

Original Article

Study of Pulmonary Function Tests in Type-2 Diabetes Mellitus

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Abstract

Background: The association of reduced lung function and diabetes mellitus (DM) has been described for many year. **Objectives:** To study the effect of diabetes on pulmonary function. **Methods:** A cross sectional descriptive study. 40 diabetics & 40 non diabetic controls who fulfill the inclusion criteria were subjected to spirometry. **Results:** Out of the total 40 patients, 19 were males and 21 were females. There is decrease in the FVC in the case group with a range of 1.51-4.25 and mean at 2.5 ± 0.8 . There is a decrease in the FEV1 in the case group with a range of 1.28l-3.94l and mean at 2.0 ± 0.6 in comparison with the controls. **Conclusion:** Diabetic patients were having decreased FVC & FEV1 compared to non-diabetic controls.

KEY WORDS: Diabetes mellitus, spirometry, FVC, FEV1.

Introduction

Diabetes mellitus is a group of common metabolic disorders that share the phenotype of hyperglycaemia¹. The association of reduced lung function and diabetes mellitus (DM) has been described for many years². Several studies have suggested that diabetes is associated with impaired pulmonary function³⁻¹¹. Ljubic *et al.*¹² showed that diabetes could lead to the development of pulmonary complications due to collagen and elastin changes. Another theory suggested that increased non-enzymatic glycation of proteins and peptides of the extracellular matrix at chronic high circulating glucose levels may also have an important role in the pathological changes of the lungs in DM patients¹³. The micro vascular complications appear early, within

5 to 10yrs and macro vascular complications appear within 15 to 20yrs from the onset of diabetes¹⁴. There are histopathological changes seen in lungs of diabetics such as thickened alveolar epithelial and pulmonary capillary basal lamina leading to reduced pulmonary elastic recoil and lung volume. There is impaired diffusion due to reduced pulmonary capillary blood volume and thickening of the basement membrane¹⁵.

Diabetes mellitus causes abnormalities in the structural components leading to the development of abnormalities in the pulmonary function such as a reduction in the vital capacity, total lung capacity, lung compliance, reduction of central and peripheral airflows, acceleration of the ageing process, alteration in the pulmonary connective tissue by thickening of the alveolar and capillary endothelial basement membranes, modifications of alveolar surfactants altering its function and pulmonary microangiopathy which brings about reduction in diffusing capacity and the muscle endurance¹⁶.

Criteria for diagnosis of DM:^{1,17,18} (American Diabetes Association Standards)

- a) Symptoms of diabetes plus random plasma glucose concentration ≥ 200 mg/dl
- b) Fasting plasma glucose ≥ 126 mg/dl
- c) A1C $\geq 6.5\%$
- d) Two-hour plasma glucose ≥ 200 mg/dl during an oral glucose tolerance test (GTT)

Random is defined as without regard to time since

the last meal.

Fasting is defined as no calorific intake for at least 8 hr.

The test should be performed in laboratory certified to A1C standards of the diabetes control and complications trial.

GTT should be performed using a glucose load containing the equivalent of 75g of anhydrous glucose dissolved in water; not recommended for routine clinical use.

Materials and Methods

Objectives: To study the pulmonary function of patients with type 2 Diabetes mellitus. To compare the spirometric findings of persons with type 2 Diabetes mellitus with that of non-diabetic controls. To correlate the abnormalities of spirometry with the duration of diabetes mellitus.

Design of the study: A cross-sectional descriptive study of the lung function of diabetics compared with age and sex-matched non-diabetic controls. 40 Type-2 diabetics of 35-55 years age group from outpatient and inpatient departments in Academy of Medical Sciences, Pariyaram were selected. 40 healthy controls of the same age group were taken as control group.

Inclusion Criteria

Subjects with history of Type-2 DM of more than 5yrs, belonging to 35-55yrs of age, was taken as study group. 40 healthy volunteers of 35-55yrs age was taken as controls.

Exclusion Criteria:

Smokers, Previous history of lung diseases, signs and symptoms of respiratory infections at the time of test, subjects who were admitted during the past 6 months for respiratory symptoms, history of cardiovascular illness and those who did not give consent for the study were excluded.

