

Effect of Core Stability Training On Postural Control In Children With Cerebral Palsy: A Systematic Review

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Abstract:

Background :Core stability training is used to improve limitations with postural control in children with cerebral palsy.It likes a corset that works to stabilize the center of the body against external perturbations. The purpose of the current systematic review was to evaluate the effectiveness of core stability training on postural control. **Methods:** A systematic review was conducted through Preferred Reporting Items for Systematic Reviews and Meta-Analyses methodology and American Academy of Cerebral Palsy and Developmental Medicine. Four databases (Pub Med ,Cochrane Library, Pedro and Google Scholar)were searched using the following keywords (“core stability “) AND (cerebral palsy OR hemiplegia OR diplegia)AND (Postural control OR balance OR equilibrium).Articles were assessed according to their level of evidence and conduct rating. **Results:** Seven articles were included in this review. The whole number of participants was 162 participants with age ranged from 1 to 18 years. Level of evidence ranged from I to V, and the conduct rating ranged from strong to weak. All studies underwent descriptive analysis due to the heterogeneity of the primary and secondary outcomes. Core stability training resulted in improvement in primary outcomes (postural control, static balance, dynamic balance), And secondary outcomes (shoulder stability, diaphragmatic motion, trunk endurance and gait. **Conclusion :** Core stability training could be considered for included in rehabilitation programs for children with spastic CP as all reviewed studies showed significant improvements of all variables although of improvements we still needed more trials due to heterogeneity of studies

Key words: Cerebral palsy; Core stability; Postural control; Systematic Review.

Introduction

A systematic review is a "study of studies". All relevant researches are analyzed in an effort to determine the overall evidence for an intervention. A systematic review uses a process to identify all studies for a specific focused question (drawn from research and other sources), appraise the methods of the studies, summarize the results, present key findings, identify reasons for different results across studies, and cite limitations of current knowledge.

Cerebral palsy (CP) is a non-progressive, but often changing disorder, motor impairment secondary to the insult of the brain arising in early stages of development(1). Cerebral palsy is a group of disorders of movement and posture that occurs due to non-progressive lesion in the developing brain(2). Symptoms include neurological disorders or developmental disabilities such as spasticity, mobility disturbances, musculoskeletal problems unstable posture control, imbalance and decreased pelvic movements(3). It is classified based on the extremities involved and the type of motor impairment. 50 to 60% of spastic cerebral palsy are (hemiplegia, diplegia and quadriplegia)(4). Diplegia refers to motor impairment in the four extremities, although it is milder in upper limbs than the lower limbs(5). Hemiplegia is impairment in one side of the body in which the muscles being in a constant state of contraction. It is the one-sided version of spastic diplegia. It counts 20 to 30% of spastic cerebral

palsy(6). Children with CP have inadequacy with anticipatory postural adjustments and postural control. Which interfere with activity of daily living(7).

Postural control is the ability to control the body in space for the purposes of orientation and steadiness (8,9). Postural control involves coordinating balance (stability and orientation of the body) among different body segments and requires interactions between motor control and the visual, vestibular and somatosensory systems(10). The preservation of postural control without changing in base of support is determined by the capability of maintaining the center of mass within the boundary of stability(11). Equilibrium is a state of zero acceleration. There is no change in the direction of the body or the speed. Equilibrium may be static or dynamic. Static equilibrium occurs when the body is at rest or completely motionless such as during sitting or standing on a stable surface (12). Dynamic equilibrium occurs when the body is moving under the effect of internal perturbations such as during walking, or in response to external perturbations (e.g. being pushed, or on a moving surface)(13).

Core area is like a box composed of 29 pairs of muscles aiming for support; the lumbo-pelvic -hip complex; the abdominal muscles form its anterior section, the spine and gluteal muscles form its posterior section, diaphragm muscle forms its roof, and pelvic girdle muscles form its floor(14).

Spinal stability is defined as the interaction between the passive, active, and neural control systems. All three systems work together to provide stability to the spine(15).The core function is maintaining dynamic postural equilibrium and postural alignment during functional activities to avoid serial distortion patterns(16).Therefore, we conducted this study to systematically review the effectiveness of core stability training on postural control in children with CP.

Subject, materials and methods

This systematic review was conducted according to the criteria included in Cochrane Handbook for Systematic Reviews of Interventions (17),American Academy of Cerebral Palsy and Developmental Medicine (AAPDM) methodology for developing systematic reviews of treatment interventions, and Preferred Reporting Items for Systematic Reviews (PRISMA) guidelines(18,19).The study was approved by the ethical committee of the department of physical therapy for pediatrics, faculty of physical therapy, Cairo University. As the study did not require human participation, therefore; ethical approval regarding participants was not required.

