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Effect of Core Stabilizing Program on Balance in Spastic Diplegic Cerebral Palsy Children

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Abstract : Background: Balance is a component of basic needs for daily activities and it plays an important role in static and dynamic activities. Core stabilization training is thought to improve balance, postural control, and reduce the risk of lower extremity injuries.
The purpose of this study was to study the effect of core stabilizing program on balance in spastic diplegic cerebral palsy children.
Subjects and Methods: Thirty diplegic cerebral palsy children from both sexes ranged in age from six to eight years participated in this study. They were assigned randomly into two groups of equal numbers, control group (A) children were received selective therapeutic exercises and study group (B) children were received selective therapeutic exercises plus core stabilizing program for eight weeks. Each patient of the two groups was evaluated before and after treatment by Biodex Balance System in laboratory of balance in faculty of physical therapy (antero posterior, medio lateral and overall stability). Patients in both groups received traditional physical therapy program for one hour per day and three sessions per week and group (B) were received core stabilizing program for eight weeks three times per week.
Results: There was no significant difference between the two groups in all measured variables before wearing the orthosis ($p>0.05$), while there was significant difference when comparing pre and post mean values of all measured variables in each group ($p<0.01$). When comparing post mean values between both groups, the results revealed significant improvement in favor of group (B) ($p<0.01$). **Conclusion:** core stabilizing program is an effective therapeutic exercise to improve balance in diplegic cerebral palsy children.
Key words: cerebral palsy, diplegia, balance and core stabilizing.

Introduction

Cerebral palsy (CP) describes a group of disorders of posture and movement that occur as a result of a non-progressive disturbance in the developing fetal or infant brain. The neurological disturbance associated with CP is non-progressive, secondary musculoskeletal impairments, pain, and physical fatigue are thought to contribute to changes in motor function in adolescents and adults with CP that may include a decline in walking[1]. Spastic diplegia historically known as Little's Disease. It is a type of CP characterized by hypertonia and spasticity in the muscles of the lower extremities specially muscles of the legs, hips and pelvis[2]**.** Diplegic Children have many neurological deficits that interfere with motor function, cares, comfort, or positioning. These impairments include neuromuscular and musculoskeletal problems such as spasticity, muscle contractures, bone deformities, loss of selective motor control and weakness[3]. Core stability is important for

appropriate load balance within the spine, pelvis, and kinetic sequence. "Core" is the group of trunk muscles that surround the spine and abdominal viscera. Abdominal, gluteal, hip girdle, paraspinal, and other muscles work in harmony to provide spinal stability. Core stability and its motor control are crucial for initiation of functional limb movements. Core strengthening, often called lumbar stabilization[4]. The active system consists of the muscles and tendons surrounding the spinal column. The neural system includes various force and motion transducers which are located in the ligaments, tendons, muscles, and neural control centers. All three systems interact with each other to provide sufficient stability to the spine to face challenges from spinal posture and static and dynamic loads. Gross instability occurs when either of these systems is disturbed[5]**.** Children with cerebral palsy (CP) have limitations with postural control and anticipatory postural adjustments. Their capacity to sit independently is delayed which interfere with daily life activities[6]. Balance is an integral component of core stability. Many clinical neuromuscular imbalances occur between synergistic and antagonistic muscles. This is characterized by early dominant activation of trunk muscles and delay in activation of synergistic muscles[7]**.** Balance deficits are one of the most common problems for hemiplegic CP treated by physical therapists. Therapists need to identify who has a balance problem and then decide the best approach to rehabilitation[8]. Biodex stability system is an important balance assessment and training system. In addition, it is the unique device, which is designed to stimulate joint mechanoreceptors and to assess the neuromuscular control by quantifying the ability to maintain dynamic postural stability also, it acts as a valuable training device to enhance the kinesthetic ability[9]. The purpose of this study is to study the effect of core stabilizing program on balance in spastic diplegic cerebral palsy children.

Subjects and Methods

This study was approved by ethics review committee of the Faculty of Physical Therapy, Cairo University during 2015 and parents signed a consent form authorizing the child's participation. Thirty children diagnosed as mild spastic diplegic cerebral palsy participated in this study.

