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The Effect of Self-directed Exercise Using a Task Board on Pain and Function in the Upper Extremities of Stroke Patients

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Abstract. [Purpose] We evaluated the effect of self-directed exercise using a task board on function and pain in the upper extremities of stroke patients [Subjects and Methods] We used the one group pre-post test design. Seven stroke patients who were selected based on the inclusion criteria participated in the program once a week for 10 weeks. The self-directed exercise comprised 5 stages that were divided according to the level of difficulty. The exercise was performed for 60 minutes using a special task board that we designed. The FMA (Fugl-Meyer Motor Assessment), VAS (Visual Analogue Scale), and speed of stacking were assessed to evaluate the amount of use of the affected arm at before and after intervention. [Results] The scores of the VAS and FMA, but not that of the speed of stacking cups, were improved. There was no significant correlation between the changes in VAS, FMA, and the speed of stacking cups. [Conclusion] The findings suggest that self-directed exercise with the task board could improve the levels of function and pain in the upper extremities. We suggest that self-directed exercise can be utilized as a clinical rehabilitation program and improve therapeutic effects.
Key words: Self-directed exercise, VAS, FMA

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INTRODUCTION

Stroke is a major cause of disability and handicap in adults[1)]. Physical therapists have developed home-based physical therapy and group rehabilitation-exercise programs for patients who have suffered a stroke after discharge[2, 3)]. Among the programs, education/self-management intervention is a safe, relatively brief intervention, and the improvements resulting from it are similar whether participants receive rehabilitations individually or in groups[4)]. Additionally, group self-management intervention is a cost-effective means of improving function compared with usual primary care without compromising clinical effectiveness[5)]. Therefore, we could design a proper self-directed exercise and verify its effect, it would be useful for stroke patients.

The most common disability of stroke patients is the reduction of upper extremity functions related to independent living like lifting objects and making the bed[6, 7)]. Also, stroke patients exhibit unilateral neglect and the learned nonuse phenomenon on the paralysis side[8)].

Some researchers have studied about the recovery of the upper extremities using methods to increase adaptability or plasticity of the brain in response to task-specific practices, drugs, robot trainers, and other ways to improve motor learning[9)]. In particular, evidence of the efficacy of task-oriented training in improving motor function related to activities of daily living (ADLs) like walking, reaching even years after stroke, has been suggested[1, 3, 10, 11)]. Task-oriented training uses motor learning through spaced practice and intermittent feedback to increase real-world activites[12)]. Thielman et al. reported that task-related training (TRT) but not resistive exercise (RE) was found to improve the path of the hand of a hemiparetic upper extremity when reaching toward targets[13)]. But French et al.[14)] reported repetitive task training produced a modest improvement in lower limb function but not upper limb function with regard to hand/arm function. Even though the effect of task-oriented training has varied between researchers, task-oriented training as a self-program would be available to patients.

Another common problem after stroke is shoulder pain, occurring in up to 84% of stroke patients. Shoulder pain is related to depression and decreased quality of life and daily life[15, 16)], and its causes are various[17)]. Limited passive shoulder range of motion can cause shoulder pain[18)], and there is a strong association between pain and abnormal shoulder joint examination, ipsilateral sensory abnormalities and arm weakness[19)]. Furthermore, impaired arm motor function increases the risk of shoulder pain[16)]. Therefore, treatment of shoulder pain has been focused on recovering sensory and motor function through various methods like Bobath, Brunnstrom and others[20)].

Most of all, stroke is a chronic diseases, and patients have to be educated by learning how to care for their situation; self-directed exercise for patients could be an alternative method of treatment after discharge for long-term care.

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Table 1. General characteristics of subjects (n=7) (M (SD))

Variables	Age (years)	Weight (kg)	Height (cm)	Duration of disability (years)
Characteristics	68.1 (7.4)	53.5 (5)	155.3 (5)	11 (3.6)

* M: mean, SD: standard deviation

But few studies of this have been performed, and few have designed treatments using self-directed exercise for stroke patients. So, we wanted to design a program of self-directed exercise focusing on increasing the function of the upper extremities using task-oriented training (with a board) and suggest information that should be considered when a physical therapist performs an intervention for stroke patients.

Our first hypothesis was that participation in self-directed exercise using a task board would with improve functioning of the upper extremities and pain. Our second hypothesis was that there were correlations between the improvement of function and pain in upper extremities and the speed of stacking cups.

SUBJECTS AND METHODS

Seven patients (male/female, 1/6; mean age, 68.1 ± 7.4 years) were recruited in Seoul City. The inclusion criteria for participation in the study were as follows: (1) living at home after discharge from all rehabilitation services, (2) ability to walk 10 m with or without an assistive device, (3) ability to accomplish upper limb exercise was stage 4 or stage 3 according to Brunnstrom, and (4) a score of more than 24 on the Mini-Mental State Examination Korea (MMSE-K). Patients were excluded if they had any medical condition that would prevent participation in the program. Before beginning the program, the study purpose and procedures were fully explained to them, and their written informed consent was obtained.

