



Effect of Sensory Integration Therapy on Foot to Foot Distribution during Gait in Children with Spastic Diplegia

Authors

Nahla M.Ibrahium¹, Nanees E Mohamed², Kamal Shoukry³, Hossam ElSabbagh⁴

Paediatric Department , Faculty of Physical Therapy, Cairo University

Corresponding Author

Nahla M.Ibrahium

Paediatric Department , Faculty of Physical Therapy, Cairo University

Tel: 0227273168 Mob: 01001937744

Email: drnahlamohamed@yahoo.com

ABSTRACT

Background: *The ability to walk is a major concern of the parents of children with cerebral palsy, and improving or maintaining this ability is often considered to be the primary focus of most therapeutic interventions addressing the motor problems seen in children with spastic diplegia.*

Purpose: *to assess the effect of sensory integration therapy on foot to foot distribution during gait in children with spastic diplegia.*

Subjects: *Twenty spastic diplegic cerebral palsy children were randomly divided into 2 groups 10 of each: Group A (control) and Group B (study), patients of both groups had received the traditional physical therapy program with sensory integration therapy was added to the gait training program for group B.*

Methods: *The Biodex gait trainer2 was used to assess foot to foot distribution for all patients pre and after 3 months of treatment.*

Results: *results revealed improvement in percent of foot to foot distribution for both groups but with significant improvement for the group B.*

Conclusion: *sensory integration therapy is effective in improving foot to foot distribution during gait for children with spastic diplegia.*

Keywords: *Spastic diplegia, gait, foot to foot distribution, Biodex gait trainer2, Sensory integration.*

INTRODUCTION

Cerebral palsy (CP) is a syndrome of non-progressive disturbances in the developing fetal or infant's brain. It is characterized by increased muscle activity to sustain posture, co-contraction of agonist/antagonist muscles, and restricted voluntary and selective control of movement which interferes with both the performance of functional activities, and the participation in leisure, community and school activities [1]. There are many categories and types of CP (spastic, hypotonic, athetoid and mixed type). The spastic type is the most common type of CP [2]. Spastic diplegic children have increased tone in their lower extremities while their upper extremities are usually affected to some degree less [3]. Diplegic children have difficulty in independent standing, they start walking with narrow base of support, cannot abduct their legs and cannot walk sideways also, they have no standing balance without support as their lower limbs show a mixed pattern of flexor and extensor spasticity that co-contraction makes balance difficult [4].

Children with spastic diplegia can walk independently but with abnormal pattern which may include deviations such as toe walking, flexed-stiff knees, flexed hips and an anteriorly tilted pelvis with lumbar lordosis. They walk at a reduced speed, with increased energy expenditure when compared with their peers [5]. In order to improve walking abilities in children with spastic diplegia, therapists usually emphasize on tone inhibiting maneuvers, balance training and gait preparatory tasks during crawling, sitting, and standing [6].

Gait represents the manner of walking. Formally it uses a repetitious sequence of limb motion to move

the body forward while simultaneously maintaining stance stability [7]. Walking is the most functional human movement. Therefore, gait impairment, or the inability to walk or walking with abnormal pattern constitutes a major challenge to professionals engaged in the rehabilitation of walking disabilities [8]. Typical walking has five attributes: Stability in stance, Sufficient foot clearance in swing, Appropriate pre-positioning of the foot for initial contact, Adequate step length and energy conservation [9].

Our senses help us to receive different sensory information from the body, environment and the surroundings that help the brain to receive these information and interpret them which help to organize a purposeful response [10]. Sensory integration refers to the ability of the brain to interpret external stimulus such as sight, sound, touch, movement and body awareness, then organize them into functional outcome. [11]. Sensory integration dysfunction occurs when a person's brain cannot organize sensory input messages from the skin, muscles and joints, inner ear and the environment. [12]. Sensory integration therapy helps children with learning disabilities to improve their sensorimotor skills, by combining different forms of sensation (vestibular, proprioceptive, and tactile stimulation) with motor activity during an individual therapy session that typically lasts 60 to 90 minutes. to elicit appropriate motor responses. [13]. Therapy is usually given in 1 to 3 sessions per week over several months or a few years [14].

In recent years, occupational therapists, speech-language pathologists, and psychologists have adopted the use of music and sounds as therapy, and a variety of auditory intervention techniques have become available. Occupational therapists use music as preparation for therapeutic activities on the basis of the belief that sensory input through the auditory and vestibular systems can be calming and organizing to children .(15) The aim of the present study was to evaluate the effect of sensory integration therapy on foot to foot distribution in children with spastic diplegia.

