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Kinesiotaping versus Wrist Wheel on Upper Extremity Functions in Children with Unilateral Cerebral Palsy

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ABSTRACT
Background: Children with Unilateral Cerebral Palsy (UCP) usually have obvious impairment of hand function and limited active supination, which causes restrictions of upper extremity functions.
Objective: This aimed to compare between Kinesiotaping and wrist wheel effect on forearm supination range of motion and its reflection on functions of upper limb in children with UCP.
Patients and Methods: Forty-eight children with UCP their age from 6 to 8 years were divided randomly into 2 groups with twenty-four in each, Kinesiotaping (KT) and Wrist Wheel (WW). KT group children were treated by a designed physical therapy program after forearm Kinesiotaping application, while children in WW group were treated by the same designed physical therapy program while using wrist wheel. Treatment program was conducted for three successive months at frequency of 3 sessions per week. Before the commencement and after the study completion forearm supination range of motion was measured using digital goniometer and Shriners Hospital Upper Extremity scale was used to evaluate upper extremity functions in the affected upper limb.
Results: A statistically significant change was observed in each group after treatment application when comparing before and post treatment mean values ($P < 0.001$). Also, a statistically significant change was noticed when comparing after treatment results between both groups in favor to wrist wheel group.
Conclusion: Both Kinesiotaping and Wrist Wheel can improve supination ROM and upper extremity functions of children with UCP, with more effectiveness to Wrist Wheel.
Keywords: Cerebral palsy, Hemiparesis, Kinesiotaping, Wrist Wheel.

INTRODUCTION

Most daily activities, including eating, brushing, as well as drinking needs the free supination. Washing face and hands, combing hair also depends on the ability to supinate forearm. Holding pencil to write and using a walker to assist gait, all depend on forearm supination and pronation movements [(1)]. The pronator teres, pronator quadratus, and supinator muscles cooperate to perform upper limb daily functions. However, the contracture of pronators that characterizes UCP children impairs these functions, which may lead to social and functional limitations. These limitations also impair the ability of children to communicate with the surroundings within their environment, which challenge them to be functionally independent in daily activities [(2)].

There is a compensatory relationship between shoulder range of motion (ROM) and the forearm rotation in different activities of daily living (ADL) that require forearm pronation and supination, forearm rotation could expose the shoulder to overuse, which could be more disabling [(3)].

Kinesiotaping is a widely used technique in the treatment of CP children to improve ROM, individual finger movements, and enhance fine motor manipulation of the hand. Some studies show an improvement in upper limb stability as well as segment alignment during reaching and grasping [(4, 5, 6)].

Wrist Wheel (WW) is a therapeutic tool that works the muscles of the wrist, forearm, and shoulder, it enables the patient to easily roll his/her wrist in and out while concentrating on their wrist and arm. It is considered as one of the simple easy devices for assisting children in performing a function [(7)].

PATIENTS AND METHODS

Patients

Forty-eight children with UCP were enrolled in the study that was carried out from October 2021 to March 2022 at the Outpatient Clinic for Pediatric Department, Faculty of Physical Therapy, Cairo University. Children were selected with age ranged from six to eight years, diagnosed as Unilateral CP with upper extremity spasticity grades 1 and 1+ in according to Modified Ashworth scale (MAS) [(8)]. They had level II and III impaired hand functions as described by Manual Ability Classification System (MACS) [(9)]. All participants had the ability to follow simple verbal commands given during assessment and treatment procedures.

Exclusion criteria: Children with severe visual or auditory problems, skin diseases at forearm and recent surgical interference (Tenotomy or muscle

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transfer) or botulinum injection in the affected upper limb before the commencement of the study by six months.

Randomization

Sample size calculation was based on power analysis calculation using G*power software, based on previous similar studies with effect size of 0.84 depending on primary outcome (Forearm supination ROM). Power set to 0.8 and significance level of 0.05.

The calculation yielded a sample size of 24 patients per group, which may be increased up to 25% to overcome the expected dropout. Sixty children of both genders were eligible for the study, seven of them did not match with the study inclusion criteria with five children declined to participate. So, forty-eight children were randomly distributed into KT and WW groups using a lottery method by using white cards that were numbered from one to sixty and after putting these cards in a box and a blind researcher assistant asked each parent to draw one card and then assign them by giving KT group odd numbers and Wrist Wheel group even. Participant flow chart is illustrated in figure (1).

