Effect of Core-Stability on Motor Function Participation in Children with Spastic Cerebral Palsy

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Abstract

Background and Aim: Recently, attention has been given to gain insight about abnormal movements that are present in spastic Cerebral Palsy (CP) that related to one's level of core stability and how it affects functional abilities. The purposes of this study were to investigate if core stability and motor function were affected in children with spastic cerebral palsy.

Material and Methods: The core stability was investigated in seventy five children aged from six to ten years. They were divided into three groups. Group A consisted of twenty five normal healthy children as normal referred data. Group B consisted of twenty five children with spastic hemiplegic while Group C consisted of twenty five children with spastic diplegic. Fifty children of spastic CP with level I & II of Gross Motor Function Classification System (GMFCS), spasticity Grade 1 & 1+. Core stability was evaluated by using biodex isokinetic dynamometer to test trunk flexors and extensors peak torques at angular velocity 90°/sec and Gross Motor Function Measure Scale (GMFM) to asses function abilities.

Results: Revealed a significance differences in the trunk flexors, extensors peak torques at angular velocity 90°/sec and (GMFM) between three groups in favour of Group A. while the peak torques and (GMFM) was higher in Group B when compared to Group C.

Conclusion: poor core stability in children with spastic CP deteriorates motor function when compared to normal group. The hemiplegic group was less affected than diplegic.

Key Words: Core stability – Motor function – Cerebral palsy.

Introduction

CEREBRAL Palsy (CP) is a complex neurological condition due to a non-progressive lesion in the developing brain which affects the child's typical development of movement and posture. The impact of the lesion (s) on function is considerable and varying. While some children may demonstrate only slight abnormalities in movement patterns, others may be unable to perform even the most basic functional activities such as sitting independently or eating [1].

Core stability is the ability to control the position and motion of the trunk over the pelvis to allow optimal production, transfer and control of force and motion to the terminal segment. Core stability is necessary to help maintain a good posture and give a stable base to allow the arms, legs and head to move in a coordinated manner [2].

Despite ongoing debate regarding the contribution of the primary impairments—muscle weakness versus spasticity—to the motor dysfunction seen in CP. The trunk muscles as core stabilizers have a very important role in lower limb function [3].

Trunk muscles are consistently activated before any limb movements. These support the theory that movement control and stability are developed in a core-to-extremity (proximal-distal) and a cephalo-caudal progression [4].

Functional movement is the ability to produce and maintain a balance between mobility and stability along the kinetic chain while performing fundamental patterns with accuracy and efficiency. Muscular strength, endurance, coordination, balance, and movement efficiency are components necessary to achieve functional movement, which is integral to the performance of gross motor skills [5].

The role of the trunk in CP however, especially in lower limb function is often anecdotally described and not clearly understood. Furthermore,
the effect of low control in the core stability on the other body function is inconclusive. Description of the strength and activation patterns of these muscles is also incomplete.

Material and Methods

Seventy five children of both sexes were recruited from the out-patient clinic Faculty of Physical Therapy, Cairo University and participated in this study. Agreement of the Ethical Committee of Faculty of Physical Therapy was obtained before beginning of the study. The practical work of this study began on 11/3/2014 and finished on 12/10/2015. Children age ranged between six to ten years as it may be difficult to measure muscle strength in very young children. Their height more than one meter to allow optimum calibration with isokinetic dynamometer. Children were classified at level I & II according to (GMFCS). Spasticity ranged from grade 1 to 1+ according to Modified Ashwarth Scale [6]. They were able to follow orders and verbal commands. The participant did not have any specific core stability training for at least six month. Children with congenital cardiorespiratory condition, behavior disorders like autism, visual and hearing disabilities were excluded as well as children with fixed musculoskeletal deformities of axial part.

Design:

All children are divided into three groups of equal number (25 in each) using observational study. Group (A): Twenty five normal healthy children (9 girls and 16 boys). Their mean ± SD of age, weight, and height were 9 ± 1.36 years, 23.4 ±4.38kg, and 121 ±6.89cm respectively. Group (B): Twenty five children (11 girls and 14 boys) with spastic hemiplegic. Their mean ± SD of age, weight, and height were 8.28 ±1.68 years, 24.13 ±4.51kg, and 120±9.72cm respectively. Group (C): Twenty five children (10 girls and 15 boys) with spastic diplegic. Their mean ± SD of age, weight, and height were 8.14 ±1.49 years, 24.93 ±5.88kg, and 122.06 ±11.04cm respectively.

