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RELIABILITY AND CONSTRUCT VALIDITY OF LATERAL STEP – UP TEST IN CHRONIC STROKE SUBJECTS: A CROSS SECTIONAL OBSERVATIONAL STUDY

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ABSTRACT

Background: In this study, functional strength is investigated by LATERAL STEPUP TEST (LSUT) which is close kinetic chain test and it is correlate with Time Up and Go test (TUG), Lower Extremity subscale of the Fugl-Meyer Assessment (FMA-LE) score, Five Times Sit to Stand (FTSTS) completion time, Berg Balance Scale (BBS). This test also checks Inter rater and Interrater and test reliability of, Lateral StepUp Test counts.

Aims & Objectives: To check inter rater and intra rater reliability and construct validity of LUST in chronic stroke subjects.

Methods: After getting approval from ethical committee, candidate was screened according to inclusion and exclusion criteria. Lateral step-up test measures were tested on 65 chronic stroke subjects. The Lateral step-up test of paretic and non paretic measure by rater one and rater two for inter rater reliability, BBS, Fugl Meyer, FTSTS and TUG scores were also recorded on first day for construct validity. A second trial of the Lateral step-up test was conducted on 7 th day, for intra rater reliability,

Result: Result shows excellent inter-rater reliability with ICC 0.930 (0.885 – 0.957) and intra rater reliability with ICC 0.976(0.961 – 0.985). and this test shows positive correlation with BBS and Fugl Meyer. however, with FTSTS and TUG it shows negative correlation.

Conclusion: This study concluded that lateral step-up test counts of the paretic limb is expected to be declined than that of the non-paretic side, it also reduces the speed of muscle activation due to muscle weakness and spasticity. Moreover, lateral step-up test has good intra rater and inter-rater reliability because 15 sec lateral step-up test was tiny and no important distinction existed between the testing trials, it seems that this test represents stable measures and will be clinically used. In addition to this, this test has also a good construct validity with other balance test.

Key Words: Construct validity, lateral step-up test, reliability.

INTRODUCTION

World wide stroke is foremost fitness trouble in step with Global Burden of disease. In addition to this, it is far second maximum cause of death world wide. ⁽¹⁾ Annually 105 to 152/100000 individuals affected by stroke and also the prevalence of stroke is ranged from 44.29 to 559/100000 per year in several a part of India. ⁽²⁾ Stroke is sudden cassation of permanent harm to a region of brain because of blockage or rupture of blood vessel. Moreover, it is divided into 2 major elements ischemic and haemorrhagic stroke. Furthermore, alternative types are cerebral thrombosis, transient ischemic stroke, cerebral embolism, lacunar stroke. ⁽¹⁾ As per proof risk factors of stroke are: - High blood pressure (70%), Cardiopathy (30%), Disorder of heart rhythm (15%), Diabetes Malitus (15%), Congestive cardiac failure (15%), Peripheral blood vessel disease (30%), Symptom and in ladies once menopause, Furthermore, others are cigarette smoking, Physical inactivity, obesity and improper diet. ⁽¹⁾ Clinically, Nonfunctional strength test measured by manual muscle testing because this test is easy to performed in clinical setting but previous study found that it has poor reliability and be intensive to strength change over time.⁽⁶⁾ Admittedly, these assessment measures are open kinetic chain muscle strength so it cannot stimulate the action of daily life. ^(4, 21) In comparison, close kinetic chain muscle strength assessments are more preferable to functional movements and consequently may provide greater perception into functional neuromuscular control in stroke subjects.^(4,21) In addition to this, close kinetic movements follow forces and neuromotor demand experienced during weight bearing activity because of specific nature of strength.⁽⁶⁾ In this study, functional strength is investigated by LATERAL STEPUP TEST (LSUT) which is close kinetic chain test ^(4,15,23) and it is correlate with Time Up and Go test (TUG), Lower Extremity subscale of the Fugl-Meyer Assessment (FMA-LE) score, Five Times Sit to Stand (FTSTS) completion time, Berg Balance Scale (BBS).^(4,17) Moreover, Lateral StepUp Test is designed to assessed concentric and eccentric muscle strength of lower extremities.^(4,15) Mainly knee extensors and planter flexors ⁽⁷⁾ along with this co-ordinated activation of the adductors and ankle dorsi flexors ⁽⁶⁾ and balance and proprioception.⁽⁸⁾

In addition to this, Lateral StepUp Test is evaluated the number of times individuals is able to place one foot on and off a low step (15 cm) in 15 sec.⁽⁹⁾ Furthermore, Lateral StepUp Test is generated greater power and total work on knee joint than forward step up.⁽¹⁰⁾

Hypothesis:

Null Hypothesis:

LSUT is not reliable in chronic stroke subjects. LSUT is not valid with BBS, FMA – LE, TUG, FTSTS in chronic stroke subjects.

