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Training postural control and sitting in children with cerebral palsy: Kinesio taping vs. neuromuscular electrical stimulation

İlkay Karabay, Asuman Doğan, Timur Ekiz*, Belma Füsun Köseoğlu, Murat Ersöz

Ankara Physical Medicine and Rehabilitation Training and Research Hospital, Department of Physical Medicine and Rehabilitation, Ankara, Turkey

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ABSTRACT

Objective: To elucidate the effects of Kinesio Taping (KT) in addition to neurodevelopmental therapy (NDT) on posture and sitting, and to compare the effects of KT and neuromuscular electrical stimulation (NMES).
Materials-methods: Seventy-five children were randomized into control, KT, and NMES groups. NDT was applied to all children 4 times a week for 4 weeks. In addition, KT and NMES were applied to KT and NMES groups, respectively. Sitting subset of Gross Motor Function Measure (GMFM) and kyphosis levels of the groups were analyzed by two way mixed ANOVA.
Results: GMFM and kyphosis values improved significantly in all groups (all $p < 0.01$), yet change levels were more prominent in the KT and NMES groups than the control group. Moreover, NMES group showed better improvement.
Conclusion: KT or NMES application for four weeks in addition to NDT is effective on improving kyphosis and sitting. Besides, NMES is more effective than KT.

1. Introduction

Posture and sitting problems are common in children with cerebral palsy (CP). Pelvis and trunk controls are imperative for sitting/mobility, the development of upper extremity, pulmonary functions, and activities of daily living (ADL) (i.e. eating, drinking, and writing) [1,2]. In this regard, it is getting more considerable to improve sitting and posture in CP children.

Until now, various rehabilitative interventions such as neurodevelopmental therapy (NDT), hippotherapy (riding on a horse with the help of a therapists), and horse back-riding have been developed for improving sitting ability and posture in children with CP [3–6]. Neuromuscular electrical stimulation (NMES) has been studied previously and it was found to be effective on sitting and posture in CP children as well. NMES has some advantages (noninvasive, improves muscle re-education and proprioception). Yet, challenges in accurate placement of surface electrodes, isolation of a specific muscle, sensory tolerance, skin reactions -particularly long-term use of electrodes- and discomfort are the disadvantages [7]. On the other hand, Kinesio Taping (KT) method is an alternative therapy developed by Kenzo Kase in 1973. Kase reported that KT facilitates circulation, improves tissue alignment, corrects muscle function, and provides positional stimuli [8]. KT is commonly used in rehabilitation settings due to its several advantages (ease of application, comfortable, no restriction in range of motion and ADL, provides mechanical support). Temporary skin reaction is the only side effect of KT application [9].

Concerning the effects of KT on sitting and posture in children with CP in the pertinent literature, the data is limited and scarce. Şimşek et al. [10] have reported that KT has been effective on sitting, yet not on functional and motor parameters. In a pilot study, immediate effects of KT have been studied whereby neuromuscular taping seems to be effective on dynamic activities, but not in static activities [11]. Moreover, Kaya Kara et al. [12] have reported that KT increases proprioceptive feedback, gross motor function, and ADL in CP children. Previous studies focused on the combination of different modalities to achieve better functional status in CP children. However, to the best of our knowledge, effects of KT in addition to NDT have not been studied yet. We hypothesized that children who received KT plus NDT would show better trunk and postural control compared with children who received NDT only. Therefore, the objective of this study was to elucidate the effects of

* Corresponding author. Türkocağı St. No:3 06230 Sıhhiye, Ankara, Turkey.
E-mail address: timurekiz@gmail.com (T. Ekiz).

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KT in addition to NDT on posture and trunk control. In addition we aimed to compare the effects of KT and NMES on postural trunk control.

2. Materials-methods

2.1. Participants

Local Ethics Committee approved the study protocol and informed consent was obtained from the parents' of the children.

