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Immediate Effect of Non-Elastic Taping on Gait Balance in Stroke Patients: Randomized Controlled Trial

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Abstract
Objective: After a stroke, most patients have poor ankle control and difficulty walking. Considering that proper foot placement will provide a more balanced and controlled gait, the aim of this study was to investigate the immediate effect of non-elastic ankle taping providing eversion support on gait balance in stroke patients.
Material-Method: The study included 30 stroke patients. Participants were randomly assigned to two groups: intervention group (n=15) and the control group (n=15). The control group received 45 min of conventional physiotherapy. The intervention group received 45 min of conventional physiotherapy after nonelastic taping, which provides eversion support. The gait balance of both groups was evaluated using the Dynamic Gait Index before and after treatment.
Results: A significant difference was found in the Dynamic Gait Index total score of the intervention and control groups before and after treatment ($p<0.05$). In the intervention group, a significant difference was found in all items of the Dynamic Gait Index before and after treatment ($p<0.05$). In the control group, a significant difference was found in the 4th and 8th items of the Dynamic Gait Index before and after treatment ($p<0.05$). There was no significant difference between the intervention and control groups in the total score and the separate scores of the eight items of the Dynamic Gait Index before and after treatment ($p>0.05$).
Conclusion: Nonelastic taping of the ankle before the physiotherapy session had a positive immediate effect on improving gait balance in stroke patients. The long-term effects of nonelastic taping on different gait parameters in stroke patients should be investigated.
Keywords: Balance, Gait, Immediate, Stroke, Taping

INTRODUCTION

Stroke is a pathology characterized by a sudden onset of neurological deficit, typically due to cerebral infarction or, less frequently, intracerebral hemorrhage. It is one of the main causes of mortality and the main neurological cause to acquired disability in adulthood.[1]
Hemiplegia (body paralysis on the left or right side), central facial paresis, and hemiparesis (body weakening on the left or right side) are common motor issues following stroke.[2] There is a direct relationship between motor impairment and function.[3] According to reports, 70% of stroke patients walk slowly three months following their stroke.[4] Post-stroke gait difficulty leads to reduced independence in activities of daily living and participation in social activities. Therefore, one of the most important goals of rehabilitation after stroke is to restore the gait pattern and optimize walking speed.[5, 6]
The ankle joint is essential for maintaining balance during gait.[7] In the paretic ankle joint, muscle weakness and spasticity are observed due to decreased neural stimulation. This condition is often accompanied by 'drop foot', characterized by plantar flexion of the foot and dragging on the ground during walking.[8] As a result, people with clubfoot are likely to either walk with excessive flexion of the hip and knee joints or walk with a circumduction movement outward from the midline with the affected lower extremity, putting body weight on the intact side.[9] These asymmetrical gait patterns cause gait disturbances, resulting in reduced walking speed[10], increased risk of falls[11]and greater energy expenditure.[12]
Another condition encountered in individuals after stroke is the presence of spastic equinovarus foot.[13]

The posterior foot muscles' imbalanced strength as a result of muscular hypertonus and the lack of efficient motor control causes the ankle posture in plantar flexion and inversion. The gastrocnemius and soleus muscles contract excessively in the equinovarus foot, whereas the tibialis anterior and peroneal muscles have paresis or weakening.[14] However, dorsi flexion is restricted in stroke patients with plantar flexor spasticity, making it challenging for the afflicted heel to make touch with the ground while standing and exercising. This is a major issue that not only affects the recovery process but also lowers quality of life.[15] Furthermore, stroke patients with spasticity has difficulty in maintaining postural control and inducing appropriate muscle strength and performing other movements.[16]

In rehabilitation; pharmacotherapeutic agents[17] transcutaneous electrical stimulation[18] and taping[19] are used to reduce the intensity of spasticity, while functional electrical stimulation[20] and foot-ankle orthosis[21] are used for drop foot treatment. Taping is one of the most economical and simple treatment methods that anybody may use without experiencing any negative side effects.[22] In order to maintain the balance between the agonist and antagonist muscles during voluntary movement, tape may also regulate muscular tone.[23]

Tapes are basically divided into two groups: non-elastic (rigid) and elastic tapes, each with its own mechanical properties, theoretical purposes and application techniques. Non-elastic tape was the first type of tape to be used and continues to be used today as an assistive method in the treatment of musculoskeletal injuries. The mechanism of the effect is to increase proprioception and protect muscles and joints by providing support.[24] In order to improve strength following musculoskeletal problems, it is frequently utilized to adjust joint alignment and stimulate muscle activation.[25] It has been shown that gluteal tape has an immediate impact on stroke patients' hip extension during the stance phase.[26]

In the current study, we aimed to assess the acute impact of eversion-supporting non-elastic taping on gait balance for stroke patients on the affected side ankle in order to provide a smoother and more regulated gait.

