Original Article

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Effect of Balance Training on Balance Control and Gait in Hemiplegic Stroke Patients

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Abstract

Objectives: 1. To study the effect of balance training on balance control of Hemiplegics. 2. To study the effect of balance training on gait in Hemiplegics. *Materials and Method*: Thirty hemiplegics were selected and divided into two groups of 15 each. Control group received conventional training and Experimental group received conventional training along with phyaction balance training.Duration of treatment was 30 minutes, five days a week for four weeks. Pre and post training evaluation of Berg Balance Scale (BBS), Wisconsin Gait Scale (WCS), and Global Balance performance Anteroposterior (GBAP), Global Balance performance Mediolateral (GBML) was done for both the groups. Statistical analysis was done by t test. *Result:* Statistically significant improvement was seen in all the outcome measures in experimental group and no significant improvement was seen in case of control group which shows that balance exercise is effective in controlling balance in hemiplegics and has an improvement in gait. *Conclusion:* Balance exercise is effective in controlling balance of Hemiplegics. So Phyaction balance training should be incorporated in the rehabilitation of Hemiplegics.

Keywords: Balance Training; Fedback; Gait; Hemiplegics.

Introduction

Hemiparesis is the most frequent neurological deficit after stroke. Hemiparetic stroke patients frequently present balance abnormalities. Balance impairments increase fall risk, resulting in high economic costs and social problems [1]. Balance is defined as a complex process involving the reception and integration of sensory inputs, planning and execution of movements, to achieve a goal requiring upright posture [2]. Hemiplegics have decreased trunk control, poor bilateral integration and impaired automatic postural control resulting in balance dysfunction [3].

Three sensory modalities are mainly involved in postural control: somatosensory, visual, and vestibular afferents. Integration of information from these systems is crucial for adequate postural control. Sensory information is regulated dynamically and modified by changes in environmental conditions [4]. When one is standing on an unstable surface, for instance, the central nervous System (CNS) increases sensory weighting to vestibular and visual information and decreases the dependence on surface somatosensory inputs for postural orientation. The ability to analyze, compare, and select the pertinent sensory information to prevent falls can be impaired in hemiparetic stroke patients. In patients with stroke, balance impairments and decreased ankle proprioception are positively correlated [4-6]. Abnormal interactions between the three sensory systems involved in balance could be the source of abnormal postural reactions [7-8] .

In situations of sensory conflict, a patient with stroke can inappropriately depend on one particular system over another [7] . Laboratory measurements of sensory organization demonstrate that patients with chronic stroke perform worse in conditions of altered somatosensory information and visual deprivation or inaccurate visual input. Excessive reliance on visual input may be a learned compensatory response that occurs over time [4]. Relying on a single system can lead to inappropriate adaptations and, hence, balance disturbances .

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Furthermore, sensory integration and reweighting can be impaired in patients with stroke, emphasizing visual input even when it provides inaccurate information[4,9-11]. The CNS has an internal representation of stability limits and uses it to determine how to move and maintain balance . In hemiparetic patients, weakness and impaired muscle control of the affected lower limb, decreased range of motion, and pain can lead to changes in the base of support (BS) [12] .

Luciana Barcala et al (2013), conducted a study on Visual Biofeedback Balance Training Using Wii Fit after Stroke.The aim of the study was to investigate the effect of balance training with visual biofeedback on balance, body symmetry, and function among individuals with hemiplegia following a stroke. The therapy program led to an improvement in body symmetry, balance, and function among stroke victims [13].

Soo Jeong Han et al (2013), studied the effect of rhythmic auditory stimulation(RAS) on gait and balance in hemiplegic stroke patients,The results of this study showed that RAS was an effective therapeutic method to improve gait velocity, stride length, cadence, and standing balance in hemiplegic stroke patients [14].

Damayanti Sethy, et al (2009) , in their study on the Effect of balance exercise on balance control in unilateral lower limb amputees,where the experimental group received conventional training along with phyaction balance exercises.They concluded that early phase exercises is effective in controlling balance of unilateral lower limb amputees [15].

