Original Article

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Variation in Spirometric Parameters among Type 2 Diabetes Mellitus Patients and their Association with Duration of Disease and Glycemic Control

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Abstract

Background: Pulmonary function test using spirometry is a simple cost effective method to identify the lung function impairment among type 2 Diabetes Mellitus (DM) patients. Even though pulmonary function is impaired among diabetics there are no signs and symptoms of reduced lung function. Hence this study was aimed to find out the pulmonary function in DM patients, to compare the spirometry parameters of Diabetic patients with non-diabetics and correlate spirometry abnormalities with duration of diabetes and HbA1C. **Subjects and Methods:** A Cross sectional comparative study done among DM patients (Group 1) and non diabetics (Group 2), in a teaching hospital from June 2018 to January 2019. There were 106 study subjects in each group. All the 212 participants were subjected to spirometry and the readings were interpreted as normal, obstructive, restrictive or mixed pattern. Both the groups were compared for spiromertric observations. Pulmonary function in group 1 was analyzed based on duration of diabetes and HbA1C. Mean and SD was calculated. p value was calculated using chi-square and T-test. **Results:** The mean age of patients with DM and non-diabetes was 53.58 and 51.27 years respectively. The spirometry inference among DM patients was 30.2%, 20.8%, 18.9% and 30.1% as normal, restrictive, obstructive and mixed pattern respectively. p value was found to be statistically significant for FVC, FEV1 and PEFR and FEF25-75%. **Conclusion :** Spirometry can be used as a tool to find out the pulmonary function among diabetic patients earlier and to reduce morbidities due to respiratory complications.

Keywords: Diabetes Mellitus, Spirometry, Pulmonary function test, non-diabetics.

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Introduction

Diabetes Mellitus (DM) is a significant public health issue. According to the World Health Organization, India will be the diabetes capital of the world by the year 2025.[1] For the foreseeable future, DM will be a prominent cause of morbidity and death due to its rising global occurrence. Because the illness affects every organ system, it can eventually cause difficulties in the lungs, which are less well-known because they are clinically silent and easily neglected. Diabetic problems are hypothesised to be caused by a microangiopathic process as well as non-enzymatic glycosylation of tissue proteins. The lung has a large amount of connective tissue and a large microvascular bed, making it a vulnerable target organ.[2] Secondary pathophysiological alterations in numerous organ systems are caused by the metabolic dysregulation associated with diabetes, putting a great load on both the diabetic and the health-care system.

Several studies on lung function in Type 1 diabetes have found lower elastic recoil, smaller lung volumes, poorer respiratory muscle performance, and a reduction in carbon monoxide (DLCO) diffusion capacity.[2–4] Diabetic individuals' autopsy results indicated thicker alveolar and pulmonary capillary basal laminae.[5,6] In the last two decades, researchers have been looking at the effects of diabetes on the respiratory system. The lung is a putative "target organ" in diabetes patients due to its quantity of microvascular circulation and connective tissue. Because the integrity of the pulmonary connective tissue and microvasculature influences normal lung mechanics

and gas exchange, defects in any of these two structural components of the lung can lead to quantifiable pulmonary function problems. Increased nonenzymatic glycosylation (NEG), which involves both lysine and hydroxylysine residues, is one of the two key processes now thought to be implicated in the interference with connective tissue cross-links in diabetes mellitus. As a result, prolonged hyperglycemia exposure of connective-tissue proteins (collagen/elastin) in diabetes mellitus may result in excessive NEG of lysine or hydroxylysine residues and the formation of defective or aberrant cross-links. Excess NEG may damage the mechanical qualities of the lungs because cross-linking of collagen and elastin is vital in providing both strength and elasticity to lung connective tissue. The second factor is an increase in lysyl oxidase activity. The oxidative deamination of the e-amino group of lysyl or hydroxylysyl residues is the initial step in cross-link production. The former groups are converted to their equivalent -semialdehydes, namely allysine or hydroxyallysine, through this deamination. The enzyme lysyl oxidase catalyses the last step, which has been found to need cuprous ion as a cofactor. Because intermolecular cross-links play such an important function in supplying strength and affecting elasticity in lung connective tissue, increased cross-link creation might interfere with the lung's mechanical qualities. As a result, it's probable that lysyl oxidase belongs to the group of enzymes that catalyse posttranslational changes of collagen and elastin and whose activities are reported to be increased in diabetics.[2]

