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Study of Arterial Blood Gas Analysis (ABG) in Patients of Obstructive Airway Diseases in Accordance with Clinical Correlation

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ABSTRACT

Arterial blood gases are often measured as a part of respiratory assessment of obstructive lung diseases. Present study was aimed to study arterial blood gas analysis (ABG) in patients of Obstructive Airway Diseases in accordance with clinical correlation. Present study was single-center, prospective, observational study, conducted in patients presenting first time with complaints of cough, breathlessness, chest tightness, wheezing and paroxysmal nocturnal dyspnea OR already diagnosed cases of Bronchial Asthma and COPD. Arterial blood gas analysis was done in all the patients. In overall study amongst 112 patients 74 (66.07 %) were males and 38 (33.92%) were females. Majority patients were from 35-44 and 45-54 years age group (27.67 % each). Amongst overall 112 patients, 63 (56.25%) were of COPD and 49 (43.75%) were of Asthma. Co_2 washout ($Paco_2$ <35 mm Hg) was seen in 29 (59.18 %) patients with Asthma, while Co_2 retention (Paco2 >45 mm Hg) was seen in 8 (16.32%) patients, normal $Paco_2$ was found in 12 (24.48 %) of the patients of Asthma. Hypoxia (PaO_2 <80 mm Hg) was seen in 20 (40.81 %) patients of Asthma while 29(59.18%) patients had normal PaO_2. pH was found to be increased(>7.45) in 28 (57.14%) patients, normal in 17 (34.69 %) patients and decreased (<7.35) in 4 (8.16%) patients of Asthma. Amongst patients with COPD 25 (39.68 %) patients had Co2 retention (>45 mm Hg), 21 (33.33 %) patients had normal Paco2 and 17 (26.98 %) patients had decreased (<35mmHg) Paco2. 52 (82.53 %) of the patients with COPD had hypoxia (PaO_2 <80 mm Hg) and 11 (17.46%) patients had normal PaO_2. Arterial blood gases are often measured as a part of respiratory assessment. PaO_2 is positively correlated with FEV1 and $Paco_2$ is negatively correlated with FEV1 in patients with COPD.

INTRODUCTION

Several diseases cause chronic airflow limitation, notably Asthma, COPD, Bronchiectasis, Obliterative Bronchiolitis. History of Atopy and improvement in Spirometry after bronchodilators or glucocorticosteroids point towards diagnosis of Bronchial Asthma[1]. COPD is usually tobacco smoking related and is diagnosed in presence of history of smoking[2]. The sites of obstruction vary from the upper airways to the most peripheral bronchioles[3]. If we consider together, Asthma and COPD represent the most common chronic lung disease worldwide[4]. Arterial blood gases are often measured as a part of respiratory assessment of obstructive lung diseases. ABG analysis is a part of pulmonary function testing is based primarily on determination of PaO_2, $Paco_2$ and pH.

In a steady state the level of $Paco_2$ reflects the level of alveolar ventilation. In the absence of a disorder in metabolic acid base balance an increase or decrease in $Paco_2$ beyond normal limits indicates a primary disorder in alveolar ventilation. Various studies have been carried out to correlate ABG derangements with severity of the disease both in COPD and Asthma[5-7]. Present study was aimed to study arterial blood gas analysis (ABG) in patients of Obstructive Airway Diseases in accordance with clinical correlation.

MATERIALS AND METHODS

Present study was single-center, prospective, observational study, conducted in department of pulmonary medicine, at Government hospital, Nanded, Maharashtra, India. Study duration was of 20 months (January 2009 to August 2010). Study approval was obtained from institutional ethical committee.

Inclusion Criteria:

- All patients presenting first time with complaints of cough, breathlessness, chest tightness, wheezing and paroxysmal nocturnal dyspnea OR already diagnosed cases of Bronchial Asthma and COPD, willing to participate in present study

Exclusion Criteria:

- Patients of age group <13 years
- Patients with active pulmonary tuberculosis
- Recent myocardial infarction (<1month)

Study was explained to patients in local language and written consent was taken for participation and study. Age, Gender, Height (in meter), weight (in kg), systolic and diastolic blood pressure (in mm Hg) were noted along with detail history, including detail smoking history like type of active smoking whether Bidi or Cigarette and smoking index was noted. Detail clinical examination for all the patients. Investigations carried out were X-ray chest PA view, Sputum for AFB-three samples (Acid fast bacilli), Complete hemogram including hemoglobin%, complete blood count, Spirometry, DLCO and Arterial blood gas analysis.

