# Effect of trunk belt on function in children with diplegia

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**Background and purpose**
Trunk control can offer many solutions for posture and movement. The purpose of this study was to determine the effect of using modified trunk belt on sitting and standing in diplegic children.
**Patients and methods**
Thirty diplegic cerebral palsy children from both sexes participated. Their ages ranged from 3 to 6 years. They were divided randomly into two groups: control and study. The control group received a designed physical therapy program, and the study group received a designed physical therapy program in addition to proprioceptive training using a modified trunk belt. The sitting and standing domains were evaluated using the Gross Motor Function Measure for both groups before and after 3 successive months of treatment.
**Results**
The Wilcoxon test revealed that the gross motor function of children from both groups improved significantly after 3 months of treatment in both the sitting and standing domains. The Mann–Whitney test revealed that children in the study group showed a significantly greater improvement in both domains compared with the control group.
**Conclusion**
Proprioceptive training using trunk belt with physical therapy program could be used as an effective method for improving gross motor function of both sitting and standing in children with diplegia.

**Keywords:**
cerebral palsy diplegia, gross motor function, proprioceptive training, trunk control

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## Introduction

Cerebral palsy (CP) describes a group of permanent disorders of the development of movement and posture, causing activity limitation [1]. It is the most common cause of physical disability during childhood that affects the child on several health dimensions including neuromuscular deficits, such as spasticity, muscle weakness, and decreased selective motor control, and secondary musculoskeletal problems such as bony malformations and contractures [2]. Children with CP tend to have abnormal sitting and standing posture, and demonstrate poor balance compared with healthy individuals of the same developmental age [3].

Children with spastic diplegia have weakness in the trunk and spasticity of the extremities. They have some motor impairment of their upper extremities milder than lower ones [4]. They suffer from poor postural reflexes, poor alignment of the trunk, and abnormal back geometry, and hence the quality of sitting and standing postures is affected and reflected on their life and activity of daily living [5].

Sitting is an important step for a child to achieve the upright posture against gravity and also an essential activity to provide the postural background tone required for the functional movement of the upper extremity. However, the spastic diplegic children with poor trunk control show rounded back when they are sitting. They often show the difficulty to achieve well-balanced sitting posture and display the poor sitting posture such as flexed trunk with kyphotic curvature of the spine and asymmetry of the trunk [6].

Trunk control is a prerequisite for adequate mobility. It involves selective movements of the trunk and stabilization that is essential for free and selective movements of the head and the extremities [7,8]. Impairments in postural muscle function are associated with upright functional activity limitations and participation restrictions in various activities, and hence treatments to improve trunk and hip muscle activation may increase functional ability [9,10]. The aim of the present study was to determine the effect of using modified trunk belt on sitting and standing in children with diplegic CP.



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## Patients and methods

### Patients

This randomized controlled trial was conducted after obtaining approval for this study from the Research Ethical Committee of the Faculty of Physical Therapy, Cairo University. Thirty diplegic CP children of both sexes participated; their ages ranged from 3 to 6 years. They were selected from the outpatient clinic, Faculty of Physical Therapy, Cairo University.

Participants were included if they had mild-to-moderate degree of spasticity (range 1, 1+, or 2) according to the Modified Ashworth scale [11]. They were able to sit with support and stand holding on. They had no fixed deformity of both lower extremities. They had normal visual and auditory functions and were able to follow the instructions. Participants were excluded if they had sensory impairment, epileptic fits, or a history of surgical interference at the lower extremities.

After sufficiently informing all participant's parents about the procedure and signing an informed consent form before their voluntary participation in the study, the participants who met the inclusion criteria were allocated randomly and equally to one of the two groups using computer programming (computer-generated random numbers in each group according to predetermined ratio 1 : 1): the control group, which received a designed physical therapy program, or the study group, which received the same therapy program in addition to proprioceptive training using a modified trunk belt.

