

Comparison of Spirometrical Variables in Patients with Asthma and COPD

Aparna Sarkar¹, Madhu Bala Bhardwaj², Dipti Gothi³

¹Corresponding Author: Associate Prof. Physiology, Amity Institute of Physiotherapy, Amity Institute of Physiology & Allied Sciences, Amity University, F 1 Block, LGF, Sector-125, Noida-201303, Uttarpradesh, India

²PG scholar, Amity Institute of Physiology & Allied Sciences, Amity University Uttarpradesh, Noida

³Associate Professor, Dept. of Pulmonary Medicine, ESIC Hospital and Research Institute, Basai Darapur, Delhi

Abstract: ***Introduction and background:** COPD is characterized by airflow limitation and the diagnosis is suggested by history and physical examination and is confirmed by spirometry where there is low FEV1 level where there is no significant reversibility in response to bronchodilators. Asthma is an inflammatory disease also characterized by airflow limitation, but in contrast with COPD, the airflow limitation is highly reversible either with therapy or spontaneously. The residual volume and total lung capacities are increased in most cases. Individuals with COPD have more frequent acute chest illnesses that invariably decrease lung function for at least 3 months. Asthma is a chronic inflammatory disorder causing recurrent episodes of variable degrees of wheezing, dyspnea, chest tightness, and cough. The inflammation also causes an associated increase in the existing bronchial hyperresponsiveness to different stimuli. **Aim:** To compare the spirometry results in patients with COPD and asthma. **Method:** Twenty subjects (ten with COPD and ten with asthma) underwent pulmonary function test (spirometry, DLCO [in COPD patients]). The study was non-experimental and observational study where ten patients were taken each for COPD and asthma in non-randomized manner. **Results:** COPD subjects had increased TLC%, RV/TLC% along with increased severity of airflow limitation (decreased FEV1%, FVC%, FEV1/FVC%) and no significant reversibility in post-bronchodilator test. Asthmatics had near normal FVC (so DLCO not done), and reduced FEV1%, FEV1/FVC%. Post-bronchodilator reversibility was not significant for all subjects but diagnosis was done on the basis of family history and symptoms. **Conclusion:** Overall lung function is poorer in COPD than asthma in spite of the lesser duration of illness in the former.*

Keywords: COPD, Asthma, Pulmonary function test, Spirometry, Bronchodilator

1. Introduction

Asthma is a disease of diffuse airway inflammation caused by a variety of triggering stimuli resulting in partially or completely reversible bronchoconstriction. Symptoms and signs include dyspnea, chest tightness, cough, and wheezing^{1, 2}. The diagnosis is based on history, physical examination, and pulmonary function tests. Prognosis is good with treatment³. In patients with asthma, TH2 cells and other cells like mast cells and eosinophils form the inflammatory infiltrate in smooth muscle and airway epithelium causing airway remodeling. Hypertrophy of smooth muscle narrows the airways and increases reactivity to allergens, irritants, infections and other triggers of bronchoconstriction. Mucus plugging and peripheral blood eosinophilia (not in all patients) are additional classic findings in asthma³.

Chronic obstructive pulmonary disease (COPD) is partially reversible airflow limitation caused by an inflammatory response to inhaled toxins, often cigarette smoke. Symptoms are productive cough and dyspnea that develop over years; common signs include decreased breath sounds, prolonged expiratory phase of respiration, and wheezing. Severe cases may be complicated by weight loss, pneumothorax, frequent acute decompensation episodes, right heart failure, and acute or chronic respiratory failure. Diagnosis is based on history, physical examination, chest x-ray, and pulmonary function tests. Treatment is with bronchodilators, corticosteroids, and, when necessary, O₂ and antibiotics. About 50% of patients with severe COPD die within 10 yr of diagnosis. COPD comprises of chronic

obstructive bronchitis and emphysema. Many patients have features of both⁴.

According to Global Initiative for Chronic Obstructive Lung Disease (GOLD), the pulmonary component of COPD is characterized by airflow limitation that is not fully reversible⁵. Global Initiative on Asthma (GINA) states asthma as 'a chronic inflammatory disorder of the airways in which many cells and cellular elements play a role associated with airway hyper-responsiveness that leads to recurrent episodes of wheezing, breathlessness, chest tightness, and coughing, particularly at night or in the early morning, airflow obstruction within the lung that is often reversible either spontaneously or with treatment⁶.

Pellegrino R et al states that both asthma and COPD will give an obstructive pattern in Pulmonary Function Testing, but asthma should show reversibility that means FEV1 and FVC will increase at least 12-15% after bronchodilator treatment, while in COPD the improvement in FEV1 will be far less. The FRC is increased in hyperinflation which is characteristic of COPD. An increase in TLC, RV or the RV/TLC ratio above the upper limits of natural variability may suggest the presence of emphysema, asthma or other obstructive disease, as well as the degree of lung hyperinflation⁷.

