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Original Article

A discriminative measure for static postural control ability to prevent in-hospital falls: Reliability and validity of the Standing Test for Imbalance and Disequilibrium (SIDE)

Toshio Teranishi, RPT, PhD,[1] Izumi Kondo, MD, PhD,[2] Shigeru Sonoda, MD, PhD,[1] Hitoshi Kagaya, MD, DMSc,[3] Yosuke Wada, RPT, MSc,[2] Hiroyuki Miyasaka, OTR, MSc,[2] Genichi Tanino, RPT, MSc,[1] Wataru Narita, MD, BM,[1] Hiroaki Sakurai, RPT, MSc,[4] Makoto Okada, RPT, MSc,[4] Eiichi Saitoh, MD, DMSc[3]

[1]Department of Rehabilitation, Fujita Health University Nanakuri Sanatorium, Tsu, Mie, Japan
[2]Division of Rehabilitation, Fujita Memorial Nanakuri Institute, Fujita Health University, Tsu, Mie, Japan
[3]Department of Rehabilitation Medicine I, School of Medicine, Fujita Health University, Toyoake, Aichi, Japan
[4]Faculty of Rehabilitation, School of Health Sciences, Fujita Health University, Toyoake, Aichi, Japan

ABSTRACT

Teranishi T, Kondo I, Sonoda S, Kagaya H, Wada Y, Miyasaka H, Tanino G, Narita W, Sakurai H, Okada M, Saitoh E. A discriminative measure for static postural control ability to prevent in-hospital falls: Reliability and validity of the Standing Test for Imbalance and Disequilibrium (SIDE). Jpn J Compr Rehabil Sci 2010; 1: 11−16

Purposes: To determine the reliability, validity, and clinical significance of the Standing Test for Imbalance and Disequilibrium (SIDE), a discriminative measure of standing balance, before using it to prevent falls in clinical settings.

Methods: In all, 30 patients (18 men and 12 women) with a mean (standard deviation) age of 57.4 (16.97) years (range, 25−85 years) who were admitted to the "Kaifukuki" rehabilitation ward voluntarily participated in this study. In the reliability study, 2 physiotherapists independently classified the level of static postural control ability by using SIDE. Functional balance control ability was simultaneously evaluated using the Berg Balance Scale (BBS). Cohen's κ statistic was used to determine the inter-rater reliability, and the Spearman rank-correlation coefficient between the BBS score and SIDE level was used to determine the criterion-related validity.

Results: Inter-rater reliability of SIDE showed excellent reproducibility (Cohen's κ statistic = 0.76). Criterion-related validity was very high between SIDE levels and BBS scores (Spearman rank-correlation coefficient = 0.93; $p < 0.01$).

Conclusion: SIDE can be used to efficiently and accurately classify balance control ability across individuals and has remarkable concurrent validity in balance evaluation compared to BBS.

Key words: evaluation methodology, postural balance, prevention of accidental falls

Correspondence: Toshio Teranishi, RPT, PhD
Division of Rehabilitation, Fujita Memorial Nanakuri Institute, Fujita Health University, 1865, Hisai-ishikichou, Tsu, Mie 514-1295, Japan
E-mail: teranisi@fujita-hu.ac.jp
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Introduction

For older adults, falls are associated with various major health-related problems and create vicious circle of the same problems, such as physical pain caused by injuries, impairments, psychological distress, limitation of activities of daily living (ADL) because of the fear of repeated falls, and deterioration of the quality of life because of reduced participation in social activities. Prevention of falls and injuries has been a major focus of research, stimulated by the increasing proportion of aging population across the world and growing awareness of the risks of mortality and morbidity resulting from falls. This is particularly important for hospitalized elderly patients because falls are known to be the most common cause of injury in these patients [1, 2].

The effectiveness of interventions related to fall prevention among hospitalized patients has been investigated in several settings [3−7]. To identify patients at high risk of falls, many fall risk-assessment tools have been developed, for example, St. Thomas's

Risk Assessment Tool in Falling Elderly Inpatients (STRATIFY), Morse Falls Scale (MFS), Hendrich II Fall Risk Model (HFRM) etc., and introduced into clinical settings. Of these fall risk-assessment tools, only HFRM retains abilities to maintain balance and to rise from a chair as a risk factor for falls [8].

Accurate evaluation of balance control ability is important for prescribing mobility aides, determining the most effective treatment interventions, and identifying safe and unsafe activities for hospitalized patients. Various assessment tools for balance control ability have been devised, including the get-up-and-go test [9], functional reach [10], Tinetti's performance-oriented assessment of mobility [11], BBS [12], and timed up-and-go test (TUG) [13].

