Influence of Ankle Kinesio Taping on Ankle Excursion and Selected Gait Parameters in Children with Hemiparesis

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ABSTRACT

Background and Purpose: *The feet play an important role in the process of normal human walking, provision of a normal ankle with proper phasing of the extensor and flexor muscles results in achievement of the normal gait. This study was to investigate the role of ankle Kinesio taping on ankle excursion and selected gait parameters in children with hemiparesis.* ***Subjects:*** *Thirty children with spastic hemiparesis (9 right and 21 left sided), ranging in age from six to eight years, represented the sample of this study. They were selected from the out-patient clinic, Faculty of Physical Therapy, Cairo University. The degree of spasticity ranged from 1 to 1^{+} grade according to the modified Ashworth scale. The lower limb was free from any structural deformities. Children were divided randomly into two groups of equal number A (control) and B (study).* ***Procedures:*** *Evaluation for each child of the two groups was conducted to determine the degree of ankle excursion, via using electrogeniometer, and to record the distance (step length) and the temporal (cadence and velocity) gait parameters before and after three months of treatment.* ***Results:*** *The results revealed no significant differences in all parameters used in evaluation when comparing the pre-treatment mean values of the two groups, while significant improvement was observed in all the measured variables of the two groups (A and B), when comparing their pre and post-treatment mean values. Significant difference was also observed when comparing the post-treatment results of the two groups in the favor of group B.* ***Discussion and Conclusion:*** *Using ankle Kinesio taping in treatment of children with hemiparetic cerebral palsy has a significant effect in improving all measured variables, which recommend its use in conjunction with different treatment procedures for children with hemiparesis*

Key words: *Kinesio Taping, Gait Parameters, Hemiparetic Cerebral Palsy.*

INTRODUCTION

Hemiplegic cerebral palsy is the most common type of cerebral palsy among children born at term, and only second to diplegia among pre-term infants. It is a unilateral, static, non-progressive motor impairment of early onset that is cerebral in origin[1]. The resulting impairment in extremities affects functional independence quality of life. Dorsiflexion and eversion of the foot are the most common impairment in the affected lower limb[2].

Children with hemiplegic cerebral palsy present with three types of motor problems, the primary impairments of muscle tone, balance strength and selectivity are directly related to the damage in the central nervous system. Secondary impairments of muscle contractures and deformities develop over time in response to the primary problems and musculoskeletal growth, and tertiary impairments are adaptive mechanisms that the child develops to adapt to the primary and secondary problems. One typical example is gastrocnemius spasticity as a primary impairment leading to secondary ankle planter flexion deformity, and knee hyperextension in stance as an adaptive mechanism[3].

Children with hemiplegia frequently demonstrate substantial gait impairments as a result of lack of normal control of the affected ankle[4].

Walker and Stranger[5] emphasized that, the ability to maintain proper joint alignment of the lower extremity, and control the position of the foot in standing is a critical treatment objective for the hemiplegic patients.

Kinesio taping is a very useful physiotherapeutic modality adjunct to therapeutic rehabilitation[6]. It is a specialized tape which is thin, elastic and can be stretched over skin. It allows a partial to full range of motion for the applied muscles and joints with different pulling forces to the skin[7].

The main goal when using Kinesio taping method is to aid in restoring normal function to the affected area being taped, as it enables the control of muscle tone which

directly translates into new possibilities of locomotor activity of the patients[8].

The method for applying the tape varies depending on the treatment goals, the taped area can be used to facilitate a weakened muscle or to relax an overused muscle[9].

This study is a trial conducted to investigate the effects of ankle Kinesio taping technique on ankle excursion and selected gait parameters in children with hemiparesis.

SUBJECTS, INSTRUMENTATION AND PROCEDURES

Subjects

Thirty children with hemiparesis (9 right sided and 21 left sided), ranging in age from 6 to 8 years (X 7.21±0.56 years) represented the sample of this study.

