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### **Effect of Various Kinesiotaping Techniques in Cerebral Palsy: an Evidence Based Study**

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#### **ABSTRACT**

Cerebral Palsy (CP) children have motor dysfunction due to non-progressive brain damage. CP is the most common movement disorder in children associated with life-long disability and multiple impairments. Kinesio taping (KT) is a relatively new technique used in rehabilitation of neurological disorders. KT, as a novel adjunctive therapy, has the potential to be the useful tool for the treatment of various impairments of CP.

**KEYWORDS:** Kinesio taping, cerebral palsy, gait, hand function, motor function, drooling were used.

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## **INTRODUCTION**

Cerebral palsy is a permanent non-progressive disease affecting the development of the brain. The causative factors are preterm birth, intrauterine infection, per ventricular leukomalacia or intraventricular hemorrhage, brain malformations, or head trauma caused by an accident occurring prenatally, during the process of birth, or within 2 years after birth<sup>11</sup>. It is associated with life-long disability and multiple impairments<sup>17</sup>. The topographic classification of CP is hemiplegia, diplegia, and quadriplegia. Another classification is based on motor function as pyramidal (spastic) and extrapyramidal (non-spastic including athetoid, ataxic, and dystonic). The prevalence of CP is about 2 to 2.5 per 1000 live births<sup>17</sup>.

It causes postural and sensory integration changes due to problems in muscle tone, balance, coordination disorders and muscle weakness. All this affects a child's motor function and his/her autonomy. Children may also show associated cognitive, behavior, and sensation alterations, perceptual, visual, and hearing problems, urinary incontinence and constipation. These all lead to restrictions in their ability to perform basic activities of daily living (BADL).<sup>18</sup>

Common therapy approaches including orthosis, botulinum toxin, Constraint-Induced Movement Therapy (CIMT) and Neurodevelopmental Therapy (NDT) focus on enhancing postural control and muscle strength, improving motor activity in the upper and lower limbs, and improving walking<sup>13</sup> and orofacial facilitation focusing on oromotor problems<sup>16</sup>.

In recent years, Kinesio taping (KT) is a relatively new therapeutic tool used in rehabilitation program of children with cerebral palsy. Although it has been used for a long time in sport or orthopedic fields, and has been approved as a supplemental intervention for other functional impairments. Kinesio tape is a specialized elastic-like tape made of latex-free cotton fibers having no medication effect. It is designed to mimic the elasticity properties of the muscle, skin and fascia.<sup>17</sup> Kase et al. proposed that KT had corrected muscle function by strengthening weak muscles, improving circulation of blood beneath the skin by muscle movement, decreasing pain through neurological suppression and repositioning subluxed joints by relieving abnormal muscle tension<sup>12</sup>. When kinesio tape is attached to skin, it lifts the skin from the muscles and creates wrinkles that create a wider space between muscles and skin, thus improving the circulation of blood and lymph fluid<sup>11</sup>. It has been hypothesized that KT may favorably stimulate the cutaneous receptors of the peripheral sensor motor system, since these receptors are associated with pain, proprioception and motor control.<sup>17</sup>

KT application, in conjunction with other regular rehabilitation programs for the children with CP, may positively influence the sensorimotor system resulting in improved voluntary control and coordination<sup>17</sup>. In addition to investigate KT as a new therapeutic intervention, the main purpose

of this study is to have an evidence in order to evaluate the effectiveness of KT in neurorehabilitation of the children with CP. Another purpose of the present study is to collect the existing literature dealing with Kinesio taping in a single article, to analyze the results and finally to reach the overall conclusion.

## METHODOLOGY

In order to collect evidences for the effectiveness of KT on different impairments like fine motor activities, postural deviations, sitting control, standing, gait, oromotor impairments including drooling, incomplete lip closure, etc articles were searched and gathered.

The articles were searched in search engines like Google scholar, Pubmed, Cochrane library, Research gate, Elsevier and Medline. Keywords like Kinesio taping, cerebral palsy, gait, hand function, motor function, drooling were used. The reference articles were taken from International journal of development research, Disability and rehabilitation journal, Physical therapy rehabilitation science, The rehab journal, Developmental medicine and child neurology, IOSR journal, Medical journal of Cairo university, South African journal of physiotherapy and Iranian journal of Neurology. These articles were taken with references to explain cerebral palsy and effect of KT on different impairments of Cerebral Palsy.

Inclusion criteria were articles published from 2000 to 2018. Pediatric subjects diagnosed with cerebral palsy. KT should be used as an intervention either alone or as an adjunct with other non-surgical treatments. Original studies, systematic reviews, case studies, quasi-experimental studies and pilot studies were included.

