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Effect of Kinesiologic Taping of Feet and Ankles on Static and Dynamic Balance in Children with Cerebral Palsy

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Abstract

Balance problems in individuals with cerebral palsy (CP) restrict their motor skills for fulfilling daily life activities and acting independently in society. This study investigates the effect of kinesiology taping (KT) on the feet and ankles for static and dynamic balance. Forty individuals with CP with an average age of 10.85 ± 3.893 were included. Records of demographic information and anamnesis of individuals were made. Gross motor function classification system, gross motor function measure and Berg balance scale (BBS) were used for evaluation. Static and dynamic balances of the individuals were measured with Techno Body Postural Line device at pre-treatment and post-treatment of KT. Following KT, falling risks of the individuals were observed to decrease significantly based on the BBS scores. We consider that usage of KT in treatment programmes along with other physical therapy methods will play an important role in improvement of balance and functional capacity.

Keywords: Cerebral palsy, kinesio tape, dynamic balance, static balance.

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1. Introduction

Cerebral palsy (CP) is the most common reason for childhood disability, which causes posture and movement disorder [1, 2]. Among individuals with CP, non-progressive lesions which emerge in the brain have destructive impacts on the musculoskeletal system. These impacts can be lined up as disorder on motor dysfunction and sensory integration, myasthenia, increased co-contraction in agonist and antagonist muscles, and decrease of selective motor control, anaerobic muscle power and agility [2, 4]. These disorders, caused by muscular tonus abnormalities on selective motor control create posture, balance, coordination and walking difficulties in individuals [5, 6]. This loss on postural control plays a role as a basic factor for disorders of balance and walking [5, 8].

The functional objective of the equilibrium system is control of postural balance, providing transitions in volitional acts and facilitating these. Because of the abnormal muscle contractions among children with CP, balance develops distinctly from a normal balance strategy and presents us with problems. Weakness of balance, which is a part of gross motor skills, decreases functionality of individuals and causes difficulty in purposive motions [9]. It prevents them from performing motor skills, fulfilling daily life activities and acting independently in society.

The kinesio taping technique presents successful results with similar structural characteristics of human skin and flexibility, without restricting joint mobility [10]. It has been concluded that, via the kinesio taping technique, motor unit ignition range and afferent feedback increase, thus proprioseptive sensation and muscle force also increase [11, 12]. When the kinesio taping technique is administered, motion is increased together with circulation as the skin and subcutaneous interstitial area is increased by removing the skin. Increase of motion and circulation causes decrease in inflammation in that area. With this technique, alleviating pain, improving performance, re-education of the neuromuscular system, preventing damage and speeding up of circulation and tissue recovery is intended [13]. Use of the kinesio taping technique among children with CP within a physical therapy programme is gaining popularity, and it is stated to be a promising technique as it helps in development of the motor function [14].

Positive effects of the kinesio tape technique on balance are included in literature studies [15–19]. However, studies of CP are few, and most of these have been evaluated with balance surveys, which are subjective methods [16, 17, 19]. Kinesio taping, whose impact is administered on people with CP on their feet and ankles for dynamic and static equilibrium, is the aim of our research study.

2.Materials and Methods

Forty people (16 males and 24 females) diagnosed with CP were included in this study. The individuals were chosen according to the criteria of not having had botulinum toxin (Botox) in the past 6 months, having levels I or II according to the gross motor functions classification system (GMFCS), having spasticity values of 3 or below 3 according to modified Ashwort scale and not having been diagnosed with severe mental retardation. The study was initiated with the approval of the Mustafa Kemal University Medical Faculty Ethics Committee on 20 October 2015, with license no: 4298783/050. Besides the license from the Ethics Committee, approval forms with signatures were taken from the families of the individuals for their approval to take part in this study.

Within the frame of the evaluation, by making a record of the demographic information and operational backgrounds of individuals, existence of their systemic disorders and the medical devices they used were interrogated. Static and dynamic balances of individuals with CP were measured with the Techno Body Postural Line device at pre-treatment and post-treatment of the kinesio taping technique, which is applied to the ankles. The taping treatment was administered on the feet and ankles using 5 cm × 5 m kinesio tape. GMFCS, gross motor function measure (GMFM) and Berg balance scale (BBS) were used for evaluation of the individuals.

