Calicut Medical Journal 2009; 7(1): e2

Original article:

Sub Clinical Impairment of Ventilatory Functions in Diabetes

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Abstract

Background: Respiratory disease is seldom attributed to diabetes mellitus (DM) directly. But, histopathology findings and abnormal pulmonary functions in various studies suggest that there is some sub clinical impairment in lung. This also affects the treatment of DM by insulin inhalation.

Aim- To study the effect of exercise on ventilatory pulmonary function tests (VPFT) in diabetics (type II DM) to see the minimal early deterioration, to evaluate their sub clinical impairment and the pattern of change.

Material & methods- In this study VPFT are recorded in 30 patients suffering from type-II DM (with out complications) before, immediately after and 5 minutes after mild exercise and compared with that of normal healthy subjects as controls.

Settings and design – Before and after exercise- VPFT comparison studies with controls (Non- Randomized).

Statistical analysis- By standard statistical method using paired and unpaired't' tests and 'p' values.

Results- Values of FEV1/FVC (Forced Expiratory Volume in one second/Forced Vital Capacity) %, FEF (Forced Expiratory Flow) at 50% & 75% of vital capacities were significantly less in diabetics and lowered further after exercise. FEV1, FVC & MVV (Maximum Voluntary Ventilation) were comparable but failed to rise significantly after exercise contrary to that seen in healthy controls. FVC, FEV1/FVC%, FEF75% and MVV failed to recover significantly 5 minutes after exercise in diabetics.

Conclusion - Spirometeric study of VPFT for various parameters reveal varying impairments, suggesting peripheral airway disease with predominantly obstructive pattern that precipitates/deteriorates further after exercise. Failure to recover indicates loss of elastic recoil, suggesting some restriction.

Key words: Diabetes, Ventilatory functions, exercise.

Introduction

DM (Diabetes mellitus) is most common metabolic disorder known to cause irreversible structural and functional derangement in various cells of the body predominantly those of vascular system, eye, kidney and nervous system.[1, 2]

Respiratory diseases are seldom attributed to DM but lungs are affected sub clinically as observed in various histopathological and experimental studies. [3-6] While assessing a diabetic for inhalation therapy of insulin, impairment of lung functions is main drawback to efficacy of treatment. [7-9]

How lungs and their functions are affected in DM is still a topic of interest. The effects of DM on pulmonary functions have been observed in large number of studies but there is great variation.[8-22] Some show mainly obstructive pattern whiles some restrictive and others do not comment.

It has been suggested to study the effect of exercise on VPFT (Ventilatory Pulmonary Function Tests). [23] Lungs have large functional reserves. There may be marked loss of function before the symptoms appear.[24] If VPFT are recorded after exercise in asymptomatic diabetics (without any complication) their minimal early abnormality can be detected which is attributable to diabetes alone.

Most of the studies on VPFT have been done on type-I diabetics. Present study has been undertaken on type-II asymptomatic diabetes patients (without any complication) with short duration of illness so as to detect minimal deterioration in lung functions.

Aims:

To study the effect of exercise on VPFT in type II DM patients (without any complication).

Settings and design: Before and after exercise VPFT comparison studies with controls (Non- Randomized).

Material & Methods: This study was carried out in the Department of Physiology and Medicine. A total of 30 patients diagnosed (with in 5 years of diagnosis) of asymptomatic type II DM of either sex with age group 40-55 years (Group I) were evaluated as per predesigned proforma. None of them was smoker or alcoholic and had no pulmonary or any other disease (cardiovascular, neural, endocrinal or metabolic) ruled out clinically or by investigations.

Thirty healthy volunteers with matched age, sex and BMI served as controls (Group II).

Routine and relevant other investigations like fundus examination, blood sugar fasting and post prandial, X-ray chest PA, ECG, blood urea, S. creatinine and urine examination were carried out. After explaining the procedure and taking consent, basic anthropometric measurements like weight and height were recorded and initial set of VPFT was taken i.e. before exercise (Pre).

Exercise:

The patient/healthy volunteers were asked to exercise on computerized (DT3917 fitness computer) Mag cycle ergo meter, starting at the rate of 60 revolution per minute against zero work load for a period of 5 minutes.[25,26] It is important to maintain the rate to produce best effort. 2nd set (Post I) of VPFT was recorded immediately after exercise and 3rd set (Post II) was recorded after 5 minutes of rest. For every VPFT parameter three readings were taken and best of the three was considered.

Results

Various parameters of VPFT viz. FVC(Forced Vital Capacity), FEV1(Forced Expiratory Volume in one second), FEV1/FVC%, PEFR(Peak Expiratory Flow Rate), FEF(Forced Expiratory Flow) at 25%, 50%, 75% of vital capacities, MVV (Maximum Voluntary Ventilation), VE(minute ventilation) were recorded in three sets i.e. before exercise (Pre), immediately after exercise (Post I) and 5 minutes after exercise (Post II) in Group I(Table-1) as well as Group II(Table-2) and compared vis-à-vis for the same parameter i.e. Pre with Post I and Post II(Table-1 & 2) and between two groups(Table-3). The results were analyzed by standard statistical methods i.e. paired and unpaired't' tests and 'p' value.

