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Original Article

The Effect of Muscle Facilitation Using Kinesio Taping on Walking and Balance of Stroke Patients

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Abstract. [Purpose] The aim of this study was to evaluate the changes in function and balance after Kinesio Taping application in stroke patients. [Subjects and Methods] Thirty subjects were randomly divided into an experimental group and control group. The experimental group was applied taping before therapeutic exercise, and the control group received only therapeutic exercise. Functional gait was measured using the straight line walking test, and dynamic balance ability was measured using the Berg Balance Scale. Walking velocity was measured with the 10 m walking test. [Results] There were statistically significant differences between the results of the straight line walking and 10 m walking tests in the pre-post analysis for the experimental group. There were a statistically significant difference in the Berg Balance Scale and 10 m walking test between the two groups. [Conclusion] Application of taping to the paralyzed parts of a stroke patient has a positive effect on improvement of typical asymmetric gait and walking speed.

Key words: Kinesio taping, Stroke, Gait

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INTRODUCTION

Stroke is a central nervous system disease that causes partial loss and functional disorder of the brain due to a disability of blood supply in blood vessels of the brain[1)]. Most stoke patients typically experience motor function disorder[2)] and show an abnormality in standing and walking because of asymmetric alignment and posture, abnormal balance ability, lack of weight movement ability to the paralyzed part, and difficulty in specific functional movements[3)]. Recovery of motor disorders related to walking represents the most common objective for rehabilitation treatment[4)].

Proprioceptive information from mechanoreceptors in the skin, articular capsule, ligament, a semilunar valve, and muscles provides dynamic stability for each joint during dynamic motion of a joint through a muscular reflex from the spinal cord level and arthrokinetics[5)]. The proprioceptive sense offers information about muscle length, muscle tone, and joint position, which participates in motor control. In addition, a decrease in proprioceptive sense causes a decrease in balance ability related to handling of postural control, joint movement position, and external sway[6)].

Stroke patients also show abnormal walking patterns as compensation due to muscular weakness and loss of balance ability[7)]. They experience a decrease in balance and walking ability because of symmetrical weight shifting incapability and display an asymmetrical step length as a result of the relatively weakened acceleration force of paralyzed extremities[8)]. Furthermore, paralyzed lower extremities result in an increase in asymmetrical walking and limitation in the movements of the upper extremities[9)]. Since the gait of hemiplegic patients shows decreases in partial muscle control and synkinetic patterns, efficient treatment plans and exercise methods are needed to achieve a normal walking pattern[10)].

The advantages of Kinesio Taping (KT) are that it has a relatively lower cost and patients can easily apply it by themselves. Moreover, it can be combined with other treatments and guarantees safety, since it is a noninvasive method without side effects[11)]. Kinesio tape, which is placed on the skin, provides a greater cutaneous nociceptive signal and improves balance and gait ability by not only stimulating proprioceptive sense but also identifying the right position of the joint even in a comfortable posture with no weight loaded[12)]. Furthermore, KT is well-known to be effective for increasing functional movements by improving muscle strength and endurance[13)]. Besides, taping helps to maintain the coordination of agonist, synergist, and antagonistic muscles by controlling muscle tones, inducing body balance and muscle control recovery[14)]. Thus, balance and muscle control recovery through KT can increase gait speed[12)].

However, previous studies have investigated the effects of KT in specific parts of the upper or lower extremities and have only revealed enhanced gait speed and balance ability

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without observing increases in asymmetric gait when the center of gravity of the human body leans to the non-paralyzed side. Nam et al. reported that treatment for patients should be focused on improvement of not only gait speed but also symmetric walking for ideal walking patterns[15].

Therefore, the present study tried to determine a clinical approach and new evaluation method that are more effective in stroke rehabilitation by analyzing symmetrical gait motion and walking and balance improvement through the straight line walking test (SWT) after applying Kt to the main parts of the upper and lower extremities of the affected side in stroke patients.

SUBJECTS AND METHODS

Subjects

Thirty post-stroke hemiparetic individuals hospitalized in C hospital were randomly recruited. Individuals who were diagnosed with stroke without orthosis and deficit in the visual field and vestibular organ participated in this study after they received a full explanation regarding the study. Subjects were randomly divided into an experimental group and a control group. The experimental group was applied KT before performing therapeutic exercise, and the control group performed therapeutic exercise but did not receive KT. Each intervention was conducted 3 times a week for 6 weeks, and measurements were performed before and after the intervention.

