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Original Article

Title: Reliability of the Japanese Version of the Berg Balance Scale

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## Abstract

Objective: The Japanese translation of the Berg balance scale (BBS) has previously been published; however, its reliability has not yet been validated. This study aimed to evaluate its reliability.

Methods: Patients took the BBS test three times; two neurologists monitored the results. The intraclass correlation coefficients (ICC) and Cronbach's alpha ( $\alpha$ ) coefficients were calculated, and the inter-rater and intra-rater reliability were determined.

Patients: Thirty-three patients with balance disturbance were recruited.

Results: The study participants included 15 men and 18 women with a mean age of 62.8 years (SD, 14.8). For the total BBS score, the inter-rater ICC and Cronbach's  $\alpha$  coefficient were 0.9337 and 0.9493, respectively, while the intra-rater ICC and Cronbach's  $\alpha$  coefficient were 0.9772 and 0.9416, respectively. Most items had a relatively high ICC. The Cronbach's  $\alpha$  coefficients were more than 0.9 for all items.

Conclusion: The Japanese version of the BBS was found to have a high inter-rater and intra-rater reliability and internal consistency.

**Key words:** Berg balance scale; balance disturbance; intraclass correlation coefficient; Cronbach's  $\alpha$  coefficient

## Introduction

Balance disturbance is a common symptom of many neurological disorders, such as spinocerebellar degeneration, multiple sclerosis and cerebrovascular disease. The Berg balance scale (BBS) (1), published in 1989, is a widely used clinical test for evaluating balance disturbance. It consists of 14 balance-related tasks or items, such as standing, sitting, transfers and standing on one leg. Each item is scored from 0 to 4, with 0 being severe balance disturbance and 4 being normal balance function; thus, the minimum score that can be achieved is 0, while the maximum score is 56. In other words, as symptoms progress, the scores will progressively decrease.

The BBS was originally developed to estimate the risk of falling among elderly subjects. Previous studies have used the BBS in assessments of elderly patients and patients with acute stroke, as well as of those with orthopedic diseases (2)(3). Recently, the BBS was used in a clinical trial for the assessment of balance in patients with Parkinson's disease (4). The BBS

has been translated into many different languages and each version is said to be reliable (4)(5)(6)(7). The Japanese translation of the BBS has also been published (8), but its reliability has yet to be validated.

This primary aim of this study was to evaluate the reliability of the Japanese version of the BBS, given its frequent use in estimating balance disturbance among patients with neurological diseases. Furthermore, we attempted to assess the BBS for various neurological diseases rather than limiting it to one particular disease.

## Materials and methods

Patients who were hospitalized in the Hokkaido University Hospital, Department of Neurology between September 2012 and October 2012 were enrolled in this study. Those enrolled were diagnosed with some kind of neurological disorder accompanied by balance disturbance. This study was approved by the institutional review board of Hokkaido University Hospital. Prior to beginning the study, written informed consent was obtained from all participants. Patients with severe cognitive impairment were excluded.

The published Japanese translation of the BBS was used (8); another study

that reported on the reliability of the Japanese version of the scale for the assessment and rating of ataxia was consulted for the study design (9). Two neurologists, evaluators A and B, examined each patient separately using the Japanese version of the BBS. Evaluator A carried out the examination first, and evaluator B examined the patients several hours later on the same day. After a few days, evaluator A performed the examination again (Figure).

Each trial was performed blindly and under the same conditions, i.e., during the “on” period in patients with Parkinson’s disease, thus avoiding any sudden change in motor symptoms. There were no interventions during the study period except for the prior treatments. Amassed data were anonymized, and the statistical analyses were performed.

#### Statistical analysis

The JMP® Pro 10.0.0 software program (SAS Institute Inc., Cary, NC, USA) was used for the statistical analysis. The inter-rater and intra-rater reliability between evaluators A and B was assessed (Figure). The total BBS score and the scores of each item were analyzed based on Cronbach’s  $\alpha$  coefficients and the intraclass correlation coefficients (ICCs). The items were

considered to have high internal consistency if Cronbach's  $\alpha$  coefficient was more than 0.8. ICC values were interpreted as follows: slight (0.000 to 0.200); fair (0.201 to 0.400); moderate (0.401 to 0.600); substantial (0.601 to 0.800) and almost perfect (0.801 to 1.000) (10). The mean values are presented with the standard deviation (SD).

