

EARLY DETECTION OF CARDIAC FAILURE IN CHRONIC OBSTRUCTIVE PULMONARY DISEASE PATIENTS

Mevo Khan Zardari, Sikander Adil Mughal, Safdar Ali Shaikh*, Muhammad Azhar Mughal**, Syed Tousif Ahmed***

Department of Physiology, People's Medical College for Girls, Nawabshah, *Department of Physiology, Chandka Medical College, Larkana, **Department of Pharmacology, Sindh Medical College, Dow University of Health Sciences, Karachi, ***Department of Physiology, Ziauddin Medical College, Ziauddin University, Clifton Karachi.

Background: During the past 20 years the incidence of Chronic Obstructive Pulmonary Disease (COPD) has increased considerably. In most patients with severe COPD if they live long enough cor pulmonale eventually developed. The present study was designed for detection of cardiac failure in COPD subjects by Valsalva manoeuvre, i.e., Valsalva ratio, may offer the best chance to check and decrease the rising trend of mortality due to COPD. **Methods:** A total of 120 male subjects were included during the course of present study. The patients suffering from COPD were selected from the Medical Department and Chest Medicine of Jinnah Postgraduate Medical Centre Karachi. The patients were selected on the basis of history and clinical examination and confirmed by x-ray chest and pulmonary function by Spirometry. **Results:** The mean value for the age subgroups B and C of control were significant when compared with age sub groups B and C of COPD subjects without cardiac failure except sub age group A. The mean values for all the three age subgroups of control were highly significant ($p < 0.001$) when compared with the mean value of corresponding age subgroups of COPD subjects with cardiac failure. This study revealed that the Valsalva ratio in the control subject of all age groups and COPD without cardiac failure in young age subgroups was above 1.5 and slightly decreased with increasing age. All the COPD with cardiac failure subjects showed an abnormal Valsalva ratio. **Conclusion:** It is concluded that in the presence of Physician, arterial pressure response during Valsalva manoeuvre, i.e., Valsalva ratio is a simple safe and non-invasive technique in early detection of cardiac failure, which also provide a reliable estimation of its severity.

Keywords: Chronic Obstructive Pulmonary Diseases, Valsalva manoeuvre, Cardiac Failure, Spirometry

INTRODUCTION

Chronic Obstructive Pulmonary Disease (COPD) is defined as airflow limitation that is not fully reversible, is gradually progressive, and is associated with an abnormal inflammatory lung response to noxious particles or gases.¹ The global burden of COPD is increasing, the disease is projected to be the third leading cause of death and fifth leading cause of over all disability world wide by 2020.^{2,3} COPD is usually the combination of chronic bronchitis and emphysema seen most often in man older than 40 years and characterized by obstruction of airways with air trapping and hyperinflation of lungs.^{4, 5} In most patients with severe COPD, if they live long enough, cor pulmonale will eventually develop. The primary factor is the development of cor pulmonale in COPD is pulmonary hypertension caused by pulmonary arteriolar constriction associated with alveolar hypoxia.⁶ Over the Past two decades, important information has been provided indicating that the severity of pulmonary hypertension and the development of cor pulmonale are major factors influencing mortality in COPD.^{7,8} Congested heart failure is a significant clinical problem and its prognosis is poor irrespective of treatment. Therefore the purpose of this study was an early detection of cardiac failure which may offer the best chances for

reducing mortality from congestive heart failure by non-invasive technique Valsalva ratio.

MATERIAL AND METHODS

A total of 120 male subjects of different age groups were included during the course of present study, out of which 80 subjects were patients and 40 subjects were control, the patients suffering from COPD were selected from the Medical Department and Chest Medicine of Jinnah Postgraduate Medical Centre, Karachi. The patients were selected on the basis of history and clinical examination and confirmed by six-feet standing postero-anterior chest radiographs and pulmonary functions by spirometry. The COPD patients were divided into two groups by echocardiography, COPD without cardiac failure and COPD with cardiac failure. The Valsalva manoeuvre was performed in a standardized manner in the lying position, and was trained to maintain an expiratory pressure of 40 mmHg for 10 seconds. During each manoeuvre heart rate was recorded continuously throughout the strain period and for 15 seconds following release of the strain by means of an electrocardiograph, the points at which Valsalva manoeuvre started and stopped were marked by a marker button. The difference between the shortest R-R interval during and the longest R-R interval after the strain period was expressed in beats/minute. The

