Interprofessional Journal of Healthcare and Research Volume 1 issue 1, 2021, 32-42

CASE REPORT

The Effect of An Isometric Trunk Training During Spinning in a Child With Cerebral Palsy: A Case Report

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Abstract

Objective: There is limited evidence to fully justify a constant speed whole body spinning intervention for children with cerebral palsy to improve trunk stability and gross motor function. The purpose of this case report is to investigate the impact of an isometric trunk training during use of the Allcore 360 seated core muscle trainer on functional abilities and independence in a child with cerebral palsy.

Participant and Method: An 11-year-old girl with cerebral palsy classified as Gross Motor Function Classification System (GMFCS) level V participated in an isometric trunk training with constant speed twice per week for 14-weeks. Assessments were performed at baseline, 7 weeks and 14 weeks of intervention using the Gross Motor Function Measure-88 (Dimensions A & B), Modified Functional Reach test, sitting posture in the wheelchair and response to trunk perturbation.

Results: Following the constant speed spinning intervention, improvements were found in trunk control, lower extremity coordination and sitting posture, as well as increases in GMFM-88 and Modified Functional Reach Test Scores. Positive outcomes from the spinning training were obtained beyond improvements in trunk stability, since improvements in functional motor performance were also achieved.

Conclusion: The results of this study suggest that the constant speed spinning intervention have been effective for improving trunk stability and physical performance in this child. However, further investigation should be needed to quantify and verify the positive result of the experiment in a larger population.

Introduction

Cerebral palsy (CP) describes "a group of disorders of the development of movement and posture, causing activity limitation, that are attributed to non-progressive disturbances that occurred in the developing fetal or infant brain. The motor disorders of cerebral palsy are often accompanied by disturbances of sensation, cognition, communication, perception, and/or behavior, and/or by a seizure disorder."(Bax et al., 2005). Magnetic resonance imaging performed in children with spastic diplegic CP shows enlarged ventricles due to cell death in the periventricular white matter referred to as periventricular leukomalacia (PVL). White matter damage due to PVL causes interruptions in transmission of signals within the brain and to the rest of the body. Magnetic resonance imaging also shows decreased gray matter stiffness as well as an increased damping ratio in the cerebrum. Neural cell death of the PVL and lower brain stiffness lead to reduced structural integrity of brain tissue, while higher damping ratio leads to functional impairment(Chaze et al., 2019). Potential factors leading to acquired CP may include intracranial hemorrhage, asphyxia, or abnormal development of the brain. Fetal stroke, infection, and trauma during or after birth are most common indications for acquired CP (Bax et al., 2005).

According to neurodevelopmental principles, movements of extremities are controlled in proximodistal fashion with the trunk, where trunk has a vital role in movement control of the extremities and further development of balance and functional mobility (Davies, 1990; Hsieh, Sheu, Hsueh, & Wang, 2002). Children with cerebral palsy show disorders of the development of movement and posture and can have difficulties achieving trunk control. They exhibit hypotonic symptoms and weakness of the trunk muscles; increased upper and lower limb muscle tone; loss or delay of postural reflexes; and the loss of the ability to flexibly move the upper and lower limbs, which is associated with poor trunk control. Without appropriate trunk control, it is hard for children with cerebral palsy to perform their activities of daily living (J. W. Shin, Song, & Ko, 2017).

ElBasatiny & Abdelaziem (2015) proposed that 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. They define trunk control as "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."

One of the many gaps is evidence on response for trunk coordination of children with CP who have multiple limitations in mobility. For this study, an 11-year-old girl with spastic triplegic CP classified at GMFCS level V was selected as a participant. Considering her limitation of gross motor function and trunk stability, an incline seated training focusing on trunk coordination seemed to be an appropriate rehabilitation alternative. Hence, the purpose of this case report was to help the child to get greater trunk stability in a shorter amount of time by engaging the core muscles in an isometric hold with an inclined seated spinning device. We investigated the impact of the isometric trunk training in functional abilities and independence in a child with CP.

