Original Article

The Utility of Spirometry in Assessment of Presumptive Diagnosis of Bronchial Asthma in a Nigerian Tertiary Hospital

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Abstract

Context: Spirometry with reversibility testing is the gold standard for definitive diagnosis of bronchial asthma. However, even in those with established bronchial asthma reversibility test result may subsequently become negative. Spirometry results may also be normal during exacerbation-free intervals. **Aims:** This study assessed the role of spirometry in diagnostic evaluation of bronchial asthma and determined the ventilatory patterns of patients with presumptive diagnosis of bronchial asthma using spirometry and the proportion of those who showed positive reversibility test. **Patients and Methods:** This was a retrospective study carried out at a teaching hospital in Nigeria. This was an audit of consecutive patients with presumptive diagnosis of asthma referred for spirometry between January 2013 and June 2015. Spirometer with disposable mouthpieces, stadiometer, and salbutamol inhalers were used. The statistical analysis was done with Statistical Package for the Social Sciences version 20. **Results:** Eighty-nine participants did spirometry of whom 28 (31.5%) had additional postbronchodilator testing. Fifty (56.3%) participants were females (mean age of 42.17 ± 15.48 years). Normal, obstructive, restrictive, and mixed ventilatory patterns were found in 39 (43.8%), 31 (34.8%), 10 (11.2%), and 9 (10.1%) participants, respectively. Positive reversibility test result occurred in 15 (53.6%) participants, 9/19 obstructive (47.4%), and 6/9 mixed patterns (66.7%). **Conclusion:** Only a few patients with presumptive diagnosis of asthma were confirmed by spirometry. Spirometry is useful in asthma diagnosis, but clinicians should be aware of its limitations in diagnostic assessment. Although asthma is typically associated with obstructive spirometry, other spirometry patterns can occur.

Keywords: Mixed pattern, obstructive, postbronchodilator test, prebronchodilator test, restrictive, ventilatory pattern

Introduction

Asthma prevalence is rising worldwide.[1,2] Symptom-based diagnosis and management of asthma are inadequate but widely practiced in Nigeria.[3] This can lead to overdiagnosis and unnecessary exposure to medications and their side effects.[4-7] Spirometry is recommended as essential in the diagnosis of asthma.[8,9] Management of patients whose asthma diagnosis later changes to chronic obstructive pulmonary disease (COPD) following spirometry has significant clinical implications.[10]

Spirometry is infrequently used for the diagnosis of asthma in Nigeria and is confined mainly to tertiary hospitals.[3,11-15] This study determined the ventilatory patterns in asthma and identified subsets of patients with spirometry-confirmed asthma and COPD.

Access this article online

Quick Response Code:

Website: www.ijrconline.org

DOI: 10.4103/ijrc.ijrc_41_18

Patients and Methods

Consecutive adult patients with presumptive diagnosis of asthma, who had spirometry between January 2013 and June 2015, were retrospectively studied. Approval for this study was obtained from the ethics committee of our hospital. Patient's data gathered included biodata, anthropometry, and details of the ventilatory measurements.

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How to cite this article: Nwosu NI, Chukwuka CJ, Onyedum CC, Odilinye HC, Nlewedim PI, Ayuk AC. The utility of spirometry in assessment of presumptive diagnosis of bronchial asthma in a Nigerian tertiary hospital. Indian J Respir Care 2019;8:102-6.

Received: 09-09-2018 **Revised:** 16-10-2018 **Accepted:** 21-01-2019

A presumptive diagnosis of asthma was made by either a senior registrar or a consultant physician, if the patient had recurrent symptoms of asthma such as cough, chest tightness, dyspnea, and/or wheezing and if history-taking, examination, and investigations had ruled out differential diagnoses of asthma. As such, pulmonary tuberculosis, pneumonia, upper respiratory tract infections, congestive cardiac failure, and interstitial lung diseases were variously ruled out on case-by-case basis.

