



## BALANCE TRAINING ATTENUATES POSTURAL INSTABILITY AND MINIMIZES FALLING PROBABILITY IN POST STROKE PATIENTS

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### ABSTRACT

Study objective was to evaluate efficacy of balance training with visual feedback on postural stability and falling in patients with stroke. Forty patients with were selected for this study and their age ranged from forty to sixty years. Patients were randomly assigned into two groups (study and control groups). Patients in both groups participated in the traditional rehabilitation program for stroke, one hour per day/ 5 days/week and for 12 weeks. Balance training using the Biodex Balance System was adding to traditional program for study group as received a twenty minutes balance training daily /5 days/ week and for 12 weeks. Pre and 3 months post- treatment evaluations for stability were conducted using the Biodex Balance System. Twelve weeks after completing the treatment programs there was significant improvements in measurements of balance training in study group. stroke Patients received balance training with visual feedback had significant improvements in comparison with control group in form of attenuating of postural instability and preventing of falling and summarized that balance training was favorable and effective for patients with stroke.

**KEY WORDS:** Balance Training, Biodex System, Postural Stability, Post Stroke Patient.



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## INTRODUCTION

Stroke is a type of cardiovascular disease affecting the bloodstream nourishing the brain. In cerebrovascular accident, there is a brain function disturbance, often long lasting, caused by either a brain vessels blockage or even rupture<sup>1</sup>. Stroke is a typical neurological disorder, the second most common overall cause of death, as well as a major cause of disability within survivors<sup>2</sup>. Cerebrovascular accident is the leading cause of severe long-term disability, with more than 1 million adults confirming difficulties in function as a consequence of stroke. In addition to the primary failures associated with stroke, there is a higher rate of secondary problems, including falls<sup>3</sup>. Postural instability in patients with stroke can be occurred by various disorders in systems involved in controlling of posture, which include; afferents for sensation, motor strategies and biomechanical factors, cognition process, and vertical perception. Clinical evaluation for stroke patients can provide that weight distributed in the lower limbs in asymmetrical way, center of gravity shifted to sound side and inability to transfer or maintain the mass center in the affected side, stability in frontal plane reduced, diminished selection of muscles with oscillatory standing. Patients with hemiparesis may have problems with weight shifting from the ill to the sound side<sup>4</sup>. Postural sway for stroke patients can be doubled that of their age-matched peers. Hemiplegia may leads to reduce stability limit of patients, which is the maximal distance that person can transfer his body weight in any direction without balance loss<sup>5</sup>. Keeping balance in all day activities (ADL), and postural control is important. Many sensory, motor, higher brain cognitive functions all participate in controlling posture<sup>6-8</sup>. Immediately after a stroke, individual lose higher brain functions as well as the motor, sensory attributes which affect and diminish balancing<sup>9-10</sup>. The Biodex balance system (BBS) is an effective, reliable and valid tool used for assessment of balance as well as treatment of imbalance. It can be used for assessment and treatment of balance defects as it has several programs for assessing and training<sup>11</sup>. In recent years, Biodex Balance System has been used to assess postural instability. The BBS is a device with multi-axis that assesses and records the ability of patient to stabilize and keep balance of involved part or joint under dynamic state. Circular platform is a part of biodex system allows free movement in medio-lateral and antero-posterior directions<sup>12</sup>. Biodex Balance System stimulates mechanoreceptors of ankle joints by allowing foot platform to tilt up to 20°. During dynamic condition, BBS evaluate the tilting about each axis in degrees and calculates a medio-lateral stability index (MLSI), antero-posterior stability index (APSI), and an overall stability index (OSI) which are fluctuating around a zero when the platform is stable prior to testing<sup>13</sup>. Rare and a few studies have mentioned about using of

balance training with visual feedback in patients with stroke. So in our study, we evaluated the efficacy of Balance training by using biodex balance system on postural instability and probability of falling in patients with Stroke.

## METHODS

### *Patients*

Forty patients with stroke participated in the study. Ages of patients ranged between forty to sixty years. They were selected from King Faisal Hospital in Makkah city, KSA. according to following criteria to be included in the study; (1) patient had history of stroke with duration approximately three months or more after beginning of stroke (embolic and thrombotic stroke), (2) patients can comprehend and execute verbal commands, (3) patients was normally ambulating prior to the stroke onset, (4) patients can stand or walk a step or more with or without aids. As well as patients were excluded from study when they had the following criteria; Patients had past neurological disorders history prior to stroke onset, past diseases affecting postural control or balance, vision loss, affection of consciousness or musculoskeletal disorders in lower limbs. Selected patients were randomly divided into 2 groups equal in number; study group and control group. Patients were assessed and received treatment in the labs of Department of physical therapy, Faculty of Applied Medical Sciences, Umm Al-Qura University.

