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Original Article

Effects of taping and proprioceptive neuromuscular facilitation for stance phase duration of stroke patients

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Abstract. [Purpose] The purpose of this study was to investigate the effects of taping and proprioceptive neuromuscular facilitation in stroke patients. [Subjects and Methods] Thirty patients who were diagnosed with hemiparalysis due to stroke were selected as subjects of study. Experiment group 1 patients had Kinesio taping applied before applying the PNF, while experiment group 2 patients had McConell taping applied before applying the PNF. The control group had only the PNF applied. The dartfish program was used to evaluate the stance phase of stroke patients. [Results] Experiment group 1 and experiment group 2 showed a significantly longer stance phase duration of the affected side than the control group in week 6. [Conclusion] Application of Kinesio taping has a more positive effect on the stance phase duration than McConell taping in the patients with stroke.

Key words: Kinesio taping, Gait, Stance phase

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INTRODUCTION

Due to the recent increase in average age and decline in birth rate, an aged society is becoming acceleratedly realized. This worldwide increase in the proportion of elderly people coincides with the development of modern medicine and improvements in the standard of living[1)]. Stroke, the most common cerebrovascular disease, is a type of acute cerebrovascular disease that causes circulatory disturbance in the cerebral vessels, inducing sudden consciousness disorder and body paralysis. About 75% of stroke patients develop chronic disorders, such as motor impairment, reduced sensory function, cognitive dysfunction, and speech defects, and often show emotional disturbance, including depression or anger[2)].

Muscular weakness, a factor limiting the functional rehabilitation of stroke patients, results in a reduction in walking speed and endurance, requires assistance with walking, and impedes independent postural changes[3)]. Recovering muscular strength to perform functional movements is a goal of therapy. Muscular weakness after a stroke usually has two causes: (1) a decrease in the number of motor units that can be mobilized because of a reduction in descending information and (2) an absence of muscular activity and exercise due to a lack of, or reduction in, descending motor commands and adaptive changes in muscles[4)]. Damage to the nerves that send motor commands to the muscles induces a reduction in muscular strength and even paralysis; damage to descending neurotabes by stroke decreases the number and the firing rate of activated motor units and injures the coordination of the units[5)].

Muscular weakness, abnormal muscle tone, abnormal movement patterns, abnormal body balance, defects in weight movement, and loss of motor factors specialized in performing delicate functions—these symptoms induce various problems in the motor control of stroke patients, including disturbance in standing balance and walking. These disturbances explain why stroke patients show slowed cycle and speed in walking[6)]. The walking of stroke patients is usually slow, requires excessive effort, and is urgently performed with poor coordination. Moreover, their movements show synergy of mass flexion and

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extension in which the trunk and the limbs are not selectively controlled[7].

When compared to healthy people, stroke patients display changes in temporal and spatial characteristics of walking; previous study reported that stroke patients showed a reduction in step length, walking speed, and the number of strides in the paralyzed and non-paralyzed limbs. Such reduction is caused by difficulty in normal walking due to loss of leg muscular strength, disequilibrium, rigidity, and stiffness induced by neurological damage after a stroke[8]. Thus, for the functional recovery of stroke patients, training is necessary to enhance muscular strength and coordination in the lower limbs and to improve weakened postures, balancing, and walking.

Most stroke patients show an increase of body sway because of an accompanying decrease in the proprioceptive senses in the affected lower limbs and a reduction in efficiency of movements since location information pertaining to the body in space is not provided[9]. Stroke patients experience basic difficulties in using their limbs due to loss of the proprioceptive senses with paralysis, resulting in severe restrictions in daily life activities. Among the several treatment methods provided to patients with these problems, taping therapy has recently been popular. Recovery of the proprioceptive senses is important in the treatment of stroke patients; the ability to change muscle contraction induced by immediate responses to external force is known to be important in reducing functional instability and re-injury of the damaged joints[10].

As part of the physiotherapy for these patients, exercise therapy, based on retraining the nerve root, is usually provided to hemiparalysis patients for several weeks after stroke. Additionally, functional task performance before movement activity such as walking, weight shift in a sitting or a standing position, standing without aid, etc., are also implemented[11].

Non-elastic taping is mainly used as a means of enhancing dynamic stability by supporting and protecting the subject so they can regain proper use of their bodies. Kinesio taping is used to reduce the pressure on the joint that is created during the walking and muscle-strength reinforcing exercises, and to stimulate muscle activity and sense[12].

This study not only examines the overlap effect of the PNF following the non-elastic taping and the elastic taping, but also examines the impact of the taping application method on the stance phase duration of the patients with stroke.

SUBJECTS AND METHODS

Among the patients that 30 patients who were diagnosed with hemiparalysis were selected as subjects of this study and they were divided into three groups. The subjects were randomly and divided into experiment group 1 (n=10), experiment group 2 (n=10), and the control group (n=10). After sufficient explanation of the purpose and procedures of the study the participants were provided a written informed consent form in accordance with the ethical standards of the Declaration of Helsinki. This study was approved by Daegu University Ethics Committee (1040621-201611-HR-017-02).

Experiment group 1 (n=10) patients had Kinesio taping applied before applying the proprioceptive neuromuscular facilitation technique, while experiment group 2 (n=10) patients had McConell taping applied before applying the proprioceptive neuromuscular facilitation technique. The control group (n=10) had only the proprioceptive neuromuscular facilitation technique applied.

