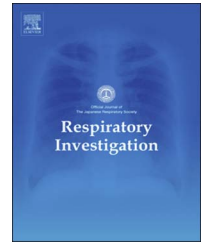




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Associations between the distance covered in the incremental shuttle walk test and lung function and health status in patients with chronic obstructive pulmonary disease

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ABSTRACT

Background: Field walk tests such as the incremental shuttle walk test (ISWT) are simple tests for assessing the degree of disability in individuals with chronic obstructive pulmonary disease (COPD). In the present study, the correlations between exercise performance in the ISWT, lung function, and health status were examined in patients with COPD of varying severities.

Methods: A retrospective examination of 277 COPD patients was performed using the ISWT and lung function tests along with assessment of health status using St. George's Respiratory Questionnaire (SGRQ). In addition, we assessed the correlations between the walking distance, lung function parameters, and SGRQ scores.

Results: ISWT distances were poorly correlated with lung function parameters and SGRQ scores in mild COPD patients. In contrast, ISWT distances were significantly correlated with pulmonary function parameters, such as vital capacity (%predicted) and forced expiratory volume in one second, and SGRQ scores in moderate and severe COPD patients.

Conclusions: The ISWT is more independent of health status and pulmonary function in patients with mild COPD compared to moderate or severe cases. Therefore, the exercise capacity of patients with mild COPD should be estimated by the ISWT.

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Abbreviations: ISWT, incremental shuttle walk test; SGRQ, St George's Respiratory Questionnaire

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1. Introduction

Exercise testing is useful to assess the degree of disability, survival prognosis, presence of exercise-induced hypoxemia, and response to treatment in patients with chronic obstructive pulmonary disease (COPD) [1]. Field walk tests are simpler to perform than other exercise tests since they require less equipment and are relatively inexpensive [2]. Furthermore, field walk tests show good correlations with other progressive exercise tests such as the electrically braked bicycle ergometer [3]. A variety of field walk tests currently exist, including time-based, fixed-distance, velocity-determined, and controlled-pacing incremental tests [4]. Of note, while time-based tests, such as the 6-min walk test, depend on the motivation of the patient since they are self-paced [5], controlled-pacing incremental tests, such as an incremental shuttle walk test (ISWT), have been reported to correlate well with maximal oxygen consumption [6,7]. Consequently, an ISWT is considered to be a more standardized test than a 6-min walk test [5].

We have previously reported that ISWT distance significantly correlated with lung function parameters, such as the forced vital capacity and forced expiratory volume in one second (FEV₁), and showed a weak correlation with health status in patients with stable COPD [5]. However, other previous studies have reported that ISWT distance did not correlate with forced vital capacity and FEV₁ and showed a good correlation with health status in patients with COPD [8,9].

We hypothesized that these conflicting results are likely influenced by differences in the severity of airflow limitation between the study patients. However, there are currently few reports in which the investigators assessed the results according to severity. Accordingly, in the present study, we examined and analyzed the correlations between ISWT distance, lung function tests, and health status in consecutive COPD patients according to the severity of air flow limitation.

2. Patients and methods

2.1. Patients

This study was a retrospective study of 277 consecutive patients with stable COPD who visited the outpatient clinic of Shinshu University Hospital from 2007 to 2013. We concurrently examined ISWT, pulmonary function tests, and health status using St George's Respiratory Questionnaire (SGRQ). COPD was diagnosed in accordance with the Global Initiative for Chronic Obstructive Lung Disease guidelines [10]. Patients with a history of long-term oxygen therapy, respiratory tract infection, or exacerbation during the preceding 3 months, and those with ischemic heart disease or locomotor problems were excluded. In contrast, patients under COPD treatment and/or pulmonary rehabilitation were not excluded. The patients were divided into 3 groups according to severity of airflow limitation: mild (FEV₁ ≥ 80% predicted), moderate (FEV₁ ≥ 50% to 80% predicted), and severe groups (FEV₁ < 50% predicted). This study was approved by

the institutional research ethics committee of Shinshu University School of Medicine (No. 3083) on January 5, 2015.

2.2. Pulmonary function tests

Spirometry, lung volume, and diffusion capacity for carbon monoxide (DL_{CO}) were measured using Chestac-8800 (Chest Co. Ltd, Tokyo, Japan) in accordance with the American Thoracic Society protocol [11]. The functional residual capacity (FRC) was measured using a gas-dilution method, in which the subject immediately inspired to total lung capacity (TLC) and expired maximally to residual volume (RV), allowing calculation of the lung volume and RV/TLC ratio. DL_{CO} was measured using the single-breath method.

2.3. Health status

Health status was assessed using the Japanese version of SGRQ, which consists of 76 items and calculates 3 component scores (symptoms, activity, and impact) and a total score. The symptom component contains items related to symptomatology, including frequency of cough, sputum production, wheezing, and breathlessness. The activity component is concerned with physical activities that either cause or are limited by breathlessness. The impact component covers factors such as employment, being in control of one's health, panic episodes, medication needs and side effects, and disturbance of daily life activities. Each score ranges from 0 to 100, with a score of 100 indicating maximum disability [12]. The Japanese version of the SGRQ is a valid and reliable measure of impaired health in COPD [13].

2.4. Incremental shuttle walk test

The ISWT was performed according to a previously reported method [6]. In summary, the patient walked up and down a 10-m course. The walking speed was defined by an audio signal and was increased every minute by a small increment, which meant that the patient was required to walk at a progressively faster pace. The test ended if the patient was too breathless to maintain the required speed, or if the investigator assessed that the patient failed to complete a shuttle in the time allowed. Oxygen saturation (SpO₂) and pulse rate were continuously monitored. Before and after the test, SpO₂, pulse rate, respiration rate, and blood pressure were measured, and dyspnea was rated using the modified Borg breathlessness scale.

2.5. Statistical analysis

The data distributions of variables for all groups were first assessed using a goodness-of-fit test. When data for variables showed a normal distribution, the 3 groups were compared using a one-way analysis of variance. When data for variables did not show a normal distribution, variables among the 3 groups were compared using Dunnett's test. Sex distribution differences among the 3 groups were compared using a Chi-square test. Simple correlations between ISWT distance and various parameters were examined using Pearson's correlation coefficient. An absolute value of the correlation

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