www.jmscr.igmpublication.org *Impact Factor 3.79*
ISSN (e)-2347-176x

IGM Publication Journal Of Medical Science And Clinical Research
An Official Publication Of IGM Publication

Impact of Backward Gait Training on Mediolateral stability index in Children with Hemiparesis

Authors
Rania G.E. Abdou, Emam H. El-Negamy, Amena S. Hendawy
Department of Physical Therapy for Growth and Developmental Disorders in Children and its Surgery, Faculty of Physical Therapy, Cairo University
Corresponding Author
Rania G.E. Abdou
Department of Physical Therapy for Growth and Developmental Disorders in Children and its Surgery, Faculty of Physical Therapy, Cairo University
Mob: 01005046542
Email: *raniagalal2011@yahoo.com ,Rania.galal@pt.cu.edu.eg*

ABSTRACT
Background*: Children with hemiplegia suffer from many problem such as difficulty in balance because of poor muscle control of the arm and leg on one side of the body and the trunk may also be affected. The importance of balance can be seen in every aspect of daily living as: walking up and down stairs, bending over to tie shoes or even in standing still. Backward walking (BW) may offer some benefits especially in balance and motor control ability beyond those experienced through forward walking (FW), and may be a potential intervention for prevention of falls.*
Objective: *To investigate the impact of backward gait training using treadmill on Mediolateral stability index in hemiparetic C.P children*
Methods*: In this study, thirty hemiparetic C.P children of both sexes were classified randomly into two groups of equal number 15 patients each, (A&B); Group (A) represents the control group; children in this group aged from 5 to 7 years, received regular physical therapy program based on neurodevelopmental approach used for rehabilitation of such patients. Group (B) represents the study group; children in this group aged from 5 to 7 years, received the same regular physical therapy program applied on the control group in addition to 20 min backward gait training using treadmill. The rehabilitation program was conducted for both groups three times per week over a period of six successive weeks. Mediolateral stability index was assessed by using Biodex stability system for both groups conducted before starting*

physical therapy program, after 3 weeks and 6 weeks of treatment.
Results: *The result of this study revealed no statistically significant difference between the two groups before treatment and after 3 weeks of treatment. After 6 weeks of treatment there was significant improvement in the two groups. The results also showed significant difference between the two groups after 6 weeks of treatment in favor of the study group*
Conclusion: *These findings suggest that adding Backward Gait Training to the physiotherapy program improve Mediolateral stability index in Children with Hemiparesis.*
The outcomesof the study highlight the role of BW in improvement of balance in children with hemiparesis.
Key Words*: Backward Gait Training, Dynamic Balance, Hemiparetic Children*

1. INTRODUCTION

Cerebral palsy (CP) describes "a group of permanent disorders of the development of movement and posture, causing activity limitation that is 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, perception, cognition, communication, and behavior, also by epilepsy, and by secondary musculoskeletal problems.(1)

Hemiplegia is a condition involving paralysis or paresis of one side of the body. In child or infant hemiplegic cerebral palsy, there is damage to part of the brain and this may occur in utero, at birth, or later, as a result of accident, illness or pediatric stroke. Weakness of the one half of the body involving upper and lower limbs and trunk is sometimes known as hemiparesis, meaning a partial paralysis of one side of the body.(2)

“Balance” is defined as the ability to maintain equilibrium in a gravitational field by keeping the body mass centered over its base of support. It is also defined as the ability to react to destabilizing forces quickly and efficiently to regain stability via postural adjustments before, during, and after voluntary movement and in response to external perturbation. Balance, is maintained by the dynamic integration of internal and external forces and factors involving the environment.(3)

A recent device to assess and train the balance ability is the Biodex Stability System (Biodex, Shirley, NY), which is a force platform used to measure balance in response to externally imposed perturbation. They introduced the Biodex stability system, as a commercially available postural stability assessment and training system designed to stimulate joint mechanoreceptors and to promote reflex muscular activation necessary for joint stability.(4)

Changing the direction of locomotion from normal forward progression to backward is done rather readily by all people. In order to change the direction from forward locomotion to backward, the pattern of muscle activation has to be changed to produce a reversal of leg movement and propulsion in backward direction.(5)Walking backward is nearly a mirror image or time-reversed copy of walking forward. In an investigation of similarities and differences in forward and backward walking, it was found that backward walking was 95% reversal of forward walking..(6)

The aim of this study was to investigate the impact of backward gait training using treadmill on mediolateral stability index in hemiparetic C.P children. We hypothesized that there will be significant effect of backward gait training using treadmill on mediolateral stability index in hemiparetic C.P children.