Study design:

This study is a systematic review aiming to review the effectiveness of core stability training on postural control in children with CP.

Participants:

This systematic review concerned children with the following inclusion criteria; hemiplegia or diplegia CP, aged between 1 and 18

years, levels (I,II,III,IV) according to the GMFCS and the level of spasticity ranged from 1 to 1+ according to the MAS.

Search methods for identification of studies

We searched for references published from January 2014 up to February 2019, using the following electronic databases: Pub Med, Google scholar, the Cochrane Library and PED ro. Search terms using the following key words “core stability”, “cerebral palsy”, “hemiplegia”, “diplegia”, “postural control”, “balance” and “equilibrium” using Boolean operators and/or. The titles and abstracts were initially screened against the inclusion and exclusion criteria for identification of the relevant studies. When the abstract revealed eligible study, the full text was obtained for complete assessment.

Treatment procedures:

The articles studying the effect of core stability training on postural control in children with CP. Control group received traditional physical therapy as stretching ,reflex inhibiting patterns, facilitation of righting, equilibrium and protection. Study group received core stability training. Training time was 30- 50 min/time, 1 time/day, 3-5 times/week, 1 to 3 months .Exercises included bridging, curl up, push up,4 point kneeling, wall squat, breathing, abdominal drawing-in maneuver (ADIM),abdominal draw with knee to chest, trunk rotation ,forward and lateral reach, hip flexion, Gym ball exercises and extension movements and co-activation of deep and superficial core muscles.

Data extraction and analysis:

Data were extracted by two authors and the third was consultant ,according to data extraction form developed by AACPDM Treatment Outcomes Committee version 2008. Data extraction summary used were relevant for either group or single-subject research study designs. The forms recorded information regarding participants, intervention(s), outcome measure(s)and results. The quality of each included article was assessed in two steps: [1] assignment of the level of evidence for group studies design(**Sackett's Level of Evidence**)(20)and the classification of level of evidence for single subject design (**Logan et al.**)(21),and [2]Quality assessment conducted through answering questions the numbered columns correspond to the numbered question. Each question was answered by "yes"(criterion –criteria present) or "no"(criterion –criteria not present).The conduct of group design consist of seven questions which were judged strong if ("yes"6 out 7), moderate if ("yes"4out 5) and weak if ("yes"3or less). While the conduct for single subject design consists of 14 questions that was judged as strong if

("yes"11 out 14), moderate if ("yes"7 out 10) and weak if ("yes"6 or less).

Results

A total of 2189 articles identified after searching (Figure 1). Pub MED recorded 17, Pedro recorded 41, Cochrane recorded 10 and Google Scholar recorded 2121. After removing of unrelated articles and duplicates, the records were 22 studies. The records screened were 22 while excluded were 13 then nine full text articles were assessed for their eligibility. Seven articles included in qualitative analysis due to heterogeneity and the two remain articles excluded with reasons. The seven articles were assessed for their level of evidence and the conduct rating according to AACPDM Treatment Outcomes Committee version 2008. Five articles were group design studies ranged from II to V, and rated from strong to moderate. While the other two articles were single subject design studies with level V and rated from moderate to weak. Summary of the included studies are shown in the table (1).

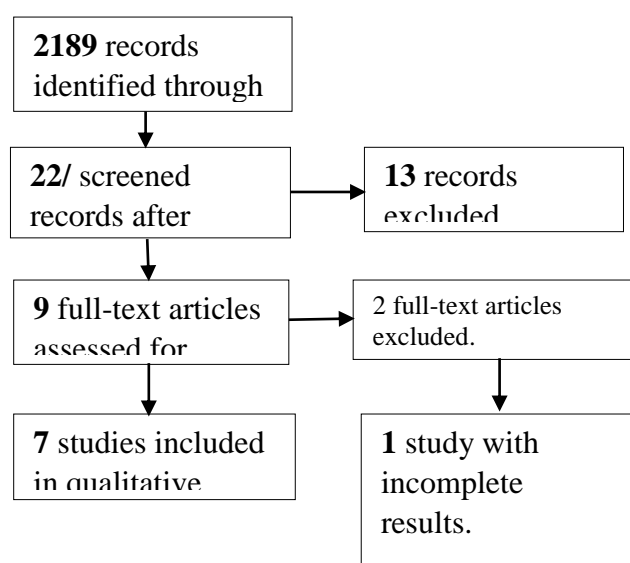


Figure (1): PRISMA Flow Chart Diagram .

Table (1): Characteristics of the included studies.

