The Prevalence of Tracheobronchomalacia in Patients with Asthma or Chronic Obstructive Pulmonary Disease

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Citation

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Abstract

Background and Objective:Tracheobronchomalacia (TBM) is an under-diagnosed condition presenting with nonspecific symptoms. Patients are often diagnosed with " difficult to treat" asthma or chronic obstructive pulmonary disease (COPD), especially in a community setting. Prevalence studies showing wide ranges have been based on selective populations. Computed tomography (CT) is a useful non-invasive test that can detect excessive collapse of the central airways. This study aims to determine the prevalence of TBM with compatible features incidentally noted on CT in patients hospitalized for asthma or COPD in a community setting. Methods:A retrospective analysis of CT scans of the chest in patients with a diagnosis of asthma or COPD from January 1, 2007 to December 31, 2007 was conducted. Images were assessed for excessive collapse of central airways between the thoracic inlet and carina. We defined a 50% reduction in the airway lumen diameter as criteria to diagnose TBM. Results:638 patients with a clinical diagnosis of asthma or COPD were admitted during the study period. Twenty-five patients (8.8%) met the criteria for TBM. The prevalence of TBM between the two groups was not statistically different. Radiology reports from index hospitalization described central airway collapse in only 5 patients in our cohort (1.8% vs 8.8%, p< 0.001). Conclusions:A significant number of patients with a diagnosis of obstructive airways disease have findings also compatible with TBM on computed tomography. TBM is under-diagnosed in the community setting. There is no difference in the prevalence of TBM among patients with asthma or COPD.

INTRODUCTION

Tracheobronchomalacia (TBM) is characterized by generalized or focal airway wall weakness, resulting in excessive variation of the luminal diameter during the respiratory cycle. Although it is seen more commonly in the pediatric population, the symptoms usually subside with age as the cartilaginous rings become more rigid, with reduction of tracheal wall compliance.[1] In the adult population, TBM develops in consequence to softening or damage of the cartilaginous structures of the airway walls. Etiologies in adults affected by TBM are idiopathic or acquired. Examples include trauma from previous intubation, tracheostomy or blunt trauma.[1,2] Additionally, chronic inflammation from connective tissue disorders, such as relapsing polychondritis and Wegener's granulomatosis, or purulent diseases including bronchiectasis, also result in weakening of the tracheobronchial wall.[1,3]

Physiologically, tracheobronchomalacia is characterized by variable intrathoracic obstruction. Airflow limitation is indistinguishable from excessive dynamic airway collapse, or EDAC, which also describes excessive collapse of the posterior membrane during passive exhalation. Individuals with TBM often complain of shortness of breath, coughing, wheezing, difficulty in clearing secretions and recurrent pulmonary infections. These symptoms are non-specific and are often attributed to overlapping COPD, bronchitis or asthma rather than TBM.[4]

TBM has been associated with chronic obstructive pulmonary disease (COPD) and asthma. In small cross-sectional studies, TBM is seen more often in smokers with chronic irritation of the airway.[5] It is hypothesized that chronic irritation and coughing occurring in asthma and COPD may weaken the airway walls and damage elastic fibers of the pars membranosa, contributing to increased compliance and resulting excessive dynamic airway collapse. Additionally, the level of obstruction in TBM, or choke point, is localized to the central airways; thus bronchodilators and steroids are not effective treatments and

may cause significant adverse side effects. Airway stabilization with silicone stents and surgical tracheoplasty has been proposed to manage properly selected patients[6], although no clinical trials have been performed to further evaluate this treatment modality to date.

Although bronchoscopy has been widely considered to be the gold standard for the diagnosis of TBM, recent advances in CT imaging provide an opportunity to non-invasively diagnose the condition with a high level of accuracy.[7,8,9] Dynamic CT of the chest exhibits tracheal collapse with cresenteric bowing of the posterior membranous trachea during expiration.[9] Examining the airway with flexible bronchoscopy during passive exhalation (functional bronchoscopy) can confirm collapse of the central airway typical of TBM.

The finding of TBM may be discovered on standard CT scanning for various nonspecific symptoms.[10] To our knowledge, the incidence of TBM in patients with a reported history of asthma or COPD has not been extensively studied. However, several large studies in the general population suggest that the overall incidence of TBM is 5-10%.[10,11] Considering the relatively high incidence of TBM in patients with dyspnea and other nonspecific respiratory symptoms, we hypothesized that a significant number of cases of airway collapse could be detected on CT scanning of the chest in patients diagnosed with asthma or COPD. This study aims to determine the incidence and features suggestive of TBM identified on computed tomography of the chest in patients clinically diagnosed with asthma or COPD.

