IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)
e-ISSN: 2279-0853, p-ISSN: 2279-0861.Volume 14, Issue 10 Ver. IX (Oct. 2015), PP 01-05
www.iosrjournals.org

Clinical Significance of Pulmonary Function Test in Smokers Compared to Non-smoker

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Abstract:
Objective: *To compare the pulmonary functions in smoker & non smoker.*
Materials and Method: *In present prospective study , two hundred male subjects were included. PFT measurements were carried out three times in each subject & highest level for forced vital capacity [FVC], forced expiratory volume in first second [FEV1]& peak expiratory flow rate[PEFR] was recorded. Data was analysed using unpaired students t test & ANOVA .*
Results: *Smoking had a negative impact on lung function, as compared to non-smokers . There was significant decrease in all pulmonary function. (p<0.05).*
Conclusion*:Young smoker within few years,of starting to smoke develop changes in pulmonary function indicating early peripheral airway narrowing. These inflammatory changes in small airways often reverse with cessation of smoking and improves lung function. This emphasises the need for a primary prevention in Indian young men .*
Keywords: *Forced vital capacity [FVC], Forced expiratory volume in one second [FEV1, Non-smoker, Peak expiratory flow rate[PEFR], Smoker*

I. Introduction

Cigarette smoking remains the leading cause of preventable premature morbidity and mortality in many countries around the world including India [1].Smokers account for one third of worlds population (47% of adult men population and 7% of adult women population). Tobacco is responsible for about 10,000 deaths each day. It is predicted that in next 20 years, the yearly death rate from tobacco use will be more than 10 million people [2]. Because of the long delay between the cause and full effect, people tend to misjudge the hazards of tobacco. About half of those killed by tobacco were still in middle age (35-55 years) and thereby, they have lost twenty five years of non smoker life expectancy [3]. Smoking is common in adolescence, as a symbol of "adult behaviour"

Tobacco use is socially accepted in many segments of Indian society , but there are considerable changes in the type and methods by which it is used. According to WHO estimation, 194 million men and 45 million women use tobacco in smoke or smokeless form in India [4].

It is the most important modifiable risk factor for chronic obstructive pulmonary disease, coronary artery disease, hypertension and carcinomas originating in the nasopharynx, bronchus etc.[5].

Cigarette smoking is by far the most important risk factor for COPD.It is currently the fourth leading cause of death in the world [6]. The diagnosis of COPD at an early stage may be done by performing pulmonary function test (PFT) in smokers using case finding or population screening method. [7]

Pulmonary function testing has come into widespread use since the 1970s. This has been facilitated by several developments because of advances in computer technology [8].It is a valuable tool for evaluating the respiratory system, representing an important adjuvant to the patient history, various lung imaging studies, and invasive testing such as bronchoscopy and open-lung biopsy [9].

Quitting smoking results in tremendous benefits, in that it reduces respiratory cancer , slows the progression of COPD and also risk of cardiovascular disease [10].Present study was undertaken to highlight the effect of quantity and duration of smoking on pulmonary functions.

II. Material & Methods

Present comparative case control study was conducted in Osmania Medical College Hospital, Hyderabad , Telangana from July 2013 to July 2014. One hundred smokers (cases) were compared with 100 healthy non smokers (control) subjects aged between 20-40 years.

Inclusion criteria:

- Healthy adult male subjects with no past or present history of smoking between the age group of 20-40 years (Control group).

- Healthy adult male subjects with a history of smoking , more than 5 cigarettes per day for more than one year (Study group)

Exclusion Criteria:

- Refusal for participation in study
- Female subjects
- Male subjects with a history of smoking less than one year.
- Male subjects suffering from diseases which directly or indirectly affects the lung functions .

All patients were explained in detail about aim, objectives of study and written consent was taken. A detailed history was taken including age, duration of smoking in years and the number of cigarettes smoked per day to see the dose response relationship. A thorough general physical examination of patient including height, weight, body mass index, pallor, vital data and thorough systemic examination were done to exclude medical problems so as to prevent confounding result.

