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Research Article

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Effects of Intensive Neuro Rehabilitation Intervention on the Motor Function Recovery and Balance in Stroke Patients

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| Abstract |

PURPOSE: The purpose of this study was to investigate the effects of differences in exercise time arrangement on the functional recovery of the lower limbs and balance of stroke patients.

METHODS: The subjects of this study were 100 patients who were hospitalized in two hospitals located in Gyeonggi-do. Before the experiment, 60 of these patients who met the inclusion criteria and did not meet the exclusion criteria were randomly divided into an experimental group (n = 30), whose exercise time was concentrated, and a control group (n = 30), whose exercise time was diffuse. The two groups underwent six weeks of physical and occupational therapy four times a day for five days a week. One session of therapy took 30 minutes, including three sets of physical therapy and one set of occupational therapy. The rest time between the sessions was different for each group. The experimental group had five minutes of rest between each therapy session, and the control group had two hours of rest time between each session. The Fugl-Meyer assessment (FMA), an assessment of each patient's limit of stability (LOS), and a timed up and go test (TUG) were used as test tools.

RESULTS: Both groups showed statistically significant increases in their FMA results, LOS measurements, and TUG results. The FMA results of the experimental group were significantly higher than those of the control group.

CONCLUSION: Thus, concentrated exercise time was more effective than diffuse exercise time for the recovery of motor function.

Key Words: Balance, Exercise, Stroke

Ⅰ. Introduction

Stroke is a neurological deficit resulting from cerebral hemorrhaging or cerebral vascular occlusion. Signs and symptoms of stroke include an inability to move or feel on one side of the body, problems understanding or speaking, and equilibrium disorder (de Haan et al., 2015; Jun et al., 2014; Mehrpour et al., 2014). The patients with stroke have significant problems with motor feedback, because of a loss of balance, muscle weakness, and

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abnormal movement pattern (Chinsongkram et al., 2014; Kwon and Shin, 2013).

Factors causing walking difficulty for stroke patients include asymmetric posture, abnormal balancing, and reduced weight movement ability (Carr and Shephered, 2003). Asymmetric posture and excessive body swaying may seriously hamper physical balance by interrupting the ability to maintain a standing position or to establish normal movement patterns, which often leads to falls (Perry et al., 1992).

Teasell et al. (2005) reported that functional recovery was closely related to therapy time in their study on the time and intensity of exercise therapy for stroke patients. In a study on animals and human beings, researchers reported that intervention for the recovery of functions should be performed as quickly as possible and that the time and intensity of exercise therapy should be gradually enhanced within patients' endurance in order to effect recovery.

Kwakkel et al. (1999) researched functional recovery after 20 weeks of complex intensive therapy on the upper and lower limbs of stroke patients, who started undergoing the therapy within 14 days of the occurrence of stroke. These authors reported that the intensive therapy did not affect the upper limbs while their lower limbs showed functional enhancement in the patients' activities of daily living and walking ability.

Various existing studies have reported that rest time between exercise sets serves as one of the important factors for ensuring the effective strengthening of muscles (Hass et al., 2001). Rest is essential not only for motion performance capability but also for physical recovery, such as the normalization of metabolism and the action potential of sarcolemma (Lindinger, 1995). According to Whang and Kim (2004), normal people had more positive effects on the reduction in body fat and changes in blood lipid concentration when the rest time between sets was shorter (40-50 seconds) than when the rest time between sets was longer (90-120 seconds). Choi et al. (1991) reported that swimmers showed a reduction in their maximum heart rate and an increase in endurance when they applied intensive training.

Although there have been many reports on the quantitative association of the functional recovery of stroke patients with intervention time, few researchers have focused on the differences between concentrated and diffuse application of exercise time with the same amount of exercise time for patients with a damaged central nervous system. Due to this lack of research on the subject, we investigated the effects of differences in the time arrangement of intensive treatment of the central nervous system on the functional recovery of the lower limbs and balance of stroke patients.

Ⅱ. Methods

1. Subjects

The subjects of this study were 100 patients who were hospitalized in two hospitals located in Gyeonggi-do. Before the experiment, 60 of these patients who met the inclusion criteria and did not meet the exclusion criteria were randomly divided into an experimental group whose exercise time was concentrated (n = 30) and a control group whose time was diffuse (n = 30).

Those who had been diagnosed with a stroke at least six months earlier, who were defined as having no cognitive impairment by scoring at least 24 points on the mini-mental state examination-Korea (MMSE-K), who were able to maintain a standing position independently, who were able to perform ten-meter shuttle walking with an assistive device, and who understood the purpose of this study and gave consent to participate were regarded as meeting the inclusion criteria.

