DOI: 10.7860/JCDR/2019/40001.12834

Original Article

Internal Medicine Section

Effectiveness of Dynamic Balance Training with and without Visual Feedback on Balance in Ambulatory Stroke Patients

KHUSHBOO C VALODWALA[1], ANJAN R DESAI[2]

ABSTRACT

Introduction: Stroke is one of the most common neurological disorders leading to chronic disability. Following stroke, patients lose functions of the motor, sensory and higher brain cognitive abilities to various degrees which lead to diminished balance. Balance can be improved with the help of various interventions.

Aim: To compare the effectiveness of conventional physiotherapy, wobble board training with and without visual feedback and also check the effectiveness of individual training in ambulatory stroke patients.

Materials and Methods: In the present experimental study, total of 51 patients were included; 17 patients per group with Berg Balance Score (BBS) of 41-56, Brunstrom's recovery stage of 3 or above for the lower limb and Mini Mental Scale Examination (MMSE) score of 24 or more. They were randomly allocated in three groups. Subjects were asked to perform set of exercises for five days a week with total duration of four weeks. Pre and post intervention assessment was carried out by using BBS and Timed Up and Go (TUG). Paired t-test was used within group comparison; ANOVA and post-HOC were applied between the groups.

Results: All the three interventions were effective for balance training. All the groups had a significant change for both outcome measures following four weeks of interventions, with $p<0.05$. The third group showed a significant improvement in balance compared to the two other groups, with $p<0.05$. The wobble board with visual feedback proved to be significantly effective.

Conclusion: This study concludes that all the three interventions are effective, but wobble board training with visual feedback (Sensamove Miniboard) is more effective for balance training than other two interventions.

Keywords: Sensamove miniboard, Visual feedback, Wobble board

INTRODUCTION

"Stroke is an acute onset neurological dysfunction caused due to abnormality in cerebral circulation with resultant signs and symptoms that correspond to involvement of focal areas of brain" [1]. According to WHO stroke is "a focal (or at times global) neurological impairment of sudden onset, and lasting more than 24 hours (or leading to death) and of presumed vascular origin" [2]. Following stroke, patients lose functions of the motor, sensory and higher brain cognitive abilities to various degrees which lead to diminished balance. Studies proved that hemiplegic or hemiparetic stroke patients present with more posture sway, asymmetric weight distribution, impaired weight-shifting ability and decreased stability capability [3-7].

Balance is defined as a "complex process involving the reception and integration of sensory input, planning and execution of movement to achieve a good upright posture" [8]. 'Practicing of balance' is one of the most frequent and important physiotherapeutic interventions in inpatient rehabilitation facilities [9,10]. Even if the survivors of stroke are ambulatory, there is an increased risk of falling mainly on paretic side, difficulty in walking on uneven terrain and difficulty in using public transport. Bobath described "walking as a constant losing and regaining of balance" [11].

By using various interventions, we can improve balance in stroke patients. For the same purpose we can train them with Conventional physiotherapy, Wobble board without visual feedback [12] and Wobble board with visual feedback (Sensamove Miniboard) {in which SMART Balance Master was used [13]}. This training improves balance and optimises function and mobility in stroke patients. Training on an unstable surface rather than a stable surface can generate more external sway, thus improving postural control ability [14].

The Berg Balance Scale (BBS) measures both static and dynamic aspects of balance [15]. BBS is 14 item scale that quantitatively assesses balance and risk for falls. A global score is calculated out of 56 possible points. The BBS is a psychometrically sound measure of balance impairment which can be used in post-stroke assessment. Timed Up and Go (TUG) test is also an objective measure of basic mobility and balance maneuvers; which assesses the ability to perform sequential motor tasks relative to walking and turning. TUG scale measures the physical agility [6]. The TUG requires subjects to stand up from a chair, walk a distance of three meters, turn around, and walk back to the chair and seat themselves [16].

However, there are very few studies in the literature which find effectiveness of dynamic balance training with visual feedback to improve balance in ambulatory stroke patients. So the objectives of the study was to compare the effectiveness of conventional physiotherapy, wobble board training with and without visual feedback and also check the effectiveness of individual training in ambulatory stroke patients.

