

Original Research Article

Study on comparison of pulmonary function tests among diabetic and non-diabetic patients in a tertiary care hospital

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Received: 29 June 2016

Accepted: 30 July 2016

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ABSTRACT

Background: Diabetes mellitus (DM) is associated with multiple metabolic derangements which in the long term lead to the damage, dysfunction, and failure of different organs like the eyes, kidneys, nerves, heart, and blood vessels, but pulmonary complications of DM have been less addressed. Microangiopathy in lungs can lead to changes in alveolar function which can manifest themselves as pulmonary function abnormalities. Most of the studies on diabetes mellitus and pulmonary function abnormalities had excluded smokers from the study group. In this study, the study design aimed at determining the effects of diabetes mellitus on pulmonary functions of smokers and non-smokers. The objectives of the study were to determine the pulmonary functions of diabetic study patients and non-diabetic controls using spirometry. Also to compare the pulmonary function changes among diabetics and non-diabetics and to compare the pulmonary function changes among diabetics who are smokers and non-smokers.

Methods: Fifty cases, aged more than 35 years, who had DM for more than five years, were selected from the inpatient and outpatient services of a tertiary care hospital. Fifty age and sex matched controls were selected from the healthy non diabetic caregivers of the patients.

Results: Diabetic cases had statistically significant reductions in mean FEV1, mean FVC and mean PEFR (as L/min) when compared to non-diabetics. Among non-smokers, 33.33% of diabetics had abnormal PFTs while only 10% of non-diabetics had abnormal PFTs ($P = 0.0498$). Among the smokers, 73.91% of the diabetics had abnormal PFT's while only 33.33% of the non-diabetics had abnormal PFTs ($P = 0.0054$).

Conclusions: Diabetes mellitus had a significant impact on pulmonary function tests independent of smoking. Diabetes mellitus predominantly causes restrictive changes in the lung function tests.

Keywords: DM, PFT, Spirometry, Non-smokers, Smokers, Type 2 diabetes

INTRODUCTION

Diabetes mellitus is a metabolic disease characterized by hyperglycemia resulting from defects in insulin secretion, insulin action, or both. The metabolic dysregulation associated with diabetes causes secondary pathophysiologic changes in multiple organ systems that impose a tremendous burden on the individual with

diabetes and on the health care system. The chronic hyperglycemia of diabetes is associated with multiple metabolic derangements which in the long term lead to the damage, dysfunction, and failure of different organs, like the eyes, kidneys, nerves, heart, and blood vessels.¹ This is well known but pulmonary complications of DM have been less addressed. There is increasing understanding about the pathogenesis of this disease at

the cellular and molecular levels. It is now thought that rather than being a metabolic disease alone, diabetes should indeed be treated as a disease of the endothelium and this endothelial dysfunction is at the heart of the myriad of manifestations of the multiorgan involvement.²

Micro vascular complication of diabetes namely retinopathy, nephropathy and neuropathy have been well recognized for a long time and have been addressed in multiple dimensions. However the alveolar capillary network in the lung, which is a large micro vascular unit maybe affected by diabetes related microangiopathy.³ This microangiopathy in lungs can lead to changes in alveolar function which can manifest themselves as pulmonary function abnormalities and also autonomic neuropathy affecting the phrenic nerves, resulting in reduced muscle tone and control of the diaphragm, has been observed to contribute to the pulmonary function abnormalities.⁴

Although a lot of research work is being carried out on the effects of diabetes mellitus on pulmonary parameters worldwide, the literature pertaining to this feature is not in abundance from India. India has the second largest diabetic population in the world and can contribute to more morbidity and mortality among Indian patients. Most of the studies on diabetes mellitus and pulmonary function abnormalities had excluded smokers from the study group. In this study, the study design aimed at determining the effects of diabetes mellitus on pulmonary functions of smokers and non-smokers.

METHODS

Study design and patient selection

This was a hospital based prospective observational study to compare the pulmonary function changes among diabetic study patients and non-diabetic controls using spirometry and also focus on pulmonary function changes among diabetic smokers and non-smokers. The study was designed to have a significance level of 95% with a power of 80% and the sample size was calculated to be at least 43 in each group. Clearance from the institutional review board and institutional ethics committee was obtained prior to the initiation of the study.

Cases selected were diabetic patients aged more than 35 years of more than 5 years duration, on treatment, attending the inpatient and outpatient services of the tertiary care hospital. Age and sex matched controls were selected from the healthy non diabetic caregivers of the patients. Patients with pre-existing lung diseases like TB, COPD, Asthma and Cardiac disease, patients with unexplained symptoms like haemoptysis, cough with expectoration and acutely ill patients who were unable to take part in this study were excluded.

