Spirometry with FEV$_{0.75}$ Increases the Sensitivity for the Diagnosis of Obstructive Disorder in Children of Asthmatic Mothers

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Abstract

Objective: To evaluate and compare the sensitivity of spirometry in children of asthmatic mothers by the parameters FEV$_1$, and FEV$_{0.75}$.

Methods: An observational cross-sectional analytical study nested in a cohort of 4,757 pregnant women. Clinical evaluation was performed for the diagnosis of asthma, besides the realization of spirometry in the children of asthmatic mothers, evaluating the following parameters and relationships: FEV$_1$, FVC, FEV$_1$/FVC, FEV$_{0.75}$ and FEV$_{0.75}$/FVC.

Results: A total of 86 children of asthmatic mothers were included in the study, with age mean of 79.8 ± 1.1 month old. Regarding the breathing pattern there was a predominance of normality. When using FEV$_1$ changes were observed in 26 children, representing 30.3% of the sample. Of these, 17 were classified as restrictive and nine as obstructive. Using the FEV$_{0.75}$ instead of the FEV$_1$ (and its consequent FEV$_{0.75}$/FVC) 29 ventilatory tests found changed, representing 33.7%. Of these, 27 were classified as obstructive and only two were restrictive. Of the 16 children diagnosed with asthma, only five had presented obstructive pattern when FEV$_1$ customization spirometry was used. In contrast, when we used FEV$_{0.75}$ 12 of these patients were considered obstructive. The sensitivity was higher in the spirometric test that used FEV$_{0.75}$ with even greater negative predictive value. On the other hand the test set for the parameter FEV$_1$ showed greater specificity and higher positive predictive value.

Conclusions: Spirometry, though with recognized value in the complementary diagnosis of obstructive disturbance, classically presents limitations in the pediatric population, especially in younger children. We observed a significantly higher sensitivity and negative predictive value when we used FEV$_{0.75}$ in substitution to the FEV$_1$. As a consequence, the parameter FEV$_{0.75}$ is probably more effective for the diagnosis of obstructive disorder in patients with clinical history or family history of asthma.

Keywords: Asthma; Child; Spirometry

Introduction

Asthma is a recognized multifactorial disease, resulting from the interaction between genetics and environment. However, heredity does not follow the classic Mendelian patterns and genetics of this disease is especially complicated because of its polygenic nature. The heritage transmitted by the mother seems to be more significant than the one transmitted by the father [1-3].

Over the past 30 years, the world population has seen a major technological breakthrough, which led to profound changes in the pattern of lifestyle and eating habits. However, parallel to this, an improvement in sanitary conditions and reduction of infectious diseases was noted. Nevertheless, asthma continues to impact on morbimortality in various age groups and all social groups [4,5].

The pulmonary function tests are usually performed with computerized systems that analyze the data and provide immediate results. Spirometry is one of these tests and it is recommended to clarify the diagnosis in patients with chronic cough (>3 weeks). Chronic cough is often an isolated manifestation of asthma. In asthma should be made in the following situations: in patients with wheezing or chest tightness applicant, to confirm the diagnosis, during the initial evaluation and after treatment with stabilization of symptoms and peak expiratory flow (PEF) to document the level of pulmonary function (normal or not), in patients with severe persistent asthma, when changes in maintenance treatment were done and the results achieved [6-8].

In respiratory evaluation of children over six years old as well as in adults, spirometry has an important role because of its simplicity and its low cost, combined with good reproducibility. It also demonstrates the importance when the symptoms are not well characterized by the patients and their respective responsible, which may result in a ranking of asthma and thus inadequate treatment. Then we use spirometry as a resource to establish the most appropriate management of the patient. The spirometry is also used extensively in research, and the most common complementary outcome in studies of respiratory diseases [9,10].

Ideally, the interpretation of spirometry should be compared with reference values. There are dozens of reference equations in use today and many included in pulmonary function equipment. However,
The "American Thoracic Society" suggests that in every place where tests of pulmonary function are performed their own reference values are produced from a random selection of individuals without lung disease [9,12].

One of the limiting factors that we can notice is the sudden interruption of expiration, which may interfere with the accuracy of spirometry. By submitting this expiratory maneuver usually shorter than that of an adult applying the criteria of acceptability of spirometry in adults is not indicated in children. This characteristic in children stimulated the formation of this study, which aims to compare the use of spirometry with FEV₁ and forced expiratory volume in time 75 hundredths of a second (FEV₀.₇₅) [13,14].

