



Investigating the Effect of Therapeutic Taping on Trunk Posture and Control in Cerebral Palsy Children with Spastic Diplegia

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Abstract

Background: Cerebral palsy (CP) is considered as the most common cause of postural problems and motor dysfunctions in neuro pediatrics.

Purpose: This study aimed to investigate the effect of kinesiotape (KT) application on the trunk posture and control in children with spastic diplegic CP that were enrolled into physical therapy program.

Methods: The study included 30 spastic diplegic children. Those with deformities that could disrupt the balance in sitting and standing were excluded. The patients were randomly divided into two equal groups. The control group received physical therapy program and study group received KT in addition to the same physical therapy program for 12 weeks. KT was applied with repetition for consecutively three days and then removed leaving the skin free for 24 hours during the period of treatment. For metric instrumentation system was used to evaluate posture parameters: trunk imbalance, pelvic tilt, pelvic torsion, surface rotation, and lateral deviation, in addition to Growth motor functional measure-88 (GMFM-88) to assess the sitting (B) and standing (D) control. Balance was evaluated using pediatric Berg balance scale (PBBS).

Results: The comparisons of the measurements of the two groups before and after the treatment showed that postural parameters, sitting control, standing control and balance were statistically significantly improved in both groups. Comparing the post treatment results, study group was more statistically significantly improved than the control group, in the previous parameters, except in pelvic torsion and surface rotation, there were no significant differences.

Conclusion: It is suggested to apply KT on trunk muscles along with the physical therapy program to improve trunk posture and control in cerebral palsy children of spastic diplegic type which is more effective than physical therapy alone.

Keywords: Cerebral palsy, spastic diplegia, Kinesiotape, Posture, Trunk control.

I-Introduction

CP is a permanent neurodevelopmental disorder of the immature brain due to lesion in a single or multiple locations causing problems of posture and movement control^[1]. This lesion produces motor and sensory deficits leading to impaired ability to maintain normal posture because of the lack of muscle co-activation

and the development of abnormal movement compensation^[2]. CP is the most common cause of neuromuscular spinal deformities in children^[3].

One of the most common clinical types of cerebral palsy is spastic diplegia in which there is sensory motor impairment in the lower extremities more than in the upper ones as well as significant weakness in their trunk musculature^[4]

Postural control is the ability to control the body position in space to achieve orientation and stability^[5]. In children with CP, the major postural dysfunction is the inability to coordinate the activation of postural muscles in the right sequence, especially during the performance of functional activities^[6]. This impairment leads to important functional constraints. Spastic diplegic children have been recognized clinically with their poor trunk posture and control that noticeably interfere with activities of daily life^[7]. These children could display rounded lower back in sitting and flexed trunk with kyphotic curvature of the spine with trunk asymmetry^[8]. Their mobility or gait are also impaired, and they may develop contractures and deformity in their spine and extremities^[9].

The goals of treatment in spastic diplegia focus on the prevention of disability and to promote functional independence by minimizing the effects of impairments, maximizing the gross motor function, decreasing the deformities and enhancement of optimal posture and movement^[10].

KT method which was first described by Dr. Kenzo Kasein 1996^[11] as it can be used to increase sensory stimulation, strengthen the weak muscles, inhibit spastic muscles, increase joint stability, increase functional motor skills, help with postural control and improve functional independence in pediatric rehabilitation clinics in addition to the physiotherapy programs^[12].

KT, according to its inventor^[11], is said to inhibit muscle tone if it is applied distally to proximally, whereas application in the opposite direction is used to facilitate a weak muscle.

Results of different research works concluded that improvement in motor control can be achieved through enhancement of postural alignment, facilitation of sensor motor system and modulation of muscle tone. The goal of this study is to determine if KT could improve trunk posture and control in CP children with spastic diplegia.

