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Lung volumes and the most common bacterial colonization in patients with allergic airways disease

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Abstract

This study was aimed to investigate the relationship between bacterial colonization and lung function tests in allergic airways disease patients .Two groups of individuals were included in this study; 17 healthy subjects group and 21 patients with allergic airways disease group, which was further subdivided into two subgroups;8 smokers and 13 non smokers .Lung function tests were estimated by using a micro medical lab spirometer. Bacterial colonization was identified in the sputum sample of each individual .The results showed significant declines in the lung function tests FEV1, FVC and FEV1 (2.74, 3.49 and 77.4) respectively ($p<o.o5$) for the patients with allergic airways disease .Bacterial colonization identification showed different type of bacterial isolates in the two studied groups .The most common bacterial isolates of the patients group belong to *Streptococcus pneumonia*, *Staphylococcus aureus* and *E coli*. There was no interaction between the lung volumes and bacterial colonization among the subjects colonized by different types of bacteria within the same group.

Key words: lung volumes, allergic airways, bacteria

1. Introduction

Allergic airways as a chronic obstructive airway disease constitutes a major health problem[1].Chronic allergic airways disease is characterized by progressive decline in lung function and inflammatory changes [2].Common triggers for allergic airways disease include : air pollution and viral or bacterial infection of the airways, but the cause of approximately one third of sever exacerbations cannot be identified and the role of bacteria species in the chronic obstructive pulmonary disease has been studied more than two decades. Despite some ongoing as debate, the preponderance of current evidence suggests that bacterial infection plays a causative role in the pathogenesis of acute exacerbation, while the role of bacteria in the initial stage is less clear [3]. Previous study has concluded that stable COPD (Chronic Obstructive Pulmonary Disease) patients have lower airway bacterial colonization which may be an important structure to airway inflammation [4]. Smoking is the most important factor to cause inflammation in the lung and the variability in smoking behavior and airways inflammation caused by bacterial colonization may contribute to the progression of COPD[5].Patients with stable chronic obstruction exhibit increased

airways inflammation and the degree of inflammation positively related to the severity of airways obstruction with more bronchial inflammation in patients with lower FEV1(Forced Expiratory Volume at the first second of expiration)[6].Previous studies performed to evaluate the relationship between the airways bacterial colonization, inflammation and lung function have been cross-sectional in design, and have note addressed the important relationship between these parameters[5].Another study has addressed that bacterial colonization lead to increase airways inflammation and can contribute to the accelerated progression of airways obstruction.

1.1The aim of the study

The study was done in order to investigate the most common bacterial colonization in allergic airways disease during stable state as compare with healthy individual, and to illustrate the proportion of bacterial colonization with the deterioration in lung function as reflected by lung volumes measurement.

2. Material and method

2.1 Patients sample

The study was carried out on two groups: 21 patients with allergic lower airway disease within the age range of (25-60), and 17 apparently healthy subjects as a control, within (30-60) range of age. Patients group was further subdivided into two subgroups:8 allergic smokers and 13 allergic non smokers.

2.2 Lung function estimation

Lung function was evaluated by measurement of the pulmonary function tests FEV1,FVC(Forced Vital Capacity) and FEV1%(the ratio of FEV1/FVC)Which are the most common parameters used to evaluate the lung function and to give the respiratory diagnosis if the individual was healthy or with COPD such as allergic lower airway disease. The medical instrument used to measure the lung volumes is the medical micro lab spirometer(MicroMedical LTd England).Micro medical Spirometer is a compact battery ,operated, hand held spirometer ,and is precision instrument design to measure FEV1,FVC. Lung volumes measurements for all patients were done before 11:00 am .Three spirometry readings were taken for each individual in order to record the best of them [8], because spirometry procedure is subjected and depends on patients' cooperation and performance.

2.3 Sputum sample

Sputum samples were collected in sterile pot from each individual after completing the spirometry procedure .The sputum samples were analyzed bacteriologically by streaking on; blood agar, MacConkey agar ;and chocolate agar .The plates were incubated for 24hrat 37C$^{\circ}$ .Bacterial isolates were identified roughly according to the colonies appearance and gram staining .Gram positive bacteria were diagnosed depending on hemolysis types .Gram negative bacteria were diagnosed by IMVIC test (WHO, 2003)[9].

