

Ventilatory functions in Diabetes Mellitus – an Assessment Made by Spirometry and Six Minute Walk Test

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ABSTRACT

Introduction: Clear decrements in lung function have been reported in patients with diabetes over the past two decades. Ventilatory function testing non-invasively quantifies physiological reserve in a large microvascular bed, and unlike myocardial and skeletal muscle function, pulmonary indices can be measured despite limitations in physical fitness and can, therefore, provide a useful measure of progression of diabetic microangiopathy. In this study we compared pulmonary functions in type 2 diabetes mellitus and controls and also assessed any correlation of pulmonary dysfunction with duration of diabetes, glycemic control, presence of chronic complications.

Material and Methods: 60 known type 2 diabetes mellitus patients between 18-65 years of age were included in the study. 60 demographically matched non diabetic healthy volunteers were taken as control. The patients were then subjected to pulmonary function tests and 6 minute walk test.

Results: In 6 min walk test mean distance covered in study group was 327 m as compared to 349 m in control group and the difference was significant ($p=0.001$). 40 patients (66.6%) of diabetes group had a decrease ventilatory function while all the controls ($n=60$) had normal ventilatory function. All 40 subjects were having a restrictive ventilatory defect. 30(75.0%) of the study subjects with decreased ventilatory function ($n=40$) were found to have microvascular complications and the association was significant ($p=0.028$).

Conclusion: The present study established an association between decreased pulmonary functions and diabetes both for spirometry and 6-min walk test. Further studies on a larger sample size with a variable profile of diabetic subjects are recommended.

Keywords: Type 2 diabetes mellitus, ventilator function, 6 minute walk distance

INTRODUCTION

The prevalence of diabetes for all age groups worldwide was 2.8% in 2000 and is estimated to reach 4.4% by 2030. The major morbidities in type 2 diabetes mellitus (T2DM) are due to its microangiopathic and macroangiopathic complications, which affect eyes, kidneys, nerves, heart, and major vessels.

Clear decrements in lung function have been reported in patients with diabetes over the past two decades, and many reports have suggested plausible pathophysiological mechanisms.¹ Ventilatory function testing non-invasively quantifies physiological reserve in a large microvascular bed, and unlike myocardial and skeletal muscle function, pulmonary indices can be measured despite limitations in physical fitness and can, therefore, provide a useful measure of progression of diabetic microangiopathy.² Histopathological changes in the lungs of subjects with diabetes, such as basal lamina thickening and fibrosis, support the effects of diabetes on lung function. Theoretically, several pathological changes may affect the lungs in patients with T2DM. Collagen and elastin changes, which may

occur due to small vessel involvement, can lead to significant structural changes. Ljubic et al. showed that diabetes could lead to the development of pulmonary complications due to collagen and elastin changes, as well as microangiopathy.³ 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 T2DM patients.⁴ These studies suggested a relationship between pulmonary complications and other chronic complications in diabetes. Since the prevalence of diabetes in Asian Indians is among the highest in the world, it would be important to study pulmonary functions in this subgroup.

In this study we compared pulmonary functions in type 2 diabetes mellitus and controls and also assessed any correlation of pulmonary dysfunction with duration of diabetes, glycemic control, presence of chronic complications.

MATERIAL AND METHODS

It was a cross sectional case control study. Informed Consent was taken from each prospective participant by way of a consent form. Approval was attained from the institutional Ethical Committee.

60 known type 2 diabetes mellitus patients between 18-65 years of age attending medicine OPD of Era's Lucknow Medical College were included in the study. Sixty (60) demographically matched non diabetic healthy volunteers were taken as control. Subjects with current smoking habit or a smoking history, fluid overload due to any cause, having any acute or chronic respiratory disease [by clinical assessment, chest x-ray, any other test], Pregnant women, BMI >30 kg/m², Chest deformity, Hb <10 gm%, unable to perform pulmonary function tests due to any disability were excluded from the study. A detailed history and clinical examination including anthropometric measurements was taken. Routine blood investigations and liver and renal function tests were also performed. The oral glucose tolerance test (OGTT) was obtained for the control group only to exclude diabetes in addition to impaired fasting glycaemia (IFG) and impaired glucose tolerance (IGT). Only control subjects with a normal fasting blood glucose of <100 mg/dl and 2 hour post oral glucose of <140mg/dL were recruited into