II- Materials and Methods

1- Subjects:

Thirty diplegic CP children who were referred to the Out-Patient Clinic of the Faculty of Physical Therapy, Cairo University, were included in this study. Children from both sexes were selected according to the following criteria: their ages ranged from 7 to 10 years (8.4 ± 1.85 years), they were free from any associated disorders, the degree of spasticity ranged from 1 to 1+ according to the Modified Ashworth scale^[13], they were able to follow instructions given to them in both testing and training sessions. All children were able to sit and stand independently even with abnormal posture. They were free from any structural deformities; however, children demonstrated variable degrees of tightness. Children were excluded for any of the following conditions: if they were medically unstable as determined by history, or medical records, if they had epilepsy, visual or auditory problems, if they had structural scoliosis, if they had participated in any previous application for therapeutic taping to the trunk muscles, and if they demonstrated allergic reactions to the adhesive KT.

Once the children met the previous inclusion criteria, all parents signed an informed consent to include their children in the study which had been approved by the Ethics Committee of Faculty of Physical Therapy, Cairo University, Egypt and in accordance with the code of ethics of the world medical association (Declaration of Helsinki) for experiments involving humans. Then, the children were engaged in a three-day skin check to rule out rare toxic responses to adhesive KT before full inclusion in this study. All children were assigned randomly (coin toss) to one of two equal groups:

- (1) **Control group** who received the physical therapy program only; or
- (2) **Study group** who received KT in addition to the same physical therapy program

2- Instrumentation

A- For evaluation: all children participated in this study were evaluated before and after 3 months of treatment by the following tools:

1. **Formetric instrumentation system (Aesculapmeditec GMBH, Holland):** It issued to assess the geometry of the vertebral column in humans. It is based on non-contact 3-D scan and spatial reconstruction of the vertebral column derived by a specific mathematical model^[14].
2. **GMFM-88:** It is a functional scale used to standardize the self-initiated movements and to measure the changes in gross motor function over time in CP children. This particular scale is widely accepted and easy to administer in outpatient clinics^[15]. The scale consists of 88 items for gross development measurement represented in five main domains (A) for lying and rolling, (B) for sitting, (C) for crawling and kneeling, (D) for standing, and (E) for walking, running and jumping.
3. **Pediatric Berg balance scale (PBBS):** This 14 items scale was developed similar to the Berg Balance Scale but organized and designed to assess a child's developing balance skills. It is a valid instrument and it is used for evaluating effectiveness of interventions and quantitative descriptions of function in clinical practice and research^[16]. Equipment and materials needed for this scale were: ruler, two standard chairs (one with arm rests and one without) and of appropriate height to maintain hips and knees in 90° flexion, footstool, stopwatch, and 15 feet walkway.

B- For Treatment:

Kinesio tape: The 5cm tape (KinesioTex, Gold; Kinesio UK, Newcastle upon Tyne, UK) was used.

III- Methods

A- For evaluation:

1. **For metric instrumentation system:** The procedures were explained to each child before assessment. Each Child was positioned two meters distant from the measurement system and in front of the black background screen with a completely bared back and buttocks and fully extended arms. Finally, the image was captured and the data was analyzed and printed out for each one. The results were plotted as a graphic protocol. Each graphic protocol contains some anatomical parameters which were calculated from certain anatomical landmarks. The anatomical landmarks were: vertebra prominence, sacrum point, left dimple, right dimple, and midpoint between both dimples. Five main values were produced (1) trunk imbalance, (2) pelvic tilt, (3) pelvic torsion, (4) surface rotation and (5) lateral deviation^[13].
2. **GMFM-88:** Here, in this study, domains (B) and (D) for sitting and standing control respectively, were evaluated. Testing was done without shoes and children wore shorts and T-shirts. The children were scored as 0 = unable to initiate task, 1 = initiates the task, 2 = partially completes the task, 3 = completes the task.

3. **PBBS:** This test was used to measure balance before and after treatment for both groups. The child was instructed to maintain his/her balance while attempting the following tasks: sitting to standing, standing to sitting, transfer, standing unsupported, transfer, sitting unsupported, standing with eye closed, standing with feet together, standing with one foot in front, standing on one foot, turning 360 degrees, turning to look behind, retrieving object from floor, placing alternate foot on stool, reaching forward with outstretched arm. The scale scoring ranged from 0-4 as "0" indicates the lowest level of function and "4" the highest level of function and the best of three trials was calculated.

