Research Article

Effects of task-oriented balance training with sensory integration in post stroke patients

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ABSTRACT

Background: Balance and functional mobility is greatly affected in stroke patients. Balance training integrated with sensory input is more beneficial for improving balance and mobility in stroke patients.

Objective: To determine the effects of task-oriented balance training with and without sensory integration on balance, postural stability, and mobility in post-stroke patients.

Methods: A randomized control trial was conducted at RHS Rehabilitation Centre, Islamabad. A total of n=60 post-stroke patients were included in the study through a non-probability purposive sampling technique. Male and female stroke patients above 40 years of age, having the ability to maintain a standing position without aid for at least 5 minutes, and patients on Grades II, III, IV on the Functional Mobility Scale were included in this study. They were randomly allocated into Group A (n=30) and Group B (n=30). Both groups received Task oriented balance training while group B was treated with additional sensory integration. The Berg Balance Scale, Dynamic Gait Index, Activities Specific Balance Confidence Scale, and Balance Error Scoring system were used for balance assessment. The assessment was done at baseline and after 6th week.

Results: The mean age of the participants was 54.47 years. After 6 weeks of intervention, a significant difference was found in group A as compared to group B for Dynamic mobility measured by Dynamic gait index with p-value (p=0.06) and for balance measured by BBS with p=0.05.

Conclusion: The task-oriented balance training with sensory integration is effective in improving dynamic balance and mobility in stroke patients.

Keywords: balance training; sensory integration; stroke rehabilitation; task-oriented balance exercises.

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INTRODUCTION

Stroke is the most common cause of mortality and morbidity [1]. That affects the individual's functional abilities and health status with compromising their quality of life [2]. According to World stroke organization Over 110 million people in the world have experienced stroke. The low- and middle-income countries have high incidence of stroke. In Pakistan its recurrence is 250/100,000 that is expected to 350 frequencies every year [3].

Stroke is a chronic condition having major impacts on patients, society and health care systems [3]. Stroke is the often cause of prolong disability in middle age population with disturbance of both lower and upper extremity functional activities [4]. In 80% of stroke survivors has recorded with limbs functional limitation. Impairment of extremity in stroke survivors leads the patients to limitations in activity of daily living, balance disturbance ambulation, and quality of life [5] . The Patients face difficulties in standing, walking and functional activities [6].

Stroke frequently causes balance problems, which can affect the level of independence. Additionally, the primary predictor of falls is balance issues, which can cause a fear of falling and a reduction in daily activities. To reduce the risk of falls in post-stroke patients, especially those residing in society, a balance needs to be improved [7,8]. Numerous interventions for improving balance are suggested in the literature, including neurodevelopmental weight shifting technique, gait training, visual reality balance training, task-specific training, obstacle stepping, and task-oriented balance training [9] .

Task oriented balance training is a goal-oriented practice of motor task for improving functional capabilities. It is an effective method for improving lower limb functions including balance, gait and gait speed. Task oriented balance training has been used for the lower extremity functional improvement in stroke patients [2, 4, 10].

Besides motor impairment sensory impairment in both upper and lower extremity is also an important contributor that affects the patient's recovery after stroke. It is already suggested in literature that if sensory training incorporated along with traditional training, then the better recovery can be achieved as sensory signals affects motor functions in stroke patients. Different types of sensory training have been used for stroke rehabilitation [11, 12].

Despite of the evidence that task-oriented training and sensory training can be beneficial to induce plasticity and improve motor recovery. However, limited evidence exists on combined effectiveness of these techniques in stroke rehabilitation. In this study we propose the hypothesis that combining the sensory stimulation with task specific training would yield more substantial benefits in terms of balance, postural stability, and mobility in post stroke patients. This research aims to explore the potential synergistic effects of combining these interventions, with the goal of introducing enhanced rehabilitative strategies to improve patient care and outcomes.

METHODOLOGY

This double blinded parallel armed randomized controlled trail (NCT-04468269) was conducted in RHS Rehabilitation Centre, Islamabad from 15th August 2019 to 29th January 2020 (RHS/EC/08/7/2019). Ethical approval was taken from Research Ethical Committee of Riphah College of Rehabilitation and Allied Health Sciences, Islamabad (Riphah/RCRS/REC/00558).

