RESERCH ARTICLE **Open Access**

Gema Lingkungan Kesehatan
Vol. 23, No. 1 (2025), pp 152-159
e-ISSN 2407-8948 p-ISSN 16933761
Doi: https://doi.org/10.36568/gelinkes.v23i1.197 *Journal Hompage: https://gelinkes.poltekkesdepkes-sby.ac.id/*

Effect of Combined Kinesio Taping and Neuro Development Therapy on Sitting Balance in Children with Cerebral Palsy

Virginia Ainurridlo Nugroho*, Djoko Witjaksono, Samiah Rachmawati, Nanik Setijowati

Specialist Doctor Education Study Program, Physical Medicine and Rehabilitation, Faculty of Medicine, Briwijaya University, Malang, Indonesia

*Correspondence: virginugroho@gmail.com

ABSTRACT

Cerebral palsy (CP) is a neurological disorder that affects movement and posture. Spastic diplegia and quadriplegia in CP patients, particularly those with GMFCS III, IV, and under five years of age, often require therapeutic interventions to improve functional ability. Neurodevelopment therapy (NDT) is frequently used for this purpose, and the addition of Kinesio Taping (KT) provides additional benefits. This quasi-experimental study focused on children under five years old with spastic diplegia and quadriplegia CP (GMFCS III and IV) at Dr. Saiful Anwar Hospital, East Java. The number of subjects analyzed was 14, divided into two groups, namely Group A, given a combination therapy of KT and NDT (7 subjects), as well as Group B, given NDT (7 subjects). Both groups were subjected to pre-test and post-test assessments using the Trunk Control Measurement Scale after an intervention period of 12 weeks. The results showed that the static sitting balance of both groups had significant improvement after the intervention ($p<0.05$). This is in accordance with a study conducted by Cubukcu and Karaoglu, which examined 30 patients with spastic CP (diplegia, quadriplegia) aged 2-5 years. A total of 15 patients were put into the neurodevelopmental treatment group (Group A), while 15 were placed into a conventional home exercise program (Group B). However, there was no significant difference between the group receiving the combination of KT with NDT and the group given NDT alone.

Keywords: Cerebral palsy, Kinesio taping, Neurodevelopmental therapy, Sitting balance

INTRODUCTION

Cerebral palsy (CP) is a group of disorders that affect movement and posture, limiting physical activity. It is caused by brain damage that occurs during fetal development or early infancy and does not worsen over time, though symptoms may change as a child grows. CP affects about 1.5–3.0 per 1,000 live births and can lead to a range of issues with movement, muscle tone, and coordination. Data from Europe shows that the average frequency of CP is 2.08 per 1000 live births, but in the group of children with a birth weight of less than 1500 grams, the frequency is 70 times higher than in those with a birth weight above 2500 grams (Sadowska et al., 2020). Approximately 764,000 children and adults in the United States have been diagnosed with CP and about 1,200 – 1,500 school-age children are diagnosed each year. The prevalence is higher in males compared to females. About 41% of infants and children with CP have crawling, walking, and running limitations. Furthermore, nearly one-third of affected children are non-ambulances and spend most of part of lives in sitting or lying position. Based on the results of Basic Health Research (Riskesdas) of the Ministry of Health of the Republic of Indonesia in 2018, the prevalence rate of CP in East Java was 10.6%, with 6.5% at the age of 5-17 years, 2.5% at 18-59 years, and 1.6% at > 60 years (Riskesdas, 2018).

CP children experience many problems, including muscle weakness, balance, coordination, and other brain tissue disorders. These disorders can impact growth and development, gross and fine motor skills, social, language, education, independence in daily activities and work, as well as increase the needs of caregivers (Karabay *et al.*, 2016).

A major problem often found in CP children is the disturbance of the postural control mechanism when sitting. Postural control disorder is the inability to control the body position in space to create balance (Pavao *et al.*, 2014). This disorder significantly affects activities in daily life, such as eating, drinking, and writing (Solomon and O'Brien, 2020).

