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Original Research Article

Pulmonary function test in patients of type 2 diabetes mellitus

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ABSTRACT

Background: We are today witnessing a pandemic of diabetes mellitus (DM), globally and nationally. DM and its complications have become the most important contemporary and challenging health problems. Diabetes is not associated with any specific pulmonary symptom and hence periodic screening for lung disease is not done in diabetic patients. However, an extensive microvascular circulation and an abundant connective tissue in the lung raise the possibility that the lung may also be a target organ in diabetic patients. The aim and objectives were to study the pulmonary function of individual with type 2 diabetes mellitus patients by performing spirometry.
Methods: Study included non-smoker diabetic patients, who had no history of respiratory disease, were selected for this study and undergone pulmonary function test by spirometry. The study was conducted at department of General Medicine Shri Ram Murti Smarak Institute of Medical Sciences, Bareilly, Uttar Pradesh, India.
Results: Present study, author found that there was significant derangement in the spirometric readings in the diabetic patients. The FEV1/FVC values further declines as the duration of diabetes increased.
Conclusions: Spirometric values (FVC, FEV1, FEV1/FVC) were consistently lower in subjects with type 2 diabetes mellitus. The effect on FVC predicted % was found to be more pronounced in subjects whose duration of DM was more than 5 years.

Keywords: Diabetes mellitus, FEV1, FVC, FEV1/FVC, Spirometry

INTRODUCTION

We are today witnessing a pandemic of diabetes mellitus (DM), globally and nationally. DM and its complications have become the most important contemporary and challenging health problems. There are 347 millions diabetics worldwide.[1] In India more than 67 millions have been affected. India has become the diabetic capital of world. WHO projects that diabetes will be the 7th leading cause of death in 2030.[1]

Diabetes mellitus is a major, rapidly growing public health care problem. It is increasing in incidence, and brings with it long term complications.[2] Diabetes mellitus is an incurable life-long disease, involving multiple systems, and with devastating complications which end up in severe disability and death.[3] Diabetes mellitus complications are mainly the consequences of macro-vascular and micro-vascular damage.[4] Chronic hyperglycemia of diabetes mellitus is associated with continuing damage, dysfunction, and failure of various organs, especially the eyes, kidneys, nerves, heart, and blood vessels.

Diabetes is not associated with any specific pulmonary symptom and hence periodic screening for lung disease is

not done in diabetic patients. However, an extensive microvascular circulation and an abundant connective tissue in the lung raise the possibility that the lung may also be a target organ in diabetic patients.[5,6] However, because of its large reserve, substantial loss of the microvascular bed can be tolerated without developing dyspnea. As a result, pulmonary diabetic micro-angiopathy may be under-recognized clinically.[5,7]

Theoretically, several pathological changes may affect the lungs in patient with DM. The patho-physiology for reduced lung functions in diabetics is still not very clear but there have been some reports of histopathological changes in the lungs of diabetic patients, including fibrosis.[8] Impairment in lung function of patients with diabetes are believed to be the consequence of biochemical alterations in the connective tissue constituents of the lung, particularly collagen and elastin, as well as microangiopathy due to the non-enzymatic glycosylation of proteins induced by chronic hyperglycemia.[9-12] The functional abnormalities ensuing from these changes manifest clinically by way of a reduction in elastic recoil of the lung, lung volumes, and pulmonary capacity for the diffusion of carbon monoxide.[12] The concomitant pulmonary structural impact of these biochemical alterations, consist of a thickening of the alveolar epithelial basal lamina and a specific type of nodular fibrosis of the lung.[13] Autonomic and phrenic neuropathy causing alterations in bronchial reactivity and respiratory muscle function was also suggested in one study.[14]

Several changes occur in DM, including

- Non-enzymatic glycosylation of connective tissue, especially collagen, which might be responsible for end organ damage causing diabetic nephropathy, diabetic neuropathy, diabetic retinopathy and lung changes
- Diabetic myopathy
- Micro-vascular angiopathy

These Could lead to development of pulmonary complications by Loss of elasticity.[12]

- Altered perfusion characteristics
- Weakness of the respiratory muscles responsible for ventilation

Ventilation may be affected by myopathy and altered elastic recoil of lung tissue. Perfusion may be affected by changes in basement membrane and micro-vascular angiopathy.