### Instrumentation

(1) The Modified Ashworth scale adopted from Bohannon and Smith [11] was used to quantify the degree of spasticity for the selection of participants.
(2) Gross Motor Function Measure (GMFM):
The GMFM has a high level of validity, with an intraclass correlation coefficient of 0.99 (95% confidence interval=0.972–0.997), and it also has an excellent reliability (intraclass correlation coefficients=0.952–1.000) [12–14]. The GMFM is the standard measure to assess change in gross motor function for children with CP aged 5 months to 16 years in five dimensions: supine/rolling, sitting, crawling/kneeling, standing, and walking/running/jumping. Each GMFM item is graded on a four-point scale (0=unable to initiate the task, 1=able to initiate the task, 2=able to perform the task partially, and 3=able to perform the task completely); these scores are then converted into a total score. A higher score indicates better gross motor function [15].
(3) Physical therapy tools:
Physical therapy tools that were used for conducting physical therapy program included mat, medical balls, rolls, wedges, sitting chair, stool, balance board, standing bars, stick, and table.
(4) Tools used for proprioceptive training:
   (a) A trunk belt made of leather adjustable with Velcro. There was a colored stick 'florescent yellow and green' of about 25 cm in length in the middle of the belt.
   (b) Different plastic, colored, holed shapes with a stick in their ends 'red circle, blue rectangle, orange triangle, pink square, and yellow star'.
   (c) Small piano and colored toys to provide visual and auditory stimulation.
   (d) A marker and board.

### Procedure

#### *Gross motor function measure*

The assessment was conducted for each child of both groups individually before and after 3 successive months of treatment. The protocol of the work was explained to children before conducting this study. Each child was asked to perform two test trials before specific tests to be familiar with the tasks. Sitting and standing domains were evaluated. The recording sheet of each participant was filled out during evaluation with calculation of total dimension score of each domain [15].

#### *Physical therapy treatment program*

Children of both groups received the designed physical therapy exercise program. For both groups, treatment was applied for 1.5 h three times weekly for 3 successive months. Physical therapy exercise program included the following:

(1) Approximation of the trunk while sitting on roll in front of the therapist.
(2) Pull to sit from supine on wedge (head at lower side) strengthening exercises for abdominal muscles.
(3) Counter positioning→reaching while sitting on roll.
(4) Stimulation of postural reactions (righting, equilibrium, and protective reactions) from sitting on ball and/or from sitting on roll.
(5) Parashot reaction from sitting on roll.
(6) Rising mechanism→from supine to sitting to standing.
(7) Rising mechanism→from prone to quadruped to kneeling sitting to half kneeling to standing

(the therapist holding the child from his/her pelvis).
(8) Gentle passive stretching to hamstring and calf muscles.
(9) From prone on ball→standing and bouncing.
(10) Standing holding on→wall bars–chair–stick(s).
(11) Standing with wide base of support→narrow base of support.
(12) Weight shifting from standing on either lower limb.
(13) Taking a step forward and a step backward (manual help).
(14) Standing on one leg (manual support).
(15) Standing on balance board (manual support).
(16) Stoop and recovery from standing (manual support).
(17) Squat from standing (manual support).
(18) Standing against a wall and kicking a ball.
(19) Standing against a wall and catch a thrown ball with his/her hands.
(20) Equilibrium and protective reactions from standing by pushing the child in different directions.

### *Proprioceptive training*

Proprioceptive training was applied for the study group after performing the designed physical therapy exercise program while wearing the trunk belt from sitting on chair or stool and standing against a wedge or the wall with a knee immobilizer splint or with manual assistance of the therapist to lock knees.

(1) Each child was asked to move the stick attached to the belt toward the therapist's hand in different depth and directions.
(2) Each child was asked to move the stick attached to the belt toward a small piano in different depth and directions and press with the stick on the keys of piano to provide visual and auditory stimuli.
(3) Each child was asked to enter the stick attached to the belt in different colored holed shapes at different depth and directions.
(4) Each child was asked to press on and then drop different colored toys placed on a chair in front of the child with the stick attached to the belt.
(5) Each child was asked to draw on a board (placed at different depth and directions in front of him/her) with a marked pen held in the stick attached to the belt.

### Statistical analysis

All statistical measures were performed using the statistical package for social science program, version 18 for windows (SPSS Inc., Chicago, Illinois, USA). Descriptive statistics and *t*-test were used for comparing the mean general characteristics. The 'Mann–Whitney test' was conducted to compare difference between groups in sitting and standing. The 'Wilcoxon test' was used to compare pretreatment and post-treatment values for sitting and standing for each group. Statistical tests were considered significant if *P* less than 0.05.

