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Construct Validity of Functional Balance Scale in Stroke Inpatients

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Abstract. The purpose of this study was to assess the construct validity of the Berg Balance Scale (BBS) in stroke inpatients. We measured the BBS score of 46 stroke patients, and simultaneously assessed the following neurological conditions: attention, mental status, emotion, agnosia, visual perception, sensation and motor status of the affected lower extremity. We also assessed functional independence in the basic activities of daily living using the Barthel Index. Patients' functional walking abilities were categorized into 4 levels (from with assistance to independent within hospital). The mean BBS scores were associated with attentional deficits, emotional distress, proprioceptive sensation problems and motor status. These neurological conditions explained 43% of the BBS scores. The BBS scores correlated with the Barthel Index and were associated with functional walking ability. The BBS scores and walking ability explained 67% of the Barthel Index. 83% of patients scoring above a score of 40 were independent within hospital in functional walking ability. These results provide information to support construct validity of the BBS in stroke inpatients.
Key words: Functional balance scale, Construct validity, Stroke.

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INTRODUCTION

The assessment and treatment of balance function is very important in stroke rehabilitation. The balance or postural control of stroke patients is affected by abnormal postural tone and abnormal movement pattern[1, 2)].

In the conceptual models of disability, Nagi's model classifies disablement in terms of pathology, impairment, functional limitation, and disability[3, 4)]. Some common impairments following stroke are impaired motor function, sensory deficits, perceptual deficits, cognitive limitations, and aphasia. Examples of physical functional limitations are functional balance ability such as standing up, transfers, standing balance and walking. Disability includes basic activities of daily living (ADL), instrumental ADL and quality of life. Balance function is influenced by any impairment, and affects walking ability and disability.

One assessment tool of balance function is the Balance Scale (BBS) developed by Berg et al[5)]. The inter and intra-rater reliability of the BBS has been reported as excellent in elderly subjects and in patients with acute stroke[6)]. The validity of the BBS has been reported with elderly subjects[7, 8)]. With stroke patients, construct validity has been supported by the relation to motor performance and basic ADL[7)]. Concurrent validity has been reported through evidence that the BBS correlated with center of pressure and electromyographic activity of leg musculature during rapid arm flexion and during quiet stance[9)]. However, the examina-

tion of the construct validity of the BBS is incomplete in that the association between BBS and stroke impairments (neurological conditions), BBS and walking ability has not yet been examined.

The purpose of this study was to assess the construct validity of the BBS in stroke inpatients with hemiplegia by association with (1) neurological conditions, and (2) functional performance (walking ability and basic ADL).

METHODS

Subjects

Forty-six patients (18 males, 28 females) participated in this study. All patients were hospitalized after stroke in Harunaso Hospital, Gunma Prefecture in Japan. Nineteen patients demonstrated right hemiplegia and 27 demonstrated left hemiplegia. Their mean (standard deviation) age was 69.3 (9.6) years, range 48–85 years. The mean time from onset of stroke to this study was 18.8 (31.1) months. All patients were receiving physical therapy and/or occupational therapy. Twenty four patients used braces, 32 patients used walking aids in treatment or daily living.

Variables and measurements

The Balance Scale

The BBS is composed of 14 common balance items in everyday life (Table 1). These tasks require the subject to maintain a static position, change positions, and diminish base of support. All items are graded on a five-point scale, 0 to 4. Points are based on the time maintaining the position, the distance the arm is able to reach, the time to complete the task, or the requiring of supervision, cueing or assistance. The maximum score is 56 points, higher scores reflect better balance. The patients who usually used braces were permitted to use braces in the measurements of BBS. The internal consistency of BBS in this study was high (Cronbach's alpha .96).

Neurological conditions

We assessed the following neurological conditions: attention, mental status, emotion, agnosia, visual perception, sensation and motor status of the affected lower extremity. Attention and emotion were assessed by clinical observations in daily living. Attentional deficits: cannot concentrate, poor selective attention or poor sustained attention. Emotional distress: depression or anxiety. Mental status was assessed using the Revised version of Hasegawa's dementia Scale (HDS-R)[10]. For mental problems the cut off point of HDS-R was 20. Agnosia, visual perception and sensation (touch and proprioceptive) were assessed by standard clinical assessment. Motor status was measured with the use of the Brunnstrom's recovery stage[11].

Table 1. The Berg Balance Scale

Item	Task
1	Sitting to standing
2	Standing unsupported for 2 min
3	Sitting unsupported for 2 min
4	Standing to sitting
5	Transfers
6	Standing unsupported with eyes closed for 10 sec
7	Standing unsupported with feet together for 1 min
8	Reaching forward with outstretched arm
9	Picking up an object from the floor
10	Turning to look over shoulder
11	Turning 360 degrees within 4 sec
12	Stool touch (8 steps in 20 sec)
13	Standing unsupported, one foot in front for 30 sec
14	Standing on one leg for 10 sec

14 items are rated 0 to 4. The total score ranges from 0 to 56.

Functional performance

The Barthel Index[12] was used to asses patients' functional independence in the basic activities of daily living: feeding, transfer, dressing, grooming, toilet use, bathing, bowels, bladder, mobility and stairs. The Index is scored from 0 to 100. Patients' functional walking abilities were categorized into 4 levels: 1 = with assistance, 2 = with supervision, 3 = independent within limited situations (only in physical therapy gym or ward), 4 = independent within hospital. This categorization did not take account of any aid or brace used.

