Validity and Reliability of a 2-Min Walk Test to Assess the Exercise Capacity in Vertebral Compression Fracture Patients: A Pilot Study

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ABSTRACT. Background: The 2-min walk test (2MWT) may be a simple and easy measurement of exercise tolerance for vertebral compression fracture (VCF) patients. But, the validity and reliability of the 2MWT in patients with VCFs have not been verified. The aim of this pilot study was to investigate the validity and reliability of the 2MWT in VCF patients. Methods: Ten patients with VCFs were selected from the inpatient convalescence rehabilitation ward. These patients were required to walk for a minimum of 6 minutes. The study was conducted over three test days. On the first and second test days, the participants completed one trial of the 2MWT each day. These data were used in the analyses for an intra-class correlation coefficient (ICC [1,1]). On the third test day, participants completed the 6-min walk test (6MWT). These data assessed the construct validity of the 2MWT. Participants completed testing on 3 days within a 5-day period. Results: A significant correlation was found between the 2MWT and the 6MWT (r=0.945; p<0.05), which suggested a high construct validity of the 2MWT. The intraclass correlation coefficient of the repeated 2MWTs was high (ICC=0.98; p<0.05), intimating that it had a high test-retest reliability. Conclusion: The 2MWT is a valid test for the assessment of exercise capacity in patients with VCFs. It is practical, simple, and well tolerated by patients with VCFs.

Key words: 2-Min Walk Test, Vertebral Compression Fracture, Validity, reliability

Vertebral compression fractures (VCFs) occur in approximately 20% of individuals over 70 years of age1). These fractures can result in persistent pain, an inability to perform the activities of daily life, and a marked decrease in quality of life2). After the onset of VCFs, patient’s physical performance including cardiorespiratory function is often drastically reduced due to pain and reduced mobility. The decreased cardiorespiratory function associated with physical inactivity can significantly diminish an individual’s functional capacity3). Therefore, therapists must evaluate the exercise capacity of VCF patients.

Progressive, incremental tests using treadmill or cycle ergometer with online monitoring of cardiac and functions are the “gold standard” for the measurement of exercise capacity (maximum oxygen uptake [VO2 max]), which is a measurement of disability, as well as an outcome measurement for treatment and rehabilitation4). Furthermore, walk tests for measuring exercise capacity have gained prominence in both clinical practice and research. The most commonly used timed walk test is the 6-min walk test (6MWT)5). Subjects are instructed to walk as much as possible in the allotted time period.

In our medical environment, it is desirable to choose an evaluation method that can be carried out in a short time.
because the therapist’s time is insufficient. There is some indication that the 2-min walk test (2MWT) provides sufficient information to assess exercise capacity in other patient populations. The reliability of the 2MWT has been established for chronic obstructive pulmonary disease (COPD), lower extremity amputation, neurologic impairment, and stroke, with published high-test-retest reliabilities with some studies demonstrating a strong association between the 2MWT and the 6MWT, suggesting that no additional information is gained from the additional time. Therefore, 2MWT may be a simple and easy measurement of exercise capacity for VCF patients.

According to the best of our knowledge, no studies have been conducted to verify validity and reliability of 2MWT in patients with VCFs. VCFs are often caused by osteoporosis frequently found in the elderly, so patients with VCFs are elderly and frail in many cases. Therefore, if exercise tolerability can be evaluated in a shorter time than the 6MWT, the burden on VCF patients will be reduced. Since 2MWT was confirmed validity and reliability in other patient populations, we hypothesized that 2MWT in patients with VCFs show results similar to the previous research. Therefore, the aim of this pilot study was to identify the validity and reliability of 2MWT in patients with VCFs.

Materials and Methods

Design

The study was conducted over three test days. On the first and second test days, participants completed one trial of the 2MWT each day. These data were used in the analyses for test-retest reliability. On the third test day, participants completed a 6MWT. These data were used to assess the construct validity of the 2MWT. Participants completed testing on 3 days within a 5-day period. All testing occurred at the same time of day to minimize the influence of meals, fatigue, leisure, and other scheduled activities on subjects’ performance. Based upon standardized verbal instructions, a single grader evaluated two trials of the 2MWT that were conducted.

Sample size calculation

Prior to data collection, a power analysis (G*Power 3.1.9.2, Franz, Universitat Kiel, Germany) was conducted to determine that particular sample size needed to detect an effect of defined size with a certain probability (statistical test-power: 1-β) as far as this effect really does exist in the population. Previous research literature reports very high positive correlation (r = 0.937-0.997) between the 2MWT and 6MWT in other patients. For this reason, main hypothesis of the present study was significant correlation can still be detected in VCF patients. Accordingly, hypothesized correlations (correlation ρ H1)=0.9 which corresponds to very high positive correlation and null hypothesis ρ H0=0 was used for this study’s power analysis. In addition, α error=0.05, and β error=0.2 was used according to Bujang. The analysis result revealed that minimum 6 participants would be required to achieve desired statistical test-power.

