, Sunghwan-eup, Cheonan, Korea
Tel: 82-41-580-2534
E-mail: rightmind@nsu.ac.kr

INTRODUCTION

Balance is essential in performing all activities of daily living and is an ability to maintain the body in an equilibrium state(1). Ability to control postural balance is to maintain the center of gravity(COG) on a platform with minimal postural sway, when standing in a fixed place, moving voluntarily, or responding to force exerted from outside(1, 2). Ability to maintain balance or recover disturbed balance during ordinary life is related to diverse sensory functions, motor functions, cognitive functions, and psychosocial functions, and environmental elements(3, 4).

When moving the body on a flat ground and moving on a narrow beam, dynamically different postural control strategies are used. In addition, when the use of ankle joint strategy is decreased according to the degree of center of body mass movement, use of the hip joint strategy increases, and when the use of hip joint strategy is reduced, use of the ankle joint strategy rises, which is called a changeable postural control strategy(5).

Janda's sensorimotor training developed from an intervention approach to chronic musculoskeletal pain syndrome emphasized the importance of appropriate functional adjustment of the sensory motor area, coordinative movement, joint stability, and proprioception in exercise pattern balance(6). Proprioception is an ability to change muscular contraction through immediate response to force exerted from outside and play an important role in reducing functional instability and redamage. Recovery of proprioception in treatment intervention is an important element in treatment process(7). Sensorimotor training has been used as rehabilitation for damage to the ankle joints and postural deficits, and previous research reported its preventive effect of ankle and knee joint damage. Recently, sensorimotor exercise has been applied to motor performance as well as rehabilitation and prevention(8-11).

Balance deficits may be identified through observation of increased postural sway during quite standing(12,13). In research on quite standing, force platform technology was used in order to evaluate characteristics of weight bearing and body sway based on center of pressure(COP) and movement characteristics of ground reaction force(14). Movement of COP obtained from force platform data is the most general method to measure postural sway during static standing(15). Most research on static standing uses kinetic measurement obtained by calculating anterior-posterior and medial-lateral displacement of COP on a force platform(16). Mean COP velocity(velocity), area of the 95% confidence ellipse(area), anterior posterior average displacement(Y mean), and medial lateral average displacement(X mean) are a COP measurement method generally used for balance evaluation(17-21).

Exercise performed on un unstable platform is a method to potentially change neuromuscular recruiting pattern and more promotes postural control and dynamic balance than exercise conducted on a stable platform(22, 23). There is research on body balance according to the types of unstable platforms such as baland board, balance beam, Swiss ball, rocking slant board, and sand ground but research on balance exercise according to the kinds of platforms is lacking(24, 25).

Accordingly, this study intends to examine the effects of balance exercise according to the kinds of platforms on static balance ability.

METHODS

Subject

The subjects of this study were 35 healthy adults and they were assigned to an unstable platform exercise group(n=18) and a stable platform exercise group(n=17). The criteria for inclusion as the subjects were: those who had no cardiovascular, orthopedic, or neurological disease; those who had no problem with balance resulting from vestibular system damage or visual disorder; and those who did not perform ay special exercise and were able to perform activities of daily living. They conducted exercise three times per week for six weeks.

This experiment was conducted from September to November 2013. Sufficient explanation on the experimental procedure was made to the subjects and a written consent to voluntarily participate in this study was obtained prior to the experiment.

Table 1. General features of research subjects

	UE(Mean±SD)	SE(Mean±SD)
Age(y)	20.53±3.51	21.59±4.01
Height(cm)	171.27±8.42	172.46±7.94
Weight(kg)	61.41±10.83	63.91±9.32
BMI(kg/m^2)	19.45±3.68	20.27±3.78

UE: Unstable platform exercise group
SE: Stable platform exercise group

Procedure

The experimental procedure is as follows. The unstable platform exercise group carried out balance exercise on TOGU(aero-step, Germany) and the stable platform exercise group performed exercise on a solid platform three times per week for six weeks. Before balance exercise, the subjects brifely conducted warm-up exercise. They carried out balance exercise as the followings by referring to exercise introduced by Janda(6). They conducted cool-down exercise for five minutes after balance exercise.

Table 2. Balance exercise

Item	Content	Time
Warm-up exercise	Freehand exercise and stretching exercise	5 min
Moving the center standing on both feet	Standing spreading both feet to an appropriate extent and maintaining balance while moving the COG back and forth and from side to side.	5 min
Standing on one foot	Maintaining balance standing on one foot and maintaining the posture by dividing a short time	5 min
Squat exercise	Maintaining balance, repetitively flexing and extending the knees lightly and slowly	5 min
Squatting	Maintaining balance while squatting and moving the weight back and forth and from side to side	5 min
Cool-down exercise	Freehand exercise and stretching exercise	5 min

Measuring Equipment

Measurement of COP values with quiet standing was carried out with BT4(Hur lap Inc.). The participants did perform on the force platform(BT4, Hur lap Inc.).

