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Original Research Article

Spirometry in Patients of Diabetes Mellitus

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Abstract

Objective: To study the prevalence of spirometric abnormalities and effects of age of onset, duration of disease, compliance and sex on spirometric parameters in diabetic patients.

Methods: The present study was a hospital based cross sectional study. Patients selected were those attending medical OPD or admitted in medical wards. 100 patients who were known case of DM with duration more than 5 years were selected.

Results: The mean FVC %, FEV1 % and FEV1 / FVC % was abnormal for age & sex insignificant percentage of cases. Study of spirometric values of patients with different age of onset and duration of disease did not revealed any decline in pulmonary function and their mean value of FVC%, FEV1% and FEV1 / FVC % were normal for age and sex. Also, there was no decline in pulmonary function in patients with relation of their sex. It was found that there was no decline in PFT in patients who were non‹compliant & was not having good glycemic control. No decline in PFT was observed in patients who were obese and had BMI > 25 kg/m^2

Conclusion: Routine screening for detection of PFT, which was found in few patients, could be because of ethnic factor or presence of early emphysematous change or due to diabetes incluced reduction in lung compliance and/ or reduced respiratory effort due to diabetes.

Keywords: Glycemic control, Pulmonary function test, Type-2 diabetes mellitus

Introduction

Diabetes mellitus is a metabolic disorder affecting almost all the system of the body. Persistent hyperglycemia resulting in formation of advanced glycosylated end products, the basic mechanism undertying the pathogenesis. Typically, as the duration of the disease increases, different complication become over one after the other although the pathogenesis starts many years before when thedisease in sub clinical.

Many studies have been done regarding various complications of diabetes mellitus like nephropathy, retinopathy,neuropathy, coronary artery disease, stroke and dermopathy but impairment of pulmonary function is relatively unexplored. [1-4]

Pulmonary complications of diabetes mellitus have been poorly characterized during recent years. The interaction between diabetes and the pulmonary system has been studied repeatedly. Despite some discrepancies diabetes in fact seems to influence the pulmonary and / or respiratory function. The reported alternations of pulmonary function, however, are still conflicting; reduce lung elasticity, with reduced total lung capacity, reduction of lung elastic recoil and diffusing capacity of the lung for CO with normal lung volumes, abnormalities of both air flow and DLCO, restricted inspiratory muscles performance and reduced inspiratory vital capacity. And finally, a reduction of DLCO and dynamic compliance with normal lung volumes. [2-5]

In most of the studies done till recent times, the common pulmonary function defects which has been found is due to loss of elastic recoil of lung tissue probably secondary to glycosytation of the interstitial connective tissue of the lungs. A reduction in diffusing capacity and in pulmonary capillary blood flow has been seen in somestudies.

Materials and Methods

The study was a hospital based cross sectional study. A total of 100 cases were taken. Detailed history of each patient regarding the age year of diagnosis, family history of diabetes, history of smoking and associated illness was taken. Measurement of height and weight weredone to calculate body mass index of all patients.

Fasting blood sugar levels, blood urea, serum creatinine, urine for albumin, urine routine and microscopic examination, ECG chest X ray P.A view and spirometry were done in earth patient to meet out the exclusion and inclusion for the study.

Inclusion Criteria:

All patients of diabetes mellitus of duration more than five years.

Exclusion Criteria:

The patient to be selected in the study should be:

1. Non-Smoker.
2. Should not have pulmonary tuberculosis or other infective lung diseases.
3. Patient should not have cardiovascular abnormalities like coronary artery disease, valvular heart disease etc.
4. Patient should not have any impairment of renal function.

Diagnostic Criteria for Diabetes Mellitus:

1. Symptoms of diabetes mellitus plus blood glucose 200mg/ dl.
2. Fasting plasma glucose ≥ 126 mg/dl.
3. Two hours plasma glucose ≥ 200 mg/dl during oral glucosetolerance test.