Study	Level of evidence	Conduct rating	Participants	Intervention		Outcomes	Results
				Treatment	Control		
Elshemy(22)	II (RCT)	Strong 6/7	30 hemiplegic CP (10 to 12 years)	Core training for 45 minutes	Traditional training	Trunk endurance, gait	4 trunk endurance test, biodix gait trainer significant improvement in post treatments measures in favor of study group
Youssri and Abdel-aziem (23)	II (RCT)	Moderate 4/7	30 hemiplegic CP (10 to 14years)	Core training for 30 minutes in addition to traditional training	Traditional training	Sitting balance abilities co – ordination dynamic walking balance	Measured by trunk impairment scale, balance berg scale, dynamic gait index significant differences between testingoccasions. P<0.05 in favor of study group
Mostafa et al. (24)	II (RCT)	Moderate 4/7	30 diplegicCP (6 to 8 years)	Traditional training plus core training	Traditional training	Balance by biodix system	Significant differences between post treatment group in favor of study group P<0.05
Mostafa et al. (25)	II (RCT)	Moderate 4/7	30 hemiplegic CP (6 to 8 years)	Traditional training plus core training	Traditional training	Balance by biodix system	
Ahmed et al. (26)	V(expert opinion)	Strong 6/7	26diplegicCP (1to 4years)	Core training for 1hour	Traditional training	Postural control and shoulder stability by GMFM	Significant improvement in favor of study group p<0.05
Son et al.(27)	V (simple baseline design)	Moderate 8/14	15diplegic CP(10 to 18)	Coretraining for 30 minutes	-----	Postural control, Dia phragmatic motion, abdominal activation	By GMFM, EMG,Ultra sonography. Significant improvement in all measurements p<0.05
Kim et al. (28)	V (simple baseline design)	Weak 5/14	A 13-year hemiparetic CP	Core training	-----	Balance and gait by Bot-2,10MWT, 6MWT,positive relationship between gait speed andbalance test performance	Significant improvement of all variables p<0.05

GMFM: Gross Motor Function Measurements. BOT-2: Bruininks-Oseretsky Test of Motor Proficiency. 10MWT: 10-Meter Walk Test. 6MWT: 6-Minute Walk Test. P: Probability.

Discussion

The purpose of the current systematic review was to evaluate the effectiveness of core stability training on postural control as a primary outcome in the form of static balance, dynamic balance and balance abilities) as well as on some secondary outcomes including gait, shoulder stability and abdominal and movements of diaphragm .

Seven studies included in this review ;five studies were intervention (Group)designs while two studies were single subject design studies . Participants in the study groups of four studies (two single designs and two group designs) received core training only while the control groups received traditional physical therapy. The three remaining studies; the study group received core training in addition to

traditional training. Due to the heterogeneity of the included studies, descriptive analysis was performed.

Cerebral palsy had a stable posture control, aberrant control of movement and imbalance (29). They had problems with controlling and coordination of voluntary muscles leading to poor selectivity (30). The results of included studies showed significant improvement of postural control within and between treatment groups in favor of the study group. Core stability training improves postural control; firstly by an increase in the intra-abdominal pressure by activation of pelvic floor muscles, diaphragm, internal oblique, external oblique, transverse abdominal and thoraco lumbar fascia in order to limit lumbar segmental motion to achieve spinal stability (31). Secondly by passive components when active components were inactivated (32,33). The core stability training enables the nervous system to continue to receive the proprioception signals from the visual, the vestibule center, the muscles, the tendons and the ligaments (34). Secondary outcomes such as gait and gait variables improved after core training, this could be explained by Hu et al. (35) and **White and McNair** (36) who reported that the core muscles work during gait is responsible for control of the trunk orientation adjustment of the pelvis and spine and breathing. Several core muscles become more active during specific phases, such as heel-strike or mid stance. Core stability provides a near-end constancy for distal limb movements, provides a proximal-to-distal force pattern, and achieves a torque that protects and moves the distal joint (37). Abdominal activation and diaphragmatic movements showed significant improvement after core training. This comes in agreement with

Yoon and You (38). Core training enhances concentric activation of the deep transverse abdominal /internal oblique and diaphragm. **Varnado** (39) reported that diaphragm and ribcage movement facilitation and trunk strengthening were beneficial for speech outcomes (sound pressure level and maximum phonation duration) in participants with spastic CP. Shoulder stability improved after core training that comes in agreement with **Dodd et al.** (40) who found that strengthening exercises and core stabilization improve fine motor control due to improve stability of shoulder joint.

Caution is warranted when interpreting the present results given the small amount of studies and the significant heterogeneity among studies. Further research is required to investigate how to sustain positive effects of core stability training over time and to determine essential attributes of core stability training (intensity, frequency and duration).

Conclusion : Considering the available data, our systematic review showed that the core stability training should be considered as an alternative method in addition to conventional physical therapy in children with CP. Well controlled RCTs are needed to a clear understand of the effects of core stability training in rehabilitation

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