The eligible individuals were identified and invited to take part in the study voluntarily. The details of the study,

costs and reimbursements, potential benefits and possible risks were explained in the native language of the patient by the investigators. They were also provided with a copy of the patient information sheet. After the patients were willing to take part in the study, they were provided with the informed written consent form and were asked to express their willingness to take part in the study. The enrolled study group patients and controls underwent detailed history taking and physical examination session and the findings were recorded in a semi structured questionnaire.

All participants of the study underwent assessment of the pulmonary function tests using a spirometer (Easy One Pro- open circuit, flow based) and findings were recorded in the above questionnaire. The forced expiratory volume in 1 second (FEV1), the forced vital capacity (FVC), and the peak expiratory flow rate (PEFR) was measured and the FEV1/FVC ratio was also calculated by the software provided with the spirometer.

Statistical analysis

The values were recorded as % of the predicted value. The data was tabulated and was analysed using Graphpad Prism 6 software. Appropriate parametric tests for continuous variables (unpaired Student's t test) and non-parametric for categorical variables (Fisher's exact test) was used for analysis. The results were deemed to be significant for P value ≤ 0.05 (Significance level 95%). All the subjects and controls that were enrolled for the study were included in the data analysis.

RESULTS

Fifty diabetic cases and fifty controls were selected. The sex ratio in both the groups was near identical. The mean age and body mass index of both the groups was not statistically different and both the groups were comparable at baseline (Table 1).

Table 1: Baseline characteristics of the study and control group.

	Study group (n=50)	Control group (n=50)	P-value
Age (years)	50.71 \pm 10.08	50.52 \pm 10.05	0.9437
Females	42% (n = 21)	44% (n = 22)	0.8399
BMI (kg/m ²)	23.88 \pm 3.47	23.27 \pm 4.27	0.4388
Smoking	46% (n = 23)	40% (n = 20)	0.5445

The mean age of the study group among diabetics were 50.71 \pm 10.08 and control group was 50.52 \pm 10.05 (P = 0.9437). The mean body mass index of the study group was 23.88 \pm 3.47 kg/m² and the control group was 23.27 \pm 4.27 kg/m² (P = 0.4388). The proportion of males was 58% (n = 29), females was 42% (n = 21) in the study

group and males was 56% (n = 28), females was 44% (n = 22) in the control group. The pulmonary function test of diabetic and non-diabetic was compared and tabulated as follows (Table 2).

Table 2: Pulmonary function tests of the study and control group.

	Study group (n=50)	Control group (n=50)	P- value
FEV1	76.44±17.46	84.05±10.91	0.0104
FVC	76.33±14.78	83.1±7.81	0.0051
FEV1/FVC	99.48±11.41	100.24±10.19	0.7261
PEFR (L/sec)	55.70±20.34	64.05±13.55	0.0176

On spirometry, the differences in mean FEV1 (% of predicted value), mean FVC (% of predicted value) and the mean PEFR (L/min) were statistically significant between the study group and the controls. However the difference in the mean FEV1/FVC (% of predicted value) was not statistically significant.

The results of pulmonary function test among the diabetics and non-diabetics was analysed as shown (Table 3). Among the fifty diabetic patients, 24 patients had normal and 26 had abnormal pulmonary function tests while among the fifty controls, 39 had normal and 11 had abnormal pulmonary function tests. This difference was found to be statistically very significant. (P = 0.0024) Among the 26 diabetic patients who had abnormal results, 46.15% (n = 12) of patients had a restrictive pattern, 30.77% (n = 8) had obstructive pattern and 23.08% (n = 6) had small airway disease pattern as shown in pie chart (Figure 1).

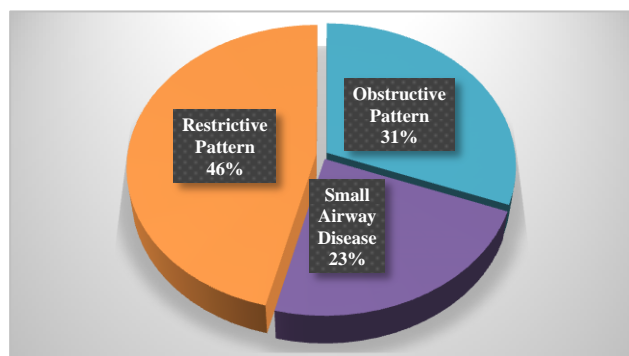


Figure 1: Pulmonary function abnormalities among diabetic patients.