They were selected from both sexes from the out-patients clinic, Faculty of Physical Therapy, Cairo University. They were free from any associated disorders other than spasticity, with minimal non- significant perceptual defects, but they were able to follow instructions given to them. The degree of spasticity ranged from 1 to 1^+ grade according to the modified Ashworth scale[10].

The involved lower limb was free from any structural deformities; however children demonstrated variable degrees of tightness of hip adductors, hamstrings and tendo-Achillis muscles. All children were able to stand and walk independently with an abnormal pattern of gait.

Children were excluded for any of the following problems which include: any previous corrective orthopedic surgery, skin disease, epilepsy, mental retardation, and visual or auditory problems.

Children were randomly assigned into two groups of equal number (A and B), by asking each child to pick up an index card out of a box which contains 30 cards (15 card for each group) to determine which group he/ she would be in.

Group A (control) received a selected therapeutic exercises program for children with hemiparetic cerebral palsy with an emphasis on gait training, while group B (study) received ankle Kinesio taping in addition to the same exercises program given to group A.

Evaluation was conducted for each child of the two groups by determination of ankle excursion and selected gait parameters including step length, cadence and velocity.

Instrumentation

I - For evaluation

1-Electrogeniometer was used to determine the degree of ankle excursion.

2-Kalk paper: A straight white kalk paper (16 meters long and 50 cm wide) was used for recording distance (step length) and temporal (cadence and velocity) gait parameters.

3- Stop watch.

4- Ruler.

II- For treatment

1- Physical therapy tools of different shapes in the form of mat, wedges, medical balls, rollers, standing bar, parallel bars, stepper and obstacles were used in conducting the exercises program.
2- Kinesio taping: A latex-free hypoallergenic water resistant cotton fiber tape with an acrylic heat-activated backing was used for ankle taping.

Procedures

I-For evaluation

After signing a written consent form by the parents, all hemiparetic children and their parents were informed about the whole steps of evaluative procedures, and demonstration was conducted before testing. Evaluation for each child in the two groups was conducted before and after three months of treatment.

1- Ankle excursion

From supine lying position with the foot outside the plinth and the knee was slightly flexed by placing small pillow under the knee, the fixed arm of the electrogeniometer was placed on the lateral aspect of the lower leg and the movable arm parallel to the lateral aspect of the foot. These arms were fastened in position via straps. Each child was then asked to move the ankle from full planter flexion to full dorsiflexion (ankle excursion) and the range of motion was determined. Three successive trials were recorded to determine the mean value for each child.

2- Gait evaluation

The kalk sheet, 16 meters in length, was positioned on the floor and fastened on both ends with adhesive tapes to prevent their slipping. Each child was asked to put his / her bare feet in a bowel filled with water then place them in the colored powder and to walk as normal as he/ she used to, from the beginning to the end of the walk way, but evaluation was conducted in the middle 8 meters only. Distance (step length) and temporal (cadence and velocity) gait parameters were recorded by using the stopwatch and ruler as follows:

- Step length (cm): It is the vertical distance from the central of the heel of one foot to the center of the heel of the other foot.
- Cadence (step/ min): It is the number of steps divided by the elapsed time for a distance.
- Velocity (cm/sec): It is the total distance between the first and last heel strikes divided by the elapsed time for the distance.

Three successive trials were allowed for testing each parameter and the mean values were obtained for each child of the two groups, before and after three months of treatment.

II- For treatment

A selected therapeutic exercises program was conducted for each child of the two groups, it include neurodvelopmental technique, proprioceptive training, facilitation of righting, equilibrium and protective reactions, stretching exercises for the muscles liable to be tight, namely hip flexors adductors, hamstrings and tendo-Achillis muscles. Strengthening exercises to the antagonistic groups of the spastic muscles and gait training in a closed and open environment were also conducted. Special attention was also given to the affected upper limb and uninvolved side.

In addition to the exercises program, group B (study) received ankle taping for function correction, using Kinesio tex tap 2 inch in width, in the form of two I strips.

