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Original Article

A Clinical Study on Pulmonary Function Tests in Adult Patients with Type-2 Diabetes Mellitus

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Abstract

Background: The effect of diabetes mellitus (DM) on pulmonary functions and the prevalence of pulmonary complications are poorly characterized. Few authors report normal pulmonary functions and even concluded that spirometry is not at all necessary in diabetic patients. Some studies have shown a reduction in lung capacity in patients of DM and reported a varied impact depending on the duration and glycemic control of DM.

Aim of the Study: The aim of this study is to evaluate pulmonary functions of patients with DM Type-2 in the northern part of Kerala.

Materials and Methods: A 104 subjects were divided into two groups, Group "A" consisted of 52 adult non-smoking patients with established diagnosis of DM Type-2 and Group "B" consisted of 52 normal healthy adult volunteers to conduct the study. All the subjects were elicited of detailed history, and demographic data were collected. All the subjects were investigated by anthropometry, lipid profile, hemoglobin A1c (HbA1c), and spirometric measurements; the measurements included forced vital capacity (FVC), forced vital capacity in 1 second (FEV_1), FEV_1/FVC, forced expiratory flow$(FEF)_{25}$, FEF_{50}, FEF_{75}, $FEF_{25–75}$, $FEF_{0.2–1.2}$, and peak expiratory flow rate. All the data were analyzed using standard statistical methods. Associations between FVC and $FEV_1$and HbA1c and duration of illness in diabetic patients were analyzed by applying Pearson's coefficient.

Observations and Results: Both the Group A and B patients were matched by age, sex, and anthropometric features. The subjects belonged to the age groups of 40–70 years with a mean age of 52.48 ± 3.60 in Group A and 53.10 ± 2.75 in Group B ($P > 0.5$). There were 28 males and 24 females in Group A. There were 26 males and 26 females in Group B. Group A patients showed a reduction in FVC and FEV_1 when compared to subjects of Group B which was significant. There was no significant difference between forced expiratory ratio and maximum mid-expiratory flow among the two groups. Serum triglyceride (TG) levels were significantly higher in Group A patients ($P < 0.05$).

Conclusions: Type-2 DM being an endocrinal systemic disease when affects over a long period may result in a reduction in lung functions caused by restrictive ventilator pathological changes.

Key words: Diabetes Type-2, Diabetes, Microangiopathy, Pulmonary functions tests, Pulmonary

INTRODUCTION

According to the WHO estimates, there are already 180 million people suffering from diabetes mellitus (DM) all over the world and the number is likely to increase by another 180 million by 2030.[1] The increase in incidence and prevalence of diabetic population is from Southern Asia.[2] Diabetes being a endocrinal disorder with micro–microvascular changes in many organs presents clinically in various forms and has debilitating effects on the individual as a whole.[3] The relation between DM and lung functions is being studied for many years by authors.[4] Among them, few authors have noted impaired pulmonary function among the DM patients.[5-8] Davis *et al.* among these authors proved that lung is a target organ due to the exposure of fluctuant glycemic levels in patients with DM, especially Type-2. The alveoli of the lung are lined by a capillary network or microvascular unit which is affected in the generalized microangiopathy of DM.[5] Due to its large vascular reserve, the substantial loss of vascular network of the lung due to DM may not itself proclaim itself symptomatically for a long time. Hence, pulmonary diabetic

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microangiopathy may be underrecognized clinically.[9] The important changes noted by various workers in the lungs of DM patients are reduced elastic recoil, reduced lung volume, diminished respiratory muscle performance, and chronic low-grade inflammation,[10,11] decreases in pulmonary diffusion capacity for carbon monoxide,[12] and autonomic neuropathy involving respiratory muscles.[13] A strong correlation between pulmonary functions and hemoglobin A1c (HbA1c) and chronicity of DM Type-2 was observed by Shah *et al*.[14] In the present context, this study was conducted with a hypothesis that pulmonary function testings are affected in DM in Indian population and the changes may correlate with HbA1c and the duration of the disease.

Institution of Study

This study was conducted in Kannur Medical College, Anjarakandy, Kannur.

Period of Study

The study period was from October 2011 to September 2014.

MATERIALS AND METHODS

A total of 104 subjects were included and divided into 2 groups. Group A consisted of 52 non-smoking DM Type-2 patients attending the Department of Medicine out patient department of a tertiary teaching hospital in the Northern Kerala. Group B consisted of healthy non-smoking volunteers' exclusively used as a control group. An ethical committee clearance was obtained from the Institute head, and an ethical committee cleared consent letter was used to collect the data.

Inclusion Criteria

The following criteria were included in the study:

1. Patients aged above 40 years and below 70 years.
2. Patients with no history of smoking, acute or chronic lung disease.

