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Effect of Different Kinesio Taping Applications on Ankle Range in Children with Spastic Cerebral Palsy: A Comparative Study

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Authors' contributions

This work was carried out in collaboration between all authors. Author ANK designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors FHA and KAO managed the analyses of the study. Authors ERAR and ORA managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Background and Purpose: Spastic cerebral palsy is accompanied with an increase in calf muscles' spasticity and a decrease in the ankle range of motion. The purpose of the study was to compare muscle inhibitory with functional corrective Kinesio taping applications on children with spastic cerebral palsy.
Methods: Thirty two children with spastic cerebral palsy were selected from the outpatient clinic of the faculty of Physical Therapy Cairo University. Muscle inhibitory and functional corrective Kinesio taping applications in addition to physical therapy program were applied for three successive months. Digital Goniometer was used to assess the ankle range of motion pre and post Kinesio tape applications.

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Results: The study revealed that that the functional corrective Kinesio taping is more effective in increasing ankle range of motion than the muscle inhibitory.
Conclusion: Functional Corrective Kinesio tape application is recommended for increasing ankle range of motion in children with spastic cerebral palsy.

Keywords: Kinesio tape; ankle; spastic; cerebral palsy.

1. INTRODUCTION

Cerebral palsy (CP) describes a group of disorders affecting the development of movement and posture, causing functional limitations that are linked to the non-progressive disturbances that occurred in the developing infant brain [1].

Movement and posture disorders are the main symptoms of CP, but recently disturbances of sensation and perception, cognitive difficulties, communication disorders, behavioral disorders, and seizures have been included in the definition [2]. Spastic form is a common type of CP where the main features are exaggerated muscle tone and reflexes [3]. Spasticity causes many motor abnormalities such as decrease in joints range of motion (ROM), feeling stiffness, difficulty in movement and muscular tightness or contracture. Equinovarus foot is the most common spasticity disorder in spastic CP; it decreases the ankle ROM towards dorsiflexion direction [4]. Kinesio tape (KT) is a thin elastic cotton strip with an acrylic adhesive that has been introduced by the Japanese chiropractor Kenzo Kase in the 70's of the last century and then invaded the entire world [5]. KT has been proven to increase muscle function, inhibit or facilitate muscle tone, increase lymphatic and blood flow, decrease pain, increase proprioception and correct joint alignment [6,7]. KT has various applications such as muscle inhibitory and functional corrective. Muscle Inhibitory KT application is applied with very light tension (15 to 25% of the available tape tension) on the muscle from insertion to origin [8]. It has been proved to be effective in inhibiting muscle activity where it's thought to stretch the Golgi tendon organ in the distal ends of the muscles [9]. Functional Corrective KT application is one of the corrective KT, showing great results in the clinical practices by assisting or restricting joint motion [10]. It is believed that it stimulates joint proprioceptors through increasing tension on the skin, so the body adjusts joint position to normalize the increased skin tension [8]. This study was to compare the two applications to see which is more effective in increasing ankle dorsiflexion ROM.

It was hypothesized that there is no difference between muscle inhibitory and functional corrective kinesio taping applications on ankle ROM in children with spastic CP.

2. METHODS

2.1 Design

This study was designed as a prospective, comparative, parallel simple randomized clinical trial between two groups, in the duration from November 2016 till April 2017. Data were collected from the Outpatient Clinic of the Faculty of Physical Therapy Cairo University. The study protocol of this trial was approved by the Research Ethical Committee of the Faculty of Physical Therapy Cairo University (Approval No.: P.T.REC/012/001323) and it was registered in The Pan African Clinical Trials Registry (PACTR) database (trial no. PACTR201702002019178).

Informed consent was obtained from all of the participants' caregivers according to the principles stated in the Declaration of Helsinki.

2.2 Participants

Thirty two children with spastic CP were chosen from the Out-Patients Clinic of the Faculty of Physical Therapy, Cairo University. The children were included if they were at level II according to Gross Motor Function Classification System (GMFCS) ,their developmental age ranged from 9 to 12 months according to Peabody Developmental Motor Scales (PDMS), their chronological age ranged from 2 to 4 years and their degree of spasticity ranged from 1 to 1+ according to Modified Ashworth' Scale. The children were excluded if they were hypersensitive to KT application, if they had fixed deformities in the ankle joint or they had previous tenotomy operation to calf muscles. Children had no Botulinum Toxin in the last six months prior the study and took no antispastic drugs during the study period.

