VALIDATION OF THE BRAZILIAN VERSION OF THE BERG BALANCE SCALE FOR PATIENTS WITH PARKINSON'S DISEASE

Paula L. Scalzo[1], Isabella C. Nova[2], Mônica R. Perracini[3], Daniel R.C. Sacramento[3], Francisco Cardoso[4], Henrique B. Ferraz[5], Antonio Lúcio Teixeira[6]

Abstract – **Background:** Changes in balance occur with the progression of Parkinson's disease (PD). **Objective:** To validate the Brazilian version of the Berg Balance Scale (BBS) for PD patients, determining its reliability and internal consistency and correlating it with PD-specific instruments. **Method:** We evaluated 53 patients (M/F 37/16, mean age±SD, 62±7.9 years) with PD (mean±SD, 7.8±4.4 years). Unified Parkinson's Disease Rating Scale (UPDRS), Schwab and England Scale (S&E), Hoehn and Yahr Staging Scale (HY) and BBS were used to assess patients. Statistical analyses for inter-rater reliability, internal consistency and correlations among BBS, UPDRS, S&E and HY were performed. **Results:** The mean scores±SD on UPDRS and BBS were, respectively, 41.6±17.8 and 47.2±8.2. The median on S&E and HY scales were 80% and 2.5, respectively. The BBS presented a high intra-class correlation coefficient (ICC=0.84) and internal consistency (Cronbrach's α=0.92). There was a statistically significant correlation between BBS and disease duration (r_s= −0.520, p<0.001), UPDRS subscales II and III (r_s= −0.467, p=0.011; r_s= −0.374, p=0.046, respectively), stage of disease (HY; r_s= −0.507, p<0.001) and the activities of daily living (S&E; r_s=0.492, p<0.001). **Conclusion:** The BBS is a promising tool for the assessment of balance in PD, correlating with the stage of disease and the level of independence.

KEY WORDS: Parkinson's disease, postural instability, Berg Balance Scale.

Validação da versão brasileira da Escala de Equilíbrio de Berg para pacientes com a doença de Parkinson

Resumo – Alterações de equilíbrio ocorrem com a progressão da doença de Parkinson (DP). **Objetivo:** Validar a versão brasileira da Escala de Equilíbrio de Berg (EEB) para pacientes com DP, determinando a confiabilidade, a consistência interna e correlacionando com instrumentos específicos da DP. **Método:** Foram avaliados 53 pacientes (H/M 37/16, idade média±DP, 62±7,9 anos) com DP (media±DP, 7,8±4,4 anos). Escala de Graduação Unificada da Doença de Parkinson (UPDRS), Escala de Schwab e England (S&E), Escala de Estágios de Hoehn e Yahr (HY) e EEB foram utilizadas. Análise estatística para confiabilidade entre examinadores, consistência interna e correlações entre EEB, UPDRS, S&E e HY foram realizadas. **Resultados:** Os escores médios±DP nas escalas UPDRS e EEB foram, respectivamente, 41,6±17,8 e 47,2±8,2. A mediana nas escalas S&E e HY foram 80% e 2,5. A EEB mostrou ter alto coeficiente de correlação intraclasse (ICC=0,84) e consistência interna (α de Cronbach=0,92). Houve correlação estatisticamente significativa entre EEB e a duração da doença (r_s= −0,520, p<0,001), sub-escalas II e III do UPDRS (r_s= −0,467, p=0,011; r_s= −0,374, p=0,046, respectivamente), estágio da doença (HY; r_s= −0,507, p<0,001), com as atividades da vida diária (S&E; r_s= 0,492; p<0,001). **Conclusão:** A EEB é um instrumento promissor para avaliar o equilíbrio na DP, correlacionando-se com o estágio da doença e o nível de independência.

PALAVRAS-CHAVE: doença de Parkinson, instabilidade postural, Escala de Equilíbrio de Berg.

