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Original Research Article

To Study the Effects of Diabetes Mellitus on Pulmonary Function Tests

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ABSTRACT

Background & objective: The purpose of this study was to evaluate pulmonary functions in patients with type 2 diabetes mellitus and to determine their correlations with anthropometric profile, glycemic control, and duration of diabetes. **Materials & methods:** Fifty diabetic and fifty Non diabetic were selected from Krishna institute Karad by random sampling. Detailed anthropometric and physiological data were collected, spirometry was performed and Forced vital capacity (FVC), Forced expiratory volume in 1 second(FEV1), FEV1/FVC, Peak expiratory flow rate (PEFR), forced expiratory flow (FEF 25 -75%) were measured. Results were analyzed by calculating Mean ± SD, using Student's t test, Karl Pearson correlation and ANOVA test. **Results**: From the above study we see that all the respiratory parameters are reduced in study group compared to control group. FEV1, FVC, FEV1/FVC, PEFR and FEF 25-75% are significantly reduced. (p value < 0.01)The study also shows that the respiratory parameters are inversely related with glycemic status and duration of Diabetes mellitus. There was reduction in dynamic lung function variables. There was a mixed pattern (restrictive and obstructive) of involvement in lung functions. **Conclusion:** The present study showed reduction in dynamic lung function variable and a mixed pattern (obstructive and restrictive) of involvement. These respiratory parameters are inversely related with glycemic status and duration of Diabetes mellitus.

Key words: Type 2 diabetes; FVC; FEV1; FEV1/FVC; PEFR; FEF 25-75%, PFTs

INTRODUCTION

Diabetes mellitus is a systemic disease that causes secondary pathophysiological changes in multiple organ systems and the complications affecting these systems is responsible for the majority of morbidity and mortality associated with the disease. [1,2]

Several theories have been proposed to explain how hyperglycemia leads to end organ damage. These include:

1) Formation of advanced glycosylation end products,
2) Glucose metabolism via sorbitol pathway,
3) Activation of protein kinase C and
4) Increased flux through hexosamine pathway.

Diabetes mellitus is accompanied by wide spread biochemical, morphological and functional abnormalities which may precipitate certain complications that affect the neural, cardiovascular, renal systems and

also organs and tissues like skin, liver, collagen and elastic fibers. These biochemical processes result in impaired collagen and elastin cross linkage with a reduction in the strength and elasticity of connective tissue [1, 3] which can cause both vascular and non-vascular complications. Vascular complications can further be subdivided into micro-vascular and macro-vascular complications. The common micro-vascular complications include retinopathy, nephropathy and neuropathy. These complications are routinely screened for in all diabetic patients. [1]

Diabetes is not associated with any specific pulmonary symptoms and hence periodic screening for lung disease is not done in diabetic patients. However an extensive micro-vascular circulation and an abundant connective tissue in the lung raise the possibility that the lung may also be a 'target organ' in diabetic patients.[4,5] There are histopathological changes seen in lungs of diabetics such as thickened alveolar epithelial and pulmonary capillary basal lamina leading to reduced pulmonary elastic recoil and lung volumes. There is impaired diffusion due to reduced pulmonary capillary blood volume and thickening of the basement membrane. Non–enzymatic glycosylation induced alteration of lung connective tissue is the most likely mechanism underlying the mechanical pulmonary dysfunction in diabetic subjects.
There have been several studies which have studied pulmonary function abnormalities in Type1 DM [5,6] which evidenced reduced elastic recoil [7,8] reduced lung volumes [7-10] diminished respiratory muscle performance [11], decreased in pulmonary diffusion capacity for carbon monoxide [11] but there are only a few studies which have measured lung function in Type 2 DM. [12]

Prevalence of diabetes is increasing in several parts of the world, especially in developing countries like India. Recent epidemiological data showed that prevalence of diabetes in India is 8-10%. By the year 2010, number of people suffering from diabetes is expected to increase to 220 million. It has been estimated that 2.4 % of rural population and 8.4% urban population is affected by diabetes already.
Western interference has lead to loss of physical activity and changes in food pattern from traditional unprocessed natural ingredients to highly refined energy dense fatty and sugary fast foods. These two core factors will be responsible for the high incidence of diabetes in the years to come. The global prevalence of diabetes is projected to be highest in Asian Indians by 2025 (57.2 million), hence it is pertinent to study pulmonary function abnormalities in this subgroup. [13]