Before application of taping, the skin of the treated area should be free from any lotions. Also, the skin sensitivity test was done by applying a square piece of Kinesio tape (2 X 1 inch) over the dorsal aspect of the foot and kept for 48 hours, then removed and the skin was observed for any reaction to the tape.

If no reaction was detected, therapeutic application of the tape was sustained for successive 4 days, then removed for 24 hours to allow skin perspiration. Repetition of tape application and removal was conducted for successive twelve weeks[11].

The first I strip tape was extended from the planter surface of the foot through the middle three toes to the anterior aspect of tibia just below the tibial tuberosity, The tape length was measured from the dorsal surface of the foot, while the ankle was dorsiflexed, to the anterior tibia just below the tibial tuberosity. Three triangular shapes were cut for toes to be placed which was become diamond-shaped when infolded. Taping method was initiated by first gently placing the toes through the wholes, then, the tape with paper-off tension was applied on the planter surface of the foot and on dorsal side of the metatarsals (distal anchor).

The foot was positioned in dorsiflexion and in mid position to fix the proximal anchor of the tape (with paper-off tension) on the anterior tibia. Then, the child was asked to planter flex his feet while the therapist move both hands towards the middle of the tape to apply the remaining of it.

The second I strip tape length was measured as twice the length of the lower leg. The tape backing in the center was splitted and the tape was placed on the planter surface of the mid-foot between calcaneus and metatarsal heads with paper-off tension. The tape was then applied diagonally over the anterior ankle with increased tension on the lateral section to promote eversion. Then, the tape was continued up the lower leg parallel to the first I strip with paper-off tension at the end of the tape.

After tape application, each child was instructed to avoid vigorous activities for thirty minutes which was required for the glue to become fully activated[12].

RESULTS

The raw data were analyzed using the SPSS program to determine the mean ± standard deviation for each measured variable

of the two groups before and after three successive months of treatment.

Student t-test was then applied to examine the significance of treatment procedures applied in each group. No significant difference was observed when comparing the pre-treatment mean values of the two groups. Significant improvement was observed in each group when comparing their pre and post-treatment mean values. After treatment, significant difference was observed when comparing the post-treatment results of the two groups in the favor of the study group.

1-Degree of ankle excursion

As shown in table (1) and demonstrated in figure (1), pre and post-treatment mean values of ankle excursion of the affected lower limb for the control group were 24.827±3.742 degree and 29.307±2.103 degree respectively (P<0.05), which was statistically significant. Also, significant improvement was observed when comparing the pre and post-treatment mean values of ankle excursion of the study group which were 24.5±3.824 degree and 38.773±2.159 degree respectively (P< 0.05).

Table (1): Pre and post-treatment mean values of the ankle excursion (degree) for the two groups A and B.

	Group A (control)		Group B (Study)	
	Pre	Post	Pre	Post
X	24.827	29.307	24.5	38.773
±SD	±3.742	±2.103	±3.824	±2.159
t-test	3.399		12.780	
P-value	0<0.05		0<0.05	
Sig.	Significant		Significant	