In experiment group 1, Kinesio taping was applied on the rectus femoris muscle and the tensor fasciae latae of the hemiparalysis patients' affected side[13]. In experiment group 2, taping was applied while the subjects slightly bent the knee joint. A 3.8 cm McConell taping was used. The taping application followed the method where the transverse tape of the upper part was applied from the lateral kneecap and was pulled from the outside to the inside to cover the rear medial semitendinous muscle. Each pattern of the proprioceptive neuromuscular facilitation technique was applied for 5 minutes and a 3 minute resting time was provided between the different patterns. In this study, gait assessment was evaluated before the intervention, 3 weeks after, and 6 weeks after. The therapy was performed for 30 minutes, three times a week, for a total of 6 weeks.

Stance phase during walking were measured using Dartfish program (Pro Suite, Dfkorea, Korea). Video recordings of affected limb locomotion were collected in the sagittal plane using a video camera at the rate of 60 Hz at 1 m distance. Only data from complete walks were included, and the average values of five sets of measurements were used.

One-way ANOVA was conducted for comparison analysis between the groups in each period regarding the normality, the balance, and the walking ability. LSD was used for the post-hoc test. For the statistical process, the PASW Win. 20 package was used, with a significance level at $\alpha<0.05$.

RESULTS

The stance phase showed significant between-group differences in week 6 ($p<0.05$). In the post-hoc test, the subjects in experimental groups 1 and 2 showed significantly longer stance phase durations for the affected side than subjects in the control group (Table 1).

DISCUSSION

Taping therapy, which has been frequently used for many years, has been used globally in the prevention and rehabilitation of sports injuries and the improvement of exercise ability[14]. This therapy has recently become popular in people's daily lives as not only therapists, but also the public can purchase and use various therapeutic tapes, and many related books have been

Table 1. Comparison of stance phase duration in each group

Group	Experimental group 1	Experimental group 2	Control group
	Mean ± SD	Mean ± SD	Mean ± SD
Pre-test (second)	0.75 ± 0.13	0.75 ± 0.10	0.80 ± 0.08
3 week (second)	0.91 ± 0.05	0.89 ± 0.05	0.86 ± 0.09
6 week (second)*	0.99 ± 0.07	0.97 ± 0.05	0.89 ± 0.05

*p<0.05, Mean ± SD: mean ± standard deviation

published. Various studies have identified that taping therapy is effective in providing structural support to attached sites, improving skin receptors and proprioceptors, increasing blood and lymphatic circulation, supporting chronically weakened muscles, and enhancing motor ability[15].

Tapes for taping therapy can be roughly divided into two types: elastic and non-elastic. Elastic tapes, called Kinesio Tapes, are attached to the target muscles to normalize actions of the agonistic muscles of the joints. Therapies using these tapes are known to be helpful in treating various diseases including stroke and relieving pain by maintaining postural stability, improving the proprioceptive senses, and promoting circulation of blood, lymph, and tissue fluid[16].

The cutaneous fusimotor reflex is used as a mechanism of the Kinesio Tapes: this reflex refers to contraction of the muscles under the skin by the gamma motor neurons when stimulation, such as skin contact, vibration, or temperature difference, is applied. Reflex-induced muscle contraction is smooth and continuous; voluntary contraction contracts the muscles through the alpha motor reflex, producing stronger power; however, after a period of time, the muscles relax as excitability of the motor nerves in the spinal cord is reduced. Gamma motor neurons control the muscle spindles, which have two types of sensory nerve endplates. One type, located in the middle of the muscle spindles, senses and responds to dynamic changes in muscular length, while the other type, located at the end of the muscle spindles, continuously transmits information of static muscular length to the central nervous system[17].

Non-elastic tapes are used to compress the body parts, fix the joints, and restrict movable range. For instance, these tapes can be used directly to prevent excessive inversion of the ankle. While non-elastic tapes can offer sufficient assistance and support, they are not convenient for use in several respects. For example, when applied, these tapes easily acquire wrinkles due to unevenness of body contour. Effective application of non-elastic tapes requires considerable practice. According to existing studies related to non-elastic tapes, these types of tapes can enhance mechanical stability by assisting and supporting functional movements of the body, which is effective in the rehabilitation and prevention of injuries for athletes. It has been reported that non-elastic taping reduces ankle movements, resulting in a decrease in the incidence of ankle sprain and the prevention of injuries[18].

In this study, significant between-group differences in the stance phase duration of the affected side according to the treatment method was observed after 6 weeks. A significant difference was observed between experiment group 1 and the control group and between experiment group 2 and the control group after 6 weeks from the initial treatment. A significant increase of stance phase duration of the affected side was observed in experiment group 1 and experiment group 2, compared to the control group. These results can be attributed to the fact that the taping application contributed to the optimal joint alignment of the affected side during weight bearing and the controlling of the muscle strength and the action of the muscular system, which decreased joint instability and corrected musculoskeletal asymmetry through mutual deterrence.

There are a few limitations of this study. There was a problem of allergy when applying taping to the patients with hemiparalysis after stroke who had sensitive skin. Also, during the research period, patients often complained about fatigue, and the placebo effects of the patients were not considered in this study. We believe that more diverse research will be required in the future, by correcting and supplementing the limitations of this study, to evaluate the effects of applying the taping method to patients with stroke.

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