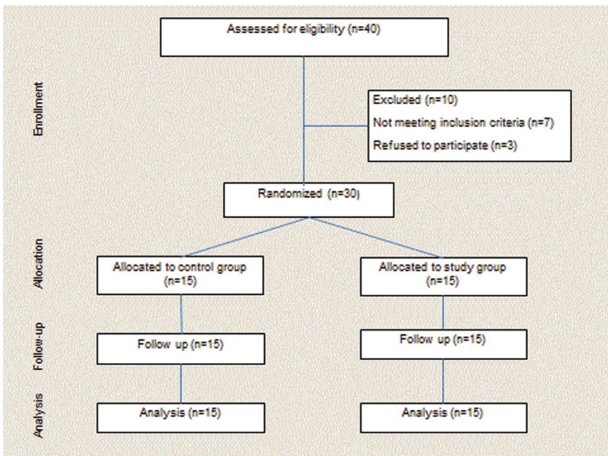
## Results

Forty CP children were assessed for eligibility. Seven children did not satisfy the inclusion criteria and three refused to participate. Thirty children (16 boys and 14 girls) were enrolled in this study. Fifteen participants were randomly allocated to the control group and the other 15 participants were allocated to the study group (as shown in consort flow chart in Fig. 1). Baseline characteristics of the participants are shown in Table 1. No statistically significant differences existed between groups with regard to age, height, and weight.

As presented in Table 2, the 'Wilcoxon test' revealed that there was a statistically significant improvement in sitting (*P*=0.002) in the control group and (*P*=0.001) in the study group. Considering the effect of the tested group on sitting, the 'Mann–Whitney test' revealed that there were no statistically significant differences (*P*=0.504) as regards pretreatment between the two groups. However, as regards post-treatment between the two groups, there was a significant improvement in sitting in favor of the study group (*P*=0.001).

The Wilcoxon test revealed that there was a statistically significant improvement in standing (*P*=0.001) in both groups. As regards the effect of the tested group on standing, the 'Mann–Whitney test' revealed that there

**Figure 1**




Consort diagram showing the flow of the study participants through each stage of the randomized trial.

**Table 1 General characteristics of participants**

| | Mean±SD | | MD | *t*-value | *P*-value | Significance |
|---|---|---|---|---|---|---|
| | Control group (*n*=15) | Study group (*n*=15) | | | | |
| Age (years) | 4.58±1.24 | 4.92±1.18 | −0.33 | −0.7 | 0.491 | NS |
| Weight (kg) | 14.95±3.24 | 14.11±3.55 | 0.84 | 0.618 | 0.543 | NS |
| Height (cm) | 98.08±1.64 | 97.1±1.05 | 0.98 | 0.503 | 0.62 | NS |

MD, mean deviation; NS, nonsignificant.

**Table 2 Comparing the median (IQR) of sitting pretreatment and post-treatment within and between both groups**

| | Median (IQR) | | *Z*-value | *P*-value |
|---|---|---|---|---|
| | Control group (*n*=15) | Study group (*n*=15) | | |
| Pretreatment | 42 (40–44) | 43 (39–45) | 0.668 | 0.504 |
| Post-treatment | 44 (43–46) | 52 (50–54) | 4.642 | 0.001* |
| *Z*-value | 3.125 | 3.427 | | |
| *P*-value | 0.002* | 0.001* | | |

IQR, inter quartile range. *Significant level is set at $\alpha$ level <0.05.

**Table 3 Comparing the median (IQR) of standing pretreatment and post-treatment within and between both groups**

| | Median (IQR) | | *Z*-value | *P*-value |
|---|---|---|---|---|
| | Control group (*n*=15) | Study group (*n*=15) | | |
| Pretreatment | 17 (14–19) | 16 (14–18) | 0.334 | 0.738 |
| Post-treatment | 21 (20–23) | 31 (29–34) | 4.653 | 0.001* |
| *Z*-value | 3.420 | 3.411 | | |
| *P*-value | 0.001* | 0.001* | | |

IQR, inter quartile range. *Significant level is set at $\alpha$ level <0.05.

were no statistically significant differences ($P$=0.738) in pretreatment values between the two groups. However, the post-treatment values between the two groups showed a statistically significant improvement in standing in favor of the study group ($P$=0.001) (Table 3).

