Effect of Modified Spiral Strapping in Hip Rotational Abnormalities in Hemiparetic Cerebral Palsy Children

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ABSTRACT

Purpose: This study was done to investigate the effect of using spiral strapping in correction of hip rotation abnormalities in hemiparetic cerebral palsy children to prevent deformity and improving hip rotation range of motion. **Participant and Methods:** Thirty children with spastic hemiparesis enrolled in his study. Their age ranges between 3 and 6 years and being assessed by digital goniometer. They were randomly assigned into two groups of equal number 15 patients each of them. The control group (A) received a designed physical therapy program and the study group (B) received the same therapy program in addition to the spiral strapping technique on the affected lower limb for 3 successive months their hip range of motion was assessed by digital goniometer. **Results:** All participated children were evaluated before and after the treatment. Comparison of post treatment results between the two groups revealed a significant difference between the mean values of external hip rotation angle in faver of the study group. **Conclusion**: From the obtained results it concluded that spinal strapping has a beneficial effect on correction of abnormal hip rotation in hemiparetic children.

Key Words: Hemiparesis, Range of motion, Abnormal hip rotation, Spiral strapping

INTRODUCTION

Cerebral palsy (CP) is defined as "a group of permanent disorders of movement and posture, causing activity limitation that are attributed to non-progressive disturbances that occurred in the developing fetal or infant brain." While the central feature of CP is a disorder with movement, difficulties with thinking, learning, feeling, communication and behavior often occur along with cerebral palsy. Those with CP, 28% have epilepsy, 58% have difficulties with communication, at least 42% have problems with their vision, and 23–56% have learning disabilities (1).

Hemiparesis is a unilateral paresis with upper limb more severely affected than the lower limb. It is seen in 56% of infants and 17% of preterm infants. Pathogenesis is multifactorial. Voluntary movements are impaired with hand functions being most affected. Pincer grasp of the thumb; extension of the wrist and supination of the forearm are greatly affected. In the lower limb, dorsiflexion and eversion of the foot are most impaired. There is increased flexor tone with hemi paretic posture, flexion at the elbow, wrist and equines position of the foot. Palmer grasp may persist for many years. Sensory abnormalities in the affected limbs are common. Stereognosis impaired most frequently. Two point discrimination and position sense is also defective. Seizures occur in more than 50%. Visual field defects, homonymous hemianopia, and cranial nerve abnormalities most commonly facial nerve palsies (2).

Rotational abnormalities are common in many neuromuscular disorders, such as cerebral palsy. Factors thought to contribute include; femoral ante-version, imbalance of hip rotators, and tightness of hip flexors, hamstrings, and hip adductors. There may be abnormal rotation at hip, knee, and ankle joints during gait as well so these deviations in transverse –plan may be torsional and rotational alignment of the pelvis and lower extremities are impaired (3).

The excessive hip flexion is more likely cause the internal rotation than the hamstrings or adductors tightness. Thus enhancing activation of the gluteus maximus in persons with internally rotated gait may help to correct both the excessive hip flexion and internal rotation (4).

Internal rotation of the leg causes abnormal posture in standing and walking leading to limited range of motion of hip rotation. Using of twisters to pull the leg into external rotation attached from the leg to the pelvic may be a method for correction of internal rotation of the legs and thus improving hip rotation range of motion. Hip flexion –adduction – internal rotation may be dictated by

valgus flexed knees as a compensatory mechanism (5).

Spiral strapping are not recommended for femoral anti-torsion, as they may promote excessive lateral tibio–fibular torsion or rotation. so using the modified spiral strapping which make the femur externally rotated versus to another one which make the tibia medially rotated ,may help posture alignment and improve joint angles of lower limbs in transverse and sagittal plane (6).

Range of motion (ROM) measurements have been included in several hip scores evaluating the results after hip management. The clinical procedures of performing these measurements vary and disagreement exists about the accuracy of visual estimates compared to goniometer measurements. So the reliability of goniometric measurements and visual estimates of hip ROM was recommended. There was also high reliability when all the six arcs of motion were summed up. Concordance between visual estimates and goniometric measurements indicates good agreement (7).

