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Influence of BMI in Pulmonary Function Test in Diabetic Subjects

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ABSTRACT

Obesity is associated with higher incidence of diabetes mellitus (DM). A variation in anthropometric indexes influences co-dependent relationship of pulmonary function and diabetes. Studies have shown that decrease in glycemic control was observed in diabetic patients with altered pulmonary functions. However, the exact correlation of body mass indices with diabetes and pulmonary function is not clear. The present study was done to assess the influence of body mass index (BMI) on pulmonary function in obese diabetic patients. Total number of type 2 diabetic patients underwent the study = 75 and they were divided into three groups: Group 1: lean, 2: overweight, 3: obese. Pulmonary function test (PFT) was done with computerized digital spirometer. Statistical analyses were done to compare the correlation of BMI on PFT and diabetes. No significant correlation was observed in PFT among the patients. However, there was significant decrease in PFT, observed when the comparison was made between BMI and diabetic restrictive lung disorder patients. The current study shows that, altered lung function is not due to obesity but it could be due to inadequate glycemic control and lung disorders. Hence, assessed parameters could be used to categorize the lung disorder in diabetic patient. Additionally this study shows that diabetic subjects have mixed ventilatory and restrictive ventilatory defect.

Keywords- *Type 2 diabetes, PFT, HbA1C, BMI, Restrictive disorder, mixed ventilator defect*

INTRODUCTION

Diabetes mellitus is a highly prevalent metabolic disease in India. Diabetes result in micro vascular [1] and macro vascular complications diagnosed at the onset of disease [2]. Complications are largely due to inadequate glycemic control, oxidative stress and advanced glycation end products.[3]. Deleterious effects of diabetes are seen in all organs of body and are studied extensively except the lungs. Lungs play important role in delivery of oxygen and oxygen is important for glucose homeostasis. This is proved when oxygen therapy for OSA (obstructive sleep apnoea) improved glycemic status of the patient[4] and chronic intermittent hypoxia as a result of OSA may cause degraded proinsulin formation and impaired insulin secretion which may led to insulin resistance[5]. Lung function assessment can be done with pulmonary function test. Obese people are more prone to diabetes and pre diabetes [6]. Obesity also cause reduction in pulmonary function parameters like ratio of FEV1/ FVC at all ages while FVC and MMEF were negatively associated with BMI[7]. Aim of this study is to find the pulmonary function test parameters in diabetic patients of different BMI groups and to determine the type of lung disease among diabetic subjects.

METHODS

Study participants are known type 2 diabetic patients on oral hypoglycaemic medications. Non smokers and without any other co morbid illness are the inclusion criteria of the current study. Ethical clearance was obtained from the institutional ethical committee. Informed consent is obtained from the study participants. Subject's are of either sex with age group between 40 – 50 years underwent the study. Height, weight, chest and waist measurement are done and based on the data obtained they divided into three groups. - Group 1: Lean diabetic - with BMI less than 25, Group 2: Overweight diabetic - BMI 25-29 and Group 3: Obese diabetic - BMI equal or greater than 30. Parameters analysed were:1.Battery of pulmonary function test with computerized digital spirometry (True flow easy on pc sensor-219281). 2. Glycated hemoglobin (HbA_1C) done on ion exchange chromotograpy (DS5 Analyzer,Drew Scientific Limited, Cumbria, U.K) from the venous blood sample. PFT study protocol was strictly adhered to American thoracic society guidelines. Test procedure was explained and prior training was given to each participant. The test was done at around 9.00 am depending on the availability of the patients in the health care unit. From the best of three trials, FVC%(forced vital capacity), FEV1 (forced expiratory volume in 1 second and 3 seconds in L/sec) MMEFR(maximum midexpiratory flow rate in percentage), FEF25%, FEF50%, FEF75% (forced expiratory force after 25%, 30%, 75% of FVC expired, FEV1/FVC ratio in percentage are taken as an index for PFT. Mean ± SD is taken for statistical analysis using SPSS software, version 17. One way ANOVA, with post hoc tukey's multiple comparison tests is done to find the effect of BMI on PFT among the study population and $p<0.05$ is considered as level of significance. In addition to this, based on the guidelines of Global initiative for obstructive lung disease[8] and method used by Majumudar et al[9], values obtained from PFT were further categorized into 4: Obstructive, 5:Restrictive and 6: Mixed lung disorder. Student t test were done to compare category 4, 5 and 6 to find the difference between the patterns of respiratory diseases.

