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ORIGINAL ARTICLE

Comparative Effectivness of Visual Feedback and Verbal Augmented Feedback for Improving Balance in Stroke Patients

NIDA CHAUDHARY[1], MARIUM ZAFAR[2], KOMAL TARIQ[3], ADEERA AZAM[4], RASHIDA MUNEER[5], HIRA ZAFAR[6]
[1]DPT (TUF), MSNMPT (TUF) Current post: Lecturer, Department of Rehabilitation sciences (The University of Faisalabad)
[2]DPT, MS-NMPT, A-HEPC, R-HEPC Current post: Assistant Professor/Academic Coordinator
[3]DPT (TUF), MS-MSKPT (UOL) Current post: Lecturer, Faisal Institute of Health Sciences, FSD
[4]DPT (TUF), MS-MSKPT (TUF) Current post: Lecturer, Department of Rehabilitation sciences (The University of Faisalabad)
[5]DPT (GCUF), MSNMPT (TUF) Current post: Lecturer at Riphah International University, FSD
[6]Degrees: DPT (TUF), MS-OMPT(TUF) Current Post: Demonstrator/Physical Therapist (MTH Clinics)
Correspondence to: Nida Chaudhary, Email: nidachaudhry36@gmail.com, Cell: 0301 6053300

ABSTRACT
Background: Stroke is a highly prevalent condition and leading cause of chronic disability in adults. Some of the important complications of stroke include complications of immobility such as pressure sores, falls and gait problems resulting from balance and coordination issues that limits person's ability to perform activities of daily living.
Objectives: To compare the effectiveness of visual feedback and visual feedback combined with verbal augmented feedback for improving balance in stroke patients.
Materials and Methods: A randomized clinical trial was conducted in which a sample of 30 chronic stroke patients was randomly allocated into 2 groups, control and treatment group. Group A received Visual Feedback and Group B received Visual and Verbal Feedback both. Berg Balance Scale was used to assess patients balance abilities of patients both pre and post intervention. Both groups received their respective interventions 3 times a week on alternate days for 8 weeks.
Results: The data was analyzed using SPSS Version 22. Results of Paired sample T Test showed improvement in both groups over the period of 8 weeks (p <0.05). Independent sample T Test demonstrated significant improvement in Berg Balance Scale scores at 8th week follow up (p <0.05).. Significant improvement was shown in the patients who received visual feedback combined with verbal feedback.
Conclusion: Visual feedback combined with verbal augmented feedback was found more effective for improving balance in stroke patients.
Keywords: Stroke, Stroke Rehabilitation, Mirror Movement Therapy, Visual Feedback, Audio Feedback, Postural Balance.

INTRODUCTION
Stroke also called as cerebrovascular accident (CVA) is a highly prevalent condition. It is the fourth common killer and number one cause of adult disability overall in the world. So, striking number of new researches are done every day to assess incidence, risk factors and outcomes which will help in better understanding of disease and its complications and treatment (1).

Stroke, according to the World Health Organization, is an indication of disturbances with normal cerebral function. Stroke is caused by a ruptured blood vessel, blood plaques in the arteries, or poor perfusion levels in the brain. A lack of oxygen, energy, and glucose is caused by a low level of blood in the brain or clogged vessels (2). Ischemic or hemorrhagic strokes induce a variety of neurological impairments. The most common clinical symptoms in stroke patients are hypertonia, hemiplegia, hemiparesis, sensory or cognitive dysfunctions. All of these factors contribute to a decrease in functional independence and quality of life (3).

Researches have shown a strong relationship between balance ability and the ability to perform activities of daily living (ADL's). Characteristics like posture, gait speed, and functional independence is heavily dependent on an individual's ability to maintain balance. Human beings rely on the integration of multiple systems including visual, vestibular and somatosensory inputs to the central nervous system which control balance. These inputs are very useful and form the basis of therapeutic methods that uses feedback given to patients for rehabilitation purposes (4).

Chronic stroke can result in many different complications and balance impairment is one of the most important complications with 83% of post stroke patients suffering from it. (1). Falls are prevalent after a stroke because of loss of balance. Falls occur in 43–70% of stroke patients, with 5–27% of stroke patients falling twice or more. Stroke patients who have fallen multiple times continue to be afraid that they will fall again, and their activity level drops by roughly 25%. This reduced activity makes everyday independent activities more challenging and lowers quality of life. So, functional rehabilitation is critical post stroke. (5).

Diminished balance control post stroke poses a huge barrier in the functional independence of a person. Post stroke damage occurs to balance controlling centers of brain which leads to loss of balance. As far as the rehabilitation of this balance deficit is concerned physical therapy can play a vital role in restoring this lost balance by performing many different exercises that will not only help to improve the balance but also regain the postural stability or gait (6).

