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Research Article

TREADMILL TRAINING WITH PARTIAL WEIGHT BEARING IN HEMIPARETIC CEREBRAL PALSIED CHILDREN

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A B S T R A C T

Background: The purpose of this study was to evaluate dynamic postural control in spastic hemiparetic cerebral palsied children following the participation of a physical therapy program including; treadmill training with partial body weight support (30% relief of total body weight) using the suspension system in addition to a specially designed exercise program. **Subjects**: Thirty spastic hemiparetic children ranged in age from 7 to 10 years old participated in this study. **Methods**: They were classified randomly into two groups of equal number, (control and study). Balance parameters were assessed using the Biodex stability system in both groups before and after three months of the application of the treatment program. The **Results**: of this study revealed statisticallyhigh significant improvement in the measuring variables of both the control and study groups when comparing their pre and post treatment mean values. **Conclusion**:, more improvement was noticed in the study group when comparing the post treatment mean values of the study group with the control group.

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INTRODUCTION

Cerebral palsy (CP) represents one of the most devastating calamities affecting human life in infancy and childhood (Behrman and Kliegman, 2004**)**.

Cerebral palsy, as a number of non-progressive syndromes of posture and motor impairment, is a common cause of disability in childhood. The disorder results from various insults to different areas within the developing nervous system, which partly explains the variability of clinical findings (Dormans, and Pellegrino, 2008). The child with spastic hemiplegia has difficulty with balance because ofpoor muscle control in the arm and leg on one side of the body (Bedford and Kinlary, 1993). Protectiveresponses of catching oneself when falling toward the invoved side are impaired. The trunk may also be affected and scoliosis may develop because ofasymmetrical muscle pull on the spine, as well as postural asymmetries in sitting, standing and walking. (Ratliffe, 2008**.)**During hemiplegic walking, there are deficits in balance, proprioception, and selective control that limit their ability to shift and support body weight onthe paretic limb (Rose and Gamble, 2004**)**. Decrease in velocity, cadence, and stride length occurs with relative increase in gait cycle duration and initial and double limb supportperiods. Marked asymmetries are evident between the paretic and uninvolved limbs in stance and swing times, single limb support, and stance-to-swing ratio(Tecklin, 2009).Postural control involves controlling the body's position in space for the dual purposes of stability and orientation. Postural stability, or balance, is theability to maintain the projected center of mass "COM" within the limits of base of support "BOS". Whereas postural orientation is the ability to maintainan appropriate relationship between the bodysegments and between the body and the environment for a task (Chaudhuri, and Aruin 2009**)**.

Balance is a complex motor skill often referred to as postural control. (Rowland, 2000**)**.Balance and posture are two concepts which cannot be considered inisolation, as they are intervenient (Macko, *et al*., 2007**)**. Posture means simply position or alignment of body parts. All body parts have a role in postural alignment, and maintaining"good posture". Good posture refers to a position that requires the least effort to maintain and puts the least strain on ligaments, bone and joints(Hesse , 2008**)**.Partial body weight support system has shown great promise in helping a wide variety of impaired patients as they relearn walking(Carmeli, 2005**)**.

SUBJECTS, MATERIALS AND METHODS

All patients have been given their informed concent for participation of in the study every precaution was taken to protect the privacy of patients.

Subjects Thirty spastic hemiparetic cerebral palsied children (nineteen children with affected right side and eleven with affected left side). The sample wasselected from both sexes (sixteen males and fourteen females). They were selected

from the out- Patient Clinic of the Faculty of Physical Therapy, CairoUniversity.

The criteria of selection of the sample were as follows:

- Their age ranged from 7to 10 years old.
- Degree of spasticity ranged from grade 1 to 2 according to modifiedAshworth scale.
- They had balance problems collected from history of repeated andfrequent falling especially when increasing speed or walking on unevensurface and confirmed by balance assessment on the Biodex stability system.
- They were able to follow simple verbal commands and instructions during evaluation and training.
- They were able to stand unassisted and ambulate with abnormal pattern.The sample was divided randomly into two groups of equal number, group A (control group) and group B (study group). Each group composed of fifteen patients.

MATERIALS

Materials used for evaluation

The Biodex Stability system consists ofthe following

Foot platform

The platform could be tilted up to 20 degrees of surface tilt from horizontal in all directions. It has a foot grid for determination offoot position which is important for the centering process of the subject before testing.

Weight and height scale

A valid and reliable weight and height scales were used.

Materials used for treatment

The unweighting system

The suspension system was used to reduce the amount of weight born by a patient (partial weight bearing) and provide proper upright posture

The treadmill apparatus

A motor driven treadmill was used for gait training
Mat, balls, rolls, wedges and balance board

METHODS

For evaluation

Evaluation of degree of spasticity

The modified Asworth scale was used to quantify the degree of spasticity for the selection of patients.