Materials and Methods

The method used was an analytical cross-sectional observational study nested in a cohort. In the original cohort (started in 2005) was applied a questionnaire to 4,757 pregnant women, with informed consent. Through this survey we identified 135 who reported physician-diagnosed asthma before pregnancy. Patients included in the study were children above cohort participants whose mothers had asthma since agreed to participate in the study signed by their parent or legal representative, the Term of Free and Informed Consent Form (ICF).

After about six years and eight months of the original work, were located and evaluated 86 children within the group of 135 mothers with a previous diagnosis of asthma. This number conforms to the expected sample size calculation; we estimated at least 82 at n. The conditions adopted for this calculation were as follows: frequency obstructive respiratory pattern for the study group equal to 15% (with an interval of 7 23%), the level of significance equal to 0.05, the test power equal to 0.80, the statistical test was used for binomial proportion, the two-tailed test, and it was considered a waste sampling of 10%. It is a non-random sample, having children was consecutively selected.

There were no losses exclusion criteria. These were previously defined as birth weight <2500 g, gestational age <37 weeks, presence of respiratory distress at birth, abdominal surgery, thoracic or ophthalmic disease [9,12]. The conditions for inclusion were the presence of at least one respiratory symptom and its frequency, and the measurement of peak expiratory flow (PEF). Finally, we conducted the evaluation of lung function by spirometry based on all children participating in the study, the tests being performed by one of the study authors. For a clinical evaluation, we used the criteria adopted for this calculation signed by their parent or legal represent, the Term of Free and Informed Consent Form (ICF).

Regarding the breathing pattern we obtained a distribution with a skewed right, which can be explained by the presence of obstructive pattern in some children. The frequency of obstructive respiratory pattern among children in this study was 15%, compared to 7% in the general population [9,12].

To start the tests we detected the beginning of the rapid peak flow and retro-extrapolation (VRE) ≤ 80 ml or 12.5% of CVF. Tests were suspended after 5 failures or before if the child shows to be fatigued. All tests were done by the same investigator (Valadares MA) [15].

The spirometer was used MicroloopR and SpiRaR software. Five tests were conducted with each child, with the advantage of better results. Not used post-bronchodilator testing not append data to preconceived goals of the research, as well as after bronchial provocation test, for similar reasons, and because it was done at home. During the tests the children were helped to conduct the test in the most appropriate (standing and nose occluded). In addition, all children received an explanation of how to position the nozzle mouth and how to perform a forced expiration.

The results were tabulated in a spreadsheet program SPSSR version 17.0. It included means and standard deviations to describe quantitative variables, while simple frequencies and percentages were used for categorical variables. For calculation of sensitivity and specificity, as well as the positive and negative predictive values were used for categorical variables. For calculation of sensitivity and specificity, as well as the positive and negative predictive values were used for categorical variables. For calculation of sensitivity and specificity, as well as the positive and negative predictive values were used for categorical variables. For calculation of sensitivity and specificity, as well as the positive and negative predictive values were used for categorical variables.

The study was approved by the Ethics Committee for Human Research of the Federal University of Sergipe (UFS-CEP), with approval number CAAE (Certificate of Appreciation Presentation for Ethics) 0104.0.107.000-11. Parents of all children included in the study signed consent form authorizing their participation in the research.

Results

The gender distribution showed 55.8% of boys and 44.2% girls, constituting the sample of 86 children with a mean age of 79.8 ± 1.1 months.

Being questioned about the presence of physician-diagnosed asthma for the child's study, 9.3% of mothers said yes (which represents eight patients). On the other hand, when responding to the minor symptoms, there was a percentage of 18.6% of asthma (16 patients). As intermittent asthma were classified eight patients. Of the other eight, six met criteria for persistent mild to moderate and two. No case of severe persistent found.

Spirometric parameters, described in their respective means and standard deviations, are shown in (Table 1).

| Variable                  | Mean   | Std deviation |
|---------------------------|--------|---------------|
| FEV₁ (absolute)           | 1.18   | 0.24          |
| FEV₁ (relative)           | 90.3   | 17.83         |
| FEV₀.₇₅ (absolute)         | 1.06   | 0.25          |
| FEV₀.₇₅/FVC (absolute)     | 1.28   | 0.25          |
| PEF                       | 2.16   | 0.73          |
| FVC (relative)            | 92.44  | 17.86         |
| FVC/FVC                   | 92.18  | 9.38          |
| FEV₀.₇₅/FVC (absolute)     | 83.43  | 12.6          |

FEV₁ (absolute) and FVC (absolute): expressed in liters; relative values described in percentages PEF expressed in liters/second

Table 1: Values obtained in spirometry base.
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Predominance of normality. When using FEV1 changes were observed at a frequency of 26%, representing 30.3% of the sample. Of these, 17 were classified as restrictive as obstructive while nine (Table 2).