2. MATERIAL AND METHODS

In this study, thirty hemiparetic C.P children of both sexes participated in this study. They were selected from out- patient clinic, Faculty of Physical Therapy, Cairo University. Patients were classified randomly into two groups of equal number fifteen patient each (A&B); their age ranged from 5 to 7 years chronologically and between 12 and 17 months developmentally according to Denver developmental screening scale.

To minimize motor variability, The Inclusive Criteria was as follows: Spasticity ranged from 1 to 1+ grade according to modified Ashwarth scale **(Bohannon and Smith, 1987).** Able to understands and follow verbal commands and instruction. Their heights not less than 1 meter to be able to see the screen of the Biodex system. They had balance problems collected from child history of repeated and frequent falling especially when increasing speed or walking on uneven surface.

Exclusive Criteria includedpatients with visual or auditory defects, patients with fixed deformities in either one of the lower limbs, patient with history of epilepsy, patient receiving anti spastic drugs and patients with history of surgical interference in the lower limbs musculoskeletal system,

The protocol of this study approved by the ethical committees of the faculty of physical therapy (Cairo University. Egypt). Following an explanation of the experimental protocols, writteninformed consent was obtained from all participant's parents.

To measure ML stability index, The Biodex balance system (Biodex Medical System, P.O.Box702, Shirley, NY 11967) was used in this study for evaluation of all children. Dynamic bilateral postural stability (Dynamic balance test), was used to assess stability index (SI) which is the child's ability to control the platform's angle of tilt.[7] At the end of test information regard to ML stability index was recorded which represent the child's ability to control his balance from side to side.

The rehabilitation program of control group (A)they received the regular physical therapy program for rehabilitation of such patients which includes Neuro developmental approach directed towards inhibiting abnormal muscle tone and abnormal postural reflexes and facilitation of normal movement patterns of postural control through reflex inhibiting positions using proximal and distal key points of control, approximation as a proprioceptive training applied in a slow and rhythmic manner for upper limbs, lower limbs and trunk to control spasticity and stimulate the joint mechanoreceptors from semi reclined and quadruped positions, training for active trunk extension to improve postural control and balance, balance training from different positions, from quadruped position, kneeling, half kneeling and standing position on mat and tilting board, facilitation of righting and equilibrium reactions to improve postural mechanisms via variety of exercises applied on ball and balance board through tilting from different positions in forward, backward and sideways, facilitation of protective reactions by applying fast and large amplitude of the stimulus to train saving reactions from sitting on roll, also from standing position by pushing the child to enhance the child to take protective steps either forward, backward or sideways to regain balance, gait training activities also will be important elements for balance training including training of walking on different floor surfaces (Spongy and hard surfaces) on mat, on the floor and on the carpets[8]

The rehabilitation program of study group (B) they received the previously mentioned physical therapy program in addition to backward gait training on treadmill by the following manner, in order to do treadmill training, initially the child performed a warm-up session for 5 minutes by walking on the treadmill at a self-selected speed and then they were given a 1-minute rest before

the training session started.[9] We should inform the child to start off slow, as this is a completely new sensation for him and it will take some time getting used to it. The child should take it slow and increase speed only when feeling comfortable, during the training session, the child walked backward on the treadmill at speed which is started from 1.2 up to 1.6 m/sec and when the child progresses speed could be increased. Instructions were given to the child to hold on to the rails while walking if they felt uncomfortable or losing balance.[10]duration of treadmill was 20 minutes for backward walking with rest periods about 5 min. between every 10 min.

3. RESULTS

In the control(group A) and study group(group B), the chronological age (mean+ standard deviation) were 6.17±1.22 and 6.0±0.91 years respectively suggesting no significant difference. Frequency distribution of the affected side in both groups (A and B) revealed that the distribution of right and left side in the groups were 66.7% and 33.3% respectively while for group B was 66.7% and 33.3% respectivelywhich reveal no significant difference..

Data were obtained from patients of the two groups (control and study) , statistically analyzed and compared with measurable variable[medio-lateral stability index]obtained before, after 3 weeks and 6 weeks of treatment; using unpaired T- test to detect level of significance between groups and one way ANOVA to compare variables within groups .

when comparing the pre-treatment and 3 weeks post treatment mean values concerning medio-lateral balance index for the two groups (A and B), the mean values± SD of group A were 2.29±0.69 and 2.26±0.71 (Degrees) and for group B 1.93±0.61 and 1.69±0.41 respectively which indicated no significant difference ($p > 0.05$).While when comparing6 weeks post treatment mean values ± SD of medio-lateral balance index for both groups (A and B) were 1.59±0.42 and 1.07±0.23 respectively. The difference between both groups in their 6 weeks post treatment mean values was significant ($p<0.05$).