## Results

Thirty-three patients (15 men and 18 women; age range, 28 to 82 years; mean age,  $62.8 \pm 14.8$  years) were enrolled in this study. The participants had balance disturbance associated with the following neurological diseases: multiple system atrophy (six patients), Parkinson's disease (five patients), amyotrophic lateral sclerosis (three patients), multiple sclerosis (three patients), myasthenia gravis (two patients), Parkinsonism (two patients), and progressive supranuclear palsy, hereditary spinocerebellar degeneration, Creutzfeldt-Jakob disease, clinical isolated syndrome, cerebral infarction, cerebral vasculitis, myelitis, spinal lymphomatoid granulomatosis, human T-cell leukemia virus type 1 associated myelopathy, idiopathic myelopathy, lumbar canal stenosis and peripheral neuropathy (one patient each). The

average time needed for each examination was  $10.4 \pm 2.1$  minutes.

The total BBS scores and the scores for each item are shown in Table 1. There were no statistically significant difference between the assessments ( $p = 0.2925$  to  $1.00$ ). Table 2 shows the distribution of the scores by evaluator A (first assessment). The second and third assessments showed similar scoring values. For item 3 of the BBS, most patients were given a score of “4.” As with the other language versions, all items had high item-total correlation coefficients, except for BBS item 3 (data not shown). The ICCs and Cronbach’s  $\alpha$  coefficients are shown in Table 3. The inter-rater and intra-rater ICCs and Cronbach’s  $\alpha$  coefficients of the total BBS score were more than 0.9. The inter-rater and intra-rater ICC values for 12 out of the 14 items were over 0.6. The inter-rater ICC of the BBS item 3 could not be calculated due to a software error. The Cronbach’s  $\alpha$  coefficients of all items were more than 0.9.

## Discussion

The total score of the Japanese version of the BBS showed a high ICC and Cronbach’s  $\alpha$  coefficient, indicating good test-retest reliability and internal

consistency. Most of the individual items exhibited high ICCs, and all items showed high Cronbach's  $\alpha$  coefficients. These findings correspond to those of previous reports of other translations (2)(4)(5)(6)(7).

The BBS is mainly used for assessing balance in elderly individuals, patients with stroke and patients with orthopedic diseases. This study demonstrates that the BBS is useful for the assessment of balance in patients with various neurodegenerative diseases associated with balance disturbance. This study differed from previous studies in that all the participants were inpatients.

The related reduction in the activities of daily living may account for the lower scores observed in this study compared to other studies; however, the scores achieved in this study were generally equivalent to those of the previously published data (2)(4-7), and the distribution of scores resembled that reported in previous studies (5)( 6).

Regarding item 3 of the BBS, almost all patients could sit safely, i.e., they received a score of "4"; however, the statistical error for item 3 was larger than the dispersion of its score, and thus, the ICC value was negative. Since ICC values are generally displayed as 0 to 1, we could not obtain a relevant

value for this item. Previous studies have reported that all participants received a score of “4” in the BBS item 3 (1)(5)(6). Due to the nature of this item, a big difference may not occur in most populations.

The BBS items 1, 3, and 5 showed low ICC values; their mean scores were higher than 3.5. A few items had low ICC values and a high Cronbach's  $\alpha$  coefficient. This may be due to the structure of the 5-point scale. If there was a disagreement between the evaluators in a few items, the Cronbach's  $\alpha$  coefficients were high but the ICCs were low; however, the scores of the evaluators were similar for most items.

The BBS is a useful scale, but there may still be room for improvement. That said, items with intra-rater and inter-rater ICC values higher than 0.8 were observed in the latter part of the BBS; those tasks were considered to be relatively difficult to perform. Tasks with high levels of difficulty are likely to be suitable for scales aimed at the differentiation of patients. Previously, brief versions of the BBS have been discussed (11)(12), and several items with high ICCs noted in Table 3 have been included in these versions. It is thought that the ICC values could therefore be useful for developing brief versions of the BBS.