MATERIALS AND METHODS

Study design:

The research design of this study was a randomized control study design. Ethical committee approval was obtained from the institutional review board at Faculty of Physical Therapy, Cairo University before study commencement with number (No. P.T. REC/ 012/002005). Informed written consent was signed from each parent after explaining the nature and purpose of the study.

Participants:

Thirty children with hemi paretic cerebral palsy participated in this study and they were selected from the outpatient clinic. Faculty of Physical Therapy, Cairo University. Their ages ranged from 3 to 6 years, both genders have been included, spasticity is grade 1 according to modified a showrth scale, they were able to stand without support, they walk with abnormal pattern of gait in the form of internal rotation of hip joint. (According to observational gait analysis and hip rotational mobility test) (8).

We excluded children with contractures, fractures, epileptic fits, hyper sensitivity to adhesive strapping and surgical interference in lower limb. They were divided into two groups, group A (control), which received a designed physical therapy program; and group B (study), which received the same therapy program of control group (A) in addition to spiral strapping on affected lower limb.

Measurements for assessment:

Digital goniometer (Fabrication Enterprises, Inc. PO Box 1500 White Plains, New York 10602 USA) is an effective tool for assessing hip joints rotational angles in the sagittal plane for all patients enrolled in this study pre and post treatment. Digital goniometer reads 0-185 degrees on LCD screen. It had ability to freeze angle measurement. Powered by one 9V battery.

To Prevents false position due to pelvis rotation, Child lies prone, hips extended, and knees flexed 90 degrees, push ankles away from midline. Normal medial hip rotation angle <70 degrees. Push ankles across midline toward other side. Normal lateral hip rotation angle >20 degrees. Clearly abnormal is less than -10 degrees. Children Lateral hip rotation range of motion of both groups were assessed pre and post treatment.

Treatment procedures:

1-measuringthe length of strape:

Tap measurement was used to determine the length of strap to be fitted for each child in study group. Firstly; the child was lied supine with pelvic horizontally aligned then, by using tap the length of the affected leg was measured from the greater trochanter of hip joint off affected limb to the medial knee condyle plus the distance between the medial condyle and the lateral malleolus of foot.

2-The spiral strapping was applied as follow:

Two pieces of the elastic straps were applied one for femur and other for tibia on the affected side in the following manner:

One strap was applied to correct the mobile hip internal rotation. The strap were applied in a spiral manner starting from inner aspect of thigh just above knee joint till sacral region to get the hip joint in mid position, the strap should be passed just above the hip joint to facilitate hip abduction and extension.

One strap was applied to correct the mobile lateral tibial rotation. The strap were applied in a spiral manner starting from outer aspect of tibia above the lateral maloli till the inner aspect of the thigh to get the knee joint in mid position, it should pass above the knee joint to assist with vastus medialis.

All children in this study group used aspinal strapping as long as possible and removed at bed time for 3 months.

3. Physical therapy program:

Side walking on rail (later on with weights above ankle),Walking with anterior walker slowly with posture correction (later on with weights above ankle),Walking

between parallel bars forward and backward slowly with postural correction (later on with weights above ankle), Walking between parallel bars in stepper (later on with weights above ankle),Walking between parallel bars over balanced board, Walking with unilateral support with ring or robe over foot print (later on with weights above ankle),Walking in stepper with unilateral hand support with ring or robe (later on with weights above ankle), Walking in stepper with unilateral hand support with ring or robe over balance beam, Walking alone without support over foot print with posture correction (later on with weights above ankle, walking alone without support over balance board with caution.

Data analysis:

Descriptive statistics and unpaired t-test were conducted for comparison of subject characteristics between both groups. Chi-squared test was used for comparison of sex and affected side distribution between groups. Mann-Whitney test was conducted for comparison of spasticity grades between groups. Normal distribution of data was checked using the Shapiro-Wilk test. Levine's test for homogeneity of variances was conducted to ensure the homogeneity between groups. Unpaired t-test was conducted to compare the mean values of external rotation between the groups. Paired t-test was conducted for comparison between pre and post treatment in each group. The level of significance for all statistical tests was set at $p < 0.05$. All statistical analysis was conducted through the statistical package for social studies (SPSS) version 22 for windows (IBM SPSS, Chicago, IL, USA).