Normal lung function has three components, which contribute to gas exchange.

- Ventilation: Movements of gas in and out of lung
- Perfusion: The perfusion of venous blood from right ventricle to capillaries of ventilated alveoli
- Diffusion: The diffusion of gases across the alveolar capillary membrane

Spirometry is a basic, widely used pulmonary function test (PFT). It typically assess the lung volumes and flow, and is ideally suited to describing the effects of obstruction or restriction on lung function.[15] It is now regarded as an integral component of any respiratory medical surveillance program.

PFT has assumed a key role in epidemiological studies investigating the incidence, natural history and causality of lung disease.[16] Spirometry is essential for diagnosing respiratory illnesses, assessing their severity, determining response to treatment and tracking patients progress over time.[17] The utility of spirometry was further recognized when its applications were highlighted in diabetic patients.[18]

Pulmonary damage at an early stage in most patients with diabetes mellitus is subclinical, and rarely present with complaints.[19] Spirometry non-invasively quantifies the physiological reserves in a large micro-vascular bed that is not clinically affected by diabetes. Lung functions may provide useful measures of the progression of systemic microangiopathy in diabetic patients.[19]

Pulmonary dysfunction may be one of the earliest measurable non-metabolic alteration in diabetes.[20,2]1 Despite the unclear nature, the relationship between DM and pulmonary function tests (PFTs) remains important because of potential epidemiological and clinical implications. The loss of pulmonary reserve may become clinically important.

The aim and objectives were to study the pulmonary function of individual with Type 2 diabetes mellitus patients by performing spirometry.

METHODS

This was a cross sectional prospective study.

Cases included non-smoker diabetic patients, who had no history of respiratory disease, were selected for this study and undergone pulmonary function test by spirometry.

The present study was conducted at department of General Medicine, Shri Ram Murti Smarak Institute of Medical Sciences Bareilly, Uttar Pradesh, India. Patients who attend medical OPD and IPD were included in the study.

Inclusion criteria

- Patients with type 2 Diabetes mellitus of at least 6 months duration, and who were able to give informed consent,
- Diabetics who have never smoked, with no recent history of respiratory illness,

- Diabetics who do not have nasal itching, running nose, sore throat, pain suggestive of sinusitis, epistaxis, dry throat, hoarseness of voice, cough and dyspnoea.

Exclusion criteria

- Present or past history of smoking,
- Present or past history of respiratory illness that might affect lung function such as bronchiectasis, tuberculosis, asthma, interstitial lung diseases, COPD,
- History of occupational exposure to any substance that could affect lung function. Individuals with current or recent respiratory tract infection that predisposes to heightened airway reactivity,
- Individuals with unacceptable spirometry techniques. Unacceptable spirometry means any effort in which FEV1 or FVC could not be measured due to:
  - Cough
  - Submaximal effort
  - Obstructed teeth
  - Air escape
  - Effort sustained for less than 6 seconds duration
  - Failure to attain a volume time curve
  - Lack of understanding the procedure
  - Recent surgery
  - Diabetics who have cardiac and liver disease on history (history of jaundice) and clinical examination (icterus, ascites, hepatomegaly, spleenomegaly) basis.

The study protocol has been evaluated and approved by the department and institutional review committee. Informed consent was taken from all the patients.

Methodology

For spirometry spirovit schiller SP-1 pneumotech flow-sensor with SEMA PC software was used. Chest X-ray was done to exclude the presence of pre-existing pulmonary disease.

Data collection

Data was obtained by taking a detailed history of patients. Information on major co-morbidities, significant past history, and occupational history was taken. Patients were thoroughly examined including general and systemic examination. The following parameter were measured FEV1, FVC, and FEV1/FVC by using spirometer.

