ORIGINAL ARTICLE

Effects of postural and kinesthetic awareness on static standing balance and plantar pressure in chronic stroke: a randomized controlled trial

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Abstract

Objective: To determine effects of postural and kinesthetic awareness on plantar pressure and static standing stability in chronic stroke patients.

Method: The cross-sectional single-blind study was conducted at the University of Lahore Teaching Hospital, Lahore, Pakistan, from January 19 to March 2, 2023, and comprised stroke patients of both genders. aged 45-60 years having visual spatial neglect. They were randomised into control group A and experimental group B. Group A received routine physical therapy, while group B additionally received postural and kinesthetic awareness sessions. Static component of the Berg balance scale was used to measure balance, and PoData Stabiliometeric plate ("Chinesport, Italy") to measure plantar pressure. Data was analysed using SPSS version 25.

Results: Of the 52 patients, 26(50%) were in group A with mean age 51.97±4.37 years and mean weight 79.48±5.7kg. The remaining 26(50%) patients were in group B with mean age 50.69±4.41 years and mean weight 78.27±4.55kg. The outcome measures were significantly better in group B compared to group A ($p<0.05$).

Conclusion: Postural and kinesthetic awareness could possibly be a well-grounded rehabilitative strategy that may support and enhance the balance of individuals with chronic stroke.

Clinical Trial Number: The study was registered at the United States National Institutes of Health (ClinicalTrials.gov) with registration number NCT05915195

Key Words: Stroke, Postural balance, Proprioception, Kinesthetic sense, Perceptual disorders.

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Introduction

Stroke can be defined as a disease caused by loss of blood supply to the brain which could either be due to blockage of blood (ischaemic) or rupture of blood vessels (haemorrhagic).[1] According to the Stroke Recovery and Rehabilitation Roundtable Taskforce, the chronic stage lasts for more than 6 months.[2]

Common impairments resulting in chronic stroke are motor weakness, spasticity, clonus along with somatosensory deficits, and changes in spatial cognition regarding postural body pattern that mostly remain neglected. These impairments may contribute to postural instability that leads to unequal weight-bearing and weight-shifting patterns[3]. Visuospatial neglect (VSN) most likely is one of the impairments that is longitudinally associated with impaired sitting balance, standing balance and ambulation (walking, stair climbing up/down and transitions).[4]

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VSN is a disorder that is seen after an episode of stroke and can be characterised as impaired realisation or difficulty with describing, acknowledging or orienting towards stimuli given to the contra-lesional side. VSN can be defined as the neglect of visual stimuli, and it is the type of neglect that is very commonly seen and studied[5]. Paper and pencil tasks, such as line crossing, simple sketching and copying activities, are the standardised methods for assessing visual aspects of unilateral neglect.[6]

Studies have suggested that the occurrence of unrepresentative sitting equilibrium and sitting position to one side with the trunk moved towards the affected side is significantly more in stroke survivors with VSN. Hemi-neglect is an important element for controlling static and dynamic standing balance[7]. Stroke patients with VSN are significantly more dependent in many transitions, like bed-to-chair, shower/bath, toilet, etc[8]. A certain divergence of the centre of pressure in the medio-lateral direction is also seen in stroke patients that results in abnormal plantar pressure, more pressure on the affected side along the lateral heel and smaller toes, and less at the medial and central forefoot that results in unequal weight-bearing and weight-shifting patterns[9]. Normal values for plantar pressure distribution are as follows: 16.67% of the total body on 5th metatarsal,

33.33% of the total body on first metatarsal, and 50% of the total body weight on the heel.

Balance is a multicentre process achieved by inter-linkage of central proactive and reflexive mechanism assisted by joints, muscles, tendons and ligaments. In terms of the sense of posture, body is the frame of reference, surrounded by gravitational forces. Basic components of this frame of references are visual, vestibular, proprioceptive and somatosensory information adapted by motor feedback which are responsible for body's anticipatory and adaptive response to balance[10]. Postural and kinesthetic prompts entail the recognition of the parts of body's position with respect to itself or to the environment, and these prompts are useful for remembering the positions of objects in space[11]. Kinesthetic awareness means direct focus on certain sensory features of the body to perceive the external (exteroception) or internal (interoception) environment to retain the body's position and movement[12].