Male and female patients aged 40-65 years who had stroke from more than six months, had ability to understand and perform exercises, at grade II, III and IV on functional mobility scale were included in this study. Participants who had deficit of somatic sensation, presence of severe hemiplegia, vestibular disorder and presence of orthopaedic disease that involve the lower limb such as arthritis were excluded. Nonprobability convenience sampling technique was used for sample collection.

Sample size was n=60 calculated by using the effect size=0.56 of berg balance scale while keeping power at 80% and level of significance 0.05. A total n=72 participants were evaluated for eligibility criteria, n=12 was excluded due to not fulfilling it. Then n=60 participants were randomly divided into Control (n=30) and Experimental group (n=30) through flip coin method. There was n=6 dropouts in experimental group n=4 dropped out due to unwilling to continue, n=1 drop out due to head injury and n=1 due to leg fracture. There was n= 4 drop out in control group due to unwilling to continue. Finally, a total n=50 participants were included in the analysis. (Figure 1).

Subjects were evaluated at baseline after 4th and 6th week. The assessments were made through four outcome measures, Berg balance scale was used for the assessment of stability and balance (ICC =.98) [13], Activities specific balance confidence (ICC=0.82) [14] was used to assess confidence of participants while performing different mobile activities without fear of fall. Balance error scoring system was used to assess postural stability, participants are guided to perform single, double leg and tandem stance on hard surface and then on soft surface (ICC=0.82) [15]. Dynamic gait index was used to assess balance during gait and mobility in stroke patients (ICC=0.80) [16].

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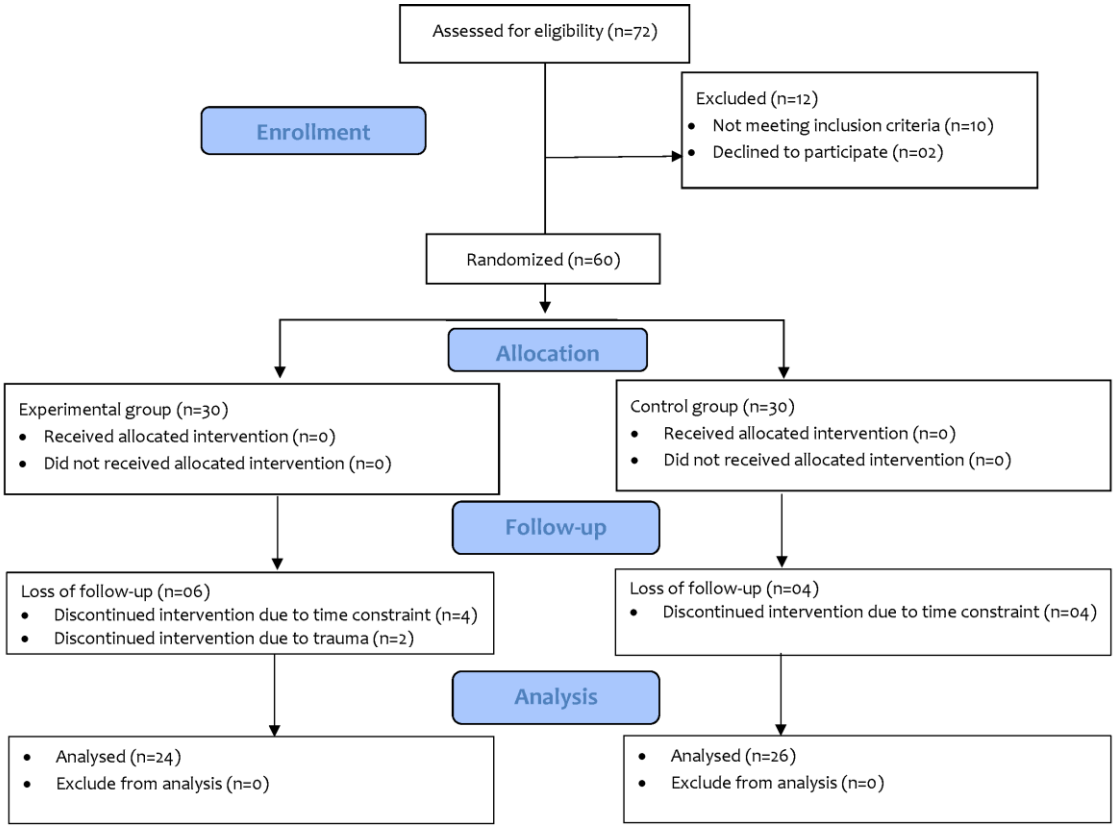