Exclusion criteria were Participants with associated diseases interfering with study intervention and outcomes. Surgical approach used as an intervention along with kinesiotaping.

**Table 1: KT for hand functions**

AUTHOR	SUBJECTS/ SAMPLE DESIGN	PROTOCOL	OUTCOME MEASURES	RESULT	LEV -EL OF EVI- DEN -CE
Marwa Ibrahim (2015) <sup>1</sup>	M. RCT(N=30 hemiplegic CP) Study group (n=15) : kinesiotaping + traditional physical therapy for hand functions Control group (n=15) : only traditional physical therapy for hand functions	Control group: Traditional physical therapy program to facilitate hand function (reaching, grasp and release, and bilateral hand use), NDT, stretching and strengthening Study group: physical therapy + KT. KT was applied at the	1-Quality of Upper Extremity Skills Test (QUEST): The primary outcome measure was two domains of the QUEST (dissociated movement and grasp). 2- The range of wrist extension was determined using digital goniometer	Both total QUEST score and wrist ROM were significantly improved in both control and study groups in favor of the study group (P < 0.05). KT is a good therapeutic adjunctive therapy for hand function in children with hemiplegic cerebral palsy.	IB

		dorsum of hand and wrist and forearm, extending from MCP joints. KT was applied for 3-5 days and left off for 1-2 days and both group were treated for 3 months.			
Rasti ZA, Shamsoddini A, Dalvand H, Labaf S. (2017) <sup>2</sup>	Experimental study (n=32 CP children) Experimental group (n=17) and control group (n=15)	Intervention group: KT was done from origin of extensor digitorum to finger MCP joint; and from origin of extensor and abductor pollicis longus to thumb MCP joint. Tension of tape in muscular zone: 30% and joint area: 75%. Control group: KT was used as placebo with no tension and as sham.	Outcomes were taken immediately and 2 days after KT application, 2 days after KT removal. Goniometer was used to evaluate active ROM of wrist extension. Vigorimeter was used to evaluate of grip strength.	In pre-test, there was no difference between groups but in post-tests; initially after application of taping, 2 days after application of taping and 2 days after KT removal significant differences between trial and control group were found. KT in neurorehabilitation of children with CP can be an useful option to promote power or grip strength and active range of motion of wrist and thumb.	IB
Sujoy Roy, Jaya Dixit, Animesh Kumar, Op Singh (2018) <sup>3</sup>	Pre Test and Post Test experimental study design(n= 60 Spastic diplegic CP) Convenient sampling used.	Control group: Received occupational therapy for 1 hour for 1 month. Experimental group: Occupational therapy + KT. KT (5cm width) was applied from the lateral epicondyle of the humerus to the dorsal aspect of the hand till the tip of fingers, like a fan. The KT was kept for 3 days then area was left open for 24 hours. Then again applied and sequence was carried for a month.	Manual Ability Classification System (MACS) & Peabody development of motor skills (PDMS) was used as instruments for measuring improvement in fine motor skills of these children.	Results of PDMS are significant for experimental group and control group. Results of MACS in experimental and control group is also significant. Also the results show that Z value of PDMS is more making it more sensitive to capture changes in fine motor functions of children than MACS. It can be concluded that application of KT along with conventional occupational therapy can be used to enhance & improve fine motor skills in children with Spastic diplegic CP.	IIA
Ahmed A. Zahr el-din, Elham E. Salem, Shorouk el-Shennawy, Kamel H. Morsy. (2018) <sup>4</sup>	A Pilot Study (n=11 spastic hemiparetic CP) Mild hand and/or wrist spasticity (grade 1 to 1+) according to the MAS, and had impaired hand functions level II, III and IV according to MACS participated in this study.	Participants received KT for wrist and thumb in addition to the conventional physical therapy program(2-3 hours/week for 4 weeks) which included NDT, stretching and strengthening exercises and occupational therapy.	Evaluation before and after 4 weeks using the Grasping subtests of the Quality of Upper Extremity Skills Test (QUEST) and Peabody Developmental Motor Scale (PDMS)	After 4 weeks of intervention results showed that no significant changes post treatment application when compared with corresponding pretreatment for the PDMS and QUEST scores. These results suggested that 4 weeks KT was not effective in improving the hand functions of spastic hemiparetic cerebral	III

					palsy children.	
Saraswati B. Chitaria, Amitesh Narayan, Sailakshmi Ganesan, Niraj Biswas (2015) <sup>5</sup>	A Quasi-Experimental Study(n=15 children) CP	Kinesio Tex tape was applied on wrist extensors (lateral epicondyle of humerus to dorsal aspect of metacarpal head) for 3 days on 15 children with CP aged 3 to 6 years.	Pre and post-outcome measures for fine motor function was PDMS-2 and active wrist extension ROM were recorded on pre-tape application, pre-tape removal and post-tape removal.	Significant changes were found in PDMS-2. AROM of wrist extension changed. However, these were not significant. Kinesio Tex tape may improve fine motor skills in children with CP, and as an adjunct to treatment, may assist in achieving goal-oriented functional activities.	IIB	