Bartolome R. Celli concludes that because of the reversible component of asthma, the use of peak flowmeters to determine airflow on continuous basis is practical and seems to have resulted in improved outcomes. In contrast, in patients with progressive COPD, the use of frequent peak

flow measurements and spirometry do not influence the outcomes⁸. Paul M. Dorinsky et al concludes that the combination of ipatropium and albuterol results in greater PFT response rates than ipatropium or albuterol alone in patients with COPD⁹. Wisnivesky J et al concludes that, spirometry screening of asymptomatic smokers may help detect a small number of patients with airway obstructions who are at high risk for COPD¹⁰. J.M.B Hughes et al states that low FRV1, normal or low FVC, low FEV1/FVC indicates obstructive whereas low FEV1, low FVC, normal or high FEV1/FVC indicates restrictive pattern¹¹.

2. Methods & Materials

Twenty subjects from both genders at the age group 10-65 years were selected for this study non-randomly from ESIC hospital and Research Institute, Basai Darapur, Delhi. Subjects with asthma and COPD from more than 1 year were selected for this study. The study was non experimental and observational study where ten patients were taken each for COPD and asthma in non-randomized manner. Subjects with restrictive lung disease, hypoxia, recent eye surgery, major psychiatric disorder, pregnancy were excluded.

Materials Used

PFT machine (Medisoft, 2010), bronchodilator (salbutamol), nasal clip, mouthpiece (of cardboard), height and weight machine.

Patient Preparation:

Subjects withhold oral and inhaled bronchodilators to establish baseline lung function and evaluate maximum bronchodilator response. Institutional ethical clearance was taken.

Statistical Analysis

Student's paired t-test was used to compare the pre and post bronchodilator effects for the spirometric variables (FEV1, FVC, and FEV1/FVC) in asthma and COPD. $p < 0.05$ was considered as statistically significant.

3. Results

Table 5: Comparison in pre bronchodilator FEV1 (% predicted) in COPD and asthma

H_0 : there is not more severe change in predicted % FEV1 (pre BD) in spite of lesser duration of illness in COPD than asthma Student's unpaired t-test will be used at (n-2) degree of freedom i.e. 8.

Condition	Mean % predicted FEV1 (PRE BD) \pm SD	Mean duration of illness (yrs)	St. error (FEV1 % predicted)	$t_{calculated}$ (FEV1 % predicted) (t_8)	$t_{critical}$	LOS
COPD	36.8 \pm 11.23	2.25	3.55	3.77	2.306	0.05 (significant)
Asthma	62.2 \pm 18.08	14.13	5.72			

Since t (calculated) $>$ t (critical), we reject our null hypothesis and conclude with 95% confidence that change in FEV1 % predicted is more severe in COPD in spite of lesser duration of illness (mean duration) as compared to asthma. So it can be concluded that COPD patients present very late either because they do not perceive the symptoms or because

Table 1: Demographic profile of the subjects.

Condition	Age (Mean \pm SD)	Weight (Mean \pm SD)	Height (Mean \pm SD)
COPD	54.9 \pm 10.47	56.3 \pm 11.62	167.6 \pm 9.47
Asthma	39.3 \pm 19.33	55.2 \pm 14.23	153.8 \pm 6.47

Table 2: Pulmonary function test parameter: FEV1

Condition	Post BD-Pre BD (Mean \pm SD)	SE	$t_{calculated}$	$t_{critical(N-1)}$	LOS(p VALUE)
COPD	0.11 \pm 0.12	0.05	2.20	2.447	0.05(NS)
Asthma	0.32 \pm 0.30	0.1	3.20	2.306	0.05*

NS: Not significant

*: significant

H_0 = No significant difference in FEV1 in pre- and post-bronchodilator

In COPD, since $t_{cal} < t_{cri}$, H_0 is accepted; i.e there is no significant difference in pre and post bronchodilator test in COPD. But in asthma, $t_{cal} > t_{cri}$, so we reject H_0 and conclude with 95% confidence that there is a change in FEV1 after giving bronchodilator.

Table 3: Forced Vital Capacity

Condition	Post BD-Pre BD (Mean \pm SD)	SE	$t_{calculated}$	$t_{critical(N-1)}$	LOS(p value)
COPD	0.09 \pm 0.20	0.07	1.28	2.447	0.05(NS)
Asthma	0.24 \pm 0.19	0.06	4.00	2.306	0.05*

H_0 : No change in FVC in pre and post bronchodilator

In COPD, since $t_{cal} < t_{cri}$, H_0 is accepted, i.e there is no significant difference in pre and post bronchodilator test in COPD. But in asthma, $t_{cal} > t_{cri}$, so we reject H_0 and conclude with 95% confidence that there is a change in FVC after giving bronchodilator.

