The Effects of a Complex Exercise Program with the Visual Block on the Walking and Balance Abilities of Elderly People

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Abstract. [Purpose] The purpose of this study was to investigate the effect of a complex exercise program for elderly people who had experienced a fall on their balance, gait, vestibular senses, and proprioceptive senses when their visual sense was blocked. [Subjects and Methods] The subjects were 30 healthy elderly people aged 65 or older. They were equally and randomly divided into a visual block (VB) group (those whose eyes were covered) and a visual permission (VP) group. The subjects performed the complex exercise program for 30 minutes, twice a day, five day a week for 4 weeks a total of 20 times. Outcome measures were the 10 meter walking test (10MWT), stair up/down test (SUDT), Berg balance scale (BBS), vestibular stepping test (VST), proprioception test (PT). [Results] After the intervention, the VB group showed improvements in 10MWT, VST, and PT. The VP group showed improvements in 10MWT and PT. The significant improvement in VST observed in the VB group was significantly greater than that in the VP group. [Conclusion] The complex exercise program for elderly people helped enhance their balance ability and gait, and improved their vestibular sense.

Key words: Complex exercise, Elderly, Visual block

INTRODUCTION

The proportion of elderly people aged 65 or older is for 9.1% of Korea’s population. The nation is expected to enter an aging society in 2018 with the elderly comprising up 14.3% of the total population1). Due to the aging process, physical changes such as decreased balance, atrophy of neurological functions, reduced gait ability, and the weakening of muscle strength occur increasing the risk of falls. A fall may restrict activities of daily living, leading to loss of independence, and increase medical costs hospitalization2). As a sequela of a fall, activities of the elderly may be through loss of independence, decrease in physical activity, and fear of another fall.

The factors that trigger a fall are divided into internal and external factors. Internal factors are visual disturbance, weakened lower limb muscle strength, reduced balance and gait ability, cognitive disorder, chronic diseases, and administration of medication. External factors include an unsafe environment3).

Balance results from appropriate interaction between the senses, movement, and the cognitive system4). Visual sense plays an important role in perceiving space and distance, and risks from the surrounding environment. Visual sense also provides information on the location of each part of the body, and the required intensity of effort for postural adjustment5). The vestibular system provides information on the movements of the head and the location of the head related to gravity or inertial force. Proprioceptive senses include the position sense that senses the locations of joints, and kinesthesia that senses the movements of joints. These senses continuously maintain and correct posture, and enable conscious perception of body movements6). If information from the visual sense is not precise, the central nervous system ignores visual input and depends on accurate vestibular and proprioceptive inputs7).

In research conducted on elderly people, balance ability has been found to correlate with function of the somatosensory system of the lower extremities, and although there is high correlation between proprioceptive sense and balance maintenance ability, the visual and the vestibular senses have been found to be auxiliary factors of balance maintenance8). In the rehabilitation of hemiplegic patients, when somatosensory and vestibular sense information is utilized in a compensatory balance strategy, more effective balance improvement was observed when the visual sense was blocked9).

The present study conducted a complex exercise program for elderly people who had experienced a fall, to investigate the changes in their balance, gait, vestibular senses, and
The subjects and methods

The subjects of this study were 30 healthy elderly people aged 65 or older registered with a welfare center located in J City, Jeollabuk-do. They understood the purpose of this study and voluntarily consented to participate in this study. This study was approved by welfare center, and all the participants provided their written informed consent. The subject were equally and randomly divided into a VB (visual block) group (those whose eyes were covered) and a VP (visual permission) group (those whose eyes were not covered) through coin flipping. The average age and height of the VP group were 71.9 years old and 154.5 cm, respectively, and the average age and height of the VB group were 73.2 years old and 153.5 cm, respectively, with no significant differences between the two groups (p = 0.64). The weight of the VP group was 63.26 kg and that of the VB group was 59.48 kg, with no significant difference (p = 0.46). The criteria for inclusion as the subjects of this study were: a fall event in the last three months. The exclusion criteria were: lesion in the central or peripheral nerves; mental disorder; orthopedic problem in the lower limbs; cardiopulmonary disease; or taking medicine that would affect balance ability.

The subjects performed a complex exercise program for 30 minutes, twice a day, five days a week for four weeks, a total of 20 times. The VB group wore an eye shade during exercise. After safety education for five minutes, the subjects conducted stretching exercise for 10 minutes, took a rest for three minutes, walked on a treadmill and pedaled on a cycle ergometer for 10 minutes, took a rest for three minutes again, and walked on a track with obstacles with the help of an assistant for 10 minutes.