Alternative Hypothesis:

LSUT is not reliable in chronic stroke subjects. LSUT is not valid with BBS, FMA LE, TUG, FTSTS in chronic stroke subjects.

Study design: Cross sectional observational study

Participant recruitment: Subjects with chronic stroke
Source of data: Bardoli and Surat. Sample size: Sample size was calculated based on observational study designs.

$$\text{sample size}(n) = \frac{(z_{1-\alpha/2})^2 (p) (q)}{(d)^2}$$

(d)²

Assuming the value of Z (At 95% CI or 5 % level of significance (type- I error) it is 1.96) a total of 63 subjects will require for the present study, but keeping the dropout rate, which was assumed to be 10 %, a total of 69 subjects will be included for the study. Sample method: Convenient Sampling was used in this study. Study duration: 6th February 2021 to 6th February 2022. Materials: Chair, stopwatch, pen, paper, 15cm step.

Inclusion criteria Stroke diagnosed with CT/MRI or ascertained by medical reports by qualified medical professionals, Age 45 to 65 years, 6 months post stroke, Mini mental scale examination > 24⁽²³⁾, Brunnstrom stage of leg recovery of stages 3 to 5⁽²⁴⁾. **Exclusion criteria:** Any neurological disease other than stroke, Any musculoskeletal conditions, Any other sensory issues affecting balance.

Procedure: After getting approval from institutional ethical committee, we conducted this research We selected subject based on inclusion and exclusion criteria for the study explain them about procedure and ask them to sign consent form. Moreover, 65 subjects were assessed because 1 subject lost follow up, 3 subjects were refused to participate. All stroke subjects were attended two sessions in duration of 1 week during which they were assessed by two evaluators [figure]. Moreover, they were also assessed by FTSTS, BBS, FMA – LE and TUG scale in random order with 5-minute gape between each test.⁽⁴⁾ Lateral Step-Up Test: -This test is estimated the stepping up and down on 15 cm block in 15 second.^(4,15) Participants starting position is tested limb on the step and non – tested limb on the floor with their parallel and shoulder wide apart. And test started with following commands “ready set go”^(4,18) Lower Extremity Fugl Meyer: - This test has mainly five items which further divided into total 14 component and scoring is done on 3 points 0 to 2.⁽¹¹⁾ This test is most commonly accepted and reliable assessment for stroke (ICC 0.83 – 0.95).^(16,17) further, people who have higher number of score suggests a lesser impairment on paretic side. Total score is 28. Berg Balance Scale: - It is highly reliable tool with ICC (0.98 – 0.99). This tool is assessed static as well as dynamic balance of subjects with chronic stroke subjects.⁽¹⁸⁾ furthermore, this includes 14 items with 0 to 4 scoring system. Total possible score is 56.21 to 40 represent acceptable balance and 41 to 56 represent good balance. Time Up and Go Test: - Assessed to check functional mobility which was previously show excellent reliability ICC 0.95 in subjects with chronic stroke.^(4,19) In

this subject required to stand for the chair and walk for 3 m and back to his or her original position this task completion tie measure by stopwatch Five Times Sit To Stand: - This test is highly reliable with ICC 0.99 measure to evaluate lower extremity muscle strength of chronic stroke subjects. Subjects have required to get up from chair for times time noted by the therapist by the stopwatch.⁽⁴⁾

STATISTICAL ANALYSIS AND RESULTS

Data analysis were done by using the SPSS software (version 21.0). The results were considered significant if the value of $p < 0.05$ and with confidence interval of 95%. Following statistical analysis were done: - Intra class correlation coefficient for inter rater reliability. Intra class correlation coefficient for intra rater reliability, Bland Altman limits of agreement analysis for intra rater and between two rater, Pearson correlation to check validity of lateral step-up test with standard scales BBS, TUG, FTSTS, Fugl Meyer LE.

