Study of Pulmonary Functions Test in Patients of Bronchial Asthma

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***ABSTRACT*: Asthma is a Syndrome Characterized by Inflow obstruction that varies markedly, both spontaneous and with treatment. asthmatics harbor a special type of Inflammation in the airways that makes then more responsive then non Asthmatic to a wide range of triggers , leading to excessive narrowing it sequent reduced airflow and symptomatic wheezing and dyspnea. Narrowing of the airways is usually reversible, but in some patient with chronic asthma there may be an element of irreversible airflow obstruction.**

The increase Global prevalence of asthma , the large burden it now imposes on patient , and high health care cost have led to extensive research in to its mechanism and treatment. The present study had following objectives:

1. To study pulmonary functions in bronchial asthma.
2. To study & compare lung function parameters in patients with bronchial asthma before and after use of bronchodilator.
3. To study correlation between severity and MRC grading of dyspnea & FEV1.

***Keywords*: Pulmonary Function Test, MRC Grading, FEV 1**

1. INTRODUCTION

The National Heart, Lung and Blood Institute define asthma as a common chronic disorder of the airways characterized by variable and recurring symptoms, airflow obstruction, bronchial hyper responsiveness (bronchospasm), and an underlying inflammation. It results in episodic bronchospasm and wheezing resulting in significant morbidity and mortality.

Epidemilogical studies indicate increasing prevalance of bronchial asthma. Bronchial asthma affects a total of 300 million people worldwide. The prevelance of bronchial asthma in adults is reported as 2.7%-4% in most European countries, 12% in England and 7.9% in US. The overall burden of asthma in India is estimated at more than 15 million patients. In Agrawal et al reported prevalence of 2.38% Indian population.

Bronchial asthma is characterized by airway obstruction. In contrast to chronic obstructive pulmonary disease and chronic bronchitis, the airway inflammation of asthma is reversible and can affect people at any age. Bronchail Asthma is the major cause of pulmonary disability. Bronchial asthma & COPD currently the fourth leading cause of death in the world and is expected to become the third leading cause of death by 2020. Smoking, air pollution and other environmental factors facilitate the occurrence of these conditions.

The positive relation between asthma in family members and development of airway hyper responsiveness or asthma in an individual is well recognized. Female sex, advancing age, usual residence in urban area, lower socioeconomic status, history suggestive of atopy, history of asthma in first degree relative and all forms of tobacco smoking are associated with higher risk of asthma.

The diagnosis of bronchail asthma is based on clinical criteria and spirometry. Over the past 20 years, major strides have been made in our understanding of the pathophysiology of this disorder, although there are still gaps in our knowledge.

The relation between respiratory symptoms and lung function has not been extensively investigated. The main respiratory symptoms are cough, dyspnea, wheeze, tightness of chest and nocturnal symptoms. Clinicians should be aware of the predictive value of these respiratory symptoms because therapeutic intervention may modify the associated decline in lung function. Dyspnea is one of the major symptoms that impact the quality of life. FEV1 is an objective index and the level of dyspnea is subjective index in assessing patients with obstructive lung diseases.

Recently there has been an increased emphasis placed on objective measurements of pulmonary function in the management of bronchial asthma. The optional approach to the diagnosis and management of bronchial asthma has remained problematic. There is a variable relationship between clinical parameters and pulmonary functions. The assessment of airflow is absolutely essential.

A quick method of detecting Bronchial asthma could lead to more aggressive secondary prevention, earlier treatment to ameliorate symptoms and improved evaluation of pulmonary complaints. The most commonly used way to express disease severity is by assessing the FEV1 as a measure of airway obstruction. The FEV1 is a reproducible and objective measurement. It is relatively simple and quick to measure and can be measured at all stages of disease. Serial measurements of FEV1 provide evidence of disease progression. The purpose of this study is to compare clinical symptoms with the actual values of FEV1 in patients with bronchial asthma. This study also determines the best clinical predictors of bronchial asthma and to define the incremental changes in the ability to diagnose disease severity when the symptoms and FEV1 are combined together. This would help in optimizing the management of patients with bronchial asthma.

Historical Review

The word 'asthma' is a Greek word meaning 'breathless' or 'to breath with open mouth. Asthma was recognized early in the history of medicine. ARATAEUS OF CAPPADOCIA gave the first reasonably accurate description of an attack of bronchial asthma in second century B.C.

Hippocrates first mentioned about allergy, though he did not differentiate asthma. Clinicians used the term 'atopy' in the beginning of 19th century to describe a group of disorders including asthma and hay fever.

