Original Article

Determination of the efficacy of FEV_6 as a surrogate for FVC in the diagnostic screening for chronic obstructive pulmonary disease through the comparison of FEV_1/FVC and FEV_1/FEV_6 ratios*

Fernando Luiz Cavalcanti Lundgren[1], Marília Montenegro Cabral[2], Danielle Cristina Silva Clímaco[3], Liana Gonçalves de Macedo[4], Marta de Andrade Lima Coelho[4], Ana Lúcia Pereira Lima Alves Dias[5]

Abstract

Objective: To determine the efficacy of using forced expiratory volume in six seconds (FEV_6) as a surrogate for forced vital capacity (FVC) in the diagnostic screening for chronic obstructive pulmonary disease (COPD) by comparing FEV_1/FVC ratios with FEV_1/FEV_6 ratios. **Methods:** In November of 2003, on World COPD Day, we conducted a campaign of diagnostic screening for COPD. The participants completed the clinical questionnaire of the Global Initiative for Obstructive Lung Disease, and those who responded affirmatively to at least three questions underwent spirometry. **Results:** A total of 134 individuals responded to three questions affirmatively and underwent spirometry. Of those, 59 were excluded: 45 for being non-smokers and 14 due to the fact that their tests did not meet the American Thoracic Society criteria for satisfactory spirometry. The number of tests in which the FEV_1/FEV_6 ratio was below 70% was similar to that found for the FEV_1/FVC ratio. The sensitivity of FEV_1/FEV_6 in diagnosing airway obstruction (defined as FEV_1/FVC below 70%) was 92%, and its specificity was 99%. The positive predictive value was 100%, and the negative predictive value was 98%. The Kendall correlation test revealed r = 0.99 (p < 0.0001). The t-test for paired samples revealed a negative correlation: t = −5.93 (p < 0.0001). **Conclusion:** The FEV_1/FEV_6 proved efficient for use in the diagnostic screening for COPD. There is a strong correlation between FEV_1/FVC and FEV_1/FEV_6.

Keywords: Pulmonary disease, Chronic obstructive; Diagnosis; Spirometry; Forced expiratory volume; Vital capacity.

Introduction

Chronic obstructive pulmonary disease (COPD) accounts for a large number of hospital admissions and medical appointments, as well as for considerable public expenditures and a high mortality rate. In Brazil, the Latin American Project for the Investigation of Pulmonary Obstruction[1] has revealed that the prevalence of COPD among the adult population varies from 6 to 16% (3 to 7 million patients).

The early diagnosis of COPD allows the introduction of measures that can slow the progression of the disease.[2] Spirometry is considered essential for the diagnosis of COPD. A forced expiratory volume in one second to forced vital capacity ratio (FEV_1/FVC) of less than 70% is the criterion used in order to confirm the diagnosis of COPD in patients presenting a pertinent history and risk factors.[3] Unfortunately, the availability of spirometry is currently limited. Therefore, only a portion of the population at risk of developing COPD is submitted to spirometry. The high cost of spirometers and the small number of portable devices in medical offices make the access to spirometry difficult. The sophistication of the existing spirometers translates to a need for specialized technicians to perform the exam.[4]

The existence of new reliable spirometric indices, which are derived from maneuvers that can be performed more easily, makes the production of simpler devices possible, allowing a cost reduction as well as increasing patient access to such tests and therefore broadening diagnostic screening for COPD.[4] Recent studies have shown the criterion of a reduction in the FEV_1/FEV_6 ratio to be a reliable parameter, with good reproducibility and sensitivity.[5-7,16] Its use is proposed as an alternative to conventional spirometry in the diagnostic screening for COPD.[5,7,8] Its measurement creates less discomfort for the patient, who does not need to perform the expiratory effort for more than six seconds, and allows the use of simpler interpretation algorithms. Reference values for FEV_6 have already been described by the American Thoracic Society[9] and the European Respiratory Society.[10]

The objective of the present study was to determine the efficacy of using FEV_6 as a surrogate for FVC in the diagnostic screening for COPD by comparing FEV_1/FVC ratios with FEV_1/FEV_6 ratios.

Methods

In November of 2003, on World COPD Day, we conducted a campaign of diagnostic screening for COPD in the city of Recife after having advertised such campaign one day prior. During the working hours of a local shopping center, volunteers (individuals with respiratory symptoms and asymptomatic smokers) completed a clinical questionnaire and underwent spirometry.

The participants completed the clinical questionnaire developed for the Global Initiative for Obstructive Lung Disease (Chart 1), which is a worldwide project that aims to raise awareness of COPD, as well as to improve prevention and treatment of this lung disease. Those who responded affirmatively to three or more questions underwent spirometry. The combination of three or more positive responses and spirometric alterations ($FEV_1/FVC < 70\%$) was used in the diagnostic screening for COPD.

Spirometry was performed according to the guidelines established by the American Thoracic Society[11] and by the Brazilian Consensus on Spirometry.[1] A minimum of two acceptable and reproducible maneuvers were performed in each test. Post-bronchodilator tests were not used. The tests were performed using a MicroLoop portable spirometer (ML3535, Micro Medical, Kent, UK), which allowed the collection of the FEV_6 and of the FEV_1/FEV_6 ratio through the use of the SPIDA 5 software.