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| S. No. | Agegroup (years) | Control Group (n=60) | | Study Group (n=60) | | P value |
|--------|--------------------------|----------------------|------|--------------------|------|---------|
| | | No. | % | No. | % | |
| 1 | 31-40 | 8 | 13.3 | 12 | 20.0 | .896 |
| | 41-50 | 28 | 46.7 | 28 | 46.7 | |
| | 51-60 | 22 | 36.7 | 18 | 30.0 | |
| | >60 years | 2 | 3.3 | 2 | 3.3 | |
| 2 | Gender | | | | | .796 |
| | Female | 30 | 50.0 | 32 | 53.3 | |
| | Male | 30 | 50.0 | 28 | 46.7 | |
| 3 | BMI (kg/m ²) | | | | | .257 |
| | Underweight (<18) | 0 | 0.0 | 2 | 3.3 | |
| | Normal (18-25) | 36 | 60.0 | 44 | 73.3 | |
| | Overweight (>25) | 24 | 40.0 | 14 | 23.3 | |

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

| Parameters | Controls (N=60) Mean±SD | Study Group (N=60) Mean±SD | P value |
|---------------|----------------------------|-------------------------------|---------|
| FEV1 (litres) | 1.99±.62 | 1.69±.54 | .02 |
| FVC (litres) | 2.34±.74 | 2.03±.90 | .03 |
| FEV1/FVC% | 84.94±4.88 | 84.04±4.17 | .86 |
| PEFR (L/sec) | 6.01±1.62 | 5.56±1.82 | .01 |

Table-2: Comparison of ventilator indices in the study and the control group.

the study. The tests were performed by kits made by Accurex Biomedics Pvt. Ltd., Mumbai. The patients were then subjected to pulmonary function tests. Peak expiratory flow rate (PEFR), forced expiratory volume in one second (FEV₁), forced vital capacity (FVC), and the ratio of the forced expiratory volume in 1 second to the forced vital capacity in percentage (FEV₁/FVC%) were measured using the MEDIKRO SPIROSTAR (M9479) FINLAND MACHINE which utilises a turbine sensor and is, therefore, not affected by temperature, pressure, or gas density and does not require calibration.⁵ The six-minute walk test was performed as per the guidelines of the American Thoracic Society (2002).⁶ Parameters measured were six minute walk distance, pre test oxygen saturation and post test oxygen saturation. Pulmonary functions were assessed by 6 minute walk test and spirometry.

STATISTICAL ANALYSIS

The statistical analysis was done using SPSS (Statistical Package for Social Sciences) Version 15.0 statistical Analysis Software. The values were represented in Number (%) and Mean±SD. Chi square test and student T test were used. P value less than .05 was considered significant.

RESULTS

A total of 120 subjects, 60 diabetic and 60 normal healthy controls were analysed. Both the groups were Age, Sex and BMI matched (Table 1). In 6 min walk test mean distance covered in study group was 327 m as compared to 349 m in control group and the difference was significant (p=0.001). Mean pre-test oxygen saturation was higher in study group as compared to control group, but the difference between two groups was not significant statistically (p=0.077). However, mean post-test oxygen saturation in two groups, 96.6% (study group) vs 98.4% (controls) showed a statistically significant difference (p<0.01). A significant inverse association was seen between six minute

walk distance and microvascular complications in the study group. An inverse trend was seen with six minute walk distance and duration of diabetes which was statically insignificant. There was no significant association between six minute walk distance and Hb1Ac levels. Association between pre and post test saturation and duration of diabetes, microvascular complications and Hb1Ac were nonsignificant in the study group. However an insignificant inverse correlation was also seen with post test oxygen saturation and age.

