

Original Article

Effects of Neuromuscular Electrical Stimulation with and without Kinesio Taping Application on Sitting Balance Among Children with Cerebral Palsy

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Abstract

Background: Children with spastic cerebral palsy often show difficulty to maintain posture and function, therefore displaying the weak sitting postural balance such as the flexed trunk. **Objective:** The study was designed to determine the effectiveness in terms of alignment and function with neuromuscular electric stimulation, Kinesio tape above the trunk muscles in combination with conventional physiotherapy for improving sitting balance in young children with spastic diplegic cerebral palsy that has presented with weak trunk control. **Methods:** In this randomized trial children aged between 5 to 12 years were involved in this study. Group A received electric stimulation and conventional physical therapy while group B received Kinesio tape, electric stimulation and conventional physiotherapy for 12 weeks, 3 alternate days per week. Data were collected at baseline, 5th and 10th week after the last session of the week. Sitting balance is evaluated by the seated postural control measurement score. **Results:** Significant differences were observed in both groups in the total score of seated postural control measurement alignment section ($p < 0.015$) and functional section ($p < 0.01$) after the 10th week; the change in group B was higher as compared to other group. There is no significant difference were seen in pre-treatment and after the 5th week in alignment and functional section in comparison of technique. **Conclusion:** With the help of neuromuscular electric stimulation, and Kinesio tape in combination with conventional physiotherapy enhance the sitting balance, in terms of alignment and function in children with spastic cerebral palsy.

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Keywords: balance; cerebral palsy; Kinesio tape; neuromuscular electrical stimulation

Introduction

Cerebral Palsy (CP) is a movement disorder that occurs due to injury of the brain in the

antenatal, perinatal and postnatal period.^{1,2} Trauma is the most prominent reason for persisting motor function impairments occurring in the cerebral cortical or sub-cortical region.³ About 2.5% per thousand live births are reported as a prevalence of CP worldwide and this condition varies with its associated areas.⁴ There were three to four children of cerebral palsy per thousand births of normal children in the prevalence studies records of the United States.⁵ The traditional classification of spastic CP includes classification according to segment and motor function. In segmental classification, it consists of hemiplegia, diplegia and quadriplegia while in motor functional classification it includes spastic and non-spastic types that are further classified into athetoid, ataxic and dystonic types.⁶

Decreased postural control is a significant difficulty faced by the CP child. Problems found in motor behavior cause difficulty in maintaining sitting balance and activities of the child in static and dynamic stabilization.⁷ The child can perform many functional movements in a sitting position and attain trunk balance by continuously using his upper limb.⁸ Conventional physical therapy (PT) focuses on functional movements and helps children engage in different activities and this is based on the communication, stimulation, and facilitation principles.⁹

In the case of attaining sitting balance, trunk control on individuals with CP, Kinesio taping (KT) and neuromuscular electric stimulation (NMES) application in addition to exercise regimes are done in clinical settings. It has been observed that sensory alertness increases in children by using NMES to the upper limb which has improved the effects on coordination, motor control and upper extremity function.¹⁰ KT is used to increase mobility, improve proprioception and muscular imbalance.¹¹ Though, the practice of KT on children has not been well conducted, investigations have shown that KT can be

effectively used in cerebral palsy children along with conventional PT treatment.¹²

Limited evidence was found on determining the effects of Kinesio taping and neuromuscular electric stimulation in combination with conventional physical therapy exercises to enhance sitting balance in CP children. Therefore, this study intended to evaluate the effects of electric stimulation with and without Kinesio taping application in children with CP.

Methods

In this single blinded randomized controlled trial, 24 patients (12 in each group) had participated in this study. Sample size was calculated using following formula at 80% power of study and 95% confidence level, where $n = 12$ for each group, $Z_{1-\alpha/2} =$ standardized level of significance = 95% = 1.96, $Z_{1-\beta} =$ power of test = 90% = 0.84, $\mu_1 =$ Mean of Seated posture control measure (SPCM) score in group Exercise + NMES = 8, $\mu_2 =$ Mean of SPCM score in control group Exercise + NMES + KT = 18.73, $\delta_1^2 =$ variance of SPCM score in group Exercise + NMES = 6.59, $\delta_2^2 =$ variance of SPCM score in control group Exercise + NMES + KT = 5.70.