Statistical analysis: Statistical analysis of the data was done using t-tes, statistical package SPSS (Statistical Packages for Social Science).Data expressed by mean ±SD. The comparison between the studied groups was tested at the level of 0.05 of significance[10].Some of the data were analyzed by finding of LSD(Less Significant Differences) to compare between studied groups in a specific parameter expressed by the means .

3. Results

The results of the lung function tests showed that there are significant differences between the two studied groups in the three major lung volumes FEV1(2.74VS 3.30,LSD=0.35)FVC(3.8 VS 3.49,LSD=0.36)and FEV1%(77.4 VS 85.4,LSD=4.67),at the level 0.05 of significance ,as in table (1),which also showed that eight bacterial strains isolated from the patients with allergic airways disease .The most common bacterial isolates included are *Streptococcus pneumonia* ,*Staphylococcus aureus and E coli.* While four bacterial strains were isolated from the healthy group, most of them belong to *Streptococcus pyogenes and Streptococcus viridans.*

Table (2) illustrates the values of pulmonary volumes and the differences among the subgroups of the disease group and the healthy group .This table shows that there are significant differences between allergic non smoking patients (n=13) and healthy subjects(n=17) in all pulmonary volumes FEV1(2.66 VS 3.30,LSD=0.45),FVC(3.32VS3.87,LSD=0.46) and FEV1%(79.4VS85.4,LSD=5.93). There are also significant differences between allergic smoking patients(n=8) and healthy subjects(n=17) in FEV1,FVC and FEV1%(2.86VS3.30),(3.77VS 3.87)and (73.5 VS 85.4)respectively at the level 0.05 of significance .On the other hand there is no significant difference between the two subgroups smoking(n=8) and non smoking(n=13) of the allergic disease patients in all of these lung parameters . The table also shows that allergic non smoking patients have the highest number of bacterial isolates types (six), and the most common bacterial isolates are *Staphylococcus aureus and E coli*.

Table1.Lung volumes (means),the most common bacterial isolates and number of bacterial isolates of the two main groups.

Groups	NO.	FEV1	FVC	FEV1%	NO.of bacterial isolates types	The most common bacterial isolates
		MEAN				
Allergic patients	21	2.74	3.49	77.4	8	*Streptococcus.pneumonia* *Staphylococcus.aureus* *E.coli*
Healthy subjects	17	3.30	3.87	85.4	4	*Streptococcus.pyogenes* *Sterptococcus.viridans*
LSD		0.34	0.36	4.67		
P		0.032	0.037	0.021		

Table 2.Lung volumes, number of bacterial isolates types and the most common bacterial isolates in smoking, non smoking allergic patients and healthy subjects.

Groups	NO.	FEV1	FVC	FEV1%	NO.of bacterial isolates types	The most common bacterial isolates
		MEAN				
Allergic smokers	13	2.66	3.32	79.4	6	*Staphylococcus.aureus* *E.coli*
Allergic non smokers	8	2.86	3.77	73.5	4	*Streptococcus pneumonia* *Klebsiella*
Healthy	17	3.30	3.87	85.4	4	*Streptococcus viridans* *Streptococcus epidermidis*
LSD		0.45	0.46	5.93		
P* P**		0.021 0.043	0.027 0.046	0.036 0.022		

P*: P values when comparing between allergic smokers and healthy subjects.
P **:P values when comparing between allergic non smokers and healthy subjects.