Methodology

The diabetics and control group were selected as per inclusion and exclusion criteria. Their written consent was taken after they were explained regarding the procedure. The basic parameters of the subjects like age, sex, weight in kgs, height in cms and BSA in m² were recorded and

fed to the computer to get predicted values for spirometry. The FBS, PPBS and HbA1c were estimated. Spirometry was done by using computerized spirometer three times for each subject and the best of the three was considered. Vitalograph 2120 pneumotach spirometer with Spirotrac IV software was used for doing spirometry. Vitalograph 2120 (with Spirotrac IV software), calibrated daily, was used for all pulmonary function measurements according to ATS performance criteria. The test procedure was explained to the subjects. The objective of the test was to obtain reproducible flow volume loop and a volume time curve. All efforts were made to secure three satisfactory and reproducible expiratory maneuvers, and the best results ("ATS best") recorded in an ATP (ambient, temperature and pressure, saturated) scale.



Fig1:Vitalograph 2120 spirometer

The results were analysed using SPSS version 10.0 software. Student 't' test was used to find the difference in spirometric parameters between healthy control and Type - 2 DM group.

Results

There is a decrease in the FVC in patients with type 2 diabetic mellitus with a range of 1.5-4.25l and mean of 2.5±0.8 in comparison with the controls with a range of 2.61-3.63l and mean of 2.8±0.6, and the P value is 0.046 which is significant.

There is a decrease in the FEV₁ in case groups with a range of 1.28-3.94l and mean of 2.0±0.6 in comparison with the controls with a range of 1.53-3.13 and mean of 2.3±0.50, with P value 0.012.

There is a decrease in the PEF in case group with a range of 1.74-9.71 and mean of 5.4±2.3 in comparison with the controls with a range of 3.59-9.78l and mean of 6.5±1.7. The P value is 0.016 which is significant; and

this shows that subjects with diabetes have reduced PEF.

There is a decrease in the FEF 25-75% in case group with a range of 0.56-4.45l, and mean of 2.2 ± 0.90 in comparison with the controls, with a range of 0.32-4.85 and mean at 3.0 ± 1.0 . The P value is 0.00, which is significant, and shows that diabetes mellitus significantly reduced FEF 25%-75%.

There is an increase in the FEV₁/FVC ratio in case groups with a range of 0.64-0.921 and mean at 0.84 ± 3.9 in comparison with the controls with a range of 0.62-0.89 and mean at 0.85 ± 6.3 , with P value 0.46 and shows that subjects with type 2 diabetes mellitus have increased FEV₁/FVC ratio.

