The effects of Kinesio Taping on body functions and activity in unilateral spastic cerebral palsy: a single-blind randomized controlled trial

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ABBREVIATIONS

BFMF	Bimanual fine motor function
BOTMP	Bruininks–Oseretsky Test of Motor Proficiency
ICF-CY	International Classification of Functioning, Disability and Health for Children and Youth
MACS	Manual Ability Classification System
PBS	Paediatric Balance Scale
SAS	Sitting Assessment Scale
STS	Sit-to-stand
TUG	Timed up and go
WeeFIM	Functional Independence Measure for Children

AIM The aim of this study was to investigate the effects of Kinesio Taping (KT) on the body functions and activity of children with unilateral spastic cerebral palsy (CP).
METHOD This study was designed as a single-blind, randomized, controlled trial. Thirty children with unilateral spastic CP were randomized and split equally between the KT group (eight males, seven females; mean age 9y [SD 2y 3mo] range 7–12y) and the control group (seven males, eight females; mean age 9y 7mo [SD 3y 4mo] range 7–14y) receiving usual care. 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. Wilcoxon signed-rank and Mann–Whitney *U* tests were used to evaluate within and between-group differences respectively. The level of significance was accepted as $p<0.05$.
RESULTS There were significant differences in muscle power sprint ($p=0.003$), lateral step-up test right ($p=0.016$), sit to stand ($p=0.018$), attain stand through half knee right ($p=0.003$), BOTMP Gross scores ($p=0.019$), and WeeFIM total ($p=0.003$) and self-care scores ($p=0.022$) between the groups ($p<0.05$).
INTERPRETATION 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.

Motor dysfunction in cerebral palsy (CP) is frequently related to muscle weakness. Impairments in sensory integration and balance, spasticity, co-activation of agonist and antagonist muscles, lack of selective motor control, and decreased anaerobic muscle power and agility cause impairment of body structures/functions and activity limitation.[1,2] Common therapy approaches (including orthosis, botulinum toxin, constraint-induced movement therapy and neurodevelopmental therapy) focus on enhancing postural control and muscle strength, improving motor activity in the upper and lower limbs, and improving walking.[3,4] Over the past decade, the use of evidence-based interventions in CP treatment has gradually increased and investigators have tried to develop more effective interventions to improve the quality of life of these children and their families. A recent review has reported that interventions based on motor learning increase activity levels in children with CP.[5] Therefore, using taping in CP might be a promising technique to ensure such improvement.[6,7]

Kinesio Taping (KT) is commonly used in sport injuries, in neurology and oncology patients following the surgical protocols, and for paediatric rehabilitation to reduce pain, facilitate or inhibit muscle activity, prevent injuries, reposition joints, aid the lymphatic system, support postural alignment, and improve proprioception.[7–9] Although its mechanism of action has not been fully understood, it is believed that activation of the cutaneous receptors could influence neuromuscular functions.[10] The cutaneous sensory system provides preliminary information about limb positions and muscle forces to the central nervous system for monitoring and controlling limb movements, planning actions, and providing fluent movement.[11] Common causes of unilateral spastic CP are middle cerebral artery infarct, hemi-brain atrophy, periventricular lesions, and brain malformations that disturb the integrity of the motor areas. Middle cerebral artery infarctions can particularly impair the somatosensory system. Children with unilateral spastic CP and middle cerebral artery infarct, therefore, often suffer sensory impairments that could affect the development of future motor skills.[12] Yasukawa et al.[7] stated that the use of Kinesio Taping might influence the cutaneous receptors of the sensory motor system, resulting in the improvement of voluntary control and coordination in a physiotherapy programme for children with CP.

There are increasing reports of the clinical use of taping techniques on children with CP. A few studies focusing on upper extremities have reported that taping application recruited upper limb function, especially the preparation for motion and the returning phases,[13] and allowed a more functional range of motion, improved selective finger movements and fine motor manipulation,[14] developed goal-directed movement, increased stability of the shoulder and hand, and supported alignment during reaching and grasping.[7] Other studies that investigated the effects of taping applications on gross motor function and postural control showed a significant improvement on postural control in the sitting position only in a child with athetoid CP,[15] improvement of locomotor motion, facilitation of normal activity, support for weak muscles,[6] increase of trunk stability,[16] and improved agility in sit-to-stand (STS) motion.[17] Kinesio Taping is a relatively new technique which uses Kinesio Tex tape. It is one of the most widely-used taping methods because of elastic, adhesive, latex-free, thin features of the material that can be stretched in the longitudinal plane. Kinesio Taping can be stretched from 40 to 60% of its resting length. This is similar to the elastic qualities of human skin. This elasticity of the tape allows more movement and feels more comfortable. Kinesio Taping can therefore be conveniently used in children with CP.[7,12]

