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Study of changes in Flow Volume curves in obese middle-aged individuals with obstructive pulmonary disease

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Abstract: *Objective:* To study the effect of obesity on Flow Volume curves of middle aged individuals with obstructive pulmonary disease. *Background:* Obesity and obstructive pulmonary disease quite often co-exist in the same individual seeking treatment for respiratory illness. Not many studies have been done about the impact of obesity on dynamic respiratory mechanics in patients with obstructive lung disease in South India. *Materials & Methods:* This is a retrospective cross sectional study where data was collected from the Department of Pulmonary Medicine, JSS hospital, Mysore. 120 normotensive non diabetic subjects in the age group of 40-60 years, were divided into four groups based on their BMI and the presence of obstructive findings. Flow Volume loop, FEV_1, FVC and FEV_1/ FVC were recorded using computerised spirometer. *Results:* The measured FEV_1/FVC % in obese patients with obstructive findings was significantly lower than in normal BMI patients with obstructive findings. Obese individuals without obstructive findings also showed significantly lower measured FEV_1/FVC % than normal BMI individuals without obstructive findings. *Conclusion:* Obese individuals have more obstruction when compared to even normal BMI individuals with symptoms. As the changes in respiratory mechanics due to obesity are almost completely reversible, early intervention in obese patients with COPD will ensure lower dependence on medicines to manage the respiratory condition.
Keywords: FEV_1, FVC, FEV_1/FVC, Obesity, Obstructive pulmonary disease

Introduction

In order to be fit, we humans have to maintain our body weight within given range as per our age, height, gender and body type. Hence food intake must be balanced with the requirement and should not exceed it on a routine basis. Also, daily physical activity is a must to expend the excess energy. Energy intake should match energy expenditure to maintain stable body weight over the long term. Certain inbuilt body mechanisms exist for this purpose. For example, signals acting on hypothalamic receptors ultimately control adipose tissue mass through their effect on autonomic nervous system [1]. But, such mechanisms are overwhelmed when there is chronic imbalance between energy intake and expenditure resulting in changes in the adipose tissue mass.

Obesity is among the important health challenges of the present century. What was earlier the preserve of the so called developed western nations has now spread its tentacles widely, engulfing the world. Rapid urbanization, increased mechanisation of chores and addiction to television, computer, videogames etc. has resulted in a very sedentary lifestyle. Added to this are the rise in disposable incomes, fast paced life and easy availability of unhealthy but tasty junk food. It is no wonder then that the prevalence of obesity is fast reaching epidemic proportions in India. Obesity is associated with numerous co-morbidities such as cardiovascular diseases (CVD), Hypertension, Type 2 Diabetes and sleep apnoea. It is also an independent risk cardiovascular disease and is associated with reduced life expectancy. The prevalence of overweight status and obesity is increasing among Indian children and adolescents which are reflected by various studies [2].

Many researchers have demonstrated the negative physiological effects of obesity on lung function [3-4]. The main characteristic of obstructive pulmonary disease is poorly reversible limitation in airflow [5]. Physiological variables such as Forced Expiratory Volume in the first second (FEV_1)

and Forced Vital Capacity (FVC) are often used to grade its severity. Chronic Obstructive Pulmonary Disease (COPD) is characterised by a reduced FEV_1 and a decreased ratio of FEV_1 to FVC. Airway obstruction in COPD is an important cause of exertional breathlessness, slowly progressing to marked disability and respiratory failure, limiting the daily activities of an individual, finally confining him/her to bed [6]. Globally, COPD has emerged as a major cause of morbidity and mortality. It is expected to become the third leading cause of death and the fifth leading cause of loss of 'Disability Adjusted Life Years' (DALYs) as per projections of the Global Burden of Disease Study (GBDS). The total burden of COPD in India has more than doubled to about 14.84 million in 2011 from about 6.45 million in 1971 [6].

In recent times, obesity and obstructive features are often observed in the same individual seeking treatment for respiratory illness. There are very few studies done in South India about the impact of obesity on dynamic respiratory mechanics, dyspnoea and exercise intolerance in patients with obstructive disease of the airways [7]. We hypothesised that if the effect of obesity on the Flow Volume curves (which assessed the respiratory capacity) in patients with Obstructive lung disease were better understood, it would be of more help to the primary care clinician to diagnose and treat such patients. Thus, our aim was to study the effect of obesity on the Flow Volume curves of middle aged individuals with obstructive pulmonary disease.