**Table 2: KT for sitting control and postural correction**

Tulay Tarsuslu Simsek, Bahriye Turkucuoglu, Nilay Cokal, Gonca Ustunbas, Ibrahim Engin Simsek (2011) <sup>6</sup>	RCT (N=31) Study Group(n=15): receiving KT and physiotherapy Control group (n=15): receiving only physiotherapy.	Control group received exercises focusing on tone regulation, activities of upper extremity like grasp–release and activities of sitting and balance reactions related to sitting (1hr/day for 3 days/week for 12 weeks) Study group: exercises with same dosage and kinesiotaping to paraspinal muscles (fan shaped) for 3 days and then removed for 24 hours and then reapplied and cycle continued for 12 weeks.	Gross motor function measure (GMFM), functional independence measure for children (WeeFIM) and Sitting Assessment Scale (SAS) were used to evaluate gross motor function, independency in the activities of daily living and sitting posture, respectively.	Both groups showed a significant difference in parameters of GMFCS and SAS scores. After 12 weeks, SAS and WeeFIM scores were significantly different in favour of the study group. No direct effects of KT were observed on gross motor function and functional independence, though sitting posture (head, neck, foot position and arm, hand function) was affected positively.	IB
Ilkay Karabay, Asuman Dogan, Timur Ekiz, Belma Fusun Koseoglu, Murat Ersoz (2016) <sup>7</sup>	RCT(n=75 spastic diplegic CP) Control group (n=25): conventional physiotherapy. KT group(n=25): KT+ PT NMES group(n=25): NMES + PT	Conventional physiotherapy included bobath approach of NDT (75 minutes/day for 4days/week for 4 weeks). Kinesiotaping was applied in I-shape from AC joint to T-12 obliquely (3-4/week for 4 weeks). NMES was given by 2 surface electrodes placed over and under umbilicus and 2 over paraspinals of lumbar region(20-30 mA; 25 Hz; 250µ; on:off = 10s:12s)	Sitting subset of Gross Motor Function Measure(GMFM). Kyphotic angles were evaluated in X-rays using cobb method.	GMFM and kyphosis values improved significantly in all groups, yet change levels were more prominent in the KT and NMES groups than the control group. Moreover, NMES group showed better improvement. 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.	IB
Wanees Badawy, Mohamed Ibrahim, Khaled Shawky. (2015) <sup>8</sup>	RCT(n=30 spastic diplegic CP) Group 1(n=15): KT + PT Group 2(n=15): PT	All patients in both groups received the designed physical therapy based on NDT which directed towards inhibiting abnormal muscle tone and abnormal reflexes	The children were evaluated by sitting score of GMFM and radiographic studies (Kyphotic and Cobb's angles) were carried out on the whole spine while the	There was a statistically significant improvement in the measured parameters in both groups but in favor of the study group. The obtained results suggest that the	IB