Exclusion Criteria

The following criteria were excluded from the study:

1. Patients with complaints of cough, sputum, or dyspnea.
2. Patients with a history of smoking even for 1 month.
3. Patients with surgeries on the chest or lungs.
4. Patients with cardiopulmonary diseases.
5. Patients with musculoskeletal or endocrine diseases.

For Group B, healthy subjects who were non-smokers and in the same identical age group of patients of Group A were included. The subjects were of the same socioeconomic status, and preferably, the relatives of Group A were included. In Group B subjects, initial fasting and post-prandial blood glucose levels were measured by glucose oxidase method to rule out Type-2 DM in them. Subjects of both groups were elicited of a thorough clinical history followed by anthropometry. Anthropometry included standing height, weight, and body mass index (BMI). Fasting and random blood sugars (RBS) and fasting lipid profile were checked. All the subjects were investigated for lipid profile, HbA1c, and spirometric measurements; the measurements included forced vital capacity (FVC), FEV_1, FEV_1/FVC, FEF_{25}, FEF_{50}, FEF_{75}, $FEF_{25–75}$, $FEF_{0.2–1.2}$, and peak expiratory flow rate (PEFR). For all these parameters, percentage of predicted values for the respective age, height, and weight were taken into consideration. All the data were analyzed using standard statistical methods. Associations between FVC and $FEV_1$and HbA1c and chronicity of DM were analyzed. HbA1c and lipid profile of all the patients was estimated.

OBSERVATIONS AND RESULTS

A total of 104 subjects were divided into two groups with 52 subjects in each. Group A consisted of patients under treatment for DM Type-2 lasting for 3–10 years with a mean duration of 7.12 ± 1.86 years. Group B consisted of human volunteers preferable among the relatives of the diabetics of Group A. Among the 52 patients of Group A, there were 28 males and 24 females with a male-to-female ratio of 1.6:1. Among the 52 patients of Group B, there were 26 males and 26 females with a male-to-female ratio of 1:1. The mean age in Group A was 53.48 ± 3.60, and in Group B, it was 52.10 ± 2.75. The mean height in group patients was 134.92 ± 3.46, and in Group B, it was 139.46 ± 60. These parameters were selected in such a way that they were matching, and hence, were not statistically significant ($P > 0.05$) [Table 1]. Similarly, the BMI was 28.32 ± 3.21 in Group A and 27.42 ± 2.41 in Group B was also not significant [Table 1]. Other anthropometric parameters such as systolic blood pressure, diastolic blood pressure, fasting blood sugar, RBS, low-density lipoprotein, triglycerides (TG), and cholesterol values were significant statistically when compared in both groups and higher in Group A DM Type-2 patients; ($P < 0.05$), [Table 1].

On spirometry, the various test values were tabulated and analyzed in Table 2 showed statistical significance among the subjects of Group A and B. This study showed that the pulmonary parameters, i.e., FVC, FEV_1, FEF_{25}, FEF_{50}, FEF_{75}, $FEF_{25–75}$, $FEF_{0.2–1.2}$, and PEFR were significantly reduced except FEV_1/FVC; ($P = 0.062$) in patients of Type-2 DM as compared with the healthy controls ($P < 0.05$), [Table 2].

Table 1: The demographic data and the anthropometric data of Group A and B subjects (*n*=104)

Variables	Group A	Group B	Mean difference (95% of CI)	*P*
Gender				
Male	28	26		0.632
Female	24	26		
Age in years	53.48±3.60	52.10±2.75	0.38 (−2.83, −3.21)	0.821
Height	164.92±3.46	169.46±3.60	4.54 (−4.60, −0.024)	0.057
Weight	62.15±2.35	67.24±3.85	5.09 (−3.20, −0.0043)	0.061
BMI	27.32±3.21	26.42±2.41	1.0 (0.9, −2.432)	0.31
Systolic B.P	141.74±18.31	124.75±17.60	16.99 (11.24, 20.50)	0.010
Diastolic B.P	85.20±8.76	79.98±9.15	5.22 (0.24, −7.14)	0.025
FBS	174.0±53.65	101.40±8.78	72.6 (46.14, −76.86	0.019
RBS	218.50±79.64	111.75±20.43	106.75 (78.42, −128.76)	0.005
LDL	111.94±27.23	120.82±24.25	−8.88 (−19.84, −0.214)	0.05
TG	194.12±98.43	132.0±53.0	62.12 (26.65, −95.43)	0.021
Cholesterol	183.20±27.60	194.53±30.42	−11.33 (−21.55, −1.20)	0.049
HbA1c	7.12±1.36	-	-	-
Duration of DM	7.12±1.86	-	-	-

DM: Diabetes mellitus, HbA1c: Hemoglobin A1c, TG: Triglycerides, LDL: Low-density lipoprotein, RBS: Random blood sugars, FBS: Fasting blood sugar, B.P: Blood pressure, BMI: Body mass index, CI: Confidence intervel

Table 2: The pulmonary function tests in both groups of the study (*n*=104)

