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The Influence of Body Support Treadmill Training with Visual Feedback on the Gait Factors of Stroke Patients

The aim of this research was to investigate how the effects of body supported treadmill training with visual feedback affect the gait factors of stroke patients. Thirty subjects (21 male, 9 female) with a diagnosis of stroke were taken to the hospital to participate in this study. The subjects received body supported treadmill training with visual feedback. The training was executed for 6 minutes, 3 times a day per week for 19 weeks after general exercise. The effects of the visual feedback in the body supported treadmill training were evaluated by measuring the average gait cycle and the average step length of the affected and unaffected. The collected data were statistically analyzed by using a paired t-test. The results of this study were a significant improvement of the average gait cycle and no statistically significant difference of the average step length. The gait cycle average had a statistically significant difference in gender, age, etiology, paretic side, and step length average. There was no statistically significant difference in infarction within etiology. Therefore, it was necessary to apply the easy and simple with the treadmill training in the rehabilitation of the stroke patients. This study will require a variety of outcome measures related to the effects of treadmill training with gait factors.

Key words: *Stroke, Treadmill Training with Visual Feedback, Gait Factors*

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INTRODUCTION

A stroke is a neurological condition characterized by fast progression and a sign of local brain function loss. Due to a decrease in the blood supplied to the brain, the brain tissue undergoes a continuous shortage of oxygen and glucose, which triggers a local abnormality in the tissue and a functional disorder. A stroke is a result of brain ischemia and hemorrhage; it is a neurological disease with a high frequency of an acute aspect under which brain function loss takes place and is sustained for 24 hours or less, which then leads to the death of the patient(1, 2).

Recently, the number of stroke cases that result in death has decreased considerably, but even though the patient survives, he or she may have severe disabilities such as hemiplegia, language disorders, communication disorders, cognitive disorders, and emotional disorders(3).

After a stroke, most patients may walk, but their gait does not recover back to their normal state(4). Independent gait ability is an essential element for most activities of daily living, and such difficulty with gait restricts the patient's ordinary routines(5).

Olney and Richards(6) noted that stroke patients' average gait speed was slower than that of healthy people, and that this disparity in gait speed reflects the degree of the severity of the stroke. They added that a decrease in stroke patient's gait speed was represented by a reduction in stride length and cadence. Ryerson and Levit(7) reported that stroke patients had a gait pattern characteristic of hemiplegia with a shorter stance phase and a relatively longer swing phase of the paretic side due to slow gait speed.

For gait training after a stroke, there are training methods such as weight loading and weight movement(8), and balance training and treadmill gait training conducted together with general treatment (9). Gait training through weight supported treadmill training includes changeable special exercise tasks such

as speed, and therefore the quality of such training may be heightened by various training methods(10).

Besides, the performance of weight supported treadmill training corresponds well with sensori-motor experiences occurring during gait on the ground, and this training may result in functional improvement, such as an increase in the speed of gait on the ground. And last but not least, weight supported treadmill training decreases and adjusts the weight patients have to bear and supports their trunk, providing stability in their gait training, reducing their fear about falling on the treadmill, and enabling the free and sufficient evaluation of patients by using a weight support system. Previously, a therapist could not assess patients properly during their treadmill training because of concerns about their safety(11).

Accordingly, this study intends to examine the effects of visual feedback provided to the subjects during weight supported treadmill training, which is known to have an enhancing effect, on gait elements.

METHODS AND METHODS

Subjects

The subjects of this study involved were 30 patients (21 male, 9 female) who were diagnosed with a stroke, hospitalized in S hospital located in Suncheon City, Jeollanam-do, and were receiving physical therapy. Those who had hemiplegia resulting from a cerebrovascular disease, who were able to respond to footprints on a monitor after training in advance, and who were able to walk independently without an aid were included. The general characteristics of the subjects are shown in Table 1.

Table 1. General characteristics of subjects (unit : %)

Characteristics		Total(%)
Gender	Male	21(70.0)
	Female	9(30.0)
Age (years)	50 less older	12(40.0)
	between 50 and 59	13(43.3)
	60 or older	5(16.7)
Etiology	Hemorrhage	12(40.0)
	Infarction	18(60.0)
Paretic Side	Left side	17(56.7)
	Right Side	13(43.3)

Measurement Tools and Measuring Methods

The subjects received weight supported treadmill gait training where visual feedback was applied for 19 weeks 3 times per week, 3 sets each time, and 6 minutes for each set after ordinary physical therapy. Training was stopped when the patients felt fatigue or pain or had changes in complexion during the training, or refused to participate before the initiation of the training.

A gait training device(Biodex Gait Trainer 2; Biodex Medical Systems Inc., NY, U.S.) enables the subjects to watch their feet's appearance on the ground on a real-time basis through shadow imaging on a monitor and compare their real-time gait speed(m/sec), gait time, and step length(m/sec) with values in the normal range stored in a histogram.