There had been very few studies that show improved balance in ambulatory stroke patient, with help of visual feedback [12,13]. Hence, the significance of this present study would be whether with or without visual feedback training with wobble board would show effect on balance or not.

MATERIALS AND METHODS

In the present experimental study, total of 51 patients were included. Subjects were taken from SPB Physiotherapy College OPD and selected by purposive sampling method. This study was conducted from December 2017-March 2018 and completed with 51 ambulatory stroke subjects. Seventeen subjects in each group were allocated. Ethical clearance (G/MPT/OO3) was taken

from the institutional committee. The purpose of this study was explained and a written informed consent was obtained from all the subjects. Subjects were allocated on the basis of the inclusion and exclusion criteria and their demographic data was collected. Sample size calculated was 42, with a drop out chances of 20%.

Inclusion and Exclusion Criteria

Subjects having 45-75 year age, first episode of cerebrovascular stroke, diagnosed according to Brunnstorm's recovery stage 3 or higher than 3, with post-stoke duration of 6 to 18 months and Mental competency (>=24) through Mini Mental Scale were included in the study. The subjects must have BBS score 41-56 and ability to walk independently for 10 meter with or without assistance. Subjects with any neurological deficit other than stroke, sensory disorders affecting balance, any known perceptual disorders including vision has been excluded from the study. Subjects have also been excluded if they had musculoskeletal disorders of lower extremity leading to instability or pain, any known cardiovascular disorders or any surgery or trauma in lower limb in the past six months.

Subjects were asked to perform set of exercises for five days a week with total duration of four weeks. Pre and post-intervention assessment was carried out by using BBS and TUG. Data was collected and analysed. Subjects were allocated in to three groups using quasi randomisation in which the first patient were allocated to Group A (Conventional physiotherapy training), second to Group B (Wobble board training without visual feedback) and third to Group C {Wobble board training with visual feedback (Sensamove Miniboard)}.

Conventional therapy included mat activities (stretching as well as strengthening), weight bearing or shifting and standing lower-extremity exercise in parallel bars and balance activities, unilateral stance activities, tandem stance, ambulation activities, training in functional activities such as bed mobility, scooting in a sitting position, standing, reaching, transfers, stair climbing and gait training. On the first day of first week, pre-test measurement of balance by using BBS and TUG scale were taken. Subjects were trained for 50 minutes each day. In each session subjects were given 20 minutes for balance training and 30 minutes for conventional therapy. These treatments were given for five days a week for total four weeks. Five repetitions were demonstrated for each exercise. Then post measurements of BBS and TUG were taken after four weeks. To prevent accidents during exercise, assistance was permitted by parallel bar.

STATISTICAL ANALYSIS

Statistical tests were performed using SPSS version 20.00 software. Significance was set at p≤0.05 for all analyses. Paired t-test was used for intra-group comparisons. ANOVA and post-HOC tests were for inter-group comparisons between all three groups for BBS and TUG.

RESULTS

The study included 51 post stroke patients of which 28 (55%) were males and 23 (45%) were females. The mean age of was 59.25±8.937. Participant baseline characteristics of Brunstrom and MMSE are given in [Table/Fig-1]. The appropriate tool for comparison of the change in the level of a variable is student's paired t-test for intra-group comparison. The level of significance is taken at 5%. For inter-group comparison ANOVA and Post HOC test was conducted. The results of the comparison of all the group participant with BBS and TUG pre-test and post-test values are presented in [Table/Fig-2,3]. The participants involved in the Wobble board training with visual feedback (Sensamove Miniboard) showed significant improvement (p<0.05) compared to conventional physiotherapy and Wobble board training with visual feedback.

Characteristics	N		Minimum	Maximum	Mean	STD
Age (years)	51		46	74	59.25	9.03
	Group A	17			59.76	9.21
	Group B	17			58.52	9.49
	Group C	17			59.47	8.58
Brunstrom	51		3	5	4.10	0.781
MMSE	51		25	30	27.90	1.360

[Table/Fig-1]: Patients baseline characteristics.

