

Effects of Low-Dye Taping Applied to Chronic Stroke Patients on Gait Speed

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Abstract

Background/Objectives: This study examines the effects of the normal biomechanical maintenance of the feet through Low-Dye taping on the gait treatment in chronic stroke patients and presents the basis of clinical intervention.

Method/Statistical Analysis: In this study, 5 cm-wide elastic tapings was applied to improve gait ability in 20 chronic stroke patients. Low-Dye taping was applied for foot alignment. Gait was measured by BTS G-walk (G-walk, BTS, Italy). In this study, taping was applied after the initial assessment, and post measurement was performed after 30 min of taping to examine the immediate effects of taping on the gait parameters. The main outcome of this study is gait speed, and the secondary outcomes are cadence and stride length.

Findings: The research group showed significant increases in gait speed and cadence except for the stride length at 30 min after applying the taping.

Improvements/Applications: After applying the Low-Dye taping to chronic stroke patients, their gait speed and cadence showed significant differences due to the effects of ankle joint alignment and medial longitudinal arch lift and support. Therefore, Low-Dye taping was effective in improving the gait ability of chronic stroke patients.

Keywords: Stroke, Low-Dye taping, gait, Balance, Simulator Exercises.

Introduction

Feet support the body weight in standing position, absorb shock during gait, provides the driving force required for body movement, and maintains balance while the center of gravity of the body is moving. Furthermore, the biomechanical changes of the feet can cause musculoskeletal diseases and gait disorder. During gait, the feet are subject to medial-lateral and anterior-posterior shear forces in addition to a vertical pressure

in stance phase. However, the feet provide dynamic and static stability by forming medial longitudinal arch on the sagittal plane and transverse arch on the coronal plane. Furthermore, the dynamic stability of the ankle joint is maintained by the muscular forces of the intrinsic and extrinsic muscles. During gait, the feet control excessive forward movement of the contralateral lower limb while supporting the ground in the stance phase and enable movement in the swing phase. In addition, the tibialis posterior muscle plays the role of absorbing shock under a body weight by adjusting the medial longitudinal arch while the feet are in contact with the support surface^[1].

The ankle joint motion disorder of stroke patients causes abnormal weight support and gait patterns. Limitation in the plantar flexion of the ankle joint decreases push-off during gait, which shortens the step length. Moreover, among the gait parameters, cadence,

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velocity, and stride length are decreased while the single support and double support are increased, the weight supports of the feet are asymmetrical and the medial longitudinal arch cannot be maintained. As a result, the shock absorption of the ground reaction force becomes limited^[2]. In standing position, the weight passes through the talonavicular joint and pushes down the talus, which lowers the medial longitudinal arch. Flat foot is a condition where the medial longitudinal arch is continuously lowered or abnormally low, in which the ligament of the foot, the plantar fascia, and the posterior tibial tendon are over-extended^[3]. In the stance phase during gait, the flat foot decreases the forward movement of the center of gravity of the body and increases the ground reaction force^[4]. These problems resulting from the biomechanical changes of the feet and ankle joint decreases the input of proprioceptive information, causing balance disorder and falls. Furthermore, lower limb damage occurs during activities of daily living and sports activities^[5].

Low-Dye taping applied to flat foot treatment was first introduced to clinical practice by Ralph Dye. Low-Dye taping is to attach a tape that induces supination of the ankle. It has the effects of decreasing the pressures on the heel and the front part of the pronated foot and decreasing the pronation by normalizing the navicular alignment^[6]. Furthermore, it can support the medial longitudinal arch, normalize the biomechanical changes of the feet, reduce the shock caused by increased ground reaction force during gait, and prevent joint damage that may occur in sports activities or activities of daily living. The maintenance of normal medial longitudinal arch also has positive effects on gait^[7].

Improvement of gait ability is critical for independent daily activities of chronic stroke patients and the gait function is the criterion for recovery of motor disorder. Therefore, much time is spent on gait treatment. This study examines the effects of the normal biomechanical maintenance of the foot by Low-Dye taping on the gait treatment of chronic stroke patients and the present basis of presents the basis of clinical intervention.

Materials and Method

Study Subjects Ethical Consideration: Taping was applied after the initial evaluation, and post measurement was performed 30 min after taping application to determine the immediate effects of taping on the gait parameters.

The main outcome of this study is gait speed and the secondary outcomes are cadence and stride length.

- 1. G-walker:** To measure the spatiotemporal gait parameters after taping application, BTS G-walk (G-walk, BTS, Italy) embedded with a three-axis accelerometer, a magnetometer, and a gyroscope was used. The G sensor was positioned at the fifth lumbar vertebra using a belt for measurement. The sensor stabilization was measured in an upright position before measurement, and then the gait parameters were measured. For measurement, the start button was pressed and then the subject was instructed to walk freely on an 8 m walkway. When it was determined that sufficient data were collected, the researcher pressed the stop button and collected the data. This equipment can measure the analysis duration, cadence (number of strides per min), speed (average gait speed), stride length (average distance from the heel of a foot to the heel of the same foot), gait cycle duration (average distance to the heel strike of one foot) step length (average distance from the heel of one foot to the heel of the other foot), stance phase duration (ratio of time during which the left and right feet support the ground in a gait cycle), swing phase duration (ratio of time during which the left or right foot is in the swing phase in a gait cycle), double support duration (ratio of time during which both feet support the ground in the stance phase), single support duration (ration of time during which only one foot is supporting the ground in the stance phase), strides elaborated (accurate number of strides used in analysis). In this study, the gait speed (m/s), cadence (steps/min), and stride length (m) were collected from the G-studio program.
- 2. Intervention Method:** Five cm-wide elastic tapings was applied to improve the gait ability of stroke patients. First, Low-Dye taping was applied for foot alignment^[7]. The longitudinal anchor taping was attached from the fifth metatarsal head, which is on the outside of the foot, to the first metatarsal head by pulling the taping from the lateral to the medial direction. The transverse arch support taping was attached along the sole from the lateral to the medial direction. The transverse arch support taping was attached to the heel, the arch, and metatarsal head of the foot, in the direction from the heel to the metatarsal head [Figure 1] [Figure 2].



