Evaluation of Trunk Balance in Stroke Patients – An Analytical Study

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Abstract

Background: Stroke is a major global health problem causing significant morbidity and mortality. The functional ability of stroke patients is largely influenced by the trunk function evaluated by trunk balance. Trunk assessment is crucial in predicting the clinical outcomes of stroke patients as well as in designing effective rehabilitation programs. Studies in this area are scarce.

Aim of the Study: To evaluate the trunk balance using the Berg balance scale (BBS) and trunk impairment scale (TIS) in stroke patients and to analyze the relationship if any between age, gender, duration, and type of stroke with trunk balance score in post-stroke survivors.

Study design: Observational study – analytical design.

Study setting: Carried out in the out-patients department of Santhosh College of Physiotherapy – Madurai, Tamil Nadu- India.

Methods: Thirty-five stroke patients participated. The trunk balance was evaluated by BBS and TIS. The trunk balance performance was analyzed statistically. The relationship of trunk balance with the basic characteristics of the stroke patients such as age, gender, type of stroke, and duration of stroke was also investigated by suitable statistical tools.

Results: The mean TIS was 15.40 ± 1.12 suggesting 67% of trunk balance performance in stroke patients. The mean BBS was 42.94 ± 1.39 with the corresponding trunk balance performance of 77%. There was no significant ($P > 0.05$) relationship between trunk balance with age, gender, duration & and type of stroke.

Conclusion: Stroke patients had considerable trunk balance deficits. The trunk balance in stroke patients is not influenced by age, gender, duration, or type of stroke.

Keywords: Stroke patients, Berg balance scale, Trunk impairment scale, Observational study.

Introduction

Stroke is a major global health problem responsible for significant morbidity and mortality, particularly in low-middle-income countries (LMICs).1 Stroke is defined as a clinical syndrome marked by sudden features of focal or global disturbance of cerebral functions, lasting more than 24 hours and leading to death with no apparent cause other than vascular origin.2 It is India's fourth leading cause of death and the fifth leading cause of disability.3 The global burden of disease, injuries, and risk factors study (GBD) 2017 demonstrated that stroke was the second leading cause of death globally in 2017. It is further stated that stroke stands 3rd in the combined cause of death and disability as measured by disability–adjusted life years (DALYs) globally in 2017.4 The recent analysis of cross-sectional studies has estimated that the incidence of stroke in India is between 105 and 152/100,000 people per year.5

Stroke causes contralateral (opposite side) limb muscle weakness contributing to poor motor recovery. Quite the contrary, trunk musculature is involved bilaterally and adversely contributes to balance and functional ability in stroke survivors. Recruitment of trunk muscle activity begins earlier than limb movements during various tasks and continues to do so even after the limb movement's stop. Hence trunk activities are very crucial in dynamic balance and functional tasks. In stroke patients, as bilateral trunk musculature is affected, the proximal spinal stabilization for limb movements is lost and patients continued to perform the activities in the spastic synergy patterns. This loss of fixation is the factor for distal spasticity in stroke patients.

Trunk muscle strength is shown to be affected multidirectional in hemiplegic patients. There is a weakness of trunk flexors and extensors as well as trunk rotators and lateral flexors measured by hand-held dynamometer.6 EMG studies have demonstrated the anticipatory postural adjustment in axial–lateral and posterior-anterior trunk muscles during upper and lower limb activities in stroke patients suggesting that there is a major impairment of activities of trunk muscles for them.7 Detailed investigations has revealed that there is a reduction in the activity of the lateral trunk muscles associated with delayed onset and a reduction in the synchronized activation of pertinent muscle pairs. The reduction in EMG activity is also noted in the latissimus dorsi and external oblique muscles of the affected side.7 The interesting finding is that motor and functional deficits are largely influenced by this defect.8

