Reliability of the Dynamic Gait Index in Individuals With Multiple Sclerosis

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ABSTRACT. McConvey J, Bennett SE. Reliability of the Dynamic Gait Index in individuals with multiple sclerosis. Arch Phys Med Rehabil 2005;86:130-3.

Objectives: To determine if the Dynamic Gait Index (DGI) is a reliable tool for assessing balance in people with multiple sclerosis (MS) and to determine the validity of the DGI by using the 6.1-m timed walk.

Design: Instrument reliability test: physical therapists viewed a videotape of 10 subjects with MS performing the DGI and scored their gait by using DGI criteria. Two weeks after the first session, therapists' viewed the videotape again and scored subjects' gait to establish interrater reliability.

Setting: Hospital-based outpatient rehabilitation clinic.

Participants: Eleven physical therapists and 10 people with MS.

Interventions: Not applicable.

Main Outcome Measures: Total DGI scores and each of the 8 DGI items were compared between and within raters (physical therapists). Time to walk 6.1m was compared with the total DGI score to examine concurrent validity.

Results: Interrater reliability for total DGI scores was .983, with each of the 8 items ranging from .910 to .976 (intraclass correlation coefficient, $P<.05$). Intrarater reliability for total DGI scores ranged between .760 and .986 (Pearson bivariate analysis, $P<.05$). An inverse relationship of $-.801$ (Pearson bivariate analysis, $P<.01$) existed between the total DGI scores and the 6.1-m walk.

Conclusions: The DGI is a reliable functional assessment tool that correlated inversely with timed walk, showing its concurrent validity.

Key Words: Balance; Gait; Multiple sclerosis; Rehabilitation.

MULTIPLE SCLEROSIS (MS), one of the most common disabling diseases of the central nervous system in young adults,[1] affects approximately 250,000 people in the United States.[2] Demyelination can occur in any part of the brain, optic nerve, and spinal cord,[3] with symptoms presented by each individual related to the area affected. Impairments commonly associated with this disease are ataxia, muscular weakness, general fatigue, spasticity, sensory disturbances, hypersensitivity to internal and external temperatures,[2] as well as visual and vestibular disturbances.

Balance dysfunction, commonly found in people with MS, occurs as a result of demyelination, which can affect the vestibular nerve or areas around vestibular nuclei in the brainstem. If the vestibular system is affected, symptoms may include dizziness, difficulty with vision, and/or balance problems. These symptoms are similar to those found in patients with peripheral vestibular dysfunction. Frzovic et al[4] reported that subjects with MS performed more poorly than control subjects in tandem stance, single-leg stance, functional reach test, arm raise test, step test, and in response to an external perturbation. They reported that the degree of balance dysfunction did not change throughout the course of the day, despite subjects' self-report of increasing fatigue.[4]

Presently, there are no functional assessment tools to measure balance dysfunction during gait in people with MS. The Dynamic Gait Index (DGI), developed by Shumway-Cook et al[5] for quantifying gait dysfunction in people with peripheral vestibular disease,[6] may be an appropriate tool to assess gait dysfunction in people with MS. Shumway-Cook reported that scores of 19 or less (maximum score, 24) indicate a high risk for falling in institutionalized older adults.[5] Reliability scores for the DGI have not been reported, but the DGI has been correlated with the Berg Balance Scale.[5] Balance dysfunction and gait deviations in patients with peripheral vestibular disease are similar to impairments and functional limitations found in individuals with MS. The purpose of the present study was to determine the interrater and intrarater reliability of the DGI when used with persons who have MS and to examine the DGI's validity by comparing it with the timed walk test.

METHODS

Ten people with MS participated in this study by performing the DGI, which was videotaped. The 10 subjects, who had Expanded Disability Status Scores that ranged from 2.0 to 6.0, used their assistive device and/or ankle-foot orthosis during performance of the DGI, which was administered by a physical therapist. The maximum score a patient can attain on the DGI is 24. The 8 walking tasks of the DGI are (1) walk 20ft (6.1m); (2) walk and change speed, fast then slow; (3) walk and look left then right; (4) walk and look up then down; (5) walk and perform 180° turn and stop; (6) walk and step over a shoe box; (7) walk around shoe box placed on the floor; and (8) ascend and descend 4 stairs.

Time to walk 6.1m was obtained at the time of videotaping the DGI and was compared with each subject's total DGI score. Timed walk is a clinical assessment tool frequently used to measure mobility and function. To establish validity of the DGI, an inverse relationship between the time to walk 6.1m and the total DGI score was expected.

To examine interrater and intrarater reliability, physical therapists scored the 10 subjects' performance of the DGI at 2

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Supported by the John R. Oishei Foundation.

No commercial party having a direct financial interest in the results of the research supporting this article has or will confer a benefit upon the author(s) or upon any organization with which the author(s) is/are associated.

