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CAN BODY PLETHYSMOGRAPHY DEMONSTRATE EARLY WORSENING OF LUNG FUNCTION IN SMOKERS?-A COMPARATIVE RANDOMIZED CROSS-SECTIONAL STUDY

PHYSIOLOGY

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ABSTRACT

BACKGROUND: Like any chronic disease, COPD undergoes a phase of transition from healthy to disease state. This transition often termed as early COPD, remains undetected, probably due to limitations with the diagnostic tools and symptom appearance. If the disease can be diagnosed at an early stage, the subsequent progression of the disease can be arrested. With this background, the present study was conducted.

MATERIAL AND METHODS: In this comparative randomized cross-sectional study, healthy control subjects (CN), smokers without COPD diagnosis (SM) who were smoking 10 packets for more than five years and smokers with COPD (SC) (n=30 each group) were included. All the subjects were males and provided written informed consent. Spirometry and body plethysmography were performed according to published guidelines. With spirometry FEV1, FEV1/FVC and FEF25-75% parameters were recorded and with body plethysmography sGaweff, sGawtot and Inspiratory Capacity (IC) were recorded. The differences in lung function were compared between the three groups using univariate analysis of variance and Tukey's post-hoc test.

RESULTS: SM and CN groups did not significantly differ in FEV1, and FEV1/FVC and FEF25-75%. However sGaweff, sGawtot and IC were significantly lower in SM group compared to CN. All the parameters were significantly lower in SC group compared to CN and SM groups.

CONCLUSION: sGaw and IC measured using body plethysmography can demonstrate early worsening of lung function in smokers without COPD diagnosis (early COPD).

KEYWORDS

Body plethysmography, smoking, airway conductance.

INTRODUCTION:

Smoking is a big ongoing hazard for mankind and regarded as an important risk factor for Chronic Obstructive Pulmonary Disease (COPD) and other systemic dysfunctions. Nearly 33-35% people die in India because of smoking for 15 years continuously. [1]

COPD is the 4th most common cause of deaths in the world and its burden has increased in recent decades, due to continuous exposure to respiratory diseases and increased life expectancy. [2] Like any chronic disease, COPD undergoes a phase of transition from healthy to diseased state. This transition often termed as early COPD, remains undetected, probably due to limitations with the diagnostic tools and symptom appearance. For diagnosing COPD, Spirometry was supposed to be a gold standard but early detection of COPD is not possible. This drawback can be overcome with Body Plethysmography specially in smokers [3,4] with its less demanding efforts by subjects and ability of technician.[5] Hence we conducted this study to understand the differences in lung function between healthy subjects, smokers and patients of COPD.

MATERIAL AND METHODS:

The study was approved by the ethical committee at B.J Govt. Medial College, Pune, Maharashtra, India. In this comparative randomized cross-sectional study, healthy control subjects (CN), smokers without COPD diagnosis (SM) who were smoking 10 packets for more than five years and smokers with COPD (SC) (n=30 each group) were considered. All the subjects were males and provided written informed consent. Spirometry and body plethysmography were carried out according to published course of action.[6,7]

Body plethysmography is used for purpose of computing thoracic gas volume (TGV) and airways conductance (Gaw). During body plethysmography, the subject was asked to sit in a chamber prepared to measure pressure, flow or volume changes. Airways resistance (Raw) was calculated as the inverse of Gaw. Specific airways conductance (that is conductance/unit of lung volume) was reported as sGaw in L/s/cm H2O (that is Liter per second per centimeter of water). For measuring sGaw dynamic pressure flow volume type plethysmograph; CRF Master Screen Body Diff., JAEGER Hochberg, Germany was used.

With spirometry FEV_1, FEV_1/FVC and $FEF_{25-75\%}$ parameters were recorded and with body plethysmography sGaweff, sGawtot and Inspiratory Capacity (IC) were recorded. The differences in lung function were compared between the three groups using univariate analysis of variance and Tukey's post-hoc test.

Table 1: Comparison of spirometry and body plethysmography measurements between CN, SM and SC groups.

