Effect of physical activity on cognition and daily living activities of the elderly with mild dementia

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Abstract. [Purpose] The purpose of this study was to examine the effects of a physical activity program on cognitive function and ADLs in elderly people with mild dementia. [Subjects and Methods] Both groups (n=60) participated in a cognition program three times a week for 30 minutes each time over an eight-week period. In addition, the experimental group (n=30) underwent a physical activity program for 30 minutes three times a week over an eight-week period. The LOTCA-G and the FIM were recorded in both groups before and after the experiment to evaluate changes in their cognition and ADLs. [Results] The experimental group showed significant results in 18 subtests and total LOTCA-G, while the control group exhibited significant results in 8 subtests and total LOTCA-G. The comparison results between groups before and after the intervention are as follows. The experimental group showed significant results in 15 subtests and FIM total, while the control group exhibited significant results in 7 subtests and FIM total. The comparison results between groups before and after the intervention are as follows: significant results were revealed in 10 subtests and FIM total. [Conclusion] The physical activity program improves cognitive function and ADLs in patients with mild dementia.

Key words: Dementia, Physical activity, ADL

INTRODUCTION

Dementia is one of the most common diseases with psychotic symptoms suffered by the elderly. Generally, it is a chronic and gradually aggravated progressive disorder that affects cognitive function, including damage to memory, thinking and learning abilities, and judgment1). One of the social and environmental approaches to prevention and management of dementia is to apply exercise programs as much as possible. Recently, activity programs have received much attention; these programs aim to bring about behavioral changes and improvements in quality of life by increasing physical and mental functions through regular and systematic physical movements2). Regular exercise is extremely important for patients with dementia3), because it can activate brain metabolism, increase secretion of cerebral blood flow and neuro-transmitters4), and prevent damage in the internal blood vessel walls by increasing elasticity of the blood vessel walls5). It can also have a significant effect on the prevention of and improvements to osteoporosis and damage caused by falls, as well as chronic diseases, such as depression and emotional stress6). In addition, it can provide an opportunity to improve quality of life by promoting independent living capabilities7), and increasing the sense of achievement and self-confidence of patients8).

The effect that physical activities have on improving the cognitive functions of patients with dementia have been thoroughly studied9-13). It is necessary to develop and apply various types of physical activity programs for patients in the early stages of mild dementia because these activities can help reduce progress into severe dementia and maintain remaining
functions\(^2\). Although a number of studies have been conducted on the effect of physical activities on the cognitive functions of patients with dementia, few studies have been conducted on the effect of physical activities on cognitive functions and daily living activities, which is the focus of the present study.

**SUBJECTS AND METHODS**

This study selected 60 patients with mild dementia who were admitted to the Day Care Center for the elderly in Daegu Metropolitan City from July to September in 2016. The selection criteria of the patients with mild dementia were as follows: Clinical Dementia Rating (CDR) was 1, no problems with hearing and vision, able to walk independently. The selected subjects were fully informed about the purpose of this study, experimental method, details and procedures, and gave their consent to participate in the study through their own expression (Table 1).

Each of the experimental and control groups was divided into 30 subjects randomly, and the Loewenstein Occupational Therapy Cognitive Assessment for Geriatric Population (LOTCA-G) was conducted to evaluate cognition capabilities prior to the training. In addition, the Functional Independence Measure (FIM) was used to assess daily living activities. Both groups conducted the cognition training for 30 minutes three times a week for eight weeks, and the experimental group added the physical activity program for 30 minutes three times a week for eight weeks. After completing the eight-week training, both subjects were evaluated again using the LOTCA-G and FIM.

The physical activity program was supplemented and modified based on a program in a study conducted by Lee et al\(^1\)). This program contains the Otago exercise program where muscle strength and balance re-training is included to prevent falls by the elderly\(^1\). The training started with a warm-up exercise followed by head, neck, and ankle movements, as well as motions to improve balance. Ankle cuffs were used in walking exercises for muscle strength by increasing the weight from 1–6 kg every two weeks depending on patient condition. The exercise times were as follows: five minutes for warm-up, 20 minutes for main exercise, five minutes for cool-down exercise, resulting in 30 minutes in total. Warm-up exercises consisted of stretching and light movements of the head, waist, and ankles. The main exercises consisted of a knee strengthening exercise, a side hip strengthening exercise, knee bends-hold support, calf raises-hold support, toe raises-hold support, calf raises-no support, knee bends-no support, heel-toe standing-no support, rising from chair with one hand support, rising from chair without hand support, and walking with ankle cuff (weight from 0–6 kg). Cool-down exercises consisted of a breathing exercise (from deep to shallow breathing), wrist and ankle turning, and knee massaging. The physical activity program was conducted by physiotherapists.