MATERIALS AND METHODS

2.1 Subjects

Upon approval of Cairo University's supreme council of postgraduate studies and research, Ethical approval was granted from the University ethical committee prior to the commencement of the study. Informed consent was obtained from all subject's parents following a verbal and written explanation of the study.

Twenty spastic diplegic cerebral palsy children of both sexes were divided randomly and equally into two groups: Group A and Group B Patients were selected from the outpatient clinic, Faculty of Physical Therapy, Cairo University. They were have the following criteria: Their age was ranged from ten to twelve years old, able to ambulate, had gait problems identified by GMFMCS (Level II or III According to Gross Motor Function Measure (GMFM)). They were have normal visual and auditory functions and able to follow the instructions, Their heights were 1 meter and more to be able to see the screen of the Biodex Gait Trainer

II TM. They had abnormal gait kinematics which was collected from assessment of gait kinematics by Biodex Gait Trainer II TM.

Exclusion criteria: They had no convulsions, had no history of surgical interference.

2.2 Instrumentation

2.2.1 for Evaluation

a. GMFCS

Children with spastic diplegia who were Level II and Level III according to GMFMCS were selected to participate in this study.

b. The Biodex Gait Trainer 2TM

The Biodex Gait Trainer 2TM is a device used to assess and train walking performance in patients with neurologic gait dysfunctions. It is composed of a treadmill with an instrumented desk that monitors and records kinematic gait parameters including: step length, walking speed and right-to-left time distribution, average step cycle, coefficient of variance and ambulation index [16].

2.2.2 for Treatment

a. Square Puzzle Mat

The square puzzle mat is a foam mat that is divided into equal squares which has different bright and contrast colours each square has a number from 0 to 9 (theses divided squares help the CP child to correct his step length, width and velocity by giving visual feedback during his walk). Different small rubber musical toys were added above the numbers on the mat to allow auditory feedback when the child press on it.

b. Square Musical Playmat

This musical playmat help the child to correct his gait pattern by visual feedback (different shapes of different colours :square,star, diamond, circle and

heart) and auditory feedback (pressing correctly on the target shape give sound telling the name of the shape to stimulate the child).

2.3 Procedure

Physical therapy exercise program:

Children of both groups had received the traditional physical therapy exercise program that include:

1-Gentle passive stretching to hamstring,calf muscles.

2-Facilitation of dynamic standing:

-From supin to sit to stand.

-From prone to quadribedto kneeling to stand.

3- Balance training exercises:

-Static balance exercises.

-Dynamic balance exercises

4-Stoops and recover from standing position.

5-Ascending and descending stairs

Children of the control group had received the traditional gait training exercises:

1. walk between barallem bar.
2. walk between barallem bar using stepper.
3. walk between barallem bar using seperator.
4. Walk from Physical therapist to parents using assistance.

Children of the study group had received gait training with sensory integration therapy:

Gait training with sensory integration therapy:

A- Square puzzle mat:

1-Gait training with visual feedback:

Children of the study group were allowed to stand on the square puzzle mat with each foot pressed correctly on each number then they were allowed to walk while looking at the mat and were asked to press their right foot on the next number and follow

it by the left foot .they were encouraged by the different colours of the different numbers.

2-gait training with visual and auditory feedback:

Children of the study group were allowed to stand on the square puzzle mat with each foot pressed correctly on each toy yhat was placed on the numbers then they were allowed to walk while looking at the mat and continue walking by pressing their feet correctly on the toys above the numbers (were asked to press their right foot on the next number and follow it by the left foot) .they were encouraged by the toy sound feedback when they press on them of the different numbers.

2.4 Data Analysis

All statistical measures were performed through the Statistical Package for Social Studies (SPSS) version 17 for windows, (SPSS, Inc., Chicago, IL). Prior to final analysis, data were screened for normality assumption, homogeneity of variance, and presence of extreme scores. This exploration was done as a pre-requisite for parametric calculations of the analysis of difference.

The researchers decided to conduct repeated MANOVs to compare each of the mean amplitude of foot to foot distribution in right and left foot (time in each foot in percentage) measured by Between control group (A) and study group (B). The MANOVs were conducted with the alpha level set at 0.05.

RESULTS

We enrolled 20 subjects into the study. Baseline characteristics of the subjects are shown in Table 1. No meaningful differences existed between groups at baseline. The mean age of all subjects was.....

