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RESEARCH

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Bronchiectasis as co morbidity with COPD or ILD: complex interactions and severe consequences

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Abstract

Background Bronchiectasis is a chronic pulmonary disease characterized by widened, malformed bronchi, with profuse expectoration and impaired quality of life. COPD and ILD are common co-morbidities with bronchiectasis.

Methods The present study evaluated the clinical, laboratory& radiological characteristics of COPD and ILD with/without bronchiectasis. A hospital-based, retrospective study was conducted for 1 year.

Results A total of 101 patients were analyzed, 60 patients had COPD, 34 had ILD and 7 patients had bronchiectasis without COPD or ILD. It was noticed that, out of the analyzed 60 COPD patients, 10 patients developed bronchiectasis (16.7%) versus10 patients of 34 ILD patients (29.4%). In COPD and ILD accompanied by bronchiectasis, the incidence of hemoptysis was significantly higher in comparison to those without bronchiectasis. Moreover, they showed a significant increase in partial pressure of carbon dioxide (PCO2) in comparison to those without bronchiectasis, as well as in comparison to bronchiectasis only. Sputum culture revealed that COPD with bronchiectasis were significantly associated with *Staphlococcus aureus* (77.8%), more than ILD with Bronchiectasis (33.3%). While *S. pneumoniae* were more evident in cases of ILD with bronchiectasis (22.2%). The bilateral, peripheral bronchiectasis was more common than the unilateral, central bronchiectasis among cases of COPD with bronchiectasis followed by ILD with bronchiectasis more than bronchiectasis only.

Conclusion Patients with COPD /ILD with bronchiectasis can be associated with serious clinical manifestations as hemoptysis. Their sputum cultures detected more positive organisms than negative in comparison to cases of bronchiectasis only. Screening of COPD and ILD patients using HRCT Scanning is a recommended preventive measure for early detection of bronchiectasis.

Keywords Bronchiectasis, COPD, ILD, Culture, HRCT

Introduction

Bronchiectasis is a chronic multidimensional respiratory disease with variable predisposing factors, mostly idiopathic with different degrees of severity and prognosis [1]. Typical clinical symptoms include chronic cough, purulent sputum, dyspnea, and hemoptysis. The pathogenesis of the disease is very complex and still poorly understood [2].

Bronchiectasis is a disease with high morbidity and mortality and defined as permanent bronchial dilatations with the destruction of the bronchial wall [3].

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A useful pathophysiological pathway postulates the remodeling and dilation of the airways observed in patients with bronchiectasis as a cycle of events enhancing impairment of mucociliary clearance with retention of airway secretions. These events disturb the host's defenses and render the airways more liable to chronic infection [4]. The persistence of bacterial pathogens prompts an inflammatory response that results in injury and remodeling of the airways leading to repeated respiratory infections with chronic sputum production [5].

Identification of the underlying etiology is of maximum importance as many etiologies have their own individual treatments which aid in reducing future exacerbations.

Bronchiectasis usually coexists with other diseases, such as chronic obstructive pulmonary diseases (COPD) and interstitial lung diseases (ILD); with some of these disorders working as true co-morbidities contributing to the development and progression of the underlying bronchiectasis [6]. This has important consequences not only for the treatment of the underlying disease, but also for the treatment and outcome of bronchiectasis. The increased risk of infections with bronchiectasis can be a barrier to aggressive treatment of systemic inflammatory diseases [7, 8].

Nowadays, with the improvement in health care and the availability of convenient antibiotics, the prevalence of bronchiectasis has declined and patients with the early disease can be treated successfully by conservative management. However, Bronchiectasis constitutes an important issue in developing countries because of tuberculosis and other co-morbid conditions particularly COPD and interstitial lung diseases (ILD) [9].

Bronchiectasis and COPD share common risk factors, clinical features, and functional abnormalities [10]. In these patients, it is unclear whether recurrent bronchiectasis exacerbations have led to airway obstruction, or whether COPD with recurrent exacerbations has led to the development of bronchiectasis. The COPD/bronchiectasis overlap should be identified as a specific phenotype [11, 12].

In Interstitial Lung diseases (ILDs), using computed tomography, a definite usual interstitial pneumonia pattern (UIP), is characterized by the presence of reticulation, traction bronchiectasis, and honeycombing. Additionally, in patients with ILD, progression and increase in severity was associated with varying degrees of traction bronchiectasis [13]. Several studies have postulated that ILD with architectural distortion, often associated with established traction bronchiectasis, has been associated with reduced quality of life [14].

One of the challenges of bronchiectasis is to detect which co-morbidities are either causative of the bronchiectasis or are just associations. Clearly, some co-morbidity will arise accidentally. Understanding which conditions cause or exacerbate bronchiectasis may be useful to improve understanding of the underlying disease process and subsequently help in management [15]. The aim of this study is to detect the incidence of bronchiectasis in a cohort of COPD and ILD patients; and to determine the clinical, laboratory and radiological characteristics of COPD and ILD patients with/without bronchiectasis.