The Biodex stability system

It was used for the assessment of the dynamic postural control of the hem paretic children before and after three months of treatment. Each child inboth groups, was evaluated by two different balance tests of the Biodex stability system; dynamic balance and dynamic limits of stability tests.

Dynamic Balance testing procedure

This test was performed to test the child's ability to control the platform's angle of tilt.
All subjects was given an explanatory session before the evaluationprocedures to be aware of the different test steps. Each child in both groupswas asked to stand on the center of the "locked" platform with two leg stance.Safety support rails and biofeedback display were adjusted for each child to ensure comfort and safety. The display adjusted so that the child can look straight at it.

The following test parameters were introduced to the device:

- Child's weight, height, and age.
- Platform firmness (stability level): All children were tested on the stability levels; stability level eight (most stable platform) and stability level one (the least stable platform) for three times repetitions for eachlevel of stability.
- Test duration: All children were tested for 2 minutes.

For treatment

Group A (Control group)

- Fifteen hemiparetic cerebral palsied children ware included in this group.
- They received the designed physical therapy program in addition to gaittraining on treadmill with full weight bearing without using the suspension system.

Each child was asked to walk on the motor-driven treadmill for 30 minutes with a speed of 0.01 m/sec and 0 degree inclination for the first 10 minutes increased gradually to reach 2.25 m/sec and 10 degrees inclination for the last 20 minutes of the session. The session was divided into three periods of activity followed by a rest period in between. Treadmill training was conducted once daily, three times/week for three successive months (12)

Group B (Study group)

- Fifteen hemiparetic cerebral palsied children were included in this group.
- They received the designed physical therapy program in addition to gaittraining on treadmill secured in a harness with partial body weight support (30%relief of total body weight).
- Each subject was mechanically supported in a modified parachute harness supported centrally by a set of pulleys connected to a flexible spring.
- Patients were asked to walk with harness- secured on the motor- driventreadmill with body weight support (30% relief of total body weight) for 30 minutes

The Designed therapeutic exercise program for both groups

- Neurodevelopmental approach.
- Approximation as a proprioceptive training was applied in a slow, regular and rhythmic manner
- Facilitation of righting, equilibrium reactions, to improve the postural mechanisms.
- Facilitation of protective reactions
- Different exercises to facilitate hand function according to each child abilities starting from bearing weight on arms to exercises to improve reaching, grasping, release and other manipulative skills of the hand. Blocks, spongy small balls and sticks were used for training of the various components of hand function according to each child abilities.

- Stretching exercises were conducted to maintain the length and elastic recoil of soft tissues liable to be tight especially the Achilles tendon, hamstrings, hip flexors
- Gait training activities are important elements for balance retraining

RESULTS

The collected data from this study represent the statistical analysis of: (1) The dynamic balance test which performed at two levels of stability, level 8 (more stable platform) . The measuring variables of the dynamic balance test were overall stability index, anteroposterior stability index and mediolateral stability index.

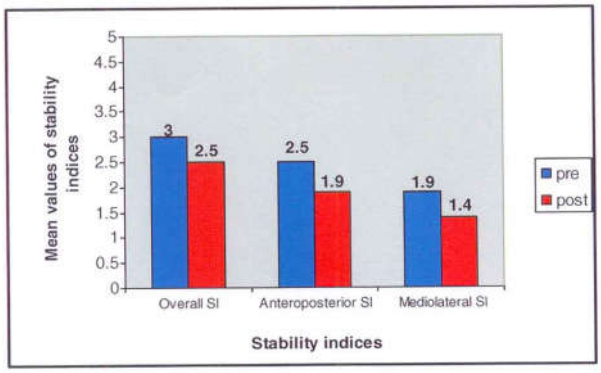

Fig 1 Mean values of the stability indices, pre and post treatment for the control group at stability level 8.

General Characteristics of both study and control groups

Table 1 Descriptive data of both study and control groups.

Item	Study			Control		
	$\overline{X}$±SD	Range		X±SD	Range	
		Minimum	Maximum		Minimum	maximum
1- Age (Years)	8.33±1.11	7	10	8.40±1.12	7	10
2- Height (Cm.)	126.33±4.53	118	134	127±3.87	120	132
3- Weight (Kg.)	30±2.75	26	34	30.13±2.41	26	33

$\overline{X}$: Mean P: Probability
SD : Standard deviation Sig.: Significance
MD : Mean Difference HS: Highly significant

As shown in table (1), the general characteristics of both study and control groups were represented including age, height and weight. The mean values of age for study and control groups were 8.33±1.11 and 8.40±1.12 respectively. The mean values of height for study and control groups were126.33±4.53 and 127±3.87 respectively. The mean values of weight for study and control groups were 30±2.75 and 30.13±2.41 respectively.

