

WITHDRAWN: Intrarater and Interrater Reliability of Dynamic Gait Index in Post Stroke Patients With Eye Movement Disorders

Sana Batool

sana.fizza@gmail.com

University Institute of Physical Therapy, Faculty of Allied Health Sciences, The University of Lahore, Lahore, Pakistan.

Hamayun Zafar

University Institute of Physical Therapy, Faculty of Allied Health Sciences, The University of Lahore, Lahore, Pakistan.

Syed Amir Gilani

University Institute of Physical Therapy, Faculty of Allied Health Sciences, The University of Lahore, Lahore, Pakistan.

Ashfaq Ahmad

University Institute of Physical Therapy, Faculty of Allied Health Sciences, The University of Lahore, Lahore, Pakistan.

Asif Hanif

University Institute of Physical Therapy, Faculty of Allied Health Sciences, The University of Lahore, Lahore, Pakistan.

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The full text of this preprint has been withdrawn by the authors while they make corrections to the work. Therefore, the authors do not wish this work to be cited as a reference. Questions should be directed to the corresponding author.

Abstract

Background: The Dynamic Gait Index is a useful scale that has been evaluated for its reliability in patients with vestibular disorder, elderly people and, in chronic stroke population but its reliability has not been evaluated yet in sub-acute stroke patients with eye movement disorders. So the purpose of this study was to evaluate the intra-rater and inter-rater reliability of the Dynamic gait index to measure the dynamic balance, gait and risk of fall in sub-acute stroke population with eye movement disorders.

Methods: A total of 30 (18 male, 12 females) stroke patients in the sub-acute phase suffering from eye movement disorders were recruited for this reliability study. Two experienced Physical therapists assessed the intra-rater and inter-rater reliability of the Dynamic gait index in two testing sessions three days apart. In the later session, two raters assessed the patients' performance simultaneously on the Dynamic gait index. Data analysis was done at 95% confidence interval using the intra-class correlation coefficient (ICC2, 1). A significance level was set at P-value <0.05.

Results: Mean tests scores by rater 1 in the first and second assessment were 17.4 ± 2.04 and 18.0 ± 2.05 . Mean tests score by rater 2 in the second assessment were 18.6 ± 2.06 . Intra-rater (ICC=0.86, CI=0.73-0.93) and inter-rater (ICC=0.91, CI=0.83-0.96) reliability of total DGI scores was found good to excellent while intra-rater (ICC=0.73-0.91) and inter-rater (ICC=0.73-0.93) reliability of individual items of DGI scores were ranged from moderate to good. Item 8 (steps) showed lowest reliability (ICC=0.73). The significant difference was seen in total and individual scores (P<0.001) of DGI scale in both intra-rater and inter-rater reliability.

Conclusions: The Dynamic gait index is found clinically a reliable tool to objectively measure dynamic balance, gait and risk of fall in sub-acute stroke individuals with eye movement disorders. The intra-rater and inter-rater reliability of the total DGI scores was found good to excellent; whereas intra-rater and inter-rater reliability for individual items of DGI were varied from moderate to good.

Background

Stroke is the second major cause of death and most common cause of disability after ischemic heart disease worldwide (1). It affects around 10.3 million people worldwide every year and estimated to rise by 60-80% in stroke cases by 2050 (2). Its incidence is increasing in Asia and mortality rate due to stroke is also higher in Asia than in America and western Europe (3). In Pakistan the annual expected prevalence of stroke is 250/100,000 population, projecting to 350,000 new cases every year (4).

Visual impairment is one of the most disabling consequences of stroke. Among all visual impairments, eye movement disorders are seen in 68% of the post-stroke population (5). Eye movement disorders that occur as a result of stroke includes, gaze palsies, cranial nerve palsies, strabismus, vergence abnormalities and nystagmus (6). With these eye movement disorders, a patient is unable to respond efficiently to visual inputs from the environment which may result in decreased dynamic stability leading to an increased risk of falls (7). Frequency of falls that occur in the post-stroke population in the initial

three to four months is about 34% and the majority of these falls (40-90%) occur during walking (8). Thus, to prevent falls in post-stroke patients with eye movement disorders the evaluation of dynamic balance and gait disorders is of significant clinical importance (9).

