DOI: http://dx.doi.org/10.33846/hn50705
http://heanoti.com/index.php/hn

RESEARCH ARTICLE
URL of this article: http://heanoti.com/index.php/hn/article/view/hn50705

Trunk Control Inhibition and Balance Training Have an Effect on Balance Control in Children with Cerebral Palsy

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ABSTRACT

Cerebral palsy is a major cause of movement and posture disorders in children. This condition is a non-progressive motor disorder caused by lesions or brain anomalies that arise in the early stages of a child's development but can change over time due to the growth and plasticity of the development and maturation of the child's central nervous system. The overall prevalence of data collected until 2013 the incidence of Cerebral Palsy was 2.11 per 1000 live births. This study aims to determine the effect of providing balance training intervention and trunk control inhibition on changes in trunk balance control in Cerebral Palsy children. This research is an experimental study with a pre-test – post-test two control group design. The research was conducted at Dr. Hospital. Wahidin Sudirohusodo Makassar, with a sample size of 30 people who were randomly divided into 2 groups, namely 15 people in the group given the balance training intervention and 15 people in the group given the trunk control inhibitor. Balance control capability data was measured using the Trunk Control Measurement Scale (TCMS). The results of the Wilcoxon test analysis showed that there was a significant effect on the provision of balance training (p=0.002) and trunk control inhibition (p=0.007) to improve balance control in children with cerebral palsy. Based on the Mann-Whitney test analysis, it was found that there was no significant difference (p= 0.683) between balance training and trunk control inhibition on changes in balance control.

Keywords: balance training; inhibition trunk control; trunk control measurement scale; balance control; cerebral palsy

INTRODUCTION

Cerebral palsy is a major cause of movement and posture disorders. This condition is a non-progressive motor disorder caused by lesions or brain anomalies that arise in the early stages of a child's development but can change over time due to the growth and plasticity of the development and maturation of the child's central nervous system[(1)] . The overall prevalence of data collected until 2013 the Cerebral Palsy birth rate was 2.11 per 1000 live births[(2)]. The incidence in premature infants is much higher than in term infants. For the majority of term infants with CP, birth asphyxia or obstetric complications cannot be considered the cause[(1).] Evidence on the epidemiology, health and nutritional status of children with CP in Indonesia is very limited and based mostly on small-scale agency-based surveys, but Indonesia is the fourth most populous country with a population density of 145.1 persons per km2[(3)]. About a quarter of the population is less than 15 years old[(3)]. However, recent predictive corroborating data indicate that 4.3% of people in Indonesia live with one or more functional disabilities (ie, hearing, seeing, walking/climbing stairs)[(4)].

The results of observations in 2017 conducted by researchers at Dr. Wahidin Sudirohusodo Hospital, data obtained that 75% of patients who visited the mother and child physiotherapy polyclinic were patients with pure cerebral palsy and 25% were pediatric patients with motor disorders. The population data obtained reached about 75 patients who visited the Mother and Child Physiotherapy Polyclinic, RSUP Dr. Wahidin Sudirohusodo in one month.

Classification of cerebral palsy is divided into two, namely based on topography and based on type. Classification based on topography is divided into 3, Classification based on topography is divided into 3, namely Tetraplegia (quadriplegia) Involvement of all limbs, both arms are the same or even more affected than the legs. Diplegia with arms is much less affected than legs. Hemiplegia i.e. the leg on one side is affected. Classification by type is divided into athetoid (dyskinetic) and rare ataxic type. There is a hypotonic type which can be spastic, athetoid, or ataxic.

Tetraplegia usually has spasticity, dystonia, tardiness (athetosis), hypotonia, or ataxia. Hemiplegia is usually the type of seizure that often begins with hypotonicity[5]. Cerebral palsy causes developmental disorders in children, including physical and mental growth and development disorders. Physical development includes gross motor development such as at the calendar age of 1-2 years which proceeds in a cephalocaudal direction: supine, head up, prone, sitting, crawling, standing, to walking. However, in children with cerebral palsy whose calendar age has reached 1-2 years, but whose growth and development age is 4-6 months, they are only able to lie on their back and then roll over, on their stomach, sit with their arms straight to support their body, and maintain their head position[6]. Balance and posture control is important for functional activity. Cerebral palsy (CP) children have poor postural balance control compared to normal children due to the slow and impaired development of their neural motor control mechanisms combined with secondary musculoskeletal disorders (e.g. muscle spasticity, muscle weakness, low proprioception, and bone deformation)[7]. Balance training is an important part of the rehabilitation of CP children because it has been shown that there is a relationship between impaired balance control and functional limitations in CP children. Specific Balance Training exercises integrated into the rehabilitation program can therefore modify postural balance by increasing postural muscle control and increasing trunk range of motion[8,9]