Methods

Case description

The participants informed consent prior to participating in this study as approved by the University of North Georgia's Institutional Review Board (2019-103). The participant was an eleven-year-old girl who had spastic triplegia due to a premature birth and was diagnosed with periventricular leukomalacia (PVL), classified as level V according to GMFCS. The participant and her mother were provided a detailed explanation of the intent and content of the intervention and agreed to participate in the training. The child had not received any surgical intervention since she was born and was not currently taking any type of medication. The child exhibited decreased muscular control due to the effects of cerebral palsy. She had low underlying trunk tone and decreased strength with very strong dynamic tone and spasticity that affected her ability to move. Her left side was more involved than her right and she had limited use of her left arm and both legs. Physical examination revealed muscle weakness (adapted Kendall scale) and spasticity (Modified Ashworth scale) predominantly in trunk and lower limb; decreased range of motion and deficits in postural control, especially in sitting position (Table 1).

Table 1. Initial examination

	Muscle tone (Ashworth Scale)	Muscle strength (Kendal Scale)
Trunk extensors	0	3
Abdominal	0	2
Hip internal rotators	3	3
Hip external rotators	2	2
Hip flexors	3	3
Hip extensors	2	1
Hip adductors	3	3
Hip abductors	2	2
Knee flexors	2	2
Knee extensors	1	2
Ankle plantarflexors	3	2
Ankle dorsiflexors	2	3

At baseline assessment, the child was able to propel her wheelchair by herself on flat surface for a short distance (20 feet) using her right upper limb. She required moderate assistance to transfer out of her wheelchair to a chair and maximum assistance to get back to her wheelchair. She could move herself around on the mat slowly and laboriously and pull up into kneeling on a stable object with maximum assistance. Her main problem was her inability to sit or stand unsupervised without support due to a persistent startle reflex that affected her functional balance. Sitting balance reactions were delayed and ineffective to prevent falling. Strong scissoring and spasms interfered with the unilateral lower extremity movement resulting in bilateral partial range hip flexion with volitional effort. The child required maximum assistance to stand and was unable to take steps.

Assessment

Assessments were performed at baseline, 7 weeks of intervention and 14 weeks of intervention. The Gross Motor Function Measure (GMFM-88) dimension A (Lying and Rolling) and B (Sitting) were conducted to measure gross motor function improvements over time. GMFM is a valid, reliable and sensitive test especially developed for children with CP (Kenyon, 2014; Salavati et al., 2017). Since the child is not able to stand up and walk, we decided to use dimension A and B for the assessment. In addition, Modified Functional Reach Test (Forward, Lateral) was performed for measuring the improvement of dynamic balance and trunk stability (Bartlett & Birmingham, 2003). We also added perturbation in sitting as an outcome assessment after 7-weeks of intervention as the child get more trunk stability and can tolerate external perturbation in sitting. The Assessments were performed by one examiner and all procedures were video recorded for further evaluation.

Intervention

The child performed an inclined spinning training in sitting with constant velocity twice per week for 14-weeks. The Allcore360 is a rehab and strength training system used for individuals of a wide range of ages and functional abilities with the goal of improving rates of recovery and functional performance. (Figure 1) The system activates the core muscles by resisting the force of gravity while contracting the trunk isometrically 360-degree arc rotation. The inclined angle was determined each session as the maximum angulation at which the child could effectively keep her head, neck and trunk stable in the body midline while the device rotates alternately clockwise and counterclockwise at a velocity of 6 degrees per second. (Appendix A)

Figure 1. The subject was performing the isometric trunk training with Allcore 360

At the beginning, we requested her to perform the training in twice weekly sessions of three sets of ten repetitions. Each repetition (spin) takes 60 seconds. We provided rest between the sets as long as she wanted. In order to get greater trunk stability, feedback including visual, verbal and somatosensory inputs was administered during the sessions so that she can maintain proper body alignment via isometric core muscle activation. After 7 weeks of intervention, she could well maintain the correct alignment without losing balance, so we decided to adjust the protocol to 3 bouts of 5 consecutive rotations in both directions to emphasize endurance while minimizing treatment time.

