Association between Six-Minute Walk Test and Expiratory Spirometry Parameters in Chronic Obstructive Pulmonary Disease

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Abstract

Background- Many studies have suggested a relationship between the six-minute walk test (6MWT) and pulmonary function test (PFT) parameters in patients with chronic obstructive pulmonary disease (COPD). This study was designed to assess the association between individual PFT parameters and the 6MWT results in our COPD patient population.

Methods- Fifty-five patients with COPD (45 men and 5 women), defined as FEV1/FVC < 0.7, were recruited in this study. Spirometry parameters, including forced vital capacity (FVC), forced expiratory volume in one second (FEV1), peak expiratory flow rate (PEFR) and FEV1/FVC ratio, were measured. All the patients underwent the 6MWT within one hour of spirometry. All the COPD subjects were classified as mild, moderate or severe as per ATS criteria.[12]

Results- There was a statistically significant association between the results of the 6MWT and FEV1, FVC% and PEFR (all p values < 0.001). However, our study did not show any relationship between FEV1 to FVC ratio and the 6MWT results (r = 0.09 and p = 0.52). Using one way analysis of variance, we found a significant relationship between the severity of COPD and the result of the 6MWT (f = 8.78 and p < 0.001).

Conclusions- In our COPD patient population, the result of the 6MWT correlated with FEV1, FVC%, as well as PEFR%. This suggests that spirometry data could also be useful in long-term management of COPD patients ***(Iranian Heart Journal 2005; 6 (3): 59-63).***

Key words: six-minute walk test Ë chronic obstructive pulmonary disease Ë pulmonary function test

Measuring the walking distance has been used to evaluate the functional capacity of patients with chronic obstructive pulmonary disease (COPD). In 1963, Balke introduced a simple method to look at the functional capacity of patients with COPD through measuring the total distance they could walk during a certain period of time.[1] In 1986, a 12-minute walk test (12MWT) was used by Cooper to assess the physical fitness of healthy individuals.[2] Butland et al. showed that there was no significant difference between the 12MWT and their 6-minute walk test (6MWT) in predicting the functional capacity of COPD patients.[3]

In 2002, the American Thoracic Society (ATS) approved the 6MWT as a standard test for clinical pulmonary function laboratories. The relationship between the walking distance in a certain period of time and the functional

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capacity of patients with COPD has been investigated in several studies.[4-7]
Moreover, the result of the 6MWT in patients suffering from COPD has been found to be more reproducible than the measurement of FEV1.[8,9] The purpose of our study was to compare the measured expiratory flow and volume values with the result of the 6MWT in our patients, who had COPD.

Methods

The study population

COPD patients with FEV1 to FVC ratio below 70% were selected from the patients seen in our out-patient pulmonary clinic or those COPD patients who were admitted to our hospital between September 2002 and March 2003. The following subjects were excluded from our study: 1) hospitalized patients with evidence of respiratory failure as per clinical assessment and/or respiratory acidosis as per arterial blood gas (i.e. pH < 7.30); 2) patients with radiologic or clinical evidence of pneumonia; 3) those with evidence of heart failure or ischemic heart disease; 4) patients with uncontrolled hypertension defined as blood pressure equal or above 180/120 prior to the 6MWT; and 5) patients with neurologic, musculoskeletal or vascular disease in the lower extremities.

Sampling method

Patients were recruited to the study using a consequence sampling method.

Study protocol

A Chestac 55V spirometer (Japan) was used for all the patients to obtain the pulmonary function test (PFT) values. The six-minute walk test was performed in a 30-meter long and ventilated indoor corridor.[10,11] All the patients underwent the 6MWT within one hour of spirometry. Each patient rested for at least 10 minutes prior to the 6MWT. Encouraging phrases such as "keep up the good work", "well done" and "good" were used during the test. The patients were informed of the time passed from the beginning of the test at 3rd and 5th minutes. All the subjects were allowed to stop during the test and then continue walking when they felt better. However, the resting time was included in the six-minute time period. The test was discontinued if patients experienced any chest pain, severe dyspnea, spasm of lower extremity muscles or if the patient wanted to quit.

Data Analysis

Statistical analysis was performed using SPSS software (version 10.0) and the Pearson relation coefficient. The spirometry data were compared to the result of the six-minute walk distance (6MWD). One way analysis of variance was used to study the relationship between the 6MWD results and the severity of COPD based on the measured FEV1 (mild, moderate and severe). As per ATS guidelines,[12] FEV1 can be used to classify the severity of COPD as stage I (mild or FEV1 ≥ 50% predicted value), stage II (moderate or FEV1 35-50% predicted value) and stage III (severe or FEV1 < 35% predicted value).