In clinical practice, various clinical tools have been used to assess dynamic balance and walking performance in stroke patients such as functional independent measure (10), functional classification ambulation (11) and timed walking tests (12) but these clinical measures provide limited information to plan treatment and outcome measurements. In addition, it has been reported that dynamic balance of chronic stroke patients during walking cannot be measured with static balance scales (13).

Thus, in order to plan and establish treatment and rehabilitation strategies and to follow up the patients' progress, a reliable and valid outcome measure for dynamic balance and gait related parameters is necessary for stroke patients with eye movement disorders to plan and establish treatment strategies and to record the outcome. Dynamic gait index (DGI), developed by Shumway-Cook and Woollacot (14) is reported to be a clinically useful measure to examine the functional balance and fall risk in a variety of conditions including elderly people (15) and patients with vestibular dysfunction (16) and multiple sclerosis (17). However the reliability of DGI has not been examined yet in subacute stroke patients with eye movement disorders.

Hence, the aim of this study was to assess the intra-rater and interrater reliability of DGI to measure the dynamic balance, gait and risk of fall in sub-acute post-stroke patients suffering from eye movement disorders.

Methods

Subjects

A sample of 30 patients suffering from post-stroke eye movement disorders was recruited from the outpatient rehabilitation department of physical therapy at the University Teaching Hospital University of Lahore, Pakistan between December 1, 2019 to May 31st, 2020. Data were collected after taking approval from the University of Lahore's Institutional Review Board. All methods were performed in accordance with the relevant guidelines and regulations. All the recruited patients signed the written informed consent after taking detailed information about the study procedure. The sample size was estimated based on data from studies done previously in the literature (13). The inclusion criteria were; post-stroke patients of both genders between the age of 19-60 years, diagnosed with an eye movement disorder by a neurophysician following a stroke for the first time, 3 to 6 months after stroke, ability to walk at least 10m distance with or without an assisted device and able to follow instructions. Patients were excluded from the study if they had a recurrent stroke, any other neurological or orthopedic impairment, organic disorder, and cognitive impairment.(18),(19),(20)

Dynamic Gait Index

DGI examines the dynamic balance, gait and risk of fall during walking. It is comprised of eight walking items that include; gait on level surfaces, changing speed, gait with horizontal and vertical head turns, pivot turns, step over and around an obstacle and stair climbing. Each individual item is scored on a 0 to 3 scale. The maximum scores that a subject can achieve on DGI are 24. Scores below or equal to 19 specifies a high risk of fall (13), (14).

Procedures

Two experienced physical therapists termed rater 1 and rater 2, independently assessed the patients' DGI based responses. The original version of DGI was used to record patients' scores (14) (see supplementary file). To measure intra-rater reliability, rater 1 assessed the patients twice in two testing sessions three days apart. To measure inter-rater reliability, rater 2 also assessed the patients simultaneously along with rater 1 in second testing session. Both assessors were not permitted to discuss with one another about the tests results and did not have access to prior results. Standard verbal instructions were given to all the patients and each test was performed in a quiet room. All subjects were allowed to use their walking aids in which they feel safe and comfortable. On average each rater took 15 minutes to complete the DGI based assessment for each patient.

Statistics

Descriptive statistics were performed to express patients' demographics and were presented as mean±standard deviation. Intra-rater and inter-rater reliability were calculated using the intra-class correlation coefficient (ICC 2,1) at 95% confidence interval. ICC values<0.05 showed poor reliability, 0.5 to 0.75 indicated moderate, 0.75 to 0.9 indicated good and 0.9 and above indicated excellent reliability (21). P-value was considered significant statistically at P<0.05.