Results

The GMFM-88 (Dimension A & B) and Modified Functional Reach Test Scores were improved after the 14 weeks of intervention. (Table 2) Regarding the GMFM test, the greatest improvements were found in the following items: flexing hip and knee in supine position, rolling to sit, left side sitting with arms free, and sitting on mat with arms free. Also, the child was able to be left in sitting position without close supervision or contact guarding; she was able to reciprocally activate lower extremities in supine position, demonstrating dissociation as contrasted with obligatory bilateral simultaneous co-activation seen at the initial evaluation. Her spontaneous sitting posture aligned her ears with the rear wheel axis of her wheelchair, as opposed to being at an approximate 30-degree posture in front of the axle bearing weight through her elbows supported on her thighs initially. She even had difficulty initially changing her trunk to a more extended posture with verbal requests and tactile cues. She was leaning forward supporting weight through upper extremities on thighs before intervention but was sitting up with full contact against the back of wheelchair post with arms in relaxed postures following the course of intervention. Positive outcomes were found in trunk control, lower extremity coordination and sitting posture.

Table 2. GMFM-88 scores (Dimension A & B), Modified functional Reach Test (Forward, lateral) in initial examination, 7 weeks of intervention and 14 weeks of post intervention

	Initial examination	7 weeks of intervention	14 weeks of post intervention
GMFM scores (%)			
Dimension A	76.5	82.3	92.1
Dimension B	63.3	71.6	80
Modified Functional Reach Test (Inches, Rt/Lt)			
Forward	6.5/6.0		6.3/7.1
Lateral	1.5/2.0		2.6/3.2

Figure 2. Sitting posture on the wheelchair (Left: Pre-intervention, Right: Post-intervention)

Discussion

Trunk stability is a subconscious process in which the muscles actively fire in coordination to achieve balance and maintain optimal posture. Individuals with CP are unable to control these movements, which leads to functional impairments (Kim, An, & Yoo, 2018). In this case, the participant appeared to benefit from partaking in the constant spinning training for a 14-week period focused on improving trunk stability and dynamic balance. Startle reflex has also significantly decreased while sitting that has a positive impact on trunk coordination. The intervention with Allcore360 may produce different results than traditional trunk stabilization exercise because the 360 activates core muscles in all planes with a wide range of force required at varying angles to combat gravity. In another study using a 3D standing tilt machine, Shin et al. (2017) determined that as the inclination angle increased, the muscles opposing the tilt were facilitated for maintaining inclination without losing balance. The stability used to perform the training is maintained through the co-contraction of agonist and antagonist muscles as well as global surrounding muscles. Interestingly, in this case, the child was able to perform dissociated lower limb motions (Dimension B in GMFM-88) throughout approximately 25% of full range against gravity after the 14 weeks of post-intervention. This improvement can directly affect locomotion activity on bed and even transferring between bed and wheelchair.

Motor learning concepts were incorporated into the training procedure. In the early stages of the training, when the child was not skillful and could not correctly perform the isometric contraction during spinning, extrinsic feedback regarding task performance was used. She had a strong tendency to contract her hip flexors rather than abdominal muscles while the device tilted backward due to increases in lower limb muscle tone. We provided tactile and verbal cues to minimize the compensatory movement to ensure effective transverse abdominal muscle contraction before training and keep her feet pressing into the footrest during spinning. She was asked to keep her arms firmly crossed over her chest or as close to this position as possible to limit the impact of arm positioning. When the device tilts one side, she was required to put most of her weight on the ipsilateral hip and foot and isometrically push towards the opposite side to inhibit abnormal tone and facilitate more her oblique muscles. In addition to that, a target point was placed in the midline to keep looking at the point during the training. Research suggests that visual biofeedback is an appropriate method for improving balance, particularly in the early stages of motor learning (Yu, Shin, Jeong, Go, & Kwon, 2014).

Verbal encouragement was always given during the session to maximize the child's participation. As the child's trunk coordination improved, extrinsic feedback was provided on a faded schedule. After 7-weeks, we adjusted the protocol allowing increased use of intrinsic feedback and decreased reliance on extrinsic feedback. In response to perturbation in sitting during evaluation, the child demonstrated an improved ability to coordinate her core muscles without losing balance while sitting.

