Bacteriologic Evaluation in Patients With Bronchiectasis

Gürsel Çok, MD; Mustafa Özhan, MD; Berrin Doğan, MD

Department of Chest Diseases, Ege University Faculty of Medicine, İzmir, Turkey

Abstract

Background: Patients with bronchiectasis have colonized airways that cause repetitive infections leading to damage in the lower respiratory tract.

Objectives: This study aimed to determine the distribution of infectious agents in patients with infective episodes of bronchiectasis and the factors that have the potential to influence the bacteriological spectra.

Methods and Results: A retrospective analysis of 181 episodes in 88 patients with bronchiectasis showed that *P. aeruginosa* was the causative agent in 23 (32%), *S. pneumoniae* in 17 (24%) and *H. influenzae* in 16 (22%) episodes. There was a slight but statistically insignificant trend to host hospital-acquired pathogens (e.g. *P. aeruginosa* and *S. aureus*) in patients with cystic bronchiectasis. No correlation was found between the isolated infectious agents and the duration of symptoms, number of previous hospitalization, radiological presentation of bronchiectasis. In patients with COPD and bronchiectasis *H. influenzae* was the leading pathogen while in bronchiectasic patients with no COPD or with comorbidities other than COPD, *P. aeruginosa* was found more frequently.

Conclusion: The bacterial spectrum in patients with bronchiectasis during acute infective episodes was consistent with the results of previous studies and no correlations were found between the isolated infectious agents and the duration of symptoms, number of previous hospitalization, or radiological presentation of bronchiectasis.

Turkish Respiratory Journal, 2005;6:(2):84-88

Keywords: *bronchiectasis, COPD, infection*

Introduction

Bronchiectasis is characterized by an irreversible dilatation of the bronchi caused by a damaged bronchial wall. The bronchial ciliary clearance is affected, leading to retention of the mucus in the dilated bronchi and facilitating development of chronic infection in the lower respiratory tract.

Although the extensive usage of antibiotics diminished the total number of bronchiectasis cases, the chronicity and disabling character of the disease still make this disorder a health problem. The patients are prone to suffer from repetitive lower respiratory tract infections that lead to a chronic inflammatory response. Many investigators have shown that inflammatory indices such as exhaled nitric oxide and hydrogen peroxide were elevated in patients with bronchiectasis (1,2).

The sterility of the lower respiratory tract is lost in the majority of patients with chronic airway diseases. In diseases like chronic obstructive pulmonary disease (COPD) and bronchi-

Corresponding Author: *Gürsel Çok*
Ege Üniversitesi Tıp Fakültesi, Göğüs Hastalıkları Anabilim Dalı, İzmir, Türkiye
Phone : +90 (232) 390 34 91
Fax : +90 (232) 388 71 92
E-mail : gürsel@med.ege.edu.tr

ectasis, the lower respiratory tract is often colonized with potentially pathogenic microorganisms (PPMs). Even in clinically stable patients PPMs may be isolated in 60-90% of patients (3,4). Sputum examination is an easy procedure to investigate respiratory colonisation but it may reflect oropharyngeal flora as well. Bronchoscopic diagnostic procedures may be used for further microbiological evaluation but these are time consuming and expensive. For this reason, there are few studies where the bacteriological flora is investigated by invasive techniques in patients with bronchiectasis.

Streptococcus pneumoniae, *Pseudomonas aeruginosa* and *Haemophilus influenzae* are three major bacteriologic agents that are accepted as causative for the exacerbations in patients with bronchiectasis (5). The severity and the extent of the bronchiectasis may alter the bacteriologic spectrum switching towards *Staphylococcus aureus* and enteric Gram (-) enterococci.

The aim of the current study is to determine the bacteriologic spectrum of our patient population and to investigate the determinants of chronic infection in patients with bronchiectasis.

Materials and Method

The study was conducted retrospectively by reviewing the files of patients who have been treated in our department with a diagnosis of bronchiectasis.

