ORIGINAL ARTICLE

Assessment of Respiratory Muscle Endurance in Type 1 & 2 Diabetes Mellitus

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Abstract

Maximum Voluntary Ventilation (MVV) test is an objective dynamic method of measuring the working capacity of respiratory muscles. Therefore, we designed the present study to determine the effect imposed by diabetes mellitus (Type 2) on respiratory muscle endurance in Jammu diabetic patients. In the present study, 100 diabetic patients of 50 Type I and 50 Type 2 and 50 healthy control. MVV showed significant decrease in male diabetic patients on oral medication. The findings suggest that there is significant decrease of respiratory muscle endurance in male diabetics on oral medication.

Key Words

Maximum Voluntary Ventilation (MVV), Type 2 Diabetes Mellitus (Type 2 DM), Enduracnce

Introduction

Diabetes mellitus is a syndrome complex with complications that affect the eyes, kidneys, nervous system, heart, skin, liver functions and colagen metabolism (1). It is the most common metabolic disorder and its prevalence is increasing in several regions of world especially developing countries like India. The prevalence of diabetes in India is 8-10%. About 2.4% of rural population and 8.4% of urban population is affected by diabetes. Asian Indians who have migrated from India have high prevalence of Type 2 DM. Western interferences and changes in food pattern from traditional unprocessed natural ingredients to highly refined, energy rich, fatty and sugary fast foods are responsible for high incidence of diabetes in the years to come (2). Type 2 DM is far more common than Type 1 DM, accounting for 80-90% of all classes of DM (3).The reduction in inspiratory vital capacity in diabetic patients may be caused partly by reduced capacity of inspiratory muscles. Inspiratory muscle strength was not impaired in diabetic patients, their endurance was reduced. This might be due to possible correlation with duration of diabetes and quality of metabolic control (HbA1c).Maximum ventilation volume is a good index of respiratory endurance. Diabetic patients showed significantly lower endurance of inspiratory muscles as assessed by 12-s MVV test despite the fact that 12-s MVV produces brief maximum rather than prolonged endurance effort. Reduction in MVV most likely reflect decrease of respiratory muscle endurance (4).Patients with IDDM may have an impaired ability to perceive inspiratory resistive loads that is diminished ability to perceive respiratory sensations (5).It was important to conduct the study as no much information is available on the association of MVV with Type 2 DM.

Materials and Methods

Study was carried out in the Department of Physiology in collaboration with Endocrinology Department of Govt. Medical College, Jammu. Subjects were selected from the Endocrinology Outpatient Department. A written informed consent was obtained. Subjects selected were not suffering from COPD, occupational diseases, smokers. A total of 100 patients and 50 health controls were included in the study. One hundred patients consist of 50 of Group I (on oral medication), 50 of Group II (on insulin administration) and rest 50 healthy controls.

Procedure: All the patients and healthy controls were subjected to general physical examination. Physical examination included anthropometric measurements such as height, weight, body surface area, BMI, chest circumference, according to the standard recommended by WHO. Also blood sugar F and random was taken to ensure the diabetic status of the patients and healthy controls. MVV tests were performed by computerized Spirometer (Records and Medicare, Chandigarh)

For MVV Test : First machine was switched over to the MVV test mode alongwith display of time period of selected test. Demonstration was given to the patient

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Table 1 Showing duration of diabetes (in years) in Group I and Group II Chi-square (2) = 7.86; df = 1; p value < 0.005

Duration	Group I (n = 50)	Group II (n = 50)	Total
5 - 10 years	46 (92%)	35 (70%)	81
10 - 15 years	4 (8%)	15 (30%)	19
Total	50	50	100

Table 2 . Table Showing Overall Comparison Of Anthropometric Profiles And MVV Among Patients With DM (Group I and Group II) And Healthy Controls (Group III) **Highly Significant; NS - Non-significant