A total of 75 children with spastic diplegic CP (involvement of the lower extremities) were included in this study. Inclusion criteria were spastic diplegic CP with kyphosis and sitting problem, and cooperative. The exclusion criteria were; concomitance of hip contracture, scoliosis, hip dislocation, severe spasticity (Modified Ashworth 3–4), previous history of hip or spinal surgery, hypersensitivity reaction to KT, and severe cognitive disorders.

2.2. Procedure & randomization

The children were allocated into three groups by using block randomization according to the order of their hospitalization as the following; Control, KT, and NMES groups. Hospitalization of the children was independent from evaluators. NDT was applied to all children for four weeks five times a day. In addition, KT was applied to KT group and NMES was applied to NMES group in addition to NDT (Flow diagram).

2.3. Measurements

Sitting balance was evaluated by sitting subset of Gross Motor Function Measure (GMFM) [13,14]. Kyphotic angles were evaluated according to the lateral radiographs of the children by using Cobb method. The upper and lower margins of the T3 and T12 vertebrae, respectively were marked with the horizontal lines, and the vertical line which originates from the horizontal lines were intersected. The resultant angle features to the kyphotic angle [6]. X-rays were evaluated by a proficient physiatrist and by the same person.

Fig. 1. Picture shows the Kinesio Taping method.

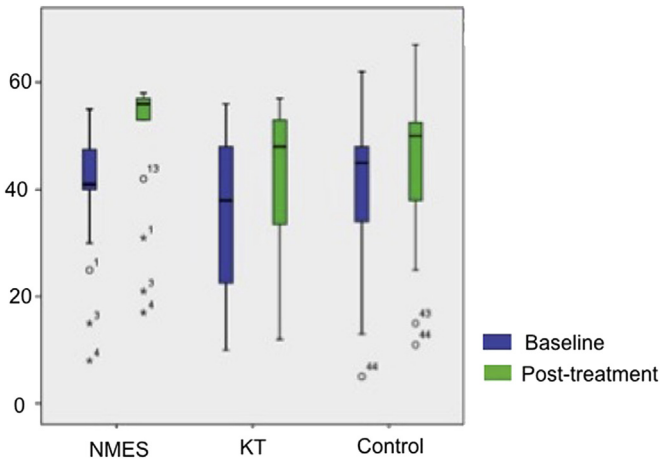


Fig. 2. Boxplot graph of GMFM levels before and after the intervention.

2.4. Interventions

2.4.1. Neuro-developmental therapy

Bobath therapy was administered for NDT. The Bobath concept is an approach for the neurological rehabilitation by facilitating of normal postural reactions and movements. Treatment sessions lasted 75 min and each child received 4 times per week for 4 weeks. NDT was administered by three different pediatric physiotherapists. All therapists had approximately five years experience in our pediatric rehabilitation center.

2.5. Neuromuscular electrical stimulation

Two-channel self-adapting multimodal electrostimulator

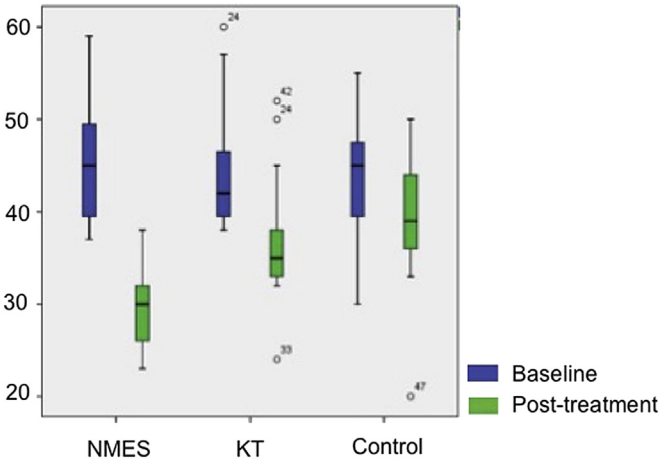


Fig. 3. Boxplot graph of kyphosis values before and after the intervention.

