

RESEARCH ARTICLE

A study on pulmonary function parameters in type 2 diabetes mellitus

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ABSTRACT

Background: In type 1 diabetes lung function has been investigated in several clinical studies and evidenced reduction in lung volumes and capacities. However, there are few studies and few data concerning pulmonary function abnormalities. The pulmonary complication of diabetes mellitus is poorly characterized. Hence, the study is to evaluate pulmonary functions in patients with type 2 diabetes mellitus and compare with control (non-diabetic) subjects.


Aims and Objectives: The aim of the study was to analyze pulmonary function parameters in type 2 diabetic patients and compare them with healthy persons and to correlate the lung volumes and capacities in diabetic patients with the duration of the disease. **Materials and Methods:** A total of 20 type 2 diabetic patients aged 40–65 years with a diabetic duration of 1–20 years were taken from medicine department 20 nondiabetic patients' age and gender-matched subjects were taken from patients attendants. Fasting blood sugar, postprandial blood sugar levels, anthropometric data, and spirometry measurements were taken from both study and control groups. Spirometry (forced vital capacity [FVC], volume forcibly exhaled in one second [FEV1], FEV1/FVC, and peak expiratory flow rate [PEFR]) was compared between study and control groups. Results are statistically analyzed using student t test. To correlate the duration of diabetes with reduced lung function tests, Pearson's correlation coefficient (r) was used. **Results:** There was a decrease in FVC (27.3%), FEV1 (21.5%), and PEFR (20.8%) but an increase FEV1/FVC (10.3%) in diabetic patients when compared to controls. A negative correlation is found when FEV1/FVC is correlated with duration of diabetes, and no significant correlation was seen between PEFR and duration of diabetes. **Conclusions:** Pulmonary function parameters (FVC, FEV1, and PEFR) are reduced in diabetics, and a negative correlation of reduced lung functions (FVC and FEV1) was observed with duration of diabetes.

KEY WORDS: Forced Vital Capacity; Volume Forcibly Exhaled in one Second; Peak Expiratory Flow Rate; Type 2 Diabetes

INTRODUCTION

There is an enormous increase in diabetes mellitus worldwide, particularly in developing countries. The prevalence of

diabetes mellitus in all age groups worldwide was 2.8% in 2000 and is estimated to reach 4.4% by 2030. The total number of diabetics is projected to rise from 171 million in 2000 to 366 million in 2030.^[1] India leads the world with largest number diabetic subjects earning the dubious distinction of being termed the "diabetic capital of world."^[2] Diabetes is a metabolic disorder with debilitating effects on many organs. Pulmonary complications of diabetes have been characterized with conflicting results. The alveolar-capillary network in the lung is a large microvascular unit and may be affected by microangiopathy.^[3] The major morbidities in type 2 diabetes are due to its microangiopathic

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and macroangiopathic complications.^[4] Diabetes mellitus is associated with several respiratory alterations which include respiratory muscle dysfunction and chest wall abnormalities. The autonomic neuropathy of diabetic patients may influence the control of breathing. Parasympathetic regulation of airway caliber may be damaged in diabetes mellitus.^[5]

In type 1 diabetes, lung function has been investigated in several clinical studies. Reduced values for FEV₁, vital capacity, functional residual capacity, total lung capacity, residual volume, and carbon monoxide transfer were found for insulin-treated diabetes mellitus patients compared to control groups. However, there are few studies and few data concerning pulmonary function abnormalities in patients with type 2 diabetes.

Pulmonary function tests (PFTs) are age-old parameters for assessing the respiratory health of person and important for diagnostic and prognostic values. The purpose of PFTs is to distinguish the normal function from obstructive lung disease, restrictive lung disease, and pathological processes that interfere with alveolar capillary diffusion. The pulmonary complications of diabetes mellitus have been poorly characterized. These complications have a significant impact on the quality of life of people. Hence, this study is to evaluate pulmonary functions in patients with type 2 diabetes mellitus and to compare with control subjects.