Instrumentation for assessment:

The Biodex Isokinetic System (Biodex Medical System, Shirley, NY, USA) which measures the internal torque produced by trunk flexors and extensors while the trunk is maintaining angular velocity of 90°/sec same range of motion. Gross Motor Function Measure scale (GMFM-88) was used to measure function abilities.

Procedure:

The first step in procedure was related to assessing the isokinetic parameters as a reference to core muscle strength through the use of Biodex Isokinetic system. The second step was related to the use of GMFM of children in standing and walking dimensions to reflect the degree of functional limitation.

First step in procedure:

The personal data of the child were collected from parents. The data included the child name, age, weight, and height. The child was allowed to sit on the adjustable seat of the Biodex Isokinetic Dynamometer system. The sitting position was reported to be the optimal resting position being more tolerated than the standing one. It allows greater range of motion both in flexion and extension and hence is the preferred testing position [7].

The pelvic strap was then applied and positioned as far as possible to press firmly, but comfortably, against the superior aspect of the proximal thighs. Two curved anterior leg pads were secured to adjust the knee block position. In addition, a lumbar support pad was located against the lower lumbar spine. Therefore, the pelvis was stabilized to minimize any contribution from the hip muscles [7]. Both thighs were then stabilized by two straps and the feet were held in place without being in contact with the floor.

The child sat erect with the head stabilized neutrally against an adjustable head seat. The two anterior force application straps were aligned vertically and then connected to another horizontal strap which was aligned with the second intercostal cartilage on the anterior chest wall when measuring the flexion torque. The posterior force application padded roller bar was placed on the posterior trunk just distal to the spine of the scapula when measuring the extension torque.

Prevent any jerky movement from the arms through instructing the child to rest his/her crossed forearms on the anterior chest wall. In addition, the child was requested to maintain a neutral head position throughout the testing procedure to avoid any contribution from the neck muscles [8].

The tested trunk ROM for each child was determined by allowing the tested participant to flex his/her trunk 50° from the vertical position. The position was confirmed with a protractor situated at the side of the testing chair. The set limit button
was then pressed to lock the ROM for this direction. The participant was then asked to extend his/her trunk 20º from the vertical position and the set limit button was pressed again to lock the ROM for this direction. Thus, the isokinetic testing procedures were conducted at a ROM of 70º.

Before the actual isokinetic testing procedures, each child performed one practice series of three sub-maximal trunk extension and flexion repetitions to get accommodated with the specificity of the Biodex speed of movement and trunk ROM. That was done to minimize any mistakes during the actual testing procedure.

Each practice session involved performing five consecutive trunk flexion-extension repetitions and the participant was instructed to push and pull as hard and as fast as possible. Verbal encouragement was given during the testing procedure to maximize the child participation. Trunk extensors and flexors were tested at the concentric mode of muscle contraction.

**Second step in procedure:**

The motor function of all children was examined by GMFM-88 which is an evaluative index of gross motor abilities and change in function over time or after therapy specifically for children with CP. It designs to assess function in quantitative manner without regard to the quality of performance.

**Statistical analysis:**

Descriptive statistics and ANOVA-test for comparison of the mean age, weight, and height of the three groups. ANOVA test was conducted for comparison of peak torque between the three groups. Kruskal-Wallis test for comparison of total GMFM between the three groups. Mann-Whitney U-test for pair wise comparison of total GMFM. Person product moment correlation coefficient was conducted to determine the correlation between peak torque and GMFM. The level of significance for all statistical tests was set at \( p < 0.05 \). All statistical measures were performed through the Statistical Package for Social Studies (SPSS) Version 19 for Windows.

**Results**

Comparison of trunk flexors peak torque at 90º/sec between Groups A, B, and C showed that the mean ± SD trunk flexors peak torque at 90º/sec of Groups A, B, and C were 78.46±10.93, 53.16±10.68, and 35.06±10.34Nm respectively. There was a significant difference in trunk flexors peak torque at 90º/sec between the three groups (\( p = 0.0001 \)) (Table 1).

The mean difference in trunk flexors peak torque between Groups A and B was 25.3Nm. There was a significant increase in trunk flexors peak torque in Group A compared with Group B (\( p = 0.0001 \)). The mean difference in trunk flexors peak torque between Group A and C was 43.4Nm. There was a significant increase in trunk flexors peak torque in Group A compared with Group C (\( p = 0.0001 \)). The mean difference in trunk flexors peak torque between Group B and C was 18.1Nm. There was a significant increase in trunk flexors peak torque in Group B compared with Group C (\( p = 0.0001 \)) (Table 1).