MATERIALS AND METHODS

Participants and setting

The current study, designed as a randomized controlled clinical study, was conducted in the Department of Physical Therapy and Rehabilitation at NP ISTANBUL Brain Hospital between July and December 2022. 30 individuals with stroke who had been identified by computed tomography or magnetic resonance imaging made up the study population, 15 individuals in the rigid banding group and 15 individuals in the control group, who continued to receive inpatient or outpatient physical therapy. Inclusion criteria were; been diagnosed with a stroke at least 6 months ago, being between the ages of 18 and 75, having a spasticity grade of 0, 1, 1+, 2 according to the Modified Ashworth Scale, having no cooperation problems and being mobilized without support. Exclusion criteria were; orthopedic problems such as surgical intervention, fracture history, presence of cognitive, visual, or cardiovascular diseases and skin sensitivity in the foot and ankle that may affect gait.

Sample size and randomization

A posthoc power analysis (G*Power 3.0.) was performed using variables related to outcome measures to determine the difference between the groups with sample size (Group 1=15, Group 2=15), α value of 0.05, effect size of 0.50. Posthoc power (1-β) was determined as 80% in the power analysis results.[27] The probability of error was accepted as $p<0.05$. Before randomization, baseline measurements of patients' abilities were performed. An independent blinded researcher assigned the participants to two groups: experimental and control using a simple randomization method via a computer-generated list.

Treatment program

The control group received a 45-min conventional physiotherapy program including range of motion exercises, balance and gait training, and neuromuscular electrical stimulation. The intervention group was taped at the beginning of the treatment and then received conventional physiotherapy with the same content as the control group.

Non-elastic taping was placed on the ankle of the affected side with a plaster band starting from the middle of the sole of the foot and extending from the lateral side of the foot to the level below the knee to provide eversion support. The method for applying a non-elastic ankle band is as follows: First, the tape is applied on the plantar surface of the foot to cover the calcaneus. Then, the foot is placed in the neutral position and in this position, the tape is stretched over the lateral malleolus and brought to 5 cm below the fibular head. To keep the tape in place, it is fixed with short bands just above the lateral malleolus and at the top of the tape (Figure 1).[28]

Figure 1. Non-elastic ankle taping

Data collection tools

A clinical and sociodemographic information form (including age, gender, educational status, medical history, etc.), the Modified Ashworth Scale (MAS) to assess spasticity, and the Dynamic Gait Index (DGI) to assess dynamic balance during walking were used in the evaluation. A physiotherapist with more than 10 years of professional experience performed non-elastic taping and conventional physiotherapy. A different physical therapist with two years of clinical experience conducted the evaluations.

Clinical and socio- demographic information form

Through this form, demographic information (age, height, weight, etc.) and clinical information such as spasticity level, medical history, presence of aphasia and use of assistive devices were questioned.

Dynamic gait index (DGI)

It was designed in 1995 by Shumway-Cook and Woollacott to assess dynamic balance while walking.[29] The scale has been translated and adapted into Turkish.[30] According to studies, the dynamic walking index is a valid and safe tool for chronic stroke patients.[31]

The dynamic gait index includes 8 items: walking, walking at different speeds, crossing an obstacle, walking around an obstacle, suddenly turning 180 degrees while walking and stopping, climbing steps, walking by turning the head left and right in the horizontal plane, and walking by turning the head up and down in the vertical plane. The performance of each item was graded with 4 points. The score scale is as follows; 3 independent walking, 2 mild impairment, 1 moderate impairment and 0 severe impairment; the total score that can be obtained varies between 0-24 points. If the total score is between 22 and 24, it can be said that individuals have safe ambulation, 20-21 points are considered to be a harbinger of fall risk, and falls are more common when a person receives a score of 19 or lower.[30-33]

Ethical considerations

The Üsküdar University Non-Interventional Research Ethics Committee accepted this study with a decision dated May 27, 2022, and numbered 61351342. This study was carried out in compliance with the ethical guidelines outlined in The World Medical Association (WMA) Declaration of Helsinki. Permissions were obtained from the chief physician of the hospital where the study was conducted. A detailed description was given to every patient taking part in the study of the study's purpose, procedures, and measurements, and they provided written consent before participating.

