Study Of Forced Vital Capacity, FEV_1 And Peak Expiratory Flow Rate In Normal, Obstructive And Restrictive Group Of Diseases

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Abstract: Background: In India, due to smoking, environmental pollution, use of bio mass as a fuel in rural areas etc, there is increase in incidence of pulmonary disorders. Hence, a review of pulmonary function tests is needed. This study has therefore been carried out to reassess the pulmonary function values in normal, Indian population and to check their variations in various obstructive and restrictive pulmonary disorders. Forced spirometry is one of the best test for assessing pulmonary disorders. This simple test provides written record of forced vital capacity (FVC), % forced expiratory volume in 1st second (FEV1%) and peak expiratory flow rate (PEFR). Method: Ours is a cross sectional, comparative study in which we measured FVC, FEV1% and PEFR in 30 normal subjects with the help of computerized spirometer. We also measured the same values in patients of pulmonary disorders and collected data of 30 patients having restrictive and 30 patients having obstructive lung disease. Thereafter, we compared the pulmonary function tests, FVC, FEV1% and PEFR in three groups. Result: Our observations show that as compared to normal values, in obstructive lung diseases, FVC remained same but there is decrease in FEV1% and PEFR. And in restrictive group of lung diseases, FVC is less than normal but FEV1% and PEFR are same as that of normal subjects. Conclusion: By our study we can conclude that pulmonary function tests like FVC, FEV1% and PEFR can be used to distinguish between obstructive and restrictive group of diseases.

Key words: lung diseases, obstructive, pulmonary function tests, restrictive.

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Introduction: We have approximately 150 million smokers in our country. According to the World Health Organization (WHO), 12% of the world's smokers are in India. A million Indians in the productive age group of 30-69 years will die every year starting 2010 from a range of conditions caused by smoking[1]. About 70% of our population live in village and a majority of them use wood and bio mass products as fuel for cooking. Burning of such fuel produces a lot of smoke and results in both restrictive and obstructive types of respiratory diseases. Environmental pollution has also increased steadily in this country in line with the industrial progress and development. Looking to all these factors a review of pulmonary function in Indian population is urgently needed. This study has therefore been carried out to reassess the pulmonary function value in normal, Indian population and to check their deterioration in various pulmonary disorders

Pulmonary function tests permit a precise and reproducible assessment of functional state of the respiratory system. With the help of specific pulmonary function tests, quantification of the severity of disease becomes easier as also the assessment of its natural history and the response to therapy. Although pulmonary function tests can specifically demonstrate a lung function that has been deranged by disease, most of these tests have their strengths and weaknesses e.g. variation can be caused by age, sex, height, occupation, smoking, climatic condition and the degree of air pollution. Forced spirometry is one of the best test for volume (load) assessment[2]. This simple test provides a written record of slow vital capacity and/or forced vital capacity (FVC), % forced expiratory volume in 1st second (FEV1%) and peak expiratory flow rate (PEFR). Consequently, simple breath pulmonary function test are used extensively in assessing the pattern of ventilatory impairment in restrictive and obstructive group of pulmonary diseases[3]. Most of the standard values of these tests are based upon western observations. They may differ in India due to variety of reasons. Spirometry has been used in this work as it helps in simple

evaluation of the level of functional impairment and at the same time it gives a general idea about the patient of such impairment and their reversibility. Our aim was to find out normal values of some pulmonary function tests like forced vital capacity (FVC), percentage of forced expiratory volume in first second (FEV1 %) and peak expiratory flow rate (PEFR) in normal, healthy individuals and to find out the difference in these values in normal persons and those suffering from obstructive and restrictive group of pulmonary diseases.