### *Procedures*

#### *Measuring Procedures*

Biodex Balance System SD: (BBS; Biodex Inc., Shirley, NY) has been used as a reliable and valid device for assessing of Stability Dynamic Limits and risk of falling. It has handle for supporting, platform, display and printer. Its program has one stationary level and twelve levels of tilting for platform in dynamic form. This balance equipment was used for evaluating of any postural changes and balance control from standing for all selected patients pre- training and 12 weeks post training.

#### *Initial assessment*

Immediately before treatment, and at initial assessment, participants had illustrations about all procedures, evaluation processes as every patient was asked to stand in platform center with bare feet and his arms were at his body sides and looked forward, concentrating on equipment monitor to enhancing the visual feedback. All patients assessed on static level and 3 trials were conducted then the mean score was measured. Adjustable Supported handles were used and the examiner stood near and beside the patient to give support if patient loses his balance as shown in figure (1).

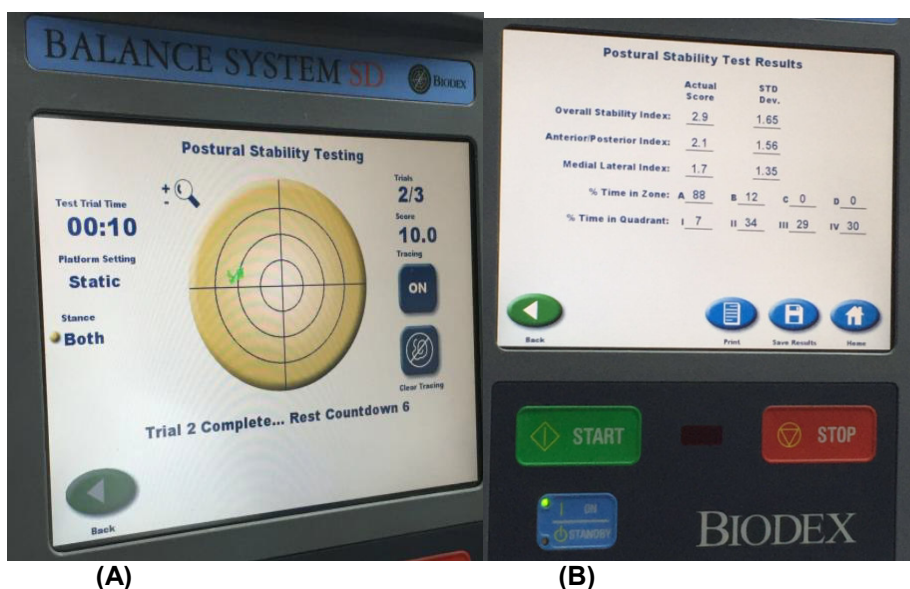


**Figure 1**

**Patient's postural stability examination while the examiner stood beside the patient to avoid falling.**

Over all stability index scores as outcome measures of Postural stability test were gained from all patients through doing test at static level for twenty seconds as the patients were asked to try to maintain pressure center in center of a target displayed on equipment monitor while keeping eyes opened. one training test was conducted by every patient prior to actual test to be

familiar with equipment and test. The results gained from tests were compared automatically to normal values related age which stored in higher falling risk as indicated balance defect. While lowering of these values post treatment to nearby normal age related scores values indicate postural stability improved. Figure 2 (A&B).



**Figure 2**

**A) - Postural stability evaluation screen. B) - Postural stability evaluation results**

**Treatment Procedures**

All patients in both groups (study and control) received traditional treatment program for stroke, one hour per day/ five days per week and for 12 weeks. The traditional treatment program formed of; Range of motion exercises, positioning technique, gradual resistance exercises, controlling posture exercises as

trying to hold in standing as well as to body weight transfer to ill side. All previous exercises were associated with gait training, and daily level activities. Neurodevelopmental and PNF techniques were added to treatment as the patients' medical condition needs. Plus traditional treatment program, study group participated in balance training program using Biodes

Balance System (BBS) for twenty minutes per day, 5 days per week and for 12 weeks. Patients were enhanced through visual feedback as try to adapt to different static sensory feedback to keep stability of their posture. While patients provide weight shift control in dynamic training, by controlling the targets that moved on monitor in all directions<sup>14</sup>. Training for postural stability in study group (A) was done through Biodex Balance System as patients stood with bared feet, and all procedures and instructions which were followed in testing phase were repeated in training phase in each set. While each weight shift training set formed of 3 separated trials as there were 5 minutes off before starting next trial .after finishing tasks in 3 trials. Then ten minutes off before starting 1 hour conventional treatment program.

#### Follow up Assessment

All previous assessment procedures which were done in initial assessment were repeated 12 weeks post treatment.