Arterial blood gas analysis was done in all the patients of bronchial asthma and COPD. Arterial blood gases oxygen tension (PaO_2) and arterial carbon dioxide tension ($PaCO_2$) were measured in patient sat rest, sitting or semi-recumbent and breathing room air. Arterial blood samples were taken in a disposable pre-heparinized system from the radial or brachial artery and processed in <5 min in Cobasb 221 blood gas analyser. PaO_2 of <8o mm hg was considered to be decreased and Pco_2 >45 mm Hg was considered to be increased Pco_2 and Pco_2 <35 mm Hg was considered to be decreased Pco_2. pH < 7.35 was considered as decreased pH and pH more than 7.45 was considered as increased pH.

Data was collected and compiled using Microsoft Excel, analysed using SPSS 23.0 version. Frequency, percentage, means and standard deviations (SD) was calculated for the continuous variables, while ratios and proportions were calculated for the categorical variables. Difference of proportions between qualitative variables were tested using chi- square test or Fisher exact test as applicable. p<0.5 was considered as statistically significant.

RESULTS AND DISCUSSIONS

In overall study amongst 112 patients 74 (66.07 %) were males and 38 (33.92%) were females. Majority patients were from 35-44 and 45-54 years age group (27.67% each). Patients in present study, were distributed as per post bronchodilators FEV_1 reversibility, as those with Asthma (>12% or200 ml reversibility in FEV_1) and those with COPD (<12% reversibility or 200 ml in FEV1). Amongst overall 112 patients, 63 (56.25%) were of COPD and 49 (43.75%) were of Asthma. Fifty one (80.95%) amongst 63 patients with COPD were smokers and 12 (19.04 %) were non-smokers, smokers non-smokers ratio was 4.2:1. In Asthma 21 (42.85 %) patients were smokers and 28 (57.14%) patients were nonsmokers. Bidi smoking seen in 49 (96.07 %) patients was common than cigarette smoking seen in 2 (3.92 %) patients with COPD.

Amongst patients with COPD Breathlessness seen in 53 (84.12 %) patients, was the commonest symptom followed by Cough in 43(68.25%) patients, Chest Tightness in 31 (49.20%) patients and Wheeze in 28 (44.44 %) patients. In Asthma, Breathlessness seen in 45 (91.83%) patients, was the commonest symptom followed by Wheeze in 42 (85.71%) patients, Cough in 40 (81.63%) patients and Chest Tightness in 25

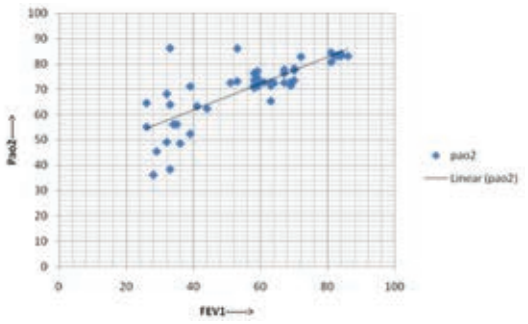

Fig. 1: This is Graph showing positive correlation of FEV1and Pao2in patients with COPD, in present study. Correlation Coefficient (r=0.79)

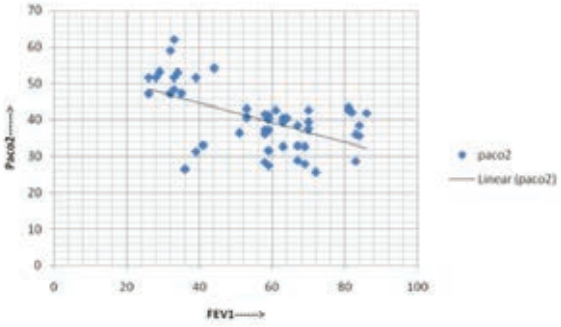

Fig. 2: This is the Graph showing negative correlation of FEV1 and Paco2 in patients with COPD in present study. Correlation Coefficient (r= -0.65).