Although a lot of research work is being carried out on the after effects of diabetes mellitus on pulmonary parameters worldwide, the literature pertaining to this is not in abundance in India. Therefore this study was undertaken to find out the effects of diabetes mellitus on pulmonary function tests in patients with type 2 DM who attend or admitted to medical OPD or ward of KIMS institute.

Aim and objectives

Aim: To study the effects of diabetes mellitus on pulmonary function tests

Objectives

- To compare the pulmonary function tests in type 2 Diabetics and Non diabetics.
- To evaluate whether the duration of diabetes has any association with severity of pulmonary functions.
- To evaluate whether the glycemic status in diabetes have an association with severity of pulmonary functions.

MATERIALS AND METHODS

Source of Data

This was a case control study which was conducted in diabetic clinic of Krishna institute of Medical science & Research Centre, Karad from October 2011 to May 2013.

Method of collection of Data

Study group*:* 50 type 2 Diabetes Mellitus patients taken from the diabetic clinic of Krishna institute of Medical science & Research Centre, Karad.

Control group*:* 50 Non diabetic age, Height, Weight & sex matched subjects were taken.

Sampling Technique*:* 100 subjects were selected using simple random sampling after taking consent for the same.

Inclusion Criteria

Established cases of type 2 DM receiving treatment in diabetic clinic from October 2011 to May 2013 in Krishna institute.

Exclusion Criteria

- Smokers
- Occupational exposure
- Presence of Ascitis
- K/c/o Respiratory disorder
- K/c/o Cardiac illness in past

Methodology of pulmonary function test.

Pulmonary functions test were carried out using the instrument MEDSPIROR (a computerized spirometer self calibrating, which fulfill the criteria for standardized lung function tests) available in the Department of Physiology, KIMS, Karad

MEDSPIROR is a type of flow sensing spirometer. It is designed to be used with an electro mechanical pneumotachometer which is attached to mouth piece to detect air flow through it. The electronic circuit converts the raw signals to actual volume and flow rates.

Diabetic and non diabetic patients were selected carefully using criteria laid down. Their written consent was taken. The history was elicited. Age, height, weight were recorded.

Thorough physical and systemic examination was carried out. The performance of the pulmonary function tests was demonstrated. Lung functions were measured by computerized MEDSPIROR (RMS Chandigarh, India) instrument. Consequently a minimum of three reading were recorded of each test for each subject and the best of three was selected for reproducibility and validity of the recorded parameters. The lung functions parameters included were FVC, FEV1, FEV1/FVC, PEFR, FEF25-75%. The actual values of cases were compared with actual values of subject.

The FVC, FEV1, PEFR, FEV1/ FVC, FEF 25- 75% were recorded. Master chart was prepared.

GLYCEMIC STATUS of a diabetic patient was determined by

1. Fasting blood sugar.
2. Postprandial blood sugar.
3. HbA1c

1. Fasting blood sugar.

Is determined by glucose oxidase and peroxidase method (GOD-POD), after 12 hours of fasting. Value ≥126mg% is diagnostic of diabetes.

2. Post prandial blood sugar

Is determined by glucose oxidase and peroxidase method. After 2 hours of meal. Value ≥200mg% is diagnostic of diabetes.

3. HbA1c

It was recorded by ion exchange resin method. Values of > 7 was considered significant for diabetics.

Statistical Analysis

Statistical analysis was done by descriptive statistics as mean, SD, percentage etc. Comparison of diabetic and non-diabetic groups were done by applying Student's Unpaired 't' test at 5%(p 0.05) and 1%(p 0.01) level of significance. t test is

used to determine if two sets of data are significantly different.

Correlation between variables was determined by Karl Pearson's correlation coefficient and significance were tested by Student's Unpaired 't' test at 5% (p 0.05) and 1% (p 0.01) level of significance.