A weight supported treadmill with a suspension unit is equipment that may prevent risk factors for a fall through the suspension unit(Lite gait; Mobility Rearch Inc., U.S.), which supports some portion of the patient's weight.

This study compared the subjects' gait cycle and step length through weight supported treadmill gait training. An average gait cycle refers to a gait cycle that lasts for one second. One gait cycle is from one lower limb's heel strike to another heel strike of the lower limb, and 100% performance time was assumed as one second. A healthy person conducts one gait cycle per second, which is translated into a gait of 100 cm per second. In other words, one gait cycle is composed of two steps and walking 100 cm per second means that one step length is 50 cm.

Data Analysis

The data analysis of this study used SPSS for Windows (Statistical Package for the Social Sciences, version 12.0), and a paired t-test was used to make comparisons of the data before and after the training. To verify statistical significance, the significance level was set at $\alpha = 0.05$.

RESULTS

1. Comparison of Gait Cycles

Weight supported treadmill gait training with visual feedback was performed by the stroke patients, and there were significant differences in the gait cycles between before and after the training ($p < 0.05$).

The differences in the gait cycles were examined according to gender, age, etiology, and paretic side. As for age, there were significant differences in those with ages between 50 and 59 with 0.68/cycle before the training to 0.74/cycle after the training ($p < 0.05$), and in those with ages 60 or older with 0.49/cycle before the training to 0.64/cycle after the training ($p < 0.05$). With regard to etiology, the gait cycle of those who had a hemorrhage changed significantly from 0.54 per cycle before the training to 0.68/cycle after the training ($p < 0.05$). As for the paretic side, those whose paretic side was on the left underwent significant changes from 0.64/cycle before the training to 0.74/cycle after the training ($p < 0.05$)(Table 2).

Table 2. Comparison of Gait Cycles

(unit : cycle/sec)

Characteristics		PreMean±SD	PostMean±SD	t-value	p-value
Gender	Male	0.69±0.14	0.75±0.11	-2.380*	0.013*
	Female	0.62±0.18	0.74±0.15	-2.832*	0.008*
Age (years)	50 less older	0.73±0.13	0.79±0.08	-1.378	0.105
	between 50 and 59	0.68±0.12	0.74±0.10	-2.762*	0.009*
	60 or older	0.49±0.16	0.64±0.19	-3.661*	0.002*
Etiology	Hemorrhage	0.54±0.14	0.68±0.14	-3.616*	0.002*
	Infarction	0.76±0.10	0.79±0.09	-1.706	0.058
Paretic Side	Left side	0.64±0.16	0.74±0.13	-3.243*	0.005*
	Right Side	0.72±0.15	0.76±0.12	-1.678	0.059
Total		0.65±0.15	0.74±0.12	-3.561*	0.003*

*$p < 0.05$

2. Comparison of the Step Length of the Patients Whose Paretic Side is on the Right

Weight supported treadmill gait training with visual feedback was performed by stroke patients whose paretic side was on the right, and there was no significant difference between before and after the training($p > 0.05$).

Differences according to gender, age, etiology, and paretic side were examined before and after the training, and infarction as an etiology changed significantly from 0.51M to 0.53M($p < .05$)(Table 3).

Table 3. Comparison of the Step Length of the Patients Whose Paretic Side is on the Right

(unit : meter)

Characteristics		PreMean±SD	PostMean±SD	t-value	p-value
Gender	Male	0.48±0.12	0.44±0.09	1.169	0.256
	Female	0.41±0.09	0.41±0.07	-0.141	0.321
Age (years)	50 less older	0.45±0.14	0.42±0.05	0.654	0.527
	between 50 and 59	0.50±0.10	0.46±0.10	1.964	0.073
	60 or older	0.39±0.08	0.39±0.09	-0.161	0.453
Etiology	Hemorrhage	0.38±0.10	0.39±0.08	-0.261	0.418
	Infarction	0.51±0.10	0.53±0.12	2.132*	0.048*
Paretic Side	Left side	0.43±0.12	0.49±0.09	1.069	0.301
	Right Side	0.50±0.11	0.48±0.08	0.757	0.464
Total		0.47±0.12	0.47±0.09	1.330	0.194

*$p < 0.05$

3. Comparison of the Step Length of the Patients Whose Paretic Side is on the Left

Weight supported treadmill gait training with visual feedback was performed by stroke patients whose paretic side was on the left, and there was no significant difference between before and after the training ($p > 0.05$).

Differences according to gender, age, etiology, and paretic side before and after the training were examined, and infarction as an etiology changed significantly from 0.53M to 0.48M ($p < 0.05$)(Table 4).

