International Journal of Health Sciences and Research
www.ijhsr.org ISSN: 2249-9571

Original Research Article

Sit to Stand Performance across Three Attentional Loading Conditions and Its Correlation with Trunk Impairment in Stroke Patients - A Cross Sectional Study

Subash Palanisamy[1], Raja Regan[2]

[1]Senior Physiotherapist, Department of Physical Medicine and Rehabilitation, PSG Hospitals, Coimbatore, India
[2]Associate Professor, Department of Clinical Physiotherapy subjects, PSG College of Physiotherapy, Coimbatore, India

Corresponding Author: Subash Palanisamy

ABSTRACT

Stroke subjects show poorer sit-to-stand performance when compared to matched-healthy subjects, but it is still unclear about the role of trunk in this poorer performance. Also, little is known about the effects of attentional loading on performance of sit to stand in individuals with stroke. The aim of the study was to determine the sit to stand performance of stroke patients across three attentional loading conditions (Single, Dual Motor and Dual cognitive) and to determine whether their performance during dual task of the sit to stand task is correlated with level of trunk impairment. A total of 52 stroke patients and 20 normal healthy adults participated in the study. The Five Time Sit to Stand (FTSTS) test was conducted under three attentional loading conditions in random order and level of trunk impairment (Trunk Impairment Scale) was measured. The Pearson correlation coefficient was used to evaluate the relationship between these variables. A repeated measures ANOVA was used to measure the difference in FTSTS test across three attentional loading conditions. A repeated measures ANOVA determined that mean FTSTS test scores differed statistically significant between the three attentional loading conditions (F= 58.095, P < 0.0005). A Pearson product-moment correlation analysis shows that there is a strong, negative correlation between single task(r=-0.848, p<.005), dual motor(r=-0.858, p<.005), dual cognitive(r=-0.772, p<.005) five FTSTS test scores and trunk impairment variable, which is statistically significant. These findings suggest that there is a decline sit to stand performance during dual task conditions which is associated with trunk impairment in individuals with stroke.

Keywords: Sit to Stand, Trunk Impairment, Five Times Sit To Stand test, Dual Tasks, Stroke

INTRODUCTION

Stroke is a common health care problem globally, and it is a leading cause of long term disability worldwide with an enormous socioeconomic burden. In India, stroke leads to 10 disability-adjusted life years (DALYs) loss per 1000 population. [1] Stroke-related impairments affect the patient's independence with functional activities both at home and community, when performing activities of daily living (ADL), where only a minority of patients is able to return to their professional lives. After stroke, individuals are usually present with motor, sensory, cognitive and perceptual impairments, that limits their ability to perform functional activities such as sit to stand, standing and walking, which is considered a fundamental prerequisite for daily activities and is commonly compromised. [2]

Sit to stand is a complex transitional movement from a stable (sitting) to an unstable (standing) position, requiring coordination between trunk and lower limb movements, muscle strength, and balance control. [3,4] Among the healthy elderly, sit-to-stand (STS) movement largely depends on: (a) trunk bending momentum, (b) centre of gravity (CG) position before the body rises and (c) lower limb extensor muscle strength. [5,6] The transfer from sit-to-stand (STS) is a major functional ability, which is extensively affected in stroke individuals. On kinetic assessment of the sit to stand movement done using an force platform, it was found that hemiplegic stroke patients took longer time to complete the movements of both rising up and sitting down compared to healthy individuals and it contribute to the incidence of falls in this population. [7]

Proximal stability of the trunk is a prerequisite for distal head and limb movement and therefore expected to be related to functional ADL. Trunk performance is an important predictor of functional recovery at 6 months after stroke. [8,9] Stroke subjects have difficulties in generating and maintaining the velocity of trunk's Centre of mass during the sit to stand transfer, which may be associated with impairments of trunk muscles. [10]

In order to be able to adapt to a challenging environment, stroke survivors may be required to learn highly complex skills like performing dual task such as performing sit to stand while carrying objects or answering phone calls. Hence the evaluation of sit to stand performance under dual task conditions is essential. Exploration of these associations is important for guiding the development of intervention for stroke survivors.

Considering the impairments of trunk and limitations in sit to stand performance in stroke subjects, it is possible that these limitations are related to one other. Hence this study aimed at a) To find differences in sit to stand performance across three attentional loading conditions in stroke patients b) To find correlation between sit to stand performance and trunk impairment in stroke patients.

