



Original Article

Effect of a 4-week balance exercise with medio-lateral unstable sole on ankle joint functional ability

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Abstract. [Purpose] This study examined the effects of 4-week of balance exercise with medio-lateral unstable sole on ankle muscle activation and functional ability. [Subjects and Methods] Thirty university students without current or past ankle injuries were assigned to either an experimental group or control group. The experimental group participated in a balance exercise program 3 times a week over 4 weeks, which consisted of one-leg stands and semi-squat exercises with medio-lateral unstable sole. The control group continued with their regular life activities without participation in the program. Electromyographic activities of peroneus longus and brevis muscles were recorded during stair descending immediately before and after the exercise program. Functional balance was tested with the Star Excursion Balance test immediately before and after the exercise program. Paired t-tests were used to assess statistical significance. [Results] Activation of peroneus longus and brevis and Star Excursion Balance Test scores in both groups did not show a significant difference between pre- and post-exercise. [Conclusion] A future study is suggested with increased level of medio-lateral perturbation during outcome measurements and exercises with addition of supervision in the exercise training and home program.

Key words: Balance exercise, Lateral ankle sprain, Medio-lateral unstable sole

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INTRODUCTION

Ankle joints are weak and easily damaged due to changes in lifestyle, reduced walking as a means for traveling, and complex movements in some activities¹⁾. Lateral ankle sprains are one of the common ankle joint injuries²⁾. 10 to 50% of patients who has experienced an ankle sprain before gets recurring sprain and experiences ongoing pain, which can eventually lead to a chronic ankle sprain³⁾. In addition, about 25% of sports-related injuries involve ankle joint problems. Rehabilitation of an ankle injury is crucial for non-athletes and athletes to be able to resume various levels of activities⁴⁾.

A previous research has proposed use of sandals for rehabilitation after ankle injuries and before injuries as a prevention. Wearing Sandals with attached hemisphere-shaped soles are found to increase muscle activity around the ankle joint and improve antero-posterior stability during a variety of exercises⁵⁾. In addition, Yang et al. reported that descending stairs with medio-lateral unstable sole (MLUS; BTP company, Korea) in healthy subjects increased the activity of ankle evertors⁶⁾. The MLUS was modified to stimulate more movement in the frontal plane (inversion and eversion). However, it is not clear whether balance exercises with the MLUS helps prevent ankle sprains or could bring more stability to the ankles. Use of MLUS in balance exercise is thought to improve the ability of the balance of the foot and ankle muscle activity is expected to contribute to strengthening the ankle. Therefore, the purpose of this study was to evaluate the changes in the activity of the peroneus longus and brevis muscles and balance capabilities during 4-week balance exercise with the MLUS.

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SUBJECTS AND METHODS

Thirty healthy volunteers with no ankle sprain or lower extremity disorder in prior 6 months were selected. The experimental procedure was fully described to the subjects, and was approved by the Silla University ethics committee. Subjects were randomly assigned to either the subject exercise group (21 ± 4.0 yrs, 166 ± 8.8 cm, 67 ± 15.2 kg) or the control group (22 ± 7.1 yrs, 170 ± 6.2 cm, 63 ± 6.9 kg), each containing 15 subjects. MLUS was made in the form of sandals attached with Velcro to put under the subject's shoes. MLUS was developed for the average men's shoe size (260 mm) and the average female shoe size (240 mm). The sole was manufactured at the height of 2 cm, breadth 3 cm⁶). Muscle activity was recorded with a multichannel electromyography Myotrace 400 (Noraxon Inc, Scottsdale, AZ, USA) 25–450 Hz, by specifying the notch filter to 60 Hz and root-mean square (RMS) average interval to 300 mm. All data was calculated at maximal voluntary contraction percentage and measured activating peroneus longus muscle (PL) and peroneus brevis muscle (PB) during ankle eversion⁵).