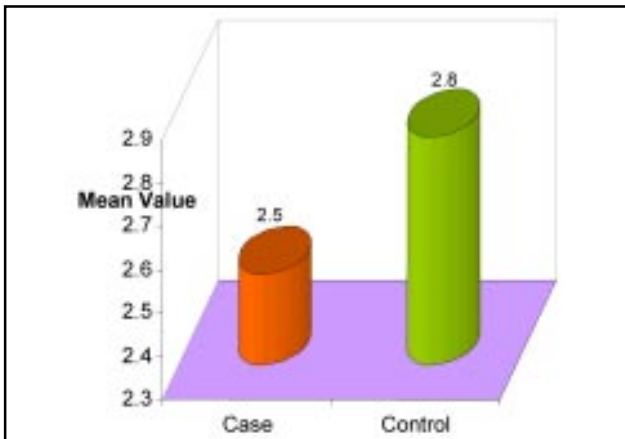


Fig 2 - Effect of Type-2 Diabetes mellitus on FVC

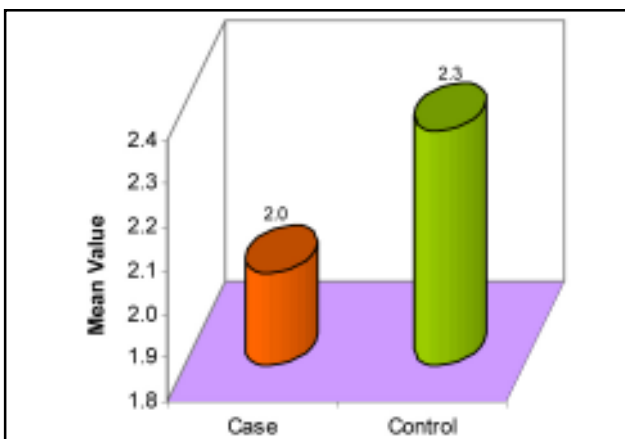


Fig 3 - Effect Type-2 Diabetes mellitus on FEV1

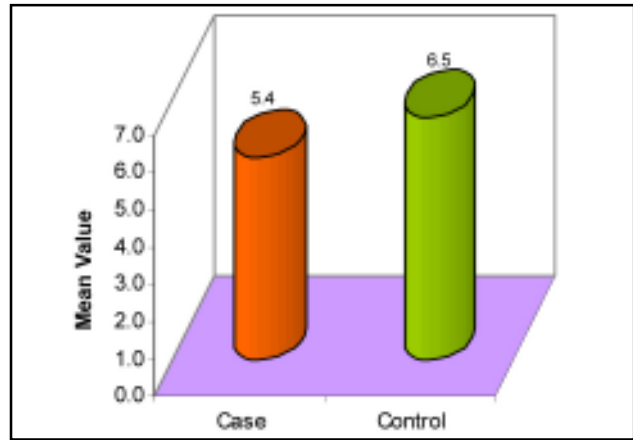


Fig 4 - Effect of Type-2 Diabetes mellitus on PEF

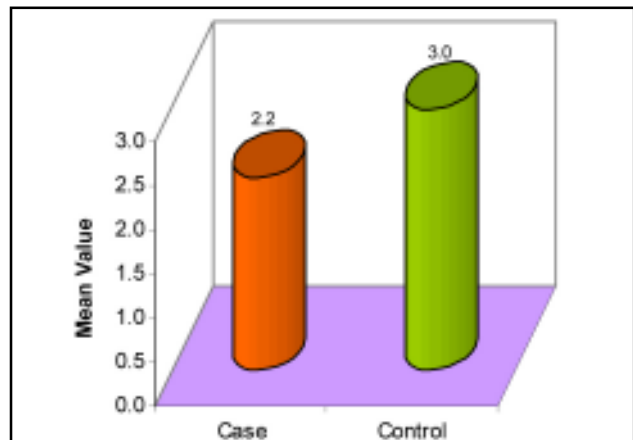


Fig 5 - Effect of Type-2 Diabetes mellitus on FEF 25%-75%

Discussion

In our study, there was a tendency for all parameters to fall in patients with diabetes mellitus. Poor diabetic control was associated with poor lung function. There was a rough association between greater decline in FVC, FEV₁ and higher values of FBS and PPBS

A study conducted by Walter. E. Robert, Alexa Beiser, Rachel J, Givelber, George T, O'Connor, et al. on "Association between glycemic state and lung function" concluded that a higher levels of FBS were associated with lower pulmonary function²¹.

In a similar study done by Davis Timothy M. E, Matthew Knuiman, Peter Kendell, Hien Vu, Wendy A. Davis et al, it was found that pulmonary function is reduced in type 2DM and diabetes duration has more influence on pulmonary function than the glycemic control²².

In another study there is significant reduction in

TABLE-1
Basic characteristics

	Case(n=40)	Control(n=40)	P value
Age in Years	45.9 ± 8.6	46 ± 8.8	p = 0.980
Sex	M = 47.5 %	M = 60 %	
	F= 52.5%	F= 40%	p=0.262
Height in cms	161.5 ±7.2	161.9±1.6	P=0.833
Weight in Kg's	65.9± 11.1	65.4± 11.5	P=0.821
BSA in M ²	1.7±0.2	1.7± 0.2	P=0.842
FBS (mg/dl)	195.7±82.1	85.6±11.5	P=0.000
PPBS (mg/dl)	262±94	124.3± 11	P=0.000
HbA1C	7.01 ± 0.91	-	-
Inference			
	Samples are age, sex, height, weight and BSA matched (P>0.05)		