Sitting is a process where ischial tuberosity and the surrounding soft tissues bear most of the body weight. The position of the pelvis and the resulting spinal curve affect the weight distribution. Furthermore, the location of the gravitational line about the ischial tuberosity is an essential factor in evaluating the muscle effort required to maintain

balance. The perpendicular distance between the gravitational line and the Fulcrum (ischial tuberosity) shows the length of the gravity lever arm. The greater this distance, the higher the moment that tends to rotate the trunk. This rotational force must be balanced with the same amount of muscle effort for balance to occur. Therefore, to reduce muscle effort and maintain balanced posture, the line of gravity must remain close to the supporting structure (Kim and Ko, 2014).

Sitting phase, or preparation for normal children, occurs at 5-6 months. During the neonatal period, when the child is seated, the spinal posture shows significant flexion due to a lack of control for the antigravity extensor muscles. When a baby is born, neck antigravity extensions and trunk start to develop. Initially, the cervical spine develops antigravity control, preventing the baby head from moving forward and lifting the head to ensure the face and mouth remain vertical. At 5 months of age, when placed in sitting position, the child tries to support with the upper extremities. The hand grip reflex decreases and generally disappears, then the child can put an open hand on the floor (Wahyuni, 2014).

CP children often have delays in sitting because the postural muscles take longer to adapt. The disorder can cause problems such as low muscle tone, weak trunk muscles, increased stiffness in the arms and legs, slow postural reflexes, and limited flexibility. These factors make it challenging for CP children to develop the strength and balance needed to sit independently. Loss of control for the trunk is an essential element in CP children. It leads to difficulty sitting, playing in sitting position, moving hands functionally and freely when eating, playing, and performing daily activities.

Postural control can be achieved when there is a supporting factor of stability. Static and dynamic stability are two determinants of the primary sitting position in developmental children. Stability is the ability to reduce body movements or swaying coming from the surroundings. Sitting in a position without support makes the trunk become unstable. It will be replaced by muscle groups that maintain body stability, against gravitational forces (static stability) and the ability to move the center of gravity (dynamic stability). When the condition does not receive appropriate and adequate intervention, there is the potential for deformity in muscle contractures and joint stiffness, further worsening posture (Ahmed and Azzam, 2014).

The nervous system generates forces to control the motion Center of Mass (COM) for stability. The regulation of postural control is attributed to the interaction of various systems, specifically the nervous and musculoskeletal. The components of the musculoskeletal system include joint area of motion, spinal flexibility, muscle properties, and biomechanics. Other components in the form of neuromuscular synergy are responses to maintain balance, sensory systems (visual, vestibular, somatosensory), anticipatory mechanisms, as well as adaptive and internal representation. The existence of anatomical and functional disorders alongside changes from the postural control component affect sitting problems in children (Zanon *et al.*, 2019).

Several interventions have been developed to improve the postural control of CP, one of which is the NDT (Neuro Development Therapy). It is most often used and known to play a role in improving posture, postural mobility, movement control, and teaching correct movement patterns with inhibition, facilitation, stimulation, and Key Point of Control (Hazmi, 2014). The Tekin study, 2018 stated that NDT is effective and significant in increasing functional motor levels and independence by improving postural control and balance in children having CP Diplegi and Hemiplegia with Gross Motor Function Classification System (GMFCS) levels I, II, and III (Tekin *et al.*, 2018).

Some studies have investigated the use of Kinesio Taping (KT). Shamsoddini et al. reported that the installation of KT on muscles helps increase joints range of motion, muscle strength, contraction in weakened muscles, and stimulation of relaxation in excessively contracted muscles. KT is also straightforward to use and comfortable when the CP child moves. Application on the skin in the trunk will stimulate receptors, which then excite the neuromuscular system in activating nerve and muscle performance when performing functional movements. KT can also shape the body posture because it stimulates mechanoreceptors to sit upright and offers a sense of comfort to the paired area (Shamsoddini *et al.*, 2016). Therefore, adding tapping during a training session (NDT) is beneficial in facilitating correct posture, movement patterns, and may also provide the benefit of creating a stable sitting.

A systematic review found that 3 out of 4 randomized controlled trials (Badawy *et al.*, 2015) showed significant results in improving gross motor function when KT was applied together with NDT in children with CP diplegia spastic for 12 weeks compared to 4 weeks (Scheepers *et al.*, 2018). KT is also effective in improving dynamic balance and functional mobility in children with spastic CP (Partoazar *et al.*, 2021).