Table (1): Pre & post 3 weeks of treatment mean values of medio-lateral balance index (Degrees) in group A

Item	X+SD	MD	% of change	T value	P value	Significance
Pre	2.29+0.69	0.36	15.72%	9.2	3.388	S
Post 3 weeks	1.93+0.61					

*Significant level is set at alpha level <0.05

$\overline{X}$: Mean SD: Standard Deviation.

MD: Mean Difference. P value: Probability value.

%: Percent. S: Significance.

Table (2): Shown the Pre and post 6 weeks of treatment mean values of medio-lateral balance index (Degrees) in group A

Item	$\bar{X}$±SD	MD	% of change	T value	P value	Significance
Pre	2.29±0.69					
Post 6 weeks	1.59±0.42	0.7	30.56%	7.75	3.706	S

Significant level is set at alpha level <0.05

$\bar{X}$: Mean SD: Standard Deviation.

MD: Mean Difference. P value: Probability value.

%: Percent. S: Significance.

As shown in table (1) in the control group (A); The pre and post 3 weeks of treatment mean values + SD of medio-lateral balance index were 2.29+0.69and 1.93+0.61(Degrees) respectively. The differences among pre and post 3 weeks of treatment mean values + SD of medio-lateral balance index was significant (P<0.05) with percent of change 15.72%, and as As shown in table (2) in the control group (A); The pre and post 6 weeks of treatment mean values + SD of medio-lateral balance index were 2.29+0.69and 1.59±0.42 (Degrees) respectively. The differences among pre and post 6 weeks of treatment mean values + SD of medio-lateral balance index was significant (P<0.05) with percent of change 30.56%

Table (3): Pre and post 3 weeks of treatment mean values of medio-lateral balance index (Degrees) in group B:

Item	X+SD	MD	% of change	T value	P value	Significance
Pre	2.26+0.71					
Post 3 weeks	1.69+0.41	0.57	25.22%	3.83	0.002	S

*Significant level is set at alpha level <0.05

$\bar{X}$: Mean SD: Standard Deviation. MD: Mean Difference.

P value: Probability value. %: Percent. S: Significance.

Table (4): Shown the Pre and post 6 weeks of treatment mean values of medio-lateral balance index (Degrees) in group B:

Item	X±SD	MD	% of change	T value	P value	Significance
Pre	2.26±0.71					
Post 6 weeks	1.073±0.23	1.19	52.52%	7.59	6.56	S

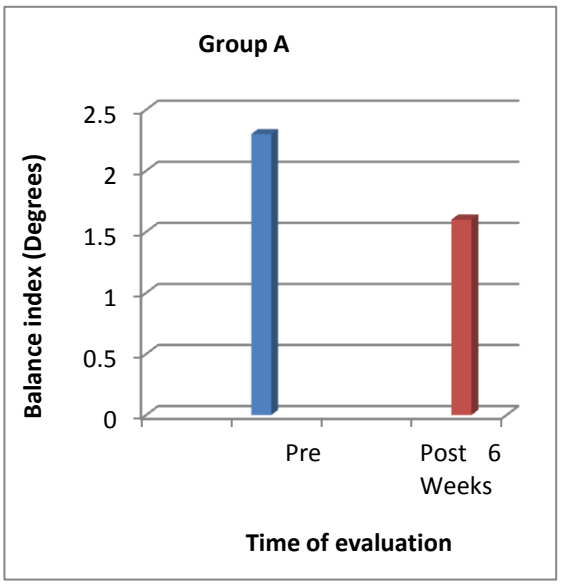
***Significant level is set at alpha level <0.05**

$\overline{X}$: Mean SD: Standard Deviation.

MD: Mean Difference. P value: Probability value.

%: Percent. S: Significance.

As shown in table (3) in study group (B); The pre and post 3 weeks of treatment mean values + SD of medio-lateral balance index were 2.26+0.71 and 1.69+0.41 (Degrees) respectively. The differences among pre and post 3 weeks of treatment mean values + SD of medio-lateral balance index was significant (P<0.05) with percent of change 25.22% ,and as shown in table (4) in study group (B); The pre and post 6 weeks of treatment mean values + SD of medio-lateral balance index were 2.26+0.71 and 1.073+0.23 (Degrees) respectively. The differences among pre and post 6 weeks of treatment mean values + SD of medio-lateral balance index was significant (P<0.05) with percent of change 52.52%.



