Effects of Fumanet Exercise Program on Risk of Falling, Body and Cognition Function in Elderly Patients

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Abstract: - This study was conducted to investigate the effect of Fumanet exercise program on risk of falling, body and cognition function in elderly patients. The purpose of this study is to investigate effective intervention methods for the prevention of falls in the elderly. The subjects of this study were 30 elderly inpatients at a nursing hospital located in South Korea. The patients were randomly divided into a experimental group and a control group. The experimental group performed Fumanet exercise program, and the control group performed conservative exercise program. Each group was trained for 20 minutes five times a week for four weeks. Risk of falling was measured using Tetrax. Balance function was measured using the TUG. Gait function was measured using 10MWT. Lower extremity strength was measured using FTSST. cognitive function was measured using MMSE-K. The results of the Fall index, TUG, 10MWT showed a significant differences after training in the experimental group ($p<.05$), but not in the control group ($p>.05$). In these two tests, significant differences were observed between the groups ($p<.05$). The results of the FTSST, MMSE-K showed no significant differences after training in both the experimental group and control group ($p>.05$). Fumanet exercise program resulted in significant improvement in balance and gait function, risk of falling in elderly patients.

Key-Words: - Fumanet Exercsie Program, Elderly Patients, Risk of Falling, Balance Function, Gait Function, Lower Extremity Strength, Cognitive Function.

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1 Introduction

Fall means falling from the original position to a lower position or to the floor regardless of one's intention while performing the activity of daily life [1]. This fall is a typical geriatric accident, and the risk of falling is 10 times higher than that of other age groups [2]. In addition, it has been reported that a fall requires a lot of rehabilitation costs, and even a slight fall can cause serious damage, and even cause life-threatening [3]. The deterioration of body functions such as lower extremity strength, balance function, and gait function and cognitive functions such as consciousness, orientation, memory, and judgment due to aging increase the risk of fall and instability in the elderly [4]. In other words, there is a need for a fall prevention program that can be applied to the elderly.

Risk factors for fall are closely related to body function and cognitive function according to the aging process. The first cognitive function is the ability to process input information to make judgments and decisions, and refers to mental processes and intellectual processes. In the case of the elderly, it has been reported that cognitive function decreases as aging progresses, and in particular, it has been reported that attention is reduced and they experience difficulties in the activity of daily life [5]. Also, it was reported that about 13% of elderly people affected the balance function and gait function due to moderate or severe cognitive function impairment, increasing the risk of fall [5]. That is, the decline in cognitive function leads to a decline in motor function and increases the incidence of fall. The second body function refers to the physical condition that maintains and enhances the activity of daily life ability. In general, body function can be evaluated directly or indirectly through evaluation of balance function, gait function, and lower extremity strength. The balance function is the ability to maintain the center of gravity of the body on the base of suppot, and plays an important role in preventing fall [7]. In the elderly, the functions of balance-related organs such as visual, vestibular, and proprioceptor decrease,

and as a result, posture sway increases, leading to a decrease in balance function [8]. It has also been reported that as the balance function decreases, the gait function decreases and the risk of fall increases [9]. In addition, the skeletal muscle of the elderly showed a marked decrease in muscle strength and a 10-fold higher risk of fall compared to other age groups [10]. In particular, a decrease in the strength of the quadriceps femoris shows a 40% decrease compared to other age groups and increases the risk of fall [11].

According to a previous study on the exercise method for fall prevention, a universal exercise program was reported to be effective in maintaining physical strength, balance function, gait function, and increase of range of motion [12]. Also, in many studies, lower extremity strength training, balance training, and gait training using an elastic band were reported to be effective in fall prevention [13] [14]. However, most of the previous studies focused on body function improvement related to fall, and studies on the fall prevention exercise program considering cognitive function impairment were lacking.