All spirometry tests were done using Spirolab III (Medical International Research, Via del Maggiolino, 12500155 Rome, Italy) and conducted by respiratory physicians and trained residents attached to the respiratory unit of the hospital. Spirometry maneuver and interpretation were done according to Global Initiative on Chronic Lung Disease and American Thoracic Society and European Respiratory Society (ERS) guidelines.[16-18]

Accordingly, ventilatory functions were classified as normal when both forced expiratory volume in 1 s (FEV_1) and forced vital capacity (FVC) were >80% predicted for race, height, age, and sex and FEV_1/FVC was ≥70%; obstructive pattern if FEV_1/FVC was < 70%; restrictive pattern if FEV_1/FVC was ≥70% with FEV_1 and/or FVC <80% predicted; and mixed pattern if FEV_1/FVC was <70% and both FEV_1 and FVC were <80% predicted. ERS reference values were used, and a correction factor of 10% was applied to adjust for our African study population.

Reversibility testing was done if prebronchodilator spirometry was of obstructive or of mixed pattern, with 400 mcg of inhaled salbutamol, and was considered positive if postbronchodilator FEV_1 or FVC was 200 ml and 12% above prebronchodilator values. Spirometry confirmation of asthma was based on positive reversibility testing. Participants who had obstructive spirometry with no record of reversibility testing were excluded [Figure 1].

Data analysis was done with Statistical Package for the Social Sciences version 20 (SPSS Inc., Chicago, IL, USA). Descriptive statistics (frequency and percentages) were used to analyze the age and sex. Data are presented in tables and charts.

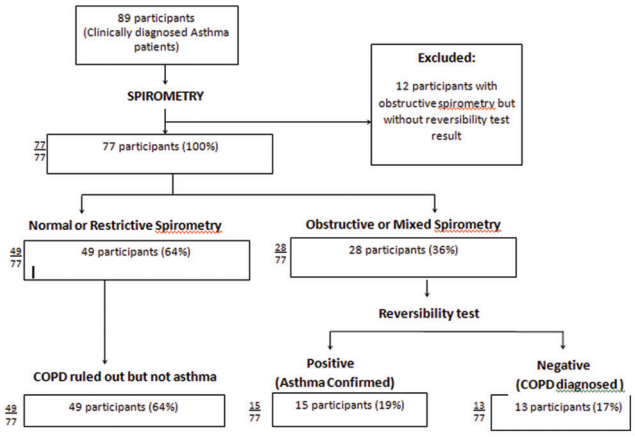

Figure 1: Flow chart showing the final diagnosis by spirometry for patients' clinically diagnosed asthma, chronic obstructive pulmonary disease

Results

Eighty-nine patients had prebronchodilator spirometry, comprising 50 females (56.2%) and 39 males (43.8%) [Table 1]. Their age ranged from 18 to 78 years, with a mean of 42.17 ± 15.48 years. Thirty-nine (43.8%) patients had normal ventilatory pattern, 31 (34.8%) showed obstructive pattern, 10 (11.2%) were restrictive, while 9 (10.1%) showed mixed pattern [Figure 2]. Further, postbronchodilator spirometry was performed on those who had obstructive or mixed ventilatory pattern (28 participants [19 prebronchodilator obstructive and 9 prebronchodilator mixed patterns]). Nine participants out of the 19 (47.4%) patients with prebronchodilator obstructive pattern and six out of the 9 (66.7%) patients with prebronchodilator mixed pattern (total of 15 [53.5%]) demonstrated positive reversibility test result [Figure 3].

Discussion

This study showed that all types of spirometric patterns (normal, obstructive, restrictive, and mixed in decreasing order of frequency) were present in patients with presumptive diagnosis of asthma. Miller and Palecki in their study made a similar observation that all four different spirometric patterns (44%

Table 1: Age and sex distribution of study participants

Age range (years)	Male, *n* (%)	Female, *n* (%)	Total, *n* (%)
18-20	1 (2.6)	3 (6.0)	4 (4.5)
21-30	11 (28.2)	11 (22.0)	22 (24.7)
31-40	9 (23.1)	12 (24.0)	21 (23.6)
41-50	4 (10.3)	10 (20.0)	14 (15.7)
51-60	10 (25.6)	6 (12.0)	16 (18.0)
>60	4 (10.3)	8 (16.0)	12 (13.5)
Total	39 (100.0)	50 (100.0)	89 (100.0)