Material and Methods

This is a retrospective cross sectional study based on the data recorded in the Department of Pulmonary Medicine, JSS hospital, Mysore during June-July 2011. The study group consisted of patients referred to the department for evaluation of their pulmonary function. The data of those 120 individuals who fulfilled the inclusion and exclusion criteria was taken up for the purpose of the study.

Following were the *inclusion criteria*:

i) Age group 40-60 years.
ii) Obstructive symptoms (shortness of breath/ exertional breathlessness) of more than one month duration.
iii) Blood pressure and Blood glucose levels within normal range.

The *exclusion criteria* were:

i) Patients who were known cases of COPD and/or taking treatment for the same.
ii) Patients with chronic systemic illness like Diabetes, Hypertension, Coronary heart disease etc. or on regular medication for the same.
iii) Those who were underweight.

Their Body Mass Index (BMI) was calculated using *Quetelet's formula* [8].

$$\text{BMI} = \frac{\text{Weight (in kilograms)}}{\text{Square of Height (in metres)}}$$

and they were classified as Obese or as Normal BMI [8].

Procedure: All the subjects were initially familiarised with the test instrument - computerised spirometer (Spirobank G - MIR). The procedure was explained clearly and sufficient demonstration given. The testing was done between 10AM – 12 Noon in the PFT room which was well ventilated. The patient was comfortably seated and was asked to exhale air as forcefully and as rapidly as possible, into the mouthpiece of the computerised spirometer, followed by a deep inspiration. Flow Volume loop, FEV_1, FVC and FEV_1/ FVC were recorded. Each patient did the test three times with a gap of minimum three minutes between two efforts. The best of the three readings was considered for analysis.

Normal values of FVC and FEV_1 indicated normal PFT. Low values indicated the presence of respiratory pathology (obstruction/ restriction). When the measured value of FEV_1/FVC was 50% or less than the predicted value, it indicated the presence of obstruction [9] as per the Global Initiative for Chronic Obstructive Lung Disease (GOLD) recommended spirometry guidelines [10].

In normal spirometry, both FEV_1 and FVC were above 80% predicted and FEV_1 / FVC ratio above 0.7.

In obstructive disease, FEV_1 is below 80% of predicted, FVC can be normal / reduced (usually to a lesser degree than FEV_1) and FEV_1/FVC ratio is below 0.7.

Based on the above, the study groups were classified as follows:

Group A - Normal weight patients (BMI 18- 22.9 kg /m^2) [8] with obstructive findings.

Group B - Obese patients (BMI > 25 kg/m^2) [8] with obstructive findings.

Group C - Normal weight patients (BMI 18-22.9 kg /m^2) without obstructive findings.

Group D - Obese patients (BMI > 25 kg/m^2) without obstructive findings.

There were 30 subjects in each of the study groups and hence a total of 120 subjects overall. Statistical analysis was done by one way ANOVA test using SPSS version-16 for Windows. p value < 0.05 was taken as significant. Post hoc statistical test applied was Scheffe's analysis.

Results

Table-1: Respiratory parameters evaluated by computerised spirometry in the study subjects

FEV1/ FVC (in %)	Group A Non-obese with obstruction		Group B Obese with obstruction		Group C Non-obese without obstruction		Group D Obese without obstruction		p-value
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	
Predicted	80.95	0.80	81.36	0.56	86.96	2.98	86.87	2.65	**0.00**
Measured	49.32	5.57	48.79	5.92	86.36	4.34	84.87	3.5	**0.00**
% of Predicted	60.94	6.88	59.95	7.23	99.3	3.8	97.69	3.62	**0.00**

The measured FEV_1/FVC % in Group B (Obese with obstruction) was significantly lower {p< 0.05} than in Group A (Non - obese with obstruction). Also the measured FEV_1/FVC % in Group D (Obese without obstruction) was significantly less {p< 0.05} than in Group C (Non - obese without obstruction).

Discussion

Obesity is defined as abnormal or excessive fat accumulation that may impair health. BMI correlates highly with body fat and is therefore a useful measure in clinical assessment and epidemiological studies [11]. While there has been a lot of focus on the impact of obesity on cardiovascular and metabolic diseases, not much attention has been paid to its effects on pulmonary function or in inflammation [11]. A pioneering study was done by Richard Jones and Mary Magdalene in 2005 on the effects of BMI on lung volumes [4]. Since then several longitudinal studies have shown that increase in body weight can lead to reduction in pulmonary function but it is unclear if obesity status alone represents an appropriate predictor of obstructive lung dysfunction.