Fumanet Exercise Program was developed to improve gait function and fall prevention for the elderly. Rather than improving muscle strength, it is an exercise that focuses on the learning process during the exercise process. It has been reported to be effective in motor and cognitive functions of the elderly [15]. The learning process of the program can prevent fall by improving collaboration of central nervous system functions including peripheral tissues and visuals, and improving gait function and balance function. In addition, the sensory that perceives the image and memory of the step, the location of the net, and the location of the foot, the sensory area of the cerebral cortex and the motor area, and the interaction with the peripheral muscles of the whole body improve the balance function and the gait function [16] . As such, it has been reported that the Fumanet Exercise Program is effective for fall prevention by improving body and cognitive functions of the elderly. However, studies have been conducted on normal elderly people, and there are insufficient studies on the elderly with a high risk of falling. In addition, most studies have investigated the effects of the Fumanet Exercise Program on the body function of the elderly, and studies examining the multifaceted effects are scarce. Therefore, the purpose of this study is to investigate the effect of the Fumanet Exercise Program on the risk of falling, balance function, gait function, lower extremity strength, and cognitive function in elderly patients with a high risk of fall. And, to investigate effective intervention methods for the prevention of falls in the elderly.

2 Methods

2.1 Subjects

This study was conducted on elderly people aged 65 and over who were admitted at S Nursing Hospital in Gyeongsangbuk-do in October 2020. After explaining the purpose and contents of the study to all study subjects, the experiment was conducted after obtaining consent to participate. The experimental procedure was approved by the Institutional Review Board. The selection criteria of the subjects were selected as the elderly who can stand and walk independently or using assistive devices, the elderly who have no abnormalities in the visual, auditory and vestibular organs, and conducted a study on the final 30 subjects.

2.2 Study Protocol

The experimental group Fumanet Exercise Program was taught by combining the steps in the square in order using the properties of the net. After that, the subject moved without stepping on the square of the net while maintaining a constant speed. The basic steps were repeated until the subject learned enough and a natural step appeared. As a tool, a net was used with a square of 50 cm wide and 50 cm long, with a total of 3 horizontal and 8 vertical rows. The first step of the Fumanet Exercise Program was a warming up step, and 10 times of standing steps and 2 basic steps were performed. In the second stage, for the purpose of learning, as part of the dual-task, the steps were performed 3 times while clapping, singing, and changing positions. The third step was stretching for relaxation. The total exercise time was 20 minutes, and the exercise program was applied every day for 4 weeks. For the control group, general balance training and gait training were applied. For the smooth progress of this exercise program, all steps were assisted and supervised by a physical therapist(fig 1).

Fig. 1: Fumanet Exercise Program

2.3 Measurement Tools and Measurement Methods

2.3.1 Fall Risk Measurement

Tetrax balancer (Israel) was used to measure the risk of falls. The Tetrax balancer uses a total of four force plates, one on each heel and toes on both sides of the lower limb. The subject took off his shoes and placed his feet on the power plate and tested in a total of eight positions. First, the posture facing the front with the eyes open (normal eye open; NO), then the posture facing the front with the eyes closed (normal eye close; NC), and the posture facing the head with the eyes closed head right (HR), head left (HL), head up (HU), head down (HD). The test is performed with the foam-rubber pillow under the feet and the eyes open (PO) and eyes closed (PC) facing the front. There is a risk of falling when eyes are closed or standing on a soft support surface, so the examiner is allowed to stand around the subject. Through the 8 postures, the degree of posture sway is measured. A fall risk score is automatically calculated based on the degree of postural sway. Fall risk consists of 0-100 points, and the higher the value, the higher the fall risk [17].

2.3.2 Berg Balance Scale (BBS)

The Berg Balance Scale (BBS) can objectively assess the fall risk, static balance ability, and dynamic balance ability of the elderly by measuring the functional performance of their balance through sitting, standing, and posture changes [18]. The scale is composed of 14 items, and if the task cannot be performed, the total score is 56, a maximum four points being applied to each item if it is independently performed. In general, the higher the score, the better the balance ability.

2.3.3 10-Meter Walk Test (10 MWT)

The 10-meter walk test (10 MWT) is a test method that evaluates walking ability by measuring the walking speed of the examinee.19 No special equipment is required, so you can easily evaluate your walking ability in a short time. The method measures the time required to walk 10 m by taking into account acceleration and deceleration between the start and the end and measures a total of three times to obtain the average.

2.3.4 Lower Extremity Strength

Five Times Sit to Stand Test (FTSST) is a test method that starts from a sitting position on a chair and measures the time to perform the sitting and sitting motion five times. FTSST is a measure that predicts the recurrence of falls and the independence of daily life performance by measuring functional aspects of the lower extremity strength [20]. Subject was instructed to wake up five times as soon as possible and then sit down.