Table 1: General characteristics

	No. of patients	Percentage
Age groups (in years)		
14-24	9	8.03
25-34	15	13.39
35-44	31	27.67
45-54	31	27.67
55-64	18	16.07
65-74	4	3.57
75-84	4	3.5
Mean age (mean±SD)		
Gender		
Male	74	66.07
Female	38	33.92
Disease		
COPD	63	56.25
Asthma	49	43.75

Table 2: Active smoking

Disease(n)	Smokers	Nonsmokers	Total
COPD(n=63)	51(80.95%)	12(19.04%)	63(100%)
Asthma(n=49)	21(42.85%)	28(57.14%)	49(100%)

Table 3: Clinical features

Clinical features	COPD (n=63)	Asthma (n=49)
Symptoms		
Breathlessness	53(84.12%)	45(91.83%)
Cough	43(68.25%)	40(81.63%)
Chest tightness	31(49.20%)	25(51.02%)
Wheeze	28(44.44%)	42(85.71%)
Signs of respiratory failure		
Cyanosis	21(33.33%)	17(34.69%)
Bounding pulse	25(39.68%)	08(16.32%)
Hypertension	09(14.28%)	01(2.04%)
Altered sensorium	03(4.76%)	01(2.04%)

Table 4: Characteristics of COPD patients

	No. of patients	Percentage
Etiology		
Smoking	51	80.95
Chullah smoke exposure	8	12.69
Post Tuberculous	4	6.34
X ray Findings		
Hyperinflation	39	61.90
Bronchovascular Prominence	20	31.74
Fibrosis	04	6.34
Severity (according to GOLD guidelines)		
Mild	09	14.28
Moderate	26	41.26
Severe	20	31.74
Very severe	08	12.69

Table 5: Characteristics of asthma patients

	No. of patients	Percentage
Family history of Asthma present	36	73.46
Severity (according to GINA guidelines)		
Intermittent	08	16.32
Mild persistent	08	16.32
Moderate	17	34.69
Severe	16	32.65

Table 6: ABG in asthma patients (n=49)

ABG Parameters	Increased	Decreased	Normal
PCo_2	08(16.32%)	29(59.18%)	12(24.48%)
PaO_2	None	20(40.81%)	29(59.18%)
pH	28(57.14%)	04(8.16%)	17(34.69%)

Table 7: ABG in COPD patients (n=63)

ABG Parameters	Increased	Decreased	Normal
PCo2	25(39.68%)	17(26.98%)	21(33.33%)
PaO2	None	52(82.53%)	11(17.46%)
pH	12(19.04%)	20(31.74%)	31(49.20%)

(51.02%) patients. Cyanosis was seen in 21(33.33%) of the patients with COPD and 17 (34.69%) of the patients with Asthma Signs of Co_2 retention like Bounding Pulse and Hypertension and Altered Sensorium were seen in 25 (39.68%), 09 (14.28%) and 3 (4.76%) respectively in COPD patients. In Asthma signs of Co2 Retention like Bounding Pulse, Hypertension and Altered Sensorium were seen in 08 (16.32%), 01(2.04%) and 01(2.04%) patients respectively.

Fifty one (80.95%) amongst 63 patients with COPD were smokers and 12 (19.04%) were nonsmokers, smokers: nonsmokers ratio was 4.2:1. Amongst non-smokers in patients with COPD, challah smoke exposure seen in 8 (12.69%) patients and old Pulmonary Tuberculosis seen in 4 (6.34%) patients, were the causes. Amongst 28 patients exposed to Chullah smoke, 8 (28.57 %) had COPD. Amongst 16 patients with past history of Pulmonary Tuberculosis,4 patients (25%) had COPD. Hyperinflation seen in 39 (61.90%) COPD patients was the most common radiological finding followed by, Bronchovascular Prominence seenin20 (31.74%) patients and Fibrosis seen in 4 (6.34%) patients with COPD. Amongst patientswithCOPD9(14.28%) were with Mild COPD, 26 (41.26%) were with Moderate COPD, 20 (31.74 %) were with Severe COPD and 8 (12.69%) were with Very Severe COPD.

Family history of Asthma was seen in most of the patients 36 (73.46%) with Asthma. Amongst patients

with Asthma 8 (16.32%) were of Intermittent Asthma, 8 (16.32%) were of Mild Persistent Asthma,17(34.69 %) were of Moderate Asthma and 16 (32.65%) were with severe Asthma.

Co_2 washout ($PaCO_2$ <35 mm Hg) was seen in 29 (59.18 %) patients with Asthma, while Co_2 retention ($PaCO_2$>45 mm Hg) was seen in 8 (16.32%) patients, normal $PaCO_2$ was found in 12 (24.48%) of the patients of Asthma. Hypoxia (PaO_2 <80 mm Hg) was seen in 20 (40.81%) patients of Asthma while 29 (59.18%) patients had normal PaO_2. pH was found to be increased(>7.45) in 28 (57.14%) patients, normal in 17 (34.69%) patients and decreased (<7.35) in 4 (8.16%) patients of Asthma.