The study population was selected only from among those patients who had a radiological confirmation of their diagnosis with high-resolution computerized tomography of the thorax (HRCT) or a chest roentgenogram with a clinical presentation consistent with bronchiectasis. Either thickened dilated bronchi, cystic lesions with or without fluid level on a chest roentgenogram or a bronchus larger than its adjacent pulmonary artery and failure of a bronchus to taper with increasing distance from the hilum on an HRCT were accepted as radiological signs of bronchiectasis.

The diagnosis of COPD as a comorbid condition was based on a smoking history, partial reversible airway obstruction in pulmonary function tests, diminished lung sounds with ronchi in auscultation and evidence of emphysema in chest X-ray.

The patient files were reviewed for demographic data, clinical and microbiologic information. The relationships between the organisms obtained from the sputum and the type, extent of the bronchiectasis and the duration of the disease were investigated. The type of the bronchiectasis could be established only in patients who had HRCT. The extent of lung involvement was estimated by recording the number of lobes that exhibited the radiological criteria for the diagnosis.

The sputum was obtained in a sterile container and Gram stained in two hours after the expectoration. Sputum samples with less than 10 epithelial cells and more than 25 leucocytes per field were processed microbiologically. The samples were plated on blood and chocolate agars.

Spirometric data was obtained in some of the patients. Pulmonary function tests were obtained using a rolling seal spirometer (SensorMedics, 2400, USA) and interpreted according to American Thoracic Society criteria.

Non-parametric and parametric statistical analyses of the data were performed using Chi-square, Levene's and Student t- tests. Statistical significance was set at a p value less than 0.05.

Results

We investigated 181 infective episodes in 88 patients (52 males and 36 females) of a mean age of 55.6±15 years. Forty- eight (55%) of the patients were current or past smokers. The demographics are presented in Table 1. A comorbid illness and/or a history of a lung disease, which could have led to bronchiectasis was present in 77 (88%) patients. COPD was the leading comorbid condition and was diagnosed in 28 (32%) of the patients. A past history

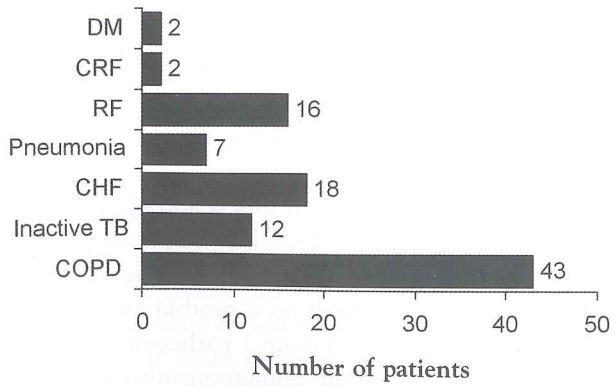

Figure 1. *The distribution of comorbid illnesses. (DM: diabetes mellitus; CRF: Chronic renal failure; RF: Respiratory insufficiency; CHF: Chronic heart failure; TB: Tuberculosis)*

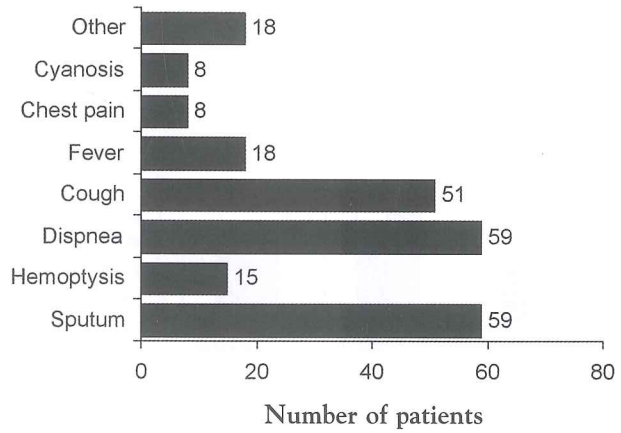

Figure 2. *The distribution of symptoms.*

Table 1. Demographic findings		
Gender [n (%)]	Male	52 (59.1)
	Female	36 (40.9)
Age, years (mean)		55.6 (±15.6)
Smoking [n (%)]	Current	25 (28.4)
	Ex-smoker	23 (26.1)
	Never	40 (45.5)
	Pack years	41.8 (±23.5)
Duration of symptoms, years (mean)		7.2 (±8.1)

of pulmonary tuberculosis was present in 21 (24%) patients. Figure 1 shows the distribution of comorbid illnesses. The clinical presentation of patients with an infective episode of bronchiectasis consisted of dyspnea on exertion and sputum expectoration in 17 (19.3%). Hemoptysis was reported in 15 (17%) patients. The distribution of the symptoms at admission is summarized in Figure 2.