Subject and methods

This is retrospective study was carried out in the department of chest diseases at Ahmed Maher teaching Hospital, Egypt. All the medical records and office charts were reviewed in the period from March 2018 to December 2019.

Our study was only applied to patients with clinically significant bronchiectasis, defined by the clinical syndrome of cough, and sputum production with or without recurrent respiratory infections associated with the presence of bronchial dilatations on computed tomography (CT) scan. Radiological bronchiectasis may be manifest in healthy asymptomatic individuals, particularly in the elderly [16], or may occur, for example, due to traction in interstitial lung disease. Such radiological bronchiectasis without clinical symptoms was not included.

The following conditions were also excluded: cystic fibrosis bronchiectasis, which has a distinct pathophysiology and treatment pathway, children with bronchiectasis, and tuberculous mycobacteria, where specific therapy is indicated.

Data collection

All personal and medical, laboratory and radiological data of the recruited patients were collected including the clinical chest and general manifestations on admission or during hospitalization.

Laboratory investigations

The laboratory investigations included complete blood count, C - reactive protein (CRP), Routine kidney function tests, routine liver function tests, glycated hemoglobin (HbA1c), and arterial blood gases.

Procedures

Fasting blood glucose was assessed using Cobass 311. A complete blood picture was done by Sysimex XS 500to assess red blood cells, white blood cells and platelets. C-reactive protein (CRP) and albumin were done on Cobas311 machine by immune-turbitimetric method. Kidney function tests were done on Cobas311 machine by Urease UV method for urea and Enzymatic FCC-IDMS standardized for creatinine. Arterial blood gases were done on Gem Premier 3000 machine.

Sputum culture

The sample was taken on a clean container, a macroscopic examination was done to describe the sample then Gram- stained smear is prepared to detect pus cells and bacteria. Sputum cultures were performed on blood agar with an optotin disc placed in the middle of the secondary smear. Chocolate agar, MacConkey agar, and Sabouraud dextrose agar were used. Susceptibility testing was performed using a standardized disc diffusion method with various antibiotic discs.

Radiological assessment

High resolution computed tomography (HRCT) of chest was performed using GE64 row 128-slice CT scanning equipment (GE HANGWEI Medical System, Beijing, China), from the level of the thoracic entrance to the level of the diaphragm, and completed at the end of inspiration. The scanning parameters were as follows: tube voltage 120 kV, tube current 250 ~ 450 mA, layer thickness 10 mm, and layer spacing 5 mm. A thin layer image with a layer thickness of 1.25 mm and a layer distance of 1.25 mm is automatically reconstructed and recorded as DICOM image data at the end of the scanning. Images of the lungs (window width 1600 HU, window level − 500) and the mediastinum (window width 350 HU, window level 50) were noticed.

Ethical aspect

Local ethical committee approval was obtained from GOTHI (General Organization for Teaching Hospitals and Institutes) with approval number: HAM 00163. This study was conducted according to the principles expressed in the Declaration of Helsinki.

Statistical analysis

The collected data were statistically analyzed using SPSS/version 20.0 software (Inc., Chicago, USA). The quantitative variables were compared using one-way ANOVA test for multiple comparisons and independent Student's t test for two group comparison, and expressed as mean ± SD. The qualitative variables were compared using Fisher's exact test or chi-square test (χ^2) and the data are expressed as numbers and percentages. Statistical significance was considered at p value < 0.05.

Results

In this retrospective cohort study, a total of 101 patients were analyzed, 60 patients had COPD, 34 had ILD and 7 patients had bronchiectasis only. The total mean age of patients was 56.8 ± 9.5 years old with total range of 25–73 years old. The interstitial lung disease (ILD) was significantly frequent among female patients than males (66.7 vs. 33.3%); on the contrary, male patients suffered more in cases of bronchiectasis only (85.7 vs. 14.3%). Furthermore, male ILD patients showed a significant higher development of bronchiectasis in comparison to female patients (60% vs.40%), ($p = 0.03$).

No significant differences were observed in the mean ages of patients, sex distribution, occupational categories as well as in smoking status in the other different studied groups ($p > 0.05$). Personal characteristics of the patients are summarized in Tables 1 and 2.

It was observed that out of the analyzed 60 COPD patients, 10 patients were developed bronchiectasis (16.7%). On the other hand, 10 patients out of 34 ILD patients (29.4%) were developed bronchiectasis as illustrated in Fig. 1.

It was noticed that, COPD and ILD accompanied with bronchiectasis were significantly associated with higher incidence of hemoptysis as compared to COPD and ILD without bronchiectasis ($p < 0.0001$) (Tables 3 and 4).