The mean ± SD trunk extensors peak torque at 90º/sec of Group A, B, and C were 81.48±11.57, 77.36±8.91, and 49.64±8.37Nm respectively. There was a significant difference in trunk extensors peak torque at 90º/sec between the three groups (\( p = 0.0001 \)) (Table 2). The mean difference in trunk extensors peak torque between Groups A and B was 4.12Nm. There was no significant difference in trunk extensors peak torque between Group A and B (\( p = 0.75 \)). The mean difference in trunk extensors peak torque between Group A and C was 31.84Nm. There was a significant increase in trunk extensors peak torque of Group A compared with Group C (\( p = 0.0001 \)). The mean difference in trunk extensors peak torque between Group B and C was 27.27Nm. There was a significant increase in trunk extensors peak torque in Group B compared with Group C (\( p = 0.0001 \)) (Table 2).

The median total GMFM of Group A, B, and C were 153, 140, and 111 respectively.

There was a significant increase in median value of total GMFM of Group A compared with Group B (\( p = 0.0001 \)). There was a significant increase in median value of total GMFM of Group A compared with Group B (\( p = 0.0001 \)). There was a significant increase in median value of total GMFM of Group B compared with Group C (\( p = 0.0001 \)) (Table 3).

The correlations between trunk flexors peak torque at 90º/sec and GMFM were moderate positive significant correlations with total GMFM (\( r = 0.55, p = 0.001 \)). The correlations between trunk extensors peak torque at 90º/sec and GMFM were moderate positive significant correlations with total GMFM (\( r = 0.61, p = 0.0001 \)) (Table 4).
Table (1): One way ANOVA for comparison of trunk flexors peak torque at 90º/sec between Groups A, B and C.

<table>
<thead>
<tr>
<th></th>
<th>X±SD</th>
<th>F-value</th>
<th>p-value</th>
<th>Sig.</th>
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<tbody>
<tr>
<td>Group A</td>
<td>78.46±10.93</td>
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<tr>
<td>Group B</td>
<td>53.16±10.68</td>
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<tr>
<td>Group C</td>
<td>35.06±10.34</td>
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Multiple comparison (Bonferroni correction)

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<tr>
<th></th>
<th>MD</th>
<th>p-value</th>
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<tbody>
<tr>
<td>Group A-B</td>
<td>25.3</td>
<td>0.0001</td>
<td>S</td>
</tr>
<tr>
<td>Group A-C</td>
<td>43.4</td>
<td>0.0001</td>
<td>S</td>
</tr>
<tr>
<td>Group B-C</td>
<td>18.1</td>
<td>0.0001</td>
<td>S</td>
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</table>

X : Mean.  
SD : Standard Deviation.  
MD : Mean Difference.  
p-value : Probability value.  
S : Significant.

Table (2): One way ANOVA for comparison of trunk extensors peak torque at 90º/sec between Groups A, B, and C.

<table>
<thead>
<tr>
<th></th>
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</table>

X : Mean.  
SD : Standard Deviation.  
MD : Mean Difference.  
p-value : Probability value.  
S : Significant.  
NS : Non Significant.

Table (3): Kruskal-Wallis test for comparison of total GMFM between Group A, B, and C.

<table>
<thead>
<tr>
<th></th>
<th>Median</th>
<th>x²</th>
<th>p-value</th>
<th>Sig.</th>
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<tr>
<td>Group A</td>
<td>153</td>
<td></td>
<td>40.38</td>
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<tr>
<td>Group B</td>
<td>140</td>
<td></td>
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<tr>
<td>Group C</td>
<td>111</td>
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U-value test

<table>
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<th>U-value</th>
<th>p-value</th>
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<tbody>
<tr>
<td>Group A-B</td>
<td>0</td>
<td>0.0001</td>
<td>S</td>
</tr>
<tr>
<td>Group A-C</td>
<td>0</td>
<td>0.0001</td>
<td>S</td>
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<tr>
<td>Group B-C</td>
<td>0</td>
<td>0.0001</td>
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x² : Chi-squared value.  
p-value : Probability value.  
S : Significant.

Table (4): Correlation between trunk flexors and extensors peak torque and GMFM.

