



Effect of universal exercise unit on balance in children with spastic Diplegia

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Abstract

Background: Dysfunctional postural control is one of the key problems in children with cerebral palsy (CP) which interfere with the activities of daily life. Balance has been viewed as a skill that the nervous system learns to achieve using many systems including passive biomechanical elements, all available sensory systems and muscles and jointly many different parts of the brain. Slowness in motor conduction or delay brain in processing are causing balance impairment, which causing frequent falling of children with CP.

Aim: To evaluate the effect of using universal exercise unit (UEU) in strengthening program for both lower limb and its effect on standing balance in spastic diplegia.

Subject: thirty spastic diplegic children of both genders (13 boys, 17 girls), their age ranged from 4 to 8 years old recruited from outpatient clinic, Faculty of Physical therapy, Cairo University. They were randomly classified into two groups of equal number (control and study).

Procedures: the control group received a designed physical therapy program while study group received UEU program in addition to the designed physical therapy program. Total work was assessed by using Biodex balance system before and after the application of the treatment program.

Results: There was a significant decrease in the overall stability index in the study group compared with control group after treatment ($p = 0.001$)

Conclusion: universal exercise unit may be considered as an effective method to improve standing balance in children with spastic CP.

Keywords: cerebral palsy (CP), postural control, children

1. Introduction

Cerebral Palsy (CP) is described as a group of disorders of the development of movement and posture, causing limitation in activity that are attributed to non-progressive disturbances that occurred in the developing fetal or infant brain. The motor disorders of CP are often accompanied by disturbances of sensation, cognition, communication, perception, and/or behavior, and/or by a seizure disorder [1]. CP is a common problem, the worldwide incidence being 2 to 2.5 per 1000 live births [2] Features of weakness, impaired balance, poor selective motor control and problems with posture and movements are considered as clinical symptoms of CP also, they may influence the child's activity level more than spasticity and deformities [3].

Balance has been viewed as a skill that the nervous system learns to accomplish using many systems including passive biomechanical elements, all available sensory systems and muscles, and many different parts of the brain [4] Children with CP have for instance difficulties in using information stemming from the initial body configuration to adapt postural activity during reaching [5].

Center of pressure (COP) is the central point of pressure that is applied to the foot during contact with the ground or the point of application of the ground reaction force on the foot [6]. The COP can be used to index the amount of movement or sway of the center of gravity during stance [7]. The Biodex Balance System (BBS) is a device that uses a circular

platform that is free to move about the anterior-posterior (AP) and medial-lateral (ML) axes simultaneously, during dynamic condition. (8) The BSS measures, in degrees, the tilt of platform in each axes during dynamic conditions and calculates a medial-lateral stability index (MLSI), anterior-posterior stability index (APSI) and an overall stability index (OSI). These indexes represent fluctuations around a zero point established prior to testing when the platform is stable [9].

Universal exercise unit (UEU) consists of system of pulleys, suspensions, belts for supporting and elastic cords. UEU is based on the concept of unloading the body against gravity and to perform movement of weak part of the body. Therapist's hands are free to provide adequate support as required by the patient during exercise training [10]. Universal exercise unit (UEU) is 3-dimensional cage made of metal including wires, rubber bands, pulleys, weights and belts. Universal exercise unit is used in combination of other therapies like Bobath or NDT for better results [11].

The aim of this study is to evaluate the effect of using universal exercise unit (UEU) in strengthening program for both lower limb and its effect on standing balance in spastic diplegia.

2. Subjects and Methods

2.1 Subjects

Thirty children with spastic diplegic CP from both sexes were

chosen from outpatient clinic, faculty of Physical therapy, Cairo University. Their age ranged from 4 to 8 years. They had standing problems and poor balance.

Children were divided into two equal groups of equal number 15 patients in each group. Group (A) received the traditional physical therapy program and group (B) received the traditional physical therapy program and UEU program for 3 sessions/week for 3 successive months.

All children were evaluated before and after treatment program which continued for 3 months. Evaluation of standing balance was conducted by Biodex balance system.

Data were collected about overall stability index between both groups. Data were collected in order to compare between pre-treatment differences of control group and study group, post treatment differences of same groups and post treatment differences between the two groups.

2.2 Materials

2.2.1 Materials that used in treatment

Belts and elastic cords for supporting and preventing any substitutions that the child may do, 3-dimensional cage made of metal including wires, rubber bands, pulleys and hocks, weights used as resistance used in UEU. Also, balance board and small step used in traditional treatment.

2.2.2 Device that used in assessment

Biodex balance system was used to assess balance progression on children of each group before and after treatment.