Anthropometric variables	Mean ± SD (Range)			'p' value (<)		
	Group I (n = 50)	Group II (n = 50)	Group III (n = 50)	Group I vs Group II	Group I vs Group III	Group II vs Group III
Age (in years)	52 ± 7.73 (40-70)	50.16 ± 8.71 (40-78)	49.32 ± 7.21 (40-71)	NS	NS	NS
Height (in cms)	159.26 ± 9.52 (138-179)	162.64 ± 9.93 (147-185)	159.66 ± 8.86 (143-147)	NS	NS	NS
Weight (in kgs)	64.76 ± 7.92 (45-82)	66.60 ± 14.50 (40-115)	63.72 ± 12.20 (35-96)	NS	NS	NS
Body Surface Area (m^2)	1.671 ± 0.12 (1.33-1.96)	1.71 ± 0.21 (1.35-2.38)	1.672 ± 0.20 (1.22-2.40)	NS	NS	NS
BMI (kg/m^2)	25.77 ± 3.74 (16.85-34.24)	25.20 ± 4.53 (16.22-37.94)	24.94 ± 4.22 (16.19-37.1)	NS	NS	NS
Chest (cms)	93.14 ± 9.24 (62-112)	95.94 ± 10.92 (70-134)	93.56 ± 8.83 (80-118)	NS	NS	NS
MVV (L/cm)	65.08 ± 28.03 (19.02-128.77)	70.05 ± 26.83 (25.85-158.04)	80.67 ± 29.70 (8.29-149.25)	NS	0.008**	NS
BGF (mgm%)	141.78 ± 36.61 (93-307)	148.06 ± 44.18 (75-276)	85.96 ± 9.25 (56-110)	NS	0.008**	0.008**
BSPP (mg%)	203.94 ± 57.96 (121-512)	213.14 ± 63.97 (126-437)	115.8 ± 8.09 (104-132)	NS	0.008**	0.008**

Table 3. Table Showing Comparison of Mean BGF Among Group I, Group II and Group III in Males and Females

Sex	BGF (mg%) Mean ± SD (Range)			'p' value (<) **Highly Significant; NS - Non-significant		
	Group I	Group II	Group III	Group I vs Group II	Group I vs Group III	Group II vs Group III
Males (n = 30)	136.8 ± 38.8 (93-307)	148.83 ± 39.26 (96-245)	87 ± 8.78 (56-102)	NS	0.008**	0.008**
Females (n = 20)	149.25 ± 32.48 (104-240)	146.9 ± 51.75 (75-276)	84.4 ± 9.93 (70-110)	NS	0.008**	0.008**

Table 4 . Table showing comparison of mean MVV among Group I, Group II and Group III in males and females

Sex	MVV (L/min) Mean ± SD (Range)			'p' value (<)		
	Group I	Group II	Group III	Group I vs Group II	Group I vs Group III	Group II vs Group III
Males (n = 30)	75.68 ± 29.4 (31.7-128.77)	77.37 ± 27.08 (29.75-158.04)	95.20 ± 29.30 (8.29-149.25)	NS	0.008**	NS
Females (n = 20)	49.16 ± 15.9 (19.02-73.17)	59.06 ± 22.92 (25.85-109.75)	58.87 ± 12.0 (38.53-85.36)	NS	NS	NS

how to perform the test. Time period was selected and entered. The patient was asked to inhale and exhale through the mouth piece of transducer till the selected time period was over (a long beep from beeper, confirmed the completion of current test). After maneover was completed, the predicted and actual value of performed test was displayed and its prints taken out. Best of three readings were taken as final.

Statistical Analysis

Data was analysed by using statistical software Microsoft Excel and SPSS 10.0 for Windows. For quantitative variables, mean and standard deviations were calcualted. Statistical significance in lung volumes was assessed by the use of One Way Analysis of Variance (ANOVA) followed by Bonferroni 't' to evaluate intergroup comparisons. Chi-square test was applied to assess significance among categorical variables. A p value of < 0.5 was considered as statistically significant except in case of posterior test after ANOVA where a p value of < 0.008 was used to reject null hypothesis.

Results

The results of anthropometry, pulmonary functions (MVV), overall and in gender are presented in *Tables 1 to 4*. The tables also show the comparison between Group I vs Group II, Group I vs Group III and Group II vs Group III.

Discussion

Maximum Voluntary Ventilation is a dynamic test of lung function and also a good index of respiratory muscle endurance (4).MVV is most widely used pulmonary function test.MVV or previously called Maximum breathing capacity is the largest volume of gas that can be moved into and out of the lungs in one minute by voluntary effort .The normal MVV is 125-170 L/min.

This test clearly demonstrates all the mechanical factors of breathing and becomes abnormal when there is increase in airway resistance, reduced compliance or respiratory muscle force. This is basically a tool in correlating with subjective dysponea and also helpful in

evaluating exercise tolerance (Respiratory reserve) and have prognostic value in preoperative and postoperative surgical respiratory problem. In addition it provides a measure of respiratory muscle fatigue which is the largest drawback of this test.The values are affected by loss of co-ordination of respiratory muscles, musculoskeltal diseases of chest wall, neurological disorders, deconditioning from any chronic illness i.e. COPD, mild or moderate restrictive lung diseases such as tachypnoea. MVV is an athletic event, a low MVV can occur in pulmonary obstructive diseases, heart diseases, in a patient who does not try or does not understand or in a frail state. It correlates well with subject's exercise capacity and also useful for estimating the subject's ability to withstand certain types of major operations (7). In the present study, overall intergroup comparisons revealed that statistical significant difference existed between Group I Vs Group III ($p< 0.008$) and no statistically significant difference existed between Group I Vs Group II and Group II Vs Group III, when Bonferroni 't'procedure was applied.Similarly, statistically significant difference existed only between Group I Vs Group II ($p < 0.008$) while in females the difference was statistically insignificant when Bonferroni 't' procedure was applied (*Table 4*). In this study the mean values of MVV was significantly lower ($p < 0.008$) in male diabetics on oral medication as compared to controls. Similar observations were reported by Wanke *et al*.(4) who observed significantly lower endurance of inspiratory muscles as assessed by12-s MVV tests .