METHODOLOGY

2.1 Participants: A total of 52 stroke patients and 20 normal healthy adults participated in the study. Participants were recruited from the Stroke Rehabilitation Centre, Department of Physical medicine and Rehabilitation and Department of Neurology in PSG IMS&R Hospitals, Coimbatore. Stroke Patients were included if they met the following criteria: (1) Post stroke duration within one year as diagnosed by physician (2) Fugl-Meyer lower extremity assessment score of 26 & above (3) ability to perform sit to stand activity independently for five times (4) able to follow the commands (5) ability to hold a glass of water in the unaffected side upper extremity (6) ability to do a simple arithmetic calculation of counting backwards. Participants were excluded if they had more than one stroke, other neurologic disorders (e.g., Parkinson's disease and traumatic brain injury), and severe orthopedic conditions (e.g., joint deformities, osteoarthritis, and rheumatoid). They were also excluded if they had visual field defects or scored less than 24 in the Mini-Mental State Examination (MMSE). The study was approved by the Institutional Human Ethics Committee, PSG Institute of Medical Sciences and Research. All the participants signed written informed consent prior to participation.

2.2 Outcome measures: This is a cross-sectional study design. We measured participants' cognitive function with MMSE, level of trunk impairment with Trunk Impairment Scale (TIS) and sit to stand performance with five times sit to stand test. Trunk Impairment Scale for patients after stroke was designed to measure ADL related selective trunk movements. The TIS assesses static and dynamic sitting balance and trunk coordination. [11] The FTSTS test has been introduced as an outcome measure in studies investigating strength training and

functional performance in subjects with chronic stroke, as well as cross-sectional studies evaluating the association of disabilities and falls in population with stroke. The test has been shown to have excellent intrarater reliability (intraclass correlation coefficient [$ICC_{3,1}$] = 0.970 − 0.976), interrater reliability ($ICC_{3,2}$ = 0.999), and test-retest reliability ($ICC_{2,1}$ = 0.994 − 1.000) in individuals with chronic stroke. [12] The test requires the subject to stand up and sit down five times as quickly possible from a chair (height of 43-45 cm) and the time taken to complete a test is noted.

2.3 Procedures: Data were collected using a stopwatch. A 5-minute rest was given between tests to minimize any fatigue effects. Participants performed one practice trial to familiarize themselves with the test before implementing the real trial. The test consisted of 3 conditions which were administered in a random order.

(i) Single task FTSTS test: During a single task condition, participants performed the FTSTS test only (without a secondary task) with a standard chair (height of 43-45 cm) without arm rest.

(ii) Dual motor task FTSTS test: In this condition, participants performed the FTSTS test while holding a glass of water in the unaffected side upper extremity. They were instructed not to spill the water while performing the test.

(iii) Dual cognitive task FTSTS test: In this condition, participants performed the FTSTS test simultaneously performing an arithmetic calculation of counting backwards from 100, using subtractions of 3.

2.4 Statistical analysis: The statistical analysis was done using the IBM SPSS version16. Paired 't' test was used to measure difference in time taken to complete five time sit to stand test scores under three attentional loading conditions between stroke and age matched healthy subjects. Pearson correlation coefficient (r) was used to measure the relationship between trunk impairment scale and time taken to complete dual task five times sit to stand scores. The strength of the relationship between the variables was based on Portney and Watkins's guidelines. Repeated measures ANOVA was used to measure difference between three variations of FTSTS test scores in stroke subjects. The significance level for all analyses was set at 0.05.

RESULTS

A total of 52 participants including 38 male and 14 female subjects successfully completed all the four tests involved in the study. Table 1 shows the General characteristics of stroke participants. The time taken to complete single task, dual motor task and dual cognitive task FTSTS test varied significantly between stroke and age matched healthy subjects with a mean difference of 8.22, 9.89 and 12.42, standard deviation of 3.11, 5.16 and 6.47 respectively. The calculated 't' value using paired test between stroke and age matched healthy subjects for single task, dual motor task and dual cognitive task FTSTS test scores were 11.813, 8.574 and 8.574 respectively, which was greater than table 't' value of 2.093 at P<0.001

ITEM	N=52
Age (years)	52.7 ± 6.6
Post Stroke Duration(Days)	70 ± 85.3
Gender(Male/Female)	38 (73%)/14 (27%)
Stroke Lesion(Ischaemic/Hemorrhagic)	43 (82%)/9 (18%)
Hemiparetic side(Right/Left)	25 (48%)/27 (52%)
Fugl Meyer Score of Lower extremity	74.3 ± 10.2.

TABLE 1: General characteristics of stroke participants

TABLE 2: Comparison of Values of five time sit to stand scores between individuals with stroke and age matched healthy individuals.