Since among the diabetic patients, both smokers and non-smokers were included and smoking could be a possible confounding factor in producing the changes in pulmonary functions, separate analysis of the influence of diabetes on pulmonary functions of smokers and non-smokers was carried out. Among non-smokers, 33.33% (n = 9) of diabetics had abnormal PFTs while only 10%

(n = 3) of non-diabetics had abnormal PFTs and this difference was statistically significant. (P = 0.0498) Among the smokers, 73.91% (n = 17) of the diabetics had abnormal PFT's while only 40% (n = 8) of the non-diabetics had abnormal PFTs and this difference was also statistically significant (P = 0.0054) (Table 3).

Table 3: Distribution of pulmonary function test results.

	PFT		P-value
	Normal	Abnormal	
Diabetics	24	24	0.0024
Non diabetics	39	39	
Diabetic smokers	6	6	0.0054
Non diabetic smokers	12	12	
Diabetic non-smokers	18	18	0.0498
Non diabetic non-smokers	27	27	

DISCUSSION

Using spirometry, pulmonary function tests was done in diabetics with age and sex matched controls. The groups were divided into smokers and non-smokers further and results were analysed.

The mean age of our study group among diabetics were 50.71±10.08 and control group was 50.52±10.05, (P = 0.9437). This is similar to the study published by Irfan M et al where the mean age was 54.3.⁵ The proportion of females was 42% (n = 21) in the study group and 44% (n = 22) in the control group. The mean Body Mass Index of the study group was 23.88±3.47 kg/m² and the control group was 23.27±4.27kg/m², (P = 0.4388). In this study BMI was within the normal range, however the BMI was more in the obesity range as reported in the literature.⁶ This probably only reflects the need for varied BMI standards based on ethnic background.

Reduced elastic recoil, reduced lung volume, chronic low grade inflammation, decrease in pulmonary diffusion capacity for carbon monoxide, autonomic neuropathy involving respiratory muscles are some of the important changes occurring in DM, that could be attributed to the pulmonary function abnormalities.^{7,8} Our study revealed that diabetic patients had reduction in FVC, FEV1, PEFR, which was statistically significant. However there was mild reduction in FEV1/FVC which was not statistically significant. The findings were similar to those reported by Irfan et al and Klein et al.^{5,6} Study conducted by Davis et al also demonstrated that VC, FVC, FEV1 and PEF were decreased in type 2 diabetic patients.⁹

Non enzymatic glycosylation induced alteration of lung connective tissue is one of the most likely underlying mechanism which is being investigated for restrictive lung disorder.¹⁰ Out of 50 diabetic patients, 26 had

abnormal pulmonary function test (PFT), out of which 12 (46%) had restrictive pattern, 8 (31%) had obstructive pattern and 6 (23%) had small airway disease. Similarly, diabetics had predominantly restrictive pattern in a study conducted by Kanyakumari et al.¹¹ Only 30% of the control group had abnormal PFT in the same study. Vojtkova et al had also demonstrated decreased vital lung capacity and pulmonary volumes, decreased diffuse lung capacity for carbon monoxide in diabetic patients.¹² Other study conducted by Sinha S et al revealed impairment of pulmonary diffusion capacity for carbon monoxide was common in type 2 DM patients having microangiopathy.¹³

In order to see PFT abnormalities independent of smoking, separate analysis of non-smoking diabetic (27 cases) and non-smoking non-diabetics (30 controls) were analysed, which revealed 33% among diabetics and 10% among control had pulmonary function abnormality which was of statistical significance ($P = 0.0498$). This was similar to the observations in a study conducted by Kanyakumari et al.¹¹

To know the impact of diabetes and smoking put together on pulmonary function abnormality, analysis was done on smoking diabetics (23 cases) and smoking non diabetics (20 control) which revealed 73.9% of cases and 33.3% of control had PFT abnormality, which was of statistical significance (P value = 0.0054). However there were very few studies to analyse the impact of smoking and diabetes together. Study conducted by Kinney GL et al found that diabetes is associated with decreased lung function in smokers who do not have obstructive airway disease.¹⁴ In future large scale studies are needed to study the impact of diabetes and smoking together on pulmonary function changes.

CONCLUSION

Diabetes mellitus and the pulmonary complications have been less addressed. Our study revealed significant reduction in pulmonary functions among diabetics compared with control and it also compared changes among the diabetic and non-diabetic smokers and non-smokers, which revealed significant impact of diabetes on pulmonary function independent of smoking. Diabetes mellitus was predominantly associated with a restrictive pattern. Routine spirometry screening in all diabetic patients will help to identify the pulmonary function changes earlier which is often detected late or missed often.

Funding: No funding sources

Conflict of interest: None declared

Ethical approval: The study was approved by the institutional ethics committee

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Cite this article as: Mahendrakumar K, Rajendran K, Suthakaran PK, Thangaraj P, Ganapathy G, Karuthodiyil R. Study on comparison of pulmonary function tests among diabetic and non-diabetic patients in a tertiary care hospital. Int J Adv Med 2016;3:938-41.