Microangiopathy manifests itself in these people as a thickening of the alveolar capillary basal lamina. Respiratory autonomic neuropathy, which is characterised by decreased cholinergic bronchomotor tone and neuroadrenergic denervation in the lung,[?] can cause abnormal lung function. When compared to subjects without diabetes and in relation to glycemic control,[7–12] patients with diabetes without a smoking history or clinical lung disease consistently demonstrate a modest restrictive ventilator defect with proportional (8–20 percent) reductions in lung volume, forced vital capacity (FVC), FEV1, and forced expiratory flow in the midrange of vital capacity.

The lung's elastic structure supports and maintains the patency of the intrathoracic airways; diabetic individuals were at risk of developing chronic airflow blockage. While modest alterations in lung elastic recoil have no obvious clinical implications, the development of chronic airflow blockage and consequent mechanical dysfunction of the lungs and airways might result in substantial impairment. To recapitulate, the microangiopathic and macroangiopathic consequences of diabetes mellitus on target organ systems cause significant morbidity. The lung is prone to difficulties due to its vast microvascular capillary network. Spirometry was used to measure pulmonary function in Type 2 diabetes patients in this cross-sectional research.

Objectives

The goals of this study are to use spirometry to measure pulmonary function in Type 2 diabetic patients, compare spirometry parameters between diabetic and non-diabetic individuals, and connect spirometry abnormalities in diabetics with diabetes duration and HbA1C.

Subjects and Methods

From June 2018 to January 2019, a descriptive cross-sectional comparison study was undertaken on Type 2 Diabetes mellitus patients and non-diabetic patients who visited the general medicine outpatient department of Vinayaka Missions Medical College Hospital and Research Institute, Karaikal. Patients with diabetes mellitus were classified as group 1 patients, whereas those without diabetes were classified as group 2. After applying exclusion criteria 106 study subjects in each group were included for the study in total 212 cases.

Inclusion criteria

Participants in the age group of 30 to 70 years who are non smokers were included for the present study. Both the sexes were considered. Patients with Tpye 2 DM were taken as group 1 and non diabetics as group 2.

Exclusion criteria

Patients with Tuberculosis, Bronchial Asthma, COPD, Occupational lung diseases Recent H/O LRTI within past 2 weeks, lung surgeries, lung trauma, cardiovascular disease and heart failure cases were excluded.

Informed consent was taken from the study participants before conducting the study. Patients were evaluated with a pretested structured questionnaire which includes history, general examination, systemic examination, clinical and laboratory parameters. All the 212 study participants were subjected to computerized Spirometric evaluation using 'KoKo nSpire'spirometer (FVC, FEV1, FEV1/FVC, PEFR). Each study subject underwent repeat spirometry on three occasions and best of the three reading was taken into consideration. Interpretation of spirometry readings were normal or obstructive pattern, restrictive pattern or mixed pattern. Both genders were compared for spiromertric observations. Further, pulmonary function in group 1 was analyzed based on duration on diabetes and HbA1C and the medical care.

Statistical analysis

SPSS V 17 was used for data analysis. All descriptive data were described as frequency and percentage, with mean values. p value was calculated using chi-square test and T-test. A p value less than 0.05 was considered, for statistical significant.

Results

The mean age of the study population with Diabetes Mellitus (group1) was 53.58 years and those without Diabetes mellitus (group 2) was found to be 51.27 years and the p value was found to be insignificant (p >0.05). The mean BMI among diabetics was 26.36 and 26.64 among non-diabetics, which was also found to be not statistically significant. Among the 106 patients with DM the mean HbA1C was 7.85±0.9.

Among the 106 Type 2 DM patients the duration of DM was less than 5 years for 24 cases, 6 to 10 years for 37 of them and for 45 patients the duration of diabetes mellitus was more than 10 years. HbA1C was less than 6.5 in 17(16%) of the DM patients, it was 6.5 to 7 and among 21(20%) of the participants and majority of the DM patients 68(64%) the HbA1C value was found to be more than 7.