An original description of the disease and mode of death was made in the 'Disease what the Greek call asthma' by Agricola in 1556.

Sir John Floyer, a sufferer himself described the disease in the general sense but confined himself largely to episodic nature of the disease in 'Treatise of Asthma' in 1698.

Hoffman in 1707 described a condition as convulsive asthma with dropsy. Henry Hyde Salter in his book 'On Asthma - Its Pathology and Treatment' in 1860 gave a vivid and comprehensive description and separated it from symptomatic or complicated organic asthma. He recognized the idiopathic or uncomplicated spasmodic asthma arose most commonly in childhood. He blamed inhalation of dust, hay fever, feather and a large psychological overlay as well. He also gave a convincing argument that asthma was due to bronchospasm.

Edwin Heinrich Henoch described the dyspeptic asthma. Use of ephedrine in asthma is said to be in use by the Chinese for over 5000 years. Lawrence described the discovery of isolated adrenaline synthesis as a boon for asthma in 1900. In 1922 Huber and Koessler reviewed fifteen autopsy cases of asthma and described its anatomical pathology.

2. MATERIAL AND METHODS

This was an observational study carried out in department of medicine, M.Y. Hospital & M.G.M. Medical College, Indore from Sep 2009 to Oct 2010.

SIXTY patient suffering from bronchial asthma presented to department of medicine M.Y. Hospital Indore from Sep 2009 to Oct 2010 formed the study sample for the present study. All patient are evaluated by detailed history and clinical examination and hematological and biochemical investigation Favoring the biochemical investigation Favoring the diagnosis bronchial asthma, diagnosis was confirmed by P.F.T.

INCLUSION CRITERIA:
Patients of either gender suffering from bronchial asthma who are willing to give consent for study.

EXCLUSION CRITERIA:
Patients with other causes of airflow obstruction like COPD, tumors, foreign bodies, laryngospasm, and carcinogenic pulmonary edema were excluded.
Hypertension
DM
Ischemic Heart Disease
Alcoholics
Renal failure

INITIAL EVALUATION

A detailed history was taken and a thorough clinical examination done in all patients. Five symptoms (cough, dyspnea, wheeze, tightness of chest, nocturnal symptoms) were recorded. Dyspnea was also graded according to Medical Research Council (MRC) grading of dyspnea (given in table below). FEV1 was measured by spriometry (Vitalogrph), meeting the standard criteria.

MRC SCALE (BREATHLESSNESS)

Grade	Degree of Dyspnea
1	No Dyspnea except with strenuous exercise
2	Dyspnea on walking uphill or climbing or hurrying on the level
3	Walks slower then most on the level or stop after 15 mint of walking on the level
4	Stop after few mint of walking on the level
5	With minimal activity such as getting dressing, to dyspneic to leave the house

FULMONARY FUNCTION TESTING:
A detailed pulmonary function testing was done in all cases. Pulmonary function testing including the following test.

Test for ventilation: Spirometry with helium dilution technique
Test for diffusion: Diffusion capacity for carbon monoxide ($DiCo_2$)
exercise testing - six meter walk test
Arterial blood gas analysis

Spirometry is the measure of airflow during inspiration and expiration. The test was carried out as per Americal Thoracic Society (ATS) Recommendation for performing spirometry given below.
The test was obtained with the patient seated and wearing nose clips and airflow is recorded as forced and sustained expiration followed by forced and sustained inspiration. The best of three reproducible measurements was taken for analysis. The post bronchodilator FEV1 was assessed at 20 minutes after the inhalation of 200 μg salbutamol using a metered dose inhaler with a spacer device. The symptom score was correlated with FEV1.

American Thoracic Society (ATS) Recommendation for performing spirometry

Effort	Maximal, smooth and cough free
Position	Sitting
Exhalation	time 6 seconds
End of test	2 second volume plateau
Reproducibility	FVC within 5% in three acceptable tests

Following is the determination of test results in a three phase effort:
Actual- How well did the patient actually performed.

Predicted - How well should the patient performs when compared to other persons of same age, sex, height and weight.

%predicted - A ratio of actual to predicted value, expressed as per percentage.

