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Original research article

Study of Lung function changes in asymptomatic smokers

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Abstract
Tobacco smoking is widely prevalent all over the world and it continues to rise in developing countries. Smoking has a deleterious effect on pulmonary functions. Smoking is the single most significant risk factor contributing to the development of Chronic obstructive airway diseases (COPD). Spirometry by a trained health professional gives an indication of lung health by measuring airway abnormality. Objectives were to study pulmonary function test (PFT) in asymptomatic smokers. The study was carried out in JSS Hospital, Mysore over the period of two years . The study was designed as cross section study which included 449 subjects of which 224 were in group 1 (0-10 Pack Year), 139 were in group2 (11-20 Pack Years), and 87 were in group 3 (21- 30 Pack Years). Subjects with history of cigarette smoking and no respiratory symptoms were subjected spirometry. Forced Vital Capacity (FVC), Timed Vital Capacity(TVC) FEV1 was included in this study . The mean value of FVC-POST in group 1 (0-10pack years) is 3.323+0.696 , in group 2 (11-20pack years) is 2.992+0.679 , and in group 3 (21-30 pack years) is 2.741+0.632 respectively. The mean values of FEV1-POST in group 1(0-10 pack years) is 2.76+0.631, Group 2 (11-20 pack years) is 2.359+0.623 and Group 3 (21-30pack years) is 1.920+0.513 respectively. The mean value of FEV1/FVC POST in Group 1(0-10pack years) is 0.831+0.575, In Group 2 (11-20pack years) is 0.784+0.075, and in Group 3 (21-30pack years) is 0.696+0.079 respectively. From the present, by comparing the Pulmonary Function Test parameters in group1 (0- 10 pack years), group2 (11-20 pack years), and group 3 (21- 30 pack years), we conclude that cigarette smoking was found to cause decrease in various Pulmonary Function Test parameters and leads to airway obstruction.
Keywords: Asymptomatic smokers, PFT. FEV1, FVC.

Introduction
Tobacco smoking is widely prevalent all over the world and it continues to rise in developing countries. Various forms of tobacco smoking practised in India, include chutta (reverse smoking), chillum (clay pipe), and hukku (hubble-bubble) with Cigarette and Beedi smoking being the commonest.[1] Tobacco smoke contains more than 4000 chemicals and around 40 carcinogens.[2] Smoking has a deleterious effect on pulmonary functions. Accumulation of inflammatory cells such as CD8+ T-lymphocytes, B cells, neutrophils and macrophages, in response to irritants found in smoke inhalation, is responsible for an inflammatory reaction.

Hence, the risk of respiratory mortality or morbidity is high with smoking. Smokers have reduced lung functions when compared to non-smokers.[3] Smoking is the single most significant risk factor contributing to the development of COPD. On an average, cigarette smokers have a high annual rate of decline in FEV1 of about 50 ml, which is nearly double the average value of 30 ml annually present in non-smokers. However, there is considerable variation in the decline in FEV1, with some smokers showing very rapid rate of decline.[4] Pulmonary function tests are useful because it is inexpensive, non-invasive and reproducible.[5] PFT may serve as a tool to convince the patient to give up smoking. The smoking epidemic is so huge that every effort is needed to launch effective campaign to create awareness regarding the consequences of smoking. Spirometry by a trained health professional gives an indication of lung health by measuring airway abnormality. Functional defect in smokers with chronic obstructive pulmonary diseases is that of air flow obstruction. Cigarette smoking is overwhelmingly the most important cause of cough and mucous overproduction.[6] Chronic exposure to cigarette smoke reduces small airways function significantly. Smoking increases inflammatory cells in lung which produces free radicals. The oxidative stress is involved in the development of smoking related respiratory conditions and other pathologies. They significantly leads to progressive deterioration lung function and affects all the parameters of pulmonary function tests.[7] This study is aimed to detect the lung function changes in asymptomatic smokers with increasing pack years to assess whether early detection of lung function abnormalities can help to provide early intervention of tobacco cessation.