Groups	Mean(Seconds)	Mean Difference	Standard Deviation	't' Value	'p' Value
Single task FTSTS Stroke Normal	 16.33 8.11	8.22	3.11	11.813	P<0.001
Dual Motor task FTSTS Stroke Normal	 18.58 8.69	9.89	5.16	8.574	P<0.001
Dual Cognitive task FTSTS					

Stroke Normal	21.63 9.21	12.42	6.47	8.574	P<0.001

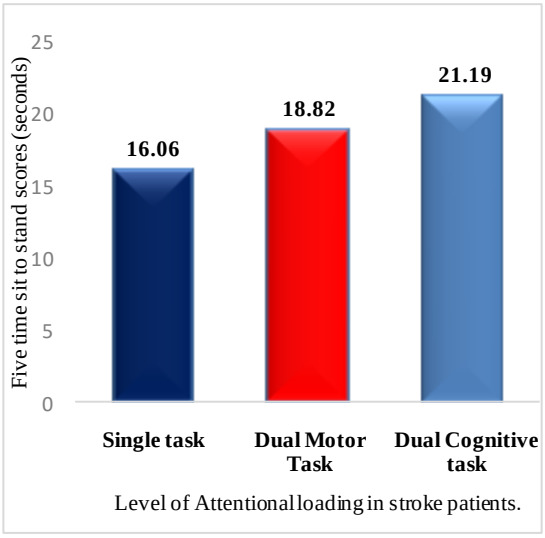

FIGURE1: Graphical representation of mean value of time taken to complete FTSTS scores under three attentional loading conditions in stroke subjects.

In FTSTS test, stroke subjects took longer time for dual cognitive test with a Mean of 21.19 ± 6.10 seconds, than both dual motor whose Mean value is 18.82 ± 5.08 seconds and single task test whose Mean value is 16.06± 4.06 seconds. A repeated measures ANOVA determined that mean FTSTS completion time differed statistically significant between the three attentional loading conditions (*F*= 58.095, *P* < 0.05). Post hoc tests using the Least Significant Difference method revealed that testing STS under three conditions elicited an increase in time taken to complete FTSTS test from single task to dual motor task to dual cognitive task (16.06± 4.06 sec vs 18.82 ± 5.08 sec vs 21.19 ± 6.10 sec, respectively), which was statistically significant (*p* <0.05).

TABLE 3: Values of within subject effects of single task, dual motor task and dual cognitive tasks of FTSTS test scores in stroke subjects.

Source	Sum of squares	df	Mean square	F	Sig.
Sit to stand	535.883	2	267.942	58.095	.000

A significant strong negative correlation was found between trunk impairment and time taken to complete all three variations of FTSTS test scores. There is a strong negative correlation between time taken to complete single task condition and Trunk impairment score (r = -0.848 with p< 0.05), dual motor task and Trunk impairment score (r = -0.858 with p< 0.05) and also the dual cognitive task and Trunk Impairment Score (r = -0.772 with p< 0.05).

TABLE 4: Person correlation coefficient values for trunk impairment score and single task, dual motor task and dual cognitive task FTSTS test scores in stroke subjects.

	Single task	Dual motor task	Dual cognitive task
Trunk Impairment score 'r'	-0.848	-0.858	-0.772
Significance (2 tailed) 'p'	0.000	0.000	0.000

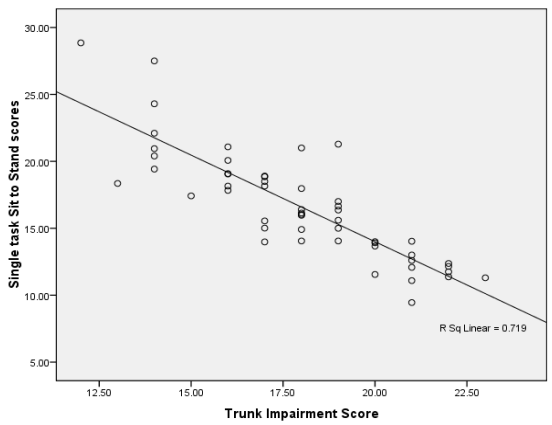

FIGURE 2: Scatter plots which estimate association between trunk impairment score and single task FTSTS test scores in stroke patients.