Kirshner and Guyatt provided a methodological framework for assessing health measures [14] and specified the theoretical importance of measures that are used for one or more purposes. Evaluative measures are needed to determine the magnitude of change in function over time or after treatment. For example, the TUG is a modified version of the get-up-and-go test, which includes a timing component to performance. The TUG responds to changes in balance control ability with time and treatment, because a variety of responses are generated with the time score rather than by simply using the response option adopted in the original version. The TUG has been used to assess treatment effectiveness in patients with stroke [15], after knee joint arthroplasty [16], with osteoarthritis [17], and with parkinsonism [18, 19].

Another measure that was categorized by Kirshner and Guyatt was discriminative measures that are used to distinguish between individuals with or without a particular characteristic or function. The TUG does not suffice as a discriminative instrument in fall prevention, because the level of balance control ability in TUG is denoted by a time score. A time score of 30 s does not indicate whether a patient will fall as a result of a particular posture or, within his/her own level of function, what kind of activity will require assistance from caregivers. In other words, quantitative indices such as amount of time will not provide information on the qualitative outcome. The problems of existing tools and measures for fall prevention are as follows: fall risk-assessment tools do not include sufficient subscales to evaluate balance control ability, and balance assessment tools provide evaluative measures and not discriminative measures.

The Standing Test for Imbalance and Disequilibrium (SIDE) is a discriminative measure developed for fall prevention by classifying static standing balance ability (Fig. 1) [20]. SIDE focuses on static standing balance because losing balance in postures adopted during ADL is an essential factor in controlling risks of falling, and the classification of static balance control ability is considered to be important for the prediction of a patient's fall risk.

Furthermore, the classification of patients on the basis of their abilities and limitations in balance control would facilitate communication among various professionals with regard to determining the needs of patients in order to avoid falls, making management decisions, and comparing and generalizing the results of fall-prevention programs and research for selecting appropriate treatments.

The purposes of this study were to determine the inter-rater reliability of the SIDE, and to assess its criterion-related validity by comparing the evaluation results to those obtained by other balance assessment instruments, before using it to prevent falls in clinical settings. We attempted to devise a quick and easy-to-use test for determining a patient's fall risk that could be validly and reliably used in typical clinical settings.

Materials and Methods

Subjects

This study was a prospective study. The inclusion criterion of this study was inpatients of the "Kaifukuki" rehabilitation ward, and the exclusion criterion was patients with consciousness disturbance or communication difficultly. Kaifukuki rehabilitation wards represent a medical service system in Japan that provide rehabilitation services for convalescing patients after various disabling diseases such as injuries involving the brain, spinal cord, or musculoskeletal system.

Subjects in the study comprised 30 patients (18 men and 12 women), with a mean (standard deviation) age of 57.4 (16.97) years (range, 25−85 years). Underlying pathologies or histories of the 30 patients included cerebral hemorrhage ($n = 15$), cerebral infarction ($n = 7$), traumatic brain injury ($n = 3$), spinal cord injury ($n = 3$), total knee arthroplasty ($n = 1$), and disuse syndrome ($n = 1$). Written informed consent was obtained from all patients or their legal guardians prior to participation after the risks of participation in this study were explained. While obtaining the informed consent, we also explained that if a patient intended to cancel the participation in this study, there would be no harm to the patient. The Medical Ethics Committee of the Fujita Health University Nanakuri Sanatorium approved the design of this study (No. 48).

Methods

In all, 17 registered physiotherapists participated in this study, with a mean experience of 5 (4.9) years (range, 1−23 years). Before the beginning of this study, therapists familiarized themselves with SIDE (Fig. 1) [20] through the instructions provided by the authors (T.T. and I.K.), and, once proficient in the use of SIDE, therapists required no more than 5 min to classify patients.