Aims and Objectives

The objectives are as follows:

1. To analyze the pulmonary function parameters in type 2 diabetes patients and compare them with age and gender-matched healthy subjects.
2. To correlate FVC volume forcibly exhaled in one second (FEV₁), and peak expiratory flow rate (PEFR) in diabetes patients and duration of disease.

MATERIALS AND METHODS

Study Group

A total of 20 type 2 diabetic patients and 20 non-diabetic persons (control group) were selected.

Study Design

This was a cross-sectional study.

Sampling Method

Simple random sampling was used.

Methodology

A total of 20 diabetic patients aged 40–65 years with a diabetic duration of 1–20 years from medicine OPD, Government

General Hospital, Anantapur, were selected for the study group. 20 nondiabetic age and gender-matched subjects from patients attendants were also selected for the control group.

Inclusion Criteria

Individuals with type 2 diabetes mellitus selected after thorough history taking and clinical examination.

Exclusion Criteria

Subjects with type 1 diabetes, subjects with history of smoking and alcohol, and subjects with hypertension, subjects with history of cardiac or respiratory or musculoskeletal disorders were excluded from the study.

Ethical clearance was taken. Informed consent was taken from all the subjects. A questionnaire that contained detailed personal and medical history was used. Anthropometric data, which includes height, weight, and BMI, were recorded in all the subjects. Fasting blood sugar and postprandial blood sugar levels (FBS and PPBS) were done using glucose oxidase-peroxidase method in Central lab, GGH, Anantapur. The subject was informed about the procedure, and spirometry was performed with the subject in sitting position, at room temperature, using a KOKO LEGEND Spirometer (Ferraris respiratory Inc., US) between 10 and 12 A.M in TB and Chest Department, Anantapur. PFT's include FVC (the volume of air exhaled with maximal effort after maximal inhalation), FEV₁, and PEFR were done in all the subjects and compared between study and control subjects.

Results were statistically analyzed using student's *t*-test. Pearson's correlation coefficient (*r*) was used to correlate the duration of diabetes with reduced lung function tests.

RESULTS

There was a decrease in FVC (27.3%), FEV₁ (21.5%), and PEFR (20.8%) but an increase in FEV₁/FVC (10.3%) in diabetic patients when compared to controls [Table 1]. Table 2 shows there is a significant difference in decrease in FVC ($p < 0.0001$) and PEFR ($p < 0.0001$) but an increase in FEV₁/FVC ($p < 0.0001$) which shows reduced lung functions in a diabetic group. A negative correlation is found when FVC [Figure 1] and FEV₁ [Figure 2] are correlated with duration of diabetes. No significant correlation was seen between PEFR and duration of diabetes. Table 3 and Figure 3 depict the Pearson's correlation coefficient (*r*) value of FVC, FEV₁, and PEFR with duration of diabetes.

DISCUSSION

In this study, we found a decrease in FVC ($p < 0.0001$), FEV₁ ($p < 0.0001$), and PEFR ($p < 0.0001$) but an increase in

Table 1: Differences between study and control groups

Parameters	Study group		Control group		T-value	P value
	Mean±SD	SE	Mean±SD	SE		
Age (years)	50.5±8.25	1.86	49.65±7.06	1.58	0.329	0.74
Height (cm)	158.45±8.9	2	159.45±7.7	1.72	0.378	0.7
Weight (kg)	65.36±9.9	2.2	67.1±6.1	1.38	0.667	0.51
BMI (kg/m)	25.86±3.1	0.68	26.32±2.2	0.5	0.578	0.56
FBS (mg%)	182.25±48.4	10.83	84.2±9.35	2.1	8.887	0.001***
PPBS (mg%)	280.1±72.7	16.25	98.7±12.39	2.77	10.996	0.004***

BMI: Body mass index, FBS: Fasting blood sugar, PPBS: Postprandial blood sugar levels, SD: Standard deviation, SE: Standard error, *** P value < 0.01: Highly significant

