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

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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.

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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. Spirometry is considered essential for the diagnosis of COPD. A forced expiratory volume in one second to forced vital capacity ratio (FEV<sub>1</sub>/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. 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.

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. Recent studies have shown the criterion of a reduction in the FEV<sub>1</sub>/FEV<sub>6</sub> ratio to be a reliable parameter, with good reproducibility and sensitivity. Its use is proposed as an alternative to conventional spirometry in the diagnostic screening for COPD. 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<sub>6</sub> have already been described by the American Thoracic Society (11) and the European Respiratory Society (11).

The objective of the present study was to determine the efficacy of using FEV<sub>6</sub> as a surrogate for FVC in the diagnostic screening for COPD by comparing FEV<sub>1</sub>/FVC ratios with FEV<sub>6</sub>/FEV<sub>6</sub> 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<sub>1</sub>/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 (11) 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<sub>1</sub> and of the FEV<sub>6</sub>/FEV<sub>6</sub> 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 (FEV₁/FVC and FEV₁/FEV₆) 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 FEV₁/FVC below 70%, serving as a reference for the diagnosis of COPD.

The data regarding FEV₁/FVC and FEV₁/FEV₆ values are shown in Table 3 and Figure 1, respectively.

The FEV₁/FEV₆ ratio was below 70% in 11 of the 12 patients with COPD. The patient in whom the FEV₁/FEV₆ ratio differed from the FEV₁/FVC ratio presented an FEV₁/FVC of 66% and an FEV₁/FEV₆ of 70%. In that patient, the FVC was 3.49 L and the FEV₆ was 3.25 L, a difference of 240 mL.

The FEV₁/FEV₆ 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 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 FEV₁/FVC and those of FEV₁/FEV₆.

Discussion

In Brazil, the use of spirometry should be encouraged. Less expensive devices that measure FEV₁ and FEV₆ could increase patient access to such

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

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

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

<table>
<thead>
<tr>
<th>Variables</th>
<th>Gender (male/female), n</th>
<th>Age (years)</th>
<th>FVC (L)</th>
<th>FVC (%)</th>
<th>FEV₁ (L)</th>
<th>FEV₁ (%)</th>
<th>FEV₆ (L)</th>
<th>FEV₆ (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>51/24</td>
<td>48.3 ± 12.4</td>
<td>3.5 ± 0.9</td>
<td>93.4 ± 18.45</td>
<td>2.7 ± 0.8</td>
<td>90.05 ± 19.83</td>
<td>3.4 ± 0.9</td>
<td>78.26 ± 10.57</td>
</tr>
</tbody>
</table>

Data expressed as means ± standard deviation.

Table 3 - Number of tests (total = 75) classified by the FEV₁/FVC ratio (below and above 70%) presented in relation to the FEV₁/FVC and FEV₁/FEV₆ ratios.

<table>
<thead>
<tr>
<th>Variables</th>
<th>FEV₁/FVC, n&lt;70%</th>
<th>FEV₁/FVC, n&gt;70%</th>
</tr>
</thead>
<tbody>
<tr>
<td>FEV₁/FVC</td>
<td>12</td>
<td>63</td>
</tr>
<tr>
<td>FEV₁/FEV₆</td>
<td>11</td>
<td>64</td>
</tr>
</tbody>
</table>

Figure 1 - Correlation between the FEV₁/FVC values and the FEV₁/FEV₆ values obtained from the 75 spirometric tests.
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 FEV₁/FEV₆ 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.¹⁾ In our study, we used a device that could measure FVC and FEV₁ 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.¹⁾ The suspected cases were advised to seek medical attention in order to confirm the diagnosis.

In our sample, the FEV₁/FEV₆ 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 FEV₁ and the FVC measurements differed, and the variation was only 240 mL.

The correlation between the FEV₁ 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.¹⁾⁻¹⁶ Some authors¹⁾ found the sensitivity and specificity to be 95% and 97%, respectively (95% CI). In another study comparing FVC and VEF₆ values¹⁾ in order to predict total lung capacity, no difference was found between the two measurements.

We conclude that measurement of the FEV₁/FEV₆ ratio is efficient for use in the diagnostic screening for COPD.

References