Material and Method: Our study is a cross sectional, comparative study in which, we included 30 normal subjects (statistician was consulted prior to the study regarding sample size. Sample size was selected after their expert advice.) and carried out pulmonary function tests on them using a computerized spirometer (RMS – Med spirometer). Pulmonary function tests were also carried out on patients having respiratory disorders and out of them, the data of 30 patients having respiratory symptoms of obstructive type of pattern and 30 patients having restrictive type of pattern was evaluated. Hence, we collected data of pulmonary function tests in 30 normal (control) subjects, 30 subjects having obstructive pulmonary diseases and 30 subjects having restrictive pulmonary diseases. Written consent of all the subjects in vernacular language was taken before performing pulmonary function tests. All subjects selected were in the age group of 20-60 yrs. Height and weight of each subject was taken.

Detail clinical history of the subjects was taken. At the time of study none of the normal subjects were suffering from a recent upper respiratory infection or allergic episodes and none was on antihistaminic or bronchodilators. All the tests were done at the same time of the day to avoid diurnal variation. The subject was made to sit in front of the electronic spirometer on the table with the mouth piece of spirometer at the level of his lips. The whole procedure was explained to the subject and demonstration was made before the subject. Tight clothing and waist belt were loosened and nostrils were closed with nose clip. The subject was then asked to take full and unhurried inspiration, then close lips around the mouth piece and expire forcefully in the mouth piece. Out of all the pulmonary function tests, FVC, FEV1% and PEFR have been taken into consideration. We have used these three parameters because they are considered standard indices for assessing and quantifying airflow limitation. These not only help in diagnosing obstructive and restrictive diseases, but also help in assessing the severity of disease.

Statistical analysis: Mean and standard deviation of all subjects was calculated. Statistical analysis was done by one way ANOVA test using GraphpadInstat. $p<0.05$ was considered as statistically significant.

Result: Following observations were made from the study of pulmonary function tests in 30 normal (control) subjects, 30 subjects having obstructive pulmonary diseases and 30 subjects having restrictive pulmonary diseases.

Table 1: Comparison of physical characteristic in normal subjects and those suffering from obstructive and restrictive pulmonary diseases.

Physical parameters	Normal subjects	Obstructive pulmonary disease	Restrictive pulmonary disease
	Mean ± SD	Mean ± SD	Mean ± SD
Age(Yrs.)	38.1 ±15.88	40.47 ± 0.69*	35.4 ± 0.88*
Height (Cms.)	162.2 ± 12.52	162.5 ± 0.09*	160.83 ± 0.43*
Weight (Kgs.)	53.87 ± 8.84	51.07 ± 1.27*	52.47 ± 0.46*

- `*P > 0.05 as compared to control

From above table it is apparent that the difference in age, height and weight in all the three group is insignificant (p> 0.05). Thus all three groups match closely for these three physical characteristics.

Table 2: Comparison of pulmonary function tests in normal subjects and those having restrictive and obstructive pulmonary diseases

Tests	Normal	Obstructive pulmonary disease	Restrictive pulmonary disease	Mixed
	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD
FVC (L)	3.57 ± 0.96	3.52 ± 0.82*	1.8 ± 0.74 **	1.64±0.13**
FEV1 %	86.34 ± 4.79	62.17 ± 7.79**	94.8 ± 0.9 *	51.2±2.95**
PEFR (L/S)	5.95 ± 2.09	2.30 ± 2.66 **	5.08 ± 0.12*	1.16±0.20**
• * P > 0.05 , ** P < 0.002				

Table 2 shows that the mean FVC in obstructive pulmonary disease does not change compared to control group because P > 0.05 but FEV1 % and PEFR are greatly reduced in obstructive pulmonary disease P < 0.002.

Similarly in restrictive group of pulmonary disease there is statistically significant reduction in FVC compared to normal subjects P < 0.002. However, FEV1 % remains normal or slightly increased P > 0.05 but value of PEFR remains almost same p > 0.05 which is not statistically significant.

As shown in table no2, 4 subjects showed mixed picture. In these subjects, FVC, FEV1% and PEFR were reduced signifantly, suggesting obstructive as well as restrictive (mixed) disease

Table 3: A comparison of FVC in normal subjects with % predicted values

Tests	Predicted value	Measured value	% predicted value
	Mean ± SD	Mean ± SD	Mean ± SD
FVC (L)	3.57 ± 0.96	3.73 ± 0.73	96.85±7.7

Discussion: From table 1 it is apparent that the difference in age, height and weight in all the three groups is insignificant (P > 0.05). Thus all three groups match closely for these three physical characteristics.