Pulmonary Function Tests:

Pulmonary function tests assess the ventilatory functions of lungs and provide a quantitative and objective assessment of the physiological derangement associated with pulmonary disorders.[8]Indeed, these tests have become a basic tool in epidemiologic studies to assess occupational respiratory disorders due to their ease of administration and also due to the growing recognition of occupational exposures as potential and actual threats to respiratory health.[9]

1) Forced Vital Capacity (FVC):

This is the maximum volume of air which can be breathed out as forcefully as possible and rapidly following a maximum inspiration. Thus, forced vital capacity is exactly similar to vital capacity except that there is a special stress on rapid forceful and complete exhalation.

2) Timed Vital Capacity (TVC)

If vital capacity is recorded on a kymograph at known speed, volume of air expired can be timed. This is Timed Vital Capacity.

Components of TVC:

i. FEV1: Forced expiratory volume in the 1stsecond i.e., volume of FVC expired in first second of exhalation. Normally 80% of FVC.

ii. FEV2: Forced expiratory volume in 2 seconds i.e., volume of FVC expired in first 2 seconds of exhalation. Normally 95% of FVC.

iii. FEV3: Forced expiratory volume in 3 seconds i.e., volume of FVC expired in first 3 seconds of exhalation. Normally 98-100% of FVC.

An attempt has been made to study the pulmonary function tests among asymptomatic smokers.

Material and Methods;

This study was carried out in the Department of Pulmonary Medicine, JSS Medical College Hospital, Mysuru over a period of 2 years. The subjects for study were selected from relatives and friends of patients in JSS Hospital, after fulfilling the inclusion and exclusion criteria.

Type of study:
Cross sectional study

Sample size:
449

Inclusion Criteria:
Clinically asymptomatic adult smokers >18 years of age
Grouped into following:
I) <10 pack years II) 10-20 pack years III) 21-30 pack years

Exclusion criteria:
1) Subjects have active pulmonary TB
2) Contraindications for spirometry like
a) History of abdominal/chest/eye surgery, MI in past 3 months.
b) Pneumothorax
c) Respiratory infections in past 3 weeks
Clinically asymptomatic adult smokers were screened for inclusion and exclusion criteria after explaining them about the study. Written and informed consent was taken for the study after explaining the procedure and its significance in their vernacular language. A pre tested structured proforma was used to collect the relevant information. A brief personal , smoking, medical, occupational history were taken and a clinical examination of all the systems was done to exclude medical problems and to prevent confounding of results. The physical characters such as height in centimeters and weight in kilograms of all the subjects were recorded and fed to the computer to get predicted values for pulmonary function tests. We used NDD for assessing the pulmonary functions. This spirometer has a mouth piece attached to a transducer assembly which is connected to an adaptor box and this is connected to the computer by a serial cable. Software from Recorders and Medicare system is loaded onto the computer. This software allows the calculation of the predicted values for age, sex, weight and height and it also gives the recorded values of all the parameters. Subject was motivated prior to the initiation of manoeuvre. He was made to sit on a stool, then place the mouth piece firmly in his mouth. He was asked to take a maximum inspiration following which we would attach a nose clip and ask him to execute a maximum forced expiration with full efforts which was followed by a maximum forced inspiration. Forced Vital Capacity (FVC), Timed Vital Capacity(TVC) FEV1 was included in this study .
Statistical methods used: All the data collected were entered into MS Access database, statistical analysis was conducted using Epi info version 7 (CDC, Atlanta, USA) and IBM SPSS version 20 . Descriptive statistics: The continuous variables like age was presented as mean (standard deviation) and categorical/nominal variables were presented as frequencies. Pearson's correlation was used to analyse the correlation of variables like pack years with spirometry values. Comparison of means was done for assessing the difference of lung function parameters between the pack year groups .Sub-group analysis to assess dose response relationship between pack-year groups and severity of lung function abnormalities was carried out.