A significant limitation of this study is that this is a case report; therefore, we cannot conclude whether the intervention is effective for children with CP with a high level of functional disability. Further investigation should be needed to quantify and verify the positive result of the experiment. However, we believe that the intervention is feasible to conduct with children with CP, and it informs a possible design for future study.

References

Bartlett, D., & Birmingham, T. (2003). Validity and reliability of a pediatric reach test. *Pediatric Physical Therapy*. https://doi.org/10.1097/01.PEP.0000067885.63909.5C

Bax, M., Goldstein, M., Rosenbaun, P., Leviton, A., Paneth, N., Dan, B., … Damiano, D. (2005). Proposed definition and classification of cerebral palsy, April 2005. *Developmental Medicine and Child Neurology*. https://doi.org/10.1017/S001216220500112X

Chaze, C. A., McIlvain, G., Smith, D. R., Villermaux, G. M., Delgorio, P. L., Wright, H. G., … Johnson, C. L. (2019). Altered brain tissue viscoelasticity in pediatric cerebral palsy measured by magnetic resonance elastography. *NeuroImage: Clinical*. https://doi.org/10.1016/j.nicl.2019.101750

Davies, P. M. (1990). Problems Associated with the Loss of Selective Trunk Activity in Hemiplegia BT - Right in the Middle: Selective Trunk Activity in the Treatment of Adult Hemiplegia. In *Right in the Middle*.

ElBasatiny, H., & Abdelaziem, A. (2015). Effect of Trunk Exercises on Trunk control, Balance and Mobility Function in Children with Hemiparetic Cerebral Palsy. *International Journal of Therapies and Rehabilitation Research*. https://doi.org/10.5455/ijtrr.00000094

Hsieh, C. L., Sheu, C. F., Hsueh, I. P., & Wang, C. H. (2002). Trunk control as an early predictor of comprehensive activities of daily living function in stroke patients. *Stroke*.

https://doi.org/10.1161/01.STR.0000033930.05931.93

Kenyon, L. K. (2014). Gross Motor Function Measure (GMFM-66 and GMFM-88) Users' Manual,. *Physical & Occupational Therapy In Pediatrics*. https://doi.org/10.3109/01942638.2014.931744

Kim, D. H., An, D. H., & Yoo, W. G. (2018). Changes in trunk sway and impairment during sitting and standing in children with cerebral palsy. *Technology and Health Care*. https://doi.org/10.3233/THC-181301

Salavati, M., Rameckers, E. A. A., Waninge, A., Krijnen, W. P., Steenbergen, B., & van der Schans, C. P. (2017). Gross motor function in children with spastic Cerebral Palsy and Cerebral Visual Impairment: A comparison between outcomes of the original and the Cerebral Visual Impairment adapted Gross Motor Function Measure-88 (GMFM-88-CVI). *Research in Developmental Disabilities*. https://doi.org/10.1016/j.ridd.2016.10.007

Shin, J. W., Song, G. Bin, & Ko, J. (2017). The effects of neck and trunk stabilization exercises on cerebral palsy children's static and dynamic trunk balance: Case series. *Journal of Physical Therapy Science*. https://doi.org/10.1589/jpts.29.771

Shin, S. H., Kang, S. R., Kwon, T. K., & Yu, C. (2017). A study on trunk muscle activation patterns according to tilt angle during whole body tilts. In *Technology and Health Care*. https://doi.org/10.3233/THC-171308

Yu, C. H., Shin, S. H., Jeong, H. C., Go, D. Y., & Kwon, T. K. (2014). Activity analysis of trunk and leg muscles during whole body tilt exercise. In *Bio-Medical Materials and Engineering*. https://doi.org/10.3233/BME-130805

