Evaluation of motor function using the two-step test in type C day care service

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Abstract. [Purpose] Evaluation of motor function in preventive care services using a convenient method is necessary. The two-step test is clinically useful in evaluating motor function. Thus, we aimed to assess motor function using the two-step test in day care service type C. [Participants and Methods] The two-step test value and motor function used in day care service type C were evaluated in 23 elderly females (mean age: 77.4 ± 6.7 years). [Results] Timed Up and Go test and two-step test results were highly correlated. [Conclusion] The results suggest that the factors constituting the two-step test showed a dynamic balance. Intervention for step or dynamic balance is important to improve the gait ability of elderly females in type C day care service.

Key words: Two-step test, Preventive care service, Elderly females

INTRODUCTION

The average lifespan in developed countries has increased1). Although the average lifespan in Japan is high, the difference between average lifespan and healthy life expectancy is approximately 10 years2). Even if maintaining life is possible with advances in medicine, problems such as poor quality of life can arise. Fractures caused by falling and the fear of falling lead to a decrease in the quality of life3-9), resulting in a decrease in physical activity. In elderly individuals in particular, falls resulting from physical activities can lead to additional episodes of falls. Thus, improving the motor function and social participation of local elderly residents is important. In Japan, preventive care services are undertaken in every region5). Study participants were aged ≥65 years, and they were selected based on daily motor function and their responses to questionnaires on dementia, swallowing, depression, and nutrition. As for day care service type C, interventions for motor function, nutrition, and swallowing function were performed by rehabilitation professionals6). Although the day care service type C involves a short intervention period of 3–6 months, improvement in physical activity and quality of life has been reported6). However, the period during which interventions can be performed with day care service type C is restricted. Presently, individual interventions cannot be implemented due to lack of time. Therefore, a convenient method to evaluate motor function is required.

In 2007, the Japanese Orthopaedic Association advocated the locomotive syndrome (LS)7). LS is a condition in which motor function is impaired. Individuals with LS may require care to prevent falls, and outdoor activities should be restricted8, 9). Furthermore, they may require care for everyday life10). When gait ability declines, they easily acquire feelings of depression and isolation. The two-step test is adopted as the evaluation criterion of LS. This test measures gait ability and is useful for hospital or rehabilitation use.

This study aimed to assess the motor function measured using the two-step test utilized in type C day care service and whether intervention by rehabilitation professionals is required. Additionally, the effectiveness of the two-step evaluation for motor function in type C day care service was investigated.
PARTICIPANTS AND METHODS

This was a cross sectional study. There were approximately 100 local residents aged ≥65 years who required support based on their responses to a questionnaire on motor function, nutrient status, and swallowing function in the target A area. Of these individuals, 26 local residents (1 male, 25 females) were selected after public office personnel reviewed their life situation. However, at the time of measurement, two individuals required gait assistance and one was in poor health; they were subsequently excluded from the study. Therefore, 23 elderly females were selected as study subjects. Their basic information was as follows: age 77.4 ± 6.7 years; height, 148.5 ± 6.0 cm; weight, 51.2 ± 6.0 kg; body mass index, 23.3 ± 3.4 kg/m² (mean ± standard deviation). The incidence rate of falls after the age ≥65 years was 39.1% (9/23). Moreover, the incidence rate of falls for less than 1 year was 21.7% (5/23 local residents).

Motor function was evaluated using the two-step test, which measures gait ability, gait speed, and gait step length; Timed Up and Go test (TUG) test, which measures dynamic balance; one-leg standing (OLS) test, which measures static balance; 5-repetition sit-to-stand test (SS-5), which measures stand function, grip, and calf circumference (CC) length; and sensory status of the foot.

The evaluation criteria were as follows:

The two-step test measures the maximum length of two steps. The participants were instructed to stop after the second step. The two-step value was calculated as follows: Two-step value=maximum length of two steps (cm)/participant’s height (cm).

Additionally, we computed gait speed, time taken to complete a 5-m walk, and number of steps, as shown below.

Gait speed (m/sec)=5 m/5 m time required (s).
Step length (cm)=5 m/5 m required steps × 100.

In the TUG test, the time taken for a participant to stand from a seated position, walk 3 m, turn around at 180°, walk back for 3 m, turn around, and sit down again was measured.