### STATISTICAL ANALYSIS

Comparison of patients' demographic data (age, weight, height and time from stroke onset) between both groups was conducted using independent t. Comparison of

overall stability index score mean values between pre-treatment and post-treatment phase within each group was conducted using paired t-test. Comparison between study and control groups at each phase (pre and post treatment phases) was done by using an unpaired t-test. SPSS program (v.16) (SPSS Inc., Chicago, IL) was used for analysis of data. Probability value less to 0.05 was considered as significant point.

### RESULTS

The Patients' characteristics were explained in Table 1. The mean value of age for study group was (53± 6.2years) while it was (51± 7.0 years) for control group, the mean value of height as well as the mean value of weight for study group were (175±6.5 cm) and (75±8.0kg) respectively while the mean value of height as well as the mean of weight for control group were (172±5.5cm ) and (74± 7.00kg) respectively and a mean time since stroke onset was (9.3±2.0) months for study group while it was (9.6±1.9) months for control group ,Initial assessment of mean value of stability index in study group was (3.75±0.72) while it was (2.8±1.2)for control group, (see Table 1). There were no significant difference between two groups regarding to patient's age, weight, height, time of stroke onset and baseline stability index scores as p value >(0.05).

**Table 1**  
**Characteristics of Patients**

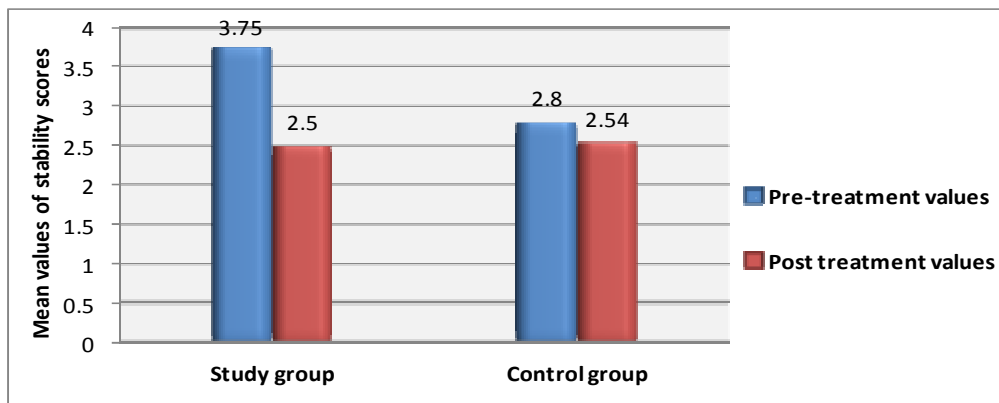
Characters	Study Group (A)	Control Group (B)	P value
Number of patients	20	20	
Age (years)	53± 6.2	51± 7.0	0.40
Height (cm)	175±6.5	172±5.5	0.25
Weight (Kg)	75±8.0	74± 7.00	0.50
Time since stroke onset (month)	9.0±2.0	9.6±1.9	0.72
Overall stability index scores (baseline)	3.75±0.72	2.8±1.2	0.12

Analysis of study results post-treatment revealed that; there was significant increase in mean value of overall stability index within study group (p<0.05) which indicated to increase controlling of posture and hence improve stability and decrease tendency to falling as illustrated in table 2. Also analysis of results between 2 groups after treatment revealed that significant increase in improvement scores mean of overall stability index in study group compared to that in control (p<0.05).Further explanation, assessment after treatment revealed that, there was significant increase

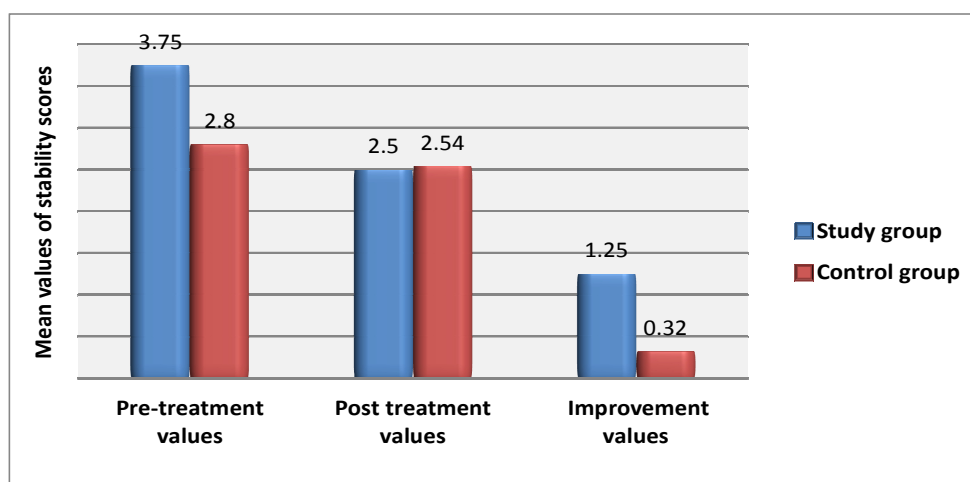
in mean value of overall stability index within study group p value =(0.002), while there was no significant difference (increase ) in mean value of overall stability index within control group as p value =(0.36) table 2 and figure 3. Also after treatment elicited that; Study group mean value was (2.5±0.8) while for control group, mean value of stability index was (2.54±0.9) and by analysis, there was high significant increase in mean scores of improvement in study group compared to that in control group as p value = (0.003) table 2 and figure 4.