The International Classification of Functioning, Disability and Health for Children and Youth (ICF-CY) describes the characteristics of childhood functions, guides the selection of measurement tools, and determines meaningful outcomes.[18] From the ICF-CY perspective, Kinesio Taping in conjunction with other therapeutic interventions could promote integration of the rehabilitation process, increase independent daily activities and social participation or the quality of these activities, and improve gross and fine motor functioning.

There are few studies on the effects of Kinesio Taping in children with CP and the results are conflicting.[7,16,17] However, no randomized control trial has been performed to show the effects of the procedure on both the upper and lower extremities. The aim of this study was to investigate the effects of Kinesio Taping on the ICF body structures/functions and activity domains in children with unilateral spastic CP. We hypothesized that Kinesio Taping might improve performance-related physical fitness, gross and fine motor capacity, and independent function in daily living activities in children with unilateral spastic CP.

METHOD

This study was designed as a single-blind randomized controlled trial of KT on both the upper and lower extremities in unilateral spastic CP compared with usual care. The permission of the University Ethics Committee was received (Project: HEK 12/176) and written informed consent was obtained from each participant and/or guardian.

What this paper adds

- Insight into the effectiveness of Kinesio Taping on body functions and activity in children with unilateral CP.
- It shows that Kinesio Taping is effective on performance-related physical fitness, gross motor function, and activities of daily living.

Participants

Thirty-seven children with unilateral spastic CP were referred to the Department of Physiotherapy and Rehabilitation by paediatric neurologists between November 2009 and October 2013. The inclusion criteria were age between 7 years and 14 years; classified in levels I or II of the Gross Motor Function Classification System (GMFCS); and able to follow and accept verbal instructions. The exclusion criteria were (1) any orthopaedic surgery or botulinum toxin injection in the past 6 months, (2) children whose parents refused to participate and (3) children with allergic reactions to the adhesive compound of Kinesio tape.

Procedure

The children were pre-stratified according to three variables: sex, Manual Ability Classification System (MACS) level (I, II–III), and age (youngest: 7–9y; oldest: 10–14y). They were subsequently randomized to one of two groups using a random number allocation table by an independent researcher. Of the 37 participants, 18 were randomized to the taping group and 17 to the control group as shown in the flow chart (Fig. 1). One participant had an allergic reaction to the tape and two patients discontinued treatment. In the control group, two participants did not attend the last evaluation.

Measurements

Gross motor function was classified using the GMFCS,[19] self-initiated manual hand function with MACS,[20] and fine motor function with the Bimanual Fine Motor Function (BFMF) scale.[21]

Body structures

Body composition was evaluated by body mass index (BMI) calculated with the formula as weight in kilogrammes divided by the square of the height in metres. Weight was measured with a standard electronic device and height with a stadiometer.

Body functions

Short-term muscle power was evaluated using the mean power and peak power obtained from the Muscle Power Sprint Test that has been found to be reliable in children with CP. Children run 6 to 15 m at maximum pace during this test.[22] Power output was calculated for each participant from the collected data by using the following equations:[22]