X: Mean SD: Standard deviation P-value: level of significance Sig.: Significance

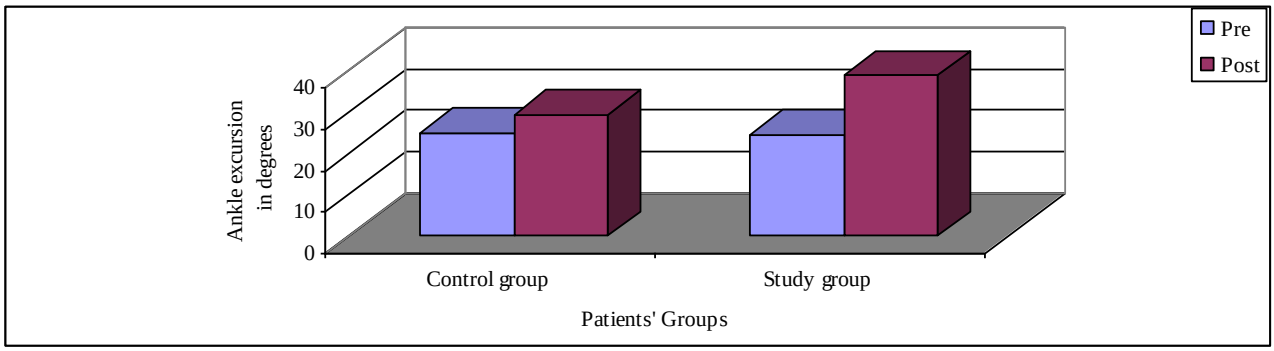

Fig. (1): Representing the pre and post-treatment mean values of ankle excursion (degree) for groups A and B.

2-Step length

Concerning the step length for the control group, pre and post- treatment mean values were 20.84±3.102 cm. and 23.346±1.291 cm. respectively (P<0.05), which denote significant improvement. While the mean values of the step length for the study group increased from 20.48±2.503 cm. before starting the treatment program, to 25.386±1.292 cm. after the application of treatment procedures (P < 0.05), which revealed significant improvement, table (2) and figure (2).

Table (2): Pre and post-treatment mean values of the step length (cm.) for the two groups A and B.

	Group A (control)		Group B (Study)	
	Pre	Post	Pre	Post
X	20.84	23.346	20.48	25.386
±SD	±3.102	±1.291	±2.503	±1.292
t-test	3.759		12.287	
P-value	0<0.05		0<0.05	
Sig.	Significant		Significant	

X: Mean SD: Standard deviation P-value: level of significance Sig.: Significance

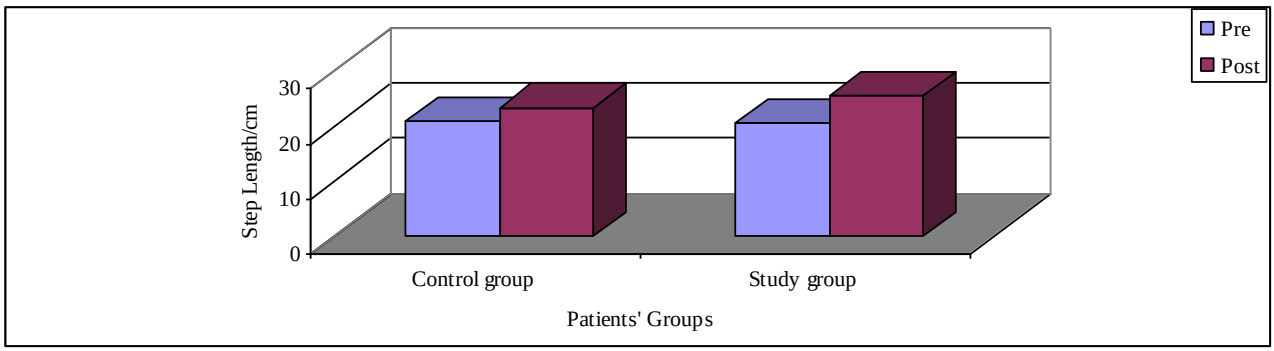

Fig. (2): Illustrating the pre and post-treatment mean values of the step length (cm.) for the control and study groups.

3-Cadence

As shown in table (3) and demonstrated in figure (3), pre and post-treatment mean values of cadence of the control group were 81.573±3.693 step/ min and 84.16±1.908 step/min, respectively (P<0.05) which was statistically significant. Also, significant improvement was observed when comparing the pre and post-treatment mean values of cadence of the study group which were 82.247±3.867 step/min. and 89.307±1.861 step/min, respectively (P<0.05).

Table (3): Pre and post-treatment mean values of cadence (step/min) for the control and study groups.

