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Immediate and Short-Term Effects of Kinesio Taping on Trunk Control in Children with Spastic Cerebral Palsy: A Repeated Measures Design

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ABSTRACT

Aim: The study aims to investigate the immediate and short-term effects of Kinesio Taping (KT), for an improved sitting trunk control in children with spastic Cerebral Palsy (CP).
Methods: 36 children with spastic CP (age group: 8-15 years), undergoing regular conventional physical therapy program, were assigned to this study. Baseline trunk control was recorded using the Trunk Control Measurement Scale (TCMS). Further readings on TCMS were recorded immediately and shortly after 48 hours of application of Kinesio Tape bilaterally on the paraspinal area.
Results: One-way analyses of variance (ANOVA) test showed statistically significant difference in the trunk control immediately after KT, and after 48 hours of KT, $F(1.492,52.21) = 38.44$; $p<0.1$.
Conclusion/Significance: The findings in this study demonstrate that the application of KT provides significant functional outcomes in terms of immediate and short-term effects on sitting trunk control in children with spastic CP.

Keywords: Spastic CP, Trunk control, TCMS, Kinesio Taping, Physiotherapy.

INTRODUCTION

Performing everyday activities requires flexible control of posture, meaning that we continuingly have to control the position of either parts of our body or the whole of our body in an often-changing environment. Postural control involves controlling the body's position in space for dual purposes of stability and orientation, and is a basis for all components of movements. (Rosenbaum, 2006; Hadders-Algra, 1998; Brogren, 1996; Brogren, 2001). Trunk control is a prerequisite for adequate mobility and is critical to subsequent perceptual, cognitive and social development. (Stamer, 2015). The static and dynamic trunk control; along with selective movement control are the three aspects of trunk control, which are strongly associated with gross motor function and mobility, thereby allowing activities such as sitting in school for long hours, while eating, reaching out and grasping various objects of requirement, fine motor skills like writing and holding different sized equipment. Postural muscle recruitment is situation-specific and depends on the degree of instability in the changing environment. (Brogren & Bower, 2008) Maintenance of erect posture requires tonic recruitment of the erector spinae muscle, which shows 70% proportion of type 1 fibers in the thoracic region and 58-69% in lumbar region. (Sirca & Kostevc, 1985) During erect sitting in healthy individuals, the property of the muscle changes from tonic to phasic and vice-versa according to the changing requirements of the task as well as that of the environment. Erector spinae muscle, which is superficially located, extends and rotates the neck, extends the spine as well as performs lateral flexion of the spine improving efficiency of the muscular control which in turn helps in achieving the trunk stability while performing dynamic reaching as well as selective trunk control movements. (Stamer, 2015; Duarte & Freitas, 2010) Trunk control impairment is an important feature seen in children with spastic Cerebral Palsy (CP) with the major postural dysfunction being the inability to coordinate the activation of these postural muscles in the right sequence, especially during the performance of functional activities. (Hadders-Algra, 1998; Heyrman et al., 2013)

Rather than a bottom-up recruitment, studies examining sitting control during surface perturbations suggest that children with spastic CP have increased frequency of antagonist activation, increased number of muscles recruited, a tendency for cephalo-caudal muscle recruitment and difficulty modulating muscle activity in response to changing task and environment, all of it possibly being a strategy to ensure stabilization. (Brogren et al., 1996; Brogren et al., 2001) The physical therapy aims at normalizing the muscle tone, improve sensory and cognitive problems as well as improve muscle strength and range of motion in the treatment of children with spastic CP. (Labaf et al., 2015; Shams et al., 2009; Lee et al., 2015) This can be achieved by fostering children's independence level in activities of daily living by means of a number of dynamic approaches. Currently various therapeutic interventions are being used for improving trunk control in children with CP which require specialized equipment, manual guidance, professional experts and supervision throughout the treatment session in order to achieve facilitatory effect on the functional development of the child. Kinesio Taping (KT) seems to be used widely in clinical set ups but limited evidence exists studying its effectiveness in pediatric population. (Güchan & Mutlu, 2016) KT works by facilitation or inhibition of the muscle function, by improving the proprioceptive feedback and helps to achieve and maintain good body alignment by supporting the joint structure and weak muscles while creating a full range of motion. (Yasukawa et al., 2006; Kase, 2003; Kaltenborn, 2007b; Kaltenborn, 2007) KT is gaining popularity as an adjunct to conventional physical therapy techniques allowing the therapists to be freer to engage in other aspects of the session goals. Few studies in the past showed use of KT for facilitating abdominal and oblique muscles in pediatric population to see an effect on activities like supine to sit, gait and hand function. (Kuo & Huang, 2013; Banas & Gorgon, 2014) While we are unaware of any large, within-subject experimental studies examining the effects of KT, our study hypothesizes significant immediate and short-term effects of KT on trunk control in sitting position in children with spastic CP; positive results of which may help in accelerating the effects of conventional physical therapy.

