



## EVALUATION OF LUNG FUNCTION TEST AND ARTERIAL BLOOD GAS FINDINGS IN PATIENTS WITH CORONARY ARTERY DISEASE

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**ABSTRACT** **Background:** Coronary artery disease (CAD) is a major cause of disability and death in the Indian population. There exist an association between impaired lung functions and increased risk of coronary artery disease. The acid-base balance provides clinical information useful for risk stratification of patients as acidosis characterizes with more severe myocardial dysfunction and outcomes. This study was undertaken with the objective to evaluate the association of lung function and arterial blood gases in patients with coronary artery disease in a tertiary centre in North-eastern region of India as there is paucity of data regarding the same in this part of the country. **Methods and Material:** A cross-sectional study was conducted among 100 patients with coronary artery disease admitted to the Intensive Coronary Care Unit (ICCU) and Medicine wards of a tertiary centre in North-East India. On presentation to hospital, routine investigations, biochemical and electrocardiographic test along with lung function test by spirometry ( $FEV_1$ , FVC,  $FEV_1/FVC$ ) and arterial blood gas findings ( $PaO_2$ ,  $PaCO_2$ , pH,  $HCO_3^-$ ) were accounted for in the study population. The study was carried out for a period of 2 (two) years from September 2018 to August 2020. **Results:** The mean age of the study population was  $62.87 \pm 7.3$  years, with age range from 41 to 80 years. 68% (68/100) were males and 32% (32/100) females. 65% (65/100) patients had hypertension as a risk factor. Coronary artery disease was more common in those with hypertension for more than 10 years at 52.3% compared to 6.2% in those with hypertension for less than 5 years. The lung function measured using the spirometric curves had restrictive pattern in 41% and obstructive pattern in 34% patients. The Arterial Blood Gas findings had 54% patients with  $pH < 7.35$ , 64% patients with partial pressure of oxygen  $PaO_2 < 75$  mmHg, 53% patients with partial pressure of carbon dioxide  $PaCO_2 < 35$  mmHg and 51% patients had  $HCO_3^- < 22$  mEq/L as measured on presentation to hospital. The study noted the association of obstructive pattern of spirometric curve in coronary artery disease patients with more severe lung function test and arterial blood gas analysis results. **Conclusions:** In our study we found that majority of coronary artery disease patients have low Lung Function Test values with associated acidosis, low  $PaO_2$ , low  $PaCO_2$  and base deficits on arterial blood gas analysis. The awareness of these complications is crucial in the management of patients of coronary artery disease so as to help mitigate the increasing burden of mortality associated with the disease.

**KEYWORDS :** Coronary Artery Disease, Hypertension, Lung Function Test, Arterial Blood Gas, Outcome

### INTRODUCTION

Ischemic heart disease is a condition resulting from an imbalance between myocardial oxygen demand and supply. The most common cause of myocardial ischemia is atherosclerotic disease of an epicardial coronary artery leading to decreased blood flow and inadequate perfusion of myocardium supplied by the involved coronary artery.<sup>1</sup> Along with the risk factors such as smoking, hypertension and diabetes, studies have noted an association between reduced pulmonary function and the risk of coronary heart disease morbidity and mortality.<sup>2</sup> The acid-base balance provides clinical information useful for risk stratification of patients as acidosis characterizes with severe myocardial dysfunction and outcomes.<sup>3</sup> The presence of anion gap acidosis is a predictor of short-term mortality independent of historical, biochemical and electrocardiographic data.<sup>4</sup> Higher forced expiratory volume in the first second ( $FEV_1$ ) and forced vital capacity (FVC) are associated with a decreased risk of coronary heart disease.<sup>5</sup>

Although the lung function test and arterial blood gas analysis in patients with coronary artery disease have been extensively studied elsewhere, there is paucity of data regarding the same in North-eastern region of India. This study was undertaken with the objective to evaluate the association of lung function and arterial blood gases in patients with coronary artery disease in North-East India.