It is demonstrated that weakness of trunk muscles in stroke patients has a major influence on the balance difficulty in these patients.9 It is found that lateral sitting balance is worst affected in stroke patients compared to anteroposterior direction.10 This is because the leg muscle supports trunk stabilization in an anteroposterior direction whereas trunk muscle strength is solely responsible for providing lateral sitting balance.10 Poor balance is the reason for falls in stroke survivors and is a predicament for reduced functional performance in these patients.11 Recent studies have shown that walking and balance in stroke patients are by and large dependent on the trunk function measured by the trunk impairment scale.12 It is further noted that trunk function is the grave functional predictor at discharge in stroke survivors.13,14 It is demonstrated that stroke patients with poor trunk function at admission are found to stay longer in the rehabilitation ward compared to a patient with good initial trunk function.14 It is further observed from a multi-center study that is significant positive correlation is observed between good sitting balance at admission and better functional ability measured at discharge. It is also documented that initial balance scores are important predictors of Barthel index score at 6

months after stroke.13,15 According to a statistical point of view, the trunk impairment scale (TIS) and static sitting balance subscales are found to be an important predictor than the Barthel index itself on admission to the rehabilitation center.13

Even though trunk performance is crucial for the balance and functional performance of stroke patients, studies evaluating trunk muscle performance in stroke patients are still scarce. It is understood that trunk function assessment post-stroke is essential to predict the clinical outcome of stroke patients as well as crucial in designing an effective rehabilitation protocol. Hence, this is a need of hour to carry out extensive research on the investigation of trunk balance in stroke patients.

The Berg balance scale (BBS) is found to be the most commonly used balance scale in stroke patients from acute care to community-based care. A systemic review of BBS in stroke patients has identified that it has a strong psychometric property with moderate to excellent reliability and good validity.16,17 Trunk impairment scale (TIS) is a trunk-specific evaluation measure in stroke patients. This scale was developed recently for the evaluation of static and dynamic sitting balance and trunk coordination in a sitting position. It is found to be sufficient reliability, validity, and internal consistency in the clinical practice of stroke patients.18,19

The present study aimed to evaluate the trunk balance using BBS and TIS in stroke patients. Additionally, the relationship of age, gender, duration, and type of stroke with trunk balance was also investigated.

Methods

Study Patients

Thirty-five stroke patients were selected based on the following selection criteria.

Inclusion criteria

- Age – 30 to 70 years
- Stroke duration between 3 to 9 months.
- Unilateral stroke patients confirmed by computerized tomography (CT) or by magnetic resonance imaging (MRI).
- Both ischemic and hemorrhagic stroke types.
- Both genders were chosen.
- Patients who were able to sit upright were only chosen.
- Patients who can stand independently for 30 seconds without a mobility aid.

Exclusion Criteria

- Medically unstable patients
- The patient underwent lower limb orthopedic surgeries.
- Patient with lower limb prosthetics or ankle foot orthosis.
- History of other neurological conditions that influence balance.
- History of Vertigo

Study Design

Observational study – analytical design.

Study Setting

The study was conducted in the Santosh College of Physiotherapy – Madurai – Tamil Nadu, India.

Ethical Clearance

The ethical clearance for the study was obtained from the institutional human ethics committee of Santosh College of Physiotherapy – Madurai – Tamil Nadu, India.

Informed Consent

The study purpose and methods were clearly explained to each patient. The written voluntary consent for participation was obtained from the patient before the commencement of the study. It was at par with the Declaration of Helsinki.

Sample – Size - Estimation

It was estimated by the sample size equation suitable for observational study. The standard deviation of two outcome measures used for the current study viz. (i) Berg balance scale (BB) and (ii) Trunk impairment scale (TIS) was calculated from the previous studies of a similar kind. The confidence interval was fixed as 95% with the corresponding value of 1.96. The sample size formula used was

$$N = \left(\frac{SD}{Confidence\,\text{int}\,erval} \right)^2$$

Where N is the sample size required, SD – standard deviation.

∴ The SD of BBS was found to be 11 in the previous studies and the SD of TIS was found to be 6.

The highest value 11 was taken as the SD.

$$N = \left(\frac{11}{1.96} \right)^2 = 32.$$

Hence, sample size required was 32.

Study Procedure

After collecting basic information such as age, gender, type of stroke, and duration of condition, the patient's trunk balance was evaluated by BBS and TIS. It was evaluated by an experienced physiotherapist who had more than 15 years of service in neurological assessment and rehabilitation. The level of trunk balance in stroke patients was analyzed statistically by descriptive analysis. The relationship of trunk balance concerning age, gender, type of stroke, and its duration was analyzed by Pearson's correlation coefficient, Mann-Whitney 'U' test, and Chi-square test.