The PFT was compared with duration of diabetes by ANOVA test (One way ANOVA) and variation among mean duration of diabetes was tested by Tukey-Kramer multiple comparison test.

RESULTS

In a case control study, we studied 50 type 2 diabetic patients and 50 Non-diabetic patients. Case and controls were selected by applying inclusion & exclusion criteria using random sampling method. Detailed anthropometric and physiological data were collected, spirometry was performed and Forced vital capacity (FVC), Forced expiratory volume in 1 second (FEV1), & FEV1/FVC are recorded. Peak expiratory flow rate (PEFR) and FEF 25-75% were recorded by Spirometer. And the results were compared with age and sex matched control (non diabetic) subjects. Statistical analysis was done by calculating Mean ± SD, using Student's t test, Karl Pearson correlation and Anova test.

In table number (1 and 2) mean of the anthropometric parameters and age in diabetic and control group were compared. There was no significant difference (p value >0.05) between the two groups.

In table (3) mean of the glycemic parameters (FBS, PPBS and HbA1c) were compared in diabetic and control group. There was a significant difference between the two group (p value <0.01).

By studying table no (4) mean of pulmonary function parameters were compared in diabetic and control group. It was observed that PFT's were significantly reduced (p value <0.01) in diabetic group as compared to control group.

In our study in table no (5,6,7,8) mean of FBS, PPBS and HbA1c were co- related in 'diabetic and control group with PFTs. By applying Karl pearsons co-relation co-efficient we found out that, a negative co-relation exist between glycemic parameters and PFT's and by applying student "t" test to it we see that the above co relation is significant with p value being < 0.05 in diabetic group. Hence we conclude that there is a inverse correlation between glycemic and pulmonary function parameters.

By studying table number (9) duration of diabetes was compared with pulmonary function parameters. Duration of diabetic patients was divided in three groups (1-3 yrs, 3-5 yrs and > 5 yrs). In our study we found out that with increase in duration there was reduction in PFT's.

In table number (10) out of 50 diabetic patients 7 (14%) were normal, 6 (12%) were having an obstructive involvement, 12 (22%) were having restrictive and 25 (50%) were having mixed pattern of involvement. Hence we conclude that mixed (restrictive and obstructive) pattern of involvement is common in diabetic group.

Table No.1: Age and sex wise distribution of the cases in Group I (Diabetic) and Group II (Non-diabetic):

Age in years	Group I (Diabetic) (n=50)		Group II (Non-diabetic) (n=50)	
	Male	Female	Male	Female
40-50	2	3	-	-
50-60	15	9	25	8
60-70	9	7	10	5
> 70	3	2	1	1
Total	29(58%)	21(42%)	36(72%)	14(28%)
Mean ± SD	61.3±9.07		59.66±6.67	

By studying the above table the mean age in case of diabetics was 61.3±9.07 and mean age of Non diabetics was 59.66±6.67. Majority of the patients were in the age group of 50-60 yrs.

Table No.2: Comparison of anthropometric parameters of Diabetic subjects Vs Non-diabetic subjects:

Anthropometric parameters	Group I (Diabetic) (n=50)	Group II (Non-diabetic) (n=50)	Student's Unpaired 't' test value	'p' value	Significance
	Mean ± SD	Mean ± SD			
Age (yrs.)	61.3±9.07	59.66±6.67	1.28	p>0.05	Not significant
Weight (kgs.)	58.24±12.67	60.2±9.03	1.21	p>0.05	Not significant
Height (cms.)	164.56±6.53	164.48±6.29	0.087	p>0.05	Not significant

After applying Student's Unpaired 't' test there is no significant difference between mean values of anthropometric parameters (i.e. age, weight, height etc.) in Diabetic group and Control (Non-diabetic) group, i.e. p>0.05.