Complete pulmonary function survey of all subjects were carried out using a standardized automated spirometer – Computerized Medspiro . The pulmonary functions of all the subject were done in the morning between 9 AM to 1 PM during college hours. Prior to pulmonary function testing, manoeuvre was demonstrated by the operator and subjects were encouraged and supervised throughout the test . Pulmonary function testing were performed according to guidelines of American Thoracic Society [11] with subjects in a standing position and wearing nose clip and ask the subject to take a maximum inspiration and then with mouth piece firmly in mouth, ask him to execute a maximum forced expiration with full efforts and followed by a maximum forced inspiration. Following parameters were studied in present study:

1. Forced Vital Capacity (FVC):-This is the maximum volume of the air that can be expired force fully after maximal inspiration. Normal value ----3.5-5.5 liters.
2. Forced Expiratory Volume in 1st second (FEV1): It is the amount of air that can be expired forcefully and maximally in the 1st second after a maximal inspiration. Normal values 80%-85% or 4-4.5 liters.
3. Peak Expiratory Flow Rate (PEFR):- It is the amount of air that can blown out of fully inflated lungs as rapidly as possible. Normal Value 6-15 liters/sec.
4. Forced Expiratory Flow FEF(25-75%): This is the average expiratory flow rate during the middle 50% of vital capacity. It is also called the maximal mid expiratory flow. Normal = 5.21 - 6 L

PFT measurements were carried out three times in each subject and highest level for forced vital capacity [FVC], forced expiratory volume in first second [FEV1], peak expiratory flow rate[PEFR] and FEF(25-75%) were noted.

Statistical Analysis: The data collected was tabulated in microsoft excel sheet and were analysed and expressed in Mean ± Standard Deviation. Comparisons were performed using students t-test for 2 group comparisons and one way ANOVA (Analysis Of Variance) for multiple groups. p value of < 0.05 was considered as statistical significance.

III. Results

Following were the observations of present study.

"Table-1" Comparison of Demographic data in smoker and Non-smokers (N=200)

S.No	Parameter	Smoker (n=100) Mean ± SD	Non-smokers (n=100) Mean ± SD	p-value
1	Age (years)	30.28±6.7	28.08 ± 3.6	> 0.05
2	Height (cms)	160.21±9.76	161.05±3.09	> 0.05
3	Weight (kg)	62.17±7.84	65.33±6.47	> 0.05

'p' value: <0.05 – significant

Demographic characteristics of both the groups were comparable

"Table-2" Comparison of pulmonary function tests between smokers and non-smokers (N=200)

S.No	Parameter	Smoker (n=100) Mean ± SD	Non-smokers (n=100) Mean ± SD	p-value
1	FVC (L)	2.48±0.67	3.19±0.59	<0.05
2	FEV1 (L)	1.97±0.34	2.88±0.47	<0.05
3	FEV 1 /FVC (%)	79.43±5.4	90.28 ±7.9	<0.05
4	FEF25-75%	2.96 ±0.54	4.32 ± 0.48	<0.05
5	PEFR (L/S)	5.67 ± 0.89	8.27 ± 0.68	<0.05

'p' value: <0.05 – significant

FVC, FEV 1 FEV /FVC, FEF25-75% and PEFR were significantly less in smoker ($p < 0.05$).

"Table-3" Comparison of pulmonary function tests in relation to number of cigarettes smoked per day (n= 100)

S.No	Frequency (Cig/ day)	FVC (%Predictive)	FEV 1 (% Predictive)	FEV 1 /FVC (%) (% Predicive)	FEF25-75% (%Predictive)	PEFR (%Predictive)
1	6-10	75.6 ± 4.2	76.2 ± 3.5	94.5 ± 3.8	74.4 ± 5.1	72.3 ± 5.2
2	11-15	72.2 ± 2.6	66.2 ± 3.9	94.32 ± 3.5	64.6 ± 3.2	61.6 ± 3.5
3	16-20	67.2 ± 2.8	53.1 ± 2.3	84.2 ± 4.2	60.32 ± 3.6	56.5 ± 2.12
p-value		<0.05	<0.05	<0.05	<0.05	<0.05

'p' value: <0.05 – significant

All parameters were significantly reduced with increase number of cigarette smoke per day ('p'<0.05)

"Table-4" Comparison of various pulmonary function tests in relation to duration of smoking (n= 100)

S.No	Duration (year)	FVC (%Predictive)	FEV 1 (% Predictive)	FEV 1 /FVC (%) (% Predicive)	FEF25-75% (%Predictive)	PEFR (%Predictive)
1	1-5	82.1 ± 4.3	78.2 ± 3.8	97.1 ± 3.8	76.6 ± 6.1	74.1 ± 4.6
2	6-10	76.6 ± 3.5	71.6 ± 3.8	95.8 ± 2.8	74.3 ± 3.8	68.5 ± 3.8
3	11-15	74.3 ± 1.3	68.5 ± 1.8	93.5 ±1.8	72.4 ± 1.8	64.7 ± 3.12
4	16-20	70.5 ± 2.6	66.17 ± 2.6	91.45 ± 5.2	68.5 ±1.7	62.1 ±2.35
p-value		<0.05	<0.05	<0.05	<0.05	<0.05

'p' value: <0.05 – significant

Significant decrease in pulmonary parameters was found with increased duration of smoking (p<0.05).