Berg Balance Scale (BBS)16,17

The patient's balance ability was evaluated by a series of predetermined tasks. It consisted of 14 items with each item ranging from 0 to 4 where 0 was the lowest level of function and 4

was the highest level of function. The materials used for evaluation include a ruler, 2 standard chairs one with armrests and one without armrests, a footstool or stepper, 15 feet walkway, and a stopwatch.

In most of the items, patients were asked to maintain a given position for a specified time. Scoring was recorded by the lowest response category that well suited each item. The score was deducted if the time or distance requirements were not met, the patient's performance warrants supervision, the patient touched external support or required assistance from the examiner. The patients were educated that they must maintain their balance while doing the tasks. The choice of which leg to stand on or how far to reach is left to the patient to decide. Their judgment was crucial in the performance and scoring. A score of 56 indicates functional balance a score of <45 indicates a greater risk of falling.

Trunk Impairment Scale (TIS)18,19

It consisted of static and dynamic sitting balance and coordination items. The minimum score was '0' and the maximum score was '23'. Three attempts were provided for each item and the best performance score was taken. The static balance was evaluated by the ability of the patient to maintain a sitting position with feet supported, and legs crossed passively and actively. Dynamic balance was evaluated by lateral trunk flexion and unilateral lifting of the hip. Coordination was tested by instructing the patient to rotate the upper and lower part of the trunk six times initiating the movements from the shoulder girdle or the pelvic girdle. For each item a 2-,3-, or 4- point ordinal scale was used.

Results

The basic characters of the study patients are shown in Table – 1.

Table – 1: Basic characters of the study patients

Age (M, S.D.)	51.66	7.89
Duration (M, S.D.)	7.71	1.13
Gender (N, %)		
Male	29	82.9
Female	6	17.1
Side (N, %)		
Right	7	20
Left	28	80

M – mean, S.D. – standard deviation, N – number, % - percentage

The common site of stroke in the present study was posterior cerebral artery (37.1%) followed by cerebellar infarction (20%) as shown in Fig.1.

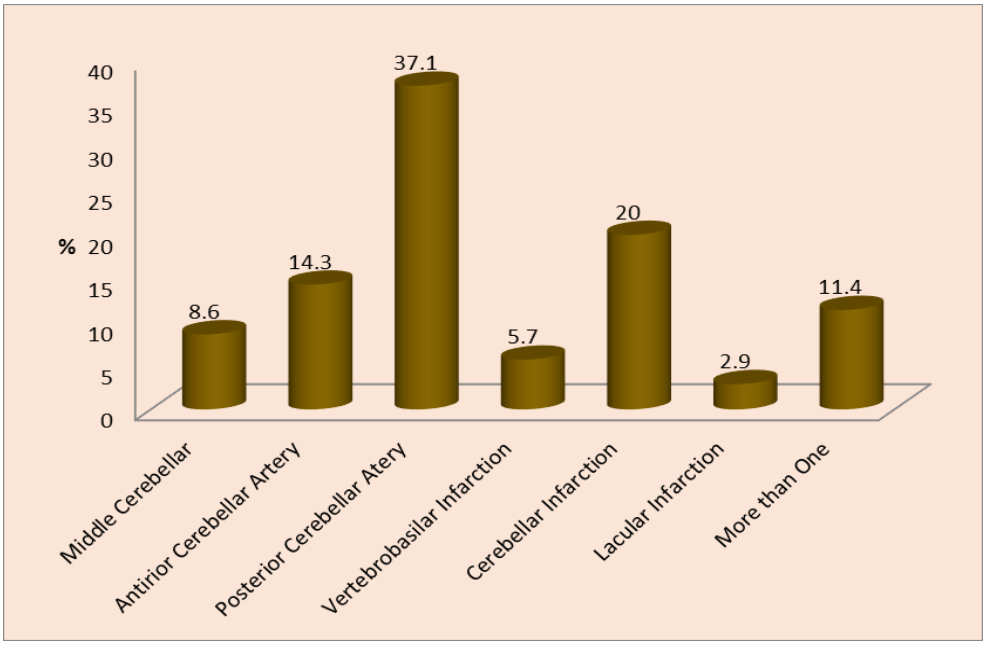

Fig. 1 Site of stroke

The data regarding performance of trunk balance is shown in Table – 2.