2.2.3 Procedure

a) Assessment

Both groups A and B had been assessed by Biodex balance system (Shirley NY 1196) using stability index text as in following:

Each child stood with erect position as possible on locked platform at the beginning and each child data entered (weight, age, height) also stability of platform was settled at 5 °. Then by pressing (start) the platform unlocked to determine foot place which make the platforms balanced. Children looked at a screen in front of them, a circle divided into four divisions had been showed, they told to keep a point in the middle of the circle. Foot print data were collected 1) angle of second metatarsal bone which represent on the platform degrees from 10° to 90°. 2) center of the heel that represent on platform by alphabetical letters A to H. 3) last line could have weight bearing on heel and this one represented through numbers one to nine. Then the test procedure began by pressing (next screen) as the platform balance un-locked so the children re-balanced the platform to make the point in the center of the circle that appeared on the screen in front of them. The test was performed with eyes opened; the full time duration of the test was 20 sec. At the end, pressing the next screen would show predictive value report preview (% in quadrant, overall balance index, ant/post balance index, med/lat balance index).

Each child's test was repeated for three trails then mean average was token.

b) Treatment

i) Traditional physical therapy program

The traditional physical therapy program had been delivered needed, kneeling and half kneeling in static and dynamic manner, squatting exercise, standing in deferent positions as

step standing and standing on balance board.

ii) Universal exercise unit exercises

Each child on group (B) tested for one repetition maximum (1-RM) which determined through the leg extension exercise, children seated upright with both foots rested on floor. Children had been instructed to extend their knees as fully as possible, from 90° of flexion to full extension and then return to the starting position. The (1- RM) was taken as the maximum resistance that could be lifted throughout the full range of motion [12]. The children performed 1 or 2 sets of 8–15 repetitions with a light to moderate load (about 60% 1RM) [13].

In this study we evaluated the effect of UEU in antigravity muscles of lower limbs. Hip extensors, knees extensor, hip abductors and hip adductors were the target group of muscles. The position of children for training hip and knee extensors: Supine position with knee flexed and band around foot attached to upper part of UEU by a rope at head side. At the end of the rope there was a weight to pull. We asked the child to push and extend this leg until it fully extend and touch the plinth.

For hip adductors: the child was in supine position with knee extended and band around ankle attached to sides of UEU (Rt or Lt side of child) by a rope. At the end of this rope there was a weight to pull. The child was asked to adduct this leg to touch other one.

Hip abductors were trained in supine position with knee extended and band around ankle attached to sides of UEU (Rt or Lt side of child) by a rope. At the end of this rope there was a weight to pull. The child asked to moves his leg away as possible.

3. Results

As observed in table [1], the mean ± SD age of control group was 6.13 ± 1.1 years, with maximum value of 8 years and minimum value of 4 years. The mean ± SD age of study group was 5.96 ± 1.3 years, with maximum value of 8 years and minimum value of 4 years. There was no significant difference between both groups in the mean age values (p = 0.7).

Table 1: Comparison of the mean age between control and study groups.

	Control group	Study group
$\bar{X} \pm SD$	6.13 ± 1.1	5.96 ± 1.3
Maximum	8	8
Minimum	4	4
MD	0.17	
t-value	0.37	
p-value	0.7	
Significance	NS	

\bar{X} : Mean
 p value: Probability value
 t value: Unpaired t value
 MD: Mean difference
 SD: Standard Deviation
 NS: Non significant

4. Overall stability index

i) Pretreatment mean values of overall stability index of both groups (control and study)

The mean ± SD overall stability index pretreatment of control group was 2.8 ± 0.4 and that of study group was 2.66 ± 0.3. The mean difference between both groups was 0.14. There was no significant difference in the overall stability index

between control and study groups pretreatment ($p = 0.3$). (Table 2).

Table 2: Comparison between pretreatment mean values of overall stability index of control and study groups.

	Overall stability index	MD	t-value	p-value	Sig
	$\bar{X} \pm SD$				
Control group	2.8 ± 0.4	0.14	1.05	0.3	NS
Study group	2.66 ± 0.3				

\bar{X} : Mean MD: Mean difference
 p value: Probability value SD: Standard Deviation
 t value: Unpaired t value NS: Non significant

ii) Pre and post treatment mean values of overall stability index of control group:

The mean \pm SD overall stability index pre treatment of control group was 2.8 ± 0.4 and that post treatment was 2.63 ± 0.46 . The mean difference between pre and post treatment was 0.17 and the percent of improvement was 6.07%. There was a significant decrease in the overall stability index in the control group post treatment compared with pre treatment ($p = 0.001$). (Table 3).

Table 3: Comparison between pre and post treatment mean values of overall stability index of control group.

