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Original Research Article

Effect of Neuromuscular Taping Along with Reactive Postural Adjustment and Anticipatory Postural Adjustment in Improving Sitting Balance in Children with Spastic Diplegic Cerebral Palsy

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ABSTRACT

Background: The purpose of this study was to examine the effect of neuromuscular taping over trunk muscles along with providing activities which gives internal and external perturbations on the static, dynamic trunk balancing abilities of children with cerebral palsy and generate some postural response in the trunk of these children with spastic diplegic cerebral palsy.
Objective: To find out the effect of neuromuscular taping along with activities providing Reactive Postural Adjustments & Anticipatory Postural Adjustments, in improving sitting balance, in children with spastic diplegic cerebral palsy.
Study Design: Pretest and Posttest experimental study design.
Method: Spastic diplegic cerebral palsy children who were fulfilling the inclusion criteria were selected by convenient sampling from Occupational Therapy unit of Sir Sunderlal Hospital, Banaras Hindu University, Varanasi, Uttar Pradesh, India with sample size of 60. A written informed consent was obtained from the guardians. Ethical permission was taken from the institute. Pediatric Balance Scale & Pediatric Reach Test was used as instruments for measuring improvement in sitting balance. A frame for reaching and a platform for external perturbation were designed for the study. Therapy for both groups was given for 1 hour per session. Children in experimental group were exposed to 30 minutes each of Reactive Postural Adjustment & Anticipatory Postural Adjustment along with application of neuromuscular taping over the muscle belly of erector spinae. While control group, was exposed to Reactive Postural Adjustment & Anticipatory Postural Adjustment without neuromuscular taping over the trunk muscles.
Results: Results of Wilcoxon signed rank test of Pediatric Reach Test were significant for experimental group and control group (P=0.004; 95% CI: 5.34 to 10.67 and P=0.014; 95% CI: 4.16 to 7.89 respectively). There was also significance of results of Wilcoxon signed rank test of Pediatric Balance Scale in experimental and control group (P=0.025; 95% CI: 8.98 to 11.12 for experimental group and P=0.005; 95% CI: 8.09 to 9.54 for control group) with the level of significance set at$P \leq 0.05$. This shows that results were significant for experimental group as well as control group. Also the results of Mann Whitney U test show that Z= -3.507 for Pediatric Balance Scale is more making it more sensitive to capture changes in balances in children than Pediatric Reach Test with Z= -3.905 with P=0.002; 95% CI: 4.14 to 9.00 and P=0.001; 95% CI: 7.56 to 9.70 with the level of significance set at$P \leq 0.05$.
Conclusion: It can be concluded that application of neuromuscular taping along with activities providing Reactive Postural Adjustment &Anticipatory Postural Adjustment can be used to enhance & improve sitting balance among children with spastic diplegic cerebral palsy; so that they can have the functional balance in sitting, to safely meet the demands of everyday life.

Key Words: Balance, Functional Activities, Perturbations, kinesiotape.

INTRODUCTION

Disabled children are of great concern to a family as well as to the society. When disability is discussed, particularly in children, about a quarter of chronic childhood problems are neurological in origin. Cerebral palsy (CP) is the leading cause of chronic disability in children (Shoals MG 2007) making them physically and mentally handicapped and socially aloof. The worldwide incidence of CP is approximately 2 to 2.5 cases per 1000 live births (Health Grades Inc; c2011).In India, it is estimated at around 3 cases per 1000 live births; however, being a developing country the actual figure may be much higher than probable figures. There are about 25 lakhs CP children in India as per the last statistical information (MedIndia Inc; c1997-2013). It is a symptom complex or syndrome condition rather than a single disease. It is an umbrella term encompassing a group of non-progressive, non-contagious condition that causes motor impairment syndrome characterized by abnormalities in movement, posture, and tone (cdc.gov 2012). In short, it is a group of symptoms occurring due to the involvement of musculature, sense organs (i.e. vision, hearing, speech, etc.), and the mind, including intelligence at variable extents. It can be caused by any of pre-natal, natal, and post-natal factors and the primary eventual pathology is any type of injury to the developing brain. Due to the non-progressive nature of the lesion, historically it is considered as static encephalopathy and excludes all the progressive neurological disorders (Parthasarathy A 2009).No effective treatment for the underlying brain damage has been formulated to date. All the sophisticated technologies and highly expensive and complicated therapies in the medical research field have failed to find a definite cure for this disease. As far as management or preventive aspect is concerned, no satisfactory criteria have been developed to date. Spastic quadriplegia constituted the predominant group (61 per cent), followed by spastic diplegia (22 per cent). Dyskinetic CP was present in 7.8 per cent of the cases. Acquired CP, particularly secondary to nervous system infections, constituted a significant proportion of cases. The clinical spectrum of CP is different in developing countries compared with developed countries. Associated problems were present in a majority (75 per cent) of cases, of which mental retardation was the commonest (72.5 per cent). Comprehensive assessment and early management of these problems are emphasized, which can minimize the extent of disabilities (Singhi PD et al 2002).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 (Tong-Wai R et al 2006). Most children with spastic diplegia have fine motor impairment in their upper extremities milder than lower ones. The primary functional problems include difficulty with reaching and grasping objects (Rosenbaum P 2008). 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 (Milner M 1992).