Statistical analysis

The results were analyzed using SPSS software. Values were expressed as a percentage of each group or as mean +/- SD unless otherwise stated. t Test was used to test the difference between two means. On the basis of p value, we defined the significance of above mentioned statistical variables. P value <0.05 was taken to be significant.

RESULTS

A total number of 100 cases were taken for analysis. There were 100 diabetic patients.

Table 1: Characteristics of diabetic patients.

Characteristics	Diabetic (n=100)			
	Male (n=50)		Female (n=50)	
	Mean+/-S.D.	Range	Mean+/-S.D.	Range
Age (years)	54.28+/-8.89	40-72	53.4+/-10.93	33-73
Weight (kg)	64.4+/-10.47	44-80	58.88+/-8.57	43-77
Height (cm)	164.28+/-6.85	140-177	152.12+/-7.62	140-168

The mean age of male subjects was 54.28 years (range 40-72 years) and the mean age of female subjects was 53.4 years (range 33-73 years) (Table 1). The mean weight of males was 64.4 kg (SD 10.47, range 44-80 kg), and the mean weight of females was 58.88 kg (SD 8.57, range 43-77 kg) (Table 1).The mean height of males was 164.28 cm (SD 6.85, range 140-177 cm), and the mean height of females was 152.12 cm (SD 7.628, range 140-168 cm (Table 1). The number of patients with diabetes duration more than 5 years were 66 and number of patients with diabetes duration less than or equal to 5 years were 34 (Table 2).

The number of patients with diabetes duration more than 5 years among males were 36 and number of patients with diabetes duration more than 5 years among females were 30, while number of patients with diabetes duration less than or equal to 5 years among males were 14 and number of patients with diabetes duration less than or equal to 5 years among females were 20 (Table 2). The spirometric values were found to be lower in diabetic individuals (Table 3).

The mean FVC value was 2.45 liter in male patients and while it was 1.74 liter in female diabetic patients.

Table 2: No. of patients according to the duration of diabetes.

Gender	Total no. of diabetic patients	No. of patients (Diabetes duration >5 years)	No. of patients (Diabetes duration </= 5 years)
Males	50	36	14
Females	50	30	20

Table 3: Analysis of spirometric findings.

Gender	Parameters	Diabetic
		Mean (SD)
Males	FVC (liter)	2.45 (0.71)
	FEV_1 (lt/sec)	1.82 (0.49)
	FEV_1/FVC)	74.28 (8.41)
Females	FVC (liter)	1.74 (0.48)
	FEV_1 (lt/sec)	1.40 (0.44)
	FEV_1/FV(%)	80.46 (13.87)

The mean FEV1 value was 1.82 lt/sec in male patients and while it was 1.40 lt/sec in female diabetic patients.

The mean FEV1/FVC value was 74.28 % in male patients and while it was 80.46 % in female diabetic patients.

Table 4: Spirometric values in male diabetic subjects according to diabetes duration.

Males	Diabetes duration >5 year (n = 36)	Diabetes duration </=5 years (n=14)	P value
Mean FVC (L)	2.36	2.70	0.014
Mean FEV_1 (lt/sec)	1.80	1.91	0.304
Mean FEV_1/FV(%)	73.15	75.27	0.290

The spirometric values were consiently lower in male diabetics with diabetes duration > 5years than in male diabetics with diabetes duration =/< 5years (Table 4).

In male diabetics with diabetes duration >5years the mean FVC, mean FEV1 and mean FEV1/FVC values were 2.36, 1.80, 73.15 respectively and in male diabetics with diabetes duration=/<5years these values were 2.70, 1.91, 75.27 respectively. (Table 4). The spirometric values were consistently lower in female diabetics with diabetes duration > 5years than in female diabetics with diabetes duration =/< 5years (Table 5).

In female diabetics with diabetes duration >5years the mean FVC, mean FEV1 and mean FEV1/FVC values were 1.65, 1.32, 79.98 respectively and in female diabetics with diabetes duration =/<5years, these values were 1.90, 1.53, 82.30 respectively (Table 5).