Descriptive statistic of baseline data of the subjects

	Mean ± SD
Age	58.14± 5.94
Duration	16.32± 10.07
Mini mental scale	28.6± 1.44
Brunstrom stage	4.35±0.68
Non-paretic limb LSUT counts	6.28± 1.23
Paretic limb LSUT counts	5.74± 0.99
	Number (percentage)
Gender(male/female)	38/27 (58.46% / 41.54%)
Affected side (right / left)	39/26(60% / 40%)

Shows intra rater reliability of paretic limb and non – paretic limb

Intra rater reliability		
Side	Mean LSUT count ± SD	ICC (95%CI)
Paretic limb	5.74± 0.99	0.976(0.961-0.985)
Non-paretic limb	6.28± 1.23	0.977(0.962-0.986)

This tables show Intra class correlation coefficient (ICC) for paretic limb and non-paretic limb Lateral step-up test test-retest reliability taken at 1st day and 7th day of week of

interval along with confidence interval 95% (CI) with a p value <0.05. The ICC value shows good reliability.

Shows inter rater reliability of paretic limb and non – paretic limb

Inter rater reliability		
Side	Mean LSUT count ± SD	ICC (95%CI)
Paretic limb	5.74± 0.99	0.930(0.885-0.957)
Non-paretic limb	6.28± 1.23	0.964(0.941 - 0.978)

Reliability taken at 1st day by two raters with confidence interval 95% (CI) with a p value <0.05. The ICC value shows good inter-rater reliability. Shows Pearson correlation coefficient between lateral step-up test step counts and BBS, Fugl Meyer LE, TUG and FTSTS.

Construct validity was computed using Pearson correlation coefficient between Lateral Step-Up tests step counts and BBS, Fugl Meyer LE, TUG and FTSTS total score.

This correlation coefficients suggest a maximum level of construct validity (0.34),(0.48),(0.47)and(0.74)respectively. As BBS and Fugl Meyer show positive correlation, which means the change or increase in score BBS is found to be correlating with the increase or change in Lateral Step-Up test scores. However, TUG and FTSTS show negative correlation, which means the change or decrease in score BBS is found to be correlating with the decrease or change in Lateral Step-Up test scores.

Discussion:

This study examined the intra-rater reliability, inter-rater reliability, and construct validity of lateral step-up test counts in subjects with chronic stroke. As same as previous researches LSUT in chronic stroke, healthy individuals⁽¹⁵⁾, nestling with cerebral palsy⁽²⁶⁾ and our study additionally enclosed during this with wonderful intra rater reliability and inter-rater reliability for LSUT counts. These values so tested reliable in spite of training, administration and recommendation it for testing functional balance in subjects with chronic stroke in clinical practice. In addition, two raters test for inter rater reliability on day 1 and the investigator tests the people for intra rater reliability on day 1 and day 7. Three previous studies Sze – Jia Hong et al, Annabelle King et al, Capt Michael et al., conjointly support our study they also same that lateral step-up test counts have good inter rater and intra rater reliability. If examiner is experience or inexperience. And BBS scores also correlate with LSUT counts.⁽⁹⁾ this test is extremely reliable compare to different unremarkably used strength measures as a result of its use to appropriate to live strength changes is rehabilitation programs wherever because it also used as a part of coaching program⁽⁶⁾ and 15 sec lateral step-

up test was tiny and no important distinction existed between the testing trials, it seems that this test represents stable measures and will be clinically used.⁽²⁷⁾ During the LSUT, activation of the dorsiflexors in the limb being tested shifts the center of gravity up and forward to initiate ascent, while co-activation of the dorsiflexors and plantar flexors improves ankle stability for balance control.⁽²⁸⁾ Challenges balance and proprioception. When the sound limb on 15 cm desk and paretic limb movement out limb become complete in extension observed through hip hiking, adduction contralateral trunk flexion and placed the ankle on steps it become relatively sluggish due to much less of muscle energy on paretic side. On the other hand, when the paretic limb was on the step and the sound limb was found, the patients were reluctant to land on the paretic limb due to lack of ankle strength and proprioception problems. The hip abductors of the limb being tested work simultaneously to keep the pelvis straight during the one-leg standing. Then, concentric and eccentric contractions of the knee extensors and flexors, respectively, were performed to fully extend the knee in a controlled manner.⁽²⁹⁾ Returning to the starting position requires an eccentric contraction of the knee extensors, which moves the COM down. It must be determined to predict functional outcomes and detect functional deficiencies. Eva Y.F. Pang et al that, he showed that the stepping sideways reflects the ability to dynamic standing balance in performing a lateral destabilization movement requiring a degree of coordination of strength and standing balance. The performance of the lateral step-up test of the paretic limb is expected to be worse than that of the non-paretic side, it also reduces the speed of muscle activation and lengthens the time to reach maximum torque.