COPD patients with bronchiectasis showed a significant increase in the mean partial pressure of carbon dioxide (PCO2) in comparison to COPD patients without bronchiectasis ($p = 0.04$), as well as in comparison to cases of bronchiectasis only ($p = 0.001$) (Tables 3 and 5). Similarly, in ILD patients with bronchiectasis, the mean PCO2 was also significantly higher than that in cases of bronchiectasis only ($p = 0.002$). Moreover, the mean total leucocytic count (TLC) showed also a significant elevation among COPD with bronchiectasis patients and ILD with bronchiectasis patients in comparison to cases of bronchiectasis only ($p = 0.006$, 0.004 respectively) as shown in (Table 5). No other statistically significant differences were detected in the clinical and laboratory characteristics of the studied groups ($p > 0.05$).

Further, It was noticed that, COPD and ILD accompanied with bronchiectasis were significantly associated with more frequent positive sputum culture (90% and 70% respectively) and more liability for bacterial and fungal colonization than COPD and ILD patients without bronchiectasis (36% and 20.8% respectively) (Tables 3 and 4). The results of sputum culture isolates are illustrated in details in Fig. 2 and Table 6.

The bilateral and peripheral bronchiectasis were the most common among cases of COPD with bronchiectasis followed by ILD with bronchiectasis in comparison to cases of bronchiectasis only as shown in Fig. 3 and Table 7.

Discussion

Bronchiectasis is defined as permanent dilation of the bronchi and is clinically a syndrome of chronic cough with sputum production and recurrent respiratory

Table 1 Personal characteristics COPD patients with and without Bronchiectasis compared to bronchiectasis only

Variable	COPD ($n=60$)		Bronchiectasis ($n=7$)	*p* value
	COPD without Bronchiectasis	COPD + Bronchiectasis		
NO.(%)	50(83.3)	10(16.7)	----	
Age	60.1 ± 7.3	56.8 ± 8.4	57.1 ± 4.1	0.4
Sex				
Male	46(92.0)	9(90.0)	6(85.7)	0.3
Female	4 (8.0)	1(10.0)	1(14.3)	
Occupation (%)				
House wife	6(12.0)	1(10.0)	2(28.6)	
Factory worker	30(60.0)	5(50.0)	3(42.8)	
Non factory worker	14(28.0)	4(40.0)	2(28.6)	0.7
Smoking status (%)				
Smoker	41(82.0)	8(80.0)	4(57.1)	
Ex- smoker	5(10.0)	1(10.0)	1(14.3)	0.5
Non smoker	4(8.0)	1(10.0)	2(28.6)	
Smoking index[a]	54.5 ± 35.9	58.8 ± 32.5	37 ± 44.9	0.4

[a] The number of cigarettes smoked per day X years of smoking/20

Table 2 Personal characteristics of ILD patients with and without Bronchiectasis compared to bronchiectasis only

Variable	ILD ($n=34$)		Bronchiectasis only ($n=7$)	*p* value
	ILD without bronchiectasis	ILD + bronchiectasis		
No.(%)	24(70.6)	10(29.4)		
Age	50.5 ± 11.0	55.5 ± 12.8	57.1 ± 4.1	0.08
Sex				
Male	8(33.3)	6(60.0)	6(85.7)	0.03*
Female	16(66.7)	4(40.0)	1(14.3)	
Occupation (%)				0.2
-House wife	12(50.0)	2(20.0)	2 (28.6)	
-Factory worker	5(20.8)	6(60.0)	3(42.8)	
-Non-factory worker	7(29.2)	2(20.0)	2(28.6)	
Smoking status (%)				0.1
Smoker	5(20.8)	5(50.0)	4(57.1)	
Ex-smoker	1(4.2)	0(0.0)	1(14.3)	
Non smoker	18(75.0)	5(50.0)	2(28.6)	
Smoking index	11.3 ± 26.6	27.9 ± 31.5	37 ± 44.9	0.1

* Significance is considered at ≤ 0.05

infections that can be caused by different underlying diseases [17].

Recently, the incidence and prevalence of bronchiectasis have increased, and it is no longer believed as a rare disease. Not only the aging of the global population; but also increased awareness and diagnosis are considered the main causes of increased prevalence. Its diagnosis requires computed tomography (CT) scan as X-rays are not sufficient. However, chest CT scans are not available in much of the world, so most of the data