Chest roentgenogram was obtained in all patients. A normal chest X-ray was found in 4 (4.5%) of patients. In patients with abnormal findings, bilateral lower lobes were involved in 27 patients (30.7%), the right lower lobe in 17 (19.3%) and the left lower lobe in 8 patients (9.1%). Upper lobe bronchiectasis was present in 12 patients (13.6%). HRCT was available in 45 patients (51%). Cystic bronchiectasis with or without fluid level was found in 25 of these 45 patients (67%), fusiform in type in 14 (14.8%) and honeycombing in 4 (4.5%). Figure 3 demonstrates the HRCT scan findings in tne study population.

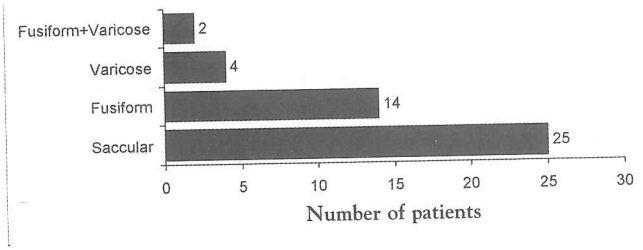

Figure 3. *The HRCT scan findings.*

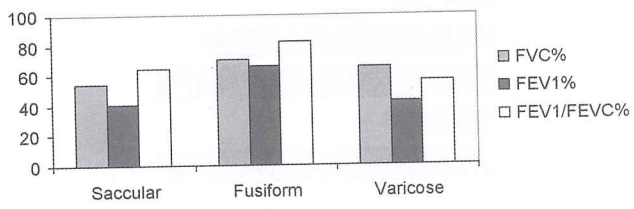

Figure 4. *The distribution of FVC and FEV_1 values as percent of predicted between patients with different types of bronchiectasis.*

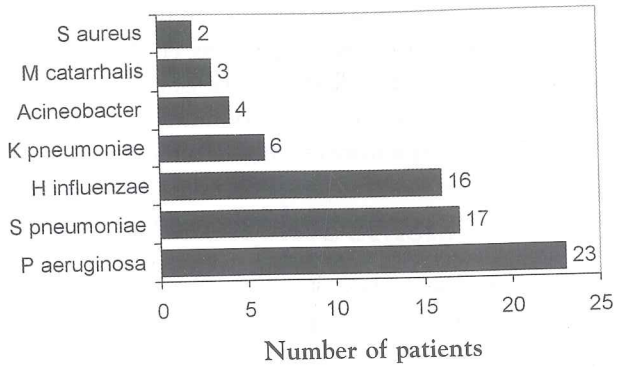

Figure 5. *The distribution of isolates obtained from patients with bronchiectasis.*

Spirometric results were available in 36 patients (41%). Forced vital capacity (FVC) and forced expiratory volume at one second (FEV_1) were found as 54±18% and 41±19% of predicted value in patients with cystic lesions respectively, and both values were significantly lower when compared to values in patients with other types of bronchiectasis (p=0.009 and p=0.047, respectively). Figure 4 shows the distribution of FVC and FEV_1 values as percent of predicted between patients with different types of bronchiectasis.

One hundred and fifty-three appropriate bacteriologic examinations of sputum were obtained in 181 episodes and 71 (46.4%) isolates were identified in the sputum. The predominant isolate was *P. aeruginosa* in 23 (32.2%), followed by *S. pneumoniae* in 17 (23.9%) and *H. influenzae* in 16 (22.5%) patients. The isolates obtained from patients with bronchiectasis are summarized in Figure 5.