Table 2: Lung function tests in study and control groups

Parameters	Study group		Control group		T value	P value
	Mean±SD	SE	Mean±SD	SE		
FVC (% predicted)	58.9±8.8	1.96	86.2±5.2	1.17	11.946	0.002***
FEV1 (% predicted)	67.5±10.88	2.43	88±7.05	1.57	7.067	0.001***
FEV1/FVC (% predicted)	121.3±9.0	2.02	101.7±1.3	1.3	8.151	0.004***
PEFR (% predicted)	64.35±19.12	4.27	58.15±5.76	1.28	4.659	0.002***

FVC: Forced vital capacity, FEV1: Volume forcibly exhaled in one second, PEFR: Peak expiratory flow rate, *** P value < 0.01: Highly significant

Table 3: Pearson's correlation coefficient (r) value with duration of diabetes

Parameters	r value
FVC	-0.26
FEV1	-0.16
PEFR	0

FVC: Forced vital capacity, FEV1: Volume forcibly exhaled in one second, PEFR: Peak expiratory flow rate

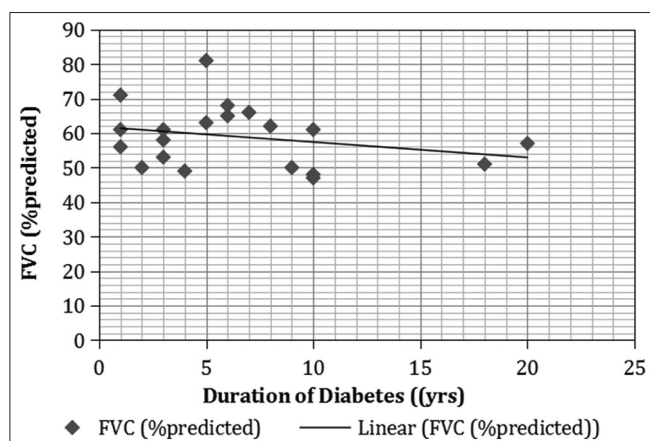


Figure 1: Correlation of forced vital capacity (% predicted) with duration of diabetes (years)

FEV1/FVC ($p < 0.0001$) in diabetic patients when compared to controls. A negative correlation is found when FVC and FEV1 are correlated with duration of diabetes. No significant correlation was seen between PEFR and duration of diabetes. FVC is more significantly decreased than FEV1. The

difference in mean percentage predicted the value of FVC is 27.3% whereas that of FEV1 and PEFR is 21.5% and 20.8%, respectively.

In a study by Aparna *et al.*, there is a significant reduction in FVC, FEV1, and PEFR in type 2 diabetes as compared to controls.^[6] In Rajani *et al.* study also there is decreased FVC, FEV1.^[7] In another study by Charak *et al.* significant reduction of FVC, FEV1, and PEFR in type 2 diabetes.^[8] Increase in PEFR values with the increase in the height of the subjects and a positive correlation between height, weight, and age was observed in a study by Mohan *et al.*^[9] A negative correlation of FVC and FEV1 was found with duration of diabetes, that is, as the duration of diabetes increases, there is a greater reduction in FVC and FEV1. However, this assessment is statistically not significant as Pearson's correlation, $r = -0.26$ and -0.16 for FVC and FEV1, respectively. A study by Davis *et al.* reported that lung is a target organ in diabetes and glycemic exposure is determinant of reduced pulmonary function in type 2 diabetes.^[10] A study by Shah *et al.* found that glycemic levels and duration of diabetes are probably not the major determinants of lung pathology.^[11] A study by Marvis *et al.* found a significant reduction of diffusing capacity of lung for carbon monoxide in patients with microalbuminuria and/or retinopathy. This study shows that apart from kidney and eye, lung is also a target organ for diabetes.^[12]