Taping treatment was administered on the feet and ankles of the patients using a 5 cm × 5 m kinesio tape. Before the treatment, the skin was cleaned of oil and moisture and the patients were asked to shave if necessary. Attention was paid that there was no tension on the start and end points of the tape. Three different taping techniques were administered to the individuals. The techniques used were as follows:

1. In order to facilitate the dorsiflexion motion, the band was situated such that one tab was in the middle of the foot dorsal aspect, the other tab was in the middle of the tibia, while the foot was on dorsiflexion [10, 20, 21] (Figure 1).

Figure 1. The effect of variables

2. In order to ensure contact of the foot with the ground, subtalar diarthrosis was positioned in a way to reach eversion and taping was applied starting from under the medial malleol until the periphery of the calcaneus lateral without tension on tape, and later with 100% tension and applied until 10–15 cm below the fibula outset [10, 20, 22] (Figure 2).

Figure 2. Subtalar taping technique

3. In order to activate peroneal tendons, taping was applied between the lateral and medial malleols by pulling the distal tab of the fibula towards the back with 100% tension [10, 20] (Figure 3).

Figure 3. Taping technique applied on the distal tab of fibula

The Techno Body Postural Line device is used to evaluate static/dynamic balance and one foot or two feet states of stabilisation. The device was developed for dynamic proprioseptive exercises of the lower extremities, flamingo tests and body proprioseptive control practices. The system is composed of three exchangeable discs. It enables studying five different balance levels through variable diameter discs. Via the chip in the device, it perceives each angular motion of the mobile platform and transfers these to the software wirelessly. Stability of the platform is provided through an electro hydraulic system, which is moved by a two-step power engine. The results can be watched live and are recorded from the screen on the device. Objective data are acquired with this device on balance measures [23].

Dynamic and static balance evaluations of 40 people through pre-taping and post-taping were conducted on two different platforms. Primarily, the operations applied were explained clearly to the individuals. They were asked not to wear shoes or socks during the evaluation, and to get on the platform barefoot and stand (Figure 4).

Dynamic balance measurement was carried out on two feet by standing on a mobile platform. Unsupported and unassisted measurements were performed for dynamic balance in the charge of two physical therapists. Age, gender, height, weight and personal notes of patients were defined on the programme. Applications of measurement were done within the framework of the parameters below.

Figure 4. Evaluation of balance on static and dynamic equilibrium device post-taping

Statistical analysis of the data acquired in our study was carried out using the IBM SPSS Statistics 22 programme. Whether there is a correlation between two categorical dependent variables was researched with the NcNemar test in 2 × 2 charts and with the NcNemar-Bowker test in 3 × 3 charts. Whether there is a correlation between the two independent categorical variables was researched with the Pearson's chi-square test and Fisher's exact chi-squared test (2 × 2) and Freeman–Halton–Fisher chi-square test (n × m) was used when Pearson's chi-square test hypotheses could not be ensured. Any discrepancy between the two dependent numeric variables was researched with the dependent sample t-test.

3.Results

A total of 40 people with CP, 40% of whom were females (n = 16) and 60% of whom were males (n = 24) were included in this study. Demographic information and levels of the people in terms of GMFCS are indicated IN Table 1.

Table 1. Demographic information of the individuals

Age (Avg ± SD)	10.85 ± 3.893
Gender (F/M)	16/24
Height (cm) (Avg ± SD)	129.20 ± 26.859
Weight (kg) (Avg ± SD)	38.25 ± 17.519
GMFCS Level 1/Level 2	13/27

Avg: Average, SD: Standard deviation, F: Female, M: Male

When the range of the features in terms of gait styles were analysed, the most common gait style was observed to be bent knee gait with a 25% ratio.

Graphic 1. Range of the individuals in terms of gait styles

Following the kinesio taping administered on the individuals, falling risks of the individuals were observed to decrease significantly according to the BBS scores ($p = 0.004$). The GMFM average was also detected to be significantly lower compared with pre-taping at ($p = 0.000$) (Table 2).