When the bacteria isolated from sputum were divided in two groups as community acquired infectious agents (Group 1 agents, e.g. *S. pneumoniae, H. influenzae)* and hospital acquired infectious agents (Group 2 agents, e.g. *P. aeruginosa, S. aureus)*, community acquired infectious agents were isolated in only patients with fusiform bronchiectasis whereas hospital acquired infectious agents were mostly isolated in patients with honeycombing or cystic bronchiectasis. There were 14 patients with fusiform bronchiectasis, a responsible pathogen was identified in 5 and all were group 1 organisms. On the other hand, 66 pathogens were isolated from 29 patients with cystic bronchiectasis and 36 of these (54.5%) were group 2 pathogens. The difference between the two groups was not significant (p=0.06).

COPD was the major comorbid illness and 43 of the patients with bronchiectasis had COPD. The distribution of pathogens in patients with bronchiectasis and COPD was not different from those with no comorbid disease or any disease other than COPD. Group 1 pathogens were isolated in 22 episodes and group 2 microorganisms in 28 episodes out of a total of 116 episodes in patients with bronchiectasis and COPD. There were 65 episodes in 45 patients with bronchiectasis alone or other comorbidities and

group 1 bacteria were isolated in 13 and group 2 in 8 episodes. The statistical analysis showed no significant difference between the two groups of patients (p=0.2).
Relationships between isolated infectious agents and the duration of symptoms, number of previous hospitalization, radiological presentation of bronchiectasis also showed no statistical significance. The duration of symptoms and the number of involved lung lobe showed a positive correlation (r=0.403, p=0.006).

Discussion

The current study demonstrates the bacteriological spectrum of 181 infective episodes of patients with bronchiectasis. *P. aeruginosa* was found to be the most frequently isolated microorganism as our patient profile consisted of patients with a high rate of hospitalization (6,7). We investigated 181 infective episodes in 88 patients. Many patients were also suffering from chronic lung diseases like COPD and inactive tuberculosis. These factors tend to influence the bacterial spectrum in patients with bronchiectasis towards Gram (-) bacilli. Nicotra et al, in a retrospective study concerning 123 patients with bronchiectasis, showed that *P. aeruginosa* was responsible for the infection in 31%, *H. influenzae* in 30% and Gram positive *coccobacilli* in 18% of their study population (6). A similar bacterial distribution was found in a Chinese study done by Ho et al, where *P. aeruginosa* was the leading pathogen affecting 33% of the patients (7). In Turkey, where tuberculosis is the predominant factor for developing adult bronchiectasis, a similar bacterial distribution was found in our patients.
In our study group, there was no genetic disorder or systemic immune deficiency as causative medical features. Bronchial damage appeared to result mostly from a past bacterial, viral or mycobacterial infection and a prior pulmonary tuberculosis was found to be the predominant infection. Absence of other bacteria like aspergillus and nocardia in the cultures may be explained by the immune status of our patient group. In a study where 150 patients with bronchiectasis were examined for causative agents, the serology for aspergillosis was positive in 19% of patients, but when other criteria for the diagnosis of aspergillosis were taken into account, aspergillus infection was found in only 7% of the patients (8).
Hemoptysis is known to be a major symptom in patients with bronchiectasis and sometimes may lead to death. In our study, hemoptysis was present in only 15% of the patients. Sputum expectoration and dyspnea were found to be leading presenting symptoms. As our patients consisted of those with an acute infective episode, it is possible that symptoms related to the infection were dominant, leaving symptoms seen in stable bronchiectasis in the background.
The radiological evaluation of our patients showed a lower lobe and right side predominance. The further radiological analysis with HRCT was available in only half of our patients and analysis as to type of bronchiectasis could be done in only these patients. The cystic type of bronchiectasis was found in 67% of these patients, a finding which can be attributed to the severity of the damage in the lung parenchyma, to the coexistence of a heavy smoking pattern and also to COPD. There was a trend towards a preponderance of Gram negative bacteria in patients with cystic bronchiectasis.
As cystic bronchiectasis and honeycombing are the two severe forms of bronchiectasis, with *Pseudomonas* as the frequently encountered microorganism, the spirometric values of our patients with cystic and honeycombing bronchiectasis were found to be lower than those of patients with less severe forms of bronchiectasis. This finding is consistent with the data presented by Evans et al and Linch et al, which show poor lung function in patients with bronchiectasis who are colonized with *Pseudomonas* (9). Chronic expectoration, evidence of varicose or cystic forms of bronchiectasis, diagnosis before 14 years of age, presence of sinusitis and lung function impairment stood out as the risk factors associated with airway colonisation by bacteria in the univariate and multivariate analysis of 77 stable patients with bronchiectasis in a recently published article by Angrill et al (10).
It is thought that invasive bronchoscopic procedures may bring out more accurately the causative agent in the lower respiratory tract. In this study, sputum examination was used in all patients for the bacteriological evaluation, as sputum collection is non-invasive and easy to apply. In the study done by Angrill, the results of BAL fluid and of sputum analysis agreed in 75% of the patients in whom both techniques were used (10). The negative predicted value was found as 66%. Some patients with negative sputum cultures may have bacteria in their lower respiratory tract and deserve further invasive investigation in order to discover the causative agents. Since this present study was based on a retrospective evaluation, it was not possible to evaluate the patients in the 110 episodes with negative sputum cultures by further bronchoscopic investigations.
In summary, this study has shown that the bacterial spectrum in patients with acute infective episode of bronchiectasis was consistent with those found in previous studies, with *H. influenzae*, *S. pneumoniae* and *Pseudomonas* species standing out as the most common causative agents. A trend towards Gram negative bacilli was found to be present in patients with more advanced disease and with cystic or varicose forms of bronchiectasis. Because of the high rate of colonization in patients with chronic destructive airway diseases, it is always advisable to monitor respiratory pathogens to avoid inappropriate antibiotic treatment.