Table No.3 : Comparison of Fasting Blood Sugar, Post Prandial Blood Sugar and HbA1c in Diabetic subjects Vs Non-diabetic subjects:

Parameters	Group I (Diabetic) (n=50)	Group II (Non-diabetic) (n=50)	Student's Unpaired 't' test value	'p' value	Significance
	Mean ± SD	Mean ± SD			
Fasting Blood Sugar	158.14±50.39	84.9±13.72	9.92	p<0.01	Highly significant
Postprandial Blood Sugar	252.18±66.04	109.26±17.71	14.78	p<0.01	Highly significant
HbA1c	9.14±1.66	5.86±1.03	11.88	p<0.01	Highly significant

By applying Student's Unpaired 't' test there is a highly significant difference between mean values of Fasting blood sugar, Postprandial sugar level and HBA1c in Diabetic group and Control (Non-diabetic) group. (i.e. p<0.01)

Table No.4: Comparison of Pulmonary Functions Parameters in Diabetic subjects Vs Non-diabetic subjects:

Pulmonary Functions Parameters	Group I (Diabetic)(n=50)	Group II (Non-diabetic) (n=50)	Student's Unpaired 't' test value	'p' value	Significance
	Mean ± SD	Mean ± SD			
FVC	1.69±0.70	2.83±0.71	8.08	p<0.01	Highly significant
FEV_1	1.43±0.64	2.50±0.65	8.29	p<0.01	Highly significant
FEV_1/ FVC	0.82±0.14	0.89±0.15	3.68	p<0.01	Highly significant
PEFR	3.65±2.14	5.90±2.05	7.50	p<0.01	Highly significant
FEF 25-75%	1.65±1.07	2.85±0.91	6.07	p<0.01	Highly significant

By applying Student's Unpaired 't' test there is a highly significant difference between mean values of FVC, FEV1, FEV1/FVC PEFR and FEF 25-75% (i.e. p<0.01) in Diabetic group and Control (Non-diabetic) group.

Table No.5: Correlation between Fasting and Post Prandial Blood Sugar with Pulmonary Function Parameters in Diabetic subjects: (Karl Pearson's correlation coefficient)

	Karl Pearson's correlation coefficient value (r)				
	FVC	FEV_1	FEV_1/ FVC	PEFR	FEF 25-75%
Fasting Blood Sugar	-0.1918	-0.2347	-0.1645	-0.1913	-0.2618
't' test value and significance	1.35, p<0.05 significant	1.68, p<0.05, significant	1.16, p<0.05 significant	1.35, p<0.05 significant	1.89, p<0.05 significant
Post Prandial Blood Sugar	-0.1753	-0.2358	-0.2498	-0.1503	-0.2926
't' test value and significance	1.24, p<0.05 significant	1.73 , p<0.05 significant	1.79,p<0.05 significant	1.05, p<0.05 significant	2.12,p<0.05, significant

And after applying Karl pearsons co-efficient of variation all the correlations in the above table are significant ($p<0.05$)

From the above table it is seen that there is a negative correlation between FBS and PPBS all pulmonary functions parameters in Diabetic subjects. That is if FBS and PPBS increase (decreases) pulmonary functions parameters i.e. FVC, FEV1, FEV1/FVC, PEFR, and FEF 25-75% decreases (increases).

Table No.6: Correlation between HBA1c with Pulmonary Function Parameters in Diabetic subjects: (Karl Pearson's correlation coefficient)

	Karl Pearson's correlation coefficient value (r)				
	FVC	FEV_1	FEV_1/ FVC	PEFR	FEF 25-75%
HBA1C	-0.2255	-0.2845	-0.2138	-0.3309	-0.4149
't' test value and significance	1.61, p<0.05 significant	2.17, p<0.05 significant	1.52, p<0.05 significant	2.43, p<0.05, significant	3.46, p<0.05 significant

And after applying Karl Pearson co-efficient of variation, all the correlations in the above table are significant ($p<0.05$) in Diabetic cases.

The correlation between HBA1C and all pulmonary function parameters is negative, that is if HBA1C increases (decreases) all pulmonary function parameters are decreases (increases) in Diabetic subjects.