Statistical analysis

The data were statistically analyzed using SPSS 11.5 (Statistical Package for Social Sciences). Qualitative data were reported as percentages (%) while quantitative data were expressed as mean and standard deviation (SD). The conformity of the data to normal distribution was examined by 'One Sample Kolmogrov-Simirnov Test' and 'Histogram Graph'. Mann-Whitney U test was used for comparisons between groups and comparisons within groups were made using the Wilcoxon signed rank test. The standard deviation for statistical significance was set at 0.05.

RESULTS

The study included a total of 30 stroke patients: 15 in the control group and 15 in the intervention group (non-elastic taping). The intervention group's mean age was 51.13±12.08 years, compared to the control group's mean age of 64.40±10.54 years. Height, weight, and body mass index, which serve as defining characteristics of the patients, were comparable between the groups ($p>0.05$) (Table 1).

Table 1. Demographic characteristics

		CG (n=15)	IG (n=15)
		Mean±SD	**Mean±SD**
Age (Year)		64.40±10.54	51.13±12.08
Height (m)		1.69±0.92	1.68±0.07
Weight (kg)		74.67±9.53	71.53±11.97
BMI (kg/m²)		2.14±3.87	25.45±4.19
		% (n)	% (n)
Gender	Female	40(6)	46.7(7)
	Male	60(9)	53.3(8)

SD: standard deviation, n: numbers of ındividuals, m: meter, kg: kilogram, BMI: Body Mass Index

Clinical characteristics of the participants such as affected side, presence of aphasia, orthosis use and spasticity levels are given in Table 2.

When the Dynamic Gait Index total score of the intervention and control groups was compared within the group before and after treatment, a substantial improvement in both groups' scores was found ($p< 0.05$). All elements of the Dynamic Gait Index significantly increased in the intervention group following therapy ($p <0.05$). Only the 4th and 8th items of the Dynamic Gait Index in the control group showed a significant improvement after therapy ($p< 0.05$). The total score and individual scores of the eight items of the Dynamic Gait Index after treatment did not significantly differ between the groups ($p>0.05$) (Table 3).

Table 2. Clinical characteristics

		CG (n=15) %(n)	IG (n=15) %(n)
Affected Side	Right	40(6)	33.3(5)
	Left	60(9)	66.7(10)
Aphasia	Yes	40(6)	46.7(7)
	No	60(9)	53.3(8)
Orthosis	Yes	6.7(1)	20(3)
	No	93.3(14)	80(12)
MAS	1	53.3(8)	20(3)
	1+	20(3)	33.3(5)
	2	26.7(4)	46.7(7)

n: numbers of individuals, %: percentage, MAS: Modified Ashworth Scale

Table 3. Intragroup and inter group comparasions

DGI (score)		CG (n=15)		IG (n=15)		p
		Mean±SD	**p**	**Mean±SD**	**p**	
Total	BT	16.86±3.94	**0.001**	14.86±4.40	**0.001**	0.211
	AT	18.66±4.08		18.86±3.11		0.917
Item 1	BT	2.60±0.50	0.317	2.40±0.50	**0.014**	0.281
	AT	2.66±0.48		2.80±0.41		0.417
Item 2	BT	2.40±0.82	0.157	2.20±0.77	**0.005**	0.416
	AT	2.53±0.74		2.73±0.45		0.552
Item 3	BT	2.33±0.48	0.317	1.73±0.59	**0.033**	**0.008**
	AT	2.40±0.50		2.26±0.59		0.562
Item 4	BT	2.33±0.61	**0.046**	2.06±0.59	**0.02**	0.224
	AT	2.60±0.50		2.53±0.51		0.717
Item 5	BT	2.06±0.59	0.14	2.00±0.65	**0.005**	0.771
	AT	2.46±0.51		2.53±0.51		0.720
Item 6	BT	1.53±0.83	0.157	1.46±1.06	**0.02**	0.844
	AT	1.66±0.81		1.93±0.88		0.351
Item 7	BT	2.00±0.75	0.083	1.66±0.72	**0.002**	0.273
	AT	2.20±0.67		2.33±0.72		0.555
Item 8	BT	1.60±0.50	**0.005**	1.33±0.72	**0.008**	0.326
	AT	2.13±0.74		1.80±0.77		0.231

