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Original Research Article

Prevalence of pulmonary function abnormalities in type 2 diabetes mellitus and its association with HbA1c in nonsmokers

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ABSTRACT

Background: Diabetes mellitus is a chronic metabolic disorder with vast social and economic consequences an ageing population and obesity due to sedentary lifestyle are one of the foremost reasons for the development of type 2 diabetes mellitus. Aim of the current study was to ascertain the burden of respiratory function abnormalities in type 2 diabetic subjects and its correlation with symptom and HbA1c in non-smokers.
Methods: This cross-sectional study was conducted in KPC medical college, Jadavpur. Patients of type 2 diabetes mellitus between the age of 30-80 years fulfilling the modified Borg dyspnoea scale were included after excluding heart failure, COPD, musculoskeletal disorders. The selected subjects were then subjected to a PFT with reversibility and DLCO assessment Pattern of PFT abnormality recorded. Total of 65 subjects were chosen for the study.
Results: In our study most of the patients had Restrictive abnormality Female 24 (42.9%) and male 32 (57.1%). Rest 3 (50.0%) Female patients and 3 (50.0%) male patients had Mixed abnormality. 2 (66.7%) female patients and 1 (33.3%) male patient had normal abnormality which was not statistically significant (p=0.6939).
Conclusions: Pulmonary function is reduced in type 2 diabetes. Diabetes duration seems a more important influence than glycaemic control, but the definitive direction as well as the exact pathophysiological mechanism to explain this association requires further investigation.

Keywords: Diabetes mellitus, Hemoglobin, PFTs, Macrovascular

INTRODUCTION

Diabetes mellitus is a dynamic metabolic disease with vast social and economic consequences. Ageing population and obesity due to sedentary lifestyle are one of the core reasons for the development of diabetes mellitus. The world health organization estimates that more than 180 million people worldwide have diabetes and by 2030 and it is expected that by 2030 the number will be doubled. There is an alarming increase in the prevalence and incidence of diabetes in Asian Indians. Diabetes is a micro-macrovascular disorder with debilitating effects on many organs. Pulmonary complications of DM have been inadequately studied and even poorly understood. The alveolar capillary network in the lung is a large micro-vascular unit and may be affected by microangiopathy.[1] However, because of its large reserve, substantial loss of the micro vascular bed can be tolerated without developing dyspnoea. As a result, pulmonary diabetic micro-angiopathy may be under-recognized clinically. In DM pulmonary functions have been studied frequently in countries other than India, while in our country there are few studies concerning these abnormalities and their relationship with glycosylated hemoglobin (HbA1c) and duration of the disease. Furthermore, it has been seen that 50% of putative diabetic subjects are not diagnosed until 10 years after onset of disease and it passes through various stages through its course commencing from

normoglycaemia then to impaired glucose tolerance to overt diabetes and finally leading to complications which maybe the initial presentation. The lung and thorax are rich in collagen and elastin, stiffening of thorax and lung parenchyma can occur because of nonenzymatic glycosylation of these structural compounds. This may lead to restrictive pattern.[2] 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. Hence, we hypothesized that PFTs are affected in DM in Indian population and the changes may correlate with HbA1c and the duration of the disease. Although the lung has not been listed as a classical target organ for diabetes, the abundant pulmonary alveolar capillary network and connective tissues raise the possibility that the lung may also be affected by chronic hyperglycemia.[3] To date, the findings in the clinical studies about the relationship between pulmonary function and T2DM are controversial. Some studies believe that the clinical value is not significant, and routine pulmonary function testing is not recommended in patients with diabetes. However, more studies support that T2DM has a deleterious effect on pulmonary function.[4]

Objectives

General objective of current study was to determine the prevalence of pulmonary function abnormalities and DLCO abnormalities in type 2 diabetic subjects aged between 30-80 years visiting the OPD of KPCMCH. Specific objectives of the study were to ascertain the burden of respiratory function abnormalities in type 2 diabetic subjects and its correlation with symptom and hba1c in nonsmokers and to ascertain the correlation if any between HbA1c and duration of diabetes with PFT abnormality.

METHODS

Study design, location, population and duration

Current study was a cross sectional study conducted on patients of type 2 diabetes mellitus between the age of 30-80 years fulfilling the modified Borg dyspnea scale were included after excluding heart failure, COPD, musculoskeletal disorders. The selected subjects were then subjected to a PFT with reversibility and DLCO assessment pattern of PFT abnormality recorded. Current study was conducted at KPC Medical College, Jadavpur on type 2 diabetic subjects who are non-smokers attending the diabetes and endocrinology OPD of KPCMCH. Study was conducted for a duration of 12 months from September 19 to August 20.

