Relationship between Fractional Exhaled Nitric Oxide and Forced Oscillometric Technique in the Assessment of Asthma

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Abstract

Background: Fractional exhaled nitric oxide (FeNO) and forced oscillometric technique (FOT) represent noninvasive and sensitive tools for measuring airway inflammation and resistance, respectively, but the studies that use FeNO and FOT to assess patients with asthma until now are few. **Objective:** This study aimed to evaluate the role of FeNO and FOT in the assessment of chronic asthma. **Materials and Methods:** This cross-sectional study involved 75 patients (10–70 years old) with chronic asthma who visited a private Spiro clinic in Al-Hilla City, Iraq, in the period from April 2022 to February 2023. They were examined by using the FeNO apparatus and FOT. **Results:** There were no significant differences between the patient and control group regarding age, gender, and body mass index. The study showed a significant relationship between expiratory flow rate and FeNO ($P = 0.000$). There was also a significant relationship between large airway resistance (Rrs) and FeNO ($P = 0.008$). In addition, there was a significant relationship between the resistance of small airways (as represented by Rrs19Hz) and FeNO level ($P = 0.04$). The study also found a significant relationship between reactance and FeNO level ($P = 0.008$). **Conclusion:** From the results, they conclude that the use of FOT and FeNO together gives considerable importance in the assessment of asthma.

Keywords: Chronic asthma, FeNO, FOT

Introduction

Asthma can be defined as a chronic respiratory disorder caused by hypersensitive airway inflammation, which usually causes reversible airway obstruction and progressively leads to airway remodeling and an increase in the severity of the disease.[1] In the past, the Global Initiative for Asthma recommended the use of history and pulmonary function tests (spirometry) to reach the diagnosis of asthma but recently other tests can help in the assessment and diagnosis of asthma-like fractional exhaled nitric oxide (FeNO) and forced oscillometry technique (FOT test).[2,3]

The bronchial epithelium during the inflammatory process produces exhaled nitric oxide (NO) through oxide synthases enzyme. Measurement of FeNO provides a noninvasive, sensitive assessment of eosinophilic airway inflammation, which correlates directly with the severity of inflammation in addition it gives guide treatment for asthma.[4,5]

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Quick Response Code:

Website: https://journals.lww.com/mjby

DOI: 10.4103/MJBL.MJBL_1742_23

The FOT measures the mechanical features of the respiratory system by the application of an oscillating pressure signal, this test represents a simple method that is effort-independent to measure the resistance (R) and reactance (X) of the respiratory system, and it is especially suitable for patients who cannot perform the standard spirometric test like children, elderly and very ill patients.[6-8] Expiratory flow limitation is an important characteristic in the pathophysiology of asthma and chronic obstructive pulmonary disease (COPD) by detecting within-breath variation of Xrs, that is, measured at 5 Hz. It can compute the difference between mean inspiratory and expiratory reactance

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Submission: 29-Nov-2023 **Accepted:** 12-Feb-2024 **Published:** 23-Dec-2024

How to cite this article: Abbas AH, Jasim AH, Alesawi KNH, Hammoud SS. Relationship between fractional exhaled nitric oxide and forced oscillometric technique in the assessment of asthma. Med J Babylon 2024;21:928-31.

(ΔXrs) at this oscillatory frequency (in both cases using 11 and 19 Hz).

Expiratory flow-limitation level can be regarded as elevated if the level of ΔXrs is more than 2.81 $cmH^2O^XsXL^{-1}$.The reactance determines the elastic properties of the airways. Many studies show that this technique can give a clear view of asthma exacerbations and level of control.[9-11] There are limited studies about the combined use of FeNO and FOT in the assessment of patients with asthma. The study aims to assess the role of FeNO combined with FOT measurements in the assessment of chronic asthma.

Materials and Methods

This cross-sectional study involved 75 patients with chronic asthma who visited a private Spiro clinic in Al-Hilla City, Iraq, in the period from April 2022 to February 2023. They were examined by using the FeNO apparatus and FOT. The ages ranged from 10 to 70 years old. Any patients who have systemic chronic diseases other than asthma were excluded from the study. History was taken from all subjects and a physical examination was performed on them. FeNO and FOT measures were performed for each subject.

The FeNO test was measured according to the guidelines of the American Thoracic Society (ATS) by using electrochemical analysis with a FeNO device (Medisoft, Sorinnes, Belgium).[12] Information was given to the patients to avoid physical exercise, food intake about 2 h, and the use of steroid inhalers about 1 week before doing the test. Moreover, if the patient had any respiratory infection, the test was delayed for 1 week. FeNO test was performed before the FOT (Medisoft). The ATS guidelines recommend that the FeNO level ≥25 ppb is interpreted as a positive test for eosinophilic T-helper type 2 (Th2)-driven airway inflammation, the level more than 50 ppb is regarded as severe inflammation.

