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Original Article

2-dimensional analysis of low limb taping methods on ambulation for stroke patients

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Abstract. [Purpose] The purpose of this study was to investigate the effect of treatment on the type of taping applied before proprioceptive neuromuscular facilitation treatment. [Subjects and Methods] This study was conducted on thirty patients diagnosed with stroke. The study subjects were divided into three groups: experimental group 1, experimental group 2, and control group 3. Experimental group 1 applied Kinesio taping to the lower limb before applying proprioceptive neuromuscular facilitation technique. Experimental group 2 applied McConnell taping to the lower limb before applying proprioceptive neuromuscular facilitation technique and control group applied only proprioceptive neuromuscular facilitation technique. In this study was used Dartfish to analyze the gait of the lower limbs. [Results] Experiment group 1 showed a significant difference of ankle angle compared to the control group, but a statistically significant difference of ankle angle was observed in week 8. Experiment group 1 and experiment group 2 showed a significantly longer stride length on the affected side than the control group. [Conclusion] Application of Kinesio taping has a more positive effect on the ambulation than McConnell taping.

Key words: Ambulation, Taping, PNF

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INTRODUCTION

Typical motor disturbance after stroke involves motion control of the face and the upper/lower limb of one side of the body, which affects approximately 80% of the patients with motor disturbance[1)]. Diminished walking ability is a disturbance that is observed in almost all of the patients after stroke[2)]. To recover their walking ability, about 40% of the patients require aid in walking. Even though the rest (the remaining 60%) are capable of walking, they are faced with limitations in independently performing outdoor movement[3)].

Despite efforts for rehabilitation, approximately 35% of the patients with stroke who have paralysis of the lower limb do not recover their walking ability and function. About 25% of all patients with stroke have difficulty in walking without aid from others before being discharged from hospital[4)]. The walking function after stroke is reported to be related to neurologic walking disturbance in most cases, and the resulting walking disturbance shows a clearly asymmetrical problem[5)]. Hence, walking recovery after stroke can be a major goal of rehabilitation.

There are diverse conventional methods for recovering walking ability, such as using an Taping, ankle-foot orthosis, a walker, or a cane[6)]. These methods provide support not only for walking, but also for body disturbance during motion performance. They are being suggested as a means of helping patients lead independent daily lives.

However, as a single intervention method is not sufficient for treating hemiparalysis patients, therapy that combines medicinal or non-medicinal intervention methods is required, which can supplement the primary intervention method[7)]. A variety of intervention methods are often combined for optimal treatment duration and treatment effects, and taping is the representative technique of such methods.

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It has been reported that taping is effective in reducing the severity of subluxation and pain level among the patients with stroke in the acute phase who have shoulder subluxation. In another study, taping around the shoulder joint enhanced the stability of the shoulder girdle and improved joint movement, while shoulder subluxation further decreased when electric excitation and taping were simultaneously applied[8]. It has also been reported that applying taping on gluteus maximus resulted in an improvement of hip joint extension in the stance phase during walking after stroke[9]. According to the study results that compared the group that received the taping application for 14 weeks and another group that did not, a significant pain reduction was observed in the taping applied group after 6 weeks[10].

As is shown in the previous study results noted above, taping is an intervention method that is necessary for enhancing joint stability, which can activate muscles with direct stimulus and return the joint to its original place. Therefore, this study examined the overlap effect of PNF technique after taping methods on the ankle joint angle and stride length of stroke patients.

SUBJECTS AND METHODS

This study was conducted on 30 patients diagnosed with stroke. The study subjects were divided into three groups: experimental group 1 (n=10), experimental group 2 (n=10), and control group 3 (n=10). Experimental group 1 applied Kinesio taping to the lower limb before applying PNF technique. Experimental group 2 applied McConnell taping to the lower limb before applying PNF technique and control group applied only PNF technique.

In this study were excluded patients as cognitive impairment, fracture of the lower limbs, skin sensitization, and gait using a brace. The criteria for inclusion in this study were patients who were diagnosed with stroke within 6 months, Mini Mental State Examination-Korea score of 21 more, Modified Ashworth scale of 2 less, and without musculoskeletal disorders of the lower extremities.

In the present study, all participants were given an explanation of the study before the experiment. After that, all subjects participated in the study after understanding the purpose of the study. The participants were provided a written informed consent form in accordance with the ethical standards of the Declaration of Helsinki.

In this study was used Dartfish software (Pro Suite, Dfkorea, Korea) to analyze the gait of the lower limbs. The patient's ambulation was photographed using a 60 Hz camera at a distance of 1 m. Before the patient's gait, the black pen was used to mark the lateral epicondyle of each patient's knee, the lateral malleolus of the ankle, and the metatarsophalangeal joint of the little toe. Only the images showing perfect walking were selected and evaluated. The mean value of three trials was used as the measurement value.

In experiment group 1, Kinesio taping was applied on the affected side limb[11]. The intact side of the tip was attached to the inferior anterior iliac spine, while the other tip was temporarily attached above the kneecap. The hip joint extension and the knee joint flexion were at the maximum condition. Next, the biforked surface was attached along the edge of the kneecap toward the tuberosity of the tibia. Here, it was important not to apply tension to the tip of the tape. An appropriate attachment could be confirmed when the kneecap was located as if it was being embraced by the two sections in the case of a stretched knee. In the case of a tensor fasciae latae, I-shaped Kinesio tape with a width of 5 cm and a length of 20 cm was prepared. The patients lay on their side with hip joint abduction. One end of the Kinesio tape was fixed at the iliac spine. The tape was attached in the maximal adduction condition to run over the greater trochanter to reach the lateral knee. The applied non-elastic tape was removed 30 minutes after applying the PNF technique.