### MATERIALS AND METHODS

#### Study design:

A hospital based cross sectional study was conducted from September 2018 to August 2020 among patients admitted in the Intensive coronary care unit (ICCU) and Medicine wards of Department of Medicine, Regional Institute of Medical Sciences (RIMS), Imphal, Manipur. The objective of the study was to evaluate the association of lung function and arterial blood gases in patients with coronary artery

disease. The study was approved by the Research Ethics Board, Regional Institute of Medical Sciences, Imphal. Vide letter No. A/206/REB-Comm(SP)/RIMS/2015/419/37/2018. The participants were informed about the nature of the study which was documented in the participant information sheet and only those who gave consent to be a part of the study were included. Their participation was completely voluntary and right to deny to participation in the study was reserved. Through out the study privacy and confidentiality was maintained at all cost for each participant by coding of patient's data. The data collected was documented and analysed statistically to draw a useful conclusion.

#### Inclusion criteria:

Patients aged above 18 years diagnosed with coronary artery disease who gave consent for participation in the study.

#### Exclusion criteria:

Patients diagnosed with Interstitial Lung Disease, kyphoscoliosis, thoracic malignancies and pleuro-pericardial effusions and those not willing to participate in the study.

#### Independent variables:

Age, Gender, Height, Weight, Smoking, Hypertension, Diabetes, Dyslipidemia.

#### Dependent variables:

Lung Function test ( $FEV_1$ , FVC,  $FEV_1/FVC$ ), Arterial Blood Gas findings ( $PaO_2$ ,  $PaCO_2$ , pH,  $HCO_3^-$ ), 12 Lead Electrocardiogram, Echocardiography, Serum Cardiac Markers CK-MB, Troponin-I, Serum Lipid profile.

#### Sample size calculation:

A sample size of 81 was calculated as per the study done by Fernandes et al<sup>10</sup>, the prevalence of abnormal lung function in Coronary artery

disease patients was 28%.

**Procedure:**

The patients were subjected to history taking and clinical examination using a predesigned pro forma. Spirometry was performed using Helios 702 spirometer, ISO 9001:2008, EN ISO 13485:2003 by recorders & Medicare systems (P) Ltd India. Pulmonary Function Tests was done for each patient when their condition allowed using a portable computerized spirometer and measured for forced vital capacity (FVC) and forced expiratory volume in the first second (FEV<sub>1</sub>). The ratio between the forced expiratory volume in the first second and the forced vital capacity (FEV<sub>1</sub>/FVC) was calculated. The values were presented as a percentage from the predictive values, computed according to the patient's age, gender and height and considered normal if the score is 80% or greater of the predictive values. The spirometry graphs were described as restrictive or obstructive patterns according to FVC and FEV<sub>1</sub> value curves. An obstructive pattern had FVC normal or reduced and FEV<sub>1</sub> and the ratio of FEV<sub>1</sub>/FVC ratio reduced. While a restrictive pattern had FVC reduced and FEV<sub>1</sub> normal or reduced but the ratio of FEV<sub>1</sub>/FVC is normal. The arterial blood gas was analysed using the Radiometer Blood Gas Analyser Flex ABL80 by Radiometer Co, Hyderabad. Electrocardiogram was recorded using Clarity Med, model: ECG 100D-3Ch, manufactured in India. Echocardiography was performed using SONOACE X8 Version 2.03.00. M345-E20300-00 manufactured in Korea. cTnI Fluorescent Immuno Assay Test Kit was used to measure Cardiac Troponin I levels. Creatine Kinase-MB and Serum Lipid levels were measured using RANDOX RX IMOLA auto-analyser Rx4900.

**Statistical analyses:**

The data collected was analyzed using IBM Statistical Package for Social Sciences (SPSS Inc. Chicago, IL, USA) Version 22.0. Microsoft word and Excel were used to generate graphs, tables etc.. Probability value ≤ 0.05 was considered as statistically significant.