In the reliability study, 2 physiotherapists, members

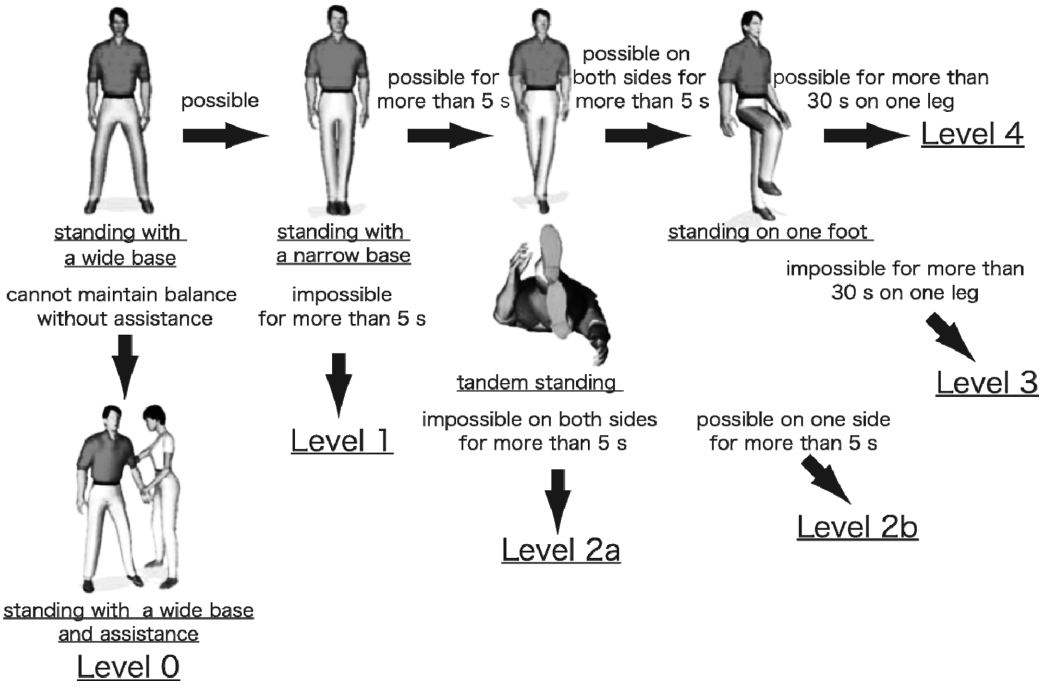

Figure 1. Flowchart to determine the level of SIDE.
The levels are arranged in order of difficulty; more levels should not be included once a subject loses balance at a certain level and requires assistance. As the level of difficulty in the test increases, the risk of falling increases.
Level 0: A standing position with a wide base cannot be maintained by a patient without assistance. Supports provided by grasping something or being assisted by caregiver are always required to maintain a standing position.
Level 1: A standing position with a wide base can be maintained without assistance, but standing with a narrow base cannot be maintained for more than 5 s. Balance is lost in a standing position with a narrow base: bringing the legs close together such that feet are in contact with each other medially at both the heel and forefoot.
Level 2a: A standing position with narrow base can be maintained by a patient for more than 5 s, but a tandem standing position cannot be maintained for more than 5 s with either leg position. The tandem standing position involves standing with the heel of one foot placed at the toe of the other foot, in a straight line (either foot may be in the front).
Level 2b: A tandem standing position can be maintained by a patient for more than 5 s with one but not the other leg in the leading position.
Level 3: A tandem standing position can be maintained with either leg in the front for more than 5 s, but standing on 1 leg is difficult to be maintained for more than 30 s with either leg.
Level 4: A position of standing on 1 leg can be maintained for more than 30 s with any one leg.

of the treatment team, independently classified the level of static postural control ability by using SIDE. Inter-rater reliability was analyzed using Cohen's κ statistic, a measure of chance-corrected agreement indicating the reproducibility of repeated trials [21].

To determine criterion-related validity, functional balance control ability was evaluated using BBS for the same patients. BBS is the most prevalent measure to evaluate functional balance control ability worldwide. It was developed and validated as a measure to assess balance and monitor changes over time (i.e., as an evaluative measure) in a series of studies [12, 22, 23]. Evaluation using BBS was performed by one of the authors (T.T.) on the same day or within a few days after the classification of the SIDE level. Each patient's level of SIDE was randomly selected from 2 therapists' assessment results, and the Spearman rank-correlation coefficient was calculated between the SIDE level and BBS score. While classifying the SIDE level, subjects were permitted to continue the use of orthoses. On the other hand, during the evaluation of BBS, subjects were not allowed to use walking aid. All analyses were conducted using JMP™ (SAS Institute Co.).

Additionally, Functional Independence Measure (FIM) motor score was used to determine the distribution of the ADL independence of the subjects.

Results

Mean FIM motor score for the subjects was 57.3 (21.92) (range, 18−89).

In the inter-rater reliability study, classifications of each pair of assessors are shown in Table 1. Overall, the ratings were evenly distributed among 6 levels, and a difference of 2 or more levels was not observed. Cohen's κ statistic was 0.76, providing evidence for the overall reliability of the test. The correlation between BBS and SIDE is shown in Fig. 2. There was a strong positive correlation between SIDE levels and BBS scores ($\rho = 0.93$; $p < 0.01$).

Discussion

SIDE was developed as a discriminative measure for easily classifying standing balance control ability at the bedside. The standing positions adopted in this test were as follows: (1) standing with a wide and narrow base; (2) tandem standing; and (3) standing on 1 foot. We considered these standing positions as representative postures adopted by patients during ADL requiring various levels of standing balance. We considered that a patient assuming a posture beyond his/her balance control ability would experience a fall. Between 50% and 70% falls were considered to occur during walking [24].