Data regarding the effect of combining KT and NDT on improving sitting balance in CP children is limited. According to previous studies, improvement of gross motor function in children having spastic and hemiplegic CP with GMFCS levels I, II, and III is not specific to assessing sedentary balance (Ibrahim, 2015). (Heyrman *et al.*, 2014) explained that the trunk control measurement scale (TCMS) is a measurement to assess sitting balance in CP children. TCMS not only considers static balance but also dynamic balance, which includes Selective Movement Control and dynamic reaching. Therefore, this study aimed to determine whether the combination of KT and NDT has better effects on Sitting Balance in CP children compared to only NDT.

RESEARCH METHODS

This study was conducted using a quasi-experimental method. This method is often used to overcome a problem by determining the difference between the treatment and control groups (Sugiyono, 2019) with the existence of pre-test and post-test without selecting randomly from both the control and the treatment group. The study population consisted of pediatric patients diagnosed with CP at Dr. Saiful Anwar Malang Hospital. The minimum sample size was calculated based on the number of repetitions in each group. The calculation was carried out using Lameshow et al formula as follows:

$$n = n2 = \frac{2\,\delta^2(z1-\alpha+z1-\beta)^2}{(\mu1-\mu2)^2}$$

n = (2 x 2.1562 (1.64+1.28)2) / 3.372 = 6.9

Information:
n1 = n2 = minimum sample size (per batch)
δ = Standard Junction (2,156)
Z (1-α) = Z value, 90% confidence degree (α value 0.10 is 1.64)
Z (1-β) = Z value at 80% test strength (β= 20% is 1.28)
μ1-μ2= difference in the average of the two interventions carried out in the previous KT and NDT studies. The mean difference in the experimental group was 40.38, while that of the control group was 43.75 (43.75 – 40.38 = 3.37)

To anticipate the possibility of selected subjects dropping out, losing to follow-up, or not adhering to instructions, corrections were made using the formula:

$$n = \frac{n}{1-f}$$

n = 6.9 / (1 - 0.1) = 7.6

n = size of the sample calculated
f = Approximate dropout proportion

Based on the calculation above, the samples in the experimental and control groups each amounted to 8, totaling 16. Sampling was carried out using non-probability and purposive methods because there are special criteria that participants must possess. The independent variable was the provision of therapy (KT + NDT compared to control, namely NDT only). Meanwhile, the dependent variable was the ability of patients to sit, as shown by the results of the TCMS score comprising (1) static sitting balance, (2) selective movement control, and (3) dynamic reaching. The data obtained were compared and analyzed through the SPSS 26 program at a confidence level of 95% (α=0.05) and power of 80%.

RESULTS AND DISCUSSION

This study was conducted at Dr. Saiful Anwar Hospital, East Java Province, from October 2022 to June 2023 and has received approval from the Ethics Committee number 070/10131/102.27/2022. During this period, 89 patients with CP were obtained. A total of 16 patients fulfilled the criteria for inclusion and signed the informed consent. Among the 16 patients, 8 received NDT only, while 8 were given NDT and KT. A total of 14 patients participated in the study until the end, 2 (12.5%) were lost to follow-up including 1 from the treatment group (NDT and KT) who continued therapy elsewhere, and the other from the control group (NDT) experienced worsening of the condition.

This study used a simple random sampling method that fulfilled the inclusion and exclusion criteria. Randomization was carried out using the Random Allocation Software application in outpatient CP patients at the Regional General Hospital (RSUD) Dr. Saiful Anwar, East Java. Based on gender, 11 men (78.57%) and 3 women (21.43%) were willing to participate.