Exteroceptive body awareness is defined as the inferred information of the body relative to space and movement resulting from exteroceptive cues (e.g., vision, touch, and sound), proprioceptive and vestibular systems, and voluntary motor systems. Interception is defined as the perception of the body's inner state[4].

In spite of the fact that the relation between VSN and balance/mobility has been substantially explored, merging clinical and instrumental analysis of balance and gait performance has been recommended[13]. The current study was planned to determine effects of postural and kinesthetic awareness on plantar pressure and static standing stability in chronic stroke patients.

Patients and Methods

The cross-sectional single-blind study was conducted at the University of Lahore Teaching Hospital, Lahore, Pakistan, from January 19 to March 2, 2023. After approval from the institutional ethics review committee, the sample size was calculated using the World Health Organisation (WHO) calculator with level of significance 95% in the light of literature[14]. The sample was raised using non-probability purposive sampling technique. Those included were stroke patients of either gender aged 45-60 years having hemiparesis. The patients had their first episode of stroke ever, scored at least 9 on the static part of the Berg Balance Scale (BBS)[15], up to grade 2 on Modified Ashworth Scale (MAS) and at least 24 on the Mini-Mental State Examination (MMSE) scale.[16] Patients with psychological diseases, dementia, orthopaedic disorders, or any insufficiency that could influence balance were excluded. The study followed the Consolidated Standards of Reporting Trials (CONSORT) 2010 guidelines.[17]

After taking informed consent from the patients, they were randomised into control group A and experimental group B using the goldfish bowl method. Group A received routine physical therapy, including active-assisted range of motion (ROM) exercises, stretching exercises, strengthening and positioning.[18]

Group B received additionally received postural and kinesthetic awareness sessions in front of a mirror during which proper body positioning, movements and balance in sitting and standing position were emphasised by using interceptive and exteroceptive reinforcements (verbal, tactile and visual). Firstly, the patients performed therapeutic activities/exercise to achieve balance in the sitting position using a chair with armrest and feet planted. They progressed to sitting on the chair without armrest with feet planted. Once the patients achieved balance while sitting on the chair, they were shifted to sitting on a stool, followed by standing on parallel bars, and balance training in independent standing. The intervention in both groups was conducted 1 hour daily 5 times a week for 6 weeks.

The static component of BBS was used to measure static standing balance, while for the static plantar pressure evaluation, a stabiliometric plate (PoData) was used. The patients stood on the foot plate, without shoes and with opened eyes for 20 seconds. They were guided to look forward without moving or talking. The trail was considered negative and was done again if a patient changed the initial position, talked or moved a part of the body (head, arm/arms, heel or foot).[18]. Both the measurements were taken at baseline and post-intervention.

Data was analysed using SPSS version 25. Data normality was tested using Kolmogorov-Smirnov test, and it was found to be not normally distributed. Non-parametric tests were used to compare means between the groups. Mann Whitney U test was used to compare means between the group at baseline and post-intervention. Wilcoxson signed rank test was used to check intragroup improvement. $P<0.05$ was considered statistically significant.

Results

Of the 62 patients initially assessed, 52(83.9%) were included. Of them, 26(50%) patients were in group A with mean age 51.97±4.37 years and mean weight 79.48±5.7kg. The remaining 26(50%) patients were in group B with mean age 50.69±4.41 years and mean

Table-1: Demographic characteristics.

Variables	Experimental Group					Control Group				
	Mean	Std.Deviation	Min	Max.	N	Mean	Std.Deviation	Min	Max	N
Age	50.69	4.41	59	45	31	51.97	4.37	45	60	31
Total Weight (kg)	78.27	4.55	77	88	31	79.48	5.7	70	90	31

Table-2: Static balance analysis.

Groups		Baseline	P-value	6th week	P-values
Control	Mean	12.57	0.75	13.76	0.000
	SD	1.73		1.96	
Experimental	Mean	12.69		16.3	
	SD	1.84		2.25	

Table-3: Plantar pressure analysis.