<table>
<thead>
<tr>
<th></th>
<th>r-value</th>
<th>p-value</th>
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<tbody>
<tr>
<td>Flexors peak torque at 90º/sec: Total GMFM.</td>
<td>0.55</td>
<td>0.001</td>
<td>S</td>
</tr>
<tr>
<td>Extensors peak torque at 90º/sec: Total GMFM.</td>
<td>0.61</td>
<td>0.0001</td>
<td>S</td>
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</table>

Discussion

The previous study focused on the core stability affection in children with spastic cerebral palsy either hemiplegic or diplegic compared to normal age population and to determine the effects of core stability on functional abilities in children with spastic cerebral palsy.

The results of the current study showed significant differences in the trunk flexors and extensors peak torque at angular velocity 90 between Group B and Group C in favor to Group B which indicate the strength of trunk muscle of hemiplegic group is higher than diplegic group. On the other hand the trunk flexors peak torque and trunk extensors peak torque at same angular velocity were higher in Group A—the typical development children—when compared to Group B & C. This agrees with Scianni opinion who report that trunk muscle weakness is a common disorder in children with CP and is associated with insufficient or reduced motor unit discharge when compared with children of typical development [9].

This also agrees with Heyrman and Desloovere who found that the children with hemiplegia obtained the highest scores of total Trunk Control Measure Scale (TCMS), followed by children with diplegic and children with quadriplegia obtained the lowest scores. TCMS scores were significantly decreased with increasing GMFCS level. They concluded that, trunk control is impaired in children with CP to a various extent, depending on the topography and severity of the motor impairment. The findings of the current study also provide specific clues for treatment interventions targeting trunk control to improve their functional abilities [10].

The gross motor function abilities of all participants in the current study were measured by GMFM. The result of the current study showed that there was a significant increase of GMFM median value of Group B compared to Group C. That mean the motor abilities of hemiplegic type is much more higher than diplegic type in the same age period and same GMFCS. While the GMFM me-
dian value of Group A is higher than in Group B & C which indicated that the gross motor function of spastic cerebral palsy children either hemiplegic or diplegic is much less than the function abilities of children with typical development.

Children with spastic CP who participated in this study showed defect in GMFM score which comes on agreement with Laura who reported that young children with CP demonstrates excessive, non-reciprocal trunk and hip muscle activation during walking compared with children with typical developed children [11].

The current study agrees with the result of other study which reported that muscle strength was highly related to gross motor function and moderately related to gait. The results are in agreement with the recent literature indicating a positive significant correlation between strength and gait and function in persons with CP [12-14].

This correlation of this study meets the provisions of the International Classification of Functioning, disability and health (ICF), which defines the health status of individuals as multi-directional relationships between different domains of health. Accordingly, changes in body structure and function (such as deficits in core stability as observed in CP) are related to the level of activity and functional participation. Therefore, the poor core stability might correlate with a child's reduced performance in functional abilities and lower level of gross motor abilities [15].

For individuals with cerebral palsy, the clearest relationship between muscle strength and physical activity is the positive relationship between muscle strength and mobility and related functions, including gait. Weakness may also play a role in the observed decline in mobility in adults with cerebral palsy who do not exercise regularly [16].

The present result disagrees with Damiano who studied the effect of progressive resistance exercise on the mobility of young people with spastic cerebral palsy and the results showed the strength was increased after twelve weeks of training but does not improve the objective measures of functional mobility in young people with cerebral palsy, there was no difference between the groups for the six-minute walk, stairs test, GMFM standing and walking dimensions [17].

A recent systematic review included seven studies that addressed efficacy or effectiveness of lower extremity strengthening interventions and concluded that there was sufficient evidence for short-term gains in the ability to produce force or torque but not for carryover to functional activities. The authors deemed it a yellow-light intervention that should probably be performed for children with cerebral palsy. It is important to examine the elements of strength training protocols for children with cerebral palsy. They are varied in the type of exercise, duration and frequency [18].

Thus, it would seem that there are many considerations when designing and implementing a strength training program for individuals with cerebral palsy including intensity, duration, which muscles to strengthen, and how to strengthen them. Choice of muscles to be strengthened should depend on the functional motor goals of the individual child [19].

On basis of the present study supported by the relevant literature, this study concluded that the children with spastic cerebral palsy either hemiplegic or diplegic with level I and II GMFCS had poor core stability represented by weakness of frontal and dorsal trunk muscles, so the ambulant spastic cerebral palsy still need core stability training programs with more concentration on trunk muscles as well as extremities. Also there is positive correlation between the strength of trunk muscle and the functional abilities in children with spastic CP.

This study was conducted and funded by Faculty of Physical Therapy, Cairo University.

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