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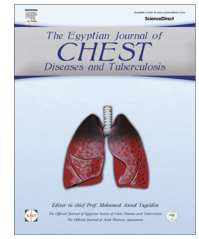

ORIGINAL ARTICLE

Role of IOS in evaluation of patients with interstitial lung diseases

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KEYWORDS

IOS;
PFT;
ILD

Abstract *Aim:* In patients with ILD, a static expiratory pressure–volume curve of the lung is generally shifted downward and rightward and spirometry results reveal reduced vital capacity (Thompson et al., 1989). However, reduced vital capacity may occur even in patients with obstructive lung diseases and in other situations, such as chest wall restriction, lung resection, inspiratory muscle weakness, or poor cooperation with spirometry. In addition, spirometry is sometimes difficult to perform with elderly, cognitively impaired patients, or severe respiratory distress (Kubota et al., 2009). IOS is a simple, noninvasive method requiring only passive patient cooperation that allows for the evaluation of lung function through the measurement of both airway resistance and airway reactance. The aim of this study is to assess the role of IOS in the evaluation of the cases of interstitial lung diseases.

Methodology: This study included 48 patients with interstitial lung diseases of different causes. Pulmonary function test by spirometry was done to measure FEV1, FVC, FEV1/FVC, MEF25-75 and pulmonary function test by impulse oscillometry (IOS). We measured R5, R20, X5, RF. Oxygen saturation and 6MWT.

Results: In our study 87% were females. The mean age in our study was 50.75 ± 11.1. Mean X5 was low in ILD denoting restrictive pattern, and there was a negative correlation between X5 and FEV1/FVC. There was a positive correlation between X5 and 6MWT. The mean R5 was 150.33 ± while mean R20 was 108.33 ± 48.66 this is within normal then this is considered an index of mild small airways obstruction.

Introduction

Pulmonary function testing is used to evaluate respiratory mechanics and physiology in both children and adults with suspected respiratory diseases. Spirometry is perhaps the most commonly used pulmonary function test with the advantage of being readily available in both inpatient and outpatient settings, including many primary care offices. Lung volume

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measurement by body plethysmography or gas dilution requires more-expensive equipment that often requires a dedicated pulmonary function testing laboratory. Simple spirometry and body plethysmography often can be performed successfully in children but may be limited by the child's ability to follow directions and provide maximal, reproducible efforts. Some of the challenges in performing spirometry in younger children, especially those aged 2–5 years, may have led to this diagnostic modality being significantly underused. Current data suggest that only 21% of primary care practitioners use spirometry in the diagnosis of asthma in children [1].

Interstitial lung diseases alter mechanical and gas exchange properties of the lungs. In general, the hallmarks of interstitial lung diseases are restrictive changes in pulmonary physiology (i.e., reduced total lung capacity, reduced residual volume, decreased static compliance, and a reduced VC, often with an increased FEV1/FVC ratio), and a reduced diffusing capacity for carbon monoxide (DlCO). A few diseases also manifest substantial components of airflow obstruction [2].

In patients with ILD, a static expiratory pressure–volume curve of the lung is generally shifted downward and rightward and spirometry results reveal reduced vital capacity [3]. However, reduced vital capacity may occur even in patients with obstructive lung diseases and in other situations, such as chest wall restriction, lung resection, inspiratory muscle weakness, or poor cooperation with spirometry. In addition, spirometry is sometimes difficult to perform with elderly, cognitively impaired patients, or patients with severe respiratory distress [4].

The forced oscillation technique is the general name for airway mechanic measurements using the noninvasive superimposition of pressure fluctuations on the airway over the subject's normal, quiet, tidal breathing. More than 50 years ago, FOT was first determined by Dubois et al. [5] and has developed with regard to configuration, standardization, and application. Impulse oscillometry is one type of FOT. Other techniques of FOT use only one frequency or change the frequency "pseudo randomly". Impulse oscillometry delivers a regular square wave of pressure 5 times per second, which has the advantage of generating a larger sample during measurements and emitting a continuous spectrum of frequencies that may provide a more detailed characterization of respiratory function [6]. Impulse oscillometry has been used in adults as well as in preschool children to identify lung dysfunction, such as in asthma [7].

IOS is a simple, noninvasive method requiring only passive patient cooperation that allows for the evaluation of lung function through the measurement of both airway resistance and airway reactance [1]. Current IOS procedures are based on the physiologic concepts of the forced oscillation technique originally described by Dubois et al. [5] in 1956. IOS uses sound waves to rapidly detect airway changes and requires only normal tidal breathing from the patient [1].

The main advantage of FOT/IOS is that the patient needs to perform simple tidal breathing maneuvers that require less effort and co-operation than spirometry, meaning that children and the elderly can therefore perform this test easily. Moreover, it can be performed in patients on ventilators and also during sleep. One of the most remarkable features of FOT/IOS in relation to spirometry is that it has much greater sensitivity to detect peripheral airways obstruction. In most cases, spirometry does not provide a clear indication of peripheral airway obstruction regardless of the information contained in the flow–volume curve and the forced expiratory flow at 25–75% of forced vital capacity ($FEF_{25–75\%}$). FOT/IOS are therefore more sensitive instruments to detect small airway obstruction in patients with asthma and chronic obstructive pulmonary disease (COPD). More recently, the within-breath analysis of R_{rs} and X_{rs} has been shown to help differentiate between asthma and COPD and also offer more useful information about the pathophysiology of asthma and COPD, which the spirometer does not [8].

IOS is well suited for conditions involving airway obstruction, but it may not provide definitive information on restrictive states [9] although more research into this area is needed [1].

Two components of respiratory impedance can be evaluated by forced oscillometry: total respiratory resistance and reactance [10]. Resistance at low frequency, 5 Hz (R5), indicates total airway resistance and resistance at high frequency, 20 Hz (R20), approximates central airway resistance. The difference between R5 and R20 (R5 − R20) is considered to be an index of the small airways [11]. Reactance at 5 Hz (X5) is thought to be reciprocally related to compliance. The resonant frequency (Fres) is the intermediate frequency at which the total reactance is 0, and reactance area (AX) is the integrated low frequency respiratory reactance magnitude (area under the curve) between 5 Hz and Fres [12]. X5, Fres, and AX have been proposed for detecting expiratory flow limitations [13–15].

Interpretation of IOS

R5 total respiratory Resistance – abnormal, if above 150% predicted
X5 distal capacitive Reactance – abnormal, if below X5 predicted – 0,15 kPa/(l/s)

Lung function is abnormal, if either R5 or X5 or both parameters are within the abnormal range. R5 and X5 are invoked together for the determination of the degree of severity of disease [15].

in [kPa/(l/s)]	X5 predicted – 0,15	$\geqslant$X5 $>$ X5 Predicted – 0,3	$\geqslant$X5 $>$ X5 Predicted – 0,6	X5 predicted-0,6
R5 $<$ 150% predicted	Normal	I (slight)	II (moderate)	III (severe)
150% $\leqslant$ R5 $<$ 200% predicted	I (slight)	II (moderate)	III (severe)	III (severe)
200% $\leqslant$ R5 $<$ 300% predicted	II (moderate)	III (severe)	III (severe)	III (severe)
R5 $\geqslant$ 300% predicted	III (severe)	III (severe)	III (severe)	III (severe)