ACRM
AMERICAN CONGRESS OF REHABILITATION MEDICINE

Archives of Physical Medicine and Rehabilitation

journal homepage: www.archives-pmr.org

Archives of Physical Medicine and Rehabilitation 2016;■:■■■-■■■

ORIGINAL RESEARCH

Effect of Leg Selection on the Berg Balance Scale Scores of Hemiparetic Stroke Survivors: A Cross-Sectional Study

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Abstract

Objective: To examine whether selection of the nonparetic or paretic leg as the weight-bearing leg in item 13 (standing unsupported one foot in front) and item 14 (standing on one leg) of the Berg Balance Scale (BBS) influences the item scores, and thus the total score.

Design: Cross-sectional study.

Setting: University-based rehabilitation laboratory.

Participants: Community-dwelling people (N=63, aged ≥50y) with chronic stroke.

Interventions: Not applicable.

Main Outcome Measure: BBS.

Results: The 4 BBS total scores ranged from 48.4 to 50.7. The total score was significantly lower when a participant was asked to step forward with the nonparetic leg in item 13, and stand on the paretic leg in item 14. Fewer participants received a maximum score with the BBS_1 formulation than the others. In addition, the correlations with walking speed and Activities-specific Balance Confidence Scale scores were greatest with the BBS_1 score.

Conclusions: Our findings suggest that BBS_1 was the most challenging formulation for our participants; this might serve to minimize the ceiling effect of the BBS. These findings provide a rationale for amending the BBS administration guidelines with the BBS_1 formulation.

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The Berg Balance Scale (BBS) was first introduced in 1989.[1] The scale consists of 14 items, each rating a participant's ability to maintain stability in a specified functional task on a 5-point (0–4) scale.[1,2] The BBS has demonstrated excellent test-retest reliability (intraclass correlation coefficient [ICC]=.95–.98)[3,4] and inter-rater reliability (ICC=.95)[5] for participants with stroke and has been extensively used for measuring the functional balance performance of elderly participants,[6,7] stroke survivors,[5,8] and participants with Parkinson disease.[9] It has also been used to evaluate the risk of falling with participants who have had a stroke.[10,11] However, one of the shortcomings of the BBS is that it demonstrated a large ceiling effect in stroke survivors who had high physical function.[12]

The last 2 items of the BBS, item 13 (standing unsupported one foot in front) and item 14 (standing on one leg), are considered the most difficult because both items require narrowing the base of support during asymmetrical weight-bearing.[13,14] In item 13, the participant is asked to stand with 1 foot in front of the other. A score of 4 is given if the participant can maintain this tandem stance for at least 30 seconds with 1 foot placed directly anterior to the other and the longitudinal axis of the 2 feet aligned.[15] A biomechanical study with healthy adults has shown that body weight is loaded significantly more on the posterior leg in that tandem stance position.[16] The single-leg stance (SLS) is an even more extreme form of asymmetrical weight-bearing. SLS duration on a paretic leg after stroke is significantly shorter than on a nonparetic leg.[8] Previous studies[17,18] have demonstrated that

Supported by the General Research Fund (reference number 562413) from the Research Grants Council, Hong Kong.

Disclosures: none.

0003-9993/2016/$36 - see front matter © 2016 by the American Congress of Rehabilitation Medicine
http://dx.doi.org/10.1016/j.apmr.2015.11.017

participants with stroke tended to bear more weight on their nonparetic leg when standing, to better control postural stability.

The standard instructions for items 13 and 14 in a BBS assessment do not restrict the selection of the weight-bearing leg,[1] but the choice is likely to affect the scores on those items and the total score, especially in patients with asymmetrical motor control.

To our knowledge, the effect of leg selection on performance of these 2 BBS items has not been studied. The primary purpose of this study was to investigate whether the total BBS score would differ when participants were required to use their more-involved leg in either weight-bearing or non−weight-bearing fashion for items 13 and 14. A secondary purpose was to examine the concurrent validity of the 4 BBS scoring strategies by considering the correlation between the BBS performances and other measures of standing balance. We hypothesized that the item scores would be significantly lower when a participant steps forward with the nonparetic leg in item 13, and stands on the paretic leg in item 14. We also hypothesized that the BBS total score with this formulation would thus be significantly lower than the scores with alternative formulations. It had been reported that the BBS demonstrated a large ceiling effect in stroke survivors who had high physical function.[12] By bringing down the total score of the BBS, this BBS formulation might also have less of a ceiling effect than the other formulations. Lastly, this BBS formulation might demonstrate a stronger correlation with other outcome measures.