Dynamic balance test at stability level 8 for the control group (pre and post treatment of overall, anteroposterior and mediolateral stability indices.)

As shown in table (2) and figure (1), the mean values of overall stability index, anteroposterior stability index and mediolateral stabilityindex at stability level 8, pre and post treatment for the control group were as follows:

Overall stability index

The mean values of overall stability index, pre and post treatment were 3.08±0.37 and 2.51±0.33 respectively which indicated highlysignificant improvement (P< 0.01).

Anteroposterior stability index

The mean values of anteroposterior stability index, pre and post treatment were 2.54±0.19 and 1.98±0.21 respectively which indicated highly significant improvement (P< 0.01).

Mediolateral stability index

The mean values of mdiolateral stability index, pre and post treatment were 1.95±0.17 and 1.46±0.22 respectively which indicated highlysignificant improvement (P< 0.01).

Dynamic balance test at stability level 8 for the study group (pre and post treatment of overall, anteroposterior and mediolateral stability indices).

AS shown in table (3) and figure (2), the mean values of overall stability index, anteroposterior stability index and mediolateral stabilityindex at stability level 8,

Table 2 Comparison of the mean values of the stability indices pre and post treatment for the control group at stability level 8.

Stability indices		$\overline{X}$±SD	MD	t Value	p Value	Sig.
Overall SI	Pre	3.08±0.37	0.57	18.15	<0.01	HS
	Post	2.51±0.33				
Anteroposterior SI	Pre	2.54±0.19	0.56	13.81	<0.01	HS
	Post	1.98±0.21				
Mediolateral SI	Pre	1.95±0.17	0.48	15.12	<0.01	HS
	Post	1.46±0.22				

$\overline{X}$: Mean **P**: Probability
SD : Standard deviation **Sig.**: Significance
MD : Mean Difference **HS**: Highly significant

pre and post treatment for the study group were as follows:

Overall stability index

The mean values of overall stability index pre and post treatment were 3.04±0.40 and 1.76±0.35 respectively which indicated highly significantimprovement (P< 0.01).

Anteroposterior stability index

The mean values of anteroposteior stability index, pre and post treatment were 2.57±0.22 and 1.34±0.15 respectively which indicated highly significant improvement (P<0.01).

treatment for the study and control groups were 1.3+0.15 and

Table 3 Comparison of the mean values of the stability indices pre and post treatment for the study group at stability level 8.

Stability indices		X±SD	MD	t Value	p Value	Sig.
Overall SI	Pre	3.04±0.40	1.28	31.62	<0.01	HS
	Post	1.76±0.35				
Anteroposterior SI	Pre	2.57±0.22	1.22	27.12	<0.01	HS
	Post	1.34±0.15				
Mediolateral SI	Pre	1.94±0.19	0.92	22.09	<0.01	HS
	Post	1.01±0.25				

X : Mean
SD : Standard deviation
MD : Mean Difference
P : Probability
Sig. : Significance
HS : Highly significant

Mediolateral stability index

The mean values of mediolateral stability index, pre and post treatment were 1.94±0.19 and 1.01±0.25 respectively which indicated highly significant improvement (P<0.01).

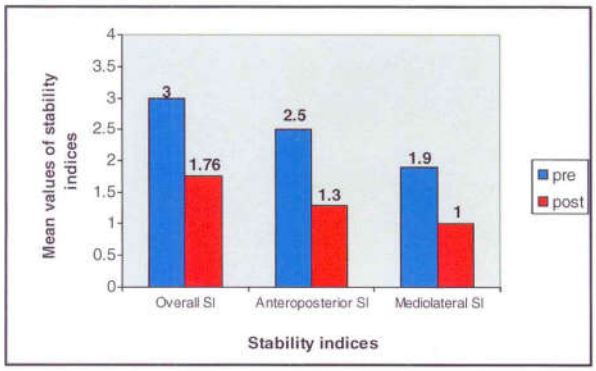

Fig 2 Mean values of the stability indices, pre and post treatment for the study group at stability level 8.

III - Post treatment results of the dynamic balance test at stability level 8 for study and control groups.

1.9+0.21 respectively. The mean difference value was 0.63 which was statistically highly significant(P<0.01).The improvement percentage was 33.3 in favor of the study group.