Table (3)illustrates lung function tests FEV1, FVC and FEV1% expressed by mean ±SD in each bacterial isolates and the percentage of each isolates of the allergic non smoking patients.The most dominant bacterial isolates within this subgroup were *Ecoli* and *Staphylococcus aureus* ,which exhibit the same percentage (3/13)(69.23%).Infected patients by these bacterial isolates *E coli* and *Staphylococcus aureus* have the lowest value of FEV1:(2.57±0.15 and 2.57±0.34 respectively .While the lowest value of FEV1%75.25±5.3 was for the patients infected by *Streptococcus pneumonia* ,the next dominant bacterial isolates (30.76%).On the other hand ,the most common bacterial isolates within the allergic smoking patients were *Streptococcus pneumonia* (4/8)(50%).Patients infected by this bacteria have lung function tests FEV1,FVC and FEV1% values(2.93±0.36,3.92±0.35 and 71.75±3.2)respectively ,as illustrated in table (4).This table shows also that the greatest deterioration in the three lung volumes are FEV1,FVC and FEV1%(2.44±0.34,3.59±0.31and 66.5±2.5)respectively was for that of patients infected by *Klebsiella* with the percentage of (25%).While the lowest percentage of bacterial isolates within this subgroup are *Staphylococcus aureus* (12.5)and mixed isolates of both *Streptococcus* and *Klebsiella* .

Table (5)shows categories of patients according to the bacterial isolates and the three lung volumes for each subgroup of subjects infected by specific bacterial isolate within the healthy group .The most common bacterial isolate was *Staphylococcus epidermidis* (35.29%).FEV1,FVCand FEV1% of this subgroup were 3.52±0.25,4.03±0.25 and 88.16±2.1)respectively While the lowest percentage of bacterial isolates was that for *Dipococci* (17.64%).Patients with this bacteria revealed the greatest decline in the three lung volumes (2.78±0.19,3.36±0.21 and 82.66±2.3)for each of FEV1,FVCand FEV1%,respectively.

Table 3. Lung volumes (mean) of patients occupied by certain type of bacterial isolation and the percentage of bacterial isolate within allergic non smoking patients subgroup.

Bacterial isolates	Percentage	Mean ±SD		
		FEV1	FVC	FEV1%
E coli	69.23	2.57 ±0.15	3.26 ±0.15	76.33 ±1.7
Staphylococcus aureus	69.23	2.67 ±0.46	3.16±0.46	82.3 ±1.7
Staphylococcus + Streptococcus	7.67	2.7 ±0.48	2.99±0.24	90.0 ±1.9
Pseudomonas	7,67	2.82 ±0.22	3.35±0.17	85.0 ±2.1
Proteus	7.67	3.1 ±0.41	4.1 ± 0.21	85.0 ±2.3
Streptococcus pneumonia	30.76	2.57 ±0.34	3.43±0.41	75.25 ±5.3

Table 4. Lung volumes (mean) of patients occupied by certain type of bacterial isolation and the percentage of bacterial isolate within allergic smoking patients subgroup.

Bacterial isolates	**Percentage**	**Mean ±SD**		
		FEV1	**FVC**	**FEV1%**
Streptococcus pneumonia	**50**	**2.93 ± 0.36**	**3.92 ±0.35**	**71.75 ±3.2**
Klebsiella	**25**	**2.44 ±0.34**	**3.59 ±0.31**	**66.5 ±2.5**
Staphylococcus aureus	**12.5**	**2.84 ±0.41**	**3.2 ±0.29**	**88.0 ±4.1**
Streptococcus+Klebsiella	**12.5**	**3.43 ±0.37**	**4.1 ±0.38**	**80.0 ±3.8**

Table 5.Lung volumes (mean) of patients occupied by certain type of bacterial isolation and the percentage of bacterial isolate within healthy group.

Bacterial isolates	Percentage	Mean ±SD		
		FEV1	FVC	FEV1%
Streptococcus pyrogens	20.54	2.93 ± 0.36	3.92 ±0.35	71.75 ±3.2
Streptococcus viridans	23.53	2.44 ±0.34	3.59 ±0.31	66.5 ±2.5
Staphylococcus epidermidis	38.19	2.84 ±0.41	3.2 ±0.29	88.0 ±4.1
Diplococcic	17.64	3.43 ±0.37	4.1 ±0.38	80.0 ±3.8

4. Discussion

Data analysis of the results of this study demonstrated that there is significant decline in the lung volumes studied FEV1,FVC and FEV1% of the allergic airway disease patients ,which is characteristic of COPD ,even during stable state .Similar finding was observed by other study[7].