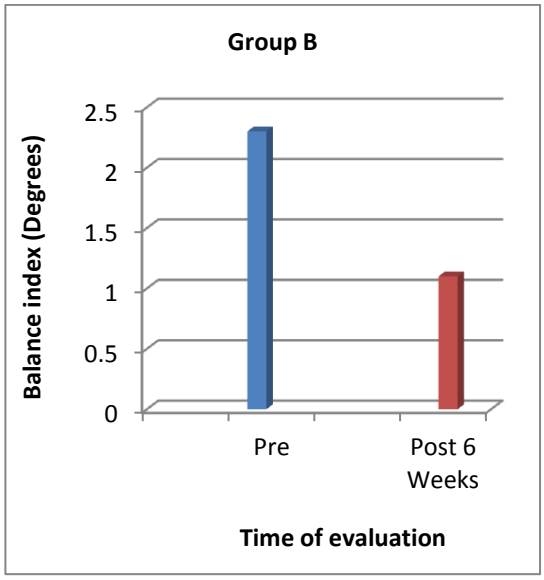


Figure.1 (A): Pre and post 6 weeks of treatment mean values of medio-lateral balance index (Degrees) in group A. **(B).**Pre and post 6 weeks of treatment mean values of medio-lateral balance index (Degrees) in group B.

4. DISCUSSION

Cerebral palsy children with hemiparesis often have difficulties maintaining their balance due to limb weaknesses leading to an inability to properly shift body weight. This makes performing everyday activities such as dressing, eating, grabbing objects, or using the bathroom more difficult.[11]

Spastic C.P children are usually associated with musculoskeletal abnormalities. Contractures secondary to spasticity or soft tissue abnormalities can restrict movement and therapy disrupt the efficacy of postural reactions, thus changes in musculoskeletal alignment and joint biomechanics can reduce the child's ability to exhibit adequate protective reactions. Adequate muscle strength is also necessary to produce joint stability and adequate equilibrium reactions, therefore conditions that result in diminished muscle strength (e.g., cerebral palsy) may be associated with deficits in postural control .[12]

The issue of the present study is to investigate the impact of backward gait training using treadmill on mediolateral stability index in hemiparetic C.P children.

The pre-treatment mean values of the dynamic balance test obtained from both groups regarding

the measuring variable (mediolateral stability index) revealed non-significant statistical difference ($p > 0.05$) in the measuring variable. These findings clearly demonstrate the homogeneity between the two groups before starting the study reflecting the validity of the sample collection and random classification of children between the two groups. The pre-treatment mean values of mediolateral stability index of the dynamic balance test, showed increase in their value which indicated that those children had balance problems.

When comparing the mean values before treatment for of the two groups, concerning medio-lateral balance index, the mean values ± SD were 2.29±0.69 and 2.26±0.71 respectively which indicated no significant differences ($P>0.05$), as the percentage of difference was (1.31%). When comparing mean values after 3 weeks of treatment for the two groups, the mean values ± SD were 1.93±0.61 and 1.69±0.41 respectively which indicated no significant differences ($P<0.05$), as the percentage of difference was (12.43%). When comparing the mean values after 6 weeks of treatment for both groups, the mean values ± SD were 1.59±0.42 and 1.07±0.23 respectively which indicated significant differences ($P<0.05$), while the percentage of difference was (32.70%).

This improvement in mediolateral stability index of study group after 6 weeks of backward gait training can be attributed to the effect of the backward gait training using treadmill which can be explained on the basis that there are many systems within the body that work in concert to move the center of mass (COM) in relation to the base of support (BOS) in a controlled manner when engaged in dynamic tasks .[13]There are three primary systems involved for the balancing process: (1) the sensory system (visual, cutaneous and proprioceptive, and vestibular senses), which gives feedback to alter the balance action during a voluntary motor task, (2) the motor system, which creates the coordinated movement to maintain balance, and (3) the biomechanical system or musculoskeletal system, which includes the muscles that create the movement torques and the bony and joint frame on which movements are made ,all those three systems may be associated with the improvement of balance by BW exercise.[13]Children rely more on visual cues than the other sensory cues .[14], but children can reweight the three afferent cues since 3 years old in order to maintain balance, and this multisensory reweighting increases with age in children .[15]During BW, the visual cues doesn't provide the child with the visual information necessary to anticipant ground condition, and motor pattern are unconventional, the children have to reorganize and adapt the changed information from visual, cutaneous and proprioceptive, and vestibular senses, and then enhance the movement control to maintain dynamic balance .[16]