Table 1: Descriptive analysis of some parameters

Parameter	Minimum	Maximum	Mean ± standard deviation
Rrs5Hz	1.56	8.73	4.8582 ± 2.37927
Rrs19Hz	−1.34	6.78	3.2082 ± 1.81970
Xrs5Hz	−4.07	−0.45	−1.9194 ± 1.18085
FeNO	2.00	70.00	31.8824 ± 21.38456

Statistical analysis

The data of this work were analyzed using the Statistical Package for the Social Sciences (SPSS; IBM, USA) version 22. Some categorical variables were expressed as numbers and percentages, whereas others variables appeared as mean ± standard deviation by using descriptive and frequency analysis. *t* Test was used to compare continuous data. *P* value < 0.05 was taken to indicate the level of statistical significance.

Ethical approval

All patients were given written informed consent and those who participated in this study had to sign this consent form.

Results

Table 1 gives descriptive analysis from minimum to maximum levels of some study parameters involving airway resistance at 5 and 19 Hz in addition to lung reactance at 5 Hz with FeNO level.

Figure 1 shows the relationship between expiratory flow rate and fractional exhaled NO (FeNO) and reveals a significant relationship between them ($P = 0.000$).

The study also revealed a significant relationship between large airway resistance (Rrs5) and FeNO ($P = 008$) as illustrated in Figure 2.

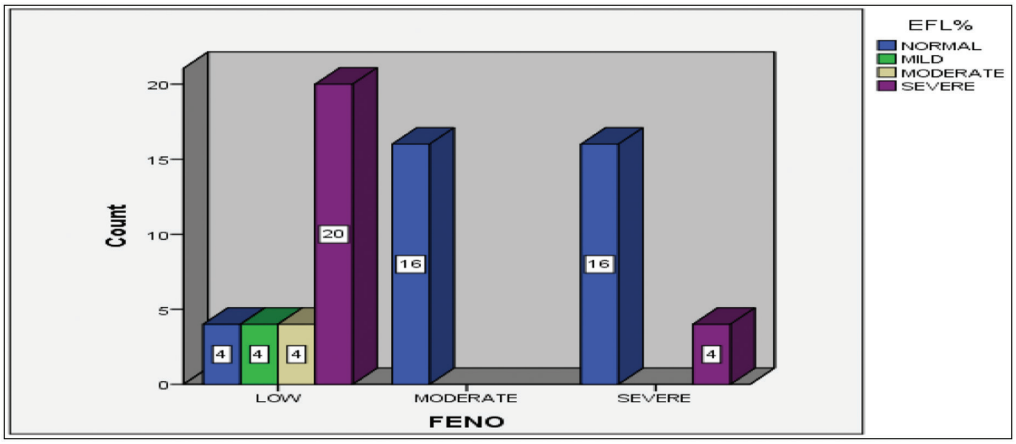

Figure 1: Relationship between expiratory flow rate and fractional exhaled NO (FeNO) (*P* value = 0.000)