The cognition program was comprised of the following activities: throwing rings and sand bags while sitting, balloon volleyball, puzzles, and stacking cups. It was conducted for 30 minutes per session, three times a week for eight weeks for both of the groups. The cognition program was conducted by occupational therapists.

The LOTCA-G is a tool to assess cognitive functions that was developed for rehabilitation in a hospital in Loewenstein in Israel in 1974\(^4\), and has subsequently been used widely in many countries, including the USA. The LOTCA-G is for adults and has been adjusted for the elderly population\(^5\). The LOTCA-G consists of six cognitive areas: orientation, visual perception, spatial perception, praxis, visuomotor organization, and thinking operation. The subtests for each area are as follows: two for orientation, four for visual perception, three for spatial perception, three for praxis, seven for visuomotor organization, and seven for thinking operation, resulting in 26 subtests in total. Each of the subtests in the orientation area can be scored from 1–8, and the subtests in the other areas can be scored from 1–4. The higher the score is, the higher the cognitive function.\(^6\) The intra-rater reliability is 0.82–0.97 and the reliability of the assessment tool is 0.89\(^7\).

The FIM developed by Granger et al. refers to the assessment tool to measure daily living operations, which consists of eight tests of self-care, five tests of mobility, and five tests of communication and social cognition\(^8\). The score criteria

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**Table 1. General characteristics of the subjects (Mean ± SD)**

|                | Experimental group (n=30) | Control group (n=30) | p   |
|----------------|--------------------------|----------------------|-----|
| Age (years)    | 76.27 ± 3.86             | 75.00 ± 4.98         | 0.311|
| Gender (M/F)   | 12 (40%)/18 (60%)        | 14 (46.7%)/16 (53.3%)| 0.526|
| Education (years) |                     |                      |     |
| 0–8            | 4 (13.3%)                | 4 (13.3%)            | 0.506|
| 9–1            | 10 (33.3%)               | 14 (46.7%)           |     |
| 13+            | 16 (53.3%)               | 12 (40.0%)           |     |
| Dementia type  |                          |                      |     |
| Alzheimer      | 10 (33.3%)               | 10 (33.3%)           | 1.000|
| Vascular       | 14 (46.7%)               | 14 (46.7%)           |     |
| Other          | 6 (20.0%)                | 6 (20.0%)            |     |

*p<0.05.
The LOTCA-G was designed to consist of seven-point scales from one, which is total dependent operation, to seven, which is independent operation without the help of others. The higher the score, the more the patient can perform daily living operations independently. The inter-rater reliability $\alpha=0.95$, the motor area $\alpha=0.77$, and the cognition area $\alpha=0.83$.

The analysis of the study results employed the PASW Statistics for Windows, Version 18.0. The paired t-test was conducted to compare the results before and after the intervention of the LOTCA-G and FIM. The independent samples t-test was conducted to compare the effect between the groups. The statistical significance level, $\alpha$ was set as 0.05.