Table 2. Comparison of the functional test scores of the individuals in terms of pre-taping and post-taping

	Pre-taping Avg ± SD	Post-taping Avg ± SD	*p*
Berg balance scale	104.37 ± 20.98	108.02 ± 20.18	**0.004****
GMFM	72.55 ± 14.39	75.05 ± 13.88	**0.000*****

Avg: Average, SD: Standard deviation
*$p < 0.05$
**$p < 0.01$
***$p < 0.001$

Table 3. Analysis of the correlation between pre-taping and post-taping of static balance scores

		Pre-taping		Post-taping		*p*
		n	%	*n*	%	
Eyes open	Good balance	21	52.5	34	85	**0.002****
	Normal balance	18	45	5	12.5	
	Poor balance	1	2.5	1	2.5	
Eyes closed	Good balance	0	0	14	35	**0.000*****
	Normal balance	25	62.5	19	47.5	
	Poor balance	15	37.5	7	17.5	

McNemar–Bowker test
*$p < 0.05$
**$p < 0.01$
***$p < 0.001$

When the static scores of pre-taping and post-taping were analysed, a statistically significant discrepancy was detected with both eyes open ($p = 0.002$) and eyes closed ($p = 0.000$) (Table 3).

Table 4. Analysis of the correlation between pre-taping and post-taping of the Romberg test

	Pre-taping		Post-taping		*p*
	n	%	*n*	%	
Good balance	11	27.5	20	50	**0.011***
Normal balance	27	67.5	18	45	
Poor balance	2	5	2	5	

McNemar–Bowker test
*$p < 0.05$
**$p < 0.01$
***$p < 0.001$

A significant recovery was detected on individuals in terms of pre-taping and post-taping in the Romberg test scores ($p = 0.011$) (Table 4).

Table 5. Analysis of the correlation between pre-taping and post-taping of balance on one foot scores

		Pre-taping		Post-taping		*P*
		n	%	*n*	%	
Right leg	Good balance	3	7.5	18	45	**0.000*** **
	Normal balance	22	55	10	25	
	Poor balance	15	37.5	12	30	
Left leg	Good balance	1	2.5	8	20	
	Normal balance	15	37.5	24	60	**0.000*** **
	Poor balance	24	60	8	20	

McNemar-Bowker test
*$p < 0.05$
**$p < 0.01$
***$p < 0.001$

Significant recovery was observed on both legs when pre-taping and post-taping of balance on one foot scores were analysed ($p = 0.000$) (Table 5).

Table 6. Analysis of the correlation between pre-taping and post-taping of dynamic balance scores

		Pre-taping		Post-taping		*p*
		n	%	*n*	%	
Antero-posterior balance	Ideal balance	0	0	3	7.5	**0.030***
	Normal balance	18	45	23	57.5	
	Poor balance	22	55	14	35	
Medio-lateral balance	Ideal balance	0	0	2	5	
	Normal balance	14	35	22	55	**0.080**
	Poor balance	26	65	16	40	

McNemar-Bowker test
*$p < 0.05$
**$p < 0.01$
***$p < 0.001$

When pre-taping and post-taping dynamic balances scores were analysed, variation of medio-lateral direction was found insignificant ($p = 0.08$), while a statistically significant variation was seen on the antero-posterior direction ($p = 0.03$) (Table 6).

4.Conclusion

CP is a disorder arising from damage in the foetal or infantile developing brain, restricting daily life activities and causing motor function, posture and motion development disorders [24, 25]. Among children with CP, due to the fact that primitive reflexes cannot be suppressed because of the lesion in the brain, latency occurs in the development of advanced postural and protective reflexes and influences the body-balance reactions preventing the child from making the expected progress [26, 27]. All these factors foregather and cause inefficacies in postural control and compensatory postural reactions, which need to develop in order to meet differences in the balance centre [28].

Children with CP have frequently static and dynamic balance problems on various levels compared to their peers [29]. In this study, in which static and dynamic balances of people with CP whose GMFCS levels are 1 and 2 are evaluated, moderate falling risk has been detected in 47.5% of those individuals in terms of BBS. Meanwhile, when the Romberg test scores were analysed, 37.5% of them were observed to have poor balances. When their balances on one foot were analysed, 37.5% of the individuals on the right leg and 60% on the left leg were within the poor balance group. When dynamic balance scores were observed, these ratios were seen to increase and 55% of the individuals were seen to rank in antero-posterior direction balance problem group and 65% in the medio-lateral balance problem group.