Observations mean values	Group A	Group B	Mean difference (95% CI)	–
FVC	2.49±0.67	2.94±0.92	−0.45 (−0.61, −0.06)	0.02
FEV_1	2.06±0.85	2.19±0.72	−0.13 (−0.49, −0.003)	0.04
FEV_1/FVC	85.05±7.93	84.99±7.21	0.056 (−2.32, −0.013)	0.62
PEFR	79.40±10.32	58.24±3.48	21.16 (09.15, −0.045)	0.043
FEF_{25}	80.37±6.88	61.80±17.26	18.57 (10.32, 11.23)	0.038
FEF_{50}	q	62.62±18.13	-	0.031
FEF_{75}	86.10±11.34	63.05±21.86	23.05 (09.21, −1.32)	0.028
FEF_{25-75}	75.43±11.12	69.42±22.42	6.01 (04.20, −9.34)	0.041
$FEF_{0.2-1.2}$	92.15±1.56	71.38±24.68	20.77 (11.32, −6.15)	0.037
SVC	2.76±0.82	2.92±0.66	0.16 (−0.58, −0.014)	0.04
MMEF	2.89±1.54	2.52±0.89	0.37 (−0.40, −0.392)	0.86

MMEF: Maximum mid-expiratory flow, SVC: Slow vital capacity, FEF: Forced expiratory flow, PEFR: Peak expiratory flow rate, FEV_1: forced vital capacity in one second, FVC: Forced vital capacity, CI: Confidence intervel

DISCUSSION

The effect of chronicity of DM Type-2 on pulmonary functions in the adult population was theoretically explained due to several pathological changes that occur in the lungs. Ljubić *et al.*[15] in his study showed that, due to collagen and elastin, changes occurring in the lung leads to pulmonary complications. Another theory was that due to chronic high circulating glucose levels there would be increased non-enzymatic glycation of proteins and peptides of the extracellular matrix resulting in pathological changes of the lungs in DM Type-2 patients.[16] The present study showed that there was a definite reduction in pulmonary functions in DM Type-2 patients. The results analyzed in this study showed that there was a significant reduction in FVC, FEV_1, and slow vital capacity (SVC) values, relative to their matched controls. However, FEV_1/FVC was less in diabetics but was statistically not significant [Table 2]. Similarly, the pulmonary function values of Group A patients in relation to FEF_{25}, FEF_{50}, FEF_{75}, $FEF_{25–75}$, $FEF_{0.2–1.2}$, and PEFR were also reduced in comparison to the control group subjects [Table 2]. In a meta-analysis by van den Borst *et al.*,[17] it was observed that the association between DM Type-2 and impaired pulmonary function was significant but in a restrictive pattern and the results were irrespective of the body weight, height, BMI, and HbA1c levels of the subjects. Even though pulmonary perfusion scintigrams are not done in this study, but as a part of the discussion, the study by Uchida *et al.*[18] needs to be mentioned here which showed decreased pulmonary diffusing capacity in patients with diabetes with perfusion defect. In a large community-based study by Davis *et al.*[4] in Western Australia among DM Type-2 patients, VC, FVC, FEV_1, and PEF were decreased. It was also suggested in the study that the reduced lung volumes and airflow limitation are likely to be chronic complications of Type-2 diabetes. In a study in Japan by Asanuma,[19] it was reported that FVC and FEV_1 were reduced in DM Type-2 subjects compared to control subjects. In a study by Ehrlich *et al.*,[20] it was observed that there was an increased risk of several pulmonary conditions such as asthma, chronic obstructive pulmonary disease, fibrosis, and pneumonia in patients

with Type-2 DM. The histopathological changes causing a reduction in pulmonary functions of DM Type-2 patients as reported by few authors were due to basal lamina thickening[21] and fibrosis.[22] Clinically, these pathological changes manifest in the form of a reduction in elastic recoil of the lung, lung volumes, and pulmonary capacity for the diffusion of carbon monoxide.[23] In the present study, there was a prevalence of high levels of TG as compared to control group subjects which was not found in other studies in the literature. Significant reduction in pulmonary function tests in this study was observed in Group A patients which was significantly higher than the control subjects of Group B, but no significant reduction in FVC/FEV^1 ratio strongly suggests a restrictive pattern of pulmonary dysfunction. Studies also have shown that diabetic polyneuropathy, which affects respiratory neuromuscular function and thus reducing pulmonary volumes.[24] The present study has a few limitations, as the study is small and hospital-based study, the results cannot be attributed to the community.

CONCLUSIONS

Type-2 DM being an endocrinal systemic disease when affects over a long period may result in a reduction in lung functions caused by restrictive ventilator pathological changes. The pulmonary functions affected are VC, FVC, FEV_1, SVC, maximum mid-expiratory flow, and PEF FVC/FEV^1 ratio being unaffected.

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