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0003-9993/05/8601-8444$30.00/0
doi:10.1016/j.apmr.2003.11.033

Table 1: Relation Between 6.1-m Timed Walk and Total DGI Scores

Patients	6.1-m Timed Walk (s)	Total DGI Score
1	5.27	22
2	5.29	20
3	5.62	15
4	7.07	18
5	7.29	14
6	7.84	13
7	8.73	16
8	8.77	15
9	9.51	13
10	13.23	10
Mean	7.86	15

viewing sessions, 2 weeks apart. Videotaping subjects' performance of a task is frequently used in research that examines interreliability of an instrument. Because an exacerbation of MS can influence balance and a subject's ability to perform gait tasks, we controlled for this variable by videotaping the subjects, thereby producing a permanent record. The therapists received a copy of the DGI scoring criteria before they viewed the videotapes. In the first session, the 11 physical therapists viewed the videotape and scored the gait of the 10 subjects performing the DGI. Scoring followed the guidelines of the DGI and criteria previously distributed.[5] The therapists were not permitted to ask questions during the viewing of the videotapes and were given only 1 opportunity to view each patient during scoring.

To examine intrarater reliability, the 11 physical therapists viewed the videotape and scored the 10 subjects again 2 weeks after the first session. A 2-week time period was chosen because that is a reasonable time between testing and retesting patients with a clinical assessment tool. The order of appearance of each subject on the videotape was altered for the second viewing of the tape. The same guidelines used in session 1 were followed in session 2.

Eleven physical therapists participated in the gait scoring sessions. All of them had previously treated patients with MS, but only 5 had worked with patients with vestibular dysfunction. Before this study, 2 therapists had previously used the DGI and 10 therapists reported using other functional assessment tools. The number of years of practice for the 11 physical therapists ranged from 4.5 to 13.5 years.

The same location was used for both sessions of this study, and the therapists met at the end of the day for both sessions. During the 2-week time period between sessions, none of the therapists practiced using the DGI.

Human experimentation was approved, and both the subjects with MS and the physical therapists signed consent forms before participating in this study.

Statistical Methods

A criterion standard does not exist to measure balance dysfunction during gait in people with MS. To examine concurrent validity of the DGI in this population, Pearson bivariate analysis was used to compare total DGI scores with the time it took to walk 6.1m.

For statistical evaluation of interrater reliability, we used the intraclass correlation coefficient (ICC). Interrater reliability was obtained with a test-retest model with 2 weeks between testing. Intrarater reliability was evaluated after training by using Pearson bivariate analysis. Individual item scores on the DGI and total DGI scores were calculated for both inter- and intrarater reliability.

RESULTS

Validity

An inverse correlation (−.801) between the time to walk 6.1m and the total DGI score was shown (Pearson bivariate analysis, $P<.01$). As subjects' time to walk 6.1m decreased, their total DGI score increased (table 1). The fastest 6.1-m timed walk was 5.27 seconds, with corresponding total DGI score of 22; the slowest time was 13.23 seconds, with corresponding total DGI score of 10. Lower DGI scores (range, 0–24) indicate more balance dysfunction.

Interrater Reliability

The ICC for the total DGI score was .983 ($P<.05$) and the 8 individual DGI components ranged from .910 to .976 (table 2).

Intrarater Reliability

Intrarater reliability for total DGI scores ranged from .760 to .986 (Pearson bivariate analysis, $P<.05$) for the 11 therapists. Correlation values for intrarater reliability for each therapist for the 8 DGI components are in table 3. Pearson bivariate analysis could not be applied for task 7 (step around obstacles) because patients did not present with adequate variability. There was little difference in therapists' perceptions of the patients' gait: their scores were very similar.

DISCUSSION

The DGI has been used in several studies examining unilateral and bilateral vestibular lesions, age-related changes in balance, and dizziness associated with migraine.[7-11] In these studies, scores below 19 (of 24) indicated a risk of falling in the study population. In the present study of subjects with MS, total DGI scores ranged from 10 to 22, with 8 scores below 19 (table 1). Eighty percent of our subjects were at risk of falling because of balance dysfunction and had slower gait speeds that correlated inversely to their DGI scores.

Timed walk is a common clinical measure of mobility and function, and in patients with neurologic dysfunction, slower ambulation speeds correlate with balance dysfunction. Brown et al[10] reported that others[12-14] have documented changes in gait after physical therapy intervention but have used gait speed as their criterion for improvement. Krebs et al[14] documented an 8% increase in gait speed after rehabilitation in persons with

Table 2: Interrater Reliability for the DGI

DGI	ICC of Videotape
1. Gait level surface	.944*
2. Change in gait speed	.962*
3. Gait with horizontal head turns	.922*
4. Gait with vertical head turns	.911*
5. Gait and pivot turn	.910*
6. Step over obstacle	.976*
7. Step around obstacles	.957*
8. Steps	.955*
Total DGI score	.983*

*Significant at the .05 level.