## Discussion

This study aimed to investigate the effect of modified trunk belt on sitting and standing in children with diplegic CP. The trunk belt provides external stabilization to the trunk and therefore allows more fluent and coordinated movement of both upper and lower extremities. In spastic diplegia, the ability to sit independently can be delayed up to 3 years of age or older. They have difficulty in independent standing and no standing balance without support [16].

Pretreatment GMFM findings revealed that both groups of children had limited abilities in sitting and standing dimensions. This might be attributed to the fact that diplegic children have well-documented balance impairments [17] and tend to rely disproportionately on visual input to position their limbs and maintain posture, which may reflect deficits in proprioception [10]. Proprioceptive input is collected in the periphery from a variety of receptors in the muscles, joints, and skin, and, with vision and vestibular input, contributes to the primary sensory information about the body's position and movements [18,19].

The trunk belt was designed for children in whom trunk weakness is the primary problem preventing function of the limbs. The trunk belt is a flexible belt designed to facilitate stability and postural awareness in the trunk and pelvis area by providing proprioceptive feedback and by positioning the body closer to being anatomically neutral to facilitate a more erect body posture. This restoration of posture and proper function of postural muscles allows the child to learn proper patterns of movement [20].

The improvement in sitting and standing in the control group may be attributed to the designed physical therapy program, which was directed toward facilitating normal patterns of postural control (righting, equilibrium, and protective reactions) and developing a greater variety of normal movement patterns, particularly in the trunk and lower extremities. This is in agreement with the findings of Dodd *et al.* [21], who stated that exercises and rehabilitation program increase the general physical capacity and functional independence of children with CP. Using neurodevelopmental therapy can improve functional sitting outcomes [22].

The improvement in sitting in the study group may be attributed to the effect of trunk belt on stability, which imparts a precise, smooth, rhythmical pattern of movement to the child. This is in agreement with the findings of Verheyden *et al.* [23], who reported that trunk stability is an essential core component of balance, and it is necessary for coordinated extremity use in daily functional activities and performance of higher level motor tasks. The core stability is essential for postural sitting control [22].

The change in sitting variable of the study group may be due to increased sensory awareness through trunk belt. This is supported by Mudie *et al.* [24], who found that training the patients with the awareness of trunk position could improve weight symmetry in sitting, which alters the sensory input to the central nervous system and subsequently influences its perception and execution of movement.

The significant improvement in post-treatment values of standing in the study group may be attributed to the effect of trunk belt on realignment of the trunk, which enhanced proper body alignment with the least expenditure of muscle energy and postural tone. Trunk belt had some proprioceptive influence, which enhances the diplegic children awareness to maintain his/her body in an upright position that means effective postural control and good body alignment. This explanation was supported by Batra *et al.* [25].

Most of the tasks on proprioceptive training program focused on dynamic activities in three planes of movements (frontal, sagittal, and transverse) rather than static positions. This is supported by Frankenburg [26], who reported that the fourth stage of movement development to develop a skill is the postural control in the three planes of movement. Thus, the significant improvement in the study group may be from enhancement of postural control during standing through improving the trunk alignment in relation to the pelvis and strengthening the back and abdominal musculatures.

Trunk exercises had a beneficial effect in improving trunk control, balance, and mobility function in children with CP [27]. The decreased cocontraction of agonist and antagonist muscles of the trunk by stimulating more selective isolated movements facilitates and organizes movement within muscle groups (agonist, antagonist, and synergist) that could be a base for more controlled posture in sitting and standing.

The trunk is the central key point of the body; proximal trunk control is a prerequisite for distal limb movement control, balance, and functional activities [28]. Trunk control is the ability of the trunk muscles to allow the body to remain upright, adjust weight shift, and perform selective movements of the trunk so as to maintain the center of mass within the base of support during static and dynamic postural adjustments [29]. The basic rationale for trunk belt is to provide support for the trunk while permitting optimal functional movement. However, the trunk belt may have some proprioceptive influences, enhanced awareness of body position, and provide support for the trunk, may possibly explain a positive effect of the trunk belt on functional performance.

## Conclusion

In conclusion, this study suggests that adding proprioceptive training with trunk belt to physical therapy program may have significant improvements in sitting and standing in children with diaplegic CP.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Nil.

### Conflicts of interest

There are no conflicts of interest.


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