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Original Article

Availability of the Two-step Test to evaluate balance in frail people in a day care service

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Abstract. [Purpose] This study evaluated balance tests in users of a day care service who needed nursing care or support, and investigated the usefulness of the Two-step Test for evaluating balance. [Subjects and Methods] The subjects were users of a day care service, and had certified need for long-term care or support. All subjects were able to undergo the balance evaluations. Balance tests included the 3-m Timed Up and Go test (TUG), the one-leg standing time, and the Two-step Test. [Results] The Two-step Test and other balance tests were strongly correlated. [Conclusion] In this study of subjects who needed nursing care or support, the results were the same as in a previous study of subjects who did not need nursing care or support. The Two-step Test should be considered as an indicator of balance ability in elderly individuals requiring nursing care or support.
Key words: Two-step Test, Balance test, Day care service

INTRODUCTION

In Japan, aging has led to a rapid increase in the percentage of the population 65 years of age or older, and it is important to prevent dependency in this population. Major factors contributing to the loss of independence in the elderly include indoor and outdoor falls. The risk of falls can be reduced by taking preventive measures, with efforts promoted by both medical insurers and the long-term care insurance system. Among these efforts to prevent falls, balance and walking exercises are provided in rehabilitation programs. These exercises can also be provided in home-based rehabilitation and by day care service.

Evaluations of balance ability such as the one-leg standing time and the Timed Up and Go (TUG) test are performed in medical facilities to assess the risk of falling[1–6]. However, evaluations focused on fall prevention are seldom performed under long-term care insurance or during home-based rehabilitation. Such evaluation methods can heavily burden frail people.

Accordingly, the Japanese Orthopaedic Association promoted the concept of "locomotive syndrome" to prevent dependency due to a musculoskeletal disorder, and began a prevention program[7]. Locomotive syndrome is defined as having a high risk of becoming dependent on nursing care due to a musculoskeletal disorder[8], with a negative effect on personal independence[9, 10].

The Two-step Test is easy to perform and has been promoted for assessment of the locomotive syndrome[11]. The Two-step Test can be used to evaluate walking ability, muscular strength, balance ability, and lower limb flexibility, and is useful for predicting ability to walk.

The Two-step Test was found to be highly correlated with the 10-m-Walk Test, the 6-min Walk Distance, and the degree of independence in daily life[12]. However, there are few reports on the relationship between the Two-step Test and other balance tests[13]. Furthermore, in almost all studies on the relationship between the Two-step Test and other balance tests, the

Table 1. Characteristics of participants

Subject	Gender	Age	Level of nursing care#	Disease	Onset date*	Day care facility start date	Visits per week	Assistance for gait
1	F	84	Care level 1	Hypertension		3/4/2015	1	none
2	F	77	Care level 2	Cerebral infarction	9/9/2014	2/2/2015	2	none
3	M	70	Support level 2	Chronic obstructive pulmonary disease	7/26/2013	7/4/2015	2	none
4	F	84	Care level 1	Left putaminal hemorrhage	2/13/2009	10/2/2014	4	none
5	M	87	Care level 1	Hypertension		12/9/2014	1	none
6	M	81	Care level 2	Parkinson's syndrome		11/15/2014	2	none
7	M	74	Care level 2	Cerebral infarction	8/11/2014	3/3/2015	3	none
8	M	83	Care level 3	Renal failure, heart failure	9/2014	3/3/2015	1	none
9	M	80	Care level 2	Cerebral thrombosis		11/11/2014	2	none
10	F	86	Care level 3	Left femoral neck fracture	6/16/2014	10/3/2014	3	T-cane
11	M	75	Care level 3	Cerebral hemorrhage sequelae	2/1997	7/27/2015	4	T-cane

#Level of nursing care determined by the long-term care insurance system. Patients apply for the care need assessment at the city office
*Blank is unknown

subjects were healthy elderly individuals who did not require nursing care or support[14–16]. If the results of the Two-step Test are correlated with those of other balance tests, this method can be used as an indicator of the balance ability of frail people.

In this study, the Two-step Test and other balance tests were evaluated in users of day care services who were in need of nursing care or support, and investigated the relationship between the Two-step Test and other balance tests. The balance ability of frail people can be sufficiently evaluated using the Two-step Test.

SUBJECTS AND METHODS

The subjects were users of the day care service attached to our facility, and had certified need for long-term care or support. Eleven subjects were able to perform all evaluations. There were 4 males and 7 females, aged 80.1 ± 5.4 years. We excluded those who we considered unable to perform the balance evaluations.