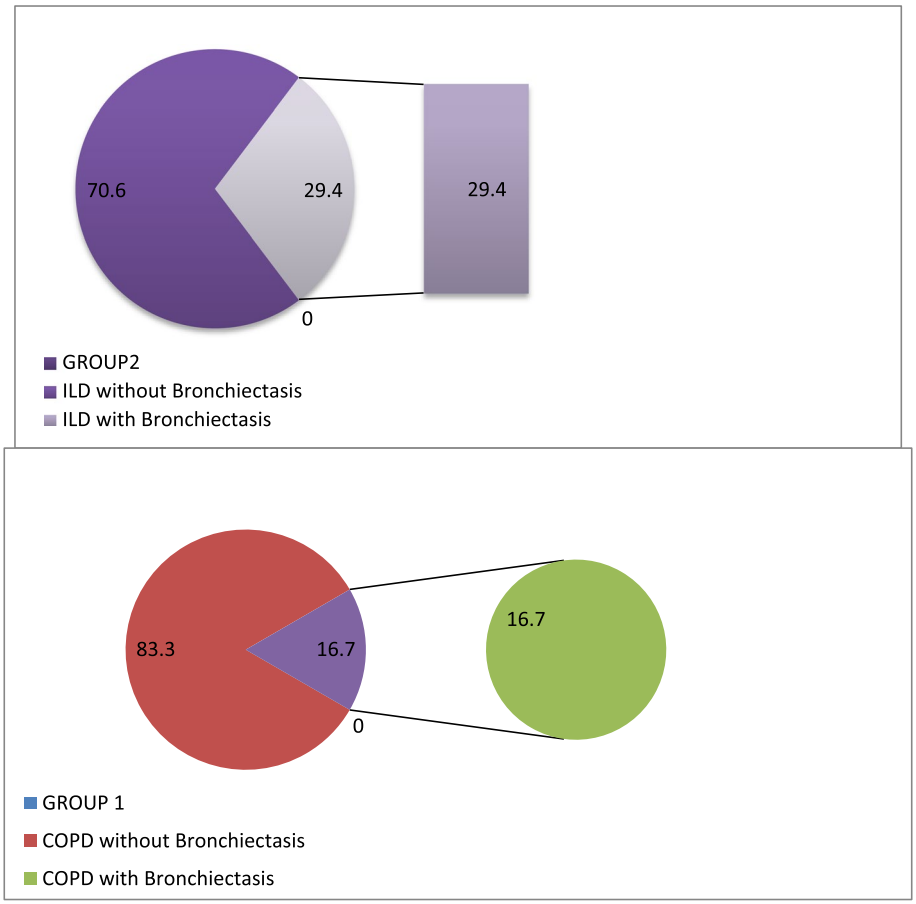

Fig. 1 Incidence of bronchiectasis among a cohort of adult COPD and ILD patients ≥ 20 years

about bronchiectasis are reported from high-income countries [18].

Etiology of bronchiectasis is broadly assessed as post-infectious, associated with underlying disease (e.g., COPD, interstitial lung disease [ILD], rheumatoid arthritis [RA], immunodeficiency, allergic bronchopulmonary aspergillosis (ABPA), pulmonary ciliary dyskinesia, and alpha-1-antitrypsin deficiency), or idiopathic [19].

Chronic obstructive pulmonary disease (COPD) is a heterogeneous disease characterized by chronic respiratory manifestations with persistent airflow limitation [20]. Additionally, interstitial lung diseases (ILD) are a group of diseases characterized by inflammatory and fibrotic infiltration of alveolar septa and interstitium that cause substantial changes in the alveolar epithelium and capillary endothelium. Both COPD and ILD have distinguished features but share some similar risk factors (e.g., old age, male sex, and tobacco exposure) and both may be co-morbidity with bronchiectasis [21].

The bronchiectasis–COPD overlap is a phenotype that is associated with increased risk of exacerbation, severe airway obstruction, and a higher mortality rate [22]. At the same time, in patients with ILD, traction bronchiectasis is recognized as the most persistent and important index of severity for fibrosis and prognosis [23]. A recent report by Hida et al. [14] indicated that the Traction Bronchiectasis Index (TBI) helps in stratification of the prognosis in patients with ILD.

In our study, it was observed that out of the analyzed 60 COPD patients, 10 patients were developed bronchiectasis (16.7%). On the other hand, 10 patients out of 34 ILD patients (29.4%) were developed bronchiectasis. Furthermore, male ILD patients showed a significant higher development of bronchiectasis in comparison to female patients (60% vs.40%). But no significant differences were observed in the mean ages of patients, sex distribution, and occupational categories as well as in smoking status in the other different studied groups including groups of COPD and those with bronchiectasis only.