Results

A total of 50 patients, consisting of 45 males and 5 females, were included in the study. They had an average age of 63 ± 10 years, height of 166 ± 7.2 cm and body weight of 65.3 ± 15.0 kg (mean ± SD). The obtained 6MWD value was 401 ± 99 meters. The details of spirometry values are shown in Table I.
Our data showed that the 6MWD significantly correlated with the expiratory flow and volume parameters ($p < 0.001$) as shown in Table II and Figures 1-3.
However, the calculated FEV1/FVC ratio was not found to correlate with the 6MWD results ($p = 0.52$ and $r = 0.09$). This relationship is shown in Figure 4.
Table III demonstrates the mean and standard deviation of the 6MWD values and their comparison to the FEV1 measurements. We

found a significant association between the severity of COPD measured by FEV1% and the result of the 6MWD (f = 8.78 and p < 0.001).

Table 1. Spirometry parameters

Spirometry parameters	Mean	SD
FEV_1%	42.5	13.99
FVC%	57.11	16.09
PEFR%	48.96	15.42
FEV_1/FVC%	58.3	7.11
$FEV_{1\ (L/S)}$	1.16	0.42
FVC (L/S)	1.98	0.62
PEFR (L/Min)	2.63	1.34

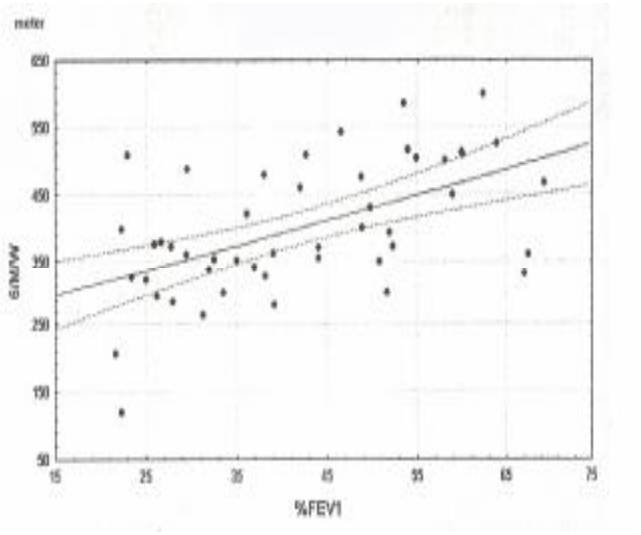

Fig. 1. Relationship between FEV_1% and six minute walk test in COPD patients.

Table II. Association between six-minute walk test and spirometry parameters

Spirometry parameters	r	p
FEV_1%	0.67	<0.001
FVC%	۰,۰۳	<0.001
PEFR%	0.71	<0.001
FEV_1/FVC%	0.56	<0.001
$FEV_{1\ (L/Sec)}$	0.58	<0.001
FVC (L/Sec)	0.53	<0.001
PEFR (L/Min)	0.9	0.52

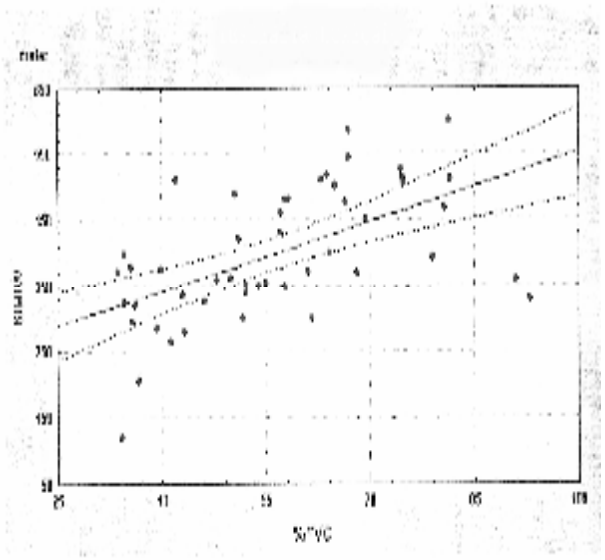

Fig. 2. Relationship between FVC% and six-minute walk test in COPD patients

Table III. Comparison between six-minute walk distance (6MWD) and the severity of COPD*

Severity	FEV_1%	Number	(mean ± SD) 6 MW
Severe	< 35	17	334.65 ± 92.65
Moderate	35-50	16	411.62 ± 74.85
Mild	≥ 50	17	457.94 ± 90.57
* FEV_1 < 35%: severe COPD, 35% ≤ FEV_1 < 50% moderate COPD, FEV_1≥ 50% mild COPD			

Discussion

The six-minute walk test is a practical and simple tool that provides a global assessment of functional capacity in patient with COPD.