2.3 Randomization

In Fig. 1, the CONSORT (Consolidated Standards of Reporting Trial) flow chart shows

the number and distribution of the subjects. Forty three subjects with spastic cerebral palsy were selected to be assessed for eligibility. Three subjects were excluded as they were not fit the selection criteria. The rest forty subjects were divided via simple randomization (using coin tossing) into two groups.

Twenty subjects entered study group (A), where four subjects discontinued the treatment, and one had an allergic reaction from the tape despite the fact that he passed the sensitivity test. The other twenty subjects entered study group (B), where three subjects discontinued the application.

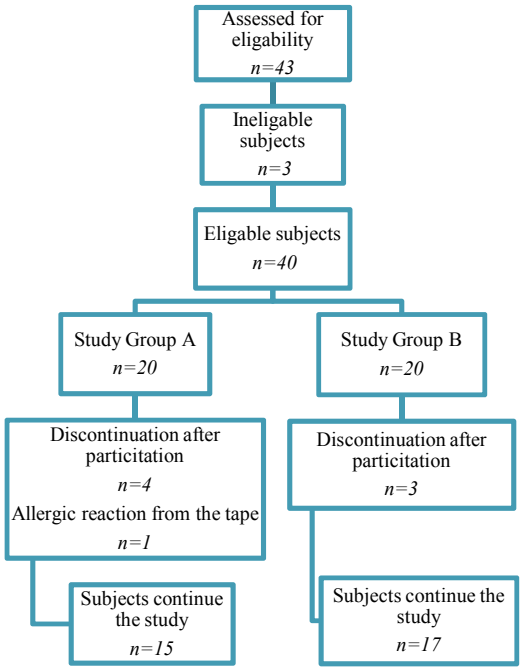

Fig. 1. Flow chart of the study based on consolidated standards of reporting trials (CONSORT)

2.4 Materials

2.4.1 Materials for sample selection

We used Modified Ashworth scale to measure the degree of spasticity. The selected children were graded 1 and 1+. Grade 1 is a slight increase in muscle tone, manifested by a catch and release or by minimal resistance at the end of the range of motion when the affected part(s) is moved in flexion or extension, while Grade 1+ is a slight increase in muscle tone, manifested by a catch, followed by minimal resistance throughout the remainder (less than half) of the ROM.

We used GMFCS to select children who just needs minimal assistance (holding on) in performing functions such as standing and walking: Level II GMFCS. The selection of level II GMFCS children for KT application was supported by Rasti et al. [11].

For sensitivity test, we applied a small patch of KT (5cm X 5cm) on the child skin for 1 week, and then if any allergic reaction (redness or itching) appeared, the child was excluded from the trial.

2.4.2 Materials for evaluation

Digital Goniometer was chosen as a method of evaluation of ankle ROM. The digital goniometer is a reliable and valid method of evaluation of joints ROM due to its high accuracy. The absolute axis goniometer eliminates the need to manually score each measurement that decreases the errors [12]. The digital goniometer consists of the integral absolute vertical and horizontal levels, reads 0-185º degrees on liquid –crystal display screen, and has ability to freeze angle measurement; Goniometer exterior is powder-coated steel with inch/cm marks screened onto arms and powered by 19V battery [13]. Digital goniometer was used for assessing ankle Dorsi flexion ROM from the ankle resting position (full planterflexion) [14] and in knee flexion before and after the trail. As a testing procedure, the child was sitting on a chair with knee and hip 90 degree flexed the ankle in the resting position of planterflexion direction. Lateral Mallulas was used as a fulcrum for measuring ankle Dorsi flexion ROM. Instructions was given to each child to actively Dorsi-flex his/her ankle. Finally the measured angle was recorded.

2.4.3 Materials for intervention

Physical therapy tools -for conducting the physical therapy program- was used : Mat, Swiss ball, tumble form set (rolls, wedges, block), adjustable stairs, balance board, stairs, stand bar, stepper, balance beam; in addition to the materials used for ankle taping application: Elastic (Kinesio Tex® Tape (5.0 cm width X 5m length) and a scissor.