$$n = \frac{(\sigma_1^2 + \sigma_2^2) \times (Z_{1-\alpha/2} + Z_{1-\beta})^2}{(\mu_2 - \mu_1)^2}$$

Data were obtained from the physical medicine and rehabilitation department of children's hospital Lahore from October 2020 to March 2021. Children with spastic diplegic cerebral palsy, 5 to 12 years of age, both gender and those who follow and admit verbalized commands having gross motor functional classification system (GMFCS) levels IV and V were included in the trial. Patients were excluded from the study if they have sensitive skin, history of any type of allergic reactions from taping, or undergo any surgery or had botulinum toxin in the past six

months, or had spasticity level 4 or 5 on Ashword Scale, or had any contracture and hip dislocation.

Almost 24 patients were divided in two groups by convenient sampling, the group A received conventional PT and neuromuscular electric stimulation (Comfystim) only. While the group B were given conventional physical therapy, neuromuscular electric stimulation and Kinesio taping as well. Initially before the start of the treatment, data were obtained at baseline, then at 5th and 10th week follow-ups by using SPCM questionnaire. Three sessions were given on alternate basis to patient each week. KT was applied on last session of each week and remove on next session before treatment.

Postural balance and functionality in sitting position were assessed by seated postural control measure. It includes two sections; alignment and functional components. Sitting posture were scored ranging from 1 to 4 assigned as normal, mild, moderate, severe and observed from all aspects.

Then manner of score was marked as 1 to 4 after assessing the patient's upper extremity function noted in the test. Lastly, SPCM total score was calculated. In this, 48 and 34 were maximum and minimum scores of alignment section and 48 and 12 were maximum and minimum scores for functional section.

Intervention

Conventional Physical Therapy

Exercises included sustained stretching, facilitation of the trunk extension, postural control, functional strengthening of abdominal and back muscles, positioning the child in the sitting position with feet on floor and facilitation of the upper extremities, balance training in sitting, reaching with arms and weight transfers in sitting position. The whole treatment was given for 30 minutes.