Participants

Participants were recruited from the inpatient convalescence rehabilitation ward at the Jyuzen Memorial Hospital. Participants included in the study had VCFs at the thoracic, thoracolumbar or lumbar spine level. Inclusion criteria for participants were as follows: 70 years of age or older, Japanese speaking, receive conservative treatment, and able to walk a minimum of 6 minutes without physical assistance by another person. Participants were excluded from the study if they were unable to provide informed consent due to cognitive impairment or had a history of neuromuscular disorders or cerebrovascular disease. Informed consent, including an acknowledgement that participation was voluntary, was obtained prior to testing. The investigators recorded the Barthel Index, age, and sex of the participant from the clinical records in advance. Severity of fracture was evaluated using semiquantitative technique by Genant. In this evaluation, higher grades indicate more severe. The study protocol was approved by research ethics board at the Jyuzen Memorial Hospital (Approval Date: 7/11/2016) and also registered with the University Hospital Medical Information Network Clinical Trials Registry (UMIN000024979).

Outcome measures

The 6MWT was conducted according to American Thoracic Society guidelines, in which patients are allowed to stop and rest at any time during the test. Participants walked between pylons separated by a distance of 20 m for the duration of the test. If participants needed to sit down, the test was considered complete at that point, and the distance up to that point was recorded.

The 2MWT was conducted similarly, following a standardized protocol as described by Brooks et al., where subjects were asked to walk as fast as they could in 2 min without further encouragement. The test administrator walked behind the participant to minimize pacing, and participants were provided with clear instructions and were allowed to stop and rest. The test ended if the participant needed to sit down.

Participants were ordered to walk in their usual gait speed during the test. They were allowed to use a usual walking aid and worn the spinal brace during the test. Distances for the 2MWT and 6MWT were recorded to the nearest 1 m using a rolling tape measure.

Before and after the 2MWT and 6MWT, arterial oxygen saturation (SaO2) and heart rate (HR) were measured.
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Table 1. Demographic and Anthropomorphic Data of the Study Participants

| Variables (n = 10)                      | Values              |
|----------------------------------------|---------------------|
| Sex (men/women)                        | (2/8)               |
| Age (yr)                               | 84±7.3              |
| Body weight (kg)                       | 50.5±11             |
| Body height (m)                        | 1.53±12.64          |
| BMI (kg/m²)                            | 21.54±3.93          |
| BI                                     | 87.5±11.4           |
| Fracture region (Thoracic/Lumbar/Thoracolumbar) | (3/6/1)           |
| Post-onset period of VCF (day)         | 26.8±8.8            |
| Severity of fracture* (Grade 1 / Grade 2 / Grade 3) | (4/2/4)            |
| Diagnosis of osteoporosis (Presence / Absence) | (5/5)              |
| Usual walk aid (Canes/Rollators/Walkers/non-use) | (2/3/2/3)       |

Values are given as the mean±SD. BMI = body mass index; BI = Barthel Index; VCF = vertebral compression fractures
*Assessed by a semiquantitative technique (Genant, 2009)

Table 2. Exercise Test Results

| Variables (n=10)     | 2MWT 1st | 2MWT 2nd | 6MWT     |
|----------------------|----------|----------|----------|
| Walking Distance (m) | 82.4±44.68 | 83.4±40.81 | 243.8±124.67 |
| HR (bpm) pre         | 77.6±12.66 | 75.8±8.75  | 77.4±11.79  |
| HR (bpm) post        | 82.3±8.17  | 80.8±8.97  | 87.4±16.53  |
| SaO2 (%) pre         | 97.2±1.03  | 96.7±1.49  | 97.0±0.94   |
| SaO2 (%) post        | 97.2±1.23  | 96.5±1.58  | 97.3±1.16   |
| RPD                  | 0.9±1.29   | 1.1±1.60   | 1.3±1.57    |
| RPD                  | 1.8±1.44   | 1.7±1.60†  | 3.7±2.50†   |

Values are given as the mean±SD. HR = heart rate; RPD = rating of the perceived dyspnea. * indicates statistically significant difference between the 2MWT 1st and 6MWT at p<0.05. † indicates statistically significant difference between the 2MWT 2nd and 6MWT at p<0.05.
2MWT: 2-min walk test; 6MWT: 6-min walk test; HR: Heart rate; SaO2: arterial oxygen saturation; RPD: rating of perceived dyspnea.

Results

Ten patients (2 men and 8 women; mean age, 84 ± 7.3 years) were recruited into the study. All patients completed the study. Demographic data and exercise test results are shown in Table 1, 2. The fracture type of all patients was a stable type (compression fracture). No patients had a neurological impairment associated with compression fracture. The data were normally distributed as confirmed by Shapiro-Wilk test (2MWT 1st, p=0.43; 2MWT 2nd, p=0.61; 6MWT, p=0.56). There was a significant difference in the RPD of post walk test: 2MWT 1st vs. 6MWT, p<0.05; and 2MWT 2nd vs. 6MWT, p<0.05 (Table 2). No significant differences were found between the 2MWT 1st, 2MWT 2nd, and 6MWT for HR or SaO2.