χ^2=5.051, *P*=0.410

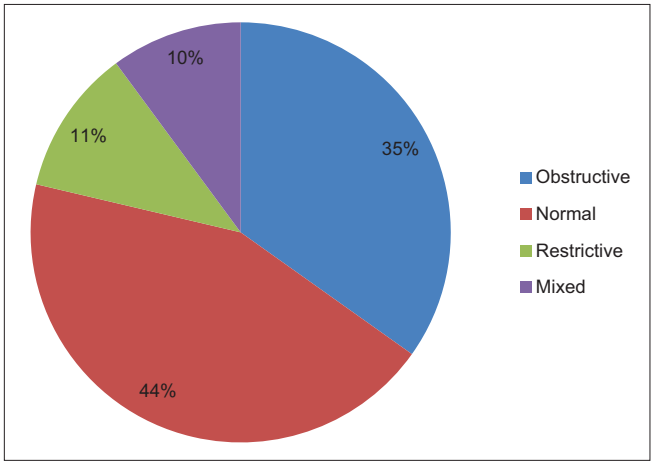

Figure 2: Pattern of prebronchodilator ventilatory function in patients with presumptive diagnosis or bronchial asthma

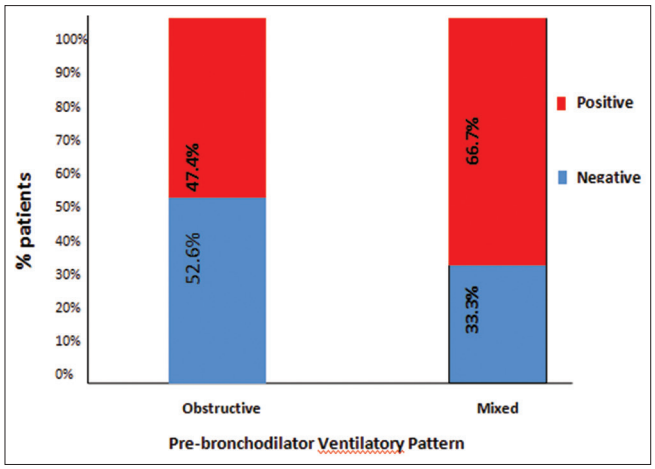

Figure 3: Reversibility test results (positive or negative) for participants with prebronchodilator obstructive and mixed ventilatory patterns

obstructive, 26% normal, 24% restrictive, and 6% mixed) occurred in their 413 asthma patients.[19] In that study, the diagnosis of asthma was made on the basis of typical symptoms of asthma in addition to the presence of repeated variability in well-performed spirometric values or positive bronchodilator response or positive methacholine challenge test.

In this study, 19% (15/77) had definitive confirmation of asthma diagnosis based on a positive reversibility test result. This was in consonance with the findings by Decramer *et al*., who confirmed asthma in 13% (55/435) of their study participants after a positive reversibility testing.[20] In their study, 50 more patients were further diagnosed with asthma after additional investigations (absolute lung volume assessment, airway resistance, and diffusing capacity of carbon monoxide [DLCO]) were carried out. More importantly, a further 264 patients were diagnosed with asthma after exhaled nitric oxide and histamine provocation tests. Asthma was eventually ruled out in only 66 (15%) of their study population. Thus, asthma was confirmed by bronchodilator spirometry test in only 13% and by using other investigative modalities in 72%. Their study findings as well as our findings show the limitation of merely using bronchodilator spirometry even though it is considered as "gold standard" in asthma diagnosis. Due to lack of further investigative tools, we were unable to determine whether the participants in our study who did not have positive reversibility results could still be asthma cases and what percentage were truly "false positives" that did not need the asthma medications they were already receiving.

Schneider *et al*.,[21] in Germany, reported a low sensitivity of 29% and a specificity of 90% in diagnosing airway obstruction in asthma using spirometry. They estimated the pretest probability of asthma as being 45%. While the positive predictive value (PPV) was 77%, they found a relatively low negative predictive value (NPV) of 53% in their population, indicating that normal spirometry result does not rule out asthma. With a lower prevalence of asthma in Nigeria[22] of 12%, the PPV and NPV after spirometry test in Nigeria would be 28% and 90%, respectively, based on Bayes' theorem.[23] This means that more Nigerian patients who test negative (normal spirometry) are more likely truly negative than the German patients or those in countries with higher prevalence.

