Original Article

Tracheobronchomalacia/excessive dynamic airway collapse in patients with chronic obstructive pulmonary disease with persistent expiratory wheeze: A pilot study

Girish Sindhwani, Rakhee Sodhi, Manju Saini[1], Varuna Jethani, Sushant Khanduri, Baltej Singh[2]

Departments of Pulmonary Medicine and [1]Radiodiagnosis, Himalayan Institute of Medical Sciences, Dehradun, Uttarakhand, [2]Lecturer Biostatistics, Guru Gobind Singh Medical College, Baba Faridkot University, Faridkot, Punjab, India

ABSTRACT

Background: Tracheobronchomalacia (TBM) refers to a condition in which structural integrity of cartilaginous wall of trachea is lost. Excessive dynamic airway collapse (EDAC) is characterized by excessive invagination of posterior wall of trachea. In both these conditions, airway lumen gets compromised, especially during expiration, which can lead to symptoms such as breathlessness, cough, and wheezing. Both these conditions can be present in obstructive lung diseases; TBM due to chronic airway inflammation and EDAC due to dynamic compressive forces during expiration. The present study was planned with the hypothesis that TBM/EDAC could also produce expiratory wheeze in patients with obstructive airway disorders. Hence, prevalence and factors affecting presence of this entity in patients with obstructive airway diseases were the aims and objectives of this study. **Materials and Methods:** Twenty-five patients with obstructive airway disorders (chronic obstructive pulmonary disease [COPD] or bronchial asthma), who were stable on medical management, but having persistent expiratory wheezing, were included in the study. They were evaluated for TBM/EDAC by bronchoscopy and computed tomographic scan of chest. The presence of TBM/EDAC was correlated with variables including age, sex, body mass index (BMI), smoking index, level of dyspnea, and severity of disease. **Results:** Mean age of the patients was 62.7 ± 7.81 years. Out of 25 patients, 14 were males. TBM/EDAC was found in 40% of study subjects. Age, sex, BMI, severity of disease, frequency of exacerbations and radiological findings etc., were not found to have any association with presence of TBM/EDAC. **Conclusion:** TBM/EDAC is common in patients with obstructive airway disorders and should be evaluated in these patients, especially with persistent expiratory wheezing as diagnosis of this entity could provide another treatment option in these patients with persistent symptoms despite medical management.

KEY WORDS: Excessive dynamic airway collapse, expiratory wheeze, obstructive airway disease, tracheobronchomalacia

Address for correspondence: Dr. Rakhee Sodhi, Department of Pulmonary Medicine, Himalayan Institute of Medical Sciences, Swami Ram Nagar, Dehradun - 248 140, Uttarakhand, India. E-mail: rakhee.sodhi@gmail.com

INTRODUCTION

Tracheobronchomalacia (TBM) is characterized by decrease in strength of airway wall, which could be congenital or secondary. Secondary causes include chronic airway inflammation, gastroesophageal reflux disease, malignant or benign tumors around trachea and trauma to airways etc., Excessive dynamic airway collapse (EDAC) is characterized by airway compromise because of invagination of posterior wall of tracheal lumen during expiration, which is secondary to dynamic forces of hyperinflation in obstructive lung diseases. Both TBM

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and EDAC can thus be found in patients with obstructive airway diseases. Both these conditions can present with cough, dyspnea, and wheezing.[1-3]

It is a common observation that some patients with obstructive airway diseases have persistent expiratory wheezing despite optimum medical management. This is generally considered to be due to inadequate response to therapy or airway remodeling. We planned the present study with the hypothesis that TBM/EDAC could be a cause of persistent wheezing in such patients. Moreover, the prevalence and factors affecting TBM/EDAC in patients with obstructive airway disorders are not known, so the present study could also give some insight into the factors affecting presence of these entities.

MATERIALS AND METHODS

The study was approved by institutional ethics committee. The study subjects were selected based on below mentioned inclusion and exclusion criteria.

Inclusion criteria

- A case of obstructive airway disease with postbronchodilator forced expiratory volume in one second/forced vital capacity <70%
- Persistent expiratory wheeze on auscultation
- Stable disease, i.e., day to day variations in patient's symptoms were mild and didn't warrant a change in treatment.

Exclusion criteria

- Patient in exacerbation. Exacerbation was considered when day to day variation in patient's symptoms warranted a change in treatment
- Comorbid cardiac disease
- History of tuberculosis
- History of previous tracheal intubation
- Presence of any other cause for wheezing
- Not willing to participate in the study.