Table 1
Basic Characteristics of CP Patients

	Study groups (NDT and KT) (n=7)	Control group (NDT) (n=7)	P
Age (months)	29.57±19.66	29.43±14.32	0,988
BB (kg)	11.51±4.83	10.20±2.88	0,548
TB (cm)	84.71±16.37	82.13±10.57	0,732
GMFM	23.83±1.93	27.88±8.10	0,461
GMFCS			
Level III	3 (42,86%)	2 (28,57%)	0,591
Level IV	4 (57,14%)	5 (71,43%)	
VFCS			
Level 1	4 (57,14%)	2 (28,57%)	0,520
Level 2	2 (28,57%)	5 (71,43%)	
Level 3	1 (14,29%)	0 (0%)	
Gender			
Woman	2 (28,57%)	1 (14,29%)	0,530
Man	5 (71,43%)	6 (85,71%)	
Types of Cerebral Palsy			
Bipolar Spastic	7 (100%)	5 (71,43%)	0,141
Quadriplegi Spastic	0 (0%)	2 (28,57%)	

Table 1 shows that statistically, there is no difference between the two groups, indicated by the p-value >0.05.

TCMS Normality Test

The normality test used was Kolmogorov Smirnov because the number of subjects was less than 30.

Table 2
TCMS Normality Test Results

Group I	Variable	Statistics	Df	Sig.
NDT+KT	Static Pre	0.258	7	0.174
	Static Post	0.338	7	0.015
	movement control Pre		7	
	movement control Post		7	
	Reaching pre		7	
	Reaching Post		7	
NDT	Static Pre	0.759	7	0.016
	Static Post	0.883	7	0.240
	movement control Pre	0.600	7	0.000
	movement control Post	0.600	7	0.000
	Reaching pre	0.600	7	0.000
	Reaching Post	0.600	7	0.000

The normality test results on the values of static sitting balance, selective movement control, and dynamic reaching before and after treatment obtained using SPSS 26 software are shown in Table 5.2. The value of the Kolmogorov Smirnov test for NDT and NDT + KT was p < 0.05, hence, Ho was rejected. It was concluded that the data were not normally distributed and then testing was continued using the Wilcoxon test.

Comparison of *TCMS* between two Groups Before and After Treatment

The test for TCMS (static sitting balance, selective movement control, and dynamic reaching) was carried out using Wilcoxon signed rank because the data was not normally distributed. This test compared the TCMS (Static sitting balance, Selective movement control, and Dynamic reaching) values in the control (C) and treatment groups before and after treatment.

Table 3
Wilcoxon Tcms Test

		Static Pre- Post	Move. contrl Pre-Post	Reaching Pre-Post
NDT and KT	Z	-2.46	0.000	0.000
	p	0.014	1.000	1.000
NDT	Z	-2.070	0.000	-1.414
	p	0.038	1.000	0.157

The Wilcoxon test results in Table 3 show that in the NDT and KT groups, the static sitting balance value demonstrated a change in the pre and post-values, with a p-value of 0.014. Given that the value of p (0.014) < α = 5%, H0 was rejected suggesting a significant difference between TCMS static sitting balance pre-and post-treatment.

In the NDT and KT groups, the value of selective movement control did not change pre and post-value with a p-value of 1,000. Given that the value of p (1,000) > α = 5%, then H0 was accepted. This result shows an insignificant difference between TCMS selective movement control pre- and post-treatment.

The dynamic reaching value did not change pre and post-values with a p-value of 1,000. Given that the p-value (1,000) > α = 5%, H0 was accepted. This suggests an insignificant difference between TCMS dynamic reaching pre- and post-test treatment.

In the NDT Only group, the static sitting balance shows a change in the pre and post-values, namely the p-value of 0.038. Given that the p-value (0.038) was < α = 5%, H0 was rejected. This suggests that there was a significant difference between TCMS static sitting balance pre-and post-treatment.

The selective movement control was not changed by the pre and post-test with a p of 1,000. Given that the p-value was (1,000) > α = 5%, H0 was accepted, suggesting there was an insignificant difference between TCMS selective movement control pre-and post-treatment.

The dynamic reaching showed a change in the pre and post-values, with a p-value of 0.157. Given that the p-value was (0.157) > α = 5%, H0 was accepted. This suggests an insignificant difference between TCMS dynamic reaching pre and post-treatment.

Comparison of TCMS Between Groups After Treatment

To determine the difference between the NDT-only group with NDT and KT, a statistical tool of the mean difference test, namely Mann-Whitney was used because it has an ordinal data scale. Table 4 shows the calculation results of the Mann-Whitney test obtained using SPSS ver 26.00 software.