Spirometry is a simple method to assess respiratory capacity even in a basic primary healthcare setup. Physicians interpreting lung function results should bear in mind obesity as a cause of decreased lung volumes even in the healthy [12]. Using a rule of thumb, an approximate 0.5% decrease in VC, TLC and RV can be expected with each unit increase in BMI in normal individuals [3].

Splinting of the diaphragm by intra-abdominal fat may prevent its complete descent. Pulmonary compliance is decreased by the deposition of subcutaneous adipose tissue, acting as a fat envelope, in the chest wall. Respiratory muscle function may also be compromised, both by an initial mechanical disadvantage caused by fat and by the need to use more energy to expand the lungs than is used by a lean individual. Gas exchange deficit may be caused by underventilation of well perfused lower lung regions, which has been observed in obesity [12]. Contrary to the norm, one study showed relatively higher BMI subjects with less obstructive pulmonary dysfunction compared to normal BMI subjects

in populations with low prevalence of obesity. Hence high BMI status alone may be inappropriate as a predictor of obstructive lung dysfunction in such cases [11].

The GOLD guidelines define COPD as a preventable and treatable disease with some significant extra-pulmonary effects that may contribute to the severity in individual patients. Its pulmonary component is characterized by airflow limitation that is not fully reversible. The airflow limitation is usually progressive and associated with an abnormal inflammatory response of the lung to noxious particles or gases [13].

The main clinical features of COPD are:

- Chronic cough, which may be continuous and productive, but can also be intermittent and unproductive.
- Breathlessness on exertion, initially intermittent, later becoming persistent.
- Sputum production: any pattern of sputum production may indicate COPD
- Frequent exacerbations of bronchitis.
- A history of exposure to risk factors, especially tobacco smoke, occupational dusts, home cooking and biomass fuels [13].

Although FEV_1 / FVC represents the most important marker of lung function (since diagnosis of both COPD and asthma is based on FEV1/FVC), most articles have proposed associations between obese status and airway obstruction in terms of FEV_1 or FVC alone. Few have argued associations with FEV_1/FVC [11]. Despite these important concerns, the limitations imposed on respiratory function by obesity are recognized only occasionally and have received relatively little attention. We believe that obesity related alterations in breathing are critical to pulmonary function at rest and during exercise in a large section of the population. This is especially true for patients with mild-to-moderate obesity who are yet to develop obesity related co-morbidity, but depend on exercise as a means to combat obesity [3].

Remarkably, a study has shown that despite having greater metabolic and ventilation requirements, obese COPD patients do not experience greater dyspnoea and exercise limitation than non-obese patients with comparable airway obstruction. This, in part, reflects the mechanical advantage of breathing at relatively lower lung volumes in obesity. But this finding has not been verified in subsequent studies [7]. Despite the GOLD guidelines, there persists confusion regarding diagnosis of COPD especially at the level of primary care physicians. Early diagnosis remains difficult as most patients come to the doctor only when the obstructive symptoms persist and worsen. This might be several months to years after the initial onset of symptoms. The destruction in airways and lung parenchyma, which has occurred by that time, cannot be reversed completely. The mainly symptomatic treatment merely serves to protect the remaining airways from pathology and limit the damage already occurred. Patients find it highly frustrating as many do not notice any improvement in their symptoms despite being treated for a long time. By their refusal, either overt or covert, to quit smoking, many patients even worsen their respiratory status.

According to our study, obese individuals suffer more obstruction in comparison to normal BMI individuals in those with symptoms of Obstructive lung disease. Similar finding was seen even in those without any respiratory disease. This was an important observation because the changes in respiratory mechanics due to obesity are almost completely reversible. Modification of lifestyle and changes in diet would help bring down their BMI to normal range, thereby improving their respiratory parameters. As they improve clinically, patients too are more compliant to treatment and more amenable to counseling. This is economically more viable in a country like ours where most patients can ill afford expensive drugs prescribed for COPD which have very less effect clinically.

Obese and overweight individuals who come for treatment of non respiratory illness may also be cautioned regarding obesity's effect on the respiratory system and the necessity to maintain BMI within normal limits. Hence early intervention, in the guise of lifestyle modifications, limited exercise and / or drugs, in obese patients with obstructive lung disease

will ensure lower dependence on medicines to manage the respiratory condition, postpone complications by delaying progress of the pathological process, improve quality of life of the patient and significantly reduce the disease burden on the community.

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