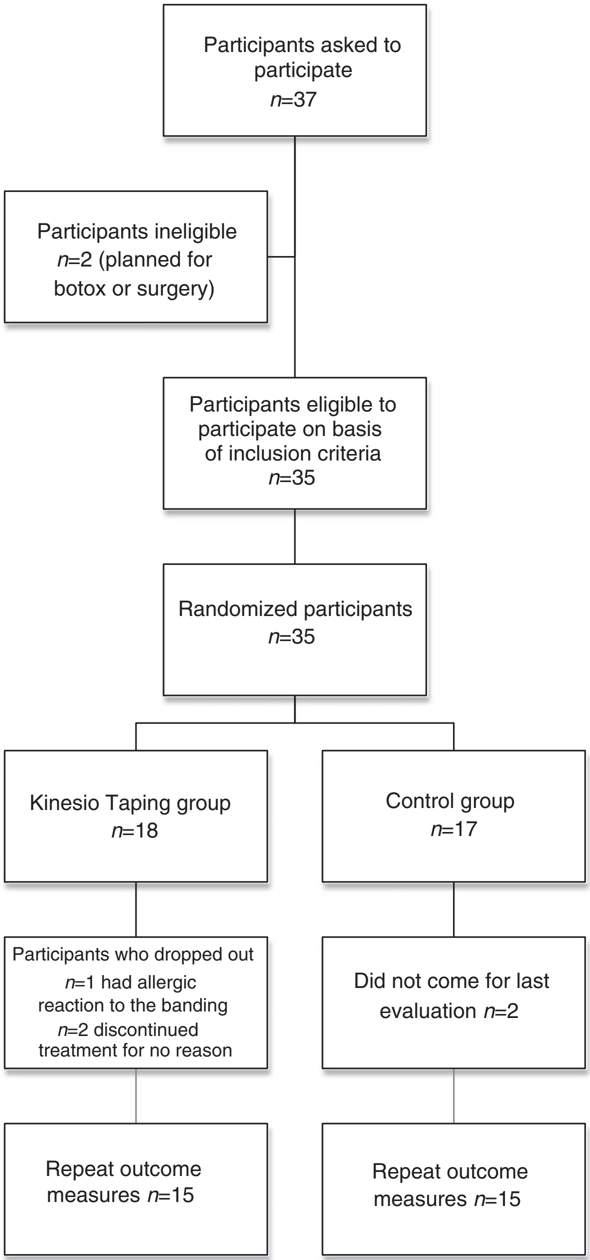

Figure 1: Flow chart of participants.

$$\text{Velocity}\ (\text{m/s}) = 15\ \text{m/time}$$

$$\text{Acceleration}\ (\text{m/s}^2) = \text{velocity/time}$$

$$\text{Force}\ (\text{kg/s}^2) = \text{body mass} * \text{acceleration}$$

$$\text{Power (watts)} = \text{force} * \text{velocity}$$

Agility was measured using the 10×5m sprint test that has been found to be reliable and valid in children with CP.[22]

The 30 seconds Repetition Maximum test, which has been found to be reliable in children with CP, was used to assess functional muscle strength of the lower extremities. The three closed kinetic chain exercises of lateral step-up test, STS and attain stand through half kneel were used. The children were instructed to perform as many repetitions as possible in 30 seconds for each of the exercises. Lateral step-up and attain stand through half kneel were evaluated bilaterally. The repetition maximum for each side was used to calculate total scores for the left and right side and thus five final scores were obtained.[23]

Activity functioning

Gross motor function was assessed using dimensions D and E of the Gross Motor Function Measurement (GMFM), which consists of standing, and walking, running, and jumping.[24]

The Bruininks–Oseretsky Test of Motor Proficiency-version 1 (BOTMP), which is a standardized, norm-referenced measure used by physical therapists and occupational therapists in clinical and school practice settings, was used to assess motor function.[25,26] This test is currently used in paediatric rehabilitation to describe motor problems of children aged between 4 years 6 months and 14 years 6 months.[27] The BOTMP includes eight norm-referenced subtests containing 46 items, which formulate a gross motor composite score and a fine motor composite score. The test consists of three composites including gross motor skills (running speed and agility, balance, bilateral coordination and strength), combined gross and fine motor skills (upper-limb coordination) and fine motor skills (response speed, visual-motor control and upper-limb speed and dexterity). Intraclass correlation coefficient values for intrarater and interrater reliabilities in the BOTMP were 0.998 to 0.999 and 0.987 to 0.998 respectively.[27]

ACTIVITIES OF DAILY LIVING

The Functional Independence Measure for Children (WeeFIM) was used to assess the level of independence in activities of daily living. The method measures functional performance in three domains: self-care, mobility, and cognition.[28] The lowest total score is 18 and the highest total score 126.[29] Intrarater (r=0.92) and interrater (r=0.81) reliability has been demonstrated using this measure.[30]

Outcome measures were evaluated at baseline and after the intervention (week 12) by two experienced physiotherapists blinded to group allocation of the children. All participants were evaluated with the WeeFIM[31] and BOTMP[25,26] by a physical therapist with 14 years' occupational therapy experience and GMFM,[32] Muscle Power Sprint Test,[22] 10×5m sprint test,[22] and 30 seconds Repetition Maximum test[23] by a physiotherapist with 8 years' experience. Oxygen saturation and heart rate were measured with a pulse oximeter just before and after, and 10 minutes after the assessments.

