

Impact of core stability education on postural control in children with spastic cerebral palsy

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Background

Postural control includes controlling the body's position in space to achieve stability and orientation. Core stability education is applied to teach children to improve balance and postural control.

Objective

The objective of this study was to detect the impact of core stability education on postural control in children with spastic cerebral palsy (CP).

Patients and methods

Thirty spastic CP children (6–8 years) received intervention in the outpatient clinic of Faculty of Physical Therapy, Cairo University.

Intervention

The participants were randomly divided into a control group and a study group; the control group received selective therapeutic exercises, while the study group received the same selective program in addition to core stability exercises three times/week for 60 min for 12 weeks.

Main outcome measures

Dynamic balance was assessed by Biodex Balance System before and after treatment (12 weeks).

Results

There was a significant improvement of all stability indices (anteroposterior, mediolateral, and overall) in each group. There was more improvement in the study group when comparing post-treatment values of both groups ($P < 0.05$).

Conclusion

According to the results of the current study, core stability program is highly recommended to be included in the treatment program of spastic CP children to improve balance.

Keywords:

cerebral palsy, children, core stability education, postural control

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Introduction

Cerebral palsy (CP) could be a cluster of disorders that have an effect on the event of movement and posture, inflicting activity limitation, and nonprogressive disturbances that occurred within the developing fetal or child brain [1]. The main therapeutic goals for children with CP are the performance of functional activities and walking [2]. Children with CP have a limitation with activities due to the existing impairments in independent walking, climbing stairs, running, or walking over uneven surface [3]. Functional limitation of children with CP may have various degrees due to loss of axial control with an imbalance of their movements [4]. Balance has been defined as the elements of postural control that allow a child to safely perform everyday tasks [5]. Poor balance control is one of the most contributing factors for poor gait and reaching movement because the maintenance of stability is critical to all movements [6]. Children with CP have defects in postural mechanisms, including righting and equilibrium reactions,

antigravity mechanism, proximal stability, and postural fixation [7]. Core stability is defined as the ability to maintain position and movement of body core. Stability training involves the abdomen muscles and pelvic and shoulder muscles, which maintain postural alignment and allow movements of extremities. Postural control is mainly for motion and depends on these muscles for stability and endurance [8]. Components of core stability include strength, endurance, balance, and the related activity of the back, abdominal, and pelvic muscles [9,10]. The core muscles act like one block to keep the body stable during static state and with extremity motion [11]. CP children lack the ability to distribute the load, that is, body weight, appropriately during static balance and transfer the body weight adequately from one

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supporting limb to another during dynamic balance tasks [12]. Children with diplegic CP are characterized by impairment of motor control in the lower extremities more than in the upper extremities. Moreover, hemiplegic children have motor disabilities of one half of the body; hence, they present with limited postural adjustment of the lower extremities in specific external disturbance [13].

Patients and methods

Patients

The current study included 30 children with mild spastic CP. Their ages ranged from 6 to 8 years (both sexes) and they did not receive core stability program before 6 months at least. The required height was 1 m and more. Their spasticity ranged from 1 to 1+ according to the Modified Ashworth Scale [14]. The included children had to have normal flexibility of the lower back muscles, as adequate flexibility with normal muscle length is essential for proper joint function and efficient movement [15]. Children who were not following instructions were excluded from the study. In addition to children with any cardiopulmonary problems, those with attitude and psychiatric disorders, length discrepancy, and seizures were also excluded. Children with tightness of the hip flexors were also excluded from the sample, as, if the iliopsoas muscle is tight or shortened, this causes inhibition of the deep abdominals and gluteus maximus muscles, which leads to improper control of the back with more shear forces on the lower lumbar vertebrae [15].

Study design randomized control trial

Randomization

Randomization was implemented simply by means of a computer-generated randomized table using the SPSS program (IBM, Armonk, New York, USA) that was prepared ahead of data collection. A specific identification number was assigned for each participant. These numbers were randomized into two groups. Individual and sequentially numbered index cards were secured in opaque envelopes. Each participant was given a hand-picked envelope and was relocated accordingly to their groups.

This randomized controlled trial was conducted from June 2017 to January 2018 at the outpatient clinic of Faculty of Physical Therapy, Cairo University in accordance with the Code of Ethics of the World Medical Association (Declaration of Helsinki) for experiments involving humans. Ethical committee approvals of the Faculty of Physical Therapy, Cairo

University, Egypt, and signed written consent form with parent acceptance for participation in the study and publication of the results was obtained before starting the procedure. The study aim and procedures were explained to their parents. They were divided into two equal groups (control and study). The control group received regular therapeutic exercise program. The study group received the same therapeutic exercise and core stability education program for 12 weeks. All children received education training for an hour three times/week for 12 weeks.

