The Effect of Kinesio Taping on Seated Postural Control in Spastic Diplegic Cerebral Palsy Children

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Abstract

Background: Children with spastic diplegic Cerebral Palsy (CP) often show the difficulty to achieve well-balanced sitting posture and display the poor sitting posture such as flexed trunk with kyphotic curvature of the spine and asymmetry of trunk.

Aim of the Study: The present study was designed to determine the effectiveness of kinesio taping over the paraspinal muscles in improving sitting balance in young children with Spastic Diplegic (CP) who displayed poor trunk control.

Material and Methods: Thirty children with Spastic Diplegic (CP) of both sexes with age ranged between 10-16 months were included in this study. Children were randomly assigned to two equal groups (Group I and Group II). The study group (Group I) was treated by kinesio taping which was applied over the paraspinal region for 12 successive weeks in addition to a designed physical therapy program. The control group (Group II) was treated by the designed physical therapy program only. The children were evaluated by sitting score of Gross Motor Function Measure (GMFM) and radiographic studies (Kyphotic and Cobb's angles) were carried out on the whole spine while the children were sitting before and after treatment.

Results: There was a statistically significant improvement in the measured parameters in both groups when comparing their pre and post treatment mean values. However, significant difference was recorded between the two groups after treatment in favor of the study group.

Conclusion: The obtained results suggest that the application of kinesio taping over the trunk become a beneficial therapeutic technique in improving the sitting posture and trunk control in children with Spastic Diplegic (CP) when adjunct to a physical therapy program.

Key Words: Cerebral palsy – Spastic diplegia – Trunk control – Kinesio taping – Dynamic splint.

Introduction

CEREBRAL Palsy (CP) describes a group of disorders of the development of movement and posture causing activity limitations that are attributed to non progressive disturbances that occurred in the developing fetus or infant brain [1]. Cerebral palsy is the major developmental disability affecting function in children. It is characterized by the inability to normally control motor functions and it has the potential to have an effect on the overall development of a child [2].

Most children with spastic diplegia have some motor impairment in their upper extremities milder than lower ones. The primary functional problems include difficulty with mobility and posture. Other problems include postural deviations, inability to sit without support, inability to stand and difficulty in movement transitions [3].

Sitting is an important step for child to achieve the upright posture against gravity and also an essential activity to provide the postural background tone required for the functional movement of upper extremity. However, the children with CP often show the difficulty to achieve well-balanced sitting posture and display the poor sitting posture such as flexed trunk with kyphotic curvature of the spine and asymmetry of trunk [4].

Therapeutic interventions for seated postural dyscontrol typically are directed at improving the quality of information feedback, as well as stabilizing the body for functional control. This can theoretically be achieved by improving postural alignment and gravitational forces concerning the body via which best possible muscle length and normalization of recruitment and timing patterns of muscles might be executed. These interventions might enable control to be gained over the entire vertically oriented column of segments [5].

The application of thermoplastic orthotic devices may allow the child to gain such control. The rigidity of this type of orthotic intervention
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Theoretically acts through biomechanical principles to reduce the degrees of freedom at which learning must simultaneously take place, to control postural alignment, to prevent deformity and to improve function [6]. While the thermoplastic orthotic intervention can be used for seated postural control, it is at the sacrifice of the child’s ability to move freely and limits the child’s sensorimotor experiences for motor learning. Dynamic bracing offers an alternative approach. Such braces are generally fabricated from lycra material and have been referred to as dynamic lycra pressure orthoses, lycra garment or lycra splints. The inbuilt flexibility of these orthoses allows movement freedom whilst ensuring close skin contact with dynamic corrective forces; therefore the child experiences more normal movement patterns, these preferred movements could be learned [7].

Results from previous intervention studies on children with CP suggest that improvements in sitting control can be achieved through the facilitation of sensorimotor systems, improvement of postural alignment and dynamic splinting usage [8]. Although dynamic splinting is certainly available as an intervention choice for poor postural control, the used brace can be: (1) Meet the an individual child needs, (2) Expensive, (3) Seemed to be unsuitable and not used friendly, (4) Hot, and (5) Not accommodative to the child growth [7].

As an alternative to lycra garments, therapeutic taping may afford similar advantages for controlling the seated posture in children with CP. It is anticipated that therapeutic taping would offer the establishment for improved functional sitting abilities by: (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) Assisting with static and dynamic balance and (6) Optimizing gravitational forces about the column of segments by improving body alignment [9].

