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ORIGINAL RESEARCH

Parallel Walk Test: Its Correlation With Balance and Motor Functions in People With Chronic Stroke

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Abstract

Objectives: To investigate (1) the intrarater, interrater, and test-retest reliability of the times and scores generated in the parallel walk test (PWT); (2) their correlations with impairments and activity limitations of individuals with stroke; and (3) the cutoff times that best discriminate individuals with stroke from healthy elderly subjects.

Design: Cross sectional study.

Setting: University-based rehabilitation center.

Participants: Participants (N=72) comprised individuals with stroke (n=37) and healthy individuals (n=35).

Interventions: Not applicable.

Main Outcome Measures: The PWT was administered along with the Fugl-Meyer Motor Assessment of the Lower Extremities (FMA-LE), handheld dynamometer measurements of ankle dorsiflexor and plantarflexor muscle strength, the 5-Times-Sit-to-Stand Test, the Berg Balance Scale (BBS), a limits of stability (LOS) test, the 10-m walk test (10-MWT), and the timed Up and Go (TUG) test.

Results: PWT times and scores showed good to excellent intrarater, interrater, and test-retest reliability in individuals with stroke. PWT times using paths of 3 different widths significantly correlated with FMA-LE scores, 5-Times-Sit-to-Stand Test times, BBS scores, some LOS test results, 10-MWT gait speed, and TUG test times. PWT times of 6.30 to 7.48 seconds, depending on the path width, were shown reliably to discriminate individuals with stroke from healthy individuals.

Conclusion: The PWT is a reliable, easy-to-administer clinical tool for assessing dynamic walking balance in individuals with chronic stroke.
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Impaired balance is common after stroke and can affect functional activity.[1] Improving dynamic walking balance is an important goal in stroke rehabilitation.[1,2] Different types of interventions are aimed at improving dynamic walking balance performance.[2] However, the commonly used dynamic walking balance tests, including the Dynamic Gait Index,[3] Functional Gait Assessment,[4] and the Tinetti Performance-Oriented Mobility Assessment,[5] are generally time-consuming[3-5] or do not provide a quantitative measure of dynamic walking balance during ambulation, or both.[3,5] Clinicians need a more reliable, valid, and easy-to-administer tool

that properly reflects changes in performance of dynamic walking balance during the rehabilitation process.

The parallel walk test (PWT) was developed to assess dynamic walking balance safely, quickly, and simply.[6] Subjects are required to walk between 2 parallel lines that are 6m long, with 3 different widths (20cm, 30.5cm, 38cm), with their usual gait pattern at a comfortable speed. The times taken to complete the test and the accuracy of foot placement within or outside the lines are recorded as PWT times and PWT scores, respectively.

The PWT has been shown to have a high degree of test-retest and interrater reliability, with intraclass correlation coefficients (ICCs) ranging from .63 to .93 with elderly fallers.[7] PWT times with the 25- and 30.5-cm widths have also been found to correlate well with the timed Up and Go (TUG) test scores in older adults.[8] However, there has been no study investigating the intrarater,

interrater, and test-retest reliabilities of the PWT in stroke survivors. In addition, no systematic study of the relationships among PWT times, PWT scores, and stroke-specific impairments has been published, nor has any published study established the best cutoff times for discriminating individuals with chronic stroke from healthy older adults.

The objectives of this study were (1) to establish the intrarater, interrater, and test-retest reliabilities of PWT times and scores in stroke survivors; and (2) to investigate the concurrent validity of the PWT by exploring any correlation between PWT times and scores and other measures of impairments and activity limitations, including the Fugl-Meyer Assessment of the Lower Extremities (FMA-LE), lower limb muscle strength, 5-Times-Sit-to-Stand Test times, Berg Balance Scale (BBS) scores, limits of stability (LOS) test, time and speed in the 10-m walk test (10-MWT), and TUG test times. It was also designed (3) to determine the cutoff PWT times that best discriminate stroke survivors from other healthy elderly subjects.

Methods

Participants

This study was a cross-sectional clinical trial. A previous study[7] demonstrated a high degree of interrater reliability (ICC range, .93−.99) and test-retest reliability (ICC range, .63−.90) for PWT times and scores of elderly fallers. Assuming that ICC values of stroke survivors are about .90, we determined that a sample size of 30 would be required to achieve 90% power to detect an ICC of .90 with a confidence level of .05.