The self-directed exercise was designed for upper extremity exercise with a task board and paper and glass cups that can be obtained easily at home. The exercise program (60 min) comprised 5 stages according to individual ability and were conducted once a week for 10 weeks from April to June in 2011. The patients were educated with regard to the movements in physical therapy sessions during the program and continued the exercise with the task board on their own at home twice a week.

We designed a one group pre-post test, and on completion of the program, we evaluated and compared the VAS (ICC=0.97)[21], FMA (ICC=0.96)[22], and speed of stacking 10 cups with regard to before and after the intervention. The self-directed exercise program was planned so that the patients completed one task before beginning the next. They were seated in a circle and were encouraged to perform the tasks without seeking assistance from physical therapists.

Tasks consisted of reaching and prehension of the hand with a special board that we designed. We drew circles that matched with the cups and were arranged in the shape of a quadrangle on the front of the board and arranged in the shape of a curve on the back of the board for diagonal motion.

The tasks included the following 5 stages: (1) bimanual reaching motion from the mouth to target circles on the board according to verbal command (by physical therapist) without a cup, (2) matching cups with target circles on the board according to verbal command, (3) stacking 10 cups at target circles on the board according to verbal command, (4) matching glass cups (add resistance) at target circles on the board according to verbal command, and (5) matching glass cups with containing coins (add more resistance) at target circles on the board according to verbal command.

The circles were numbered with Arabic numerals, and the participants matched the cups at target circles on the board according to verbal commands that were random in order to optimize learning by patients[23]. Verbal commands were given by a physical therapist calling out Arabic numerals 1 to 8. If the physical therapist called out the number 3, the participants were supposed to find the target circle with the same number written inside it. The patients were challenged to complete increasingly difficult tasks each week. At the beginning, we encouraged subjects to use the front of the board and then we changed to the back of the board to increase the level of difficulty.

Wilcoxon's signed-rank test was performed to compare the differences before and after intervention, and correlation analysis was used to verify the correlation between pain and function of the upper extremities. All statistical tests were conducted with alpha(α) set at 0.05, and all data were presented as the mean and standard deviation.

Table 2. The difference between before and after intervention with regard to the FMA, VAS, and stacking cups (Mean (SD))

	Before	After
FMA (score)*	20.3 (20.3)	35.9 (17.1)†
VAS (score)+	7.3 (3.0)	4.4 (2.1)†
Stacking cups (sec)	62.7 (61.8)	53.6 (23.5)

* FMA: Fugl-Meyer Motor Assessment, + VAS: Visual Analog Scale, † $p<0.05$, SD: standard deviation

RESULTS

Table 1 presents the patient demographics.

We used the Wilcoxon's signed-rank test to verify the improvement in VAS, FMA, and speed of stacking 10 cups after intervention. We found a significant improvement in VAS and Fugl-Meyer Motor Assessment ($p<0.05$). This means that the pain and the function of the upper extremities were improved after intervention. But there was no significant difference between before and after intervention in terms of the speed of stacking 10 cups (Table 2).

There was no correlation between the changes in VAS, FMA, and speed of stacking 10 cups. This means that

shoulder pain would not predict the function of the upper extremities.

DISCUSSION

Self rehabilitation refers to patients taking care of themselves. After discharge, most of patients give up on receiving treatment at a hospital because of the cost. Therefore, if the patients were educated with an appropriate program before discharge or at a community institute like a public health center, they could continue to treat themselves at home as well with low cost. But the effect of this kind of program is not clear, there are few studies concerning self-rehabilitation programs after stroke even though the demand for them has increased. So, we wanted to develop and suggest a proper self-rehabilitation program for stroke patients, and the present program was designed focusing on upper extremities exercise. The function of the upper extremities is most important for these patients because it forms the foundation of independent daily living.

Stroke patients have reduced ipsilateral upper extremity function with regard to hand strength and dexterity[24], and retraining of the ipsilesional hand may transfer to improved function and motor learning on the contralesional hand[25]. Grip dysfunction after stroke is caused by excessive grip force, prolonging the time needed to grip and lift objects[26]. So, tasks manipulated by isometric contractions are needed. Weakness of voluntary activation of the fingers causes deficits in hand motor control, and so the target for therapy is improving voluntary strength through resistance training[27]. The strategy of bimanual tasks altered the force production of the paretic hand due to the combined effect of extensor weakness and strong flexor[28], and bilateral arm movement with active stimulation is most effective for stroke patients[29]. For the above reasons, we planned for both hands to be used when patients executed the tasks and graded the resistance with paper cups, glass cups, and coins.

