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Original Article

Effects of visual feedback balance training on the balance and ankle instability in adult men with functional ankle instability

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Abstract. [Purpose] This study examined the effects of visual feedback balance training on the balance and ankle instability in adult men with functional ankle instability. [Subjects and Methods] Twenty eight adults with functional ankle instability, divided randomly into an experimental group, which performed visual feedback balance training for 20 minutes and ankle joint exercises for 10 minutes, and a control group, which performed ankle joint exercise for 30 minutes. Exercises were completed three times a week for 8 weeks. Bio rescue was used for balance ability. It measured limit of stability at one minute. For ankle instability was measured using Cumberland ankle instability tool (CAIT). This measure was performed before and after the experiments in each group. [Results] The experimental group had significant increase in the Limit of Stability and CAIT score. The control group had significant increase in CAIT score. While the Limit of Stability increased without significance. [Conclusion] In conclusion, visual feedback balance training can be recommended as a treatment method for patients with functional ankle instability.

Key words: Visual feedback balance training, Functional ankle instability

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INTRODUCTION

In recent years, participation in sports has increased, resulting in an increase in sports-related injuries. These injuries frequently involve the lower extremities, with sprains of ankle joints, which damage the lateral ankles due to inversion, accounting for 85% of the incidents[1, 2)]. Among patients with ankle-joint sprains, 20% to 40% progress into functional ankle instability, which refers to repetitive ankle sprains or re-damage, and complain of the subjective feeling that the ankle may give way during daily activities[3)]. Functional ankle instability is one of the main causes of activity disorder, the symptoms of which include pain, edema, muscle weakness, deterioration of proprioception, and lack of balance[4)]. The deterioration of proprioceptive sensibility causes difficulties in postural control and induces instability in the ankle joints. Balance ability refers to the ability to maintain one's center of gravity over the base of support during static and dynamic movements, and deterioration in balance ability increases ankle instability as well as lateral movements in ankle joints. Thus, balance training, proprioceptive-stimulation training, muscle-strengthening exercises, and manual therapy are used to increase the stability of ankle joints. In particular, balance training is a widely used treatment method to improve posture control, proprioception, and balance ability as well as to increase the stability of the ankle joints[5, 6)].

In this study, visual feedback balance training was conducted rather than simple balance training. Balance training that utilizes visual feedback has been reported to improve balance ability through constant repetitive autonomous modification while the participant performs motor tasks and experiences constant stimulation of motor plan and motor control abilities. Furthermore, it has been reported to compensate for instability and absorb impacts on the ankle joints through strategic

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Table 1. General characteristics of subjects

	Experimental group (n=13)	Control group (n=15)
Age (years)	23.0 (± 2.9)	23.7 (± 1.8)
Height (cm)	177.4 (± 6.8)	174.0 (± 4.0)
Weight (kg)	76.1 (± 16.7)	66.9 (± 6.4)
CAIT (scores)	19.6 (± 4.3)	21.3 (± 3.2)

CAIT: Cumberland Ankle Instability Tool.

movements of the knee joints that induce horizontal and vertical movements of the center of gravity according to the visual feedback[7, 8]. This study aimed to determine the effects of visual feedback balance training on the balance and ankle instability of male adults with ankle instability.

SUBJECTS AND METHODS

This study was conducted from May to July 2015 after receiving approval from the Bioethics Committee of Daegu University. All of the subjects understood the purpose of this study and gave their written consent before participating. The participants were 28 adult male subjects who had functional ankle instability determined by the Cumberland Ankle Instability Tool (CAIT) (Table 1). Twenty eight subjects were divided into two groups randomly. The selection criteria were as follows: men in their 20s who had experienced an ankle sprain at least once, those who felt giving way in their ankle joints, those with a CAIT score below 24 points, and those who could support their body weight fully while conducting the tasks in this study. The exclusion criteria were as follows: those with no other particular diseases than ankle instability, those who had experienced ankle joint surgery in the past. In this study, subjects were divided into an experimental visual feedback balance training group, and an exercise control group, which conducted muscle stretching and muscle strengthening exercises. Examination was conducted prior to intervention, and a post-examination was conducted after 8-weeks of intervention.

For the visual feedback balance trainer, a Bal Pro (Man&Tel Co., Korea) was used. The visual feedback balance trainer consists of a screen, a pressure sensor that can sense the horizontal movements of weight loads on the foothold, a tilt sensor that can perceive the angle of the knee joint, and a main body containing programs to process the information perceived by the tilt sensor. The pressure sensor at the foothold can sense the body weight centers of patients to help them move horizontally using a finger-shaped cursor on the screen during the game as the body weight is moved to the right or left. A tilt sensor detects the angle of flexion and extension of the knee joints. For example, when the knees are bent, a cursor is raised, and when the knees are extended, a cursor descends, thereby performing training to touch various fruits arranged randomly on a tree on the screen[1, 9]. The visual feedback balance training was conducted three times a week for 8 weeks. Each exercise timespan was 30 minutes. Out of the 30 minutes, 20 minutes were allocated for balance training, while 10 minutes were allocated for exercise treatment of the ankle joints. The control group applied stretching and muscle-strengthening exercises. The exercise was conducted three times a week for 8 weeks, and the intensity was adjusted gradually according to the patient's condition.