Chun Chen et al, (2002) conducted a study on Effects of Balance Training on Hemiplegic Stroke Patients, total of 41 ambulatory hemiplegic stroke patients were recruited. Visual feedback balance training with the SMART Balance Master was used in the trained group. After 6 months of training Dynamic balance function of patients in the visual feedback training group had significant improvements when compared with the control group [16].

David Levine et al (1996), performed the Test-retest reliability of the Chattecx Balance System in the patient with Hemiplegia The results using the testing protocol showed COBX(center of pressure of mediolateral direction) to be highly reliable for the static and moderately reliable for linear and angular testing protocols [17].

Traditional balance training is based on the automatic repetition of specific movements. These methods can become repetitive and aimless, and thus reduce the motivation and adherence to treatment.

Given this background of the dynamics of balance, postural control and adaptation and the deficits in these areas among ambulatory hemiplegics, it was postulated that the balance training in ambulatory hemiplegics with Phyaction balance may be a useful exercise and may result in better out comes.

The aim of this study is to evaluate the effect of balance training on balance control and gait in ambulatory hemiplegics .

Aims and Objectives

1. To study the effect of balance training on balance control in ambulatory hemiplegics.
2. To study the effect of balance training on gait in ambulatory hemiplegics.

Materials and Method

The study was conducted in the Department of Occupational Therapy, at National Institute For Locomotor Disabilities on an outpatient basis, on a convenience sample.

Participants

A total of 30 subjects,equally divided to experimental and control group (28 males, 2 female; 20 left hemiplegia, 10 right hemiplegia) secondary to unilateral cerebro vascular accident were tested. Subjects were of age ranging from 40 to 60 years.Time since the onset of hemiparesis ranged from 12 months to 30 months. Subjects were medically stable and their secondary illnesses such as hypertension and diabetes mellitus were under control.

To qualify for this study hemiparetic subjects were required to meet the following criteria,

1. Understand instructions and be oriented to name, time and place.
2. No history of Orthopedic, Vestibular and other neurological conditions.
3. No perceptuo – cognitive deficits like hemispatial neglect, attention, and memory deficits.
4. No wernicke's or global aphasia.
5. Voluntary movements at the hip, knee and ankle present at >3 of Brunnstrom's stages in affected lower limb.
6. Functional and community ambulators with or

without ankle foot orthosis and cane. Before the investigation and assessment, the objectives and design of the study were explained to all subjects.

All subjects gave informed consent and took part in the experiment on a voluntary basis.

Materials

Phyaction balance exercise version 2.0, October 2005.

Laptop and connecting cables.

Apparatus

Phyaction balance exercise is an apparatus having a balance exercise soft ware installed in the personal computer/Laptop and a hard ware (Proprioceptive board/tablet) attached to it with a connecting cable. The apparatus is fitted with an internal electrical supply. The Board is of moving fulcrum type. The fulcrum changes with the changes in the board position. The board rolls on the balancing shapes that have a suitable diameter. Three pairs of interchangeable shapes are available. The board is attached with an encoder that detects its position. The encoder is operated through a lever that is in contact with the floor. The encoder is connected to an electronic card that reads the angle of the board top surface with respect to the floor on which the board rests and sends the reading to the PC through a USB port. The interface graphics of the tablet were designed by using the interactive graphic controls that are typical of the Windows operating systems.

- Dimensions: 420x430x65mm
- Weight 2.5Kg
- Maximum patient's weight: 100Kg
- Movement range:- -15,+15degrees

The equipment provides perturbation along with auditory and visual feedback.

Outcome Measures

Each participant underwent a clinical evaluation including the

1. Berg Balance Scale (BBS),
2. Global balance performance Anteroposterior (GBAP) and Mediolateral (GBML).
3. Wisconsin gait scale.

Experimental Procedure

After completing the evaluation procedure, Balance training was given to the experimtental group as seen in Figure 1 along with the conventional therapy and control group was given only conventional therapy.

