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Research Article

Impact of Obstructive Sleep Apnoea on Blood Glucose Control and Pulmonary Functions in Type 2 Diabetes mellitus

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Abstract

Background: *Obstructive sleep apnoea (OSA) has an increased prevalence in type 2 Diabetes mellitus (T2DM) .OSA as a co morbid condition in T2DM is associated with insulin resistance. Type 2 Diabetes mellitus is associated with many systemic complications and it includes involvement of lungs also .OSA is asymptomatic disorder which is not routinely screened in T2DM.OSA and lung involvement in diabetes are associated with poor oxygen saturation of blood. The impact of OSA in blood glucose control and pulmonary functions are poorly studied*

Methods: *This prospective cross sectional study was conducted on T2DM patients in a tertiary care hospital. About 104 T2DM patients recruited from department of general medicine. Stop Bang questionnaire was used evaluate the presence of OSA. Pulmonary function test assessed with computerized spirometer. The Patient's FBS, PPBS HbA1c and anthropometry were measured. Based on the presences of OSA, T2D Patients grouped in to two categories. Group 1 -T2 DM with OSA and group 2 T2DM without OSA. Influence of OSA on blood glucose studied by comparing the variables between two groups*

Results: *A total of 104 T2DM studied .A total of 52 patients in the OSA group and 52 in Non-OSA group were encountered.OSA scores showed a positive correlation with weight and duration of diabetes and a negative correlation with FEV1 and PEFR*

Conclusions: *Obstructive sleep apnoea thus causes an impairment in the blood glucose control. OSA may cause a decreases in the pulmonary functions*

Keywords: *OSA, T2DM, HbA1c, PFT, FBS, PPBS, Waist circumference and Duration of Diabetes.*

Introduction

Obstructive sleep apnoea (OSA) is a sleep related breathing disorder associated with snoring, repetitive upper airway collapse during sleep leading to oxygen desaturation, sleep fragmentation, excessive daytime sleepiness[(1)]. Studies suggest that OSA is a important risk factor for insulin resistance and there is a relation between OSA severity and insulin resistance[(2)]. Lungs play an important role in delivery of oxygen. The oxygen plays a vital role in glucose metabolism as proved in a study were CPAP (continuous positive airway pressure) therapy administered for OSA reduced blood glucose[(3,4)]

T2DM subjects have interstial lung disease which manifest as restrictive lung disease as a complication of T2DM[5]. While lung disease may cause oxygen de saturation, OSA will Cause nocturnal hypoxemia[6] .The hypoxia produced as a result of both will future cause glucose metabolism deregulation and poor outcome in T2DM patients. The primary pathophysiology of OSA is intermittent hypoxemia[7,8] The anaerobic threshold for diabetes is considerable low than nondiabetic[9]. In humans, exposure to intermittent hypoxia for thirty minutes resulted in increase in sympathetic activity, chemo reflex activity and pancreatic beta cell apoptosis.[10,11]. Insulin resistance and beta cell dysfunction does not reverse after cessation of hypoxia[12]. Impaired glycemic control caused altered diffusion capacity for oxygen and carbon dioxide in the capillaries of T2DM after controlling for duration of diabetes [13,14]. T2DM are not routinely screened for OSA and for presence of pulmonary function disorders .The aim of the present study is to find the presence of OSA in T2DM using stop bang questionnaire and to study the effect of OSA in glucose control and pulmonary functions .We hypothesized OSA and pulmonary function relationship is dependant in the study sample .The sleep heart study established a relationship between OSA and T2DM. The assessment of OSA in that study was done through polysomanography which was a time consuming and an expensive procedure .We hypothesized to predict OSA with a simple pulmonary function test and a stop bang questionnaire so that OSA could be predicted in a T2DM in a primary care hospitals and in rural areas.

Methods

Description of subjects:

Study was started after obtaining the institutional ethics committee approval. Data was collected from 2015 June to 2015 December .Informed consent in the written format was taken from all the patients who participated in the study. About 104 T2DM patients participated in the study T2DM patients greater than 18years old and on documented treatment were included in the study. Subjects with respiratory disorders, neuromuscular disorder, stroke, history of use of alcohol, sedatives, on CPAP treatment for OSA or any other breathing related sleep disorder were excluded from study. History of duration of diabetes mellitus was recorded.