Intervention

The children were taped 6 days per week for a total of 72 days extending over a period of 12 weeks. The 5cm tape (Kinesio Tex, Gold; Kinesio UK, Newcastle upon Tyne, UK) we used was kept in position for 3 days and the region was then left to rest for 24 hours. Kinesio Taping was then re-applied by the same experienced research assistants for another 3 days. One of them taped upper extremities and the other taped lower extremities. For upper and lower limb application, the buttonhole wrist extension for space correction technique, fascia correction technique with 'I' taping for scapular stabilization and postural control, the muscle technique with 'I' taping for forearm supination support, 'I' band to facilitate hip abduction (gluteus medius muscle facilitation technique), and functional correction for knee hyperextension and dorsiflexion were used for all patients. The control group received routine traditional therapy twice a week over the period of 12 weeks. This routine traditional treatment consisted of neurodevelopmental treatment by the same clinical physiotherapist (stretching, weight bearing, functional reaching, walking, and so on). The Taping group also attended these traditional treatments. Parents were informed about the application of Kinesio Taping.

Statistical analysis

The Statistical Package for the Social Sciences (SPSS) version 21 for the Macintosh (IBM SPSS Statistics; IBM Corporation, Armonk, NY, USA) was used to analyze the obtained data. One-sample Kolmogorov–Smirnov Tests were used to evaluate distribution of variables before test selection. Descriptive analyses were presented using medians and the interquartile ranges for the non-normally distributed and ordinal variables. Differences in physical characteristics between the Taping and control groups were analyzed using the χ^2 test for categorical variables (sex, hemiplegic side, MACS, GMFCS E&R, and BFMF) and the Mann–Whitney *U* test for continuous variables (age, height, weight, BMI). Baseline, post intervention, and change scores were calculated. The Wilcoxon signed-rank test was used to compare the difference in dimensions D and E of the GMFM, short-term muscle power, agility, functional muscle strength, BOTMP, and the WeeFIM between baseline and post intervention scores within groups. The Mann–Whitney *U* test was used to compare change scores and the improvement differences of dimensions D and E of the GMFM, short-term muscle power, agility, functional muscle strength, BOTMP, and WeeFIM between groups. Effect sizes (ES) were calculated by using GPower V.3.1.7 (University of Kiel, Kiel, Germany). Mean differences were represented with paired and independent *t*-tests. The level of significance was set at $p<0.05$.

RESULTS

Participants comprised 30 children with unilateral spastic CP randomized and split equally between the Kinesio Taping group (eight males, seven females; mean age 9y [SD 2y 3mo] range 7–12y) and the control group (seven males, eight females; mean age 9y 7mo [SD 3y 4mo] range 7–14y) receiving usual care. Descriptive statistics are shown in Table I. There were no statistical differences between the groups. Baseline data showed that each group was well-matched including age, height, weight, BMI, sex, hemiplegic side, and functional level.

Body functions

At baseline, there were no statistically significant differences between the Kinesio Taping and control groups. Median scores and comparison of baseline scores before and after treatment are presented in Table II. After 12 weeks, the Taping group showed improvement in the Muscle Power Sprint Test (mean −8.15, ES 0.56, p=0.011), lateral step-up test right and left (mean −3.93, ES 0.85, p=0.01; mean: −6.4, ES 1.28, p=0.008), STS (mean −2.46, ES 1.14, p=0.004), and attain stand through half kneel right and left (mean −3.13, ES 1.46, p=0.001; mean: −1.93, ES 0.62, p=0.039). According to the change in outcomes from baseline to 12 weeks (Table III) the Kinesio Taping group showed significant differences in the Muscle Power Sprint Test (mean −6.63, ES 0.54, p=0.003), lateral step-up test right (mean 3.53, ES 0.89, p=0.016), STS (mean 2.06, ES 1.01, p=0.018), and attain

Table I: Physical characteristics of the participants[a]