A very useful physiotherapeutic modality if applied properly is the kinesio tape, which is a valuable adjunct to therapeutic rehabilitation. It is a specialized tape which is thin, elastic and can be stretched up to 120-140% of its original length making it quite elastic, compared with the conventional taping. It allows a partial to full range of motion for the applied muscles and joints with different pulling forces to the skin [9]. It is a technique that allows a therapist to work on more purposeful activities through improved proper alignment but with the tape acting as an extra hand [10].

Therefore, this study was designed to determine the effect of using kinesio taping over paraspinal musculature on functional sitting control in children with spastic CP.

Patients and Methods

Thirty CP children aged from 10-16 months were enrolled in this study as subjects. Children were selected from the outpatient clinic of the Faculty of Physical Therapy, Cairo University in the period from January 2015 to June 2015. Subjects were divided randomly into two equal groups. The first group (Group I) was treated by kinesio taping which was applied over the paraspinal region in addition to a designed physical therapy program. The second group (Group II) received the same designed physical therapy program only.

The patients were diagnosed as having CP with spastic diplegia based on careful clinical assessment by a neuropaediatrican and magnetic resonance imaging of the brain. The subjects' parents signed a written consent forms approved by the Ethics Committee of the Faculty of Physical Therapy, Cairo University.

Study design: This was a randomized controlled trail.

Inclusion criteria were children who have had CP since birth. Patients displayed abnormal neurologic signs such as hypertonia in both lower limbs, ankle clonus, hyperactive deep tendon reflexes and delayed motor development. The muscle tone of the lower limbs ranged from 1+ to 2 according to Modified Asworth Scale (MAS) for muscle tone grading [11]. Patients were unable to sit alone according to Gross motor function measure scale [12].

Exclusion criteria include patients who had fixed skeletal hip deformities, structural scoliosis, history of surgical interference, seizures or allergic reactions to the adhesive kinesio tape or any other materials used in this study.

Instrumentation:
- Modified Ashworth Scale for assessment of muscle tone.
- The sitting section of the Gross Motor Function Measure (GMFM-88) was used to evaluate the functional sitting abilities of the subjects. The GMFM-88 is an observational measurement tool.
that incorporates 88 items that address five gross motor function domains: (A) Lying and rolling, (B) Sitting, (C) Crawling and kneeling, (D) Standing, (E) Walking, running and jumping [12].

- Plain anterior-posterior and lateral radiographs of the whole spine. Radiographs were taken while the child was sitting on chair without arm rest with 90° of knee flexion and neutral ankle position. The upper extremities of the child were positioned at their sides.

In this study, the kyphotic angle might represent the magnitude of round back and the Cobb's angle might represent the magnitude of functional trunk asymmetry of the spine. The kyphotic angle was measured as usual method; first both ends of vertebrae of kyphotic curve were identified on the lateral whole spine film and then a line along the upper end plate of upper end vertebrae and the other line along the lower end plate of the lower vertebrae were drawn. At last the angle formed by these two lines was measured. The Cobb's angle was measured by finding the upper and lower limits of the primary curve by drawing tangents to the vertebral bodies then draw erect perpendiculars from the vertebrae which form the limits of the curve. The angle formed between the erect intersecting perpendicular lines and facing the parallel lines (tangents) is the Cobb's angle [13].

- Kinesio® Tex Classic tape.
- 2 inches width.
- Physical therapy tools of different shapes in the form of: Mats, wedge, rolls and medical balls.

A- Evaluation session:

Assessment of spinal curvatures (kyphotic and Cobb’s angles) using the Radiographs and were conducted at the Radiology Department, Faculty of Medicine, Cairo University. Also, assessment of the functional sitting abilities was done using the sitting section of the Gross Motor Function Measure (GMFM-88). These tests were done pre- and post treatment.

B- Training Session:

In the study group (GI) before using kinesio taping a skin sensitivity test was done by applying a square piece of kinesio tape (5 X 2.5cm) over the back and kept for 48 hours then removed and the skin was observed for a reaction to the tape. Since no reaction was detected, the tape was applied for 3 days as the elastic qualities of the kinesio tape are effective for 3-5 days before the elastic polymer diminishes. The kinesio taping was applied as the protocol followed by Footer [5]:

1- The subjects were positioned in a supported upright sitting position.