In restrictive lung diseases, both FVC and FEV1 are lowered, but decline in FVC is more than that in FEV1. This results in high FEV1/FVC ratio (>0.8). This is seen in the diabetics in the present study. Diabetes mostly affects the intrinsic

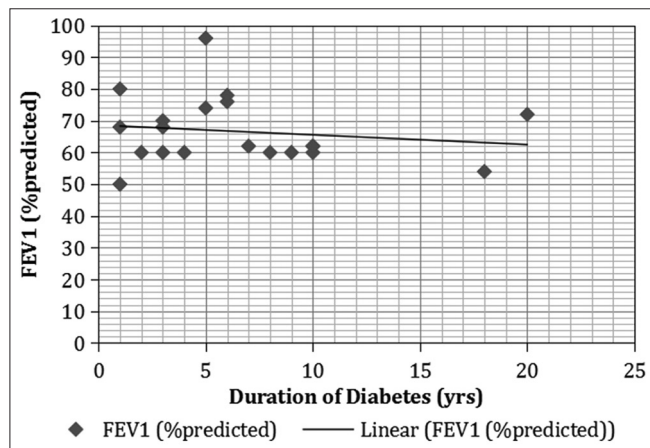


Figure 2: Correlation of Volume forcibly exhaled in one second (% predicted) with duration of diabetes (years)

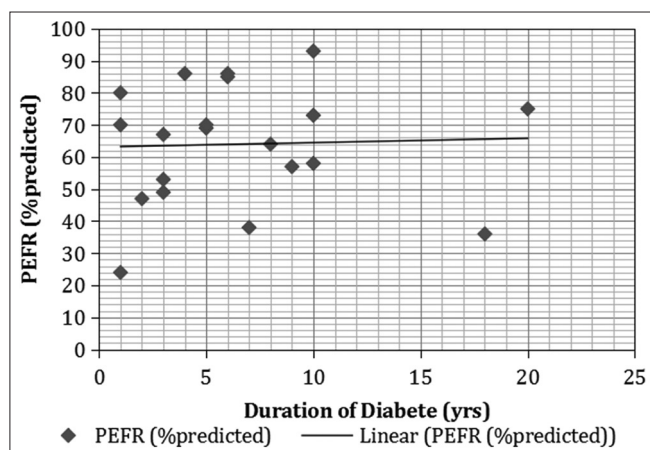


Figure 3: Correlation of peak expiratory flow rate (% predicted) with duration of diabetes (years)

parenchyma, leading to loss of lung volume. Pulmonary capillary network may be affected by microangiopathy leading to thickening of basement membrane, affecting the diffusion of gases across respiratory membrane. Alveolar basal lamina is also thickened due to diabetes. The main cause for this thickening is hyperglycemia.^[13,14]

Interstitial lung fibrosis may also occur in diabetes, increase in activity of lysyl oxidase.^[15] The enzyme hyperactivity may be one of the reasons for alveolar thickening in diabetes. Due to hyperglycemia, there is nonenzymatic glycosylation of proteins such as collagen and elastin. Loss of complete elastic recoil of lung after inspiration may be the reason for decreased PEFR values in the study group. Respiratory muscle weakness due to diabetic neuropathy may also lead to decreased lung functions.^[16,17] Parasympathetic dysregulation in diabetics may also account to reduced pulmonary functions.^[5]

Strength and Limitation of the Study

There is a significant decrease in lung functions in diabetics. Hence, we can suggest physicians perform spirometry on

diabetics occasionally for reduced PFTs, and breathing exercises could be prescribed for improving lung function for which further research is required. Sample size is small. The correlation of duration of diabetes and blood glucose levels with reduced lung function requires further research.

CONCLUSIONS

The pulmonary function parameters (FVC, FEV1, and PEFR) are reduced in type 2 diabetes, indicating a restrictive pattern of lung pathology. A negative correlation between reduced lung functions (FVC and FEV1) was observed with duration of diabetes.

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