Table – 2: Trunk balance assessment – descriptive statistics

Balance Evaluation	M	S.D.	Balance Performance in Percentage
Trunk Impairment scale	15.40	1.12	67
Berg balance scale	42.94	1.39	77

M – mean, S.D. – standard deviation

The level of performance of the study patients with reference to TIS was 67% whereas in BBS it was 77%. The relationship of balance score with age and duration of the condition is shown in Table – 3.

Table – 3: Relationship of age and duration of the condition with level of balance performance

Characters	Trunk Impairment		Berg balance scale	
	r	p	r	p
Age	-0.03	0.846	-0.31	0.070
Duration	-0.09	0.593	-0.07	0.702

r – Pearson's correlation coefficients, p - probability

There was negative correlation between age and both trunk impairment scale and berg balance scale suggesting that as age advances balance was low and vice-versa but this relationship was statistically insignificant. There was no significant relationship was observed between duration of the condition and balance performance. The relationship of gender and side of involvement with the balance performance is presented in Table – 4.

Table – 4: Relationship of gender and side of involvement with trunk balance performance

Characters	Trunk impairment scale				Berg balance scale			
	M	S.D.	Z	P	M	S.D.	Z	P
Gender								
Male	15.48	1.12	0.95	0.342	43.00	1.28	0.56	0.577
Female	15.00	1.09			42.67	1.97		
Side								
Right	16.00	0.82	1.60	0.110	43.43	1.27	1.01	0.312
Left	15.25	1.14			42.82	1.41		

M – mean, S.D. – standard deviation, Z – Mann-Whitney 'U' test, P - probability

The mean balance performance for male patients in TIS was 15.48 ± 1.12 and it was 15.00 ± 0.95 for female patients. There was no significant difference in the balance performance in BBS between male and female patients. It is revealed that there was no significant difference in the trunk balance performance with reference to side of involvement.

Discussion

The current study results showed that the level of trunk balance performance was 67% concerning TIS, with a mean score of 15.40 ± 1.12. The level of trunk performance was 77% concerning BBS, with a mean score of 42.94 ± 1.39. Kong KH et. al. have identified that mean trunk balance performance by TIS was 17.2 ± 5.2 in their study.20 The author had identified trunk balance performance after vigorous rehabilitation training for up to 2 months after the onset of stroke. But in the present work, TIS was evaluated randomly between 3 months to 9 months following the onset of stroke irrespective of whether the patients had been involved in the rehabilitating training or not. Hence the mean TIS of the current patients was comparatively low. Ahmed et al., have identified a mean TIS of 11.69 ± 3.01 in their work.21 It was comparatively lower compared to the present work. The mean duration of the condition of their study was 07.2 ± 3.27 months more or less similar to the present work. The severity of the stroke and the site of the lesion could have played a role in causing a difference in the TIS between the current work and the study by Ahmed U et. al.21

The mean BBS of stroke patients in the study conducted by Ahmed U was 35.83 ± 7.10 and it was comparatively less than the present work.21 The current study results concerning BBS were correlated well with the study by Patterson KK et. al., who identified a mean BBS of 45.7 ± 9.3.22 It is inferred from the current study that trunk balance performance based on TIS was 67% for the stroke survivors. TIS evaluate static as well as dynamic sitting balance as well as coordination of trunk movement. Stroke survivors had still a loss of considerable proportions (33%) of trunk balance based on the TIS score. The performance of trunk balance with respect to BBS was better (77%) when compared to TIS in the present study. Previous studies have also found that BBS performance was better compared to TIS in stroke survivors.21 But in BBS, a score of 56 (maximal score) is needed for functional balance. Even though the patient had achieved 77% of performance in BBS, the mean score was 42.94 ± 1.39. A score of at least 45 is needed in BBS for prevention of fall risks, as this is not the case in the present finding, stroke survivors are still belonging in the category of high risk of falling.