In agreement with our results was the India bronchiectasis registry, which reported that 57% of patients were male [24]. The dominant cause of bronchiectasis

Table 3 Clinical and laboratory characteristics of COPD patients with and without bronchiectasis

Variable	COPD without Bronchiectasis ($n=50$)	COPD + bronchiectasis ($n=10$)	*p* value
Cough (%)	47 (94.0)	10 (100.0)	0.4
Expectoration (%)	45(90.0)	10(100.0)	0.3
Dyspnea (%)	50(100.0)	10(100.0)	-
Chest pain (%)	18(43.9)	5(50.0)	
Hemoptysis (%)*	5(10.0)	9(90.0)	< 0.0001*
Fever (%)	7(14.0)	0(0.0)	0.2
Wheezes (%)	44(88.0)	9(90.0)	0.8
Clubbing (%)	3(6.0)	0(0.0)	0.4
Tachypnea (%)	12(24.0)	2(20.0)	0.7
CRP(+ ve)	6 (12.0)	0(0.0)	0.2
Random Blood Sugar			
-Non diabetic	24 (48.0)	7(70.0)	0.3
-Diabetic	22 (44.0)	3.(30.0)	
-Pre-diabetic	4 (8.0)	0(0.0)	
Impaired kidney function (%)	6(12.0)	0(0.0)	0.2
Pulse (beat/m)	82.8 ± 8.5	81.9 ± 8.4	0.7
SBP (mmHg)	122.5 ± 11.5	124.5 ± 9.5	0.6
DBP (mmHg)	79.0 ± 7.5	77.0 ± 7.1	0.4
TLC (thousands/c.mm)	8.4 ± 3.2	7.7 ± 1.3	0.5
Hemoglobin (g/dl)	13.4 ± 1.2	13.6 ± 0.9	0.7
Platelets)thousands/ c.mm)	249 ± 62.1	259.0 ± 74.8	0.6
ESR(2nd h) (mm/hr)	22.7 ± 27.3	14.5 ± 9.6	0.3
Serum albumin (g/dl)	4 ± 0.5	3.8 ± 0.2	0.4
PCO2 (mmHg)	49.5 ± 7.8	54.8 ± 4	0.04*
PO2 (mmHg)	73.9 ± 13.4	75.9 ± 12.3	0.6
SaO2 (%)	91.7 ± 4.4	92.1 ± 2.1	0.8
Positive sputum culture (%)	18(36.0)	9(90.0)	0.001*

ESR Erythrocyte sedimentation rate, *PCO2* Partial pressure of carbon dioxide, *PO2* Partial pressure of oxygen, *SaO2* Oxygen saturation

**p* is significant at ≤ 0.05

in India was tuberculosis, which was reported more frequently in males [25].

On the other hand, Taveira and Moss [26] reported that when following lung diseases in the context of sex and gender, bronchiectasis is well described to have a female predisposition. Also, Townsend et al. [27] and Vink et al. [28] postulated that, in common lung diseases including COPD and bronchiectasis, there is a tendency for increased severity in adult females.

For unknown reasons, bronchiectasis is a female predominant disorder in many countries worldwide [29]. This is evident across different age groups and although bronchiectasis is caused by a wide range of different etiologies, the female incidence predominates across the majority [30].

Research of the European Bronchiectasis Registry using the bronchiectasis severity index that included 11,204 patients, reported that males had more co-morbidities,

Table 4 Clinical and laboratory characteristics of ILD patients with and without bronchiectasis

Variable	ILD without bronchiectasis ($n=24$)	ILD + bronchiectasis ($n=10$)	*p* value
Cough (%)	23(95.8)	10(100.0)	0.5
Expectoration (%)	21(87.5)	9 (90.0)	0.8
Dyspnea (%)	23(95.8)	10(100.0)	0.5
Chest pain (%)	11(45.8)	6(60.0)	0.4
Hemoptysis (%)*	4(16.7)	9(90.0)	< 0.0001*
Fever (%)	3 (12.5)	0(0.0)	0.2
Wheezes (%)	18(75.0)	7(70.0)	0.7
Clubbing (%)	2(8.3)	0(0.0)	0.3
Tachypnea (%)	4(16.7)	2(20.0)	0.8
CRP(+ ve)	2(8.3)	0(0.0)	0.3
Random blood sugar			
-Non-diabetic	10(41.7)	5	0.5
-diabetic	11(45.8)	5	
-Pre-diabetic	3(12.5)	0	
Impaired kidney function (%)	1)4.2)	1(10.0)	0.5
Pulse (beat/min)	83.9 ± 8.4	80.7 ± 9.7	0.3
Systolic blood pressure (mmHg)	121.6 ± 13.4	121.2 ± 8.3	0.9
Diastolic blood pressure (mmHg)	77.9 ± 8.0	77.5 ± 7	0.9
Total leucocyte count (thousands/ c.mm)	7.7 ± 3.2	7.5 ± 1.8	0.8
Hemoglobin (g/dl)	13.1 ± 1.3	13.3 ± 1.1	0.8
Platelets)thousands/ c.mm)	246.9 ± 72.6	237.5 ± 27.5	0.7
ESR(2nd h) (mm/h)	29.7 ± 32.1	18.3 ± 20.1	0.3
Serum albumin (g/dl)	4 ± 0.5	4.1 ± 0.4	0.6
PCO2 (mmHg)	46.5 ± 11.4	53.6 ± 4.8	0.1
PO2 (mmHg)	71.9 ± 14.7	72.5 ± 12.2	0.9
SaO2 (%)	91.1 ± 5.3	90.3 ± 7	0.7
Positive sputum culture (%)	5(20.8)	7(70.0)	0.006*

Significance is considered at ≤ 0.05

were more likely to have co-existing COPD, and had a higher severity of disease [31, 32].