All participants who smoked or presented respiratory symptoms, or both, and whose tests were performed in accordance with the guidelines of the American Thoracic Society were selected for the study. Participants presenting altered results were advised to seek medical attention.

The present research project was approved by the Ethics and Research Committee of the Otávio de Freitas General Hospital.

Chart 1 – Global Initiative for Obstructive Lung Disease Clinical questionnaire:

1. Do you cough frequently on most days?
2. Do you produce phlegm or mucus on most days?
3. Do you get out of breath more easily than do others your age?
4. Are you over 40 years of age?
5. Are you a current or former smoker?

The data were analyzed using the Epi Info 2002 statistical program, and the statistical correlation between the two variables studied (FEV_1/FVC and FEV_1/FEV_6) was calculated using the Kendall test and the t-test for paired samples, using the Analyse-It software. The sensitivity and specificity were calculated in a 2×2 table using the Bayesian model analysis.

Results

The data regarding the total number of spirometric tests performed, as well as that of those excluded from and selected for the study, are shown in Table 1.

Data regarding the population selected for the study (n = 75) are shown in Table 2.

The analysis of the 75 spirometric tests selected for the study revealed that 12 presented FEV_1/FVC below 70%, serving as a reference for the diagnosis of COPD.

The data regarding FEV_1/FVC and FEV_1/FEV_6 values are shown in Table 3 and Figure 1, respectively.

The FEV_1/FEV_6 ratio was below 70% in 11 of the 12 patients with COPD. The patient in whom the FEV_1/FEV_6 ratio differed from the FEV_1/FVC ratio presented an FEV_1/FVC of 66% and an FEV_1/FEV_6 of 70%. In that patient, the FVC was 3.49 L and the FEV_6 was 3.25 L, a difference of 240 mL.

The FEV_1/FEV_6 ratio presented a sensitivity of 92% and a specificity of 99%, with a positive predictive value of 100% and a negative predictive value of 98%. The correlation between the two measurements was performed using the Kendall test (comparison of ratios between two paired measurements), which revealed r = 0.98, with p < 0.0001

Table 1 – Total number of spirometric tests performed, excluded from and selected for the study.

Total number of spirometric tests performed = 134
Number of spirometric tests excluded from the study = 59
Spirometric tests of participants who were nonsmokers or who responded negatively to the questions on the questionnaire = 45
Spirometric tests that were not performed in accordance with the American Thoracic Society guidelines = 14
Number of spirometric tests selected for the study = 75

Table 2 – Characteristics of the population selected for the study (total = 75).

Variables	
Gender (male/female), n	51/24
Age (years)	48.3 ± 12.4
FVC (L)	3.5 ± 0.9
FVC (%)	93.4 ± 18.45
FEV_1 (L)	2.7 ± 0.8
FEV_1 (%)	90.05 ± 19.83
FEV_6 (L)	3.4 ± 0.9
FEV_1/FVC (%)	78.26 ± 10.57
FEV_1/FEV_6 (%)	79.6 ± 10.04

Data expressed as means ± standard deviation.

for a 0.97 confidence interval (Figure 1). In the t-test, the paired samples showed no statistically significant differences between the mean values of FEV_1/FVC and those of FEV_1/FEV_6.

Discussion

In Brazil, the use of spirometry should be encouraged. Less expensive devices that measure FEV_1 and FEV_6 could increase patient access to such

Table 3 – Number of tests (total = 75) classified by the FEV_1/FVC ratio (below and above 70%) presented in relation to the FEV_1/FVC and FEV_1/FEV_6 ratios.

Variables	FEV_1/FVC, n	
	<70%	>70%
FEV_1/FVC	12	63
FEV_1/FEV_6	11	64
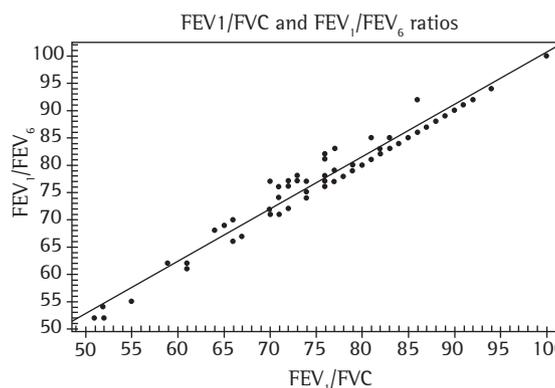
r = 0.98; p < 0.0001; Kendall test

Figure 1 – Correlation between the FEV_1/FVC values and the FEV_1/FEV_6 values obtained from the 75 spirometric tests.

Determination of the efficacy of FEV_6 as a surrogate for FVC in the diagnostic screening for chronic
obstructive pulmonary disease through the comparison of FEV_1/FVC and FEV_1/FEV_6 ratios

151

tests, so that most cases of suspected COPD could be confirmed in the office of a general practitioner. Patients suspected of having COPD and presenting no obstruction in spirometric tests involving FEV_1/FEV_6 determination should be referred to a specialist, thereby reducing the number of visits as well as the use of the pulmonary function laboratory. The use of these devices in screening campaigns has achieved satisfactory results.[12] In our study, we used a device that could measure FVC and FEV_6 in order to confirm data in the literature, although a simpler device could be used to screen for spirometric alterations.