For postural adjustment ability, center of pressure was measured using Biorescue (RM Ingenierie, Rodes, France). The element measured included the Limit of stability (LOS) to evaluate the balance ability. High value indicated good balance ability. LOS were measured for one minute. Ankle instability was measured using CAIT. CAIT has been reported to have high reliability and validity. This evaluation tool is composed of 9-item questionnaire according to degree of instability ankle. CAIT enables classification according to a score between 0 and 30, where scores greater than or equal to 28 points no instability and defined as having an unstable ankle below 24 points. High score indicated good ankle stability[10].

Data analyses were performed using the SPSS program version 18.0. The Kolmogorov-Smirnov test was used to test for normality. To identify the changes in each parameter between before and after training of the two groups, a paired t-test was used. Statistical significance was accepted for values with $p<0.05$.

RESULTS

The measurement results of the LOS showed that the experimental group had a significant increase values before and after the exercise ($p<0.05$), and the control group had no significant increase values before and after the exercise ($p>0.05$). The measurement results of the CAIT score showed that both the experimental and control groups had a significant increase values before and after the exercise ($p<0.05$) (Table 2).

DISCUSSION

Ankle strains have a high recurrence rate and thus often progress into chronic ankle instability. One cause of ankle instability is a lack of balance ability. Most injuries to ankle joints occur when people land on irregular surfaces. Thus, balance ability is more important than muscle strength in preventing a recurrence of instability[11]. This study aimed to determine the effect of visual feedback balance training on balance ability and ankle instability in male adults with functional ankle instability to

Table 2. Comparison of the Limit of stability (LOS), Cumberland Ankle Instability Tool (CAIT) score for each group at pre-test and post-test

	Experimental group		Control Group	
	Pre-test	Post-test	Pre-test	Post-test
LOSL (mm)	5,572.4 (± 1,190.7)	6,768.8 (± 779.9)*	5,386.4 (± 933.6)	5,693.8 (± 1,299.8)
LOSR (mm)	5,258.7 (± 1,806.4)	6,682.9 (± 1,202.9)*	5,052.2 (± 1,043.7)	5,225.7 (± 1,037.7)
LOSF (mm)	7,177.4 (± 2,316.3)	8,328.4 (± 1,251.0)*	7,419.1 (± 1,285.5)	7,562.8 (± 1,432.2)
LOSB (mm)	3,653.8 (± 1,054.6)	4,679.5 (± 1,281.8)*	3,323.0 (± 934.2)	3,578 (± 850.4)
CAIT (scores)	19. 6 (± 4.3)	20.6 (± 3.7)*	21.3 (± 3.2)	22.7 (± 2.3)*

Values are expressed as mean (± standard deviation).
LOSL: limit of stability left; LOSR: limit of stability right; LOSF: limit of stability front; LOSB: limit of stability back.
*Significant difference between pre-test and post-test ($p<0.05$).

assess whether it can be recommended as a new therapy method.

The present study found that the increase in balance ability of male adults with functional ankle instability in the experimental group was statistically significant. This result indicated that the training stimulated proprioception in the subjects as they moved their own body weight and returned back to their original positions with stability, thereby increasing sensory nerve signal transmission, followed by an increase in balance abilities and motor control of the muscles around the knee joints. Previous studies on balance training with visual feedback with regard to healthy adults and elderly adults reported significant improvements in postural balance ability, which is consistent with the present study's results[12, 13]. Moreover, the present study showed that the CAIT score increases were statistically significant in both the experimental and the control groups because the training improved muscle strength around the ankles and thereby reduced subjective feelings of ankle instability. The present study's results were consistent with those of previous studies, in which balance training and muscle strengthening exercises increased muscle activity around ankles, including the tibialis anterior and peroneus longus muscles, as well as isokinetic muscular strength, improving ankle stability[1, 14].

The limitations of this study are as follows. First, the present study was conducted only with male adults with ankle instability; no female patients with ankle instability were included. Second, follow-up observations were not conducted to identify changes over time.

The present study results showed that balance training with visual feedback effectively improved balance ability and ankle instability in male adults with functional ankle instability. In addition, the balance training increased patients' interest and participation rate in treatment more than existing therapy methods. Therefore, balance training with visual feedback can be recommended as an efficient training method for patients with ankle instability.

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