2.5 Intervention

2.5.1 Designed physical therapy program for both groups

We designed a physical therapy program that was based on Neuro-Developmental treatment (NDT) approach with emphasis on exercises that encouraged independent standing, enhancement and facilitation of gait patterning.

Stretches exercises, strengthening exercises, approximation and ankle ROM exercises were also included in the program. The program was applied for one hour, three times per week for three successive months. All physical therapy exercises were the same to all subjects and applied by blind therapists who didn't know the purpose of the study.

2.5.2 Preparation prior Kinesio Tape application for both groups

All KT applications for all subjects in both groups were applied by the first author who is a certified kinesio tape practitioner.

As a preparation, the skin area of tapping was cleaned before applying the tape by water then dried or by organic solvent (alcohol pad).

The KT in both applications was applied for six days and removed for 1 day as supported by Gómez-Soriano et al. [15] to allow skin perspiration, for three successive months.

2.5.3 Muscle inhibitory Kinesio Tape application for Group A

One Y strap was prepared for each child individually. Maximum stretch of calf muscle was applied, then the distance from tendonachllis and the crease of the knee was measured. The KT was cut according to the measured distance. The Y strap was applied from insertion to origin direction (from the tendonachllis to the origin of soles muscle and gastrocnemius) with a very small amount of stretch applied to the KT (15% of the initial tape length (Fig. 2).

2.5.4 Functional Corrective Kinesio Tape application for Group B

One I strap was prepared for each child individually (Fig. 3). The distance from tibial plateau along with dorsal aspect of the lower leg down to the ankle crease was measured for the preparation of the strap. We decreased the measured tape length by 1/3 (stretch for the tape) to provide joint reposition by taking the ankle to dorsi-flexion.

Fig. 2. Muscle Inhibitory KT

Fig. 3. Functional corrective KT

2.6 Data analysis and Statistical Design

We collected and analyzed the descriptive data of both groups concerning gender, spasticity distribution and developmental age. Graphpad Quickcalc software was used for statistical analysis. Data were statistically described in terms of means and standard deviation. Paired t-test was used to compare the results pre and post treatment in the same group; while unpaired test was used to compare the results between the two groups. Significant level was set at alpha level <0.05.

3. RESULTS

3.1 General Characteristics of the Subjects

Study Group (A) included fifteen children (3girls and 12 boys) with spastic CP (5 bilateral, 7 left unilateral and 3 right unilateral) were included in

this group, where 20 calf muscles and ankle joints were assessed. The mean developmental ages (in months) were 10.40± 1.29835. Study Group (B) included seventeen children (8 girls and 9 boys) with spastic CP (10 Bilateral, 5 right unilateral and 2 left unilateral) were included in this group, where 26 calf muscles and ankle joints were assessed. The mean of developmental age (in months) were 10.47±1.4194. Comparing the general characteristics of the subjects of both groups revealed that there was no significance difference between them in the developmental mean age (See Table 1).

The spasticity distributions in lower limbs in study group (A) was 33.33% bilateral, 20% right unilateral and 46.67 % left unilateral, and study group (B) was 58.82% bilateral, 29.41% right unilateral and 11.76% left unilateral.

3.2 Results within Subjects

In Study Group (A), the mean and standard deviation of ankle ROM towards dorsiflexion direction from ankle resting position pre and post treatment for group (A) was statistically analyzed. There was an extremely significant difference in the ankle ROM between Pre treatment and Post treatment values, as t-value was (6.2788) and P-value was (0.0001). The percentage of improvement was 52.52%. In Study Group (B), the mean and standard deviation of ankle ROM towards dorsiflexion direction from ankle resting position pre and post treatment for group (B) was statistically analyzed. There was an extremely significant difference of ankle ROM between Pre treatment value and Post treatment value as t-value was (10.5645) and P-value was (0.0001). The percentage of improvement was 71.12%.

3.3 Results Comparison between the Two Study Groups

Pre treatment: It showed that there was no significant difference between the mean values of ankle ROM towards dorsiflexion direction from ankle resting position between study group (A) and study group (B) (P= 0.5347).

Post treatment: It was showed that the mean values between study group (A) and study group (B) were statistically significantly different as P = 0.0318 in favour to study group B (see Table 2).