Results:
In present study total of 449 subjects were included are grouped in to:
224 in to 0-10 pack years.
139 in to 11-20 pack years.
87 in to 21-30 pack years.

Table 1: Comparison Age among Group 1,2& 3

COMPARISON AGE AMONG GROUP 1,2& 3			
Variable	Study group	Mean	SD
AGE (yrs)	0-10 pack years	49.25	16.11
	11- 20 pack years	56.93	10.05
	21-30 pack years	65.94	7.94

Table 2: FVC-PRE among Group 1,2& 3

FVC-PREAMONG GROUP 1,2& 3						
	Pack years	N	Mean (L)	SD	Min	Max
FVC-PRE	0 to 10	223	3.29	0.701	1.32	4.91
	11 to 20	139	2.90	0.679	1.65	4.80
	21 to 30	87	2.60	0.619	1.47	4.31

The mean value of FVC-PRE in 0-10pack years is 3.29. ±0.701, in 11-20 pack years is 2.90±0.679 and in 21-30pack years is 2.60±0.619. There is a significant difference in FVC-PRE values in all the three groups.

Table 3: FVC-PRE Bronchodilator % PRED among Group 1,2 & 3

FVC-PRE BRONCHODILATOR % PRED AMONG GROUP 1,2 & 3								
	Pack years	N	Mean (%)	SD	Min	Max	P Value	Post HOC
FVC-PRE BRONCHODILATOR % PRED	0 to 10	223	100.46	13.591	19	137	<0.001	1 & 2, 1& 3
	11 to 20	139	91.62	13.809	55	144		
	21 to 30	87	90.39	18.641	48	184		2&3 Not significant

The mean value of FVC-% PRED IN 0-10pack years is 100.461±13.59,in 11-20 pack years is 91.62±13.80 and in 21-30pack years is 90.39±18.64.

Table 4: FVC-POST among Group 1,2& 3

FVC-POST AMONG GROUP 1,2& 3						
	Pack Years	N	Mean (L)	SD	Mini	Max
FVC-POST	0 to 10	223	3.3239	.69611	1.43	4.96
	11 to 20	139	2.9922	.67993	1.62	4.90
	21 to 30	87	2.7413	.63212	1.68	5.05

The mean value of FVC-POST in 0-10pack years is 3.32 ±.696,in 11-20 pack years is 2.99. ±.679 and in 21-30pack years is 2.741. ±.632.

Table 5: FVC -POST Bronchodilator % PRED among Group 1,2& 3

FVC -POST BRONCHODILATOR % PRED AMONG GROUP 1,2& 3								
	Pack Years	N	Mean (%)	SD	Min	Max	P Value	Post HOC
FVC POST BRONCHODILATOR % PRED	0 to 10	223	101.31	14.757	17	139	<0.001	1 & 2, 1 & 3 2&3 Not significant
	11 to 20	139	94.02	16.808	19	149		
	21 to 30	87	94.93	18.225	63	174		

The mean value of FVC-%POST PRED in 0-10pack years is 101.31±14.75,in 11-20 pack years is 94.02±16.80 and in 21-30pack years is 94.931±18.22. There is a significant difference in FVC % PRED values in all the three groups.

Table 6: FEV1-PRE among Group 1,2& 3

FEV1-PREAMONG GROUP 1,2& 3						
	Pack Years	N	Mean (L)	SD	Min	Max
FEV1-PRE	0 to 10	223	2.6901	.61442	1.11	4.37
	11 to 20	139	2.2414	.60880	.95	3.86
	21 to 30	87	1.7786	.49949	.74	3.24

The mean value of FEV1-PRE in 0-10pack years is 2.69±.614, in 11-20 pack years is 2.241±.608 and in 21-30pack years is 1.778±.499.