2.3.5 Korean Version, Mini-Mental State Examination (MMSE-K)

The Korean version of the Mini-Mental State Examination (MMSE-K) is the most widely used dementia screening tool in Korea and has the advantage of being able to easily assess the intellectual condition and cognitive function of the subject in a short time. The Korean version of the MMSE-K consists of 12 questions, including five points of orientation relating to time, five points of orientation relating to place, three points pertaining to memory registration, three points to memory recall ability, five points to attention and computation, and nine points to understanding, judgment, and language. It consists of 30 points [21].

2.4 Statistical Analyses

The Shapiro-Wilk test was performed to check for the normal distribution of each measurement item, and the results for all items satisfied normality. The data were presented as mean ± standard deviation (Mean ± SD), and the general characteristics of the subjects were presented as descriptive statistics. A paired t-test was performed to compare pre and post training performance within the experimetal and control groups. An independent t-test was performed for between group comparisons. The data collected for this study was statistically processed using SPSS 23.0 for Windows (IBM, New York, USA) and the statistical significance level P value of <0.05.

3 Results

A homogeneity test showed no statistical difference between the groups (p>.05) (Table 1). The results of the Fall index, TUG, 10MWT showed a significant differences after training in the experimental group (p<.05), but not in the control group (p>.05). In these two tests, significant differences were observed between the groups (p<.05). The results of the FTSST, MMSE-K showed no significant differences after training in both the experimental group and control group (p>.05), with no significant difference between the groups (p>.05)(Table 2).

Table 1. General characteristics of subjects

Group	EG (N=15)	CG (N=15)	x^2/t	*p*
Gender (M/F)	4/11	5/10	.159	.690
Age (year)	78±7.69	80.93±6.61	-1.119	.741
Height (㎝)	155.33±11.43	154.8±9.71	.138	.993
Weight (㎏)	51.73±13.34	48.46±10.72	.739	.944

Mean±SD: Mean±Standard Deviation
EG: Fumanet exercise program group; CG: Conservative exercise program group
$^{*}p<.05$

Table 2. Comparison of fall index, balance and gait function, lower extremity strength for each group

		EG (Mean±SD)	CG (Mean±SD)	*p*
Fall index	pre	93.53±5.19	90±7.34	.140
	post	81.13±5.38	88.4±7.37	.005
	p	.000*	.260	
TUG	pre	14.38±2.37	15.14±1.63	.316
	post	12.47±1.93	14.07±1.84	.028
	p	.000*	.057	
10MWT	pre	14.07±2.08	14.82±2.76	.411
	post	12.14±1.42	13.81±2.12	.017
	p	.000*	.108	
FTSST	pre	21.57±3.39	21.73±3.93	.907
	post	21.73±3.93	20.44±3.45	.347
	p	.922	.253	
MMSE-K	pre	20.4±1.54	20±2.29	.581
	post	21.13±2.23	20.13±2.47	.255
	p	.202	.610	

Mean±SD: Mean±Standard Deviation
EG: Fumanet exercise program group; CG: Conservative exercise program group
TUG: Time Up & Go; 10MWT: 10-Meter Walk Test; FTSST: Five Sit to Stand Test; MMSE-K: Korean version Mini-Mental State Examination
$^{*}p<.05$

4 Discussion

This study was conducted to investigate the effect of the Fumanet Exercise Program on the risk of falling, balance function, gait function, lower extremity strength, and cognitive function in elderly patients with a high risk of fall. As the risk of fall increases with aging, this study was presented as one of the fall prevention exercise programs for the elderly. Previous studies simply focus on body function evaluation, so there are insufficient studies on cognitive function and objective risk of falling. In addition, in the previous study, an exercise program was simply implemented to improve body function. However, this study also focused on improving cognitive function by conducting the Fumanet Exercise Program.

