Original Article

DOI: 10.7860/JCDR/2013/6182.3237

Pulmonary Function Tests in Type 2 Diabetics and Non-Diabetic People -A Comparative Study

Physiology Section

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ABSTRACT

Background: The complications which are associated with type 2 Diabetes mellitus are mostly caused by macro vascular and micro vascular damages. The pulmonary complications of diabetes mellitus have been poorly characterised. The present study has focused on the mechanical aspects of lung dysfunction which are attributable to type 2 Diabetes Mellitus; maximal forced Spiro metric Pulmonary Function Tests (PFTs) like Forced vital capacity (FVC), Forced Expiratory Volume in 1sec (FEV1),. FEV1/FVC % and Peak expiratory flow rate (PEFR), to be specific.

Aims and objectives: 1. To do a comparative analysis of the PFTs in type 2 diabetics and non-diabetics by using computerised spirometry.
2. To assess the effects of chronic hyperglycaemia on lung functions and functional limitations of activities of daily living which are ascribable to pulmonary complications, in patients with type 2 diabetes.

Material and Methods: Spirometry was performed by using a computerised electronic spirometer, (RMS Helios 401, version 3-1-59, transducer number 4-16-1669) on 40 type 2 diabetics who were between 40-65 years of age and on 40 controls (who were matched for age, sex and BMI). Any person with a H/O smoking or any condition which affected the lung functions, was excluded from the study. The study was a cross sectional and a retrospective study. Data was analyzed and processed with the help of EPI INFO statistical software by using unpaired Student's 't'–test (two-tailed). The level of significance was taken as a p–value of <0.025.

Results: This study clearly showed a statistically significant reduction in FVC, FEV1, PEFR in type 2 diabetics as compared to those in the controls. FEV1/FVC% was increased in type 2 diabetics as compared to that in controls and the increase was statistically significant.

Conclusion: This study concluded that type 2 diabetes adversely affects the mechanical functions of the lung, the pattern of disease being primarily restrictive in nature.

Key words: Type 2 diabetes, Spirometry, FVC, FEV1, FEV1/FVC %, PEFR

INTRODUCTION

Type 2 Diabetes mellitus is characterised by persistent hyperglycaemia and abnormal metabolisms of carbohydrates, proteins and lipids. These metabolic disorders result from impaired insulin secretion, an altered tissue sensitivity to insulin or coexistence of both these mechanisms.

Type 2 Diabetes mellitus is associated with long term damage, dysfunction and failure of various organs and its complications are mostly caused by macro vascular and micro vascular damages [1,2].

Though great attention was centred on the diabetic complications which had a cardiovascular nature, nephropathy, diabetic retinopathy, and neuropathy, the pulmonary complications of type 2 diabetes mellitus have been poorly characterised. Of late, the concept of the lung as a target organ for diabetic microangiopathy is receiving continuing attention. The aim of the present study was to assess the effects of chronic hyperglycaemia on lung functions, which focused on mechanical aspects of lung dysfunction-maximal forced spirometric Pulmonary Function Tests like FVC, FEV1, PEFR, FEV1/FVC%, to be specific.

Spirometry (which means 'measuring the breath') is the most common of the pulmonary function tests (PFTs) which measures mechanical lung function, specifically the amount (volume) and/or speed (flow) of air that can be inhaled and exhaled.

Reasons for undertaking this study:

1. The pulmonary complications of type 2 diabetes mellitus have been poorly characterised.

2. These complications have a significant impact on the quality of life of the affected individuals and they impose a heavy burden on health care providers world wide.

3. Relatively few studies have been done on pulmonary mechanical function. The present study focused on mechanical aspects of lung dysfunction, maximal forced spirometric PFTs, to be specific.

4. Most of the studies were done on type I diabetics. The present study was done on type 2 diabetics.

MATERIAL AND METHODS

This cross-sectional and retrospective study was conducted in Department of Physiology, Mediciti Institute of Medical Sciences (MIMS), Ghanpur, Medchal Mandal, RR district, Andhra Pradesh, India. The subjects of the study included forty type 2 diabetics who were between 40-65 years of age and a similar number of age, sex and BMI matched controls. Both were selected on the basis of exclusion criteria.

Persons with any condition which affected the lung functions were excluded from the study, viz. the subjects with gross abnormalities of the vertebral column or thoracic cage, those with a known history of acute or chronic respiratory infections, neuromuscular disease, malignancy and cardiopulmonary disease and those who had undergone major abdominal or chest surgeries. In addition, subjects with current or previous drug or tobacco (smoked or chewed) addictions or who chewed betel nuts were also excluded.