		and facilitation of normal Kyphotic angle(1.5hr/day for 3 times/week for 12 weeks). Kinesiotaping was applied to paraspinals in caudal-cephalo direction and lower portion of trapezius (3 days applied and 24 hrs removed for 12 weeks).	children were sitting before and after treatment.	application of kinesio taping over the trunk become a beneficial therapeutic technique in improving the sitting posture and trunk control when adjunct to a physical therapy program.	
Marianne Unger, Juan P. Carstens, Natasha Fernandes, Rulanda Pretorius, Suzelle Pronk, Ashleigh C. Robinson, Kara Scheepers. (2018) <sup>9</sup>	A systematic review Seven databases and Five level IIB RCTs that scored 3–6/8 on the PEDro scale were included.	Interventional group of all RCTs received Kinesiology taping applied to the trunk(fan technique for paraspinals and I-shaped for scapular stabilization) and conventional physiotherapy (including NDT, constraint-induced manual therapy [CIMT], stretching, muscle strengthening, tone modulation exercises, gait reeducation and balance re-education exercises). Control group received only conventional physiotherapy as mentioned above.	Studies were included if they used outcome measures assessing GMF – including, but not limited to, motion analysis, the Gross Motor Function Measure (GMFM), Paediatric Balance Scale (PBS), Timed-Up-And-Go (TUG), Bruininks–Oseretsky Test of Motor Proficiency (BOTMP) and Sitting Assessment Scale (SAS). Only one study evaluated effects after 4 weeks rest all RCTs were evaluated after 12 weeks.	Meta-analysis showed that taping was effective for improving GMF in sitting and standing as measured by the Gross Motor Function Measure. There is moderate evidence to support kinesiology taping applied to the trunk as an effective intervention when used as an adjunct to physiotherapy to improve GMF in children with CP, especially those with GMF Classification Scale levels I and II, and particularly for improving sitting control.	IA
Cheryl Burditt Footer (2006) <sup>10</sup>	RCT (n=18 quadriplegic CP) Group 1(n=9): KT+ physiotherapy Group 2(n=9): only physiotherapy	Physiotherapy included Program for physically impaired (group 1; n=4 and group 2; n=5) and program for profoundly mentally handicap. Kinesiotaping to group 1 was applied to paraspinal muscle in caudal-cephalo direction and another tape to lower course of trapezius. (72 hours/week and for 12 weeks)	The effects were assessed with the Gross Motor Function Measure (GMFM-88) at baseline, six weeks, and 12 weeks. A factorial analysis of variance was used to examine group differences over time.	No significant differences were found for the GMFM-88 scores between groups over time. Therapeutic taping does not evoke a positive functional change in the seated postural control of children with quadriplegic cerebral palsy.	IB

**Table 3: KT for Gait performance**

Sun-Hye Junga, Sun-Hae Song, Da-Rye Kim, Seul-Gi Kim, Ye-Jin Park, Yeon-Jung Son, GyuChang Lee. (2016) <sup>11</sup>	A pilot and a cross-sectional study (n=4 spastic diplegic CP) Kinesiotaping for rectus femoris, gluteus maximus and tibialis anterior is applied.	For the tibialis anterior muscle, the kinesio tape was attached along a line that passed the medial condyle of the ankle and the medial sole and went to the centerline of the instep with the ankle in a state of plantar flexion. For the rectus femoris muscle, the tape was	The participants were asked to walk a 10m distance 3 times in each condition with and without kinesio taping, with a 5-minute rest between each condition. Parameters including gait velocity, cadence, step length, stride length, single	There were significant improvements in gait velocity, step length, stride length, and single support time of the right leg with kinesio taping condition compared to the without kinesio taping condition. However, there were no significant differences in cadence, single support	III
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		<p>applied from 10 cm below the ASIS to the superior edge of the patella (without tension) then crossed from the edges of the patella (with maximum tension) and fixed below the inferior edge of the patella while the knee was flexed.</p> <p>For the gluteus maximus muscle, two Y-shaped pieces of tape were applied.</p>	<p>support time, and double support time were evaluated using GAITRite.</p>	<p>time of the left leg, or double support time. The results show that kinesio taping may have a positive effect for improving gait parameters of children with spastic diplegia.</p>	
<p>Tank Ozmen, Ece Acar, Tuba Zoroglu, Hammet Isik. (2017) <sup>12</sup></p>	<p>Pre-post comparative study (N=19 ambulant spastic hemiplegic CP)</p>	<p>Pre evaluations were done. Then KT was applied for gastrocnemius muscle in Y shape with 25% tension to inhibit it and to Tibialis Anterior muscle in a I-shape for functional correction and facilitating dorsiflexion. KT was applied for 48 hrs.</p>	<p>Baseline, immediately after KT application and after 48 hrs evaluations were recorded. ROM : plantar and dorsiflexion of ankle. Plantar flexor muscle tone using Modified Ashworth Scale. Gait performance using 1-min walk test. Balance using PBS and mTUG.</p>	<p>ROM and tone were unchanged. However, there were significant changes found in gait performance, PBS and mTUG after 48 hrs but not immediately. So KT don't have any effect on tone and ROM but improves gait and balance after 48 hours.</p>	<p>IIB</p>
<p>Ozgun Kaya Kara, Songul Atasavun Uysal, Duygu Turker, Sedef Karayazgan, Mintaze Kerem Gunel, Gul Bal Taci (2014) <sup>13</sup></p>	<p>A single-blind, RCT. (n=30 unilateral spastic CP) Control group (n=17): only conventional physiotherapy. KT group(n=18): KT+PT (mentioned about 7 dropouts)</p>	<p>The control group received traditional therapy consisted of NDT (stretching, weight bearing, functional reach, walking, etc) (2 times/week for 12 weeks) KT was applied for upper limb [wrist extension and scapular stabilization] and for lower limbs ['I' band to facilitate hip abduction i.e. gluteus medius muscle facilitation technique, and functional correction for knee hyperextension and dorsiflexion]. 3 days taping was applied and then rest for 24 hours. (6 days/week for 12 weeks).</p>	<p>All participants were evaluated with the Functional Independence Measure for Children (WeeFIM), the Bruininks–Oseretsky Test of Motor Proficiency (BOTMP), the Gross Motor Function Measure (GMFM), short-term muscle power, agility and functional muscle strength tests.</p>	<p>There were significant differences in muscle power sprint, lateral step-up test right, sit to stand, attain stand through half knee right, BOTMP Gross scores, and WeeFIM total and self-care scores between the groups. Kinesio Taping is a promising additional approach to increase proprioceptive feedback and improve physical fitness, gross motor function, and activities of daily living in children with CP.</p>	<p>IB</p>
<p>Carolina Souza Neves Da Costa, Fernanda Simioni Rodrigues, Fernanda Mustafe Leal, Nelci Adriana</p>	<p>A pilot study(n=4 left hemiplegic CP) Assessed without taping as control condition (CC) and then taping was applied and assessed</p>	<p>Before taping, through motion analysis 3 reps. of sit to stand (STS), PBS and TUG were recorded and then 3 min rest was given. After rest KT was</p>	<p>A motion analysis system was used to measure total duration of STS movement and angular movements of each joint.</p>	<p>Compared to CC, decreased total duration of STS, lower peak ankle flexion, higher knee extension at the end of STS, and decreased total time in TUG; but no</p>	<p>III</p>

