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ORIGINAL RESEARCH ARTICLE

CORRELATION OF ARTERIAL BLOOD GAS MEASUREMENT WITH PERIPHERAL VENOUS BLOOD GAS VALUES IN ADULTS PATIENTS ADMITTED IN ICU

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ABSTRACT

Arterial blood gas (ABG) sampling is an essential investigation for assessment of acid-base status, oxygenation and ventilation in critical care practice. Arterial puncture to obtain arterial blood is more invasive procedure than venous and has more potential complications. To find out the correlation between arterial and peripheral venous blood gas values for pH, PCO2 and bicarbonate. Patients admitted in ICU requiring arterial blood gas analysis to determine their acid-base status or ventilatory status was included in the study. One milliliter of venous blood was obtained in a heparin flushed syringe within 5 minutes of getting arterial blood sample. Both labeled samples were processed immediately. Data were analyzed by student's t-test. A total of 50 paired samples from 36 patients were evaluated. The mean differences between arterial and venous blood gas values for pH, PCO2 and bicarbonate were 0.02 units, -2.37 mmHg and -0.45 mEq/L respectively. Similarly, the correlation coefficients between arterial and venous parameters were 0.964, 0.881 and 0.906 for pH, PCO2 and bicarbonate respectively, which were statistically significant ($p<0.001$). Venous pH, PCO2 and bicarbonate showed a very high level of correlation with the respective arterial values.

Key words: *Arterial blood gas, bicarbonate, pH, PCO2.*

INTRODUCTION

Arterial blood gas (ABG) analysis is an essential investigation for assessment of ventilation, oxygenation and acid-base status in critically ill patientsboth in the acute settings and during periods of clinical stability.[1,2] Oxygenation can be assessed by pulse oximeter and carbon dioxide concentration can be monitored by end tidal carbon dioxide ($ETCO_2$) but information about pH, partial pressure of oxygen (PO_2), and bicarbonate is not obtainable by non-invasive methods.[3]

Although ABG sampling is the gold standard for assessment of many respiratory and metabolic disorders, it is painful procedure and can cause local hematoma, bleeding, arterial spasm, occlusion and digital ischemia, infection, nerve injury, and needle stick injury to health staffs.[4] The procedure

is technically demanding and difficult outside the intensive care units, especially in children and elderly patients.

Venous blood sampling on the other hand is simpler than and not as invasive as arterial puncture. The procedure is less painful, and the sample may be drawn simultaneously while drawing blood samples for other laboratory tests. A number of studies have found strong correlation between arterial pH, partial pressure of CO2 (PCO2) and calculated bicarbonate and corresponding venous values in different clinical conditions.[5-8] Chu YC et al found that venous blood gas values accurately predicted arterial values of pH, PCO2 and HCO3 in patients with acute respiratory failure being treated with mechanical ventilation.[9]

In our part, arterial blood gas analysis is not performed as many as it should be, partly because of the problems and difficulties associated with arterial puncture whereas venous blood sampling is often the first diagnostic tests performed on admission to the hospital. In Nepal, there is no study done to compare two blood gas sample values- arterial and venous. This study was aimed to find out the correlation etween arterial and venous blood gas values in patients admitted in our intensive care units.

METHODS

This cross-sectional observational study was conducted in the affiliated hospitals of the National Academy of Medical Sciences (NAMS), Kathmandu, Nepal from August 2014 to January 2015. Patients were included for the study if they were deemed by their treating doctor to require an arterial blood gas analysis to determine their acid-base status or ventilatory status. The study was approved by the institutional Review Board of the National Academy of Medical Sciences (NAMS), Kathmandu, Nepal. One milliliter arterial blood was sampled in a flushed heparin syringe from radial artery or arterial catheter. Similarly, 1ml of venous sample was drawn from peripheral vein (anti-cubital or dorsal palmer vein) within 5 minutes of arterial sampling. Both labeled samples were processed for analysis by the same blood gas analyzer. Peripheral oxygen saturation was recorded at the time of arterial sampling. For patients receiving oxygen supplementation, samples were drawn only after 10 minutes of oxygen flow adjustment. If blood thought to be arterial proved to be venous, samples were discarded. Multiple samples (up to 5) from the same patients were allowed.