Measurement of Pulmonary function and OSA:

Parameters analysed include pulmonary function test with computerized digital spirometry (True flow easy on pc sensor-219281). Spirometry calibration was checked every day. Calibration was adjusted for Indian race. Disposable mouth piece used and filters were also changed for each subject. Nose clips used. A demonstration was given to the subject regarding the procedure. Subject practiced the manoeuvre before the test. Three test recordings done. Recording done on the same time of everyday to prevent a diurnal variation. Flow volume loops recorded. The best of the three readings considered. PFT study protocol was strictly adhered to American thoracic society guidelines. Test procedure was explained and prior training was given to each participant. The test was done at around 9.00 am depending on the availability of the patients in the health care unit. From the best of three trials, FVC% (forced vital capacity), FEV1 (forced expiratory volume in 1 second and 6 seconds in L/sec) MMEFR (maximum mid expiratory flow rate in percentage), PEFR (Peak expiratory flow rate) FEV1/FVC ratio in percentage were recorded 2.Stop bang questionnaire. STOP- BANG questionnaire is a standard recommended scoring tool used to screen for OSA. This questionnaire was given to all the study subjects to find out the prevalence of OSA. A score of greater than 3 was considered positive for obstructive sleep apnea. Based on the scores obtained the study population was divided into two groups: Group 1: T2DM patients with STOP - BANG questionnaire score greater than 3 and Group 2: T2DM patients with

STOP- BANG questionnaire score lesser than 3.[15]

Biochemical and anthropometry

Height, weight, neck circumference and waist circumference recorded by investigator who was trained Neck circumference measured at a level just above thyroid cartilage. Patients were instructed to stand erect and remove all the items from the pocket emptied, height and weight recorded with electronic weighing machine and stadiometer. Waist circumference was measured with non stretchable measuring tape. The patients were asked to stand erect with feet close to each other. Measuring tape was placed around the waist, at the level of umbilicus and measurement recorded in centimeters**.** Glycatedhemoglobin (HbA1C) measured using ion exchange chromatography (DS5 Analyzer, Drew Scientific Limited, Cumbria, U.K) from the venous blood sample**.** Fasting and postprandial blood glucose measurement were done and reported in g/dl. Patients were diagnosed as type2 diabetes according to American diabetes association recommendation(16) of fasting plasma glucose of 126mg/dl or greater and post prandial glucose of 200mg/dl or greater and patients who were on documented treatment for diabetes were included.

Statistical Analysis

Statistically analysis was done with SPSS 18 software using a level of significance $p < 0.05$. Quantitative variables with normal distribution were expressed as mean and standard deviation. t test used was used for comparison of continuous variable between OSA group and non OSA group .Pearson's correlation was used to study the relationship of OSA scores with different variables.

Results

The characteristics of the study population and the comorbidities are summarized in table 1 .The average age of the OSA group (48.77±8.46) was considerably higher than non OSA group (38.00±9.70) and it was statistically significant $p<0.005$.The average HbA1c in OSA group (11.48±2.67) and in Non OSA (and 8.75±3.29) was significant $p<.029$. Comorbid condition like systolic and diastolic blood pressure were also significant increased in OSA group. The Peak expiratory flow was considerably low in OSA group than in non OSA group and it was significant while other pulmonary functions like FVC, FEV1, MMEF and FEV1/FVC ratio was considerably less in OSA group than in Non OSA group they were not significant. The Mean fasting blood sugar in OSA group was 210mg/dl in Non OSA it was only 184mg/dl the PPBS was 292mg/dl in OSA group while in non OSA group it was 184mg/dl though it was not significant . Analysis showed a positive correlation of OSA scores of stop bang questionnaire with systolic blood pressure, waist measurement, neck circumference and duration of diabetes and showed a negative correlation with FEV1, FEV and PEFR

The pulmonary function of OSA group is considerably reduced when compared to non OSA group.OSA scores showed a negative correlation with FEV1, FEV6 and PEF showing with increase in scores the pulmonary functions would be adversely affected. PEFR is significantly reduced in T2DM. The neck circumference was significantly highly in the OSA group and many of them had high blood pressure.

Table I Comparison of type2 DM with OSA and Non OSA

Parameter	T2DM without OSA	T2DM with OSA	P
N	52	52	
Age	38.00±9.70	48.77±8.46	0.006*
Height cms	157.00± 6.16	163.08± 5.95	0.017
Weight Kgs	67.00± 12.79	74.37± 12.71	.154
HbA1c(%)	8.75± 3.29	11.48± 2.67	.029*
FBS(g/dl)	184.31 ± 90.40	210.67± 78.39	.446
PPBS(g/dl)	285.00± 22.58	292.92± 23.46	.874
FVC (%)	67.61±17.59	59.96± 42.78	.560
FEV1(lit)	2.15± .77	1.58± .88	.088
FEV6(%)	2.29±.78	1.79 ± 1.22	.226
MMEFR(%)	64.81± 38.96	45.80 ± 40.72	.236
PEFR(%)	51.99± 22.00	29.83 ± 29.95	.042*
FEV1/FVC	68.28± 47.70	55.53± 29.37	.210
OSA score	5.0±1.58	2.5± 1.50	.000*
NC	41.69± 2.17	31.69± .854	.000*

All the data given are mean ± SD. All the comparison were made with ANOVA and Turkey's multiple comparison with level of significance (P<0.05).* - denotes significant difference

