A lung sound analysis in a child thought to have cough variant asthma: A case report

Dear Editor,

Cough variant asthma (CVA) is an asthma phenotype and a common cause of chronic cough. Clinically, CVA is diagnosed by a prolonged cough without wheezing, bronchial hyperresponsiveness and effectiveness of β2 agonist inhalation. Recently, the utility of lung sound analyses for assessing airway constriction has been studied. In this report, we describe a child diagnosed with CVA who underwent a lung sound analysis from the first visit to the day after developing asthma.

A 5-year-old boy attended our hospital for an investigation of prolonged dry coughing in February, 2013. He had been healthy all his life, with no history of wheezing. His total serum IgE was 24 IU/ml, and no specific IgEs to main allergens were detected (positivity to Japanese cedar pollen developed at 7 year of age). A chest X-ray examination showed no abnormalities. Other diseases, such as asthma, post nasal drip syndromes and prolonged cough with respiratory infections, were ruled out. Although we were unable to perform spirometry due to the patient’s refusal, bronchial reversibility was measured by a forced oscillation technique. The total respiratory resistance (R5) was decreased by −2.8 cmH2O/L/sec (−20.4%) after β2 agonist inhalation.

An analysis of the lung sounds was carried out using an exclusive pulmonary sound analysis device (LSA-2000, Kenz Medico, Saitama, Japan). The sound spectrogram (Fig. 1a) was used to confirm the existence of wheezing. In addition, the inspiratory lung sounds were analyzed by a fast Fourier analysis and displayed as a spectrogram (Fig. 1b). The parameters of the sound spectrum were determined for a single segment, which had the maximum power and the highest frequency range (Fig. 1c). The data were automatically calculated by an original personal computer software program. Common parameters, namely the frequency limiting 99% of the power spectrum (F99) and the parameters obtained using the ratio of parameters, the ratio of the third and fourth area to total area under the curve (A3/A4 and B4/A4 [dBm Hz]) and the ratio of power and frequency at F75 and F50 (RPF75 and RPF50 [dBm Hz]), were calculated. It has been reported that bronchodilatation with β2 agonist inhalation increases A3/A4, B4/A4, RPF75 and RPF50 values.

At the first visit, no wheezes were detected. We noted no marked changes in the sound spectrogram (Fig. 2a, b), and the main lung sound parameters before and after β2 agonist inhalation (A3/A4: 12.4–9.7, B4/A4: 6.4–6.3, RPF75: 4.7–3.1, RPF50: 4.5–4.7). Two-week treatment of inhaled β2 agonist was clearly effective against his cough. Given the results of bronchial reversibility, CVA was diagnosed and his treatment was started according to the asthma guidelines. Treatment with leukotriene receptor antagonist (montelukast) and LABA (tulobuterol patch) induced a clear improvement of prolonged cough. He visited our hospital regularly and was able to stop LABA after the 8-week visit.

Eight months later, he suddenly visited our hospital for two-week history of coughing. He was complicated only with dry coughing, and a physician did not detect any wheezes by auscultation. However, on a sound spectrogram, polyphonic wheezes were confirmed as several horizontal lines (Fig. 2c). Arrow #1 indicates one of the polyphonic wheezes (>250 ms, the maximum point: 770 Hz, 15.6 dBm). After β2 agonist inhalation, these lines had clearly disappeared (Fig. 2d). Furthermore, an analysis of the lung sound spectrum showed that the values of reliable parameters, A3/A4, B4/A4, RPF75 and RPF50, were increased (A3/A4: 9.1–10.1, B4/A4: 4.6–5.3, RPF75: 5.8–6.4, RPF50: 5.9–7.0). After restarting the treatment with leukotriene receptor antagonist and LABA, the patient showed good long-term control with regular visit which was confirmed by an asthma diary until next visit.

In April, 2016, he visited our hospital without a reservation because of a one-week history of dry coughing. Although he had no complaints of wheezing or dyspnea, a physician confirmed a high-pitched wheeze during expiration by auscultation. On a sound spectrogram, horizontal lines indicating a polyphonic wheeze were found (Fig. 2e). Arrow #2 indicates one of the wheezes (>250 ms, the maximum point: 920 Hz, 20.8 dBm). After β2 agonist inhalation, these lines disappeared (Fig. 2f). An analysis of the lung sound spectrum showed that the values of A3/A4, B4/A4, RPF75 and RPF50 were remarkably increased after β2 agonist inhalation (A3/A4: 12.7–14.1, B4/A4: 7.0–8.3, RPF75: 5.7–8.8, RPF50: 5.5–6.3). In addition, the FEV1 increased 24% and R5 decreased 23% after β2 agonist inhalation. The treatment of asthma with inhaled steroid (fluticasone), LABA (salmeterol) and leukotriene receptor antagonist was started. Over the next six months, he showed a recurrent audible wheeze with acute upper respiratory infection. Over the next six months, he showed recurrent audible wheezing with acute upper respiratory infection. He was ultimately diagnosed with asthma by a chief physician based on his recurrent wheezing and the significant bronchial reversibility.

Wheeze is defined as a continuous high-pitched adventitious lung sound with variable frequencies ranging from 350 to 950 Hz in children and 125–375 Hz in infants. However, it is an unstable symptom that depends on the depth of the breathing and the hearing ability of the examiners. However, a wheeze obviously cannot be confirmed when the sound power is too low to detect with
background noises. As such, a number of audio techniques have been developed to facilitate the objective analysis of certain lung sounds. To study the pathophysiology of CVA, we must address the issue of whether or not a lack of wheezing indicates no bronchoconstriction. CVA patients may be able to produce remarkable coughing by slight airway constriction that does not induce an audible wheeze. In our case, the inaudible wheezes were only recognized by a sound spectrogram in a child with CVA, and these
inaudible wheezes disappeared with β2 agonist inhalation. The parameters of the lung sound analysis were also improved after β2 agonist inhalation. These results indicate the presence of reversible bronchial constriction in CVA patients.

In the present report, the patient's wheezing became gradually apparent by auscultation and based on his symptoms, and he was ultimately diagnosed with asthma. These results suggest that studying the mechanisms underlying why a slight constriction of the airways induces a prolonged cough and why wheezing sounds are inaudible in CVA patients is meaningful. While we were unable to provide answers to these questions in the present study, a lung sound analysis may be useful for observing slight changes in the airway tracts. Using this method, we will evaluate the mechanism underlying pediatric CVA in the future.

Acknowledgments

This study was supported by funding from the Environmental Restoration and Conservation Agency of Japan 2009–2014.

Conflict of interest

HM received honoraria from Taisho Toyama Pharmaceutical. The rest of the authors have no conflict of interest.

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References


Received 6 April 2017
Received in revised form 22 May 2017
Accepted 23 May 2017
Available online 30 June 2017