Duration of Balance Training

30 minutes a day, five times a week for four weeks

Procedure

The hemiplegic patients who fit the inclusion criteria were allotted to two groups by convenient sampling method after getting informed consent. A general history was taken from the patient and individual patient demographics along with date of onset were saved in the data sheet . Baseline measurement of WCS, BBS, GBAP and GBML stability control were taken. Global performance is weighed average (a number from 0 to 100) of the 8 calculated parameters. The parameters are total area covered within the profile, Extra area outside the profile, Extra time taken and Recovery time. A score of 100 is the worst case and zero is the best. Experimental group received Phyaction balance training with conventional training and control group received conventional training only, which consisted of wobble board, single limb stance ,step up and step down activity walking on a straight line.

Phyaction Balance Training

On the first day of training level of balance training performance of the patients' was evaluated. Patients' stood erect on the moving Board with their hands alongside their bodies. Patients' were instructed to stand with both feet on the floor as motionless as possible to maintain balance while the board sways over a diameter of 40 centimeter both in ML and AP direction. For safety purpose one therapist stood nearby the patient. The movement of the board was set in the exercise program for individual patients. Feet position selected for the patient was bilateral, position of the patient was standing, and Board heading was straight for ML balance control training and transversal for AP balance training. Graphic presentation of the exercise was set complete which will show the board and the graphic presentations on the screen. Each patient got both visual and auditory feedback from the screen. The amplitude and frequency of movement was set to be 3 degrees and 3 cycles/min respectively. Patient was asked to stand on the Proprioceptive board and the program was set starting from level one exercise. If the patient could do level-1 without any error then the next level of exercise was done. Initially most of the patients could do balance level two, so the exercise was set starting from balance level-3 and progressed to the next levels as the patient's ability to control balance progressed without covering extra area. With the improvement of the patient's ability the level of difficult was increased. All the patients in the Experimental group received 15 minutes of medio-lateral balance control exercise and 15 minutes of antero-posterior balance control exercise. Each 15 minutes were divided into 5 sets of exercise of 3 minutes each set. After each three minutes of exercise patients received 1 minute rest. Each patient received anteropostero balance control exercise after completing 15 minutes of medio-lateral exercise in the same manner. Exercise performance was noted on initial evaluation and after 4 weeks of training.

Results

Paired t- test was used to analyze the data within each group and Un-paired t test was used to analyze the data between the two groups. Result was considered significant at $p<0.05$. Data was analyzed by using SPSS software version 21.0

Table 1 (Demographic Data) shows the distribution of patients in Experimental Group (phyaction balance training) and Control Group (Conventional Occupational Therapy group). Graph 1 shows the mean age.

The table 2 and Graph 2 shows the GBAP it shows significant improvement in balance in the experimental group as compared to the control group in the between group analysis after 4 weeks. P value is significant(0.029).

Table 3, and Graph 3 shows the GBML it shows significant improvement in balance in the experimental group as compared to the control group in the between group analysis after 4 weeks. P value is significant (0.006)

In Table 4 and Graph 4, the BBS shows significant improvement in balance in the experimental group as compared to the control group in the between group analysis after 4 weeks. P value is significant(0.000)

The table 5 and Graph 5, depicts that the WCS shows significant improvement in balance and gait in the experimental group as compared to the control group in the between group analysis after 4 weeks. P value is significant (0.019).

Table 1: Baseline characteristics

Sl. No	Baseline Characteristics	Experimental Group	Control Group
1	Number of subject	15	15
2	Age (Range)	17-79 years	17-79years
3	Age (Mean ± SD)	43.2±15.6 years	43±12.99 years
4	Gender (Male/Female)	14/1	14/1

Table 2: Between Group Post of GBAP

GBAP	Mean (SD)	P value
Experimental Group	91.62±44.25	0.029
Control Group	133.68±69.32	

Table 3: Between group analysis GBML

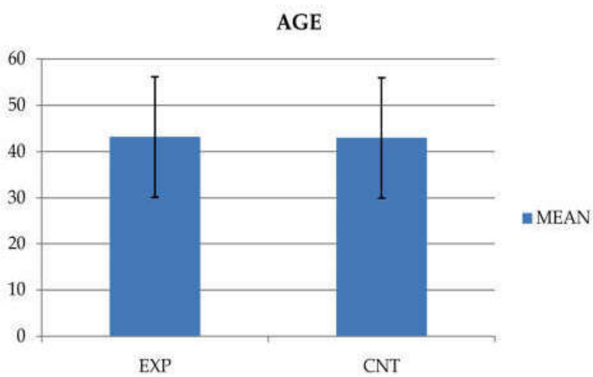
GBML	Mean(SD)	P value
Experimental Group	75.73±38.53	
Control Group	131.37±69.40	0.006