### Table 2. LOTCA-G (Mean ± SD)

|                          | Experimental G | Control G | Experimental G | Control G |
|--------------------------|----------------|-----------|----------------|-----------|
|                          | Pre test       | Post test | Pre test       | Post test |
| **Orientation**          |                |           |                |           |
| Place                    | 6.33 ± 0.95    | 6.80 ± 1.24* | 6.46 ± 0.81    | 6.53 ± 0.73 |
| Time                     | 5.46 ± 1.10    | 6.16 ± 1.14* | 5.60 ± 0.96    | 5.86 ± 0.62* |
| **Visual perception**    |                |           |                |           |
| Object identification    | 3.46 ± 0.50    | 3.80 ± 0.40* | 3.46 ± 0.73    | 3.60 ± 0.72 |
| Shape identification     | 3.46 ± 0.50    | 3.83 ± 0.59* | 3.66 ± 0.47    | 3.73 ± 0.69 |
| Overlapping figures      | 3.40 ± 0.62    | 3.46 ± 0.57  | 3.40 ± 0.49    | 3.33 ± 0.47  |
| Object constancy         | 3.20 ± 0.40    | 3.43 ± 0.50* | 3.33 ± 0.47    | 3.40 ± 0.72  |
| **Spatial Perception**   |                |           |                |           |
| On self                  | 3.46 ± 0.50    | 3.76 ± 0.43* | 3.26 ± 0.44    | 3.40 ± 0.72 |
| On examiner              | 3.13 ± 0.50    | 3.23 ± 0.56  | 3.00 ± 0.52    | 2.86 ± 0.62* |
| Self and surrounding     | 3.33 ± 0.47    | 3.80 ± 0.40* | 3.33 ± 0.47    | 3.40 ± 0.62  |
| **Praxis**               |                |           |                |           |
| Motor imitation          | 3.33 ± 0.47    | 3.70 ± 0.59* | 3.33 ± 0.47    | 3.46 ± 0.50* |
| Utilization of object    | 3.40 ± 0.49    | 3.76 ± 0.50* | 3.33 ± 0.47    | 3.46 ± 0.50* |
| Symbolic actions         | 3.60 ± 0.49    | 3.86 ± 0.34* | 3.46 ± 0.50    | 3.46 ± 0.50* |
| **Visuomotor organization** |            |           |                |           |
| Copy geometric forms     | 3.60 ± 0.49    | 3.93 ± 0.44* | 3.40 ± 0.49    | 3.46 ± 0.50 |
| Two dimension model      | 2.60 ± 0.72    | 3.03 ± 0.71* | 2.46 ± 0.50    | 2.60 ± 0.49 |
| Pegboard construction    | 2.46 ± 0.73    | 2.86 ± 0.68* | 2.33 ± 0.71    | 2.46 ± 0.73* |
| Block design (color)     | 2.83 ± 0.46    | 3.06 ± 0.44* | 2.46 ± 0.50    | 2.86 ± 0.34* |
| Reproduction of a puzzle| 2.53 ± 0.50    | 2.66 ± 0.60  | 2.26 ± 0.58    | 2.33 ± 0.60 |
| Drawing a clock          | 2.63 ± 0.76    | 3.16 ± 0.91* | 2.40 ± 0.49    | 2.66 ± 0.60* |
| **Thinking operations**  |                |           |                |           |
| Categorization           | 2.73 ± 0.44    | 2.86 ± 0.68 | 2.26 ± 0.58    | 2.46 ± 0.62* |
| Pictorial sequencing     | 2.60 ± 0.49    | 2.76 ± 0.50 | 2.46 ± 0.50    | 2.46 ± 0.50 |
| **Memory**               |                |           |                |           |
| A famous personality     | 3.40 ± 0.62    | 3.50 ± 0.73 | 3.33 ± 0.47    | 3.26 ± 0.44 |
| A personal possession    | 2.20 ± 0.76    | 2.46 ± 0.73* | 2.60 ± 0.49    | 2.73 ± 0.44* |
| Everyday objects         | 1.46 ± 0.50    | 1.86 ± 0.50* | 1.73 ± 0.69    | 1.80 ± 0.66 |
| Attention & concentration| 2.33 ± 0.47    | 3.00 ± 0.64* | 2.73 ± 0.44    | 2.80 ± 0.40 |
| **Orientation**          | 11.80 ± 1.93   | 12.96 ± 1.95* | 12.06 ± 1.63  | 12.40 ± 1.22* |
| Visual perception        | 13.53 ± 1.73   | 14.53 ± 1.27* | 13.86 ± 1.16  | 14.06 ± 1.01 |
| Spatial perception       | 9.93 ± 1.31    | 10.80 ± 0.92* | 9.60 ± 0.96   | 9.66 ± 0.95 |
| Praxis                   | 10.33 ± 1.15   | 11.33 ± 1.02* | 10.13 ± 1.10  | 10.46 ± 0.97* |
| Visuomotor organization  | 16.66 ± 3.00   | 18.73 ± 2.31* | 15.33 ± 2.86  | 16.40 ± 1.88* |
| Thinking operations      | 5.33 ± 0.00    | 5.63 ± 0.88  | 4.73 ± 0.94   | 4.93 ± 0.86 |
| Memory                   | 7.06 ± 1.52    | 7.83 ± 1.46* | 7.66 ± 1.42   | 7.80 ± 0.92 |
| **Total LOTCA-G**        | 77.00 ± 7.70   | 84.83 ± 5.81* | 76.13 ± 7.78  | 78.53 ± 4.51* |

*p<0.05.