Neuropsychiatric Branch and Movement Disorders Clinic, Neurology Unit, University Hospital, Federal University of Minas Gerais (UFMG), Belo Horizonte MG, Brazil and Movement Disorders Clinic, Federal University of Sao Paulo, São Paulo SP, Brazil: [1]Physical Therapist, Pontifical Catholic University of Minas Gerais (PUC Minas, Betim) and Estácio de Sá University, Belo Horizonte MG, Brazil; [2]Physical Therapist, Federal University of São Paulo, São Paulo SP, Brazil; [3]Neurologist, University Hospital, Federal University of Minas Gerais, Belo Horizonte MG, Brazil; [4]Neurologist. Department of Internal Medicine, School of Medicine, Federal University of Minas Gerais, Belo Horizonte MG, Brazil; [5]Neurologist, Department of Neurology, Federal University of São Paulo, São Paulo SP, Brazil; [6]Neurologist and Psychiatrist, Department of Internal Medicine, School of Medicine, Federal University of Minas Gerais, Belo Horizonte MG, Brazil. This work was supported by Rede Instituto Brasileiro de Neurociência (IBN Net/Finep), Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) and Fundação de Amparo à P esquisa do Estado de Minas Gerais (Fapemig), Brazil.

Received 19 March 2009, received in final form 8 July 2009. Accepted 30 July 2009.

Dr. Antonio Lucio Teixeira – Departamento de Clínica Médica / Faculdade de Medicina da UFMG - Av. Alfredo Balena 190 - 30130-100 Belo Horizonte MG - Brasil. E-mail: altexr@gmail.com

Parkinson's disease (PD) is the most common neuro-degenerative movement disorder, affecting 0.3% of the general population[1]. Pathologically, it is characterized by the progressive and irreversible loss of the dopaminergic neurons from substantia nigra pars compacta (SNpc). Clinically, PD is characterized by motor dysfunctions, including bradykinesia, resting tremor and rigidity. Postural instability occurs with the progress of the disease, and subsequently it causes falls in patients, which in turn restricts mobility, functional independence and social participation[2-5]. Once balance deteriorates in PD, it is important to have a quantifiable tool that health care professionals can use to monitor these changes. The Berg Balance Scale (BBS) has been the main instrument used to identify and to evaluate balance impairment in different populations, although this scale was originally designed to assess the risk of falling in elderly patients[6-9]. The BBS is a 14-item scale that measures static and dynamic standing balance[6,7]. Each item is scored on a five-point ordinal scale ranging from 0 (unable to perform) to 4 (normal performance). The total score range is 0 to 56 and higher scores denote better balance. Scores of 0 to 20 refer to those patients restricted to a wheelchair; 21 to 40 refer to assistance during the gait and 41 to 56 points correspond to independence.

Psychometric properties of this scale have been examined by various researchers. These studies showed strong internal consistency and inter- and intra-rater reliability in neurological diseases, such as stroke and PD[8,10]. Nova et al. demonstrated that the BSS had enough sensitivity to detect balance changes during on-off fluctuation in PD patients on levodopa therapy[11]. Recently, Qutubuddin et al. validated the English version of the BBS for PD after evaluating 38 male patients[12]. BBS scores showed significant correlations with PD-specific instruments that measure motor functioning, stage of disease and daily living capacity. These researchers proposed that the BBS may be used for screening and ongoing assessment for PD. Franchignoni et al. proposed to determine unidimensionality, internal construct validity and the rating scale for PD patients[13].

The aim of the present study was to assess the clinimetric properties of the Brazilian version of the BBS in patients with idiopathic PD. For this purpose, we assessed inter-rater reliability and internal consistency, and correlated BBS with PD-specific instruments.

METHOD

Demographic and clinical data were collected from 53 patients with PD from the Movement Disorders Clinic of the Federal University of Minas Gerais (UFMG) and the Movement Disorders Clinic of the Federal University of São Paulo (UNIFESP). Local ethics committees approved the study and all participants provided written consent prior to data collection.

Eligibility for the study was determined by the presence of a clinical diagnosis of PD and findings of up to stage 3 on the Modified Hoehn and Yahr Staging Scale (HY). Participants were included if they were able to stand and walk independently without the use of an assistive device. Participants were excluded if they had another neurological disease or orthopedic impairment.