The present work has shown that age, gender, duration of the stroke, and side of involvement are not independent predictors of trunk balance in stroke patients. Therefore, the severity of the stroke, the site of the lesion, and initial motor level and trunk balance could have been factors in the present physical performance of the stroke patients. More extensive work is warranted in this regard. The present study revealed that stroke survivors had short trunk balance. Good trunk balance is the prerequisite for ambulation and functional activity in stroke patients. The need of the hour is to introduce a novel method of physical therapy approach to enhance trunk balance in stroke survivors. A comprehensive, in-depth research is warranted in this area.

Conclusion

It is concluded that stroke patients have considerable trunk balance deficit evaluated by the trunk impairment scale and Berg balance scale. It is identified that the trunk balance of stroke patients is not influenced by age, gender, duration, and type of stroke. It is suggested to carry out a sound randomized controlled trial to investigate the novel physiotherapeutic strategies for improving trunk balance in stroke survivors.

References

1. Adogu PO, Ubajaka CF, Emelumadu OF, Alutu CO. Epidemiologic transition of diseases and health-related events in developing countries: a review. American Journal of Medicine and Medical Sciences. 2015;5(4):150-7.
2. Warlow CP. Epidemiology of stroke. Lancet. 1998 Oct;352 Suppl 3:SIII1-4. doi: 10.1016/s0140-6736(98)90086-1. PMID: 9803954.
3. Directorate General of Health Services: Ministry of Health and Family Welfare. National Programme for Prevention and Control of Cancer, Diabetes, Cardiovascular Diseases and Stroke. *Government of India* 2019, July 13, https://main.mohfw.gov.in/Major-Programmes/non-communicable-diseases-injury-trauma/Non-Communicable-Disease-II/National-Programme-for-Prevention-and-Control-of-Cancer-Diabetes-Cardiovascular-diseases-and-Stroke-NPCDCS (2019, accessed 21 September 2020).
4. Krishnamurthi RV, Ikeda T, Feigin VL. Global, Regional and Country-Specific Burden of Ischaemic Stroke, Intracerebral Haemorrhage and Subarachnoid Haemorrhage: A Systematic Analysis of the Global Burden of Disease Study 2017. Neuroepidemiology. 2020;54(2):171-179. doi: 10.1159/000506396. Epub 2020 Feb 20. PMID: 32079017.
5. Kamalakannan S, Gudlavalleti ASV, Gudlavalleti VSM, Goenka S, Kuper H. Incidence & prevalence of stroke in India: A systematic review. Indian J Med Res. 2017 Aug;146(2):175-185. doi: 10.4103/ijmr.IJMR_516_15. PMID: 29265018; PMCID: PMC5761027.
6. Bohannon RW. Lateral trunk flexion strength: impairment, measurement reliability and implications following unilateral brain lesion. Int J Rehabil Res. 1992;15(3):249-51. PMID: 1428392.
7. Pereira LM, Marcucci FC, de Oliveira Menacho M, Garanhani MR, Lavado EL, Cardoso JR. Electromyographic activity of selected trunk muscles in subjects with and without hemiparesis during therapeutic exercise. J Electromyogr Kinesiol. 2011 Apr;21(2):327-32. doi: 10.1016/j.jelekin.2010.10.003. Epub 2010 Nov 10. PMID: 21071243.