Patients who presented difficulty in walking associated with stroke and participating in this project due to cognitive deficit or had a total joint replacement, fracture, or non specific skin disease were excluded from the study. All subjects provided written informed consent prior to participation according to the ethical standards of the Declaration of Helsinki.

Methods

A physical therapist applied 5-cm wide elastic Kinesio Tape to subjects as described below. It was applied to the major parts of the affected side, quadriceps femoris, and tibialis anterior of the lower extremities, as well as to the biceps brachii and upward rotators of the scapulas of the upper extremities. The flexible tape was attached to the skin not elongated from the origin to the insertion of fully stretched muscles. The subjects were informed that they could shower but that they should dry off completely and that they should remove the tape immediately if they experienced any itchiness or skin allergy. After application of the taping to the main parts of the upper and lower extremities for 6 weeks, evaluation of the subjects' gait and balance and comparison between before and after the intervention were performed.

Functional gait was measured using the SWT. After blocking the subjects' vision with a blindfold, they were instructed to walk straight and stably to a target spot 10 m away from the start point in a straight line, and the angle between the start and end spots was measured with a goniometer to analyze the gait difference as subjects veered in one direction or another. Any possible noise was removed to avoid compensatory movement by subjects depending on auditory information. Additionally, in the case of falling, an experienced therapist was on stand by in the back silently not to lead directions unconsciously for the patients who were walking with shut eyes.

Table 1. Comparison of pre- and post-intervention test results in the experimental group (mean±SD)

	Pre-test (n=15)	Post-test (n=15)
SWT (°)*	12.67±7.28	11.60±7.08
BBS (score)	35.60±6.81	36.33±6.36
10MWT (seconds)*	35.33±15.85	33.93±15.14

*$p<0.05$; SWT = Straight line walking test; BBS = Berg balance scale; 10MWT = 10-meter walking test

Dynamic balance was measured using the Berg Balance Scale (BBS). The BBS is clinically used to evaluate balance ability in a standing position or movement of hemiplegia patients with stroke or geriatric illness. This scale consists of 14 items, and each item is scored from 0 to 4 points on a 56-point scale. It has been reported that patients with 46 points or less need assistive devices when walking and have a higher risk of falling.

The 10 m walking test (10MWT) was also measured with a tapeline, and duct tape was attached to the start and end points of the 10 m course to mark the path. An additional distance of 4 m was also marked with tape, providing 2 m at the back and in the 2 m at the front of the lane to give the subjects sufficient room for acceleration and deceleration. The subjects were asked to walk at a normal speed as usual. The walking time was measured from the moment patient's foot passed the start line to the end line in 0.01-second increments with a stopwatch. Each patient performed the test 3 times after an initial practice run, and the average was calculated as the result. The 10MWT showed highly reliable results the test-retest reliability was 0.95 and the interobserver reliability was 0.90.

Regarding the statistical analysis for this study, the average values and standard deviations were calculated using SPSS for Windows (version 20.0). The paired t-test was performed to investigate the effects of the test before and after the intervention in each group, and the independent t-test was performed to evaluate the differences between the 2 groups. The significance level was $\alpha=0.05$.

RESULTS

There were a statistically significant differences in the results of the SWT and 10MWT test in the experimental group ($p<0.05$) (Table 1). In the control group, there were no statistically significant differences in the results of the SWT, BBS, and 10MWT ($p>0.05$) (Table 2). There were statistically significant differences in the results of the BBS and 10MWT between the two groups ($p<0.05$) (Table 3).

DISCUSSION

In this research, KT was applied to the upper and lower extremities of the paralyzed parts of the stroke patients to

Table 2. Comparison of pre- and post-intervention test results in the control group (mean±SD)

	Pre-test (n=15)	Post-test (n=15)
SWT (°)	12.33±7.30	12.00±7.42
BBS (score)	34.93±7.88	35.20±7.93
10MWT (seconds)	32.40±18.32	32.20±18.19

*p<0.05; SWT = Straight line walking test; BBS = Berg balance scale; 10MWT = 10 meter walking test

Table 3. Comparison of SWT, BBS, and 10MWT between groups (mean±SD)

	Experimental group (n=15)	Control group (n=15)
SWT (°)*	1.07±0.88	0.33±0.62
BBS (score)	−0.73±1.49	−0.27±0.70
10MWT (seconds)*	1.40±1.50	0.20±0.41

*p<0.05; SWT = Straight line walking test; BBS = Berg balance scale; 10MWT = 10 meter walking test

analyze the effects on gait and balance ability.