Table 5: Spirometric values in female diabetic subjects according to diabetes duration.

Females	Diabetes duration >5 yrs (n=30)	Diabetes duration </=5 years (n=20)	P value
Mean FVC (L)	1.65	1.90	0.011
Mean FEV_1 (lt/sec)	1.32	1.53	0.124
Mean FEV_1/FVC (%)	79.98	82.30	0.346

The spirometric values in predicted % were consistently lower in diabetics with diabetes duration >5 years than in diabetics with diabetes duration =/<5 years (Table 6).

Table 6: Spirometric values in predicted % of diabetics >5 years and </=5 years.

Parameters in predicted %	Diabetics>5 years (n=66)	Diabetics </= 5 years (n=34)	P value
FVC %	71.49	82.82	0.014
FEV_1%	81.31	81.60	0.480
FEV_1/FVC%	80.00	90.92	0.241

In diabetics patients with diabetes duration > 5years, the mean FVC predicted %, mean FEV1 predicted % and mean FEV1/FVC predicted % values were 71.49, 81.31, 80.00 respectively and in diabetics with diabetes duration =/< 5years these values were 82.82, 81.60, 90.92 respectively.

DISCUSSION

This study was undertaken to assess the ventilatory functions of type 2 diabetes mellitus patients.

In the present study, 100 diabetics were taken. The parameters (age, height and weight) being the major determinant of the spirometric values, were comparable in this study.

Spirometric values were found to be consistently lower in diabetics Our results confirm the results observed in other studies that showed decreased pulmonary functions in diabetics.

Davis WA et al, conducted a large community based study in Western Australia in type 2 diabetic patients and demonstrated that FVC, FEV1, and PEF were decreased in type 2 diabetic patients.[22] They also suggested that the reduced lung volumes and airflow limitation are likely to be chronic complications of type 2 diabetes.

Meo SA et al, in their study on Saudi diabetic patients showed significant reduction in FVC, FEV1 and PEF, as compared to their matched controls.[23] They also showed a

strong association with a dose-effect response of duration of disease and decreased pulmonary functions impairment in their diabetic patients. Lange P et al, and Boulbou MS et al, have reported that FVC and FEV1 are reduced in diabetic subjects, as compared to the control subjects.[24,25] Asanuma Y et al, also reported that FVC and FEV1 were reduced in Japanese diabetic subjects compared to control subjects.[26]

Similarly, Cazzato S et al, conducted a cross sectional study to assess pulmonary functions in children with insulin dependent diabetes mellitus (IDDM), and reported that FVC and FEV1 were significantly lower in diabetics than in controls.[27] Similarly, Makkar P et al, performed spirometry on patients with IDDM, and reported that the IDDM patients had reduced FVC, FEV1 as compared to their matched control.[28]

In present study, there was a tendency for all parameters to fall with longer duration of diabetes. However, statistical analysis showed that this was not significant except for FVC predicted %. Diabetics with more than 5 years duration, showed a more pronounced fall in FVC. This revealed that longer duration of diabetes was associated with more significant spirometry abnormalities. This was supported by many other studies.

Rosenecker J et al, demonstrated that in patients with diabetes, FVC and FEV1 declined significantly over the five year study period, whereas patients without diabetes did not show a significant decline during this period.[29]

In kanya kumari DH et al, study spirometric findings showed that as the duration of diabetes increased the restrictive profile was more prominent.[30] In a study by Davis WA et al, there was a decrease in mean FVC value as the duration of DM increased.[22]

CONCLUSION

Spirometric values (FVC, FEV1, FEV1/FVC) were consistently lower in subjects with type 2 diabetes mellitus. The effect on FVC predicted % was found to be more pronounced in subjects whose duration of DM was more than 5 years. Even though diabetic patients did not have any respiratory symptoms, they did have underlying subclinical restrictive pattern of lung functions. There is a need for further study in this area, extending the study to a larger group, with inclusion of diffusion studies in the protocol.

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Ethical approval: The study was approved by the Institutional Ethics Committee

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