Methods

This is an experimental study with within-subjects or repeated measures design, where all the children were assessed at three different interval of time using the same intervention of KT.

Participants

The study was conducted in accord with the declaration of Helsinki guidelines and had ethical approval from the Institution's Ethics Committee. Written consent was obtained from the parents and/or their legal guardians prior to beginning the study. 82 children with spastic CP (mean age: 11.5 years) were screened out of which 43 met the eligibility criteria. 7 children dropped out for various reasons, such as acute illness and allergy to Kinesiotape. Thus, data from a total of 36 children (23 boys and 13 girls) were used to investigate the effects of KT. Patient characteristics are summarized in **Table 1**. Eligibility criteria for children with CP included: a diagnosis of spastic CP, ability to sit independently on a bench, ability to follow simple directions and had been attending a 30-minute session of outpatient physical therapy thrice a week. Children who demonstrated allergy to Kinesio Tape, sensory deficits, cognitive impairments and other severe neurological or musculoskeletal impairments were excluded from the study.

Table 1: ***Demographic Data***

	No. of Participants
Total	36
Diplegia, n (%)	21 (58.3%)
Quadriplegia, n (%)	13 (36.1%)
Hemiplegia, n (%)	2 (5.55%)
Male sex, n (%)	23 (63.89%)
Female sex, n (%)	13 (36.11%)

Measures

Trunk Control Measurement Scale (TCMS) was used to assess the trunk control; with an inter-rater repeatability - ICC of 0.98 (excellent repeatability), test-retest repeatability - ICC of 0.97 (excellent repeatability) and construct validity of 0.88. (Heyrman et al., 2011). The TCMS is a 15-item assessment scale that examines sitting balance on a plinth and takes 20 to 30 min to perform. It consists of two main components: (a) the trunk being a stable base of support and (b) the trunk being an actively moving body segment. The first five items test Static Sitting Balance followed by ten items testing Dynamic Sitting Balance. Static sitting balance assesses 'static trunk control' during movements of the upper and lower limbs with maximum sub-score of 20. Dynamic sitting balance is further divided into two subscales, seven items testing 'Selective Movement Control' and three items testing 'Dynamic Reaching'. Within dynamic sitting balance, the subscale 'Selective Movement Control' measures selective trunk movements of flexion, extension, lateral flexion and rotation (maximum sub-score: 28). The subscale 'Dynamic Reaching' evaluates performance during reaching tasks outside the base of support (maximum sub-score: 10). All items are scored on a two, three, or four point ordinal scale; some items are scored bilaterally if of clinical importance. Each item is performed three times and the child's best performance is scored with a total score ranging from 0 to 58. Higher scores indicate better performance.

Procedure

The primary, trained physiotherapist performed allergy testing, by applying a small patch of Kinesiotape on the paraspinal region of the child **(Figure 1)**. The child was required to keep the patch for a minimum of 24 hours to test for any allergic reactions. If there was any irritation or itching,

the parents were asked to remove the patch immediately. For the rest of the children, the skin was kept exposed to air for the next 24 hours before the actual intervention. Each child was assessed on TCMS to obtain a baseline trunk control score and recorded as Baseline reading. Kinesio Tex Tape® was then applied over the paraspinal region bilaterally from the Posterior Superior Iliac Spine (PSIS) up to the seventh cervical vertebra (C7) using a facilitation technique from origin to insertion of the superficial erector spinae muscle, with a tension of 15-35%. **(Figure 2)** It was followed by assessment using TCMS and recorded as second reading to note immediate effects of KT on trunk control. The child was required to keep the Kinesio Tape on for 48 hours during daily activities. The child was assessed again after 48 hours on TCMS and this was recorded as third reading, to note the short-term effects on TCMS with the Kinesiotape kept on. Kinesiotape was then removed off completely after assessment and intervention was concluded.

Data Analysis

All three readings for each child were recorded and then analyzed with the Repeated Measures Analysis of Variance (ANOVA) test using the GraphPad Prism version 7.00. A *p*-value less than 0.1 were considered statistically significant.