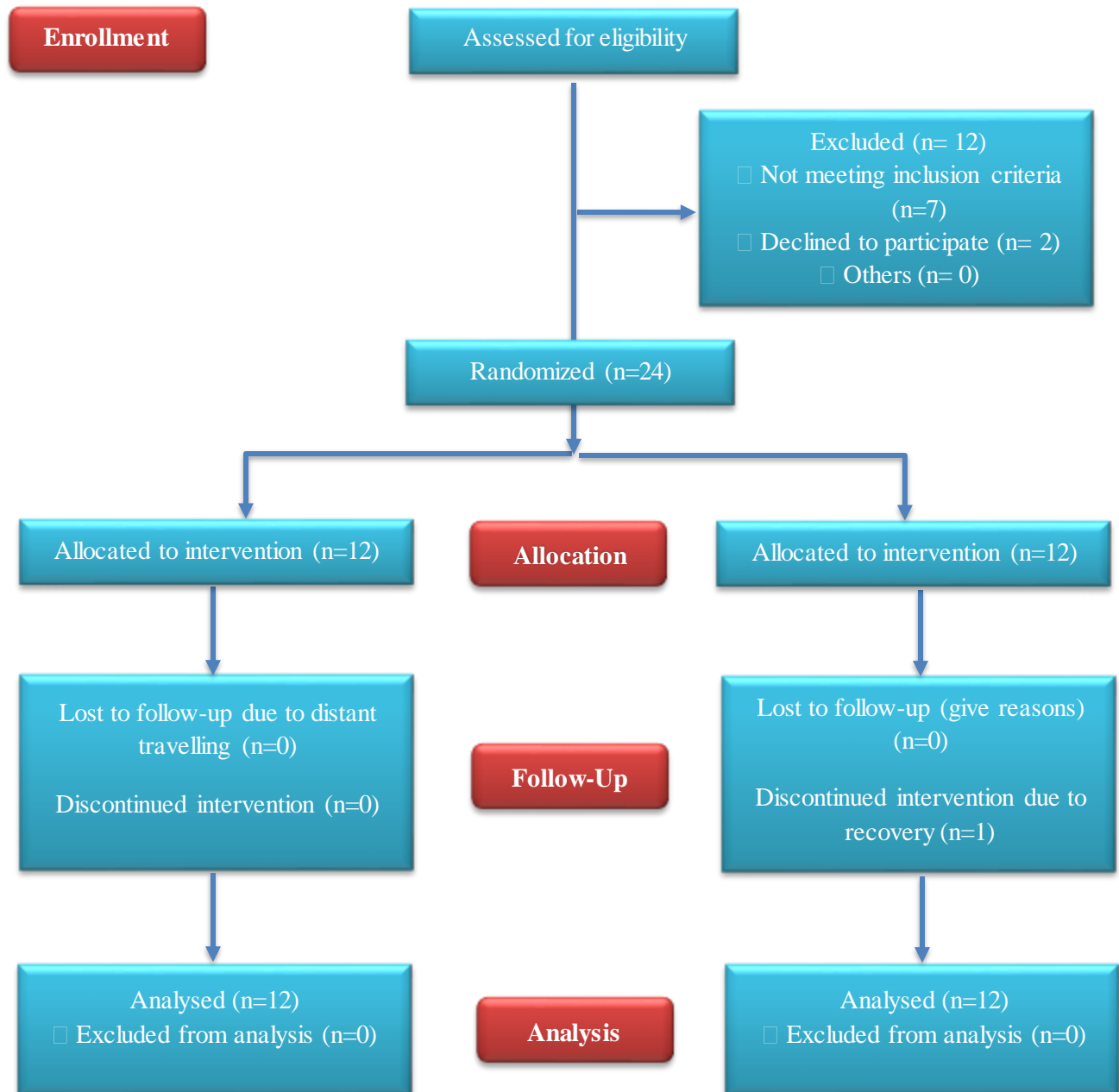
Neuromuscular Electrical Stimulation

Synced option of NMES of Comfystim® was applied to the paravertebral muscles when the patient was in sitting position.



Figure-I: Application of neuromuscular electrical stimulation in group A (left) and kinesio tape in group B (right)

Figure-II: CONSORT flow diagram



Children were asked to maintain the trunk extension during treatment. Application time was 15 minutes, frequency 20 Hz, pulse width 110ms, intensity as per tolerated. Treatment given for three days per week for 10 weeks (30 sessions), as shown in Figure-I.

Kinesio Tape

The first 'I' taping was applied for the facilitation of the paravertebral muscles and performed longitudinally on the muscles from sacrum to cervical region in sitting posture. Taping was applied with 50% stretch of its resting length. The second 'X' taping was applied in order to provide proprioceptive input and to correct the sitting position at the interscapular area with an "X" shape taping,

when the participant was in the upright posture and scapulae are retracted. (Figure-I) The numerical data like age, height, weight, BMI were shown in the form of mean and standard deviation. The data was analyzed using SPSS 25. After fulfilling the parametric assumptions, t-test was used to determine the mean difference between two groups. The p-value less than or equal to 0.05 were considered as significant.

Results

In this study, 24 patients had been recruited and randomly allocated in two groups (12 in each group). Demographic characteristics of cerebral palsy children were presented in Table-I).

Table-I: Demographics of both groups

Demographic data	Treatment groups	
	Group A NMES+conventional PT (Mean±SD)	Group B KT+NMES+conventional PT (Mean±SD)
Age (Years)	8.33±2.57	8.58±2.35
Height (cm)	1.23±0.11	1.24±0.12
Weight (kg)	21.75±5.02	21.08±6.25
BMI (kg/m ²)	14.02±1.03	13.33±1.68
GMFCS	8 4	7 5

Table-II: SPCM score (Alignment component)

Alignment	Technique		
	Group A NMES+conventional PT (Mean±SD)	Group B KT+NMES+conventional PT (Mean±SD)	p-value
Baseline	36.50±1.93	35.42±1.83	0.173
5 th week	37.42±2.23	38.00±1.91	0.499
10 th week	40.33±1.67	42.00±1.41	0.015*

Although there was no significant difference found between the groups in comparison of technique with the alignment section of SPCM during pre-treatment $p > 0.173$ and after 5th week $p > 0.499$, but after 10th week their difference was found significant $p > 0.015$. In the control group, the difference between pre-treatment and 5th week was not statistically significant ($p: 0.493$) but pre-treatment and 10th week alignment scores were statistically significant ($p < 0.001$). Similarly, the difference between the alignment score of 5th and 10th weeks was statistically significant (p -value: 0.003) as shown in table-II.

