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ORIGINAL ARTICLE

Role of the impulse oscillometry in the evaluation of tracheal stenosis

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Abstract
Introduction and objectives: Tracheal stenosis is a rare and challenging disease. Bronchoscopy is the gold standard for diagnosis and assessment but brings inherent risks. Spirometry is commonly used to access obstructions but is not always feasible due to patient related factors. We therefore considered impulse oscillometry (IOS) as a non-invasive method to quantify airway obstruction and its potential use for diagnosis and follow-up of tracheal stenosis.
Materials and methods: Patients with confirmed tracheal stenosis were recruited between January 1st, 2015 and December 31st, 2016. Before bronchoscopy, all subjects underwent IOS and spirometry; for patients submitted to interventional bronchoscopy the same techniques were also performed after the procedure. We assessed the correlation between IOS measurements and airway narrowing as well as between IOS and spirometry values.
Results: Twenty-one patients were included. Tracheal narrowing was inversely correlated with X5% (r −0.442, p 0.045) and positively correlated with FEV1/PEF (r 0.467, p 0.033). The stenosis length was inversely correlated with PEF and PEF% (r −0.729, $p = 0.001$ and r −0.707, $p = 0.002$, respectively). There was a strong correlation between spirometric and IOS values. We did not find any significant differences between pre- and post-intervention IOS values for patients assessed after interventional bronchoscopy.

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Conclusions: Our study showed a weak correlation between X5% and tracheal narrowing making it unclear whether IOS can be used for physiological assessment of patients with tracheal stenosis. Stenosis length correlated with PEF making it a potential predictor of successful surgical approach. The correlation between IOS and spirometric values makes IOS a potential alternative in patients with suspected tracheal stenosis who are not able to perform spirometry. Larger scale studies should clarify the role of IOS in this pathology.

Introduction

Laryngotracheal stenosis refers to a heterogeneous myriad of rare disorders that cause abnormal narrowing of the central air passageways between the larynx and carina.[1] The problem is rare and challenging and may be congenital or acquired. The majority of cases of acquired laryngotracheal stenosis result from endotracheal intubation; the reported incidence of tracheal stenosis following tracheostomy and laryngotracheal intubation ranges from 0.6% to 21% and 6% to 21%, respectively[2–4] but only 1–2% of these patients are symptomatic or have severe stenosis.[5–7]

Bronchoscopy is considered the gold standard for the diagnosis and assessment of airway abnormalities, including those due to endotracheal intubation.[8] Although it provides direct visualization of the airway, it is an invasive procedure with its inherent risks.

Inspection of the maximal expiratory and inspiratory flow volume loops is currently the simplest and most widely used method to detect the presence of upper airway obstruction (UAO) including tracheal stenosis. Spirometry, however, is not always feasible in patients with UAO, due to patient-related factors that do not allow or interfere with an optimal forced expiratory manoeuvre (e.g. severe dyspnoea, cough, fatigue, language barrier, cooperation and cognitive impairment). Furthermore, significant changes in spirometry appear relatively late in the course of the upper airway narrowing process[9] and spirometry values may not correlate with the degree of airway narrowing.[10,11] These observations indicate the need for a method that can detect UAO and specifically tracheal stenosis in high risk patients.

Impulse oscillometry (IOS) was developed by Michaelson et al.[12] and was based on the physiologic concepts of the forced oscillation technique (FOT) originally described by Dubois et al. in 1956.[13] This non-invasive method requires minimal patient collaboration and provides an estimate of respiratory system impedance and its components (resistance and reactance) at different frequencies. The data can be collected rapidly and the equipment is easy to operate.[14] Compared to forced expiration parameters, IOS could play an important role in cases of tracheal stenosis, even in stable and normally breathing patients, considering the important distortions of the airway, which are deeply affected by forced manoeuvres.

In view of the considerable burden caused to the patient by bronchoscopy and the time needed for the examination, we looked for a non-invasive way of quantifying airway obstruction that could serve as a potential screening and follow-up method. So the aim of the present study was to assess the correlation between IOS measurements and airway narrowing evaluated by bronchoscopy. We also assessed the correlation between IOS and spirometry values and compared those parameters in the patients submitted to interventional bronchoscopy before and after the procedure.

Methods

Subjects

Patients with confirmed tracheal stenosis were consecutively recruited at our Centre between January 1st, 2015 and December 31st, 2016. Before the bronchoscopy, all the subjects underwent IOS and spirometry.

The ethics committee of Centro Hospitalar Vila Nova de Gaia/Espinho approved this study.

Bronchoscopy

All bronchoscopy procedures were performed under sedation managed by an anaesthesiologist, and by an experienced bronchoscopist. In most cases, a flexible bronchoscopy was performed first and if tracheal dilatation was needed the procedure was converted to rigid bronchoscopy and anaesthetic procedures were performed accordingly.

The requirements for patients being submitted to the procedure were in accordance with the standard of care protocol in our institution. Before the procedure, risks and possible complications were explained to each patient and an informed consent was obtained. During bronchoscopy, the pneumologist estimated the percentage of lumen narrowing and the length of the tracheal stenosis through visual inspection; two bronchoscopists jointly performed and confirmed each measurement in all cases. Endoscopic dilatation was performed with insertion of progressively larger rigid bronchoscopes. In some cases diode laser, electro-knife or scalpel were used prior to sequential dilation with rigid bronchoscopes. In some cases in which granulation tissue was persistently observed, topical mitomycin C (1 mg/mL) was applied before finishing the procedure.

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