Results

Baseline Characteristics:

Table 1 describes the demographic details and stroke-related characteristics of stroke patients. A sample of 30 stroke patients (18 males, 12 females) participated in this reliability study. Age was ranged from 19-60 years and the mean age was 53.3±11.0 years. Out of 30 patients, 19 were suffering from ischemic stroke and 11 were having a hemorrhagic stroke. While 17 patients were left hemiplegic and 13 patients were suffering from right hemiplegia. Out of 30 patients, 07 were using assisted devices. The patients were diagnosed with different eye movement disorders. 3 patients were diagnosed with strabismus, 2 with nystagmus, 4 with disconjugate eye movement, 10 with homonymous hemianopia, 5 with saccadic eye movement and 6 patients were suffering from smooth pursuit eye movement.

Mean DGI scores obtained by the first rater for the first session was 17.4±2.04 and the corresponding value for the second session which was three days apart was 18.0±2.05. Mean DGI scores obtained by rater 1 and rater 2 in the second session were 18.0±2.05 and 18.6±2.06 respectively.

Intra-rater Reliability:

The ICC value for total scores of DGI was found to be high (ICC=0.86 at 95% CI, .73-.93) to measure the intra-rater reliability. ICC scores for individual items of DGI were ranged from (0.73-0.91). All DGI items showed good to excellent reliability ICC=0.83-0.91 except for item 8 (steps) which had moderate reliability (ICC=0.73). The significant difference was seen in total and individual scores ($P<0.001$) of DGI scale in intra-rater reliability. (Table 2)

Inter-rater Reliability:

The ICC value for total scores of DGI (ICC=0.91 at 95% CI, .83-.96) was found very high to determine inter-rater reliability. Only Item 8 (steps) had moderate reliability (ICC=0.73) but all other individual items showed good to excellent reliability (.84-0.93). The significant difference was seen in total and individual scores ($P<0.001$) of DGI scale in inter-rater reliability. (Table 3)

Discussion

Dynamic balance and gait impairments are the most commonly seen functional limitations in stroke patients with eye movement disorders. DGI is a clinically reliable scale to measure functional balance during walking activities (22). To the author's knowledge, this was the first research study to assess the intra-rater and interrater reliability of DGI to measure the dynamic balance, gait and risk of fall in sub-acute stroke population with eye movement disorders. Our findings provide evidence that DGI is a reliable outcome measure to evaluate the balance and walking functions during gait activities in stroke patients with eye movement disorders.

Our results showed that both the intra-rater and inter-rater reliability of total DGI scores was found good to excellent in this study. Previously, reliability of DGI has been reported moderate to excellent in older people (23), in patients with vestibular dysfunction (24), chronic stroke (25) and Parkinson's patients (26). The reliability of individual items ranged considerably from moderate to excellent in this study, compared to poor to excellent reliability in the studies done previously (23)-(26). Due to difference in study designs, patients' population, and techniques used in statistical analysis, it is difficult to compare results of different studies; though the findings of previous studies support this view that DGI is clinically a reliable tool when assessment is done based on total scores (27).

In the current study, with regard to the inter-rater reliability, total DGI scores obtained by rater 1 and rater 2 simultaneously in the second assessment were in the range of 14-21 and 15-22. It has been described by Shumway-Cook et al. a score equals to 19 or below, out of possible 24 specifies a high risk of fall (14). According to this criteria, 40-50% patients in our study were at high risk of fall. Also, mean DGI scores obtained by rater 1 (mean 18.0) and rater 2 (mean 18.64) were also high, showing that most of the patients in the current study exhibited mild impairments in the dynamic balance tasks that were assessed. Our findings are similar to the study conducted by Wrisley et al. (16) who documented that their sample signified a range of 13-24 with 6 points less than 19 (showing 60% population at risk of fall) with

(mean 18.4) and to the findings reported by Cattaneo et al. (28) (mean 15.5). It is more likely that their sample represented a population who were in fair to good condition.