Method of selection of study population

The study population was selected from the first 65 patients attending the diabetes and endocrinology outdoor and fulfilling the inclusion criteria

Statistical analysis

Statistical analysis was done by SPSS (Version 27.0 SPSS Inc Chicago IL USA) and graph pad prism version

Inclusion criteria

Inclusion criteria for current study were; all subjects fulfilling the modified Borg dyspnoea scale and all type 2 diabetic subjects who are non-smokers within the age group of 30-80 years.

Exclusion criteria

Exclusion criteria for current study were; chronic obstructive pulmonary disease, heart failure ascertained by Framingham criteria, Smokers and musculoskeletal disorders.

RESULTS

In our study, the most common age group, 29 (44.6%) was 61-70 years old. 29 (44.6%) patients were female and 36 (55.4%) patients were male. In our study, 6 (9.2%) patients had Pattern of Mixed abnormality, 3 (4.6%) patients had normal pattern and 56 (86.2%) patients had Pattern of Restrictive abnormality.

Table 1: Age distribution.

Age group (years)	N	%
31-40	3	4.6
41-50	7	10.8
51-60	18	27.7
61-70	29	44.6
71-80	8	12.3
Total	65	100

Table 2: Sex distribution.

Sex	N	%
Female	29	44.6
Male	36	55.4

The mean duration of diabetes was higher in Restrictive group compared to Normal and Mixed group which was statistically significant, mean HbA1c was statistically significant in Pattern of abnormality. It was found that the positive correlation was found between HbA1c vs. diabetes duration in years though the result was not statistically significant.

The mean FVC, FEV1/FVC and DLCO were higher in normal group compared to Mixed and normal groups which were statistically significant, DLCO was negatively correlated with BORG Scale and diabetes duration in years which were statistically significant and duration of diabetes was positively correlated with BORG scale which was statistically significant. Pulmonary function is reduced in type 2 diabetes. Diabetes duration seems a more

important influence than glycaemic control, but the definitive direction as well as the exact pathophysiological mechanism to explain this association requires further investigation.

Table 3: Association between co-morbidity: pattern of abnormality.

Comorbidity	Mixed	Normal	Restrictive	Total
T2DM	4	1	40	45
Row %	8.9	2.2	88.9	100.0
Col %	66.7	33.3	71.4	69.2
T2DM, Hypothyroid	1	1	2	4
Row %	25.0	25.0	50.0	100.0
Col %	16.7	33.3	3.6	6.2
T2DM, HTN	0	1	14	15
Row %	0.0	6.7	93.3	100.0
Col %	0.0	33.3	25.0	23.1
T2DM, IHD	1	0	0	1
Row %	100.0	0.0	0.0	100.0
Col %	16.7	0.0	0.0	1.5
Total	6	3	56	65
Row %	9.2	4.6	86.2	100.0
Col %	100.0	100.0	100.0	100.0

Chi-square value: 17.3333; p value: 0.0081.

Table 4: Distribution of mean HbA1c: pattern of abnormality.

Parameters		N	Mean	SD	Minimum	Maximum	Median	P value
HbA1c	Mixed	6	8.5500	0.5541	7.7000	9.4000	8.5000	0.3019
	Normal	3	9.9333	1.6503	8.3000	11.6000	9.9000	
	Restrictive	56	9.4268	1.5027	7.5000	18.0000	9.2000	

Table 5: Correlation between all parameters.

Correlations							
Parameters		**BORG Scale**	**HbA1c**	**FEV1/ FVC**	**DLCO**	**Diabetes duration (years)**	**FVC**
BORG Scale	Pearson CC (r)	1	-0.027	-0.044	-0.319	0.428	-0.092
	P value	000	0.830	0.727	0.010	0.000	0.466
	N	65	65	65	65	65	65
HbA1c	Pearson CC (r)	-0.027	1	0.116	-0.057	0.122	0.046
	P value	0.830	-	0.359	0.654	0.331	0.719
	N	65	65	65	65	65	65
FEV1/FVC	Pearson CC (r)	-0.044	0.116	1	0.405	-0.226	0.288
	P value	0.727	0.359	-	0.001	0.070	0.020
	N	65	65	65	65	65	65
DLCO	Pearson CC (r)	-0.319	-0.057	0.405	1	-0.420	0.204
	P value	0.010	0.654	0.001		0.000	0.103
	N	65	65	65	65	65	65
Diabetes Duration (years)	Pearson CC (r)	0.428	0.122	-0.226	-0.420	1	-0.387
	P value	0.000	0.331	0.070	0.000		0.001
	N	65	65	65	65	65	65
FVC	Pearson CC (r)	-0.092	0.046	0.288	0.204	-0.387	1
	P value	0.466	0.719	0.020	0.103	0.001	
	N	65	65	65	65	65	65

CC: corelation coefficient

DISCUSSION

This cross-sectional study was conducted in KPC Medical College, Jadavpur. Patients of type 2 diabetes mellitus between the age of 30-80 years fulfilling the modified borg dyspnoea scale were included after excluding heart failure, COPD, musculoskeletal disorders.