This test has been used for both pre- and post-operative evaluations of lung transplantation and lung volume reduction surgery in patients suffering from COPD.

Moreover, the 6MWT has been employed to monitor the response to therapy and to predict the mortality and morbidity of patients with COPD. This study showed a significant association between the 6MWD and expiratory flow and volume measured by spirometry. Our study confirmed the lack of association between the 6MWD and FEV1/FVC ratio previously reported by other researchers[8,13,14] and contradicted the data published by Chulmsky et al.[14] We also reproduced the result published by Knox et al., proving the relationship between the peak expiratory flow rate (PEFR) value and the 6MWD.[9] Unlike the 6MWD, the peak expiratory flow rate can be easily and affordably employed in out-patient settings by a physician and can provide us with valuable information regarding the functional capacity of patients with COPD. This enables us to monitor the effect of the current treatments and tailor further therapeutic measures as needed in individual cases.

Our study identified the relationship between different stages of COPD, FEV1 and the result of the 6MWD test. This would suggest that the 6MWT can be used to evaluate the severity of COPD.

This study, however, had some limitations. We tried to exclude the patients with heart failure from our study. Nonetheless, not all the patients underwent echocardiography. Moreover, some hospitalized patients were included in this study whose spirometry and 6MWD values might have been worse than those obtained from individuals in an out-patient setting. Additionally, a previous study suggested that using inhaled bronchodilators prior to the 6MWT might improve the results.[12] This factor was not considered in our study.

References

1. Balke B. A simple field test for the assessment of physical fitness. CARI Report 1963; 63:18.
2. Cooper KH. A means of assessing maximal oxygen intake: correlation between field and treadmill testing. JAMA 1968:203:201-204.
3. Butland RJA, Pang J, Groos ER, et al. Two, six and 12-minute walking tests in respiratory disease. BMJ 1982; 284:1607 – 1608.
4. American Thoracic Society "ATS Statement: Guidelines for the six-minute walk test". Am J Resp Crit Care Med; 2002; vol.: 166; 111-117
5. Murray and Nadel: Textbook of Respiratory Medicine, 3rd edition, 2000, Chapter 38, 1187-1245.
6. Braunwald E, Fauci AS, Kasper DL, et al: Harrison's Principles of Internal Medicine 15th edition 2005, McGraw-Hill, chapter 258, 1491-1498.
7. McGavin CR, Gupta SP, McHardy GJ: Twelve – minute walking test for assessing disability in chronic bronchitis. BMJ 1976; 1:822-823.
8. Wijkstra PJ, Ten Vergert EM, Vander Mark ThW, et al: Relation of lung function, maximal inspiratory pressure, dyspnea, and quality of life with exercise capacity in patients with chronic obstructive pulmonary disease. Thorax 1994:49:468-472.
9. Knox AJ, Morrison JF, Muers MF. Reproducibility of walking test results in chronic obstructive airways disease. Thorax 1988; 43:388.
10. Niederman MS, Clement PH, Fein AM, et al: Benefits of multidisciplinary pulmonary rehabilitation program: improvements are independent of lung function. Chest 1991; 99: 798-804.
11. Hodgkin JE, Celli BR, Connors GL: Pulmonary rehabilitation guidelines to success; 3rd edition, 2000; Williams and Wilkins; Chap11;180-181.
12. American Thoracic Society: standards for diagnosis and care of patients with chronic obstructive pulmonary disease Am J Respir Crit Care Med 1995; 152: 120.

13. Chiang LL, Ho SC, Cheny HF: Relation between 6 MWT and pulmonary function and ventilatory drive in patients with airflow limitation: Chang Gung Med J 2001, Mar; 24(3):159-166.

14. Chulmsky et al: Relation between pulmonary ventilation parameters, exercise tolerance and quality of life in patients with chronic obstructive lung disease; vnitr lek; Apr 2002; 48(4)320-324.

15. Bittner V: Six-minute walk test in patients with cardiac dysfunction; Cardiologia; 1997 Sep; 42 (9) 897-902.

16. Bittner V, Wiener DH, et al: Prediction of mortality and morbidity with 6-minute walk test in patients with left ventricular dysfunction. JAMA; 1993Oct; 270(14):1602-7.

17. Hay JG, Stone P, Carter J, et al; Bronchodilator reversibility, exercise performance and breathlessness in stable chronic obstructive pulmonary disease. Euro Respir J: 1992; 5: 659.