We included the task in which the subjects matched number in circles and stacking cups because stacking cups is effective in improving hand-eye coordination and reaction time[30]. Additionally, we induced motion of the head while patients moved their hand from their noses to the task board because the head is an important factor for moving through space as the center of the spatial reference system, which enables the rest of the body to orient itself.

Regarding improvement of function, the score of the FMA in our study was increased after intervention. Similar to our study, Kim et al.[31] also claimed that the self -directed exercise in an upper extremity training program improved the functional outcome and reduced the duration of hospital stay in stroke patients. Pang et al.[32] reported that a community-based upper extremity group exercise program designed using self-directed exercise improved motor function and performance of functional activities in chronic stroke. Thielman et al. found that improving paretic limb reaching with compensatory trunk use was more effective in task-oriented training than progressive resistance exercise for low-level subjects but not high-level subjects, whose kinematics were fairly normal[33], and he suggested that restricted compensatory trunk motion during task-oriented training improved the precision of reaching more than during resistance exercise[13].

On the other hand, French et al.[14] reported that repetitive task training produced a modest improvement in lower limb function for walking distance, walking speed, and sit to stand but not in upper limb function for hand/arm function in a study using the Cochrane Stroke Trials Register. The reason that our study is different with Cochrane's study may be diversity of task oriented training and difficulty to classify it. So, the task was not same one in our study. Our task–oriented training was composed of tasks performed using a task board.

Therefore, we suggest that self-directed exercise using a task board would affect the function of the upper extremities.

Chon et al.[34] and Oujamaa et al.[8] reported that bilateral arm training with rhythmic auditory cues improved motor performance of the paretic upper extremity and that visual feedback helps in training force modulation because the somatosensory system is critical for performing voluntary movements[35]. It is required for linking accurate grasping force with a particular object, while visual feedback acting as cues engages the lateral premotor area[25]. Repeated training with visual feedback of force direction improved grip force control in stroke patients[30]. Auditory cues cannot be used when patients do exercise at home. Therefore, we added visual feedback as well. It might have a synergy effect and would increase function.

Mental imagery as a self-directed exercise has been used, and it can improve motor impairment and arm action capacities; however, cognitive condition would affect the training, and some of patients could not perform it correctly or perform it at all[8].

Unlike the case of mental imagery, our program could be performed correctly because we used visual feedback and bilateral exercise in which the sound side could help the affected side. So, our program had benefits with regard to effectiveness, safety, and improvement of function.

In our study, shoulder pain was decreased after intervention. According to Niessen[36], pain can alter proprioception and kinematics of the shoulder. So, our self-directed exercise might improve the sense of proprioception and kinematics of the shoulder. We designed the program with bilateral tasks. This might help shoulder external rotation and increase motion without pain.

However, we could not find a relationship between the changes in VAS, FMA, and speed of stacking cups. Numerous studies have suggested a relationship between post-stroke shoulder pain and spasticity, paralysis, shoulder subluxation, adhesive capsulitis, impingement syndrome, and rotator cuff injury[37]. It would cause problems with balance, walking, transfers, performance of self-care activities, and quality of life.

Its relationship to motor impairment and pain is not clear. Roy et al.[38] and Wanklyn et al.[39] reported that stroke patients with pain had more severe motor impairment during recovery and significantly greater activity limitation.

However, another study showed no relationship between shoulder pain and FMA[40, 41].

One possible explanation for the relationship to motor impairment and pain may be related to the characteristics of the subjects. Our subjects all had significant shoulder pain and motor impairment, and the mean FMA and VAS scores were 20.3 and 7.3, respectively. The studies of Chae[36] and Lee[37] assessed subjects with only shoulder pain. But previous studies[34, 35] have evaluated stroke patients with and without shoulder pain.

We also did not evaluate shoulder subluxation of patients that may influence the relationship between shoulder pain and motor impairment. It could act as a parameter that should be controlled for in the future studies.

From the above results, we surmise that 1) since patients performed the self-directed exercises, they improved the function of their upper extremities and their pain. 2) There was no relationship between improvement of pain and function of the upper extremities. Therefore, shoulder pain did not predict the functional ability of the upper extremities.

Interpretation of the results of our study is limited because the number of subjects was small, because we did not consider the control group, and because we did not evaluate depression and check the subluxation of the shoulder, which could affect the function. In the future, we need to consider these factors and perform studies with more subjects.

In conclusion, self-directed exercise with task-oriented training improved function and pain in upper extremities. We suggest that a self-directed exercise program using a task board can be utilized as a clinical rehabilitation program and improve therapeutic effects.

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