Based on the analysis of the data obtained from a population using an advertising campaign, in which we explained that the patients who responded positively to the questions on the Global Initiative for Obstructive Lung Disease questionnaire would undergo spirometry, we selected patients suspected of having COPD for inclusion in the study. In screening campaigns for COPD, it is acceptable not to perform post-bronchodilator tests.[2] The suspected cases were advised to seek medical attention in order to confirm the diagnosis.

In our sample, the FEV_1/FEV_6 values used to identify individuals with COPD presented high specificity and sensitivity, thereby allowing us to either confirm the diagnosis of COPD (positive predictive value of 100%) or rule it out (negative predictive value of 98%) in more than 95% of the cases. In the sample studied, there was only one case in which the FEV_6 and the FVC measurements differed, and the variation was only 240 mL.

The correlation between the FEV_6 and the FVC measurements was linear, with values close to 1 (r = 0.97), proving such measurements to be practically equal and interchangeable.

The data obtained in our study are similar to those reported by other authors.[13-16] Some authors[13] found the sensitivity and specificity to be 95% and 97%, respectively (95% CI). In another study comparing FVC and VEF_6 values[14] in order to predict total lung capacity, no difference was found between the two measurements.

We conclude that measurement of the FEV_1/FEV_6 ratio is efficient for use in the diagnostic screening for COPD.

References

1. SBPT 2004. II Consenso Brasileiro sobre Doença Pulmonar Obstrutiva Crônica. J Pneumol. 2004;30(5):S1-5.
2. van den Boom G, van Schayck CP, van Mollen MP, Tirimanna PR, den Otter JJ, van Grunsven PM, et al. Active detection of chronic obstructive pulmonary disease and asthma in the general population. Results and economic consequences of the DIMCA program. Am J Respir Crit Care Med. 1998;158(6):1730-8.
3. Global Strategy for the diagnosis, management and prevention of chronic obstructive pulmonary disease. Executive Summary. NHBL/WHO Update. 2003.
4. Ferguson GT, Enright PL, Buist SA, Higgins MW. Office spirometry for lung health assessment in adults: A consensus statement from the National Lung Health Education Program. Chest. 2000;117(4):1146-61.
5. Vandevoorde J, Verbanck S, Schuermans D, Kartounian J, Vincken W. FEV1/FEV6 and FEV6 as an alternative for FEV1/FVC and FVC in the spirometric detection of airway obstruction and restriction. Chest. 2005;127(5):1560-4.
6. Vandevoorde J, Verbanck S, Schuermans D, Kartounian J, Vincken W. Obstructive and restrictive spirometric patterns: fixed cut-offs for FEV1/FEV6 and FEV6. Eur Respir J. 2006;27(2):378-83.
7. Akpinar-Elci M, Fedan KB, Enright PL. FEV6 as a surrogate for FVC in detecting airways obstruction and restriction in the workplace. Eur Respir J. 2006;27(2):374-7.
8. Gleeson S, Mitchell B, Pasquarella C, Reardon E, Falsone J, Berman L. Comparison of FEV6 and FVC for detection of airway obstruction in a community hospital pulmonary function laboratory. Respir Med. 2006;100(8):1397-401.
9. Hankinson JL, Crapo RO, Jensen RL. Spirometric reference values for the 6-s FVC maneuver. Chest. 2003;124(5):1805-11.
10. Garcia-Rio F, Pino JM, Dorgham A, Alonso A, Villamor J. Spirometric reference equations for European females and males aged 65-85 yrs. Eur. Respir. J. 2004;24(3):397-405.
11. American Thoracic Society. Standardization of spirometry. Am Rev Respir Dis. 1987;136(5):1299-307.
12. Schoh RJ, Fero LJ, Shapiro H, Aslor JP, Kaelin OJ, Rollins DR, et al. Performance of a new screening spirometer at a community health fair. Respir Care. 2002;47(10):1150-7.
13. Swanney MP, Jensen RL, Crichton DA, Beckert LE, Cardno LA, Crapo RO. FEV(6) is an acceptable surrogate for FVC in the spirometric diagnosis of airway obstruction and restriction. Am. J. Respir Crit Care Med. 2000;162 (3 Pt 1):917-9.
14. Swanney MP, Beckert LE, Frampton CM, Wallace LA, Jensen RL, Crapo RO. Validity of the American Thoracic Society and other spirometric algorithms using FVC and forced expiratory volume at 6 s for predicting a reduced total lung capacity. Chest. 2004;126(6):1861-6.
15. Enright RL, Connett JE, Bailey WC. The FEV1/FEV6 predicts lung function decline in adult smokers. Respir Med. 2002;96(6):444-9.
16. Enright RL, Studnicka M, Zielinski J. Spirometry to detect and manage chronic obstructive pulmonary disease and asthma in the primary care setting. Eur Respir Mon. 2005;31:1-14.