Construct validity			
Test	Mean ±SD	Validity with paretic LSUT	r value
BBS	42.45±6.57	0.34**	0.005
FMA LE	19.4±3.98	0.48**	0.00
TUG	18.39±5.51	-0.47**	0.000
FTSTS	16.82±3.37	-0.74**	0.00
**Correlation is significant at the 0.01 level			

⁽²⁹⁾This test shows negative correlation with TUG (ICC = -0.47) and FTSTS (ICC= -0.736) if timing of TUG and FTSTS increase lateral step-up test counts are reduced. Moreover, BBS (ICC = 0.34) and fugl Meyer (ICC = 0.48) gives positive correlation with Lateral step-up test counts. Both paretic and non-paretic LSUT counts correlate with multiple functional assessment including BBS score, Fugl Meyer score, TUG completion time, FTSTS completion time. Paretic side lateral step-up test count could be explained by the fact that that FMA-LE is complete quantitative measures of motor impairment following stroke. While lateral step up test counted number degree of functional balance requiring good lower limb muscle

function.⁽²⁹⁾ FMA – LE indicates significant correlation ($r = 0.00$, p value 0.01) with lateral step up test counts. In deed numerous items of FMA – LE (test IIa , IIb and VI) in particular VI is 90 degree knee flexion and dorsiflexion which required hamstring muscle group and dorsiflexion work and lateral step up test additionally required coordination of ankle dorsiflexors and knee flexor power so, the correlation isn't surprising .The counts of lateral step test give a significant positive correlation ($r = 0.005$, $p < 0.01$) with the BBS scores because the BBS scale also assesses the dynamic foot protocol. Item 12 (putting alternate feet on the table for 8 steps in 20 seconds) and item 14 (standing on one foot for 10 seconds) require knee muscle strength. then the BBS would explain the significant correlation. The significant negative correlation ($r = 0.000$, $p < 0.01$) shows between the counts of lateral steps and the TUG times can be explained by the fact that the TUG test is a functional balance assessment tool that measures COP changes in different directions while standing, walking and turning.⁽³⁰⁾ In addition, it is known that TUG times in chronic stroke people are strongly associated with the extent of lateral displacement of the pelvis and asymmetry in the position of a single limb during gait. Which also same of the impairments affecting sideways stepping. Shmay S et al., support our study that the increase in TUG score is consistent with stroke symptoms manifesting as muscle weakness and spasticity. Muscle weakness and spasticity are characterized by the difficulty in generating sufficient muscle force at the right time to perform a specific functional task. Which could explain the prolonged TUG time score in stroke subjects.⁽²⁵⁾ The Lateral step-up Test requires functional muscle strength and balance as it involves standing on one leg and lower limb raises. The FTSTS test is a quantitative measure of functional lower extremity strength that has previously been shown to have a strong negative correlation with the BBS score.⁽³¹⁾ The significant negative correlation observed between lateral step-up test counts and FTSTS ($r = 0.00$, $p < 0.01$) test time is therefore not unexpected. Shmay S. M. et al, also support our research that FTSTS test scores is slower consistent with the muscle weakness, spasticity and impaired somatosensory function characteristic of stroke subjects. All sensorimotor impairments cause difficulty in generating approximate timed and sufficient muscle force to shift balance during a transitional movement which could explain the subject's lengthened times in FTSTST.⁽³¹⁾ So, this study concluded that lateral step-up test counts of the paretic leg is expected to be declined than that of the non-paretic side, it also reduces the speed of muscle activation due to muscle weakness and spasticity. Moreover, lateral step-up test has good intra rater and inter-rater reliability because 15 sec lateral step-up test was tiny and no important distinction existed between the testing trials, it seems that this test represents stable measures and will be clinically used. In addition to this, this test has also a good construct validity with other balance test. **Limitation of Study:** - Small sample size, Muscle strength was not check. **Future Recommendation:** - The study was done with small sample size, so recommended with large sample size , This test is also recommended to improve strength and compare pre and post counts.

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