Stroke survivors from a local self-help group were included if they (1) were at least 55 years of age, as the incidence of stroke approximately doubles each decade in adults older than 55 years[9]; (2) had sustained a single stroke at least 1 year previously; (3) were able to walk 10m with no physical assistance with or without a walking aid; (4) had an Abbreviated Mental Test[10] score ≥7; and (5) had a stable general medical condition. Individuals were excluded if they had neurologic disorders other than stroke or if they had other comorbid disabilities that would hinder proper assessment.

Healthy individuals were recruited from the local community using poster advertising if they were older than 55 years to serve as controls. Healthy subjects were excluded if they had any conditions that might affect the assessment protocol, such as uncontrolled diabetes mellitus or any neurologic or musculoskeletal problems affecting mobility and hindering proper assessment.

The study was approved by the ethics committee of the Hong Kong Polytechnic University and was conducted according to the guidelines of the Declaration of Helsinki. All participants were

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List of abbreviations:

10-MWT	10-m walk test
AUC	area under the curve
BBS	Berg Balance Scale
COG	center of gravity
FMA-LE	Fugl-Meyer Assessment of the Lower Extremities
ICC	intraclass correlation coefficient
LOS	limits of stability
MXE	maximum excursion
PWT	parallel walk test
TUG	timed Up and Go

Table 1 Demographics of the 2 subject groups

Characteristics	Stroke (n=37)	Healthy (n=35)	P
Age (y)	62.0±6.2	64.3±7.8	.172
Sex (M/F)	26/11	11/24	.001*
Height (cm)	164.1±7.7	160.6±9.2	.086
Weight (kg)	67.5±9.0	58.5±10.9	<.001*
Body mass index (kg/m^2)	25.1±2.7	22.6±3.7	<.001*
Years since stroke	7.8±3.0	NA	NA

NOTE. Values are mean ± SD, n, or as otherwise noted.
Abbreviations: F, female; M, male; NA, not applicable.
 * A significant difference at the P≤.05 level of confidence.

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informed about the testing procedures, and written consents were obtained before the start of the study.

Outcome measurements

Parallel walk test
All subjects were asked to walk at their comfortable walking speed for 6 metres between 3 sets of parallel lines (installed 20cm, 30.5cm, and 38cm apart), wearing their usual footwear and with any usual walking aids if required. The time taken to complete each walk was recorded as a PWT time. The PWT scores were calculated based on the accuracy of foot placement. No marks were awarded if the foot placement was always completely between the lines. Stepping on a line earned 1 point, stepping outside the lines or maintaining balance by grasping something scored 2 points.[6] Two trials were recorded for each width, with a 2-minute rest between each trial. The testing order for the different widths was randomized by drawing lots.

Fugl-Meyer Assessment of the Lower Extremities
The FMA-LE quantifies motor impairment after stroke using 17 items that assess reflexes, movement, and coordination. Each item is scored on an ordinal scale from 0 to 2, adding up to a maximum possible score of 34.[11] The FMA-LE is well known to have high interrater (ICC=.89−.95) and intrarater reliability (ICC=.96) when used with individuals with chronic stroke.[12]

Lower limb muscle strength
The muscle strength of the subjects' ankle dorsiflexors and plantarflexors was measured using a Nicholas handheld dynamometer (model 01160).[a] Such dynamometry has demonstrated high test-retest reliability (ICC=.98)[13] and interrater reliability (ICC=.91)[14] The subjects were positioned in supine and were asked to produce a sustained maximum isometric contraction against the examiner's resistance for 3 seconds. The dynamometer was placed across the midshafts of the first to fifth metatarsal bones, anteriorly for testing the dorsiflexors and posteriorly for the plantarflexors. Each muscle group was tested 3 times, alternating between the feet and with a 1-minute rest between trials.

5-Times-Sit-to-Stand Test
The 5-Times-Sit-to-Stand Test measures the functional strength of the lower extremities.[15] It has shown excellent intrarater reliability (ICC=.97−.98), interrater reliability (ICC=1.00), and test-retest reliability (ICC=.99−1.00) with chronic stroke subjects.[16] The subjects were instructed to stand up fully and sit down in a