Usefulness of a 50-meter round walking test for fall prediction in the elderly requiring long-term care

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Abstract. [Purpose] This study aimed to verify the usefulness of a 50-m round walking test developed as an assessment method for walking ability in the elderly. [Subjects] The subjects were 166 elderly requiring long-term care individuals (mean age, 80.5 years). [Methods] In order to evaluate the factors that had affected falls in the subjects in the previous year, we performed the 50-m round walking test, functional reach test, one-leg standing test, and 5-m walking test and measured grip strength and quadriceps strength. [Results] The 50-m round walking test was selected as a variable indicating fall risk based on the results of multiple logistic regression analysis. The cutoff value of the 50-m round walking test for determining fall risk was 0.66 m/sec. The area under the receiver operating characteristic curve was 0.64. The sensitivity of the cutoff value was 65.7%, the specificity was 63.6%, the positive predictive value was 55.0%, the negative predictive value was 73.3%, and the accuracy was 64.5%. [Conclusion] These results suggest that the 50-m round walking test is a potentially useful parameter for the determination of fall risk in the elderly requiring long-term care.

Key words: 50-meter round walk test, Local elderly individuals, Falls

INTRODUCTION

Falls in the elderly may result in significant morbidity and a need for long-term care1]. The prevalence of falls in the elderly is reported to be 28–42%2–6]. In addition, falling not only potentially causes somatic injuries such as fractures but also limits a patient’s physical activity due to a fear of falling. Limiting falls in the elderly is an important health management issue. The walking ability of an elderly individual is associated with activities of daily living (ADL) and physical activity7, 8], as well as self-reported health9]. Longitudinal studies have shown that walking ability is a predictive factor for a decline in physical performance10], admission to a long-term care facility11], and death11, 12]. We believe that walking ability reflects an elderly individual’s physical performance and is related to the risk of falling in that individual.

Recording the time and speed to walk a straight course of a specified distance is a method used for assessment of walking ability. However, a prior study reported a nonlinear relationship between walking speed and leg strength in a 10-m walk in the elderly13]. In those individuals with a decreased walking speed, there was a relationship between walking speed and leg strength, while in those without a decrease in walking speed, leg strength was not related to walking speed. A short-distance test, such as 5- or 10-m walk, is useful for assessing walking ability in frail or chronically ill elderly patients, but it does not necessarily reflect physical performance accurately in the healthy elderly.

Hachiya et al. developed a 50-m round walking test as an assessment method for walking ability in the elderly and reported the reproducibility and validity of the measured values14]. They confirmed the high reproducibility of the measurements [interclass correlation coefficient (1.1): 0.92–0.99] and showed that the measured values included a measurement error of 1.5 sec and that the acceptable range of error was 3.1 sec. They also demonstrated the relationships between the 50-m round walking test and walking ability as well as balance ability. However, in that study, they only analyzed the relationships between the 50-m round walking test and walking and balance abilities and did not sufficiently confirm the clinical usefulness of the measured values. In order to use the 50-m round walking test clinically, or in local health services, clinical significance needs to be demonstrated for the obtained measurements.

In this study, we investigated the individual fall histories of elderly individuals in the past year and conducted a 50-m round walking test. Additionally, we measured physical
performance with methods readily available at clinical sites. The study aimed to verify the usefulness of the 50-m round walking test by evaluating the factors that affect falls.

SUBJECTS AND METHODS

The subjects were 166 individuals who completed a 50-m round walking test from among 168 elderly individuals requiring long-term care and participating in outpatient rehabilitation [55 males and 111 females; mean age, 80.5±7.9 years; mean height, 151.7±9.1 cm; mean weight, 50.1±10.8 kg (mean ± standard deviation)]. The study purpose and details were explained to all participants in writing and orally, and written consent was obtained in advance of any measurements in all patients. We explained that participation in the study was voluntary, and subjects were allowed to withdraw their consent even after measurements were obtained. We conducted this study with the approval of the ethics committee of the Graduate School of Medicine, Saga University (No. 26-4).

The study items were a 50-m round walking test, grip strength, quadriceps strength, functional reach test (FRT), one-leg standing test, 5-m walking test, and fall history in the past year.