In contrast, another study reported on vestibular dysfunction patients, inter-rater reliability (0.63) using the composite kappa statistics was found as compared to the inter-rater reliability (ICC=0.91) calculated in the present study using intra-class correlation coefficient. There may be different reasons why low reliability was found in vestibular dysfunction patients (29). One reason is that the raters who assessed the patients with vestibular dysfunction on DGI were not experienced and might not have used standardized instructions and were not briefed properly about the scale. Nevertheless, the raters in this study were trained physical therapists and received uniform briefing before the assessment. So the rater's training in grading the patient's performance on the scale and the patient's behavior would have increased the reliability scores in the present study. Secondly, stroke patients in the present study were having balance problems that have not showed any improvement in performance in three days interval between tests. Whereas patients with vestibular dysfunction exhibited more acute symptoms so even after an hour interval they showed changes in subject's performance leading to low inter-rater reliability.

In the present study, item 8 (steps) showed the lowest DGI scores, while all other items demonstrated good to excellent intra-rater and interrater reliability. These results are similar to the previous study on Parkinson's patients which reported that intra-rater (ICC=.88 -1.00) and inter-rater (ICC=.87 -1.00) reliability of all single items demonstrated good to excellent reliability, only item 8 (steps) (ICC=0.73) showed moderate reliability (26). This is because Parkinson's patients had difficulty in looking up from a distance during walking and in the present study, post stroke patients with different types of eye movement disorders also had difficulty in moving eyes, had rapid eye movements and difficulty in looking up towards a task. In both studies, the assessment was performed on day one and with the interval of three days. However, the mean age of the Parkinson's patients was found to be much higher 80.4 years as compared to the mean age of sub-acute stroke patients in the current study i.e, 53.2 years.

In the present study stroke patients with different types of eye movement disorders were observed but due to limited number of patients reported in each type we cannot conclude that which type of eye movement disorder showed more influence on balance, gait and fall risk. Future studies should be conducted on large sample to determine this difference. However, findings of this study showed that DGI is found principally a scientific, reliable, and quick to administer tool to examine the quality of dynamic balance, gait and fall risk during walking activities. This study will help the practitioners to adopt the DGI to plan and establish more scientific interventions for post- stroke individuals with eye movement disorders.

Limitations Of The Study

In this study, two assessors who assessed the patients' performance were neurologic physical therapists and have previous experience with the DGI scale. It is more likely that reliability of scale may vary if the raters have a different background. Secondly, most of the patients in this study were ambulatory and were capable to walk without assistance but with an assisted device if necessary. Hence, the results of

the current study will be generalized to the same population. As with walking aid DGI becomes a 3-point scale. This may result in better reliability of this scale. Thirdly, the study participants who were recruited in the current study were quite younger than the average age of stroke onset. This is because we didn't include more severe patients who could not able to walk or follow instructions. So the findings of present study are only applicable to the same population.

Strengths

The foremost strength of current study was that, intra-rater and inter-rater reliability of DGI was assessed for the first time in post-stroke patients with eye movement disorders. No reliability study of DGI has been done before on this population. Secondly, statistical methods used in this study were most appropriate according to the current guidelines and were comparable to the results from other studies. Thirdly, DGI scale takes less than 15 minutes to administer. The scale can be utilized clinically in post-stroke patients with eye movement disorders to evaluate dynamic balance during walking and for training dynamic balance.

Conclusions

Our results suggest that the Dynamic Gait Index is a reliable instrument to objectively assess dynamic balance, gait and risk of fall in sub-acute stroke population with eye movement disorders. The intra-rater and inter-rater reliability of the total DGI scores was found good to excellent; whereas for individual items of DGI it varied from moderate to excellent and thus, dynamic gait index is recommended and can be used in clinical settings by both clinicians and researchers. Further research is needed to investigate its validity, responsiveness and to correlate DGI with other measures to examine the dynamic balance during gait activities and to determine risk of fall in patients with post- stroke eye movement disorders.