Table 4
Test Mann Whitney

	Static Pre	Movement Control Pre	Reaching pre	Static Post	Movement Control Post	Reaching Post
Mann Whitney	22.500	17.500	17.500	20.000	17.500	17.500
P	0.784	0.141	0.141	0.552	0.141	0.141

Table 4 shows the comparative test results between pre-TCMS and post-TCMS of the NDT with KT and NDT groups. The comparison of the TCMS static sitting balance pre-value in the NDT group and the NDT with KT showed

a p-value of 0.784. Given that the p-value (0.784) was > α = 5%, H0 was accepted suggesting an insignificant difference between the pre-TCMS static sitting balance.

The comparison of TCMS selective movement control pre-value in the NDT and NDT with KT group showed a p-value of 0.141. Given that the p-value (0.141) was > α = 5%, H0 was accepted suggesting an insignificant difference between the pre-TCMS selective movement control.

The comparison of TCMS dynamic reaching pre-value in the NDT and NDT with KT group shows a p-value of 0.141. Given that the p-value (0.141) was > α = 5%, H0 was accepted suggesting an insignificant difference between the pre-TCMS dynamic reaching.

The comparison of TCMS static sitting balance post-value in the NDT and NDT with KT group showed a p-value of 0.784. Given that the p-value (0.784) was > α = 5%, H0 was accepted, suggesting an insignificant difference between the post-TCMS static sitting balance.

For the selective movement control, the comparison of TCMS post-value in the NDT and NDT with KT showed a p-value of 0.552. Given that the p-value (0.552) was > α = 5%, H0 was accepted suggesting an insignificant difference between the post-TCMS selective movement control.

The comparison of TCMS dynamic reaching post-value in the NDT and NDT with KT group showed a p-value of 0.141. Given that the p-value (0.141) was > α = 5%, H0 was accepted, suggesting an insignificant difference between the post-TCMS of dynamic reaching.

Table 5
Mann Whitney Change (Delta) TCMS

Variable	Group	Median	Minimum	Maximum	p
Static Change	NDT	1.0000	0.00	2.00	0.080
	KT and NDT	2.0000	1.00	2.00	
Movement Control Changes	NDT	0.0000	0.00	0.00	1.00
	KT and NDT	0.0000	0.00	0.00	
Reaching Post Changes	NDT	0.0000	0.00	1.00	0.141
	KT and NDT	0.0000	0.00	0.00	

Table 5 shows the TCMS delta comparison test between NDT with KT and NDT only. The comparison of TCMS static sitting balance in the two groups showed a p-value of 0.080. Given that the p-value (0.080) was > α = 5%, H0 was accepted suggesting an insignificant difference between the change in TCMS static sitting balance.

The comparison of TCMS selective movement control in the NDT and NDT with KT group showed a value of p 1,000. Given that the value of p (1,000) was > α = 5%, H0 was accepted suggesting an insignificant difference between the change in TCMS selective movement control.

The comparison of TCMS dynamic reaching in the NDT and NDT with KT group showed a p-value of 0.141. Given that the p-value (0.141) was > α = 5%, H0 was accepted, suggesting an insignificant difference between the change in TCMS dynamic reaching.

GMFM Normality Test.

Table 6
GMFM Normality Test Results

Group	Variable	Statistics	Df	Sig.
NDT and KT	Pre GMFM	0.282	7	0.097
	Post GMFM	0.152	7	0.200
NDT	Pre GMFM	0.236	7	0.200
	Post GMFM	0.228	7	0.200

Table 6 shows that the Kolmogorov-Smirnov test with a significance value (p) for NDT and NDT + KT has a p-value> 0.05. Ho was accepted, suggesting that the data used was normally distributed. Therefore, the test used the Paired t-test.

Data Homogeneity Testing

Before using the t-test, the data obtained for each treatment were analyzed for homogeneity using the Levene test to determine whether the data used had the same variety. The results of the homogeneity test are shown in Table 7.