Over a period of four months, from March 2012 to June 2012, about 120 files of type 2 diabetic patients who visited the General Medicine Department of MIMS hospital were reviewed. After

reviewing the files, their detailed histories were taken to determine whether they could be included in the study or not. Individuals were classified as having diabetes if any of the following criteria, which were adapted from 1997. American Diabetes Association criteria were met: a fasting glucose level of at least 7.0 mmol/L (126 mg/dL); a nonfasting glucose level of at least 11.1 mmol/L (200 mg/dL); current use of anti-diabetic medications; and a positive response to the question "Has a doctor ever told you that you had diabetes (sugar in the blood)?" After the initial interview, 22 apparently healthy, male, type 2 Diabetic patients who were within age range of 40-65 years and 18 apparently healthy female type 2 Diabetic patients who were within age range of 40-65 years were selected and the other 80 were excluded. Among the controls, from among approximately 100 subjects who were interviewed, 40 age, sex and BMI matched controls were selected.

Type 2 diabetics were individually matched for gender, age and BMI with controls. The matching was done in such a manner that the age difference between the two groups was 3 years and the difference for BMI was 0.0003. On the basis of above criteria, 22 male pairs and 18 female pairs were formed. Controls and type 2 diabetics, both were assessed by using a proforma and written informed consents were obtained from them. The study was approved by the institutional ethical committee and it was in accordance with the Helsinki Declaration of 1975 that was revised in 2000.

Spirometry was performed by using a computerised electronic spirometer, (RMS Helios 401, version 3-1-59, transducer number 4-16-1669). All tests were carried out at a fixed time of the day (10.00 – 14.00 hours), to minimize diurnal variations. The apparatus was calibrated daily and it was operated within the ambient temperature range of 30-40 degrees centigrade. The precise technique of executing various lung function tests for the present study was based on the operation manual of the instrument, as well as the recommendations which were made by the American Thoracic Society for a standard technique of spirometry [3].

After taking the anthropometric data, the subjects were informed about the whole maneouver. The subjects were encouraged to practise this maneouver before doing the pulmonary test. The test was performed with the subjects in the sitting position, by using a soft nose clip. The test was repeated three times after the subjects took adequate rest and results were printed by using the inbuilt printer which was available in the spirometer. The values of parameters (FVC, FEV1, FEV1/FVC% and PEFR) of the best maneouver were taken and they were analyzed with the help of EPI INFO statistical software by using unpaired Student's t–test (two-tailed). The level of significance was taken as a p value of <0.025.

OBSERVATION AND RESULTS

In the female group, the age and BMI were matched for type 2 diabetics and controls (p=NS*). FVC, FEV1 and PEFR were significantly reduced in type 2 diabetics as compared to those in controls and FEVI/FVC % was significantly increased in type 2 diabetics as compared to that in controls [Table/Fig-1].

Similar results were found in the male group also, after the age and BMI were matched for the type 2 diabetics and controls (p=NS*) [Table/Fig-2].

DISCUSSION

The present study was done to test the hypothesis that type 2 diabetes was independently associated with reduced lung functions, by doing forced Spirometric Pulmonary Function Tests.This study clearly showed a highly statistically significant p value when the lung function tests (FVC, FEV1, and PEFR) were compared between type 2 diabetics and controls (age, sex and BMI matched). Asanuma [4] and Lange et al., [5] reported that FVC and FEV1 were reduced in type 2 diabetic subjects as compared to those in control subjects.

Parameter	Type-2 diabetics (Mean ± SD)	Controls (Mean ±SD)	p value
Age (years)	48.39±1.56	47.83±1.59	0.8046 NS*
BMI	0.002681±0.0001597	0.002616±0.001499	0.7685 NS*
FVC (liters)	1.882±0.0989	2.8094±0.1644	0.0001
FEV1 (liters)	1.5233±0.0764	1.9889±0.0941	0.0005
FEV1/FVC %	84.1156±1.8781	72.2661±2.4706	0.0005
PEFR (liters/sec)	3.5594±0.2383	4.5200±0.2842	0.0242

[Table/Fig-1]: Anthropometric and spirometric lung function test data for female type 2 Diabetics compared with their matched controls

Parameter	Type-2 diabetics (Mean ± SD)	Controls (Mean ±SD)	p value
Age (years)	49.73±2.06	48.86±1.9	0.76 NS*
BMI	0.002382±0.000075	0.002418±0.000070	0.7249 NS*
FVC (liters)	2.385±0.1859	3.3691±0.1126	0.0001
FEV1 (liters)	1.9955±0.1624	2.6086±0.0748	0.0014
FEV1/FVC %	82.5468±3.9130	72.3209±1.2573	0.0004
PEFR (liters/sec)	5.0073±0.3633	7.1232±0.3108	0.0001

[Table/Fig-2]: Anthropometric and spirometric lung function test data for male type 2 Diabetics compared with their matched controls

The results of present study were similar to the results which were observed by Asanuma and Lange et al., On contrary, Benbassat [6] showed that FVC and FEV1, were within the predicted values in type 2 diabetics. The most probable reason for this contradiction was that Benbassat had studied pulmonary functions in a group of patients with type 2 diabetes, but they had not compared their results with a matched control group.