	KT group (n=15)	Control group (n=15)	p^b
Age (y)	7.5 (7–11.5)	7.2 (7–13.7)	0.83
Mean (SD)	9.07 (2.39)	9.76 (3.41)	
Height (cm)	1.22 (1.15–1.40)	1.21 (1.18–1.55)	0.40
Weight (kg)	24 (21–33)	23 (19–48)	0.83
BMI (kg/m^2)	16.12 (14.66–17.39)	15.70 (14.36–19.91)	0.95
	n (%)	n (%)	
Sex			
Female	7 (46.6)	8 (53.3)	0.72
Male	8 (53.3)	7 (46.6)	
Hemiplegic side			
Left	9 (60)	8 (53.3)	0.71
Right	6 (40)	7 (46.7)	
GMFCS E&R			
Level I	10 (66.7)	14 (93.3)	0.07
Level II	5 (33.3)	1 (6.7)	
MACS			
Level I	7 (46.7)	7 (46.7)	0.66
Level II	3 (20)	5 (33.3)	
Level III	5 (33.3)	3 (20)	
BFMF			
Level I	6 (40)	7 (46.7)	0.62
Level IIA	4 (26.7)	5 (33.3)	
Level IIB	1 (6.7)	1 (6.7)	
Level IIIA	4 (26.7)	2 (13.3)	

[a]Values are median (25th, 75th centile) for continuous variables, frequency for categorical variables. [b]Mann–Whitney *U*-test for continuous variables and the χ^2 test for categorical variables. *p*-values of <0.05 were considered significant. KT, Kinesio Taping; BMI, body mass index; GMFCS E&R, Gross Motor Function Classification System, Extended and Revised; MACS, Manual Ability Classification System; BFMF, Bimanual Fine Motor Function Scale.

Table II: Before and after treatment values of the Kinesio Taping and control groups[a]

	KT group (n=15)				Control group (n=15)				Comparison of baseline scores	
	Before median (25–75%)	After median (25–75%)	Z	p^b	Before median (25–75%)	After median (25–75%)	Z	p^b	Z	p^c
Body functions										
10×5m sprint test	37.85 (30.0–44.97)	35.2 (30.25–39.8)	−1.533	0.125	31.75 (27.45–42.00)	35.10 (28.15–37.66)	−0.312	0.755	−1.05	0.290
Muscle Power Sprint Test (s)	5.23 (4.18–6.0)	4.58 (4.06–5.42)	**−2.840**	**0.005**[d]	6.31 (4.64–7.38)	5.91 (4.6–7.4)	−0.028	0.977	−0.95	0.340
Mean power (watts)	24.41 (15.58–57.84)	38.12 (24.3–63.06)	**−2.556**	**0.011**[d]	11.66 (8.16–40.37)	13.76 (8.50–35.57)	−0.341	0.733	−0.726	0.468
Peak power (watts)	30.86 (16.47–75.33)	49.94 (26.28–84.59)	**−2.953**	**0.003**[d]	14.91 (10.28–55.23)	9.56 (16.18–40.65)	−0.734	0.463	−0.892	0.373
Lateral step-up test right	23.0 (19.0–27.0)	26 (23–32)	**−2.560**	**0.010**[d]	25 (19–30)	27 (20–30)	−0.985	0.324	−0.89	0.371
Lateral step-up test left	21.0 (19–29)	23 (20–31)	**−2.632**	**0.008**[d]	23 (19–30)	25 (18–32)	−1.263	0.207	−0.58	0.560
Sit to stand	8 (7–12)	11 (9–13)	**−2.915**	**0.004**[d]	10 (7–10)	10 (8–11)	−0.724	0.469	−0.31	0.751
Attain stand through half knee right	17 (15–23)	20 (18–25)	**−3.194**	**0.001**[d]	20 (15–22)	19 (10–22)	−0.600	0.549	−0.35	0.723
Attain stand through half knee left	18 (16–22)	21 (17–24)	**−2.069**	**0.039**[d]	17 (13–21)	17 (13–20)	−0.275	0.784	−0.85	0.394
Activity										
Functioning										
GMFM D (standing)	94.87 (87.17–100)	97.43 (94.87–100)	**−2.201**	**0.028**[d]	97.43 (89.74–100)	97.43 (94.87–100)	−1.604	0.109	−0.40	0.684
GMFM E (walking, running, jumping)	95.83 (91.66–98.61)	97.22 (97–100)	**−2.812**	**0.005**[d]	94.44 (93.04–98.61)	95.83 (94.44–100)	−2.096	**0.036**[d]	−0.23	0.818
BOTMP total	2 (0–3)	2 (0–4)	−1.099	0.272	2 (1–4)	2 (1–5)	−0.323	0.746	−0.84	0.399
Gross	12 (3–16)	13 (8–21)	**−2.240**	**0.025**[d]	12 (6–23)	11 (0–18)	−1.340	0.180	−0.62	0.533
Fine	11 (5–16)	11 (7–15)	−0.900	0.368	9 (6–19)	11 (5–19)	−0.491	0.624	−0.47	0.633
WeeFIM total	113 (91–119)	116 (104–120)	**−3.315**	**0.001**[d]	120 (117–126)	121 (117–126)	−1.414	0.157	**−2.49**	**0.013**[d]
Self-care	34 (24–38)	33 (28–40)	**−2.437**	**0.015**[d]	40 (37–42)	40 (40–42)	−1.638	0.101	**−2.84**	**0.004**[d]
Sphincter	14 (14–14)	14 (14–14)	−1.414	0.157	14 (14–14)	14 (14–14)	0.000	1000	−1.79	0.073
Mobility	19 (15–21)	20 (17–21)	**−2.232**	**0.026**[d]	21 (19–21)	21 (20–21)	−1.857	0.063	−1.55	0.119
Locomotion	13 (11–14)	14 (12–14)	−1.841	0.066	14 (14–14)	14 (14–14)	−1000	0.317	−1.90	0.057
Communication	14 (11–14)	14 (14–14)	−1.633	0.102	14 (12–14)	13 (12–14)	−0.816	0.414	−2.27	0.785
Social communication	20 (15–21)	20 (18–21)	−1.841	1000	21 (18–21)	21 (18–21)	−1.414	0.157	−1.08	0.279