Table 4: FEV1: FVC

Condition	Post BD-Pre BD (Mean \pm SD)	SE	$t_{calculated}$	$t_{critical(N-1)}$	LOS(p value)
COPD	1.71 \pm 2.96	1.12	1.52	2.447	0.05(NS)
Asthma	5.85 \pm 8.27	2.75	2.13	2.306	0.05(NS)

H_0 : No significant change in FEV1: FVC in pre and post bronchodilator

In both COPD and asthma, $t_{cal} < t_{crit}$, so we accept H_0 i.e., there is no change in FEV1: FVC in pre and post tests. So diagnosis of asthma is confirmed on the basis of symptoms and positive family history.

they want to hide their symptoms or they just attribute symptoms to smoking and not to disease.

4. Discussion and Conclusion

10 cases each for asthma and COPD were selected randomly. In subjects with **asthma**, 5 were having positive family history of bronchial asthma while others not having family history of BA. Almost all cases had same symptoms like, nocturnal, paroxysmal dyspnea, episodic cough, recurrent rhinitis, wheeze, atopy and are symptomatically better with medication. On investigation, in some cases there were elevated IgE and eosinophilia denoting the infection and allergic response. Spirometry was done before and after inhalation of short acting bronchodilator (salbutamol) except in 5 subjects as they were the follow up cases in which only pre bronchodilator PFT was done but their previous spirometric values were used for study.

In all the cases there was reduced FEV1 and FEV1: FVC ratio denoting the signs of airflow limitation before bronchodilator inhalation. FVC was normal in all cases except for 1 case (Appendix 1) where it was decreased and diffusion test was done for this particular case where RV was less than the predicted value. So it was concluded that low FVC in this case is because of restrictive pattern along with obstructive airway disease.

There was an improvement in FEV1/FVC ratio of >12% and ≥ 200 ml in FEV1 or an increase $\geq 10\%$ of predicted FEV1 in response to bronchodilator treatment in 2 case* (table 4) that confirms reversible airway obstruction whereas in other cases only either of 1 criteria was being fulfilled thereby there was no significant reversibility in other 8 cases but there symptoms and family history confirmed the bronchial asthma. Among these 10, 2 subjects were chronic smokers.

When the flow volume loops were reviewed, all curves shows less effort by subjects during respiration due to airflow obstruction and also small airway disease was noticed in 1 case (Appendix 2) from its typical flow volume curve and on seeing MEF values.

Since FVC in almost all cases were normal, so there was no need of performing diffusion test. Therefore, the inferences for spirometry in asthma are:

- 1) Spirometry helps in categorizing the asthmatic subjects. Among 10, 2 subjects were having **mild** asthma i.e., case 4 and 6 (FEV1 > 60%), 3 were having **moderate** asthma i.e., case 1, 2, 9 (FEV1: 60-80%), and 5 subjects i.e., case 3, 5, 7, 8, 10 were having **severe** asthma (FEV1: <60%). (Table 4)
- 2) Spirometry helps in seeing the improvement with medication as 6 were follow up cases and among them, 4 were showing the improvement with the treatment. So, the cases which are not improving, the treatment protocol can be changed for the same.
- 3) If the percentage predicted FEV1 is lower, the subsequent prognosis is worse.
- 4) Spirometry demonstrates the presence and reversibility of airflow obstruction to the subjects (Appendix 3) but the absence of airflow obstruction does not exclude the diagnosis of asthma as in other cases.

In subjects with **COPD**, all of the 10 were above 40 in age and males. They all were chronic smokers consuming near about 1-2 packs bidi per day since >10 years except 1 who had the history of exposure to wood burning for near about

15 years. The signs and symptoms include productive cough, breathlessness, and shortness of breath on exertion, wheeze and hyper inflated lungs. One subject had spontaneous pneumothorax which may be due rupture of emphysematic bullae leading to abruptly worse pulmonary status.

Spirometry was done before and after inhalation of short acting bronchodilator (salbutamol) to confirm airflow limitation. There was decrease in FEV1, FVC AND FEV1/FVC ratio in all 10 subjects with COPD and no post bronchodilator reversibility was there. Usually, in obstructive airway disease, FVC is normal, however as FVC was less than 80% predicted, diffusion test was done to find out diffusion capacity and RV/TLC ratio. In 7 out of 10 cases, RV was more than the predicted value which indicates that low FVC was due to air trapping (Appendix 4). But in 3 subjects (Appendix 5), RV was less than predicted along with less FVC, and also total lung capacity was also less than the predicted value. This was because of the fibrotic changes causing restrictive disease along with the obstructive i.e., both were overlapping. RV/TLC ratio was increased in all the cases (normal is 25%- 35%) confirming the diagnosis as COPD. A post-bronchodilator forced expiratory volume in one second (FEV1)/forced vital capacity (FVC) ≤ 0.7 was present in all 10 cases thus confirms the presence of airflow limitation that is not fully reversible.