Meanwhile, those who were not able to communicate, had a visual field defect, had an orthopedic disorder in

the lower limbs, or had a cardiopulmonary disease were excluded from this study.

We applied the six-week program to the stroke patients who satisfied the inclusion criteria.

2. Assessment tools and measurement

1) Fugl-Meyer assessment

The Fugl-Meyer assessment (FMA) is used in various areas of stroke treatment as a comprehensive tool for the quantitative measurement of the motor impairment of patients with hemiparalysis due to stroke. The FMA was developed in order to measure poststroke motor function, balance, sensory, range of motion, and pain (Fugl-Meyer et al., 1975).

The FMA's inter- and intrainvestigator reliabilities are high (.995 and .992, respectively), and the confidence interval between test and retest is .94–.99 (Woodbury et al., 2007).

2) Limit of stability

The patients' limit of stability (LOS) was measured using a pressure-sensitive platform (BIORESCUE, RM INGENIERIE, France). When a barefooted subject stood on the platform comfortably, we measured the subject's stability three times in order to obtain the average from the result values. The effects of muscle fatigue from this assessment method were minimized by giving each subject a three-minute rest between each measurement.

3) Timed up and go test

The timed up and go test (TUG) was developed to assess the balance of elderly patients. In this study, a subject sat down on a 50CM high armchair, rose from the armchair at the word of command "go," walked straight for three meters, and then walked back to sit down on the chair again. The time taken to complete this series of actions was measured. These measurements were taken three times, and the average of the three measurements was determined. The inter- and intrainvestigator reliabilities of the TUG are high (r = .99 and r = .98, respectively) (Jonsdottir and Cattanceo, 2007).

3. Procedure

We sufficiently explained the method of each test and the training to the subjects in advance, performed tests on the general characteristics of the subjects, tested the subjects' LOS, and performed the FMA and the TUG before training. The subjects were divided into the experimental group and the control group, which were defined based on rest time between the therapeutic sets. The therapy was performed four times a day five times a week for six weeks. One session took 30 minutes. The experimental group had a five-minute rest time after the 30-minute therapy session, while the control had a two-hour rest time after the 30-minute session (Table 1). Both groups were treated with physical therapy interventions. The interventions were composed of range of motion exercise, strengthening exercise, functional movement re-education, and mat exercise. The distribution of time was composed based on Lee (2014), Kim and Oh (2010) study.

Table 1. Process of exercise

sequence	Experimental group	Control group
1	Physical therapy	Physical therapy
2	5minute rest	2hours rest
3	Physical therapy	Physical therapy
4	5minute rest	2hours rest
5	Physical therapy	Physical therapy
6	5minute rest	2hours rest
7	Physical therapy	Physical therapy

4. Data analysis

PASW 18.0 (IBM/SPSS Inc, USA) for Windows was used for all the statistical analyses in this study. A chi-squared test and an independent t-test were conducted

Table 2. The general characteristics of the subjects.

Variable \ group	EG(n=30)	CG(n=30)	X^2/t	p
Sex				
Male	15(50.0%)	16(53.3%)	.067	.796
Female	15(50.0%)	14(46.7%)		
Affected side				
Left	14(46.7%)	17(56.7%)	.601	.438
Right	16(53.3%)	13(43.3%)		
Time since stroke (month)	18.23 ± 11.46	15.16 ± 6.82	1.260	.214
Age	59.17 ± 8.93	60.80 ± 7.08	-.785	.436
Height (㎝)	167.37 ± 11.02	166.17 ± 6.68	.510	.612
Weight (㎏)	66.06 ± 11.26	66.17 ± 8.56	-.045	.964
FMA (score)	46.77 ± 6.51	45.63 ± 4.48	.786	.435
LOS (㎟)	8369.50 ± 1655.73	8331.00 ± 1460.11	.096	.924
BBS-K (score)	34.43 ± 9.32	35.63 ± 8.99	-.507	.614
TUG (sec)	29.21 ± 4.99	29.56 ± 7.26	-.217	.829

Values are N (%) or Mean ± standard deviation, EG: Experimental group, CG: Control group, FMA: Fugl-Meyer Assessment, LOS: Limit of stability, BBS-K: Korean version of Berg balance scale, TUG: Time Up and Go Test
General characteristics and dependent variables are calculated by Chi-squared test and Independent t-test

to analyze the general characteristics of the groups. The pretraining dependent variables of each group were analyzed by an independent t-test. A paired t-test was used to identify differences in significance based on intragroup elapsed time, while an independent t-test was used to compare the two groups based on elapsed time. For these tests, a value of $p<.05$ was considered statistically significant.