**Table 2**  
**Comparisons between pre and post treatment stability scores values within each group as well as between improvement score values.**

Mean ± SD	Stability Scores			Confidence Interval (95%)
	Study Group	Control Group	P value	
Pre-treatment value	3.75±0.72	2.8±1.2	0.12	Not significant
Post-treatment value	2.5±0.8	2.54±0.9		
P value	0.002	0.36		
Confidence Interval (95%)	Highly significant	Not significant		
Improvement value	1.25±0.44	0.32±0.5	0.003	Highly significant



**Figure 3**  
Comparisons of stability scores within each group.



**Figure 4**  
Comparisons of stability scores and improvement scores between both groups.

## DISCUSSION

Cerebrovascular accident is critical medical problem<sup>15</sup>. After stroke, Standing disability, postural instability, weight distribution in a symmetrical way, weight transfer or shift disability and imbalance may be occurred<sup>16-20</sup>. One of social problem with stroke that increases costs economically is postural instability and falling<sup>21-23</sup>. Hemiplegia may leads to reduce stability limit of patients, which is the maximal distance that person can transfer his body weight in any direction without balance loss as theoretically illustrating a cone surround feet of individual<sup>24</sup>. Postural disturbance are very common in patients with stroke<sup>25</sup>. Gait analysis of hemi paretic patient characterized by decreased weight bearing load on affected limb<sup>26-28</sup> and increased swaying of posture<sup>29, 30</sup>. Postural instability and balance problem affect daily activities and ambulation. So speeding up postural stability improvement via balance rehabilitation is vital for patient independency and active participation in society<sup>31</sup>. Different therapeutic techniques and treatments were conducted to enhance postural stability, but no final conclusions determined which approach is the best. Our study is conducted to evaluate postural instability and probability of falling as problems in post stroke patients and how visual

feedback training through using Balance Biodex System visual biofeedback affect these problems. The study results post-treatment revealed that; there was significant increase in mean value of overall stability index (OASI) within study group as well as there was high significant increase in mean scores of improvement in study group compared to that in control group which indicated to increase controlling of posture and hence improve stability and decrease probability of falling in study group. Our results are consistent with previous studies review as follow: Balance control relearning via biofeedback training is good, favor therapeutic method to improve postural stability and balance, in Biodex Balance training, patient trying to concentrate on their pressure center in device screen reflecting visual or auditory feedback to them so realignment of their posture and balance. In other word, feedback is considered as external information introduced to patient reflects his posture's displacement and alignment during training<sup>32</sup>. Maintenance of postural stability on movable platform by stroke patient can be relearned and improved by training regularly<sup>33</sup>. A study confirmed that postural stability training biofeedback was better than traditional treatment program in improving balance control in stroke patients<sup>34</sup>. In a review study, a reviewer concluded that

biofeedback training on platform encouraged symmetrical alignment in standing and in stance phase in post stroke, without using repercussion for body sway or issues related to ambulation and independent activities daily living<sup>35</sup>. For maintenance the independency in activities daily living, balance control and postural stability are very vital issues. In study evaluating the relation between visual feedback training effect and postural stability, sway and activity daily living function, it found that there were significant improvement in postural stability, and activity daily living function in Biodex training group<sup>36</sup>. Chen et al. evaluated balance training effect on patients with stroke, two groups were included; control group received traditional treatment while treatment group received balance training with visual feedback in addition to traditional treatment. They concluded that balance and activities daily living were significantly improved at the end of six months in biodex training group<sup>37</sup>. Yavuzer et al. evaluated the relation between balance training and characteristics of gait. They found that biofeedback balance training plus a traditional

treatment program is favorable and effective in enhancing postural stability and increasing bearing load on the affected side, six months post hemiplegia<sup>38</sup>.

## CONCLUSION

Balance training through using Biodex Balance System (BBS) attenuates postural instability and prevents probability of falling in patients with Stroke.

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## CONFLICT OF INTEREST

Conflict of interest declared none.

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