The selected subjects were then subjected to a PFT with reversibility and DLCO assessment Pattern of PFT abnormality recorded. Total of 65 subjects were chosen for the study. Nemagouda et al conducted a study with thirty were males (58%) and twenty-two (42%) were females. Forty-five patients (86%) had restrictive abnormality on PFT in their study.[5] In our study majority was present in the group of patients who had Restrictive abnormality 56 (86.2%) where only 6 (9.2%) patients had Mixed abnormality and (4.6%) patients had Normal abnormality. We found that most of the patients of our study had T2DM 45 (69.2%) where only 4 (6.2%) patients had T2DM with hypo-thyroid, 15 (23.1%) patients had T2DM with HTN and 1 (1.5%) patient had T2DM with IHD. It was found that the mean BORG Scale (mean±SD) of patients was 5.8000±0.9048. The mean FBS (mean±SD) of patients was 257.2154± 61.8705. The mean PPBS (mean±SD) of patients was 385.7077±78.4279. The mean HbA1c (mean±SD) of patients was 9.3692±1.4596. The mean FEV1/FVC (mean±SD) of patients was 75.7949± 6.0930. The mean DLCO (mean±SD) of patients was 61.5534± 13.6728. The mean diabetes duration in years (mean±SD) of patients was 13.4219± 5.9517. The mean FVC (mean±SD) of patients was 58.2415±12.2216. We found that in mixed abnormality, 1 (16.7%) patient were 41-50 years old, 2 (33.3%) patients were 51-60 years old and 3 (50.0%) patients were 61-70 years old. In Normal abnormality, 1 (33.3%) patient were 41-50 years old and 2 (66.7%) patients were 61-70 years old.

In restrictive abnormality, 3 (5.4%) patients were 31-40 years old, 5 (8.9%) patients were 41-50 years old, 16 (28.6%) patients were 51-60 years old, 24 (42.9%) patients were 61-70 years old and 8 (14.3%) patients were 71-80 years old. It was not statistically significant (p=0.7707). In our study most of the patients had Restrictive abnormality, Female 24 (42.9%) and male 32 (57.1%). Rest 3 (50.0%) Female patients and 3 (50.0%) male patients had Mixed abnormality. 2 (66.7%) female patients and 1 (33.3%) male patient had Normal abnormality which was not statistically significant (p=0.6939). Benbassat et al found that 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.[6] In mixed abnormality, 4 (66.7%) patients had T2DM, 1 (16.7%) patient had T2DM with hypo thyroid and 1 (16.7%) patient had T2DM with IHD. In Normal abnormality, 1 (33.3%) patient had T2DM, 1 (33.3%) patient had T2DM with Hypo Thyroid and 1 (33.3%) patient had T2DM with HTN. In Restrictive abnormality, 40 (71.4%) patients had T2DM, 2 (3.6%) patients had T2DM with Hypo Thyroid and 14 (25.0%) patients had T2DM with HTN.

Association of Co morbidity vs. Pattern of abnormality was statistically significant (p=0.0081). In our study the mean Age (mean±SD) of patients with Mixed abnormality was 60.1667± 7.1110 years. The mean Age (mean±SD) of patients with Normal pattern was 56.0000±12.2882 years. The mean Age (mean±SD) of patients with Restrictive abnormality was 61.3571± 9.9571 years which was not statistically significant (p=0.6426). It was found that the mean of BORG Scale (mean±SD) was higher in patients who had Normal pattern (6.3333±0.5774) compared to patients with Mixed abnormality (5.1667±.9832) and patients with Restrictive abnormality (5.8393±0.8899). It was not statistically significant (p=0.1293). In our study the mean of FBS (mean±SD) was also higher in patients with Normal pattern (262.0000±84.0179) compared to patients with Mixed abnormality (230.8333± 56.4993) and patients with restrictive abnormality (259.7857±61.8349) which was not statistically significant (p=0.5546). We found that the mean PPBS (mean±SD) of patients with Mixed abnormality was 338.8333±72.8599. The mean PPBS (mean±SD of patients with normal pattern was 375.6667±76.3697.