Subjects performed a 3-m TUG test[17], one-leg standing time measurement[18], and Two-step Test.

The TUG test was performed over a 3-m distance from the front of a chair to the back of a marker. The subjects sat on the chair and stood at the signal to start, walked 3 m to the marker, returned, and sat down again. The time was measured with a stopwatch. Walking was performed at the fastest possible pace. The time was measured twice and used the faster pace for evaluation. This measurement was also performed when a subject used a walking aid, when needed in daily life.

In the one-leg standing time measurement, the subjects were instructed to remain standing on one leg with their eyes open and with arms at their sides, for a maximum of 30 seconds. The measurement was performed three times on each leg. The maximum time was used for evaluation. Measurement was stopped when the other leg touched the floor or when the tested leg wavered. During the examination, subjects were closely monitored for fall prevention from the side of the non-tested leg.

The Two-step Test measured the length of two steps, and the Two-step value was the ratio of the maximum length of two steps to the subject's height. Measurement was performed for the maximum length at which balance was maintained. We measured this twice and used the maximum value for evaluation. We also measured when a subject used a walking aid in daily life.

SPSS Statistics 22 (IBM Corporation) was used for statistical analysis. Pearson's coefficient was used to determine correlations between the evaluations. The statistical significance level was set at $p < 0.05$. This study was conducted with the approval of the Kawasaki University of Medical Welfare Ethics Committee (approval number 16-013). The aims and methods of the study were explained to the participants and their families, and the study was conducted after securing their permission and willingness to participate voluntarily. The characteristics of the participants are shown in Table 1.

RESULTS

The evaluation results for each subject are shown in Table 2. The average TUG test time and one-leg standing time, and the Two-step value are also shown. The correlation coefficients between measures are shown in Table 3. The correlation coefficient between the Two-step value and TUG test and the correlation coefficient between the Two-step value and one-leg standing time both showed a strong correlation.

Table 2. The evaluation results for each subject

Subjects	TUG (seconds)	One-leg standing time (seconds)	Length of two steps (cm)	Two-step value
1	9.67	0	125	0.83
2	9.67	30	171	1.07
3	8.2	30	213	1.24
4	9.6	4.03	116	0.78
5	15.72	5.02	145	0.86
6	11.25	18.72	175	1.07
7	9.78	30	168	1.04
8	11.5	0	160	0.94
9	14	3.35	124	0.78
10	21.3	0	71.5	0.46
11	47.28	0	48	0.31
Average	15.27	11.01	137.86	0.85
SD	11.26	13.30	47.84	0.27

TUG: Timed Up and Go test. Two-step value: length of two steps (cm)/height (cm)

Table 3. Correlations coefficients between measures

	Two-step value	TUG	One-leg standing time
Two-step value		−0.82*	0.75*
TUG			−0.43
One−leg standing time			

*p<0.05
TUG: Timed Up and Go test

DISCUSSION

Oberg et al. reported that step length increases with an increase in walking speed[19]. Fujiwara et al. examined the similarity in kinematics between normal walking and front-stepping movement[20]. They showed that front-stepping movement could be generalized to walking, as each movement was similar to that in the ankle rocker period.

In a prior study by Sugawara et al., the Two-step value was significantly improved at four weeks after initial evaluation in inpatients with a cerebrovascular accident[21]. In their study, as the Two-step value approached 1.0, there was a shift toward independent walking ability; this can be used as a predictive target value for independence. Ninomiya et al. found a significantly low Two-step value in a group with diabetic polyneuropathy[22].

Muranaga et al. reported that fall risk increases when the Two-step value decreases; therefore, fall risk rises with a value less than 1.0. In this study, the average Two-step value was 0.85, indicating a higher risk of falling[12]. Strong correlations between Two-step Test and TUG test values as well as Two-step value and one-leg standing time were shown in this study. In previous studies on the correlation between the Two-step Test and other balance tests in healthy elderly individuals who did not need nursing care or support, the Two-step value showed a correlation with the TUG and Functional Reach Test[14, 15]. In this study, the result was the same in subjects who needed nursing care or support. Therefore, the Two-step Test can be used as an indicator of balance ability. For frail people, this balance test can be easily performed with little burden. Therefore, this test is useful for evaluating the balance ability of elderly individuals who require nursing care or support. Because the number of subjects was limited, we were not able to examine the effects of gender, comorbidities, age, etc., which require further study.

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