As a result of this study, there was an improvement in balance function and gain function in the experimental group. There was a significant difference between groups. It is thought that the experimental group did not step on the net and the repetitive activity of gaiting according to the steps improved the balance function of the weight shift and improved the gait function. According to previous studies, the Fumanet Exercise Program enables interaction with the sensory area of the cerebral cortex, the motor area, and the peripheral muscles of the whole body [22]. Also, according to previous studies, the Fumanet Exercise Program was consistent with the research results that improved the gait function of the elderly [23]. That is, the Fumanet Exercise Program remembers the steps, perceives the edge of the net and one's own foot location, and the repetitive process of walking improves gait function by promoting the interaction of the motor and sensory of the central nervous system and the muscles and joints of the peripheral nervous system. It is presumed that it was done Also, according to a previous study, it was reported that multi-directional step-up Training with rhythmic auditory Stimulation had a significant effect on improving the gait and balance function of stroke patients. These results were consistent with the effect of Fumanet training providing visual feedback, and it is thought that the provision of sensory feedback was effective in enhancing balance and gait function[24].

As a result of this study, the risk of falling was decreased in the experimental group. There was a significant difference between groups. This result is thought to be due to the improvement of balance function and gait function in the experimental group. According to a previous study, it was reported that there was a statistically significant correlation between the static and dynamic balance function, the gait function and the risk of falling as a result of analysis of the correlation between the body function and the risk of falling [25]. In addition, it was reported that when the balance function decreases with the increase of age, the incidence of fall increases. [26] According to a previous study, it was reported that the elderly who experienced a fall had a narrower step length, a slower gait velocity, and a difference in the gait pattern than the elderly who did not experience a fall [27]. Gait is the most basic movement for locomotion of the human body and is an essential element in activities daily of life. In the elderly, it is difficult to control the central nervous system and maintain body balance, and as the balance function decreases, the gait function decreases, which is thought to increase the risk of fall.

As a result of this study, there was no significant improvement in lower extremity strength in both the experimental group and the control group. According to a previous study, it was reported that the strength through resistance exercise of lower extremity should be included in the fall prevention exercise program [28]. In addition, since simple resistance exercise can easily lose interest, it is necessary to construct a fall prevention exercise program that complexly deals with factors such as balance, gait, and cognitive function [28]. According to a previous study, it was inconsistent with the research result that there was a significant effect on lower extremity strength by giving resistance as a weight band to gait when performing the Fumanet Exercise Program [16]. In other words, in this study, it is considered that there was no effect on improving lower extremity strength because the Fumanet Exercise Program was conducted in a situation where no weight was given. In future studies, it is necessary to plan an exercise program that focuses on improving lower extremity strength.

As a result of this study, there was no significant improvement in cognitive function in both the experimental group and the control group. According to previous studies, the Fumanet Exercise Program did not agree with the research results showing improvement in memory among the subdomains of cognitive function [16]. The Fumanet Exercise Program is a program that combines cognitive training and exercise, and it is said that the interaction between the body and the environment restores the cognitive function by maximally developing the function to plan and execute the sequence of exercises [29]. However, in this study, it is considered that this is the result of

insufficient cognitive stimulation during the Fumanet Exercise Program. In addition, according to previous studies, the average MMSE-K score of the fall risk group was 17.28 and the MMSE-K score of the non-fall risk was 22.13. did not match [30]. As such, it is thought that cognitive function is highly correlated with fall when it reaches the level of severe cognitive impairment, and in this study, the MMSE-K score averaged 20.2 points, which is a mild cognitive impairment level, suggesting that it is difficult for the Fumanet Exercise Program to improve cognitive function.
The limitations of this study are: First, the short experimental period requires continuous observation of effectiveness. Second, spatial control is required so that the subject can focus on the program. Third, in order to generalize the results of this study, it is necessary to apply a fall prevention exercise program comparable to the control group.

5 Conclusion

The Fumanet Exercise Program of this study is a complex task activity composed of the body activity of walking according to the net space and the cognitive activity of thinking and remembering the order of stepping left and right according to the difficulty at the same time. Summarizing the results of this study, the Fumanet Exercise Program had a significant effect in reducing the risk of falling and enhancing balance and gait function in elderly patients. Therefore, the Fumanet Exercise Program can be usefully used as a fall prevent exercise program for elderly patients.

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Contribution of Individual Authors to the Creation of a Scientific Article (Ghostwriting Policy)

-IkHwan Eun has organized and executed the experiments.
-SeungMin Nam was responsible for the Statistics.