With the purpose of treating these balance problems seen among children with CP and treating gait disorders, which are also commonly seen problems, various treatment modalities are used in rehabilitations [30, 31]. Among these treatments, kinesio taping has begun to find more approval in the field of paediatric rehabilitation in the recent years [16, 32, 33]. When the literature is researched, taping treatments among children with CP are emphasised to develop active joint motion, support postural control and develop functional motions since they increase proprioseptive and tactile inputs [34, 35].

da Costa *et al*. [18] evaluated the impacts of kinesio taping treatment on dynamic postural control and functional balance in terms of 'sit to stand' (STS) performance, timed Up & Go test and Berg paediatric balance scale at a gait analysis laboratory with camera. The Y tape treatment has been administered on quadriceps femoral and tibias anterior muscles in their study. As a result, taping has been indicated to increase agility and performance on STS, decrease test span and promote knee extension. Consequently, the kinesio taping treatment is emphasised to increase stabilisation and balance, and to have positive impacts on the range of motions.

In the case report of Kepenek *et al.* [17], carried out to decrease hip internal rotation, increase foot dorsiflexion, improve heel stabilisation and decrease foot inversion of a 6-year-old diplegia diagnosed patient, bilateral kinesio tape treatment was been applied to the lower extremities. Via the BBS balance measurements and the 'timed Up & Go' test, the functional impacts of the kinesio tape treatment on walking were researched. As a result of the study, the span of the 'timed Up & Go' test was reported to decrease after the kinesio tape treatment, especially in treatments applied with orthesis. As for the BBS, risk of falling was reported to decrease post-treatment.

Similarly, in our study, falling risk of post-taping decreased significantly according to the BBS scores ($p = 0.04$). Also, in terms of balance device scores, a significant increase was observed in the post-taping static balance scores with both eyes open ($p = 0.002$) and eyes closed ($p = 0.000$). This increase in post-taping balance was supported with the Romberg test scores ($p = 0.011$). Besides, when balance on one foot scores were analysed, a statistically significant variation was detected in post-taping on both the sides ($p = 0.000$). When dynamic balance scores were analysed, a statistically significant variation was observed in the antero-posterior direction (p = 0.03), while there was insignificant variation in the medio-lateral direction (p = 0.08). We believe this variation in balance stems from the impact of corrective kinesio taping technique on the stabilisation of ankles. Robbins *et al.* [36] had suggested that the improvement of performance can be related to the tape creating an increase in the proprioseptive sense by pulling the superficialis or stabilising the joint.

Simsek *et al.* [16] researched the impacts of the kinesio tape treatment on sitting posture, gross motor function and functional independence levels in their study on individuals with CP. They randomly separated 31 people with CP, who were on GMFCS III–IV–V levels into two groups and 15 people were administered only physical therapy while 16 people were administered kinesio tape treatment on their paraspinal muscles (C7-S1) together with physical therapy. In consequence of this 12-week study, a significant increase was recorded in the independence levels and sitting postures of the people in the taping group [16].

In a similar study, Footer *et al.* [37] researched the impacts of therapeutic taping on gross motor function in children with CP. Eighteen quadriparetic people between the ages of 13 and 18, at levels of IV–V in terms of GMFCS, were included in the study. Randomly dividing the facts into two groups, kinesio taping onto paravertebral muscles (C7-T1) was administered to one group in addition to physical therapy for 12 weeks. As a result of the study, functional taping was stated not to cause any positive changes on postural control in quadriparetic children; however, purposive motions were stated to increase in an athetoid child and involuntary movements to decrease.

Cortesi *et al.* [38] researched the impacts of ankle kinesio taping on balance parameters in patients with multiple sclerosis, and they indicated a significant recovery, especially in antero-posterior stability. In a study in which kinesio taping technique was administered on the ankles of eight spastic unilateral children with CP, the children were evaluated at pre-treatment and post-treatment with 3-D gait analysis. After treatment, walking speed and GMFM scores were reported to increase, step width and genu recurvatum to decrease and similar step lengths were seen between two extremities [19]. Positive impact of taping on gross motor function was detected in our study (p = 0.00). We believe that kinesio taping supports the muscle tissues around the ankle joint and thus provides a positive impact on balance by increasing joint stability.

As a consequence, positive impacts of kinesio taping technique applied to patients of CP are obviously seen both in the literature and in our study [16, 18, 37]. As for the supremacy of our study over others, the data are supported not only with scales but also with balance devices and includes objective results. In the light of our findings, we consider that usage of kinesio taping in treatment programmes in addition to other physical therapy methods is going to play an active role on the improvement of balance and functional capacity.

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