Brain damage causes hemiparalysis depending on the region in which the damage is located, and 70 to 75% of patients have difficulty in full recovery and have accompanying problems such as motor, gait, sense, and activities of daily living disturbances[16]. Such disorders reduce mobility and activities of daily living, and a lack of mobility in the lower extremities in particular has an adverse effect on gait and balance[17]. Balance and gait disturbances especially result in an unstable standing posture and walking due to muscle tone disorder and weight bearing on the non-affected side rather than visible or vestibular abnormalities[18].

The representative asymmetric walking pattern of stroke patients is believed to be the result of weakened strength due to deteriorated hip flexors in the paralyzed lower extremity increasing the swing time during the swing period, causing excessive motion of non-paralyzed parts of the body as a means of compensation to increase the gait speed, which may lead to a more asymmetric gait pattern. Such improvement is believed to be just speed increase without any effect on walking cycle and symmetry[19]. The most ideal walking pattern for stroke patients is to increase the walking speed and improve the asymmetric walking pattern[20]. Page et al. reported that functional independence of stroke patients can be improved through the treatment for symmetry[21]. From this, it can be inferred that improvement of balance and walking ability can be induced by direct stimulation of muscles of the paralyzed parts of extremities[22].

The initial mechanism with regard to the enhancement of muscle strength and muscle control is that cutaneous fusimotor reflex increases fiber tension, resulting in excitation of primary and secondary nerve endings, thus, helping afferent sensory nerve activity[23, 24]. The mechanism of taping is improvement of muscle strength by excitation of gamma motor nerves in skeletal muscle, as the taped part raises the tension of the fiber[25, 26]. In addition, spatial summation makes neurotransmitter isolated and postsynaptic potential is generated without action potential of pre-synaptic nerve. In other words, an additive effect occurs by stimulating many nerve fascicles that compose synapses simultaneously through taping. Finally, an irradiation phenomenon occurs in the area of increased reaction strength.

This study showed significant differences in the results of the SWT and 10MWT applying KT directly to paralyzed parts of the body (p<0.05). Based on these results, it can be inferred that applying KT facilitated muscle activation in non-paralyzed parts of the body, induced gait symmetry, and decreased weight bearing on the non-affected side. In addition, there was a significant decrease in the results of the 10MWT in which walking speed was measured after KT (p<0.05). This suggests that applying KT leads to improvement not only in gait symmetry but also in walking speed through muscle facilitation in the paralyzed parts of the body[27]. This is because KT effectively stimulated the proprioceptive sense, muscle spindles, Golgi tendons, etc., and strengthened muscles in the affected parts. Furthermore, the results for the BBS generally seemed to be improved, but there was no significant statistical difference in the experimental group. There were no significant differences in the results of the SWT, BBS, and 10MWT in the control group.

This study found a significant differences in comparison of the effects of treatment between the 2 groups on the results of the SWT and 10MWT (p<0.05). The experimental group showed significant improvement in the SWT and 10MWT compared with the control group.

This research was conducted to investigate the effects of KT applied to the upper and lower extremities on asymmetric gait, walking speed, and balance ability in stroke patients. The experimental group, which received KT, showed significant improvement in the SWT and 10MWT. Additionally, the experimental group showed significant improvement in comparison with the control group in the SWT and 10MWT. Thus, it can be interpreted that applying KT to the paralyzed parts of a stroke patient has a positive effect on improvement of typical asymmetric gait and walking speed.

However, this research had small number of subjects and needs more validity as an evaluation index of asymmetric gait in stroke patients, and it was not possible to control every effectible situation excepting treatment arbitration. Moreover, there was also a geographical limitation, as a limited number of patients were recruited from one local hospital, so it may be difficult to generalize the results to stroke patients in general.

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