Nearly one-half of our study participants had normal ventilatory pattern. These may possibly be explained by lack of airway obstruction at the time of spirometry due to the variability in asthma, prior use of asthma medications, or those presenting with symptoms of asthma caused by other unrecognized asthma mimics, such as upper airway cough syndrome, anxiety causing dyspnea, and deconditioning. It has been suggested that a single spirometry test is not sufficient in making a definitive diagnosis of asthma.[24] Nevertheless, our patients were placed on asthma medications before or after the first spirometry making the likelihood of obstructive spirometry results on subsequent visit very slim, except in circumstances of renewed exacerbation.

In the study by Schneider *et al*.,[21] where they used bronchodilator spirometry, methacholine challenge tests, and whole-body plethysmography as investigative tools, 219 participants who had symptoms in keeping with obstructive airway disease were diagnosed to have asthma (41.1%) or COPD (22.8%) or neither of the two conditions (36.1%). Bronchial challenge test with methacholine to elicit bronchial hyperresponsiveness is considered by some authors as the best method to diagnose asthma,[25] and they would proceed to subjecting participants with normal ventilation to bronchial challenge test using methacholine. We were, however, unable to do this.

We also did not conduct reversibility test on our participants with normal spirometry as this was not recommended in the guidelines.[16-18] However, Hegewald *et al*. have shown that patients with normal spirometry could have positive reversibility test result. Of 1394 participants with normal spirometry in their study, 3.1% showed positive reversibility test, but the study did not mention the various indications for spirometry for those patients.[26]

Just over half of the participants with prebronchodilator obstructive pattern and few with mixed pattern in our study failed to show positive reversibility test, leading to an alternative diagnosis of COPD. However, it is known that the lack of acute improvement with bronchodilator inhalation during reversibility testing does not completely rule out asthma, especially when the history is more suggestive of asthma rather than COPD.[27] Furthermore, chronicity of asthma with airway remodeling may lead to poor reversibility results, and this may explain the observation in some of our study participants.[28]

Positive reversibility test result noted in some of our study participants confirmed asthma. It is also known that positive reversibility although rare may also occur in patients with COPD and a subset of patients known as asthma-COPD overlap

syndrome.[29] However, additional history and lung function measurements in keeping with COPD help distinguish it from asthma. Unlike in asthma, postbronchodilator FEV_1/FVC in COPD is expectedly <70%.

Using a fixed FEV_1/FVC ratio of <70% obstructive or mixed ventilatory pattern was noted in a third of our study participants. The pattern may have been slightly different if the more current global lung function initiative equation was used, which defines obstructive ventilation as FEV_1/FVC ratio below the lower limit of normal, that is, the 5th percentile of the predicted value.[30]

Restrictive pattern was found in a fifth of our study participants These may be a reflection of early airway closure with air trapping as seen in severe airway obstruction occurring in asthma whereby FVC is greatly reduced leading to false normalization of FEV_1/FVC ratio.[31,32] This can also result from failure to exhale sufficiently to empty the lung.[17] With whole-body plethysmography, this distinction can be further made between true and false restrictive pattern. In work by Miller and Palecki, in 413 patients with confirmed asthma, 100 (24%) were noted to have a restrictive pattern.[19] They attributed the restrictive pattern to obesity with body mass index (BMI) >30 and/or decreased DLCO in 68 (16%) participants and to asthma in 32 (8%) in whom BMI and DLCO were within normal range. Only seven participants (2%) had pseudorestriction in that cohort. True restriction in asthma patients is reported to be due to the closure of the terminal lung units by contraction of alveolar ducts.[32] In a study by Keddissi *et al*., in Oklahoma, USA,[32] among 7502 patients referred for spirometry with provisional diagnosis of asthma and COPD, 21 showed reversible restrictive spirometry, of whom 33% was true restrictive. The remaining 67% was pseudorestriction attributed to air trapping.

Our study had some limitations. Excluding those who did not receive or had a record of postbronchodilator spirometry may have affected our result. We, however, reported what was available in the patients' spirometry records. We did not assess for variability in lung function by conducting serial spirometry on the same patients. Furthermore, we could not carry out further investigation to confirm asthma on patients that showed negative bronchodilator reversibility.

Conclusion

Spirometry is useful in confirming diagnosis of asthma, but clinicians should be aware that normal spirometry does not confidently rule out asthma, and that follow-up spirometry may be needed to further evaluate asthma patients with normal spirometry result. We suggest that further research using other diagnostic tools for asthma should be undertaken to understand their relative utility in asthma diagnosis compared to spirometry.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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