Continuous adventitious respiratory sound analysis for the assessment of bronchodilator response in asthma patients

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1. Introduction

Clinical features of asthma include variable respiratory symptoms and airflow limitation [1]. Variation in airflow limitation is measured by spirometry during a bronchodilator response (BDR) test. Respiratory symptoms, such as continuous adventitious sounds (CAS), should be assessed as often as possible, together with lung function [1]. Nevertheless, previous approaches to CAS analysis were limited by certain methodology issues. We have proposed a new integrated approach to CAS analysis [2] that provides distinct and complementary information about BDR, beyond that provided by spirometry.

2. Methodology

Respiratory sounds and flow were recorded in 7 asthma patients with positive BDR (BDR+), 13 asthma patients with negative BDR (BDR-), and 5 healthy controls, in the Respiratory Function Laboratory at Germans Trias i Pujol University Hospital. Acoustic components were characterized from the respiratory sound signals of all the participants, using our automatic segmentation algorithm [3], based on the Hilbert spectrum (Fig. 1).

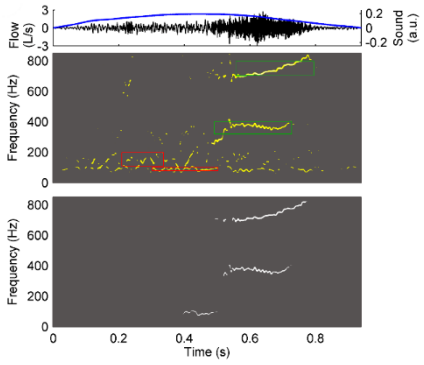

Figura 1.*Segmentation of CAS from the Hilbert spectrum of a respiratory sound signal of an inspiratory cycle.*

5149 acoustic components were used to train and validate a support vector machine classifier, which distinguished CAS from other sounds (87.7% of sensitivity and 96.9% of accuracy). BDR was assessed in all participants by CAS analysis, and compared to BDR assessed by spirometry.

3. Results and conclusion

BDR+ patients had a homogenous high change in the number of CAS ($n\Delta CAS_{Glob}$) after bronchodilation, indicating high reversibility of airway obstruction. An appreciable $n\Delta CAS_{Glob}$ was also found in many BDR- patients, revealing alterations in airway obstruction that were not detected by spirometry. BDR- patients could be divided into three consistent groups: high response (6 patients), noteworthy medium response (4 patients), and low response (1 patient) (Fig. 2).

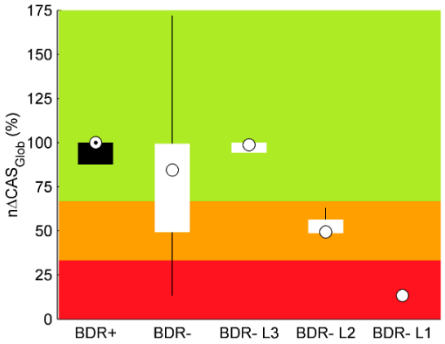

Figura 2. *Change in the number of CAS ($n\Delta CAS_{Glob}$) after bronchodilation in 5 BDR+ and 11 BDR- asthma patients.*

The proposed non-invasive and integrated approach to CAS analysis is a high-sensitive tool for assessing BDR in terms of acoustic parameters which, together with spirometry, contribute to improving the stratification of BDR levels in clinical practice for patients with obstructive pulmonary diseases.

Acknowledgements

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References

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