Table 7
Homogeneity Test

Test of Homogeneity of Variances				
	Levene Statistic	df1	DF2	Sig.
Perubahan_GMFM	.579	1	12	.461

The Levene test value for GMFM was 0.579, with a significance value of 0.461. The sig. Value was greater than alpha 0.05, hence, Ho was accepted. It was concluded that the data used has a homogeneous variety.

Paired t-test between Pre and Post GMFM

To determine the difference between pre-and post-test, a statistical tool, namely the t-paired test was used. Table 8 shows the results obtained using the SPSS ver 26.00 software.

Table 8
Paired T-Test

		Mean	N	Std. Deviation	Average difference	p
NDT and KT	GMFM Pre	23.83	7	1.93	-4.627	0.000
	GMFM Post	28.46	7	2.45		
NDT	GMFM Pre	27.88	7	8.10	-2.210	0.001
	GMFM Post	30.09	7	8.78		

Table 8 shows the results of the t-paired test. The NDT and KT groups showed a change in pre and post-GMFM with a p-value of 0.000. Given that the p-value (0.000) < α = 5%, H0 was rejected suggesting a significant difference between pre- and post-GMFM with a mean increase of 4.627%.

The NDT group test showed a change in pre and post-GMFM with a p-value of 0.001. Given that the p-value (0.001) was < α = 5%, H0 was rejected suggesting a significant difference between pre and post-GMFM, with a mean increase of 2.21%.

Independent t-test between groups at GMFM

To determine the difference between the NDT and NDT with KT, a statistical tool, namely the independent t-test was used because it has a ratio data scale and a normal distribution. Table 9 shows the calculation results of the independent t-test obtained using SPSS ver 26.00 software.

Table 9
Independent T Test GMFM

	Group	N	Mean±sd	P
Pre GMFM	KT and NDT	7	23.830±1.927	0.242
	NDT	7	27.876±8.104	
Post GMFM	KT and NDT	7	28.457±2.450	0.651
	NDT	7	30.086±8.785	

The comparative test for the increase in Pre GMFM of the NDT and NDT with KT showed a p-value of 0.242. Given that the p-value (0.242) was > α = 5%, H0 was accepted, suggesting an insignificant difference between the mean GMFM.

The comparative test of the increase in post-GMFM showed a p-value of 0.651. Given that the p-value (0.651) was > α = 5%, H0 was accepted suggesting an insignificant difference between the mean GMFM of the NDT and the NDT with KT group.

Table 10
Independent Test Change (Delta) GMFM

Group	N	Mean±sd	Average difference	p
KT and NDT	7	4.63±1.09		
NDT	7	2.21±0.95	-2.41714	0.001

Table 10 shows the comparative test of increase in GMFM for the NDT and NDT with KT group with p-value of 0.001. Given that the p-value (0.001) was < α = 5%, H0 was rejected suggesting a significant difference between the change in the mean GMFM. The NDT+KT group had a higher increase compared to NDT only.

Effect of KT and NDT Administration on TCMS

In this study, children with spastic and quadriplegic diplegia CP in the intervention group who received KT in the paraspinal region experienced significant improvements in terms of static sitting balance. The results are consistent with Hsu et al., who reported that KT could be an additional intervention in therapeutic procedures to improve strength, functional activity, proprioceptive, control, and position during static sitting (Hsu *et al.*, 2019).

KT applied to the skin will stimulate receptors in the cutaneous area, which then excites the neuromuscular system to activate nerve and muscle performance when performing functional movements. Furthermore, KT forms body posture because it stimulates mechanoreceptors to sit upright and gives a sense of comfort to the installed area (Yasukawa *et al.*, 2016).

A study conducted by Badawy (2015) stated that KT given to the back muscles can be used as an additional therapeutic modality to improve sitting control in children with CP. KT, attached to the trunk area provides direct stabilization of the paraspinal muscles and helps improve sitting ability (Badawy *et al.*, 2015).

Effect of KT and NDT on GMFM Value

GMFM values before and after KT + NDT showed a significant increase in CP patients aged 10 months to 5 years. A systematic review study conducted by (Tahmasebi Boroujeni *et al.*, 2018) showed that KT applied to the trunk of children with CP accompanied by exercise improved gross motor function.