Interpretation of Spirometry results
Various parameters recorded during spirometry are interpreted as below:

	Normal	Obstructive	Restrictive
FVC	>80%	Normal/Decreased	Decreased
FEV1	>80%	Normal/Decreased	Decreased
FEV1/FVC	>75%	Decreased	Normal/Decreased
FEF25-75	>80%	Decreased	Normal/Decreased
TLL	80-120%	Normal/Decreased	Decreased

FEV1/FVC %predicted Normal	Severity of Obstruction
>80%	No obstruction
60-79%	Mild obstruction
40-59%	Moderate obstruction
<40%	Severe obstruction

FVC %predicted Normal	Severity of Restriction
>80%	No restriction
60-79%	Mild restriction
40-59%	Moderate restriction
<40%	Sever restriction

PEER & FEF 25-76 Predicted Normal	
≥60%	Normal
≤70%	Early small airway obstruction

In general, in restrictive lung disease all volumes and capacities are reduced proportionally so that various ratios remain unaltered, expiratory flow rates are normal as there is no obstruction. In obstructive lung diseases, lung capacity is increased moderately but with increase in residual volume, inspiratory reserve volume is encroached upon and alternatively, TLC decreases. All flow rates decrease with increasing severity of obstruction. Good bronchodilator reversibility (BDR) is considered when improved in FEV1 by 200 ml and >12% both occur alter a dose of inhaled bronchodilator.

The information was recorded on a pre-designed proforma, which was then transferred to a computer database.

3. OBSERVATIONS

This study was carried out in department of medicine, M.Y. Hopsital, Indore from Sep 2009 to Oct 2010. In our study, 60 clinically diagnosed cases of bronchial asthma were reviewed.

1. Age

In our study, out of 60 patients maximum (48%) were in the age group of 41-50 years (n=30), followed by 20% in age group of 51-60 years (n=12), 14% in age group of 21-30 years and 31-40 years (n=8) and 4% in age group of 61-70 years (n=2). Agewise distribution of patients is given below:

Table 5
Age-wise distribution of patients

Age Group	No. of Patients	Percentage
21-30	8	14
31-40	8	14
41-50	3	48
51-60	12	20
61-70	2	4
Total	**60**	**100**

2. Gender

Out of 60 cases of bronchial asthma 48 (80%) were male and 12 (20%) were female. The distribution of patients according to sex is given below:

Table 6
Distribution of patients according to sex

Characteristics	No. (%)
Male	48 (80%)
Female	12 (20%)
Total	**60 (100%)**

3. Risk Factors

Various risk factors identified in patients during clinical history; most common being h/o smoking in 32 patients (52%) followed by atopy (15%), h/o asthma in family (13%) and h/o atopy in family in 6%.

Table 7
Various risk factors for asthma amongst patients

Risk Factors	Male (n=48)	Female (n=12)	Total (n=60)
Atopy	7 (14%)	2 (16%)	9 (15%)
Atopy in family	3 (6%)	1 (8%)	4 (6%)
Asthma in family	6 (12%)	2 (16%)	8 (13%)
Current Smoker	26 (54%)	2 (16%)	28 (46%)
Former Smoker	4 (8%)	0 (0%)	4 (6%)

4. Respiratory Symptoms

In our study all patients present with dyspnea followed by cough (90%) wheezing (60%), nocturnal symptoms (57%), morning chest tightness (35%).

Table 8
Distribution of patients according to respiratory symptoms

Symptoms	No. of patients (%)
Cough	54 (90)
Dyspnoea	60 (100)
Morning chest tightness	21 (35)
Nocturnal symptoms	34 (57)
Wheezing	36 (60)

5. Distribution of patients according to MRC grading

In our study, out of 60 cases, maximum 30(50%) cases were presented with grade II dyspnea followed by 15 patients with grade III dyspnoea (25%), 10 patients with grade I dyspnoea (17%) and 5 patients with grade IV dyspnoea (9%).

Table 9
MRC Grading of patients (N=60)

MRC grade	No.
Grade I	10
Grade II	30
Grade III	15
Grade IV	5
Grade V	0

6. Pulmonary function tests

In our study, out of 60 cases, 54(90%) cases had obstructive pattern in and rest 6(10%) cases had mixed pattern in pulmonary function test. None of the patients had restrictive pattern.

Table 10
Distribution of patients according to PFT pattern (N=60)

Sr.	Test	No. of Patient	Percent
1	Normal	0	0
2	Obstructive Pattern	54	90
3	Mixed Pattern	6	10
4	Restrictive Pattern	0	0

7. Correlation of FEV1 with severity of Dyspnoea according to MRC grading:

In patients with dyspnoea MRC grade I, mean FEV1 was found to be 2.24 litre; in patients presenting with MRC grade II, mean FEV1 was found to be 2.12 litre; in patients presenting with MRC grade III, mean FEV1 was found to be 1.86 litre and in patients presenting with MRC grade IV, mean FEV1 was found to be 1.74 litre.

