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Research Article

SPIROMETRY EVALUATION OF PULMONARY FUNCTIONS IN TYPE 2 DIABETES MELLITUS PATIENTS: A CROSS-SECTIONAL STUDY

GIRIJA SHANKAR UDGATA[1]*, BHANJAN MEHER[2], SARITA BEHERA[3], HOTA S[4], ANANYA UDGATA[5], ANWESHA UDGATA[6], ANKANPATEL[7], KOMARI VENKAT KRANTHI KRISHNA[8]

[1]Department of Pulmonary Medicine, BBMCH, Balangir, Odisha, India. [2]Department of Surgery, BBMCH, Balangir, Odisha, India. [3]Department of Medicine, BBMCH, Balangir, Odisha, India. [4]Department of Ophthalmology, BBMCH, Balangir, Odisha, India. [5]Department of Pharmacology, BBMCH, Balangir, Odisha, India. [6]Department of Medicine, Veer Surendra Sai Institute of Medical Sciences and Research, Burla, Odisha, India. [7]Department of Medicine, Kalinga Institute of Medical Sciences, Bhubaneswar, Odisha, India. [8]Department of Pulmonary Medicine, Veer Surendra Sai Institute of Medical Sciences and Research , Burla, Odisha.
***Corresponding author: Girija Shankar Udgata; Email: girijaudgata777@gmail.com**

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ABSTRACT

Objective: Type 2 diabetes mellitus (T2DM) during the chronic stage elicits significant micro and macrovascular complication and imposes mortality and morbidity among the individuals. However, the effect of T2DM on the lung as a target end organ damage was not widely studied. Hence, the present study was done for the spirometry analysis of pulmonary functions in T2DM patients.

Methods: This was a cross-sectional study conducted on 50 T2DM patients and they were subjected to spirometry evaluation. The restrictive pattern of lung functions was analyzed by evaluating the following parameters forced vital capacity (FVC) in liters, forced expiratory volume in 1 second (FEV1), and FEV1/FVC were evaluated. The association between lung function parameters and duration of diabetes, glycated hemoglobin (HbA1c) were also analyzed.

Results: In this study among the diabetic patients, the mean FVC was 2.45±0.36 L, the mean FEVI was 1.82±0.12 (L/s) and the mean FEV1/FVC was 87.42±7.54, respectively. Regarding lung complication, out of 50 diabetic patients, 25 (50%) had normal lung functions, 16 (32%) had mild restriction and 9 (18%) had moderate restriction. The FVC, FEVI, and FEV1/FVC were significantly reduced in diabetic patients with moderate lung restriction as compared to normal and mild restriction patterns. Diabetes duration displayed no significant association with a decline in pulmonary function and FEV1/FVC showed weak significant negative correlation (r=−0.412; p=0.02) with HbA1c levels.

Conclusion: The study shows that in diabetics patients there was a marked decline in pulmonary function and it might be due to uncontrolled diabetes-related complications.

Keywords: Type 2 diabetes mellitus, Pulmonary functions, Spirometry, Forced vital capacity, Glycated hemoglobin.

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INTRODUCTION

Type 2 diabetes mellitus (T2DM) is a global health issue and imposes a significant economic burden in developing countries like India [1]. Globally in 2021, around 537 million adults aged between 20 and 79 years are living with diabetes, and in India, around 74.2 million are affected with T2DM and India ranks 2nd position among the global diabetes population [2]. Further, it has been estimated that the number to be increased by 124.9 million in the next 25 years [3].

In uncontrolled T2DM, it leads to diabetic complications like microvascular complications such as peripheral neuropathy, diabetic kidney disease, retinopathy, and macrovascular complications such as coronary artery disease and stroke. The progression or onset of microvascular complications appears within 5–10 years and microvascular complications appear 15–20 years after the initiation of diabetes [4].