After entering data on MS-Excel, analysis was done using IBM SPSS-v20. Independent sample t-test was used to find the correlation between arterial and venous blood gas parameters.

RESULTS

A total of 50 paired samples from 36 patients were evaluated. Thirty two paired samples were from acute respiratory distress (ARDS) patients and 14 paired samples from patients with COPD exacerbation.

Table 1 shows the mean values of ABG and VBG parameters with mean differences. There was statistically significant difference ($p < 0.001$) in mean values of SO2 in ABG and VBG but not in pH, PCO2 and HCO3.

Table 1: Mean values of ABG and VBG parameters with mean differences.

Parameters	ABG (mean ± SD)	VBG (mean ± SD)	Mean difference	P value
pH	7.39±0.09	7.37±0.08	0.02	0.181
PCO2 (mmHg)	36.37±11.75	39.34±13.08	-2.37	0.343
HCO3 (mmol/L)	22.36±5.67	22.81±6.17	-0.45	0.708
SO2 (mmHg)	92.46±9.89	75.68±16.21	16.79	<0.001

The Pearson's Correlation coefficient of pH, PCO2 (mmHg), HCO3 (mmol/L) between ABG and VPG values were statistically significant at p value <0.001. There was no evidence of correlation of SO2 between ABG and VBG with p value 0.087. (Table 2)

Table 2: Pearson's correlation values of ABG and VBG in different parameters

Characteristics	Correlation	P value
PH between ABG and VBG	0.969	<0.001
PCO2 (mmHg) between ABG and VBG	0.949	<0.001
HCO3 (mmol/L) between ABG and VBG	0.928	<0.001
SO2 (mmHg) between ABG and VBG	0.244	0.087

Figure 1 showed that strong correlation pH between ABG and VBG with R^2 was 0.939. The linear regression model was Y = 1.031x - 0.211

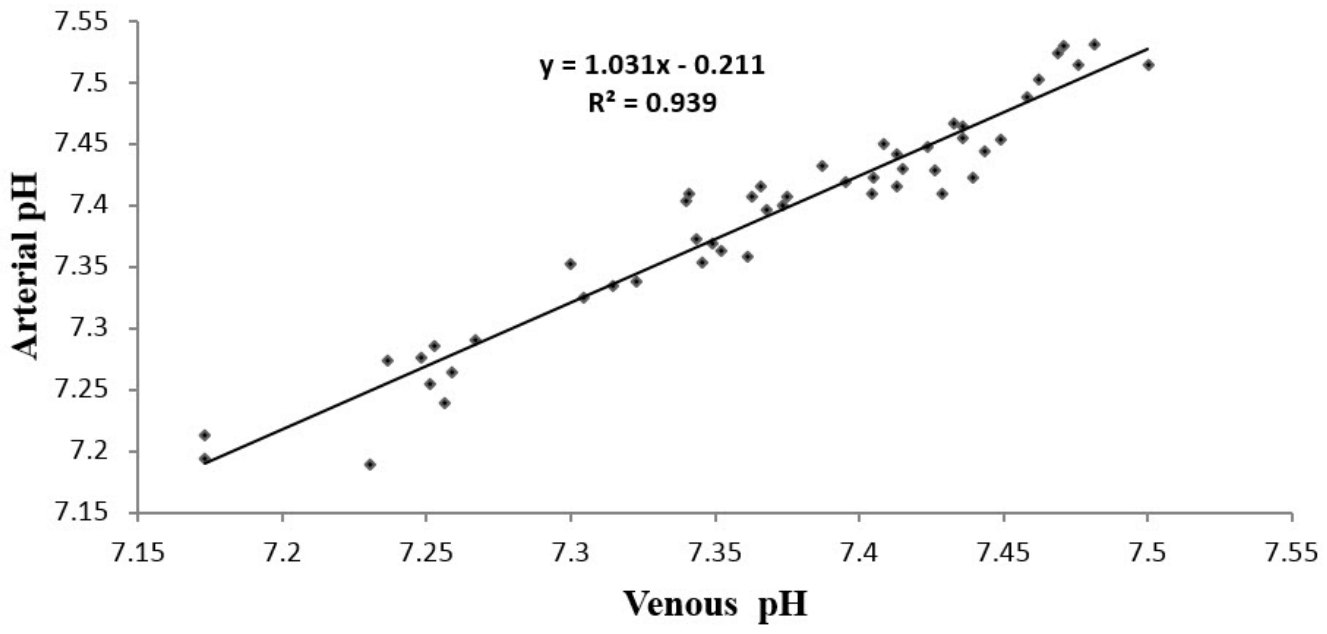

Figure 1: Correlation between venous and arterial pH values (r=0.969)