Qualitative detection of the bacteriological analysis showed that allergic patients have more variety of bacterial colonization from sputum sample than healthy subjects There are about eight bacterial strains in allergic patients .These are *E coli* ,*Staphylococcus aureus* ,*Pseudomonas* ,*Proteus, Streptococcus pneumonia* and mixed growth of *Staphylococcus* and *Streptococcus* . Healthy subjects have only four bacterial genus .These are *Streptococcus pyrogens* ,*Streptococcus viridians* ,*Staphylococcus epidermidis* and *diplococci* ,as reported by many other studies [11 ,12],which identified presence of bacterial colonization in the lower airways of healthy non smoking ,while another study [7] found that the lower airways of healthy non smoking individuals are sterile. In a brief meaning the resent study showed that allergic patients have clear decline in lung function tests and increased varieties of bacterial colonization .This finding is in constant with the finding of other study, that is the individual who exhibited changes in the nature of bacterial colonization suffered from faster declines in lung function than those with persistence of one or more bacterial species [13].

Bacterial colonization is preinflammatory and can result in a range of pathological effects that deleterious to lung function tests [14,15].Bacteria affect the airways epithelium directly increasing inflammatory process .Airways inflammation has been shown to increase as airways obstruction worsens and bacterial colonization has been shown to be detrimental to lung function in number of pathological conditions[16,17,18].

Each of table 3, 4, 5 illustrated the analysis of each individual bacterial species and associated lung function test within each particular apart subgroup: allergic non smoking, allergic smoking individual and healthy non smoking demonstrating no significant differences in lung volumes between subjects colonized with different bacterial species. This finding is exactly in agreement with another study [7],which found that lung function change did not reveal any attributable significant difference in lung volumes between subjects colonized with different bacteria within the same subgroup .But the significant differences in the lung function and the variability of the bacterial colonization type were revealed when comparing the three studied subgroup with each other, although that the allergic smoking patients show less diversity in bacterial colonization compared to allergic non smoking patients and despite it is established that cigarette smoking is a risk factor for bacterial colonization and itself lead to increased airway inflammation and lower airway bacterial colonization is increased by active smoking and with progressive airway obstruction [11,12]. This may be explained by the fact that smoking is a trigger factor in allergic lower airways patients leading them to use antimicrobial therapy ,as a result reducing the number of bacterial colonization types within this subgroup compared to allergic non smoking patients. Other possible explanation may be due to the presence of ex-smoking patients within the allergic non smoking subgroup during stable state and that airways inflammation may persist in spite of smoking cessation [19]. This study supports the finding of other studies: the changes in bacterial species were not related to the number of cigarette smoked, sputum collection method and the recorded exacerbation frequency [7].On the other hand healthy subjects showed less bacterial colonization than the patients group. It's found that most of these individuals are colonized by non specific growth(NSG),which was defined as isolation of non pathogenic microorganisms ;not usually involved in respiratory infections in immunocompetent host such as *Streptococcus viridans* ,negative staphylococci and *Neisseria spp* [20].That is why antimicrobial therapy in allergic lower airway disease patients has an important therapeutic effect, and this made me think of the microbial presence and which are the most common bacterial isolates in allergic airway disease. Anyhow in order to detect the conclusive role of bacteria in causing a significant change, further quantitative and qualitative detection are required.

5. Conclusion

The most common bacterial isolates in allergic lower airways disease patients were *Streptococcus pneumonia* ,*Staphylococcus aureus* and *E coli* .This group showed significant declines in lung volumes FEV1,FVC and FEV1%,compared to healthy subjects group ,which their lower airways inhabited by another type of bacterial isolates: *Streptococcus pyogenes* and *Streptococcus viridans* commonly .There is no clear interaction in the lung volumes between subjects colonized with different bacteria within the same group .In order to find the definite effect of bacterial isolates on lung function tests ,more quantitative and qualitative detection are required.

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