Group name	Outcome scale	Pre-post differences	t-value	p-value
Group A	Pre BBS	47.18±3.76	-2.269	0.032
	Post BBS	50.0±3.48		
	Pre TUG	18.47±3.12	2.260	0.030
	Post TUG	16.24±2.61		
Group B	Pre BBS	46.71±2.95	-5.571	<0.000
	Post BBS	52.29±2.89		
	Pre TUG	18.76±4.29	4.463	<0.000
	Post TUG	12.94±3.24		
Group C	Pre BBS	43.59±1.37	-26.968	<0.000
	Post BBS	54.88±1.05		
	Pre TUG	18.18±2.27	10.425	<0.000
	Post TUG	10.53±2.00		

[Table/Fig-2]: Intra-group comparision of BBS and TUG: (paired t-test).

DISCUSSION

The present study results show that all the interventions such as conventional physiotherapy training, wobble board training without visual feedback and wobble board training with visual feedback are effective to improve balance in ambulatory stroke patients but wobble board with visual feedback is highly significant as p <0.05 to improve balance in ambulatory stroke patients as compared to other two intervention groups. Hoseinabadi MR et al., studied the effects of physical therapy on exaggerated muscle tonicity, balance and quality of life on hemiparetic patients due to stroke, and showed that the average balance and quality of life significantly improved and tonicity of muscle also decreased [17]. Thus, physical therapy can enhance balance and quality of life of hemiparetic patients. Jeya Raman RK et al., found that the intensive strength training intervention is an effective procedure and found that balance was improved in post-stroke hemiplegics [18]. These findings are suggestive that balance and mobility can be improved by conventional physiotherapy training.

Outcome measure	Pre BBS	Post BBS	Pre TUG	Post TUG	Mean difference of BBS	Mean difference of TUG
Group A	47.18±3.76	50.0±3.48	18.47±3.12	16.24±2.61	2.82±0.80	2.41±0.79
Group B	46.71±2.95	52.29±2.89	18.76±4.29	12.94±3.24	5.59±0.50	5.71±2.17
Group C	43.59±1.37	54.88±1.05	18.18±2.27	10.53±2.00	11.29±1.68	7.47±1.12
F-value	7.834	14.100	0.132	19.561	253.26	50.80
p-value	0.001	0.000	0.876	0.000	0.000	<0.000

[Table/Fig-3]: Inter-group comparision of outcome measures using Anova and post-hoc test.

Wobble board exercise regimen can be used to strengthen weak lower extremity muscles and improve static balance of subjects. The reason for improvement in Group B can be due to effect of training on reflex control of muscle activity when exercising in close kinematic chain (wobble board). There was improved intramuscular and intermuscular coordination and more activation of agonists helps in achieving stabilisation of extremities and thus help in improving balance which improves strength. It also improves standing balance by controlling center of gravity and maintains a standing posture on unstable surface conditions. Teslim O et al., performed a study on the effect of six weeks wobble board exercises on static and dynamic balance of stroke survivors and concluded that wobble board exercise improved both static (eye closed) and dynamic balance of stroke survivor [19]. This supports our finding too, in hemiparetic patients after few weeks of stroke there occurs excessive postural oscillations and instability [20]. With time these abnormalities improve, reflecting better somatosensory integration, with gradual increase in use of proprioceptive and exteroceptive afferent information of the paretic lower limb [21]. In our study, for group C (Wobble board training with visual feedback) there was a noticeable improvement in balance when compared to Group A and Group B. Visual information can be used to compensate the inappropriate proprioception and correct the body asymmetry through the reorganisation of information. By providing constant visual feedback specially during tasks make the patients more aware and patients can autocorrect their body position and this mechanism help patients to improve balance. Authors have reported gains in more stance symmetry in subjects with hemiparesis who were trained with either visual feedback of the position of the center of pressure or weight distribution over those who received conventional training [19,22]. Gung found improvement in visual training group, compared to control group and also found improvement in the ADL and improvements at six months of follow-up in the trained group [13,20]. Nichols DS et al., and Betker AL et al., reported that balance training with visual feedback achieved higher participation and compliance, a lower incidence of falls, and a lower center of mass amplitude [23,24]. Some studies also indicate that the use of visual biofeedback/ force plate training improves stance symmetry in subjects with hemiplegia following stroke [9,25]. This helps to improve balance and the fact is supported by the present study too.