Cicuto Ferreira Rocha. (2012) <sup>14</sup>	as interventional group.	applied to quadriceps (Y-shape) and tibialis anterior (I-shape) from origin to insertion. After that 2 reps. of STS were recorded and PBS and TUG were also evaluated.	Pediatric Balance Scale (PBS) and Timed up and Go (TUG) were also applied.	differences were obtained on PBS score in KT. Neuromuscular taping seems to be beneficial on dynamic activities, but not have the same performance in predominantly static activities studied.	
Adriana Neves dos Santos, Livia Pessarelli Visicatto, Ana Beatriz de Oliveira, Nelci Adriana Cicuto Ferreira Rocha (2018) <sup>15</sup>	A placebo-controlled, repeated-measure design(n=11 unilateral CP) All children were assessed without taping, with taping and placebo taping.	All the 3 conditions were assessed in all children within 2 days. 2 conditions on 1 day with 15 min. interval in between and remaining condition on next day. Kinesiotaping was applied to rectus femoris in Y-shape with 100% tension and in placebo group without tension. In all conditions, children performed sit-to-stand for 5 times (30s rest in between) and 3 recordings were selected. 3 different seat heights were used (80°,90° & 120°)	Muscle activity (EMG) and trunk and lower limb alignment (kinematics) were evaluated as body structures and function measures. Time required to perform sit-to-stand was used as a functionality measure. A portable surface electromyograph synchronized with the Qualisys system was used to evaluate rectus femoris activity.	KT increased rectus femoris activity, decreased peak flexion of the trunk, knee, hip, and ankle, and increased trunk extension in the end of sit-to-stand when compared with without Kinesio taping and placebo. Total duration was decreased with lower effect sizes. Immediate application of Kinesio taping modified body structures and function measures during sit-to-stand in children with unilateral CP, but it did not alter functionality.	IIA

## CONCLUSION

There are different levels of evidences found for different types of application of KT in CP children. It can be concluded that there is a strong evidence supporting the improvement in hand functions by using kinesio taping as an adjunctive therapy (Marwa, 2015). KT in neurorehabilitation of children with CP can be an useful tool to promote Active Range of Motion of wrist and thumb, grip strength and fine motor skills. There is strong evidence supporting the improvement in sitting and postural control after the application of KT. Sitting subset of GMFM and kyphotic angles were improved significantly which suggests strong evidence supporting KT as an effective adjunctive intervention for sitting and postural control. There is moderate evidence supporting KT as an adjunctive method for improving gait performance and static and dynamic balance. The majority of consistent findings showed that KT technique as part of a multimodal therapy program can be effective in the rehabilitation of children with CP to increase proprioceptive feedback and improve physical fitness, gross motor function, and activities of daily living especially in higher developmental and motor stages.

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## **CONFLICT OF INTEREST**

There was no personal or institutional conflict of interest for the study.

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