Ht-height, Wt-weight,. FVC-Forced Vital capacity,FEV1-Forced expiratory volume in 1 second,FEV6-Forced expiratory volume in 6 seconds, MMEF-Maximum Mid Expiratory flow rate, PEF-Peak expiratory flow, FBS-fasting blood sugar, PPBS-Post Prandial blood sugar, NC-Neck Circumference

Table II Correlations of Stop Bang OSA scores with clinical measurements and metabolic variables derived through univariate analysis

Parameter	R	P	Sig
Age	.409	.038	*
Htcms	.165	.422	NS
Weight cms	.378	.057	NS
Pulse rate	-.044	.285	*
SBPmm/Hg	.593	.001	**
DBP mm/Hg	.372	.061	NS
CM cms	.139	.049	NS
WM cms	.392	.048	*
HbA1c(%)	.307	.127	NS
DM Duration	.571	.002	**
FVC (lit)	-.289	.461	NS
FEV1(%)	-.597	.001	**
FEV6(%)	-.433	.027	*
MMEF(%)	-.154	.451	NS
PEF(%)	-.480	.015	*
FEVI/FVC (%)	-.057	.783	NS
FBS (g/dl)	.203	.330	NS
PPBS (g/dl)	.229	.271	NS

level of significance (P<0.05).*- denotes significant single tailed **-denotes significance double tailed, Ht-height, Wt-weight, SBP-systolic blood pressure, DBP-Diastolic blood pressure, CM-Chest measurement, WM-Waist measurement, FVC-Forced Vital capacity,FEV1-Forced expiratory volume in 1 second,FEV6-Forced expiratory volume in 6 seconds, PEF-Peak expiratory flow, FBS-fasting blood sugar, PPBS-Post Prandial blood sugar

Discussion

In this study we used stop bang questionnaire to find out the prevalence of OSA in T2DM and with that we had documented a 50% prevalence of OSA in T2DM. while in general population in India the prevalence is 13% as stated by Udwadi et al .In USA pillai reported a incidence of 58%[3]

West *et al.* reported that about 23% of patients with type 2 diabetes mellitus (T2DM) had OSA and most of these patients were not diagnosed[19]. The OSA positive group presented with high mean age than non OSA group similar to findings in previous studies in a study done by young et al it was stated that T2DM aged greater than 60 are

more prone for OSA, so all aged T2DM patients must be screened for OSA.OSA is a predisposing factor for insulin resistance and lipogenesis due to endothelial disorder. Fat distribution in the body plays an important role in the development of OSA .Fat deposition in neck leads to narrowing of airway. Patients in the OSA group had a statistically higher neck circumference .The waist circumference was positively correlated with OSA scores that substantiate other studies T2DM with increased waist circumference are more prone for OSA[17]. The waist circumference is a proxy of insulin resistance .The increased insulin resistance explained the high blood glucose values in the T2DM with OSA than in non- OSA group. A waist circumference of more than 90 cm is considered a risk factor.[18] The blood glucose control in the OSA group was poor as reflected by HbA1c. The HbA1c values correlated with OSA scores which reflected that with increase in OSA scores there would be increase in blood glucose. The autonomic neuropathy of diabetes mellitus may also cause OSA where in a study it was proved that osa is more common in diabetes with autonomic neuropathy[19] in our study we had excluded participants with autonomic neuropathy. Diabetes is associated with endothelial injury[20] this had been proved in our study were the systolic blood pressure was high in the OSA group than in the Non OSA group and correlated to the OSA scores in a study with urban population hypertension was a predictor of OSA[21] . The FBS and PPBS mean values were considerably elevated in T2DM in the OSA group than in Non OSA even though it is not a significant difference proving OSA will lead to glucose control deregulation as was observed in these studies[22]. Decreased pulmonary volumes and its negative correlation with OSA scores suggest that with increase in OSA scores there is a decrease in pulmonary functions. Diabetes cause more damage to microcirculation of lungs[23] this may cause nocturnal parasympathetic instability[24] which will further increase blood sugar value. In a study when apnea revision was done with CPAP there as a improvement in the blood sugar[25]. The coexistences of OSA and decreased pulmonary functions is associated with risk of hypercapnia and hypertension of pulmonary arteries[26] so there is a need for early diagnosis of OSA and pulmonary dysfunction in T2DM .CPAP treatment for OSA reduce the levels of oxidative stress[27], so CPAP can used as a treatment for T2DM with OSA for better control of blood sugar and prevention of pulmonary complications. Thus all T2DM patients need to be screened for OSA and treated adequately to control the blood sugar and to prevent pulmonary dysfunction

Conclusion

OSA in T2DM is associated with impaired blood glucose control and pulmonary dysfunction

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Ethical approval: Institutional ethical committee approval obtained

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