RESULTS

***- Subject characteristics*:**

Table (1) showed the subjects' characteristics of the group A and B. There was no significant difference between both groups in age, weight, height and spasticity grade ($p > 0.05$). Also, there was no significant difference in sex and affected side distribution between groups ($p > 0.05$). Table (1).

Table (1): Comparison of subject characteristics between group A and B.

	Control group	**Study group**	**P-value**
	Mean ± SD	**Mean ± SD**	
Age (years)	4.44 ± 0.82	4.5 ± 0.97	0.88
Weight (kg)	15.7 ± 1.7	16.47 ± 1.73	0.23
Height (cm)	100.93 ± 5.57	103.4 ± 6.81	0.28

Spasticity grade (median)	1	1	0.26
Sex			
Girls	6 (40%)	5 (33%)	0.7
Boys	9 (60%)	10 (67%)	
Affected side			
Right side	8 (53%)	6 (40%)	0.46
Left side	7 (47%)	9 (90%)	

SD, Standard deviation; p value, Probability value

Effect of treatment on external rotation ROM:

- Within group comparison:

There was a significant increase in external rotation ROM post treatment in the group A and B compared with that pre treatment ($p < 0.001$). The percent of increase in external rotation ROM of the group A and B were 37.01% and 49.64% respectively. Table (2).

- Between groups comparison:

There was no significant difference in external rotation ROM between the two groups pre-treatment ($p > 0.05$). Comparison between groups post treatment revealed a significant increase external rotation ROM of the group B compared with that of the group A ($p < 0.001$). Table (2) Figure (1).

Table (2): Mean external rotation ROM pre and post treatment of the group A and B:

	Group A	**Group B**		
	Mean ± SD	**Mean ± SD**	**t- value**	**p value**
External rotation ROM (degrees)				

Pre	30.53 ± 1.02	30.68 ± 0.89	-0.43	0.66
Post	41.83 ± 1.13	45.91 ± 1.91	-7.08	0.001
MD	-11.3	-15.23		
% of change	37.01	49.64		
t- value	-38.92	-40.45		
	p = 0.001	***p = 0.001***		

SD, Standard deviation; MD, Mean difference; P value, Probability value

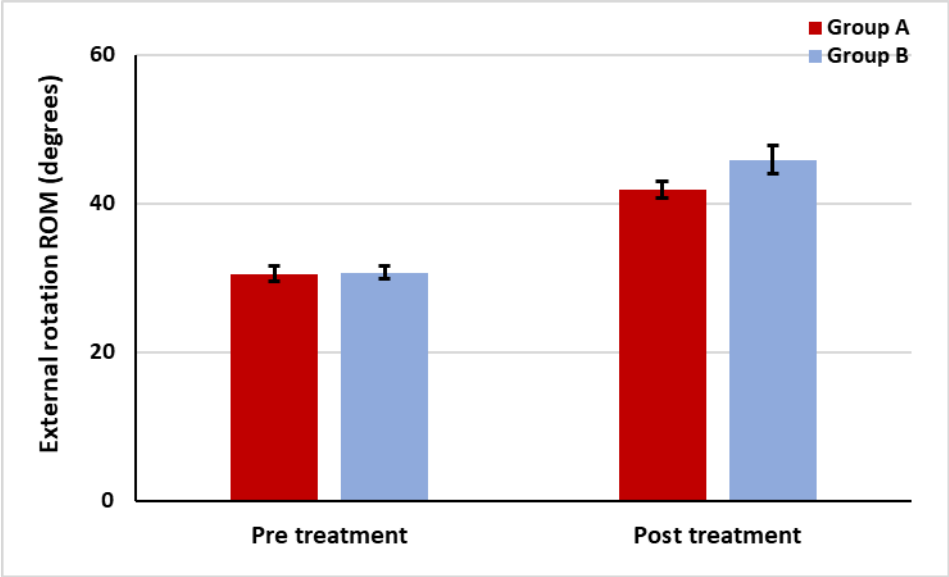

Figure (1): Mean external rotation ROM pre and post treatment of the group A and B:

DISCUSSION

This study was designed to investigate the effect of spinal strapping in correction of hip rotation abnormalities in hemiparetic cerebral palsy children.