The control mechanism for reacting to unexpected external postural perturbation is called as Reactive Postural Adjustment (RPA) (Westcott Sarah L 2004) and that for anticipating internal postural perturbation related to production of voluntary movements in upper extremity is Anticipatory Postural adjustment (APA) (Westcott Sarah L 2004). The children with cerebral palsy failed to demonstrate, anticipatory activation of postural muscles as found not be activated first in these children when they reach in any directions, which shows that anticipatory postural adjustment in spastic diplegic cerebral palsy children is severely impaired (Gayle A et al 2006). Reactive Postural Adjustment is impaired among the children with spastic diplegic type of cerebral palsy (A Shumway

cook et al 2003). Results of sitting perturbation studies suggest that the children with cerebral palsy have disordered muscle activations during perturbations.

Kinesio Taping (KT) or neuromuscular taping method which was first described by Dr. Kenzo Kasein 1996 (Kase Ket 1996)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 other therapeutic techniques (Kase K, Martin P, Yasukawa A 2006).KT, according to its inventor (Kase Ket 1996), 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. One of the most important problems in cerebral palsied children is the disturbance of normal postural control mechanisms, which seriously affect both functional activities of upper extremity and activities of daily living of the children (Carlberg EB 2005). Children with CP often rely upon inappropriate control strategies and faulty feedback mechanisms when learning to perform upper extremity functions and fine motor functions, which inevitably leads to functional dependency .The fundamental thought behind the therapeutic approaches applied in CP relies on achieving normal postural control and regaining motor functions and maximum possible independency in the activities of daily living. Neuromuscular taping is also used in pediatric clinical settings commonly, though, without proper evidence of its effectiveness in pediatric applications. Thus, this study may be considered as one of the fundamental works investigating the effectiveness of neuromuscular taping on sitting postural control related to independency in activities of daily living in cerebral palsied children. Effect of neuromuscular taping over the trunk muscles have been studied & followed however; there is a paucity of studies showing its effect along with Reactive Postural Adjustment & Anticipatory Postural Adjustment on improving sitting balance in children with spastic diplegic cerebral palsy.

METHOD

The study was conducted between November 2014 and July 2015 at Occupational Therapy unit of Sir Sunderlal Hospital, Banaras Hindu University, Varanasi, Uttar Pradesh, India. 60 children who were diagnosed as spastic diplegic cerebral palsy and referred to Occupational therapy unit by Department of pediatrics were included for the study. All cases were selected by convenient sampling. This study was a pretest& posttest experimental study.

Inclusion Criteria

1. Children with Spastic diplegic cerebral palsy were included.
2. Both male & female children were included in the study.
3. Children between age group of 3 to 8 years were included.
4. Children in level 3 & 4 of Chailey floor sitting assessment were recruited.
5. Children having grade 1 criteria of Modified Ashworth scale were included.

Exclusion Criteria

1. Children having other types of cerebral palsy were excluded.
2. Those children who were having cognitive problems making it difficult to follow the instructions were discarded from the study.
3. Children having associated neurological problems were excluded from the study.
4. Children having severe to moderate mental retardation were not taken for the study.
5. Children who were medically unstable as determined by history, or medical records, if

they had epilepsy, visual or auditory problems.

6. Children who had structural scoliosis.

7. Children who had participated in any previous application for therapeutic taping to the trunk muscles.

8. If children demonstrated allergic reactions to the adhesive neuromuscular taping.

9. All the children were free from any structural deformities; however, children demonstrated variable degrees of tightness

Variables of Study

Application of neuromuscular taping and Activities providing Reactive Postural Adjustments & Anticipatory Postural Adjustments were provided to the children as independent variables & sitting balance was considered as dependent variable.