Visual feedback is a technique that employs an optical illusion in which the movement of paralytic limbs appears to be normal due to the reflection of non-paretic limb motions in a mirror. This is one way for treating individuals with brain nerve injury that is based on the neuroplasticity principle (7).

Therapists frequently employ instructions and verbal feedback on ongoing task performance to improve motor learning. Feedback gives information based on prior movement attempts in order to reduce movement errors and make subsequent attempts easier to attain the movement goal. Statements providing knowledge about performance or results relevant to the task can be included in instructions. Physical therapists offer vocal directions and feedback often during stroke balance therapy (8).

Several studies have shown that physiotherapy can play a vital role in overall rehabilitation of patients. Along with the use of the conventional physical therapy currently there is an increase in the use of biofeedback training for improving balance and this has proven to be very effective for posture control and visual feedback training especially helps in improving functional balance, gait speed and mobility in post stroke patients (9).

Berg Balance Scale (BBS) is a widely used scale for assessing balance impairments resulting from a wide range of diseases. The BBS is an extremely valid and reliable tool used in assessment of stroke patients and their recovery. The BBS can also be used as a predictor of risk of falls (10).

METHODOLOGY
A randomized clinical trial was conducted by using non probability purposive sampling technique. Data was collected after getting approval from ethical committee of The University of Faisalabad. Sample size was calculated to be 30 with the help of following formula: (11)

$n=2SD^2(Z_{\alpha/2}+Z_{\beta})^2/d^2$

*S.D= Standard Deviation, d= effect size= difference between the mean values, $Z_{\alpha/2} = Z_{0.05/2} = 1.96$ (from Z table), $Z_{\beta} = Z_{0.20} = 0.842$ (from Z table) at 80% power.

Subjects were recruited from 2 hospitals of Faisalabad including Safi Teaching Hospital and Faisal Hospital. Consent was obtained from the hospital management prior to data collection. Subjects were screened for recruitment in research. 30 patients were recruited in the study which fulfilled the inclusion criteria.

Consent forms were obtained from the patients through the assurance that their data would only be used for research purposes. Subjects were randomly divided into 2 groups with 15 patients in each group by online randomization generator.

Inclusion criteria comprised of diagnosed chronic hemiplegic stroke patients in age range from 40-55 years, having Berg Balance score between 21-56 (low to medium risk of fall), having no visual or vestibular deficit. Patients with any other neurological disease, history of brain tumor, previous lower limb fracture, diabetic or peripheral neuropathy, cognitive impairments or any other vestibular disorders that affect balance were excluded.

Group A received the Visual Feedback, which was provided by using a mirror which was placed in front of the parallel bars. The subjects were able to visualize their frontal reflected image in a mirror placed on the wall 1 m in front of them while they stand in parallel bars for balance training (12).

Both groups underwent a baseline treatment in addition to receiving respective group treatment. Baseline treatment comprised of static and dynamic balance training. Static balance training was performed by asking the patients to assume following positions in parallel bars, Single leg stance (SL), tandem stance (T), single leg stance on medium density foam (SLF), and tandem stance on medium density foam (TF). All the positions were assumed in the parallel bars. Three trials of each of the four positions were performed and each of the position was maintained for 10 seconds with a 1 min rest period provided between each position (13).

Dynamic balance training was performed by standing with double limb support and then progressing to single limb support first on the ground and then on a wobble board to increase difficulty level. Activities included anterior/posterior tilt, medial/lateral tilt, sideways tilt and clockwise/counter clockwise rotations. Step ups that included standing with one leg on top of an 8 in step, other leg in front and behind step and at last Balance & reach standing was trained by standing on one leg, other leg steps forward and then back to original position. The patients were supervised by the physiotherapist throughout the treatment session to prevent any risks of falls. All of the training was performed in the parallel bars in order to provide additional support and in front of a mirror to receive visual feedback throughout training. Patients performed 2 sets of 6 repetitions of each maneuver and each movement was performed for 10 seconds (14).

Group B received visual feedback combined with verbal augmented feedback. Subjects in this group received all the same conditions as in group A, additionally the subjects also received verbal feedback which was provided by the therapist regarding posture correction and balance maintenance while the patient stand in parallel bars and looked in the mirror.

Treatment was provided 3 times a week every alternative day for 8 weeks. Each session lasted 30 minutes and the total 24 sessions were provided to both groups.

Berg Balance Scale was used as primary outcome measure. Measurements of Berg Balance Scale were taken pre treatment and 8th week post treatment.