Figure 1: CONSORT diagram

Table 1: Intervention Protocol

Group A (40 Minutes)	Group B (40 Minutes)
In this group exercises performed with eyes open and hard surface.	In this group exercises for 1st and 2nd week performed under normal condition (with eyes open and hard surface). Exercises for 3rd and 4th week performed with eyes open and on soft surface (Foam 2.5 cm thick) Exercises for 5th and 6th weeks performed with eyes closed and on soft surface.
Sitting position: (7 Minutes) Sit in a chair without backrest while keeping the feet on floor. Sit on a ball while keeping the feet on the floor. **Sit to stand: (7 Minutes)** Sit in a chair without a backrest with and perform the sit-to-stand motion repeatedly. Sit on a ball and perform the sit-to-stand motion repeatedly. Standing position: (8 Minutes) Perform bipedal standing Control of Weight Shifting. Perform a semi-tandem stance. One Foot Standing. Walking: (8 Minutes) Walk forward Walk forward cross an obstacle, and then continue to walk. Walk Lateral Walk Backward Tandem walk Conventional treatment : (10 Minutes) Static stretching exercises such as trunk rotation, flexion, and extension; hip flexors stretch, standing hamstring stretch; plantar flexors stretch, shoulder, elbow and wrist flexors and supinator. Stretching applied for 30 sec hold with 30 sec rest. 5 times for each muscle group.	

Group A received task-oriented balance training (TOBT) alone. In this group the patients performed exercises for 40 minutes, 3 times/ week for 6 weeks. Intervention time consisted of 10 minutes of conventional training and 30 minutes of balance training. In this group the patients performed balance exercises under normal condition, eye open and on the hard surface.

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Group B received task-oriented balance training (TOBT) with sensory integration therapy Subjects performed 40 minutes exercises 3 times/ week for 6 weeks. That includes 10 minutes of conventional training and 30 minutes of balance training. In this group the patients performed balance exercises initially under normal condition (eye open and hard surface) and progression were made after two weeks and patient performed exercises under the eye closed and on a hard surface. (table 1)

Analysis was done through SPSS. Version.22. Normality of data assessed and according to Shapiro-Wilk test data was non normally distributed ($p<0.05$) for BBS, DGI, ABC Scale and normally distributed for BESS ($p\geq0.05$), Mann-Whitney U test and independent sample t test were applied for between group analysis. While Wilcoxon Sign rank test and paired sample t test were applied for within group pairwise comparison of BBS, DGI, ABC and BESS respectively.

RESULTS

The mean age of group A was 54.12±5.42 years and group B was 54.82±5.04 years. The n=17(67.7%) males and n=8(32.3%) females were in group A, while n=18(72%) males and n=6(27.6%) females were in group B. The mean of post stroke duration was 11.12 ±2.96 and 11.44±3.30 months for control and experimental group respectively.

Between groups comparison showed that there was no statistically significant difference between groups at base line but there was statistically significant difference between groups after 6 weeks of intervention for balance and mobility with greater improvement in experimental group for BBS and DGI ($p<0.05$). (Table 2)

Table 2: Comparison group A and group B (BSS, DGI, ABC, BESS)