2- Prior to kinesio tape application, the therapist used medical cotton damped with alcohol to clean the skin over the paraspinous musculature from the first thoracic vertebra (T 1) to the level between the third and fourth lumbar vertebrae (L3-4) as well as over the lower trapezius muscle from the twelfth thoracic vertebra (T12) obliquely to the acromion process.

3- The kinesio tape was applied bilaterally in the following manner: Two strips were placed immediately lateral to the vertebral spinous processes in a caudal-cephalo direction from L3-4 to T1 Fig. (1A) and two other strips were placed along the course of the lower portion of the trapezius muscle in a lateral to medial direction from the acromion process obliquely to T12 Fig. (1B).

4- The tape was applied for 3 days then removed for 24 hours to allow skin perspiration and then a new one was reapplied again [5] and the procedure was repeated throughout the whole study (12 successive weeks).

All patients in both groups (GI and GII) received the designed physical therapy program for one and half hour, 3 times per week, day after day for 12 successive weeks. The program was based on Neurodevelopmental Technique (NDT) which directed towards inhibiting abnormal muscle tone and abnormal reflexes and facilitation of normal
movement patterns of postural control through reflex inhibiting positions using proximal and distal key points of control [14].

- Facilitation of rolling from lower limbs.
- Exercises to facilitate static sitting and dynamic sitting.
- Facilitation of different sitting positions (e.g. side sitting, ring sitting, half-ring sitting, crossed sitting).
- Positioning to improve sitting posture (e.g. sitting in adaptive seating chair, sitting in corner).
- Exercises to facilitate active trunk extension to improve trunk control and sitting balance (e.g. prone on wedge, sitting on edge of roll, performing stooping and recovery).
- Facilitation of righting and equilibrium reactions to improve postural mechanism via variety of exercises applied on ball from different positions in forward, backward and sideways.
- Approximation as a proprioceptive training applied in a slow and rhythmic manner for upper limbs, lower limbs and trunk to control spasticity and stimulate the joint mechanoreceptors from semi reclined and quadruped positions.
- Hand weight bearing exercises from different sitting positions and from quadruped position.
- Facilitation of hand functions from sitting positions (e.g. reaching, grasping, release, transferring objects) according to the child abilities.

Statistical analysis:

GraphPad Prism 5 (Graph Pad Software Inc., La Jolla, CA, USA) was used for data analysis. Data were presented as mean ± standard deviation of the mean (SD). In comparing the improvement after the intervention in each group, paired t-test was used and for the difference between the two groups; independent t-test was used. A (p) value of less than 0.05 was considered to represent a statistically significant difference.

Results

Demographic and clinical characteristics of the patients in both groups:

There was no statistically significant difference between both groups regarding mean age, kyphotic angle, Cobb's angle and GMFM-Sitting domain pre treatment (p>0.05) (Table 1). GI included 9 boys and 6 girls while GII included 10 boys and 5 girls.

I- Comparison of kyphotic angle, Cobb's angle and GMFM-Sitting scores within groups:

Group (I):

There was a statistically significant decrease in kyphotic angle and Cobb's angle values post treatment in GI (p<0.05). The mean value of kyphotic angle was 44.64° pre treatment and 18.09° post treatment. While the mean value of Cobb's angle was 14.33° pre treatment and 5° post treatment. Also, there was a statistically significant increase in GMFM-Sitting values post treatment in GI (p<0.05). The mean value of GMFM-Sitting score was 29.76% pre treatment and 69.87% post treatment [(Table 2), Figs. (2-4)].

Group (II):

There was a statistically significant decrease in kyphotic angle and Cobb's angle values post treatment in GII (p<0.05). The mean value of kyphotic angle was 44.38° pre treatment and 35.26° post treatment. While the mean value of Cobb's angle was 14.75° pre treatment and 9.28° post treatment. Also, there was a statistically significant increase in GMFM-Sitting values post treatment in GII (p<0.05). The mean value of GMFM-Sitting score was 29.85% pre treatment and 45.37% post treatment [(Table 2), Figs. (2-4)].

II- Comparison between both groups as regards kyphotic angle, Cobb's angle and GMFM-Sitting scores post treatment:

Data presented in (Table 3) showed that there were statistically significant difference between both groups in their post treatment mean values of kyphotic angle, Cobb's angle and GMFM-Sitting scores in favor of the study group (GI) (p<0.05).
Table (1): Demographic and clinical characteristics of the patients in both groups (GI & GII).