8. Dickstein R, Shefi S, Marcovitz E, Villa Y. Anticipatory postural adjustment in selected trunk muscles in post stroke hemiparetic patients. Arch Phys Med Rehabil. 2004 Feb;85(2):261-7. doi: 10.1016/j.apmr.2003.05.011. PMID: 14966711.
9. Karatas M, Cetin N, Bayramoglu M, Dilek A. Trunk muscle strength in relation to balance and functional disability in unihemispheric stroke patients. Am J Phys Med Rehabil. 2004 Feb;83(2):81-7. doi: 10.1097/01.PHM.0000107486.99756.C7. PMID: 14758293.
10. van Nes IJ, Nienhuis B, Latour H, Geurts AC. Posturographic assessment of sitting balance recovery in the subacute phase of stroke. Gait Posture. 2008 Oct;28(3):507-12. doi: 10.1016/j.gaitpost.2008.03.004. PMID: 18424149.
11. Mackintosh SF, Hill K, Dodd KJ, Goldie P, Culham E. Falls and injury prevention should be part of every stroke rehabilitation plan. Clin Rehabil. 2005 Jun;19(4):441-51. doi: 10.1191/0269215505cr796oa. PMID: 15929514.
12. Verheyden G, Vereeck L, Truijen S, Troch M, Herregodts I, Lafosse C, Nieuwboer A, De Weerdt W. Trunk performance after stroke and the relationship with balance, gait and functional ability. Clin Rehabil. 2006 May;20(5):451-8. doi: 10.1191/0269215505cr955oa. PMID: 16774097.
13. Verheyden G, Nieuwboer A, De Wit L, Feys H, Schuback B, Baert I, Jenni W, Schupp W, Thijs V, De Weerdt W. Trunk performance after stroke: an eye catching predictor of functional outcome. J Neurol Neurosurg Psychiatry. 2007 Jul;78(7):694-8. doi: 10.1136/jnnp.2006.101642. Epub 2006 Dec 18. PMID: 17178824; PMCID: PMC2117706.
14. Duarte E, Marco E, Muniesa JM, Belmonte R, Diaz P, Tejero M, Escalada F. Trunk control test as a functional predictor in stroke patients. J Rehabil Med. 2002 Nov;34(6):267-72. doi: 10.1080/165019702760390356. PMID: 12440800.
15. Di Monaco M, Trucco M, Di Monaco R, Tappero R, Cavanna A. The relationship between initial trunk control or postural balance and inpatient rehabilitation outcome after stroke: a prospective comparative study. Clin Rehabil. 2010 Jun;24(6):543-54. doi: 10.1177/0269215509353265. PMID: 20511303.
16. Alghadir AH, Al-Eisa ES, Anwer S, Sarkar B. Reliability, validity, and responsiveness of three scales for measuring balance in patients with chronic stroke. BMC Neurol. 2018 Sep 13;18(1):141. doi: 10.1186/s12883-018-1146-9. PMID: 30213258; PMCID: PMC6136166.
17. Miranda-Cantellops N, Tiu TK. Berg Balance Testing. 2023 Feb 17. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2023 Jan–. PMID: 34662032.
18. Verheyden G, Nieuwboer A, Mertin J, Preger R, Kiekens C, De Weerdt W. The Trunk Impairment Scale: a new tool to measure motor impairment of the trunk after stroke. Clin Rehabil. 2004 May;18(3):326-34. doi: 10.1191/0269215504cr 733oa. PMID: 15137564.
19. Sorrentino G, Sale P, Solaro C, Rabini A, Cerri CG, Ferriero G. Clinical measurement tools to assess trunk performance after stroke: a systematic review. Eur J Phys Rehabil Med. 2018 Oct;54(5):772-784. doi: 10.23736/S1973-9087.18.05178-X. Epub 2018 Apr 20. PMID: 29684980.
20. Kong KH, Ratha Krishnan R. Truncal impairment after stroke: clinical correlates, outcome and impact on ambulatory and functional outcomes after rehabilitation. Singapore Med J. 2021 Feb;62(2):87-91. doi: 10.11622/smedj.2019153. Epub 2019 Dec 2. PMID: 31788705; PMCID: PMC8027135.

21. Ahmed U, Karimi H, Amir S, Ahmed A. Effects of intensive multiplanar trunk training coupled with dual-task exercises on balance, mobility, and fall risk in patients with stroke: a randomized controlled trial. J Int Med Res. 2021 Nov;49(11):3000605211059413. doi: 10.1177/03000605211059413. PMID: 34812070; PMCID: PMC8647262.
22. Patterson KK, Inness E, McIlroy WE, Mansfield A. A Retrospective Analysis of Post-Stroke Berg Balance Scale Scores: How Should Normal and At-Risk Scores Be Interpreted? Physiother Can. 2017;69(2):142-149. doi: 10.3138/ptc.2015-73. PMID: 28539694; PMCID: PMC5435391.