Table 1
Demographic and clinical features of the children.

Variables	Control group (n = 19)	KT group (n = 19)	NMES group (n = 23)	P value
Age (month)	68.4 ± 28.8	78.05 ± 28.75	71.0 ± 24.04	0.526
Gender (n, %)				
Male	11 (57.9)	10 (52.6)	12 (52.2)	0.923
Female	8 (42.1)	9 (47.8)	11 (47.8)	
GMFM				
Sitting subset	39.3 ± 14.4	34.2 ± 16.5	40.1 ± 11.2	0.183
Kyphosis				
Baseline	43.6 ± 6.3	44.5 ± 6.7	45.0 ± 6.6	0.071

KT, Kinesio Taping; ***NMES***, Neuromuscular electrical stimulation; **GMFM**, Gross Motor Function Measure.

Table 2
GMFM sitting subset and kyphosis levels of the patients before and after the interventions.

Variables	Control group (n = 19)	KT group (n = 19)	NMES group (n = 23)	P value
GMFM sitting subset				
Baseline	39.3 ± 14.4	34.2 ± 16.5	40.1 ± 11.2	<0.01[a]
Post-intervention	43.7 ± 14.5	41.0 ± 15.5	51.1 ± 11.8	
Kyphosis				
Baseline	43.6 ± 6.3	44.5 ± 6.7	45.0 ± 6.6	<0.01[a]
Post-intervention	39.3 ± 7.0	36.8 ± 6.7	29.7 ± 4.2	

KT, Kinesio Taping; ***NMES***, Neuromuscular electrical stimulation; **GMFM**, Gross Motor Function Measure.
[a] Two way mixed ANOVA was used to determine the differences between baseline and post-intervention values.

(SAMMS Mod, Professional; BEAC Bio-Medical, Italy) and four surface electrodes (5.5 × 6.5 cm) were used for NMES. Two electrodes were placed over and under the umbilicus. Other two electrodes were place over the paravertebral muscles at the midline level of lumbar region. The settings were adjusted as the following; intensity: 20–30 30 mA; sequence pulse width: 250 μ; frequency: 25 Hz; sequence: on for 10 s, and then off for 12 s.

2.6. Kinesio taping

Kinesio Tex Gold (Kinesio Tex Gold, Kinesio®; Albuquerque, New Mexico) was used for KT application while the children were seated in upright position. Tapes were prepared as I shapes and fixed to the acromioclavicular joint (the first 5 cm without stretching). Then, the tapes were stripped to the T12 obliquely with stretching and the last 5 cm without stretching (Fig. 1). KT was applied bilaterally during 4 weeks and was changed in every 3–4 days by a certificated physiatrist who has previously attended the KT training course. KT was applied by the same physiatrist.

2.7. Statistical analysis

SPSS version 16.0 (SPSS Inc., Chigaco, IL, USA) was used for statistical analysis. Descriptive statistics were expressed as means ± standard deviations. Shapiro-Wilk test was used to determine if the continuous variables were normally distributed. Pretest and posttest GMFM and kyphosis values of the three groups were evaluated by Shapiro-Wilk test. The data were normally distributed except for a few subgroups. However, ANOVA is considered a robust test against the normality assumption. Besides, since the sample sizes in all groups were similar and df for error more than 20, we performed Two Way Mixed ANOVA. Age was compared by One Way ANOVA test and genders were compared by pearson chi-square among the groups. Change levels in the GMFS and kyphosis levels of the groups were analyzed by two way mixed ANOVA. Boxplot graphs of GMFM and kyphosis values are shown in Figs. 2 and 3. In our study df of error is 58 and the range of z value is (−2.46–1.67) for GMFM values and (−3.2–2.07) kyphosis values. A p value of 0.05 was set as significant.