METHODS

Evaluation procedures

Baseline® & Digital Absolute Axis Goniometer (12-1027 China) was used for assessing forearm supination range of motion (ROM) [10] and SHUEE was used to measure person capabilities in performance of daily functional tasks. It is a validated reliable tool that scores the alignment segment and the effective upper limb usage in the activities. It also evaluates object grasp and release of the hand [11].

The scale consists of two parts Spontaneous Functional Analysis (SFA) and Dynamic Positional Analysis (DPA) sections.

Each child was asked to perform the desired tasks in both sections, and after full demonstration and feminizing the child with the test procedures, the therapist started recording a video by mobile camera, and after that these videos were analyzed for scoring.

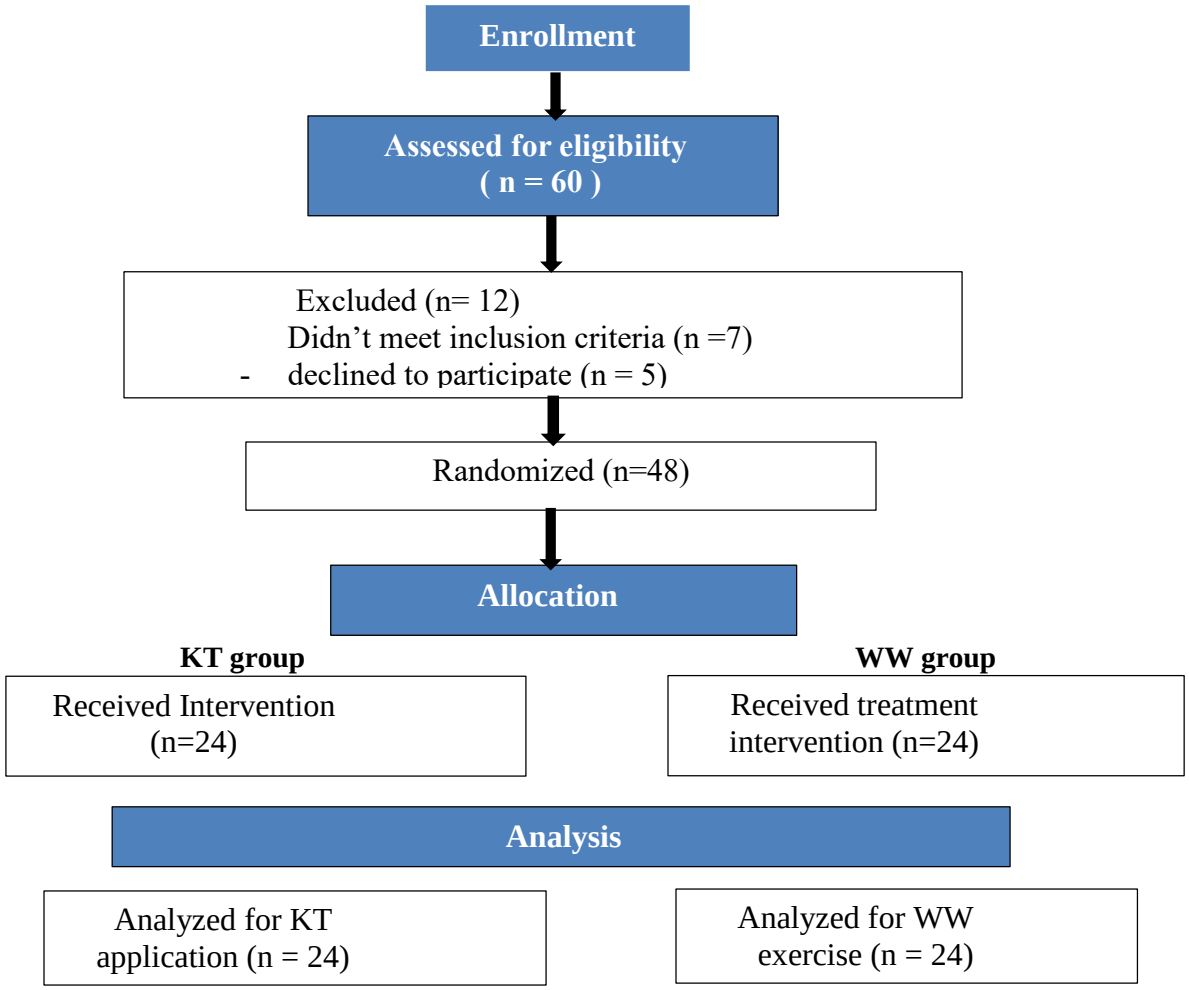

Figure (1): Participants´ flow chart.