		Baseline				After 6th week			
Outcome measures	**Groups**	**Md(IQR)/ x̄±σ**	**MR/MD**	**U-test**	**p-value**	**Md(IQR)/ x̄±σ**	**MR/MD**	**U-test**	**p-value**
Berg Balance Scale (BBS)	Group A	34(10)	29.19	409.00	0.53	36(10)	26.15	314.50	0.05
	Group B	34(7)	31.90			38(6)	35.16		
Dynamic Gait Index (DGI) for Mobility	Group A	14(5)	30.11	437.50	0.86	16(4)	24.55	265.00	.006*
	Group B	14(4)	30.91			18(3)	36.86		
Activities-Specific Balance Confidence Scale (ABC) for balance confidence	Group A	39(8)	30.84	449.00	0.99	36(5)	29.11	406.50	0.52
	Group B	38(5)	30.52			32(6)	31.98		
Balance Error Scoring System (BESS) for Postural Stability	Group A	37.61±6.99	-.042		0.99	34.16±5.61	2.02		0.50
	Group B	37.65±3.67				32.13±3.04			

*Significance level: p<0.05*p<0.01**, p<0.001****

Md-Median; IQR-Inter Quartile Range; x̄-Mean; σ-Standard deviation; MR-Mean Rank; MD-Mean difference

Within group analysis of experimental group showed statistically significant improvement from baseline to sixth week for balance and postural stability and mobility ($p<0.05$). Control group also displayed significant ($p<0.05$) improvement from baseline to sixth week for balance. (table 3)

Table 3: With-in group changes from baseline to 6th week in Group A and B:

		Group A (n=26)			Group B (n=24)		
Outcome measures	**Duration**	**Md(IQR)/ x̄±σ**	**MR/MD**	**p- value**	**Md(IQR)/ x̄±σ**	**MR/MD**	**p- value**
Berg Balance Scale (BBS)	0 week	34(10)	10.00	0.00***	34(7)	9.50	0.00***
	6 weeks	36(10)	16.00		38(12)	15.00	
Dynamic Gait Index (DGI) for Mobility	0 week	14(5)	10.22	0.00***	14(4.5)	11.79	0.00***
	6 weeks	16(4)	15.50		18(3)	14.94	
Activities-Specific Balance Confidence Scale (ABC) for balance confidence	0 week	41(23)	13.00	0.00***	43(20.5)	12.50	0.00***
	6 weeks	47(10)	16.00		51(21)	15.00	
Balance Error Scoring System (BESS) for Postural Stability	0 week	37.61±1.25	1.38	0.00***	37.65±0.68	2.10	0.00***
	6 weeks	34.16±1.01	3.45		32.14±0.56	5.51	

*Significance level: p<0.05*p<0.01**, p<0.001****

Md-Median; IQR-Inter Quartile Range; x̄-Mean; σ-Standard deviation; MR-Mean Rank; MD-Mean difference

DISCUSSION

The study aimed to determine the effects of task-oriented balance training with and without sensory integration in post stroke patients. The results of this study suggest that task-oriented balance training with sensory integration yielded greater effectiveness than task-oriented balance training alone. Notably, the experimental group exhibited significant improvements in balance as assessed by the Berg Balance Scale (BBS), Activities-specific Balance Confidence (ABC) scale, and Dynamic Gait Index (DGI) scales.

Balance is a multifactorial process that heavily relies on input from the sensory system, encompassing the visual, vestibular, and somatosensory systems. Following the stroke, the relative dependence of the sensory changes undergoes re-weighted in response to changes in the sensory environment, particularly when sensory information is integrated. This adaptive process may play a critical role in functional recovery of Stroke patients during balance training.

The finding of this study aligns with the previous research, such as that of Choi J-U et al., which supports the efficacy of task-oriented training as an

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intervention to improve not only balance but also activities of daily living (ADL) performance and self-efficacy in stroke patients. This emphasizes the broader implications of task-oriented training as a valuable approach in rehabilitation of lower extremity in stroke[17]. Ahn et al. concluded that task-oriented training for chronic stroke patients significantly improve balance and symmetrical weight bearing and lower extremity function [18].