All patients completed their intervention protocols with no loss to follow up. Protocol violation was dealt with intention to treat analysis. SPSS version 22 was used to analyze the data. Independent sample t test was performed for between group analysis of A and B Groups.

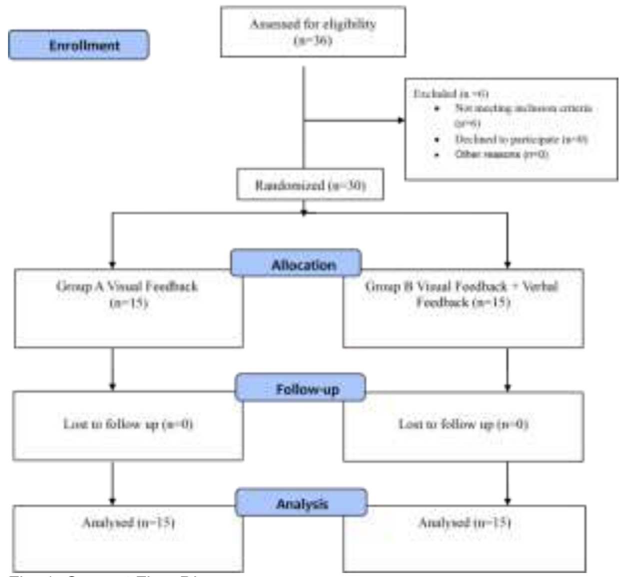

Fig. 1: Consort Flow Diagram

RESULTS

Normality of data was analyzed before the application of statistical tests. Normality of data was checked through skewness, kurtosis and Shapiro-Wilk test values. For the sample size of less than 50, if values of skewness and kurtosis are between +1.96 to -1.96 and p value is more than 0.05, then data is considered to be normally distributed (15).

Values of data were falling between -1.96 to 1.96 and p value >0.05 of Shapiro-Wilk's test showed that data for Berg Balance Score was normally distributed (Table 1). As, data was found to be normally distributed, then parametric tests were applied. Independent sample t test was conducted to find difference between group A and B. Paired sample t test was applied to find within group difference for Berg Balance Score at pre treatment and 8th week post treatment.

Table 1: Normality test for the Berg Balance Score

Pre-Treatment		Skewness	Kurtosis	Shapiro Wilk Sig.
Berg Balance Score	Group 1	-.186	-1.642	.093
	Group 2	.454	-.408	.168

Demographics of the sample including age and gender are depicted in Table 2. Mean age in Group A was 48.53+ 4.549 years and in Group B was 47.27+ 3.826 years. Total 14 were male and 16 were female (n=30).

Table 2: Demographic characteristics of patients from both groups

Parameters		Visual Feedback Group (Group A)	Visual + Verbal Feedback Group (Group B)
Age in Years (Mean ± SD)		48.53+ 4.549	47.27+ 3.826
Gender (f, %)	Male (n= 14)	11 (78.57%)	3 (21.43%)
	Female (n= 16)	4 (25%)	12 (75%)

Table 3: Within Group Comparison for Berg Balance Score in Both Groups.

Outcome Measure		Week 1	Week 8	P. value
	Group	Mean+ S.D	Mean+ S.D	
Berg Balance Score	Group 1	28.07+ 5.021	33.20+ 4.346	0.000
	Group 2	29.40+ 6.456	38.00+ 4.520	0.000

Within group comparison for Berg Balance Score, which was analyzed using paired sample t test is shown in Table 3. Results showed that there was significant improvement in Berg Balance Score across 8 weeks of treatment in patients of both groups with p value < 0.05.

Results of Independent sample t test demonstrated significant improvement in mean Berg Balance score with p value < 0.05 at 8th week (Table 4).

Table 3: Between Group Comparison for Berg Balance Score.

Outcome Measure	Session	Group A (Visual Feedback)	Group B (Visual + Verbal Feedback)	
		Mean+ S.D	Mean+ S.D	P. Value
Berg Balance Score	Week 1	28.07+ 5.021	29.40+ 6.456	0.533
	Week 8	33.20+ 4.346	38.00+ 4.520	0.006

Multiple line chart shows the mean scores of Berg Balance Score at week 1 and week 8. Increase in the height of line of Berg Balance Score showed improvement in both groups from week 1 to week 8 (Fig 2). Mean differences in Berg Balance Score between both groups at week 1 and week 8 demonstrated greater improvement in Group B.