RESULTS

The number of diabetic subjects participated in the study were 75. The population of lean diabetic in our study was 41%, overweight 32% and obese 26%. Weight, chest circumference and waist circumference difference among the above three groups showed significance as shown in table 1. Comparison of Pulmonary function parameters has got no significance among the three groups (lean, overweight and obese diabetic). Based on Global initiative for obstructive lung disorder criteria, our study showed 13 out of 75 diabetic patients with restrictive lung disease, which showed a prevalence of 17.33%, Less than 1% had obstructive lung disease. 15 diabetic patients had normal lung function with a prevalence of 20%. This reveals that on the basis of global initiative for obstructive lung disease, our study could categorize only 37% of the total pulmonary function tests. The remaining 63% of the pulmonary function tests did not fit into the above categorization. Therefore, another method was added. According to the method of majumudar, the FEV1/FVC ratio was normal or supernormal with FVC less than <70% and FEF25-75% <70% which was suggestive of a mixed type of ventilator defect. Applying this principal in our study it was evident that 34 out of 75 diabetic patients had mixed ventilator defect which gives a prevalence of 45.33%. But still, 23% could not be categorized into any group. On another note, it is evident that the pulmonary function parameters are significantly reduced among diabetic subjects than the normal predictive value. On this basis the pulmonary function parameters among diabetics restrictive lung disorder are compared with other categories of lung disorder. Comparison of the above as shown in table 2, showed parameters such as FVC, FVC6, MMEFR, PEF, FEF25-75%, FEF and FEV1% were significantly reduced among diabetics with restrictive lung disease. In our study we have found restrictive pattern of lung disease is more prevalent in lean with the prevalence of 46.15%. In overweight it was 23.09% and in obese it was 30.76%. There was no significant correlation for BMI and HbA1c with pulmonary function parameters in restrictive lung disease as shown in table III. Among type2 diabetics with restrictive lung disease 61.53% had HbA1c greater than 8.4, 23% with HbA1c 8.4-7.5 and 1% each in HbA1c 7.4-6.5 and <=6.5.

Table1: Pulmonary functions parameters of three BMI groups

BMI Classification kg/m2	< 25	26 - 29	>= 30	P value
Height (cm)	159.26±10.35	158.54 ±8.25	158.35 ± 9.38	.935
Weight (kg)	55.74 ± 9.04	69.67 ± 8.04	81.95 ± 9.11	.000*
Chest Measurement(cm)	86.26 ± 8.50	91.46 ± 7.48	98.90 ± 6.92	.000*
Waist Measurement(cm)	87.29 ± 11.82	95.71 ±10.39	103.35 ± 8.69	.000*
FVC (%)	54.96 ± 26.14	66.31 ±30.56	55.14 ± 22.94	.255
FVC1 (L/sec)	3.51 ± 7.66	1.99 ± .69	1.58 ± .77	.351
FVC3 (L/sec)	1.92 ± 1.28	1.97 ± .64	1.99 ± 1.08	.976
MMEFR (%)	53.73 ± 42.73	60.48 ±36.15	73.73 ± 62.34	.348
PEF (%)	38.67 ± 32.22	40.38 ±24.80	48.52 ± 36.89	.542
FEF 25(%)	40.56 ± 38.24	38.55 ±25.17	54.13 ± 43.28	.328
FEF 50(%)	59.87 ± 48.15	74.57 ±66.12	67.23 ± 50.71	.639
FEF 75(%)	89.34 ± 57.51	75.88 ±60.47	92.07 ± 85.34	.701
FEF 75 - 85(%)	127.56±93.66	96.91 ±79.13	116.70±98.93	.500
FEV1/FVC (%)	90.56 ± 9.04	91.40 ± 8.08	91.78 ±9.82	.891
FEV1(%)	59.53 ± 26.93	91.87±142.18	61.35±26.13	.344

All the data given are mean ± SD. All the comparison were made with ANOVA and Turkey's multiple comparison with level of significance (P<0.05).* - denotes significant difference

Table II: Difference in pulmonary function test parameter in restrictive pattern and other patterns

Restrictive pattern of lung disease	**Present**	**Absent**	**P-value**
Height (cm)	159.51 ± 9.89	157.23 ± 7.38	.439
Weight (kg)	66.94 ± 14.46	67.31 ± 12.99	.934
BMI (kg/m2)	26.23 ± 4.83	27.34 ± 5.47	.469
Chest Measurement (cm)	90.75 ± 9.46	93.38 ± 9.71	.371
Waist Measurement (cm)	93.78 ±12.94	93.92 ± 12.76	.972
FVC (L/sec)	52.46 ±26.33	83.48± 12.13	**.000***
FVC in 1 Second (L/sec)	2.64 ± 5.80	2.37 ±.67	.869
FVC in 3 Seconds (L/sec)	1.76 ± .98	2.85 ± .94	**.001***
MMEFR (%)	56.22	95.21 ±	**.006***

