國科會專題計畫成果報告

早期步行器訓練對中風病人步行能力之效果: 肌電圖與動作學之分析

(Effects of Early Treadmill Training on Ambulatory Ability in Stroke Patients: Electromyographic and Kinematic Analyses)

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中文摘要

本研究比較使用步行器與使用傳統物理治療方法對中風病人步行訓練的效果。共十一位中風病人參與此計劃，但完成計劃之全程者只有七位，其中四位為控制組，三位為實驗組。兩組受試者都接受為期五週、每週至少三次的物理治療。治療時控制組所接受的步行訓練為以神經生理學為基礎之步行訓練，實驗組則接受步行器步行訓練。在訓練前、訓練後、及訓練後一個月，研究者測試受試者的步行功能、步態、以及日常生活自理能力，並用重覆性共變數分析比較實驗組與控制組於三次測試時在這些變項上的差異。結果顯示兩組人在訓練前、訓練後、及訓練後一個月的步行功能、步態、以及日常生活自理能力並無顯著差異。過去的研究顯示，密集的步行器步行訓練比密集的傳統物理治療步行訓練效果為佳。但本研究發現：以一般的臨床治療量給予步行器步行訓練時，其訓練結果並未優於傳統之物理治療步行訓練。因此，建議物理治療師們在使用步行器作步行訓練時，應審慎選擇合適的治療量，以充分發揮步行器步行訓練的療效。

關鍵詞：中風，偏癱，步態，步行訓練，神經物理治療

English Abstract

This study compared the effectiveness of treadmill training and conventional physical therapy training on improving ambulatory ability, gait pattern, and functional independence of stroke patients. Eleven stroke patients participated in the study, but only seven completed the study. There were four subjects in the control group and three subjects in the experimental group. Both groups received a five-week physical therapy program with a minimum of three sessions every week. The control group received ambulation training based on knowledge in neurophysiology, whereas the experimental group received treadmill training. Ambulatory function, gait patterns, and level of independence in performing daily activities were compared between the groups before, immediately after, and one-month after training. The results did not reveal any significant group difference on these gait and functional measures across the three tests. Past research has shown that intensive treadmill training results in better improvement in gait velocity than intensive conventional therapy. The present study, however, showed that treadmill training with moderate intensity did not produce better effectiveness than conventional therapy of similar intensity. It is suggested that when treadmill training is used as the primary gait-training program for stroke patients, an appropriate intensity should be chosen for this type of training to show superior treatment effects.

Key Words: stroke, hemiplegia, gait, ambulation training, neurologic physical therapy

Background and Aims

Restoration of independent ambulatory ability is one of the most common functional goals of patients with hemiplegia after stroke. Ambulation training, therefore, is an important element of physical therapy intervention for treating these patients. Conventional neurologic physical therapy, based primarily on neurophysiology, emphasizes that patients must be well trained on pre-ambulation activities before ambulation activity is introduced to the treatment regimen. It was deemed that early ambulation experience after stroke would cause the development of abnormal gait patterns.[1,2] However, Such an conventional approach, intensive or not, has shown limited effectiveness in improving patients' independent ambulatory ability and environmental adaptability.[3,4]

This study explored an alternative therapeutic approach that emphasized task specificity of ambulation training by using a treadmill. It was hypothesized that repetitive exposures to treadmill training would enhance the control of reciprocal lower extremity movements during walking, which in turn, would help patients regain better gait pattern, ambulatory ability, and functional independence. Gait characteristics, ambulatory ability, and functional independence were compared before, immediately after and one-month after training between hemiplegic patients who received treadmill training as their primary gait training programs and those who received conventional physical therapy as their gait training programs during a 5-week training period.

Subjects and Methods

Subjects. Hemiplegic patients who met the following inclusion criteria were recruited from the National Taiwan University Hospital in Taiwan: (1) hemiplegia due to first episode of an cerebral vascular accident, (2) good communication ability, (3) stable medical conditions, and (4) the ability to walk independently with an assistive device for at least 15 meters. Subjects were divided into the control and experimental groups in a pseudo-random manner by matching their severity of hemiplegia.