Table No.7: Correlation between Fasting and Postprandial Blood Sugar with Pulmonary Function Parameters in Control group i.e. Non- Diabetic subjects: (Karl Pearson's correlation coefficient)

	Karl Pearson's correlation coefficient value (r)				
	FVC	FEV_1	FEV_1/ FVC	PEFR	FEF 25-75%
Fasting Blood Sugar	-0.0372	-0.0755	-0.0863	-0.0741	-0.0302
't' test value and significance	0.26, p>0.05, not significant	0.60, p>0.05, not significant	0.61 p>0.05, not significant	0.523 p>0.05, not significant	0.21 p>0.05, not significant
Postprandial Blood Sugar	-0.2959	-0.1935	-0.3153	-0.2297	-0.0565
't' test value and significance	1.87, p>0.05, not significant	1.39, p>0.05, not significant	1.48, p>0.05, not significant	1.68, p>0.05, not significant	0.39, p>0.05, not significant

And after applying Karl Pearson co-efficient of variation all the correlations in the above table are not significant ($p>0.05$)

Table No. 8: Correlation between HBA1c with Pulmonary Function Parameters in Control group i.e. Non-Diabetic subjects: (Karl Pearson's correlation coefficient)

	Karl Pearson's correlation coefficient value (r)				
	FVC	FEV_1	FEV_1/ FVC	PEFR	FEF 25-75%
HBA1c	-0.1968	-0.1734	-0.03457	-0.0649	-0.03047
't' test value and significance	1.39, p>0.05, not significant	1.26, p>0.05, not significant	0.244, p>0.05, not significant	0.459, p>0.05, not significant	0.215, p>0.05, not significant

And after applying Karl Pearson co-efficient of variation all the correlations in the above table are not significant ($p>0.05$)

Table No.9 : Comparison of Pulmonary Functions Parameters in Diabetic subjects in relation to duration of diabetes:

Pulmonary Functions Parameters	Duration of diabetes in years		
	1-3 years (n=11)	3-5 years (n=12)	> 5 years (n=27)
	Mean ± SD	Mean ± SD	Mean ± SD
FVC	1.73±0.78	1.74±0.67	1.65±0.64
FEV_1	1.47±0.57	1.57±0.67	1.35±0.66
FEV_1/ FVC	0.87±0.09	0.89±0.08	0.80±0.17
PEFR	3.60±1.62	4.86±2.72	3.13±1.89
FEF 25-75%	1.86±0.78	2.33±1.42	1.26±0.82

ANOVA TEST

Source of variation	d.f.	Sum of squares	Mean squares
Treatment (between columns)	5	1407.6	281.53
Residuals (within columns)	294	1041	3.541
Total	299	2448.6	

Value of F = 79.511, significant, p<0.05

By applying Tukey-Kramer multiple comparison test, variation among average duration of diabetes and PFTS is significantly greater than expected by chance. By the study of above table it is seen that greater the duration of diabetes, there occurs significant reduction in FVC, FEV1, FEV1/FVC, PEFR and FEF 25-75% (i.e. p<0.05)

Table No 10: Distribution of respiratory pattern of involvement among diabetics:

	NORMAL	OBSTRUCTIVE	RESTRICTIVE	MIXED
DIABETICS	7(14%)	6(12%)	12(22%)	25(50%)
NON DIABETICS	38(76%)	8(16%)	2(4%)	2(4%)
	45	14	14	27

Thus from above table we see that respiratory involvement was more in diabetics with 6(12%) patients belonging to obstructive pattern, 12(22%) in restrictive pattern and 25(50%) in mixed pattern.

DISCUSSION

In our study it was seen that mean age in case group was 61.3±9.07 and mean age in control group was 59.66±6.67.

According to a study by Muhammad Irfan et al[14] the mean age of diabetics and matched control is 54.3±9 and 54.0±8 (P<0.87) years, respectively. Hence our study is in co-relation with the above study.

Weight and height was matched in the two study groups. Mean weight in case group was 58.24±12.67 and mean weight in control group was 60.2±9.03 with p value of > 0.05 which was not significant. Similarly mean Ht in case group was 164.56±6.53 and in control group was 164.48±6.29 with p value > 0.05. Hence it is seen that in our study case and control were Height and weight matched.