M ± SD: Mean ± Standard Deviation.
RESULTS

The comparison results within the groups and between the groups of the LOTCA-G after applying the physical activity program are presented in Table 2. The results within the groups are as follows: The experimental group showed significant results in 18 subtests and areas of orientation, visual perception, spatial perception, praxis, visuomotor organization, memory, and total LOTCA-G, while the control group exhibited significant results in eight subtests and areas of orientation, praxis, visuomotor organization, and total LOTCA-G (p<0.05). The comparison results between groups before and after the intervention are as follows: significant results were revealed in 11 subtests and areas of orientation, visual perception, spatial perception, praxis, visuomotor organization, memory, and total LOTCA-G (p<0.05).

The comparison results within the groups and between the groups of the FIM after applying the physical activity program are presented in Table 3. The results within the groups are as follows: the experimental group showed significant results in 15 subtests and areas of motor total, cognition total, and FIM total, while the control group exhibited significant results in seven subtests and areas of cognition total and FIM total (p<0.05). The comparison results between groups before and after the intervention are as follows: significant results were revealed in 10 subtests and areas of motor total, cognition total, and FIM total (p<0.05).

DISCUSSION

This study aimed to determine the effect of physical activity programs on cognitive functions and daily living activities of the elderly with dementia using the LOTCA-G and FIM assessment tools. This study aimed to contribute to delaying progress into severe dementia for patients with mild dementia, as well as increasing their participation in overall social activities.
This study was conducted on 60 patients with mild dementia whose CDR was 1. The cognition program was applied to both of the experimental and control groups and the physical activity program was additionally applied to the experimental group. The cognitive assessment was conducted through the LOTCA-G before and after the experiment and daily living activities were assessed through the FIM. Significant results were revealed in total LOTCA-G in both of the groups during the cognitive assessment. This was due to the cognitive treatment conducted on both of the groups. However, significant results were revealed in 11 subtests and areas of orientation, visual perception, spatial perception, praxis, visuomotor organization, memory, and total LOTCA-G, and significant results were also found in a comparison between the groups.

A study by Lee et al. proposed that the physical activity of an occupational therapy program had a positive effect on the operational functions of the elderly with mild to moderate dementia20, and a study by Kim et al. reported that a physical activity program was effective for improving immediate memory, recent memory, and past memory21. These previous study results are consistent with the LOTCA-G results in the present study. The additional application of the physical activity program improved cognitive functions in various areas, such as orientation, perception, praxis, visuomotor organization, memory, attention, and concentration. This indicated that the parallel application of a cognitive program and physical activities was effective for improving the cognitive functions of patients with dementia.

Reduced balancing abilities of the elderly have been reported to increase falls, which are followed by decreased physical activities, resulting in changes to daily independent activities, and balance abilities and daily living activities are significantly different depending on the level of cognitive capability22. Thus, it is necessary for patients with dementia to maintain daily living activities to delay any progression into more severe symptoms. The physical activity program applied to the experimental group in this study affected significant results in motor, cognition, and FIM total areas, while the control group had a significant difference in cognition and FIM total areas, but not for the motor results. The comparison between groups also revealed significant results in the motor, cognition, and FIM total areas. A study by Yu and Yang reported that a motor exercise in parallel with cognitive activities increased the balancing ability of the elderly with dementia23. Their result is consistent with the functional improvements of the motor area in the experimental group in this study. This means that the physical activity program improved the cognitive functions of patients with mild dementia, thereby inhibiting the progress into more severe dementia, as well as improving motor abilities and daily living activities. Furthermore, the physical activity program can improve the balance capabilities of patients with mild dementia, which will help increase their participation in social activities.

The limitations of this study are as follows. The study results cannot be generalized to all patients with mild dementia due to the insufficient number of subjects. This study also did not verify the follow-up effect after the intervention. Thus, future studies should be conducted on a higher number of patients with mild dementia. It is also necessary to employ various assessment tools and develop various physical activity programs.

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**Conflict of interest**

None.

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