Methods

Participants

Sixty-three community-dwelling chronic stroke survivors were recruited. Demographic characteristics of participants are shown in table 1. Participants were recruited from local self-help groups by posting advertisements in local community centers. Participants were eligible for this study if they (1) were aged ≥50 years; (2) had received a diagnosis of stroke; (3) had sustained a single stroke at least 1 year previously; and (4) were able to walk 6m without assistance, with or without a walking aid. Participants were excluded if they were (1) cognitively impaired (Abbreviated Mental Test score <6)[19]; (2) medically unstable; or (3) had any other neurologic or musculoskeletal condition that would affect mobility and balance performance. Sample size estimation was conducted with the aid of G*Power (version 3.1[a]). A sample size of 62 participants would be adequate to detect a significant difference (α=.05; power=0.8) between the 4 formulations of BBS total scores. The sample size estimation was based on the assumption that a small effect size (Cohen's f=.15) and moderate correlation among repeated BBS scores measurements (r=0.5) existed.

The ethics committee of the administrating institution approved the study's assessment protocol. All participants gave written consent before starting the experiments. The study was conducted in accordance with the Declaration of Helsinki for human experiments.

Table 1 Characteristics of participants (n=63)

Characteristics	Values
Sex (M/F)	43 (68.3)/20 (31.7)
Side of hemiplegia (R/L)	37 (62.2)/26 (37.8)
Type of stroke (ischemic/hemorrhagic)	41 (65.1)/22 (34.9)
Faller (≥1 fall within previous 6mo)	14 (22.2)
Age (y)	61.9±6.8 (50−79)
Height (cm)	161.9±7.0 (142.0−178.0)
Body weight (kg)	64.9±10.7 (41.0−93.2)
Body mass index (kg m^{-2})	24.6±3.0 (18.0−32.2)
Poststroke duration (y)	7.7±4.5 (1.0−20.8)

NOTE. Values are n (%) or mean ± SD (range).
Abbreviations: F, female; L, left; M, male; R, right.

List of abbreviations:

ABC	Activities-specific Balance Confidence Scale
AUC	area under the curve
BBS	Berg Balance Scale
FMA-LE	Fugl-Meyer Assessment−Lower Extremity
FTSTS	5 times sit-to-stand test
ICC	intraclass correlation coefficient
SLS	single-leg stance

Assessment procedures

This cross-sectional study was conducted in the Balance and Neural Control Laboratory of The Hong Kong Polytechnic University. All participants completed the BBS and other assessments in a random order determined by drawing lots. Five minutes of rest was allowed between each assessment to avoid fatigue.

Outcome measures

Fall history

Participants were asked whether they had fallen in the past 6 months, regardless of whether the fall resulted in an injury. A fall was defined as "an unexpected event in which the participants come to rest on the ground, floor, or lower level."[20(p1619)] The accuracy of fall recall by the elderly has been reported to be satisfactory for a 1-year period (sensitivity, 89%; specificity, 95%).[21]

BBS score

Items 1 to 12 of the assessments were conducted in accordance with the standard instructions. Items 13 (tandem stance) and 14 (SLS) were performed twice so that both legs could execute the weight-bearing component of the item (ie, for item 13, the posterior leg was weight-bearing; for item 14, the stance leg was weight-bearing). The sequence of performance was randomized for these 2 items. This produced 4 total BBS scores (appendix 1).

Fugl-Meyer Assessment−Lower Extremity score

The lower extremity motor subscale of the motor domain of the Fugl-Meyer Assessment (FMA-LE) was used to measure the participants' lower extremity motor recovery after stroke. Quality of reflexes, coordination, and voluntary movements of the paretic leg were assessed using a 34-point scale.[22] Excellent interrater and intrarater reliability[23] (ICC=.959−.963) and test-retest repeatability[3] (ICC=.94) have been reported for the FMA-LE.

Five times sit-to-stand test

The 5 times sit-to-stand test (FTSTS) was used to examine the functional muscle strength of the participants' lower limbs.[24] The