According to a study by Aparna A [15] case and control group is Wt and Ht matched.

Mean of FBS, PPBS, HbA1c values in case group was 158.14±50.39, 252.18±66.04, 9.14±1.66 and mean values in control group was 84.9±13.72, 109.26±17.71, 5.86±1.03 and p value in each group was < 0.01 which was highly significant. Thus it seen that there is a significant difference in glycemic index of two groups

In the study by Aparna A [15] mean values of FBS, PPBS and HbA1c values of diabetic and control group has significant difference with p value of <0.05. Hence our study is in relation with the above study.

Comparison of pulmonary function parameters in both the group:

It was seen that there was a highly significant difference between mean values of FVC, FEV1, FEV1/FVC, PEFR and FEF 25-75% (i.e. p<0.01) in Diabetic group and Control (Non-diabetic) group by applying Student's Unpaired 't' test

According to a study by Shravya Keerthi et al [16] the mean FVC, FEV1, FEV1/FVC%, PEFR, FEF 25-75%, MVV values are low in diabetics (p value <0.001) compared to non-diabetics. This study is in relation to our study.

According to study by Sanjeev Verma, Mumtaz Goni, Rattan P Kudyar [17] there is a significant decrease in FEV in patients with Type 2 compared with normal healthy controls. The ratio of FEV1 / FVC

was found to be statistically insignificant. This is not in relation with our study.

According to a study by Aparna A [15] it is seen that there is a statistically significant reduction in FVC, FEV1, PEFR in type 2 diabetics as compared to those in the controls. This is in relation to our study. FEV1/FVC% was increased in type 2 diabetics as compared to that in controls and the increase was statistically significant. This is in not in relation with our study.

TABLE 11: STUDIES SHOWING COMPARISON OF FVC IN DIABETICS AND NON DIABETICS.

STUDY	DIABETIC	NON-DIABETIC	P VALUE
APARNA A[15]	2.28±0.18	3.36±0.11	<0.001
SANJEEV VERMA et al[17]	2.12±0.07	2.45±0.54	0.008
SHRAVYA KEERTI et al[16]	2.04±0.4	3.16±0.3	<0.01
OUR STUDY	1.69±0.70	2.83±0.71	<0.01

TABLE 12: SHOWING STUDIES ON FEV1 IN DIABETICS AND NON DIABETICS

STUDY	DIABETIC	NON-DIABETIC	P VALUE
APARNA A[15]	1.99±0.16	2.60±0.07	<0.001
SANJEEV VERMA et al[17]	1.93±0.53	2.20±0.49	0.008
SHRAVYA KEERTI et al[16]	1.65±0.49	2.86±0.36	<0.001
OUR STUDY	1.43±0.64	2.50±0.65	<0.01

TABLE 13: SHOWING STUDIES ON FEV1/FVC IN DIABETICS AND NON DIABETICS

STUDY	DIABETIC	NON-DIABETIC	P VALUE
APARNA A[15]	82.54±3.91	72.32±1.25	0.001
SANJEEV VERMA et al[17]	90.96±9.36	90.19±5.86	0.008
SHRAVYA KEERTI et al[16]	81.67±16.8	90.59±6.08	<0.001
OUR STUDY	0.82±0.14	0.89±0.15	<0.01

TABLE 14: SHOWING STUDIES ON PEFR IN DIABETICS AND NON DIABETICS

STUDY	DIABETIC	NON-DIABETIC	P VALUE
APARNA A[15]	5.007±0.36	7.12±0.31	<0.05
SANJEEV VERMA et al[17]	5.59±1.68	5.50±1.68	<0.001
SHRAVYA KEERTI et al[16]	3.35±1.05	5.97±0.28	<0.001
OUR STUDY	3.65±2.14	5.90±2.05	<0.01

TABLE 15: SHOWING STUDIES ON FEF25-75% IN DIABETICS AND NON DIABETICS

STUDY	DIABETIC	NON-DIABETIC	P VALUE
APARNA A[15]			
SANJEEV VERMA et al[17]	2.29±1.23	2.80±0.73	<0.05
SHRAVYA KEERTI et al[16]	1.92±0.87	3.360.69	<0.001
OUR STUDY	1.65±1.07	2.85±0.91	<0.01