3. Results

Sixty-one children among 75 who participated in this study finished the study. One child could not tolerate NMES, three developed allergic reaction to KT, and others dropped out or were discharged. Overall, there were 19 children in the KT group, 19 in the control group, and 23 in the NMES group for the analysis. Demographic and clinical features of the children are shown in Table 1. There were no significant differences between the groups regarding age and gender.

Comparison of the baseline and post-intervention levels of GMFM sitting subset and kyphosis are shown in Table 2. Baseline sitting subset of GMFM were similar in the groups ($F(2.58) = 1.75$, $p = 0.183$, $p > 0.05$). Compared with baseline, GMFM improved significantly in all groups after the intervention ($F(1.58) = 192.4$, $P = 0.000$). However, the improvement levels in GMFM were different among the groups ($F(2,58) = 13.280$, $P = 0.000$) (Fig. 4).

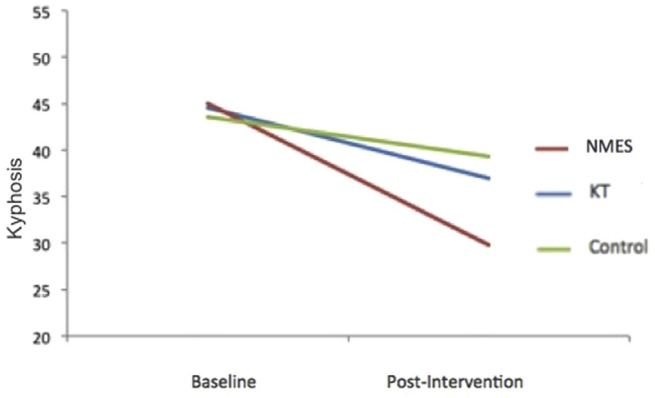


Fig. 4. Baseline and post-intervention GMFM levels. The mean change levels were 11, 6.84, and 4.47 in the NMES, KT, and control groups, respectively (all $p < 0.01$). ***NMES***, neuromuscular electrical stimulation; ***KT***, Kinesio Taping; ***GMFM***, Gross Motor Function Measure.

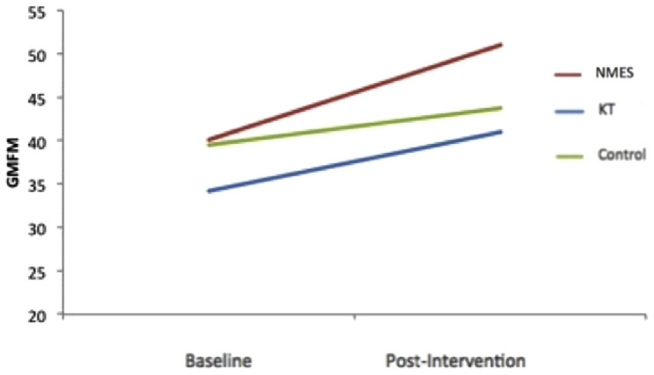


Fig. 5. Baseline and post-intervention kyphosis levels. The mean change levels were 11, 6.84, and 4.47 in the NMES, KT, and control groups, respectively (all $p < 0.01$).

The mean change levels were 11, 6.84, and 4.47 in the NMES, KT, and control groups, respectively (all $p < 0.01$).

Baseline kyphosis values were similar in the groups ($F(2.58) = 2.77$, $p = 0.071$, $p > 0.05$). Compared with baseline, kyphosis values decreased significantly in all groups after the intervention ($F(1.58) = 349.7$ $p = 0.000$, $p < 0.001$) (Fig. 5). Nonetheless, the decrement levels were significantly different among the groups ($F(2.58) = 46.77$, $p = 0.000$). The mean decrement levels in kyphosis values were 15.3, 7.68, and 4.32 in the NMES, KT, and control groups, respectively (all $p < 0.01$). An exemplary image of the change in the kyphotic angle is shown in Fig. 6.

4. Discussion

In this study, we objected to explore if KT application in addition to NDT is effective on posture and GMFM in diplegic CP children. Moreover, we compared the effects of KT and NMES. The most significant result of our study was that both KT and NMES did improve kyphosis and GMFM, besides NMES was more effective than KT.