Instruments Used

1) Pediatric Balance Scale (PBS) (MR Franjoine et al 2003) & Pediatric Reach Test (PRT) (Bartlett D 2003) were used as instruments, to measure the changes in sitting balance in these children.
2) A frame was made with plastic to encourage horizontal & cross midline functional reach. This frame has 2 vertical plastic tubes placed over the wooden base & small platform made of ether flex secured in three positions. The width of wooden base was 45cm and height of two vertical plastic pipes was 46 cm. Three platforms were position on the frame each consecutive platform was 10cm above previous platform located on the far right & the far left of the frame. Two vertical plastic pipe along with small platforms were connected to the wooden base, which allowed the frame to slide forward & away from the child to accommodate each child's arm length .Reach was consider successful when child touched the sticker which were placed over the platforms in the frame. Children were verbally encouraged to touch the sticker with one hand & then the other. We consider reach to be successful when the child touched (i.e. not grasped) the sticker. To assure consistency the motivators chosen were according to child's preferences.(Gayle A 2006)
3) A platform for providing external perturbation was made with wood of 48x37 cm with 10cm height from the floor. It had four small wheels in the inferior surface, which made it move in forward & backward directions. Speed of movement was 60 mm at 100-350 mm/s. (A Shumway cook 2003)
4) Kinesio tape is thin, cotton, porous fabric with acrylic adhesive that is non mediated and latexfree (Kinesio Tex 2005). Kinesio tape can be comfortably worn for 3–4 consecutive days, (including in the shower), without compromising the adhesive quality (Kase et al. 2003; Kinesio Tex 2005). Furthermore, due to the latex-free quality of Kinesio tape, moisture and air can flow through this porous fabric, limiting skin irritation (Kase et al. 2003; Kinesio Tex 2005). Kinesio tape can be stretched up to 130%–140% of its original length and can contract back to the normal resting position (Kase et al.2003; Kinesio Tex 2005). The elastic properties of Kinesio tape makes it unique, however, the efficacy of kinesio tape compared with other types of elastic tapes has yet to be investigated, and, therefore, substitution at this juncture cannot be recommended.

Procedures

The parents of the selected children were explained about the application of neuromuscular taping and activities providing Reactive Postural Adjustments & Anticipatory Postural Adjustments to their children and were told about the outcome of study. Written ethical consent was taken from the guardians of children with cerebral palsy who were taking part in the study. Ethical permission was also obtained from the institute for conducting the study. This study adhered to the tenets of Declaration of Helsinki. The children who were fulfilling the inclusion criteria were randomly distributed into two equal groups,

experimental group & control group. Then, the children were engaged in a three-day skin check to rule out rare toxic responses to adhesive neuromuscular taping before full inclusion in this study. A baseline assessment score of PBS and PRT was collected for children present in both the groups. Therapy for both the groups consisted of 1 hour of session

(1) Control group who received activities providing RPA and APA.

(2) Study group who received neuromuscular taping in addition to the same activities providing RPA and APA. Post test scores of Pediatric Balance Scale& Pediatric Reach Test were recorded after 9 months of study.

Protocol

Neuromuscular tape 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) (Kase K 1966). 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, and then neuromuscular taping was applied again. In experimental group, Anticipatory Postural Adjustment activity was provided to the children by placing them in a comfortable & secured sitting over the mat. They were encouraged to touch cartoon stickers over the platform in the frame placed in front of them. For providing activity of Reactive Postural Adjustment children were placed comfortably & securely over the movable platform & were given forward / backward perturbations, which caused body to sway, forward &backward. Two mats were placed on either sides of platform to avoid injury to the children. All the activities given were demonstrated initially.

RESULTS

Data analysis: The test parameters were compared before & after therapy. Statistical calculations were performed with SPSS version 16.0 package. Statistical test were carried with the level of significance set at$P \leq 0.05$.The raw score of Pediatric Balance Scale & Pediatric Reach Test pre intervention &post intervention were added & summed up into final scores. It was 2-tailed non parametric study because of ordinal data and small sample size. The changes in the Pediatric Balance Scale and Pediatric Reach Test within experimental and control groups were analyzed using Wilcoxon signed rank test. Mann Whitney U test was performed for knowing the significance outside the group.