Variable	Group		At baseline	P-value	At 6th week	P-values
Plantar Pressure at right foot	Control	Mean	39.33	0.31	38.11	0.000
		SD	1.88		2.58	
	Experimental	Mean	48.08		51.20	
		SD	8.12		9.3	
Plantar Pressure at Right 1st Metatarsal	Control	Mean	13.13	0.284	12.20	0.000
		SD	0.64		1.64	
Plantar Pressure at Right 1st Metatarsal	Control	Mean	13.13	0.284	12.20	0.000
		SD	0.64		1.64	
	Experimental	Mean	16.11		16.21	
		SD	2.54		3.87	
Plantar Pressure at Right 5th Metatarsal	Control	Mean	7.15	0.000	5.62	0.277
		SD	0.37		0.91	
	Experimental	Mean	9.80		8.11	
		SD	1.13		1.22	
Plantar Pressure at Right Heel	Control	Mean	19.68	0.337	19.35	0.000
		SD	0.96		1.41	
	Experimental	Mean	24.14		24.87	
		SD	3.81		4.59	
Plantar Pressure at Left Foot	Control	Mean	52.76	0.139	52.13	0.000
		SD	3.46		4.01	
	Experimental	Mean	48.39		48.30	
		SD	6.85		6.11	
Plantar Pressure on Left 1st metatarsal	Control	Mean	17.66	0.145	17.86	0.000
		SD	1.20		2.95	
	Experimental	Mean	16.06		16.16	
		SD	2.31		3.30	
Plantar Pressure on Left 5th metatarsal	Control	Mean	8.82	0.145	7.76	0.000
		SD	0.60		0.55	
	Experimental	Mean	8.06		6.64	
		SD	1.14		1.09	
Plantar Pressure on Left heel	Control	Mean	26.46	0.145	26.69	0.000
		SD	1.80		3.14	
	Experimental	Mean	24.19		24.61	
		SD	3.42		3.61	

weight 78.27±4.55kg (Table 1).

The outcome measures were significantly better in group B compared to group A (Tables 2-3).

Discussion

The current study showed that ffect of postural awareness on balance and plantar pressure were significant. A systematic review presented the evidence of 8 studies in which effect of postural awareness therapy on balance was investigated, with 7 studies suggesting that using body awareness therapy programme could bring a significant improvement in balance capacity of stroke patients, while in 1 study, the body awareness programme was less effective[20]. On the other hand, two studies revealed noticeable improvement in stroke patients with VSN and functioning[21].

The current results showed significant difference between the two groups. However, a study in 2012 reported no significant differences between postural awareness therapy with routine physical therapy and routine physical therapy alone. The study proposed that such an intervention for aged stroke sufferers might be laborious due to the complexity of the treatment[22]. Besides, 4 trials comparing postural awareness therapy with conventional physical therapy groups showed improvement in static balance and gait function[23].

