Airspace dimension test (ADT) with nanoparticles for identification of patients with respiratory disease

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An early diagnosis of respiratory disease is important for a good treatment of patients. However, many respiratory conditions are difficult to identify only based on basic spirometry and alternative tools may be both expensive and include unwanted exposure to radiation (e.g. X-ray computed tomography, CT). Thus, there is a need for cheap and easy methods to measure the structure of the lung – especially for the pulmonary region.

The objective of this work is to evaluate a novel method named airspace dimension test (ADT) in a group of healthy volunteers and patients with respiratory disease.

Methods

An instrument has been constructed for measurement of lung deposition of nanoparticles over a single breath (Jacobson et al., 2013). Subjects, wearing a nose clip, inhale low concentrations of nanoparticles (<10000 cm^{-3}) through a mouthpiece. The lung deposited fraction of nanoparticles is measured over a single breath hold for air exhaled from the pulmonary region. The total time for a measurement is about 60 s. The measurement was repeated three times for each subject.

Deposition measurements were carried out for 26 healthy volunteers and 20 patients with varying degree of respiratory disease. Of the patients, 6 were normal as measured with common spirometry, 7 were mild obstructive and 7 had obstruction or emphysema.

Results

Figure 1 illustrates the deposition fraction of 50 nm particles for the subjects. Mean values were 0.98 in the normal, 0.96 in the probably normal, 0.94 in the mild obstructive and 0.92 in the obstruction/emphysema group. There is a significant difference between the healthy group and patients.

From a clinical perspective, the most interesting comparison is between the groups classified as normal and “probably normal”. In the group “probably normal”, there was no conclusive evidence of airflow limitation at spirometry, but according to the ADT measurements they may have early stages of lung disease.

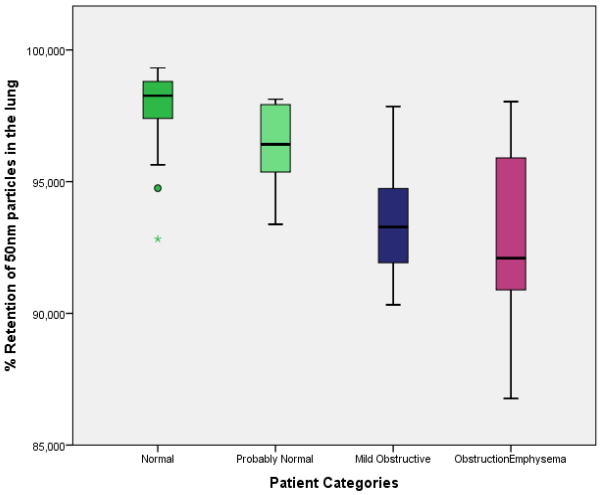

Figure 1: The result of measurements on 20 healthy volunteers (normal) and 26 patients with varying degree of respiratory disease.

Conclusions

The preliminary results indicate that ADT data show differences between various types of respiratory disease. Because of the low cost and limited time needed for measurement and analysis (typically less than 4 minutes in total), the method could be used on patients with just suspected lung disease. Thus, it could be valuable to discover disease at an early stage.

We believe that the ADT measurements provide information on the dimensions of the peripheral airspaces and alveolar volumes. The test may then be a fast and cheap alternative to more time consuming and expensive methods such as CT and MRI with hyperpolarized ^{3}He. However, comparison with these methods remains to be carried out.

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