**RESULTS**

**Table 1. Baseline characteristics of the study population.**

Characteristics	Percentage % (n)
Age in years	
41 - 50	9% (09)
51 - 60	53% (53)
61 - 70	26% (26)
71 - 80	12% (12)
Gender	
Male	68% (68)
Female	32% (32)
Presenting symptoms	
Chest Pain	90% (90)
Shortness of breath	14% (14)
Syncope	8% (08)
Radiation of pain to left arm	35% (35)
Risk Factor	
Hypertension	65% (65)
Smoking	53% (53)
Diabetes	48% (48)
Dyslipidemia	64% (64)
Family history of CAD	15% (15)
Duration of hypertension	
>10 years	52.3% (34)
5-10 years	41.5% (27)
<5 years	6.2% (04)
Electrocardiogram	
ST elevation	31% (31)
ST depression	28% (28)
Hyper acute T wave	15% (15)
Deep T inversion	26% (26)
ECHO findings	
Normal	6% (6)
RWMA	39% (39)
RWMA & LV dysfunction	44% (44)
RWMA & complications (MR, VSD, Ruptured papillary muscle)	11% (11)

Characteristics	Percentage % (n)
Spirometric curve pattern	
Normal	25% (25)
Obstructive	34% (34)
Restrictive	41% (41)
Blood gas-pH	
<7.35	54% (54)
7.35-7.45	46% (46)
>7.45	0%
PaO <sub>2</sub> (mmHg)	
<75	64% (64)
75-100	36% (36)
PaCO <sub>2</sub> (mm Hg)	
<35	53% (53)
35-45	47% (47)
>45	0%
HCO <sub>3</sub> (mEq/L)	
<22	51% (51)
22-26	49% (49)
>26	0%

**Table 2. Associations between the arterial blood gas and spirometric parameters.**

ABG parameters	FEV <sub>1</sub> /FVC (%)			P value
	Normal (n=25)	Obstructive (n=34)	Restrictive (n=41)	
pH				0.001
<7.35	7(12.9%)	29(53.7%)	18(33.4%)	
7.35-7.45	18(39.1%)	5(10.8%)	23(50.0%)	
PaCO <sub>2</sub> (mmHg)				0.001
<35	7(13.2%)	29(54.7%)	17(32.1%)	
35-45	18(38.2%)	5(10.7%)	24(51.1%)	
HCO <sub>3</sub> (mEq/L)				0.001
<22	6(11.8%)	27(52.9%)	18(35.3%)	
22-26	19(38.8%)	7(14.3%)	23(46.9%)	

The baseline characteristics of the study population are listed in Table 1. A total of 100 patients with coronary artery disease were enrolled. The mean age of the study population was 62.87±7.3 years. 53% of the study population belonged to the age group of 51-60 years. The gender distribution of the study population had 68% males compared to 32% female participants. The most common presenting symptom was chest pain in 90% patients, which was followed by radiation of pain to the left arm in 35%. The most common risk factor was hypertension seen in 65% patients, followed by dyslipidemia in 64%. In our study the incidence of coronary artery disease was higher in patients with longer duration of hypertension. Among the 65 patients with hypertension as a risk factor, 52.3% (34) patients had history of hypertension for more than 10 years compared to 6.2% (4) patients who were hypertensive for less than 5 years. On presentation to hospital, the most common electrocardiogram (ECG) change noted was ST segment elevation in 31% of the total study population. On echocardiography 44% patients had regional wall motion abnormality (RWMA) with left ventricular dysfunction, followed by regional wall motion abnormality (RWMA) alone in 39% patients.

Pulmonary function test (FEV<sub>1</sub>, FVC, FEV<sub>1</sub>/FVC) done by spirometry in the study population had spirometric curve described as normal, restrictive or obstructive pattern according to forced vital capacity (FVC) and forced expiratory volume in the first second (FEV<sub>1</sub>) values. Among the 100 participants, pulmonary function test values were normal in 25% patients and abnormal in 75% patients. Restrictive pattern with FVC reduced and FEV<sub>1</sub> normal or reduced but the ratio of FEV<sub>1</sub>/FVC was normal was seen in 41% (41) patients, while 34% (34) had obstructive pattern where FVC normal or reduced and FEV<sub>1</sub> and the ratio of FEV<sub>1</sub>/FVC ratio reduced.

Arterial blood gas sampling in the study populations had 54% patients with pH <7.35 (acidosis) on presentation. 36 % patients had normal partial pressure of oxygen at PaO<sub>2</sub> 80-100 mmHg, while 64 % patients had low partial pressure of oxygen at PaO<sub>2</sub> <80 mmHg. 53% patients had low partial pressure of carbon dioxide at PaCO<sub>2</sub> <35 mmHg. 51% participants had low levels of bicarbonate.