All consecutive patients with obstructive airway disease, diagnosed by history and spirometry, were evaluated for inclusion and exclusion criteria. Echocardiography was done to rule out any co-morbid cardiac disease. Study subjects were explained about the study and written informed consent was obtained for participation in the study. History, physical examination, and routine investigations of study subjects were done. All study subjects were subjected to bronchoscopy to look for evidence of TBM or EDAC. Bronchoscopy was done under local anesthesia with nebulization by 4% xylocaine and instillation of 2% xylocaine on vocal cords and major airways. Sedation was avoided because the patients had to be instructed to perform inspiration, expiration and forceful expiratory maneuver. During bronchoscopy, patients were instructed to perform forceful expiration. TBM/EDAC was considered to be present if the decrease in antero-posterior or transverse diameter of trachea was more than 50% when the patient was asked to perform forceful expiration. TBM/EDAC was not considered during cough as cough can also produce collapse of major airways, which can be misinterpreted as TBM/EDAC. All study patients underwent computed tomographic (CT) scan and sections were taken during inspiration and expiration to confirm the findings of bronchoscopy.

Statistical analysis

Quantitative variables were expressed as the mean and standard deviation, and categorical variables were expressed as percentages. The association between bronchoscopic finding of TBM/EDAC and the other variables was calculated using Chi-square test. Data were considered statistically significant at $P < 0.05$. The statistical analysis was performed using Statistical Package for the Social Sciences (SPSS) 17.0 statistical software for Windows (SPSS, Chicago, IL, USA).

RESULTS

Baseline data of study subjects is given in Table 1. Mean age of patients was 62.7 ± 7.81 years. Out of 25 subjects, 14 were males and 11 were females. TBM/EDAC was found in ten out of 25 subjects (40%). TBM/EDAC was found to be more common in the age group of 45–60 years but its association with age was statistically insignificant [Table 2].

Table 1: Baseline data of study subjects

Demographic details	Frequency
Mean age (years)	62.7±7.81
Age	
45-60	10
60-70	1
70-80	04
Male/female	14/11
Smoking history	
Light smoker (1-20 pack years)	15
Moderate smoker (20-40 pack years)	08
Heavy smoker (>40 pack years)	02
BMI	
<18.5	05
18.5-25	11
>25	09
Severity of dyspnea	
MRC Grade-I	09
MRC Grade-II	13
MRC Grade-III	03
Findings on skiagram chest	
Normal	02
Chronic bronchitis	19
Emphysema	04
Frequency of exacerbation	
Nil per year	06
1 per year	12
2 per year	03
3 per year	03
>3 per year	01

MRC: Medical Research Council, BMI: Body mass index

A negative association between TBM/EDAC and gender was seen although it was found to be more common in females [Table 3]. No association between TBM/EDAC and body mass index (BMI) was found [Table 4]. TBM/EDAC was not found to be associated with annual frequency of chronic obstructive pulmonary disease (COPD) exacerbation or level of dyspnea, meaning thereby that TBM/EDAC didn't affect the symptom severity [Tables 5 and 6 respectively]. The absence of TBM/EDAC was more common with light smokers, although its presence did not show significant association with smoking status [Table 7]. Chronic bronchitis was a common finding in patients without TBM/EDAC, but its presence was not associated significantly with chest skiagram findings [Table 8].

Table 2: Association between age and tracheobronchomalacia/excessive dynamic airway collapse

Age group (years)	TBM/EDAC		χ^2	*P*
	No	Yes		
45-60	4	6	2.784	0.249
60-70	8	3		
>70	3	1		
Total	15	10		

TBM: Tracheobronchomalacia, EDAC: Excessive dynamic airway collapse

Table 3: Association between gender and tracheobronchomalacia/excessive dynamic airway collapse

Sex (years)	TBM/EDAC		χ^2	*P*
	No	Yes		
Male	8	3	1.326	0.321
Female	7	7		
Total	15	10		

TBM: Tracheobronchomalacia, EDAC: Excessive dynamic airway collapse

Table 4: Association between body mass index and tracheobronchomalacia/excessive dynamic airway collapse

BMI	TBM/EDAC		χ^2	*P*
	No	Yes		
<18.5	3	2	2.155	0.340
18.5-25	5	6		
>25	7	2		
Total	15	10		

BMI: Body mass index, TBM: Tracheobronchomalacia, EDAC: Excessive dynamic airway collapse

Table 5: Association between frequency of exacerbation and tracheobronchomalacia/excessive dynamic airway collapse

Frequency of exacerbation (per year)	TBM/EDAC		χ^2	*P*
	No	Yes		
0	4	2	1.736	0.784
1	7	5		
2	2	1		
3	1	2		
4	1	0		
Total	15	10		

TBM: Tracheobronchomalacia, EDAC: Excessive dynamic airway collapse

DISCUSSION

The lumen of the airway can narrow up to 35% with coughing or forced expiratory maneuvers[3,4] but narrowing of lumen by more than 50% is considered abnormal.[2,3] TBM and EDAC are two pathological entities with such presentation. TBM is pathological weakness of cartilaginous structure of trachea and/or main bronchi while EDAC is invagination of membranous part of trachea because of hyperinflation of lungs as in emphysema.[1]