The OLS test conducted with open eyes was performed for a maximum of 60 s. The time was measured from the moment one leg was raised from the floor until the same leg was put down or was in contact with the floor or until the supporting leg took a step.

In the SS-5 test, the time taken to perform five repetitions from a seated position to a standing position from the chair was measured.

Grip strength of the right and left hands was measured using a hand dynamometer, and the maximum value was used for the analysis.

CC length was measured from the maximum posterior part of the lower thigh using a measuring tape.

Sensorial evaluation of the foot was performed using a 128-Hz C tuning fork. The sensorial status of both medial malleoli was measured. The degree of impairment of the sensory function of both feet was measured. In addition, for the statistical analysis, we used “0” to indicate a normal person and “1” to indicate people with impaired sensation.

Furthermore, we used “0” for those who had never fallen and “1” for those who had fallen after 65 years of age. Pearson’s product-moment correlation coefficient was used to determine the correlation between each item of basic information and motor function. Moreover, Spearman’s correlation coefficient was used to determine the correlation between each item of fall history and sensation. The significance level was set at 5%. SPSS 21.0 J (IBM SPSS Japan, Inc., Tokyo, Japan) was used for statistical analysis. Study details were fully explained to the participants. Participants who provided informed consent were included. Furthermore, this study was approved by the ethics committee of Niigata University of Rehabilitation (receipt number 131).

RESULTS

Table 1 shows the basic information and motor function of the participants. The correlation of each item of basic information and motor function is presented in Table 2. The scatter diagram of the item with two-step value and high correlation more than |0.600| is shown in Fig. 1.

DISCUSSION

In this study, the two-step test value showed 1.10 ± 0.23. Two-step values <1.1 are considered to be Locomo’s score II. In such a case, the possibility that independent life becomes unfeasible is high(10). Motor functions exhibiting high correlation with the two-step test values were TUG test and step length.

Particularly for the two-step test, dynamic balance is important during walking, as unusual movement and shift in the center of gravity greatly reflect gait ability(11, 12). Furthermore, to be able to stop at the second step, the ability to maintain balance is a must. Similarly, in the TUG test, movement is stopped at a sitting position at the start and end of the test. Therefore, the common feature of the two-step and TUG tests is not the speed of movement but the ability to move from a still position and stopping movement safely. The two-step test does not measure simple gait ability but is considered to be an index of
Two-step test showed a high correlation with gait speed. Therefore, a step is an important factor in gait ability. However, since the two-step test did not measure the time required, the gait at maximum speed reflects the maximum gait ability. Moreover, gait speed is calculated from step length and cadence.

Table 2. Correlation of basic information with motor function

| Age  | Height | Weight | BMI   | Gait speed | Two-step value | Stride length | TUG   | OLS   | SS-5   | Grip | CC   | Foot of sense | Fall  |
|------|--------|--------|-------|-----------|----------------|---------------|--------|-------|--------|------|------|--------------|-------|
| 1    | 0.207  | -0.025 | 0.134 | 0.100     | 0.094          | -0.076        | 0.196  | 0.134 | -0.262 | 0.083 | -0.040 | -0.113        | -0.102|
| -0.076 | 0.212  | 0.427  | 0.094 | 0.226     | 0.567          | -0.495        | 0.194  | -0.212 | 0.468* | 0.033 | -0.016 | -0.054        | -0.054|

Mean ± SD. TUG: Timed Up and Go test; OLS: One Leg Standing with the eyes open; SS-5: Sit to stand-5; CC: calf circumference.

Table 1. Evaluation results of 23 local residents who participated in the type C day care service

| Two-step value | Gait speed (m/s) | Step length (cm) | TUG (s) | OLS (s) | SS-5 (s) | Grip (kg) | CC (cm) |
|----------------|-----------------|-----------------|--------|--------|----------|-----------|--------|
| 1.10 ± 0.23    | 1.49 ± 0.28     | 57.8 ± 8.3      | 8.2 ± 1.8 | 17.0 ± 17.6 | 13.0 ± 3.1 | 19.8 ± 3.3 | 31.9 ± 2.0 |

The two-step test measured the two greatest steps, and correlation with a high step length was found. The step length of gait at maximum speed reflects the maximum gait ability. Moreover, gait speed is calculated from step length and cadence. Therefore, a step is an important factor in gait ability. However, since the two-step test did not measure the time required, the two-step test showed a high correlation with gait speed. Falls associated with gait ability are also a concern. Therefore, interventions for the gait ability of elderly people with short life expectancy are important. We propose a dynamic balance training test, such as TUG or two-step test, to evaluate gait ability. To improve gait ability, conscious gait exercises are effective. Before commencing gait exercises, individuals should perform leg stretching to improve pliability.