SD:Standard Deviation, n: numbers of individuals, DGI: Dynamic Gait Index, BT: Before treatment, AT: After Treatment, p<0.05 statistically significant differance

DISCUSSION

This study investigated at how non-elastic ankle tape affected individuals with chronic strokes' gait balance acutely and how it contributed with rehabilitation. In the taping group, there was a significant intragroup increase in all parameters of the Gait Balance Index and a significant improvement in the 3rd item of the Gait Balance Index between the groups in favor of the intervention group. In summary, it was found that non-elastic ankle tape prior to physiotherapy had a favorable acute impact on gait balance in stroke patients. These results are particularly noteworthy because there is little information about the short-term effects of nonelastic tape on gait balance in chronic stroke patients.

Stroke is the primary cause of chronic disability.[34] The consequences of stroke include impairments in strength, balance, communication, and cognitive disorders; impairments in activities of daily living and gait.[35,36] Among all these effects associated with stroke, most patients consider gait disturbance to be one of the most important problems.[37] Accordingly, gait improvement is reported as the most common goal for rehabilitation.[38]

In post-stroke therapy, kinesiologic taping benefits the lower extremity.[39] Kinesiologic taping of the ankle after stroke has been reported to acutely improve walking function.[40] Additionally, studies on patients with chronic stroke have looked into the effects of nonelastic ankle tape. One study demonstrated that patients with chronic stroke benefited from nonelastic ankle taping in terms of walking speed and stride length. It has been proposed that nonelastic ankle taping acutely improves walking ability by stabilizing the ankle.[19] Our findings are consistent with this study. In another study, it was found that gait function improved acutely in chronic stroke patients after taping providing ankle eversion support; walking speed, stride length, and cadence increased significantly compared to the non-taping group.[41] According to a research by Kim et al., taping the lower extremity that was injured after a stroke improved the patient's characteristic asymmetric gait and walking speed.[42] Another study suggested that kinesiological taping might be helpful for stroke patients undergoing rehabilitation, especially for enhancing balance and mobility.[43] In our study, in accordance with previous studies, inelastic ankle taping was found to have a positive acute effect on gait in individuals with chronic stroke, and dynamic walking balance was found to improve acutely because of this method.

The acute effect of non-elastic ankle taping on gait balance in addition to a conventional physiotherapy programme may be due to the improvement in ankle stability provided by the tape. Another explanation may be that taping provides an increase in cutaneous sensory input. One study reported that tactile input added to exercise training can significantly improve double-support time.[44] Tactile input can activate fast conducting sensory and proprioceptive fibres to initiate a faster muscle response.[45] In our study, a non-elastic tape was applied to the ankle of the affected side, starting from the middle of the sole and extending down the side of the foot to below the knee. Individuals in the intervention group reported that they could easily feel a stimulus from the non-elastic tape stretching the skin during the exercise, which made it easier to move the ankle. We believe that this may have some benefits for motor relearning.

Several studies have been conducted with the goal of enhancing stroke sufferers' quality of life. It has been established that functional ability, particularly balance and walking ability, is a significant determinant of a stroke patient's quality of life. The quality of life of stroke patients is significantly impacted by social isolation, balance issues, and gait difficulties. In programs intended to improve stroke sufferers' quality of life, it has been stated that balance and gait metrics should be taken into account.[46] Our current study is important in this regard and has the thinkable to improve quality of life through long-term follow-up.

CONCLUSION

The non-elastic band that provides eversion support to the ankle was found to acutely improve the walking balance of stroke patients. In clinical practice, this intervention is recommended for short-term goals in stroke patients. However this research has several limitations. The learning effects of walking could not be assessed, nor could it be determined that the learning effect was completely excluded. Further research should consider additional outcomes, longer treatment, and continuous observation. The long-term effects of this intervention and its effects on different walking parameters should be investigated.

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