Statistical analysis

Data analysis was carried out using SPSS/Mac 6.1 software. Student's t-test was performed to examine the associations between BBS score and neurological conditions, except motor status. Spearman rank correlation coefficients were computed to examine the relationship between BBS score and motor status of affected lower extremity, and the Barthel Index. Analysis of variance and

Table 2. Mean Balance Scale scores of stroke patients by neurological condition and t-test results (n=46)

		n	mean	sd	p value
Attentional deficits	yes	21	16.0	16.7	<0.01
	no	25	30.4	15.0	
Mental problems	yes	9	19.0	18.0	n.s.
	no	37	26.3	16.6	
Emotional distress	yes	15	13.9	13.7	<0.01
	no	31	28.4	16.3	
Agnosia	yes	10	18.9	14.5	n.s.
	no	36	26.5	17.1	
Visual problems	yes	14	23.2	17.5	n.s.
	no	32	26.1	16.4	
Sensation problems					
touch	yes	24	23.0	15.4	n.s.
	no	22	32.8	16.3	
proprioceptive	yes	20	21.0	15.8	<0.05
	no	26	33.3	14.8	
Motor status*			$r_s = 0.563$		<0.001

*: Brunnstrom's recovery stage of the affected lower extremity. n.s.: not significant. r_s: Spearman rank correlation coefficient.

chi-square test were used to examine the relationship between BBS score and functional walking ability level. A linear multiple regression analysis was performed on the relationships between BBS score and the neurological conditions, and BBS and the functional performance. The critical value for statistical significance was set at $p<0.05$.

RESULTS

Table 2 shows the mean BBS scores of 46 stroke patients by neurological condition. The mean BBS scores of patients who have attentional deficits, emotional distress and proprioceptive sensation problems of neurological conditions were lower than these of patients who don't have these conditions. Motor status of the affected lower extremity and the BBS scores were significantly related. These four neurological conditions explained 43% of the BBS scores by multiple regression analysis ($R=0.66$, $F=5.69$, $p<0.01$).

Table 3 shows the mean BBS scores of stroke patients by functional walking ability. The mean BBS scores of those whose level of functional walking ability was 4 was higher than these of each of the other levles. The BBS scores for two groups

Table 3. Mean Balance Scale scores of stroke patients by functional walking ability (n=46)

level	n	mean	sd	min	max	95%CI
1	18	7.1	8.5	0	27	2.8–11.3
2	12	24.6	10.2	11	41	18.0–31.3
3	5	29.2	11.0	19	43	15.5–42.9
4	11	44.5	4.9	37	52	41.1–47.8

$F=44.552$, $p<0.0001$. Functional walking ability level 1: with assistance, 2: with supervision, 3: independent within limited situations, 4: independent within hospital.

(level 2 and 3) were comparable. Only one subscale of the BBS, (13) one foot in front in standing, did not relate with functional walking ability by chi-square test. Eighty-three percent (10/12) of patients scoring above a score of 40 were categorized as level 4 of functional walking ability (eg, independent within hospital). In contrast, 97% (33/34) of patients scoring below this score were categorized as under level 3.

The correlation of the BBS scores with the Barthel Index was 0.84 ($p<0.001$). The BBS scores and functional walking ability explained 67% of the Barthel Index by multiple regression analysis ($R=0.82$, $F=42.62$, $p<0.001$).

DISCUSSION

The associations of the BBS scores with neurological conditions (attentional deficits, emotional distress, proprioceptive sensation problems and motor status), functional walking ability, and the Barthel Index were statistically significant in stroke inpatients. These results provide information supporting the construct validity of the BBS.

Many studies have reported that postural control or balance function of stroke patients is related neurological conditions[1, 2, 13]. The motor status of the upper and lower extremity in stroke patients is affected by abnormal postural tone and abnormal movement patterns. The lower extremity function influences the balance function in the standing position. Neuropsychological problems related to balance function are attentional deficits, emotional distress, agnosia, visual perception and sensation problems. The attentional deficits, including poor concentration, selective attentional deficits and sustained attentional deficits disturb the performance of safe activities and may be one of the important

causes of falls in stroke patients. Emotional distress affects apathy, fear of falling and decreases the activities of patients. Sensory or perceptual deficits influence the feed-back or feed-forward process in motor control.

The association between the balance ability and functional performance, walking and basic ADL, is important in stroke clinical settings. Dettmann[14] reported that postural control in standing is closely related to walking performance and the Barthel index in stroke patients. Suzuki, et al.[15] also reported that the maximum walking speed of stroke patients is related to the sway path of the center of feet pressure in standing and the isokinetic muscle strength of the affected side. Furthermore, Bertozzi, et al.[16] showed that the length of stay in hospital is related to basic ADL and the Tinetti balance scale in elderly patients. The findings of this study substantiate construct validity of the BBS in stroke patients.

For the cut-off points of the BBS, based on clinical experience, Berg, et al.[7] reported that a score of 45 seems to be a cut-off point between safe in independent ambulation and need for assistive devices or supervision in the home for the elderly. Based on physical therapy evaluation of the standard, Harada, et al.[17] showed a score of 48 in elderly individuals living in residential care facilities determined by plotting receiver operating characteristic curves. In this study, a score of 40 is the cut-off point between independent walking within hospital and within limited situations or need for supervision. These differences will be influenced by the differences in the environment of daily living. In community-dwelling stroke survivors, cut-off points of independent walking may be higher than in this study.

The BBS is a useful tool not only in hospital stroke rehabilitation but also community rehabilitation. Good validity, high sensitivity and good simplicity of the BBS will facilitate clinical or research use. The BBS will be measured to predict falls, functional goals, the length of stay in hospital, judge the effect of treatment and analyze the model of disability in stroke rehabilitation.

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