ANOVA and post HOC tests demonstrated that the balance improvement of BBS and TUG is highly significant in Group C compared to Group B and Group A. This shows that the wobble board training with visual feedback is the most effective than all the interventions for improving balance in ambulatory stroke patients. Catherine walker suggests that BBS scores provide support that activity-based balance performance improved over time [26]. Study by Shrivastava A et al., showed that balance training by Force Platform Visual Feedback technique significantly improves balance by using BBS and functional outcome, even in chronic phase after stroke [27]. In present study both outcome measure BBS and TUG were improved. Major improvement was noted in Group C.

Researchers suggested that visual information can be compensated for sensory motor loss and with training, subjects can assimilate the information, thus establishing a central motor program such that the external feedback would no longer be required [28]. In majority of stroke patients motor function was impaired and they weretotally dependent on visual feedback to perform motor tasks. The tasks were new to patients but with the help of adequate feedback as well as clear instructions, greater improvement was achieved.

LIMITATION

Long term follows-up of the patients were not done after completion of the intervention duration; hence long term benefits of intervention are unknown in this study. Same study can be performed including equal number of male and female patients comparing results of males and females.

CONCLUSION

All the three interventions used in the present study like conventional physiotherapy, wobble board without visual feedback and with visual feedback are effective for providing balance training in ambulatory stroke patients. Major improvement was noted in training with wobble board with visual feedback (Sensamove Miniboard). Here, with the help of Sensamove miniboard, patients can get visual feedback and balance improvement was maximum. So administrating training with wobble board with visual feedback (Sensamove Miniboard) is the most effective.