Neuromuscular electrical stimulation provides muscle re-education, cutaneous proprioception, and strengthening muscles by stimulating the agonist muscles and inhibiting the antagonist muscle via the reflex arc [15]. NMES has been previously studied in CP children and found to be effective on trunk control. It has also been reported that it is more effective when NMES is combined with other conventional rehabilitation methods [6]. Park et al. [16] randomized patients into conventional therapy only and conventional therapy plus NMES group. While kyphotic angles changed 18° in the NMES group, it changed 8° in the control group. In our study, the mean decrement levels in kyphosis values were 15.3°, 7.68°, and 4.32° in the NMES, KT, and control groups, respectively. Park et al. reported the change of GMFM sitting subscale as 18 and 9 in the NMES and control groups, respectively. In our study, the mean change levels were 11, 6.84, and 4.47 in the NMES, KT, and control groups, respectively. Compared with our study, the better improvement in their study could be attributed that Park et al. applied conventional therapy two weeks longer than us.

Kinesio Taping method is speculated to activate and strengthen muscles with two mechanisms. First, KT stimulates cutaneous receptors and provides proprioception. Second, increased subcutaneous space and blood enhancement with KT application result in muscle activation [8]. However, there are only a few studies in the data evaluating the effects of KT on posture in children with CP. In the literature, Kaya Kara et al. [12] have studied the effects of KT on body functions and activity in unilateral spastic CP in a single-blind, randomized, controlled trial. Thirty children were randomized into KT and control group whereby KT group showed improvement in physical fitness, gross motor function, and activities of daily living. Immediate effects of KT on sit-to-stand movement, balance, and dynamic postural control in CP have been studied in four children in a pre-test and post-test design [11]. Although dynamic activities did improve, static activities did not. Şimşek et al. [10] randomized 31 patients into study (KT + physiotherapy) and control (only physiotherapy) groups. KT was applied for 12 weeks. In their study, although KT showed beneficial effects on posture, no significant effects were observed on GMFM and functional independence.

In our study -differently from the previous studies- KT was applied in addition to NDT. The sample included diplegic CP children and sample size was larger. Furthermore, effects of KT and NMES were compared. According to our results, improvement in the both kyphotic angles and GMFM (sitting subset) were observed, with more prominent in the NMES group. NDT therapy was applied four weeks in our study. This duration is not enough to see the exact changes in CP children compared with the data. Butler et al. [17] have summarized the studies in their review and NDT has been applied up to 12 months. Since we apply NDT to inpatient children, we could not apply longer than four weeks. NMES group did show better improvement than the KT group. This result could be attributed to the fact that NMES provides an actual muscle contraction with a stimulation of an intact motor neuron [7].