Recent literature has reported that sensory integration is a critical factor for improving balance in stroke patients. It is reported that healthy individuals stand on a firm surface under good light conditions, they rely 70% on somatosensory information, 10% on visual information, and 20% on vestibular information. However, stroke patients rely particularly on visual information to maintain balance this is perhaps due to their inability to make accurate use of proprioceptors and somatosensory system. Therefore, stroke patients should be trained with altered sensory 'visual, vestibular, and somatosensory' inputs during balance exercises [17] .Hence, this study was conducted to target the somatosensory system through balance training with and without sensory integration, and effect of this type of training was assessed on the balance recovery, dynamic mobility and postural stability in patients with stroke.

Similarly the findings of this study are in accordance with studies conducted by, Jang SH et al. that balance training with sensory integration is more effective for improvement of balance and mobility in stroke patients by increase in muscle activity of gluteus medius and trunk extensors and also increase the limits of stability [19], Moreover, Bayouk et al. reported significant balance and mobility improvements in post stroke patients with task-oriented training program including sensory inputs after 8 week of intervention [2] .Similarly, study by Yelnik et al. and Morioka S et al also concluded that task-oriented exercises performed with altered sensory input had greater effects on patients balance than task-oriented exercises alone [10, 20]. Another study by Peterka RJ et al. reported that, the significant decrease in the medio-lateral sway during standing for the control condition (eyes open, firm surface) after sensory training was likely to be the result of the increased use of somatosensory, visual, and vestibular information when performing the various exercises under sensory deprivation conditions. This sensory compensation might have improved sensorimotor integration of postural control in the central nervous system, serving to activate and coordinate motor processes [21]. Additionally, Kuberan P et al. conducted that Task oriented training, known to be very effective in rehabilitation of stroke patients, when incorporated with altered sensory input are challenging in nature and progressively induce the patients to use lower limb somatosensory inputs to maintain balance [22].

Only six months post stroke patients were recruited in this study, potentially limiting the generalizability of the findings to acute and subacute stroke patients. To enhance the comprehensiveness of future research, it is recommended to include other patient groups in further studies.

The study did not focus on the retention effects of the intervention after the termination of treatment. To gain a more inclusive understanding of the long-term benefits of the task-oriented balance training with sensory integration, future studies should explore the retention effects of this training in post-stroke patients.

The scales used for assessment in this study were not subjective which might have introduced biasness in assessing the intervention's effects on balance and gait. Future research could employ objective assessment tools to provide more accurate and reliable measurements of the intervention's impact on post-stroke patients' balance and gait.

The study did not extensively explore the optimal duration and intensity of the task-oriented balance training with sensory integration. Further research could investigate into these aspects to determine the most effective parameters for maximizing the intervention's benefits.

CONCLUSION

This study concluded a significant improvement in task-oriented balance training with sensory integration group as compared to task-oriented balance training alone. The observed improvements in balance outcomes, as indicated by the BBS, ABC, and DGI scales, underscore the importance of integrating sensory information during rehabilitation exercises. Stroke patients' heavy reliance on visual information for balance emphasizes the need to incorporate altered sensory inputs during balance training. These findings contribute to the growing body of evidence supporting task-oriented training as an effective intervention to improve balance, ADL performance, and self-efficacy in stroke rehabilitation.

DECLARATIONS & STATEMENTS

Author's Contribution

AS: substantial contributions to Concept, Article review, Statistical Analysis
SI: Data collection, Draft preparation
SI and SB: interpretation of data for the study. Draft preparation
SW and HGK: draft review
AS, SI, SB, SW, HGK and HJ: revised it critically for important intellectual content.

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HJ: Review and Editing
AS, SI, SB, SW, HGK and HJ: final approval of the version to be published and agreement to be accountable for all aspects.
Of the work of ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. All authors contributed to the article and approved the submitted version.

Ethical Statement

The study conducted in RHS Rehabilitation Centre, Islamabad from 15th August 2019 to 29th January 2020 (RHS/EC/08/7/2019). Ethical approval was taken from Research Ethical Committee of Riphah College of Rehabilitation and Allied Health Sciences, Islamabad (Riphah/RCRS/REC/00558).

Consent Statement

Informed consent was obtained from all subjects involved in the study.

Data Availability Statement

The data presented in this study are available on request from the corresponding author.

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Funding Sources

None to declare.

Conflicts of Interest

None to declare.

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