[a]Values are median (25th, 75th centile). [b]p-value for within-group change calculated using Wilcoxon signed-rank test. [c]p-value for between-group difference in baseline scores calculated using Mann–Whitney U tests. [d]Statistically significant at p<0.05. KT, Kinesio Taping; GMFM, Gross Motor Function Measurement; BOTMP, Bruininks–Oseretsky Test of Motor Proficiency-version 1; WeeFIM, Functional Independence Measure for Children. Bold values statistically significant $p < 0.05$.

Differences between baseline and 12 weeks[a]	KT group	Control group	Mann–Whitney U	p[b]
Body functions	Mean (SD)	Mean (SD)		
Muscle Power Sprint Test (s)	−0.60 (0.67)	−0.0527 (0.44)	**37.50**	**0.002[c]**
Mean power (watts)	8.15 (14.55)	1.51 (9.49)	**42.00**	**0.003[c]**
Peak power (watts)	13.74 (13.97)	−0.61 (14.66)	**33.00**	**0.001[c]**
Lateral step-up test right	3.93 (4.5)	0.4 (3.31)	**55.00**	**0.016[c]**
Lateral step-up test left	2.26 (2.57)	0.73 (3.57)	85.00	0.259
Sit to stand	2.46 SD 2.16	0.4 (1.88)	**56.50**	**0.018[c]**
Attain stand through half knee right	3.13 (2.13)	0.06 (2.76)	**42.00**	**0.003[c]**
Attain stand through half knee left	1.93 (3.12)	0.2 (1.85)	67.50	0.059
BOTMP Gross	3.33 (4.95)	−2.33 (6.99)	**56.00**	**0.019[c]**
Activity functioning				
GMFM D (standing)	3.23 (4.88)	1.37 (3.47)	89.50	0.239
GMFM E (walking, running, jumping)	2 (2.12)	0.94 (1.81)	84.00	0.227
WeeFIM total	4.4 (3.88)	0.93 (2.18)	**42.00**	**0.003[c]**
Self-care	1.46 (2.06)	0.6 (1.24)	**59.00**	**0.022[c]**
Mobility	0.8 (1.2)	0.4 (0.73)	94.50	0.371

Table III: Comparison of change in outcomes from baseline to 12 weeks in the Kinesio Taping and control groups

[a]Post-intervention change calculated by subtracting baseline value from post-session value. [b]p-value for between-group difference calculated using Mann–Whitney U tests. [c]Statistically significant at p<0.05. KT, Kinesio Taping; SD, standard deviation; GMFM, Gross Motor Function Measurement; BOTMP, Bruininks–Oseretsky Test of Motor Proficiency-version 1; WeeFIM, Functional Independence Measure for Children. Bold values statistically significant $p < 0.05$.

stand through half knee right (mean 3.06, ES 1.24, p=0.003).