The main purpose of this study was to find out the differences in certain pulmonary function tests like FVC, FEV1% and PEFR in normal (control) group, patients having obstructive lung pathology and patients having restrictive lung pathology.

Ventilatory capacity is greatly influenced by the size of the lungs, which for many purposes is represented by FVC. Our results indicate that the value of mean FVC in normal subjects is 3.57±0.96 L. It is normally greater than 80% of the predicted value[4](Table 3) This was also concluded by Ashok[5] in their study. In obstructive group of pulmonary disorders, the mean FVC was 3.52±0.82 L and p>0.005, which is not statistically significant. This suggests that FVC is not appreciably reduced in pure obstructive lung diseases. Our studies also indicate that in the restrictive group of lung disorders the mean FVC is 1.8±0.74 and p<0.002 compared to normal subjects. This decrease of FVC in restrictive disorders is highly significant. Decreased FVC is a hallmark of restrictive pattern of pulmonary disorders.

FVC is used to standardize the forced expiratory volume for lung size. For this purpose FEV1 is reported as % of FVC. It is used as a guide to airway caliber and is independent of body size and stature.

$$FEV1\% = \frac{FEV1}{FVC} \times 100$$

Our results show that the mean value of FEV1 in normal subjects is 86.34±4.79. In normal subjects FEV1% > 80% of predicted value. In case of subjects having obstructive pulmonary disease, FEV1% is 62.17% ±7.79 with p<0.002 compared to normal subjects, which is highly significant. FEV1% is low when the airway resistance is high, which occurs in obstructive group of lung diseases. This observation is comparable with work of Deborah Leader, RN[6,7]. Joshil, Sushma[8,9,10] also concluded that there is little decrease in FVC but statistical decrease in FEV1% in obstructive lung diseases.

According to our results, mean FEV1% in restrictive pattern of respiratory disorder is 94.87% ±0.9, p>0.005, which is not statistically significant, Hence, in restrictive disorders, FEV1% is normal or increased[11]. Here, both FEV1 and FVC are reduced proportionately.

Our results indicate that the value of PEFR in normal subjects is 5.95L/sec±2.09. In obstructive group of pulmonary disorders, according to our study, mean value of PEFR is 2.30±2.6 and p<0.002, which is highly significant compared to normal subjects. Decreased PEFR is a hallmark of obstructive pulmonary disease and is a highly sensitive index. This observation is comparable with work of Deborah Leader, RN[6,7]. Joshil, Sushma[8,9] also concluded that there is decrease in PEFR in obstructive lung diseases. The peak flow mainly reflects the caliber of the bronchi and larger bronchioles which are subject to reflex bronchoconstriction due to airway obstruction, airway resistance is increased leading to decrease PEFR. Our results indicate that in restrictive group, the value of PEFR is 5.08L/sec±1.66. p=0.12, hence p>0.002. Therefore reduction in PEFR in restrictive group is not significant. i.e. in restrictive pattern of pulmonary disorders, expiratory flow rates are usually preserved as there is no airway resistance[11].

While evaluating and studying the pulmonary function tests in obstructive and restrictive group of pulmonary diseases, we encountered a group of subjects having mixed (obstructive + restrictive) pulmonary disorders. (Table 2). In these subjects, FVC was reduced but FEV1% is decreased and PEFR is also decreased.

Conclusion: By this study our results indicate that as compared to normal subjects, in subjects with obstructive group of pulmonary disorder, the hallmark is decreased PEFR. FEV1 is reduced but FVC is normal. Also, as compared to normal subjects, subjects having restrictive group of lung diseases, hallmark is reduction in FVC. FEV% is normal and so is PEFR. Hence, FVC, FEV1% and PEFR can be used to distinguish obstructive and restrictive group of disorders,

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