RESULTS

Descriptive statistics for all 36 subjects based on the three TCMS readings presented in Table 2 indicated improvement in mean, median and the percentile scores. Mean values of TCMS at various points of intervention indicated improvement in scores. It was further noted that the effect on trunk control was highly significant (p=0.0001) immediately and even after 48 hours of the KT application as given in Table 3.

Table 2: ***Descriptive Statistics***

	Baseline (Reading 1)	**Immediate Effects (Reading 2)**	**Short-term Effects (Reading 3)**
Number of values	36	36	36
Minimum	14	20	20
25% Percentile	22.25	30	30.25
Median	29	35	37
75% Percentile	37.75	42	44.75
Maximum	48	51	50
Mean	29.89	35.67	37.44
Std. Deviation	9.118	8.387	7.897
Std. Error of Mean	1.52	1.398	1.316
Lower CI	26.8	32.83	34.77
Upper CI	32.97	38.5	40.12

Table 3: ***Effects Of Kinesio Taping On Trunk Control At Various Points Of Intervention Using Repeated Measures One-Way ANOVA Test***

ANOVA table	SS	DF	MS	F (DFn, DFd)	P value
Treatment (with baseline)	1124	2	561.8	F (1.492,52.21) = 38.44	P<0.0001
Individual (within subjects)	6531	35	186.6	F (35,70) = 12.77	P<0.0001
Residual (random)	1023	70	14.62		
Total	8678	107			

DISCUSSIONS

Pre-treatment scores on TCMS remained low for all subjects undergoing regular physical therapy, thereby, indicating the need for a supplementary intervention to improve recruitment of erector spinae muscle activity. The structure provided by the International Classification of Functioning, Disability and Health for Children and Youth (ICF-CY) has moved the focus of physiotherapists beyond interventions which are not only impairment-directed but also towards enabling the child to overcome activity and participation restrictions. From this perspective, KT in conjunction with other therapeutic interventions could promote integration of the rehabilitation process, increase independent daily activities and social participation or the quality of these activities, and improve gross and fine motor functioning. (Lee, 2010) Our study being a repeated measures study design, the ability to control potential influence of individual differences posed as an advantage, considering characteristic variations of children with spastic CP. The TCMS was able to detect significant changes in all the three dimensions of sitting trunk control immediately and after 48 hours post-taping. Previous studies explained the neurological basis of the facilitating effect of KT. KT lead to physiological changes in the cutaneous mechanoreceptors in the taped area and improved muscle excitability. The tactile stimulation seemed to interact with the kinetic control at the central nervous system level, reaching up to the hypothalamus. (Vithoulka et al., 2010) These tactile receptors get stimulated due to sustained pressure from the Kinesio tape, thus affecting the global muscle tonus, dynamics of fluids in the tissues of the muscles and fascia, and smooth-muscle cells in fascia. (Schleip, 2003a; Schleip, 2003) It was also noted to have led to an altered proprioceptive input to the central nervous system, which then resulted in a changed tonus regulation of motor units associated with this tissue. In addition, the wrinkles of the skin, formed after the application of Kinesio Tape, in combination with the direction of the tape (from origin to insertion) created a pull on the muscle facilitating the muscle tone. (Vithoulka et al., 2010) The effectiveness of KT comes in agreement with Yasuwaka et al., (2006) who performed a pre-post measure study in children with spastic hemiplegia and found a significant difference in upper limb fine-motor functions post-taping (immediately, and after 3 days of taping) on Melbourne Assessment. Another study which brought light on the effectiveness of KT by Santos et al. (2018) where the rectus femoris of children with unilateral CP was targeted during sit-to-stand activity. Muscle activity and kinematics of the lower limb showed significant difference immediately post-taping, thus implying the benefit of KT.Although the improvements, in our study, were seen as long as the tape was applied, further studies should examine the carryover effects of KT after its removal. We also believe studies which record change in bioelectrical muscle activity post-taping would bring more insight into the effectiveness of KT. We thereby hope for Kinesio Tape to provide a "helping hand" to the clinical physical therapists and thus help them engage in other aspects of the physical therapy session.

CONCLUSION

Application of Kinesiotape over the paraspinal region in order to facilitate erector spinae muscle has significant immediate as well as short-term effects on trunk control in sitting position in children with spastic CP of age group 8-15 years. This evidence-based practice of use of Kinesio Tape may improve the child's functional independence by not only allowing the child to perform better during therapy but also in different environments encountered daily.

Abbreviations

Cerebral Palsy: CP
TCMS: Trunk Control Measurement Scale
Kinesio Taping: KT

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