Table 11
MRC grade and average FEV1

MRC grade of dyspnoea	Average FEV1 volume in litre
I.	2.24
II.	2.12
III.	1.86
IV.	1.74

8. Bronchodilator response

In our study during spirometry, out of 60 cases of clinically diagnosed cases of bronchail asthma, 48(80%) cases shows good brochodilator response. In these cases after brochodilator therapy mean FEV1 increased from 1.97 and 2.54.

Table 12
Bronchodilator response in patients with bronchial asthma

BRNCHODILATOR RESPONSE	No. (%)
GOOD	48 (80%)
POOR	12 (20%)

9. Reversibility using bronchodilator

Mean FEV1 found before and after bronchodilator is given below:

Table 13
Mean FEV1 before and after bronchodilator

Mean FEV1 before bronchodilator	1.97 + 0.82
Mean FEV1 after bronchodilator	2.54 + 0.86

10. PFT parameters
Different parameters observed in during PFT are given below:

Table 11
PFT parameters of patients

PARAMETER	SEX	PREDICTIVE VALUE (MEAN±SD)	OBJECTIVE VALUE (MEAN±SD)	P VALUE
FVC (1sec)	Male	3.05 ± 0.7	2.9 ± 0.9	insignificant
	Female	2.5 ± 0.40	2.09 ± 0.76	<0.001
FEV1 (1sec)	Male	2.5 ± 6.3	2.27 ± 0.92	<0.05
	Female	2.5 ± 0.37	1.84 ± 0.75	<0.001
FEV1/FVC%	Male	82 ± 4.2	75 ± 13	<0.001
	Female	84 ± 4	86 ± 11	<0.05
PEFR (1sec)	Male	6.5 ± 0.8	5.44 ± 2.52	<0.001
	Female	4.9 ± 0.53	4.73 ± 2.01	insignificant
MVV (1sec)	Male	134.8±20.35	83.9 ± 40.6	<0.001
	Female	96.1 ± 15.1	69.8 ± 34.4	<0.001

11. Relationship of individual symptoms & with FEV1 in Bronchial asthma

Relationship of individual symptoms & with FEV1 in Bronchial asthma is given below:

Symptoms	FEV_1pre	FEV_1post
Cough	(r=0.05, p=0.66)	(r=0.05, p=0.66)
Dyspnea (MRC Grade)	(r=0.19, p=0.2)	(r=0.22, p=0.14)
Wheeze	(r=0.27, p=0.07)	(r=0.23, p=0.12)
Tightness of chest	(r=0.09, p=0.5)	(r=0.07, p=0.56)
Nocturnal Symptoms	(r=0.06, p=0.62)	(r=0.06, p=0.62)
Total	**(r=0.19, p=0.2)**	**(r=0.18, p=0.23)**

In Bronchial asthma there was no statistically significant relation between any individual symptom and FEV_1 although there was a trend towards significance between subjective wheeze and FEV_1.

DISCUSSION

This was an observational study carried out in department of medicine, M.Y. Hospital & M.G.M. Medical college, Indore from Sep 2009 to Oct 2010. In our study, 69 patients of bronchial asthma diagnosed by clinical history, examination and pulmonary function tests were included.

Age and Sex
The mean age of patients was found to be 44.2±18 years ranging from 21 to 70 years. Amongst them, 48(80%) were male and 12(20%) were female patients. In our study maximum 30(48%) cases were in the age group of 41-51 years. In our study the male:female ratio was 4:1.

Risk factors
Various endogenous and exogenous risk factors have been described as predisposing factor for bronchial asthma. In our study, various risk factors have been identified in patients of bronchial asthma; most common being h/o smoking in 32 patients (52%) followed by atopy (15%), h/o asthma in family (13%) and h/o stopy in family in 6%. This is consistent with Agrawal et al who reported smoking is the most common association with bronchial asthma.

Respiratory Symptoms
In our study; most common symptoms reported by patients is dyspnea (100%) followed by cough (90%) wheezing (60%), nocturnal symptoms (57%), morning chest tightness (35%).

Correlation of FEV1 volume and severity dysponea according to MRC scale
In our study, we have found that FEV1 volume decreased as the severity of dysponea increased from MRC grade 1 to 5. This is consistent with JC Bestall et al who demonstrated that MRC dyspnea grading scale is a simple and valid method of categorizing asthmatic patients. FEV1 was lowest with the highest MRC grade, though it was not statistically significant.

Reversibility
In our study we have concluded that significant pulmonary function abnormalities were seen in our patient as compared to data from western country. In our study 80% of patients of bronchial asthma have reversibility and remaining 20% showed poor bronchodilator response.