METHODS

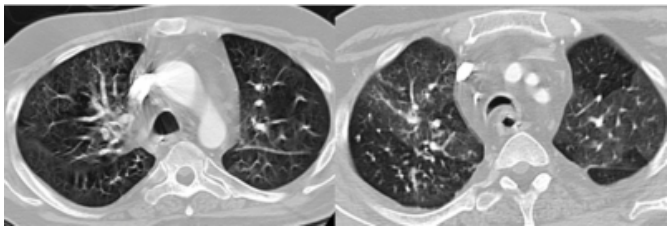
A list of patients with a principal admission diagnosis of asthma or COPD from January 1, 2007 to December 31, 2007 was generated with the assistance of our medical records department. A retrospective chart analysis was performed. Patients with CT imaging of the chest were identified and their charts were reviewed. Patients without CT imaging were excluded from this study. Our hospital institutional review board approved the review of radiologic and clinical data for this study. Informed consent was not required for this retrospective analysis, but patient confidentiality was protected.

All available CT scans were imaged with 16 MDCT scanners (LightSpeed, General Electric Medical Systems, Milwaukee, WI). In the majority of the studies, the CT's were performed using routine protocol in which patients were asked to maintain an end-inspiratory breath hold during scanning. Gantry rotation times were 0.5 seconds. The imaging parameters used are collimation of 5mm with a pitch of 0.94. The studies were interpreted on a PACS (Picture Archiving and Communication System, Cerner Provision) and reviewed using combined cine stack with static one-on-one viewing. All images were displayed in both mediastinal (window level, 50 H; window width 350 H), and lung (window level, -500 H; window width, 1500 H) settings.

The computed tomography images were screened and reviewed in an unblinded fashion by a pulmonary fellow and a thoracic radiologist. The images were visually assessed for collapse of the trachea through the bronchi. The axial diameter was measured at the site of maximal collapse of the airway and at the closest adjacent region of the trachea without collapse between the levels of thoracic inlet to the carina. A 50 % reduction in the airway lumen diameter was used as the criteria to diagnose TBM. Figure 1 shows an example of a patient with airway collapse. Clinical histories were also reviewed retrospectively to identify reason for undergoing CT scans and demographic data (age, gender and race). Fisher's exact test and Chi-square test were used to compare categorical variables.

Figure 1

Figure 1. Axial CT of a 39-year-old female with shortness of breath. Left: Axial CT scan showing a normal tracheal diameter. Right: Axial CT scan obtained at a higher level showing excessive reduction in the tracheal lumen, consistent with tracheomal



RESULTS

A total of 638 patients meeting inclusion for the study were admitted in 2007 with obstructive lung disease, 321 with an admitting diagnosis of asthma and 317 with COPD. Of these patients, 285 (130 asthma, 155 COPD) had CT of the chest performed. Twenty-five patients (8.8 %) met the criteria defined for the diagnosis of TBM on CT chest images. In the same cohort of patients, the overall rate of detection in the initial radiology report, with a description specifying TBM or tracheal collapse, was 1.8%(5/285), as compared to our

detection rate of 8.8%(25/285), where we specifically looked for tracheal narrowing (p<0.001, Fisher's Exact). Twelve of 25 patients identified were diagnosed with asthma and 13 with COPD (See Table 1).

Figure 2

Table 1: Distribution of patients

638 Patients diagnosed with obstructive lung disease in 2007 were identified	
321 Patients diagnosed with asthma	317 Patients diagnosed with COPD
130 Patients had CT chest on file	155 Patients had CT chest on file
12 Patients met the criteria for TBM	13 Patients met the criteria for TBM

Of the total population of patients diagnosed with asthma, 9.2% were found to exhibit CT findings of TBM, 8.4% of the patients with COPD demonstrated TBM; there was no difference between the groups in prevalence of TBM (p=0.83, Fisher's Exact). Analysis of those patients with TBM diagnosed by CT chest scanning revealed several characteristics (See Table 2). The mean age of the overall patient population was 76±16 years. There were a higher percentage of females, 16/25(64%), in the TBM population. No racial predilection was noted in either the COPD or asthma group. Although the overall reasons for performing the CT scans were non-specific, a majority of the patients underwent CT scanning for symptoms of dyspnea, 22/25(88%). Interestingly, fifteen of 25(60%) of the scans were performed to rule out pulmonary embolism, with only one confirmed pulmonary embolism.