<table>
<thead>
<tr>
<th>Demographic and clinical characteristics</th>
<th>GI</th>
<th>GII</th>
<th>Comparison</th>
<th>S</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (months)</td>
<td>12.7</td>
<td>12.6</td>
<td>1.3</td>
<td>0.084</td>
</tr>
<tr>
<td>Kyphotic angle (°)</td>
<td>44.64</td>
<td>44.38</td>
<td>1.46</td>
<td>0.327</td>
</tr>
<tr>
<td>Cobb’s angle (°)</td>
<td>14.33</td>
<td>14.75</td>
<td>1.49</td>
<td>0.355</td>
</tr>
<tr>
<td>GMFM-sitting (%)</td>
<td>29.76</td>
<td>29.85</td>
<td>0.076</td>
<td>0.076</td>
</tr>
</tbody>
</table>


Table (2): Comparison between pre and post treatment mean values of kyphotic angle, Cobb's angle and GMFM-Sitting scores in both groups.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Pre-treatment Mean ± SD</th>
<th>Post-treatment Mean ± SD</th>
<th>Mean difference ± SD</th>
<th>t-value</th>
<th>p-value</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kyphotic angle (°):</td>
<td>GI 44.64±1.88</td>
<td>GII 44.38±1.24</td>
<td>18.09±0.87</td>
<td>26.55</td>
<td>33.47</td>
<td>&lt;0.05 S</td>
</tr>
<tr>
<td></td>
<td>GI 44.33±1.3</td>
<td>GII 45.26±1.98</td>
<td>9.12</td>
<td>11.76</td>
<td>11.49</td>
<td>&lt;0.05 S</td>
</tr>
<tr>
<td>Cobb’s angle (°):</td>
<td>GI 14.33±1.3</td>
<td>GII 14.75±1.7</td>
<td>5.00±0.66</td>
<td>9.33</td>
<td>11.76</td>
<td>&lt;0.05 S</td>
</tr>
<tr>
<td></td>
<td>GI 9.28±1.1</td>
<td>GII 9.28±0.98</td>
<td>5.47</td>
<td>6.89</td>
<td>6.89</td>
<td>&lt;0.05 S</td>
</tr>
<tr>
<td>GMFM-sitting (%):</td>
<td>GI 29.76±3.4</td>
<td>GII 29.85±3.5</td>
<td>69.87±4.1</td>
<td>40.11</td>
<td>50.57</td>
<td>&lt;0.05 S</td>
</tr>
<tr>
<td></td>
<td>GI 29.85±3.5</td>
<td>GII 45.37±3.2</td>
<td>15.52</td>
<td>19.56</td>
<td>19.56</td>
<td>&lt;0.05 S</td>
</tr>
</tbody>
</table>


Table (3): Comparison of the mean values of kyphotic angle, Cobb's angle and GMFM-Sitting scores between both groups post treatment.

<table>
<thead>
<tr>
<th>Independent t-test</th>
<th>Kyphotic angle (°)</th>
<th>Cobb’s angle (°)</th>
<th>GMFM-sitting (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>18.09</td>
<td>5.00</td>
<td>69.87</td>
</tr>
<tr>
<td>SD</td>
<td>0.87</td>
<td>0.66</td>
<td>4.1</td>
</tr>
<tr>
<td>Mean difference</td>
<td>17.17</td>
<td>4.28</td>
<td>24.5</td>
</tr>
<tr>
<td>t-value</td>
<td>21.64</td>
<td>5.39</td>
<td>30.89</td>
</tr>
<tr>
<td>p-value</td>
<td>&lt;0.05</td>
<td>&lt;0.05</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>Significance</td>
<td>S</td>
<td>S</td>
<td>S</td>
</tr>
</tbody>
</table>

Discussion

To verify the effect of kinesio taping on the trunk control, sitting posture and sitting balance were evaluated. Our concern was how to evaluate those quantitatively in very young children. The cerebral palsied children with poor trunk control show rounded back and trunk asymmetry while they are sitting. From the perspective of this point, we postulated that the kyphotic and Cobb’s angles in sitting posture be able to represent the functional kyphosis and trunk asymmetry respectively.