In the 50-m round walking test (Fig. 1), participants walked a total of 50 m by making two-and-a-half trips between two road cones placed 10 m apart on a walking path. The time required to walk from the start to the end (for 50 m) was measured with a stopwatch. Landmarks for turning (road cones) and a stopwatch capable of measuring lap times were utilized. Measurements were conducted as follows. A pre-test explanation was provided that covered the following points: 1. Before the start of the test, participants were to assume a standing position. Participants were free to stand either to the right or left of the cone. 2. Participants were allowed to use a cane for walking assistance, but they were instructed to not place the tip of their walking canes near the cone or to allow contact with the cone while turning. The participants were asked to start walking at a signal given by the investigator and instructed to walk at their fastest speed around the outside of the cones. Participants were not allowed to rest while making the two-and-a-half trips on the 10-m walking path. The stopwatch was used to record the time (sec) required to walk each of the five 10-m “laps” of the walk along with the total time to walk the 50 m. A “Lap” was defined as the distance from one cone to the other placed 10 m away. If it was difficult to continue taking measurements while a participant was walking, the times required to complete the previous laps were recorded, and the reason for the stopping was described. For example, if a participant became tired before completing lap 3 and the test was discontinued, the times for laps 1 and 2 would be recorded on the record sheet. In addition, “cancelled due to fatigue” was recorded as the reason.

Grip strength was measured with a digital grip dynamometer (T.K.K. 5401, Takei Scientific Instruments Co., Ltd., Niigata, Japan). In a standing position with both arms dangling at their sides, grip strength was measured twice for each hand, and the maximum value (kg) was used as a representative value.

A handheld dynamometer (μTas F-1, ANIMA Corp., Chohu-shi, Tokyo, Japan) was used to measure quadriceps strength. The participant was placed in a seated position on a platform with both knees bent at 90°. The dynamometer was fixed with a belt to a pad that was placed on the distal lower leg in order to prevent the hip from rising from the table during measurement. Maximum isometric contraction strength was measured twice for each leg, and the maximum value was used as a representative value for conversion to percentage per weight (%).

We used a functional reach measuring instrument (T.K.K. 5802, Takei Scientific Instruments Co., Ltd., Niigata, Japan) in the FRT. The participant stood with the feet approximately shoulder width apart, keeping the forearms pronated, the elbows extended, and the shoulder joints bent at 90° as the starting posture. The participant was asked to reach forward as far as possible while standing. We conducted the measurements twice, and the larger value (cm) was used as a representative value.

In the one-leg standing test, the participant raised one leg at any time, and the time during which the leg was held up was recorded using a stopwatch. The measurement was terminated when the supporting leg was shifted from the start position or when the raised leg touched the floor. The measurement was conducted twice for each leg, and the maximum value (sec) was used as a representative value.

In the 5-m walking test, the time required to walk 5 m on flat ground at the individual’s fastest speed was measured using a stopwatch. In consideration of the acceleration when starting and deceleration when stopping, an extra 3-m section was included before and after the measurement section, resulting in an 11-m walk in total. Measurement was conducted twice, and the smaller value (sec) was used as a representative value.

We collected fall histories by interview and divided participants into a “faller group” composed of those individuals with a fall experience in the past year and a “non-faller group” composed of those individuals without a fall experience in the past year. Falls were defined as “unintentionally falling to the ground, floor, or other lower place.”

In the statistical analysis, the normality of each measured item was confirmed with the Shapiro-Wilk test. Each measured item was compared between the faller group and non-faller group using the independent t-test.
the non-faller group by the Mann-Whitney U test, followed by a multiple logistic regression analysis of likelihood ratios in which the independent variables were items with a significant difference and the dependent variables were the presence/absence of fall experience. Prior to the analysis, correlation coefficients were tested to exclude the effect of multicollinearity, and the correlation strength of each item was confirmed. Variables were selected by a variable increasing method. We obtained the receiver operating characteristic (ROC) curve for selected variables and determined the conformance from the area under the ROC curve (AUC) to obtain a cutoff value. The cutoff value was determined using the Youden Index. We used IBM SPSS Statistics 22 (IBM Corp., Armonk, NY, USA) for statistical analysis.

RESULTS

Sixty-seven participants had a fall experience (faller group), and 99 participants had no fall experience (non-faller group). Comparison revealed that the values from the 5-m walk test and 50-m round walking test in the faller group were significantly higher than those in the non-faller group (p<0.01) (Table 1). On the other hand, there were no significant differences in the values from the grip strength test, quadriceps strength test, FRT, and one-leg standing test between the two groups. In the analysis of correlation coefficients between the two items showing a significant difference, there was no combination with p<0.9. Therefore, a multiple logistic regression analysis was performed using the 5-m walk test and 50-m round walking test as independent variables. As a result, the 50-m round walking test was selected as a variable indicating fall risk (odds ratio: 0.09, 95% confidence interval: 0.02–0.46). The model was significant (p<0.01) according to the χ² test, and p=0.05 in the Hosmer-Lemeshow test, indicating that the regression equation fit. The cutoff value in the 50-m round walking test for discriminating fall risk was 0.66 m/sec. The AUC was 0.64 (95% confidence interval: 0.55–0.72). The sensitivity of the cutoff value was 65.7%, the specificity was 63.6%, the positive predictive value was 55.0%, and the negative predictive value was 73.3%, and the accuracy was 64.5%.