Neuro Development Treatment, trunk control inhibition is a holistic approach that deals with the quality of balance-coordination patterns and not only with individual muscle function problems but also involving all organs, not only sensory-motor problems, but also growth, cognitive-perceptual decline, emotional problems, social, and functional of daily life as well[10–12]. In this study, the researcher will examine the level of balance control, especially the trunk in children with cerebral palsy with spastic quadriplegia by comparing the different effects of two interventions, namely Balance Training with Inhibition Trunk Control. The results of this study can provide benefits to the functional ability of children with cerebral palsy, especially the ability to control balance as the most important factor in carrying out life activities.

METHODS

This research was an experimental study with a pretest-posttest two-group design. This research was conducted from May to July 17, 2017, at Dr. RSUP. Wahidin Sudirohusodo. This study aimed to study the effect of given trunk control inhibition exercises with balance exercises on the ability to controlled balance in children with cerebral palsy. The population was children with cerebral palsy with a history of ischemic hypoxia who have experienced impaired balance control, which is marked by the inability of the child to maintained a sitting position. The sample inclusion categories were children under the age of 5 years with a combination of spastic or spastic, and quadriplegia topography. The sample size was obtained using the Slovin formula so that a sample size of 30 people was obtained. The sample was obtained by accidental sampling technique which was then randomly divided into 2 groups, namely 15 subjects in the group who were given balance training interventions with asymmetric exercise techniques by sat on a moving ball and the child still maintaining a sat position on the ball and 15 other subjects in the group receiving given trunk control inhibition exercise with the technique of inhibiting abnormal attitude reflexes to obtain better muscle tone by stimulating the feeling of movement.

Data were obtained by measured the sample's ability to balance in static sat, dynamic sat balance, and dynamic range before and after the intervention used the trunk control measurement scale (TCMS) in both groups. The data collected was processed by descriptive statistical tests to analyzed the sample characteristics data, Normality Test with Shapiro Wilk test to determine whether the research data were normally distributed or not. Research hypotheses were analyzed using a non-parametric test. Because the data was not normal, the Wilcoxon test analysis was used, which showed a significant effect of giving balance training ($p=0.002$) and trunk control inhibition exercise ($p=0.007$) on improving balance control in children with cerebral palsy. Based on the analysis of the Mann-Whitney test, the results showed that there was no significant difference ($p = 0.683$) between balance training and trunk control inhibition exercise on changes in balance control in children with cerebral palsy.

RESULTS

This section presented the analysis and interpretation of the data collected through direct interviews with the patient's guardians in response to the problems in this study. Based on the results of the analysis showed in Table 1, it is known that the most common subjects experiencing cerebral palsy with impaired balance control were female patients with an average of 2 years and under.

Table 1. Characteristics of cerebral palsy patients by age and sex

Sample characteristics	Balance training		Trunk control inhibition	
	Mean	SD	Mean	SD
Age (years)	2.73	1.280	3.20	1.014
	n	%	n	%
Sex:				
Male	5	33.3	9	60.0
Female	10	66.7	6	40.0

Table 1 showed that children with cerebral palsy in this study had the same age range between treatment groups, where boys and girls had the same probability of developing cerebral palsy. Thus, it can be concluded that age and gender have the same risk in children under five years of age, both male and female.

Table 2. TCMS mean difference test before and after intervention

Intervention	Measurement time				Difference in average		p-value
	Pre-test		Post-test				
	Mean	SD	Mean	SD	Mean	SD	
BT	8.600	6.0004	12.627	8.9223	4.027	3.9380	0.002
ITC	10.453	6.6267	13.453	8.1568	3.000	3.6557	0.007

BT= Balance Training; ITC= Inhibisi Trunk Control; SD= standar deviation; Wilcoxon Test

Table 2 showed the mean value before and after the intervention, showed a difference in the mean value for the BT treatment of 4.027 ± 3.9380 with a p-value of 0.002 (<0.05) and for the ITC intervention of 3.000 ± 3.6557 with a p-value of 0.007 (< 0.05) which means that the intervention of balance training (BT) and intervention of inhibition of trunk control can significantly improve the control of sitting balance in cerebral palsy patients. Thus, the provision of balance training (BT) intervention and trunk control inhibition intervention had a significant effect on increasing balance control in children with cerebral palsy.