COP excursion was tested using a four-channel portable force platform(Hur Labs BT4) that was calibrated prior to testing; channels were checked before every test. Participants were instructed to look straight ahead and stand as still as possible with arms hanging down. The foot position was standardised: a 2cm heel-to-heel distance and an angle of 30° between the feet. The participants stood still for at least 5 sec(pre-phase) before the measurement. After the pre-phase, COP was measured for the next 60 sec; signals were sampled at 200 Hz and filtered with a digitally low-pass filter at 7.8 Hz cut-off frequency prior to sampling, signals were filtered with two low-pass filters, first stage filter is sinc3 type and second stage filter is 22-tap filter. This research selected area of the 95% confidence ellipse(Area), anterior posterior average displacement(Y mean), medial lateral average displacement(X mean) for COP values.

Data Analysis

For data analysis, SPSS ver 18.0 was used. The general characteristics of the subjects were described using average values calculated. A paired t-test was used to analyze differences in balance ability within each group and an independent t-test was conducted to analyze differences in balance ability between the two groups. All the statistical significance level was set at $\alpha = .05$.

RESULTS

According to the result of comparing static balance ability between prior to and after the exercise according to the types of platforms, area significantly changed both in the unstable platform exercise group and the stable platform exercise group. There was statistically significant change in Y mean in the

Table 3. Changes in area, X mean, and Y mean in each group after the exercise

Variable	Group	Pre(Mean±SD)	Post(Mean±SD)	t	p
Area	UE	314.70±16.26	289.80±10.81	3.492	.007*
	SE	313.10±21.23	294.30±8.34	2.690	.025*
X mean	UE	18.10±1.66	17.70±1.88	1.809	.104
	SE	16.90±.99	16.70±1.15	1.500	.168
Y mean	UE	12.50±1.08	9.70±.67	9.635	.000*
	SE	12.90±1.28	12.20±.78	2.689	.025*

*p<.05
UE: Unstable platform exercise group, SE: Stable platform exercise group
Area: Center of pressure area, X mean: medial-lateral displacement, Y mean: anterior-posterior displacement

Table 4. Comparison of area, X mean, and Y mean between the two groups after the exercise

Variable	UE post-pre(Mean±SD)	SE post-pre(Mean±SD)	t	p
Area	-24.90±7.13	-18.80±6.98	-.611	.549
X mean	-.40±.22	-.20±.133	-.775	.449
Y mean	-2.80±.29	-.70±.26	-5.382	.000*

*p<.05
UE: Unstable platform exercise group, SE: Stable platform exercise group
Area: Center of pressure area, X mean: medial-lateral displacement, Y mean: anterior-posterior displacement

stable platform exercise group but there was no statistically significant change in the unstable platform exercise group. There was no significant change in the X mean in both groups(Table 3)($p<.05$).

According to the result of comparing differences in balance ability between the two groups, Y mean statistically significantly improved in the unstable platform exercise group more than in the stable platform exercise group(Table 4)($p<.05$).

DISCUSSION

Balance is an ability to continuously maintain the central of gravity, body alignment, and postural alignment on one's base of support(26). Such balance is an element necessary for all functional behaviors and essential in activities of daily living such as sitting, standing, and walking(27). This study intended to examine the effects of balance exercise according to the kinds of platforms on static balance ability.

Yu(28) reported that balance exercise on an unstable platform was effective in improving proprioception and enhancing leg muscle strength. Kim et al.(25) reported that balance exercise on an unstable platform ameliorated muscle activity and balance ability. In the present study as well, balance exercise on an unstable platform improved one group's balance ability.

In a study by Lee of exercise on an unstable platform with a BOSU balance trainer, activity of the abdominal muscles, the rectus abdominis, external abdominis, and internal abdominis oblique was higher than their activity on a stable platform(29). The rectus abdominis, external abdominis, internal abdominis oblique, and transversus abdominis provide stability during functional movement of the trunk and play a crucial part in balance ability of the body(30). In the present study, balance ability of the balance exercise group on an unstable platform improved probably because balance exercise affected their trunk muscles, enhancing their balance ability.

An unstable platform and a stable platform may stimulate different somatic senses. Mere efforts to maintain balance on an unstable platform lead to various reaction forces by each second and unit area and much activate tendons, ligaments, and joint receptors(31). Fabio et al.(32) reported that when the vision was blocked, static balance ability improved. DiStefano et al.(31) observed that equilibrium training on an unstable base of support was effective in enhancing forward and backward and left and right angles of postural sway and postural sway distance. Balance exercise on an unstable platform changes afferent input in the central nervous system and promotes postural control and dynamic balance more than balance exercise on a stable platform(33). Such result is similar to the present study result that balance exercise on an unstable platform was more effective for static balance than balance exercise on a stable platform.

In the present study, leg exercise on an unstable platform was found to have greater effect on balance ability improvement than leg exercise on a stable platform. Nonetheless, sufficient consideration of stability according to application of an unstable platform and selection of subjects is considered necessary. Moreover, balance control mechanism involves very complex interaction and an approach considering these factors is regarded necessary in evaluating balance as well.

CONCLUSION

This study was conducted in order to examine the effects of balance exercise on an unstable platform on balance ability enhancement relative to balance exercise on a stable platform, with students at N university as subjects. As a result, this study reached the following conclusions.

First, there was significant difference in COP area between the unstable platform exercise group and the stable platform exercise group.

Second, there was significant change in anterior-posterior movement of the unstable platform exercise group.

Third, there was significant difference in anterior-posterior movement after the exercise between the unstable platform exercise group and the stable platform exercise group .

Thus, exercise on an unstable platform is more effective than exercise on a stable platform in strengthening balance ability.

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