Table 1: Demographic characteristics of subjects:

Characteristics Mean ± SD	Control Group Mean ± SD	Study Group Mean ± SD
Age (years)	7.505±0.424	7.465±0.386
Weight (kg)	26.8±1.32	26.65±1.79

Regarding the foot to foot distribution between right and left foot in control group (A) and study group (B) pre- and post- training period, statistical analysis revealed that there was insignificant effects of tested group on the dependent variable ($F=1.396$, $p=.253$). However, there was significant effects of the training periods on the dependent variable ($F=6.582$, $p=.019$). The pirwise comparison tests (Post Hoc tests) revealed that there was non-significant difference in control roup (A) pre- and post- training period ($p=.724$), however, there was a significant difference in study group (B) ($p=.004$). Table (2) presents the mean (SD) values of foot to foot distribution.

Finally, the pirwise comparison tests (Post Hoc tests) were then conducted to find the improvement. The study group (B) showed significant improvement when compared with the control group (A) ($p=.012$). It demonstrated a mean difference of 16.422, 31.935 (95% CI) for right and left sided respectively.

Table 2: Descriptive statistics of the mean values of foot to foot distribution in children with spastic diplegia:

	Foot to Foot Dtribution (in percentage)			
	Control Group (A)		Study Group (B)	
	Right Side	Left Side	Right Side	Left Side
Pre-training period	53.50 (18.16)	46.50 (18.16)	69.8 (22.90)	30.20 (22.90)
Post training period	51.50 (17.90)	48.50 (17.90)	51.60 (9.90)*	48.40 (9.91)*
Mean Difference (95% CI)	2		18.2	

(*) Significant at alpha level 0.05

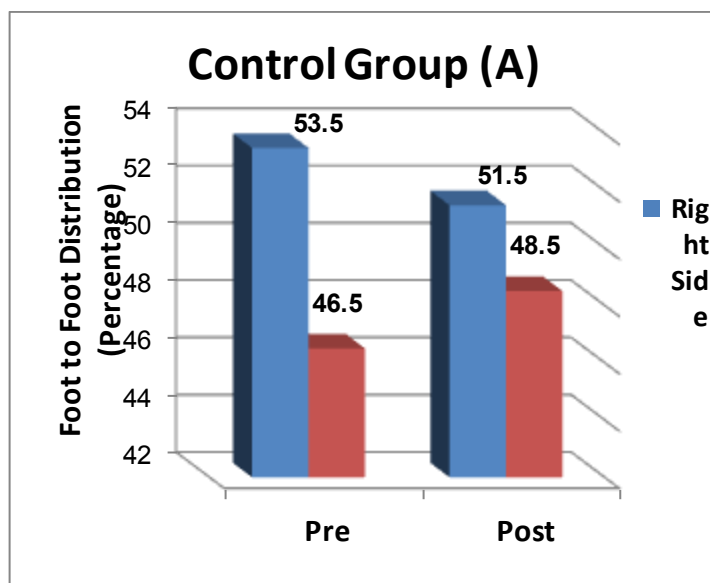


Fig (1): Mean values of foot to foot distribution pre- and post- training period in control group (A)

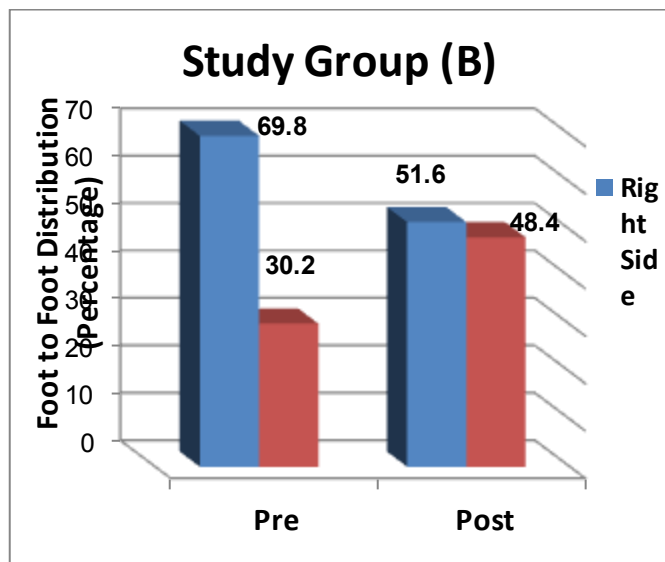


Fig (1): Mean values of foot to foot distribution pre- and post- training period in study group (B)

DISCUSSION

Studies in the published literature have shown that SI therapy programs have been used to facilitate motor functions. Each type of treatment (SI therapy or exercise) might be expected to yield different changes in motor performance. Because the SI therapy approach included goals of improving both gross motor function and postural stability, it may be that the treatment effects would be most obvious in the postural set used for gross motor function .(17).