The mean FVC value among 106 DM patients was found to be 2.3795 with standard deviation (SD) of 0.7567 and among non-diabetic patients the mean was 2.7125 and SD 0.84637. The mean ± SD for FEV1 among group 1 and group 2 participants were found to be 2.0749 ± 0.6489 and 2.3755 ± 0.72266 respectively. Among group 1 FEV1/FVC the mean value was 0.8839 and SD 0.14434 and in group 2 mean was 0.8787 and SD 0.06808. The mean and SD of PEFR in the diabetic patients was found to be 5.7500 and 1.97423 respectively. FEF25-75% mean was 2.4713 and SD 0.9586 in group 1 and 3.094 and 1.0612 in the non diabetic group. Two tailed t test was done and the p value was significant for FVC (p-value 0.003), FEV1 was also found to be statistically significant. PEFR in 1/s and FEF25-75% in 1/s was also found to be statistically significant, shown in [Table 2].

The spirometry inference among the 106 patients in group 1, 32(30.2%) were normal, 22(20.8%) showed restrictive pattern, 20 (18.9%) showed obstructive pattern and 32 (30.1%) had mixed. In group 2, without DM 80(75.5%) were normal, 10 (9.4%) had obstruction, 13(12.3%) showed mixed pattern only 3 (2.8%) had restriction in pulmonary function test shown in [Figure 1].

Among the 106 diabetic patients with duration of DM < 5 yrs, spirometry was normal in 96% of patients. With duration DM 6-10yrs and >10yrs, spirometry was normal only in 11% of patients. FVC and FEV1when compared to duration of DM <5 yrs and >10 yrs was significant. (p value 0.001). FEV1 when compared to duration of DM <10 yrs and >10 yrs was found to be statistically significant (p 0.049). FEF26-75% when compared to duration of DM <5yrs to 6-10yrs and >10 yrs was significant (p 0.0001)

With HbA1C < 6.5 spirometry was normal in 65% of patients. When HbA1C > 6.51-7.0 spirometry was normal only in 33% and further reduced when HbA1C is >7.0 and 21% of the diabetic patients had normal spiromertric reading. However p value was not found to be statistically significant.

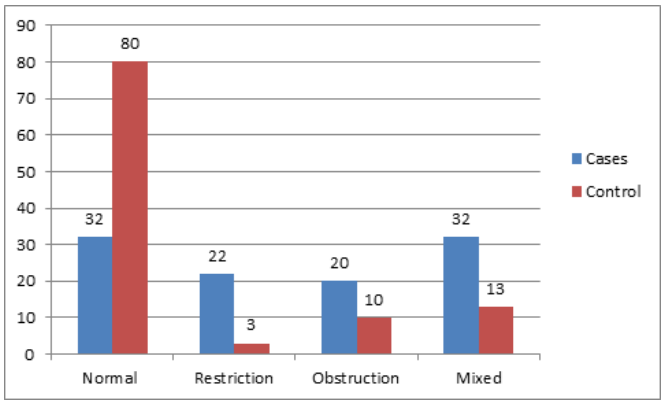

Figure 1: Spirometric inference of study groups

Discussion

In this study, 106 non-smoking type 2 diabetes patients and 106 non-diabetics were chosen. Spirometric data were linked to diabetes duration and HBA1C. Many studies have shown that changes in pulmonary volume, diffusion and elastic characteristics of the lungs, as well as the function of the respiratory muscles, indicate that the respiratory system is involved. In the current study, the Spirometric evaluation of the patients revealed features of obstruction (18.9%), restriction (20.8%) and mixed (30.1%) and normal respiratory function (30.2%). It was found that diabetic cases when compared to non-diabetics showed statistically significance of FVC (p 0.003), FEV1 (p 0.002), PEFR (p 0.044) and FEF25-75% (p 0.000). These shows there are restrictive, obstructive and mixed changes in diabetes when compared to non diabetics.