Eleven hemiplegic patients initially volunteered for this study. Four dropped out due to unstable medical condition or inconvenient transportation. Of the remaining seven subjects, four (all males; one left hemiplegia; one infarct and three hemorrhagic) were in the control group and three (one female, all right hemiplegia; one infarct and two hemorrhagic) were in the experimental group. The mean ages for the experimental and control group were 67.0 (∀12.5) and 60.8 (∀11.1) years of age, respectively. The average number of days post onset were 134.3 (∀177.6) and 77.5 (∀36.7) days, respectively, for the experimental and control groups. The lesion site and size were comparable between the two groups. All of the subjects signed an informed consent approved by the Human Subjects Committee of the National Taiwan University Hospital.

Assessments and Apparatus. The Fugl-Meyer motor function test of the affected leg and the Fugl-Meyer balance test were used to evaluate the severity of hemiplegia and patient's balance ability, respectively. Subjects' level of functional independence was evaluated by using the Barthel Index[5] and their ambulatory ability was examined by using the Motor Assessment Score[6]. The left-right symmetry in gait patterns and walking velocity were examined by having the subjects walk along a 6-meter-long walkway six times at their comfortable speed. In the center of the walkway, a 4-meter-long mat (GaitMatII, E. Q. Inc., Philadelphia, USA) was used to record and calculate the spatial-temporal characteristics of gait patterns. All of these assessments were conducted three times: before, immediately after, and one-

month after the 5-week training period.

Training Regimen. After the pre-training test, both groups received a five-week physical therapy program, during which the experimental group received treadmill training as their primary gait training, whereas the control group received conventional ambulation training. Each subject received at least three 25- to 30-minute physical therapy sessions every week. When a subject was unable to walk independently on the treadmill in the early stage of treadmill training, a suspension harness was used to provide partial body weight support.

Data and Statistical Analysis. Descriptive statistics were used to analyze the Fugl-Meyer motor score of the affected leg, the Fugl-Meyer balance score, the Motor Assessment Score, and the score on Barthel Index for each group across the three tests. Walking velocity and the affected-to-sound-leg single support time ratio were analyzed to indicate the overall gait function and symmetry. A 2 x 3 (Group x Test) factorial design analysis of variance with repeated measures on Test (RM ANCOVA) was performed on these two gait parameters to compare groups differences across the pre-, post-, and one-month post-training tests. To adjust for the group difference in the severity of hemiplegia at the baseline, the Fugl-Meyer motor score of the affected leg at pre-training test served as a covariate in the RM ANCOVA procedure.

Results

The average amounts of time dedicated to ambulation training per physical therapy session during the 5-week training period were 12 min and 10 min for the experimental and control groups, respectively. Table 1 shows the means and standard deviations of the Fugl-Meyer motor score of the affected leg, the Fugl-Meyer balance score, the Motor Assessment Score, and the score on Barthel Index for each subject group across the three tests. Independent-T tests did not reveal significant differences on these variables between the two groups before training ($p > .05$).

The 2 x 3 (Group x Test) RM ANCOVA procedure did not revealed any significant Group or Test main effect, or Group x Test interaction effect, on walking speed and the affected-to-sound-leg single support time ratio ($p > .05$). The two groups were not different on these two gait parameters. Both groups did not show significant changes on these two gait parameters across the pre-, post-, and one-month post-training tests either. However, the mean walking velocity of the experimental group showed slight improvement from 0.22m/s in the pre-training test to 0.30m/s in the post-training test, and then maintained at the velocity of 0.30m/s in the one-month post-training test. On the other hand, the mean walking velocity of the control group showed a tendency of improvement from 0.45m/s in the pre-training test to 0.53m/s in the post-training test, and then deteriorated to 0.47m/s in the one-month post-training test (Fig. 1). For the affected-to-sound-leg single support time ratio, both groups showed a tendency of increasing this ratio from the pre-training test to the post-training test, and then a reduction of this ratio from the post-training test to the one-month post-training test (Fig. 2).

Discussion

The use of treadmill training to facilitate the restoration of independent walking ability is based on the new 'task-oriented model' of physical therapy.[7] It is thought that treadmill training could provide stroke patients with many opportunities to practice walking behaviors repetitively before they reach the ability to walk

independently.