Relationship of individual symptoms with FEV_1 in Bronchial asthma
In our study, there was no statistically significant relation found between any individual symptom and FEV_1 although there was a trend towards significance between subjective wheeze and FEV_1.

Asthmatics tended to more frequently over estimate their level of airway obstruction and some also tend to underestimate it. This further emphasizes the importance of using objective measures of lung function in the assessment of asthma patients. Subjective wheezing is the best predictor of airway obstruction is athmatics. Though asthmatics have been shown to more frequently identify wheezing as a characteristic of their exertional breathing difficulty than patients with other forms of cardio respiratory disease. Persistent wheezing has also been shown to be predictive of airway obstruction in population based studies of wheezy and asthmatic individuals. Kelsen et al found that approximately 10 percent of patients who were believed to have clinical improvement, in Bronchial asthma did not demonstrate any improvement in post bronchodilator FEV_1.

John and Eugene et al also demonstrated that asthma symptoms did not correlate with the degree of airway obstruction as determined by the FEV_1. Subjective wheezing was the best individual predictor of the level of airway obstruction in this group of patients. Our study yielded similar results showing that subjective wheezing was the only symptom which had a trend towards statistical significance.

Together with these studies, the present study results suggests that wheezing is the asthma symptom most predictive of the level of the airway obstruction. Other common asthma symptoms such as cough and dyspnea may be more reflective of the state of Bronchial hyper responsiveness and lung hyperinflation, respectively.

4. SUMMERY

BACKGROUND AND OBJECTIVES
Bronchial asthma is a major cause of pulmonary disability. These diseases are characterized by airway obstruction. There is a variable relationship between clinical parameters and pulmonary function. To study & compare lung function parameters in patients with bronchial asthma before and after use bronchodilator. To study correlation between severity and MRC grading of dyspnea & FEV1.

METHODS
This was an observational study carried out in department of medicine, M.Y. Hospital & M.G.M. Medical College, Indore from Sep 2009 to Oct 2010. In our study, 60 patients of bronchial asthma diagnosed by clinical history, examination and pulmonary function tests without any patients of either gender suffering from Bronchial asthma who are willing to give consent for study. Patients with other causes of airflow obstruction like, COPD, tumors, foreign bodies, laryngospasm, and carcinogenic pulmonary edema were excluded.

Five symptoms (cough, dyspnea, wheeze, tightness of chest & nocturnal symptoms) were recorded. Dyspnea was also graded according to Medical Research Council (MRC) grading scale. FEV_1 was measured by spiroanalyser (vitalogrpah) and the best of three reproducible measurements was taken for analysis. The post bronchodilator FEV_1 was also assessed. Symptoms were correlated with FEV_1 by finding correlation coefficient between them.

5. RESULTS

In our study, 60 clinically diagnosed cases of bronchial asthma were reviewed. The mean age of patients was found to be 44.2 ± 18 years ranging from 21 to 70 years. Out of 60 patients maximum (48%) were in the age group of 41-50 years.

Out of 60 cases of bronchial asthma, 80% were male and 20% were female giving male to female ratio 4:1.

Various associated risk factors identified in patients during clinical history; most common being h/o smoking in 52% patients followed by atopy in 15%, h/o asthma in family in 13% and h/o atopy in family in 6% cases.

All patients presented with dyspnea followed by cough (90%) wheezing (60%), nocturnal symptoms (57%), and morning chest tightness (35%).

Out of 60 cases, maximum (50%) cases were presented with grade II dyspnea followed by 25% patients with grade III dyspnea, 17% patients with grade I dyspnea and 9% patients with grade IV dyspnea.

Ninety percent cases had obstructive pattern in & rest 10% cases had mixed pattern in pulmonary function test. None of the patients had restrictive pattern.

In our study we have found a good bronchodilator response. Eighty percent cases showed good brochodilator response.

All the pulmonary parameters showed significantly less observed values than the normal predicted values except PEFR in female and FVC in male asthmatic patients. No stastically significant relation found between any individual symptom and FEV_1 although there was a trend towards significance between subjective Wheeze and FEV_1.

6. CONCLUSIONS

Bronchial asthma patients tend to both over & under estimate their level of airway obstruction, i.e. severity of symptoms does not statistically correlate with FEV_1 measurements. Subjective wheeze is the individual symptom best approaching correlation with FEV_1. FEV_1 increased more than 15% above the baseline value after administration of a bronchodilator. Our study emphasizes the importance of using objective assessment of pulmonary function in Bronchial asthma patients prior to implementation of medical treatment strategies.

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