Table 4. Comparison of the Step Length of the Patients Whose Paretic Side is on the Left (unit : meter)

Characteristics		PreMean±SD	PostMean±SD	t-value	p-value
Gender	Male	0.50±0.13	0.47±0.08	1.258	0.223
	Female	0.45±0.10	0.42±0.11	0.773	0.462
Age (years)	50 less older	0.52±0.13	0.47±0.12	1.815	0.097
	between 50 and 59	0.47±0.12	0.45±0.06	0.636	0.537
	60 or older	0.43±0.11	0.43±0.09	-0.050	0.573
Etiology	Hemorrhage	0.41±0.89	0.41±0.10	0.023	0.982
	Infarction	0.53±0.12	0.48±0.07	2.189*	0.043*
Paretic Side	Left side	0.49±0.09	0.45±0.10	1.540	0.143
	Right Side	0.48±0.16	0.46±0.09	0.467	0.649
Total		0.48±0.19	0.45±0.09	1.502	0.143

*$p < 0.05$

DISSCUSSION

Stroke patients are able to partially walk independently, but the adjustment of their movements may not be easy in their daily routines(12). Nonetheless, the ultimate goal of rehabilitation in stroke patients is an independent and functional gait(13).

This study applied treadmill training to stroke patients to improve their independent gaits, and applied weight supported gait training with visual feedback for the adjustment of their movements according to the environment of their daily routines, thereby intending to examine the stroke patients' gait elements that are affected by such training.

Currently, opinions differ about the effects of treadmill gait training and ground gait training. There have been differences in the effects according to the subjects' disease duration, paralysis type, and degree of gait support. The training period and intensity are also controversial(14). However, Fisher and Sullivan(15) reported that treadmill training was helpful for the functional reorganization of the motor cortex in neural plasticity and recovery, and emphasized the training as an optimal measure for gait training.

This study aimed to examine the effects of weight supported treadmill training with visual feedback on stroke patient's gait cycle and step length, which are gait elements.

According to the gait cycle, for age, there were significant differences in those aged between 50 and 59, with 0.68/cycle to 0.74/cycle, and in those aged 60 or older, with 0.49/cycle to 0.64/cycle. With regard to etiology, the gait cycle of those who had a hemorrhage changed significantly from 0.54/cycle to 0.68/cycle. As for the paretic side, those whose paretic side was on the left underwent significant changes from 0.64/cycle to 0.74/cycle.

For those whose paretic side was on the right and had infarction as an etiology, their right step length changed significantly from 0.51M to 0.53M. For those whose paretic side was on the left and had infarction as an etiology, their left step length of changed significantly from 0.53M to 0.48M.

Gait speed was measured using ground gait training and treadmill gait training, and there was more significant improvement in the treadmill gait training group than in the ground gait training group (16).

The treadmill gait training improved the stroke patients' gait speed, number of steps, and gait symmetry(17), but the present study is also meaningful

in that it imposed a visual feedback task.

In treadmill training, conducting speed-dependent gait training rather than maintaining gait speed or having the subject self-select the speed of the improved gait speed(18, 19) and according to the result of applying training at a self-selected speed, a slow speed, and a fast speed, there was a statistically significant change in training with fast gait speed (20). Based on the results of these previous papers, this study presents the need to mention speed adjustment together with visual feedback.

It is known that when raising a foot from a treadmill, balance should be kept by sufficiently supporting the other side with the other leg(21). Weight supported treadmill training promotes coordination movement control by the lower extremities and provides postural support through weight loss control during the patient's training(22). A decrease in weight support heightens patients' confidence during gait and minimizes the muscle use necessary for gait, enabling the development of effective movement strategies(23). The results of previous studies show that when raising the foot of the non-paretic side, effective weight support is provided by a decrease in the weight support of the non-paretic side, which is related to significant changes in the step length of the paretic side in the present study. However, step length of the paretic side is the swing phase in the gait cycle. If you know the effect of the stance phase of the step length to evaluate the non-paralyzed side, could help in gait function in stroke rehabilitation program.

Previous studies, weight supported treadmill training is provided stability in their gait training, reduced their fear about falling and quality of life was improved (10).

The limitations of this study are as follows. First, the number of male and female in the compared groups was not the same; among the 30 stroke patients, the number of male was 21 and the number of female was 9, with great differences. Second, the weight supported treadmill training with visual feedback was carried out for 19 weeks, and if the measurements had been taken by dividing the period into post-test and follow-up, when the effects of the intervention began would be known. In addition, it is not known whether the subjects continued the intervention after the study stopped. Third, in the selection criteria of the subject is that participants did not consider stroke onset period and region.

Nonetheless, this study is meaningful in that the addition of a visual feedback task together with treadmill training whose effects have been proven also had an effect on the gait elements.

Treadmill gait training where tasks related to auditory, tactile, and proprioceptive senses are imposed is considered necessary; such training is expected to increase stroke patients' rehabilitation effects.

CONCLUSION

The result of applying weight supported treadmill gait training with visual feedback to stroke patients was that there were significant changes in according to gender, age, etiology, and paretic side after the intervention compared to before the intervention. Thus, in the rehabilitation of stroke patients, the development of an easier and simpler task than treadmill training where using a complex task was applied is necessary, and the measurement of diverse results related to the effects of treadmill training on the gait elements is needed.

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