The experimental group completed one-leg stands and semi-squats, 5 sets of 10 times over one week at home. One leg stands were performed on the dominant leg with the sandals, and with the eyes open and knee and hip of the non-dominant leg flexed to a comfortable position. The semi-squat exercise was performed with the MLUS sandals about shoulder width apart, and shoulders in 90-degree flexion. In the squat position, knees were flexed to 120 degrees and held flexed for thirty seconds, with a one-minute rest period after each of 5 sets⁷). The control group maintained daily life without any specific exercise requirements for four weeks. To investigate the activity of the peroneus longus and brevis, subjects descended stairs immediately before and after the exercise program with electrodes attached in their PL and PB. The participants stood on a 27-cm-high platform with bare feet, while maintaining the spacing of both feet to maintain balance. Subjects had to transfer their weight forward with the start of a verbal signal and they touched the floor with right foot first and followed by the left leg. Subjects needed to keep their balance on top of the platform. This was repeated three times. To evaluate the dynamic stability of the ankle joint, the Star Excursion Balance Test (SEBT) performed in bare feet. The same examiner proctored all of the tests. Immediately before and after the exercise program, SEBT was performed with a one leg lunge on the center of a taped floor while the opposite leg reaches as far as possible without loss of balance in line with the tapes that points to 8 different directions: anterior, antero-medial, medial, postero-medial, posterior, postero-lateral, lateral, and antero-lateral⁸). Activations of PL and PB during stair descending and results of SEBT were analyzed with paired t-test. The significant level was set at 0.05 and all statistical analyses were calculated by SPSS (ver. 20.0) for Windows.

RESULTS

Table 1 summarizes PL and PB muscles activation and SEBT scores. Activities of both PL and PB in the control and experimental groups during SEBT did not show significant changes between pre- and post-exercise.

DISCUSSION

Activities of PL and PB during stair descending or SEBT did not change significantly before and after the exercises in the sandals with MLUS in the present study. In the previous study, the hemisphere sandal increased activation of the PL (22.52 to 45.01%) and the PB (27.45 to 63.03%) during a single-leg stance⁹). In addition, Cha and Kim reported that anterior SEBT increased from 73.2 to 74.1 cm in BAPS board exercise group (BEG) and from 76.5 to 77.5 cm in the Trampoline exercise group (TBG). Posterolateral and posteromedial SEBT also increased in BEG and TBG³). Unlike previous studies, this study included stair descending in addition to SEBT as outcome measurements 4-week of balance exercise with MLUS. A future study will need to increase the level of perturbation during outcome measurements that could further challenge the ankle joints of healthy subjects in the medial-lateral direction. In addition, the balance exercise program with the semi-squats and one-leg stands also require a higher level of perturbation to provide enough challenges to healthy subjects. For a future study, including more dynamic movements such as side stepping and side-jumping with MLUS could better stimulate PL and PB activities.

Table 1. Muscle activations and Star excursion balance test (SEBT) score

	Control			Exercise		
	Pre	Post	p	Pre	Post	p
PL (%)	8.7 ± 24.1	9.6 ± 35.5	0.708	11.7 ± 0.1	13.3 ± 3.3	0.348
PB (%)	10.1 ± 24.6	11.0 ± 6.4	0.201	12.8 ± 41.2	15.1 ± 5.4	0.518
SEBT 1 (cm)	76.7 ± 37.9	80.5 ± 17.2	0.692	80.5 ± 4.5	88.5 ± 32.5	0.204
SEBT 2 (cm)	74.1 ± 40.2	75.8 ± 15.8	0.871	66.4 ± 50.9	83.0 ± 30.7	0.182
SEBT 3 (cm)	80.9 ± 29.3	81.9 ± 18.6	0.929	75.3 ± 18.0	81.1 ± 18.4	0.442

PL: peroneus longus; PB: peroneus brevis; SEBT 1: Anterior; SEBT 2: Posterolateral; SEBT 3: Posteromedial

A limitation of this study is that the exercises were performed without supervision so that the compliance and the exercise forms were not monitored. Moreover, the SEBT results may not have shown a significant difference between before and after exercise program because healthy subjects already have high scores. In a future study, it is suggested to include supervision during the trainings of the exercises and specific instructions for the home exercise program. The 4-weeks balance exercises with the MLUS showed no significant difference between the results for the improvement of muscle activity and balance ability. However, a future study is necessary to discover the effects of the MLUS through a long-term training and systematic exercise program.

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