Table 7: FEV1- Bronchodilator PRE % PRED among Group 1,2& 3

FEV1- BRONCHODILATOR PRE % PRED AMONG GROUP 1,2& 3								
FEV1-PRE BRONCHODILATOR % PRED	Pack Years	N	Mean (%)	SD	Min	Max	P Value	Post HOC
	0 to 10	223	100.60	12.984	70	177	<0.001	All three groups
	11 to 20	139	86.63	15.239	47	177		
	21 to 30	87	76.83	17.439	39	139		

The mean value of FEV1 %PRED in 0-10pack years is 100.60±12.98,in 11-20 pack years is 86.63±15.23 and in 21-30pack years is 76.83±17.43.

Table 8: Comparison OF FEV1-POST among Group 1,2,& 3

COMPARISION OF FEV1-POST AMONG GROUP 1,2,& 3						
	Pack Years	N	Mean (L)	SD	Min	Max
FEV1-POST	0 to 10 years	223	2.7663	.63164	1.27	4.65
	11 to 20 years	139	2.3596	.62340	1.03	4.02
	21 to 30 Years	87	1.9202	.51371	.93	3.41

The mean value of FEV1-post in 0-10pack years is 2.766±.63, in 11-20 pack years IS 2.35±.623 and in 21-30pack years is 1.92±.513.

Table 9: FEV1- POST Bronchodilator % PRED among Group 1,2,& 3

FEV1- POST BRONCHODILATOR % PRED AMONG GROUP 1,2,& 3								
FEV1-POST BRONCHODILATOR % PRED	Pack Years	N	Mean (%)	SD	Min	Max	P value	Post HOC
	0 to 10 years	223	103.30	12.957	72	147	<0.001	All three groups
	11 to 20 years	139	90.87	14.212	51	133		
	21 to 30 Years	87	81.64	18.155	1	124		

The mean value of FEV1 %PRED in 0-10pack years is 103.3±12.95,in 11-20 pack years is 90.87±14.21 and in 21-30pack YEARS is 81.64±18.15. There is a significant difference in FEV1 -POST values in all the three groups.

Table 10: FEV1/FVC POST among Group 1,2,& 3

FEV1/FVC POST AMONG GROUP 1,2,& 3						
FEV1/FVC-POST	Pack Years	n	Mean	SD	Min	Max
	0 to 10 years	223	.83178	.057520	0.681	0.991
	11 to 20 years	139	.78499	.075204	0.516	0.957
	21 to 30 Years	87	.69677	.079297	0.483	0.840

The mean value of FEV1/FVC-POST in 0-10pack years is .831±.057,in 11-20 pack years is .784±.075 and in 21-30pack years is .696±.079.

Table 11: FEV1/FVC POST Bronchodilator

		GROUP 1 (0-10 pack years)	GROUP 2 (11-20 pack years)	GROUP 3 (21-30 pack years)
FEV1/FVC POST BRONCHODILATOR	Abnormal (<0.7 PRED)	4/223 (1.7%)	16/139 (11.51%)	39/87 (44%)
	Normal (>0.7 PRED)	219/223 (98.2%)	123/139 (88.4%)	48/87 (56%)

P value: <0.001

We found that abnormal FEV1/FVC post values in 4 subjects of group 1, 16 subjects of group 2, 39 subjects of group 3.

Discussion:

Evidence accumulated in the past 30years,shown an Irrefutable association between the long term inhalation of cigarette smoke and the development of obstructive airway disease.[10]The available data indicate that the life expectancy of habitual smokers is reduced by 15-20 years and approximately half will die as a consequence of their habit. [11] Cigarette smoking has extensive effects on the respiratory function and it has been clearly implicated in the aetiology of a number of respiratory diseases, particularly chronic bronchitis, emphysema and bronchial carcinoma. Tobacco smoke contains number of substances which may exert some effects upon body. During burning of tobacco in cigarettes various processes such as pyrolysis, prosynthesis, distillation, sublimination, hydrogenation, oxidation,decarboxylation, dehydration result in generation of more than 4000 identifiable compounds present in tobacco itself or new compound generated thereof. The tobacco smoke inhalation causes an immediate rise in the airway resistant which persist for at least an hour. This is due to vagally mediated smooth muscle constriction presumably by way of stimulating submucosal irritant receptors. Experimental studies have shown that prolong cigarette smoking impairs cilliary movements, inhibition of function of alveolar macrophages leads to hypertrophy and hyperplasia of mucus secreting glands. It is probable that smoke also inhibits antiproteases and causes polymorphonuclear leucocytes to release proteolytic enzymes acutely.[12]In smokers, changes occurs in respiratory system due to inflammation, and fibrosis. So all dynamic pulmonary parameters under consideration are significantly lower than normal values. Pulmonary function is a good test to describe the pattern of pulmonary disease. The decrease in FEV1, FEV1/FVC RATIO and other flow rates indicates obstructive lung changes and decrease in FVC indicates restrictive lung changes. [13]