Test Technique:

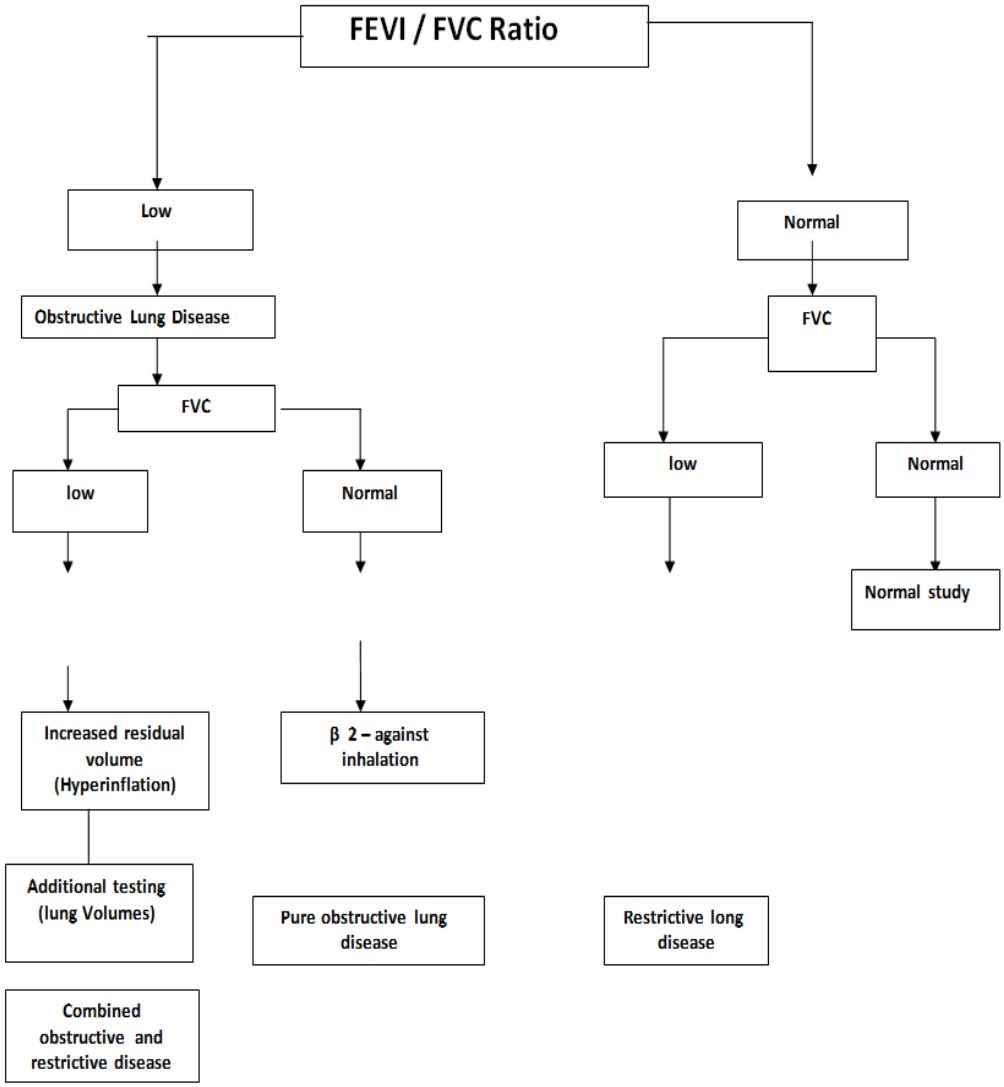
The patient breathes into the machine using a mouthpiece and a nose clip on the nose. The technician instruct the patient on how the breathing maneuver is to be carried out.The patient is asked to breathe normally a few times and then to take in a deep inspiration, as much as he can. Then, he is immediately instructed to blow out as hard and as fast as possible and keep breathing out till he can do so no more. Then, he is asked to breathe in again. The spirometer calculates the forced vital capacity and FEV1 describe earlier along with certain other measurements of how fast one is able to breatheour and displays the values along with the graphs. The FVC and FEVI values are the most important measurements. At least test of acceptable efforts are performed to ensure reproducing ofresults.

Classification of Severity of Lung Abnormality

Normally the FVC, FEV_1 and FEV_1/FVC is>80% of predicted

S. No.	Abnormality /severity	Percent variation of predicted
1.	Obstructive abnormality Mild Moderateservere	$FEV_1/FVC<75\%$ of predicated $FEV_1<80\%$ of predicted ≥60% and<80% of predicated ≥40% and <60% of predicted <40% of predicted
2.	Restrictive abnormality Mild Moderateservere	FVC< 80% of predicted ≥60% and<80% of predicated ≥40% and <60% of predicted <40% of predicted

Interpretation of Spirometry:



Observation Chart

Table 1: Correlation of Spirometry with Age of Onset

Age of onset	Mean FVC%	Mean FEV1%	Mean FEV1/FVC%
1-25	95.85	97.77	98.50
26-50	95.18	91.71	95.18
51-75	96.77	94.74	98.77

Table 2: Correlation of Spirometry with Duration of Diabetes Detection

Duration inyears	Mean FVC%	Mean FEVI%	Mean FEVI/FVC%
5-10	95.52	92.89	97.32
11-16	95.47	93.11	97.69

Table 3: Correlation of Duration of Diabetes Detectionwith Abnormal Spirometric Function

Duration inyears	FVC	FEV1	FEV1/FVC
5-10	3	5	2
11-16	2	1	1

Table 4: Correlation of Spirometry with Fasting BloodSugar Levels.

FBC level inmg%	Mean FVC%	Mean FEVI%	Mean FEVI/FVC%
90-120	94.69	92.42	97.67
121-150	96.07	93.25	98.58

Table 5: Correlation of Fasting Blood Sugar Levels inPatient with Spirometric Abnormalities.

FBS level inmg%	FVC	FEV1	FEV1/FVC
90-120	4	4	3
121-150	1	2	0

Table 6 Correlation of Spirometry with Compliance

Status	Mean FVC%	Mean FEVI%	Mean FEVI/FVC%
Compliant	95.46	91.9	96.35
Non-compliant	95.61	95.29	99.75

Table 7: Correlation of Spirometry & Body Mass Indexin Diabetic Patients

BMI	Mean FVC%	Mean FEVI%	Mean FEVI/FVC%
<18	95.61	93.52	97.79
18-25	95.80	92.55	96.79
>25	94.11	91.58	97.54

Table 8: Correlation of Body Mass Index in DiabeticPatients with Deranged Spirometric Abnormalities.

BMI	FVC	FEV1	FEV1/FVC
<18	4	2	1
18-25	1	4	1
>25	0	0	1

Results

Table 1 shows that the mean percentage of FVC, FEV1 and FEVI/FVC were 95.85,97.77 and 98.50 respectively of the predicted values for the age group 1-25.

Similarity the values were 95.18,91.71and 95.18 for age group 26-50 and 96.77, 94.74 and 98.77 for 51-75 years age group. These values are within normal limits of predicted ones.

Table 2 shows that the mean percentage of FVC, FEV1 and FEV1/FVC were 95.52, 92.89 and 97.32 respectively of the predicted values for disease duration 5-10 years. Similarly, the values were 95.47, 93.11 and 97.69 for duration 11-16 years. Table 3 shows that of patients with FVC < 80% of predicted 3 had disease duration in 5-10 years range and 2 had in 11-16 years range. For abnormal FEV1 5 were in 5-10 years range and one was in 11-16 years range. Those with abnormal FEV1/FVC 2 had disease duration in 5-10 years range and I had disease for more than ten years.

Table 4 shows that the mean percentages of FVC, FEV1 and FVC were 94.69,92.42 and 97.67 respectively of the predicted values for fasting blood sugar levels between 90-120 mg %. similarly, the values were 96.07, 93.25 and 98.58 for fasting blood sugar levels between 121-150 mg %.

Table 5 shows that in patients with FVC < 80% of predicted values, 4 were in FBS range less than 120 and I was in range 121-150. Out of six patients with abnormal FEV1 4 had FBS in < 120 and 2 had it in 121-150 mg % range all three patients with FEV1/FVC deranged werw having FBS levels< 120 mg %.

Table 6 shows that the mean percentage of FVC, FEVI and FEVI/FVC were 95.46,91.9 and 96.35 respectively of the predicted values for compliant patients. Similarly, the values were 95.61, 95.29and 99.75 for non-compliant patients.

Table7 shows that the mean percentage of FVC, FEVI and FEV1/FVC were 95.61, 93.52 and 97.79 respectively of the predicted values for BMI less than 18. Similarly, the values were 95.80, 92.55 and 96071 for BMI 18 to 25 & for BMI more than 25 the values were94.11, 91.58 and 97.54. Table 8 shows that in patients with deranged FVC BMI was < 18 in 4, 18-25 in I patient and none had BMI>25.In those with abnormal FEV1 2 had BMI <18 and had it in the range of 18-25. Out of three patients who showed abnormal FEV1 / FVC, one each had BMI<18, 18-25 and >25 respectively.