According to study by Muhammad Irfan, Abdul Jabbar, Ahmed Suleman Haque, Safia Awan, Syed Fayyaz Hussain [14] reduction in lung capacity has been reported previously among diabetics. In Diabetic patients there is a significant reduction in the forced vital capacity (FVC) [mean difference (95% CI) –0.36 (–0.64, –0.07) P<0.01], forced expiratory volume in one second (FEV1) [–0.25(–0.50, –0.003) P<0.04],and slow vital capacity (SVC) [– 0.28(–0.54, –0.01) P<0.04], relative to non-diabetic controls. This is in relation to our study. There was no significant difference noted in the forced expiratory ratio and maximum mid-expiratory flow between the groups. This is not in relation to our study.

According to study of Davis timothy et al [18] it is seen that there is a decrease in FEV1, FVC, PEFR in diabetic group patients (p<0.01) which supports our study. Sreeja et al [19] study also reveals decrease in pulmonary function such as FVC, FEV1, PEF, FEF25%-75% (p value <0.05) as compared to controls. This is in relation to our study.

Dr. Bruce M Schnapf [20] in his study reveals that FEV1, FRC, TLC and residual volume are significantly reduced in diabetic patients. This is in relation to our study.

Thus by comparing PFT parameters in diabetic and control group we can see that there is reduction in parameters in diabetic as compared to control group.

Relation of glycemic indices on PFTS

1) Relation of FBS, PPBS with PFTS in diabetic group

In this study FBS, PPBS level were correlated with PFTs of diabetic group. By applying Karl pearson co-relation it was seen that there is negative correlation between FBS, PPBS with PFTs i.e. with increase in FBS, PPBS level there decrease in the PFTs values. The above relation was significant in diabetic group with p value being <0.05 in each variable.

In a study by Robert E. Walter [21] the relationship of FBS to FEV1, FVC, FEV1/FVC, FEF25-75%, PEFR shows significant fall (p value<0.01). This is in relation to our study.

In a study by Sheikh GP et al [22] high FBS levels (>160mg%) are associated with significant reductions in FEV1, FVC, FEV1/FVC, FEF25-75%, PEFR (p value <0.005). These study also shows that PPBS levels as high (>210mg%) the PFT abnormalities were present across all the parameters(p value< 0.05). Hence our present study is in agreement with the present study. This is in relation to our study.

In a study by P Lange et al [23] (Copenhagen City Heart study), raised plasma glucose concentrations (>200mg%) are associated with significant reductions in lung functions. On an average FVC, FEV1 were reduced by 334 ml and 239ml respectively. Hence our study is in agreement with above authors. This is in relation to our study.

According to a study of Davis A Wendy [24] spirometric measures are decreased >10% and above at baseline and absolute measures continued to decline at an annual rate 45 of 68ml, 71ml, and 17ltr/min for FVC, FEV1 , and PEFR respectively. Declining lung function measures were consistently predicted by poor glycemic control. This is in relation to our study.

2) Relation of HbA1c with PFTs in diabetic group

Similarly HbA1c was also correlated with diabetic group. By applying Karl pearson co-relation test it was seen that there is negative correlation between HbA1c with FEV1, FVC, FEV1/FVC, FEF25-75%, PEFR i.e. with increase in FBS and PPBS level there is decrease in above mentioned values. The above relation was significant in diabetic group with p value being <0.05 in each variable.

In a study by P. Makkar et al [25] ,when the HbA1c levels >7% there is reduction in FVC, FEV1, FEV1/FVC, PEFR values (p < 0.01).This is in relation to our study.

In a study by Sheikh GP et al [22] , patients with HbA1c > 7% FEV1, FVC, FEV1/FVC, PEFR, FEF 25-75% shows significant reduction (p value<0.01). This is in relation to our study.