In experiment group 2, McConnell taping was applied on the affected side limb[12]. The V-shaped tape in the lower part was applied so that it started at the tuberosity of the tibia to reach the medial and the lateral knee joint crevice. Any potential skin allergy of the subjects was prevented by applying protective tape following the same method as McConnell taping attachment before applying the actual McConnell taping on the knee joint. The applied McConnell taping was removed immediately after applying the PNF technique.

Subjects were in the supine position with a posture of the hip joint in extension-abduction-internal rotation with knee extension, the ankle in plantar flexion-eversion. Next, they began with a posture of the hip in extension-adduction-external rotation, the knee in extension, the ankle in plantar flexion-inversion, and the toe in flexion, and then performed the position of the hip in flexion-abduction-internal rotation, the knee in flexion, the ankle in dorsiflexion-eversion, and the toe in extension, after which they performed the opposite pattern to return to the starting position. The PNF technique pattern was performed for 30 minutes a day, three times a week for 6 weeks (a total of 18 times).

The effects of taping methods and the comparison between the evaluation period were analyzed by two-way ANOVA. One-way ANOVA was used for comparison analysis between the groups and 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

Two-way ANOVA was performed to investigate interaction between groups and time for ankle angle and stride length. The Two-way ANOVA for the angle change of the ankle joint and stride length with time showed a significant difference of 0.000 ($p<0.05$). Time and group interactions were significant at 0.001 ($p<0.05$).

Table 1. Comparison of initial contact of ankle angle in each group

Group	Experimental group 1	Experimental group 2	Control group
	Mean ± SD	Mean ± SD	Mean ± SD
Pre-test (°)	125.66 ± 6.15	127.44 ± 7.13	129.14 ± 6.63
4 week (°) *	123.70 ± 9.68	128.59 ± 9.25	128.28 ± 6.25
8 week (°)	127.36 ± 8.26	128.64 ± 6.45	129.35 ± 6.12

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

Table 2. Comparison of stride length in each group

Group	Experimental group 1	Experimental group 2	Control group
	Mean ± SD	Mean ± SD	Mean ± SD
Pre-test (meter)	0.59 ± 0.08	0.62 ± 0.14	0.58 ± 0.09
4 week (meter) *	0.74 ± 0.11	0.75 ± 0.11	0.63 ± 0.08
8 week (meter) *	0.81 ± 0.11	0.74 ± 0.12	0.64 ± 0.11

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

The ankle angle showed a significant between-group difference in week 4 ($p<0.05$) (Table 1). In the post-hoc test, experiment group 1 showed a significant difference of ankle angle compared to the control group, but a statistically significant difference of ankle angle was observed in week 8.

The stride length showed a significant between-group difference in week 4 and week 8 ($p<0.05$) (Table 2). In the post-hoc test, experiment group 1 and experiment group 2 showed a significantly longer stride length on the affected side than the control group.

DISCUSSION

Currently, there are a number of studies that examine ways to improve the self-care status of patients during the stroke rehabilitation procedure. The goal of those studies is largely centered on enhancing the patient's quality of life by supporting their return to a normal, social life. A number of rehabilitation methods have been introduced for hemiparalysis patients due to stroke, and their effects are proven. Some examples include progressive task-oriented resistive training, which can improve lower-limb muscle strength, balancing, and walking[13]; elastic band training, which enhances the quality of life for the disabled who have function degradation; and electromechanical gait training and treadmill gait training, which allow the patients to experience more gait training during the same therapy time[14].

However, among the symptoms that are generally observed among the hemiparalysis patients due to stroke, their balance and the degradation of their walking ability act as interfering factors that prevent the hemiparalysis patients from actively participating in regular rehabilitation treatment. Hence, the primary goal of rehabilitation for the hemiparalysis patients due to stroke is the recovery of their balancing and walking abilities[15]. This study also examined the balancing and walking ability of hemiparalysis patients due to stroke according to the taping application method. Berg balance test was used for the evaluation of their balancing ability, while their walking ability was evaluated using 10MWT and the Dartfish program by categorizing them into the ankle angle in the early stance phase, the stride length, and the stance phase duration.

According to the analysis results, the hemiparalysis patients due to stroke showed cadence and gait velocity during the gait cycle of 77.57 steps/min and 0.47 m/s, respectively, which are lower than that of normal adults, which is 108.50 steps/min and 1.07 m/s, respectively[16]. It was also reported that the gait velocity in a stable condition and an optimal safe gait velocity of the hemiparalysis patients due to stroke is 30.24 m/min and 42.22 m/min, respectively, which is lower than that of normal adults, which is 68.06 m/min and 98.91 m/min[17].

In this study, the ankle joint angle in the early stance phase showed a significant change between groups in week 4, but no significant difference was observed in week 8. According to the post-hoc analysis results, there was a significant difference between experiment group 1 and the control group in week 4. It can be interpreted that the significant change occurred when the paralyzed ankle joint movement was stimulated by the overlap effect of the PNF and the taping application before treatment. Moreover, it was confirmed that the proprioceptor-stimulating elastic taping was more effective than the joint-fixating non-elastic taping. It is conjectured that the short-term taping application had a more positive impact compared to the long-term taping application.

In this study, there were between-group differences of stride length according to the application method. Stride length showed between-group differences after 4 weeks from the initial treatment. A significant difference of stride length was observed between experiment group 1 and the control group, and between experiment group 2 and the control group after 4

weeks and 8 weeks from the initial treatment. A significant increase in stride length 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 applied before the therapy contributed to the improvement of the balancing sense of joint stability while activating the muscles during walking. Chae, who investigated the stride length, cadence, and gait velocity of hemiparalysis patients following the stimulation of proprioceptive sense, observed a statistically significant increase of stride length in a group that received the activation of proprioceptive sense[18].

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