Thirty diplegic cerebral palsy children from both sexes were initially assessed to determine Inclusion and exclusion criteria. They ranged in age from six to eight years of both sexes without receiving any specific core stability training for at least 6 month. Their height was not less than one meter. Their degree of spasticity was ranged from 1 to 1+ according to the Modified Ashworth Scale[10]. The patients should have normal flexibility of the lower back muscles because adequate muscle length and flexibility are important for proper joint function and efficiency of movement[11]. The height of the children is not less than one meter. The children were able to follow instructions and understand commands given to them during the testing procedure. The Exclusion criteria included any congenital cardiorespiratory condition, psychiatric or behavior disorders like autism and visual and hearing disabilities. Children with leg length discrepancy; children with convulsions; Tightness in the hip flexors. When the iliopsoas muscle is tight or shortened, it is believed that this inhibits the deep abdominals and gluteus Maximus muscles. Inhibition of the gluteus maximus muscle may result in inadequate stabilization of the lumbar spine, and increasing the extension and anterior shear forces on the lower lumbar vertebrae[11]. Finally children fixed musculoskeletal deformities of axial part.

Randomization: All children were randomly divided into two groups of equal number (fifteen children each) using closed envelopes procedure.

Control Group (A):- fifteen diplegic cerebral palsy children who received selective therapeutic exercises.

Study Group (B):- fifteen diplegic cerebral palsy children who selective therapeutic exercises plus core stabilizing program for 8 weeks.

Both groups received a traditional physical therapy program for one hour per day and three sessions per week and study group received core stabilizing program for three times per week for eight months.

Tools and Instrumentation:

A- For subjects selection

- Modified Ashworth Scale to assess the degree of spasticity [10].

- Weight and height scales to determine the children's weight and height.

B- For assessment

Biodex stability system (945-300-E617) was used to assess balance and postural stability[9].

c- For treatment

- Group (A) children who received selective therapeutic exercise.
- Group (B) children who received selective therapeutic exercise plus core stabilizing program for eight weeks.

Procedures:

At the start of the study, the personal data of the child were collected from parents, including the child name, age, weight, and height. A brief explanation of the study was done for the parents and how this study can help their children. Each child in the two groups was asked to stand on the center of locked platform within the device with two legs stance while grasping the handrails, the display screen was adjusted so that each participant can look straight at it. At first, certain parameters were fed to the device as child's weight, height and age and stability level (platform firmness).Each participant was asked to achieve a centered position in a slightly unstable platform by shifting his/her feet position until it was easy to keep the cursor (representing the center of the platform) centered on the screen grid while standing in comfortable upright position. Once the participant was centered, the cursor was in the center of the display target, he/ she were asked to maintain his/her feet position till stabilizing the platform. Heels coordinates and feet angles from the platform were recorded as follows: heels coordinates were measured from the center of the back of the heel, and foot angle: was determined by finding a parallel line on the platform to the center line of the foot. The test began after introducing feet angles and heels coordinates into the Biodex system. The platform advanced to an unstable state, then the child was instructed to focus on the visually feedback screen directly in front of him while both arms at the side of the body without grasping handrails and attempted to maintain the cursor in the middle of the bulls eye on the screen. Duration of the test was 20 seconds for each participant and the mean of the three repetitions was determined. Each child in both groups received a traditional physical therapy program (Neurodevelopmental approach, facilitation of postural reaction, Balance training and stretching exercises) for one hour per day and three sessions per week for six weeks and the study group (B) received core stabilizing program that included three levels for eight weeks, three times per week on alternate days, with 30 min in each session. Each exercise takes 5 minutes and shift from one exercise to the next after complete performance of the first. These exercises are Supine hip twist on physioball, Supine Abdominal Draw In, Abdominal Draw In with Double Knee to Chest, Supine Twist, Superman's, abdominal crunch, modified push-up, pelvic bridging, Seated on Physioball, Russian Twist with medicine ball, Bridging with Head on Physioball, and Prone bridging, A print out was obtained at the end of each test including overall stability index, antero-posterior stability index, and medio-lateral stability index. The high values mean that the child had balance difficulty. This test procedure was carried out for each child at level 5 (the most stable level) of the two groups before and after eight weeks of treatment program.