Presumed that bronchiectasis is an incurable and chronic condition, the underlying inflammation and destruction of the lung may lead to recurrent bleeding [33].

This is in agreement with our study as it was noticed that COPD and ILD accompanied with bronchiectasis were significantly associated with a higher incidence of hemoptysis as compared to COPD and ILD without bronchiectasis. Bronchiectasis is a common etiology in hemoptysis presentations [34]. In a French cohort of bronchiectasis patients, one in five patients had a history of hemoptysis [35].

Blood gas analysis is a common diagnostic tool to evaluate the partial pressures of gases in blood and acid–base status. Understanding and use of blood gas analysis enable clinicians to interpret respiratory, circulatory, and metabolic disorders [36].

How far bronchiectasis affects function in cases of COPD or ILD is not well studied. In this study, using arterial blood gases as a measure of the COPD patients with bronchiectasis

Table 5 Comparison between COPD with bronchiectasis and ILD with bronchiectasis vs. cases of bronchiectasis only

Variable	COPD + Bronchiectasis ($n=10$)	ILD + Bronchiectasis ($n=10$)	Bronchiectasis only ($n=7$)	*p* value
Cough (%)	10(100.0)	10(100.0)	7(100.0)	––––-
Expectoration (%)	10(100.0)	9(90.0)	6(85.7)	0.5
Dyspnea (%)	10(100.0)	10(100.0)	7(100.0)	–––––
Chest pain (%)	5(50.0)	6(60.0)	3(42.8)	0.7
Hemoptysis (%)*	9(90.0)	9(90.0)	7(100.0)	0.6
Fever (%)	0(0.0)	0(0.0)	2(28.6)	0.06
Wheezes (%)	9(90.0)	7(70.0)	6(85.7)	0.5
Clubbing (%)	0(0.0)	0(0.0)	1(14.3)	0.2
Tachypnea (%)	2(20.0)	2(20.0)	4(57.1)	0.2
CRP(− ve)	10(100.0)	8(80.0)	5(71.4)	0.2
Random blood sugar				0.4
-Non-diabetic	7(70.0)	5(50.0)	4(57.1)	
-Diabetic	3(30.0)	5(50.0)	2(28.6)	
-Pre-diabetic	0(0.0)	0(0.0)	1(14.3)	
Impaired kidney function (%)	0(0.0)	1(10.0)	2(28.6)	0.1
Pulse (beat/min)	81.9 ± 8.4	80.7 ± 9.7	85.3 ± 8.6	0.6
SBP (mmHg)	124.5 ± 9.5	121.2 ± 8.3	133.3 ± 15	0.1
DBP (mmHg)	77 ± 7.1	77.5 ± 7	83.3 ± 11.7	0.3
TLC (thousands/ c.mm)	7.7 ± 1.3	7.5 ± 1.8*	10.8 ± 3**	0.008
Hemoglobin (g/dl)	13.6 ± 0.9	13.3 ± 1.1	13.6 ± 1.5	0.7
Platelets)thousands/ c.mm)	259.0 ± 74.8	237.5 ± 27.5	256.5 ± 39.8	0.6
ESR(2nd h) (mm/hr)	14.5 ± 9.6	18.3 ± 20.1	13.2 ± 5.2	0.7
Serum albumin (g/dl)	3.8 ± 0.2	4.1 ± 0.4	4 ± 1	0.6
PCO2 (mmHg)	54.8 ± 4*	53.6 ± 4.8##	43.8 ± 6.3#	0.001
PO2 (mmHg)	75.9 ± 12.3	72.5 ± 12.2	83.6 ± 7.6	0.2
SaO2 (%)	92.1 ± 2.1	90.3 ± 7	93.1 ± 2.1	0.4
Positive sputum culture (%)	9(9.0)	7(70.0)	6(85.7)	0.08

* *P* is significant when ILD with bronchiectasis compared to bronchiectasis ($p=0.004$)

** *p* is significant when COPD with bronchiectasis compared to bronchiectasis ($p=0.006$)

\# *p* is significant when ILD with bronchiectasis compared to bronchiectasis ($p=0.002$)

\#\# *p* is significant when COPD with bronchiectasis compared to bronchiectasis ($p=0.001$)

showed a significant increase in the mean partial pressure of carbon dioxide (PCO2) in comparison to COPD patients without bronchiectasis, as well as in comparison to patients with bronchiectasis only. Similarly, in ILD patients with bronchiectasis, the mean PCO2 was also significantly higher than that in patients with bronchiectasis only. While arterial oxygen tension (PO2) and arterial oxygen saturation (SaO2%) were statistically insignificant in all groups.