Abbreviations

DGI: Dynamic gait index, ICC: Intra-class correlation coefficient, SD: Standard deviation.CI: Confidence interval, SPSS: Statistical package for the social sciences

Declarations

Ethics approval and consent to participate: The study got approval from the Institutional review board of the University of Lahore, Lahore Pakistan. A written informed consent was provided to the study participants.

Consent for publication: Not applicable

Availability of data and materials: All data generated or analyzed during this study are included in this published article [and its supplementary information files]. Data is available with the corresponding author and can be produced at any time when required by the journal.

These are the links of databases used in this study. <https://www.google.com/>, <https://scholar.google.com/>, <https://pubmed.ncbi.nlm.nih.gov/>. Access to these databases is open.

Competing interests: The authors declare that they have no competing interests.

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Authors' contributions:

SB,HZ and SAG: Substantial contribution to study conception and design.

SB,HZ and AA: Acquisition of data.

AH, SB: Analysis and interpretation of data.

SB and HZ: Drafting of the manuscript.

HZ, SAG and AA: Critical revision of the manuscript for important intellectual content.

SB and AH: Statistical analysis.

All authors: Final approval of the manuscript.

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Tables

Table 1: Baseline Characteristics of the subjects (N=30)

Characteristics	Mean±S.D	Range
Age (Years)	53.3±11.0	21-60
DGI 1	17.4±2.04	14-21
DGI 2	18.0±2.05	14-21
DGI 3	18.6±2.06	15-22
Characteristics	Category	Frequency
Gender	Male	18
	Female	12
Type of Stroke	Ischemic Stroke	19
	Hemorrhagic Stroke	11
Hemiplegic Side	Right	13
	Left	17
Use of assistive device	Yes	07
	No	23
Post Stroke Eye Movement Disorders	1.Strabismus	03
	2.Nystagmus	02
	3. Disconjugate eye movement	04
	5. Homonymous hemianopia	10
	6. Saccadic eye movement	05
	7. Smooth pursuit eye movements	06

N= Total number of patients, S.D: Standard deviation

DGI: Dynamic Gait Index

DGI 1: Mean tests score by rater 1 in the first assessment

DGI 2: Mean tests score by rater 1 in the second assessment

DGI 3: Mean tests score by rater 2 in the second assessment

Table 2: Intra-rater Reliability of Total and Single Item Scores of Dynamic Gait Index

Test items	ICC Intra-rater	95% CI	P-value
Item 1: Gait on level surfaces	0.87	.75 .94	
Item 2: Change in gait speed	0.83	.68 .92	
Item 3: Gait with horizontal head turns	0.90	.81 .95	
Item 4: Gait with vertical head turns	0.84	.69 .92	
Item 5: Gait and pivot turns	0.86	.73 .93	<0.001*
Item 6: Step over obstacle	0.91	.83 .96	
Item 7: Step around obstacles	0.83	.67 .91	
Item 8: Steps	0.73	.51 .86	
Total Scores	0.86	.73 .93	

CI: Confidence Interval

ICC: Intra-correlation coefficient

Table 3: Inter-rater Reliability of Total and Single Item Scores of Dynamic Gait Index

Test items	ICC Inter rater	95% CI	P-value
Item 1: Gait on level surfaces	0.93	.87 .97	<0.001*
Item 2: Change in gait speed	0.86	.72 .93	
Item 3: Gait with horizontal head turns	0.84	.69 .92	
Item 4: Gait with vertical head turns	0.86	.72 .93	
Item 5: Gait and pivot turns	0.93	.85-.97	
Item 6: Step over obstacle	0.87	.75 .94	
Item 7: Step around obstacles	0.87	.75 .94	
Item 8: Steps	0.73	.51 .86	
Total Scores	0.91	.83 .96	

CI: Confidence Interval

ICC: Intra correlation coefficient

Supplementary Files

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