Statistical Analysis:

Descriptive statistics and t-test was conducted for comparison of the mean age, weight, and height between both groups (control and study). T test for comparison between pre and post treatment mean values of anteroposterior, mediolateral, and overall stability index between groups. Paired T test was conducted for comparison between pre and post treatment mean values of anteroposterior, mediolateral, and overall stability index 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 19 for windows. (IBM SPSS, Chicago, IL, USA)[12]**.**

Results:

As shown in table (1) there were no significant differences between both groups in the mean age, weight, and height ($p > 0.05$).

The pre treatment results revealed non significant difference ($p>0.05$) in all measuring variables (anteroposterior, mediolateral, and overall stability indices) between the two groups which confirm the homogeneity of the sample in both groups before applying core stabilizing program.

There was a significant improvement in anteroposterior, mediolateral, and overall stability indices of group (A) post treatment compared with pre treatment ($p < 0.01$). Where, means and standard deviations of anteroposterior, mediolateral, and overall stability indices of group (A) decreased post treatment by 1.88 ± 0.3, 1.81 ± 0.38, and 2.68 ± 0.3 respectively and the percentage of improvement in the measured variables was 25.98%, 24.26% and 13.54% respectively. Also, there was a significant improvement in anteroposterior, mediolateral, and overall stability indices of group (B) post treatment compared with pre treatment ($p > 0.0001$). Means and standard deviations of anteroposterior, mediolateral, and overall stability indices of group (B) decreased post treatment by 1.34 ± 0.28, 1.36 ± 0.33, and 1.88 ± 0.46 respectively and the percentage of improvement in the measured variables was 46.4%, 44.71% and 38.96% respectively, as shown in table (2) and illustrated in figure (1).

When comparing post mean values between both groups, the results revealed that there was a significant improvement in anteroposterior, mediolateral, and overall stability indices of group B compared with group A ($p < 0.01$) as shown in table(3) and illustrated in figure (2).

Table (1): Comparison of $\bar{X}$±SD age(y), weight (kg), and height (cm) between group A and B:

	$\bar{X}$±SD			
	Group A	**Group B**	**t- value**	**p-value**
Age (y)	6.98 ± 0.55	7.01 ± 0.6	-0.15	0.87*
Weight (kg)	21.13 ± 2.34	21.7 ± 2.46	-0.91	0.36*
Height (cm)	120.33 ± 3.93	119.66 ± 6.3	0.49	0.62*

$\bar{X}$, Mean; SD, standard deviation; p-value, level of significance; * Non significant.

Table (2): Comparison of stability indices between pre and post treatment in group A and B

	$\bar{X}$±SD				
Stability index	**Pre treatment**	**Post treatment**	**% of change**	**t-value**	**p-value**
Group A					
Antero-posterior	2.54 ± 0.24	1.88 ± 0.3	25.98	7.17	0.0001**
Medio-lateral	2.39 ± 0.45	1.81 ± 0.38	24.26	4.56	0.0001**
Overall	3.1 ± 0.2	2.68 ± 0.3	13.54	7.15	0.0001**
Group B					
Antero-posterior	2.5 ± 0.46	1.34 ± 0.28	46.4	11.7	0.0001**
Medio-lateral	2.46 ± 0.5	1.36 ± 0.33	44.71	9.17	0.0001**
Overall	3.08 ± 0.25	1.88 ± 0.46	38.96	9.01	0.0001**

$\bar{X}$, Mean; SD, standard deviation; p-value, level of significance; ** Significant

Table (3): Comparison of stability indices between group A and B post treatment:

	$\bar{X}$±SD			
Stability index	**Group A**	**Group B**	**t-value**	**p-value**
Post treatment				
Antero-posterior	1.88 ± 0.3	1.34 ± 0.28	3.48	0.0001**
Medio-lateral	1.81 ± 0.38	1.36 ± 0.33	4.16	0.0001**
Overall	2.68 ± 0.3	1.88 ± 0.46	2.63	0.001**