The mean PPBS (mean±SD) of patients with restrictive abnormality was 391.2679± 78.6517. Difference of mean PPBS with three Pattern of abnormality was not statistically significant (p=0.2946). Chidri et al found that the mean FEV1, FVC, PEFR, and FEF25–75% were significantly lesser in type 2 diabetic cases than control subjects. The mean FVC, FEV1, FEF25–75%, and PEFR were low in cases with HbA1c <7 compared to the cases with HbA1c >7. The mean differences between pulmonary function tests were statistically not significant. There was a negative correlation between FVC, FEV1, and HbA1c levels.[7] Our study showed that the mean of HbA1c (mean±SD) was higher in patients with Normal pattern (9.9333±1.6503) compared to patients with Mixed abnormality (8.5500±0.5541) and Restrictive abnormality (9.4268± 1.5027). It was also not statistically significant (p=0.3019). Saxena et al (2020) observed that P value was highly significant for forced vital capacity (FVC), forced expiratory volume in 1s (FEV1), FEV1/FVC, and peak expiratory flow rate (PEFR) between the cases and the controls (i.e., <0.05). P value was highly significant for FVC, FEV1, slow vital capacity, and PEFR between <5 years and 5–10 years duration of diabetes (i.e., <0.05), showing that these pulmonary functions were reduced significance.[8] Our study showed that the mean FVC (mean±SD) of patients with Mixed abnormality was 60.1467±11.2155. The mean FVC (mean±SD) of patients with Normal pattern was 92.4300±7.3813. The mean FVC (mean±SD) of patients with restrictive abnormality was 56.2059±9.5929 which was statistically significant (p<0.0001). The mean FEV1/FVC (mean±SD) of patients with Mixed abnormality was 63.3367±3.5215 and with

restrictive abnormality was 76.6221±4.2373 but the mean FEV1/FVC (mean±SD) of patients with Normal abnormality was 85.2700±6.6172 which was higher than the other patterns. It was statistically significant (p<0.0001). In our study the mean DLCO (mean±SD) of patients was higher in Normal patter patients (93.2733± 8.987) compared to Mixed abnormality (62.3050± 11.5059) and Restrictive abnormality (59.7736± 12.0164) groups of patients which was statistically significant (p<0.0001).

Acharya et al found a statistically significant reduction was seen in diffusing capacity with increasing duration of DM (p<0.05). Statistically in significant reductions were observed in forced expired volume in 1s (FEV1), forced vital capacity (FVC), peak expiratory flowrate, (PEFR) forced expiratory flow (FEF 25%-75%) in patients with >20 years of DM in comparison to their counterparts with Type 2 DM is associated with a reduction in diffusing capacity with increasing duration of disease.[9] We found that the mean of diabetes duration (mean±SD) was higher in the patients with Restrictive abnormality (14.2364±5.7670 years). In other side the mean Diabetes Duration (mean±SD) of patients with Mixed abnormality was 8.6667±5.4650 years and the mean diabetes duration (mean±SD) of patients with Normal pattern was 8.0000± 3.6056 years. This was also statistically significant (p=0.0227).

In our study the negative correlation (-0.319) was found between BORG Scale vs. DLCO which was statistically significant (p=0.010). The negative correlation (-0.057) was found between HbA1c vs. DLCO. The p value was 0.654. The result was not statistically significant. The positive correlation (0.405) was found between FEV1/FVC vs. DLCO. The p value was <0.0001. The result was statistically significant. The negative correlation (-0.420) was found between diabetes duration in years vs. DLCO. The p value was <0.0001. The result was statistically significant. The positive correlation (.204) was found between FVC vs DLCO. The p value was 0.103. The result was not statistically significant. Rani et al a negative correlation is found when FEV1/FVC is correlated with duration of diabetes, and no significant correlation was seen between PEFR and duration of diabetes. Pulmonary function parameters (FVC, FEV1, and PEFR) are reduced in diabetics, and a negative correlation of reduced lung functions (FVC and FEV1) was observed with duration of diabetes.[10] We found that the positive correlation (0.428) was found between BORG Scale vs. diabetes duration in years. The p value was <0.0001. The result was statistically significant. The positive correlation (0.122) was found between HbA1c vs. diabetes duration in years. The p value was 0.331. The result was not statistically significant. The negative correlation (-0.226) was found between FEV1/FVC vs. diabetes duration in Years. The p value was 0.070. The result was not statistically significant. The negative correlation (-0.420) was found between diabetes duration in years vs diabetes duration in years. The p value was <0.0001. The result was statistically significant. The negative correlation (-0.387) was found between FVC vs. diabetes duration in years. The value was <0.0001. The result was statistically significant.

Limitations

Limitations of current study were; the sample size was very small. Only 65 cases are not sufficient for this kind of study. The study has been done in a single centre. The study was carried out in a tertiary care hospital, so hospital bias cannot be ruled out.

CONCLUSION

Pulmonary function is reduced in type 2 diabetes. Diabetes duration seems a more important influence than glycaemic control, but the definitive direction as well as the exact pathophysiological mechanism to explain this association requires further investigation.

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