	Group A (control)		Group B (Study)	
	Pre	Post	Pre	Post
X	81.573	84.16	82.247	89.307
±SD	±3.693	±1.908	±3.867	±1.861
t-test	2.506		5.823	
P-value	0<0.05		0<0.05	
Sig.	Significant		Significant	

X: Mean SD: Standard deviation P-value: level of significance Sig.: Significance

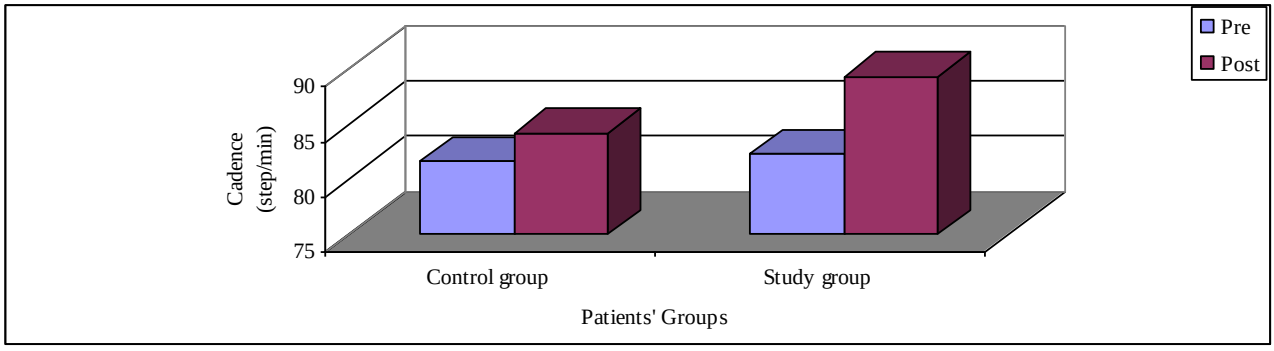

Fig. (3): Showing the pre and post-treatment mean values of cadence (step/ min) for the control and study groups.

4-Velocity

As shown in table (4) and demonstrated in figure (4), the mean values of the gait velocity for the control group were 38.02±1.847 cm/sec pre-treatment and 40.76±1.585 cm /sec post-treatment, (P<0.05) which was significant. While, the mean values of the gait velocity for the study group before treatment was 37.58±2.902 cm/sec, which increased after the suggested period of treatment to 45.427±1.606 cm/sec, which revealed a significant improvement (P<0.05).

Table (4): pre and post-treatment mean values of the velocity (cm/ sec) for the control and study groups.

	Group A (control)		Group B (Study)	
	Pre	Post	Pre	Post
X	38.02	40.76	37.58	45.427
±SD	±1.847	±1.585	±2.902	±1.606
t-test	5.370		10.037	
P-value	0<0.05		0<0.05	
Sig.	Significant		Significant	

X: Mean SD: Standard deviation P-value: level of significance Sig.: Significance

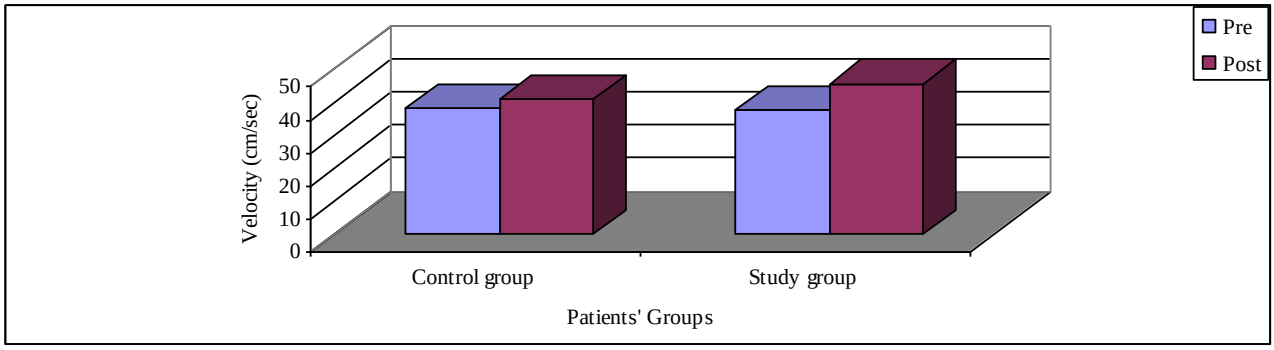

Fig. (4): Demonstrating the pre and post-treatment mean values of the velocity (cm/sec) for the control and study groups.