Children with hemiparetic CP show increased muscle weakness and limited range of motion, all of which affect gross and fine motor functions (9).

Functional prognosis in hemi paretic children is good compared to other types because one side of the body is normal and they learn to walk by the age of three but with internal rotation abnormalities (10).

The internal rotation of the lower limb is one of some common abnormal posture in standing and walking in hemiparetic children, femoral and hip internal rotation, knee flexion and lateral tibial torsion or rotation is look like valgus flexed knee are seen as compensatory mechanism (5).

Rotational abnormalities in the lower limbs of hemi paretic cerebral palsied children may be due to bony torsion or joint rotation due to soft tissue factors, it comes in agreement with Davies, (2011) who described that, rotational abnormalities are common in many neuromuscular disorders, such as cerebral palsy. (Torsional bony deformities) identified during the clinical examination, may be present in the femur and tibia, and there may be (abnormal rotation) at the hip and knee joints during gait as well.

There are many techniques which used to correct the deformities in the sagittal plane like ankle foot orthoses, knee cage….etc. but there is no clear techniques which could be used to correct hip rotational deformities. Many clinicians used the twister cable or a spiral strapping from the leg till the pelvis in one direction but it will increase the lateral tibio-fibular rotation so if we prove the effectiveness of modified spiral strapping for femur and tibia versus to each other it may help to correct the pattern with avoidance of increasing the lateral tibial rotation. levitt,(2015) confirmed that, many clinicians used spiral strapping from the leg till the pelvic in one direction to pull the lower limb into external rotation attached from the leg to the pelvis as a way of correction of internal rotation. So it will allow proper pattern in standing and walking.

The study results revealed a significant difference post treatment in favor of the study group compared to the control group, represented as improvement of hip abnormal rotation and muscle imbalance due to the effect of spiral strapping on the affected lower limb, this is confirmed

by Becher (2017) who stated that the placement of elastic straps can assist weak muscles and correct abnormal body positions or movement patterns from nonstructural sources (such as tight muscles rotating the leg). Also this come in agreement with Symes and Ellis (2010) who stated that the elastic straps are adjusted by therapists to get normal extensor patterns of major muscle groups in an attempt to reposition limbs to correct abnormal muscle alignment.

In the present work the significant improvement in post treatment results obtained from measurement of all variables of the study group might attributed to the following; realigning of hip and knee joint which improves the muscle pulling action by immediate effect (biomechanical effect), correction of the proprioceptive input from the peripheral muscles and joints to central nervous system resulting in correction of the output signals of how CNS wants our body to respond by the prolonged effect (neuro developmental effect).

Also, Goble et al., (2005) stated that the proprioceptive input which produced via elastic cords increases the significant effects on the patients ability to form new motor plans. Due to the ability to provide artificial formation and reinforcement of appropriate movement habits through the spiral strapping with repetitive exercise, patients learn the new motor plans and build strength at the same time.

The theory is that once the body is in proper alignment, aggressive movement therapy can be performed that will reeducate the brain to recognize correct movement of the muscles. All in all, this enable to bring the body into a positon as close to normal as possible in both static and dynamic positions (align them when they are not moving and also when walking).

This findings comes in agreement with Rosenblum, (2003) who suggested that, the re-training the central nervous system occurred by allowing the child to overcome increasingly complex pathological movement and to execute and repeat previously unknown movement patterns.

CONCLUSION

It concluded from the result of this clinical study that spinal strapping is effective in improving abnormal hip rotation in hemiparetic cerebral palsy children.

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