Among the 5 journals reviewed, 4 showed that KT and exercise therapy were effective in improving gross motor function in patients with CP after 12 weeks of intervention. However, under 12 weeks of KT use and exercise therapy, there was no significant difference (Scheepers *et al.*, 2018).

GMFM examines children functional behavior about primary motor activity from infancy to age 16 (Snodgrass *et al.*, 2018). It is a comprehensive measurement tool used to assess the effectiveness of various therapies due to the high sensitivity and repetition. Studies conducted by Badawy et al. (2015), Ibrahim (2015), and Karabay et al.

(2016), explained that there was an improvement in sitting function (GMFM component B) in children with CP who were given KT and NDT for 12 weeks.

Effect of NDT on GMFM value

In this study, the GMFM value after NDT exercise therapy alone experienced a significant increase. This is in accordance with a study conducted by Cubukcu and Karaoglu, which examined 30 patients with spastic CP (diplegia, quadriplegia) aged 2-5 years. A total of 15 patients were placed into the neuro developmental treatment group (Group A), while 15 were placed into a conventional home exercise program (Group B). Group A received three 60-minute neuro developmental treatment sessions a day, three times a week, for 3 months on an outpatient basis. Gross motor function is assessed using Gross Motor Function Measure 88 (GMFM-88) before and after treatment. After 3 months, all dimensions of GMFM-88 improved significantly in Group A. Neuro developmental treatment contributes to all areas of gross motor function in children with spastic CP.

CONCLUSION

In conclusion, the administration of KT and NDT increased static sitting balance in patients with spastic diplegia and quadriplegic CP in GMFCS III and IV less than 5 years after 12 weeks of treatment at Saiful Anwar Hospital, East Java Province. The administration of NDT only increased static sitting balance.

The administration of KT and NDT, compared to NDT only, had a similar effect in improving the static sitting balance but did not affect selective movement control and dynamic reaching. Based on the results, NDT treatment did not affect selective movement control and dynamic reaching. The administration of KT and NDT improved gross motor function. Similar results were also obtained with the single NDT treatment. In general, KT and NDT treatment were more influential in improving gross motor function.

RECOMMENDATION

This study can be repeated with a larger number of samples. Considering that only a homogeneous type of CP, namely spastic diplegia was examined, future studies should determine whether there is a weaning effect (weaning) of KT use. There is also a need to compare the short/long-term effects of using KT to establish a reference for the recommended time limit of use.

REFERENCES

Ahmed, M. and Azzam. (2014), "Efficacy of Induced Spherical Based Modified Balance Board on Improvement of Sitting Level Stage on Spastic Cerebral Palsy Children", *J Novel Physiotherapies. 4:210*. [Crossref], [Publisher]

Badawy, W.M., Ibrahim, M.B. and Shawky, K.M. (2015), "The Effect Of Kinesio Taping On Seated Postural Control In Spastic Diplegic Cerebral Palsy Children.", *Med. J. Cairo Univ.*, Vol. 83 No. 2, pp. 37–44. [Publisher]

Hazmi, A. (2014), "A combination of neuro developmental treatment and sensory integration is better than just neurodevelopmental treatment for children with Down syndrome", Vol. 13, pp. 85–94. [Crossref], [Publisher]

Heyrman, L., Molenaers, G., Desloovere, K., Verheyden, G., De Cat, J., Monbaliu, E. and Feys, H. (2014), "A clinical tool to measure trunk control in children with cerebral palsy: the Trunk Control Measurement Scale", *Research in Developmental Disabilities*, Vol. 36 No. 2, pp. 2624–2635. [Crossref], [Publisher]

Hsu, H.., Chen, W.Y., Lin, H.C., Wang, W.T.J. and Shih, Y.F. (2019), "The effects of taping on scapular kinematics and muscle performance in baseball players with shoulder impingement syndrome", *Journal Of Electromyography And Kinesiology*, Vol. 19 No. 6, pp. 1092–1099. [Crossref], [Publisher]

Ibrahim, M.M. (2015), "Investigating effect of therapeutic taping on trunk posture and control in cerebral palsy children with spastic diplegia", *Journal of Medical Science and Clinical Research*, Vol. 03 No. 09, pp. 7452–7459. [Crossref], [Publisher]