Ⅲ. Results

1. General characteristics of the subjects

There were 60 subjects in this study, who were divided into the experimental group (n = 30) and the control group (n = 30). Table 2 shows the general characteristics of each subject and the results of each subject's homogeneity test.

2. Comparison of lower limb functions and balance between the experimental group and the control group

Both groups showed a statistically significant increase in their FMA results after the six weeks of training, but the experimental group showed a more statistically significant increase than the control group ($p<.05$) (Table 3).

The values of the LOS and the results of the TUG showed a significantly significant increase in both groups after the six weeks of training ($p<.05$). No statistically significant differences were found between the experimental group and the control in terms of the changes in the subjects' LOS and TUG results (Tables 4, 5).

Ⅳ. Discussion

The purpose of this study was to identify the effects of differences in exercise interval for therapy on the motor

Table 3. The comparison of FMA between EG and CG.

Variable	Group	EG (n=30) Mean±SD			CG (n=30) Mean±SD			t	p
FMA	Pre	46.77	±	6.51	45.63	±	4.48		
	post	49.03	±	6.33	46.07	±	4.37		
	change	2.27	±	1.17	.43	±	.94	2.113	.039*
	p	.000*			.017*				

*p<.05, change: post - pre,

Table 4. The comparison of LOS between EG and CG.

Variable	Group	EG (n=30) Mean±SD			CG (n=30) Mean±SD			t	p
LOS	Pre	8369.50	±	1655.78	8331.00	±	1460.11		
	post	8745.50	±	1851.13	8517.43	±	1601.37		
	change	376.00	±	682.90	186.43	±	444.75	.510	.612
	p	.005*			.029*				

*p<.05, change: post - pre,

Table 5. The comparison of TUG between EG and CG.

Variable	Group	EG (n=30) Mean±SD			CG (n=30) Mean±SD			t	p
TUG	Pre	29.21	±	4.99	29.56	±	7.26		
	post	28.08	±	4.98	28.87	±	7.13		
	change	-1.14	±	.74	-.68	±	1.04	-.502	.618
	p	.000*			.001*				

*p<.05, change: post - pre,

function recovery and balance of stroke patients. The patients were divided into the experimental group and the control group, which were defined according to differences in rest time between the therapeutic exercise sets. The results of this study showed that both groups improved in terms of motor function and balance, indicating that the six-week rehabilitation exercise intended to develop the central nervous system may help patients recover from a stroke.

We used the FMA to investigate changes in motor function recovery, and there were statically significant increases in both groups. Such results were consistent with those presented by Yoon et al. (2000), who reported significant differences in motor capacity measured as an activity index of stroke patients after the subjects underwent passive exercise, exercise for improving movement of the side of the body affected by the stroke, and systemic gait movements and exercise for maintaining patients' posture and changing their tension degrees.

We measured the patients' LOS and performed the TUG in order to investigate changes in balance, and there were statically significant increases in both groups. Such results

were consistent with those presented by Shim et al. (2014), who reported that exercise for trunk stabilization using treatment to develop the central nervous system was effective at increasing muscular activity in the waist and at improving balance, and by Oh et al. (2013), who observed that rehabilitation exercises to develop the central nervous system were more effective than general rehabilitation when the balancing and temporal-spatial gaiting factors of stroke patients were measured before and after the exercise.

In this study, the experimental group showed more improvement than the control group in terms of motor function recovery. Given that (Choi et al., 1991) reported that intensive training reduced maximum heart rate and increased strength endurance, the results of this study may indicate that the intensified therapy increased the muscular strength of the patients, which improved their motion control.

This study might be limited because the results are insufficient for generalization; the study included only 60 stroke patients who met the inclusion criteria, and the external environments and willpower of the patients were not controlled except their exercise time and daily life activities.

Ⅴ. Conclusion

In this study, we divided stroke patients into a group of concentrated exercise time and a group of diffuse exercise time to identify changes in the patients' FMA results, LOS, and TUG results after six weeks of physical therapy. The results showed that both groups showed increases in their FMA results, LOS, and TUG results, and the improvements in FMA results were statistically more significant in the concentrated exercise group than in the diffuse exercise group.

Both concentrated and diffuse exercise times were effective for motion function recovery and balance, but concentrated exercise may be more effective for motion function recovery than diffuse exercise.

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