Figure 3

Table 2: Characteristics of patients with TBM

Variable	All	Asthma	COPD
Age (years)	76 ±16	70±17	81±12
Male	36%	42%	31%
Race			
Caucasian	11(44%)	6 (50%)	5 (38%)
Black	6(24%)	5 (42%)	1 (4%)
Hispanic	8(32%)	1 (8%)	7 (54%)
Reason for study			
Dyspnea	22(88%)	10 (83%)	12 (92%)
Wheeze	3(12%)	2 (17%)	1 (8%)
Evaluate for PE	15(60%)	7 (58%)	8 (62%)
TBM overall prevalence*	25/285 (8.8%)	12/130 (9.2%)	13/155 (8.4%)
TBM identified on CT report	5/25 (20%)	2/12 (17%)	3/13 (23%)

*No significant difference by chi-square test

DISCUSSION

The results of this study demonstrate that significant subgroups of patients with a reported history of asthma or COPD have features consistent with TBM on CT scanning of the chest. The diameter of the tracheobronchial tree narrows during expiration due to the increasing intrathoracic pressure, causing symptoms that are non-specific and can mimic asthma and COPD. Narrowing of greater than 50% of the airway lumen has been reported to be generally considered diagnostic for TBM, although it is not clear what threshold is required to cause symptoms including dyspnea, coughing and wheezing. Nevertheless, using this criterion, 8.8% of patients were diagnosed as having TBM. A similar finding was reported in a smaller cohort in a recent article investigating the incidence in patients with emphysema.[12] The incidence of TBM in patients presenting with asthma or COPD has not been extensive studied, partly because it is a condition frequently under-diagnosed, as demonstrated by the low detection rate of TBM by the initial radiology report in our cohort. We understand that using the criteria of greater than 50% airway narrowing may be too lenient of a criteria for diagnosis of TBM, resulting in many false positives. However, the goals of our study were not to diagnosis TBM, the syndrome, but rather identify radiographic features compatible with TBM on CT.

To our knowledge, the rate of radiologic reporting of airway narrowing on initial reading has not been formally studied. Although this was not the primary goal of this study, it was surprising to see a high percentage of initial CT reports without mention of significant airway narrowing. This further reinforces that TBM seems to be an underreported entity and justifies that a criteria using 50% as the cutoff may actually improve the detection of TBM, albeit with the understanding that there will be more false positives. Identification of these features in this patient population from a community setting may function as a screening tool for which ultimately further confirmation utilizing functional bronchoscopy, dynamic CT, or paired inspiratory/expiratory CT performed at a tertiary center would be beneficial.

The literature on the diagnosis of TBM by CT chest scanning largely comes from tertiary centers with central airway expertise.[8,10,13] A strength of our study is that the data is derived from a community hospital setting, distinguishing it from the available literature. Also, the majority of previous studies review TBM in patients with multiple pulmonary disorders. There is marked variability in the incidence of TBM in the literature. Several large studies suggest that the overall incidence of TBM is 5-10%.[10,11] Jokinen et al showed a 23% incidence rate in 214 patients examined by

bronchoscopy for a history of chronic bronchitis.[5] A larger, Japanese study evaluating the general population found an incidence of 12.7% (542/4283).[11] Our study focuses specifically on its incidence in patients with asthma or COPD, and our population size is large for these specific groups. Additionally, many patients in a community setting are diagnosed with asthma or COPD clinically and treated empirically, but in effect, may have a significant contribution of symptoms from TBM and are therefore managed with suboptimal therapy. This article highlights the importance of including TBM in the differential diagnosis in individuals with the aforementioned non-specific symptoms.

One limitation of this study is that the cohort was selected from admitting diagnoses of asthma or COPD. Diagnosis was therefore made on clinical grounds with the patient's clinical history and reporting. Thus, physiologic confirmation by pulmonary function testing from the outpatient setting was not universally available. Furthermore, the degree of expiratory collapse of TBM can become exaggerated during acute episodes of infections, such as bronchitis or pneumonia. However, recurrent airway infection is one of the sine qua non of TBM, predisposing to further worsening of the syndrome.[5]

By virtue of its retrospective nature, several other limitations also exist. The images evaluated were performed under standard protocol at end-inspiration, which is not the ideal test of choice to detect TBM. However, we feel that the detection rate of TBM using the standard CT protocol would underestimate the degree and incidence of airway collapse, given that the maximal airway collapse is seen during active expiration, i.e. variable intra-thoracic collapse due to pleural pressure exceeding intra-tracheal pressure. This justifies the need for prospective studies in a community setting using a dynamic expiratory maneuver with 64 MDCT scanner, which is regarded as the best available correlating CT imaging technique.[13,14]

In conclusion, the results of this study clarify that a significant subgroup of patients with a reported clinical diagnosis of asthma or COPD have features consistent with TBM on conventional CT scanning of the chest. This indicates that TBM may be specifically identified on dedicated expiratory CT imaging if careful investigation is pursued. Prospective studies are needed to identify these groups of patients, as treatment strategies are very different.

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