Similarly Zhaosheng et al. [37] postulated that in bronchiectasis patients, co-morbidity with COPD and ILD are independent risk factors for impaired pulmonary function.

The dilated airways in patients with bronchiectasis become a focus for colonization of different types of bacteria and fungi predisposing patients to exacerbations, so sputum culture remains the most important investigation

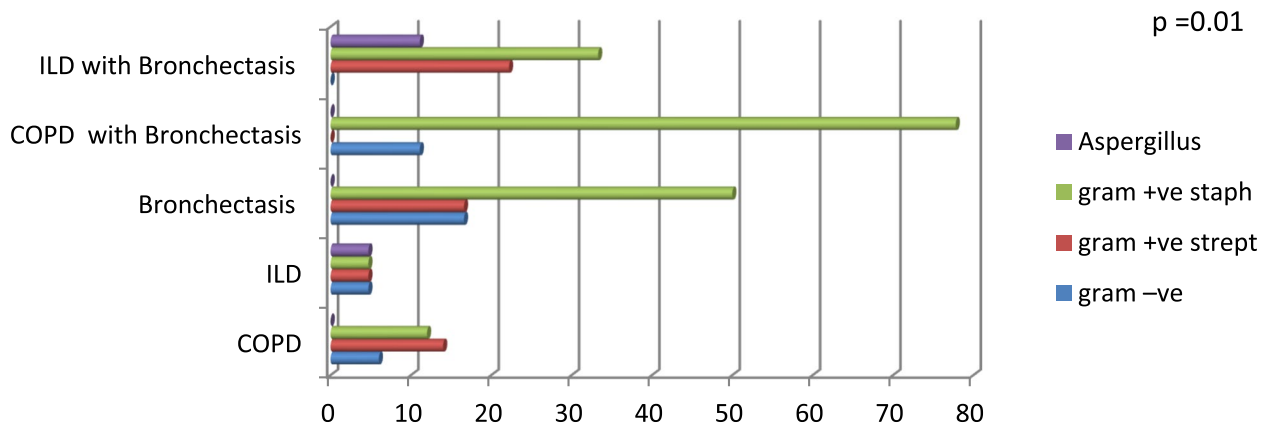

Fig. 2 Bar chart of sputum culture isolates among the different studied groups

Table 6 Results of sputum culture isolates in the studied patients

Disease	Sputum culture ($n = 88$)						
	No organism No. (%)	Normal Flora No. (%)	grame –ve No. (%)	grame + ve strept No. (%)	grame + ve staph No. (%)	Aspergillus No. (%)	Total
COPD	13 (30.2)	14 (32.5)	3 (7.0)	7 (16.3)	6 (14.0)	0 (0.0)	43
ILD	4 (19.0)	13 (61.9)	1 (4.7)	1 (4.7)	1 (4.7)	1 (4.7)	21
Bronchiectasis	0 (0.0)	1 (16.6)	1 (16.6)	1 (16.6)	3 (50.0)	0 (0.0)	6
COPD + bronchiectasis	1 (11.1)	0 (0.0)	1 (11.1)	0 (0.0)	7 (77.8)	0 (0.0)	9
ILD + ronchiectasis	B	2 (22.2)	0 (0.0)	2 (22.2)	3 (33.3)	1 (11.1)	9

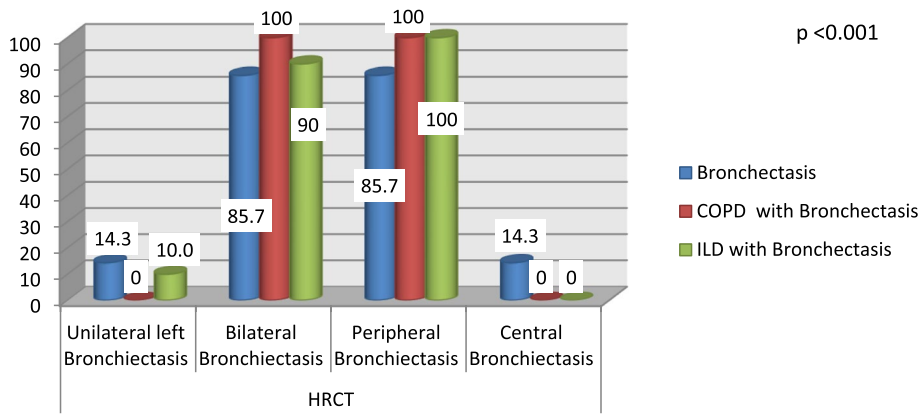

Fig. 3 Statistical Distribution of different bronchiectasis types based on HRCT findings

in diagnosis as well as for monitoring of bronchiectasis progression [38].