There was a reduction in mean FVC levels in a research by Davis A Wendy et al.[12] The yearly rate of decrease in FVC was 68 ml in their research. In a research by Robert E. Walter et al,[13] mean FVC levels decreased by 109 ml/year over time. In diabetics, mean FVC levels decreased by 9.5 percent, according to a research by Timothy M.E Davis.[14]

A cross-sectional study done by Hsin- chieh et al,[15] further supported the data mentioned in studies that lung was indeed the target organ in diabetic individuals, and restrictive pattern of changes were seen in them.

Lange et al,[16] found that both IDDM and NIDDM are related with a modest decline in FVC in the Copenhagen city heart research. In diabetics who were given insulin, the drop was even greater. The ventilator functions of newly diagnosed diabetes mellitus patients declined twice as much. This was assumed to be related to pulmonary collagen cross-linking, according to the authors.

Table 1: Mean age and BMI of the study participants

Variable	Diabetics (group1) (mean ± SD)	Non diabetics (group2) (mean ± SD)	P value
Age in years	53.58 ± 12.10	51.27 ± 14.00	0.104
BMI	26.36 ± 2.20	26.64 ± 1.00	0.609

Table 2: Spirometry parameters between diabetic group and non-diabetic group

Variable	Diabetics Group 1 (mean ± SD)	Non-diabetics Group 2 (mean ± SD)	p-value
FVC (L)	2.3795 ± 0.7567	2.7125 ± 0.8463	0.003
FEV1 (L)	2.0749 ± 0.6489	2.3755 ± 0.7226	0.002
FEV1/FVC %	88.39 ± 0.1443	87.87 ± 0.0680	0.735
PEFR in L/ s	5.7500 ± 1.9742	7.2175 ± 7.1947	0.044
FEF 25-75% in L/s	2.4713 ± 0.9586	3.094 ± 1.0612	0.000

FVC was considerably lower in diabetics, according to studies by Asanuma et al and Ramirez et al, indicating a restrictive trend.[8,17] They went on to say that this might be due to a lack of protection against environmental threats including smoking and airway infections.

In their investigation, Ramirez et al found a significant difference in FVC between individuals taking oral hypoglycemic medications and those taking insulin.[8] Sanjeev varma et al found a substantial drop in mean FVC in all diabetes participants in their study.[18] The mean FEV1 was lower in all male diabetics, but it was lower in female diabetics who were using oral medicine. Femognari et al,[19] published a research that found restrictive impairment in lung function, as seen by substantial decreases in FVC, FEV1, and normal FEV1/FVC. Barrett-Conner E et al,[20] found that FEV1 and FVC were both lowered in males with diabetes for 10 years or longer, which is comparable to the findings of the current investigation.

In a study by Md Omar Ali et al,[21] in Bangladesh in a 60 diabetic male patients between the age group of 40-60yrs, PEFR and FEF25-75% was lower in diabetic males and inversely proportional to duration of disease. Davis et al,[12] found that individuals with greater baseline HbA1C experienced faster decreases in FVC and FEV1. Prior cross-sectional investigations have found poorer FVC and FEV1 in persons with prevalent diabetes compared to their non-diabetic counterparts, especially when diabetes has been present for a longer period of time. In diabetics, mean FVC levels decreased by 9.5 percent, according to a research by Timothy M.E Davis.[14]

Conclusion

Despite the fact that type 2 diabetes individuals did not have any respiratory symptoms, they did have a subclinical mixed pattern of lung functions and reduced lung capacity. Restrictive, obstructive, and mixed patterns of respiratory abnormalities are all linked to type 2 diabetes mellitus. The varied character of respiratory dysfunction worsens as the duration of diabetes rises. With poor glycemic control signified by increasing HbA1C, there are more obstructive and mixed changes, which show uncontrolled diabetic patients, are at risk. Body mass index also influence the pulmonary function. Spirometry is a cost-effective, non-invasive diagnostic technique that, when used correctly, can provide a warning signal to patients, allowing them to adopt early preventive actions. Spirometry should be used as one of the screening tests for diabetes individuals who have been diagnosed with the disease for a long time in order to prevent morbidity from respiratory issues and to allow for early identification and treatment.

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