FVC

In our study the mean value of FVC-POSTin group 1(0-10pack years) is 3.323+0.696; in group 2(11-20pack years) is 2.992+0.679 ;and in group 3 (21-30 pack years)is 2.741+0.632 respectively. We found that abnormal FVC post value in 2 subject of group 1, 6 subjects of group 2, 3 subject of group 3 respectively. Similar finding were reported by Bano R et al,

Anang T, ANAND M, Saba Ibrahim, Hani A et al.[14]The irritants present in the smoke cause release of elastase from alveolar macrophages, that degrades structural elements of the lung .which leads to loss of elastic recoil causing decrease in FVC%, FEV1, PEFR.

FEV1

We found that, the mean values of FEV1,POST in group 1(0-10 pack years) is 2.76+0.631, Group 2 (11-20 pack years)is 2.359+0.623 and Group 3 (21-30pack years) is 1.920+0.513 respectively.This results are in agreement with studies done by Dwarakanath et al,[3]S I Saba et al, Diane R et al, REXHIP et al F,Prasad S K.[15]

In our study we also found that the reduction of FEV1 is directly associated with the number of pack years. A similar association is found in Isbel U et al study.[16] We found that abnormal FEV1 post value in 2 subject of group 1, 22 subjects of group 2, 34 subject of group 3. Decline in the FEV1 is strongly related to cumulative cigarette consumption and severity of pre-existent bronchial hyperresponsiveness in smokers with COPD. Decline in FEV1 is also related to the number of cigarettes smoked ,heavy smokers with mild to moderate COPD showed a greater decline than light smokers and these heavy smokers showed greater FEV1 improvement after smoking cessation than light smokers.[17]

FEV1/FVC

In our study the mean value of FEV1/FVC POST IN Group 1(0-10pack years)is 0.831+0.575, In Group 2 (11-20pack years) is 0.784+0.075, and in Group 3 (21-30pack years) is 0.696+0.079 respectively. Similar observations were reported by Dhand R et al, Fain S B et al, Ritesh M K et al.[18] Sumita N et al, Anand Kumar et al, Shireen J et al, Yasunga K et al.[19] In contrast Harita et al observed that there is no significant change in FEV1 and FEV1/FVC ratio in smokers and non smokers. We found that abnormal FEV1/FVC post values in 4 subjects of group 1, 16 subjects of group 2, 39 subjects of group 3. It also showed that ratio of FEV1/FVC was decreased with increase in duration of smoking and also with increase in number of cigarette per day. Smoking may directly induce an arterial endothelial injury and an increased platelet consumption may reflect the adherence or the deposition of these cells to damage site was suggested by Hind C R. All the parameters of pulmonary function tests like FVC,FEV1, FEV1/FVC ratio and FEF25-75% showed statistically significant dose response relationship between group 1and group 2, 3(p value <0.001). Finally we conclude that smoking causes decline in pulmonary function test parameters especially obstructive type.

Conclusion:

From the present, by comparing the Pulmonary Function Test parameters in group1 (0- 10 pack years), group2 (11-20 pack years), and group 3 (21- 30 pack years), we conclude that cigarette smoking was found to cause decrease in various Pulmonary Function Test parameters and leads to airway obstruction. So tobacco smoking control programme to be strengthened to prevent morbidity and mortality from smoking.

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