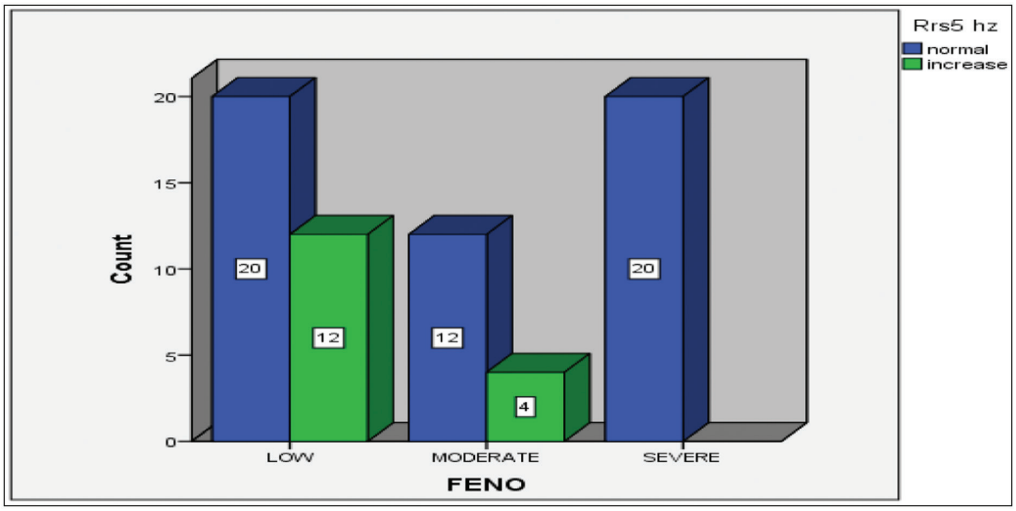

Figure 2: Relationship between large airways resistance (Rrs) and FeNO

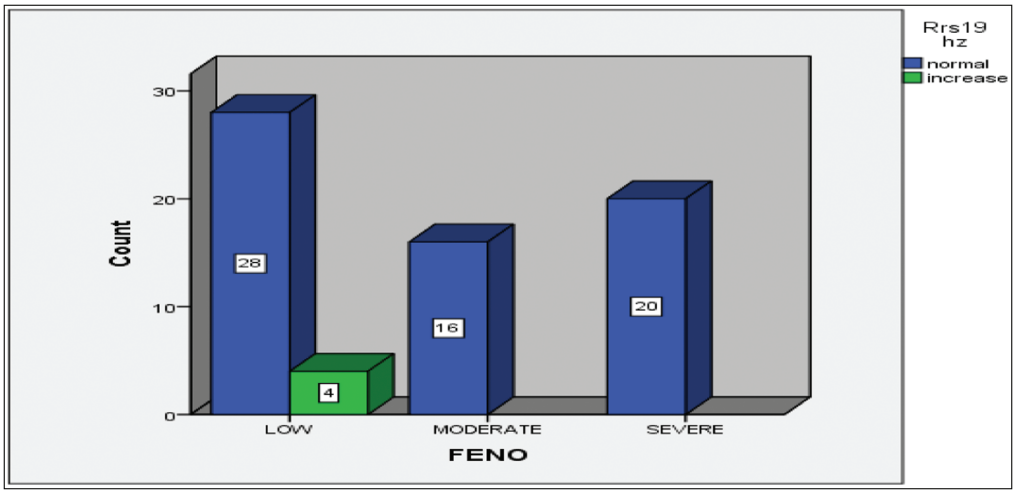

Figure 3: Relationship between small airways resistance and FeNO

Figure 3 shows the relationship between small airways resistance and FeNO and it revealed a significant relationship between resistance of small airways as represented by Rrs19Hz and FeNO level ($P = 0.04$).

There was also a significant relationship between reactance and FeNO level ($P = 0.008$) as illustrated in Figure 4.

Discussion

The evaluation of airway inflammation in asthma by simultaneous measurement of FeNO and FOT attracts attention.[13] Some studies found a correlation between FOT and FeNO,[14] whereas other studies found no correlation between them.[15,16] In our work, there was a significant relationship between FeNO level and FOT, this means that airway inflammation, that is, measured by the FeNO test has an effect on airflow limitation and this is revealed by the significant relationship between FeNO and resistance and reactance and this was in contrast to a study performed by Jacobs[17] showed that FeNO does not correlate with any FOT parameters.

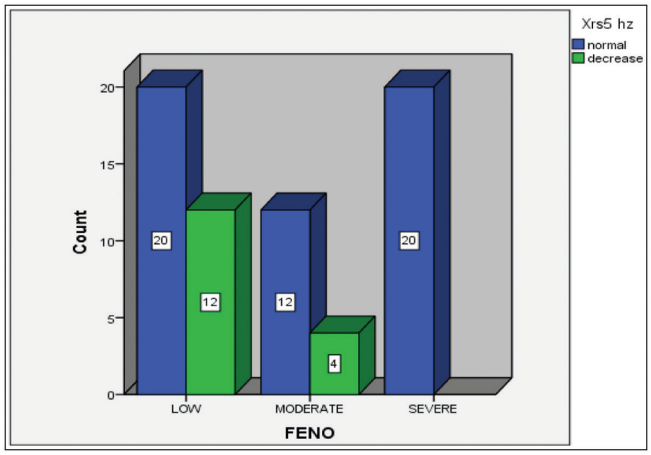

Figure 4: Relationship between reactance and FeNO level ($P = 0.008$)

The findings of the study show a significant association between small airway obstruction and FeNO level in patients with poor asthma control. The study also revealed that the values of FOT and FeNO were higher in patients with uncontrolled asthma. There was a significant negative correlation between FeNO and R5 and this gives strong evidence about the relationship between airway obstruction and eosinophilic inflammation.

There was considerable association between small airway dysfunction and future loss of asthma control even in patients who took inhaled steroids as a treatment as reported in many previous studies.[17,18]

Many studies revealed that loss of asthma control is interpreted as continuous inflammation and obstruction of peripheral airways of the lungs.[18,19] A longitudinal birth cohort study illustrated that airway dysfunction as evidenced by the use of FOT and FeNO values can indicate the relationship between asthma and eosinophilic airway inflammation in adolescents.[20]

The lack of asthma control was strongly associated with persistent inflammation and peripheral airway narrowing as proved by many studies and this suggests that eosinophilic airway inflammation can determine small airway dysfunction in asthmatic control.[18,19]

Conclusion

FeNO test gives an important view of airway inflammation, whereas FOT gives a clear view of airway resistance and reactance so the combined use of FeNO and FOT is important in the assessment of asthma, which helps greatly in treatment.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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