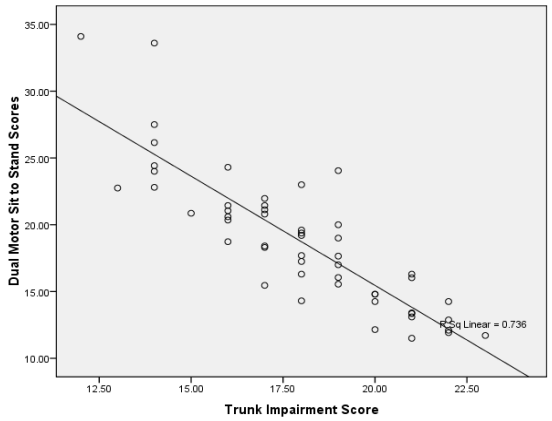

FIGURE 3: Scatter plot which estimates association between trunk impairment score and dual motor task FTSTS test scores in stroke patients.

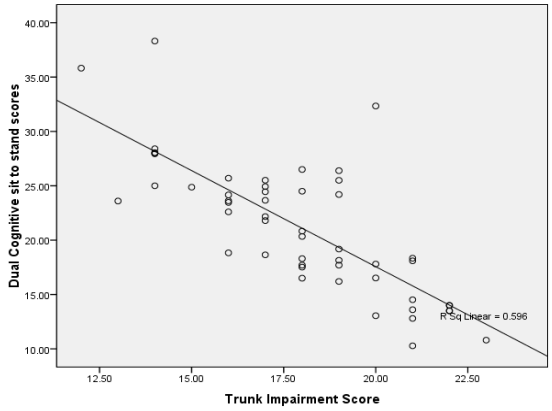

FIGURE 4: Scatter plots which estimates association between trunk impairment score and dual cognitive task FTSTS scores in stroke patients.

DISCUSSION

In this study, the relationship between the trunk impairment and sit to stand performance (time taken) during FTSTS across different attentional loading conditions (single, dual-motor, and dual-cognitive) in stroke survivors was examined. The important findings are that attentional loading led to deterioration of sit to stand performance, trunk impairment significantly correlated with FTSTS completion time during single, dual-motor, and dual-cognitive task testing in stroke subjects. Stroke subjects with more impairment of trunk showed an increased duration of FTSTS test under all three conditions, compared to the less impaired individuals. Because of the asymmetrical nature of stroke-related deficits, most of the altered movement patterns during the task were observed in the medio-lateral plane, with the centre of pressure moving toward the non-affected side.

Lateral trunk tilt towards the non-affected side and weight bearing asymmetry during the sit to stand movement would have led to increased timing in FTSTS tests. Thus patients who took longer time to perform five time sit to stand tests are the ones who required additional time to stabilise their body's Centre of Mass (COM) or prevent excessive sway of the COM, during the transitional movement. [13] It seems possible that longer duration of sit to stand are due to difficulties in seat off, longer pauses in extension phase between repetitions and slower sitting down as observed.

Patients who took longer time for the FTSTS under all three conditions demonstrated a lower score on the coordination component of the Trunk impairment scale, which emphasizes on the interaction required between trunk and lower limb for effective performance of transitional movements.

Addition of a motor/cognitive task to a performance based test, distracts attention capacity of the individual, hence the subject shows a decline in the performance based test. [14] Dual-task interference is expected to be seen if the available attentional resource capacity is exceeded, thus provoking a performance reduction in either one task or both tasks depending on task prioritization approach.[15] In this study, stroke participants were instructed to hold the glass without spilling the water (dual motor) and performed counting (dual cognitive) as accurately as they could. As a result, participants demonstrated deterioration in sit to stand performance on addition of either a motor/cognitive task. Thus it is shown that, in dual tasking the addition of a secondary task impedes the performance of the primary task, according to capacity interference theory. [15]

Comparing the differences in FTSTS across three attentional loading conditions in stroke patients, the standard deviation (SD = 6.10) of dual cognitive FTSTS was

found to be higher than that of both Single task and dual motor task FTSTS. This may be due to learned effects of the patient, due to repeated trials and lack of variability of the task given. The difficulty of cognitive task was found to cause some of the participants to compromise the cognitive task performance for stability. Stroke survivors with impaired trunk are presented with greatest deterioration of sit to stand performance across all task conditions. Hence adequate trunk control is required for effective performance of sit to stand movement in individuals following stroke. The ability to carry out dual tasks after stroke is crucial to ensure a safe and effective sit to stand movement.

A few limitations for this study include that, some of the participants were asked to repeat failed trials that may cause training effects. A few suggestions for future research include future studies involving identification of factors to predict sit to stand performance in chronic stroke patients is recommended. Future research involving dual tasking as a part of sit to stand training in stroke rehabilitation is recommended. It is recommended that sit to stand testing under dual task conditions can be used as a measure of functional performance in stroke subjects.