$\bar{X}$, Mean; SD, standard deviation; p-value, level of significance; ** Significant

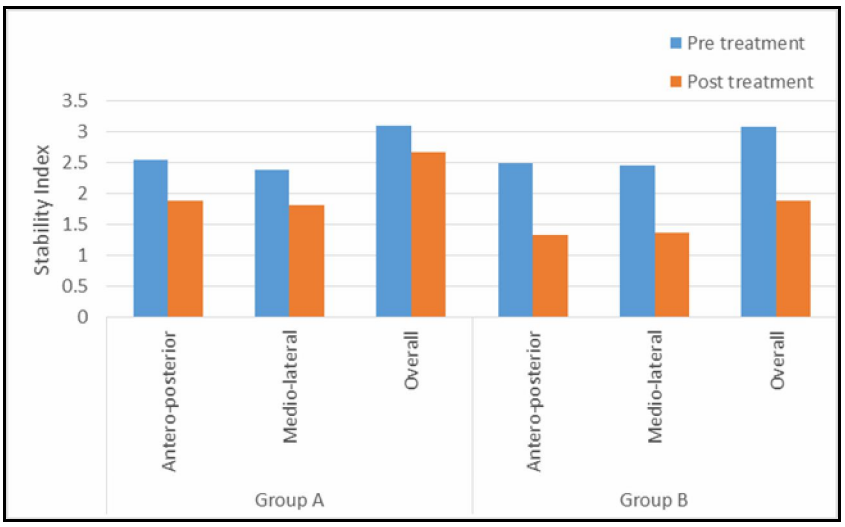

Figure (1). Pre and post treatment mean values anteroposterior, mediolateral, and overall stability indices of group A and B.

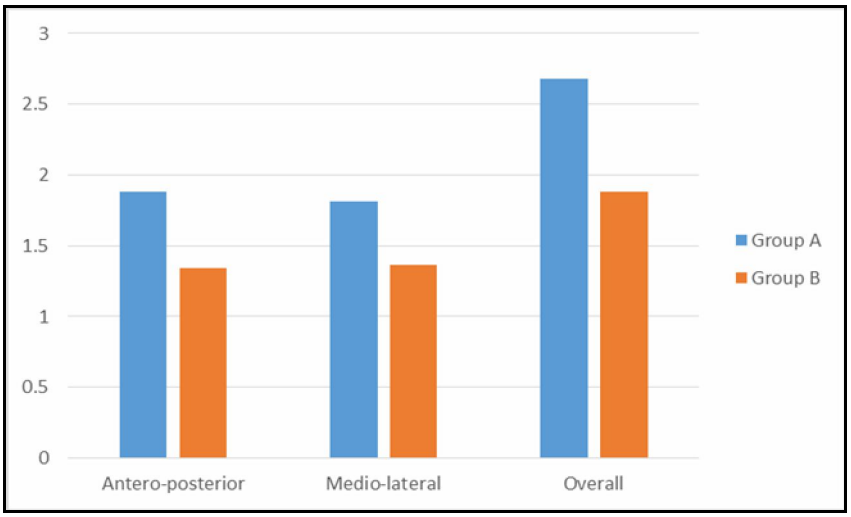

Figure (2). Post treatment mean values anteroposterior, mediolateral and overall stability indices of group A and B.

Discussion:

The current study aimed to study the effect of core stabilizing program on balance in spastic diplegic cerebral palsy children. As has earlier been stated, little information was available in the literature regarding the role of core stabilizing program on balance in children with spastic cerebral palsied children. However, most of the literature represented effect of core stabilizing program on different cases of sport injuries and orthopedic cases in adult and children and very little on trunk control in spastic cerebral palsy children. The stabilization of