DISCUSSION

Functional limitations of the children with spastic hemiparetic cerebral palsy are mainly in mobility, balance and delay in acquiring motor milestones[13].

Taping is now recognized as a skill which is essential for all those involved in the treatment and rehabilitation of injuries. It is used not only for sports injuries, but also for many other conditions such as muscle imbalance, unstable joints and impaired neural control[14].

The popularity of the application of tape during the rehabilitation process and the need for empirical evidence on the effects of Kinesio tape and its potential effect on ankle excursion and on selected gait parameters in children with hemiparetic cerebral palsy were compelling reasons to perform this study.

In the present study, the ankle excursion has been evaluated using electrogeniometer. Furthermore, deviations in some selected gait parameters were also evaluated. They were chosen to be a main representative parameters for delayed gross motor development and to determine the effect of treatment program on functional abilities.

Choosing the measured variables, (ankle excursion and selected gait parameters including step length, cadence and velocity) for evaluation comes in agreement with Russman and Ashwal[15] who concluded that the neurological disturbance associated with hemiplegic cerebral palsy is secondary, as musculoskeletal impairments, pain, and physical fatigue which is thought to cause the changes in motor function that may include a decline in walking .This also confirmed by Chang et al.,[16] who reported that, in cerebral palsy, foot deformity develops over time and often need orthotics and surgical treatment.

Some ambulatory abilities can usually be restored by immobilizing or assisting the ankle with an orthotics, but this assistance tends to inhibit neural rehabilitation, that depends on active neuromuscular efforts[17].

In this study application of ankle Kinesio taping, to maximize the functional outcome, agrees with Helseth et al.,[18] who reported that Kinesio taping is a novel method of ankle taping utilizing a specialized type of tape. The fabric of this tape is air permeable and water resistant and can be worn for repetitive days. This also come in agreement with Neumann[19] who revealed that, Kinesio taping allows support and stability to muscles and joints

without restricting the body's range of motion, and it is used to successfully treat a variety of orthopedic, neuromuscular and neurological conditions.

The pre-treatment results of the two groups revealed non-significant difference, indicating homogeneity of the sample in the two groups.

Statistical analysis of the post-treatment results revealed significant improvement in all the measured variables of the two groups A and B when comparing their pre and post-treatment mean values.

Improvement fulfilled in the control group (A) might be attributed to the effect of the therapeutic exercises program for children with hemiparetic cerebral palsy. This agree with Kern et al.,[20] who established that traditional methods of treatment for children with cerebral palsy are focused on the attainment of sequential developmental milestones and facilitation of normal movement patterns for the training of functional activities.

Significant improvement in the study group (B) may be attributed to the use of ankle Kinesio taping which gives the opportunity to actually give support while maintaining range of motion, enabling the individual to participate in physical activity with functional assistance as reported by Miller and Osmotherly[21].

The period of tape application which was conducted in this study supported by Paige[22] who stated that, Kinesio taping method allows the individual to receive the therapeutic benefits 24 hours a day. It was designed to be the approximate thickness and elasticity of skin and can be worn three to five days at a time. This is also come in consistent with Herrington and Payton[11] who revealed that repetition of tape application and removal was conducted for successive twelve weeks.

The significant improvement in the degree of ankle excursion in the study group was supported by the findings of Welson et al.,[23] who recommended that, application of tape is believed to adjust joint mal-alignment, caused by shortened muscle, thus, improving active range of motion.

Improvement fulfilled in the study group regarding the measured gait parameters confirmed by Simoneau et al.,[24] who concluded that, the effects of taping may be attributed to the cutaneous stimulation of the sensorimotor and proprioceptive systems, as it provides immediate sensorimotor feedback regarding functional abilities.