Overall, time and evaluation tools are necessary to estimate physical activity. The two-step test used in the Locomo test has a high serviceability to evaluate physical action conveniently. Moreover, factors constituting the two-step test were TUG test, step length, and dynamic balance ability. Thus, a program aimed at identifying gait exercises, including conscious steps, accompanied by turn, and perpendicular stable movement accompanied by stand and sit, is necessary. This study had some limitations. Only females from one local area were included in the analysis. Therefore, the results could not be applied to both genders, and gender associations were not considered. Moreover, the analysis only focused on motor function. Therefore, factors such as physical activity and nutrition or disease conditions should be investigated in the future. In this study, we did not investigate leg mobility or pliability in each step. In this study, we found that TUG test and the two-step test used in type C day care service exhibited a high correlation. More...
over, factors that constitute the two-step test are mobility and dynamic balance during gait. Thus, interventions for improving step and dynamic balance during gait are important to enhance gait ability of individuals participating in type C day care service.

**Funding and Conflict of interest**

The authors declare that they have no competing interests.

### REFERENCES

1. Ministry of Health, Labour and Welfare. Vital statistics in Japan. https://www.mhlw.go.jp/toukei/list/dl/81-1a2.pdf (Accessed Dec. 14, 2018)
2. Ministry of Health, Labour and Welfare. A shift of an average lifespan and healthy life expectancy. https://www.mhlw.go.jp/file/05-Shingikai-10601000-Dai-jinkanboukouseikagakuka-Kouseikagakuka/sinntyoku.pdf (Accessed Dec. 14, 2018)
3. Makino K, Makizako H, Doi T, et al.: Fear of falling and gait parameters in older adults with and without fall history. Geriatr Gerontol Int, 2017, 17: 2455–2459. [Medline] [CrossRef]
4. Shimada H, Ishizaki T, Kato M, et al.: How often and how far do frail elderly people need to go outdoors to maintain functional capacity? Arch Gerontol Geriatr, 2010, 50: 140–146. [Medline] [CrossRef]
5. Wada Y, Sakuraba K, Kubota A: Effect of the long-term care prevention project on the motor functions and daily life activities of the elderly. J Phys Ther Sci, 2015, 27: 199–203. [Medline] [CrossRef]
6. Ministry of Health, Labour and Welfare. The synopses of preventive care services. https://www.mhlw.go.jp/file/06-Seisakujouhou-12300000-Roukenkyoku/0000192996.pdf (Accessed Dec. 14, 2018)
7. Nakamura K: A “super-aged” society and the “locomotive syndrome”. J Orthop Sci, 2008, 13: 1–2. [Medline] [CrossRef]
8. Park H, Park W, Lee M, et al.: The association of locomotive and non-locomotive physical activity measured by an accelerometer with functional fitness in healthy elderly men: a pilot study. J Exerc Nutrition Biochem, 2018, 22: 41–48. [Medline] [CrossRef]
9. Jackson CA, Jones M, Tooth L, et al.: Multimorbidity patterns are differentially associated with functional ability and decline in a longitudinal cohort of older women. Age Ageing, 2015, 44: 810–816. [Medline] [CrossRef]
10. The Japanese Orthopaedic Association: Locomo on line. https://locomo-joa.jp/check/test/two-step.html (Accessed Oct. 1, 2018)
11. Kojima K, Kamai D, Ishitani S, et al.: Availability of the Two-step Test to evaluate balance in frail people in a day care service. J Phys Ther Sci, 2017, 29: 1025–1028. [Medline] [CrossRef]
12. Muranaga S, Hirano K: Development of a convenient way to predict ability to walk, using a two-step test. J Showa Med Assoc Jpn, 2003, 63: 301–308.
13. Sun Q, Townsend MK, Okereke OI, et al.: Physical activity at midlife in relation to successful survival in women at age 70 years or older. Arch Intern Med, 2010, 170: 194–201. [Medline] [CrossRef]