References

1. Kharitonov SA, Wells AU, O'Connor BJ, Cole PJ, Hansell DM, Logan-Sinclair RB, Barnes PJ. Elevated levels of exhaled nitric oxide in bronchiectasis. Am J Respir Crit Care Med 1995;151(6):1889-1893.
2. Loukides S, Horvath I, Wodehouse T, Cole PJ, Barnes PJ. Elevated levels of expired breath hydrogen peroxide in bronchiectasis. Am J Respir Crit Care Med 1998;158(3):991-994.
3. Cabello H, Tores A, Celis R, El-Ebiary M, Puig de la Bellacasa J, Xaubet A, Gonzalez J, Agusti C, Soler N. Bacterial colonisation of distal airways in healthy subjects and chronic lung disease: a bronchoscopic study. Eur Respir J 1997;10:1137-1144.
4. Pang JA, Cheng A, Chan HS, Poon D, French G. The bacteriology of bronchiectasis in Hong Kong investigated by protected catheter brush and bronchoalveolar lavage. Am Rev Respir Dis 1989;139:14-17.
5. Barker AF. Bronchiectasis. N Engl J Med 2002;346(18):1383-93
6. Nicotra MB, Rivera M, Dale AM, Shepherd R, Carter R. Clinical, pathophysiologic and microbiologic characterization of bronchiectasis in an aging cohort. Chest 1995;108:955-961.
7. Ho PL, Chan KN, Ip MS, Lam WK, Ho CS, Yuen KY, Tsang KW. The effect of Pseudomonas aeruginosa infection on clinical parameters in steady-state bronchiectasis. Chest 1998;114:1594-1598.
8. Pasteur MC, Helliwell SM, Houghton SJ, Webb SC, Foweraker JE, Coulden RA, Flower CD, Bilton D, Keogan MT. An investigation into causative factors in patients with bronchiectasis. Am J Respir Crit Care Med 2000;162(4):1277-1284.
9. Evans SA, Turner SM, Bosch BJ, Hardy CC, Woodhead MA. Lung function in bronchiectasis: the influence of Pseudomonas aeruginosa. Eur Respir J 1996;9:1601-1604.
10. Angrill J, Agusti C, Celis R, Rano A, Gonzalez J, Sole T, Xaubet A, Rodriguez-Roisin R, Torres A. Bacterial colonisation in patients with bronchiectasis: microbiological pattern and risk factors. Thorax 2002; 57:15-19.