Past research has reported effective treatment outcomes on ambulatory abilities in stroke patients using this approach. Most of these previous studies, however, used a single-case study design[8-10] or lacked a control group in the study design.[7] Two recent studies[11,12] have investigated the

TABLE 1. Means (and standard deviations) of the Fugl-Meyer leg motor score, the Fugl-Meyer balance score (Balance), the Motor Assessment Score (MAS), and the score on Barthel Index (BI) for the experimental (E) and control (C) groups

Group	Test	Fugl-Meyer Motor Score Of the Lower Extremity	Balance	MAS	BI
E	Pre	21.3 (9.2)	9.7 (3.8)	2.7 (2.9)	58.3 (35.1)
	Post	24.7 (6.7)	12.0 (2.6)	3.7 (2.1)	78.3 (24.7)
	1M	26.3 (6.5)	12.0 (2.6)	4.0 (1.7)	83.3 (16.1)
C	Pre	27.0 (5.4)	10.5 (3.1)	4.3 (2.4)	82.5 (18.5)
	Post	29.8 (5.3)	11.3 (2.5)	4.8 (1.9)	86.3 (21.0)
	1M	30.8 (5.3)	12.0 (1.6)	4.8 (1.9)	87.5 (21.8)

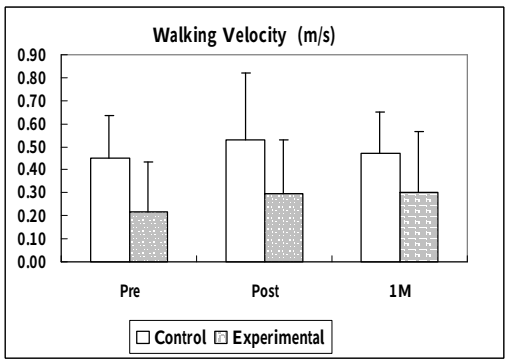

Fig. 1. Walking velocity of the two groups across the three tests.

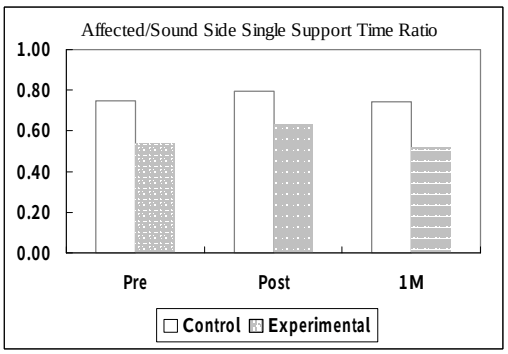

Fig. 2. Affected-to-sound-leg single support time ratio of the two groups across the tests.

influence of amount of body weight support provided during treadmill training on gait improvement in stroke patients. It remains unresolved with regard to whether or not treadmill training is more effective than conventional ambulation training in improving stroke patient's ambulatory ability and gait pattern.

To answer this question, the present study compared the effectiveness of treadmill training with conventional training in improving ambulatory function, gait patterns, and functional independence of stroke patients. The results showed that treadmill training did not produce significantly better effects on these gait and functional measurements than the conventional training. There was a tendency, however, for the treadmill-training group to maintain the slightly improved post-training walking speed at one month following the termination of the treadmill training. Richards et al. [13] reported the only study that compared training effects between treadmill and conventional physical therapy training. The study revealed that early intensive treadmill training resulted in faster gait velocity than early intensive conventional physical therapy after a 5-week training period, but no significant group difference was found in the 3- and 6- month follow-up tests. Stroke patients enrolled in that study[13] spent about 40~50 minutes on ambulation training in their daily physical therapy sessions. The experimental and control group in the present study, on the contrary, received gait training for only about 12 min and 10 min, respectively, per physical therapy session. Thus, it may be possible that superior gait training effect of using the treadmill would not become evident unless the training is conducted intensively.

Moreover, the lack of significant differences in training effects between the two training regimens could also be partially attributed to the small sample sizes and high variability among the subjects.

Evaluation of the Outcomes of the Present Study

The primary contribution of the present study is on the comparison of effectiveness between treadmill and conventional training, using treatment intensity comparable to that most commonly practiced in physical therapy clinics. It was found that with such moderate intensity, treadmill training did not produce better treatment outcomes than conventional physical therapy. When conducting this study, the authors also found that treadmill training required greater amount of manpower than conventional gait training when the training was introduced early in patient's recovery phase. Thus, from the cost-effectiveness perspective, whether treadmill training is a generally feasible and realistic approach in physical therapy clinics remains to be further studied.

Two major difficulties we faced during the conduction of this study were the recruitment of potential subjects and the high dropout rate. Richards et al.[13] also reported similar difficulties. In addition, because no funding was available for purchasing the electromyography (EMG) system when we began this research, EMG data were not recorded here.

The results of this study are definitely worth being reported in a refereed journal.

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