	±41.43	57.96	
PEF (%)	37.49 ±26.27	67.80 ± 40.37	**.001***
FEF 25 (%)	36.17 ±27.98	83.62 ± 44.94	**.000***
FEF 50 (%)	61.88 ±51.79	96.89 ± 57.65	**.036***
FEF 75 (%)	84.39 ±63.96	105.89 ±77.92	.300
FEF 75 - 85 (%)	115.22±88.28	136.34±101.98	.454
FEV1/FVC (%)	90.48 ± 9.20	93.79 ± 7.35	.232
FEV1 (%)	53.14 ±21.57	141.32±169.29	**.000***

All the data given are Mean ± SD. All comparisons were made using student t test. * - Denotes significance at p < 0.001

Table III: Pearson correlation analysis of restrictive lung disease with BMI and HbA1c

Parameters	value	P
BMI	1.830	0.401
HbA1c	2.987	0.394

P – pearsons correlation

DISCUSSION

The current study is the first of kind to compare the pulmonary function parameters among diabetic subjects of different BMI. This study showed prevalence of lean diabetes as 41.33%. In an earlier study the prevalence of lean diabetes was 3% with calculation of BMI for lean diabetics as <18.5% [10] which is comparatively low when compared with the present study with the calculation of lean BMI as <25. The normative aging study demonstrated the relationship between body mass index and spirometry values in non diabetic subjects, with positive association to FEV1/ FVC ratio at all ages and negative association of FVC and MMEF to the BMI[7]. Studies have explained that the reduced pulmonary function test parameters among obese people were due to the mechanical obstruction and metabolic dysfunction produced by the trunk fat [11]. Abdominal fat which is presented as abdominal obesity will strongly predict reduced lung function [12]. Thus all these findings indicate that BMI affects the pulmonary function but these studies were done in non diabetic subjects. Our study showed no significant difference in pulmonary function test parameters between the three BMI groups among type2 diabetic subjects although the difference in waist and chest circumference between the three groups was significant. The prevalence of restrictive lung disease in our study is 17.33%. In an earlier study done among type1 diabetics, the prevalence of restrictive lung disease was 43.58% [13] which was quite high when compared with our study. In Korean population study, prevalence of restrictive lung disease in type2 diabetes was 18% which was similar to our study. Restrictive pattern of lung disease is independently associated with type 2 diabetes and in patients with restricted lung disorder, the triglycerides and insulin levels were high in fasting state [14]. In diabetic patients with restrictive pattern majority belonged to lean diabetic category. Thus lean diabetics with poor glycemic control were more prone for restrictive lung disease. In the current study 45.33% of type 2 diabetic patients suffer from mixed ventilatory defect, 17.33% suffer from restrictive lung disease, less than 1% from obstructive lung disease, 20% had normal pulmonary function, while about 23% could not be categorized into any group. Thus, majority of diabetic patients had lung abnormality as shown by pulmonary function test. Majority of the patients with restrictive lung pattern in lean diabetic category had higher value of HbA1c and this showed poor glycemic control in lean type2 diabetic patients. The poor glycemic control in turn would have caused the altered lung function. Earlier study in 1,784 lean type2 diabetics, demonstrated high HbA1c values in lean diabetic, which has been attributed to the accelerated β cell failure [15]. The current study showed significant reduction in FVC, FEV1, MMEFR, PEF, FEF25% and FEF50% among diabetic patients with restrictive pattern of pulmonary dysfunction, this is in accordance with findings of Aparnal et al [16]. Sandler et al had demonstrated that elastic recoil of lung will be reduced in diabetic patients which is due to the glycosylation of tissue proteins [17]. Diabetes mellitus is associated with decreased lung elastic recoil and lung volume and Matsubara et al contributes these to the thickened basal lamina of capillaries and alveolus [18]. Absence of correlation for reduced spirometry parameter to BMI substantiate that BMI is not affecting the pulmonary function. The glycated hemoglobin also shows no correlation, but majority of patients with restrictive lung disease had HbA1c greater than 8.4 indicating poor glycemic control. Therefore this study concludes that the pulmonary function test could provide an inexpensive tool to assess lung function in diabetes irrespective of BMI and it might also serve as an index of glycemic control. The study has its own limitation like small sample size and absence of other pulmonary function test and absence of clinical evaluation to confirm the findings.

CONCLUSION

The current study shows that diabetic patients suffer from restrictive lung disease and also mixed ventilatory defect. This study shows that the reduction in pulmonary function parameters is not due to obesity. However further studies should be done with TLC (total lung capacity) and residual volume to confirm the mixed ventilatory defect. Thus pulmonary function tests could provide an ideal tool to detect lung abnormality and it could be an indicator of glycemic control.

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