A wide range of studies have shown that there is a substantial lung fibrotic changes and pulmonary microcirculation pathologies in T2DM patients [5,6]. In addition, various studies evaluated abnormal respiratory functions in the diabetic population [7,8]. The lungs of T2DM show marked histopathological changes with characteristic thickening of alveolar epithelial cells and capillary basal lamina of pulmonary tissue leading to decreased pulmonary elastic recoil and lung volume. In addition, a decrease in pulmonary capillary volume and basement membrane thickening causes impairment in lung diffusion. Further, glycosylation of lung connective tissue also leads to pulmonary damage in T2DM patients [9]. Earlier reports showed that there is a marked decrease in forced expiratory volume (FEV1) and forced vital capacity (FVC) in T2DM patients [10]. Hence, we have evaluated the pulmonary function tests in T2DM patients and its association with disease duration and glycated hemoglobin (HbA1c) levels.

METHODS

This was a cross-sectional study conducted among the 50 diabetic patients attending the Department of Pulmonary Medicine, Bhima Bhoi Medical College and Hospital, Balangir, Odisha. The study was carried out for 1 month, from April 2022 to April 2023.

Inclusion criteria

T2DM patients of both sexes aged between persons in age 40–80 years were included in the study. The patient who gave informed consent was included in the study.

Exclusion criteria

T2DM patients with COPD, bronchial asthma, pulmonary tuberculosis, and current smokers were not included in the study.

Study procedure

The anthropometric parameters were recorded, and fasting and post-prandial blood sugar levels were estimated using the standard autoanalyzer. High-performance liquid chromatography method was used for the estimation of HbA1c.

The pulmonary function test among the T2DM patients was measured using Winspiro PRO MIR as per the guidelines recommended by the American Thoracic Society/European Respiratory Society [11]. The diabetic patients underwent the maneuver 3 times at the duration of 15 min, and the best of three values were considered for analysis. The following variables were evaluated for the assessment of pulmonary functions FVC in liters, forced expiratory volume in 1 second (FEV1), FEV1/FVC were evaluated, respectively.

Data analysis

The data were represented as mean±SD for categorical variables. Based on the spirometry evaluation, the diabetic patients were categorized as normal, moderate, and mild restriction of lung functions. Using one-way ANOVA followed by Tukey's multiple comparison, the blood glucose levels, HbA1c levels and FVC, FEV1, and FEV1/FVC were compared among the diabetic patients. Pearson correlation was done to evaluate the association between the lung function parameters and the duration of diabetes. P<0.05 denotes statistically significant.

RESULTS

The demographics, clinical characteristics, and biochemical values among the diabetic patients were as follows, the mean age of the diabetic patients was 58.13±9.28 years and a majority of them were males, 32 (64%). The mean duration of diabetes was 6.12±1.76 years and a majority of the patients had a duration between 4 and 6 years 28 (56%), followed by 7–10 years 12 (24%) and 1–3 years 10 (20%), respectively. The mean HbA1c level was 8.12±2.29% and out of 50 patients, 35 (70%) had HbA1c levels >7% and 15 (30%) had <7%.

The mean FVC was 2.45±0.36 L, the mean FEVI was 1.82±0.12 (L/s) and the mean FEV1/FVC was 87.42±7.54, respectively. Regarding lung complication, out of 50 diabetic patients, 25 (50%) had normal lung functions, 16 (32%) had mild restriction and 9 (18%) had moderate restriction. The data are shown in Table 1.

The comparison of fasting and post-prandial blood glucose and HbA1c levels among the normal, mild-to-moderate lung functions are shown in Table 2. In the present study fasting blood glucose levels were significantly (p=0.00) higher in patients with moderate restriction as compared to patients with normal functions (185.26±54.12 vs. 122.12±18.54) and mild restrictions (185.26±54.12 vs. 174.12±12.65). Likewise, the post-prandial blood glucose level was significantly (p=0.00) higher in patients with moderate restriction as compared to patients with normal functions (279.12±72.32 vs. 182.05 ± 45.76) and mild restrictions (279.12±72.32 vs. 268.42±42.76). Further, the HbA1c levels were significantly (p=0.01) higher in patients with moderate restriction as compared to patients with normal functions (8.12±0.27 vs. 6.72 ± 0.18) and mild restrictions (8.12±0.27 vs. 7.45±0.23).