	Overall stability index	MD	% of improvement	t-value	p-value	Sig
	$\bar{X} \pm SD$					
Pre	2.8 ± 0.4	0.17	6.07	2.66	0.001	S
Post	2.63 ± 0.46					

\bar{X} : Mean MD: Mean difference
 p value: Probability value SD: Standard Deviation
 t value: Unpaired t value NS: Non significant

iii) Pre and post treatment mean values of overall stability index of study group:

The mean \pm SD overall stability index pretreatment of study group was 2.66 ± 0.3 and that post treatment was 2.04 ± 0.56 . The mean difference between pre and post treatment was 0.62 and the percent of improvement was 23.3%. There was a significant decrease in the overall stability index in the study group post treatment compared with pretreatment ($p = 0.001$). (Table 4).

Table 4: Paired t test for comparison between pre and post treatment mean values of overall stability index of study group.

	Overall stability index	MD	% of improvement	t-value	p-value	Sig
	$\bar{X} \pm SD$					
Pre	2.66 ± 0.3	0.62	23.3	4.39	0.001	S
Post	2.04 ± 0.56					

\bar{X} : Mean MD: Mean difference
 p value: Probability value SD: Standard Deviation
 t value: Unpaired t value NS: Non significant

iv) Post treatment mean values of overall stability index of both groups (control and study):

The mean \pm SD overall stability index post treatment of control group was 2.63 ± 0.46 and that of study group was 2.04 ± 0.56 . The mean difference between both groups was 0.58. There was a significant decrease in the overall stability index in the study group compared with control groups post

treatment ($p = 0.004$). (Table 5).

Table 5: Comparison between post treatment mean values of overall stability index of control and study groups.

	Overall stability index	MD	t-value	p-value	Sig
	$\bar{X} \pm SD$				
Control group	2.63 ± 0.46	0.58	3.1	0.004	S
Study group	2.04 ± 0.56				

\bar{X} : Mean MD: Mean difference
 p value: Probability value SD: Standard Deviation
 t value: Unpaired t value NS: Non significant

5. Discussion

Biodex balance system was selected to measure standing balance and this came with approval with Shumway-Cook and Woollacott who stated that measuring of reactive balance control could be recorded through platform balance movement at which a child can still maintain balance without taking a step or reaching for a handrail.

Selection of the age of participated children in this study aimed to make them understand and follow verbal commands and orders in both test and training. The age of participants in the study ranged from 4-8 years.

As a limitation in this study, it wasn't easy to find large number of children to participate in this study, lack of available possibilities in the outpatient clinic, Faculty of Physical therapy.

Significant difference were observed in this study when comparing before and after treatment mean values of measuring variables for both control and study groups which supported by using physical therapy modalities in improving lower limbs strength and functional standing abilities in spastic diplegic children. Comparing the post treatment values for both groups revealed significant difference in standing balance abilities. A high stability index score is indicative of a lot of movement during a test and less stability. On the other side, a lower stability index score reflects less time spent away from the level position and interpreted as a better balance score [18].

Burtner *et al.* and Woollacott *et al.*, stated that poor neuromuscular response organization might be reason for the crouched posture in which the diplegic children typically stood. They measured neuromuscular responses to platform in these children; they found children showed 1) more co-activation of agonists/antagonists and 2) more proximal-to-distal muscle response timing. These results suggest that one contributing factor to disorganized muscle responses in these children is their musculoskeletal alignment leading to a crouched posture [14, 15]. Practice and training may reduce the amount of co-contraction of agonists and antagonists throw allowing greater activation in agonists and a greater net force production by the prime movement [16]. Some studies documented positive outcomes from strengthening programs, which include increased stride length and decreased crouch posture, greater energy efficiency when walking, and higher scores on the Gross Motor Function Measure (GMFM) especially in ambulatory CP children [17].

In a study in which UEU was used with intensive protocol, concluded that it can improve the motor functional skills [19] and in other study, improvement in score of gross motor functional measurement (GMFM) was reported [20]. This has come with an agreement from another research that the UEU has an effect on improving balance [21].

The universal exercise unit therapy is new technique used to

strengthen weak muscles and improve the motor function without increasing of spasticity^[20]. The pulley system allows therapists to strength a desired muscle group in isolation from the rest body parts. This allows the particular muscle group to work without compensations in order to enhance and encourage a specific movement necessary to achieve a functional skill. Besides that, the pulley system can be used to improve endurance, increase ROM and flexibility^[22].

6. Recommendation

We recommend more researches about UEU as there is lack of numbers of researches that had done about it.

- More studies should be done on other types of cerebral palsy.
- Further studies to know the effect of UEU on upper limb functional activities.

7. Conclusion

The results that had been obtained of this study supported by a number of related scientific research work, it can be concluded that UEU can be considered as a useful therapeutic modality to improve lower limb muscles and therefore improve standing balance in diplegic CP children

8. References

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