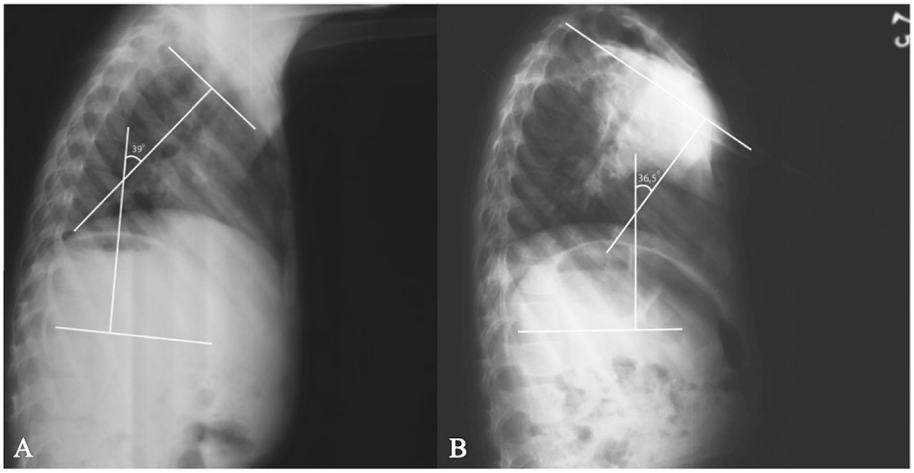
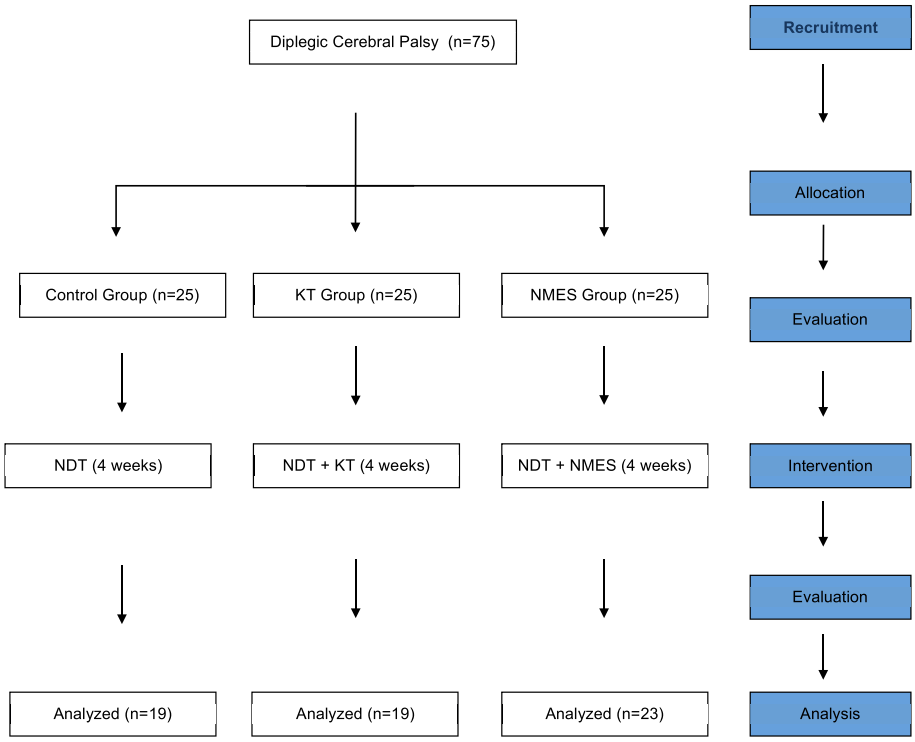


Fig. 6. Exemplary radiographs illustrating the change in kyphotic angles.



NDT, Neuro-developmental therapy; ***NMES***, Neuromuscular electrical stimulation, **KT**, Kinesio Taping

However, KT provides a tactile stimulation rather than an actual contraction [9].

4.1. Limitations

There are some important drawbacks of this study. First, although GMFM gives some idea about sitting balance, lack of evaluation by important scales or tests such as functional independence measure, sit-to-stand movement, Gross motor functional classification scale, and pediatric balance scale is a limitation. Second, lack of an only KT or NMES group is a limitation as well. Third, the children could be followed-up after interventions and duration of NDT could be more than four weeks. Lastly, although the X-rays were evaluated by the same physiatrists, lack of intra-rater reliability is a limitation.

5. Conclusion

The results of this study suggest that KT or NMES application for at least four weeks in addition to NDT seem to be effective on improving kyphosis and GMFM. Besides, NMES is more effective than KT. Further studies concerning the combination of KT and NMES with different rehabilitation modalities in different CP samples are awaited.

Conflict of interest

None.

Acknowledgement

None.