The improvement in the measured parameters can be also attributed to the mechanical and neural responses to backward walking were based on two primary modifications: a reduction in hip movement which probably increases stability by minimizing the anterior-posterior displacement of the center of gravity, and a shorter absolute swing / stance duration. They also noted that plantar flexion and doriflexion angles were greater during forward than backward walking. This marked change in ankle movement altered the functional demands placed upon the ankle joint. These modifications imply differential effects of afferent input on the neural circuits controlling ankle movements in comparison to the mechanical aspect of the movements affecting the hip and knee joints. This alteration at ankle joint influences proprioceptive responses during backward walking as compared to forward walking.[17]

CONCLUSION

From the obtained results of this study, it can be concluded that Backward Gait Training on

Treadmill can be used to improve mediolateral stability index in Hemiparetic Cerebral Palsy Children; so, it can be added to the active physiotherapy program to improve Dynamic Balance in Hemiparetic Cerebral Palsy Children.

REFERENCES

1. **Rosenbaum P, Paneth N, Leviton A, Goldstein M, Bax M, Damiano D, Dan B and Jacobsson B (2006):** A report: the definition and classification of cerebral palsy. Dev Med Child Neurol. 49:8–14.
2. **CHASA (2009):** Children's Hemiplegia and Stroke Association. www.chasa.org.AccessedAugust 2010**.**
3. **Cetin, N., Bayramoplu, M., and Aytar, A. (2008):** Effects of lower extremity and trunk muscle fatigue onbalance. The Open Sports Medicine Journal, 2:16-22.
4. **Maxwell, P., De camposb, T., Marcelo, B., and Jefferson, R. (2008):** Influence of knee position on the posturel stability index registrated by the Biodex stability system. Gait Posture, 28(4):668:672.
5. **Andrea, N.L., Hass, C.J., & Gregor, R.J. (2007):** The effects of sloped surfsces on ocomotion:Backward walking as a perturbation. J Biomech, 40:3050-3055.
6. **Winter, D.A., Plauck N., & Yang, J.F. (1989):** Backward walking a simple reversal of forward walking? Motor Behav, 21:291-305
7. **Hamman, R. G., Mekjavic, I. A., Mallinson, A. I., and Longridge, N.S. (1992):** Training effects during repeated therapy sessions of balance training using visual feedback. Arch Phys Med Rehabl. 73: 738-744.
8. **Levitt S. (2004):** Treatment of cerebra; palsy and motor delay, 2nd ed. Black well scientific publisher, London.
9. **Spendiff, O., Longford, N.T.,&Winter, E.M (2002):** Effects of fatigue on the torque velocity relation in muscle. Br J Sports Med., 3(6):431-435.
10. **Li, J.X., &Hong, Y (2007):** Kinematics and electromyographic analysis of trunk and lower limb during walking in negatives heeled shoes. J Am Podiat Med Assn., 97(6):447-456.
11. **O'Sullivan J. and Susan B. (2007).** "Chapter 18 - Stoke". In Susan B. O'Sullivan and Thomas J. Schmitz. *Physical Rehabilitation, 5th edition*. Philadelphia, PA: F.A. Davis. pp. 746.
12. **Niam and Andreson (1999|):** Balance and Physical impairment after stroke. Arch. Phys. Med, Rehabil, 80, PP: 1227-1233.
13. **Westcott, S.L., Lowes, L.P., and Richardson, P.K (2007):** Evaluation of postural stability in children: current theories and assessment tools. Phys Ther., 77(6): 629-645.
14. **Sparto PJ, Redfern MS, Jasko JG, Casselbrant ML, Mandel EM and Furman JM. (2006):** The influence of dynamic visual cues for postural control in children aged 7-12 years. Exp Brain Res 2006, 168:505-516.
15. **Bair WN, Kiemel T, Jeka JJ and Clark JE (2007):** Development of multisensory reweighting for posture control in children. Exp Brain Res , 183:435-446.
16. **Nadeau S, Amblard B, Mesure S and Bourbonnais D (2003):** Head and trunk stabilization strategies during forward and backward walking in healthy adults. Gait & Posture, 18:134-142.
17. **Flynn, T.W., and Soutas- little, R.W (1993):** Mechanical power and muscle action during forward and backward running. J Orthop Sports Phys Ther, 17: 108-112.