Recent studies which were conducted by Lange et al., indicated that the type 2 diabetic patients are associated with a slight reduction in FVC and that it was because of impaired defenses against environmental challenges such as smoking and airway infections in diabetes [7,8]. In a study which was done by Davis. A Wendy et al., it was found that there was a decrease in mean FVC values in type 2 diabetics [7,9]. In a study which was done by Robert E. Walter et.al., it was found that there was a progressive decrease in mean FVC values by 109 ml/year [10]. A study which was done by Timothy M. Davis, showed there was an average decrease of 9.5% in mean FVC values in diabetics [11].

The FEV1/FVC % was increased in type 2 diabetics as compared to that in the controls and the increase was statistically significant. The increased FEV1/FVC % suggested that the impairment of pulmonary functions in type 2 diabetics was primarily restrictive in nature. In a study which was done by Robert E Walter, it was found that this ratio was increased by 1.5% in diabetics, which was statistically significant [10].

In a study which was done by Timothy ME Davis, it was found that there was an average decrease in mean value of PEFR by 9.5%.23 As per the study of Sreeja et al., the decrease in PEFR was 267.65L/sec [7].

Davis et al., [11] determined the association between type 2 diabetes mellitus and reduced lung functions and reported that the forced vital capacity (FVC), forced expiratory volume in 1st (FEV1), vital capacity (VC) and peak expiratory flow (PEF), when expressed as percentages of those which were predicted (% pred) for age, sex and height, the means of all spirometric measures were reduced by > or =9.5%. This study, along with the findings of other similar studies, strongly suggests that type 2 diabetes mellitus adversely affects the pulmonary functions.

Although the underlying mechanisms which relate type 2diabetes to reduced lung functions remains unclear, previous studies

have suggested several possible explanations, which include glycosylation of chest wall and bronchial tree proteins [12] and increased cross-linkage formation between polypeptides of collagen in pulmonary connective tissue, which decrease FVC and hence are responsible for restrictive respiratory defects [13], thickening of basal lamina [14], and increased susceptibility to respiratory infections [15].

The study which was done by Mario Cazzola et al., on human isolated bronchi elucidated the obstructive nature of pulmonary pathology in diabetes at a molecular level [16]. Thus, hyperglycaemia may contribute independently to airflow obstruction, in a manner which is analogous to that by which peripheral airway inflammation may lead to airflow obstruction in asthma [17].

The lungs are affected by diabetic microangiopathy. This was evidenced by autopsy findings in human diabetic subjects, which showed thickening of alveolar epithelia, pulmonary capillary basal lamina, centrilobular emphysema, and pulmonary microangiopathy [18]. Type 2 Diabetes mellitus can cause the development of pulmonary complications due to collagen and elastin changes as well as microangiopathy.

The pulmonary complications in asymptomatic diabetic patients are more prevalent than those which are generally recognized. The study which was done by David A Kaminsky in 2004 speculated that abnormal lung functions may precede the diagnosis of diabetes, suggesting that lungs may contribute to or at least be commonly affected by factors which are involved in the pathogenesis of diabetes [19].

CONCLUSIONS

The findings of this study are in sync with the findings of others, which strongly suggest that type 2 diabetes mellitus adversely affects the pulmonary functions and that the lung function impairment is primarily restrictive, although the recent studies also suggest an obstructive pathology.

Nevertheless, the findings of present study conclude that lung is a target organ for damage in diabetes and that the glycaemic exposure is a strong determinant of reduced pulmonary functions in type 2 diabetics. Thus, an intensive glycaemic management may reduce the risk of death through an improved ventilatory function which is independent of other beneficial effects. Also, as pulmonary dysfunction may be one of the earliest and easily measurable non–metabolic alterations in diabetes, the patients with diabetes are suggested to undergo pulmonary function testing along with other investigations.

It is advisable, therefore, that diabetic patients must undergo periodic Spirometry tests to assess the severity of lung function impairment. These measures will help in preventing lung damage in initial stage, and thus contribute to reduction in morbidity and mortality in type 2 diabetic patients. Additional research is required to identify pathophysiologic mechanisms and to determine clinical significance of this association. In the meantime, clinicians should pay utmost attention to pulmonary functions in their patients with type 2 diabetes.

Suggestions

A longitudinal study may be done to study the correlation between duration of diabetes, extent of control of type 2 diabetes and the extent of lung damage, which are depicted by decrements in the lung volumes and capacities on spirometry.

Ethical Standards

This study was conducted after getting approval from the Institutional Ethics Committee and after obtaining written consents from all subjects.

ACKNOWLEDGEMENT

I am thankful to the Laboratory staff, Department of Physiology, Mediciti Institute of Medical Sciences , Ghanpur, for their technical support.

Conflict of Interest: I declare that there is no conflict of interest

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FINANCIAL OR OTHER COMPETING INTERESTS: None.

Date of Submission: **Apr 04, 2013**
Date of Peer Review: **May 17, 2013**
Date of Acceptance: **Jun 21, 2013**
Date of Publishing: **Aug 01, 2013**