Summary

The clinical indications for CT in patients with asthma include detection of bronchiectasis in patients with suspicion of allergic bronchopulmonary aspergillosis; documentation of the presence and extent of emphysema in smokers with asthma; and identification of conditions, such as hypersensitivity pneumonitis, that may be confused with asthma. However, high-resolution volumetric helical acquisition using MDCT and improvement image analysis techniques have made possible accurate and reproducible quantitative assessment of airway wall and lumen areas and lung density. This may permit the in vivo assessment of the degree of airway wall remodeling and the extent of small airway obstruction. These parameters should become accepted biomarkers for assessing effect of treatments in clinical trials and ultimately in the clinical management of individual patients.

Key Words: Asthma; air trapping; airway wall remodeling; small airway obstruction; bronchial wall thickening.

1. INTRODUCTION

Asthma is a chronic inflammatory condition involving the airways. This inflammation causes a generalized increase in existing bronchial hyperresponsiveness to various stimuli. This feature is commonly used in practice to confirm the clinical diagnosis of asthma. In susceptible individuals, this inflammation induces recurrent episodes of wheezing, chest tightness, breathlessness, and coughing usually associated with widespread but variable airflow obstruction that is often reversible either spontaneously or with treatment. The chronic inflammation process leads to structural changes, such as new vessel formation, airway smooth muscle (ASM) thickening, and fibrosis, which may result in irreversible airway narrowing.

In cases of mild persistent asthma, the current therapy is based on an inhaled corticosteroid as a controller (anti-inflammatory) medication. When necessary, bronchodilator (β2 agonist) used for additional symptomatic relief. For moderate persistent asthma, additional treatment may include a long-acting beta agonist, a leukotriene receptor antagonist or theophylline. For severe persistent asthma, in addition to the above, anti-immunoglobulin E therapy and/or oral steroids may be considered. Additional therapeutic impact can be achieved by allergen immunotherapy and by evaluation and treatment for sinusitis and gastroesophageal reflux.

CT is not commonly indicated in the routine assessment of patients with asthma. However, it is sometimes used particularly when complications of asthma such as allergic bronchopulmonary aspergillosis (ABPA) are suspected or in documenting the presence and extent of emphysema.
in smokers with asthma. ABPA is associated with more severe bronchial dilation than that typically seen in patients with uncomplicated asthma. CT may also be helpful to identify conditions that may be confused with asthma, such as hypersensitivity pneumonitis.

Beyond these classical indications, the real current challenge for CT in asthma is to visualize and quantify the lung attenuation and the airway lumen and wall to assess the extent of airway obstruction, the degree of inflammatory changes in small airways, and to evaluate in vivo the degree of airway wall remodeling. This has been used for getting better insights in pathophysiology of asthma, and it will become crucial in the monitoring of current and future therapy.

2. CT FINDINGS

Bronchial dilatation, bronchial wall thickening, mucoid impaction, centrilobular bronchiolar abnormalities, patchy areas of mosaic perfusion, and regional air trapping on expiratory scans may be identified on high-resolution CT (HRCT) in patients with uncomplicated asthma. On the whole, the severity of these abnormalities correlates with the severity of asthma measured by pulmonary function tests. In one study, forced expiratory volume in 1 s (FEV1) values were inversely correlated with bronchial wall thickening, hyperlucency, mucoid impaction, linear shadows, centrilobular prominence, and bronchial dilatation. The prevalence of these thin-section CT abnormalities increases with increasing severity of symptoms. Considerable variation exists however in the reported frequency of abnormalities. This variation is related to differences in diagnostic criteria and patient selection. Smoking may influence the type of airway inflammation observed in asthma and its response to therapy. On HRCT, airway and parenchymal abnormalities have proven to be more common in smoking asthma patients than in non-smokers. The presence and frequency of airway and parenchymal abnormalities on HRCT in elderly asthmatic patients are related to the duration of asthma. In a study of 68 clinically stable asthmatic patients aged 60 years or more, those with early-onset asthma (disease duration ≥ 5 years) had significantly higher frequency of focal or diffuse area of lung hypoattenuation, bronchial dilatation, and bronchial wall thickening than late-onset asthmatic patients (disease duration <5 years).

Only few of the published studies compared the frequency of the findings observed in asthmatics with a control group. Park et al. demonstrated that only three findings were significantly more frequent in asthmatic patients than in normal individuals: bronchial wall thickening, bronchial dilatation, and expiratory air trapping.

2.1. Bronchial Wall Thickening

Bronchial wall thickening has been reported in 16–92% of patients, a discrepancy that cannot be ascribed to the effects of smoking: although nearly half of the subjects in the study of Lynch et al. were smokers, only 12 of 50 asthmatic individuals in the study of Grenier et al. were current or ex-smokers. On all these studies, there is a tendency for the degree of bronchial wall thickening to correlate with the severity of disease (Figs 1 and 2).

2.2. Bronchial Dilatation

Identification of bronchiectasis in patients with asthma but without ABPA is plausible because bronchiectatic changes are seen at autopsy in patients who have died with long-standing asthma. The true prevalence of bronchiectasis or bronchial dilatation in patients with uncomplicated chronic asthma however remains unclear. In a study by Lynch et al., 77% of asthmatic patients and 153 (36%) of 429 bronchi assessed in asthmatic patients were associated with a bronchial–pulmonary arterial diameter ratio greater than 1. In a study by Grenier et al., bronchial dilatation was found in 28.5% of the asthmatic subjects, primarily involving subsegmental and distal bronchi (Fig. 2). Takemura et al. found at least one dilated bronchus in 62% of 23 asthmatics and in 2 of 10 (2%) controls. Mild cylindrical bronchial dilatation, based on a mild elevation of the bronchoarterial