Descriptive characteristics: Number of subjects in experimental & control group were 30 in each within the age range of 3 to 7years in experimental group & 3 to 8 in control group. Mean age was 5.20±1.31 in experimental group and 6.00 ±1.63 in control group. There were 15 male and 15 female in experimental group were as there were 13 male and 17 female in control group. Wilcoxon signed rank test for Pediatric Reach Test: Significant results of experimental group and control group were obtained with (P=0.004; 95% CI: 5.34 to 10.67 and P=0.014; 95% CI: 4.16 to 7.89 respectively) and Z=-2.877 &Z=2.449 respectively with the level of significance set at $P \leq 0.05$.

Wilcoxon signed rank test for Pediatric Balance Scale: The results (P=0.025; 95% CI: 8.98 to 11.12 for experimental group and P=0.005; 95% CI: 8.09 to 9.54 for control group) shows that findings were more significant for experimental group as compared to control group with Z= -2.236 & Z= -2.810 respectively with level of significance set at $P \leq 0.05$.

Results of Mann Whitney U test: Z= -3.507 for Pediatric Balance Scale making it more sensitive to capture changes in balances in children as compared to Pediatric Reach Test with Z =-3.905 and P=0.002; 95% CI:4.14 to 9.00 and P=0.001; 95% CI: 7.56 to 9.70 respectively with level of significance set at $P \leq 0.05$.

Figure 1: Showing a Child, Performing an Activity Providing Anticipatory Postural Adjustment on frame

Figure 2: Showing a Child, Performing an Activity Providing Reactive Postural Adjustment over the platform

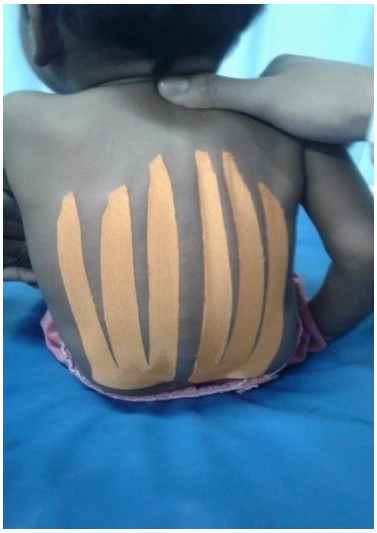

Figure 3: Showing the fanning technique of kinesiotaping over the trunk of a child

Table 1: Descriptive Characteristics		
Characteristics	Control	Experimental
Number of Subjects	30	30
Age Range (Years)	3-8	3-7
Mean Age(± Standard Deviation)	6.00±1.63	5.20±1.31
Gender (Male/Female)	13/17	15/15

Table 2:Results of Wilcoxon Signed Rank Test (Pediatric Reach Test)				
Groups	*Z*(2 tailed)	*P* (2 tailed)	95% Confidence Interval Value	
			Lower Limit	Upper Limit
Experimental	-2.877	0.004	5.34	10.67
Control	-2.449	0.014	4.16	7.89

*For both the groups *P* value is significant

Table 3:Results of Wilcoxon Signed Rank Test (Pediatric Balance Scale)				
Groups	*Z* (2 tailed)	*P* (2 tailed)	95% Confidence Interval Value	
			Lower Limit	*Upper Limit*
Experimental	-2.236	0.025	8.98	11.12
Control	-2.810	0.005	8.09	9.54

*For both the groups *P* value is significant

Table 4: Results of Mann Whitney U tests (Pediatric Balance Scale & Pediatric Reach Test)				
Outcome Measures	*Z*	*P*	95% Confidence Interval Value	
			Lower Limit	Upper Limit
PRT	-3.507	0.002	4.14	9.00
PBS	-3.905	0.001	7.56	9.70

*For both the groups *P* value is significant *PRT: Pediatric Reach Test; PBS: Pediatric Balance Scale

DISCUSSION

Sitting balance is commonly affected in children with cerebral palsy leading to difficulty in functional performance of upper extremity, as these children frequently use upper extremity for maintaining balance in sitting. Hence sitting is an important area for intervention to be considered while treating children with spastic diplegia cerebral palsy. The pre treatment results of the two groups indicated that children with spastic diplegic cerebral palsy often shows the difficulty to achieve well-balanced sitting posture and display poor trunk control. This agrees with Shumway-Cook A et al 2000 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.

The purpose of this study was to determine that, if children with spastic diplegic cerebral palsy, who were given kinesiotape over the trunk muscles along with activities providing Reactive Postural Adjustment & Anticipatory Postural Adjustment, would exhibit greater improvement in sitting balance, than those who merely received the RPA and APA.