Treatment procedures

Before starting tape application, the sensitivity test was done for children in KT group by applying a piece of Kinesiotaping with no tension on the affected UE and it was left for 24 hours (unless the parents notice any skin irritation) to detect the skin sensitivity. Depending on the arm length from the center of the wrist to the elbow joint the therapist determined the length of the tape, then the forearm was positioned in a maximum available passive supination position before application of kinesiotape, the base of the tape was attached to the crease on the volar aspect of the wrist, the tape was applied in a spiral shape around the forearm with 50 % tension, the tape end was attached over the elbow and left for 5 successive days then removed for 2 days for rest and the process was repeated again till the end of the treatment period [(12)]. Physical therapy treatment program was conducted for children of KT and WW groups as follows:

- Flexibility exercises: for wrist and fingers flexors, forearm pronators of the affected UE, and subscapularis muscles.
- Strengthening exercises: for weak shoulder flexors, elbow and wrist extensors.
- Upper limb weight bearing exercises, Balance exercise and Gait training.

Children in the KT group underwent a physical therapy exercise program aiming to improve the affected upper extremity skills after applying Kinesiotaping on forearm in addition to rotational activities including (Turning the card over - Twisting a towel- Turning pages in a book - Playing clapping games) for 10 minutes.

Children in the (WW) group received a designed exercise program for children with unilateral CP while using the wrist wheel which is characterized by having non-slippery rubber surface on the outer surface of the wheel to provide smooth, stable motions when making supination and pronation exercise. It needs little physical strength to use. The weight of the wheel can be used according to ability of child [(13)].

The child was sitting on a comfortable chair with his back erect and supported, with elbow right angle and forearm resting on a table in front of him. The child was holding the wheel on the table by his/her hand and he/she was asked to rotate it towards pronation then return to end of supination with holding 15 seconds at the end of each movement, repetition was done for 10 minutes. Therapist may aid the child using the wheel by gently pushing wheel or put it on inclined surface to help the child roll it through supination exercises.

Ethical approval:

This study has been registered in the Clinical Trials (Gov PRS NCT05238259) after approval of The Research Ethical Committee Board, Faculty of Physical Therapy, Cairo University (no P.T.REC/012/003255). The procedure of the study was explained to the participant's parents. Also, the benefits were explained to the parents then they signed a written consent for participation in this study and publication of the results. This work has been carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki) for studies involving humans.

Statistical analysis

To evaluate normality of data, the Shapiro-Wilk test was used, and to compare SHUEE between both groups, Mann-Whitney test was used and to compare pre- with after treatment mean values in each group Wilcoxon test was adequate. Also, independent t test was used to compare ROM between the two groups, and paired t test was used to compare ROM pre- and post-treatment in each group. significance level was 0.05. The arithmetic mean as an average description of central tendency of the results and standard deviation as a mean of dispersion of the results. The Statistical Package for Social Sciences (SPSS) version 27 for windows was selected for all statistical analysis.

RESULTS

A total of 48 children participated in this study. The baseline general characteristics of the participants are outlined in Table (1).

Table 1. The general characteristics of the participants

Variables	Kinesiotaping	Wrist Wheel	P value
Age (year)	1.19 ±6.13	0.97 ± 6.75	0.266
Sex (boy / girl)	13-Nov	13-Nov	0.715
Side distribution (Rt / Lt)	13-Nov	13-Nov	0.715

Pretreatment showed that there was no significant difference between groups ($P > 0.05$), while a statistically significant improvement was recorded after treatment in each group ($P < 0.001$), when comparing after treatment results between groups Also a statistically significant difference was noticed in favor of WW group.