Demographic and clinical assessments were completed on the same day. All patients were assessed after the use of levodopa, i.e. at "on" period. The Brazilian version of the Mini Mental State Examination (MMSE) was used to assess cognitive function[14]. The PD-specific instruments used were: Unified Parkinson's Disease Rating Scale (UPDRS), Modified Hoehn and Yahr Staging Scale and Modified Schwab and England Capacity for Daily Living Scale (S&E). These instruments were applied by an experienced neurologist. The UPDRS is currently the most widely accepted scale for measuring the different components of PD. It has 3 sub-scales: UPDRS I – mentation, behavior and mood (range 0–16); UPDRS II – activities of daily living (ADL) (range 0–52) and UPDRS III – motor examination (range 0–108). Each item is scored on a scale from 0 to 4. A total of 176 points is possible with 176 representing maximal (or total) disability and 0 representing no disability[15-17]. The HY classifies PD patients in five stages according to body distribution of symptoms and dependency. Patients in stage I are mildly affected, while in stage V they are bedridden[15-17]. The S&E is widely used to assess disability in performing ADL in people with PD. It uses a percentage scale divided into deciles, with 100% representing completely normal and independent functioning and 0% representing total helplessness[15-17].

The Brazilian version of the BBS was used to measure balance abilities[18] and was completed by two other examiners who received identical training. BBS consists of 14 items that evaluate balance abilities during tasks involving sitting, standing and changing position. Scoring is based on the individual's ability to perform each task independently and/or meet certain time or distance requirements. The scale consists of 14 tasks common in everyday life. The items test the subject's ability to maintain positions or movements of increasing difficulty by diminishing the base of support from sitting to standing to single leg stance. The ability to change positions is also assessed. The 14 items are, in this order: sitting to standing (B1); standing unsupported (B2); sitting with back unsupported but feet supported on the floor or on a stool (B3); standing to sitting (B4); transfer (B5); standing unsupported with eyes closed (B6); standing unsupported with feet together (B7); reaching forward with outstretched arm while standing (B8); picking up an object from the floor from a standing position (B9); turning to look behind over left and right shoulders while standing (B10); turning 360 degrees (B11); placing alternate feet on step or stool while standing unsupported (B12); standing unsupported with one foot in front (B13) and standing on one leg (B14)[6,7].

Statistical analyses were performed with SPSS v12.0 software for Windows. Mean and standard deviation (SD) were calculated for each of the measures. Intra-class coefficient correlation (ICC)

was calculated to evaluate inter-rater reliability and Chronbach's Đ was calculated to evaluate internal consistency of the total BBS score. Correlation analyses between PD-specific instruments and the BBS were calculated using Spearman's rank correlation coefficient, and such correlation indicated the criterion-related validity. The magnitude of correlation was classified according to Munro (low=0.26–0.49; moderate=0.50–0.69; high=0.70–0.89; very high=0.90–1.00) for interpretation of the correlation coefficients[19]. Statistical significance was set at $p<0.05$.

RESULTS

The study sample was composed of 53 patients, including 16 (30.2%) women and 37 (69.8%) men. Severity of disease according to the UPDRS was moderate in most participants (Table 1). Patient distribution on the HY scale generally showed mild-to-moderate disease involvement: stage 1, 3 patients (5.7%); stage 1.5, 3 patients (5.7%); stage 2, 15 patients (28.3%); stage 2.5, 17 patients (32%) and stage 3, 15 patients (28.3%). Percentile ratings on the S&E likewise suggested the relatively high and generally independent functioning of the patients: rating of 100%, 2 patients (3.8%); rating of 90%, 18 patients (33.9%), rating of 80%, 17 patients (32.1%); rating of 70%, 14 patients (26.4%); rating of 60% and 50%, 1 patient (1.9%).