Table 4: Between group analysis of BBS

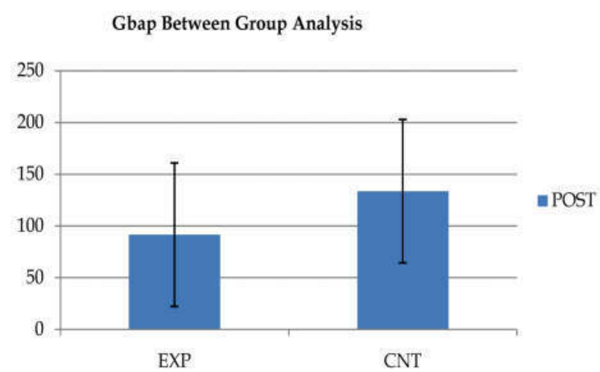
BBS	Mean (SD)	P value
Experimental Group	45.27±3.82	0.000
Control Group	37.93±3.24	

Table 5: Between Group Analysis WCS

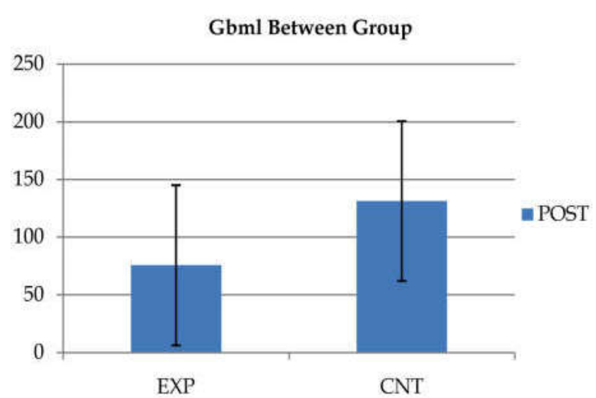
WCS	Mean(SD)	P value
Experimental Group	24.67±4.32	0.019
Control Group	24.67±7.24	



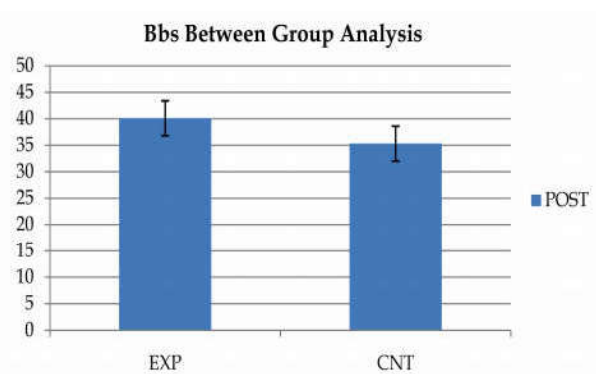
Graph 1: Mean Age



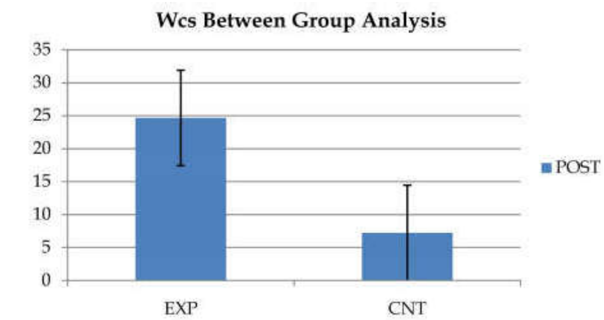
Graph 2: Between Group Post of GBAP



Graph 3: Between Group Analysis GBML



Graph IV: Between Group Analysis of BBS



Graph 5: Between Group Analysis WCS

Fig. 1:

Discussion

The result of the study showed that there is a significant improvement in, balance control (BBS), and the (GBAP), (GBML), and gait (WCS) in the experimental group and no significant improvement in these outcome measures in the control group**.** The subject showed significant results in balance control (BBS) ($p= 0.000$), and for GBAP ($p= 0.029$) and GBML ($p=0.006$) was significant in experimental group.