FEV1/FVC%, FEF50%, FEF75% were significantly less in diabetics as compared to controls and the values lowered further after exercise (Post- I)[Table-3].

FEV1, FVC & MVV rose significantly in controls on exercise (Post-I) [Table-2] but in diabetics there was no significant rise [Table-1].

FVC, FEV1/FVC%, FEF75% and MVV failed to recover after 5 minutes of rest (Post II) in diabetics, contrary to that seen in control group [Table-1].

Discussions

Hyperglycemia in DM by non enzymatic glycosylation (NEG) affects various body systems viz. cardiovascular system, eyes, renal, nervous system. [2, 27]

Lung tissues are involved as seen in human autopsy findings and experimental studies probably mechanism remains the same. Physiologically lung functions have been seen to be impaired in 60% of diabetic population in a cross sectional study. [28] Incidence of death from pulmonary diseases has been reported as 14% in a study of 1351 diabetic autopsy cases. Diabetes is associated with varying impairment of lung functions. [29]

Present study was performed to see the pattern of VPFT impairment in type II DM patients (uncomplicated) a step in the pathogenesis. These cases of diabetes were assessed for early ventilatory impairment by evaluating the effect of exercise on VPFT. This has become important now a day before giving insulin as inhalation.

On recording the various parameters of VPFT, it was observed that FEV1/FVC, FEF-50% and 75% were significantly lower in diabetics (Pre exercise stage) and they decreased further significantly on exercise (Post-I stage). The decrease in FEV1/FVC% may be related with poor mechanical properties of the lungs viz. Lung compliance and elastic recoiling and give an indication of obstructive pattern. Low FEF-50% & 75% suggest small airways involvement indicating minimal but significant early obstruction or COPD (Chronic obstructive pulmonary disease). Ventilation-Perfusion mismatching is the hallmark of COPD. [30] Inhalation of Insulin is affected (improper) for the same reason.

Normally, the gradual decline in pulmonary functions is seen with ageing. [9, 30] In DM there is early ageing that has been seen in lung connective tissue too. [3, 12, 31, 32] So obstruction is there that precipitates further on exercise. Other important observation is that FEV1, FVC & MVV were comparable in two groups, but in diabetics failed to rise on exercise (Post-I) which is seen in healthy volunteers. This hints that in diabetics VPFT are normal at rest but in compromise state. In the need of the hour respiratory abnormality is liable to precipitate

FVC, FEV1/FVC%, FEF75% and MVV failed to recover promptly on taking rest after exercise (Post-II state). This suggests easy fatigue ability and loss of elastic recoil which restrict the lung function in DM patients. The strength and stability of the connective tissue is provided by cross link formation of both collagen and elastic components.[23] In DM, mechanical properties of the lung are impaired due to NEG of both these components.[27] Non significant (NS) variation in some parameters in different states in two groups indicates that more such studies should be conducted to have significant results for them. [33]

Conclusions:

The present study concludes that in uncomplicated type-II DM mainly obstructive pattern is seen in VPFT that may be early change or sub clinical. It worsens on exercise and also do not improve quickly on taking rest after exercise (sign of fatigue).

Further if we extend this study and make the similar observations in diabetics with advanced disease at various levels and with different complications we can have better understanding of effects of DM and its complications on respiratory physiology. With advanced disease the restrictive pattern is likely to dominate.

Table-1 VPFT values (Mean±SD) in DM patients (Group I) in three states and Comparison between Pre & Post I and Pre & Post II in same group using paired 't' test

Parameters	Pre value (Mean±SD)	Post I (Mean±SD) t value, Pre vs. Post I	Post II (Mean±SD) t value, Pre vs. Post II
FEV1 (L)	2.73±0.67	2.77±0.76 0.9 , p>0.05(NS)	2.74±0.72 0.40, p>0.05(NS)
FVC(L)	3.49±0.79	3.55±0.95 1.02, p>0.05(NS)	3.61±0.90 2.30, p<0.05(S)
FEV1/FVC%	78.7±5.49	78.06±6.32 0.60, p>0.05(NS)	75.96±5.72 3.26, p<0.01(S)
PEFR(L/m)	411.6±112.23	408.46±110.06 0.23, p>0.05(NS)	408.73±110.29 0.30, p>0.05(NS)
FEF25%(L/s)	5.73±1.77	5.60±1.80 0.84, p>0.05(NS)	5.49±1.87 1.95, p>0.05(NS)
FEF50%(L/s)	3.43±1.16	3.52±1.18 0.088, p>0.05(NS)	3.26±1.04 1.77, p>0.05(NS)
FEF75%(L/s)	0.99±0.39	0.99±0.42 0.08, p>0.05(NS)	0.87±0.35 2.77, p<0.01(S)
MVV(L/m)	114.40±31.30	111.23± 35.10 1.19, p>0.05(NS)	108.13±31.93 2.16, p<0.05(S)
VE(L)	16.72±7.13	26.39±8.93 5.00, p<0.001(HS)	17.16±7.40 0.70, p>0.05(NS)