heart rate changes induced by each manoeuvre were expressed as the ratio of the maximal tachycardia to the maximal bradycardia. This ratio was defined as the Valsalva ratio and was calculated as the ratio of the maximal R-R interval to the minimal R-R interval.⁹

$$\text{Valsalva Ratio} = \frac{\text{Maximal tachycardia (beats/minutes)}}{\text{Maximal bradycardia (beats/minutes)}}$$

As suggested by Levin⁹ that, the Valsalva ratio of 1.50 was a convenient lower limit of normal and below this value was defined as the abnormal Valsalva ratio.

RESULTS

Table-1 shows the mean age of subjects in the three age sub groups of control, COPD subjects without cardiac failure, and COPD subjects with cardiac failure, when compared with the corresponding age subgroups of controls, the mean age of subjects in the three age sub groups of COPD subjects without and with cardiac failure were statistically insignificant. Similarly the mean age of subjects in the three age sub groups of COPD without cardiac failure was statistically insignificant, when compared with the corresponding age sub groups of COPD subjects with cardiac failure.

Table-2 shows the mean value for the age sub groups B and C was significant ($p < 0.01$) when compared with the corresponding age sub groups of COPD subjects without cardiac failure while sub age group A of controls was statistically insignificant. The mean values of all the three age sub groups of controls were highly significantly ($p < 0.001$) decreased when compared with the mean values of corresponding age sub groups of COPD with cardiac failure. The Valsalva ratio was above 1.5 in all age subgroups of control subjects while decreasing with increasing age, while Valsalva ratio in COPD with cardiac failure subjects was abnormal.

Table-1: Age of Controls, COPD without Cardiac Failure and COPD with Cardiac failure subjects

Group No.	Subjects	Age Sub-Groups (Years)		
		A 30-44	B 45-59	C 60-74
1.	Control (40)	35.73 ±1.32 (14)	50.60 ±1.41 (13)	66.44 ±1.40 (13)
2.	COPD without cardiac failure (40)	36.40 ±1.31 (13)	52.00 ±1.08 (15)	65.54 ±1.19 (12)
3.	COPD with cardiac failure (40)	37.89 ±1.71 (12)	51.10 ±1.40 (14)	66.45 ±1.47 (14)

Number of subjects is given in parenthesis; Values are in years as Mean±SEM. Compared with normal, all the values are insignificant.

Table-2: Valsalva Ratio in Different Age Groups of Control, COPD without Cardiac Failure, and COPD with Cardiac failure subjects

Group No.	Subjects	Age Sub groups (years)		
		A 30-44	B 45-59	C 60-74
1.	Control (40)	1.70 ±0.07 (14)	1.62 ±0.05 (13)	1.58 ±0.06 (13)
2.	COPD without cardiac failure (40)	1.52 ±0.09 (13)	1.38 ±0.06* (15)	1.35 ±0.08* (12)
3.	COPD with cardiac failure (40)	1.20 ±0.06** (12)	1.10 ±0.04** (14)	1.02 ±0.05** (14)

* $p < 0.01$ as compared with group 1

** $p < 0.001$ as compared with group 1

DISCUSSION

During the past twenty years the incidence of chronic obstructive pulmonary disease (COPD) has increased considerably and it has become the most prevalent chronic respiratory problem in even many developed countries of the world^{6,10} and also the mortality from COPD has increased considerably during this period.^{11,12,13} The two major factor implicated in the mortality due to COPD are severity of pulmonary hypertension and development of cor pulmonale.^{7,8} Cor pulmonale develops in response to acute or chronic changes in the pulmonary vasculature and/or the lung parenchyma that are sufficient to cause pulmonary hypertension.¹⁴ Thus early detection of cardiac failure in COPD subjects, may offer the best chance to check and decrease this rising trend of mortality due to COPD. Heart rate variation during Valsalva manoeuvre, i.e., Valsalva ratio has been suggested to assess the prognosis of COPD subjects to the development of cardiac failure.^{4,9} The study reveals that the Valsalva ratio in the control subjects of all age group was above 1.5 and slightly decreased with increasing age, these results are in agreement with Levin.⁹ The Valsalva ratios in COPD without cardiac failure subjects except the sub age group A were significantly decreased ($p < 0.01$), while in COPD with cardiac failure subjects were highly significantly ($p < 0.001$) decreased when compared to control subjects. All the COPD with cardiac failure subjects showed an abnormal Valsalva ratio, these observations are in agreement with the work of Burrows and Earle⁴, Levin⁹, Malmberg *et al*¹⁵. In fact, the Valsalva ratio provides a valuable guidance to the development of right ventricular failure in patients with chronic obstructive pulmonary disease.