Figure 2 showed that strong correlation PCO2 between ABG and VBG with R^2 was 0.901. The linear

regression model was Y = 0.852X + 3.439

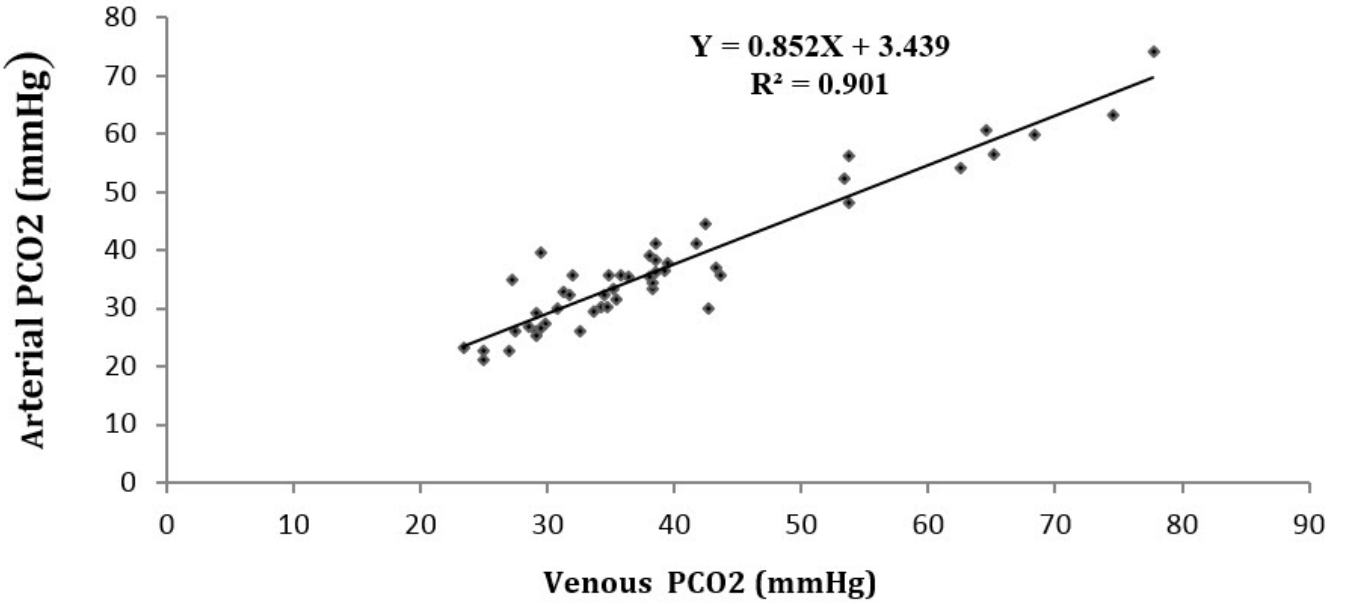

Figure 2: Correlation between venous and arterial PCO2 values (r=0.949)

Figure 2 showed that strong correlation HCO3 between ABG and VBG with R^2 was 0.901. The linear regression model was Y = 0.854X + 2.872