The FVC was significantly (p=0.003) reduced in patients with moderate restriction as compared to patients with normal functions (1.28±0.12 vs. 2.45±0.32) and mild restrictions (1.28±0.12 vs. 2.01±0.25). The FEV1 was significantly (p=0.005) reduced in patients with moderate restriction as compared to patients with normal functions (1.32±0.17 vs. 2.12±0.28) and mild restrictions (1.32±0.17 vs. 1.75±0.15). In addition, FEV1/FVC ratio was significantly (p=0.002) reduced in patients with moderate restriction as compared to patients with normal functions (76.12±15.42 vs. 89.42±12.32) and mild restrictions (76.12±15.42 vs. 82.24±9.87). The results are shown in Table 3.

There was no significant correlation between the duration of diabetes and PFT parameters. FVC showed a weak negative correlation for the duration and it was not significant (p=0.14). Meanwhile, FEV1 showed a weak positive correlation and FEV1/FVC showed a weak positive correlation for the duration of diabetes and also not significant (p=0.23; p=0.56). The results are shown in Table 4.

The FVC and FEV1 displayed a weak negative correlation with HbA1c and it was not significant (p=0.28, p=0.36). Meanwhile, FEV1/FVC showed a weak negative correlation with (r=-0.412; p=0.02) and it was found to be significant. The results are shown in Table 5.

DISCUSSION

The main objective of the study was to evaluate the effect of T2DM on pulmonary functions. The diabetic patients showed compromised pulmonary functions such as shortness of breath, dyspnea, wheezing, and easy fatigability. Diabetes is also an important risk factor for the development of coronary heart disease along with compromised

Table 1: Spirometry evaluation of lung functions in diabetic patients

Pulmonary functions	No of patients (%)
Mild restriction	14 (32)
Mod restriction	9 (18)
Normal	25 (50)

Table 2: Comparison of blood glucose and HbA1c levels among the diabetic patients with pulmonary restriction

Parameter	Pulmonary functions	Mean	p-value
FBG (mg/dl)	Normal	122.12±18.54	0.00*
	Mod restriction	185.26±54.12	
	Mild restriction	174.12±12.65	
PPBG (mg/dl)	Normal	182.05±45.76	0.00*
	Mod restriction	279.12±72.32	
	Mild restriction	268.42±42.76	
HbA1C (%)	Normal	6.72±0.18	0.01
	Mod restriction	8.12±0.27	
	Mild restriction	7.45±0.23	

One way ANOVA, * denotes p value<0.05 (Significant)

Table 3: Comparison of spirometry parameters in diabetes patients with pulmonary restrictions

Parameter	Pulmonary functions	Mean	p-value
FVC (L)	Normal	2.45±0.32	0.003*
	Mod restriction	1.28±0.12	
	Mild restriction	2.01±0.25	
FEV1 (one second)	Normal	2.12±0.28	0.005*
	Mod restriction	1.32±0.17	
	Mild restriction	1.75±0.15	
FEV1/FVC	Normal	89.42±12.32	0.002*
	Mod restriction	76.12±15.42	
	Mild restriction	82.24±9.87	

One-way ANOVA, *denotes p value<0.05 (Significant)

Table 4: Correlation of pulmonary function test parameters with duration of diabetes

Parameters	Pearson's correlation	p-value
FVC	−0.210	0.14^{NS}
FEV1	0.176	0.23^{NS}
FEV1/FVC	0.124	0.56^{NS}

NS: Non-significant, p>0.05

Table 5: Correlation of pulmonary function test parameters with glycated hemoglobin

Parameters	Pearson's correlation	p-value
FVC	−0.141	0.28^{NS}
FEV1	−0.129	0.36^{NS}
FEV1/FVC	−0.412	0.02*

NS: Non-significant, p>0.05; *denotes significant p<0.05

pulmonary functions. Spirometry is a valid tool for the detection of abnormalities in patients with pulmonary complications. It evaluates the lung volumes and flows and detects the obstruction and restriction pattern on lung functions [12].