B- For treatment: KT was applied on the erector spinae muscles from spinal level S1 to spinal level of C7 in the way Dr. Kase recommended (from insertion to origin) [11]. KT of 5 cm width was used in the form of "fan technique" bilaterally applied to provide a predominantly sensory inhibition on the erector spinae muscles. The bands were applied for three days and then removed leaving the skin free for 24 hours, then KT was applied again. The children who participated in the study received physiotherapy program for one hour, three days a week, for 12 weeks. The physiotherapy program included exercises to improve the sitting and standing position, exercises directed to increase sitting and standing balance and activities to improve the upper extremity function including reaching, grasping and release.

Statistical analysis:

The mean \pm standard deviation (mean \pm SD) were calculated for each variable (thoracic kyphosis angle, lumbar lordosis angle, and pelvic inclination angle, for both groups (A and B) before and after treatment. The pre and post treatment results within groups were compared using paired t-test. The differences between groups were carried out using independent t-test. The level of significance was set at $P < 0.05$.

IV- Results

I- Physical characteristics of the children:

Children of both groups were ranging in age from 7 to 10 years (8.4 ± 1.85 years), their heights ranged from 123 to 138 cm (132.2 ± 5.6 cm), and their weights ranged from 28 to 32 kg (29.657 ± 2.08). The preliminary data revealed no significant differences between the pretreatment values in both groups.

The collected data was statistically analyzed using paired t-test and independent t-test. As shown in table (1), the results revealed a significant improvement ($P < 0.05$) in all the measuring variables including trunk imbalance, pelvic tilt, pelvic torsion, surface rotation and lateral deviation, in addition to GMFM (B) and (D), and PBBS in both study and control groups, when comparing their pre and post treatment results (table 1).

Table (1) comparison between pre and post treatment mean values (mean \pm SD) for both study and control groups

Variable		Control group		Study group	
		Pre	Post	Pre	Post
Trunk imbalance (mm)	mean \pm SD	16.3 \pm 3.677	13.6 \pm 2.261	16.8 \pm 4.534	9.8 \pm 3.75
	p-value	0.02		0.0001	
Pelvic tilt (mm)	mean \pm SD	9.65 \pm 2.13	7.61 \pm 2.01	10.43 \pm 2.70	5.98 \pm 1.251
	p-value	0.01		0.0001	
Pelvic torsion (°)	mean \pm SD	11.353 \pm 3.11	8.98 \pm 2.91	12.122 \pm 3.64	8.918 \pm 2.32
	p-value	0.03		0.007	
Surface rotation (°)	mean \pm SD	6.7 \pm 2.397	4.83 \pm 2.554	6.5 \pm 2.391	3.75 \pm 2.320
	p-value	0.04		0.003	
Lateral deviation (mm)	mean \pm SD	10.53 \pm 4.316	7.75 \pm 2.58	9.93 \pm 4.508	4.63 \pm 2.302
	p-value	0.04		0.0004	
GMFM (B) (%)	mean \pm SD	34.84 \pm 8.40	42.48 \pm 9.21	35.85 \pm 7.25	49.9 \pm 2.11

	p-value	0.02		0.0001	
GMFM (D) (%)	mean ± SD	28.73± 5.76	33.23±4.83	27.11±1.45	37.85±2.82
	p-value	0.02		0.0001	
PBBS	mean ± SD	30 ±2.2	32±2.78	31±2.3	37±2.85
	p-value	0.03		0.0001	

SD: Standard deviation, P- value: Level of significance, GMFM (B): Growth motor function measure for sitting control, GMFM (D): Growth motor function measure for standing control, PBBS: pediatric Berg balance scale

When comparing the post treatment results of both groups (study and control), there was a more significant improvement ($P < 0.05$) in the study group than in the control group table (2) in all parameters, except in pelvic torsion and surface rotation, there was no significant difference between both groups.