The flow volume loop denotes kinking in expiratory curve typically seen in COPD. The inferences that can be concluded for COPD are:-

- 1) COPD has more severe obstruction as compared to asthma.
- 2) None of the cases had significant bronchodilator reversibility.
- 3) Spirometry helps in categorizing the COPD patients as among these 10 subjects no one comes under grade 1 or **mild** whereas 2 subjects (6,8) are under grade 2 (**moderate**), 5 patients (1,2,4,5,10) under grade 3 (**severe**) and 3 patients (3, 7, 9) under grade 4 (**very severe**) according to GOLD classification for COPD. (Table 2)
- 4) All the patients had abnormality in spirometry i.e, all 10 cases had low FVC among which 5 patients have low FVC with increased RV and we can conclude that low FVC is due to air trapping, 3 patients had low FVC with low RV and thus, it can be concluded that these patients have fibrotic changes also and have restrictive and obstructive pattern overlapping. 7 had increased RV/TLC ratio, 1 had normal RV/TLC ratio with decreased TLC.

Comparisons between COPD and Asthma

- 1) **Symptoms:** - Dyspnea, chronic cough and sputum production in an adult with a history of smoking or exposure to noxious particles or gases favors COPD whereas if there is a history of childhood wheezing, atopy and diurnal variation in peak flows in an adult who coughs, wheezes or is dyspneic favors a diagnosis of asthma.
- 2) **Duration Vs Abnormality in lung function** - In spite of more duration of illness in asthma there are less decrease in FEV1 as compare to COPD where patients are

- symptomatic from 2-3 years but they have more abnormality in their lung functions (Table 9).
- 3) **Overall lung function** is poorer in COPD as compared to asthma.
 - 4) **Improvement** with medication is much better in asthma as compared to COPD.
 - 5) **Post bronchodilatorreversibility** in asthma is good as compared to COPD.
 - 6) Low **FVC** with increased RV/TLC RATIO in COPD whereas FVC is near normal in asthma.
 - 7) Some of the cases of asthma have **normal** lung function but are symptomatic and have positive family history whereas in COPD, there is always abnormal lung function.
 - 8) **Onset** of COPD is in mid-life whereas it's early onset in asthma.
 - 9) **Symptoms** are slowly progressing in COPD whereas varying in asthma
 - 10) Previous studies have demonstrated that COPD subjects have more severe airway obstruction and more hyperinflation when compared to those reporting asthma only, they have greater lung volumes and have a significantly increased RV as compared to asthmatics.^{12, 13}

- [12] J.M.B Hughes et al, Interpreting PFT http://www.ersnet.org/learning_resources_player/-breath-e/6_2/5/index5.html
- [13] Dykstra BJ, Scanlon PD, Kester MM, Beck KC, Enright PL. Lung Volumes in 4,774 Patients with obstructive lung disease. CHEST.1999; 115(1): 68-74
- [14] Sciruba FC. Physiologic similarities and differences between COPD and asthma. Chest2004; 126: 117-124.

References

- [1] American Thoracic Society. (1995) Standards for the diagnosis and care of patients with chronic obstructive pulmonary disease (COPD) and asthma. Am J Respir Crit Care Med 152,77-120
- [2] National Asthma Education and Prevention Program. Expert panel report 2: guidelines for the diagnosis and management of asthma. Bethesda, MD: National Institutes of Health, April 1997; Publication 97-4051;1-4.
- [3] Matthew C. Miles, revision April 2013,
- [4] http://www.merckmanuals.com/professional/pulmonary_disorders/asthma_and_related_disorders/asthma.html
- [5] Robert A.Wise, content last modified on June 2014, http://www.merckmanuals.com/professional/pulmonary_disorders/chronic_obstructive_pulmonary_disease_and_related_disorders/chronic_obstructive_pulmonary_disease_copd.html
- [6] Global strategy for the Diagnosis, Management and Prevention of COPD, Global Initiative for Chronic Obstructive Lung Disease (GOLD). www.goldcopd.org
- [7] Global strategy for asthma management and prevention. GINA (Global Initiative on Asthma), 2007. www.ginasthma.org/download.asp?intld=309
- [8] Pellegrino R et al. Interpretative strategies for lung function tests. Eur Respir J 2005; 26: 948-967.
- [9] Bartolome R. Celli, MD, FCCP. http://journal.publications.chestnet.org/article.aspx?articleid=1078629&issueno=2_suppl&apgewanted=al
- [10] Paul M. Dorinsky et al, April 1999, vol.115, no.4, <http://journal.publications.chestnet.org>
- [11] Wisnivesky J et al, spirometry screening for airway obstruction in asymptomatic smokers. www.ncbi.nlm.nih.gov/pubmed/25006609