Mediolateral stability index

The mean values of mediolateral stability index post treatment for the study and control groups were 1±0.25 and 1.4±0.22

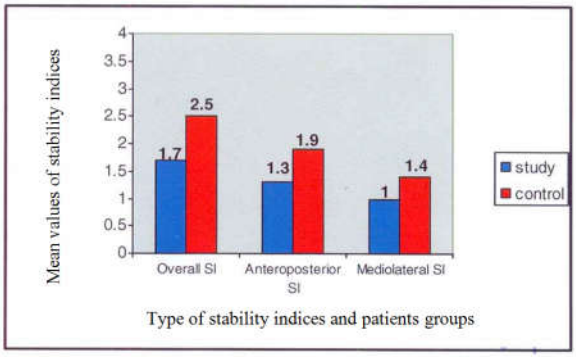

Fig 3 Mean values of the stability indices, post treatment for the study and control groups at stability level 8.

Table 4 Post treatment results of the dynamic balance test at stability level 8 for study and control groups**.**

Item		X±SD	MD	Improvement Percentage	t Value	p Value	Sig.
Overall SI	Study	1.76±0.35	0.75	30	5.97	<0.01	HS
	Control	2.51±0.33					
Anteroposterior SI	Study	1.3±0.15	0.63	33.3	9.08	<0.01	HS
	Control	1.9±0.2					
Mediolateral SI	Study	1±0.25	0.45	32.3	5.11	<0.01	HS
	Control	1.4±0.22					

X : Mean
SD : Standard deviation
MD: Mean Difference
P : Probability
Sig. : Significance
HS : Highly significant

As shown in table (4) and figure (3), the mean values and the improvement percentage of overall stability index, anteroposterior stability index and mediolateral stability index at stability level 8, post treatment forthe study and control groups were as follows:

Overall stability index

The mean values of overall stability index post treatment for the study and control groups were 1.76±0.35 and 2.51±0.33 respectively. The mean difference value was 0.75 which was statistically highly significant (P<0.01).The improvement percentage was 30 in favor of the study group.

Anteroposterior stability index

The mean values of anteroposterior stability index post

respectively. The mean difference value was 0.45 which was statistically highly significant (P< 0.01). The improvement percentage was 32.3 in favor of the study group.

DISCUSSION

The present study was conducted to investigate the effect of treadmill training with suspension (partial weight bearing) and without suspension (fullweight bearing) in addition to the physical therapy program on dynamic postural control in hemiparetic cerebral palsied children.

For this purpose, thirty spastic hemiparetic children were chosen from the Out Patient Clinic of the Faculty of Physical Therapy, Cairo University.Both sexes were involved. Subjects were divided randomly into two groups of equal number.

Each group composed of fifteen children.All patients were assessed before and after the treatment program by using the Biodex stability system using two balance tests (**Behrman and Kliegman, 2004)**) Dynamic balance test which was performed on two levels of stability (level eight and level one) (**Dormans and Pellegrino, 2008)**Dynamic limits of stability test which was performed on two levels of stability (level eight and level one).

The study group received the designed physical therapy program in addition to treadmill training with the suspension system using partial body weight support (30% relief of total body weight), while the control group received the designed physical therapy program in addition to treadmill training with full weight bearing without using the suspension system.

The dynamic postural control was impaired in hemiparetic children due to the following: (l) Loss of selective muscle control. (2) Abnormal muscle tone (3) Relative imbalance between muscle agonists and antagonists across joints, (4) Deficient equilibrium reactions. (5) Dependence on primitive reflex patterns for ambulation. **(McNevin *et al*., 2009).**

Hemiplegic children have deficits in the selection of appropriate sensory inputs for postural control. Since the accurate interpretation of sensory cuesfrom the environment is necessary for effective motor planning to occur, thus, deficits in sensory processing and integration are expected to affect theacquisition of mature postural control.

The post treatment results of this study revealed highly significantimprovement in the mean values of the measuring variables of the control group which received the designed physical therapy program in addition to gaittraining on treadmill with full weight bearing without using the suspension system which confirm the validity of the physical therapy techniques in treatment of hemiparetic C.P. patients .
The highly significant improvement obtained in the post-treatment mean values of the measuring variables of the control group may be attributed to theeffect of neurodevelopment treatment activities and a specially designed exercise program which was directed toward inhibiting the abnormal muscletone and abnormal postural reflexes, The post treatment mean values of the measuring variables of the study group revealed highly significant improvement and the highly significant difference in all variables in favour of the study group may be attributed to the effect of the suspension system with partial body weight support.

The high significant improvement in the study group may be attributed to the use of the suspension system which provided more stabilization to the child and minimized the displacement of COP under each foot, so keeping the COP near the middle also it helped the child to 'keep small amplitude of COP motionand decrease postural sway, which reflected a good balance control during treadmill training.

So treadmill training with partial body weight bearing suspension can be added as an additional therapeutic measure to improve balance duringlocomotion and functional abilities ofhemiparetic children.

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