Significant improvement was also noticed when comparing the post-treatment results of the two groups in the favor of group B receiving ankle Kinesio taping, in addition to the same selected exercises program given to group A.

These results might be attributed to the increased sensory awareness through tape application. This agree with the findings of Blanch et al.,[25] who recommended that taping stimulate the underlying sensory receptors via surface contact or stretch of the skin that alters the sensory input to the central nervous system and subsequently influence its perception and execution of movement.

This explanation come in agreement with Grigg et al.,[26] who reported that applying pressure to, and stretching the skin via using tape can stimulate cutaneous mechanoreceptors. This sense of stretching is thought to possibly signal information of joint movement.

This also confirmed by Cools et al.,[27] who revealed that cutaneous stimulation and traction or pressure on the skin, via using tape application, provides cutaneous sensory cues, that providing additional proprioceptive input to the central nervous system.

In conclusion, ankle Kinesio taping for children with spastic hemiparetic cerebral palsy might be used as an additional supplement to regularly schedualed exercises program for the purpose of assisting those children in maximizing their functional outcomes.

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الملخص العربى

تأثير لصق مفصل الكاحل بشريط الكاينيزيو على المدى الحركى لمفصل الكاحل وقياسات المشى المختارة لدى الاطفال المصابين بالفالج الشقى

يلعب القدم دروراً هاماً فى عملية المشى الطبيعى لدى الانسان . أجريت هذه الدراسة لتحديد تأثير لصق مفصل الكاحل بشريط الكاينيزيو على المدى الحركى لمفصل الكاحل وبعض قياسات المشى المختارة لدى الاطفال المصابين بالفالج الشقى . عينه البحث : أشتملت العينة على ثلاثين طفلاً مصاباً بالفالج الشقى (تسعة جانب أيمن وإحدى وعشرون جانب أيسر) ممن تراوحت اعمارهم من ستة الى ثمان سنوات وقد تم إختيارهم من العيادة الخارجية للاطفال بكلية العلاج الطبيعى – جامعة القاهرة . وقد حددت درجة التشنج العضلى على أساس مقياس أشورث المعدل لتتراوح بين 1^{+} ، 2 درجة ، تم تقسيم هؤلاء الاطفال بشكل عشوائى إلى مجموعتين متساويتين ، مجموعة (أ) (مجموعة ضابطة) ومجموعة (ب) (مجموعة اجراء موضوع البحث). طريقة البحث: تم تقييم المدى الحركى لمفصل الكاحل بالاضافة الى بعض قياسات المشى (طول الخطوة ، عدد الخطوات فى الدقيقة ، وسرعة المشى) عند جميع الاطفال قبل وبعد ثلاثة شهور من العلاج. وقد تلقت المجموعة (أ) برنامج من التمرينات العلاجية بينما تلقت المجموعة (ب) تطبيق لاصق الكاينيزيو على مفصل الكاحل بالاضافة الى برنامج التمرينات العلاجية المطبق على المجموعة (ا) . النتائج : وقد أظهرت النتائج أنه لا يوجد اختلافات ذات دلالة إحصائية عند مقارنة نتائج ما قبل العلاج للمجموعتين بينما كشفت النتائج عن وجود فروق ذات دلالة احصائية فى جميع القياسات عند مقارنه نتائج ما قبل العلاج بنتائج ما بعد العلاج للمجموعتين وايضاً عند مقارنة نتائج ما بعد العلاج للمجموعتين لصالح مجموعة إجراء موضوع البحث.المناقشة : التحسن الملحوظ فى نتائج المجموعة (ب) قد ينسب الى تأثير لاصق الكاينيزيو على مفصل الكاحل فى تحسين نشاطه الوظيفى وطبقاً لهذه النتائج يوصى باستخدام لاصق الكاينيزيو بالاضافة الى البرامج العلاجية المختلفة لعلاج حالات الاطفال المصابين بالفالج الشقى.