40 patients (66.6%) of diabetes group had a decrease ventilatory function while all the controls (n=60) had normal ventilatory function. All the 40 subjects were having a restrictive ventilatory defect. FEV1, FVC and PEFR were significantly lower in the study group (p=.02,.03 and .01 respectively).FEV1/FVC% was not significantly different in the two groups (Table 2). 30(75.0%) of the study subjects with decreased ventilatory function(n=40) were found to have microvascular complications and the association was significant(p=.028).A inverse association of decrease ventilator function was found with duration of diabetes and Hb1Ac levels in study subjects but it was not statistically significant. There was no significant association of decreased ventilator function with age and BMI .

DISCUSSION

Diabetes mellitus is primarily a disease in middle and older persons in India. Mohan et al. assessed the risk of diabetes to be around 7 times higher in patients aged above 30 years.⁷ In our study majority of patients were above 40 years of age (80%). Almost all the epidemiological studies have shown a male preponderance among the Indian diabetics inspite of increased rates of obesity in women.⁸ Although a shift in genderwise incidence could be predicted in the last decade owing mainly to lifestyle changes with urbanization and development yet the slightly higher incidence in women (53.3%) in present study could be attributed to a chance occurrence only. Many of subjects had normal BMI. Only one-quarter of subjects were in overweight category. Though type 2 diabetes is associated with obesity yet the difference from the present study could be attributed to the selection criteria of the present study where subjects in high BMI (>30 kg/m²) were excluded from the assessment.

The findings of six minute walk test and pre and post test oxygen saturation were comparable to those observed by Ozdirenc et al. who evaluated the exercise capacity of diabetic subjects as compared to healthy control and found that VO_{2max} was

significantly lower in diabetic subjects as compared to control groups.⁹ The poor exercise capacity of patients with diabetes based on the 6-min walk test might be because of the link between diabetes and adverse cardiac effects.¹⁰ Adeniyi et al had found a significant association between the six-minute walk test outcome and fasting blood glucose, age, waist circumference, waist hip ratio and body mass index but in the present study there was no such association.¹¹ One of the limiting factors for this discrepancy might be the selection criteria. In present study we had excluded the obese patients. Most of the studies have reported the difference in outcome of 6-minute walk test to adiposity and deposition of fat among diabetic patients hence exclusion of obese subjects from the study ruled out the possible to explore the relationship vividly and clearly.^{11,12} As compared to control group the PFT ventilatory functions were significantly reduced in the diabetic subjects. Ventilatory dysfunction in diabetes subjects was predominantly restrictive as shown by the preserved ratio of FEV1/FVC% and the number of diabetes subjects with restrictive defect compared with controls. The findings in present study confirm the findings in large population studies in Australia, Denmark, and the United States, including those in which the measured values were compared with predicted values.¹³⁻¹⁵ In a study by Dennis et al. among subjects with type 2 diabetes, it was observed that subjects with inadequate diabetic control had lower FVC and FEV1 than predicted and than those of subjects with adequate control.¹⁶ In present study we observed an association between microvascular complications and pulmonary functions. These findings were similar to the findings of Sinha et al. who observed a significant reduction in pulmonary functions among patients with microangiopathy.¹⁷ Much of the variables assessed in present study did not show a significant association with pulmonary function, thereby establishing the fact that diabetes itself emerged as an independent risk factor for pulmonary function deterioration. Yang et al., Lauruschkat et al and Lecube et al. established it as an independent risk factor amongst morbidly obese women.¹⁸⁻²⁰

CONCLUSION

The present study established an association between decreased pulmonary functions and diabetes both for spirometry and 6-min walk test. However, no other association with various demographic, clinical and biochemical variables affecting diabetes could be seen with pulmonary functions except for microvascular complications which were seen to be significantly associated with decreased ventilatory function on spirometry. The utility of 6-min walk test as a cost-effective alternative for pulmonary function tests to measure the performance of diabetics was also established. Further studies on a larger sample size with a variable profile of diabetic subjects are recommended.

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