Improvement in experimental group

In respect to the study group who received kinesio taping which applied over the paraspinal region in addition to the designed RPA and APA therapeutic activity 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., who reported that neuromuscular taping as an adjunct to the therapeutic procedures can improve strength, functional activities, proprioception, control and positioning. The postural control system in children with cerebral palsy 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 (Hsu Y.H et al 2009). KT increases blood circulation in the taped area (Ogura1998; Oliveria 1999; Vorhies 1999; Wallis 1999; Kase 1994; Kase and Hashimoto 2005; Murray 2005), and this physiological change may affect the muscle and myofascia functions after the application of neuromuscular taping helping the children to generated the necessary force required for the function. An additional theory is that neuromuscular taping stimulates sensory receptors and cutaneous mechanoreceptors at the taped area. Cutaneous mechanoreceptors activate nerve impulses when mechanical loads create deformation. The activation of cutaneous mechanoreceptors by an adequate stimulus causes local depolarizations that trigger nerve impulses along the afferent fiber traveling toward the central nervous system (Garcia 2001; Goo 2001; Halseth et al. 2004; Maruko 1999; Mori 2001; Murray and Husk 2001; Ogura1998; Vorhies 1999; Wallis 1999; Kase et al. 2003). The application of KT may apply pressure to the skin or stretch the skin, and this external load may stimulate cutaneous mechanoreceptors causing physiological changes in the taped area. Studies previously conducted to determine the effects of neuromuscular taping on cutaneous mechanoreceptors (Garcia 2001; Goo 2001; Halseth et al. 2004; Maruko 1999; Mori 2001; Murray and Husk 2001;Ogura 1998; Vorhies 1999; Wallis 1999) have reported that neuromuscular taping on select muscles and joints may improved muscle excitability. There is no study in the literature investigating the use of neuromuscular taping application with RPA and APA which is used in CP children with spastic diplegia. The current work is the first study conducted to investigate the effect of neuromuscular taping application on trunk posture along with RPA and APA in CP children with spastic diplegia.

Improvement in control group

The results of this study indicate that, there was improvement in control group. Perturbations were given to children with spastic diplegic cerebral palsy, by providing activities which challenge their Reactive Postural Adjustment & Anticipatory Postural Adjustment in neck, trunk & lower extremity, which helped them to improve sitting balance. These results can be supported by the results of A Shumway cook 2003 he found that typically developing children showed improvement in sitting balance in response to the massed practice on a moveable platform providing external perturbations. Also the results can be supported by the results of TR Kaminski 2001 which suggest that, during the performance of a functional task, dynamic changes that occur in the trunk and lower extremities prior to initiation of arm movement serve to stabilize the body and are used to initiate and assist whole body reaching .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. The sensory system cues the individual that there has been a perturbation which is provided by tactile, verbal and visual system Motor system organizes& cues appropriate activation of the muscle. While musculoskeletal system provides frame work on which we move and create the force to produce the postural activity (Westcott Sarah L 2004). The state of any of these system affects the overall postural activity in the individual .Other system can also have an effect on the postural activity, like the directions given to the individuals, or the behavioral state and alertness of the individual (Nashner LM 1982) .These components of balance were also taken care of while providing the activities. The improvement in balance as measured by Pediatric Balance Scale and Pediatric Reach Test can be attributed to an improvement in the coordination and recruitment of trunk and limb musculature that occurs as a result of practicing Anticipatory Postural Adjustment & Reactive Postural Adjustment through different type of activities .Repetition of task is a prerequisite to skill acquisition, including balance in sitting, repetition in this study is provided by giving same activities throughout the study duration in each session (Dean CM 1997). Activities providing Anticipatory Postural Adjustment and Reactive Postural Adjustment which are used in his study need both cognition and motor process for performance.

Limitations

1. Duration of study was small
2. Small sample size
3. Overhead reaching activities were not taken for activities providing Anticipatory postural Adjustment
4. No follow up study done.

Recommendations

1. Study could be made by providing functional activities which provide balance perturbations along with kinesiotaping over the trunk musculatures for improving sitting balance in children with cerebral palsy.
2. Additional study can be conducted of long term benefits on children with cerebral palsy and other functional disabilities.
3. Future efforts also need to examine the effectiveness of balance perturbations along with kinesiotaping over the trunk musculature with a large sample.
4. Future studied in which improvement in sitting balance after application of kinesiotaping is captured by different measure which should include some functional measures.

CONCLUSION

It can be concluded that application of neuromuscular taping along with activities providing Reactive Postural Adjustment & Anticipatory Postural Adjustment can enhance & improve sitting balance among children with spastic diplegic cerebral palsy, so that they can have the functional balance in sitting, to safely meet demands of everyday life.

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