Activity functioning

This data is presented in the second part of Table II. The control group had statistically significantly greater WeeFIM total and self-care scores than the Taping group at baseline (p=0.013; p=0.004). The Taping group showed significant improvement in the GMFM dimension D and E, BOTMP Gross, and WeeFIM total, self-care, and mobility scores after 12 weeks (mean −3.23, ES 0.66, p=0.028; mean −2.00, ES 0.94, p=0.005; mean −3.33, ES 0.67, p=0.025; mean −4.4, ES 1.12, p=0.001; mean −1.46, ES 0.70, p=0.015; mean −0.8, ES 0.66, p=0.026 respectively). The control group showed improvement only in the GMFM dimension E score after 12 weeks (mean −0.94, ES 0.52, p=0.036). A significant difference was found between the Taping group and the control group (Table III) for the BOTMP Gross scores, and WeeFIM total and self-care scores (mean: 5.66, ES 0.16, p=0.019; mean 3.46, ES 1.102, p=0.003; mean 0.86, ES 0.505, p=0.022 respectively).

DISCUSSION

This is the first single-randomized controlled study on the effects of Kinesio Taping on performance-related physical fitness, gross and fine motor capacity, and functional independence in daily living activities in children with unilateral spastic CP. Our primary findings indicate that Kinesio Taping improves short-term muscle power, functional muscle strength, gross motor function, and independent activities in the daily life of children with unilateral CP.

Performance-related physical fitness is associated with balance, agility, short-term muscle power (anaerobic performance), and functional muscle strength in CP. Verschuren et al.[2] found a moderate to high correlation between performance-related physical fitness and gross motor capacity in children with CP who were classified in GMFCS levels I and II. In the current study, a 12-week application of Kinesio Taping led to increased functional muscle strength, short-term muscle power, and gross motor capacity with no statistically significant difference in agility. A possible explanation for this is that the short duration of 12 weeks may not have provided the task-specific practice necessary to improve agility, and the ability to change the direction of the body in an efficient and effective manner. Agility requires the child to possess a combination of balance, speed, and coordination. Routine physiotherapy programmes should, therefore, focus on the ability to change the direction of the body suddenly without losing balance. There is only one recent pilot study that investigated the effects of Kinesio Taping on the STS movement and kinematic changes in four children with CP.[17] The authors also assessed dynamic postural control and balance with the Paediatric Balance Scale (PBS) and timed up and go (TUG) tests. They found significant improvements in the PBS dynamic score, TUG, STS performance, peak ankle flexion, and knee extension of end point of motion. These results proved that Kinesio Taping improved STS motion. Da Costa et al.[17] clarified the reason for this improvement as better postural orientation leading to development of postural control, greater knee extension and less ankle flexion at the end of the STS movement, and better stabilization in the gravity centre. Similarly, our results indicate that Kinesio Taping improved STS performance. We agree with da Costa et al. regarding the reasons for this improvement. Furthermore, we think that other possible reasons for the improvement are increasing the stability and weight bearing of the affected side by facilitation of the gluteus medius, tibialis anterior, and quadriceps muscles.

The gross motor capacity increased according to the BOTMP Gross scores and GMFM dimensions D and E results in the Taping group in our study. However, GMFM dimension E scores were also enhanced in the control group. When the groups were compared regarding the effectiveness of Kinesio Taping after 12 weeks, there was no statistically significant difference between the groups for GMFM dimensions D and E but the BOTMP Gross score was improved in the Taping group. GMFM scores tend to reach their highest levels in children with CP with high motor ability, and especially in those at GMFCS level I. BOTMP is a well-validated measure of motor coordination.[27] BOTMP includes more functional parameters and can, therefore, be another option for assessing gross motor function in children with CP. Improvement of functional muscle strength and short-term muscle power might also positively affect gross motor capacity. Only a few studies have previously investigated the effect of taping techniques on gross motor function. Footer focused on the effects of therapeutic taping on gross motor function in children with CP.[15] The author divided 18 children with quadriplegia into taping and control groups and found no significant improvement on postural control in the sitting position according to the GMFM-88 with a decrease in involuntary movement and increase in trunk stability in only one child with athetoid CP.[15] Our study showed an increase in GMFM dimension E in both groups and GMFM dimension D in only the Kinesio Taping group. Footer included children at GMFCS levels IV and V who had severe limitations while our study included children at GMFCS levels I and II. Iosa et al.[6] applied functional taping (6d/wks for 6mo) to the ankles of eight unilateral spastic children. Nevertheless, using taping in children for 6 days may cause allergic reactions and difficulties in the clinic. As a precaution, we used Kinesio Taping twice a week for 12 weeks and removed it for 72 hours, had the child rest 1 day, then applied it again to the necessary muscles and joints. The functional and mechanical effect of taping could therefore be seen more clearly and the procedure was more tolerable for the children and parents.