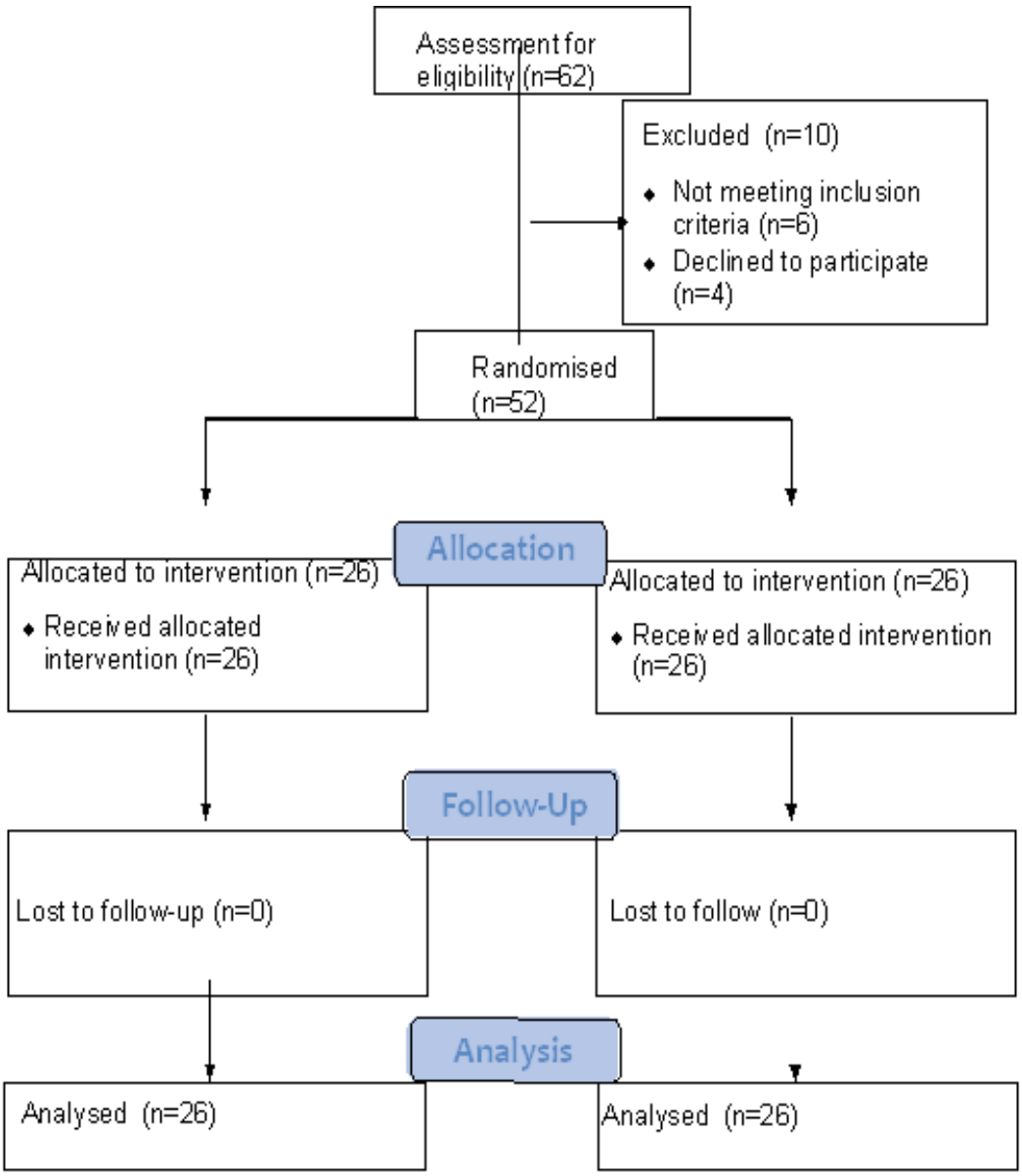

Figure: Consort Diagram.[17]

The current study used BBS to assess balance and PoData stabiliometric plate to assess planter pressure. Two studies using BBS[24, 25] and 2 other studies using PoData plate [26,27] supported the findings of the current study.

In the current study, 62 patients were divided into 2 equal groups, and the intervention lasted 5 times a week for 6 weeks. Another study with matching population, intervention, duration of intervention presented similar results.[28].

The current study showed that VSN was longitudinally associated with impaired balance and motor function. A study in 2014 also revealed that treatment strategies to improve VSN also improved post-stroke immobility and motor improvement[29].

A systematic review on the efficacy of different interventional modalities for the treatment of unilateral neglect in stroke survivors showed that mirror therapy, somatosensory electro-stimulation and virtual reality (VR) training were the most effective interventions for unilateral neglect in stroke patients that ultimately led to motor gains[30].

The current study had limitations as it was done at a single centre. The PoData foot plate, while proficient in evaluating pressure distribution, faces challenges due to external factors, such as footwear differences, varying postures and participant fatigue, all of which could have affected data accuracy. Additionally, the diversity in foot morphology and size among individuals presented a hurdle in terms of comparing data. Moreover, the static nature of measurements overlooked dynamic movements and real-life weight distribution patterns during various activities, which could have differed significantly from static assessments. Besides, the study was clinic-based and no home plan was given to the patients. Finally, there was no long-term follow-up. The generalisability of the current findings is not feasible, particularly with respect to different stages of stroke.

Conclusion

Postural and kinesthetic awareness could possibly be a well-grounded rehabilitative strategy that may support and enhance the balance of individuals with chronic stroke. Such a programme should be made a part of routine physical therapy in clinics and hospitals.

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Conflict of Interest: None.

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Authors' Contribution:
WR: Concept, design and writing.
SS: Revision, concept and final approval.
SL: Data collection and assembly.
SS: Editing, formatting, trial registration and submission.
MJ, MA: Data entering and analysis.