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Case Study

The effect of task-oriented training on the muscle activation of the upper extremity in chronic stroke patients

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Abstract. [Purpose] The aim of this study was to determine the effects of task-oriented training on upper extremity muscle activation in daily activities performed by chronic stoke patients. [Subjects and Methods] In this research, task-oriented training was conducted by 2 chronic hemiplegic stroke patients. Task-oriented training was conducted 5 times a week, 30 minutes per day, for 2 weeks. Evaluation was conducted 3 times before and after the intervention. The Change of muscle activation in the upper extremity was measured using a BTS FreeEMG 300. [Results] The subjects' root mean square values for agonistic muscles for the reaching activity increased after the intervention. All subjects' co-coordination ratios decreased after the intervention in all movements of reaching activity. [Conclusion] Through this research, task-oriented training was proven to be effective in improving the muscle activation of the upper extremity in chronic hemiplegic stroke patients.

Key words: Task-oriented training, Stroke, Muscle activation

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INTRODUCTION

Task-oriented training is an intervention method used to enhance the upper limb function of stroke patients and the ability to perform the activities of daily living. It is assumed to lead to patient learning by allowing them to try solving problems actively by providing them with a functional task, instead of having them repetitively practice the normal patterns of movements. When applied to stroke patients, such task-oriented training is an approach suggested to be an efficient treatment method, as it consists of tasks that encourage various functional activities in the patients and help enhance their actual ability to perform the activities of living[1, 2)]. Recently, various objective assessments of upper limb movement have been introduced, and kinetic and analytical research using an electromyogram are among them. The data from analysis of muscle activity measured while performing activities of daily living are particularly helpful in establishing functional goals and setting alternative strategies for problems that impede functions[3)]. The present study aimed to apply task-oriented training for 2 weeks to stroke patients and examine the influence of task-oriented training on the upper limb muscle activity in them through surface electromyogram analysis.

SUBJECTS AND METHODS

The subjects of this research were 2 patients who were diagnosed with hemiparalysis due to stroke and were receiving hospital treatment at A Hospital in the Republic of Korea. The general characteristics of the subjects are noted in Table 1. The subjects received an explanation about the purpose and methods of the study prior to participation and provided informed consent according to the ethical principles of the Declaration of Helsinki. Both patients were receiving conservative physical

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Table 1. General characteristics of the subjects

	Participant 1	Participant 2
Age	64	67
Gender	Female	Female
Diagnosis	Ischemic stroke	Ischemic stroke
Affected side	Rt.	Rt.
Dominant hand	Rt.	Rt.
Months after stroke onset	39	22
MMSE-k	29	26

Table 2. Mean pre- and post-intervention scores and mean Difference (unit: μV)

Measure RMS	Participant 1				Participant 2			
	Deltoid anterior	Deltoid posterior	Biceps brachii	Triceps brachii	Deltoid anterior	Deltoid posterior	Biceps brachii	Triceps brachii
Pre-test	49.46	15.32	14.86	13.19	35.83	7.88	41.72	10.9
Post-test	79.18	9.42	13.92	15.8	36.62	5.34	15.44	15.15
Mean difference	29.7	−5.9	−0.9	2.61	0.79	−2.5	−26	4.25

RMS: root mean square

therapy and occupational therapy for 30 minutes each, 5 times a week. The study subjects were selected based on the following criteria: diagnosis of stroke by a medical specialist, score of 24 or higher on the Korean Mini-Mental State Examination (MMSE-K) and able to communicate, no hemineglect, and a Brunnstrom stage of 4 or higher. This study used an interrupted time series (ITS) design to determine whether task-oriented activity had an effect greater than that of natural recovery on impairment of the hemiplegic upper muscle activation in subjects after a stroke. Next, assessment of subjects was carried out 4 times during the 3 weeks before and after the task-oriented training intervention. To measure the upper limb muscle activity of subjects, a surface electromyogram measuring device (BTS FreeEMG 300, BTS S.p.A., Milan, Italy) was used. In addition, to reduce errors in the experiment, electrodes were attached after removing the hair on the part where they would be attached and wiping the area clean with medical alcohol. The muscles for measurement included the entire shoulder deltoid anterior, shoulder deltoid posterior, biceps brachii, and triceps brachii, which greatly influence the reaching activity of the upper limb. The muscle activity was measured, and data were collected by having the subjects reach the affected arm to grab a plastic cup while sitting in front of a desk; the average values of measurements performed 3 times were used. The measured electromyogram signals were analyzed by the root mean square (RMS) method. Also, CCRs (co-coordination ratios) were calculated based on the RMS values measured before and after the intervention, in order to analyze the coordination while performing the activity and the improvement in movement. The CCR is calculated as the ratio of the RMS value of the antagonistic muscle to the RMS value of the agonistic muscle, which is measured during the movement of those parts. A decreased CCR means more enhanced coordination and softer movement[4]. The task-oriented training for the subjects was carried out for 30 minutes once a day, five times a week for a total of two weeks. The task-oriented training applied to the subjects included 6 types of activities used in a study by Park and Yoo[5], and the details of the activities are as follows: changing top; throwing a tennis ball into a basket, stacking cones, moving pegs, wiping a table with a towel, and passing a ring along a curved bar.

RESULTS

Through task-oriented training, the subjects' RMS value for the deltoid anterior and triceps brachii, which act as agonistic muscles for stretching activity, increased after the intervention. However, the RMS value of the deltoid posterior and biceps brachii, which act as antagonistic muscles, decreased after the intervention. All subjects' CCRs decreased after the intervention in all movements of the reaching activity (Tables 2 and 3).

DISCUSSION

The results of this study showed that the muscle activity of the deltoid anterior and triceps brachii, which are the agonistic muscles for shoulders flexion and elbow extension during the reaching activity, increased. In contrast, the muscle activity of the deltoid posterior and biceps brachii, which are antagonistic muscles, decreased. Also, the CCR, which shows improved coordination and softer movement as the value decreases, was decreased after the intervention, confirming that

Table 3. Pre- and post-intervention CCRs and percent change

CCR	Participant 1		Participant 2	
	Shoulder flexion [DP/DA]	Elbow extension [BI/TRI]	Shoulder flexion [DP/DA]	Elbow extension [BI/TRI]
Pre	0.31	1.13	0.22	3.82
Post	0.12	0.88	0.14	1.01
Percent change	−61.29	−22.12	−36.36	−73.56

CCR: co-contraction ratio = RMS of antagonist / RMS of agonist; DP: deltoid posterior; DA: deltoid anterior; BI: biceps brachii; TRI: triceps brachii

the task-oriented approach had a positive influence on upper limb function and muscle activity in chronic stroke patients. This result supports the findings of many previous studies that have demonstrated using task-oriented assessment tools such as the FMA (Fugl-Meyer Assessment) and MFT (Manual Function Test) that task-oriented training has a positive influence on enhancement of upper limb function in chronic stroke patients[6]. The clinical significance of this research is that it used a more objective assessment tool than many previous studies that applied task-oriented training for chronic stroke patients, calculated direct muscle activity values and CCRs in the upper limb, and verified the treatment effects. However, the limitations of this research include the fact that it is difficult to generalize the results due to the small number of subjects and the fact that the possible influences of variables outside the treatment could not be excluded, as subjects were treated at different times.

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