To our knowledge, there is only one study with a control group that investigated the effect of Kinesio Taping on sitting posture, gross motor function, and functional independence as assessed with GMFM, the WeeFIM, and the Sitting Assessment Scale (SAS).[16] GMFM and SAS scores improved in both groups after treatment but the WeeFIM scores increased significantly only in the Taping group.[16] This improvement of WeeFIM scores was because of increased trunk stability and better postural alignment.[16] Simsek et al. assessed independence of daily living activities using WeeFIM total scores. However, they did not provide the section scores, making it impossible to determine where the improvement they noticed originated.[16] Although our control group's WeeFIM total and self-care baseline scores were better than in the Taping group, the WeeFIM total and self-care scores improved significantly after 12 weeks in the Taping group. WeeFIM mobility scores also improved after 12 weeks in the Taping group. The Kinesio Taping group therefore had more improvement regarding independence in activities of daily living.

Physical fitness is often poor and affects daily living activities in children with spastic CP. Almost all daily activities in the childhood period are short-burst and high intensity. Therefore, increasing short-term muscle power and functional muscle strength could be a sign of improved performance of daily living activities in children with CP.

Other studies related to taping have commonly focused on the upper extremities. Although we found no significant difference regarding fine motor functions according to BOT-MP, the WeeFIM total and self-care scores improved significantly with Kinesio Taping. Improvement of daily life activities and self-care may be associated with fine motor skills but we were unable to show this association using the BOTMP and we believe that it is not easy to identify the quality of fine motor movements. Mazzone et al.[14] explored the effects of functional taping on the upper extremity of children with CP and assessed motor performance using the Upper Limb Assessment. They reported a significant improvement in the 5-month period of functional taping, while the gains were not preserved in the physiotherapy-only period. They indicated that functional taping could allow a more functional range of motion, and improve selective finger movements and fine motor manipulation.[14] Yasukawa et al.[7] investigated the effects of Kinesio Taping in acute paediatric rehabilitation settings as assessed with the Upper Limb Assessment before and just after taping and after 3 days of wearing the tape. They showed that Kinesio Taping enabled goal-directed movement, increased stability of the shoulder and hand, and supported alignment during reaching and grasping.[7] However, we chose the BOTMP to demonstrate the effects of taping on fine motor activities. The BOTMP fine motor subtest consists of visual motor, upper-limb speed, and dexterity parameters. Participants often perform test parameters using a pencil. Children with hemiplegia have to use their non-dominant hand for such tests if their dominant side is affected and we believe that this is the primary reason we could not show improvement. In a case study, Camerota et al. assessed a 17-year-old female with left hemiplegia with 3D motion analysis before and after neuromuscular taping. Their results have proved that Kinesio Taping recruited upper limb function, especially the preparation of motion and returning phases.[13] Future randomized controlled studies with instrumented 3D movement analysis might ensure objective measurement of fine motor movements.

The main strength of the current study is that it is the first single-blind randomized controlled trial. Previous studies have also shown that the facilitating effect of Kinesio Taping on cutaneous mechanoreceptors results in physiological changes in the taping area and improves muscle excitability.[33] We think that Kinesio Taping could stimulate cutaneous mechanoreceptors in children with unilateral spastic CP and thus improve proprioceptive inputs for muscles to perform task-specific functions. These positive effects of mechanoreceptors could cause improvement in performance-based physical fitness, gross motor capacity, and independent function in daily activities. Clinically, our results could help physiotherapists to enhance their rehabilitation programme as well as contribute to the growing evidence on Kinesio Taping.

Limitations

The limitation of this study was that the effects of Kinesio Taping on the social participation section of ICF-CY parameters were not evaluated. Future studies should focus on investigating the effects of taping techniques on the social participation of children with CP and long-term follow up of Kinesio Taping.

CONCLUSION

Kinesio Taping is a promising additional approach to increasing proprioceptive feedback and improving physical fitness, gross motor function, and activities of daily living. Future randomized controlled studies are needed to investigate the effects of taping with instrumented 3D movement analysis in both the upper and lower extremities of children with unilateral CP.

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