Figure 1. Low-dye taping



Figure 2. Low-dye taping

Data Analysis: The statistical data analysis was performed using the statistical software package SPSS 20.0 (SPSS Inc., Chicago, IL, USA). For the general characteristics of the subjects, the mean and standard deviation were obtained by using descriptive statistics. The normality test was performed by the Shapiro-Wilk Test. In addition, paired t-test was performed to examine the effects of taping on the spatiotemporal gait parameters. The alpha value for statistical significance level was set to .05.

Findings:

1. **General Characteristics of Subjects:** [Table 1] lists the general characteristics of the subjects.

Table 1. General characteristics

| Classification | Experimental Group (n=20) |
|---|---------------------------|
| Gender (male/female) | 16/4 |
| Paretic side (right/left) | 9/11 |
| Age (years) | 60.75±10.90 |
| Height (cm) | 164.60±6.45 |
| Weight (kg) | 65.15±6.08 |
| K-MMSE (point) | 27.15±1.09 |
| Onset (month) | 12.15±2.43 |
| K-MMSE, Korean version of the Mini Mental State Examination | |

2. **Effects of intervention on gait parameters:** The research group showed significant increases in gait

speed and cadence after taping application for 30 min, but stride length showed no significant increase [Table 2].

Table 2. Changes of gait parameters in the experimental group before and after the intervention

| Classification | Pre-test | Post-test | P |
|----------------|-------------|-------------|-------|
| Gait Speed | 84.24±16.06 | 90.97±19.51 | .024* |
| Cadence | .76±.22 | .83±.22 | .002* |
| Stride Length | 1.10±.21 | 1.13±.18 | .107 |

Discussion

The anatomical deformations of feet influence the tactile stimulation input during motions in various environments and decrease the stability of posture control during standing position and gait. Furthermore, the decreased stability of posture control causes injuries in the activities of daily living and sports activities. The structural deformations of the feet have a greater effect on dynamic stability than static stability. Treatment of foot deformation can increase the limits of stability of posture control and improve physical functions^[8]. Foot deformation due to abnormal muscle tone and muscle weakness of the hemiplegic side causes more pronation deformation than supination deformation, and limits weight support and physical movement while the foot is in contact with the ground^[9]. The pronation deformation of stroke patients does not affect gait more than supination deformation. However, due to the reduced medial longitudinal arch, the sole pressure is concentrated on a specific site, which increases the instability of the ankle joint and affects gait^[10].

Low-Dye taping applied to the pronated foot can control excessive pronation by decreasing the medial pressure and increasing the lateral pressure on the sole^[11]. Furthermore, it can raise the medial longitudinal arch that has been lowered by the decrease of the excessive muscular activity of the tibialis anterior muscle and the descended navicular, and can maintain the stability of the ankle joint during standing on one foot. This stability of the ankle joint allows the body to maintain normal weight load while the foot is in contact with the ground^[12].

The parameters according to the change in the sole pressure and the extrinsic muscles of the ankle joint after applying Low-Dye taping were not measured. The foot deformation of stroke patients is different from

the pronation deformation of normal persons caused by muscle tone and anatomical changes following the damaged central nervous system. However, the significant changes in the gait parameters after applying Low-Dye taping seem to have enabled the maintenance of ankle joint alignment and the lift and support of the medial longitudinal arch, which had a positive impact on the stable weight support and weight movement during gait. In this study, Low-Dye taping was applied to subjects who could walk, but further studies are needed on the balance parameters related to weight support and movement following the foot deformations of stroke patients in the future.

Applying the Kinesio taping to chronic unstable ankle joints decreases the body sway in the base of support during standing on one foot^[13] and has the effect of muscle tone control and proprioceptive information input in patients with central nervous system impairment^[14]. After applying the Kinesio taping to the ankle joints of chronic stroke patients, gait speed increased due to the increased motion of the ankle joint^[15]. Furthermore, after applying the Low-Dye taping, velocity, stride length, and cadence increased among the gait parameters^[7].

Conclusion

In this study, after applying Low-Dye taping to the feet using an elastic tape for 30 min, gait speed and cadence increased significantly, but the stride length did not increase. The elasticity of the elastic tape used in this study is focused on supporting motion rather than fixing. Inelastic taping fixes the arch of the foot and simply increases the arch during motion, whereas elastic taping supports the motion in the supination direction until the foot becomes pronation by using elasticity. Therefore, in this study, the gait speed increased because the elasticity of tape during middle stepping, toe touch, and toe push raised the arch (hoist effect). In addition, number of steps per min increased, and the stride length also increased, although it was not statistically significant. It showed an increase in the number of steps and movement at the same distance during gait, which supports the result of the increased gait speed. However, this study had a few limitations, the concrete effects on gait parameters were not presented, the application time of Low-Dye taping was short, and the effects of the elastic and inelastic taping method were not clarified. Low-Dye taping had a positive effect on gait despite the short application time, which suggests that it is helpful for improving the

gait function of chronic stroke patients. In the future, qualitative research is required to present the basis for expanding the application scope of Low-Dye taping in clinical practice.

Ethical Clearance: Not required

Source of Funding: Self

Conflict of Interest: Low-Dye taping applied to chronic stroke patients.

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