Table -2

TABLE-2- PFT in FBS wise subgroups of Type-2 diabetes mellitus

FBS	90-110	111-200	201-300	>300	MEAN	STD DEVIATION	P value
FVC	2.721	2.622	2.43	2.23	2.50	0.217	0.15
FEV1	2.149	2.134	2.02	1.98	2.07	0.083	0.34
PEF	5.84	5.263	5.34	5.40	5.46	0.259	0.07
FEF25-75	2.321	2.24	1.952	1.847	2.09	0.217	0.15
FEV1/FVC	78.9	88.4	83.12	86.78	84.27	4.412	0.27

TABLE-3

PFT in PPBS wise subgroups of Type-2 diabetes mellitus

PPBS	100-200	201-300	301-400	>400	MEAN	STD DEVIATION	P value
FVC	2.742	2.584	2.404	2.34	2.51	0.181	0.16
FEV1	2.432	2.241	2.04	1.92	2.15	0.225	0.11
PEF	5.45	5.81	5.701	4.95	5.47	0.382	0.19
FEF25-75	2.43	2.221	2.08	1.973	2.176	0.197	0.09
FEV1/FVC	87.68	85.72	83.8	82.05	84.8	2.429	0.11

TABLE-4
SPIROMETRY FINDINGS IN DIABETICS &NON-DIABETICS

SPIROMETRIC FINDING	Diabetic		Non diabetic		p VALUE
	Mean	Std. Deviation	Mean	Std. Deviation	
Recorded FVC	2.51	0.78	2.82	0.60	0.05
Recorded FEV1	2.01	0.64	2.34	0.49	0.01
Recorded PEF	5.41	2.27	6.51	1.72	0.02
Recorded FEF 25-75%	2.18	0.92	2.97	1.01	0.00
Recorded FEV1/FVC	84.29	3.89	85.16	6.29	0.46

FEV1/FVC% in diabetes mellitus groups compared with controls²³.

Lange P. Studied the possible association between diabetes mellitus, plasma glucose, forced vital capacity and forced expiratory volume in 1 second. There was a slight impairment of lung function & it was more prominent in subjects treated with insulin than those taking oral hypoglycemic agents and/or diet²⁴.

Two groups of studies^{25,26} reported a thickening of pulmonary basal laminae. In addition, Kodolova et al²⁶ reported the existence of microembolization in the pulmonary arteries and some degree of emphysema.

Hsin-Chieh Yeh, and colleagues of The Atherosclerosis Risk in Communities (ARIC) conducted a Cross-Sectional and Prospective Study of Lung Function in Adults With Type 2 Diabetes in four U.S. communities with analysis of diabetes status and lung function decline using baseline and 3-year follow-up data on 1,100 diabetic and 10,162 nondiabetic middle-aged adults. Forced vital capacity (FVC) and forced expiratory volume in 1sec (FEV₁) were measured at baseline and at the 3-year follow-up using standard spirometry and found to be at a lower predicted value for diabetics than those without diabetes²⁷.

SK Rajan et al²⁸ conducted a study on spirometric evaluation of type 1 DM, and study shows normal findings in 10 patients (33%), & abnormal findings in 20 patients (67%). Among these 20 patients (67%) with abnormal findings, obstructive pattern was present in 12 patients (60%), restrictive pattern was present in 6 patients (30%) and mixed pattern was observed in 2 patients (10%). Muhammad Irfan, Abdul Jabbar et al concluded in their study that diabetic patients showed impaired lung function

independent of smoking. This reduced lung function is likely to be a chronic complication of diabetes mellitus²⁹.

Conclusions

This study confirms the following :

1) Spirometric values were consistently lower in subjects with Type 2 diabetes mellitus than in non-diabetics, the trend was seen across all parameters

2) FVC, FEV1, PEF and FEF25%-75% are decreased in Type-2 diabetes mellitus compared to controls. FEV1/FVC% increased in type-2 diabetes mellitus.

3). Subjects with poorer diabetic control have worse spirometric function.

4). The pulmonary function were decreasing with the increasing FBS, PPBS, which underlines the respiratory system as one of the target organs of Type-2 DM

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