The present study included spastic diplegic type of CP, which constitutes a major classification among spastic types. This finding was reported by Damiano [15] who reported that spastic diplegic patients basically had better trunk control and more potential of functional reorganization than spastic quadriplegic patients. It was suggested that the children with spastic diplegic CP show better response to treatment than the children with spastic quadriplegic CP. The functional skill of sitting is required for many activities that children encounter in their daily lives. In typical development, the maturation of a child’s postural control system generally ensures task-specific stability and orientation to support the primary movements required for functional activities [16].

The pre treatment results of the two groups indicated that those children often show the difficulty to achieve well-balanced sitting posture and display poor trunk control. This agrees with Shumway-Cook and Woolacott [16] who revealed that children with CP often rely upon inappropriate control strategies and faulty feedback mechanisms when learning to maintain both static and dynamic sitting postures, which predictably leads to postural dyscontrol and functional dependency. In other words, the postural control system cannot effectively control the body’s position and motion in space because it lacks the ability to generate appropriate muscular force and to coordinate and integrate the sensory information received from various receptors throughout the body.

Statistical analysis of the post treatment results of the two groups revealed significant improvement in postural stability and functional ability which is represented by keeping the body segments properly aligned in upright sitting posture. Improvement fulfilled in the control group might be attributed to the effect of the therapeutic exercise program which emphasized on a group of exercises for facilitation of normal erect posture, this comes in agreement with Kern et al., [17] who established that methods of physical therapy treatment for children with CP focus on the attainment of sequential developmental milestones and facilitation of normal movement patterns.

The significant improvement in the post treatment results in the control group also comes in agreement with Sterba et al., [18] who recommended strengthening of the trunk and core muscles, promotion of postural and equilibrium reactions and focus on postural alignment in sitting, standing and walking considered as components of physical therapy treatment plans for pediatric therapists who rehabilitate children with neurological conditions.

In respect to the study group who received kinesio taping which applied over the paraspinal region in addition to the designed therapeutic exercise program, there was significant improvement in the sitting posture and trunk control in young children with spastic diplegic CP. This comes in consistent with Hsu et al., [19] who reported that kinesio tape as an adjunct to the therapeutic procedures can improve strength, functional activities, proprioception, control and positioning.

In addition this comes in agreement with Miller et al., [20] who conducted a study to examine the effect of kinesio taping on hypotonia. Four special needs children were selected to participate in the study. Kinesio taping was applied to the internal and external oblique muscles once a week for four consecutive weeks. They concluded that kinesio taping may be an effective tool for children with hypotonia to improve core stability, attention to task, sitting posture and fine motor skills.

Another study was performed by Yasukawa et al., [21] to investigate the effects of kinesio taping in an acute pediatric rehabilitation setting, they used the kinesio taping for the upper extremity in enhancing functional motor skills of children. They concluded that kinesio taping may be associated with improvement in upper extremity control and function in the acute pediatric rehabilitation setting.

In the current study, kinesio taping was applied on the paraspinal muscles from origin to insertion. In the context, Vithoulk et al., [22] stated that application of the tape from muscle origin to insertion is supportive, improves contraction and increases muscle strength. The wrinkles of the skin formed after the application of kinesio taping in combination with the direction of the tape pulls the insertion of the muscle towards the direction of the contraction and increases the muscle tone.
Kinesio tape improves proprioception by providing constant cutaneous afferent stimulation of the skin. This activity improves joint function, stimulates sensory mechanisms, decreases pain as a result of a reduction in neurological activation, enhances blood and lymph circulation to the local area by lifting fascia and soft tissue, realigns fascia tissue function through normalizing muscle tension, and improves muscle function. Conducted studies which examined the effects of kinesio taping on cutaneous mechanoreceptors have reported that, kinesio taping application on selected muscles and joints may improve muscle excitability [23-26]. On the other hand, Slupik et al., [27] proved that kinesio taping showed a significant increase in the bioelectrical activity of the vastus medialis muscle after 24 hours of kinesio taping application and that effect was maintained for another 48 hours after removal of the tape.

The improvement observed in the study group comes in agreement with Simsek et al., [28] and Kaya Kara et al., [29] who concluded that kinesio taping was valuable when adjunct to an exercise or manual therapy programs to achieve the required goals and maximize functional independence and there are no absolute contraindications to the use of kinesio taping as a part of comprehensive physiotherapeutic management.

**Conclusion:**

The children with spastic diplegic CP showed better response to given treatment. Therefore, kinesio taping applied over back muscles might be a useful therapeutic tool and can be added with the physical therapy as an additional modality to improve sitting control in diplegic children.

**References**


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