## Conclusion

The Japanese version of the BBS was found to have high intra-rater and inter-rater reliability while showing a high internal consistency. Furthermore, the BBS may be a helpful indicator of balance disturbance in patients with neurodegenerative diseases.

## Acknowledgements

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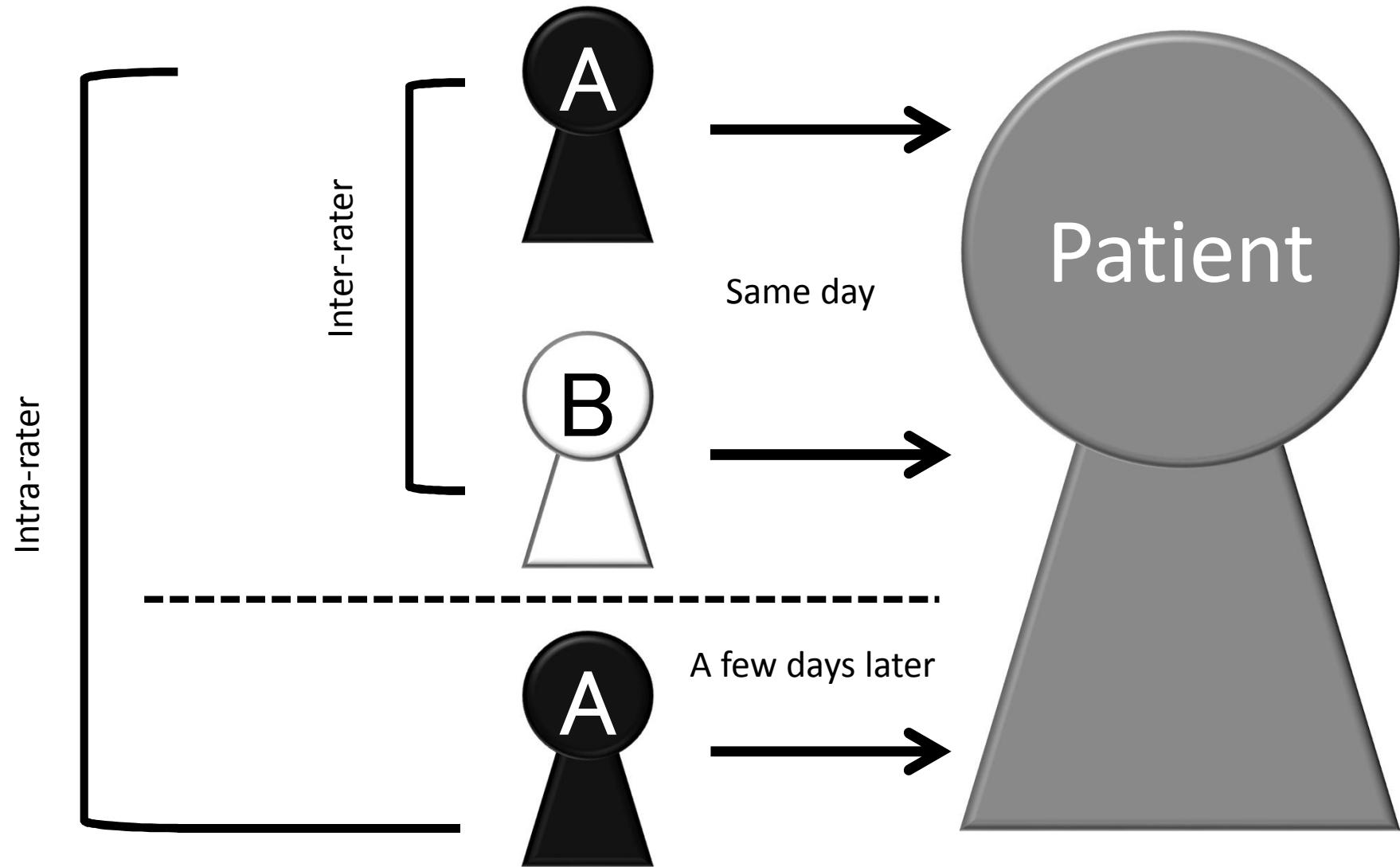
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### Figure legend

The assessment procedure used in this study.