Regarding the psychometric properties of the BBS, the scale showed high inter-rater reliability (ICC=0.84) and internal consistency (Cronbach's α=0.92). There was a statistically significant negative correlation between the BBS and disease duration, ADL and motor examination subscales of the UPDRS and stages of disease when assessed by the HY. There was a statistically significant positive correlation between the BBS and the worst level of functional independence evidenced by the S&E (Table 2). There were statistically significant correlations among all 14 items of the BBS (Table 3). The magnitude of the correlation between individual BBS items was moderate.

Table 1. Demographic and clinical features of 53 patients with Parkinson's disease (PD).

Variables	N (%) or Mean ± SD (range)
Gender (male/female)	37 (69.8%) / 16 (30.2%)
Age (years)	62.0±7.9 (46−82)
Age of PD onset (years)	54.6±8.6 (40−77)
Disease duration (years)	7.8±4.4 (2−20)
MMSE	25.1±3.3 (18−30)
UPDRS	41.6±17.8 (12−91)
UPDRS I	3.2±2.4 (0−10)
UPDRS II	14.8±6.9 (3−27)
UPDRS III	31.3±11.8 (9−54)
HY*	2.5 (1−3)
S&E*	80% (50−100%)
BBS	47.2±8.2 (27−56)

*Median (range). SD: standard deviation; MMSE: Mini-Mental State Examination; UPDRS: Unified Parkinson's Disease Rating Scale; HY: Hoehn-Yahr Staging Scale; S&E: Schwab and England Activities of Daily Living Scale; BBS: Berg Balance Scale.

Exploratory factorial analysis using the principal components method found that two factors accounted for 64.6% of total variance of the BBS. Factor 1 was responsible for 37.1% of total variation and factor 2 was responsible for 27.4% of total variation. Table 4 shows the factorial loads for each question for two factors from the BBS.

DISCUSSION

Despite the BBS not being specific to PD, this instrument has been a valid tool for screening and assessing PD patients[12]. Landers et al. suggested that the BBS is most effective at discriminating PD fallers from non-fallers[20].

Our results showed higher inter-rater reliability and internal consistency of the BBS in PD patients. Only two

Table 2. Spearman's rank correlation coefficient (r_s) and p-value between demographic, clinical variables, and BBS; and classification of Munro for the magnitude of the correlations[18].

| Variables | BBS | | |
	r_s	p-Value	Classification
Age (years)	−0.016	0.911	No correlation
Age of PD onset (years)	0.193	0.171	No correlation
Disease duration (years)	**−0.520**	**<0.001**	Moderate
UPDRS	−0.067	0.635	No correlation
UPDRS I	−0.190	0.261	No correlation
UPDRS II	**−0.467**	**0.011**	Low correlation
UPDRS III	**−0.374**	**0.046**	Low correlation
HY	**−0.507**	**<0.001**	Moderate correlation
S&E	**0.492**	**<0.001**	Low correlation

PD: Parkinson disease; UPDRS: Unified Parkinson's Disease Rating Scale; HY: Hoehn-Yahr Staging Scale; S&E: Schwab and England Activities of Daily Living Scale; BBS: Berg Balance Scale.

Table 3. Spearman's rank correlation coefficient (r$_s$) and p-value between BBS items.

	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11	B12	B13	B14
B2	.582 <0.001													
B3	.351 0.009	.807 <0.001												
B4	.648 <0.001	.622 <0.001	.465 <0.001											
B5	.580 <0.001	.689 <0.001	.620 <0.001	.657 <0.001										
B6	.561 <0.001	.829 <0.001	.785 <0.001	.566 <0.001	.639 <0.001									
B7	.574 <0.001	.875 <0.001	.798 <0.001	.582 <0.001	.662 <0.001	.986 <0.001								
B8	.456 <0.001	.339 .011	.285 .035	.573 <0.001	.453 .001	.376 .005	.389 .003							
B9	.582 <0.001	.782 <0.001	.713 <0.001	.505 <0.001	.643 <0.001	.901 <0.001	.910 <0.001	.398 .003						
B10	.274 .043	.281 .037	.256 .060	.260 .055	.256 .059	.333 .013	.351 .009	.114 .406	.320 .017					
B11	.322 .017	.436 .001	.366 .006	.524 <0.001	.434 .001	.475 <0.001	.481 <0.001	.393 .003	.465 <0.001	.163 .233				
B12	.563 <0.001	.616 <0.001	.513 <0.001	.488 <0.001	.683 <0.001	.690 <0.001	.695 <0.001	.406 .002	.690 <0.001	.370 .005	.451 <0.001			
B13	.502 <0.001	.641 <0.001	.574 <0.001	.674 <0.001	.609 <0.001	.671 <0.001	.673 <0.001	.549 <0.001	.574 <0.001	.238 .080	.558 <0.001	.481 <0.001		
B14	.310 .021	.504 <0.001	.416 .002	.487 <0.001	.548 <0.001	.622 <0.001	.610 <0.001	.375 .005	.530 <0.001	.218 .110	.563 <0.001	.601 <0.001	.613 <0.001	