In the experiment group the difference between pre-treatment with 5th week and 10th week alignment score was statistically significant ($p < 0.003$). Similarly, the difference between the alignment score of 5th and 10th weeks was statistically significant ($p < 0.001$). Certainly, in the comparison of technique with the functional section of SPCM also showed no difference between two groups during pre-treatment $p > 0.55$ and after 5th week 0.251 while after 10th week difference was found significant $p > 0.015$ between the groups as shown in table-III.

In the control group, the difference between pre-treatment and 5th week was not

statistically significant (p -value 0.366) but pre-treatment and 10th week functional scores were statistically significant (p -value < 0.001). Similarly, the difference between the functional score of the 5th and 10th week was statistically significant (p -value 0.009).

In the experiment group the difference between pre-treatment and 5th week was statistically significant (p -value < 0.01) and also pre-treatment and 10th week functional scores were statistically significant (p -value < 0.001). Similarly, the difference between the functional score of 5th and 10th weeks was statistically significant ($p: 0.003$).

Discussion

The purpose of this study was to examine if NMES used in combination with KT is beneficial in improving postural balance and functional activities of diplegic and quadriplegic children of cerebral palsy. In a study conducted by Dewar *et al.*, shows that exercise centered treatment form the foundation of whole treatment to enhance postural balance in cerebral palsy children.¹³ Another study by Simon *et al.*, describes the effects of neuro-developmental therapy (NDT) technique has facilitate muscle activity of neck and improved head control which was seen by

Table-III: SPCM score (Functional component)

Technique			
Functional	Group A NMES+conventional PT (Mean±SD)	Group B KT+NMES+conventional PT (Mean±SD)	p-value
Baseline	23.58±8.65	21.58±7.75	0.557
5 th week	27.75±7.39	30.83±5.25	0.251
10 th week	37.33±6.02	42.17±2.04	0.015*

the EMG of the neck muscles.¹⁴ Knox and Evan concluded that gross motor functional measure scores were enhanced as a consequence of exercise therapy. There was 15 CP children taken on level V of gross motor functional classification system treating with NDT.¹⁵ These outcomes were correlated with the conclusion of our investigations as a result of conventional exercise that in cerebral palsy children significant difference was seen in SPCM alignment and functional scores. Another study by Perk *et al.*, describes that the Cobb's angle exhibited substantial changes in electrical stimulation group (ES) and it might have supposed as a result of decrease trunk asymmetry and improved trunk postural balance. As related to the control group, GMFM score were increases in group getting muscle electrical stimulation.¹⁶ In a study conducted by Sherief and Hamed identifies that the application of NMES helps in improving head control of spastic diplegic CP children. They also found that only exercised based program has no sufficient effect in increasing head control.¹⁷

In our study results of the NMES group (control group) score of SPCM showed improvement in alignment (posture control) component after 10th week and in functional control (motor control) after 5th week as compared to baseline. Kaya Kera have investigated the effectiveness of KT on body movements and action in one-sided spastic CP in a single-blinded randomized clinical trial. Thirty children were taking into KT group and control group, however KT group presented progress in bodily fitness, gross motor function, and actions of everyday living.¹⁸ Simsek *et al.*, took 31 patients randomly into study as KT along with physical therapy and in control group only physical therapy treatment.

Sessions were given for 12 weeks. They concluded that KT only showed positive

effects on posture, but not significant changes were shown on functional independence and GMFMS.¹⁹ In our study unlike the prior studies KT was used in adjunct with neuro-muscular electric stimulation and conventional PT. The important outcome of our investigation was that the combination of KT and neuro-muscular electric stimulation increases postural balance and sitting function and KT is more effective when used with neuromuscular electrical stimulation. Limitations of study were short time duration, small sample size, poor follow up due to Covid-19 lockdown restrictions. In future, more trials should be conducted on larger sample size, to produce general effects.

Conclusion It is concluded that combined use of kinesio tape and neuro-muscular electric stimulation application in addition to conventional physical therapy is effective in improving sitting postural control and motor function as well as sitting balance in children with spastic diplegic cerebral palsy. Significant results were found as compared to group receiving NMES along with conventional PT.

Declarations

Consent to participate Written consent had been taken from patients. All methods were performed following the relevant guidelines and regulations.

Availability of data and materials: Data will be available on request. The corresponding author will submit all dataset files.

Competing interests: None

Funding: No funding source was involved.

Authors' contributions: All authors read and approved the final manuscript.

CONSORT Guidelines: All methods were performed following the relevant guidelines and regulations.

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