	Healthy CN (mean ± SD)	Smokers without COPD SM (mean ± SD)	Smokers with COPD SC (mean ± SD)
No of subjects	30	30	30
Age (years)	44.9±3.67	45.66±4.56^	47.63±6.73^
FEV_1, L	2.50±0.67	2.32±0.36	1.03±0.37#*
$FEF_{25-75\%}$, L/s	2.59±1.33	2.17±0.40	0.85±0.53#*
FEV_1/FVC	0.82±0.05	0.79±0.09	0.53±0.09#*
sGaweff, KPa.L/s	1.54±0.48	0.86±0.45#	0.42±0.15#*
sGawtot, KPa.L/s	1.31±0.45	0.85±0.45#	0.35±0.16#*
IC, L	2.45±0.71	2.05±0.53#	1.54±0.65#*

Table. 1

= p-value <0.01 in comparison with CN

* = p-value<0.01 in comparison with SM

^ = p-value > 0.05 non-significant.

RESULT AND DISCUSSION:

In present study males of similar age group with no demographical differences were taken inconsideration. Results of spirometry and body plethysmography are depicted in table 1.

Smoking causes inflammation of airways along with rise in inflammation. Sustained smoking then may land subject in to diseased condition like COPD increasing chances of morbidity and mortality.[8,9] For uncovering of changes in pulmonary function test spirometry is generally used. But spirometry is having its own limitations, hence different techniques like body plethysmography can be used. Body plethysmography gives us idea about airway conductance and total lung capacity which are supposed to be more sensitive and specific for

revealing the changing form in airways causing diseases.[10]

In present study we observed that differences in FEV_1, FEV_1/FVC and $FEF_{25-75\%}$ values was insignificant when compared between healthy (CN) and smokers without COPD (SM) , but significant changes in the same parameters were found when healthy(CN) were compared with COPD (SC) patients inferring obstructive changes.[11,12]

In present study age matched male subjects were taken in consideration. Hence fall in FEV_1 is attributed to smoking causing increased mucus secretion but to diagnose early COPD other techniques should also be considered. [13,14]

On the other side when values of conductance (sGaweff and sGawtot) and Inspiratory Capacity (IC) were compared between CN and SM it showed statistical significant difference. Also comparison between CN and SC was statistically significant which clearly suggests that early changes in SM were picked up by using body plethysmography.

As far as IC values were concerned, similar results were observed by CM Houghton et al they concluded that IC goes on decreasing with advancement of disease. And similar changes can also be observed in other parameters of body plethysmography specially related to conductance.[15]

In present study significant difference was observed for all parameters when controls and COPD patients were compared. According to Reilly JJ, in COPD patients there is increased residual air inside lungs, loss of elastic recoil of lung parenchyma and there is decreased airway conductance. All of these contribute in increased work of breathing. Increased work will give burden on active processes of respiration that is inspiration. This may lead to reduction in volume of air entering lungs explaining fall in IC. These findings could be attributed to mechanisms mentioned. [16]

Borrill ZL studied effect of bronchodilator drugs amongst smokers without COPD, severe COPD and controls by measuring airway conductance and concluded that sGaw values can sensitively differentiate between different drug effects as compared to spirometric parameters. At the same time they also stated that sGaw gives values were suggestive of disease progression in smokers and COPD. This observation goes in accordance with present study.[5,13]

From the above discussion it can be concluded that measurement of body plethysmographic parameters like sGaw is of importance to identify budding stage of COPD and progression of disease.

Van Noord *et al.* in their study assessed the physiological effects of drug in COPD by measuring sGaw by body plethysmography. They performed histamine challenge test and evaluated pulmonary resistance. According to them, most sensitive measurements for detecting the physiological effects of drugs in COPD is sGaw. They implemented histamine challenge test and pulmonary resistance was checked. According to them plethysmography should be used more often to assess the effects of pharmacological interventions in various grades of COPD to assess the prognosis of the disease. [17] Results of present study are well in harmony with Van Noord.

Considering spirometry and body plethysmography results; similar results were found by Thomas R Gildea and they stated that with spirometry there are limitations as it cannot measure Residual Volume, Forced Residual Capacity, and Total Lung Capacity but with body plethysmography in addition to these parameters other parameters like sGawtot and sGaweff can also be measured which can give comprehensive evaluation of COPD for early diagnosis, progression and assessment of severity of disease.[18]

Therefore it can be concluded that body plethysmography can help in early detection, progression and grading of severity of COPD as compared to spirometry alone sGaw and IC measured using body plethysmography can demonstrate lung function worsening in smokers without COPD diagnosis (early COPD).

So if these people could be refrained from smoking, then there will be reduction in the rate of damage to the lungs. Hence the early detection of changes in pulmonary function test is possible which will reduce morbidity and mortality.

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