IV. Discussion

In present study, age range was 20-40 years. Difference in age, height and weight in both the groups is insignificant (p > 0.05) (Table 1). Thus cases & control groups match closely for physical characteristics. The aim of present study was to find out any alterations in certain pulmonary function tests like FVC, FEV1% , FEV 1 /FVC , FEF25-75% and PEFR between both the groups.

FVC :

In present study there was a statistically significant decrease in FVC in smokers compared to non smokers. It is also shown that FVC level decreases more with both increase in duration of smoking and number of cigarettes smoked per day. Similar findings were also reported in various studies, by Nancy NR et al [12],Miller A et al[13] and Mhase VT et al [14].

FVC measures "Ventilable" lung volume; a decrease therefore reflects,

1) Restriction secondary to pulmonary or pleural fibrosis.

2) Air trapping secondary to airway obstruction.[15] The decreased FVC in present study might be due to second cause.

FEV1 :

In present study there was a statistically significant decrease in FEV1 in smokers compared to non smokers. It was observed that FEV1 decreases more with both increase in duration of smoking and increase in number of cigarettes smoked per day. Similar findings were also reported by Camilli AE et al [15], Hogg CJ et al [16] and Apostol GG et al[17].

The reduction in FEV1 associated with chronic cigarette smoking can be partially explained by loss of lung elastic recoil which reduces the force required to drive air out of the lung. This can also be attributed to microscopic enlargement of air spaces [16]. It has also been shown that, bronchial reactivity increases in smokers, resulting in increase in IgE. This may also affect the FEV1 in smokers[18].

FEV1/FVC :

In present study there was a significant decrease in FEV1/FVC ratio. Also this ratio was more decreased with increase in duration of smoking and also with increase in number of cigarettes per day. These findings are in agreement with many other studies from Walter S et al [19], Miller A et al [13] .

FEV1/ FVC ratio is a more sensitive index of early disease [20]. As mentioned above smoking leads to changes in FVC and also FEV1, Thus this ratio is also affected.

FEF25-75% :

In present study the level of forced expiratory flow between 25% and 75% of FVC or average forced expiratory flow was reduced in smokers compared to non smokers which was statistically significant. It was also observed that level of FEF25-75% decreased more with increase in duration of smoking as well as with increase

in number of cigarette smoked per day. Similar findings were also reported from Nancy NR et al.[12], Mhase VT et al[14] and Walter S et al.[19].

The major cause of the reduction in FEF25-75% is an inflammatory process in small conducting airways, that causes them to narrow and close prematurely [16].

PEFR :

Present study has shown a significant decrease in the level of PEFR. As with other parameters , it also decreases more with increase in duration of smoking and increase in number of cigarettes smoked per day. These findings were similar to those reported by Nancy et al[12]. This may be due to smoking induced inflammation and narrowing of airways which results in increase in resistance to airflow and a decrease in elastic recoil of the lungs[12].

Thus in present study, all the parameters of lung function which are analysed showed a decrease in their value, with an increase in duration of smoking and number of cigarettes smoked per day.

It was shown, that the effect was also dependent on the extent of exposure, both in the form of duration and number of cigarettes. Possible mechanism for this could be accumulation of inflammatory exudates, excess mucus secretion, altered surface tension or altered smooth muscle tone. Also mediators released from cells present in or brought to the airway could contribute to these changes. The progressive nature of these changes with continued smoking indicates that at least a proportion of these smokers develop chronic obstructive airways diseases [21,22].Human body has tremendous reserve to cope with adversities. Disability develops only when impairment has progressed up to a certain level.

Our findings suggest more decrease in lung functions in the first five years of smoking and is similar to the finding of Camilli AE et al [15] suggesting that the earliest effects of smoking are relatively rapid and atleast in part a bronchoconstrictive effect. Hence the inflammatory changes in small airways often reverse with cessation of smoking and improves the lung function.

V. Conclusion

To conclude, Smoking accounts for 80-90% risk of developing chronic obstructive pulmonary disease and 80-85% of bronchogenic carcinoma. All the parameters, has decreased more, showing that smoking has affected the small conducting airway more, where disease of chronic airflow obstruction is thought to originate.

Young smokers within few years of starting of smoking, develop changes in pulmonary functions indicating early peripheral airway narrowing and these effects worsen progressively with continued smoking.
We recommend further larger multicentric studies to confirm results of present study.

Health education on hazards of smoking and legislation on Banning of smoking in public places to be encouraged.

Acknowledgements

We express our deep gratitude to all patients for their co-operation.

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