Statistical Analysis:

The collected data was summarized by using frequency, percentage, mean & S.D. To compare the qualitative outcome measures Chi-square test or Fisher's exact test was used. To compare the quantitative outcome measures independent t test was used. If data was not following normal distribution, Mann Whitney U test was used. SPSS version 22 software was used to analyse the collected data. p value of <0.05 was considered to be statistically significant.

Discussion

Spirometry is a widely used pulmonary function test (PFT), ideally suited to describing the effects of obstruction or restriction on lung function. It is a powerful diagnostic tool that plays a significant role in the early diagnosis of lung damage and its associated structures. It is also used to monitor the therapeutic efficacy of various treatment regimens and the course of the disease. The spirometric parameters have gained more popularity when it has been reported that impaired Forced Vital Capacity (FVC) and Forced Expiratory Volume in 1 s (FEV1) are emerging novel risk factors for type 2 diabetes mellitus. These spirometric parameter derangements have been evident on spirometry long before the clinical diagnosis of diabetes mellitus or insulin resistance.

The concept of the lung as a target organ for diabetic microangiopathy received continuing attention. Reports of lung function tests in patients with diabetes over the next 15 years have focused largely on pulmonary microangiopathy

with relatively few studies of pulmonary mechanical function. Lung function tests relating specifically to pulmonary microangiopathy include CO transfer capacity and pulmonary capillary blood volume. Clear decrements in lung function have been reported in patients with diabetes over the past 2 decades, and many reports have suggested plausible pathophysiological mechanisms. However, at the present time, there are no reports of functional limitations of activities of daily living ascribable to pulmonary disease in patients with diabetes.

Suresh V et al and Rossi S et al saw high prevalence of spirometric abnormalities in patients with type 1 diabetes mellitus. Both did a retrospective, cross sectional study. Respiratory complications are relevant in DM1, leading to a significantly increased morbidity and mortality risk in these patients; however, so far only few studies concerning respiratory function have been conducted in DM1 patients.51.9% patients showed a restrictive syndrome, and half of them had indication to non-invasive ventilation (NIV), yet only 50% resulted compliant to NIV. A high prevalence of restrictive syndrome in our DM1 cohort, mainly due to respiratory muscles weakness, was observed and documented; the severity of muscle impairment and the CTG expansion size confirmed to be independent predictors of respiratory restriction. [1,2]

Review by Goldman MD et al is directed toward lung dysfunction in diabetes, with an emphasis on the emerging potential clinical implications of such dysfunction. As their subjects were lifelong nonsmokers without allergies or lung disease, their finding that lung elastic recoil was decreased in these young patients with diabetes was interpreted to reflect effects of diabetes on lung elastic proteins. Because the elastic structure of the lung supports the intrathoracic airways and helps to maintain their patency, the authors suggested that patients with diabetes were at risk for developing chronic airflow obstruction. While small changes in lung elastic recoil do not have direct clinical implications, subsequent development of chronic airflow obstruction could incur significant disability due to mechanical dysfunction of the lungs and airways. [3]

Benbassat CA et al studied pulmonary function in patients with diabetes mellitus. He found abnormalities in lung volumes, pulmonary mechanics, and diffusing capacity. They studied pulmonary function in a group of patients with diabetes using a combined cardiopulmonary exercise test. Forced vital capacity, forced expiratory volume in 1 second, and forced expiratory flow, midexpiratory phase, were within the predicted values, but the residual volume/total lung capacity ratio was slightly elevated. Comparison by diabetes type showed nonsignificant differences in forced expiratory volume in 1 second and forced expiratory flow, midexpiratory phase. Residual volume/total lung capacity ratio was significantly elevated in type 1 patients compared with type 2. Carbon monoxide diffusion capacity (DLCO) was normal in both groups. There was no correlation between the results on pulmonary function test and duration of disease, presence of microangiopathy, or glycemic control. The concept of the lung as a target organ for diabetic microangiopathy received continuing attention. Lung function tests relating specifically to pulmonary microangiopathy include CO transfer capacity and pulmonary capillary blood volume. The authors concluded that spirometric values are preserved in patients with diabetes mellitus, and there are no defects in diffusing capacity. Cardiovascular factors may account for impaired physical performance. There is no need for routine screening of pulmonary function among diabetic patients. [4]