Amongst patients with COPD 25 (39.68 %) patients had Co_2 retention (>45 mm Hg), 21 (33.33 %) patients had normal $PaCO_2$ and 17 (26.98 %) patients had decreased (<35mmHg) $PaCO_2$. 52 (82.53 %) of the patients with COPD had hypoxia (PaO_2< 80 mm Hg) and 11 (17.46%) patients had normal PaO_2. pH was normal in most 31 (49.20 %) of the patients, decreased (<7.35) in 20 (31.74 %) patients and increased (>7.45) in 12 patients(19.04%) with COPD.

The working definition of COPD, as noted in the Global Initiative for Obstructive Lung Disease (GOLD) guidelines, is that COPD is "a preventable and treatable disease with some significant extra pulmonary effect that may contribute to the severity in individual patient. Its pulmonary component is characterized by airflow limitation that is not fully reversible[4]. The airflow limitation is usually progressive and associated with an abnormal inflammatory response of the lungs to noxious particles or gases.

In present study, Diagnosis of COPD was based on Global Initiative for obstructive lung Disease guidelines i.e. cough with sputum production for most of the days in a year at least 3 months for 2 consecutive years or dyspnea with history of exposure for risk factors (e.g. tobacco smoking), progressive breathlessness and Spirometry showing FEV_1/ FVC <70% and FEV_1 less than 80% predicted with poor bronchodilator reversibility.

Most common cause for COPD in present study was Smoking which was present in 51 (80.95%) patients. Amongst nonsmokers in patients with COPD, Chullah Smoke exposure seen in 8 (12.69 %) patients and past history of Pulmonary Tuberculosis seen in 4 (6.34%) patients, were the causes. In present study amongst 28 patients exposed to Chullah Smoke 8 (28.57 %) had COPD. This coincides with study by Carlos Torres-Duque, Darío Maldonado, Rogelio Pérez-Padilla *et al.*[8] where COPD was prevalent in 22% of the population exposed to Biomass fuel.

Also Tasleem Akhtar *et al*.,[9] mentioned that Chronic Bronchitis was prevalent in 7.01% of population exposed to Biomass fuel. In present study amongst 16 patients with past history of Pulmonary Tuberculosis 4 (25%) had COPD. This correlates with the study by Andre Caballero *et al*.,[10] who found that 25.8% of the patients with past history of pulmonary tuberculosis developed COPD. Also Richard Hooper[11] mentions that amongst patients with past history of Pulmonary Tuberculosis 6% had COPD.

In present study amongst 49 patients with Asthma family history of Asthma was present in 36 (73.46%) patients, this correlates with the study by Mathur *et al*.,[12] in which, family history of Asthma was present in 73% of Asthma patients. It also coincides with the study by Gupta[13] in which family history of Asthma was present in 80.1% of Asthma patients.

In present study amongst patients with COPD, 25 (39.68%) had Co2 retention and all of these had severe to very severe disease and there was negative correlation between FEV1 and $PaCO_2$ in COPD patients. 52 of the patients with COPD had hypoxia and decline in PaO_2 was directly proportional to decline in FEV1.

These findings in present study correlate with the study by B. Delclaux *et al.,*[5] in COPD, which stated that PaO_2 is positively correlated with FEV1 and $PaCO_2$is negatively correlated with FEV1. It also coincides with study by Mansour Fard[14] which also states, the positive correlation between FEV1 and PaO_2 and negative correlation between FEV1and $PaCO_2$ in patients with COPD. Charles Emerman states that Co2retention ($PaCO_2$ >45mmHg) occurs in COPD patients with severe to very severe disease and when FEV1 <35% predicted. In present study, Co2washout ($PaCO_2$ <35mmHg) was seen in 29(59.18%) patients with Asthma while Co_2 retention ($PaCo_2$ >45 mm Hg) was seen in 8 (16.32 %) patients, normal $PaCo_2$ was found in (24.48%) of the patients. Hypoxia (PaO_2 <80 mm Hg) was seen in 20 (40.81 %) Asthma patients while 29 (59.18%) had normal PaO_2. pH was found to be increased (>7.45) in 28 (57.14%) patients, normal in 17 (34.69%) patients and decreased (<7.35) in 4 (8.16%) patients with Asthma. Hypoxia is less common amongst Asthma patients as compared to COPD patients. Co_2 washout rather retention is common amongst Asthma patients.

CONCLUSION

Arterial blood gases are often measured as a part of respiratory assessment. PaO_2 is positively correlated with FEV1 and $PaCo_2$ is negatively correlated with FEV1 in patients with COPD. Co_2 washout rather than retention is common in Asthma. Also in Asthma hypoxia occurs less commonly as compared to COPD patients.

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