4. DISCUSSION

The current study rejected the hypothesis where the functional corrective KT application was found to be statistically and clinically more significant in increasing the ankle ROM than the muscle inhibitory KT application. The subjects of the study were selected according to the developmental age or in other word the functional age, where our subjects ranged from 9 to 12 months as mentioned. The decision to use the developmental age - which is an expression of a child's maturational progress of motor skills stated in ages and determined by standardized measurements such as PDMS- was built on the fact that the developmental age is a great indicator for the child's current and future motor functional abilities, that agreed with a study that link the developmental age to the predication of the child's further abilities [16].

The current study refused to choose the subjects on the topographical classification of American Academy of Pediatrics Classification of CP, as Hurvitz and Brown stated that terms like quadriplegia, hemiplegia and diplegia should be

Table 1. Comparison of mean values of the developmental age of both groups

Items	Group A		Group B		t-value	P- value	s
	Mean	±SD	Mean	±SD			
Developmental age (Months)	10.40	1.2983	10.47	1.419	-0.146	0.8848	NS

SD= Standard Deviation, P =Probability, S= Significance NS= Non Significant

Table 2. Comparison of mean values of ankle ROM pre and post treatment in both groups

Scoring	Pretreatment M ± SD	Post treatment M ± SD	P- value
Study Group A *n=20*	22.85±10.04	34.85±11.79	**0.0001**
Study Group B *n=26*	24.9038±11.7361	42.6152±11.7952	**0.0001**
P-value	0.5347	0.0318	

abandoned in researches and a reliable method of classification like GMFCS should be used instead [17]. The current study chose for the selection criteria to use the GMFCS as it have been a reliable method to use in research studies as a type of CP classification [18,19].

The ankle joint was reported to be in stiffness in children with spastic CP as a result of several muscular components that include muscular spasticity which decreases the child motor functional skills and abilities [20] that was support by our pretreatment assessment results that show a decrease in the ankle range of motion in spastic cerebral palsy children. This study assessed the ankle joint total ROM towards dorsiflexion range from the resting position of the ankle joint, not from 90°, as it was more accurate for assessing the child ankle ROM as it didn't hinder their progress, that was supported by study assessing the ankle joint ROM [14]. In a previous study, we formed a correlation between soleus muscle spasticity and the ankle ROM in children with spastic CP, we revealed that the more spastic the soleus muscle was, the less degree of available ankle ROM towards the dorsiflexion, this agreed with the idea that calf muscle spasticity should be controlled in the rehabilitation program in order to increase the ankle range of action which would lead to more functional activities to the child [21].

Concerning the rehabilitation program it was confirmed that physical therapy was essential for the progression of CP children [22]

KT application is an approved method based on the extensive clinical studies and proven to have positive results in various areas of rehabilitation via increasing the ROM and reducing the muscular hypertonia [23], especially in pediatric population with upper motor neuron abnormalities.

As to our knowledge, till now there is no study concerned about comparing the effects of different KT applications on children with spastic CP. We decided to try to fulfill this gap by studying and comparing two applications of KT and test their effect in increasing the ankle ROM. Researches around the world have been interested in evaluating the KT effects and beneficial in the last decade widely [5,24].

The current study shows that the KT has a great impact in increasing the ankle joint range and repositioning of the joint; that have been confirmed with a study mentioned that KT have enhanced the perceptual motor sensitivity of the joints proprioception [25]. An increase in ankle ROM was found in patients with spasticity after the KT application [26].

The muscle inhibitory KT application was proven to increase the dorsiflexion ankle ROM in subjects with spasticity [27,28], that confirmed our study results that showed an increase in ankle range after the muscle inhibitory KT was applied.

The functional corrective KT application have been proven to be effective in ankle positioning and in decreasing spasticity [29], and that confirmed our study results that showed a progress in the ankle ROM and inhibition of the calf muscle spasticity after the functional corrective KT was applied. Functional corrective also was found to reposition joints and increase the available joint ranges [30,31] and that confirmed our study results.

A pilot studies confirmed the great impact of the functional corrective KT in improving function via increasing the joint range [32,33] that supported the current study results.

5. CONCLUSION

From the obtained results of this study, it was concluded that the functional corrective KT application in addition to a specific physical therapy program is more beneficial in increasing the ankle ROM than the muscle inhibitory KT application, so it is suggested to include the functional corrective KT technique in the rehabilitation program when the goal of the treatment plan is to increase the ankle dorsiflexion ROM.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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