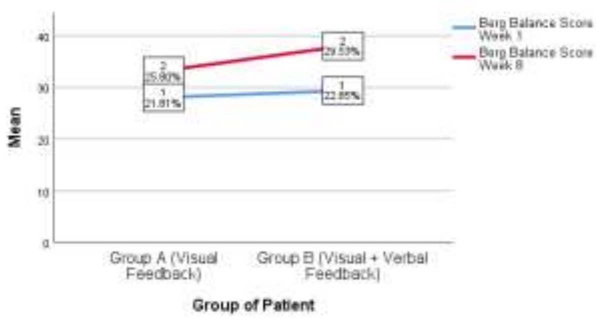

Fig. 2: Comparison of Mean Berg Balance Score in Both Groups

DISCUSSION

In the current study each individual component of the Berg Balance Score were also analyzed in addition to the total score. There are a total of 14 components in the Berg Balance Scale which all help in analyzing the overall balance capacity of an individual.

According to the results, some components showed no significant improvement between groups and some showed significant improvements but in general major differences between groups were observed in the following components of berg balance scale: sitting unsupported, standing to sitting, retrieving objects from the floor, turning to look behind, turning 360 degrees, placing alternate foot on stool while the other showed no drastic changes between groups. However, each component of the berg balance improved in within group comparisons in both groups. The current study has demonstrated improvement in overall balance in both groups. However, present study has shown significant improvement in balance in patients who received visual feedback combined with verbal feedback.

The results of recent study are in compliance with the results of a study conducted by Kim et al. (2016) which concluded that visual feedback provided by using mirror was found effective for improving the balance ability of patients suffering from sub-acute stroke especially during the stance phase as well as standing on uneven surfaces. In this study it was observed that stroke patients who received visual feedback from a mirror had a significant reduction in problems of postural sway on either sides especially on the more unstable surfaces (16).

Storberget et al. (2017) conducted a systematic review on the topic of verbal augmented feedback in the rehabilitation of lower extremity musculoskeletal dysfunctions. Results revealed positive results in the postural control, balance, gait, coordination as well as overall biomechanics of the limbs in groups that received verbal augmented feedback (17). Hence its findings are congruent to the current study that also suggests that when verbal feedback is combined with visual feedback it has better effects on the balance abilities of stroke patients.

Another researcher also goes in line with the findings of the current study, Zalecki et al. (2013) documented in their article that when visual feedback was provided using Wii Fit training program it resulted in considerable improvement in balance capacity of the patients with Parkinson's Disease. Results suggested that visual feedback can be a great aid in improvement of physical abilities of the patients in addition to the conventional treatment programs (9).

A study by Yu and Kang (2017) aimed to compare the effects of FES-gait training with augmented feedback to FES training alone on gait and functional performance in individuals with chronic stroke. In comparison to the existing FES gait training, providing augmented feedback led to improvements in walking ability, gait parameters, and dynamic balance. The study findings are concurrent with the present study which shows that stroke patients benefit from augmented feedback because it provides motivation for motor learning (18).

Another study was conducted Pellegrino et al. (2017) to determine if and to what extent chronic stroke survivors could learn the task and transfer the learned ability to conditions lacking visual feedback and to directions and displacement amplitudes different from those experienced during training. The majority, however, did not show any improvement compared to their pre-training performance with the visual feedback removed. Results of the study supports the recent findings by showing the impact of visual feedback on balance performance (19).

A systematic review by Stanton et al. (2017) demonstrated that biofeedback increased activity performance more than traditional therapy in lower limb activities in patients post-stroke (20). Findings of a large number of studies both theoretical as well as clinical support the use of feedbacks that is either in form of visual feedback, verbal feedback in terms of speech, feedback from touch, biofeedback , or any other form of feedback for improving the physical capabilities of the patients. According to the literature based on movement sciences and neurophysiology it is believed that that augmented feedback can greatly enhance performance and motor learning. During the recent years the electronic computer-based feedback has gained immense popularity and is readily available and considerate to be highly effective when combined with movement therapy (21).

Strengths of the study

- There were no dropouts. Each patient hat was included in the study completed his her complete session over the course of 8 weeks.
- This study provides as a single source of evidence for the comparison between the effectiveness of visual feedback and visual feedback combined with verbal augmented feedback.

Limitations

- Due to the global pandemic of COVID - 19 patients were reluctant to participate in the study.
- Small sample size

Recommendations

- Future studies can be conducted by taking broad age range to analyze age related differences.
- New researches could be conducted by analyzing the effect of same interventions on other parameters of balance like risks of falls, postural sway and even gait abilities.
- Future researches can analyze other forms of feedback on balance training.
- Another productive path for prospect research could be a comparative examination of the effects of external vs internal feedback.

CONCLUSION

Results have shown significant improvement in the patients who received visual feedback combined with verbal. Hence visual feedback combined with verbal augmented feedback is more effective for improving balance in stroke patients.

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