Table 3. TCMS mean difference test before and after intervention

Intervention	Control of balance after treatment		p-value
	Mean	SD	
BT	12.627	8.9223	0,674
ITC	13.453	8.1568	

BT= Balance Training; ITC= Inhibisi Trunk Control; SD= standar deviation; Mann Whitney test

The results of data analysis in table 3 showed that p-value = 0.674 (> 0.05), which means that there was an insignificant difference between the two forms of treatment on increasing balance control on the trunk. The intervention of balance training and inhibition of trunk control had a no different effect on increasing balance control in children with cerebral palsy.

DISCUSSION

The description of the sample based on age and gender has shown the above results that the average age of Cerebral Palsy children is in the same age range. This study took children with criteria for pure spastic Cerebral Palsy or mixed spastic quadriplegia with a maximum age of 5 years and without other comorbidities such as hydrocephalus and meningitis, also not children with Cerebral Palsy due to post-surgery, but only children with a history of ischemic hypoxia during childbirth. Age and gender have the same risk in children under five years, both boys and girls. Epidemiological studies show that cerebral palsy tends to occur at the age of 2 years and under. If it is associated with a newborn child, then the cause is birth trauma. Recent advances in neonatal management and obstetric care have not shown a reduction in the incidence of Cerebral Palsy[(1)]. In addition, it is estimated that 8,000 infants and children suffer from Cerebral Palsy, and 1.200 to 1.500 children of preschool age suffer from Cerebral Palsy each year[(13)].

The results of the analysis show that the provision of balance exercises has a significant effect on changes in balance control in cerebral palsy patients. This can happen because balance training can affect the activity of the muscles responsible for posture stability, balance exercises will stimulate muscles to contract to increase muscle strength in a group[(23)]. Children with cerebral palsy often exhibit somatosensory problems such as joint positional posture and kinesthetic deficits. CP children tend to rely disproportionately on visual input to maintain their posture and limb position, suggesting that they severely lack proprioception. Individuals with hemiplegia and spasticity of cerebral palsy have a proprioception deficit in terms of the ability to determine whether the movement of the index finger has occurred and in which direction[(18)]. Balance training can result in significant improvements in muscle and joint stability because stability and orientation are the two most important aspects of improving postural control. Neuromuscular control relies heavily on sensory feedback that influences the response to changing external demands, where the normal response during movement and the pattern of muscle activation is to adapt to repetitive disturbances. Patients with cerebral palsy have complaints of muscle weakness, joint stiffness, and impaired neuromuscular control that can affect external disturbances. The effects of balance training can stimulate increased proprioception or optimal neuromuscular adaptation in joints during exercise[(12)(14)].

Several studies have shown that balance training is an important intervention program for people with cerebral palsy, where exercises close to the kinematic chain with repeated frequency can show great benefit in improving balance control in children with cerebral palsy[(14)(16)]. Close kinematic chain exercise is part of a balanced training program, performed by positioning the distal joint in a closed state. Balance exercises using a close kinematic chain can improve postural stability which will also affect the strength of controlling trunk balance

in children with cerebral palsy [15]. A close kinematic chain is a movement that uses more than one joint that moves by relying on body weight to provide loading on more than one muscle group that works simultaneously with both agonists and antagonists and increases the activation of lower limb proprioception[17]

Closed Kinetic Chain exercises provide the effect of increasing muscle strength, proprioception, and functional ability. In principle, Closed Kinetic Chain exercises can train muscles in concentric and eccentric control which are carried out systematically by utilizing biomechanical phenomena and functional physiology that do not depend on gravity[17][18].