Table (2) comparison between the post treatment mean values (mean± SD) for both study and control groups

Variable	Control group (mean± SD)	Study group (mean± SD)	P- value
Trunk imbalance (mm)	13.6±2.261	9.8±3.75	0.002
Pelvic tilt(mm)	7.61±2.01	5.98±1.251	0.01
Pelvic torsion (°)	8.98±2.91	8.918±2.32	0.9
Surface rotation (°)	4.83±2.554	3.75±2.320	0.2
Lateral deviation (mm)	7.75±2.58	4.63±2.302	0.001
GMFM (B) (%)	42.48± 9.21	49.9±2.11	0.005
GMFM (D) (%)	33.23±4.83	37.85±2.82	0.003
PBBS	32±2.78	37±2.85	0.0001

SD: Standard deviation, P- value: Level of significance, GMFM (B): Growth motor function measure for sitting control, GMFM (D): Growth motor function measure for standing control, PBBS: pediatric Berg balance scale

V- Discussion

In fact, to maintain a good and stable posture is a challenge, because stability requires complex interactions between nervous system, motor system, and the sensory system. In children with CP, these interactions are known to be affected, which may be a reason of postural control impairment and the inability to maintain stability^[5].

In children with spastic diplegia who develop postural disorder because of muscle imbalance and spinal deformities, providing a straight posture is important in terms of preventing spinal and lower extremity deformities, and developing hand function^[17,18].

As the application of KT becomes widely used, it is found that the number of research works investigating the effect of KT in the literature increases. There is no study in the literature investigating the use of KT application which is used in CP children with spastic diplegia. The current work is the first study conducted to investigate the effect of KT application on trunk posture and control in CP children with spastic diplegia.

The gained results of this study were positive with significant improvement in all the measuring parameters related to trunk imbalance, pelvic tilt, pelvic torsion, surface rotation and lateral deviation, with consequent improvement in sitting and standing abilities and balance in both study and control groups in favor of the study group, except in pelvic torsion and surface rotation parameters, there was no significant difference between both groups.

The positive results may be due to the effects of KT:(1) increasing proprioceptive and tactile facilitation; (2) controlling trunk movement in the frontal and sagittal planes; (3) restoring optimal muscle length to provide a foundation for normal firing and recruitment patterns; (4) orienting the muscle force along more normal vectors; (5) stabilizing hypermobile joints and reducing relative flexibility; (6) assisting with static and dynamic balance; and (7) optimizing gravitational forces about the column of segments by improving body alignment^[19].

Recently, through their electromyographic data, authors suggested that KT can decrease spasticity by means of enhancing sensory inputs which will stimulate the supraspinal centers and thus enhancing the kinesthetic and joint position sense which have the key role in the development of a proper motor schemas^[20].

KT was also investigated for its effects on gross and fine motor capacity, and functional independence in activities of daily living on a number of children with hemiplegic CP with significant improvements after 12 weeks of application^[21].

Some studies have revealed that KT is beneficial in improving trunk flexion in patients with acute spinal cord injuries and in treatment of pain due to osteoarthritis^[22,23].

In one study, it was found that KT applied in association with other treatment methods was effective in improving muscle function and proprioceptive awareness in hemiplegic patients, in decreasing pain, and in providing body straightness^[24]. Authors also concluded that KT application in addition to occupational therapy programs were beneficial to improve upper extremity control and function in acute pediatric rehabilitation clinics^[25].

In a study applied to children diagnosed as hypotonic CP, KT applied on the abdominal muscles was reported to increase transition from supine position to sitting position^[26].

It has been observed in this study that KT application in addition to physiotherapy aiming to improve trunk posture and control by modulating the muscle tone, increasing proprioceptive perception and to support weak muscles had a good effect on functional levels and sitting postures of children. Improvement of trunk posture and control in children with diplegic CP is an important factor providing independence in activities of daily living.

Conclusion

It can be concluded that KT application was clinically beneficial to improve sitting posture and poor sitting balance in children with a diagnosis of spastic diplegic CP. This study is thought to be important in terms of lighting the way for future studies about KT application.

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Declaration of interest:

The author reports no conflict of interest. The author alone is responsible for the content and writing of this paper.

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