References

[1] L. Barks, P. Shaw, Wheelchair positioning and breathing in children with cerebral palsy: study methods and lessons learned, Rehabil. Nurs. 36 (4) (2011) 146–152, 174.
[2] C. Stavness, The effect of positioning for children with cerebral palsy on upper-extremity function: a review of the evidence, Phys. Occup. Ther. Pediatr. 26 (3) (2006) 39–53.
[3] C.B. Footer, The effects of therapeutic taping on gross motor function in children with cerebral palsy, Pediatr. Phys. Ther. 18 (4) (2006) 245–252.
[4] D. Hamil, K.A. Washington, O.R. White, The effect of hypotherapy on postural control in sitting for children with cerebral palsy, Phys. Occup. Ther. Pediatr. 27 (4) (2007) 23–42.
[5] J.A. Sterba, B.T. Rogers, A.P. France, D.A. Vokes, Horseback riding in children with cerebral palsy: effect on gross motor function, Dev. Med. Child. Neurol. 44 (5) (2002) 301–308.
[6] İ. Karabay, A. Dogan, M.D. Arslan, G. Dost, N. Ozgirgin, Effects of functional electrical stimulation on trunk control in children with diplegic cerebral palsy, Disabil. Rehabil. 34 (11) (2012) 965–970.
[7] P.A. Wright, S. Durham, D.J. Ewins, I.D. Swain, Neuromuscular electrical stimulation for children with cerebral palsy: a review, Arch. Dis. Child. 97 (4) (2012) 364–371.
[8] K. Kase, J. Wallis, T. Kase, Clinical Therapeutic Application of the Kinesio Taping Method, Ken Ikai Co Ltd, Tokyo, Japan, 2003.
[9] T. Ekiz, M. Doğan Aslan, N. Özgirgin, Effects of Kinesio tape application to quadriceps muscles on isokinetic muscle strength, gait, and functional parameters in patients with stroke, J. Rehabil. Res. Dev. 52 (3) (2015) 323–332.
[10] T.T. Şimşek, B. Türkücüoğlu, N. Çokal, G. Üstünbaş, İ.E. Şimşek, The effects of Kinesio Taping on sitting posture, functional independence and gross motor function in children with cerebral palsy, Disabil. Rehabil. 33 (21–22) (2011) 2058–2063.
[11] C.S. de Costa, F.S. Rodrugues, F.M. Leal, N.A. Rocha, Pilot study: investigating the effects of Kinesi0 taping on functional activities in children with cerebral palsy, Dev. Neurorehabil. 16 (2) (2013) 121–128.
[12] O. Kaya Kara, S. Atasavun Uysal, D. Türker, S. Karayazgan, M.K. Günel, G. Baltaci, The effects of Kinesio taping on body functions and activity in

unilateral spastic cerebral palsy: a single-blind randomized controlled trial, Dev. Med. Child. Neurol. 57 (1) (2014) 81–88.
[13] D.J. Russell, P.L. Rosenbaum, D.T. Cadman, C. Gowland, S. Hardy, S. Jarvis, The gross motor function measure, Dev. Med. Child. Neurol. 31 (3) (1989) 341–352.
[14] C. Gowland, W.F. Boyce, V. Wright, D.J. Russell, C.H. Goldsmith, P.L. Resenbaum, Reliability of the gross motor performance measure, Phys. Ther. 75 (7) (1995) 597–602.
[15] M.T. Yıldızgören, G.F. Nakipoğlu Yüzer, T. Ekiz, N. Özgirgin, Effects of neuromuscular electrical stimulation on the wrist and finger flexor spasticity and hand functions in cerebral palsy, Pediatr. Neurol. 51 (3) (2014) 360–364.
[16] E.S. Park, C.I. Park, H.J. Lee, Y.S. Cho, The effect of electrical stimulation on the trunk control in young children with spastic diplegic cerebral palsy, J. Korean Med. Sci. 16 (3) (2001) 347–350.
[17] C. Butler, J. Darrah, Effects of neurodevelopmental treatment (NDT) for cerebral palsy: an AACPDM evidence report, Dev. Med. Child. Neurol. 43 (11) (2001) 778–790.