Sample size

The sample size was calculated by assuming the difference in the mean value of the change in overall stability index between the two groups, with an effect size of 1.1. Assuming $\alpha=0.05$ and power of 80%, a sample size of 15 patients per group would be required (G Power 301; <http://www.psych.uni-duesseldorf.de>). If further dropout of any child in this study occurred, it was replaced automatically (G Power 301; <http://www.psych.uni-duesseldorf.de>).

Procedures

Biodex stability system is an important balance assessment and training system. In addition, it is a unique device that is designed to evaluate dynamic postural control and exercising method to improve balance and motion ability [14]. The aim is to investigate the impact of core stability program on postural control in children with spastic CP. Balance test was performed to investigate the child's ability to stabilize the angle of the tilting platform. Postural control was assessed before and after the intervention to determine which group was more affected, using The Biodex Balance System to measure overall stability index (anteroposterior stability index and mediolateral stability index). All participants were given instructions before conducting the test to perform the different test steps. Each child was asked to stand on the locked platform center with both legs in the stance phase. Hand rails and screen biofeedback were adjusted for each child to attain optimal safety and to look straight at it. The child was instructed to maintain position on the platform by moving his feet position while keeping the center of the platform in the center on the screen grid with the body in upright comfortable position. When the cursor was placed in the center of the screen, the command was given to the child to maintain position to control the tilting platform. Thereafter feet angles were recorded and the test began. After introducing angles into the

device system, as the platform moved, the child was asked to lock on the screen and keep the cursor in the middle. At the end of each child test trial, the report was printed, which included measurable variables of stability indices. When high values of stability indices were attained, this implied that there were balance problems. This procedure was performed for each child at level 5 of both groups before and after 12 weeks.

Intervention

All children received a regular therapeutic exercise program (neurodevelopmental techniques, balance exercises, facilitation of milestones, and facilitation of postural reaction) for 1 h/day three times/week for 12 weeks, while the study group received core stability education program with three levels for 12 weeks, three times/week for 60 min in each session. The core stability education program included three levels. Each exercise takes 5 min, and there is a shift from one exercise to the next after complete performance of the first. The first simple level included supine abdominal draw in (repeat 20 times), abdominal draw in with double knee to chest (repeat 10–20 times), and supine twist (repeat 10–20 times). The second medium level included pelvic bridging (three to five times) and twist with medicine ball (repeat 10–20 times). The third difficult level included bridging with head on physioball (hold this position for 3–5 s then slowly relax and repeat 10–20 times) and prone bridging (repeat entire sequence three to five times). These exercises have been used in previous studies to determine the effects of core stability exercises [16].

Data analysis

Results are expressed as mean±SD. Test of normality, the Kolmogorov–Smirnov test, was used to measure the distribution of data. Accordingly, comparison between normally distributed data in the two groups was performed using unpaired *t* test. Comparison between pretreatment and post-treatment data

within the same group was performed using paired *t* test. Statistical package for social sciences computer program (version 19, Windows) was used for data analysis. *P* value less than or equal to 0.05 was considered significant.

Results

There were no significant differences of the descriptive data (mean age, weight, and height) between both groups ($P \leq 0.05$) (Table 1) and also between both groups before conducting core stability education training. However, there was a high improvement in all measuring variables of control group before treatment and after treatment, wherein the percentage of improvement in the measured variables was 29.19, 32.66, and 19.85%, respectively. In addition, there was a significant improvement in all stability indices of the study group before treatment and after treatment. The improvement percentage in the measured variables was 46.38, 46.94, and 41.23%, respectively (Table 2), and the results revealed that there was a significant reduction in all measuring variables of the study group compared with the control group (Table 3).

Discussion

The purpose of the current study was to detect the effect of core stability education on postural control in children with spastic CP. The results of the current study revealed a significant reduction in all stability indices, which might improve by the effect of regular physiotherapy program and core stability program, but there was a significant improvement in postural control

Table 1 Descriptive data

	Control group (mean ±SD)	Study group (mean±SD)	<i>t</i> value	<i>P</i> value
Age	6.98±0.33	6.71±0.51	-0.13	0.87*
Weight	22.12±2.245	22.9±2.32	-0.88	0.36*
Height	119.32±3.88	118.41±6.6	0.41	0.62*

*Nonsignificant.