Table 2. Comparison between both groups, pre and post treatment

Variables	Kinesiotaping group (Mean ± SD)	Wrist Wheel group (Mean ± SD)	P value
Spontaneous Functional Analysis			
Pre	52.467 ± 8.983	50.133±6.978	0.764
Post	60.733 ± 8.413	61.667±7.287	0.302
P value	< 0.001*	< 0.001*	
Dynamic Positional Analysis			
Pre	48±10.142	48.667±10.154	0.794
Post	53.733±9.33	61.333±7.862	< 0.001*
P value	< 0.001*	< 0.001*	
Supination range of motion			
Pre	13.867±3.271	15.867±6.289	0.284
Post	20.133±3.871	29.333±5.233	< 0.001*
P value	< 0.001*	< 0.001*	

* Significant value (P < 0.001)

DISCUSSION

The purpose of this work was to compare between the effect of Kinesiotaping and wrist wheel on supination ROM and its reflection on upper extremity functions in children with UCP. Since many tasks performance require the use of two hands in every aspect of daily life, children with UCP, regardless of age, who have impaired function of one hand, continue to have challenges with daily upper limb activities performance, which affects their participation in daily circumstances [(14)].

Results revealed a significant improvement in supination ROM after Kinesiotaping application, which may improve forearm supination ROM of the affected upper extremity by aiding in restoring normal function of the affected area being taped, as it makes it possible to modulate muscle tone, which directly translates into improved patient mobility [(15)]. Kinesiotaping permits free ROM for the applied muscles and joints with different tension on the skin [(4)], it can improve muscle function, support weak joint, stimulating proprioception as well as skin receptors and correcting the malalignment segment positions [(16)]. Kinesiotaping apply pressure to stimulate skin mechanoreceptors. This stimulation causes sufficient firing in the pattern of muscle recruitment, which activates mechanoreceptors resulting in local depolarization [(17)]. It also stimulates proprioception and enhances motor function leading to a greater motor unit firing. Tension by the tape applies a pulling force to the skin by the stretch effect of the tape that promotes communication with the mechanoreceptors and enhances the activation of different motor units [(18, 19)]. Kinesiotaping assists the child in adjustment of forearm segment while task performance. Tape's elasticity results in avoiding restricting the soft tissue while supporting the weak muscles allowing for full range of motion [(20)].

Our study results concerning KT group showed a significant improvement in the function of affected upper extremity, which may be explained by helping in wrist, palm, and thumb alignment in a functional posture (opening the hand to sensorial stimulate and improve the function of the thumb and other fingers), controlling the spasticity, encouraging active forearm supination, wrist and fingers' ROM, while keeping the shoulder in a normal position [(21-24)]. Improvement in KT group may also be explained as Kinesiotaping is a simple and efficient approach in children with neuromotor deficits by improving hand grip strength and range of motion [(25)]. This is supported by **Alireza *at al.*** [(26)] who reported that KT has a positive effect on balance, sitting/standing control, standing control, and both fine and gross motor skills in children with neuromotor disorders. Kinesiotaping along with conventional physical and occupational therapy can enhance and improve functions of upper extremity among children with UCP, this combination improves their functional independence helping them to meet necessary demands of everyday life [(27)].

In this study WW group showed better results than KT group in forearm supination ROM and DPA. In order to maintain the stretch posture, the agonist muscle group needs to contract while the patient is stretching, causing an exercise overload in that muscle group. Greater improvements in muscular strength would result from an increased exercise overload experienced by the 15 second. [(28)]. Wrist Wheel allowed self-independence of the child by holding the wheel by his/her hand and try to move forearm in supination which may be helpful in correcting forearm position during functional tasks such as hand to mouth and shaking hands. Significant difference between both groups may be explained as WW allowed improvement in proprioception and usage of sensory feedback helping in correcting image in brain, visual feedback allows increase supination ROM by setting a goal and stimuli for the child to reach and make supination exercise. It has also been shown that visual feedback affects the forces and enhance movements produced by individuals with brain injury [(29)]. Increasing forearm supination ROM of WW group was reflected on DPA and that increasing affected upper extremity functions and corrected alignment of forearm during task performance.

LIMITATIONS

Our study was limited to assess forearm muscle strength. It was difficult to follow up all participants for the investigation of long-term effects of Kinesiotaping and Wrist Wheel.

CONCLUSION

From the obtained results of the current study, wrist wheel exercises were more effective in improving supination ROM reflected on upper extremity functions in children with UCP.

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