Commentary

Quantitative computed tomography: what does airway obstruction look-like?

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Both COPD and asthma are heterogeneous diseases, characterized by airway obstruction and chronic airway inflammation (1). Small airway obstruction is present in both diseases, although there is a lack of accurate and reproducible measures of small airway function suitable to be used in clinical practice (1,2). Spirometry is the most widely used non-invasive test of pulmonary function and provides an assessment of lung function and an objective method for following disease progression or improvement and therapeutic response over time (3). However, FEV_1 mainly assesses large airways, providing only limited information regarding airway remodeling, small airway obstruction, air trapping and emphysema (4). Although the presence of a post-bronchodilator $FEV_1/FVC < 0.70$ confirms the presence of airflow limitation (5) it does not assess all aspects of obstructive diseases. Tests that are often accessible to most respiratory departments such as the measurement of RV/TLC via body plethysmography and FEF 25–75% via spirometry are only moderately sensitive to detect air trapping and small airway involvement respectively in asthma and COPD (2).

In the recent study of Hartley *et al*. (6) the authors have used quantitative computed tomography (QCT) to compare the degree of airway remodeling, air trapping and emphysema between patients with asthma and COPD, and to explore their potential association with lung function. With this method, the authors were able to recognize (I) the extent of proximal airway involvement (as a surrogate for remodeling) expressed by the ratio of the mean airway lumen area (LA)/body surface area (BSA) and the percentage wall area (%WA); (II) air trapping, as the ratio of mean lung density on expiration/inspiration (MLDE/I); and (III) the extent of emphysema as the Hounsfield units below which 15% of the voxels lie (Perc15) (6). After excluding patients with current or recent exacerbation, the authors have shown that proximal airway remodeling and air trapping are QCT features observed in both asthmatic and COPD patients while emphysema was restricted to patients with COPD (6).

Airway remodeling is an important feature in both asthma and COPD and is believed to be the result of tissue injury due to chronic inflammation (7). However, it has been shown that small airways in asthma are thicker than in COPD, which possibly represents different underlying mechanisms of remodeling (8,9). The observation that %WA was increased in both asthma and COPD (6) provides evidence that QCT might be used as an alternative method for the detection of airway remodeling in both conditions, avoiding the necessity for performing more invasive methods such as lung biopsies.

Studies have shown that the airway lumen is larger in patients with asthma compared to those with COPD (8), providing a plausible explanation to the fact that asthmatic patients do not develop emphysema despite the presence of chronic inflammation in the small airways (1), and is in accordance with the observation of Hartley *et al*. in this manuscript that emphysematous changes were a feature characteristic of COPD patients only (6). This observation, in combination to the fact that asthmatic patients with concomitant emphysematous lesions fulfill the features of asthma COPD overlap syndrome (ACOS) (10), provides evidence that QCT might serve as an important tool for the

identification of such patients, since the diagnosis of ACOS is often very difficult and inaccurate (5).

In both asthma and COPD, small airways obstruction affects the distribution of ventilation leading to small airway closure accompanied by air trapping (2). Common measures of static lung volumes related to air trapping and hyperinflation are functional residual capacity (FRC), residual volume (RV), total lung capacity (TLC) and the RV/TLC ratio (2). Although the Perc 15 value in asthmatic patients was comparable to healthy controls (6), in patients with severe asthma, Perc 15 was similar to COPD patients with matched airflow limitation giving the impression that these patients might have emphysema (6). However, further analysis has shown that in fact these severe asthmatics have significant air trapping rather than emphysema. Since persistent airflow obstruction is known to be related to air trapping in patients with severe asthma (11) the observation of Hartley *et al*. suggests that Perc15 is associated with severe airflow obstruction but may not be diagnostic of the presence of emphysema in asthmatics with severe airflow impairment. This finding, in combination with the weak associations in the regression analyses between the QCT parameters and FEV_1% pred. suggests that we have not reached yet the level of accuracy or selection of appropriate parameters where a QCT scan will replace spirometry in the evaluation of disease severity. A potential exception would be the patients with severe airflow impairment that are characterized by decreased Perc15 and increased MLDE/I values, more prominently in COPD

Interestingly, in asthmatic patients the stronger predictor of lung function was %WA, while air trapping was the stronger predictor of lung function in subjects with either asthma or COPD and an FEV_1 <80%. A plausible explanation might be that in asthma airway inflammation and remodeling is the main factor causing functional impairment while in both asthma and COPD air-trapping seems to influence FEV_1 only when significant obstruction of the proximal airways coexist.

Overall, this study shows that similar changes in pulmonary lung function tests in obstructive lung diseases may represent entirely different morphological alterations in the lung related to different pathophysiological background, supporting the clinical observation that lung function alone is not enough for the appropriate characterization of a patient with airways disease. Alternatively, QCT measures alone may also present limited discriminative. Bearing in mind that inhaled bronchodilators and anti-inflammatory drugs are the mainstay of treatment for both diseases, information provided by QCT may be of great value for the identification of the optimal target site in the lung of each individual patient, and may provide an alternative or rather a complementary tool for assessing treatment efficacy.

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Footnote

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References

1. Postma DS, Reddel HK, ten Hacken NH, et al. Asthma and chronic obstructive pulmonary disease: similarities and differences. Clin Chest Med 2014;35:143-56.
2. van den Berge M, ten Hacken NH, Cohen J, et al. Small airway disease in asthma and COPD: clinical implications. Chest 2011;139:412-23.
3. Pierce R. Spirometry: an essential clinical measurement. Aust Fam Physician 2005;34:535-9.
4. Bonini M, Usmani OS. The role of the small airways in the pathophysiology of asthma and chronic obstructive pulmonary disease. Ther Adv Respir Dis 2015;9:281-93.
5. Global Strategy for the Diagnosis, Management and Prevention of COPD, Global Initiative for Chronic Obstructive Lung Disease (GOLD) 2016. Available online: http://www.goldcopd.org
6. Hartley RA, Barker BL, Newby C, et al. Relationship between lung function and quantitative computed tomographic parameters of airway remodeling, air trapping, and emphysema in patients with asthma and chronic obstructive pulmonary disease: A single-center study. J Allergy Clin Immunol 2016;137:1413-1422.e12.
7. Mauad T, Dolhnikoff M. Pathologic similarities and

differences between asthma and chronic obstructive pulmonary disease. Curr Opin Pulm Med 2008;14:31-8.
8. Carroll N, Elliot J, Morton A, et al. The structure of large and small airways in nonfatal and fatal asthma. Am Rev Respir Dis 1993;147:405-10.
9. Kuwano K, Bosken CH, Paré PD, et al. Small airways dimensions in asthma and in chronic obstructive pulmonary disease. Am Rev Respir Dis 1993;148:1220-5.
10. Xie M, Wang W, Dou S, et al. Quantitative computed tomography measurements of emphysema for diagnosing asthma-chronic obstructive pulmonary disease overlap syndrome. Int J Chron Obstruct Pulmon Dis 2016;11:953-61.
11. Park SW, Park JS, Jeong SH, et al. Air trapping is a major determinant of persistent airway obstruction in asthmatics. Respir Med 2012;106:786-93.

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