Table 2 The results of pretreatment and post-treatment in control and study groups

Stability indices	Before treatment (mean±SD)	After treatment (mean±SD)	% of change	<i>t</i> value	<i>P</i> value
Control group					
Anteroposterior	2.49±0.27	1.7±0.3	29.19	8.49	0.0001**
Mediolateral	2.38±0.40	1.67±0.39	32.66	5.25	0.0001**
Overall	2.91±0.18	2.40±0.47	19.85	4.90	0.001**
Study group					
Anteroposterior	2.51±0.29	1.30±0.25	46.38	9.79	0.0001**
Mediolateral	2.33±0.48	1.20±0.26	46.94	8.99	0.0001**
Overall	2.92±0.25	1.71±0.38	41.23	12.94	0.0001**

**Significant.

Table 3 The results between post-treatment in control and study groups after 12 weeks

Stability indices	Control group	Study group	t value	P value
After treatment				
Anteroposterior	1.7±0.3	1.30±0.25	4.48	0.0001**
Mediolateral	1.67±0.39	1.20±0.26	4.16	0.0001**
Overall	2.40±0.47	1.71±0.38	2.63	0.01**

**Significant.

in post-treatment scores of the study group after 12 weeks of treatment, as compared with the control group, which clarifies the effect of the core stability program. The prime factor for improvement of postural control in both the groups could be an improved trunk stability and postural alignment as a result of increased trunk muscle strength by conventional exercises [17,18]. Balance is correlated to trunk muscle strength [19]. The education of core stability education program encourages body control, which stimulates the feed-forward system to achieve postural activity of extremities. The co-ordination between the trunk and the upper extremities can be integrated by functional motions, which allow the body to move without regard to starting position in the available range of motion [20]. The improvement in trunk stabilization by performing core stability program led to (a) improved length tension relationship of the upper and lower limb muscles that originate from the girdles, which in turn are linked to the spine, (b) improved phasic contraction of spinal muscles, and (c) decreased freezing and improved degree of freedom, leading to smoother and more appropriate and purposeful movements [21]. Observation of pretreatment mean values of the current study confirms the findings of Chow *et al.* [22] who reported that both bilateral and coactivation of abdominals and back muscles are unavoidable during trunk movement, because they act as one block to gain balance between motion and fixation of the axial part. The results of the dynamic postural control test obtained from both groups with regard to the measuring variables revealed nonsignificant difference. An increase in their values indicates postural control problems that were consistent with Rose *et al.* [23] who concluded that the higher the stability indices, the more movements and the less stability during the test. The dynamic postural control may be explained by the study carried out by Carr and Shepherd [24] who reported that it was impaired in diplegic children because of relative imbalance between muscle agonists and antagonists across joints, equilibrium reactions disorders, and persistence of primitive reflex patterns for ambulation and muscle tone problems. The results came in agreement with the study by Niam and

Anderson [25] who explained that patients with spastic CP have incoordination within motor strategies, abnormal muscle tone and movement control, postural imbalance, and loss of superficial and deep sensation that lead to loss of static and dynamic balance. The study group received a specially designed program for core stability, as core muscles are important for CP children to move in and out of the standing position. This follows the study results of Dodd and colleagues who reported that core muscles stabilize the central part of the body to allow controlled movements of the upper limbs and lower limbs. Thus, a core stability program may be modified to enhance postural control and balance for CP children [26]. The exercise of bridging causes all back muscles to contribute in a similar way to control spine positions and movements in a healthy population [27]. Veerle *et al.* [17] have supported the above-mentioned view by studying the relative muscle activity and the ratios of the back muscles in three bridging exercises (single bridging, ball bridge, and unilateral bridging), demonstrating similar activity levels for all back muscles, resulting in ratios about [1]. The results of the current study were reinforced by Gillen, who concluded that children with spastic CP have a defect with the timing gain motor response to support surface perturbations like delayed muscle activation onset, which moves the center of the mass towards the limit of stability and leads to more proximal muscles' activation before distal muscles, when responding to support surface perturbations in standing, which is the opposite to that found in a child with normal control. Finally, children with spasticity have been found to have postural adjustment deficit associated with voluntary control in static and dynamic activities [28]. The improvement in post-treatment values for both groups in all measured variables was achieved through activation of abdominal and back muscles in various exercises to reach optimal muscle strength. This was consistent with Park *et al.* [29] who explained that better Sitting posture improved due to strength of back and abdominal muscle at the same time. Moreover, the results might be caused by postural control improvement from different patterns. This agreed with Harbourne *et al.* [30] who concluded that postural control improves dynamic balance.

There was a significant improvement in postural control in post-treatment scores of the study group after 3 months of treatment, as compared with the control group, which clarifies the effect of core stability education program applied to the study group. This was consistent with the outcome of the study by Cowley and Swensen, [10] who reported that core stabilization training improves dynamic balance in mentally retarded students. Improvement of balance in the study group might be explained by Sterba *et al.* [31] who reported that trunk and pelvic strengthening exercises will improve postural and equilibrium reactions in children with CP. Postural control and reciprocal co-ordination of the lower extremities to achieve equilibrium during dynamic activities occurred in the study group with regard to core stability education program; these results came in agreement with Visintin *et al.* [32] who explained the effect of strengthening exercises of the trunk (core stability training) on dynamic balance and postural control in diplegic children.

Study limitations

- (1) The number of children in each group was small.
- (2) Postural control test was performed on Biodex Balance System for one trial only.

Conclusion

It can be concluded that core stability education program is a good strategy to solve postural control and balance deficits in children with spastic CP.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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