Karabay, I., Dogan, A., Ekiz, T., Koseoglu, B.F. and Ersoz, M. (2016), "Training postural control and sitting in children with cerebral palsy: Kinesio taping vs. neuromuscular electrical stimulation", *Complementary Therapies in Clinical Practice*, Vol. 24 No. 67–72. [Crossref], [Publisher]

Kim, M. and Ko, J. (2014), "Reliability and responsiveness of the gross motor function measure-88 in children with cerebral palsy", *Physical Therapy*, Vol. 93 No. 3, pp. 393–400. [Crossref], [Publisher]

Partoazar, B., Ganji, B., Dalvand, H. and Shamsoddini, A. (2021), "The effect of trunk kinesio taping on static and dynamic balance and functional mobility in children with cerebral palsy", *Sport Sciences for Health*, Vol. 17 No. 1, pp. 111–117. [Crossref], [Publisher]

Pavao, S.L., Dos Santos, A.N., de Oliveira, A.B. and Rocha, N.A.C.F. (2014), "Functionality level and its relation to postural control during sitting-to-stand movement in children with cerebral palsy", *Research in Developmental Disabilities*, Vol. 35 No. 2, pp. 506–511. [Crossref], [Publisher]

Riskesdas. (2018), "Main Results of Riskesdas Data 2018". [Publisher]

Scheepers, K., Unger, M., Pronk, S., J.P, C., Pretorius, R., Robinson, A.. and Fernandes, N. (2018), "The efficacy of kinesiology taping for improving gross motor function in children with cerebral palsy: A systematic review", *South African Journal of Physiotherapy*, Vol. 74 No. 1, pp. 1–8. [Crossref], [Publisher]

Shamsoddini, A., Rasti, Z., Kalantari, M., Hollisaz, M.T., Sobhani, V., Dalvand, H. and Bakhshandeh-Bali, M.K. (2016), "The impact of Kinesio taping technique onchildren with cerebral palsy", *Iranian Journal of*

Neurology, Vol. 15 No. 4, p. 219. [Publisher]

Snodgrass, S., Farrell, S. and Tsao, H. (2018), "Shoulder Taping and Neuromuscular Control", *Journal of Athletic Training*, Vol. 53 No. 4, pp. 395–403. [Crossref], [Publisher]

Solomon, J.. and O'Brien, J.. (2020), *Pediatric Skills for Occupational Therapy Assistants E-Book*, Elsevier Health Sciences. [Publisher]

Sugiyono. (2019), *Metode Penelitian Kualitatif, Kuantitatif Dan R&D*, Alfabeta. [Publisher]

Tahmasebi Boroujeni, S., Shadmehri, M. and Pishdar, F. (2018), "The Effect of Selected Physical Activity on Eye-hand Coordination of Students with Dysgraphia", *Journal of Learning Disabilities*, Vol. 7 No. 2, pp. 55–71. [Publisher]

Tekin, F., Kavlak, E., Cavlak, U. and Altug, F. (2018), "Effectiveness of Neuro-Developmental Treatment (Bobath Concept) on postural control and balance in Cerebral Palsied children", *Journal of Back and Musculoskeletal Rehabilitation,* Vol. 31 No. 2, pp. 397–403. [Crossref], [Publisher]

Wahyuni, L.K. (2014), *Infant Functional Motor Development*, PB Perdosri, Central Jakarta. [Publisher]

Yasukawa, A., Patel, P. and Sisung, C. (2016), "Pilot study: Investigating the effects of Kinesio Taping® in an acute pediatric rehabilitation setting", *American Journal of Occupational Therapy*, Vol. 60 No. 1, pp. 104–110. [Crossref], [Publisher]

Zanon, M.A., Pacheco, R.L., Latorraca, C.D.O.C., Martimbianco, A.L.C., Pachito, D.V. and Riera, R. (2019), "Neurodevelopmental treatment (Bobath) for children with cerebral palsy: a systematic review", *Journal of Child Neurology*, Vol. 34 No. 11, pp. 679–686. [Crossref], [Publisher]