Table 4. Factorials loads for each item in two factors extracted from BBS by varimax rotation.

Item description of the BBS	Factor	
	1	2
B7 – Standing unsupported with feet together	**.896**	.274
B9 – Pick up object from the floor from a standing position	**.860**	.235
B6 – Standing unsupported with eyes closed	**.849**	.294
B2 – Standing unsupported	**.834**	.350
B3 – Sitting with back unsupported but feet supported on floor or on a stool	**.773**	.256
B12 – Place alternate foot on step or stool while standing unsupported	**.697**	.552
B10 – Turning to look behind over left and right shoulders while standing	**.426**	.130
B4 – Standing to sitting	.087	**.817**
B13 – Standing unsupported with one foot in front	.523	**.699**
B8 – Reaching forward with outstretched arm while standing	.151	**.681**
B5 – Transfers	.498	**.669**
B11 – Turning 360 degrees	.263	**.668**
B14 – Standing on one leg	.442	**.609**
B1 – Sitting to standing	.394	**.478**

studies have assessed the clinimetric properties of the BBS in patients with idiopathic PD[12,13]. Qutubuddin et al. measured the criterion-related validity of the BBS in 38 men, correlating the BBS with PD-specific instruments[12]. Franchignoni et al. assessed 57 patients with PD, calculated Cronbrach's α and correlated the BBS with instruments used in PD[13]. Internal consistency in that study was also high[13].

Our results showed that balance performance was negatively affected by longer duration of disease, severity of symptoms and greater impairment on subscales II and III of the UPDRS, advanced stage of disease when assessed by HY stages and worst level of functional independence evidenced by the S&E. This is in line with previous works that have demonstrated similar findings in PD patients, but only Franchignoni et al have showed correlation between the BBS and the subscale II of the UPDRS[10,12,21]. As PD progresses, significant changes in posture and predisposition to fall may develop. This predisposition to fall may induce psychological reactions characterized by fear of future falling[5,22]. This fear of falling can be maladaptive when it compels patients to restrict their mobility, independence and social participation, leading to further limitation and gradual physical disability.

As seen in Table 4, items directly related to static balance (items B2, B3, B6, B7, B9, B10, B12) belonged to factor 1. The items related to dynamic balance (B1, B4, B5, B8, B11, B13, B14) had the highest load factor in factor 2. These items require major postural adjustments, both anticipatory and continuous, when compared to items of component 1. Both factors accounted for a great percentage of total variance of the BBS and their items were grouped in a logical way. However some minor inconsistencies should be noticed. Item B3 showed ceiling effect in 83% of patients. Many patients (52%) in item B11 were able to turn to both sides safely, but slowly, which may have been influenced mainly by bradykinesia, not by the lack of balance. Item B12 also loaded on factor 2, but less significantly. Accordingly, Franchignoni et al. suggested that some items on this scale should be revised to improve its validity in PD patients.

In conclusion, the instrument seemed to be suitable for the assessment of PD patients. BBS correlated with the severity of symptoms, the stage of disease and the level of independence. Studies evaluating the effect of pharmacological treatments and/ or rehabilitation techniques on PD should use BBS.

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