DISCUSSION

We investigated the fall history in the past year and physical performance in 166 elderly individuals requiring long-term care to examine the possibility of discriminating fall risk. Our study demonstrated that the 50-m round walking test is a performance test that allows discrimination of fall risk. The cutoff value of the 50-m round walking test for this discrimination was 0.66 m/sec (AUC: 0.64). We calculated the discrimination accuracy using the obtained cutoff value. The rate of individuals demonstrating a measured value of ≥ 0.66 m/sec with no fall experience (negative predictive value: 73.3%) was higher than the rate of those demonstrating a measured value of < 0.66 m/sec with a fall experience (positive predictive value: 55.0%), which indicates that the 50-m round walking test is more useful in discriminating “individuals who do not fall” rather than “individuals who do fall.” However, the values of discrimination accuracy are influenced by the fall rate in a targeted group, as the calculated positive predictive value becomes higher when the fall rate in the targeted population is higher. In this study, the fall rate in the participants was 40.4%. In a previous study showing fall rates in the elderly by age, the fall rate in those 75–84 years old was reported to be 39.0%15). Other studies have reported rates of 28–35% in subjects ≥ 65 years old3, 4, 16) and 32–48% in subjects ≥ 70 years old3, 5, 6, 17). The mean age of subjects in this study was 80.5 years, and the fall rate was similar to those in the previous studies; thus, the discrimination accuracy obtained using the 50-m round walking test is considered to be good.

These results suggest that the 50-m round walking test is a potentially useful parameter for fall prediction in the elderly requiring long-term care. The fall risk is expected to be higher in elderly individuals walking at < 0.66 m/sec during the 50-m round walking test. Identification of these individuals makes it possible to intervene with measures such as education for the prevention of falls, exercise programs, and ADL guidance to lessen the risk of a fall.

After multiple logistic regression analysis of a 50-m round walking test and a 5-m walking test that have been used to predict fall risk, the 50-m round walking test was selected as a variable indicating fall risk. In addition, the 50-m round walking test was completed at a high rate (166 out of 168 individuals, or 98.8%) in this study. This study indicated that a 50-m round walking test can be useful for determining fall risk in local elderly individuals requiring long-term care. However, in order to generalize the 50-m round walking test, elderly individuals who are highly independent and those with a variety of physical conditions should be included in future studies. This was a retrospective study in which fall experiences in the past were investigated. We are currently conducting a prospective study and plan to publish a report.

Table 1. Comparison of physical function of fallers and non-fallers

| All (n = 166) | Faller (n = 67) | Non-faller (n = 99) |
|--------------|----------------|-------------------|
| Grip strength (kg) | 17.4 (13.7-21.8) | 17.9 (12.9-22.8) | 17.1 (13.7-20.8) |
| Quadriceps strength (%) | 29.1 (19.8-37.2) | 26.5 (19.1-37.0) | 29.3 (20.4-37.8) |
| Functional reach test (cm) | 24.0 (18.9-29.0) | 23.0 (18.0-29.0) | 24.0 (19.0-29.0) |
| One-leg standing test (sec) | 4.4 (2.3-8.4) | 5.1 (1.9-8.6) | 4.2 (2.3-8.4) |
| 5-m walking test (m/sec) | 0.80 (0.65-0.96) | 0.76 (0.56-0.88) | 0.83 (0.73-1.00) ** |
| 50-m round walking test (m/sec) | 0.68 (0.53-0.82) | 0.63 (0.50-0.73) | 0.72 (0.59-0.85) ** |

Values are shown as medians (25th–75th percentiles). **p<0.01 (Mann-Whitney U test)
of our findings in the future.

This study demonstrated the usefulness of the 50-m round walking test for discriminating fall risk in elderly individuals requiring long-term care. The use of measured values from the 50-m round walking test enables determination of the desired values for prevention of falls in the elderly, and these numerical target values can be used to improve walking ability training.

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