The results of the analysis of the administration of inhibitory trunk control exercises can affect changes in balance control significantly in children with cerebral palsy. This can happen because the trunk control inhibition exercise can improve the child's ability to control the trunk so that it has a better effect on weight-bearing activities. Children with the inability to control the body will have difficulty holding weight[19]. Children with cerebral palsy have implications for movement and posture disorders that occur due to injury or developmental malformations in the central nervous system. Central nervous system malformations will cause problems in the muscles of the extremities, such as high spasticity. Spastic type of cerebral palsy with stiffness experienced in the hands causes inhibition of fine motor development. In addition, the key to the development of normal movements is the child's postural tone[5][20]. Children learn to use the same patterns for useful activities and are influenced by the force of gravity. The posture of a child with cerebral palsy can change, and without the basic readiness of the muscles to react it can make it difficult for the child to develop good functional skills without assistance. Inhibition of trunk control is part of the Bobath technique known as Neuro-Developmental Treatment (NDT) which can result in decreased muscle tone in children with high spastic cerebral palsy. Inhibition is an attempt to inhibit and reduce muscle tone ([10][12]). Through the action of inhibition, spasticity will be reduced or muscle tone will be close to normal and it is hoped that the child can move freely with a wider range and sensory experience will increase. Through the Reflex Inhibitory Pattern technique, changes in postural tone and movement patterns cause CP children to move closer to normal by inhibiting abnormal movement patterns. Reflex Inhibitory Pattern is a technique used to inhibit trunk control disturbances with elongation and approximation techniques. The elongation technique is a muscle lengthening technique with a pulling frequency of no more than the usual stretching technique applied, only to inhibit high spastic postural tone without forcing the child. While the approximation technique is repetitive soft joint compression to activate proprioceptive receptors that have joint receptor deficits[21]. Regular muscle lengthening can increase muscle elasticity. Muscle lengthening techniques can increase muscle flexibility, where muscle flexibility is needed to produce free functional movement. Physiologically, elongation can stimulate proprioceptors, especially muscle proprioceptors consisting of muscle spindles and Golgi tendon organs. Thus, the elongation technique can cause muscle elongation and cause a decrease in muscle tone spasticity through light stretching. If muscle tone has decreased to near normal, then the effects of further training will produce a good response. Then, the approximation technique will stimulate the proprioceptors in the joints. Stimulation of these neurons causes a brief increase in contraction. Thus, stimulation of the Golgi spindle and tendon muscles will be informed via afferents to the central nervous system so that it will contribute to both facilitation and inhibition[8]. Inhibition of trunk control can result in improved balance control in CP children, this is evident from the results of studies that show significant results in changes in balance control in cerebral palsy patients.

The results of the comparative analysis between the intervention of balance exercise and trunk control inhibition showed that there was an insignificant difference in improving balance control in children with cerebral palsy, meaning that both balance training and inhibition trunk control exercise had the same effect on changes in balance control ability in children with cerebral palsy. palsy, but when viewed from the change in the average difference before and after the intervention, it showed that trunk inhibition exercise had a greater difference than giving balance training to the ability to control balance in children with cerebral palsy This happens because both types of exercise have an influence on muscle strength as one of the main factors in influencing the ability to control balance[22][23]. In addition to increasing muscle strength, both exercises aim to increase spinal muscle strength and control[24]. Trunk inhibition exercise will facilitate increasing muscle strength and pelvic control as one of the determinants of a child's ability to control his body balance[22]. Likewise, balance training will facilitate motor control of the trunk muscles, especially activities on the therapy ball. In addition, balance training will also result in the emergence of reactive postures[24]. Therefore, the two forms of exercise both have an effect on muscle strength, especially elongation and approximation which cause a decrease in muscle spasticity through activating proprioceptive deficits in joint receptors, as well as activating muscle proprioceptors consisting of muscle spindles and Golgi tendon organs so that they affect the ability to function. children to control their balance.

CONCLUSION

The results of this study concluded that the gender factor supported by the age of the subject is a factor that has a major contribution to the imbalance in the control trunk which is characterized by the inability of children with cerebral palsy to maintain a sitting position. The findings of this study are clinically important because balance exercises and inhibition of trunk control can improve balance control, especially trunk balance in the

sitting position of children with cerebral palsy. The existence of elongation and approximation techniques causes a decrease in muscle spasticity by activating proprioceptive deficits in joint receptors, as well as activating muscle proprioceptors consisting of muscle spindles and Golgi tendon organs.

Because the number of samples determines the results of statistical analysis in this study, the researchers suggest the need for further research with methods and a larger number of samples.

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