REFERENCES

[1] Physical Rehabilitation-Assessment and Treatment, Stroke-Susan B O'Sullivan.
[2] Hatano S. Experience from a multicentre stroke register: A preliminary report. Bull WHO. 1976;54:541-53.
[3] Shumway-Cook A, Anson D, Haller S. Postural sway biofeedback: Its effect on reestablishing stance stability in hemiplegic patients. Arch Phys Med Rehabil. 1988;69:395-400.
[4] Goldie PA, Matyas TA, Evansom. Maximum voluntary weight bearing by the affected and unaffected legs in standing following stroke. Clin Biomech. 1996;11:333-42.
[5] Dettmann MA, Lindermt, Sepic SB. Relationships among walking performance, posture stability, and functional assessments of the hemiplegic patient. Am J Phys Med. 1987;66:77-90.
[6] Badke MB, Duncan PW. Patterns of rapid motor responses during postural adjustments when standing in healthy subjects and hemiplegic patients. Phys Ther. 1983;63:13- 20.
[7] Horak FB, Esselman P, Anderson ME. The effects of movement velocity, mass displaced, and task certainty on associated postural adjustments made by normal and hemiplegic individuals. J Neurol Neurosurg Psychiatry. 1984;47:1020-28.
[8] Darcy A. Umphread "Neurological Rehabilitation" 4th Edition, 2001, Mosby 741-786.
[9] Tyson S, Selleya A. A content analysis of physiotherapy for postural control in people with stroke: An observational study. Disabil Rehabil. 2006;28:865-72.
[10] Jette DU, Latham NK, Smout RJ, Gassaway J, Slavin MD, Horn SD. Physical therapy interventions for patients with stroke in in-patient rehabilitation facilities. Phys Ther. 2005;85:238-48.
[11] Shepherd R. The Bobath concept in the treatment of cerebral palsy. The Australian Journal of Physiotherapy. 1968;14(3):79-85.
[12] Cheng PT, Wu SH, Liaw MY. Symmetrical body-weight distribution training in stroke patients and its effect on fall prevention. Arch Phys Med Rehabil. 2001;82:1650-54.
[13] Chen IC, Cheng PT, Chen CL. Effects of balance training on hemiplegic stroke patients. Chan Gung Med J. 2002;25(9):583-90. [PMID: 12479619].
[14] Shumway-Cook A, Horak FB. Assessing the influence of sensory interaction of balance. Suggestion from the field. Phys Ther. 1986;66:1548–50.
[15] Blum L, Bitensky NK. Usefulness of the berg balance scale in stroke rehabilitation: a systematic review. Journal of the Physical Therapy Association Phys Ther. 2008;88:559-66.
[16] Nam HC, Cha HG, Kim MK. The effects of exercising on an unstable surface on the gait and balance ability of normal adults. J Phys Ther Sci. 2016;28(7):2102-04.
[17] Hoseinabadi MR, Taheri Torbati HR, Keavanloo F. The effects of physical therapy on exaggerated muscle tonicity, balance and quality of life on hemiparetic patients due to stroke. J Pak Med Assoc. 2013;63(6):735-38.
[18] Jeya Raman RK, Sethu G, Samy SR. An intensive strength training intervention to improve balance in post stroke hemiplegics-A PROBE pilot study. International Journal of Health Sciences & Research. 2012;2(5):64-71.
[19] Teslim O, Awotidebe T, Awosika H. Effect of 6 weeks wobble board exercises on static and dynamic balance of stroke survivors. Technology and Health Care. 2009;17:387-92.
[20] De Haart M, Geurts AC, Huidekoper SC. Recovery of standing balance in postacute stroke patients: A rehabilitation cohort study. Arch Phys Med Rehabil. 2004;85(6):886-95.
[21] Barros de Oliveira C, Torres de Medeiros IR, Frota N. Balance control in hemiparetic stroke patients: Main tools for. Journal of Rehabilitation Research & Development. 2008;45(8):1215-26.
[22] Winstein CJ, Gardner ER, McNeal DR. Standing balance training: Effect on balance and locomotion in hemiparetic adults. Arch Phys Med Rehabil. 1989;70:755-62.
[23] Nichols DS. Balance retraining after stroke using force platform biofeedback. Phys Ther. 1997;77:553-58.
[24] Betker AL, Szturm T, Moussavi ZK, Nett C. Video game-based exercises for balance rehabilitation: A single-subject design. Arch Phys Med Rehabil. 2006;87:1141-49.

[25] Wee JYM, Hopman WM. Stroke impairment predictors of discharge function, length of stay, and discharge destination in stroke rehabilitation. Arch Phys Med Rehabil. 2005;84:604-12.
[26] Sackley CM, Baguly BI. Visual feedback after stroke with balance performance monitor: Two single case studies. Clin Rehabil. 1993;7:189-95.
[27] Shrivastava A, Taly A, Gupta A, Kumar S, Murali T. Post-stroke balance training: Role of force platform with visual feedback technique. Journal of the Neurological Sciences. 2009;287(1-2):89-93.
[28] Mulder T, Hulstyn W. Sensory feedback therapy and theoretical knowledge of motor control and learning. Am J Phys Med. 1984;63:226-44.

PARTICULARS OF CONTRIBUTORS:
1. Assistant Professor, Department of Physiotherapy, Shrimad Rajchandra College of Physiotherapy, Uka Tarsadiya University, Maliba campus, Surat, Gujarat, India.
2. I/C Principal, Department of Physiotherapy, SPB Physiotherapy College, Ugat-Bhesan Road, Surat, Gujarat, India.

NAME, ADDRESS, E-MAIL ID OF THE CORRESPONDING AUTHOR:
Dr. Khushboo C Valodwala,
Assistant Professor, Department of Physiotherapy, Shrimad Rajchandra College of Physiotherapy, Uka Tarsadiya University,
Maliba Campus, Bardoli, Surat-395009, Gujarat, India.
E-mail: khushboovalodwala92@gmail.com

FINANCIAL OR OTHER COMPETING INTERESTS: None.

Date of Submission: **Oct 17, 2018**
Date of Peer Review: **Nov 26, 2018**
Date of Acceptance: **Feb 27, 2019**
Date of Publishing: **May 01, 2019**