Appendix A

Incline degrees, Repetitions and training time for each session

Sets	1	2	3	4	5	6
Session 1: 1/14/2019						
Degrees	85	85				
Repetitions	10	10				
Time	4:50-5:30 pm (40 mins)					
Session 2: 1/18/2019						
Degrees	80	75	75			
Repetitions	10	10	10			
Time	4:45-5:50pm (65 mins)					
Session 3: 1/22/2019						
Degrees	80	75	75	70		
Repetitions	10	10	10	2		
Time	5:15-6:20pm (65 mins)					
Session 4: 1/28/2019						
Degrees	80	75	75	70		
Repetitions	6	10	10	4		
Time	4:45-6:10pm (85 mins)					
Session 5: 2/1/2019						
Degrees	80	75	75			
Repetitions	4	10	10			
Time	4:40-5:45 (65 mins)					
Session 6: 2/4/2019						
Degrees	80	75	75	70		
Repetitions	4	10	10	6		
Time	4:40-5:50 (70 mins)					
Session 7: 2/11/2019						
Degrees	80	75	75			
Repetitions	4	10	6			
Time	4:40-5:45 (65 mins)					
Session 8: 2/15/2019						
Degrees	80	75	75	70		
Repetitions	4	10	10	6		
Time	10:30-11:25 am (55 mins)					
Session 9: 2/18/2019						
Degrees	75	75	70	65		
Repetitions	10	10	10	1		
Time	3:10-4:40 pm (90 mins)					
Session 10: 2/22/2019						
Degrees	75	75	70			

Repetitions	10	10	10			
Time	4:45-6:10 pm (85 mins)					
Session 11: 2/25/2019						
Degrees	75	70				
Repetitions	15	15				
Time	4:37-6:03 pm (85 mins)					
Session 12: 3/1/2019						
Degrees	75	70				
Repetitions	15	15				
Time	4:35-6:00 pm (105 mins)					
Session 13: 3/4/2019						
Degrees	70	70				
Repetitions	5	5				
Time	4:40-5:05 pm (25 mins)					
Session 14: 3/8/2019						
Degrees	75	75	70	70		
Repetitions	5	5	5	5		
Time	3:30-4:10 pm (40 mins)					
Session 15: 3/11/2019						
Degrees	75	75	75	75	75	75
Repetitions	5	5	5	5	5	5
Time	4:30-5:30 pm (60 mins)					
Session 16: 3/15/2019						
Degrees	75	75	75	75	75	75
Repetitions	5	5	5	5	5	5
Time	4:45-5:45 pm (60 mins)					
Session 17: 3/18/2019						
Degrees	75	75	75	75	75	75
Repetitions	5	5	5	5	5	5
Time	4:35-5:35 pm (60 mins)					
Session 18: 3/22/2019						
Degrees	75	75	75	75	75	75
Repetitions	5	5	5	5	5	5
Time	4:45 - 5:50 pm (65 mins)					
Session 19: 3/25/2019						
Degrees	75	75	75	75	70	70
Repetitions	5	5	5	5	5	5
Time	4:35-5:40 pm (65 mins)					
Session 20: 4/1/2019						
Degrees	75	75	75	75	70	70
Repetitions	5	5	5	5	3	3
Time	3:30-4:20 pm (50 mins)					

Session 21: 4/5/2019						
Degrees	75	75	75	75	70	70
Repetitions	5	5	5	5	5	5
Time	10:00-11:00 am (60 mins)					
Session 22: 4/8/2019						
Degrees	75	75	75	75	70	70
Repititions	5	5	5	5	5	5
Time	4:30-5:15 pm (45 mins)					
Session 23: 4/12/2019						
Degrees	75	75	75	75	70	70
Repetitions	5	5	5	5	5	5
Time	4:40-5:45 pm (65 mins)					
Session 24: 4/15/2019						
Degrees	75	75	75	75	70	70
Repetitions	5	5	5	5	5	5
Time	4:45-5:50 pm (65 mins)					
Session 25: 4/19/2019						
Degrees	75	75	75	75	70	70
Repetitions	5	5	5	5	5	5
Time	4:45-5:55 pm (70 mins)					
Session 26: 4/22/2019						
Degrees	75	75	75	75	70	70
Repetitions	5	5	5	5	5	5
Time	4:40-5:40 pm (60 mins)					