This is in accordance in with another study conducted by Meo SA *et al* (8) that showed that in type 2 diabetic patients, respiratory muscle endurance is impaired as evidenced by decrease in MVV values .This further showed that diabetic patients have a reduced inhaled and exhaled volumes during consecutive breaths. The results of our study are in agreement with study conducted by Correa *et al* (9) that showed patients with type 2 DM may frequently present inspiratory muscle weakness. In these patients inspiratory muscle training improves inspiratory muscle function. Similar observations were made by Fusol *et al* (10) that showed that in type 2 DM respiratory muscle strength was reduced which was significantly related to lung volumes and quality of metabolic control where as impaired endurance of respiratory muscles prevailed in patients with micro vascular complications. Recently study conducted by Nandhini R *et al* (11) showed reduced MVV in type 2 DM patients. The reduced MVV indicated the reduced endurance of the respiratory muscles thus indicating the respiratory muscle weakness in DM. The possible explanation is that in DM thickening of basement membrane of various tissues including phrenic nerve tissue leads to demyelination and chromatolysis of axons and schwann cells which would be the reason for reduced respiratory muscle strength. Hence early detection of respiratory myopathy through simple spirometry as a routine test is essential for preventing respiratory complications outcome which is caused by DM.There is no review of literature to negate the observations made during this study.

Conclusion

On the basis of results it was concluded that mean MVV was significantly decreased in male diabetic patients on oral medication only i.e. type 2 DM that shows decrease in respiratory muscle endurance in male diabetics on oral medication. This finding is in agreement with most of studies so far undertaken by different authors.

References

1. Ramirez LC, Nagare AD, Hsia C, *et al.* Relationship between diabetes control and pulmonary function in insulin dependent diabetes mellitus. *Am J Med*1991:91: 371-76
2. Sreeja CK, Samuel E, Kesavach andran C,Shashidhar S. Pulmonary function in Patients with Diabetes Mellitus. *IJPP* 2003:47(1):87-93
3. Hall JE. Insulin, Glucagon and Diabetes Mellitus.Guyton and Hall textbook of Medical Physiology, 12th Edition :Saunders, Philadelphia. 2011.pp. 939-54.
4. Wanke T, Formanek D, Auinger M, *et al*. Inspiratory muscle performance and pulmonary function changes in insulin dependent diabetes mellitus. *Am Rev Respir Di*s 1991:91 371-76
5. Donell CR, Friedman LS, Russomanna JH, Rose RM. Diminished perception of inspiratory - resistive loads in insulin depenent diabetics. *NEJM* 1998 : 319 (21) : 1369-73.
6. Barrett KE, Barman SM , Boitano S,Brooks HL.Endocrine functions of pancreas and regulation of carbohydrate metabolism.Ganong's Review of Medical Physiology, 23rd Edition : Tata McGraw-Hill Education Pvt. Limited ,New Delhi. 2010 .pp.315-36.
7. Hyatt RE, Scanlon PD, Nakamura M. Spirometry : Dynamic lung functions.Interpretation of Pulmonary Test - A Practical Guide, 2nd Edition,Lippincott, William's and Wilkin's, Philadelphia.2003.pp.5-26.
8. Meo SA , Al-Dress AM, Arif M ,Shah, FA, Al-Rubean K. Assessment of respiratory muscles endurance in diabetic patients.*Saudi Med J* 2006 : 27: 223-26.
9. Correa AP, Ribeiro JP ,Balzan FM,*et al.* Inspiratory muscle training in Type 2 Diabetes with inspiratory Muscle Weakness. *Med Sci Sports Exerc* 2011:43(7) :1135-41
10. Fusol ,Pitocco D, Longobardi A, *et al*. Reduced respiratory muscle strength and endurance in type 2 Diabetes Mellitus *Diabetes Metab Res Rev* 2012 :28(4) : 370-75.
11. Nandhini R,Syed Safina SS,Saikumar P.Respiratory myopathy in type 2 Diabetes mellitus. *JCDR* 2012: 4107 : 2084.