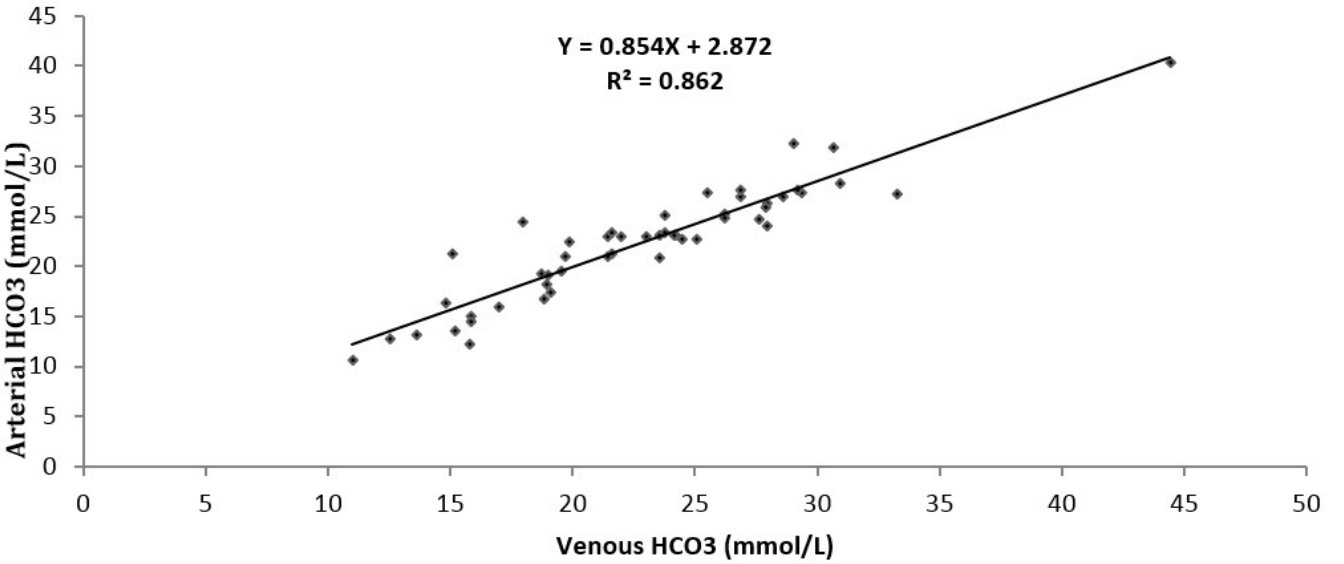

Figure 3: Correlation between venous and arterial HCO3 values (r=0.928)

DISCUSSION

Measurement of arterial values of pH, bicarbonate, PCO2 and PaO2 is important for monitoring clinical status and the response of therapy in critically ill patients. Getting samples for ABG is invasive, technically difficult and has potential complications. This study aimed to find the extent to which arterial and venous values for

pH, PCO2 and bicarbonate are related. The patient population in this study was fairly representative of the disease conditions encountered in many medical ICUs.

The mean difference between arterial and venous pH values was 0.02 with high degree of correlation (r=0.969) was found in this study. Kelly AM et al[10] studied the arterial and venous blood samples of 196 patients with acute respiratory disease and 50 patients with suspected metabolic derangement. They found the mean difference of pH between arterial and venous sample to be 0.04 units with high correlation (r=0.92). Brandenburg MA et al[11]also observed similar findings in 38 patients with 44 episodes of diabetic ketoacidosis. Gokel and his colleagues[12] also found high degree of correlation (r) =0.979 and 0.989 between arterial and venous blood pH values in patients with chronic uremia and diabetic ketoacidosis respectively.

The mean difference for PCO2 between arterial and venous blood was found in the range of -1.20 to -8.27 with the mean partial pressure of carbondioxide ranged from 29.6 to 75.9 mmHg depending up on the study population. Similarly, correlation co-efficient of PCO2 was also wide (r= 0.86 to 0.92).[14-16]The greatest discordance was found in subjects with cardiac failure and hemodynamic instability.[17]

Excellent degree of correlation of calculated bicarbonate values between arterial and venous blood was also observed in previous studies like our study (r=0.928). Rang LC et al[5] found correlation co-efficient (r) 0.953 in a study carried out on 218 patients with respiratory and metabolic diseases. Similarly Chu YC et al[9] in their study of 46 patients with acute respiratory failure admitted in ICU found bicarbonate values between arterial and venous blood to be highly correlated (r= 0. 91). Bilan N et al in a study done in Tabriz University of Medical Sciences, Iran, found that VBG analysis showed high sensitivity and specificity with suitable clinical agreement in respiratory distress syndrome, pneumonia, renal failure etc. but not in shock and congestive heart failure.[18]

The limitation of our study was reasonably small number of patients for sub-group analysis. Potential confounders such as severity of illness, use of vasopressors were not analyzed. Conclusions

Venous pH, PCO2 and bicarbonate showed a very high level of correlation with the respective arterial values in patients with ARDS and acute exacerbation of COPD admitted in ICU in our hospitals.

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