For outcome measurement, the following instruments were used. For the 10 meter walking test (10MWT), the subjects walked at a comfortable speed over a distance of 14 meter. In consideration of acceleration and deceleration, the time taken to walk the 10 meter excluding the first and last 2 meter was measured\(^\text{10}\). For the stair up/down test (SUDT), the subjects ascended and descended stairs whose width was 135 cm, whose height was 15 cm, and whose depth was 30 cm. The average time of the two measurements was calculated. The rest time between each measurement was 30 seconds\(^\text{11}\). The Berg balance scale (BBS) has a total of 14 assessment items which are categorized into three areas: sitting, standing, and postural change. Each item is scored on a 5-point scale with a minimum score of zero (cannot perform at all) and a maximum score of four (can perform normally). The scores of each item are summed and the minimum score (zero) indicates “very severe damage” and the maximum score (56 points) indicates “normal”; a lower score suggests a higher risk of fall\(^\text{12}\). The methods of measurement were demonstrated to the subjects with explanation and then measurements were taken. In the vestibular stepping test (VST), the subjects put on an eye patch and walked on the spot for one minute\(^\text{8}\). Then, distance from the start point was measured. The subjects stood barefoot in a comfortable position with the right big toe over a circle with a radius of 1 cm. The subjects concentrated on not deviating from the circle while walking on spot. After one minute, the deviation distance was recorded. After one practice, the subjects performed the test twice, and the average value was calculated. In the proprioception test (PT), the subjects had their eyes covered with an eye patch and stood in front of a paper whose width and length were marked at intervals of 0.1 cm. The subjects put their right foot on the paper. Then the subjects placed the left foot shoulder width apart with their the left big toe at the location the subjects perceived to be in line with the right big toe. The difference in alignment of the two big toes was calculated. After one practice, measurements were taken twice and the average value was calculated.

For comparison between the groups, the independent t-test was used, and for within group comparisons balance, gait, vestibular function, and proprioceptive senses between before and after the training, the paired t-test was employed. The significance level was chosen as α=0.05.

### RESULTS

There were significant improvements in 10MWT, VST, and PT in the VB group after the intervention (p<0.05). There were significant improvements in 10MWT and PT in the VP group after the intervention (p<0.05). The significant improvement in VST in the VB group was significantly greater than that of VP group (p<0.05). There was no significant differences in SUDT and BBS within each group between before and after the intervention (Table 1).

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**Table 1. The within-group and between-group comparisons of the outcome measures**

|                      | VB group       | VP group       |
|----------------------|----------------|----------------|
|                      | Pre-test       | Post-test      | Pre-test       | Post-test      |
| 10MWT                | 28.5 (4.0)*    | 25.1 (2.7)*    | 27.8 (6.1)     | 24.0 (4.7)*    |
| SUDT                 | 21.9 (3.1)     | 20.4 (3.4)     | 18.9 (8.3)     | 18.5 (7.0)     |
| BBS                  | 47.5 (3.1)     | 48.0 (3.8)     | 50.1 (3.8)     | 50.9 (2.5)     |
| VST                  | 101.7 (28.7)   | 70.0 (15.2)*   | 92.1 (18.0)    | 93.9 (24.2)    |
| PT                   | 2.0 (1.4)      | 1.3 (0.7)*     | 2.1 (1.1)      | 1.3 (0.9)*     |

*Significant difference between groups (p<0.05).
*Significant difference within group (p<0.05).

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*Means (SD).

The within-group and between-group comparisons of the outcome measures demonstrated significant improvements in 10MWT, VST, and PT in the VB group after the intervention (p<0.05). The significant improvement in VST in the VB group was significantly greater than that of VP group (p<0.05). There was no significant differences in SUDT and BBS within each group between before and after the intervention (Table 1).

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**Note:** The significance level was chosen as α=0.05.
DISCUSSION

The purpose of this study was to examine the effect of a complex exercise program, performed with the eyes covered, to assess its utility as a program for improving the balance and gait ability of people who have experienced a fall. This study divided the subjects into a VP group and a VB group. There were significant differences in 10MWT, VST, and PT after the intervention in the VB group (p<0.05), and in 10MWT and PT after the intervention in the VP group (p<0.05). However, there were no significant differences in SUDT and BBS after the intervention in either group.

For elderly people to lead a safe and ordinary life, they need balance ability as well as muscle strength. Decreased balance ability increases the risk of a fall and degrades their quality of life. Therefore, research on postural and balance adjustment is being continuously carried out. Decline in proprioceptive sense due to aging is closely related to decreased balance ability, and the elderly complain of difficulties in activities of daily living and movement\(^1\). In particular, these difficulties take place during walking and climbing stairs. In addition, because of fracture, brain injury, or musculoskeletal system disease after a fall, elderly people’s fall is related to decreased self-confidence about balance and movement. Stolze et al.\(^{13}\) and Carmeli et al.\(^{14}\) reported that performance of a complex exercise program led to an improvement in balance ability, enhancements in muscle strength and endurance, and an increase in gait speed. Their study results are similar to those of present study. Both groups’ gait speed and balance improved in the present study because muscle strength was enhanced by pedaling, stepping and treadmill training.

VST significantly changed after the intervention in the VB group, and there was also a significant difference in VST between the two groups after the intervention. PT significantly changed after the intervention in the VB group. The present study result was similar to the results of a study that conducted muscle strengthening exercises for elderly people\(^{15}\). When visual senses are blocked, muscle response is primarily organized and postural control is made more swiftly, because maintenance of vestibular and proprioceptive senses increases the capabilities of the postural control system. Some researchers also consider that the proprioceptive and vestibular systems are engaged in balance control\(^{16}\).

Research on balance and visual sense examines balance ability with subjects’ eyes open and closed, but the present study measured balance ability after training with the eyes covered and the uncovered. This method is a meaningful technique since the subjects participate in the intervention without the visual sense completely blocked.

The limitations of this study are that the experimental period was short and the subjects’ ordinary life was not controlled.

In conclusion, a complex exercise program for elderly people helped enhance their balance ability and gait, and improved their vestibular senses.

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