CONCLUSION

The results of the study conclude that there was a decline in the sit to stand performance on addition of a secondary task in stroke subjects. Also, the level of trunk impairment is associated with a decline in the performance of sit to stand across all three attentional loading conditions in individuals with stroke. This study concludes that "There is significant difference in sit to stand performance across three attentional loading conditions and there is significant negative correlation between trunk impairment and sit to stand performance in stroke subjects".

Conflict Of Interest: None

Abbreviations

STS	-	Sit to Stand
FTSTS	-	Five Times Sit To Stand Test
TIS	-	Trunk Impairment Scale
MMSE	-	Mini Mental Status Examination
MCA	-	Middle Cerebral Artery
CoM	-	Centre of Mass
CoG	-	Centre of Gravity
ADL	-	Activities of Daily Living
CMI	-	Cognitive Motor Interference
ANOVA	-	Analysis Of Variance

REFERENCES

1. Khurana D, Pandian J, Sylaja PN, et al. The Indo-US Collaborative Stroke Registry and infrastructure development project. Neurol India. 2018; Jan-Feb; 66(1):276-278.
2. Boukadida A, Piotte F, Dehail P, Nadeau S. Determinants of sit-to-stand tasks in individuals with hemiparesis post stroke: a review. Ann Phys Rehabil Med. 2015;58(3):167-172
3. Galli M, Cimolin V, Crivellini M, Campanini I. Quantitative analysis of sit to stand movement: experimental set-up definition and application to healthy and hemiplegic adults. Gait Posture 2008; 28; 80–5
4. Whitney SL, Wrisley DM, Marchetti GF et al. Clinical measurement of sit-to-stand performance in people with balance disorders: validity of data for the Five-Times-Sit-to-Stand Test. Phys Ther. 2005;85(10):1034–1045;
5. Janssen WG, Bussmann HB, Stam HJ. Determinants of the sit-to-stand movement: a review. Phys Ther 2002; 82:866–79
6. Cheng PT, Liaw MY, Wong MK, Tang FT, Lee MY, Lin PS. The sit-to-stand movement in stroke patients and its correlation with falling. Arch Phys Med Rehabil 1998; 79:1043–50.
7. Duclos C, Nadeau S, Lecours J. Lateral trunk displacement and stability during sit-to-stand transfer in relation to foot placement in patients with hemiparesis. Neurorehabil Neural Repair. 2008; 22: 715-722.
8. Verheyden G, Nieuwboer A, De Wit L, et al. Trunk performance after stroke: an eye catching predictor of functional outcome. J Neurol Neurosurg Psychiatry. 2007; 78(7):694-698,
9. Verheyden, G., Vereeck, L., Truijen, S et al. Trunk performance after stroke and the relationship with balance, gait and

functional ability. Clinical Rehabilitation. 2006; 20(5), 451-458.
10. Silva P, Quintino L, Franco J, et al. Trunk kinematics related to generation and transfer of the trunk flexor momentum are associated with sit-to-stand performance in chronic stroke survivors. Neuro Rehabilitation. 2017; 40(1):57-67.
11. Verheyden, G., Nieuwboer, A., Feys, H., et al. Discriminant ability of the Trunk Impairment Scale: A comparison between stroke patients and healthy individuals. Disability and Rehabilitation. 2005; 27(17), 1023-1028.
12. Mong Y, Teo TW, Ng SS. 5-repetition sit-to-stand test in subjects with chronic stroke: reliability and validity. Arch Phys Med Rehabil 2010; 91:407–413.
13. Lecours J, Nadeau S, Gravel D et al, Interactions between foot placement, trunk frontal position, weightbearing and knee moment asymmetry at seat-off during rising from a chair in healthy controls and persons with hemiparesis. J Rehabil Med. 2008; 40(3):200-207,
14. Manaf H, Justine M, Omar M. Functional Balance and Motor Impairment Correlations with Gait Parameters during Timed Up and Go Test across Three Attentional Loading Conditions in Stroke Survivors. Stroke Res Treat. 2014; 2014:439304.
15. Plummer P, Eskes G, Wallace S, et al. Cognitive-motor interference during functional mobility after stroke: state of the science and implications for future research. Arch Phys Med Rehabil. 2013; 94(12):2565–2574.e6.

How to cite this article: Palanisamy S, Regan R. Sit to stand performance across three attentional loading conditions and its correlation with trunk impairment in stroke patients - a cross sectional study. Int J Health Sci Res. 2019; 9(7):162-168.

******