There was a significant correlation between the 2MWT 2nd distance and the 6MWT distance (r=0.945; p<0.05).

The mean distances walked during the first and second 2MWTs were 82.4 ± 44.7 and 83.4 ± 40.8 m, respectively.

by pulse oximetry (MD300-C22, FUKUDA DENSII, Tokyo, Japan). The rating of the perceived dyspnea (RPD) was evaluated by modified Borg scales.

Statistical analysis

All data were analyzed using a statistical software package (IBM SPSS Statistics 24, SPSS Tokyo, Japan). Data were checked for normal distribution by Shapiro-Wilk test, and the means ± SDs were calculated. The results of the RPD were analyzed by the appropriate nonparametric tests. A p value of <0.05 was considered to be statistically significant. We used the t-test and Wilcoxon signed-rank test to detect a statistically significant difference between the results of tests completed on different days. The Pearson correlation test was used to analyze the relationships between the 2MWT on the second test day and the 6MWT. The test-retest reliability of the 2MWT was determined by an intra-class correlation coefficient (ICC) of a 1-way Classification (ICC1,1).
Discussion

This is the first study to present validity and test-retest reliability data of the 2MWT in people with VCFs. The study found that 2MWT has validity as a measure of exercise capacity in a range of patients with VCFs. Furthermore, it is intimated that 2MWT is reliable when performed by a single observer in patients with VCFs.

The distance of 2MWT has been reported on men (164.4 ± 30.1 m) and women (145.4 ± 27.5 m) in Community-dwelling 70 to 79 year old people). In this study, the distance of 2MWT were 82.4 ± 44.7 m (1st) and 83.4 ± 40.8 m (2nd) in patients with VCFs. It is assumed that reduction of 2MWT walking distance in VCF patients reflects lowering of physical function including cardiopulmonary function due to persistent pain and mobility decrease by VCF.

The validity of the 2MWT represented by the correlation with the 6MWT has been established in patients with other disease (r=0.938-0.997). In this study, there was a significant correlation between the 2MWT and 6MWT in VCF patients (r=0.945; p<0.05). The strength of the correlation was large, based upon a grading scheme used by Cohen and Hollliday. This result indicates that the 2MWT is as useful as the 6MWT and supports the validity of the 2MWT as a measure of exercise capacity in VCF patients.

Meanwhile, the 2MWT, with the 6MWT, reflects walking speed and balance function in addition to exercise capacity. In this study, there were significant increases in the RPD after 6MWT when compared with the 2MWT. Other studies have shown small but significant differences in the end of test RPD between the 2MWT and the 6MWT, similar to this study. This finding indicates that the 6MWT was more exhausting to perform than the 2MWT. From this result, it is possible that 2MWT is an indicator more reflecting other factors (walking speed, balance function, etc.) than exercise capacity compared to 6MWT.

Nevertheless, in this study, the distance of 2MWT was almost one-third of the distance of 6MWT in proportion to the difference in walking time. A similar trend can be seen in previous studies. These findings show that the distance walked at 2MWT is an effective indicator to estimate the distance walked at 6MWT. Therefore, it was suggested that 2MWT may be a clinically useful index that can evaluate exercise tolerability of VCF patients with less fatigue than 6MWT.

The test-retest reliability of 2MWT has been reported in people with COPD (ICC=0.99), lower extremity amputation (ICC=0.83), neurologic impairment (ICC=0.97), and stroke (ICC=0.98). This study demonstrated that in a group of VCF patients, the distance walked in the two trials of 2MWTs was highly reproducible (ICC=0.98; p<0.05). The acceptable values of ICC were 0.75 or greater, based upon the work by Portney and Watkins. In this study, there was only very small variation across the trials (82.4 ± 44.7 and 83.4 ± 40.8 m) as the effect caused by patients fatigue and physical condition variability was minimized since the different trials were conducted at the same time of day within a 5-day period. Therefore, it is considered that the reliability of 2MWT in this study was high. This finding suggests that clinicians can use a single measure of 2MWT distance to monitor the capacity change in VCF patients.

This study had three limitations. First, it was suggested that 2MWT has less element of exercise capacity than 6MWT and more strongly reflects the influence of other factors. In the future, it is necessary to clarify to what extent 2MWT reflects exercise capacity, and to examine whether 2MWT can be used as an evaluation method of exercise capacity instead of 6MWT. Secondly, our study used a convenience sample of patients with VCF who, by design, were expected to have stable physical condition (stable fracture type, and no fracture-related neurological impairment). Findings from our convenience sample cannot be generalized to all patients with VCF. The validity and reliability of 2MWT in VCF patients with more severe symptoms in the acute phase should be examined in the future. Third, it was impossible to examine sufficient reliability since the sample size was small in this study. In the future research, it is necessary to consider the reliability of 2MWT by more than 50 sufficient Participants.

Conclusion

In conclusion, this study demonstrated that the 2MWT is a valid test for the assessment of exercise capacity in patients with VCFs. It is practical, simple, quick, easy to administer, and well tolerated by patients with low exercise capacity.

Conflict of Interest: Authors have no conflict of interests to disclose.

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