Meo SA et al studied significance of spirometry in diabetic patients. Its role is neither fully explored, nor fully utilized to

achieve quality of life when managing diabetes mellitus. The aim of the present review is to highlight the evidence-based significance of spirometry in the light of peer reviewed published literature. It may serve as a brief reference for diabetes management teams to enable spirometry to be included in the algorithm of the routine assessment of diabetic patients. [5]

Hamdy G et al studied pulmonary function changes in diabetic lung. Diabetes mellitus is a chronic and debilitating disease. Its complications give rise to micro and macrovascular diseases which affect eyes, kidneys, heart, blood vessels, nerves and also lungs. There may be a relationship between diabetes and reduced lung function, so this study was designed to evaluate the impairment of lung function on spirometry among diabetic patients. Spirometric tests were done for all groups by computerized Spirometry with six parameters There was a predominant reduction in all the Spirometric parameters of diabetic patients toward the restrictive pattern as there was significant deterioration in DLCO in comparison with healthy controls. FVC ($p < 0.01$), and FEV1/FVC% ($p < 0.001$) were significantly lower in type1 diabetic patients in comparison to those of type II. Impairment of lung functions was obvious with a longer duration of diabetes. Diabetes is associated with a significant impaired pulmonary function in a restrictive pattern as compared to non-diabetics. The pulmonary function impairment was found to be more marked with diabetic duration especially after 10 years. Subjects with type I diabetes had lower FVC and FEV1/FVC% than predicted; it could be related to poor glycemic control. [6]

Klein OL et al found that lung spirometry parameters and diffusion capacity are decreased in patients with Type 2 diabetes. After excluding patients with diseases causing abnormal lung function, 4164 subjects were available for analysis. These differences remained significant after adjustment for covariates. After race stratification, only Caucasians with diabetes had a significant decrease in all lung function measures. It was concluded that patients with diabetes have decreased lung function compared with those without diabetes. Caucasians with diabetes have more global lung function impairment compared with African Americans and Hispanics. [7]

Uz-Zaman S et al did assessment of lung function by spirometry and diffusion study and studied the effect of glycemic control on pulmonary function in type 2 diabetes mellitus patients of the eastern India. Total of 60 type 2 diabetes patient of age between 35-55 y and same number of age and sex matched apparently healthy control individual were included in the present study. All subjects were evaluated for PFT by flow sensitive spirometer. Significant differences in the spirometric parameters (FVC, FEV1/FVC) and diffusion capacity (DLCO% and DL/VA%) existed between cases and controls. There was a significant decrease in FVC, DLCO and DL/VA and significant increase in FEV1/FVC in that groups having HBA1c level >7% than the other groups. FEV1, FVC, DLCO, and DL/VA were negatively correlated with HbA1c whereas FEV1/FVC has positive association with HbA1c.Significant deterioration of lung function and diffusing capacity was observed in type 2 diabetes patients with poor glycemic control. [8]

Tiwari S et al did a clinical study on outcome of breathing exercise (pranayam) on spirometric parameters in type 2 diabetic individuals. Pranayama aims by carrying the involuntary functions of the respiratory mechanism within human control. In present time emphasis is on the beneficial effects of Pranayam in various diseases i.e. diabetes mellitus, hypertension, obesity and depression by application of specific exercise like

walking in a planned way. The respiratory System, central nervous system and cardiovascular system are the important systems which are mostly affected by Pranayam and other physical activities. Breathing exercise is highly effective in endorsement of respiratory system management of diseases related to respiratory system.[9,10]

Conclusion

It was concluded that diabetes mellitus did not affect pulmonary function inpatient of DM irrespective of duration, sex, glycemic control or BMI. Therefore we assume that routine screening for detection of PFT, which was found in few patients, could be because of ethnic factor or presence of early emphysematous change or due to diabetes incluced reduction in lung compliance and/ or reduced respiratory effort due to diabetes and required further studies for confirmation.

Declarations:

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Availability of data and material: Department of Medicine RKDF Medical College and Reaserch Center Bhopal

Code availability: Not applicable

Consent to participate: Consent taken

Ethical Consideration: There are no ethical conflicts related to this study.

Consent for publication: Consent taken

Contribution by Different Authors

First author Dr Vasant Shrivastava Assistant Professor Department of Medicine RKDF Medical College and Reaserch Center Bhopal. Data collection and statistical analysis

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Fourth and Corresponding Author Dr Monica Shringirishi Assistant Professor Department of Psychiatry Chirayu Medical College Bhopal. References and Discussion

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