CONCLUSION

We concluded from our study that in the presence of a physician, arterial pressure response during Valsalva manoeuvre, i.e., Valsalva ratio is a simple safe and non-

invasive technique, in early detection of cardiac failure in COPD patients, which also provides a reliable estimation of its severity.

REFERENCES

1. Klaus FR, Suzanne H, Antonio A. Global strategy for the diagnosis, Management and Prevention of chronic obstructive pulmonary disease. *Am J Respir Crit Care Med* 2007;176:532–55.
2. Mannino DM, Homa DM, Akinbami LJ. Chronic obstructive pulmonary disease Surveillance-United States, 1971–2000. *Respir Care* 2002;47:1184–99.
3. Peters S. COPD: Will early detection and aggressive intervention control disease progression? *CME Today. Cardiopulm Crit Care* 2003;2(6):7–14.
4. Burrows, B. and Earle, R. H Course and prognosis of chronic obstructive lung disease. *N Engl J Med* 1969;280:397–404.
5. Williams MH. Jr, Shim CS. Ventilatory failure: Etiology and clinical forms. *Am J Med* 1970;48:477–83.
6. Ross JC. *Internal medicine*, 1st ed., Brown and Company Boston, 1983, pp: 335–47.
7. Renzetti AD. Jr, Mc Clement JH, Litt BD. The veterans Administration cooperative study of pulmonary function. III. Mortality in relation to respiratory function in chronic obstructive pulmonary disease. *Am J Med* 1966;41:115–29.
8. Burrows B, Kattel LJ, Niden AH, Rabinowitz M, Diener CF. Patterns of cardiovascular dysfunction in chronic obstructive lung disease. *N Engl J Med* 1972;286:912–8.
9. Levin AB. A simple test of cardiac function based upon the heart changes induced by the Valsalva manoeuvre. *Am J Cardiology* 1966;18:90–9.
10. Cochran GM, Prieto F, Hickey B, Benatar SR, Clark TJH. Early diagnosis of airways obstruction. *Thorax* 1974;29:389-93.
11. Bishop JM. Cardiovascular Publications of Chronic Bronchitis and Emphysema. *Medical Clinics of North America* 1973;57:771–80.
12. Keller CA, Shepard JW Jr., Chan DS, Vasquez P, Dolan GF. Pulmonary hypertension in chronic obstructive pulmonary disease. *Chest* 1986;90:185–92.
13. Anthonisen N. Chronic obstructive pulmonary disease. In L Goldman and Ausiello (eds.), *Cecil text book of Medicine*, 23rd ed. Philadelphia: Saunders Elsevier 2008, Ch. 18.
14. Douglas LM. Heart failure and Cor pulmonale. *Harrison's Principles of Internal Medicine*. Fauci AS, Braunwald E, Kasper DL, *et al.* Editors. 17th edition, Mc. Graw-Hill Companies, 2008:1453.
15. Malmberg R, Albrecht G, Baltazaar A, Buckingham WB, Levin H, Cugell DW. The Valsalva manoeuvre as a test of cardiac function in patients with pulmonary disease. *Am Rev Resp Dis* 1964;89:64–72.

Address for Correspondence:

Dr. Mevo Khan Zardari, Department of Physiology, People's Medical College for Girls, Nawabshah, Sindh, Pakistan.
Tel: +92-244-370085, Cell: +92-302-3205410.
Email: mkzardari@yahoo.com