Traditionally 5 sources of response-related input have been distinguished in relation to motor learning: 1) proprioceptive information, 2) tactile information, 3) vestibular information, 4) visual information and 5) auditory information. All these 5 sources are directly related to the actual execution of movement.(18).

Extensive musical training resulted in multi-regional changes in the brain (gray matter volume)..(19).

Even simple movements, repeated over a short period of time, are effective in inducing cortical representational changes (20).

Limitations:

Several limitations were identified in this study. A larger sample size would have been desirable.

CONCLUSION

In this study, it was concluded that sensory integration therapy (using visual and auditory feedback) is effective in improving foot to foot distribution time in children with spastic diplegia.

REFERENCES

1. Prosser LA, Lee SC, VanSant AF, Barbe MF, Lauer RT. Trunk and hip muscle activation patterns are different during walking in young children with and without cerebral palsy. *Phys Ther*; 90(7):986-97.
2. Soleimani F, Vameghi R, Rassafiani M, Akbar Fahimi N, Nobakht Z. Cerebral Palsy: Motor Types, Gross Motor Function and Associated Disorders. *Iran Rehabil J*. 2011;9:21-31.
3. Morrissy, R.T. and Weinstein, S.L. (2001): *Pediatric orthopedics*. Fifth edition, PP,741-750,565-575.
4. Damiano, D.L., Kelly, L.E. and Vaughn, C.L. (1995): Effect of quadriceps femoris muscle strengthening on crouch gait in children with spastic diplegia. *Phys.Ther*.75 (8):658-57.
5. Rodda JM, Graham HK, Carson L, Galea MP, Wolfe R: Sagittal gait patterns in

- spastic diplegia. *J Bone Joint Surg Br* 2004, 86:251–258.
6. Schindle-Ivens, S. and Shields, P.K. (2000): Low frequency depression of H-reflex in humans with acute and chronic spinal cord injury. *Exp Brain Res.*, 133:233-241.
 7. Ashutosh Kharb¹, Vipin Saini², Y.K Jain³, Surender Dhiman :A REVIEW OF GAIT CYCLE AND ITS PARAMETERS *IJCEM International Journal of Computational Engineering & Management*, Vol. 13, July 2011.
 8. Rowland, L. (2000).Gait disorders: In: Merritt's Neurology (Lippincott, ed). Philadelphia: Williams and Wilkins, 1st ed. Baltimore, New York, PP:45-50.
 9. Gage J (2004): A qualitative description of normal gait. In: Gage J (Ed.). *The Treatment of Gait Problems in Cerebral Palsy*. London: Mac Keith Press. PP: 42-70.
 10. Kranowitz, C. Koomar, J., and Szklut, S. (2005). *Answers to Questions Teachersask about Sensory Integration*. Las Vegas: Sensory Resources LLC. Kranowitz, C.S. 2003. *The Out-of-Sync Child has fun*. New York. The Berkley Publishing Group.
 11. -Heilbronner, P. Why "Sensory Integration Disorder" Is a Dubious Diagnosis. *Quackwatch*. May 1,2005.
 12. Heller, S. 2003. *Too loud too bright too fast too tight*. New York: Quill.
 13. Salokorpi T, Rautio T, Kajantie E, et al.(2002) Is early occupational therapy in extremely preterm infants of benefit in the long run? *Pediatr Rehabil*. 2002;5(2):91-98.
 14. Uyanik M, Bumin G, Kayihan H. (2003)Comparison of different therapy approaches in children with Down syndrome. *Pediatr Int*. 2003;45(1):68-73.
 15. Frick, S. M., & Hacker, C. (2001). *Listening with the whole body*. Madison, WI: Vital Links.
 16. Gharib N.M, AbdElMaksoud G. and Rezk-Allah S.S: Efficacy of gait trainer as an adjunct to traditional physical therapy on walking performance in hemiparetic cerebral palsied children: a randomized controlled trial, *Clin. Rehab*. 25: 924 – 934,2011.
 17. Mayston MJ (2001a) Setting the scene In: Edwards S, Ed, *Neurological Physiotherapy – a Problem Solving Approach* 2nd edition Churchill Livingstone (in press).
 18. (Schmidt RA and Lee TD (2005) *Motor Learning: A Behavioral Emphasis*, 4th edn. Champaign, IL: Human Kinetics.
 19. Gaser, C. & G. Schlaug. 2003. Brain structures differ between musicians and non-musicians. *J. Neurosci*. 23: 9240–9245.
 20. Classen J, Liepert J, Hallett M, Cohen L.(1999) Plasticity of movement representation in the human motor cortex. *Electroencephalogr Clin Neurophysiol Suppl* 51: 162–173.