The etiology of reduced pulmonary functions in diabetic patients is not well studied, but the histopathological analysis reveals the thickening of basal lamina and fibrosis in chronic hyperglycemia patients [13]. In addition, biochemical changes in the lung connective tissue (collagen and elastin) and also microangiopathy as a result of protein glycation during diabetes showed significant association with pulmonary abnormalities [14]. Further chronic hyperglycemia also reduced elastic recoiling of lungs, lung volume, and pulmonary capacity for carbon monoxide diffusion [14].

In the current report, the mean duration of diabetes among the study participants is 6.12±1.76 years. Similar to our report in a study by Kumari *et al*. [15], the mean duration of diabetes was 6.15±3.56 years. We have observed that majority of the patients had a duration between 4 and 6 years 28 (56%), followed by 7–10 years, 12 (24%), and 1–3 years 10 (20%), respectively. Likewise, in Roselin *et al*. [16], the duration of diabetes was <5 years in 24 cases, 6 to 10 years in 37 patients and 10 years or higher in 45 patients.

The mean HbA1c level among the diabetic patients in the present study was found to be 8.12±2.29%. In Kumari *et al*.'s study [15], the mean HbA1c was 9.75±2.62. Further in their study, 10 (22.22%) of cases had HbA1c level ≤7, whereas 77.78% of cases had uncontrolled diabetes with HbA1c >7, which is in line with the present study.

Regarding spirometry parameters, the mean FVC was 2.45±0.36 L, the mean FEVI was 1.82±0.12 (L/s), and the mean FEV1/FVC was 87.42±7.54. In Irfan *et al*.'s study [4], the mean FVC was 2.46±0.83, FEV1 was 2.04±0.75, and FEV1/FVC was 81.94±8.26. In Mittal *et al*.' study [17], the mean FVC was 2.47±0.65, FEV1 was 1.91±0.49, and FEV1/FVC was 81.70±3.17. Davis *et al*. [18] reported a significant decrease in FVC and FEV1 in T2DM patients and they also reported that decreased lung volumes and airflow obstruction as a result of chronic diabetic complications.

In our patients, 25 (50%) had normal lung functions, 16 (32%) had mild restriction, and 9 (18%) had moderate restriction. In a study by Nemagouda *et al*. [19], 60% of the patients had mild restriction and 28.9% of the patients had moderate restriction and 13.46% of the patients had normal lung functions.

In the present study, fasting and post-prandial blood glucose levels were significantly (p=0.00) higher in patients with moderate restriction than patients with normal functions. Likewise, HbA1c levels were significantly (p=0.01) higher in patients with moderate restriction as compared to patients with normal functions (8.12±0.27 vs. 6.72 ± 0.18) and mild restrictions (8.12±0.27 vs. 7.45±0.23). Similarly, in a study by Lee *et al*. [20], the HbA1c level was higher in restrictive pulmonary functions as compared to normal and obstructive pulmonary functions (6.14±0.09 vs. 5.71±0.02 vs. 5.93±0.06).

There was no significant correlation between the duration of diabetes and PFT parameters, FVC (p=0.14), FEV1 (p=0.23), and FEV1/FVC (p=0.56) in our study. In a study by Shah *et al*. [21], on correlating the FVC (r=8.80; p=0.99) and FEV1 (r=0.007; p=0.55) showed no significant correlation with diabetes duration.

We observed that FVC and FEV1 displayed a weak negative correlation with HbA1c and it was not significant (p=0.28, p=0.36). Meanwhile, FEV1/FVC showed a weak negative correlation with (r=−0.412; p=0.02). In Mishra *et al*.'s study [22], there was a significant negative correlation with HbA1c among the diabetic patients for FEV1(r=−0.421, p<0.001) and FVC (r= 0.471, p<0.001) and thus, poor glycemic control showed marked association with decline in lung functions.

CONCLUSION

The lung is also a target organ for diabetic-related complications. Diabetes patients with moderate restriction showed reduced FVC, FEV1, and FEV1/FVC values compared to diabetic patients with normal lung functions. Increased HbA1c levels showed a significant association with the progression of pulmonary complications.

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CONFLICT OF INTEREST

Nil.

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