According to Davis A Wendy [24] there is decrease in spirometric measures for FVC, FEV1, PEFR (p value <0.05). The decrease in PFT measures were consistently predicted by poor glycemic control in the form of higher HbA1c >7%.This is in relation to our study.

3) Relation of FBS, PPBS with PFTS in non-diabetic group

In our study after applying Karl Pearson co-efficient of variation there was a negative co relation established between FBS and PPBS with PFTs. But the Co-relations were not significant with p>0.05 in each variable.

4) Relation of HbA1c with PFTs in non-diabetic group

In this study after applying Karl Pearson co-efficient of variation there was a negative co relation established between FBS and PPBS with PFTs. But the Co-relations were not significant with p>0.05 in each variable.

Effects of duration of diabetes mellitus on PFTs

Diabetics were divided according to the duration of disease in three groups 1-3, 3-5, >5 yrs. By applying Anova test and Tukey-Kramer multiple comparison tests, it was seen that variation among average duration of diabetes and PFTs is significantly greater than expected by chance. It was seen that all the parameters of PFTs showed statistical significant reduction with the duration of diabetes with value of degree of freedom (F) =79.511, significant, p value <0.05.

Relation of FVC with duration

In our study there was reduction in Mean values of FVC as duration of the disease increased.

In a study by Davis A. Wendy et al [24] there is a decrease in mean FVC values as the duration of DM increased. In their study the annual rate of fall in FVC was 68 ml. This is in relation to our study.

In a study by Robert E. Walter et al [21] there is a progressive decrease in mean FVC values by 109 ml/year. This is in relation to our study

A study by Timothy M.E Davis [18] showed there is an average decrease of 9.5% in mean FVC values in diabetics. This is in relation to our study. In our study also there was a progressive decrease in mean FVC values as the duration of diabetes increased.

Relation of FEV1 with duration

In our study there was reduction in Mean values of FEV1 as duration of the disease increased.

In a study by Davis A. Wendy [24] the decrease in FEV1 is at an annual rate of 71 ml/year.

Relation of FEV1/FVC with duration

In our study there was reduction in Mean values of FEV1/ FVC as duration of the disease increased.

In a study by Shravya Keerti et al [16] shows decrease in FEV1/FVC to 1.92 ±0.87 which is in relation to our study.

In a study by Robert e. Walter [21] the ratio increases by 1.5% in diabetics which is statistically significant. This is not supported by our study.

Relation of PEFR with duration

In our study there was reduction in Mean values of PEFR as duration of the disease increased.

In a study by Timothy ME Davis [18] there is an average decrease in mean value of PEFR by 9.5%.

As per the study of Sreeja et al [19], the decrease in PEFR was 267.65L/sec. Both the studies are showing a decrease in PEFR which is in relation to our study.

Relation of FEF 25-75% with duration

In our study there was reduction in Mean values of FEF 25-75% as duration of the disease increased.

As per the study of Sreeja et al[19] there is a decrease in FEF 25-75% by 2.45 ± 0.55L. So the result coincides in both the study. As the duration of diabetes increases, there is a prominent decrease in PFT parameters.

Pattern of involvement

Lastly by studying the respiratory pattern of involvement in diabetic patients it was seen that 6 patients were falling in obstructive pattern, 12 in restrictive pattern and 25 in mixed pattern. Thus we conclude that mixed pattern is more in diabetic group. Sreeja et al [19] study also revealed decrease in FEV1, FVC, PEFR in diabetics as compared to non diabetics. There was also a

mixed pattern of involvement which is in conjunction with our study.

According to Davis A Wendy [24] there is a decrease in spirometric measures for FVC, FEV1, PEFR. Mixed pattern of involvement was seen in diabetic group which is in conjunction with our study.

According to study by Muhammad Irfan n et al [14] shows a restrictive pattern of involvement and this is not in relation to our study.

CONCLUSION

- In our study we conclude that Diabetes is associated with significantly impaired dynamic Pulmonary Functions
- There is correlation between Duration of Diabetes & Glycemic control with impairment of pulmonary function
- There is Mixed Pattern (restrictive and obstructive) of Pulmonary Dysfunction.

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