Table 3: Correlation Values Using Pearson Bivariate for Intrarater Reliability

DGI	PT 1	PT 2	PT 3	PT 4	PT 5	PT 6	PT 7	PT 8	PT 9	PT 10	PT 11
1. Gait level surface	1.000†	1.000†	0.606	1.000†	1.000†	1.000†	0.802†	1.000†	0.893†	1.000†	1.000†
2. Change in gait speed	0.667*	0.524	0.769†	0.836†	0.602	0.756*	0.667*	0.557	0.748*	0.700*	0.717*
3. Gait with horizontal head turns	1.000†	0.836†	0.272	0.816†	0.356	0.816†	0.967†	0.456	1.000†	0.816†	0.802†
4. Gait with vertical head turns	1.000†	0.371	‡	0.716*	0.408	1.000†	0.802†	0.867†	1.000†	0.802†	0.667*
5. Gait and pivot turn	1.000†	0.829†	0.690*	0.375	0.667*	0.612	0.773†	0.373	0.408	1.000†	0.667*
6. Step over obstacle	0.824†	0.515	0.726*	0.861†	0.848†	0.436	1.000†	0.717*	0.792†	0.827†	0.696*
7. Step around obstacles	‡	‡	0.583	‡	‡	‡	‡	‡	‡	‡	‡
8. Steps	1.000†	0.802†	1.000†	0.893†	1.000†	0.709*	0.893†	0.893†	0.802†	1.000†	1.000†
Total DGI score	0.960†	0.903†	0.760*	0.894†	0.949†	0.929†	0.986†	0.851†	0.976†	0.946†	0.960†

Abbreviation: PT, physical therapist.
*Significant at the .05 level (2 tailed).
†Significant at the .01 level (2 tailed).
‡Pearson bivariate analysis could not be applied for task 7 because subjects did not present with adequate variability.

bilateral vestibular disease. Gait speed and the Timed Up & Go test have previously been shown to correlate ($r=-.61$).[15]

An inverse relation between the time a person takes to ambulate 6.1m and total DGI score was demonstrated in the present study. (This finding signifies that a patient with a 6.1-m timed walk of 5.27 seconds and a total DGI score of 22 displays less balance dysfunction than a patient with a 6.1-m timed walk of 13.23 seconds and a total DGI score of 10.) This correlation between the timed walk and the DGI supports concurrent validity of the DGI as a measure of balance impairment with gait when used with subjects with MS.

The reliability of the DGI in other patient populations has not been published. Reliability coefficients obtained in the present study will be of use in other studies examining specific patient populations and the DGI. The interrater reliability in this study ranged from .983 to .987 for total DGI scores. Intrarater reliability established with Pearson bivariate analysis ranged from .760 to .986 for total DGI scores but could not be computed for the DGI task of stepping around obstacles (task 7), because at least 1 of the variables was constant. For this task, all the therapists scored the subjects similarly, indicating little gait variability. The task of stepping around obstacles may not be sensitive enough to distinguish balance deficits between some people with MS. Intrarater reliability scores were also lower for task 2 (change in gait speed) and task 5 (gait and pivot turn). Therapists commented that interpretation of the scoring categories for mild, moderate, and severe impairment for task 2 was somewhat confusing and expressed difficulty selecting between mild and moderate impairment and between moderate and severe impairment. When scoring for task 5 therapists commented that the criterion of turning within 3 seconds was difficult to determine in some participants.

Other questions and concerns of the therapists related to the definitions of "minimal gait deviations" and "significant gait deviations" because a description of the magnitude of the gait change is not provided. Therapists also expressed difficulty interpreting scoring criteria for task 6 (step over obstacle). The criterion does not distinguish whether both feet have to step over the shoebox or if only 1 foot must clear the shoebox. During gait analysis, it is important to assess single-limb stance for functional activities such as stepping up a curb. If this is the intent of task 6, then only 1 foot has to clear the shoebox. For this particular task, more specific instructions may be required, for example, "both limbs need to clear the shoe box."

Extraneous Variables

There are unique extraneous variables that must be controlled in studies of persons with MS. One must consider that the performance capabilities of individuals with MS may be affected by weather, time of year, time of day, and environment. One factor that cannot be controlled, however, is the natural progression of the disease. Exacerbations or deterioration will influence balance and the person's ability to perform gait tasks. In this study, we controlled for the extraneous variables by videotaping, thereby producing a permanent record. Subjects with MS participating in this study were videotaped once, and the videotape was used in both gait scoring sessions.

CONCLUSIONS

Balance dysfunction, commonly found in people with MS, affects ambulation. Concurrent validity of the DGI was shown with an inverse relation (−.801) between the DGI and the 6.1-m timed walk. Interrater reliability for total DGI scores was .983, and intrarater reliability for total DGI scores ranged between .760 and .986. From these results, it appears that the DGI, developed to assess balance dysfunction with gait in individuals with peripheral vestibular disease, is a reliable functional assessment tool for individuals with MS.

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