## Legend

Supplementary figure. The assessment procedure used in this study.

Table1. The mean scores ± standard deviation (SD) for each item and the total BBS score.

The first and third assessments were conducted by evaluator A, and the second assessment was performed by evaluator B.

	First assessment (A)	Second assessment (B)	Third assessment (A)
Item	Score ± SD	Score ± SD	Score ± SD
BBS1 Sit to stand	3.697 ± 0.521	3.606 ± 0.851	3.576 ± 0.698
BBS2 Standing unsupported	3.894 ± 1.043	3.636 ± 1.010	3.364 ± 1.039
BBS3 Sitting unsupported	3.909 ± 0.378	3.909 ± 0.514	3.909 ± 0.287
BBS4 Stand to sit	3.364 ± 1.096	3.545 ± 0.988	3.424 ± 0.922
BBS5 Transfers	3.636 ± 0.771	3.576 ± 0.780	3.606 ± 0.886
BBS6 Standing with eyes closed	3.212 ± 1.008	3.424 ± 1.016	3.273 ± 1.023
BBS7 Standing with feet together	3.000 ± 1.044	3.182 ± 1.167	3.152 ± 1.019
BBS8 Reaching forward while standing	2.485 ± 1.019	2.645 ± 1.123	2.515 ± 0.957
BBS9 Retrieving object from floor	3.455 ± 1.076	3.455 ± 1.233	3.485 ± 1.158
BBS10 Turning trunk (feet fixed)	3.394 ± 1.099	3.364 ± 1.201	3.394 ± 1.043
BBS11 Turning 360°	2.545 ± 1.373	2.818 ± 1.486	2.727 ± 1.377
BBS12 Placing alternate foot on stool	2.848 ± 1.373	3.121 ± 1.451	3.030 ± 1.359
BBS13 Tandem standing	2.182 ± 1.749	2.091 ± 1.781	2.212 ± 1.719
BBS14 Standing on one leg	1.758 ± 1.634	2.061 ± 1.536	2.000 ± 1.670
Total	42.879 ± 11.793	44.273 ± 12.790	43.667 ± 11.990

Table2. Distribution of scores for evaluator A (first assessment).

Item	Score				
	0	1	2	3	4
BBS1	0	0	1	8	24
BBS2	2	0	2	8	21
BBS3	0	0	1	1	31
BBS4	0	5	1	4	23
BBS5	0	2	0	6	25
BBS6	2	0	2	14	15
BBS7	2	0	6	13	12
BBS8	2	3	9	15	4
BBS9	2	1	0	7	23
BBS10	1	2	4	2	24
BBS11	3	4	12	0	14
BBS12	4	2	4	8	15
BBS13	11	2	3	4	13
BBS14	13	3	3	7	7
Sum	42	24	48	97	251
(%)	(9.09)	(5.19)	(10.39)	(21.00)	(54.33)

Table3. Inter-rater and intra-rater ICCs and Cronbach's  $\alpha$  coefficients for the BBS.

Item	Inter rater		Intra rater	
	ICC	Cronbach's $\alpha$	ICC	Cronbach's $\alpha$
BBS1	0.5560	0.9560	0.6930	0.9498
BBS2	0.7814	0.9532	0.8233	0.9458
BBS3	Not calculated	0.9603	0.2099	0.9592
BBS4	0.8127	0.9550	0.8278	0.9478
BBS5	0.8043	0.9543	0.5928	0.9473
BBS6	0.7880	0.9538	0.8859	0.9465
BBS7	0.7377	0.9522	0.7938	0.9448
BBS8	0.7530	0.9539	0.7131	0.9475
BBS9	0.9121	0.9522	0.9411	0.9453
BBS10	0.6771	0.9534	0.7688	0.9472
BBS11	0.8513	0.9529	0.8917	0.9454
BBS12	0.8183	0.9532	0.9218	0.9451
BBS13	0.7493	0.9573	0.9070	0.9499
BBS14	0.8385	0.9569	0.8824	0.9491
Total	0.9337	0.9493	0.9772	0.9416