the core addresses static postural alignment which facilitates appropriate anticipatory postural activity of the feed-forward system (weight bearing and functional movement patterns reorganizes the feedback systems). Functional motions integrate the neuromuscular coordination between the trunk and the upper extremities, which leaves the body as a linked system that can now move without referring to static start position available range of motion or dynamic stability (functional stability) [13]. The Biodex stability system was used for evaluation using dynamic balance test which was performed on stability level 5 this agree with [14] who reported that, balance assessment should attempt to stimulate dynamic condition in order to stress the postural control system fully and reveal the presence of balance disorder. Pretreatment mean values confirmed the findings of ***Harbourne,*** who reported that children with cerebral palsy (CP) have limitations with postural control and anticipatory postural adjustments. Their capacity to sit independently is delayed which interfere with daily life activities [6]. The height for all children was not less than one meter and their weight more than 20 kg which are the lower limits of height and weight needed by the biodex balance system. The percentage of improvement in group (A) in all measured variables was 25.98%, 24.26% and 13.54% respectively and the percentage of improvement in group (B) in all measured variables was 46.4%, 44.71% and 38.96% respectively. The results of this study may be attributed to the effect of core stabilizing program on balance in spastic cerebral palsy children, through stabilizing the trunk. As Core muscle contraction of the member, the reaction between postural disorders of the central nervous system that prevents postural and core stability exercise program, can result in improved prediction of activity, and thereby reducing the disruption displacement and fluctuates of the center of gravity which confirmed by[15]. Also, these findings of this study support the use of core stabilizing program which agree with [16] who reported that Core stabilization training program leads to sequencing the anticipatory activity and then reduces early perturbations of the center of gravity, which is a benefit for the individuals who need to remain in constant postural control. It is important to train movements and not muscles, so that everything works together. Training movements integrates and improves the function of the neuromuscular system in postural control. Furthermore the core is important because it is the anatomical location in the body where the center of gravity is located and movements stem from, therefore it seems strengthening of muscles of core causes the improvement of neuromuscular system and decrease of center of gravity displacement and sway. This improvement comes in agreement with [17] who stated that Core stabilization training may be used to enhance dynamic balance in mentally retarded students and is applied in the clinical setting. In addition**, *Steinberg,*** demonstrated improvements in strength and stability of the core muscles for unbalanced walking, increased functional mobility and postural control in spastic cerebral palsy child [18]. These findings can be attributed to the use of core stabilizing program which came in agreement with [19] who examined the potential role of core stabilization in children with cerebral palsy CP. After two months of core stabilizing program, 3 times a week, 30 minutes a session, the major findings showed that core stability exercises was associated with a clinically relevant improvement of walking of CP children. The significant improvement in stability after using core stability exercises came in agreement with [20] who reported that Core stabilization training improves neuromuscular system efficiency which leads to optimal arthrokinematics in the lumbopelvic-hip complex during functional kinetic chain movements, optimal acceleration, deceleration, optimal muscular balance and provides proximal stability for efficient lower extremity movements.. Also, according to [21] was examined effects of core stability training in balance and posture of female collegiate swimmers versus a control group. They followed a nine-week core stabilization-training program and used the Biodex Stability System to measure pre- and posttest balance. Results showed that the program did effect postures but not balance; hence a core stabilization program may improve isometric postures without effecting dynamic stability. Such results were supported by the finding of [22] who found that core stabilization training may result in better patterns of activation for trunk muscles**.** In addition, spine stability and the importance of proper activation of core muscles have been addressed which supported by [23]. This also came in agreement with [24] who found that increase proprioception and muscular strength are equally effective in promoting joint stability and balance maintenance and strength training increased dynamic balance capabilities**.** Also these results came in agreement with [25] who found that CP children showed stronger single and agonist/antagonist muscle activations comparing to normal children. This finding came in agreement with [26] who conducted a study to examine the effect of core stabilizing program on balance and trunk control in diaplegic subjects. They concluded that a period of core stabilizing program of 8 weeks has significant carry over to balance in diaplegic subjects. The significant improvement in the results of the study group may be due to core stabilizing program which enabled spastic cerebral palsy patients to maintain posture and perform reciprocal coordinated movements of the lower limbs, providing postural adaptations and good alignment to improve equilibrium during dynamic activities e.g. walking and finally to use these adaptable motor patterns as a basis for the development of skilled functional abilities [27]**.**

Conclusion

On basis of the current study supported by relevant literature, it can be concluded that core stabilizing program can be effective in improving balance in children with diplegic CP.

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