TEF median was 1.4seg, with 25 and 75 percentiles of 0.9 and 2.6 seg. A total of 29 patients (33.7%) had TEF below 1 second. Of these, 23 (26.7%) presented this time superior to 0.75 seconds.

Using the FEV0.75 in the place of the FEV1 (and its consequent relative to the FVC) 29 ventilatory tests found changed, representing 33.7%. Of these, 27 were classified as obstructive and restrictive as only two (Table 3).

Of the 27 patients who demonstrated obstructive lung disease using the FEV0.75 as observed spirometric parameter 23 as mild, two as moderate and two as severe. When using FEV1, the nine appointed as having obstructive, seven were characterized as mild and two moderate, none severe was found.

Of the 16 children diagnosed with asthma, only five had presented obstructive pattern when used in FEV1 customization spirometry. In contrast, when used FEV0.75, 12 of these patients proved to have obstructive. This difference in sensitivity can be seen in the results shown in Table 4.

By analyzing the sensitivity and specificity of spirometric tests using either forced expiratory volume (FEV1 and FEV0.75) met the above in Table 4. The sensitivity was higher in the spirometric test that used FEV0.75 with even greater negative predictive value. On the other hand the test set for the parameter FEV1 showed greater specificity and higher positive predictive value.

When we associated clinical diagnose of asthma to the FEV1/FVC relation using ROC curve we found 0.632 ± 0.087 (95% CI: 0.461-0.804; p=0.10) under the curve (Figure 1). Inversely when clinical diagnosis of asthma was associated to FEV0.75/FVC relation, the area under the curve was 0.860 ± 0.440 (CI 95%: 0.775-0.948; p<0.0001) (Figure 2).

Discussion

The studied population had a previous diagnosis of asthma in the prevalence of 9.3%. When subjected to critical evaluation, there was an increase that rate to 18.6%, which clearly indicates a possible under diagnosis of this disease in our country. Asthma is recognized as the most common chronic illness in children, affecting about 15% of the

| Variable | T1 | T2 |
|----------|----|----|
| Sensitivity | 31.25 (5.41-57.09) | 75 (50.66-99.34) |
| Specificity | 94.29 (88.13-100) | 78.57 (68.24-88.9) |
| Positive predictive value | 55.56 (17.54-93.57) | 44.44 (23.85-65.04) |
| Negative predictive value | 85.71 (77.25-94.18) | 93.22 (85.96-100) |

T1: spirometry with FEV1; T2: spirometry with FEV0.75.

Values expressed in % (95% CI)

Prevalence of asthma in the sample: 18.6%

Table 4: Comparison of spirometric tests using FEV1 and FEV0.75.
pediatric population. However, it is estimated that the prevalence of symptoms associated with asthma is higher than 20% [13].

Spirometry, though with recognized value in the diagnosis of obstructive supplement, classically presents limitations in the pediatric population, especially in younger children. The obstructive pattern expected to be observed in a population with a clinical diagnosis of asthma may sometimes not be evidenced by the technical implementation of spirometry, which requires patient cooperation. The expiratory time limited, characterizing the so-called "short breath" is the largest of these limitations. This limitation was describe in the research of Veras and Pinto [16].

In the present study, we used the traditional FEV1 and its correspondent relationship with FVC, met only nine children with obstructive pattern. That number rose to 27 when used FEV0.75 and their corresponding relationships. In 2007, as the studies of Piccioni et al., involving children younger than 6 years old proposed equations with correspondent relationships. In 2007, as the studies of Piccioni et al., involving children younger than 6 years old proposed equations with correspondent relationship with FVC, met only nine children with obstructive pattern. That number rose to 27 when used FEV0.75 and its corresponding lower positive predictive value when we used FEV0.75 in substitution to the FEV1. As a consequence, the parameter FEV0.75 is probably more effective for the diagnosis of obstructive disorder in patients with clinical history or family history of asthma.

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