The phyaction balance board has auditory cues and visual feedback. The post Phyaction Balance training, balance control improved in hemiplegics which is similar to the findings of a study by Michael W. Kennedy et al, in their study Enhanced Feedback was given using the Nintendo Wii Balance Board[18]. Improvement in balance is also corroborated in a similar study by Damayanti et al, in the study phyaction balance exercise was administered to unilateral lower limb amputees ,and concluded early phase balance exercise is effective in controlling balance [15].

Visual feedback based on objective data is one option to improve the efficacy of balance rehabilitation in stroke patients, and the use of visual center of pressure (COP) feedback as measured with a force plate has been a topic of balance retraining research since the mid-1980's [19]. A number of studies have demonstrated that providing visual feedback yields improvements in postural sway [19,20], symmetry [21-23], dynamic balance [24] , and functional abilities[25]. Change in the post training score on Berg Balance Scale is in agreement with the study by Garland, Williams in Recovery of standing balance and functional mobility after stroke where all subjects showed an improvement in functional balance(BBS) over the course of 1 month of rehabilitation resulting in an increased gait speed [26].

It is thought that training on phyaction balance board provided the patient with proprioceptive feedback at each challenge level. This is supported by the study "Relationship of Sensory Organization to Balance Function in Patients with Hemiplegia "by Richard Fabio, Mary Badke who found that balance behaviour can be influenced by somatosensory, visual and vestibular system [27].

The significant results in the experimental group for improvement in gait (WCS) (P = 0.019), is supported by Prassas et al, the study results suggest that acoustic rhythmic signals facilitate the audio-spinal mechanism in the CNS, exerting positive effects on motor activities including gait [28]. Also Horak et al, stated that medial-geniculate nucleus related to the vestibular system in ears mainly affects on standing balance. As auditory stimulation reaches to the organ of Corti, the signal is transmitted to medial geniculate nucleus. Then, the signal reaches to the auditory cortex in the temporal lobe. This activates the vestibular system to improve the standing balance.Following stroke, postural deficits are common . In the hemiparetic gait there is reduced weight-bearing on the paretic limb [29].

The results of the study are supported by another study by Portugal et al. The authors conducted a study on Rehabilitation of postural stability in ataxic/hemiplegic patients after stroke, disability rehabiliataion [30]. The results suggest that a training programme using force platform visual biofeedback improves objective measures of bilateral postural stability in patients with hemiplegia and/or ataxia after stroke. The results are also corroborated by another study done by Ledebt et al, Balance training was given with visual feedback in children with hemiplegic cerebral palsy to the effect on stance and gait [30].

Shumway-Cook et al showed that postural sway biofeedback was more effective than conventional therapy in retraining postural stability in hemiplegic patients.[31].Srivastava et al, in a prospective study, trained the balance on a force plate with visual feedback and verified an improvement in the rate of BBS and stabilometry, that lead to the functional independence observed through the scores of Barthel Index. In the current research also, significant results was obtained on BBS scores [32].

The repercussion related to the CNS recurring from the Stroke change the posture reactions endangering significantly the daily activities, what makes the training of the postural control a fundamental strategy for the rehabilitation of these patients [32-35].

Reesults of study is also supported by Hocherman et al,they concluded that the hemiplegic patients stability of stance on a moving platform could be improved by regular training [36].

However this study has limitations. Limitations of this study are the reduced number of patients and the use of the same instrument for assessment and training. This study has a heterogeneous sample due to various types of stroke, different impairments and different times since stroke, with most patients in a chronic phase. More studies with homogeneous groups of patients are needed.

In conclusion, the results suggest that a training programme using Phyaction Balance Board with visual biofeedback and auditiory cues improves objective measures balance and gait in hemiplegia after stroke, even in a chronic phase when significant motor recovery or neurological gains are not expected.

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