Effects of Gait Training Using Functional Electrical Stimulation on Stroke Patients’ Balance and Gait Velocity

The purpose of this study is to examine the effects of gait training using functional electrical stimulation on the improvement of hemiplegic patients’ functions for balance and gait velocity. The subjects of the experiment were determined to be 10 each hemiplegic patients who had been diagnosed with stroke or brain damage six months or longer earlier assigned to an experimental group and a control group respectively. The subjects were evaluated before the experiment using Tetrax and 10M gait tests, received gait training five times a week for four weeks using functional electrical stimulation and were evaluated after the experiment in the same method as used in the evaluation before the experiment. In order to examine differences between the experimental group that received gait training using functional electrical stimulation and the control group that was treated by functional electrical stimulation and received gait training thereafter, differences between before and after the experiment were analyzed using paired sample t-tests and differences in changes after the experiment between the experimental group and the control group were analyzed using independent sample t-tests in order to compare the two groups with each other. Experimental results showed significant differences in weight bearing, balance and gait velocity between before and after the experiment in the experimental group (p<.05). In the control group, whereas weight bearing and gait velocity did not show any significant difference between before and after the experiment (p>.05), balance showed significant differences (p<.05). Weight bearing, balance and gait velocity change rates showed significant differences between the experimental group and the control group (p<.05). In conclusion, it was indicated that gait training using functional electrical stimulation is effective for enhancing stroke patients’ weight bearing rates, balance abilities and gait velocity.

Key words: Back pain; LLD; Muscle Power; Flexibility; Spinal Decompression Therapy

INTRODUCTION

Hemiplegia or hemiparesis that occur secondarily due to stroke causes motor disturbance. This motor disturbance becomes a cause of asymmetric postures, abnormal physical balance, lack of the ability to move weight and the loss of special motor elements that perform fine functions. In particular, asymmetric standing postures and weight bearing hinder the establishment of normal movement patterns and disturb hemiplegic patients in maintaining standing postures. Hemiplegic patients are also disturbed in abilities to sit down or get up, abilities to recover balance and abilities to safely maintain balance while making functional movements by themselves, and they typically move weight more severely toward the sound side than toward the affected side. These unstable postures are quite general damage to hemiplegic patients and the recovery of balance thereafter is an essential element in activities in daily life (ADL).
Therefore, one of functional objectives in the rehabilitation of hemiplegic patients is inducing symmetric standing postures and important basic items in the evaluation of central nervous system damage patients are balance and postural stability(4). Functional electrical stimulation therapies applied to hemiplegic patients in order to improve these conditions are improving the gait of patients with foot drop in most cases. For stimulation, functional electrical stimulation devices consisting of surface electrodes are commercialized. However, because of displeasure due to stimulation and the problem of the necessity to replace the electrodes every day, completely implanted electrode type devices have been developed and used in the USA and functional electrical stimulation devices with transcutaneous electrodes inserted near the common peroneal nerve that can be controlled with foot switches are used and studied in Japan(9). However, functional electrical stimulation therapies generally used in clinics do not provide finely differentiated selective stimulation as simply patches are attached and choices of treatment methods are not diverse among different patients but are uniform due to many temporal and spatial restrictions. In addition, because of the electrical stimulation that is continued constantly with passive movements and that fact that programs are operated in a limited space of wheel chair, states where patient’s concentration is low can be frequently seen. The purpose of this study is to promote the development of new functional electrical stimulation devices and present the direction of treatment methods.

METHODS

Subjects

The subjects of this study were 20 subjects selected from those who were diagnosed with stroke or brain damage and were hospitalized or being treated as outpatients in J Hospital in Gyeonggi-do between March and June 2011 and agreed to the study after the intent of this study was explained to the patients and their protectors. In order to obtain reliable statistical significance, the patients were randomly assigned to make an experimental group of 10 patients and a control group of 10 patients.

Selection conditions of subject in the study are as follows. First, hemiplegic patients diagnosed with stroke or cerebral infarction that occurred at least 6 months earlier. Second, those who can understand instructions and show appropriate responses to instructions. Third, those who show satisfactory ankle dorsiflexion at heel strikes during gaits induced by electrical stimulation without intolerable pain. Fourth, those who have no problem in their visual system or auditory system and can communicate while tests are being conducted. Fifth, patients whose ankle joints are not plantar flexed during gaits due to their paralyzed dorsiflexor of affected side or those who can independently walk at least 45m using or without using a stick.

Measurement Instruments

FES(Functional Electrical Stimulation)

The functional electrical stimulation device used during gait training consists of a Microstim(Medel GmbH, inc., German) that can adjust frequency, contraction time, relaxation time and on–time, a foot switch and disposable surface electrodes(0.5cm). The stimulation conditions used were biphasic rectangular waves at a pulse rate of 35pps, a pulse width of 250μV and a short on–time of 0.3sec so that electrical stimulation can be given as soon as the heel gets off the ground(Fig. 1).

![Fig. 1. FES(Functional electrical stimulation)](image)

TETRA

The TETRA which is a system for balance diagnosis and biofeedback training developed by Sunlight Co, in Israel was used to test weight bearing and balance. This treatment device was developed to measure the degree of risk of falls or the balance states of the body that has force plates installed on the rear and front sides of the left and right side feet respectively so that weight bearing and balance of each region can be tested and has a monitor on the front side that can be used for biofeedback training. Out of the results of measurement, the weight bearing shows the degrees of weight