Moreover, this study revealed that the mean total leucocytic count (TLC) showed also a significant elevation among COPD with bronchiectasis patients and ILD with bronchiectasis patients in comparison to patients with bronchiectasis only. COPD and ILD accompanied with bronchiectasis were significantly associated with more

Table 7 Statistical Distribution of different bronchiectasis types based on HRCT findings

HRCT findings	CT finding		
	Bronchiectasis No. (%)	COPD + bronchiectasis No.(%)	ILD + bronchiectasis No. (%)
Unilateral left bronchiectasis	1(14.3)	0 (0.0)	1(10.0)
Bilateral bronchiectasis	6(85.7)	10(100.0)	9(90.0)
Peripheral bronchiectasis	6(85.7)	10(100.0)	10(100.0)
Central bronchiectasis	1(14.3)	0(0.0)	0(0.0)
Total no. (%)	7(100.0)	10(100.0)	10(100.0)
p value	< 0.001[a]		

[a] Significance is considered at ≤ 0.01

frequent gram-positive sputum culture (90% and 70% respectively) and more liability for bacterial and fungal colonization than COPD and ILD patients without bronchiectasis (36% and 20.8% respectively).

Pseudomonas aeruginosa is a familiar, opportunistic, Gram-negative bacterium that is commonly cultured in bronchiectasis patients [39]. The most common microorganisms isolated from Europe and Asia included Pseudomonas aeruginosa and H. influenza. In contrast, data from the US Bronchiectasis Research Registry suggested a predominance of non-tuberculous mycobacteria (NTM) about 50%, followed less frequently by Pseudomonas aeruginosa (33%), and staphylococci (12%) [35]. While pane et al. [40] reported that, from sputum cultures of the 60 cases of bronchiectasis, Pseudomonas aeruginosa (36%) was the primary pathogen isolated, followed by Klebsiella pneumonia (20%). Also, Singh et al. [41] reported that; patients with Pseudomonas growth in sputum cultures had the more severe disease in the form of a greater number of lobes involvement and cystic destruction.

Goeminne et al. [42] discussed the risk factors in bronchiectasis cases and found that; 10% were ILD and 12% were COPD while the main bacteria were, Haemophilus influenza in31%, Pseudomonas aeruginosa in 30%, Staphylococcus aureius in 23%, Streptococcus pneumonia in 20%, Aspergillus fumigatus in 20%, and Moraxella catharralis in 15% of the patients. Pseudomonas aeruginosa, Moraxella cattharalis, Streptococcus pneumonia were seen significantly more often in COPD patients and less in patients with interstitial lung disease.

The variability of predisposing factors and disease severity brings to light the need for clinico-radiographic correlation for providing the patients with their ultimate diagnosis and treatment plan [43].

In our study, using HRCT for the detection of bronchiectasis distribution in cases of COPD and ILD in comparison with cases with bronchiectasis only revealed that bilateral and peripheral bronchiectasis was the most common among cases of COPD with bronchiectasis followed by ILD with bronchiectasis more cases with bronchiectasis only.

While Pane et al. [40] reported that left lower lobe had more involvement in bronchiectasis patients, Singh et al. [41] study revealed the involvement of two or more lobes in bronchiectasis, and the most common pattern was bilateral lower lobe involvement.

Conclusion

The coexistence of bronchiectasis with other chronic respiratory diseases is recognized increasingly. When these co-morbidities are present like COPD or ILD, the prognosis is worse. Both are associated with a higher incidence of hemoptysis with bacterial and fungal colonization, their sputum cultures detected more positive organisms than negative in comparison to cases of bronchiectasis only. A combination of clinical, radiological, and microbiological features of COPD and ILD can be used to assess the severity of bronchiectasis. Follow-up and screening of COPD and ILD patients using HRCT scanning is a recommended preventive measure for early detection of bronchiectasis. Future work will be a large-scale longitudinal prospective cohort study to determine the cause-effect relationship between bronchiectasis and COPD or ILD.

Limitations and strengths

One of the important strengths of this study is that it was the first Egyptian study to establish clinical comparisons between COPD with/without Bronchiectasis and ILD with/without Bronchiectasis which may be very important in the implementation of treatment strategies. The study was retrospective and therefore it relied on the available data only, for example, it was necessary to include pulmonary function tests for all patients in this study, but unfortunately, it was not available to everyone and therefore it was canceled from the statistical analysis, and we relied on the arterial blood gases.

Authors' contributions
The author(s) read and approved the final manuscript.

Availability of data and materials
The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Competing interests
The authors declare that they have no competing interests.

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