**Associations between arterial blood gas and Spirometric parameters.**

In our study, obstructive pattern (53.7%) of spirometric curve was more common in those with arterial blood gas pH <7.35 on presentation, with statistically significant p value 0.001 (Table 2). Also, a partial pressure of carbon dioxide PaCO<sub>2</sub> <35 mmHg on presentation had more association with obstructive pattern (54.7%) compared to restrictive pattern (32.1%) of spirometric curves, with statistically significant p value 0.001. We also noted that majority of the patients with base deficits HCO<sub>3</sub> <22 mEq/L had obstructive pattern (52.9%) of spirometric curves, with statistically significant p value 0.001.

**DISCUSSION**

A reduction in the lung function indicated by a low forced expiratory volume in 1 second (FEV<sub>1</sub>) and forced vital capacity (FVC) is associated with an increased risk of coronary artery disease (CAD) and cardiovascular mortality.<sup>2,6</sup> In our study to evaluate the lung function among 100 patients with Coronary Artery Disease (CAD) spirometry study done to assess the lung function revealed that 75% of the study population had reduced lung functions in addition to the known risk factors for coronary artery disease such as hypertension, smoking and diabetes. The association between the reduced lung function and incident of myocardial infarction persisted even after multiple adjustments for potential confounders and was a reliable risk factor for incident of myocardial infarction.<sup>7</sup> In our spirometry study 41% had restrictive pattern and 34% had obstructive pattern, while only 25% of the study population had normal spirometric curve. In consistent to our finding, a study done in Sweden reported stronger association between ischemic heart disease and impaired lung function with higher proportions of heart diseases among patients with restrictive lung function.<sup>8</sup>

Acidosis is invariably associated with a fall in plasma bicarbonate levels. A failure in respiratory compensation for metabolic acidosis and fall in pH is associated with a higher mortality rate.<sup>9</sup> In our study of arterial blood gas analysis, we found a pH <7.35 in 54% patients, PaO<sub>2</sub> < 75 mmHg in 64% patients, PaCO<sub>2</sub> < 35 mmHg in 53% and also 51% patients had HCO<sub>3</sub> ≤ 22. In line with our findings a previous study reported association between acidosis, a fall in bicarbonate level, low PaCO<sub>2</sub> <35 mmHg and abnormal bicarbonate level.<sup>9</sup> In contrast to our findings, a study of acid base imbalance in patients of myocardial infarction had acidosis in only 4.2% patients and base deficit in 24.1%. However it addressed the association of acidosis with worse clinical outcomes.<sup>7</sup> In our study of associations between arterial blood gas and Spirometric parameters, the majority of patients with acidosis (pH <7.35) had obstructive pattern (53.7%) of spirometric curves. The patients who presented with a normal pH (7.35-7.45) had normal pattern study of spirometric curves. This association is found to be statistically significant with a p value 0.001. It was also noted that the majority of the patients with low PaCO<sub>2</sub> (<35 mmHg) had obstructive pattern (54.7%) of spirometric curves compared to 32.1% who exhibited a restrictive pattern (32.1%) of spirometric curves. This association is found to be statistically significant with a p value 0.001. Likewise the majority of the patients with base deficits (HCO<sub>3</sub> <22mEq/L) also had obstructive pattern of spirometric curve. These findings reflect the association of obstructive pattern of spirometric curve with a more severe outcome.

In conclusion, lung function test and arterial blood gas analysis in patients with Coronary Artery Disease remains an important diagnostic tool to access and monitor the outcome of the disease. The awareness of these complications is crucial in the management of patients of coronary artery disease so as to help mitigate the increasing burden of mortality associated with the disease.

**Limitations of the study:**

The limitations of our study is attributed to it being a cross sectional observational study without control group for comparison of the measured parameters. The study included only patients with available lung function test and arterial blood gas reports. There was no follow up to find out any changes in lung functions and arterial blood gas parameters or clinical outcomes of the cases. Preceding treatment of the patients were not considered which could act as confounding factor leading to inaccurate findings of lung function and arterial blood gas parameters.

**Declaration:**

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**Conflict of Interest:** None declared

**Approval of research ethics board:** Approved

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