Several etiologies that cause TBM and EDAC are a result of airway inflammation.[1] Prolonged intubation, the presence of tracheostomy tubes, inhalation of chemicals like smoke, combustive fuels, aspiration of irritants such as gastric acid or food, trauma, tracheal surgeries, malignancies, thyroidal enlargement and congenital anomalies such as Ehler–Danlos and Mounier–Kuhn are other etiological reasons for the development of TBM and EDAC.[1]

Obstructive airway disorders like COPD and asthma also share common pathological factors including chronic airway inflammation which are implicated in TBM and EDAC.[2,3]

Table 6: Association between level of dyspnea and tracheobronchomalacia/excessive dynamic airway collapse

MRC dyspnea scale	TBM/EDAC		χ^2	*P*
	No	Yes		
1	5	4	0.142	0.931
2	8	5		
3	2	1		
Total	15	10		

TBM: Tracheobronchomalacia, EDAC: Excessive dynamic airway collapse, MRC: Medical Research Council

Table 7: Association between smoking status and tracheobronchomalacia/excessive dynamic airway collapse

Smoking status	TBM/EDAC		χ^2	*P*
	No	Yes		
Light smoker	10	5	3.299	0.192
Moderate smoker	05	3		
Heavy smoker	00	2		
Total	15	10		

Light smoker: 0.1-20 pack years, Moderate smoker: 20-40 pack years, Heavy smoker: >40 pack years, TBM: Tracheobronchomalacia, EDAC:Excessive dynamic airway collapse

Table 8: Association between chest skiagram finding and tracheobronchomalacia/excessive dynamic airway collapse

Chest skiagram finding	TBM/EDAC		χ^2	*P*
	Yes	No		
Chronic bronchitis	13	6	2.686	0.261
Emphysema	1	3		
Normal	1	1		
Total	15	10		

TBM: Tracheobronchomalacia, EDAC: Excessive dynamic airway collapse

The signs and symptoms of TBM and EDAC are nonspecific.[1] Patients with TBM and EDAC may have an intractable cough, wheezing, dyspnea, and recurrent bronchitis or pneumonia.[2,3] Wheezing is a common symptom among TBM/EDAC and obstructive airway diseases.[1] The present study was done on the hypothesis that TBM/EDAC may be a cause of persistent auscultatory wheeze in patients with obstructive airway disorders besides other causes like poor response to bronchodilators and airway remodeling etc. In the study, subjects with obstructive airway disorders and persistent wheezing were evaluated for presence of TBM/EDAC. Bronchoscopy and CT scan were used to diagnose this entity. The prevalence of TBM/EDAC in patients with obstructive airway disorders is not known[5] and probably not studied. The present study gives an insight into presence of this co-morbid condition and various factors that might affect its presence in patients with obstructive airway disorders.

Bronchoscopy with airway examination is considered the gold standard to diagnose TBM and EDAC.[2] Bronchoscopy allows for the real-time evaluation of the airways with tidal respirations and with forced expiratory maneuvers.[1] We also used bronchoscopy as a first investigation to diagnose TBM/EDAC. Chest CT scan with dynamic expiratory imaging may also be utilized to confirm presence of this entity.[6,7] We, in our study, also confirmed presence of this entity by CT scan during inspiratory and expiratory phases.

Our study revealed that TBM or EDAC was present in 40% patients of COPD who had persistent wheezing despite maximum medical management. We also assessed association of TBM/EDAC with factors including age, sex, smoking status, BMI, levels of dyspnea, frequency of exacerbations. None of these factors were found to have a significant association with presence or absence of TBM/EDAC in study subjects. Similar results were also observed by Represas-Represas *et al*.[6] where 50 patients were evaluated for EDAC by computed tomogram. They found that degree of dynamic central airway collapse was not related to the patient's epidemiological or clinical features, and did not affect lung function, symptoms, capacity for effort, or quality of life. They, however, reported EDAC in 9.4% of COPD patients. The difference can be attributed to the fact that our selection criteria for assessing EDAC were different. While we evaluated only those patients with COPD who had persistent wheezing despite maximum medical management, latter evaluated all patients with COPD.

We, in our study, treated our patients with COPD with TBM/EDAC by giving them continuous positive airway pressure trial. We started with 6 cm water pressure, and pressure was incremented till auscultatory wheeze was no longer present and patient also reports improvement in symptoms. Our all patients had improvement in symptoms and wheezing was noticed in those patients. Continuous positive pressure ventilation has been successfully used as a pneumatic splint by Ferguson and Benoist.[8] Other modes of treatment include tracheal stenting[9] and tracheobronchoplasty.[10]

Our study has limitation of small sample and argues for a larger study to validate the preliminary results of our study.

CONCLUSION

It can be stated that patients with obstructive airway disease with persistent wheezing despite medical management must be screened for TBM/EDAC as the presence of this entity provides another additional treatment option for such patients.

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Conflicts of interest

There are no conflicts of interest.

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