Table 1. Classifications determined by each pair of assessors

	Classification by the 1st assessor					
Classification by the 2nd assessor	0	1	2a	2b	3	4
0	4	1	0	0	0	0
1	1	2	1	0	0	0
2a	0	0	5	1	0	0
2b	0	0	0	2	1	0
3	0	0	0	1	4	0
4	0	0	0	0	0	7

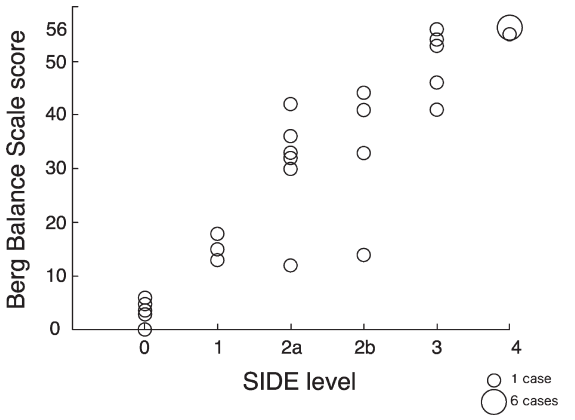

Figure 2. Relationship between the BBS score and SIDE level for the 30 patients (Spearman rank-correlation coefficient; $\rho = 0.93$; $p < 0.01$).

There were several strategies to avoid fall when the balance was lost during ADL performed in the standing position or during walking. During ADL, one often takes one or few steps to shift the center of gravity toward the base of the support and finally returns to a static standing posture or holds a desk or handrail. During walking, one might rapidly take a few steps forward and after the balance is restored, one may resume the former walking speed. Both the dynamic strategies, i.e., taking steps or holding handrail, and the static strategies, i.e., shifting the center of gravity toward the base of the support and returning to the static posture, were used according to the situation. Although the dynamic balance control ability was obviously important, attention should also be paid to the static balance control ability of patients in order to prevent falls.

For health professionals and families, accurate knowledge of the balance control ability of a patient is important to determine the risk of fall from a specific standing position. Avoiding a specific at-risk posture beyond the balance control ability would be extremely useful in preventing fall-related accidents. The balance control ability of a patient, however, changes depending on various factors, such as (1) compliance, arousal level, and cognitive problems of a patient; and (2) a patient's current physical environment for fall prevention management, and various drugs affecting arousal levels in a patient. The instrument for assessing balance control ability needs to be simple, time-saving, and reliable; this is important both to obtain consistent results under any situation and allow consistency in patient management.

The overall level of chance-corrected agreement (Cohen's $\kappa = 0.76$) supported inter-rater reliability of SIDE when used to classify the balance control ability of patients in a rehabilitation ward. Landis and Koch [21] suggested that a Cohen's κ of >0.60 denotes sufficient reproducibility. In addition, the results of the SIDE spread over all its levels, increasing the comprehensive reliability of SIDE. Balance control ability in each patient was independently classified by 2 therapists who were members of the treatment team. The time required to classify each patient was no more than 5 min once the therapists were familiar with the use of SIDE. The results suggested that balance control ability could be simply and accurately classified by physiotherapists who are already familiar with SIDE.

Our data showed a strong positive relationship between BBS and SIDE ($\rho = 0.93$), indicating that SIDE has ample concurrent validity in balance evaluation compared to BBS. BBS is a 14-item scale that quantitatively assesses balance and risk of fall in

older community-dwelling adults by direct observation of task-related performance. Items are scored as 0–4, where a score of 0 represents inability to complete a task, and a score of 4 represents ability to independently complete a task. A global score is calculated using 56 possible points. BBS measures both static and dynamic aspects of balance and has been reported to be a psychometrically sound measure of balance impairment, particularly useful for the assessment of patients with stroke [25]. Compared to BBS, SIDE has various advantages in clinical use because it does not require any tools other than a watch and is completed in a short time. Further studies are needed to clarify the psychometric properties of SIDE, including (1) a reliability study, using a larger sample size, for a variety of professionals such as nursing staff and occupational therapists, and (2) a prognostic validity study in a fall-prevention program. We are currently conducting a criterion-validity study investigating the degree of postural sway of healthy subjects in postures adopted in this test to determine whether the order of difficulty in maintaining balance with each posture is the same as that of the sub-test in SIDE. As expected, if the test proves useful, clinicians may have objective data for controlling the risk of falls among elderly patients in clinical settings.

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