Three states ; Pre- Basal (before exercise), Post I- After exercise (immediately), Post II- 5 minutes after exercise.
t-values compared by probability 'p'
p value : > 0.05 is non significant (NS)
< 0.05 is probably significant(S)
<0.01 is significant(S)
<0.001 is highly significant (HS)

Table-2 VPFT values (Mean±SD) in controls (Group II) in three states with Comparison between Pre & Post I and Pre & Post II in same group using paired 't' test

Parameters	Pre value Mean±SD	Post I(Mean±SD) t value, Pre vs. Post I	Post II(Mean±SD) t value, Pre vs. Post II
FEV1(L)	2.83± 0.62	2.92± 0.62 4.98. P<0.001 (HS)	2.82± 0.65 0.32, p>0.05 (NS)
FVC(L)	3.49± 0.80	3.65 ± 0.79 3.86 P<0.001 (HS)	3.50 ±0.81 0.11, p>0.05 (NS)
FEV1/FVC%	81.26± 4.02	81.03± 3.50 0.48, p>0.05 (NS)	80.46± 3.73 0.98, p>0.05 (NS)
PEFR(L/m)	453.26±116.52	456.2± 105.84 0.26, p>0.05 (NS)	437.36± 95.73 1.25, p>0.05(NS)
FEF-25% (L/s)	6.00± 1.33	6.13± 1.15 1.22, p>0.05(NS)	5.86± 1.15 0.80, p>0.05(NS)
FEF-50% (L/s)	4.04± 0.75	4.18 ±0.79 3.14, p<0.01(S)	3.92± 0.94 0.94, p>0.05(NS)
FEF-75% (L/s)	1.19 ±0.26	1.21± 0.29 0.61, p>0.05(NS)	1.17± 0.25 0.73, p>0.05(NS)
MVV(L/m)	106.70± 23.88	117.80± 20.361 3.48, P<0.01(S)	109.70± 20.34 1.09, p>0.05(NS)
VE(L)	15.20 ±4.39	30.92± 9.21 5.00, p<0.001(HS)	16.34± 6.00 1.38, p>0.05(NS)

Table- 3 VPFT -Comparison between diabetics (group-I) and controls (group-II) using unpaired 't' test

Parameters	Pre (gp I) vs. Pre (gp II) Mean±SD t value, p value	Post I (gp I) vs. Post I (gp II) Mean±SD t value, p value	Post II (gp I) vs. Post II (gp II) Mean±SD t value, p value
FEV1(L)	2.73±0.67 vs. 2.83±0.62 0.62, p>0.05(NS)	2.77±0.76 vs. 2.92 ±0.60 1.04, p>0.05(NS)	2.74±0.72 vs. 2.82±0.65 0.42, p>0.05(NS)
FVC(L)	3.49±0.79 vs. 3.49±0.80 0.03, p>0.05(NS)	3.55±0.95 vs. 3.65±0.79 0.45, p>0.05(NS)	3.61±0.90 vs. 3.50±0.81 0.50, p>0.05(NS)
FEV1/FVC%	78.7±5.49 vs. 81.26±4.02 2.06, p<0.05(S)	78.06±6.32 vs. 81.03±3.50 2.24, p<0.05(S)	75.96±5.72 vs.80.46±3.73 3.60, p<0.001(HS)
PEFR(L/m)	411.6±112.2 vs. 453.2±105.8 1.41, p>0.05(NS)	408.4±110.0 vs. 456.2±105.8 1.71, p>0.05(NS)	408.7±110.2 vs. 437.3±95.7 1.07, p>0.05(NS)
FEF-25%(L/s)	5.73±1.77 vs. 6.00±1.33 0.67, p>0.05(NS)	5.60±1.80 vs. 6.13±1.15 1.35, p>0.05(NS)	5.49±1.87 vs. 5.86±1.15 0.92, p>0.05(NS)
FEF-50%(L/s)	3.43±1.16 vs. 4.04±0.75 2.40, p<0.05(S)	3.52±1.18 vs. 4.18±0.79 2.52, p<0.01(S)	3.26±1.04 vs. 3.92±0.94 2.54, p<0.01(S)
FEF-75%(L/s)	0.99±0.39 vs. 1.19±0.26 2.28, p<0.05(S)	0.99 ±0.42 vs. 1.21±0.29 2.27, p<0.05(S)	0.87±0.35 vs. 1.17±0.25 3.70, p<0.001(HS)
MVV(L/m)	114.4±31.3 vs.106.7±23.8 1.07, p>0.05(NS)	111.2±35.1 vs. 117.8±20.3 0.88, p>0.05(NS)	108.1±31.9 vs 109±7 20.3 0.22, p>0.05(NS)
VE(L)	16.72±7.13 vs. 15.20±4.39 0.99, p>0.05(NS)	26.39±8.93 vs. 30.92±9.21 1.96, p<0.05(S)	17.16±7.40 vs 16.34± 6.00 0.46, p>0.05(NS)

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